Keysight B-Series FieldFox Analyzers - User's Guide (Unabridged)

This manual provides documentation for the following models:

N9913B, N9914B, N9915B, N9916B,
N9917B, N9918B

N9933B, N9934B, N9935B, N9936B,
N9937B, N9938B

N9950B, N9951B, N9952B, N9953B

N9960B, N9961B, N9962B, N9963B

This is the unabridged version of the abridged N9938-90003 B-Series FieldFox User's Guide that is available in printed format.
The abridged User's Guide can be found here:
http://www.keysight.com/us/en/assets/9018-04841/usermanuals/9018-04841.pdf

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Where to Find the Latest Information

Documentation is updated periodically. For the latest information about these products, including instrument software upgrades, application information, and product information, browse to one of the following URLs, according to the name of your product:

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https//www.keysight.com/find/PreventingInstrumentRepair

Is your product software up-to-date?

Periodically, Keysight releases software updates to fix known defects and incorporate product enhancements. To search for software updates for your product, go to the Keysight Technical Support website at:

http://www.keysight.com/find/fieldfoxsupport

A.13.02+ Firmware – Release C Series FieldFox

For customers upgrading FieldFox firmware, the following is a list of changes from the previous release:

- Initial N99xxC Series FieldFox firmware release –
  - Learn more, refer to the FieldFox Configuration Guide: https://www.keysight.com/us/en/assets/7018-06515/configuration-guides/5992-3701.pdf.
- SA mode, OTA mode and USB Antenna –
  - Added: Statements to indicate support for EMF measurements in LTE FDD (Option 370), LTE FDD (Option 371), and 5G NR (Option 378).
- Channel Scanner mode –
  - Added: New functionality 'Relative Mode' and 'Relative Units' to the Channel Scanner in Scan Mode, introducing the 'EMF Custom List' feature.
  - Updated: Table display to include new columns for EMF Custom List Column Display 'Summary' and 'Exposure Ratio'.

Contacting Keysight

Assistance with test and measurements needs and information on finding a local Keysight office are available on the Web at: https://www.keysight.com/find/assist/.

If you do not have access to the Internet, please contact your Keysight field engineer.

In any correspondence or telephone conversation, refer to the Keysight product by its model number and full serial number. With this information, the Keysight representative can determine whether your product is still within its warranty period.

To contact Keysight for sales and technical support, refer to support links on the following Keysight websites: http://www.keysight.com/find/support (product specific information and support, software and documentation updates) https://www.keysight.com/find/assist/ (worldwide contact information for repair and service).

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1 Overview

Models and Options

Table 1-1 Models

Model	Max Freq (GHz)	Description
N9913B	4	Vector Network Analyzer AND Spectrum RF Analyzer
N9914B	6.5	Vector Network Analyzer AND Spectrum RF Analyzer
N9915B	9	Vector Network Analyzer AND Spectrum Microwave Analyzer
N9916B	14	Vector Network Analyzer AND Spectrum Microwave Analyzer
N9917B	18	Vector Network Analyzer AND Spectrum Microwave Analyzer
N9918B	26.5	Vector Network Analyzer AND Spectrum Microwave Analyzer
N9933B	4	Spectrum Microwave Analyzer
N9934B	6.5	Spectrum Microwave Analyzer
N9935B	9	Spectrum Microwave Analyzer
N9936B	14	Spectrum Microwave Analyzer
N9937B	18	Spectrum Microwave Analyzer
N9938B	26.5	Spectrum Microwave Analyzer
N9950B	32	Vector Network Analyzer AND Spectrum Microwave Analyzer
N9951B	44	Vector Network Analyzer AND Spectrum Microwave Analyzer
N9952B	50	Vector Network Analyzer AND Spectrum Microwave Analyzer
N9953B	54	Vector Network Analyzer AND Spectrum Microwave Analyzer
N9960B	32	Spectrum Microwave Analyzer
N9961B	44	Spectrum Microwave Analyzer
N9962B	50	Spectrum Microwave Analyzer
N9963B	54	Spectrum Microwave Analyzer

Minimum Frequency: 30 kHz for all VNA models; 9 kHz for all SA models (SA usable to 5 kHz)

FieldFox Options: For a comprehensive list, view the FieldFox Configuration Guide at: https://www.keysight.com/us/en/assets/7018-06515/configuration-guides/5992-3701.pdf.

Accessories

The following accessories are included with every FieldFox. Spare accessories can be ordered at any time. Refer to Table 1-2. Some of the optional accessories—not included unless requested—are listed in Table 1-3. For more, refer to http://www.keysight.com/find/fieldfox.

Table 1-2 Accessories

Accessory Part Number	Description
N9910X–873	AC/DC Adapter (except for US/Canada)[a]
N9910X-876	Lithium-Ion Battery (High Capacity)
N9910X–877	AC/DC Adapter for US / Canada only[a]
N9910X–880	Soft-case w/ Backpack & Shoulder Strap
N9910X–891	Quick Reference Guide (printed copy)

a. Depending on your region, the FieldFox comes with either a N9910X-873 AC/DC adapter or a N9910X-877 AC/DC adapter.

Optional Accessories

Table 1-3 Optional Accessories (partial list)

Optional Accessory Part Number	Description
N9910X-872	External battery charger
N9910X–886	17 mm torque wrench
N9910X-887	Replacement Fan Kit

NOTE Although not supplied, a USB keyboard and mouse CAN be used with the FieldFox.

To see a complete list of accessories that are available for the FieldFox, please visit: http://www.keysight.com/find/fieldfox.

FieldFox Manuals, Software, and Supplemental Help

The following manuals and software are available for the FieldFox.

To access all of these, visit: www.keysight.com/find/fieldfoxsupport

- **User's Guide (Abridged)**
  - This abridged manual, can be included as an option with shipment.
  - This abridged online help version, can be downloaded from https://rfmw.em.keysight.com/wireless/helpfiles/B_Series_FieldFox_WebHelp/index.htm#Home.htm.
- **Quick Reference Guide** – Printed copy with laminated pages for outdoor use included with shipment.

Supplemental Online Help - Concepts and Reference information. Refer to https://rfmw.em.keysight.com/wireless/helpfiles/FieldFoxOnlineSupplementalHelp/Home.htm.

- **FieldFox Data Link Software and Help** – Free download. Includes help on editing calibration kits and cable files. Refer to FieldFox Data Link Software | Keysight.
- **Service Guide** – Free download. FieldFox MW VNA/SA Service Guide (keysight.com)
- **Firmware Updates** – Check to see if you have the latest FieldFox firmware. FieldFox Current Firmware (New CPU) | Keysight

Conventions that are used in the Manual

- **Hardkey** indicates a front panel button. The functionality of these buttons does not change.

  The five Softkey menus change dynamically and follow these color conventions:

- **Softkey** Blue indicates an available setting.
- **Softkey** Green indicates a change in menu level when selected.
- **Softkey** Black indicates the default or selected setting.
- **Softkey** Yellow indicates an active entry in process.
- **Softkey** Grey indicates a key that is NOT available.

Safety Notes

The following safety notes are used throughout this manual. Familiarize yourself with each of the notes and its meaning before operating this instrument. More pertinent safety notes for using this product are located in Chapter 36, “Safety Considerations”, on page 913.

CAUTION

Denotes a hazard. It calls attention to a procedure that, if not correctly performed or adhered to, would result in damage to or destruction of the product or loss of important data. Do not proceed beyond a caution note until the indicated conditions are fully understood and met.

WARNING

Denotes a hazard. It calls attention to a procedure which, if not correctly performed or adhered to, could result in injury or loss of life. Do not proceed beyond a warning note until the indicated conditions are fully understood and met.

2 Preparing for Initial Use of Your New FieldFox

Check the Shipment

When you receive your FieldFox, check the shipment according to the following procedure:

1. Inspect the shipping container for damage. Signs of damage may include a dented or torn shipping container or cushioning material that indicates signs of unusual stress or compacting. If not damaged, save the packaging material in case the FieldFox needs to be returned.
2. Carefully remove the contents from the shipping container, and verify that the standard accessories and your ordered options are included in the shipment according to the Box Contents List.
3. For any question or problems, refer to "Contacting Keysight" on page 5.

Meeting Power Requirements for the AC/DC Adapter

Voltage:	100 VAC to 240 VAC
Frequency:	50 Hz to 60 Hz
Current:	1.5 A (100 VAC) to 0.75 A (240 VAC)

The AC/DC adapter supplied with the analyzer is equipped with a three-wire power cord, in accordance with international safety standards. The power cable appropriate to the original product shipping location is included with the FieldFox.

Various AC power cables are available from Keysight that are unique to specific geographic areas. You can order additional AC power cables that are correct for use in different areas. For the power cord part number information please visit: http://www.keysight.com/find/fieldfox

Install the Lithium-Ion Battery

Step	Notes
1. Open the battery door	Push the button on the battery compartment door while sliding the door outward.
2. Insert the battery.	The terminals end of the battery is inserted into the compartment.
3. Close the battery door.	Slide the battery compartment door upwards until it latches.

Battery Usage

When you receive your FieldFox, the lithium-ion battery is not installed, and it is partially charged to approximately 30% to preserve battery life. A lithium-ion battery has no memory effect, so it can be used partially charged, as shipped.

A fully charged battery will power your FieldFox for about four hours, so if you plan to use it for this long, you should fully charge the battery.

NOTE

The FieldFox will shut down to prevent the battery from discharging to a level that is damaging. If this occurs, charge the battery either internally or externally.

Learn more about the lithium-ion battery in Chapter 35, "Working with the Lithium-Ion Battery."

Battery charge status is viewable:

- 84% In the upper-right corner of the screen.
- On the Battery screen. To access the screen, select **System** > **Service Diagnostics** > **Battery**.

– On the battery. Open the FieldFox battery compartment door to view the battery LCD.

To conserve battery power:

– Use **Run/Hold** to single-trigger a measurement when needed. Hold is shown on the display.

– Press **System** > **Display** > **Brightness**. Use the ▲|▼ arrows, the rotary knob, or numeric keypad to adjust the brightness to dim the FieldFox display as much as possible.

– Briefly press the power button > Standby, to switch to Standby mode when the FieldFox is not being used. Press power button again to restore power. All current settings are preserved.

NOTE When powered by the battery only, the FieldFox can stay in Standby mode for a maximum of four hours and then it powers off automatically. When the relative battery charge drops by about 20%, the FieldFox will power off to preserve the remaining charge.

To recharge a battery:

Use ONLY a FieldFox charger to recharge a battery.

– The battery can be fully charged while in the FieldFox in about 4 hours with the FieldFox either ON or OFF.

– The battery can be fully charged externally using the external battery charger in about 4 hours.

– When the battery is removed, the FieldFox can still be powered by the AC/DC adapter.

FieldFox ON/OFF Settings

NOTE The FieldFox power button shut down/standby sequence includes a 10 second counter that allows you to either choose a softkey to immediately initiate the action (**Standby** / **Shut down** / **Restart***), or to let the countdown counter expire after 10 seconds then perform the action.
*Restart can only be enabled via the Restart softkey.

– To turn power **ON**, briefly press the power button. Boot-up takes about 1 minute.

– To switch to **Standby** mode (low battery drain), briefly press the power button. See the Note above concerning Stand By.

- To turn Power **OFF** (very low battery drain), press the power button briefly and press the Shutdown softkey. Data and instrument state are NOT automatically saved when the FieldFox is powered OFF. Learn how to save data and instrument state in Chapter 34, "File Management", on page 887. See the Note above concerning Shut down.
- To restart FieldFox, press the power button and press **Restart**. See the **Note** above concerning Restart.
- Press **Cancel** to exit the power down sequence.
- You can also access the power down softkey menu choices (**Standby**, **Shut down**, **Restart**, and **Cancel**) by using the **Mode** hardkey:
- Press **Mode**
  - Then **More**
  - Then **Shut down**
- You can make a setting to automatically **Power ON** the FieldFox when a power source is connected. Learn how on "Power ON" on page 876.

Power Button LED Status

Solid green	Power is ON
Blinking green	FieldFox in Stand By mode
Steady amber[a]	The amber LED will remain on after the battery is fully charged, if the AC adapter remains powered and connected.
Blinking amber and green	Stand By mode and battery charging
Not lit	Power is Off and battery is not charging

a. Instrument firmware versions dated May/June 2015 and above.

FieldFox High Temperature Protection

The following features prevent degradation or damage in the event of high internal temperatures in the FieldFox.

NOTE Do NOT store the FieldFox in the soft-case while powered ON or in Standby mode.

How to monitor the internal FieldFox temperature:

- Press **System** > **Service Diagnostics**.
- Then **Internal Temperatures**.

– The average temperature that is displayed for the Internal Temperature is the average of the RF1, RF2, SB1, SB2 temperatures. These temperatures come from internal sensors embedded within the FieldFox.

  The average temperature does **not** include the CPU or the battery temperatures. The FieldFox does **not** measure the CPU and battery temperatures.

Temperature Control Mode

The FieldFox's internal temperature control preserves measurement accuracy and maintains the long-term reliability of the FieldFox. See also, "High-Temp Shutdown Warning (RTSA Mode Only)" on page 37.

NOTE Measurement speed specifications do NOT apply in Temperature Control Mode.

Entering Temperature Control Mode

At an average internal temperature of above approximately 64°C, the FieldFox enters Temperature Control mode by reducing display intensity. This should decrease the internal temperature which preserves measurement accuracy and maintains the long-term reliability of the FieldFox. Refer to Figure 2-1.

In addition, duty cycling is enabled when the internal average temperature of the FieldFox reaches the duty cycling threshold of above ~64°C. All applications (except RTSA): Power for internal circuitry is turned off between sweeps and delaying occurs for the next sweep. In RTSA mode, power is only turned off, if the FieldFox is in Single Sweep or Hold.

All applications (including RTSA): Display dims to 40% at ~64°C.

For all modes, except RTSA mode, you will see the following messages displayed for ~3 seconds:

```
"Automatic Meas Duty Cycling activated for thermal
management"
```

Later if the temperatures are reduced:

```
"Temperatures reduced, ending Automatic Meas Duty Cycling"
```

For RTSA mode (where duty cycling is not possible), you will see the following messages displayed for ~3 seconds:

```
"Entering Auto Protect mode for thermal management"
```

Later if the temperatures are reduced:

```
"Temperatures reduced, exiting Automatic Protect Mode"
```

Entering Auto Protect (Maximum) Threshold Temperature Mode

At above approximately 75°C, the FieldFox enters (Maximum) Auto Protect temperature control mode by displaying the “Entering Auto Protect mode...”. See also Table 2-1 on page 38.

When you enter the Auto Protect (Maximum) Threshold, the following message is displayed:

```
"Entering Maximum Auto Protect mode for thermal management"
```

When temperature reaches the maximum protection threshold (~75°C), some applications take additional measures.

Figure 2-1 Entering Auto Protect mode message (above ~64°C)—(Displays for 3 sec)

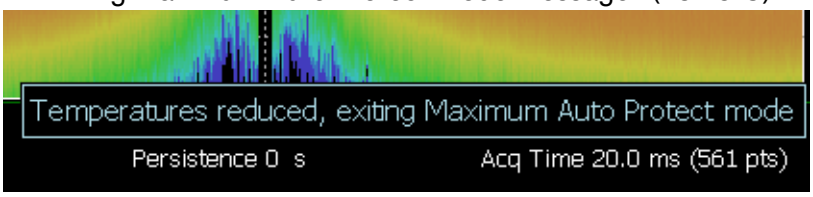
Exiting Maximum Auto Protect Threshold Temperature Mode

When the temperature drops to approximately 73.5°C, a message is displayed indicating that the FieldFox is leaving Temperature Control Mode and normal operating settings are restored (refer to Figure 2-2). See also, Table 2-1 on page 38.

When you exit the Auto Protect (Maximum) Threshold control mode, the following message is displayed:

```
"Temperatures reduced, exiting Maximum Auto Protect mode"
```

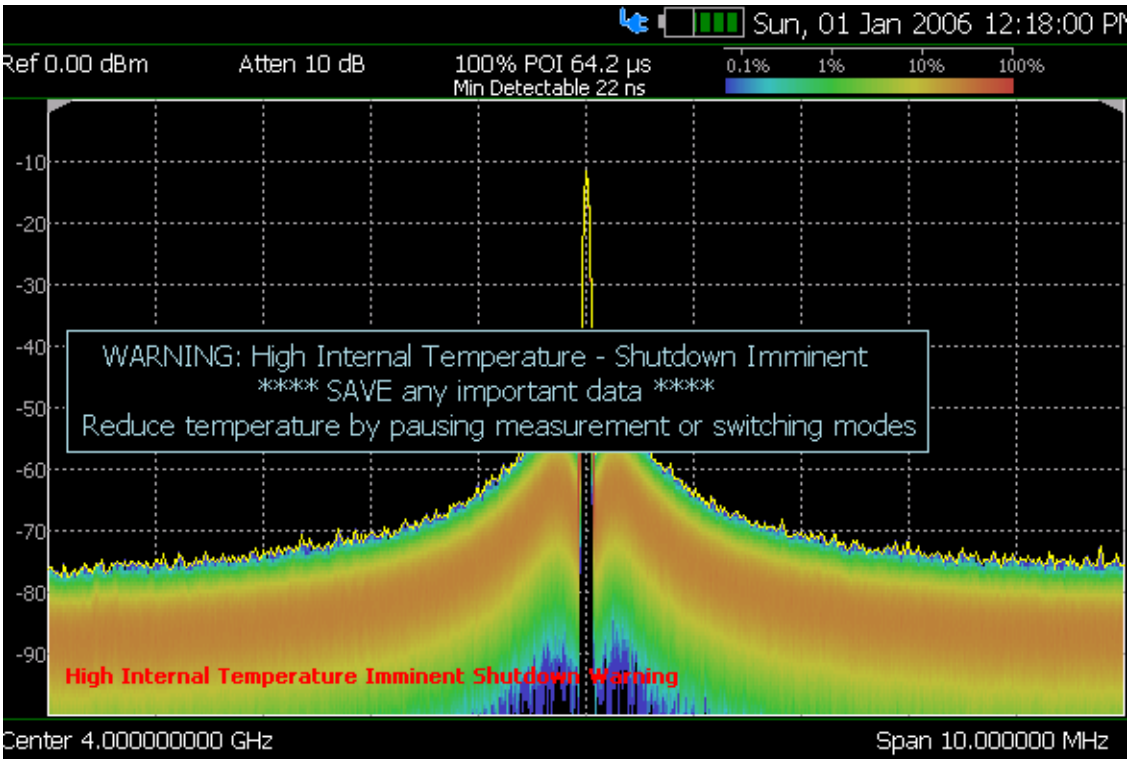
Figure 2-2 Exiting Maximum Auto Protect mode message—(~62.5°C)



High-Temp Shutdown Warning (RTSA Mode Only)

In extreme situations, Temperature Control mode may not stop an increase in the FieldFox internal temperature. Just prior to shut down, the FieldFox will display a warning of imminent shut down and the instrument turns off. At above approximately 77°C, a Maximum Auto Protect message—(Top "WARNING..." message) displays for 9 sec. Red text at left bottom corner of display remains on until internal temperature returns to ~75.5°C. At above ~78°C, High-Temperature Shut down will engage and turn OFF the FieldFox. Refer to Figure 2-3. See also, Table 2-1 on page 38.

Figure 2-3 Shutdown Warning message—(above ~77°C) - (RTSA Mode Only!)



Summary of FieldFox Average Internal Temperature Protection Behavior

Table 2-1 Summary of FieldFox Temperature Protection

Threshold	Average Internal Temperature	Description of Behavior
Duty cycling	~64°C	Duty cycling is enabled when the internal average temperature of the FieldFox reaches the duty cycling threshold of ~64°C. Power is turned off between sweeps and delaying occurs for the next sweep. In RTSA mode power is only turned off in Single Sweep or Hold. This enables you to control your instrument's temperature when you don't need to make a measurement by using the "Run/Hold" hardkey to pause the sweep. All applications (including RTSA): Display dims to 40% at ~64°C.
Maximum Protect (Initial)	~75°C	When temperature reaches the maximum protection threshold (~75°C) some applications take additional measures.
1 degree below shutdown (RTSA Mode Only)	~77°C	RTSA Shutdown Warning (~77°C) – (Top "WARNING..." message displays for 9 sec). Red text at bottom of display remains on until internal temperature returns to ~75.5°C. Refer to Figure 2-3 on page 37.
Shutdown	~78°C	Instrument shuts down.
Exit Duty Cycle	~62.5°C	The temperature required to come out of the duty cycle threshold.

Avoid Overpowering the FieldFox

The FieldFox can be damaged with too much power or voltage applied. Exceeding the maximum RF power levels shown below will cause an ADC Over Range message to appear on the screen.

CAUTION

Maximum Input Voltages and Power:

RF Output Connector: 50V DC, +23 dBm RF

Ext Trig/Ref Connector: 5.5 V DC

RF Input:

- +27 dBm RF, ±50 VDC Max. (N991xA/B, N9925B, N9926A, N9928A, N993xA/B)
- +23 dBm RF, ±50 VDC Max. (N9923A, N9923AN)
- +25 dBm RF, ±40 VDC Max. (N995xA/B, N996xA/B)

DC Input: 19VDC, 4ADC, 60 Watts maximum when charging battery

Learn more about Maximum power and voltages in the FieldFox Data Sheet. Refer to https://www.keysight.com/us/en/assets/7018-06516/data-sheets/5992-3702.pdf.

NOTE

Very often, coaxial cables and antennas build up a static charge, which, if allowed to discharge by connecting to the FieldFox, may damage the instrument input circuitry. To avoid such damage, it is recommended to dissipate any static charges by temporarily attaching a short to the cable or antenna prior to attaching to the FieldFox.

Take the FieldFox Tour

Front Panel

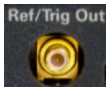
No.	Caption	Description	Learn More:
1	Power	ON: press momentarily. STAND BY: with FieldFox power ON, press briefly. OFF: press and hold until the FieldFox shuts off (about 4 seconds).	"FieldFox ON/OFF Settings" on page 33
2	LED	Not lit: FieldFox OFF, not charging Green: FieldFox ON. Charging status indicated by battery icon on screen Orange, flashing: FieldFox STAND BY Orange, intensity increasing, flashing slowly: FieldFox OFF, charging	"Power Button LED Status" on page 34
3	**System**	Displays a sub-menu for system setup	"System Settings" on page 835
4	Function keys	Includes: **Freq/Dist**, **Scale/Amptd**, **BW**, **Sweep**, **Trace**, **Meas Setup**, **Measure**, and **Mode**.	Refer to specific Mode.
5	**Preset**	Returns the analyzer to a known state	"How to Preset the FieldFox" on page 838
6	**Enter**	Confirms a parameter selection or configuration	--
7	**Marker**	Activates marker function	"All about Markers" on page 797
8	**Mkr-->Tools**	Displays a sub-menu for marker functions	"All about Markers" on page 797
9	**Esc**	Exits and closes the Active Entry dialog box or clears the character input	--
10	**Save/Recall**	Saves the current trace or recalls saved data from memory	"Saving and Recalling Files" on page 888

No.	Caption	Description	Learn More:
11	**Limit**	Sets limit lines for quick Pass/Fail judgment	"All about Limit Lines" on page 812
12	**Run/Hold**	Toggles between free Run and Hold/Single operation.	"Run/Hold" on page 837
13	**Cal**	Displays a sub-menu for calibration functions	"Calibration Method Summary" on page 149
14	Arrow keys	Increases or decreases a value or setting.	--
15	**◄Back**	Returns to the previous menu selection.	--
16	Rotary knob	Highlights an item for selection, or enables incremental changes to values.	--
17	Softkeys	Allows selection of settings for configuring and performing measurements, and for other FieldFox functions.	--
18	Screen	Transflective screen, viewable under all lighting conditions. If you are using your FieldFox in direct sunlight, you do not need to shield the display from the sunlight. In bright lighting conditions, the display is brighter and easier to read when you allow light to fall directly on the screen. Alternative color modes exist that maximize viewing in direct sunlight conditions, as well as other conditions such as nighttime work. **NOTE** Clean the Transflective screen with gentle and minimal wiping using Isopropyl alcohol applied to a lint-free cloth.	"Screen Tour" on page 46

Top Panel

Caption	Descriptions	Learn More:
Port 1 RF Output	For CAT and NA measurements, use to make reflection measurements. Maximum: ±50 VDC, +27 dBm RF Also, for SA source output in SA mode.	"CAT Mode Settings" on page 53 "NA Mode Settings" on page 93 Chapter 9, "SA (Spectrum Analyzer) Mode (Option 233–Mixed Analyzers)", on page 151
Port 2 SA RF Input	For SA, use to make all measurements. For CAT, NA, and VVM mode, use to make Port 2 transmission measurements. Maximum: ±50 VDC, +27 dBm RF.	"SA Mode Settings" on page 155
GPS Ant	SMA (f) connector for use with built-in GPS. Produces a settable 3.3 VDC or 5 VDC bias voltage for the antenna pre-amplifier. Use with a GPS antenna such as N9910X-825. Other GPS antennas can also be used.	"GPS – Distance Settings" on page 857
Ref In Trig In	SMA (f) connector for use with Frequency Reference Source and External Trigger Input signal. Maximum: 5.5 VDC.	"Frequency Reference Source" on page 870. "Triggering" on page 202

Right Side Panel

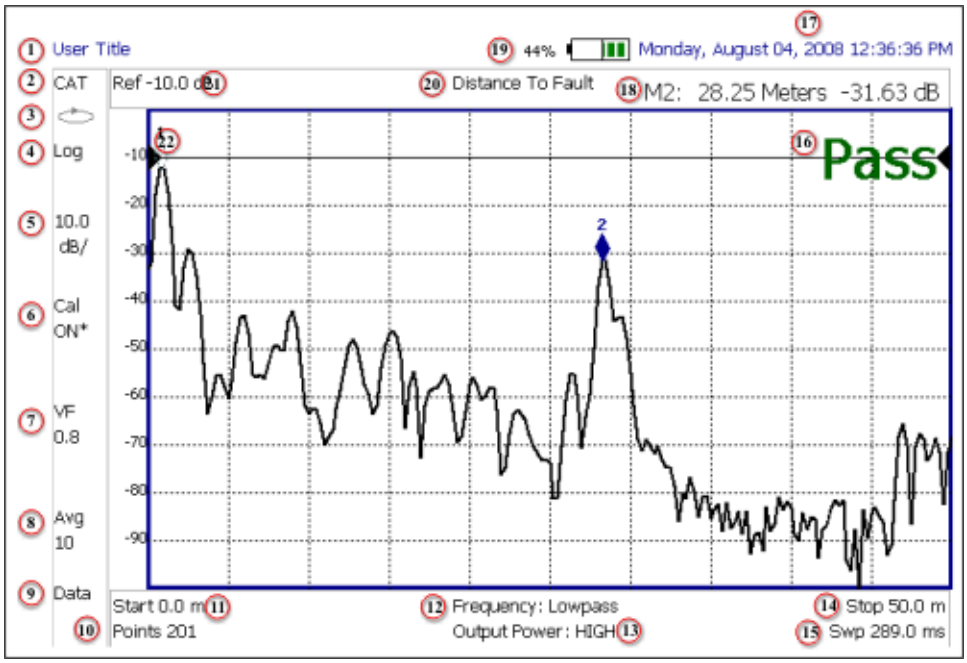
Connector	Description	Learn More:
	Ethernet cable connector[a] to read trace data using the FieldFox Data Link Software and connect to the FieldFox remotely. Download the latest version of the software at: www.keysight.com/find/fieldfoxsupport	"LAN Settings" on page 874
	IF Out used in SA mode for external signal processing.	"IF Output" on page 195
	Frequency Reference Source Output Trigger Output (ERTA mode).	Chapter 27, "ERTA (Extended Range Transmission Analysis) Mode - Option 209", on page 677 Also, see "Frequency Reference Source" on page 870
	Secure Digital slot. Use to extend the memory of the FieldFox.	"Saving and Recalling Files" on page 888
	The mini-USB port can be connected to your PC's standard USB port to send SCPI commands. NOTE IMPORTANT! It is recommended that only USB certified cables are used with the FieldFox.	Chapter 33, "Using the Mini-USB Port to send SCPI Commands and Queries", on page 885
	Two standard USB connectors[a] used to connect a power sensor for Power Meter Mode. Also used to save files to a USB flash drive. NOTE IMPORTANT! It is recommended that only USB certified cables are used with the FieldFox.	"Saving and Recalling Files" on page 888

a. Refer to page 936 for the NOTE on performance loss.

Left Side Panel

Connector	Description	Learn More:
	Audio output jack for use with SA Mode Tune and Listen.	“Tune & Listen (AM/FM)” on page 172
	DC Voltage Source for use with external DC Bias.	“Variable Voltage Source (Opt. 309)” on page 871
	DC power connector used to connect to the AC/DC adapter. Maximum: 19 VDC, 4 ADC.	“Internal Charging with the AC/DC Adapter ” on page 907

Screen Tour



Caption	Description	Learn More:
1	Title – write your own text here	"Title" on page 841
2	Current Mode	--
3	Run / Hold	"Run/Hold" on page 837
4	Display Format	Mode dependent
5	Scale/division	Mode dependent
6	Calibration Status (CAT and NA) Detection Method (SA)	"Cal ON? – Questionable Accuracy" on page 145
7	Velocity Factor (Fault Meas)	"About Velocity Factor and Cable Loss" on page 71
8	Averaging Status and Count	Mode dependent
9	Data / Mem Display (CAT and NA) Step / FFT (SA)	"All about Trace Math" on page 829 "Resolution Bandwidth (Res BW)" on page 193
10	Resolution Setting	Mode dependent
11	Measurement Start Freq or Distance	Mode dependent

Caption	Description	Learn More:
12	Bandpass / Lowpass setting (Fault Meas) IF BW in NA Mode	"DTF Measurement Settings" on page 68
13	Output Power Level (CAT and NA)	"Output Power" on page 59
14	Measurement Stop Freq or Distance	Mode dependent
15	Actual Sweep Time	Mode dependent
16	Limit Line Status	"All about Limit Lines" on page 812
17	Time and Date	"Date and Time" on page 857
18	Marker Readout	"All about Markers" on page 797
19	Battery Status	"Viewing the Battery Charge Status" on page 906
20	Measurement Type (CAT and NA)	--
21	Acquisition	Mode dependent
22	Reference Position	Mode dependent

How to Enter Numeric Values

Many settings on the FieldFox require the entry of numeric values.

How to enter numeric values

Use any combination of the following keys:

- Numeric 0–9 keys, along with the polarity (**+/-**) key.
- Up/Down arrow keys (▲|▼) to increment or decrement values.
- Rotary knob to scroll through a set of values.
- **Back** erases previously entered values.
- **Esc** exits data entry without accepting the new value.

To complete the setting, press **Enter** or a different **softkey** or **hardkey**.

Multiplier Abbreviations

Many times after entering numeric values, a set of multiplier or suffix softkeys are presented. The following explains the meaning of these abbreviations.

Select Frequency multipliers as follows:

- **GHz** Gigahertz (1e9 Hertz)
- **MHz** Megahertz (1e6 Hertz)
- **KHz** Kilohertz (1e3 Hertz)
- **Hz** Hertz

Select Time multipliers as follows:

- **s** Seconds
- **ms** milliseconds (1e–3)
- **us** microseconds (1e–6)
- **ns** nanoseconds (1e–9)
- **ps** picoseconds (1e-12)

Connector Care

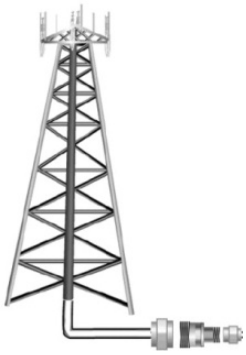
- Never store connectors, airlines, or calibration standards loose in a box. This is a common cause of connector damage.
- Install protective end caps when connectors are not in use.
- Keep connector temperature the same as the test instrument. Holding the connector in your hand or cleaning connector with compressed air can significantly change the temperature. Wait for connector temperature to stabilize before using in calibration or measurements.
- Do not touch the mating plane surfaces. Natural skin oils and microscopic particles of dirt are difficult to remove from these surfaces.
- Do not set connectors contact-end down on a hard surface. The plating and mating plane surfaces can be damaged if the interface comes in contact with any hard surface.
- Wear a grounded wrist strap and work on a grounded, conductive table mat. This helps protect the analyzer and devices from electrostatic discharge (ESD).
- Refer to Appendix A:, “Connector Care Review,” on page 939.

CAUTION

Because of the very small and precise mechanical tolerances of mmWave connectors, minor defects, damage, and dirt can significantly degrade repeatability and accuracy. In addition, a dirty or damaged connector can destroy connectors that are mated to it. For this reason, NEVER use a damaged connector. See also “Connector Care” with the PNA Help https://rfmw.em.keysight.com/wireless/helpfiles/N52xxB/Tutorials/Connector_Care.htm.

See also,
https://www.keysight.com/us/en/assets/9018-04357/user-manuals/9018-04357.pdf (85051-90032).

3 CAT (Cable and Antenna Test) Mode



CAT Mode is typically used to test an entire transmission system, from the transmitter to the antenna. This process is sometimes referred to as Line Sweeping.

CAT Mode is similar to NA (Network Analyzer) Mode. Learn more in the Supplemental Online Help: https://rfmw.em.keysight.com/wireless/helpfiles/FieldFoxOnlineSupplementalHelp/Home.htm.

CAT Mode Distance to Fault measurements are discussed in Chapter 4, "DTF (Distance to Fault) Measurements.".

NOTE

IMPORTANT! For CAT and NA modes, limit lines do not apply where F1 = F2.

In this Chapter

"Measurement Selection" on page 53
"Quick Settings Table" on page 54
"Frequency Range" on page 55
"Scale Settings" on page 55
"Averaging" on page 56
"Smoothing" on page 57
"Single or Continuous Measure" on page 57
"Resolution (Number of Data Points)" on page 58
"Sweep Time" on page 58
"Output Power" on page 59
"Interference Rejection" on page 60
"Coupled Frequency" on page 60

Procedures

"Return Loss Measurements" on page 61

"1-Port Cable Loss Measurements" on page 62

"2-Port Insertion Loss Measurements" on page 63

See Also

Chapter 8, "Calibration for NA, CAT, and VVM Modes", on page 127

"All about Markers" on page 797

"All about Limit Lines" on page 812

"All about Trace Math" on page 829

Learn more in Making 75Ω (ohm) Measurements in the Supplemental Online Help at: https://rfmw.em.keysight.com/wireless/helpfiles/FieldFoxOnlineSupplementalHelp/Home.htm.

CAT Mode Settings

Select CAT Mode before making any setting in this chapter.

How to select CAT Mode

1. Press **Mode**.
2. Then **CAT/TDR**.

Measurement Selection

How to select a CAT Mode Measurement

Learn more in the Supplemental Online Help at: https://rfmw.em.keysight.com/wireless/helpfiles/FieldFoxOnlineSupplementalHelp/Home.htm.

Press **Measure 1**.

Then choose one of the following: These softkeys also appear after CAT Mode is selected.

- **Distance To Fault** 1-port reflection measurement that uses Inverse Fourier Transform (IFT) calculations to determine and display the distance to, and relative size of, a fault or disruption in the transmission line. Units are in return loss format, expressed as a positive number in dB, unless the measurement selected is DTF (VSWR). Learn more about DTF Measurements refer to Chapter 4, “DTF (Distance to Fault) Measurements.”.
- **Return Loss & DTF** Displays both a Return Loss measurement and a DTF measurement. Use this format to display the frequency settings that are used to make the DTF measurement. The frequency range settings for these two measurements can be coupled or uncoupled. Learn more, “Coupled Frequency” on page 60.
  - Calibrations are applied to both traces
  - When in Hold mode and Single sweep is performed, only the active trace is triggered. Use the ▲|▼ arrows to activate a trace
- **Return Loss** 1-port reflection measurement that displays the amount of incident signal energy MINUS the amount of energy that is reflected. The higher the trace is on the screen, the more energy being reflected back to the FieldFox. Learn how to measure Return Loss on “Return Loss Measurements” on page 61.
- **VSWR** (Voltage Standing Wave Ratio – also known as SWR) 1-port reflection measurement that displays the ratio of the maximum reflected voltage over the minimum reflected voltage. The higher the trace is on the screen, the more energy being reflected back to the FieldFox.

- **DTF (VSWR)** Distance to Fault in VSWR format.
- **Cable Loss (1-Port)** 1-port reflection measurement that displays the loss of a transmission line. Learn more, see "1-Port Cable Loss Measurements" on page 62.
- **Insertion Loss (2-Port)** 2-port transmission measurement that accurately displays the loss through a cable or other device in dB. Both ends of the cable must be connected to the FieldFox. NO phase information is included in this measurement. Learn more, see "2-Port Insertion Loss Measurements" on page 63. This feature is available only with an option on some FieldFox models. For detailed information, please view the FieldFox Configuration Guide at: https://www.keysight.com/us/en/assets/7018-06515/configuration-guides/5992-3701.pdf.
- **DTF (Lin)** Distance to Fault in Linear format.
- **TDR (Lin rho)** The Y-axis of the display is linear, real, unitless values. A trace without reflections shows as 0 (zero). Maximum reflections from an open or short show as 1.
- **TDR (ohm)** The Y-axis of the display is impedance (ohms).
- **TDR & DTF** Both TDR and DTF traces are displayed.

Quick Settings Table

Both CAT and NA Modes allow you to view and change most relevant settings from a single location. All of these settings are discussed in this chapter and, unless otherwise noted, ALL of these settings can also be made using the standard softkey menus.

How to view and change Quick Settings

- Press **Meas Setup 4** > **Settings**.
- Press **Next Page** and **Previous Page** to view all settings. If these softkeys are NOT available, then all available settings fit on one page.
- To change a setting:
  - Use the arrows ▲|▼ to highlight a setting.
  - Then press **Edit**. The current setting changes to **yellow**.
  - Some settings require you to press a softkey to change the value.

    Otherwise, use the numeric keypad, ▲|▼ arrows, or rotary knob to change the value.
  - When finished changing a value, press **Done Edit**.

- Press **Dock Window** to relocate the Settings table to a position relative to the trace window. The Dock Window setting persists through a Preset. Choose from the following:
  - **Full** (Default setting) Only the Settings table is shown on the screen. The trace window is temporarily not shown
  - **Left** The Settings table is shown to the left of the trace window
  - **Bottom** The Settings table is shown below the trace window
- When finished changing ALL settings, press **Done** to save your settings

Frequency Range

Set the range of frequencies over which you would like to make CAT Mode measurements.

When the frequency range is changed after a calibration is performed, the cal becomes interpolated. Learn more in "Interpolation *" on page 145.

How to set Frequency Range

- Press **Freq/Dist**.
- Then choose from the following
  - **Start** and **Stop** frequencies - beginning and end of the sweep.
  - **Center** and **Span** frequencies – the center frequency and span of frequencies (half on either side of center).
- Follow each setting by entering a value using the numeric keypad, arrows ▲|▼, or the rotary knob.
  - After using the keypad, select a multiplier key. Learn about multiplier abbreviations in Chapter 1, "Overview."
  - After using the arrows ▲|▼ or the rotary knob, press **Enter**. The amount of frequency increment is based on the current span and can NOT be changed in CAT Mode.

Scale Settings

Adjust the Y-axis scale to see the relevant portions of the data trace. The Y-axis is divided into 10 graticules.

This setting can be changed at any time without affecting calibration accuracy.

How to set Scale

- Press **Scale / Amptd**.
- Then choose from the following three methods:

1. **Autoscale** Automatically adjusts the Y-axis to comfortably fit the Minimum and Maximum amplitude of the trace on the screen.
2. Set Scale, acquisition, and Reference Position:
   - **Scale** Manually enter a **scale per division** to view specific areas of the trace
   - **Ref Level** Manually set the value of the reference line. Enter a negative value by pressing **Run/Hold (+/-)** either before or after typing a value
   - **Ref Pos** Manually set the position of the reference line. Values must be between **0** (TOP line) and **10** (BOTTOM line)
3. Set Top and Bottom graticule values. The scale per division is calculated.
   - **Top** to set the value of the Top graticule.
   - **Bottom** to set the value of the Bottom graticule.
   - Enter a negative value by pressing **Run/Hold (+/-)** either before or after typing a value.

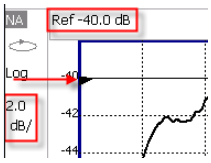
Scale annotation on the FieldFox screen

Reference Line = red arrow

Ref Level = -40 dB

Ref Position = 1

Scale = 2 dB per division



Averaging

Trace Averaging helps to smooth a trace to reduce the effects of random noise on a measurement. The FieldFox computes each data point based on the average of the same data point over several consecutive sweeps.

Average Count determines the number of sweeps to average; the higher the average count, the greater the amount of noise reduction.

An average counter is shown in the left edge of the screen as **Avg N**. This shows the number of previous sweeps that have been averaged together to form the current trace. When the counter reaches the specified count, then a 'running average' of the last **N** sweeps is displayed. Average Count = 1 means there is NO averaging.

This setting can be changed at any time without affecting calibration accuracy.

NOTE

Averaging is often used to increase the dynamic range of a measurement. To achieve the highest dynamic range, select NA mode and reduce the IF Bandwidth setting. Learn more about dynamic range in "Increase Dynamic Range" on page 114.

How to set Trace Averaging

1. Press **BW 2**.
2. Then **Average N** where **N** is the current count setting.
3. Enter a value using the numeric keypad. Enter 1 for NO averaging.
4. Press **Enter**.
5. While Trace Averaging is in process, press **Sweep 3** then **Restart** to restart the averaging at 1.

Smoothing

Trace smoothing averages a number of adjacent data points to smooth the peak-to-peak noise values on a displayed trace. The number of adjacent data points that are averaged is known as the smoothing aperture. Aperture is set by specifying a percentage of the X-axis span.

Trace smoothing does NOT significantly increase measurement time.

Smoothing can be used with any CAT format.

When enabled, Smo appears on the FieldFox screen.

How to set Smoothing

1. Press **BW 2**.
2. Then **Smoothing ON OFF**.
3. Then **Sm. Aperture** and enter a value between 0 and 25 (percent) using the numeric keypad.
4. Press **Enter**.

Single or Continuous Measure

This setting determines whether the FieldFox sweeps continuously or only once each time the **Single** button is pressed. Use **Single** to conserve battery power or to allow you to save or analyze a specific measurement trace.

This setting can be changed at any time without affecting calibration accuracy.

How to set Single or Continuous

– Press **Sweep 3**.

– Then choose one of the following:

  – **Single** Automatically sets Continuous OFF and causes FieldFox to make ONE sweep, then hold for the next Single key press. Hold is annotated in the upper left corner of the display when NOT sweeping, and changes to an arrow --> while the sweep occurs

  – **Continuous** Makes continuous sweeps. This is the typical setting when battery power is not critical.

You can also use **Run / Hold +/-** to toggle between Single and Continuous.

Resolution (Number of Data Points)

Data points are individual measurements that are made and plotted across the X-axis to form a trace. Select more data points to increase measurement resolution. However, more data points require more time to complete an entire measurement sweep.

When the Resolution is changed after a calibration is performed, the calibration becomes interpolated. Learn more in "Interpolation *" on page 145.

How to set Resolution

1. Press **Sweep 3** > **Resolution**.
2. Then choose one of the following:
   101 | 201 | 401 | 601 | 801 | 1001 |1601 | 4001 | 10001.

Using SCPI, or measurement quick settings table, Resolution can be set to any number of points between 3 and 10001. See the Programming Guide at https://www.keysight.com/us/en/lib/resources/service-manuals/keysight-fieldfox-library-help-and-manuals-2153870.html. Learn more, "Quick Settings Table" on page 54.

Sweep Time

The fastest possible sweep time is always used as the default setting. Use the **Min Swp Time** setting to slow the sweep time when measuring long lengths of cable.

Learn more in the FieldFox Supplemental Help at:
https://rfmw.em.keysight.com/wireless/helpfiles/FieldFoxOnlineSupplementalHelp/Home.htm.

The actual sweep time is shown on the FieldFox screen. See "Take the FieldFox Tour" on page 40. To increase the sweep time, enter a value that is higher than the actual sweep time. The increase will not be exactly the amount that you enter, as the actual sweep time is the composite of many factors.

NOTE Measurement speed specifications do NOT apply in Temperature Control Mode. Learn more in Chapter 1, "Overview."

How to set Sweep Time

– Press **Sweep 3** > **Min Swp Time**.

– Enter a value using the numeric keypad.

– Press a multiplier key. Learn more in "Multiplier Abbreviations" on page 48.

Output Power

Set the power level out of the FieldFox to High, Low, or manually set power level to a value between High and Low.

Generally, the high power setting is used when measuring passive, high-loss devices to place the signal farther from the noise floor. Increasing the power can also help reduce trace noise. However, for devices that are sensitive to high power levels such as amplifiers, use the Low power setting.

For best measurement accuracy, use the Manual power setting at –15 dBm. After calibration, the power level can be decreased for amplifiers, or increased for higher dynamic range.

CAUTION Power Level settings in this mode will NOT change Power Level settings in other modes. To help prevent damage to your DUT, use caution when changing modes with your DUT connected to the FieldFox test ports.

How to set Output Power

1. Press **Meas Setup 4** > **Power**
2. Then **Output Power**
   - **High** Sets output power to the maximum achievable power at all displayed frequencies. Output power is NOT FLAT across the displayed FieldFox frequency span. Use the High power setting, when better dynamic range and lower noise is desired. Please see Appendix B:, "Specifications/Data Sheet," on page 941 for expected power levels.
   - **Low** Sets output power to approximately –50dBm, FLAT across the displayed FieldFox frequency span.
   - **Man** (Default setting) Sets the output power to –15 dBm, FLAT across the displayed FieldFox frequency span. If flattened power can NOT be achieved, a warning message and beep occurs. To achieve a flattened output power, reduce the power level or stop frequency.
   - Then press **Power Level**
   - Then enter a value using the numeric keypad, the ▲|▼ arrows, or the rotary knob.
   - Press **Enter**.

Interference Rejection

Use this setting when you suspect that other signals in the area are interfering with a measurement. Interference may look like a spike or lack of stability in the measurement trace. While monitoring a measurement at a specific frequency, toggle this setting between ON and OFF. If the measurement result decreases while ON, then there is an interfering signal in the area. Continue to make measurements with Interference Rejection ON. However, this will slow the measurement speed.

Once enabled, up to SIX sweeps may be required before the interfering signal is neutralized.

This setting can be changed at any time without affecting calibration accuracy.

How to set Interference Rejection

1. Press **Meas Setup 4** > **Interference Rejection [current setting]**.
2. Then choose from the following:
   - **Off** No interference rejection and fastest possible sweep speed
   - **Minimum** The lowest level of Interference rejection.
   - **Medium** The medium level of Interference rejection.
   - **Maximum** The highest level of Interference rejection.

Coupled Frequency

This setting, especially useful for a Return Loss & DTF measurement, allows both measurements to have different frequency ranges.

How to set Coupled Frequency

With a Return Loss & DTF measurement present:

1. Press **Meas Setup 4**.
2. Select the DTF measurement (Tr2) using the ▲|▼ arrows.
3. Then choose from the following:
   - **Coupled Freq ON** - Both the Return Loss and DTF traces have the same frequency range settings.
   - **Coupled Freq OFF** (default setting) - Both traces are allowed to have individual frequency range settings. When set to OFF:

- The Return Loss measurement frequency settings are made in the usual manner. Learn how at "Frequency Range" on page 55. When a new Start or Stop frequency is selected, Coupled Frequency is automatically set to OFF.
- The DTF measurement is made using the frequencies as determined by the **DTF Frequency Mode** setting. Learn more in "DTF Measurement Settings" on page 68.

Return Loss Measurements

Return loss can be thought of as the absolute value of the reflected power compared to the incident power.

When measuring an OPEN or SHORT, all incident power is reflected and approximately 0 dB return loss is displayed.

When measuring a LOAD, very little power is reflected and values of 40 dB to 60 dB are displayed.

The minus sign is usually ignored when conveying return loss. For example, a component is said to have 18 dB return loss, rather than –18 dB.

How to Measure Return Loss

- Connect the jumper cable or any adapter used to connect the device under test (DUT).
- Select **Preset** then **Preset** Returns the FieldFox to known settings
- Select **Mode** then **CAT/TDR** (Cable and Antenna Test)
- Then **Return Loss** (Default measurement).
- Press **Freq/Dist** and enter **Start** and **Stop** frequency values of the measurement.
- Press **Meas Setup 4** then **Settings** to make appropriate settings before calibrating.
- Disconnect the jumper cable or DUT and press **Cal 5** then follow the calibration prompts.
- Reconnect the jumper cable or DUT.
- The return loss trace is displayed on the FieldFox screen.

1-Port Cable Loss Measurements

While all cables have inherent loss, weather and time will deteriorate cables and cause even more energy to be absorbed by the cable. This makes less power available to be transmitted.

A deteriorated cable is not usually apparent in a Distance to Fault measurement, where more obvious and dramatic problems are identified. A Cable Loss measurement is necessary to measure the accumulated losses throughout the length of the cable.

A 2-port Insertion Loss measurement is usually more accurate than a 1-port Cable Loss measurement. However, to perform a 2-port Insertion Loss measurement, both ends of the cable must be connected to the FieldFox.

NOTE In high-loss conditions, a Cable Loss measurement becomes 'noisy' as the test signal becomes indistinguishable in the FieldFox noise floor. This can occur when measuring a very long cable and using relatively high measurement frequencies. To help with this condition, use High Power (page 59) and Averaging (page 56).

How to make a 1-port Cable Loss Measurement

1. Press **Preset** then **Preset**.
2. Then **More** then **Cable Loss (1-Port)**
3. Connect the cable to be tested.
4. Press **Freq/Dist** and enter **Start** and **Stop** frequency values of the measurement.
5. Press **Sweep 3** then **Min Swp Time**. Increase the Sweep Time until a stable trace is visible on the screen. The amount of time that is required increases with longer cable lengths. Learn more in the Supplemental Online Help at: https://rfmw.em.keysight.com/wireless/helpfiles/FieldFoxOnlineSupplementalHelp/Home.htm.
6. Remove the cable to be tested.
7. Press **Cal 5**, then **Mechanical Cal**.
8. Follow the prompts to perform calibration at the end of the jumper cable or adapter. Learn more about Calibration in "How to Perform a Calibration" on page 130
9. Connect the cable to be tested.

NOTE Low-level standing waves (also known as 'ripple') which may be visible in reflection measurements, can hide the actual loss of the cable. Steps 10 through 13 can minimize the ripple. Perform the measurement with and without steps 10 through 13 and choose the method with the least amount of ripple.

10. Connect a LOAD at the end of the cable to be tested. This limits the reflections to faults that are located in the cable under test.
11. Press **Trace 6** then **Math and Memory** then **Data->Mem** to store the trace into Memory.
12. Remove the LOAD and leave the end of the cable to be tested open.
13. Press **Data Math** then **Data – Mem**. The ripple in the measurement is removed. These minor imperfections in the cable should not be considered in the Cable Loss measurement.
14. Use Averaging to remove random noise from high-loss measurements. Press **BW 2** then **Average**.

The displayed trace shows the Cable Loss values in one direction through the cable. A Return Loss measurement would show the loss for both down the cable and back. Therefore, a Cable Loss measurement is the same as a Return Loss measurement divided by 2.

The average Cable Loss across the specified frequency range is shown on the screen below the graticules.

2-Port Insertion Loss Measurements

A 2-port Insertion Loss measurement is used to measure the loss through a DUT (device under test) – or cable – over a specified frequency range. The FieldFox signal source is transmitted out the RF OUT connector, through the DUT, and into the RF IN connector. Both ends of the DUT must be connected to the FieldFox, either directly or indirectly using the cable used in the normalization cal.

'Insertion' loss simply means **loss** through a device, usually expressed in dB. It is exactly the same measurement as "S21 Transmission" in NA Mode.

NOTE

Exception: In CAT mode, if the TDR data are saved in S1P format, the values represent the real part of the complex transform; the imaginary part is set to zero. To obtain complex data, either as real/imaginary or magnitude/phase pairs, use NA mode.

2-port Insertion Loss measurements are generally more accurate than 1-port Cable Loss measurements.

How to make a 2-port Insertion Loss Measurement

- Press **Mode** then **CAT**.
- Then **More** then **Insertion Loss (2-Port)**.
- Press **Freq/Dist** and enter **Start** and **Stop** frequency values of the measurement.

– Press **Sweep 3**, then select a **Resolution** setting.

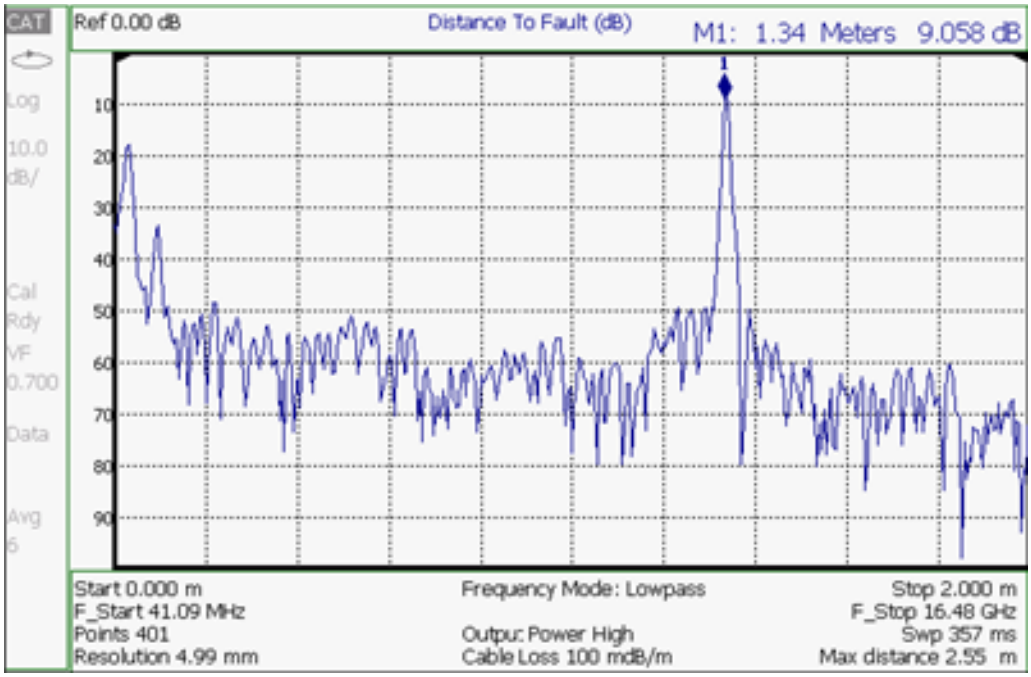
– Press **Cal 5**, then perform a calibration. Learn more on "How to Perform a Calibration" on page 130.

– Connect the DUT and view the insertion loss measurement results.

When measuring very long lengths of cable, it may be necessary to increase the sweep time. Learn how on page 58. Learn how in the Supplemental Online Help at:
https://rfmw.em.keysight.com/wireless/helpfiles/FieldFoxOnlineSupplementalHelp/Home.htm.

4 DTF (Distance to Fault) Measurements

CAT Mode **Distance to Fault** (DTF) measurements are generally used to locate problems, or faults, in a length of cable or transmission line. In this chapter, the cable to be tested is referred to as the DUT (Device Under Test).



Settings that are NOT unique to DTF measurements are documented in the CAT Mode Chapter 3, "CAT (Cable and Antenna Test) Mode."

In this Chapter

"How to make DTF Measurements" on page 67

"DTF Settings Table" on page 68

"DTF Measurement (Format)" on page 68

"DTF Start and Stop Distance" on page 69

"Frequency Mode" on page 69

"Coupled Frequency" on page 70

"Cable (Correction) Specifications" on page 70

"Window Settings" on page 74

"DTF Units" on page 74

"Calculated DTF values" on page 74

"About Alias Faults" on page 75

Optional settings

"All about Markers" on page 797

"All about Limit Lines" on page 812

"Saving and Recalling Files" on page 888

Trace Math is NOT available in DTF Measurements.

How to make DTF Measurements

Before starting, you may need the following:

- Jumper cable or adapter to connect the beginning of the DUT to the FieldFox.
- LOAD with correct connector type and gender to terminate the end of the DUT (if possible).
- The known length and cable type of the DUT. If the cable type is not known, then the Cable Loss (dB/Meter) and Velocity Factor of the DUT are required.

1. Connect any necessary jumper cable or adapter to the FieldFox RF OUT port. Do NOT connect the DUT.
2. Press **Preset** then **Preset** to return the FieldFox to the default settings.
3. Then **Mode** then **CAT**.
4. Then **Meas 1** then **DTF**.
5. Press **Freq/Dist**, then **Stop Distance** and enter the length of the DUT. You can optionally set the Start Distance
6. Press **Cal 5** and follow the Cal prompts. Learn all about Calibration in "How to Perform a Calibration" on page 130.
7. Disconnect any components or antenna that should NOT be measured and connect a LOAD at the end of the DUT.
8. Press **Meas Setup 4** then **DTF Cable Specifications**.
9. Either press **Edit/Save/Recall Cables** then **Recall Cable**, or directly enter the Velocity Factor/Cable Loss of the DUT using the **Velocity Factor** and **Cable Loss** keys.
10. Connect the start end of the DUT to the FieldFox.
11. Press **Meas Setup 4** then **Settings** then **Next Page**. If the **Alias-free Range** setting is False, then you may see Alias faults on the screen. Learn more on page 75.

DTF Measurement Settings

DTF Settings Table

You can set and view all of the DTF settings, including some calculated values, on the DTF Settings table. Learn about the calculated values in "Calculated DTF values" on page 74.

How to make settings on the DTF settings table

1. Press **Meas Setup 4** > **Settings**.
2. Press **Next Page** and **Previous Page** to view all settings.
3. To change a setting:
   - Use the ▲|▼ arrows or rotary knob to highlight a setting.
   - Numeric settings can be changed by pressing numbers using the numeric keypad. Then press Enter or select a suffix if available.
   - Other settings require you to press **Edit**, then press a softkey to change the value.
   - When finished changing a value, press **Done Edit**.
4. Press **Dock Window** to relocate the Settings table to a position relative to the trace window. The setting persists through a Preset. Choose from the following:
   - **Full (Default setting)** Only the Settings table is shown on the screen. The trace window is temporarily not shown.
   - **Left** The Settings table is shown to the left of the trace window.
   - **Bottom** The Settings table is shown below the trace window.
5. When finished changing ALL settings, press **Done** to save your settings.

DTF Measurement (Format)

You can select from 3 different DTF Formats.

1. Press **Measure 1**
2. Then choose from:
   - **Distance to Fault (dB)** Faults are displayed on the Y-axis in return loss format, expressed as a positive number in dB.
   - **DTF (VSWR)** Faults are displayed on the Y-axis in SWR. Learn more about SWR at the FieldFox Supplemental Online Help at: https://rfmw.em.keysight.com/wireless/helpfiles/FieldFoxOnlineSupplementalHelp/Home.htm.

– More then DTF (Lin) Faults are displayed on the Y-axis in linear (unitless) format.

DTF Start and Stop Distance

In DTF measurements, you set the physical length of cable or other device to be tested. The FieldFox calculates the frequency range of the measurement from this distance. The longer the cable to be tested, the lower the frequencies that are used. You can also set the frequencies manually using the Frequency Mode [Bandpass] setting.

How to set Start and Stop Distance

– With a DTF measurement present, press **Freq/Dist**.

– Then choose from the following:

– Start Distance Enter a value using the numeric keypad, the ▲|▼ arrows, or the rotary knob, then **Enter**. By default, the Start Distance is set to 0 Meters. This means that the measurement will display faults starting at the point at which calibration standards are connected.

– Stop Distance Enter a value between the start distance and 5 km (or 16,404 ft.) using the numeric keypad, the ▲|▼ arrows, or the rotary knob, then **Enter**.

Frequency Mode

All DTF measurements are made with frequency settings and, using Inverse Fourier Transform (IFT), the time and distance to faults are calculated.

NOTE The start and stop frequencies for the measurement are always annotated on the screen below the start and stop distances.

How to set Frequency Mode

With a DTF measurement present:

1. Press **Meas Setup 4** > Freq Mode
2. Choose one of the following:

– Lowpass The frequency range of a DTF measurement is set automatically based on the Start and Stop Distances. Use Lowpass mode when the DUT is a cable ONLY.

– Bandpass (Default setting) The frequency range of a DTF measurement is set manually. Use Bandpass mode when the DUT contains a diplexer or other filtering device which does not pass some frequencies.

Typically, you will set the frequency range of the measurement to the passband of the filter. However, you may also want to test the ability of the filter to reject unwanted frequencies. In this case, set the frequency range to include those frequencies which the filter may not be adequately rejecting.

How to manually set Frequencies in Bandpass Mode

1. Press **Freq/Dist**
2. Then **Min Start Freq** and type the start frequency to use for the DTF measurement.
3. Then **Max Stop Freq** and type the stop frequency to use for the DTF measurement.

OR

1. Press **More**
2. Then **Max Freq Span** and type the frequency range to use for the DTF measurement.
3. Then **Center Frequency** and type the center frequency of the range to use for the DTF measurement.

When the DTF frequencies are set manually, they may not be the optimum frequencies for measuring the distance to fault. The distance may no longer be alias-free. Learn more about alias-free range on page 75.

These settings specify the minimum and maximum frequencies to be used for the DTF measurement. These exact frequencies may not be used, but a narrower frequency range may be used that will still pass through the bandpass filter.

Coupled Frequency

When a Return Loss & DTF measurement is present, this setting allows you to have different frequency ranges for each measurement. Learn more in "Coupled Frequency" on page 60.

Cable (Correction) Specifications

By default, the FieldFox does NOT correct DTF measurements to account for the inherent loss of a cable. However, to make more accurate DTF measurements, the Cable Loss and Velocity Factor values should be considered.

NOTE

The following describes Coax Media type. However, you can create or edit Waveguide Media Standards. Learn how in "Waveguide Calibrations" on page 143.

About Velocity Factor and Cable Loss

– Velocity Factor is a property of the physical material of a cable. A VF of 1.0 corresponds to the speed of light in a vacuum, or the fastest VF possible. A polyethylene dielectric cable has VF = 0.66 and a cable with PTFE dielectric has VF = 0.7.

– Cable Loss is specified in dB/meter. In addition to the length of the cable, loss is also directly proportional to the frequency of the signal that passes through the cable.

The following is an example showing how DTF cable correction works:

The DUT is a 100 meter transmission cable. The Cable Loss value is 0.1 dB/meter. This means that a signal traveling ONE WAY through the cable will lose 10 dB of power (100 m * 1dB/m). Because the FieldFox performs this measurement with 1 port, the test signal travels down the cable and then back, for a total loss of 20 dB.

After a calibration has been performed, for the purpose of illustrating this point, connect an OPEN to the end of the cable – a maximum-sized fault - for 100% reflection of the 300 MHz test signal.

Without compensation for the loss of the cable, a –20 dB response would be visible at 100 meters, which is the OPEN at the end of the DUT. This is from 10 dB of loss through the cable in each direction.

With compensation for the loss using the manufacturer's specification, the FieldFox compensates the trace as though the signal traveling through 100 meters was increased by +20 dB. Therefore the response will show 0 dB for 100% reflection.

How to enter Cable Loss and Velocity Factor

Cable Loss and Velocity factor can be entered using one of the following methods:

– Manually enter cable loss and velocity factor for the measurement.

– Select or create a cable file which contains the cable loss and velocity factor.

With a DTF measurement present:

1. Press **Meas Setup 4** > **DTF Cable Specifications**.
2. Select **Cable Corr**
   - **Auto** Use Cable Loss and Velocity Factor values from a Cable file. See "How to Edit a Cable File" on page 72 and "How to Save or Recall a Cable" on page 72 below. This will overwrite a manually-entered value.
   - **Man** (Default setting) Manually enter a value for Cable Loss and Velocity Factor.

3. Then:
   - Velocity Factor Using the numeric keypad, enter a value between 0.01 and 1. Then press Enter.
   - Cable Loss Using the numeric keypad, enter a positive Cable Loss value in dB/m, then press Enter.

How to Edit a Cable File

The FieldFox includes many predefined cable files with the manufacturer's specifications. You can edit these files or create new cable files using the following procedure or using the FieldFox Data Link Software.

The Cable correction data survives a Mode Preset and Preset.

With a DTF measurement present:

1. Press Meas Setup 4 > DTF Cable Specifications > DTF Cable Specifications
2. Press New Cable then Yes to clear all data from the existing DTF Cable table and reset header information to default settings.
3. Then Edit Cable to open the Cable Editor.
4. Then use the ▲|▼ arrows to select a field,
   - When editing Cable Description information, press Edit then modify the selected field using the FieldFox labeler.
   - When editing Frequency/Loss pairs, enter numbers using the numeric keypad, then select a frequency suffix. Then Enter. Learn more about "How the Freq/Loss pairs are applied" on page 73 below.
5. Optionally choose from the following:
   - Previous / Next Page Quickly scrolls through pages of Freq/Loss data.
   - Add Data Add a blank Freq/Loss pair to the table,
   - Delete/Clear then:
   - Delete Row Remove the selected Freq/Loss pair from the table.
   - Clear All then Yes. Remove all Freq/Loss pairs from the table and resets header information
6. Press Done to close the Cable Editor.

How to Save or Recall a Cable

- Press Save Cable to saves your changes to the specified Storage Device. Enter a filename using the FieldFox labeler (learn more on "How to use the FieldFox labeler " on page 891). Learn more about Cable files below.

– Press **Recall Cable** to load a Cable file from the specified Storage Device

– **Storage Device** Changes the device used to save or recall Cable files. This is a different setting from the Save/Recall Storage Device setting. Choose from Internal (default setting), **USB** (must be connected) or **SD card.**

About Cable files

– Cable files are saved to, and recalled from, the **Cables** folder. If the folder does not already exist on a USB or SD card, it is created automatically before storing the file.

– Cable files are stored as *.xml files. Existing cable files that are preloaded into the FieldFox firmware can be overwritten. Your edited file will NOT be overwritten when firmware is updated.

– To **DELETE** a Cable file, use the Manage Files feature. Learn more in "Manage Files" on page 897.

How the Freq/Loss pairs are applied

When the cable file contains one Freq/Loss pair, that correction value is applied to the entire displayed frequency span.

When the cable file contains two or more Freq/Loss pairs, the Loss value that is used is interpolated from the Freq/Loss pairs and the DTF center frequency. For example, using a cable file with the following Freq/Loss pairs:

1 GHz: 0.1 dB/m

2 GHz: 0.2 dB/m

The center frequency for the measurement is determined from the calculated (Stop – Start) frequency values (seen on the second page of DTF Settings):

Calculated Start = 2.0 MHz

Calculated Stop = 3.598 GHz

Center Freq = 1.80 GHz

The Loss value for the measurement is interpolated from the Freq/Loss pairs at the Center Freq:

1 GHz = 0.1 dB/m

1.8 GHz = 0.18 dB/m

2 GHz = 0.2 dB/m

The correction for loss at 5 meters in one direction: 0.18 dB/m * 5m = 0.9 dB.

All DTF measurements correct for loss for travel down the DUT and back, so double the correction: 0.9 dB * 2 = 1.8 dB.

Window Settings

Window settings provide the ability to choose between optimizing DTF measurements for resolving closely-spaced faults or for the ability to measure low-level faults.

How to select Window settings

1. Press **Meas Setup 4** > **Settings**
2. Then press ▲|▼ arrows to move to the Window row.
3. Then press **Edit**.
4. Then press **Window** and choose from the following:
   - **Maximum** **(Maximum – Optimized for dynamic range)** the noise floor is lowered to provide the ability to measure low-level responses. (Default setting)
   - **Medium** – Compromise between Minimum and Maximum window settings.
   - **Minimum** – Best Response Resolution, providing the ability to resolve between two closely-spaced responses.
5. Then press **Done Edit**.
6. Again press **Done**.

DTF Units

The DTF Units setting is available ONLY on the DTF Settings table.

By default, X-axis units for DTF measurement settings are displayed in Meters.

How to change DTF units

1. With a DTF measurement present, press **Freq/Dist**.
2. Then **More** then **Distance Unit m feet**.
3. The current selection is underlined **m (meters) Feet**.

Calculated DTF values

Press **Next Page** on the DTF Settings Table to view the following **calculated Values** noted on the FieldFox screen with c - <setting>

Start Frequency – Start frequency that is used to calculate DTF.

Stop Frequency – Stop frequency that is used to calculate DTF.

Range Resolution. Indicates the accuracy of the distance to fault measurement. For example, with range resolution of 500 mm, if the distance to fault is 10 meters, this value could be inaccurate by +/- 500 mm or between 9.5 to 10.5 meters. This value is calculated from frequency span / resolution (points).

Response Resolution, not displayed, indicates the distance that could be between two faults and still show as separate faults. Learn more in "Window Settings" on page 74.

Maximum Distance. The distance that could be viewed with the current settings. Defined by: Vf*c*Points/(2*Bandwidth) where:

- Vf = velocity factor
- c = speed of light
- Points = resolution
- Bandwidth = frequency range

Alias-free Range (On/Off)

- On = No Alias images
- Off = Alias images may appear in the response.

About Alias Faults

An alias fault is not a true device response. An alias fault appears because of the method used to convert frequency to time.

On the DTF Settings page (above) the c - Alias-free Range = Off setting indicates alias images MAY appear on the screen.

Shorter stop distances (less than 10 meters) and a higher resolution (1001 points) will be **more** likely to result in **Alias-free Range = Off.**

When the Alias-free Range = Off, the following procedure will help to determine if a response is true or an alias response:

1. **Put a marker on the response in question and note the distance to the fault.**
2. **Change the start or stop distance.**

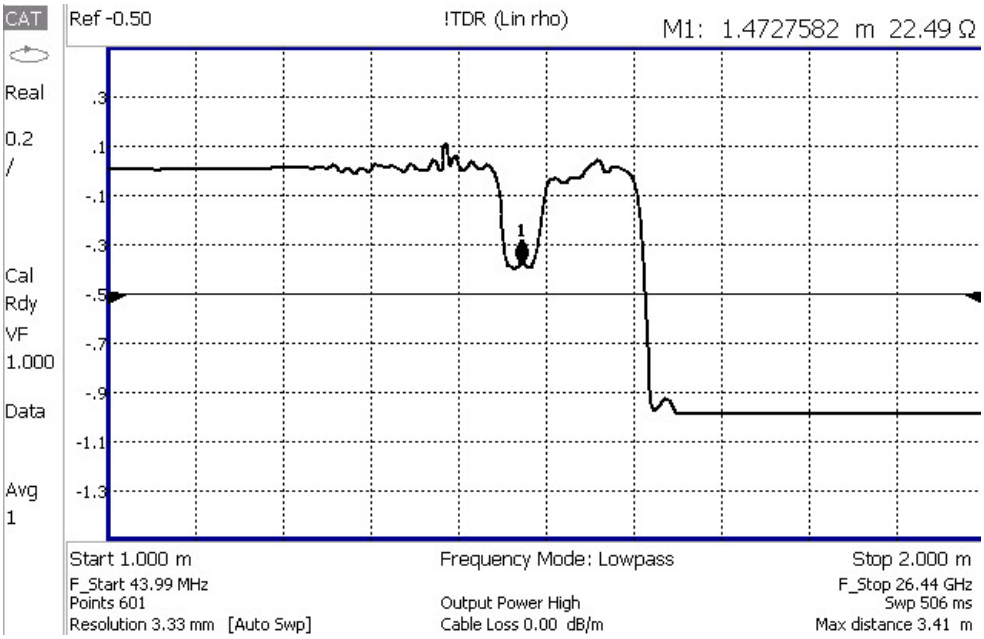
A true fault response will not move in distance. That is, if a true fault is present at 10.3 meters, changing the stop distance from 15 m to 20 m will not move the fault; the fault will remain at 10.3 meters. However, an alias response will appear to move.

An unterminated cable (with NO perfect load at the end) will show faults that appear to be beyond the end of the cable. These are NOT alias faults. These faults appear as the signal reflects off the open at the end of the cable and travels back down the cable toward the connection at the FieldFox.

Re-reflections are measured at the FieldFox as mirror images of the original faults. The largest fault is the open end of the cable. To avoid confusion, set the Stop distance shortly after that fault.

5 TDR (Time Domain Reflectometry) - Option 215

CAT Mode **Time Domain Reflectometry (TDR)** measurements are generally used to locate problems, and identify the type of problem, in a length of cable or transmission line.



Settings that are NOT unique to TDR measurements are documented in Chapter 3, "CAT (Cable and Antenna Test) Mode", on page 51.

In this chapter, the cable to be tested is referred to as the DUT (Device Under Test).

In this Chapter

"TDR Measurement (Format)" on page 80

"TDR Settings Table" on page 80

"TDR Start and Stop Distance" on page 81

"TDR Sweep" on page 81

"Frequency Mode" on page 82

"Cable (Correction) Specifications" on page 83

"Window Settings" on page 86

"TDR Units" on page 87

"Calculated TDR values" on page 87

"About Alias Faults" on page 88

"How to Prevent Undersampling" on page 89

Optional Settings

"All about Markers" on page 797

"All about Limit Lines" on page 812

"Saving and Recalling Files" on page 888

Trace Math is NOT available in DTF Measurements.

How to Make TDR Measurements

Before starting, you may need the following:

- Jumper cable or adapter to connect the beginning of the DUT to the FieldFox.
- LOAD with correct connector type and gender to terminate the end of the DUT (if possible).
- The known length and cable type of the DUT. If the cable type is not known, then the Cable Loss (dB/Meter) and Velocity Factor of the DUT are required.

1. Connect any necessary jumper cable or adapter to the FieldFox RF OUT port. Do NOT connect the DUT.
2. Press **Preset** then **Preset** to return the FieldFox to the default settings.
3. Then **Mode** then **CAT/TDR**.
4. Then **Meas 1** then **More** then **DTF (Lin)** or **TDR (Lin rho)** or **(ohm)**.
5. Press **Freq/Dist**, then **Stop Distance** and enter the length of the DUT. You can optionally set the **Start Distance**
6. Press **Cal 5** and follow the Cal prompts. Learn all about Calibration in "How to Perform a Calibration" on page 130.
7. Disconnect any components or antenna that should NOT be measured and connect a LOAD at the end of the DUT.
8. Press **Meas Setup 4** then **DTF Cable Specifications**.
9. Either press **Edit/Save/Recall Cables** then **Recall Cable**, or directly enter the Velocity Factor/Cable Loss of the DUT using the **Velocity Factor** and **Cable Loss** keys.
10. Connect the start end of the DUT to the FieldFox.
11. Press **Meas Setup 4** then **Settings** then **Next Page**. If the **Alias-free Range** setting is **Off**, then you may see Alias faults on the screen. Learn more in "About Alias Faults" on page 88

TDR Measurement Settings

Select CAT Mode, then TDR before making any setting in this chapter.

How to select CAT Mode

- Press **Mode**.
- Then **CAT/TDR**.

TDR Measurement (Format)

You can select from 3 different TDR Formats.

- Press **Measure 1**
- Then **More**.
- Then choose from:
  - **TDR (Lin rho)** The Y-axis of the display is linear, real, unitless values. A trace without reflections shows as 0 (zero). Maximum reflections from an open or short show as 1.
  - **TDR (ohm)** The Y-axis of the display is impedance (ohms).m
  - **DTF (Lin)** The Y-axis of the display is linear, real, unitless values. X-Axis displays distance to fault in meters.
  - TDR & DTF TDR and DTF are displayed.

TDR Settings Table

You can set and view all of the TDR settings, including some calculated values, on the TDR Settings table. Learn more in “Calculated TDR values” on page 87.

How to make settings on the TDR settings table

- Press **Meas Setup 4**.
- Then **Settings**.
- Press **Next Page** and **Previous Page** to view all settings.
- To change a setting:
  - Use the ▲|▼ arrows or rotary knob to highlight a setting.
  - Numeric settings can be changed by pressing numbers using the numeric keypad. Then press Enter or select a suffix if available.
  - Other settings require you to press **Edit**, then press a softkey to change the value.
  - When finished changing a value, press **Done Edit**.

– Press **Dock Window** to relocate the Settings table to a position relative to the trace window. The setting persists through a Preset. Choose from the following:

  – **Full (Default setting)** Only the Settings table is shown on the screen. The trace window is temporarily not shown.

  – **Left** The Settings table is shown to the left of the trace window.

  – **Bottom** The Settings table is shown below the trace window.

– When finished changing ALL settings, press **Done** to save your settings.

The following TDR settings are available ONLY on the settings table:

Mkr Format – The format of marker readout. Choose from:

– **Z Magnitude** – Impedance (magnitude only)

– **Default** – The current TDR measurement format.

Auto: Max Freq – When TDR Sweep is set to Auto, this is the maximum stop frequency of the measurement. The minimum value of this setting is 100 MHz.

TDR Start and Stop Distance

In TDR measurements, you set the physical length of the DUT. The FieldFox calculates the frequency range of the measurement from this distance. The longer the DUT, the lower the frequencies that are used.

You can NOT set the frequencies manually in TDR. However, you CAN limit the maximum frequency using the TDR Sweep setting. Learn more in "TDR Sweep" on page 81.

How to set Start and Stop Distance

– With a TDR measurement present, press **Freq/Dist**.

– Then choose from the following:

  – **Start Distance** Enter a value using the numeric keypad, the ▲|▼ arrows, or the rotary knob, then **Enter**. By default, the Start Distance is set to **0** Meters. This means that the measurement will display faults starting at the point at which calibration standards are connected.

  – **Stop Distance** Enter a value between the start distance and **5 km** (or 16,404 ft.) using the numeric keypad, the ▲|▼ arrows, or the rotary knob, then **Enter**.

TDR Sweep

This setting allows you to choose the method by which the Stop Frequency and Resolution are set.

– Press **Sweep 3**
– Then **TDR Sweep**
– Choose one of the following:
  – **Auto** Low pass frequency settings are calculated based on the current number of points. The Stop Frequency and Resolution settings can be changed to any value.
    ––To set Stop Frequency, press **Meas 4**, then **Settings**, then scroll to Auto: Max Freq.
    ––To set Resolution, press **Sweep 3**, then **Resolution**.
  – **Cable** Provides a higher resolution measurement. Use when under-sampling is suspected. The Stop Frequency is limited to 500 MHz maximum. The Resolution is fixed to 1601.

NOTE Because of its greater measurement accuracy, **Cable** is the default setting. Refer to "Preferences" on page 850.

Frequency Mode

All TDR measurements are made with frequency settings and, using Inverse Fourier Transform (IFT), the time and distance to faults are calculated.

NOTE **The start and stop frequencies for the measurement are always annotated on the screen below the start and stop distances.**

How to set Frequency Mode

With a TDR measurement present,

– Press **Meas Setup 4**
– Then **Freq Mode**
– Choose one of the following:
  – **Lowpass** The frequency range of a TDR measurement is set automatically based on the Start and Stop Distances. Use Lowpass mode when the DUT is a cable ONLY.
  – **Bandpass** This setting changes the measurement to DTF. Bandpass is NOT ALLOWED with TDR because the DC component is required for TDR measurements.

Cable (Correction) Specifications

By default, the FieldFox does NOT correct TDR measurements to account for the inherent loss of a cable. However, to make more accurate TDR measurements, the Cable Loss and Velocity Factor values should be considered.

NOTE

The following describes Coax Media type. Waveguide Media can NOT be measured with TDR as waveguide is inherently a high pass device.

About Velocity Factor and Cable Loss

- Velocity Factor is a property of the physical material of a cable. A VF of 1.0 corresponds to the speed of light in a vacuum, or the fastest VF possible. A polyethylene dielectric cable has VF = 0.66 and a cable with PTFE dielectric has VF = 0.7.
- Cable Loss is specified in dB/meter. In addition to the length of the cable, loss is also directly proportional to the frequency of the signal that passes through the cable.

The following is an example showing how DTF cable correction works:

The DUT is a 100 meter transmission cable. The Cable Loss value is 0.1 dB/meter. This means that a signal traveling ONE WAY through the cable will lose 10 dB of power (100 m * 1dB/m). Because the FieldFox performs this measurement with 1 port, the test signal travels down the cable and then back, for a total loss of 20 dB.

After a calibration has been performed, for the purpose of illustrating this point, connect an OPEN to the end of the cable – a maximum-sized fault - for 100% reflection of the 300 MHz test signal.

Without compensation for the loss of the cable, a –20 dB response would be visible at 100 meters, which is the OPEN at the end of the DUT. This is from 10 dB of loss through the cable in each direction.

With compensation for the loss using the manufacturer's specification, the FieldFox compensates the trace as though the signal traveling through 100 meters was increased by +20 dB. Therefore the response will show 0 dB for 100% reflection.

How to enter Cable Loss and Velocity Factor

Cable Loss and Velocity factor can be entered using one of the following methods:

- Manually enter cable loss and velocity factor for the measurement.
- Select or create a cable file which contains the cable loss and velocity factor.

With a TDR measurement present:

- Press **Meas Setup 4**.

- Then **DTF Cable Specifications**
- Select **Cable Corr**
  - **Auto** Use Cable Loss and Velocity Factor values from a Cable file. See "How to Edit, Save, and Recall a Cable File" below. This will overwrite a manually-entered value.
  - **Man** (Default setting) Manually enter a value for Cable Loss and Velocity Factor.
- Then:
  - **Velocity Factor** Using the numeric keypad, enter a value between 0.01 and 1. Then press **Enter**.
  - **Cable Loss** Using the numeric keypad, enter a positive Cable Loss value in dB/m, then press **Enter**.

How to Edit a Cable File

The FieldFox includes many predefined cable files with the manufacturer's specifications. You can edit these files or create new cable files using the following procedure or using the FieldFox Data Link Software.

The Cable correction data survives a Mode Preset and Preset.

With a TDR measurement present:

- Press **Meas Setup 4**
- Then **DTF Cable Specifications**
- Then **Edit/Save/Recall Cables**
- Press **New Cable** then **Yes** to clear all data from the existing DTF Cable table and reset header information to default settings.
- Then **Edit Cable** to open the Cable Editor.
- Then use the ▲|▼ arrows to select a field,
  - When editing Cable Description information, press **Edit** then modify the selected field using the FieldFox labeler.
  - When editing Frequency/Loss pairs, enter numbers using the numeric keypad, then select a frequency suffix. Then **Enter**. Learn more about "How the Freq/Loss pairs are applied" below.
- Optionally choose from the following:
  - **Previous / Next Page** Quickly scrolls through pages of Freq/Loss data.
  - **Add Data** Add a blank Freq/Loss pair to the table,
  - **Delete/Clear** then:
  - **Delete Row** Remove the selected Freq/Loss pair from the table.

  - **Clear All** then **Yes**. Remove all Freq/Loss pairs from the table and resets header information

- Press Done to close the Cable Editor.

How to Save or Recall a Cable

- Press **Save Cable** to save your changes to the specified Storage Device. Enter a filename using the FieldFox labeler (see "How to use the FieldFox labeler " on page 891. Learn more about Cable files below
- Press **Recall Cable** to load a Cable file from the specified Storage Device
- **Storage Device** Changes the device used to save or recall Cable files. This is a different setting from the Save/Recall Storage Device setting. Choose from Internal (default setting), **USB** (must be connected) or **SD card.**

About Cable files

- Cable files are saved to, and recalled from, the **Cables** folder. If the folder does not already exist on a USB or SD card, it is created automatically before storing the file.
- Cable files are stored as *.xml files. Existing cable files that are preloaded into the FieldFox firmware can be overwritten. Your edited file will NOT be overwritten when firmware is updated.
- To **DELETE** a Cable file, use the Manage Files feature. Learn more in "Manage Files" on page 897.

How the Freq/Loss pairs are applied

When the cable file contains one Freq/Loss pair, that correction value is applied to the entire displayed frequency span.

When the cable file contains two or more Freq/Loss pairs, the Loss value that is used is interpolated from the Freq/Loss pairs and the TDR center frequency. For example, using a cable file with the following Freq/Loss pairs:

1 GHz: 0.1 dB/m

2 GHz: 0.2 dB/m

The center frequency for the measurement is determined from the calculated (Stop – Start) frequency values (seen on the second page of TDR Settings):

Calculated Start = 2.0 MHz

Calculated Stop = 3.598 GHz

Center Freq = 1.80 GHz

The Loss value for the measurement is interpolated from the Freq/Loss pairs at the Center Freq:

1 GHz = 0.1 dB/m

1.8 GHz = 0.18 dB/m

2 GHz = 0.2 dB/m

The correction for loss at 5 meters in one direction: 0.18 dB/m * 5m = 0.9 dB.

All TDR measurements correct for loss for travel down the DUT and back, so double the correction: 0.9 dB * 2 = 1.8 dB.

Window Settings

Window settings provide the ability to choose between optimizing TDR measurements for resolving closely-spaced faults or for the ability to measure low-level faults.

How to select Window settings

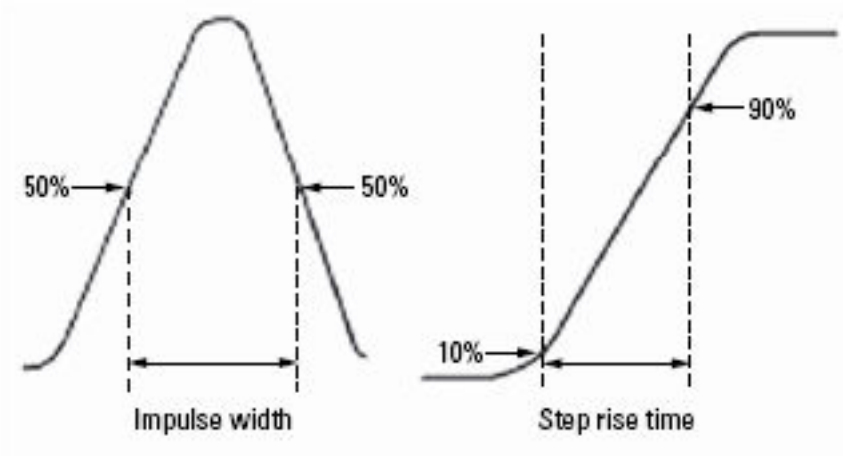
- Press **Meas Setup 4**.
- Then **Settings**.
- Then press ▲|▼ arrows to move to the Window row.
- Then press **Edit**.
- Then press **Window** and choose from the following:
  - **Maximum (Maximum – Optimized for dynamic range)** the noise floor is lowered to provide the ability to measure low-level responses. (Default setting)
  - **Medium** – Compromise between Min and Max window settings.
  - **Minimum** – Best Response Resolution, providing the ability to resolve between two closely-spaced responses.
- Then press **Done Edit**.
- Again press **Done**.

Network Analyzer Windows Frequency Span and TDR Window Selection for Step Rise Time (Approximated)

The following table shows the approximated relationship between the frequency span and the window selection for impulse width and step rise time. Refer to Figure 5-1 on page 87.

Window	Low-pass step (10% to 90%)	Low-pass impulse	Bandpass impulse
Minimum	0.45/ f span	0.60 / f span	1.20 / f span
Medium	0.99 / f span	0.98 / f span	1.95 / f span
Maximum	1.48 / f span	1.39 / f span	2.77 / f span

Figure 5-1 Network Analyzer TDR Rise Time



TDR Units

By default, X-axis units for TDR measurement settings are displayed in Meters.

How to change TDR units

- With a TDR measurement present, press **Freq/Dist**.
- Then **More** then **Distance Unit m feet**.
- The current selection is underlined **m (meters) Feet**.

The TDR Units setting is also available on the TDR Settings table.

Calculated TDR values

Press **Next Page** on the TDR Settings Table to view the following **calculated Value**s noted on the FieldFox screen with c - <setting>

Start Frequency – Start frequency that is used to calculate TDR.

Stop Frequency – Stop frequency that is used to calculate TDR.

Range Resolution. Indicates the accuracy of the distance to fault measurement. For example, with range resolution of 500 mm, if the distance to fault is 10 meters, this value could be inaccurate by +/- 500 mm or between 9.5 to 10.5 meters. This value is calculated from frequency span / resolution (points).

Response Resolution, not displayed, indicates the distance that could be between two faults and still show as separate faults. Learn more in Window Settings in "Window Settings" on page 86.

Maximum Distance. The distance that could be viewed with the current settings. Defined by: Vf*c*Points/(2*Bandwidth) where:

- Vf = velocity factor
- c = speed of light
- Points = resolution
- Bandwidth = frequency range

Alias-free Range (On/Off)

- On = No Alias images
- Off = Alias images may appear in the response.

About Alias Faults

An alias fault is not a true device response. An alias fault appears because of the method used to convert frequency to time.

On the TDR Settings page (above) the **c - Alias-free Range = Off** setting indicates alias images MAY appear on the screen.

Shorter stop distances (less than 10 meters) and a higher resolution (1001 points) will be more likely to result in **Alias-free Range = Off**.

When the Alias-free Range = Off, the following procedure will help to determine if a response is true or an alias response:

1. **Put a marker on the response in question and note the distance to the fault.**
2. **Change the start or stop distance.**

A true fault response will not move in distance. That is, if a true fault is present at 10.3 meters, changing the stop distance from 15 m to 20 m will not move the fault; the fault will remain at 10.3 meters. However, an alias response will appear to move.

An un-terminated cable (with NO perfect load at the end) will show faults that appear to be beyond the end of the cable. These are NOT alias faults. These faults appear as the signal reflects off the open at the end of the cable and travels back down the cable toward the connection at the FieldFox. Re-reflections are measured at the FieldFox as mirror images of the original faults. The largest fault is the open end of the cable. To avoid confusion, set the Stop distance shortly after that fault.

How to Prevent Undersampling

Undersampling is when the TDR measurement is inaccurate because the frequency step size (resolution) is too large. The predominant symptom of this is when the measured impedance is incorrect. For example, when measuring a 75Ω cable, a marker that is on a part of the trace without reflections shows 56Ω.

To prevent undersampling, set **TDR Sweep** to **Cable**. If undersampling still occurs, set **TDR Sweep** to **Auto**. Then set **Auto Max Frequency** to a lower value. Manually increase the Resolution so that the Start Frequency setting is less than about 500 kHz.

6 NA (Network Analyzer) Mode

Learn more about NA Mode measurements in the FieldFox Supplemental Online Help: https://rfmw.em.keysight.com/wireless/helpfiles/FieldFoxOnlineSupplementalHelp/Home.htm.

In this Chapter

"About S-parameters" on page 93
"Mixed-Mode S-Parameters" on page 94
"Parameter Conversion" on page 95
"Receiver Measurements" on page 96
"Multi-Trace Configurations" on page 97
"Quick Settings Table" on page 98
"Calibration Settings" on page 99
"Format" on page 100
"Frequency Range" on page 101
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"Magnitude Offset" on page 102
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"Averaging" on page 104
"IF Bandwidth" on page 105
"Smoothing" on page 105
"Single or Continuous Measure" on page 105
"Resolution (Number of Data Points)" on page 106
"Sweep Time" on page 106
"Triggering (NA)" on page 107

"Output Power" on page 109

"System Impedance (Z0)" on page 110

"Port Extensions" on page 110

"Velocity Factor" on page 111

"Increase Dynamic Range" on page 114

See Also

"Why and When to Calibrate" on page 129

"All about Markers" on page 797

"All about Limit Lines" on page 812

"All about Trace Math" on page 829

Learn how to make 75Ω (ohm) Measurements in the Supplemental Online Help:
https://rfmw.em.keysight.com/wireless/helpfiles/FieldFoxOnlineSupplementalHelp/Home.htm.

NA Mode Settings

Select NA Mode before making any setting in this chapter.

How to select NA Mode

1. Press **Mode**.
2. Then **NA**.

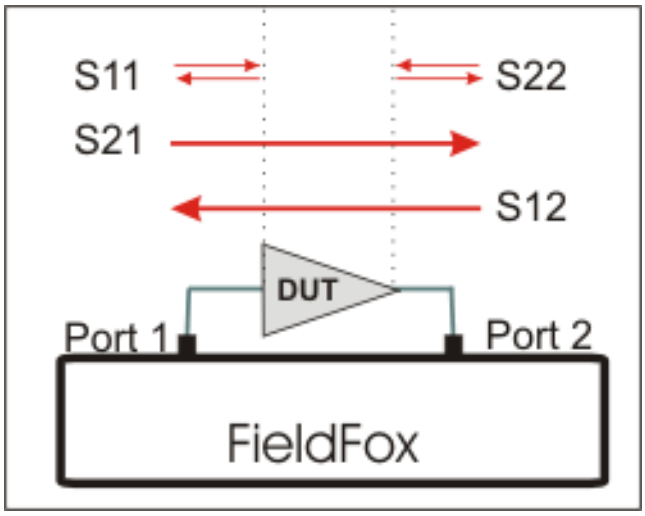
About S-parameters

S-parameters (scattering parameters) are used to describe the way a device modifies a signal. The FieldFox can measure **four S-parameters**. The syntax for each parameter is described by the following:

S22 | S11 (out | in)

out = FieldFox receiver port

in = FieldFox source port



The FieldFox automatically switches the internal source and receivers to make both forward and reverse measurements. Therefore, the FieldFox can measure all four S-parameters with a single connection.

When the source comes from port 1, the measurement is said to be in the forward direction.

When the source comes from port 2, the measurement is said to be in the reverse direction.

S11 and S22 reflection measurements are used to measure the amount of reflections off the corresponding DUT port. Low reflections means there is a good impedance match between the source and DUT.

S21 and S12 transmission measurements are used to measure the loss or gain through a DUT over a specified frequency range. Both ends of the DUT must be connected to the FieldFox. The FieldFox signal source is transmitted out one of the test port connectors, through the DUT, and into the other test port connector

How to measure S-parameters

1. Press **Preset** then **Mode Preset (Factory)**
2. Press **Measure 1** then choose from the following:
   - **S11** Reflection measurement at port 1.
   - **S21** Forward 2-port transmission measurement.
   - **S12** Reverse 2-port transmission measurement. May require an option.
   - **S22** Reflection measurement at port 2. May require an option.

OR select a multi-trace configuration. Learn more on "Multi-Trace Configurations" on page 97.

3. Press **Freq/Dist** then either **Start** and **Stop** or **Center** and **Span** to enter a Frequency Range for the measurement.
4. Press **BW 2** then **IFBW** to select the IF Bandwidth for the measurement. Narrower bandwidths require more time to sweep, but lowers trace noise.
5. Press **Sweep 3** then **Resolution** to select the number of data points for the measurement. More data points require more time to sweep.
6. Press **Cal 5** to calibrate the measurement. Learn more in "How to Perform a Calibration" on page 130.
7. All other settings can be made AFTER calibration without compromising measurement accuracy.

Mixed-Mode S-Parameters

In NA Mode ONLY, mixed-mode S-parameters (also known as Balanced measurements) are available with Option 212.

Because the FieldFox has only two test ports, only reflection measurements are available. Connect the balanced input or output of your DUT to the FieldFox ports 1 and 2

For highest accuracy, a Full 2-port calibration is required.

All FieldFox settings and features are supported (except Parameter Conversion) with mixed-mode S-parameters.

NOTE

Learn more about Balanced Measurements with the FieldFox in the FieldFox Supplemental Online Help: https://rfmw.em.keysight.com/wireless/helpfiles/FieldFoxOnlineSupplementalHelp/Home.htm.

How to make mixed-mode S-parameter measurements

1. Press **Measure 1**.
2. Then **More**.
3. Then choose from the following:
   - **Scc11** Common reflect/common incident for logical port 1.
   - **Sdd11** Differential reflect/differential incident for logical port 1.
   - **Sdc11** Differential reflect/common incident for logical port 1.
   - **Scd11** Common reflect/differential incident for logical port 1.

To make balanced reflection measurements at the DUT output, connect the DUT output to the FieldFox ports.

Parameter Conversion

In NA Mode ONLY, converts the active S-parameter trace to an equivalent impedance (Z), admittance (Y), or reciprocal 1/S-parameter

How to select parameter conversions

- Press **Measure 1**
- Then select an S-parameter
- Then **More**
- Then **Conversion**
- Then choose from the following:
  - **Off** (default) No conversion is performed.
  - **Z Conv** or **Y Conv** Perform conversion for impedance (Z) or admittance (Y). Then choose from the following for either:
    - **Auto** The displayed S-parameter is converted to the appropriate Z or Y parameter: Refl for S11 and S22; Trans for S21 and S12. When the S-parameter is changed, the appropriate conversion changes automatically.
    - **Refl** The displayed S-parameter is converted to Z or Y reflection, regardless of whether the S-parameter is reflection (S11 or S22) or transmission (S21 or S12).

——**Trans** The displayed S-parameter is converted to Z or Y transmission, regardless of whether the S-parameter is reflection (S11 or S22) or transmission (S21 or S12).

– **1/S** The displayed S-parameter is converted to 1/S-parameter.

Receiver Measurements

In NA Mode ONLY, you can make unratioed, uncorrected receiver measurements. These measurements are typically used as diagnostic tools for service personnel.

NOTE

Receiver measurements are NOT corrected for absolute power. They are only useful for making relative measurements. The Y-Axis and markers are labeled in dB - NOT dBm. Specifically, R1 and R2, do NOT indicate the actual power levels out of the source ports.

How to make receiver measurements

– Press **Measure 1**

– Then **More**, then **Advanced**

– Then choose from the following:

A Port-1 test port (*1)	**B** Port-2 test port (*2)
R1 Port-1 reference receiver (*1)	**R2** Port-2 reference receiver (*2)
(*) indicates the Auto-selected source port for the measurement	

Source Port The FieldFox port to provide the source signal. Choose from the following:

—**Auto** The FieldFox sets the source port based on the selected receiver.

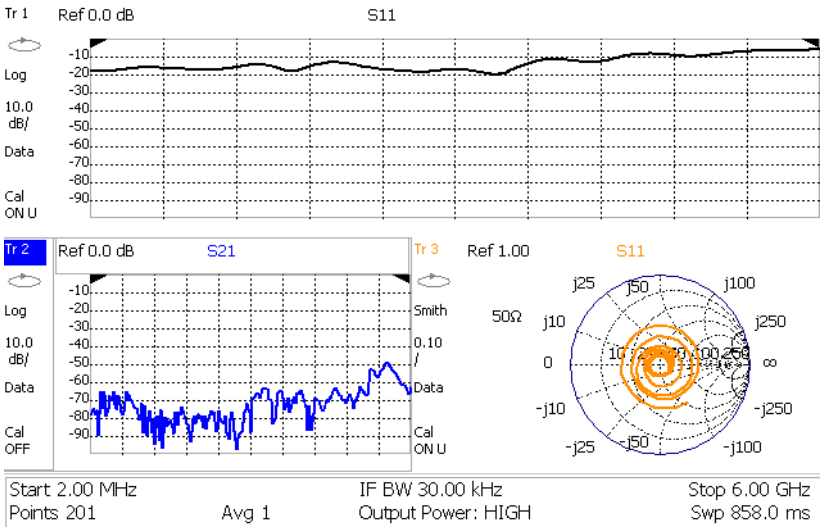
—**Port 1** Select when measuring transmission at B receiver.

—**Port 2** Select when measuring reverse transmission at A receiver.

Learn more about Raw Receiver Measurements at the FieldFox Supplemental Online Help:
https://rfmw.em.keysight.com/wireless/helpfiles/FieldFoxOnlineSupplementalHelp/Home.htm.

Multi-Trace Configurations

In NA Mode you can display multiple traces on the FieldFox screen.



The graphic above shows a x3H configuration. Tr2 is the ACTIVE trace as indicated by the highlighted Tr2.

Trace Setting Notes

- The Frequency Range, IF BW, Resolution, Average, and Output Power settings are common for all displayed traces.
- All other trace settings, such as measurement, format, and limit lines, are applied individually to the ACTIVE trace in the same manner as when a single trace is present.

NOTE

IMPORTANT! For CAT and NA modes, limit lines do not apply where F1 = F2.

- By default, a marker is created on ALL traces. However, they can be created individually by disabling Coupled Markers. Learn more in “Coupled Markers (NA Mode)” on page 800.

How to select a multi-trace configuration

1. Press **Trace 6** > **Num of Traces**
2. Then choose from the following:
   The default measurements depend on the options that are installed

	x1	1 trace standard configuration
	x2	2 traces overlayed on a single graticule
	x2H	2 traces on separate graticules
	x3H	3 traces on separate graticules
	x3	3 traces overlayed on a single graticule
	x4	4 traces overlayed on a single graticule
	x4H	4 traces on separate graticules

How to activate a trace in order to change a setting

– Use the ▲|▼ arrows **OR**

– Press **Trace 6** then select **Trace 1**, **Trace 2**, **Trace 3**, or **Trace 4**, Only traces that are shown can be activated.

How to maximize the viewing of the active trace

1. Press **System 7** > **Full Screen**.
2. Press any key to return to the standard display.

Quick Settings Table

Both CAT and NA Modes allow you to view and change most relevant settings from a single location. All of these settings are discussed in this chapter and, unless otherwise noted, ALL of these settings can also be made using the standard softkey menus.

How to view and change Quick Settings

- Press **Meas Setup 4** > **Settings**.
- Press **Next Page** and **Previous Page** to view all settings. If these softkeys are NOT available, then all available settings fit on one page.
- To change a setting:
  - Use the ▲|▼ arrows to highlight a setting.
  - Then press **Edit**. The current setting changes to **yellow**.
  - Some settings require you to press a softkey to change the value.

    Otherwise, use the numeric keypad, ▲|▼ arrows, or rotary knob to change the value.
  - When finished changing a value, press **Done Edit**.
- Press **Dock Window** to relocate the Settings table to a position relative to the trace window. The Dock Window setting persists through a Preset. Choose from the following:
  - **Full (Default setting)** Only the Settings table is shown on the screen. The trace window is temporarily not shown.
  - **Left** The Settings table is shown to the left of the trace window.
  - **Bottom** The Settings table is shown below the trace window.

  When finished changing ALL settings, press **Done** to save your settings.

Calibration Settings

NA Mode has a page specifically for making settings that pertain to Port Extensions, including Velocity Factor and Media Type.

Learn more in "Port Extensions" on page 110.

Learn more about Media Type in "Waveguide Calibrations" on page 143.

See also, Chapter 8 "Calibration for NA, CAT, and VVM Modes" and to "Apply Nearest (NA Mode Only)" on page 147.

How to view and change Calibration Settings

- Press **Meas Setup 4**.
- Then **Calibration Settings**
- Make these settings in the same manner as Quick Settings in the previous section.

Format

Select the display format in which to present measurement results. This setting can be changed at any time without affecting calibration accuracy.

NOTE

Learn more about Display Formats in the FieldFox Supplemental Online Help: https://rfmw.em.keysight.com/wireless/helpfiles/FieldFoxOnlineSupplementalHelp/Home.htm.

The marker on screen readout can be changed to formats other than the display format. Learn more in "Marker Format" on page 802.

How to select a NA Format

1. Press **Measure 1** > **Format [current setting]**.
2. Then choose from the following:
   - **Log Magnitude** Displays magnitude in dB
   - **Linear** Displays positive values only. Y-axis: Unitless (U) for ratioed measurements; Watts (W) for unratioed measurements.
   - **VSWR** Used mainly for S11 and S22. Displays unitless reflection data.
   - **Phase** Displays phase in degrees. The trace 'wraps' every 360 degrees, from +180 to –180, for easy scaling.
   - **Smith** Used mainly for S11 and S22, which are plotted on a Smith Chart. Displays series resistance and reactance.
   - **More** then...
   - **Polar** Used mainly for S11 and S22. Displays magnitude and phase of the reflection coefficient.
   - **Group Delay** Used mainly for S21 and S12. Displays signal transmission (propagation) time through a device in seconds. The Group Delay aperture is the current Smoothing aperture. Default is 1.5% of the X-axis.
     - Learn how to set Smoothing aperture on "Smoothing" on page 105.
     - Learn more about Group Delay measurements at the FieldFox Supplemental Online Help: https://rfmw.em.keysight.com/wireless/helpfiles/FieldFoxOnlineSupplementalHelp/Home.htm.
   - **Real** Displays only the real (resistive) portion of the measured complex data. The Y-axis is Unitless. Often used for Time Domain measurements.

- **Imaginary** Displays only the reactive portion of the measured complex data. The Y-axis is Unitless.
- **Z Magnitude** Displays the effective impedance in ohms.
- **Unwrap Phase** Same as Phase, but without 180 degree wrapping.

NOTE

Phase is unwrapped by comparing the phase from one data point to the next. If the phase difference between two data points is greater than 180 degrees, or if the phase of the first data point is greater than 180 degrees from DC, than the phase measurement is probably NOT accurate. To ensure that the phase measurement is accurate, increase the resolution setting. When making a narrow band measurement, reduce the start frequency for the unwrapped phase measurement to ensure the first data point is less than 180 degrees from DC.

Frequency Range

Set the range of frequencies over which you would like to make measurements.

When the frequency range is changed after a calibration is performed, the calibration becomes interpolated. Learn more in "Interpolation *" on page 145.

How to set Frequency Range

This can be done in two ways:

- Press **Freq/Dist**
- Then choose from the following:
  - **Start** and **Stop** frequencies – Specify the beginning and end of the sweep.
  - **Center** and **Span** frequencies - Specify the center frequency and span of frequencies (half on either side of center).
- Follow each by entering a value using the numeric keypad, the ▲|▼ arrows, or the rotary knob.
- After using the ▲|▼ arrows or the rotary knob, press **Enter**. The increment setting of the arrows is based on the current span and can NOT be changed in NA Mode.
- After using the keypad, select a multiplier key. Learn more in "Multiplier Abbreviations" on page 48.

Scale Settings

Adjust the Y-axis scale to see the relevant portions of the data trace. The Y-axis is divided into 10 graticules.

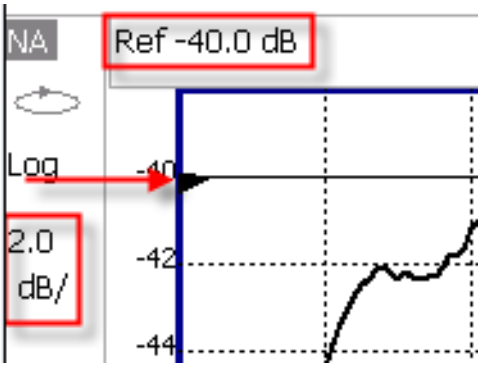
This setting can be changed at any time without affecting calibration accuracy.

How to set Scale

1. Press **Scale / Amptd**.
2. Then choose from the following methods:
   - **Autoscale** Automatically adjusts the Y-axis to comfortably fit the Minimum and Maximum amplitude of the trace on the screen.
   - **Autoscale All** Autoscales all of the traces on the screen, useful only for multi-trace configurations.
   - Set Scale, acquisition, and Reference Position
     - **Scale** Manually enter a scale per division to view specific areas of the trace.
     - **Ref Level** Manually set the value of the reference line. Enter a negative value by pressing **Run/Hold (+/-)** either before or after typing a value.
     - **Ref Pos** Manually set the position of the reference line. Values must be between 0 (TOP line) and 10 (BOTTOM line)

Scale annotation on the FieldFox screen

–**Reference Line = red arrow**
–**Ref Level = –40 dB**
–**Ref Position = 1**
–**Scale = 2 dB per division**



Magnitude Offset

Magnitude Offset allows you to offset the magnitude (not phase) data by a fixed and/ or sloped value in dB. If the display format is Linear Magnitude or Real (unitless), the conversion from dB is performed and the correct amount of offset is implemented.

The Magnitude offset setting affects only the active trace.

How to set Magnitude Offset

1. Press **Scale / Amptd**
2. Then **More**

- Then **Magnitude Offset** - Offsets the entire data trace by the specified value.
  - Then enter a positive or negative offset value in dB using the numeric keypad, the ▲|▼ arrows, or the rotary knob. Press a multiplier key. Learn about multiplier abbreviations.
- And/or press **Slope** - Offsets the data trace by a value that changes linearly with frequency. The offset slope begins at 0 Hz. and continues to the stop frequency. The offset value at the start frequency is then calculated from 0 Hz.
  - Then enter a positive or negative offset slope value in dB/GHz using the numeric keypad, the ▲|▼ arrows, or the rotary knob. Press a multiplier key. Learn about multiplier abbreviations in "Multiplier Abbreviations" on page 48.

Electrical Delay

Electrical delay is a mathematical function that simulates a variable length of lossless transmission line. Use the electrical delay feature to compensate for the linear phase shift through a device and view only the deviation from linear phase of the device.

You can set the electrical delay independently for each measurement trace. To apply an electrical delay to all measurement traces, use Port Extensions. Learn how in "Port Extensions" on page 110.

Learn how to set Phase formats in "Phase Offset" on page 103.

How to set Electrical Delay

1. Press **Scale / Amptd** > **More** > **Electrical Delay**
2. Enter a time value using the numeric keypad, the ▲|▼ arrows, or the rotary knob.
3. Press a multiplier key. Learn about multiplier abbreviations in "Multiplier Abbreviations" on page 48.

Electrical Delay can also be set using the **Mkr->Delay** feature. Learn how on "Marker Functions" on page 810.

Phase Offset

Phase offset mathematically adjusts the phase measurement by a specified amount, up to 360°. Use this feature in the following ways:

Improve the display of a phase measurement. This is similar to the way you would change the acquisition in an amplitude measurement. Change the phase response to center or the response on the screen.

Emulate a projected phase shift in your measurement. For example, if you know that you need to add a cable and that the length of that cable will add a certain phase shift to your measurement, you can use phase offset to add that amount and simulate the complete device measurement.

You can set the phase offset independently for each measurement trace.

How to set Phase Offset

1. Press Scale / Amptd > More > Phase Offset
2. Enter a value in degrees using the numeric keypad, the ▲|▼ arrows, or the rotary knob. Press Enter.

Averaging

Averaging helps to reduce the effects of random noise on a measurement. You specify the number of measurements to be averaged. The more measurements averaged, the greater the amount of noise reduction. An average counter is shown in the left edge of the screen as Avg <n> where <n> is the number of measurements that are averaged.

Averaging can be set before or after calibration. When set before calibration, each calibration standard is measured <n> times and averaged. More time is needed to perform the calibration, but there will be less noise in the resulting error terms which means that subsequent measurements will also have less noise. In addition, noise is further reduced by continuing to average after calibration.

How to set Averaging

1. Press BW 2.
2. Then Average <n> where <n> is the number of measurements to average.
3. Enter a value using the numeric keypad. Enter 1 for NO averaging.
4. Press Enter.
5. Then Average Mode Choose from the following:
   - **Sweep** - Each data point is based on the average of the same data point being measured over <n> consecutive sweeps. The average counter shows the number of previous sweeps that have been averaged together to form the current trace. When the counter reaches the specified count, then a 'running average' of the last <n> sweeps is displayed.
   - **Point** - Each data point is measured <n> times and averaged before going to the next data point. On subsequent sweeps, averaging restarts by measuring each data point again <n> times. The average counter is not updated because data is not displayed until all the averages have been applied.

– **Point averaging is usually faster than sweep averaging.** However, you may need to increase the Point Average count to obtain the same level of noise reduction as with sweep averaging.

6. While averaging is in process, press **Sweep 3** then **Restart** to restart the averaging at 1.

IF Bandwidth

The FieldFox converts the received signal from its source to a lower intermediate frequency (IF). The bandwidth of the IF bandpass filter is adjustable. Reducing the IF receiver bandwidth reduces the effect of random noise on a measurement. However, narrower IF bandwidths cause longer sweep times.

How to set IF BW

1. Press **BW 2** > **IF BW**
2. Then choose from the following:

– **10 Hz** | **100 Hz** | **1 kHz** | **10 kHz** | **100 kHz**
More **30 Hz** | **300 Hz** | **3 kHz** | **30 kHz**

Smoothing

Trace smoothing averages a number of **adjacent** data points to smooth the peak-to-peak noise values on a displayed trace. The number of adjacent data points that are averaged is known as the smoothing aperture. Aperture is set by specifying a percentage of the X-axis span.

Trace smoothing does NOT significantly increase measurement time.

Smoothing is used in Group Delay measurements, although it can be used with any NA formatEXCEPT Polar or Smith Chart. Learn more about NA Mode formats, including Group Delay, in “Format” on page 100.

When enabled, Smo appears on the FieldFox screen.

How to set Smoothing

1. **Press BW 2** > **Smoothing ON OFF**
2. Then **Sm. Aperture** and enter a value between 0 and 25 (percent) using the numeric keypad.
3. Press **Enter**

Single or Continuous Measure

This setting determines whether the FieldFox sweeps continuously or only once each time the **Single** button is pressed. Use Single to conserve battery power or to allow you to save or analyze a specific measurement trace.

This setting can be changed at any time without affecting calibration accuracy.

How to set Single or Continuous

1. Press **Sweep 3**.
2. Then choose one of the following:
   - **Single** Automatically sets Continuous OFF and causes FieldFox to make ONE sweep, then hold for the next Single key press. Hold is annotated in the upper left corner of the display when NOT sweeping, and changes to an arrow --> while the sweep occurs.
   - **Continuous** Makes continuous sweeps. This is the typical setting when battery power is not critical.
   - You can also use **Run / Hold +/-** to toggle between Single and Continuous.

Resolution (Number of Data Points)

Data points are individual measurements that are made and plotted across the X-axis to form a trace. Select more data points to increase measurement resolution. However, more data points also takes more time to complete an entire measurement sweep.

When the Resolution is changed after a calibration is performed, the cal becomes interpolated. Learn more in "Interpolation *" on page 145.

How to set Resolution

1. Press **Sweep 3** > **Resolution**.
2. Then choose from the following:
   101 | **201** | **401** | **601** | **801** | **1001** | **1601** | **4001** | **10001**.

Using SCPI, or measurement quick settings table, Resolution can be set to ANY number of points between 3 and 10001. See the Programming Guide Help: https://www.keysight.com/us/en/lib/resources/service-manuals/keysight-fieldfox-library-help-and-manuals-2153870.html. Learn more, "Quick Settings Table" on page 98.

Sweep Time

The fastest possible sweep time is always used as the default setting. Use the Min Swp Time setting to slow the sweep time when measuring long lengths of cable. Learn more at the FieldFox Supplemental Online Help: https://rfmw.em.keysight.com/wireless/helpfiles/FieldFoxOnlineSupplementalHelp/Home.htm.

The actual sweep time is shown on the FieldFox screen. See the Screen Tour on "Screen Tour" on page 46. To increase the sweep time, enter a value that is higher than the actual sweep time. The increase will not be exactly the amount that you enter, as the actual sweep time is the composite of many factors.

NOTE

Measurement speed specifications do NOT apply in Temperature Control Mode. Learn more in "Temperature Control Mode" on page 35.

How to set Sweep Time

1. Press Sweep 3.
2. Then Min Swp Time.
3. Enter a value using the numeric keypad.
4. Press a multiplier key. Learn about multiplier abbreviations in "Multiplier Abbreviations" on page 48.

Triggering (NA)

External triggering (NA and SA modes ONLY) allows you to initiate a sweep when an external DC voltage is sensed at the Ref In/Trig In connector on the FieldFox top panel. See External Triggering for SA Mode in "Triggering" on page 202.

Trigger Source

1. Press Sweep 3 > Trigger > Trig Source
2. Then choose from the following:
   - Int (Internal) Sweeps are initiated by the FieldFox internal circuitry. When Sweep is set to Continuous, a new sweep begins automatically when the previous sweep ends.
   - Ext (External) A sweep is initiated on the rising or falling edge of an external TTL signal at the Ref In/Trig In connector on the FieldFox top panel.
     - When the FieldFox is armed for an external trigger signal, Wait is annotated on the display.
     - A sweep can NOT be initiated by an external signal while a sweep is in progress.
     - A sweep can NOT be initiated by an external signal when in HOLD mode. Learn more about HOLD mode in.
   - Pnt (Point) An external trigger type that acquires exactly one point per trigger input.

CAUTION

IMPORTANT!

If trigger signals come faster than the FieldFox can process them, some triggers may be ignored or lost.

NOTE

To ensure triggers are recognized and processed in order, use the external trigger output function to indicate when the FieldFox is ready for another input trigger. Alternatively, slow the external triggers coming in from external equipment to a rate where FieldFox does not miss a trigger.

The External Trigger output signal is only selectable when Point Mode Trigger is enabled. Not supported in other trigger modes.

External Trigger output signal is sent as soon as FieldFox has processed the last trigger signal that was detected.

As each point is acquired, the data will show up on screen. If a trigger has not been detected, a yellow Wait indicator will show on the sweep status icon area.

– When the FieldFox is armed for an external trigger signal, Wait is annotated on the display.

——A sweep can NOT be initiated by an external signal when in HOLD mode. Learn more about HOLD mode in.

Error Handling and Recovery

– Point Mode trigger is not compatible with sweep setups that require forward and reverse sweeps such as:

  – Full 2port cal

  – Cal ready (Full 2Port)

  – Multiple displayed parameters that include the requirement for forward and reverse sweeps such as S11 and S22 together on the display

– When point mode trigger is already enabled, if conditions are changed requiring forward and reverse sweeps, an error "`Error: Point trigger not compatible with 2-port cal`." will be displayed and point mode trigger will revert to Internal trigger. This includes turning on a CAL that requires forward and reverse sweeps or displaying multiple parameters that would require forward and reverse sweeps.

– If the FieldFox is in a state requiring two sweeps and the user selects point mode triggering, an error "`Error: Point trigger not compatible with 2-port cal.`" will be displayed and point mode trigger will revert to Internal trigger.

Trigger Slope

Determines which edge of an External trigger signal initiates a sweep.

1. Press Sweep 3 > Trigger > Trig Slope
2. Then choose from the following:
   - Positive Sweep is initiated by the rising edge of signal at about 1.7V.
   - Negative Sweep is initiated by the falling edge of signal at about 1.0V.

Output Power

Set the power level out of the FieldFox to High, Low, or manually set power level to a value between High and Low.

Generally, the high power setting is used when measuring passive, high-loss devices to place the signal farther from the noise floor. However, for devices that are sensitive to high power levels such as amplifiers, use the Low power setting.

For best measurement accuracy, use the Manual power setting at -15 dBm. After calibration, the power level can be decreased for amplifiers, or increased for higher dynamic range.

CAUTION Power Level settings in this mode will NOT change Power Level settings in other modes. To help prevent damage to your DUT, use caution when changing modes with your DUT connected to the FieldFox test ports.

How to set Output Power

1. Press Meas Setup 4.
2. Then Output Power
   - **High** Sets output power to the maximum achievable power at all displayed frequencies. Output power is NOT FLAT across the displayed FieldFox frequency span. Please see "Specifications/Data Sheet" on page 941 for expected power levels.
   - **Low** Sets output power to approximately –50 dBm, FLAT across the displayed FieldFox frequency span.
   - **Man** (default setting at -15 dBm) Set output power to an arbitrary value, FLAT across the displayed FieldFox frequency span. If flattened power can NOT be achieved, a warning message and beep occurs. To achieve a flattened output power, reduce the power level or stop frequency.
     a. Then press Power Level

b. Then enter a value using the numeric keypad, the ▲|▼ arrows, or the rotary knob.

c. Press **Enter**.

System Impedance (Z0)

To accurately view data presented in Smith Chart format, first set the System Impedance.

Learn how to select Smith Chart format in "Format" on page 100.

Learn how to make 75Ω measurements at the FieldFox Supplemental Online Help:
https://rfmw.em.keysight.com/wireless/helpfiles/FieldFoxOnlineSupplementalHelp/Home.htm.

How to set System Impedance

1. Press **Meas Setup 4** > **Settings**.
2. Then scroll to System **Z0** and press **Edit**
3. Then type either **50** or **75** and press **Enter**

Port Extensions

Port extensions allow you to electrically move the calibration reference plane on either port 1 or port 2 after you have performed a calibration.

Why use Port Extensions

Use port extensions if you are unable to perform a calibration directly at your device because the location is not accessible. Perform a calibration at a convenient place, then use port extensions to compensate for the time delay (phase shift) to the desired reference plane. On the FieldFox, port extensions does not compensate for the loss of the additional electrical length, nor any mismatch errors beyond the calibration reference plane.

Also, use port extensions if you have already performed a calibration, and then decide that you need to add a length of transmission line in the measurement configuration. Use port extensions to "tell" the FieldFox that you have added the length to a specific port.

– With S11 and S22 reflection measurements, the FieldFox doubles the port extension valued that you enter to account for the additional delay in the forward and reverse directions.

– With S21 and S12 transmission measurements, the port 1 and port 2 extensions are added together. This accounts for the total transmission delay going through ports 1 and 2.

Port extensions and Electrical Delay differ in the following ways:

– Electrical delay applies to a specific trace

– Port extensions apply to specific hardware ports

Port Extensions and Electrical Delay can be set independently. When both are set, the delay adds together. Learn more about Electrical Delay in "Electrical Delay" on page 103.

How to apply Port Extensions

1. Press **Meas Setup 4** > **Port Extensions** > **Port Extensions ON** > **Port1 Extension**

2. Then enter time value using the numeric keypad, the ▲▼ arrows, or the rotary knob. Press **Enter** or select a seconds (time) multiplier.

You can also set Port Extensions by pressing **Meas Setup 4** then **Calibration** (settings).

While setting Port Extension, the physical length of the extension, at the current Velocity Factor setting, is visible to the right (red box in above image).

Velocity Factor

The electrical delay or port extension value is entered as delay, or **electrical length**, in units of time.

Entering the velocity factor causes the FieldFox to accurately display the equivalent **physical length** in meters (NOT available in feet) that corresponds to the entered electrical delay.

Velocity factor is the ratio of the velocity of wave propagation in a coaxial cable to the velocity of wave propagation in free space. This velocity depends on the relative permittivity of the cable dielectric (er).

Velocity factor = 1/sqrt(er)

VF = 0.66 corresponds to wave propagation through a polyethylene dielectric.

VF = 1.0 (default setting) corresponds to wave propagation through free space (a vacuum).

How to set Velocity Factor

1. Press **Meas Setup 4** > **Port Extensions** > **Velocity Factor**

2. Then enter a value between 0.1 and 1 using the numeric keypad, then press **Enter**.

You can also set Velocity Factor by pressing **Meas Setup 4** then **Calibration (Settings)**.

Big Marker Display States (A and B)

This feature, available ONLY in NA Mode, allows you to view up to three Big or Super Big marker readouts. This is done by using up to two different display states called A and B. Each display state is comprised of the settings listed below. When the Big Readout setting is toggled through A and B, these display states are recalled.

How to create Big Marker Display States

To have big readouts, markers MUST be created using the following procedure.

If you have already set up your display and do not want to lose it, then save the current state to a state file. Learn how in "State Files" on page 893. The following procedure will overwrite your display state.

- Press **Mkr ->/ Tools**
- Then **Big Readout**
  - **A** or **B** - The A or B display state is recalled. If none have been defined, then the default display state is recalled.
  - **OFF** - The B display state is visible but without the Big Marker Readout.
- With A or B selected, then press **Edit Big Marker (A or B)**
- Then edit the following display state settings:
- **Num Traces** – Choose the Multi-Trace configuration x1, x2, or x3. Only Overlayed configurations are allowed. Learn more in "Multi-Trace Configurations" on page 97.
- **Font Size** – Choose either Big or Super Big. Super Big marker readout #3 will cover some of the measurement grid.
- **Trace Settings** - For each possible trace (1, 2, and 3) select from the following:
  - **Measurement** – S-parameter or Receiver measurement to display. **S11** is default. Learn more in "About S-parameters" on page 93.
  - **Meas Format** – **Log** is default. Learn more in "Format" on page 100.
  - **Bandwidth (ON)** – Marker readout for marker bandwidth search. OFF is default. Learn how to set BW parameters in "How to Search with Markers" on page 803.
- **Big Readout** - For each marker readout (1, 2, and 3), select from the following:
  - **Marker #** - Enter a number from 1 to 6 to create the marker. 1 is created by default.

—**Trace #** - The marker# is created on this trace. Tr1 is selected by default. The corresponding Num Traces must first be selected. For example, to create a marker on Trace 3, first select Num Traces = x3.

—**Format** – Format for the marker readout. Select Default to make the marker readout format the same as the display format. Default is selected by default.

— **Mkr Tracking** – ON: Select the parameter to track on the standard Marker Search menu. OFF is selected by default. When set to ON, Peak tracking is set by default. Learn about Marker Tracking in "Marker Functions" on page 810.

— **State** – Choose from Normal, Delta, or OFF. The default marker (1) is created in Normal. Learn more in "Marker Functions" on page 810.

—**Enabled** – Turns the Big Readout of the corresponding marker ON and OFF. The default marker (1) is set ON by default.

NOTE

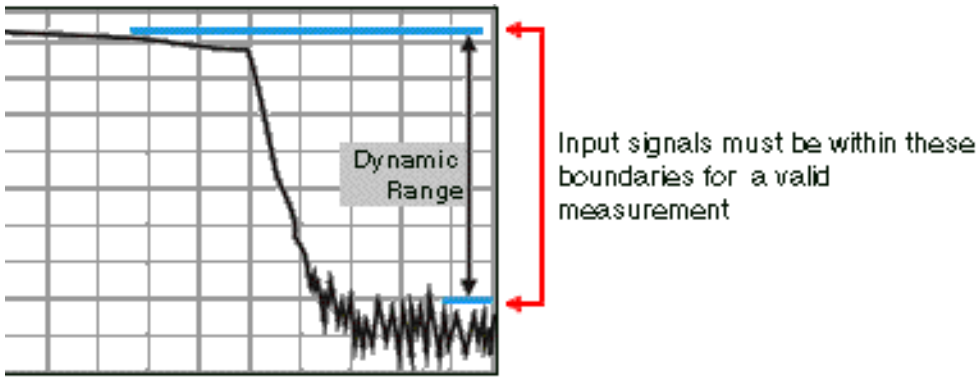
—To move a marker, press **Marker**, then **Marker**, then scroll to the marker number to be moved. The new marker position can NOT be saved with the A or B display state.

— Settings that are NOT listed above are NOT affected by the recalled display states.

— Changes to the above settings outside the Big Readout menu will be overwritten when Big Readout (A or B) is selected. For example, suppose the display format for the B state is Log. If you change the display format to Lin using the standard menu (Meas 1, Format), the setting will show on the display. But if you then use the Big Readout (A | B | OFF) setting, when B is recalled, the Lin setting will be overwritten with the original Log setting.

Increase Dynamic Range

Dynamic range is the difference between maximum input power to the FieldFox receiver (without compressing the receiver), and the minimum measurable power (noise floor). Measurement accuracy is increased when the DUT response is at least 10 dB above the noise floor. For a measurement to be valid, input signals must be within these boundaries.



The following settings will increase the dynamic range of your NA mode measurement.

- Increase Power Level: Press **Meas 4** then **Output Power High**
- Lower the IFBW: Press **BW 2** then **IF BW**
- Increase Averaging: Press **BW 2** then **Average**

The following procedure MAY increase the dynamic range of your NA mode measurement. The results you see will depend on the performance of your DUT.

With an S21 trace active:

1. With RF OUT (port-2) open, press **Trace 6** then **Math and Memory** then **Data->Mem**
2. Re-connect the DUT.
3. Press **Data Math** then **Data-Mem**

7 Time Domain – Option 010

With NA Mode, Time Domain (Opt 010), frequency information is used to calculate and display measurements with time as the horizontal display axis. The response values appear separated in time allowing a different perspective of the test device's performance and limitations.

NA Mode settings that are NOT unique to Time Domain are documented in Chapter 6, "NA (Network Analyzer) Mode", on page 91.

In This Chapter

"Overview" on page 117

Time Domain (Transform) Settings

"Transform Settings Table" on page 118
"Start/Stop (Frequency Range) and Points" on page 118
"Stimulus (Mode)" on page 119
"Set Frequency Lowpass" on page 119
"Start/Stop Time" on page 119
"Distance Units" on page 120
"Window Layout" on page 120
"Transform Window" on page 120
"Line Loss and Velocity Factor" on page 121
"Data Chain" on page 122
"Gating Type" on page 125

Trace Settings

"Transform Enable" on page 123
"Gate Enable" on page 123

Gating Settings

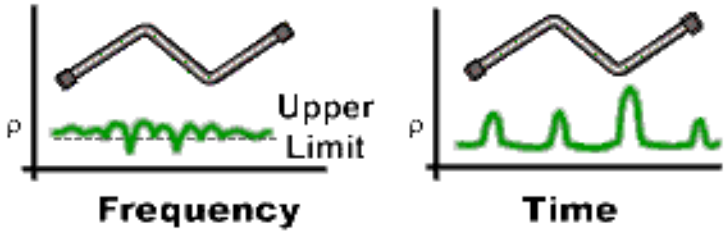
"Start, Stop, Center, and Span Gate Times" on page 125

"Gating Type" on page 125

Overview

In normal NA Mode operation, the FieldFox measures the characteristics of a test device as a function of frequency. With Time Domain (opt 010), frequency information is used to calculate the inverse Fourier transform and display measurements with time on the horizontal display axis. The response values appear separated in time, allowing a different perspective of the test device's performance and limitations.

The graphic below compares the same cable reflection measurement data in both the frequency and time domain. The cable has two bends. Each bend creates a mismatch or change in the line impedance.



The frequency domain of an S11 measurement shows reflections caused by mismatches in the cable. It is impossible to determine where the mismatches physically occur in the cable.

The Time Domain response shows both the location and the magnitude of each mismatch. The responses indicate that the second cable bend is the location of a significant mismatch. This mismatch can be gated out, allowing you to view the frequency domain response as if the mismatch were not present. Learn more about gating in “Gating” on page 124.

Markers that are created on a Time Domain trace can be used to pinpoint the distance of the mismatch from the reference plane.

For more information on Time Domain theory, see https://www.keysight.com/us/en/assets/7018-01451/application-notes/5989-5723.pdf.

Time Domain (Transform) Settings

You can set and view most of the Time Domain settings on the Transform Settings table.

Transform Settings Table

The following settings (from Transform Stimulus Settings to Data Processing) are listed in the order they appear on the Transform Settings menu selection.

How to make settings on the Transform settings table

- Press **Meas Setup 4**.
- Then **Transform**
- Then **Transform Settings**.
- Press **Next Page** and **Previous Page** to view all settings.
- To change a setting:
  - Use the ▲|▼ arrows or rotary knob to highlight a setting.
  - Numeric settings can be changed by pressing numbers using the numeric keypad. Then press Enter or select a suffix if available.
  - Some settings allow you to press **Edit** to toggle the value. Other settings require that you then press a softkey to change the value.
  - When finished changing a value, press **Done Edit**.
- Press **Dock Window** to relocate the Settings table to a position relative to the trace window. The Dock Window setting persists through a Preset. Choose from the following:
  - **Full (Default setting)** Only the Settings table is shown on the screen. The trace window is temporarily not shown.
  - **Left** The Settings table is shown to the left of the trace window.
  - **Bottom** The Settings table is shown below the trace window.
- When finished changing ALL settings, press **Done** to save your settings.

Start/Stop (Frequency Range) and Points

All Time Domain measurements are made in the frequency domain and, using Inverse Fourier Transform (IFT), time is calculated. Select the frequency range from which Time Domain measurements are calculated. Increasing the data points will improve measurement resolution. However, more data points will usually result in slower sweep updates.

Set frequency range and points before selecting Stimulus Mode.

Stimulus (Mode)

– There are three variations on how the Time Domain transform algorithm is applied to the frequency domain measurement. Each method has a unique application.

– **Lowpass Impulse** - Highest resolution. Most useful for seeing small responses in devices that pass low frequencies, such as cables.

– **Lowpass Step** - Easiest to identify inductive and capacitive discontinuities in devices that pass low frequencies such as cables.

In both Lowpass modes, frequencies down to DC and negative frequencies are extrapolated. Therefore, when either Lowpass mode is selected, Set Freq.Low Pass is automatically applied to adjust the start frequency. Learn more about Set Frequency Lowpass below.

When the Start Frequency or resolution is changed AFTER selecting a Lowpass mode, then Stimulus mode is set to Band Pass and Transform is disabled.

– **Bandpass Impulse**– Easiest method - can be used with any frequency sweep. Most useful for measuring band limited devices such as filters and DC blocked cables. This mode does NOT show capacitive and inductive reactance. For the same frequency span and number of points, band pass mode has twice the impulse width, which hides closely spaced responses degrading the response resolution.

Set Frequency Lowpass

NOTE This setting is made automatically when either Lowpass mode is selected.

USE ONLY IN LOW PASS MODES. The Low Pass Start frequency is adjusted so that the Low Pass Stop frequency is at harmonics of the Low Pass Start frequency. Start frequency is computed by the following formula:

Low Pass Start Frequency = Stop Frequency / Number of points.

Start/Stop Time

The following settings adjust the **display resolution**, allowing you to zoom IN or OUT on a response. When the start or stop time is updated, they may be automatically adjusted to limit the display to one alias-free response on either side of zero time.

How to set Start and Stop time

– Press **Measure Setup 4**

– Then **Transform**

– Then **Transform Start Stop**

– Then choose from:

  – **Start** Sets the transform start time.

  – **Stop** Sets the transform stop time.

NOTE **Zero (0) seconds is always the calibration reference plane. Negative values are useful if moving the reference plane.**

Distance Units

When markers are present on a Time Domain trace, marker X-axis values are shown both in units of time (seconds) and distance. Select the units in which the marker distance data is presented.

Distance Units are also used when setting Time Domain Line Loss. Learn more in. "Distance Units" on page 120.

Choose from: m (meters), or Feet.

Window Layout

This setting is used to create additional traces, or select a new layout for traces that are already created,

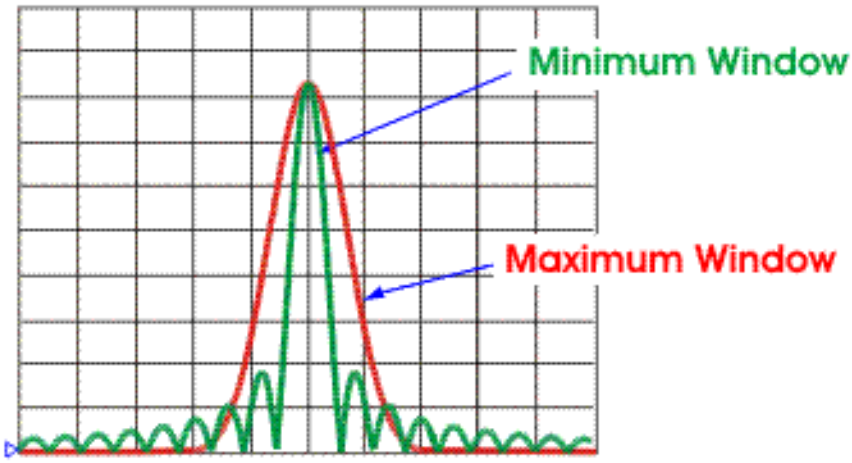
Choose from: x1, x2, x2H, x3H, x3, x4H.

Learn more about multi-trace configurations in "Multi-Trace Configurations" on page 97.

Transform Window

There are abrupt transitions in a frequency domain measurement at the start and stop frequencies, causing overshoot and ringing in a Time Domain response. The Window setting reduces the abruptness of the frequency domain transitions. This causes you to make a trade off in the Time Domain response.

The Window setting applies to ALL traces.



How to make Window setting

- Press **Measure Setup 4**
- Then **Transform**
- Then **More**
- Then **Transform Window**
- A settings table appears that allows you to navigate and select the following settings. These settings are made exactly like those made on the Transform Settings table. Learn how in "Transform Settings Table" on page 118.

NOTE **Any of the following four methods can be used to make this same Window setting. Impulse Width values are calculated from the frequency span and Kaiser Beta value.**

1.	Window	Min	Medium	Max
2.	Percent	0	50	100
3.	Kaiser Beta	0	6.50	13.00
4.	Impulse Width	100.455 ps	168.501	231.284

Line Loss and Velocity Factor

By default, the FieldFox does NOT correct Time Domain measurements to account for the inherent loss of a cable. However, to make more accurate measurements, Line Loss and Velocity Factor should be considered.

About Velocity Factor and Line Loss

– Velocity Factor is a property of the physical material of a cable. A VF of 1.0 corresponds to the speed of light in a vacuum, or the fastest VF possible. A polyethylene dielectric cable has VF = 0.66 and a cable with PTFE dielectric has VF = 0.7.

– Line Loss is specified in dB/m (or ft). In addition to the length of the cable, loss is also directly proportional to the frequency of the signal that passes through the cable.

The following is an example showing how Line Loss works:

The DUT is a 100 meter transmission cable. The Line Loss value is.1 dB/meter. This means that a signal traveling ONE WAY through the cable will lose 10 dB of power (100 m *.1dB/m). Because the FieldFox performs this measurement with 1 port, the test signal travels down the cable and then back, for a total loss of 20 dB.

For the purpose of illustrating this point, connect an OPEN to the end of the cable – a maximum-sized fault - for 100% reflection of the 300 MHz test signal.

Without compensation for the loss of the cable, a –20 dB response would be visible at 100 meters, which is the OPEN at the end of the DUT. This is from 10 dB of loss through the cable in each direction.

With compensation for the loss using the manufacturer's specification, the FieldFox compensates the trace as though the signal traveling through 100 meters was increased by +20 dB. Therefore the response will show 0 dB for 100% reflection.

Data Chain

This setting, available only on the Transform Settings Table, reverts to **Standard** when the FieldFox is Preset. Choose from the following:

– **Standard** – The normal FieldFox data processing chain. Transform calculations are performed AFTER error correction and trace math.

8510 – The data processing chain used by the Keysight 8510 network analyzer. Transform calculations are performed BEFORE error correction and trace math. Learn more with the FieldFox Supplemental Online Help: https://rfmw.em.keysight.com/wireless/helpfiles/FieldFoxOnlineSupplementalHelp/Home.htm.

Trace Settings

The following two settings apply to specific traces.

Transform Enable

Enable Time Domain transform for the specific trace.

- Select the trace.
- Press **Measure Setup 4**
- Then **Transform**
- Then choose from:
  - **Transform On** Trace displays Time Domain data.
  - **Transform Off** Trace displays frequency domain data.

Gate Enable

Enable Gating for the specific trace.

- Select the trace.
- Press **Measure Setup 4**
- Then **Transform**
- Then choose from:
  - **Gating On** Trace displays Time Domain data.
  - **Gating Off** Trace displays frequency domain data.

Gating

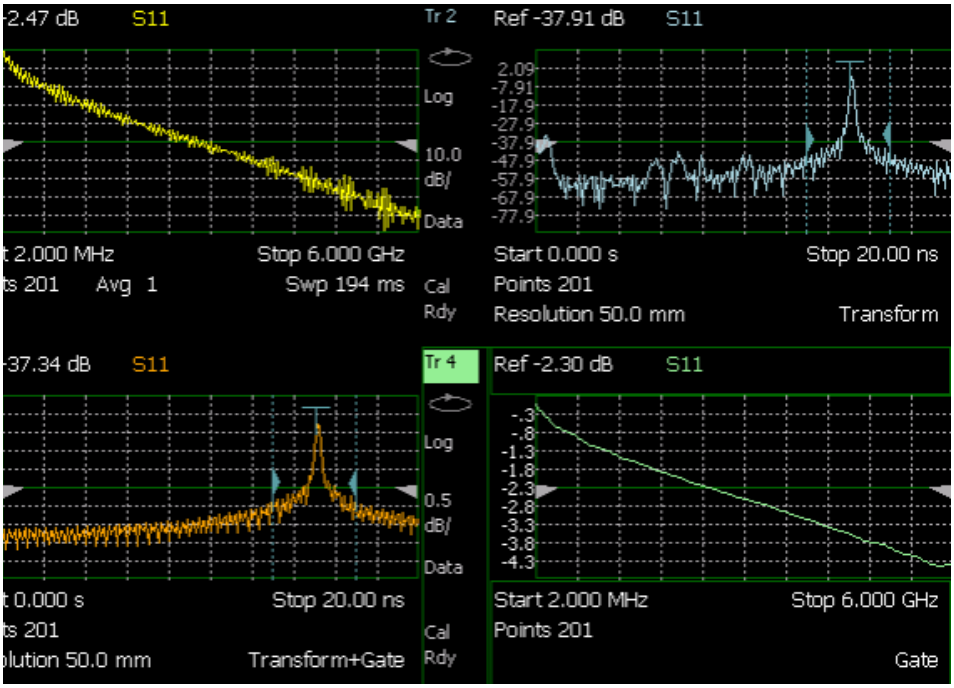
Perhaps the most beneficial feature of Time Domain transform is the Gating function. When viewing the Time Domain response of a device, the gating function can be used to “virtually” remove undesired responses. You can then simultaneously view a frequency domain trace as if the undesired response did not exist. This allows you to characterize devices without the effects of external devices such as connectors or adapters.

Gating is best performed while viewing a Time Domain trace. Then, either disable Transform, or separately view a frequency domain trace to see the trace with the gated effects removed.

NOTE

When a discontinuity in a test device reflects energy, that energy will not reach subsequent discontinuities. This can “MASK”, or hide, the true response which would have occurred if the previous discontinuity were not present. The Gating feature does NOT compensate for this.

The following image shows how gating can affect measurement results.



All 4 traces show the same S11 measurement.

Trace 1 shows the **frequency** response **without** gating enabled.

Trace 2 shows the **transform** response **without** gating enabled.

Trace 3 shows the **transform** response **with** gating enabled.

Trace 4 shows the **frequency** response **with** gating enabled.

How to make Time Domain Gating settings

- Press **Measure Setup 4**
- Then **Transform**
- Then **Gating**
- Then choose from:
  - **On** Gating is being performed.
  - **Off** Gating is NOT being performed.

Start, Stop, Center, and Span Gate Times

These settings specify the time in the trace to be gated (in or out). The gate times can be specified using either Start and Stop or Center and Span.

- Press **Gating Start Stop**
- A settings table appears that allows you to navigate and select the following settings. These settings are made exactly like those made on the Transform Settings table. Learn how in "Transform Settings Table" on page 118.

Gating Type

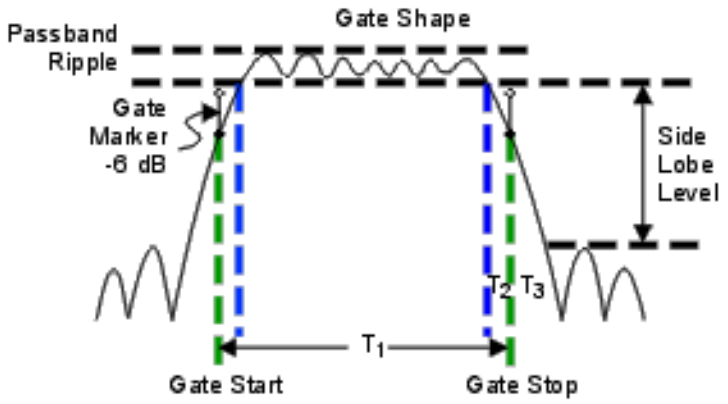
This setting defines the type of filtering that will be performed for the gating function. The gate start and stop flags on the display point toward the part of the trace you want to keep.

Choose from the following:

- **Bandpass** KEEPS the responses within the Gating Start and Stop times.
- **Notch** REMOVES the responses within the Gating Start and Stop times.

Gating Shape

This setting defines the filter characteristics of the gate function. Choose from Minimum, Normal, Wide, Maximum.



Time domain Gate Shape setting is shown in the graphic above.

Gate Shape	Passband Ripple	Sidelobe Levels	Cutoff Time	Minimum Gate Span
Minimum	±0.1 dB	-48 dB	1.4/Freq Span	2.8/Freq Span
Normal	±0.1 dB	-68 dB	2.8/Freq Span	5.6/Freq Span
Wide	±0.1 dB	-57 dB	4.4/Freq Span	8.8/Freq Span
Maximum	±0.01 dB	-70 dB	12.7/Freq Span	25.4/Freq Span

Cutoff time is the time between the stop time (-6 dB on the filter skirt) and the peak of the first sidelobe.

- T_1 is the gate span, which is equal to the stop time minus the start time.
- T_2 is the time between the edge of the passband and the 6 dB point, representing the cutoff rate of the filter.
- T_3 is the time between the 6 dB point and the edge of the gate stopband.

For all filter shapes T2 is equal to T3, and the filter is the same on both sides of the center time.

Minimum gate span is twice the cutoff time. Each gate shape has a minimum recommended gate span for proper operation. This is a consequence of the finite cutoff rate of the gate. If you specify a gate span that is smaller than the minimum span, the response will show the following effects:

- distorted gate shape that has no passband
- distorted shape
- incorrect indications of start and stop times
- may have increased sidelobe levels.

8 Calibration for NA, CAT, and VVM Modes

Calibration removes the systematic errors that are associated with measurements in NA, CAT, and VVM Modes. Key presses are identical in all of these Modes.

In this Chapter

"Why and When to Calibrate" on page 129
"Definitions" on page 129
"CalReady" on page 130
"How to Perform a Calibration" on page 130
"Mechanical Cal" on page 132
"ECal" on page 134
"Simple Response Cals" on page 137
"View Cal" on page 139
"Calibration Type" on page 139
"Enhanced Response Optimization" on page 144
"Interpolation *" on page 145
"Cal ON? – Questionable Accuracy" on page 145
"Compatible Mode Calibrations" on page 145
"Save the Calibration" on page 146
"CalReady Properties" on page 146
"Apply Nearest (NA Mode Only)" on page 147
"Verify a Calibration" on page 147
"Test the Jumper Cable" on page 148

See Also

Learn How to Make 75 ohm Measurements at the FieldFox Supplemental Online Help:
https://rfmw.em.keysight.com/wireless/helpfiles/FieldFoxOnlineSupplementalHelp/Home.htm.

Comprehensive Guide for Calibration

Why and When to Calibrate

There are well-defined and understood systematic errors that are measured and calculated during the calibration process. These errors are caused by leakage signals inside the FieldFox, by the frequency response of the FieldFox receivers, and by reflections inside the FieldFox that interact with the DUT. After calibration, these errors are removed from subsequent measurements.

To maintain highest measurement accuracy, perform a new calibration when any of the following changes occur:

- When any of the following measurement settings change: Frequency Range, Power Level, IF BW, and Resolution. Therefore, make these measurement settings before calibrating. Increased Averaging, lower IF BW, and higher Resolution all cause slower sweeps and slower calibration times. Learn about Interpolation and Questionable Accuracy in "Interpolation *" on page 145.
- When the FieldFox temperature changes more than about 10°F (5°C). Learn more in "How to monitor the internal FieldFox temperature:" on page 34.
- When the connection to the DUT changes, requiring a different jumper cable or adapter.

Definitions

DUT (Device Under Test) The cable, antenna, transmission line, amplifier, or anything else that is connected to the FieldFox that is to be measured.

Calibration Standards - OPEN, SHORT, LOAD, and THRU

- **OPEN, SHORT,** and **LOAD** are 'reflection' standards that are used during calibration. When an RF signal 'hits' these components, the signals are reflected in a predictable manner. These components can also be used to terminate a DUT port during some measurements.
  - SHORT and OPEN standards both cause 100% of an RF signal to be reflected. The difference between these two standards is what happens to the phase of the reflected signal, which is beyond the scope of this discussion. Although an OPEN standard is a precision component, simply leaving **nothing** connected at the end of a cable can be a reasonable substitute for an OPEN.
  - A LOAD standard absorbs almost ALL of the incident signal and very little signal is reflected back to the source.

– A **THRU** standard is used during some calibration steps to connect PORT 1 to PORT 2 in place of the DUT. A Flush THRU connection can be made when cables that connect with the DUT can mate with each other. Learn more in "Mechanical Cal" on page 132. Otherwise, any reasonably short cable can be used as a THRU standard.

Calibration Reference Plane is the point (or points) at which the DUT and cal standards are connected during a calibration. This can be at the FieldFox test port connectors, or at the end of jumper cables or adapters.

CalReady

Every FieldFox contains a factory calibration that was performed at the port 1 and port 2 connectors, with –15 dBm input power, over the entire frequency range of the FieldFox using a number of data points that allows reasonable interpolation over the FieldFox frequency range.

This calibration, known as CalReady, allows you to immediately make measurements of a DUT that is connected directly at the test ports (PORT 1 and/or PORT 2). CalReady corrects measurements when the FieldFox is turned ON and when a measurement is created with no other correction in place.

When measuring a DUT using a jumper cable or adapter - NOT a direct connection to a test port connector – then a Mechanical Cal is recommended. CalReady can also be used to check the integrity of the jumper cable that is attached to the test ports.

CalRdy is shown when a measurement is corrected using CalReady.

You can change the properties of the CalReady calibration. Learn more in "CalReady" on page 130.

Learn how to see when your factory CalReady calibration was performed in "System Information" on page 879.

How to Perform a Calibration

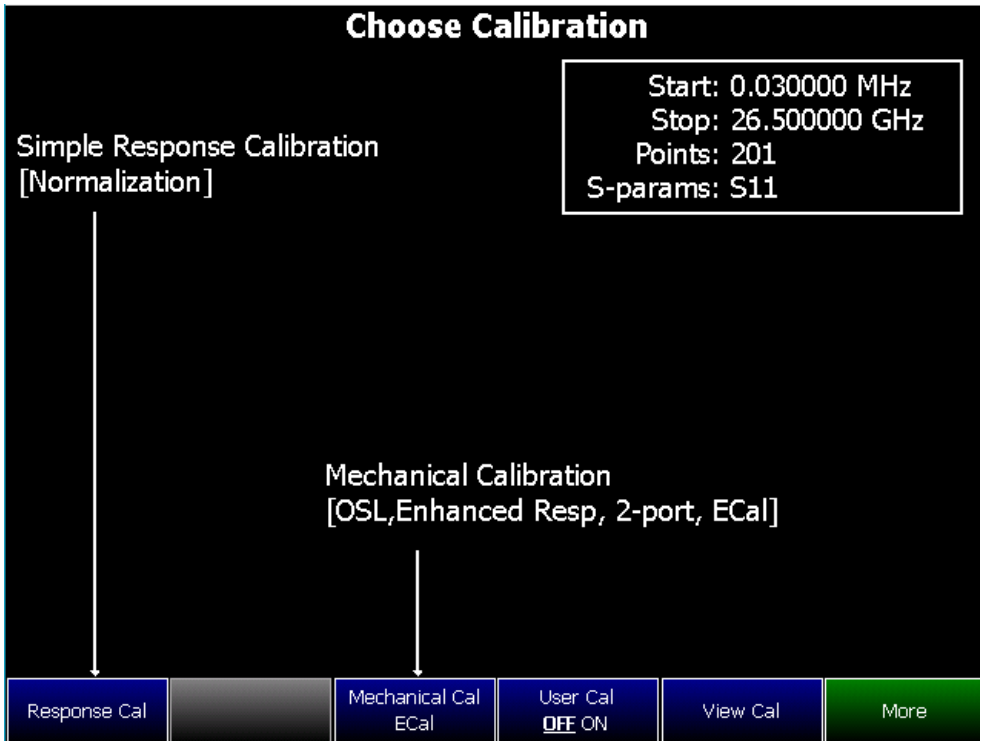
NOTE

Press **Esc** at any time to end the calibration process.

When performing a calibration that contains a large number of points (5000 to 10,001 points) be aware that the calibration progress bar may not move for 2 or 3 minutes during the calibration process.

In CAT, NA, or VVM Mode, press **Cal 5**.

The following appears:



Choose Calibration Method screen

- **Response Cal** – Used to quickly calibrate ONE type of measurement using mechanical standards. Measurement accuracy is generally low. Learn more in "Simple Response Cals" on page 137.
- **Mechanical Cal/ECal** – Using mechanical cal standards from a cal kit, perform an accurate calibration at one or both test ports, adapters, or jumper cables. Full 2-port mechanical calibration is the most accurate calibration available with FieldFox. Learn more in "ECal" on page 134.
- **User Cal OFF ON** – Turns ON and OFF the effects of the user calibration that you performed. The OFF state reverts to CalReady.
- **View Cal** – Shows the properties of the current calibration. Learn more in "View Cal" on page 139.
- **More** – Learn about Cal Ready Properties in "CalReady" on page 130.

NOTE

Source Unleveled errors - During calibration, the frequency range of the measurement MAY be extended to provide maximum flexibility. During the calibration, the output power may become unleveled at the added high frequencies. You can ignore the "Source Unleveled" error, or to avoid the error, select either High power or –15 dBm before calibrating. Learn more about setting Output Power in "Output Power" on page 59.

Mechanical Cal

Mechanical Calibration is performed using discrete standards from a Cal Kit. Several Cal Kit definitions are built into the FieldFox. To learn about Cal Kit definitions, refer to the Application Note, “Specifying Calibration Standards and Kits for Keysight Vector Network Analyzers,” available online at https://www.keysight.com/us/en/assets/7018-01375/application-notes/5989-4840.pdf.

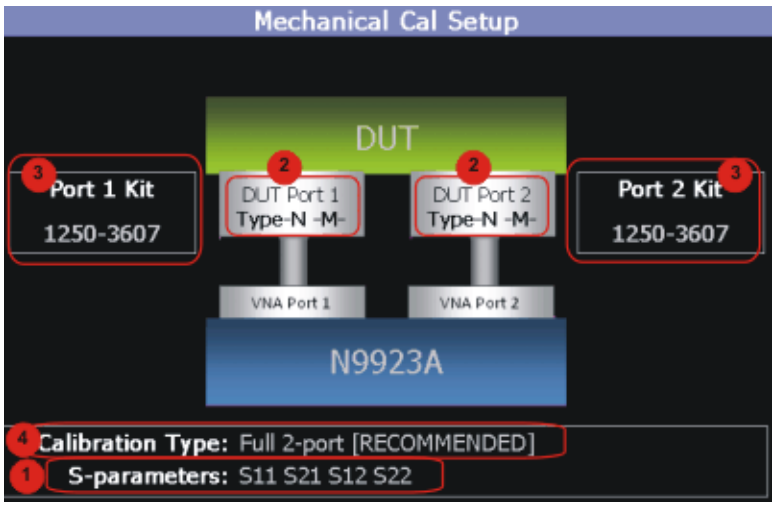
NOTE

Visit www.keysight.com/find/fieldfoxsupport to see a complete list of supported Cal Kits. Also at this website, download Data-Link software that allows you to edit Cal Kit definitions or add a new Cal Kit.

Mechanical Cals are extremely accurate when performed using the correct Cal Kits with standards that are clean and in good repair, and when using correct connection procedures.

How to perform a Mechanical Cal

- Disconnect the DUT from the FieldFox.
- If a jumper cable or adapter is required to connect the DUT to the FieldFox, then connect **those** components to the FieldFox connectors. The effects of those components will be measured and removed during the calibration, and only the effects of the DUT will be displayed in the measurement results. **These should be high-quality components!**
- In NA, CAT, or VVM Mode, press **Cal 5**.
- Then **Mechanical Cal**



This page summarizes the Mechanical Cal to be performed and allows you to make changes. For best results, review the screen and make changes in the following order:

1. **S-parameters** – Verify that these are all of the S-parameters that you want calibrated. If not, press **Esc** to terminate the calibration process, then return to the Trace menu to display all of the traces to be calibrated. Learn how in "Multi-Trace Configurations" on page 97
2. **DUT Connectors** – For each DUT port that is shown, verify the correct type and gender of the DUT connector. If a DUT port is not shown, then that port is not included in the list of S-parameters to be calibrated.
3. **Cal Kit** - Verify the correct Cal Kit for each DUT port to be calibrated. See a list of supported Cal Kits in the FieldFox Data Sheet. Learn more in Appendix B: "Specifications/Data Sheet," on page 941.

   If the DUT connector type, gender, or Cal Kit is **NOT** correct for the DUT ports to be calibrated, then:

   - Press **Change DUT Connectors** to select the correct connector types that are on your DUT.
   - For each port:
     - Use the ▲|▼ arrows or rotary knob to change the DUT connector type.
     - Press **Change Gender** to change the gender of the DUT connector.
     - Then press **Next...** to confirm the selection and continue the process.
   - For each port:
     - Use the ▲|▼ arrows or rotary knob to select the Cal Kit that you have, and are going to use, for the specified ports.
     - Press **Next...** to confirm the selection and continue the process.
     - Then press **Finish** to end the selection process.
4. **Calibration Type** - The FieldFox always RECOMMENDS a Cal Type that will quickly and accurately calibrate all of the displayed S-parameters. Change from the RECOMMENDED Cal Type ONLY if you understand the implications. Learn more about Cal Types in "Calibration Type" on page 139.

   To select a different Cal Type:

   - Press **Change Cal Type**.
   - Then using the ▲|▼ arrows or rotary knob, select a Cal Type,
   - Then press **Select and Finish**.

Begin Calibration

1. Press **Start Calibration**.

NOTE

If an error appears ("`Failure to compute calibration steps…`"), check to ensure that the frequency range of the Cal Kit covers the frequency range of the measurement. You can verify the frequency range of your Cal Kit at: www.keysight.com/find/fieldfoxsupport. Click Cal Kits.

2. Follow the Cal Wizard prompts. Connect the specified standard at the point where the DUT will be connected, then press **Measure**.
3. At any time, press **Back** to re-measure a standard if you feel it was not properly connected.
4. Press **Finish** to complete the calibration.

CAL ON U is shown on the screen for all displayed measurements that are corrected with the Mechanical Cal.

ECal

CAUTION

ECals each have a recommended input power level. Depending on the measurement setup, the FieldFox may default to an input power level that exceeds your ECal's recommended input power level. Refer to the reference guide for your ECal module to determine the correct input power levels. Exceeding an ECal's recommended input power level results in a compression and an invalid data condition. Refer to www.keysight.com/find/ecal.

ECal is a complete solid-state calibration solution. Every ECal module contains electronic standards that are automatically switched into position during a calibration. These electronic standards have been measured at the factory and the data stored within the memory of the ECal module. The FieldFox uses this stored data, along with the measured data, to calculate the error terms for a measurement calibration.

You can perform the following calibrations with ECal:

- 1-Port Reflection calibration
- Full 2-Port calibration

CAUTION

Simple ECal ON: When choosing **Full 2-port** calibration, if you are able to connect your ECal simultaneously to both device ports, you should use **Simple ECAL** (i.e., this ensures that you are using the correct Thru calibration model).

Simple ECal OFF: Set simple ECal to OFF when you have a test setup where you cannot connect port 1 and port 2 simultaneously to the ECAL module (Then during the calibration when prompted: "**Connect port 1 to port 2**", use a coaxial cable or an appropriate thru adapter to connect port 1 to port 2).

'Unknown THRU': When prompted: "**Connect port 1 to port 2**", then you can connect them, using a coaxial cable or an appropriate thru adapter. Do NOT use the internal ECal THRU, because the thru calibration will be incorrect.

'Flush THRU': When prompted: "**Connect port 1 directly to port 2**", then you must connect the ports directly together at the calibration reference plane with no adapter or other cabling.

Learn more in "Calibration Type" on page 139.

All Keysight USB ECal modules are supported. ECal modules are available in a variety of connector types, covering many frequency ranges. For information about available ECal modules, see http://www.keysight.com/find/ecal

Select an ECal module that has connectors of the same type and gender as the DUT. If such an ECal module is not available, a module with connectors different from the DUT can be used by selecting a User Characterization. This selection is located on the Mechanical Cal Setup page of the CalWizard. However, a User Characterization can NOT be PERFORMED using the FieldFox. It must be performed using a bench top Keysight VNA, such as the PNA or ENA. Learn more about user characterizations by referring to "User-Characterization" in the PNA Help https://rfmw.em.keysight.com/wireless/helpfiles/N52xxB/S3_Cals/ECal_User_Characterization.htm.

How to Perform a Calibration Using ECal

1. Make measurement settings on the FieldFox (frequency range, number of points, etc.)

NOTE

The frequency range of the measurement MUST be within the frequency range of the ECal module or an error will appear when “Calculating Steps” during the calibration.

2. Connect the ECal module USB cable to the FieldFox USB.
3. Allow the module to warm up until it indicates READY. This may take several minutes.
4. Connect the ECal module ports to the FieldFox at the calibration reference plane (where the DUT will be connected).
5. Press **Cal 5** to start the Calibration.
6. Press **Mechanical Cal / ECal**
7. Press **Change DUT Connectors**. For each test port to be calibrated, select the **Connector Type** and **Gender** of the DUT / ECal module. The connected ECal module and relevant User Characterizations will appear, with the ECal factory default as the default Cal Kit.
8. Optionally press **Advanced** then **ECal Auto Orient**.
   - **ON** (default) The FieldFox automatically senses the direction in which the ECal module ports are connected to the FieldFox ports.
   - **OFF** If power to the ECal module is too low, it cannot detect which FieldFox ports it is connected to. If you are having this problem, select OFF. Then during the calibration, the FieldFox will prompt you to connect the ECal module ports to specific FieldFox ports.
9. Optionally press **Advanced** then **Extended Cal** (N995xB/6xB Only).
   - **ON** The FieldFox Extended Cal measures additional points outside the current frequency range in order to enable adjusting the frequency range after the calibration procedure. With these extra points, the error correction may be applied when it otherwise might not. Without extended cal, if you adjust your frequency outside the calibrated range after the calibration has been completed, the error correction is turned off.
   - **OFF** (default) The FieldFox does not measure any frequency points outside the current displayed frequency range. If the frequency is adjusted outside of the set of points calibrated the error correction is turned off and the following message is displayed: "`Error correction disabled. Stimulus outside calibrated range.`"

10. Press Start Calibration. When prompted, verify the ECal module connection, then press Measure. The standards within the ECal module are automatically connected and measured.

CAUTION

'Unknown THRU': When prompted: "**Connect port 1 to port 2**", then connect port and port 2, using a coaxial cable or an appropriate thru adapter. Do NOT use the internal ECal THRU, because the ECal thru calibration model is incorrect for this calibration type.

'Flush THRU': When prompted: **"Connect port 1 directly to port 2"**, then you must connect the ports directly together at the calibration reference plane with no adapter or other cabling.

Learn more in "Calibration Type" on page 139.

Simple Response Cals

Simple Response Cals are used to quickly calibrate the magnitude and phase of a measurement using any Open, Short, or Thru component. These may be calibration standards, but because a Cal Kit is not selected, they are not modeled. Measurement accuracy is generally low. Use a Simple Response Cal to make quick measurements when using a jumper cable to connect the DUT to the FieldFox. Otherwise, CalReady is usually more accurate.

CAUTION

IMPORTANT!

The Simple Response calibration assumes an ideal response for the standard. DUT measurements after a Simple Response calibration will have a measurement bias equivalent to the deviation of the response of the device used as the Simple Response standard from the ideal response. Note, that an Open Response is simply a normalization, a Short response is a normalization with 180 degree phase offset. When selecting a standard from the 85058B calibration kit for a Short Response we suggest using short # 1 because it has the smallest delay of the four shorts and would thus be most similar to an ideal short.

For better accuracy, perform a mechanical calibration by referring to "Mechanical Cal" on page 132.

NOTE

You can perform a Simple Response Cal for either: S11, or S22, or S21 AND S12.

When prompted, choose a standard based on the displayed measurements to be calibrated. For example, to calibrate S11, connect either an OPEN or SHORT to the port 1 reference plane.

When Simple Response Cals are performed, the source match and reflection tracking terms from CalReady are updated by the measured Short or Open that is used during the calibration.

1-port response cals are also available from the Mechanical Cal menu. Learn more in "Calibration Type" on page 139.

Normalize uses a THRU standard or cable between port 1 and port 2 to cal an S21 and S12 Transmission measurement (NA Mode) and a 2-port Insertion Loss measurement (CAT Mode). In VVM Mode, this is performed using Zero.

When a Normalization is performed, the forward and reverse transmission tracking terms from CalReady are updated to account for the THRU that is used during the normalization process.

How to perform a Simple Response Cal

1. Select the measurements to be calibrated. See the relevant Mode (NA, CAT, or VVM) for measurement selections.
2. Press Cal 5 then Response Cal
3. For 1-port measurements:
   - Select either Open Response or Short Response for the port to be calibrated. The availability of this calibration on Port 2 may require an option.
   - Connect an OPEN or SHORT standard to the specified port and press Measure
4. For 2-port measurements:
   - Select Normalization
   - Connect a short, high-quality, phase stable cable between the FieldFox port 1 and port 2 connectors, then press Measure

NOTE

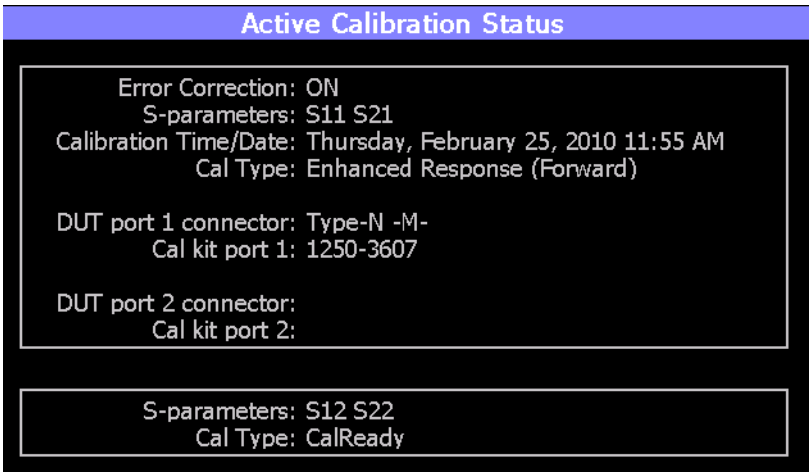
With a Normalization Cal, all subsequent insertion loss measurements are made relative to the insertion loss of the cable used as the THRU standard. For example, if you use a cable with 1 dB of loss, then after Normalization, the display will show 0 dB of loss with this cable in place. Therefore, for highest accuracy, when measuring the DUT also attach the cable that was used in the normalization cal.

5. Press Finish.
6. Connect the DUT.

CAL ON U is shown on the screen when a User Cal (Ex: Response Cal) is correcting ONLY the appropriate measurement. For example, when an Open Response Cal on Port 2 is performed, CAL ON U is shown for an S22 measurement only.

View Cal

From the **Choose Calibration** screen (see "How to Perform a Calibration" on page 130), press View Cal to see the following screen:



The top box shows the properties of the current calibration that you performed and the displayed S-parameters that it is correcting.

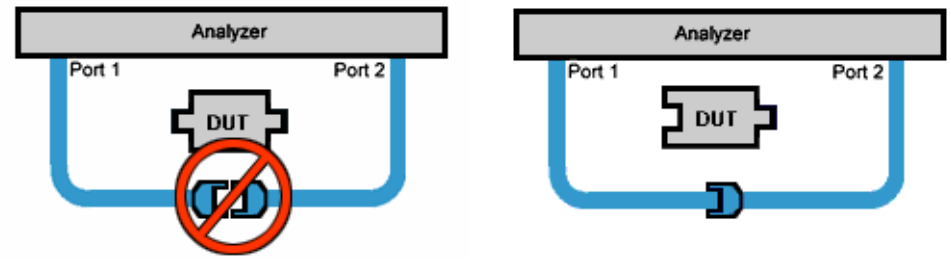
The bottom box shows the S-parameters that are displayed but NOT corrected by the current performed calibration, but rather the CalReady calibration. Learn more about CalReady in "CalReady" on page 130.

Calibration Type

The FieldFox simplifies the calibration process by recommending the most accurate and efficient calibration type based on the displayed S-parameters.

However, there may be times when you may want a little more accuracy or a little faster sweep time. The following information can help you learn about the various calibration choices.

Definitions:



Non-insertable DUT – A device whose connectors could NOT mate together. They either do not have the same type of connector or they have the same gender. This also means that the test port cables could NOT mate together as in the above diagram.

Insertable DUT – A device whose connectors could mate together. They have the same type of connector and opposite or no gender. This also means that the test port cables could mate together, as in the above diagram.

Defined THRU – A THRU standard for which there is a Cal Kit definition such as in the 8551xA Cal Kits.

Flush THRU (also known as Zero length THRU) – When the test port cables mate together when measuring an Insertable DUT. No actual THRU standard is required because the test port cables are directly connected. Flush THRU is also a Defined THRU with a definition of zero loss and zero length.

Unknown THRU - Any THRU connection between the test ports. For more information see the FieldFox Supplemental Online Help**:** https://rfmw.em.keysight.com/wireless/helpfiles/FieldFoxOnlineSupplementalHelp/Home.htm.

Sweep Directions – Both FULL 2-Port Cals listed below result in correction that requires background measurements sweeps in both directions, regardless of the displayed measurements. The displayed traces are updated at a slower rate than Enhanced Response and 1-port calibrations, which require sweeps in one direction only.

1-Port (OSL)

DUT: No restrictions

S-parameters Corrected: S11 or S22

Standards: OPEN, SHORT, LOAD

Sweeps in ONE direction.

FULL 2-Port (May require an option)

Most comprehensive calibration. Corrects all S-parameters

DUT: Non-Insertable or Insertable

Standards: OPEN, SHORT, LOAD on **BOTH** ports. Any THRU between ports.

Based on the SOLR/Unknown THRU calibration. For more information on the Unknown THRU process, see the FieldFox Supplemental Online Help: https://rfmw.em.keysight.com/wireless/helpfiles/FieldFoxOnlineSupplementalHelp/Home.htm

Sweeps in BOTH directions.

FULL 2-Port (QSOLT) – Mechanical Cal ONLY (May require an option)

Quicker to perform QSOLT than Full 2-port. Corrects all S-parameters.

DUT: Insertable only

Standards: OPEN, SHORT, LOAD on port 1. Flush THRU between ports.

Recommended cal type for Insertable DUTs. A Cal Kit is NOT required for port 2.

Sweeps in BOTH directions.

Enhanced Response Cal - Forward OR Reverse (May require an option)

Faster measurements than Full 2-Port.

DUT: Non-Insertable or Insertable. S-parameters PARTIALLY Corrected: S21 and S11 (Forward) **OR** S12 and S22 (Reverse)

Standards: OPEN, SHORT, LOAD on **ONE** port. Defined or Flush THRU between ports.

Sweeps in ONE direction.

NOTE

Also select an Enhanced Response Optimization. Learn more in “Enhanced Response Optimization” on page 144.

TRL – Mechanical Cal ONLY

A complete 2-Port calibration with potentially better accuracy than Full 2-port. Corrects all S-parameters.

DUT: Non-Insertable or Insertable

Standards: Thru, Reflect, Line or variations of these. A TRL Cal Kit MUST be selected to see this Cal Type

Sweeps in BOTH directions.

Learn more about TRL Calibration in the Supplemental Online Help: https://rfmw.em.keysight.com/wireless/helpfiles/FieldFoxOnlineSupplementalHelp/Home.htm

1-port Response Cals (Open or Short)

Calibrate the magnitude and phase of a measurement using 'modeled' mechanical standards. Measurement accuracy is better than Simple Response Cals (available on the main Cal page - see "Calibration Type" on page 139) but NOT as good as full 1-port cal. Corrects either S11 or S22. Can be used with Isolation (see following section). Learn more in "Simple Response Cals" on page 137.

DUT: Non-Insertable or Insertable

S-parameters Corrected: S11 or S22

Standards: OPEN or SHORT on ONE port

Sweeps in BOTH directions.

Isolation Step

The optional isolation step of a calibration corrects for crosstalk which is the internal signal leakage between the test ports. The Isolation step measures Load standards that are connected to one or both FieldFox test ports.

Perform an isolation calibration when you are testing a device with high insertion loss, such as the stop band of a filter or a switch in the open position.

The isolation step can add noise to the error model when the measurement is very close to the noise floor of the analyzer. To improve measurement accuracy, set a narrow IF Bandwidth during the calibration.

The Isolation step is NOT allowed with ECal.

How to perform the Isolation step

1. Press **Cal 5** then **Mechanical Cal / ECal**
2. Then **Advanced**
3. Then **Omit Isolation**
   - **OFF** Perform the Isolation step
   - **ON** (default) Omits the Isolation step
4. Then **<Back**
5. Configure and perform the calibration as usual. At the first step of the Cal you will be prompted to connect a Load standard to one or both test ports.

NOTE

If the first calibration step does NOT prompt you to connect Load standards, then the Cal Kit probably does not contain an Isolation standard. You can use DataLink software to edit the Cal Kit and add an isolation standard using a Load standard. See Data Link Help for more information:
https://www.keysight.com/us/en/lib/resources/service-manuals/keysight-fieldfox-library-help-and-manuals-2153870.html

– This setting survives an Instrument Preset.

Waveguide Calibrations

In general, calibrating with Waveguide is very similar to calibrating with coax. However, most coax mechanical Cal Kits have standards that can be used over a very wide frequency range. Waveguide Cal Kits are used over a narrow frequency range. Therefore, it is VERY IMPORTANT to set the frequency range of the measurement WITHIN the frequency range of the waveguide Cal Kit. Otherwise, an error message will appear during the 'Calculating Steps' portion of the calibration.

Waveguide Cal Kits

Keysight sells two waveguide Cal Kit series: the premium 11644A series and the economy N9911X series. Both are available online at www.Keysight.com

Effective Velocity Factor

Velocity factor is the speed at which an electromagnetic signal passes through the transmission medium relative to the speed of light. This value is important when distance is being calculated in DTF measurements (CAT mode) and Time Domain (NA mode).

When the media is waveguide, the velocity factor changes with frequency. FieldFox calculates this 'effective' velocity factor automatically. However, the settings are different for CAT mode and NA mode.

CAT Mode - How to make Waveguide settings

These settings are necessary ONLY when making DTF measurements.

1. Press **Measure 1** then **Distance to Fault (dB)** to select a **DTF** measurement.
2. Press **Meas Setup 4**
3. Then **Settings** (Learn how to use the Quick Settings table in "How to view and change Quick Settings" on page 54.)
4. Set **Media = Waveguide**. Frequency Mode = **BandPass** is automatically selected for you.
5. Scroll down to **Waveguide Definitions**. Select the **Waveguide Standard** being used. If your waveguide standard is NOT listed:

a. Select **User Waveguide**. Then press **Done**.

b. Then **DTF Cable Specifications** > **Edit/Save/Recall Cables** > **Edit Cable**.

c. Scroll to set **Waveguide Definition**. The default setting is **VF Corr** = Auto.

d. Set the Min, Max, and Cutoff Frequencies.

6. Press **Done**, then press **Back**.

– **Cable Correction = Auto** is the default setting. The Effective Velocity Factor is calculated automatically based on the frequencies of the waveguide standard. To override this setting, set Cable Corr = **Man**.

NA Mode - How to make Waveguide settings

These settings are necessary ONLY when your measurement requires electrical delay or port extensions, or if using Time Domain Transform.

1. Press **Meas Setup 4** > **Transform** > **Transform Settings**
2. Under **Transform Stimulus Settings**, set the **Start** and **Stop** frequencies to those of the Waveguide.
3. Set **Stimulus = Bandpass Impulse**
4. Press **Done**
5. Press **Meas Setup 4** or **Back**
6. Then **Calibration Settings**
7. Set **Media = Waveguide**
8. Set **Cutoff Frequency**. This is the absolute minimum frequency of the waveguide. This value must be less than the Start Frequency of the Waveguide.
9. Enter the calculated **Effective VF** value into the Velocity Factor setting.

Enhanced Response Optimization

When Enhanced Response Cal Type is selected, either for one calibration or for CalReady, this setting optimizes the calibration based on the type of DUT being measured. See also: CalReady Properties in "CalReady" on page 130.

This setting does NOT survive Preset.

1. Press **Cal 5** > **More** > **Enh.Response**
2. Then choose from:

- **NonReciprocal** (default) An amplifier is a Non-Reciprocal device because it has gain in the forward direction, and very high loss (isolation) in the reverse direction. This choice provides the best correction for non-reciprocal devices, and reasonable correction for reciprocal devices.
- **Reciprocal** A reciprocal DUT is a device in which the insertion loss through the device is equal in both the forward (S21) and reverse (S12) directions. A cable is a reciprocal device. This choice provides the best correction for reciprocal devices. However, S11 measurements on non-reciprocal devices will appear to have more return loss than the non-reciprocal choice.

Interpolation *

Highest measurement accuracy is achieved when the frequency range or resolution settings remain the same during the measurement as when the FieldFox was calibrated. If these settings change after performing a calibration, the FieldFox will interpolate the calibration so that VERY accurate measurements continue to be made.

Interpolated Calibrations are only slightly less accurate than a calibration performed at the measurement settings. Learn more about the relative accuracy of FieldFox calibrations in "Cal ON? – Questionable Accuracy" on page 145.

When a calibration that you performed is being interpolated, an asterisk is added to the Cal annotation. For example: **Cal ON U*** is shown on the screen when the current Response or Mechanical cal is being interpolated. An * is never added to a CalRdy.

Cal ON? – Questionable Accuracy

When the Output Power, Interference Rejection, or IF BW (NA Mode ONLY) setting is changed AFTER performing a calibration, a question mark is added to the Cal annotation.

The resulting measurement accuracy depends on how much the setting has changed. For highest accuracy, recalibrate using the new settings.

Compatible Mode Calibrations

The FieldFox can have only ONE calibration present for all modes. Because NA, CAT, and VVM modes are very similar, a calibration that is performed in one mode can also be applied in the other modes with the same type of measurements (1-port or 2-port).

To apply a Cal that was performed in a different mode, press **Cal 5** then select **User Cal ON**.

Save the Calibration

After performing any type of calibration, you can save the FieldFox settings along with the calibration into a STATE (*.sta) file. These settings and calibration can then be recalled as necessary. To learn how, see "Saving and Recalling Files" on page 888.

CalReady Properties

There are several factory calibrations (CalReady) on every FieldFox. These can be selected based on the type of DUT that you measure most often, and the compromise that you prefer to make between measurement speed versus measurement accuracy. Remember, CalReady was performed at the test ports. Therefore, a CalReady calibration is most accurate when the DUT is directly connected to the test ports. Learn more in "CalReady" on page 130.

This setting does NOT survive Preset or Power ON/OFF.

1. Press **Cal 5** > **More**
2. Then press **CalReady** to toggle between the following selections:
   - **2-Port Cal** (default) Corrects all four S-parameters. Requires a forward and reverse sweep, which causes slower trace measurements. Learn why in "Calibration Type" on page 139.
   - **Enh. Response** Corrects forward (S21 and S11) and reverse (S12 and S22) measurements separately. Therefore, when measurements in only one direction are required, this choice provides faster trace measurements than a full 2-port cal. Also choose an Enhanced Response Optimization. Learn more in "Enhanced Response Optimization" on page 144.

To find the best choice for your DUT:

1. Press **Preset** > **Preset**.
2. Select the appropriate S-Parameter and other settings (frequency range, resolution, and so forth).
3. Press **Trace 6** > **Math and Memory** > **Data->Mem**.
4. Press **Data & Memory**.
5. Press **Cal 5** > **More**
6. Select a CalReady Cal to compare with the current setting.
7. Press **Esc** to exit the cal menu.
8. View the differences in the two traces.

Apply Nearest (NA Mode Only)

When **Apply Nearest** is pressed, interpolation is turned off and the nearest calibration point is applied when the start stop frequencies are changed for the current sweep.

CAUTION

IMPORTANT!

– Apply Nearest needs to re-selected after each pair of start and stop frequency points is entered, because the Apply Nearest feature is disabled when a new start stop frequency pair is selected.

– Apply Nearest calculates the number of points based on the start and stop frequency points entered.

– Apply Nearest will display the following error when there is no valid calibration found:

"`Error: 225, The required user calibration is not present.`"

To use **Apply Nearest**:

– Press **Cal 5** > **More** > **Apply Nearest**

Verifying Calibration and Jumper Cable Integrity

After calibrating, it is important to verify that the calibration is good. When using a jumper cable, also verify that the cable is of high quality.

Verify a Calibration

– Connect a LOAD standard at the calibration reference plane (where calibration standards were connected). This may be at the end of the jumper cable or at FieldFox **PORT 1** connector.

– In CAT Mode, select **Return Loss**.

– In NA Mode, select **S11** with Log Mag format.

– For frequencies **lower than 9 GHz**, observe the trace on the FieldFox screen:

  – Lower than 35 dB indicates a GOOD calibration.

  – Higher than 30 dB indicates that you should recalibrate.

Verifying Phase Accuracy

– Connect a LOAD standard at the calibration reference plane (where calibration standards were connected).

– In NA Mode, select a S11 Reflection with Polar or Smith Chart format.

– Because all LOAD standards have delay, you should see a small amount of phase rotation as a function of frequency. In general, the measurement result should agree with the characteristics of the calibration standard.

Test the Jumper Cable

With the LOAD standard still connected, move the jumper cable while observing the trace.

– If the measurement trace is relatively stable, the jumper cable is of good quality.

– If you observe significant movement in the peaks of the measurement trace when moving the cable (>5 dB), the jumper cable may need to be replaced.

Calibration Method Summary

- **Mechanical Full 2-port Cal** is ALWAYS the most accurate Cal method. The quality of a Mechanical Cal is completely dependent on the quality of the OPEN, SHORT, LOAD standards and the quality of the standard connections. Use the correct high quality standards to ensure the most accurate calibration.
  - Even with the optional Load, phase accuracy begins to degrade when the return loss is greater than about 20dB.
- **CalReady** is accurate ONLY when the DUT is directly connected at the test ports and most accurate at room temperature.
- **For highest accuracy**, a new Mechanical Cal should be performed:
  - When the temperature changes more than about 10°F (5°C)
  - When the connection to the DUT requires a different jumper cable or adapters.
  - When any of the following measurement settings change: Frequency Range, Power Level, IF BW, and Resolution.

9 SA (Spectrum Analyzer) Mode (Option 233–Mixed Analyzers)

NOTE

To better reflect the enhancements implemented during the alignment process, for firmware versions >A.10.15 "IF Flatness Alignment" is now referred to as "Channel Equalization" or "Channel Equalization Alignment" (ChanEQ Alignment)

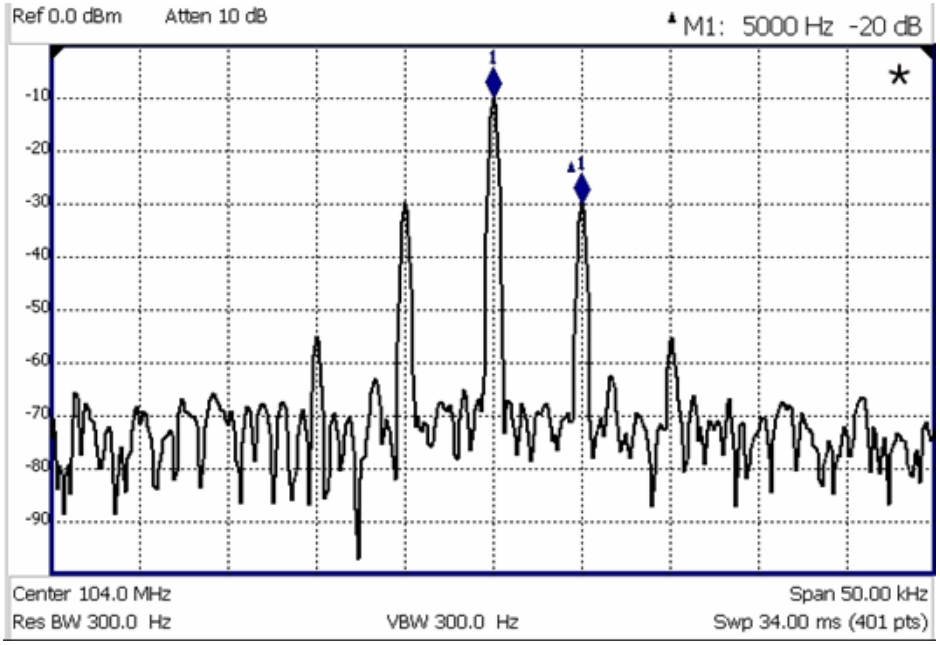
SA Mode measures signals at the **SA RF IN** connector.

SA Mode measurements require NO calibration.

For a comprehensive SA mode tutorial, see Spectrum Analysis Basics (Application Note 150) at https://www.keysight.com/us/en/assets/7018-06714/application-notes/5952-0292.pdf

For information on using the FieldFox Remote Viewer which enables you to view the FieldFox from your iOS device, refer to https://www.keysight.com/us/en/assets/7018-04070/application-notes/5991-2938.pd f

Figure 9-1 SA Display with Markers



**The graphic above shows an SA display with markers.
Carrier with 5 kHz frequency modulation and deviation of 1 kHz.**

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"Reverse Swap" on page 160

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"Preamplifier Control (Opt 235)" on page 164

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"Average Type" on page 210
"Average Count" on page 211
"Alignments" on page 211
"RF Burst Amplitude Alignment" on page 217
"Detection Method" on page 219
"Display Line" on page 222
"Noise Marker" on page 223
"Power Spectral Density (PSD) Function (SA Mode Only)" on page 224
"Logarithmic X-axis Limit Line Interpolation (EMI and SA modes Only)" on page 225
"Band/Interval Power Marker" on page 225
"Frequency Counter at Marker" on page 226
"Audio Beep at Marker Power" on page 227
"Meas UNCAL Error" on page 227
"Old Data Indicator (*)" on page 228
"Radio Standards and Channel Measurements" on page 228
"Measurement Preset" on page 229
"Averaging" on page 229
"Traces" on page 229
"Channel Power (CHP)" on page 230
"How to Set Up EMF Settings (Requires EMF (Option 358), GPS (Option 307), and SA Mode (Option 233–Mixed Analyzers))" on page 238
"Spectrum Emission Mask (SEM) — (SA Mode Only)" on page 252
"IQ Analysis (SA Mode Only)" on page 259
"Effective Isotropic Radiated Power (EIRP) – (SA Mode Only)" on page 262

See Also

Interference Analyzer:

"Spectrogram Display (SA Option)" on page 564

"Waterfall Display" on page 568

"Record/Playback (SA Option)" on page 570

Optional Settings:

"All about Markers" on page 797

"All about Limit Lines" on page 812

"Saving and Recalling Files" on page 888

SA Mode Settings

Select SA Mode before making any setting in this chapter.

Because there is no calibration, these settings can be made in any order.

How to select SA Mode

– Press **Mode**

– Then **SA**.

Frequency Range

The X-axis frequency range determines the frequencies that are measured for each sweep. The default Start frequency is 0 Hz. However, the Start frequency can be set as low as –100 MHz. The internal LO of the FieldFox can be seen at 0 Hz, which will mask signals that may be present.

NOTE

Although the start frequency can be set as low as -100 MHz, amplitude accuracy is specified above 9 kHz. Below 9 kHz, frequency accuracy is maintained, but amplitude accuracy is degraded.

The FieldFox can be used with an OML frequency extender. Refer to **"Utilities" on page 842****, the** B Series FieldFox Configuration Guide 5992-3701EN**, and to** **"Contacting Keysight" on page 5**

Available ONLY with Opt. 209 and while in Step sweep, SA mode allows reverse sweeps. This means the Start frequency can be higher than the Stop frequency. In addition, the **Reverse Swap** feature can be used to quickly reverse the Start and Stop frequencies. Learn how in "Reverse Swap" on page 160.

The frequency range of the measurement can be changed using the following methods:

– Set Center and Span frequencies

– Set Start and Stop frequencies

– Toggle between Zero and Last selected span

– Set Full Span of the FieldFox

– Using Channel selection. Learn how in "Channel Selection" on page 158.

– Using Marker > Center (frequency). Learn how in "SA Marker Functions" on page 811.

How to set Frequency Range

– Press **Freq/Dist**.

– Then choose from the following:

– **Center** and **Freq Span** frequencies. This is the most common method of entering frequency range. Enter the frequency of interest. The Center frequency is at the exact center of the X-axis. The Frequency Span places half of the frequency range on either side of center. When the Center and Frequency Span values are entered, then the X-axis annotation on the screen shows the Center and Span frequencies.

NOTE

Integration BW (IBW) is coupled to the Frequency Span setting. Frequency Span is 50% wider than the IBW (e.g., if the IBW value is 1 MHz, then the Frequency Span value is 1.5 MHz).

– **Start** and **Stop** frequencies. Start is the beginning of the X-axis and Stop is the end of the X-axis. When the Start and Stop frequencies are entered, then the X-axis annotation on the screen shows the Start and Stop frequencies.

– Follow each of these by entering a value using the numeric keypad, the arrows ▲|▼, or the rotary knob.

– When using the arrows ▲|▼, press **Enter**. The increment setting of the arrows is based on the current span. This can be changed in SA Mode. See "How to change frequency step size" on page 156 below.

– After using the keypad, select a multiplier key. Learn more in ."Multiplier Abbreviations" on page 48

Two more ways to change the frequency range

– Press **Freq/Dist**

– Then choose from the following:

– **Zero/Last Span** Each key press toggles the frequency span between 0 Hz and the last specified frequency span. Learn more about Zero Span in "Zero Span Measurements" on page 200.

– **More**

– Then **Full Span** Selects the entire frequency span of the FieldFox. The Center frequency is set automatically.

How to change frequency step size

When using the ▲|▼ arrows to change any of the frequency settings, the size of the frequency step can be changed.

– Press **Freq/Dist**

– Then **More**

– Then **CF Step Auto Manual**

– **Auto** Each press of the ▲|▼ arrows increments or decrements the value by 1/10th (one division) of the current frequency span. **Note**: To change this setting from **Manual** to **Auto**, press **CF Step** twice.

– **Manual** Type a step size value using the numeric keypad, then select a multiplier key. Learn more in "Multiplier Abbreviations" on page 48.

How to change from Linear to Log Axis View

– Press **Freq/Dist** > **More**

– Then choose from the following:

  – **Log Freq AxisX** enables/disables the log frequency X-axis. Disabling the log frequency X-axis, enables the linear frequency X-axis (Default == OFF).

  – **Full Span** Selects the entire frequency span of the FieldFox. The Center frequency is set automatically.

Radio Standard

A Radio Standard is a collection of settings that are applied to the FieldFox for specific RF protocols. When a Radio Standard is applied, the FieldFox frequency and channel settings change to that of the standard.

By default, the FieldFox locates the center frequency of the standard in the middle of the screen and sets the frequency span to cover all of the Uplink and Downlink frequencies. The selected Radio Standard name appears in the center of the screen below the X-axis.

After a Radio Standard has been selected, the frequency range can be changed by selecting channel numbers rather than frequency. Learn how in "How to set Frequency Range" on page 155.

When a Channel Measurement is selected such as ACPR, other relevant settings will be changed such as Integration BW. Learn more about Radio Standards and Channel Measurements in "Radio Standards and Channel Measurements" on page 228.

How to select a Radio Standard

– Press **Measure 1** OR **Freq/Dist** then **More**

– Then **Radio Standard**

– Then **Radio Standard**

– Then select a standard using the ▲|▼ arrows or rotary knob and press **Enter**.

Custom Radio Standards

Your own custom Radio Standards can be imported into the FieldFox. Custom standards are created in *.csv (spreadsheet) format.

A template and instructions for creating your custom Radio Standard is Concepts and Reference information (i.e., CustomTemplate.csv). Refer to the Supplemental Help here:

https://rfmw.em.keysight.com/wireless/helpfiles/FieldFoxOnlineSupplementalHelp/Reference/CustomRadioStandard.htm.

Once imported, the *.csv file is stored in the FieldFox \User Data\ folder. The custom Radio Standards are read and presented at the top of the list of internal Radio Standards.

How to Import and Delete a Custom Radio Standard

First, press **Save/Recall** and select the **Device** from which the Radio Standard will be read. Most likely this will be **USB** or **SD Card**.

- Press **Measure 1** OR **Freq/Dist** then **More**
- Then **Radio Standard**
- Then **Radio Standard**
- Then **Import Radio Standards**
- Then select the *.csv file using the ▲|▼ arrows or rotary knob and press **Enter**.
- Custom Radio Standards can be removed from the FieldFox by selecting **Measure 1** then **Radio Standard** then **Delete Radio Standard**.
- Then select the *.csv file to delete using the ▲|▼ arrows or rotary knob and press **Enter**.

NOTE To overwrite a custom standard that is already uploaded to the FieldFox, you must first delete the *.csv file from the FieldFox, then re-upload the file that contains the standard. A predefined internal standard (such as GSM 450) can NOT be deleted from the FieldFox.

Channel Selection

After a Radio Standard has been selected, the frequency range can be changed by selecting channel numbers rather than frequency. Once enabled, the channel number is appended to the X-axis frequency range.

How to Enable Channel selection

1. Press **Freq/Dist** > **More**
2. Then **Unit Freq Chan**

With Unit = **Chan**, **Channel Direction** becomes available and **CF Step** alters to **Channel Step**.

How to change the Channel Number of the Measurement

With Unit = **Chan** the FieldFox will NOT allow you to specify channels outside of the selected Radio Standard.

– Press **Freq/Dist**

– Then choose from the following:

–**Center Channel** Places the center frequency of the specified channel in the middle of the X-axis.

–**Start Channel** Places the lowest frequency of the specified channel at the beginning of the X-axis.

–**Stop Channel** Places the highest frequency of the specified channel at the end of the X-axis.

–**Freq Span** Changes the span of frequencies while the center frequency remains unchanged.

NOTE Integration BW (IBW) is coupled to the Frequency Span setting. Frequency Span is 50% wider than the IBW (e.g., if the IBW value is 1 MHz, then the Frequency Span value is 1.5 MHz).

–Follow each of the above settings by entering a value using the numeric keypad or the rotary knob.

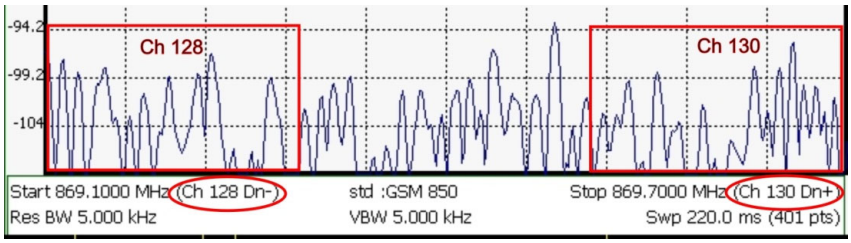
–Use the ▲▼ arrows to increment the channel number by an amount specified by the Channel Step value (see below).

– Then press **Enter** or **Enter**.

Select either Uplink or Downlink Frequencies

Press **Freq/Dist** then **More**. Press **Chan Direction** to toggle between **Uplink** and **Downlink**. If either of these selections is not available, then the selected Radio Standard does not contain those frequencies. In that case, **Chan Direction** is grayed out.

Channel number X-axis annotation



– **Dn** indicates **Downlink** channels.

– **Up** (not shown) indicates **Uplink** channels
– **(–)** indicates that the lowest frequency in the channel (128) is at the left edge of the screen.
– **(+)** indicates that the highest frequency in the channel (130) is at the right edge of the screen.
– When Center Channel or Freq Span is specified, the X-axis shows the Center Freq (Channel) and Frequency Span.
– When Start or Stop Channel is specified, the X-axis shows the Start Freq (Channel) and Stop Freq (Channel).

Change Channel Step Size (Optional)

This setting allows you to use the ▲|▼ arrows to increment the channel number by the specified value. The **Channel Step** softkey appears only when it is valid. Learn how to make it valid in the section, see "How to change the Channel Number of the Measurement" on page 159.

– Press **Freq/Dist** then **More**.
– Press **Channel Step**
– Enter a step value using the numeric keypad, the ▲|▼ arrows, or the rotary knob. Then press **Enter**.

Reverse Swap

Available ONLY with Opt. 209 and while in Step sweep mode. Each press of the softkey causes the Start and Stop frequencies to swap. The Start becomes the Stop and vice versa. Learn more about Step versus FFT sweeps in "FFT Gating (Opt 238)" on page 206.

– Press **Freq/Dist** then **More**.
– Then **Reverse Swap**

Scale and Units

Adjust the Y-axis scale to see the relevant portions of the data trace.

The Y-axis is divided into 10 graticules. A acquisition is shown on the screen as a solid horizontal bar that can be placed at any graticule.

When RF Attenuation set to **Auto**, the RF Attenuation is coupled to acquisition.

How to set Scale

Press **Scale / Amptd**. Then choose from the following:

- **Autoscale** Automatically adjusts the Y-axis to comfortably fit the Minimum and Maximum amplitude of the trace on the screen.
- **Scale** Manually adjust the scale per division to view specific areas of the current trace. Enter a value using the numeric keypad, the ▲|▼ arrows, or the rotary knob. Then press **Enter**.
- **Ref Level** Manually set the value of the reference line. Enter a negative value by pressing **Run/Hold (+/-)** either before or after typing a value. This can also change the RF Attenuation setting. See “Attenuation Control” on page 163.
- **Preamp** Refer to “Preamplifier Control (Opt 235)” on page 164.
- **RF Atten** Refer to “Attenuation Control” on page 163.
- **More** opens another set of scale softkeys.

Manually set Scale Type, acquisition, and Reference Position.

- **Scale Type [current setting]**
  - **Log** Logarithmic scale (default setting). The Y-axis reference line represents the specified absolute acquisition in the current Unit selection. Y-axis graticules show dB below or above the reference line.
  - **Lin** Linear scale. The Y-axis reference line represents the specified absolute acquisition in the current Unit selection. Y-axis graticules show percent of acquisition (%) below or above the reference line.
- **Unit** Refer to “How to Set Y-axis Units” on page 162.
- **Corrections** Refer to “How to select and edit corrections for Field Strength measurements” on page 165.
- **External Gain** Refer to “External Gain” on page 162.
- **Ref Pos** Manually set the position of the reference line. Values must be between 0 (TOP line) and 10 (BOTTOM line). Default position is zero (top).

– **PSD Function** Enables/disables the Power Spectral Density Function (PSD Function) which is a way to normalize the SA measurement to a 1 Hz Bandwidth. (Default == OFF). Learn more, see "Power Spectral Density (PSD) Function (SA Mode Only)" on page 224.

How to Set Y-axis Units

The Unit setting appears for the reference line, marker readouts, and trigger level. All Unit choices are available in both Log and Linear Scale Types.

The UNIT setting survives Mode Preset, but NOT Preset.

– Press **Scale / Amptd**, then **More**, then **Unit**

– Then choose from the following:

–**dBm** (default setting), **dBmV** (dB milli Volts), **dBuV** (dB microVolts), **W** (watts), **V** (volts), **A** (amps), **dBmA** (dB milliAmps), **dBuA** (dB microAmps).

"Learn more, refer to "Using the Antenna/Cable Editor" on page 167".

Antenna correction units are available ONLY by loading or editing an Antenna file that contains the desired units setting. Learn more in "Manage Files" on page 897.

External Gain

When using an external amplifier or attenuator, the SA mode trace amplitude values can be offset to compensate for the effect of the external device. This effectively moves the reference plane of the SA measurement port out to just beyond the external device. For example, when using an external preamp with gain of +10 dB, enter this value for External Gain, and the data trace across the displayed frequency span will be adjusted down by 10 dB.

When RF Atten is set to Auto, you may see a change in the RF Attenuation value. This is an attempt to measure the signal at top of screen (the acquisition) without overloading the SA first mixer.

How to Set External Gain

1. Press **Scale/Amptd**.
2. Then **More**
3. Then **External Gain**
4. Enter a value using the numeric keypad, the ▲|▼ arrows, or the rotary knob (positive for gain; negative for loss). Values less than 5 dB must be typed using the numeric keypad. Then press **Enter**

   ExtGain xx dB is shown at the top of the screen.

Attenuation Control

Both the RF Attenuation and Preamp functions control the power level into the SA.

When too much power is present at the RF Input port, ADC Over Range appears on the FieldFox screen. This does not necessarily mean that damage has occurred, but that the measurement is probably compressed.

When high power levels are present at the RF Input port, internal attenuation can be switched in to keep the FieldFox receiver from compressing. At extremely high power levels, use external attenuation to protect the internal circuitry from being damaged.

CAUTION

The FieldFox can be damaged with too much power. Refer to the FieldFox Data Sheet for your model on https://www.keysight.com/us/en/assets/7018-03314/data-sheets/5990-9783.pdf.

Maximum Input Voltages and Power:

RF Output Connector: 50V DC, +23 dBm RF

Ext Trig/Ref Connector: 5.5 V DC

RF Input:

+27 dBm RF, ±50 VDC Max. (N991xA/B, N9925B, N9926A, N9928A, N993xA/B)

+23 dBm RF, ±50 VDC Max. (N9923A, N9923AN)

+25 dBm RF, ±40 VDC Max. (N995xA/B, N996xA/B)

DC Input: 19VDC, 4ADC, 60 Watts maximum when charging battery

NOTE

Learn more about ADC over range warnings by referring to Chapter 32, “System Settings,” and then to “SA” on page 863

The displayed power level is automatically adjusted for RF Attenuation. As the attenuation value changes, the displayed power level should NOT change.

How to set Attenuation

1. Press **Scale/Amptd**.
2. Then **RF Atten Auto Man**.
   - **Auto** RF Attenuation is set by adjusting the acquisition. As the acquisition is lowered, for example from –10 dBm to –30 dBm, the FieldFox assumes that you are looking at low-level signals. The RF Attenuation value is automatically lowered in 5 dB steps to allow low-level signals to be viewed. The RF Attenuation value is never automatically lowered below 5 dB.

– **Man** RF Attenuation is set manually. The default Attenuation setting is 10 dB. Enter a value between 0 to 30 dB in 5 dB steps using the numeric keypad, the ▲|▼ arrows, or the rotary knob. Then press **Enter**

#Atten xx dB is shown at the top of the screen. (#) means manual setting.

Preamplifier Control (Opt 235)

When **very low-level** signals are analyzed, an internal preamplifier can be used to boost the signal level by approximately 22 dB. The gain of the preamp is NOT adjustable. The displayed signal level is automatically adjusted for the increase in system gain.

How to control the Preamp

By default, the preamp is OFF.

– Press **Scale/Amptd**.

– Then **Preamp ON OFF** The underlined setting is the current setting. When ON, PA is shown to the left of the graticules on the display.

Check for Compressed Measurements

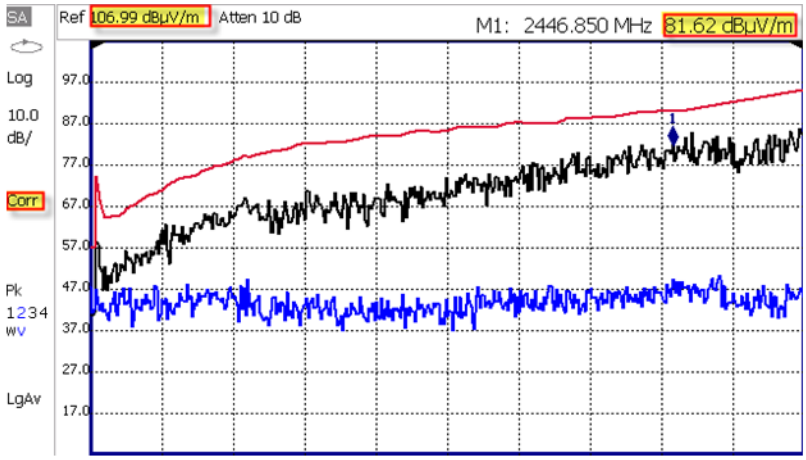
Compression occurs when too much power into an amplifier causes it to no longer amplify in a linear manner. When too much power goes into the FieldFox RF Input connector, the amplifiers in the SA receiver compress and signal power will not be displayed accurately. This can occur even if ADC Over Range is not displayed because devices other than the ADC, such as the mixer, might be compressed. Increase the RF Attenuation value to prevent the SA receiver from being compressed.

How to Check for a Compressed Measurement

1. Using a marker at the signal peak, make note of the signal power level.
2. Increase the RF Attenuation level by 5 dB.
   – If the signal level does NOT change, then NO compression exists. This indicates that the signal is in the linear region of the FieldFox receiver.
   – If the signal level DOES increase, then the receiver was compressed. Set the RF Attenuation value at the setting when further increases no longer result in an increase in the displayed power level.

Field Strength Measurements

To measure the strength of any signal transmitted through the air, an antenna must be connected to the FieldFox. The Field Strength feature allows you to enter the frequency response of the receiving antenna (the Antenna Factor) and associated cabling, and then have amplitude corrections automatically compensate the displayed trace for that response.



Setting Field Strength Measurements

Trace 1 - Corrected trace with antenna factor. (Antenna == ON, Apply Corr == ON)

Trace 2 - Uncorrected trace (Apply Corr == OFF). The Trace 2 trace state is "View." For information, refer to "Trace Display States (SA Mode)" on page 209

Pink Trace - Current correction factor. See below.

- Learn how to set Y-Axis **Units** on "How to Set Y-axis Units" on page 162.
- Use a Band Power marker to measure total power over a range of frequencies. Learn how in "Band/Interval Power Marker" on page 225

How to select and edit corrections for Field Strength measurements

The Antenna and Cable correction data survives a Mode Preset and Preset.

All Correction ON/OFF states survive a Mode Preset, but NOT a Preset.

- Press **Scale/Amptd** > **More** > **Corrections**
- Then choose from the following:
  - **Apply Corrections Auto Disabled** Use Auto and Disabled correction for all settings. (Default == Auto).

- **Antenna Off** – Opens a softkey menu to enable/disable a antenna and edit, save, create a new antenna factors table, recall, and set a storage device location. See also, "How to Use the Antenna and Cable Softkeys" on page 167.
- **Cable Off** – Opens a softkey menu to enable/disable a cable and edit, save, create a new cable description table, recall, and set a storage device location. See also, "How to Use the Antenna and Cable Softkeys" on page 167.
- **More** – Opens a softkey menu to View Corrections and set the Amplitude Correction type for your antenna.

  Learn more, see "Selecting and Viewing Corrections" on page 166.
- **More** – Edit/Recall an Antenna file to be used to transmit.
- **RcvrSide Antenna Off / On** Edit/Recall an Antenna file to be used to receive.
- **SrcSide Cable Off / On** Edit/Recall a Cable file to be used on the Source side.
- **RcvrSide Cable Off / On** Edit/Recall a Cable file to be used on the Receiver side.

Selecting and Viewing Corrections

- Press **Scale/Amptd** > **More** > **Corrections** > **More**
- **View Corrections ON OFF** Turn ON and OFF Pink Trace - Antenna/Cable corrections. This is a composite of all cable/antenna corrections that are currently applied. Available as a useful visual aid, the zero "dB" level (no net correction) is mapped to appear at the -50 dBm on-screen level.
- **Amp Corr Select [Triaxial XYZ]** - then choose one of the following:
  - **Default** Receiver side only antenna measurements.
  - **Src/Rcvr Split** to work with non-triaxial receiver and source side antenna measurements.
  - **Triaxial XYZ** (default, when Channel Power is on and when a compatible triaxial antenna's factors have been imported) for measuring channel measurements and EMF.
- **<Back** To return to previous softkey menu.

How to Use the Antenna and Cable Softkeys

The following menu appears when any of the above Antenna Off or Cable Off softkeys are pressed:

- **Antenna ON OFF** or **Cable ON OFF** – Turn correction ON or OFF for this Antenna/Cable.
- **Edit Antenna** or **Edit Cable**– Edit an Antenna/Cable Correction table. See "Using the Antenna/Cable Editor" on page 167 for more information.
- **New** – Create a new Antenna/Cable. See Using the Antenna/Cable Editor (below) for more information.
- **Save Antenna/Cable** – Save the modified Antenna/Cable to a file on the specified Storage Device.
- **Recall Antenna/Cable** – Read an existing Antenna/Cable file from the specified Storage Device.
- **Storage Device** – Choose from: Internal, USB, SD. Learn more about these selections in "Set File Type and Select Device" on page 894.

When finished, press **Back** to return to the previous menu.

Using the Antenna/Cable Editor

The Antenna Editor and the Cable Editor menus are very similar. Both tables include header information, and a Frequency/Value table.

Figure 9-2 FieldFox Antenna Editor– E–Field and H-Field Units Displayed

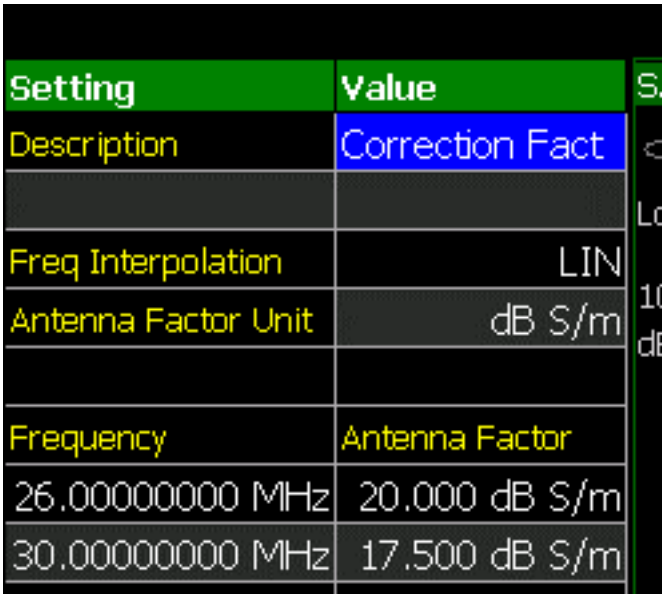
Description	Correction Fac
Freq Interpolation	LIN
Antenna Factor Unit	dB /m
Frequency	Antenna Factor
26.00000000 MHz	20.00 dB /m
30.00000000 MHz	17.50 dB /m
40.00000000 MHz	13.50 dB /m
50.00000000 MHz	10.50 dB /m
60.00000000 MHz	8.20 dB /m
70.00000000 MHz	7.20 dB /m
80.00000000 MHz	7.10 dB /m
90.00000000 MHz	7.30 dB /m
100.0000000 MHz	7.50 dB /m
110.0000000 MHz	7.60 dB /m
120.0000000 MHz	7.50 dB /m

E-Field Units

Description	Correction Fact
Freq Interpolation	LIN
Antenna Factor Unit	dB S/m
Frequency	Antenna Factor
26.00000000 MHz	20.000 dB S/m
30.00000000 MHz	17.500 dB S/m
40.00000000 MHz	13.500 dB S/m
50.00000000 MHz	10.500 dB S/m
60.00000000 MHz	8.200 dB S/m
70.00000000 MHz	7.200 dB S/m
80.00000000 MHz	7.100 dB S/m
90.00000000 MHz	7.300 dB S/m
100.0000000 MHz	7.500 dB S/m
110.0000000 MHz	7.600 dB S/m
120.0000000 MHz	7.500 dB S/m

H-Field Units

Figure 9-3 FieldFox Antenna Editors – Settings and Values



How to use the Antenna/Cable Editor

CAUTION

Before editing the antenna settings, it is important to know whether you are using a magnetic H-field (dB S/m) or electric E-field (dB /m) antenna. When you setup the Antenna Factor Correction table, you will select one of these two units so that the FieldFox knows how to convert the measurement data to various Field Strength Amplitude units.

1. Press **Scale/Amptd** > **More** > **Corrections** then choose:
   - **Antenna Off** to open the antenna editing softkeys
   - **Cable Off** to open the cable editing softkeys
2. Then **Edit Antenna** or **Edit Cable** to open the Antenna / Cable Editor.
3. Press **New** then **Yes** to clear all data from the existing Antenna or Cable table and reset header information to default settings.
4. Then use the ▲|▼ arrows to select a field.
   - To edit header information, press **Edit** then modify the selected field using the FieldFox labeler.
     - **Description**: Enter a description for the antenna or cable correction table. This is NOT the filename used to save the file.
     - **Antenna Factor Unit**: Determines whether Field Strength measurement Amplitude units will be available or not, and how to convert between them. Select **None** (default

setting) if you just want standard Amplitude units, with a simple dB offset supplied by the correction table. This makes the correction basically identical to a Cable correction. To get Field Strength units, you must choose either **dB /m** (E-field or dipole antenna), or **dB S/m** (H-field or loop antenna) to properly identify the Antenna Factors in the table. The scalar measurement Amplitude units (either standard or Field Strength) will then be available at Ampl/more Unit. Learn how in "Scale and Units" on page 161. For details on standard Amplitude units, refer to "How to Set Y-axis Units" on page 162.

- Freq Interpolation: Set to LINear by the FieldFox and can NOT be edited.

- To edit Frequency/Value pairs, enter numbers using the numeric keypad, and a frequency suffix when necessary.
  - For both Cable Loss and Antenna Factor values, Positive numbers indicate loss (we need ADD something positive to compensate for it), and Negative is indicative of some existing gain.
  - Antenna Factor describes the dB value needed to accurately display a far-field signal in terms that are in the units listed below. When the antenna has low gain, or low efficiency, the dB value to be added is larger.
  - Antenna Factor Unit sets the type of antenna factor unit used in your measurement (i.e., dB /m or dB S/m).
- When one Freq/Value pair is entered, that correction value is applied to the entire displayed frequency span.
- When two or more Freq/Value pairs are entered, the data points between the lowest and highest frequencies are corrected. Linear interpolation is applied between frequencies when necessary.

5. Optionally choose from the following:
   - Previous / Next Page Quickly scrolls through pages of Freq/Value data.
   - Add Row Add a blank Freq/Value pair to the table,
   - Delete/Clear then:
     - Delete Row Remove the selected Freq/Value pair from the table.
     - Clear All then Yes Remove all Freq/Value pairs from the table and resets header information to default settings.

When the table edits are complete

1. Press **Done** to close the Antenna/Cable Editor.
2. Press **Antenna Off On** > **On**.

   Then choose your final measurement amplitude unit, under Scale/more. If you selected either **dB /m** or **dB S/m** for the Antenna Factor unit, you should see this list of available Field Strength units
3. Press **Scale/Amptd** > **More** > **Unit dBuV/m** and choose from:
   - **dBµV/m** == dB micro Volts per meter
   - **dBm/m^2** == dBm per meter squared
   - **V/m** == volts per meter
   - **W/cm^2** == watts per cm squared
   - **W/m^2** == watts per meter squared
   - **dBµA/m** == dB micro Amps per meter
   - **dBG** == dB gauss
   - **dBpT** == dB pico tesla
4. Press **Back** > **Back** > **Save Antenna** or **Save Cable** to save your changes to the specified Storage Device. Enter a filename using the FieldFox labeler (learn more in "How to use the FieldFox labeler " on page 891). Learn more about Antenna and Cable files below.

Optional:

- Press **Recall Antenna** or **Recall Cable** to load an Antenna or Cable file from the specified Storage Device.
- **Storage Device** Changes the device used to save or recall files. Choose from Internal (default setting), USB (must be connected) or SD card. This is a different setting from the Save/Recall Storage Device setting.

About Antenna and Cable files

- Cable files are saved and recalled from the **Cables** folder.
- Antenna files are saved and recalled from the **Antenna** folder.
- To **DELETE** Cable or Antenna files, use the Manage Files feature. Learn more in "Manage Files" on page 897.
- If the folder does not already exist on a USB or SD card, it is created automatically before storing the file.

- All Antenna and Cable files are saved and recalled as *.csv files, which allows them to also be read by spreadsheet programs.
- The FieldFox can also read *.ANT (Antenna) files that were created from older Keysight Spectrum Analyzers.
- Cable and Antenna (*.csv or *.ANT) files canNOT be edited in Data Link software.

How to create a Cable file from an S21 (NA mode) or an Insertion Loss (CAT mode) measurement

1. Measure the S21 or Insertion Loss of a cable. In NA mode, select either LogMag, Linear, or VSWR formats.
2. Use Manage Folders to change the active folder to CABLES. Learn how in "Manage Files" on page 897.
3. While in NA mode, save the measurement as a *.csv file. Learn how in "How to Save a File" on page 888.
4. In Channel Scanner or SA mode, select **Corrections**, then recall the *.csv file for correction.

Source Tracking Offset and Offset Reversal

This feature requires:

- N991xB and N995xB FieldFox Combination Analyzers to have Options 209, 210, and 233
- N993xB and N996xB Spectrum Analyzers to have Options 209 and 220

Source offset tracking is used to offset the Source frequency from the Receiver frequency by a fixed offset at every tune frequency. This feature is used when the DUT contains a frequency translation device or mixer.

How to set Tracking Offset and Offset Reversal

1. On the Receiver unit, press **Measure 1** > **Source** > **Advanced**
2. Then choose one or both of the following:
   - **Tracking Offset** Enter an offset value (Default == OFF).
   - **OffsetReversal** Determines whether Receiver Freq is added to or subtracted from the Offset Freq.
     - **OFF** SourceFreq = Offset + RecFreq. Use to measure Upconverters.

– **ON** SourceFreq = Offset - RecFreq. Use to measure Downconverters. The source sweeps in Reverse direction. Note: The Offset Freq. MUST be larger than the Receiver Stop Freq.

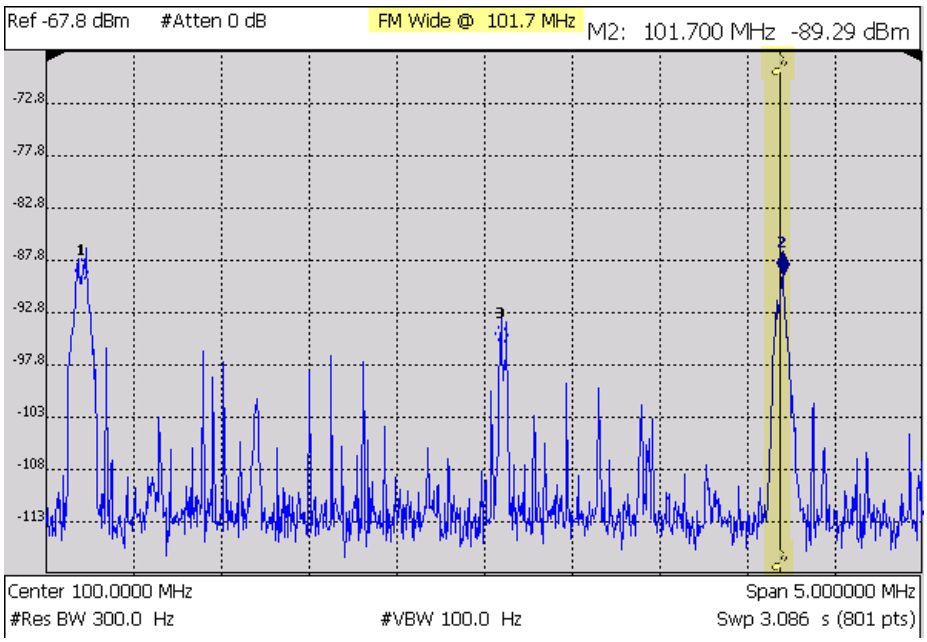
Tune & Listen (AM/FM)

The Tune & Listen feature can be used to identify an interfering AM or FM signal.

The demodulated AM or FM signal can be heard through the internal speaker or through headphones using the 3.5 mm jack located on the FieldFox side panel.

The Tune & Listen tuner is separate from the SA display. This allows you to listen to one frequency while displaying a different range of frequencies. The Tune & Listen measurement alternates between normal SA sweeps for the display and performing audio demodulation at the Tune Frequency. See the Listen Time setting for more information.

Figure 9-4 Tune & Listen ON



In the graphic above, Tune & Listen ON with Tune Frequency is indicated by a vertical bar (highlighted).

This section contains the following:

"How to select Tune & Listen" on page 173
– "TnL AM SSB Gain" on page 173
"Tune Frequency" on page 174

"Listen Time" on page 174
"To select Listen Time:" on page 175
"Volume Control" on page 175
"Audio Demod ON and OFF" on page 175
"Setting the Marker Counter Precision Softkey" on page 175
"Setting the Mkr->TuneFreq Softkey" on page 176

How to select Tune & Listen

– Press **Measure 1** > **Analog Demod Tune & Listen** > **Tune & Listen**

– Then choose a demodulation type. Select a setting based on the type of interfering signal you suspect is being broadcast.

  Press **Meas Setup 4** > **Tnl Demod Type** then

  – **AM** – Sets AM (Double-sideband with carrier) as the modulation type.

  – **FM Narrow** – Sets Frequency Modulation; Narrow bandwidth. Choose when interfering transmission consist of voice or data.

  – **FM Wide** – Sets Frequency Modulation; Narrow bandwidth. Choose when interfering transmission consist of voice or data.

  – **AM USB** – Sets the modulation type to AM upper sideband. Annotation: AM USB @ *Center Frequency* displayed at the top of display. See also, "TnL AM SSB Gain".

  – **AM LSB** – Sets the modulation type to AM lower sideband. Annotation: AM LSB @ *Center Frequency* displayed at the top of display. See also, "TnL AM SSB Gain".

See also, "How to select Analog Demod (Metrics)" on page 178.

TnL AM SSB Gain

When you select **AM USB** or **AM LSB** softkeys, the **TnL AM SSB Gain** softkey becomes active.

– Press **Meas Setup 4** > **More** then

– **TnL AM SSB Gain** – sets the gain in the IF path for TnL SSB measurements (the optimal IF path gain is automatically determined/set for regular AM and all the other demod types, but it cannot be automatically determined for AM SSB so it has to set it manually).

The goal is to set the gain as high as possible (to take advantage of the range of the IF and audio paths) without distorting the audio signal. It is recommended that you keep increasing the gain until you hear distortion in the audio and then back off until you no longer hear any distortion. (Default == 0, Minimum == –50 dB, Maximum == +50 dB)

NOTE The system volume setting should still be used to determine the final desired volume/level of the audio output. Learn more, see also Chapter 32, "System Settings." and "Audio (Volume) Control" on page 839.

Tune Frequency

The Tune & Listen tuner is separate from the SA display. This allows you to listen to one frequency while displaying a different range of frequencies.

Set the Tune Frequency using one of three methods:

1. Selecting **Preset** > **Mode Preset**, sets Tune Frequency to 3.25 GHz (e.g., for a N9914B FieldFox).
2. Specify Tune Frequency:
   a. Press **Meas Setup 4** > **Tune Freq**
   b. Enter a value using the numeric keypad, ▲|▼ arrows, or the rotary knob. Then select a multiplier key. Learn about multiplier abbreviations "Multiplier Abbreviations" on page 48.
3. Using Mkr->Tune Freq:
   – Create a normal marker at the frequency of interest. Learn how in "How to create Markers" on page 797.
   a. Press **Mkr->/Tools**
   b. Then **Mkr->TuneFreq** to change the Tune Frequency to that of the marker.

NOTE To improve sound quality, try increasing power by reducing the Attenuation setting and, if available, turn ON the Preamplifier. Learn how in "Attenuation Control" on page 163

Listen Time

While Tune & Listen is actively demodulating a signal, the SA does not sweep and update the display. Listen Time sets the amount of time that the FieldFox demodulates, then stops to perform a single sweep and update the display, then again demodulates.

To select Listen Time:

– Press **Meas Setup 4** > **Listen Time**

– Enter a value using the numeric keypad, ▲|▼ arrows, or the rotary knob. Then select a multiplier key. Learn about multiplier abbreviations.

Volume Control

To increase or decrease the Volume of the demodulated signal:

– Press **Meas Setup 4** > **Volume**

– Enter a value in percent between 0 and 100 (loudest) using the numeric keypad, ▲|▼ arrows, or the rotary knob.

– Volume can also be changed and easily muted from the **System** menu. Learn more in "How to set the FieldFox Volume Control" on page 839.

Audio Demod ON and OFF

To quickly stop the audio demodulation and perform only the normal SA sweeps, select the following:

– Press **Meas Setup 4** > **Audio Demod ON OFF** > **OFF**

Setting the Marker Counter Precision Softkey

When **AM Tune & Listen**, **FM (narrow) Tune & Listen**, or **FM (wide) Tune & Listen** are selected, you can choose from the following:

– Press **Marker** > **Peak**

– Press **Mkr->/Tools** > **More** > **Mkr Properties** > **Counter Precision** – Sets the AM or FM Metric demodulated signal's marker precision (.1 Hz, 1 Hz, 10 Hz; Default == 0.1 Hz).

The Counter Precision softkey is **not** available when AM Metric or FM Metric are enabled. See also, "Setting the Mkr->TuneFreq Softkey" on page 176.

Setting the Mkr->TuneFreq Softkey

When **AM Tune & Listen**, **FM (narrow) Tune & Listen**, or **FM (wide) Tune & Listen** are selected, you can choose from the following:

– Press **Marker** > **Normal**

– Press **Mkr->/Tools** > **Mkr->TuneFreq** – The Tune & Listen Frequency becomes the frequency of the active marker (When **AM Metrics** or **FM Metrics** are selected this softkey is inactive).

See also, "How to use Marker Functions" on page 810.

Analog Demod

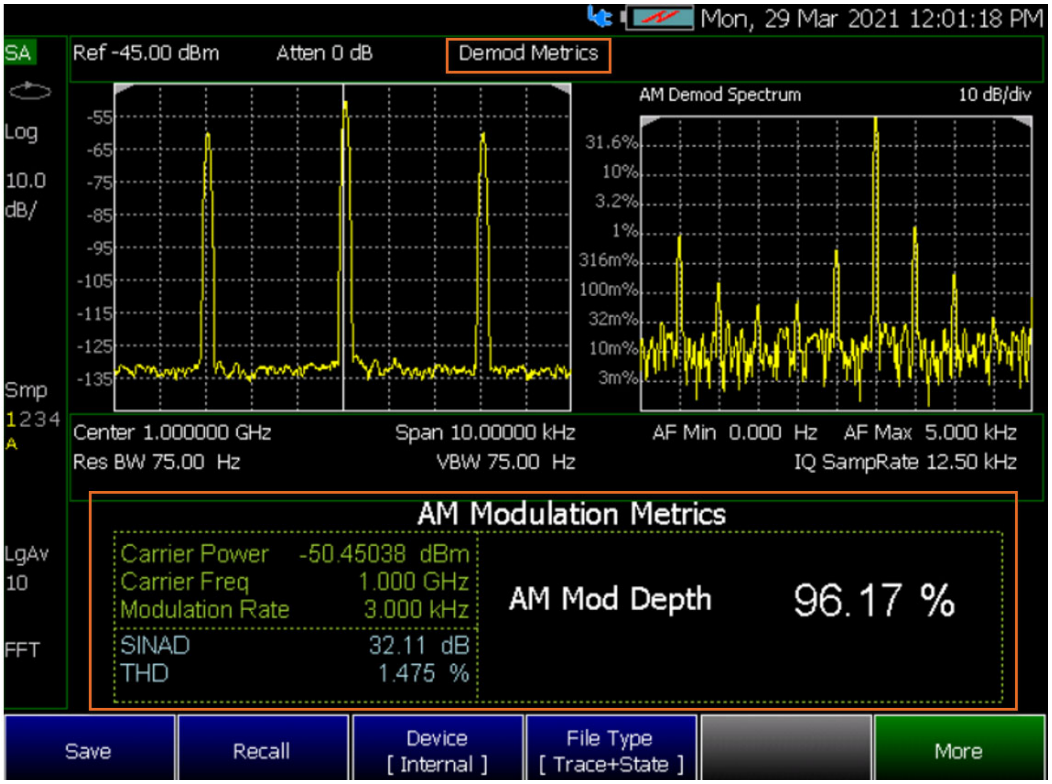
CAUTION Triggering is not available when you are using the Analog Demod feature.

The Tune & Listen feature can be used to identify an interfering AM or FM signal. Also, AM/FM Metrics displays the demodulated signal and the audio frequency spectrum.

The demodulated AM or FM signal can be heard through the internal speaker or through headphones using the 3.5 mm jack located on the FieldFox side panel.

The Analog Demod spectrum is displayed alongside the SA displayed trace. This enables you to listen and display a carrier frequency and it's harmonics. The Analog Demod measurement displays a normal SA sweeps for the display while performing audio demodulation at the carrier Frequency. See the "How to select Analog Demod (Metrics)" on page 178 setting for more information.

Figure 9-5 AM DSB (Metrics) – Demodulation Spectrum



In the graphic above, Analog Demod ON and Demod Metrics is indicated above in the x2 displays of carrier spectrum content. For this example, AM Modulation Metrics are displayed in the lower half of the display. See also, Figure 9-6 on page 185, Figure 9-7 on page 185, Figure 9-8 on page 186, and Figure 9-9 on page 186.

This section contains the following:

"How to select Analog Demod (Metrics)" on page 178

"How to make Analog Demodulation (Metrics) Settings" on page 179

"Setting the Alternate Frequency (AF) Freq/Dist Softkeys" on page 180

"Setting the Alternate Frequency (AF) RBW Softkey" on page 180

"Setting the Audio Capture Playback Softkeys" on page 181

"How to Set the Demod Filters" on page 182

"Setting the Marker Counter Gate Softkey" on page 184

How to select Analog Demod (Metrics)

Analog demodulation can demodulate AM DSB, AM SSB, FM, FM Stereo / RDS, PM signals. Under analog demodulation metrics the following information is reported for each signal type: Carrier power, modulation rate, SINAD, THD, plus deviation, depth, or RMS depending on the signal. Metrics also displays the demodulated signal and the audio frequency spectrum.

Learn more, Chapter 28, “AM/FM Metrics (SA Only and Option 355).”

– Press **Measure 1** > **Analog Demod Tune & Listen** > **Analog Demodulation**

– **Demod Type** – Then choose a demodulation metric type. Select a setting based on the type of interfering signal you suspect is being broadcast.

NOTE

IMPORTANT! The FieldFox contains only one speaker that supports mono audio output (i.e., if you play a stereo WAVE file, the Left and Right channels are output in mono audio). If you want to output a stereo WAVE file in stereo (to hear the left and right channels separately on the FieldFox) you have to use the headphone jack and stereo headphones (i.e., most earbuds, headphones, etcetera support stereo). Learn more, see also Chapter 32, “System Settings.” and “Audio (Volume) Control” on page 839.

– **AM** – AM (double sideband). Displayed values for AM Modulation (metrics) – (i.e., includes AM Mod Depth, AM Demod Waveform, SINAD, THD, Carrier Power, Carrier Freq, Modulation rate).

– **AM SSB** – AM single sideband. Displayed values for AM SSB (metrics) – (i.e., includes SSB RMS Level, SSD Demod Waveform, SINAD, THD, RF Power, Modulation rate).

– **FM** – Displayed values for FM Modulation (metrics) (i.e., includes Freq Deviation, FM Demod Waveform (Time)/Spectrum (Frequency), Carrier Power, Carrier Freq, Modulation Rate, SINAD, THD).

– **FM Stereo / RDS** – Displayed values for FM Stereo / RDS (Radio Design System); (Metrics) – (i.e., includes Freq Deviation, FM Demod Waveform (Time)/Spectrum (Frequency), Carrier Power, Carrier Freq, Modulation Rate, SINAD, THD, Dist/ Total VRMS).

NOTE

When FM Stereo /RDS is selected as the demodulation type, a Warning message is displayed for a few seconds at the start of the sweep; the sweep is 30 to 50 seconds long.

The message reads:

```
"Warning: Slow Measurement. RDS Measurement in Progress."
```

– **PM** – Displayed values for PM Modulation Metrics (i.e., includes PM Deviation, PM Demod Waveform, SINAD, THD, Carrier Power, Carrier Freq, Modulation Rate).

– **Tune & Listen OFF** – Opens a menu of Tune & Listen demod softkeys. Tune & Listen can be set when you are in Analog Demodulation mode, so you can enable Tune & Listen sweeps in between your Analog Demod sweeps. To learn more about the Tune & Listen softkey menu choices, refer to "Tune & Listen (AM/FM)" on page 172.

See also, "How to make Analog Demodulation (Metrics) Settings" on page 179.

How to make Analog Demodulation (Metrics) Settings

The following softkeys are available when one of the Analog Demodulation metrics measurements is pressed. See also, "How to select Tune & Listen" on page 173.

If **AM DSB**, choose from:

– **AM Top Y** – Determines the Y axis percentage (0% to ±100%) of the AM demodulation waveform is displayed (Default == 100%).

If **AM SSB**, choose from:

– **SSB Top Y** – Determines the Y axis voltage (0 nV to ±100mV) of the AM SSB demodulation waveform is displayed (Default == 100 mV).

If **FM**, choose from:

– **FM Top Y** – Determines the Y axis frequency (1 kHz to 1 GHz) of the FM demodulation waveform is displayed (Default == 100 kHz).

If **FM Stereo / RDS**, choose from:

– **FM Top Y** – Determines the Y axis frequency (1 kHz to 1 GHz) of the FM demodulation waveform is displayed (Default == 100 kHz).

If **PM**, choose from:

– **PM Top Y** – Determines the Y axis phase (0 to 100 radians) of the PM demodulation waveform is displayed (Default == 5).

For any of the following: **AM DSB**, **AM SSB**, **FM**, **FM Stereo / RDS**, or **PM**, choose from:

Refer to Figure 9-6 on page 185, Figure 9-7 on page 185, Figure 9-8 on page 186, and Figure 9-9 on page 186.

– **Demod SwpT** – Sets the X-axis to display the demodulation sweep time for the demodulated waveform (minimum == 50 µs; maximum == 50 ms).

- **Peak OFF ON** – This adds peak positive and peak negative metrics to the main metrics measurement. For example, in FM peak ON will include peak positive (Peak +) and negative (Peak -) frequency deviation metrics to appear. Peak ON will also enable peak traces on the demodulation waveform and audio frequency spectrum (Default == OFF).
- **Demod Type** – Sets the demodulation type.

  Choose from **AM**, **AM SSB**, **FM**, **FM Stereo / RDS**, and **PM**.
- Then, press **More** – opens a menu of softkeys: **Average Type**, **Average Count**, and **Demod View Time Freq**.
- **Average Type** – Selects the way the demodulated signal values are averaged. Choices are Power (`#PAvg` annotation is displayed), Log (`#LgAv` annotation is displayed), Voltage (`#VAvg` annotation is displayed). Auto is the default and when selected the FieldFox chooses the type of averaging that is used based on the current settings.
- **Average Count** – Determines the amount of averaging used (1 to 10K; Default == 10).
- **Demod Filters** – Refer to "How to Set the Demod Filters" on page 182.
- **Demod View Time Freq** – Toggles how the demodulated signals are displayed (Time (waveform) or Frequency (spectrum)); Default == Time).
- **Audio Capture Playback** – Refer to "Setting the Audio Capture Playback Softkeys" on page 181.

Setting the Alternate Frequency (AF) Freq/Dist Softkeys

When **AM DSB**, **AM SSB**, **FM**, **FM Stereo / RDS**, or **PM** are selected and **Demod View** = **Freq**, you can choose from the following:

- Press **Freq/Dist** then choose:
- **AF Start Freq** – Sets the AF start frequency for the AM or FM demodulated signal.
- **AF Stop Freq** – Sets the AF stop frequency for the AM or FM demodulated signal.
- **AF Full Span** – Sets the AF full span frequency for the AM or FM demodulated signal.

  Also, you can set the standard Center, Freq Span, and other frequency softkeys.

Setting the Alternate Frequency (AF) RBW Softkey

When **AM DSB**, **AM SSB**, **FM**, **FM Stereo / RDS**, or **PM** are selected and **Demod View** = **Freq**, you can choose from the following:

– Press **BW 2** then choose:

– **AF RBW** – Sets the audio frequency (AF) resolution BW for the AM or FM demodulated signal (Manual or Auto; Default == Auto).

Setting the Audio Capture Playback Softkeys

The FieldFox analog demodulation audio capture playback feature allows you to capture/record the demodulated audio associated with an analog demodulation measurement (AM DSB, AM SSB, FM, FM Stereo or PM) and save it as an audio file. It also allows you to recall and playback audio files through FieldFox's built-in speaker or headphones.

NOTE

Currently, the audio capture playback feature supports WAVE files with mono or stereo LPCM data sampled at 48,000 Hz with 16 bits per sample.

If you are unable to hear your audio data files (*.wav), verify that your System > Preferences > Preferences > Audio is set to On.

When **Analog Demod** is selected, you can choose from the following:

– Press **Meas Setup 4** > **More** > **Audio Capture Playback** then

– If you want to initiate an audio capture:

  Press **Capture**

– If you want to stop an audio capture:

  Press **Stop** to stop the current capture of audio data and depending on the timing of pressing Stop, possibly prevent the audio data from being stored.

– If you have previously stored an audio file:

  Press **Playback** then

  – **Play** – to play the last current audio file (*.wave) loaded into memory.

  – **Stop** – to disable playback of the current audio file.

  – **Volume Mute** – to enable disable volume and to adjust the volume from 0 to 100 (Default == Mute /Volume == 10).

  – **Load Audio File** – to load a previously stored audio (.wave) file.

  – **Cap Auto–Load** – enable/disables automatically loading of a captured audio (.wav) file (Default == OFF).

– Press **Capture Settings** then

  – **Capture Count** – sets the number of audio captures for a measurement (Default == 1; Settable: 1 to 100K).

  – **Capture Time** – sets the capture time (Default == 100 ms). Minimum/Maximum capture times vary with other settings.

– **Stereo Channel** – When **Demod Type = FM Stereo / RDS**, this softkey sets the type of audio to be captured and stored: (Choose single channel: **Mono (L+R)**, **Left (L)**, **Right (R)**, and **Difference (L–R)**. Or choose two channel: **Stereo (L&R)**. Default == Mono (L+R). See Stereo Channel Softkey Descriptions table.

Stereo Channel Softkey Descriptions:

Mono (L+R)	Sets the audio recording to Mono (single channel) and combining left and right speaker sounds. This is the default.
Stereo (L&R)	Sets the audio recorded to be stereo (two channels).
Left (L)	Sets the audio to be recorded to be the left speaker only.
Right (R)	Sets the audio to be recorded to be the right speaker only.
Difference (L–R)	Sets the audio to be recorded to be the value of the left side minus the right side of the audio data (single channel).

– Press **Back** to return to previous menu.

– Then **File Settings** then

– **Filename** – Opens the filename labeler to specify a filename.

– **Timestamp OFF ON** – Enables/disables a timestamp label on your audio (.wav) filename.

– **Storage Device** – Sets the storage device location for your audio (.wav) file. Select **Internal** (default), **SD Card**, or **USB**.

For more on file settings refer to Chapter 34, “File Management.”

How to Set the Demod Filters

The demodulation (Demod) filters and de-emphasis options help you accurately recover and analyze the modulating signal. The demod filters apply to all demod types (AM DSB, AM SSB, FM, FM Stereo and PM), while the de-emphasis options only apply to the FM and FM stereo demod types.

– Press **Meas Setup 4** > **Demod Filters** then

– **Lowpass Filter None** – then choose:

None	No lowpass filter is selected.

300 Hz	5-Pole Butterworth LPF with 3 dB cutoff frequency of 300 Hz.
3 kHz	5-Pole Butterworth LPF with 3 dB cutoff frequency of 3 kHz.
15 kHz	5-Pole Butterworth LPF with 3 dB cutoff frequency of 15 kHz.
30 kHz	3-Pole Butterworth LPF with 3 dB cutoff frequency of 30 kHz.
80 kHz	3-Pole Butterworth LPF with 3 dB cutoff frequency of 80 kHz.
100 kHz	3-Pole Butterworth LPF with 3 dB cutoff frequency of 100 kHz.
20 kHz	9-Pole Bessel LPF with 3 dB cutoff frequency of 20 kHz.
300 kHz	3-Pole Butterworth LPF with 3 dB cutoff frequency of 300 kHz.
Custom	5-Pole Butterworth LPF with a custom 3 dB cutoff frequency (determined by the LPF 3 dB Cutoff setting).

– **LPF 3 dB Cutoff 300.000 Hz** – When the Lowpass filter is set to **Custom**, sets the customized LPF 3 dB cutoff frequency for the lowpass filter (Default == 300 Hz; Minimum == 90 Hz, Maximum == 5 MHz).

– **Highpass Filter None** – then choose:

None	No highpass filter is selected.
20 Hz	2-Pole Butterworth HPF with 3 dB cutoff frequency of 20 Hz.
50 Hz	2-Pole Butterworth HPF with 3 dB cutoff frequency of 50 Hz.
300 Hz	2-Pole Butterworth HPF with 3 dB cutoff frequency of 300 Hz.
400 Hz	10-Pole Butterworth HPF with 3 dB cutoff frequency of 400 Hz.
Custom	5-Pole Butterworth HPF with a custom 3 dB cutoff frequency (determined by the HPF 3 dB Cutoff setting).

- **HPF 3 dB Cutoff 500.000 Hz** – When the Highpass Filter is set to **Custom**, sets the customized HPF 3 dB cutoff frequency for the highpass filter (Default == 500 Hz; Minimum == 20 Hz, Maximum == Varies, depending on the AF Span).
- **Bandpass Filter None** – Sets the Bandpass Filter for the current measurement (Choices: None, CCITT, A-Weighted, C-Weighted, C-Message, CCIR-1k Weighted, CCIR-2k Weighted, or CCIR Unweighted). Default == None.
- **More** – **FM and FM Stereo only**. Opens a softkey menu to enable/disable the De-Emphasis softkeys.
  - **De-Emphasis OFF ON** – Enables/disables the de-emphasis applied to the demodulated signal.
  - **De-Emphasis T** – Sets the amount of de-emphasis applied to the demodulated signal.

Setting the Marker Counter Gate Softkey

When **AM Metric** or **FM Metric** are selected, you can choose from the following:

- Press **Marker** > **Peak**
- Press **Mkr->/Tools** > **More** > **Mkr Properties** > **Counter Gate** – Sets the AM or FM Tune & Listen demodulated signal's counter window time (Minimum == 1 ms and Maximum == 2s; Default == 100 ms).

  The Counter Gate softkey is **not** available when AM Tune & Listen, FM (narrow) Tune & Listen, or FM (wide) Tune & Listen are enabled. Refer to Figure 9-9 on page 186.

See also, "How to use Marker Functions" on page 810.

Figure 9-6 AM DSB (Metrics) – Demodulation Waveform

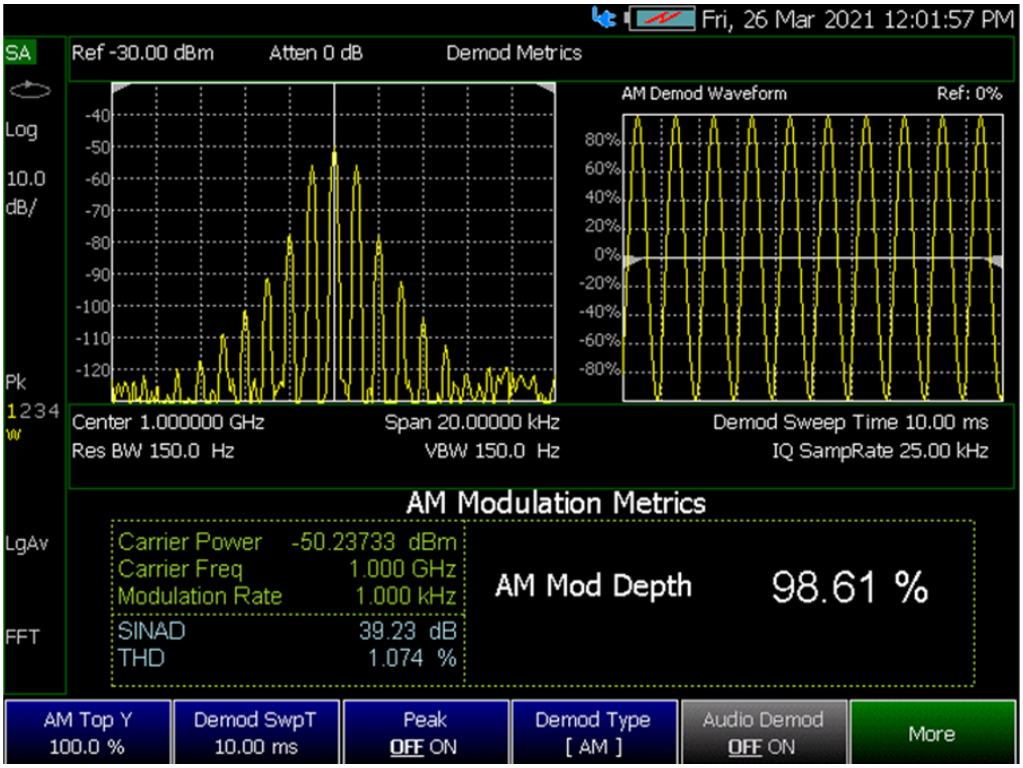


Figure 9-7 FM Metrics – Demodulation Spectrum

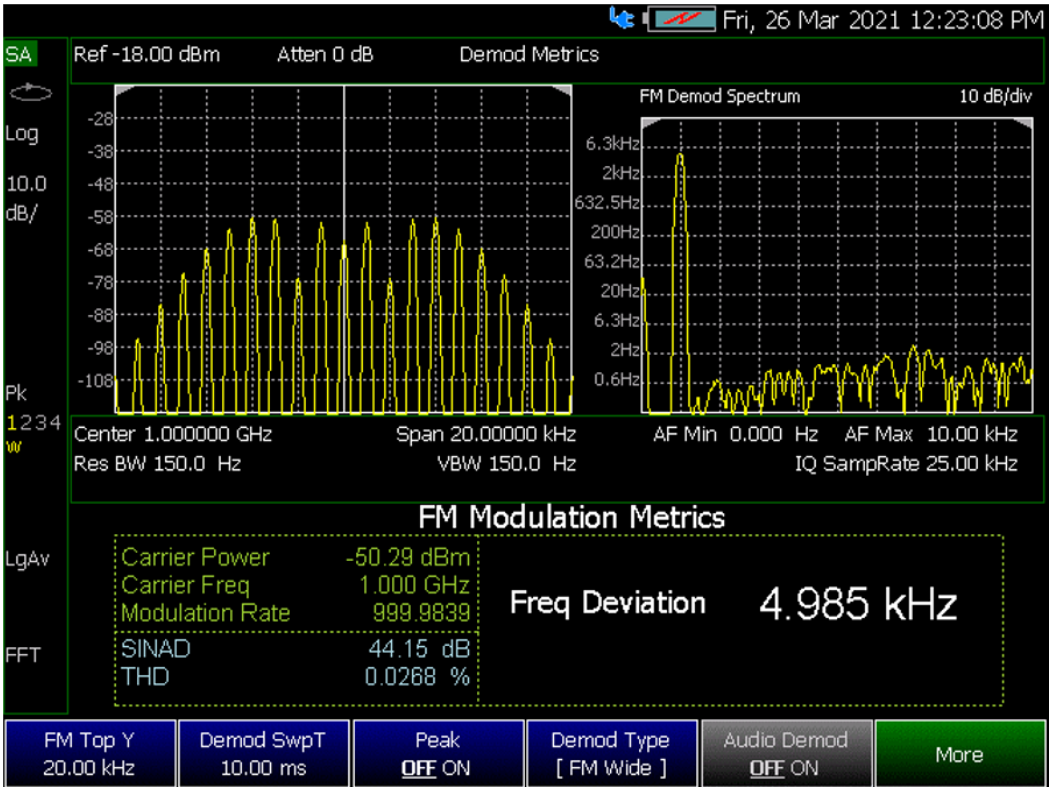


Figure 9-8 FM (Metrics) – Demodulation Waveform

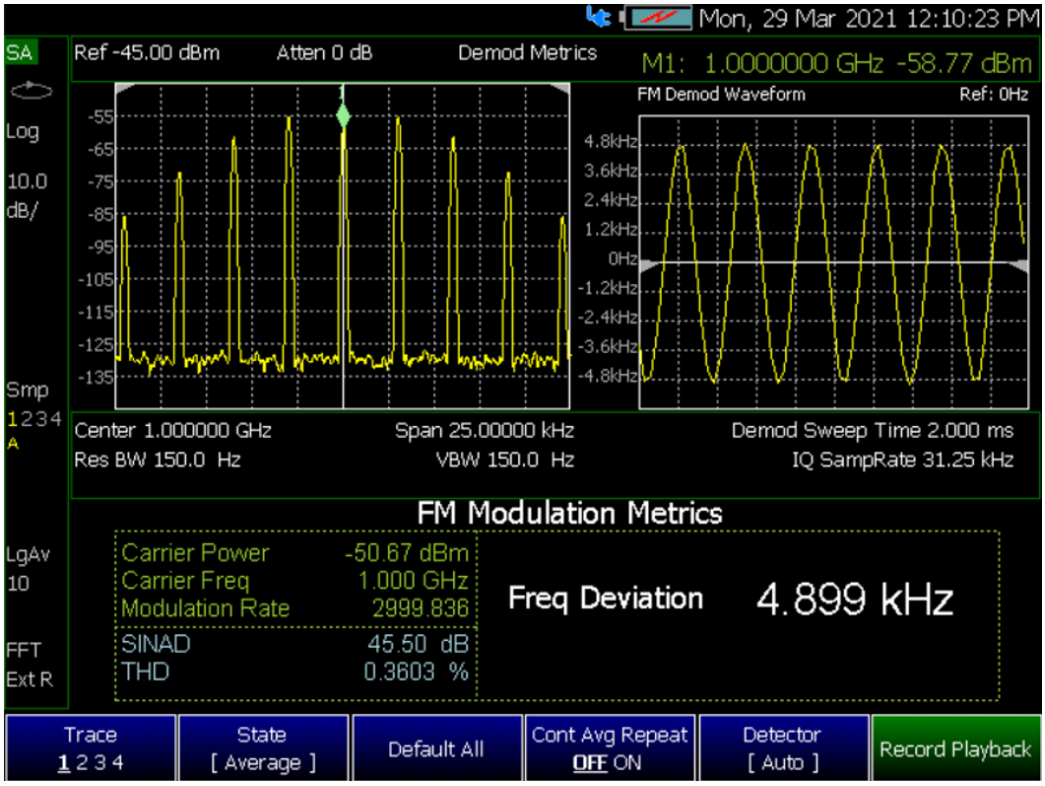


Figure 9-9 FM (Metrics) - Counter Gate and FM Demodulation Waveform

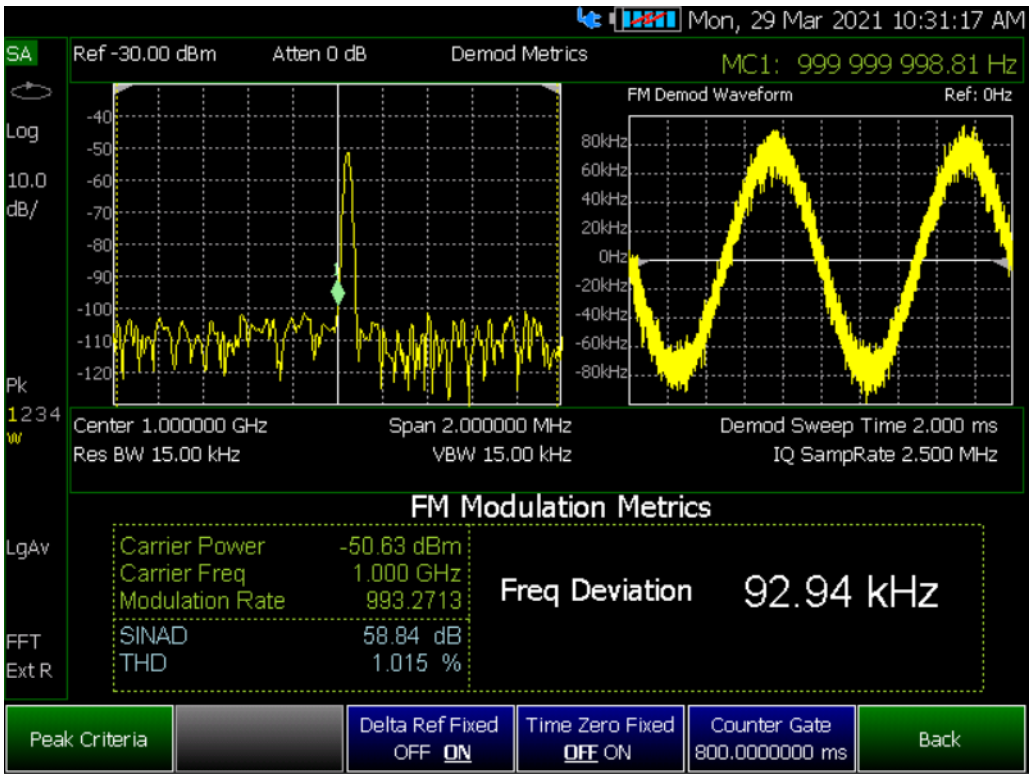
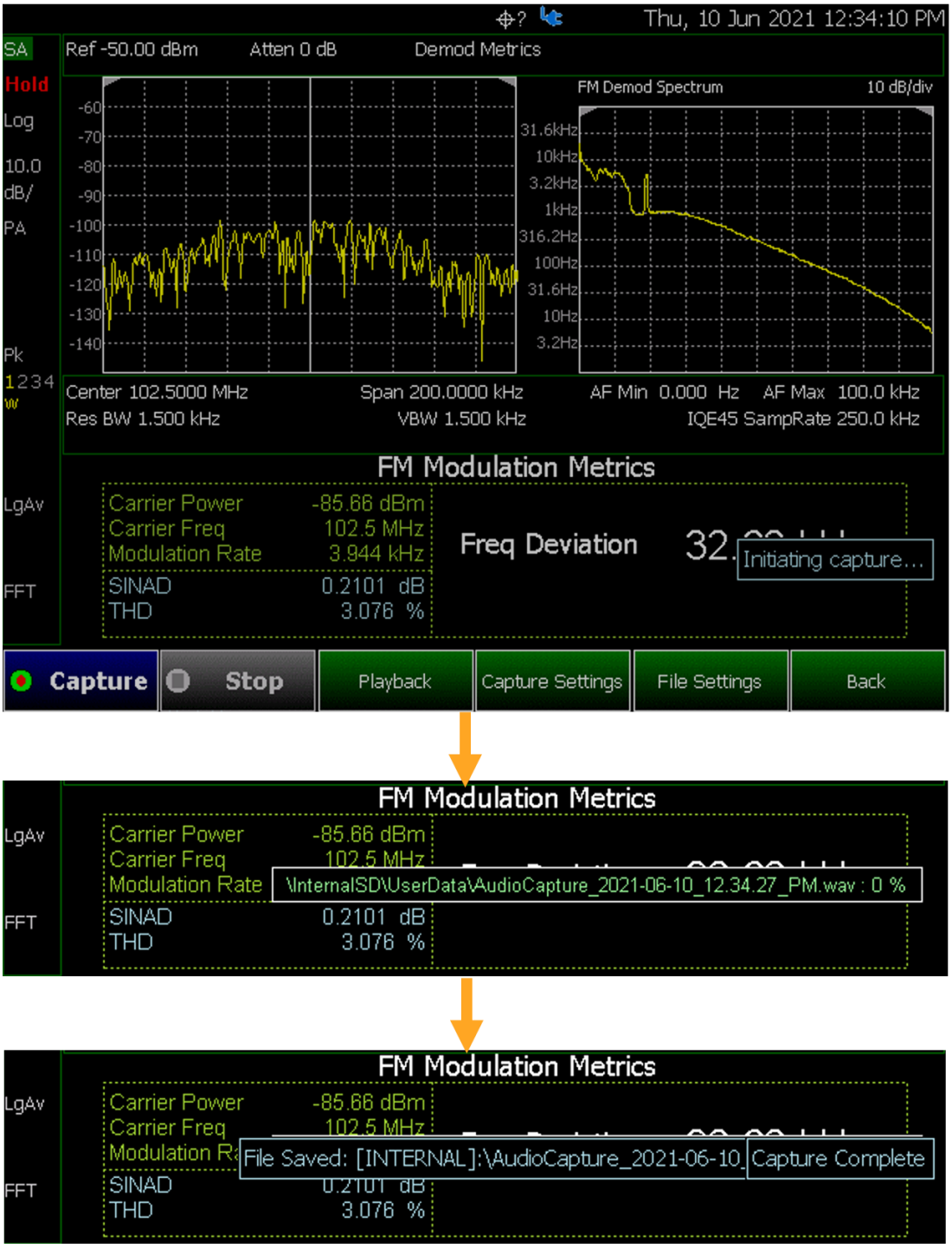


Figure 9-10 Audio Capture with Annotation Examples



Independent Source/Tracking Generator

NOTE

For best results, when using the independent source feature, InstAlign and the battery saver features should be turned off. Refer to "All Alignment and Align All Now" on page 215 and "Preferences" on page 850.

This feature may require an option. For a comprehensive list, view the FieldFox Configuration Guide at:
https://www.keysight.com/us/en/assets/7018-06515/configuration-guides/5992-3701.pdf

A tracking generator, a popular option with Spectrum Analyzers, is a source which always tracks the SA receiver.

Like a traditional tracking generator, the Independent Source feature can set the internal FieldFox source to track the SA receiver frequency range. It can also set the internal source to a CW frequency that is independent of the SA frequency.

To view the internal source, you must connect a cable or device between the RF Output connector and the RF Input connector.

How to make Independent Source Settings

- Press **Measure 1** > **Source**
- **Source Enable ON OFF**
  - **ON** Turns ON the internal source.
  - **OFF** Turns OFF the internal source.
- **Source Tracking** Choose from the following:
  - **Sweep** The internal source frequency can track the SA receiver. Center frequency Src is annotated on the screen

NOTE

Sweep softkey is only available if the SA is licensed with Tracking Generator capability (Option 220 for SA only model or Option 210 for combo boxes VNA/NA model). Refer to Figure 9-12 on page 190.

  - **OFF** The source is set to a CW frequency independent from the SA settings. Srcw is annotated on the screen.
  - **Center Freq** The source is set to a CW frequency, but that frequency "tracks" the SA receiver Center Frequency settings. Therefore, the signal always appears at center of the display. Srcp is annotated on the screen.

- **Pulse Gen** Only enabled for B/C model equipped with Pulse Generator license (Option 357) and operating in SA mode. SrcPg is annotated on the screen. Refer to "Track the Pulse Generator " on page 191

- **Source Power** Sets the source power level. Choose from:
  - **Leveled** Enter a value from –60 dBm to 10 dBm using the numeric keypad, ▲|▼ arrows, or the rotary knob[1]. The source power is reasonably flat across the frequency span.
  - **MAX** The power level is set to the maximum achievable power level at each frequency. This results in the power level NOT being flat across the frequency span.
- **Source CW Freq** Sets the CW frequency that is used.

NOTE When Source Enable is ON, **Source CW Freq** softkey is enabled ONLY when Source Tracking is set to OFF.

- **Advance** Only activated exclusively with the Sweep Tracking license (TG capability). Choose one or both of the following:
  - **Tracking Offset** Enter an offset value using the numeric keypad, ▲|▼ arrows, or the rotary knob. The offset value range is +/- maximum frequency of the model.
  - **OfsTrk Reversal** Determines whether Receiver Freq is added to or subtracted from the Offset Freq.
    - **OFF** SourceFreq = Offset + RecFreq. Use to measure Upconverters.
    - **ON** SourceFreq = Offset - RecFreq. Use to measure Downconverters. The source sweeps in Reverse direction.

NOTE For the OfsTrk Reversal ON, the Offset Frequency MUST be larger than the Receiver Stop Frequency.

NOTE The Independent Source output signal may be momentarily interrupted for automatic SA Receiver alignments or Battery Saver functionality.

To prevent automatic alignments from interrupting the source, turn off all alignment. Refer to "All Alignment and Align All Now" on page 215.

- Press **Cal 5**
- Then press **All Alignment** and select **OFF** or **Hold** to disable All Alignment

1. N995xB/6xB cannot have the Leveled value set lower than –35 dBm.

To prevent Battery Saver from interrupting the source, turned off Battery Saver. Learn more in “Battery Saver” on page 853.

– Press **System 7** > **Preferences** > **Preferences**
– Then in the table, select Battery Saver value column and press **Edit**
– Then press **Battery Saver** to toggle OFF to disable Battery Saver
– Then press **Done Edit** to commit the edit

Figure 9-11 Source Tracking Softkey Menu in SA mode without Tracking Generator Capability

Figure 9-12 Source Tracking Softkey Menu in SA mode with Tracking Generator Capability

Track the Pulse Generator

This feature required Pulse Generator license (Option 357), allows the Independent Source mode to effectively retain the settings from the most recent activity, specifically when the Pulse Generator mode was last used with RF enabled.

To utilize this new features, users should navigate to the Pulse Generator, configure a signal and ensure that RF is set to ON. Learn more in Chapter 25, “Pulse Generator – Option 357”, on page 635.

How to make Pulse Generator Tracking Settings

– Press **Measure 1** > **Source** > **Source Tracking**

– Then press **Pulse Gen** Only enabled for B/C model equipped with Pulse Generator license (Option 357) and operating in SA mode. Track the pulse generator signal to replicate the same signal setup established in Pulse Generator mode. SrcPg is annotated on the screen

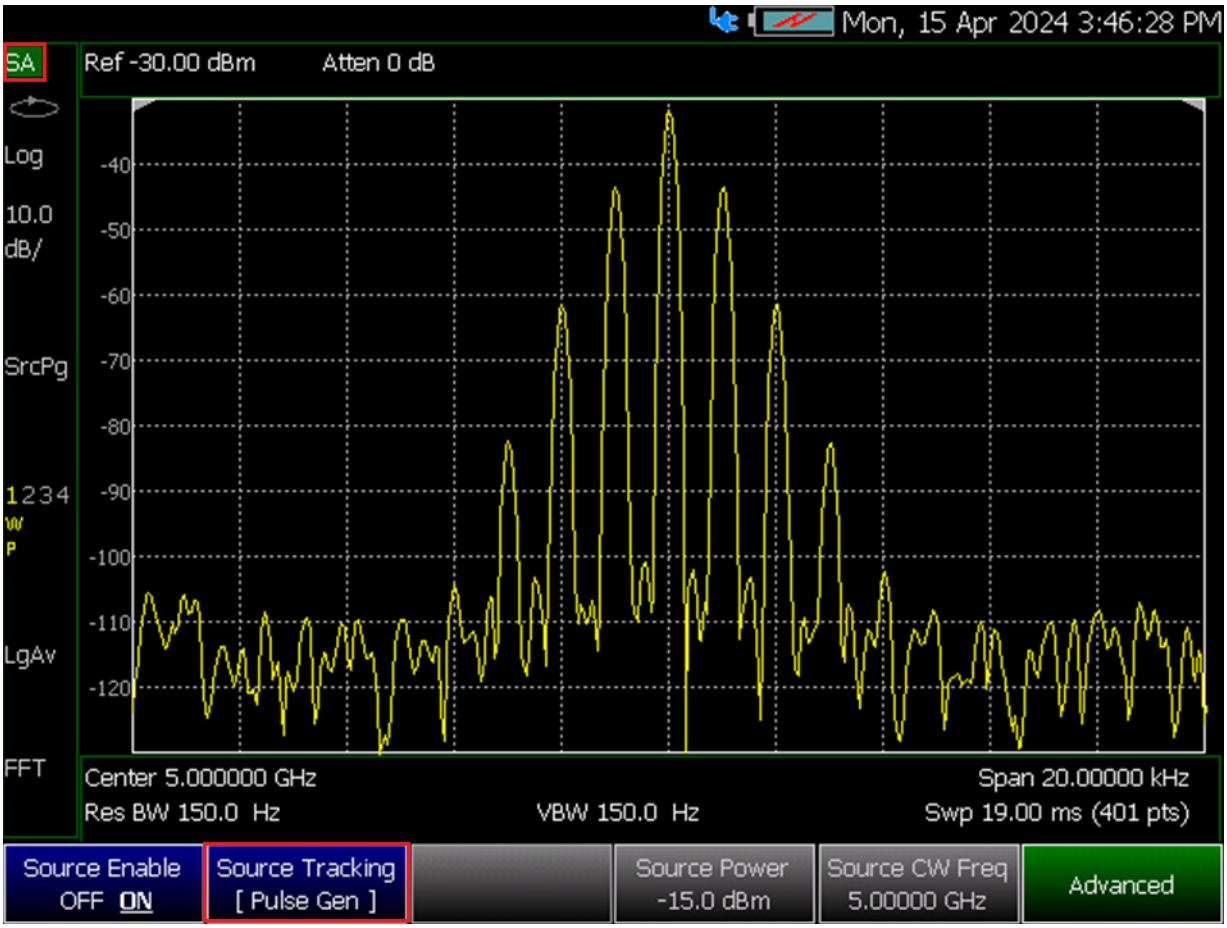
NOTE **Pulse Gen** softkey appears greyed out and cannot be selected despite having Option 357 on B/C model. Refer to Figure 9-13 on page 191. This occurs because the signal has not been configured with RF ON within the Pulse Generator mode. Learn more in Chapter 25, “Pulse Generator – Option 357”, on page 635.

NOTE When Source Tracking is set to Pulse Gen, Source Power and Source CW Freq are disabled and cannot be adjusted. The Source CW Freq reveals the RF Freq relayed from the Pulse Generator mode. Refer to Figure 9-14 on page 191 and Figure 9-15 on page 192 for track the Pulse Gen example.

Figure 9-13 Softkey Menu: Pulse Generator Not Configured (RF OFF) - Pulse Gen Greyed out

Figure 9-14 Softkey Menu: Pulse Generator Configured (RF ON) - Pulse Gen Enabled

Figure 9-15 Track the Pulse Gen in SA mode Example - FM Sine Modulated Signal Setup Using Pulse Generator Mode



Resolution Bandwidth (Res BW)

In SA Mode, the Res BW provides the ability to resolve, or see closely spaced signals. The narrower (lower) the Res BW, the better the spectrum analyzer can resolve signals. In addition, as the Res BW is narrowed, less noise is measured by the spectrum analyzer ADC and the noise floor on the display lowers as a result. This allows low level signals to be seen and measured. However, as the Res BW is narrowed, the sweep speed becomes slower. See "Very Long Sweep Times" on page 200.

How to set Res BW

1. Press **BW 2** > **Res BW**.
2. Then choose from the following:
   - **Auto** Res BW is coupled to the frequency span. As the frequency span is narrowed, the Res BW is also narrowed providing increased ability to resolve signals.
     To change this setting from **Man** to **Auto**, press **Res BW** twice.
   - **Man** Enter a Res BW value using the numeric keypad, the ▲|▼ arrows, or the rotary knob. Then press a multiplier if necessary or press **Enter**

The current Res BW setting is shown at the bottom of the screen.

#Res BW x.xx XHz (#) means manual setting.

This setting could impact the accuracy of the measurement. See Specifications in Appendix B.

NOTE The Res BW setting also affects the Sweep Type setting. Learn how in "Sweep Type" on page 194.

Video Bandwidth (Video BW)

Video BW is a smoothing operation that is performed after measurement data is acquired. The trace data is effectively smoothed so that the average power level of the displayed noise is the same, but the peaks and valleys of adjacent data points are smoothed together. More smoothing occurs as the Video BW is set lower. However, as the Video BW is narrowed, the sweep speed becomes slower.

How to set VBW

1. Press **BW 2**.
2. Then **Video BW**
3. Then choose from the following:
   - **Auto** Couples Video BW to the ResBW in a 1-to-1 ratio.

– Man Enter a Video BW value using the numeric keypad, the ▲|▼ arrows, or the rotary knob. Then press a multiplier if necessary or press Enter. Setting VBW higher than RBW may smooth the trace.

NOTE To change this setting from Man to Auto, press Video BW twice.

The current Video BW setting is shown at the bottom of the screen.

 # VBW x.xx XHz (#) means manual setting.

When the Res BW/Video BW ratio exceeds 10,000, a Meas UNCAL warning may appear to indicate that the Video BW filter has reached the maximum capacity for averaging.

AF RBW (Audio-Frequency Resolution BW)

AF RBW - sets the audio-frequency resolution bandwidth for the selected frequency (Default == Auto).

How to set AF RBW

1. Press BW 2 > AF RBW
2. Then choose from the following:
   – Auto Couples AF BW to the Resolution BW in a 1-to-1 ratio.
   – Man Enter a AF BW value using the numeric keypad, the ▲|▼ arrows, or the rotary knob. Then press a multiplier if necessary or press Enter. Setting AF BW higher than RBW may smooth the trace.

NOTE To change this setting from Man to Auto, press AF RBW twice.

The current AF RBW setting is shown at the bottom of the screen.

 # AF RBW x.xx XHz (#) means manual setting.

When the Res BW/AF RBW ratio exceeds 10,000, a Meas UNCAL warning may appear to indicate that the AF RBW filter has reached the maximum capacity for averaging.

Sweep Type

In SA mode, the FieldFox uses two sweep types to process inputs signals. The sweep type that is currently being used (**FFT** or **Step**) is displayed in the lower-left corner of the FieldFox screen.

For a more comprehensive tutorial, see Spectrum Analysis Basics (App Note 150) at https://www.keysight.com/us/en/assets/7018-06714/application-notes/5952-0292.pdf

How to set Sweep Type

1. Press BW 2 > Advanced > Sweep Type
2. Then choose from the following:
   - Auto The FieldFox selects the most efficient sweep type based on the Res BW. When Res BW is set to 200 kHz and below, FFT sweep type is selected. Above 200 kHz, Step sweep type is being performed.
   - FFT The FieldFox uses FFT sweep type regardless of the Res BW.
   - Step The FieldFox uses Step sweep type regardless of the Res BW. This is useful for capturing impulsive noise that may be generated from nearby electrical equipment.

Oversweep

In SA mode, the FieldFox uses Oversweep to quickly analyze input signals. Oversweep is meant to verify that your setup is correct, but Oversweep is **not** meant to be as accurate as **FFT** and **Step** sweeps. See also, "How to set Sweep Type" on page 195.

How to set Oversweep

1. Press BW 2 > Advanced then
2. Press Oversweep –To enable/disable the Oversweep. Over sweep enables you to quickly evaluate your setup.

IF Output

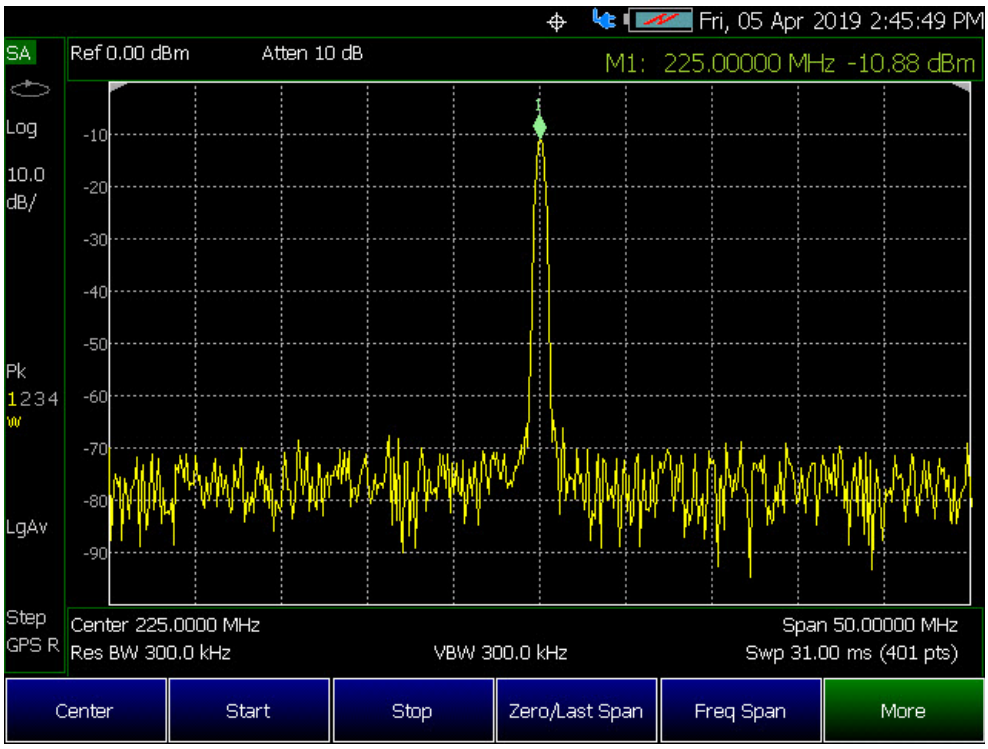
The FieldFox IF (intermediate frequency) can be output for external signal processing. The signal is available from the IF Out connector on the FieldFox right-side panel. See the connector in "Right Side Panel" on page 44.

The IF Out signal, centered at approximately 33.75 MHz (Narrow) or 225 MHz (with Wide path Option B04 or Option B10), is simply a down-converted version of the RF Input signal that is present at the tuned frequency.

While outputting an IF signal, the FieldFox stops performing the InstAlign process. Therefore, the amplitude of traces on the FieldFox screen is NOT accurate and Meas UNCAL appears on the screen to indicate this. Learn more in "Individual Alignments" on page 215. See also Figure 9-16 on page 196.

Learn more about the IF Output frequencies and bandwidths in the Supplemental Online Help: https://rfmw.em.keysight.com/wireless/helpfiles/FieldFoxOnlineSupplementalHelp/Home.htm.

Figure 9-16 IF Output Wide with CF=225 MHz (Requires Option B04 or Option B10)



How to select IF Output

The IF Output signal is useful only in Zero Span. Learn more about Zero Span in "Zero Span Measurements" on page 200.

At least one sweep must be made in order to tune the FieldFox.

1. Press **BW 2** > **Advanced** > **IF Output Use**
2. Then choose from the following:
   - **OFF** The translated IF signal at the IF OUT connector is no longer guaranteed to be centered at 33.75 (Narrow) or 225 MHz (Wide). Requires Option B04 or B10 respectively.
   - **Narrow** The IF output signal has approximately 10 MHz bandwidth.
   - **Wide** Requires B04 or B10. The IF output signal has approximately 100 MHz bandwidth with either B04 or Option B10.

Figure 9-17 SA Display Wide BW IF Out - Center Frequency 4 GHz (Requires Option B10)

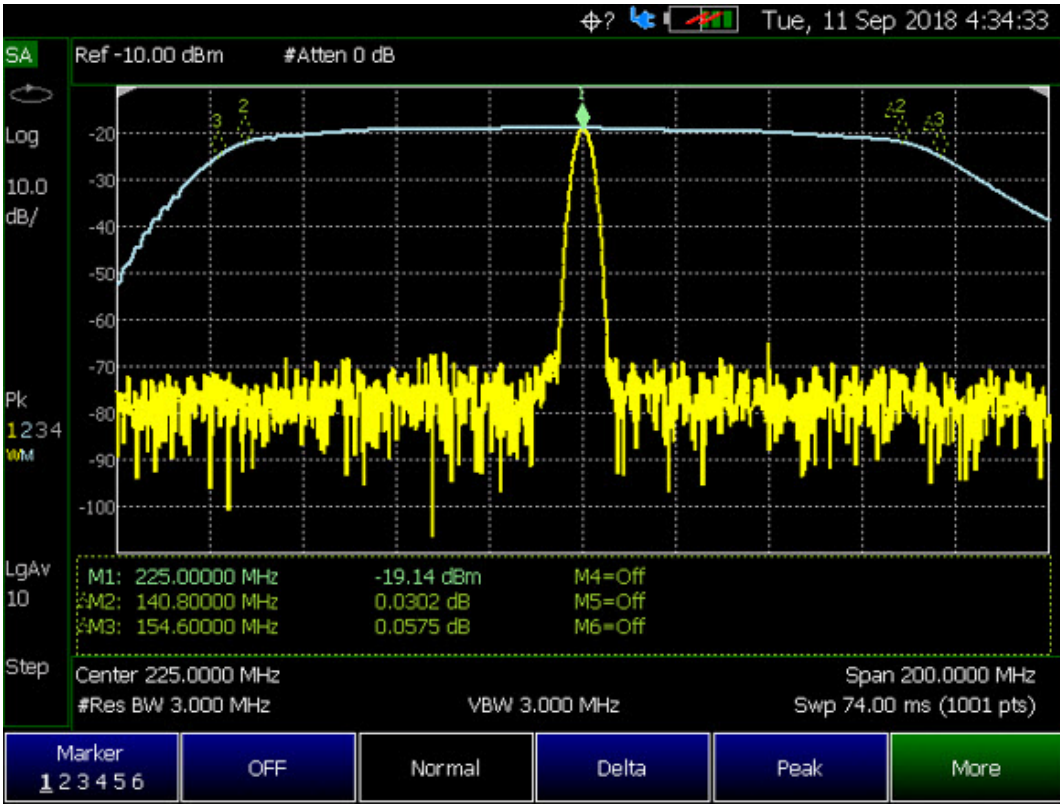
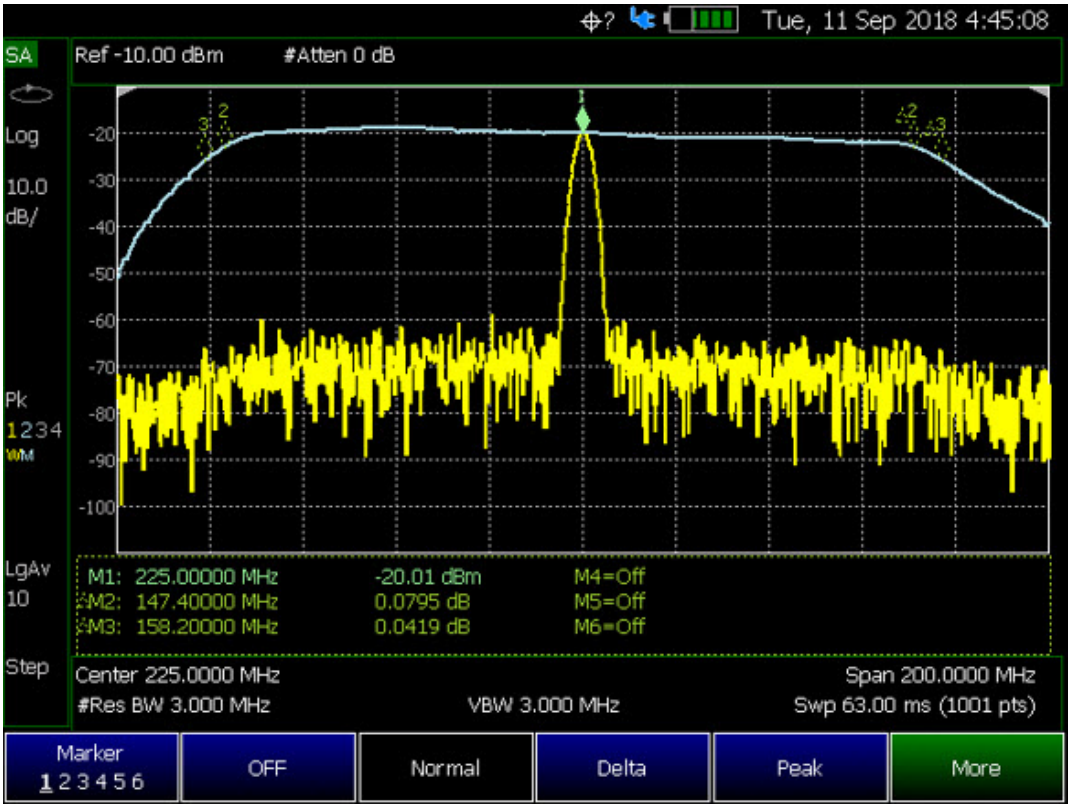


Figure 9-18 SA Display Wide BW IF Out - Center Frequency 10 GHz (Requires Option B10)



Sweep Acquisition

Available only in non-zero span measurements, when Sweep Acquisition is set to Auto, the fastest sweep rate is achieved while maintaining full amplitude accuracy.

NOTE

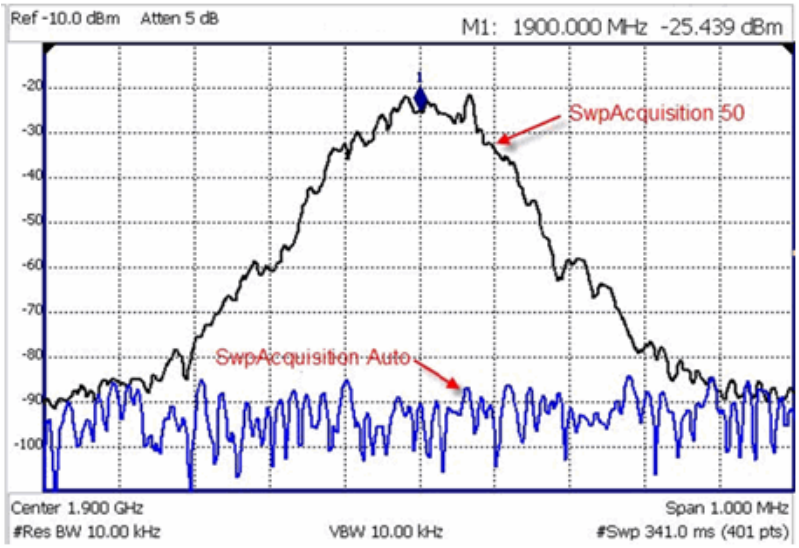
For zero span measurements, refer to "Zero Span Measurements" on page 200.

However, you can adjust this setting in order to increase the probability of intercepting and viewing pulsed RF signals.

For example, with **SwpAcquisition set to Auto** a pulsed GSM signal is NOT visible on the FieldFox screen, as shown in a blue trace in the following image.

While watching the trace, increase the SwpAcquisition value until the pulse spectrum rises out of the noise and reaches its maximum level. Increasing the SwpAcquisition value beyond this point only slows the update rate (increases the actual Sweep time readout) but does not improve measurement quality.

Figure 9-19 GSM Signal in Framed Data Format



In the graphic above, a GSM signal in a framed data format; timeslot zero ON; all others OFF;
PRF = 218 Hz, Duty Cycle = 12.5%. The pulsed signal becomes visible on every sweep update with SwpAcquisition = 50.

How to set Sweep Acquisition

SwpAcquisition is NOT an absolute measure of time, but a relative number between 1 (fastest) and 5000 (slowest) sweep time. The actual time that was required to complete a sweep is annotated on the screen.

1. Press **Sweep 3**.
2. Then **SwpAcquisition Auto Man**.
3. Then choose from the following:
   - **Auto** Sweep is set to the fastest sweep possible with the current settings.
   - **Man** Enter a relative acquisition value between 1 and 5000, where:
   - Man Enter a relative acquisition value between 1 and 5000, where:
     - 1 = Fastest sweep possible
     - 5,000 = Slowest sweep possible
     - # is shown in front of the actual sweep time to indicate a manual setting.

Some Detector and Video Bandwidth settings will raise the Auto Sweep Acquisition value greater than 1. In these cases, manually setting Sweep Acquisition lower than the Auto value may have NO effect.

NOTE easurement speed specifications do NOT apply in Temperature Control Mode. Learn more in "Temperature Control Mode" on page 35

Learn more about SA mode SwpAcquisition time in the Supplemental Online Help:
https://rfmw.em.keysight.com/wireless/helpfiles/FieldFoxOnlineSupplementalHelp/Home.htm.

Very Long Sweep Times

Two primary settings are responsible for the sweep time: Res BW and SwAcquisition.

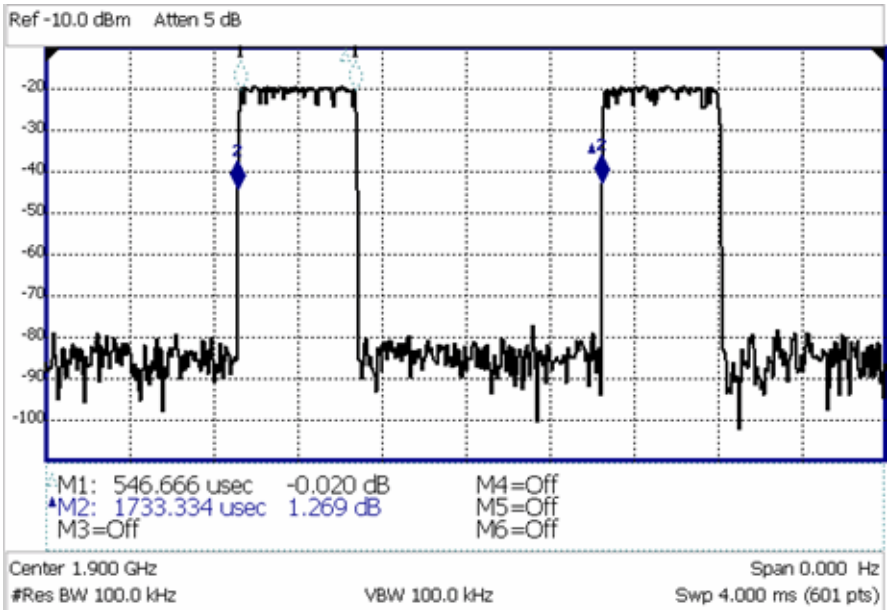
- When the sweep time exceeds 1200 seconds (20 minutes), an informational message: Alert: Very long sweep in progress... is annotated on the screen for the duration of the sweep.
- When the sweep time exceeds 4000 seconds (about 1 hour), Meas UNCAL is annotated on the screen. Accuracy cannot be guaranteed.
- InstAlign is always performed only at the beginning of the sweep regardless of the sweep time. Learn more in "How to Access Individual Alignments" on page 216.

Zero Span Measurements

When setting the frequency span to Zero, there is NO spectrum of frequencies to display, so the X-axis units becomes Time. The SA becomes like a tunable oscilloscope, with the center frequency being the frequency of interest. This capability is useful for analyzing modulation characteristics, such as pulsed measurements.

NOTE For non-zero span measurements, refer to "Sweep Acquisition" on page 198

Figure 9-20 GSM Signal, Framed Data Format



The graphic above shows a GSM signal, framed data format, with timeslot 0 and 3 “on”. Sweep Time is set to approximately the frame interval. Press Single several times until the waveform section of interest is viewable and stable. Then markers can be used to measure the timeslot width and interval as shown.

How to set Zero Span

- Set **Center** to the frequency of interest
  - then set **Span** to 0 Hz
  - or select **Zero/Last Span**. Each key press toggles the frequency span between 0 Hz and the last specified frequency span.

How to change Sweep Time in Zero Span

- Press **Sweep 3**
- Then **Sweep Time**
- Enter a value using the numeric keypad. Sweep time is limited to 1000 seconds for N991xB/2xB/3xB models.
- Then select a multiplier key. Learn more in “Multiplier Abbreviations” on page 48.

Learn more about SA mode Sweep Time in the Supplemental Online Help: https://rfmw.em.keysight.com/wireless/helpfiles/FieldFoxOnlineSupplementalHelp/Home.htm.

Triggering

NOTE

SA **STEP** sweeps do not have trigger behavior. So, they are essentially always in "**FREERUN**" mode. If you try to set a trigger (other than FREERUN) in SA Step sweep, the FieldFox displays the following popup message:
"`Note: Trig Type has no effect while in STEP sweep mode`"

External, Video, and RF Burst triggering allows you to initiate an SA mode sweep using an external event such as a signal burst.

All three trigger types can be used in either Zero Span (time domain) or FFT frequency sweeps. Learn more in "Zero Span Measurements" on page 200. Learn more in "Sweep Type" on page 194.

FFT Gating is available for non-zero span measurements. Learn more about FFT Gating in "FFT Gating (Opt 238)" on page 206.

Trigger Type

- Press **Sweep 3** > **Trigger Settings** > **Trig Type**
- Then choose from the following:
  - **Free Run** Triggering is provided by the FieldFox internal circuitry. A new sweep begins when the previous sweep ends.
  - **External** A sweep is triggered on an external TTL signal at the Ref In/Trig In connector on the FieldFox top panel. Choose to trigger on the rising slope at about 1.7 V or on the falling slope at about 1.0 V using the Trigger Slope setting (below).
  - **Periodic** sets a trigger that repeats at the period rate entered. Periodic trigger's phase can be altered by the Offset value.

The following two selections are similar in that they both trigger a sweep from a signal at the **SA RF Input** connector. Experiment with both selections to find the best trigger type for your application.

- **Video** A sweep is initiated when the displayed amplitude of an incoming signal crosses the settable Trigger Level. This selection can detect low-amplitude signals, but also has been filtered considerably and may not be a true representation of the incoming signal.
- **RF Burst** A sweep is initiated when the signal at the third IF (analog) stage crosses the settable Trigger Level. This selection offers a wider bandwidth and may be a better representation of the incoming signal than Video trigger. However, RF Burst is not as sensitive to triggering on low-level signals.

Sync

NOTE

This softkey is ONLY available when **Trigger Type** is set to **Periodic**. SA **STEP** sweeps do not have trigger behavior. So, they are essentially always in "**FREERUN**" mode. If you try to set a trigger (other than FREERUN) in SA Step sweep, the FieldFox displays the following popup message:

```
"Note: Trig Type has no effect while in STEP sweep mode"
```

Selects the type of signal the periodic trigger is synchronized.

- **None** No synchronization is selected for a Periodic trigger.
- **External** A sweep is triggered on an external TTL signal at the Ref In/Trig In connector on the FieldFox top panel. Choose to trigger on the rising slope at about 1.7 V or on the falling slope at about 1.0 V using the Trigger Slope setting (below).
- **RF Burst** uses an alignment process which is performed in the background to set the detected signal level accuracy. Learn more in "RF Burst Amplitude Alignment" on page 217.
- **1 PPS GNSS** Periodic trigger is synchronized to a 1 pulse per second GNSS signal.

Trigger Slope

NOTE

This softkey is unavailable when **Trigger Type** is set to **Periodic**.

Trigger Slope determines which edge of an External, Video, or RF Burst trigger signal initiates a sweep.

1. Press **Sweep 3** > **Trigger Settings** > **Trig Slope**
2. Then choose from the following:
   - **Pos** Sweep is triggered by the rising (positive) edge of signal.
   - **Neg** Sweep is triggered by the falling (negative) edge of signal.

Trigger Delay

After a valid trigger signal is received, the sweep begins after the specified Trigger Delay time.

To see the rising edge of a repetitive signal which is triggered on that edge, enter a negative trigger delay value (also known as pre-trigger). Adjust the sweep time to observe the pre-trigger time if necessary.

1. Press **Sweep 3** > **Trigger Settings** > **Trig Delay**

2. Enter a value using the numeric keypad, the ▲|▼ arrows, or the rotary knob.
3. Then select a multiplier key or press **Enter**. Learn more in "Multiplier Abbreviations" on page 48.

In Zero span, you can use Trigger Position as an easy way to set Trigger Delay by positioning the trigger event on the FieldFox screen. See "Triggering" on page 202.

Period

NOTE This softkey is ONLY available when **Trigger Type** is set to **Periodic**.

Sets the length of time in seconds before a waveform repeats. (Default == 20.00 ms).

Offset

NOTE This softkey is ONLY available when **Trigger Type** is set to **Periodic**.

Sets the periodic trigger offset. (Default == 0.00s)

Trigger Level

Used with Video and RF Burst triggering, a sweep is initiated when an incoming signal crosses this level. The units depend on the Units setting. Learn more in "Scale and Units" on page 161.

RF Burst Trigger Level uses an alignment process which is performed in the background to set the detected signal level accuracy. Learn more in "RF Burst Amplitude Alignment" on page 217. **Video Trigger Level** is a zero span signal level comparison. Therefore, the sweep will trigger close to the displayed level in zero span measurements. In non-zero span measurements, processing can cause broadband signal energy to display at lower power levels than the originating time domain signal. Therefore, you may need to set the trigger level higher than the displayed level.

1. Press **Sweep 3** > **Trigger Settings** > **Trig Level**
2. Enter a value using the numeric keypad, the ▲|▼ arrows, or the rotary knob.

3. Then select a multiplier key or press **Enter**. Learn more in "Multiplier Abbreviations" on page 48.

Auto Trigger Time

While waiting for a valid trigger signal, **Wait** is annotated in the top left corner of the FieldFox screen.

If a valid trigger signal is not received before the specified Auto Trig Time, a sweep will occur automatically.

Enter **0** to set Auto Trigger **OFF**. When Auto Trigger is OFF, the FieldFox does NOT sweep unless a valid trigger signal is received.

1. Press **Sweep 3** > **Trigger Settings** > **Auto Trigger [current setting]**
2. Enter an Auto Trig Time using the numeric keypad.
3. Then select a multiplier key. See "Multiplier Abbreviations" on page 48.

Trigger Position

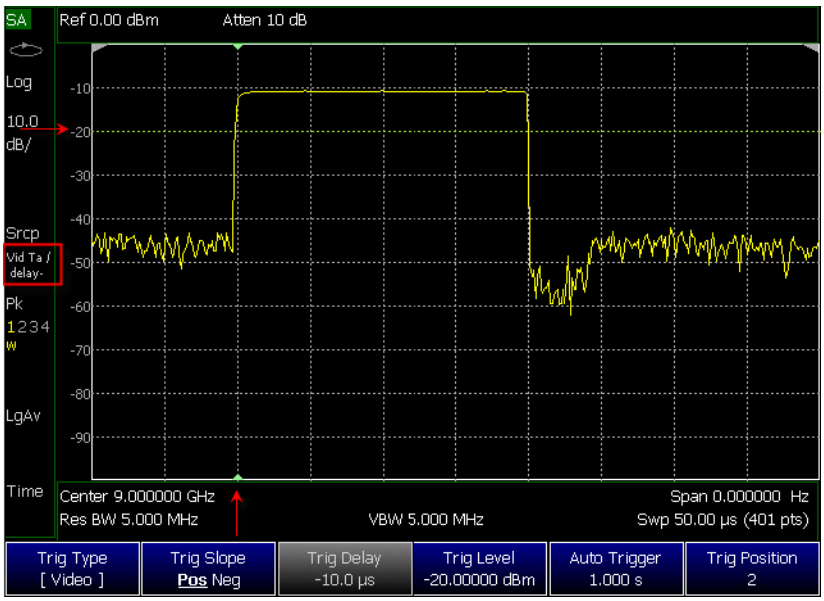
Available ONLY in zero span measurements, this setting is an easy way to automatically set the Trigger Delay by positioning the trigger event (also known as T-zero) at any graticule along the X-axis. With T-zero in the center of the screen, you can zoom in and out by increasing or decreasing the sweep time. Using the Trigger Position and Sweep Time settings is a quick and efficient way to examine artifacts of a pulse, much easier than trying to set the Trigger Delay manually.

When Trigger Position is set to OFF, the Trigger Delay softkey is not available. The amount of Trigger Delay that is being used is displayed on the softkey. The Trigger Position is annotated on the screen. Learn how in the following section.

1. Press **Sweep 3** > **Trigger Settings**
2. Then **Trig Position**. If Sweep Time is longer than 0.15 sec, this softkey is grayed out.
   - **ON**: The position of T-zero is set by the trigger delay.
   - **OFF**: Select, then enter a position value from 0 to 10 using the numeric keypad, the ▲|▼ arrows, or the rotary knob.
     - **0**: T-zero occurs at the left graticule.
     - **5**: T-zero occurs at the center of the screen.
     - **10**: T-zero occurs at the far right graticule.
   - Then press **Enter**.

Trigger Settings Annotation

Trigger settings are annotated on the FieldFox screen as highlighted in red in the following image:



– Square: Trig Type (**VidT**), AutoTrigger (**a**), Pos Slope (**/**), Neg Delay (**delay-**)

– Horizontal arrow: Trig Level (green horizontal graticule at -20 dBm)

– Vertical arrow: Trig Position T-zero indicators (green arrows at 2nd vertical graticule)

FFT Gating (Opt 238)

Time-gated spectrum analysis allows you to obtain spectral information about signals occupying the same part of the frequency spectrum that are separated in the time domain. Using an external trigger signal to coordinate the separation of these signals, you can perform the following operations:

– Measure any one of several signals separated in time; for example, you can separate the spectra of two radios time-sharing a single frequency.

– Measure the spectrum of a signal in one time slot of a TDMA system.

– Exclude the spectrum of interfering signals, such as periodic pulse edge transients that exist for only a limited time.

FFT Gating is a simple, efficient way to set the proper amount of trigger delay and capture time so that signal artifacts of a repeating waveform or pulse can be examined in the frequency domain. Learn more about trigger settings in “Triggering” on page 202.

For best results, Auto Trigger should be used with this feature to ensure that the sweep does not wait indefinitely for a trigger. Set Auto Trigger to a time that is longer than the expected periodic rate of the signal. This is especially

important when using RF Burst or Video triggering in wider spans, because the signal providing those triggers has limited bandwidth. Learn more about Auto trigger in "Auto Trigger Time" on page 205.

For more conceptual information on this topic, please refer to Spectrum Analysis Basics (App Note 150), pages 31 - 35, at https://www.keysight.com/us/en/assets/7018-06714/application-notes/5952-0292.pdf.

How to set FFT Gating

1. Create a non-zero span measurement. Wider frequency spans take more time to acquire.
2. Press **Sweep 3** > **Trigger Settings** > **FFT Gating Setup**
3. Then choose from the following:
   - **Gate View OFF ON** When ON, a separate zero span measurement is displayed below the non-zero span window. The gate view measurement helps to configure the gate width and delay by revealing (with green markers) the location of the gate relative to the trigger event. The zero span measurement is tuned to the center frequency of the non-zero span measurement with about 5 MHz of bandwidth. The Y-axis scale is the same for both windows.
   - **Gate View Time** Set the X-axis span for the non-zero span window.

     Enter a value using the numeric keypad, the ▲|▼ arrows, or the rotary knob. This value is annotated as Swp (nn) below the window.
   - **FFT Gating OFF ON** When ON, the trigger type, gate width, and delay are applied to the non-zero span measurement. The Res BW is set to a value that is inversely proportional to the gate width.
   - **Gate Width** Set the width of the gating area within the non-zero span window. The gating area is indicated by two vertical green

     lines. Enter a value using the numeric keypad, the ▲|▼ arrows, or the rotary knob.
   - **Gate Delay** Effectively moves the gating area left (negative delay) or right (positive delay) relative to the trigger event. Enter a value

     using the numeric keypad, the ▲|▼ arrows, or the rotary knob.

When you have properly setup the Gate Trigger, Width, and Delay using the Gate View measurement, you can turn **Gate View OFF** to return to the full screen non-zero span measurement with FFT Gating ON, the RBW set, and the Trigger settings active.

Single / Continuous / Restart

This setting determines whether the FieldFox measures continuously or only once each time the **Single** or **Run / Hold +/-** button is pressed. Use **Hold / Single** or to conserve battery power or to allow you to save or analyze a specific trace.

How to set Single or Continuous

1. Press **Sweep 3**.
2. Then choose one of the following:
   - **Continuous**
     - **ON** Causes the SA to make continuous sweeps. This is the typical setting for making measurements. Each **Run / Hold +/-** press causes the SA to toggle between continuous sweep and Hold.
     - **OFF** Causes the SA to Hold. Each **Run / Hold +/-** or **Single** press causes the SA to make ONE sweep, then Hold. The Hold annotation changes to an arrow --> while the sweep occurs.
   - **Single** Automatically sets Continuous OFF and causes the SA to make ONE sweep, then Hold.
   - **Restart** Resets the Average counter to 1. The Average counter also is used with MaxHold and MinHold Trace States. Learn more in "Average Count" on page 211.

Points

Points is the number of measurements that are displayed along the X-axis. The higher number of data points, the better the ability to resolve closely spaced signals and the slower the sweep speed.

How to set number of points

1. Press **Sweep 3** > **Points [current setting]**
2. Then choose from:
   - **101 | 201 | 401 | 601 | 801 | 1001**
   - **# Points** to enter a trace points value manually (Maximum == 20001).

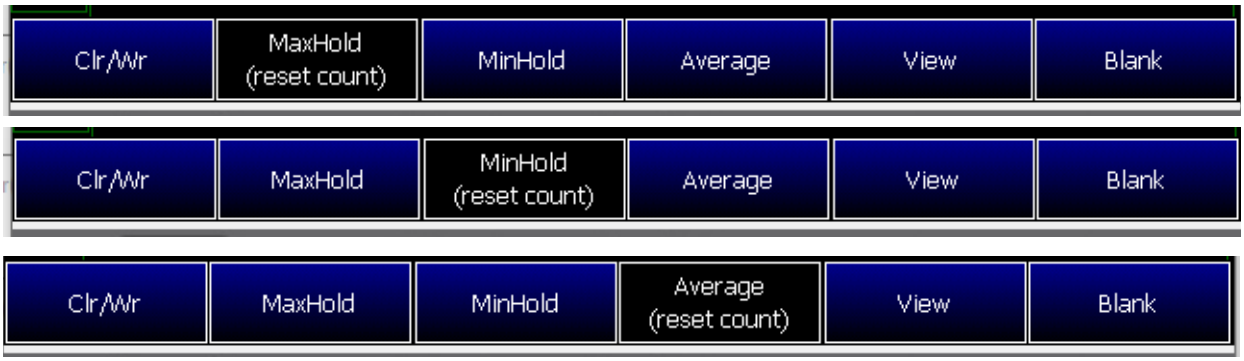
Trace Display States (SA Mode)

In SA Mode you can display up to four of the following types of trace states. All SA trace settings can be independently **reset** (either automatically, or manually) for each trace counter (**MaxHold**, **MinHold**, or **Average**) without resetting any other traces.

Additionally, this independent trace feature provides:

- annotates **ONE** such trace counter as the **minimum** trace count of all of the traces (**even if multiple counters are active**)
- automatically **RESET** any single Trace counter when parameter couplings dictate that a counter needs to be reset (e.g., **TraceMode** or **TraceDetector** changes)
- enables a user to manually reset a single Trace, via the Trace State menu selection (**6 Trace** > **State**)
- a manual reset is performed by pressing the same trace **State** again (i.e., trace state is already enabled), and the selection softkey says "Reset" or "Reset Count" as a hint to the user

Figure 9-21 Trace State Reset Softkeys



A color-coded legend for displayed traces is visible in the left pane of the SA mode screen:

W = Clear/Write; **M** = MaxHold; **m** = MinHold; **A** = Average; **V** = View

How to display the Trace States

1. Press **Trace 6**.
2. Then **Trace 1,2,3,4** repeatedly to select a trace number to display or change its state. Traces are displayed in the following colors:
   - Trace 1 – **Yellow** Trace 2 – **Blue**
   - Trace 3 – **Orange** Trace 4 – **Green**
3. Then **State [current setting]**
4. Then choose from the following Trace States:

- **Clr /Wr** (Clear/Write) Displays the actual measured data for each sweep.
- **MaxHold** Displays the maximum response of the input signal at each data point over multiple sweeps. See also Average Count in "Average Count" on page 211.
- **MinHold** Displays the minimum response of the input signal at each data point over multiple sweeps. See also Average Count in "Average Count" on page 211.
- **Average** Each data point is averaged over multiple sweeps as set by the Average Count setting. Learn more in "Average Count" on page 211.
- **View** Displays and then holds the last complete measurement trace on the screen. This is similar to storing a trace in memory.
- **Blank** Displays no trace.

5. Press **Default All** to return all traces to their default settings: Trace 1 (Clear/Write); all other traces (Blank).

NOTE Trace 4 data WILL be overwritten by the FieldFox when using the Independent Source Normalize feature ("Independent Source/Tracking Generator " on page 188) or using Field Strength antenna or cable corrections ("Field Strength Measurements" on page 165)

Average Type

In SA Mode, there are four different processes in which Averaging is performed:

- Average Traces – Learn more in "Averaging" on page 229.
- Detection Method Averaging – Learn more in "Detection Method" on page 219.
- Noise Marker Averaging - Learn more in "Noise Marker" on page 223.
- Video BW filtering (for non-Zero Span measurements) - Learn more in "Video Bandwidth (Video BW)" on page 193.

There are three types of mathematical averaging that can be performed – Log, Linear, or Voltage (see "How to set Average Type" on page 210). Select ONE of these types and it is used for all of the above averaging processes.

How to set Average Type

1. Press **Meas Setup 4** > **Average Type [current setting]**
2. Then choose from the following:

- **Auto** - The FieldFox chooses the most appropriate type of averaging for the current settings. When Detection Method is set to Average, a Noise Marker is present, or a Channel measurement is active, then Power Average is ALWAYS selected. Otherwise, Log Average is selected.
- **Log** Averaging – Best for displaying Trace Averaging. #LgAv is shown on the left side of the FieldFox screen when selected.
- **Power** (Linear) Averaging – Best for measuring true power levels. Used in Detection Average and Noise Marker Average. Mathematically, trace noise is 2.5 dB higher than when using Log Average. PAvg is shown on the left side of the FieldFox screen when selected.
- **Voltage** Averaging – Converts the amplitudes to a magnitude unit before averaging (e.g., Volts, Amps, microVolts, milliVolts, etc.) #VAvg annotation is displayed.

Average Count

The Average Count setting is used mainly with the Average Trace State described in "Trace Display States (SA Mode)" on page 209. In this Trace State, the Average Count setting determines the number of sweeps to average. The higher the average count, the greater the amount of noise reduction.

When Trace (display) State is set to **Average**, **MaxHold**, or **MinHold**, the average counter is shown in the left edge of the screen below the Average Type.

For all three of these Trace States, when **Sweep 3** **Continuous** is set to OFF, press **Restart** to reset the sweep count to 1, perform <n> sweeps, then return to **Hold**.

How to set Average Count

1. Press **Meas Setup 4** > **Average Count**
2. Enter a value from 1 to 10,000 using the numeric keypad, the ▲|▼ arrows, or the rotary knob.
3. Press **Enter**

Alignments

NOTE To better reflect the enhancements implemented during the alignment process, for firmware versions >A.10.15 "IF Flatness Alignment" is now referred to as "Channel Equalization" or "Channel Equalization Alignment" (**ChanEQ Alignment**).

This section contains the following:

– “Overview” on page 212
– “All Alignment and Align All Now” on page 215
– “Individual Alignments” on page 215

Overview

The alignments softkeys are located by pressing the **Cal 5** hardkey.

All Alignment or **Align All Now** corrects for receiver drift over temperature and time. SA measurement applications monitor changes in internal temperature and the time since last alignment update and trigger the need for a new update when the alignment becomes stale. The alignment is deemed stale after a significant change in temperature or a significant time elapsed from the last update. The temperature change and time duration necessary to trigger an alignment update is predetermined in the factory. Until the update is performed, annotation indicating “questionable amplitude” is displayed AMPTD?.

When **All Alignment** is enabled (by default) the FieldFox performs an alignment process using the internal RF source. Although some sweeps are delayed, measurement results are never disturbed.

If the Independent Source (tracking generator) is enabled for your measurement, it will be borrowed to perform the alignment. Again, the measurement results are not disturbed. Learn about the Independent Source in “Independent Source/Tracking Generator ” on page 188.

The alignment process can be disabled. You may want to do this, for example, if you are analyzing the amplitude stability of a signal.

SA and all modes built on its infrastructure require three types of alignments:

– InstAlign Amplitude Alignment
– RF Burst Amplitude Alignment
– Channel Equalization

These are referred to as **Individual Align**.

All three or a subset of the individual alignments are required for each specific mode, depending on the type of measurement supported by it:

SA:

– InstAlign Amplitude Alignment
– RF Burst Amplitude Alignment

RTSA:

– InstAlign Amplitude Alignment
– WidePath Burst Trigger Alignment
– Channel Equalization

Channel Scanner:

– InstAlign Amplitude Alignment

EMI Measurements:

– InstAlign Amplitude Alignment

– WidePath Burst Trigger Alignment

– Channel Equalization

ERTA:

– InstAlign Amplitude Alignment

IQA:

– InstAlign Amplitude Alignment

– RF Burst Amplitude Alignment

– Channel Equalization

Built-in Power meter

– InstAlign Amplitude Alignment

Default settings and recommended use model for many applications:

– Coupled individual alignments

– Coupled state is Auto

– Individual alignments are not accessible via front panel soft-keys

– Individual alignments cannot be UnCoupled

For special cases, the individual alignments can be accessible via the front panel soft-keys using the Preference setting **SA** - **Individual Alignment Control** > **On/Off**. This enables a soft-key for access to **Individual Alignments** when this preference is set to ON: **Cal 5** > **Individual Align**. For more refer to "Preferences" on page 850, in Chapter 32 System Settings.

The individual alignments may be:

– Coupled (default) - when they are in the same state, or

– Uncoupled - when at least one of them is in a different state than the other ones

– Executed on demand, all of them, using the **Align All Now** softkey.

Each of the individual alignments:

– could be in one of three states:

  – **Off** - the alignment is not applied and is not updated automatically

  - **Auto** (default) - the alignment will be updated over time and temperature as needed, no user interaction required
  - **Hold** - the unit holds the alignment values from the last alignment-execution and does not execute another alignment automatically

- can be updated on demand using the corresponding **Align Now** soft-key. Refer to "Individual Alignments" on page 215.
- The **All Alignment** soft-key has the following functionality:
  - when the individual alignments are Coupled, the state of all of them can be changed simultaneously using the **All Alignment** soft-key sub-menus
  - when the individual alignments are UnCoupled, they will be coupled when using the **All Alignment** soft-key sub-menus and their state will be simultaneously changed accordingly

All Alignment and Align All Now

NOTE

IMPORTANT! It is recommended that you use **Align All Now**, because it includes the individual alignment InstAlign **Amptd Align Now**, as well as, **Burst Align Now**, and **ChanEQ Align Now**. But, if you would prefer to have manual control over the individual alignments, then refer to the **SA Individual Alignment Control** setting in "Preferences" on page 850, in Chapter 32 System Settings.

The notification AMPTD? displayed on screen means the InstAlign amplitude alignment or channel equalization is stale (if its state is Hold) and requires an update or it is in the OFF state. This situation does not occur when the respective alignment is in the Auto state. To clear this notification, press the Align All Now softkey.

How to set All Alignment and Align All Now

- Press **Cal 5**
- Then **All Alignment [Auto]** (to enable or disable the All Alignment) – Default is Auto.
- or
- Then **Align All Now** (to manually perform an Align All Now.) This performs an alignment on all three individual alignments: Amptd Align Now, Burst Align Now, and ChanEq Now). Refer to "Individual Alignments" on page 215.
- Press **Back**

If you want to disable the All Alignment [Auto], you can do so in the FieldFox preferences (i.e., you may want to do this, for example, if you are analyzing the amplitude stability of a signal).

Refer to the **SA Individual Alignment Control** setting in "Preferences" on page 850, in Chapter 32 System Settings. See also, "Individual Alignments".

Individual Alignments

NOTE

IMPORTANT! It is recommended that you use **All Alignment [Auto]** or **Align All Now** in lieu of the individual alignments (**Amptd Align Now**, **Burst Align Now**, and **ChanEQ Align Now**), because All Alignment [Auto] and Align All Now includes the individual alignment InstAlign **Amptd Align Now**, **Burst Align Now**, and **ChanEQ Align Now**. But, if you would prefer to have manual control over the individual alignments, then refer to the **SA Individual Alignment Control** setting in "Preferences" on page 850, in Chapter 32 System Settings.

The Individual Alignment softkey is only available, when the preference SA - Individual Alignment Control is set to On in the FieldFox Preferences menu. Refer to "Preferences" on page 850, in Chapter 32 System Settings.

How to Access Individual Alignments

This section assumes access to individual alignments was activated using the FieldFox's system settings' Preferences. Once enabled, an **Individual Alignments** softkey is displayed. Refer to "Preferences" on page 850, in Chapter 32 System Settings.

1. Press Cal 5
2. Then Individual Align
3. Then Amptd Align Now or

   Then Burst Align Now or

   Then ChanEq Align Now
4. Press Enter

How to make Amplitude Alignment settings

NOTE

During continuous sweep ("acquisition" for IQA) operation, automatic Alignments will NOT interrupt the ongoing measurement, but when necessary, will occur opportunistically as settings are changed. When no automatic alignment updates occur, existing alignments can become stale over time and temperature drift, so a warning annotation on the left panel will light up indicating that alignments need updating.

SA, IQA, RTSA, and other modes use a proprietary amplitude alignment algorithm to make extremely accurate amplitude measurements over the full frequency range of the FieldFox.

These settings do NOT survive a Preset or Mode Preset.

1. Press Cal 5 > Individual Align > Amptd Alignment
2. Then choose from the following:
   - Auto (Default setting) Alignments are required and are performed automatically, when necessary, at times when interrupting the RF Output is deemed acceptable. The alignment process is performed opportunistically when changes in settings require the measurement to stop momentarily and a significant time elapsed since the last alignment (predetermined in the factory) or the internal instrument temperature has changed sensibly (predetermined in the factory).

     Some examples of the conditions when alignments occur are: This could be a Center frequency change, or it could be as simple as requesting a Single sweep. Also, unique alignments are required at

different FieldFox receiver frequency bands, so even if the temperature hasn't changed, an alignment may be required when one changes the Center frequency.

If a needed alignment cannot be performed, the user is notified about questionable amplitude AMPTD?.

- **OFF** Alignments are not performed. The most recent alignment result is cleared. Only factory corrections are applied to SA Receiver measurements. Questionable amplitude AMPTD? is always displayed.
- **Hold** The alignment process is stopped, but the last alignment values are applied to subsequent sweeps.

– **Amptd Align Now** An alignment is performed immediately, thus updating (clearing) any questionable amplitude status. If the Mode was previously Off, it is changed to Hold.

Amptd? is annotated in the lower left corner of the FieldFox screen when amplitude alignment is questionable. This is always true when OFF, and is conditionally true in Auto or Hold when the most recent alignment is deemed stale.

RF Burst Amplitude Alignment

RF Burst alignment calibrates the circuitry to provide accurate external RF Burst triggering. Learn more about RF Burst triggering in "Triggering" on page 202.

When enabled (by default) the FieldFox performs an alignment process using the internal RF source. Although some sweeps are delayed, measurement results are never disturbed.

If the Independent Source is enabled for your measurement, it will be borrowed to perform the alignment. Again, the measurement results are not disturbed. Learn about the Independent Source in "Independent Source/Tracking Generator " on page 188.

The alignment process can be disabled. You may want to do this, for example, if you are analyzing the amplitude stability of a signal.

How to use Burst Alignment settings

These settings do NOT survive a Preset or Mode Preset.

1. Press **Cal 5** > **Individual Align** > **Burst Alignment**
2. Then choose from the following:

- **Auto** (Default setting) SA measurement applications monitor changes in internal temperature and the time since last alignment update and trigger the need for a new update when the alignment becomes stale. The alignment is deemed stale after a significant change in temperature or a significant time elapsed from the last update. The temperature change and time duration necessary to trigger an alignment update is predetermined in the factory.
- **OFF** The alignment process is NOT performed. Only factory correction values are used.
- **Hold** The alignment process is stopped, but the last alignment values are applied to subsequent sweeps.

Burst Align Now An alignment is performed once and applied to subsequent sweeps.

Channel Equalization (IQA and RTSA Only)

NOTE

During continuous sweep operation for RTSA and continuous acquisition for IQA, automatic Alignments will NOT interrupt the ongoing measurement, but when necessary, will occur opportunistically as settings are changed. When no automatic alignment updates occur, existing alignments can become stale over time and temperature drift, so a warning annotation on the left panel will light up indicating that alignments need updating. When alignments need updating, you will see a “Channel Equalization” or “ChanEq” error message displayed.

IQA and RTSA modes use proprietary channel equalization algorithms to make extremely accurate channel measurements over the full frequency range of the FieldFox.

How to use Channel Equalization Alignments settings

These settings do NOT survive a Preset or Mode Preset.

1. Press **Cal 5** > **Individual Align** > **ChanEq Alignment**
2. Then choose from the following:
   - **Auto** (Default setting) SA measurement applications monitor changes in internal temperature and the time since last alignment update and trigger the need for a new update when the alignment becomes stale. The alignment is deemed stale after a significant change in temperature or a significant time elapsed from the last update. The temperature change and time duration necessary to trigger an alignment update is predetermined in the factory.

     Some examples of the conditions when alignments occur are: This could be a Center frequency change, or it could be as simple as requesting a Single sweep. Also, unique alignments are required at

different FieldFox receiver frequency bands, so even if the temperature hasn't changed, an alignment may be required when one changes the Center frequency.

- **Hold** The alignment process is stopped, but the last alignment values are applied to subsequent sweeps.
- **OFF** The alignment process is NOT performed, and the channel equalization is deactivated.

When you press **ChanEq Align Now** An alignment is performed immediately.

The **Amptd?** annotation lights up whenever the current channel equalization is deemed stale.

Detection Method

NOTE

SA mode is capable of multiple simultaneous detector setup. Multiple trace detectors are NOT available when:

– the FieldFox is set to Zero Span

– Channel Measurements are enabled (i.e., Channel Power, Occupied Power, Adjacent Channel Power, and Spectrum Emission Mask)

– Whenever Trace Playback is enabled

(i.e., Chanel Measurements and Trace Playback are single trace only.)

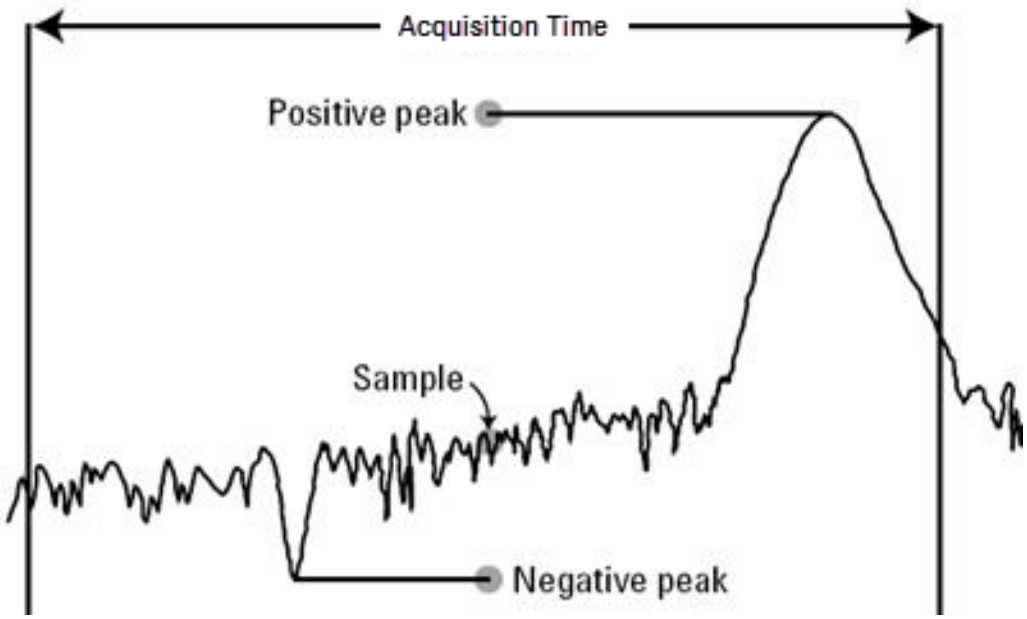
Learn more, see Figure 9-23 on page 221.

In SA Mode, the X-axis is comprised of data points, also known as “buckets”. The number of data points is specified using the Points setting. Learn more in “Points ” on page 208.

Regardless of how many data points are across the X-axis, each data point must represent what has occurred over some frequency range and time interval.

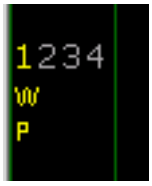
From the frequency span of the measurement, the span of each data point is calculated as (frequency span / (data points-1)). The detection method allows you to choose how the measurements in each bucket are displayed.

Figure 9-22 Detection using One Bucket



In the graphic above there is one bucket showing Positive peak, Sample, and Negative peak Detection methods.

Figure 9-23 Single and Multiple Detection Annotation - Examples



Multiple Detector - with only detector 1, trace 1 active, and trace 1 is set to Clear-Write (Clr/Wr) and detector 1 is set to Peak (P). When the FieldFox is powered up this is the default condition when SA mode is selected.

Multiple Detectors Enabled - first two traces (ClrWrite (W) and MaxHold (M)) are auto-couple to Peak (P), Trace 3 Average (A) auto-couples to Sample (S) detector, and Trace 4 MinHold (m) auto-couples to NegPeak (p).

– Here the first two detectors are auto-coupled to Peak (P) and Sample (S) for trace states ClearWrite and Average
–And the last two detectors are manually (#) forced to Average (A) and NegPeak (p) for trace states Average and MaxHold.

For the same x4 trace setup, if the Freq Span is then toggled to Zerospan (== 0 Hz), the detector coupling reverts to Sample (Smp) detection for all traces (i.e., multiple simultaneous detectors are not supported in Zerospan, so all traces revert to use of a single detector, in this case “Sample”. The trace/detector annotation changes back to this legacy style, where only one detector is specified).
Learn more, this Simultaneous Multi-Detector behavior is described above in the NOTE on page 219.

Then toggle back using Zero/Last Span, the multiple-detector functionality and annotations are again displayed.

How to set Detection Method

The current Detection method is labeled on the left edge of the screen. When a method is selected manually, a **#** is displayed above the trace’s label. For example: **#Nrm** means that **Normal** was selected from the softkeys.

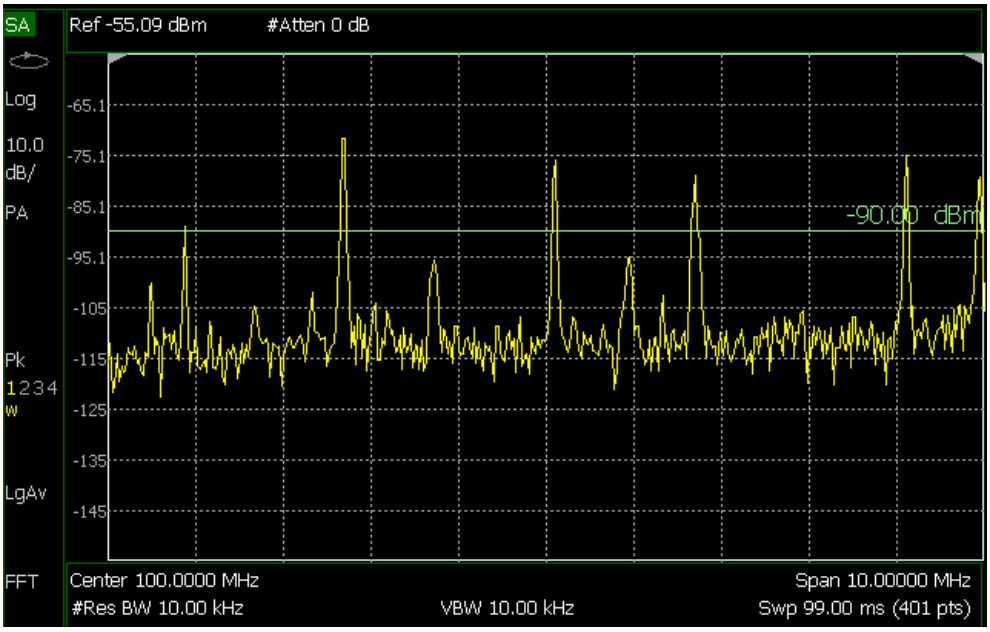
1. Press **Trace_6** > **Trace Detector**
2. Then choose from the following:

- **Auto** Displays the most appropriate Detection method based on other settings. [**# is NOT shown**]
- **Normal** [**#Nrm**] Provides a better visual display of random noise than **Positive peak** and avoids the missed-signal problem of the **Sample** Mode. Should the signal both rise and fall within the bucket interval, then the algorithm classifies the signal as noise. An odd-numbered data point displays the maximum value encountered during its bucket. An even-numbered data point displays the minimum value encountered during its bucket. If the signal is NOT classified as noise (does NOT rise and fall) then Normal is equivalent to Positive Peak.
- **Positive Peak** [**#Pk**] Displays the maximum value of all the measurements in each bucket. This setting ensures that no signal is missed. However, it is not a good representation of the random noise in each bucket.
- **Negative Peak** [**#NPk**] Displays the minimum value of all the measurements in each bucket.
- **Sample** [**#Smp**] Displays the center measurement of all the measurements in each bucket. This setting gives a good representation of the random noise in each bucket. However, it does not ensure that all signals are represented.
- **Average** [**#Rms**] Displays the Root Mean Squared (RMS) average power of all the measurements in each bucket. This is the preferred method when making power measurements.

Display Line

A display line is a simple, horizontal line that can be placed at any amplitude level on the SA screen or set to any level in IQA. Use a display line as mental guide for visual feedback. A display line is similar to a Limit Line, except that no PASS/FAIL testing occurs. A display line is easier to create than a Limit Line. Learn more in “All about Limit Lines” on page 812.

Figure 9-24 Display Line with Annotations



How to create and move a Display Line

1. Press **Limit 8** > **Display Line OFF ON**
2. Then enter a Y-axis value using the ▲|▼ arrows or the rotary knob, then press **Enter**. Or enter a value using the numeric keypad and press a suffix key or press **Enter**.

Learn more, "All about Limit Lines" on page 812.

Noise Marker

For comparison purposes, electronic noise measurements are often displayed as though the measurement was made in a 1 Hz Res BW. However, making an actual measurement at a 1 Hz Res BW is extremely slow.

A Noise Marker, unique to SA Mode, mathematically calculates the noise measurement as though it were made using a 1 Hz bandwidth.

Several data points (or 'buckets') are averaged together to calculate the Noise Marker readout. To accurately measure noise, the Noise Marker should NOT be placed on, or too close to, a signal. The distance from a signal depends on several factors. To know if an accurate reading is being made, move the Noise Marker until consistent measurements are displayed in adjacent data points.

In addition, when a Noise Marker is displayed, the Detection method is automatically switched to Average and PAvg is shown on the FieldFox screen. This occurs only when Detector is set to Auto. Learn more in "Detection Method" on page 219.

With a Noise Marker present, the Res BW can be changed and the displayed noise floor will also change, but the Noise Marker readout will remain about the same.

Noise Markers can be used like regular markers. A Noise Marker is distinguished from a regular marker by (**1Hz**) after the marker readout value. Learn more about regular markers in "All about Markers" on page 797.

How to measure Noise with a marker

1. Press **Marker** to create or select a Normal or Delta marker to use to measure Noise.
2. Then **More** > **Marker Function** > **Noise ON OFF**.

Power Spectral Density (PSD) Function (SA Mode Only)

The Power Spectral Density Function (PSD Function) is a way to normalize the SA measurement to a 1 Hz Bandwidth. Every SA Resolution Bandwidth is characterized by an "Equivalent Noise Bandwidth" (ENBW) that in general is a few percent wider than the Resolution Bandwidth itself. To normalize the measurement to this ENBW, an offset is added in this amount:

```
PsdOffset = -10 * Log10( ENBW )
```

This offset is added to the Reference Level, the Trace values, and Marker values and s annotation is updated with "/Hz" or "(1Hz)" as an indication that the results are now normalized to 1Hz. This is similar to what the Noise Marker function does, but the Noise Marker also first averages several trace points around the marker location. Similar to a Noise Marker, the PSD Function will also auto-couple the Detector to RMS.

See also, "Noise Marker" on page 223.

Learn more, see "Creating and Importing *.csv Limit Line Files" on page 819.

How to measure the PSD function:

– Press **Scale/Type** > **More** > **PSD Function ON OFF** (Default == OFF).

Logarithmic X-axis Limit Line Interpolation (EMI and SA modes Only)

Normally, limit lines are interpolated linearly between the defined limit points (i.e., as a delta dB per Hz). Sometimes the user may want to change the limit line interpolation so that it is logarithmic vs. X (i.e., as a delta dB per log10(Hz)). The “AUTO” state for this control will automatically switch to logarithmic interpolation, if the Trace is being drawn on a logarithmic frequency axis (Log Freq Axis X, available by **Freq/Dist > More** for SA and EMI modes). The “OFF” state keeps limit line interpolation happening linearly, regardless of the current choice of logarithmic frequency axisX.

Learn more, see “How to change from Linear to Log Axis View” on page 157.

How to set Logarithmic X-axis Interpolation (Log Freq AxisX)

1. Press Limit 8 > Options > LogX Interp Auto Off – Enables/disables logarithmic interpolation of the X–axis (Default == Auto).
2. Then choose from the following:
   - Auto – (default) reacts to the trace data. If the you chooses LogX axis for your trace data, then Auto will cause the interpolation of the Limit Lines to also act “logarithmically vs. X”. But, for normal Linear X axis trace data, the interpolation of the limit line remains as before, straight line interpolation vs. the x axis data.
   - Off – forces the limit lines to interpolate linearly vs. X.

Band/Interval Power Marker

A Band/Interval Power marker—available in IQA and SA Modes—accumulates the power that is measured over several adjacent data points (or ‘buckets’). The range of buckets being measured is displayed with vertical posts around the marker. This Band Span value is selectable.

This feature is very similar to a channel power measurement (“Channel Power (CHP)” on page 230).

When the frequency span is set to Zero span, the marker is referred to as an Interval Band Marker because it averages power over a specific time interval. In this case the range is specified as the Interval Span. Learn more about Zero span measurements in “Zero Span Measurements” on page 200.

If the Detection method and Averaging type are set to Auto when you enable a Band/Interval Power marker, the Detection method will change to Average (RMS) and Averaging type will change to Power average. Other Detection methods or Averaging type settings will usually cause measurement inaccuracy. Learn more about Detection method in “Detection Method” on page 219, and Averaging Type in “Average Type” on page 210.

Summary:

- In Zero span, an Interval Power Marker yields the average power over the specified time interval.

– In non-Zero span, a Band Power Marker yields the total power over the specified frequency range.

How to measure Band/Interval Power with a marker

1. Press **Marker** to create or select a Normal or Delta marker to use to measure Band/Interval Power.
2. Then press **More** > **Marker Function** > **Band/Int Power** > **Band (or Interval) Span**
3. Then choose from the following:
   - **Auto** Measures power over 5% of the displayed span, or ½ graticules. The Band Span is automatically updated to remain at 5% when you change the frequency span.
   - **Man** Enter a frequency or time value using the ▲|▼ arrows or the rotary knob, then press **Enter**. Or enter a value using the numeric keypad and select a frequency or time suffix. The Band Span remains at the frequency or time value that you set as the span changes.

Frequency Counter at Marker

Available in SA Mode ONLY. Use any existing marker to make highly-accurate frequency counter readings. For highest accuracy, lock the FieldFox to a stable external frequency reference. Learn how in "Frequency Reference Source" on page 870.

When Frequency Counter is ON, the FieldFox uses background sweeps to zoom on the signal, measure the signal peak with 1 Hz resolution, and display the frequency of the signal peak in the marker annotation area. The marker does not move to the signal peak.

When Freq Counter is ON, measurement sweeps are considerably slower.

How to use Frequency Counter

1. Press **Marker**.
2. Press Normal, Delta, or Peak, or select an existing marker to use as a frequency counter.
3. Locate the marker somewhere on a CW signal. It does NOT have to be on the peak.
4. Then **More** > **Freq Count ON**
5. With Freq Count ON, you can scroll through the existing markers that are located on a discrete CW signal, and read the frequency of the signal peak. However, each frequency count update requires another sweep. If the FieldFox is in HOLD, press **Single** to update the frequency count results.

Time Zero Fixed Marker

This feature was created to allow recall of vintage instrument states (older than Rev. 7.0) that included Zero span sweep with a trigger delay and at least one marker. Before Rev. 7.0, these instrument states were saved and recalled with the equivalent of the ON state of this setting. The default setting is OFF. Learn more about Triggering with negative delay in "Triggering" on page 202.

1. Press **Mkr->/Tools** > **More** > **Mkr Properties** > **Time Zero Fixed**
2. Then choose from the following:
   - **ON** Time Zero is fixed at the left-edge of the screen. A marker in negative delay resides at this point. This is the vintage behavior.
   - **OFF** (default) Time Zero is located at the T-zero indicators. A marker in negative delay appears to the left of T-zero.

Audio Beep at Marker Power

When enabled, the Audio Beep feature emits a repetitive beep sound which varies in tone pitch and repetition rate to indicate the relative power level of the active marker. The highest tone pitch and fastest beep rate occurs when the marker Y-axis position is at the top of the display. Conversely, the lowest pitch and repetition rate occurs at the bottom of the display. Therefore, it is important to scale the signals that you intend to measure between the top and bottom of the screen. Learn more about Scale in "Scale and Units" on page 161.

Audio Beep can be used with any marker type or function, including Band/Interval Power. Learn more in "Audio" on page 856.

How to use Audio Beep

1. Press **Marker**
2. Optionally, press **Marker 1 2 3 4 5 6** to select an existing marker to use with Audio Beep. A marker will be created if one does not already exist.
3. Then **More** > **Marker Function** > **Audio Beep ON OFF**

Audio Beep does NOT beep when the FieldFox is in Hold mode.

While Audio Beep is ON, press **Marker 1 2 3 4 5 6** to toggle Audio Beep through the existing markers.

To set FieldFox speaker volume control, press **System**, then **Volume**. Learn more in "Audio" on page 856.

Meas UNCAL Error

Meas UNCAL appears in the lower-left corner of the screen when the FieldFox can NOT display accurate measurement results with the current settings. Usually, the part of the trace that is inaccurate is shown at –200 dB.

The following situation can produce **Meas UNCAL**:

– When the ResBW/VBW ratio exceeds 10,000, causing the VBW filter to reach the maximum capacity for averaging.

Old Data Indicator (*)

In SA mode, when the current trace does not exactly match the annotation that is on the screen, an asterisk is displayed in the upper-right corner of the screen graticule area. This would occur, for example, when the Res BW setting is changed while in sweep Hold mode. The annotation is changed immediately, but the trace is not updated until the next sweep occurs. Therefore, the current data trace does not match the screen annotation. See the asterisk in Figure 9-1 on page 151.

Channel Measurements

The following Channel Measurements are offered in SA Mode:

Channel Power	“Channel Power (CHP)” on page 230
Occupied Bandwidth	“Occupied Bandwidth” on page 231
Adjacent Channel Power Ratio	“Adjacent Channel Power Ratio (ACPR)” on page 233

Radio Standards and Channel Measurements

To tune the frequency range of any of the Channel Measurements using channels instead of frequency, first select a Radio Standard, then select Units = CHAN. Learn how to select a Radio Standard and channels in “How to select a Radio Standard” on page 157.

When you first select a Radio Standard, then select a Channel Measurement:

– With Units = FREQ selected, the center frequency and span will ALWAYS change to the full frequency range of that standard (Uplink and Downlink) to allow for a quick scan of energy. The X-axis annotation indicates the frequency range.

– With Units = CHAN selected, the FieldFox chooses either the uplink or downlink band, and displays that range of frequencies. You can then tune within that Standard using Start CHAN, Stop CHAN, or Center CHAN. The X-axis annotation indicates the frequency range.

When you **first select a Channel Measurement**, then select a **Radio Standard**, the BW, Offset, RRC, Integration BW, and Span settings are changed to those of the standard. In addition, Res BW can also change when set to 'Auto(couple)'. However, center frequency is NOT changed unless you first select Units = CHAN.

Measurement Preset

Measurement Preset allows you to easily reset any of the channel measurements to its default settings. The Center Frequency, Preamp ON|OFF, RF Attenuation, Markers, Limits, and Radio Standard settings are NOT reset.

How to select Measurement Preset:

– Press **Preset** > **Mode Preset**

Averaging

By default in ALL Channel measurements, averaging is enabled and set to display the average of the last 15 measurements. When enabled, this average setting is automatically making the following 'averaging' settings in order to provide the most accurate power measurements:

– Averaging Type is set to Power.

– Trace State is set to Average.

– Detector is set to Average.

– Count is set to 15.

Any of these settings can be changed manually during a Channel measurement. Learn more about these settings starting in "Average Type" on page 210.

To change Averaging:

1. Press **Meas Setup 4**.
2. Then **Average Enable ON OFF** OFF effectively sets the Average Count to 1.
3. Then **Average Count**
4. Enter a value between 1 and 10,000 using the numeric keypad, ▲|▼ arrows, or the rotary knob.
5. Press **Enter**.

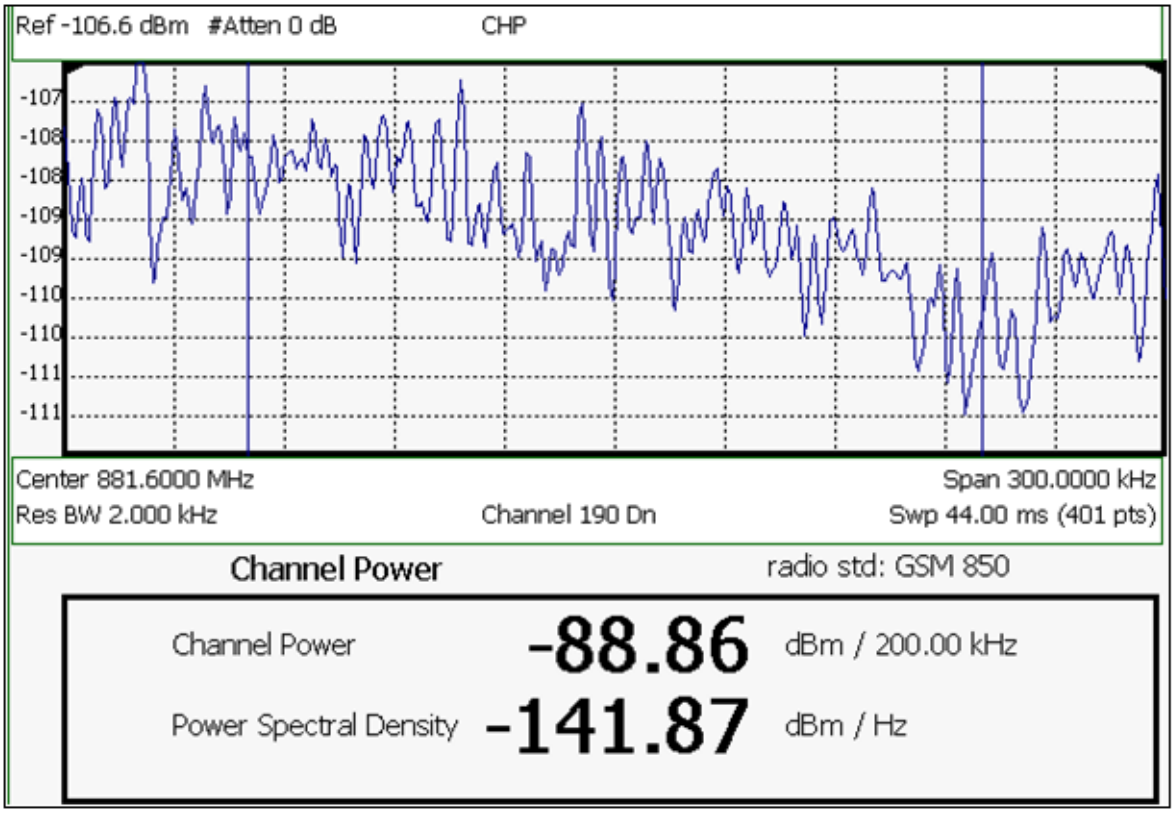
Traces

Only one measurement trace can be displayed in Channel Measurements.

Channel Power (CHP)

Channel Power measures total power over the specified Integrated BW. The Integration Bandwidth (IBW) can be adjusted to measure the power over multiple channels.

Figure 9-25 Channel Power Measurement



The following two Channel Power levels are displayed:

- **Channel Power** - measures total power over the specified Integrated BW.
- **Power Spectral Density** – same measured power, but mathematically normalized to a 1 Hz bandwidth using the same algorithm as Noise Marker. Learn more about the Noise Marker in “Noise Marker” on page 223.

How to select Channel Power

1. Press **Measure 1**
2. Then **Channel Power**

When Channel Power is selected, the following settings are maintained from a previous measurement: Center Frequency, Preamp ON|OFF, and RF Attenuation.

Integration Bandwidth

When Channel Power is selected, vertical posts appear on the display to mark the current Integration Bandwidth setting. The displayed Channel Power and Power Spectral Density values are measured and calculated over the specified Integration Bandwidth.

By default, the displayed frequency span is automatically coupled to the Integration Bandwidth. As you change the Integration Bandwidth, the frequency span is adjusted so that the vertical posts appear to NOT move. However, when you manually change the frequency span, the Integration Bandwidth is no longer coupled to the frequency span.

When a Radio Standard is selected, the appropriate Integration Bandwidth is set automatically. Learn more about Radio Standards in “Radio Standard” on page 157.

To change Integration Bandwidth:

1. Press **Meas Setup 4** > **Integrating BW** (Integrating Bandwidth)
2. **Enter a value between 100 Hz and 5 GHz using the numeric keypad, ▲|▼ arrows, or the rotary knob.**
3. Press **Enter**

Other Channel Power Settings

All relevant FieldFox settings are made automatically to ensure the highest accuracy, such as ResBW, VideoBW, and sweep (SwpAcquisition) speed. These, and all other SA Mode settings, can be changed manually in a Channel Power measurement.

– Learn about Measurement Preset in “Measurement Preset” on page 229.

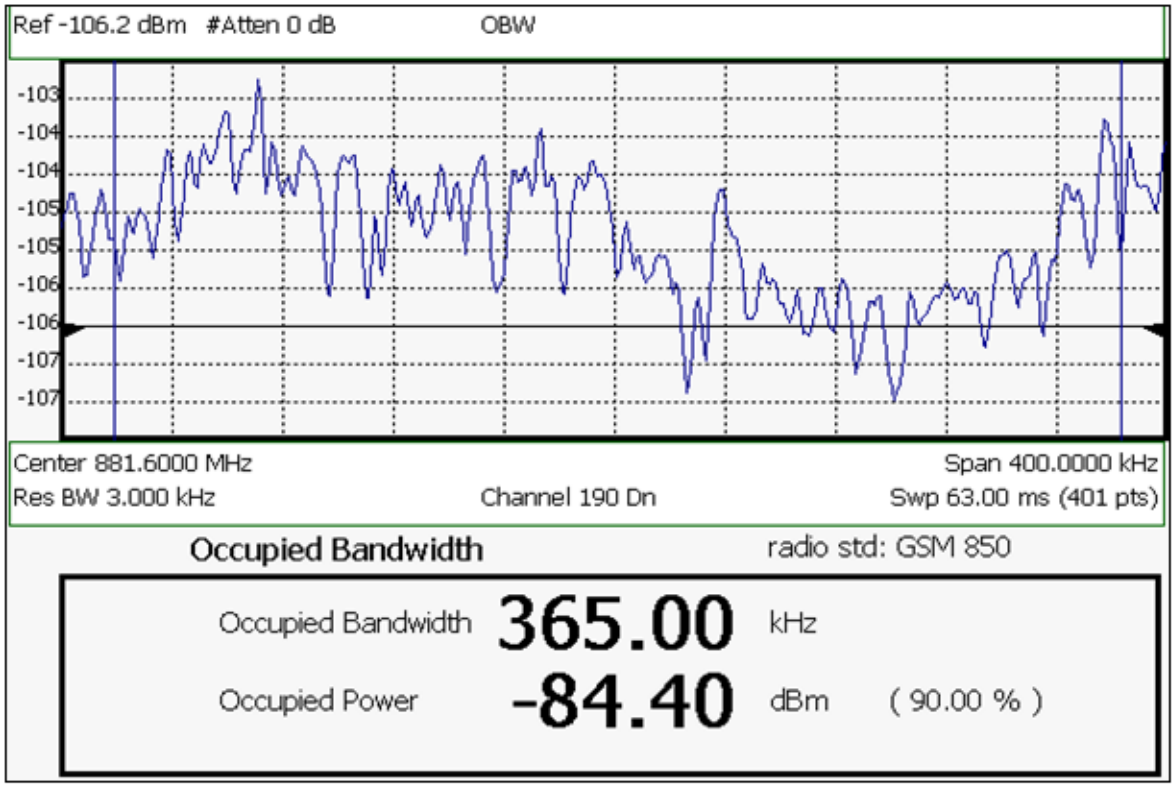
– Learn about Averaging in “Averaging” on page 229.

– Learn about RRC Weighting in “RRC Weighting” on page 237.

Occupied Bandwidth

Occupied Bandwidth measures the power of the displayed frequency span and displays vertical posts at the frequencies between which the specified percentage of the power is contained. The frequency span between the two vertical posts is the Occupied Bandwidth. The Occupied Power, the power that is contained between the two posts, is also displayed in dBm.

Figure 9-26 Occupied Bandwidth Measurement



The graphic above shows an OBW measurement; Chan 190 Downlink; GSM850 Radio Standard

How to Select Occupied Bandwidth

1. Press **Measure 1**
2. Then **Channel Measurements**
3. Then **Occupied BW**

When Occupied Bandwidth is selected, the following settings are maintained from a previous measurement: Center Frequency, Preamp ON|OFF, and RF Attenuation.

Frequency Span

Occupied BW is calculated from power that is measured over the entire displayed Frequency Span. The frequency span can be entered using arbitrary frequencies or by using a Radio Standard in conjunction with channel numbers. Learn how to select a Radio Standard and channels in "Channel Selection" on page 158.

To change Frequency Span:

1. Press **Freq/Dist** > **Freq Span**

NOTE

Integration BW (IBW) is coupled to the Frequency Span setting. Frequency Span is 50% wider than the IBW (e.g., if the IBW value is 1 MHz, then the Frequency Span value is 1.5 MHz).

2. Enter a value using the numeric keypad, ▲|▼ arrows, or the rotary knob.
3. Press **Enter**

Power Percent

This setting specifies the percentage of total measured power to display between the vertical posts. The measurement defaults to 99% of the occupied bandwidth power. The remaining power (1% of default setting) is evenly distributed;.5% of the power on the outside of each side of the vertical posts.

To change Power Percent:

1. Press **Meas Setup 4** > **Power Percent**
2. Enter a value between 10 and 99.99 using the numeric keypad, ▲|▼ arrows, or the rotary knob.
3. Press **Enter**.

Other Occupied Bandwidth Settings

All relevant FieldFox settings are made automatically to ensure the highest accuracy, such as ResBW, VideoBW, and sweep (SwpAcquisition) speed. These, and all other SA Mode settings, can be changed manually in a Occupied Bandwidth measurement.

– Learn about Measurement Preset in "Measurement Preset" on page 229.

– Learn about Averaging in "Averaging" on page 229.

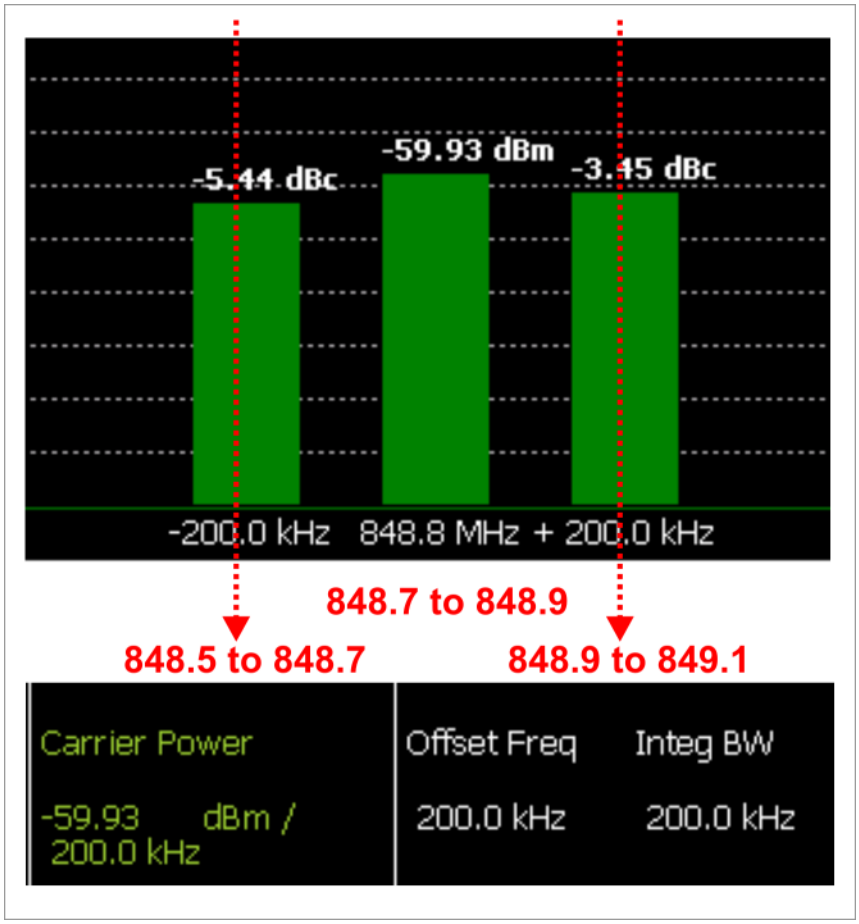
Adjacent Channel Power Ratio (ACPR)

ACPR measures the power of a carrier channel and the power in its adjacent (offset) channels. The measurement results can help you determine whether the carrier power is set correctly and whether the transmitter filter is working properly.

You can measure the channel power in one, two, or three adjacent (offset) channels on the low frequency and high frequency side of the carrier channel.

Limits can be used to quickly see if too much power is measured in the adjacent channels.

Figure 9-27 GSM 850-Ch 251-Up with one Offset



In the graphic above, red frequencies (MHz) are added to illustrate offset and integ BW.

Data in the ACPR graphical chart is always presented in dBm for the carrier, and dBc (dB below the carrier) for the offsets. This can NOT be changed. Use the **Meas Type** setting (next page) to change how the data is presented in the table below the graph.

How to select ACPR

- Press **Measure 1**
- Then **Channel Measurements**
- Then **Adjacent Channel Power**

When ACPR is selected, the following settings are maintained from a previous measurement: Center Frequency, Preamp ON|OFF, and RF Attenuation.

Frequency Range/Channel

When a Radio Standard is selected, the appropriate center frequency or channel and span is set automatically. The frequency or channel number can then be changed from the **Freq/Dist** menu. Learn how to select a Radio Standard and channels in "Radio Standard" on page 157.

The frequency range of an ACPR measurement can also be entered using arbitrary frequencies.

When a Radio Standard is NOT selected, the center frequency of a previous measurement is maintained when ACPR is selected.

Changing the Integration Bandwidth

The Integration Bandwidth of the carrier and offsets is the frequency span over which power is measured.

To change Integration Bandwidth:

1. Press **Meas Setup 4** > **Integrating BW**
2. Enter a value between 100 Hz and 100 MHz using the numeric keypad, ▲|▼ arrows, or the rotary knob.
3. Press **Enter**

How to define adjacent (Offset) channels

An offset represents a difference in center frequencies of the carrier channel and its adjacent channel to be measured. The frequency range for each offset is specified with an Offset Freq and Integ BW. Each offset that is created has a Lower (carrier MINUS Offset Freq) and Upper (carrier PLUS Offset Freq) set of frequencies.

1. Press **Meas Setup 4** > **Offsets**
2. Press **Offset 1 2 3** to select an offset.
3. Then **Offset State** to set that offset ON or OFF.
4. Select **Offset Freq** This is the difference between the **carrier center frequency** and the **center frequency of the offset channel**. Then enter a value using the numeric keypad.
5. Select **Offset Integ BW** This is the frequency range over which power is measured in that offset; half of the range below and half above the Offset Freq.

How to set limits for adjacent channels

You can set a unique threshold power for each of the offsets that will cause a FAIL indication (RED bar). This occurs when the calculated **dBc** power (on top of the offset bar) is ABOVE the specified level.

To set limits, with an ACPR measurement on the screen:

1. Press **Limit 8** > **Offset (1,2,3)**
2. Then choose from the following:
   - **LowerOffsetLimit** Sets a limit for the lower-frequency offset.
   - **Upper OffsetLimit** Sets a limit for the higher-frequency offset.
3. Then enter a value using the numeric keypad, ▲|▼ arrows, or the rotary knob.
4. Then **Limit Test ON OFF**

Measurement Type

This setting determines how the measured carrier and offset power levels in the **table** are presented. (Data in the graphical chart is always presented in dBm for the carrier and dBc for the offsets.)

To select Meas Type:

1. Press **Meas Setup 4** > **More** > **Meas Type**
2. Then choose from the following:
   - **Total Pwr Ref** – Integrated carrier power is represented in dBm, and relative powers between offsets and carrier are represented as dBc (dB below the carrier).
   - **PSD Ref** **(Power Spectral Density)** – Integrated carrier power is normalized to a 1 Hz density as dBm/Hz using a similar algorithm as Noise Marker. Learn more about the Noise Marker in "Noise Marker" on page 223.

   For both Meas Types, choose the reference for the offset data.
3. Press **Ref Value** to toggle between these settings:
   - **Auto** - dB or dBc value is computed by subtracting the measured carrier power from the measured offset power.
   - **Man** – dB or dBc value is computed by subtracting the entered RefValue from the measured offset power.
   - Then enter a value to be used to reference the data using the numeric keypad, ▲|▼ arrows, or the rotary knob.

Other ACPR Settings

All relevant FieldFox settings are made automatically to ensure the highest accuracy, such as ResBW, VideoBW, and sweep (SwpAcquisition) speed. These, and all other SA Mode settings, can be changed manually in a ACPR measurement.

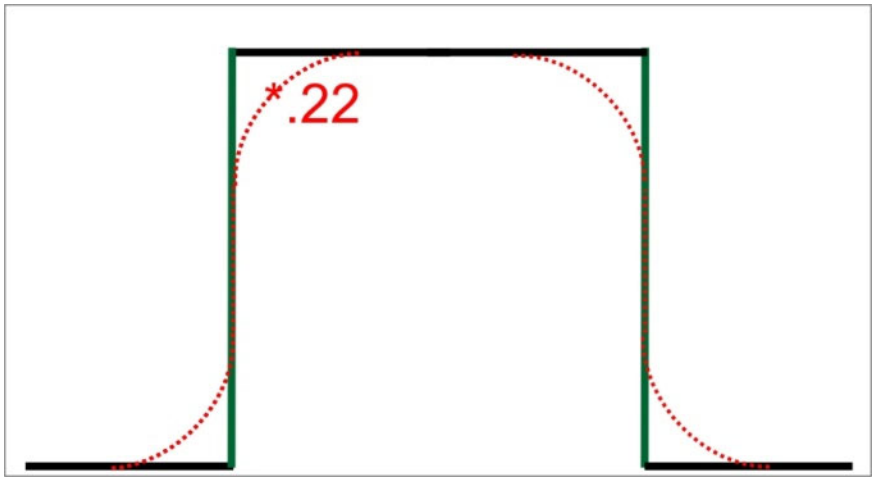
- Learn about Measurement Preset in "Measurement Preset" on page 229.
- Learn about Averaging in "Averaging" on page 229.

RRC Weighting

RRC, or Root-Raised-Cosign weighting, is offered with Channel Power and ACPR measurements.

When RRC Weighting is applied to transmitted and received power, the edges of the channel are 'smoothed' to help prevent interference. To accurately measure a channel that has RRC weighting, set the same value of RRC weighting as that used in the transmitter and receiver.

Figure 9-28 Channel power measurement with.22 RRC applied



RRC Weighting is set and enabled automatically when included in a selected radio standard.

To set and enable RRC Weighting:

1. Press **Meas Setup 4** > **RRC Weighting ON OFF** > **More** > **RRC Alpha [current setting]**
2. Enter a value between 0 (no smoothing) and 1 (most smoothing) using the numeric keypad, ▲|▼ arrows, or the rotary knob. A standard level of filtering is 22.
3. Press **Enter**.

How to Set Up EMF Settings (Requires EMF (Option 358), GPS (Option 307), and SA Mode (Option 233–Mixed Analyzers))

CAUTION If OTA or SA mode does not detect an EMF Option 358 license, then the EMF application and the USB antenna's axes must be set up manually. This use model is not recommended or supported by Keysight.

CAUTION The USB antenna's cable loss is **not** included, in the antenna's correction factors. For an accurate EMF measurement, the cable loss values should be accounted for. Refer to "Editing Cable Correction Factors and Adding New Cable Factors" on page 249.

NOTE **IMPORTANT!** The EMF antenna, ARIA6000 or FSH3D or equivalent—is required for EMF measurements. Refer to Chapter 15, "USB Antennas – (Full Capability Requires EMF Option 358, and either SA mode (Option 233 Mixed Analyzers) or OTA—LTE FDD (Option 370), LTE TDD (Option 371), 5G NR / 5G NR EVM Conducted (Option 378)."

CAUTION The antenna operation for single-polarization measurements is different between ARIA6000 and FSH3D. Please consult the datasheet corresponding to each antenna for specific details.

EMF mode measures signals at the SA RF Input Port 2 connector.

EMF mode requires the FieldFox to have SA mode (Option 233 on combination analyzers), or OTA-LTE FDD (Option 370), LTE TDD (Option 371), 5G NR (Option 378), GPS (Option 307), and CPU2 installed.

Recommended, but not required, preamplifier (Option 235) to improve receiver sensitivity.

With Option 358 (EMF), network designers can measure and verity the RF exposure compliance as required by each country.

If SA mode is licensed for EMF Option 358, the primary measurement performed is Channel Power (CHP) which automatically switches amongst the 3 TriAxial antenna axis (X/Y/Z), to provide a summation of "total power" detected, using unique Antenna supplied corrections for the individual axis, with results in FieldStrength units. This is accomplished within the existing SA Channel Power measurement.

With or without license EMF Option 358, the System Utilities menu enables one to Import Corrections and manually drive the Antenna to a particular axis (X, Y, or Z). The manual control thus allows any SA Receiver measurement to sweep that axis just like any other antenna transducer, however without license the imported corrections are not usable from the Apps. But with license

the SA provides for easy use of the imported XYZ corrections, thus allowing presentation of correctly compensated FieldStrength measurements, for 1 axis at a time.

This section reviews the steps in setting up an EMF measurement, using a USB antenna. If you are not familiar with this process or would like more information, refer to Chapter 15, "USB Antennas – (Full Capability Requires EMF Option 358, and either SA mode (Option 233 Mixed Analyzers) or OTA–LTE FDD (Option 370), LTE TDD (Option 371), 5G NR / 5G NR EVM Conducted (Option 378)."

This section consists of:

– "EMF Features" on page 239
– "EMF Setup Procedure" on page 241

EMF Features

EMF has the following features:

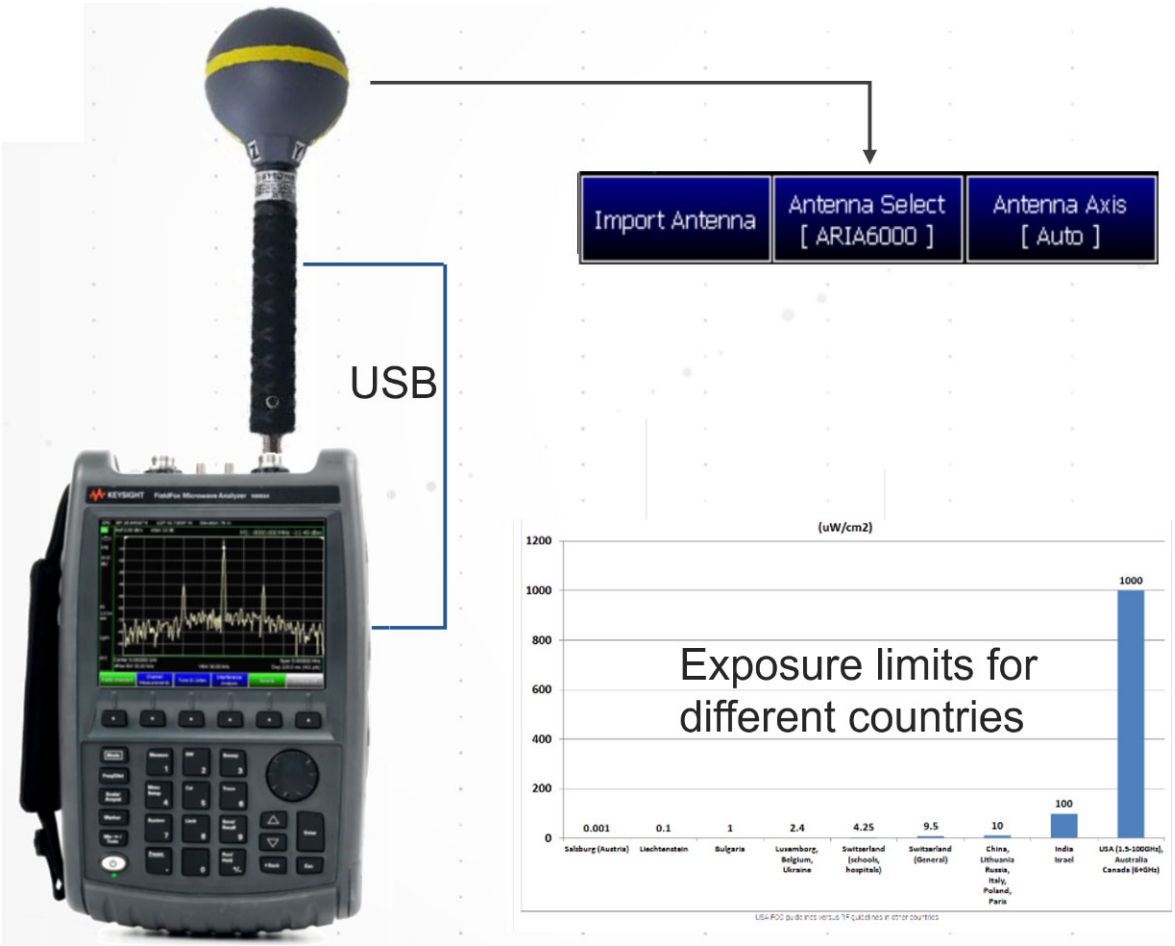
EMF Measurement Results:

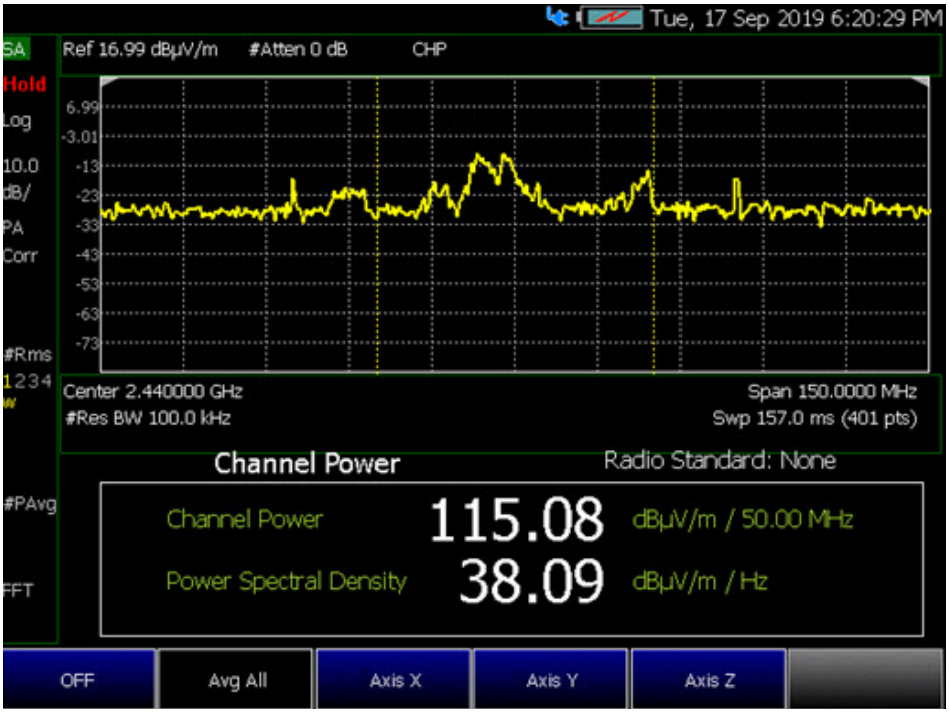
- Measure and display corrected field strength in RMS average power
- Antenna control over X, Y, and Z antenna factors downloaded via USB for ARIA6000 antenna or import a CSV file for FSH3D antenna
- Pass/Fail limit testing supported
- External PC **not** required

EMF uses the following data formats:

- Field Strength units:
  - dBµV/m – For use with E-field signals
  - dBµA/m – For use with H-field signals
  - dBG – dB Gauss
  - dBpT - dB Tesla

Figure 9-29 Example of EMF with Triaxial Antenna





EMF Setup Procedure

NOTE

When the USB antenna correction factors are imported, EMF (Option 358) couples many settings to ease setting up the EMF measurement (e.g., **Apply Corrections** is enabled, all X, Y, and Z antenna axes are enabled, and **Amp Corr Select** is set to **ARIA6000 or FSH3D TriAxial XYZ**).

NOTE

IMPORTANT!

The softkey menu selection and display of Axis X, Y, Z, corresponds to Loop 1, 2, 3, respectively for EMF antenna FSH3D.

1. Setup the FieldFox Spectrum Analyzer for a Channel Power measurement.
   a. Press **Mode** > **SA** >
   b. Press **Measure 1** > **Channel Measurements** > **Channel Power**

   See also, "Channel Measurements" on page 228.

NOTE

If necessary, this step can be skipped and done after the USB antenna is set up

2. Connect a USB antenna's RF cable to the **SA RF Input**, port 2 and the USB connector to a FieldFox USB port. See also, Figure 9-29 on page 240 and to Chapter 15, "USB Antennas – (Full Capability Requires EMF Option 358, and either SA mode (Option 233 Mixed Analyzers) or OTA–LTE FDD (Option 370), LTE TDD (Option 371), 5G NR / 5G NR EVM Conducted (Option 378)."

CAUTION

Only Agos Advanced Technologies ARIA6000 and Schwarzbeck Mess-Elektronik FSH3D Triaxial Isotropic USB antenna is currently compatible with EMF (Option 358).

3. Importing and selecting the X/Y/Z antenna factors:
   a. Press **System** > **Utilities** > **EMF Antennas**
   – For ARIA6000 EMF antenna, press **Antenna Select** and select "ARIA6000".

     Then press **Import Antenna** – to import the antenna factors from the antenna's memory over the USB connection (this may take 5 seconds or so and vary with the triaxial antenna).

NOTE

IMPORTANT!

The Import Antenna softkey is only activated when Antenna Select is set to ARIA6000 or FSH3D.

NOTE

If the antenna factor import is successful, the FieldFox displays: "`Success: Antenna Factors Imported: EMF Antenna ID: ->[R] Antenna ID: ARIA6000-1006 ->[]`". The last 4-digits will vary for each antenna (i.e., "1006" value will vary).

If the FieldFox displays this error `Error: EMF antenna Error: Not found` or `Unable to communicate with antenna. Ensure it is connected.` is displayed, verify the EMF antenna is connected correctly. See also, "Troubleshooting" on page 487.

– For FSH3D EMF antenna, press **Antenna Select** and select "FSH3D".

  Then press **Import Antenna** > **Import Files** - to import FSH3D antenna factor CSV file from external storage device e.g. USB or SD Card to the INTERNAL storage. **Recall File** to retrieve these imported CSV files directly from INTERNAL when necessary.

Figure 9-30 FSH3D antenna factor CSV Import Files storage device selection Softkey

Press the storage device containing FSH3D antenna factor CSV file you wish to import from. The window will navigate to the chosen storage device and display all available CSV files.

Choose a single FSH3D antenna factor CSV file from the list, then press **Import**.Once imported, press **Done** to complete the process.

To recall INTERNAL FSH3D antenna factor CSV, press **Import Antenna**, then select the target CSV file and press **Recall File**.

CAUTION

FSH3D antenna factor CSV files MUST be saved in the "AntennaEMF" folder within the storage device to import from.

– By selecting **Antenna Select** and choosing either ARIA6000 or FSH3D to verify the EMF antenna selected (Default == Manual). Only compatible EMF antennas can be used for EMF measurements.

  See also, "How to Use the Manual EMF Channel Power" on page 246.

– Optional: Press **Antenna Axis** the antenna axis should be set to **Auto** for default operation. When AUTO is selected the application (e.g., Channel Power or OTA) controls the axes and switches as needed. With the AUTO setting, all antenna elements (X, Y, and Z) are OFF.

NOTE

The Antenna Axis softkey is only activated when Antenna Select is set to ARIA6000 or FSH3D.

– Press **Back** > **Back** to exit the EMF Antenna softkey menu.

4. Enabling the imported USB antenna factors and Cable factors:

   a. Verify that the Channel Power measurement is set: **Measure 1** > **Channel Measurements** > **Channel Power**

   b. To enable the Triaxial antenna for EMF: Press **Meas Setup 4** > **EMF Off** > **EMF Triaxial [OFF]** > **Sum All**

      With **Sum All**, the field strength from all three axes is summed and displayed. The RF measurements are switched between the three different antennas (three dipoles), and the resulting summation of the total power collected, and averaged.

      Alternatively, you can select either of three axes to individually measure the field strength in the one direction.

   c. Else, to manually set one of the triaxial antenna's three axes to individually measure the field strength in one direction.

      i. Press **EMF Off** > **EMF Axis Select [OFF]** then

      ii. Select a single **Axis X**, **Axis Y**, or **Axis Z** antenna dipole for **uncorrected** use. [X, Y, or Z] is displayed to indicate which one of the X/Y/Z dipole axes is enabled. If for example the X axis has been selected in the **System** > **Utilities** > **EMF Antennas** menu, then **Antenna Axis [X]** is displayed to indicate the X axis measurement (i.e., this uncorrected manual mode is typically used when no EMF Option 358 is installed). Refer to Figure 9-31. See also step f.

      For **corrected** manual single axis EMF measurements, refer to "How to Use the Manual EMF Channel Power" on page 246.

Figure 9-31 EMF Axis Select [N] Softkey – With the X–Axis Dipole Selected

   d. Modifying the Amplitude Correction Selection:

      Press **Scale/Amptd** > **More** > **Corrections** > **More** then

      – **Amp Corr Select [Tri Axial XYZ]** - then choose one of the following:

         – **Default** Receiver side only antenna measurements (Default – when no Tri Axial antenna is detected).

         – **Src/Rcvr Split** to work with non-triaxial receiver and source side antenna measurements.

         – **Triaxial XYZ** (default, when Channel Power is on and when a compatible triaxial antenna's factors have been imported) for measuring channel measurements and EMF.

– Then **<Back** to exit to the previous softkey menu.

e. Optional (Tri-Axial XYZ Antenna):

Verifying antenna and cable corrections are applied:

i. Press **Scale/Amptd** > **More** > **Corrections**

– Then verify the **Apply Corrections Auto Disabled** softkey is set to **Auto** (This is the default setting when a compatible USB antenna's correction factors have been imported, via the System softkeys).

– Then verify the **X axis Antenna**, **Y axis Antenna**, and **Z axis Antenna** are all **OFF**. These can each be enabled or disabled individually, but for EMF measurements all three axes should be enabled (i.e., Antenna == Off, the applications are setting the X/Y/Z).

– Then Press **Cable Off** to open the cable correction softkeys menu.

Verify **Cable** is **ON**. This can be disabled for applications where an additional cable has not been connected to the triaxial antenna. Before a cable can be used with the EMF measurements it needs to have corrections loaded. If you are going to use a cable, then choose as needed:

– **Cable Off** to enable a cable for use in your antenna measurement.

– **Edit Cable** displays a cable corrections table that you can edit

– **New** displays a cable corrections table that you can edit with new cable correction content.

Yes	– Choose **Yes** to overwrite the current cable data
No	– Choose **No** to exit the cable data edit table view

– **Save Cable** Opens a menu to name and save the cable corrections data

– **Recall Cable** Recalls the selected cable correction file from the `\Cables` folder.

– **Storage Device** to select the storage device where your cable correction file is located (Internal/USB/SD Card)

ii. **Optional**: Press More then

- Press View Corrections OFF ON to turn ON and OFF Pink Trace - Antenna/Cable corrections. This is a composite of all cable/antenna corrections that are currently applied. Available as a useful visual aid, the zero “dB” level (no net correction) is mapped to appear at the -50 dBm on-screen level.
- Press Src/Rcv Split - selecting **Src/Rcv Split** selects Source and Receiver side measurements.

f. **Optional**: Example of editing X, Y, and Z axes manually.

NOTE

The USB antenna factors stored in the triaxial antenna itself cannot be overwritten. The antenna factors on FieldFox imported into FieldFox can be modified. To reset the antenna factors in FieldFox to the original factors, re-import the antenna factors.

- Press X axis Antenna – opens the X axis Antenna softkey menus. Then choose one or more of the following:
  - X axis Antenna – enable/disable the X axis antenna factors (default is coupled to other settings).
  - Edit Antenna – to edit the current imported X factor (if available). Refer to “Editing Antenna Correction Factors and Adding New Antenna Factors” on page 247.
  - New – to edit/define a new X factor value. Refer to “Editing Antenna Correction Factors and Adding New Antenna Factors” on page 247.
  - Save Antenna – to save either an edited X antenna factor or a new X antenna factor. See also See also Chapter 32, “System Settings” and then to “Alpha Numeric Editing” on page 859.
  - Recall Antenna – to recall a stored X antenna factor. See also Chapter 32, “System Settings.”
  - Storage Device – to select the location to store your new antenna factor. See also Chapter 32, “System Settings.”

5. Modifying the EMF settings:

   Press Meas Setup 4 > More > EMF OFF then

   - EMF TriAxial [OFF] disable/enable the EMF tri-axial measurement (Default == OFF)).

- Press **Scale/ Amptd** > **More** > **Unit dBm** choose units (Default == dBm).
- **Back** to exit to the previous softkey menu.

For more details on editing the USB antenna, refer to Chapter 15, "USB Antennas – (Full Capability Requires EMF Option 358, and either SA mode (Option 233 Mixed Analyzers) or OTA–LTE FDD (Option 370), LTE TDD (Option 371), 5G NR / 5G NR EVM Conducted (Option 378)."

How to Use the Manual EMF Channel Power

This manual EMF channel power method procedure is used to adjust the antenna axes when the antennas are to be moved physically and then the X, Y, and Z axes setting values are assigned.

CAUTION

The saved results are only accurate as long as User Corrections do not change. The User Corrections include Antenna and Cable compensation, and if those compensations change in any way, it will invalidate the saved measurement results.

Is is recommended that the **Clear Saved Results** softkey is pressed for a new equipment setup or the Antenna Corrections are modified.

To indicate that a user correction has been changed, an asterisk(*) is displayed to indicate that the Saved results has been compromised and no longer valid.

Importing and selecting the X/Y/Z antenna factors:

1. Press **System** > **Utilities** > **EMF Antennas**
2. Press **Antenna Select [Manual]** (Default) then
3. Verify you are measuring **Channel Power** (refer to step 1 on page 241) then
4. Press **Meas Setup 4** > **EMF Off** then
5. Press **EMF Axis Select [Off]** – to select an antenna axis
6. For this example, press **Axis X**

   The FieldFox display updates to read "`X axis Channel Power`" and channel power values (dBm /Hz).
7. Move the antenna to the correct physical location/position for your measurement.
8. **Antenna corrections:** Press **Corrections** > **X-Axis Antenna Off** > **Antenna OFF** to **ON** – learn more, refer to "How to Use the Antenna and Cable Softkeys" on page 167.
9. When done press **<Back**

10. Press **Meas Setup 4** > **EMF Active** > **Save Axis Result** – the display is updated with antenna's current position channel power values and display trace.

    X axis channel power (CHANPOW) data and trace are frozen in the upper right of the EMF Channel Power window.

11. Repeat steps 5 through 10 for the axis Y and Z.

    After pressing the Axis Y softkey, the **Axis-X Antenna** softkey changes to read **Enabled** (Axis-X measurement saved) and because the Y-Axis is now the active antenna (measuring data). Axis-Y softkey behaves similarly after it is saved and Axis-Z is pressed.

12. **Sum Channel Power:** Press **Save Axis Result**. The **Live Sum CHP** value now displays the summed values of the 3 axes.

Other softkey choices are **Restart**, **Corrections**, **Clear Saved Results**, and **Save Traces Blank View**.

Editing Antenna Correction Factors and Adding New Antenna Factors

This section contains two procedures illustrating how to edit the Antenna Factors settings table values.

NOTE

If New is selected under the X, Y, or Z Antenna or Cable softkey menu, whatever antenna or cable factors that have been imported as the default values and are displayed in the Settings table

1. Selecting an antenna softkey menu:

   Press **Scale/Amptd** > **More** > **Corrections** then choose one of these softkey menus:

   - **X axis Antenna** – to open a softkey menu to edit the X axis of a triaxial antenna.
   - **Y axis Antenna** – to open a softkey menu to edit the Y axis of a triaxial antenna.
   - **Z axis Antenna** – to open a softkey menu to edit the Z axis of a triaxial antenna.
   - **Cable** – to open a softkey menu to edit the cable factors for an antenna setup.

2. For this example, the X axis Antenna softkey menu has been selected:

   a. Then press **Edit Antenna** to edit the existing X axial antenna factor's Frequency and Antenna Factor table values that are stored in the FieldFox `[:Internal]:\Antenna\` directory (Refer to Figure 9-32). Then you can edit the following:

- **Description** – edits the name of the current antenna settings table
- **Antenna Factor Unit** – edits the units from dB /m electric antenna factor to dB S/m for the magnetic antenna factors. **None** is displayed, when no antenna is detected.
- **Frequency** – edits the frequency value measured that corresponds to a particular Antenna Factor.
- **Antenna Factor** – edits the Antenna Factor (amplitude) that corresponds to a particular frequency.

  Refer to next step for details on editing the antenna Settings table.

b. Use the ▲|▼ arrows, the rotary knob, or numeric keypad to select the table cell value to be edited (i.e., the Frequency Interpolation value is not editable). Then:

i. Press **Edit Antenna** to edit your existing antenna factors or press **New** to add a a new antenna's factors or to write over your existing antenna's file (i.e., Overwrite existing Antenna data? is displayed above the table).

- Choose **Yes** to write over the existing antenna file.
- Choose **No** to create a new antenna file (default filename is `Example`).

ii. Press **Add Row** to create additional Frequency and Antenna Factor values.

iii. Press **Delete/Clear** then choose one of these:

- **Delete Row** – when pressed this choice deletes the currently selected row of Frequency and Antenna Factors (i.e., you must press **Yes** to delete a row or **No** to exit the current softkey menu).
- **Clear All** – when pressed this choice deletes all of the currently selected rows of Frequency and Antenna Factors (i.e., you must press **Yes** to deleted the rows or **No** to exit the current softkey menu).
- **Back** – To exit to previous softkey menu.

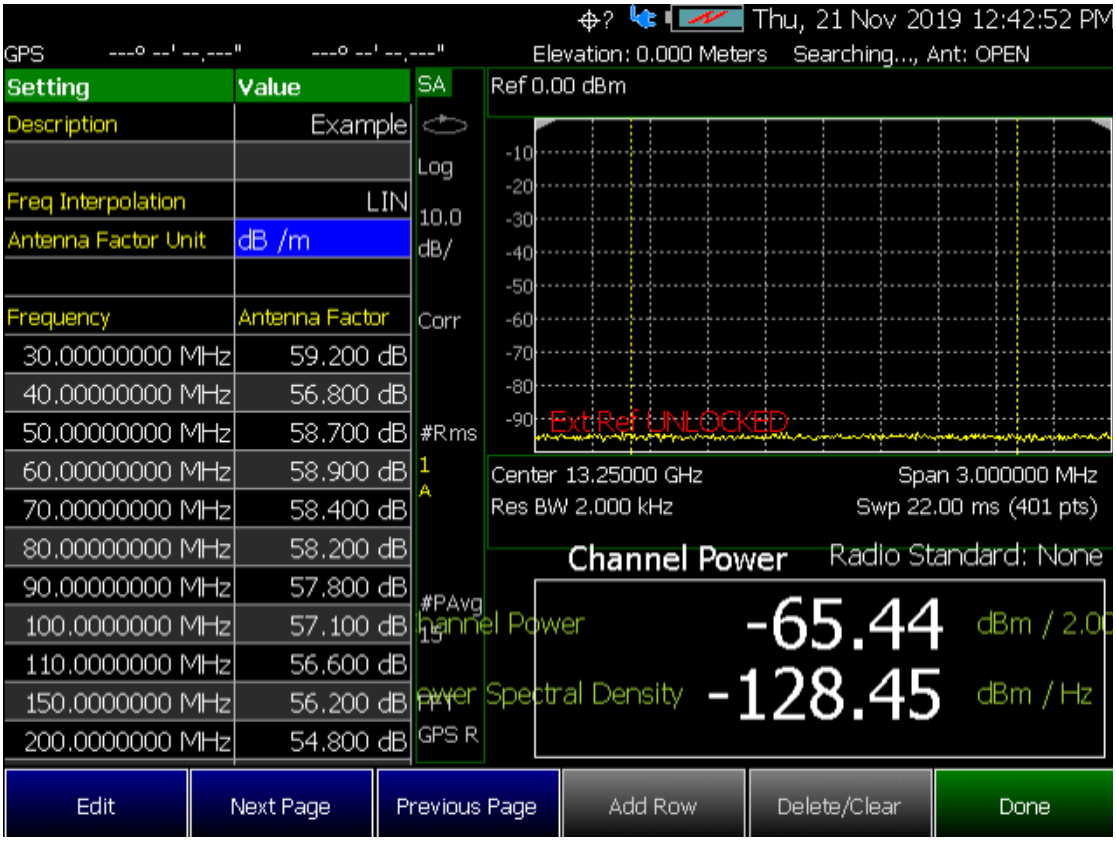
iv. Press **Done** when finished editing to exit.

c. Press **Save Antenna** to save your changes. See also Chapter , "File Saving Naming Options" and then to "Alpha Numeric Editing" on page 859.

For more information:

- See also "GNSS (GPS+) and GPS" on page 865.

Figure 9-32 Example Editing and Adding a New X axis antenna is shown.



Editing Cable Correction Factors and Adding New Cable Factors

This section contains two procedures illustrating how to edit the Cable Factors settings table values.

NOTE

If New is selected under the X, Y, or Z Antenna or Cable softkey menu, whatever antenna or cable factors that have been imported as the default values and are displayed in the Settings table

1. Selecting an cable softkey menu:

   Press **Scale/Amptd** > **More** > **Corrections** then choose one of these softkey menus:

   – **Cable Off** – to open a softkey menu to edit the cable factors for an antenna setup.

2. For this example, the Cable Off softkey menu has been selected:

a. Then press **Cable Off** > **Edit Cable** to edit the existing cable's Frequency and Cable Loss table values that are stored in the FieldFox `[:Internal]:\Cable\` directory (Refer to Figure 9-32). Then you can edit the following:

- **Description** – edits the name of the current cable correction settings table
- **Frequency Interpolation** – sets the frequency interpolation to linear or to log.
- **Frequency** – edits the frequency value measured that corresponds to a particular Cable Loss.
- **Cable Loss** – edits the Cable Loss value that corresponds to a particular frequency.

  Refer to next step for details on editing the cable Settings table.

b. Use the ▲|▼ arrows, the rotary knob, or numeric keypad to select the table cell value to be edited (i.e., the Frequency Interpolation value is not editable). Then:

- Press **Edit Cable** to edit your existing cable loss data or

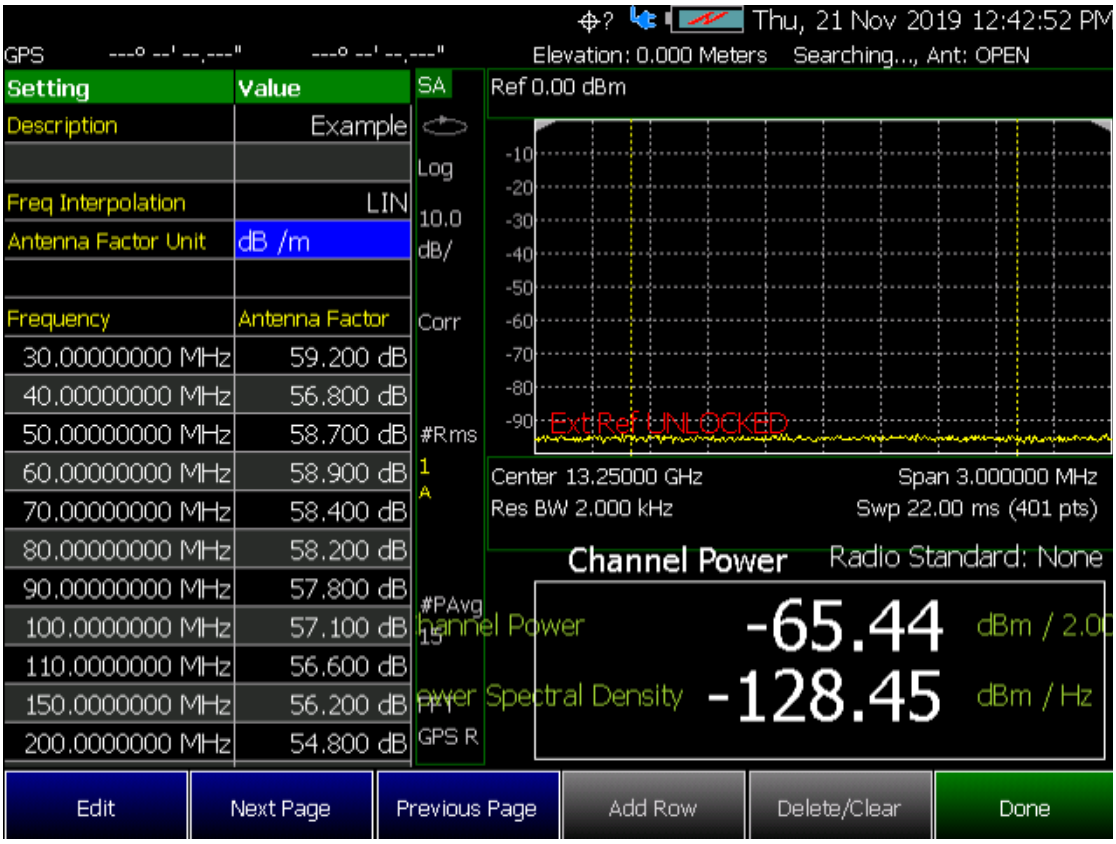
  press **New** to add a a new antenna's factors or to write over your existing antenna's file (i.e., **Overwrite existing Cable data?** is displayed above the table).
  - Choose **Yes** to write over the existing cable file.
  - Choose **No** to create a new cable file (default filename is `Example`).
- Press **Add Row** to create additional Frequency and Cable Loss values.
- Press **Delete/Clear** then choose one of these:
  - **Delete Row** – when pressed this choice deletes the currently selected row of Frequency and Cable Loss (i.e., you must press **Yes** to delete a row or **No** to exit the current softkey menu).
  - **Clear All** – when pressed this choice deletes all of the currently selected rows of Frequency and Cable Loss (i.e., you must press **Yes** to deleted the rows or **No** to exit the current softkey menu).
  - **Back** – To exit to previous softkey menu.
- Press **Done** when finished editing to exit.

c. Press **Save Cable** to save your changes. See also Chapter , “File Saving Naming Options” and then to “Alpha Numeric Editing” on page 859.

For more information:

– See also “GNSS (GPS+) and GPS” on page 865.

Figure 9-33 Example: Editing and Adding a New X axis antenna is shown. But, the Cable Loss table is similar.



Spectrum Emission Mask (SEM) — (SA Mode Only)

This section explains how to make the spectrum emission mask, (SEM), measurement. SEM compares the total power level within the defined carrier bandwidth and offset channels on both sides of the carrier frequency, to levels allowed by standard. Results of the measurement of each offset segment can be viewed separately.

Purpose

The Spectrum Emission Mask measurement includes the in-band and out-of-band spurious emissions. It is the power contained in a specified frequency bandwidth at certain offsets relative to the total carrier power. It may also be expressed as a ratio of power spectral densities between the carrier and the specified offset frequency band.

The spectrum emission mask measurement is a composite measurement of out-of-channel emissions, combining both in-band and out-of-band specifications. It provides useful figures-of-merit for the spectral regrowth and emissions produced by components and circuit blocks.

Measurement Method

The spectrum emission mask measurement measures spurious signal levels in up to 8 pairs of offset/region frequencies and relates them to the carrier power.

The integration bandwidth method is used to perform a data acquisition. The reference channel integration bandwidth (Meas BW) is analyzed using the user defined resolution bandwidth (Res BW), which is much narrower than the channel bandwidth. The measurement computes an average power of the channel or offset/region over a specified number of data acquisitions, automatically compensating for resolution bandwidth and noise bandwidth.

This measurement requires the user to specify the measurement bandwidths of carrier channel and each of the offset/region frequency pairs up to 12 (A - L). Each pair may be defined with unique measurement bandwidths. The results are displayed both as relative power in dBc and as absolute power in dBm.

Summary

Similar to other Radio Channel measurements, SEM sweeps and measures the total power within a Reference channel. It also optionally performs sweeps of user defined offset segments both above and below the reference channel. The peak signals within the offsets are compared against limits, to determine PASS or FAIL results. Tabular data is presented showing individual offset segment results, one row for each offset. A final trace is displayed that contains all of offset segment sweeps and the reference channel sweep is formed and plotted along with the limits.

The following are displayed:

— **Total Power Ref (dBm / Hz)** - measures total power over the specified Integrated BW.

– **Spectrum Emission Mask Pass/Fail** – A PASS indicates the displayed SEM is within the current boundaries specified. A FAIL indicates the current signal fails with the specified parameters.

Figure 9-34 SEM Example

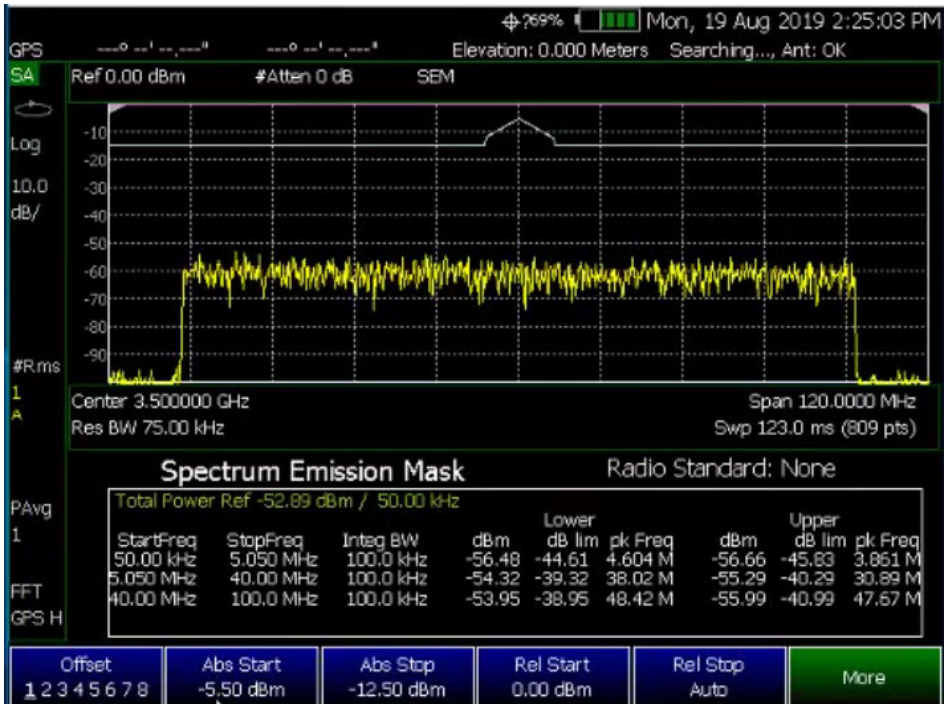
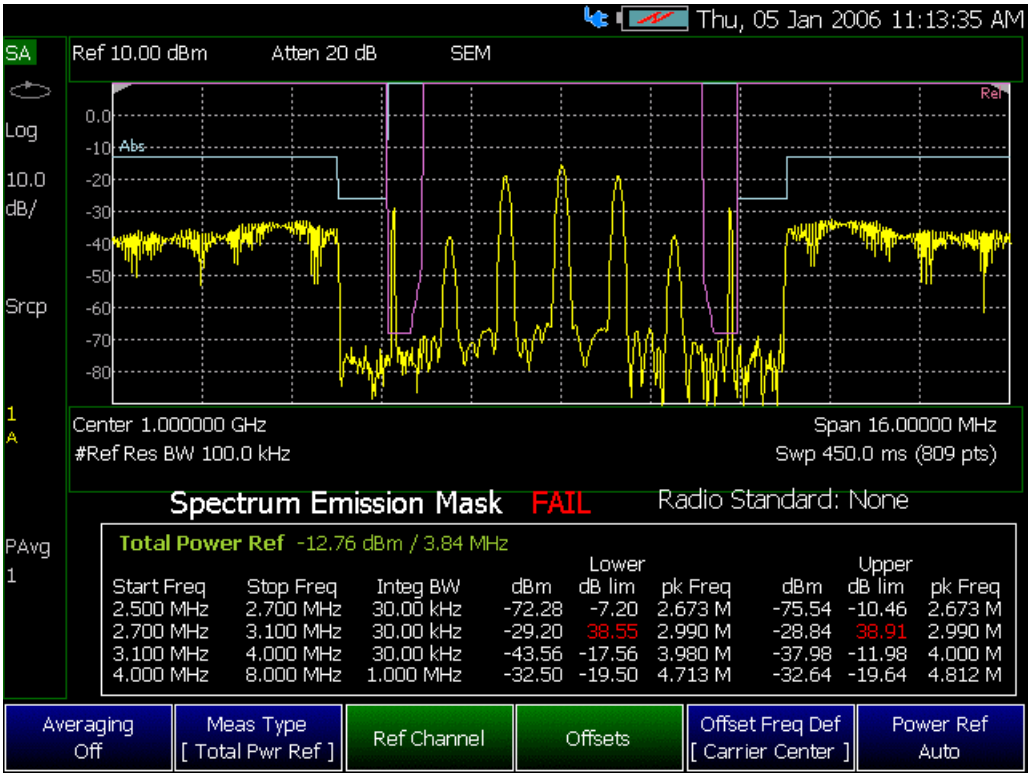


Figure 9-35 SEM Example FAIL Data - Absolute Limit (Blue), Relative Limit (Violet), Trace (Yellow), and Tabular Data



How to select Spectrum Emission Mask (SEM) Measurement

– Press **Measure 1** > **Channel Measurements** > **Spectrum Emission Mask**

When SEM is selected, the following settings are maintained from a previous measurement: Center Frequency, Preamp ON|OFF, and RF Attenuation.

Setting up the FieldFox for Spectrum Emission Mask (SEM) Measurement

1. Press **Measure 1** > **Channel Measurements** > **Spectrum Emission Mask**
2. Press **Meas Setup 4** then optionally select:
   - **Averaging** Enable/disables averaging and sets the number of trace averages (Default is OFF).
   - **Meas Type** Then select one of the following:

     Measurement Type (Meas Type) enables the user to select the method used to calculate the reference power level.

NOTE The displayed green power (dBm)/frequency (Hz) text changes as the Meas Type is toggled

- **Total Pwr Ref** (Default is Total Pwr Ref) is the total integrated reference channel power (dBm) is measured and used as the Auto Power Ref value. Peaks found in Offset segments remain in (dBm) units for direct comparison with (dBm) limits.
- **PSD Ref** the power spectral density (dBm/Hz) is measured and used as the Auto Power Ref value. Absolute Limits and Peaks found in Offset segments are normalized to their equivalent PSD value (dBm/Hz).
- **Spec Pk Ref** the spectral peak value measured within the reference channel (dBm) is used as the Auto Power Ref value. Peaks found in Offset segments remain in (dBm) units for direct comparison with (dBm) limits. Values in the table are compared to the peak power of the spectrum.

– **Ref Channel** Opens the Reference Channel softkey menu. Then select one of the following:

- **Integ BW** Sets the Integrated bandwidth.
- **Ref Chan Span** Sets the reference channel span. usually set equal or greater than the Integ BW, it is simply a way to reserve additional freq range to be measured for display presentation, if that range is not overlapped by the offset regions. The reference channel is always measured completely as specified, but only the central part of the reference channel that is NOT overlapped by active offset regions is displayed. (Minimum == 10 Hz/ Maximum == Value varies with model and options).
- **Carrier Center** Tracks currently displayed carrier center frequency (Default == TrackCF). Set to Hold to disable the carrier frequency tracking.
- **Res BW** Auto/Manual (Default is Auto). Sets the resolution bandwidth. See also, “Resolution Bandwidth (Res BW)” on page 193.

– **Offsets** Opens the frequency Offsets softkey menu. Then select one of the following:

- **Offset** Sets the number of pairs of frequencies to be offset (up to eight pairs can be selected).
- **Ofst Enable** Enables/disables the currently selected Frequency Start/Stop Offset values.
- **Ofst Freq Start** Sets the offset frequency start value. (Default/Maximum == Value varies with model and options, Minimum == 0 Hz).

- **Ofst Freq Stop** Sets the offset frequency stop value. (Default/Maximum == Value varies with model and options, Minimum == 0 Hz).
- **Res BW** Auto/Manual (Default is Auto). Sets the current resolution bandwidth value. See also, "Resolution Bandwidth (Res BW)" on page 193.
- **Offset Side Neg Both Pos** (Default is Both). Sets the offset side measurement value. Select Negative (Neg) to measure the negative side of the spectrum. Select Positive to measure the positive side of the spectrum.

– **Offset Freq Def** then select one of the following:

- **Carrier Center** (Default) applies the frequency offsets to the current carrier center frequency.
- **Carrier Edge** Selects the edge of the carrier for frequency offset definition.

– **Power Ref** – the reference power value can be fixed (which also fixes the Relative Limit line), but the user must then consider the unit being used (dBm or dBm/Hz) depending on the Meas Type selected. If Power Ref is left AUTO (Default) then its value will track the Meas Type and change units automatically. Both fixed and Auto settings display the power reference value measured.

3. Setting Center Frequency and Span

NOTE

Frequency control menu (Center and Span) provides an SEM Auto Span control (defaulted to ON) which automatically tracks the necessary span to cover all enabled offset segments. In the example in Figure 9-35 on page 254, the necessary span is 16 MHz. But the you can de-couple the span simply by narrowing or widening Span it in order to zoom.

The Carrier Frequency (Ref Channel Center) by default tracks the specified Center Frequency, but can be forced to "Hold" at a particular location which would then allow the user Center Frequency to pan above or below for reasons similar to zooming with span.

Press **Freq/Dist** then

- **Center** - sets the center frequency.
- **SEM Auto Span** - Enables/disables the SEM Auto Span.
- **Freq Span** - sets the frequency span of the SEM measurement.
- **More** - optional to set Radio Standard controls. Refer to "Radio Standard" on page 157.

4. Setting the Limit Lines

   Two Limit traces are available, an Absolute Limit and a Relative Limit. Both are defined and applied only over the Offset measurement regions. There is no Limit definition or application for the Reference Channel itself. The final Limit Trace displayed is a concatenation of all the individual Offset Limit segments, just as the final measurement trace is. Success or Failure is determined by Fail Mask per offset, to be based on either Relative or Absolute limits, Both (Abs AND Rel), or Either (Abs OR Rel).

   Press **Limit 8** then

   - **Offset** - selects the offset region to be edited.

     The Limits per offset are determined by Start/Stop Amplitude level endpoints, which correspond exactly to the user specified Start/Stop frequency locations in the Offsets sub-menu. So each offset segment is a LINE defined by its two endpoints. In the Limit "Auto" means to match the Start limit value, hence creating a FLAT (horizontal) Limit Line segment. But the Stop value can be manually set as well, creating sloped Limit segments.

   - **Abs Start** - Sets the start of an absolute limit line segment.
   - **Abs Stop** - Sets the stop of an absolute limit line segment.
   - **Rel Start** - Sets the amplitude limit at the start frequency of the offset, relative to the reference power level.

NOTE

The reference power level is displayed in green. The reference power level type can be selected through **Measure 1** > **Meas Type**, and the reference power settings defined through **Meas Setup** > **Ref Channel**.

Example: If the reference power level reads -15 dBm, and **Rel Start** is set to -10 dB, the level is -25 dBm. Since this limit line type is relative, it moves with the reference power reading.

   - **Rel Stop Auto** - Sets the amplitude limit at the stop frequency of the offset, relative to the reference power level.
   - **Fail Mask** - Sets the Fail Mask offset parameters for the measurement. Then choose:
     - **Absolute** - The absolute mask is tested for all offsets.
     - **Relative** - The relative mask is tested for all offsets.
     - **Abs OR Rel** - Either Absolute or Relative data failure generates a fail message.
     - **Abs AND Rel** - Requires a relative and an absolute data failure to generate a fail message.

5. Setting the Detectors

The Trace menu shows that two Detector controls are available, one for the Reference Channel (default Auto is Average to facilitate the Power Integration), and another for all the Offset segments (default Auto is PEAK, to facilitate finding PEAK signal energy when comparing against Limits). There is only 1 Trace available, and like the other Channel Measurements, it is set to average.

Press **Trace 6** then

- **State** - sets the measurement state. Refer to "Trace Display States (SA Mode)" on page 209.
- **Default All** - Sets the SEM settings to default
- **Chan Detector** - Sets the Reference Channel detector (default Auto is Average to facilitate the Power Integration). See also "Detection Method" on page 219.
- **Offset Detector** - Sets all of the Offset segments (default Auto is Peak, to facilitate finding peak signal energy when comparing against the Limits). See also "Detection Method" on page 219.
- **Record Playback** - Refer to "Record/Playback (SA Option)" on page 570.

IQ Analysis (SA Mode Only)

CAUTION

This feature's intended use is that the Streamed data will be sent to another computer. That computer or another one will act as a SCPI controller and is required for actually controlling the streaming, in particular setting up network configuration data and starting and stopping the streaming.

NOTE

IMPORTANT!

- IQ Streaming is used by configuring the desired setup and then starting the acquisition/data stream. In order to make measurement changes (bandwidth, center frequency, etcetera) streaming must be stopped, the new setup configured, and then streaming restarted.
- During streaming, the data displayed on the FieldFox is not updated.
- For both Decodio and VITA49, FieldFox encodes all streamed I and IQ data as 32-bit IEEE 754 floating point values.
- FieldFox does not support TCP networking.
- Data for both protocols is 2 floating point values per sample (I and Q).
- Except for the 32-bit floating point only option for I and Q data, FieldFox implements VITA 49A a subset of the VITA 49.2 protocol.
- While in any IQ Analysis mode, the sample rate to frequency span will stay locked/coupled in a ratio of 1.25:1.

How to Select IQ Analysis

- Press **Meas Setup 4**
- Then **IQ Analysis** then choose from
  - Then **General** –
  - Then **Streaming** – to emit a sequence of packets from a specific location in a VRT (VITA49) enabled architecture (e.g., VRT packet class with a defined packet attribute used in one or more places in a a architecture to create packet streams).

When IQ Analysis is selected, the following settings are maintained from a previous measurement: Center Frequency, Span, BW, Sample Rate, Preamp ON|OFF, and RF Attenuation.

How to Setup IQ Analysis General

General setup for IQ Analysis:

1. Press **Meas Setup 4** > **IQ Analysis** > **General**
2. Press **IQE Sample Rate** > Auto (default).
3. Press **Average Count** > 10 (default). Learn more refer to "Adjusting the Measurement Setup Settings" on page 320.
4. Press **Average Type** > Auto (default). Learn more refer to "Adjusting the Measurement Setup Settings" on page 320.
5. Press **Freq/Dist** > **Center** > 1 GHz
6. Press **Freq Span** > 1 MHz (default).

How to Setup IQ Analysis Streaming (Requires Option 353 IQ Streaming, SA Mode Only)

CAUTION

This feature's intended use is that the Streamed data will be sent to another computer. That computer or another one will act as a SCPI controller and is required for actually controlling the streaming, in particular setting up network data and starting and stopping the streaming.

The feature provides continuous streaming of IQ data up to 1.25 MSamples/sec over the Ethernet port in either VITA49A or Decodio formats.

If locked to GPS, will populate the timestamp applied to streamed data packets. If **not** locked to GPS, the system clock time is used to stamp the streamed data packets. Refer to Chapter 32, "System Settings" and to "Frequency Reference" on page 858.

General setup for IQ Streaming:

1. Press **Meas Setup 4** > **IQ Analysis** > **Streaming**
2. Then **IQE SampRate** > **Manual** > 1.25 MHz (default when set to **Auto**).

   Setting the IQE sample rate to **Manual**, forces the Span to be:
   `Span = 0.8 * Sample rate.`
3. Configure Center Frequency, Span, Preamp, and RF Attenuation
   a. Press **Freq/Dist** > **Center** > 1 GHz 1 GHz
   b. Press **Freq Span** > 1 MHz (default).

      This forces the Span to be:
      `Span = 1.25 * Span.`

c. Then to adjust receiver gain:

CAUTION

Typically, the goal is to be able to see the desired signal that you want to capture as close as possible to the top of the display grid on the screen, without causing an ADC over range to be displayed. This maximizes the signal-to-noise ratio.

Press **Scale/Amptd** then

- To configure automatically: Press **Ref Level** – adjust as needed.

  or

  To adjust manually:

- Press **Preamp ON** (Default == OFF)
- Press **RF Atten** > Manual > 15 dB (default)

4. Setup IQ Streaming protocol, destination host, and port:

To set the destination host, IQ streaming protocol, and samples per packet, refer to the `[:SENS]:IQST` subsystem commands in the FieldFox Handheld Analyzer SCPI Programming Guide on www.keysight.com.

- Destination Host
- Destination Port – (default is 4991)
- Protocol – Choose Vita or Decodio
- Samples per packet

5. Start Streaming: Refer to the FieldFox Handheld Analyzer SCPI Programming Guide on www.keysight.com.

6. When done press **Exc** to stop streaming or refer to the FieldFox Handheld Analyzer SCPI Programming Guide on www.keysight.com.

Or via the FieldFox front panel, choose:

- Press **Meas Setup 4** > **IQ Analysis** > **None**

Or simply choose:

- Press **Measure 1** > **All Meas Off**

Effective Isotropic Radiated Power (EIRP) – (SA Mode Only)

How to Select Effective Isotropic Radiated Power (EIRP)

1. Press **Measure 1**
2. Then **Channel Measurements** > **EIRP Off** to open a menu of softkeys to set up EIRP.

How to Setup EIRP (Effective Isotropic Radiated Power)

General setup and an example for EIRP:

For this example we are using an isotropic antenna with the following specifications:

- Frequency range: 9 kHz to 9 GHz isotropic antenna
- Preamp stages: 2 (+15 dB each (@2 GHz)
- Chop/Switch speed rate: 1 Hz to 50 kHz
- Assume: 600 Series 50Ω coaxial cable with 2.5 dB/100 feet

1. Press **Measure 1** > **Channel Measurements** > **Channel Power** > **EIRP Off** then choose from the following:
   - **EIRP Meas OFF ON** – Enables and disables the EIRP measurement.
   - **Rx Ant Gain** – Enter the receiver ant gain (–100 db to 100 db; Default == 0 dB).

     For this example: **30** dB > **Enter**.
   - **Dist to Ant** – Enter the distance between the receiving and transmitting antennas (0 m to 25 km; Default == 100m)

     For this example: **100**m (default)
   - **Rx Cable Loss** – Enter the receiver cable loss (0 to –100 dB; Default == 0 dB).

     For this example: **2.5** dB
   - **Margin Comp** – Enter the margin compensation to remove known self-interference, antenna efficiency, fading and other errors (–100 db to 100 db; Default == 0 dB).
   - Then **More** and choose from the following:
   - **Restart** – Press this softkey to restart an antenna measurement.

- **Save Horizontal** – Saves the current horizontal EIRP value (dBm).
- **Save Vertical** – Saves the current vertical EIRP value (dBm).
- **Clear H & V** –Clears the saved horizontal and vertical EIRP values (dBm).

2. Configure Center frequency, Span, Preamp, and RF Attenuation
   - Press **Freq/Dist** > **Center** > 2 GHz
   - Press **Freq Span** > 3 MHz (default)
   - Press **Scale Amptd** > **Preamp** > **ON** (Default == OFF)
   - Press **RF Atten Auto** (Default == Auto)
3. Summary of EIRP setup, per step 1.
   - Press **Rx Ant Gain** For this example: **30** dB > **Enter**.
   - Press **Dist to Ant** For this example: **100**m (default)
   - Press **Rx Cable Loss** For this example: **2.5** dB
   - Press **Margin Comp**
4. Start EIRP: Press **Restart**
5. When done press:

   Save Horizontal and

   Save Vertical
6. Optional: To clear the saved horizontal and vertical EIRP values press:

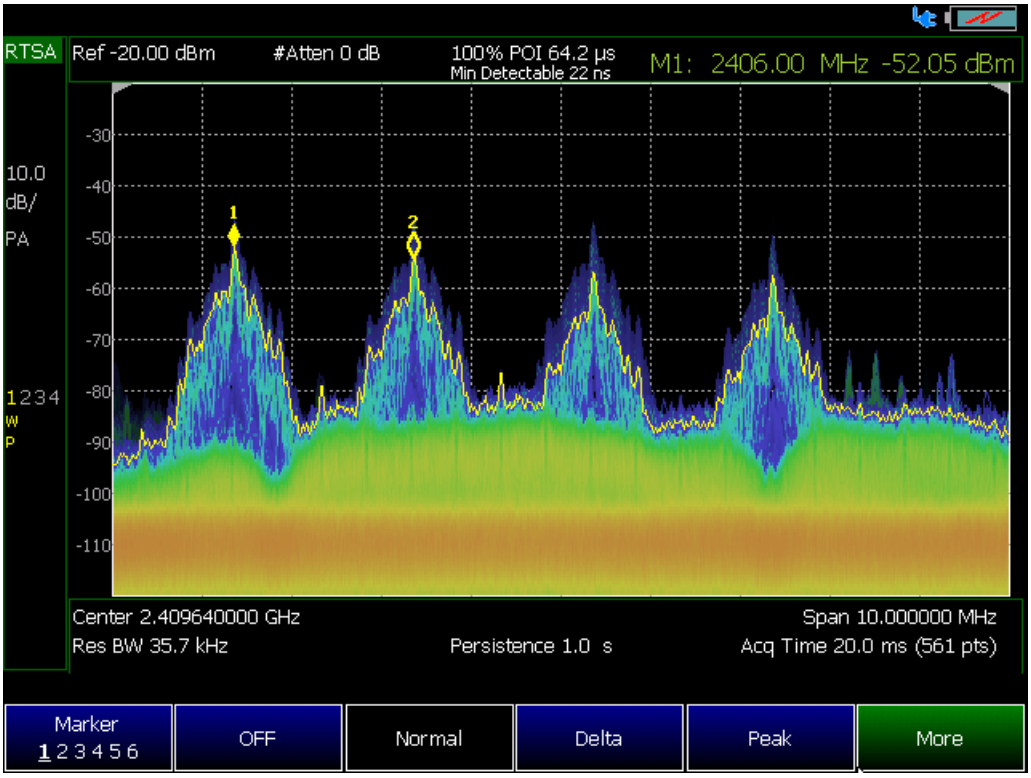
   Clear H & V

10 RTSA (Real-time Spectrum Analyzer) Mode–Option 350

RTSA Mode measures signals at the **SA RF IN** connector.

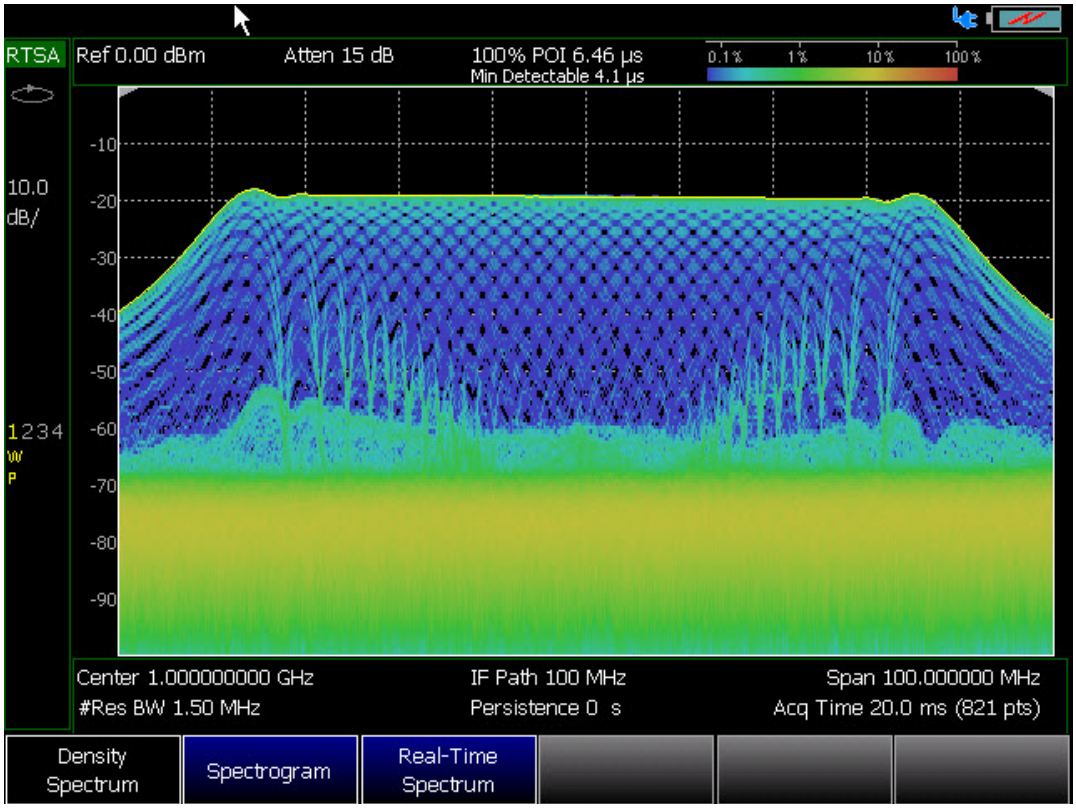
For a comprehensive RTSA mode tutorial, see Understanding and Applying Probability of Intercept in Real-time Spectrum Analysis (App Note) at https://www.keysight.com/us/en/assets/7018-04381/application-notes/5991-4317.pdf.

Figure 10-1 RTSA Display using Markers



The graphic above shows an RTSA display of a *Bluetooth* signal using markers.

Figure 10-2



The graphic above shows an RTSA display shows an RTSA display of an 80 MHz linear FM chirp with a center frequency of 1 GHz (requires Option B10).

In this Chapter:

"Frequency Range" on page 268
"Scale and Units" on page 270
"External Gain" on page 270
"Attenuation Control" on page 271
"Preamplifier Control (Opt 235)" on page 272
"Check for Compressed Measurements" on page 272
"Spectrum Selection" on page 273
"Setting the IF Path" on page 277
"Resolution Bandwidth (Res BW)" on page 277
"Triggering" on page 278
"Single / Continuous / Restart / Time Per Div" on page 281
"Points (not user settable)" on page 282
"Trace Display States (RTSA)" on page 283
"Average Count, Show Density, Blue, and Red Percentage Limits" on page 285
"Average Count" on page 286
"Alignments" on page 287
"Detection Method" on page 284
"Display Line" on page 287
"Limit Lines" on page 288
"Audio Beep at Marker Power" on page 288
"Spectrogram Display (RTSA Option)" on page 289
"Record/Playback (RTSA Option)" on page 291

See Also

Optional Settings:

"All about Markers" on page 797
"All about Limit Lines" on page 812
"Saving and Recalling Files" on page 888

RTSA Mode Settings

Select RTSA Mode before making any setting in this chapter.

Because there is no calibration, these settings can be made in any order.

How to select RTSA Mode

– Press **Mode**

– Then **Real-Time SA**.

NOTE

When you initially select I/Q Analyzer, Real-time SA, or some of the other spectrum settings (such as center frequency) a factory channel Equalization measurement is applied to the signal. During channel equalization measurement, the FieldFox displays a “Start Channel Equalization”. Stopping channel equalization is not permitted. See also, “Alignments” on page 211, in Chapter 9, “SA (Spectrum Analyzer) Mode (Option 233–Mixed Analyzers).”

Frequency Range

The X-axis frequency range determines the frequencies that are measured for each sweep. The default Start frequency is 950 MHz. However, the Start frequency can be set as low as –150 MHz. The internal LO of the FieldFox can be seen at 0 Hz, which will mask signals that may be present.

NOTE

Although the start frequency can be set as low as -150 MHz, amplitude accuracy is specified above 9 kHz (depending on your model). Below 9 kHz (depending on model), frequency accuracy is maintained, but amplitude accuracy is degraded. Refer to https://www.keysight.com/us/en/assets/7018-03314/data-sheets/5990-9783.pdf.

The FieldFox can be used with an OML frequency extender. Refer to “Utilities” on page 842, the B Series FieldFox Configuration Guide 5992-3701EN, and to “Contacting Keysight” on page 5.

The frequency range of the measurement can be changed using the following methods:

– Set Center and Span frequencies (Frequency Span varies with instrument model)

– Set Start and Stop frequencies

– Toggle between Zero and Last selected span

– Using Marker -> Center

How to set Frequency Range

– Press **Freq/Dist**.

– Then choose from the following:

–**Center** and **Freq Span** frequencies. This is the most common method of entering frequency range. Enter the frequency of interest. The Center frequency is at the exact center of the X-axis. The Frequency Span places half of the frequency range on either side of center. When the Center and Frequency Span values are entered, then the X-axis annotation on the screen shows the Center and Span frequencies.

–**Start** and **Stop** frequencies. Start is the beginning of the X-axis and Stop is the end of the X-axis. When the Start and Stop frequencies are entered, then the X-axis annotation on the screen shows the Start and Stop frequencies.

– Optionally, press **More** then:

––**CF Step** then type a step size value using the numeric keypad, then select a multiplier key.

––**Freq Annotation** and one of the following:

AutoSelect (Default) – The FieldFox selects a frequency annotation setting (CenterSpan or StartStop).

CenterSpan -The center frequency and span are displayed.

StartStop - The start and stop frequencies of the frequency span are displayed.

––**Full Span** the frequency span changes the instrument's full frequency span (frequency span is model dependent).

NOTE When in full span, ADC dither raises the noise floor at the edges of the 120 MHz.

– Follow each of these, when prompted, by entering a value using the numeric keypad, the ▲|▼ arrows, or the rotary knob.

– When using the ▲|▼ arrows, press **Enter**. The increment setting of the arrows is based on the current span. This can be changed in RTSA Mode.

– After using the keypad, select a multiplier key. Learn more in "Multiplier Abbreviations" on page 48.

Scale and Units

Adjust the Y-axis scale to see the relevant portions of the data trace.

The Y-axis is divided into 10 graticules. A acquisition is shown on the screen as a solid horizontal bar that can be placed at any graticule.

RTSA always uses logarithmic scale. The Y-axis reference line represents the specified absolute acquisition (dBm). Y-axis graticules show dB below or above the reference line.

When RF Attenuation set to **Auto**, the RF Attenuation is coupled to acquisition.

How to set Scale

Press **Scale / Amptd**. Then choose from the following:

Manually set Scale, acquisition, and Reference Position.

- **Scale** Manually adjust the dB scale per division to view specific areas of the current trace. Enter a value using the numeric keypad, the ▲|▼ arrows, or the rotary knob. Then press **Enter**.
- **Ref Level** Manually set the value of the reference line. Enter a negative value by pressing **Run/Hold (+/-)** either before or after typing a value. This can also change the RF Attenuation setting. See "Attenuation Control" on page 271.
- **Ref Pos** Manually set the position of the reference line. Values must be between 0 (top line) and 10 (bottom line). Default position is zero (top).

External Gain

When using an external amplifier or attenuator, the RTSA mode trace amplitude values can be offset to compensate for the effect of the external device. This effectively moves the reference plane of the RTSA measurement port out to just beyond the external device. For example, when using an external preamp with gain of +10 dB, enter this value for External Gain, and the data trace across the displayed frequency span will be adjusted down by 10 dB.

When RF Atten is set to Auto, you may see a change in the RF Attenuation value. This is an attempt to measure the signal at top of screen (the acquisition) without overloading the RTSA first mixer.

How to Set External Gain

- Press **Scale/Amptd**.
- Then **External Gain**

– Enter a value using the numeric keypad, the ▲|▼ arrows, or the rotary knob (positive for gain; negative for loss). Values in increments less than 5 dB must be typed using the numeric keypad. Then press **Enter**

ExtGain xx dB is shown at the top of the screen.

Attenuation Control

Both the RF Attenuation and Preamp functions control the power level into the RTSA.

When too much power is present at the RF Input port, ADC Over Range appears on the FieldFox screen. This does not necessarily mean that damage has occurred, but that the measurement is probably compressed.

When high power levels are present at the RF Input port, internal attenuation can be switched in to keep the FieldFox receiver from compressing. At extremely high power levels, use external attenuation to protect the internal circuitry from being damaged.

CAUTION

The FieldFox can be damaged with too much power. Refer to the FieldFox Data Sheet for your model on https://www.keysight.com/us/en/assets/7018-06516/data-sheets/5992-3702.pdf.
Maximum Input Voltages and Power:

RF Output Connector: 50V DC, +23 dBm RF

Ext Trig/Ref Connector: 5.5 V DC

RF Input:

+27 dBm RF, ±50 VDC Max. (N991xA/B, N9925B, N9926A, N9928A, N993xA/B)

+23 dBm RF, ±50 VDC Max. (N9923A, N9923AN)

+25 dBm RF, ±40 VDC Max. (N995xA/B, N996xA/B)

DC Input: 19VDC, 4ADC, 60 Watts maximum when charging battery

NOTE

Learn more about ADC over range warnings by referring to Chapter 32, “System Settings,” and then to “SA” on page 863.

The displayed power level is automatically adjusted for RF Attenuation. As the attenuation value changes, the displayed power level should NOT change.

How to set Attenuation

– Press **Scale/Amptd**.

– Then **RF Atten Man Auto**

– **Auto** RF Attenuation is set by adjusting the acquisition. As the acquisition is lowered, for example from –10 dBm to –40 dBm, the FieldFox assumes that you are looking at low-level signals. The RF Attenuation value is automatically lowered in 5 dB steps to allow low-level signals to be viewed.

– **Man** RF Attenuation is set manually. Enter a value between 0 to 40 dB in 5 dB steps using the numeric keypad, the ▲▼ arrows, or the rotary knob. Then press **Enter**.

#Atten xx dB is shown at the top of the screen. (#) means manual setting.

Preamplifier Control (Opt 235)

When **very low-level** signals are analyzed, an internal preamplifier can be used to boost the signal level by approximately 15 to 20 dB (depending on model). The gain of the preamp is NOT adjustable. The displayed signal level is automatically adjusted for the increase in system gain, therefore turning the Preamp ON should NOT cause a change to the displayed signal.

How to control the Preamp

By default, the preamp is OFF.

– Press **Scale/Amptd**.

– **Preamp ON OFF** When ON, PA is shown to the left of the graticules on the display.

– **Auto** When Auto is selected, the preamp setting is coupled to the RF attenuation and to the acquisition. When the acquisition reaches a certain value, the preamp is turned on and PA is shown to the left of the graticules on the display.

Check for Compressed Measurements

Compression occurs when too much power into an amplifier causes it to no longer amplify in a linear manner. When too much power goes into the FieldFox RF Input connector, the amplifiers in the RTSA receiver compress and signal power will not be displayed accurately. This can occur even if ADC Over Range is not displayed because devices other than the ADC, such as the mixer, might be compressed. Increase the RF Attenuation value to prevent the RTSA receiver from being compressed.

How to Check for a Compressed Measurement

– Using a marker at the signal peak, make note of the signal power level.

– Increase the RF Attenuation level by 5 dB.

–If the signal level does NOT change, then NO compression exists. This indicates that the signal is in the linear region of the FieldFox receiver.

—If the signal level DOES increase, then the receiver was compressed. Set the RF Attenuation value at the setting when further increases no longer result in an increase in the displayed power level.

Spectrum Selection

CAUTION **Density Spectrum and Spectrogram data is lost when you change modes, because the FieldFox optimizes the instrument's resources during mode changes.**

To select the spectrum-type for your measurement:

How to make Spectrum Settings

– Press **Measure 1**

– Then Press:

  – **Density Spectrum** The signal displayed is a real-time spectrum with a histogram bitmap. Refer to Figure 10-3 on page 274 and Figure 10-4 on page 275.

  – **Spectrogram** The signal is displayed is a real-time spectrum with a spectrogram bitmap. Spectrogram views are valuable in capturing signals that include both time and frequency variations. Refer to Figure 10-5 on page 275.

  – **Real-time Spectrum** The signal is displayed as a real-time spectrum. Use real-time spectrogram to quickly display measurements. Refer to Figure 10-6 on page 276.

    In all three spectrum measurements, there are four available traces for representation of the real-time spectrum.

Figure 10-3 Density Spectrum (Histogram) FM Signal with 1 MHz FM Deviation & 400 Hz FM Rate

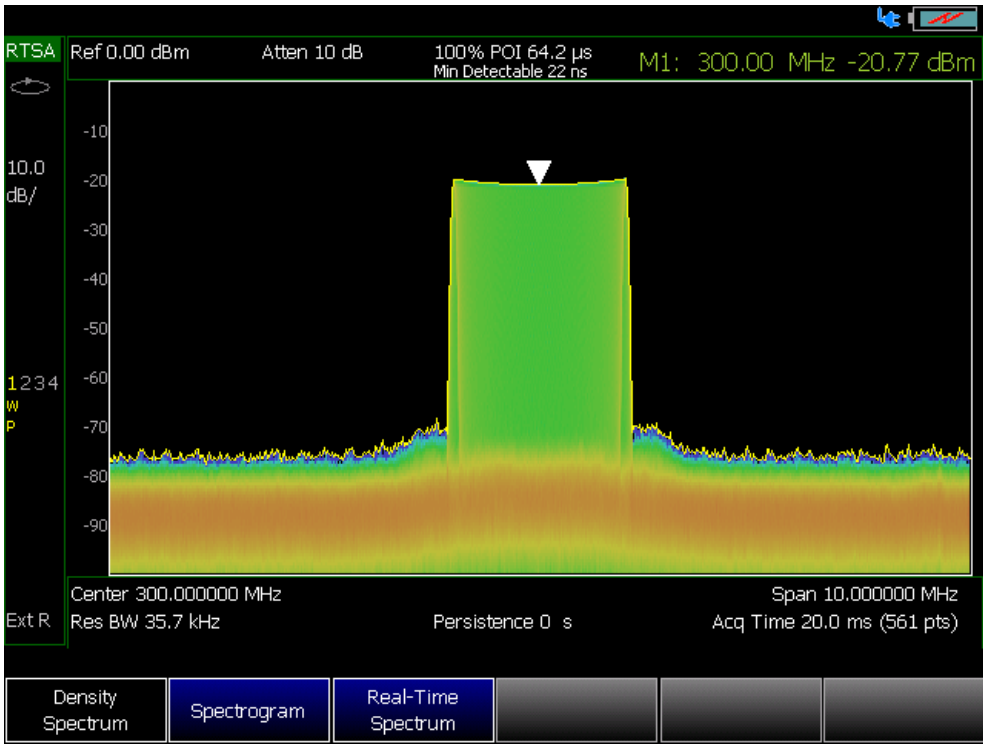


Figure 10-4 Density Spectrum (Histogram) with 2 Pulses, 100 MHz Span (Blue color indicates pulse that occurs less frequently)

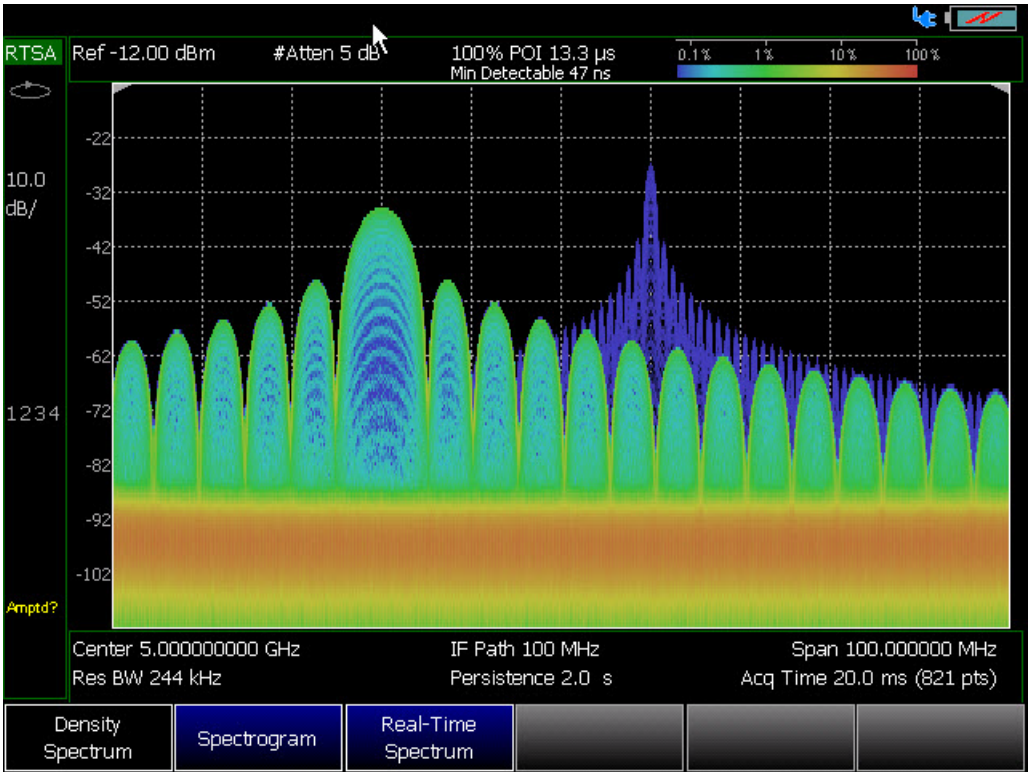


Figure 10-5 Spectrogram (100 MHz Span)

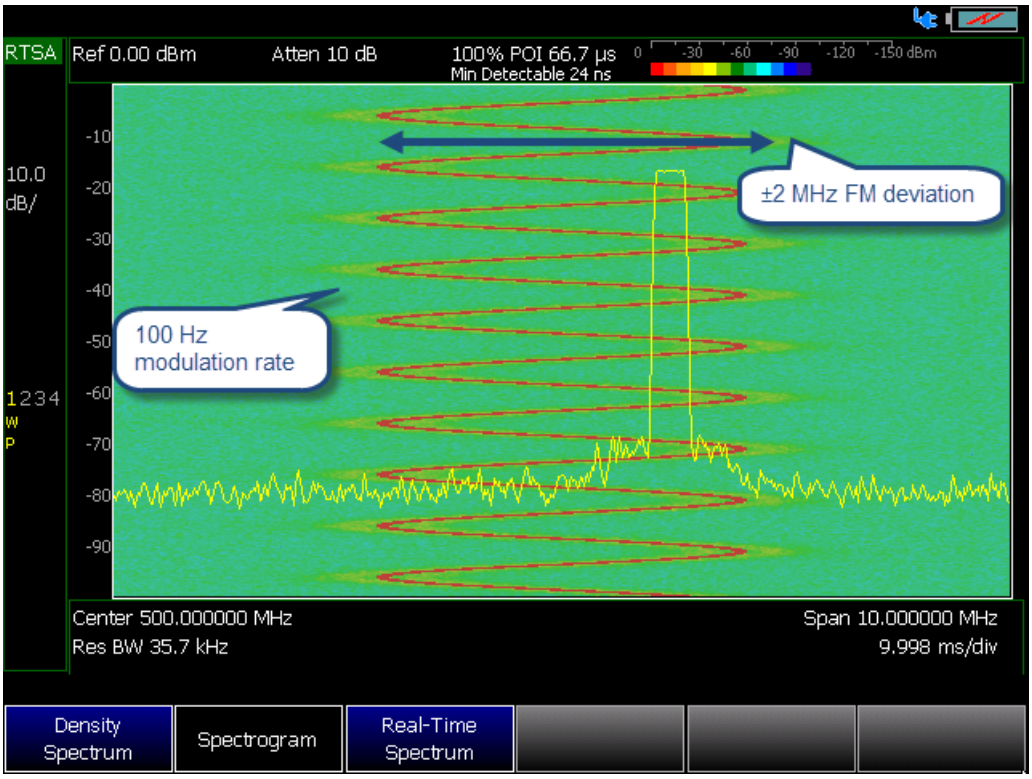
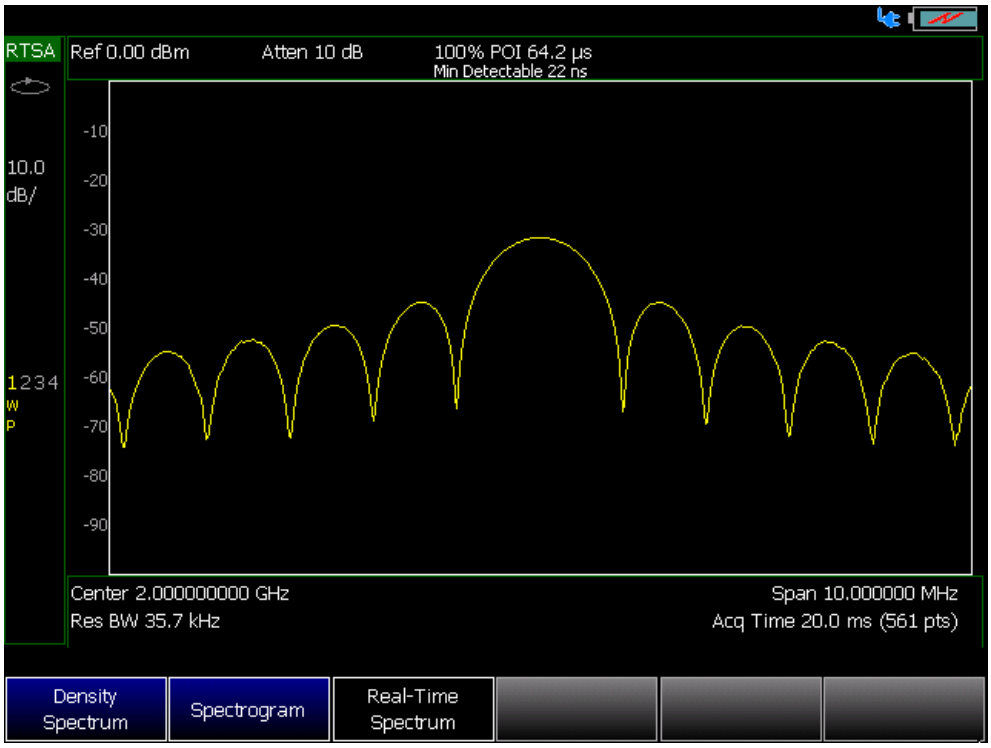


Figure 10-6 Real-time Spectrum



Setting the IF Path

How to check or set the IF Path. By default the IF Path is set to Auto.

1. Press **BW 2**.
2. Then **IF Path** The underlined setting is the current setting. Choose **Auto**, **10 MHz**, or **100 MHz** (100 MHz requires Option B04 or B10 and either Option 350 RTSA or Option 351 IQ Analyzer).

   Optional: After you click 100 MHz, you can use the **Freq/Dist** hard key and the number pad or using the numeric keypad, the ▲|▼ arrows, to increase your IF path bandwidth to 120 MHz.

NOTE When in full span, ADC dither raises the noise floor at the edges of the 120 MHz.

Resolution Bandwidth (Res BW)

CAUTION For best results, use the AUTO setting for the Res BW values. Increasing the resolution BW could reduce pulse measurement capability by affecting the 100% POI duration and the minimum detectable signal level. The resolution BW must be as narrow as possible to maintain gapless measurements.

When Manual RBW is selected, the FieldFox attempts to set the RBW to the setting you request, but this setting is coupled to the current span settings. If the manually set RBW is not settable with the current frequency span value, the FieldFox defaults to the nearest achievable RBW setting to meet the manual RBW value.

In RTSA Mode, the Res BW provides the ability to resolve, or see closely spaced signals. The narrower (lower) the Res BW, the better the spectrum analyzer can resolve signals. In addition, as the Res BW is narrowed, less noise is measured by the spectrum analyzer ADC and the noise floor on the display lowers as a result. This allows low level signals to be seen and measured.

How to set Res BW

- Press **BW 2**.
- Then **Res BW**.
- Then choose from the following:
  - **Auto** Res BW is coupled to the frequency span. As the frequency span is narrowed, the Res BW is also narrowed providing increased ability to resolve signals.
    To change this setting from **Man** to **Auto**, press **Res BW** twice.

– **Man** Enter a Res BW value using the numeric keypad, the ▲|▼ arrows, or the rotary knob. Then press a multiplier if necessary or press **Enter**

The current Res BW setting is shown at the bottom of the screen.

#Res BW x.xx XHz (#) means manual setting.

This setting could impact the accuracy of the measurement. See Specifications in Appendix B.

Triggering

NOTE Triggering only applies to Density Spectrum and Real-time Spectrum.

External, Video, and RF Burst triggering enable you to initiate an RTSA mode sweep using an external event such as a signal burst.

Trigger Type

– Press **Sweep 3**

– Then **Trigger Settings**

– Then **Trig Type**

– Then choose from the following:

– **Free Run** Triggering is provided by the FieldFox internal circuitry. A new sweep begins when the previous sweep ends.

– **External** A sweep is triggered on an external TTL signal at the Ref In/Trig In connector on the FieldFox top panel. Choose to trigger on the rising slope at about 1.7 V or on the falling slope at about 1.0 V using the Trigger Slope setting (below).

– **Periodic** sets a trigger that repeats at the period rate entered. Periodic trigger's phase can be altered by the Offset value.

The following two selections are similar in that they both trigger a sweep from a signal at the **SA RF Input** connector. Experiment with both selections to find the best trigger type for your application.

– **Video** A sweep is initiated when the amplitude of an incoming signal crosses the settable trigger level. The comparison is done in the time domain, before conversion to frequency domain. Refer to "Trigger Slope", "Trigger Delay", "Trigger Level" on page 280, "Auto Trigger Time" on page 280, and to "Trigger Hold-Off" on page 281.

NOTE

If your trigger level is set too high for the current measurement gain setup, you will see an error message, similar to this one, displayed: "Video TrigLevel was HW Limited, it is x.xx dB above current capability". Adjust your trigger level settings until the message is no longer displayed.

– **RF Burst** A sweep is initiated when the signal at the third IF (analog) stage crosses the settable Trigger Level. This selection reacts to a wider bandwidth of the incoming signal than Video Trigger, which could be beneficial. However, RF Burst is not as sensitive to triggering on low-level signals. Refer to "Trigger Slope", "Trigger Delay", "Trigger Level" on page 280, "Auto Trigger Time" on page 280, and to "Trigger Hold-Off" on page 281.

– **Periodic** Trigger repeats at the period rate entered. Periodic trigger's phase can be altered by the Offset value.

  Then choose from the following:

  – **Period** Enter a value for the trigger to repeat (100 ns to 400 ms).

  – **Offset** Enter a offset value to offset the phase of the periodic trigger (–100 ms to 100 ms).

  – **Reset Offset Display** Resets Offset to default 0.000000 s.

Trigger Slope

Trigger Slope determines which edge of an External, Video, or RF Burst trigger signal initiates a sweep.

– Press **Sweep 3**

– Then **Trigger Settings**

– Then **Trig Slope**

– Then choose from the following:

  – **Pos** Sweep is triggered by the rising (positive) edge of signal.

  – **Neg** Sweep is triggered by the falling (negative) edge of signal.

Trigger Delay

After a valid trigger signal is received, the sweep begins after the specified Trigger Delay time.

– Press **Sweep 3**

– Then **Trigger Settings**
– Then **Trig Delay**
– Enter a value using the numeric keypad, the ▲|▼ arrows, or the rotary knob. (0 to 10 seconds)
– Then select a multiplier key or press **Enter**. Learn more in "Multiplier Abbreviations" on page 48.

Trigger Level

Used with Video and RF Burst triggering, a sweep is initiated when an incoming signal crosses this level. See also "Scale and Units" on page 270.

RF Burst Trigger Level uses an alignment process which is performed in the background to set the detected signal level accuracy. **Video Trigger Level** is a comparison done on the time domain signal, before conversion to the spectral frequency domain. Processing from the time to frequency domain can cause broadband (e.g., pulsed) signal energy to display at lower power levels than the peak power levels of the time domain signal. Therefore you may need to the set trigger level higher than the displayed spectral level.

– Press **Sweep 3**
– Then **Trigger Settings**
– Then **Trig Level**
– Enter a value using the numeric keypad, the ▲|▼ arrows, or the rotary knob. (–210 to 30 dBm)
– Then select a multiplier key or press **Enter**. Learn more in "Multiplier Abbreviations" on page 48.

Auto Trigger Time

While waiting for a valid trigger signal, **Wait** is annotated in the top left corner of the FieldFox screen.

If a valid trigger signal is not received before the specified Auto Trig Time, a sweep will occur automatically.

When Auto Trigger is OFF, the FieldFox does NOT sweep unless a valid trigger signal is received.

– Press **Sweep 3**
– Then **Trigger Settings**
– Then **Auto Trigger**
– Enter an Auto Trig Time using the numeric keypad. (1 ms to 100 seconds)
– Then select a multiplier key. See "Multiplier Abbreviations" on page 48.

– Enter **0** to set Auto Trigger **OFF** or press the Auto Trigger softkey a second time to turn OFF Auto Trigger.

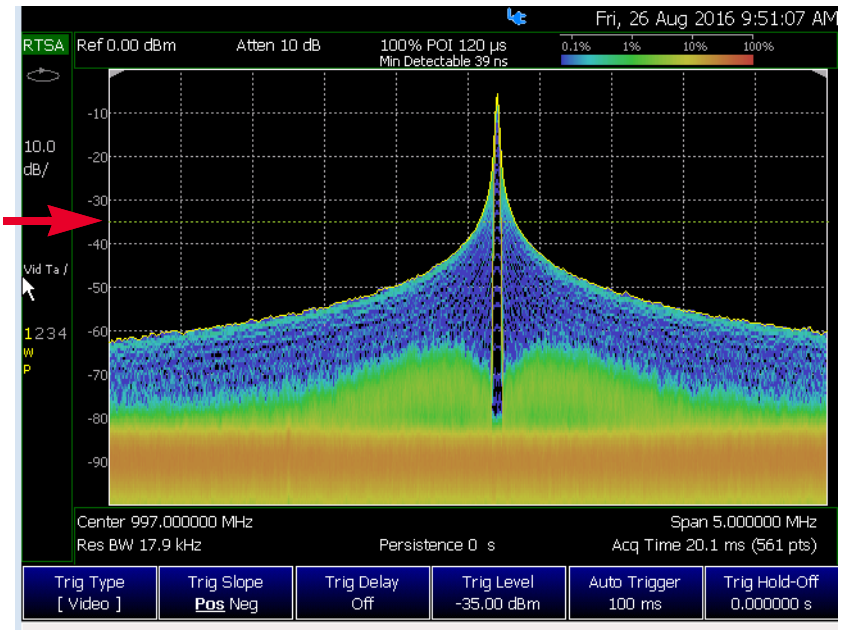
Trigger Hold-Off

Used with External, Video, and RF Burst triggering, sets the hold-off time between triggers. (Range: 0.000000 to 10.000000 seconds)

Once a trigger occurs, future triggers are ignored until the trigger hold-off time expires. Setting the trigger hold-off to zero, essentially turns off the trigger hold-off feature. Also, you can press **Trig Hold-Off** > **OFF**.

Trigger Settings Annotation

Trigger settings are annotated on the FieldFox screen as shown in the following figure:



– Trig Type (**VidT**), AutoTrigger (**a**), Pos Slope (**/**)

– Horizontal arrow: Trig Level (green horizontal graticule at -35 dBm)

Single / Continuous / Restart / Time Per Div

This setting determines whether the FieldFox measures continuously or only once each time the **Single** or **Run / Hold +/-** button is pressed. Use **Hold / Single** to conserve battery power or to allow you to save or analyze a specific trace.

NOTE

– To conserve battery power, in addition to using Hold / Single, you must also, set the System > preferences >Preferences > Battery Saver to On. For more, refer to the System Settings chapter and “Preferences” on page 850.

How to set Single or Continuous

– Press **Sweep 3**.

– Then choose one of the following:

  – **Continuous**

    ––**ON** Causes the RTSA to make continuous sweeps. This is the typical setting for making measurements. Each **Run / Hold +/-** press causes the RTSA to toggle between continuous sweep and Hold.

    ––**OFF** Causes the RTSA to Hold. Each **Run / Hold +/-** or **Single** press causes the RTSA to make ONE sweep, then Hold. The Hold annotation changes to an arrow --> while the sweep occurs.

  – **Single** Automatically sets Continuous OFF and causes the RTSA to make ONE sweep, then Hold.

  – **Restart** Resets the average counter to 1. If Continuous sweep is OFF, it also causes Average Count (*n*) sweeps to occur if any Trace State is set to RMS Average, MinHold, or MaxHold. This softkey is also used to clear the Spectrogram display. Learn more in "Average Count" on page 286.

Acq Time

Use the **Acq Time** setting to adjust acquisition time interval for each trace update in Density or Real-time Spectrum measurements.

How to set Acq Time

– Press **Sweep 3**.

– Then choose:

  – **Acq Time** Acq Time affects the quantity of information being captured during a density or real-time spectrum measurement.

    ––**Auto** (default) the FieldFox chooses the optimum Acq Time based on the span setting (default is 20 ms, when span is set to full span).

    ––**Manual** enables user settable acquisition time values.

Points (not user settable)

Points is the number of measurements that are displayed along the X-axis. RTSA automatically sets the points to 821 and is not user settable.

Trace Display States (RTSA)

NOTE

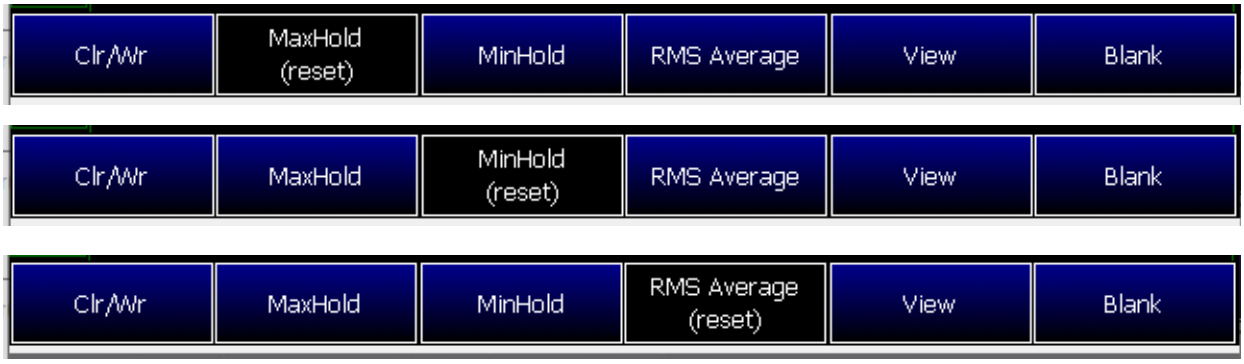
You can use the FieldFox's Remote Server mode (89600 VSA software connectivity) to parse playback files and captured data as MATLAB files (*.mat). Learn more about FieldFox and 89600 VSA software, refer to Chapter 18, "Remote Server Mode (Requires SA Hardware/SA Option 233)" and to http://rfmw.em.keysight.com/wireless/helpfiles/89600B/WebHelp/89600.htm.

In RTSA Mode you can display up to four of the following types of trace states. All RTSA trace settings can be independently **reset** (either automatically, or manually) for each trace counter (**MaxHold**, **MinHold**, or **RMS Average**) without resetting any other traces. These traces represent the Real-time Spectrum in each of the three measurement modes.

Additionally, this independent trace feature provides:

- annotates **ONE** such trace counter as the **minimum** trace count of all of the traces (**even if multiple counters are active**)
- automatically **RESET** any single Trace counter when parameter couplings dictate that a counter needs to be reset (e.g., **TraceMode** or **TraceDetector** changes)
- enables a user to manually reset a single Trace, via the Trace State menu selection (**6 Trace** > **State**)
- a manual reset is performed by pressing the same trace **State** again (i.e., trace state is already enabled), and the selection softkey says `"Reset"` or `"Reset Count"` as a hint to the user

Figure 10-7 Trace State Reset Softkeys



A color-coded legend for displayed traces is visible in the left pane of the RTSA mode screen:

W = Clear/Write; **M** = MaxHold; **m** = MinHold; **A** = Average; **V** = View

How to display the Trace States

– Press **Trace 6**.

– Then **Trace 1,2,3,4** repeatedly to select a trace number to display or change its state. Traces are displayed in the following default colors (i.e., the colors are user settable):

  – Trace 1 – **Yellow** Trace 2 – **Blue**

  – Trace 3 – **Orange** Trace 4 – **Green**

– Then **State [current setting]**

– Then choose from the following Trace States:

  –**Clr /Wr** [**W**] (Clear/Write) Displays the actual measured data for each sweep.

  –**MaxHold** [**M**] Displays the maximum response of the input signal at each data point over multiple sweeps. See also Average Count in “Average Count” on page 286.

  –**MinHold** [**m**] Displays the minimum response of the input signal at each data point over multiple sweeps. See also Average Count in “Average Count” on page 286.

  –**RMS Average** [**A**] Each data point is averaged over multiple sweeps as set by the Average Count setting. Learn more in “Average Count” on page 286.

  –**View** [**V**] Displays and then holds the last complete measurement trace on the screen. This is similar to storing a trace in memory.

  –**Blank** Displays no trace.

– Press **Default All** to return all traces to their default settings: Trace 1 (Clear/Write); all other traces, including trace detectors (Blank).

Detection Method

In RTSA Mode, the X-axis is comprised of data points, also known as “buckets”. Learn more in “Points (not user settable)” on page 282.

Regardless of how many data points are across the X-axis, each data point must represent what has occurred over some frequency range and time interval.

From the frequency span of the measurement, the span of each data point is calculated as (frequency span / (data points-1)). The detection method allows you to choose how the measurements in each bucket are displayed.

Using the RTSA feature, each of the four available traces can have an independent detection method.

How to set Detection Method

The current Detection method for each trace is labeled on the left edge of the screen. A corresponding letter appears below the corresponding Trace number selected. For example: **N** means that **Normal** was the selected detector.

1. Press **Trace 6** > **Detector**
2. Then choose from the following:
   - **Auto** [...] Displays the most appropriate Detection method based on other settings. **[No annotation]**
   - **Normal** [**N**] Provides a better visual display of random noise than **Positive peak** and avoids the missed-signal problem of the **Sample** Mode. Should the signal both rise and fall within the bucket interval, then the algorithm classifies the signal as noise. An odd-numbered data point displays the maximum value encountered during its bucket. An even-numbered data point displays the minimum value encountered during its bucket. If the signal is NOT classified as noise (does NOT rise and fall) then Normal behaves equivalently as Positive Peak.
   - **Positive Peak** [**P**] Displays the maximum value of all the measurements in each bucket. This setting ensures that no signal is missed. However, it is not a good representation of the random noise in each bucket.
   - **Negative Peak** [**p**] Displays the minimum value of all the measurements in each bucket.
   - **Sample** [**S**] Displays the center measurement of all the measurements in each bucket. This setting gives a good representation of the random noise in each bucket. However, it does not ensure that all signals are represented.
   - **RMS Average** [**A**] Displays the Root Mean Squared (RMS) average power of all the measurements in each bucket. This is the preferred method when making power measurements.

Repeat the detection setup process as needed for up to 4 traces and 4 detection methods.

Average Count, Show Density, Blue, and Red Percentage Limits

How to set:

– Press **Meas Setup 4**

Then choose one of the following:

– **Average Count** – Changes the quantity of traces averaged for certain trace states (i.e., MaxHold, MinHold, or RMS Average). Refer to “Average Count”.

- **Show Density** – (Density Spectrum Only) Displays a histogram image of the traces.
- **Blue Limit %** – (Density Spectrum Only) Changes the percentage of the trace that has a blue limit (0.05% to 100%, default is 0.05%). This setting is coupled to the color bar in the upper right corner of the FieldFox display.
- **Red Limit %** – (Density Spectrum Only) Changes the percentage of the trace that has a blue limit (0.05% to 100%, default is 100%). This setting is coupled to the color bar in the upper right corner of the FieldFox display.
- **Blue Limit dBm** – (Spectrogram Only) Changes the power level (dBm) of the trace that has a blue limit (–210 dBm to 30, default is –90 dBm). This setting is coupled to the color bar in the upper right corner of the FieldFox display.
- **Red Limit dBm%** – (Spectrogram Only) Changes the power level (dBm) of the trace that has a blue limit (–210 dBm to 30, default is –50 dBm). This setting is coupled to the color bar in the upper right corner of the FieldFox display.

NOTE

Blue limit and red limit percentages are coupled to the density percentage limit bar in the upper right of the FieldFox display. Or, for the blue limit and red limit power levels (dBm) are coupled to the Spectrogram power level (dBm) limit bar in the upper right of the FieldFox display.

Average Count

The Average Count setting is used mainly with the RMS Average Trace State described in "Trace Display States (RTSA)" on page 283. (But, also applies to the MaxHold or MinHold trace states.) In the RMS Average Trace State, the Average Count setting determines the number of sweeps to average. The higher the average count, the greater the amount of noise reduction.

For all three of these Trace States (RMS Average, MaxHold, or MinHold), when **Sweep 3** **Continuous** is set to OFF, press **Restart** to reset the sweep count to 1, perform <*n*> sweeps, then return to **Hold**.

How to set Average Count

- Press **Meas Setup 4**
- Then **Average Count**
- Enter a value from 1 to 10,000 using the numeric keypad, the ▲|▼ arrows, or the rotary knob.
- Press **Enter**

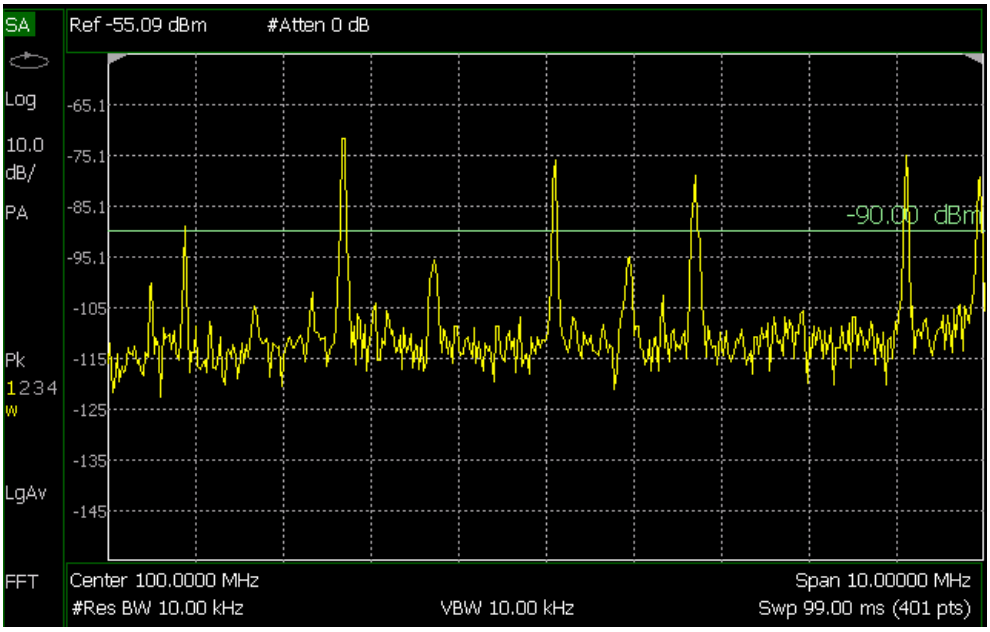
Alignments

The RTSA mode requires all three alignment types: amplitude, RF burst, and channel equalization. Refer the SA chapter's "Alignments" on page 211 for information on all Alignments.

Display Line

A display line is a simple, horizontal line that can be placed at any amplitude level on the RTSA screen. Use a display line as mental guide for visual feedback.

Figure 10-8 Display Line with Annotations



How to create and move a Display Line

- Press **Limit 8**
- Then **Display Line OFF ON**
- Then enter a Y-axis value using the ▲|▼ arrows or the rotary knob, then press **Enter**. Or enter a value using the numeric keypad and press a suffix key or press **Enter**.

Learn more, "All about Limit Lines" on page 812.

Limit Lines

CAUTION

–When using the Spectrogram measurement, Limit lines are only available when the display Measurement Type for Spectrogram View used is: Overlay.

–RTSA mode does not support any PASS or FAIL features.

–Beep, Warning, and Margin softkeys are grayed out (not active) in RTSA mode.

For more on using limit lines, refer to Chapter 31 and to "All about Limit Lines" on page 812.

Audio Beep at Marker Power

When enabled, the Audio Beep feature emits a repetitive beep sound which varies in tone pitch and repetition rate to indicate the relative power level of the active marker. The highest tone pitch and fastest beep rate occurs when the marker Y-axis position is at the top of the display. Conversely, the lowest pitch and repetition rate occurs at the bottom of the display. Therefore, it is important to scale the signals that you intend to measure between the top and bottom of the screen. Learn more about Scale in "Scale and Units" on page 270.

Audio Beep can be used with any marker type or function, including Band/Interval Power. Learn more in "Audio" on page 856.

How to use Audio Beep

1. Press **Marker**
2. Optionally, press **Marker 1 2 3 4 5 6** to select an existing marker to use with Audio Beep. A marker will be created if one does not already exist.
3. Then **More** > **Audio Beep ON OFF**

Audio Beep does NOT beep when the FieldFox is in Hold mode.

While Audio Beep is ON, press **Marker 1 2 3 4 5 6** to toggle Audio Beep through the existing markers.

To set FieldFox speaker volume control, press **System**, then **Volume**. Learn more in "Audio" on page 856.

Spectrogram Display

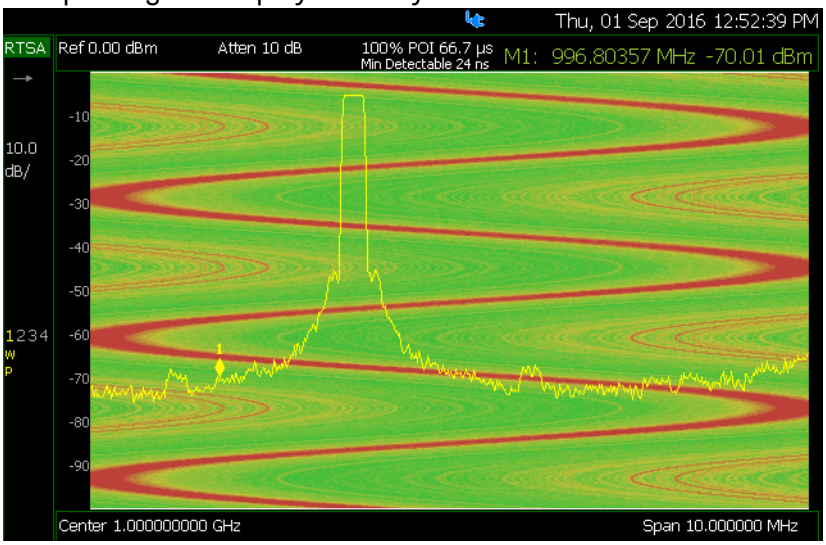
Spectrogram display provides a visual history of the measured spectrum. This display type can be used to locate intermittent signals or to view signal levels and frequencies over time.

This display can NOT be used with Channel Measurements.

Spectrogram Display (RTSA Option)

Spectrogram draws the most recent trace record at the bottom of the stack of previously-drawn trace records. Drawing the live trace on the display is optional.

Figure 10-9 Spectrogram display- Overlay view



How to select Spectrogram

– Press **Meas 1**

– Then **Spectrogram**

How to modify the Spectrogram

You can change how the spectrogram is displayed relative to the data trace. This setting affects the total number of trace records that can be displayed.

For RTSA Mode:

– Press **Meas Setup 4**.

– Then **Spectrogram View**

– Then choose from the following:

  – **Overlay** Displays the data trace over the spectrogram with NO graticules. Total trace records: 340.

- **Top** Displays the data trace below the spectrogram. Total trace records: 130.
- **Bottom** Displays the data trace above the spectrogram. Total trace records: 130.

Common Settings for Spectrogram

Set Red and Blue Limits

The colors displayed on the Waterfall and Spectrogram represent the various measured power levels:

- Red = Highest power levels
- Blue = Lowest power levels

NOTE The full Red-to-Blue color spectrum is visible only with Indoor display colors. Learn more in "Display Colors" on page 840.

Adjust the Red and Blue limits to the power levels that you expect to measure.

The Blue limit must always be less than the Red limit.

For RTSA Mode:

- Press **Meas Setup 4**.
- Then choose from the following:
  - **Red Limit** Using the ▲|▼ arrows, rotary knob, or keypad, select the HIGHEST power level that you expect to measure. This power level, and those measured higher than this level, appear Red.
  - **Blue Limit** Using the ▲|▼ arrows, rotary knob, or keypad, select the LOWEST power levels that you expect to measure. This power level, and those measured lower than this level, appear Blue.

How to Restart the Spectrogram

Press **Sweep 3** then **Restart**

Record/Playback (RTSA Option)

CAUTION Density Spectrum information is not recorded. Only the trace data is saved. See "How to Record a Session" on page 295.

NOTE Record/Playback is only available in Density Spectrum and Real-time Spectrum measurements. Record/Playback is NOT supported on Spectrogram. See "How to Record a Session" on page 295.

Record Playback allows you to record RTSA trace sweeps and play them back at a later time. Use this feature to monitor spectrum activity over a period of time.

You can record traces continuously or record a specified number of traces (segments).

When GPS is enabled, the current location and elevation are saved and played back with traces.

Recordings can be saved to the FieldFox Internal memory, an SD Card, or a USB flash drive.

About Sessions

A Recording Session is a collection of recorded traces and the instrument states that generated them.

Before recording can occur, a new session must be initiated or an existing session must be opened. Sessions can later be opened for playing or continued recording. Only one session can be open at a time.

You close the session when finished recording or playing. A session is also closed when the FieldFox is Preset (or Mode Preset), an Instrument State is recalled, or when Mode is changed from RTSA.

Each session is saved as a folder containing a set of files on the specified storage device.

How long can a recording session last?

There are many variables that determine the possible length of a recording session. But one key variable is the amount of available memory.

When a session is opened or a new session is initiated, an estimate is made of the maximum number of traces that can be saved based on the available disk space and the current number of data points (resolution). Recording will stop when that number is reached. This estimate always keeps 4 MB of available disk space on the specified storage device. You can decrease the number of traces to further limit recording.

To maximize the amount of space that is available, save recorded traces to a USB Flash drive or SD card. Learn how in "Manage Sessions" on page 298.

You can determine the length of time over which recording can occur by setting the Record Interval (the time between recorded traces) and other settings. Learn more in "Recording Configuration" on page 296.

To view and edit the maximum number of records

Just after opening or initiating a session:

1. Press **Session Data**
2. Press **CSV SaveStyle <n>** (*n* = Max number of traces that can be recorded).
3. Press **TraceRecordLimit <SingleTrace>** (Default == SingleTraces).
   - **SingleTrace** – just a single trace is saved as a record.
   - **RangeTraces** –
   - **AllTraces** – All active traces are recorded.
4. Optional: **Clear All Records** Empties that session of recorded traces. Learn more in "Manage Sessions" on page 298.

CAUTION IMPORTANT! Pressing Clear All Records causes a loss of ALL of the session data.

FieldFox Setting Changes during Record and Playback

During Recording

When any of the following State settings are changed during recording, the State counter is incremented ("About State and User Tags" on page 293) and the settings are saved to the Session file along with the first trace to be recorded with the new setting. During playback, the trace and display annotation will reflect the change on the screen.

State settings:

Refer to Table 10-1 on page 293 for a list of the applicable state settings for the RTSA options.

Table 10-1 Summary of RTSA State Settings

Option	Settings
RTSA	
	Acquisition Time
	Detector(s)
	External Gain
	Frequency Range
	Preamp On/Off
	Resolution BW
	RF Attenuation
	Trace State(s)
	Trigger Settings

Other display settings, such as Scale and acquisition, can also be changed during recording but are not saved with the session file. Think of these as settings that help YOU see the recording and playback activity. They do NOT change the data that is recorded.

During Playback

Changes to the states listed above are NOT allowed during playback.

However, all other display settings can be changed during playback to help you analyze the recorded data.

In RTSA mode, trace recordings are played back as is and the Trace State cannot be modified. No measurement post processing is allowed, and no Density or Spectrogram information can be recovered. This is because RTSA's Real-time Spectrum and Density displays are not derived from the trace data, but instead require independent high speed hardware acquisition.

Record/Playback Exceptions

Markers can be activated and moved to help analyze recorded data. However, marker position control is only available when playback is Paused.

About State and User Tags

When any of the State settings (listed above) are changed during a recording, a 'state tag' is inserted at the first trace number to be recorded with the new setting.

In addition, you can insert a 'User Tag' at any time during a recording session to indicate an external event, such as when an antenna is moved. During playback, you can move quickly to any of these tags, or scroll through these tags.

A symbol is used on the screen annotation to distinguish a User Tag from a State Tag when scrolling through tags during playback.

Screen Annotation

During a record or playback session, the following is displayed in the top-left area of the screen:

– AutoSession02: 92/95 (state 4/5)_*_
Sep.22.2018 09:15:15 AM

where:

– **AutoSession** is an auto-generated name for sessions. **02** is the auto-generated number, incremented with each new session. The name can be changed using Manage Sessions. Learn more in "Manage Sessions" on page 298.

– **92/95** is the current and total trace number: currently trace is 92 of 95 total traces.

– **state 4/5** is the current and total state tag or user tag number: 4 of 5 total tags.

– * (Asterisk) indicates that a state has changed. # (Pound) indicates that a User Tag has been inserted.

– **Sep.22...** is the date and time of recording.

When GPS is enabled`, the current location and elevation are annotated at the bottom of the playback display. Learn more in "GPS – Distance Settings" on page 857.

NOTE

If Recording or Playback is not occurring when you think it should, check the following:

– Is the sweep in HOLD? (upper-left annotation), or check the Sweep menu for Continuous set to OFF.

– Is Recording or Playback Paused? (mid-left annotation)

– Is the Record or Playback Interval set too long? (Configuration settings.)

How to Record a Session

1. Press **Trace 6** > **Record Playback**
2. Then either:
   - **New Session** OR
   - **Recall Session** then **Open** and select a session.
3. Press **Recorder Player**
4. Press **Record**

REC is displayed in the left of screen graticules.

During recording, choose from the following:

- **Pause Resume** Temporarily halts recording until pressed again. The incoming trace continues to sweep. Press again to continue recording.
- **Stop** Immediately stops recording. Then choose from the following:
  - Press **Play** to start replaying the recording from the beginning.
  - Press **Record** to continue recording.
- **User Tag** Press to insert a User Tag at the current recorded trace. This allows you to quickly move to this location during playback. Learn more in About State and User Tags in "About State and User Tags" on page 293.

How to Playback a Session

1. Press **Trace 6**
2. If the session is already open, skip the following step. Otherwise:
3. Press **Record Playback Setup**
   - Press **Recall Session** Then select a session to playback and press **Open**.

NOTE If these are large recordings on a device, it could take several seconds for the FieldFox to display the list.

4. Press **Recorder Player**
5. Press **Play**

PLAY is displayed in the left of screen graticules during playback. When the end of the recording is reached, playback begins again at trace 1 and continues to loop indefinitely.

During playback, choose from the following:

- **Pause Resume** Temporarily halts playback. Then choose from the following:

- **Pause Resume** Press to continue playing.
- **Playback State/Tag** Allows you to continue playback from a state tag, or scroll through the state tags. Enter a value between 1 and the total number of state tags using the numeric keypad, ▲|▼ arrows, or the rotary knob. Active when playback is paused. Learn more in **About State and User Tags** in "About State and User Tags" on page 293.
- **Playback Trace** Activated automatically when Paused. Allows you to continue playback from a specific trace, or scroll through traces manually. Enter a value between 1 and the total number of traces using the numeric keypad, ▲|▼ arrows, or the rotary knob.

– **Stop** Immediately stops playback. Then choose from the following:

- **Play** Start playback from trace 1.
- **Record** Resume recording from the last recorded trace.
- **Record Playback Setup** Return to the setup menu to change Configuration settings or Close the session.

Recording Configuration

To change Recording Configuration settings:

1. Press **Trace 6** > **Record Playback**
2. Press **New Session** or **Recall** an existing session.
3. Press **Recording Configuration**
4. Then choose from the following:

– **Record Time** Sets the amount of time to record traces. Default is MAX, which is to record indefinitely. Enter a value between 1s and 1 Ms (million) seconds using the numeric keypad, ▲|▼ arrows, or the rotary knob. When set, a timer appears during recording in the lower-left corner which counts DOWN from the specified time.

– **Record Source** Determines which trace is recorded. Sets where, in the FieldFox data flow, data is recorded. Learn more in "Record Source" on page 297. Choose from the following:

- **First Active Trace** (Default) This setting automatically selects the first active trace (1,2, 3 or 4) (i.e., any state other than View or Blank).
- **Trace 1,2,3,4** Records data from the corresponding trace in its current state.

– **Record Interval** Sets the amount of time to wait between individual trace recordings. Default is MIN, which is to wait 0 seconds (record traces as fast as possible). Enter a value in seconds between 0 (no delay) and 10,000 seconds - about 3 hrs) using the numeric keypad, ▲|▼ arrows, or the rotary knob.

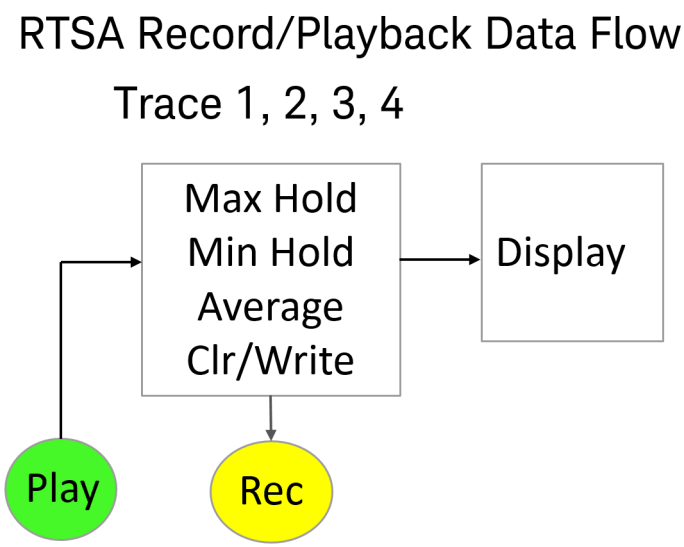
– **Segment Count** Sets the number of traces to record, after which the recording will automatically pause. Press Pause/Resume or Record to capture another N traces, or Stop to end recording. Default is OFF, which is NO limit to the number of traces to be recorded.

When set, a counter appears in the lower-left corner which counts UP to the specified number of recordings.

Record Source

NOTE For this discussion, it is important to understand Trace States. Learn more in "Trace Display States (SA Mode)" on page 209.

Figure 10-10 FieldFox RTSA Mode: Data Flow and Record Playback Data Points



RTSA Data Recording:

CAUTION Density Spectrum information is not recorded. Only the trace data is saved.

– Data is recorded at the trace state processing block.

– Data can be recorded from Traces 1,2,3, or 4 which includes the trace state (Max Hold, Min Hold, and so forth).

– Data is ALWAYS played back into the same trace number that was recorded. If four traces were active during the recording, but only one trace was recorded, then during Playback only that one recorded trace is visible.

Playback Configuration

By default, trace sweeps are played back as fast as the trace can be drawn on the screen. The following setting allows you to slow playback. In addition, you can manually scroll through individual traces using Playback Trace, or scroll through State and User Tags using Playback State/Tag. Learn more in **How to Playback a Session** in "How to Playback a Session" on page 295.

To slow playback of a session:

1. Record a new session or Open an existing session.
2. Press **Playback Configuration**
3. Press **Playback Interval**
4. Enter a value in seconds between 0 (no delay) and 100 using the numeric keypad, ▲|▼ arrows, or the rotary knob. After using the keypad, select a multiplier key. Learn about multiplier abbreviations.
5. Press **Enter**

Manage Sessions

1. Press **Trace 6** > **Record Playback**
2. Press **Record Playback Setup** The following selections are available ONLY when a session is NOT open.
3. Press **Storage Device** to select the media which stores the sessions to be managed. This is a different setting from the Save/Recall Storage Device setting.
4. Choose from the following:
   - **Internal** FieldFox memory (default)
   - **SD Card** An external SD Card (must be inserted)
   - **USB** An external USB flash drive (must be inserted)
5. Press **Manage Sessions**

NOTE If these are large recordings on a device, it could take several seconds for the FieldFox to display the list.

6. Choose from the following:

- **Rename** Using the FieldFox labeler, change the name of the session. AutoSession (n) is the default name where (n) is the next-available number. Learn more in "How to use the FieldFox labeler " on page 891.
- **Sort** Arrange the listing of sessions **by Name**, **by Date**, or **by Size**. Sort can also be used during a Recall Session, before choosing a session to open.
- **Delete** After a confirmation prompt, removes the contents of the selected session from the list.
- **Copy** Copies the selected session to a different storage device, or the same storage device with 'Copy(n)_' appended to the beginning of the name so that duplication is prevented.
- **Copy All** Copies ALL of the listed sessions to a different storage device, or the same storage device with 'Copy(n)_' appended to the beginning of the names so that duplication is prevented.
- **Delete All** Deletes ALL of the listed sessions.

Record Playback Example (RTSA Mode Only)

The following "Interval Recording" example shows how you can record spectral activity over a longer period of time with less trace storage.

1. Press **Trace 6** > **Record Playback** > **New Session** > **Recording Configuration**
2. Press **Record Source** to Trace1
3. Press **Back** > **Recorder Player**
4. Press **Record** let the recorder run for several seconds.
5. Press **Stop** to end the recording.

This session can be played back: For example:

- Press **Trace 6**
- Then **Record Playback**
- Then **Play**

11 IQ Analyzer (IQA) – Option 351

IQA mode measures signals at the **SA RF IN** connector.

IQA mode requires the FieldFox to have SA mode installed.

CAUTION

IMPORTANT!

85571A-028 (28 GHz 5G Phased Array Antenna) accessories not suitable for use in wet locations.

NOTE

The FieldFox can be used with an OML frequency extender. Refer to "Utilities" on page 842, the Configuration Guide at: https://www.keysight.com/us/en/assets/7018-06515/configuration-guides/5992-3701.pdf (5992-3701EN), and to "Contacting Keysight" on page 5.

Figure 11-1 IQ Analyzer (IQA) Display - LTE–TDD signal captured using the FieldFox's I/Q analyzer

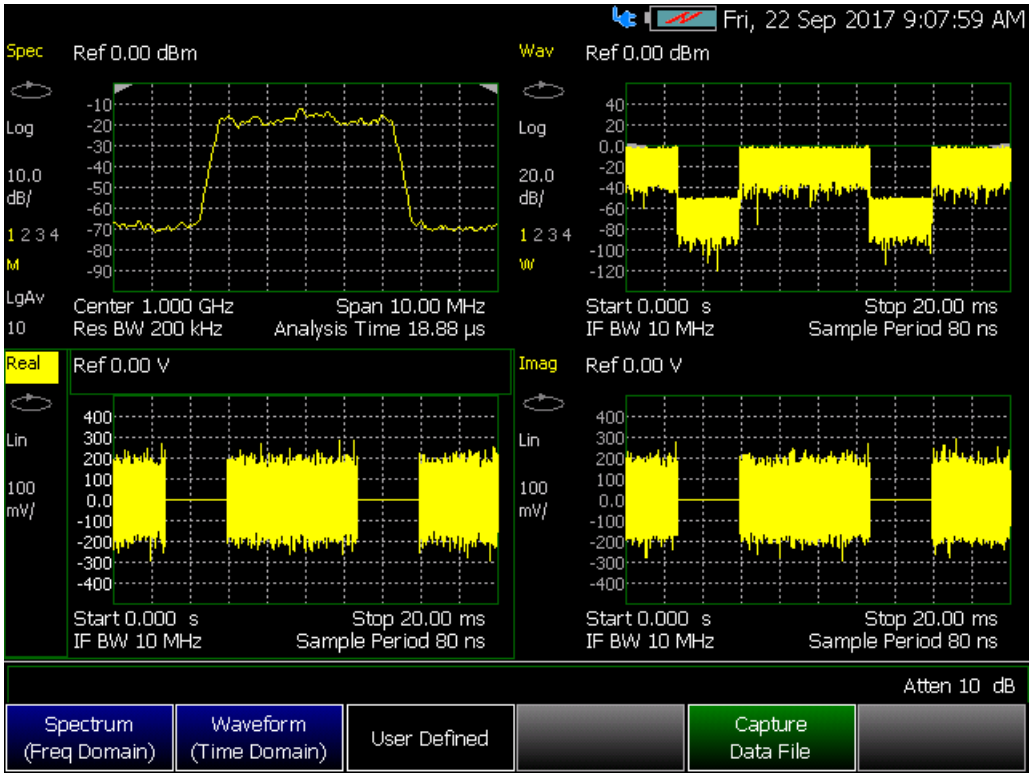
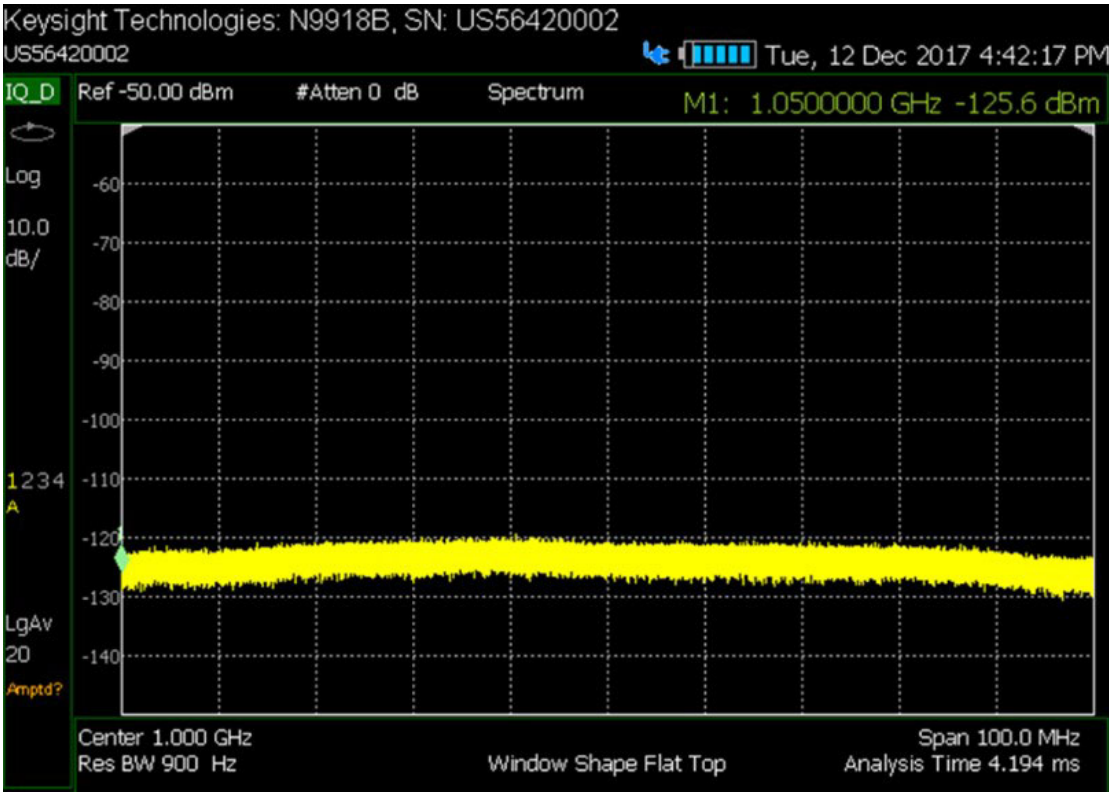


Figure 11-2 IQ Analyzer (IQA) Display - Window Shape Flat Top spur free 1 GHz center frequency (span=100 MHz) captured using the FieldFox's I/Q analyzer (Requires Option B10)



In this Chapter

"About I/Q Analyzer (IQA) Measurements" on page 306

– "Setting the IF Path" on page 306

"I/Q Analyzer (IQA) Mode Settings" on page 307

– "How to Make Measurements Using the I/Q Analyzer Mode" on page 307

– "How to Make Independent Source Settings and Pulse Generator Tracking" on page 309

– "How to Capture I/Q Data to a File" on page 312

– "How to modify the I/Q data measurement parameters" on page 315

"Using Markers (IQA)" on page 326

– "Noise Marker" on page 326

– "Band/Interval Power Marker" on page 327

– "Band Span Marker (Spectrum Only)" on page 328

– "Interval Span Marker (Waveform Only)" on page 328

– "Coupled Markers (Waveform Only)" on page 328

– "Continuous Peak Search Marker" on page 330

"Alignments" on page 331

"Trace Display States (IQA Mode)" on page 331

– "How to display the Trace States" on page 331

"Other Features Available" on page 333

– Constellation and Frame Summary – "IQ Analysis (SA Mode Only)" on page 259

– External Gain (SA chapter) – "External Gain" on page 162

– Display lines (SA chapter) –"Display Line" on page 222

– Limit Lines (Data Analysis chapter) – "All about Limit Lines" on page 812

See Also

"Why and When to Calibrate" on page 129

"All about Markers" on page 797

"All about Limit Lines" on page 812

"All about Trace Math" on page 829

Chapter 31, "Data Analysis Features."

Chapter 34, "File Management."

About I/Q Analyzer (IQA) Measurements

The I/Q Analyzer Mode makes general purpose frequency domain and time domain measurements. The mode enables two types of I/Q measurements:

– frequency domain and

– time domain measurements

NOTE Noise level in time-domain measurements are higher for IF-BW >100 MHz due to raised noise levels at the edges of the 120 MHz bandwidth.

In order to ensure consistent results between frequency domain and time domain, spectrum measurement and waveform measurement are based on the same I/Q acquisition. The following acquisition parameters are automatically calculated to satisfy these requirements:

1. RBW and IF BW specified in Spectrum measurement BW (**BW 2**) menu.
2. Start time and Stop time specified in Waveform measurement Sweep (**Sweep 3**) menu and IF BW specified in Waveform measurement BW (**BW 2**) menu. See also, "Setting the IF Path".
3. I/Q signal capture related parameters specified in the Measurement Setup (**Meas Setup 4**) menu. See also, "Setting the IF Path".

Some measurement parameters are auto-coupled and are not user-settable.

Setting the IF Path

How to check or set the IF Path. By default the IF Path is set to Auto.

1. Press **Meas Setup 4** > **General**
2. Press **BW 2**.
3. Then **IF Path** The underlined setting is the current setting. Choose **Auto**, **10 MHz**, or **100 MHz** (100 MHz requires Option B04 or B10 and either Option 350 RTSA or Option 351 IQ Analyzer).

   Optional: After you click 100 MHz, you can use the **Freq/Dist** hard key and the number pad or using the numeric keypad, the ▲|▼ arrows, to increase your IF path bandwidth to 120 MHz.

NOTE When in full span, ADC dither raises the noise floor at the edges of the 120 MHz.

I/Q Analyzer (IQA) Mode Settings

NOTE

When you initially select I/Q Analyzer, Real-Time SA, or some of the other spectrum settings (such as center frequency) a factory channel Equalization measurement is applied to the signal. During channel equalization measurement, the FieldFox displays a “Start Channel Equalization”. Stopping channel equalization is not permitted. See also, “Alignments” on page 211, in Chapter 9, “SA (Spectrum Analyzer) Mode (Option 233–Mixed Analyzers).”

Select IQA Mode before making any settings in this chapter.

How to select IQA Mode

– Press **Mode** .
– Then **More** (may not be available—number of installed options dependent)
– Then **IQ Analyzer**.

How to Make Measurements Using the I/Q Analyzer Mode

The Measure menu is used to set common parameters, predefined views selection, and measurement switching.

Spectrum has only one predefined view and Waveform measurement has two predefined views. There is a User Defined measurement, which can be used to display up to four different views (windows) simultaneously on the display screen. You can select which type of data to display in each of the views from the **Trace** menu.

See also, “How to Capture I/Q Data to a File” on page 312 and “Setting the IF Path” on page 306.

1. Press **Preset** then **Mode Preset (Factory)**
2. Press **Measure 1** then choose from the following:
   – **Spectrum (Freq Domain)** (Default) – Selects frequency spectrum as the current displayed measurement.
   – **Waveform** then choose one of the following:
      – **RF Envelope** Selects log RF envelope in time domain (default).

NOTE

Noise level in time-domain measurements are higher for IF-BW >100 MHz due to raised noise levels at the edges of the 120 MHz bandwidth.

      – **IQ Waveform** Selects linear Real and imaginary I/Q waveform values.

- **User Defined** Selects a default user defined 4-quadrant display showing the following data:
  - Log magnitude of the spectrum of the I/Q data versus frequency
  - Log magnitude of the I/Q data (RF Envelope) versus time
  - The real component of the I/Q data versus time
  - The imaginary component of the I/Q data versus time

  The user defined measurement can be modified to change the number of displays from 4 to 3, 2, or 1.
- **Source** Opens a softkey menu for Independent Source and Source Tracking settings. This softkey menu is only available for B/C model equipped with Pulse Generator license (Option 357) and operating in IQA mode. Refer to "How to Make Independent Source Settings and Pulse Generator Tracking" on page 309
- **Capture Data File** Opens a menu to enable saving I/Q data to a file. When you press the **Start** capture softkey the data is saved to a file and the default file `IQDataFile.csv` is stored in the internal memory. Refer to "How to Capture I/Q Data to a File" on page 312.

How to Make Independent Source Settings and Pulse Generator Tracking

NOTE

For best results, when using the independent source feature, InstAlign and the battery saver features should be turned off. Refer to "All Alignment and Align All Now" on page 215 and "Preferences" on page 850

This feature may require an option. For a comprehensive list, view the FieldFox Configuration Guide at: https://www.keysight.com/us/en/assets/7018-06515/configuration-guides/5992-3701.pdf (5992-3701EN).

Independent Source can be enabled in IQA mode for B/C model equipped with Pulse Generator license (Option 357).

To view the internal source, you must connect a cable or device between the RF Output connector and the RF Input connector.

The Pulse Generator Tracking feature required Option 357, allows the Independent Source tracking to effectively retain the settings from the most recent activity, specifically when the Pulse Generator mode was last used with RF enabled.

To utilize Pulse Generator Tracking feature, users should navigate to the Pulse Generator, configure a signal and ensure that RF is set to ON. Learn more in Chapter 25, "Pulse Generator – Option 357", on page 635

- Press **Measure 1** > **Source**
- **Source Enable ON OFF**
  - **ON** Turns ON the internal source.
  - **OFF** Turns OFF the internal source.
- **Source Tracking** Choose from the following:
  - **OFF** The source is set to a CW frequency independent from the SA settings. Srcw is annotated on the screen.
  - **Center Freq** The source is set to a CW frequency, but that frequency "tracks" the SA receiver Center Frequency settings. Therefore, the signal always appears at center of the display. Srcp is annotated on the screen.
  - **Pulse Gen** Only available for B/C model equipped with Pulse Generator license (Option 357) and operating in IQA mode. Track the pulse generator signal to replicate the same signal setup established in Pulse Generator mode. SrcPg is annotated on the screen.

NOTE Pulse Gen softkey appears greyed out and cannot be selected despite having Option 357 on B/C model. Refer to Figure 11-3 on page 311. This occurs because the signal has not been configured with RF ON within the Pulse Generator mode. Learn more in Chapter 25, "Pulse Generator – Option 357", on page 635.

– **Source Power** Sets the source power level. Choose from:
  – **Leveled** Enter a value from –60 dBm to 10 dBm using the numeric keypad, ▲|▼ arrows, or the rotary knob. The source power is reasonably flat across the frequency span.
  – **MAX** The power level is set to the maximum achievable power level at each frequency.
– **Source CW Freq** Sets the CW frequency that is used.

NOTE When Source Enable is ON, **Source CW Freq** softkey is enabled ONLY when Source Tracking is set to OFF.

NOTE When Source Tracking is set to Pulse Gen, Source Power and Source CW Freq are disabled and cannot be adjusted. The Source CW Freq reveals the RF Freq relayed from the Pulse Generator mode. Refer to Figure 11-4 on page 311 and Figure 11-5 on page 311 for track the Pulse Gen example.

NOTE The Independent Source output signal may be momentarily interrupted for automatic SA Receiver alignments or Battery Saver functionality.

To prevent automatic alignments from interrupting the source, turn off all alignment. Refer to "How to Access Individual Alignments" on page 216.

– Press **Cal 5**
– Then press **All Alignment** and select **OFF** or **Hold** to disable All Alignment

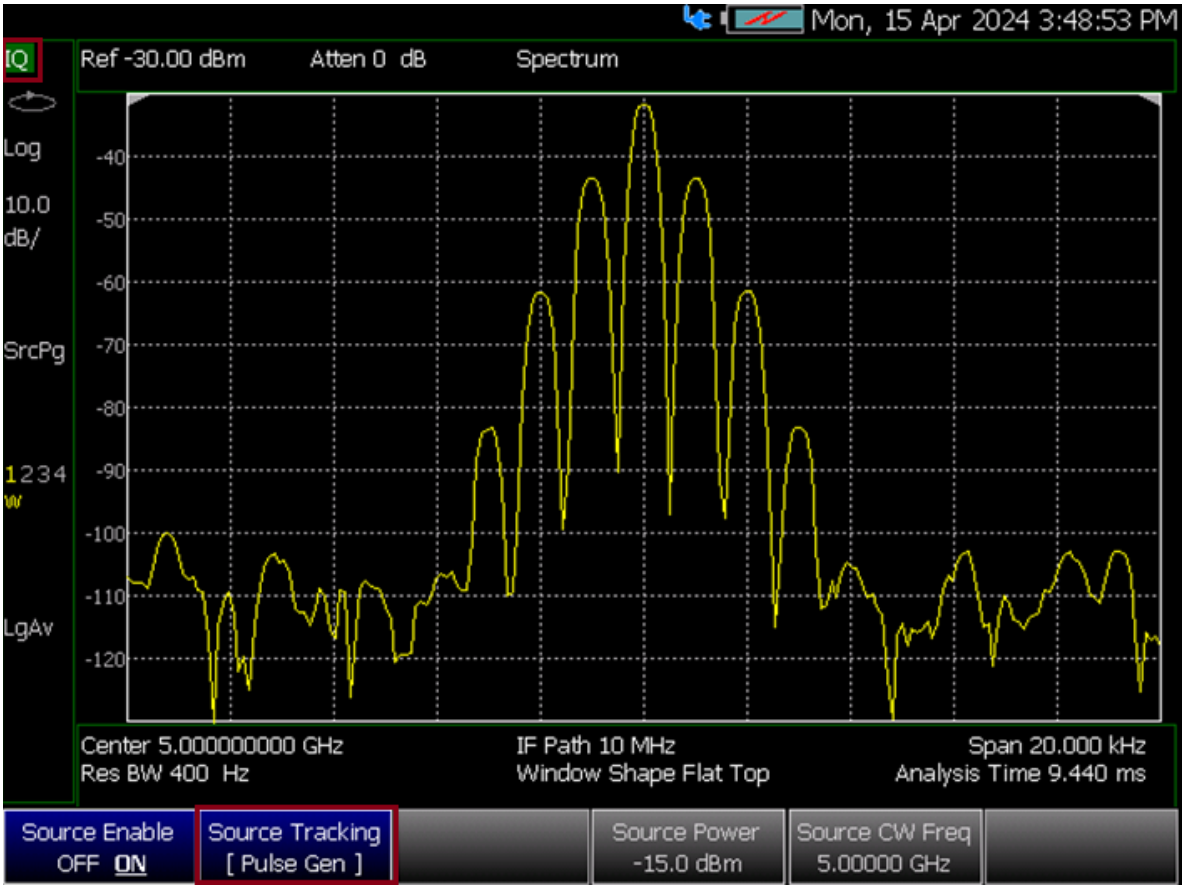
To prevent Battery Saver from interrupting the source, turned off Battery Saver. Learn more in "Battery Saver" on page 853.

– Press **System 7** > **Preferences** > **Preferences**
– Then in the table, select Battery Saver value column and press **Edit**
– Then press **Battery Saver** to toggle OFF to disable Battery Saver

Figure 11-3 Softkey Menu: Pulse Generator Not Configured (RF OFF) - Pulse Gen Greyed out

Figure 11-4 Softkey Menu: Pulse Generator Configured (RF ON) - Pulse Gen Enabled

Figure 11-5 Track the Pulse Gen in IQA mode Examples - Modulated Signal Setup Using Pulse Generator Mode



How to Capture I/Q Data to a File

CAUTION **I/Q data cannot be recalled or displayed in the FieldFox instrument. The data file is intended for use in a PC.**

There are two I/Q data file count capture modes, **Single** and **Multiple**. To capture your IQA data measurements:

– Press **Measure 1** > **Capture Data File** then choose one of the following:

  – **File Settings** Opens a menu to set the file choices:

    ––**File Count** File count can be set to **Single** or 1 (all data saved into a single file for the current displayed data) or **Multiple**. When using Multiple as the file count, the user can enter the number of files to save, and the FieldFox is auto-coupled to Continuous acquisition mode and to Multiple capture and all data is saved to either an external SD card or USB storage device. Each acquisition is saved, before the next data acquisition occurs. (default: 1, minimum: 1, maximum: 1,000,000,000)

      ––Single capture example (default): IQDataFile.csv

      ––Multiple capture (default):
      Example is: IQDataFile_20171031 14.33.26.1050.csv).
      (format is: IQDataFile_yyyymmdd hh.mm.ss.ffff.csv).

      ––Refer to the **Start** softkey on page 313 and to the "Example:" on page 313.

    ––**File Type** Selects the format of the output data file (CSV, TXT, SDF, or MAT). (Default: CSV)

    ––**Device** Selects the storage location for your data files (Internal, SD Card, or USB). Internal is not available, if the File Count is set to Multiple (default: Internal).

    If you do not have an external device connected and attempt to save your data, a warning message is displayed: "`Warning: Only an external storage device can be used in multiple file mode.`"

    Then select:

      ––**Internal** (default) Selects the internal memory of the FieldFox as the storage location for all data files. Internal is only available when File Count is set to Single.

      ––**SD Card** Selects the external SD card slot as the storage location for all data files.

      ––**USB** Selects an external USB storage device as the storage location for all data files.

——**Filename** Opens a file manager Labeler menu that enables you to customize your data filenames. Refer to "File Management" on page 887 (default: IQDataFile).

——**Back** Returns to the previous softkey menu.

– **Capture Settings** then choose one of the following:

——**Capture Time** Sets the length of the I/Q trace capture time (default: 100 µs, range: 80 ns to dynamic (i.e., Maximum capture time is 1.07374s, which is associated with a sample rate of 125 MHz)).

——**Sample Rate** Sets the I/Q data sample rate value (default: 125 MHz, maximum: 125 MHz, couplings: 1.25 * IF Bandwidth).

——**Sample Period** Sets the 1/Sample Rate value (default: 8 ns, maximum: 80 ms, couplings: Sample Rate).

——**Capture Samples** Sets the capture length using a sample number (default: 12501, minimum: 1, maximum: 134217728, couplings: Capture Time).

——**Back** Returns to the previous softkey menu.

– **Start** Starts the I/Q data capture and stores the data into a default file and location (internal). Filenames and storage location can be customized. See also, the "Example:" on page 313 and to Chapter 34, "File Management."

——Refer to the **File Count** softkey on page 312.

CAUTION

Each time you press the Start softkey the I/Q data writes to the current filename (i.e., Single capture default is IQDataFile.csv or for Multiple format is IQDataFile_yyyymmdd hh.mm.ss.ffff.csv). To avoid overwriting your Single capture data or to add a unique filename for Single or Multiple capture data, use the Measure 1 > Capture Data Settings > File Settings > Filename softkey to modify your filename Refer to the File Count softkey on page 312.

– **Stop** immediately stops the I/Q data file capture and stops writing data to the current I/Q data file (no data is saved). If the I/Q data was being saved when the Stop softkey is pressed, the file is deleted. Refer to "Example:" on page 313.

Example:

Single:

——If the **Capture Time** is set to 100 µs, and you press the **Start** softkey, in **Single** mode the FieldFox saves 100 µs of the current I/Q data.

Multiple:-

——If the File Count is set to 200, and you press the **Start** softkey, the FieldFox saves your 200 I/Q data files and stops. The I/Q data files are saved into 200 files similar to: IQDataFile_yyyymmdd hh.mm.ss.ffff.csv.

——If you press **Stop**, before the 200 I/Q data files have been saved, the FieldFox stops (interrupts) the multiple I/Q data file saving at the number of the current file. So, if you press Stop on file number 175, the saving process stops. If file number 175 has not been saved, it is deleted. But, I/Q data files 1 through 174 that have been saved prior to pressing **Stop**, are still saved for reference.

See also, Chapter 34, “File Management.”

How to modify the I/Q data measurement parameters

The following sections assume you have already selected your I/Q data measurement type (i.e., Spectrum, Waveform (RF Envelope or I/Q Waveform), or User Defined).

This section contains the following:

"Adjusting the Bandwidth Settings" on page 315
"Changing between the Continuous and Single captures and adjusting the Trigger settings" on page 317
"Adjusting the Measurement Setup Settings" on page 320
"Adjusting the Trace Settings" on page 321
"Adjusting the Frequency Settings" on page 322
"Adjusting the Scale and Amplitude Settings" on page 322
"Preamplifier Control (Opt 235)" on page 325

Adjusting the Bandwidth Settings

– Press **BW 2**.

– Then choose from the following:

– **Res BW** (Spectrum only) – Sets the resolution bandwidth of the FFT analysis. Changing this value changes the FFT window size, analysis length, and the sweep time (data acquisition capture length). This softkey is only available when IQA is set to Spectrum (Freq Domain). When the resolution bandwidth value is set to Auto (default) the FieldFox automatically sets the optimum resolution bandwidth value. (Default: 100 Hz, Minimum: 10 Hz, maximum: 100 MHz).

NOTE

There is a significant difference between resolution BW in FFT measurements and the resolution BW of a traditional "sweeping" spectrum analyzer (SA) measurement. The resolution BW in FFT measurements does not directly control the IF BW like a traditional SA swept measurement. Resolution bandwidth is directly related to the analysis length (window) and or data acquisition capture length (sweep time).

– **Analysis Length** Sets the FFT analysis length that is the length of the complex I/Q data points (I/Q–pairs) vector that is used for spectrum analysis, expressed in the number of samples. (Couplings: In Auto, this setting is directly coupled to the Res BW and to Span. Minimum: 8, Maximum: 524,288. Where each FFT length "point" is equal to 1 I and 1 Q point. So, 237 is equal to 237 I and 237 Q points).

– **FFT Window** Sets the FFT filtering window (spectrum analysis window) shape for the I/Q data. Default: Flat Top

Then select one of the following:

FFT Window	Description
Uniform	No windowing
Triangular	Barlett windowing
Hanning	This is a Hann window, sometimes called Hanning or “raised cosine”.
Hamming	This window has lower side-lobe peaks than the Hann window, but has worse main-lobe flatness and poor side-lobe roll-off.
Blackman	This window is similar to the three-term Blackman-Harris window, but it has simpler fixed-form coefficients and better side-lobe roll-off.
Blackman Harris 3	This is the three-term Blackman-Harris window. This has the minimum side-lobe level for a three-term cosine window.
Blackman Harris	This is the four-term Blackman-Harris window. This has the minimum side-lobe level for a four-term cosine window with 60 dB/decade roll-off.
Gaussian Top	This is a five-term cosine window that resembles a Gaussian window.
Flat 4	This is a four-term flat-top window.
Flat Top (default)	This is the five-term flat-top window.
Flat 6	This is a six-term flat-top window.
Flat 7	This is a seven-term flat-top window.
P501	This is an alternative six-term flat-top window.
P601	This is an alternative seven-term flat-top window.
K-B (70 dB)	This is a Kaiser-Bessel window whose maximum side-lobe level is -70 dB.
K-B (80 dB)	This is a Kaiser-Bessel window whose maximum side-lobe level is -80 dB.
K-B (90 dB)	This is a Kaiser-Bessel window whose maximum side-lobe level is -90 dB.
K-B (100 dB)	This is a Kaiser-Bessel window whose maximum side-lobe level is -100 dB.
K-B (110 dB)	This is a Kaiser-Bessel window whose maximum side-lobe level is -110 dB.

FFT Window	Description
K-B (120 dB)	This is a Kaiser-Bessel window whose maximum side-lobe level is -120 dB.
Gaussian (60 dB)	This is a Gaussian window whose maximum side-lobe level is -60 dB.
Gaussian (70 dB)	This is a Gaussian window whose maximum side-lobe level is -70 dB.
Gaussian (80 dB)	This is a Gaussian window whose maximum side-lobe level is -80 dB.
Sinc	This window is the central lobe of the sin(x)/x (often called sinc(x)) function.
Tukey25	This is a tukey (cosine-tapered) window with alpha equal to 0.25.

- **IF BW** Sets the Digital IF bandwidth of the instrument. The relationship between the IF bandwidth and sample rate can be described by the following equation:
  `sample rate = 1.25 * IF BW.`

  (Default: 10 MHz, minimum: 10 Hz, maximum: 120 MHz)

NOTE When in full span, ADC dither raises the noise floor at the edges of the 120 MHz.

Changing between the Continuous and Single captures and adjusting the Trigger settings

- Press **Sweep 3**.
- Then choose from the following:
  - **Single** When pressed, Single automatically sets Continuous to OFF and causes the application to make one acquisition.
  - **Continuous** Toggles Continuous between ON and OFF. When Continuous is ON, each Run/Hold press causes the application to toggle between continuous acquisitions and Hold. When Continuous is OFF, each Run/Hold or Single press causes the application to make one acquisition.
  - **Restart** When pressed, Restart causes the FieldFox to restart trace averaging at count of 1. When in Single sweep mode, the IQA will perform a complete set of averages before returning to the hold state.

– **Start Time** (**Waveform only**) Sets the start time of the waveform measurement (default: 0s, minimum: 0s, maximum: dynamic). In Waveform mode Setting the Start and stop time enables you to display a subset of the data on the display in order to speed up the refresh rate when the acquisition time is long. Changing the Start Time changes which data point is displayed on the left side of the screen.

  Couplings: When the change of Stop Time makes time domain display length exceed the limitation, the Start Time will change to satisfy time domain display length limitation:

  ––The maximum value is determined by current Sample Rate and the maximum capture samples.

  ––Start Time is adjusted to the nearest sample point based on the Sample Period.

  ––The maximum time domain display length is 524,288 points.

  ```
  Time Domain Display Length [pts] = {[Sample
  Rate[pts/s] x (Stop Time[s] - Start Time[s])] +
  1}
  ```

  Where:

  pts = points

  s = seconds

– **Stop Time** (Waveform only) Sets the stop time for the waveform display (default: 100 μs, minimum: 0s, maximum: dynamic). In Waveform mode Setting the Start and stop time enables you to display a subset of the data on the display in order to speed up the refresh rate when the acquisition time is long. Changing the Stop Time changes which data point is displayed on the right side of the screen.

  Couplings: When the change of Stop Time makes time domain display length exceed the limitation, the Start Time will change to satisfy time domain display length limitation:

  ––The maximum value is determined by current Sample Rate and the maximum capture samples.

  ––Stop Time is adjusted to the nearest sample point based on the Sample Period.

  ––The maximum time domain display length is 524,288 points.

  ```
  Time Domain Display Length [pts] = {[Sample
  Rate[pts/s] x (Stop Time[s] - Start Time[s])] +
  1}
  ```

  Where:

pts = points

s = seconds

– **Trigger Settings** Opens the Trigger Settings softkey menu.

Then:

––**Trig Type** Then select one of the following:

Softkey	Description
Free Run	(Default.) – Triggering is provided by the FieldFox internal circuitry. A new acquisition begins when the previous acquisition ends.
External	An acquisition is triggered on an external TTL signal at the Ref In/Trig In connector on the FieldFox top panel. Choose to trigger on the rising slope at about 1.7 V or on the falling slope at about 1.0 V using the Trigger Slope setting (below).
Video	An acquisition is initiated when the displayed amplitude of an incoming signal crosses the settable Trigger Level. This selection can detect low-amplitude signals, but also has been filtered considerably and may not be a true representation of the incoming signal.
RF Burst	An acquisition is initiated when the signal at the third IF (analog) stage crosses the settable Trigger Level. This selection offers a wider bandwidth and may be a better representation of the incoming signal than Video trigger. However, RF Burst is not as sensitive to triggering on low-level signals.
Periodic	Periodic sets a trigger that repeats at the period rate entered. Periodic trigger's phase can be altered by the Offset value.

––Then depending on the trigger type selected, choose from the following:

Trig Level – Sets the trigger level. This softkey is only active for Video or RF Burst (default: –25 dBm, minimum: –210 dBm, maximum: 30 dBm).

Trig Slope – Sets the negative/positive trigger slope. This softkey is only active for External, Video, or RF Burst (default: Pos).

Trig Delay – Sets the trigger delay. This softkey is only active for External, Video, or RF Burst (default: 0s, minimum: –150 ms, maximum: 500 ms).

Glitch Mask – Enables the glitch mask to reduce incorrect triggering due to fast changes/glitches in the signal level that can be mistaken to be the edge of the RF burst. This softkey is only active for RF Burst (default: 0 ms, minimum: 0s, maximum: 5 ms).

Auto Trigger – While waiting for a valid trigger signal, Wait is annotated in the top left corner of the FieldFox screen.

If a valid trigger signal is not received before the specified Auto Trig Time, a acquisition will occur automatically.

Enter **0** to set Auto Trigger **OFF**. When Auto Trigger is OFF, the FieldFox does NOT perform an acquisition unless a valid trigger signal is received.

(Default: 100 ms, minimum: 1 ms, maximum: 100s)

Adjusting the Measurement Setup Settings

– Press **Meas Setup 4**.

– Then choose from the following:

  – **Average Type** Opens a menu of averaging softkeys.

    Then select one of the following:

    ––**Power** (Linear) Averaging – Best for measuring true power levels. Used in Noise Marker Average. Mathematically, trace noise is 2.5 dB higher than when using Log Average. PAvg annotation is displayed.

    ––**Log** Averaging (default) – Best for displaying Trace Averaging. Also known as video averaging. LgAvg annotation is displayed.

    ––**Voltage** (Magnitude) Averaging – Converts the amplitudes to a magnitude unit before averaging (e.g., Volts, Amps, microVolts, milliVolts, etc.) VAvg annotation is displayed.

  – **Average Count** The Average Count setting is used with the Average Trace State. In this Trace State, the Average Count setting determines the number of acquisitions to average. The higher the average count, the greater the amount of noise reduction (default: 10, minimum: 1, maximum: 10000).

  – **Sample Rate** Sets the I/Q data sample rate value (default: 125 MHz, maximum: 125 MHz, couplings: 1.25 * IF Bandwidth).

  – **Sample Period** Sets the 1/Sample Rate value (default: 8 ns, minimum: 8 ns, maximum: 80 ms, couplings: `1/Sample Rate`).

Adjusting the Trace Settings

The Trace menu is used to modify the existing predefined view, or create a customized view. Window and Win State softkeys are used to modify layout of view, the Data softkey is used to specify the displayed data results for the current window. Please note only in User Defined measurement are all of the data results from Spectrum measurement and Waveform measurement available. Otherwise, only the data results from the current measurement (Spectrum or Waveform) are available. See also "Trace Display States (IQA Mode)" on page 331.

The Trace and Trace State keys are used to choose how many traces of the data result are displayed, and the trace data type (Clr/Wr, MaxHold, MinHold, Average, View, or Blank) that are displayed for each measurement.

– Press **Trace 6**.

– Then choose from the following:

  – **Window 1 2 3 4** Changes the selected window (default: 1).

    Then select one of the following:

  – **Win State ON OFF** Enables or disables the current Window (1, 2, 3, or 4) selected by the Window 1 2 3 4 softkey (default: Window 1 is set to ON).

  – **Data** Sets the data type displayed.

    Then select one of the following:

    For **Spectrum Measurement:**

Mag Spectrum
Time Summary – Time Summary result includes the capture time, spectrum analysis time and waveform start/stop time.

    For **Waveform Measurement:**

I vs. Time – Imaginary vs. Time
Q vs. Time – Quadrature vs. Time
Q vs. I – Quadrature vs. Imaginary
RF Envelope
Phase vs. Time
Unwrapped Phase vs. Time
Time Summary – Time Summary result includes the capture time, spectrum analysis time and waveform start/stop time.

– **Trace 1 2 3 4** Pressing the Trace key enables you to select a different trace number. This softkey is active when Data is set to Spectrum or RF Envelope.

NOTE

Spectrum and RF Envelope have six markers that can be applied to any of the 4 traces.
Waveform's six markers can be applied to RF Envelope, Real, Imaginary, Phase, Unwrapped Phase, and Q vs. I.

– **RF Envelope has four traces.**

– **Real, Imaginary, Phase, Unwrapped Phase, and Q vs. I have 1 trace each.**

– **Trace State** Sets a different trace state to each of four traces. This softkey is active when the data is set to Spectrum or RF Envelope (Log). Pressing the Trace State softkey enables you to change the State of the selected Trace number of the Trace Data (default: Clr/Wr – assigned to trace 1. Traces 2, 3, and 4 are set to Blank).

Adjusting the Frequency Settings

– Press **Freq/Dist**.

– Then select from the following:

– **Center** Sets the center frequency of the measurement trace (default: 1 GHz, minimum: 0 Hz, maximum: FieldFox model dependent).

– **Freq Span** (Spectrum Only) Sets the frequency span of the measurement trace. The analyzer's digital IF bandwidth is always equal to this value.

Changing the span causes the IF bandwidth and the sample rate to change automatically:

Span = IF bandwidth, sample rate = 1.25 * IF bandwidth

Res BW = Span /50, if resolution bandwidth = Auto.

Default: 100 MHz, minimum: 10 Hz, maximum: 120 MHz

NOTE

When in full span, ADC dither raises the noise floor at the edges of the 120 MHz.

Adjusting the Scale and Amplitude Settings

Enables you to change attenuation settings. When RF Attenuation Auto is ON, the RF Attenuation is set by adjusting the acquisition. As the acquisition is lowered, for example from -10 dBm to -40 dBm, the FieldFox assumes that you

are looking at low-level signals. The RF Attenuation value is automatically lowered in 5 dB steps to allow low-level signals to be viewed. The RF Attenuation value is never automatically lowered below 5 dB.

How to set Scale/Amptd

– Press **Scale/Amptd**.

Manually set Log or Linear Scale Type (Spectrum and RF Envelope Only)

Then select from the following:

– **More**

––**Scale Type [current setting]** (Spectrum and RF Envelope) –Only)

––**Log** Logarithmic scale (default setting). The Y-axis reference line represents the specified absolute acquisition in the current Unit selection. Y-axis graticules show dB below or above the reference line (default: 10 dB, minimum: 0.01 dB, maximum: 20 dB).

––**Lin** Linear scale. The Y-axis reference line represents the specified absolute acquisition in the current Unit selection.

––Y-axis graticules show percent of acquisition (%) below or above the reference line (Spectrum).

––Y-axis graticules show voltage (V) – (RF Envelope).

Manually set Scale, Unit, Acquisition, and Reference Position.

– **Autoscale** Automatically adjusts the Y-axis to comfortably fit the Minimum and Maximum amplitude of the trace on the screen. Also, optimizes the FieldFox's signal level at the mixer and adjusts the reference level to with the autoscale settings.

– **Scale/Div** Manually adjust the scale per division to view specific areas of the current trace. Enter a value using the numeric keypad, the ▲|▼ arrows, or the rotary knob. Then press **Enter**.

– **Ref Level** Manually set the value of the reference line. Enter a negative value by pressing **Run/Hold (+/-)** either before or after typing a value. Use acquisition in combination with the RF attenuator and the Preamp so that the signal at the acquisition is at the optimum level for the FieldFox (Spectrum and RF Envelope Only). This can also change the RF Attenuation setting (default: 0). See "Attenuation Control" on page 324.

– **Ref Pos** Manually set the position of the reference line. Values must be between 0 (TOP line) and 10 (BOTTOM line). Default position is zero (top) (default: 0, minimum: 0, maximum: 10).

– **More**, then

  – **Unit** Sets the display units.

Attenuation Control

Both the RF Attenuation and Preamp functions control the power level into the FieldFox mixer.

When too much power is present at the RF Input port, ADC Over Range appears on the FieldFox screen. This does not necessarily mean that damage has occurred, but that the receiver is probably compressed.

When high power levels are present at the RF Input port, internal attenuation can be switched in to keep the FieldFox receiver from compressing. At extremely high power levels, use external attenuation to protect the internal circuitry from being damaged.

CAUTION

The FieldFox can be damaged with too much power. Refer to the FieldFox Data Sheet for your model on https://www.keysight.com/us/en/assets/7018-06516/data-sheets/5992-3702.pdf.

RF Damage Level: +27 dBm

DC Damage Level: ±50 VDC

The displayed power level is automatically adjusted for RF Attenuation. As the attenuation value changes, the displayed power level should NOT change.

How to set Attenuation

– Press **Scale/Amptd**.

– Then **RF Atten Auto Man**.

– **Auto** RF Attenuation is set by adjusting the input power level. As the acquisition is lowered, for example from –10 dBm to –40 dBm, the FieldFox assumes that you are looking at low-level signals. The RF Attenuation value is automatically lowered in 5 dB steps to allow low-level signals to be viewed.

– **Man** RF Attenuation is set manually. The default Attenuation setting is 15 dB. Enter a value between 0 to 40 dB in 5 dB steps using the numeric keypad, the ▲|▼ arrows, or the rotary knob. Then press **Enter**

#Atten xx dB is shown at the top of the screen. (#) means manual setting.

(Default: 15 dB, minimum: 0 dB, maximum: 40 dB.)

Preamplifier Control (Opt 235)

When very low-level signals are analyzed, an internal preamplifier can be used to boost the signal level by approximately 18 to 22 dB. The gain of the preamp is NOT adjustable. The displayed signal level is automatically adjusted for the increase in system gain.

How to control the Preamp

By default, the preamp is OFF.

– Press **Scale/Amptd**.

– Then **More**

– Then **Preamp Off** The displayed setting is the current setting. When ON, PA is shown to the left of the graticules on the display (default: OFF). When OFF, nothing is displayed in the left graticules.

  When Auto is selected, the preamp setting is determined by the RF attenuation and to the input power level. When the input power level reaches a certain value, the preamp is turned on and PA is shown to the left of the graticules on the display.

Using Markers (IQA)

The markers described here are for I/Q Analyzer mode (exceptions are noted). For additional marker features, refer to "All about Markers" on page 797.

NOTE

IMPORTANT! When using I/Q markers, it is important to either be in Single acquisition mode or for Continuous acquisition mode, to set the measurement in advance on the FieldFox to Waveform or to Spectrum. Refer to "How to Make Measurements Using the I/Q Analyzer Mode" on page 307.

The spectrum measurement's six markers can only be applied to a single displayed set of traces (Magnitude Spectrum).

The waveform measurement's six markers can be applied to any of the six displayed parameter traces (RF Envelope, I (Imaginary), Q (Real), Phase, Unwrapped Phase, or Polar).
See also "Trace Display States (IQA Mode)" on page 331.

This section contains the following:

"Noise Marker" on page 326
"Band/Interval Power Marker" on page 327
"Band Span Marker (Spectrum Only)" on page 328
"Interval Span Marker (Waveform Only)" on page 328
"Coupled Markers (Waveform Only)" on page 328
"Continuous Peak Search Marker" on page 330

Noise Marker

For comparison purposes, electronic noise measurements are often displayed as though the measurement was made in a 1 Hz Res BW. However, making an actual measurement at a 1 Hz Res BW is extremely slow.

A Noise Marker mathematically calculates the noise measurement as though it were made using a 1 Hz bandwidth.

Several data points are averaged together to calculate the Noise Marker readout. To accurately measure noise, the Noise Marker should NOT be placed on, or too close to, a signal. The distance from a signal depends on several factors. To know if an accurate reading is being made, move the Noise Marker until consistent measurements are displayed in adjacent data points.

With a Noise Marker present, the Res BW can be changed and the displayed noise floor will also change, but the Noise Marker readout will remain about the same.

Noise Markers can be used like regular markers. A Noise Marker is distinguished from a regular marker by (**1Hz**) after the marker readout value. Learn more about regular markers in "All about Markers" on page 797.

How to measure Noise with a marker

- Press **Marker** to create or select a Normal or Delta marker to use to measure Noise.
- Then **More**.
- Then **Marker Function**
- Then **Noise**.

Band/Interval Power Marker

A Band/Interval Power marker—available in IQA and SA Modes—integrates the power that is measured over several adjacent data points. The range of points being measured is displayed with vertical posts around the marker. This Band Span value is selectable.

This feature is very similar to a channel power measurement (see SA chapter, "Channel Power (CHP)" on page 230).

When the IQA is set to a waveform measurement, the marker is referred to as an Interval Marker because it averages power over a specific time interval. In this case the range is specified as the Interval Span.

How to measure Band/Interval Power with a marker

- Press **Marker** to create or select a Normal or Delta marker to use to measure Band/Interval power.
- Then press **More**
- Then **Marker Function**
- Then **Band/Int Power**
- Then **Band Span** (Spectrum) or **Interval/Span** (Waveform)
- Then choose from the following:
  - **Auto** Measures power over 5% of the displayed span, or ½ graticule. The Band Span is automatically updated to remain at 5% when you change the frequency span.
  - **Man** Enter a frequency or time value using the ▲|▼ arrows or the rotary knob, then press **Enter**. Or enter a value using the numeric keypad and select a frequency or time suffix. The Band Span remains at the frequency or time value that you set as the span changes.

Band Span Marker (Spectrum Only)

Sets the width of the span (Hz) for the selected marker.

How to measure with the Band Span marker

- Press **Marker** to create or select a Normal or Delta marker to use to measure Band/Interval Power.
- Then press **More**
- Then **Marker Function**
- **Band Span** Enables or disables the Band Span marker (default: 500 kHz, minimum: 1 Hz, maximum: 10 MHz).

Interval Span Marker (Waveform Only)

Sets the width of the interval span (seconds) for the selected marker.

How to measure with the Interval Span marker

- Press **Marker** to create or select a Normal or Delta marker to use to measure Band/Interval power.
- Then press **More**
- Then **Marker Function**
- **Band/Int Power** Enables or disables the Band Interval Power marker (default: 5% of the (start time – stop time), minimum: 1 ns, maximum: 10s.

Coupled Markers (Waveform Only)

When a Coupled marker is enabled in a window on the FieldFox, the current active marker in that window is enabled as the 'reference' coupled marker on the current trace and the x-axis value of any other active waveform markers on any other traces in other windows are updated to track that of the 'reference' coupled marker. Refer to Figure 11-6 on page 329.

How to measure with the Coupled marker

- Press **Marker** to create or select a Normal, Delta, or Peak marker to use the Coupled Marker.
- Then **More**
- Then **Coupled Markers** Enables or disables the coupled marker (default: OFF).

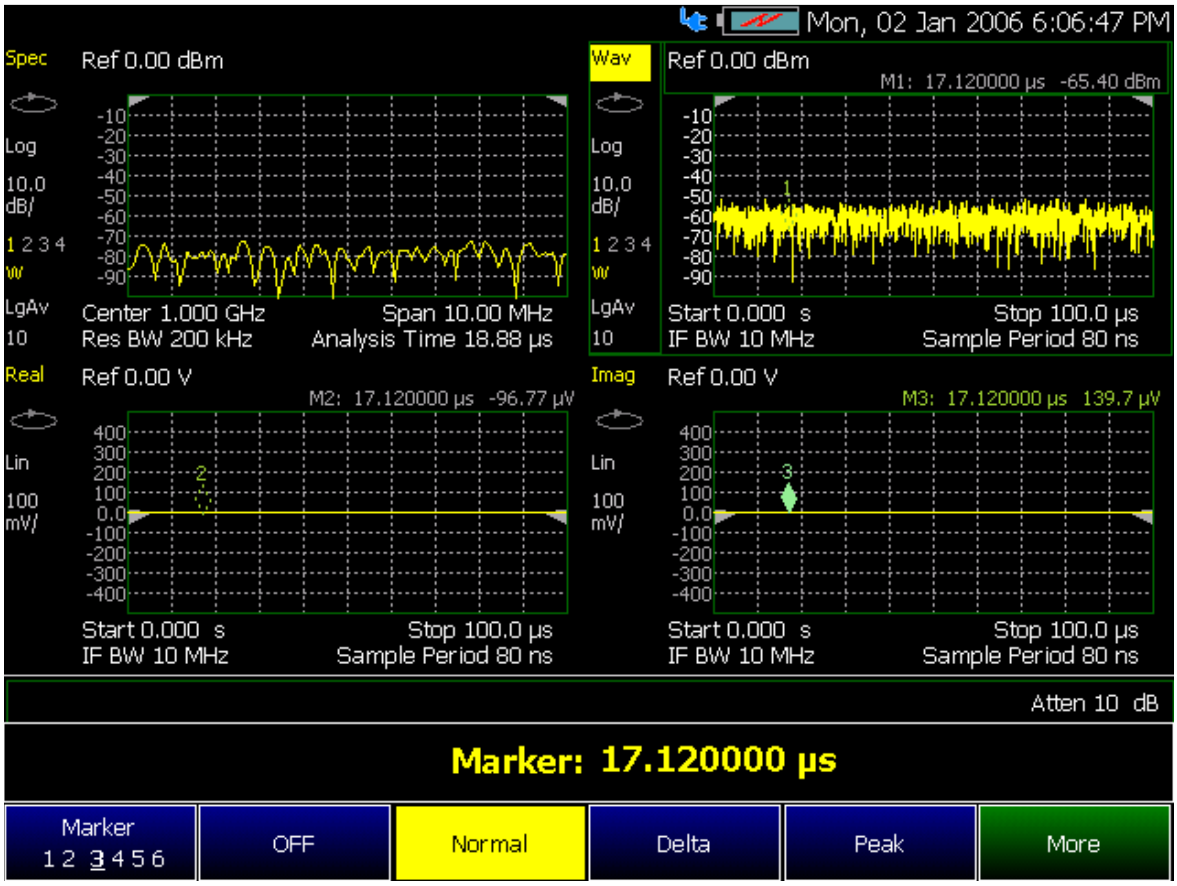
Procedure to set coupled markers (Refer to Figure 11-6 on page 329):

1. Press **Preset** > **Mode Preset (Factory)**
2. Press **Measure 1** > **User Defined**

Four windows are displayed (Spectrum, Waveform, Real, and Imaginary)

3. Using the ▲|▼ arrows or the rotary knob, move so Window 2 Waveform is selected (green border).
4. Press **Marker** > **Marker 1** > **Normal**
5. Press **Esc**
6. Repeat steps 3 through 5 while selecting the other measurement windows and markers:
   - Real using marker 2 and
   - Imaginary using marker 3
7. Press **Marker** > **More** > **Coupled Markers ON**
8. Press **Marker** and use the ▲|▼ arrows or the rotary knob to move the coupled markers along the traces in Window 2 (Waveform), Window 3 (Real), and Window 4 (Imaginary).

Figure 11-6 IQ Analyzer (IQA) Display - Coupled markers with Waveform (marker 1), Real (marker 2), and Imaginary (marker 3) displays



Continuous Peak Search Marker

When the Continuous Peak Search marker is on, a peak search is automatically performed for the selected marker after each acquisition. For additional marker functionality, refer to "All about Markers" on page 797.

Summary:

- **Cont Peak Search** Enables or disables the continuous peak search
- The rules for finding the peak are exactly the same as for Peak Search, including the use of peak criteria rules.

How to measure with the Continuous Peak Search marker

- Press **Mkr->/Tools** to create or select a Normal or Delta marker to use the Continuous Peak Search marker.
- Then press **More** (RF Spectrum Only)
- Then press **Mkr Properties**
- Then **Peak Criteria**
- Then **Cont Peak Search** Enables or disables the Continuous peak search marker (default: OFF).

Alignments

The IQA mode requires all three alignment types: amplitude, RF burst, and channel equalization. Refer to the SA chapter's "Alignments" on page 211 for information on all alignments.

Trace Display States (IQA Mode)

NOTE

If you have Option 351 I/Q Analyzer option, you can directly save your data as MATLAB files (*.mat). Refer to Chapter 11, "IQ Analyzer (IQA) – Option 351", on page 301 and to Chapter 34, "File Management", on page 887.

If you have the FieldFox's Remote Server mode (89600 VSA software connectivity), you can use the VSA software to capture and record your data as MATLAB files (*.mat). Learn more about FieldFox and 89600 VSA software, refer to Chapter 18, "Remote Server Mode (Requires SA Hardware/SA Option 233)" and to http://rfmw.em.keysight.com/wireless/helpfiles/89600B/WebHelp/89600.htm.

– In IQA Mode you can display up to four of the following types of trace states. All IQA settings are applied to all displayed traces. See also "Marker Trace (IQA and SA Mode)" on page 801.

A color-coded legend for displayed traces is visible in the left pane of the SA mode screen:

W = Clear/Write; **M** = MaxHold; **m** = MinHold; **A** = Average; **V** = View

How to display the Trace States

– Press **Trace 6**.

– Then **Trace 1,2,3,4** repeatedly to select a trace number to display or change its state. Traces are displayed in the following colors:

  – Trace 1 – **Yellow** Trace 2 – **Blue**

  – Trace 3 – **Orange** Trace 4 – **Green**

– Then **State [current setting]**

– Then choose from the following Trace States:

  – **Clr /Wr** (Clear/Write) Displays the actual measured data for each acquisition.

  – **MaxHold** Displays the maximum response of the input signal at each data point over multiple acquisitions. See also Average Count in "Adjusting the Measurement Setup Settings" on page 320.

– **MinHold** Displays the minimum response of the input signal at each data point over multiple acquisitions. See also Average Count in "Adjusting the Measurement Setup Settings" on page 320.

– **Average** Each data point is averaged over multiple acquisitions as set by the Average Count setting. Learn more in "Adjusting the Measurement Setup Settings" on page 320.

– **View** Displays and then holds the last complete measurement trace on the screen. This is similar to storing a trace in memory.

– **Blank** Displays no trace.

Other Features Available

- **External Gain** - Refer to refer to the SA chapter's section, "External Gain" on page 162.
- **Limit Lines** - For information on using Limit Lines, refer to "All about Limit Lines" on page 812.
- **Display Lines** - For information on using Limit Lines, refer to the SA chapter's section, "Display Line" on page 222.

12 Electromagnetic Interference (EMI) Measurements – Option 361

Requirements

- EMI mode measures signals at the **SA RF Input Port 2** connector.
- EMI mode requires the FieldFox to have SA mode (Option 233 on combination analyzers) installed.

Recommended, but not required:

- EMI chamber.
- Preamplifier (Option 235) to improve receiver sensitivity.
- Filters
- Line impedance stabilization network (LISN) – conducted emissions testing
- Transient limiter – conducted emissions testing
- Calibrated antenna – radiated emissions testing
- Signal generator (e.g., EXG, MXG)
- Set of antennas
- Set of near field probes (e.g., Keysight N9311X Series of antennas and field probes.)

EMI Option 361 measures radiated and conducted emissions. With EMI you can measure the unintentional generation, propagation, and reception of electromagnetic energy that might cause your device to violate pre-compliance/compliance testing. This includes the emissions and immunity (susceptibility) levels of electromagnetic energy.

In this Chapter

The following outline of this chapter is separated into two main sections:

– "EMI Measurements" and

– "Chapter Overview of EMI Measurements"

EMI Measurements

"Using EMI Measurements (Option 361)" on page 339

"EMI Measurements Mode Settings" on page 340

– "How to select EMI Measurements Mode" on page 340

– "Scale and Units" on page 342

– "CISPR (International Special Committee on Radio Interference) Control" on page 343

– "Resolution Bandwidth (Res BW)" on page 348

– "Single / Continuous / Restart" on page 349

– "Points" on page 350

– "Trace Display States (EMI Mode)" on page 350

– "Detection Method" on page 352

– "Input – (Trace Input for APD Measurements)" on page 353

"About Electromagnetic Interference (EMI) Measurements" on page 354

– "EMI Measurement Features (Option 361)" on page 354

"How to Set Up Electromagnetic Interference (EMI) Mode Settings" on page 356

– "EMI Measurement Mode Setup Procedure" on page 356

"Glossary (EMI)" on page 357

Chapter Overview of EMI Measurements

"Using EMI Measurements (Option 361)" on page 315 – see "EMI Measurements" on page 336

"EMI Measurements Mode Settings" on page 316 – see "EMI Measurements" on page 336

– "How to Select EMI Measurements Mode" on page 318 – see "EMI Measurements" on page 336

– "Frequency Range" on page 340

– "Scale and Units" on page 318 – see "EMI Measurements" on page 336

– "External Gain" on page 342

– "Attenuation Control" on page 343

– "CISPR (International Special Committee on Radio Interference) Control" on page 318 – see "EMI Measurements" on page 336

– "Preamplifier Control (Opt 235)" on page 348

– "Resolution Bandwidth (Res BW)" on page 323 – see "EMI Measurements"

– "Single / Continuous / Restart" on page 324 – see "EMI Measurements" on page 336

– "Points" on page 325 – see "EMI Measurements" on page 336

– "Trace Display States (EMI Mode)" on page 325 – see "EMI Measurements" on page 336

– "Trace Averaging" on page 351

– "Alignments" on page 352

– "Detection Method" on page 328 – see "EMI Measurements" on page 336

– "Input" on page 330 – see "EMI Measurements" on page 336

"About Electromagnetic Interference (EMI) Measurements" on page 332 – see "EMI Measurements" on page 336

– "EMI Measurement Features (Option 361)" on page 333 – see "EMI Measurements" on page 336

"How to Set Up Electromagnetic Interference (EMI) Mode Settings" on page 335 – see "EMI Measurements" on page 336

– "EMI Measurement Mode Setup Procedure" on page 335 – see "EMI Measurements" on page 336

"Glossary (EMI)" on page 337 – see "EMI Measurements" on page 336

Other Features Available – Refer to Chapter 9, "SA (Spectrum Analyzer) Mode (Option 233–Mixed Analyzers)" and Chapter 31, "Data Analysis Features":

– **Alignments (SA)** – "Alignments" on page 211
– **Attenuation Control (SA)** – "Attenuation Control" on page 163
– **External Gain (SA)** – "External Gain" on page 162
– **Field Strength Corrections (SA)** – "How to select and edit corrections for Field Strength measurements" on page 165
– **Preamp Control (SA)** – "Preamplifier Control (Opt 235)" on page 164
– **Source Tracking Offset and Offset Reversal (SA)** – "Source Tracking Offset and Offset Reversal" on page 171.
– **Independent Source/Tracking Generator (SA)** – "Independent Source/Tracking Generator " on page 188
– **Logarithmic X-axis Interpolation (EMI and SA modes Only)** – "Logarithmic X-axis Limit Line Interpolation (EMI and SA modes Only)" on page 225
– **Scale Settings (SA and Data Analysis)** – "Scale and Units" on page 161 and "All about Scale Settings" on page 831

Optional Settings:

"All about Markers" on page 797

"All about Limit Lines" on page 812

"Saving and Recalling Files" on page 888

See Also

"Why and When to Calibrate" on page 129

"Using the Antenna/Cable Editor" on page 167

Chapter 32, "System Settings." (Changing display colors)

Chapter 34, "File Management."

Using EMI Measurements (Option 361)

EMI enables you to do the following:

Measure and display emission signals to verify your device/instrument's pre-compliance performance	
Electromagnetic Interference Features (EMI) – (Option 361)	

– Amplitude Probability Distribution (APD) Statistics, both CCDF and Histogram
– Selectable CISPR bands (A, B, C, D, E)
– Fast SA Scan for quick setup check
– Frequency range coupled to CISPR bands
– Logarithmic frequency axis
– 200 Hz, 9 kHz, 120 kHz 6 dB resolution bandwidths, and 1 MHz impulse bandwidth, auto–coupled to CISPR bands
	– EMI Detector settings, selectable per trace
	  – Quasi-Peak
	  – EMI Average
	  – Positive Peak
	– Simple Color coded Trace/Detector pair controls

EMI Measurements Mode Settings

This section contains content unique to EMI measurements mode and some features that are similar to SA mode settings. Unique Option 361 EMI measurements content can be found in this chapter. But, when EMI/SA mode's shared feature content is referenced, you are referred to Chapter 9, "SA (Spectrum Analyzer) Mode (Option 233–Mixed Analyzers)."

How to select EMI Measurements Mode

– Press **Mode** > **EMI Measurements**

Learn more see, "CISPR (International Special Committee on Radio Interference) Control" on page 343.

NOTE

When you initially select EMI, I/Q Analyzer, Real-time SA, or some of the other spectrum settings (such as center frequency) a factory channel Equalization measurement is applied to the signal. During a channel equalization measurement, the FieldFox displays a "Start Channel Equalization". Stopping channel equalization is not permitted. See also, "Alignments" on page 211, in Chapter 9, "SA (Spectrum Analyzer) Mode (Option 233–Mixed Analyzers)."

Frequency Range

The X-axis frequency range determines the frequencies that are measured for each sweep. The default Start and stop frequencies are dependent on the CISPR band selected.

NOTE

Although the start frequency can be set as low as -100 MHz, amplitude accuracy is specified above 9 kHz (depending on your model). Below 9 kHz (depending on model), frequency accuracy is maintained, but amplitude accuracy is degraded. Refer to https://www.keysight.com/us/en/assets/7018-06516/data-sheets/5992-3702.pdf.

The frequency range of the measurement can be changed using the following methods:

– Set Center and Span frequencies (Frequency Span varies with instrument model)

– Set Start and Stop frequencies

– Using Marker > Center

How to set Frequency Range and Frequency Context

For EMI mode, you are able to change the center, frequency span, start, and stop frequencies or select a specific CISPR band. See also, "CISPR (International Special Committee on Radio Interference) Control" on page 343.

– Press **Freq/Dist**.

– Then choose from the following:

  – **Center** and **Freq Span** frequencies. This is the most common method of entering frequency range. Enter the frequency of interest. The Center frequency is at the exact center of the X-axis. The Frequency Span places half of the frequency range on either side of center. When the Center and Frequency Span values are entered, then the X-axis annotation on the screen shows the Center and Span frequencies.

NOTE

In the CISPR Band Scan measurement, the default span is the full range of the particular CISPR band selected. The Span can be changed, to examine part of the CISPR band in more detail, but the Span can never exceed the full width of the CISPR band, and never be less than the minimum span which CISPR Zoom Scan achieves. The Full Span button causes a CISPR Band Scan to return to the default full range of the particular CISPR band. Learn more, see "CISPR (International Special Committee on Radio Interference) Control" on page 343.

  – **Start** and **Stop** frequencies. Start is the beginning of the X-axis and Stop is the end of the X-axis. When the Start and Stop frequencies are entered, then the X-axis annotation on the screen shows the Start and Stop frequencies. **Start** and **Stop** are not active choices for **CISPR Zero Scan** (i.e., for **CISPR Band Scan** and **CISPR Zero Scan** ZSpan in the lower right of the display indicates you are at the span limit).

  – **Zero/Last Span** For EMI mode, which defaults to log sweep, this softkey toggles between log (FFT) – previous screen and start/stop frequencies and linear (Time) – in zero Span.

  – Optionally, press **More** then:

    ––**Freq Annotation** and one of the following:

      AutoSelect (Default) – The FieldFox selects a frequency annotation setting (Center Span or Start Stop).

      CenterSpan -The center frequency and span are displayed.

      StartStop - The start and stop frequencies of the frequency span are displayed.

——**Log Freq AxisX** enables/disables the log frequency X-axis. Disabling the log frequency X-axis, enables the linear frequency X-axis (Default = ON).

——**CF Step** then type a step size value using the numeric keypad, then select a frequency unit terminator key (Default = Auto).

——**Full Span** the frequency span changes the instrument's full frequency span (frequency span is model & Option dependent).

This softkey is inactive (grayed out), for **CISPR Zoom Scan** and **APD Statistics**, because RF tuning is fixed and Span changes are not allowed.

For CISPR Band Scan the Full Span varies based on the 6 dB resolution BW setting:

If the 6dB Resolution BW is auto-coupled, Full Span changes the span to match the Full CISPR Band you have selected. Learn more see, "How to Set the EMI Measurement Settings (Fast SA Scan, CISPR Band Scan, CISPR Zoom Scan, and APD Statistics)" on page 343.

If the 6 dB resolution BW is set to manual, Full Span changes the span to the maximum span limits described in the table in "Resolution Bandwidth (Res BW)" on page 348.

– Follow each of these, when prompted, by entering a value using the numeric keypad, the ▲|▼ arrows, or the rotary knob.

– When using the ▲|▼ arrows, press **Enter**. The increment setting of the arrows is based on the current span.

– After using the keypad, select a multiplier key. Learn more in Chapter 2, "Preparing for Initial Use of Your New FieldFox" and "Multiplier Abbreviations" on page 48.

Scale and Units

NOTE EMI Measurements mode defaults to Scale Type: Log.

Learn more, refer to "Scale and Units" on page 161.

External Gain

Learn more, refer to "External Gain" on page 162.

Attenuation Control

Learn more, refer to "Attenuation Control" on page 163.

CISPR (International Special Committee on Radio Interference) Control

This section describes the FieldFox EMI measurement mode's instrument controls for evaluating pre-compliance EMI of the equipment under test.

After EMI mode is selected or after a Mode Preset, the **Measure** menu is displayed. Two primary controls are available:

CISPR band and **Measurement** – there are 5 CISPR bands (A/ B/ C/ D/ E) which, when selected, automatically set the instrument to a CISPR defined frequency range and CISPR defined measurement bandwidth. Learn more, see "Resolution Bandwidth (Res BW)" on page 348.

For this section, refer to Figure 12-1 on page 345, Figure 12-2 on page 346, Figure 12-4 on page 347, and Figure 12-5 on page 347.

This section contains:

- "How to Set the EMI Measurement Settings (Fast SA Scan, CISPR Band Scan, CISPR Zoom Scan, and APD Statistics)" on page 343
- "How to set a CISPR Band" on page 345

Learn more, see "How to set the EMI Traces" on page 350.

How to Set the EMI Measurement Settings (Fast SA Scan, CISPR Band Scan, CISPR Zoom Scan, and APD Statistics)

Screen defaults to Log sweep, but you can toggle using **Freq/Dist > Zero/Last Span**. Learn more, see "Frequency Range" on page 340 and "How to set the EMI Traces" on page 350.

NOTE

Point quantities are not manually controllable within CISPR Band Scans or CISPR Zoom Scans. Rather, they are automatically derived from the bandwidths and Spans being used. CISPR Band E requires the most points to achieve the full band scan, but in all cases, total point quantity will not be allowed to exceed 75001. For manually coupled EMI Resolution BW, this hard limit on point quantity results in Span limitations (e.g., If the 9 kHz BW is used in CISPR band E, the hard point limit will cause the Span to be limited far short of the expected 17 GHz full range of CISPR band E).

NOTE

When selected, CISPR Band and Zoom Scan measurements use one of the 5 CISPR band frequency ranges to set the frequency range (Start and Stop) on the FieldFox. CISPR Zoom Scan selects a limited fix span (<entire band range). Learn more, see "Resolution Bandwidth (Res BW)" on page 348 and "How to set Frequency Range and Frequency Context" on page 341.

NOTE

Hint!

With any of the EMI measurement settings described in this section, you can toggle Zero Span and back (i.e., back to your previous measurement) using the "Zero / Last Span" softkey. Learn more, see "How to set Frequency Range and Frequency Context" on page 341.

– Press **Measure 1** > **Measurement [Fast SA Scan]** then choose:

  – **Fast SA Scan** – (Default) Sets the Fast SA Scan. Fast SA Scan applies peak detection and is used to do a quick verification of your EMI measurement setup check similar to a normal SA speed sweep. Pk annotation is displayed when enabled.

  – **CISPR Band Scan** – Sets the primary EMI measurement which: sweeps over the specified CISPR band frequency range, uses CISPR defined specific EMI 6 dB Resolution bandwidths ((200 Hz, 9 kHz, and 120 kHz), and 1 MHz impulse bandwidth), with 3 specific detectors (Positive Peak, EMI Average, or Quasi Peak) which can be independently set per Trace. Individual trace annotation is displayed for the three traces (P, Q, and A). See also, "How to set the EMI Traces" on page 350.

  – **CISPR Zoom Scan** – When set, behaves the same as CISPR Band Scan, except it represents the minimum Span setting, for any EMI resolution bandwidth selected, where the RF tuning can remain stationary (i.e., like Zero Span). While in CISPR Zoom Scan, you cannot change the Span, because it is meant to provide the fastest updates of the CISPR bandwidths and Detectors while targeting a specific RF frequency within the current CISPR band (i.e., A/B/C/D/E). Individual trace annotation is displayed for the three traces (P, Q, and A) and ZSpan is displayed in the lower right side of the display. See also, "How to set the EMI Traces" on page 350.

  – **APD Statistics** – Sets a measurement that evaluates pulses statistically. APD statistics is essentially a Zero Span measurement of the Center Frequency. APD statistics uses a specific APD 6 dB resolution bandwidth (APD Res BW) to measure the power level detected while creating a histogram of those power levels over the **APD Dwell Time**. Next APD Statistics uses that histogram data to create a set of values to define that probability that the signal power is above a certain level (CCDF == complementary cumulative density function). The graphical axis changes radically, to reveal that

probability (i.e., a fraction from 0 to 1.0) on the Y axis, vs. Power on the X axis. Markers adapt correspondingly. **Histogram** and **CCDF** become the **Input** choices per trace, replacing **Detector** on the **Trace** menu. APD annotation is displayed on the left side when enabled. See also, "Input – (Trace Input for APD Measurements)" on page 353 and "How to set the EMI Traces" on page 350.

How to set a CISPR Band

By default, the preamp is OFF.

– Press **Measure 1** > **CISPR Band** then choose:
  – **A – 9 kHz to 150 kHz**
  – **B – 150 kHz to 30 MHz**
  – **C – 30 MHz to 300 MHz** (Default)
  – **D – 300 MHz to 1 GHz**
  – **E – 1 GHz to 18 GHz**

Learn more, see "Resolution Bandwidth (Res BW)" on page 348.

Figure 12-1 CISPR Band C Example

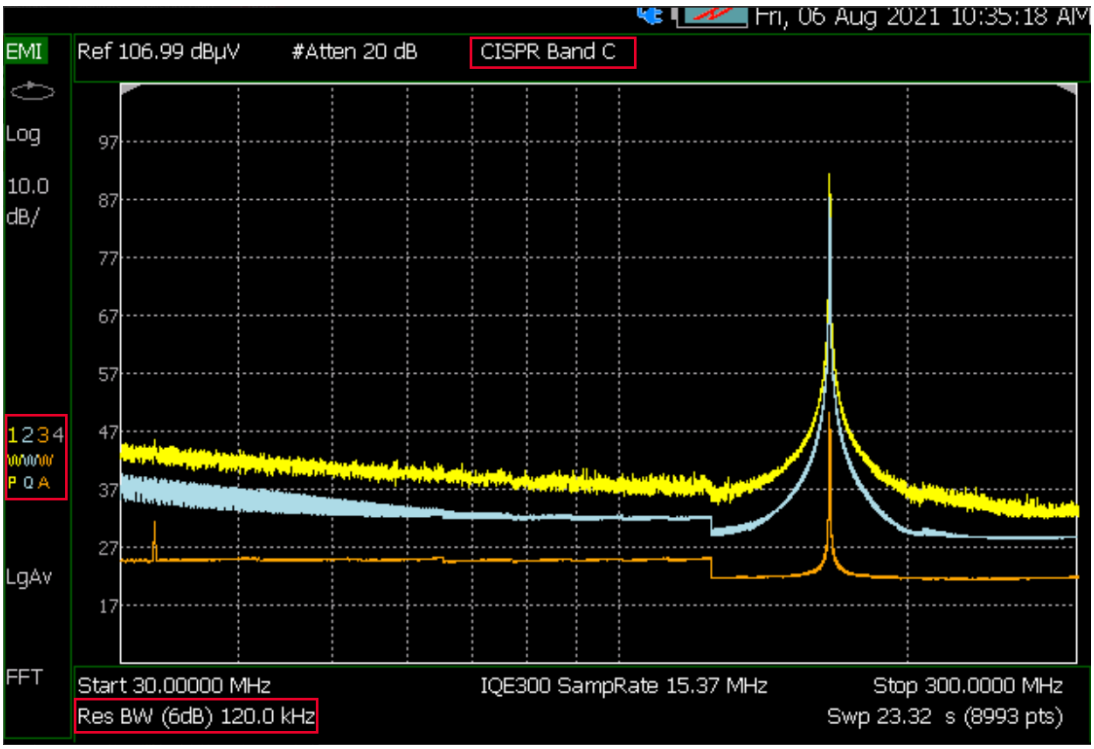


Figure 12-2 CISPR Band C Zoom Example 1 – Response to Pulse

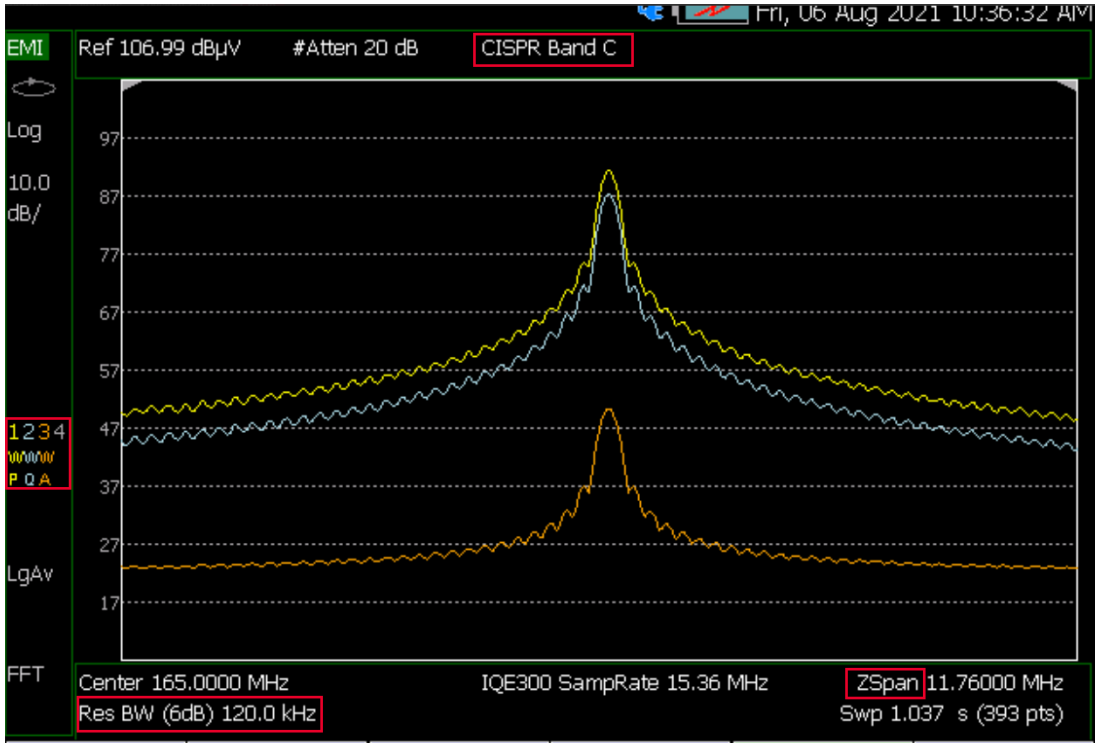


Figure 12-3 CISPR Band C Example 2 – Response to CW Signal

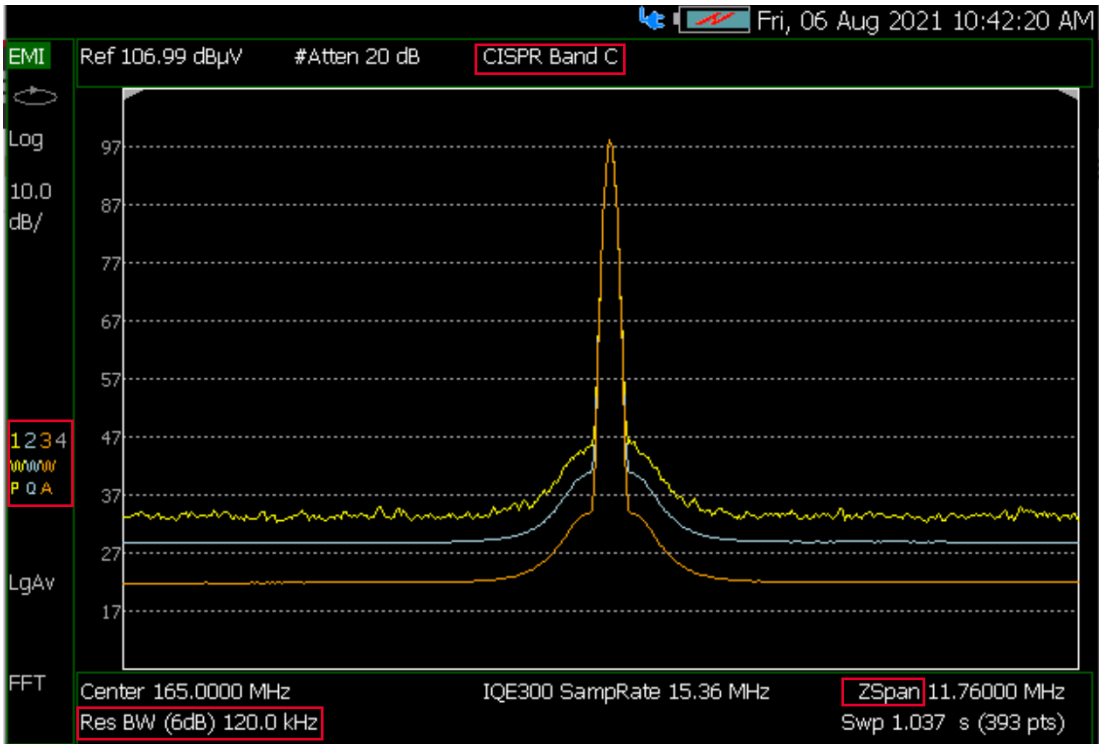


Figure 12-4 APD Statistics Example 1 – Pulse 5µS/1mS

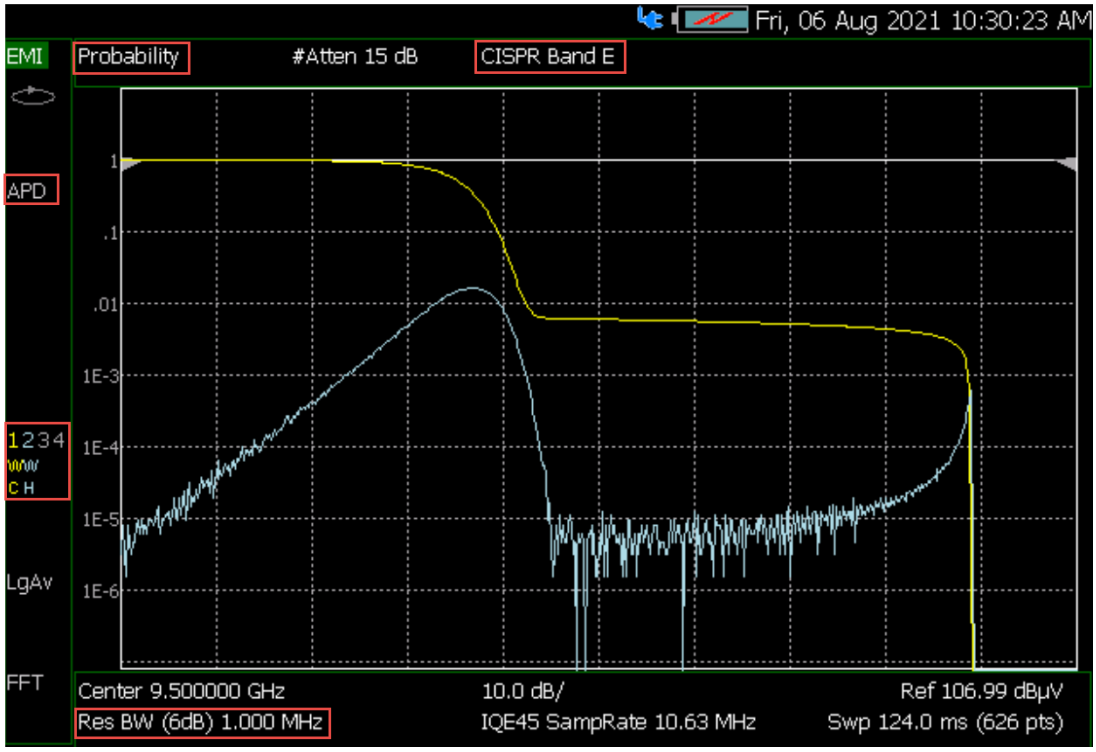


Figure 12-5 APD Statistics Example 2 – CW

Preamplifier Control (Opt 235)

Learn more, see Chapter 9 refer to "Preamplifier Control (Opt 235)" on page 164.

Resolution Bandwidth (Res BW)

EMI mode has a different resolution bandwidth type for each type of EMI measurement:

– **CISPR Band Scan**, **CISPR Zoom Scan**, and **APD Statistics** have of set values of 6 dB resolution bandwidths ((i.e., 200 Hz, 9 kHz, 120 kHz), and 1 MHz impulse bandwidth). "6 dB" is displayed in the Res BW value on the bottom left side of the display (e.g., Res BW (6 dB) 120 kHz).

CAUTION

The EMI Resolution bandwidth is auto-coupled to keep frequency range with the selected CISPR band. If the Start or Stop frequencies are changed, the FieldFox displays a reminder message about the CISPR band limits.

Example of CISPR messages: "CISPR band StartFreq limited to 30000000" and "CISPR band StopFreq limited to 300000000".

CISPR Band[a]	EMI 6 dB Resolution Bandwidth[d]	CISPR Band Scan Maximum Span Value[b,c]	CISPR Zoom Scan Minimum Span Value[d,e]
A – (9 kHz to 150 kHz)	200 Hz	3.735 MHz	19.6 kHz
B – (150 kHz to 30 MHz)	9 kHz	168.1 MHz	882 kHz
C – (30 MHz to 300 MHz)	120 kHz	2.243 GHz	11.76 MHz
D – (300 MHz to 1 GHz)	120 kHz	2.243 GHz	11.76 MHz
E – (1 GHz to 18 GHz)	1 MHz (impulse BW)	17.6 GHz	7.895 MHz

a. The maximum spans displayed in the CISPR Band table, are only achievable when one manually couples the resolution bandwidth (Res BW). Typically, the entire **CISPR Band** span (displayed in the first column) is used with auto-coupled resolution bandwidth (Res BW). The **CISPR Band Scan Maximum Span Values** (displayed in the third column) are actually the 75001 point limit applied to each resolution bandwidth (Res BW) when *manual coupling* (Manual) is used. When *manual coupling* (Manual) is used, you can go outside the selected CISPR Band.

b. The maximum number of points for a CISPR Band Scan is 75001 points.

c. The 75001 point limit is put in place, to keep the mode from trying to build traces that are any bigger than necessary. Basically, enough to cover CISPR Band E (1 GHz to 18 GHz) with its 1 MHz bandwidth, plus a little extra margin. This same point limit (75001) is applied to the other resolution bandwidths (Res BW), and also to the other **CISPR Band Scan Maximum Span Values** (displayed in the third column). There is no direct control permitted over the number of points used in the EMI scans. But, indirectly the SPAN and resolution bandwidth (Res BW) values, determine the number of points.
Exception: When using **Fast SA Scan** measurement (displayed in the fourth column), then you can control the number of points, similar to SA mode, where the point limit then becomes 20001.

d. The Zoom scan span limits are associated with the **EMI 6 dB Resolution Bandwidth**(s) (Res BW (6 dB)) that are (displayed in the second column). The auto-coupled bandwidth choices match those CISPR Bands (displayed in the first column), but you can also choose to *manual couple* (Manual) the bandwidth. When the bandwidth is set to *manual couple* (Manual), the Zoom scan span limit follows the resolution bandwidth (Res BW), **not** the CISPR band.
e. The Zoom scan span limits are actually the width of the FFT that is being used for the **EMI 6 dB Resolution Bandwidth** (minimum == 1 FFT, so the span is limited to 1 FFT width).

– But, when using **Fast SA Scan**, you have a standard 3 dB resolution bandwidth over the entire range of 1 Hz to 5 MHz.

Learn more, see Chapter 9 and then "Resolution Bandwidth (Res BW)" on page 193.

Single / Continuous / Restart

This setting determines whether the FieldFox measures continuously or only once each time the **Single** or **Run / Hold +/-** button is pressed. Use **Hold / Single** or to conserve battery power or to allow you to save or analyze a specific trace.

How to set Single or Continuous

– Press **Sweep 3**.

– Then choose one of the following:

– **Continuous**

––**ON** Causes the EMI to make continuous sweeps. This is the typical setting for making measurements. Each **Run / Hold +/-** press causes the SA to toggle between continuous sweep and Hold.

––**OFF** Causes the EMI to Hold. Each **Run / Hold +/-** or **Single** press causes the SA to make ONE sweep, then Hold. The Hold annotation changes to an arrow --> while the sweep occurs.

– **Single** Automatically sets Continuous OFF and causes the SA to make ONE sweep, then Hold.

– **Restart** Resets the Average counter to 1. The Average counter also is used with MaxHold and MinHold Trace States.

– **Dwell /Point** (Active when the CISPR Measurement type == **CISPR Band Scan** or **CISPR Zoom Scan**.) Specifies a settling time (in seconds) between sweeps.

– **SwpAcquisition** – (Active only for **Fast SA Scan**) Specifies a the number of sweep acquisitions. Press manual to enter a sweep acquisition value. (Default = Auto). Learn more, see Chapter 9 and then "Sweep Acquisition" on page 198.

– **APD Dwell Time** – (Active only when the CISPR Measurement type = **APD Statistics**.) Sets the time to acquire statistics each cycle, and Trace Points (control grayed out) are derived from the total Amplitude range displayed on the X axis.

Points

In the EMI measurements mode, the Points softkey is only active when the Measurement CISPR softkey is set to **Fast SA Scan**. Otherwise EMI mode automatically sets the points (Default = 401). Learn more, see Chapter 9 and then "Points " on page 208.

Trace Display States (EMI Mode)

NOTE

For EMI measurements mode, this section defines the four trace state choices for the Fast SA Scan and for CISPR Band Scan, CISPR Zoom Scan, and APD Statistics choices. Also, this section defines the 4th trace display state choices. Learn more, see "How to set the EMI Traces" on page 350.

The behavior of EMI mode is similar to SA mode. This section describes the softkeys that have similar, but also different behaviors than SA mode. Learn more, refer to Chapter 9, "SA (Spectrum Analyzer) Mode (Option 233–Mixed Analyzers).". See also "Marker Trace (IQA and SA Mode)" on page 801.

How to display the Trace States

– Press **Trace 6** > **Default All** is measurement specific and returns all traces to their default settings. For EMI mode the defaults are: Trace 1 (PosPeak T1), Trace 2 (QuasiPeak T2), Trace 3 (EMI Average T3); Trace 4 (Off, but defaults to Pos Peak).

How to set the EMI Traces

When the EMI measurement type is set to **CISPR Band Scan** or **CISPR Zoom Scan** Trace 1, Trace 2, Trace 3 have default values assigned. The trace can be disabled under the **Measure 1** (toggle to enable/disable) or the **Trace 6** hardkeys or re-assigned to measure a different value on the trace by using the **Trace 6** hardkey (e.g., you can re-assign trace 1 to measure Quasi-peak or EMI averaging). These detector choices are inactive when the EMI measurement type is set to, Fast SA Scan or APD Statistics. (i.e., APD statistics does not uses detection; it uses inputs. Refer to "Measure 1 Hardkey – EMI 'Convenience' Softkeys" on page 351 and "Input – (Trace Input for APD Measurements)" on page 353).

Learn more, see "How to Set the EMI Measurement Settings (Fast SA Scan, CISPR Band Scan, CISPR Zoom Scan, and APD Statistics)" on page 343.

NOTE

These softkeys are inactive when the EMI measurement choices are Fast SA Scan or APD Statistics. Learn more, see "Input – (Trace Input for APD Measurements)" on page 353.

Measure 1 Hardkey – EMI 'Convenience' Softkeys

NOTE

IMPORTANT!

When you press the **Measure 1** hardkey a softkey menu is displayed and has, as a convenience, fixed values for Trace 1 (PosPeak T1), Trace 2 (QuasiPeak T2), Trace 3 (EMIAverage T3) assigned. While the softkey labels cannot be re-assigned, the trace values can be changed manually under the **Traces 6** hardkey using the **Detector** softkey. Learn more, refer to "How to set Detection Method" on page 352.

– Press **Measure 1** then choose:

  – **PosPeak T1** – Enable/Disable trace 1 to display positive peak data and retains the peak value of a signal, indicating the worst-case summary data (Default = on). P annotation is displayed. This softkey is inactive, when APD Statics is ON.

  – **QuasiPeak T2** – Enable/Disable trace 2 to display quasi-Peak data that weighs each component based on its repetition rate: the faster repetition rate, the higher the weight given to that component (Default = on). Q annotation is displayed. This softkey is inactive, when APD Statics is ON and or CISPR Band E is selected.

  – **EMIAverage T3** – Enable/Disable trace 3 to display EMI average data displays the average amplitude of each signal component across its period (Default = on). A annotation is displayed. This softkey is inactive, when APD Statics is ON.

Trace Averaging

Within EMI mode, the detectors provide the critical necessary averaging (i.e., EMI Average and Quasi Peak), but similar to SA mode, if needed, you can perform Trace Averaging. Refer to "Average Type" on page 210 and "Average Count" on page 211 in Chapter 9, "SA (Spectrum Analyzer) Mode (Option 233–Mixed Analyzers)."

Alignments

EMI measurements mode uses amplitude alignment and channel equalization. Learn more, refer to the SA chapter's "Alignments" on page 211 for information on all alignments.

Detection Method

Using the EMI feature, can have one of three specific independent detection methods: **Fast SA Scan**, is similar to the original detection method used in SA mode that can use only one detector. **CISPR Band Scan** and **CISPR Zoom Scan** use a newer detection method that uses one detector per trace (e.g., up to three detectors and three traces simultaneously). Learn more, refer to "Trace Display States (EMI Mode)" on page 350.

APD Statistics uses trace inputs in lieu of detection. Learn more, refer to "Input – (Trace Input for APD Measurements)" on page 353.

How to set Detection Method

The current Detection method for each trace is labeled on the left edge of the screen. A corresponding letter appears below the corresponding Trace number selected. For example: **P** means that **Positive Peak** was the selected detector.

– Press **Trace 6** > **Detector**

– Then choose from the following:

The following softkeys are available when **CISPR Band** is set to **Fast SA Scan**:

– **Auto** Displays the most appropriate Detection method based on other settings. [**# is NOT shown**]

– **Normal** [**#Nrm** also referred to as Rosenfell] Provides a better visual display of random noise than **Positive peak** and avoids the missed-signal problem of the **Sample** Mode. Should the signal both rise and fall within the bucket interval, then the algorithm classifies the signal as noise. An odd-numbered data point displays the maximum value encountered during its bucket. An even-numbered data point displays the minimum value encountered during its bucket. If the signal is NOT classified as noise (does NOT rise and fall) then Normal is equivalent to Positive Peak.

– **Negative Peak** [**#NPk**] Displays the minimum value of all the measurements in each bucket.

– **Sample** [**#Smp**] Displays the center measurement of all the energy detected in each bucket. This setting gives a good representation of the random noise in each bucket. However, it does not ensure that all signals are represented.

– **Average** [**#RMS**] Displays the Root Mean Squared (RMS) average power of all the measurements in each bucket. This is the preferred method when making power measurements.

The following softkey is available for most **CISPR Band** choices, but **not** APD Statistics:

– **Positive Peak** [**P**] Displays the maximum value of all the measurements in each bucket. This setting ensures that no signal is missed. However, it is not a good representation of the random noise in each bucket.

The following softkeys are only available when the **CISPR Band** softkey is set to **CISPR Band Scan** scan or **CISPR Band Zoom Scan**.

– **Quasi Peak** [**Q**] Displays the quasi-peak response, as defined by CISPR 16.

– **EMI Average** [**A**] Displays the Root Mean Squared (RMS) average power of all the EMI measurements in each bucket. This is the preferred method when making power measurements.

Repeat the detection setup process as needed for up to 4 traces and 3 detection methods.

Input – (Trace Input for APD Measurements)

This softkey is active when **APD Statistics** is the selected CISPR Measurement. See also, "CISPR (International Special Committee on Radio Interference) Control" on page 343.

– Press **Trace 6** > **Input** – Selects the type of data type that is used to display the APD statistics trace based on the APD Dwell Time. Then choose:

– **CCDF** – A CCDF curve shows how much time the signal spends at or above a given power level. The power level is expressed in dB relative to the average power. The percentage of time a signal spends at or above each line defines the probability for that particular power level. A CCDF curve is a plot of relative power levels versus probability.

– **Histogram** – Displays the power levels detected over the APD Dwell Time.

About Electromagnetic Interference (EMI) Measurements

EMI mode enables you to make the following types measurements:

- Radiated – wireless EMI signals
- Conducted – emissions from wires or other conducted paths.

Some measurement parameters are auto-coupled and are not user-settable.

EMI Measurement Features (Option 361)

CAUTION

The EMI Resolution bandwidth is auto-coupled to keep frequency range with the selected CISPR band. If the Start or Stop frequencies are changed, the FieldFox displays a reminder message about the CISPR band limits.

Example of CISPR messages: "`CISPR band StartFreq limited to 30000000`" and "CISPR `band StopFreq limited to 300000000`".

NOTE

In the CISPR Band Scan measurement, the Span can be changed. (Exception: CISPR Zoom Scan cannot change the Span.) As the SPAN changes, the resultant trace point quantity also changes proportionally, since every FFT spectral sample measured undergoes detection by the FieldFox firmware and becomes part of the trace (Maximum points == 75001). Learn more, see "CISPR (International Special Committee on Radio Interference) Control" on page 343.

NOTE

When selected, CISPR Band and Zoom Scan measurements use one of the 5 CISPR band frequency ranges to set the frequency range (Start and Stop) on the FieldFox. CISPR Zoom Scan selects a limited fix span (<entire band range). Learn more, see "Resolution Bandwidth (Res BW)" on page 348 and "How to set Frequency Range and Frequency Context" on page 341.

NOTE

Hint!

With any of the EMI measurement settings described in this section, you can toggle Zero Span and back (i.e., back to your previous measurement) using the "Zero / Last Span" softkey. Learn more, see "How to set Frequency Range and Frequency Context" on page 341.

NOTE

For EMI measurements mode, this section defines the four trace state choices for the Fast SA Scan trace display states and for CISPR Band Scan, CISPR Zoom Scan, and APD Statistics choices, it defines the 4th trace display state choices. Learn more, see "How to set the EMI Traces" on page 350.

EMI has the following features:

EMI Measurement Results:

- Amplitude Probability Distribution Statistics (APD)
  - Histogram
  - CCDF traces displayed
- Center frequency (active with APD Statistics)
- Selectable CISPR Bands (A, B, C, D, or E)
  - Positive Peak trace (active with APD Statistics OFF)
  - Quasi-Peak trace (active with APD Statistics OFF)
  - EMI Average trace (active with APD Statistics OFF)
- 200 Hz, 9 kHz, 120 kHz 6 dB resolution bandwidths, and 1 MHz impulse bandwidth
- Frequency bands can be coupled to CISPR bands
- Logarithmic frequency axis

Refer to "EMI Measurement Mode Setup Procedure" on page 356.

How to Set Up Electromagnetic Interference (EMI) Mode Settings

NOTE

IMPORTANT! See also, "Alignments" on page 211, in SA mode, Chapter 9, "SA (Spectrum Analyzer) Mode (Option 233–Mixed Analyzers)."

This section reviews the steps in setting up an example EMI measurement. If you are not familiar with this process or would like more information, refer to "Using EMI Measurements (Option 361)" on page 339.

EMI Measurement Mode Setup Procedure

1. Selecting EMI Measurement mode:

   Press **Mode** > **More** (Depends on number of Options) > **EMI Measurements**

2. Setting the EMI Measurement type:

   For this example, press **Measure 1** > **Measurement** > **CISPR Band Scan**

   – The display updates to show three traces: PosPeak T1 (**P**), QuasiPeak T2 (**Q**), and EmiAverageT3 (**A**). Learn more, see "CISPR (International Special Committee on Radio Interference) Control" on page 343.

3. Setting the CISPR Band:

   For **CISPR Band Scan**, these traces become active and begin sweeping. Optional: for this example, press **PosPeak T1**, **QuasiPeak T2**, or **EmiAverage T3** to enable/disable each detector/trace. (default = all on.)

   Learn more, see "How to set the EMI Traces" on page 350.

4. Setting the EMI detectors for each trace:

   For this example, press **CISPR Band** > **C 30 – 300 MHz** (default).

CAUTION

The EMI Resolution bandwidth is auto-coupled to keep frequency range with the selected CISPR band. If the Start or Stop frequencies are changed, the FieldFox displays a reminder message about the CISPR band limits.

Example of CISPR messages: "`CISPR band StartFreq limited to 30000000`" and "`CISPR band StopFreq limited to 300000000`".

   Learn more, see "How to set a CISPR Band" on page 345.

5. Setting the Log Freq AxisX state for the displayed trace:

   For this example, press **Log Freq AxisX** > **ON** (default). Optional: Press to **OFF** to change display to linear view.

   Learn more, see "How to set Frequency Range and Frequency Context" on page 341.

6. Setting the EMI resolution bandwidth state for the displayed trace:

   For this example, press **EMI Res BW** > **Manual** (default = Auto). 120 kHz is displayed, but you can set other **fixed** resolution bandwidths (i.e., 200 Hz, 9 kHz, and 1 MHz).

   Learn more, see "Resolution Bandwidth (Res BW)" on page 348.

7. Setting the Dwell Time:

   For this example, press **Sweep 3** > **Dwell Time** >100 ms (default).

Glossary (EMI)

This section provides a description of some of the terms used in the FieldFox's EMI mode.

Table 12-1 EMI Abbreviations and Descriptions

Abbreviation	Description
APD Statistics	Amplitude Probability Distribution Statistics – Evaluates pulses statistically. Measurement done in zero span, at the specified center frequency, with a specific APD dB resolution bandwidth.
– CCDF	Complementary Cumulative Density Function – The probability of the signal power being above a certain level generated from the APD statistics' histogram results.
– Histogram	Results of the APD statistics measurement and the power levels detected over the APD specified dwell time used to generate a CCDF results.
CISPR	International Special Committee on Radio Interference

13 Over–the–Air Measurements (OTA) – LTE FDD Option 370, LTE TDD Option 371, 5G TF Option 377, 5G NR / 5G NR EVM Conducted Option 378

NOTE

Some examples in this chapter include the electromagnetic field (EMF) mode. EMF requires Option 358. See also, Chapter 9, "SA (Spectrum Analyzer) Mode (Option 233–Mixed Analyzers)" and Chapter 13, "Over–the–Air Measurements (OTA) – LTE FDD Option 370, LTE TDD Option 371, 5G TF Option 377, 5G NR / 5G NR EVM Conducted Option 378."

OTA mode measures signals at the **SA RF Input Port 2** connector.

OTA mode requires the FieldFox to have SA mode (Option 233 on combination analyzers), GPS (Option 307), and CPU2 installed.

5G NR requires 100 MHz wide path Option B10.

Recommended, but not required:

– Preamplifier (Option 235) to improve receiver sensitivity.

– EMF (Option 358) to measure the EMF levels of 5G signals.

With Options 370 (LTE FDD), LTE TDD (Option 371), 5G TF (Option 377), and 5G NR (Option 378) network designers can ensure that networks have enough resources to carry out handovers (re-selection) when users move between cell towers on the same 5G network as well as in between 5G and 4G networks (intra/inter-radio access technology).

The FieldFox OTA measurements support LTE FDD (Option 370), LTE TDD (Option 371), Verizon 5G TF (Option 377), and 5G NR (Option 378) over-the-air demodulation for single or multiple component carriers (CCs) and multiple cell towers for each CC. Additionally, 5G NR EVM Conducted provides EVM measurement capabilities for conducted signals. The FieldFox display can be configured to show data formats such as table, bar chart, spectrum and strip chart of key performance e indicators (KPI's).

By integrating over-the-air (OTA) measurements with cable and antenna test (CAT), full 2-port vector network analysis, spectrum analysis, and real-time spectrum analysis (RTSA), the FieldFox can be used for base station setup and verification.

In this Chapter

"Using OTA (Options 370 – LTE FDD, 372 – TDD, 377 – 5G TF, and Option 378 – 5G NR / 5G NR Conducted)" on page 362

"About Over–the–Air (OTA) Measurements" on page 364

– "LTE FDD and LTE TDD Features (Option 370 and Option 371)" on page 364

– "5G TF Features (Option 377)" on page 372

– "5G NR Features (Option 378)" on page 373

– "5G NR EVM Conducted Features (P/O: Option 378)" on page 376

"How to Set Up Over–the–Air (OTA) Mode Settings" on page 377

– "OTA Setup Procedure" on page 377

– "Optional: Using RTSA to verify the signal quality (Requires Option 350 and Preamp Option 235)" on page 395

– "How to Define a Cell or Cell(s) and Use OTA" on page 396

"How to Set Up EMF Mode Settings (Requires EMF (Option 358) and LTE FDD (Option 370), LTE TDD (Option 371), or 5G NR (Option 378))" on page 412

"How to Use Data Logging (OTA Options 370, 372, 377, and 378)" on page 420

– "Screen Annotation" on page 420

– "How to Record a Data Log Procedure" on page 421

– "To change Data Logging Configuration settings:" on page 422

– "How to Play a Data Log" on page 423

"Other Features Available" on page 424

– Alignments (SA chapter) – "Alignments" on page 211

– External Gain (SA chapter) – "External Gain" on page 162

"About the Auto-Range Feature" on page 425

"Troubleshooting" on page 429

"Glossary (OTA)" on page 430

See Also

"Why and When to Calibrate" on page 129

Chapter 32, "System Settings." (Changing display colors)

Chapter 34, "File Management."

Using OTA (Options 370 – LTE FDD, 372 – TDD, 377 – 5G TF, and Option 378 – 5G NR / 5G NR Conducted)

OTA enables you to do the following:

Measure and display one component carrier (CC) with multiple cells or multiple component carriers (CCs) with a single cell[ab]	
Four Display Types:	
– Bar chart (color coded based on the selected scheme CC | PCC | Level) – Table	– Strip Chart – Spectrum
Color Coded Display Types:	
– Specify high and low power with color bars	
Flexible Data Sorting:	
– LTE FDD: Sort Cells, component carriers (CCs), Frequency, RSRP, RSRQ, RSSI, PSS, SSS, and SINR scan results displayed by low to high, or high to low, or Auto (no order is involved) – LTE TDD: Sort Cells, component carriers (CCs), Frequency, RSRP, RSRQ, RSSI, PSS, SSS, and SINR scan results displayed by low to high, or high to low, or Auto (no order is involved) – 5G NR: Sort Cells, component carriers (CCs), Frequency, RSRP, RSRQ, RSSI, SINR, PSS, SSS, DMRS, Freq Error, SSB Index, and Time Offset (us) scan results displayed by low to high, or high to low, or Auto (no order is involved)	– 5G TF: Sort Carrier Info, PSS, SSS, Sync Correlation (%) scan results displayed by low to high, or high to low, or Auto (no order is involved) – 5G NR EVM Conducted: Sort Carrier Info RSRP, RSRQ, RSSI, PSS, SSS, PBCH, DMRS, Power, Sync Corr, Freq Error, Time Offset, PSS EVM, SSS EVM, PBCH EVM, DMRS EVM, Composite EVM scan results displayed by low to high, or high to low, or Auto (no order is involved) – All: Sort Carrier Info, PCI (aka Cell IDs), Power scan results displayed by low to high, or high to low, or Auto (no order is involved)
Data Logging GPS stamped data measurements	
– Define measurement interval by time or distance – Show results in Table or Bar Chart	– Display files (KML) on Google Maps or Google Earth
New Radio Features (Option 378)	

Over–the–Air Measurements (OTA) – LTE FDD Option 370, LTE TDD Option 371, 5G TF Option 377, 5G NR / 5G NR EVM Conducted Option 378
Using OTA (Options 370 – LTE FDD, 372 – TDD, 377 – 5G TF, and Option 378 – 5G NR / 5G NR Conducted)

- FR1 (410 MHz to 7.125 GHz) and
- FR2 (24.25 GHz to 5.26 GHz[c])
- EMF measurements (Requires Option 358)
- EVM synchronization signal measurements
- Single acquisition multiple simultaneous measurements
  - Measure CC, Cell IDs, and KPI's for multiple cells
  - SSB Beam index

a. When multiple component carriers are selected, the results of the component carrier (CC) with the highest power is displayed.
b. LTE FDD, LTE TDD, and 5G NR can measure and display multiple cells. 5G TF and 5G NR EVM Conducted only have the ability to measure and display a single cell.
c. With frequency extension via OML downconverter. Refer to Chapter 32, "System Settings." and then "Utilities" on page 842.

About Over–the–Air (OTA) Measurements

OTA mode supports these standards:

- LTE FDD
- LTE TDD
- 5G TF measurements
- 5G NR
- 5G NR EVM Conducted

Some measurement parameters are auto-coupled and are not user-settable.

LTE FDD and LTE TDD Features (Option 370 and Option 371)

NOTE

IMPORTANT! LTE FDD, LTE TDD, and 5G TF only demodulate PSS and SSS signals using the FieldFox's demodulation path. User data channels are **not** demodulated.

LTE FDD and LTE TDD have the following features:

NOTE

IMPORTANT! LTE FDD and LTE TDD generally have similar cell features, but the Band and Channel choices are different for the Channel Table settings.

Cell Scan Results:

- Center frequency
- Physical Cell Indentifier (PCI) – (Cell ID–Sector ID–Group ID) – (C/S/G)
- RSRP (Reference Signal Received Power) (dBm)
- RSRQ (Reference Signal Received Quality) (dB)
- RSSI (Received Signal Strength Indicator) (dBm)
- PSS (Primary Synchronization Signal) (dBm)
- SSS (Secondary Synchronization Signal) (dBm)
- SINR (Signal to Interference & Noise Ratio) (dB)
- Frequency error (Hz)

Refer to step 11 in the "OTA Setup Procedure" on page 377.

Display Types:

User can set up and display 1, 2, 3 or 4 simultaneous measurements of key performance indicators (KPI's) for any component carrier (CC0 through CC4), up to 5 carriers, in any combination of the following:

– Table – Cell scan numeric results, including PCI, RSRP, RSRQ, RSSI, PSS, SSS, SINR and Freq Err, for up to 5 CCs or 6 cells

– Bar Chart – Vertical power bar graph of selectable cell scan result metric with adjustable color “heat” amplitude scale, for up to 5 CCs or 6 cells. And, color coded based on the selected scheme (i.e., CC, PCC, and Level). Refer to Figure 13-2 on page 366, Figure 13-3 on page 366, and Figure 13-4 on page 367.

– Spectrum – Magnitude frequency spectrum (fixed span) for a selected CC

– Strip Chart – Magnitude of selectable cell scan result metric graphed over time, for up to 5 CCs or 6 cells

Figure 13-1 Example of the LTE FDD with Four Multiple Display Options – (LTE TDD is similar)

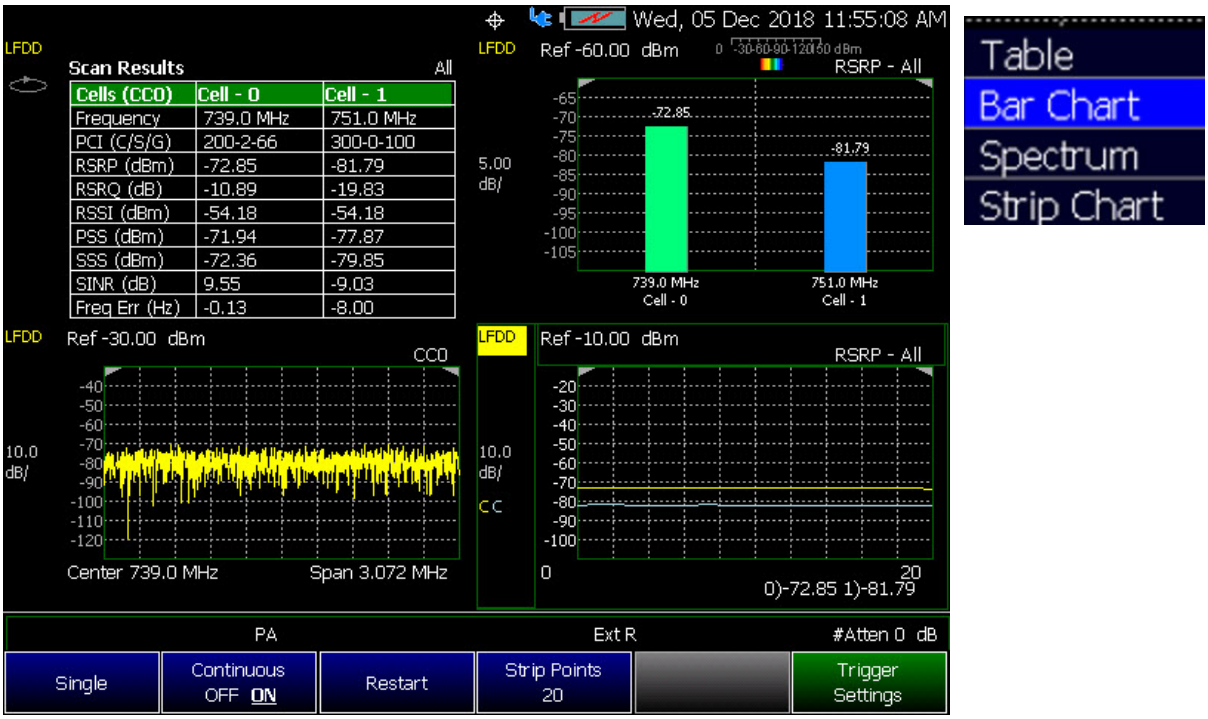


Figure 13-2 LTE FDD Bar Chart – CC Example

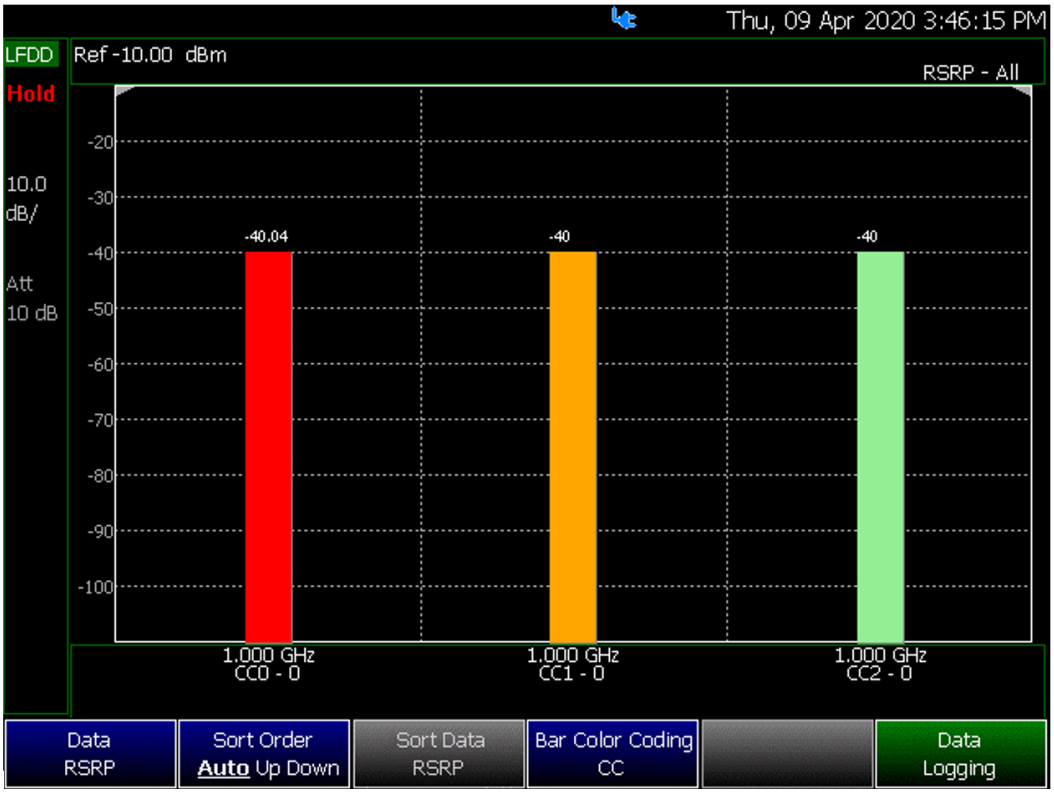


Figure 13-3 LTE FDD Bar Chart – PCC Example

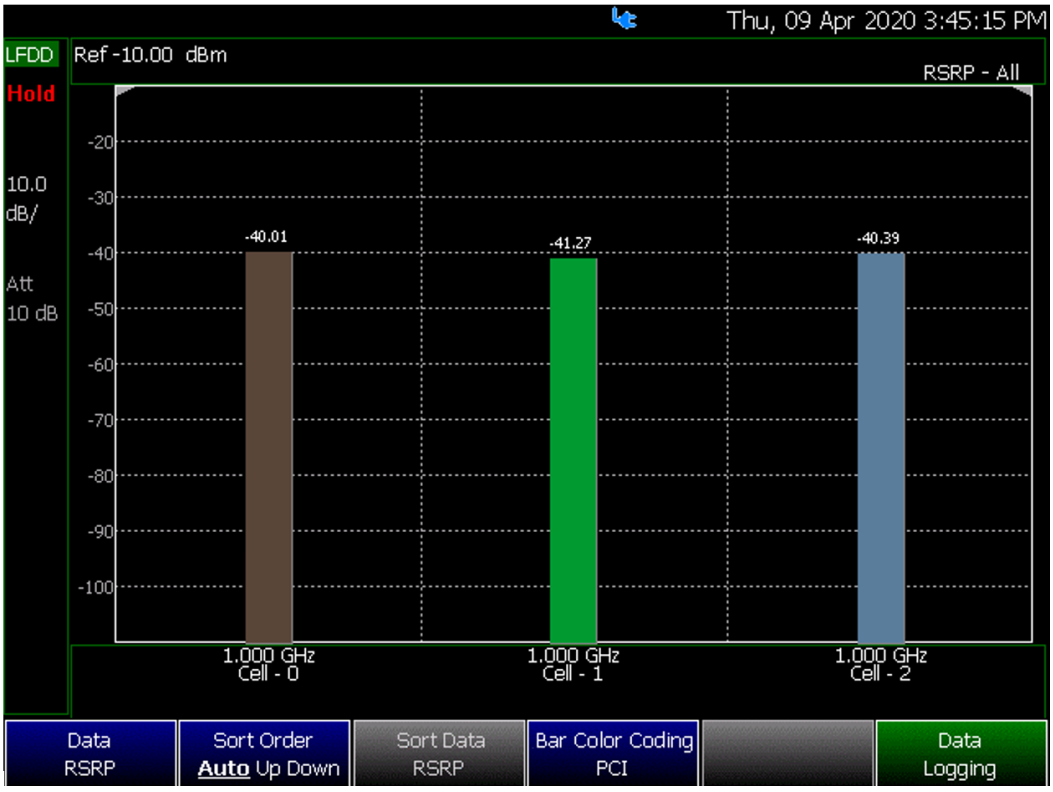


Figure 13-4 LTE FDD Bar Chart – Level Example

Figure 13-5 Example of the 5G TF with Four Multiple Display Options

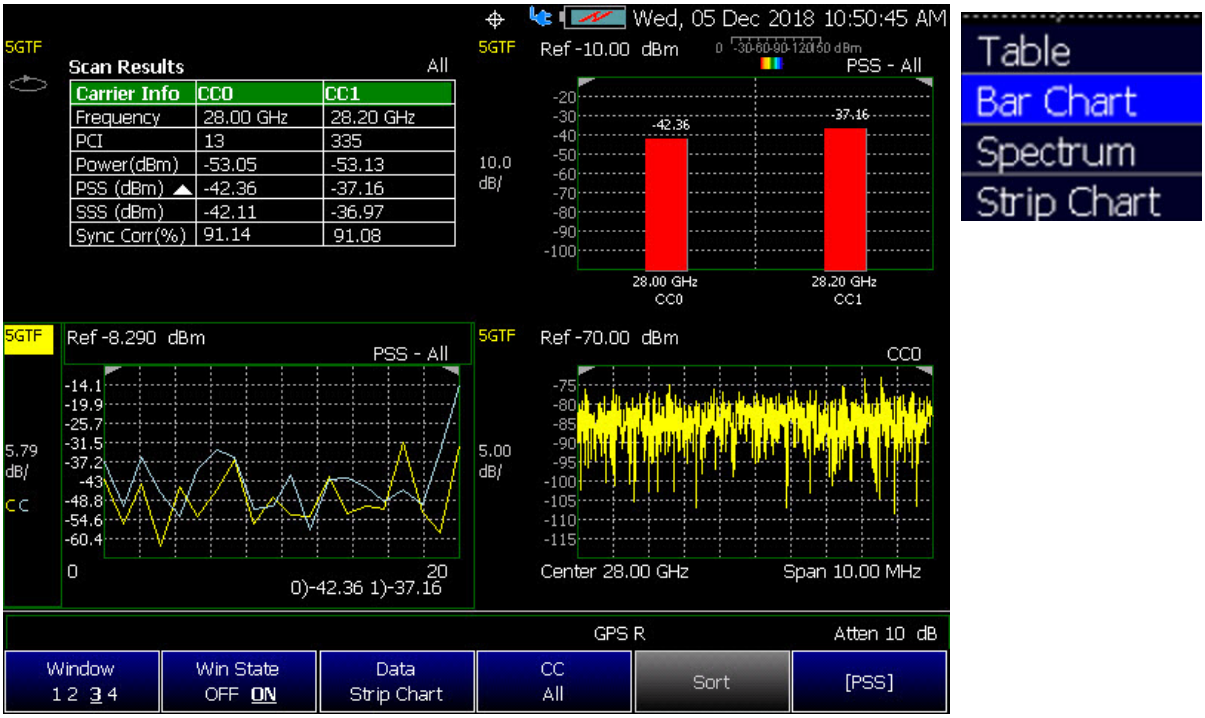


Figure 13-6 Spectral Emission Mask Example

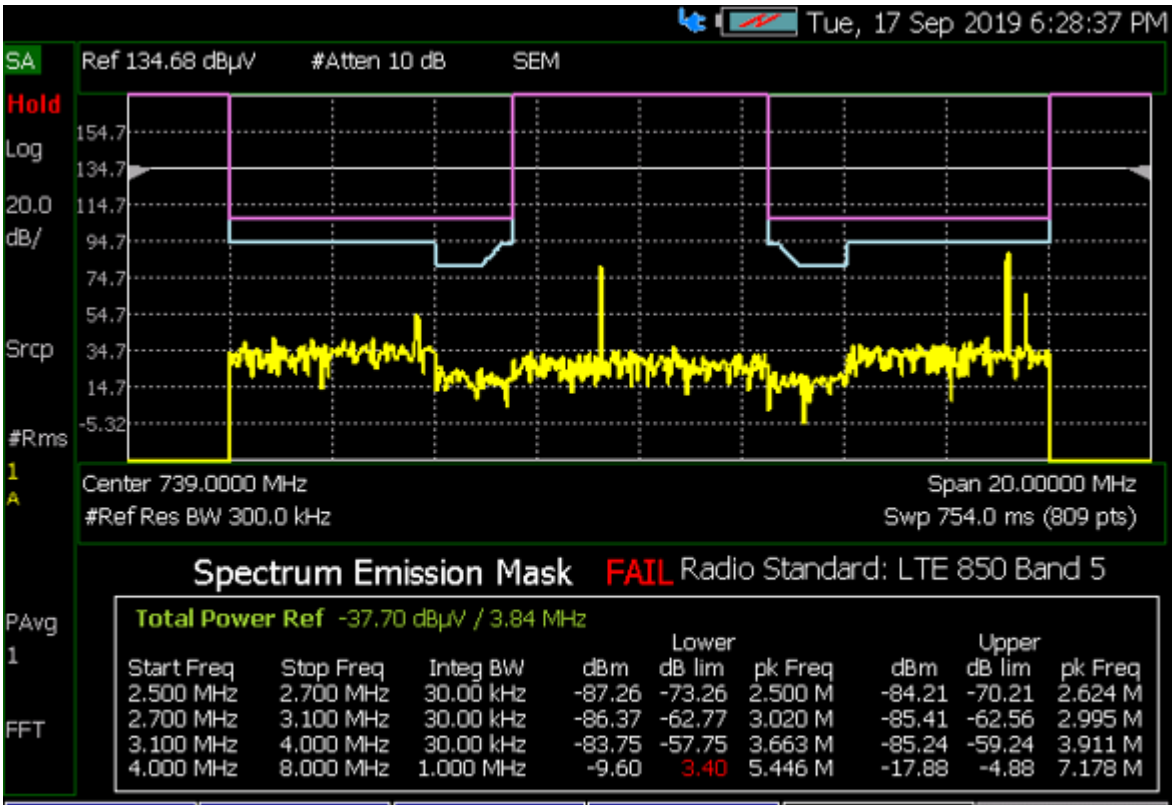


Figure 13-7 SSB Index Example

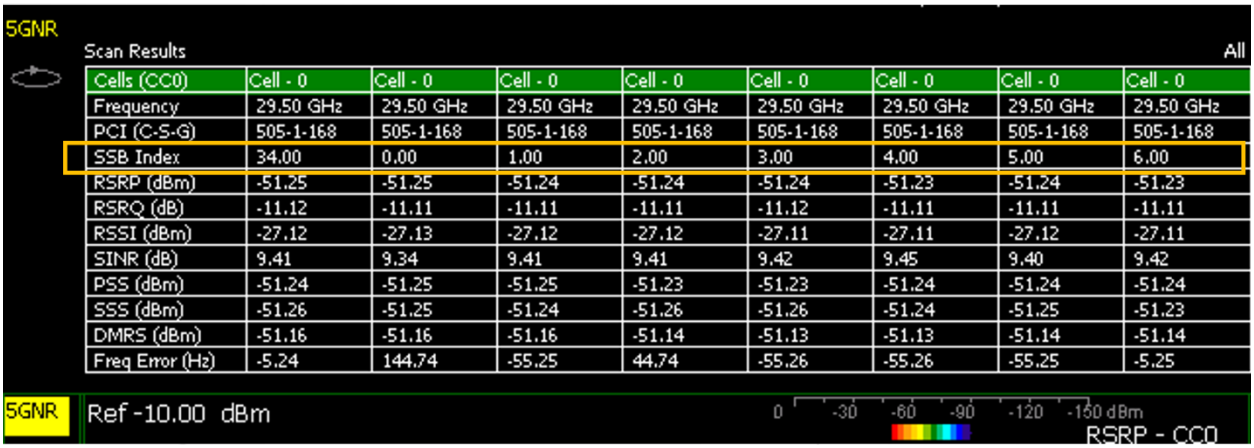


Figure 13-8 5G NR Center Frequency and SSB Offset, Before Multiple Cell IDs Example

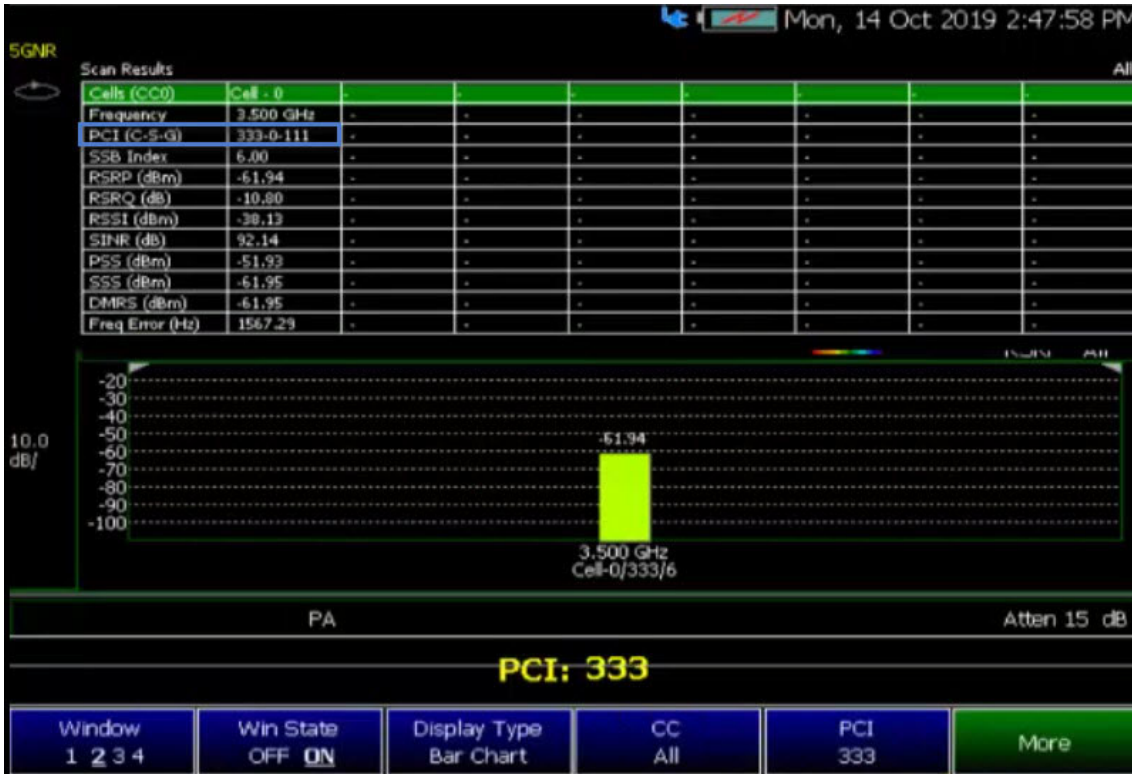


Figure 13-9 5G NR Center Frequency and SSB Offset and SSB Index and PCI Single With Multiple Cell IDs Example

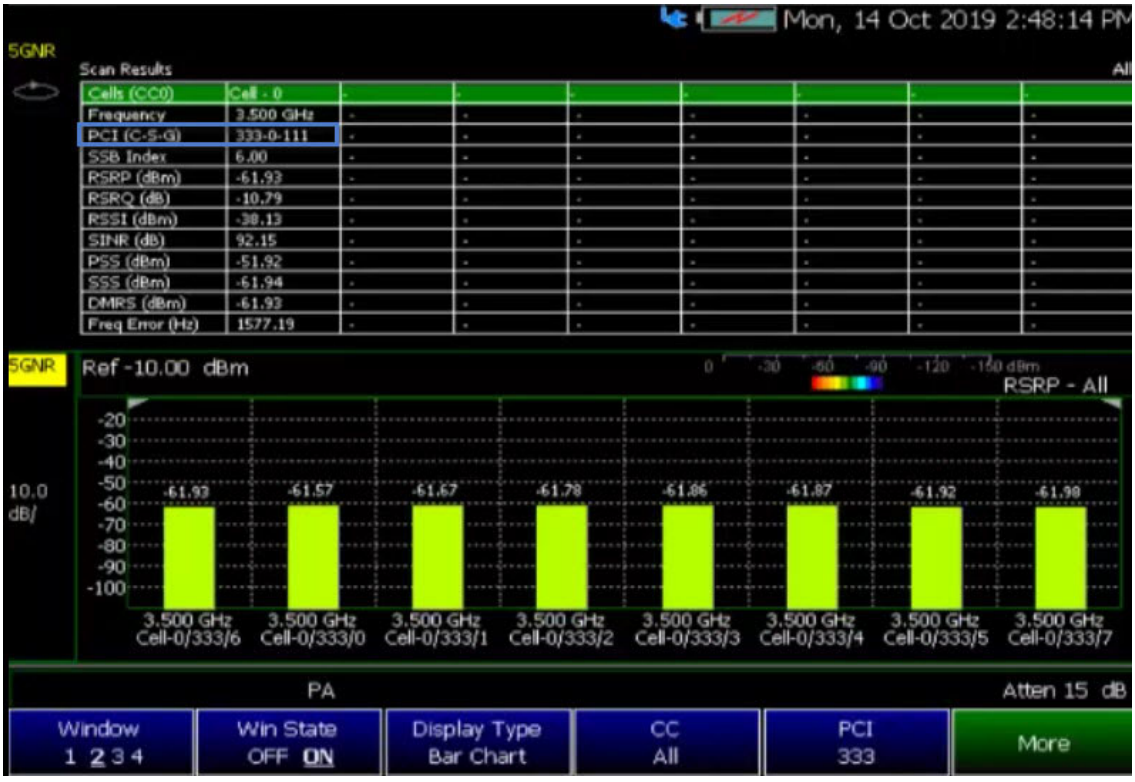
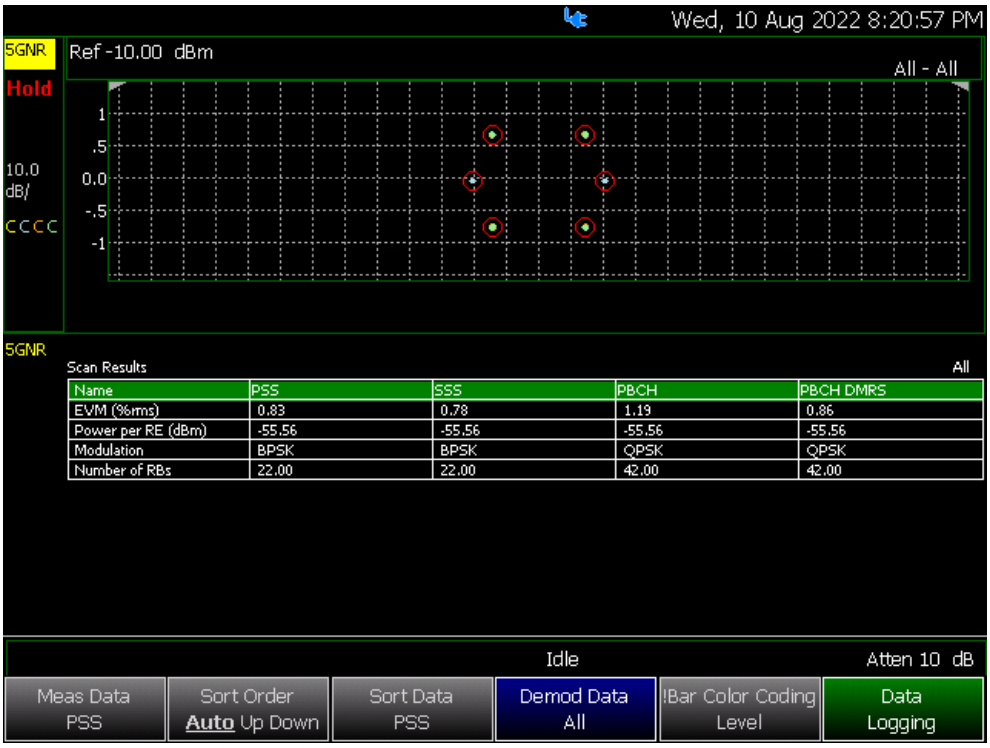


Figure 13-10 5G NR EVM Constellation Example – Measure Data set to All

Figure 13-11 5G NR EVM Constellation Example – Measure Data set to PBCH

Figure 13-12 5G NR EVM Frame Summary Example

Figure 13-13 5G NR EVM – Constellation and Frame Summary Example



5G TF Features (Option 377)

NOTE

IMPORTANT! LTE FDD, LTE TDD, and 5G TF only demodulate PSS and SSS signals using the FieldFox's demodulation path. User data channels are **not** demodulated.

5G TF has the following features:

Cell Scan Results:

- Center frequency
- Physical Cell Information (PCI) – (Cell ID)
- Power (Channel Power) (dBm)
- PSS (Primary Synchronization Signal) (dBm)
- SSS (Secondary Synchronization Signal) (dBm)
- Sync correlation (%)

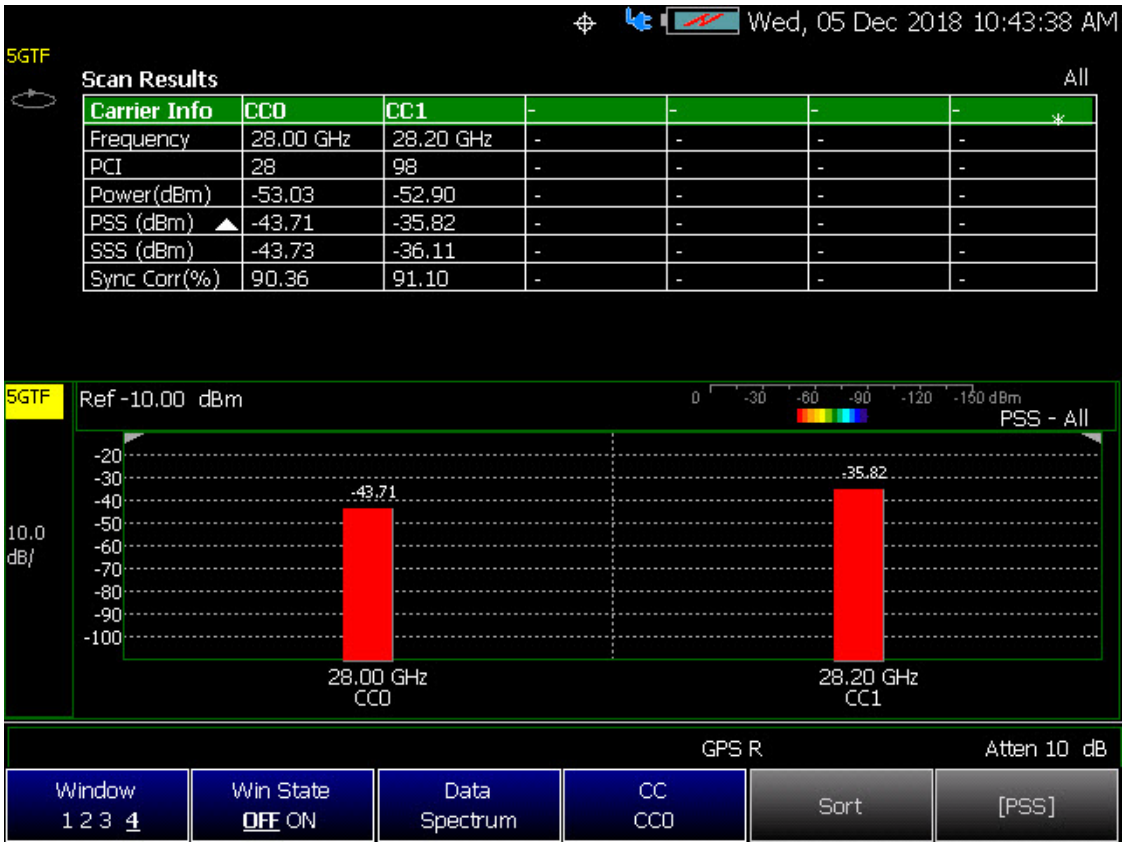
Refer to step 11 in the "OTA Setup Procedure" on page 377.

Data Formats:

User can set up and display 1, 2, 3 or 4 simultaneous measurements of key performance indicators (KPI's) for any component carrier (CC0 through CC7), up to 8 carriers, in any combination of the following:

- Table – Cell scan numeric results (for up to 6 cell sites (ID's) including Cell ID, Channel Power, PSS, SSS, Sync Corr
- Bar Chart – Vertical power bar graph of selectable cell scan result metric for up to 8 cell sites with adjustable color "heat" amplitude scale. And, color coded based on the selected scheme (i.e., CC, PCC, and Level). See also, Figure 13-2 on page 366, Figure 13-3 on page 366, and Figure 13-4 on page 367.
- Spectrum – Magnitude spectrum frequency domain (fixed span). You can only view a single component carrier at a time with Spectrum (e.g., CC0 or CC2, etcetera).
- Strip Chart – Magnitude of selectable cell scan result metric graphed over time

Figure 13-14 Example of 5G TF Single Carrier and Single Cell



5G NR Features (Option 378)

NOTE

IMPORTANT! 5G NR only demodulates PSS, SSS and PBCH DMRS signals using the FieldFox's 100 MHz demodulation path. User data channels are not demodulated.

5G NR has the following features:

Refer to step 11 and “**5G NR**:” on page 385. See also, “5G NR EVM Conducted Features (P/O: Option 378)” on page 376.

Cell Scan Results:

- Center frequency
- PCI (Physical Cell Identifier) – (Cell ID-Sector ID-Group ID) – (C-S-G)
- SSB (Synchronization Signal Block) Index
- RSRP (Reference Signal Received Power) (dBm)
- RSRQ (Reference Signal Received Quality) (dB)

- RSSI (Received Signal Strength Indicator) (dBm)
- SINR (Signal to Interference & Noise Ratio) (dB)
- PSS (Primary Synchronization Signal) (dBm)
- SSS (Secondary Synchronization Signal) (dBm)
- DMRS (Physical Broadcast Channel Demodulation Reference Signal) (dBm)
- Frequency error (Hz)
- Time Offset (us) – Not shown in the 5G NR figures, but is part of the **Carrier Info** scan results.

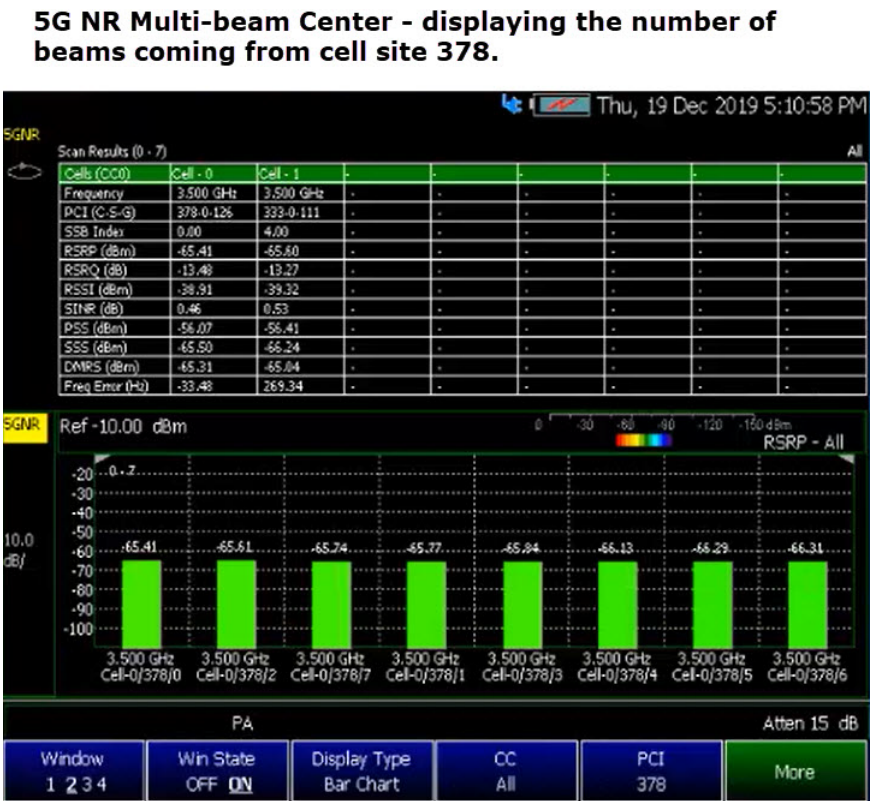
Display Types:

User can set up and display 1, 2, 3 or 4 simultaneous measurements of key performance indicators (KPI's) for any component carrier (CC0 through CC7), up to 8 carriers, in any combination of the following:

- Table – Cell scan numeric results, including PCI, RSRP, RSRQ, RSSI, PSS, SSS, SINR and Freq Err, for up to 8 CCs and 6 cells for each CC
- Bar Chart – Vertical power bar graph of selectable cell scan result metric with adjustable color “heat” amplitude scale, for up to 8 CCs and 6 cells for each CC. And, color coded based on the selected scheme (i.e., CC, PCC, and Level). See also, Figure 13-2 on page 366, Figure 13-3 on page 366, and Figure 13-4 on page 367.
- Spectrum – Magnitude frequency spectrum (fixed span) for a selected CC
- Strip Chart – Magnitude of selectable cell scan result metric graphed over time, for up to 8 CCs and 6 cells for each CC

Figure 13-15 Example of 5G NR Single Carrier and Single Cell

Figure 13-16 Example of 5G NR Multi-Beam – Displaying Multiple Beams From Cell Site 378



5G NR EVM Conducted Features (P/O: Option 378)

NOTE

IMPORTANT! 5G NR only demodulates PSS, SSS, PBCH and PBCH DMRS signals using the FieldFox's 100 MHz demodulation path. User data channels are not demodulated.

FieldFox EVM Measurements

5G NR EVM Conducted can make EVM measurements of 5G NR signal synchronization channels. Refer to step 11, and **"5G NR EVM Conducted NR:" on page 386**, in section "OTA Setup Procedure" on page 377.

The FieldFox's 5G NR EVM Conducted measurements are similar to the X-Series Multi-touch Signal Analyzers. For more on making FieldFox EVM-related measurements with the X-Series Multi-touch Signal Analyzers, refer to http://rfmw.em.keysight.com/wireless/helpfiles/5GNRMode/FlexUI.htm and then http://rfmw.em.keysight.com/wireless/helpfiles/5GNRMode/FlexUI.htm#meas_5gnr_evm/Modulation Analysis.htm content.

The FieldFox can make more comprehensive EVM measurements with the 89600 VSA software using the FieldFox's Remote Server feature. See the Chapter 18, "Remote Server Mode (Requires SA Hardware/SA Option 233)."

NOTE

The FieldFox 5G NR EVM Conducted (p/o Option 378) does not have all of the features of a X-Series Multi-touch Signal Analyzers.

How to Set Up Over–the–Air (OTA) Mode Settings

NOTE

IMPORTANT! See also, “Alignments” on page 211, in NA mode, Chapter 9, “SA (Spectrum Analyzer) Mode (Option 233–Mixed Analyzers).”.

The FieldFox can be used with an OML frequency extender. Refer to “Utilities” on page 842, the B Series FieldFox Configuration Guide 5992-3701EN, and to “Contacting Keysight” on page 5.

This section reviews the steps in setting up an OTA measurement. If you are not familiar with this process or would like more information, refer to “How to Define a Cell or Cell(s) and Use OTA”

This section consists of:

- “OTA Setup Procedure”
- “Optional: Using RTSA to verify the signal quality (Requires Option 350 and Preamp Option 235)”

OTA Setup Procedure

1. Modifying the Frequency Reference and GPS settings:

   Press **System**

   - Then **System Configuration** > **GNSS (GPS+)** > **GNSS Receiver** > **Internal** > **Esc**
     - The left portion of the screen displays satellites and the corresponding number on the adjacent Satellite Power chart.
     - The right portion of the screen displays Satellite Power Carrier to Noise (C/No) dBHz values on the tops of the satellite power chart.
   - Then **System** > **System Configuration** > **Frequency Ref** > **Freq Ref Source [GPS]** > **Back**

NOTE

IMPORTANT! It is **not** sufficient to be locked to the GNSS satellite, the frequency reference must be locked to GPS.

For more information:

- Refer to Figure 13-18 called, “Example of the LTE FDD Scan Results Table (Five CCs and one cell) – LTE TDD is similar,” on page 391.
- And, refer to Figure 13-19 called, “Example of the 5G TF Scan Results Table (Two cc and one cell),” on page 392.
- And, refer to Figure 13-16 called, “Example of 5G NR Multi-Beam – Displaying Multiple Beams From Cell Site 378,” on page 375.

– See also “GNSS (GPS+) and GPS” on page 865.

2. Selecting OTA mode:
   - Press **Mode** .
   - Then **More** (may not be available—number of installed options dependent)
   - Then **OTA**.
3. Selecting an OTA format:

   Press **Measure** – (When you initially select OTA mode, the FieldFox defaults to the Measure menu.)
   - The Measure menu is used to select an OTA format (e.g., Option 370 LTE FDD, Option 371 LTE TDD, Option 377 5G TF, etcetera):

     (Available modes are Option dependent.)
     - **LTE FDD** (Default) or
     - **LTE TDD**
     - **5G TF**
     - **5G NR**
     - **5G NR EVM Conducted**

       The OTA format chosen begins scanning for signals. Additional FieldFox setting changes are required for OTA to display the available signals. Refer to the steps below and see also, “How to Define a Cell or Cell(s) and Use OTA” on page 396.
4. Define some carrier and cell measurement information. See also, “How to Define a Cell or Cell(s) and Use OTA”.

   Then modify the carrier and cells based on the selected OTA technology (i.e., LTE FDD, LTE TDD, 5G TF, and 5G NR /5G NR EVM Conducted).

NOTE

If after making the setting changes in the steps below, no data is displayed, refer to “Troubleshooting” on page 429.

Display does not update (refresh), until all active component carriers (CCs) have been scanned.

5. Press **Freq/Dist**
   - Then **CC CC0** (Default == CC0) – Selects the CC number to be displayed (LTE FDD/LTE TDD choices: CC0-CC4, 5G NR Choices: CC0-CC7). If only one CC is selected, the FieldFox will not allow you to disable the scan. See also, the **Trace** hardkey in step 7.

- Then **Enabled ON** (Default == ON) – Enables/disables the CC scan results. If only one CC is selected, the FieldFox will not allow you to disable the scan.
- Then **Center** – You can enter a center frequency, or for LTE FDD, LTE TDD, and 5G NR (only) you can use the Channel Table menu to enter an auto-coupled Center frequency (see LTE FDD, LTE TDD, and 5G NR Channel Table softkey menus below).
- Then **Offset** (Option 378 – 5G NR and 5G NR EVM Only) – You can enter an synchronization signal block (SSB) offset frequency.

6. Optional (Option 370 – LTE FDD, Option 371 – LTE TDD, and Option 378 – 5G NR /5G NR EVM Only): Press **Freq/Dist** > **Freq Mode** > **Chan**

   This changes the Center frequency value.

   Press **Channel Table** opens a softkey menu, where you can select define your carrier, by Band and Channel. The Center frequency value is auto-coupled to the Band/Channel entered.

   Option 370 LTE FDD and Option 371 LTE TDD Only:

   - Then **Band** > *n* > **Enter**
     (The **Channel**, **Band**, and the **Center** values are auto-coupled.)

NOTE

Band and Channel values vary between LTE FDD and LTE TDD.

- Then **Favorites List** (Option 370 LTE FDD and Option 371 LTE TDD Only) opens a softkey menu, where you can save your current Band and Channel setup.
  - Then **Setup 1** In the Favorites list softkey menu, the softkey displays the current Band and Channel displayed (e.g., **Setup 1 3,1200**). Select the Favorites List softkey again to observe the updated Setup 1 softkey.
  - Then **Back**

   Option 5G NR /5G NR EVM Only):

   - Then **Band** > *n* > **Enter**
     (The **Channel**, **Band**, and the **Center** values are auto-coupled. frequency **Offset** is settable.)
   - Then **Channel Raster** (Option 378 5G NR /5G NR EVM Only) opens the Channel Raster softkey menu.

- Then **Channel ARFCN** Sets the Absolute Radio-Frequency Channel Number signal to be measured. Setting an ARFCN automatically sets a corresponding Center frequency for the component carrier.
- Then **Center** sets the ARFCN center frequency.
- Then **Offset** sets the offset from the Center frequency.

- Then **Sync Raster** (Option 378 5G NR and 5G NR EVM Only) opens a softkey menu, where you can set the Global Synchronization raster Channel using wider SSB frequency search. **Sync ARFCN** is coupled with **Sync GSCN**. ARFCN and GSCN minimum and maximum values vary with band setting and licensed frequency.
  - Then **Sync ARFCN** sets the ARFCN reference signals to be synchronized.
  - Then **Sync GSCN** sets the GSCN signals to be synchronized.
  - Then **Center** sets the GSCN center frequency.
  - Then **Offset** sets the offset from the Center frequency.
- Then **Back**

7. Select **Trace 6**–choose:
   - **Window 1 2 3 4**
   - Then **Win State OFF ON** to **ON**
   - Then **Display Type**
     - **Table** or
     - **Bar Chart** or
     - **Spectrum** or
     - **Strip Chart** or
     - **Constellation** (5G NR EVM only) or
     - **Frame Summary** (5G NR EVM only)

NOTE

The Spectrum view in 5G TF uses a center frequency that is +2.6 MHz offset from the carrier's center frequency. This is done so that FieldFox can capture the necessary xPBCH (physical broadcast channel) information to demodulate the signal. Be aware that all of the instrument's displayed numbers are rounded to three significant digits (e.g., 5.0026 GHz is displayed as 5.003 GHz).

   - Then **CC** (select component carriers)

- All (Not applicable for Spectrum. When **All** is specified, for Spectrum, the FieldFox defaults to CC0) or
- CC0, CC1, CC2, CC3, or CC4 (i.e., 5G TF and 5G NR have up to eight component carrier choices (CC5, CC6, and CC7))

Repeat process as needed for additional Windows, Data, and CC settings.

NOTE

IMPORTANT! When multiple component carriers are selected, the results of the component carrier (CC) with the highest power are displayed. Refer to Figure 13-17 on page 391.

8. Select a substep:

   a. When Display Type is set to **Bar Chart** or **Strip Chart** then for all for all OTA Options: Press Trace 6 > More

   - Then Meas Data *n* – Then select the data type:

     LTE FDD and LTE TDD: RSRP, RSRQ, RSSI, SINR, PSS, SSS (Default == RSRP).

     5G TF: PSS, SSS or Power (Default == PSS).

     5G NR: RSRP, RSRQ, RSSI, SINR, PSS, SSS or DMRS (Default = = RSRP).

     5G NR EVM: RSRP, RSRQ, RSSI, PSS, SSS, PBCH, DMRS, or Power (Default == PSS).

   - Then Sort Order and choose Up or Down (Default == Auto). Refer to "About Over–the–Air (OTA) Measurements" on page 364. When this softkey is inactive the **Sort Order** is set to **Auto**.

   - Then Sort Data *n* – Then select the type of data to be sorted:

     LTE FDD and LTE TDD: RSRP, RSRQ, RSSI, SINR, PSS, SSS, Freq Error.

     5G TF: PSS, SSS, Power, Sync Corr.

     5G NR: RSRP, RSRQ, RSSI, SINR, PSS, SSS, DMRS, Freq Error, SSB Index.

     5G NR EVM: RSRP, RSRQ, RSSI, PSS, SSS, PBCH, DMRS, Power, Sync Error, Time Offset, PSS EVM, SSS EVM, PBCH EVM, DMRS EVM, Composite EVM.

   - Then Data Logging – to record data. Refer to "How to Use Data Logging (OTA Options 370, 372, 377, and 378)" on page 420.

   b. 5G NR Only:

Press **More**

- Then **SSB Index All Single** when the SSB value is set, the SSB Index mode is automatically set to single. SSB Index values are for the currently displayed cell results.

  Enabling and disabling multi-beam display is useful when displaying the results from multiple cells.

- Then **Multi-Beam OFF ON** enable/disable Multi-Beam. Enables/disables displaying multiple beams (SSB results) for the currently displayed cell results.

  Enabling and disabling multi-beam display is useful when displaying the results from multiple cells.

- Then **Next Result Set** updates the Scan Results table with the next set of scanned data

c. 5G NR EVM Only (When Display Type is set to **Constellation** or **Frame Summary**):

Press **More**

- Then **Demod Data All** choose the demodulation data type: PSS, SSS, PBCH, PBCH DMRS, or All (Default == All).
- Then **Data Logging** – to record data. Refer to "How to Use Data Logging (OTA Options 370, 372, 377, and 378)" on page 420.

9. Optional: **Display Type Table** – Different softkey menus are displayed for up to six different Display Types: **Table** (Default), **Bar Chart**, **Spectrum**, and **Strip Chart**, **Constellation** and **Frame Summary** (i.e., Constellation and Frame Summary are on available when measurement is set to **5G NR EVM**):

a. Optional (When Display Type == **Table** or the **More** softkey is pressed for the other Display Types): Modify RF attenuator, Preamp, and other settings:

If Display Type == **Table**, then press **Scale/Amptd** or

If Display Type == **Bar Chart**, **Spectrum**, or **Strip Chart**, then press **Scale/Amptd** > **More**

Then choose from the following:

- Press **RF Atten** to set the attenuator power (Default == –10 dB). Set to **0 dB**.
- Press **Preamp** change to **ON**.
- Press **Range** to set the absolute power (dBm)

- Press Auto-Range Executes an auto-range, which determines the optimal RF attenuation and preamp settings for the current input signal.

  Executing an auto-range does NOT change any of the display settings (i.e., Ref Level, Scale or Ref Pos).

  See also, "About the Auto-Range Feature" on page 425.

- Press External Gain

b. Optional (When Display Type == **Bar Chart**): Modify scale and specify color bar limit values—Modify the bar chart display color coding scheme for the power channels (bars):

Press Trace > More > Bar Color Coding

Then one of the following:

- CC to set the CC (Component Carrier) associated with each bar.
- PCI to set the PCI (Physical Cell Identifier) associated with each bar.
- Level to set the level of the value associated with each bar.

When level is selected, you can set the channels' red and blue power level limits with the **Scale/Amptd** softkeys:

Press Scale/Amptd

Then one of the following:

- Red Limit to set the power level and color scale for high power channels.
- Blue Limit to set the power level and color scale for low power channels.
- Others: Scale, Ref Level, etcetera as desired.
- More opens a menu of softkeys that are the same as those that are defined when the Display Type == **Table**.
- Others (optional): Autoscale

c. Optional (When Display Type == **Spectrum**): Modify RF attenuator, Preamp, and other settings:

Press Scale/Amptd

Then press the following:

- Ref Pos Manually set the position of the reference line. Values must be between 0 (TOP line) and 10 (BOTTOM line).
- Scale Manually enter a **scale per division** to view specific areas of the trace.

- Ref Level Manually set the value of the reference line. Enter a negative value by pressing Run/Hold (+/-) either before or after typing a value.
- More opens a menu of softkeys that are the same as those that are defined when the Display Type == **Table**.
- Others (optional): Autoscale

d. Optional (When Display Type == **Strip Chart**): Modify RF attenuator, Preamp, and other settings:

Press Scale/Amptd

Then press the following:

- Scale Manually enter a **scale per division** to view specific areas of the trace.
- Ref Level Manually set the value of the reference line. Enter a negative value by pressing Run/Hold (+/-) either before or after typing a value.
- More opens a menu of softkeys that are the same as those that are defined when the Display Type == **Table**.
- Others (optional): Autoscale

e. Optional (When Display Type == **Constellation** or **Frame Summary**): Modify RF attenuator, Preamp, and other settings:

Press Scale/Amptd and

Then choose from the following:

- Press Range to set the absolute power (dBm)
- Press External Gain

10. Optional: Modify scale and specify color bar limit values—Modify the scale and assign colors to low and high power channels (bars):

Press Scale/Amptd

Then one of the following:

- Red Limit to set the power level and color scale for high power channels.
- Blue Limit to set the power level and color scale for low power channels.
- Others: Scale, Ref Level, etcetera as desired.

11. Optional (i.e., If the Scan Results table does not populate): Press Meas Setup 4

- **LTE FDD and LTE TDD**:

- Then FreqError Th > 5 kHz (enables data with larger frequency error to be displayed)

  or Extend Freq Lock > ON (disables **FreqError Th** softkey and displays all available cell results. (This may result in longer scan times, because display does not update until all potential cells and their frequency offsets are detected between signal and the OTA center frequency.)

- **LTE TDD (Only)**: UL-DL Config (selects the type of Uplink-Downlink switch-point periodicity configuration). Choose from Config 0 (Default) through Config 6.

- MBSFN (opens a menu to configure the Multi–broadcast Single Frequency Network (MBSFN) frames to transmit 5G NR control channels (SSBs) and can be used to enable dynamic spectrum sharing (DSS)).

  - MBSFN OFF ON – Enables the MBSFN frames for NR control channels (SSBs). (Default == OFF.)
  - Toggle All Subframes – Enables or disables all of the MBSFN frames. Enabled by default when MBSFN is set to ON.
  - Subframe 3 OFF ON – Enables or disables subframe 3 as one of the MBSFN frames for NR control channels (SSBs). Subframe 4 OFF ON, Subframe 7 OFF ON, Subframe 8 OFF ON, and Subframe 9 OFF ON are similar to Subframe 3.
  - More – Opens a menu to enable/disable the **Subframe 8** and **Subframe 9** MBSFN frames that are NR control channels.

- **5G TF**: Then SyncCorr Th > 0% (enables data with greater than 0% of the specified Sync Correlation percentage to be displayed)

- **5G NR**:

  - Then FreqError Th > 7.5 kHz (enables data with larger frequency error to be displayed)
  - Then SCS Sets the data channel sub-carrier spacing: 15 kHz, 30 kHz, 120 kHz, or 240 kHz (Default == 30 kHz).

    The SCS is coupled to the Center Frequency setting based on the 5G NR FR1 & FR2 frequency ranges.
  - Then SSB Case Sets the signal SSB case: A, B, C, D, or E (Default == Auto).

- Then **Lmax** Sets the current half frame SS/PBCH blocks indexing in ascending order in time 0 to (L_{max} – 1). Choices are 4, 8, or 64 (Default == Auto).
- Then **More** opens a menu for **Capture Length**, **Drive Speed**, **SS Meas DMRS**, **SSB Offset Detection**, **LTE Coexistence (NSA / DSS)**, **EMF**, **Advanced**. See also, "How to Define a Cell or Cell(s) and Use OTA" on page 396.
  - –Then **Advanced** opens a menu for **Capture Length**, **Drive Speed**, **Phase Comp**, **SS Meas DMRS**. See also, "How to Define a Cell or Cell(s) and Use OTA" on page 396.

- **5G NR EVM Conducted NR**:
  - Then **Cell ID Auto** Sets the Cell ID to Auto or to Manual (Default == Auto).
  - Then **Bandwidth** Sets the FR1 / FR2 bandwidth (Default == FR1 100 MHz).
  - Then **Resource Grid** Opens a softkey menu to select the component carrier and optionally export scan results to 5G NR.
    - –Then **SCS Auto** - the SCS value is coupled to the center frequency and FR1 and FR2. Manual choices are 15 kHz and 30 kHz. Default == Auto.
    - – Then **Grid Start** only settable when SSB Auto is set to OFF. Default == 0.
    - – Then **Grid Size** only settable when SSB Auto is set to OFF. Default == 273.
    - –Then **Export to 5G NR Setup** – Export the current scanned table of information to 5G NR.
  - Then **SSB** Opens a softkey menu to select the SSB settings that are coupled to the Resource Grid SCS setting.
    - –Then **SSB Auto-Detect OFF ON** - Enables/disables SSB Auto-Detect state. When SSB auto-detection is enabled, the SSB offset, SSB Case, Lmax, Periodicity and, optionally, SCS are all auto-detected in the measurement. When disabled, the settings can be set manually. Default == ON.
    - –Then **SSB Offset** - Opens a menu to set the SCS values.

SCS Common	The signal sub-Carrier Spacing Common setting is coupled to the Bandwidth setting. When an FR1 bandwidth is selected, 15 kHz & 30 kHz SCS are available; When an FR2 bandwidth is selected, 60 kHz SCS & 120 kHz SCS are available.
RB Offset	Sets the Resource Block (RB) offset of the signal SSB relative to CRB0. Choices: Min: Dynamic. Varies based on the Resource Grid Start setting. Max: Dynamic. Varies based on the Resource Grid Start and Grid Size settings.
kSSB	Sets the kSSB of the signal SSB. Choices: Min: 0 Max: Dynamic. Varies based on the Resource Grid SCS setting.

- – –Then **SSB Case** – Sets the SSB Case when SSB Auto-Detect is disabled. This setting is coupled to the Resource Grid SCS setting. Choices: 15 kHz SCS - Case A, 30 kHz SCS - Case B & C, 120 kHz SCS - Case D, and 240 kHz SCS - Case E.
- – –Then **Lmax** – Sets the Lmax when SSB Auto-Detect is disabled. This setting is coupled to the Bandwidth setting. Choices: an FR1 bandwidth is selected, 4 and 8; When an FR2 bandwidth is selected, 64 is available.
- – –Then **SSB Periodicity** – Sets the SSB Case when SSB Auto-Detect is disabled. Choices: 5 ms, 10 ms, and 20 ms.

– Then **Results –> Setup** Opens a softkey menu to select the component carrier and optionally export scan results to 5G NR.

- – –Then **CC CC0** - Selects the cc signal information to be scanned (CC0 to CC4). Default == CC0.
- – –Then **Copy to Manual Setup** - Selects the cc signal information to be copied to the manual SSB.
- – –Then **Export to 5G NR Setup** – Export the current scanned table of information to 5G NR.

– Then Advanced Opens an Advanced softkey menu.

––Then Phase Comp- Enables/disables phase compensation.

– Once the table populates, enter the desired frequency error (LTE FDD, LTE TDD, and 5G NR), Sync Correlation (5G TF) threshold for your measurement (LTE FDD and LTE TDD: Default == 900 Hz, i.e., if a carrier signal's error is greater than 900 Hz, no data is displayed. 5G TF/5G NR/5G NR EVM Conducted: Default == 1%, i.e., if a carrier signal's sync correlation is smaller than 1%, no data is displayed).

NOTE

If after making the setting changes in this section, no data is displayed, refer to "Troubleshooting" on page 429.

Display does not update (refresh), until all active component carriers (CCs) have been scanned.

12. Enable the Data Logging settings:

– Press Trace 6 > More (All Modes) > More (5G NR only) then Data Logging to view the Data Logging softkeys and set the Record Settings, Record Save/Recall, and Indoor Map Data Logging

– Record (Outdoor Logging) or

– Play (If you have previously stored data recordings.)

CAUTION

Spectrum and Strip Chart information is not recorded. Only the Table and Bar Chart data are saved. See "How to Record a Data Log Procedure" on page 421.

NOTE

Data Log-Play files are saved to:

– If File Folder is set to Default then Data Log-Play files are save-recalled to: "`[CurrentDevice]\RecordPlayback\OTA`"

– If File Folders are set to System, then Data Log-Play files are save-recalled to: "`CurrentDevice\<UserSelectedFolder>\`

a. To set the Record Settings (Outdoor Mapping only) – then choose:

– Then Meas Interval > ON

– Then Interval Type > choose **Time** or **Distance**.

– Then, if applicable Time Interval enter time interval in seconds.

Or

– Then, if applicable Distance Interval enter distance interval in miters.

– Then Back

b. Then press **Record Save/Recall** To set file settings choose

NOTE Learn more about file settings, refer to Chapter 34, “File Management.”

- **Save Log File** to save the current Table data (i.e., default save device is Internal). i.e., *.KML or *.CSV (Default) files are saved to the file name and device type. See Settings below and “To change Data Logging Configuration settings:” on page 422
- **Recall Log File** select a filename from the list
- **File Folder**
  Default - selects `[Internal]:RecordPlayback\OTA` (Default) or **System** - selects `[Internal]` top of internal directory.
- **Device** choose where to store your data files
- **File Type** > **CSV** or **KML** choose a file type (Default == CSV)
- **Auto Save** OFF (Default)/ON. When enabled, a temporary log file (e.g. `TempAutoSave.csv`) is automatically saved after each new record is recorded to guard against data lose in the case of an unexpected shutdown. The temporary log file is automatically deleted after you stop recording and manually save the log file.

  or

- **Back**

c. **Indoor Map Data Logging** - then **Record Indoor Data** or **Recall Indoor Log File**.

- Then choose **Navigate OFF ON**, **Data Selection**, **Zoom**, **Pan**, **Record Data**, **More**

Learn more, refer to Chapter 16 Mapping and “Setting up Data Logging” on page 519. See also, Chapter 34, “File Management.”

13. Outdoor Mapping only: If recording, then:

- **View Map OFF ON** To enable/disable the current map view (Default == latitude/longitude == 0.00/00. Need GPS to view current location (Default == OFF).
- **Pause Resume** Temporarily halts recording until pressed again. The incoming trace continues to sweep. Press again to continue recording.
- **Stop** Immediately stops recording and a “Save the Log File” menu opens to rename and save your data log file.

- (Press **Record** to begin a new recording.)
- Then **Maps** To enable map view and related features (e.g., Data Selection, Red/Blue Limits, Labels & Icons, Zoom).
  - **Data Selection** Opens a softkey menu to set the active data channel, sort type, and sort order. See also previous step 8 above.
  - **Red/Blue Limits** Opens a softkey menu to assign power values to the red (high power limits) and blue (low power limits) heat map display limits (Defaults: Red Limit == –20 dBm, Blue limit == –90 dBm).
  - **Labels & Icons** Opens a softkey menu to enable/disable map data point labels and icon types.

Labels OFF ON	Enables/Disables map data point labels. When enabled, a label is displayed for every map data point (e.g., "Data 1"). When disabled, labels are not displayed for the map data points.
Icons Flag Point Line	Sets the type of icon that is used to display a map's data points (Default == Flag).

- **Save Image (PNG)** Saves the current displayed map to a *.png file (default filename is "MapImageFile").

NOTE

Data Log-Play files are saved to:

- If File Folder is set to Default then Data Log-Play files are save-recalled to: "`[CurrentDevice]\RecordPlayback\OTA`"
- If File Folders are set to System, then Data Log-Play files are save-recalled to: "`CurrentDevice\<UserSelectedFolder>\`

14. Export KML file into 3rd party mapping software (i.e., Google Map or Google Earth). Refer to "Step 6: Import and Play back KML Files into 3rd Party Software (Example: Google Earth with Animation Tool)" on page 410.

Figure 13-17 Single cell selected, but other cells displayed when CC0 to CC*n* has been enabled. If ALL is selected, only the CC with the highest power is displayed. (Not all of the detected data is displayed.)

Model	N9952A													
Serial	US55040053													
Standard	OTA-LTE FDD													
Record Nu	140													
Rec Num	Date	Time	Longitude	Latitude(	Altitude(	GPS Statu	Freq Ref S	Frequency	Carrier Inf	Cells	PCI (C/S/G	RSRP (dBm	RSRQ (dB)	RSSI (dB
Rec-1	12/10/2018	08:57:30 A	0	0	0	INT	INT	1.00E+09	CC0	Cell - 0	6-0-2	-42.6557	-10.4134	-24.46
	12/10/2018	08:57:41 A	0	0	0	INT	INT	1.00E+09	CC1	Cell - 0	3-0-1	-42.8541	-13.2659	-21.80
										Cell - 1	18-0-6	-42.8063	-13.2182	-21.80
	12/10/2018	08:57:47 A	0	0	0	INT	INT	1.01E+09	CC2	Cell - 0	15-0-5	-43.2514	-10.3075	-25.16
Rec-2	12/10/2018	08:57:57 A	0	0	0	INT	INT	1.00E+09	CC0	Cell - 0	6-0-2	-42.6552	-10.432	-24.44
	12/10/2018	08:58:08 A	0	0	0	INT	INT	1.00E+09	CC1	Cell - 0	3-0-1	-42.8407	-13.2599	-21.79
										Cell - 1	18-0-6	-42.7929	-13.2121	-21.79
	12/10/2018	08:58:20 A	0	0	0	INT	INT	1.01E+09	CC2	Cell - 0	15-0-5	-43.2722	-10.3097	-25.1
Rec-3	12/10/2018	08:58:27 A	0	0	0	INT	INT	1.00E+09	CC0	Cell - 0	6-0-2	-42.6485	-10.4182	-24.44
	12/10/2018	08:58:40 A	0	0	0	INT	INT	1.00E+09	CC1	Cell - 0	3-0-1	-42.848	-13.2686	-21.79
										Cell - 1	18-0-6	-42.8	-13.2206	-21.79
	12/10/2018	08:58:50 A	0	0	0	INT	INT	1.01E+09	CC2	Cell - 0	15-0-5	-43.287	-10.319	-25.18
Rec-4	12/10/2018	08:58:54 A	0	0	0	INT	INT	1.00E+09	CC0	Cell - 0	6-0-2	-42.6599	-10.4128	-24.46
	12/10/2018	08:59:08 A	0	0	0	INT	INT	1.00E+09	CC1	Cell - 0	3-0-1	-42.8711	-13.2694	-21.82
										Cell - 1	18-0-6	-42.8258	-13.224	-21.82
	12/10/2018	08:59:19 A	0	0	0	INT	INT	1.01E+09	CC2	Cell - 0	15-0-5	-43.2606	-10.3014	-25.17

Figure 13-18 Example of the LTE FDD Scan Results Table (Five CCs and one cell) – LTE TDD is similar[1]

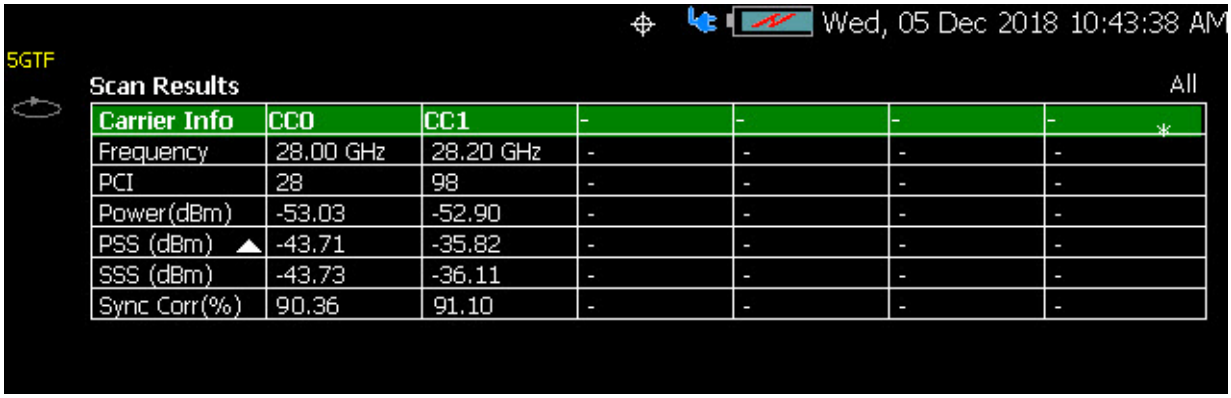
FDD

Scan Results All

Carrier Info	CC0 - 0	CC1 - 0	CC2 - 0	CC3 - 0	CC4 - 0	-
Frequency	1.000 GHz	1.003 GHz	1.006 GHz	1.012 GHz	1.030 GHz	-
PCI (C/S/G)	6-0-2	3-0-1	9-0-3	15-0-5	18-0-6	-
RSRP (dBm)	-42.50	-42.68	-42.76	-43.09	-43.08	-
RSRQ (dB)	-10.42	-10.36	-10.25	-10.31	-10.30	-
RSSI (dBm)	-24.31	-24.54	-24.73	-25.01	-25.00	-
PSS (dBm)	-42.49	-42.67	-42.74	-43.07	-43.05	-
SSS (dBm)	-42.50	-42.65	-42.75	-43.06	-43.08	-
SINR (dB)	29.29	27.45	28.63	27.14	29.21	-
Freq Err (Hz)	0.00	0.02	0.00	0.00	0.00	-

1. When multiple component carriers are selected, the results of the component carrier (CC) with the highest power is displayed.

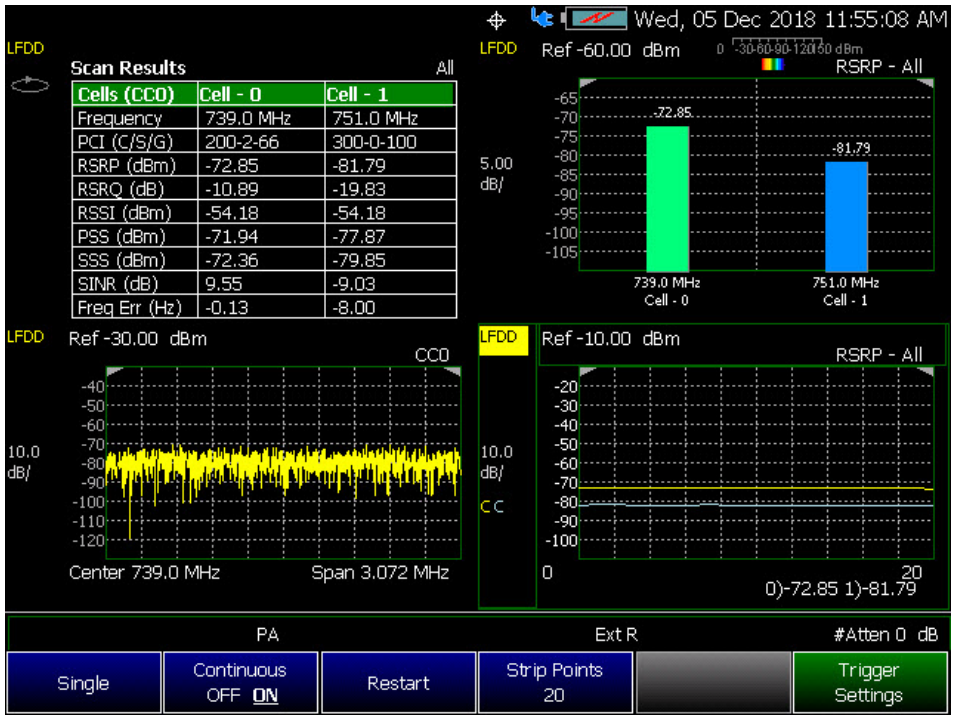
Figure 13-19 Example of the 5G TF Scan Results Table (Two cc and one cell)



Carrier Info	CC0	CC1	-	-	-	-
Frequency	28.00 GHz	28.20 GHz	-	-	-	-
PCI	28	98	-	-	-	-
Power(dBm)	-53.03	-52.90	-	-	-	-
PSS (dBm)	-43.71	-35.82	-	-	-	-
SSS (dBm)	-43.73	-36.11	-	-	-	-
Sync Corr(%)	90.36	91.10	-	-	-	-

Additional LTE FDD Examples (LTE TDD is Similar)

Figure 13-20 Example of LTE FDD with Single Carrier, Multiple Cell Sites, KPIs



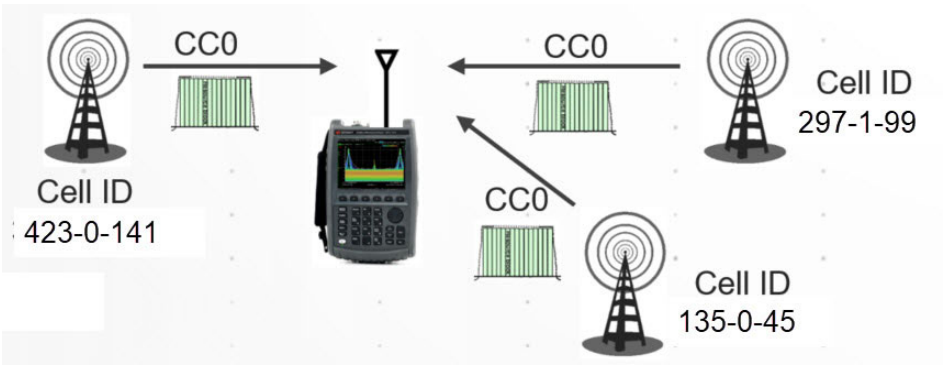
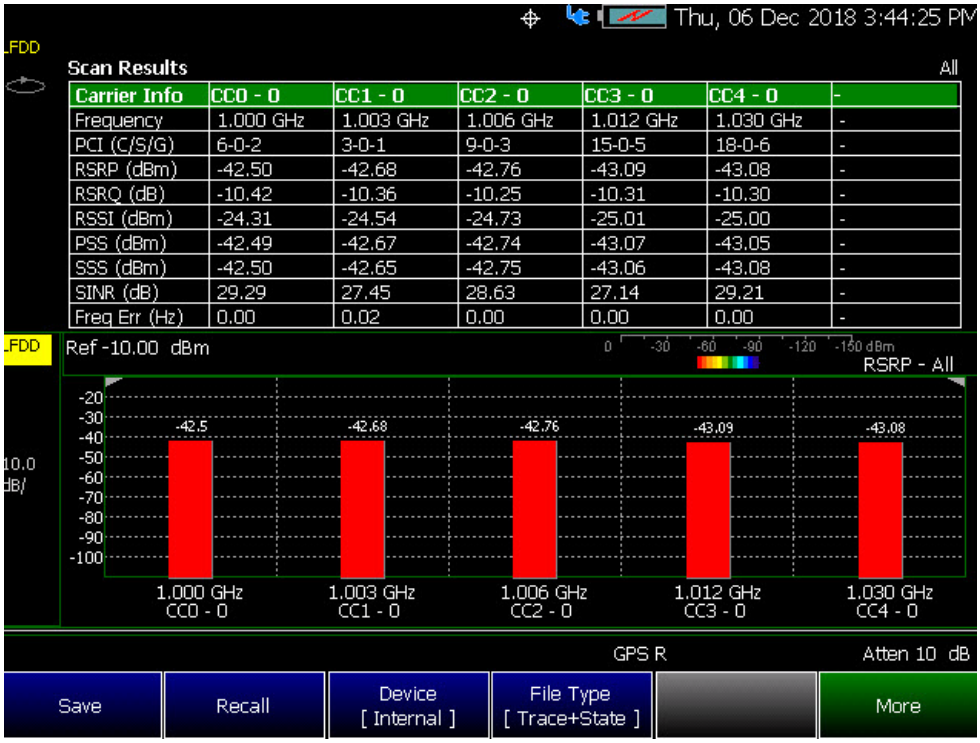
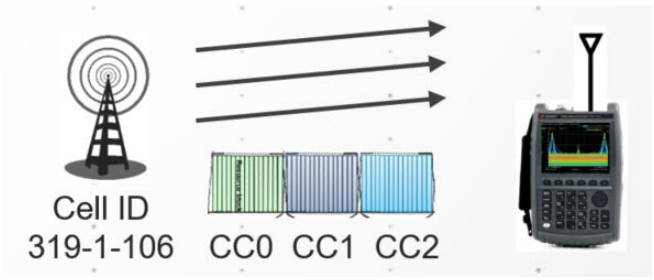


Figure 13-21 Example of LTE FDD with Multiple Carriers, Single Cell Site, and KPI's





Optional: Using RTSA to verify the signal quality (Requires Option 350 and Preamp Option 235)

– Press **Mode** > **RTSA**

  – Then **Density Spectrum** (Default)

– Press **Freq/Dist** > **Center** (Default) > **751 MHz**

  (For this example, Center == 751 MHz.)

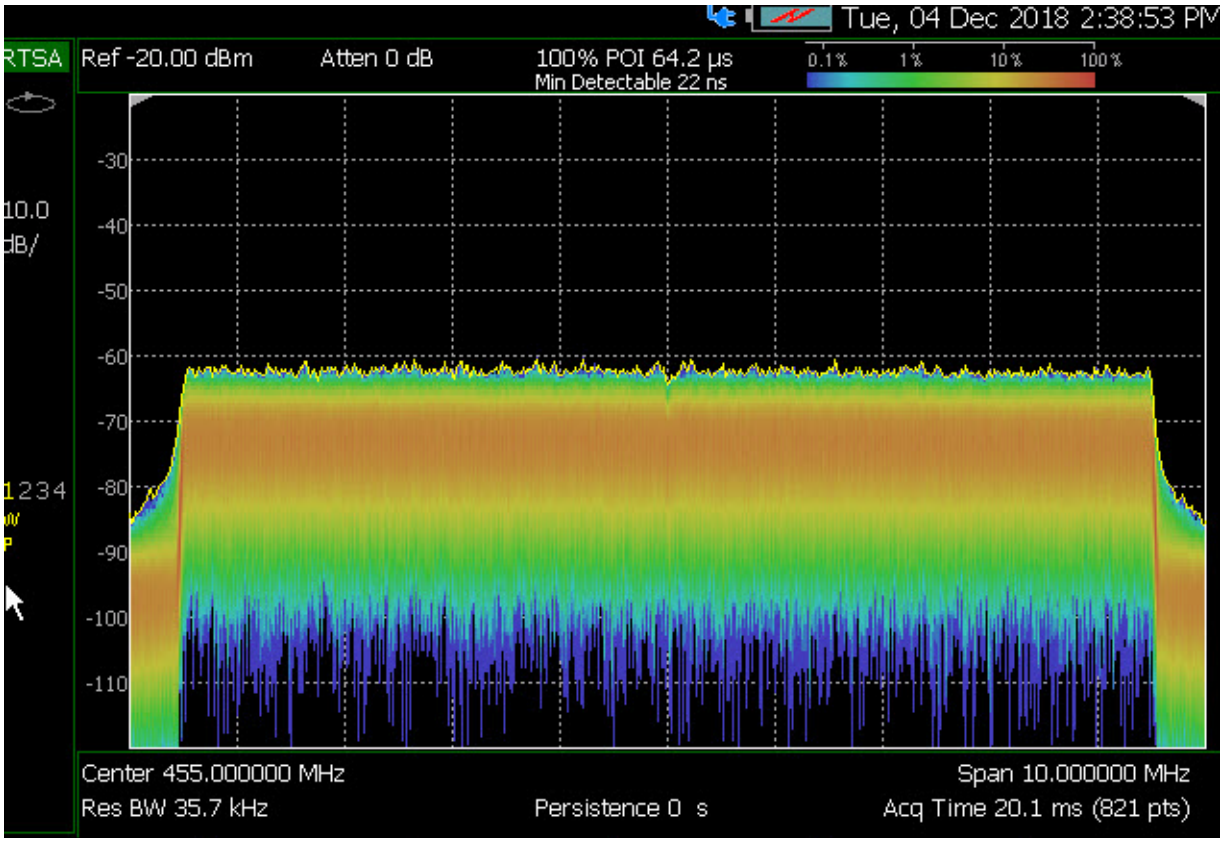
– Press **Scale/Amptd**

  – Then **Preamp [ON]**

  – Then **Ref Level** (Default). Then use the ▲|▼ arrows, the rotary knob, or numeric keypad to position the trace for optimum viewing on the FieldFox display. Refer to Figure 13-22 on page 395.

  You should see a ~20 dB or greater LTE FDD signal–to–noise level. If not refer to "Troubleshooting" on page 429.

Figure 13-22 Using RTSA to verify LTE FDD 751 MHz signal quality–20 dB Signal to Noise Displayed (Requires Option 350 and Preamp Option 235)



How to Define a Cell or Cell(s) and Use OTA

LTE FDD, LTE TDD, 5G TF, 5G NR, and 5G NR EVM Conducted have only one predefined view (Table). You can define measurements, which can be used to display up to four different views (windows) simultaneously on the display screen. You can select which type of data to display in each of the views from the Trace menu.

Cell definitions consist of the following:

– Set frequency according to DUT requirements

– Define cell settings

– Define component carrier(s) (CCs) settings

Example: Using OTA LTE FDD or 5G TF, refer to:

– “Step 1: LTE FDD (Option 370), LTE TDD (Option 371), 5G TF (Option 377), and 5G NR (Option 378): Component Carrier (CC) and Cell Defined” on page 396

Then:

– “Step 2: Select Trace Type” on page 402

– “Step 3. Modify Scale and the Display Color Bar Settings” on page 404

– “Step 4: Enable Data Logging and Playback the Results” on page 405

– “Save 5: Save the Log Results:” on page 409

– “Step 6: Import and Play back KML Files into 3rd Party Software (Example: Google Earth with Animation Tool)” on page 410

Figure 13-23 Cell Definition (LTE FDD) – (LTE TDD is similar)

Step 1: LTE FDD (Option 370), LTE TDD (Option 371), 5G TF (Option 377), and 5G NR (Option 378): Component Carrier (CC) and Cell Defined

1. Press Preset then Mode Preset (Factory)

2. Selecting and OTA mode: Press Measure > LTE FDD or LTE TDD or 5G TF or 5G NR or 5G NR EVM Conducted
3. Optimizing the FieldFox to scan for signals:
   - Set the System > System Configuration > Frequency Ref > Freq Ref Source [GPS] >Back
   - Set the GNSS (GPS+) > GNSS Receiver > Internal > Esc

     See also "GNSS (GPS+) and GPS" on page 865.
   - Set the Scale/Amptd to:
     - RF Atten > 0 dB
     - Preamp > ON
   - Set the Freq/Dist > then optionally:

     All Measurement Setups:
     - Press CC CCO
     - Press Enabled OFF ON Enable/disable selected component carriers. If only one CC is enabled, the OFF key press is ignored (Default == ON).
     - Press Center to select the currently displayed component carrier center frequency.

     For **LTE FDD** and **LTE TDD** (instrument dependent)
     - Optional (LTE FDD and LTE TDD only):
       - ––Freq Mode > Chan
       - ––Then Channel Table – Opens a menu to choose your CC, Band, Channel, and then use Favorites List, to open a softkey menu to save your Setup n.

     For **5G NR** (instrument dependent)
     - Optional (5G NR only):
       - ––Offset frequency offset of the measurement frequency from the center frequency
       - ––Freq Mode > Chan
       - ––Then Channel Table – Opens a menu to choose your CC, Band, Raster Mode Chan Sync, and then use Channel Raster to open a softkey menu:

         Then Channel ARFCN, Center, or Offset

         Else

then use **Sync Raster**, to open a softkey menu:

Then **Sync ARFCN**, **Sync GSCN**, **Center**, or **Offset**

For **5G TF** and **5G NR EVM Conducted** (instrument dependent). For more on 5G NR EVM Conducted, refer to "FieldFox EVM Measurements" on page 376.

4. Select **Trace 6**–choose:
   - **Window 1 2 3 4**
   - Then **Win State OFF ON** to **ON**
   - Then **Display Type**
     - **Table** or
     - **Bar Chart** or
     - **Spectrum** or
     - **Strip Chart**

NOTE

The Spectrum view in 5G TF uses a center frequency that is +2.6 MHz offset from the carrier's center frequency. This is done so that FieldFox can capture the necessary xPBCH (physical broadcast channel) information to demodulate the signal. Be aware that all of the instrument's displayed numbers are rounded to three significant digits (e.g., 5.0026 GHz is displayed as 5.003 GHz).

   - Then **CC** (select component carriers)
     - **All** (Not applicable for Spectrum. When **All** is specified, for Spectrum, the FieldFox defaults to CC0) or
     - **CC0**, **CC1**, **CC2**, **CC3**, or **CC4** (i.e., 5G TF and 5G NR has up to seven component carrier choices).
   - Then **PCI All** (select PCIs)
     - **All** (Not applicable for Spectrum. When **All** is specified, for Spectrum, PCI is set to single). For all other display types, the results for any cells with any PCI are displayed (Default == All).
     - **Single** displays the results for the selected PCI.

Repeat process as needed for additional Windows, Data, and CC settings.

NOTE

IMPORTANT! When you select multiple *CCs* (e.g., CC0, CC1, etcetera) and record data, you may actually see other cell signals that do not have sufficient power to be displayed, but are still detectable. When you select ALL, multiple component carriers are selected, but the results of the component carrier (CC) with the highest power is displayed. Refer to Figure 13-17 on page 391.

5. Optional: Press **Sweep 3** and modify/select items:
   - **Single**
   - **Continuous OFF ON** to **ON** (Default)
   - **Restart**
   - **Strip Points**
   - **Log Meas Status OFF ON**
6. Press **Trigger Settings**
   - **Freerun** (Default) or
   - **External** sets a sweep to trigger on an external TTL signal at the External Trigger connector. External trigger is available only after initial setting.
   - **Periodic** sets a trigger that repeats at the period rate entered. Periodic trigger's phase can be altered by the Offset value.
7. Optional: Press **Meas Setup 4** – LTE FDD, LTE TDD, and 5G TF softkeys are only required if scan does not display data.
   - **LTE FDD** and **LTE TDD**: Press **FreqError Th** and change to **5 kHz** – Wait a few seconds until Table populates or set **FreqLock Range** to **Extended**.
     - Then change back to the desired Frequency Error Threshold for your measurement.
   - **5G TF**: Press **SyncCorr Th** and change to **0%** – wait a few seconds until the Table populates and
     - Then change back to the desired Sync Correlation Threshold for your measurement.
   - **5G NR**: Press **FreqError Th** and change to **7.5 kHz** (Default)– Wait a few seconds until the Table populates or set **SCS**, **SSB Case**, or **Lmax** values.
     - Then press **More**
       - –Then **SSB Offset Detection** opens the SSB offset detection softkey menu):

Then **SSB Offset Detection OFF ON** Enables/disables the SSB Offset Detection (Default == OFF). Determines whether the measurement is a normal 5G NR measurement or an SSB offset measurement. When disabled, the measurement will be a normal 5G NR measurement. When enabled, the measurement will be an SSB offset measurement.

Then **Bandwidth** Sets the FR1 and FR2 bandwidth. FR1/FR2 active bandwidths are coupled to the currently selected SCS value.

Then **Snap Sync Raster** When enabled this softkey, determines whether or not the results from the SSB offset detection measurement are automatically snapped to the synchronization raster. When the results are snapped to the synchronization raster, the ARFCN / GSCN is included in the results.

Then **Results -> Setup** opens a menu of SSB offset copy-related softkeys of to copy the selected SSB offset, and SSB Freq to the selected component carrier(s) center frequency.

Then choose:

CC ALL (Default == All)	Selects the active SSB offset component carriers for copying SSB offset or SSB frequency information (CC0 to CC7 or All).
Copy SSB Offset	Copies the SSB offset result values to the selected component carriers (CCs).
Copy SSB Freq	Copies the SSB frequency result values to the selected component carriers (CCs).

––Then **LTE Coexistence (NSA / DSS)** opens the LTE Coexistence softkey menu):

Then **NSA / DSS OFF ON** Enables/disables the NSA /DSS feature and softkeys (Default == OFF). Determines whether the measurement is a normal 5G NR measurement or an NSA / DSS measurement. When disabled, the measurement will be a normal 5G NR measurement. When enabled, the measurement will be an LTE Coexistence measurement.

Then **LTE Duplex Mode FDD TDD** Selects the type of LTE signal to be used in the LTE Coexistence measurement (LTE FDD or TDD). Default == FDD.

Then **CC All** Selects the which component carriers are used in the measurement (CC0 to CC7). Default == All.

Then **Display Type Table Bar** Selects how the data is displayed (Table or Bar). Default == All.

Then **LTE Setup** opens a menu of softkey menu choices to set the 5G NR signal values (**Freq/Dist**, **Meas Setup**, and **Trace**. For details on these softkey menus, refer to the hardkey descriptions and their related softkeys in steps 5, 6, 7, and 11.

Then **5G NR Setup** opens a menu of softkey menu choices to set the LTE signal values (**Freq/Dist**, **Meas Setup**, and **Trace**. For details on these softkey menus, refer to the hardkey descriptions and their related softkeys in steps 5, 6, 7, and 11.

––Then **EMF** opens the EMF softkey menu (See also, "How to Set Up EMF Mode Settings (Requires EMF (Option 358) and LTE FDD (Option 370), LTE TDD (Option 371), or 5G NR (Option 378))" on page 412):

Then **EMF Meas OFF ON** Enables/disables EMF measurements (Default == OFF).

Then **EMF Triaxial [Sum All] ON** Sets the axis (X, Y, or Z) or axes (Sum All) of the Triaxial antenna to be used in the EMF measurements (Default == Sum All).

Then **EMF Units dBuV/m** Sets the EMF units (dBuV/m)

––Then **Advanced** opens the advanced softkey menu:

Then **Capture Length** Sets the length in frames for the current scan 4, 8, 16 24, 32, or 40 frames are the choices (Default == 4 Frames).

Then **Drive Speed** Sets the scan rate. Choices are Low, Medium, or High (Default == Low). Use slower speeds higher-mobility cases to track faster changes in channel.

Then **Phase Comp OFF ON** Enables/disables the phase compensation to compensate for phase differences between symbols during the upconversion or downconversion.

Then **SS Meas DMRS OFF ON** Enables/disables the current synchronized signal's demodulation reference signal.

8. Press **Trace 6**
   - And, set up your Windows and component carriers (CCs) as indicated in "How to Set Up Over–the–Air (OTA) Mode Settings" on page 377.
9. Press **System**
   - Press **GNSS** > **GNSS Receiver** > **Internal** > **Esc**
   - Press **System** > **FrequencyRef** > **Internal** > **Back**

NOTE

IMPORTANT!

It is **not** sufficient to be locked to the GNSS satellite, the frequency reference must be locked to GPS

Step 2: Select Trace Type

Select one of the following display orientations:

– Press **Trace 6**–choose:
  - **Table** or
  - **Bar Chart** or
  - **Spectrum** or
  - **Strip Chart** or

Figure 13-24 Table and Bar Chart Display Types – LTE FDD – (LTE TDD is similar)

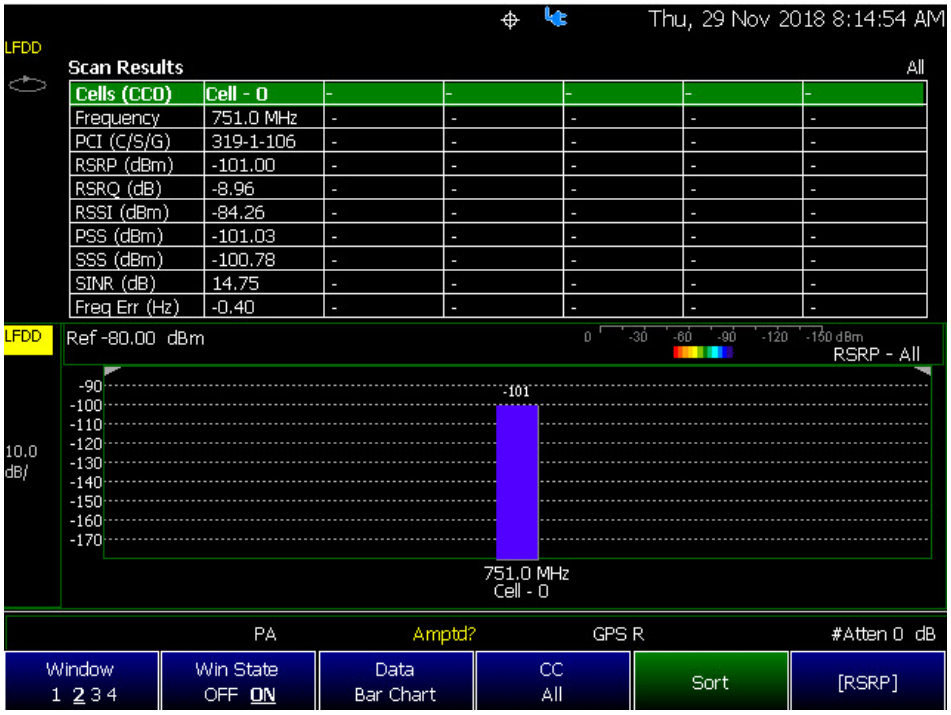


Figure 13-25 Spectrum and Strip Chart Display Type – 5G TF

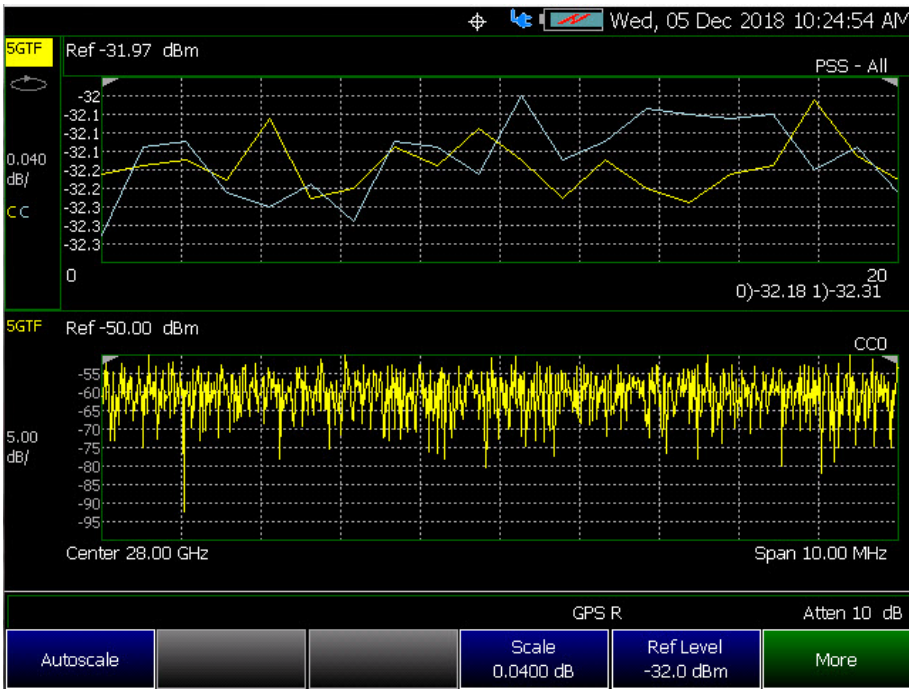
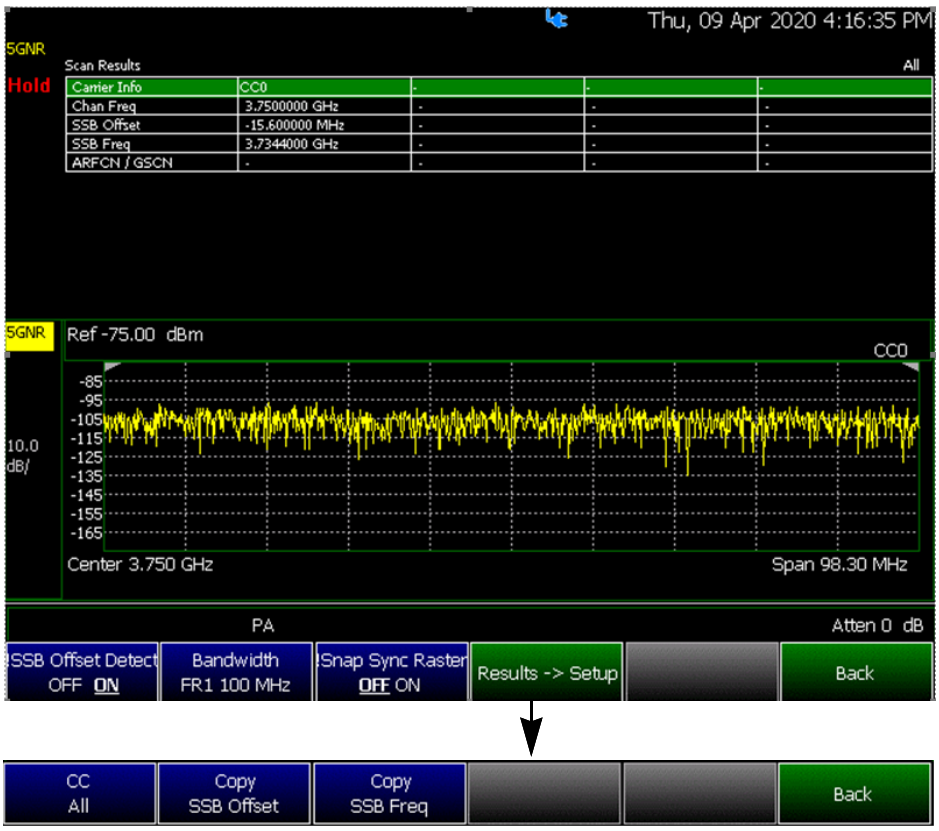


Figure 13-26 Spectrum and Table Type (SSB Offset Detection Softkeys) – 5G NR

Freq/Dist > Freq Mode > Chan or Freq

If Freq then: Meas Setup > More > SSB Offset Detection



If Chan then: Meas Setup > More

Step 3. Modify Scale and the Display Color Bar Settings

To assign colors to low and high power values:

1. Press Scale/Amptd > Red Limit to set high power values and to set the color.
2. Press Blue Limit to set low power values and to set the color.
3. And, then press System > Display > Display Colors, to set Indoor, Outdoor, or other display colors. See also Chapter 32, “System Settings.”

Figure 13-27 Outdoor Display Colors

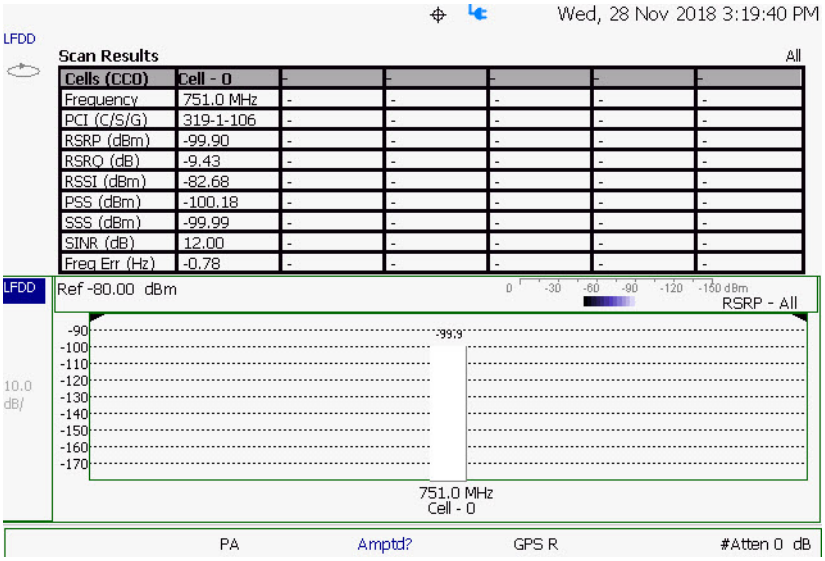
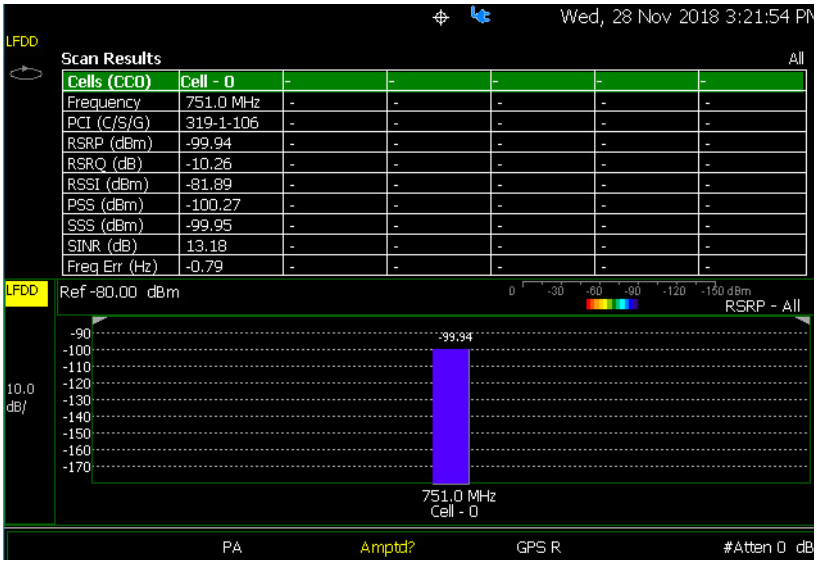


Figure 13-28 Indoor Display Colors



Step 4: Enable Data Logging and Playback the Results

CAUTION

Spectrum and Strip Chart information is not recorded. Only the Table and Bar Chart data are saved. See “How to Record a Data Log Procedure” on page 421.

Data Logging creates a record of your data with a timestamp and GPS stamp (refer to "GNSS (GPS+) and GPS" on page 865). GPS must be enabled for the log results to include a GPS stamp or use Preferences to enable the timestamp. Refer to Chapter 32, "System Settings."

Features

- Log files contain cell results for different component carriers (CCs) including timestamps and/or distance stamps.
  - Timestamps are included in log files with or without GPS.
  - GPS must be enabled for log altitude results.

    See also "GNSS (GPS+) and GPS" on page 865.
- Data results can be logged
- Data results can be saved to a *.CSV or *.KML file. Refer to "Save 5: Save the Log Results:" on page 409.
- User specifies how often results are stored.
  - Time: Store results every "n" seconds
  - Altitude: Store results every "n" meters. GPS must be enabled to store results by altitude.

Procedure

1. Press Trace 6 > More > Data Logging to view the Data Logging softkeys and set the Record Settings, Record Save/Recall, and Indoor Map Data Logging
   - Record (Outdoor Logging) or
   - Play (If you have previously stored data recordings.)
   a. **Outdoor Mapping only**: To set the Record Settings–choose:
      - Meas Interval
      - Interval Time
      - Time Interval or
      - Distance Interval
   b. Then press Record Save/Recall
      - Then File Folder Default System
        - Default – Sets the default User Folder path:

          ––List files (*.csv and *.kml) are save-recalled to:
          "`[CurrentDevice]:\RecordPlayback\OTA\`"

——Data Log-Play files are save-recalled to: "[CurrentDevice]:\RecordPlayback\OTA\"

Or

– System – Sets the User Folder to the user defined system folder path/name:

——List files are save to-from "CurrentDevice\<UserSelectedFolder>\"

——Data Log-Play files are save-recalled to: "CurrentDevice\<UserSelectedFolder>\"

Refer to “File Management” on page 887.

– Then File Type

– KML (default) or

– CSV

– Then Save Log File.

or

– Then Recall Log File.

– Auto Save OFF ON - (Default == OFF) Press to toggle to ON to enable Auto Save.

– Then Back

c. Optional: Press Indoor Map Data Logging then

– Record Indoor Data or Recall Indoor Log File. Refer to “How to Use Data Logging (OTA Options 370, 372, 377, and 378)” on page 420.

Learn more, refer to Chapter 16 Mapping and “Option 352 Indoor Maps Setup Procedure” on page 507 and “Setting up Data Logging” on page 519.

2. Press Back to return to previous menu.

3. Outdoor Mapping: Press Record to begin a new recording and then

– Then Maps To enable map view and related features (e.g., Data Selection, Red/Blue Limits, Labels & Icons, Zoom).

– View Map OFF ON Displays the current GPS location.

- **Data Selection** Opens a softkey menu to set the active data channel, sort type, and sort order. See also previous step 8 in "How to Set Up Over–the–Air (OTA) Mode Settings" on page 377.
- **Red/Blue Limits** Opens a softkey menu to assign power values to the red (high power limits) and blue (low power limits) heat map display limits (defaults: Red Limit == –20 dBm, Blue limit == –90 dBm).
- **Labels & Icons** Opens a softkey menu to enable/disable map data point labels and icon types.

Labels OFF ON	Enables/Disables map data point labels. When enabled, a label is displayed for every map data point (e.g., "Data 1"). When disabled, labels are not displayed for the map data points.
Icons Flag Point Line	Sets the type of icon that is used to display a map's data points (Default == Flag).

- **Save Image (PNG)** Saves the current displayed map to a *.png file (default filename is "Pilgrimage").

4. When done press **Stop**. The log file is automatically saved to the defined Device Type and File Type (i.e., when you press **Done**).

   Else, edit the file name, and then press **Done**.

   See also, Chapter 16 Mapping and "Setting up Data Logging" on page 519.

NOTE Learn more about file settings, refer to Chapter 34, "File Management."

5. Press **Back**

Playing a Data Log and Viewing the Data

To play the log results:

1. Press **Record Save/Recall** > **Recall Log File**

   And, use the Use the RPG or the ▲▼ arrow keys to highlight the file to be played.

2. Press **Recall File** > **Back** > **Play**
3. Optional: Press **Scale/Ampltd**

   Then choose:

- Optional (Bar Chart and Spectrum only): To adjust the following, use the RPG (fine adjust) or the ▲|▼ arrow keys (coarse adjust) to change the color bar.
  - **Autoscale** to have the FieldFox optimize the scale for the current measurement.
  - **Ref Pos** to change the reference line position (0 to 10).
  - **Scale** to change the reference line position (0.01 to 100 dB).
  - **Ref Level** to change the top reference position in the Bar Chart, Strip Chart, and Spectrum.
  - **Red Limit** to change the red color high power value (dBm). Bar chart only.
  - **Blue Limit** to change the blue color low power value (dBm). Bar chart only.

4. Press **Stop** to exit the log playing.

To pause the log play:

1. Press **Pause Resume** to pause or resume the log playing.
2. Press **Stop** to exit the log playing.

Learn more, refer to Chapter 16 Mapping and “Setting up Data Logging” on page 519.

Save 5: Save the Log Results:

Two file types are supported for save or recall log results:

- KML file format
  - Files stored in this format can be imported into 3rd party applications like Google Earth or Google Maps.
- CSV file format. Files stored into this format can be imported into spreadsheet applications.

Procedure:

1. Press When done press **Stop**. Immediately stops recording and a “Save the Log File” menu opens to rename and save your data log file.

NOTE

Record-Play files are saved to:

- If File Folder is set to Default then Record-Play files are save-recalled to: "`[CurrentDevice]\RecordPlayback\[Current mode]\`"
- If File Folders are set to System, then Record-Play files are save-recalled to: "`CurrentDevice\<UserSelectedFolder>\`

2. In the “Save the log file” window that opens, optionally change the name of the default file displayed, else press **Done**.

   Saves the file and exits the current softkey menu.

3. ‘To begin recording: Press **Record**
4. When done press **Stop**. The file is automatically saved to the defined Device Type and File Type.

   Else, edit the file name and folder path, under **Record Save/Recall** > **File Folder** where the file results will be stored.

NOTE

Learn more about file settings, refer to Chapter 34, “File Management.”

5. Press **Back**

Learn more, refer to Chapter 16 Mapping and “Setting up Data Logging” on page 519.

Step 6: Import and Play back KML Files into 3rd Party Software (Example: Google Earth with Animation Tool)

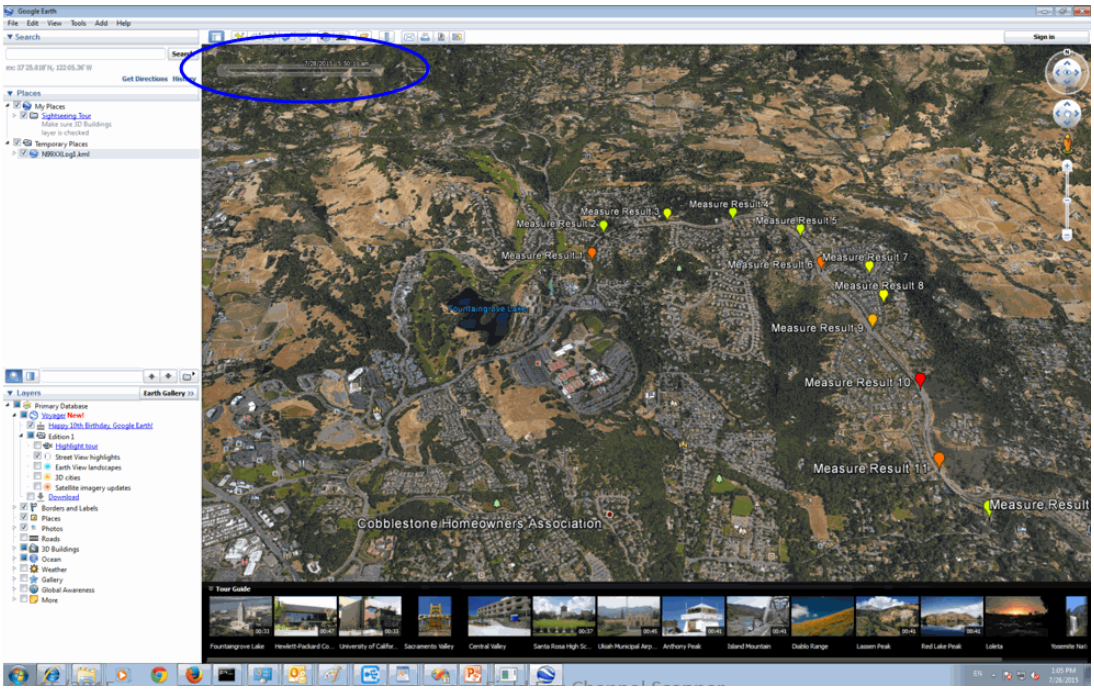
Features

Use the Playback Slider to replay measurement results. See also Google Maps and or Google Earth’s help.

- Open the FieldFox *.KML file in Google Earth. Time Slider appears in upper left of the map.
- Manual Mode – Move the time slider cursor to see color-coded icons pop-up according to the timestamp.
- Loop mode has a Fast-Slow Replay Option.

– Click on each color coded balloon to see the table of measurement results for that location.

Figure 13-29 Importing a KML File Into Google Earth



How to Set Up EMF Mode Settings (Requires EMF (Option 358) and LTE FDD (Option 370), LTE TDD (Option 371), or 5G NR (Option 378))

CAUTION If OTA or SA mode does **not** detect an EMF Option 358 license, then the EMF application and the EMF antenna's axes must be set up manually. This use model is **not** recommended or supported by Keysight.

CAUTION The EMF antenna's cable loss is not included, in the antenna's correction factors. For an accurate EMF measurement, the cable loss values should be accounted for. Refer to "EMF Setup Procedure" on page 241.

NOTE **IMPORTANT!** The EMF antenna, ARIA6000 or FSH3D or equivalent—is required for EMF measurements. Refer to Chapter 15, "USB Antennas – (Full Capability Requires EMF Option 358, and either SA mode (Option 233 Mixed Analyzers) or OTA—LTE FDD (Option 370), LTE TDD (Option 371), 5G NR / 5G NR EVM Conducted (Option 378)."

CAUTION The antenna operation for single-polarization measurements is different between ARIA6000 and FSH3D. Please consult the datasheet corresponding to each antenna for specific details.

EMF mode measures signals at the SA RF Input Port 2 connector.

EMF mode requires the FieldFox to have SA mode (Option 233 on combination analyzers), LTE FDD (Option 370), LTE TDD (Option 371), or 5G NR (Option 378), and CPU2 installed.

Recommended, but not required, preamplifier (Option 235) to improve receiver sensitivity.

With Option 358 (EMF), network designers can measure and verity the RF exposure compliance as required by each country.

This section reviews the steps in setting up an EMF measurement, using a EMF antenna. If you are not familiar with this process or would like more information, refer to Chapter 15, "USB Antennas – (Full Capability Requires EMF Option 358, and either SA mode (Option 233 Mixed Analyzers) or OTA—LTE FDD (Option 370), LTE TDD (Option 371), 5G NR / 5G NR EVM Conducted (Option 378)."

This section consists of:

- "EMF Features"
- "EMF Setup Procedure"

EMF Features

EMF has the following features:

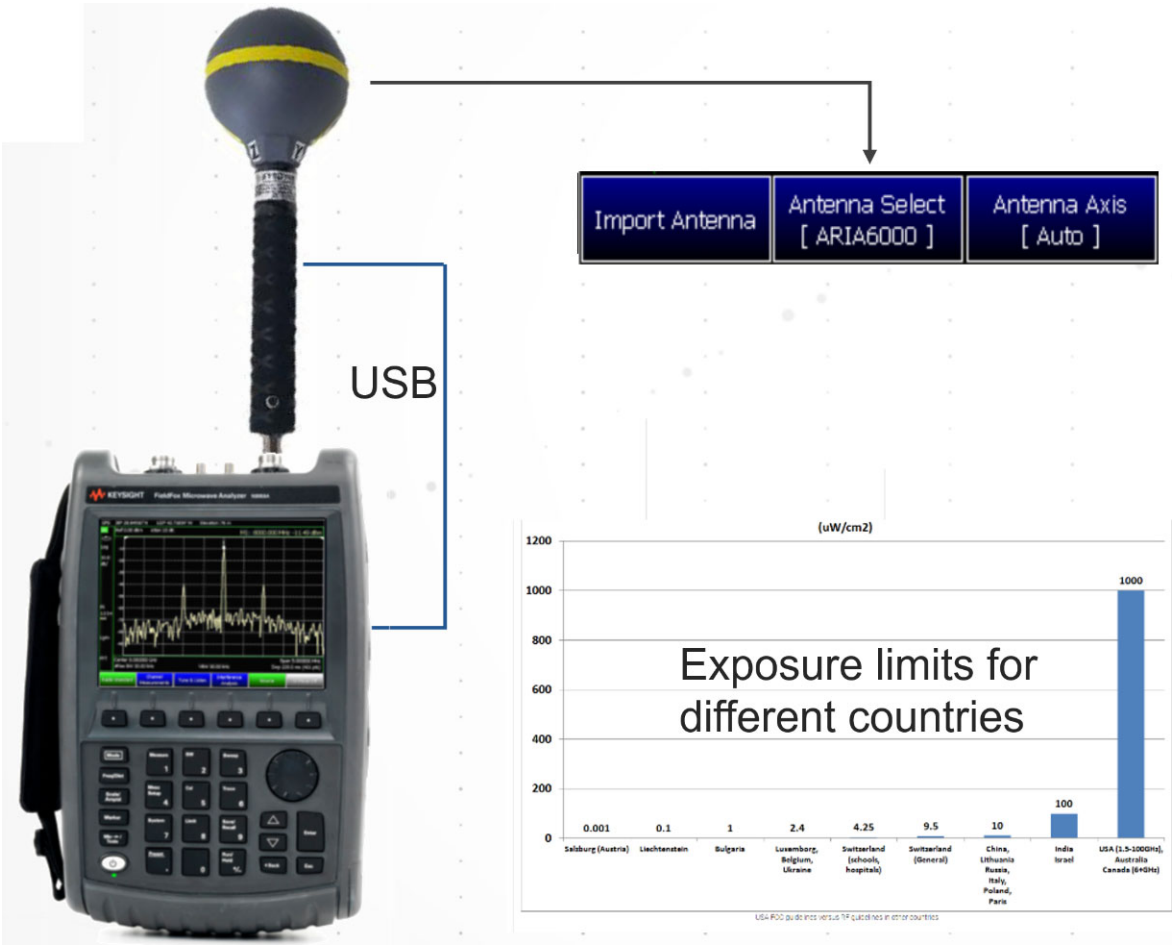
EMF Measurement Results:

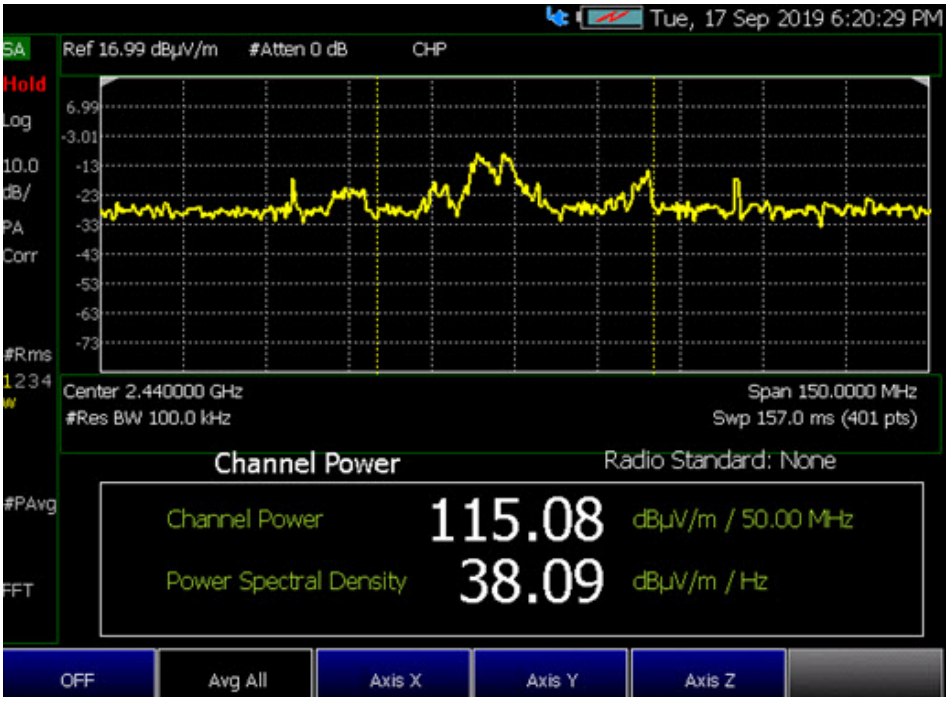
- Measure and display corrected field strength in RMS average power
- Antenna control over X, Y, and Z antenna factors downloaded via USB for ARIA6000 antenna or import a CSV file for FSH3D antenna
- Pass/Fail limit testing supported
- External PC **not** required

EMF uses the following data formats:

- Field Strength units:
  - dBµV/m – For use with E-field signals
  - dBµA/m – For use with H-field signals
  - dBG – dB Gauss
  - dBpT - dB Tesla

Figure 13-30 Example of EMF with Triaxial Antenna





EMF Setup Procedure

CAUTION

When the EMF antenna correction factors are imported, EMF (Option 358) couples many settings to ease setting up the EMF measurement (e.g., **Apply Corrections** is enabled, all X, Y, and Z antenna axes are enabled, and **Amp Corr Select** is set to **ARIA6000 or FSH3D Triaxial XYZ**)

NOTE

IMPORTANT!

The softkey menu selection and display of Axis X, Y, Z, corresponds to Loop 1, 2, 3, respectively for EMF antenna FSH3D.

1. Setup the FieldFox Spectrum Analyzer for a Channel Power measurement.
   a. Press **Mode** > **OTA** >

   Press **Measure 1** then one of the following:
   - **LTE FDD**
   - **LTE TDD**
   - **5G TF**
   - **5G NR**
   - **5G NR EVM Conducted**

NOTE

If necessary, this step can be skipped and done **after** the EMF antenna is set up

2. Connect the EMF antenna to the **SA RF Input**, port 2 and to a FieldFox USB port. See also, Chapter 15, “USB Antennas – (Full Capability Requires EMF Option 358, and either SA mode (Option 233 Mixed Analyzers) or OTA–LTE FDD (Option 370), LTE TDD (Option 371), 5G NR / 5G NR EVM Conducted (Option 378)” and to Chapter Figure 15-1, “FieldFox With EMF antenna”.

CAUTION

Only Agos Advanced Technologies ARIA6000 and Schwarzbeck Mess-Elektronik FSH3D Triaxial Isotropic EMF antenna is compatible with EMF (Option 358).

3. Importing and selecting X/Y/Z antenna factors:
   a. Press **System** > **Utilities** > **EMF Antennas**
   - For ARIA6000 EMF antenna, press **Antenna Select** and select "ARIA6000".

Then press **Import Antenna** – to import the antenna factors from the antenna's memory over the USB connection (this may take 5 seconds or so and vary with the triaxial antenna).

NOTE The Import Antenna softkey menu is only activated when Antenna Select is set to ARIA6000 or FSH3D.

NOTE If the antenna factor import is successful, the FieldFox displays: "`Success: Antenna Factors Imported: EMF Antenna ID: ->[R] Antenna ID: ARIA6000-1006 ->[]`". The last 4-digits will vary for each antenna (i.e., "1006" value will vary).

If the FieldFox displays this error `Error: EMF antenna Error: Not found` or `Unable to communicate with antenna. Ensure it is connected.` is displayed, verify the EMF antenna is connected correctly. See also "Troubleshooting" on page 429.

– For FSH3D EMF antenna, press **Antenna Select** and select "FSH3D".

Then press **Import Antenna** > **Import Files** - to import FSH3D antenna factor CSV file from external storage device e.g. USB or SD Card to the INTERNAL storage. **Recall File** to retrieve these imported CSV files directly from INTERNAL when necessary.

Figure 13-31 FSH3D antenna factor CSV Import Files storage device selection Softkey

Press the storage device containing FSH3D antenna factor CSV file you wish to import from. The window will navigate to the chosen storage device and display all available CSV files.

Choose a single FSH3D antenna factor CSV file from the list, then press **Import**.Once imported, press **Done** to complete the process.

To recall INTERNAL FSH3D antenna factor CSV, press **Import Antenna**, then select the target CSV file and press **Recall File**.

CAUTION FSH3D antenna factor CSV files MUST be saved in the "AntennaEMF" folder within the storage device to import from.

– By selecting **Antenna Select** and choosing either ARIA6000 or FSH3D to verify the EMF antenna selected (Default == Manual). Only compatible EMF antennas can be used for EMF measurements.

See also, "How to Use the Manual EMF Channel Power" on page 246.

- Optional: Press **Antenna Axis** the antenna axis should be set to **Auto** for default operation. When AUTO is selected the application (e.g., Channel Power or OTA) controls the axes and switches as needed. With the AUTO setting, all antenna elements (X, Y, and Z) are OFF.

NOTE The Antenna Axis softkey is only activated when Antenna Select is set to ARIA6000 or FSH3D.

- Press **Back** > **Back** to exit the EMF Antenna softkey menu.

4. Modifying the EMF settings:

   Press **Meas Setup 4**

   - Then **More** > **EMF** then
     - **EMF Meas OFF ON** disable/enable the EMF measurement.
     - **EMF TriAxial [Sum All]** Sets the axis (X, Y, or Z) or axes (Sum All) of the triAxial antenna to be used in the EMF measurements (Default == Sum All).
     - **EMF Units** choose dBuV/m (default) or V/m.
     - **Extrap Factor** Enter positive value in dB (Default == 0.00, Maximum ==1000.00). Learn more about Extrapolation Factor in "Using Extrapolation Factor" on page 735
     - **Back** to exit to the previous softkey menu.

   For more details on editing the EMF antenna, refer to Chapter 15, "USB Antennas – (Full Capability Requires EMF Option 358, and either SA mode (Option 233 Mixed Analyzers) or OTA–LTE FDD (Option 370), LTE TDD (Option 371), 5G NR / 5G NR EVM Conducted (Option 378)."

5. Once you have finished with your EMF antenna setup:

   a. Press **Sweep 3** > **Single** > **Restart**

      The FieldFox should display in order `Analyzing CCO X-Axis`, `Analyzing CCO Y-Axis`, and `Analyzing CCO X-Axis` and then do a square root sum of the X, Y, and Z measurement values in the FieldFox. Multi-cell measurements are done similarly for each cell ID (i.e., Cell CC0 to CC*n*). Refer to Figure 13-32 on page 418.

   b. Verify OTA 5G NR X, Y, and Z Axes Factors in SA Mode (e.g., 3.5 GHz signal)). Refer to Figure 13-33 on page 419.

      i. Press **Mode** > **SA** then

      ii. Press **Freq/Dist** > **Center** > **3.5 GHz** then

      iii. Press **Freq Span** > **120 GHz** then

      iv. Press **System** > **Utilities** > **EMF Antennas** > **Antenna Axis [Auto]** – (Default == Auto) then

v. Press X to view the X axis

vi. Press Y to view the Y axis and

vii. Press Z to view the Z axis

6. Verify EMF in 5G NR Mode:

   a. Press Mode > OTA > 5G NR then

   b. Press Meas Setup 4 > More > EMF > dBuV/m

      (i.e., For this example. Other units are selectable.)

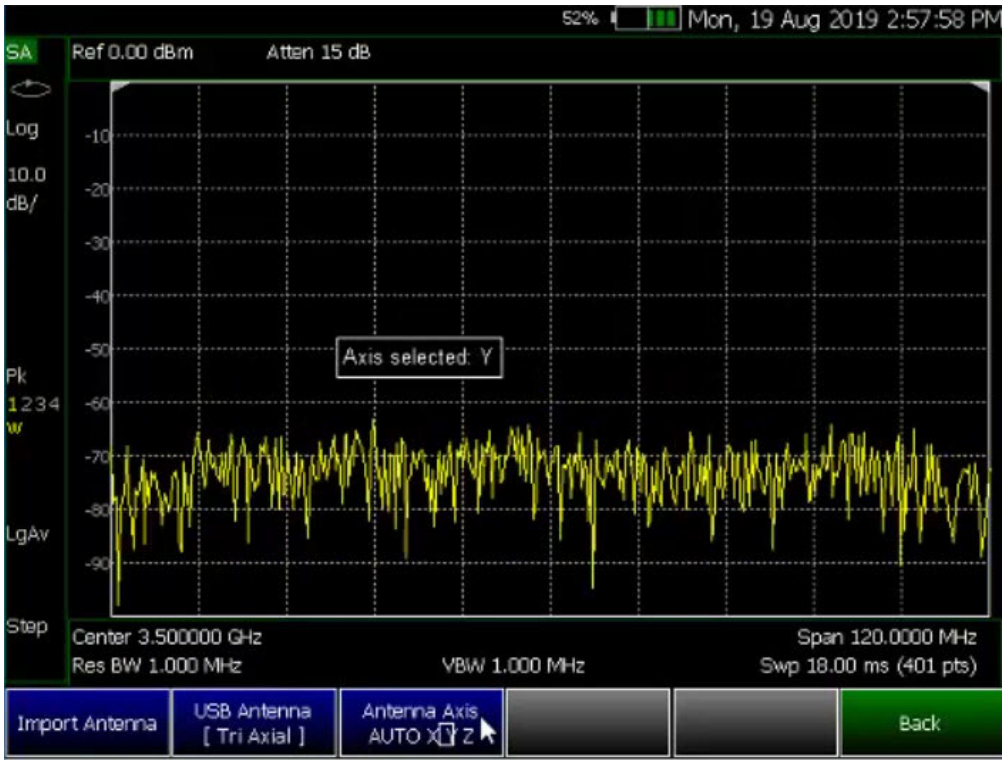
   For more information:

   – Refer to Figure 13-32 on page 418.

   – See also “GNSS (GPS+) and GPS” on page 865.

Figure 13-32 Example Summing of Triaxial Values

Figure 13-33 Using SA Mode (Example) to Verify the Triaxial Values – Axis Y is Displayed



How to Use Data Logging (OTA Options 370, 372, 377, and 378)

CAUTION Spectrum and Strip Chart information is not recorded. Only the Table data is saved. See "How to Record a Data Log Procedure" on page 421

NOTE While the Record/Play softkey is displayed in all measurements, Record/Play only logs and plays back Table and Bar Chart data. See "How to Record a Data Log Procedure" on page 421

NOTE Data Log-Play files are saved to:

- If File Folder is set to Default then Data Log-Play files are save-recalled to: `"[CurrentDevice]\RecordPlayback\OTA"`
- If File Folders are set to System, then Data Log-Play files are save-recalled to: `"CurrentDevice\<UserSelectedFolder>\`

Data Logging allows you to record OTA trace data and play them back at a later time. Use this feature to monitor table data activity over a period of time.

Data logs can be saved to the FieldFox Internal memory, an SD Card, or a USB flash drive.

This section assumes you have already completed the initial setup and have either an LTE FDD, LTE TDD cell, or 5G TF setup displayed on the FieldFox.

Screen Annotation

During a record or playback session, the following is displayed in the top-center area of the screen:

- **Rec: 55/55 2018-12-31 03:26:11 PM**

where:

- **55/55** is the current and total trace number: currently trace is 55 of 55 total scans.
- **2018-12-3103:26:11 PM** is the date and time of recording.
- The name of a recording can be changed using Manage Sessions. Learn more in "To change Data Logging Configuration settings:" on page 422.

See also Chapter 32, "System Settings."

When GPS is enabled, **GPS R** is indicated at the bottom of the FieldFox display. Learn more in "GNSS (GPS+) and GPS" on page 865.

NOTE

If Data Logging or Playback is not occurring when you think it should, check the following:

- Is the sweep in HOLD? (upper-left annotation), or check the Sweep menu for Continuous set to OFF.
- Is Recording or Playback Paused? (mid-left annotation)
- Is the Data Logging or Playback Interval set too long? (Configuration settings.)

How to Record a Data Log Procedure

NOTE

Data Log-Play files are saved to:

- If File Folder is set to Default then Data Log-Play files are save-recalled to: `"[CurrentDevice]\RecordPlayback\OTA"`
- If File Folders are set to System, then Data Log-Play files are save-recalled to: `"CurrentDevice\<UserSelectedFolder>\`

- Press **Trace 6** > **More** > **Data Logging** >
- Then for Outdoor Logging, press **Record**

REC is displayed in the left of screen graticules.

During recording, choose from the following:

- **Pause Resume** Temporarily halts recording until pressed again. The incoming trace continues to sweep. Press again to continue recording. See also "How to Play a Data Log" on page 423.
- **Stop** Immediately stops recording and opens a menu to name/rename and save your data log. For more, refer to "How to use the FieldFox labeler " on page 891.
- **Record Settings** (Outdoor Mapping only) opens a softkey menu to enable you change your record related settings. For more, refer to "To change Data Logging Configuration settings:" on page 422.
- **Recall Save/Recall** opens a softkey menu to enable you to save and recall your data log and related file settings. For more, refer to "To change Data Logging Configuration settings:" on page 422.

  Learn more, refer to Chapter 16 Mapping and "Setting up Data Logging" on page 519

To change Data Logging Configuration settings:

1. Press **Trace 6** > **More** > **Data Logging**
2. Then choose from the following:
   - **a.** To set the **Record Settings** (Outdoor Mapping only)–choose:
     - **Meas Interval OFF ON** Enable to make the measurement interval softkeys active (Default == OFF).
     - **Interval Type** Choose: Time or Distance
     - If applicable, **Time Interval** Enter time in seconds (1s to 3.6 ks) or
     - If applicable, **Distance Interval** Enter time in miters (10m to 10 km)
   - **b.** To set the **Record Save/Recall**
     - **File Folder Default System**
       - **Default** – Sets the default User Folder path:
         - ––List files (*.csv and *.kml) are save-recalled to:
           `"[CurrentDevice]:\RecordPlayback\CS\"`
         - ––Data Log-Play files are save-recalled to:
           `"[CurrentDevice]:\RecordPlayback\CS\"`

           Or
       - **System** – Sets the User Folder to the user defined system folder path/name:
         - ––List files are save to-from
           `"CurrentDevice\<UserSelectedFolder>\"`
         - ––Data Log-Play files are save-recalled to:
           `"CurrentDevice\<UserSelectedFolder>\"`

       Refer to “File Management” on page 887.
     - Then **File Type**
       - KML (default) or
       - CSV
     - Then **Save Log File**.

       or

- Then **Recall Log File**
- **Auto Save** (Default == OFF)
- Then **Back**

c. Optional: Press **Indoor Map Data Logging** then

- **Record Indoor Data** or **Recall Indoor Log File**. Learn more, refer to Chapter 16 Mapping and "Option 352 Indoor Maps Setup Procedure" on page 507.
- Then choose **Navigate OFF ON**, **Data Selection**, **Zoom**, **Pan**, **Record Data**, **More**

Learn more, refer to Chapter 16 Mapping and "Setting up Data Logging" on page 519. See also, Chapter 34, "File Management."

How to Play a Data Log

- Press **Trace 6**
- If the session is already open, skip the following step. Otherwise:
- Then **More** > **Data Logging** > **Playback**
  - Then **Recall Log File** and select a file

NOTE If these are large recordings on a device, it could take several seconds for the FieldFox to display the list.

  - ––Then **Recall File**
  - Then **Play** to playback your Table data.

PLAY is displayed in the left of screen graticules during playback. When the end of the recording is reached, playback begins again at trace 1 and continues to loop indefinitely.

During playback, choose from the following:

- **Pause Resume** Temporarily halts playback. Then choose from the following:
  - **Pause Resume** Press to continue playing.
- **Stop** Immediately stops playback. Then choose from the following:
  - **Play** Start playback from trace 1.
  - **Recall Log File** Opens a list of stored data files.

    Select a file to playback.
  - **Recall File**

- **Back**
- **PlayTrace ID Auto** resume playing by selecting a trace number to playback between 1 and the record length (MAXimum == 2000 (multiple CC) and 1000 (single CC)).

Other Features Available

- **Alignments** - For information on using alignments, refer to the SA chapter's section, "Alignments" on page 211.
- **Scale Settings** – For information on using scale settings, refer to the Data Analysis chapter's section, "All about Scale Settings" on page 831 (not all settings apply to OTA Options 370 and 377).
- **External Gain** - Refer to refer to the SA chapter's section, "External Gain" on page 162.

About the Auto-Range Feature

Executing an auto-range, which determines the optimal RF attenuation and preamp settings for the current input signal.

See also, "OTA Setup Procedure" on page 377.

Couplings: The current measurement settings help determine the auto-range parameters. If more than one CC is enabled when an auto-range is executed, the range is determined for each CC separately and the final range setting is set using the maximum.

NOTE

Executing an auto-range sets the Range, RF Attenuator, and Preamp settings.

Executing an auto-range does NOT change any of the display settings (Ref Level, Scale or Ref Pos).

Figure 13-34 OTA 5G NR Signal Before Auto-Range – Table

Signal Info	CC0	-	-	-	-
Frequency	1.000 GHz	-	-	-	-
PCI	0	-	-	-	-
SSB Numerology	30 kHz	-	-	-	-
ScsCommon	30 kHz	-	-	-	-
SSB Case	B	-	-	-	-
Lmax	4	-	-	-	-
SSB Periodicity (ms)	20	-	-	-	-
SSB RB Offset	253	-	-	-	-
SSB SC Offset	0	-	-	-	-
SSB Delta Center (kHz)	0.000	-	-	-	-
Sync Corr (%)	99.070	-	-	-	-
Channel Power (dBm)	-40.140	-	-	-	-
Freq Error (Hz)	-0.020	-	-	-	-
Time Offset (us)	17837.820	-	-	-	-
PSS EVM (%rms)	12.480	-	-	-	-
SSS EVM (%rms)	13.440	-	-	-	-
PBCH EVM (%rms)	20.980	-	-	-	-
PBCH DMRS EVM (%rms)	15.630	-	-	-	-
Composite EVM (%rms)	17.970	-	-	-	-
SS-RSRP (dBm)	-75.530	-	-	-	-

Figure 13-35 OTA 5G NR Signal Before Auto-Range – Spectrum

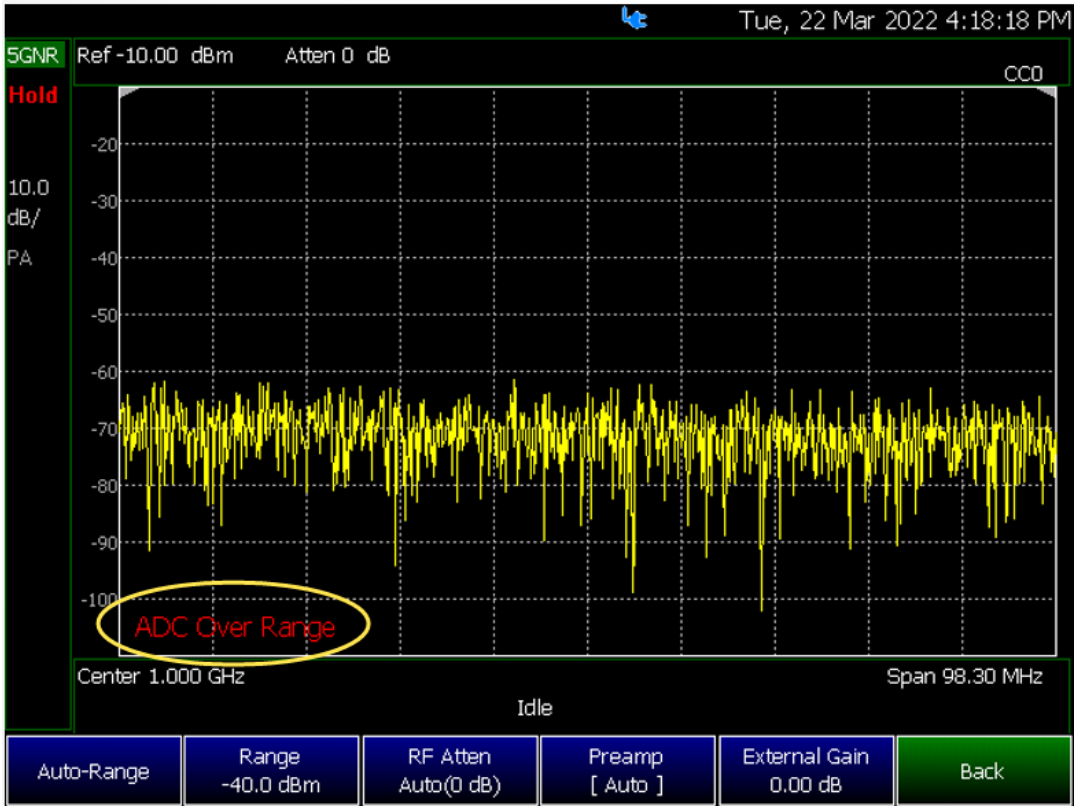


Figure 13-36 OTA 5G NR Before Auto-Range – Windows State ON

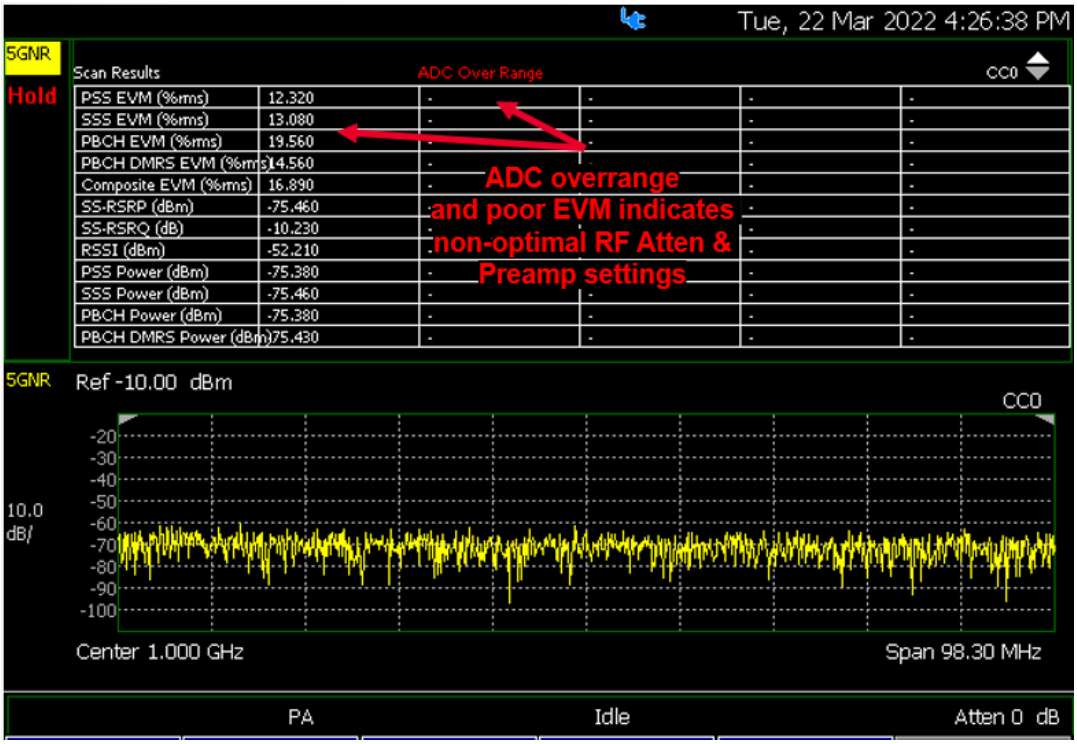


Figure 13-37 OTA 5G NR Ongoing Auto-Range – Performing Auto-Range

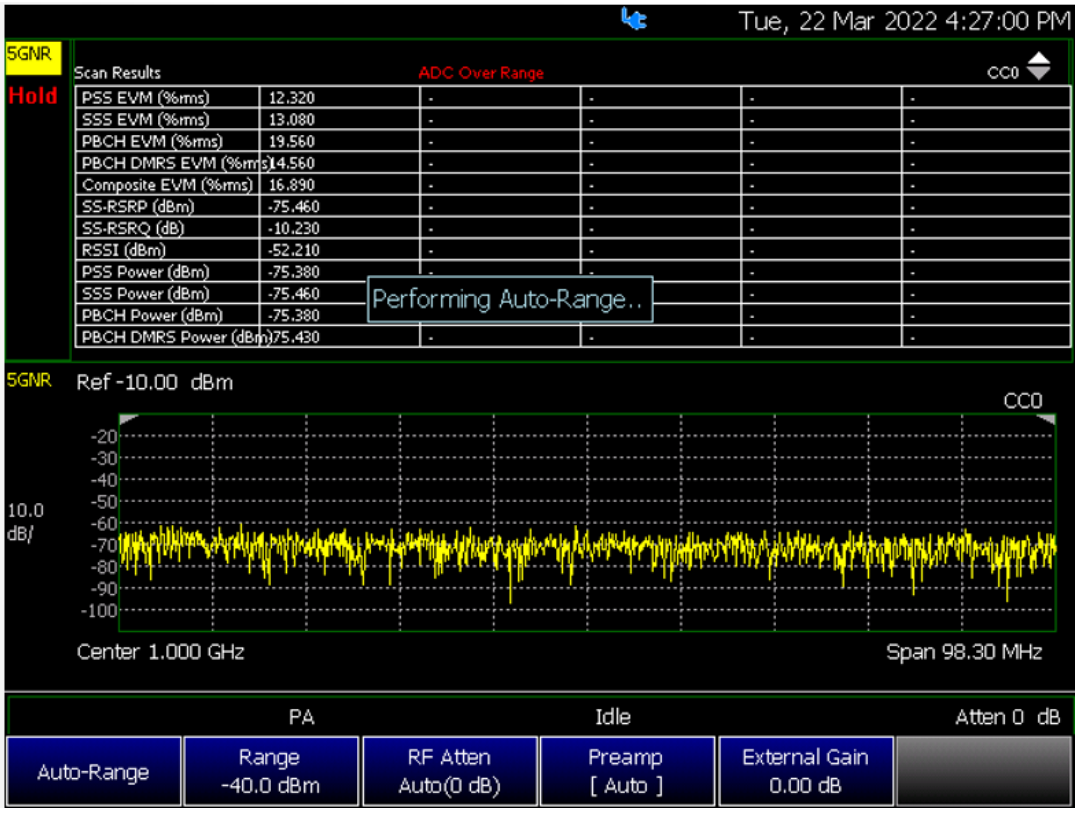


Figure 13-38 OTA 5G NR After Auto-Range, but RF Atten or Preamp Settings Changed

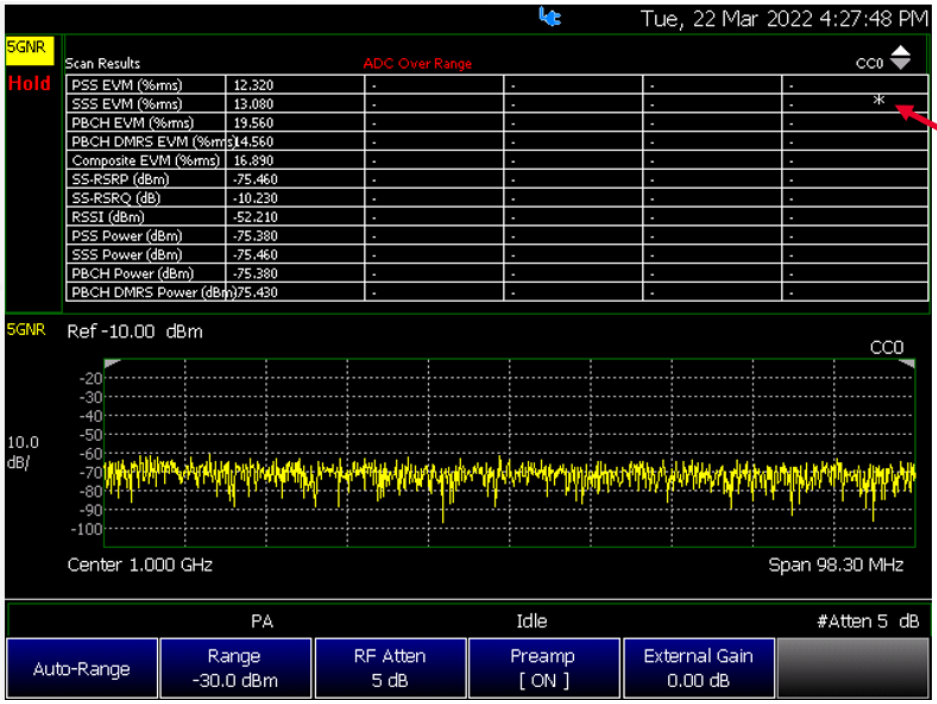
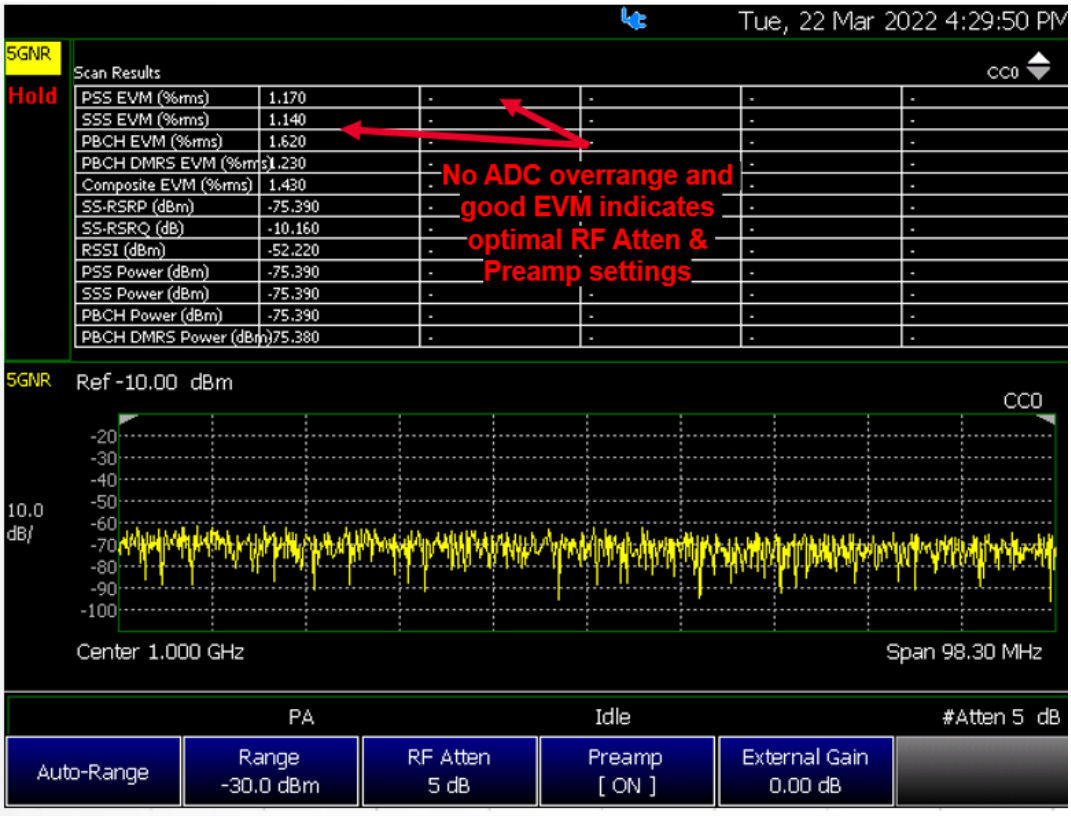


Figure 13-39 OTA 5G NR After Auto-Range and Clean Sweep



Troubleshooting

If your OTA setup is not behaving as expected:

- Verify setup is correct by referring to "How to Set Up Over–the–Air (OTA) Mode Settings" on page 377.
  - Attenuator set to **0 dB**
  - Preamplifier set to **ON**
  - Correct **Band**, **Channel**, and **Center** Frequency entered
  - GNSS set to **Internal**
  - Frequency Ref set to **GPS**
  - For LTE FDD and LTE TDD: Verify that the Frequency Error Threshold (dB)–(**FreqError Th**) value is large enough or not too large
  - For LTE FDD and LTE TDD: Verify that the **Extend Freq Lock** value is enabled and then adjust settings to improve your measurement
  - . For 5G TF: Check that the Frequency Correction Threshold value (%)– (**Sync Corr Th %**) is small enough or not too large.
  - ADC errors: Use **Scale/Amptd** > **Range** to adjust the absolute power level (dBm).

    For some data views, you need to press **More** to view the **Range** softkey.
  - No data displayed: Press **Meas Setup 4** – Only required if scan does not display data.
    - **LTE FDD** and **LTE TDD**: Press **FreqError Th** and change to **5 kHz** – Wait a few seconds until table populates or set **FreqLock Range** to **Extended**.
      - Then change back to the desired Frequency Error Threshold for your measurement.
    - **5G TF**: Press **SyncCorr Th** and change to **0%** – wait a few seconds until the Table populates and
      - Then change back to the desired Sync Correlation Threshold for your measurement.

Glossary (OTA)

This section provides a description of some of the terms used in the FieldFox's OTA mode.

Table 13-1 OTA Abbreviations and Descriptions

Abbreviation	Description
LTE FDD & LTE TDD	
Center Frequency	The specified LTE FDD carrier center frequency.
C/S/G	Physical Cell information (PCI), or Cell ID – C/ S /G
Cell ID (PCI)	Physical cell ID – The Primary Sync Signal and Secondary Sync Signal largely define the PCI. PCI is also referred to sometimes as Cell ID.
PSS	PSS (dBm) is the Primary Synchronization signal for an LTE downlink frame.
RSRP	Reference Symbol Received Power (dBm)
RSRQ	Reference Signal Received Quality (dBm)
RSSI	Reference Signal Strength Indicator (dBm)
SINR	Signal to Interference & Noise Ratio (dB)
SSS	SSS is the Secondary Synchronization signal for an LTE downlink frame (dBm).
Freq Error Th	LTE FDD and LTE TDD Frequency Error Threshold (Hz). Any data that is does not meet the defined Frequency Error value, is not displayed.
5G TF	
Center Frequency	The specified 5G TF carrier center frequency.
Cell ID (PCI)	Physical cell ID – The Primary Sync Signal and Secondary Sync Signal largely define the PCI. PCI is also referred to sometimes as Cell ID.
Power	(Channel Power) (dBm)
PSS	PSS (dBm) is the Primary Synchronization signal for an LTE downlink frame.
SSS	SSS is the Secondary Synchronization signal for an 5G TF downlink frame (dBm).
SyncCorr Th	5G TF Synchronization Correlation Threshold (%). Any data with errors that are less than the Synchronization Correlation Threshold (%) are not displayed.
5G NR	
Center Frequency	The specified 5G NR carrier center frequency.

Table 13-1 OTA Abbreviations and Descriptions

Abbreviation	Description
Cell ID (PCI (C-S-G))	Physical cell ID – The Primary Sync Signal and Secondary Sync Signal largely define the PCI. PCI is also referred to sometimes as Cell ID.
SSB Index (dBm)	Synchronization Signal Block Index
SS-RSRP /RSRP (dBm)	Synchronization Signal Reference Signal Received Power – The linear average over the power contributions (in [W]) of the resource elements that carry cell-specific reference signals within the considered measurement frequency bandwidth. For RSRP determination the cell-specific reference signals R0 according TS 36.211 [3] shall be used. If the UE can reliably detect that R1 is available it may use R1 in addition to R0 to determine RSRP. The reference point for the RSRP shall be the antenna connector of the UE.
SS-RSRQ /RSRQ (dB)	Synchronization Signal Reference Signal Received Quality
RSSI (dBm)	Received Signal Strength Indicator measures the average received power found only in OFDM symbols that for an antenna port that are part of the measurement bandwidth over N resource blocks.
SS-SINR/SINR (dB)	Synchronization Signal-to-Noise and Interference Ratio – Reference Signal to interference and noise ratio – indicates the values measured over the same bandwidth and normalized to one subcarrier bandwidth.
PSS (dBm)	PSS (dBm) is the Primary Synchronization signal for a 5G NR frame.
SSS (dBm)	SSS is the Secondary Synchronization signal for a 5G NR downlink frame (dBm).
DMRS (dBm)	Physical Broadcast Channel Demodulation Reference Signal (dBm). Used by 5G NR receiver to produce channel estimates for demodulation of associated physical channel.
Freq Error (Hz)	Frequency error is the difference of the transmitted signal quality from the ideal (Hz).
Chan Freq	Chan Freq is the channel frequency, when SSB Offset Detection has been enabled.
SSB Offset	Determines whether the measurement is a normal 5G NR measurement or an SSB offset measurement. When disabled, the measurement will be a normal 5G NR measurement; When enabled, the measurement will be an SSB offset measurement. The purpose of the SSB offset measurement is to measure the offset of the SSB from the current Center Frequency. Once you measure the SSB offset, you can use the results to update the Offset Frequency and make a normal 5G NR measurement.
SSB Freq	This is the SSB center frequency (the offset of the SSB from the channel center frequency).
ARFCN/GSCN	The synchronization raster ARFCN / GSCN associated with the SSB frequency (only displayed when Snap Sync Raster is enable).
Time Offset (us)	Time offset is defined as the time difference between the NR frame boundary and the beginning of the capture. And, is meant to be used with a “frame trigger” (GPS synced periodic trigger when measuring base station OTA signals). The frame boundary closest to the beginning of the capture is always used for the measurement (NR signals are periodic; so a single capture contains multiple frame boundaries).

Table 13-1 OTA Abbreviations and Descriptions

Abbreviation	Description
5G NR EMF Conducted	
Center Frequency	The specified 5G NR carrier center frequency.
Cell ID (PCI)	Physical cell ID – The Primary Sync Signal and Secondary Sync Signal largely define the PCI. PCI is also referred to sometimes as Cell ID.
SSB Numerology	Synchronization Signal Block (SSB)
ScsCommon	Subcarrier spacing common (ScsCommon)
SSB Case	Synchronization Signal Block Case (SSB Case)
SSB Lmax	Synchronization Signal Block (SSB Lmax) is the maximum number of SSBs within a SSB.
SSB Periodicity (ms)	Synchronization Signal Block Periodicity (SSB Periodicity (ms))
SSB RB Offset	Synchronization Signal Block Resource Block Offset (SB RB Offset)
SSB SC Offset	Synchronization Signal Block (SSB SC Offset)
SSB Delta Center (kHz)	Synchronization Signal Block Delta Center (SSB Delta Center (kHz))
Sync Corr (%)	Synchronization Correlation (Sync Corr (%))
Channel Power (dBm)	Channel power
Freq Error (Hz)	Frequency error (Hz)
Time Offset (ms)	Time Offset (ms) is one of the required EVM calculations.
PSS EVM (%rms)	PSS EVM (%rms) is the Primary Synchronization signal for 5G NR EVM.
SSS EVM (%rms)	SSS is the Secondary Synchronization signal for a 5G NR EVM (%rms).
PBCH DMRS EVM (%rms)	Physical Broadcast Channel Demodulation Reference Signal for EVM (%rms).
Composite EVM (%rms)	Composite EVM (%rms) analyzes the output of the combined signal from multiple transmit antennas.
SS-RSRP (dBm)	Synchronization signal reference signal received power (SS -RSRP) is defined as the linear average over the power contributions (in [W]) of the resource elements that carry secondary synchronization signals (SS).

Table 13-1 OTA Abbreviations and Descriptions

Abbreviation	Description
SS-RSRQ (dB)	Synchronization signal reference signal received quality (SS -RSRQ) is defined as the ratio of N x SS-RSRP/NR carrier RSSI. Here N refers to number of resource blocks in NR carrier RSSI measurement Bandwidth. The measurements in N (Numerator) and D (Denominator) are made over the same set of resource blocks (RBs)
RSSI (dBm)	Received Signal Strength Indicator measures the average received power found only in OFDM symbols that for an antenna port that are part of the measurement bandwidth over N resource blocks.

14 5G Rapid Prototype Phased Array Antenna – Option 360

CAUTION

IMPORTANT!

85571A-028 (28 GHz 5G Phased Array Antenna) accessories not suitable for use in wet locations.

PAA mode is compatible with the frequency converter heads, but cannot apply or edit the frequency head corrections. Refer to "Utilities" on page 842.

Learn more, refer to https://www.keysight.com/us/en/assets/9018-04847/user-manuals/9018-04847.pdf (N9938-90005).

NOTE

The FieldFox can be used with an OML frequency extender. Refer to "Utilities" on page 842, the B Series FieldFox Configuration Guide 5992-3701EN, and to "Contacting Keysight" on page 5.

Option 360 measures signals at the **SA RF Input Port 2** connector.

Option 360 requires the FieldFox to have SA mode (Option 233 on combination analyzers), and GPS (Option 307) installed.

Recommended, but not required, preamplifier (Option 235) to improve receiver sensitivity.

Keysight's FieldFox handheld analyzer (with Option 360) combined with a Ball Aerospace / Anokiwave 64-element antenna array provides a unique, portable solution for measuring and analyzing the 5G air interface in the field.

- Reduce measurement complexity with integrated RF probe and phased array solution to capture energy radiated from gNB
- Calibrated metrology milli-meter wave phased array antenna simulates 5G UE antenna performance
- Troubleshoot the 5G radio access network with 3D test coverage and path loss measurements utilizing the built-in CW generator
- Phased array performance verification showing bore sight, polar antenna pattern with compass, heat map and beam sweep to map display views

In this Chapter

"Using the Phased Array Antenna (Option 360)" on page 437

"About Phased Array Antenna Measurements" on page 438

– "Phased Array Antenna Features (Option 360)" on page 438

"How to Set Up Phased Array Antenna Settings" on page 447

– "Option 360 Setup Procedure" on page 447

– "How to Define a Set Up a Scan and Use Option 360" on page 459

"How to Use Data Logging/Playback (Option 360)" on page 468

– "Screen Annotation" on page 468

– "How to Record a Data Log" on page 470

– "To change Data Logging Configuration settings:" on page 470

– "How to Playback a Data Log" on page 471

"Using Mapping" on page 472

"Other Features Available" on page 472

– **Alignments (SA chapter)** – "Alignments" on page 211

– **External Gain (SA chapter)** – "External Gain" on page 162

– **Field Strength Corrections (SA)** – "How to select and edit corrections for Field Strength measurements" on page 165

– **Scale Settings (Data Analysis)** – "All about Scale Settings" on page 831

"Troubleshooting" on page 473

See Also

"Why and When to Calibrate" on page 129

Chapter 16, "Indoor and Outdoor Mapping – Option 352 (Requires Spectrum Analyzer Mode (Option 233), and GPS Receiver (Option 307))."

Chapter 32, "System Settings." (Changing display colors)

Chapter 34, "File Management."

Using the Phased Array Antenna (Option 360)

Option 360 enables you to do the following:

Measure and display phased array antenna elevation and azimuth	
Four Display Types:	
– Bore-Site	– Park Antenna
– Heat Map	– Polar with Image Overlay
– Polar Antenna	
Color Coded Display Types:	
– Specify high and low power with color bars	
Azimuth and Elevation:	
– 8 x 8 phased array antenna	– Covers beam sweep –60 to +60 degrees azimuth, 90-degree elevation with 1 degree per step
– Individually factory characterized elements, magnitude and phase	
Data Logging GPS stamped data measurements	
– Define measurement interval by time or distance	– Display files (KML) on Google Maps or Google Earth
– Show results in TableChart	

About Phased Array Antenna Measurements

Some measurement parameters are auto-coupled and are not user-settable.

Phased Array Antenna Features (Option 360)

NOTE

IMPORTANT! Option 360 antenna requires a static IP address. If it is required to have available an IP address that can be accessed over your company's network, work with your company's IT team to set up a static IP that works over the network.

IMPORTANT! If you forget you N9910X-028 Ball Antenna's static IP address, refer to this link and the **Support** tab for assistance: www.keysight.com/find/fieldfox and then to the **Phase Array Antenna Support Document**.

Phased array antenna has the following features:

Scan Results:

- 28 GHz operation
- gNB RF parametric test over-the-air in the field
- Measure EIRP (effective isotropic radiated power)
- Milli-meter wave beam sweep survey with map
- Support for real-time spectrum analysis, transmitter power and spectrum emission mask (SEM)

Data Formats:

User can set up and display the following:

- **Bore-Sight** – Elevation angle is fixed. Scan azimuth –60 degrees to +60 degrees.
- **Heat Map** – Scan both elevation and azimuth angle with adjustable color "heat" amplitude scale.
- **Polar ANT** – Scan azimuth angle. Elevation is fixed.
- **Park ANT** – Polar image overlay load image:
  - Resize polar coordinates
  - Specify alignment angles
  - Specify compass true north
  - Define antenna direction (azimuth degrees)

Figure 14-1 Example of local point-to-point LAN connection

Figure 14-2 Bore-Sight Scan – CW RF

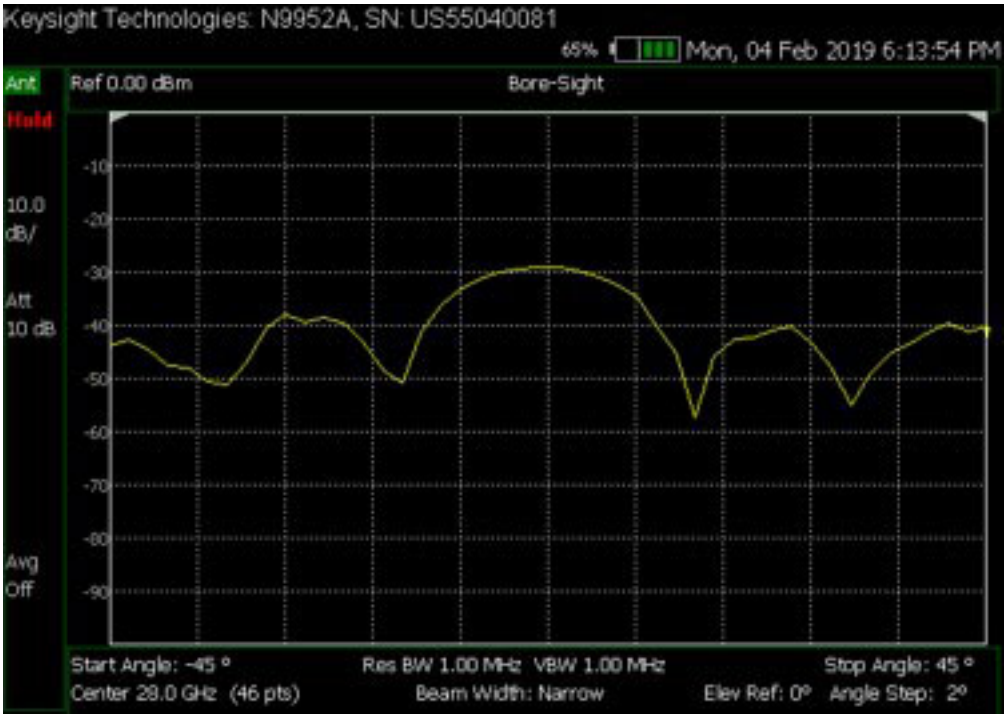


Figure 14-3 Polar Scan with compass displayed

Figure 14-4 Heat Map (Azimuth vs. Elevation) - Parked Antenna

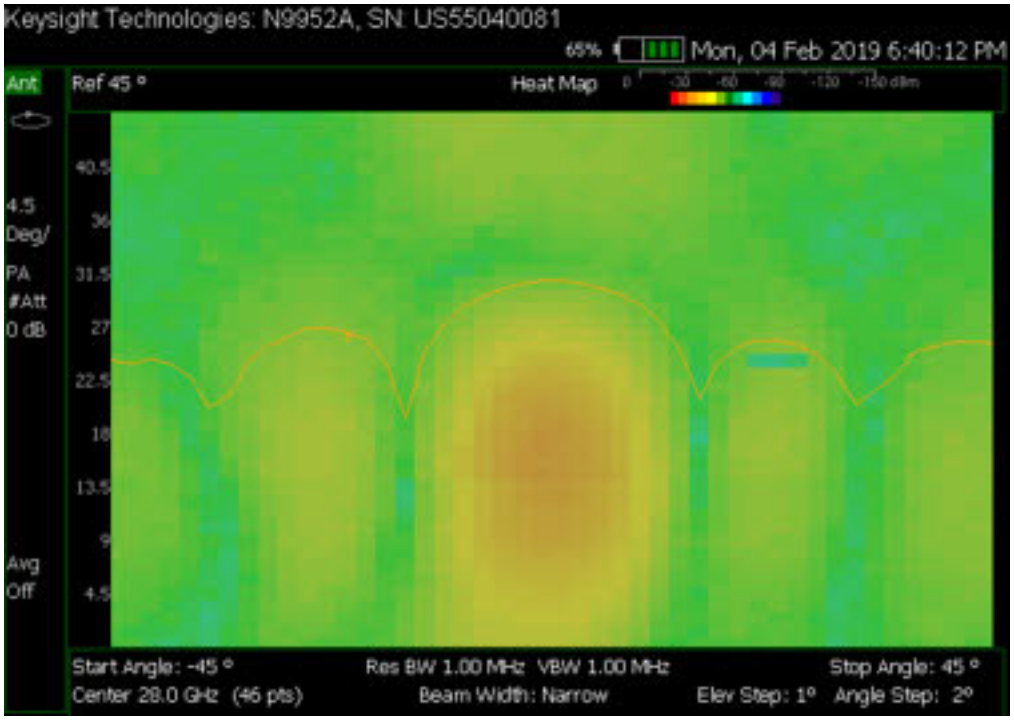
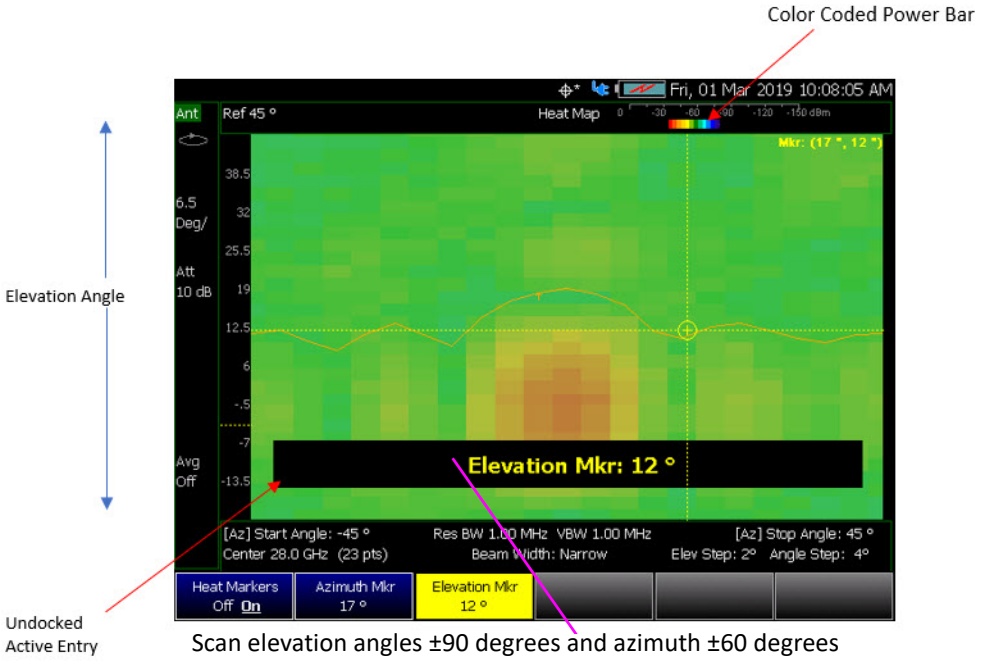
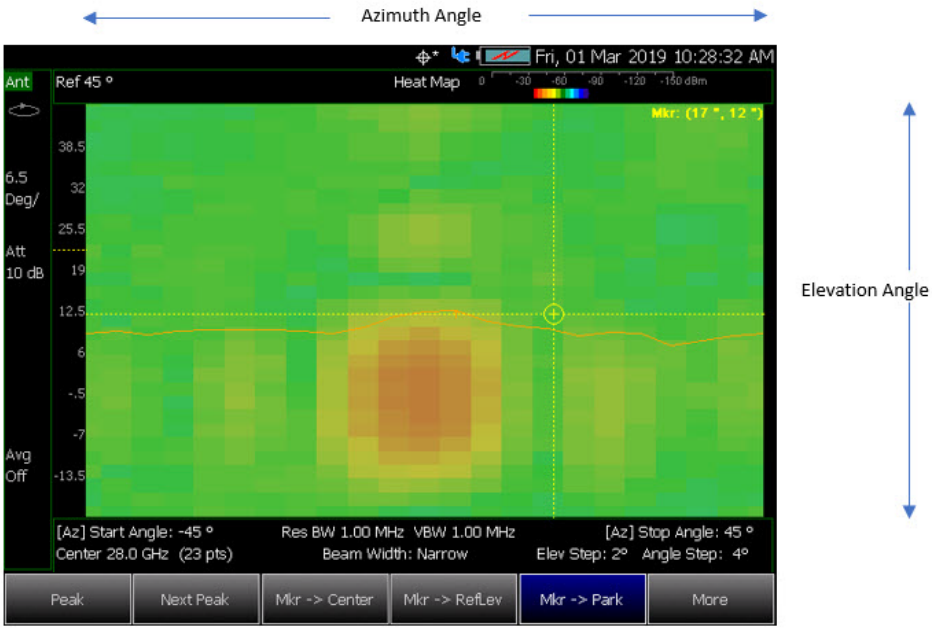


Figure 14-5 Heat Map and Undocked Active Entry – Parked Antenna



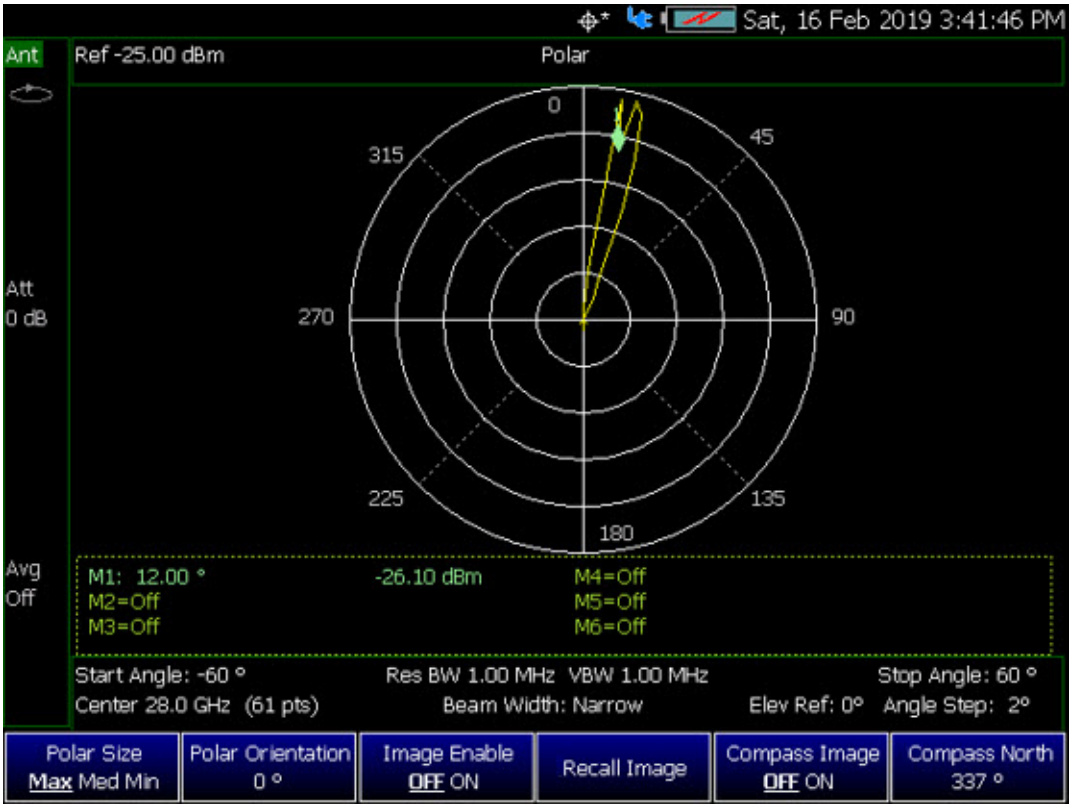
Scan elevation angles ±90 degrees and azimuth ±60 degrees

Scan Elevation Angle (Y) vs Azimuth Angle (X)



- Select [Mkr > Park] to park the antenna at fixed elevation, azimuth.
- Marker value shows (azimuth, elevation) pair on Heat Map

Figure 14-6 Polar Assign Orientation and Polar with Compass Orientation



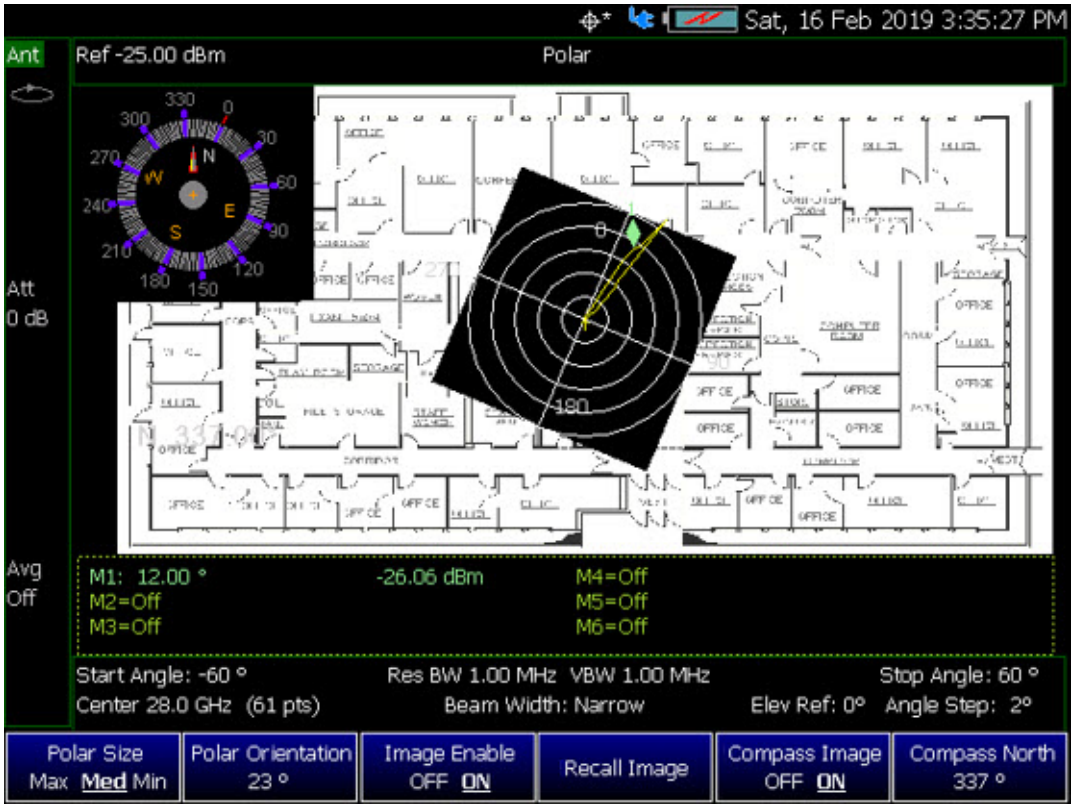
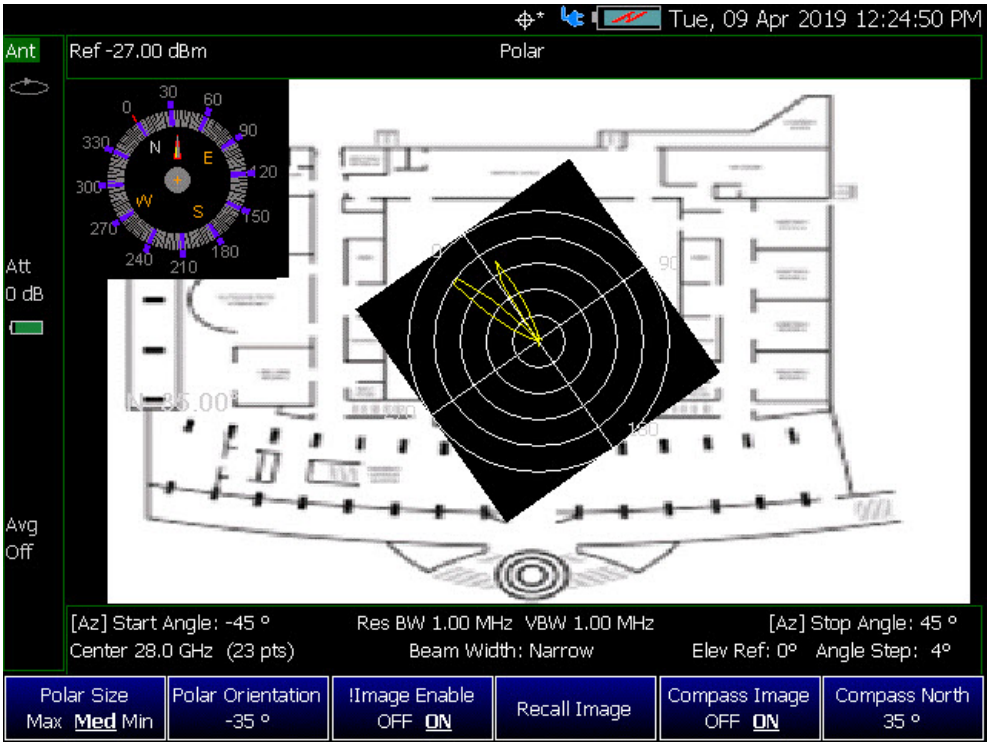


Figure 14-7 Polar Measurement with Compass with Recalled Image of Indoor Auditorium



CW vs. Pulsed RF Measurements

NOTE

IMPORTANT! For pulsed RF measurements, increasing the Dwell Time is recommended for faster throughput and accurate signal capture in a single sweep.

Figure 14-8 Bore-Site Measurement with CW RF (Dwell Time=10 ms, Max Hold=OFF)

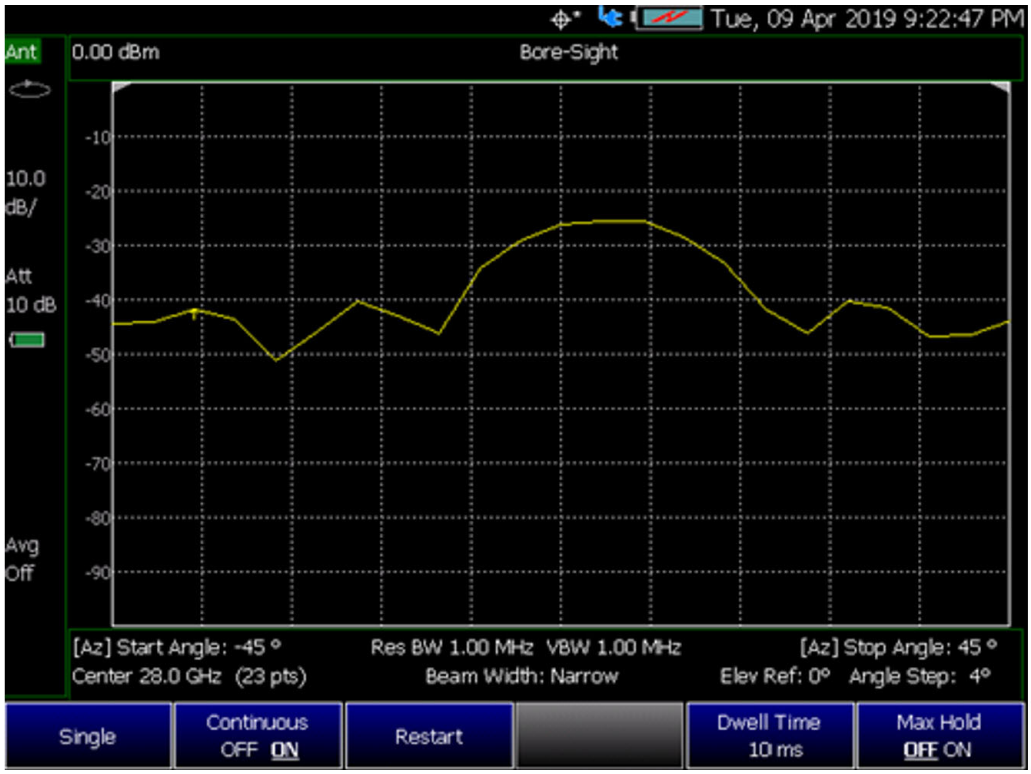


Figure 14-9 Bore-Site Measurement with Pulsed RF (Dwell Time=10 ms, Max Hold=OFF)

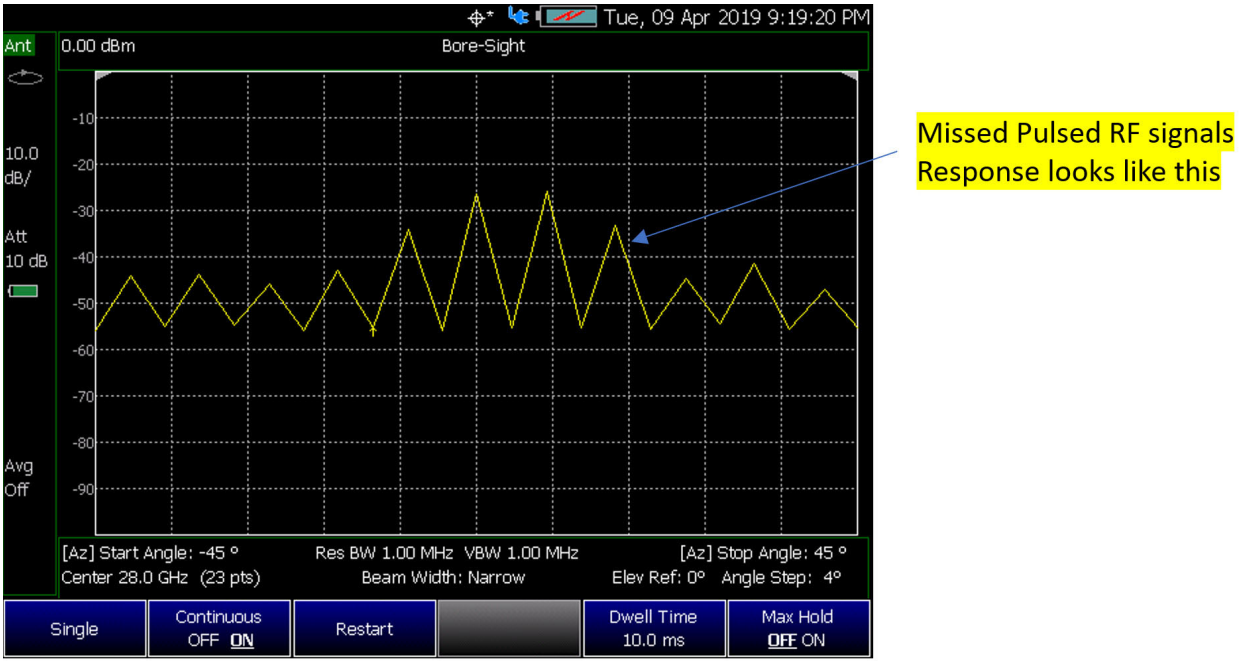
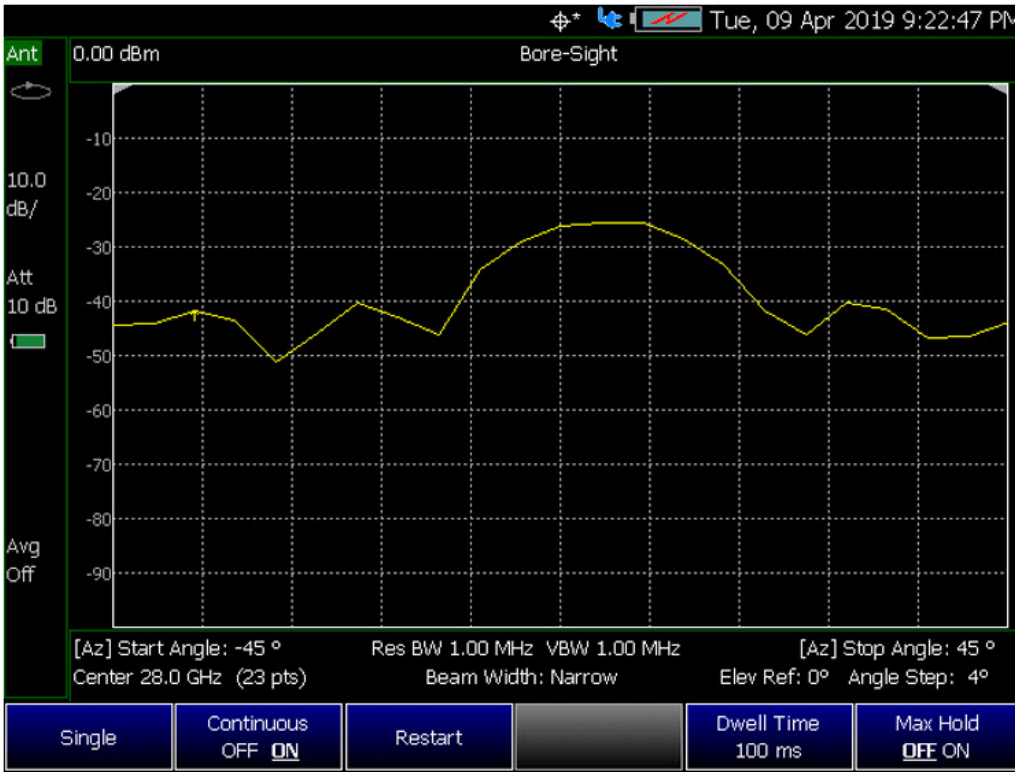


Figure 14-10 Bore-Site Measurement with Pulsed RF (Dwell Time=100 ms, Max Hold=OFF)



How to Set Up Phased Array Antenna Settings

NOTE

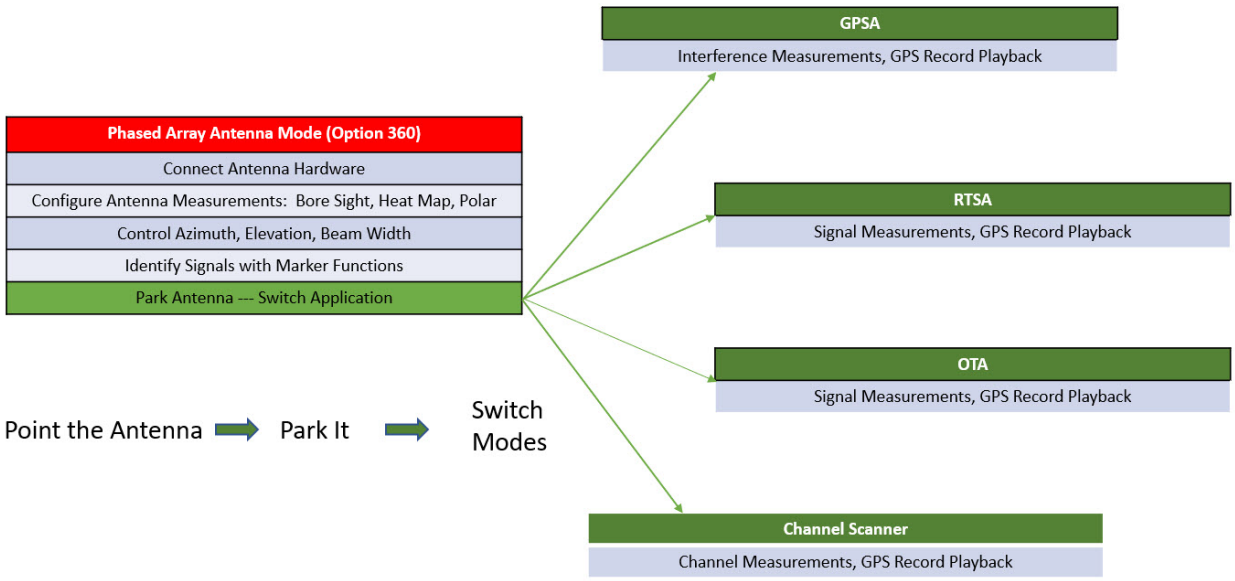
IMPORTANT! See also, “Alignments” on page 211, in NA mode,Chapter 9, “SA (Spectrum Analyzer) Mode (Option 233–Mixed Analyzers).”

This section reviews the steps in setting up an Option 360 measurement. If you are not familiar with this process or would like more information, refer to “How to Define a Set Up a Scan and Use Option 360”

This section consists of:

– “Option 360 Setup Procedure”

Figure 14-11 Setting Up Option 360 Using Other Modes



Option 360 Setup Procedure

1. Connect your equipment similar to Figure 14-1 on page 439.
2. Set FieldFox to use static IP address:

   Press **System**

   – Then **System Configuration** > **More** > **LAN**

   a. In the Setting screen, use the ▲|▼ arrows, the rotary knob, or numeric keypad to highlight Obtain IP.

   b. Press Edit >**Obtain IP Static**

   c. Press **Done Edit** > **Done**

NOTE

IMPORTANT! The LAN address for first 3 fields must match the Static IP address of FieldFox. For example, if the Ball Antenna IP address is **192.168.1**.10, set FieldFox Static IP address to **192.168.1**.xx. "xx" must be different number than shown in the last field of the for Ball Antenna. Refer to Figure 14-15 on page 457.

IMPORTANT! If you forget you N9910X-028 Ball Antenna's static IP address, refer to this link and the **Support** tab for assistance: www.keysight.com/find/fieldfox and then to the **Phase Array Antenna Support Document.**

3. Selecting phased array antenna mode using the Antenna Wizard:
   a. Press **Measure**.
   b. Then **Antenna Wizard**
   c. Follow the prompts. See Figure 14-12.

NOTE

Once the connect is correct, the FieldFox's displayed annotation indicating "`Check LAN connection. Check IP address.`" is no longer displayed during pinging of the Host IP address.

Figure 14-12 Antenna Wizard Screen

4. Aligning the antenna's azimuth and elevation orientation:

   Refer to Figure 14-14 on page 450.

Figure 14-13 Site Wide LAN Configurations and Field Measurements Configurations

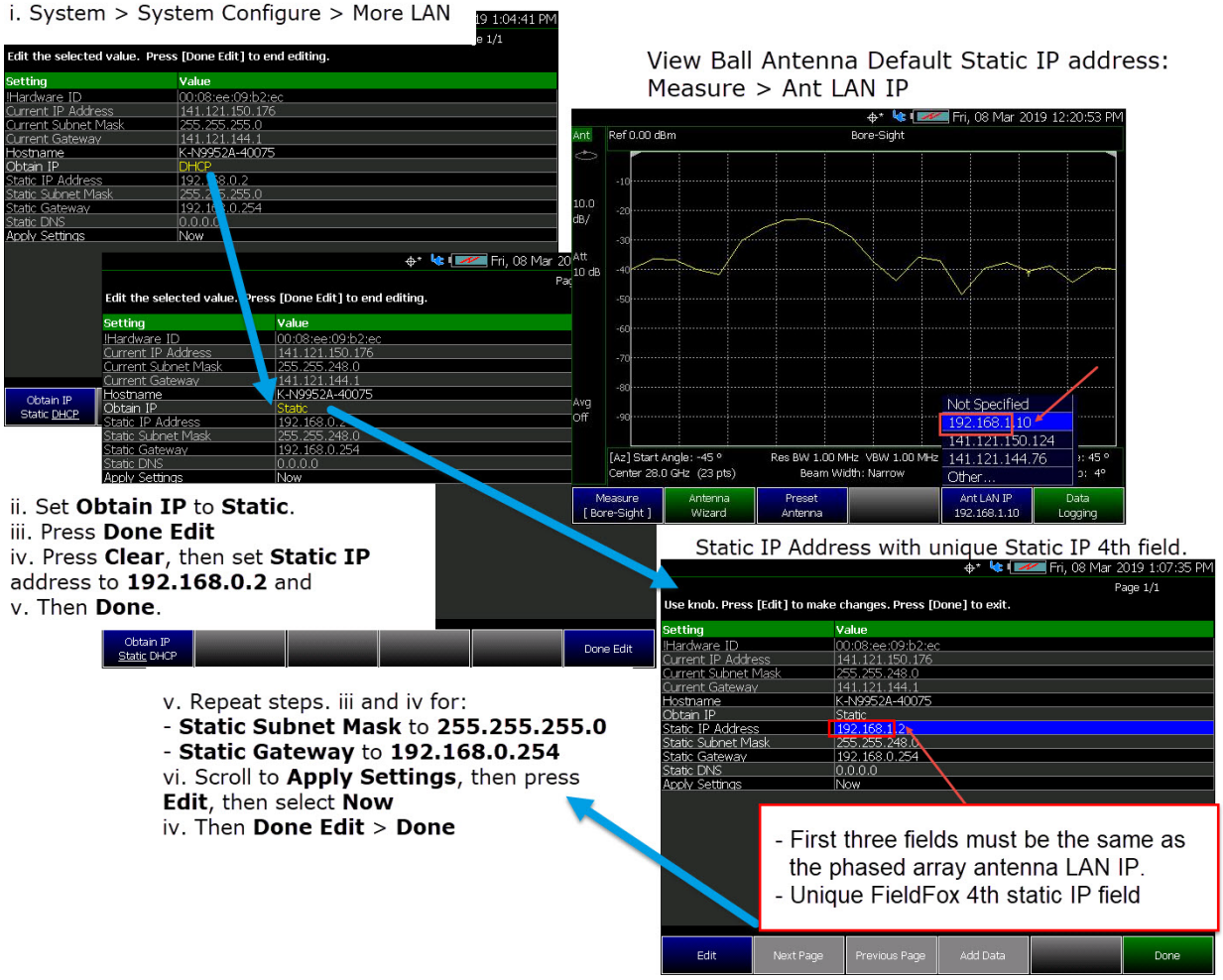
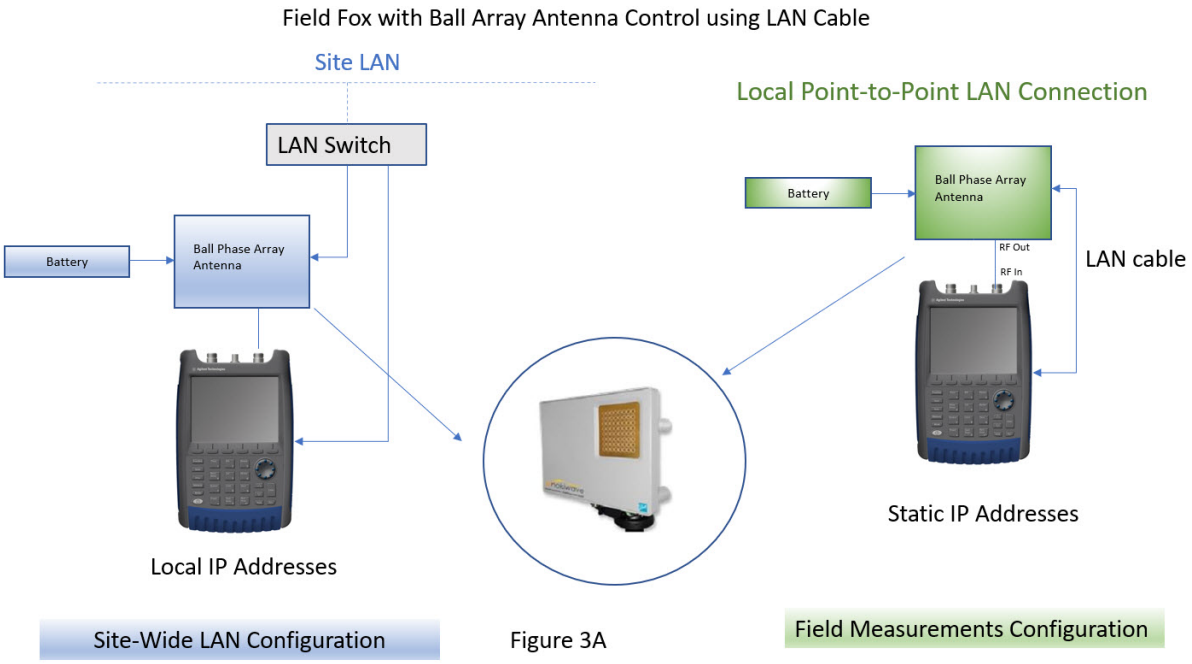
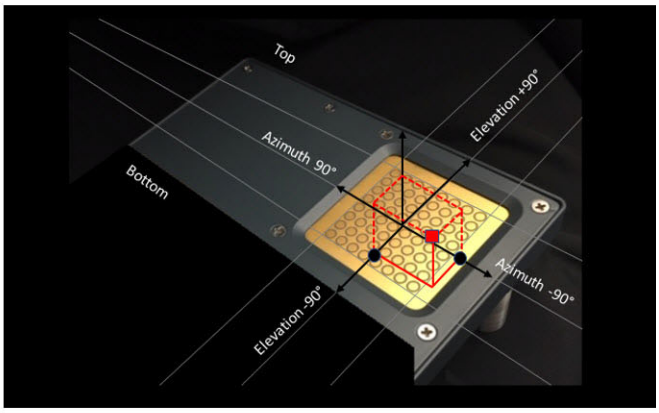


Figure 14-14 Site Wide LAN Configurations and Field Measurements Configurations



Azimuth and Elevation Alignment Orientation Diagram

Antenna Orientation Diagram



5. Entering the phased array antenna measurement type:

   Refer to "Data Formats:" on page 438.

   Select **Measure**:

   - **Measure**–choose:
     - **Bore-Sight** or
     - **Heat Map** or
     - **Polar ANT** or
     - **Park ANT**

6. Using the table to enter phased array antenna settings, presetting the antenna, setting the antenna LAN IP, and clearing the graphics:

   Refer to Figure 14-16 on page 458.

   Select **Meas Setup**:

   - **Antenna Settings**–choose:
     - **Ball Antenna** > LAN Address
     - **Settings**–choose:
       - ––Res BW or
       - ––Video BW
       - ––Beam Width
     - **Array Antenna**–choose:
       - ––Center
       - ––Azimuth Ref
       - ––Elevation Ref
     - **Polar Display** >**Ref**
     - **Sweep** > **Dwell Time** (Optional. For pulsed RF measurements it is recommended that the Dwell Time is increased.)
     - **Sweep** > **Max Hold** (Optional. For pulsed RF measurements it is recommended that Max Hold is set to OFF when using the Heat Map display. (Default = OFF).)
   - **Preset Antenna** presets the antenna settings factory defaults.
   - **Ant LAN IP** enter the Ball antenna's LAN IP. First three fields must match the FieldFox's static IP address (default: 192.168.1.10). Refer to Figure 14-15 on page 457.

– Clear Graphics If applicable, this clears the current displayed PNG graphic from the screen.

NOTE

If after making the setting changes in the steps below, no data is displayed, refer to "Troubleshooting" on page 473.

7. User markers to identify azimuth and elevations settings:

   Select Marker –choose:

   – Marker 1 2 3 4 5 6 – You can set up to six markers. The OFF, Normal, Delta, or Peak softkey is black to indicate the current setting of each marker.
   – Normal displays a marker.
   – Delta displays a marker relative to another active marker.
   – Peak displays a marker on the peak point of the displayed trace.
   – More – choose.
   – Marker Trace – You can set up to four traces.
   – Marker Table – Enable or disable the marker table that displays the current markers and their values.

   Learn more about markers. Refer to the Chapter 31, "Data Analysis Features.".

   See also Figure 14-5 on page 442.

8. Enable the **Data Logging** settings:

   – Press Trace 6 > Data Logging then
      – Record (Outdoor Logging) or
      – Play (If you have previously stored data recordings.) or
   – To set Data Logging–choose:
      a. Record Settings (Outdoor Mapping only) – then choose:
         – Optional: Then Meas Interval > **ON**
         – Then Interval Type > choose **Time** or **Distance**.
         – Then, if applicable Time Interval enter time interval in seconds.

           Or
         – Then, if applicable Distance Interval enter distance interval in miters.
         – Then Back

b. Record Save/Recall (If you have previously stored data recordings.)

- Save Log File or
- Recall Log File or
- User Folder Def System (Default = Default) or
- File Type (Default = KML) CVS or DREC (DREC is only available with Option 360 only)
- Then Auto Save OFF ON (Default = OFF).

CAUTION Spectrum information is not recorded. Only the TableChart data are saved. See "How to Record a Data Log" on page 470.

NOTE Data Log-Play files are saved to:

- If File Folder is set to Default then Data Log-Play files are save-recalled to: "[CurrentDevice]\RecordPlayback\PAA"
- If File Folders are set to System, then Data Log-Play files are save-recalled to: "CurrentDevice\<UserSelectedFolder>\

NOTE Learn more about file settings, refer to Chapter 34, "File Management.".

c. Indoor Map Data Logging - then Record Indoor Data or Recall Indoor Log File.

- Then choose Navigate OFF ON, Data Selection, Zoom, Pan, Record Data, More

9. Press Back to return to previous menu.

10. If recording, then:

- Pause Resume Temporarily halts recording until pressed again. The incoming trace continues to sweep. Press again to continue recording.
- Stop Immediately
  - The Save the log file menu opens. Edit the filename and press Done to exit menu. See Settings below and "To change Data Logging Configuration settings:" on page 470.
  - To change your file settings or measurement interval. Learn more, refer to "To change Data Logging Configuration settings:" on page 470.
- (Press Record to begin a new recording.)

– Then Maps To enable map view and related features (e.g., Data Selection, Red/Blue Limits, Labels & Icons, Zoom).

  Then choose from the following:

  – View Map OFF ON To enable/disable the current map view (default = latitude/longitude = 0.00/00. Need GPS to view current location (default = OFF).

  – Data Selection Opens a softkey menu to set the active data channel, sort type, and sort order.

    Learn more, refer to Chapter 16 Mapping and “Setting up Data Logging” on page 519. See also, Chapter 34, “File Management.”

  – Red/Blue Limits Opens a softkey menu to assign power values to the red (high power limits) and blue (low power limits) heat map display limits (defaults: Red Limit = –20 dBm, Blue limit = –90 dBm).

  – Labels & Icons Opens a softkey menu to enable/disable map data point labels and icon types.

Labels OFF ON	Enables/Disables map data point labels. When enabled, a label is displayed for every map data point (e.g., “Data 1”). When disabled, labels are not displayed for the map data points.
Icons Flag Point Line	Sets the type of icon that is used to display a map’s data points.

– Save Image (PNG) Saves the current displayed map to a *.png file (default filename is “MapImageFile”).

NOTE

Data Log-Play files are saved to:

– If File Folder is set to Default then Data Log-Play files are save-recalled to: "`[CurrentDevice]\RecordPlayback\PAA`"

– If File Folders are set to System, then Data Log-Play files are save-recalled to: "`CurrentDevice\<UserSelectedFolder>\`

11. Export KML file into 3rd party mapping software (i.e., Google Map or Google Earth). Refer to “Step 7: Import and Play back KML Files into 3rd Party Software (Example: Google Earth with Animation Tool)” on page 467.

12. Select Trace 6–choose:

    For this step, refer to Figure 14-6 on page 443.

    – Polar Size Max Med Min Sets the size of the polar display. Smaller sizes used to overlay PNG maps. (Default = Max)

- **Polar Orientation** Aligns the antenna polar display to a selected direction.
- **Image Enable OFF ON** (Optional to overlay antenna bore-sight direction. Only active if you have recalled a PNG image to display on the FieldFox as a map. (Default = OFF)
- **Recall Image** Use to recall PNG map to overlay antenna direction.
- **Compass Image OFF ON** To display a compass indicating true north for antenna. (Default = ON)
- **Compass North** Use this softkey to align the compass' true north value in degrees.

Repeat process as needed for additional settings.

13. Optional: Press **Freq/Dist**

- Press **Antenna Settings** opens the table antenna settings softkey menu, where you can define your phased array antenna settings, Ball Antenna: LAN address, Settings: Resolution BW, Video BW, Beam Width, Array Antenna: Center frequency, Azimuth Ref, Elevation Ref, and Polar Display: Ref. For details, refer to step 6 above.
- Then **Start Azimuth** +/-45 degrees. (Default = 45 degrees)
- Then **Stop Azimuth** +/-45 degrees. (Default = 45 degrees)
- Then **Ref Elevation** +/-45 degrees. (Default = 0 degrees)

14. Optional: choose change sweep, dwell time, and max hold settings:

Press **Sweep**

Then choose:

- **Dwell Time** to set the delay between the antenna positioning from 1 ms to 10 seconds (default: 10 ms). For pulsed RF measurements it is recommended that you increase the Dwell Time to ~100 ms.
- **Max Hold** For pulsed RF measurements, it is recommended that Max Hold is set to OFF when using the Heat Map display. (Default = OFF)
- **Single**
- **Continuous** to enable or disable the continuous sweep (default: ON).

  Learn more, refer to Chapter 9, "SA (Spectrum Analyzer) Mode (Option 233–Mixed Analyzers)."
- **Restart**

15. Optional: choose devices and save files:

Press **Save/Recall**

Then choose:

- Save to set the attenuator power (default: –10 dB). Set to **0 dB**.
- Recall change to **ON**.
- Device to set the absolute power (dBm)
- File Type then choose:
  - State Saves the current state settings
  - Trace+State Saves the current Trace+State information
  - Picture (PNG) to save the current displayed trace as a PNG
  - Data (CSV) save files as a CSV file

Learn more, refer to Chapter 34, “File Management.”

16. Optional: Modify scale and amplitude values:

Press Scale/Amptd

Then one of the following:

- Autoscale Automatically adjusts the Y-axis minimum and maximum values.
- Scale Manually enter a **scale per division** values.
- Others: Scale, Ref Level, etcetera as desired.

Learn more, refer to Chapter 31, “Data Analysis Features.”

17. Optional: Modify the averaging and Integrated BW settings:

Press BW

Then one of the following:

- Average Enable OFF ON
- Average Count
- Integ BW

Learn more, refer to Chapter 31, “Data Analysis Features” and Chapter 9, “SA (Spectrum Analyzer) Mode (Option 233–Mixed Analyzers).”

Figure 14-15 Example of Phased Array Antenna and FieldFox Static IP Setup - First Three Static IP Fields Are the Same

Setting the phased array antenna IP address

Setting the FieldFox static IP address - First three fields the same as the antenna

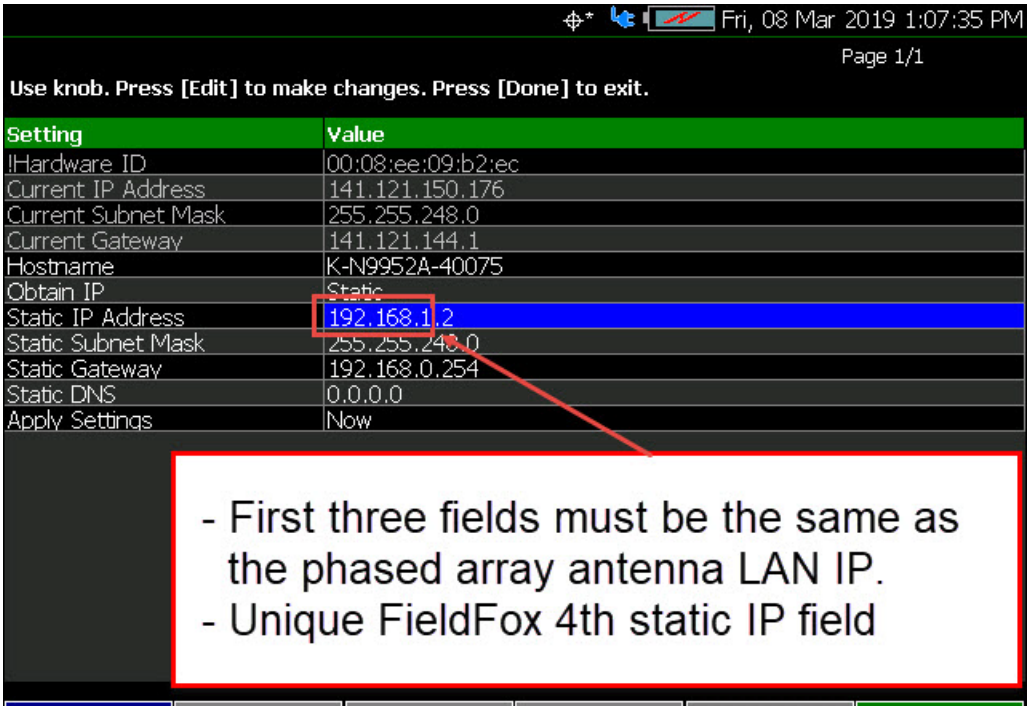


Figure 14-16 Example Antenna Settings Table

How to Define a Set Up a Scan and Use Option 360

You can define measurements by selecting which type of data to display.

Data definitions consist of the following:

– Select the measurement type

– Define the antenna setting, using the antenna settings table

– Define other optional marker, sweep, averaging, bandwidth settings

Example: Refer to:

– "Step 1. Connect Your Equipment" on page 459

– "Step 2. Set FieldFox to Use Static IP with Your Ball Antenna" on page 459

– "Step 3. Define the measurement" on page 460

Then:

– "Step 4: Select Polar Settings" on page 462

– "Step 5. Modify Scale and Attenuator Settings" on page 462

– "Step 6: Enable Data Logging and Playback the Results" on page 463

– "Step 7: Import and Play back KML Files into 3rd Party Software (Example: Google Earth with Animation Tool)" on page 467

Step 1. Connect Your Equipment

Connect your equipment similar to Figure 14-1 on page 439.

Step 2. Set FieldFox to Use Static IP with Your Ball Antenna

NOTE

IMPORTANT! The LAN address for first 3 fields must match the Static IP address of FieldFox. For example, the Ball Antenna's factory IP address is **192.168.0**.10, set FieldFox Static IP address to **192.168.0**.xx. "xx" must be different number than shown in the last field of the for Ball Antenna. Refer to Figure 14-15 on page 457.

IMPORTANT! If you forget you N9910X-028 Ball Antenna's static IP address, refer to this link and the **Support** tab for assistance: www.keysight.com/find/fieldfox and then to the **Phase Array Antenna Support Document**.

– The Ball antenna's default static IP address is: `192.168.1.10`

– Set FieldFox to use static IP address:

  Press **System**

  – Then **System Configuration** > **More** > **LAN**

1. In the Setting screen, use the ▲|▼ arrows, the rotary knob, or numeric keypad to highlight Obtain IP.
2. Press **Obtain IP Static**
3. Press **Clear**, then set the **Static IP Address** to: `192.168.1.2`

   and
4. Press **Done**
5. Press **Clear**, then set the **Static Subnet Mask** to: `255.255.255.0`

   and
6. Press **Done**
7. Press **Clear**, then set the **Static Gateway** to: `192.168.1.254`

   and
8. Press **Done**
9. Using the ▲|▼ arrows, the rotary knob, or numeric keypad to select Apply Settings.
10. Press **Edit**, then select **Now**.
11. Press **Done Edit** > **Done**

Step 3. Define the measurement

1. Press **Preset** then **Mode Preset (Factory)**
2. Selecting Phased Array Antenna mode: Press **Mode** > **Phased Array Antenna**. Depending on the number of options loaded on your FieldFox, it may be necessary to press **More**.
3. Optimizing the FieldFox to scan for signals:
   a. Run the Antenna Wizard: Measure > **Antenna Wizard** and follow the prompts.
   b. Set the **Measure** type (i.e., Bore-Sight, Heat Map, Polar ANT, or Park ANT).

      See also "How to Set Up Phased Array Antenna Settings" on page 447.
   c. Set the **Meas Setup** > **Antenna Settings** table:
      - Ball Antenna: LAN address
      - Settings: Res BW, Video BW, and Beam Width

- Array Antenna: Center frequency, Azimuth Ref, and Elevation Ref
- Polar Display: Ref

See also "How to Set Up Phased Array Antenna Settings" on page 447.

d. Optional: **Measure** > **Data Logging**:

- **Record Settings** (Outdoor Mapping only) then choose
  - **Measure Interval OFF ON**
  - **Interval Type Time Distance**
  - **Time Interval** if applicable (only active when Interval Type = Time) or
  - **Distance Interval** if applicable (only active when Interval Type = Distance)
  - **Auto Save OFF ON**
  - **Back** to return to previous menu

e. **Record Save/Recall** (Save Log File, Recall or

f. **Record** or

g. **Play** if you have a previously stored data scan

See also "How to Set Up Phased Array Antenna Settings" on page 447 and "Step 6: Enable Data Logging and Playback the Results" on page 463.

Learn more, refer to Chapter 16 Mapping and "Setting up Data Logging" on page 519

h. Optional: Press **Sweep 3** and modify/select items:

- **Single**
- **Continuous OFF ON** to **ON** (default)
- **Restart**
- **Dwell Time** For pulsed RF measurements, it is recommended that the Dwell Time is increased to ~100 ms.
  Default = 10 ms.
- **Max Hold** For pulsed RF measurements, it is recommended that Max Hold is set to OFF when using the Heat Map display. (Default = OFF)

NOTE

IMPORTANT! It is **not** sufficient to be locked to the GNSS satellite, the frequency reference must be locked to GPS. Refer to Chapter 32, "System Settings" and then to "How to make GPS settings" on page 866.

Step 4: Select Polar Settings

Select one of the following display orientations:

Select **Trace 6**–choose:

For this step, refer to Figure 14-6 on page 443 and see also "How to Set Up Phased Array Antenna Settings" on page 447.

- **Polar Size Max Med Min** or
- **Polar Orientation** or
- **Image Enable OFF ON** or
- **Recall Image** or
- **Compass Image OFF ON** or
- **Compass North** or

Step 5. Modify Scale and Attenuator Settings

To set the scan's scaling and receiver corrections:

Learn more, see "How to select and edit corrections for Field Strength measurements" on page 165.

1. Press **Scale/Amptd** >**Corrections** then choose:
    - **Apply Corrections OFF ON**
    - **RcvrSide Antenna** then choose:
        - **Antenna OFF ON**
        - **Edit Antenna**
        - **New**
        - **Save Antenna**
        - **Recall Antenna**
        - **Storage Device**
    - **RcvrSide Cable** then choose:
        - **Cable OFF ON**
        - **Edit Cable**
        - **New**
        - **Save Cable**
        - **Recall Cable**
        - **Storage Device**

2. Press Scale/Amptd then choose:
   - Autoscale
   - Unit dBm
   - External Gain
   - External Gain

Step 6: Enable Data Logging and Playback the Results

CAUTION

Spectrum and Strip Chart information is not recorded. Only the Table and Bar Chart data are saved. See "How to Record a Data Log" on page 470.

Data Logging creates a record of your data with a timestamp and GPS stamp (refer to "GNSS (GPS+) and GPS" on page 865). GPS must be enabled for the log results to include a GPS stamp or use Preferences to enable the timestamp. Refer to Chapter 32, "System Settings."

Features

- Log files contain cell results for different component carriers (CCs) including timestamps and/or distance stamps.
  - Timestamps are included in log files with or without GPS.
  - GPS must be enabled for log altitude results.

    See also "GNSS (GPS+) and GPS" on page 865.
- Data results can be logged
- Data results can be saved to a *.CSV, DREC (Option 360 only), or *.KML file. Refer to "" on page 466.
- User specifies how often results are stored.
  - Time: Store results every "n" seconds
  - Altitude: Store results every "n" meters. GPS must be enabled to store results by altitude.

Procedure

1. Press Trace 6 > Data Logging to view the Data Logging softkeys and set the Record Settings, Record Save/Recall, and Indoor Map Data Logging.
   - Record (Outdoor Logging) or
   - Play (If you have previously stored data recordings.)

   a. **Outdoor Mapping only**: To set the Record Settings—choose:
      - Meas Interval

- Interval Type Time or Distance
- Time Interval or
- Distance Interval

b. Then press Record Save/Recall

- Then File Folder Default System
  - Default – Sets the default User Folder path:
    - List files (*.csv and *.kml) are save-recalled to:
      "[CurrentDevice]:\RecordPlayback\PAA\"
    - Data Log-Play files are save-recalled to:
      "[CurrentDevice]:\RecordPlayback\PAA\"

    Or
  - System – Sets the User Folder to the user defined system folder path/name:
    - List files are save to-from
      "CurrentDevice\<UserSelectedFolder>\"
    - Data Log-Play files are save-recalled to:
      "CurrentDevice\<UserSelectedFolder>\"

    Refer to “File Management” on page 887.
- Then File Type
  - KML (default) or
  - CSV
  - DCREC (Option 360 only)

NOTE

Three file types are supported for save or recall log results:

- KML file format
  - Files stored in this format can be imported into 3rd party applications like Google Earth or Google Maps.
- CSV file format. Files stored into this format can be imported into spreadsheet applications.
- DREC file format. This file type is a binary file. File contains recorded state and trace data, with GPS time and locations stamps if enabled. Available with Option 360 only.

- Then Save Log File.

  or

- Then Recall Log File.
- Auto Save (default = OFF)
- Then Back

c. Optional: Press Indoor Map Data Logging then

- Record Indoor Data or Recall Indoor Log File. Learn more, refer to "How to Use Data Logging/Playback (Option 360)" on page 468, Chapter 16 Mapping and "Option 352 Indoor Maps Setup Procedure" on page 507.
- Then choose from Navigate OFF ON, Data Selection, Zoom, Pan, Record Data, More
- Learn more, refer to Chapter 16 Mapping and "Setting up Data Logging" on page 519.

2. Press Back to return to previous menu.
3. Outdoor Mapping: Press Record to begin a new recording and then

- Pause Resume Temporarily halts recording until pressed again. The incoming trace continues to sweep. Press again to continue recording.
- Stop Immediately stops recording and a "Save the Log File" menu opens to rename and save your data log file.
- (Press Record to begin a new recording.)
- Then Maps To enable map view and related features (e.g., Data Selection, Red/Blue Limits, Labels & Icons, Zoom).
  - View Map OFF ON Displays the current GPS location.
  - Data Selection Opens a softkey menu to set the active data channel, sort type, and sort order. See also previous steps 10 in "How to Set Up Phased Array Antenna Settings" on page 447.
  - Red/Blue Limits Opens a softkey menu to assign power values to the red (high power limits) and blue (low power limits) heat map display limits (defaults: Red Limit = –20 dBm, Blue limit = –90 dBm).

– **Labels & Icons** Opens a softkey menu to enable/disable map data point labels and icon types.

Labels OFF ON	Enables/Disables map data point labels. When enabled, a label is displayed for every map data point (e.g., "Data 1"). When disabled, labels are not displayed for the map data points.
Icons Flag Point Line	Sets the type of icon that is used to display a map's data points (default = Flag).

– **Save Image (PNG)** Saves the current displayed map to a *.png file (default filename is "MapImageFile").

4. When done press **Stop**. The log file is automatically saved to the defined Device Type and File Type.

   Else, edit the User Folder and File Type, under **Record Save/Recall** where the file results will be stored.

NOTE Learn more about file settings, refer to the Chapter 34, "File Management".

5. Press **Back**

Playing a Data Log and Viewing the Data

To play the log results:

1. Press **Record Save/Recall** > **Recall Log File**

   And, use the Use the RPG or the ▲▼ arrow keys to highlight the file to be played.

2. Press **Recall File** > **Back** > **Play**
3. Press **Stop** to exit the log playing.

To pause the log play:

1. Press **Pause Resume** to pause or resume the log playing.
2. Press **Stop** to stop the log playing.

Learn more, refer to Chapter 16 Mapping and "Setting up Data Logging" on page 519. See also, Chapter 34, "File Management."

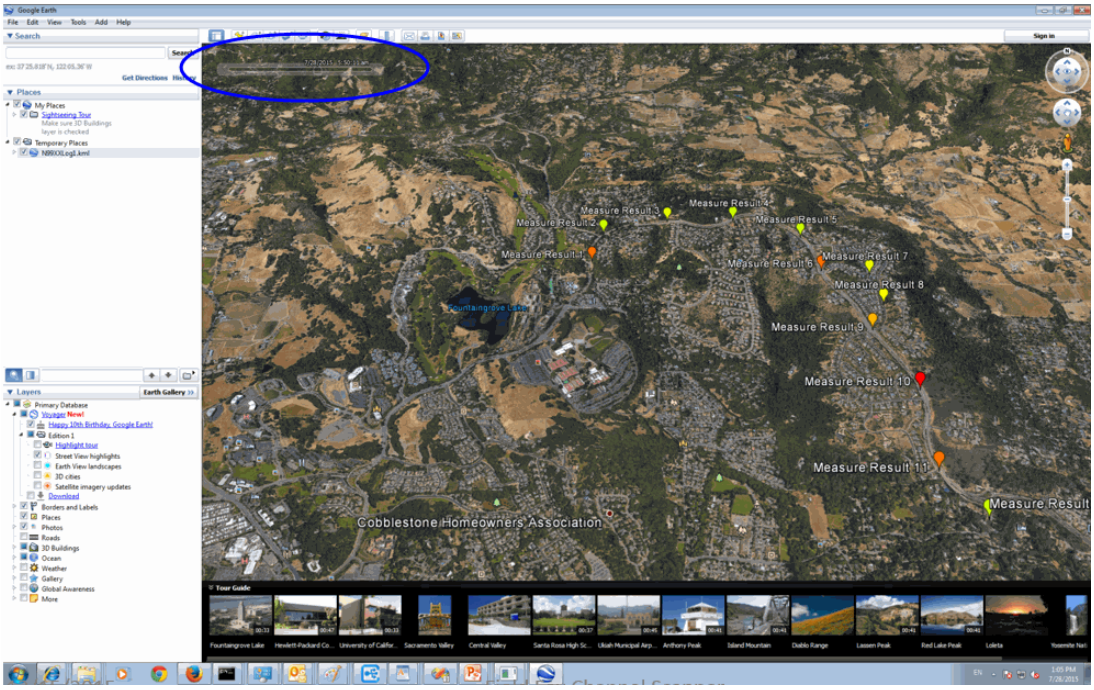
Step 7: Import and Play back KML Files into 3rd Party Software (Example: Google Earth with Animation Tool)

Features

Use the Playback Slider to replay measurement results. See also Google Maps and or Google Earth's help. Refer to Figure 14-17 on page 467.

- Open the FieldFox *.KML file in Google Earth. The time slider appears in upper left of the map.
- Manual Mode – Move the time slider cursor to see color-coded icons pop-up according to the timestamp.
- Loop mode has a Fast-Slow Replay Option.
- Click on each color coded balloon to see the table of measurement results for that location.

Figure 14-17 Importing a KML File Into Google Earth



How to Use Data Logging/Playback (Option 360)

NOTE

Data log-Play files are saved to:

- **If File Folder is set to Default then Data Log-Play files are save-recalled to:** `"[CurrentDevice]\RecordPlayback\PAA"`
- **If File Folders are set to System, then Data Log-Play files are save-recalled to:** `"CurrentDevice\<UserSelectedFolder>\`

Data Logging and Playback enables you to log phased array antenna trace data and play them back at a later time. Use this feature to monitor table data activity over a period of time.

Data logs can be saved to the FieldFox Internal memory, an SD Card, or a USB flash drive.

This section assumes you have already completed the initial setup and have a phased array antenna scan displayed on the FieldFox.

Screen Annotation

During a data logging or playback session, the following is displayed in the top-center area of the screen:

- **Rec: 55/55 2018-12-31 03:26:11 PM**

where:

- **55/55** is the current and total trace number: currently trace is 55 of 55 total scans.
- **2018-12-3103:26:11 PM** is the date and time of recording.
- The name of a recording can be changed using Manage Sessions. Learn more in “To change Data Logging Configuration settings:” on page 470.

See also, the FieldFox User’s Guide’s “System Settings” chapter.

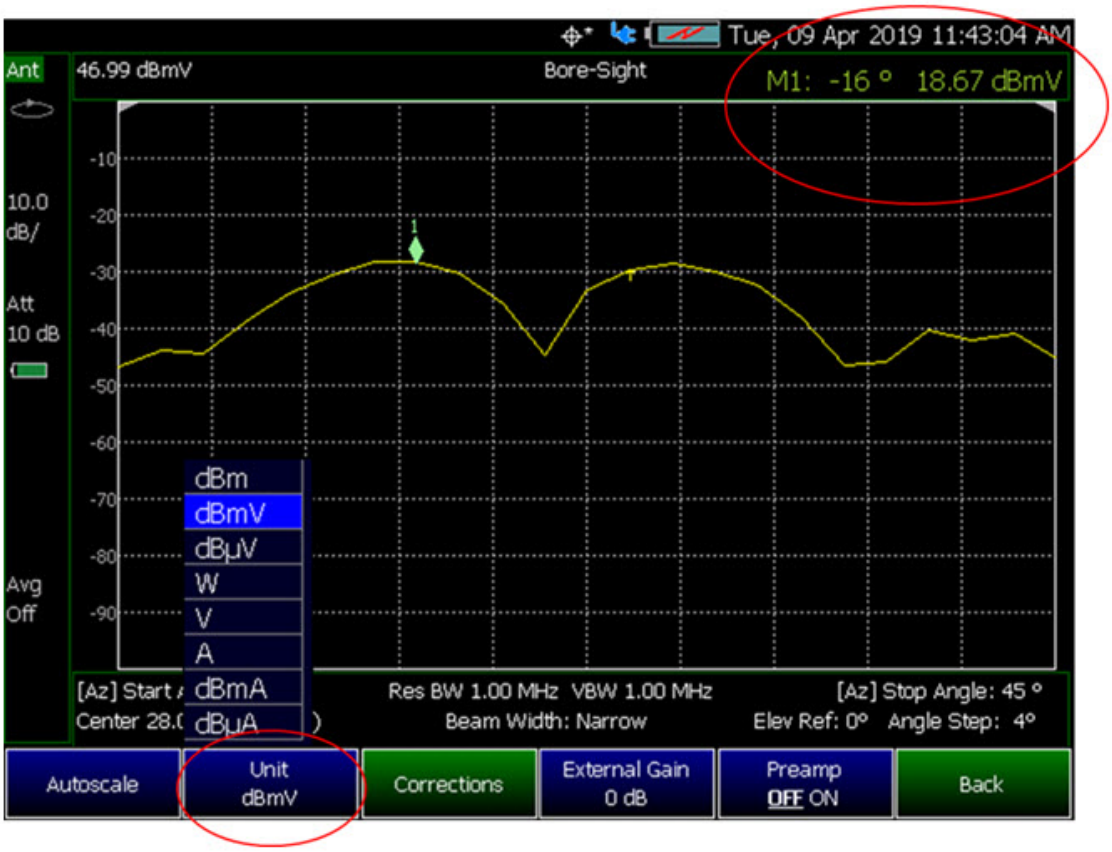
When GPS is enabled, **GPS R** is indicated at the bottom of the FieldFox display. Learn more, see the FieldFox User’s Guide’s “System Settings” chapter.

The Phased Array Antenna mode can display and be data logging/played back in field strength units, when the units are changed:

- Press **Scale /Amptd** > **More** > **Unit** then choose:
  - **dBmV**, **dBuV**, **W**, **V**, **A**, **dBmA**, or **dbuA** (Default Units: dBm)

    See Figure 14-18 on page 469.

Figure 14-18 Field Strength Annotation that can be Logged and Played Back



NOTE

If Data Logging or Playback is not occurring when you think it should, check the following:

- Is the sweep in HOLD? (upper-left annotation), or check the Sweep menu for Continuous set to OFF.
- Is Recording or Playback Paused? (mid-left annotation)
- Is the Data Logging or Playback Interval set too long? (Configuration settings.)

How to Record a Data Log

NOTE

Data Log-Play files are saved to:

- If File Folder is set to Default then Data Log-Play files are save-recalled to: "[CurrentDevice]\RecordPlayback\PAA"
- If File Folders are set to System, then Data Log-Play files are save-recalled to: "CurrentDevice\<UserSelectedFolder>\

- Press **Trace 6**
- Then **Data Logging**
- Then **Record**

REC is displayed in the left of screen graticules.

During recording, choose from the following:

- **Pause Resume** Temporarily halts recording until pressed again. The incoming trace continues to sweep. Press again to continue recording.
- **Stop** Immediately stops recording. Then choose from the following:
  - Then **Record Save/Recall** To save a log file, recall log file, or change your file settings. Learn more, refer to "To change Data Logging Configuration settings:" on page 470.
    - ––Press **Save Log File** to save the current Table data (i.e., default save device is Internal).
  - Then **Record Settings** (Outdoor Logging) To change your measurement interval settings. Learn more, refer to "To change Data Logging Configuration settings:" on page 470.

To change Data Logging Configuration settings:

- Press **Trace 6**
- Then **Data Logging** then choose:
- Then **Record Settings** (Outdoor Mapping Only)
  - Optional: Then **Meas Interval** > ON
    - ––Then **Interval Type** > choose **Time** or **Distance**.
    - ––Then, if applicable **Time Interval** enter time interval in seconds.

      Or
    - ––Then, if applicable **Distance Interval** enter distance interval in miters.

– Then **Record Save/Recall**
  – Then **Device** (**Internal** (default), **SD Card**, or **USB**)
  – Then **File Type** (**CSV**, **DREC** (Option 360 only), or **KML** (default))

Learn more, refer to the Chapter 34, “File Management”.

How to Playback a Data Log

– Press **Trace 6**
– If the session is already open, skip the following step. Otherwise:
– Then **Data Logging** > **Record Save/Recall**

NOTE **If these are large recordings on a device, it could take several seconds for the FieldFox to display the list.**

  – Then **Recall Log File** use the Use the RPG or the ▲|▼ arrow keys to highlight the file to be played.
    ––Then **Recall File**
    ––Then **Back**
  – Then **Play** to playback your Table data.

PLAY is displayed in the left of screen graticules during playback. When the end of the recording is reached, playback begins at the start of scan and continues to loop indefinitely.

During playback, choose from the following:

– **Pause Resume** Temporarily halts playback. Then choose from the following:
  – **Pause Resume** Press to continue playing.
– **Stop** Immediately stops playback. Then choose from the following:
  – **Play** Start playback from start of scan.
  – **Recall Log File** Opens a list of stored data files.

    Select a file to playback.
  – **Recall File**
  – **Back**
– **Cursor Position** use this softkey to move the data log play cursor in the current data log being played (i.e., **Cursor Position** is active only when playback is paused).

This softkey is only available in Channel Scanner and Phased Array Antenna modes (i.e., The Cursor Position softkey is **not** available for OTA mode).

– **Red Limit** to edit the red limit dBm value.

– **Blue Limit** to edit the blue limit dBm value.

Using Mapping

The Phased Array Antenna mode has indoor and outdoor mapping capability. Refer to Chapter 16, “Indoor and Outdoor Mapping – Option 352 (Requires Spectrum Analyzer Mode (Option 233), and GPS Receiver (Option 307)).”

Other Features Available

– **Alignments** - For information on using alignments, refer to the SA chapter’s section, “Alignments” on page 211.

– **External Gain** - Refer to refer to the SA chapter’s section, “External Gain” on page 162.

– **Field Strength Corrections** – “How to select and edit corrections for Field Strength measurements” on page 165

– **Scale Settings** – For information on using scale settings, refer to the Data Analysis chapter’s section, “All about Scale Settings” on page 831 (not all of the settings apply to OTA Option 360).

Troubleshooting

If your Phased Array Antenna setup is not behaving as expected:

- Verify setup is correct by referring to "How to Set Up Phased Array Antenna Settings" on page 447.
  - Attenuator set to **0 dB**
  - Preamplifier set to **ON**
  - Correct **Band**, **Channel**, and **Center** Frequency entered
  - GNSS set to **Internal**
  - Frequency Ref set to **GPS**
  - ADC errors: Use **Scale/Amptd** > **Range** to adjust the absolute power level (dBm).

    For some data views, you need to press **More** to view the **Range** softkey.
  - No data displayed: Press **Meas Setup 4** then
    - ––Verify the correct **Antenna Settings** have been entered.
  - The FieldFox's displayed annotation indicates "`Check LAN connection. Check IP address.`" during pinging.

    Verify:
    - ––The LAN address for first 3 fields matches the Static IP address of FieldFox. For example, if the Ball Antenna IP address is **192.168.1**.10, set FieldFox Static IP address to **192.168.1**.xx. "xx" must be different number than shown in the last field of the for Ball Antenna. Refer to Figure 14-15 on page 457.
    - ––Power is connected to the PAA. If the power is **not** connected indicator is flashing ( ) on the left side of the FieldFox display, verify your connections.

NOTE

IMPORTANT! If you forget you N9910X-028 Ball Antenna's static IP address, refer to this link and the **Support** tab for assistance: www.keysight.com/find/fieldfox and then to the **Phase Array Antenna Support Document**.

15 USB Antennas – (Full Capability Requires EMF Option 358, and either SA mode (Option 233 Mixed Analyzers) or OTA—LTE FDD (Option 370), LTE TDD (Option 371), 5G NR / 5G NR EVM Conducted (Option 378)

CAUTION Triaxial USB antennas (also, referred to as EMF antennas) can be used without EMF Option 358, but with limited capability and doing so is **not** recommended or supported by Keysight.

NOTE **IMPORTANT!** EMF is only compatible with LTE FDD (Option 370), LTE TDD (Option 371), 5G NR/5G NR EVM Conducted (Option 378) and SA Mode (Requires Option 233—combination analyzers). User data channels are **not** demodulated.

CAUTION The antenna operation for single-polarization measurements is different between ARIA6000 and FSH3D. Please consult the datasheet corresponding to each antenna for specific details.

EMF antennas measures signals at the **SA RF Input Port 2** connector.

EMF antennas mode requires the FieldFox to have SA mode (Option 233 on combination analyzers), EMF (Option 358), GPS (Option 307), and CPU2 installed.

Recommended, but not required, preamplifier (Option 235) to improve receiver sensitivity.

With EMF antennas, 377 (5G TF), and 378 (5G NR) network designers can ensure that networks have enough resources to carry out handovers (re-selection) when users move between cell towers on the same 5G network as well as in between 5G and 4G networks (intra/inter-radio access technology). The FieldFox OTA measurements support LTE FDD (Option 370), LTE TDD (Option 371), 5G NR (Option 378) / 5G NR EVM Conducted (P/O: Option 378) and over-the-air demodulation of single acquisition, multiple cell towers, or multiple acquisitions for multiple component carriers (CCs). Additionally, 5G NR / 5G NR EVM Conducted among other 5G NR capabilities, has new FR1 and FR2 spectrums. The FieldFox display can be configured to show data formats such as table, bar chart, spectrum and strip chart of key performance indicators (KPI's).

USB Antennas – (Full Capability Requires EMF Option 358, and either SA mode (Option 233 Mixed Analyzers) or OTA–LTE FDD (Option 370), LTE TDD (Option 371), 5G NR / 5G NR EVM Conducted (Option 378)

By integrating over-the-air (OTA) measurements with cable and antenna test (CAT), full 2-port vector network analysis, spectrum analysis, and real-time spectrum analysis (RTSA), the FieldFox can be used for base station setup and verification.

With EMF antennas (P/O EMF measurements – Option 358):

- Reduce measurement complexity with a triaxial antenna to capture energy radiated from gNB
- Calibrated metrology milli-meter wave triaxial antenna simulates 5G UE antenna performance
- Troubleshoot the 5G radio access network with 3D test coverage and path loss measurements utilizing the built-in CW generator
- Triaxial antenna performance verification showing bore sight, polar antenna pattern with compass, heat map and beam sweep to map display views
- Measure and display corrected field strength in RMS average power
- Antenna control and X, Y, and Z antenna factors can be downloaded via a USB for ARIA6000 antenna or import a CSV file for FSH3D antenna

Figure 15-1 FieldFox With EMF antenna

USB Antennas – (Full Capability Requires EMF Option 358, and either SA mode (Option 233 Mixed Analyzers) or OTA–LTE FDD (Option 370), LTE TDD (Option 371), 5G NR / 5G NR EVM Conducted (Option 378)

In this Chapter

"Using USB Antennas (Also, Known as EMF Antennas)" on page 478

"About USB Antenna (Also, Known as EMF Antenna) Measurements" on page 479

– "EMF Antenna Features" on page 479

"How to Set Up a USB Antenna (Also, Known as EMF Antenna)" on page 481

– "EMF Antenna Setup Procedure" on page 481

"Other Features Available" on page 486

– Alignments (SA chapter) – "Alignments" on page 211
– External Gain (SA chapter) – "External Gain" on page 162
– Record Playback – "Record/Playback (SA Option)" on page 570
– Scale Settings – "All about Scale Settings" on page 831

"Troubleshooting" on page 487

See Also

"Why and When to Calibrate" on page 129

"Using the Antenna/Cable Editor" on page 167

Chapter 32, "System Settings." (Changing display colors)

Chapter 34, "File Management."

Using USB Antennas (Also, Known as EMF Antennas)

CAUTION **Triaxial EMF antennas can be used without EMF Option 358, but with limited capability and doing so is not recommended by Keysight.**

EMF antennas enables you to do the following:

Measures electro-magnetic fields (EMF) for radio frequencies in proximity of radio and television stations, and repeaters for cell phones[a]	
Seven Independent Antenna/Cable Amplitude Correction Types:	

– Triaxial antenna (X/Y/Z)
– Cable – triaxial connection
– Cable – Receiver Side
– Antenna – Receiver side
– Cable – Source Side
	– Antenna – Source Side
	– Antenna – (triaxial off)
	  – Source and
	  – Receiver sides

Color Coded Display Types:	
– Specify high and low power with color bars	
Features:	
– Automatic detection of previously imported EMF antenna corrections (i.e., to view pre Apply Corrections) – OTA (LTE FDD, LTE TDD, 5G NR) mode can connect to the EMF antenna, when an Option 358 license is detected	– Automatic selection of field strength units, when EMF antenna corrections are applied – Auto selection provides ability to cycle through each axis (X, Y, and Z) to provide RMS average of the three axes results in trace and channel power
Record GPS stamped data measurements	
– Define measurement interval by time or distance – Show results in Table or Bar Chart (Channel Power)	– Display files (KML) on Google Maps or Google Earth

a. Requires Option 358 for EMF measurements. Else, antenna can be used manually with X/Y/Z axis.

About USB Antenna (Also, Known as EMF Antenna) Measurements

EMF antenna feature supports these standards:

– SA

– OTA – LTE FDD, LTE TDD, 5G NR

Some measurement parameters are auto-coupled and are not user-settable.

EMF Antenna Features

NOTE

For more information on the ARIA6000 EMF antenna, refer to https://www.es-france.com/index.php?controller=attachment&id_attachment=11763.

For more information on the FSH3D EMF antenna, refer to https://www.schwarzbeck.de/Datenblatt/kFSH3D.pdf

EMF antenna feature has the following features:

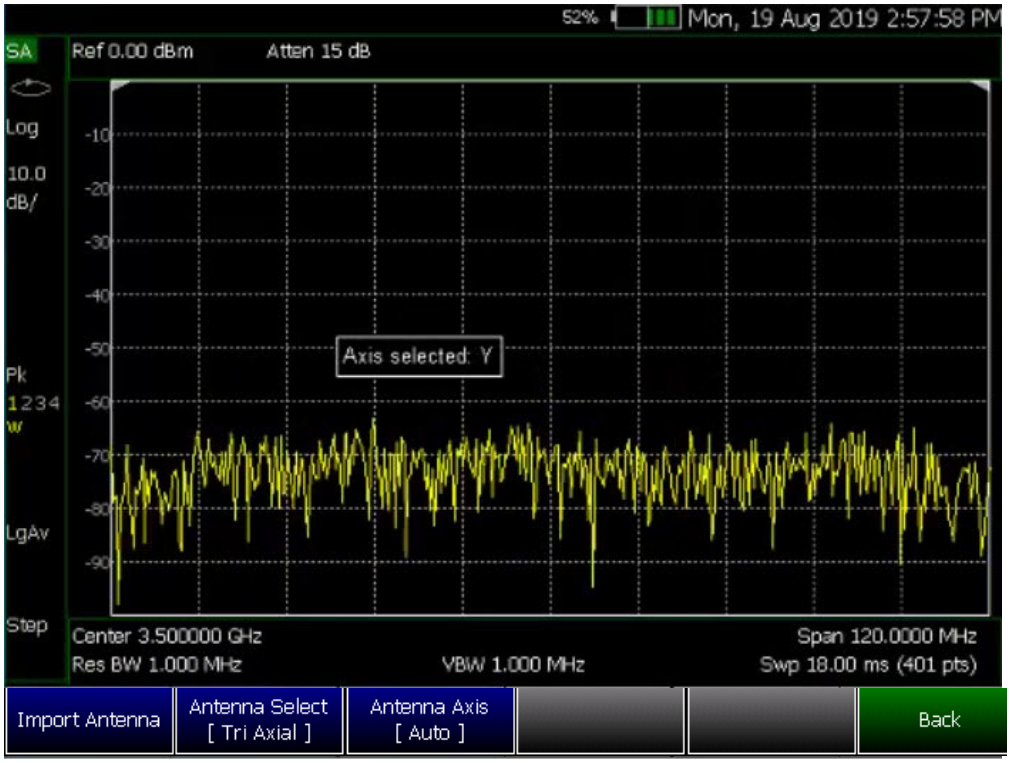
– SA mode automatically detect if Import antenna factors are present applies correct X/Y/Z antenna amplitude corrections for EMF measurements

– SA mode X/Y/Z factors–if available–are enabled by default

– OTA mode LTE FDD, LTE TDD, 5G NR – EMF can be manually enabled

Figure 15-2 Example Summing of Triaxial Values

Figure 15-3 Example Verifying the Triaxial Values – Axis Y is Displayed



How to Set Up a USB Antenna (Also, Known as EMF Antenna)

NOTE

IMPORTANT! See also, "Alignments" on page 211, in NA mode,Chapter 9, "SA (Spectrum Analyzer) Mode (Option 233–Mixed Analyzers)."

This section reviews some general high level steps in setting up a EMF antenna measurement. If you are not familiar with this process or would like more information on specific EMF measurement setups, refer to:

– SA Mode: "How to Set Up EMF Settings (Requires EMF (Option 358), GPS (Option 307), and SA Mode (Option 233–Mixed Analyzers))" on page 238

– OTA Mode: "How to Set Up EMF Mode Settings (Requires EMF (Option 358) and LTE FDD (Option 370), LTE TDD (Option 371), or 5G NR (Option 378))" on page 412

EMF Antenna Setup Procedure

1. Select the mode and set up your measurement. Refer to Chapter 13, "Over–the–Air Measurements (OTA) – LTE FDD Option 370, LTE TDD Option 371, 5G TF Option 377, 5G NR / 5G NR EVM Conducted Option 378" or to Chapter 9, "SA (Spectrum Analyzer) Mode (Option 233–Mixed Analyzers)".

NOTE

If necessary, this step can be skipped and done **after** the EMF antenna is set up.

2. Connect a EMF antenna. Refer to Figure 15-1.

CAUTION

Only Agos Advanced Technologies ARIA6000 and Schwarzbeck Mess-Elektronik FSH3D Triaxial Isotropic EMF antenna is compatible with EMF (Option 358). See also Chapter 9, "SA (Spectrum Analyzer) Mode (Option 233–Mixed Analyzers)" and Chapter 13, "Over–the–Air Measurements (OTA) – LTE FDD Option 370, LTE TDD Option 371, 5G TF Option 377, 5G NR / 5G NR EVM Conducted Option 378".

3. Importing and selecting the X/Y/Z antenna factors:

NOTE

IMPORTANT!

The softkey menu selection and display of Axis X, Y, Z, corresponds to Loop 1, 2, 3, respectively for EMF antenna FSH3D.

   a. **OTA – 5G NR and SA mode:**

   – Press System > Utilities > EMF Antennas >

   – For ARIA6000 EMF antenna, press Antenna Select and select "ARIA6000".

Then press **Import Antenna** – to import the antenna factors from the antenna's memory over the USB connection to the FieldFox (this may take 5 seconds or so and vary with the triaxial antenna).

NOTE The Import Antenna softkey is only activated when Antenna Select is set to ARIA6000 or FSH3D.

NOTE If the antenna factor import is successful, the FieldFox displays: "`Success: Antenna Factors Imported: EMF Antenna ID: ->[R] Antenna ID: ARIA6000-1006 ->[]`". The last 4-digits will vary for each antenna (i.e., "1006" value will vary).

If the FieldFox displays this error `Error: EMF antenna Error: Not found` or `Unable to communicate with antenna. Ensure it is connected.` is displayed, verify the EMF antenna is connected correctly. See also "Troubleshooting" on page 487.

– For FSH3D EMF antenna, press **Antenna Select** and select "FSH3D".

Then press **Import Antenna** > **Import Files** - to import FSH3D antenna factor CSV file from external storage device e.g. USB or SD Card to the INTERNAL storage. **Recall File** to retrieve these imported CSV files directly from INTERNAL when necessary.

Figure 15-4 FSH3D antenna factor CSV Import Files storage device selection Softkey

Press the storage device containing FSH3D antenna factor CSV file you wish to import from. The window will navigate to the chosen storage device and display all available CSV files.

Choose a single FSH3D antenna factor CSV file from the list, then press **Import**.Once imported, press **Done** to complete the process.

To recall INTERNAL FSH3D antenna factor CSV, press **Import Antenna**, then select the target CSV file and press **Recall File**.

CAUTION FSH3D antenna factor CSV files MUST be saved in the "AntennaEMF" folder within the storage device to import from.

– By selecting **Antenna Select** and choosing either ARIA6000 or FSH3D to verify the EMF antenna selected (Default == Manual). Only compatible EMF antennas can be used for EMF measurements.

See also, "How to Use the Manual EMF Channel Power" on page 246.

- Optional: Press **Antenna Axis** with **Auto** (default) selected the FieldFox determines the X/Y/Z settings for the current measurement. Alternately, you can select either X, Y, or Z to enable and to edit a position manually (i.e., an example of editing X, Y, and Z axes is covered in step 5).

NOTE The Antenna Axis softkey is only activated when Antenna Select is set to ARIA6000 or FSH3D.

4. If you have not selected a mode and set up your measurement, then do so now. Refer to step 1.
5. Enabling the imported EMF antenna factors and Cable factors:

   Choose one of these:

   - SA Mode: "How to Set Up EMF Settings (Requires EMF (Option 358), GPS (Option 307), and SA Mode (Option 233–Mixed Analyzers))" on page 238.
   - OTA Mode: "How to Set Up EMF Mode Settings (Requires EMF (Option 358) and LTE FDD (Option 370), LTE TDD (Option 371), or 5G NR (Option 378))" on page 412.
6. If you need to edit or add new antenna factors or cable factors, then repeat step 5 as required for Y, Z, and the Cable Factors. See also, "How to Set Up EMF Settings (Requires EMF (Option 358), GPS (Option 307), and SA Mode (Option 233–Mixed Analyzers))" on page 238 and "How to Set Up EMF Mode Settings (Requires EMF (Option 358) and LTE FDD (Option 370), LTE TDD (Option 371), or 5G NR (Option 378))" on page 412.
7. Once you have finished with your EMF antenna setup:

   a. Press **Sweep 3** > **Single** > **Restart**

   The FieldFox should display in order `Analyzing CCO X-Axis`, `Analyzing CCO Y-Axis`, and `Analyzing CCO X-Axis` and then do a square root sum of the X, Y, and Z measurement values in the FieldFox. Multi-cell measurements are done similarly for each cell ID (i.e., Cell CC0 to CC*n*). Refer to Figure 15-5 on page 484.

Figure 15-5 Example Summing of Triaxial Values

Figure 15-6 Example Verifying EMF

Editing Antenna Correction Factors and Adding New Antenna Factors

CAUTION

Keysight does **not** recommend editing a EMF antenna's correction factors.

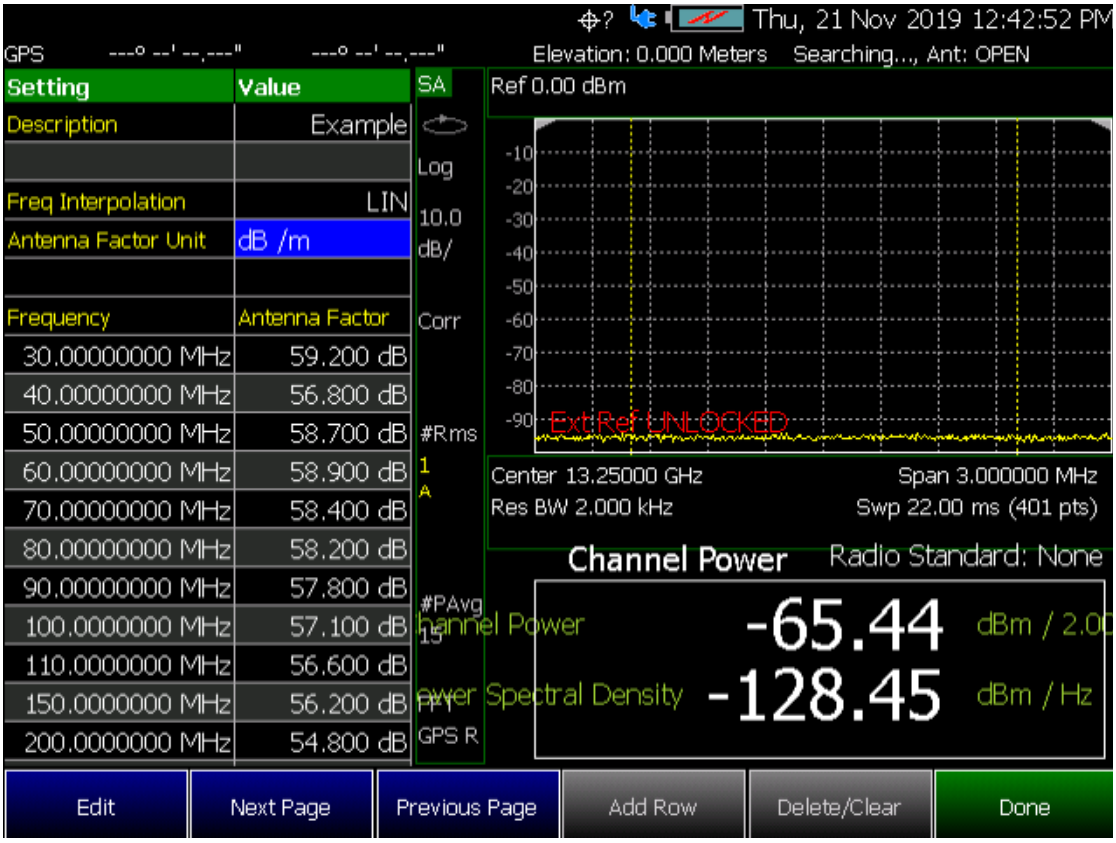
NOTE

If **New** is selected under the **X, Y, or Z Antenna** or **Cable** softkey menu, whatever antenna or cable factors that have been imported as the default values and are displayed in the **Settings** table

For procedures illustrating how to edit the Antenna Factors settings table values, refer to:

- SA Mode: "How to Set Up EMF Settings (Requires EMF (Option 358), GPS (Option 307), and SA Mode (Option 233–Mixed Analyzers))" on page 238
- OTA Mode: "How to Set Up EMF Mode Settings (Requires EMF (Option 358) and LTE FDD (Option 370), LTE TDD (Option 371), or 5G NR (Option 378))" on page 412

Figure 15-7 SA Mode – Example Editing and Adding a New X axis antenna



Other Features Available

- **Alignments** - For information on using alignments, refer to the SA chapter's section, "Alignments" on page 211.
- **Scale Settings** – For information on using scale settings, refer to the Data Analysis chapter's section, "All about Scale Settings" on page 831 (not all settings apply to a EMF antenna.
- **External Gain** - Refer to refer to the SA chapter's section, "External Gain" on page 162.
- **Record Playback** - Refer to refer to the Interference Analyzer chapter's section, "Record/Playback (SA Option)" on page 570 and to the OTA chapter's "How to Use Data Logging (OTA Options 370, 372, 377, and 378)" on page 420.

Troubleshooting

If your EMF antenna setup is not behaving as expected:

- Verify setup is correct by referring to "How to Set Up a USB Antenna (Also, Known as EMF Antenna)" on page 481.
  - If the FieldFox displays this error `Error: EMF antenna Error: Not found is displayed, verify the EMF antenna is connected correctly` or `Unable to communicate with antenna. Ensure it is connected.` Verify the antenna connection (i.e., Disconnect and reconnect the USB cable).

    Press **EMF Antennas** > **Import Antenna**

    If the FieldFox still displays the EMF antenna error, try a different EMF antenna.
  - If you are unable to view the X,Y, and Z antenna correction factors, then:

    Press **Scale/Amptd** > **More** > **Corrections** > **Antennas Off** > **Antenna (Off)** to On (Default == Off)
  - If you are having problems with your measurement, verify the antenna corrections have been enabled:

    Press **Scale/Amptd** > **More** > **Corrections** > **Apply Corrections [Auto]** (Default == Auto, enabled)
  - Preamplifier set to **ON**

16 Indoor and Outdoor Mapping – Option 352 (Requires Spectrum Analyzer Mode (Option 233), and GPS Receiver (Option 307))

CAUTION

IMPORTANT!

B Model FieldFoxes measurements require an OML head[a]. Refer to https://www.omlinc.com/.

a. Requires external mixer to down convert millimeter wave frequency to intermediate frequency (IF). Recommend OML Inc. WR-28 26.5 to 40 GHz harmonic mixer, model number M28H2A1DC. Contact OML directly www.omlinc.com for ordering information.

Option 352 maps signals that were measured using the **SA RF Input Port 2** connector.

The FieldFox requires Option 352 for outdoor mapping and GPS (Option 307) installed. And, one of the following, an Over–the–air (OTA) mode (LTE FDD Option 370, 5G TF Option 377, or 5G NR / 5G NR EVM Conducted Option 378), or Channel Scanner mode (Option 312), or Phased Array Antenna (Option 360). Also, requires browser that supports HTML5 (i.e., web browsers **not** supported: IE6, IE7, and IE8).

Recommended, but not required, preamplifier (Option 235) to improve receiver sensitivity.

Keysight's FieldFox handheld analyzer (with Option 352) combined with a USB triaxial antenna (p/o EMF Measurements – Option 358) provides a unique, portable solution for indoor and outdoor mappings in the field. Option 352 adds indoor and outdoor mapping capability to FieldFox analyzers, so that FieldFox can import maps from OpenStreetMap (OSM) for data collection and data plotting to the map directly on the FieldFox instrument display. The FieldFox **Map Explorer** resides at the System level and enables you to download, import/export, and view outdoor maps. All of the other data logging, record/playback, plotting data on indoor/outdoor maps can be enabled within the following modes:

- Channel Scanner (Option 312)
- Phased Array Antenna Support (Option 360)
- Over-the-Air (OTA) LTE FDD (Option 370)

- Over-the-Air (OTA) LTE TDD (Option 372)
- Over-the-Air (OTA) 5G TF (Option 377)
- Over-the-Air (OTA) 5G NR (Option 378)

Using a direct wired LAN connection with access to a network and the internet, FieldFox will automatically access OSM once location coordinates (latitude and longitude) and zoom levels are entered the Map Explorer menu. If using the FieldFox Map Support Tool, OSM map files can be downloaded to a *.zip file and imported to FieldFox internal memory. If the FieldFox GPS receiver is enabled and OSM maps have been previously saved to FieldFox with those GPS coordinates, FieldFox will automatically load the corresponding map to match the GPS coordinates.

With Indoor Mapping:

Using the FieldFox:

- Import floor plans or site maps from picture files (PNG, JPG, BMP)
- Interactive Walk Test data collection with location pointer.
- Save Indoor Map files (kDAT)
- Indoor Map file Viewer with results presentation options

With RF Coverage Mapping:

Using the FieldFox:

- Begin with Data Logging recorded data results
- Overlay GPS-stamped located measured results onto maps on FieldFox
- LAN connection optional. GPS is required.
- Built-in Longitude, Latitude map search
- Save KML or CSV files
- Built-in Map Viewer with results presentation options

Using Google Earth or other software:

- View KML files

In this Chapter

"How to Install Node.js and Running the FieldFox Mapping Software" on page 494

"Downloading and Using the FieldFox Map Support Tool" on page 496

"Importing a .zip File to the FieldFox" on page 501

"How to Set Up Mapping Settings" on page 504

- "How to Set Up Mapping When the FieldFox Is On The LAN" on page 505
- "Option 352 Indoor Maps Setup Procedure" on page 507
- "Option 352 Outdoor Maps Setup Procedure" on page 511
- "Setting up Data Logging" on page 519

"How to Use Data Logging (Option 352)" on page 527

- "Screen Annotation" on page 527
- "How to Add Directional Finding (DF) Bearing" on page 529
- "How to Record a Data Log (Outdoor Logging Only)" on page 532
- "To change Data Logging Configuration settings:" on page 533
- "How to Play a Data Log" on page 533
- "Update Available Message" on page 538

"Troubleshooting" on page 535

- "General Troubleshooting" on page 536
- "Port 5000 in Use Error" on page 536
- "Miscellaneous Mapping Errors" on page 539

See Also

Other Features Available:

- Alignments (SA chapter) – "Alignments" on page 211
- External Gain (SA chapter) – "External Gain" on page 162
- Scale Settings (Data Analysis chapter) – "All about Scale Settings" on page 831

"Why and When to Calibrate" on page 129

Chapter 32, "System Settings." (Changing display colors)

Chapter 34, "File Management."

Option 352 enables you to do the following:

Measure and display indoor and outdoor mapping	
Two Mapping Types:	
– Indoor Maps	– Outdoor Maps (Requires Option 307)
Color Coded Display Types:	
– Specify high and low power with color bars	
Store Geo-location to external or connect to LAN and Download to PC memory:	
– SD card	– Connect to LAN and download to PC memory
– USB card	
Data Logging GPS stamped data measurements	
– Define measurement interval by time or distance – Show results in TableChart	– Add Directional Finding bearing – Display files (KML) on Google Maps or Google Earth

Figure 16-1 Maps (Outdoor) With Line Feature Enabled

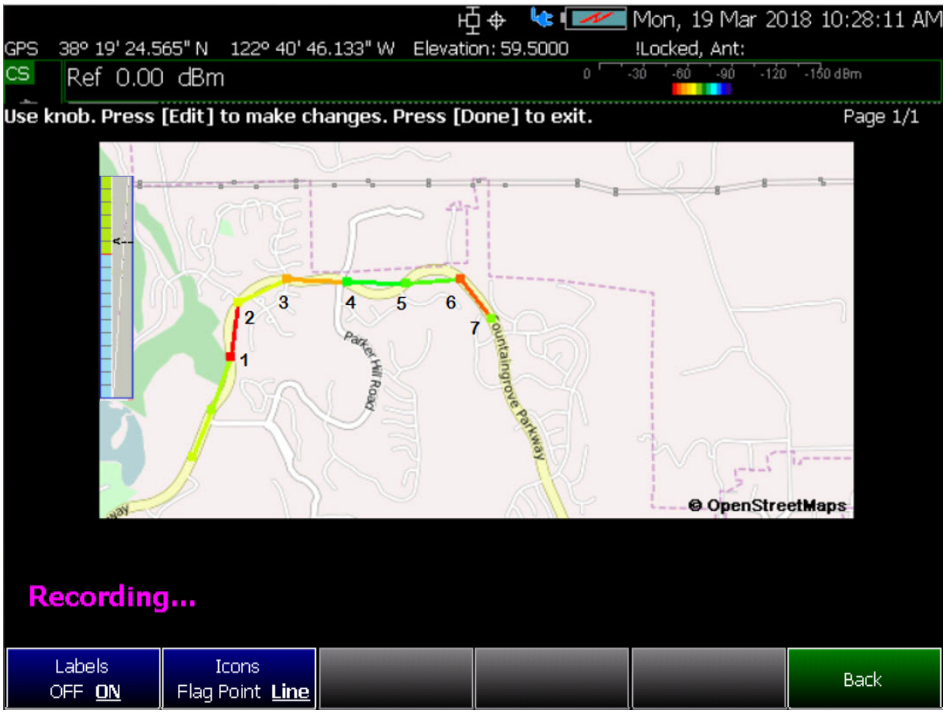


Figure 16-2 Maps With Current Position Marker Displayed - (OpenStreetMaps)

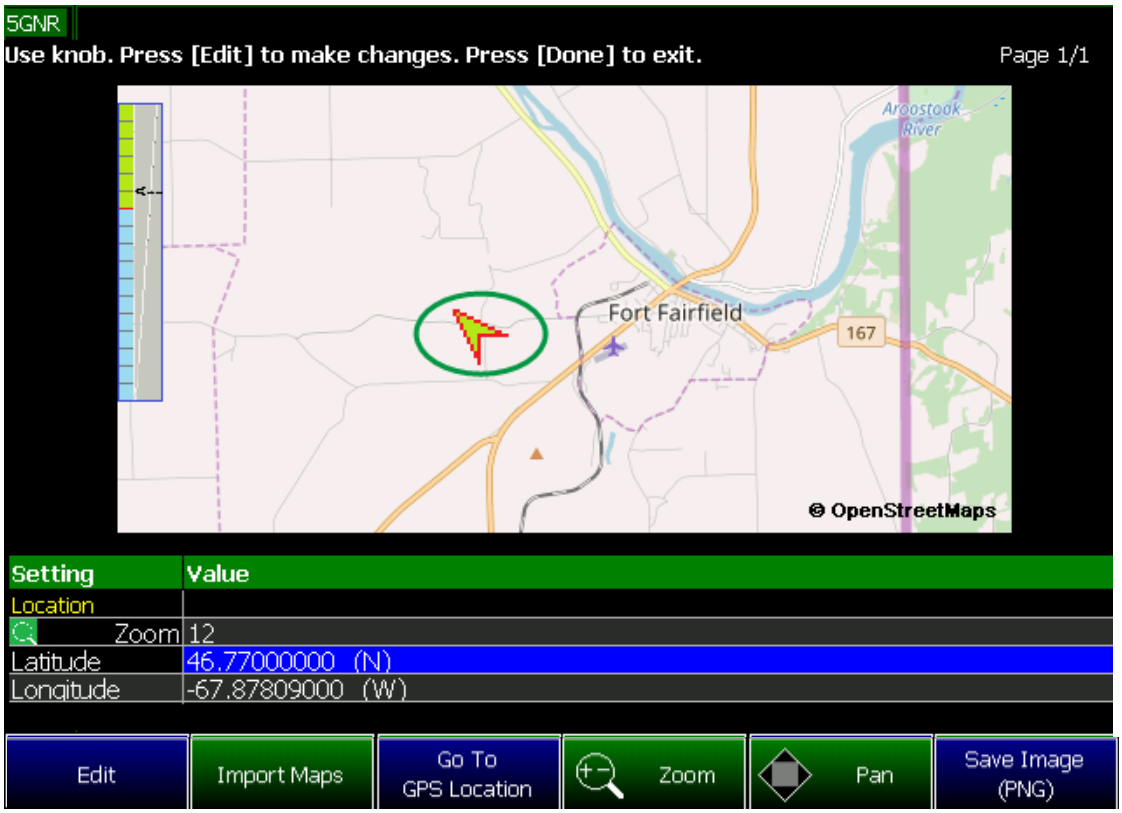
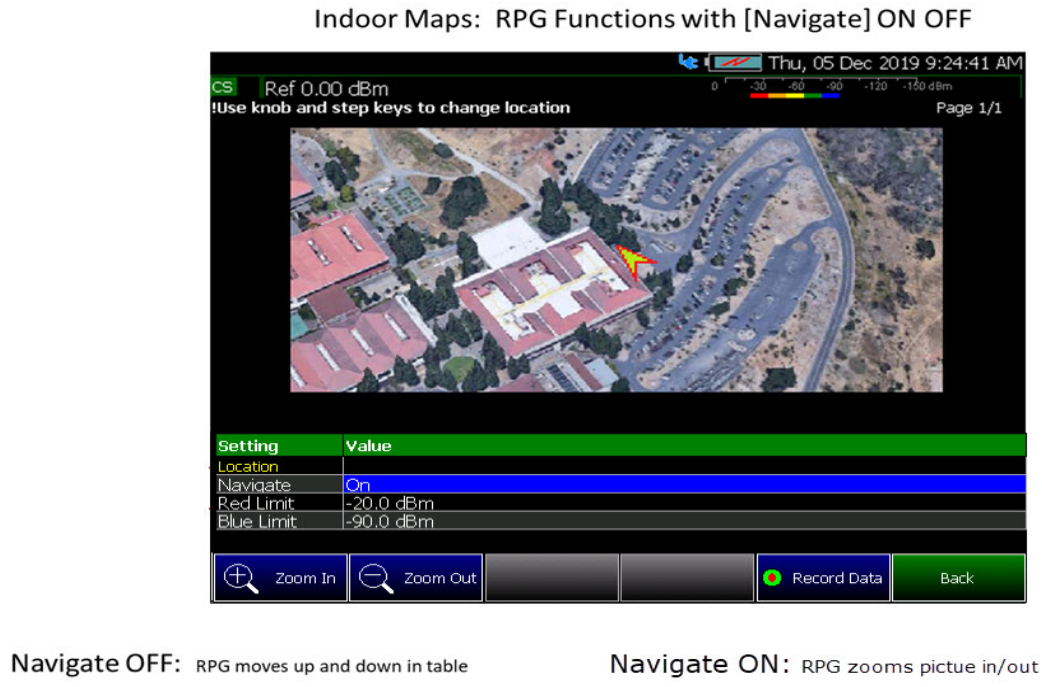


Figure 16-3 Using Mapping (Option 352) - Satellite View for Indoor Mapping



How to Install Node.js and Running the FieldFox Mapping Software

NOTE

IMPORTANT! If your FieldFox is connected directly to the LAN, you can skip the section on downloading `Node.js` and go to "How to Set Up Mapping When the FieldFox Is On The LAN" on page 505.

This section contains the procedure to download Node.js to access OpenStreetMap files and to process and save those files using the FieldFox mapping software. For details on how to use these files once they are downloaded to the FieldFox, refer to "How to Set Up Mapping Settings" on page 504.

1. Open an HTML5 compatible browser and download Node.js to a PC (e.g., Google Chrome, Mozilla Firefox, Safari, or Microsoft Edge):

   https://nodejs.org/en/download

CAUTION

IMPORTANT!

Do not change the default name of the directory path for downloading the Node.js program, because FieldFox uses the default program path name to run the Mapping feature. Refer to Figure 16-4.

Examples of Web Browsers that not supported are Internet Explorer 6, 7, and 8.

2. Run the Node.JS installation file, by accepting the wizard's defaults (i.e., including leaving the "`Automatically install the necessary tools. Note that`..." checkbox **empty (unchecked)**). Refer to Figure 16-4 and Figure 16-5 on page 495.

Figure 16-4 Downloading the Node.js Installer to a PC

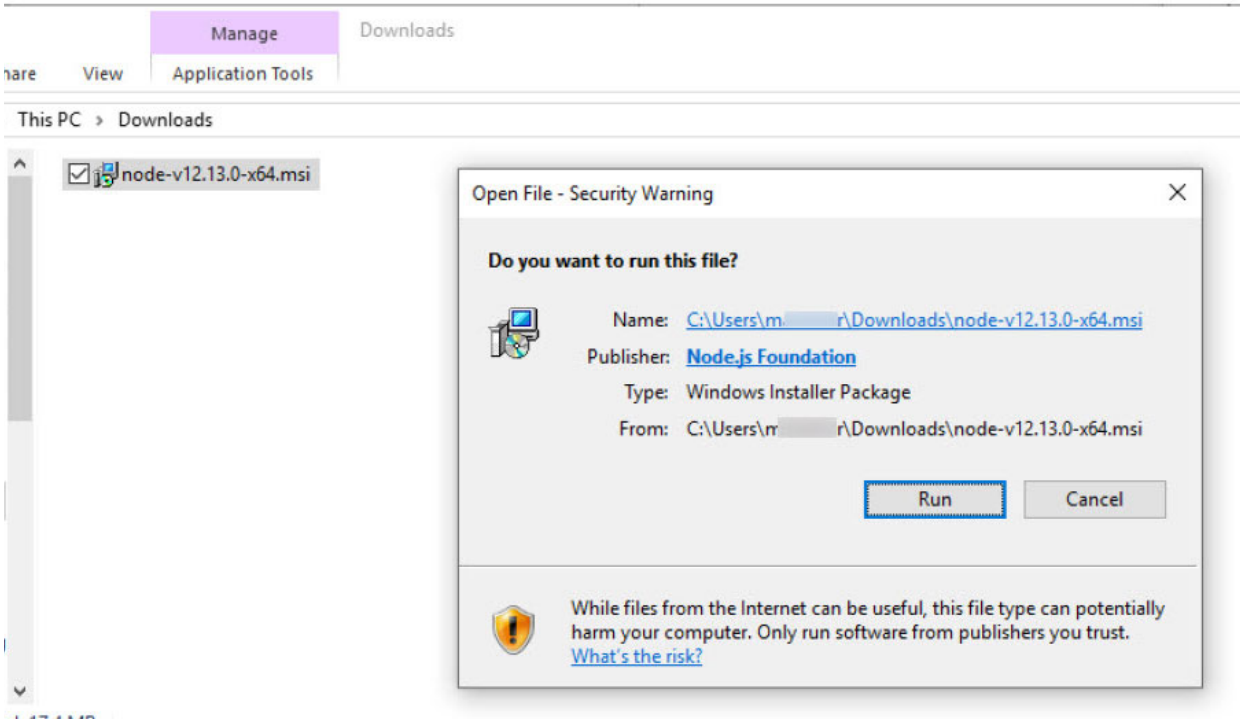
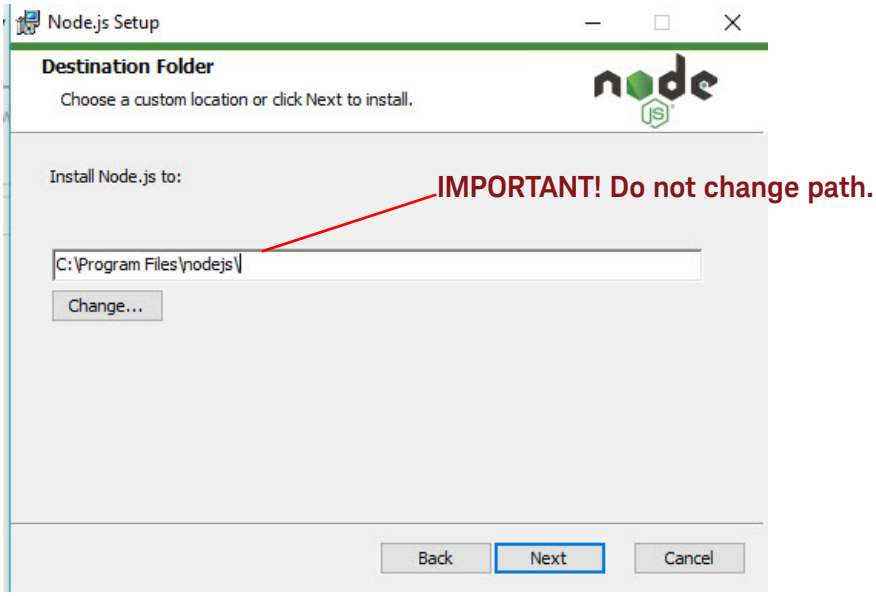


Figure 16-5 Default Download Path for Node.js Installer to a PC



Downloading and Using the FieldFox Map Support Tool

1. Download the FieldFox Mapping software (“FFMapSupportInstall.msi”) to a PC’s `Downloads` folder. Refer to www.keysight.com/find/fieldfoxsupport and then download the `FieldFoxMapping.zip`.

   Refer to Figure 16-7.

2. Run the FieldFox Map Support Tool software’s, installation software by going to the folder where the FieldFox Tool software is installed and double-click `Run.bat`.

   Refer to Figure 16-6 on page 496.

3. Paste and Enter the address into a HTML5 compatible browser. Refer to Figure 16-7 (The Mapping software is **not** compatible with Internet Explorer).

Figure 16-6 Command Window Opens With Address Copied to Clipboard

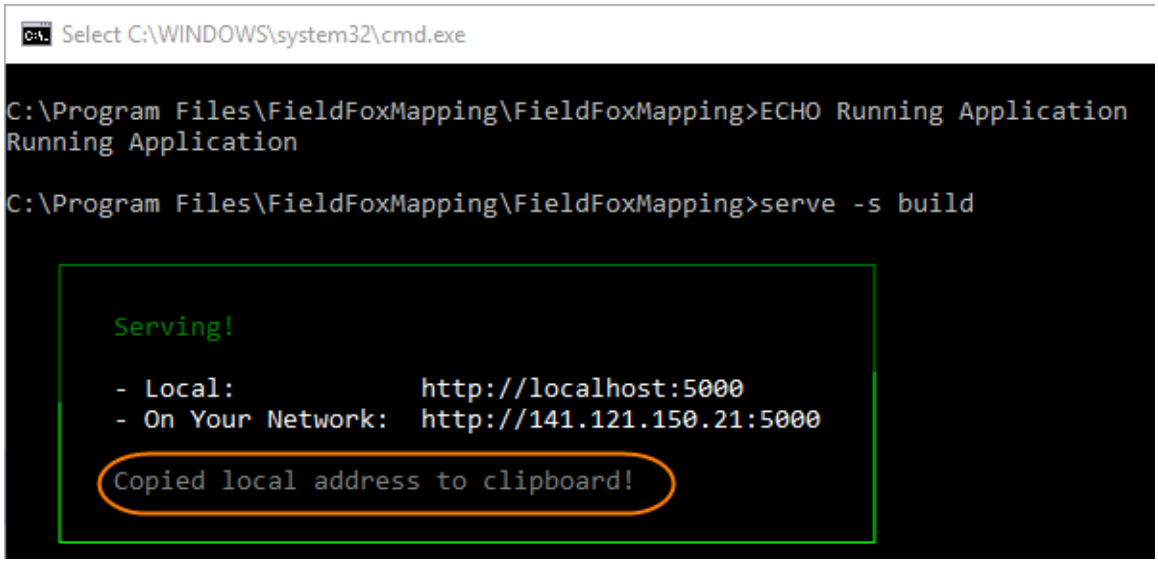
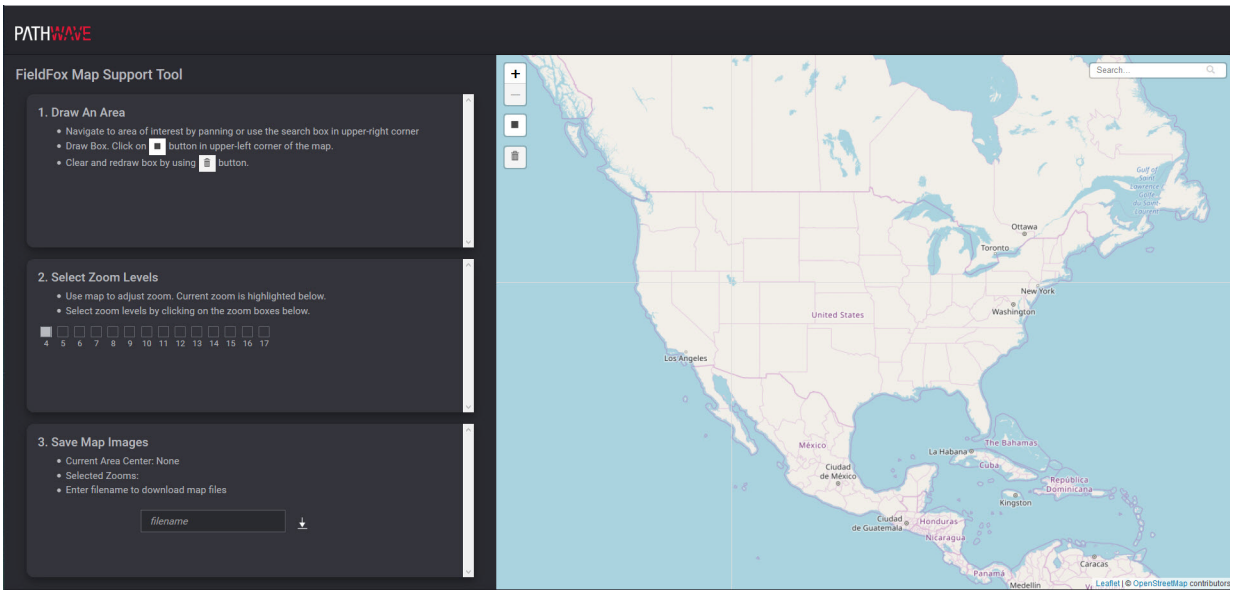


Figure 16-7 FieldFox Mapping Opens in HTML5 Compatible Browser (Overview)



4. If the FieldFox is connected directly to the LAN, begin here: Select **Draw An Area** to map and download the selected area:

   For this step and sub-steps, refer to Figure 16-8 on page 499.

CAUTION

IMPORTANT!

The more Zoom boxes that you check, the more data is selected for download. For faster downloads click Zoom boxes. Refer to Figure 16-8 on page 499.

   a. **Step 1. Select Draw An Area to map:**

      – Enter a location in the search area and click on the map and use the Zoom In/Zoom Out buttons (+ / −) to select the area to map. Also, your mouse scroll wheel can be used for zooming in and out.

        Hint: The larger the map area selected for final mapping, the longer it takes for the file download.

      – Click on the box button (■) and click and drag to select the map area.

        Hint: To clear and redraw the box choices, click the trashcan button (🗑).

   b. **Step 2. Select Zoom Levels** to Save and Download:

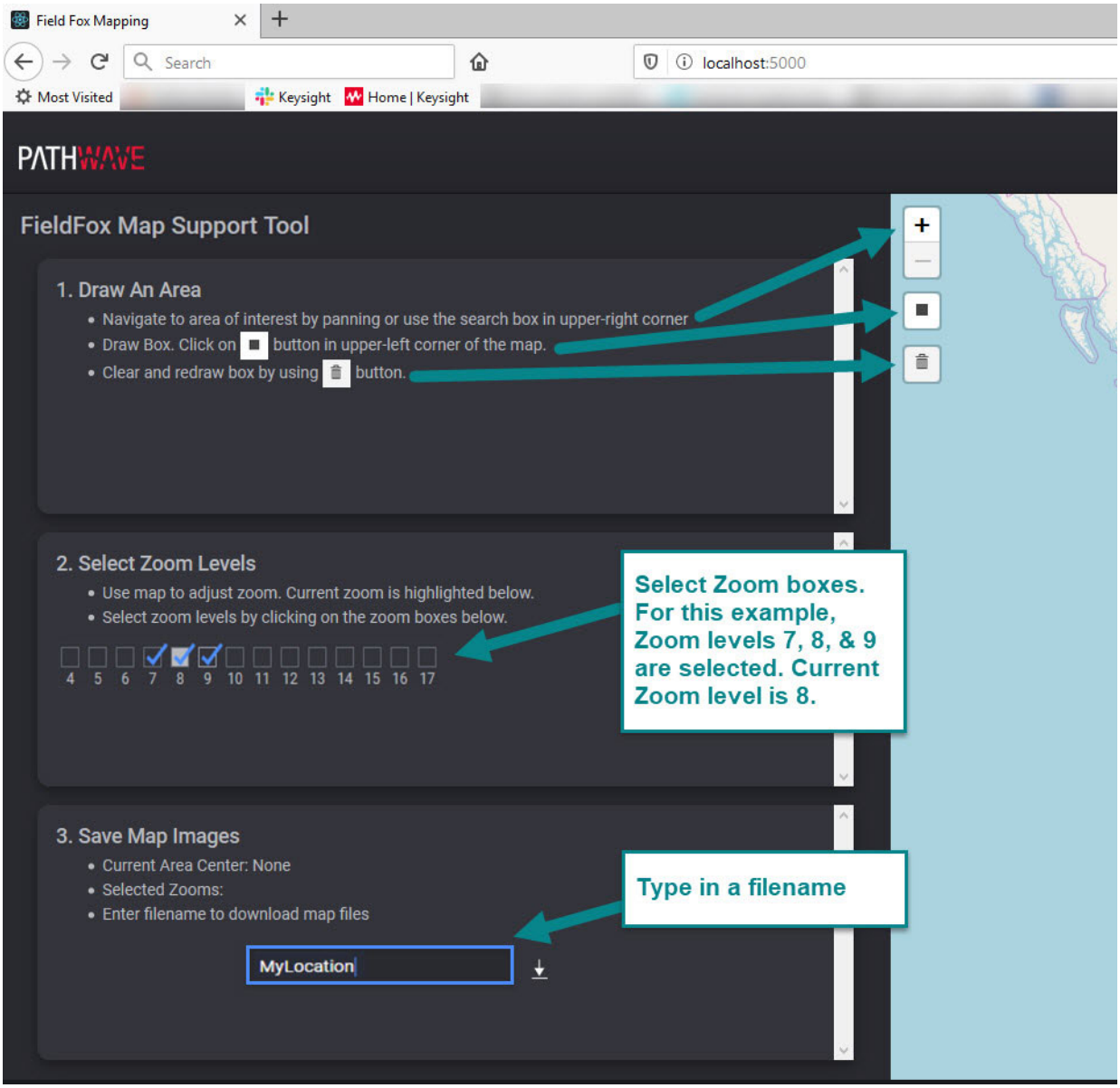
- Select all Zoom levels of the map you wish to save.

  Hint:

  - To select Zoom levels, click the zoom boxes.
  - The more Zoom levels checked, the more map images that have to be saved and it will take longer to download the images.

c. **Step 3. Input a filename** to store your requested images from OpenStreetMaps. The *.zip file is then stored in your PC's `Downloads` folder.

Figure 16-8 FieldFox Mapping Opens in HTML5 Compatible Browser (Zoom)



5. Saving your *.zip file to a storage device and importing your *.zip to the FieldFox:

NOTE

For FTP, refer to Refer to “Move (Copy) Files” on page 893 and to the :MMEM SCPI commands in the FieldFox Programming Guide on www.keysight.com.

a. Insert an SD card or USB storage device into your PC.

b. Open the PC's Downloads folder and find your *.zip file. (e.g., MapsZIP_Example_1). Refer to Figure 16-9 on page 500.

c. Copy the *.zip file to your SD card or USB storage device.

d. Remove the SD card/USB storage device from your PC.

e. Insert the SD card/USB storage device into the FieldFox.

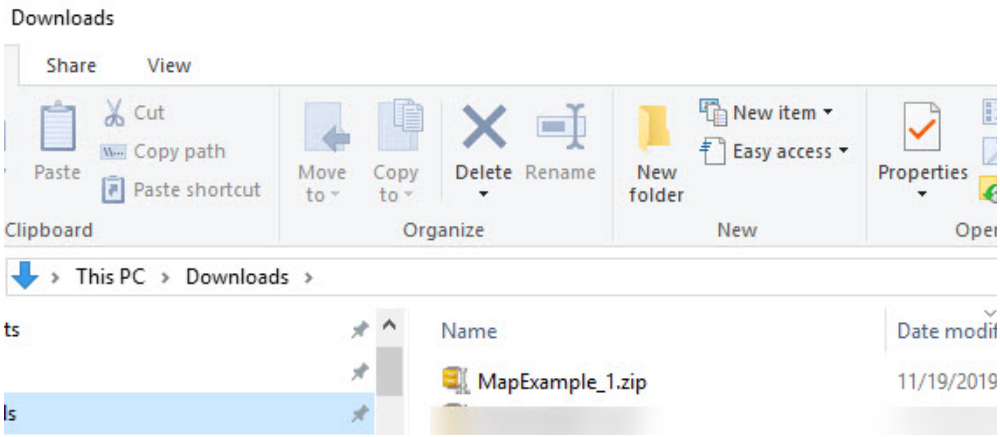
CAUTION

IMPORTANT!

In the folder that contains your unzipped files, do not change any of the Map file folders or filenames. Doing so will prevent the FieldFox from being able to recognize the map files.

New downloaded Map folders, for the same map locations and zoom levels, will overwrite any existing folders on the FieldFox.

Figure 16-9 New Maps Zip File – MapExample_1



Importing a .zip File to the FieldFox

NOTE

For FTP, refer to Refer to "Move (Copy) Files" on page 893 and to the :MMEM SCPI commands in the FieldFox Programming Guide on www.keysight.com. See also, "How to Set Up Mapping When the FieldFox Is On The LAN" on page 505.

On the FieldFox:

Press **System 7** > **Utilities** > **Mapping** > **Map Explorer (Get Maps)**

1. Press **Import Maps**
2. Verify your SD card/USB Source Device is selected.

   If not then:

   Press **Source Device [Internal]** > **SD Card** | **USB**
3. Press **Import Maps (ZIP)**
4. In the "`Select .zip file to import`" window that opens, if there is more than one .zip file listed, select the .zip file you want to load by using the ▲|▼ arrows, or the rotary knob and then press **Recall File**.

   Refer to Figure 16-11 on page 503 and Figure 16-11 on page 503.
5. Press **Back** to return to the previous menu.

Figure 16-10 Example of a Maps *.zip Being Recalled From a USB Storage Device

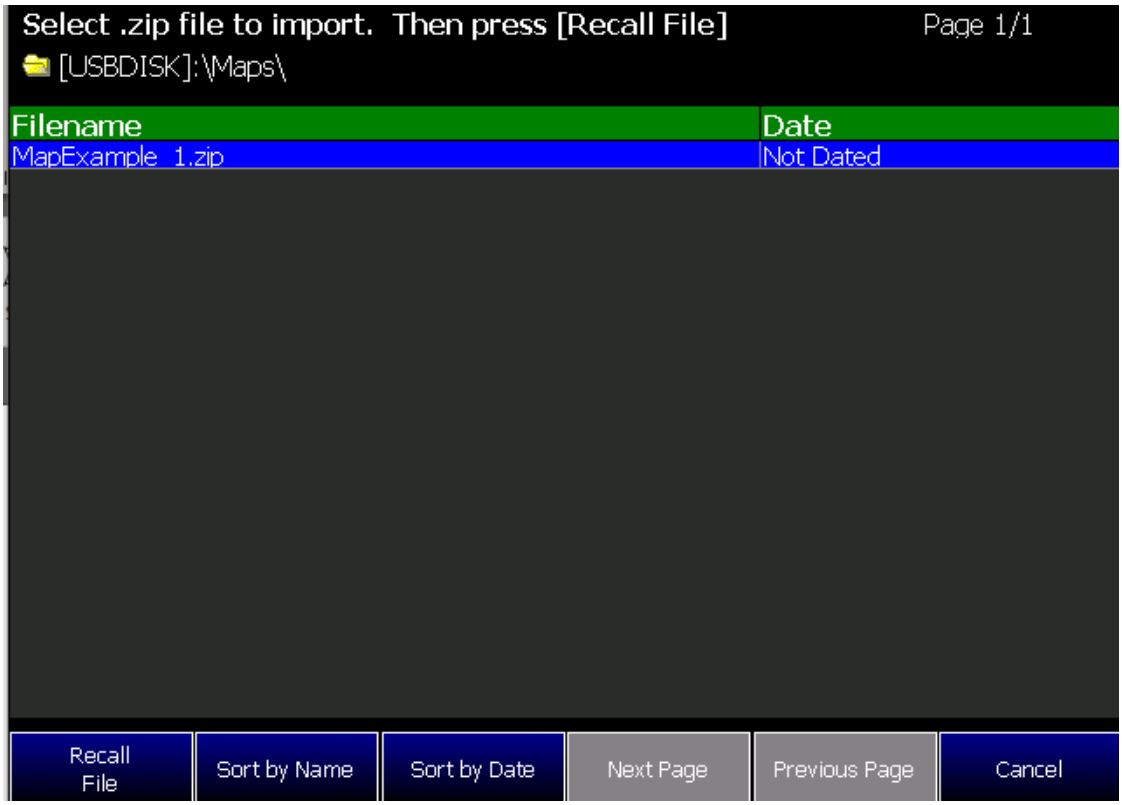
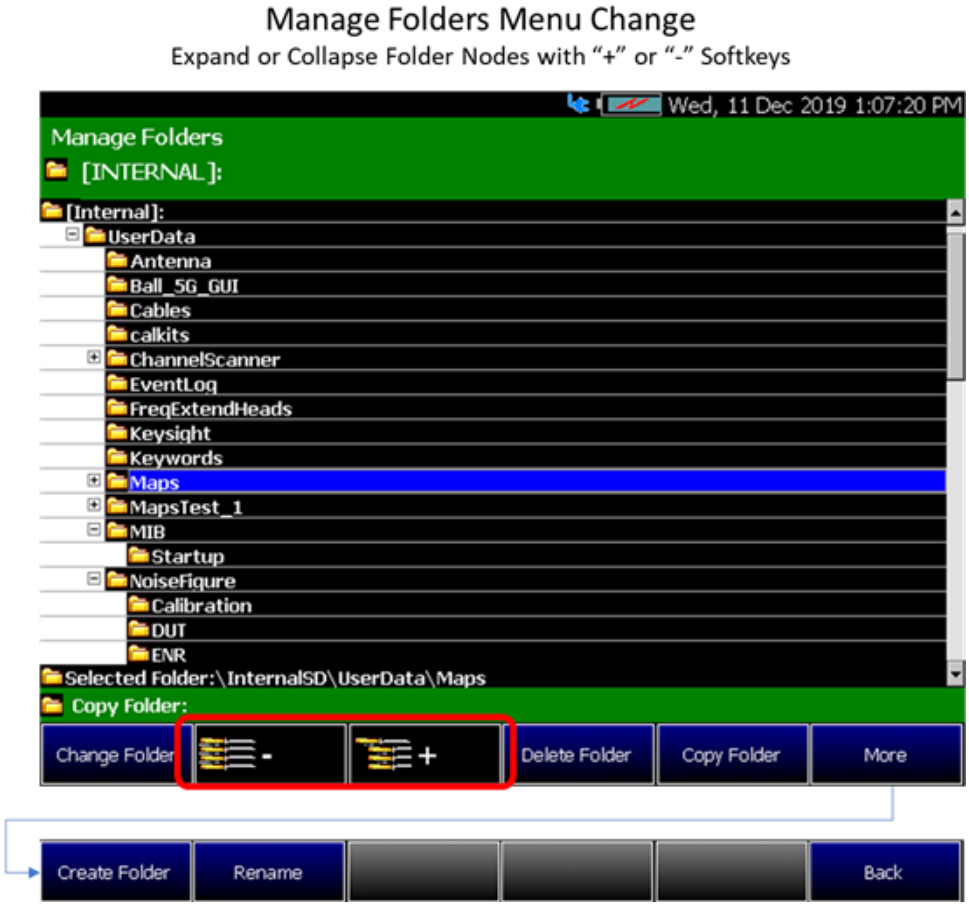


Figure 16-11 Example of Maps Folder Containing Imported Maps *.zip Files to the FieldFox's InternalSD\UserData\Maps Folder



How to Set Up Mapping Settings

NOTE

IMPORTANT! See also, "Alignments" on page 211, in SA mode.

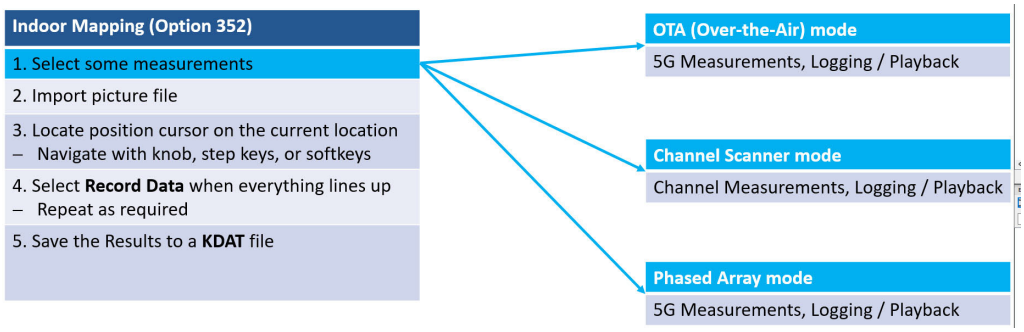
This section reviews the steps in setting up an Option 352 Mapping measurement.

This section consists of:

– "How to Set Up Mapping When the FieldFox Is On The LAN"

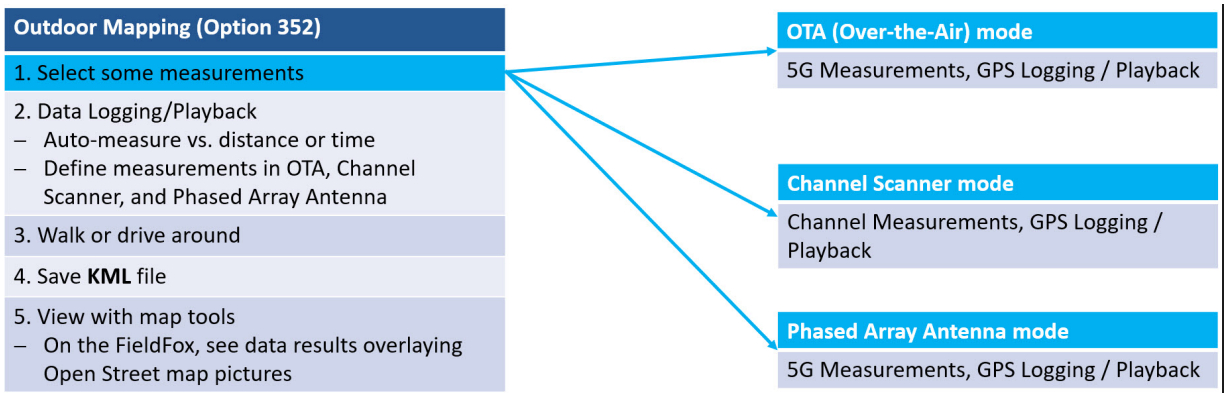
– "Option 352 Indoor Maps Setup Procedure"

Figure 16-12 Overview – Setting Up Option 352 (Indoor Mapping) Using Other Modes



– "Option 352 Outdoor Maps Setup Procedure" (Requires GPS Option 307)

Figure 16-13 Overview – Setting Up Option 352 (Outdoor Mapping) Using Other Modes



How to Set Up Mapping When the FieldFox Is On The LAN

If your FieldFox is connected directly to the LAN, you can view your maps by using OpenStreetMaps directly (i.e., no need to use the FieldFox Map Support Tool to download the maps as a *.zip file). But, you will need a valid GPS signal (Option 307 required). Refer to "Display a Map File" on page 505.

Display a Map File

1. Press System 7 > Utilities > Mapping > Map Explorer (Get Maps)
2. Then choose from the following:
   - Press Edit
     - Enter a **Zoom** by using the RPG or the ▲|▼ arrow keys to highlight Zoom and then enter a value between 4 and 17.
   - Press Go to GPS Location – sets the current displayed map to the current GPS location.

NOTE

If a "`Warning: GPS data invalid - GPS data must be valid to show current GPS location`" is displayed, verify your GPS signal is connected and working properly.

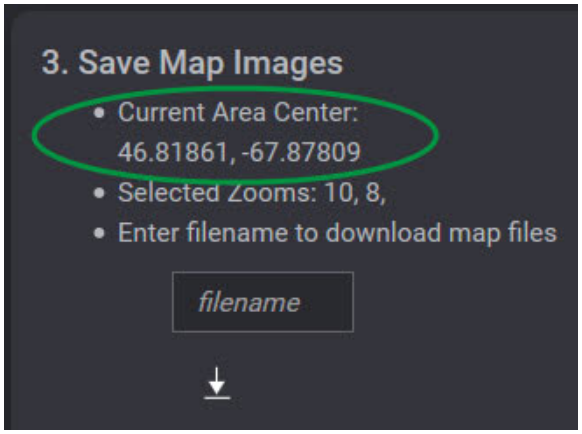
   - Press Zoom – opens a menu of Zoom In and Zoom Out softkeys
   - Press Pan – Opens a menu of softkeys to move East, West, North, and South on the current displayed map area
   - Save Image (PNG) – To save the current map as a PNG file. When selected, the "`Save Map picture file`" feature opens to the current storage location (default = [INTERNAL]:) where you can name and save your current displayed map area.
3. Enter a **Zoom** by using the RPG or the ▲|▼ arrow keys to highlight Zoom and then enter a value between 4 and 17.
4. If you do not see your Map on the FieldFox display:
   - Use the RPG or the ▲|▼ arrow keys to highlight **Latitude** and **Longitude** and then enter a value for latitude and longitude that corresponds closely to the "Current Area Center" value displayed in the FieldFox Mapping software.
   - Use the **Go to GPS Location** softkey.

     Refer to Figure 16-14.

   Optional: If you want to stop the "`Reading map...`" process, press Esc to stop map search.

5. Repeat step 4 for **Longitude**.

Figure 16-14 Example of Current Area Center Latitude and Longitude Values



Option 352 Indoor Maps Setup Procedure

CAUTION

IMPORTANT!

85571A-028 (28 GHz 5G Phased Array Antenna) accessories not suitable for use in wet locations.

1. Set up your measurements in Channel Scanner, OTA, or Phased Array Antenna. See also, Chapter 13, "Over–the–Air Measurements (OTA) – LTE FDD Option 370, LTE TDD Option 371, 5G TF Option 377, 5G NR / 5G NR EVM Conducted Option 378," and Chapter 29, "Channel Scanner (Option 312)."

   One or more are required:

   – For setting up a phased array antenna, refer to Chapter 14, "5G Rapid Prototype Phased Array Antenna – Option 360."

   – For setting up a USB antenna, refer to Chapter 15, "USB Antennas – (Full Capability Requires EMF Option 358, and either SA mode (Option 233 Mixed Analyzers) or OTA–LTE FDD (Option 370), LTE TDD (Option 371), 5G NR / 5G NR EVM Conducted (Option 378)."

   Optional:

   – For setting up GPS Option 307, refer to Chapter 32, "System Settings," and then "GNSS (GPS+) and GPS" on page 865.

2. Plan your **Indoor** Map:

NOTE

Import your floor plan, before the locations are going to be measured.

   a. Save mapping pictures to the FieldFox using USB storage device, SD card, or connect to LAN with internet and download.

   b. Import floor plans or site maps to the FieldFox from pictures (PNG, JPG, and BMP).

      Press System 7 > Utilities > Mapping > Map Explorer (Get Maps) > Import Maps > Import Maps (ZIP)

      Optional:

      – Press Source Device [Internal] – Internal (default), SD Card, USB, or CD Drive

      – Press Destination Device [Internal] – Internal (default), SD Card, USB, or CD Drive

   c. Recommended: Do an interactive Walk Test data collection using the location pointer.

3. If you are using an antenna with your measurements, then Connect your equipment similar to Figure 14-1 on page 439 in Chapter 14, “5G Rapid Prototype Phased Array Antenna – Option 360” or to Figure 15-1 on page 476 in Chapter 15, “USB Antennas – (Full Capability Requires EMF Option 358, and either SA mode (Option 233 Mixed Analyzers) or OTA—LTE FDD (Option 370), LTE TDD (Option 371), 5G NR / 5G NR EVM Conducted (Option 378)”.
4. Then press **Esc** > **Back** > **Measure 1** or **Trace 6** > **More** (required for OTA only) > **Data Logging** to view the Data Logging softkeys and set the **Record Settings**, **Record Save/Recall**, and **More** > **Indoor Map Data Logging** or **Signal Locate**.
   - For Outdoor Mapping: **Record Save/Recall** > **File Folder Default System**
     - **Default** – Sets the default User Folder path:
       - ––List files (*.csv and *.kml) are save-recalled to: `"[CurrentDevice]:\RecordPlayback\CS\"`
       - ––Record-Play files are save-recalled to: `"[CurrentDevice]:\RecordPlayback\CS\"`

       Or
     - **System** – Sets the User Folder to the user defined system folder path/name:
       - ––List files are save to-from `"CurrentDevice\<UserSelectedFolder>\"`
       - ––Record-Play files are save-recalled to: `"CurrentDevice\<UserSelectedFolder>\"`

       Refer to “File Management” on page 887.
   - Then **File Type**
     - KML (default) or
     - CSV
   - Then **Save Log File**.

     or
   - Then **Recall Log File**.
   - Optional **Auto Save ON** (default = OFF). To avoid loss of data, if power loss occurs.
   - Then **Back**
5. Set up indoor mapping press **More** > **Indoor Map Data Logging** then choose

- Press **Record Indoor Data** – opens a menu of previously stored PNG files to select to record a new data log.

a. Scroll to indoor floor plan *.png file.

b. Press **Recall File** - enables you to recall previously stored *.kdat file that you can view or modify.

c. Move the position cursor to current location:

- Then press **Pan** to open a menu of softkey to enable you to move the position cursor to current location and mark data points, using **East**, **West**, **North**, and **South** softkeys.

- Or you can use the ▲|▼ arrows, the rotary knob, or numeric keypad locate the position cursor to current location.

d. Then press **Record Data** when pointer is in desired position to enter a new data point.

NOTE

If a "`Error: This data point not ready...`" is displayed, verify the measurement setup, including the antenna setup, if applicable, and ensure the measurement is successful.

e. Repeat step c and d for all other required position locations.

Else, continue to next step.

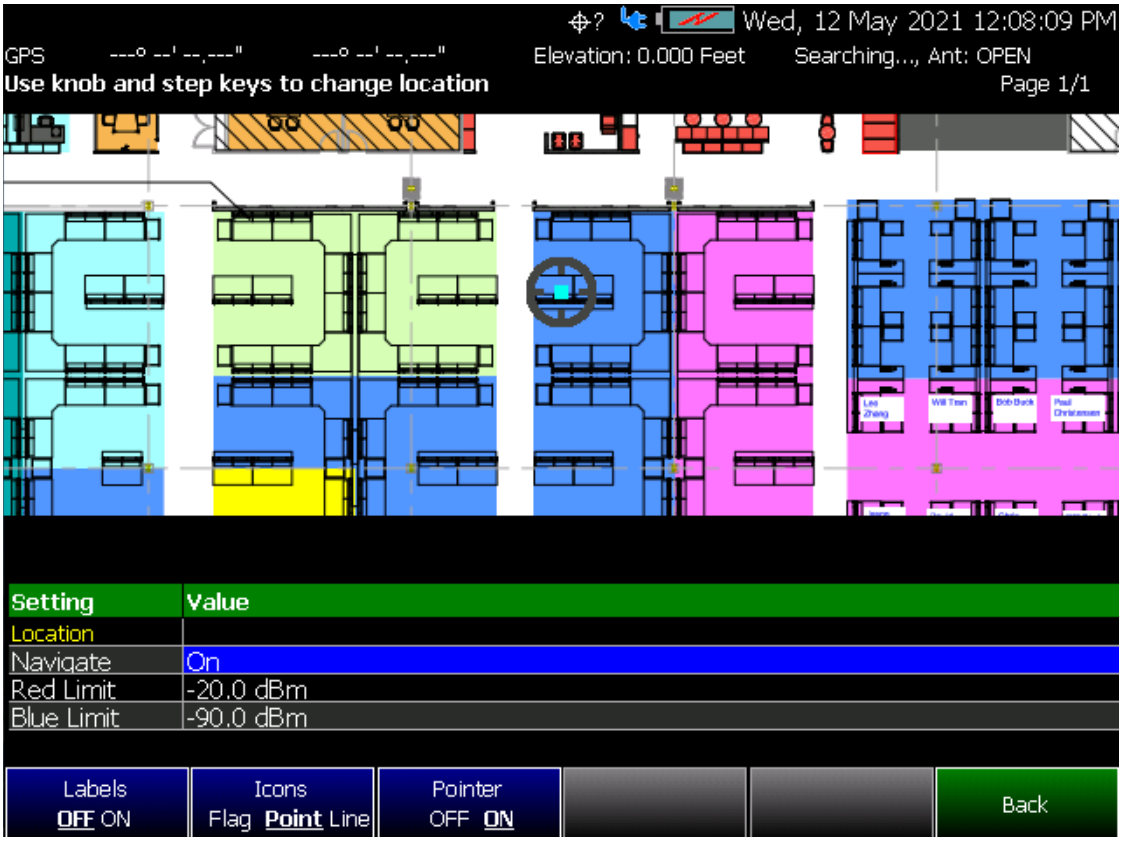
f. When done, press **Back** (If you used the Pan softkey menu) > **More** > **Save Map** to save results to a *.KDAT file.

NOTE

A KDAT file is the file FieldFox uses to recall an indoor mapping/data logging session (“Recall Indoor Log File”). It's an archive file that contains information about the original image file, the location of the recorded data on the image and the actual recorded data. KDAT files can only be opened with FieldFox itself. KDAT files cannot be opened via Data Link.

An auxiliary CSV data file is generated automatically, each time a KDAT file is saved during an indoor mapping session. The CSV contains the recorded data, without the image, location of the recorded data, etcetera.

Figure 16-15 Example of an Indoor Building Map with Single Icon and Bore Sight Pointer



Option 352 Outdoor Maps Setup Procedure

Outdoor mapping requires GPS Option 307.

CAUTION

IMPORTANT!

85571A-028 (28 GHz 5G Phased Array Antenna) accessories not suitable for use in wet locations.

NOTE

Saving and importing maps can be done now or after the outdoor map locations have been measured. Before you can save and import maps via the internet, your PC requires the FieldFoxMapping software. Refer to "How to Install Node.js and Running the FieldFox Mapping Software" on page 494.

1. Set up your measurements in Channel Scanner, OTA, or Phased Array Antenna. See also, Chapter 13, "Over–the–Air Measurements (OTA) – LTE FDD Option 370, LTE TDD Option 371, 5G TF Option 377, 5G NR / 5G NR EVM Conducted Option 378," and Chapter 29, "Channel Scanner (Option 312)."

   One or more are required:

   - For setting up GPS Option 307, refer to Chapter 32, "System Settings," and then "GNSS (GPS+) and GPS" on page 865.
   - For setting up a phased array antenna, refer to Chapter 14, "5G Rapid Prototype Phased Array Antenna – Option 360."
   - For setting up a USB antenna, refer to Chapter 15, "USB Antennas – (Full Capability Requires EMF Option 358, and either SA mode (Option 233 Mixed Analyzers) or OTA–LTE FDD (Option 370), LTE TDD (Option 371), 5G NR / 5G NR EVM Conducted (Option 378)."

2. Plan the area you want to map with GPS Option 307 enabled.

NOTE

Saving and importing maps can be done now or after the outdoor map locations have been measured. Refer to "How to Install Node.js and Running the FieldFox Mapping Software" on page 494.

   a. Optional (Can be done later): Save mapping pictures to the FieldFox using USB storage device, SD card, or connect to LAN with internet and download. Refer to "How to Install Node.js and Running the FieldFox Mapping Software" on page 494. For FTP, refer to :MMEM SCPI in the FieldFox Programming Help https://www.keysight.com/us/en/lib/resources/service-manuals/keysight-fieldfox-library-help-and-manuals-2153870.html (via Keysight FieldFox Library, Help and Manuals (near bottom of page).

   b. Optional (Can be done later):

- Set up the **Record Settings** (Outdoor Mapping only): Press Trace 6 > More (OTA mode) > Data Logging > Record Settings > Meas Interval ON > Interval Type Time Distance (*select one of these*) then Back, to exit the Record Settings menu.
- To enable Auto Save to avoid loss of data, if loss of power occurs: Press Record Save/Recall > Auto Save OFF ON > ON

c. Walk or drive around the area you want to map.

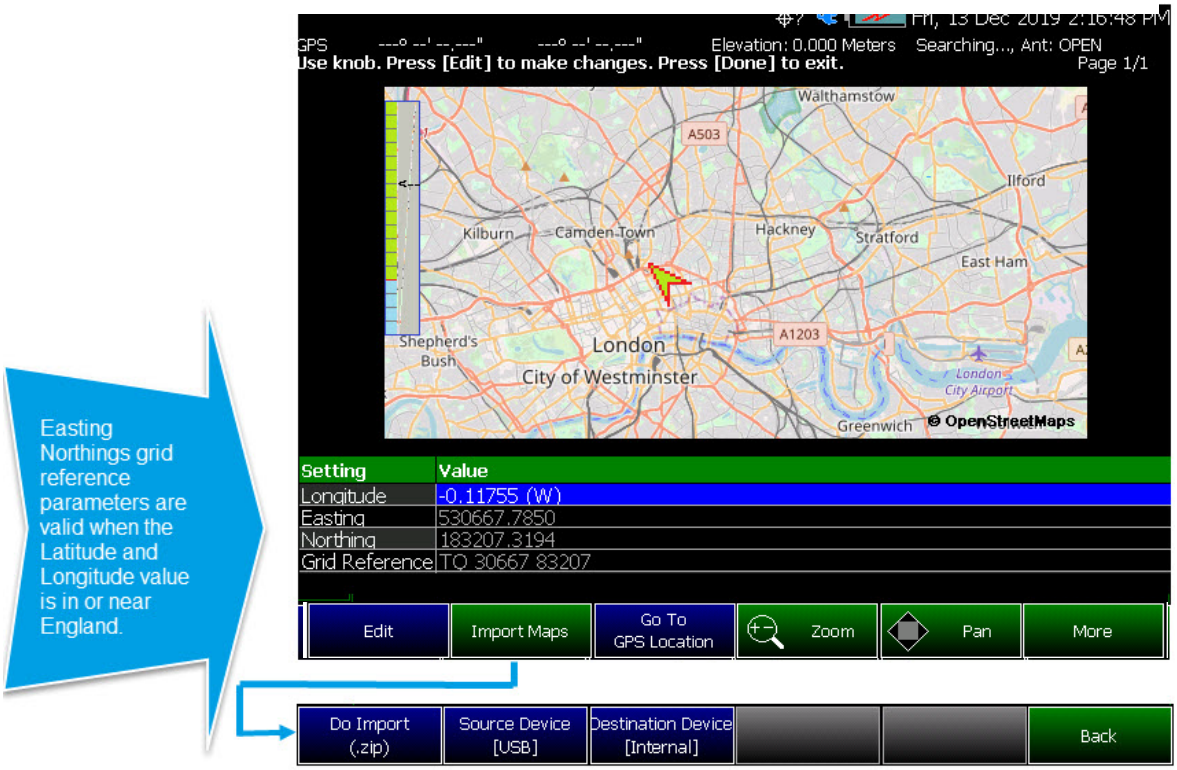
d. Optional: If you know your route, and have already downloaded a zip file of your mapping location or are connected to the LAN, then press System 7 > Utilities > Mapping > Map Explorer (Get Maps) then:

- Move the position cursor to current location:
  - Then use the ▲|▼ arrows, the rotary knob, or numeric keypad locate the position cursor to current location.
- Then Edit to change the value of:
  - **Zoom** – If a zoom value is not found, the FieldFox ignores the entered value and returns to the previously displayed Zoom setting (i.e., values must be between 4 and 17).
  - **Latitude** – If a latitude value is not found the FieldFox displays a gray grid.
  - **Longitude** – If a longitude value is not found the FieldFox displays a gray grid.
  - **Easting** – Enter an eastern measured distance (i.e, x Cartesian coordinate).
  - **Northing** – Enter an northward-measured distance (i.e., y Cartesian coordinate).
  - **Grid Reference** – Valid in UK only.
  - **Red Limit** – Determines the dBm value of the red limit (default = –20 dBm).
  - **Blue Limit** – Determines the dBm value of the blue limit (default = –90 dBm).

  When done entering each setting, press Enter.

Figure 16-16 Example of England Displayed Text

Import ZIP file using FieldFox Map Support Tool with Import Maps (ZIP)



Unzip file found on **Source Device**. Store contents to /Maps folder of **Destination Device**.

e. Else, to import a *zip file (i.e., you can come back and do this later after the mapping route is defined).

i. Press **System 7** > **Utilities** > **Mapping**

ii. Then to import map pictures, press **Map Explorer (Get Maps)** > **Import Maps**

iii. Press **Import Maps (ZIP)** > **Recall File** and change latitude and longitude values to view site maps from pictures (KML).

3. If not done, connect your equipment similar to Chapter 14, “5G Rapid Prototype Phased Array Antenna – Option 360”, Chapter 15, “USB Antennas – (Full Capability Requires EMF Option 358, and either SA mode (Option 233 Mixed Analyzers) or OTA–LTE FDD (Option 370), LTE TDD (Option 371), 5G NR / 5G NR EVM Conducted (Option 378)”, and to Figure 14-1 on page 439

See also,

– For setting up GPS Option 307, refer to Chapter 32, “System Settings,” and then “GNSS (GPS+) and GPS” on page 865.

– For setting up a phased array antenna, refer to Chapter 14, “5G Rapid Prototype Phased Array Antenna – Option 360.”

- For setting up a USB antenna, refer to Chapter 15, “USB Antennas – (Full Capability Requires EMF Option 358, and either SA mode (Option 233 Mixed Analyzers) or OTA–LTE FDD (Option 370), LTE TDD (Option 371), 5G NR / 5G NR EVM Conducted (Option 378).”

4. Install street maps into the FieldFox. Refer to “How to Install Node.js and Running the FieldFox Mapping Software” on page 494.

   Downloading map options:

   - Store the maps *.zip file onto USB or SD card and the FieldFox can load from USB, SD card, or internal drive (if the maps are saved to the FieldFox).
   - Connect the FieldFox to the LAN with internet access and use the FieldFox Mapping software to download a maps image *.zip file.
   - If necessary, you can download the maps at later time.

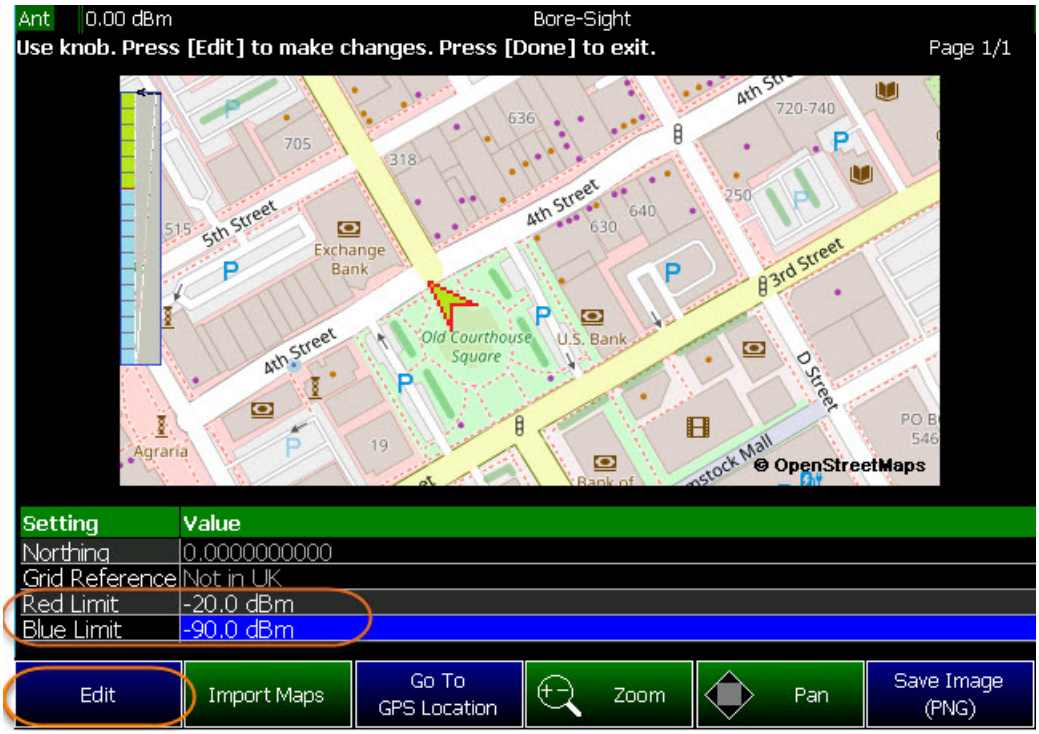
5. Using Discrete Colors softkey Menu, set the red (maximum) and blue (minimum) values. For setting color coded bar scale preferences, refer to Chapter 32, “System Settings,” and “Using the Discrete Colors Softkey Menu” on page 864.

   a. Press **System 7** > **Utilities** > **Mapping** > **Map Explorer (Get Maps)**

   b. Optional: Select the Red or Blue Limits to edit by using the ▲|▼ arrows, the rotary knob, or numeric keypad to position the trace for optimum viewing on the FieldFox display.

      Then **Edit** (the color coded bar scale Red or Blue limits are at the top of the FieldFox display).

Figure 16-17 Using Maps Explorer to Set the Red and Blue Power Limits



c. Optional: Then **Preferences** > **Discrete Colors** > **Discrete Colors** > **Discrete Colors** and change value as desired (Maximum = 6).

Figure 16-18 Display Example: Color Coded Bar Scale Before Selecting x6 Colors

Figure 16-19 Display Example: Color Coded Bar Scale After Selecting x6 Colors

6. Verify you have enabled GPS. Refer to your measurements procedure and to "GNSS (GPS+) and GPS" on page 865.

7. Then press **Esc** > **Back** > **Trace 6** > **More** (required for OTA only) > **Data Logging** > **Record Save/Recall**

– Then **File Folder Default System**

– **Default** – Sets the default User Folder path:

——List files (*.csv and *.kml) are save-recalled to:
"[CurrentDevice]:\RecordPlayback\CS\"

——Record-Play files are save-recalled to:
"[CurrentDevice]:\RecordPlayback\CS\"

Or

– System – Sets the User Folder to the user defined system folder path/name:

——List files are save to-from
"CurrentDevice\<UserSelectedFolder>\"

——Record-Play files are save-recalled to:
"CurrentDevice\<UserSelectedFolder>\"

Refer to “File Management” on page 887.

– Then File Type
  – KML or
  – CSV (default)
– Then Save Log File.

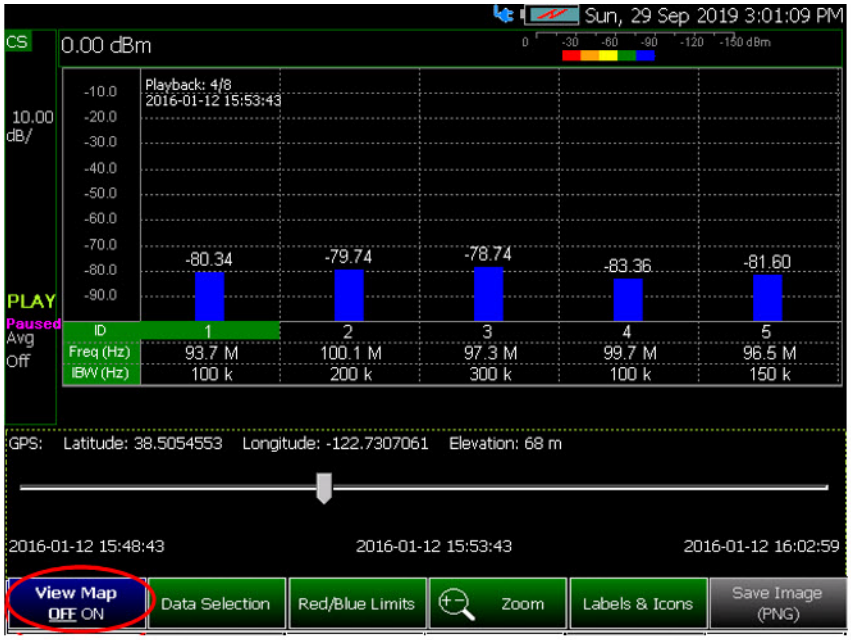
  or

– Then Recall Log File.
– Optional Auto Save ON (default = OFF). To avoid loss of data, if power loss occurs.
– Then Back

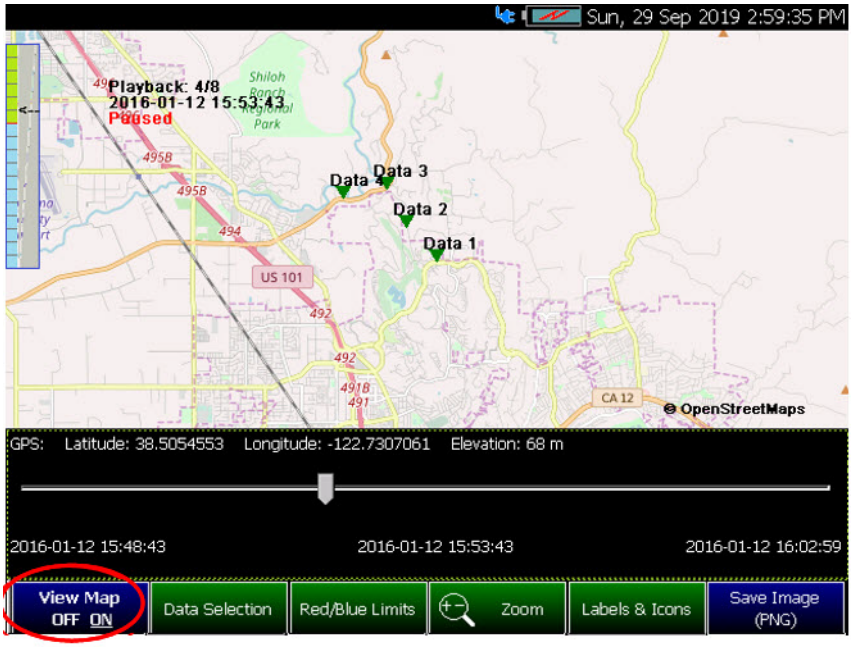
8. Set up the outdoor mapping:
   a. Press Trace 6 > Data Logging
   b. Then press Record
   c. When done, Stop
   d. Save results to KML file.
9. View KML with map tools.
   – On the FieldFox, see the data results overlaying OpenStreetMaps' pictures.

     Or use Google Maps or similar to view your maps on your PC. Refer to “Import and Play back KML Files into 3rd Party Software (Example: Google Earth with Animation Tool)” on page 517.

Figure 16-20 FieldFox Display with View Map ON and OFF Displayed



[Playback] with View Map OFF



[Playback] with View Map ON

Import and Play back KML Files into 3rd Party Software (Example: Google Earth with Animation Tool)

Features

Use the Playback Slider to replay measurement results. See also Google Maps and or Google Earth's help. Refer to Figure 16-21 on page 518.

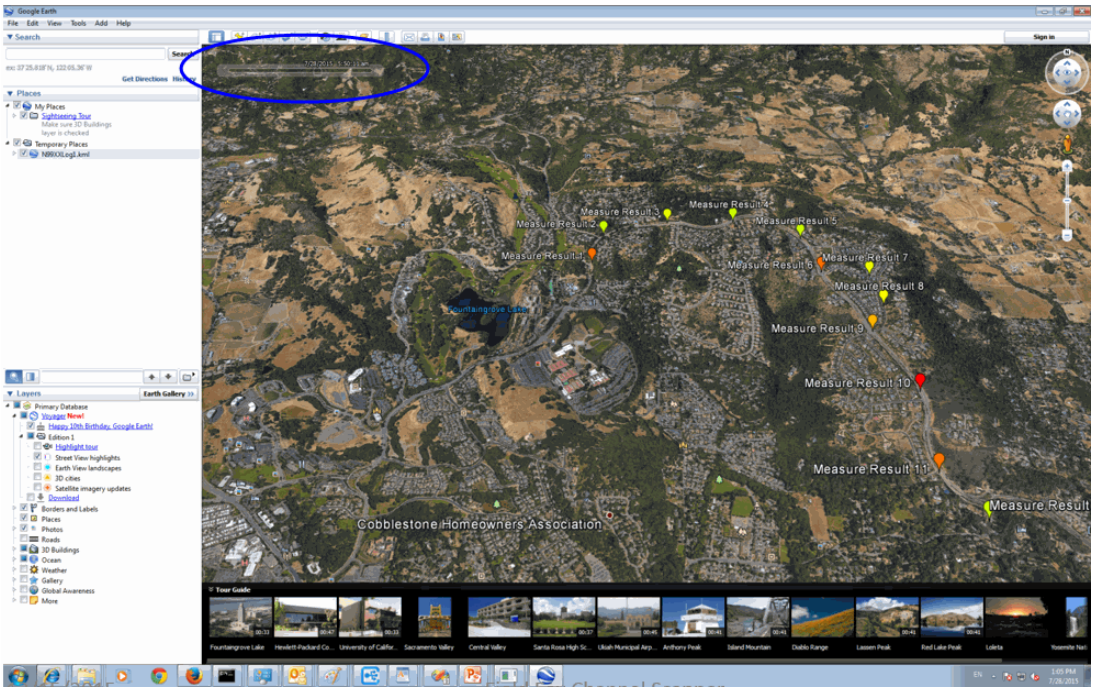
– Open the FieldFox *.KML file in Google Earth. The time slider appears in upper left of the map.

– Manual Mode – Move the time slider cursor to see color-coded icons pop-up according to the timestamp.

– Loop mode has a Fast-Slow Replay Option.

– Click on each color coded balloon to see the table of measurement results for that location.

Figure 16-21 Importing a KML File Into Google Earth



Setting up Data Logging

There are two types of data logging:

"Enabling Outdoor Map Logging" on page 519 and

"Enabling and Setting Up Indoor Map Logging" on page 522

See also, "Option 352 Indoor Maps Setup Procedure" on page 507 and "Option 352 Outdoor Maps Setup Procedure" on page 511.

Opening the **Data Logging** settings:

- Press **Mode** (Channel Scanner (Option 312) only) > **More** (Depending on the number of options installed, may not be necessary) > **Channel Scanner**
- Press **Measure 1** (Channel Scanner (Option 312) only) or **Trace 6** > **Data Logging**

Enabling Outdoor Map Logging

If you have already setup your outdoor or indoor map logging:

- Then **Record** to being logging data or
- Then **Play** If this softkey is active, you are currently recording or you have recalled a previously stored data logging file

  When Play is pressed, then choose:

  - **Cursor Position** use this softkey to move the data log play cursor in the current data log being played (i.e., **Cursor Position** is active only when playback is paused).

    This softkey is only available in Channel Scanner and Phased Array Antenna modes (i.e., The Cursor Position softkey is **not** available for OTA mode).
  - **Maps** – to open a softkey menu enable map view and related features (e.g., Data Selection, Red/Blue Limits, Zoom, and Labels & Icons). Learn more, refer to step 3.

  or

- Then **View** (available in Channel Scanner mode and with Outdoor Mapping only)

  Then choose:

  - **Exit** to leave the current View softkey menu and return to the previous menu.
  - **Zoom** use this softkey zoom in/out.

This softkey is only available in Channel Scanner and Phased Array Antenna modes (i.e., The Cursor Position softkey is **not** available for OTA mode).

- **Red Limit** to edit the red maximum power limit dBm value.
- **Blue Limit** to edit the blue minimum power limit dBm value.

Setting up **Outdoor** Mapping

1. Press **Record Settings** – then choose:
   - **Meas Interval OFF ON** Enable to make the measurement interval softkeys active (default = OFF).
   - **Interval Type** choose **Time** or **Distance**.
   - **Time Interval** Enter time in seconds (1s to 3.6 ks) or
   - **Distance Interval** Enter time in miters (10m to 10 km)

2. Press **Record Save/Recall** Opens a softkey menu to manage your data logging filenames and file folder locations
   - **Save Log File** or
   - **Recall Log File** (if you have previously stored data)
   - **File Folder Default System** (Default = Default) or
   - **File Type** (Default = CSV) KML or DREC (DREC applies to Option 360 only)
   - **Auto Save OFF ON** To enable/disable auto save to protect your data, if power is lost (Default = OFF)
   - Then **Back**
3. Then choose from the following:
   - Press **Record** to begin a new data log recording.
   - Press **Pause Resume** (only displayed after **Record** has been pressed) Temporarily halts recording until pressed again. The incoming trace continues to sweep. Press again to continue recording.
   - Press **Play** If this softkey is active, you are doing a new recording or you have recalled a previously stored data logging file.
   - Press **Stop** Immediately
     - The Save the log file menu opens. Edit the filename and press Done to exit menu. See Settings below and "To change Data Logging Configuration settings:" on page 533.

- To change your file settings or measurement interval. Learn more, refer to "To change Data Logging Configuration settings:" on page 533.

– Press **Maps** – to open a softkey menu enable map view and related features (e.g., Data Selection, Red/Blue Limits, Labels & Icons, Zoom).

Then choose from the following:

––**View Map OFF ON** To enable/disable the current map view (default = latitude/longitude = 0.00/00. Need GPS to view current location (default = OFF).

––**Data Selection** Opens a softkey menu to set the active data channel, sort type, and sort order.

Then Choose:

Channel 1	Sets the data channel being recorded. Available channels will vary within each mode.
Sort Power Freq	Sets the type of measurement displayed (Power or Frequency).
Sort Order Up Down	Sets the sort order to ascending (Up) greater power/frequencies displayed first or descending (Down) lowest power or frequency values displayed first.
Back	Returns to previous softkey menu.

––**Red/Blue Limits** Opens a softkey menu to assign power values to the red (high power limits) and blue (low power limits) heat map display limits (defaults: Red Limit = –20 dBm, Blue limit = –90 dBm).

––**Zoom** Zoom in/out on the map displayed.

––**Labels & Icons** Opens a softkey menu to enable/disable map data point labels and icon types.

Then choose from the following:

Labels OFF ON	Enables/Disables map data point labels. When enabled, a label is displayed for every map data point (e.g., "Data 1"). When disabled, labels are not displayed for the map data points.

Icons **Flag Point** **Line**	Sets the type of icon that is used to display a map's data points.

–– **Save Image (PNG)** Saves the current displayed map to a *.png file (default filename is "MapImageFile"). This softkey is available (active) when View Maps = ON.

NOTE

Record-Play files are saved to:

- If File Folder is set to Default then Record-Play files are save-recalled to: `"[CurrentDevice]\RecordPlayback\[Current mode]\"`
- If File Folders are set to System, then Record-Play files are save-recalled to: `"CurrentDevice\<UserSelectedFolder>\`

NOTE

Learn more about file settings, refer to Chapter 34, "File Management."

Enabling and Setting Up Indoor Map Logging

1. Press **Measure 1** > **Data Logging** > **More**
2. Press **Indoor Map Data Logging** – then choose:
   - **Record Indoor Data** – Use this option to load a new floor–plan image to plot data points and lines of bearing to emitter signals.
   - **Recall Indoor Log File** – (if you have previously stored data (*.kdat)). You can recall a log file and add/delete directional finding lines of bearing and map data to previously saved files. Re-save them and resume data collection at a later time.

     After a *.png is opened for a new recording or a *.kdat file is recalled for editing and displayed on the FieldFox, then choose from the following:

CAUTION

IMPORTANT!

When you recall a *.kdat file, you are able to add mapping points, but you will only be able to save the changes as a *.png. file. Optionally, if you save a file as a *.png file and then recall the file, you can add data points and save the changes as a *.kdat file.

NOTE

A KDAT file is the file FieldFox uses to recall an indoor mapping/data logging session (“Recall Indoor Log File”). It's an archive file that contains information about the original image file, the location of the recorded data on the image and the actual recorded data. KDAT files can only be opened with FieldFox itself. KDAT files cannot be opened via Data Link.

An auxiliary CSV data file is generated automatically, each time a KDAT file is saved during an indoor mapping session. The CSV contains the recorded data, without the image, location of the recorded data, etcetera.

- **Navigate OFF ON** To enable/disable map location changes using arrow keys and the RPG (when **ON**). When **OFF** the arrow keys and RPG enable you to highlight and **Edit** the Navigate, Red Limit, and Blue Limits in the **Setting** table. (Default = OFF)
- **Pan** Navigate map East, West, North, South using arrow keys).
- **Zoom** Zoom in/out on the map displayed.
- **Bearing Line** This similar to the outdoor direction finding feature. It allows a “Bearing line” to be on or off, the angle of Bearing Line to be setup, and its length to be set. All very similar to the outdoor direction finding procedure. From this Bearing Line menu, you can also select a point to edit/change.

NOTE

Before you can set a Bearing Line value, you first must “Record” a point, before you can turn its bearing line on or off, change its length, and angle. See also, “How to Add Directional Finding (DF) Bearing” on page 529.

Bearing Line OFF ON	Enables and disables the Bearing Line between two points.
Angle	Sets the angle of the Bearing Line (default = 0°, 0 to 360°).
Line Length	Sets the length of the Bearing Line to connect two points (default = 100).
Select Point	Sets the point to be edited.
Back	Takes you back to the previous softkey menu.

- **Record Data** To record a data point in the specified intervals using currently selected labels and icons.

To enable the **Record Data** softkey, move the cursor using the arrow hardkeys or the RPG to highlight the Location: **Value** cell in the table. Begin walking with an antenna and press Record Data as required to map a location.

– More Opens a menu of softkeys to Undo, set Labels & Icons, RPG actions, Save Image, and Back.

Labels & Icons	Opens a softkey menu where you can enable/disable and select map icons: ––Labels OFF ON - Enables/Disables map data point labels. When enabled, a label is displayed for every map data point (e.g., “Data 1”). When disabled, labels are not displayed for the map data points. ––Icons Flag Point Line - Sets the type of icon that is used to display a map’s data points. ––Pointer OFF ON- Enables/disables the bore sight pointer.
Undo	To undo last indoor map setting change
RPG [Zoom]	Opens a menu to set the RPG’s functionality for mapping. Choose from: ––Zoom - (default) Zooms in/out. ––<--> - RPG knob moves the map East or West. ––^|v - RPG knob moves the map north or south.

Data Selection	Opens a softkey menu to set the active data channel, sort type, and sort order. ––Channel 1 - Sets the data channel being recorded. Available channels will vary within each mode. ––Sort Power Freq - Sets the type of measurement displayed (Power or Frequency). ––Sort Order Up Down - Sets the sort order to ascending (Up) greater power/frequencies displayed first or descending (Down) lowest power or frequency values displayed first.
Save	Opens a softkey menu to enable you to save your map (.kdat) or your image (.png). ––Save Map - Opens "Save the log file" where you can name and save your map file (kDAT). Softkey is only visible when data is recorded on a *.png file using Labels & Icons feature and the Record softkey. ––Save Image (PNG) - Saves the current displayed map to a *.png file (default filename is "MapImageFile"). This softkey is on active when View Maps = O.
Back	Returns to previous softkey menu.

NOTE

A KDAT file is the file FieldFox uses to recall an indoor mapping/data logging session ("Recall Indoor Log File"). It's an archive file that contains information about the original image file, the location of the recorded data on the image and the actual recorded data. KDAT files can only be opened with FieldFox itself. KDAT files cannot be opened via Data Link.

An auxiliary CSV data file is generated automatically, each time a KDAT file is saved during an indoor mapping session. The CSV contains the recorded data, without the image, location of the recorded data, etcetera.

3. Press Record Save/Recall Opens a softkey menu to manage your data logging filenames and file folder locations
   - Save Log File or
   - Recall Log File (if you have previously stored data)

- File Folder Default System (Default = Default) or
- File Type (Default = CSV) KML or DREC (DREC applies to Option 360 only)
- Auto Save OFF ON To enable/disable auto save to protect your data, if power is lost (Default = OFF)
- Then Back

NOTE

Record-Play files are saved to:

- If File Folder is set to Default then Record-Play files are save-recalled to: "[CurrentDevice]\RecordPlayback\[Current mode]\"
- If File Folders are set to System, then Record-Play files are save-recalled to: "CurrentDevice\<UserSelectedFolder>\

NOTE

Learn more about file settings, refer to Chapter 34, "File Management."

Outdoor Mapping Only: Export KML File Into 3rd Party Mapping Software

- Export KML file into 3rd party mapping software (i.e., Google Map or Google Earth). Refer to "Import and Play back KML Files into 3rd Party Software (Example: Google Earth with Animation Tool)" on page 517.

How to Use Data Logging (Option 352)

NOTE

Data Log-Play files are saved to:

- **If File Folder is set to Default then Record-Play files are save-recalled to:** `"[CurrentDevice]\RecordPlayback\[Current mode]\"`
- **If File Folders are set to System, then Record-Play files are save-recalled to:** `"CurrentDevice\<UserSelectedFolder>\"`

Data Logging enables you to use GPS mapping data and play them back at a later time. Use this feature to overlay Maps pointers on your indoor or outdoor files.

Data logs can be saved to the FieldFox Internal memory, an SD Card, or a USB flash drive.

This section assumes you have already completed the initial setup and have a measurement setup in the FieldFox.

This section contains the following sections:

- "Screen Annotation" on page 527
- "How to Add Directional Finding (DF) Bearing" on page 529
- "How to Record a Data Log (Outdoor Logging Only)" on page 532
- "To change Data Logging Configuration settings:" on page 533
- "How to Play a Data Log" on page 533

Screen Annotation

During a record or playback session, the following is displayed in the top-center area of the screen:

- **Rec: 55/55 2018-12-31 03:26:11 PM**

where:

- **55/55** is the current and total trace number: currently trace is 55 of 55 total scans.
- **2018-12-3103:26:11 PM** is the date and time of recording.
- The name of a recording can be changed using Manage Sessions. Learn more in "To change Data Logging Configuration settings:" on page 533.

  See also, the FieldFox User's Guide's Settings" chapter.

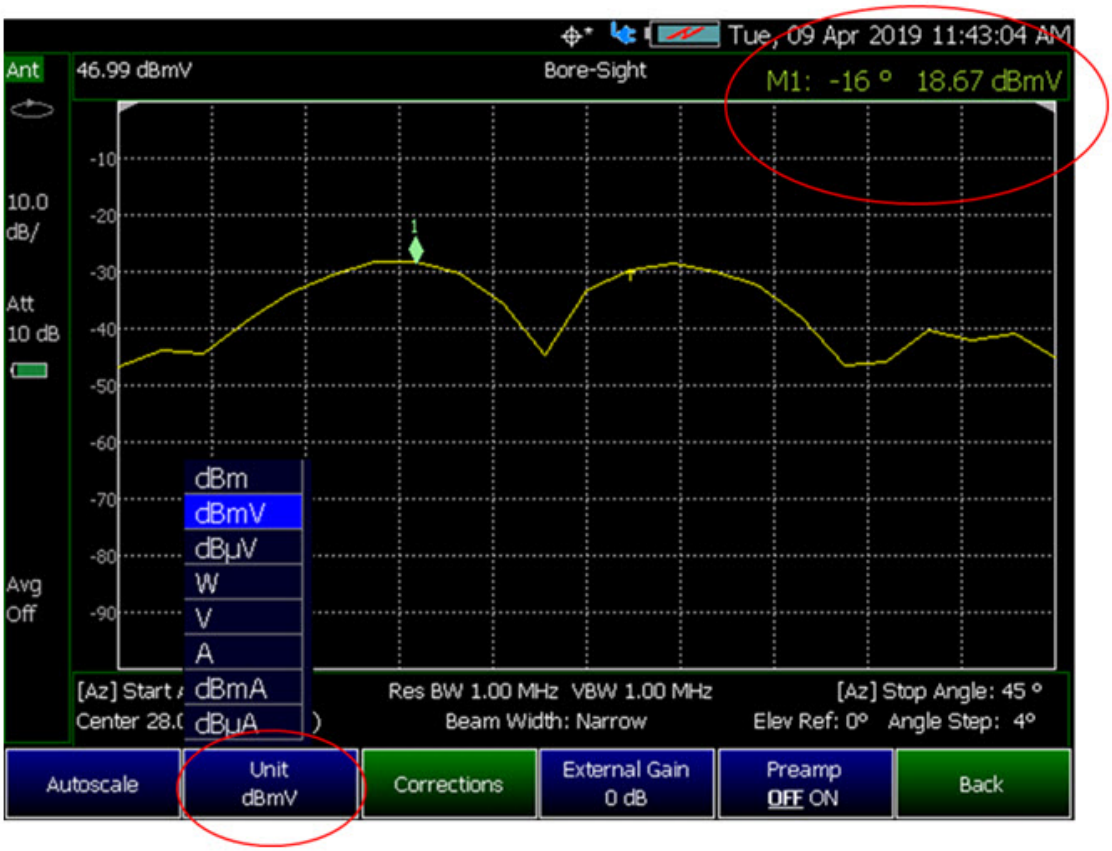
When GPS is enabled, **GPS R** is indicated at the bottom of the FieldFox display. Learn more, see the FieldFox User's Guide's "System Settings" chapter.

The Mapping mode can display and be data logging can be recorded/played back in field strength units (Option 360 only), when the units are changed:

– Press **Scale /Amptd** > **More** > **Unit** then choose:
  – **dBmV**, **dBuV**, **W**, **V**, **A**, **dBmA**, or **dbuA** (Default Units: dBm)

See Figure 16-22 on page 528.

Figure 16-22 Field Strength Annotation that can be Recorded and Played Back



NOTE

If Data Logging or playback is not occurring when you think it should, check the following:

– Is the sweep in HOLD? (upper-left annotation), or check the Sweep menu for **Continuous** set to **OFF**.
– Is Recording or Playback Paused? (mid-left annotation)
– Is the Data Logging measurement **Interval** set too long? (Configuration settings.)

How to Add Directional Finding (DF) Bearing

NOTE

IMPORTANT! You must be in Channel Scanner Mode to use this feature.

DF Bearing adds the ability add points to the map at your current location indicating a signal emitter's strength and direction relative to your position. Refer to Figure 16-23 on page 531 and Figure 16-24 on page 532.

See also, "Downloading and Using the FieldFox Map Support Tool" on page 496.

- Press **Mode** > **More** (Depending on installed options, may not be necessary.) > **Channel Scanner**
- Press **Measure 1** > **Data Logging** > **More**
- Optional (Ignore for Outdoor Mapping): Press **Indoor Map Data Logging** then choose:
  - Press **Record Indoor Data** – Use this softkey to load a new floor-plan image (*.png) to plot data points and lines of bearing to emitter signals or
  - Press **Recall Indoor Log File**– (if you have previously stored data (*.kdat)). You can recall a log file and add/delete directional finding lines of bearing and map data to previously saved files. Re-save them and resume data collection at a later time.

CAUTION

IMPORTANT!

When you recall a *.kdat file, you are able to add mapping points, but you will only be able to save the changes as a *.png. file. Optionally, if you save a file as a *.png file and then recall the file, you can add data points and save the changes as a *.kdat file.

Indoor and Outdoor Data Logging

- Then **Signal Locate**
- Then **Add Point** – adds a new bearing location then:
  - Press **Direction Line OFF ON** – Enables/disables the line of bearing (default = OFF).
  - Press **Adjust Angle** – Enters the angle of the current point's line. Rotate the line about the current point (your current location) to point towards the highest signal strength seen by your directional antenna. You can rotate the knob to rotate the line, or you can type an angle into the active entry directly.

  - Press **Line Length** – Enters a value for the line's length. Adjusts the length of the line of bearing to extend it far enough to allow other points to cross, indicating a possible emitter location.
  - Press **Accept Point** or **Back** – verifies the new point is to be added and returns to the previous menu.

- Then **Edit Points** – Opens up menu of bearing point editing softkeys. Choose from:
  - Press **Select Point** – Enter the point you want to edit. Then you can directly enter a new angle or line length or use the ▲|▼ arrows, or the rotary knob to edit these values.
  - Press **Direction Line OFF ON** – Enables/disables the direction line (default = OFF).
  - Press **Adjust Angle** – Enters the angle of the current point's line. Rotate the line about the current point (your current location) to point towards the highest signal strength seen by your directional antenna. You can rotate the knob to rotate the line, or you can type an angle into the active entry directly.
  - Press **Adjust Angle** – Enters a value for the line's length. Adjusts the length of the line of bearing to extend it far enough to allow other points to cross, indicating a possible emitter location.
  - **Delete Point** – deletes the currently selected point.
- Then **Clear Points** – Deletes all of the displayed bearing points and lines.

Figure 16-23 Directional Finding (DF) Bearing – Outdoor Map Data Logging Example

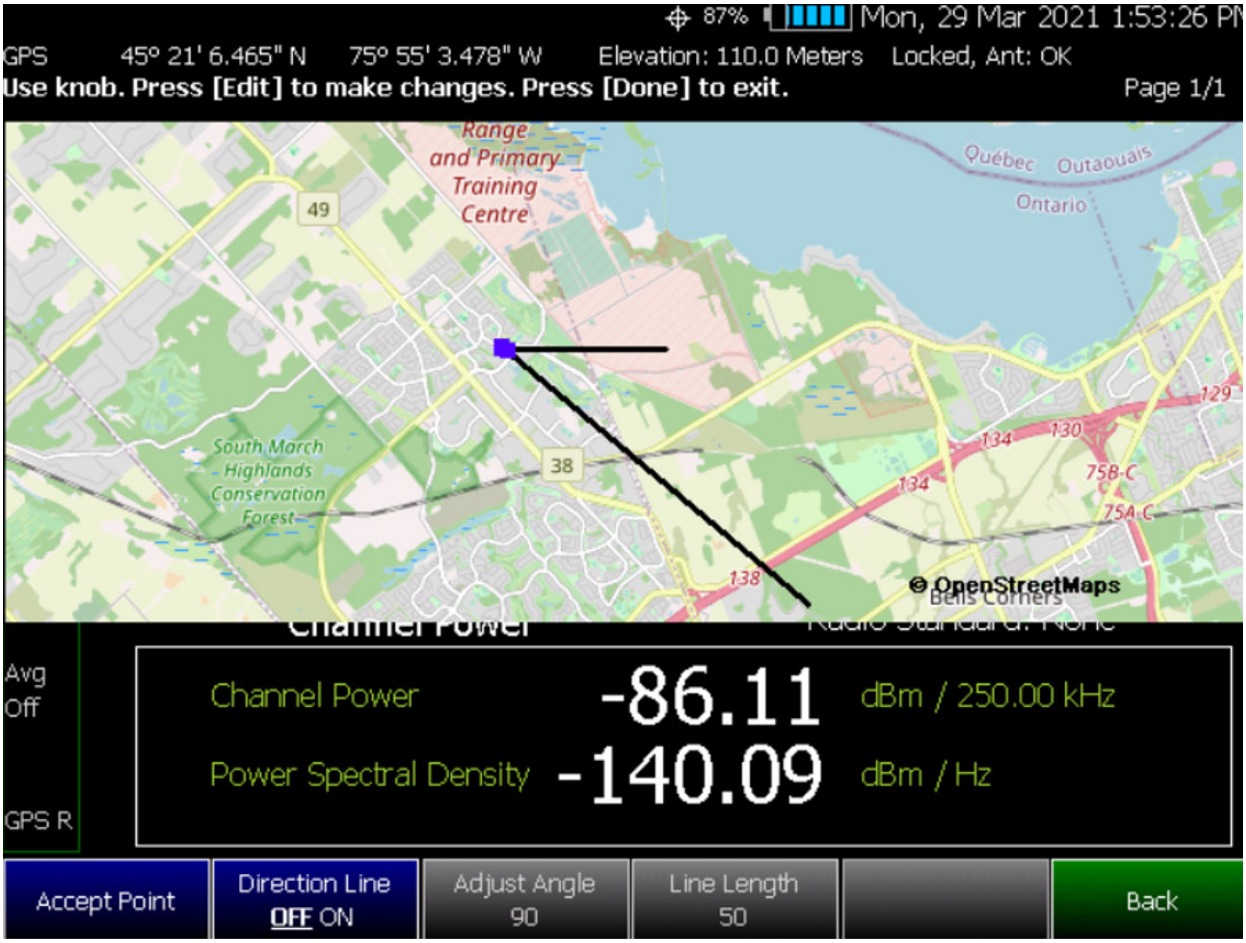
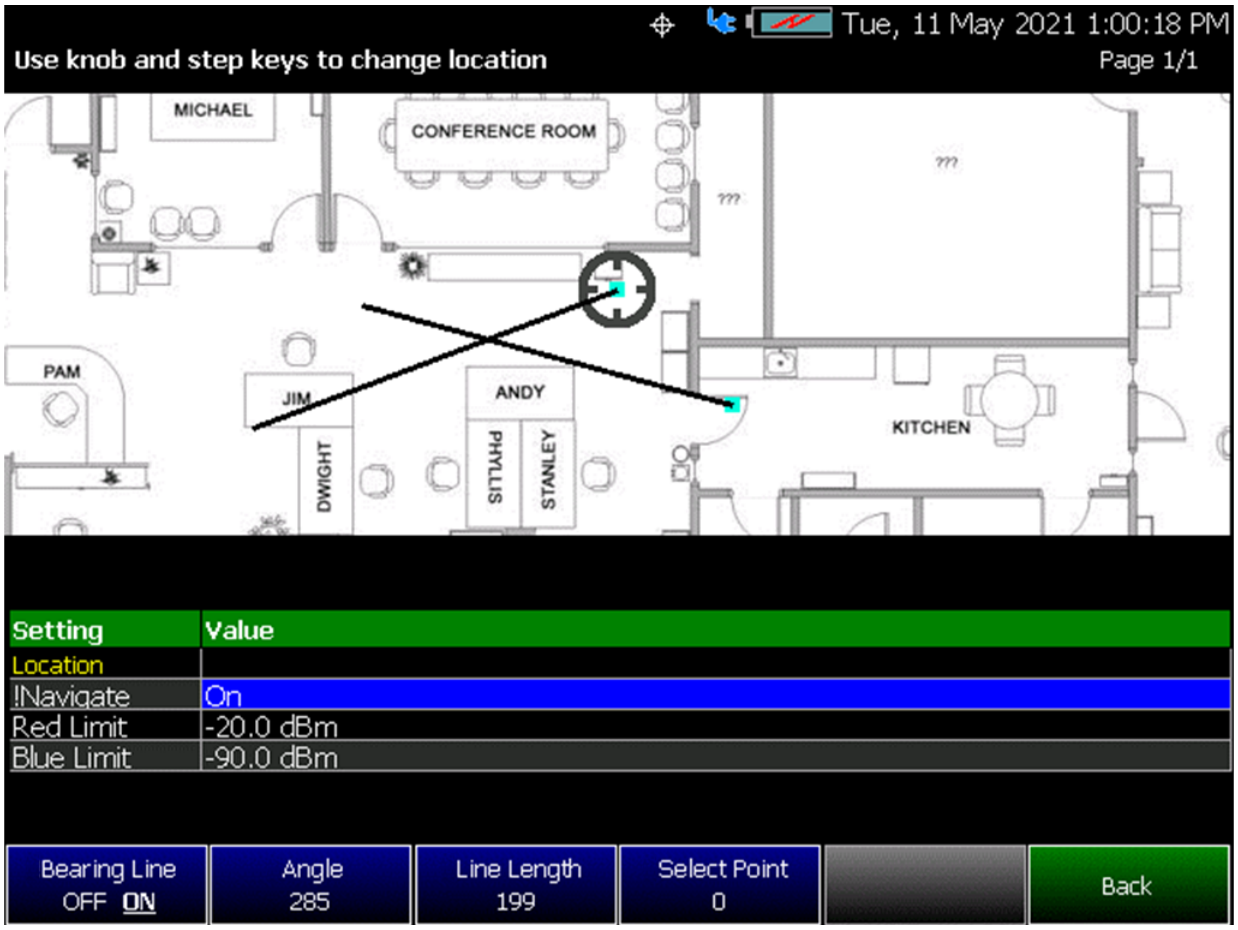


Figure 16-24 Directional Finding (DF) Bearing – Indoor Map Data Logging Example



How to Record a Data Log (Outdoor Logging Only)

For Indoor Logging, refer to "Enabling and Setting Up Indoor Map Logging" on page 522.

NOTE

Data Log-Play files are saved to:

- If File Folder is set to Default then Data Log-Play files are save-recalled to: `"[CurrentDevice]\RecordPlayback\[Current mode]\"`
- If File Folders are set to System, then Data Log-Play files are save-recalled to: `"CurrentDevice\<UserSelectedFolder>\`

- Press **Trace 6**
- Then **Data Logging**
- Then **Record** (Outdoor Logging Only)

REC is displayed in the left of screen graticules.

During recording, choose from the following:

– **Pause Resume** Temporarily halts recording until pressed again. The incoming trace continues to sweep. Press again to continue recording.

– **Stop** Immediately stops recording. Then choose from the following:

  – Then **Record Save/Recall** To save a log file, recall a log file, or change your file settings. Learn more, refer to "To change Data Logging Configuration settings:" on page 533.

    ––Press **Save Log File** to save the current Table data (i.e., default save device is Internal).

  – Then **Record Settings** **(Outdoor Mapping only)** To change your measurement interval settings. Learn more, refer to "To change Data Logging Configuration settings:" on page 533.

To change Data Logging Configuration settings:

– Press **Trace 6**

– Then **Data Logging** then choose:

– Then **Record Settings** (Outdoor Mapping only)

  – Optional: Then **Meas Interval** > ON

    ––Then **Interval Type** > choose **Time** or **Distance**.

    ––Then, if applicable **Time Interval** enter time interval in seconds.

    Or

    ––Then, if applicable **Distance Interval** enter distance interval in miters.

– Then **Record Save/Recall**

  – Then **Device** (**Internal** (default), **SD Card**, or **USB**)

  – Then **File Type** (**CSV** (default), **DREC** (Option 360 Only), or **KML**)

Learn more, refer to the Chapter 34, "File Management".

How to Play a Data Log

– Press **Trace 6**

– If the session is already open, skip the following step. Otherwise:

– Then **Data Logging** > **Record Save/Recall**

NOTE If these are large recordings on a device, it could take several seconds for the FieldFox to display the list.

– Then **Recall Log File** use the Use the RPG or the ▲▼ arrow keys to highlight the file to be played.

––Then **Recall File**

––Then **Back**

– Then **Play** to playback your Table data.

PLAY is displayed in the left of screen graticules during playback. When the end of the recording is reached, playback begins at the start of scan and continues to loop indefinitely.

During playback, choose from the following:

– **Pause Resume** Temporarily halts playback. Then choose from the following:

  – **Pause Resume** Press to continue playing.

– **Stop** Immediately stops playback. Then choose from the following:

  – **Play** Start playback from start of scan.

  – **Recall Log File** Opens a list of stored data files.

    Select a file to playback.

  – **Recall File**

  – **Back**

– **Cursor Position** use this softkey to move the data log play cursor in the current data log being played (i.e., **Cursor Position** is active only when playback is paused).

  This softkey is only available in Channel Scanner and Phased Array Antenna modes (i.e., The Cursor Position softkey is **not** available for OTA mode).

– **Red Limit** to edit the red limit dBm value.

– **Blue Limit** to edit the blue limit dBm value.

Troubleshooting

This section contains the following:

– "General Troubleshooting"
– "Port 5000 in Use Error" on page 536
– "Miscellaneous Mapping Errors" on page 539

CAUTION

IMPORTANT!

Do not change the default name of the directory path for downloading the Node.js program, because FieldFox uses the default program path name to run the Mapping feature. Refer to Figure 16-4.

Examples of Web Browsers that not supported are Internet Explorer 6, 7, and 8.

General Troubleshooting

If your Mapping setup is not behaving as expected:

- Verify setup is correct by referring to "How to Set Up Mapping Settings" on page 504.
  - Attenuator set to **0 dB**
  - Preamplifier set to **ON**
  - Correct **Band**, **Channel**, and **Center** Frequency entered
  - GNSS set to **Internal**
  - Frequency Ref set to **GPS**
  - ADC errors: Use **Scale/Amptd** > **Range** to adjust the absolute power level (dBm).

    For some data views, you need to press **More** to view the **Range** softkey.
  - No data displayed: Press **Meas Setup 4** then
    - Verify the correct **Antenna Settings** have been entered.
  - The FieldFox's displayed annotation indicates "`Check LAN connection. Check IP address.`" during pinging.

    Verify:
    - The LAN address for first 3 fields matches the Static IP address of FieldFox. For example, if the Ball Antenna IP address is **192.168.1**.10, set FieldFox Static IP address to **192.168.1**.xx. "xx" must be different number than shown in the last field of the for Ball Antenna. Refer to Figure 14-15 on page 457.

NOTE

IMPORTANT! If you forget you N9910X-028 Ball Antenna's static IP address, refer to this link and the **Support** tab for assistance: www.keysight.com/find/fieldfox and then to the Phase Array Antenna Support Document.

Port 5000 in Use Error

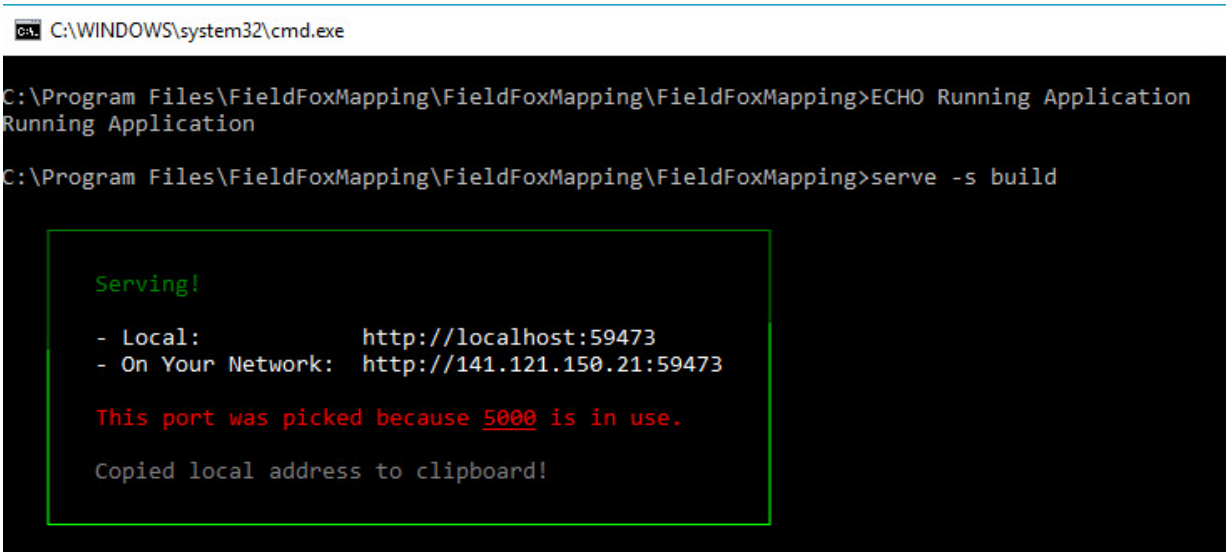
- If the cmd.exe window displays a "`This port was picked because 5000 is in use.`" error, then:
  a. Type `Ctrl + c` in the command window
  b. Press **Enter**
  c. The command window should display text "Terminate batch job? (Y/N)":

Type `Y` and then press **Enter**

The command window should display message confirming the termination of the batch job and close.

Refer to Figure 16-25.

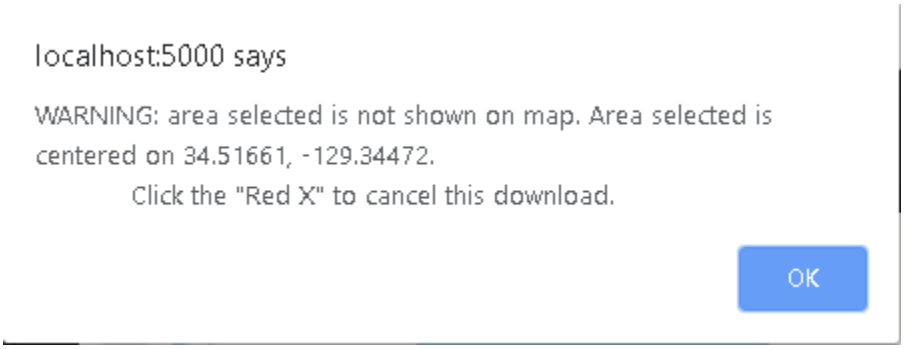
Figure 16-25 Example of “This port...because 5000 is in use.” Error



If the Map Support Tool displays the error shown in Figure 16-26, it means the selected map area is outside the current viewable area.

- You can either:
  - Move the map area by clicking the left mouse to the area you have selected or
  - Click the “Red X” to cancel the download

Figure 16-26 Example of “This port...because 5000 is in use.” Error



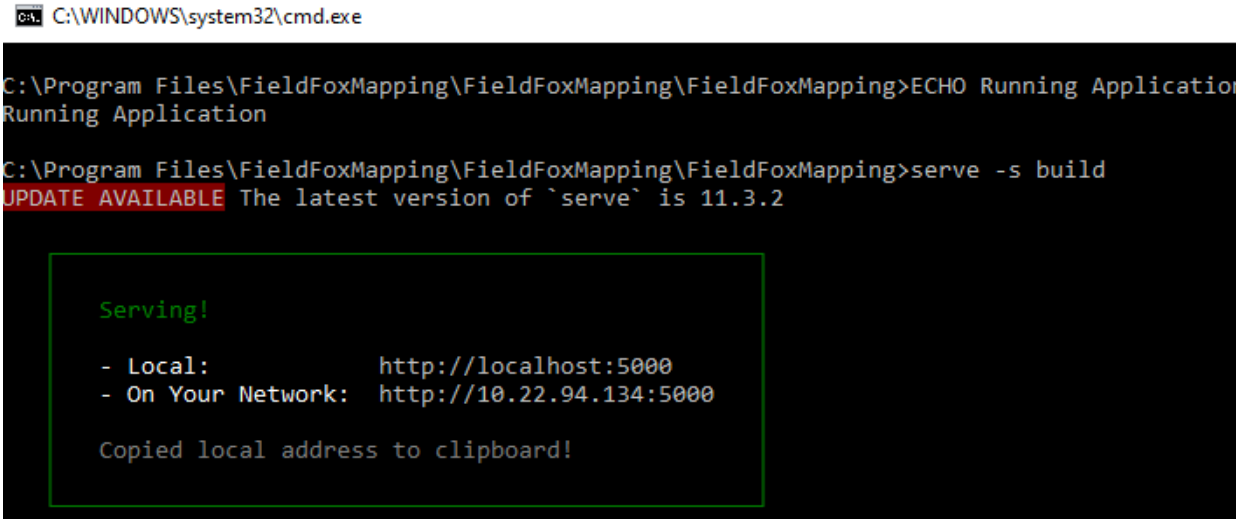
Update Available Message

– If you see this message after opening and running the `Run.bat` file, ignore it and follow the procedure listed in,“Downloading and Using the FieldFox Map Support Tool” on page 496.

If you are unsuccessful in opening and running the FieldFox Map Support Tool when using the `Run.bat` then refer to, “Contacting Keysight” on page 5.

Refer to Figure 16-27.

Figure 16-27 Example of “UPDATE AVAILABLE” Message



Miscellaneous Mapping Errors

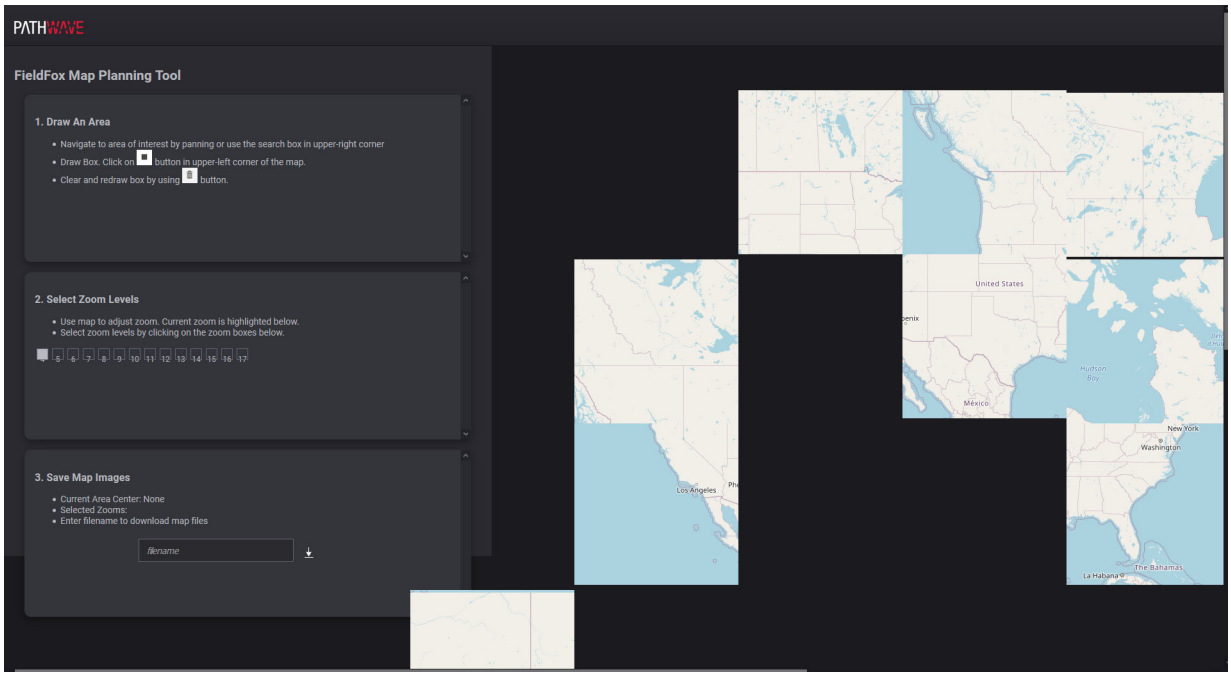
When you are you are on step 3. Save Map Images, you may see a “fetch” error or a ’checkerboard’ map displayed. Refer to Figure 16-28 and Figure 16-29 on page 539.

If you see a “fetch”, ’checkerboard’, or other map errors:

1. Close your current browser window with OpenStreetMaps.org.
2. Open a different browser.
3. If necessary, re-run the FieldFox mapping script (`run.bat`) to re-copy the “localhost:5000” address into your clipboard.
4. Paste the “localhost:5000” address into a different browser and use OpenStreeMaps.org to save your Map image zip file.

Figure 16-28 Example of “This site says... Got error: Failed to fetch” Error

Figure 16-29 Example of ’Checkerboard’ Mapping Error



17 Direction Finding (Interference Finder Option 366 /Time Difference of Arrival (TDoA) Option 390) – Requires Spectrum Analyzer Mode (Option 233), and GPS Receiver (Option 307)

CAUTION

IMPORTANT!

B model FieldFox units require S9910A Pathwave Keysight Signal Measurement Software KSMS software to use the TDoA Option 390. Learn more, refer to https://www.keysight.com/us/en/products/software/pathwave-test-software/pathwave-measurements.html.

NOTE

Alaris antennas are required for all Direction Finding measurements:

– Interference Finder (i.e., Manual AoA) requires a handheld 85574A DF-antenna (i.e., with digital compass and pre-amp).

S9910A Keysight Signal Measurement Software (KSMS) is a PC-based software which enables you to use the FieldFox as a receiver in direction finding measurements. Refer to https://www.keysight.com/find/assist/.

The following Option(s) are available for use with KSMS:

– Option 390 TDoA used to geo–locate signals that were measured using the **SA RF Input Port 2** connector. The FieldFox requires Option 390 for TDoA direction finding and GPS (Option 307) installed.

– Option 366 Manual-AoA used to geo–locate signals that were measured using the **SA RF Input Port 2** connector. The FieldFox requires Option 366 for Manual-AoA direction finding and GPS (Option 307) installed.

  Additionally, requires 85574A handheld DF-antenna (i.e., with digital compass and pre-amp).

To install the Pathwave Keysight Signal Management Software (KSMS) on your PC, refer to https://www.keysight.com/us/en/products/software/pathwave-test-software/pathwave-measurements.html.

Direction Finding (Interference Finder Option 366 /Time Difference of Arrival (TDoA) Option 390) – Requires Spectrum Analyzer Mode (Option 233), and GPS Receiver (Option 307)

For help using the Pathwave Keysight Signal Management Software (KSMS), refer to the KSMS web help https://www.keysight.com/us/en/products/software/pathwave-test-software/pathwave-measurements.html.

In this Chapter

"Time Difference of Arrival (TDOA) – (Requires Option 390)" on page 543

"Troubleshooting" on page 555

– "GPS lock Errors" on page 555

See Also

Other Features Available:

- Alignments (SA chapter) – "Alignments" on page 211
- External Gain (SA chapter) – "External Gain" on page 162
- Markers (Data Analysis chapter) – "All about Markers" on page 797
- Limit Lines (Data Analysis chapter) – "All about Limit Lines" on page 812
- Trace Math (Data Analysis chapter) – "All about Trace Math" on page 829
- Scale Settings (Data Analysis chapter) – "All about Scale Settings" on page 831

"Why and When to Calibrate" on page 129

Chapter 32, "System Settings." (Changing display colors)

Chapter 34, "File Management."

Time Difference of Arrival (TDOA) – (Requires Option 390)

The Time Difference of Arrival (TDOA) measurements are generally used for geo-locating RF sources. It requires three or more remote FieldFox units set up as receivers (sensors) capable of detecting the signal-of-interest. All FieldFox units are synchronized using a GPS signal.

The Spectrum measured by all FieldFox units selected is measured and used to identify the signal of interest which is then geo-located using TDoA.

NOTE

IMPORTANT! It is **not** sufficient to be locked to the GNSS satellite, the frequency reference must be locked to GPS.

Learn more about time difference of arrival (TDoA) Option 390, by referring to S9910A Keysight Signal Measurement Software (KSMS) web help https://www.keysight.com/us/en/products/software/pathwave-test-software/pathwave-measurements.html.

Angle of Arrival (AoA) – (Manual-AoA Requires Option 366)

The FieldFox requires Option 391 for Automatic Angle of Arrival (AoA) and Option 366 for Manual Angle of Arrival (AoA) direction finding and GPS (Option 307) installed.

This section contains the following:

– "How to Access Direction Finding Mode Settings (AoA)" on page 544
– "For more information: Refer to the FieldFox Configuration Guide here: https://www.keysight.com/us/en/assets/7018-06515/configuration-guides/5992-3701.pdf.AoA Bearing - Azimuth with respect to AoA Bearing DisplayAoA Features" on page 545

How to Set Up an AoA Measurement:

– "How to Set Up a Manual AoA Measurement – Option 366" on page 547

Hardkey and Softkey Descriptions:

– "Hardkey and Softkey Descriptions –Interference Finder (i.e., Manual AoA) – (Option 366)" on page 551
–
"Troubleshooting" on page 555
– "GPS lock Errors" on page 555

The Time Difference of Arrival (TDoA) measurements are used for geo-locating RF sources. It requires three or more FieldFox units used as receiver with an Alaris antenna. The FieldFox unit uses its internal GNSS receiver to position the measurement location on the map.

The Angle of Arrival (AoA) measurements are used for geo-locating interfering signals. It requires one FieldFox unit to be used as receiver with an 85574A antenna. Manual AoA uses a handheld 85574A antenna (with digital compass and pre amp). The FieldFox unit uses its internal GNSS receiver to position the measurement location on the map.

AoA systems provide the direction from which the transmission is received. The Spectrum measured by the FieldFox and used to identify the signal of interest which is then geo-located using AoA.

NOTE

IMPORTANT! It is sufficient to be locked to the GNSS satellite, but it is recommended to lock the frequency reference to GNSS.

How to Access Direction Finding Mode Settings (AoA)

Direction Finding Setup Procedure

– Modifying the Frequency Reference and GPSS settings:

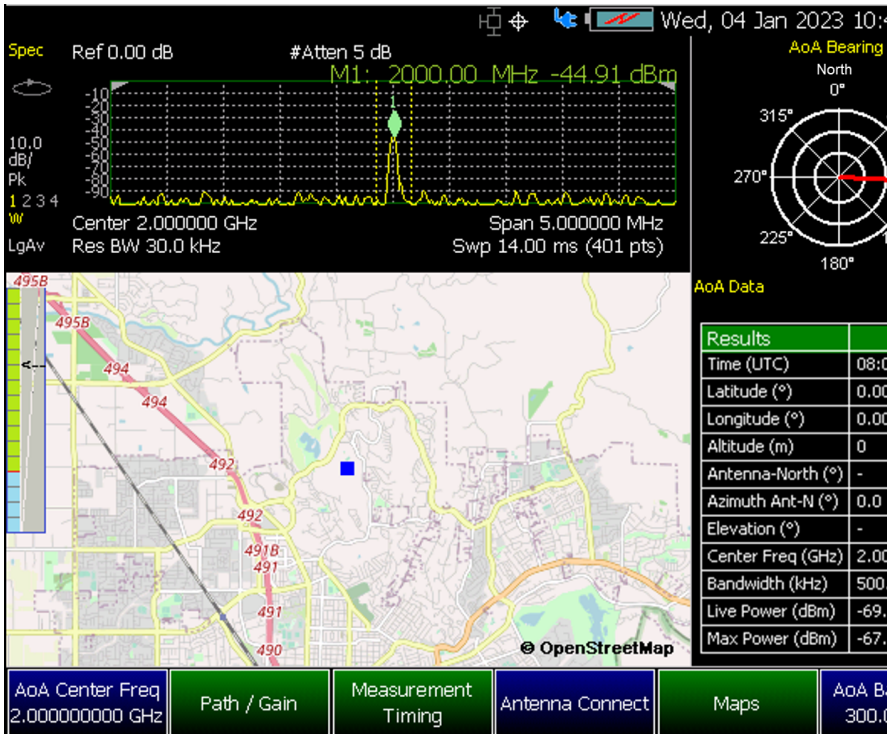
Direction Finding (Interference Finder Option 366 /Time Difference of Arrival (TDoA) Option 390) – Requires Spectrum Analyzer Mode (Option 233), and GPS Receiver (Option 307)

Angle of Arrival (AoA) – (Manual-AoA Requires Option 366)

Press **Mode** > **More** (number of More depends on number of Options on the FieldFox) > **Direction Finding**. Refer to Figure on page 545. Then choose from:

- **None** - If either Option 366 Interference Finder (Manual AoA) is or 391 Auto AoA are installed on the FieldFox, then this softkeys displays a General SA view/features (Default).
- **Manual AoA** - Also known as Interference Finder.

For more information: Refer to the FieldFox Configuration Guide here: https://www.keysight.com/us/en/assets/7018-06515/configuration-guides/5992-3701.pdf.**AoA Bearing - Azimuth with respect to AoA Bearing Display**AoA Features



This section contains the following:

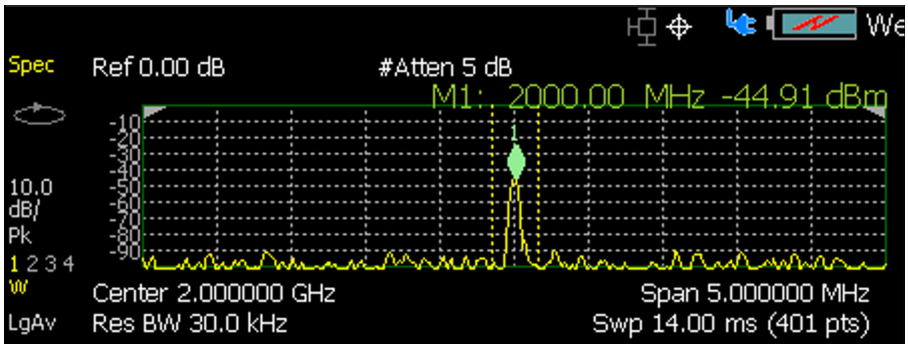
- "Spectrum Monitoring Display"
- "AoA Bearing - Azimuth with respect to AoA Bearing" on page 546
- "AoA Data Results Table Descriptions - Requires Enabled GNSS (See also, Figure on page 545)" on page 547

Direction Finding (Interference Finder Option 366 /Time Difference of Arrival (TDoA) Option 390) – Requires Spectrum Analyzer Mode (Option 233), and GPS Receiver (Option 307)

Angle of Arrival (AoA) – (Manual-AoA Requires Option 366)

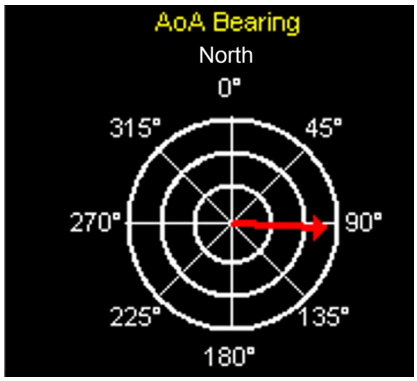
Spectrum Monitoring Display

Figure 17-1 Spectrum Monitoring Display



AoA Bearing - Azimuth with respect to AoA Bearing

Figure 17-2 AoA Bearing Display



AoA Bearing displays the azimuth of the signal being monitored.

Direction Finding (Interference Finder Option 366 /Time Difference of Arrival (TDoA) Option 390) – Requires Spectrum Analyzer Mode (Option 233), and GPS Receiver (Option 307)

Angle of Arrival (AoA) – (Manual-AoA Requires Option 366)

AoA Data Results Table Descriptions - Requires Enabled GNSS (See also, Figure on page 545)

Results	Description
Time (UTC)	– Coordinated Universal Time (UTC) is accurate with GPS active. But, when the GPS is disabled the UTC time is estimated internally by the FieldFox.
Latitude (°)	– Latitude of the AoA antenna
Longitude (°)	– Longitude of the AoA antenna
Altitude (m)	– Altitude of the AoA antenna
Antenna-North (°)	– This is the azimuth of the calibrated antenna North with respect to the geographic North
Azimuth Ant-N (°)	– Azimuth reported by the AoA measurement (0° to 360°) with respect to calibrated antenna-North (0°)
Elevation (°)	– Elevation reported by the AoA measurement, with respect to the calibrated horizontal plane of the antenna
Center Freq (Hz)	–spectrum center frequency for the AoA measurement
Bandwidth (Hz)	–spectrum bandwidth for the AoA measurement
Live Power (dBm)[a]	–Displays the current power being measured.
Max Power (dBm)	–Displays the cumulative power being measured. This cumulative maximum power is reset when the sweep is restarted (i.e., Sweep > Restart).

a. Only available in Results table with Option 366, Manual AoA.

How to Set Up a Manual AoA Measurement – Option 366

This section contains an example procedure for using Interference Finder (Manual AoA). To learn more about the AoA softkey menus, refer to “Hardkey and Softkey Descriptions –Interference Finder (i.e., Manual AoA) – (Option 366)” on page 551.

Example Procedure:

Direction Finding (Interference Finder Option 366 /Time Difference of Arrival (TDoA) Option 390) – Requires Spectrum Analyzer Mode (Option 233), and GPS Receiver (Option 307)

Angle of Arrival (AoA) – (Manual-AoA Requires Option 366)

Sequence of measurement is: Spectrum monitoring and then Manual AoA measurement. Press **Mode** > **More** > * > **Direction Finding** > **Meas Type** > **Manual AoA**

(*Number of **More** softkeys – Varies by the number of Options loaded on your instrument.)

5. If you have not calibrated your 85574A Alaris handheld antenna with your FieldFox, you need to:
   a. Connect your 88574A Alaris antenna to a FieldFox USB port.
   b. Press **Cal 5** > **Run Antenna Cal** then
   c. Follow the Calibration Wizard's prompts.
6. **Setup a spectrum measurement for a monitoring a frequency range of interest:**
   Press **Freq/Dist** then choose from
   - **Monitor Center** – Spectrum monitoring center frequency (Default == Varies with model and options)
   - **Monitor Start** – Spectrum monitoring start frequency (Default == Varies with model and options
   - **Monitor Stop** – Spectrum monitoring stop frequency (Default == Varies with model and options)
   - **Monitor IF Path** – IF path used internally in FieldFox for spectrum monitoring (Default = U Auto; Choices: Auto, 10 MHz, 100 MHz)
   - **Monitor Span** – Spectrum span frequency (Default == 120 MHz, varies vary with model options)
7. **Setup a Interference Finder (Manual AoA) measurement:**

NOTE

IMPORTANT! A compatible USB antenna must be connected to the FieldFox, before proceeding (e.g., 85574A).

Press **Measure Setup 4** then

a. **Antenna Connect** – When pressed, verifies a valid AoA antenna is connected on a USB port of the FieldFox, the antenna has the correct calibration information for the current DF measurement center frequency and loads the calibration data for that specific frequency.

   Verification of the 85574A antenna calibration information and loading new calibration data, if needed, is done automatically before a measurement is initiated manually. Learn more, see step 5 above in this procedure.

b. **Maps** – Opens a softkey menu enabling operation on a map used in the AoA measurement process.

- **Zoom** – Similar functionality to Chapter 16, “Indoor and Outdoor Mapping – Option 352 (Requires Spectrum Analyzer Mode (Option 233), and GPS Receiver (Option 307)).”
- Press **Pan** – Similar functionality to Chapter 16, “Indoor and Outdoor Mapping – Option 352 (Requires Spectrum Analyzer Mode (Option 233), and GPS Receiver (Option 307)).”
- **Labels & Icons** – Opens a a softkey menu to enable/disable map data point labels and icon types.
  - **Labels** – (Default == OFF). Similar functionality to Chapter 16, “Indoor and Outdoor Mapping – Option 352 (Requires Spectrum Analyzer Mode (Option 233), and GPS Receiver (Option 307)).”
  - **Icons** – (Default == Flag). Similar functionality to Chapter 16, “Indoor and Outdoor Mapping – Option 352 (Requires Spectrum Analyzer Mode (Option 233), and GPS Receiver (Option 307)).”
  - **Icon Color** – This softkey enables you to select the color of your map icons. (Choices: Blue (default), Black, Green, Yellow, Orange, and Red.)
  - **Back** – Returns to the previous softkey menu.
- **Center Map GPS Manual** –
  - If GPS is Enabled: Centers the current map using GPS (Option 307).
  - If Manual is Enabled: The map center can be manually adjusted using the **Meas Setup** > **Maps** > **Pan** softkeys (East, West, North, South).

    (Default == GPS)
- **Save Image** – Saves the current displayed map to a *.png file (default filename is “MapImageFile”). (Default == ON)

c. **Bearing Colors** - (Optional) Opens a menu of editable Bearing color softkeys (i.e., One Trigger Bearing softkey and four Bearing 1 though 4 softkeys). Click on each to edit the current color.

8. AoA Measurement:

a. **On the handheld 85574A Antenna:** Press the antenna trigger for more than 2 seconds to capture a Temporary bearing value (default color == black).

b. If the temporary bearing value is correct, Press **Measure 1** then press a **Bearing** 1 through 4 softkey to save the bearing value. When bearing softkey is pressed, the temporary bearing changes color to match the bearing *n* softkey color. See Figure 17-3. Learn more, refer to step 7 sub-step c on page 549.

CAUTION

IMPORTANT! If no Bearing softkey is selected to save the temporary bearing and the antenna trigger is pressed for more than 2 seconds again, the Temporary bearing value is overwritten with a new bearing value.

Figure 17-3 Bearing Softkeys 1 though 4

Hardkey and Softkey Descriptions –Interference Finder (i.e., Manual AoA) – (Option 366)

This section contains the following:

- "Measure 1 Hardkey and Softkeys" on page 551
- "BW 2 Hardkey and Softkey Menus" on page 551
- "Sweep 3 Hardkey and Softkey Menus" on page 552
- "Measure Setup 4 Hardkey and Softkey Menus" on page 552
- "Cal 5 Hardkey and Softkey Menus" on page 553
- "Trace 6 Hardkey and Softkey Menus" on page 553
- "Freq/Dist Hardkey and Softkey Menus" on page 554
- "Scale/Amptd Hardkey and Softkey Menus" on page 554

Learn more, see "Troubleshooting" on page 555.

Path: **Mode** > **More** > * > **Direction Finding** > **Meas Type** > **Manual AoA** > **Hardkey** (i.e., Interference Finder (i.e., Manual AoA) path is the same for all of the hardkeys described below.)

(*Number of **More** softkeys – Varies by the number of Options loaded on your instrument.)

Measure 1 Hardkey and Softkeys

Press **Measure 1** then

Bearing 1 though **Bearing 4** – Saves the temporary bearing value to the Bearing *n* pressed.

Advanced – Opens a softkey menu with a **Bearing Results View** softkey. –

– **Bearing Results View** – Opens tables for **Bearing 1** through **Bearing 4** and displays their content.

Press **Back** to return to previous menu.

Sequence of measurement is: Spectrum monitoring and then AoA measurement.

BW 2 Hardkey and Softkey Menus

Press **BW 2** then

Direction Finding (Interference Finder Option 366 /Time Difference of Arrival (TDoA) Option 390) – Requires Spectrum Analyzer Mode (Option 233), and GPS Receiver (Option 307)

Angle of Arrival (AoA) – (Manual-AoA Requires Option 366)

Monitor Res BW – Sets the resolution bandwidth of the spectrum monitoring measurement. When set to Auto the FieldFox sets the monitor resolution bandwidth based on the other instrument settings. The monitor resolution BW value can be set manually. (Default == Auto)

Average Type – Selects the way the spectrum monitoring trace is averaged. Choices are Power (#PAvg annotation is displayed), Log (#LgAv annotation is displayed), Voltage (#VAvg annotation is displayed). Auto is the default and when selected the FieldFox chooses the type of averaging that is used based on the current settings (Default == Auto).

Sweep 3 Hardkey and Softkey Menus

Press **Sweep 3** then

Single, **Continuous**, **Restart**,– Learn more, refer to "Single / Continuous / Restart" on page 208.

Points – Learn more, refer to "Single / Continuous / Restart" on page 208. (Default == 401)

Measure Setup 4 Hardkey and Softkey Menus

Press **Measure Setup 4** then

Antenna Connect – When pressed, verifies a valid AoA antenna is connected on a USB port of the FieldFox, the antenna has the correct calibration information for the current DF measurement center frequency and loads the calibration data for that specific frequency.

Maps – Opens a softkey menu for setting the antenna gain and direction finding gain and attenuations settings.

- **Zoom** – Similar functionality to Chapter 16, "Indoor and Outdoor Mapping – Option 352 (Requires Spectrum Analyzer Mode (Option 233), and GPS Receiver (Option 307))."
- **Labels & Icons** – Opens a a softkey menu to enable/disable map data point labels and icon types.
  - **Labels** – (Default == OFF). Similar functionality to Chapter 16, "Indoor and Outdoor Mapping – Option 352 (Requires Spectrum Analyzer Mode (Option 233), and GPS Receiver (Option 307))."
  - **Icons** – (Default == Flag). Similar functionality to Chapter 16, "Indoor and Outdoor Mapping – Option 352 (Requires Spectrum Analyzer Mode (Option 233), and GPS Receiver (Option 307))."

Direction Finding (Interference Finder Option 366 /Time Difference of Arrival (TDoA) Option 390) – Requires Spectrum Analyzer Mode (Option 233), and GPS Receiver (Option 307)

Angle of Arrival (AoA) – (Manual-AoA Requires Option 366)

——**Icon Color** – This softkey enables you to select the color of your map icons. (Choices: Blue (default), Black, Green, Yellow, Orange, and Red.)

——**Back** – Returns to the previous softkey menu.

– **Center Map On GPS Manual** – Centers the current map using GPS (Option 307) or when Manual is pressed/enabled the map center can be manually. Adjust using the Pan softkeys (Refer to Chapter 16, "Indoor and Outdoor Mapping – Option 352 (Requires Spectrum Analyzer Mode (Option 233), and GPS Receiver (Option 307))."") – (Default == GPS).

– **Save Image** – Saves the current displayed map to a *.png file (default filename is "MapImageFile"). (Default == ON)

Bearing Colors – (Optional) Opens a menu of editable Bearing color softkeys (i.e., One Trigger Bearing softkey and four Bearing 1 though 4 softkeys). Click on each to edit the current color.

Cal 5 Hardkey and Softkey Menus

Press **Cal 5** then

All Alignment – (Default == Auto) Learn more, see "All Alignment and Align All Now" on page 215.

Align All Now – Learn more, see "All Alignment and Align All Now" on page 215).

Fast ChanEq – Enables/disables the fast channel equalizer measurement (Default == ON)

Run Antenna Cal – Opens a Calibration Wizard for calibrating your 85574A Alaris handheld Antenna.

Trace 6 Hardkey and Softkey Menus

Press **Trace 6** then

Spectrum Trace – Pressing the Trace key enables you to select a different trace number. (Default == 1; Choices: 1, 2, 3, and 4)

Trace State – Sets a different trace state to each of four traces. Pressing the Trace State softkey enables you to change the State of the selected Trace number of the Trace Data (Default == Clr/Wr – assigned to trace 1. Traces 2, 3, and 4 are set to Blank; Choices: Clr/Wr, MaxHold, MinHold, Average, View, and Blank).

Average Count – (Default == 10; Minimum == 1, Maximum == 10000)

Learn more, see Chapter 9, "SA (Spectrum Analyzer) Mode (Option 233–Mixed Analyzers)" and then to "Average Count" on page 211.

Direction Finding (Interference Finder Option 366 /Time Difference of Arrival (TDoA) Option 390) – Requires Spectrum Analyzer Mode (Option 233), and GPS Receiver (Option 307)

Angle of Arrival (AoA) – (Manual-AoA Requires Option 366)

Detector – (Default == Auto)

Learn more, see Chapter 9, "SA (Spectrum Analyzer) Mode (Option 233–Mixed Analyzers)" and then to "How to set Detection Method" on page 221.

Window Layout – Changes the selected window layout. (Default == Quad; Choices: Single, Dual, Tri, and Quad)

Freq/Dist Hardkey and Softkey Menus

Path: **Freq/Dist** then

Monitor Center – Spectrum monitoring center frequency (Default == Varies with model and options)

Monitor Start – Spectrum monitoring start frequency (Default == Varies with model and options)

Monitor Stop – Spectrum monitoring stop frequency (Default == Varies with model and options)

Monitor IF Path – IF path used internally in FieldFox for spectrum monitoring (Default = U Auto; Choices: Auto, 10 MHz, 100 MHz)

Monitor Span – Spectrum span frequency (Default == 120 MHz, varies vary with model options)

Scale/Amptd Hardkey and Softkey Menus

Press **Scale/Amptd** then

Scale, **Ref Level**, **Preamp**, and **RF Atten**

Learn more, refer to Chapter 9, "SA (Spectrum Analyzer) Mode (Option 233–Mixed Analyzers)" and then to "Scale and Units" on page 161.

More – opens a softkey menu, then choose:

– **Unit** (Default == dBm; Choices: dBm, dBmV, dBµV, W, V, A, dBmA, dBµA).

  Learn more, refer to Chapter 9, "SA (Spectrum Analyzer) Mode (Option 233–Mixed Analyzers)" and then to "How to Set Y-axis Units" on page 162.

– **External Gain** (Default == 0.00 dB)

  Learn more, refer to Chapter 9, "SA (Spectrum Analyzer) Mode (Option 233–Mixed Analyzers)" and then to "External Gain" on page 162.

– **Ref Pos** (Default == 0)

  Learn more, refer to Chapter 9, "SA (Spectrum Analyzer) Mode (Option 233–Mixed Analyzers)" and then to "Scale and Units" on page 161.

– **Back** – Returns to previous softkey menu.

Troubleshooting

Antenna Errors

Figure 17-4 Interference Finder (i.e., Manual AoA) Error Messages[1]

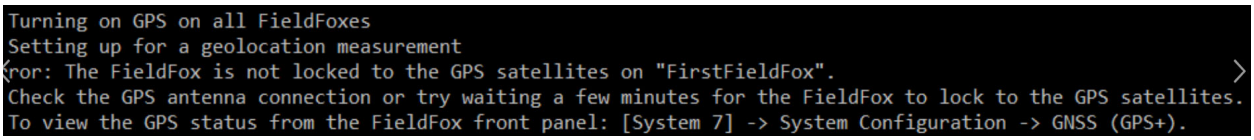
Possible solutions:

- Verify the antenna is correctly connected and that the cable and connector connections are clean.
- GNSS receiver must be locked for a successful test, but it may take some time to achieve lock condition. Allow enough time for the GNSS receiver to achieve lock after activating it.
- Alternatively, check the GPS state directly on each FieldFox unit before proceeding with the test.

GPS lock Errors

- GNSS receiver must be locked for a successful test, but it may take some time to achieve lock condition. Allow enough time for the GNSS receivers to achieve lock after activating them on all FieldFox units.
- The following error message is displayed when the GNSS receiver is unlocked.

Figure 17-5 GPS Error Messages



Possible solutions:

- Running the test again after this error is usually successful because the GNSS receiver would have enough time to lock.
- Alternatively, check the GPS state directly on each FieldFox unit before proceeding with the test.

1. If following the instructions in the Figure 17-4 error message fails to connect to your antenna, then follow the Possible solutions:.

18 Remote Server Mode (Requires SA Hardware/SA Option 233)

Remote server mode enables you to connect your FieldFox to compatible PC-based licensed software applications (e.g., 89600 VSA software[1]). Refer to https://www.keysight.com/find/assist/ and https://www.keysight.com/us/en/products/software/pathwave-test-software/89600-vsa-software.html.

CAUTION 89600 VSA (via the Remote Server feature) are compatible with the frequency converter heads, but cannot apply or edit the frequency head corrections. Refer to "Utilities" on page 842.

NOTE The FieldFox can be used with an OML frequency extender. Refer to "Utilities" on page 842, the B Series FieldFox Configuration Guide 5992-3701EN, and to "Contacting Keysight" on page 5.

NOTE FieldFox with a Remote Server mode (available with FieldFox firmware ≥A.10.00) does not display a mode softkey, because Remote Server mode is only enabled when you have a SA Option 233 on the FieldFox, compatible 89600 VSA software license loaded and running on a remote PC, and connected via LAN to your FieldFox. (i.e., Requires 89600 VSA software version ≥22.01). Refer to: https://www.keysight.com/find/assist/.

When in Remote Server mode, **most** of the front panel hardkeys are locked and will beep, but perform no actions when pressed (i.e., the FieldFox front panel hardkeys are not relevant when connected via LAN to the 89600 VSA software on your remote PC). In Remote Server mode only:

- **System 7** hardkey lets you change the system settings
- **Esc** (escape) hardkey lets you forcefully disconnect from the PC-based software

To **gracefully** disconnect (recommended) from the software, exit using the PC-based software's disconnect option or shutdown the software. Refer to "Initial Waiting for a Connection from a PC-based and Compatible Licensed Software or No Remote Connection" on page 559.

If you to attempt connect a non-compatible FieldFox you will see the following error message:

"`Error: 38, The requested functionality is not available.`"

1. To order the 89600 VSA Software, refer to https://www.keysight.com/find/assist/.

In this Chapter

"Connecting Using Remote Server" on page 559

"89600 VSA Software Overview (Requires N991xB/3xB/5xB/6xB and SA Option 233)" on page 561

See Also

Optional Settings:

"LAN Settings" on page 874

"All about Markers" on page 797

"All about Limit Lines" on page 812

"All about Trace Math" on page 829

Connecting Using Remote Server

CAUTION

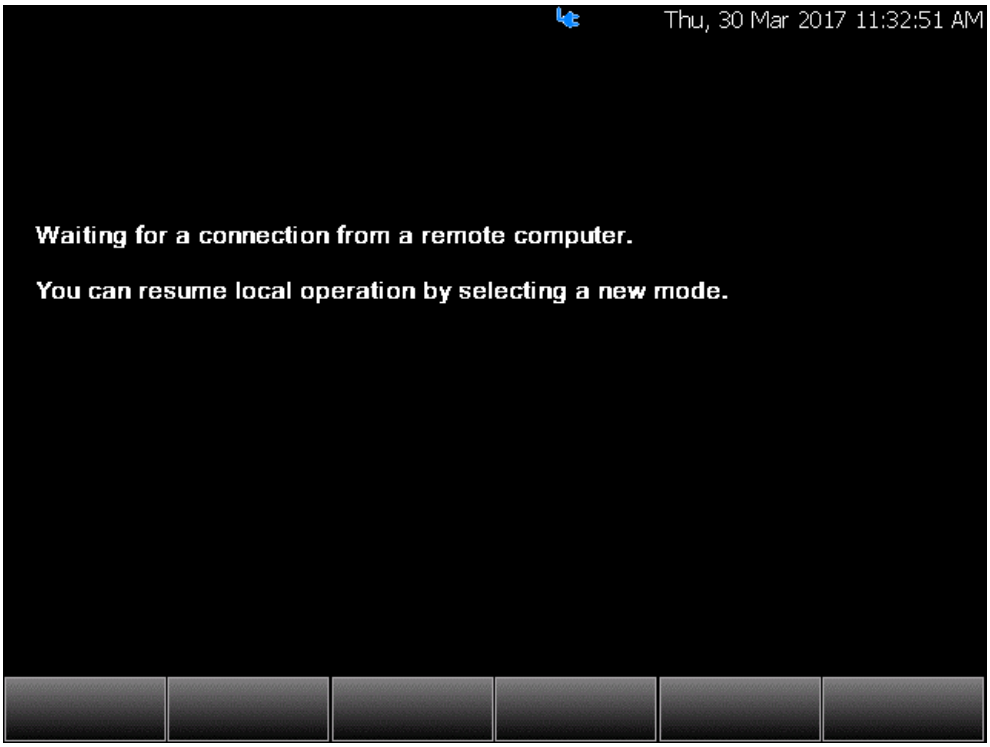
IMPORTANT!

When using a frequency converter head with remote server and 89600A VSA software, first verify the head has been selected in SA mode, before connecting to the VSA using IO Libraries. See also, “Utilities” on page 842.

This section provides an overview of the FieldFox’s Remote Server mode instrument display messages that occur during the remote connection process. For more information on specific compatible PC-based licensed procedures refer to:

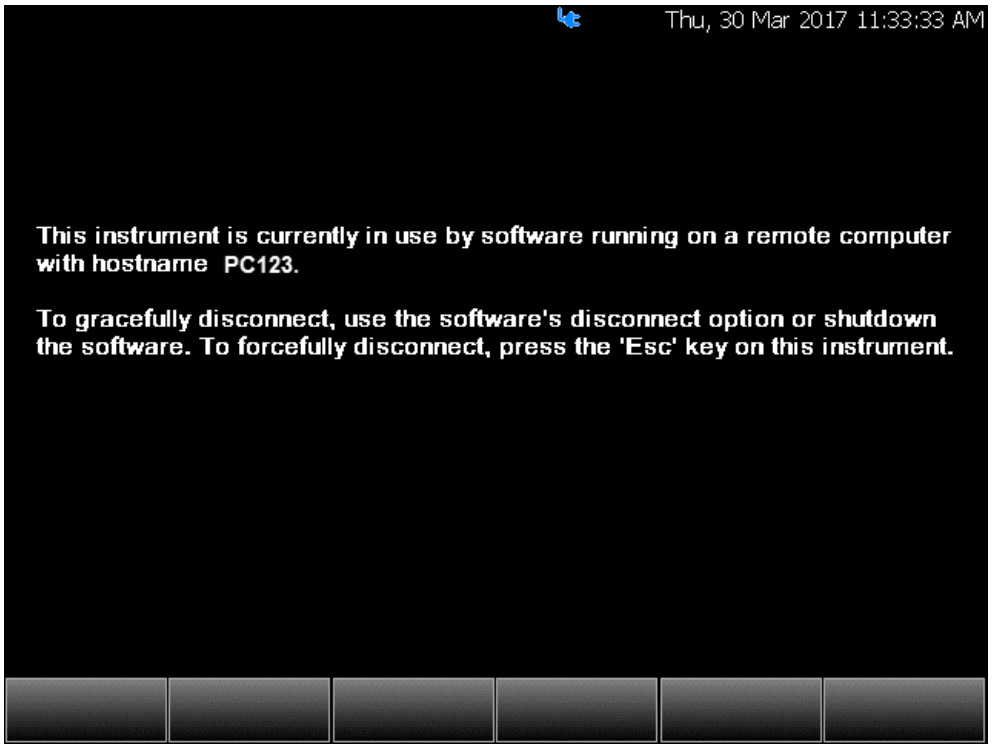
– “89600 VSA Software Overview (Requires N991xB/3xB/5xB/6xB and SA Option 233)” on page 561

Figure 18-1 Initial Waiting for a Connection from a PC-based and Compatible Licensed Software or No Remote Connection



The graphic above shows the FieldFox in the process of connecting to a PC-based and compatible licensed software.

Figure 18-2 FieldFox Display When Remotely Connected to a PC-based Software



The graphic above shows the FieldFox successfully connected to a PC—with an example hostname "PC123"—and to a compatible licensed PC-based software.

Changing Frequency Converter Head Settings

If you want to change the frequency converter head settings while using the VSA, first it is necessary to disconnect from the 89600A VSA:

1. Disconnect from the 89600A VSA software, using the VSA's disconnect icon ( ).
2. Change modes to another frequency converter compatible mode (e.g., SA/RTSA/IQA/...)
3. Change the settings on your frequency converter head.

   The frequency range in the VSA should always reflect the frequency converter head settings when you last connected.

4. Reconnect the FieldFox to the VSA using the VSA's software ( ).

For more information, refer to "89600 VSA Software Overview (Requires N991xB/3xB/5xB/6xB and SA Option 233)" on page 561.

89600 VSA Software Overview (Requires N991xB/3xB/5xB/6xB and SA Option 233)

NOTE

IMPORTANT! The following is a description of the 89600 VSA Software's overall capabilities. Your instrument may not have all of the hardware and firmware required to use all of the 89600 VSA Software's listed features.

The FieldFox remote server mode, requires 89600 VSA Software with firmware version ≥22.01.

NOTE

If you have the FieldFox's Remote Server (89600 VSA software connectivity), you can use the VSA software to capture and record your data as MATLAB files (*.mat). Learn more about FieldFox and 89600 VSA software, refer to: https://www.keysight.com/find/assist/.

If you have Option 351 I/Q Analyzer option, you can directly save your data as MATLAB files (*.mat). Refer to Chapter 11, "IQ Analyzer (IQA) – Option 351", on page 301 and to Chapter 34, "File Management", on page 887.

Connecting the FieldFox remotely to a PC running the 89600 VSA software, will start the FieldFox's Remote Server mode. The 89600 VSA software is powerful, PC-based software, offering the industry's most sophisticated general purpose and standards specific signal evaluation and troubleshooting tools for R&D engineers. Even for proprietary and non-standard signals in SATCOM or MILCOM applications, you can make signal quality measurements with customized IQ constellation. Reach deeper into signals, gather more data on signal problems, and gain greater insight.

- General-purpose analog and digital demodulators ranging from 2FSK to 4096QAM
- Flexible and custom IQ and OFDM signal analysis
- Standards specific modulation analysis including:
  - Cellular: 5G, LTE & LTE-Advanced (FDD, TDD), W-CDMA, GSM/EDGE, cdma2000, 1xEV-DO, TD-SCDMA,
  - Wireless connectivity: 802.11ax, 802.11n/ac, 802.11a/b/g/j/p, 802.16 WiMAX (fixed/mobile), 802.15.4 Wi-SUN
  - RFID
  - Digital satellite video and other satellite signals, radar, LMDS
- Up to 400K bin FFT, for the highest resolution spectrum analysis
- A full suite of time domain analysis tools, including signal capture and playback, time gating, and CCDF measurements
- Unlimited trace displays and the industry's most complete set of marker functions

– Easy-to-use Microsoft Windows graphical user interface

For a comprehensive FieldFox VSA mode help, refer to http://rfmw.em.keysight.com/wireless/helpfiles/89600B/WebHelp/89600.htm

For additional information on the 89600 VSA Software brochure, refer to https://www.keysight.com/us/en/assets/7018-02714/brochures/5990-6553.pdf

For Technical Overview, refer to https://www.keysight.com/us/en/assets/7018-02679/technical-overviews/5990-6405.pdf

19 Interference Analyzer (SA Mode) – Option 236

Option 236 provides Spectrogram display, Waterfall display, and Record/Playback.

In this Chapter

"Spectrogram Display (SA Option)" on page 564

"Common Settings for Waterfall and Spectrogram" on page 567

"Waterfall Display" on page 568

"About Sessions" on page 570

"FieldFox Setting Changes during Record and Playback" on page 571

"About State and User Tags" on page 572

"How to Record a Session" on page 573

"How to Playback a Session" on page 574

"Recording Configuration" on page 577

"Playback Configuration" on page 581

"Manage Sessions" on page 581

"Record Playback Example (SA Only)" on page 582

Spectrogram and Waterfall Displays

Spectrogram and Waterfall displays provide a visual history of the measured spectrum. Each display type can be used to locate intermittent signals or to view signal levels and frequencies over time.

Spectrogram is a single horizontal line of color-coded power while Waterfall uses a 3-D color-coded display. The functional difference between these two displays is that Spectrogram provides less trace detail than Waterfall display. However, it also allows more traces to be viewed.

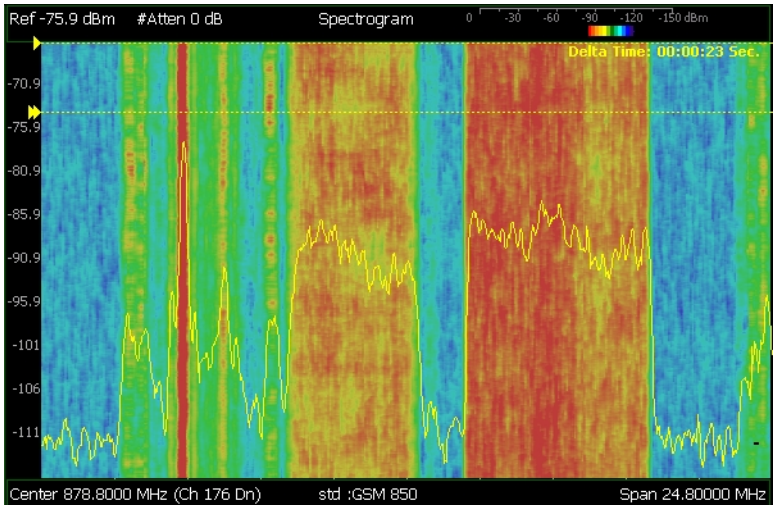
These two displays can NOT be used with Channel Measurements.

In SA mode, Traces can be recorded from, or played back into, any measurement type (such as Channel Power or Occupied BW) or any display type (such as Spectrogram and Waterfall). See “How to Record a Session” on page 573 to learn how to save traces.

Spectrogram Display (SA Option)

Spectrogram draws the most recent trace record at the bottom of the stack of previously-drawn trace records. Drawing the live trace on the display is optional.

Figure 19-1 **Spectrogram display- Overlay view- with time markers 23 seconds apart.**



The following settings all contribute to the sweep time of an individual trace, and therefore, the total elapsed time that can appear on the screen in Spectrogram display:

- Frequency Range. Learn more in “Frequency Range” on page 155.
- Resolution BW and Video BW. Learn more in “Resolution Bandwidth (Res BW)” on page 193 and “Video Bandwidth (Video BW)” on page 193.
- Sweep Time (Acquisition). Learn more in.“Sweep Acquisition” on page 198

– Resolution (Number of Points). Learn more in "Points " on page 208.

How to select Spectrogram

– Press Meas 1 > Interference Analysis > Spectrogram

How to modify the Spectrogram

You can change how the spectrogram is displayed relative to the data trace. This setting affects the total number of trace records that can be displayed.

For SA Mode:

1. Press Meas Setup 4 > Spectrogram Settings > Spectrogram View
2. Press choose from the following:
   - Overlay Displays the data trace over the spectrogram with NO graticules. Total trace records: 340.
   - Full Screen Displays the spectrogram with NO data trace. Total trace records: 340.
     - Top Displays the data trace below the spectrogram. Total trace records: 130.
     - Bottom Displays the data trace above the spectrogram. Total trace records: 130.

How to create Time Markers (SA Only)

Use Time Markers to determine the elapsed time between any two displayed records. The most recent record appears at the bottom of the screen.

Moving a time marker will also 'push' the displayed spectrogram (by modifying the Playback Trace Number) to keep the marker on the screen (if possible). Markers that indicate (mark) a trace 'off screen' will be displayed at the top or bottom of the plot - the location nearest to where that trace would be if the spectrogram plot extended off the screen.

1. Press Meas Setup 4 > Time Markers > Time
2. Then enter a value from 0 (the most recent sweep record) to the maximum value, using the numeric keypad, ▲|▼ arrows, or the rotary knob. A ">" indicates the Time Marker.
3. Then Delta
4. Then enter a value from 0 (the most recent sweep record) to the maximum value, using the numeric keypad, ▲|▼ arrows, or the rotary knob. A ">>" indicates the Delta Marker.
   - At the current sweep speed, the difference in time between these two markers appears at the upper-right corner of the view as Delta Time: hh:mm:ss Sec.

– An invalid number (very large positive or negative) appears when a trace record is not available at either marker. 00:00:00 Sec appears when both markers are not available.

Figure 19-2 Time marker display

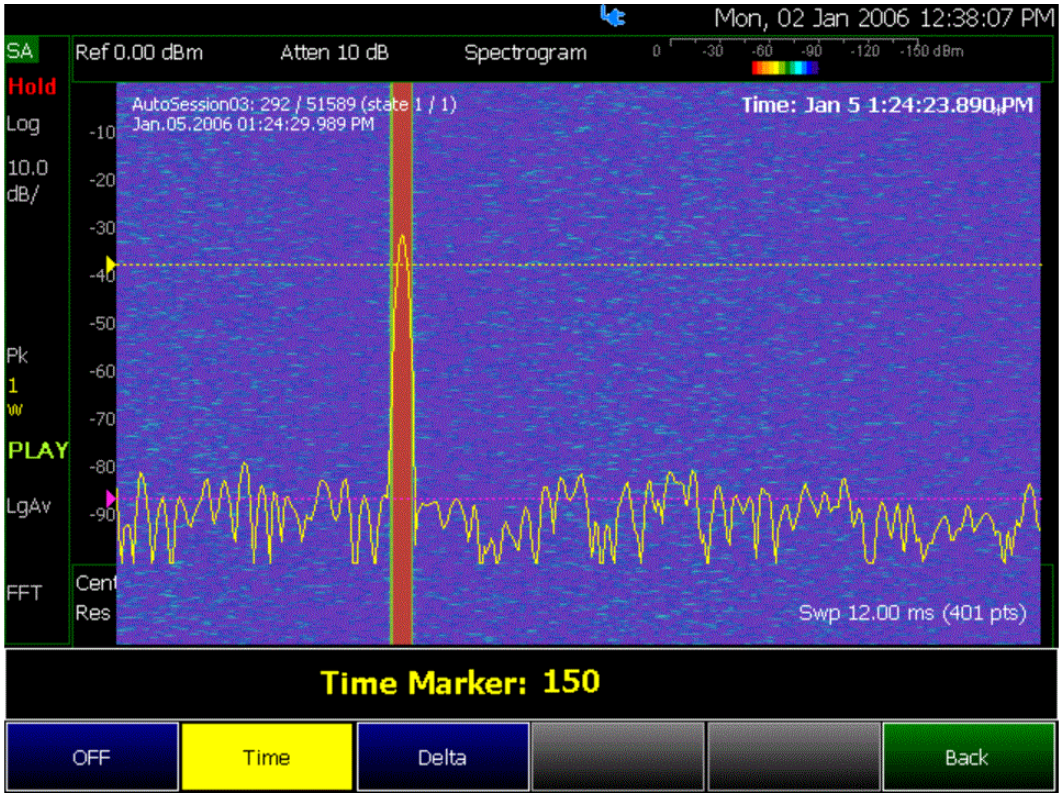
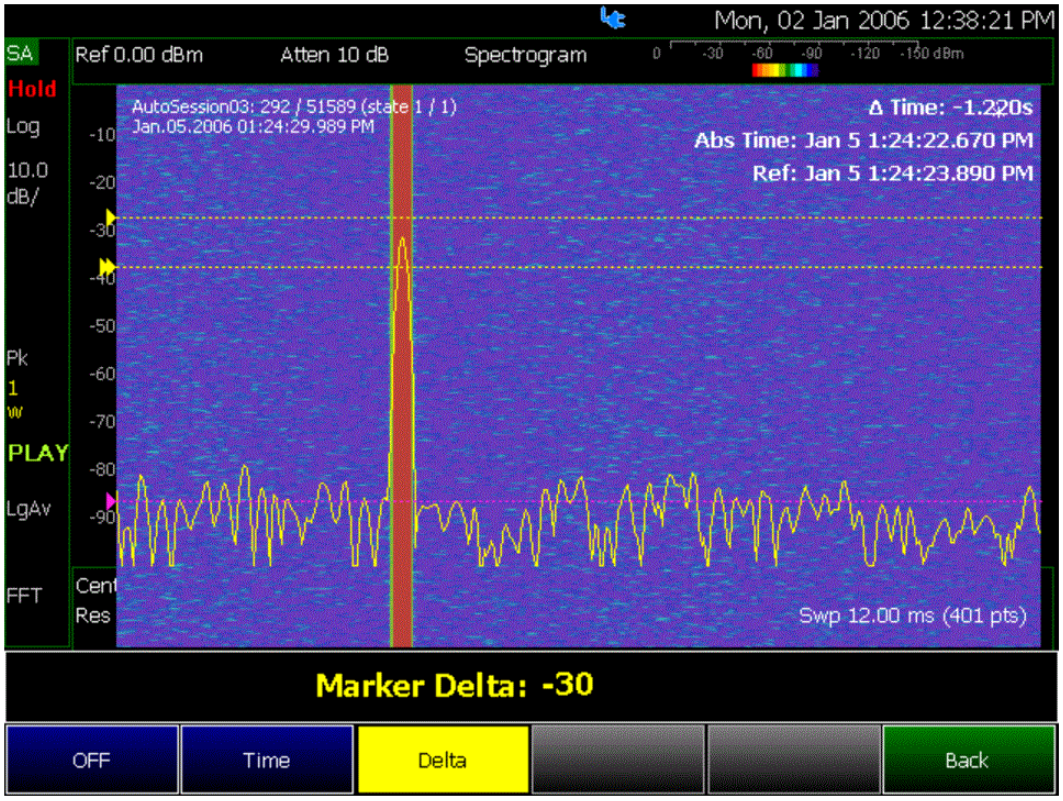


Figure 19-3 Delta marker display



Common Settings for Waterfall and Spectrogram

NOTE Waterfall settings only apply to the SA option.

Set Red and Blue Limits

The colors displayed on the Waterfall and Spectrogram represent the various measured power levels:

- Red = Highest power levels
- Blue = Lowest power levels

NOTE The full Red-to-Blue color spectrum is visible only with Indoor display colors. Learn more in “Display Colors” on page 840.

Adjust the Red and Blue limits to the power levels that you expect to measure.

The Blue limit must always be less than the Red limit.

For SA Mode:

– Press **Meas Setup 4**.

– Then **Spectrogram Settings** or **Waterfall Settings**

– Then choose from the following:

  – **Red Limit** Using the ▲|▼ arrows, rotary knob, or keypad, select the HIGHEST power level that you expect to measure. This power level, and those measured higher than this level, appear Red.

  – **Blue Limit** Using the ▲|▼ arrows, rotary knob, or keypad, select the LOWEST power levels that you expect to measure. This power level, and those measured lower than this level, appear Blue.

How to Restart the Spectrogram/Waterfall

Press **Sweep 3** then **Restart**

Averaging

Averaging can be enabled on the underlying measurement. Press **Meas 4** then **Average Type**. Learn more in "Average Type" on page 210.

Mode Preset

Mode Preset resets ONLY the Spectrogram and Waterfall display settings. It does not reset the measurement settings.

– Press **Preset**

– Then **Mode Preset**

Waterfall Display

The live trace is always drawn on a Waterfall display. Older trace records scroll up from the displayed trace and eventually off the screen. Because of this, locate the live trace on the bottom of the screen using the scale and reference settings. Learn how in "Scale and Units" on page 161.

NOTE

Although this document refers to past traces as 'records' these traces are not saved. They are only drawn on the FieldFox screen. See "Record Playback Example (SA Only)" on page 582 for how to save traces.

The following settings all contribute to the sweep time of an individual trace, and therefore, the total elapsed time that can appear on the screen in Waterfall display:

– Frequency Range. Learn more in "Frequency Range" on page 155.

– Resolution BW and Video BW. Learn more in “Resolution Bandwidth (Res BW)” on page 193 and “Video Bandwidth (Video BW)” on page 193.
– Sweep Time (Acquisition). Learn more in.“Sweep Acquisition” on page 198
– Resolution (Number of Points). Learn more in “Points ” on page 208.

Waterfall Angle

This setting allows you to show more or less detail. More detail provides fewer (time) records.

– Press **Meas Setup 4**
– Then **Waterfall Settings**
– Then **Waterfall Angle**
– Then choose from the following:
  – **Moderate** Compromise between detail and number of records.
  – **Steep** Least detail with highest number of records.
  – **Gradual** Most detail with lowest number of records.
  – **Wide Angle** Moderate angle with increased space between records.

Learn how to set **Red and Blue Limits** in “Set Red and Blue Limits” on page 567.

Record/Playback (SA Option)

Record Playback allows you to record SA trace sweeps and play them back at a later time. Use this feature to monitor spectrum activity over a period of time.

You can record traces continuously, record a specified number of traces (segments), or record when triggered by a specified power level.

Traces can be recorded from, or played back into, any measurement type (such as Channel Power or Occupied BW) or any display type (such as Spectrogram and Waterfall).

When GPS is enabled, the current location and elevation are saved and played back with traces.

Recordings can be saved to the FieldFox Internal memory, an SD Card, or a USB flash drive.

About Sessions

A Recording Session is a collection of recorded traces and the instrument states that generated them.

Before recording can occur, a new session must be initiated or an existing session must be opened. Sessions can later be opened for playing or continued recording. Only one session can be open at a time.

You close the session when finished recording or playing. A session is also closed when the FieldFox is Preset (or Mode Preset), an Instrument State is recalled, or when Mode is changed from SA.

Each session is saved as a folder containing a set of files on the specified storage device.

How long can a recording session last?

There are many variables that determine the possible length of a recording session. But one key variable is the amount of available memory.

When a session is opened or a new session is initiated, an estimate is made of the maximum number of traces that can be saved based on the available disk space and the current number of data points (resolution). Recording will stop when that number is reached. This estimate always keeps 4 MB of available disk space on the specified storage device. You can decrease the number of traces to further limit recording. The resolution setting can NOT be changed after a session is opened.

To maximize the amount of space that is available, save recorded traces to a USB Flash drive or SD card. Learn how in “Manage Sessions” on page 581.

You can determine the length of time over which recording can occur by setting the Record Interval (the time between recorded traces) and other settings. Learn more in “Recording Configuration” on page 577.

To view and edit the maximum number of records

Just after opening or initiating a session...

- Press **Session Data**
- Then **TraceRecordLimit <n>** (n = Max number of traces that can be recorded).
- **Clear All Records** Empties that session of recorded traces. Learn more in "Manage Sessions" on page 581.

FieldFox Setting Changes during Record and Playback

During Recording

When any of the following State settings are changed during recording, the State counter is incremented ("About State and User Tags" on page 572) and the settings are saved to the Session file along with the first trace to be recorded with the new setting. During playback, the trace and display annotation will reflect the change on the screen.

State settings:

Refer to Table 19-1 for a list of the applicable state settings for the SA option.

Table 19-1 Summary of SA State Settings

Option	Settings
SA	
	Average Type
	Detector(s)
	External Gain
	Frequency Range
	Preamp On/Off
	Resolution BW
	RF Attenuation
	Source Settings
	Sweep Acquisition
	Trigger Settings
	Video BW
	Zero Span Sweep Time

Other display settings, such as Scale and acquisition, can also be changed during recording but are not saved with the session file. Think of these as settings that help YOU see the recording and playback activity. They do NOT change the data that is recorded.

During Playback

The State setting changes listed above are NOT allowed during playback.

However, all other display settings can be changed during playback to help you analyze the recorded data.

In SA mode, when recordings are played back further trace processing is possible. The Trace State(s) can be modified for post processing, and different measurements such as Channel Power, Occupied BW, Spectrogram, and Waterfall can be activated. This is because in SA all these measurements are derived from the raw traces. If not compatible with the measurement type, a MEAS UNCAL message will appear on the screen.

Record/Playback Exceptions

- Markers can be activated and moved to help analyze recorded data. However, marker position control is only available when playback is Paused.
- Field Strength Corrections is saved with the session file and it is also allowed during playback. Learn about this Field Strength Corrections in “Field Strength Measurements” on page 165.
- Frequency Counter at Marker is NOT allowed during Recording or Playback. Learn about this feature in “Frequency Counter at Marker” on page 226.

About State and User Tags

When any of the State settings (listed above) are changed during a recording, a ‘state tag’ is inserted at the first trace number to be recorded with the new setting.

In addition, you can insert a ‘User Tag’ at any time during a recording session to indicate an external event, such as when an antenna is moved. During playback, you can move quickly to any of these tags, or scroll through these tags.

A symbol is used on the screen annotation to distinguish a User Tag from a State Tag when scrolling through tags during playback.

Screen Annotation

During a record or playback session, the following is displayed in the top-left area of the screen:

- AutoSession02: 92/95 (state 4/5)_*_
  Sep.22.2018 09:15:15 AM

where:

- **AutoSession** is an auto-generated name for sessions. **02** is the auto-generated number, incremented with each new session. The name can be changed using Manage Sessions. Learn more in "Manage Sessions" on page 581.
- **92/95** is the current and total trace number: currently trace is 92 of 95 total traces.
- **state 4/5** is the current and total state tag or user tag number: 4 of 5 total tags.
- ***** (Asterisk) indicates that a state has changed. **#** (Pound) indicates that a User Tag has been inserted.
- **Sep.22..** is the date and time of recording.

When GPS is enabled`, the current location and elevation are annotated at the bottom of the playback display. Learn more in "GPS – Distance Settings" on page 857.

NOTE

If Recording or Playback is not occurring when you think it should, check the following:

- Is the sweep in HOLD? (upper-left annotation)
- Is Recording or Playback Paused? (mid-left annotation)
- Is the Record or Playback **Interval** set too long? (Configuration settings.)

How to Record a Session

- Press **Trace 6**
- Then **Record Playback**
- SA Only: Optionally set resolution (points). Learn how in "Points " on page 208. This can NOT be changed after a session is opened.
- Then either:
  - **New Session** OR
  - **Recall Session** then **Open** and select a session.
- Then **Recorder Player**
- Then **Record**

REC is displayed in the left of screen graticules.

During recording, choose from the following:

- **Pause Resume** Temporarily halts recording until pressed again. The incoming trace continues to sweep. Press again to continue recording.
- **Stop** Immediately stops recording. Then choose from the following:

- Press **Play** to start replaying the recording from the beginning.
- Press **Record** to continue recording.

How to Playback a Session

- Press **Trace 6**
- If the session is already open, skip the following step. Otherwise:
- Then **Record Playback**
  - Press **Recall Session** Then select a session to playback and press **Open**.
- Then **Recorder Player**
- Then **Play**

PLAY is displayed in the left of screen graticules during playback. When the end of the recording is reached, playback begins again at trace 1 and continues to loop indefinitely.

During playback, choose from the following:

- **Pause Resume** Temporarily halts playback. Then choose from the following:
  - **Pause Resume** Press to continue playing.
  - **Play** Press to restart playback.
  - **Stop** Press to stop playback.
  - **Advanced Playback** Activated automatically when paused. Opens a menu of advanced playback softkey choices:

Pause Resume	Temporarily pauses or resumes playback.
Playback State/Tag	Enables you to continue playback from a state tag, or scroll through the state tags. Enter a value between 1 and the total number of state tags using the numeric keypad, ▲|▼ arrows, or the rotary knob. Active when playback is paused. Learn more in About State and User Tags in "About State and User Tags" on page 572.
Page Up **Page Down**	Page Up and Page Down navigate the recorded data one 'screenful' at a time by modifying the Playback Trace Number. Page Down will advance Playback Trace Number to a higher value by the number of lines on the screen, and Page Up, will reduce Playback Trace Number to a lower value by the number of lines on the screen.

Playback Ref Line	Controls the placement of the pink line across the screen. The playback ref line is displayed 1 pixel under the trace identified by a Playback Trace Number. Said another way, the spectrogram trace identified by Playback Trace Number is drawn 1 pixel above the playback reference line. **CAUTION** Playback Ref Line is only available for spectrogram lines, but not for Waterfall, because there is no spectrogram line. Playback Ref Line is displayed as pink in Figure 19-4 on page 576, but color may vary with settings.
Playback Trace Date/Time	This softkey launches a time/date entry dialog box. With the time/date collected from that dialog, the recorded trace with the time nearest (exact, or previous to the entered time) is set to the Playback Trace Number. This allows the user to jump to an approximate time in the recording, rather than navigating by index. See also, "Playback Trace Date/Time Dialog Box" on page 577.

– **Playback Trace Number** Activated automatically when Paused. Allows you to continue playback from a specific trace, or scroll through traces manually. Enter a value between 1 and the total number of traces using the numeric keypad, ▲|▼ arrows, or the rotary knob.

– **Stop** Immediately stops playback. Then choose from the following:

  – **Play** Start playback from trace 1.

  – **Record** Resume recording from the last recorded trace.

  – **Record Playback Setup** Return to the setup menu to change Configuration settings or Close the session.

Figure 19-4 Spectrogram Measurement – Active Playback Ref Line Softkey

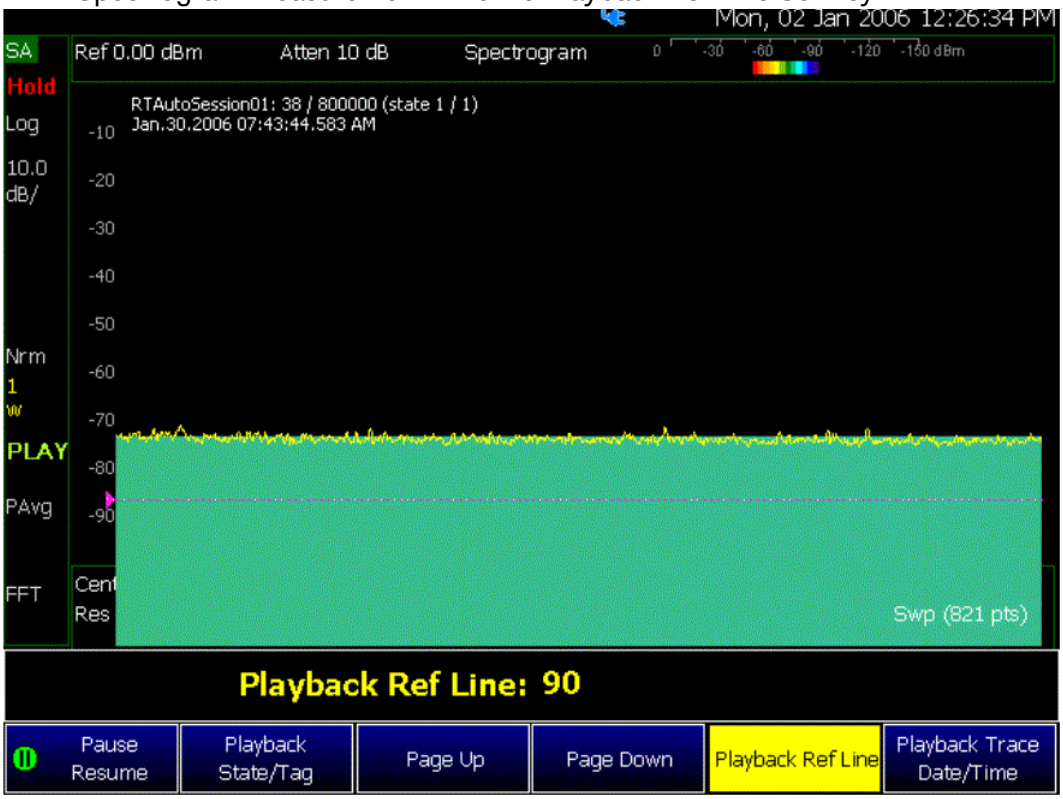


Figure 19-5 Waterfall Analysis Measurement – Inactive Playback Ref Line Softkey

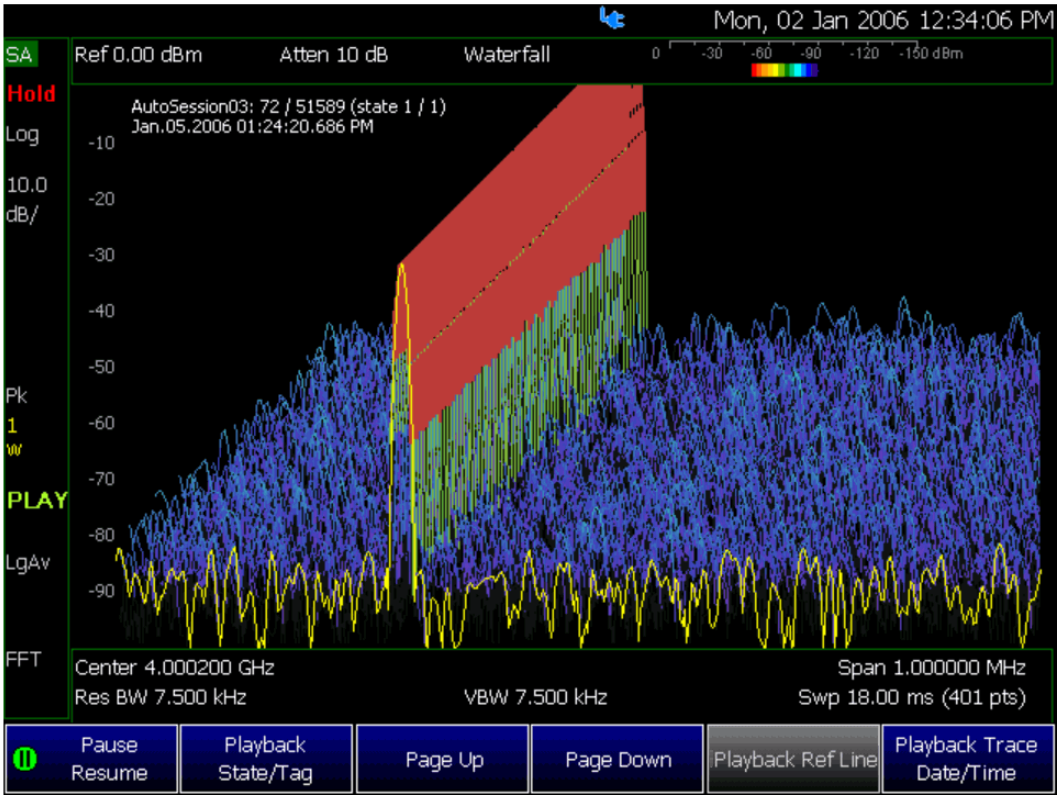
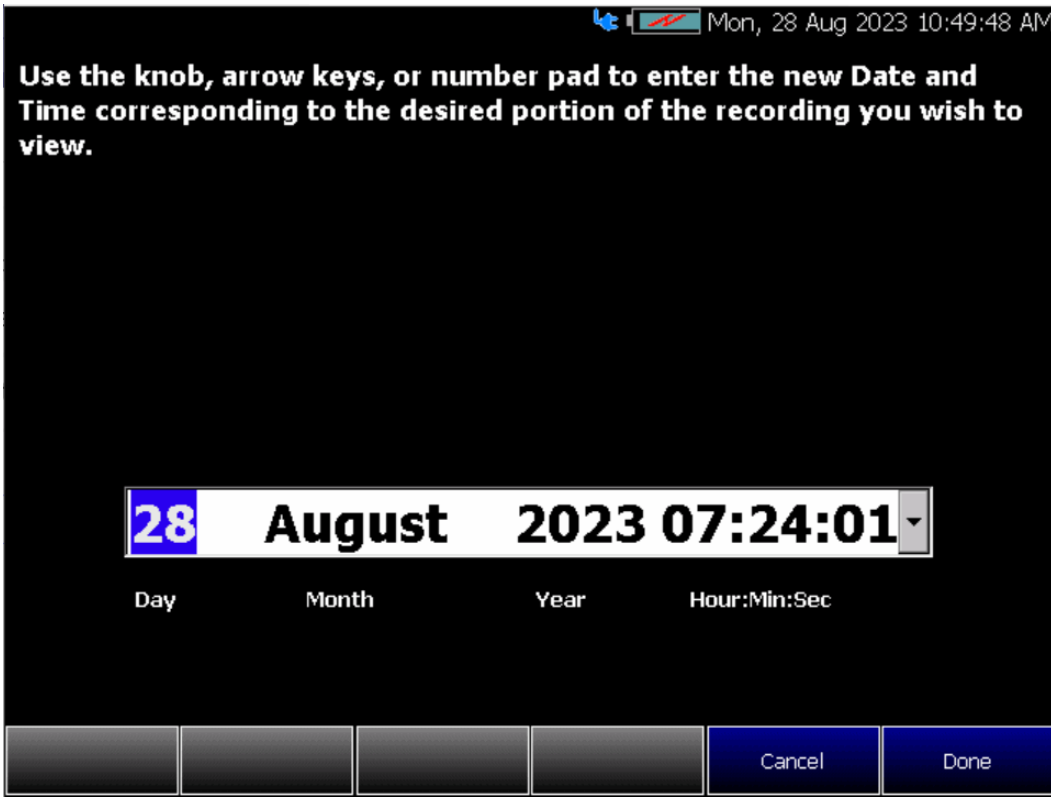


Figure 19-6 Playback Trace Date/Time Dialog Box



Recording Configuration

To change Recording Configuration settings:

– Press **Trace 6**

– Then **Record Playback**

– Then **New Session** or **Recall** an existing session.

If **New Session** is selected:

– Then **Session Data** and choose one of the following:

– Then **CSV SaveStyle**

––**Single Trace** (default) saves the currently displayed trace.

––**Range Traces** saves the currently displayed trace. This selection requires you to manually select a range of traces to be recorded in the Playback Configuration menu. Refer to "Playback Configuration" on page 581.

––**AllTraces** saves all traces.

– Then **TraceRecordLimit** to change the maximum recording file size.

  - Then **Clear AllRecords** to clear all traces out of memory.
  - Then **Back** to return to previous menu.
- Then **Recording Configuration**

Then choose from the following:

- **Record Time** Sets the amount of time to record traces. Default is MAX, which is to record indefinitely. Enter a value between 1s and 1 Ms (million) seconds using the numeric keypad, ▲|▼ arrows, or the rotary knob. When set, a timer appears during recording in the lower-left corner which counts DOWN from the specified time.
- **Record Source** Sets where, in the FieldFox data flow, data is recorded. Learn more in "Record Source" on page 580. Choose from the following:
  - **RawMeas** Records raw measurement data.
  - **Trace 1,2,3,4** Records data from the corresponding trace in its current state.
- **Record Interval** Sets the amount of time to wait between individual trace recordings. Default is MIN, which is to wait 0 seconds (record traces as fast as possible). Enter a value in seconds between 0 (no delay) and 10,000 seconds - about 3 hrs) using the numeric keypad, ▲|▼ arrows, or the rotary knob.
- **Segment Count** Sets the number of traces to record, after which the recording will automatically pause. Press Pause/Resume or Record to capture another N traces, or Stop to end recording. Default is OFF, which is NO limit to the number of traces to be recorded.

  When set, a counter appears in the lower-left corner which counts UP to the specified number of recordings.
- **FreqMaskTrigger OFF ON**

  Sets the power level which will trigger a recording. Set these power levels (mask) exactly as you would set Limit Lines. (See "All about Limit Lines" on page 812.) With **Record ON**, when any data point measurement is higher than an upper limit, or lower than a lower limit, recording begins. See Frequency Mask Trigger Configuration in the following section to learn how to configure the mask.

Typically you would use FreqMaskTrigger with Segment Count, but it can also be used with Record Time and Record Interval.

When used with **Segment Count**:

- When a mask limit is exceeded, subsequent traces are recorded until the specified segment count is reached. Once segment count is reached, exceeding another mask limit will again cause traces to be recorded until the segment count is reached, and so forth.

– To record only those traces that exceed the limit, set Segment Count to 1

– To record ALL traces after a limit is exceeded, set Segment Count OFF.

When used with **Record Time**, the timer counts down even when traces are not being recorded (limits are not being exceeded). Recording starts when a limit is exceeded and stops when the timer reaches 0.

When used with **Record Interval**, a trace is recorded when a limit is exceeded, then no recordings during the specified 'wait' interval, then the next trace is recorded, followed by another time delay, and so forth. This pattern repeats indefinitely if Segment Count is OFF, or (if ON) until Segment Count is reached.

Frequency Mask Trigger Configuration (SA Mode Only)

Create or recall a Frequency Mask to be used with the FreqMaskTrigger feature.

NOTE Frequency Mask Trigger only applies to SA mode.

NOTE The Mask file is saved to, and recalled from, the Save /Recall Storage Device location – NOT from the Record Playback Storage Device location. These are two different settings. Learn how to set the Save /Recall Storage Device in "Set File Type and Select Device" on page 894.

A mask that is in use during a recording is NOT saved with the recording and does NOT automatically appear during playback. Like Limits Lines, it is saved and recalled with a state file.

Although they are created in the same manner, Limit Line files and FreqMask files can NOT be used interchangeably.

– Press **Trace 6**

– Then **Record Playback**

– Then **New Session** or **Recall** an existing session. The current mask appears as soon as a session is opened.

– Then **FreqMaskTrigger Configuration**

– Then choose from the following

  – **Edit Mask** Create or modify the current mask. Learn how to edit the Mask / Limit Line table in "All about Limit Lines" on page 812.

  – **Save Mask** Saves the current mask to a file.

  – **Recall Mask** Loads a mask file.

Record Source

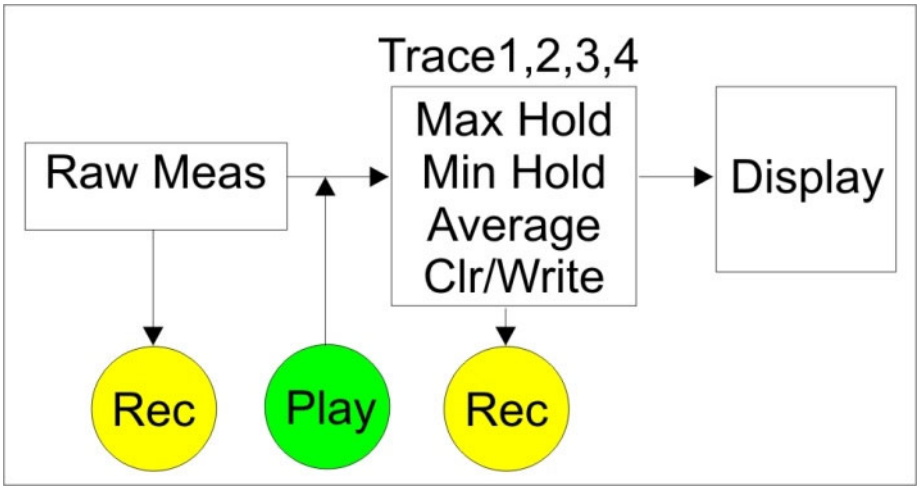
NOTE The RawMeas data setting only applies to SA Mode.

For SA mode, the simplest way to use Record Playback is to record RawMeas data, which can then be played back into all of the current Trace States.

However, for more complicated processing, refer to the following diagrams. These figures illustrate where in the FieldFox data flow data is recorded and played back.

NOTE For this discussion, it is important to understand Trace States. Learn more in "Trace Display States (SA Mode)" on page 209.

Figure 19-7 FieldFox SA Mode: Data Flow and Record Playback Data Points



SA Data Recording:

- Data can be recorded at the **Raw Meas** block where data is acquired after ResBW, VideoBW, and Detector processing, but before any trace state processing.
- Data can be recorded from Traces 1,2,3, or 4 which includes the trace state (Max Hold, Min Hold, and so forth).
- Recording from a Clear/Write trace yields exactly the same data as recording from the Raw Meas block.
- Data is ALWAYS played back at the same location in the data flow: just after the Raw Meas block, through all currently active Traces, and onto the display.
- See an **example** using Record Playback with Max Hold traces in "Record Playback Example (SA Only)" on page 582.

Playback Configuration

By default, trace sweeps are played back as fast as the trace can be drawn on the screen. The following setting allows you to slow playback. In addition, you can manually scroll through individual traces using Playback Trace, or scroll through State and User Tags using Playback State/Tag. Learn more in **How to Playback a Session** in "How to Playback a Session" on page 574.

To slow playback of a session:

1. Record a new session or Open an existing session.
2. Press **Playback Configuration**
3. Press **Playback Interval**
   - Enter a value in seconds between 0 (no delay) and 100 using the numeric keypad, ▲|▼ arrows, or the rotary knob. After using the keypad, select a multiplier key. Learn about multiplier abbreviations.
   - Press **Enter**
4. Press **First Trace** to define the first trace in a Range of traces to be recorded/played/saved.

Manage Sessions

1. Press **Trace 6**
2. Press **Record Playback** The following selections are available ONLY when a session is NOT open.
3. Press **Storage Device** to select the media which stores the sessions to be managed. This is a different setting from the Save/Recall Storage Device setting.
4. Choose from the following:
   - **Internal** FieldFox memory (default)
   - **SD Card** An external SD Card (must be inserted)
   - **USB** An external USB flash drive (must be inserted)
5. Press **Manage Sessions**
6. Choose from the following:
   - **Rename** Using the FieldFox labeler, change the name of the session. AutoSession (n) is the default name where (n) is the next-available number. Learn more in "How to use the FieldFox labeler " on page 891.
   - **Sort** Arrange the listing of sessions **by Name**, **by Date**, or **by Size**.

- **Delete** After a confirmation prompt, removes the contents of the selected session from the list.
- **Copy** Copies the selected session to a different storage device, or the same storage device with 'Copy(n)_' appended to the beginning of the name so that duplication is prevented.
- **Copy All** Copies ALL of the listed sessions to a different storage device, or the same storage device with 'Copy(n)_' appended to the beginning of the names so that duplication is prevented.
- **Delete All** Deletes ALL of the listed sessions.

Record Playback Example (SA Only)

The following "Interval Recording" example shows how you can record spectral activity over a longer period of time with less trace storage.

1. Press **Trace 6** then, with **Trace** = 1, press **State** then **Max Hold**
2. Press **Record Playback** > **New Session** > **Recording Configuration** then
3. Press **Record Source** to Trace1
4. Press **Record Interval** to 10 **s** (seconds).
5. Press **Back** > **Recorder Player**
6. Press **Record** At the end of each 10 second record interval, the Max Hold trace is recorded and the Max Hold processing is reset for the next 10 second record interval.
7. Press **Stop** to end the recording.

This session can be played back into any Trace State. For example:

Play the Max Hold recording into a **Clear/Write trace** to see the data exactly as it was recorded.

1. Press **Trace 6** then with **Trace** = 1 and press **State** then **Clr/Wr**
2. Then **Record Playback** > **Play**

Play the Max Hold recording into a Max Hold trace to show the accumulation of "Max Hold" activity over the entire recording.

1. Press **Trace 6** then with **Trace** = 1 and press **State** then **Max Hold**
2. Then **Record Player** > **Play**

20 Reflection Mode (SA Models) - Option 320

NOTE

Option 320 requires Option 220 Tracking Generator. N9938B models require Option 100 3.5 mm connectors and Option 220.

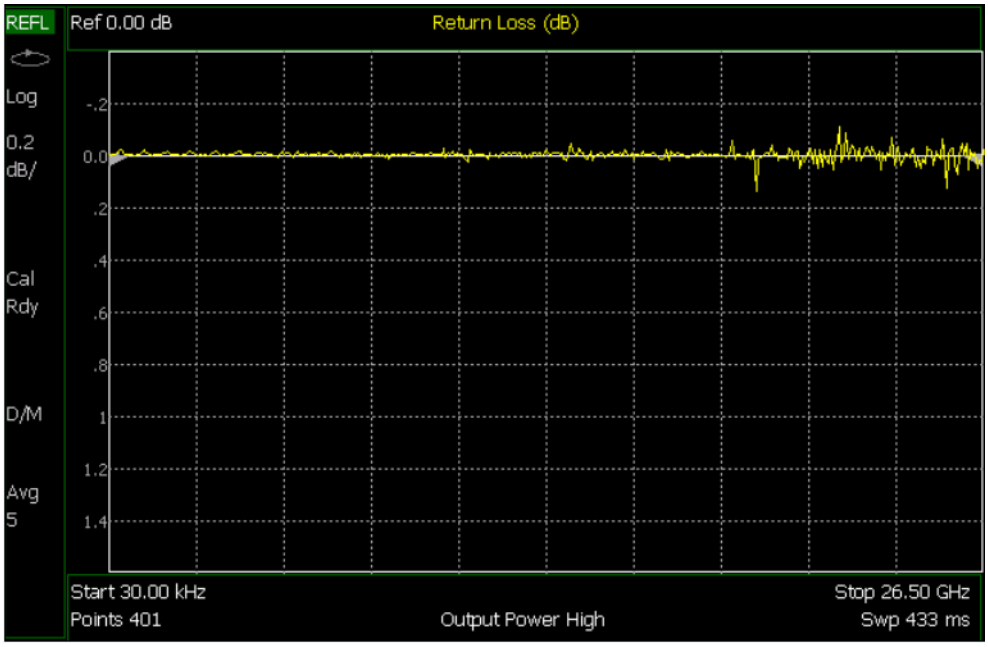
- Option 100 3.5 mm connectors must be installed by the factory. Option 100 is only available on N9938B at the time of purchase. It is not available as a trial/upgrade.
- Option 220 Tracking Generator can be ordered via software license on www.keysight.com.

Option 320 is not available on N991xB, N992xB, or N995xB models.

This feature may require an option. Please view the FieldFox Configuration Guide at:
https://www.keysight.com/us/en/assets/7018-06515/configuration-guides/5992-3701.pdf.

Reflection Mode measurements are very similar to CAT mode reflection measurements. They provide 1-port scalar reflection measurements in selected FieldFox **SA-Only** models. The FieldFox source is routed internally to Port 1 and used to stimulate a Device Under Test (DUT). The energy that is reflected off the DUT is measured and displayed on the screen.

SA mode reflection measurements are **CalReady**. Learn more in "CalReady" on page 130. In addition, Normalization is available. Learn how "Normalize" on page 585. However, other calibration types are NOT offered.



In this Chapter

"How to select Reflection Mode" on page 585

"Measurement Selection" on page 585

"Normalize" on page 585

The following settings are available exactly as they function in CAT mode:

"Frequency Range" on page 55

"Scale Settings" on page 55

"Averaging" on page 56

"Single or Continuous Measure" on page 57

"Resolution (Number of Data Points)" on page 58

"Sweep Time" on page 58

"Output Power" on page 59

"Interference Rejection" on page 60

"All about Markers" on page 797

"All about Limit Lines" on page 812

Reflection Mode Settings

Select **Reflection Mode** before making any setting in this chapter.

How to select Reflection Mode

- Press **Mode**
- Then **Reflection**

Measurement Selection

How to select a Reflection Mode Measurement

Learn more about these two measurements in the Supplemental Online Help: https://rfmw.em.keysight.com/wireless/helpfiles/FieldFoxOnlineSupplementalHelp/Home.htm.

- Press **Measure 1**
- Then choose one of the following: These softkeys also appear after Reflection Mode is selected.
  - **Return Loss** 1-port scalar reflection measurement that displays the amount of incident signal energy MINUS the amount of energy that is reflected. The higher the trace is on the screen, the more energy being reflected back to the FieldFox.
  - **VSWR** (Voltage Standing Wave Ratio – also known as SWR) 1-port reflection measurement that displays the ratio of the maximum reflected voltage over the minimum reflected voltage. The higher the trace is on the screen, the more energy being reflected back to the FieldFox.

Normalize

Normalization can be used to effectively 'Zero' a trace, which removes frequency response errors introduced by the components of the test setup before making the measurement. To normalize a reflection measurement, the DUT is removed and a known device is connected to Port 1. When you choose Normalize, the displayed trace is stored into memory and then the displayed data is divided by the memory trace. The displayed data trace now shows the difference between the stored memory response and the measured response.

You could normalize while measuring the reflection response of any type of device. For example, the device could be:

- An Open or Short (with maximum reflection)

How to perform Normalization

To Port 1, connect a known device (usually an Open or Short) to which reflection measurements are to be normalized.

– Press **Trace 6**

– Then **Normalize**

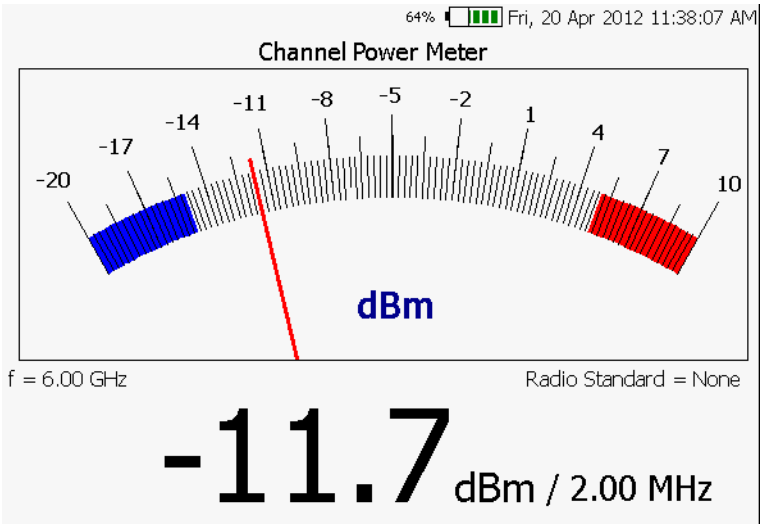
The yellow data trace displays the current measurement with trace math applied. The math operation symbol [**D/M**] is displayed on the lower left corner of the screen. Learn more about Trace Math in "All about Trace Math" on page 829.

NOTE

Data interpolation is NOT supported. If the Resolution setting is changed with Trace Math enabled, the FieldFox will disable the math operation.

21 Built-in Power Meter Mode – Option 310

Built-in Power Meter (also known as Channel Power Meter) uses the SA input connector to make quick and simple power measurements over a selectable frequency band. A power sensor is NOT required.



In this Chapter

"Frequency/ Span / Step" on page 589

"Radio Standard" on page 590

"How to set Attenuation" on page 590

See Also

The following Built-in Power Meter settings are identical to the standard Power Meter settings:

"Scale" on page 599

"Relative and Offset Power Measurements" on page 601

"Display Units" on page 601

"Averaging" on page 602

"Single or Continuous Measure" on page 602

“Limits” on page 603

The following Built-in Power Meter settings are identical to SA Mode settings:

“Radio Standard” on page 590

“How to Access Individual Alignments” on page 216

Built-in Power Meter Settings

Select Built-in Power Meter Mode before making any setting in this section.

How to select Built-in Power Meter Mode

- Press **Mode**
- Then **More**
- Then **Power Meter (Built-in)**

CAUTION

Please observe the SA RF Input port damage level.

+27 dBm (320 mW) average

+33 dBm peak (2 W) <10µs

+50 VDC

Frequency/ Span / Step

Valid Built-in Power Meter measurements can be made over the entire frequency range of the FieldFox. Although it is possible to enter a center frequency below the FieldFox minimum frequency, the LO feed-thru of the internal SA hardware will invalidate these Built-in Power Meter measurements.

The measurement span (also known as Channel Width and Integration BW) is the frequency range, half above and half below the center frequency, over which power is detected and displayed. The maximum measurement span is 100 MHz.

How to enter center frequency, step size, and span

The default frequency is 50 MHz.

- Press **Freq/Dist**
- Then **Center**
- Then type a value using the numeric keypad. Then press a multiplier key. Learn about multiplier abbreviations "Multiplier Abbreviations" on page 48. The current frequency (f) is shown on the FieldFox screen.
- Optionally, use the ▲|▼ arrows or rotary knob to quickly change Center frequency. The size of the frequency step can also be changed. Press **CF Step** then type a step size value using the numeric keypad, then select a multiplier key.
- Optionally press **Span** Type a value using the numeric keypad. Then press a multiplier key. The default span is 20 MHz. The maximum span is 100 MHz. The current span setting is shown as the dividend in the digital display. For example: -10 dBm / 1.00 MHz

Radio Standard

A Radio Standard can used to integrate power within specific radio channels. When a Radio Standard is selected, the **Span** setting is automatically coupled to the defined Channel Width for that standard. (Width is the same for all channels within a standard.) Also, **Unit** is set to **Chan**, and **CF** is set to the nearest specific Channel defined in the standard.

Learn more about Radio Standards, including Importing and Deleting Custom Radio Standards, beginning in "Custom Radio Standards" on page 158

How to select a Radio Standard

- Press **Measure 1** OR **Freq/Dist**
- Then **Radio Standard**
- Then select a standard using the ▲|▼ arrows or rotary knob and press **Enter**.

Attenuation

The Attenuation setting controls the power level into the FieldFox.

To compare Built-in Power Meter Mode measurements to SA Channel Power measurements, use the same attenuation settings. Built-in Power Meter Mode defaults to 30 dB attenuation, while SA mode defaults to 10 dB attention. In Built-in Power Meter, the attenuation setting is NOT annotated on the screen.

How to set Attenuation

- Press **Scale/Amptd**
- Then **More**
- Then **RF Atten**
- Then use the ▲|▼ arrows or rotary knob to choose from either **30 dB** or **10 dB**

NOTE

The following Built-in Power Meter settings are identical to the standard Power Meter settings. To learn about these settings, please refer to the following pages:

"Relative and Offset Power Measurements" on page 601

"Display Units" on page 601

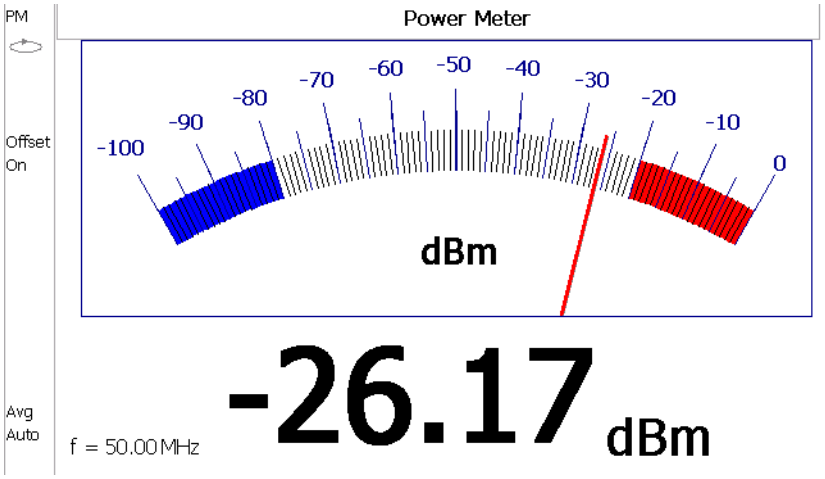
"Averaging" on page 602

"Scale" on page 599

"Limits" on page 603

22 Power Meter (USB/LAN) Mode - Option 302

Power Meter measurements, available with Option 302, are made with Keysight USB power sensors. Power readings are displayed on the FieldFox screen.



In this Chapter

"Supported Power Sensors" on page 593

"How to Connect a USB Power Sensor" on page 594

"How to Connect a LAN Power Sensor" on page 595

"How to select Power Meter Mode" on page 597

"Average / Peak" on page 597

"Zeroing" on page 598

"Frequency" on page 598

"Source Control" on page 599

"Source Power Measurements" on page 600

"Relative and Offset Power Measurements" on page 601

"Display Units" on page 601

"Resolution" on page 602

"Averaging" on page 602

"Single or Continuous Measure" on page 602

"Step Detection Mode" on page 603

"Limits" on page 603

"Troubleshooting" on page 605

See Also

"FOPS Settings" on page 610

"All about Markers" on page 797

"All about Limit Lines" on page 812

"All about Trace Math" on page 829

"All about Scale Settings" on page 831

Supported Power Sensors

For a complete list of supported Keysight USB and LAN Power Sensors, please visit: www.keysight.com/find/usbsensorsforfieldfox

NOTE The FieldFox does NOT support the following Keysight USB and LAN Power Sensor features: External Triggering (Time Gated Burst Power Measurement), Power Sweep Operation, and Frequency Sweep Operation. External Zeroing is NOT allowed on the U2020 X-series Power Sensors.

CAUTION Please refer to your USB and LAN Power Sensor User's Guide and observe the damage levels of your device.

How to Connect a USB Power Sensor

Connect your Power Sensor to one of the FieldFox USB ports.

NOTE

IMPORTANT! When a USB power sensor is initially connected to the FieldFox, it may take ~10 seconds for the USB power sensor to finish zeroing and for the FieldFox to recognize the USB power sensor. If your USB power sensor is not operating as expected:

- Verify the latest firmware is loaded on the FieldFox. Refer to www.keysight.com\find\fieldfoxsupport.
- Verify the latest firmware is loaded on the Power Sensor. Refer to https://www.keysight.com/main/editorial.
- Remove and re-connect the USB power sensor

NOTE

Use an attenuator between the DUT and the power sensor when measuring power levels that are higher than +20 dBm. The attenuator value can be subtracted from the measurement using the Offset feature, discussed in "Relative and Offset Power Measurements" on page 601.

A sequence of status lights are displayed on the base of the power sensor, when the FieldFox is in Power Meter (USB Sensor) mode.

- **Green blinking** light indicates the power sensor is communicating or self-tests are being performed. Because the FieldFox is usually communicating with the power sensor when it is connected, this is the normal mode of operation.
- **Amber light** indicates Zeroing is being performed.
- **Red light** indicates an error has occurred with the power sensor. Refer to power sensor documentation.
- **No light** indicates the FieldFox is not communicating with the power sensor. This is the case when in Hold mode or when NOT in Power Meter Mode.

How to Connect a LAN Power Sensor

CAUTION

Disconnecting a LAN sensor from its cable or disconnecting a LAN sensor while communicating with the FieldFox is not recommended. Either of these actions causes the LAN sensor to lose its internal state settings. Learn more, refer to "LAN Sensor Settings" on page 595 and to "Troubleshooting" on page 605.

NOTE

IMPORTANT!

LAN sensors require that the FieldFox has a CPU2 installed.

Connect the LAN power sensor to a LAN port. This section provides some general LAN power sensor connection information and some specific FieldFox-related LAN connection information. For more details, refer to your LAN power sensor's User's Guide.

Connect the LAN sensor via any of the following LAN operating modes:

- Dynamic IP (Dynamic Host Configuration Protocol or DHCP)
- Auto IP (Local PC control or isolated (non-site) LAN)
- Static IP (Manual mode)

The default LAN operating mode of the LAN sensor is Dynamic IP.

Dynamic IP and Auto IP are enabled on the LAN sensor shipped from Keysight. This allows the LAN sensor to automatically obtain an address on the network.

The LAN sensor communicates with the DHCP server to obtain the LAN interface configuration. If the DHCP server is not detected, then either the DHCP server is not present or it does not allow the LAN sensor to obtain an IP address. The LAN sensor will then try to obtain the LAN configuration using AutoIP if enabled, otherwise the LAN sensor will try to use the static IP set in the LAN sensor. If required, push the LAN reset switch to reset the LAN sensor LAN configuration to a known default state.

LAN Sensor Settings

The LAN Sensor settings enable you to

- Select your model of sensor
- Enter your **Sensor I.D**. via **DNS serial number** or **IP address**

Learn more, refer to "USB and LAN Power Meter Settings" on page 597.

To access the LAN Sensor Settings:

- Press **Meas Setup 4** > **More** > **LAN Sensor Settings**

Using the LAN Sensor Settings

- Press **Sensor Name [U2049XA]** – then select your LAN sensor model from the drop down list.
- Press **Sensor ID** – then choose
  - **DNS Ser num** – Enter the DNS Serial Number's last 5 digits as a way for the FieldFox to connect with your LAN power sensor.
  - **IP Address** – Enter the IP address of your LAN power sensor as a way for the FieldFox to connect with your LAN power sensor.
- Press **DNS Ser Num** – to enter a DNS serial number's last 5 digits to enable the FieldFox to identify a LAN power sensor. This softkey is inactive Sensor I.D. is set to **IP Address**.
- Press **LAN IP Addrs Not Specified** – to enter an IP address to enable the FieldFox to identify a LAN power sensor. This softkey is inactive Sensor I.D. is set to **DNS Ser Num**.
- Press **Reconnect** – While it is not recommended to remove the LAN cable from either the Sensor or the FieldFox during a LAN Sensor based measurement, the **Reconnect** button should allow the measurements to resume if they are lost. Learn more, refer to "Troubleshooting" on page 605.

NOTE

The LED indicator will turn red indicating the following error when the DHCP server is not detected: –310, "`System error; The sensor could not obtain a LAN configuration using DHCP. The sensor will try to obtain IP address using AutoIP if enabled`". For more information on LAN instrument connectivity, refer to the *Keysight IO Libraries Suite Connectivity Guide*.

NOTE

IMPORTANT! When a LAN power sensor is initially connected to the LAN, it may take ~10 seconds for the LAN power sensor to finish zeroing and for the FieldFox to recognize the LAN power sensor. If your LAN power sensor is not operating as expected:

- Verify the latest firmware is loaded on the FieldFox. Refer to www.keysight.com\find\fieldfoxsupport.
- Verify the latest firmware is loaded on the Power Sensor. Refer to https://www.keysight.com/main/editorial.
- Press the LAN reset switch to reset the LAN sensor LAN configuration to a known default state
- Remove and re-connect the LAN power sensor

NOTE

Use an attenuator between the DUT and the power sensor when measuring power levels that are higher than +20 dBm. The attenuator value can be subtracted from the measurement using the Offset feature, discussed in "Relative and Offset Power Measurements" on page 601.

A sequence of status lights are displayed on the base of the power sensor, when the FieldFox is in Power Meter (LAN Sensor) mode.

- **Green / Green blinking** light indicates the power sensor's identification indicator is communicating. After successful identification, the green LED stops blinking. No indication when the operating speed is 10 Mbps or during line isolation.
- **Amber light** indicates Zeroing is being performed. And, blinks when a valid link activity is detected.
- **Red light** indicates an error has occurred with the power sensor. Refer to power sensor documentation.
- **No light** indicates the FieldFox is not communicating with the power sensor. This is the case when in Hold mode or when NOT in Power Meter Mode.

USB and LAN Power Meter Settings

Select Power Meter Mode before making any setting in this section.

How to select Power Meter Mode

- Press **Mode**.
- Then **Power Meter (USB/LAN Sensor)**.

How to select a Sensor Type

- Press **Meas Setup 4**.
- Then **Sensor Type USB LAN** (Default = USB).

Average / Peak

- Press **Measure 1**
- Then choose from the following:
  - **Average** Measures and reports the average of the power measurements.
  - **Peak** Available ONLY on some of the X-Series power sensors. Measures and reports peak power detected at sensor input. See also, Table 24-1, "Pulse Measurement X-Series USB and LAN Power Sensors," on page 618.

Zeroing

The Keysight USB and LAN Power Sensors perform Internal Zeroing automatically. Because Keysight USB and LAN Power Sensors have an internal switch, Internal Zeroing does NOT require that the power source be turned OFF.

For highest measurement accuracy, when measuring power levels below –30 dBm, External Zeroing should be performed.

During External Zeroing, the power source MUST be turned OFF or the power sensor disconnected from the power source (device under test). Power is OFF when power sensor measurements are below –60 dBm (–50 dBm for LAN sensors). When power higher than this is detected at the sensor, a warning message is shown on the FieldFox and External Zeroing will not proceed.

NOTE External Zeroing is NOT allowed on the U2020 X-series Power Sensors.

How to perform External Zeroing

– Press **Cal 5**.

– Then **External Zero**.

While either Internal or External Zeroing is being performed, “Zeroing...” is shown on the FieldFox screen. While this message is present, do NOT make any changes to the FieldFox.

In addition, once External Zeroing has started, the power source must be OFF for the entire time that the Zeroing message is present. Otherwise, the calibration will be compromised but NO warning is shown.

Frequency

A table of correction factors versus frequency is stored within Keysight Power Sensors. The frequency of the power to be measured is entered in the FieldFox so that the appropriate correction factor can be used.

The Source Control feature (see following section) will determine the frequency range of the power measurement.

How to enter Frequency of the Power Measurement

– Press **Freq/Dist**

– Then **Src Center**

– Then type a value using the numeric keypad. The default frequency is 50 MHz.

– Then press a multiplier key. Learn about multiplier abbreviations in “Multiplier Abbreviations” on page 48.

The current frequency is shown on the FieldFox screen.

Source Control

This feature may require an option on some FieldFox models.

With the FieldFox internal source enabled, these settings allow you to make simple, absolute power measurements. The source and the power sensor can be physically separated by a long distance when using a long USB cable.

Set the internal source frequency by setting the frequency of the power measurement. Learn how in the previous section.

Power Meter measurements are limited by the combined frequency ranges of the internal source when enabled and the frequency range of the power sensor. For example, assume the frequency range of your sensor is 9 kHz to 18 GHz and the frequency range of the FieldFox is 2 MHz to 6 GHz.

– With the Source ON, measurements are limited to 2 MHz to 6 GHz.

– With the Source OFF, measurements are allowed from 9 kHz to 18 GHz.

How to Set Source Control and Power Level

– Press **Sweep 3** > **Advanced**

NOTE

When Option 208 (FOPS) is enabled, to access Source Control, press **Sweep 3**, then **Power Setup**. **Power Setup**. Learn more about FOPS beginning on page Chapter 23, “Frequency Offset Using Power Sensor (FOPS) – Option 208”, on page 607.

– Then **Source Enable**

  – **ON** Turn ON the internal source

  – **OFF** Turn OFF the internal source

Optionally set the power level.

– Press **Src Nom Power** (-15 dBm default setting) Set output power to an arbitrary value at the displayed CW frequency.

– Then enter a value using the numeric keypad, the ▲|▼ arrows, or the rotary knob.

– Press **Enter**

Scale

The scale of the Power Meter display can be set manually or automatically. The major and minor ticks are set automatically and can NOT be changed. Although the scale settings are limited, you can view measurements beyond these settings by performing Autoscale.

How to Scale the Power Meter Display

These softkeys are **not** available when **Rx Power** is enabled. See also "Source Power Measurements" on page 600.

Manually:

- Press **Scale / Amptd**.
- Then choose from the following:
  - **Scale Min** Sets the low power level of the power meter display. Type a number and select the units or press Enter. This value is limited to –100 dBm.
  - **Scale Max** Sets the high power level of the power meter display. Type a number and select the units or press Enter. This value is limited to 100 dBm.

Autoscale:

Using Autoscale, the current reading is used for the center of the scale, and Min and Max values are set accordingly.

- Press **Scale / Amptd**.
- Then **Autoscale**.

Source Power Measurements

Before making a source power measurement, a calibration is required. Requires a compatible USB power sensor. Learn more about supported Keysight USB and LAN Power Sensors, please visit: www.keysight.com/find/usbsensorsforfieldfox.

How to make a Source Power Measurement

- Press **Measure 1** > **Src Power Measure** to open the Source Power Measure wizard.
- Follow the Source Power Measure Wizard's instructions.

  When you select the **Src Power Measure** softkey the **Rx Power** is enabled and the **Average** (default) is disabled. And, the displayed power meter is replaced by a Power vs. Frequency grid display of the source and receiver power.
- Press **Src Power Memory** - to store the source power measurement
- Press **Gain** - applies the stored source power measure

Relative and Offset Power Measurements

Power measurements can be made that are relative to another reading or that are offset by a fixed value.

- Use Relative to measure the difference between power levels.
- Use Offset to account for components or a long length of cable that is used before the power sensor. For example, if using a 10 dB attenuator to protect the FieldFox, enter an Offset Value of 10 to read the power as it would appear without attenuation. If using a 10 dB amplifier, enter an Offset Value of –10 to read the power as it would appear without amplification.

How to set Relative and Offset Power Measurements

- Press **Scale / Amptd**.
- Then choose from the following:
  - **Relative Off On** When switched to ON, the FieldFox measures and stores the current power level. Subsequent power measurements display a power level which is relative to the stored value. When relative is ON, the units change from dBm to dB or from Watts to %.

    This softkey is **not** available when **Rx Power** is enabled. See also “Source Power Measurements” on page 600.
  - **Offset Off On** Toggles ON and OFF the displayed power level using the Offset value (default = Off (0.000 dB)).

    This softkey is **not** available when **Rx Power** is enabled. See also “Source Power Measurements” on page 600.
  - **Offset Val** Value by which the power meter display is offset. A positive value compensates for a component with loss. A negative value compensates for a component with gain. Offset values are limited to +/– 100 dB (default = 0.000 dB).

Display Units

Select whether to display power in dBm or Watts. When making relative power measurements, these change to dB and %.

These softkeys are **not** available when **Rx Power** is enabled. See also “Source Power Measurements” on page 600.

How to set Power Meter display units

- Press **Meas Setup 4** or **Scale / Amptd**, **More**
- Then **Unit**.
- Then choose from the following:

- **dBm (dB)** Sets Power Meter display to dBm or dB.
- **Watt (%)** Sets Power Meter display to Watts or %.

Resolution

Resolution sets the number of digits to display after the decimal point on the digital power meter display.

These softkeys are **not** available when **Rx Power** is enabled. See also "Source Power Measurements" on page 600.

How to set Resolution

- Press **Scale / Amptd.**
- Then **More**.
- Then, in **Resolution**, choose from 0, 1, 2, or 3.

Averaging

Averaging is used to improve measurement accuracy in low power or noisy power situations. Increased averaging improves measurement accuracy, but also reduces measurement speed.

How to set Power Meter Averaging

- Press **BW 2** or **Meas Setup 4**.
- Then choose from the following:
  - **Averaging Auto Man Off**
  - **Auto** Allows the USB Power Sensor to use its Auto Averaging settings. See the USB Power Sensor documentation for details.
  - **Man** Manually enter an averaging count by setting **Num Averages**.
  - **OFF** Performs NO averaging.
  - **Num Averages** Sets the number of Power Meter readings to be averaged before a valid reading is displayed. When the number is changed, **Averaging** is automatically set to Man.

Single or Continuous Measure

This setting determines whether the FieldFox measures continuously or only once each time the **Single** button is pressed. Use **Single** to conserve battery power or to allow you to save or analyze a specific measurement.

This setting can be changed at any time without affecting calibration accuracy.

How to set Single or Continuous

- Press **Sweep 3**.
- Then choose one of the following:
  - **Single** Automatically sets Continuous OFF and causes FieldFox to make ONE measurement, then hold for the next **Single** key press. When a data trace is displayed, the entire trace is measured, then holds. The **Hold** annotation changes to an arrow --> while the measurement occurs.
  - **Continuous OFF ON** Makes continuous measurements. This is the typical setting when battery power is not critical.

You can also use **Run / Hold +/-** to toggle between Single and Continuous.

Step Detection Mode

The FieldFox supports the Step Detection feature that is present in Keysight USB power sensors. When enabled, this feature reduces settling time after a significant step in the measured power. For more information, please refer to the USB Power Meter documentation.

How to set Step Detection mode

- Press **Meas Setup 4**.
- Then **Step Detection OFF ON**
- Then choose from the following:
  - **ON** Enables step detection (default setting)
  - **OFF** Disables step detection

Limits

In Power Meter Mode, Minimum and Maximum limits set a visible range of acceptable readings between these two values. Readings that are below the minimum or above the maximum are clearly visible on the power meter display.

How to set Limits

- Press **Limit 8**.
- Then choose from the following:
  - **Min Limit OFF ON** Toggles the display of the Minimum limit ON and OFF.
  - **Min Limit Value** Sets the Minimum limit power value. Power reading lower than this will exceed the limit.

- **Max Limit OFF ON** Toggles the display of the Maximum limit ON and OFF.
- **Max Limit Value** Sets the Maximum limit power value. Power reading higher than this will exceed the limit.

Troubleshooting

This section contains the following:

LAN Sensors

– "If the FieldFox LAN is removed during the use of the LAN sensor, the following steps can be taken to re-establish control of the Sensor:" on page 605
– "If the Sensor LAN is removed during the use of the LAN sensor, the following steps can be taken to re-establish control over the measurement:" on page 605

LAN Sensors

If a LAN sensor cable or LAN sensor is not communicating properly with the FieldFox:

If the FieldFox LAN is removed during the use of the LAN sensor, the following steps can be taken to re-establish control of the Sensor:

1. Reconnect the LAN sensor to the FieldFox and await confirmation the FieldFox has obtained its IP address via the connection.

   A self-assigned IP address may be shown briefly while FieldFox tries to get connected to the LAN again after it has been removed. Before proceeding to the next step, ensure the correct IP has been obtained by the FieldFox.

   a. You can view the IP address by selecting: System > System Configuration > More > LAN to display the current IP address.

   b. Press Done to exit the LAN menu.

2. Once FieldFox has obtained its IP address again, press the **Reconnect** button:

   Press Meas Setup 4 > More > LAN Sensor Settings > Reconnect location in the softkey menu.

   The FieldFox will attempt to restore the connection and the settings for the sensor.

If the Sensor LAN is removed during the use of the LAN sensor, the following steps can be taken to re-establish control over the measurement:

1. Reconnect the LAN cable to the sensor.
2. Observe the LEDs near the LAN cable connection:

   a. The PWR LED will turn on while the Sensor is waking up and initializing.

b. The PWR LED will turn off when the Sensor is ready to be reconnected. The other LED next to it should be off as well.

c. Then press, **Meas Setup 4** > **More** > **LAN Sensor Settings** > **Reconnect**.

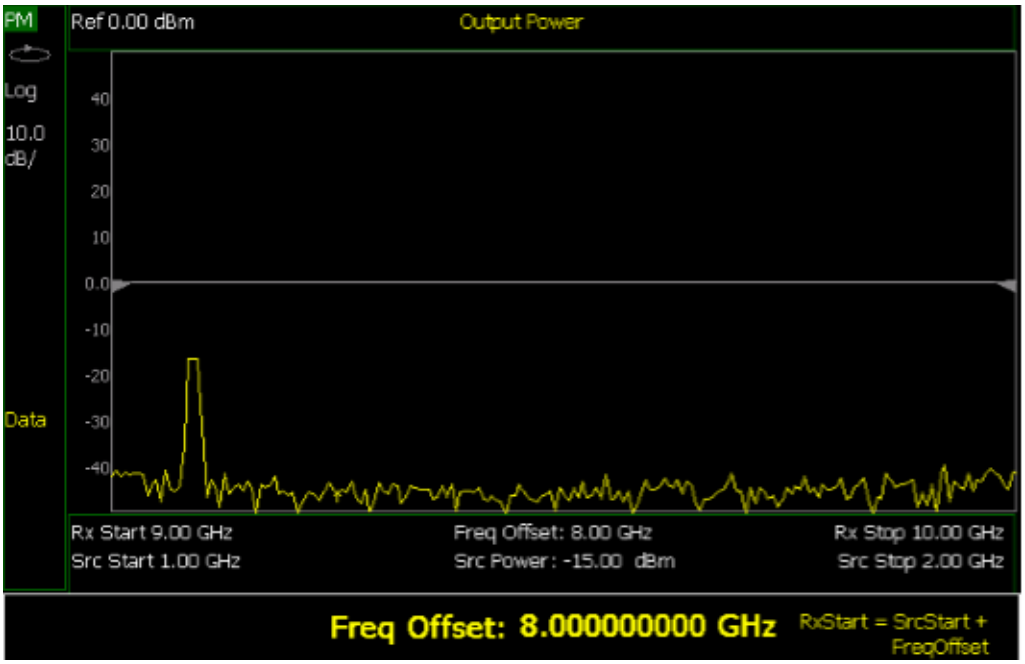
NOTE

The LEDs may turn on and off during the reconnection, and the sensor may report “Zeroing” or “Attempting to connect” messages. This reconnection attempt could take up to a minute or so. The data acquisition will resume once the connection is re-established.

23 Frequency Offset Using Power Sensor (FOPS) – Option 208

FOPS is accessed through (and requires) Option 302 USB Power Meter Mode. With both options installed, you can send a signal with the FieldFox internal source at one frequency, and measure this signal with a Keysight U-Series USB Power Sensor at another frequency.

Figure 23-1 Display for FOPS



In this Chapter

"How to select Power Meter (USB Sensor)" on page 610

"Measurement Selection" on page 610

"Sweep Type and Frequency" on page 611

"Power Sensor Settling" on page 613

"Sweep Settings" on page 613

"Amplitude Markers" on page 614

"Trace Math" on page 614

See Also

"All about Trace Math" on page 829

Overview

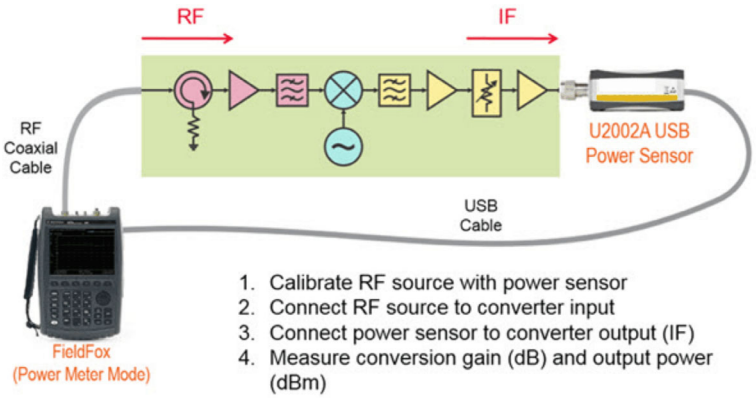
This feature allows the FieldFox source frequency to be set independently from the power sensor (receiver) frequency. With frequency offset using power sensor (FOPS), the frequency of both the source and receiver are swept, and the two track each other. The offset frequency can be negative, zero, or positive.

FOPS can be used to characterize the scalar transmission response of devices such as mixers and converters. This frequency offset capability is necessary for conversion loss/gain measurements on frequency-translating devices since, by definition, the input and output frequencies of the DUT are different. The FieldFox source stimulates the DUT and the power sensor is used as the measurement receiver.

Since power sensors are inherently broadband devices (not frequency-selective), it is your responsibility to ensure that ONLY the signal of interest is present at the power sensor input and that all others signals are filtered appropriately.

For some DUTs, the output frequency may sweep in a reverse direction, as compared to the source frequency. The FieldFox analyzer includes an offset calculator that ensures a fast measurement setup.

The following shows a typical use case for FOPS:



– The DUT is a long section of cable and a frequency converter.

– The FieldFox source is tuned to the RF frequency.

– The USB power sensor, with an equally long USB/LAN cable, is connected to the IF Output. USB/LAN extenders are NOT provided with the FieldFox or Keysight USB power sensors.

– Conversion gain/loss is measured at power sensor.

NOTE The dynamic range with FOPS may be significantly different when using various power sensors. In general, the lower frequency range sensors have better dynamic range.

FOPS Settings

The following settings are unique to FOPS. Standard USB Power Meter mode settings, which may be useful with FOPS, are documented in that chapter starting in "USB and LAN Power Meter Settings" on page 597

Select Power Meter (USB Sensor) before making any setting in this section.

How to select Power Meter (USB Sensor)

- Press **Mode**
- Then **Power Meter (USB Sensor)**
- Then connect a USB Power Sensor to either FieldFox USB port.
- For a complete list of supported Keysight USB Power Sensors, please visit: www.keysight.com/find/usbsensorsforfieldfox

Measurement Selection

- Press **Measure 1**
- Then choose from the following:
- **Src Power Measure** Similar to a 'normalization' cal, this selection guides you through the following steps to make a measurement at the reference plane and then store the data trace into memory.
  - Connect the power sensor to the measurement reference plane. This is the location to where power measurements are to be referenced. For example, to measure only the conversion loss through a converter, attach the power sensor to the cable that connects to the converter input.
  - Press **Measure**. When finished, press **Src Data -> Mem** to store the measured data into FieldFox memory. Preset or Mode Preset will clear the stored memory.
  - 3.Optionally choose from the following:
    - **Re-Measure** Make another measurement
    - **Src Data** View only the re-measured data.
    - **Src Memory** View only the stored memory data.
    - **Src Data & Memory** View both the re-measured data and the stored memory data.
  - 4.Press **Done**
- **Src Power Memory** Not available until source data is stored into memory. Displays only the source power memory trace.

– **Gain** Not available until source data is stored into memory. Displays the Output power / Source power (memory trace).

– **Rx Power** Displays the raw received power at the USB power sensor.

Sweep Type and Frequency

Set the source and receiver frequencies for the FOPS measurements. The receiver is a Keysight U-Series Power Sensor. These are broadband measurement devices, which means that they measure power over a very wide frequency range. Tables of frequency and power correction factors are stored within the power sensors. The receiver (Rx) frequencies are used ONLY to apply the appropriate correction factors to the power levels measured with the power sensor.

NOTE **It is YOUR responsibility to ensure that ONLY the signal of interest is present at the power sensor. All other signals MUST be filtered appropriately.**

How to set Sweep Type and Frequency

– Press **Freq/Dist**

– Then **Sweep Type**

– Then choose from the following:

– **CW** Used to make standard (non-offset) power meter measurements at a single frequency. Learn more in "USB and LAN Power Meter Settings" on page 597.

NOTE **To make FOPS measurements at a single frequency, choose Swept, then enter a Src Center frequency, then Span = 0 Hz.**

– **Swept** Used to make swept FOPS measurements.

—— Then enter source (Src) frequencies as either Center and Span or Start and Stop. Both methods set the FieldFox internal source sweep range out the Port 1 RF Output connector.

——The frequency limits are determined by the limits of both the FieldFox and the power sensor.

——The LOW frequency is limited by the higher of either the FieldFox or the power sensor minimum frequencies.

——The HIGH frequency is limited by the lower of either the FieldFox or the power sensor maximum frequencies.

——Then **More**.

——Then **Freq Display**. This determines how the receiver frequencies below the graticules are displayed. Choose from the following:

——**Start** Annotated as Start and Stop frequencies.

——**Center** Annotated as Center and Span frequencies.

——Then choose from the following two methods to determine the **offset frequency** (the frequency that the receiver is offset from the source). This is typically the frequency of the LO that is used with the frequency converter. The frequency offset may be positive, negative, or zero.

——**Freq Offset** Enter an Offset frequency. The receiver frequencies are calculated.

——**Offset Calculator** Enter the Receiver Start and Stop frequencies. Then press **Calculate Offset**.

——Press **Rx Sweep** to select the receiver sweep direction.

——**Fwd** Used for systems for which the output frequency is Offs + Src. The output frequency of the DUT and the receiver sweeps in the same direction as the source.

——**Rev** Used for systems for which the output frequency is Offs - Src. The output frequency of the DUT and the receiver sweeps in reverse direction as compared to the source.

Invalid Settings

Violations of the following conditions will return an error message:

– The frequency span for the source and receiver must be the same.

– Both the source and receiver frequencies must be positive.

FOPS Configuration Examples

Negative Offset, RxSwp = **Fwd** (Offs + Src)

Src = 2 GHz to 3 GHz

Offset = -1 GHz

Rx = 1 GHz to 2 GHz

Positive Offset, RxSwp = **Rev** (Offs - Src)

Src = 2 GHz to 3 GHz

Offset = 3.8 GHz

Rx = 1.800 GHz to 800 MHz

Positive Offset, RxSwp = **Fwd** (Offs + Src)

Src = 2 GHz to 3 GHz

Offset = 3.8 GHz

Rx = 5.8 GHz to 6.8 GHz

Power Sensor Settling

The following two settings work together to allow you to choose the right compromise between measurement speed and accuracy.

Each power sensor reading is considered "settled" when either:

- The difference between two consecutive readings are within the Tolerance value.
- **Or** the Max (number of) Readings has been made.

The readings that were taken are averaged together to become the displayed reading.

How to choose Power Sensor settling

- Press **BW 2**
- Then **Tolerance**. Enter a value in dB between 0 and 10 using the numeric keypad, the ▲|▼ arrows, or the rotary knob. Tolerance of 0 will never be achieved, so the Max Readings will always be made. Press **Enter**
- Then **Max Readings**. Enter a value between 1 and 20 using the numeric keypad, the ▲|▼ arrows, or the rotary knob. Press **Enter**

Sweep Settings

These settings provide added control of the FOPS measurement.

How to make additional sweep settings

- Press **Sweep 3**
- Then choose from the following:
- **Power Setup**
  - **Source Enable**
    - –**ON** Turn ON the internal source (required for FOPS).
    - –**OFF** Turn OFF the internal source
  - **Src Nom Power** (-15 dBm default setting) Set output power to an arbitrary value at the source CW frequency. Then enter a value using the numeric keypad, the ▲|▼ arrows, or the rotary knob. Press **Enter**

- **Num Points** or **Freq Step Size** Both settings control the number of power sensor measurements between the Start and Stop frequencies. Enter one setting and the other will be changed automatically. There must be at least two data points.
- **Dwell /Point** Specifies a settling time (in seconds) after the internal source steps to the next frequency and before the power sensor makes a measurement.

Amplitude Markers

Amplitude markers are horizontal dotted lines that you can move to any amplitude level on the screen. The two amplitude markers can be set independently or used as a pair of delta markers. Amplitude markers can be used as a visual comparison aid with the data trace.

How to make Amplitude Marker settings

- Press **Marker** > **More** > **Ampl Markers**
- Then choose from the following:
  - **OFF** Amplitude markers are NOT displayed.
  - **ON** Amplitude markers ARE displayed at their previous positions.
- Then **Ampl Mkr 1 or 2**
- Enter a value in dBm for the marker using the numeric keypad, the ▲|▼ arrows, or the rotary knob.
- Press **Delta Ampl Mkr**
- Then choose from the following:
  - **ON** AmplMkr 2 value is relative to AmplMkr 1. When AmplMkr 1 is moved, AmplMkr 2 also moves to maintain the AmplMkr 2 value between them.
  - **OFF** The two amplitude markers move independent of one another.

Trace Math

Trace Math allows you to compare data traces and perform simple math. Learn how to use Trace Math in "All about Trace Math" on page 829. All Data and Memory features work as documented EXCEPT for the following:

NOTE

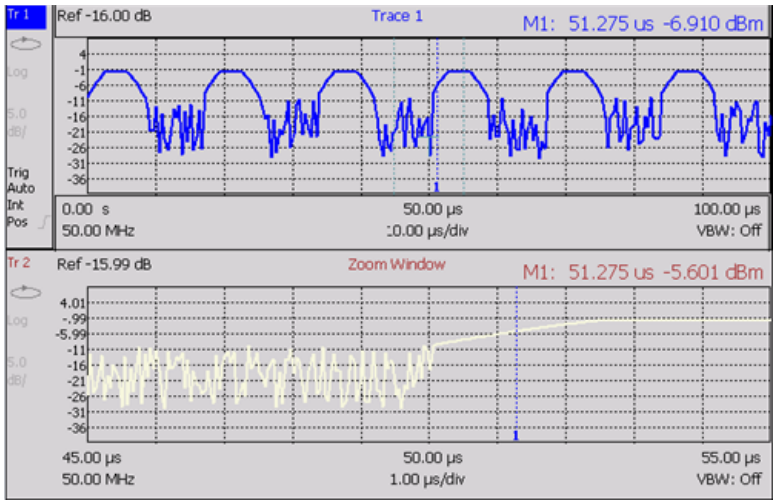
When Trace, then Data -> Mem is pressed, if a Src Power trace is active, then RxPower is actually stored into memory.

To Compare Src Power (Input) and Rx Power (Output):

1. Meas Rx Power
2. Store to memory
3. View Data & Memory
4. Meas Src Power.

24 Pulse Measurements Mode – Option 330

Pulsed power meter measurements, available with Option 330, are made with Keysight X-Series USB and LAN Peak Power Sensors. These sensors are capable of detecting, measuring, and storing data from a train of pulses at the RF input. This data is queried from the USB and LAN Power Sensor and displayed on the FieldFox screen. You can then analyze the data using several selectable settings. Refer to Table 24-1 on page 618.



In this Chapter

"Supported Power Sensors" on page 618

"Measurement Selection" on page 622

"Frequency / Time" on page 622

"Zoom Window" on page 623

"Scale" on page 624

"Averaging " on page 624

"Video Bandwidth" on page 625

"Single or Continuous Measure" on page 626

"Resolution" on page 626

"Triggering" on page 626

"Marker Settings" on page 629

"Amplitude Markers" on page 630

"How to Search with Markers" on page 630

"How to enable Auto Analysis" on page 632

"Pulse Top" on page 632

"Grid" on page 632

"Trace Memory" on page 633

See Also

"FOPS Settings" on page 610

"All about Markers" on page 797

"All about Limit Lines" on page 812

"All about Trace Math" on page 829

"All about Scale Settings" on page 831

NOTE

Many of the features included with the FieldFox Pulse Measurements Mode are discussed in detail in the following documents:

USB Power Sensors[a]

- Keysight U2020 X-Series USB Peak Power Sensors User's Guide (U2021-90002). https://www.keysight.com/us/en/assets/9018-02579/user-manuals/9018-02579.pdf
- Keysight U2020 X-Series USB Peak Power Sensors Programmer's Guide (U2021-90003). https://www.keysight.com/us/en/assets/9018-06011/programming-guides/9018-06011.pdf

LAN Power Sensors[a]

- Keysight U2050/60 X-Series USB Peak Power Sensors User's Guide (U2063-90002). https://www.keysight.com/us/en/assets/9018-04734/user-manuals/9018-04734.pdf
- Keysight U2050/60 X-Series USB Peak Power Sensors Programmer's Guide (U2063-90003). https://www.keysight.com/us/en/assets/9018-04755/programming-guides/9018-04755.pdf

USB and LAN Power Sensors[a]

– "Best Practices For Making The Most Accurate Radar Pulse Measurements" https://www.keysight.com/us/en/assets/7018-03483/application-notes/5991-0434.pdf

a. Learn more, refer to the User's Guide and Programming Guide for your USB or LAN model power sensor.

Supported Power Sensors

Pulse measurements are made using any of the Keysight the following X-Series USB and **LAN** Peak Power Sensors.

Table 24-1 Pulse Measurement X-Series USB and LAN Power Sensors

USB Power Sensor Model Numbers	LAN Power Sensor Model Numbers[a]
U2021XA	L2061XA
U2022XA	L2062XA
U2042XA	U2063XA
U2044XA	L2064XA
U2049XA	L2065XA
U2062XA	L2065XT
U2063XA	
U2065XA	

a. LAN power sensors require FieldFoxes to have CPU2 installed.

Zeroing of the compatible X-Series USB and LAN Peak Power Sensors is performed automatically at power up, every 5 seconds, and prior to measuring low level signals.

Switching between Pulse Measurement Mode and Power Meter Mode

NOT Supported - Using a single USB or LAN Peak Power Sensor and switching between Power Meter Mode and Pulse Measurement Mode. Both modes will attempt to program the sensor, which could cause one or both modes to hang, or at least report inaccurate data.

Supported - Using one X-Series Average Power Sensor connected to the top USB port for Power Meter Mode, and one X-Series Peak Power Sensor connected to the bottom USB port for Pulse Measurement Mode.

How to Connect the USB Power Sensor

Connect your Power Sensor to one of the FieldFox USB ports.

NOTE

Use an attenuator between the DUT and the power sensor when measuring power levels that are higher than +20 dBm. The attenuator value can be subtracted from the measurement using the Offset feature, discussed in “Relative and Offset Power Measurements” on page 601.

A sequence of status lights are displayed on the base of the power sensor.

- **Green blinking** light indicates the power sensor is communicating or self-tests are being performed. Because the FieldFox is usually communicating with the power sensor when it is connected, this is the normal mode of operation.
- **Amber light** indicates Zeroing is being performed.
- **Red light** indicates an error has occurred with the power sensor. Refer to power sensor documentation.
- **No light** indicates the FieldFox is not communicating with the power sensor. This is the case when in Hold mode or when NOT in Pulsed Measurement Mode.

How to Connect the LAN Power Sensor

Connect the LAN power sensor to a LAN port. This section provides some general LAN power sensor connection information and some specific FieldFox-related LAN connection information. For more details, refer to your LAN power sensor's User's Guide.

Connect the LAN sensor via any of the following LAN operating modes:

- Dynamic IP (Dynamic Host Configuration Protocol or DHCP)
- Auto IP (Local PC control or isolated (non-site) LAN)
- Static IP (Manual mode)

The default LAN operating mode of the LAN sensor is Dynamic IP.

Dynamic IP and Auto IP are enabled on the LAN sensor shipped from Keysight. This allows the LAN sensor to automatically obtain an address on the network.

The LAN sensor communicates with the DHCP server to obtain the LAN interface configuration. If the DHCP server is not detected, then either the DHCP server is not present or it does not allow the LAN sensor to obtain an IP address. The LAN sensor will then try to obtain the LAN configuration using AutoIP if enabled, otherwise the LAN sensor will try to use the static IP set in the LAN sensor. If required, push the LAN reset switch to reset the LAN sensor LAN configuration to a known default state.

LAN Sensor Settings

The LAN Sensor settings enable you to

- Select your model of sensor
- Enter your **Sensor I.D**. via **DNS serial number** or **IP address**

Learn more, refer to "USB and LAN Power Meter Settings" on page 597.

To access the LAN Sensor Settings:

- Press **Meas Setup 4** > **More** > **LAN Sensor Settings**

Using the LAN Sensor Settings

- Press **Sensor Name [U2049XA]** – then select your LAN sensor model from the drop down list.
- Press **Sensor ID** – then choose
  - **DNS Ser num** – Enter the DNS Serial Number's last 5 digits as a way for the FieldFox to connect with your LAN power sensor.
  - **IP Address** – Enter the IP address of your LAN power sensor as a way for the FieldFox to connect with your LAN power sensor.
- Press **DNS Ser Num** – to enter a DNS serial number's last 5 digits to enable the FieldFox to identify a LAN power sensor. This softkey is inactive Sensor I.D. is set to **IP Address**.
- Press **LAN IP Addrs Not Specified** – to enter an IP address to enable the FieldFox to identify a LAN power sensor. This softkey is inactive Sensor I.D. is set to **DNS Ser Num**.

NOTE

The LED indicator will turn red indicating the following error when the DHCP server is not detected: –310, "`System error; The sensor could not obtain a LAN configuration using DHCP. The sensor will try to obtain IP address using AutoIP if enabled`". For more information on LAN instrument connectivity, refer to the *Keysight IO Libraries Suite Connectivity Guide*.

NOTE

IMPORTANT! When a LAN power sensor is initially connected to the LAN, it may take ~10 seconds for the LAN power sensor to finish zeroing and for the FieldFox to recognize the LAN power sensor. If your LAN power sensor is not operating as expected:

- Verify the latest firmware is loaded on the FieldFox. Refer to www.keysight.com\find\fieldfoxsupport.
- Verify the latest firmware is loaded on the Power Sensor. Refer to https://www.keysight.com/main/editorial.
- Press the LAN reset switch to reset the LAN sensor LAN configuration to a known default state
- Remove and re-connect the LAN power sensor

NOTE

Use an attenuator between the DUT and the power sensor when measuring power levels that are higher than +20 dBm. The attenuator value can be subtracted from the measurement using the Offset feature, discussed in "Relative and Offset Power Measurements" on page 601.

A sequence of status lights are displayed on the base of the power sensor, when the FieldFox is in Power Meter (LAN Sensor) mode.

- **Green / Green blinking** light indicates the power sensor's identification indicator is communicating. After successful identification, the green LED stops blinking. No indication when the operating speed is 10 Mbps or during line isolation.
- **Amber light** indicates Zeroing is being performed. And, blinks when a valid link activity is detected.
- **Red light** indicates an error has occurred with the power sensor. Refer to power sensor documentation.
- **No light** indicates the FieldFox is not communicating with the power sensor. This is the case when in Hold mode or when NOT in Power Meter Mode.

Pulse Measurement Settings

Select Pulse Measurement Mode before making any setting in this section.

How to select Pulse Measurement Mode

- Press **Mode**
- Then **More** if your FieldFox contains more than five measurement modes.
- Then **Pulse Measurements**

Measurement Selection

The pulse measurement results are presented as either a traditional power meter display or as a trace graph.

How to select the Measurement

- Press **Measure 1**
- Then choose from the following:
  - **Average** Average power (Meter display)
  - **Peak** Peak power (Meter display)
  - **Pk to Avg** Displays the difference between the above two measurements (Meter display)
  - **Trace Graph** (default) The primary trace (Tr 1) plots pulse data in amplitude versus time. Optionally, you can enable a secondary 'zoom' trace. Learn how in "Zoom Window" on page 623.
  - When a 'Meter display' measurement is selected, the following Pulse Measurement Mode settings are identical to the standard USB Power Meter Mode settings.
  - Learn how to set Scale in "Scale" on page 624.
  - Learn how to set **Relative and Offset Power** in "Relative and Offset Power Measurements" on page 601.
  - Learn how to set **Display Units** in "Display Units" on page 601.
  - Learn how to set **Limits** in "Limits" on page 603.

Frequency / Time

How to set Frequency

- Press **Freq/Dist**
- Then choose from the following:

  - **Frequency** Sets the center frequency of the carrier on which pulse modulation resides. This is used to set amplitude correction of the USB Power Sensor.

How to set Time

Specify the time over which data will be acquired by the USB Power Sensor. When Trace Graph is selected, **Tr 1** is annotated with these values. Time can be specified using either of the following pairs of values:

- **Center 1** and **Time/div 1** Specify the center time and time per division.
- **Start Time** and **Time Length** Specify the start time and length of acquisition.
- A positive start time indicates a delay after the sensor detects a pulse signal.
- A negative start time displays data that is acquired BEFORE the sensor detects a pulse signal (or T-zero).
- Follow each by entering a value using the numeric keypad, the ▲|▼ arrows, or the rotary knob.
- After using the keypad, select a multiplier key. Learn about multiplier abbreviations.

Zoom Window

When Trace Graph is selected as the measurement, a secondary Zoom Trace can be used to view a zoomed portion of **Tr 1**. When Zoom Window is ON, blue vertical posts appear on **Tr 1** to indicate the current start, center, and stop times of the zoom window. The zoom window can be scaled using the standard Scale settings.

How to make Zoom Window settings

- Press **Measure**
- Then **Trace Graph**
- Press **Trace 6** or **Freq/Dist** > **More**
- Then **Zoom Window OFF ON**
- Then choose from the following:
  - **ON** Opens the zoom window on the bottom half of the FieldFox screen. The window includes the zoomed trace.
  - **OFF** Closes the zoom window.
- **Zoom Center** While monitoring the T within the blue vertical posts on **Tr 1**, enter a value for the center time using the numeric keypad, the ▲|▼ arrows, or the rotary knob.

- **Zoom Time/div** While monitoring the blue vertical posts on the primary trace, enter a value for the zoom window span using the numeric keypad, the ?|? arrows, or the rotary knob.
- **Trace 1** (Only available under the **Trace 6** hardkey.) Press to select **Tr 1**. This can also be done by using the ▲|▼ arrows. Select a trace before making trace settings, such as Scale.
- **Zoom Trace** (Only available under the **Trace 6** hardkey.) Press to select the zoom trace.

Scale

For Meter-style measurements, learn how to set Scale, Relative and Offset Power, display Units, and Resolution beginning in "Scale" on page 624.

How to set Scale for Trace Graph measurements

- Select a trace to scale using the ▲|▼ arrows.
- Press **Scale / Amptd**
- Then choose from the following methods:
- **Autoscale** Automatically adjusts the Y-axis to comfortably fit the Minimum and Maximum amplitude of the trace on the screen.
- Set Scale, acquisition, and Reference Position:
  - **Scale** Manually enter a **scale per division** to view specific areas of the trace.
  - **Ref Level** Manually set the value of the reference line. Enter a negative value by pressing **Run/Hold (+/-)** either before or after typing a value.
  - **Ref Pos** Manually set the position of the reference line. Values must be between 0 (TOP line) and 10 (BOTTOM line).
  - **Offset ON** Enable Offset. When only trace 1 is visible, Offset ON appears to the left of the trace.
  - **Offset Val** Enter a value by which all amplitude values will be offset. This can have the effect of virtually removing a component from the measurement path. A positive value compensates for a component with loss. A negative value compensates for a component with gain. Offset values are limited to +/- 100 dB.

Averaging

Averaging helps to reduce the effects of random noise on a measurement. The more measurements that are averaged, the greater the amount of noise reduction. Averaging is allowed for all pulse measurements.

Averaging is performed in the USB and LAN Power Sensors before the data is sent to the FieldFox.

Annotation in the left pane shows the state of the Average setting. When Manual is selected, the 'Num of Averages' is setting is also shown.

How to set Averaging

- Press **BW 2**.
- Then **Averaging**
- Then choose from the following:
  - **Auto** Averaging is set to a reasonable value by the USB Power Sensor.
  - **Man** Averaging is set to the value specified in the 'Num Averages' setting.
  - **Off** Averaging is OFF
- **Num Averages** Select a value using the numeric keypad, then press **Enter**.

Video Bandwidth

The Video Bandwidth setting enables an FIR (finite impulse response) filter within the USB Power Sensor. The filter setting affects the appearance of the trace results.

Video Bandwidth is allowed for all pulse measurements

How to set Video Bandwidth

- Press **BW 2**.
- Then **Video Bandwidth**
- Then choose from the following:
  - **Off** Video Bandwidth is disabled.
  - **Low** Similar to a low pass filter, ripple in the pass band is minimized but allows higher side-lobes on the filter skirt.
  - **Medium** Smooth pass band with reasonable transition ripple.
  - **High** The pass band ripple is similar to the OFF setting, but the transition skirts are smoother.

Single or Continuous Measure

This setting determines whether the FieldFox continuously queries the USB Power Sensor for data, or only once each time the **Single** button is pressed. Use **Single** to conserve battery power or to allow you to save or analyze specific data.

How to set Single or Continuous

- Press **Sweep 3**
- Then choose one of the following:
  - **Single** Automatically sets Continuous OFF and causes the FieldFox to query the USB Power Sensor ONCE, then hold for the next Single key press. Hold is annotated in the upper left corner of the display.
  - **Continuous OFF ON** Queries the USB Power Sensor whenever a valid trigger signal is present. This is the typical setting when battery power is not critical.

You can also use **Run / Hold +/-** to toggle between Single and Continuous.

Resolution

Resolution is the number of individual acquisitions that occur in the USB Power Sensor. This data is read by the FieldFox and plotted across the X-axis to form a trace. More data points increases measurement resolution. However, more data points requires more time to acquire, query, and plot.

How to set Resolution

- Press **Sweep 3**
- Then **Resolution**
- Then choose from the following:
  - **Low** 240 data points.
  - **Medium** 1000 data points.
  - **High** Calculated value - approximately 8000 data points.

Triggering

For pulse measurements, a trigger signal refers to the event that causes the USB Peak Power Sensor to initiate measurement acquisition. It does NOT refer to triggering the FieldFox.

Trigger settings can be used with ALL pulse measurements unless stated otherwise.

A **Waiting for Trigger** message on the FieldFox screen is posted on behalf of the USB Power Sensor when it is waiting for a pulse signal at the RF Input (Internal) or a TTL signal at the USB Sensor External Trigger input.

How to make Trigger settings

- Press **Sweep 3**
- Then **Trigger**
- Then **Trig Type**
- Then choose from the following:
  - **Freerun** The USB Power Sensor acquires data without waiting for a trigger. This mode is NOT supported for Trace Graph measurements.
  - **Internal** The USB Power Sensor acquires data when a valid pulse signal is detected at the RF input. The following Trigger settings determine the validity of the trigger signal.
  - **External** The USB Power Sensor acquires data when a valid TTL signal is detected at the USB Power Sensor external trigger input.

Trigger Edge

This setting determines which edge of a trigger signal initiates data acquisition.

- Press **Sweep 3**
- Then **Trigger**
- Then **Trigger Edge**
- Then choose from the following:
  - **Pos** Acquisition is triggered by the rising (positive) edge of a valid signal.
  - **Neg** Acquisition is triggered by the falling (negative) edge of a valid signal.

Trigger Delay

After a valid trigger signal is received at the USB Power Sensor, data acquisition begins after the specified Trigger Delay time PLUS the specified Start time. See the Pulse Timing diagram in "Trigger Settings Annotation" on page 629 for more information.

- Press **Sweep 3**
- Then **Trigger**
- Then **Trigger Delay**

– Then enter a value using the numeric keypad, the ▲|▼ arrows, or the rotary knob.

Auto Trigger

Used ONLY when Trigger Type = Internal, this setting determines whether the trigger level is set manually or is set to the default level in the USB Power Sensor firmware.

– Press **Sweep 3**
– Then **Trigger**
– Then **Auto Trigger**
– Then choose from the following:
  – **ON** Trigger level is determined by the USB Power Sensor firmware.
  – **OFF** The trigger level is set manually using the Trigger Level setting.

Trigger Level

Used when Trigger Type = Internal AND Auto Trigger = OFF (Manual).

– Press **Sweep 3**
– Then **Trigger**
– Then **Trig Level**
– Then set the trigger level using the numeric keypad, the ▲|▼ arrows, or the rotary knob. A line appears on **Tr 1** at the current trigger level setting. Data acquisition occurs when the RF input signal crosses the line. This setting can be used with either Positive or Negative edge triggering.

Qualification

Use the qualification setting to avoid triggering on false pulses and to aid in stabilizing the power trace.

The qualification time defines the time the signal has to remain below the trigger threshold before a transition through the threshold will qualify as a trigger. This can help stabilize a power trace, particularly with digitally modulated pulses that may have many transitions through the trigger threshold. By setting the qualification time longer than the short transitions of the data signal the sensor will reliably trigger on the pulse and not on the data. It will also eliminate triggering on very short noise spikes when the trigger level has to be set to low power.

NOTE It may be may be necessary to set the qualification time to the minimum 20 ns in order to trigger on very short pulses.

– Press **Sweep 3**

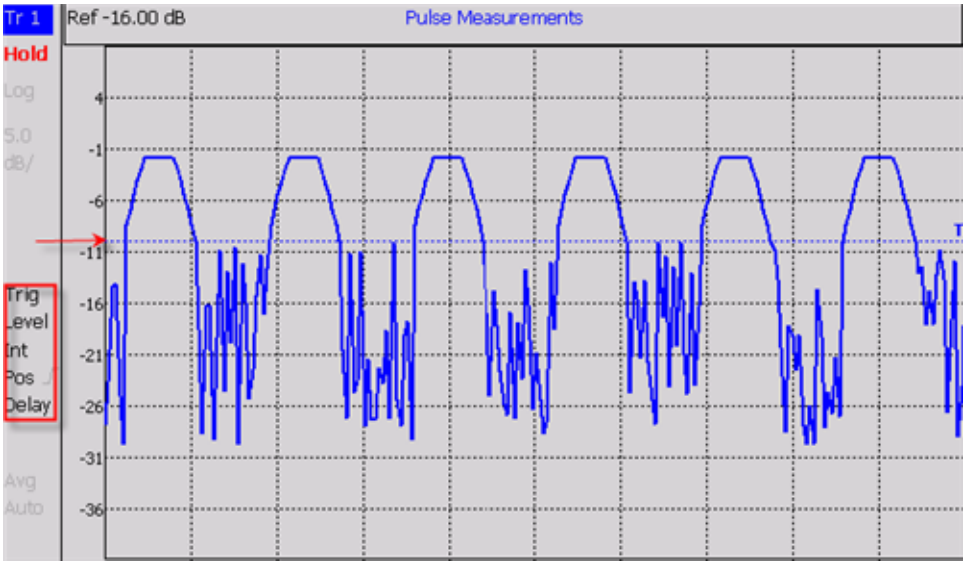
– Then **Trigger**

– Then **Qualification**

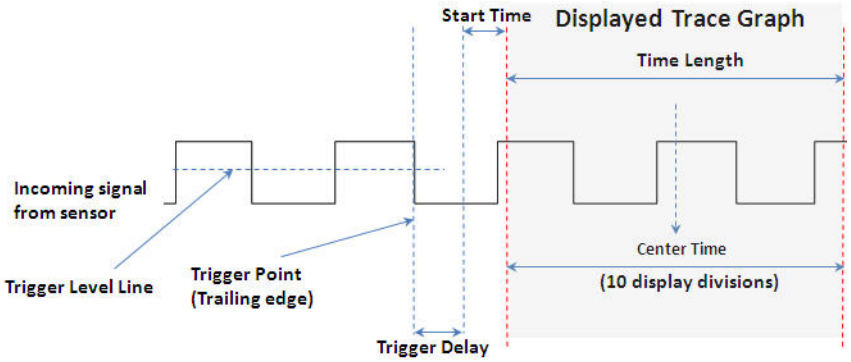
– Then set the qualification value using the numeric keypad or the rotary knob (default: 100 ns, minimum: 25 ns, maximum: 50 µs).

Trigger Settings Annotation

Trigger settings are annotated on the FieldFox screen as highlighted in **red** in the following image:



In the previous graphic, the settings are: Trig Level = -10 dBm, Trig Type (Int), Pos Slope (/), Delay



Marker Settings

Markers are not allowed with Meter-style measurements.

Markers are displayed on **Tr 1** and also on the zoom trace if the marker is within the zoom window time span.

Up to six standard markers can be used to provide readouts of the Y-axis amplitude at the current X-axis location.

The six standard markers can also be used as Delta Markers.

Learn more about standard markers in "All about Markers" on page 797.

Amplitude Markers

Amplitude markers are horizontal dotted lines that you can move to any amplitude level on the screen. The two amplitude markers can be set independently or used as a pair of delta markers.

Amplitude markers can be used as a visual comparison aid with the pulse measurement traces.

How to make Amplitude Marker settings

- Press **Marker**
- Then **More**
- Then **Ampl Markers**
- Then choose from the following:
  - **OFF** Amplitude markers are NOT displayed.
  - **ON** Amplitude markers ARE displayed at their previous positions.
- Then **Ampl Mkr 1 or 2**
- Enter a value in dBm for the marker using the numeric keypad, the ▲|▼ arrows, or the rotary knob.
- Press **Delta Ampl Mkr**
- Then choose from the following:
  - **ON** AmplMkr 2 value is relative to AmplMkr 1. When AmplMkr 1 is moved, AmplMkr 2 also moves to maintain the AmplMkr 2 value between them.
  - **OFF** The two amplitude markers move independent of one another.

Marker Search

Use Marker Search to find and move markers to locations on the **Tr 1** trace.

How to Search with Markers

- Activate the marker to be used for the search
- Then press **Mkr ->/Tools**.
- Then **Marker Search**

- Then **Zone Search**
- Then choose from the following:
  - **ON** Available ONLY when the zoom window is enabled, the search is limited to the zone defined by the zoom window.
  - **OFF** The search is performed over the entire Tr 1 trace.

Then choose from the following:

- **Target**, **Peak**, and **Minimum**. Learn more about these standard features beginning in "Searching with Markers" on page 803.
- **Rise Time** Select, then set a value in dB. Delta markers are created and placed at the Peak and at the specified value BEFORE the Peak.
- **Fall Time** Select, then set a value in dB. Delta markers are created and placed at the Peak and at the specified value AFTER the Peak.

NOTE Rise and Fall time in Marker Search uses different criteria than in Auto Analysis and will therefore result in different reported values.

Auto Analysis

Auto Analysis reports the following TEN pulse measurements:

NOTE For more information on peak power measurements refer to the documentation for your power sensor. Learn more, https://www.keysight.com/us/en/assets/7018-03076/application-notes/5990-8708.pdf.

1 - Average Power	Average power level of all measured data points
2 - Peak Power	Highest reading of all measured data points
3 - Peak minus Average	Difference between the above two results
4 - Pulse Top	Power value based on the specified Pulse Top setting.
5 - Rise Time	The time it takes for a pulse to rise from 10% to 90% of its peak value.

6 - Fall Time	The time it takes for a pulse to fall from 90% to 10% of its peak value.
7 - Pulse Width	The time between the rising edge and falling edge of a pulse.
8 - Pulse Period	The time of one complete pulse cycle
9 - Duty Cycle	The ratio of the pulse width / pulse period.
10 - Pulse Rep Freq	The rate, in pulses / sec, at which pulses recur.

How to enable Auto Analysis

- Press **Mkr ->/Tools**.
- Then **Auto Analysis**
- Then choose from the following:
  - **OFF** Analysis OFF
  - **ON** The Analysis values appear below trace 1.

Pulse Top

Pulse Top is NOT the same as the pulse Peak. Pulse Top is used to set and report the reference power level. You enter a value in percent, and the Pulse Top value is reported in the Auto Analysis table in dB down from 100% of the reference power level.

How to set Pulse Top

- Press **Mkr ->/Tools**
- Then **Pulse Top**
- Then enter a percent value between 0 and 100 using the numeric keypad, the ▲|▼ arrows, or the rotary knob.
  - When set to 10%, 10 dB down from the 100% acquisition is reported.
  - When set to 50%, 3 dB down from the 100% acquisition is reported.
  - When set to 90%, 0.5 dB down from the 100% acquisition is reported.

Grid

Enables and disables the display of a 10 x 10 grid on the FieldFox screen.

How to enable Grid display

- Press **Mkr ->/Tools**

– Then **Grid**
  – **OFF** Grid OFF
  – **ON** A grid of X/Y lines appears on the screen.

Trace Memory

A memory trace is a pulse measurement **Tr 1** data trace (NOT the trace in the Zoom window) that has been stored in the FieldFox volatile memory. It then becomes static, meaning it is not updated with normal pulse measurements. It can be displayed on the screen by itself, or with a pulse trace for comparison purposes.

The **Tr 1** data trace is displayed in **yellow**.

The memory trace is displayed in **blue**.

How to display data and memory traces

– Press **Trace 6**.
– Then **Trace Memory**
– Then **Data->Mem** to store the current live trace into memory. A 'beep' sounds to confirm the data trace has been saved to memory. There is no display annotation that indicates that the memory trace has been stored.
  – Press **Data** to view only the data trace.
  – Press **Memory** to view only the memory trace.
  – Press **Data & Memory** to view both the live trace and the stored memory trace.

25 Pulse Generator – Option 357

NOTE

Under certain conditions, Battery saver mode is not permitted when using Pulse Generator Option 357, because battery saver mode would interrupt the source output signal.

When using Pulse Generator Option 357 with the RF Output ON, normal periodic power saving maneuvers used by Battery Saver mode and Smart Power Management are disabled, to avoid interrupting the source output signal. Turning RF Output OFF will allow power management to resume normal operation.

Option 357 enables the RF signal generator output from port 1 to support pulse and analog (AM, FM) modulation. Source power level control to –90 dBm enables testing of receiver sensitivity. The pulse source supports 4 pulse types, continuous AM and FM, and the ability to create and generate pulse sequences. The FieldFox's Source Sync Trigger OUT, which is synchronized with the RF pulse output, can be input to an oscilloscope trigger input to provide triggering for very low level sensitivity measurements. Refer to "Pulse Generator Settings" on page 639.

Calibration of the source is required for accurate receiver sensitivity testing. Refer to "How to make Pulse Generator Measurements" on page 639, "How to do a Single Point Frequency Calibration" on page 661, and "How to do Cable Calibration Measurements" on page 658.

Full access to all features of Option 357 is available even without a Pulse Generator Calibration for power levels as low as -60 dBm. In this scenario, the cal indicators display "Default Power" on the screen. Refer to Figure 3 on page 637.

When the CW frequency is calibrated, the cal indicators display "Calibrated Power" on the screen. Refer to Figure 1 on page 636 for an example display. The power level can be set below -60 dBm when using the calibrated CW frequency.

If the CW frequency is not calibrated, the cal indicators display "Default Power" on the screen. When the power level is set to below -60 dBm at the non-calibrated CW frequency, the screen will show "THIS POWER NOT CALIBRATED". Refer to Figure 2 on page 636 for an example display. Calibration for the CW frequency is required for power levels below -60dBm. See "How to do a Single Point Frequency Calibration" (page 661).

Figure 1 CW = 10.1 GHz is Calibrated and Power Level Below -60 dBm

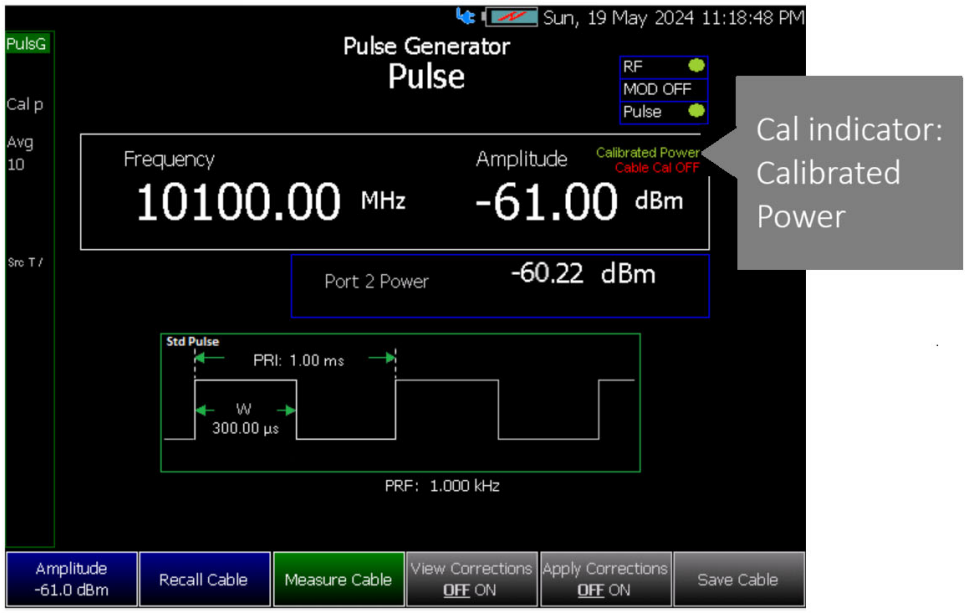


Figure 2 CW = 10 GHz Not Calibrated and Power Level Below -60 dBm

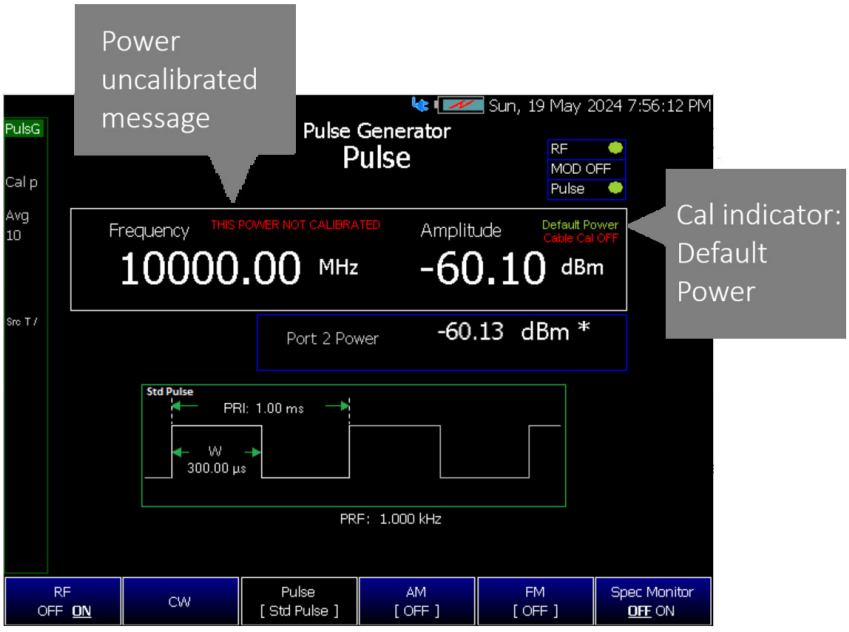
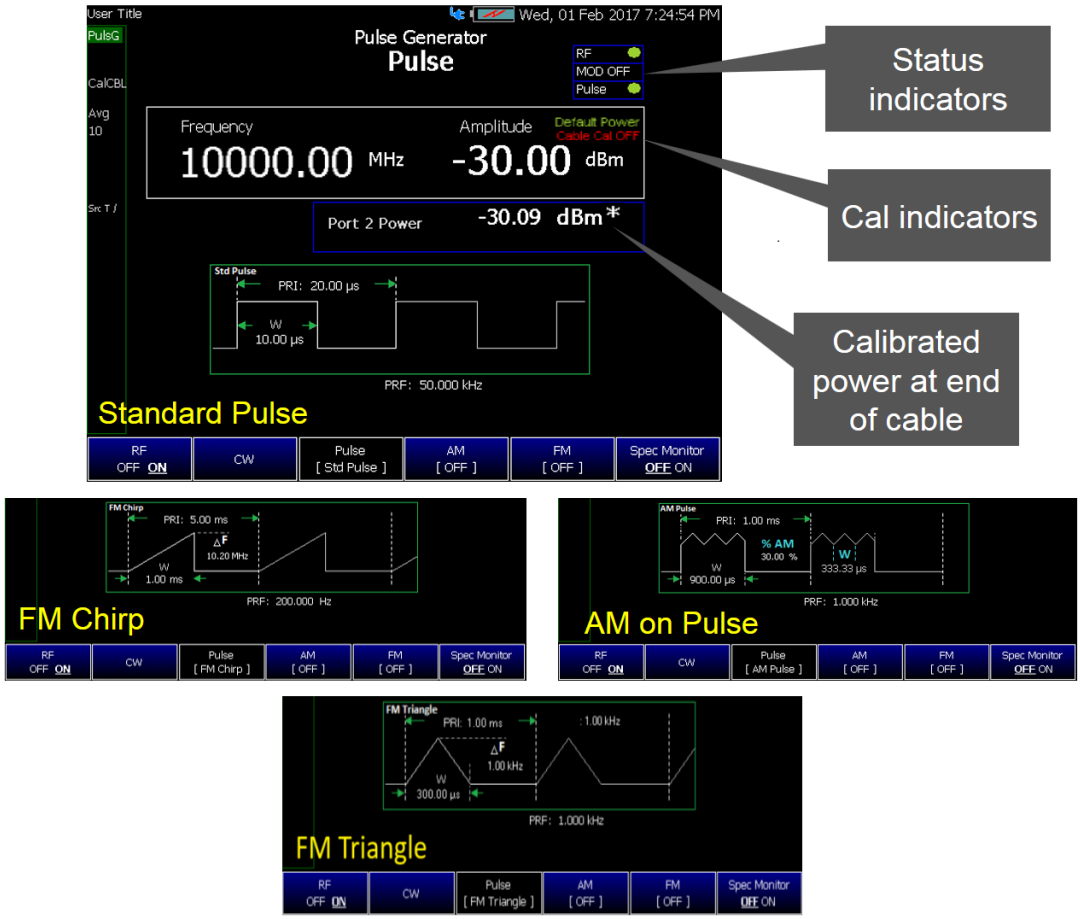


Figure 3 Pulse Generator Display and Annotation Overview



The graphic above shows an overview of the Pulse generator display with a sample of the pulse generation types.

NOTE

Some of the features included with the FieldFox Pulse Generator Mode are discussed in detail in the following documents:

Additional information:

For additional background on some of the features mentioned in this chapter, refer to the FieldFox User's Guide, https://www.keysight.com/se/en/assets/9921-01763/user-manuals/User-Guide-B-Series-N991xB-3xB-5xB-6xB-Unabridged.pdf

In this Chapter

"Pulse Generator Settings" on page 639

– "How to select Pulse Generator Mode" on page 639

– "How to make Pulse Generator Measurements" on page 639
– "How to Setup a pulse sequence table" on page 642
– "How to Set the Amplitude" on page 655
– "How to Set the Trigger Type" on page 655
"Making Calibration Measurements" on page 656
– "Using the Calibration Wizard, Recall Cal, and Amplitude Alignment Softkeys" on page 656
– "How to do Cable Calibration Measurements" on page 658
– "How to do a Single Point Frequency Calibration" on page 661
"FM Deviation Limits (Hz) – (N9953B and N9963B Shown—Other FieldFox Models are Similar)" on page 662

Pulse Generator Settings

Select Pulse Generator Mode before making any setting in this chapter.

A calibration is required, before using the pulse generator. Refer to the "Making Calibration Measurements" on page 656.

In this Section

– "How to select Pulse Generator Mode" on page 639
– "How to make Pulse Generator Measurements" on page 639
– "How to Setup a pulse sequence table" on page 642
– "How to Set the Amplitude" on page 655
– "How to Set the Trigger Type" on page 655

How to select Pulse Generator Mode

– Press **Mode**
– Then **More**, if your FieldFox contains more than five measurement modes.
– Then **More**, if your FieldFox contains more than ten measurement modes.
– Then **Pulse Generator**.

How to make Pulse Generator Measurements

See also, "Modifying Pulse Type Parameters" on page 641.

Before starting the following are recommended (refer to Figure 4 on page 640):

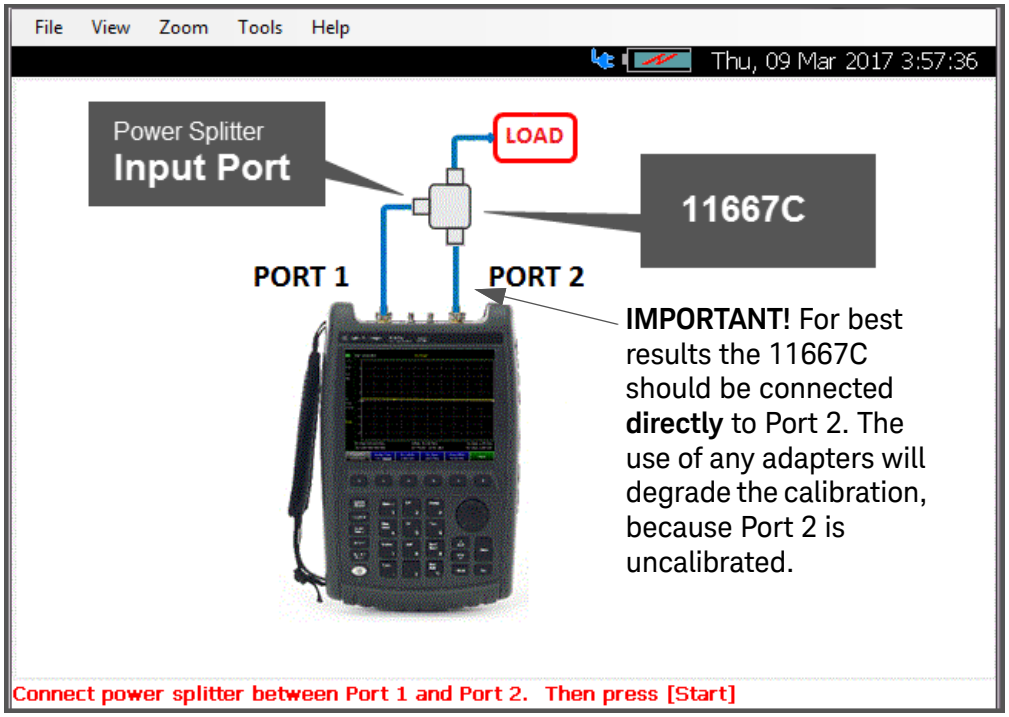
– Keysight 11667C 2-resistor power splitter connected to port 2

CAUTION

While an 11667A/B 2-resistor power splitter may be used in the calibration, they require an adapter on Port 2. Port 2 is uncorrected and adding an adapter will degrade the overall calibration results. Refer to Figure 4 on page 640.

– Short low loss jumper cable or adapter to connect port 1 to the input of the splitter
– Adapters (miscellaneous) as needed to connect the cables
– 50 ohm load to terminate the open splitter arm during calibration

Figure 4 Cal Wizard "Prepare for calibration..." and "Connect power splitter..." Screen



1. Press **Preset** then **Preset (Factory)** to return the FieldFox to the default settings.
2. Then **Mode**
   - Then **More**, if your FieldFox contains more than five measurement modes.
   - Then **More**, if your FieldFox contains more than ten measurement modes.
   - Then **Pulse Generator**.
3. Press **CW**
4. Leave the rest of the settings in their default values.
5. Press **Cal 5**
6. Then **Calibration Wizard**
7. Follow the Calibration Wizard prompts and then **Done**.
8. Disconnect any components or adapters that should not be measured and connect the DUT.

Modifying Pulse Type Parameters

The pulse generation method defaults to **CW** measurement on with **RF**, **MOD**ulation, **Pulse**, and SA measurement monitor (**Spec Monitor**) OFF.

– Press **Measure 1**

– Then choose from the following:

  – **RF OFF ON** Enables Port 1 RF source. Also, enables the RF source graphics and annotation. Default is RF OFF.

  – **CW** Continuous Wave (default). CW is disabled when a Pulse menu choice is enabled.

  – **Pulse** opens a menu of pulse softkey types.

    Then press one of the following:

    ––**Std Pulse** sets the pulse type to standard pulse.

    ––**FM Chirp** sets the pulse to type FM chirp.

NOTE

FM chirps cannot span across band crossings. Refer to "FM Deviation Limits (Hz) – (N9953B and N9963B Shown–Other FieldFox Models are Similar)" on page 662.

    ––**FM Triangle** sets the pulse type to FM triangle.

    ––**AM Pulse** sets the pulse type to AM pulse.

    ––**Sequence** enables you to input a list of different pulse types into a Pulse Sequence table. Refer to "How to Setup a pulse sequence table".

  – **AM** opens a menu of amplitude modulation types.

    Then press one of the following:

    ––**OFF** disable amplitude modulation.

    ––**AM Triangle** enables AM triangle modulation.

    ––**AM Sine** enables AM sine modulation.

  – **FM** opens a menu of continuous frequency modulation types.

    Then press one of the following:

    ––**OFF** disable frequency modulation.

    ––**Sawtooth** enables FM sawtooth modulation.

    ––**FM Triangle** enables FM triangle modulation.

    ––**FM Sine** enables FM sine modulation.

    ––**FSK** enables FM Frequency Shift Keying (FSK) modulation.

——**BPSK** enables FM Binary Phase Shift Keying (BPSK) modulation.

– **Spec Monitor** (default == OFF) enables the SA monitor that displays the pulse signal's RF signal source frequency and receiver offset.

How to Setup a pulse sequence table

This section will guide you through the creation of a pulse sequence table. The Sequence softkey menu enables you to choose different pulse types and to modify the pulse sequence behavior via the pulse sequence table. Some pulse sequence parameters are only available for editing for specific pulse types (e.g., Mod Width is only active for editing when AM Pulse is the selected Pulse Type).

This section contains the following:

– "Pulse Sequence Table Selection"
– "Sequence Table Set Up Example"

Pulse Sequence Table Selection

The section provides an overview of the Pulse Sequence table's softkey menus. Refer to Figure 5 on page 644 and Figure 6 on page 644.

– Press **Measure 1**
  – Then **Pulse**
  – Then **Sequence**
  – Then **Meas Setup 4** opens a menu of pulse sequence table softkeys:.
    ——**Pulse Sequence Table** and select one of the following:
    ——**Selection** then select one of the following:

On (default)	All rows are on in the sequence table and all will be continually played as a pulse train.
Continuous	The currently selected pulse plays continuously and all other pulses (rows) are off.
Off	Disables the current selected pulse.

  – **Optional**: When you move the ▲|▼ arrow keys or the knob, the **Edit** softkey is displayed in lieu of the **Selection** softkey:

    Edit enables editing of each of the currently selected pulse row's column parameters.

——**Next Page** moves the cursor to the top of the next page, if the table extends onto the next page or to the end of the current table, if table is on one page.

——**Next Up** moves the cursor to the top row of the previous page.

——**Add Row** adds a new pulse/row.

——**Delete/Clear** and select one of the following:

Delete Row	removes the currently selected pulse row from the sequence table. **IMPORTANT!** No opportunity to undo.
Clear All	opens a menu that enables you to clear/delete the sequence table. Then confirm the selection by: **Yes** to confirm delete. **No** to return to previous menu without deleting the sequence table's contents.
Back	cancels Delete/Clear and returns to the previous menu.

– Then **Freq /Dist** opens the frequency menu softkeys.

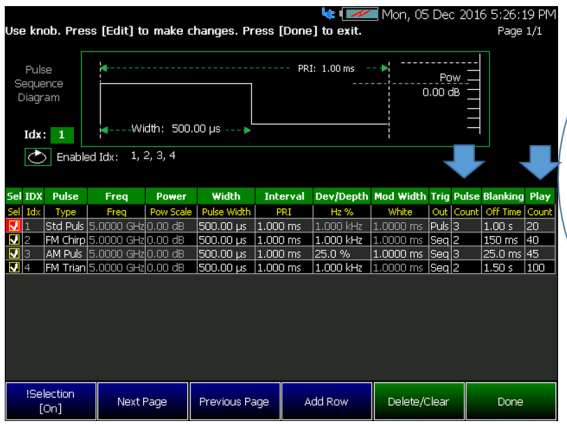
——Then choose **Freq** and use the ▲|▼ arrow keys or the knob to edit the frequency being measured on the display.

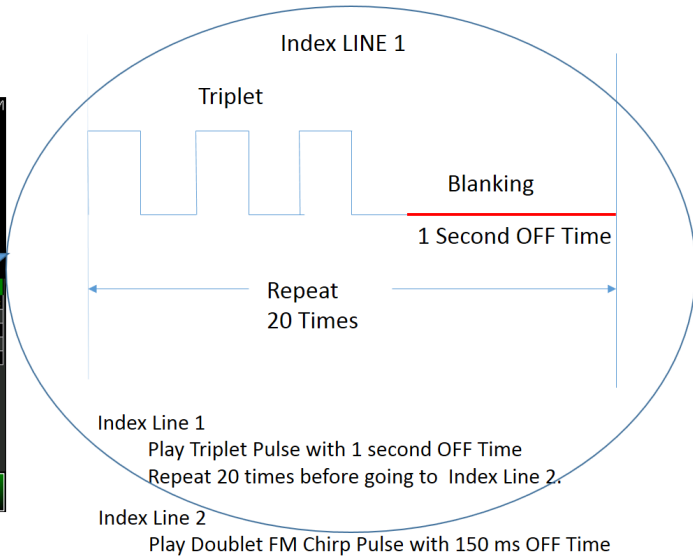
– Then **Scale/ Amptd** opens the amplitude menu softkeys.

——Then choose **Amplitude** and use the ▲|▼ arrow keys or the knob to edit the amplitude being measured on the display.

Figure 5 Pulse Sequence Table

Sequence Table
"Pulse Count" and "Play Count"

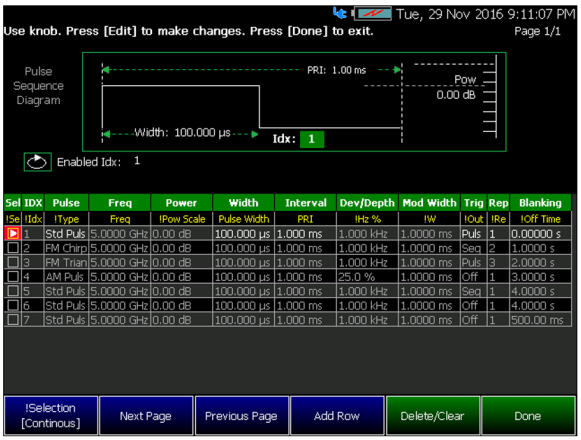




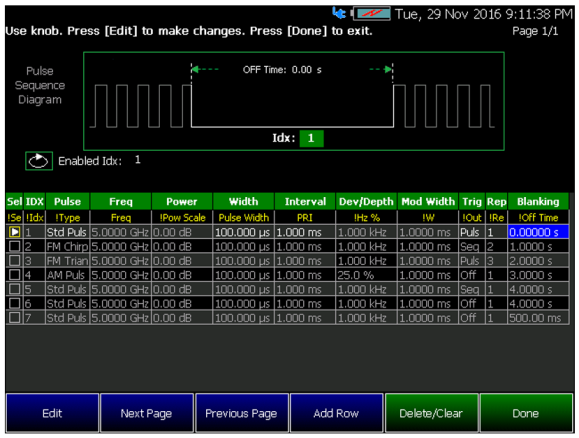
Index Line 1
Play Triplet Pulse with 1 second OFF Time
Repeat 20 times before going to Index Line 2.

Index Line 2
Play Doublet FM Chirp Pulse with 150 ms OFF Time
Repeat 40 times before going to Index Line 3.

Figure 6 Editing a Pulse Sequence Table



Define how this pulse will be played.
Continuous, OFF, or normal
Modify relevant pulse settings



- Edit trigger setting: Off, Per Pulse, Begin of Sequence
- Modify Pulse repetition count
- Modify Blanking/OFF Time time-interval.
- 0.0s is the same as NO blanking

Sequence Table Set Up Example

– Press **Measure 1**

– Then **Pulse**

– Then **Sequence**

– Then **Meas Setup 4** opens a menu of pulse sequence table softkeys.

––Then **Pulse Sequence Table**

––Then in the Pulse Sequence Table, use the ▲|▼ arrow keys or the knob to edit the Selection (**Sel**–disable/enable sequences to play), Pulse Type (**Type**–change the pulse type), **Pulse Width**, Interval (**PRI**), Dev/Depth (Hz %), Mod Width (**Width**), Trig (**Out**), Trig (**Delay**), Pulse (**Count**), Blanking (**Off Time**), and Play (**Count**).

––When you have finished editing the Pulse Sequence Table:

Then **Save Pulse List** (pulse sequence files can only be saved as *.xml files).

– Then **Freq /Dist** opens the frequency menu softkeys.

––Then choose **Freq** and use the ▲|▼ arrow keys, the knob, or the numeric keypad to set the frequency of the pulse sequence.

– Then **Scale/ Amptd** opens the amplitude menu softkeys.

––Then **Amplitude** use the ▲|▼ arrow keys, the knob, or the numeric keypad to set the power level of the output pulse sequence.

NOTE

To verify peak power level amplitude accuracy, after a test has been completed at the frequency of interest, select CW and read the Port 2 power.

Figure 7 Pulse train plays continuously with per pulse trigger out

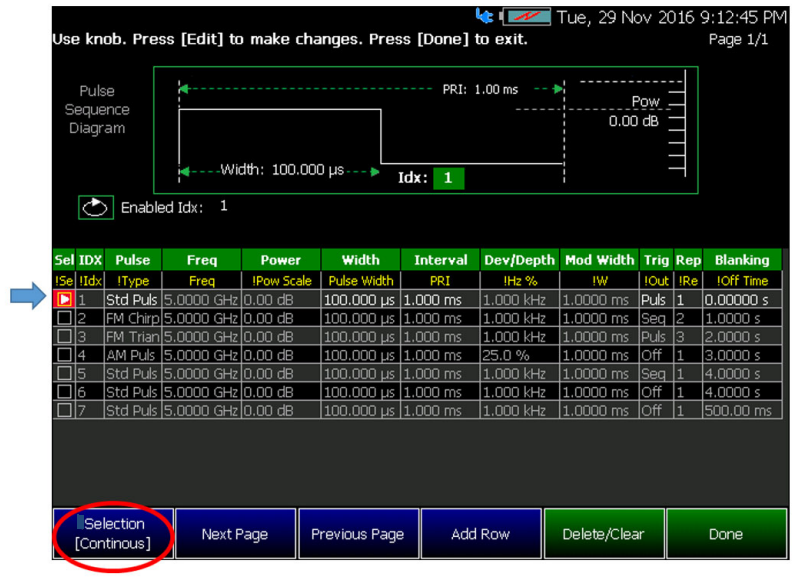


Figure 8 Chirped pulse plays continuously with trigger out every pulse

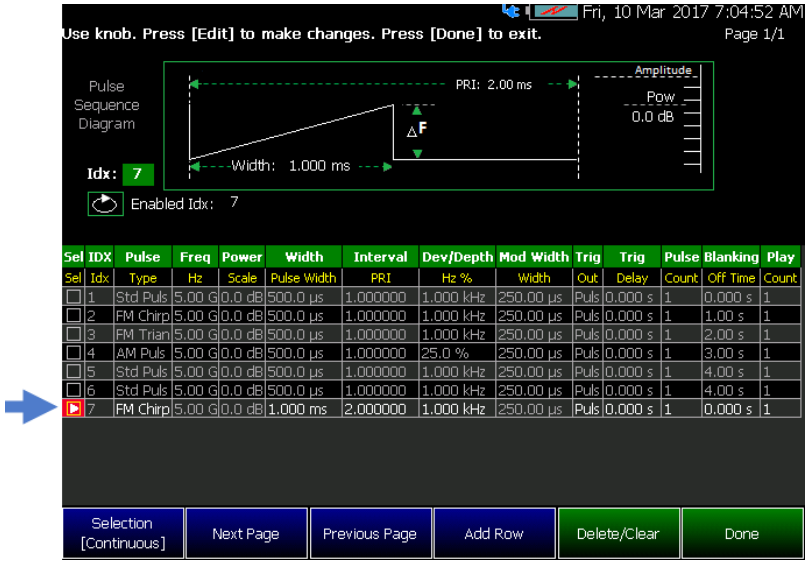


Figure 9 FM triangle doublet with 10.0 ms blanking (OFF time) continuously with trigger out every sequence

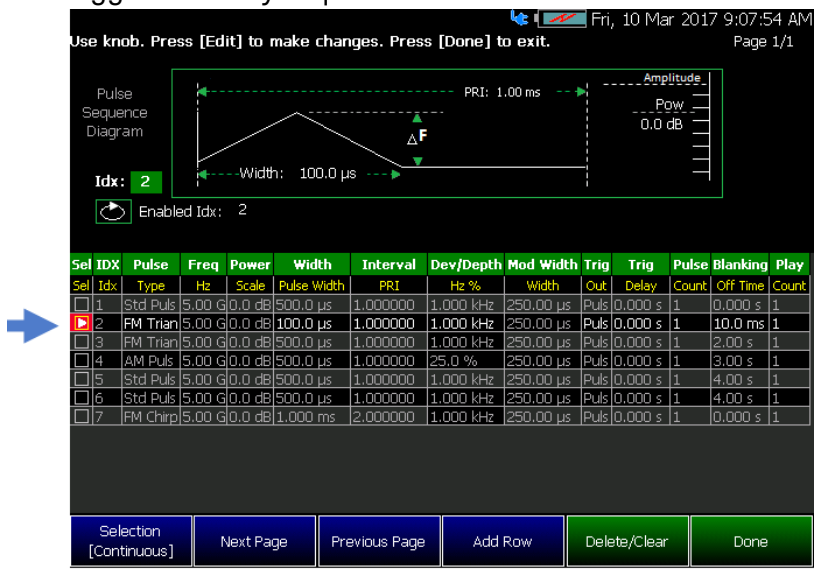


Figure 10 FM triangle doublet with 2.0 s blanking (OFF time) continuously with trigger out every pulse

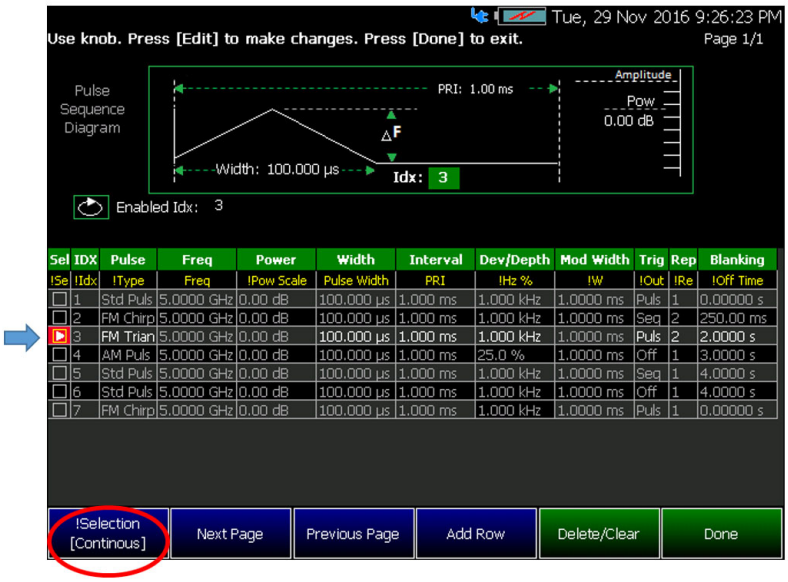


Figure 11 AM triplet with 3.5 s blanking (OFF time) plays continuously with trigger out OFF

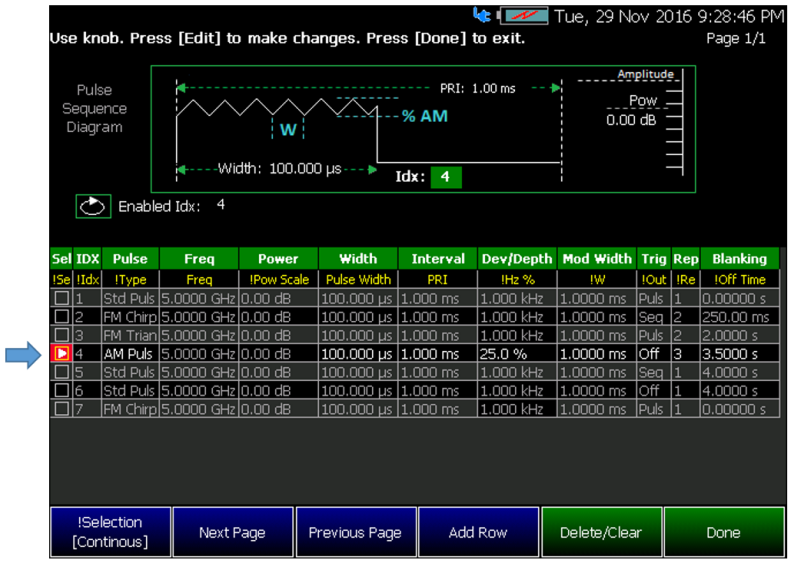
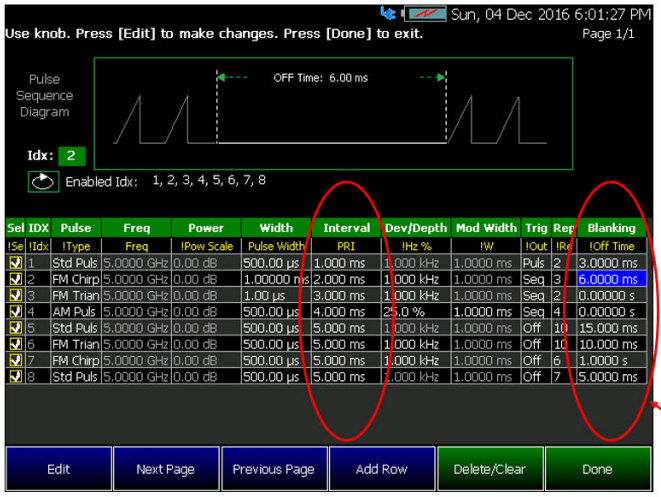


Figure 12 Pulse Sequence Blanking (OFF Time)

Pulse Sequence Blanking (OFF Time)

- GUI maintains valid blank time setting automatically



Example Sequence

Resolution Table for Example Sequence

Index	Blanking Resolution
1	+- .5 ms
2	+- 1 ms
3	+- 1.5 ms
4	+- 2.0 ms
5	+- 2.5 ms
6	+- 2.5 ms
7	+- 2.5 ms
8	+- 2.5 ms

- GUI restricted value
- Set and maintain the closest customer requested value
- GUI maintains integer multiple of the PRI interval OFF Time automatically

How to Set the Pulse Measurement Setup Parameters

This section provides details how to set up each type of Pulse Generator type.

NOTE **Measurement setup menu available softkeys depend on the selected pulse type.**

After selecting your pulse type, the measurement parameters need to be selected for your pulse measurement. Refer to “Pulse Generator Settings” on page 639.

This section contains the following topics:

– Selecting a pulse generator type:

  – “Measure Setup Settings for Pulse Generator Types” on page 648

– Selecting a modulation waveform (CW) type:

  – “Measurement Setup Settings Pulse Generator Modulation Waveform (CW) Types” on page 652

Measure Setup Settings for Pulse Generator Types

– Press **Meas Setup 4**

– Then choose from the following:

– **PRF** sets the pulse repetition frequency. Not available with AM pulse.

NOTE

The default duty cycle is 30%. Additionally, whenever a pulse width is changed to a value that is incompatible with the current pulse period setting, the pulse period is set to a 30% duty cycle with the new pulse width. Also, when a pulse period is changed to a value that is incompatible with the current pulse width, the pulse width is changed to give a 30% duty cycle with the new pulse period.

The duty cycle (on time) cannot be directly measured, but can be calculated via the following equation:

```
Duty cycle = [(Pulse width (seconds) * PRF (pulse repetition
frequency)) * 100]
```

– **PRI** sets the pulse repetition interval for the time from the start of one pulse to the start of the next pulse. The PRI must be at least 2.33 µs longer than the pulse width (e.g., if the pulse width = 1.000 µs, then the PRI must be 1.000 µs + 2.330 µs or 3.330 µs).

– **Pulse Width** sets the 50% pulse width (1.000 µs to 1.00s, default varies with pulse type selected). The minimum useful Pulse Width duration depends on the frequency setting, the FM deviation, and the pulse type.

For recommended setting limits, refer to FM Deviation softkey below. See also Table 12-1 on page 651 and “FM Deviation Limits (Hz) – (N9953B and N9963B Shown–Other FieldFox Models are Similar)” on page 662.

NOTE

The default duty cycle is 30%. Additionally, whenever a pulse width is changed to a value that is incompatible with the current pulse period setting, the pulse period is set to a 30% duty cycle with the new pulse width. Also, when a pulse period is changed to a value that is incompatible with the current pulse width, the pulse width is changed to give a 30% duty cycle with the new pulse period.

A pulse’s duty cycle cannot be directly measured, but can be calculated via the following equation:

```
Duty cycle = [(Pulse width (seconds) * PRF (pulse
repetition frequency)) * 100]
```

– **Mod Width** sets the modulation width (50.000 µs to 10s, default is 250.000 µs). Only available with AM pulse. Modulation width is coupled to other pulse settings (e.g., Frequency). See also Table 12-1 on page 651.

– **Depth** sets the AM depth (0.000 to 100.0%, default is 25.00%. Only available with AM pulse.

– **FM Deviation** sets the FM deviation. Refer to Table 12-1 on page 651. See also, Pulse Width softkey description above and "FM Deviation Limits (Hz) – (N9953B and N9963B Shown–Other FieldFox Models are Similar)" on page 662, and to Table 1 on page 663.

NOTE

You are able to set the FM deviation to a particular maximum value for the current coupled settings (e.g., pulse type, carrier frequency), if your FM deviation is set too high for the pulse width, pulse type, or other settings, the FieldFox displays an error message similar to the example below.

Example:

```
FM Deviation request exceeds 1% FM overrange @5000 MHz band
crossing.
```

– **Trig Delay** sets the trigger delay. (Calculated by `(-1 x the PRI to +1 x the PRI)`, default is 0.000 s).

NOTE

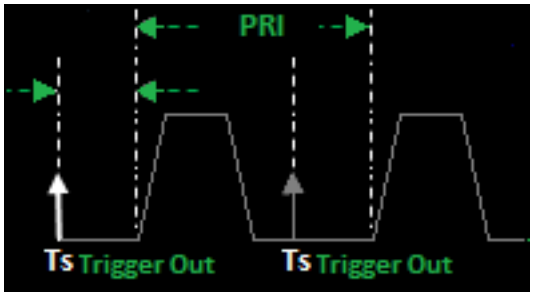
Trigger delay can be positive or negative. The magnitude of trigger delay cannot exceed the PRI (pulse repetition interval).
Examples:

PRI = 1.00 ms

Trigger delay can be set anywhere from -1.00 ms to +1.00 ms for a PRI setting of 1.00 ms.

PRI = 3.5 ms

Trigger delay can be set anywhere from -3.5 ms to +3.5 ms for a PRI setting of 3.5 ms.
Ts = Start time



– **Export Pulse to Sequence** Exports the current pulse to the last pulse sequence table in memory and displays "Pulse sequence list updated". Refer to "How to Setup a pulse sequence table" on page 642.

Table 12-1 Recommended Modulation Limits[a]

Type of Signal (Pulsed or Non-Pulsed)	Maximum FM Deviation	Maximum FM Rate	Minimum Pulse Width	Minimum Modulation Width	Maximum AM Rate	Maximum AM Depth	Minimum Time Interval
Pulsed							
AM Pulse	--	--	50 µs	50 µs	--	75%	--
FM Chirp / FM Triangle	10 MHz	--	1 ms	--	--	--	--
	1 MHz	--	500 µs	--	--	--	--
	100 kHz	--	250 µs	--	--	--	--
	≤10 kHz	--	100 µs	--	--	--	--
Non-Pulsed							
AM Triangle / AM Sine	--	--	--	--	20 kHz	75%	--
FM Triangle / FM Sine	10 MHz	1 kHz	--	--	--	--	--
	1 MHz	2 kHz	--	--	--	--	--
	100 kHz	4 kHz	--	--	--	--	--
	≤10 kHz	10 kHz	--	--	--	--	--
FM Sawtooth	≤100 kHz	10 kHz	--	--	--	--	--
FSK	≤100 kHz	--	--	--	--	--	100 µs
BPSK	--	--	--	--	--	--	100 ns

a. Measurement quality may be impacted, if the recommended modulation values are exceeded.

Measurement Setup Settings Pulse Generator Modulation Waveform (CW) Types

– Press **Meas Setup 4**

– If **AM Triangle** or **AM Sine** –

Then choose from the following:

– **AM Rate** sets the AM rate. (0 to 50 kHz, default is 1 kHz)

NOTE

While you are able to set the AM Rate up to 50 kHz. The maximum recommended value is 15 kHz. Setting AM Rate to greater than 15 kHz may degrade your measurements.

– **AM Depth** sets the AM depth (0 to 100%, default is 25%)

– If **FM Sine** or **FM Triangle** or **Sawtooth** –

Then choose from the following:

– **FM Rate** sets the FM rate. (0 to 50 kHz, default is 1 kHz). For the recommended maximum frequency rates, refer to Table 12-1 on page 651.

– **FM Deviation** sets the FM modulation positive or negative deviation or total deviation. The highest and lowest frequencies must be within the same frequency band. Refer to Table 12-1 on page 651 and to “FM Deviation Limits (Hz) – (N9953B and N9963B Shown–Other FieldFox Models are Similar)” on page 662, and to Table 1 on page 663. (default is 1kHz)

– If **BPSK** –

Then choose from the following:

– **Time Interval1** sets the time duration of the first phase (1ns to 1s, default == 1ms).

– **Time Interval2** sets the time duration of the second phase (1ns to 1s, default == 1ms) which is shifted by 180 deg from the first phase.

– If **FSK** –

Then choose from the following:

– **Freq Index** press to toggle between 1, 2, 3 and 4 to edit each frequency tone.

– **Enable** default == OFF except Freq Index == 1.

––**ON** enables the selected frequency tone.

––**OFF** disables the selected frequency tone.

– **Deviation** set the frequency deviation of the selected frequency tone.

– **Time Interval** set the time duration of the selected frequency tone.

NOTE

Freq Index == 1 represents the CW, therefore Enable is fixed to ON and Deviation is fixed at 0 Hz with no option for adjustment.

The following is an example showing 3-Tone FSK: F1 = 5GHz, F2 = 5GHz + 1kHz, F3 = 5GHz - 1kHz, and each frequency tone is activated for 1ms. Below are the corresponding entries:

– Sets CW frequency to 5 GHz in Pulse Generator mode.

—— Press **Mode** > **More** > **More** > **Pulse Generator**

—— Press **Freq/Dist**

—— Press **Freq** then enter 5GHz

– Sets the FSK parameters for a frequency tone, Deviation and Time Interval.

—— Press **Measure 1** > **FM** > **FSK**

—— Press **Meas Setup 4**

—— Press **Freq Index** to toggle 1 to set frequency tone F1

—— Press **Time Interval** then enter 1ms

Figure 13 Meas Setup FSK setting for frequency tone F1 example

—— Press **Freq Index** to toggle 2 to set frequency tone F2

—— Press **Enable** to toggle ON

—— Press **Deviation** then enter 1kHz

—— Press **Time Interval** then enter 1ms

Figure 14 Meas Setup FSK setting for frequency tone F2 example

—— Press **Freq Index** to toggle 3 to set frequency tone F3

—— Press **Enable** to toggle ON

—— Press **Deviation** then enter -1kHz

—— Press **Time Interval** then enter 1ms

Figure 15 Meas Setup FSK setting for frequency tone F3 example

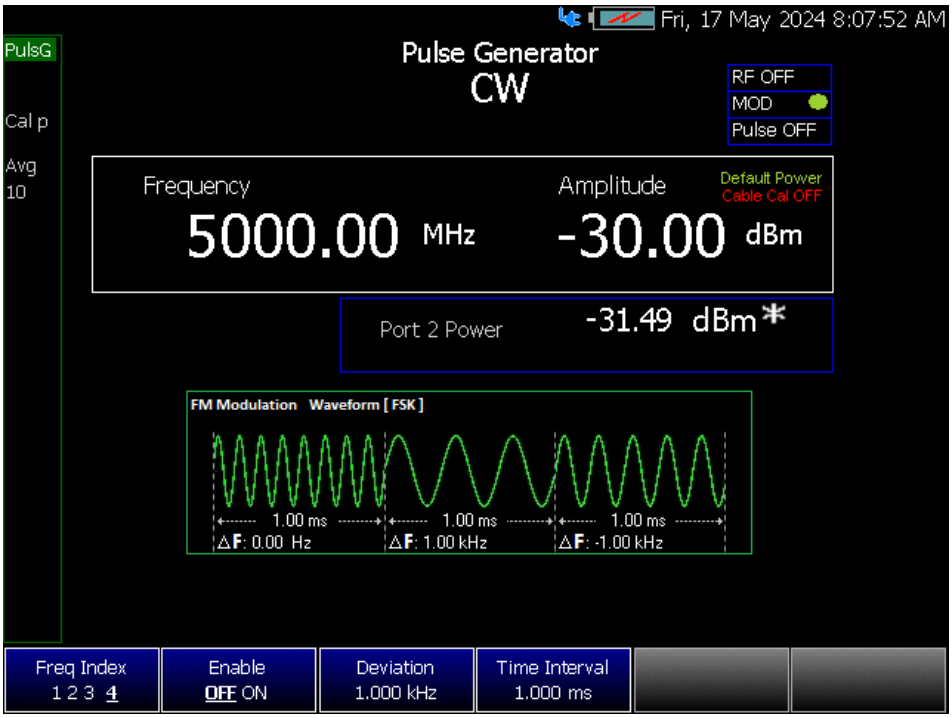
—— Press **Freq Index** to toggle 4 to disable the frequency tone

—— Press **Enable** to toggle OFF

Figure 16 Meas Setup FSK setting to disable frequency tone for Freq Index == 4

– The graphic below shows the corresponding FSK entries sample above (the waveform is not to scale).

Figure 17 The graphic corresponding to 3-Tone FSK sample



How to Set the Amplitude

How to set Amplitude

Press **Scale / Amptd**. Then choose from the following:

– **Amplitude** sets the RF port power from -110 dBm to 10 dBm. (default is –30 dBm)

How to Set the Trigger Type

Freerun/RefOut and SSync/TrigOut Video allows you to select a trigger type.

Use the **Sweep 3** hardkey to access the trigger type softkey.

– **Trig Type [Freerun/RefOut]** default is Freerun/RefOut.

  – **Freerun/RefOut** sets the trigger to freerun. (This is the default setting when the RF is OFF. No signal is output at **Ref/Trig Output** SMB.)

  – **SSync/TrigOut** uses the FieldFox's side panel **Ref/Trig Output** SMB connector to output a trigger synchronized with the start of a RF pulse output or the falling edge of a pulse.

    Pulse sequences can have positive or negative delay.

    This trigger output can be input to a scope trigger input to provide triggering for very low level sensitivity measurements. (This is the default setting when the RF is ON.)

Making Calibration Measurements

Use this procedure to calibrate and store source, test cable, and single point calibrations in the FieldFox. Refer to Figure 20 on page 660 and Figure 21 on page 660.

In this Section

– "Using the Calibration Wizard, Recall Cal, and Amplitude Alignment Softkeys" on page 656
– "How to do Cable Calibration Measurements" on page 658
– "How to do a Single Point Frequency Calibration" on page 661

Using the Calibration Wizard, Recall Cal, and Amplitude Alignment Softkeys

– Press **Cal 5**

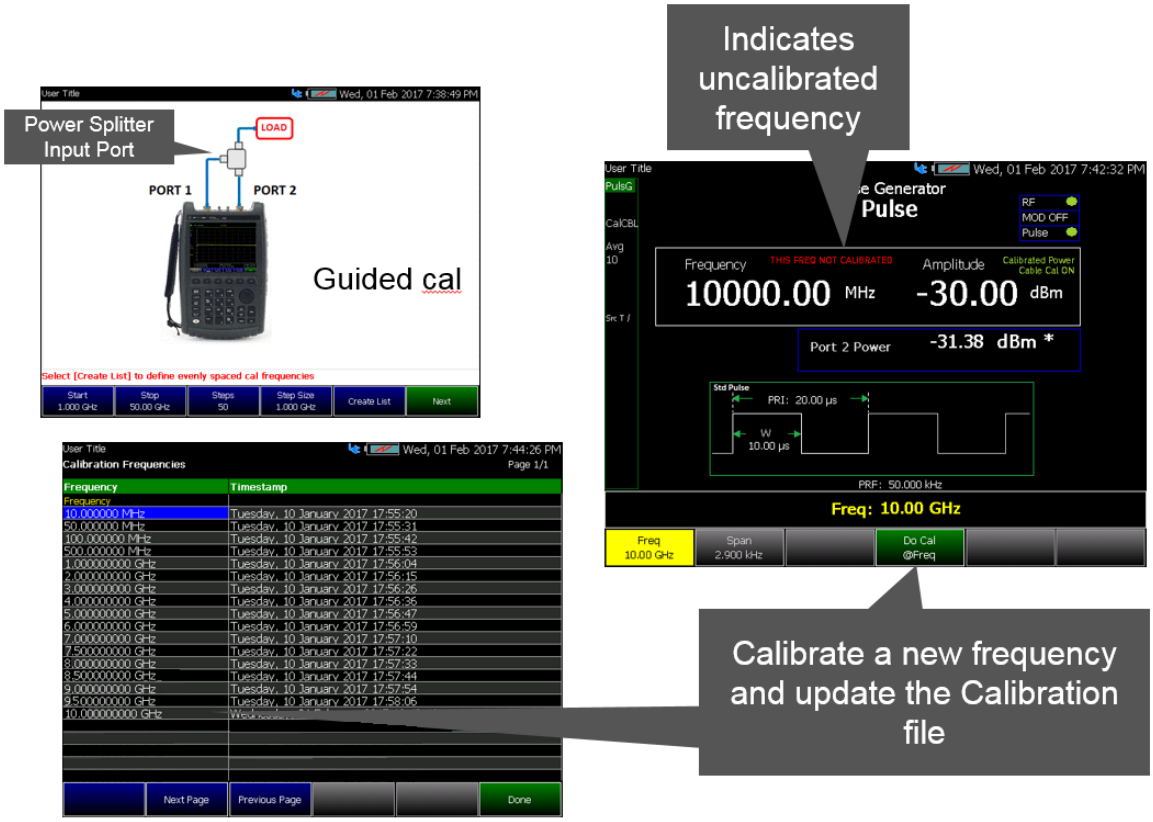
Then choose from the following

Calibration Wizard Softkey

Calibration Wizard takes you to the Calibration Wizard softkey menu, where you are guided through a source calibration with a power splitter, cables, and 50 ohm load that are connected from Port 1 to Port 2.

Follow the Calibration Wizard prompts.

Figure 18 Calibration Wizard: Pulse Generator Source Calibration



Recall Calibration Softkeys

- **Recall Cal** if a calibration has been previously stored in the current memory location, this menu enables you to recall a previously stored calibration file.
- **View Cal** if a calibration has been previously performed, this screen displays a table of the current calibration values for each frequency point and the time stamp for each calibrated frequency point.

Amplitude Alignment Softkeys

This is the same as **InstAlign** which operates in SA mode, to correct for Receiver drift over temperature and time. SA measurement applications monitor changes in internal temperature to trigger the need for an update to this alignment. After 1 degree C of temperature change, or 25 minutes, an alignment is deemed stale requiring an update. Until the update is performed, annotation indicating “questionable amplitude” is displayed AMPTD?. The alignment requires use of the internal source, which thus interrupts the integrity of the Pulse Generator’s RF Output. For more, refer to the FieldFox’s

User's Guide:
https://www.keysight.com/se/en/assets/9921-01763/user-manuals/Users-Guide-B-Series-N991xB-3xB-5xB-6xB-Unabridged.pdf.

NOTE

IMPORTANT! Pulse Generator mode handles the Amptd? condition differently than SA Mode. Setting the Amplitude Alignment may not correct the Amptd? condition, unless the RF is OFF or when changing frequencies.

- Press **Cal 5**
- Then **Amptd Alignment**
- Then choose from the following:
  - **Auto** (Default setting) Alignments are performed automatically when necessary at times when interrupting the users RF Output are deemed acceptable. In the Pulse Generator application, these times are restricted to either when the RF Output is OFF, or when the RF Source carrier frequency changes. If a needed alignment cannot be performed, the user is notified about questionable amplitude AMPTD?.
  - **OFF** Alignments are not performed. The most recent alignment result is cleared. Only factory corrections are applied to SA Receiver measurements. Questionable amplitude AMPTD? is always displayed.
  - **Hold** The alignment process is stopped, but the last alignment values are applied to subsequent sweeps.
- **Amptd Align Now** An alignment is performed immediately, thus updating (clearing) any questionable amplitude status. If the Mode was previously Off, it is changed to Hold.

Amptd? is annotated in the lower left corner of the FieldFox screen when amplitude alignment is questionable (because of time/temperature) and this setting is in Hold or OFF.

How to do Cable Calibration Measurements

Use this procedure to calibrate and store a test cable in the FieldFox. Refer to Figure 19 on page 659, Figure 21 on page 660, Figure 21 on page 660, and to "Using the Independent Marker" on page 660.

- Press **Scale / Amptd**
- **Recall Cable** recalls existing cable calibration corrections from the current memory location selected (i.e., FieldFox Internal, SD Card, or USB stick).
- **Measure Cable** takes you to a Cable Loss Measurement Wizard, where you can calibrate a cable connected from Port 1 to Port 2.

Follow the Cable Loss Measurement Wizard prompts. Refer to Figure 19 on page 659.

– **View Corrections** toggles a display on/off that enables you to view your cable's loss.

– **Apply Corrections** applies the current cable corrections in memory. **Cable Cal ON** annotation is displayed.

– **Save Cable** opens the Create Filename display where you can name your file and saves the current cable being measured to the memory location selected (i.e., FieldFox Internal, SD Card, or USB stick). **Cable Cal ON** annotation is displayed. Refer to Figure 20.

Figure 19 Calibration Wizard: Pulse Generator Cable Loss Calibration

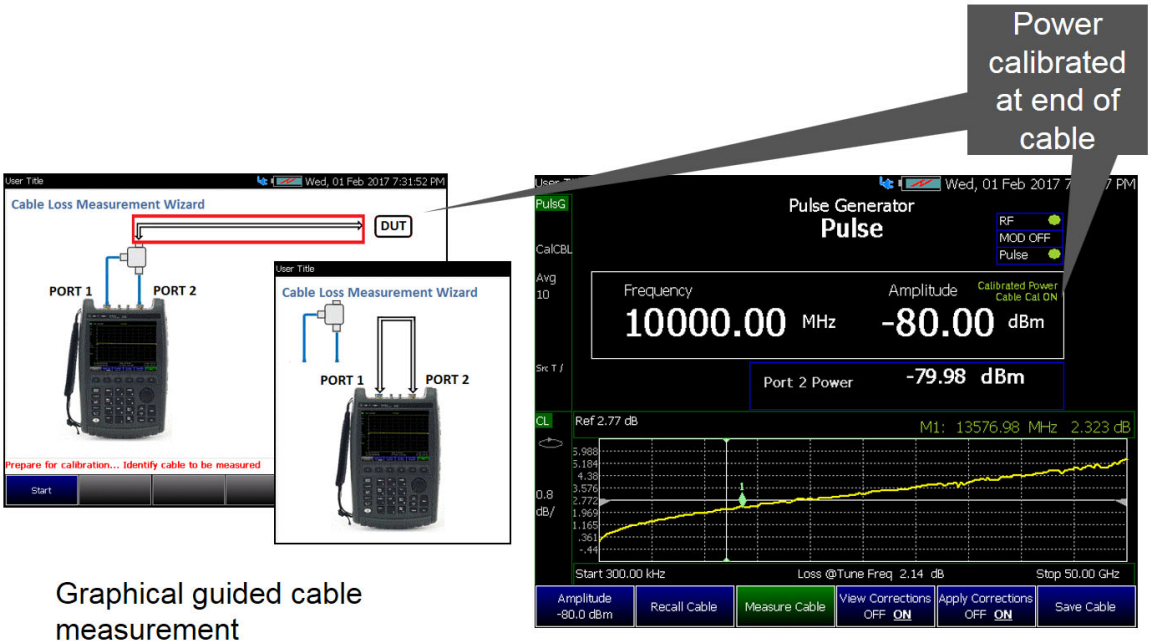


Figure 20 Cable Calibration Annotation

Cal File Loaded

Green “Calibrated Power” Text

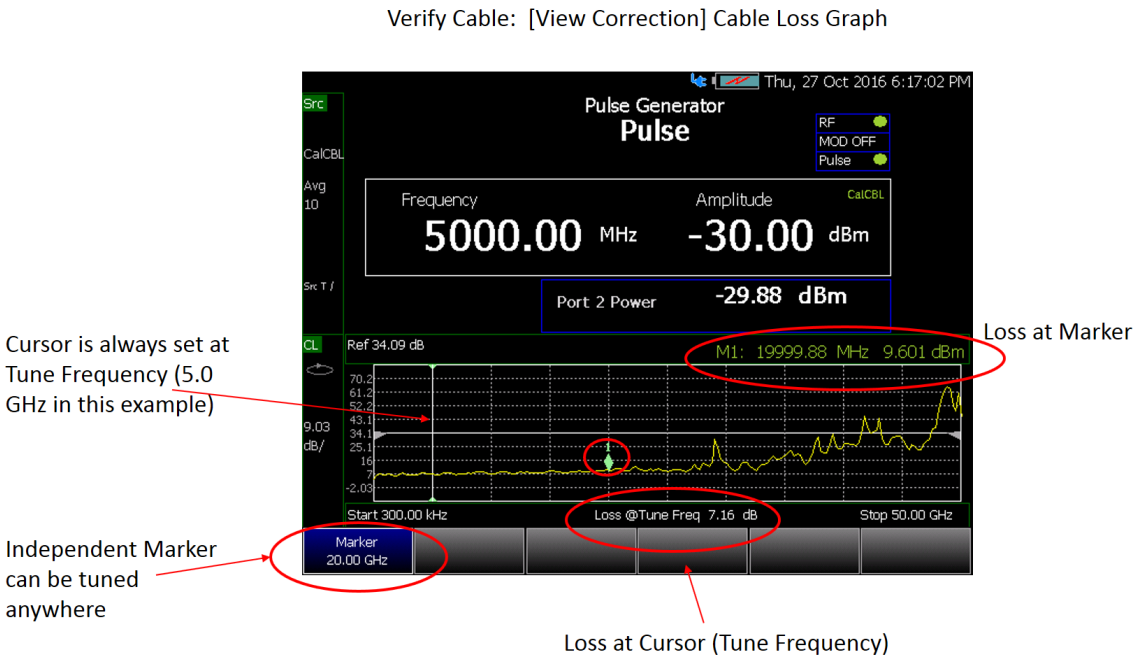
Cable Calibration is OFF --- Red Text

Cal File Loaded

Green “Calibrated Power” Text

Cable Calibration is ON --- Green Text

Figure 21 Verify Cable: [View Correction] Cable Loss Graph



Using the Independent Marker

Use the FieldFox independent marker to measure the loss along the displayed cable trace.

– Press **Marker** and use the ▲|▼ arrow keys, or knob to adjust the marker along the trace.

How to do a Single Point Frequency Calibration

After setting up your Frequency.

- Press **Freq/Dist**
- Then choose from the following:
  - Press **Do Cal @Freq** to do a single frequency point calibration
  - Follow the Calibration Wizard prompts.

FM Deviation Limits (Hz) – (N9953B and N9963B Shown–Other FieldFox Models are Similar)

NOTE Table 1 on page 663 shows the frequency values for N9953B and N9963B, other FieldFox models are similar, but the applicable frequency range varies.

Using FM Deviation Limits–Examples

- For 10 GHz tune frequency, customer may select positive FM deviation of +100 MHz (1%) above the band switch frequency at 10 GHz.
- For a 5 GHz tune frequency, you can select negative FM deviation of –2.525 GHz, since the lowest frequency for the band is 2.5 GHz, and the FM deviation limit is 1% below that value, or 2.475 GHz, giving a total deviation of 2.475 GHz - 5 GHz = –2.525 GHz.
- For mid band tune frequency at 7.5 GHz, customer can select anything up to +2.6 GHz / –2.55 GHz FM deviation.

Pulse Generator – Option 357
FM Deviation Limits (Hz) – (N9953B and N9963B Shown—Other FieldFox Models are Similar)

Table 1 Frequency Bands FM Deviation Limits

Tune Frequency (Hz)	FM Lower Limit	FM Upper Limit	Worst Case Available % Deviation From Tune Frequency	N, Number Use For Maximum Deviation Setting
1,870,001 - 3,735,300	1,851,301	3,772,653	1	1
3,735,301 - 7,470,700	3,697,948	7,545,407	1	2
7,470,701 - 14,920,000	7,395,994	15,069,200	1	4
14,920,001 - 29,882,800	14,770,801	30,181,628	1	8
29,882,801 - 59,375,600	29,583,973	59,969,356	1	16
59,375,601 - 119,141,200	58,781,845	120,332,612	1	32
119,141,201 - 238,672,500	117,949,789	241,059,225	1	64
238,672,501 - 477,735,000	236,285,776	482,512,350	1	128
477,735,001 - 955,860,000	472,957,651	965,418,600	1	256
955,860,001 - 1,912,110,000	946,301,401	1,931,231,100	1	512
1,912,110,001 - 3,824,610,000	1,892,988,901	3,862,856,100	1	1024
3,824,610,001 - 5,999,610,000	3,786,363,901	6,059,606,100	1	2048
5,999,610,001 - 15,299,610,000	5,939,613,901	15,452,606,100	1	4096
15,299,610,001 - 26,500,610,000	15,146,613,901	26,765,616,100	1	8192
26,500,610,001 - 45,899,610,000	26,235,603,901	46,358,606,100	1	2048
45,899,610,001 - 79,502,610,000	45,440,613,901	80,297,636,100	1	4096

Maximum Settable FM Deviation

For each FM type, whether it's Pulse or Non-Pulse excluding BPSK, there exists a maximum deviation setting. This setting relies on the FM rate and a value called 'N', which you can locate in the Table 1, "Frequency Bands FM Deviation Limits", on page 663.

Table 2 Frequency Modulation

Modulation Type	Maximum Deviation at 1 kHz FM Rate	FM Rate
FM Sawtooth	N x 25 kHz	
FM Triangle	N x 393 kHz	
FM Sine	N x 196 kHz	
FSK	N x 25 kHz	1 / Time interval
Pulse FM Triangle	N x 393 kHz	1 / Pulse width
Pulse FM Chirp	N x 20 kHz	1 / Pulse width

NOTE

Maximum Deviation x FM Rate = constant

The following examples demonstrate how to determine the maximum deviation at specific CW frequency using the number N and FM rate.

Example 1: For FM == Sawtooth, N == 4, and FM rate == 1 kHz. maximum deviation at 1 kHz FM rate = N x 25 kHz, yielding a maximum deviation (1 kHz) of 100 kHz.

Example 2: With the same parameters as example 1 but an FM rate == 10 kHz, the principle of maximum deviation x FM rate = constant is applied. Therefore, the maximum deviation at 10 kHz FM rate = (N x 25 kHz) / 10, yielding a maximum deviation (10 kHz) of 10 kHz.

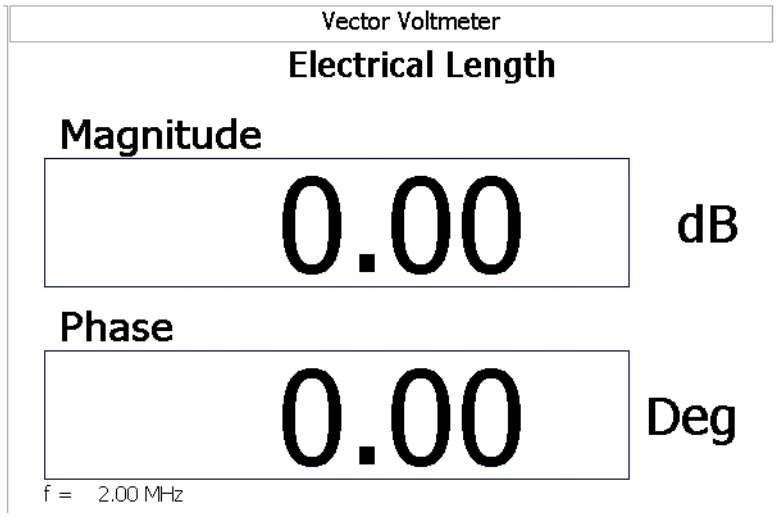
To optimal modulation performance and adherence to frequency standards can be achieved by ensuring below FM deviation setting:

- Must not cross more than 1% of Frequency Bands in Table 1, "Frequency Bands FM Deviation Limits", on page 663.
- Must not be greater than the Maximum Settable FM deviation for a given FM rate in Table 2, "Frequency Modulation", on page 664.

26 VVM (Vector Voltmeter) Mode - Option 308

VVM Mode (Option 308) measures the electrical length of cables and other devices. The 1-Port Cable Trimming and 2-Port Transmission measurement displays the electrical length in both Magnitude and Phase.

Figure 26-1 Display for the 1-Port Cable Trimming measurement



In this Chapter

"Overview" on page 667
"Measurement Selection" on page 668
"Frequency Selection" on page 668
"Display Resolution" on page 668
"IF Bandwidth" on page 669
"Output Power" on page 669
"Averaging" on page 670
"Single or Continuous Measure" on page 671
"VVM Calibration" on page 671
"Zeroing" on page 671

Procedures

"1-Port Cable Trimming Measurements " on page 673

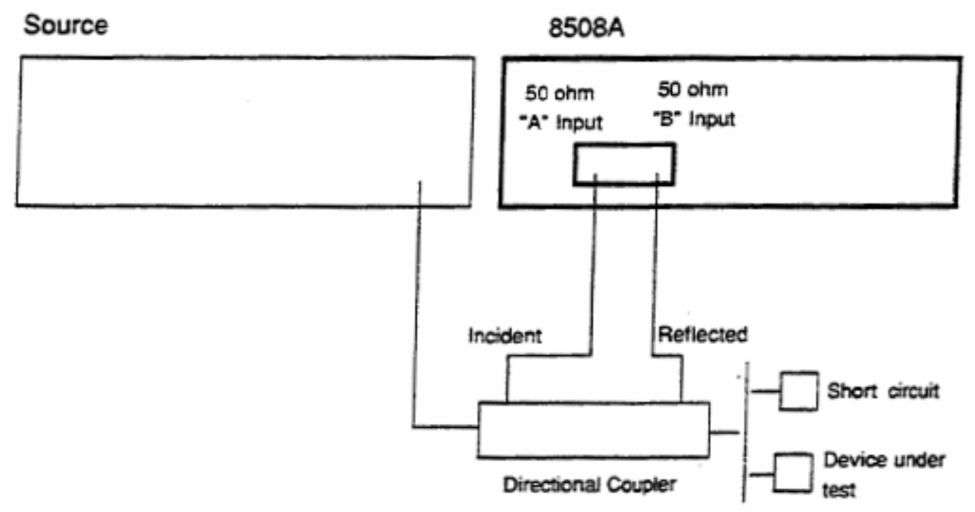
"2-Port Transmission Measurements" on page 675

"A/B and B/A Measurements" on page 676

Overview

In the FieldFox, both 1-port and 2-port measurement types use a different configuration setup from the HP/Keysight 8508A Vector Voltmeter.

Figure 26-2 Typical 8508A measurement configuration –as shown in the 8508A manual.



The above block diagram requires an external source and directional coupler to measure the electrical length of a DUT or cable to be trimmed. Separate paths are used to measure the Incident signal (A) and Reflected signal (B). To measure the ratio of the Reflected/Incident signals, you were required to select B/A for both the Magnitude and Phase display.

In the FieldFox, the source and directional coupler are inside the instrument. This allows you to connect the DUT to ONLY the FieldFox PORT 1, with NO external instruments, in order to make Cable Trimming measurements.

See the FieldFox block diagram and Cable Trimming procedures beginning in “1-Port Cable Trimming Measurements ” on page 673.

VVM Mode Settings

Select VVM Mode before making any setting in this section.

How to select VVM Mode

- Press **Mode**
- Then **VVM**

Measurement Selection

How to select a VVM Measurement

- Press **Measure 1**
- Then choose from the following:
  - **1-Port Cable Trimming** 1-port reflection measurement. Learn how to make this measurement in "1-Port Cable Trimming Measurements " on page 673.
  - **2-Port Transmission** 2-port transmission measurement. Learn how to make this measurement in "2-Port Transmission Measurements" on page 675.
  - **B/A** and **A/B** 2-port ratioed receiver measurements using external sources. Learn more in "A/B and B/A Measurements" on page 676.

Frequency Selection

How to set Frequency

- Press **Freq/Dist**
- Then **Frequency**
- Enter a value using the numeric keypad, the ▲|▼ arrows, or the rotary knob.
- After using the ▲|▼ arrows or the rotary knob, press **Enter**. The increment setting of the arrows is based on the current span and can NOT be changed in VVM Mode.
- After using the keypad, select a multiplier key. Learn about multiplier abbreviations in"Multiplier Abbreviations" on page 48.

Display Resolution

You can display either one digit or two digits after the decimal point for both magnitude and phase readings.

This setting survives a Preset and Mode Preset.

How to set Resolution

- Press **Scale/Amptd**
- Then **Resolution**
- Then choose:
  - **1** 0.0 (default)
  - **2** 0.00

IF Bandwidth

Reducing the IF receiver bandwidth reduces the effect of random noise on a measurement. However, narrower IF bandwidths cause longer measurement times.

For highest accuracy, Zero AFTER changing the IF Bandwidth. Learn about Zeroing in "Zeroing" on page 671.

How to set IF BW

- Press **BW 2**
- Then **IF BW**
- Then choose from the following:
- **10 Hz | 100 Hz | 1 kHz | 10 kHz | 100 kHz**
  More 30 Hz | 300 Hz | 3 kHz | 30 kHz

Output Power

Set the power level out of the FieldFox to High, Low, or manually set power level to a value between High and Low.

Generally, the high power setting is used when measuring passive, high-loss devices to place the signal farther from the noise floor. Increasing the power can also help reduce trace noise. However, for devices that are sensitive to high power levels such as amplifiers, use the Low power setting.

For best measurement accuracy, use the Manual power setting at -15 dBm. After calibration, the power level can be decreased for amplifiers, or increased for higher dynamic range.

CAUTION **Power Level settings in this mode will NOT change Power Level settings in other modes. To help prevent damage to your DUT, use caution when changing modes with your DUT connected to the FieldFox test ports.**

How to set Output Power

- Press **Meas Setup 4**.
- Then **More**
- Then **Output Power**
  - **High** Sets output power to the maximum achievable power at all displayed frequencies. Output power is NOT FLAT across the displayed FieldFox frequency span. Use the High power setting, when better dynamic range and lower noise is desired. Please see "Specifications/Data Sheet" on page 941 for expected power levels.
  - **Low** Sets output power to approximately –50 dBm.
  - **Man** (Default setting) Sets the output power to –15 dBm, FLAT across the displayed FieldFox frequency span. If flattened power can NOT be achieved, a warning message and beep occurs. To achieve a flattened output power, reduce the power level or stop frequency.
  - Then press **Power Level**
  - Then enter a value using the numeric keypad, the ▲|▼ arrows, or the rotary knob.
  - Press **Enter**.

Averaging

Averaging helps to reduce the effects of random noise on a measurement. The FieldFox computes the displayed value over several consecutive readings. Average count determines the number of readings to average. The higher the average count, the greater the amount of noise reduction.

An average counter is shown in the left edge of the screen as **Avg N**. This shows the number of previous readings that have been averaged together. When the counter reaches the specified count, then a 'running average' of the last **N** readings is displayed.

Average count = 1 means there is NO averaging.

This setting can be changed at any time without affecting calibration accuracy.

How to set Averaging

- Press **Meas Setup 4**
- Then **More**
- Then **Avg N** where **N** is the current count setting.
- Enter a value using the numeric keypad. Enter **1** for NO averaging.
- Press **Enter**.

To restart the averaging process, press **Meas Setup 4**, then **More**, then **Restart**

Single or Continuous Measure

This setting determines whether the FieldFox measures continuously or only once each time the **Single** button is pressed. Use **Single** to conserve battery power or to allow you to save or analyze a specific measurement.

This setting can be changed at any time without affecting calibration accuracy.

How to set Single or Continuous

- Press **Meas Setup 4**
- Then choose one of the following:
  - **Single** Automatically sets Continuous OFF and causes the FieldFox to make ONE measurement, then hold for the next **Single** key press. The **Hold** annotation changes to an arrow --> while the measurement occurs.
  - **Continuous OFF** and **Hold** both put the FieldFox in Hold mode.
  - **Continuous ON** Makes continuous measurements. This is the typical setting when battery power is not critical.
- You can also use **Run / Hold +/-** to toggle between Single and Continuous.

VVM Calibration

CalReady is accurate for most zeroed VVM measurements at frequencies below about 6 GHz. For the very highest accuracy, especially above 6 GHz, then perform a Mechanical Cal. Learn more in "How to Perform a Calibration" on page 130.

Press **Zero OFF** before calibrating (sets Zero to OFF).

Zeroing

Zeroing, also known as Normalization, or Data/Memory, simply "Zeroes" the Magnitude and Phase display when **Zero ON** is pressed. All subsequent measurements are relative to the measurement that was made when Zero was pressed.

When an instrument state is saved with Zero ON, the zeroing data is saved with the state file, similar to how a calibration is saved with a state file.

- When performing a 1-Port Cable Trimming operation, a reference cable is connected and measured. Then Zero is pressed, and subsequent cables are measured and trimmed to match electrical length of the reference cable.

– For 2-port measurements, Zero is typically pressed when a THRU connection is made in place of a DUT. Learn more in “2-Port Transmission Measurements” on page 675.

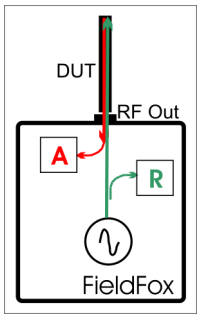
Press Zero OFF before performing a Mechanical Cal (sets Zero to OFF).

How to select Zeroing

– Press **Meas Setup 4**
– Then **Zero Ref**
  – **Open** – select to display Phase = 0.0 Deg when zeroed.
  – **Short** - select to display Phase = 180.0 Deg when zeroed.
– Then **Zero ON**
– Select **Zero OFF** to turn zeroing off.

1-Port Cable Trimming Measurements

A 1-Port Cable Trimming measurement is used in a cable fabrication procedure to validate proper electrical length.



- The R receiver measures incident signal (green line) out of the source.
- The A receiver measures reflected signal (red line) from the end of the DUT (black line).
- In VVM mode, the display ALWAYS shows ratioed (A/R) measurements which is the electrical length of the DUT.

How to make a 1-Port Cable Trimming Measurement

1. Press **Mode** then **VVM** then **1-Port Cable Trimming**.
2. Press **Freq/Dist** then enter the frequency for the measurement.
3. To improve measurement stability, change the IF Bandwidth, Output Power, and Averaging settings as needed.
4. 4.Press **Meas Setup 4** then **Zero OFF**.
5. Optionally calibrate the FieldFox. Learn more about VVM calibration in "VVM Calibration" on page 671.
6. To ensure that the calibration is adequate, perform the following **optional Measurement Verification** procedure.

NOTE This measurement verification procedure is suitable for low frequency measurements. However, for high frequency measurements, a more sophisticated procedure is required.

   a. Connect a short standard to **PORT 1** where cables to be trimmed will be connected.
   b. Press **Meas Setup 4** and press **Zero**.
   c. Remove the short standard and connect the open standard.
   d. Confirm that magnitude measurement is less than –0.1 dB and that the phase value reads 180° degrees.

7. Attach the shortest cable to the FieldFox **PORT 1** connector. This cable is the reference cable. Leave the end of the reference cable open (unterminated).
8. Press **Meas Setup 4** then press **Zero**.

9. Remove the reference cable from the FieldFox **PORT 1** connector.
10. Connect an unterminated, longer cable to the FieldFox **PORT 1** connector.
11. Observe the displayed phase difference between the reference cable and the untrimmed cable.

NOTE

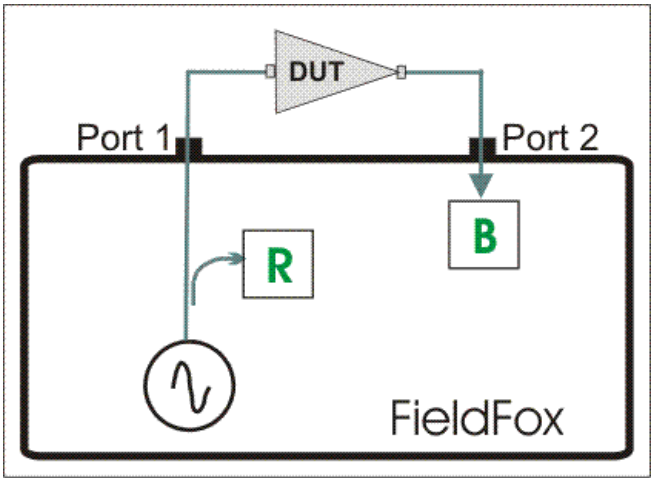
The VVM phase reading shows a maximum of ±180°. Therefore, the electrical length of the untrimmed cable MUST be within 180° of the reference cable.

12. Carefully trim the cable until the phase shift reads zero. The attached cable's electrical length is now matched to the reference cable.
13. Repeat steps 10 through 12 for the remaining cables to be trimmed.

2-Port Transmission Measurements

A 2-Port Transmission measurement is used for measuring electrical length, insertion loss, gain, or isolation of a DUT at a single CW frequency. The FieldFox signal source is transmitted out the port 1 connector, through the DUT, and into the port 2 connector. In the following image, the gain of an amplifier is being measured.

Figure 26-3 2-Port Transmission measurement of an amplifier



How to make a 2-Port Transmission Measurement

1. Press **Mode** then **VVM** then **2-Port Transmission**.
2. Press **Freq/Dist** and enter the measurement frequency.
3. Press **Meas Setup 4** then **More** then **Output Power**. Select **High** for passive devices. Select Low for amplifiers.
4. Calibrate the FieldFox using one of the methods described in "VVM Calibration" on page 671. Before performing a Mechanical Cal, press **Meas Setup 4** then **Zero OFF**.
5. Connect the DUT.

Notes:

– The magnitude value is the gain (positive value) or the loss (negative value) of the DUT.

– The phase value is the difference in phase (in degrees) between the DUT input and output.

– To measure isolation of the amplifier, reverse the connection to the amplifier (**PORT 1** to the amplifier output).

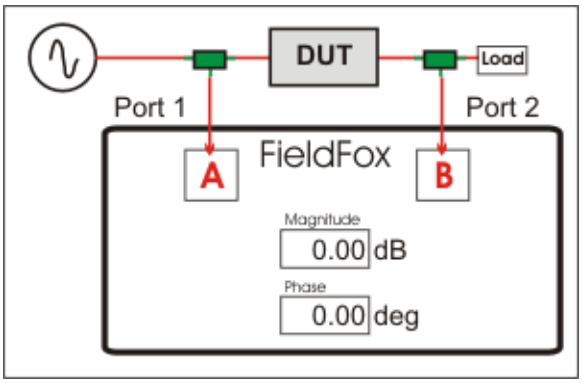
A/B and B/A Measurements

These measurements allow you to use the FieldFox A and B receivers, along with an external source, to make ratioed measurements.

NOTE These measurements require the “Full 2-port S-parameters” option.

The image below shows a typical configuration for a B/A magnitude and phase measurement of a 2-port DUT. This DUT can be an antenna / probe setup. Using network analyzer terms, the image shows the A receiver as the reference receiver which measures the signal that is applied to the DUT. The B receiver is the test port receiver which measures the DUT response.

Figure 26-4 B/A Transmission measurement with external source



Procedure

1. Connect the external source’s frequency reference output to the FieldFox **Freq Ref IN** on the top panel. If you are unable to use a common frequency reference, then increase the IFBW to ensure you are measuring the peak of the correct signal. After locating and tuning to the signal, you may be able to lower the IFBW to reduce noise.
2. On the FieldFox, select **System 7**, then **System Configuration**, then **Frequency Ref**, then **Freq Ref Source** then **Ext**.
3. Press **Mode**, then **VVM**, then **B/A** or **A/B**
4. The FieldFox internal source is NOT used, so the output power setting is not relevant.
5. To calibrate, replace the DUT with a THRU connection, preferably by connecting together the two Power Splitters (shown in green). For low frequency measurements, TEEs can be used.
6. Press **Meas Setup 4**, then **Zero**.
7. Connect the DUT and measure.

27 ERTA (Extended Range Transmission Analysis) Mode - Option 209

ERTA (also known as **FoxTrot**) uses two FieldFox units to make long-distance scalar transmission measurements. One unit is the source and the other unit is the Receiver.

In this Chapter

"Overview" on page 678

"Requirements and Limitations" on page 679

"Start Connection Wizard" on page 680

"Configure Measurement Settings" on page 684

"Select Measurement" on page 684

"Normalize" on page 685

"Source Tracking Offset and Offset Reversal" on page 685

"Improve Dynamic Range" on page 686

"Source Enable and Source Mode" on page 686

Overview

ERTA uses two FieldFox units to make long-distance scalar, tracking transmission measurements. One unit is the source and the other unit is the Receiver.

Communication takes place between the two units with a LAN connection and hard-wired trigger signals. Once the two units are synchronized, the Receiver unit becomes the **primary** and measures the output of a DUT, while the Source unit responds as secondary supplying signal at the DUT input. The two units, possibly separated by hundreds of meters, step together through the selected frequency range making measurements such as long cable characterization.

With a power splitter at the Source unit, the SA Receiver can be used to measure the reference signal to make a true B/R ratio measurement. Because the reference trace is updated on every sweep, there is no need for static trace normalization. Accuracy is further enhanced with input and output cable corrections. Furthermore, the alignment process keeps the SA receivers calibrated. For information on alignments, refer to the SA mode chapter's section, "Alignments" on page 211.

Requirements and Limitations

Requirements

- Two FieldFox units with option 209 installed. SA Mode is required for option 209.
- Ethernet LAN cable(s). Either TWO cables that are used to connect both units to the internet or ONE cable that is long enough to connect the two FieldFox units. This may require a cross-over cable.

NOTE

When you change network connections, it may take up to 2 minutes for the old address to be replaced by the new address. If the FieldFox was initially assigned an IP address by a DHCP server, and then the FieldFox LAN connection with a DHCP server is removed and is the FieldFox is reconnected to a LAN segment with no DHCP server (such as a direct connect to another FieldFox), the FieldFox may take up to two minutes to self-assign an automatic private IP address. During this connection time the last recognized DHCP address is displayed on the FieldFox, but is invalid.

- Two trigger cables that are long enough to connect the two FieldFox units, each with SMB (m) to SMA (f) connectors.
- RF cabling to and from DUT.
- Power Splitter (Optional) for enhanced B/R ratio measurements.

Limitations

The following SA features are removed in ERTA mode (Option 209):

- Channel Measurements, Tune and Listen, Interference Analysis, Radio Standards, and Sweep Triggering.

The following SA features are disabled during partnership synchronization:

- Video BW, SwpAcquisition, Frequency Count, Record/Playback, and certain Amplitude Units.
- The only keystrokes allowed on the Source unit are **Send Text Message** and **Exit**.

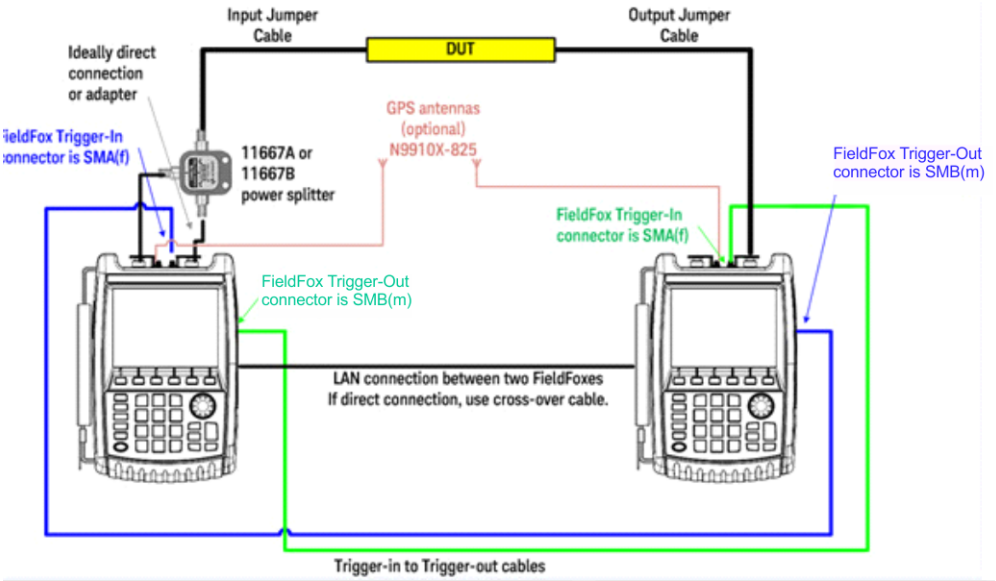
Start Connection Wizard

Use the FieldFox Connection Wizard to guide you through the following physical setup.

On the Receiver unit:

– Press **Mode** then **ERTA**

– Then **Meas Setup 4** then **Connection Wizard** then **Start**.



STEP 1: Select [Start] when ready

– Press **Start**

– At any step, press **Exit** to end the wizard.

STEP 2: Connect Trigger and LAN cables

– **LAN**: Connect a LAN cable to each unit. The units can either both be connected to the internet on the same network through a switch or router, or they can be connected directly to each other (a crossover cable may be necessary).

– **Trigger signals**: On each unit, connect the **Ref/Trig Out** SMB (m) connector on the FieldFox side panel to the **Ref/Trig** In SMA (f) connector on the other FieldFox top panel.

– **RF connections**

Preferred method (pictured above):

- On the Source unit, connect the Port 1 RF Output connector to the input of a power splitter.
- Connect one power splitter output to the Source unit Port 2 RF Input.
- Connect the other power splitter output to the DUT input.
- Connect the DUT output to the Port 2 RF Input of the Receiver unit.

Simplified method (not shown):

- Omit the power splitter. Connect the Source unit Port 1 RF Output connector to the DUT input. **The measurement is a raw B receiver**. Specs do NOT apply.

STEP 3: Select LAN address of ERTA Partner

The Receiver unit is the primary partner, annotated with **RCVR Primary**.

The Source unit is the secondary partner, annotated with **SRC Secondary**.

On the Receiver unit:

- Press **ERTA Partner (not specified)**. The IP addresses of potential FieldFox units are displayed. Select the IP address of the Source unit. If 10.10.10.1 appears, then NO FieldFox units were found. The LAN setting "Obtain IP Address using" MUST be set to DCHP. Learn more in "LAN Settings" on page 874. Also be sure that Opt. 209 has been installed correctly on the Source unit.
- Press **Continue**.

STEP 4: Test Partnership

- Press **Test Partnership**. If the Source unit is NOT already in ERTA mode, it will be started, which may take a several seconds. When successful, LAN OK and Trigger OK will appear on the screen.
- If either the LAN or Trigger test fails, then press **Clear Test**, then **Test Partnership** to retry the test.
- Optional: Press **Send Text Message**, then enter a message to send to the Receiver unit. A LAN connection is necessary. For quick communication, custom Keywords can be setup using the FieldFox labeler. Learn how in "Edit Keywords" on page 899.

Any of the following will end the partnership:

- Press **EXIT Partnership**
- Select Global or Mode Preset
- Change Modes
- Recalling a non-ERTA State file. Recalling an ERTA State file can re-establish a partnership if the Source unit is still on the network at the same location.

– Press **Continue**.

STEP 5: Measure Jumper Cables

These steps can be used to characterize an Input and Output jumper cable that may be connect the DUT to the FieldFox. The loss of the characterized jumper cables can then be removed from the DUT measurements. The measurements are stored to the internal Cables folder using an auto-generated *.csv filename.

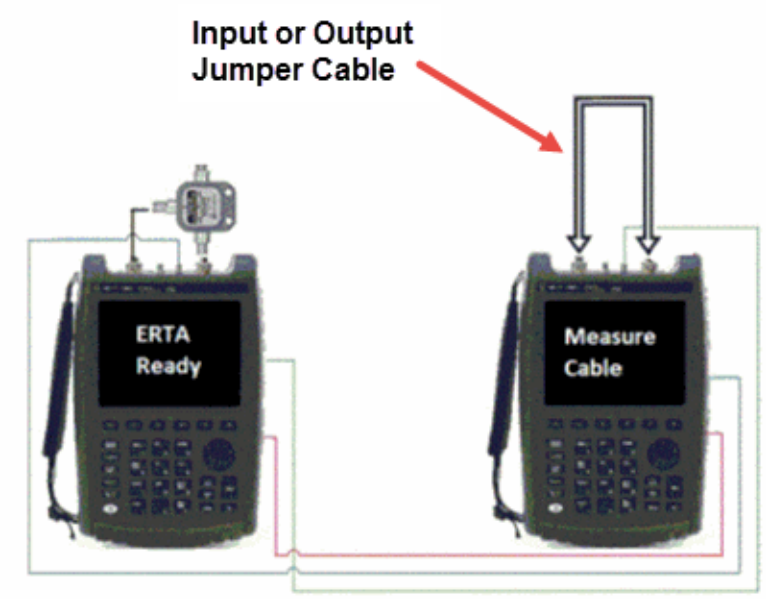
– The Input cable is attached between the Source/splitter output and the DUT input.

– The Output cable is attached between the DUT output and the Receiver unit.

NOTE

For optimum flexibility, use the Scale, then More, then Corrections menu to measure, save, and recall cable characterizations. These softkeys are duplicated from the SA Field Strength - Antenna/Cable characterization. Learn more in "Field Strength Measurements" on page 165.

Figure 27-1 Input and Output jumper cables are measured on the Receiver unit



If your DUT input **AND** output is connected directly to the FieldFox, or you choose to ignore the loss of BOTH jumper cables, then press **Skip this step**.

Otherwise, press **Measure Jumper Cables**.

Do the following for both the Input and Output jumper cables:

– Press **Skip this step** to skip the cable measurement.

– Otherwise, connect the Input / Output jumper cable as shown below, then press **Measure Input (or Output) Cable**.

- Press **Re-measure** or **Continue**.
- Press **Apply Corrections Auto** to remove the jumper cables from subsequent DUT measurements (Default = Auto).
- Press **Done** to exit the Connection Wizard.
- On the Receiver unit, press **Primary ERTA Partnership**. The Source unit enters ERTA mode as the secondary.

Configure Measurement Settings

On the Receiver unit, select measurement settings such as Frequency range, Res Be, Points, and so forth. Zeros pan frequency is allowed even though the frequency is fixed and no stepping is required.

Learn about these settings in "SA Mode Settings" on page 155.

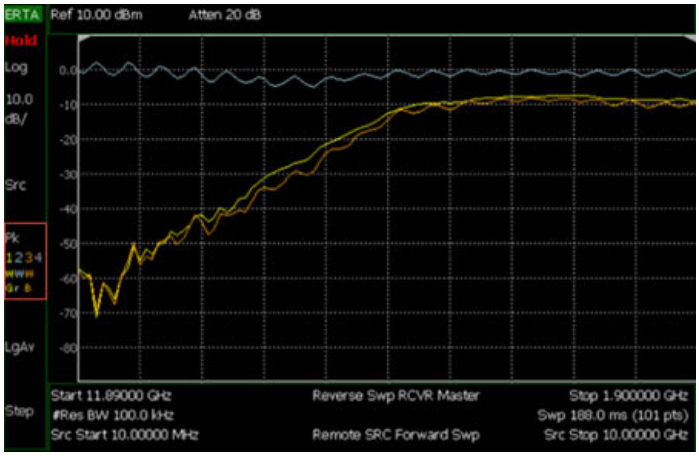
Select Measurement

The following traces are provided for your convenience. They are all configured as Clear/Write.

Press **Meas 1**, then choose one or more of the following:

Softkey	Shown on screen	Description
Input Power R	2 w r	R receiver. Reference power measured by the Source unit before entering the DUT.
Output Power B	3 w B	B receiver. Power out of the DUT measured at the Receiver unit.
Gain or Loss B/R	1 w G	Gain or Insertion Loss. The B receiver data divided by the R receiver data (B/R) This measurement can be displayed accurately with, or without, displaying the R or B measurements.

Figure 27-2 Input power, Output power, and gain measurement traces



To change the trace numbers of these three measurements, or to select a trace state other than Clear/Write, press **Trace 6**.

Learn more about Trace Display States in "Trace Display States (SA Mode)" on page 209.

Normalize

Normalize can be used to quickly provide 'zeroing' for any of the ERTA (B, R, or G) traces. On the sweep AFTER selecting Normalize, Trace 1 is copied to Trace4. It is then put into View state and subtracted from that input on subsequent sweeps. Any trace (1, 2, or 3) which is set to process that same input (B, R, or G) will therefore be processing normalized measurement data. This continues as long as the frequency span, number of points, and the trace input (B, R, or G) is NOT changed. If any of these settings change, Normalize is deactivated.

How to Normalize the B trace

- Press **Meas Setup 4**
- Then **Remote Source**
- Then **Normalize ON**

Source Tracking Offset and Offset Reversal

Source offset tracking is used to offset the Source frequency from the Receiver frequency by a fixed offset at every tune frequency. This feature is used when the DUT contains a frequency converter.

How to set Tracking Offset and Offset Reversal

- On the Receiver unit, press **Meas Setup 4**,
- Then **Remote Source**
- Then **Advanced**
- Then choose one or both of the following:
  - **Tracking Offset** Enter an offset value.
  - **OfsTrkReversal** Determines whether Receiver Freq is added to or subtracted from the Offset Freq.
    - **OFF** SourceFreq = Offset + RecFreq. Use to measure Upconverters.
    - **ON** SourceFreq = Offset - RecFreq. Use to measure Downconverters. The source sweeps in Reverse direction.

NOTE The Offset Freq. MUST be larger than the Receiver Stop Freq.

Improve Dynamic Range

The following settings can be made to reduce measurement noise which improves Dynamic Range.

Increase source power as much as possible while maintaining a leveled source.

How to set Source Power

- Press **Meas Setup 4**
- Then **Remote Source**
- Then **Source Power**
- Then either **Max Power** or **Leveled** - Increase source power until the unleveled warning appears. Then decrease power until power is again leveled.

  To further reduce measurement noise, on the Receiver unit:
- Reduce **Attenuation** to 5 dB, then turn the **Preamp ON**. Learn how in "Preamplifier Control (Opt 235)" on page 164.
- Decrease the **Res BW**. Learn how in "Resolution Bandwidth (Res BW)" on page 193.
- Set **Frequency Reference** to **GPS** on both units. This requires Option 307 (Built-in GPS) and two GPS antennae. The GPS reference can be enabled for several sweeps. Then if you move to a location without an adequate GPS signal, Hold-over Mode will occur. Learn more about GPS as a frequency reference in "Frequency Reference Source" on page 870.

Source Enable and Source Mode

When **Source Enable [OFF]** is selected, or when **Source Mode** [**CW** or **CoupledCW**] is selected, then synchronization ends and the two partner units revert to general SA (non-tracking) sweeps. However, the units are still in partnership, and other settings continue to be synchronized such as Frequencies, ResBw, and Points.

28 AM/FM Metrics (SA Only and Option 355)

NOTE

The FieldFox assumes you have manually set up the CF, span, and amplitude settings. Refer to Chapter 9, "SA (Spectrum Analyzer) Mode (Option 233–Mixed Analyzers).".

In this Chapter

"Using AM/FM Metrics" on page 688

"SINAD and THD Calculations" on page 694

"Interpreting AM/FM Metrics Error Messages" on page 697

Using AM/FM Metrics

Using FieldFox's analog demodulation, users maintaining AM/FM radio systems can demodulate and characterize AM and FM signals. They can tune to the signal and listen to the audio tones using FieldFox's built-in speakers or a headphone. They can also display the RF spectrum, the demodulated waveform and AM/FM metrics such as carrier power, modulation rate, and SINAD.

AM/FM Metrics enables you to make the following measurements:

AM Measurements:
- AM Measurements: Carrier power, AM rate, AM modulation index

FM Measurements:
- FM deviation (peak and RMS), Modulation Rate, Carrier power, Demodulated voltage, SINAD, THD (total harmonic distortion)

And, can be enabled/disabled simultaneously with Tune and Listen.

Overview of Measurement Types

If you are familiar with the AM/FM measurements and terms, skip to "How to Set Up AM/FM Metrics" on page 690.

Table 28-1 Measurement Details (Sheet 1 of 2)

Measurement details	
Modulation Rate	The modulation rate quantifies how fast the modulation is and equates to the frequency of the baseband signal that modulates the carrier.
SINAD (Signal to Noise and Distortion Ratio)	Another commonly used distortion measure is signal to noise and distortion ratio (SINAD). SINAD, in nature, is the reciprocal of the modulation distortion provided by the "distortion/total Vrms," but the SINAD is usually expressed in a logarithmic term as follows: Where: S = Signal Power D = $\sum_{k=0}^{n} Dn$ N = Noise SINAD = [(S + D + N) / (D + N)] OR Refer to "SINAD and THD Calculations" on page 694.

Table 28-1 Measurement Details (Continued) (Sheet 2 of 2)

THD (Total Harmonic Distortion)	The total harmonic distortion (THD) measurement further isolates the total harmonic distortion component from the noise component in the total unwanted signal. It helps the user to troubleshoot the root causes of modulation distortion. S = Signal Power D = $\sum_{k=0}^{n} Dn$ N = Noise THD = [(D + N) / (S + D + N)]
RF spectrum of the modulated signal	This is the most traditional spectrum analyzer measurement viewing the modulated carrier signal power in frequency domain. Prior to being modulated, the signal power of a sinusoidal carrier concentrates at the carrier frequency. By contrast, modulation causes sidebands indicating the power redistribution over frequencies. The pattern of the sidebands depends upon the modulation format.
Demod waveform	This measurement retrieves the baseband signal from the modulated signal via the demodulation process, and displays the baseband signal in a pattern of modulation depth/deviation versus time. Since the modulation depth/deviation is directly proportional to the instantaneous amplitude of the baseband signal, the measurement result helps to intuitively evaluate the quality of the baseband signal.
AM modulation depth	AM modulation depth = (Peak-to-Peak / 2)

Modulation Metrics	
FM deviation	The FM deviation reflects the amount of the frequency modulation to which the baseband signal modulates the carrier signal. The quantity being measured is the peak frequency deviation that is the maximum frequency excursion from the carrier frequency.
Carrier power	This measures the power of the carrier signal without the modulation. Ideally, power for a sinusoidal carrier signal is concentrated around its carrier frequency.

How to Set Up AM/FM Metrics

– Connect a test tone to the FieldFox SA Port 2 (Port 2)

– Press **Measure** > **Analog Demod Tune & Listen** > **Analog Demod**

NOTE

Selecting FM Wide vs. FM Narrow does not effect the displayed waveforms or metrics. But, if you are using the Audio Demod feature and listening to the demodulated waveform, then select the appropriate FM type, because the tones do differ based on the FM type selected. Refer to Table 28-1 on page 688.

See also, Chapter 9, "SA (Spectrum Analyzer) Mode (Option 233–Mixed Analyzers)" and to "Analog Demod" on page 176.

Left display - Frequency Spectrum (Power vs. Frequency)

Right display - Demodulated waveform vs. time where **Demod SwpT** sets the width of the demod window.

– Then **Freq/Dist** > **Center** to set the carrier frequency.

– Set **Freq Span** so that all sidebands above -60 dB are displayed in the left window.

– Optionally, adjust the **AF Res BW** to better identify audio frequency side bands. Learn more, refer to Chapter 9, "SA (Spectrum Analyzer) Mode (Option 233–Mixed Analyzers)" and "AF RBW (Audio-Frequency Resolution BW)" on page 194.

– Optionally, **Freq/Dist** > **Tune & Listen OFF** – Opens a menu of Tune & Listen demod softkeys. Tune & Listen can be set when you are in Analog Demodulation mode, so you can enable Tune & Listen sweeps in between your Analog Demod sweeps. To learn more about the Tune & Listen softkey menu choices, refer to "Tune & Listen (AM/FM)" on page 172.

Metrics are displayed in the **AM/FM Modulation Metrics** table on the FieldFox. For AM and FM Metrics examples, refer to Figure 28-1 through Figure 28-8 on page 699.

Figure 28-1 AM Metrics - Example 1

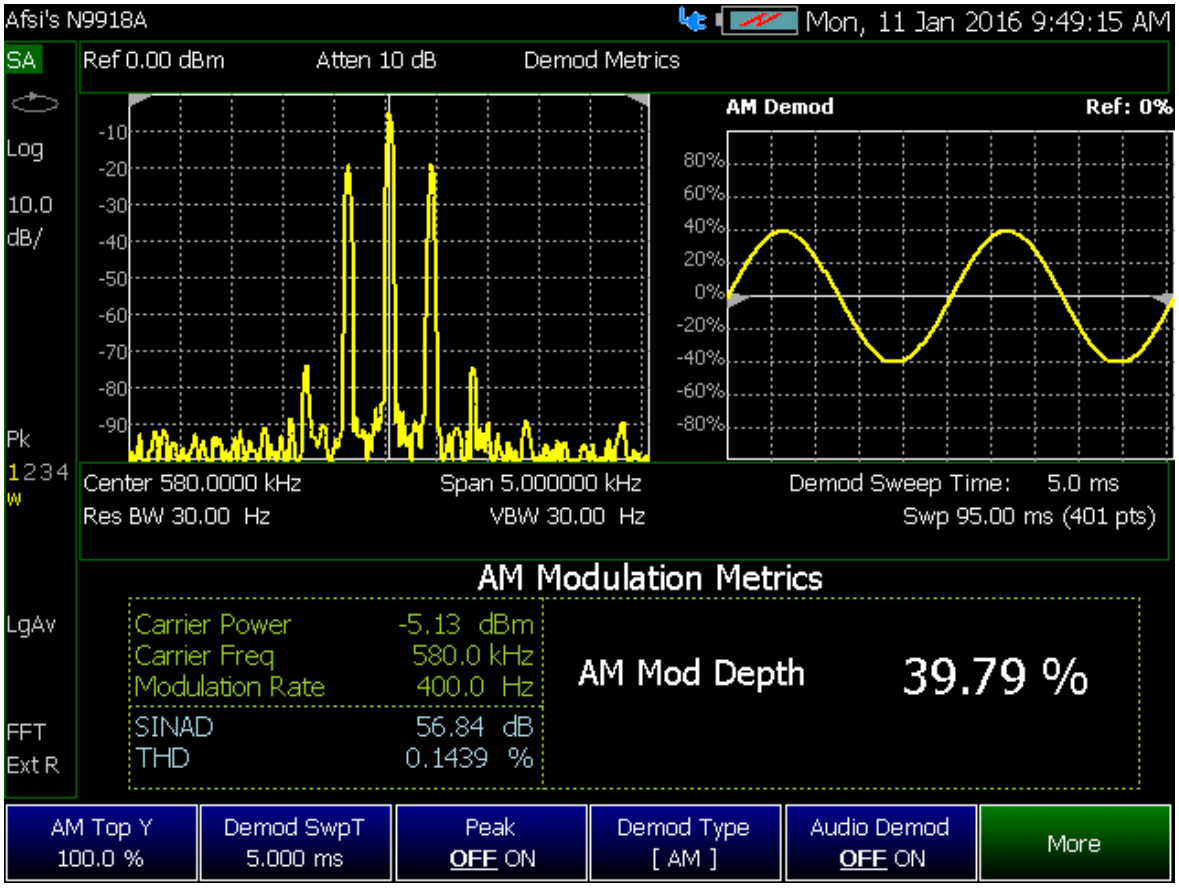


Figure 28-2 AM Metrics - Example 2

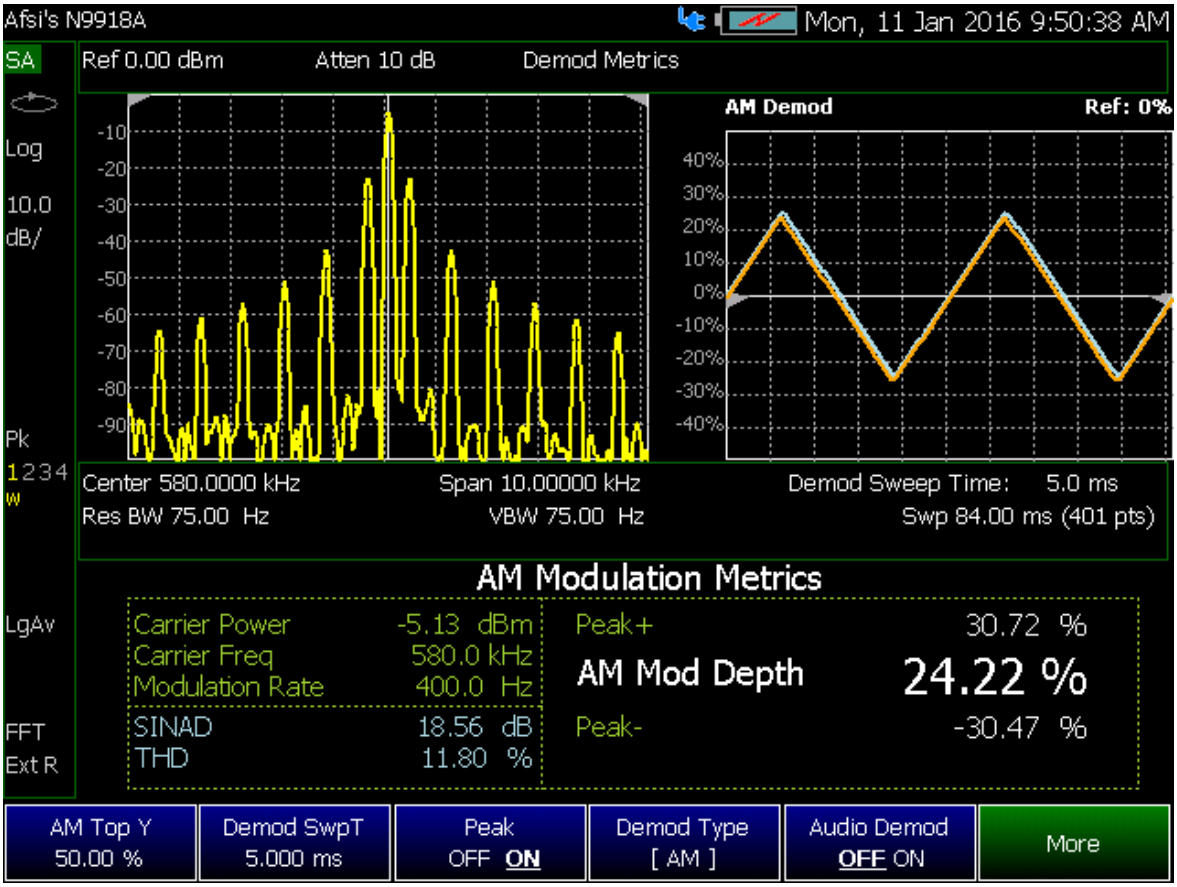
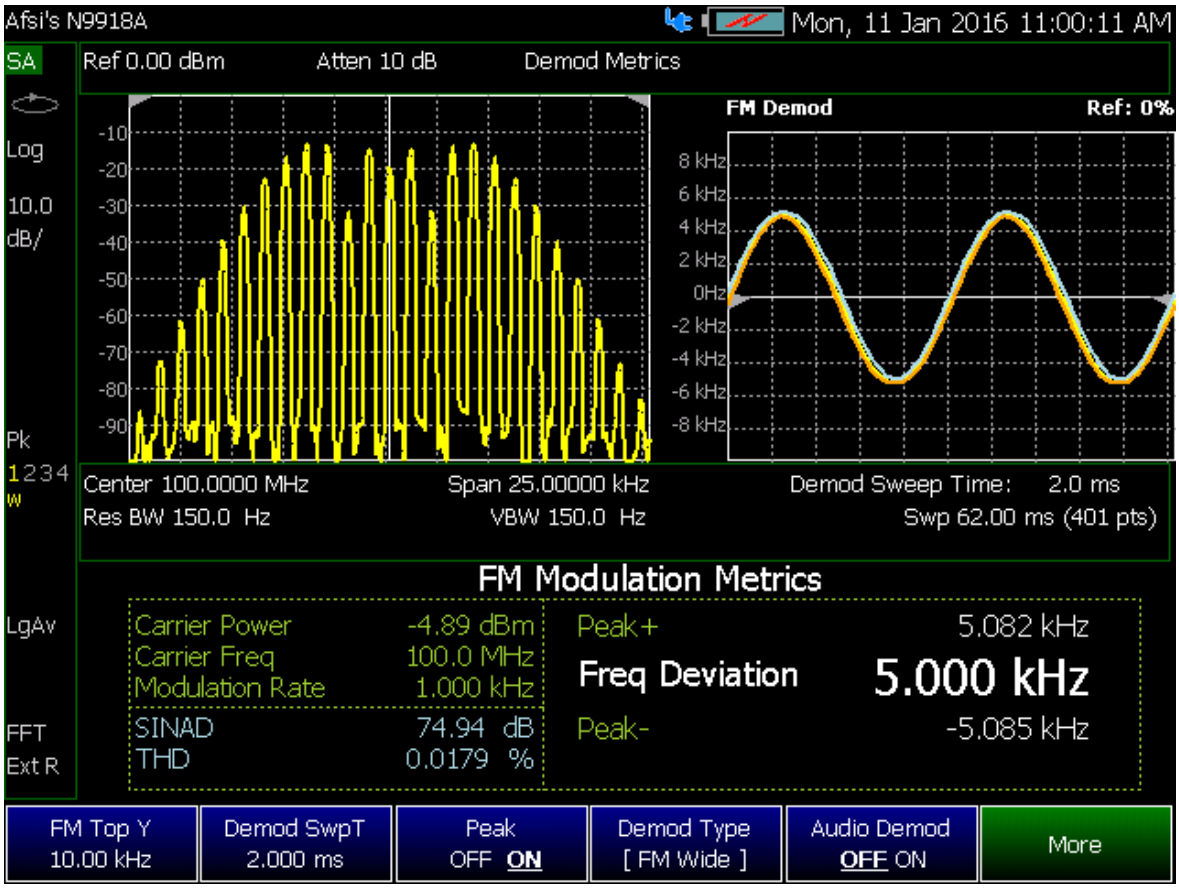


Figure 28-3 FM Metrics - Wide band Example



SINAD and THD Calculations

- FieldFox converts the audio waveform to the audio frequency spectrum using an FFT (i.e., The FFT result is not displayed). Refer to Figure 28-4 on page 694.
- The FFT waveform is used to calculate SINAD and THD distortion metrics
- The fundamental signal, harmonics, and noise from 0 Hz to 24 kHz are applied to the formulas. Refer to Figure 28-5 on page 695.
- For more on calculations, refer to "Overview of Measurement Types" on page 688.
- See also, https://www.keysight.com/us/en/assets/7018-04493/application-notes/5991-4913.pdf.

Figure 28-4 Audio Waveform with FFT Calculations

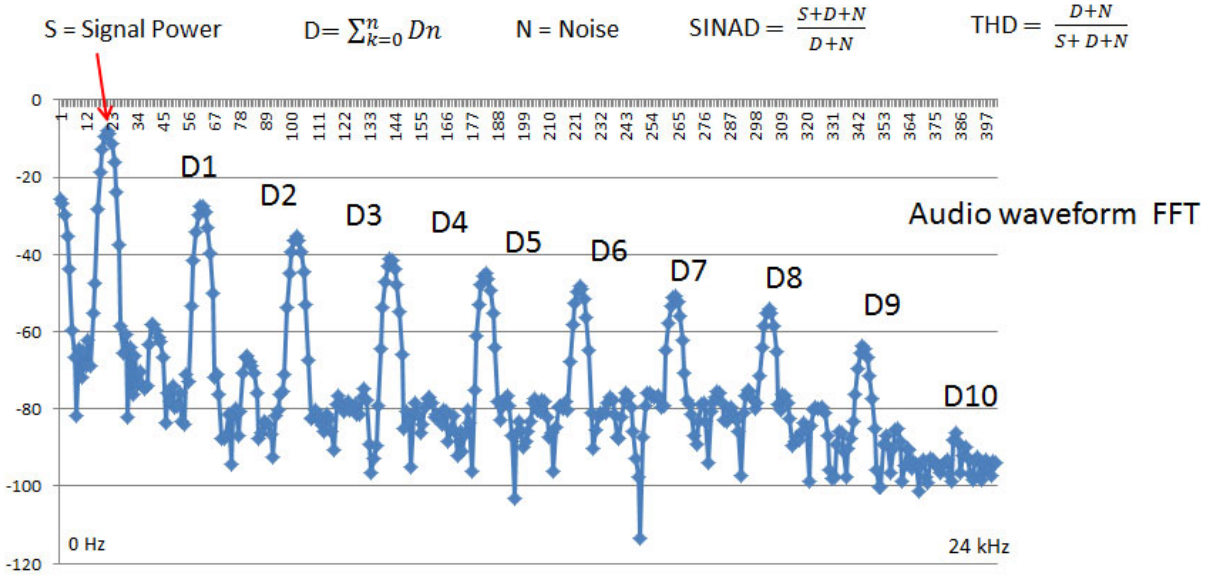


Figure 28-5 SINAD and THD Results - Example 1

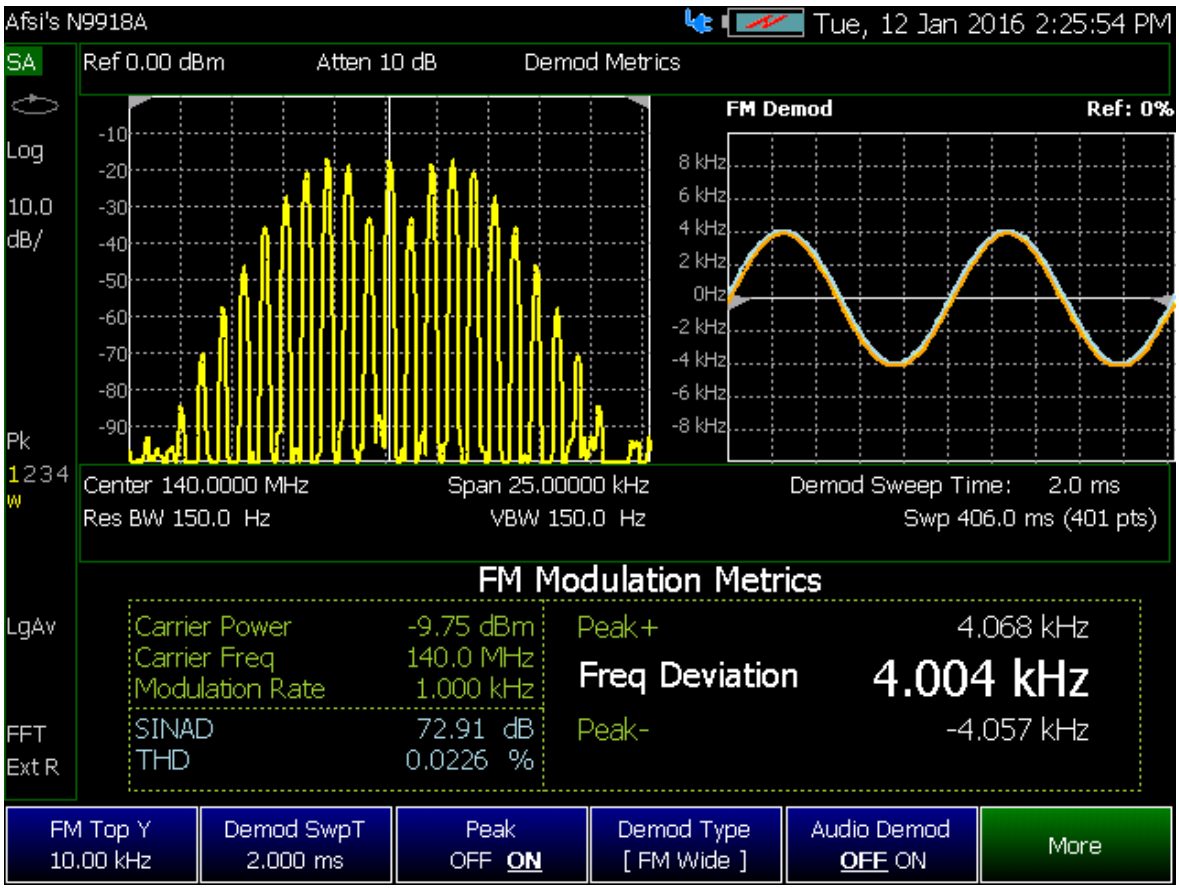
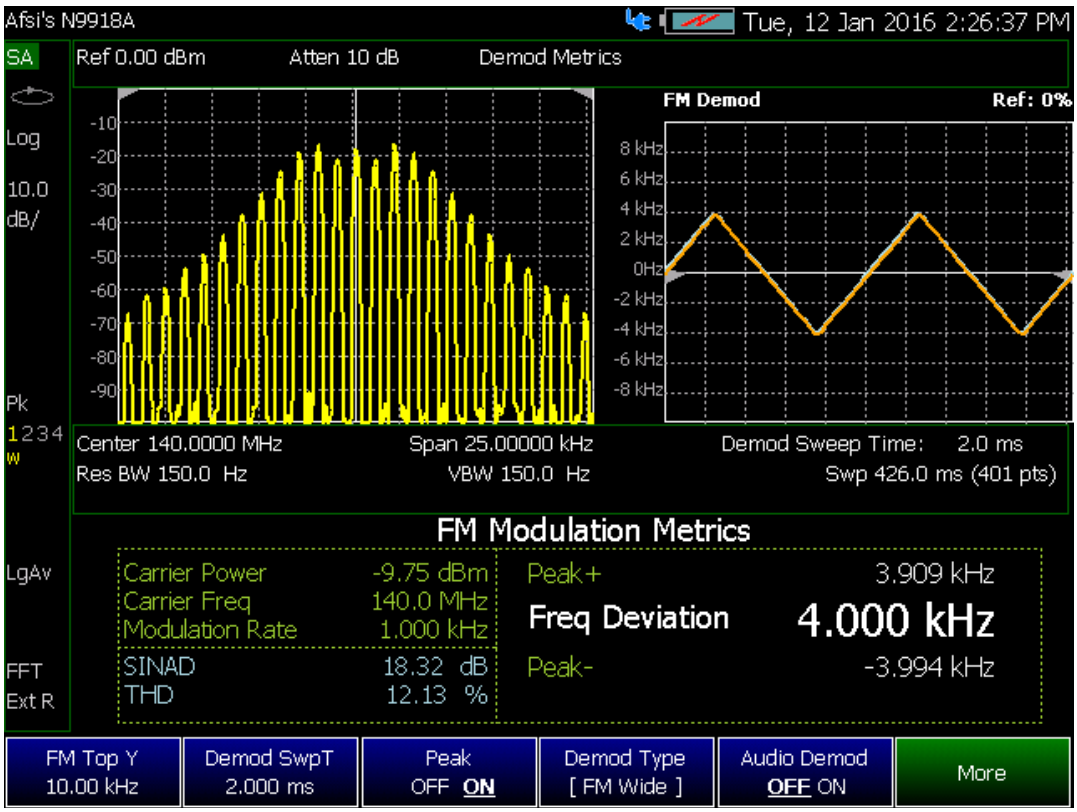


Figure 28-6 SINAD and THD Results - Example 2



Interpreting AM/FM Metrics Error Messages

This section discusses possible AM/FM Metrics error messages and how to correct them.

Test Tone Not Found

A Test Tone Not Found message is displayed under the following circumstances:

- FieldFox frequency span is too wide
- No side lobes are displayed in the results

Refer to the examples in "Test Tone Not Found - Example" on page 698 and "Test Tone Not Found - Corrected Example" on page 699.

Test Tone Not Found - Example

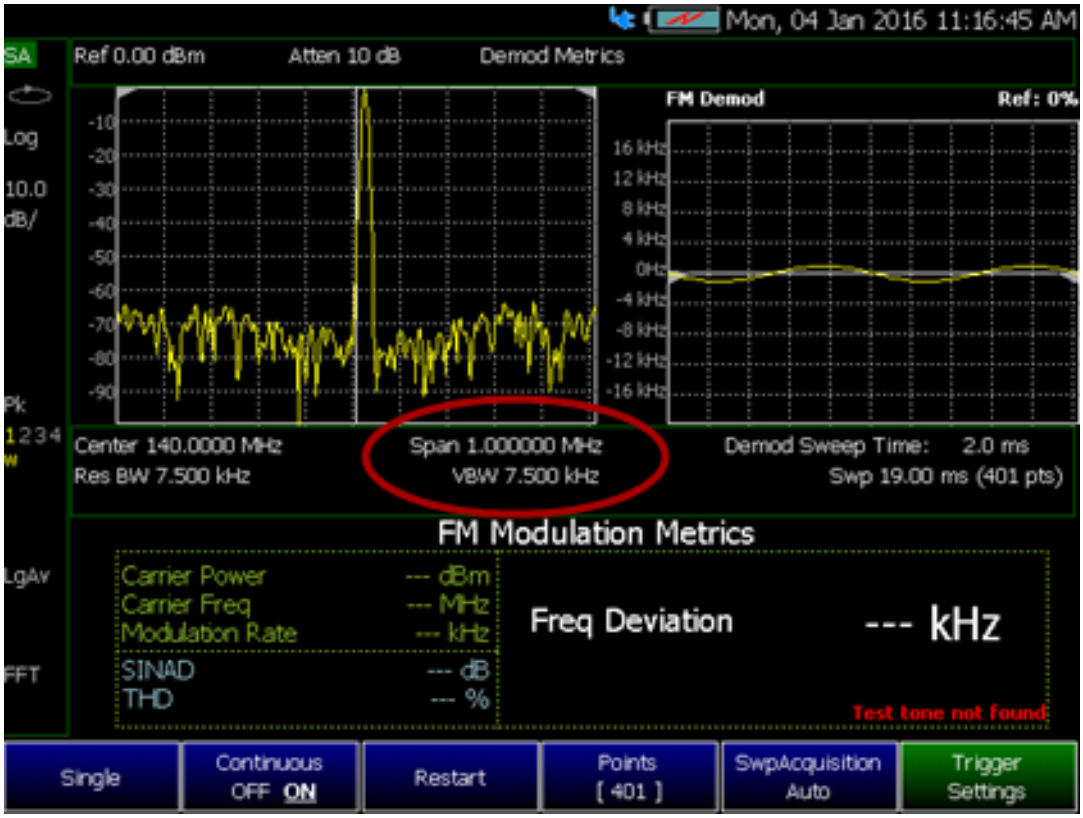
The following response had the following settings:

- Source CF: 140 MHz
- FM Deviation: 18 kHz
- Modulation Rate: 1 kHz

Reasons for error:

- Frequency span of 1.0 MHz is too wide
- No side lobes displayed, so test tone not found

Figure 28-7 Test Tone Not Found - Example



Test Tone Not Found - Corrected Example

The following response was corrected with these setting changes:

– Frequency set to narrower frequency span of 50 kHz

– Ideally the frequency span should show the modulation envelope down to –60 dB below the RF power level

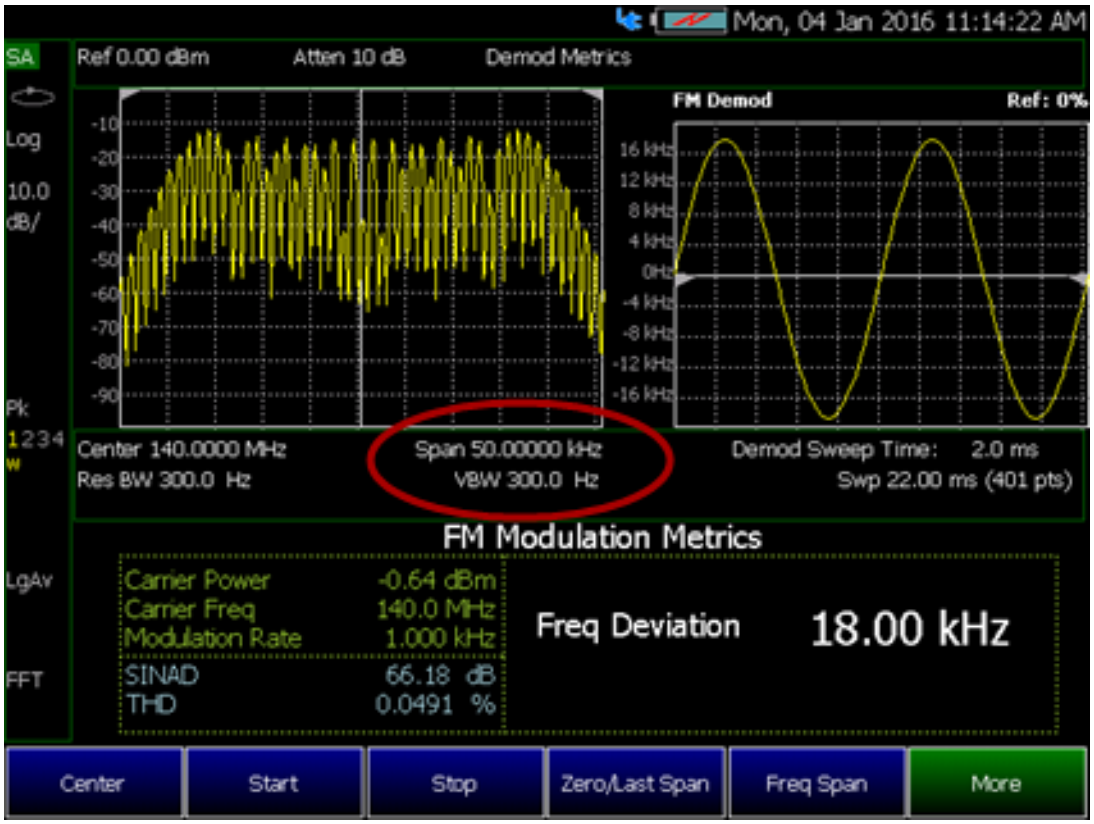
Response corrected, because:

– Narrowing the frequency span enables the modulation envelope's side lobes to be identified

– FM algorithm identifies the side lobes

– The algorithm matches the modulation envelope to the mathematically calculated FM modulation or distortion patterns

Figure 28-8 Test Tone Not Found - Corrected Example



29 Channel Scanner (Option 312)

In this Chapter:

"Using Channel Scanner" on page 702

"How to Set Up Channel Scanner" on page 703

– "Field Strength Measurements" on page 730

– "Using the Antenna/Cable Editor" on page 735

– "Using Mapping" on page 735

– "Using Extrapolation Factor" on page 735

– "Using the Uncertainty List" on page 735

– "Using Resolution Bandwidth Tradeoff (Res BW Tradeoff)" on page 736

See Also

"Why and When to Calibrate" on page 129

Chapter 16, "Indoor and Outdoor Mapping – Option 352 (Requires Spectrum Analyzer Mode (Option 233), and GPS Receiver (Option 307))."

Chapter 32, "System Settings." (Changing display colors)

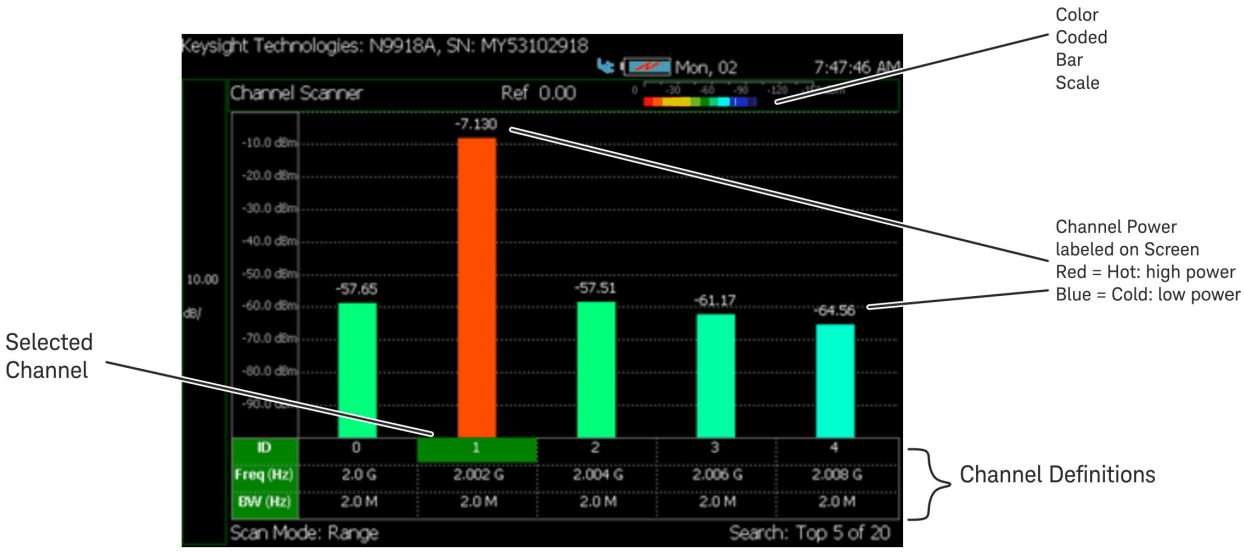
Chapter 34, "File Management."

Using Channel Scanner

Channel Scanner enables you to do the following:

Measure and display channel power vs. frequency for up to 20 channels simultaneously.	
Six Display Types:	
– Bar graph vertical display orientation – Bar graph horizontal display orientation – Channel Power	– Table – Strip Chart – Strip Chart and Overlay – Scan & Listen
Color Coded Display Types:	
– Specify high and low power with color bars	
Flexible Data Sorting:	
– Sort results displayed by power or frequency, low to high, or high to low	
Data Logging GPS stamped data measurements	
– Define measurement interval by time or distance – Show results in spectrogram	– Replay files on Google Maps or Google Earth – Manual directional mapping

Figure 29-1 Display Example: Measure 5 Channels Spaced 2 MHz Apart



How to Set Up Channel Scanner

This section briefly reviews the steps in setting up a channel scan measurement. If you are not familiar with this process or would like more information, refer to "How to Define a Channel and Use Channel Scanner".

1. Define some channels (refer to "How to Define a Channel and Use Channel Scanner").
   a. Select a **Scan Mode**–choose:
      - **Range** Specify total channels, channel spacing or
      - **Custom List** Specify a list of channels from an editor or
      - **EMF Custom List** Specify a list of items related to EMF measurement from an editor
   b. Then modify channels based on the selected scan mode
2. Select **Display Type**–choose:
   - **Bar ChartV** or
   - **Bar ChartH** or
   - **Channel Pow** or
   - **Table** or
   - **Strip Chart** or
   - Then **More** and
     - **Chart Overlay** or
     - **Scan&Listen**
3. Modify scale and specify color bar coding–Modify the scale and assign colors to low and high power channels (bars):

   Press **Scale/Amptd**

   Then one of the following:
   - **Red Limit** to set the power level and color scale for high power channels.
   - **Blue Limit** to set the power level and color scale for low power channels.
   - Others: **Scale**, **Ref Level**, **RF Atten**, etcetera as desired.

4. In the EMF Custom List scan mode, to adjust the Relative Mode setting and select specify column for display in the result table:

NOTE

IMPORTANT!

The EMF softkey menu is only activated when the scan mode is in the EMF Custom List.

   a. Press **Trace 6** > **EMF**, refer to Figure 29-6

   b. Then one of the following:

NOTE

When Relative Mode is enabled, the first row of the table is highlighted in a different color from the other rows. If the table includes a column ID, it will be labeled '1-ref'.

Expected Use Case: Channel 1 contains the entire band, which should be evaluated by each of the subsequent channels (2 through n), where n is the total number of channels.

Example:

Channel 1: 50MHz - 100MHz (Reference Band when Relative Mode is enabled.

Channel 2: 50MHz - 75MHz

Channel 3: 75MHz - 100MHz

   - **Relative Mode** (Default == OFF) ON to enable Relative Mode.
   - **Relative Unit** Select the unit of measurement for ratio type results.
      - **Auto** (Default) - Firmware will decide [%] or [dB] based on the current Amplitude Unit setting, **Scale /Amptd6** > **More** > **Unit**.
      - **%** - Ratio type results in unit %.
      - **dB** - Ratio type results in unit dB.

CAUTION

To view relevant ratio type results, ensure that both Relative Mode and Limit Lines are enable.

   - **Column Display** Select a custom column to display in the table when the Display Type is set to "Table".
      - **Summary** - Display all channels across the following columns: Service, Band, P Live, P Min, P Avg, P Max, PMin/PLim, PAvg/PLim, and PMax/PLim in the table when

Relative Mode is disabled, where P is Channel Power. Refer to Figure 29-6. When Relative Mode is enabled, the Column Display automatically switches to Exposure Ratio.

- **P/F** - Pass (P) or Fail (F) if Limit Tests are enabled for the channel or '-' if Limit Tests are not enabled. Refer to "Disable Limit Test in Channel Scanner mode," on page 813
- **IBW** – Integration bandwidth (IBW) of a channel relative to the first (reference) channel in Relative Units (% or dB) when Relative Mode is enabled. When Relative Mode is disabled, the IBW value is displayed in Hz.
- **CHP** – Channel power (CHP) of a channel relative to the first (reference) channel in Relative Units (% or dB) when Relative Mode is enabled. When Relative Mode is disabled, the CHP value is displayed in amplitude units (e.g., V/m).
- **PMax** - The maximum power measured since the most recent restart. When Relative Mode is enabled, the PMax value displayed in Relative Units (% or dB). When Relative Mode is disabled, it is displayed in measured units.
- **PMin** - The minimum power measured since the most recent restart. When Relative Mode is enabled, the PMin value displayed in Relative Units (% or dB). When Relative Mode is disabled, it is displayed in measured units.
- **Exposure Ratio** - The table view is similar to the Summary table view, but with Relative Mode ON, which calculate the exposure ratio for each Channel Power reading. When Relative Mode is disabled, the Column Display automatically switches to Summary.

5. Enable **Data Logging** Settings: Press **Measure 1** or **Trace 6** > Data Logging to view the Data Logging softkeys and set the **Record Settings**, **Record Save/Recall**, and **More** > **Indoor Map Data Logging** or **Signal Locate**.
   - Record (Outdoor Logging) or
   - Play (If you have previously stored data recordings.) or
   - View

   a. To set the **Record Settings** (Outdoor Mapping only)—choose:
      - **Meas Interval**
      - **Interval Type** Time or Distance
      - **Time Interval** or
      - **Distance Interval**

- Then **Back**

b. Then press **Record Save/Recall**

- Then **File Folder Default System**
  - **Default** – Sets the default User Folder path:
    - ––List files (*.csv and *.kml) are save-recalled to:
      `"[CurrentDevice]:\RecordPlayback\CS\"`
    - ––Data Log-Play files are save-recalled to:
      `"[CurrentDevice]:\RecordPlayback\CS\"`

    Or
  - **System** – Sets the User Folder to the user defined system folder path/name:
    - ––List files are save to-from
      `"CurrentDevice\<UserSelectedFolder>\"`
    - ––Data Log-Play files are save-recalled to:
      `"CurrentDevice\<UserSelectedFolder>\"`

    Refer to “File Management” on page 887.
- Then **File Type**
  - KML (Default) or
  - CSV
- Then **Save Log File**

  or
- Then **Recall Log File**
- **Auto Save** (Default == OFF)
- Then **Back**

c. Optional: Press **Indoor Map Data Logging** then

- **Record Indoor Data** or **Recall Indoor Log File**. Learn more, refer to Chapter 16 Mapping and “Option 352 Indoor Maps Setup Procedure” on page 507 ans “Setting up Data Logging” on page 519.

d. Optional: Press **Signal Locate** – Opens a softkey menu of directional finding (DF) bearing softkeys. Learn more, refer to Chapter 16 Mapping and "How to Add Directional Finding (DF) Bearing" on page 529.

6. Press **Back** to return to previous menu.

7. **Outdoor Mapping only**: If recording, then:

- **View Map OFF ON** To enable/disable the current map view (Default == latitude/longitude == 0.00/00. Need GPS to view current location (Default == OFF).
- **Pause Resume** Temporarily halts recording until pressed again. The incoming trace continues to sweep. Press again to continue recording.
- **Stop** Immediately stops recording and a "Save the Log File" menu opens to rename and save your data log file.
- (Press **Record** to begin a new recording.)
- Then **Maps** To enable map view and related features (e.g., Data Selection, Red/Blue Limits, Labels & Icons, Zoom).
  - **Data Selection** Opens a softkey menu to set the active data channel, sort type, and sort order.

    Learn more, refer to Chapter 16 Mapping and "Setting up Data Logging" on page 519. See also, Chapter 34, "File Management."
  - **Red/Blue Limits** Opens a softkey menu to assign power values to the red (high power limits) and blue (low power limits) heat map display limits (Defaults: Red Limit == –20 dBm, Blue limit == –90 dBm).
  - **Labels & Icons** Opens a softkey menu to enable/disable map data point labels and icon types.

Labels **OFF ON**	Enables/Disables map data point labels. When enabled, a label is displayed for every map data point (e.g., "Data 1"). When disabled, labels are not displayed for the map data points.
Icons **Flag Point Line**	Sets the type of icon that is used to display a map's data points (Default == Flag).

– **Save Image (PNG)** Saves the current displayed map to a *.png file (default filename is “MapImageFile”).

NOTE

Data Log-Play files are saved to:

– If File Folder is set to Default then Data Log-Play files are save-recalled to: "[CurrentDevice]\RecordPlayback\CS"

– If File Folders are set to System, then Data Log-Play files are save-recalled to: "CurrentDevice\<UserSelectedFolder>\

8. Outdoor Mapping: Export KML file into 3rd party mapping software (i.e., Google or Google Earth)

Learn more, refer to Chapter 16 Mapping and “Setting up Data Logging” on page 519. See also, Chapter 34, “File Management.”

How to Define a Channel and Use Channel Scanner

Channel definitions consist of the following:

– Each channel is defined by CF and Integration BW.

– Frequency span is set automatically to 1.5 x Integration BW

– Power is measured over the Integration BW

Using Channel Scanner, refer to:

– “Step 1A: Scan Mode: Range Channel Defined” on page 709 or

– “Step 1B: Scan Mode: Custom List Channel Defined” on page 710

– “Step 1C: Scan Mode – EMF Custom List Channel Defined” on page 711

Then:

– “Step 2: Select Display Type” on page 715

– “Step 3. Modify Scale and the Display Color Bar Settings” on page 721

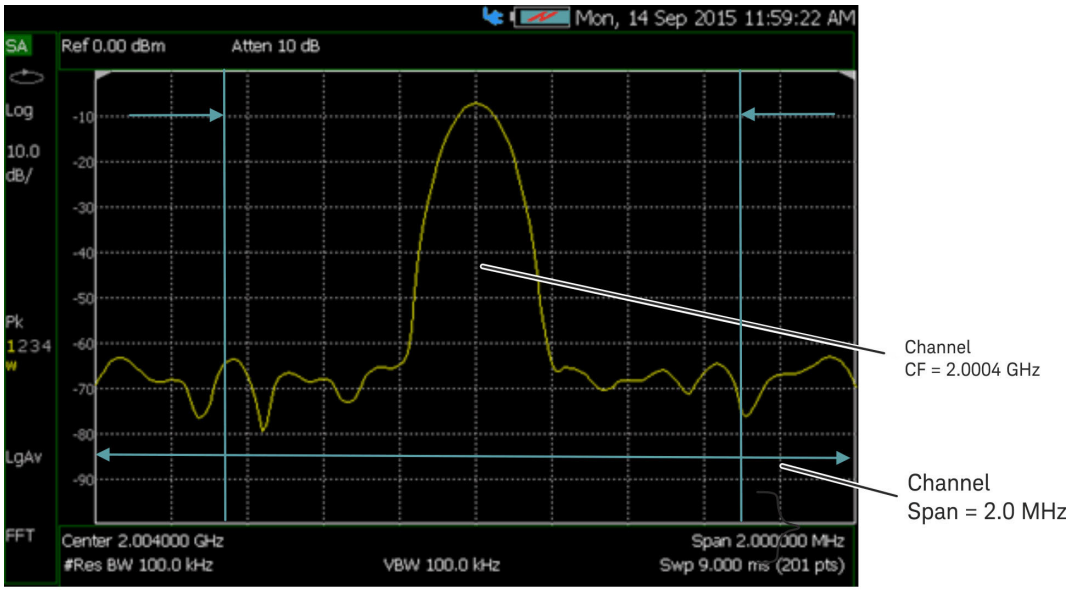
– “Step 4. Sort and Search softkey menu” on page 722

– “Step 5: Enable Data Logging and Play Results” on page 724

– “Step 6: Save the Log Results:” on page 727

– “Step 7: Import and Play back KML Files into 3rd Party Software (Example: Google Earth with Animation Tool)” on page 728

Figure 29-2 Channel Definition



Step 1A: Scan Mode: Range Channel Defined

1. Define some channels: Press **Measure** > **Scan Mode** > **Range**
2. Press **Edit Range** and modify table items:
   - Total Channels
   - Search Count
   - Start Channel CF
   - CF Step Size

Figure 29-3 Range Table Settings

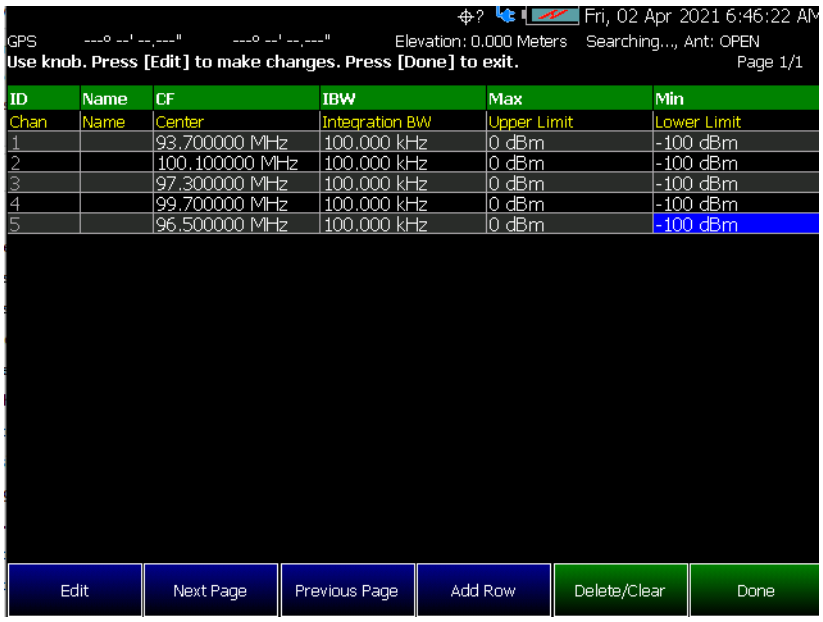
3. Press **Done**

Step 1B: Scan Mode: Custom List Channel Defined

1. Define some channels: Press **Measure** > **Scan Mode** > **Custom List**
2. Press **Edit Custom List** and modify table items:
   - Add table rows
   - Then for each row:
     - Edit Center Frequency (CF)
     - Edit Integration BW (IBW)

NOTE Integration BW (IBW) is coupled to the Frequency Span setting. Frequency Span is 50% wider than the IBW (e.g., if the IBW value is 1 MHz, then the Frequency Span value is 1.5 MHz).

Figure 29-4 Custom List Table Settings



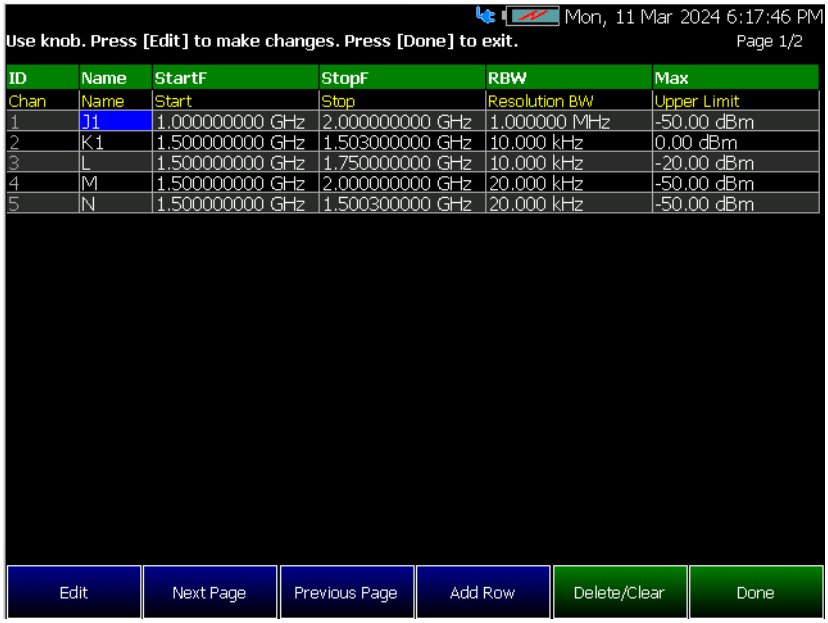
3. Press **Done**
4. Press **Save Recall List** > **Save List** to save a custom list. See also "How to use the FieldFox labeler " on page 891.

NOTE Press **Recall List** to bring back a previously stored custom list

Step 1C: Scan Mode – EMF Custom List Channel Defined

1. Define some channels: Press **Measure 1** > **Scan Mode** > **EMF Custom List**
2. Press **Edit EMF Custom List** and modify table items:
   a. Press **Add Row** to add table rows
   b. Then for each row
      - Edit the Channel ID (ID)
      - Edit the Channel Name (Name)
      - Edit Start Frequency (StartF)
      - Edit Stop Frequency (StopF)
      - Edit Resolution Bandwidth (RBW)
      - Edit the Upper Limit (Max). Set to 200 dBm to disable the Upper Limit Test.

Figure 29-5 EMF Custom List Table Settings



3. Press **Done**
4. Press **Save Recall List** > **Save List** to save a EMF Custom List. See also "How to use the FieldFox labeler " on page 891.
5. Press **Done**

NOTE

A template EMF Custom List file named EMF_Channel_List_Template.csv is located in the same directory used for storing user-defined channel lists "ChannelScanner\ChannelLists". This template can be utilized to verify the syntax used for populating EMF metadata information, such as antenna serial number, model, etc. These details will generate annotations on the table display and will also be logged when performing a recording.

To Export EMF Custom List to Limit Line File (EMF Custom List Only)

1. Press **Measure 1** > **Save Recall List** > **Export List To Limit Line File** to Export EMF Custom List to Limit Line File. See also "How to use the FieldFox labeler " on page 891.
2. Press **Done**. The file is saved to the same default location as all limit files
3. To utilize this Limit Line file, press **Limit 8** >**Recall Limits**.

NOTE

The Export List function generates a CSV file wherein each data point corresponds to the Center Frequency and the current Upper limit and current unit of each channel.

NOTE

IMPORTANT!

The EMF softkey menu is only activated when the scan mode is in the EMF Custom List.

Using EMF softkey menu

1. Press **Trace 6** > **EMF** to EMF menu. Refer to Figure 29-6. Then
2. Press **Column Display** and select a custom column from the following to display in the table when the Display Type is set to "Table":
   - **Summary** - Display all channels across the following columns: Service, Band, P Live, P Min, P Avg, P Max, PMin/PLim, PAvg/PLim, and PMax/PLim in the table with Relative Mode disabled, where P is Channel Power. When Relative Mode is enabled, the Column Display automatically switches to Exposure Ratio.
   - **P/F** – displays P (Pass) or F (Fail) if Limit Tests are enabled for the channel, or '-' if Limit Tests are not enabled. Refer to "Disable Limit Test in Channel Scanner mode," on page 813
   - **IBW** – displays the integration bandwidth (IBW) of a channel relative to the first (reference) channel in Relative Units (% or dB) when Relative Mode is enabled.
   - **CHP** – displays the channel power (CHP) of a channel relative to the first (reference) channel in Relative Units (% or dB) when Relative Mode is enabled.
   - **PMax** – display the maximum power measured since the most recent restart. When Relative Mode is enabled, the PMax value displayed in Relative Units (% or dB).
   - **PMin** – display the minimum power measured since the most recent restart. When Relative Mode is enabled, the PMin value displayed in Relative Units (% or dB).
   - **Exposure Ratio** - The table view is similar to the Summary table view, but with Relative Mode enabled, which calculate the exposure ratio for each Channel Power reading. When Relative Mode is disabled, the Column Display automatically switches to Summary.

CAUTION

When Relative Mode is disabled, the result table displays the selected IBW, CHP, PMax, or PMin values in columns labeled BW (Hz), P Live (V/m), P Max or P Min with the corresponding measured units.

CAUTION

When Relative Mode is enabled, the result table displays the selected IBW, CHP, PMax or PMin values in columns labeled BW, P/Ref, P Max, or P Min using Relative Units (% or dB). These values represent the relative measurement compared to the first channel, which is labeled as the reference channel (ID column labeled '1-ref').

3. Press **Relative Mode** and choose
   - **ON** to enable Relative Mode (Default == **OFF**).

NOTE

When Relative Mode is enabled, the EMF Custom List Editor labels the first row in the ID column as '1-ref'.

4. **Relative Unit** Changes the unit of ratio type results. To view relevant ratio results, ensure that both Relative Mode and Limit Lines are enable.
   - **Auto** (Default) - Firmware will decide [%] or [dB] based on the current Amplitude Unit setting, **Scale /Amptd6** > **More** > **Unit**.
   - **%** - Ratio type results in unit %.
   - **dB** - Ratio type results in unit dB.

CAUTION

To view relevant ratio type results, ensure that both Relative Mode and Limit Lines are enable.

Learn more, refer to "Creating and Importing *.csv Limit Line Files" on page 819.

Figure 29-6 EMF Custom List - EMF Menu

Step 2: Select Display Type

Select one of the following display orientations:

– Select **Display Type**—choose:
  – **Bar ChartV** or
  – **Bar ChartH** or
  – **Channel Pow** or
  – **Table** or
  – **Strip Chart** or
  – **Chart Overlay** or
  – **Scan&Listen**

NOTE

In the EMF Custom List scan mode, when limit lines are configured, users will notice a red line representing the limit on a channel in both the Vertical and Horizontal Bar Charts. If the channel passes the limit test, the bar will show "P". If the channel fails the limit test, it will display "F". If the limit test for a channel is disabled, neither "P" nor "F" will appear on the bar, and there will be no red limit line displayed for that channel. Refer to Figure 29-8 and Figure 29-10

Figure 29-7 Bar Chart Vertical Display Type

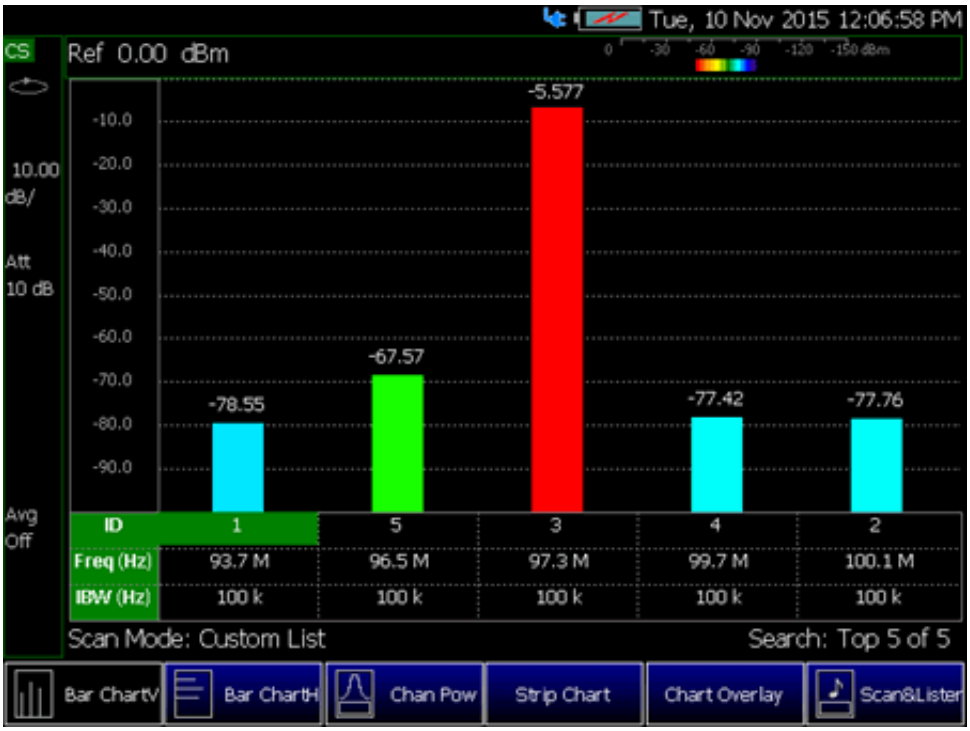


Figure 29-8 Bar Chart Vertical Display Type - EMF Custom List with Limit Line Configured

Figure 29-9 Bar Chart Horizontal Display Type

Figure 29-10 Bar Chart Horizontal Display Type - EMF Custom List with Limit Line Configured

Figure 29-11 Channel Power Display Type

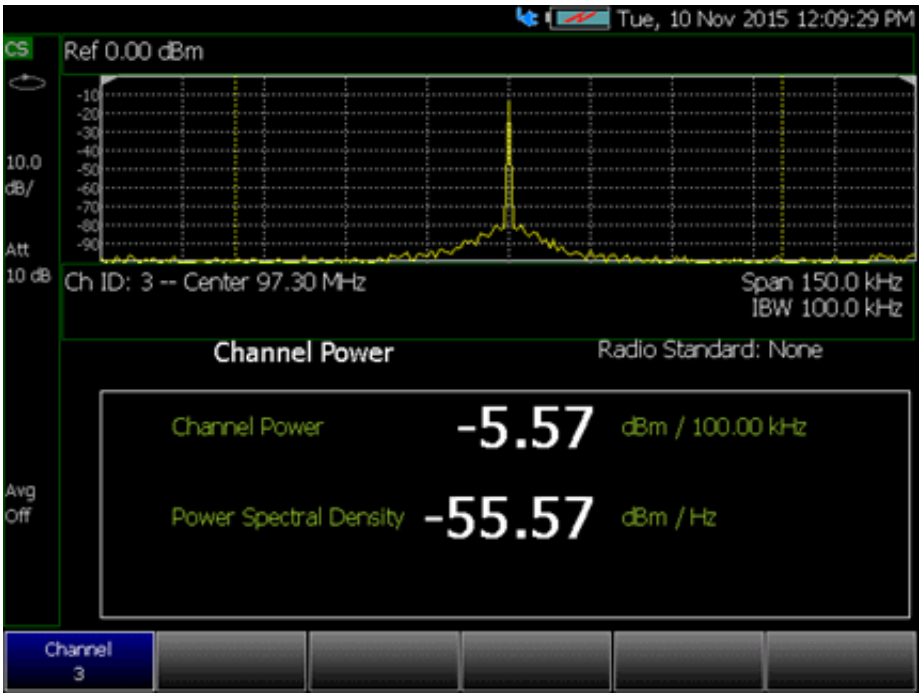


Figure 29-12 Table Display Type

Figure 29-13 Table Display Type - EMF Custom List with Limit Line Configured

Service	Band(MHz)	P Live (dBm)	P Min (dBm)	P Avg (dBm)	P Max (dBm)	PMin/PLim (dBL)	PAvg/PLim (dBL)	PMax/PLim (dBL)
J1	1000-3000	-38.30	-38.76	---.---	-38.15	11.244	11.703	11.852
K1	1250-1500	-47.19	-47.30	---.---	-47.07	-47.298	-47.186	-47.075
L1	1500-1750	-47.90	-48.08	---.---	-47.84	-28.080	-27.899	-27.844
M1	1750-2000	-46.93	-47.02	---.---	-46.72	-17.018	-16.934	-16.724
N1	2000-2250	-47.01	-47.16	---.---	-46.87	-7.1590	-7.0122	-6.8702
O1	2250-2500	-46.55	-46.74	---.---	-46.32	3.2609	3.4475	3.6779
P1	2500-3000	-45.67	-45.79	---.---	-45.43	14.211	14.333	14.571
TER (dB)						16.234	16.469	16.677

NOTE In EMF Custom List scan mode Table, the P/PLim column will show data when EMF Custom List Upper limit or Limit Lines are configured. P/PLim represents the relative power compared to the limit.

Figure 29-14 Strip Chart Display Type

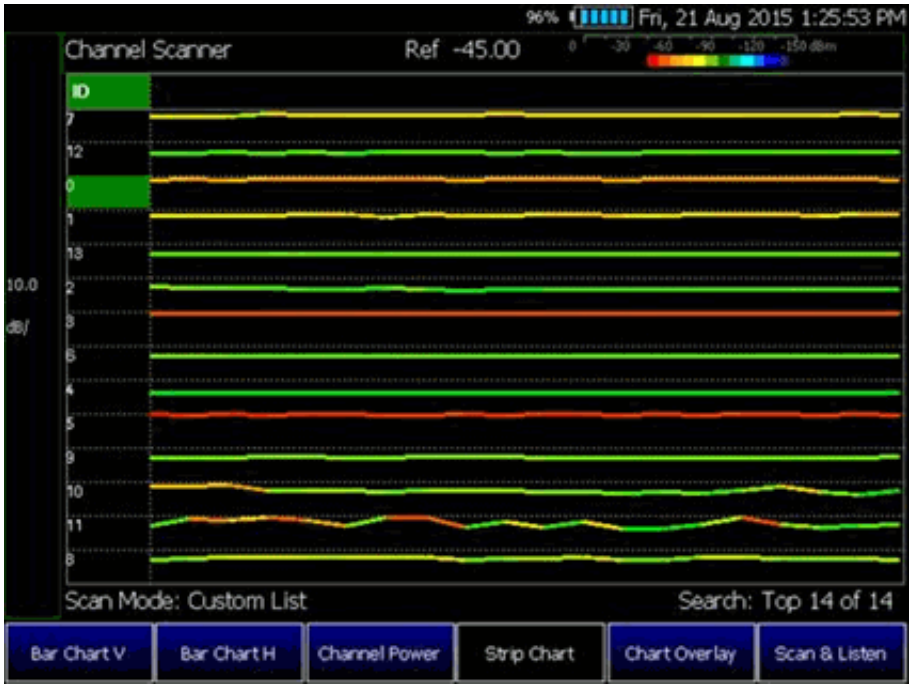


Figure 29-15 Strip Chart Overlay Display Type

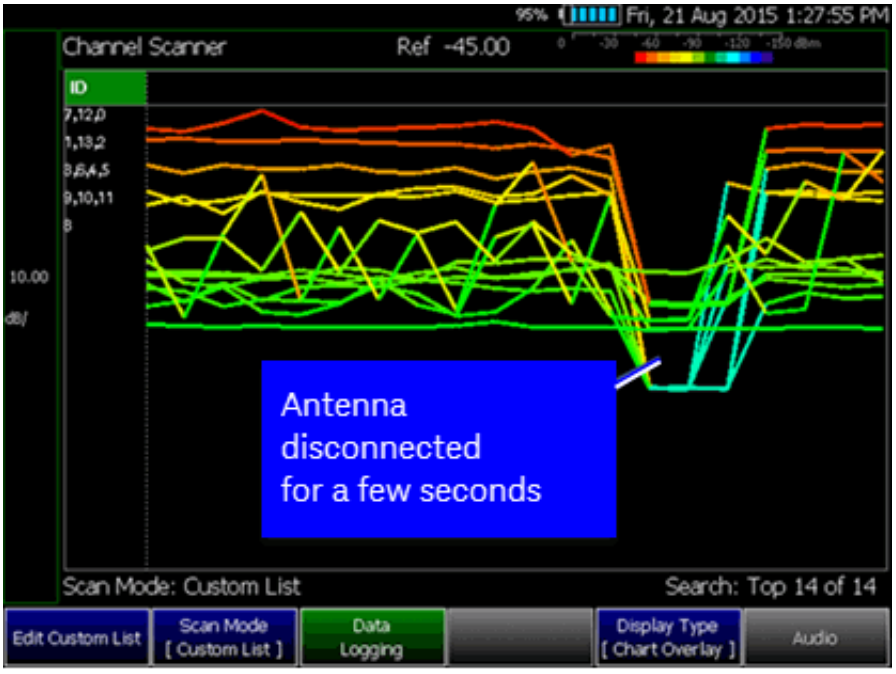
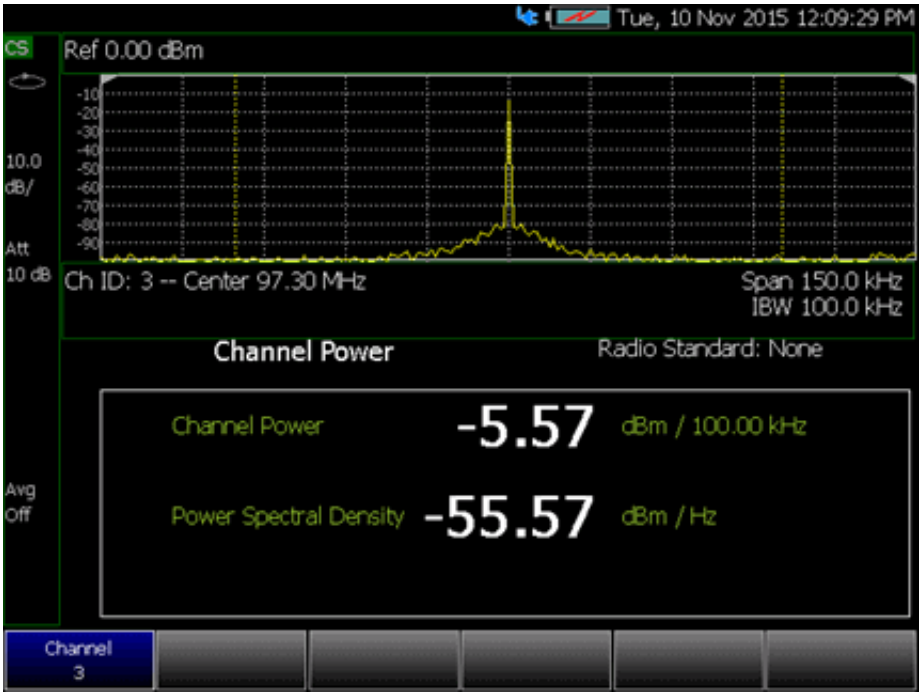


Figure 29-16 Scan & Listen Display Type



Step 3. Modify Scale and the Display Color Bar Settings

To modify the scale values:

1. Press Scale/Amptd > Scale and input desired scale value.
2. Then press dB/ to set the new scale unit.

To assign colors to low and high power values:

1. Press Scale/Amptd > Red Limit to set high power values and to set the color.
2. Press Blue Limit to set low power values and to set the color.
3. And, then press System > Display > Display Colors, to set Indoor, Outdoor, or other display colors. See also Chapter 29, “Channel Scanner (Option 312)”, on page 701.

Figure 29-17 Outdoor Display Colors

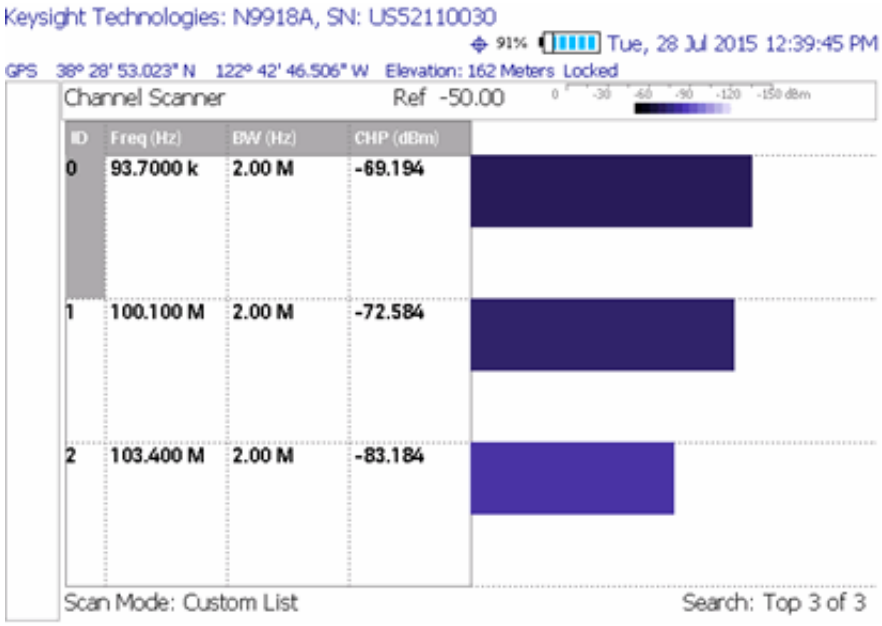
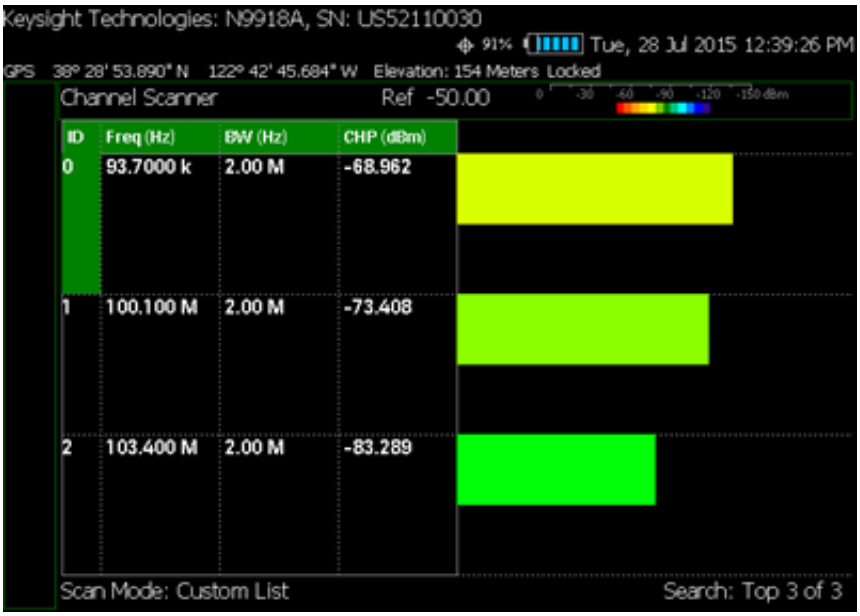


Figure 29-18 Indoor Display Colors



Step 4. Sort and Search softkey menu

Use the **Sort and Search** softkey menu to organize your data.

– Press Trace 6 > Sort and Search then choose from the following:

  – Sort – Opens a softkey menu, then choose

- ––Sort Power Freq – Sort by frequency or power. Default is Sort by Frequency (Freq).
- ––Sort Order Up Down – Sort order of the frequency or power values can be done Up (increasing values) or Down (decreasing values).

– Next Page – Inactive by default.

- ––Press Search > Page to enable Next Page softkey if more than one page of data to display.
- ––Press Next Page to display next page list of data. Next page is disabled when you are at the bottom of the list.

– Previous Page – Inactive by default.

- ––Press Search > Page to enable Previous Page softkey if more than one page of data to display.
- ––Press Previous Page to display previous page list of data. Previous page is disabled when you are at the top of the list.

– Search Count (Default == Auto)

- ––Auto – FieldFox chooses the search count values based on other coupled settings. Only Custom List or EMF Custom List.
- ––User – Manual input the search count values then press Enter to set the search count for Search function. Only Custom List or EMF Custom List.

NOTE

Search Count indicates the number of displayed channel. The maximum number of channels that can be shown on the screen is 20. In Auto mode, the Search Count value will not be displayed on the button.

– Search – Choose from the following. Total data to display depends the Search Count setting.

- ––Top (Default) – Display data from the Top Channel ID.
- ––Bottom – Display data from the Bottom Channel ID.
- ––ID – Display data by specific Channel ID.
- ––Page – Display data by Page.

– Search ID – inactive by default.

- ––Pressing Search > ID enables Search ID softkey.
- ––Pressing Search ID enables editing of the Channel ID number to search and display the channel ID number entered in the screen.

– Next Page and Previous Page – inactive by default.

——Pressing Search > Page enables Next Page and Previous Page softkey if more that one page of data to display.

Step 5: Enable Data Logging and Play Results

Data logging records your data with a timestamp and GPS stamp (refer to "GPS – Distance Settings" on page 857). GPS must be enabled for the log results to include a GPS stamp.

Features

- Log files contain measured channel results including timestamps and/or distance stamps.
  - Timestamps are included in log files with or without GPS.
  - GPS must be enabled for log results to include distance stamps.
- Data results can be logged
- Data results can be saved to a *.CSV or *.KML file. Refer to "Step 6: Save the Log Results:" on page 727.
- User specifies how often results are stored.
  - Time: Store results every "n" seconds
  - Distance: Store results every "n" meters. GPS must be enabled to store results by distance.

Outdoor Mapping Procedure

For Indoor Mapping and more on Outdoor Mapping, see also Chapter 16 Mapping and "Option 352 Indoor Maps Setup Procedure" on page 507, "Option 352 Outdoor Maps Setup Procedure" on page 511, and "Setting up Data Logging" on page 519. See also, Chapter 34, "File Management."

1. Press Measure 1 or Trace 6 > Data Logging
2. **Outdoor Mapping Only:** Press Record Settings then:
   - Meas Interval OFF ON (Default == OFF) - set to ON
   - Interval Type Time Distance (Default == Time) - choose a setting
   - Time Interval 1 sec to 3,600 seconds or
   - Distance Interval from 1m to 10 km
   - When done, press Back
3. Press Record Save/Recall then:
   - Recall Log File
   - File Folder Default System - (Default == Default).

- File Type - CSV or KLM
- Auto Save OFF ON - (Default == OFF). Press to enable/disable.
- then Back

Learn more, see "How to Set Up Channel Scanner" on page 703, step b.

4. To begin outdoor logging recording: Press Record

   If Auto Save is On (Default == OFF) Measurements are stored automatically accorded to the specified time or distance interval values. Refer to step 5.

5. Optional: Auto Save OFF (Default)—When Auto Save is on, during recording, the FieldFox stores intermediate results in a temporary file. If the power fails during recording you can retrieve the results. Select Recall Log File. Select the temporary file name.

   Press Record Save/Recall > Auto Save On Off

6. When done press Stop or Esc. The files save dialog is displayed. Edit the file name where the file results will be stored.
7. Press Done

Learn more, refer to Chapter 16 Mapping and "Option 352 Outdoor Maps Setup Procedure" on page 511 and "Setting up Data Logging" on page 519. See also, Chapter 34, "File Management."

Playing a Data Log and Viewing the Spectrogram

To play the log results:

Refer to Figure 29-19 on page 726.

1. Press Data Logging > Play
2. Then choose:
   - Optional: Use the RPG (fine adjust) or the arrow keys (coarse adjust) to change the color bar.

     See also, "How to Set Up Channel Scanner" on page 703.
3. Press Stop or Esc to exit the log recording.

To pause the log play:

1. Optional: Press Pause Resume to pause or resume the log recording.
2. Then choose:
   - Optional: Use the RPG (fine adjust) or the arrow keys (coarse adjust) to change the color bar.

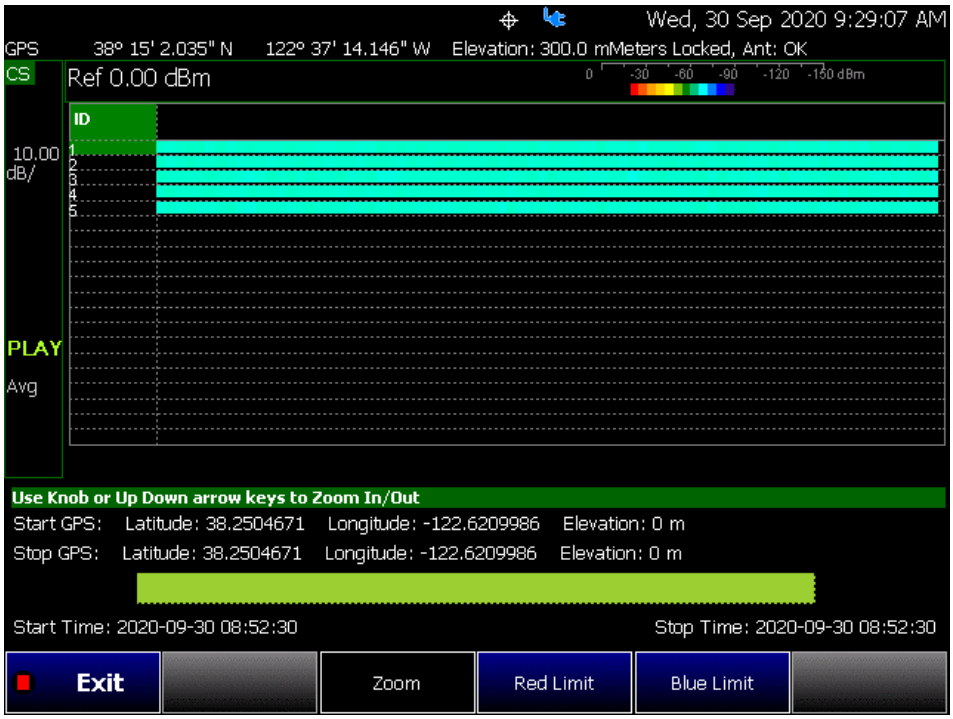
- Cursor Position to change the position along the time record's results (i.e., **Cursor Position** is active only when playback is paused).
- Maps > Red/Blue Limits then
  - Red Limit to change the color bar.
  - Blue Limit to change the color bar.

3. Press Stop or Esc to stop the log recording.

To View the spectrogram of recorded results:

1. Press View (Applies to Option 312 Only)
2. Then choose:
   - Zoom to zoom in on spectrogram time record results.
   - Red Limit to change the color bar.
   - Blue Limit to change the color bar.
3. Press Exit or Esc to exit view.

Figure 29-19 Spectrogram View



Step 6: Save the Log Results:

Two file types are supported for save or recall log results:

- KML file format
  - Files include bar color
  - Files stored in this format can be imported into 3rd party applications like Google Earth or Google Maps.
- CSV file format. Files stored into this format can be imported into spreadsheet applications.

1. Press **Record Save/Recall** > **File Type** CSV or KLM > **Back**
2. To begin recording: Press **Record**

   Measurements are stored automatically according to the specified time or distance interval values.
3. When done press **Stop**. The files save dialog is displayed. Edit the file name where the file results will be stored.
4. Press **Done**
5. Optional: **Auto Save** ON (Default == OFF)—When Auto Save is on, during recording, the FieldFox stores intermediate results in a temporary file. If the power fails during recording you can retrieve the results. Select **Recall Log File**. Select the temporary file name.

   Press **Record Save/Recall** > **Auto Save On Off** >**On**

Optional Step: Indoor Map Data Logging

Once you have selected a channel to measure, you can record data logging using Indoor Mapping. Refer to "Step 1A: Scan Mode: Range Channel Defined" on page 709.

Learn more, see "How to Set Up Channel Scanner" on page 703, step 5.

1. Press **Measure 1** > **Data Logging** > **More** then
2. Press **Indoor Map Data Logging** then
   - **Record Indoor Data** (new indoor mapping file (*.png)) or **Recall Indoor Log File** (recall a previously stored *.kdat, to modify). Learn more, refer to Chapter 16 Mapping and "Option 352 Indoor Maps Setup Procedure" on page 507 and "Setting up Data Logging" on page 519.
3. Measurements are displayed on the current indoor map in the specified intervals.
   - Use **More** > **Data Selection** softkey menu to select the **Channel** displayed, the **Sort Power Freq**, and the **Sort Order Up Down**.

Then **Back**.

– Use the **Labels & Icons** softkey menu to select **Labels OFF ON**, **Icons Flag Point Line**, and **Pointer OFF ON**.

Then **Back**.

Learn more, refer to Chapter 16 Mapping and to "Enabling and Setting Up Indoor Map Logging" on page 522.

Use the **Labels & Icons**, **RPG [Zoom]** settings, **Save Map**, and **Save Image (PNG)**.

Learn more, refer to Chapter 16 Mapping and to "Enabling and Setting Up Indoor Map Logging" on page 522.

– Use the **PAN** softkey menu to change locations on the indoor map.

4. To begin recording (add a data point): Press **Record Data**.
5. Optional: Set **Bearing Line**, refer to "Enabling and Setting Up Indoor Map Logging" on page 522.
6. Repeat steps 4 and 5 as necessary.
7. When done press **Back** or **Esc**. The files save dialog is displayed. Edit the file name where the file results will be stored as a *.kdat file.
8. Press **Done**

Learn more, refer to Chapter 16 Mapping and "Setting up Data Logging" on page 519. See also, Chapter 34, "File Management."

Step 7: Import and Play back KML Files into 3rd Party Software (Example: Google Earth with Animation Tool)

Features

Use the Playback Slider to replay measurement results. See also Google Maps and or Google Earth's help.

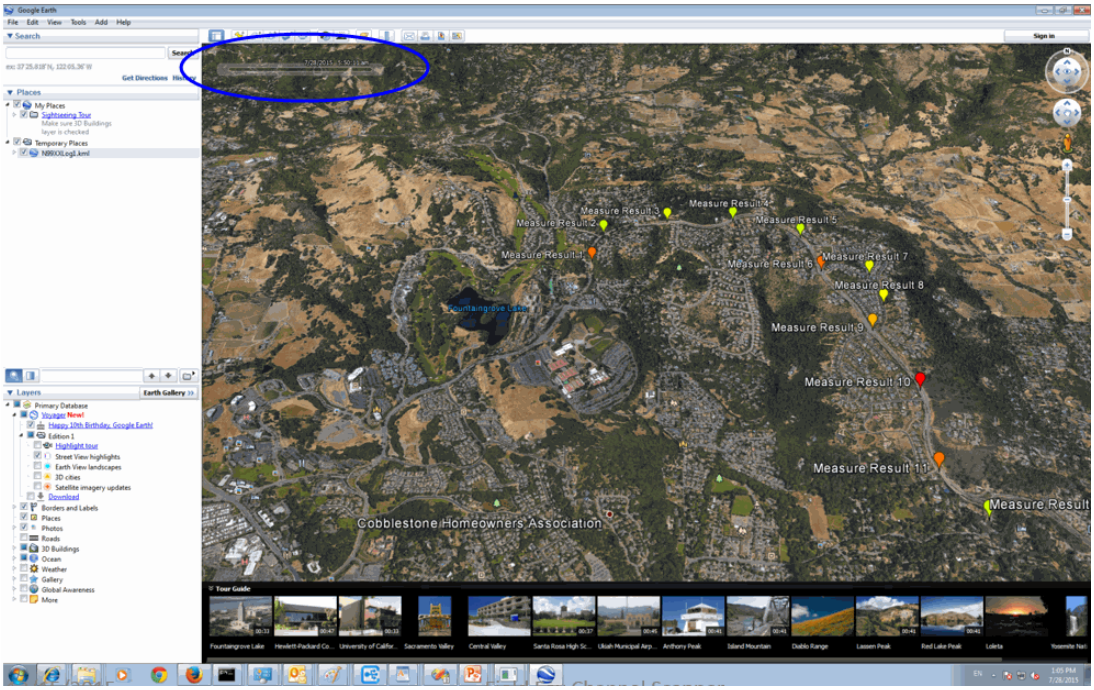
– Open the FieldFox *.KML file in Google Earth. Time Slider appears in upper left of the map.

– Manual Mode – Move the time slider cursor to see color-coded icons pop-up according to the timestamp.

– Loop mode has a Fast-Slow Replay Option.

– Click on each color coded balloon to see the table of measurement results for that location.

Figure 29-20 Importing a KML File Into Google Earth



Field Strength Measurements

To measure the strength of any signal transmitted through the air, an antenna must be connected to the FieldFox. The Field Strength feature allows you to enter the frequency response of the receiving antenna (the Antenna Factor) and associated cabling, and then have amplitude corrections automatically compensate the displayed trace for that response.

Figure 29-21 Overview of Field Strength for Channel Scanner (See also, Figure 29-22 on page 731.)

FieldFox Field Strength Channel Scanner

Refer to Figure 29-22 on page 731

Figure 29-22 Editing Antenna Factor (See also, Figure 29-21 on page 730.)

Figure 29-23 Yellow Trace with Cable and Antenna Corrections

Yellow trace: Cable correction, which is the sum of the antenna correction and the cable correction (These corrections are linearly interpolated).

Field Strength Measurements

Yellow Trace - Corrected trace with antenna factor. This correction, includes the sum of the antenna correction and the cable correction (These corrections are linearly interpolated). (Antenna == ON, Apply Corr == ON). Refer to Figure 29-23 on page 731.

For information, refer to "Trace Display States (SA Mode)" on page 209

- Learn how to set Y-Axis **Units** on "How to Set Y-axis Units" on page 162.
- Use a Band Power marker to measure total power over a range of frequencies. Learn how in "Band/Interval Power Marker" on page 225

How to select and edit corrections for Field Strength measurements

The Antenna and Cable correction data survives a Mode Preset and Preset.

All Correction ON/OFF states survive a Mode Preset, but NOT a Preset.

- Press **Scale/Amptd**.
- Then **More**
- Then **Corrections**
- Then choose from the following:
  - **Apply Corrections Auto Disabled** Use Auto and Disabled correction for all settings.
  - **RcvrSide Antenna Off / On** Edit/Recall an Antenna file to be used on the receiver side.
  - **RcvrSide Cable Off / On** Edit/Recall a Cable file to be used on the Receiver side.
  - **View Corrections** > **View Corrections ON OFF** Turn ON and OFF Yellow Trace - Antenna/Cable corrections. This is a composite of all cable/antenna corrections that are currently applied. Available as a useful visual aid, the zero "dB" level (no net correction) is mapped to appear at the -50 dBm on-screen level.

The following menu appears when any of the above Antenna or Cable softkeys are pressed:

- **Antenna/Cable ON OFF** Turn correction ON or OFF for this Antenna/Cable.
- **Edit Antenna/Cable** Edit an Antenna/Cable Correction table. See Using the Antenna/Cable Editor (below) for more information.
- **New** Create a new Antenna/Cable. See Using the Antenna/Cable Editor (below) for more information.
- **Save Antenna/Cable** Save the modified Antenna/Cable to a file on the specified Storage Device.

– **Recall Antenna/Cable** Read an existing Antenna/Cable file from the specified Storage Device.

– **Storage Device** Choose from: Internal, USB, SD. Learn more about these selections in "Set File Type and Select Device" on page 894.

When finished, press **Back** to return to the previous menu.

Field Strength Correction Examples

Refer to Figure 29-24 on page 733 and Figure 29-25 on page 734.

Figure 29-24 Apply Corrections Set to Auto

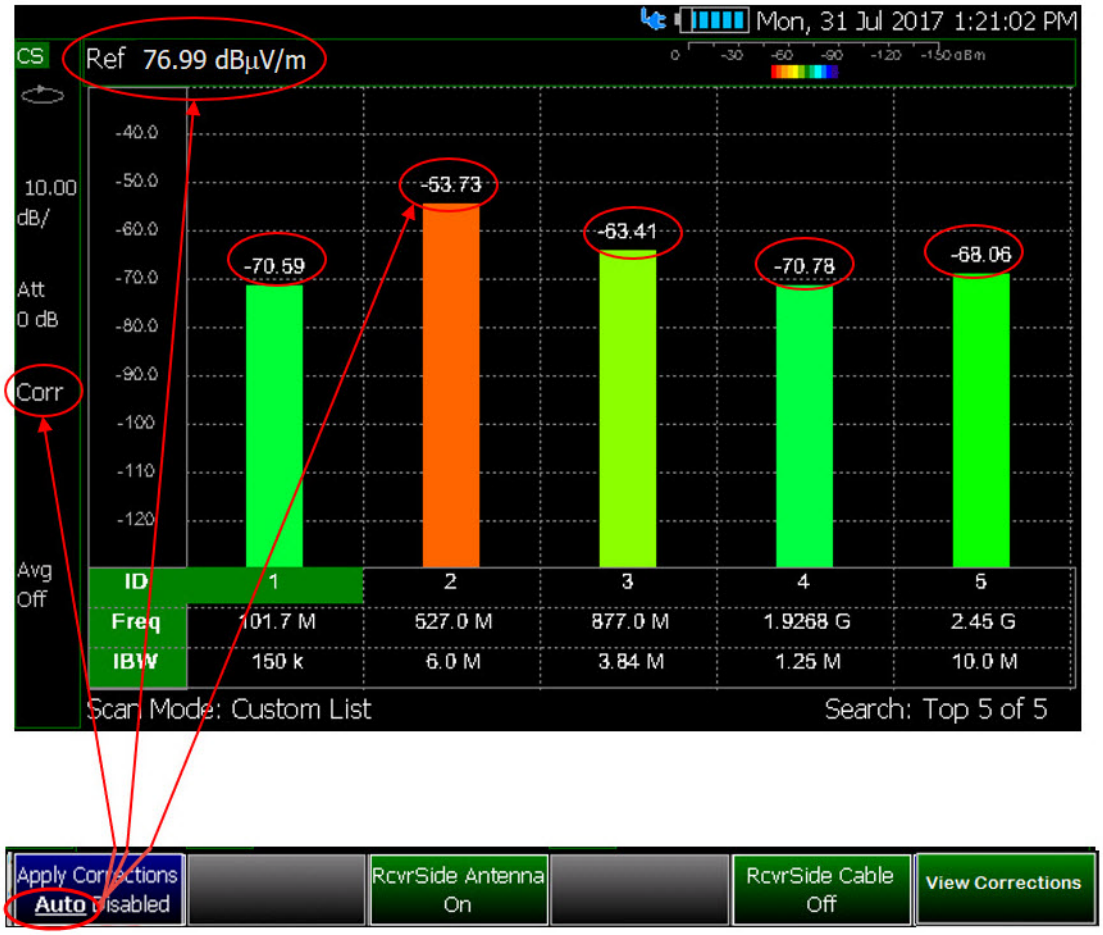
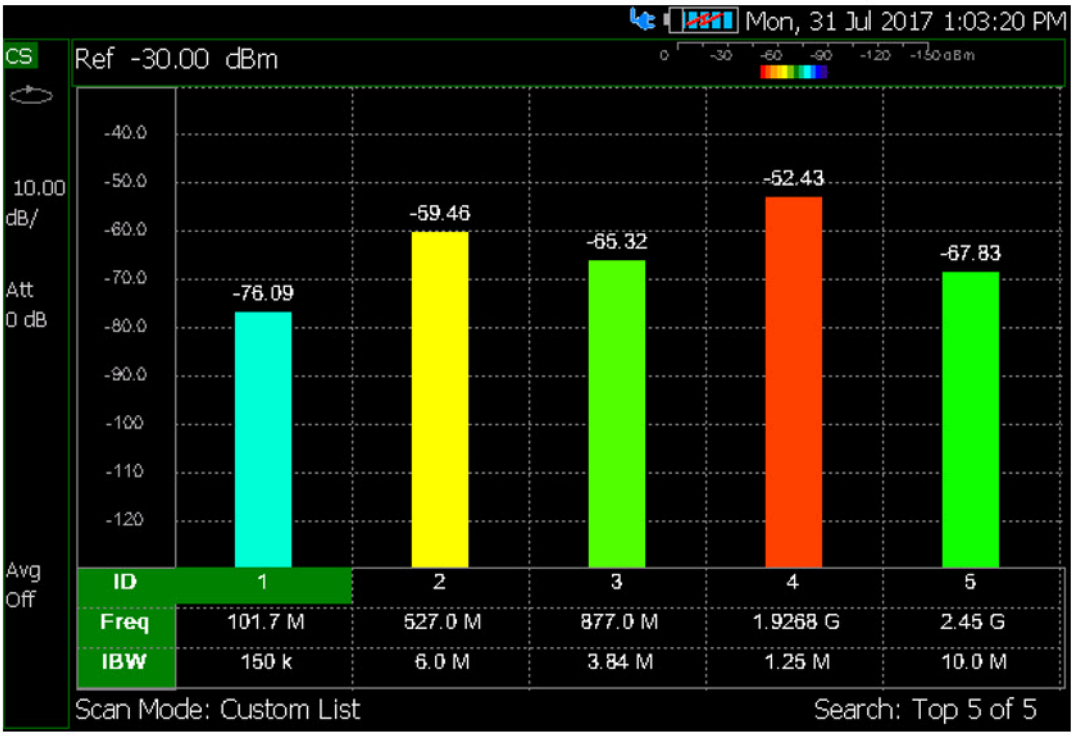


Figure 29-25 Apply Corrections Set to Disabled



Using the Antenna/Cable Editor

To learn more, refer to Chapter 9, “SA (Spectrum Analyzer) Mode (Option 233–Mixed Analyzers).” and to “Using the Antenna/Cable Editor” on page 167.

Using Mapping

Channel Scanner mode has indoor and outdoor mapping capability. Refer to Chapter 16, “Indoor and Outdoor Mapping – Option 352 (Requires Spectrum Analyzer Mode (Option 233), and GPS Receiver (Option 307)).”

Using Extrapolation Factor

Extrapolation factor is a correction factor that is applied as an offset to channel power results. Whatever positive or negative value is set will be added to the channel power results. The setting is in dB, and if channel power results are in a linear unit form, the extrapolation factor will be applied **before** the channel power is converted to those units. There is no annotation on screen to indicate the extrapolation factor, but it will be logged when making a recording as part of the header metadata in the *.csv recording log file.

The Extrapolation Factor softkey is located here:

– Press **Scale/Amptd** > **More** > **Corrections** > **More** > **Extrap... Factor**

  To edit, enter a negative or positive value in dB (Default == 0, Maximum == 100, Minimum == –100).

  Learn more, refer to “Creating and Importing *.csv Limit Line Files” on page 819.

Using the Uncertainty List

– To open the Uncertainty Table: Press **Mode** > **More** > **Channel Scanner** > **Cal 5** > **Uncertainty List**.

  To edit the Uncertainty List table click the right side column.

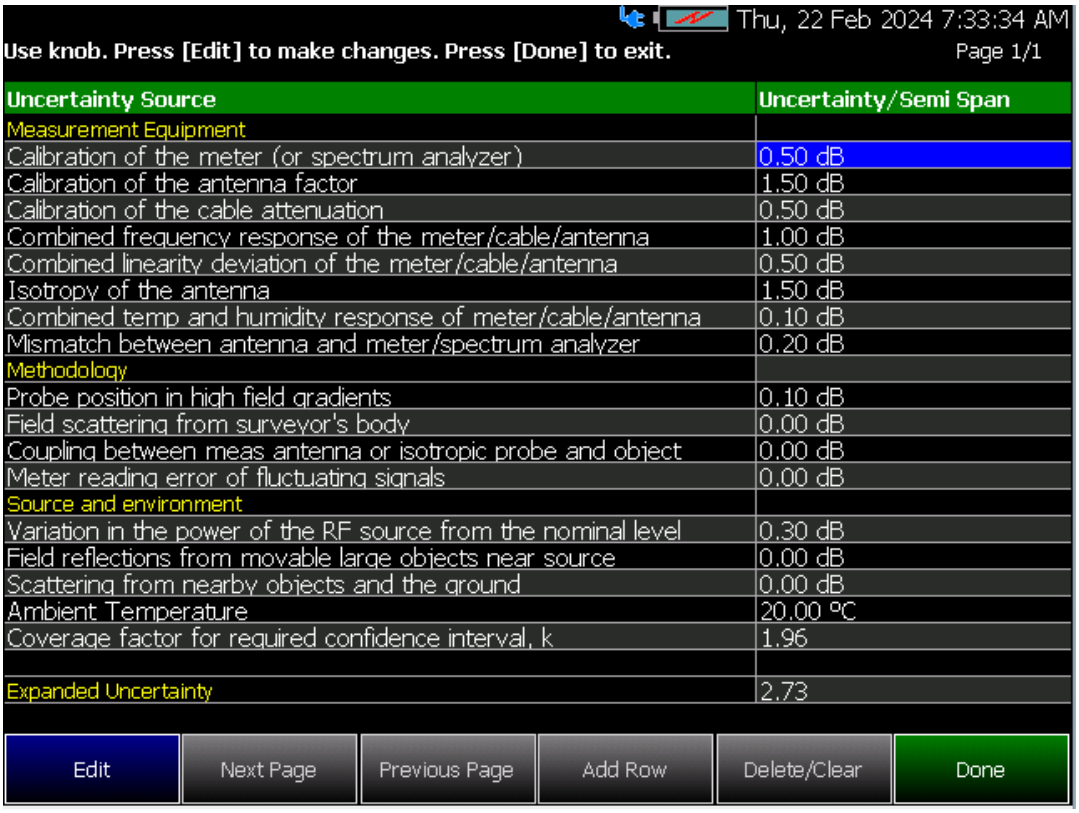
– To save Uncertainty List table values:

  1. Press **Save Recall Uncertainty List** > **Save Uncertainty List**
  2. Input filename
  3. Press **Done**.

– To recall Uncertainty List table values:

  1. Press **Save Recall Uncertainty List** > **Recall Uncertainty List**
  2. Select filename to recall
  3. Press **Recall File**.

Figure 29-26 Uncertainty List Table



To learn more, refer to Chapter 9, “SA (Spectrum Analyzer) Mode (Option 233–Mixed Analyzers).” and to “Using the Antenna/Cable Editor” on page 167.

Using Resolution Bandwidth Tradeoff (Res BW Tradeoff)

This feature controls the resolution bandwidth for the current measurement.

To use this feature, press **BW 2** > **Res BW Tradeoff** then choose from the following:

- **High Sensitivity** – Use this setting for greatest accuracy (Res BW == 1500).
- **Medium** – This is the default setting (Res BW == 450).
- **Speed** – When you want the fastest possible measurement (Res BW == 150).

NOTE In EMF Custom List scan mode, the Res BW Tradeoff feature will be deactivated and switched to manual mode. Users will input these values manually in the EMF Custom List Table.

30 Noise Figure Mode (Option 356)

CAUTION

IMPORTANT! Noise Figure mode uses DC variable voltage source (VVS) – (Option 309) during the measurements. The voltage might be as high as 28V during the measurement. During the noise figure measurement, always make sure there are no voltage sensitive devices connected to the DC SMB output port. When you exit the Noise Figure mode, the VVS voltage is reset to 1V to avoid potentially damaging your devices. Refer to "Variable Voltage Source (Opt. 309)" on page 871.

When you initially change the FieldFox m ode to Noise Figure, the FieldFox displays the following message for ten seconds:
"`Ensure your Noise Source is connected to the VVS DC Output It (VVS) will be driven up to +28V during the measurement`".

When connecting a Smart Source similar to a U1832/U1833A/B/C/D, please wait 10 to 20 seconds, for the FieldFox analyzer to recognize your device.

NOTE

Noise figure requires these options:

– Spectrum analyzer mode (Option 233—Combination Analyzers Only)

– Preamplifier (Option 235)

– DC variable voltage source (Option 309)

– Noise source refer to https://www.keysight.com/us/en/assets/7018-06515/configuration-guides/5992-3701.pdf

Not required, but recommended for improved accuracy:

External preamplifier (U7227A/C/F and U7228A/C/F). Refer to www.keysight.com/find/usb-preamp.

NOTE

Noise figure mode sets the sweep to **Continuous OFF** to allow time for connecting a noise source, before beginning any measurements.

Figure 30-1 Example of Jitter Uncertainty (21 points)—with Uncertainty Bars. Learn more in “How to use Auto-Integration” on page 789.

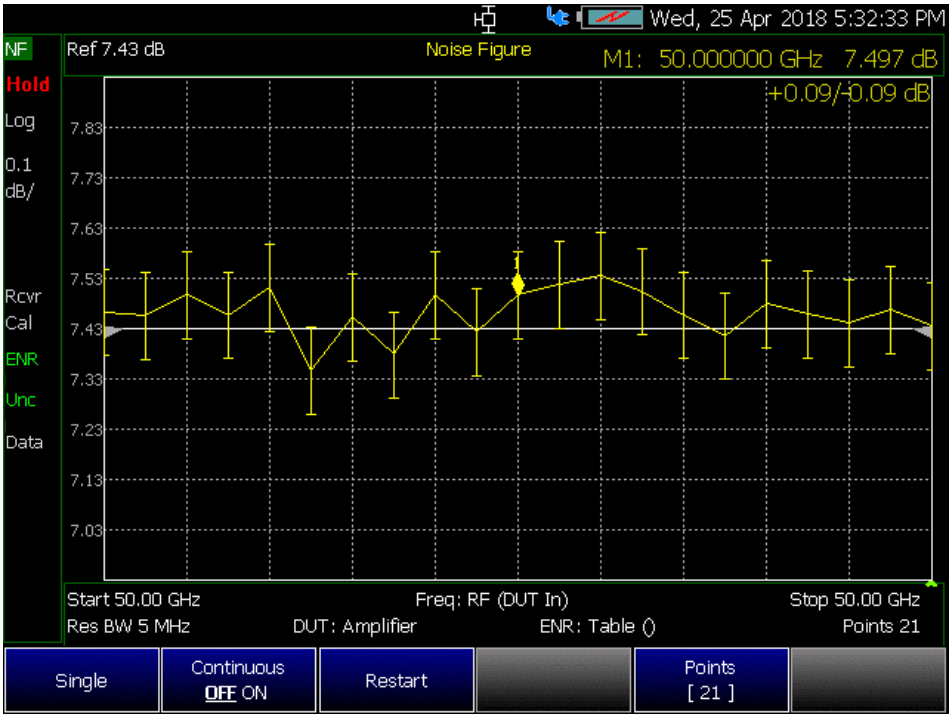
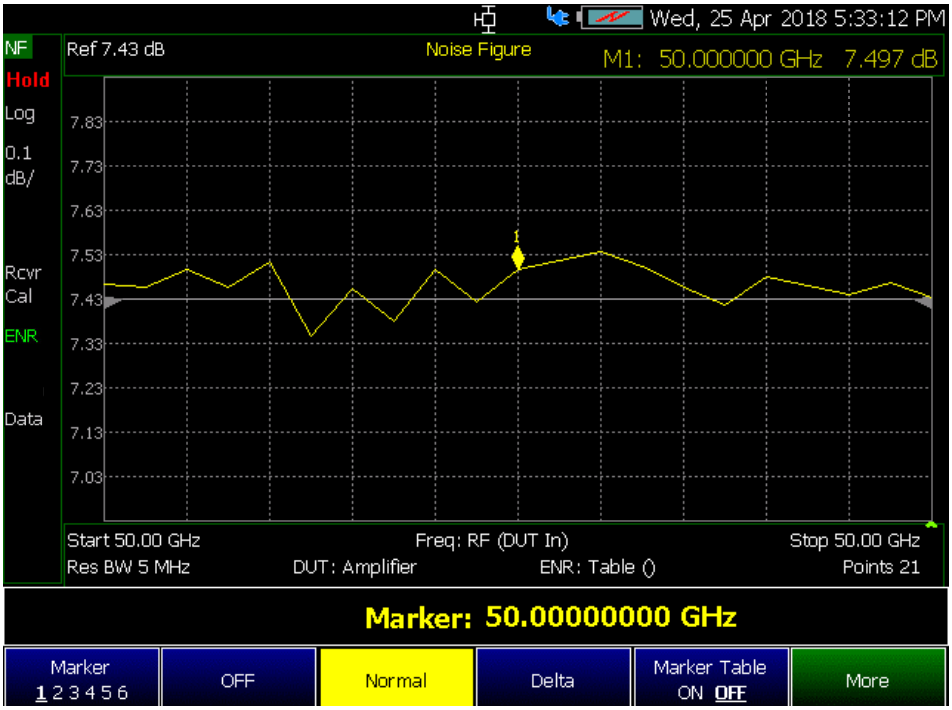


Figure 30-2 Example of Jitter Uncertainty (21 points)—with Uncertainty Bars Disabled. Learn more in “How to use Auto-Integration” on page 789.



In this Chapter:

"Using Noise Figure" on page 740

"How to Define a Noise Figure Measurement" on page 746

– "Example: Typical Noise Figure Measurement Procedure" on page 747

– "Overview of Softkey Menus" on page 748

– "How to Use DUT Measurement Setups" on page 756

– "Single / Continuous / Restart" on page 772

– "Points " on page 772

– "Alignments" on page 773

– "Calculating Noise Figure Measurement Uncertainty" on page 774

– "Using ENR Tables" on page 779

– "About ENR (*.enr), Preamplifier (*.amp), and DUT (*.dut) Files" on page 780

– "Using Markers (Noise Figure)" on page 782

"Calibration Wizard" on page 783

"How to use Auto-Integration" on page 789

"Other Features Available" on page 793

"Troubleshooting" on page 794

See Also

"All about Markers" on page 797

"All about Limit Lines" on page 812

"All about Trace Math" on page 829

"All about Scale Settings" on page 831

Chapter 31, "Data Analysis Features."

Chapter 34, "File Management."

Using Noise Figure

Noise Figure enables you to do the following:

The FieldFox uses the Y-Factor technique to accurately verify and characterize the noise figure of devices. Option 356 has these features:	
Five Measurement Types	
– Noise Figure	– Noise Temperature
– Noise Factor	– Y-Factor
– Gain	
Four Measurement Setup Types	
– Noise Source	– Integration
– DUT	– Uncertainty
Four Pre-configured DUT Measurement Types	
– Amplifier	– Upconverter
– Downconverter	– Multi-Stage Converter
Uncertainty Contribution Values can be Customized for Your Device	
– Jitter uncertainty	– Mismatch uncertainty
– ENR uncertainty	– User calibration uncertainty
– Uncertainty bars	

Select Noise Figure Mode before making any setting in this chapter.

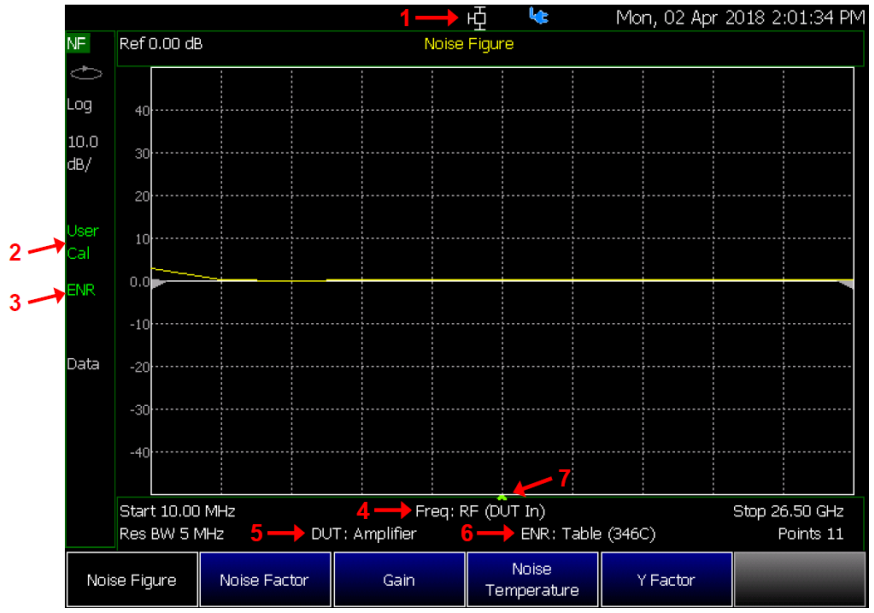
How to select Noise Figure Mode:

– Press **Mode**.

– Then **More**.

– Then **Noise Figure**.

Figure 30-3 Display Annotation—Overview



1. Variable Voltage Source (VVS) Status (appears when VVS is on. Refer to "Variable Voltage Source (Opt. 309)" on page 871.

2. Calibration Status

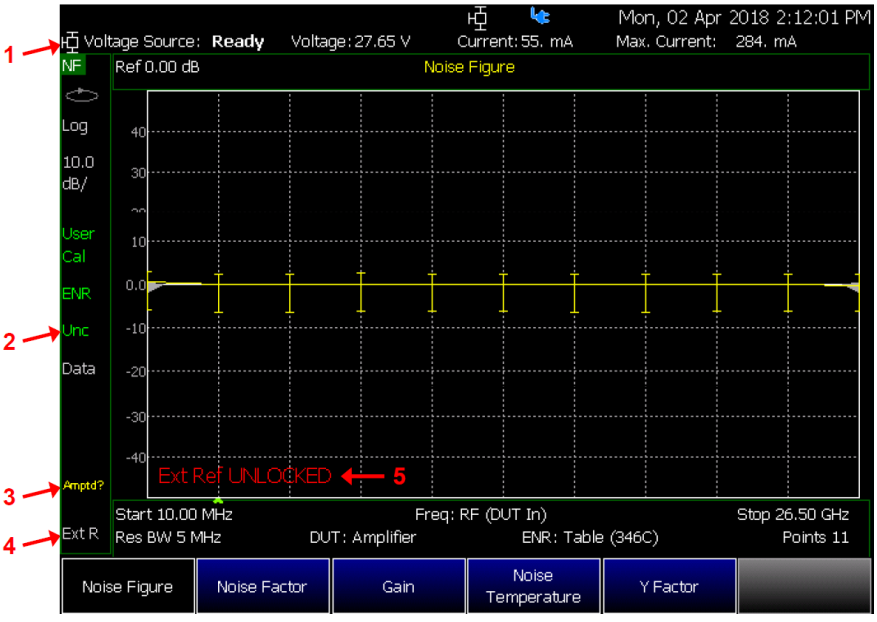
3. Excess Noise Ratio (ENR) Status

4. Frequency Context

5. DUT Type

6. Excess Noise Ratio (ENR) Mode

7. Sweep point caret (shows last point measured)



1. Variable Voltage Source (VVS) Status line (appears when the VVS status line is turned on in the system menu). Refer to "Variable Voltage Source (Opt. 309)" on page 871.

2. Uncertainty status annotation (displayed when the uncertainty bars are enabled)

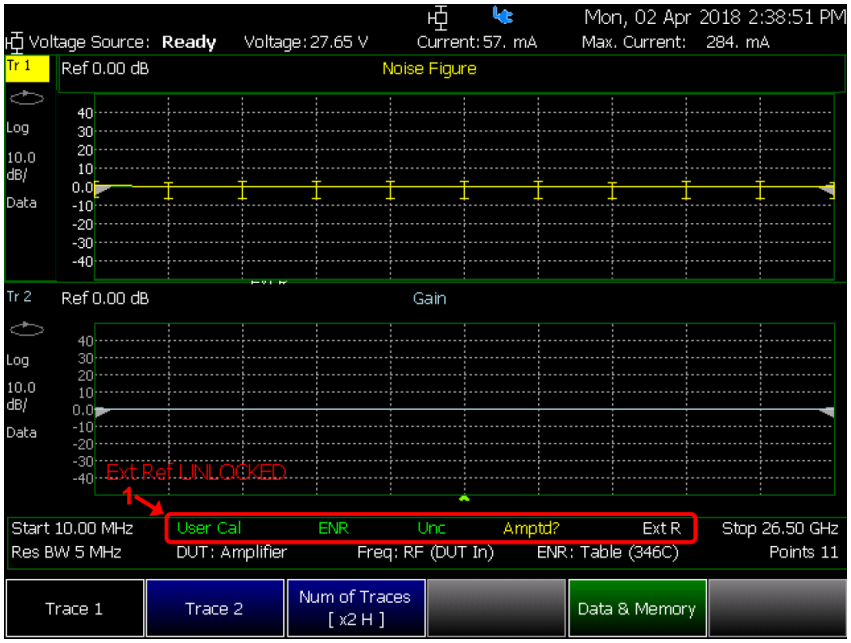
3. Questionable Amplitude annotation (displayed when the Amplitude Alignment is stale)

4. External Reference annotation (displayed when external reference is selected)

5. Warning message annotation. Used to display the following warnings:

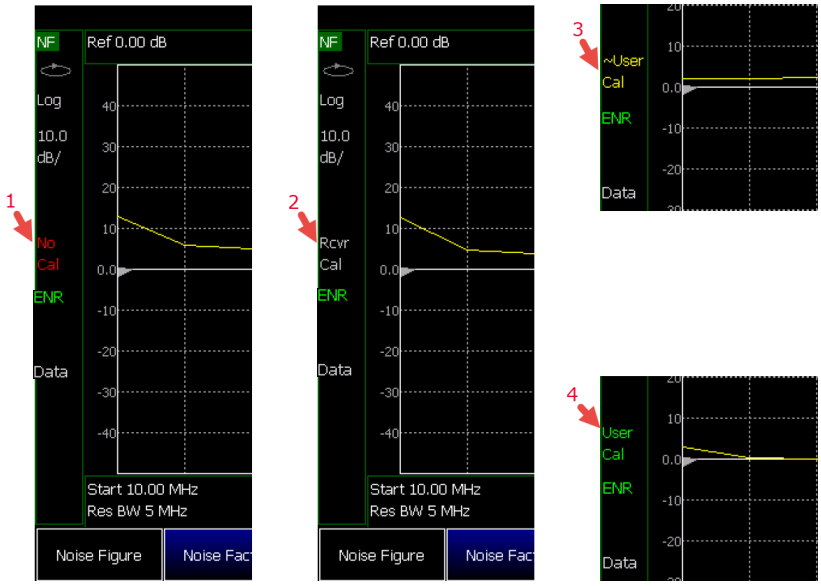
–Invalid frequency settings
–VVS trip
–ADC Over Range
–Ext Ref unlock

Figure 30-4 Dual Window Display Annotation



1. In the dual-window layout, non-trace-specific annotations are moved from the left of the traces to the bottom of the traces

Figure 30-5 Calibration Annotation



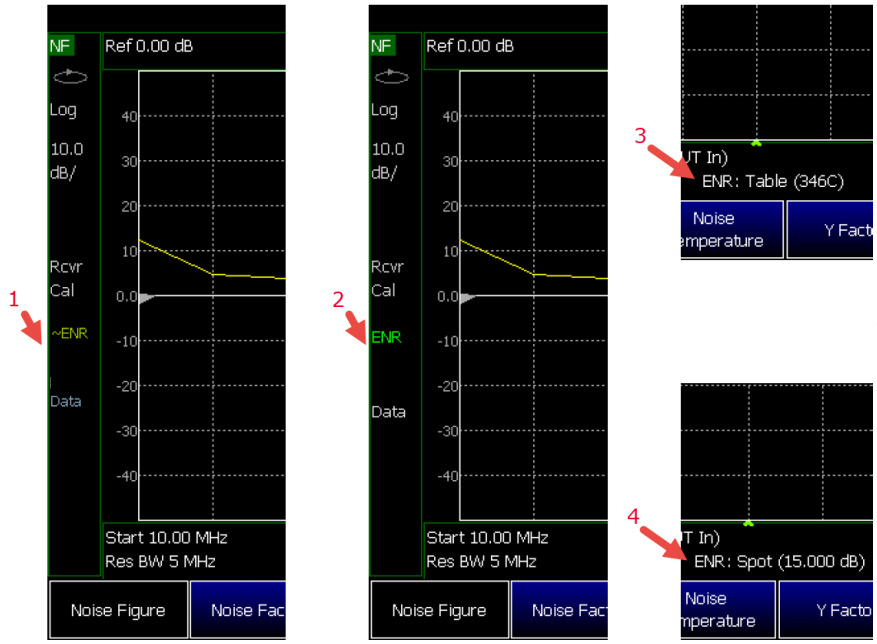
1. No Cal = No calibration applied

2. Rcvr Cal = Only receiver calibration applied

3. ~User Cal = Receiver Cal + User Cal applied, but User Cal is interpolated (the calibration frequency points do not match up with sweep frequency points)

4. User Cal = Receiver cal + User Cal applied and User Cal is not interpolated (the calibration frequency points match up with sweep frequency points)

Figure 30-6 ENR Status and Mode Annotation



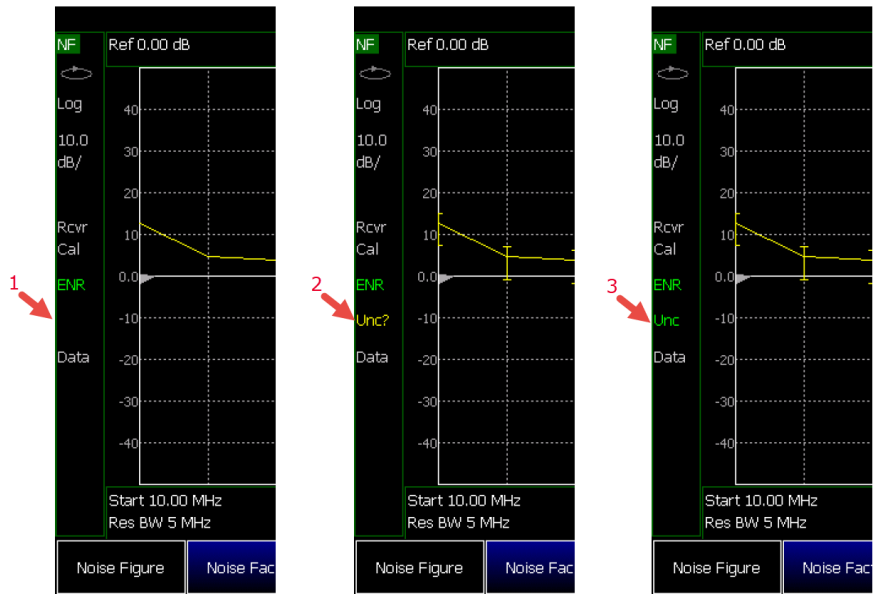
ENR Status annotation

1. ~ENR = Using ENR table, but it's extrapolated (the sweep frequency range goes beyond the table frequency range)
2. ENR = Using ENR table and it's not extrapolated (the sweep frequency range is within the table frequency range) or using spot ENR

ENR Mode annotation

3. Table (346C) = ENR table is selected (the mode number is pulled from the current ENR table)
4. Spot (15.000 dB) = Spot ENR table is selected (the value is the current spot ENR)

Figure 30-7 Uncertainty Annotation



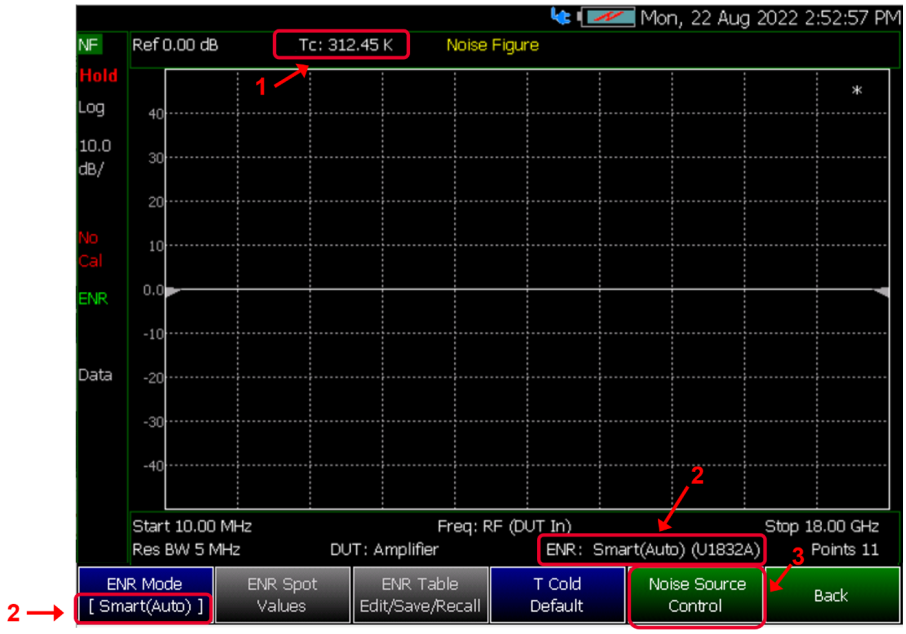
Uncertainty Status annotation (Only displayed when the Uncertainty bars have been enabled)

1. Uncertainty Bars are disabled.

2. Unc? = Uncertainty bars are enabled and uncertainty values are questionable (not all uncertainty contributions are turned on or one or more of the contributions was calculated to be 0.00 based on the ENR, DUT, and Preamp uncertainty values). If you see that your uncertainty values are questionable, make sure all contributions are turned on (if you're not using a preamplifier and User Calibration (User Cal), you do not have to turn on the User Cal contribution) and you have entered uncertainty values for your noise source, DUT, and preamplifier if applicable.

3. Unc = Uncertainty bars are on and uncertainty values are valid.

Figure 30-8 Smart Noise Source Annotations



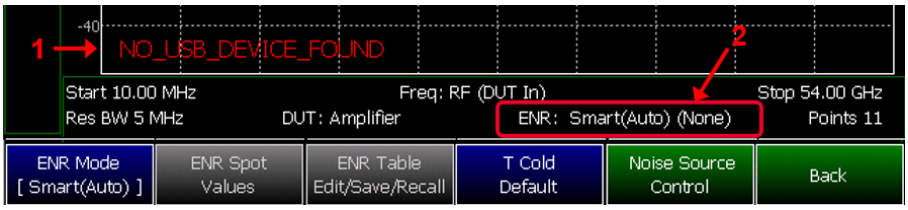
Top Figure:

1. Automatically loaded T Cold value from the USB Noise Source, measured in Kelvin.

2. "Smart (Auto)" under ENR Mode notation.

– The device model will say "(None)" if there is no USB Noise Source connected.

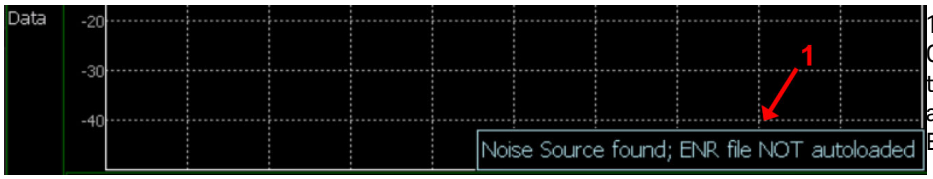
3. Noise Source Control menu allows user to manage the USB Noise Source.



2nd Figure:

1. General warning message annotation notifying that "NO_USB _DEVICE_FOUND" no USB Noise Source is connected.

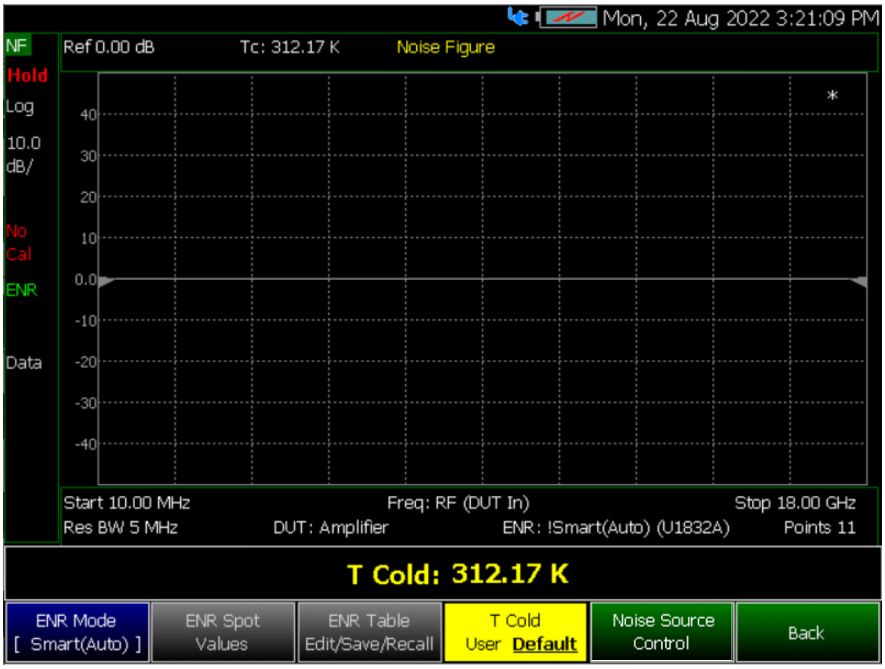
2. When in Smart (Auto) mode, if there is no connected device then ENR model is "None".



3rd Figure:

1. User set Auto load ENR to OFF. Information to user that the latest ENR data was not automatically loaded into the ENR Table.

Figure 30-9 Smart Noise Source – Source Menus



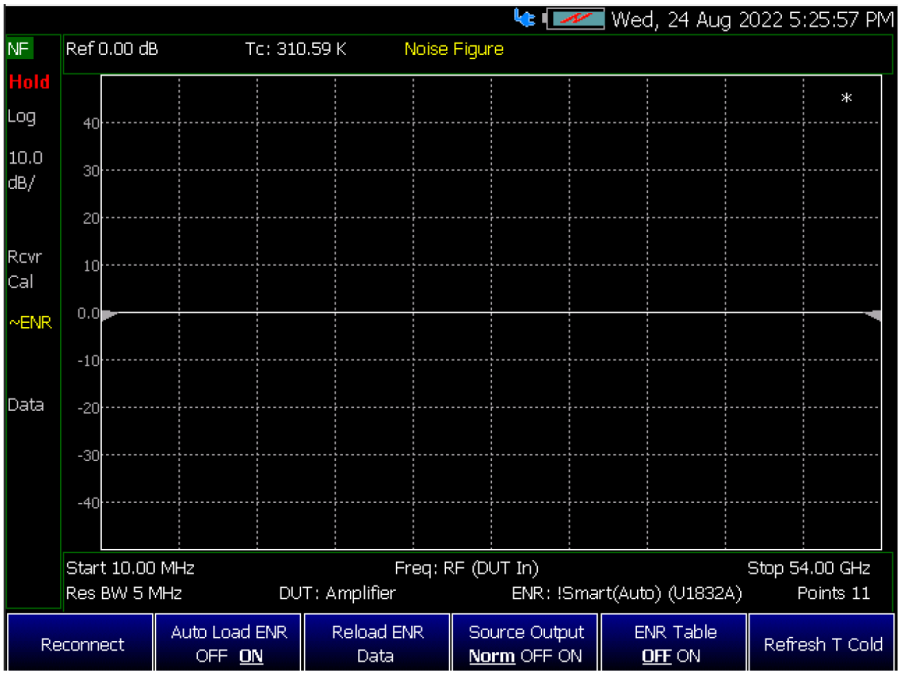
ENR Mode: Smart (Auto) only:

– T_{cold} value gets automatically loaded into FieldFox when the USB Noise Source is connected.

– This value is applied as the Default value for T Cold menu.

– If not in Smart (Auto) mode, the T Cold value gets set to Default: 296.5 K.

Figure 30-10 Smart Noise Source – Meas Setup > Noise Source > Noise Source Control



ENR Mode: Smart (Auto) only:

1. Reconnect: Attempts to connect to USB Smart Noise Source.

2. **Auto Load ENR [OFF ON]**:

– If ON: The ENR Data will be automatically loaded into the ENR Table when the USB Noise Source is plugged in.

– If OFF: The ENR Data will not be automatically loaded into the ENR Table when the USB Noise Source is plugged in.

– Default: ON

3. **Reload ENR Data**: The ENR Data from the USB Noise Source get loaded into the ENR Table.

4. **Source Output [Norm OFF ON]**:

– Sets the Noise Source drive status.

– Default: NORMal, the FieldFox controls the Noise Source drive status.

– This button is disabled if no USB Noise Source is connected.

5. **ENR Table [OFF ON]**:

– Allows User to view the ENR Table Data in previous menu (Edit/Save/Recall).

– Default: OFF

6. **Refresh T Cold**:

– Retrieves the current temperature reading from the USB Noise Source then updates the Annotation and T Cold Default value.

How to Define a Noise Figure Measurement

The Option 356 Noise Figure mode uses the Y-factor method to calculate the noise figure.

This section contains the following:

– "Example: Typical Noise Figure Measurement Procedure" on page 747
– "Overview of Softkey Menus" on page 748
– "How to Use DUT Measurement Setups" on page 756
– "Single / Continuous / Restart" on page 772
– "Points " on page 772
– "Resolution Bandwidth (Res BW)" on page 773
– "Alignments" on page 773
– "Calculating Noise Figure Measurement Uncertainty" on page 774
– "Using ENR Tables" on page 779
– "Using Markers (Noise Figure)" on page 782

To learn more about Smart Noise Sources, refer to https://www.keysight.com/us/en/products/noise-figure-analyzers-noise-sources/noise-sources.html.

Example: Typical Noise Figure Measurement Procedure

This section briefly reviews the steps in setting up a noise figure measurement. If you are not familiar with this process or would like more information, refer to "Overview of Softkey Menus" on page 748 and "How to Use DUT Measurement Setups" on page 756.

1. Set up a Noise Source ENR Table: (**Meas Setup** > **Noise Source** > **ENR Table Edit/Save/Recall**).
2. Set the resolution bandwidth: **BW** > **Res BW**
3. Set the frequency range: **Freq/Dist** >
   – **Start**,
   – **Stop**,
   – **Center**, and
   – **Span**
4. Set the number of points: **Sweep** > **Points** (minimum = 3 points, maximum = 1001 points, default = 21)
5. Use **Meas Setup** > **Integration** Setup Integration (See also "How to use Auto-Integration" on page 789.)
   – **Max. Time/Pt.** (Available when Mode = Auto) or
   – **Time/Pt.** (available when Mode = Fixed)
6. Perform a Receiver Calibration: (**Cal** > **Run Receiver Cal** and follow prompts).
7. Enter DUT setup type: **Meas Setup** > **DUT** > **Type**

- **Amplifier** (default),
- **Downconverter**,
- **Upconverter**, or
- **Multi-Stage Converter**

8. Run a User Calibration (i.e., If you are using an external preamp). (**Cal** >**Run User Cal** and follow prompts).
9. Use **Measure** to select the type of noise figure measurement:
   - **Noise Figure**,
   - **Noise Factor**,
   - **Gain**,
   - **Noise Temperature**, or
   - **Y-Factor**
10. Use **Meas Setup** > **Uncertainty** > **Uncert Contributions** to Enable/Disable Uncertainty Contributions:
    - **Jitter Uncert OFF ON**,
    - **ENR Uncert OFF ON**,
    - **Mismatch Uncert OFF ON**,
    - **User Cal Uncert OFF ON** (applies the current User Cal uncertainty to the current measurement's uncertainty calculations), and
    - Then **Back** > **Uncert Bars** to **ON**.

Overview of Softkey Menus

This sections describes the Noise Figure's Measure, Measure Setup softkeys, and related sub-menu softkeys.

1. Define a measurement type.
   a. Select a **Measure**–choose:
      - **Noise Figure** Specify Noise Figure (default) or

NOTE

Noise Figure has asymmetrical uncertainty (i.e., log measurement). Noise Factor and Noise Temperature have symmetrical uncertainty (i.e., linear measurement). Uncertainty is not displayed for Gain and Y-Factor.

      - **Noise Factor** Specify a Noise Factor or
      - **Gain** Specify Gain or
      - **Noise Temperature** Specify Noise Temperature or
      - **YFactor** Specify Y-Factor

b. Then modify the settings based on the selected noise figure type

2. Select **Measure Setup**—choose:

– **Noise Source** or "**DUT** or" on page 752, "**Integration** or" on page 752, or "**Uncertainty**" on page 753.

Opens a menu of softkeys to define the Noise Figure's ENR Mode Smart (Smart Source), Spot, and Table and uncertainty values.

To learn more, refer to Figure 30-8 on page 744, Figure 30-9 on page 745, and Figure 30-10 on page 746.

Then choose:

– **ENR Mode [Table]** then choose from:

––**Spot** You can enter ENR data for the noise source you are using as a single spot value.

The single spot value is used either for measurements at a single frequency, or for measurements across a range of frequencies that is narrow enough such that the ENR value does not change significantly across that range. (Default == Spot).

––**Smart (Auto)** The FieldFox checks for a valid USB noise source and automatically loads any ENR and calibration values. And, automatically loads a T Cold value from the USB Noise Source, measured in Kelvin.

––**Table** You can enter ENR data for the noise source you are using as a table of values. The values held in the table can be used for measurements at a range of frequencies as well as at a fixed frequency.

– **ENR Spot Values** Opens a menu to enter a spot value either for measurements at a single frequency or for measurements across a range of frequencies that is narrow enough such that the ENR value does not change significantly across that range (Active when ENR Mode set to Spot).

Then choose:

––**ENR** sets the ENR spot value in dB (default is 15 dB).

––**ENR Uncert.** sets the ENR spot uncertainty value in dB (default is 0.000 dB).

––**On | Γ** sets the On value (hot) of the ENR spot value's 50Ω match, Γ (0.000 to 1.000).

- – – Off | Γ sets the Off value (cold) of the ENR spot value's 50Ω match, Γ (0.000 to 1.000).
- – – ENR Uncert. Cov. [2σ] Opens a menu to set the value of the ENR uncertainty coverage.

  Then choose: 1σ, 2σ (default), or 3σ.
- – – More opens additional ENR Spot Value softkey menu choices
- – – Γ Spec. Style [Fixed] Opens a menu of softkeys to set the Γ specification style.

  Then choose Maximum, 95th %ile (default), 80th %ile, Median, Mean, or Fixed (Default == Fixed).
- – – Γ Distribution [Rayleigh] Opens a menu of softkeys to set the type of Γ distribution.

  Then select Rayleigh (default), Fixed, or Uniform in Circle.

– ENR Table Edit/Save/Recall Opens the ENR table menu to edit, save, or recall noise source values (Active when ENR Mode set to Table).

Then choose:

- – – Edit ENR Table Opens the currently selected table of noise source values (generic default noise source values are populated for quick check). Enter your noise source's values for more accurate measurements.

CAUTION

IMPORTANT! Save your noise source table with a unique filename to avoid loss of table data. All noise figure files are saved with *.enr type suffixes.

- – – New ENR Table opens a new ENR table for entering and saving additional noise source values.

CAUTION

The FieldFox displays `Replace existing file?`, because the displayed default filename is the one last saved. Enter a unique filename to avoid loss of table data (i.e., all noise figure files are saved with *.enr type suffixes).

- – – Save ENR Table Opens a menu of softkeys to enable you to enter a unique noise source filename.

- – –Recall ENR Table Opens a menu of file recall softkeys and displays a list of stored noise source files.
- – –Storage Device [Internal] Opens a menu of softkeys to set the storage location for your files.

  Then choose Internal (default), SD Card, or USB.
- – –Back to return to previous menu.

– T Cold Default When making measurements at different ambient temperatures, you can set the T_{cold} value in Kelvin (K) manually (User). When set to Default, the T_{cold} value is set to the 296.5 K (Default == Default).

– Noise Source Control Opens a menu of ENR noise source control softkey choices. (Active only when ENR Mode == Smart (Auto)).

Then choose:

- – –Reconnect Automatically reconnects the FieldFox to a noise source. If one is not found, the FieldFox displays "`Noise Source is NOT CONNECTED`". Allow 10 to 20 seconds for the instrument to detect the noise source.
- – –Auto Load ENR OFF ON When Auto Load is enabled the FieldFox automatically searches for a compatible USB noise source and reloads the stored calibration and temperature data. When disabled no existing search is made for USB noise source data to be loaded. (Default == ON)

  When Auto Load == ON and compatible USB noise source is detected (e.g., U1832/U1833A/B/C/D) the FieldFox briefly displays:

  "`Recalled \temp\U1832A.enr`"

  When Auto Load == OFF, but a valid USB noise source is discovered, the following message is displayed:

  "`Noise Source Found;ENR file NOT auto loaded.`"
- – –Reload ENR Data Manually reloads any existing USB noise figure sensor data. This softkey is inactive/grayed out when a Noise Source is not detected. When a USB noise source is detected

and this softkey is pressed, the data from the noise source is loaded into the ENR table overwriting any previous ENR table data.

- – –Source Output Norm OFF ON Controls the automatic noise source control (Default == Normal). This softkey is inactive/grayed out when a Noise Source is not detected.

  When set to **Normal**, the noise source ON/OFF is automatically controlled by the noise source application.

  When set to ON or OFF **Re-Run Receiver Cal** and **Run User Cal** softkeys are inactive/grayed out. No valid results is provided by the noise source application.

- – –ENR Table OFF ON Enables/disables the ENR Table data for use in the current measurement (Default == OFF).

  If the ENR Table is set to ON, when Auto Load ENR is set to ON and a noise source is connected to the analyzer, the ENR table data is overwritten.

  If the Auto Load ENR is set to OFF, no data is loaded into the ENR table.

- – –Refresh T Cold] When the noise source is set to Smart (Auto) and a U1832/U1833A/B/C/D noise source is detected the T Cold value can be read from the noise source. This softkey is inactive/grayed out when a compatible Noise Source is not detected.

– Back to return to previous menu.

– DUT or

Opens a menu of softkeys to define your DUT Type (Amplifier, Downconverter, Upconverter, or Multi-Stage Converter), frequency context, and loss compensation. Refer to “How to Use DUT Measurement Setups” on page 756.

– Integration or

Opens a menu of softkeys to define the Integration's Mode Auto or Fixed and Jitter values.

CAUTION

For optimum speed and performance measurement results, it is recommended that auto-integration is used in all noise figure measurements.

Then choose:

- **Mode Auto Fixed** Select Auto (default) to let the FieldFox select the optimum coupled instrument settings. Changes can be made to the Jitter Goal and Max Time/Pt. values. When integration Mode is set to Fixed, the Time/Pt. softkey is active and can be modified.
- **Jitter Goal** Sets the maximum peak-to-peak jitter value. Values greater than this value triggers the Jitter Warning (i.e., if Jitter Warning = ON). (Only active when Mode = Auto.) (Default is 0.5 dB.)
- **Max Time/Pt.** Sets the maximum amount of time the jitter is measured at a given point to attempt to reach the Jitter Goal value (i.e., the measurement time per point is automatically adjusted to the minimum time required, but will never exceed the displayed Max Time/Pt.). After this time, values in excess of the jitter Goal value trigger the Jitter Warning.
- **Jitter Warning** Enables/Disables the Jitter Warning. The Jitter Warning displays when the Jitter value exceeds the Jitter Goal value. (Default = ON.)
- **Time/Pt.** Sets the Time/Pt. when Mode is set to Fixed. (Only active when Mode = Fixed.)
- **Back** to return to previous menu.

- **Uncertainty**

  Opens a menu of uncertainty softkeys for setting the DUT, Preamp, and Uncert. Contributions.

  Then choose:

  - **DUT** Sets the DUT Mode to either Spot (default) or Table.

    Then choose:

    - **DUT Mode** Set to Spot (default) or to Table

      For DUT MODE Spot choose:

––DUT Spot Values (Only active when DUT Mode = Spot).

Then choose:

––Input |Γ| Sets the input Γvalue.

––Output |Γ| Sets the output Γvalue.

––Γ Spec. Style [Fixed] Opens a menu of softkeys to set the Γ specification style.

Then choose Maximum, 95th %ile, 80th %ile, Median, Mean, or Fixed (default).

––Γ Distribution [Fixed] Opens a menu of softkeys to set the type of Γ distribution.

Then select Rayleigh, Fixed (default), or Uniform in Circle.

––Back to return to previous menu.

––DUT Table Edit/Save/Recall (Only active when DUT Mode = Table).

Then choose:

––Import DUT Data Opens a menu of softkeys where you can select a DUT *.csv or *.snp data file to import into your table.

Then choose Recall File, Sort by File Name, Sort by Date, Next Page, Previous Page, or Cancel.

––Edit DUT Data Opens a menu of softkeys where you can edit the current selected DUT table data file (e.g., serial number, model number, Γ Spec. Style, Γ Distribution, Input |Γ|, Output |Γ|, and frequencies).

Then choose Edit, Next Page, Previous Page, Add Row (only active for Frequency), Delete/Clear (only active for Frequency), or Done.

––New DUT Table Opens a menu of softkeys to choose a new DUT table.

CAUTION

IMPORTANT! The FieldFox displays `Replace existing file?`, because the displayed default filename is the one last saved. Enter a unique filename to avoid loss of table data.

- ––Save DUT Table Opens a Create a filename menu of softkeys to enter a DUT table filename and then to save the file.
- ––Recall DUT Table Opens a Select a file menu of softkeys to enter a DUT table filename to recall.
- ––Storage Device [Internal] Opens a set of softkeys to select where your DUT table is saved.

  Then choose Internal, SD Card, or USB.

– Back to return to previous menu.

– Preamp Sets the DUT Mode to either Spot (default) or Table.

Then choose:

- ––Preamp Mode Set to Spot (default) or to Table.

  For Preamp MODE Spot choose:
- ––Preamp Spot Values (Only active when DUT Mode = Spot).

  Refer to similar "DUT Spot Values (Only active when DUT Mode = Spot)." on page 754.
- ––Back to return to previous menu.
- ––Preamp Table Edit/Save/Recall (Only active when Preamp Mode = Table).

  Refer to similar "DUT Table Edit/Save/Recall (Only active when DUT Mode = Table)." on page 754.
- ––Back to return to previous menu.

– Uncert Contributions Opens a menu of uncertainty contribution softkeys.

Then choose:

- ––Jitter Uncert. Enable/disable the Jitter Uncertainty.

- – – ENR Uncert. Enable/disable the ENR Uncertainty.
- – – Mismatch Uncert. Enable/disable the Mismatch Uncertainty.
- – – User Cal Uncert. Enable/disable the User Cal Uncertainty.
- – – Back to return to previous menu.

- Uncert Cover Sets the uncertainty coverage value for the current settings.

  Then choose: 1σ, 2σ (default), or 3σ.
- Uncert Bars Enables/disables the uncertainty calculator uncertainty bars values for the current settings.
- Back to return to previous menu.

How to Use DUT Measurement Setups

Noise figure Option 356 has four predefined measurement setups:

- Amplifier
- Downconverter
- Upconverter
- Multi-Stage Converter

Refer to "Using Measure Setup to Choose DUT Type" on page 756.

Each of the four measurements has frequency context and loss compensation softkeys that can used to optimize the DUT's noise figure measurement. Refer to "DUT Type and Frequency Context" on page 765 and to "DUT Type Loss Compensation" on page 770.

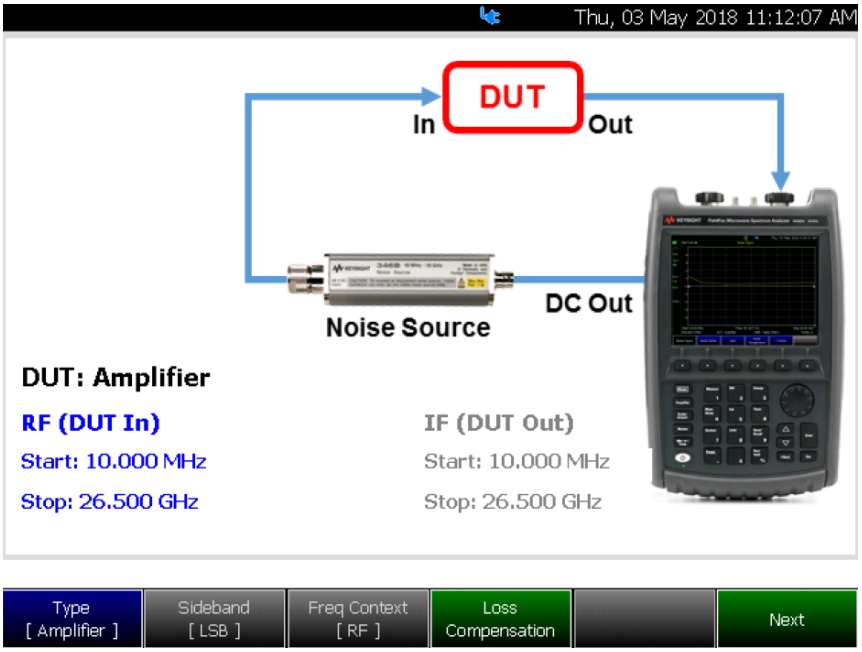
Using Measure Setup to Choose DUT Type

This section contains the following:

- Setting DUT > Type [Amplifier], see Figure 30-11 on page 757 and for Smart Noise Source, see Figure 30-15 on page 761.
- Setting DUT > Type [Downconverter], see Figure 30-12 on page 758 and for Smart Noise Source, see Figure 30-16 on page 762.
- Setting DUT > Type [Upconverter], see Figure 30-13 on page 759 and for Smart Noise Source, see Figure 30-17 on page 763.
- Setting DUT > Type [Multi-Stage Converter], see Figure 30-14 on page 760 and for Smart Noise Source, see Figure 30-18 on page 764.

Figure 30-11 DUT – Measurement Setup – Type [Amplifier] Screen

DUT – Measurement Setup – **Type [Amplifier]**



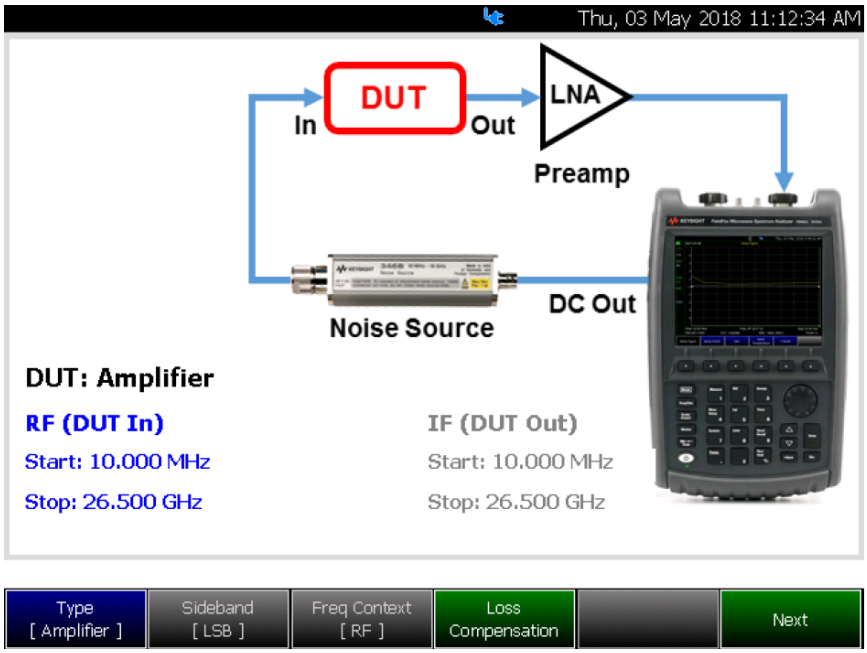
Used for setting up DUT parameters without an external preamplifier (LNA)

– **Type [Amplifier]**

––DUT displays does not display LO if not frequency converting

––Displays preamp (LNA), if User Cal is available. See next image this figure.

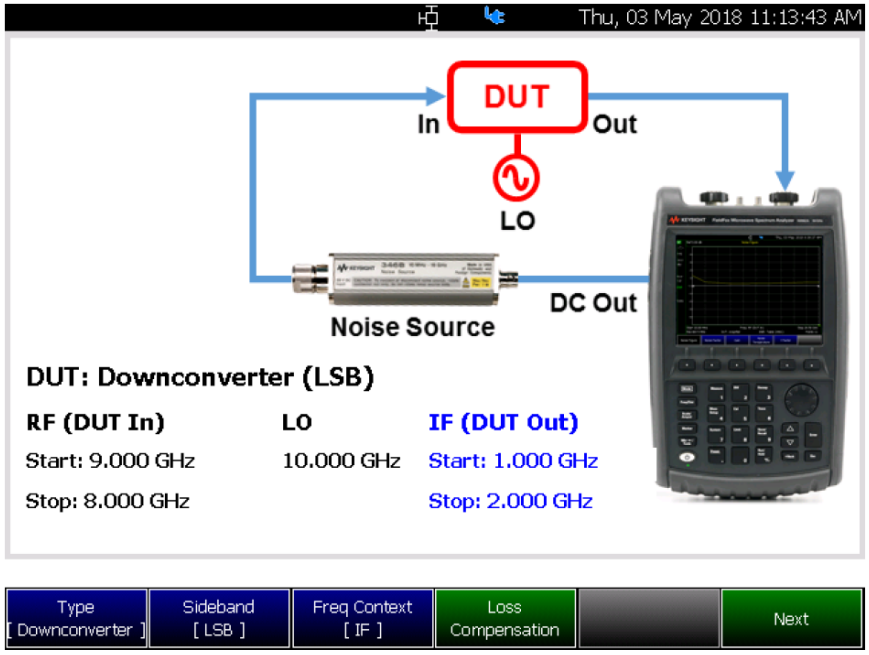
DUT – Measurement Setup – **Type [Amplifier]** with External Amplifier (LNA) and User Calibration



Used for setting up DUT parameters with an external preamplifier (LNA)

Figure 30-12 DUT Measurement Setup – Type [Downconverter] Screen

DUT – Measurement Setup – **Type [Downconverter]**



Used for setting up DUT parameters without an external preamp

– **Type [Downconverter]**

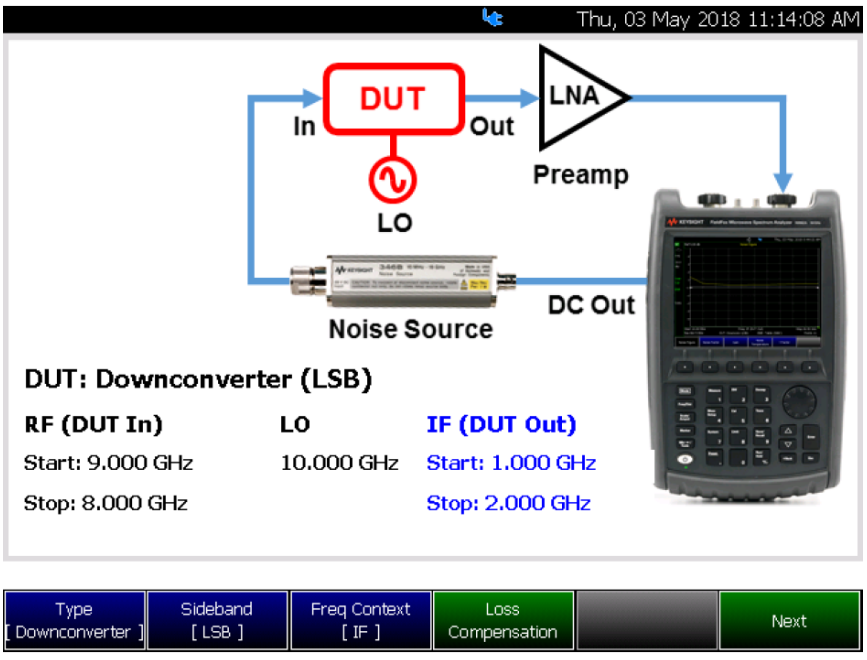
––Performs internal frequency downconversion (converts RF down to IF)

–Sideband:
––LSB: Lower Sideband (available for downconverter and upconverter)

––USB: Upper Sideband (available for downconverter and upconverter)

––DSB: Double Sideband (available for downconverter; averages LSB and USB ENR values)

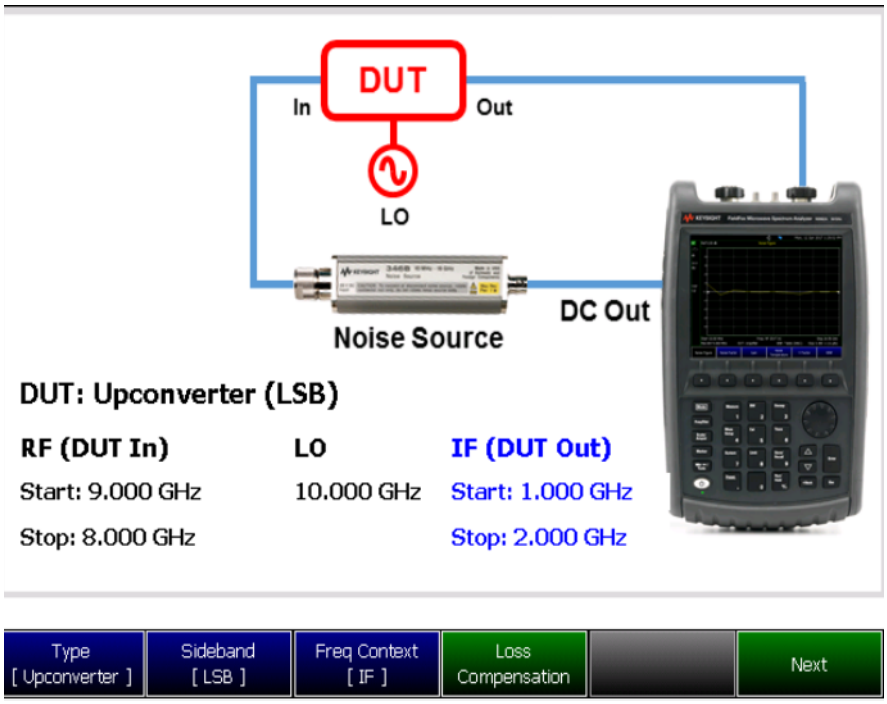
DUT – Measurement Setup – **Type [Downconverter]** with External Amplifier (LNA) and User Calibration



Used for setting up DUT parameters with an external preamp

Figure 30-13 DUT Measurement Setup – Type [Upconverter] Screen

DUT – Measurement Setup – **Type [Upconverter]**



Used for setting up DUT parameters without an external preamp

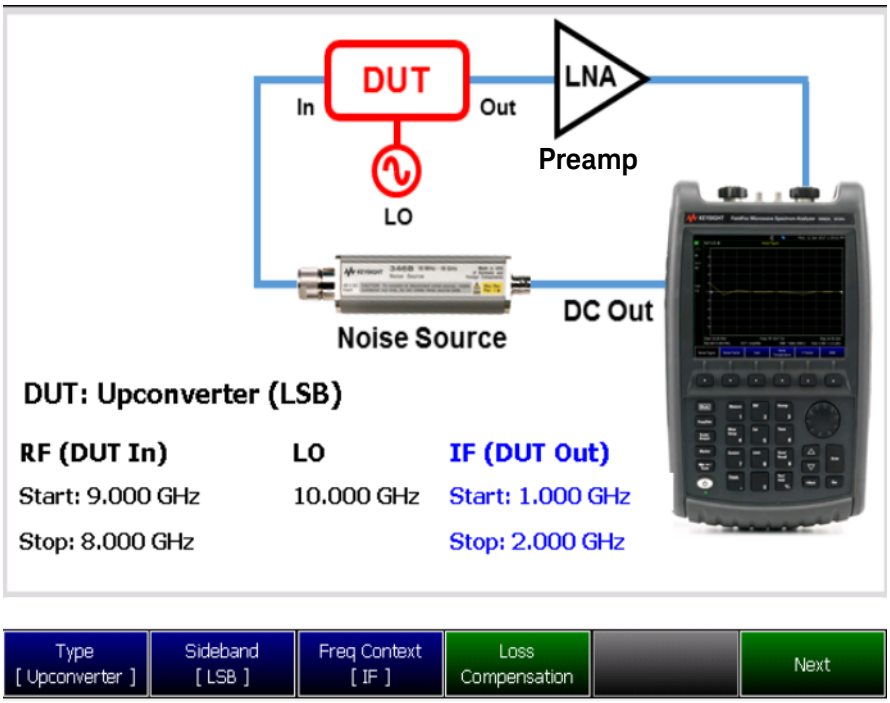
–**Type [Upconverter]**
––Performs internal frequency upconversion (technically, converts IF up to RF, but for this case RF always = DUT In and IF always = DUT Out and so, converts RF up to IF)

–Sideband

––LSB: Lower Sideband (available for downconverter and upconverter)

––USB: Upper Sideband (available for downconverter and upconverter)

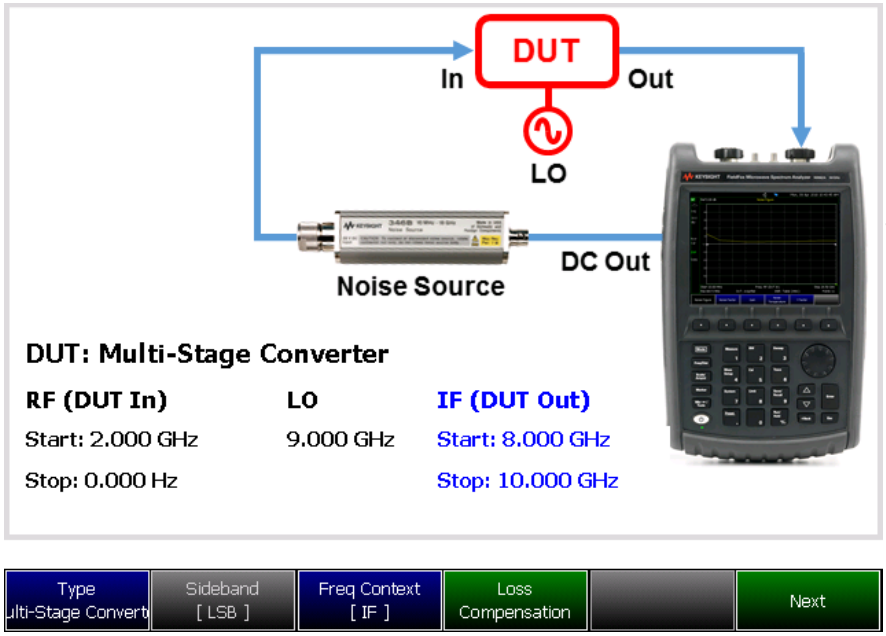
DUT – Measurement Setup – **Type [Upconverter]** with External Amplifier (LNA) and User Calibration



Used for setting up DUT parameters with an external preamp

Figure 30-14 DUT Measurement Setup – Type [Multi-Stage Converter] Screen

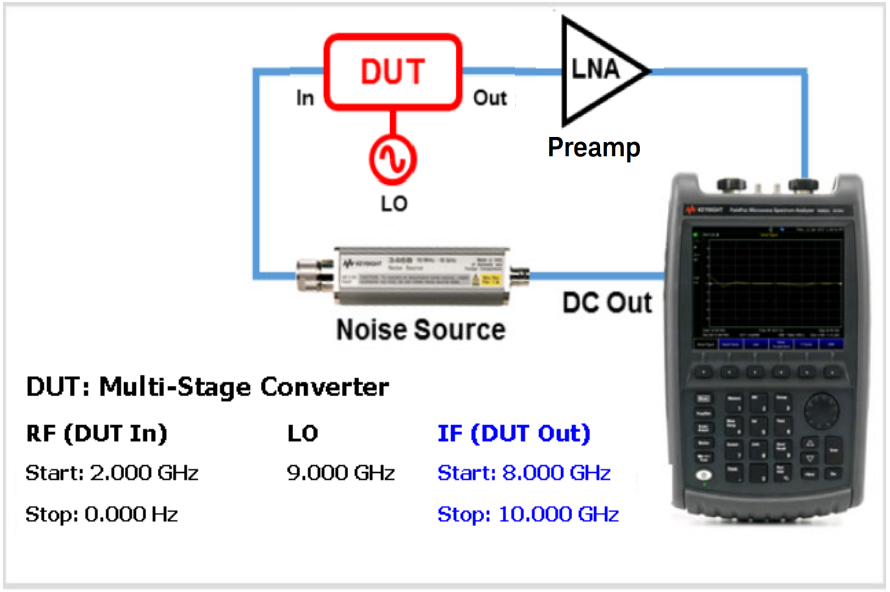
DUT – Measurement Setup – **Type [Multi-Stage Converter]**



Used for setting up DUT parameters

– **Type [Multi-Stage Converter]**
––Multi-Stage Converter: Performs multi-stage frequency conversion (converts RF down/up to IF)

DUT – Measurement Setup – **Type [Multi-Stage Converter]** with External Preamp (LNA) and User Calibration

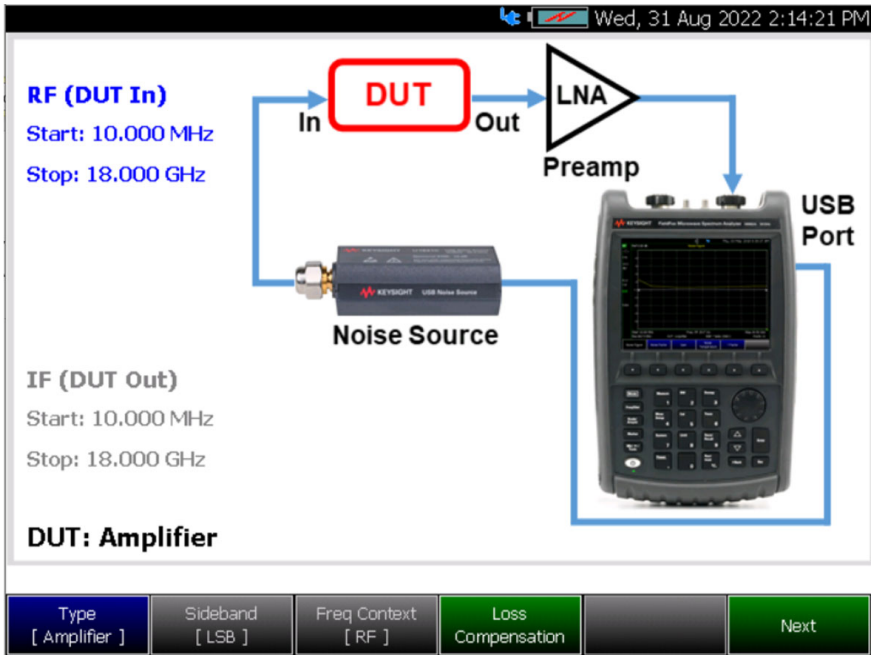


Used for setting up DUT parameters with preamp and User Cal

ENR Mode: Smart (Auto) – Calibration Wizard (DUT)

Figure 30-15 DUT – Measurement Setup – Type [Amplifier] Screen – ENR Mode: Smart (Auto)

DUT – Measurement Setup – **Type [Amplifier]** with External Amplifier (LNA) – ENR Mode: Smart (Auto)



USB Smart Mode DUT Wizard visibility:

– If User is in ENR Mode: Smart (Auto)

– If USB Noise Source is connected to the FieldFox

Plug in USB Noise Source BEFORE entering this menu

– Expect a 10-20s of delay for the FieldFox to recognize the USB Noise Source

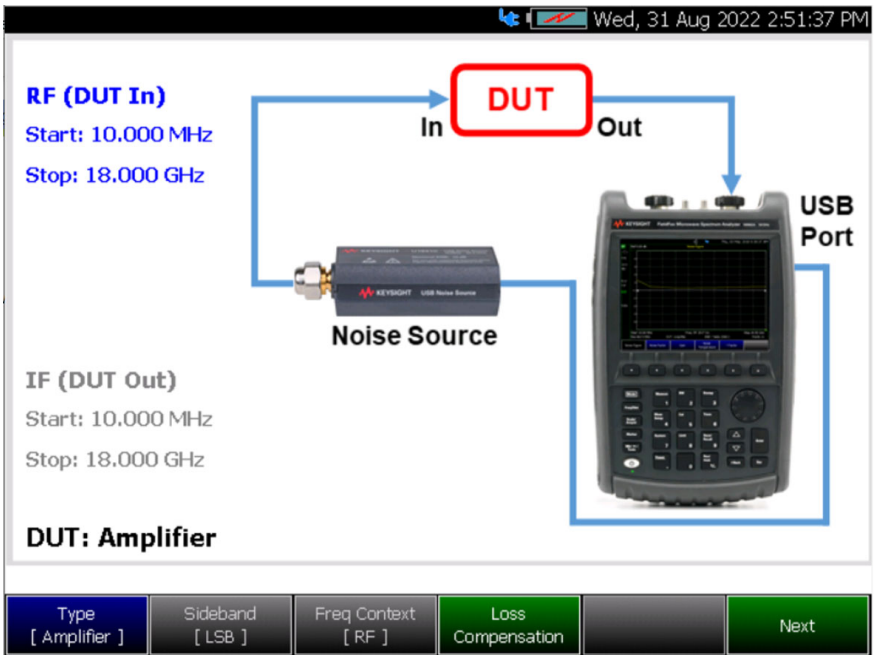
Setup Diagram

– FieldFox USB Port

–USB Noise Source

– Displays preamp (LNA), if User Cal is available. See next image this figure.

–DUT (shows LO if frequency converting)

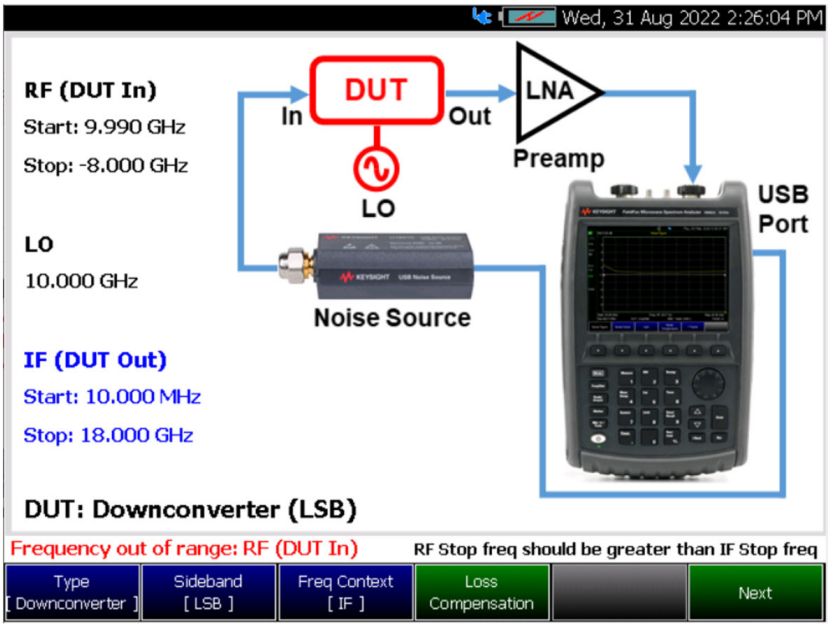


USB Smart Mode DUT Wizard visibility (No User Cal):

– Setup does not display preamp, because no User Cal is applied

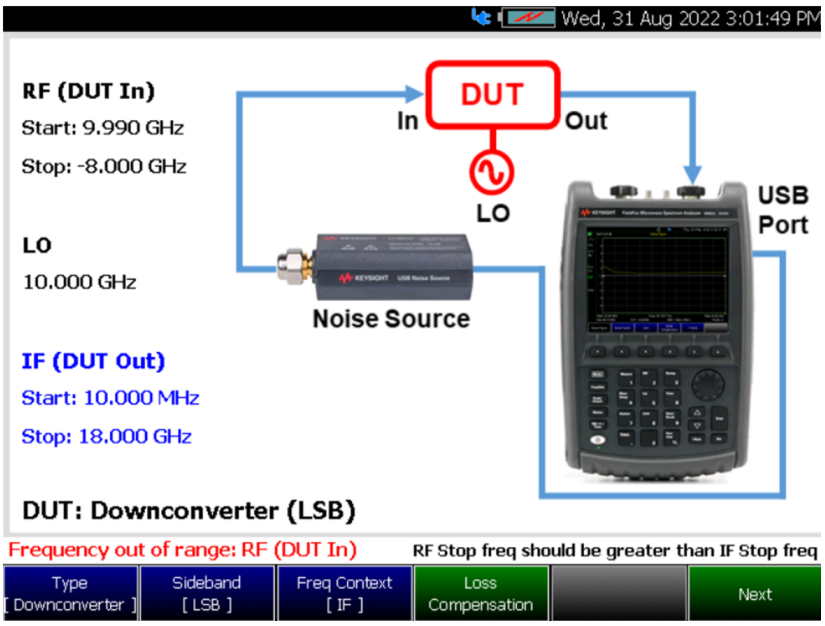
Figure 30-16 DUT – Measurement Setup – Type [Downconverter] Screen – ENR Mode: Smart (Auto)

DUT – Measurement Setup – **Type [Downconverter]** with External Amplifier (LNA) – ENR Mode: Smart (Auto)



USB Smart Mode DUT Wizard visibility:

- Setup shows that Preamp is visible because a User Cal is applied
- DUT (shows LO if frequency converting)

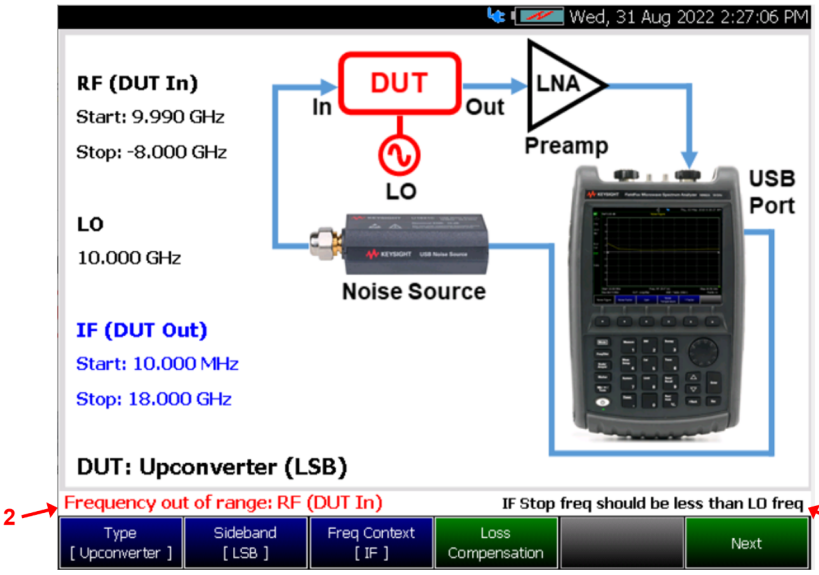


USB Smart Mode DUT Wizard visibility:

- Setup shows that Preamp is not visible because no User Cal is applied
- DUT (shows LO if frequency converting)

Figure 30-17 DUT – Measurement Setup – Type [Upconverter] Screen – ENR Mode: Smart (Auto)

DUT – Measurement Setup – **Type [Upconverter]** with External Amplifier (LNA) – ENR Mode: Smart (Auto)



USB Smart Mode DUT Wizard visibility:

1. Frequency warning

Tells you the setup is illogical and how to fix it

Does not stop measurement

2. Frequency error

Tells you that the frequency values are out of range (RF < 0 or IF < FF Minimum Start Freq or IF > FF Maximum Stop Freq)

Stops measurement until you fix it

Frequency warnings/errors also show up on main screen:

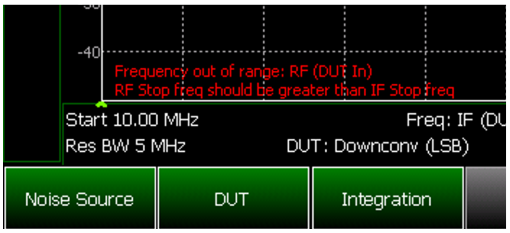
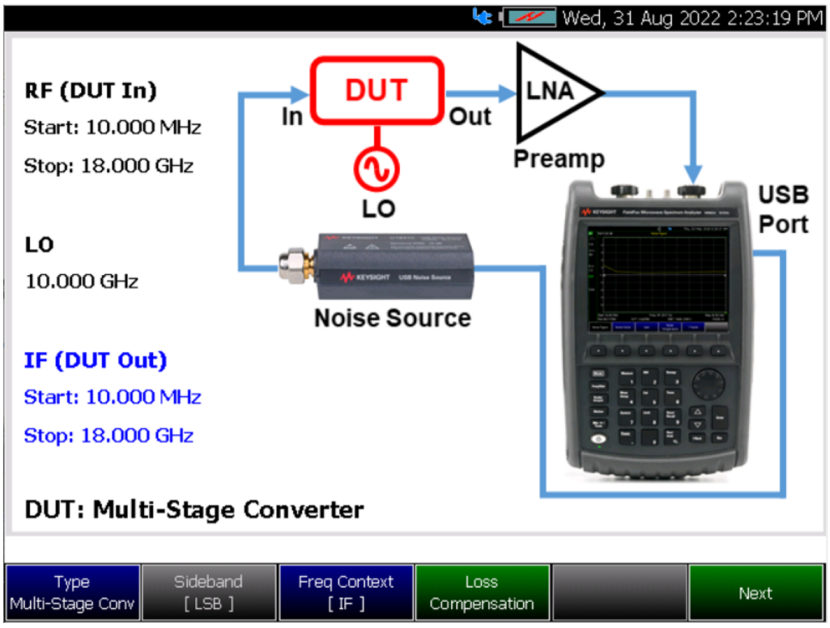


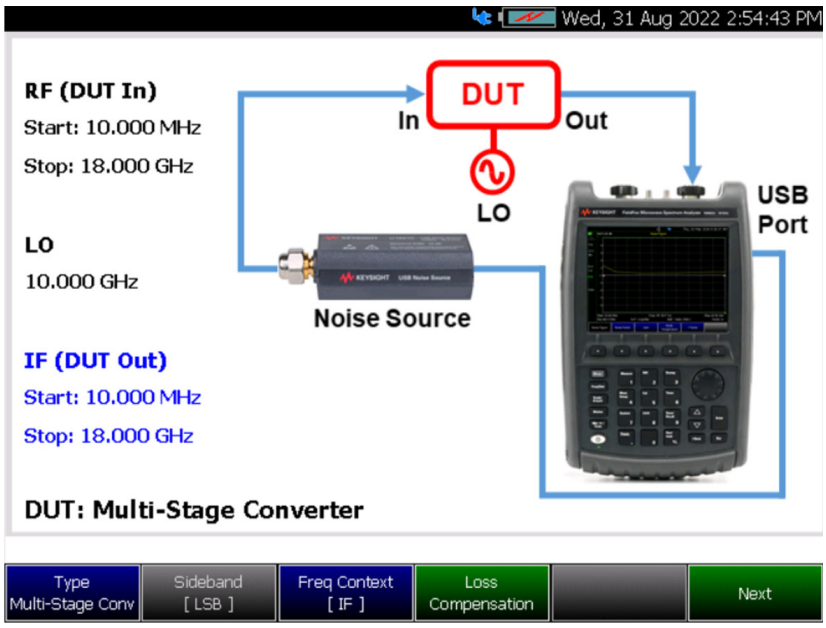
Figure 30-18 DUT – Measurement Setup – Type [Multi-Stage Conv] Screen – ENR Mode: Smart (Auto)

DUT – Measurement Setup – **Type [Multi-Stage Conv]** with External Amplifier (LNA) – ENR Mode: Smart (Auto)



USB Smart Mode DUT Wizard visibility:

- Setup shows that Preamp is visible, because no User Cal is applied.
- DUT (shows LO if frequency converting).



USB Smart Mode DUT Wizard visibility:

- Setup shows that Preamp is not visible because no User Cal is applied
- DUT (shows LO if frequency converting)

DUT Type and Frequency Context

Noise figure enables you to define the frequency context for your noise figure measurements:

- RF (DUT In):
  - Start
  - Stop
  - Center
  - Span
- Freq Context—(Inactive for Amplifier):
  - RF
  - IF
- LO—(Inactive for Amplifier)
- IF (DUT Out)—(Inactive for Amplifier)
  - Start
  - Stop
  - Center
  - Span

This section contains the following:

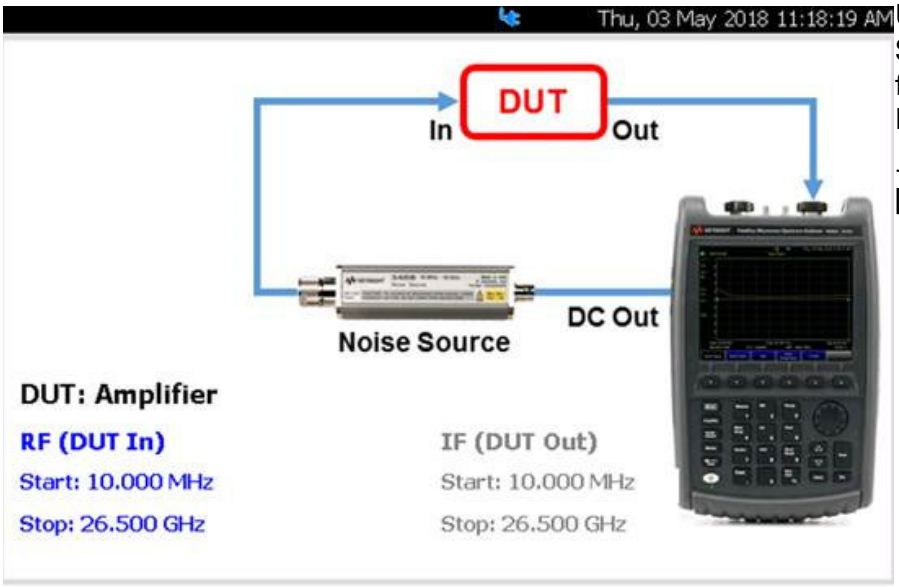
- Setting **Meas Setup** > **DUT** > **Next** > **RF (OUT in)**, see Figure 30-19 on page 766
- Setting **Meas Setup** > **DUT** > **Next** > **IF (DUT Out)**, see Figure 30-20 on page 767
- Setting **Meas Setup** > **DUT** > **Freq Context [IF]**, see Figure 30-21 on page 768

Frequency Context – RF (DUT In)

The RF (DUT In) softkey can be used to define the DUT Type's RF Start, Stop, Center, and Span frequencies. Refer to "Frequency Range and Frequency Context" on page 769.

Figure 30-19 DUT >Type [Amplifier] and [Multi-Stage Converter] > RF (DUT In)—Frequency Context

DUT – Measurement Setup – **Type [Amplifier] and [Multi-Stage Converter]**



Used for setting up Start, Stop, Center, and Span frequency context for a DUT

– **Type [Amplifier] and [Multi-Stage Converter]**

--Set the frequency context based on the DUT Type

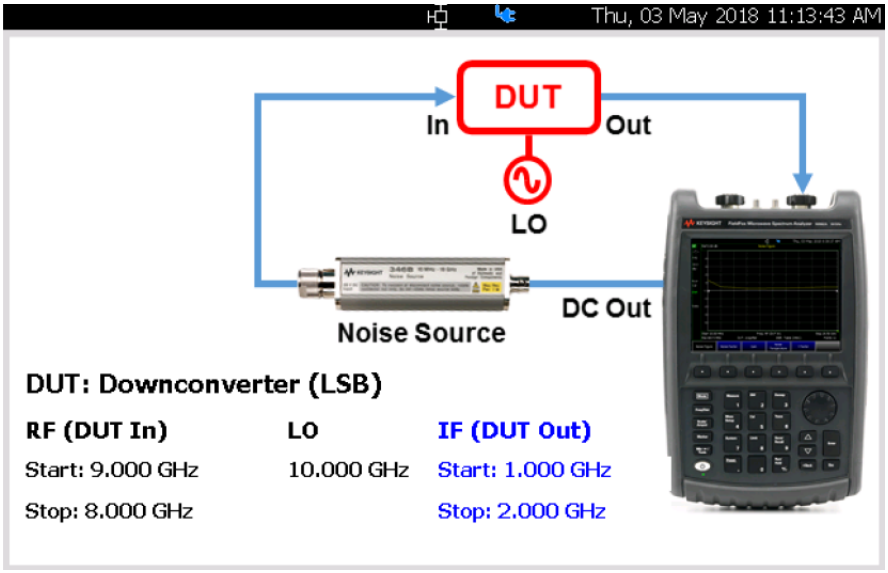
––Enter the RF (DUT In) values for Start, Stop, Center, and Span frequencies

Frequency Context – IF (DUT Out) – Inactive for Type [Amplifier]

The IF (DUT Out) softkey can be used to define the DUT Type's IF Start, Stop, Center, and Span frequencies. Refer to "Frequency Range and Frequency Context" on page 769.

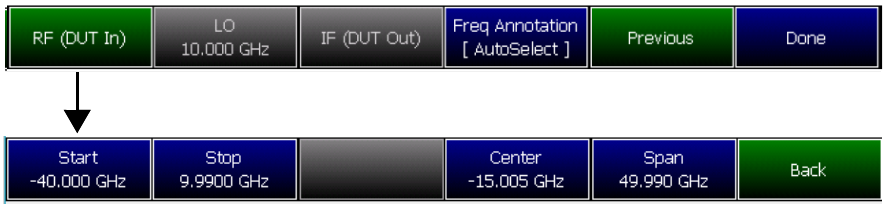
Figure 30-20 DUT >Type [Downconverter], [Upconverter], and [Multi-Stage Converter] > IF (DUT Out)—Frequency Context (Inactive for Type [Amplifier]

DUT – Measurement Setup – **Type [Downconverter], [Upconverter], and [Multi-Stage Converter]**



Used for setting up Start, Stop, Center, and Span frequency context for a DUT

– **Type [Downconverter], [Upconverter], and [Multi-Stage Converter]**



--Set the frequency context based on the DUT Type

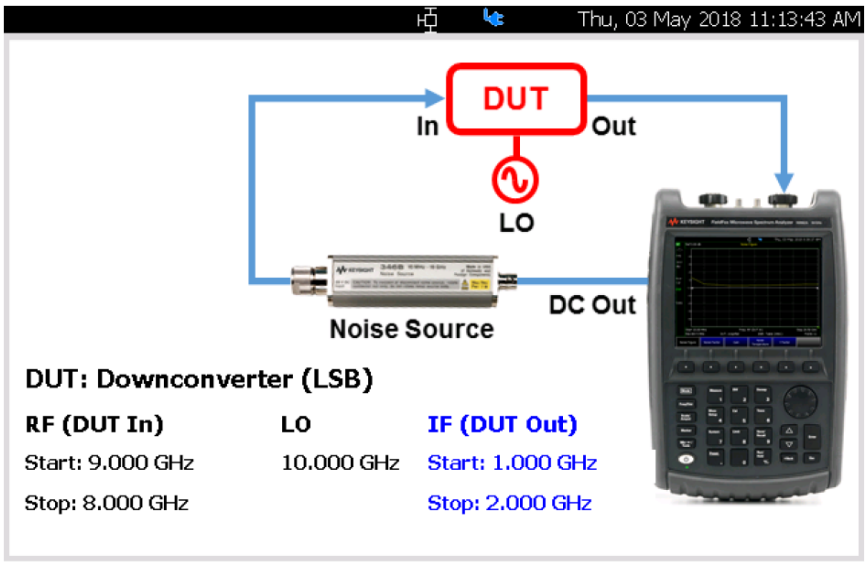
––Enter the RF (DUT In) values for Start, Stop, Center, and Span frequencies

DUT Type–Freq Context (IF or RF)–(Inactive for DUT Type [Amplifier])

Frequency context can be used to define the DUT Type's RF Context **IF** (default) and **RF** values. Refer to "Frequency Range and Frequency Context" on page 769.

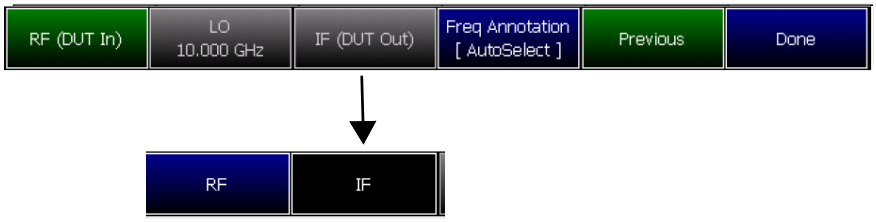
Figure 30-21 DUT >Type [Downconverter], [Upconverter], and [Multi-Stage Converter] > Freq Context [IF] or [RF]–(Inactive for Type [Amplifier])

DUT – Measurement Setup – **Type [Downconverter], [Upconverter], and [Multi-Stage Converter]**



Used for setting up frequency context for a DUT

– **Type [Downconverter], [Upconverter], and [Multi-Stage Converter]**



--Set the frequency context based on the DUT Type

––Enter the frequency context IF (default) or RF

Frequency Range and Frequency Context

Set the range of frequencies over which you would like to make DUT type measurements and frequency context for noise measurements.

When the frequency range is changed after a calibration is performed, the cal becomes interpolated. Learn more in "Interpolation *" on page 145.

How to set Frequency Range and Frequency Context

- Press **Freq/Dist** (Measurement) or

  for Frequency Context:

- Press **Meas Setup** > **DUT)** > **RF (DUT In)** and **IF (DUT Out)**
- Then **Freq/Dist** and choose from the following
  - **Start** and **Stop** frequencies - beginning and end of the sweep.
  - **Center** and **Span** frequencies – the center frequency and span of frequencies (half on either side of center).
  - **Freq Annotation** and one of the following:

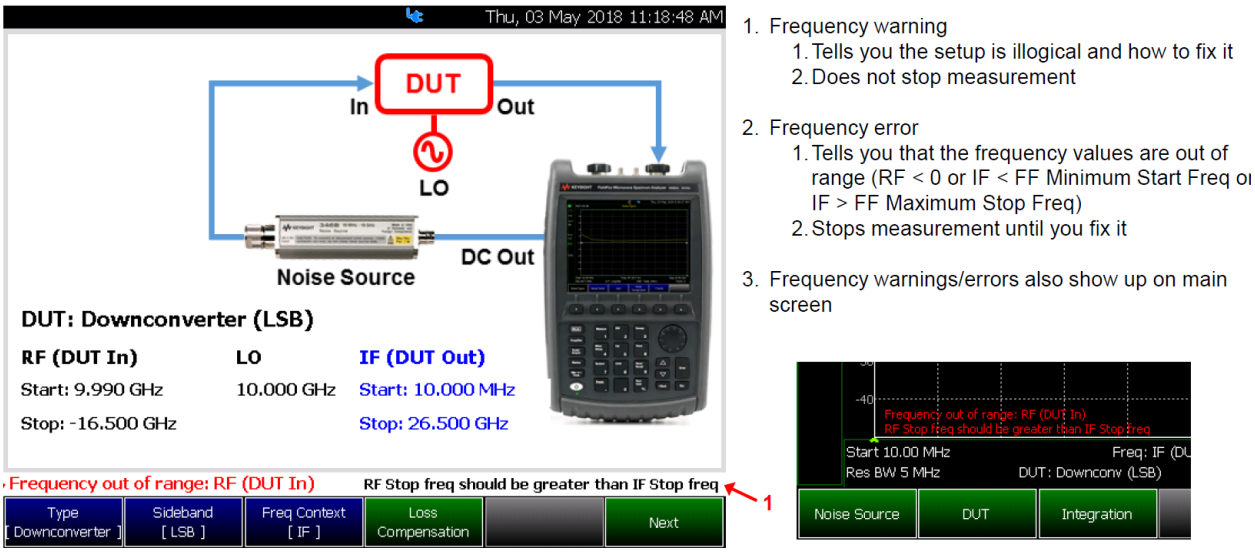
    AutoSelect (Default) – The FieldFox selects a frequency annotation setting (CenterSpan or StartStop).

    CenterSpan -The center frequency and span are displayed.

    StartStop - The start and stop frequencies of the frequency span are displayed.

- Follow each setting by entering a value using the numeric keypad, ▲|▼ arrows, or the rotary knob.
  - After using the keypad, select a multiplier key. Learn about multiplier abbreviations in Chapter 1, "Overview."
  - After use the ▲|▼ arrows or the rotary knob, press **Enter**.

Figure 30-22



1. Frequency warning
   1. Tells you the setup is illogical and how to fix it
   2. Does not stop measurement
2. Frequency error
   1. Tells you that the frequency values are out of range (RF < 0 or IF < FF Minimum Start Freq or IF > FF Maximum Stop Freq)
   2. Stops measurement until you fix it
3. Frequency warnings/errors also show up on main screen

DUT Type Loss Compensation

For all of the DUT Types (Amplifier, Downconverter, Upconverter, and Multi-Stage Converter) the loss compensation, before the DUT (**BeforeDUT**) and after the DUT (**AfterDUT**) can be enabled or disabled for loss and for temperature.

Loss compensation can be used to compensate for double sidebands (DSB). Loss compensation can be used in the case of DSB measurements to compensate for the doubling of the measured noise level (i.e., 3.01 dB increase). For all sideband cases you can enable or disable **Loss** (device loss) and **Temperature** (device temperature). Refer to Figure 30-23 on page 771.

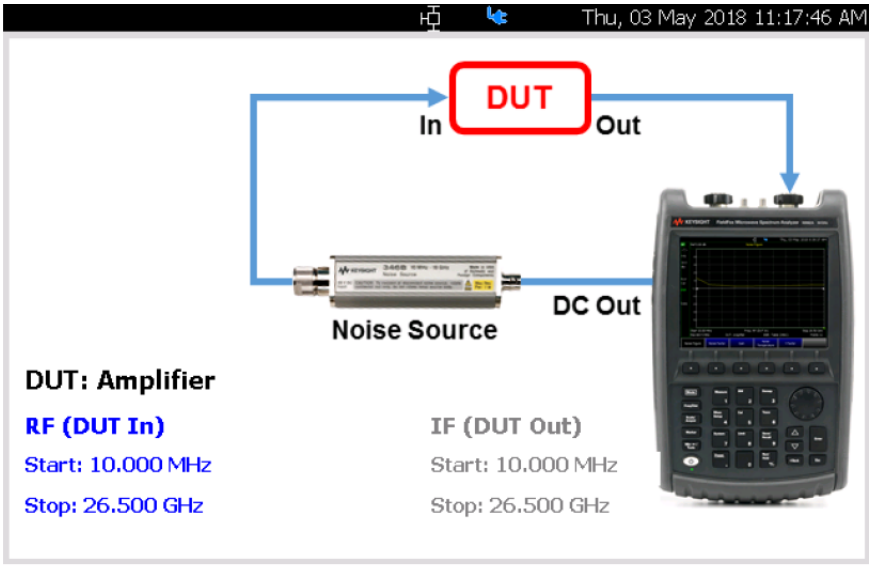
This section contains the following:

– Setting **Meas Setup** > **DUT** > **Loss Compensation** > **Before DUT** and **After DUT**, see Figure 30-23 on page 771.

Setting DUT Loss Compensation

Figure 30-23 DUT Loss Compensation

DUT – Measurement Setup – **Type [Amplifier], [Downconverter], [Upconverter], and [Multi-Stage Converter]**



Used for setting up loss compensation for a DUT

– **Type [Amplifier], [Downconverter], [Upconverter], and [Multi-Stage Converter]**

––Loss compensation can be set before and after the DUT

––Enable or disable the Loss (device loss) and the temperature (device temperature)

Single / Continuous / Restart

This setting determines whether the FieldFox measures continuously or only once each time the **Single** or **Run / Hold +/-** button is pressed. Use **Hold / Single** or to conserve battery power or to allow you to save or analyze a specific trace.

How to set Single or Continuous

– Press **Sweep 3**.

– Then choose one of the following:

–**Continuous**

––**ON** Causes noise figure (NF) to make continuous sweeps. This is the typical setting for making measurements. Each **Run / Hold +/-** press causes NF to toggle between continuous sweep and Hold.

––**OFF** Causes NF to Hold. Each **Run / Hold +/-** or **Single** press causes NF to make ONE sweep, then Hold. The Hold annotation changes to an arrow --> while the sweep occurs.

–**Single** Automatically sets Continuous OFF and causes NF to make ONE sweep, then Hold.

–**Restart** Resets the sweep to the current defined start frequency point.

Points

Points is the number of measurements that are measured and displayed along the X-axis. The higher number of data points, the better the ability to resolve closely spaced signals and the slower the sweep speed.

How to set number of points

– Press **Sweep 3**

– Then **Points [current setting]**

– Then choose from: **03 | 05 | 11 | 21 | 51 | 101 | 201 | 401 | 601 | 801 | 1001**

Resolution Bandwidth (Res BW)

CAUTION **Avoid setting the resolution bandwidth (Res BW) greater than the bandwidth of the measured DUT.**

In NF Mode, the Res BW settings increase the measurement speed and quality of a measured noise figure. The wider (higher) the Res BW, the faster and better the noise figure measurement. However, as the Res BW is narrowed, the sweep speed becomes slower and the measurement quality is degraded.

So: Wider Res BW = better noise measurement and faster measurement time

How to set Res BW

- Press **BW 2**.
- Then **Res BW**.
- Then choose from the following:
  - **300 kHz | 1 MHz | 3 MHz | 5 MHz** Press the desired resolution bandwidth.

The current Res BW setting is shown at the bottom of the screen.

This setting could impact the accuracy of the measurement. See Specifications in https://www.keysight.com/us/en/assets/7018-03314/data-sheets/5990-9783.pdf.

Alignments

The Noise Figure mode requires alignment types: amplitude. Refer to the SA chapter's "Alignments" on page 211 for information on all alignments.

Calculating Noise Figure Measurement Uncertainty

The Noise Figure mode can calculate and display the uncertainty of the noise measurement, whether it is a Noise Figure, Noise Factor, or Noise Temperature measurement.

The uncertainty calculation accounts for the following sources of uncertainty, both in the measurement and in the user calibration (Run User Cal):

- Noise power uncertainty caused by finite sample size (Jitter)
- Noise power uncertainty caused by mismatch
- ENR uncertainty of the noise standard

The following are not included because they have been determined to be insignificant:

- Linearity (i.e., due to the linear wide dynamic range receiver, the automatic gain adjustment, and the small power excursions of the hot/cold measurement)
- Residual temperature drift of the FieldFox (i.e., due to the internal reference switch)

Other possible causes of uncertainty that are not included in the uncertainty analysis are temperature drift of the following:

- DUT,
- Noise source, or
- Preamplifier

CAUTION Generally, the drift immunity of the Y-factor noise figure measurement is quite good. Nevertheless, caution is advised when temperature changes are significant between the user calibration and measurement.

NOTE When any one of the four uncertainty values reads all "0.00" across the band, a yellow `UNC?` annotation is displayed on the left side of the FieldFox display.

Refer to ENR "Using ENR Tables" on page 779.

Reverse noise wave generation by the DUT or preamplifier

All amplifiers, including the DUT and preamplifiers used in the noise figure measurement, are active devices which may generate noise power from both their input and output ports. The Noise Figure mode uncertainty calculation does not account for uncertainties caused when the input generated noise reflects back into the amplifier and adds to the total measured noise power. These types of uncertainties are minimized by using well matched noise

sources in the measurement and in the user calibration. And, in the case of very low power output DUTs (<15 dB gain + noise figure), by using an isolator on the input of the preamplifier.

Electromagnetic interference

DUTs, preamplifiers, noise sources, and connectors may all potentially be affected by radiated signals present in the test environment. Care should be taken to establish an appropriate test environment for the noise figure measurement.

DUT oscillations, microphonic behavior, etcetera

Any instability in the DUT will cause unaccounted noise measurement uncertainties.

Entering Uncertainty Information

In addition to information gathered during the measurement, the following information must be provided by the user in order to determine the noise measurement uncertainty:

– **DUT Reflection Coefficient**

  For this section, see also "Overview of Softkey Menus" on page 748 (Uncertainty > DUT on page 753).

  DUT Reflection Coefficients values may be imported to a DUT table from *.snp or *.csv Files, entered by editing a DUT table, recalled as a previously saved DUT table (in a *.dut file), or set as a spot value to be applied across all frequencies.

NOTE DUT and preamplifier *.snp files may be generated in the FieldFox VNA mode, and then imported into the Noise Figure mode.

Specified Style (Spec Style): Following the GUM method for Type B evaluation of standard uncertainty described in Reference[1][1], the uncertainty calculation takes into account not only the entered value of the reflection coefficient, but also the nature of this value. This can either be a measured value for the DUT, or some form of specified value. This is indicated by the Spec Style setting. Specified Styles may be either a percentile value, maximum, fixed, median or mean. This value indicates the nature of the entered value relative to the population of values it represents. Refer to Table 30-1 on page 776.

Distribution: Distribution settings refer to the population distribution of the $|\Gamma|$ values for the device. Refer to Table 30-2 on page 776.

Table 30-1 Specify Style – of the entered value relative to the represented population

Style	Description
Maximum	Use this if this value represents the largest possible reflection coefficient for the population of devices to which the DUT belongs. This is true for "does not exceed" specifications.
Fixed	Use this if the value is a measured value for the DUT.
Median / Mean	Use this if this value represents the median / mean reflection coefficient for the population of devices to which the DUT belongs.
95th %ile	Use this if 95% of the population has a lower reflection coefficient than the value entered. This is the case for "2 standard deviation" (2σ) type specifications.
80th %ile	Use this if 80% of the population has a lower reflection coefficient than the value entered.

Table 30-2 Distribution – of the population of the reflection coefficients

Distribution	Description
Fixed	The reflection coefficient magnitude is always at the given level. This is often the case when measured values are used.
Rayleigh	The probability density function (pdf) of the magnitude of the reflection coefficient is a Rayleigh distribution. This is normally the case for specified values when the overall mismatch is due to several interacting impedance transitions within the device.
Uniform (within a Circle)	A distribution that was historically used in the industry, before the Rayleigh research, as documented in Keysight Application Note 1449-3, but is rarely accurate. Refer to https://www.keysight.com/us/en/assets/7018-01152/application-notes/5988-9215.pdf.

1. Reference [1]: GUM 1995 with minor corrections Evaluation of measurement data - Guide to the expression of uncertainty in measurement JCGM 100:2008 First Edition September 2008.

– **Noise Source Reflection Coefficient, ENR Uncertainties, and ENR values:**

For this section, see also "Overview of Softkey Menus" on page 748 (Noise Source on page 749) and "Using ENR Tables" on page 779.

Noise source reflection coefficients, ENR Uncertainties, and ENR values may be entered by Recalling a previously generated *.enr file, editing an ENR table, or set as a spot value to be applied across all frequencies. Note that any *.enr file which uses the standard *.enr file format may be recalled by the Noise Figure mode.

NOTE

Template *.enr files for several common models of noise sources may be found in the default `ENR` table directory of the FieldFox. In these files, the reflection coefficients have been set to the values specified for the respective model numbers, but the values for the ENR or ENR uncertainty will need to be entered at each frequency. Refer to "ENR (*.enr) Files" on page 780.

As in the case of the DUT, in addition to entering the magnitude reflection coefficient values, the uncertainty calculation takes into account the distribution and specified style for the noise source reflection coefficient value. Additionally, the ENR table requires a value for the ENR uncertainty coverage (Uncert Coverage), which states how the entered ENR uncertainty (ENR Uncert) value is related to the population of possible ENR uncertainties. This is typically set to 2σ which means that 95% of the time, the actual ENR is within the range of ENR +/- ENR Uncertainty.

– **Preamplifier Reflection Coefficients (User Calibration Only):**

For this section, see also "Overview of Softkey Menus" on page 748 (Uncertainty > Preamp on page 755).

When a user calibration is performed, the Preamplifier Reflection Coefficient values may be imported to a Preamp table from *.snp or *.csv files, entered by editing a preamplifier table (Preamp Table), recalled as a previously saved preamp table (in a *.amp file), or set as a spot value to be applied across all frequencies.

NOTE

Template preamplifier (*.amp) files for several common models of preamplifiers may be found in the default `Preamp` table directory of the FieldFox. In these files, the reflection coefficients have been set to the values specified for the respective model numbers.

NOTE

DUT and preamplifier *.snp files may be generated in the FieldFox VNA mode, and then imported into the Noise Figure mode.

As in the case of the DUT, In addition to entering the magnitude reflection coefficient values, the uncertainty calculation takes into account the distribution (Γ Distribution) and specified style (Spec Style) for the preamplifier reflection coefficient value.

– **User Calibration Noise Source Reflection Coefficient, ENR Uncertainties and ENR values (User Calibration Only):**

  These are identical to the noise source values entered for the measurement, but are entered prior to performing the user calibration (Run User Cal).

– **Controlling the Uncertainty Calculation and Display**

  For this section, see also "Overview of Softkey Menus" on page 748 (**Uncertainty** > **Uncert Contributions** on page 755).

  When enabled, uncertainty bars are displayed on the data trace, indicating the uncertainty range for the current Noise Figure, Noise Factor, or Noise Temperature measurement. By default, the displayed uncertainty range is the measured data +/- the default coverage factor of two times the calculated standard deviation (2σ), which is based on all included uncertainties. Optionally, the coverage factor may be changed to 1σ, 2σ or 3σ. Also, as an aid in determining the cause of measurement uncertainty, any of the individual contributors (user calibration (User Cal Uncert), mismatch uncertainty (Mismatch Uncert), ENR uncertainty (ENR Uncert), or jitter uncertainty (Jitter Uncert) may be excluded from the uncertainty analysis.

Using ENR Tables

ENR tables are used to define the noise source(s) used in DUT measurements, receiver, and user calibration(s). Additionally, ENR tables are used along with DUT tables, preamplifier tables, and information collected during the measurement to compute the measurement uncertainty. Refer to Figure 30-24 on page 780.

– Both gain and noise figure measurement accuracy will be enhanced by using a noise source with as low a reflection coefficient as possible for both the noise figure measurement and the user calibration.

– It is not necessary to use the same noise source in the user calibration as will be used in the measurement. In some cases, it might be better to use a different noise source in the user calibration than will be used in the measurement. If this is done, it is important to select the ENR table for the calibration noise source prior to the calibration. And, then to select the ENR table for the measurement noise source prior to measuring the DUT.

  See also, "Calibration Wizard" on page 783.

How to Create an ENR Table

To create an ENR table:

This procedure assumes you have previously set your frequency, resolution bandwidth, and number of points. Refer to "Example: Typical Noise Figure Measurement Procedure" on page 747.

For this procedure, refer to Figure 30-24 on page 780.

1. Press **Measure** > **Noise Source** > **ENR Mode Table** (default)
2. Then **ENR Table Edit/Save/Recall**
3. Then choose:

   Edit ENR Table (to modify the currently loaded ENR table)

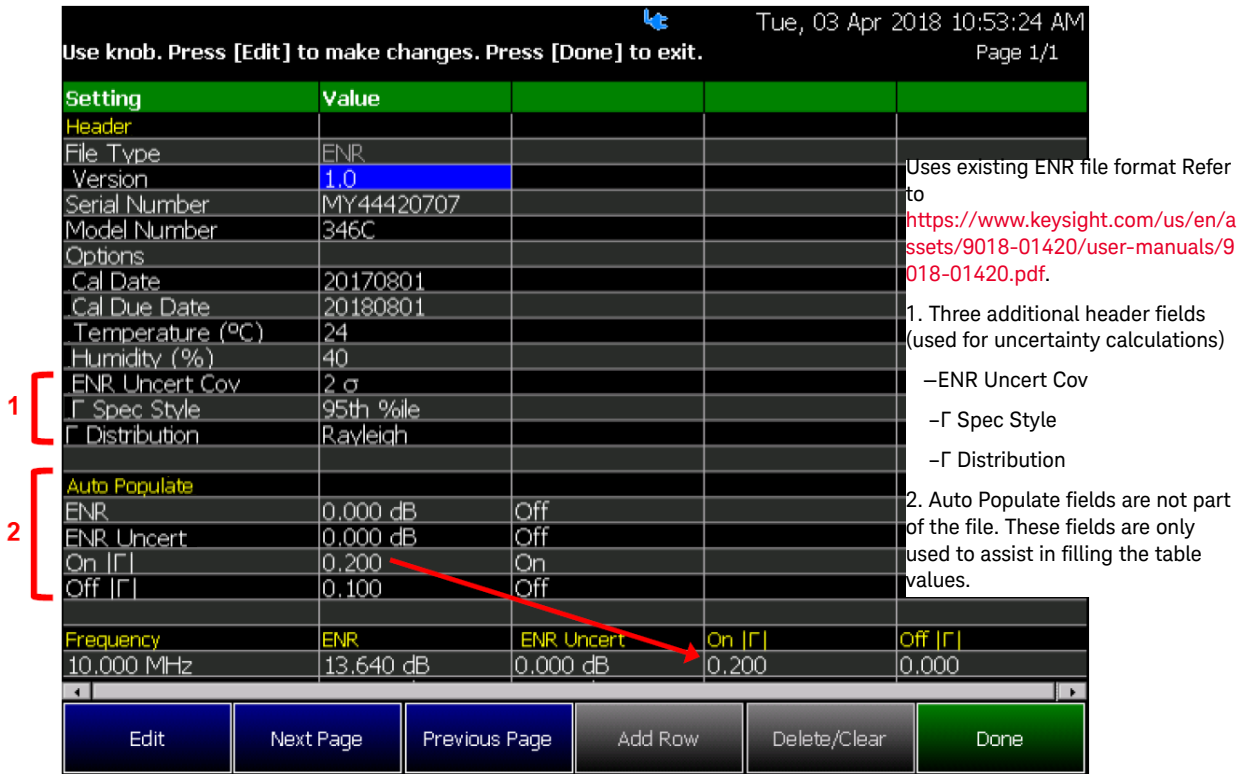
   New ENR Table (to create a new table)

   Save ENR Table (to save any changes to the currently loaded ENR table)

   Recall ENR Table (to recall a previously saved table)

   Back (to return to previous softkey menu)
4. Then edit the table as necessary for your devices and measurements by entering in Header, Auto-populate, ENR, ENR uncertainty, On $|\Gamma|$, and Off $|\Gamma|$. Refer to Figure 30-24 on page 780.

Figure 30-24 Editing ENR Tables



About ENR (*.enr), Preamplifier (*.amp), and DUT (*.dut) Files

This section contains the following:

– "ENR (*.enr) Files" on page 780
– "Preamplifier (*.amp) Files" on page 781
– "DUT (*.dut) Files" on page 781

ENR (*.enr) Files

– ENR files are saved to, and recalled from, the **NoiseFigure\ENR** folder. If the folder does not already exist on a USB or SD card, it is created automatically before storing the file.

– ENR files are stored as *.enr files. Existing ENR files that are loaded into the FieldFox can be overwritten. Your edited file will NOT be overwritten when firmware is updated.

– To **DELETE** a *.enr file, use the Manage Files feature. Learn more in "Manage Files" on page 897.

Preamplifier (*.amp) Files

- Preamplifier (*.amp) files are saved to, and recalled from, the **NoiseFigure\Preamp** folder. If the folder does not already exist on a USB or SD card, it is created automatically before storing the file.
- Preamplifier files are stored as *.amp files. Existing *.amp files that are loaded into the FieldFox can be overwritten. Your edited file will NOT be overwritten when firmware is updated.
- To **DELETE** a *.amp file, use the Manage Files feature. Learn more in "Manage Files" on page 897.

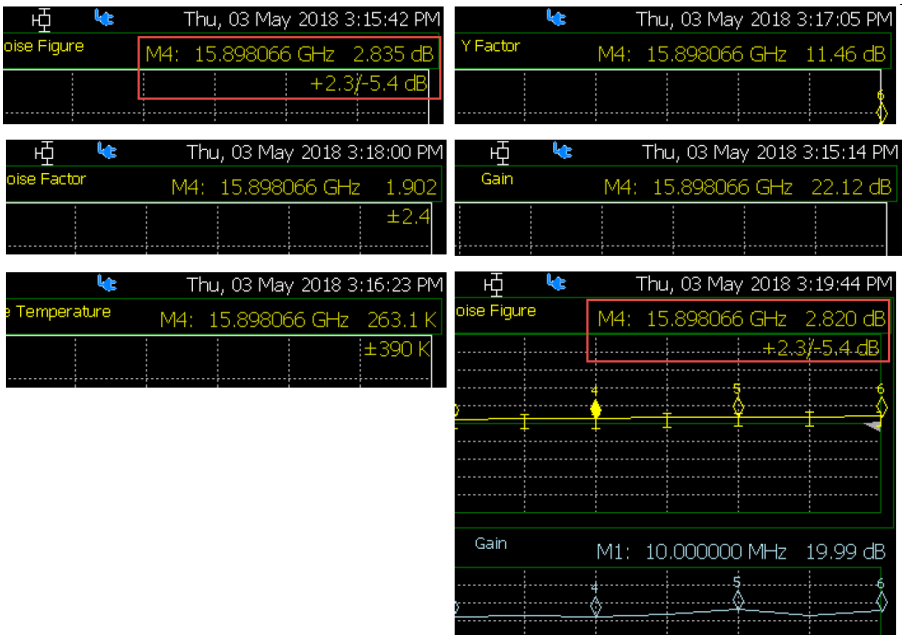
DUT (*.dut) Files

- DUT (*.dut) files are saved to, and recalled from, the **NoiseFigure\DUT** folder. If the folder does not already exist on a USB or SD card, it is created automatically before storing the file.
- DUT files are stored as *.dut files. Existing *.dut files that are loaded into the FieldFox can be overwritten. Your edited file will NOT be overwritten when firmware is updated.
- To **DELETE** a *.dut file, use the Manage Files feature. Learn more in "Manage Files" on page 897.

Using Markers (Noise Figure)

In addition to the features shown here, noise figure has many of the same marker features as other FieldFox modes. See also "All about Markers" on page 797.

Figure 30-25 Marker Annotation



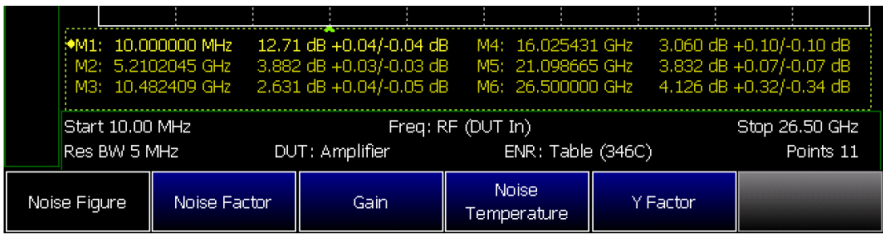
Marker annotation

– Marker readout in top right corner of graticule.

– Displays uncertainty values for select measurements.

IMPORTANT! Noise Figure has asymmetric uncertainty (see red box in figure). Noise Factor and Noise Temperature have symmetric uncertainty.

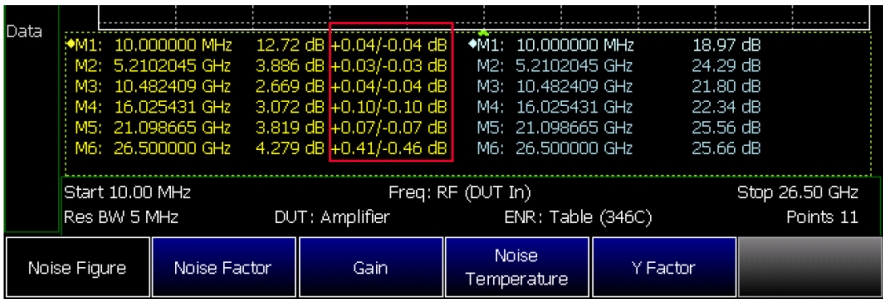
Figure 30-26 Marker Table Annotation



Marker table annotation under the graticule.

– Marker table data under the graticule.

– Displays uncertainty values for select measurements.



IMPORTANT! Noise Figure has asymmetric uncertainty (see red box in figure). Noise Factor and Noise Temperature have symmetric uncertainty.

Calibration Wizard

The Noise Figure mode has two types of calibration wizard softkeys: Receiver Cal and User Cal.

NOTE A receiver calibration is required for a user calibration. On the Fieldfox, after you have completed a user calibration, the User Cal (`User Cal`) annotation overwrites the displayed Receiver Cal (`Rcvr Cal`) annotation.

To access the calibration wizards:

- Press **Cal** then
  - **Run Receiver Cal** or
  - **Run User Cal** and then
  - follow the prompts

When to Calibrate

Noise Figure has two different calibrations that are important to run, depending on the type of measurement you are using:

- Receiver calibrations (required for all measurements).
- User calibrations (required, if the setup uses an external preamplifier).

Understanding Receiver and User Calibrations

This section contains the following:

- "Receiver Calibration (Receiver Cal):"
- "User Calibration (User Cal):"
- "User Calibration (User Cal):"
- "Optimizing Measurement Accuracy:"

Receiver Calibration (Receiver Cal):

NOTE When there is no preamplifier in the measurement, only a receiver calibration is required.

The receiver calibration's purpose is to establish the true measurement bandwidth of the receiver when making noise measurements. This bandwidth information is used to calculate the gain of the DUT when there is no user calibration. But, if there is a user calibration, the gain calculation is

independent of the receiver bandwidth from the receiver calibration. The receiver calibration has virtually no influence on the noise figure measurement, either with or without a user calibration. The receiver calibration only effects the gain measurement, and only when there is no user calibration.

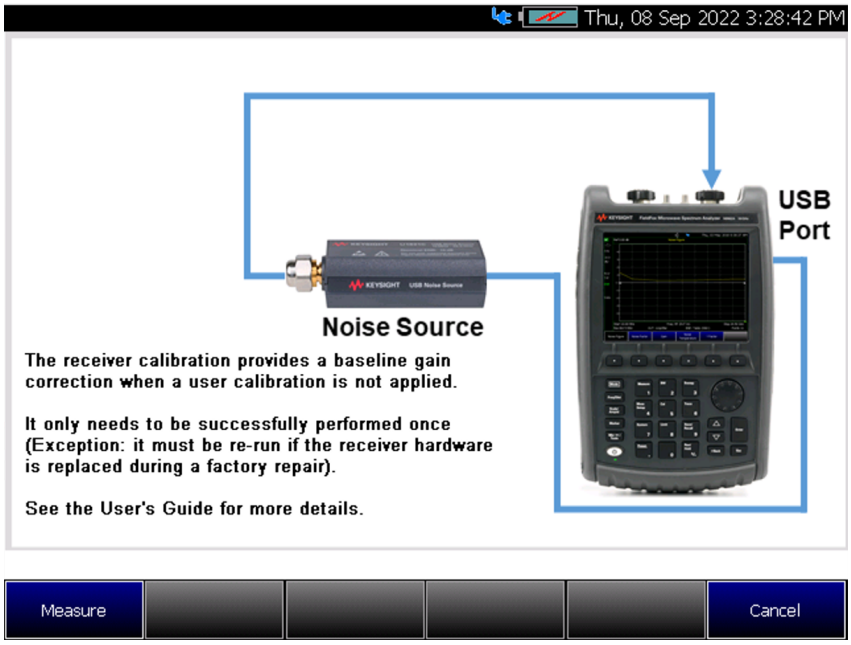
As already stated, the receiver calibration measures the measurement bandwidth of the receiver. In most cases, this is set primarily by the digital processing of the receiver. The receiver calibration is needed, because it is influenced by the IF analog circuitry of the FieldFox. Additionally, the bandwidth is extremely stable, and does not vary significantly with time or temperature. So, once the receiver calibration has been successfully performed there is no need to repeat the receiver calibration.

Exceptions: Re-do the receiver calibration when the FieldFox receiver hardware is changed (factory repair) or in the rare case where a filter is added to the measurement system which has a narrower bandwidth than the receiver (i.e., the external bandwidth is less than the lowest resolution bandwidth (Res BW) setting of 300 kHz).

For example of Smart Noise Source Receiver Cal, refer to Figure 30-27 on page 785.

Figure 30-27 DUT – Measurement Setup – Receiver Calibration Screen – ENR Mode: Smart (Auto)

DUT – Measurement Setup – **Receiver Calibration** withOUT External Amplifier (LNA) – ENR Mode: Smart (Auto)



USB Smart Mode DUT Wizard visibility:

1. Receiver Cal Wizard for Smart Noise Source. (Walks user through Receiver Cal.)

2. The Receiver Cal measures the gain-bandwidth product (GBW) of the FF receiver

3. Should be run before making any measurements

4. Only needs to be carried out about once every year (it does not need to be carried out for different measurement parameters, different noise sources, when temperature drifts, etc.)

5. If USB Noise Source is NOT connected to the FieldFox, “Measure” will be grayed out.

User Calibration (User Cal):

NOTE

Performing a user calibration is recommended only when the measurement setup includes a preamplifier. The user calibration is unnecessary for accurate measurements when no preamplifier is used.

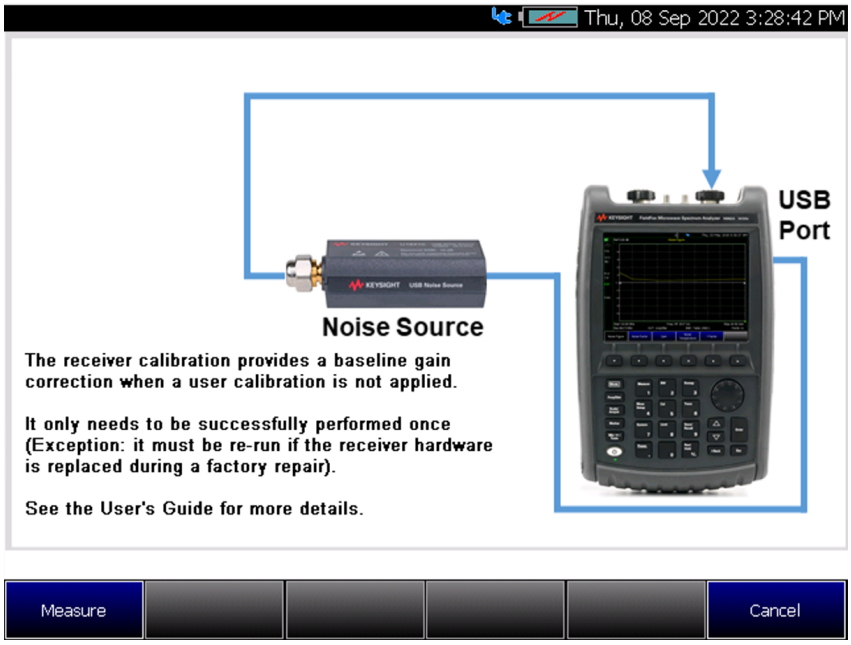
In general, a user calibration should be performed whenever a preamplifier is used in the noise figure measurement. If there is no preamplifier, the user calibration is not necessary.

Although it will be interpolated if other frequencies are used, when a user calibration is performed, it should be made at the same frequencies as the measurement. The user calibration also needs to be performed with the same resolution bandwidth as is used in the measurement. The user calibration determines the noise contribution of the preamplifier, so that it can be removed from the measurement when computing the noise figure of the DUT. Also, the user calibration establishes the power gain of the receiver—preamplifier system so that the reported gain of the DUT will be the gain between input of the DUT (where the noise source is connected during the measurement) and the calibration plane (which is the point where the noise source is connected during the user calibration). Therefore, for the best gain accuracy, the noise source used in the calibration, should be connected at the same point as the DUT will be during the measurement.

For example of Smart Noise Source User Cal, refer to Figure 30-28 on page 787.

Figure 30-28 DUT – Measurement Setup – Run User Cal Screen – ENR Mode: Smart (Auto)

DUT – Measurement Setup – **Run User Cal** with External Amplifier (LNA) – ENR Mode: Smart (Auto)



USB Smart Mode DUT Wizard visibility:

1. Receiver Cal Wizard for Smart Noise Source. (Walks user through User Cal)
2. The User Cal measures the noise contribution of the external preamp
3. Should only run if using an external preamp
4. Must have a Receiver Cal to run a User Cal
5. Needs to be carried out for current preamp, current frequency range, and current temperature (within reason)
6. The current User Cal is automatically invalidated if you go outside of its frequency range
7. If USB Noise Source is NOT connected to the FieldFox, “Measure” will be grayed out.

Optimizing Measurement Accuracy:

- Both gain and noise figure measurement accuracy will be enhanced by using a noise source with as low a reflection coefficient as possible for the user calibration.
- When the DUT output noise power is relatively low (i.e., the gain plus noise figure of the DUT is less than 15 dB), measurement accuracy may also be improved by using a low loss isolator on the preamplifier input. Due to the output reflection coefficient of the DUT, reverse noise waves from the preamplifier, when present, will contribute a different amount of noise power during the measurement of the DUT than during the user calibration. And, this change in receiver noise power can impact the measurement accuracy.
- It is not necessary to use the same noise source in the user calibration as will be used in the measurement. In some cases, it might be better to use a different noise source in the user calibration than will be used in the measurement. If this is done, it is important to set the ENR table for the calibration noise source prior to the calibration, and to set the measurement noise source prior to measuring the DUT.
- Prior to starting a user calibration, it is a good practice to connect the preamplifier and noise source that will be used during the user calibration and perform a noise figure measurement of the preamplifier itself (without a user calibration). Use the same bandwidth and frequency settings that will be used in the user calibration. A successful noise figure measurement ensures that all of the connections (bias, control, and RF) have been made properly. The user calibration can be started immediately following the successful noise figure measurement of the preamplifier, with no change to the setup.

How to use Auto-Integration

CAUTION **For optimum speed and performance measurement results, it is recommended that auto-integration is used in all noise figure measurements.**

This section provides an example procedure for measuring a device using noise figures' auto integration feature. This example does not use an external preamp and was performed over a long time duration. Auto-integration is recommended to achieve greater accuracy and speed for all of your device measurements. Refer to Figure 30-30 on page 792 and Figure 30-30 on page 792.

For the following example, these settings were used on the FieldFox with a Keysight 346C K01 noise source that had the following characteristics:

Keysight 346C K01 characteristics at 50 GHz
ENR of 11. 8 dB
Noise figure 8.7 dB
Gain 9.5 dB
Total Noise = 18.2 dB above kTB.
FieldFox N9952B noise figure (as tested): 39.3 dB

NOTE **For this example, the cold noise generation of the 346C K01 is 21.1 dB below the FieldFox's noise power (i.e., 39.3 dB – 18.2 dB = 21.1 dB).**

About Auto-Integration

With auto integration, the FieldFox Noise Figure application chooses the optimum integration time for each of the noise power measurements needed (i.e., noise source on, noise source off, and receiver reference) to compute the device's noise figure with the selected amount of measurement jitter in the shortest possible time. The auto integration feature calculates the time required to satisfy the jitter goal from the relative power levels as they are measured. One significant advantage of auto integration is that it ensures that the best possible instrument speed is used in achieving the necessary jitter requirement.

If, on the other hand, it is determined that the time required to meet the jitter goal exceeds the maximum allowed time set by the user, auto integration will divide the maximum allowed time between the power measurements in order to produce the smallest possible jitter in the noise figure measurement. In

these cases, since the jitter goal has not been reached, a jitter warning marker will appear on the data trace (unless disabled by the user), indicating that the jitter goal could not be achieved within the selected time constraint.

Due to the stability of the FieldFox receiver with its internal reference switch and the design of the auto integration feature, it is possible to achieve a stable, accurate, low jitter measurement results even under challenging measurement conditions, such as when measuring low noise power output devices at high frequencies with no pre-amplifier, by setting very long maximum integration times. For example, stable measurements with 0.1 dB jitter and no discernible drift have been demonstrated measuring a low gain, low noise amplifier at 50 GHz using maximum integration times of 5000 seconds per point, in spite of ambient temperature drift of several degrees Centigrade over the course of the measurement.

While auto integration can achieve very low jitter measurements, it is a good practice to consider the contribution of the jitter uncertainty to the total measurement uncertainty when selecting a jitter goal. If the measurement uncertainty from other contributors is known to be 0.5 dB, for example, it would make little sense to set a jitter goal of 0.1 dB. Setting a jitter goal of 0.3 dB in this case would only increase the RSS uncertainty to 0.58 dB, and would potentially speed up the measurement by a factor of 9 relative to a jitter goal of 0.1 dB. Auto integration makes it possible to select the jitter level with confidence, and is therefore a valuable tool in obtaining the required level of accuracy with the fastest possible measurement time.

Auto-Integration Procedure

No user cal was performed for this measurement, because no external preamp was used.

Set the equipment up in an area where it will remain undisturbed for the determined amount of measurement time. Refer to Figure 30-29 on page 792 and Figure 30-30 on page 792. See also, Figure 30-1 on page 738 and Figure 30-1 on page 738.

1. Enter the Measurement type:

   Select **Measure** > **Noise Figure** (default)

2. Enter the Noise Source ENR information into a table:

NOTE If you have previously saved your noise source's ENR information into a table, skip this step and proceed to step 4.

Select **Measure Setup**

Then choose:

– **Noise Source** then

– **ENR Mode Table** (default)

- ENR Table Edit/Save/Recall
- Edit ENR Table
  - Enter the serial number and model number of your noise source. If desired, enter other information (e.g., Options, Cal Date, etcetera).

    Enter a value using the numeric keypad, the ▲|▼ arrows, or the rotary knob.
  - Done to finish table and return to previous menu.

3. Save the ENR table:

   If you are not familiar with saving and recalling files, refer to Chapter 34, "File Management." and then to "Saving and Recalling Files" on page 888.

   Choose:

   - Save ENR Table

     Enter the filename of your noise source.

     Enter a value using the numeric keypad, the ▲|▼ arrows, or the rotary knob.
   - Done to finish table and return to previous menu.

4. Enter the noise figure measurement's frequency, number of points, and span settings:

- Freq/Dist > Center > 50 GHz
- Sweep 3 > More > 401 points
- BW 2 > Span > 0 Hz

5. Define the noise figure's integration settings:

   Meas Setup 4 > Integration

   Then choose

   - Mode Auto (default)
   - Jitter Goal > 0.10 dB
   - Max. Time/Pt > 300s
   - Jitter Warning ON (default)
   - Back to return to previous menu

   Press Uncertainty then

   - Uncert. Bars ON

6. Leave the setup to run for desired time.

Figure 30-29 Example of Jitter Uncertainty (401 points)—with Uncertainty Bars

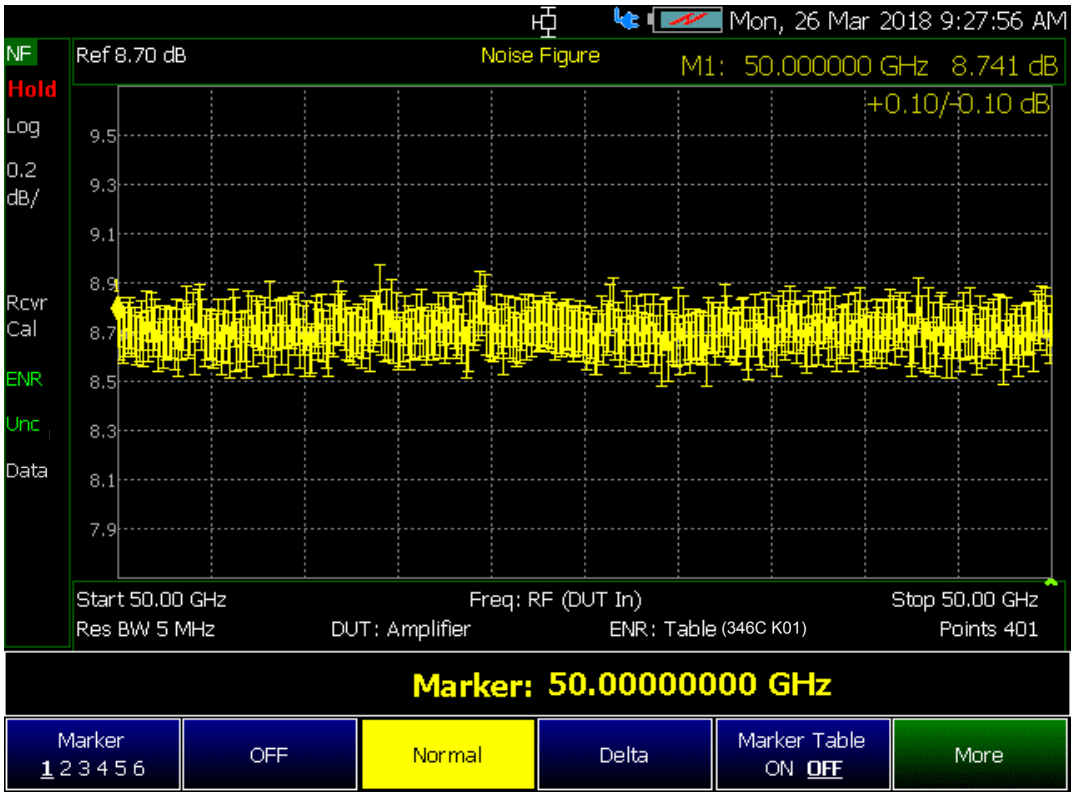


Figure 30-30 Example of Jitter Uncertainty (401 points)—without the Uncertainty Bars

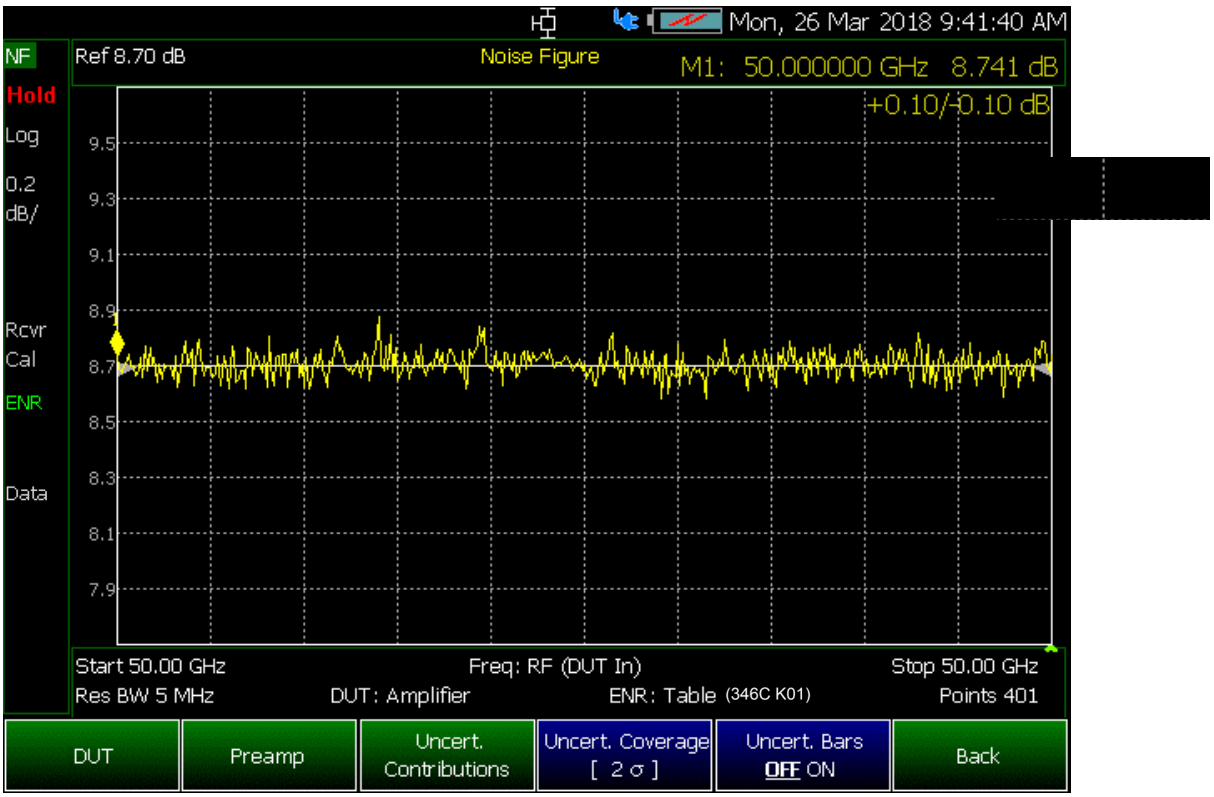
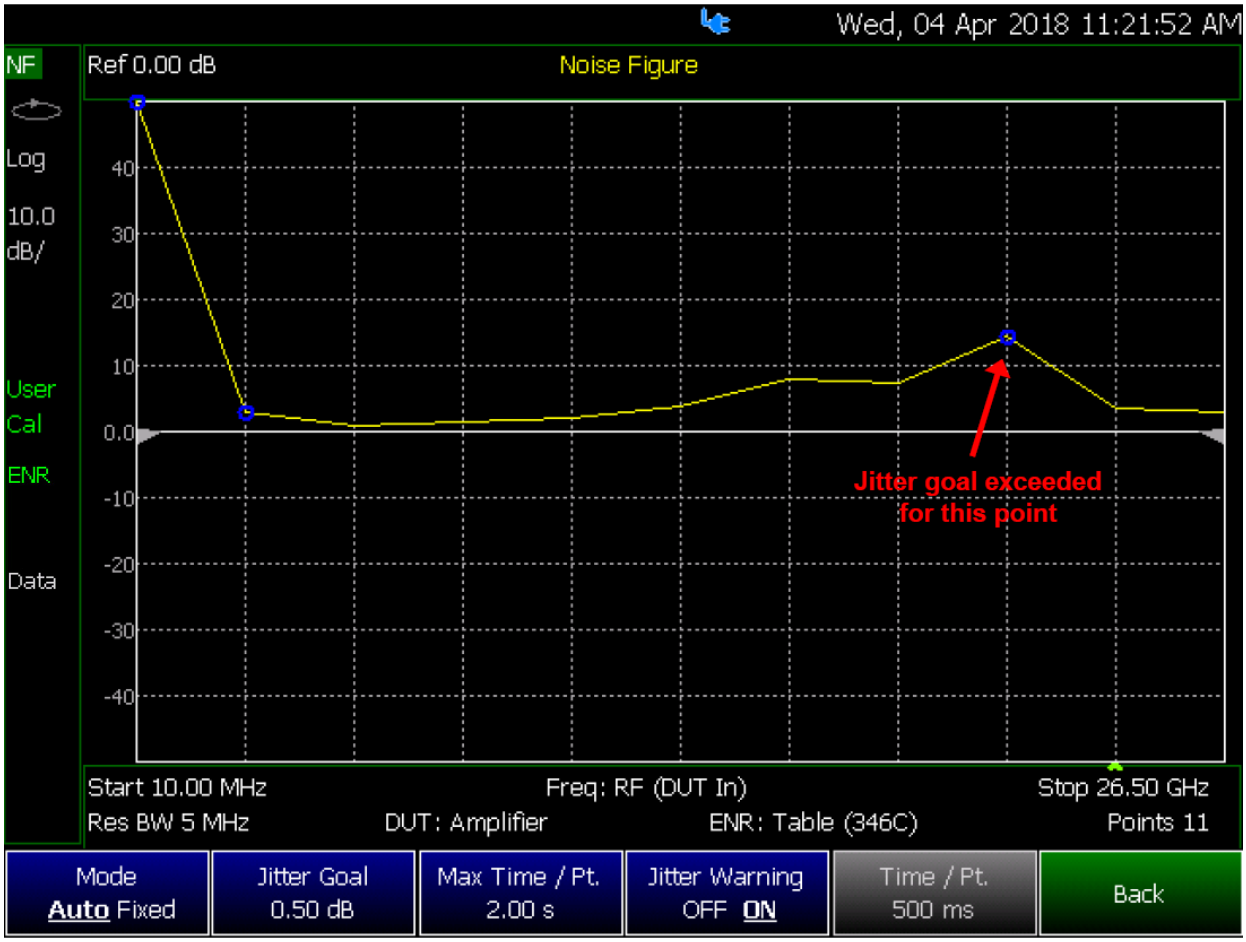


Figure 30-31 shows an example of a noise figure visual Jitter Warning elements that can be enabled/disabled (i.e, blue circles around points where the jitter goal was exceeded).

– Press to toggle **Jitter Warning OFF ON** (default = ON)

Figure 30-31 Example of Jitter Uncertainty—with Jitter Uncertainty Trace



Other Features Available

– **Limit Lines** - For information on using Limit Lines, refer to "All about Limit Lines" on page 812.

– **Display Lines** - For information on using Limit Lines, refer to the SA chapter's section, "Display Line" on page 222.

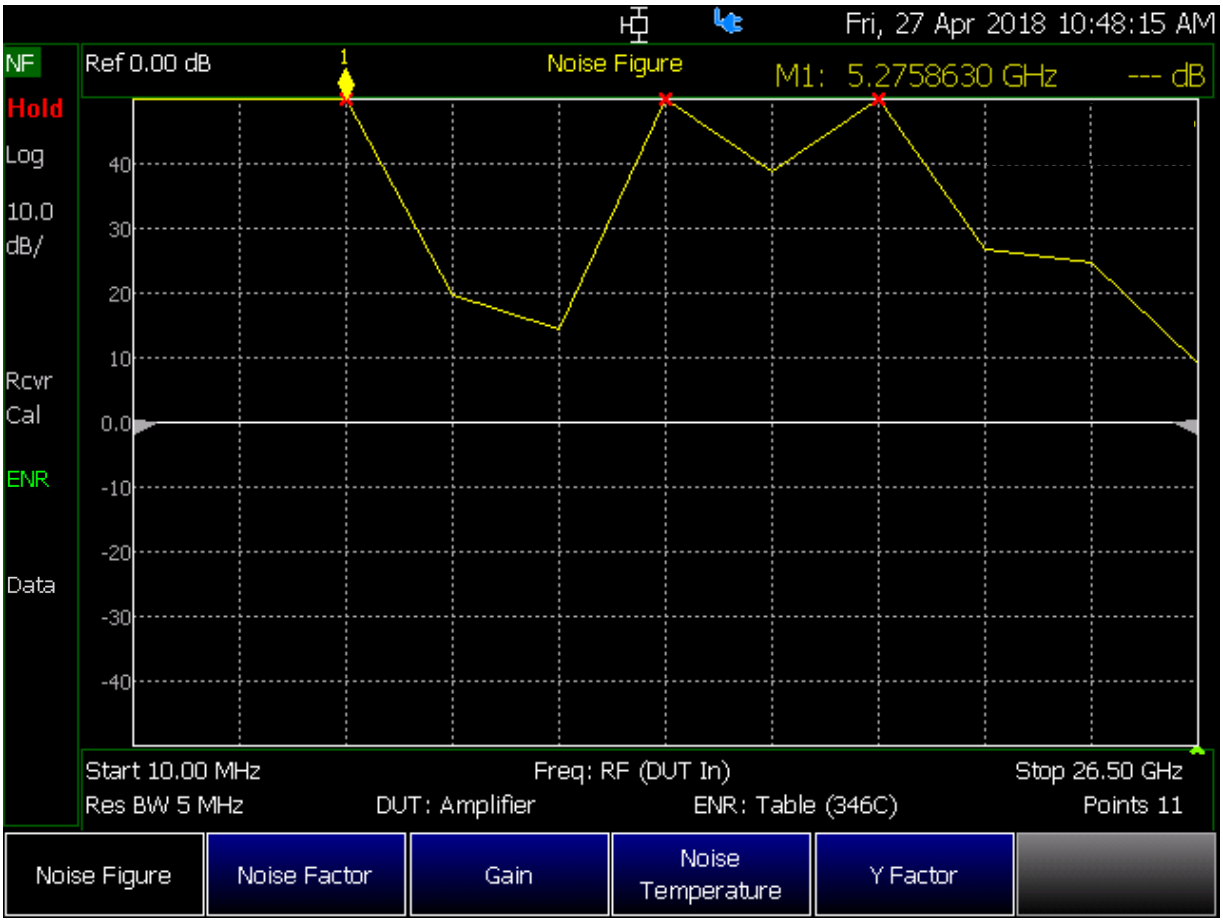
– **Scale Settings** – For information on using Autoscale, Autoscale All, and Scale settings, "All about Scale Settings" on page 831.

Troubleshooting

Some measurements can result in invalid results (NaNs). In these cases the FieldFox's Noise Figure Option 356 displays the following:

- Red X on the NaN point
- Marker readout displays: "---"
- SCPI will return its NaN representation (i.e., 9.91E+37)

Figure 30-32 Example of an invalid measurement



31 Data Analysis Features

The following features can be used after a measurement to analyze the results.

In this Chapter

"How to create Markers" on page 797
"How to move a Marker after it is created" on page 797
"About Delta Markers" on page 798
"Marker Table" on page 799
"Coupled Markers (NA Mode)" on page 800
"Marker Trace (CAT, NA, NF Modes)" on page 801
"Marker Trace (IQA and SA Mode)" on page 801
"Marker Format" on page 802
"Searching with Markers" on page 803
"What Is a 'Peak'" on page 808
"Marker Functions" on page 810
"SA Marker Functions" on page 811
"How to Create Fixed Limit Lines" on page 813
"Relative Limit Lines" on page 814
"Build From Trace" on page 815
"Limit Options" on page 817
"Auto Sync Limit (EMF scan mode Limit Lines Only)" on page 818
"How to Save and Recall Limits" on page 818
"Creating and Importing *.csv Limit Line Files" on page 819
"How to display data and memory traces" on page 829
"How to perform Trace Math " on page 829

"About Math Operations" on page 830

"How to Use Scale Settings" on page 831

"Averaging (CAT, NA, Power Meter, Channel Scanner, and Pulse Measurement Modes Only)" on page 832

All about Markers

Markers move along the X-axis range of the measurement trace to provide a numerical readout of each measured data point. Markers also allow you to search for specific Y-axis values.

A trace can contain up to six markers.

The marker readout on the FieldFox screen displays X and Y-axis information for the current active marker ONLY.

A Marker Table can be displayed that allows you to simultaneously view X and Y-axis information for all markers.

Markers can be used in **CAT**, **EMI Measurements**, **I/Q Analyzer**, **NA**, **NF**, **RTSA, SA**, **Phased Array Antenna**, and **Pulse Measurements** Modes.

How to create Markers

1. Press **Marker**.
2. Then **Markers 1...6** to select a marker to activate.
3. Then **Normal** to activate that marker. A marker is created on the trace in the middle of the X-axis. That marker is now **active**.
4. Then move the marker using the rotary knob, the ▲|▼ arrows, or by entering an X-axis position with the number keys.
5. Then press **Enter**.

How to move a Marker after it is created

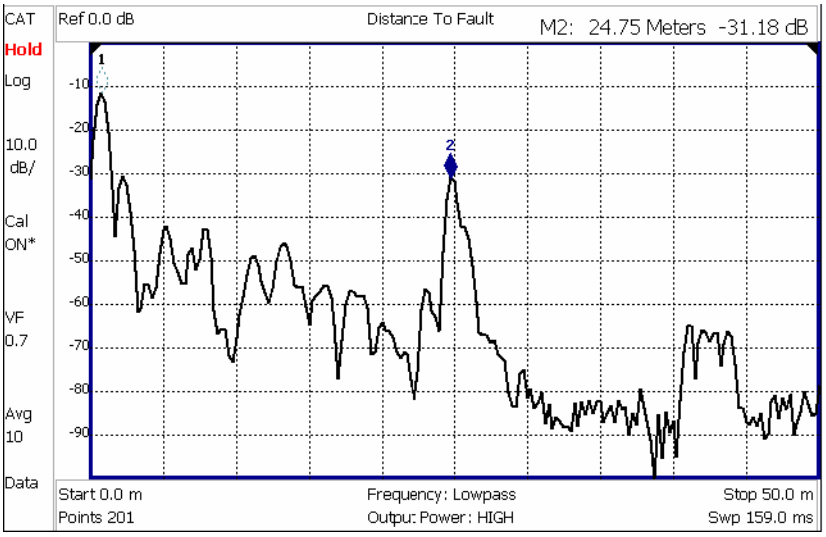
– Press **Marker**.

– Then **Markers 1...6** repeatedly until the marker of interest is selected. The OFF, Normal, or Delta softkey is black to indicate the current setting of each marker.

– Then move the marker as when it was first created.

– Markers can also be moved using one of the marker search functions. Refer to “Searching with Markers” on page 803.

Figure 31-1 Marker 2 is Active, marker 1 is NOT active.



About Delta Markers

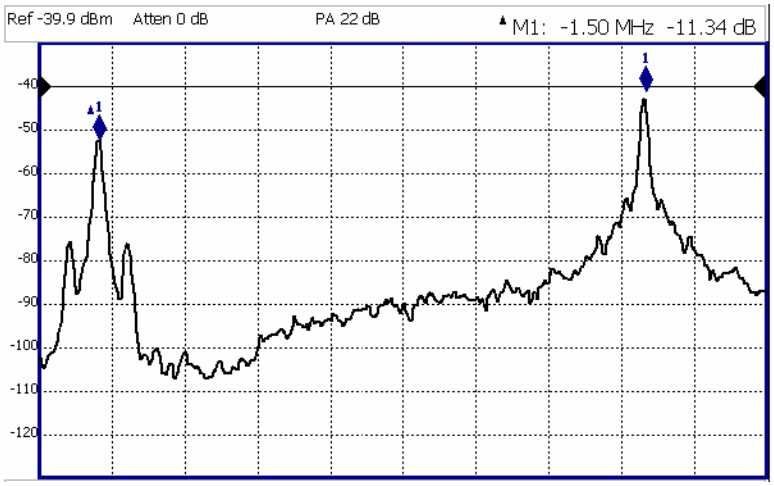
A Delta marker provides X-and Y-axis readout information that is **relative** to a 'reference' marker.

A Delta marker is created with a Δ (delta symbol) to distinguish it from the reference marker.

All six markers can be a Delta marker pair.

Peak search functions can be performed using delta markers.

Figure 31-2 A Delta marker and its associated reference marker.



In the graphic above, the marker readout shows the difference between the two markers in frequency and amplitude.

How to Create a Delta Marker

- Create a **Normal** marker and move it to the reference position.
- Press **Delta**. The marker becomes the reference marker and fixed in its X-Axis position.
- Move the **Delta** marker using the numeric keypad, the ▲|▼ arrows, or the rotary knob.
- Press **Enter** when finished.

How to move the Reference marker

- Press **Normal** to turn the Delta marker OFF.
- Move the marker to the new position.
- Then press **Delta** again, to turn the Delta marker back ON.

Fix the position of the Reference marker (I/Q Analyzer, RTSA, and SA Modes ONLY)

In SA mode, the reference marker can be fixed at the Y-axis position of the data trace when the marker was created, or it can 'float' with each sweep at the Y-axis position of the data trace. In CAT and NA mode, the reference marker always floats with the data trace.

- Create a Delta marker.
- From the **Mkr ->/Tools** menu, press **More** (SA mode only), then **Marker Properties**, then **Delta Ref Fixed**
  - **OFF** – The reference marker floats at the data trace Y-axis position.
  - **ON** – The reference marker is fixed at the Y-axis position of the data trace when the marker was created (Default IQA and SA modes).

Signal Track Marker (NF and SA Mode ONLY)

In NF and SA mode, the marker can be peaked at the Y-axis position of the data trace and the marker is centered on the screen. This setting applies to all NF and SA markers.

- Create a Signal Track marker (peak).
- From the **Mkr ->/Tools** menu, press **More**, then **Marker Search**
  - **OFF** – The reference marker floats at the data trace Y-axis position.
  - **ON** – The reference marker is peaked at the Y-axis position of the data trace and the marker is centered on the screen.

Marker Table

The Marker Table can be displayed at the bottom of the FieldFox screen. It can display information for up to 6 markers in a full-width window, and up to 3 markers for a half-width window (NA mode). The marker table "squeezes" the graticule area when activated.

How to display the Marker table

1. Press **Marker**.
2. Then **More**
3. Then **Marker Table On Off**.

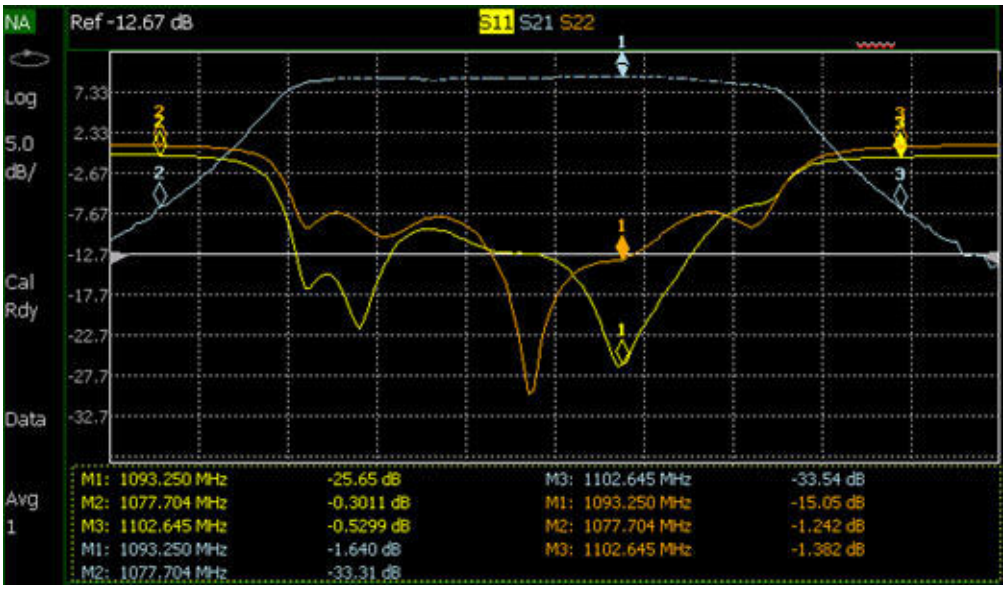
Coupled Markers (NA Mode)

NOTE I/Q Analyzer (IQA) mode has coupled markers. but the behavior is different than the NA mode Coupled Markers behavior. Refer to "Coupled Markers (Waveform Only)" on page 328

Coupled Markers, available in NA mode only[1] and allows you to simultaneously create and move markers that have the same number for all traces. For example, when marker 2 is created on a trace, a marker 2 is created for ALL traces. When any marker 2 is moved, they all move together to the same X-axis position.

- Coupled markers are allowed only in NA mode and are relevant only in multi-trace configurations.
- You can have markers that are coupled and others that are uncoupled.
- Peak functions move the marker to the peak on the active trace, while all other markers move to the same X-axis position.

Figure 31-3 Coupled Markers move on ALL traces at the same time (NA shown).



1. IQA mode has coupled markers, but the behavior is different than NA mode's coupled markers. Refer to "Coupled Markers (Waveform Only)" on page 328.

How to create Uncoupled Markers

NOTE Markers are coupled by default.

To create markers that are NOT coupled (move independently on each trace):

1. Press **Marker**
2. Then **More**
3. Then **Coupled Markers OFF**

Marker Colors

As shown in the above image, in NA and CAT Modes, markers are the same color as the trace to which they are assigned. In SA Mode, the marker color is NOT the same as the trace.

Marker colors can NOT be changed.

Marker Trace (CAT, NA, NF Modes)

The Marker Trace setting is used to move markers between the data trace and memory trace.

When Coupled Markers is ON, this setting applies to the active marker for ALL traces that are coupled. Otherwise, this setting applies to the active marker on only the active trace.

How to move a CAT, NA, and NF mode marker between traces

1. With at least one marker present, press **Marker** then **More**.
2. Then select the marker to move using **Marker 1,2,3,4,5,6**.
3. Then toggle **Marker Trace Auto Data Mem**.
   - **Auto** - Marker resides on data trace when it is visible. Marker resides on memory trace when only IT is visible (Default setting).
   - **Data** - Marker resides on data trace, even when not visible.
   - **Mem** - Marker resides on memory trace, even when not visible.

Marker Trace (IQA and SA Mode)

Marker Trace determines the trace number on which a marker resides. A marker is created on, or can later be changed to, the trace number specified by the Marker Trace selection. When changed, a marker moves to the same X-axis location on the specified trace.

Learn more about IQA Traces in “Trace Display States (IQA Mode)” on page 331.

Learn more about SA Traces in “Trace Display States (SA Mode)” on page 209.

How to move an IQ and SA mode marker between traces

1. With two or more traces present, press **Marker** and **Enter** to create a marker. The marker is created on the current Marker Trace selection (default setting is 1).
2. Then **More**
3. Then select the marker to move using **Marker 1,2,3,4,5,6**.
4. Then toggle **Marker Trace 1,2,3,4**
   - The selected marker is moved to the specified trace.
   - When a marker is moved to a 'blank' trace (not visible) the marker moves to the same X-axis position at either the Y-axis position of the last data, or to the ZERO position.

Marker Format

The Marker Format setting allows you to choose the format of the marker readout that appears in the upper-right corner of the screen and in the marker table. The marker format can be independent of the trace format, and can be set independently for each trace. All markers on a trace have the same marker format.

How to choose marker format

- Press **Marker**
- Then **More**
- Then **Marker Format**
- For **NA Mode** measurements, choose from the following:

Selection	Example Y-axis value
Default Same as displayed format	
R + jX Complex impedance format (3rd number is distance for Time Domain)	22.8Ω -j61.4Ω 287.9fF
Z Magnitude Impedance Mag.	66.08Ω
Phase	73.8°
Real	0.2003
More	
Imaginary	-0.6727
Mag & Phase	0.705, -73.7°
dB Angle	-2.1 dB, -138.2°

There are more trace formats available than marker formats. To display marker readouts in more formats than are shown here, change the trace format, then select **Default**. Learn how to change format in "Format" on page 100.

– For **TDR (CAT) Mode**, choose from **Default** and **Z Mag**.

Searching with Markers

Marker Searches are used to move markers to locations on the trace which exhibits the characteristics of the search criteria. Learn What is a 'Peak' in "What Is a 'Peak'" on page 808.

How to Search with Markers

The following menu structure applies to NA Mode. Keystrokes will be slightly different for CAT, Pulse Measurements, and SA Modes.

1. Activate the marker to be used for the search (NOT necessary with Bandwidth search.)
2. Then press **Mkr ->/Tools**.
3. Then choose one of the following:
   - **Tracking ON OFF** (NA Mode ONLY)
     - **ON** causes the active marker to search for the specified criteria with each new sweep. Search criteria can include: Target, Bandwidth, Peak, Min. The searches begin with the first sweep after Tracking is turned ON, based on the current search type. **Trk** appears next to the marker number.
     - **OFF** causes a new marker search only when the search feature is re-executed.
   - **Peak** Moves the active marker to the HIGHEST amplitude data point of the trace. Peak Excursion and Peak Threshold value is ignored. In SA Mode, the LO feed-through signal (0 Hz) is also ignored.
   - **Next Peak** Moves the active marker to the next highest amplitude data point of the trace. Peak Excursion value is ignored.
   - **Mkr -> Center** Moves the current active selected marker to the center frequency for the current frequency range displayed.
   - **Mkr -> RefLev** Moves the current active marker to the acquisition.
   - **Minimum** (Not available in DTF, RTSA, SA, or I/Q Analyzer) Moves the active marker to the LOWEST amplitude data point of the trace.
   - **Min Search** (I/Q Analyzer, RTSA, and SA modes Only) Moves the active marker to the LOWEST amplitude data point of the trace. If a marker is turned off, it is turned on before the minimum search is performed.
   - **Target** (NA Mode and Pulse Measurements ONLY) Enter the Target value. The marker moves to the first occurrence of the Target value to the right of its current position. The FieldFox interpolates between measured data points to find the exact Target value to two decimal points. The interpolated X-axis value is displayed in the marker readout or marker table. Subsequent presses of the Target softkey cause the marker to move to the

right to find the next occurrence of the Target value. When the marker reaches the end of the stimulus range, it “wraps around” and continues the search from the beginning of the stimulus range.

- **Bandwidth ON OFF** (NA Mode ONLY) Use to quickly toggle BW Markers ON and OFF. When OFF, the marker table appears showing the X and Y-axis positions of all enabled markers.
- **Bandwidth** (NA Mode ONLY) Specify the level in dB from the peak or valley where bandwidth is measured.
  - **Negative** numbers search for a **Peak** bandpass, such as a filter S21 response.
  - Either of the following TWO methods can be used to search for a **Valley** or Notch filter, such as the S11 response of a bandpass filter.
  - **Negative** values search down from the TOP (MAX) of the response.
  - **Positive** values search up from the BOTTOM (MIN) of the notch.
  - If you first enter Negative, then Positive values, it may be necessary to press **Marker**, then **More**, then **Markers All Off**.

Figure 31-4 S21 of a filter with BW Markers and associated readout values. The search criteria is -3 dB.

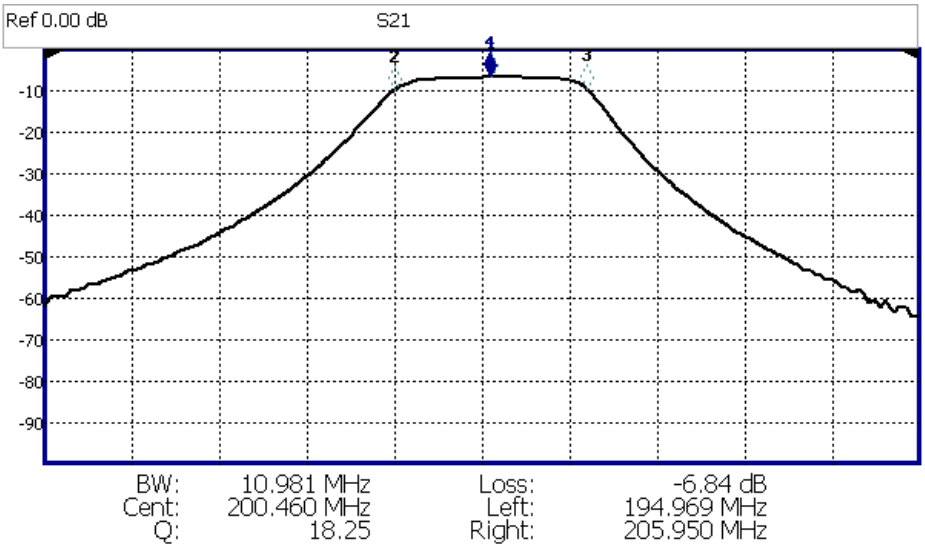
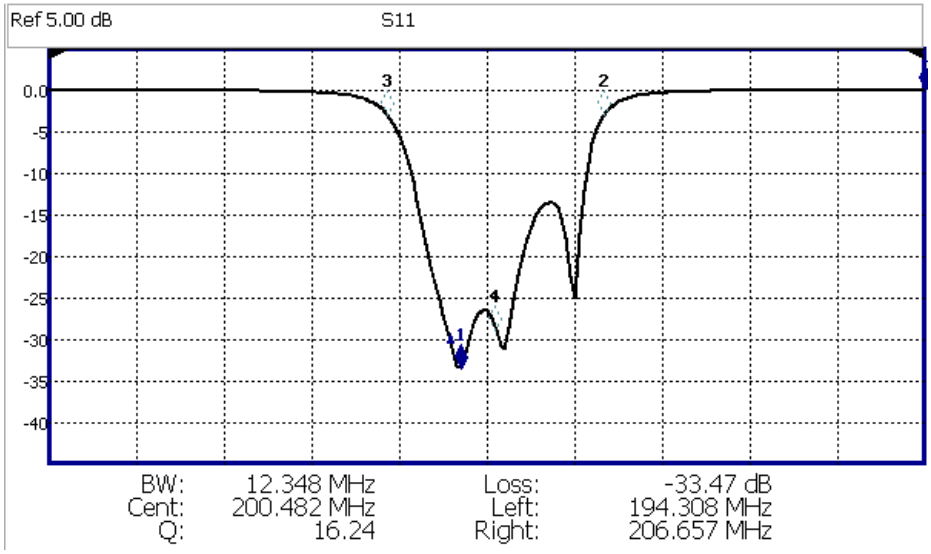


Figure 31-5 S11 of the same filter with same search criteria: -3 dB.
The same values would result from a search criteria of approximately +30.4 dB.



After pressing **Bandwidth**, four markers are automatically created to find the first negative or positive bandpass over the displayed frequency range.

Bandwidth Search can be used ONLY with Log Mag display format.

- The following six values are displayed for Bandwidth Search:
  - **BW**: Width of the filter. (marker 2 freq) **minus** (marker 3 freq).
  - **Center**: Marker 4 frequency. Mathematical midpoint between marker 2 and marker 3.
  - **Q**: Center Frequency / Bandwidth.
  - **Loss**: Marker 1 amplitude.
  - **Left**: Frequency of marker 2 or 3 (to left of marker 1).
  - **Right**: Frequency of marker 2 or 3 (to right of marker 1).
  - Press **Back** to return to the previous menu.

Press **Peak Search** then choose from the following:

- **Peak** Moves the active marker to the HIGHEST amplitude data point of the trace. Peak Excursion value is ignored. In SA Mode, the LO feed-through signal (0 Hz) is also ignored.
- **Next Peak** Moves the active marker to the next highest amplitude peak from where it currently resides.
- **Peak Left** (Not IQA) Moves the active marker to the next data point to the left that meets the 'Peak' criteria. When no data points to the left meet the 'Peak' criteria, the marker does not move.

– **Peak Right** (Not IQA) Moves the active marker to the next data point to the right that meets the 'Peak' criteria. When no data points to the right meet the 'Peak' criteria, the marker does not move.

The following applies to DTF Measurements ONLY:

– **More** then:
  – **Track Peaks ON OFF** When Track Peaks is ON, markers will find the new peak with every sweep. While in this Mode, the markers can NOT be turned OFF or moved.
  – **Find 3 Peaks** Three markers are created and find the highest peaks (faults) on the trace.

The following applies to IQA Measurements ONLY:

– **More** then:
– **Min Search** Moves the active marker to the minimum frequency (IQA displays time) currently displayed on the screen.
– **Mkr Properties** then:
  – **Peak Criteria** then refer to "How to set Peak Criteria" on page 808:
  – **Delta Ref Fixed** Enables or disables the delta reference fixed marker.
– **Peak Left** (IQA Spectrum Only) Moves the active marker to the next data point to the left that meets the 'Peak' criteria. When no data points to the left meet the 'Peak' criteria, the marker does not move.
– **Peak Right** (IQA Spectrum Only) Moves the active marker to the next data point to the right that meets the 'Peak' criteria. When no data points to the right meet the 'Peak' criteria, the marker does not move.

Using Mkr5/Mkr6 to find mins/maxs between Mkr1 and Mkr2 / Mkr3 and Mkr4 (CAT and NA Mode)

Use this feature to search minimum and maximum values within sub-spans defined by Mkr1 and Mkr2, and Mkr3 and Mkr4. This facilitates measuring minimum and maximum values on your uplink and downlink channels, or only in the passband of a DUT. Use in conjunction with marker table and limit lines to verify your DUT's signals and to adjust or tune as needed. See also, "All about Limit Lines" on page 812.

When markers are set to Normal, Mkr5 and Mkr6 can be used to find the minimum and or maximum values between Mkr1 and Mkr2 (using Mkr5) and Mkr3 and Mkr4 (using Mkr6). Refer to Figure 31-6 on page 808.

NOTE

If your Markers are positioned and in Normal marker mode, no changes are made to the Mkr1 through Mkr4 settings.

If your Markers are not previously positioned and in Normal marker mode, when you select the Mkr5 and Mkr6 maximum and minimum setting, your markers are set as follows:

- Markers are all set to **Normal**
- Mkr1 and Mkr3 are set to 1/4 full span
- Mkr2 and Mkr4 are set to 3/4 full span

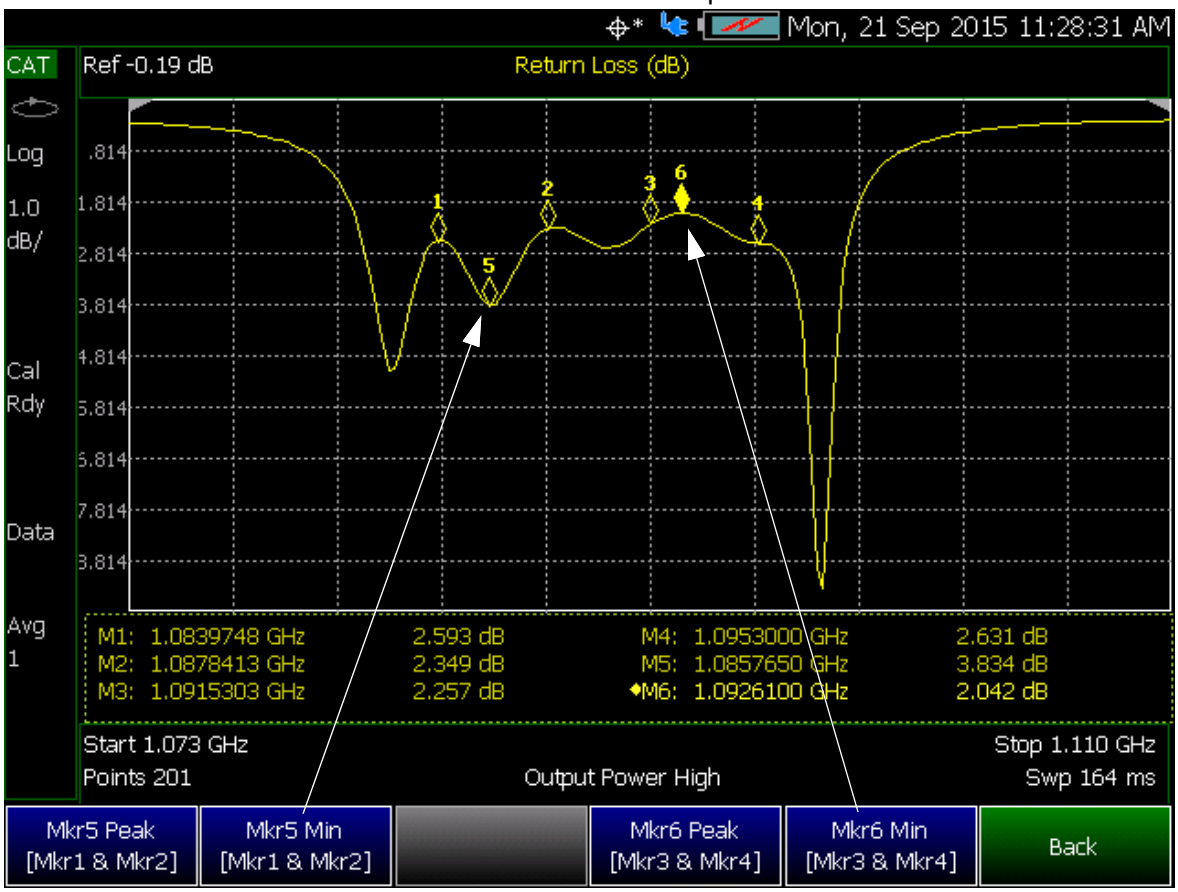
How to use the Mkr5 and Mkr6 markers to find maximums and minimums between your Normal markers (CAT and NA Mode):

This section assumes you understand the previous marker features. And, that you have previously positioned your markers (Mkr1 and Mkr2 or and Mkr3 and Mk4) and set the markers up as **Normal** markers using "How to create Markers" on page 797 and other previous marker sections. For example, if your markers are set to **Delta**, change to **Normal**, and verify the marker positions are correct. Refer to Figure 31-6 on page 808.

- Then press **Mkr ->/Tools**.
- Then **More** (For DTF, TDR measurements, and NA Mode, skip this step and proceed to the next step.)
- Then **Mkr5 & Mkr6 Search**
- For Mkr1 & Mkr2 maximum or minimum value search:
  - Then **Mkr5 Peak** or
  - **Mkr5 Min**

  Or for Mkr3 & Mkr4 maximum or minimum value search:
  - Then **Mkr6 Peak** or
  - **Mkr6 Min**

Figure 31-6 CAT Mode Mkr5 and Mkr6 Search Example



What Is a 'Peak'

You define what the FieldFox considers a "peak" by setting the Peak **Threshold** and Peak **Excursion** and for I/Q Analyzer Only **Cont Peak Search**.

These two peak criteria settings are set individually for each trace and for each mode (CAT, SA, or NA).

These settings do NOT survive a FieldFox or Mode Preset.

NOTE The Peak Threshold and Excursion settings are NOT available in DTF measurements. To make these settings, create a non-DTF CAT mode measurement, then change the measurement back to DTF.

How to set Peak Criteria

- Press **Mkr ->/Tools**.
- In **CAT** and **NA** modes:
  - Then **Peak Search**.
  - Then **Peak Criteria**

– In **IQA** (Spectrum) and **SA** mode:
  – Then **More**
    ––Then **Mkr Properties**
    ––Then **Peak Criteria**
– In **IQA** (Waveform) mode:
  – Then **Mkr Properties**
    ––Then **Peak Criteria**

After selecting **Peak Criteria** for CAT, IQA, NA, or SA mode:

––Then select the following:

––**Peak Threshold** Minimum amplitude (dB). To be considered valid, the peak must be above the threshold level. The valley on either side can be below the threshold level.
Default == –190 for CAT and NA Modes; –90 for SA Mode.

NOTE CAT mode Loss measurements are displayed in positive values. In these cases, the Peak Threshold setting is inverted. For example, Peak Threshold = –20 will consider any peak that has less Loss than 20 dB to be valid.

––**Peak Excursion** The vertical distance (dB) between the peak and the valleys on both sides. To be considered a peak, data values must “fall off” from the peak on both sides by the excursion value. Default == 0.5 dB for CAT and NA Modes; 6 dB for SA Mode.

––**Cont Peak Search** (I/Q Analyzer Only) Enables or disables the Continuous Peak Search marker. When Continuous Peak Search is on, a peak search is automatically performed for the selected marker after each sweep. The rules for finding the peak are exactly the same as for Peak Search, including the use of peak criteria rules. See also, “Using Markers (IQA)” on page 326.

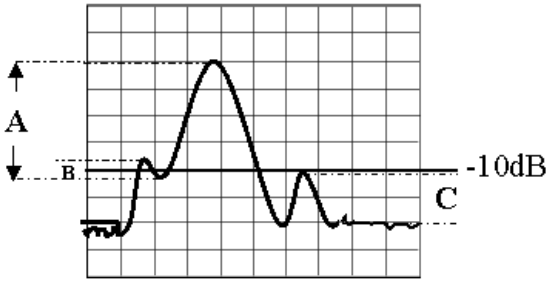
––**Delta Ref Fixed** Enables or disables the delta reference fixed marker.

Peak Excursion and Peak Threshold example—the settings for the trace in the following image are:

——Threshold: –10 dB

——Excursion: 1 dB

——Scale = 1 dB / Division.



Peak A = **Valid Peak** (Above Threshold and Excursion Settings)

Peak B = Invalid Peak (Below 1 dB Excursion Setting)

Peak C = Invalid Peak (Below –10 dB Threshold Setting)

Marker Functions

Marker functions are used to change FieldFox frequency or distance settings to those of the active marker.

How to use Marker Functions

1. Activate the marker to move.
2. Then press **Mkr ->/Tools**
3. Then **Mkr ->** (this step **not** required for all modes)
4. Then choose one of the following:
   - **Mkr -> Center** (**Not** available in DTF, I/Q Analyzer (waveform), or SA mode with zero span) The center frequency of the measurement becomes the value of the active marker. The frequency span is adjusted accordingly.
   - **Mkr -> Delay** (NA mode ONLY.) The group delay value of the active marker becomes the electrical delay setting of the trace. Learn how to set group delay format in "Calibration Settings" on page 99. Learn more about electrical delay in "Electrical Delay" on page 103.
   - **Mkr-> RefLev** (IQ Analyzer (NOT waveform) and SA mode ONLY) The acquisition becomes the magnitude of the active marker.
   - **Mkr->TuneFreq** (SA mode with Tune & Listen ONLY) The Tune & Listen Frequency becomes the frequency of the active marker (When **AM Metrics** or **FM Metrics** are selected this softkey is inactive).

The following applies to DTF Measurements ONLY:

- **More** then:
- **Mkr->Start Distance** The Start Distance of the measurement becomes the value of the active marker. Markers that would no longer appear on the screen are moved to the new Start Distance.
- **Mkr->Stop Distance** The Stop Distance of the measurement becomes the value of the active marker. Markers that would no longer appear on the screen are moved to the new Stop Distance.

I/Q Analyzer (IQA) Marker Functions

The following Marker Functions are available in I/Q Analyzer Mode ONLY (exceptions are noted):

- Noise Marker (Available in SA mode)
- Band/Interval Power Marker (Available in SA mode)
- Coupled Markers
- Band Span
- Interval Band Span
- Continuous Peak Search

Learn more about Noise and Band/Interval Power marker functions starting in the IQA chapter here: "Noise Marker" on page 326.

SA Marker Functions

The following Marker Functions are available in SA Mode ONLY (exceptions are noted):

- Noise Marker (Available in I/Q Analyzer mode)
- Band/Interval Power Marker (Available in I/Q Analyzer mode)
- Frequency Counter at Marker
- Audio Beep with Marker
- Time Zero Fixed Marker

Learn more about these marker functions starting in the SA chapter here: "Noise Marker" on page 223.

All about Limit Lines

Limit lines are visual representations, drawn on the FieldFox screen, of the specified limits for a measurement. With this capability, you can easily compare measured data versus specifications. Optionally, you can enable an audible beep and display **Pass or Fail** information for each measurement.

CAUTION

The following are Limit Options for Limit Lines in CAT, NA, NF, RTSA, SA and Channel Scanner (EMF Custom List Only). But, RTSA mode has some exceptions:

–When using the Spectrogram measurement, Limit lines are only available when the display Measurement Type for Spectrogram View used is: Overlay.

–RTSA mode does not support any PASS or FAIL features.

–Beep, Warning, and Margin softkeys are grayed out (not active) in RTSA mode.

–The **Limit 8** › **Option** is not available in Channel Scanner mode.

NOTE

IMPORTANT! For CAT and NA modes, limit lines do not apply where F1 = F2.

- You can have up to as many limit line segments as there are data points for each measurement trace allowing you to test all aspects of your measurements.
- Limit lines are available in CAT Mode, NA Mode, NF Mode, and SA Mode. Power Meter Mode uses different limit settings. Learn more in “Limits” on page 603.
- Limit lines and limit testing are NOT allowed in NA Mode with **Smith Chart** or **Polar** display formats.
- A simple Display Line is also available in I/Q Analyzer, NF, and SA Modes ONLY. Learn more in “Display Line (I/Q, NF, and SA Modes Only)” on page 828.
- Limit lines can be saved and recalled with an *.sta file. Learn more in“How to Save and Recall Limits” on page 818. *.sta files can also be saved and recalled independently from the Limit softkeys. Learn more inChapter 34, “File Management.”

How to Create Fixed Limit Lines

CAUTION

The following are Limit Options for Limit Lines in CAT, NA, NF, RTSA, and SA. But, RTSA mode has some exceptions:

–When using the Spectrogram measurement, Limit lines are only available when the display Measurement Type for Spectrogram View used is: Overlay.

–RTSA mode does not support any PASS or FAIL features.

–Beep, Warning, and Margin softkeys are grayed out (not active) in RTSA mode.

There are two ways to build a Fixed limit line:

1. Build (limits) From a Trace. Learn how in "Build From Trace" on page 815.
2. Enter X/Y data points into the on-screen editor. The limit line is formed as the FieldFox 'connects the dots' on the screen. To create frequency gaps that are NOT tested, use separate limit lines. The X-axis values for two lines can overlap.
3. Press **Limit 8** > **Edit Limits**. A limit line table appears.
4. Use the Up / Down arrows and rotary knob to navigate the cursor to the following editable cells.
   - **Description** - Press **Edit**, then enter a description for the limit line using the FieldFox labeler. Learn how in "How to use the FieldFox labeler " on page 891.
   - **Fixed/Relative** – Press **Edit** to toggle between the following:
     - **Fixed** - (Default) the limit line does not move. The X/Y coordinates are absolute locations on the screen.
     - **Relative** - the limit line moves relative to the center frequency and acquisition. **Note**: It is easiest to first create Fixed Limits, then change this setting to Relative. Learn more "Relative Limit Lines" on page 814.
   - **Upper/Lower** – Press **Edit** to toggle between the following:

NOTE

In Channel Scanner EMF Custom List scan mode,

- Only limits configured as "Upper" limit types will be utilized for testing and displayed graphically.
- If the limit is configured as "Lower", it will be ignored in this mode, regardless of the limit is configuration as "ON" or "OFF".

NOTE

Disable Limit Test in Channel Scanner mode,

- Use 200 dBm to disable Upper Limit Test.
- Use -200 dBm to disable Lower Limit Test.

- **Upper**:
  - **All modes except RTSA:** (Default) FAILS any measured data point **ABOVE** the line.
  - **RTSA mode:** (Default) Draws visible “ears” going upward from any measured data point **BELOW** the line.
- **Lower:**
  - **All modes except RTSA:** FAILS any measured data point **BELOW** the line.
  - **RTSA mode:** Draws visible “ears” going downward from any measured data point **ABOVE** the line.

- **Off/On** – Press **Edit** to toggle between the following:
  - **On:**
    - **All modes except RTSA:** Limit line is drawn on the screen and PASS/FAIL testing occurs.
    - **RTSA mode:** Limit line is drawn on the screen, but **no** PASS/FAIL testing occurs.
  - **Off** - **All modes:** Limit line is NOT drawn on the screen and testing does NOT occur.
- **Frequency** – Enter a numeric X-axis value of the data point.
- **Amplitude** – Enter a numeric Y-axis value of the data point.

5. Then optionally choose from the following:
   - Press **Add** then choose from the following:
     - **Add Point** - Adds a blank X/Y data point below the cursor.
     - **Add Limit** - Adds a default limit line below the current limit.
   - Press **Clear** then choose from the following:
     - **Clear Point** - Removes the X/Y data point on which the cursor resides.
     - **Clear Limit** - Removes the limit Line on which the cursor resides.
     - **Clear All** - Removes ALL limit lines.
   - Press **<Back** to return to the Limit menu.

Relative Limit Lines

Relative limit lines are X/Y coordinates that are referenced to the center frequency (X-axis) and acquisition (Y-axis).

Use relative limits to test devices or signals that are identical except for the center frequency or amplitude. With relative limit lines in place, you change the center frequency of the measurement and the limits look as though they are in the same location.

The same is true for acquisition. When you expect to measure a different power level, instead of changing the Y-axis value of all of the fixed limits, simply change to relative limits. The limits will then remain a constant Y-axis distance from the acquisition.

Each limit line can be changed at any time from Fixed to Relative, and Relative to Fixed.

How to Create a Relative Limit Line

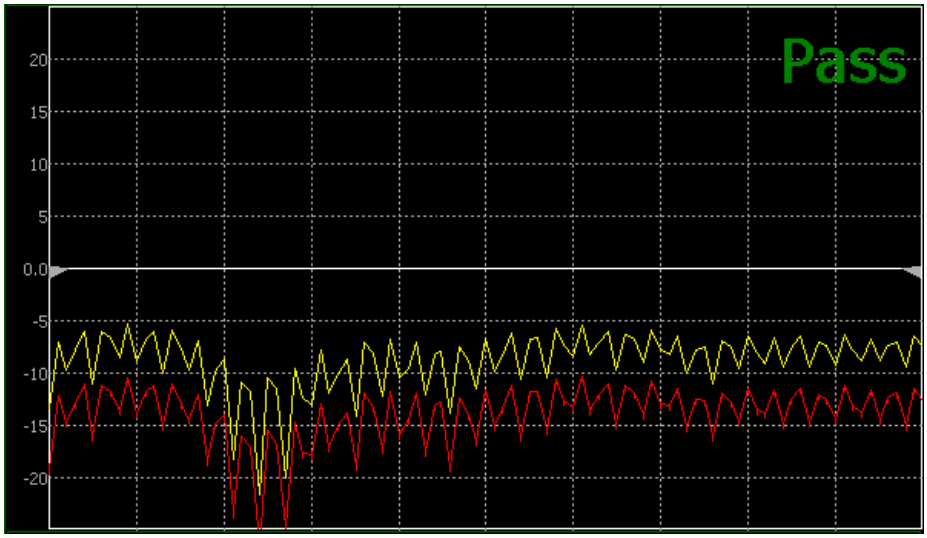
The easiest way to create a Relative limit line is to create a Fixed Limit at a specific center frequency and acquisition. Learn how "Relative Limit Lines" on page 814. Then change the limit line to Relative. The X/Y data points will be re-calculated relative to the center frequency and acquisition.

Build From Trace

A limit line can be built from an existing trace. One X/Y point is made from each measured data point. Then, using an offset value, you can shift the limit line UP for upper limits or DOWN for lower limits.

Once limit lines have been built from the trace, changes that you make to the trace, such as frequency range, do NOT change the limits. However, the limit line properties can be edited just like standard limit lines.

Figure 31-7 A lower limit line (red) built from the trace (yellow) shifted down 5 dB.

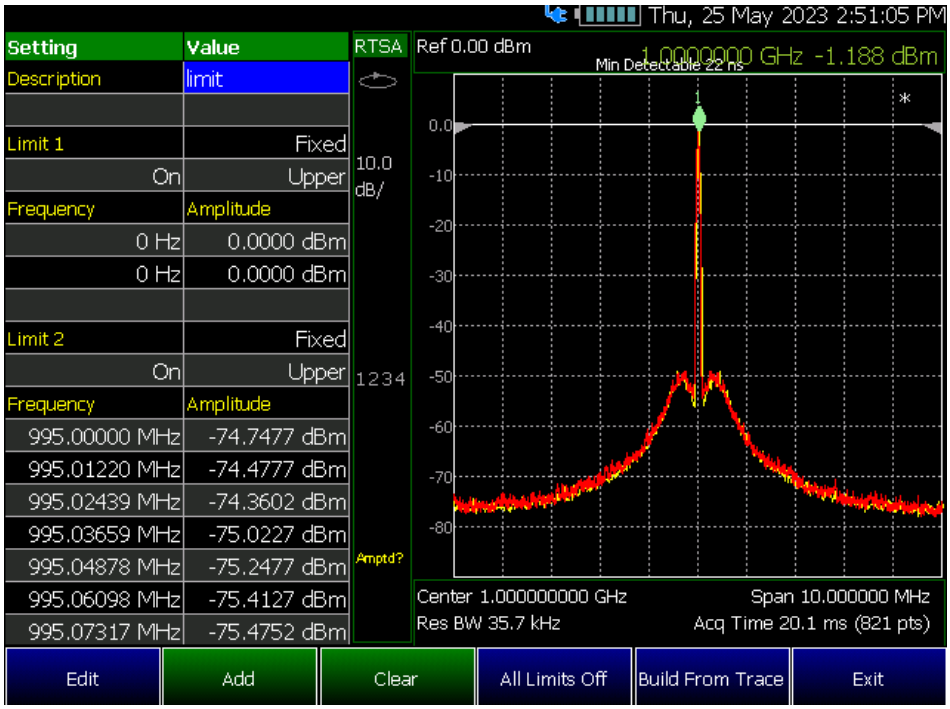


How to Build Limit Lines from a Trace

NOTE Build from Trace is NOT allowed for traces with more than 1001 data points.

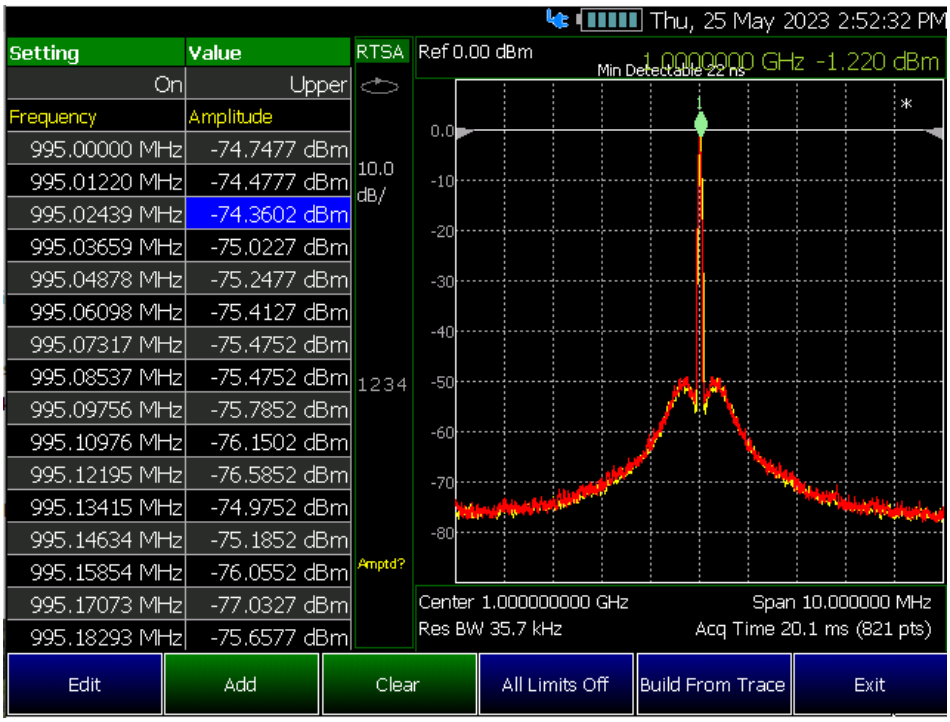
1. Select the trace from which limits will be built.
2. Press **Limit 8** > **Edit** > **Build From Trace**. A limit line table appears.

Figure 31-8 Build From Trace (1 of 2)



3. Use the ▲|▼ arrows to select ON.
4. Use **Offset** to shift the limit line UP or DOWN. Learn how below.

Figure 31-9 Build From Trace (2 of 2)



Limit Options

CAUTION

The following are Limit Options for Limit Lines in CAT, NA, NF, RTSA, and SA. But, RTSA mode has some exceptions:

–When using the Spectrogram measurement, Limit lines are only available when the display Measurement Type for Spectrogram View used is: Overlay.

–RTSA mode does not support any PASS or FAIL features.

–Beep, Warning, and Margin softkeys are grayed out (not active) in RTSA mode.

How to set Limit Options

1. Press **Exit** if the limit table is visible.
2. Then **Options**.
3. Then choose from the following:
   - **Beep**
     - **On Pass** Audible beep sounds when a sweep passes.
     - **On Fail** Audible beep sounds when a sweep fails.
     - **Off** No audible beep sounds.
   - **Warning On Off** Shows Pass or **Fail** indication on the display with each sweep. Data points that fail are highlighted.
   - **Limit Type** Then Fixed or Relative.
   - **Offset** Only available when the units are in V/m in SA mode.
     - **Offset Type dB %** Press to toggle Offset Type from dB to %. (Default == dB)
     - **dB Offset 0.0 dB** Adjust the limit line up or down by dB offset when toggle Offset Type to dB.

       Enter desired offset value using the rotary knob, the ▲|▼ arrows, or by entering a value with the number keys.
     - **% Offset 100.0%** Adjust the limit line up or down by % offset when toggle Offset Type to %.

       Enter desired % offset value using the rotary knob, the ▲|▼ arrows, or by entering a value with the number keys.

   Offset Available only when the units are **not** in V/m in SA mode. Shifts the limit line up or down. Enter an offset value using the rotary knob, the ▲|▼ arrows, or by entering a value with the number keys.
     - Enter a **positive** offset to shift the limit line UP, usually used with UPPER limits.

  - Enter a **negative** offset to shift the limit line DOWN, usually used with LOWER limits.

- Margin Shifts the limit line up or down like an offset, but only virtually. The limit line does NOT appear to move. Enter a Margin value using the rotary knob, the ▲|▼ arrows, or by entering a value with the number keys.

  Enter a **positive** margin to virtually shift the limit line UP.

  Enter a **negative** margin to virtually shift the limit line DOWN.

- LogX Interp Auto Off – Enables/disables the logarithmic X-axis interpolation trace (Default == Auto). Learn more, refer Chapter 9, “SA (Spectrum Analyzer) Mode (Option 233–Mixed Analyzers)” and to “Logarithmic X-axis Limit Line Interpolation (EMI and SA modes Only)” on page 225.

Auto Sync Limit (EMF scan mode Limit Lines Only)

By enabling or disabling this Auto Sync Limit feature, users can control whether the limits set in the limit line editor are automatically transferred to the EMF Custom List “Upper Limit” column and consequently utilized for channel limit testing

1. Press Limit 8.
2. Then press Auto Sync Limits to toggle between the following selections:
   - ON (Default) The values in the EMF Custom List will be overwritten when recalling a limit line file or making edits to the limit line.
   - OFF The values in the EMF Custom List will remain unchanged when recalling a limit line file or editing the limit line.

NOTE

The FieldFox evaluates frequencies and corresponding amplitude values by comparing them against the EMF Custom List. Here's how it operates:

- The FieldFox first checks if any frequencies in the Limit Line file match the center frequencies of any channel. If a match is found, it uses the corresponding amplitude value for the Upper limit test on that channel.
- In cases where a channel's Start/Stop frequencies overlap with those in the Limit Line file, the FieldFox calculates the least permissive limit based on the amplitude values from the Limit Line file. This calculated value is then used for the Upper limit test on that channel.

How to Save and Recall Limits

1. Press Save/Recall 9 then Device to set the Device (Internal, SD card, or USB flash drive) to be used for the Save or Recall. Learn more in “Set File Type and Select Device” on page 894.
2. Press Limit 8.
3. Then choose from the following:

– Save Limits After limit lines have been defined, this saves the line definition to a file on the specified device (e.g., *.xml).

– Recall Limits Recalls a limit Line definition from the specified device (e.g., *.csv).

NOTE **Recall** can recall both *.xml or *.csv file types. But, **Save** can only save files as *.xml.

CAUTION The Limit Line file must be closed before recalling that file.

Creating and Importing *.csv Limit Line Files

This sections defines the procedure for creating a importable *.csv file that defines the limit lines for your current trace.

CAUTION Data delimiter Usage:

– Data delimiters of “,” or “;” can be used.

– Data delimiters must be **consistent** in a file: Either “,” or “;” can be used.

– Data delimiters are auto-detected.

– If the “;” data delimiter is detected, then the numeric format is assumed to use “.” as the grouping separator.

– When “,” is used as the decimal separator (e.g. 1,103.45 would be written as 1.103,45 or 1.4e8 is written as 1,4e8).

1. Define your measurement (e.g., expected maximum and minimum power levels, frequency band breaks, etcetera).
2. Create and save a *.csv file to your PC using these values using parameters defined in Table 31-1 on page 821 and similar to the example in Figure 31-10 on page 823.
3. Copy the limit line *.csv file from your PC to a SD card or USB storage device.
4. Remove the SD card or USB storage device from your PC.
5. Install the SD card or USB storage device into the FieldFox.
6. Set the device type (SD Card or USB storage device) by referring to “Set File Type and Select Device” on page 894.
7. Press Limit 8 > All Limits ON > Recall Limits or
   press Limit 8 > Recall Limits
8. Use the ▲|▼ arrows or the rotary knob to select the limit lines *.csv file to display on the FieldFox.

9. Look for the following messages:

   – When successful, the FieldFox displays a message similar to this: “`Recalled [USBDISK]:\LimitLineExample.csv`”.

   – If unsuccessful, the FieldFox displays a message similar to this: “`212, Operation failed. Possible file content error.`”

   For an example trace with limit lines, refer to Figure 31-12 on page 827.

Table 31-1 Example: Limit Line Formatting (i.e., Not a Power Spectral Density (PSD) Measurement (i.e., no Field Strength units)[a], so no Bandwidth required) – (*.csv) (Sheet 1 of 2)

Description of Limit Line		Notes
#Comments start with "#"		Any row that begins with # is ignored by the FieldFox.
Description	LimitExample	Example "LimitExample" name only. Use any descriptive name.
#Bandwidth	5000000	Bandwidth values are not required for Field Strength. Comment using **'#'**.
Unit	VPM[b]	Learn more, see https://rfmw.em.keysight.com/wireless/helpfiles/FFProgrammingHelpWebHelp/Home.htm.
Enabled	TRUE	Choose: TRUE or FALSE
Fixed/Relative	Fixed	Choose: Fixed or Relative
Lower/Upper	Upper	Choose: Lower or Upper
LimitLines		Must literally read: "LimitLines". This indicates the limit line's definitions begins below.
Frequency[c]	Amplitude[d]	These must be written literally as "Frequency" and "Amplitude".
5000000000	–70	
10000000000	–70	
20000000000	–80	
30000000000	–80	
#Comment 2 (Example)		Any row that begins with # is ignored by the FieldFox.
#Comment 3 (Example)		Any row that begins with # is ignored by the FieldFox.
Enabled	TRUE	

Table 31-1 Example: Limit Line Formatting (i.e., Not a Power Spectral Density (PSD) Measurement (i.e., no Field Strength units)[a], so no Bandwidth required) – (*.csv) (Continued) (Sheet 2 of 2)

Description of Limit Line		Notes
Fixed/Relative	Fixed	
Lower/Upper	Upper	
LimitLines		
Frequency[c]	Amplitude[d]	
5000000000	–50	
10000000000	–50	
20000000000	–50	
30000000000	–50	
#Comment 4 (Example)		Any row that begins with # is ignored by the FieldFox.

a. Field Strength units: dBµV/m, dBµA/m, V/m, A/m, dBm/m^2, W/m^2, W/cm^2, dBG, dBpT
b. For non-PSD measurements, enter a standard Scalar Amplitude SCPI here. Learn more, see https://rfmw.em.keysight.com/wireless/helpfiles/FFProgrammingHelpWebHelp/SENSe_AMPLitude_UNIT.htm.
c. Fractional frequency values are OK (e.g., 50000000.99, etcetera). All values rounded to a resolution of 1 Hz.
d. Fractional amplitude values are OK (e.g., –49.99, –35.5, etcetera).

Figure 31-10 Example: Table Limit Line in Text Format (i.e., Not a Power Spectral Density (PSD) Measurement (i.e., no Field Strength units)[1,2], so no Bandwidth required) – (*.txt)

1	#Comment (Example)	
2		
3	Description	LimitExample
4	Enabled	TRUE
5	Fixed/Relative	Fixed
6	Lower/Upper	Lower
7	LimitLines	
8	Frequency	Amplitude
9	5000000000	-70
10	10000000000	-70.5
11	20000000000	-80
12	30000000000	-80
13		
14	#Comment 2 (Example)	
15	#Comment 3 (Example)	
16		
17	Enabled	TRUE
18	Fixed/Relative	Fixed
19	Lower/Upper	Upper
20	LimitLines	
21	Frequency	Amplitude
22	5000000000	-50
23	10000000000	-50
24	20000000000	-50.5
25	30000000000	-50.5
26		
27	#Comment 4 (Example)	

1. Field Strength units, dBµV/m, dBµA/m, V/m, A/m, dBm/m^2, W/m^2, W/cm^2, dBG, dBpT
2. This table does not show any Standard Scalar Amplitude Unit SCPI commands. For an example of a Limit Line table using a Standard Scalar Amplitude unit, refer to Table 31-1 on page 821.

Table 31-2 Example: Limit Line Formatting for Power Spectral Density (PSD) (i.e., Bandwidth required) (*.csv) (Sheet 1 of 2)

Description of Limit Line		Notes
#Comments start with "#"		Any row that begins with # is ignored by the FieldFox.
Description	LimitExample	Example "LimitExample" name only. Use any descriptive name.
Bandwidth	5000000	Bandwidth values are required for Power Spectral Density (PSD) measurements which applicable to SA only. Learn more, see "Power Spectral Density (PSD) Function (SA Mode Only)" on page 224.
Unit	VPM/Hz[a]	**CAUTION** All parameters require "/Hz" added when using the SA mode's PSD feature. Learn more, see https://rfmw.em.keysight.com/wireless/helpfiles/FFProgrammingHelpWebHelp/Home.htm.
Enabled	TRUE	Choose: TRUE or FALSE
Fixed/Relative	Fixed	Choose: Fixed or Relative
Lower/Upper	Upper	Choose: Lower or Upper
LimitLines		Must literally read: "LimitLines". This indicates the limit line's definitions begins below.
Frequency[b]	Amplitude[c]	These must be written literally as "Frequency" and "Amplitude".
5000000000	–70	
10000000000	–70.5	

Table 31-2 Example: Limit Line Formatting for Power Spectral Density (PSD) (i.e., Bandwidth required) (*.csv) (Sheet 2 of 2)

Description of Limit Line		Notes
20000000000	–80	
30000000000	–80	
#Comment 2 (Example)		Any row that begins with # is ignored by the FieldFox.
#Comment 3 (Example)		Any row that begins with # is ignored by the FieldFox.
Enabled	TRUE	
Fixed/Relative	Fixed	
Lower/Upper	Upper	
LimitLines		
Frequency[b]	Amplitude[c]	
5000000000	–50	
10000000000	–50	
20000000000	–50.5	
30000000000	–50.5	
#Comment 4 (Example)		Any row that begins with # is ignored by the FieldFox.

a. For PSD measurements, enter a Field Strength SCPI here. Learn more, see https://rfmw.em.keysight.com/wireless/helpfiles/FFProgrammingHelpWebHelp/SENSe_AMPLitude_UNIT.htm.
b. Fractional frequency values are OK (e.g., 50000000.99, etcetera). All values rounded to a resolution of 1 Hz.
c. Fractional amplitude values are OK (e.g., –49.99, –35.5, etcetera).

Figure 31-11 Example: Table Limit Line in Text Format (*.txt)

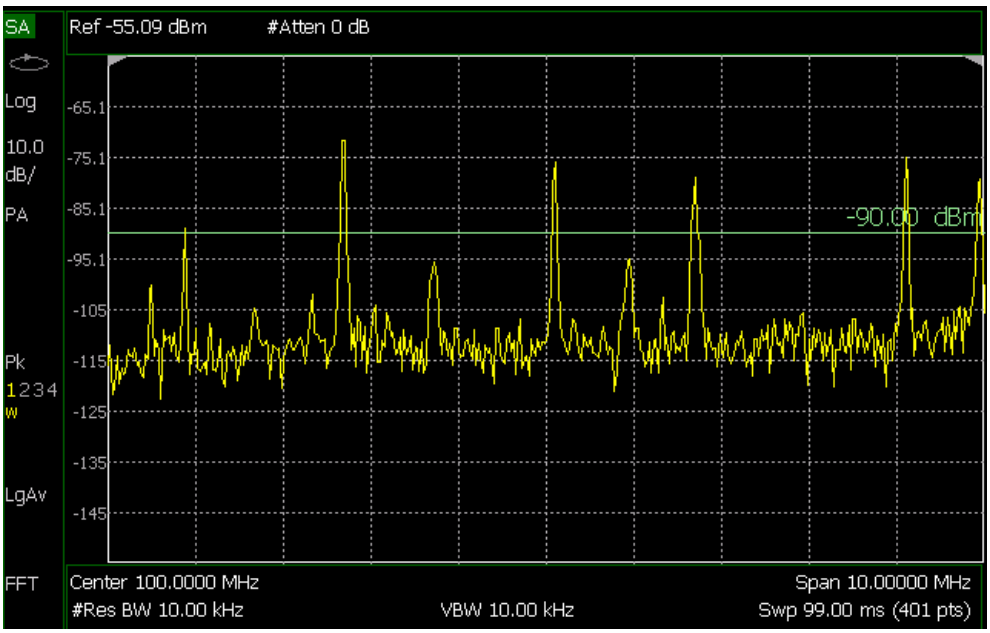
```
#Comment (Example)
,
Description,LimitExample
Enabled,TRUE
Fixed/Relative,Fixed
Lower/Upper,Lower
LimitLine,
Frequency,Amplitude
5000000000,-70
10000000000,-70
20000000000,-80
30000000000,-80
,
#Comment 2 (Example)
#Comment 3 (Example)
,
Enabled,TRUE
Fixed/Relative,Fixed
Lower/Upper,Upper
LimitLines,
Frequency,Amplitude
5000000000,-50
10000000000,-50
20000000000,-50
30000000000,-50
,
#Comment 4 (Example)
```

Figure 31-12 Example: Recalled Limit Line Formatting LimitExample.csv

Display Line (I/Q, NF, and SA Modes Only)

A display line is a simple, horizontal line that can be placed at any amplitude level on the SA screen or set to any level in IQA. Use a display line as mental guide for visual feedback. A display line is similar to a Limit Line, except that no PASS/FAIL testing occurs. A display line is easier to create than a Limit Line. Learn more in “All about Limit Lines” on page 812.

Figure 31-13 Display Line with Annotations (SA mode shown, but others are similar)



How to create and move a Display Line

1. Press **Limit 8** > **Display Line OFF ON**
2. Then enter a Y-axis value using the ▲|▼ arrows or the rotary knob, then press **Enter**. Or enter a value using the numeric keypad and press a suffix key or press **Enter**.

All about Trace Math

Trace Math is available in **CAT** (excluding DTF measurements), **NA** Mode, and FOPS (under USB Power Meter mode).

NOTE Noise Figure (NF—Option 356) does not have trace math, but does have the ability to display data and memory traces. Refer to "How to display data and memory traces".

A trace is a series of measurement data points that are connected to form a line. This 'live' data trace is updated as data points are measured.

A memory trace is a live trace that has been stored in the FieldFox volatile memory. It then becomes static, meaning it is not updated with measurements. It can be displayed on the screen by itself, or with a data trace for comparison purposes.

- In NA mode, memory traces are the same color as data).
- In CAT mode and FOPS, the data trace is displayed in **yellow** and the memory trace is displayed in **blue**.

How to display data and memory traces

1. Press **Trace 6**.
2. Press **Math and Memory** then **Data->Mem** to store the current live trace into memory. A 'beep' sounds to confirm the data trace has been saved to memory. There is no display annotation that indicates that the memory trace has been stored.
3. Then choose from:
   - Press **Data** to view only the data trace.
   - Press **Memory** to view only the memory trace.
   - Press **Data & Memory** to view both the live trace and the stored memory trace.

How to perform Trace Math

Trace math is performed between a live trace and a memory trace. When one of the following math operations are selected, the yellow data trace displays the current measurement with the selected trace math applied. The math operation symbol indicated below in [brackets] is displayed on the lower left corner of the screen.

1. Press **Trace 6**.
2. If not already stored, press **Data->Mem** to store the current live trace into memory.
3. Then **Data Math**.
4. Then choose one of the following:
   - **Data + Mem** [D+M] Current measurement data is added to the data in memory.

- **Data – Mem** D-M] Current measurement data is subtracted from the data in memory.
- **Data / Mem** [D/M] Current measurement data is divided by the data in memory.
- **Math Off** [Data] Displays trace data with NO math applied.

About Math Operations

Data / Memory and **Data - Memory** math operations are performed on complex linear data before it is formatted. Because data is often viewed in log format, it is not always clear which of the two math operations should be used. Remember: dividing linear data is the same as subtracting logarithmic data. The following illustrates, in general, when to use each operation.

Use **Data / Memory** for normalization purposes, such as when comparing traces “before” and “after” a change is made or when measuring trace noise. In the following table, the Data/Mem values intuitively show the differences between traces. It is not obvious what Data-Mem is displaying.

Values to compare	Data/Mem	Data-Mem
0.5 dB and 0.6 dB	0.1 dB	–39 dB
0.5 dB and 0.7 dB	0.2 dB	–33 dB

Use **Data - Memory** to show the relative differences between two signals. Use for comparison of very small signals, such as the S11 match of two connectors.

In the following table, Data/Mem shows both pairs of connectors to have the same 2 dB difference. However, the second pair of connectors have much better S11 performance (–50 and –52). The relative significance is shown in **Data-Mem**.

Values to compare	Data/Mem	Data-Mem
–10 dB and –12 dB	2 dB	–24 dB
–50 dB and –52 dB	2 dB	–64 dB

All about Scale Settings

NOTE **IMPORTANT!** Some of the scale settings do not apply to all of the modes.

How to Use Scale Settings

Adjust the Y-axis scale to see the relevant portions of the data trace. The Y-axis is divided into 10 graticules.

This setting can be changed at any time without affecting calibration accuracy.

How to set Scale

1. Press **Scale / Amptd**.
2. Then choose from the following three methods:
   - **Autoscale** Automatically adjusts the Y-axis to comfortably fit the Minimum and Maximum amplitude of the trace on the screen.
   - Set Scale, acquisition, and Reference Position:
     - **Scale** Manually enter a **scale per division** to view specific areas of the trace
     - **Ref Level** Manually set the value of the reference line. Enter a negative value by pressing **Run/Hold (+/-)** either before or after typing a value
     - **Ref Pos** Manually set the position of the reference line. Values must be between **0** (TOP line) and **10** (BOTTOM line)
     - **Range** Manually set the absolute power (dBm).
   - Set Top and Bottom graticule values. The scale per division is calculated.
     - **Top** to set the value of the Top graticule.
     - **Bottom** to set the value of the Bottom graticule.
     - Enter a negative value by pressing **Run/Hold (+/-)** either before or after typing a value.

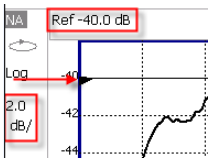
Scale annotation on the FieldFox screen

Reference Line = red arrow

Ref Level = –40 dB

Ref Position = 1

Scale = 2 dB per division



Averaging (CAT, NA, Power Meter, Channel Scanner, and Pulse Measurement Modes Only)

Trace Averaging helps to smooth a trace to reduce the effects of random noise on a measurement. The FieldFox computes each data point based on the average of the same data point over several consecutive sweeps.

Average Count determines the number of sweeps to average; the higher the average count, the greater the amount of noise reduction.

An average counter is shown in the left edge of the screen as **Avg N**. This shows the number of previous sweeps that have been averaged together to form the current trace. When the counter reaches the specified count, then a 'running average' of the last **N** sweeps is displayed. Average Count = 1 means there is NO averaging.

This setting can be changed at any time without affecting calibration accuracy.

NOTE Averaging is often used to increase the dynamic range of a measurement. To achieve the highest dynamic range, select NA mode and reduce the IF Bandwidth setting. Learn more about dynamic range in "Increase Dynamic Range" on page 114.

How to Enable/Disable Averaging

1. Press **BW 2** or **Meas Setup 4** (Channel Scanner mode).
2. Then choose from:
   - **Channel Scanner:** **Average OFF ON** change to ON to enable averaging (Default == OFF).
   - **Power Meter, Pulse Measurements:** **Average Auto Man OFF** change to Auto or Man to enable averaging (Default == Auto, Auto == FieldFox sets the average count based on current mode settings).
   - **CAT, NA:** **Average 1** change to a number >1 to enable/set averaging (Default == 1 (OFF)).
3. Press **Enter**.
4. Refer to "How to set Trace Averaging" on page 832.

How to set Trace Averaging

1. Press **BW 2** or **Meas Setup 4** (Channel Scanner mode).
2. Then choose from:
   - **Channel Scanner**: **Average Enable OFF ON** change to ON to enable averaging and then set the current count or Time, using **Average Count** (Default == 10) or **Average Timed** (Default == OFF) softkey.

- Pressing the Average Count will allow to set a count for averaging. **Average Count** settings: Minimum count == 1 and Maximum count == 10000
- Pressing the Average Timed will allow to set a time for averaging. **Average Timed** settings: Minimum time == 10 ms and Maximum time == 1000000s

When the **Average Timed** softkey is disabled (Default), averaging behaves normally using the **Average Count** softkey value. But, when **Average Timed** softkey is enabled, averaging continues until the specified time and then the measurement will automatically hold. Pressing Run/Hold +/- to restart the measurement from 0s.

NOTE

For the Average Timed mode, press Run/Hold +/- before the averaging time has elapsed to pause time averaging and hold the measurement. Press Run/Hold +/- again to resume to continue time averaging and measurement.

- Power Meter, Pulse Measurements: Average Auto Man OFF change to Auto or Man to enable averaging (Default == Auto, Auto == FieldFox sets the average count based on current mode settings).
  - Or set the current count, using the Num Averages softkey
- CAT, NA: Average 1 change to a number >1 to enable/set averaging (Default == 1 (OFF)).

3. Enter a value using the numeric keypad. Enter 1 for NO averaging.
4. Press Enter.
5. While Trace Averaging is in process, press Sweep 3 then Restart to restart the averaging at 1.

32 System Settings

In this Chapter

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"Date and Time, Format, and Time Zone Settings" on page 873
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"Service Diagnostics" on page 878
"Understanding the Fan Controls" on page 881

See Also:

"Install the Lithium-Ion Battery" on page 32
"FieldFox High Temperature Protection" on page 34

Run/Hold

The **Run/Hold** key determines whether the FieldFox sweeps continuously or does NOT sweep, but holds the display results of the last sweep that was performed.

Use **Hold** to conserve battery power or to allow you to save or analyze the results of a specific measurement sweep.

The current sweep mode is shown on the screen as:

– Continuous

– Hold

– is displayed while a single sweep occurs.

How to perform a single sweep while in Hold

1. Press **Sweep 3**.
2. Then choose one of the following:
   - **Single** Automatically sets Continuous OFF (Hold) and causes FieldFox to make ONE measurement sweep, then hold for the next Single key press.
   - **SA Mode ONLY** – With **Continuous OFF** each successive **Run/Hold** press also causes a single sweep.
   - **Continuous ON OFF** Makes continuous sweeps. This is the typical setting when battery power is not critical.

Preset

The Preset key restores the FieldFox measurement settings to a known condition. You can preset the entire instrument, or just the current Mode (CAT, SA, and so forth).

When Preset, the FieldFox CalReady calibration is recalled for use in CAT and NA Modes. Learn more in “CalReady” on page 130.

In addition to all **Preference** settings, the following settings always survive Preset and Mode Preset:

– External Reference state (see “Frequency Reference Source” on page 870)

– SA Scale and Units (see “Scale and Units” on page 161)

– SA Correction states (see “Field Strength Measurements” on page 165)

– VVM Display Resolution (see “Display Resolution” on page 668)

– Marker Peak Excursion and Threshold (see "What Is a 'Peak'" on page 808)

How to Preset the FieldFox

1. Press **Preset**.
2. Then choose one of the following:
   – **Preset** Returns ALL Modes to the factory default settings.
   – **Mode Preset** Returns only the current Mode to the factory default settings. The current settings for all other Modes remain.

User Preset

User Preset allows you to store custom settings for each mode, then recall the settings when the Preset key is pressed. Your custom settings are saved to a standard State file (UserPreset.sta). However, unlike State files, calibration data is NOT saved. Learn more about State files in "Set File Type and Select Device" on page 894.

How to set User Preset

1. Make your custom settings for all modes.
2. When finished, press **Preset**.
3. Then **Save User Preset,** then select **Yes** to confirm.
4. Then **User Preset ON**

How to recall User Preset

– Press **Preset**.
– Then choose from the following:
   – **Preset (User)** The entire UserPreset.sta file is recalled. ALL modes assume the settings that were in place when the User Preset was saved. The active mode is the mode that was visible when the file was saved.

– **Mode Preset (User)** The settings for only the current mode are recalled from UserPreset.sta.

NOTE

– Only the instrument settings are saved to UserPreset.sta. No trace data or calibration data is saved.

– User Preset ON / OFF is saved as a Preference setting. Like all preferences, this setting survives a FieldFox shut down and power ON. Therefore, when User Preset is ON during shut down, the FieldFox will load UserPreset.sta when it is powered ON.

– To return to Factory Preset, select **User Preset OFF**. The contents of UserPreset.sta remain stored on the FieldFox. When User Preset is OFF, you can also set the Startup Mode preference that determines which mode will be visible after powering ON. Learn more in "Startup Mode" on page 854.

Audio (Volume) Control

System volume control is a FieldFox global setting which sets speaker volume for ALL success beeps, key press clicks, and individual features that use the FieldFox speaker, such as SA Mode Tune and Listen.

The volume control setting remains through a FieldFox Preset. To cause your volume control setting to remain through a FieldFox shut down, save the setting as a Preference. Learn how in "Save and Reset Preferences" on page 852.

How to set the FieldFox Volume Control

1. Press **System 7**
2. Then **Volume**

   – Use the ▲|▼ arrows, the rotary knob, or numeric keypad to enter a value between 0 (lowest volume) and 100 (highest volume).

   – Press **Volume** again and select Mute to quickly turn OFF the speaker volume.

   – Press **Volume** again to set volume ON to the previous volume control.

Display (Settings)

You can adjust the FieldFox for optimum viewing in a wide range of lighting conditions.

Display settings are persistent after a FieldFox shut down. Save the display settings as Preferences. Learn how in "Save and Reset Preferences" on page 852.

NOTE Clean the transflective screen with gentle and minimal wiping using Isopropyl alcohol applied to a lint-free cloth.

Display Brightness

Change the brightness of the background.

How to set Display Brightness

1. Press System 7 > Display > Brightness
2. Use the ▲|▼ arrows, the rotary knob, or numeric keypad to enter a value between 0 and 100%.

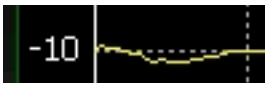
Display Colors

Change Display Colors to alter the viewing scheme.

How to set Display Colors

1. Press System 7 > Display > Display Colors
2. Then choose one of the following:

Indoor



Outdoor Dusk

Outdoor Clouds

Outdoor Sun

Night Vision

Trace Width

You can set width of all displayed traces on the FieldFox. This may allow better viewing or enhance the look of screen images. This setting can be saved with Preferences.

How to set Trace Width

1. Press System 7 > Display > More > Trace Width
2. Then choose one of the following:
   - Normal - Standard width.
   - Wide - Enhanced width

Title

A custom title can be made to appear in the upper-left corner of the FieldFox screen. The title can contain up to approximately 65 alpha-numeric characters. To view the Title area, see the Screen Tour in "Screen Tour" on page 46.

How to add or edit a Title

1. Press System 7 > Display > Title
2. Then enter or edit a title using the FieldFox labeler. This is the same labeler function that is used to name files. Learn how to use the labeler in "How to use the FieldFox labeler " on page 891.
3. Then Title ON OFF to make the title appear and disappear from the screen.

Edit Keywords

During a file save operation, keywords can be quickly appended to other text to create unique filenames. The Edit Keywords feature allows you to create custom keywords. Learn all about Edit Keywords in "Edit Keywords" on page 899.

Full Screen Mode

Full Screen Mode maximizes the display of trace. The screen annotations and the soft keys are removed.

1. Press System 7
2. Then Full Screen

To **Exit** full screen Mode, press any key.

Utilities

FieldFox utilities settings will not survive a shut down. When your FieldFox is turned OFF, then back ON, these settings default to their factory settings.

NOTE

For information on the **Phase Array Antenna** and **EMF Antennas** softkeys, refer to Chapter 14, “5G Rapid Prototype Phased Array Antenna – Option 360.” and “USB Antennas” an Chapter 15.

How to view and change Utilities Settings

– Press **System 7**

– Then **Utilities** Opens the Utilities softkey menu.

Utilities Softkey Choices

Then choose one of the following:

– **Mapping** – (Requires Option 352) opens a menu of softkeys that enables the Indoor / Outdoor on–the–box mapping features. Refer to Chapter 16, “Indoor and Outdoor Mapping – Option 352 (Requires Spectrum Analyzer Mode (Option 233), and GPS Receiver (Option 307)).”

– **Phased Array Antenna** (PAA – Requires Option 360) - opens a menu of softkeys that enables the PAA measurements. Refer to Chapter 14, “5G Rapid Prototype Phased Array Antenna – Option 360.”

– **EMF Antennas** – opens a menu of softkeys that enables the triaxial antenna feature, for use in EMF measurements. Refer to Chapter 15, “USB Antennas – (Full Capability Requires EMF Option 358, and either SA mode (Option 233 Mixed Analyzers) or OTA–LTE FDD (Option 370), LTE TDD (Option 371), 5G NR / 5G NR EVM Conducted (Option 378).”

– **Freq Extnd** – opens a menu of softkeys that enables frequency extender feature, for use with OML heads. Refer to “How to view and change the Frequency Extender (Freq Extnd) Settings” on page 843.

NOTE

IMPORTANT!

The Frequency Extender (Freq Extnd) is only active (available) when one of the following modes are enabled: SA/RTSA/IQA/OTA/PAA/VSA (via the Remote Server feature).

When OML millimeterwave extenders are used, Cable and Antenna corrections, if On, are included in eCorr, or Extended Corrections.

How to view and change the Frequency Extender (Freq Extnd) Settings

The following are the only supported modes for the frequency extender feature: SA (Option 233), mixed analyzers, RTSA (Option 350), IQA (Option 351), OTA (Option 370/377/378), PAA (Option 360) modes, and VSA (via the Remote Server feature).

CAUTION

IMPORTANT!

When using a frequency extender with the FieldFox you need to manually set the LO power:

– When using the mixer, the LO power should be reduced to –12 dBm and

– Reduce frequency span to make measurements until the “unleveled power” message goes away (requires ≥A.12.40 firmware)

If you upgrade your FieldFox firmware to ≥A.12.40, but find you are unable to adjust the LO power level to –12 dBm, refer to “Erase User Data” on page 880.

CAUTION

IMPORTANT!

Due to limitations in the OML hardware, the heads have a 6 GHz frequency span.

Examples

Using a 24 to 40 GHz mixer, you can sweep:

– 24 to 30 GHz and 25 to 31 GHz, but not

– 24 to 31 GHz

Assuming the same 24 to 40 GHz mixer, using OTA mode, you can

– Set a CC0 to 24 GHz and CC1 to 31 GHz, but not

– CC0 to 4 GHz and CC1 to 32 GHz, because you have to remain within the mixer’s band

CAUTION

PAA and 89600 VSA (via the Remote Server feature) are compatible with the frequency converter heads, but cannot apply or edit the frequency head corrections.

For this section, refer to Figure 32-1 on page 847, Figure 32-2 on page 848, Figure 32-3 on page 848, Figure 32-4 on page 849, Figure 32-5 on page 849, and Figure 32-6 on page 850.

These settings are used to set up a frequency extender head (e.g., OML head). The frequency extender feature can be used in OTA FR2 measurements. See also, Chapter 13, “Over–the–Air Measurements (OTA) – LTE FDD Option 370, LTE TDD Option 371, 5G TF Option 377, 5G NR / 5G NR EVM Conducted Option 378.”

The frequency extender heads are an external down converter that extends the FieldFox's range. The frequency extender head makes use of the FieldFox's source and uses USB port for power. The FieldFox support for the frequency extender head includes:

– The frequency extender heads are compatible with to SA, IQA, OTA, PAA, RTSA, and 89600 VSA (via the Remote Server feature—with VSA license).

CAUTION **The OML frequency extenders have approximately 4 to 10 dB of gain depending on the mixer and frequency.**

  – The USB ports are used to supply power to the head
  – Port 1 is used to supply an LO signal to the head. The LO signal is automatically generated, using the internal source. Therefore the application disables normal Port 1 access to the internal source. But, automatic alignments of the SA Receiver still remain active using an internal path for the source.
  – Port 2 is where the head delivers the downconverted signal to the SA receiver.

– High Sensitivity ON OFF selection: able to choose between showing largest span (wide) available (6 GHz) or best noise floor (narrow).

Frequency Extender Procedure:

General Comment on Frequency Converter Usage:

OML heads are limited to 6 GHz span.

Example:

If you are using a 24–40 GHz OML head you can sweep:

– 24–30 GHz and 25–31 GHz, but not:

– 24–31 GHz

But, in OTA mode, because each frequency is set separately, you can set CC0 to 24 GHz and CC1 to 31 GHz.

But, you cannot set CC0 to 4 GHz and CC1 to 32 GHz. You have to stay within the band of the OML mixer (24-40 in this example), if you are enabling an external head.

1. Press System 7 > Utilities > Freq Extnd > Select Freq Extnd Head

2. To select the frequency extender head, use the numeric keypad, , arrows, or rotary knob to change the value.
3. Press **Recall File** to make the highlighted head the current selection.
4. Press **Freq Extnd ON OFF** to **ON** to enable the frequency extender head. When a compatible mode is enabled, all supported modes annotate `Freq Extnd` at the bottom of the display. See also, step 8.
5. **Optional**: Press **High Sensitivity ON OFF** OFF is selected for maximum span (up to 6 GHz). Narrow is selected for lowest noise floor for a given RF input (100 MHz). Default is OFF (maximum span – 6 GHz).
6. **Optional**: Press **Setup Corr Auto Edit SA** when Auto is selected the default corrections for a frequency converter head are automatically loaded ("`...Default.csv`"). These corrections are defaults for the specific head, to improve nominal accuracy of the amplitude readings, but this accuracy is not specified. Press **Edit SA**, when you want to view or edit the corrections using the SA mode corrections. This state stops all auto-loading of the default corrections. Refer to step 8.

   The other non-SA supported modes do not allow viewing or editing of the corrections, but they all share the same corrections.

   Therefore, any manual changes to the corrections (using SA via Edit SA) are then used by other supported modes (RTSA/IQA/OTA) as well.
7. **Optional**: Press **Apply Corr ON OFF** OFF is selected to not apply the default nominal file corrections. Press to apply corrections for the Converter, all supported modes will apply corrections and annotate "`eCorr`" in the left panel. The corrections applied (regardless of mode) are either default/nominal (if Auto loading was used) or custom/specific (if manual editing Edit SA was used). Default is OFF.
8. Press **Mode** > and then your preferred mode for testing.

NOTE

IMPORTANT! The softkey menu for editing of the frequency converter correction files is only available when the FieldFox is in SA mode.

- Optional: If you pressed **Edit SA** in step 6 above and want to display and to edit a "`*.csv`" corrections file then:
  - Press **Scale/Amptd** > **More** > **Corrections** > **OML Converter** then:
    a. **Converter** to enable/disable the frequency converter corrections.
    b. **Edit Converter** to opens a corrections table of the currently selected file (*.csv).

To select a setting/value to edit, use the numeric keypad, ▲|▼ arrows, or rotary knob to change the value.

Refer to Figure 32-4 on page 849.

CAUTION

It is important to save any changes that are made to the Settings table. If the Setup Corr softkey is reset to Auto, it will recall the last "`...Default.csv`" used, and any unsaved changes will be lost.

c. **New** to opens a corrections table of the currently selected file (*.csv), but enables you to create a new converter corrections file. Displays "`Overwrite existing Converter data?`" Then choose:

- **Yes** to clear all of the frequency converter correction table's values and enter your own.
- **No** to leave the current correction table values and edit just some of the entries.

To select a setting/value to edit, use the numeric keypad, ▲|▼ arrows, or rotary knob to change the value.

Refer to Figure 32-4 on page 849.

d. **Save Converter** opens a 'labeler' menu where you can name and save your frequency converter corrections file (*.csv) to the default `[INTERNAL]:\Converter` folder.

e. **Recall Converter** opens a menu where you can recall a frequency converter corrections file (*.csv).

f. **Storage Device** opens a menu where you can change the storage location of your frequency converter correction files (*csv). (Default = **Internal**. Else press, **SD Card** or **USB**.)

See also, Chapter 13, "Over–the–Air Measurements (OTA) – LTE FDD Option 370, LTE TDD Option 371, 5G TF Option 377, 5G NR / 5G NR EVM Conducted Option 378."

Figure 32-1 FieldFox with OML Downconverter

Figure 32-2 FieldFox Frequency Converter High Sensitivity (ON: Narrow—Lowest Noise Floor—Displayed)

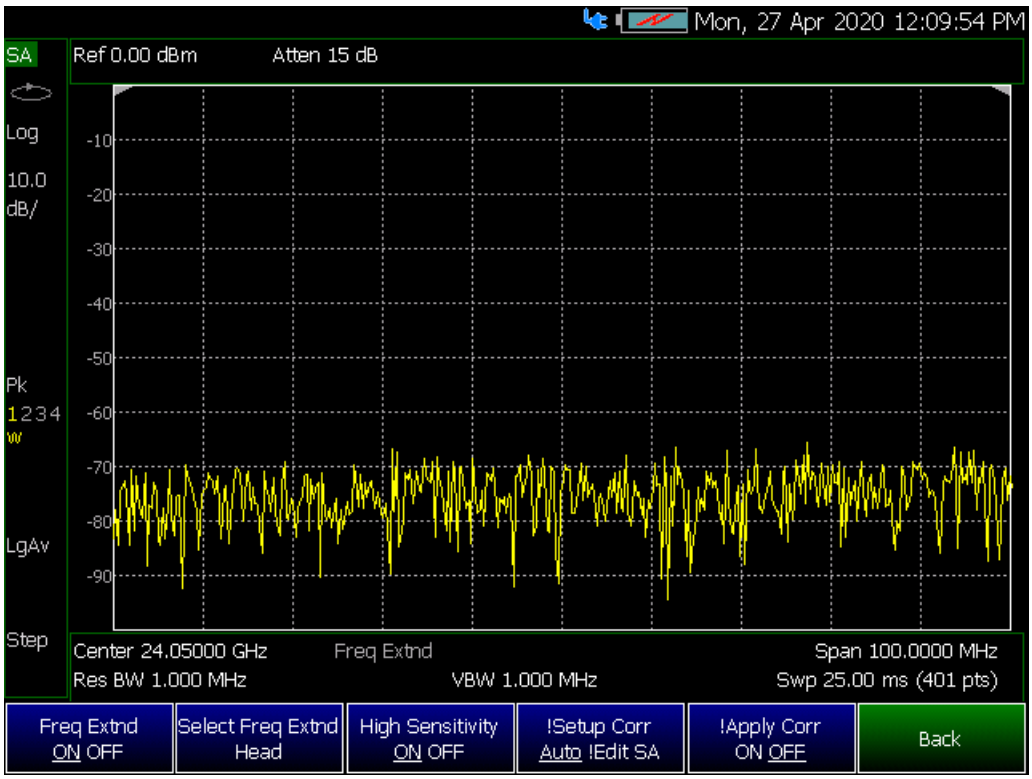


Figure 32-3 FieldFox Frequency Extender Select Frequency Extender Head

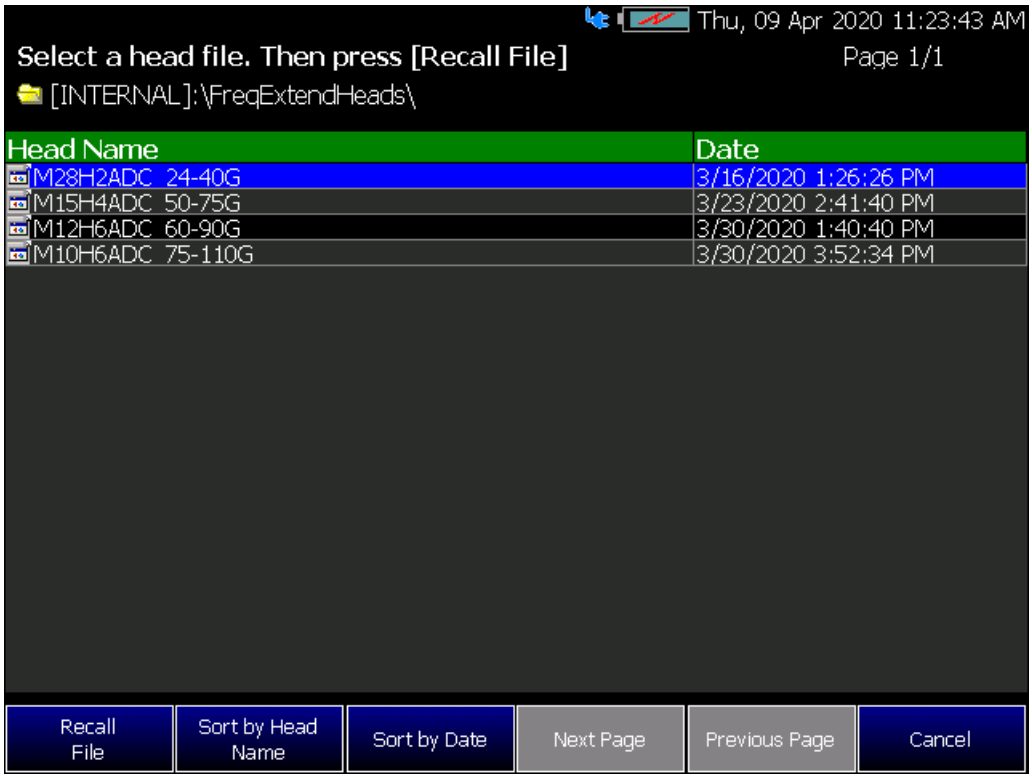


Figure 32-4 FieldFox Frequency Converter Corrections Table

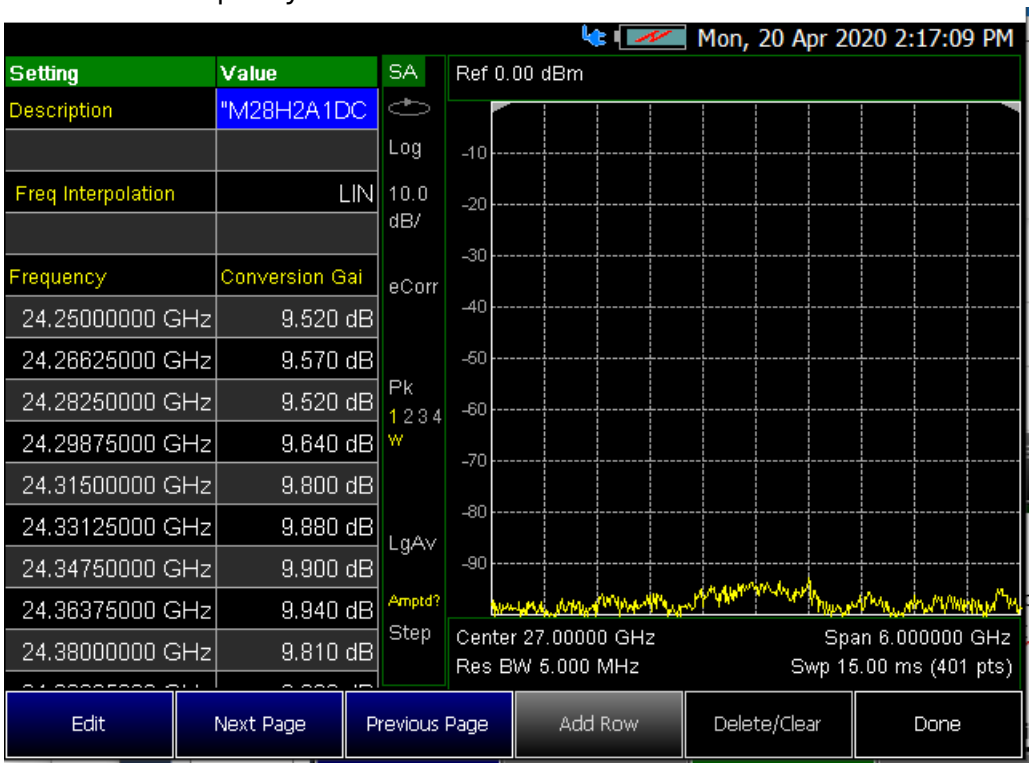


Figure 32-5 FieldFox Frequency Converter (Freq Extend) On And Corrections (eCorr) Enabled (SA mode shown; other compatible modes are similar.)

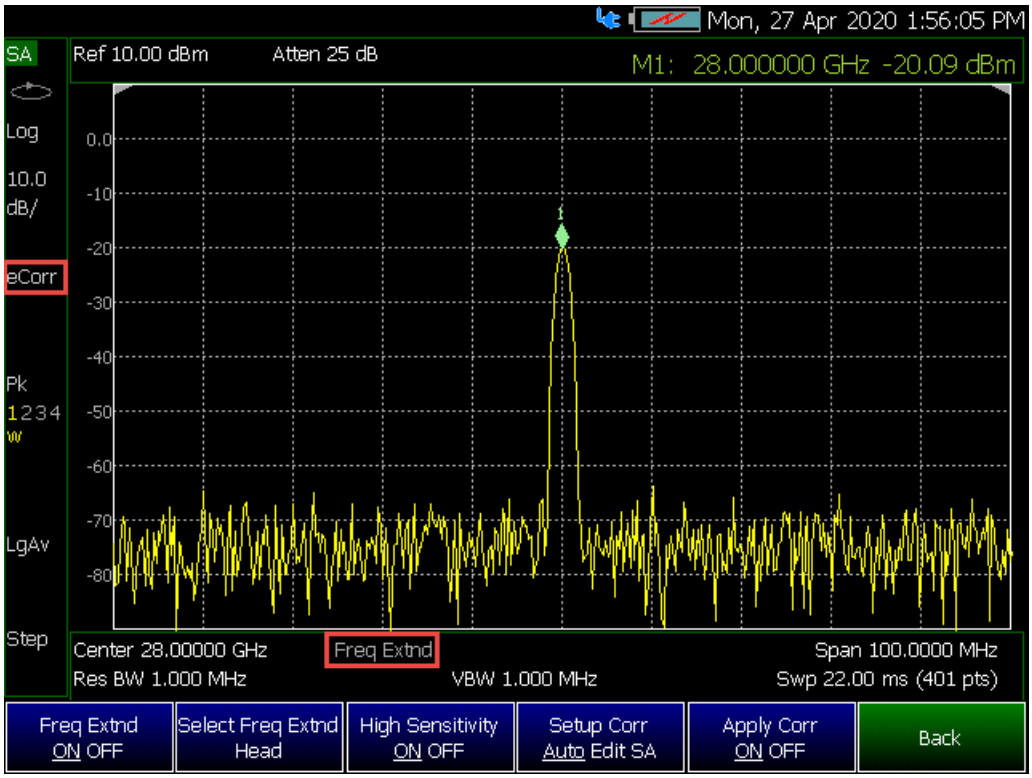
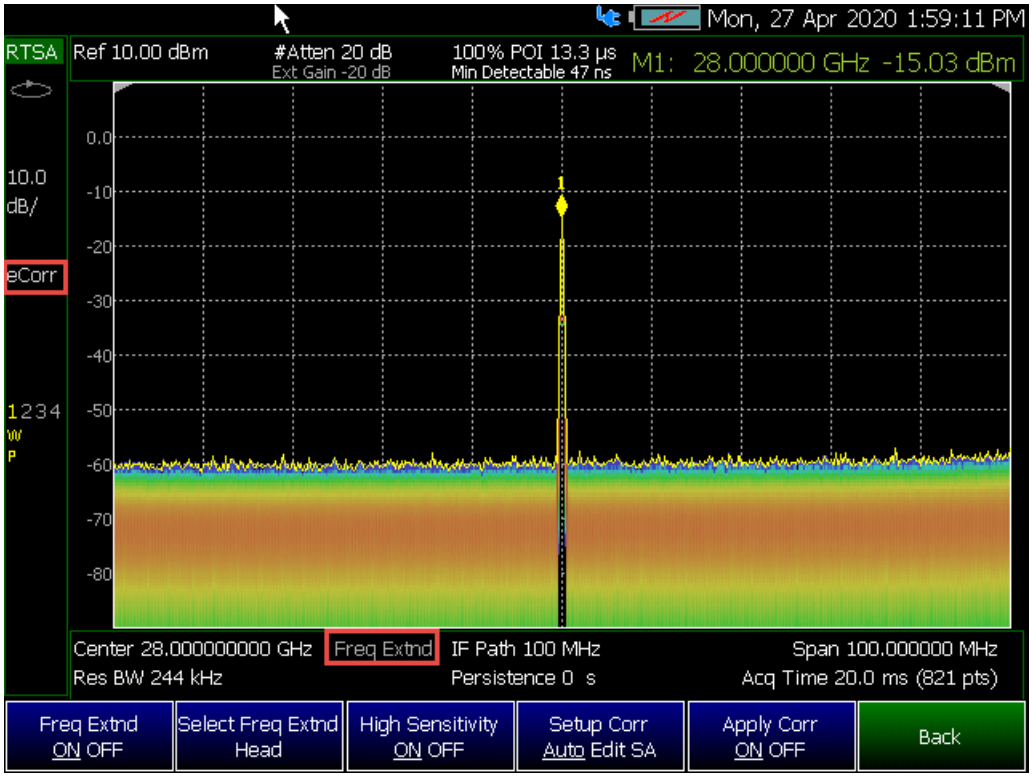


Figure 32-6 FieldFox Frequency Converter (Freq Extend) On And Corrections (eCorr) Enabled (RTSA mode shown; other compatible modes are similar.)



Preferences

FieldFox preferences are settings that survive a shut down. When your FieldFox is turned OFF, then back ON, these settings remain. All preference settings can be restored to their factory defaults. Learn how in "Save and Reset Preferences" on page 852.

There are two ways to make FieldFox preference settings:

- From softkey selections throughout the FieldFox menu structure. Do this to temporarily try a setting, then press **Save Current Preferences**. Learn how in the next section.
- From the Quick Settings table.
- Also, refer to: "Audio (Volume) Control" on page 839 and "Display (Settings)" on page 839.

Quick Settings Table

All preferences can be set from the Quick Settings table. They are immediately saved as Preferences when **Done** is pressed.

How to view and change Preference Quick Settings

1. Press System 7 > Preferences > Preferences
2. Press Next Page and Previous Page to view all settings.
3. To change a setting:
   a. Use the arrows (▲▼) to highlight a setting.
   b. Then press Edit. The current setting changes to yellow.
   c. Some settings require you to press a softkey to change the value.

      Otherwise, use the numeric keypad, arrows (▲▼), or rotary knob to change the value.
   d. When finished changing a value, press Done Edit.
4. When finished changing ALL preferences, press Done. All changes are immediately saved as Preferences.
5. To exit the editing session without saving changes, press Esc at any time.

Learn more about these preference settings:

Settings

"Save and Reset Preferences" on page 852 (Part of Preferences Softkey Menu)

"Global Settings (Overview)" on page 852

– "Language" on page 852 (Similar features as Language in the Preferences softkey menu).

  See also, "How to select a Language" on page 853

– "Battery Saver" on page 853

– "Startup Mode" on page 854

– "Startup Option" on page 855

"Display (Settings)" on page 839

"Audio (Volume) Control" on page 839and "Audio" on page 856

"Date and Time" on page 857

"GNSS (GPS+) and GPS" on page 865

"Frequency Reference Source" on page 870

"File folders" on page 859

"Alpha Numeric Editing" on page 859 (i.e., ABC/Qwerty keyboard styles)

"File Saving Naming Options" on page 859

Settings
“Quick Save Editing” on page 859
“Group Save File Types Editing” on page 860
“CAT (Distance Units)” on page 861
“CAT/NA” on page 862
“SA” on page 863
“Discrete Colors Softkey Menu” on page 864 - Part of Preferences softkey menu.

Save and Reset Preferences

All preference settings can be made at one time from the Quick Settings table.

All settings that can be saved as preferences (except Battery Saver and Startup Mode) can also be made from individual softkey selections throughout the FieldFox menu structure. However, they remain through a FieldFox shut down ONLY when the current settings are saved as preferences.

The table above shows a list of all of these settings and where they are discussed in this User’s Guide.

How to save current settings as Preferences

1. Using softkeys, configure the settings as you would like them to remain.
2. Press **System 7** > **Preferences**
3. Then **Save Current Settings** There is a beep when your settings have been saved.
4. Press **Reset Preferences** to restore the factory default settings.

Language

Choose the language in which to display FieldFox softkeys and other messages. Select Save Current Settings to set this language as a preference.

– Press **System 7** > **Preferences** > **Language**

See also, “How to select a Language” on page 853.

Global Settings (Overview)

Choose the Global Settings values (Language, Battery Saver, and Startup Mode). See also “Quick Settings Table” on page 850.

How to select Global Settings:

1. Press System 7 > Preferences > Preferences
2. Then use arrow softkeys (▲|▼) or the knob to select Global Settings
3. Then Edit for each of the following:
   - Language (see)
   - Batter Save Mode (see)
     - On
     - Off (default)
   - Startup Mode (see)
4. Then Done Edit (for each change in setting)

How to select a Language

1. Press System 7 > Preferences > Language OR

   This setting is available under Global Settings by:

   Press System 7 > Preferences > Preferences
2. Then choose from the following:
   - English
   - Espanol – Spanish
   - Deutsch – German
   - Italiano – Italian
   - Francais – French
   - Russian
   - Japanese
   - Chinese
   - Turkish

Battery Saver

When the battery saver is OFF, the RF source power is left ON at the end of the sweep which consumes more battery power. This feature is used in CAT, NA, VVM modes, and SA mode when the internal source is turned ON.

Battery Saver is the ONLY FieldFox setting that must be made as a Preference from the Quick Settings table. This setting remains until you change it again.

NOTE The FieldFox internal temps will run 2°C – 5°C cooler with the Battery Saver on (the temperature range is dependent on the ambient temp).

How to set Battery Saver

1. Press System 7 > Preferences > Preferences
2. Then scroll to **Global Settings** > **Battery Saver**
   - **ON** – To conserve battery power, the RF source power is turned OFF at the end of each CAT, NA, and VVM mode sweep. This behavior does not impact FieldFox measurements.
   - **OFF** – Source power is kept ON at all times, including during trigger Hold mode and between single sweep acquisitions. The RF source stays at the stop frequency until another sweep begins.
     This provides a constant, uninterrupted RF output from the RF OUT port. This behavior also provides the highest trace stability sweep-to-sweep which may only be evident while using either single sweep or Run/Hold. With Battery Saver OFF, the use of a full battery charge is reduced by approximately 45 minutes.

Startup Mode

The Startup Mode setting determines the mode that becomes active (visible) when User Preset is set to OFF (Factory Preset) and the FieldFox is powered ON. See “User Preset” on page 838.

How to setup Startup Mode

1. Press System 7 > Preferences > Preferences
2. Then scroll to **Global Settings** > **Startup Mode** and press Edit.
3. Then repeatedly press the Startup Mode to scroll through the available choices.
   - ‹Default› is the factory default mode for your FieldFox model.
   - Built-in Power Meter Mode is NOT allowed as a Startup Mode.

Startup Option

The Startup Option setting determines the behavior of the FieldFox after a restart.

CAUTION

An instrument can never power up for the first time in **LAST**.

If line power to the instrument is interrupted, by any of the following, **Last Power Off State** may not work properly:

– If there is no battery and the line cord plug is removed

– If the test rack/bench power is switched off power.

For proper operation, **Last Power Off State** depends on your shutting down the instrument via softkeys **Mode** > **More. . .** (Varies with number of Options loaded) > **"Shut down"** | **"Restart"**.

– If the Startup Option is set to **Last Power Off State** the mode that the FieldFox was set to before a reboot is displayed on power up.

– When the Startup Option is set to **User (See Startup Mode)**, (Default) the Startup Mode selected is the first mode visible on startup and is Option dependent. If User Preset is set to ON, it is loaded on power up.

See "User Preset" on page 838.

How to setup Startup Option

1. Press **System 7** > **Preferences** > **Preferences**
2. Then scroll to **Global Settings** > **Startup Option** and press **Edit**.
3. Then repeatedly press the **Startup Option** to toggle through the available choices.
   - **User (See Startup Mode)** or
   - **Last Power Off State**

Display

Choose the Display values (Display Colors, Trace Width, Brightness, Title Enabled, Title). See "Display (Settings)" on page 839.

How to select Display values:

1. Press **System 7** > **Preferences** > **Preferences**
2. Then use arrow softkeys (▲|▼) or the knob to select **Display**
3. Then **Edit** for each of the following:
   - Display Colors
   - Indoor (default)

- Night Vision
- Outdoor Sun
- Outdoor Dusk
- Outdoor Clouds

4. Trace Width
   - Normal (default)
   - Wide

NOTE Setting trace width to **Wide**, will result in slower trace refresh rates.

5. Brightness
   - 0 to 100% (80% default)
6. Title Enabled
   - On
   - Off (default)
7. Title
   - User Title (default)
8. Then **Done Edit** (for each change in setting)

Audio

Choose the Audio values (Mute, Volume). See also "Audio (Volume) Control" on page 839.

How to select Audio values:

1. Press **System 7** > **Preferences** > **Preferences**
2. Then use arrow softkeys (▲|▼) or the knob to select **Audio**
3. Then **Edit** for each of the following:
   - Mute
     - On
     - Off (default)
4. Volume
   - 0 to 100 (default is 50)
5. Then **Done Edit** (for each change in setting)

Date and Time

Choose the Date and Time values (Date and Time, Time Format, Date Format, and Time Zone). See also "Date and Time, Format, and Time Zone Settings" on page 873.

How to select Date and Time units:

1. Press System 7 > Preferences > Preferences
2. Then use arrow softkeys (▲|▼) or the knob to select **Date and Time**.
3. Then Edit for each of the following:
   - Date and Time
     - Edit as needed (Refer to "Date and Time, Format, and Time Zone Settings" on page 873):
       - ––Time Format
       - ––Date Format
       - ––Time Zone
4. Then Done Edit (for each change in setting)

GPS – Distance Settings

Choose the GPS values (GPS State, Elevation Unit, GPS Sync Clock, Display, Lat/Lon Format). See also "GNSS (GPS+) and GPS" on page 865.

How to select GPS distance units:

1. Press System 7 > Preferences > Preferences
2. Then use arrow softkeys (▲|▼) or the knob to select **GPS**.
3. Then Edit for each of the following:
   - GPS State
     - Off (default)
     - Internal
     - External
   - Elevation Unit
     - Meters (default)
     - Feet
     - Inches
   - GPS Sync Lock

  - Off (default)
  - Internal
  - External
- Display
  - On
  - Off
- Lat/Lon Format
  - ddd° mm’ ss.sss”
  - ddd.dddddd°
  - ddd° mm.mmmmm’
  - Brit. Natl. Grid
- Then Done Edit (for each change in setting)

Frequency Reference

When Internal or External is selected, a search is made for satellites overhead. GPS (default) works best when outdoors and in full view of the open sky.

See also, “GNSS (GPS+) and GPS” on page 865.

How to set the frequency reference settings:

This procedure saves your frequency reference settings using the Quick Settings Table in Preferences. Learn more in “Quick Settings Table” on page 850.

1. Press System 7 > Preferences > Preferences then
2. Press Next Page until Frequency Reference is displayed.
3. Use arrow keys ▲|▼ or knob to scroll down to until Frequency Ref Source is highlighted.
4. Press Edit > Frequency Ref Sou [GPS] then
5. Choose from the following:
   - GPS - (default setting).
   - External - Enable GPS using an external, customer-supplied, USB dongle device. A check is made to detect a USB GPS device at the USB connectors.
   - Internal - Enable GPS using Option 307 – Built-in GPS. Connect a GPS antenna to the top-panel GPS connector. Learn more about additional GPS antenna accessories at http://www.keysight.com/find/fieldfox. Internal is set

automatically when Frequency Reference Source is set to GPS. Learn more in "Frequency Reference Source" on page 870.

File folders

When enabled, FieldFox uses the last selected Device and Folder location as the default device location after instrument power cycle.

NOTE

Before setting the preferences for the File Folders, you must select the Device and Folder locations. Refer to Chapter 34, "File Management."

How to set File Folders

1. Press **System 7** > **Preferences** > **Preferences**
2. Then scroll to User Folder Persist:
   - **User Folder Persist (On/Off)** – Defaults to the current Device and folder location at power up. Toggle User Folder Persist On/Off when a new Device location is selected location.
   - **User Folder** – displays the default folder location.
   - **User Device** – displays the default device location.

See also: "Alpha Numeric Editing" and "File Saving Naming Options".

Alpha Numeric Editing

- **Keyboard Style** – Toggles through Qwerty/ABC style keyboards that the Labeler displays. Refer to "How to use the FieldFox labeler " on page 891.

File Saving Naming Options

- **Prefix** – Displays the current choice for Prefix. Choices are User, Last File (default), or Off. Refer to Prefixes and Suffixes for Filenames in "Prefixes and Suffixes for Filenames" on page 900.
- **Auto Append** – Displays the current choice for Auto Append to a filename (Suffix). Choices are Off (default), Number, Date. Refer to "Prefixes and Suffixes for Filenames" on page 900.

Quick Save Editing

Enables/disables the Quick Save feature. Quick Save saves any files you have set to On in the Group Save File Types preferences. Refer to "Group Save File Types Editing" on page 860.

To save the **User Device** storage location, refer to Chapter 34, "File Management."

CAUTION

IMPORTANT!

To avoid losing data, before using the Quick Save feature, verify that you have all of the correct data file types enabled for saving.

1. Press System 7 > Preferences > Preferences then
2. Press Next Page until is displayed.
3. Use arrow keys ▲|▼ or knob to scroll down to until your choice is highlighted then choose one or more of the following:

– **Save/Recall Long Press** – Enables/Disables the Quick Save feature. When enabled (default == On) and then hold down the Save/Recall 9 hardkey for >600 ms, the specified files are saved to a file with the `FFoxData` prefix. See also, **Quick Save Show File Dialog** below and "Prefixes and Suffixes for Filenames" on page 900.

– **Quick Save Prefix** – Chooses the name of the Quick Save data file's prefix. Press the Edit softkey to edit the prefix name in the "Quick Save Prefix" menu (default == FFoxData). Refer to "Prefixes and Suffixes for Filenames" on page 900.

– **Quick Save Suffix** – Chooses the name of the Quick Save data file's suffix. Press the Edit softkey to edit the suffix type Number or Data (default == Date). Refer to "Prefixes and Suffixes for Filenames" on page 900.

– **Quick Save Show File Dialog** – When the Quick Save Show File Dialog is set to On (default == Off), pressing Save /Recall 9 for >600 ms causes the FieldFox Labeler to open and displays the current filename that is going to be used or can be edited to save your data. Learn more, see "Prefixes and Suffixes for Filenames" on page 900 and to "Group Save File Types Editing" on page 860.

Group Save File Types Editing

Enables/disables the selected file types to be saved as part of the Group Save File Types feature. (Default for all group save file types = Off.) Refer to "Quick Save Editing" on page 859.

Group Save File Types Procedure

1. Press System 7 > Preferences > Preferences OR

   Press Save/Recall 9 > More > Preferences then
2. Press Next Page until Group Save File Types is displayed.

3. Use arrow keys ▲|▼ or knob to scroll down to until your choice is highlighted then:
4. Press **Edit** then
5. Press **'file type' Data (.xxx)** to enable/disable the data file type (default = Off). (e.g., **Image (.png) ON OFF**, **CSV Data (.csv) ON OFF**, etcetera).
6. Repeat steps 3 through 5 as required.
7. Press **Done Edit** to exit the current data type softkey menu.
8. Press **Done** to exit the Preferences menu and save your Preferences.

Group Save File Types

- **State+Trace (.sta)** – Enables/Disables .sta as a group. file to be saved when the Quick Save (Save/Recall 9) hardkey is pressed for ~3 seconds.
- **State (.sta)** – Enables/disables .sta files as a group file to be saved when the Quick Save (Save/Recall 9) hardkey is pressed for ~3 seconds.
- **Image (.png)** – Enables/disables .png files as a group file to be saved when the Quick Save (Save/Recall 9) hardkey is pressed for ~3 seconds.
- **CSV Data (.png)** – Enables/disables .csv data files as a part of the group files to be saved when the Quick Save (Save/Recall 9) hardkey is pressed for ~3 seconds.
- **S1P Data (.s1p)** – Enables/disables .s1p data files as a part of the group files to be saved when the Quick Save (Save/Recall 9) hardkey is pressed for ~3 seconds.
- **S2P Data (.s2p)** – Enables/disables .s2p data files as a part of the group files to be saved when the Quick Save (Save/Recall 9) hardkey is pressed for ~3 seconds.
- **Matalab Data (.mat)** – Enables/disables .mat data files as a part of the group files to be saved when the Quick Save (Save/Recall 9) hardkey is pressed for ~3 seconds.
- **SDF Data (.sdf)** – Enables/disables .sdf data files as a part of the group files to be saved when the Quick Save (Save/Recall 9) hardkey is pressed for ~3 seconds.

CAT (Distance Units)

Choose the CAT distance units (i.e., Meters (default), Feet, Inches). See "DTF Units" on page 74.

How to select CAT distance units:

1. Press **System 7** > **Preferences** > **Preferences**
2. Then **Edit** for each of the following:

- Distance Units:
  - Meters (default)
  - Feet
  - Inches
- TDR Sweep:
  - Cable (default and the most accurate)
  - Auto

3. Then **Done Edit** (after each change in setting)

CAT/NA

Choose the CAT/NA settings for SnP file save, default factory error corrections, extended cal default. See also "> What Data Processing functions are included in saved SNP Data:" on page 897.

How to select CAT/NA defaults:

1. Press **System 7** > **Preferences** > **Preferences**
2. Then use arrow softkeys or the knob to select CAT/NA
3. Then Edit for each of the following:
   - SnP File Save
     - Default
     - Advanced
   - Default Factory Error Corr. (N995xB/6xB Only)
     - Enhanced Response
     - Full 2 Port
   - Extended Cal Default (N995xB/6xB Only)
     - On
     - Off (default on models >6 GHz)
4. Then **Done Edit** (after each change in setting)

SA

Choose the SA setting for Individual measurement Control default. See also "Alignments" on page 211.

How to select SA defaults:

1. Press System 7 > Preferences > Preferences > Next Page until the SA setting is visible.
2. Then use arrow softkeys or the knob to select SA
3. Then Edit for each of the following:
   - **Individual Alignment Control**
     - **On** (Default - recommended)
     - **Off**
   - **ADC Over Range Warn Emphasis**
     - **Small Font** (Default) no added emphasis to the ADC Over Range warning on the screen.
     - **Big Font + Beep** – this option makes the ADC Over Range warning have a larger text which is accompanied by a Beeping sound to alert you of the ADC Over Range.
     - **Beep** – this option keeps the default text size, but alerts you of an ADC Over Range with a Beeping sound.
     - **Big Font** – this option makes the ADC Over Range warning have a larger text, no sound with this option.
   - **Beep Length (RTSA and SA Modes Only)**

     When **ADC Over Range Warn Emphasis** is set to either, **Big Font + Beep** or **Beep**, the FieldFox audible beep sounds whenever an ADC Over Range error occurs.

     You can adjust the Beep Length from 500 ms (default /minimum) up to 2 seconds.

     To set the Beep Length: Highlight the **Beep Length** setting then, press Edit > 2s (i.e., in this example, to set the audible beep to be on 2 seconds). There is always a gap of at least 1s between audible beeps.
4. Then Done Edit (after changing setting)

Discrete Colors Softkey Menu

The discrete colors softkey menu can be used to increase the choice of colors displayed from two to up to six colors, for easier measurement readings. Refer to Figure 32-7.

Figure 32-7 Display Example: Color Coded Bar Scale (x6 Colors)

Using the Discrete Colors Softkey Menu

1. Press **System 7** > **Preferences** > **Discrete Colors**
2. Choose from the following:
   - **Discrete Colors ON OFF** – to enable/disable the discrete colors greater than 2.
   - **Number of Colors** – choose up to 6 discrete colors (Minimum (default) = 2, red and blue).
   - **High Power Red Blue** – choose red or blue to choose the color to indicate the highest power levels (default = Red).

System Configuration

Options (Licensing)

You can view and install options on your FieldFox. To see a comprehensive list of the options that are available, view the FieldFox Configuration Guide at: https://www.keysight.com/us/en/assets/7018-06515/configuration-guides/5992-3701.pdf.

How to view the Installed Options

1. Press **System 7** > **System Configuration** > **Options (Licensing)**
2. Then **Show Options**

The currently installed options are listed.

How to Install Options (License File)

A license file (*.lic file) must already be on a USB Flash Drive. To learn how to obtain a. license file (*lic file), visit: https://www.keysight.com/us/en/lib/resources/service-manuals/keysight-fieldfox-library-help-and-manuals-2153870.html.

1. Insert the USB Flash Drive in the FieldFox.
2. Press System 7 > System Configuration > Options (Licensing)
3. Then Install Options The FieldFox reads, validates, then installs the options.
4. Press and hold the power button to shut down, then restart the FieldFox.

How to Delete ALL Options

Deleting individual options is NOT supported.

1. Press System 7 > System Configuration > Options (Licensing) > Advanced
2. Then Delete All Options

After a warning message, all options on the FieldFox are deleted.

NOTE

IMPORTANT!
Delete All CFG Options is to be used by Service Personnel ONLY.

For more information about Licensing, see the FieldFox Service Manual at: https://edadocs.software.keysight.com/kkbopen/fieldfox-manuals-firmware-software-and-product-support-589310103.html.

GNSS (GPS+) and GPS

NOTE

IMPORTANT! The FieldFox may display "`Ant OPEN`", even when a GPS antenna is connected to the FieldFox. If the GPS antenna is powered by another power supply **and** has a DC blocking capacitor where the feed is connected to FieldFox, then minimal amounts of current will be drawn from the FieldFox, so the instrument will display "`Ant OPEN`". The threshold to detect the presence of an antenna is approximately 1.6 mA.

GPS (Global Positioning System) allows you to 'stamp' each data trace with your physical position in latitude/longitude/elevation format. This can be useful when making measurements on cell towers or other antennas at remote locations.

– **With Option 307**, GPS is available with the built-in receiver accessed through the top-panel SMA (f) connector. This connector has a settable 3.3 VDC or 5 VDC bias voltage which is switched ON when GPS is set to Internal. This system is designed for use with an active antenna such as the Keysight N9910X-825.

– **Without Option 307**, GPS is usable ONLY with an external GPS receiver that is shipped with Microsoft “Streets and Trips” and “AutoRoute”. The GPS receiver is NOT available from Keysight. Only the GPS USB receiver is used with the FieldFox. Therefore, it is NOT necessary to purchase the very latest version of the map software.

How to make GPS settings

GPS settings are the same with, or without, Option 307.

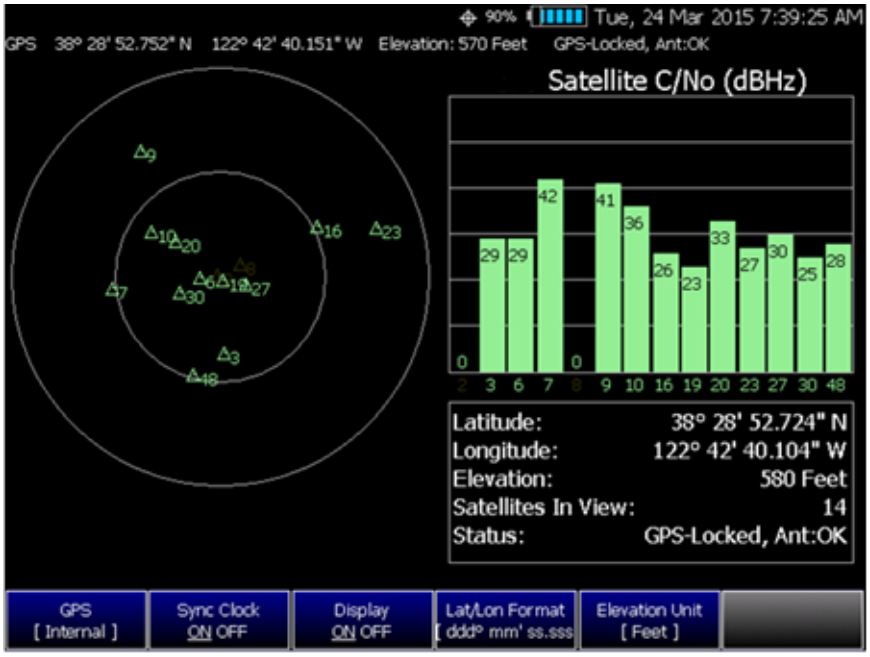
Your GPS settings can be saved with Preferences. Learn more in “Quick Settings Table” on page 850.

1. Press System 7 > System Configuration > GPS
2. Then choose from the following:
3. Display ON OFF Enable and disable the GPS display on the FieldFox main window.
4. GPS then choose from:
   - OFF - Disable GPS (default setting).
   - External - Enable GPS using an external, customer-supplied, USB dongle device. A check is made to detect a USB GPS device at the USB connectors.
   - Internal - Enable GPS using Option 307 – Built-in GPS. Connect a GPS antenna to the top-panel GPS connector. Learn more about additional GPS antenna accessories at http://www.keysight.com/find/fieldfox. Internal is set automatically when Frequency Reference Source is set to GPS. Learn more in “Frequency Reference Source” on page 870.

When Internal or External is selected, a search is made for satellites overhead. GPS works best when outdoors and in full view of the open sky. When several satellites are found, the following screen appears (when Display is set to ON) and is updated frequently:

NOTE As the bar graph count exceeds 9 bars, the “dB” text is dropped from the number displayed on the bar. Units for C/No are dBHz.

Figure 32-8 GPS Display



– The left portion of the screen displays satellites and the corresponding number on the adjacent Satellite Power chart.

– The right portion of the screen displays Satellite Power Carrier to Noise (C/No) dBHz values on the tops of the satellite power chart.

NOTE

The C/No values returned are not calibrated at the factory or warranted for accuracy. The numbers retrieved are passed unprocessed directly from the GPS receiver in use.

GPS Status

With GPS enabled the following is displayed at the top of the FieldFox screen:

The following icons (located in RED circle above) indicate the GPS lock status:

- GPS ON and locked on satellites.

- GPS ON, but NOT locked on satellites.

- GPS ON, but no GPS receiver is present or detected.

The following annotation (BLUE circle in above image) indicates the **INTERNAL**, top-panel antenna status:

– Ant: **INIT** – antenna status initializing.

- Ant: **OK** – antenna present and working.
- Ant: **OPEN** – antenna is not drawing DC bias current. This could occur when an active antenna is not connected properly or the antenna does not require DC bias current. Antennas that do not require bias current can still provide an accurate GPS reading.
- Ant: **SHORT** – antenna center pin has been shorted to ground. The internal bias circuitry is disabled for about one minute, then re-enabled. You can also press **GPS OFF**, then **GPS Internal** to quickly re-enable the antenna bias.

More GNSS and GPS settings

See also, "GNSS and GPS Freq Ref Source Settings" on page 870.

1. Press **System 7** > **System Configuration**
2. Then **GNSS (GPS+)** or **GPS** (depending on options) > **GNSS Settings**
3. Then choose from the following:

- Enable and disable the synchronization of the FieldFox internal clock to the GPS UTC time standard.

NOTE The GPS Sync setting has the same restrictions as the Date and Time setting. Learn more in "Date and Time" on page 857

  - **ON** The FieldFox clock is synchronized and updated approximately once every hour to the time of the GPS clock.
  - **OFF** The FieldFox clock is NOT synchronized with GPS. When set to OFF after Sync was ON, the date and time does NOT revert back to the settings before the clock was synchronized.
- **Display ON OFF** Enables or disables displaying Lat/Lon Format and Elevation Units.
- **Lat/Lon Format** Change th format of the GPS display on the FieldFox screen. Choose from:
  - **ddd°mm' ss.sss"** degrees, minutes, seconds (default setting)
  - **ddd°mm.mmmmm'** degrees, minutes, fractional minutes
  - **ddd.dddddd°** decimal degrees
- **None** Lat/Lon is not displayed.
- **Elevation Unit** Choose from:
  - **m** (Meters)
  - **Feet**
  - **Inches**

– **Antenna Voltage** Choose from:

  – **3.3V 5V** – Settable to: 3.5 VDC or 5 VDC. When the bias voltage is set to ON and when the GPS is set to Internal. This system was designed for an active antenna such as the Keysight N9910X-825

Saving Data with GPS Enabled

GPS position and clock data are included when data is saved with the following files types: *.csv, *.SnP, State, State+Trace data save.

A warning is shown if the GPS is ON but unlocked at time of save, or if the GPS feature is ON but no GPS is physically present at time of save.

The following is a sample S1P file with GPS information:

```
!GPS Latitude: 38 28.87717 N
!GPS Longitude: 122 42.66625 W
!GPS TimeStamp: 06/25/2010 16:24:48
!GPS Seconds Since Last Read: 2s
```

Saving GPS Display Data

To save the current GPS data displayed:

1. Press **Save/Recall 9**
2. Then **Save File Picture (PNG)**

A menu opens to enable naming the file you are saving (*.png).

More GNSS Settings

1. Press **System 7** > **System Configuration** > **GNSS Selection**
2. Then choose from the following:
   – **GPS** Refer to “How to make GPS settings” on page 866.
   – **GLONASS** Global navigation system, operating as part of a radio navigation-satellite system. Learn more “More GNSS and GPS settings” on page 868.
   – **BDS** - China’s BeiDou navigation system. Learn more “More GNSS and GPS settings” on page 868.
   – **GALILEO** - European navigation system. Learn more “More GNSS and GPS settings” on page 868.

GNSS and GPS Freq Ref Source Settings

For convenience, the GNSS Settings menu includes the **Freq Ref Source** softkey.

1. Press System > System Configuration > GNSS (GPS+) > Freq Ref Source [GPS] then
2. Choose one of the following:
   - Int, Ext, or GPS

For more, on the **Freq Ref Source** softkey choices, refer to "Frequency Reference Source" on page 870.

Frequency Reference Source

The FieldFox internal frequency reference source is used to make accurate and stable measurements. To improve measurement accuracy and stability, you can use a highly-stable external 10 MHz reference source or a precision timing signal provided with Built-in GPS (Opt. 307).

The Frequency Reference setting will survive a Factory Preset or Mode Preset and is saved as part of the Instrument State. When resuming after Standby, the FieldFox will display an Unlock message while it acquires a lock to an external or GPS source.

How to select Frequency Reference Source

1. Press System 7 > System Configuration > Frequency Ref > Freq Ref Source then
2. Then choose from the following:
   - Int Internal frequency reference
   - Ext External frequency reference. Connect the 10 MHz External Reference to the **Ref In/Trig** In SMA (f) connector on the FieldFox top panel. The FieldFox may take up to 10 seconds to lock to a valid External Reference source
   - GPS Available ONLY with Built-in GPS (Opt. 307). When selected, the internal GPS is immediately enabled and a search for satellites begins. When satellites are found, the precision timing signal is NOT used directly, but is used to correct the absolute frequency of the internal reference many times per second.

Hold-over mode

When the GPS signal is lost, the last GPS reading is used as a hold-over correction value for the internal reference. The hold-over correction value is no longer used, but instead the factory-set correction value is used, when any of the following occur:

– when GPS is disabled.

– when Reference Source is set to Internal.

– when the FieldFox resumes from Standby mode or shut down.

Frequency Reference Status

When switched to Ext or GPS, one of the following annotations appears in the lower-left corner of the screen:

– **EXT R** – External reference is selected.

– **GPS R** – GPS reference is selected.

– **GPS H** – Internal Reference is used with last 'hold-over' correction reading.

If the FieldFox does NOT find an appropriate **Ext** or **GPS** reference signal, then **Ext Ref UNLOCKED** is displayed in the lower-left corner of the graticule area. This can occur when any of the following conditions exist:

– NO reference signal is present.

– A low or very high-level external reference signal is present. For best results, the signal should be between –5 dBm and +5 dBm.

– The external reference is off-frequency.

To learn the expected measurement accuracy when connected to a frequency reference source, see the FieldFox specifications in Appendix B: "Specifications/Data Sheet".

Reference OUT

The internal 10 MHz frequency reference is available from the Ref/Trig output connector on the right-side panel. Use this signal as a common frequency reference when making measurements using external equipment. See this connector in "Top Panel" on page 43.

Variable Voltage Source (Opt. 309)

CAUTION

IMPORTANT! Noise Figure mode uses DC variable voltage source (VVS) – (Option 309) during the measurements. The voltage might be as high as 28V during the measurement. During the noise figure measurement, always make sure there are no voltage sensitive devices connected to the DC SMB output port. Refer to Chapter 30,"Noise Figure Mode (Option 356)", on page 737.

When you initially change the FieldFox mode to Noise Figure, the FieldFox displays the following message for ten seconds:
"Ensure your Noise Source is connected to the VVS DC Output It (VVS) will be driven up to +28V during the measurement".

An internal DC source, available with Opt. 309, may be used to provide power for external devices. The maximum power available is 8 watts.

The voltage is output through an SMB (m) output connector located on the left-side panel. See the connector in “Left Side Panel” on page 45.

An optional SMB (f) to BNC (m) bias-tee power cable is available with Keysight part number: N9910X-713.

The following status line is provided near the top of the FieldFox screen.

Figure 32-9

Voltage Source Status Line
1. Voltage source state: ON, OFF, TRIPPED.
2. **Voltage** setting from 1.00 V to 32.00 V with.01 V resolution.
3. **Current:** The amount of current (in Amperes) being drawn from the source.

4. Max Current: A conservative estimate of maximum current possible given the present voltage setting. The actual ‘trip’ level may be slightly different.

How to make Voltage Source settings

1. Press **System 7** > **System Configuration** > **Voltage Source**
2. Then **Source ON OFF** to enable and disable the voltage source output.

Then choose:

– Then Voltage x.xx V Using ▲|▼ arrows, the rotary knob, or numeric keypad, enter a value between 0.001 and 32 volts.

– **Clear Overload** If the voltage source becomes ‘TRIPPED’ press to re-enable the voltage source output. Then set **Source ON**.

– **Status Line ON OFF** Turn ON and OFF the voltage source status line that appears near the top of the screen. The status line is always ON while making Voltage Source settings.

– **Hi Impd. Load ON OFF** Enables/Disables low current use (Step) and high current use (Ramp). Default = OFF (Low current (Step)).

Security Level

For security reasons, you can prevent frequency information from appearing on the FieldFox while in SA, NA, or CAT modes.

How to set Security Level

1. Press **System 7** > **System Configuration** > **Security Level**
2. Then choose from the following:

- **None** All frequency settings are visible.
- **High** Frequency information is blanked from the following:
  - Display annotation
  - Softkeys
  - Marker display and marker table
  - Calibration properties
  - All settings tables
  - Limit line tables
  - All saved .png files
- Any of the following will re-display frequency information:
  - Set to **None**, **Preset**, **Mode Preset**, or FieldFox restart.

Date and Time, Format, and Time Zone Settings

Set the local date and time, Date and Time format, and Time Zone that is shown on the FieldFox screen. The Date and Time is also used to identify files that are saved.

The Date and Time can also be set by synchronizing with GPS satellites. Learn more in "GPS – Distance Settings" on page 857.

How to Update Date and Time using Internet

This method of setting the Date and Time does NOT have the security restrictions of the other methods (listed below).

This method will NOT set the correct Time Zone. You must do that using the manual method. See below.

1. Press **System 7** > **System Configuration** > **More** > **Update Time using Internet**
2. Connect a LAN cable that is also connected to the Internet.
3. Then press **Update Time using Internet**. When successful, a message is displayed indicating the amount of time correction that occurred.

- Optional: Set the following when a Proxy server is used to connect to the internet:
  - **Proxy Host** – Enter the name of the proxy host.
  - **Proxy Port** – Enter the port number of the proxy host.

How to MANUALLY set Date and Time, Format, and Time Zone

NOTE

Because of licensing security, the manual and GPS Sync methods to set Date and Time are restricted as follows:

– Can be set backward no more than 5 hours at a time.

– Can be set forward any amount of time.

– Can be set backward or forward no more than once in a day. A new day begins at midnight.

– There is no restriction for setting the Time Zone.

– To change the Date and Time backward a significant amount, send an email to csg.servicedesk@keysight.com.

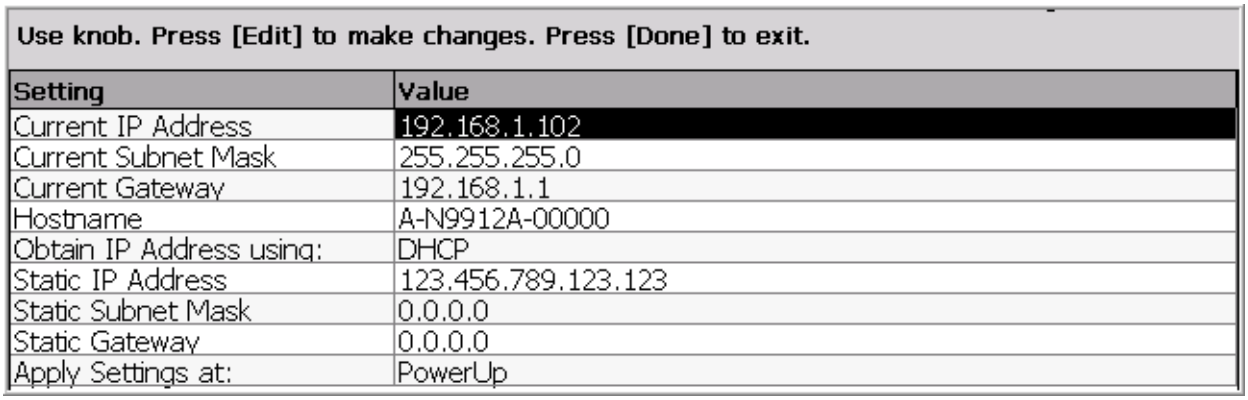
NOTE

BEFORE manually setting the Date and Time, be absolutely certain that the Time Zone setting is correct.

1. Press System 7 > System Configuration > More > Date and Time.
2. Press the ▲|▼ arrows to highlight the row to be edited.
3. Then press Edit.
4. Use the ▲|▼ arrows or rotary knob to select and to edit a field.
5. Press Cancel or Done when the edits are complete.
6. Press Done to exit the Date and Time settings. The readout in the upper-right corner of the FieldFox screen will update accordingly.

LAN Settings

Configure the LAN settings to be used to communicate with the Data Link Software and connect to the FieldFox for remote SCPI operation. Learn more about Data Link at: www.keysight.com/find/fieldfoxsupport.



Use knob. Press [Edit] to make changes. Press [Done] to exit.

Setting	Value
Current IP Address	192.168.1.102
Current Subnet Mask	255.255.255.0
Current Gateway	192.168.1.1
Hostname	A-N9912A-00000
Obtain IP Address using:	DHCP
Static IP Address	123.456.789.123.123
Static Subnet Mask	0.0.0.0
Static Gateway	0.0.0.0
Apply Settings at:	PowerUp

Table 32-1 LAN LEDs

LAN LEDs
When FieldFox is connected to the LAN, the flashing LAN LEDs have the following definitions:
Green: Flashing indicates packets are being transferred.
Yellow: – Flash, pause = 10 Mbit link speed – Flash, flash, pause = 100 Mbit link speed – Flash, flash, flash, pause = 1 GBit link speed

How to configure LAN settings

The first three 'Current...' settings can NOT be edited.

1. Press System 7 > System Configuration > More > LAN.
2. Then choose from the following:

– Use the ▲|▼ arrows to select one of the following, then press Edit.

– **Hostname** Change the name that can be used to address the FieldFox if your server supports this feature. The default hostname is generated automatically.

– **Obtain IP** Choose from:

  – **DHCP** - IP Address is assigned dynamically. If your server supports this feature, the IP Address for the FieldFox is assigned each time it is started.

  – **Static** - Set the IP Address manually. The Address remains until you change it.

– **Static IP Address** - Enter the IP Address – including periods - in the format nnn.nnn.nnn.nnn

NOTE

For all FieldFoxes with firmware ≤A.08.18 and ≤A.09.50 FW, when using Static IP addresses:

– Either a valid Static Gateway is required or 0.0.0.0.

– Either a valid Static DNS is required or 0.0.0.0. (If entry is available.)

– **Static Subnet Mask** - Enter the Subnet Mask – including periods - in the format nnn.nnn.nnn.nnn

– **Static Gateway** - Enter the Static Gateway – including periods - in the format nnn.nnn.nnn.nnn

– **Static DNS** - Enter the Static DNS – including periods - in the format nnn.nnn.nnn.nnn

– **Apply Settings** Choose from:

  – **Power Up** The above settings take effect when the FieldFox is started.

  – **Now** The above settings take effect immediately.

NOTE

To make the LAN settings persist after power up, toggle Apply Settings to Now then back to Power Up. You should see a message indicating that the LAN config file was saved.

3. Press Done Edit when finished.

Power ON

When the FieldFox is without a power source, this setting allows the FieldFox to power ON when the DC Adapter is inserted without pressing the power button.

NOTE

For this feature (Auto Power ON) to function properly, the battery must not be present.

How to set Power ON

1. Press System 7 > System Configuration > More > Power ON
2. Then choose from the following:
   – Auto The FieldFox will power ON when the DC Adapter is inserted.
   – Manual The FieldFox will power ON only when the power button is pressed.

FieldFox Package Installer

The FieldFox Package Installer enables you to download new versions of firmware from either a USB memory or SD Card. Additionally, the Utility softkey enables you to backup user files or restore user files.

How to run the Installer

NOTE Before running the Installer to update your firmware, you might want to back up your user data. Refer to "How to restore files" on page 878.

1. Press System _7 > System Configuration > More > Firmware Update > Start Installer.

   The Installer software opens after a couple of seconds.

NOTE If no files are displayed, verify that a USB memory or SD Card is installed and press Refresh List.

2. Then chose from the following:

– Then the ▲|▼ arrows or the knob to scroll to the firmware you want to install.

3. Press Start Install and the following occur:

   "`Current Step Progress:`" bar and a "`Total Progress:`" bar are displayed along with this message: "`Copying package. Do not remove install media.`"

When the installation is completed, the FieldFox reboots.

How to backup files

This procedure backs up your user data to a USB or SD card. See also "How to restore files" on page 878.

NOTE If you backup multiple versions of the user files, the FieldFox appends a "_#" to each subsequently stored file. During restore, the file with the highest appended number is loaded into the FieldFox.

From the initial Installer menu:

1. Press Utility > Backup Data

   A message is displayed: "`Choose backup file location.`"

2. Then choose either SD Card or USB

   A progress bar and a message is displayed: "`Saving user data…`"

3. Press **Cancel** to exit without backing up your files and returning to the initial Installer menu.

How to restore files

This procedure restores user files from a USB or SD card. See also "How to backup files" on page 877.

CAUTION

Restoring files overwrites the existing user data on the FieldFox.

NOTE

If you backup multiple versions of the user files, the FieldFox appends a "_#" to each subsequently stored file. During restore, the file with the highest appended number is loaded into the FieldFox

If your stored any user files to a USB or SD card, this procedure restores those files.

From the initial Installer menu:

– Press **Utility**

– Then **Cancel** to exit without restoring your files and returning to the initial Installer menu.

Or

Press **Restore Data**

– A message is displayed: "`This option will COMPLETELY ERASE existing user data. ARE YOU SURE?`"

– Then **No** to return to the previous menu without restoring files.

Or

Press **Yes**

– Then choose either SD Card or USB

A progress bar and a message is displayed: "`Restoring user data…`"

Service Diagnostics

CAUTION

When the FieldFox is powering up, the firmware does a very high level verification of the hardware components. This high level verification does **not** involve applying any power to any of the internal hardware components. The FieldFox will generate an error message, if the hardware fails the verification. To learn more, refer to the FieldFox Programming Help and to the Service Guide for your FieldFox.

– The Service diagnostics menu is generally used to display service-related information. To access these menu items, press **System** 7 then **Service Diagnostics**.

System Information

The System information table shows important information about your FieldFox. The following is the most useful information:

– **Model Number** – FieldFox model

– **Serial Number** – Identification number of your FieldFox

– **Firmware Release** – The currently installed version of software. Check to see if you have the latest firmware at:
www.keysight.com/find/fieldfoxsupport

– **Network Identity** – The network name and current IP address of your FieldFox.

– **Reflectometer Factory Cal** - The Factory (CalReady) Calibration shows the date and time that the factory cal was performed for each test port and the Thru connection. The format is P1 <date time>, P2 <date time>, P1-P2 <date time>. The factory calibration is updated when you send your FieldFox to Keysight for Instrument Calibration. Learn more in Appendix C: "Instrument Calibration".

Event Log

The Event Log shows the information that has appeared on the FieldFox screen. The most recent information is at the top of the table.

Press **Clear Events** to erase this information.

Battery

Learn more in Chapter 35,"Working with the Lithium-Ion Battery", on page 905.

Internal Temperatures

Learn about the importance of the internal FieldFox temperatures in "FieldFox High Temperature Protection" on page 34.

Erase User Data

CAUTION

IMPORTANT!

The process in this section erases all User Data from the FieldFox. Before proceeding, Keysight strongly recommends that you back up all of your User Data to an external storage device. refer to “How to backup files” on page 877.

All data that you have written to the FieldFox can be erased with the press of a button. You would do this if your FieldFox is located in a secure environment and must be routinely erased of sensitive data.

All data is removed from the FieldFox internal “`UserData`” partition. This includes all State files and Trace + State files (*.sta), all Data files (*.csv, *.snp), all Picture files (*.png), all Cal Kit files, and all Cable files.

External media that is inserted (mini-SD card or USB flash drive) is NOT erased.

The “`Lost Clusters`" folder and files are NOT erased because they are part of the file system housekeeping.

How to Erase User Data

1. Press **System 7** > **Service Diagnostics** > **Advanced** > **Erase User Data**
2. Then **Confirm Erase**

– Then the following occurs:

  – All data files and folders are deleted from the “UserData” partition.

  – The FieldFox is rebooted, which manages the newly-freed data and re-writes the factory cal kits and cable files.

Understanding the Fan Controls

CAUTION

If the FieldFox displays a “Fan Stuck” or “Error: Internal Fan has stopped spinning”, to avoid incorrect measurements and possibly damaging your FieldFox, shut your FieldFox down and contact Keysight. Refer to “Contacting Keysight” on page 5.

The fan is replaceable, but not removable by non-Keysight trained personnel.

This section contains the following:

– “How to find the Fan Control Softkey Menu”
– “Fan Error Messages” on page 882

How to find the Fan Control Softkey Menu

This section discusses how to locate the fan control softkeys to monitor your fans performance (i.e., the fan control softkeys are for informational purposes only).

1. Press **System 7** > **Service Diagnostics** > **Advanced**.
2. Then **Fan Control**
3. These softkeys are for informational purposes only:
   - **Fan Mode Auto** – Manual is not selectable.
   - **Manual Speed [Medium]** – this is the default. No other speeds are selectable.
   - **Fan RPM** – displays the current fan RPM.
   - **Fan Temp** – displays the current fan air temperature.
   - **Back** –to exit the fan control softkey menu

Figure 32-10 Fan Control Softkeys – Informational Use Only (Not Editable)

Fan Error Messages

The FieldFox displays fan error messages, when the fan is not functioning properly. Refer to Figure 32-11, Figure 32-12 on page 883, and Figure 32-13 on page 883.

CAUTION

If the FieldFox displays a “FanStuck” or “Error: Internal Fan has stopped spinning” message, to avoid incorrect measurements and possibly damaging your FieldFox, shut your FieldFox down and contact Keysight. Refer to “Contacting Keysight” on page 5.

If the FieldFox displays a “Fan: Service” message the fan needs replacing. Call Keysight and request a fan kit. Refer to Figure 32-13 on page 883 and to “Contacting Keysight” on page 5.

Figure 32-11 Initial Fan Stuck Error Message – Displays For a Few Seconds

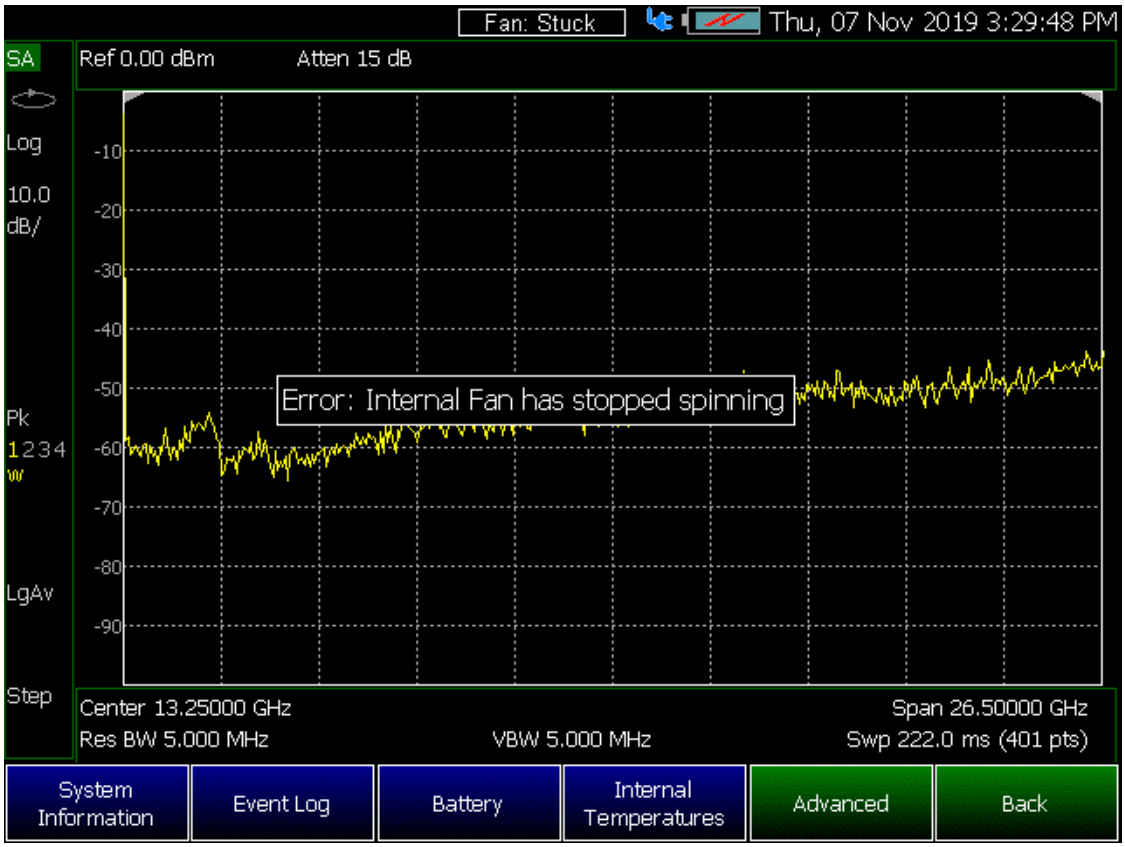


Figure 32-12 Persistent Fan Stuck Error Message

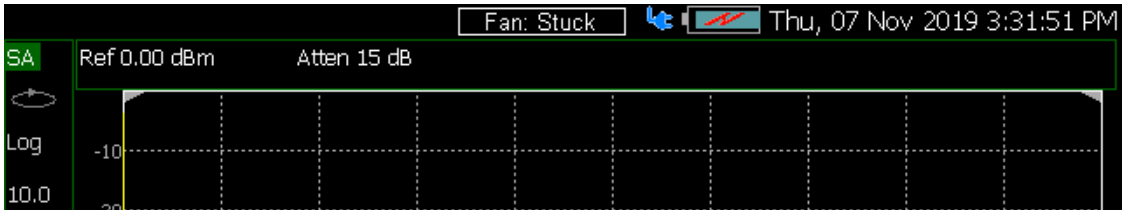
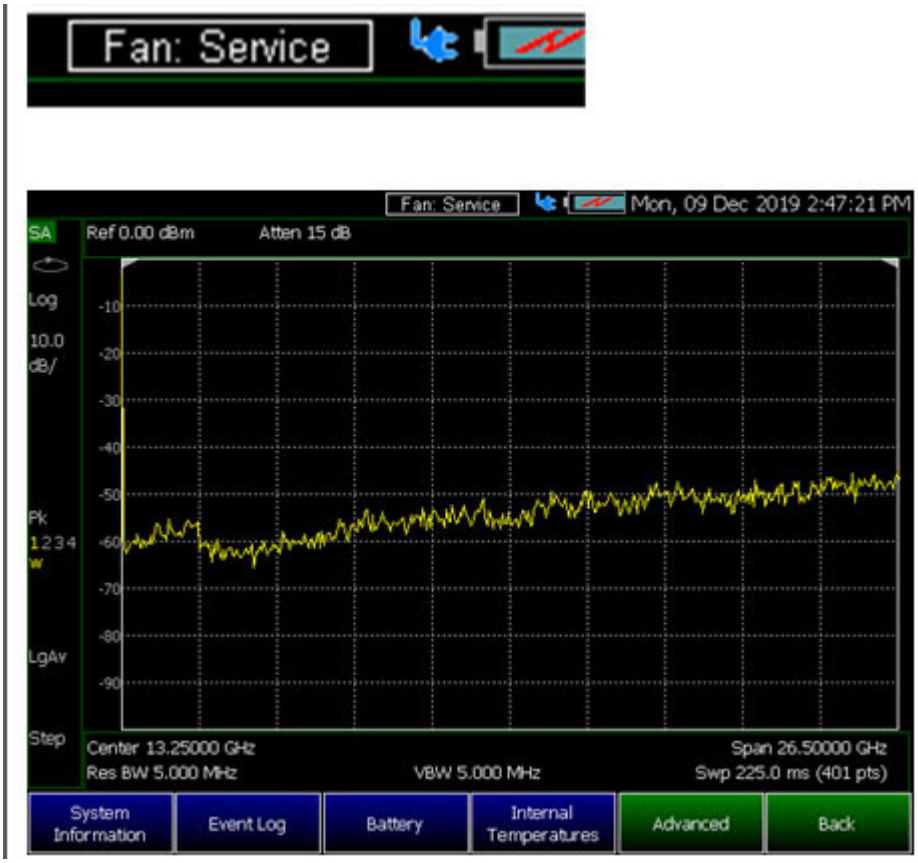


Figure 32-13 Fan: Service Message



33 Using the Mini-USB Port to send SCPI Commands and Queries

NOTE IMPORTANT! It is recommended that only USB certified cables are used with the FieldFox.

In this Chapter

"Mini-USB Connection to PC with IO Libraries" on page 885

Mini-USB Connection to PC with IO Libraries

The FieldFox comes with a mini-USB port that can be used to connect to your PC's standard USB 2.0 port. Using Keysight IO Libraries, Connection Expert and connecting via a VISA connection, you can send SCPI commands via the **Keysight Interactive IO** window to the FieldFox. Refer to your IO Libraries online help for the details on connecting to your instrument. Refer to keysight.com to download the IO Libraries.

NOTE The FieldFox may be communicated with via the VISA libraries. This makes it available to VEE, LabView, and other software tools that can communicate with VISA instruments.

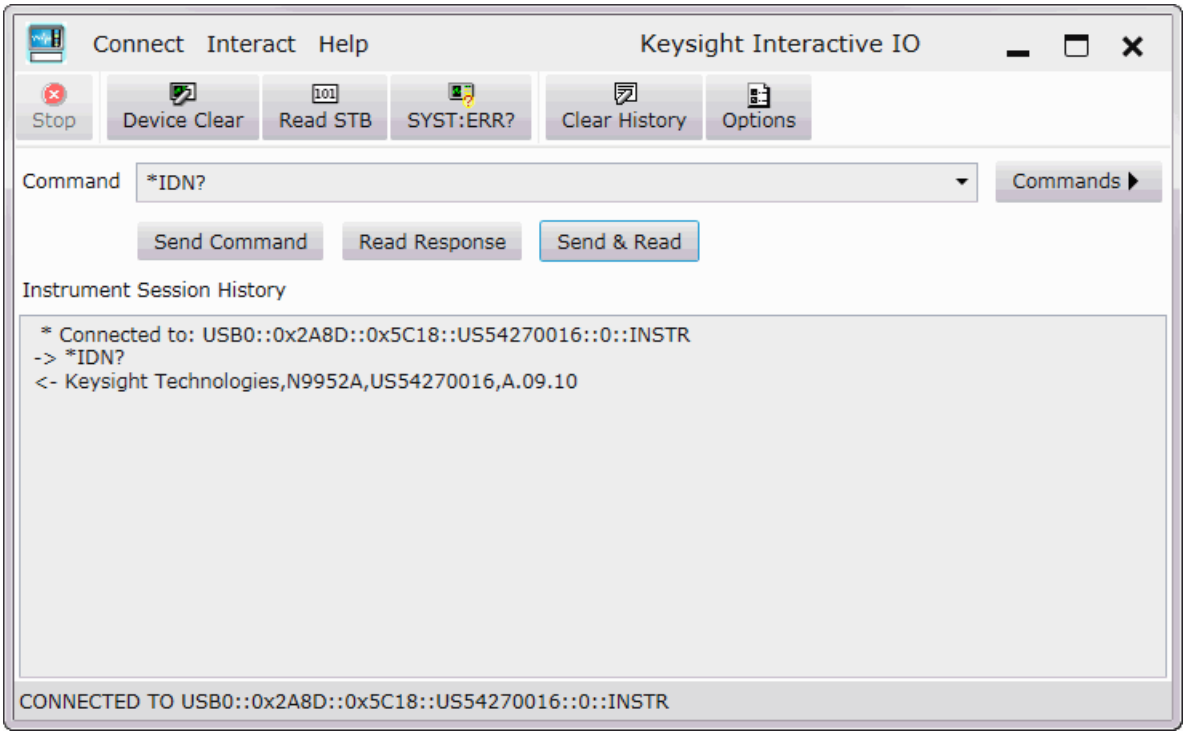
You can connect to USB ports that are not type 2.0 USB. But, the mini-USB port is optimized for a type 2.0 USB ports.

Overview of mini-USB to PC setup for sending SCPI commands and queries:

- Connect a mini-USB (FieldFox device-side) to standard USB (host-PC)
- **On the FieldFox**: Power on the instrument.
- Click **System 7** > **System Diagnostics** > **System Information** and find the FieldFox serial number.
- **On your PC**: Open the **Keysight IO Libraries** software, **Connection Expert** and connect to the FieldFox using the VISA connection. Refer to the Keysight Connection Expert Help.

– In the **Keysight Interactive IO** window: Type in your SCPIs on the Command line and click **Send Command**, **Read Response**, or **Send & Read**. Refer to the Keysight Connection Expert Help and Figure 33-1 on page 886.

Figure 33-1 Keysight Interactive IO Window



34 File Management

The FieldFox can save any of the following types of files:

- Current settings and calibration
- Trace data (*.csv, *.S1P, *.S2P)
- Picture of the FieldFox screen

In addition, files can be saved to the internal memory, a USB Flash drive, or a standard SD card.

In this Chapter

"Save Files" on page 888

"Recall Files" on page 893

"Move (Copy) Files" on page 893

"Set File Type and Select Device" on page 894

"Manage Files" on page 897

"Manage Folders" on page 899

"Edit Keywords" on page 899

"Prefixes and Suffixes for Filenames" on page 900

See Also:

"Erase User Data" on page 880

Saving and Recalling Files

NOTE

FieldFox State files are intended to be recalled on the same instrument model on which they were saved. Sometimes you may able to recall them within model families. An error will result when trying to recall a state file that was saved on a different model family.

The FieldFox model families are:

- N991x (VNA/SA) model family
- N992x (VNA) model family
- N993x (SA) model family
- N995x (VNA/SA) model family
- N996x (SA) model family

Save Files

How to Save a File

1. Press **Save/Recall 9**
2. Then **Save**
3. At the top of the current 'labeler' screen (see following image) check the **File Type** to save and **Device** (Internal, USB, Storage Card) to which the file is saved. Learn how to change these settings in "Set File Type and Select Device" on page 894.
4. Then use the labeler to specify a filename.

CAUTION

If you are having difficulty saving to a USB flash drive, it may be a timing issue. The turn-around time for "file open, write data, file close" to a USB drive is much longer than to FieldFox's internal memory. Alternative methods are:

– Save your content to the FieldFox's internal memory; and then move your files off to a USB flash drive using FTP SCPI programming. Refer to "Move (Copy) Files" on page 893 andto the :MMEM SCPI commands in the FieldFox Programming Guide (via FieldFox Manuals, Firmware, Software and Product Support).

– Save your data to the FieldFox's internal memory, then move the data to a PC using a binary block transfer, and delete the data from the FieldFox's internal memory. An example for transferring an image in the FieldFox Programming Guide (via FieldFox Manuals, Firmware, Software and Product Support).

Please note that the receiving computer program needs to be able to handle the binary block transfer.

See also What Should I Do If My USB Flash Drive Could Not Be Recognized by FieldFox? - Technical Support Knowledge Center Open (keysight.com).

NOTE

Insert only ONE USB flash drive in the FieldFox when saving or copying files.

Saving MATLAB files

NOTE

If you have Option 351 I/Q Analyzer option, you can directly save your data as MATLAB files (*.mat). Refer to Chapter 11, "IQ Analyzer (IQA) – Option 351", on page 301.

If you have the FieldFox's Remote Server mode (89600 VSA software connectivity), you can use the VSA software to capture and record your data as MATLAB files (*.mat). Learn more about FieldFox and 89600 VSA software, refer to Chapter 18, "Remote Server Mode (Requires SA Hardware/SA Option 233)" and to http://rfmw.em.keysight.com/wireless/helpfiles/89600B/WebHelp/89600.htm.

Figure 34-1 I/Q Analyzer Mode (IQA) MATLAB File Save

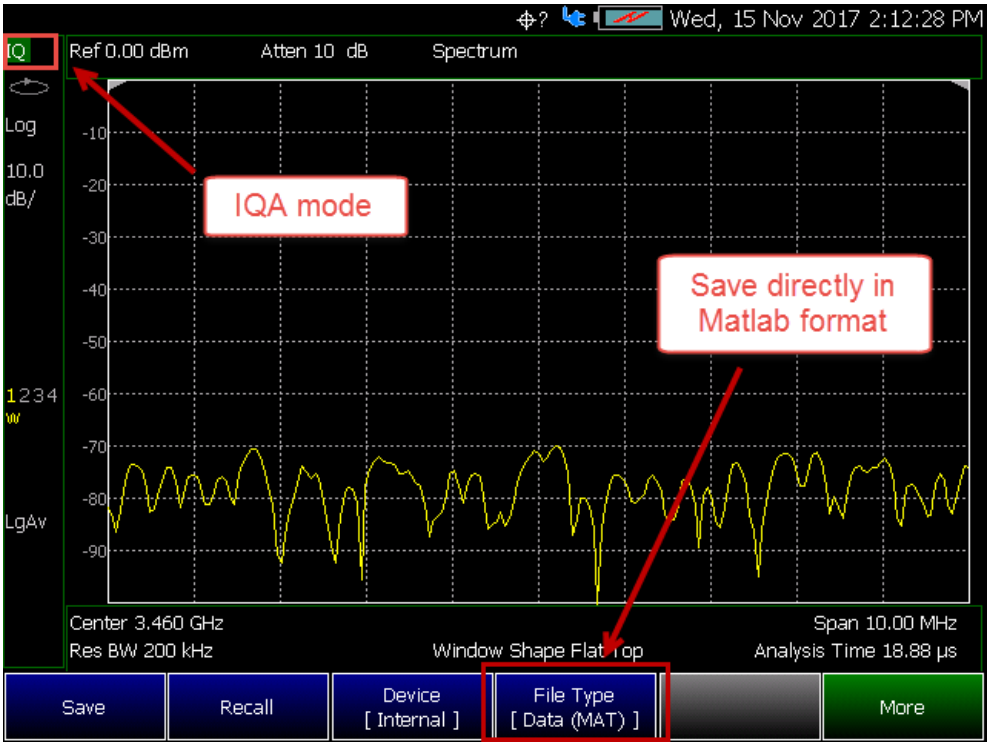
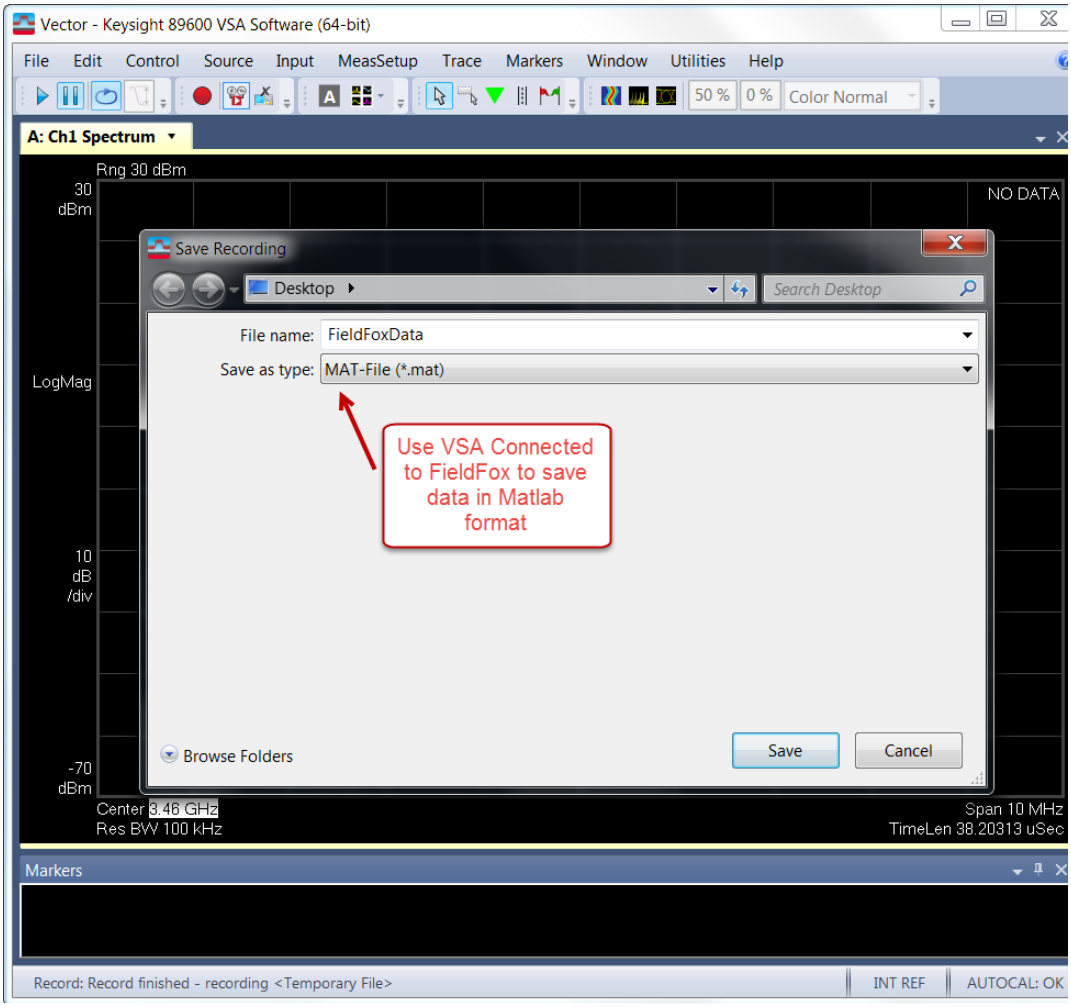


Figure 34-2 VSA Software MATLAB File Save



How to use the FieldFox labeler

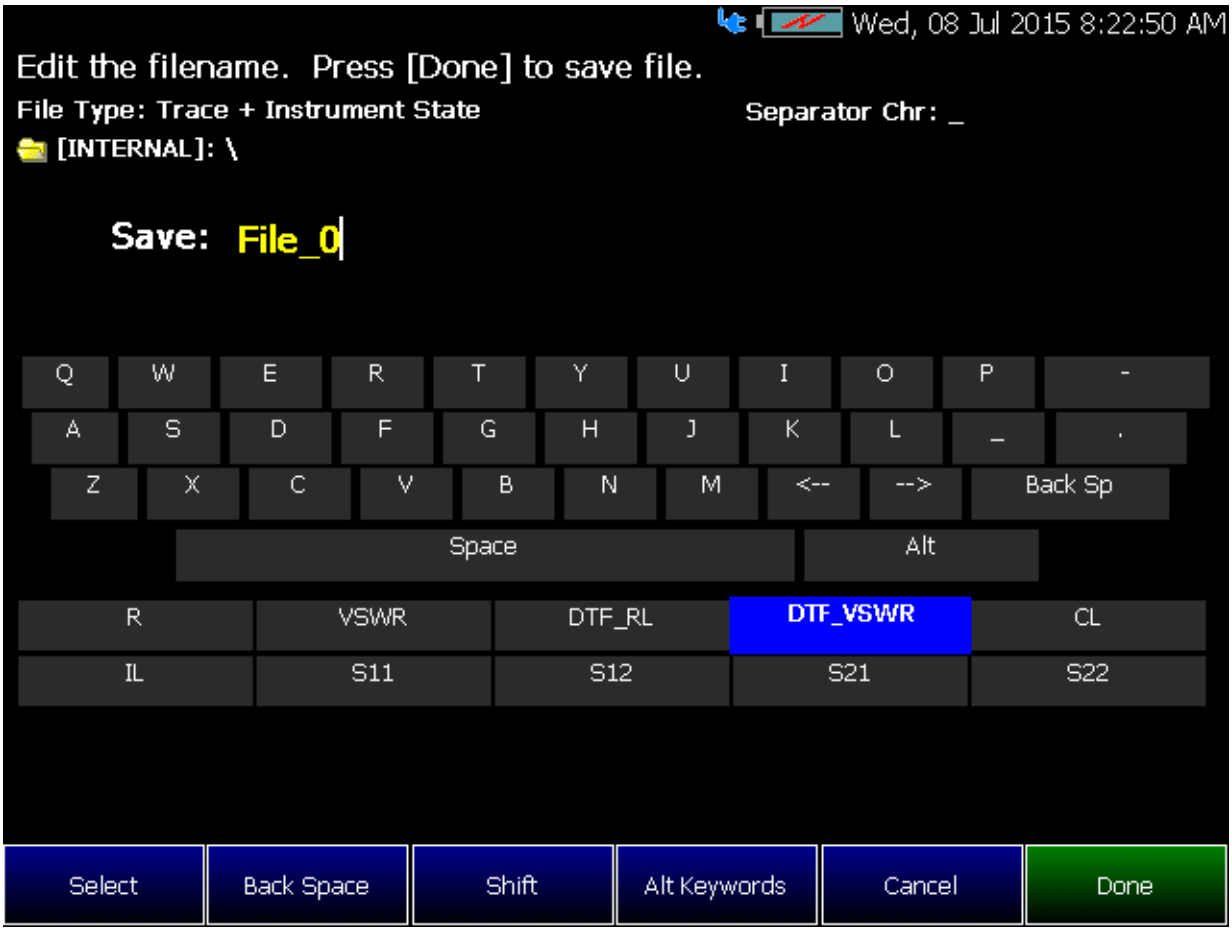
The FieldFox labeler is used to edit or change the current filename. It is also used for many other labeling functions, such as creating a title, prefix, and keyword to display on the FieldFox screen. Learn about Titles in "How to Manage files" on page 897.

- Move the cursor (see section below, How to move the cursor), then press **Select** to add the cursor character to the end of the existing filename.
- **Back Space** to erase the last character(s) from the end of a filename.
- Press **Shift** to toggle keyboard between lower case and upper case characters.
- Press **Alt Keyboards** to display the different keyword choices.

NOTE You can select either an ABC or Qwerty style keyboard. Refer to "Alpha Numeric Editing" on page 859.

The preselected keywords (File, Site, and so forth) can be selected just like a single character. These keywords can also be edited. Learn more in “Edit Keywords” on page 899.

Figure 34-3 The FieldFox labeler



In the graphic above, the current filename is File_0. The cursor is on the custom DTF_VSWR keyword. The file will be saved to USB (flash drive). File Type is “Trace + State” (Instrument State).

How to move the cursor

– Use the rotary knob to move cursor on the same row. The cursor will change rows when it comes to a row end.

– Use the arrows ▲|▼ to move the cursor up and down the rows.

When the current filename is complete

– Press Done to save the file to the specified filename.

– Press Cancel to close the labeler without saving a file.

– If the filename already exists, you are prompted to choose from the following:
  – Press **Yes** to overwrite the existing file.
  – Press **Cancel** to return to edit the filename.

Recall Files

The FieldFox can recall **State** files, **Trace + State** files, and image files.

State Files

ALL FieldFox instrument settings for ALL Modes are saved and recalled in a *.sta file. If error correction is ON in CAT or NA Mode, then calibration data is also saved and recalled.

If error correction is OFF (CalRdy is active), calibration data is NOT saved in the *.sta file. When a Trace + State file is recalled on a FieldFox other than the one it was saved on, differences in the CalRdy calibration data may result in differences between the displayed traces.

Image Files

The FieldFox can open and display *.png, *.jpg, and *.jpeg images.

How to Recall a File

NOTE Before recalling a file, first Select the Device and Location from which the file will be recalled. See the following section for more information.

1. Press **Save/Recall 9**
2. Then **Recall File** or **Enter**
3. Navigate to the file to be recalled using the Up/Down arrow keys ▲|▼.

– Optional: **Sort by Name** to list the current files by name.
– Optional: **Sort by Date** to list the current files by date.
– Optional: **Next Page** if available, to go to the next page of filenames.
– Optional: **Previous Page** if available, to go to the previous page of filenames.

4. Then **Recall File** or **Enter**.
5. **Cancel** to cancel recall file and return to the previous menu.

Move (Copy) Files

The FieldFox can **Move** files (i.e., including **Trace + State** files, and image files).

How to move a file

1. Press **Save/Recall 9**
2. Then **Device** to be copied from (i.e., Internal, SD, or USB). Refer to "Set File Type and Select Device" on page 894.
3. Then **More** > **Manage Files** > **Select Files**
4. Navigate to the file(s) to be copied using the Up/Down arrow keys or the knob.
5. Then **Copy**
   - Select the destination device using the softkeys:
     - **Copy to Internal** Copies to FieldFox's internal memory.
     - **Copy to USB** Copies to a USB memory device.
     - **Copy to SD Card** Copies to a SD/SDHC memory card.
     - **Cancel** to cancel copy file and return to the previous menu
6. Use the close folder icon or the open folder icon to locate the target folder for your files.
7. Then **Do Copy** copies files to selected location and FieldFox displays a confirmation message of a successful file copy.
8. **Cancel** to cancel copy file and return to the previous menu.

Set File Type and Select Device

The following File TYPE and DEVICE settings are used to determine the type of file to save, and the location to be used for all file operations.

These two settings remain through an instrument preset, but are reset to the default values when the FieldFox power is shutdown.

Select Device (location of File Save/Recall)

- Press **Save/Recall 9**
- Then **Device** to set the LOCATION where the file is to be saved, recalled, or moved. Choose from the following:
  - **Internal** Saves/Recalls/Moves (Copies) files to/from the FieldFox internal memory. To specify a folder, first select Manage Folders (learn how in "Manage Folders" on page 899). The Data Link software will read data ONLY from the \UserData folder.
  - **SD Card** Saves/Recalls/Moves (Copies) files to/from the SD card (not included), inserted in the card slot. See "Take the FieldFox Tour" on page 40. Only the root folder is available.

– **USB** Saves/Recalls/Moves (Copies) files to or from a USB Flash drive (not included) that is inserted in one of the USB connectors. Only the root folder is available.

NOTE Insert only ONE USB Flash Drive in the FieldFox when saving or copying files.

How to set File Type

– Press **Save/Recall 9**

– Then **File Type**. Choose one of the following:

– **State** Saves ALL FieldFox instrument settings for ALL Modes to a *.sta file. If a calibration is ON in CAT or NA Mode, calibration data is also saved. This file can be opened ONLY by a FieldFox. State files can be saved between compatible FieldFox models. See note in."Saving and Recalling Files" on page 888.

– **Trace+State** Saves the current trace and instrument settings to a *.sta file. In SA Mode, all traces are saved. This file can be opened ONLY by a FieldFox. When recalled, the FieldFox sweep is set to Hold.

CAUTION When using RTSA, the Density Spectrum information is not saved using Trace+State. Only the last displayed trace settings is saved.

– **Picture (PNG)** Saves a 640 x 453 pixel image of the FieldFox screen to a *.png file. The picture does NOT include the softkeys.

– **Data (csv)** Saves trace data from the current Mode to a *.csv file. This format can be imported into spreadsheet software such as Microsoft Excel. Column A is always the frequency at which the data is measured.

––In **SA Mode**, all visible data traces are saved. Each trace is saved to a separate column that is labeled with the Trace State.

––In **CAT** and **NA** Modes, only the data trace is saved – not the memory trace.

––In **Power Meter** (with Option 208 Frequency Offset Power Sensor (FOPS)), all visible traces are saved. Each trace is saved to a separate column labeled `Output Power` or `Memory`.

––In **VVM** Mode, NO data is saved.

- **Group** Saves a group of file types that have been selected in the Preferences menu. Learn more, see "Group Save File Types Editing" on page 860.
- **Data (S1P) / (S2P)** Saves **CAT** and **NA** Mode trace data to an *.S1P or *.S2P file, depending on the active measurement. This file format is used by CAE programs such as Keysight's Microwave Design System (MDS) and Advanced Design System (ADS). It can also be imported into spreadsheet software such as Microsoft Excel.

About SNP Files

The SNP file includes header information, and the following data:

- S1P - saves 1-port (receiver) data for the active data trace. *.s1p Files contain 1 stimulus value and 1 S-parameter (total of 3 scalar values) **Stim Real(Sxx) Imag(Sxx)**
- S2P (NA Mode ONLY) - saves 2-port data for the active trace. *.s2p **Files** contain 1 stimulus value and 4 S-parameters (total of 9 scalar values) **Stim Real(S11) Imag(S11) Real(S21) Imag(S21) Real(S12) Imag(S12) Real(S22) Imag(S22)**
- Only data traces are saved – not memory traces.

Corrections

- When parameters are corrected, data is returned even when not displayed. Data is returned with the correction type that is applied for each S-parameter. The correction type for each S-parameter is annotated in the header.
- When parameters are NOT corrected or displayed:
  - With Smith chart and Polar formats, Real/Imag zero-filled data appears as (1.0, 0.0).
  - With all other formats, LogMag/Phase zero-filled data appears as (0.0, 0.0).

› Display formats

In CAT Mode, S1P files are always Magnitude (dB) / Phase (angle) format.

In NA Mode:

- Smith chart and Polar display formats are ALWAYS saved in Real/Imag data pairs.
- All other display formats are saved in LogMag/Phase (dbAngle).

> What Data Processing functions are included in saved SNP Data:

In NA Mode, the data processing functions (such as trace math) that are included in the SNP data depends on a Preference setting. Click **System**, then **Preferences**, then **Preferences**, then scroll to **NA**, **SNP File Save**, then select from the following:

- **Default** – SNP data does NOT include smoothing. SNP data saves are taken AFTER data processing (location 2) on the processing chain.
- **Advanced** – SNP data includes the following:
  - With Smith or Polar display format, SNP data saves are taken BEFORE most processing (location 1 on the data processing chain).
  - With any other display format, SNP data saves are taken just AFTER Formatting and Smoothing is applied (location 3 on the data processing chain). For each non-active trace, SNP trace data is reprocessed using the data processing chain of the active trace.

See the FieldFox data processing chain at the Supplemental Online Help: https://rfmw.em.keysight.com/wireless/helpfiles/FieldFoxOnlineSupplementalHelp/Home.htm. Learn more about System Preferences in "Preferences" on page 850.

Manage Files

Files that are stored in the FieldFox internal memory, standard SD card, and USB Flash drive, can be copied to another device or deleted.

How to Manage files

1. Press **Save/Recall 9**
2. Then **Device** to select the location (Internal, USB, standard SD Card, or CD Drive) of the file to copy or delete.

NOTE When selecting Internal, it may also be necessary to first select Manage Folders to specify an active folder which contains the files to copy or delete. Refer to "Manage Folders" on page 899.

3. Then **More** > **Manage Files**
4. Then choose from the following:

- **Select Files** Selects a file or files to sort, copy, or delete.
- **Sort**
  - **Sort by Name** Sorts the displayed list of files by name.
  - **Sort by Date** Sorts the displayed list of files by date.
- **Copy** Select a file or files to copy.

– Then select a device to copy the file to. Choose from **Copy to Internal**, **Copy to USB** (must be inserted), or **Copy to SD Card** (must be inserted).
– **Do Copy** to complete the file copy to the media/folder selected.

NOTE **Copy** can be done to any FieldFox internal folder, standard SD folder, or USB storage device.

– **Delete**
  – **Yes** The selected file is deleted.
  – **Cancel** To cancel Delete and return to previous menu.
– **More**
  – **Select Files** Selects a file or files to sort, copy, or delete.
  – **Select All** selects all of the displayed files. All files that are displayed are to be copied. Then select a device and a folder to copy the file to. Choose from Internal, USB (must be inserted), SD Card (must be inserted), or CD Drive (must be inserted).
  – **Clear All** Deselects all of the displayed files.
  – **Rename Files**

NOTE "How to use the FieldFox labeler " on page 891 and "Prefixes and Suffixes for Filenames" on page 900.

  – Enter the string in the filename or filenames that are to be replaced.

NOTE **String to Replace** is case sensitive.

  – **Replace With** Enter the string that is to be replaced by the characters entered with the String to Replace softkey.
  – **Prefix** Enter a prefix (one time) that the current filename or filenames are to be renamed. To add a prefix to subsequent filenames (persistent), refer to How to edit the Prefix and Suffix (Auto Append) in "How to edit the Prefix and Suffix (Auto Append)" on page 901.
  – **Suffix** Enter a suffix that the current filename or filenames are to be renamed.
  – **Do Rename** Enable renaming of the current file or files.

NOTE Insert only ONE USB Flash Drive in the FieldFox when saving or copying files.

Manage Folders

You can create new folders, delete old folders, and select the active folder to which files can be saved. The Parent folder [..] is listed when not in the root directory.

Creating and Managing Folders

1. Press Save/Recall 9 > More > Manage Folders
2. Then choose from the following:
   - Change Folder Changes the active folder to which files can be saved. The active device and current folder is displayed at the top of the screen, and below, a list of files in that folder. Use the ▲▼ arrows to highlight a folder within the current folder. Each time the **Change Folder** softkey is pressed, the highlighted folder becomes the active folder.
   - Create Folder A new folder is created in the current folder. Select a name for the new folder from one of the displayed keywords: You can change these keywords using the following **Edit Keywords** function. Refer to Edit Keywords in "Edit Keywords" on page 899.
   - Delete Folder The **selected** folder and its contents are deleted after a warning prompt is displayed. A "Parent" folder or system folder can NOT be deleted.
   - Copy Folder The **selected** folder and its contents are copied and a message is displayed telling you that the copy was successful.
     - Then select a device to copy the folder to. Choose from Copy to Internal, Copy to USB (must be inserted), or Copy to SD Card (must be inserted).
     - Do Copy to complete the file copy to the media/folder selected.
   - Rename The rename folder menu opens and the selected folder's title is displayed and available for editing.

NOTE For more on renaming folders/files, refer to "How to use the FieldFox labeler " on page 891, and "Prefixes and Suffixes for Filenames" on page 900.

   - Press Exit when finished.

Edit Keywords

The preselected keywords (FILE, SITE, and so forth) can be edited to meet your specific needs. Your keywords will remain in the FieldFox until you change them. Keywords are limited to 30 characters.

How to edit keywords

1. Press **Save/Recall 9** > **More** > **Edit Keywords**
2. Then **Next Page** and **Previous Page** to view all keywords.

– Use the ▲|▼ arrows to select a keyword to edit.

– When a keyword is selected, then press **Edit**.

– Then choose from the following:

  – Press **Select** to add the cursor character to the end of the selected keyword.

  – Press **Backspace** to erase the last character from the end of the selected keyword.

  – Press **Shift** to change from upper-case to lower-case and vice versa.

  – Press **Alt Keywords** to toggle through different keyword choices.

How to move the cursor:

– Use the rotary knob to move the cursor along the same row. The cursor will change rows when it comes to a row end.

– Use the ▲|▼ arrows to move the cursor up and down between rows.

When the selected keyword is complete:

– Press **Done** to save all keywords and close the Edit Keywords labeler. These keywords will exist on the FieldFox until changed.

– Press **Cancel** to close the labeler without saving changes.

Prefixes and Suffixes for Filenames

The prefix and suffix (Auto Append) can be used together to organize files. Once set and enabled, they are automatically entered as the beginning (Prefix) and end (Suffix - using Auto Append) of a filename when performing a Save operation. These settings are persistent, until disabled. Refer to "How to edit the Prefix and Suffix (Auto Append)" on page 901 and "How to enable/disable Auto Append (Number and Date)" on page 903.

NOTE

If you are only interested in adding a prefix or a suffix to a new file or files one time, refer to "Manage Files" on page 897.

File–Save Naming Options are settings are persistent through Preset and power cycling (e.g., Prefix, Auto Append).

This section contains the following sections:

– "How to edit the Prefix and Suffix (Auto Append)" on page 901.

- "How to move the cursor" on page 892.
- "When the Prefix is complete" on page 902.
- "How to enable/disable Auto Append (Number and Date)" on page 903.

How to edit the Prefix and Suffix (Auto Append)

If you want to edit a prefix on a finite set of files one time, refer to "Manage Files" on page 897.

- Press **Save/Recall 9** > **More** > **Prefix Suffix**
- **Auto Append** (Suffix)
  - **OFF** (default) to disable Auto Append.
  - **Number** to auto-append a number using format "nnnn" sequentially to all saved files (default).
  - **Date** to auto-append a date and time using format "YYYY-MM-DD.HH.MM.SS" sequentially to all saved files.
- **Prefix/Suffix**
  - **OFF** (default) to disable the prefix/suffix. The Edit Prefix, Edit Number, and Edit Suffix softkeys are grayed out (inactive). Refer to "How to enable/disable the Prefix/Suffix (persistent)" on page 902.
  - **Last File** to use the last filename saved, as your filename for subsequent saved filenames. The Edit Prefix, Auto Append, Edit Number, and Edit Suffix softkeys are grayed out (inactive).
  - **User** to use the user-selected prefix. All softkeys are active, unless Auto Append is disabled, then Edit Number Suffix is grayed out (inactive). Learn more, see "How to enable/disable the Prefix/Suffix (persistent)" on page 902 and "How to enable/disable Auto Append (Number and Date)" on page 903.
- **Edit Prefix** – the last Prefix used in saving a file is displayed (default == CustomPre).

  Couplings: For the softkey to be active, Prefix/Suffix == MyFilePrefix.
  - Then choose from the following:
    - **Select** to add the cursor character to the end of the Prefix.
    - **Back Space** to delete the last character(s) from the end of the prefix.
    - **Shift** to toggle between capital letters and lower case letters.
    - **Alt Keywords** to display the different preselected keywords (File, Site, and so forth) can be selected just like a single character. These keywords can also be edited. See Edit Keywords.

——**Cancel** to cancel edits and return to the previous menu.

—— **Done** to save changes and return to previous softkey menu.

– **Edit Number Suffix** – Sets the Auto Append number suffix formatting (e.g., "0001").

Couplings: Auto Append must be set to "Number". This softkey is inactive (grayed out) when Auto Append == Date.

– **Edit Suffix** to edit the suffix using the labeler. For more information on the Edit Suffix softkey menu refer to the **Edit Prefix** softkey menu descriptions above. (Default == UserSuffix).

Couplings: For this softkey to be active, the Prefix/Suffix softkey must be set to "User". Learn more, see "Preferences" on page 850 and to "File Saving Naming Options" on page 859.

– **Back** to return to the previous menu.

NOTE

When Last File is selected, the Edit Prefix, Auto Append, Edit Number Suffix, and Edit Suffix softkeys are grayed out (inactive). Refer to "Prefixes and Suffixes for Filenames" on page 900.

How to move the cursor

– Use the rotary knob to move cursor on the same row.

– Use the ▲|▼ arrows to move the cursor up and down the rows.

When the Prefix is complete

– Press **Done** to save the Prefix and close the labeler. This Prefix will exist on the FieldFox until it is changed.

– Press **Cancel** to close the labeler without saving changes.

When the Suffix is complete

– Press **Done Edit** to save the Suffix and close the labeler. This Suffix will exist on the FieldFox until it is changed (i.e., with subsequent increments).

– Press **Cancel** to close the labeler without saving changes.

How to enable/disable the Prefix/Suffix (persistent)

1. Press **Save/Recall 9** > **More** > **Prefix Suffix**
2. Then **Prefix/Suffix**
   – **OFF** (default) to disable the prefix and suffix on subsequently saved files. Edit Prefix and Edit Suffix softkeys are grayed out (inactive).

How to enable/disable Auto Append (Number and Date)

1. Press **Save/Recall 9** > **More** > **Prefix Suffix**
2. Then **Auto Append**
   - **OFF** (default) to disable the Auto Append (number suffix) on subsequently saved files. The Edit Number Suffix softkey is grayed out (inactive).

Press Printing

The current screen or selected files can be printed using a PCL-compatible printer (like older HP Deskjet printer) connected to one of the FieldFox USB ports. Newer PCL3GUI photo and all-in-one printers are NOT supported.

Measurements can also be printed using the FieldFox Data Link software.

How to print the current screen or a saved file

To save ink, first select an outdoor (white background) display color. Learn how in "Display Colors" on page 840.

1. Connect the printer to a FieldFox USB port. **The print softkey will appear ONLY when a compatible printer is connected**.
2. Then press **Save/Recall 9**
3. Then **Print** and choose from the following:
   - **Printer & Page\nSetup** - Confirm that the printer is connected and configured properly. The Status line should read "Ready'.
4. Make other print settings as desired.
   a. **Select Files\nfor Printing** - Print up to 16 *.PNG images on one page that are stored on the Internal drive. Images can NOT be printed from the USB and SD card.
   b. Edit the Quick Settings table to select up to FOUR Rows and FOUR Columns for up to 16 total images to be printed on a single page.
   c. If necessary, edit the filenames to be printed.
   d. Select **Done**. Then **Print Selected\nFiles** to begin printing.
      - **Print Current Screen** – Immediately prints the FieldFox screen using the selected Printer and Page Setup settings.

35 Working with the Lithium-Ion Battery

In this Chapter

"Viewing the Battery Charge Status" on page 906
"Charging the Battery" on page 907
"Reconditioning Battery" on page 910
"Battery Care" on page 910
"Maximizing Battery Life" on page 910
"Lithium-Ion Battery Disposal" on page 911

See Also:

"Install the Lithium-Ion Battery" on page 32
"To conserve battery power:" on page 33
"For the Battery" on page 918

Viewing the Battery Charge Status

You can view the battery charge status in the following ways:

- Icons in the upper right of the front panel screen.
- Battery screen - select System then Service Diagnostics then Battery.
- Built-in battery gauge. Learn more in the following section.

Table 35-1 Front Panel Icons

Icon	Status
	Connected to external power through the AC/DC adapter. Battery installed and charging. The amount of charge is indicated by the number of bars shown.
	Battery not charging with 84% battery life remaining.
	Battery fully charged. A fully charged battery MAY NOT read 100%.

Service Diagnostics—Battery Screen

The Battery screen displays the following information. To access the screen, select System then Service Diagnostics then Battery.

Additional battery information is available using SCPI commands.

1. **Status** – Fully charged, No battery, Charging, Empty, or Discharging.
2. **External DC Supply** – ON or OFF indicates if an external DC supply is connected.
3. **Battery Present** – ON or OFF indicates if a battery is installed.

NOTE Items 4 through 8 are read directly from the battery. The information is based on the battery's internal sensors and memory.

1. **Voltage** – measured by the battery's sensor.
2. **Current** – amount of current being consumed when operating from internal battery. If battery is charging, indicates amount of charging current.
3. **Battery Temperature** – internal temperature of the battery as measured by a sensor embedded in the battery.
4. **Present Run Time to Empty** – minutes of power remaining based on amount of current being used now.

5. **Charge Cycles** – number of charge cycles the battery has experienced. Charge cycle defined as ≥80% change in relative state of charge.

Built-In Battery Gauge

Each lithium ion battery has an LED gauge that displays its charge status. The gauge is active unless the battery is in shut down mode.

To view the LED gauge, open the FieldFox battery compartment door, remove the battery, then press the button on the battery.

The battery in your FieldFox will have either 4 or 5 LED segments.

5-segment Gauge	Charge Remaining	4-segment Gauge	Charge Remaining
5 segments	≥80%	4 segments	≥75%
4 segments	60% to 79%	3 segments	50%,to 74%
3 segments	40% to 59%	2 segments	25% to 49%
2 segments	20% to 39%	1 segment	< 25%
1 segment	< 20%		

Charging the Battery

When you receive your FieldFox, the lithium-ion battery is partially charged to approximately 30% to 40% to preserve battery life. Allow four hours to fully charge the battery internally, or three and a half hours () by using the external battery charger (N9910X–872). A fully charged battery will power your FieldFox for about four hours. Upon receiving your FieldFox, it is NOT necessary to charge your FieldFox's battery before using your instrument.

The FieldFox circuitry ALWAYS prevents the battery from discharging to a level that is damaging. However, if the battery is completely discharged, the FieldFox may not turn ON. If this occurs, the battery can still be charged either internally or externally.

Because a lithium-ion battery has no memory effect, you can charge a battery at any time regardless of the current charge status.

Internal Charging with the AC/DC Adapter

NOTE

Read the safety information in "For the AC/DC Adapter" on page 916.

Internal charging time for a fully depleted battery is approximately 4 hours with the FieldFox either ON or OFF.

Figure 35-1 AC/DC Adapter

To charge a battery inside the FieldFox, insert the AC/DC adapter plug into the Power connector on the FieldFox side panel, then plug the adapter into an AC outlet.

- FieldFox ON: Charging is indicated by a battery icon in the upper right of the front panel screen.
- FieldFox OFF: Charging is indicated by the FieldFox power LED glowing amber, with its intensity increasing from dim to bright every few seconds. This pattern repeats until the LED turns off when charging is done. Learn more on "Front Panel" on page 40.

Using the External Battery Charger (N9910X–872)

NOTE Read the safety information in "For the External Battery Charger (N9910X-872)" on page 917.

Figure 35-2 External Battery Charger (N9910X-872)

The external battery charger (N9910X–872), lets you charge a fully depleted battery in approximately three hours. It is a two bay, level–3 stand-alone battery charger that is compliant with the standard Smart Battery System. The two bays are charged sequentially on a first-come, first-served basis, though a discharge can be performed in the left bay while the right bay is charging.

External Battery Charger LED	Charging Status
Green	Fully charged
Green flashing	Fast charging
Yellow flashing	Reconditioning – the accuracy of the battery's internal LED charge gauge is being renewed. See "Reconditioning Battery" on page 910
Yellow/green	Battery is reconditioned
Red flashing	Error
Yellow	Standby

For more information, refer to the Instruction Manual included with the external battery charger.

Reconditioning Battery

Reconditioning a battery can be performed ONLY with the External Battery Charger (N9910X–872).

1. Insert a battery into the left bay of the external charger.
2. Press the button labeled Push to Recalibrate Left Battery Bay
3. The charger will charge the battery fully, discharge it completely, then recharge it fully again. The entire process can take up to 12 hours.
4. Install the battery into the FieldFox.
5. On the System, Battery screen, verify that the battery is fully charged.

Battery Care

Visually inspect the battery periodically for signs of degradation, such as swelling, cracking of the battery shell, or leakage of fluid. If degradation occurs, replace the battery and dispose of it properly. Refer to "Lithium-Ion Battery Disposal" on page 911. Operation with a degraded battery could result in damage to the FieldFox.

Maximizing Battery Life

- If AC power is not continuously available (Ex: in a field environment), use the battery and recharge it when it holds a 20% to 50% charge, as shown on the screen's battery charge icon. At this charge level, 2 or 3 segments show on the battery gauge.
- If the FieldFox is not going to be used for more than a week, remove the battery. Best practice is to store the battery with a charge of about 50%. At this charge level, 3 segments show on the battery gauge.
- Allow a battery to warm to room temperature before charging it. Temperature shock can damage the battery chemistry and in some cases cause a short circuit.
- Store batteries in a cool, dry location, away from metal objects and corrosive gases.
  Storage temperature limits (20% to 50% relative charge is recommended):
  Transportation: –20°C to 50°C
  Within 1 month: –20°C to 45°C
  Within 6 months: –20°C to 40°C
  Within 1 year: –20°C to 35°C

– Battery charging limits:
  Charge temperature: 0°C to 45°C (<10°C slows charge on some batteries)
  Discharge temperature: –10°C to 60°C

– Operate the FieldFox on battery power between the ambient temperatures of –10 and +50°C (–14 to +122°F). Using the battery at lower or higher temperatures can damage it and reduce operating life. Cold temperatures affect battery chemistry, reducing charge capacity, especially below 0°C (32°F).

Lithium-Ion Battery Disposal

When you notice a large decrease in charge capacity after proper recharging, it's probably time to replace the battery.

Lithium-Ion batteries need to be disposed of properly. Contact your local waste management facility for information regarding environmentally sound collection, recycling, and disposal of the batteries. Regulations vary for different countries. Dispose of the battery in accordance with local regulations.

Keysight Technologies, through Rechargeable Battery Recycling Corporation (RBRC), offers free and convenient battery recycling options in the U.S. and Canada. Contact RBRC at 877-2-RECYCLE (877.273.2925) or online at: http://www.call2recycle.org/ for the nearest recycling location.

36 Safety Considerations

Keysight has designed and tested the FieldFox in accordance with IEC Publication 61010-1Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use, and the FieldFox is supplied in a safe condition. The FieldFox is also designed for use in Installation Category II and pollution Degree 2 per IEC 61010-1. Read the following safety notices carefully before you start to use this FieldFox to ensure safe operation and to maintain the product in a safe condition.

NOTE The input terminals for this product are classified as Measurement Category None.

For the FieldFox

WARNING No operator serviceable parts inside except for the lithium-ion battery. Refer servicing to qualified personnel. To prevent electrical shock do not remove covers.

WARNING If this product is not used as specified, the protection provided by the equipment could be impaired. This product must be used in a normal condition (in which all means for protection are intact) when attached to the AC–DC adapter.

WARNING The unit may be used only in the operating conditions and positions specified by the manufacturer.

WARNING Do not install substitute parts or perform any unauthorized modification to the product. Return the product to Keysight Technologies or a designated repair center for service to ensure that safety features are maintained.

WARNING Applicable local or national safety regulations and rules for the prevention of accidents must be observed in all work performed.

WARNING Ensure that the connections with information technology equipment comply with IEC950 / EN60950.

WARNING Observe all ratings and markings of the instrument before connecting the instrument.

Maximum Input Voltages and Power:

RF Output Connector: 50V DC, +23 dBm RF

Ext Trig/Ref Connector: 5.5 V DC

RF Input:

+27 dBm RF, ±50 VDC Max. (N991xA/B, N9925B, N9926A, N9928A, N993xA/B)

+23 dBm RF, ±50 VDC Max. (N9923A, N9923AN)

+25 dBm RF, ±40 VDC Max. (N995xA/B, N996xA/B)

DC Input: 19VDC, 4ADC

Learn more about Maximum power and voltages in the FieldFox Data Sheet. Refer to https://www.keysight.com/us/en/assets/7018-03314/data-sheets/5990-9783.pdf.

WARNING	When performing a measurement, ensure that the right safety and performance ratings of the instrument and accessories are used. Do not expose the circuit or operate the instrument without its cover or while power is being supplied. Do not operate the instrument in any environment at risk of explosion.
WARNING	Only Keysight approved accessories shall be used.
WARNING	Cleaning connectors with alcohol shall only be done with the instruments power cord removed, and in a well-ventilated area. Allow all residual alcohol moisture to evaporate and the fumes to dissipate prior to energizing the instrument.
CAUTION	The power cord and connectors shall be compatible with the connector used in the premise electrical system. Failure to ensure adequate earth grounding by not using the correct components may cause product damage and serious injury.
CAUTION	The measuring terminals on this instrument are designed to be used with external signals described in Measurement Category NONE, but NOT with external signals described in Categories II, III, and IV. The input of this instrument cannot be connected to the mains.
CAUTION	It is not recommended to operate the FieldFox when it is laying on its back on a table top or other flat surface, with the kickstand folded in. The cooling is less effective when the FieldFox is placed lying down flat on back of the instrument.
CAUTION	Use original packaging or comparable for shipping or transporting the instrument.

For the AC/DC Adapter

WARNING	Use only the designated AC/DC adapter supplied with the instrument.
WARNING	Use only the designated power cord supplied with the AC/DC adapter.
WARNING	Operated at an ambient temperature: 0 to 40°C; full power rating; derate linearly at a rate of 3 watts per degree C, from 90W at 40°C to 45W at 55°C, 30W at –20°C. Input: 100-240 VAC, 1.5-0.75A, 50-60 Hz Output: 15 VDC, 6A
WARNING	To prevent electrical shock, disconnect the AC to DC adapter from the mains before cleaning. Use a dry cloth or one slightly dampened with water to clean the external case parts. Do not attempt to clean internally.
WARNING	When the FieldFox is connected to the AC/DC adapter, position the adapter so the power cord is readily accessible. The power cord is the disconnecting device. It removes main power to the AC/DC adapter. The FieldFox front panel switch is only for the DC power within the instrument, and not for the AC/DC adapter. Alternately, an AC switch or circuit breaker (which is readily identifiable and is easily reached by the operator) may be installed and used as a disconnecting device to remove mains power from the AC/DC adapter.
WARNING	To avoid overheating, always disconnect the FieldFox from the AC/DC adapter before storing the FieldFox in the backpack. If you prefer to leave the FieldFox connected to the AC/DC adapter while inside the backpack, you can disconnect the AC/DC adapter from its AC power source to prevent overheating.
WARNING	Safety of any system incorporating the equipment is the responsibility of the assembler of the system.
WARNING	This is a Safety Protection Class I Product (provided with a protective earthing ground incorporated in the power cord). The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. Any interruption of the protective conductor inside or outside of the product is likely to make the product dangerous. Intentional interruption is prohibited.

CAUTION The AC/DC adapter has an auto–ranging line voltage input – be sure the supply voltage is within the specified range and voltage fluctuations do not to exceed 10 percent of the nominal supply voltage.

CAUTION The AC/DC adapter is for indoor use only.

CAUTION Never use a modified or damaged charger. Use the original AC–DC adapter ONLY.

CAUTION The AC/DC adapter is designed for use in Installation Category II and Pollution Degree 2 per IEC 61010-1.

CAUTION The instrument can operate with mains supply voltage fluctuations up to ±10% of the nominal voltage.

Samples of this product have been type tested in accordance with the Keysight Environmental Test Manual and verified to be robust against the environmental stresses of Storage, Transportation and End-use; those stresses include but are not limited to temperature, humidity, shock, vibration, altitude and power line conditions. Test Methods are aligned with IEC 60068-2 and levels are similar to MIL-PRF-28800F Class 3.

For the External Battery Charger (N9910X-872)

CAUTION If charging batteries externally, use the optional external charger available from Keysight, or another SMBus charger of level II or higher.

Never use a non–SMBus charger because the battery issues commands over the SMBus to the charger to control the charge rate and voltage.

Never use a modified or damaged charger.

External AC/DC power supply, U.S. FCC compliance

Meets the required verification equipment authorization rules.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

For the Battery

Lithium battery packs may get hot, explode, or ignite and cause serious injury if exposed to abuse conditions.

This section contains the following:

– "High Capacity Lithium Battery (N9910X-876)"
– "Standard Capacity Battery (N9910X-870)"

High Capacity Lithium Battery (N9910X-876)

Lithium battery (High Capacity): N9910X-876 (battery Keysight part number: 1420-0937) is used to provide power to a family of portable microwave test instruments produced by Keysight Technologies. Be sure to follow these safety warnings:

External battery, U.S. FCC compliance	Battery storage:
	The only instructions related to storage have to do with temperature and are listed below – "Temperature (1 month): -20°C to +45°C – "Temperature (6 month): -20°C to +40°C – "Temperature (12 month): -20°C to +35°C
Rating:	10.8V 6400mAh 70Wh

WARNING

Lithium–ion batteries:

– Must not be exposed to high temperatures (>70°C) or fire.
– Must be kept away from children.
– Must not be short circuited.
– Must be replaced only with Keysight qualified Li–ion batteries.
– If replaced or charged improperly, there is a danger of explosion.

WARNING

Do not connect the positive terminal and negative terminal of the battery to each other with any metal object (such as wire).

WARNING

Do not carry or store the battery with necklaces, hairpins, or other metal objects.

WARNING

Do not pierce the battery with nails, strike the battery with a hammer, step on the battery, or otherwise subject it to strong impacts or shocks.

WARNING	Do not solder directly onto the battery.
WARNING	Do not expose the battery to water or salt water, or allow the battery to get wet.
WARNING	Do not disassemble or modify the battery. The battery contains safety and protection devices, which if damaged, may cause the battery to generate heat, explode, or ignite.
WARNING	Do not place the battery in direct sunlight, or use or store the battery inside cars in hot weather. Doing so may cause the battery to generate heat, explode, or ignite. Using the battery in this manner may also result in a loss of performance and a shortened life expectancy.
WARNING	There is a danger of explosion if the battery is incorrectly replaced. Replace only with the same or equivalent type of battery recommended. Discard used batteries according to manufacturer's instructions.
WARNING	If you are charging the batteries internally, even while the FieldFox is powered off, the FieldFox may become warm. Allow for proper ventilation. Do NOT run the FieldFox with the vents blocked or in the carrying case.
WARNING	Do not discharge the battery using any device except the FieldFox or the external battery charger (N9910X–872). When the battery is used in a device other than those specified, it may damage the battery or reduce its life expectancy. If the device causes an abnormal current to flow, it may cause the battery to become hot, explode, or ignite and cause serious injury. The external battery charger discharges during recalibration.
WARNING	For a Korean battery safety consideration translation, refer to Appendix D:, "Korean Battery Safety Translation."
WARNING	For a Russian battery safety consideration translation, refer to Appendix E:, "Russian Battery Safety Translation."
WARNING	The external battery is not rated for use in a wet location. Do not use the external battery in a wet location.

Standard Capacity Battery (N9910X-870)

WARNING

Lithium–ion batteries:

- Must not be exposed to high temperatures (>70°C) or fire.
- Must be kept away from children.
- Must not be short circuited.
- Must be replaced only with Keysight qualified Li–ion batteries.
- If replaced or charged improperly, there is a danger of explosion.

WARNING

Do not connect the positive terminal and negative terminal of the battery to each other with any metal object (such as wire).

WARNING

Do not carry or store the battery with necklaces, hairpins, or other metal objects.

WARNING

Do not pierce the battery with nails, strike the battery with a hammer, step on the battery, or otherwise subject it to strong impacts or shocks.

WARNING

Do not solder directly onto the battery.

WARNING

Do not expose the battery to water or salt water, or allow the battery to get wet.

WARNING

Do not disassemble or modify the battery. The battery contains safety and protection devices, which if damaged, may cause the battery to generate heat, explode, or ignite.

WARNING

Do not place the battery in direct sunlight, or use or store the battery inside cars in hot weather. Doing so may cause the battery to generate heat, explode, or ignite. Using the battery in this manner may also result in a loss of performance and a shortened life expectancy.

WARNING

There is a danger of explosion if the battery is incorrectly replaced. Replace only with the same or equivalent type of battery recommended. Discard used batteries according to manufacturer's instructions.

WARNING

If you are charging the batteries internally, even while the FieldFox is powered off, the FieldFox may become warm. Allow for proper ventilation.

WARNING	Do not discharge the battery using any device except the FieldFox or the external battery charger (N9910X–872). When the battery is used in a device other than those specified, it may damage the battery or reduce its life expectancy. If the device causes an abnormal current to flow, it may cause the battery to become hot, explode, or ignite and cause serious injury.
WARNING	For a Korean battery safety consideration translation, refer to Appendix D:, “Korean Battery Safety Translation.”
WARNING	For a Russian battery safety consideration translation, refer to Appendix E:, “Russian Battery Safety Translation.”

Battery Protective Functions

This section contains the following:

– "Battery Protective Functions (N9910X-876)"
– "Battery Protective Functions (N9910X-870)" on page 924

Battery Protective Functions (N9910X-876)

The following protective functions are designed into the lithium-ion rechargeable battery system used in FieldFox.

The protective functions can be divided between two categories: active and passive. Active protection refers to the type of protection that depends on at least two or more protection devices working together to enable the protection Passive protection refers to the type of protection that is always enabled independent of any other protection device.

Active Protection

Primary Overcharge Voltage: This prevents the battery from being charged if the voltage across any cell exceeds approximately 4.25 V per cell. Once the overcharge protection is tripped, the voltage across each cell must drop below approximately 4.10 V to reset the protection and permit charging.

Overdischarge Voltage: This prevents the battery from discharging if the voltage across any cell drops below approximately 2.5 V. Once the overdischarge voltage protection is tripped, the voltage across each cell must be charged to approximately 3 V to reset the protection and permit discharging.

Primary Overcharge Current: This prevents the battery from being charged if the average charging current reaches or exceeds 3.3A for a time period of 5 seconds or more.

Primary Overdischarge Current: This prevents the battery from being discharged if the average current out of the battery reaches or exceeds 7A for a time period of 5 seconds or more. This protection can be reset by removing the load.

Short Circuit Protection: This prevents the battery from being charged or discharged and protects against damage or lost data if the current in or out of the battery reaches or exceeds 33.3A for a time period of 274.5 microseconds or more. This protection can be reset by removing the load.

Overtemperature Charging: The system microcontroller prevents the battery from being charged if the cell temperature exceeds 48C. Once the overtemperature charging protection is tripped, the cell temperature has to drop to or below 43C to reset the protection and permit charging.

Overtemperature Discharging: The system microcontroller prevents the battery from being discharged if the cell temperature exceeds 67C. Once the overtemperature discharging protection is tripped, the battery is automatically shut off which results in turning off the instrument as well.

Passive Protection

Reverse Charging: A reverse protection diode prevents against damage or lost data due to a reverse charge polarity applied to the battery terminals.

Primary Overtemperature: The maximum operating temperature of this fuse is 85C. An overtemperature cutout permanently opens at 85C with no recovery.

Secondary Overtemperature: A second PTC polyfuse built into each Li-ion cell will open up and limit current flow at high currents.

Tertiary Overtemperature: A current interrupt device (CID) within each Li-ion cell will permanently open up when an individual cell's internal pressure is too high. As each cell fuse is permanently interrupted, overall battery performance will become severely degraded, up to and including disabling the battery.

Battery Protective Functions (N9910X-870)

The following protective functions are designed into the lithium-ion rechargeable battery system used in FieldFox.

The protective functions can be divided between two categories: active and passive. Active protection refers to the type of protection that depends on at least two or more protection devices working together to enable the protection Passive protection refers to the type of protection that is always enabled independent of any other protection device.

Active Protection

Primary Overcharge Voltage: This prevents the battery from being charged if the voltage across any cell exceeds approximately 4.35 V per cell. Once the overcharge protection is tripped, the voltage across each cell must drop below approximately 4.15 V to reset the protection and permit charging.

Secondary Overcharge Voltage: This is a one-time, permanent protection that is triggered when the voltage across any cell exceeds approximately 4.45 V. Once this protection is tripped, the battery can no longer be used and must be replaced.

Overdischarge Voltage: This prevents the battery from discharging if the voltage across any cell drops below approximately 2.6 V. Once the overdischarge voltage protection is tripped, the voltage across each cell must be charged to approximately 3 V to reset the protection and permit discharging.

Primary Overcharge Current: This prevents the battery from being charged if the average charging current reaches or exceeds 3.5A for a time period of 120 seconds or more.

Secondary Overcharge Current: This prevents the battery from being charged if the charging current reaches or exceeds 4A+/–20% for a time period of 20 milliseconds or more.

Primary Overdischarge Current: This prevents the battery from being discharged if the average current out of the battery reaches or exceeds 5A for a time period of 120 seconds or more. This protection can be reset by removing the load.

Secondary Overdischarge Current: This prevents the battery from being discharged if the current out of the battery reaches or exceeds 6A for a time period of 20 milliseconds or more. This protection can be reset by removing the load.

Short Circuit Protection: This prevents the battery from being charged or discharged and protects against damage or lost data if the current in or out of the battery reaches or exceeds 12.5A for a time period of 183 microseconds or more. This protection can be reset by removing the load.

Overtemperature Charging: The system microcontroller prevents the battery from being charged if the cell temperature exceeds 46C. Once the overtemperature charging protection is tripped, the cell temperature has to drop to or below 45C to reset the protection and permit charging.

Overtemperature Discharging: The system microcontroller prevents the battery from being discharged if the cell temperature exceeds 65C. Once the overtemperature discharging protection is tripped, the battery is automatically shut off which results in turning off the instrument as well.

Passive Protection

Reverse Charging: A reverse protection diode prevents against damage or lost data due to a reverse charge polarity applied to the battery terminals.

Primary Overtemperature: A PTC (positive temperature coefficient) polyfuse in series between the Li-ion cells and the charging and discharging transistors will open up and limit current flow to the battery terminals as a function of very high currents. This protection is resettable once the overstress condition is removed.

Secondary Overtemperature: A second PTC polyfuse built into each Li-ion cell will open up and limit current flow as a function of very high currents.

Tertiary Overtemperature: A current interrupt device (CID) within each Li-ion cell will permanently open up when an individual cell's internal pressure is too high. As each cell fuse is permanently interrupted, overall battery performance will become severely degraded, up to and including disabling the battery.

Overcurrent Fuse: This is a one-time blow fuse with a rated current of 12A.

Batteries: Safe Handling and Disposal

Refer to battery manufacture Safety Data Sheet (SDS) for safe handling and disposal information. Battery SDS's are located at:
https://regulations.about.keysight.com/msds/default.htm

Battery Transportation

Batteries are generally subject to transportation regulations, refer to the battery Safety Data Sheet (SDS) and contact your shipping department for transportation requirements.

Environmental Requirements

Refer to the FieldFox Specifications in Appendix B:, “Specifications/Data Sheet,” on page 941.

Electrical Requirements

The FieldFox allows you to use either the lithium-ion battery or the AC/DC adapter - both are included.

Electrostatic Discharge (ESD) Precautions

The FieldFox was constructed in an ESD protected environment. This is because most of the semiconductor devices used in this instrument are susceptible to damage by static discharge.

Static charges are generated in numerous ways, such as simple contact, separation of materials, and normal motions of persons working with the FieldFox. To prevent instrument damage, practice industry accepted techniques for handling static sensitive devices when using the FieldFox.

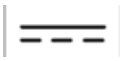
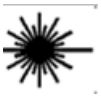
Very often, coaxial cables and antennas also build up a static charge, which, if allowed to discharge by connecting to the FieldFox, may damage the instrument input circuitry. To avoid such damage, it is recommended to dissipate any static charges by temporarily attaching a short to the cable or antenna prior to attaching to the instrument.

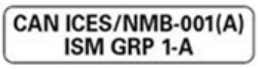
FieldFox Markings

The table below lists the definitions of markings that may be on or with the product. Familiarize yourself with each marking and its meaning before operating the instrument.

NOTE **All labels and symbols may not apply to the instrument.**

	This symbol marks the standby position of the power line switch.
	This symbol marks the ON position of the power line switch.

	This symbol marks the OFF position of the power line switch.
	This symbol indicates that the input power required is AC.
	This symbol indicates DC voltage
	This symbol indicates a three-phase alternating current.
	This symbol indicates Frame or chassis Terminal.
	The instruction documentation symbol. The product is marked with this symbol when it is necessary for the user to refer to the instruction in the documentation.
	This symbol indicate the presence of a Laser device.
	This symbol indicates the surface can be hot.
	This symbol indicated the product is sensitive to electrostatic discharge.
	This symbol identifies the Protective Conductor terminal.
	This symbol indicates the equipment is protected throughout by double or reinforced insulation.
	The CE mark is a registered trademark of the European Community (if accompanied by a year, it is the year when the design was proven). It indicates that the product complies with all the relevant directives.
	The UK conformity mark is a UK government owned mark. Products showing this mark comply with all applicable UK regulations.
	The Keysight email address is required by EU directives applicable to our product.
	The CSA mark is a registered trademark of the CSA International.

	Two person lift required.
CA N ICE S/NMB-001(A)	Canada EMC label. Interference-Causing Equipment Standard for industrial, scientific and medical (ISM) equipment. Matériel industriel, scientifique et médical (ISM).
	CE/ICES/ISM label. (Old mark for reference only.) This is a space saver label that combines three markings - CE with CAN ICES and ISM (see above) and ISM (see below).
	This is a space saver label that combines three markings - CE with CAN ICES and ISM (see above) and ISM (see below).
	The RCM mark is a registered trademark of the Australian Communications and Media Authority.
	This is a space saver label that combines two markings - CAN ICES and ISM.
ISM 1-A	This is a symbol of an Industrial Scientific and Medical Group 1 Class A product (CISPR 11, Clause 5).
	South Korean Certification (KC) mark. It includes the marking's identifier code.
	The crossed-out wheeled bin symbol indicates that separate collection for waste electric and electronic equipment (WEEE) is required, as obligated by the EU DIRECTIVE and other National legislation. Please refer to www.keysight.com/go/takeback to understand your trade-in options with Keysight, in addition to product takeback instructions.
	China Restricted Substance Product Label. The EPUP (environmental protection use period) number in the center indicates the time period during which no hazardous or toxic substances or elements are expected to leak or deteriorate during normal use and generally reflects the expected useful life of the product.
	Universal recycling symbol. This symbol indicates compliance with the China standard GB 18455-2001 as required by the China RoHS regulations for paper/fiberboard packaging.
IP x y	This mark indicates product has been designed to meet the requirements of "IP x y", where "x" is the solid particle protection and "y" is the liquid ingress protection.

Battery Markings

The table below lists the definitions of markings that may be on or with the product. Familiarize yourself with each marking and its meaning before operating the instrument.

NOTE All labels and symbols may not apply to the instrument.

The CE marking is a registered trademark of the European Community (if accompanied by a year, it is the year when the design was proven). It indicates that the product complies with all relevant directives.

Eurasian Conformity Mark indicating conformance to all technical regulations of the Eurasian Customs Union.

Dispose of properly. Do not throw batteries away—collect as small chemical waste.

Recycle the old battery properly. Consult local or country regulations related to disposal.

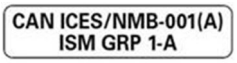
Keep battery away from excessive heat. Do not dispose of by burning.

Taiwan recycling symbol.

Korean Certification (KC) mark.

India mark from the Bureau of Indian standards. IS 13252 is the equivalent India standard to IEC 60950-1.

GOST, Russia's safety and EMC mark.

	The UL Marks are registered certification marks of Underwriters Laboratories Inc. (UL). It means that UL has tested and evaluated representative samples of that product and determined that it meets UL's safety requirements. When accompanied by a 'C' and 'US', it indicates compliance to both Canadian and US requirements.
	Taiwan's safety and EMC compliance mark.
	Indicates the time period which no hazardous or toxic substance elements are expected to leak or deteriorate during normal use. Ten years is the expected useful life of the product. This symbol indicates the Environmental Protection Use Period (EPUP) for the product's toxic substances and for the China RoHS requirements.
	The UK conformity mark is a UK government owned mark. Products showing this mark comply with all applicable UK regulations.
	The CSA mark is a registered trademark of the CSA international.
CAN ICES/NMB-001(A)	Canada EMC label. Interference-Causing Equipment Standard for industrial, scientific and medical (ISM) equipment. Matériel industriel, scientifique et médical (ISM).
	CE/ICES/ISM label. This is a space-saver label that combines three markings – CE with CAN ICES (see above) and ISM (see below).
	The RCM mark is a registered trademark of the Australian Communications and Media Authority.
	This is a combined marking to indicate product compliance with the Industry Canadian Interference-Causing Equipment Standard (ICES/NMB-001). This is also a symbol of an Industrial Scientific and Medical Group 1 Class A product (CISPR 11, Clause 5).
ISM 1-A	This is a symbol of an Industrial Scientific and Medical Group 1 Class A product (CISPR 11, Clause 5).
	South Korean Certification (KC) mark. It includes the marking's identifier code.
	Universal recycling symbol. This symbol indicates compliance with the China standard GB 18455-2001 as required by the China RoHS regulations for paper/fiberboard packaging.

	This symbol marks the standby position of the power line switch.
	This symbol marks the ON position of the power line switch.
	This symbol marks the OFF position of the power line switch.
	This symbol indicates the input power required is AC.
	This symbol indicates DC voltage.
	This symbol indicates a three-phase alternating current.
	This symbol indicates frame or chassis terminal.
	This symbol indicates the presence of a laser device.
	This symbol identifies the Protective Conductor Terminal.
	This symbol indicates the equipment is protected throughout by double or reinforced insulation.

Packaging Markings

Universal recycling symbol. This symbol indicates compliance with the China standard GB 18455–2001 as required by the China RoHS regulations for paper/fiberboard packaging.

AC/DC Adapter Markings

The table below lists the definitions of markings that may be on or with the product. Familiarize yourself with each marking and its meaning before operating the instrument.

NOTE All labels and symbols may not apply to the instrument.

The UL Marks are registered certification marks of Underwriters Laboratories Inc. (UL). It means that UL has tested and evaluated representative samples of that product and determined that it meets UL's safety requirements. When accompanied by a 'C' and 'US', it indicates compliance to both Canadian and US requirements.

NOM Mark (Normality of Mexico) indicates that the product was tested by an accredited laboratory in Mexico and meets Mexico's safety requirements.

Japan's safety and EMC compliance mark.

China's safety and EMC compliance mark.

Taiwan's safety and EMC compliance mark.

Singapore's safety mark.

Korean Certification (KC) mark; includes the marking's identifier code.

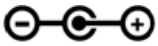
GOST, Russia's safety and EMC mark.

AC (Alternating Current).

Direct current (DC) equipment

CAUTION, risk of danger, refer to safety information in manual.

DC connector polarity



Ingress Protection Code

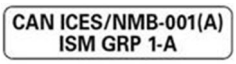
Operating instructions should be considered when operating the device.

U.S. Energy efficiency rating

Eurasian Conformity Mark indicating conformance to all technical regulations of the Eurasian Customs Union.

UL component mark. Recognized in Canada and the United States.

Operation for indoors only.

	India mark from the Bureau of Indian standards. IS 13252 is the equivalent India standard to IEC 60950-1.
	IRAM/S-mark is the safety mark for Argentina.
	The crossed out wheeled bin symbol indicates that separate collection for waste electric and electronic equipment (WEEE) is required, as obligated by the EU DIRECTIVE and other National legislation. Please refer to keysight.com/go/takeback to understand your Trade in options with Keysight in addition to product takeback instructions.
	Dispose of properly
	The UK conformity mark is a UK government owned mark. Products showing this mark comply with all applicable UK regulations.
	The CSA mark is a registered trademark of the CSA international.
CAN ICES/NMB-001(A)	Canada EMC label. Interference-Causing Equipment Standard for industrial, scientific and medical (ISM) equipment. Matériel industriel, scientifique et médical (ISM).
	CE/ICES/ISM label. This is a space-saver label that combines three markings – CE with CAN ICES (see above) and ISM (see below).
	The RCM mark is a registered trademark of the Australian Communications and Media Authority.
	This is a combined marking to indicate product compliance with the Industry Canadian Interference-Causing Equipment Standard (ICES/NMB-001). This is also a symbol of an Industrial Scientific and Medical Group 1 Class A product (CISPR 11, Clause 5).
ISM 1-A	This is a symbol of an Industrial Scientific and Medical Group 1 Class A product (CISPR 11, Clause 5).
	South Korean Certification (KC) mark. It includes the marking's identifier code.
	Universal recycling symbol. This symbol indicates compliance with the China standard GB 18455-2001 as required by the China RoHS regulations for paper/fiberboard packaging.

	This symbol marks the standby position of the power line switch.
	This symbol marks the ON position of the power line switch.
	This symbol marks the OFF position of the power line switch.
	This symbol indicates the input power required is AC.
	This symbol indicates DC voltage.
	This symbol indicates a three-phase alternating current.
	This symbol indicates frame or chassis terminal.
	This symbol indicates the presence of a laser device.
	This symbol identifies the Protective Conductor Terminal.
	This symbol indicates the equipment is protected throughout by double or reinforced insulation.

Certification and Compliance Statements

Certification

Keysight Technologies, Inc. certifies that this product met its published specifications at the time of shipment from the factory. Keysight Technologies, Inc. further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology, to the extent allowed by the Institute's calibration facility, and to the calibration facilities of other International Standards Organization members.

Manufacturer's Declaration

This product has been designed and tested in accordance with accepted industry standards, and has been supplied in a safe condition. The documentation contains information and warnings that must be followed by the user to ensure safe operation and to maintain the product in a safe condition.

Declaration of Conformity

Should the Declaration of Conformity be required, visit:

http://www.keysight.com/go/conformity.

For more information, see "Where to Find the Latest Information" on page 3.

EMC

Complies with the essential requirements of the European EMC Directive as well as current editions of the following standards (dates and editions are cited in the Declaration of Conformity):

- IEC/EN 61326-1
- CISPR Pub 11 Group 1, class B
- AS/NZS CISPR 11
- ICES/NMB-001

This ISM device complies with the Industry Canada Interference-Causing Equipment Standard (ICES-001);

Cet appareil ISM est conforme a la norme NMB-001 du Canada.

NOTE

This apparatus may experience performance degradation (intermittent, self-recoverable LAN and/or USB-A communication errors or GNSS unlocks) when exposed to ambient continuous electromagnetic phenomenon up to 10V/m in the frequency range of 80MHz to 1GHz (similar to those used in testing per IEC 61000-4-3).

Safety

Complies with the European Low Voltage Directive

- IEC/EN 61010-1
- Canada: CSA C22.2 No. 61010-1
- U.S.A.: UL std no. 61010-1

Acoustic Statement (European Machinery Directive)

Acoustic Noise Emission
LpA <70 dB
Operator position
Normal operation position per ISO 7779

A: Connector Care Review

Proper connector care and connection techniques are critical for accurate and repeatable measurements. The following table contains for tips on connector care.

Prior to making connections to your analyzer, carefully review the information about inspecting, cleaning, and gauging connectors. For course numbers about additional connector care instruction, contact Keysight Technologies.

Connector Care Table

Handling and Storage	
Do	Do Not
– Keep connections clean	– Touch mating-plane surfaces
– Extend sleeve or connector nut	– Set connectors contact-end down
– Use plastic end-caps during storage	– Store connectors or adapters loose
Visual Inspection	
Do	Do Not
– Inspect all connectors carefully	– Use a damaged connector—ever
– Look for metal particles, scratches, and dents	
Connector Cleaning	
Do	Do Not
– Try compressed air first	– Use any abrasives
– use isopropyl alcohol[a]	– Get liquid into plastic support beads
– Clean connector threads	
Gaging Connectors	
Do	Do Not
– Clean and zero the gage before use	– Use an out-of-specification connector
– Use the correct gage type	
– Use correct end of calibration block	
– Gage all connectors before first use	
Gaging Connectors	
Do	Do Not
– connectors carefully	– Apply bending force to connection
– Make preliminary connection contact lightly	– Over Tighten preliminary connection
– Turn only the connector nut	– Twist or screw any connection
– Use a torque wrench for final connection	– tighten past torque wrench “break” point

a. Cleaning connectors with alcohol shall only be done with the DC power cord removed, in a well-ventilated area, and with the power to the FieldFox turned OFF. Allow all residual alcohol moisture to evaporate, and the fumes to dissipate prior to energizing the instrument.

B: Specifications/Data Sheet

To ensure the highest accuracy and consistency, the FieldFox Specifications are now stored ONLY at:
https://www.keysight.com/us/en/assets/7018-06516/data-sheets/5992-3702.pdf.

C: Instrument Calibration

Over time, the active components in the FieldFox age and the performance may degrade or drift. To ensure that the FieldFox is performing to the published specifications, you should have an instrument calibration performed periodically.

How Often Should Calibrate My Instrument?

You determine the calibration period which best meets your requirements. However, a 12 month calibration cycle is appropriate for most users.

There are two things to consider: performance drift and connector wear.

The instrument specifications are set to consider the performance drift that may occur over a 12 month period. Therefore, getting the instrument calibrated at 12 month intervals ensures that the analyzer maintains performance within the operating specifications. If you need the analyzer to maintain more consistent operation, you may want to have the instrument calibrated more often.

Connector wear is a bigger factor and depends on the number of connections that are made. The test ports become noticeably worn after 500 to 700 connections. This could represent about 12 months with average use. With more frequent connections, the calibration cycle should be sooner. You can extend the time between calibrations and thereby save money by using connector savers and by performing proper Connector Care. Learn more in "Connector Care Review" on page 939.

How do I Get an Instrument Calibration?

To get your Keysight instrument calibrated, send it to one of the Keysight Technologies service centers. Please visit this website to learn how:
www.keysight.com/find/calibration.

What Are My Choices of Instrument Calibration?

The following types of instrument calibration are available from Keysight Technologies service center:

Keysight Calibration	Includes the test data from the calibration and the certificate of calibration, stating the instrument has been calibrated and is operating within the published specifications.
ANSI Z540 Calibration	Includes the test data from the calibration and the certificate of calibration, stating the instrument has been calibrated using a process in compliance with ANSI Z540.1 and is operating within the published specifications
ISO 17025 Calibration	Includes the test data from the calibration and the certificate of calibration, stating the instrument has been calibrated using a process in compliance with ISO 17025 and is operating within the published specifications.Chapter 3, “CAT (Cable and Antenna Test) Mode.”

D: Korean Battery Safety Translation

안전 고려 사항
외부 배터리 충전기(N9910X-872)용

배터리 정보

리튬 배터리 팩은 잘못된 조건에서 사용하면 뜨거워지거나 폭발하거나 점화될 수 있으며 심각한 부상을 초래할 수 있습니다.

이 섹션에는 다음과 같은 내용이 포함됩니다.

– "대용량 리튬 배터리(N9910X-876)"
– "표준 용량 배터리(N9910X-870)"

대용량 리튬 배터리(N9910X-876)

리튬 배터리(대용량): N9910X-876(배터리 키사이트 품목 번호: 1420-0937)은 키사이트테크놀로지스가 생산한 휴대용 마이크로파 계측기 제품군에 전원을 공급하는 데 사용됩니다. 다음 안전 경고를 따르십시오.

외부 배터리, 미국 FCC 규정 준수	배터리 보관:
	보관과 관련한 유일한 지침은 아래의 온도 기준입니다.
	– "온도(1개월): -20°C ~+45°C
	– "온도(6개월): -20°C ~+40°C
	– "온도(12개월): -20°C ~ +35°C
Rating:	10.8V 6400mAh 70Wh

배터리 안전 고려 사항	
경고	리튬-이온 배터리: – 고온(>70°C)이나 화기에 노출시키면 안 됩니다. – 어린이의 손이 닿지 않는 곳에 두어야 합니다. – 합선되면 안 됩니다. – 키사이트에서 인증한 리튬-이온 배터리로만 교체해야 합니다. – 부적절하게 교체하거나 충전하면 폭발의 위험이 있습니다.
경고	배터리의 양극 단자와 음극 단자를 금속 물체(예: 와이어)를 사용하여 서로 연결하지 마십시오.
경고	목걸이, 머리핀 또는 기타 금속 물체와 함께 배터리를 보관하거나 가지고 다니지 마십시오.
경고	배터리를 손톱으로 긁거나 망치로 두드리거나 배터리 위에 올라가지 마십시오. 또한 배터리가 강한 충돌 또는 충격을 받지 않도록 주의하십시오.
경고	배터리에 직접 납땜기를 사용하지 마십시오.
경고	배터리가 물 또는 소금물에 노출되어서는 안 되며 배터리가 젖지 않도록 주의하십시오.
경고	배터리를 분해 또는 개조하지 마십시오. 배터리에는 손상 시 과열, 폭발 또는 점화가 유발될 수 있는 안전 및 보호 장치가 포함되어 있습니다.
경고	배터리를 직사광선에 노출시켜서는 안 되며 더운 날씨에 배터리를 자동차 안에서 사용하거나 자동차 안에 보관하지 마십시오. 이 점에 주의하지 않으면 배터리가 과열 또는 폭발하거나 점화될 수 있습니다. 또한 배터리 성능이 저하되고 기대 수명이 짧아질 수 있습니다.
경고	배터리를 잘못 교체하면 폭발의 위험이 있습니다. 동일하거나 유사한 유형의 배터리로만 교체할 것을 권장합니다. 다 쓴 배터리는 제조업체의 지침에 따라 폐기하십시오.
경고	실내에서 배터리를 충전할 경우에는 FieldFox 전원이 꺼졌더라도 FieldFox가 뜨거워질 수 있습니다. 적절하게 환기되도록 하십시오. 환기구가 막힌 채로 또는 운반 케이스에 담긴 상태에서 FieldFox를 작동하면 안 됩니다.

안전 고려 사항
배터리 정보

경고	FieldFox 또는 외부 배터리 충전기(N9910X-872)를 제외한 다른 장치를 사용하여 배터리를 방전시키지 마십시오. 지정된 것 이외의 장치에서 배터리를 사용하면 배터리가 손상되거나 배터리 수명이 줄어들 수 있습니다. 장치가 비정상적인 전류 흐름을 유발할 경우, 배터리가 뜨거워지거나 폭발하거나 점화될 수 있으며 심각한 부상을 초래할 수 있습니다. 외부 배터리 충전기는 검교정 도중 방전됩니다.
경고	한국어 배터리 안전 고려사항 번역본은 부록 D:, "한국어 배터리 안전 번역본"을 참조하십시오.
경고	러시아어 배터리 안전 고려 사항 번역본은 부록 E:, "러시아어 배터리 안전 번역본"을 참조하십시오.
경고	외부 배터리는 물기가 있는 곳에서 사용할 수 있도록 설계되지 않았습니다. 물기가 있는 곳에서는 외부 배터리를 사용하지 마십시오.

표준 용량 배터리(N9910X-870)

경고	리튬-이온 배터리: – 고온(>70°C)이나 화기에 노출시키면 안 됩니다. – 어린이의 손이 닿지 않는 곳에 두어야 합니다. – 합선되면 안 됩니다. – 키사이트에서 인증한 리튬-이온 배터리로만 교체해야 합니다. – 부적절하게 교체하거나 충전하면 폭발의 위험이 있습니다.
경고	배터리의 양극 단자와 음극 단자를 금속 물체(예: 와이어)를 사용하여 서로 연결하지 마십시오.
경고	목걸이, 머리핀 또는 기타 금속 물체와 함께 배터리를 보관하거나 가지고 다니지 마십시오.
경고	배터리를 손톱으로 긁거나 망치로 두드리거나 배터리 위에 올라가지 마십시오. 또한 배터리가 강한 충돌 또는 충격을 받지 않도록 주의하십시오.
경고	배터리에 직접 납땜기를 사용하지 마십시오.
경고	배터리가 물 또는 소금물에 노출되어서는 안 되며 배터리가 젖지 않도록 주의하십시오.

배터리 안전 고려 사항

경고	배터리를 분해 또는 개조하지 마십시오. 배터리에는 손상 시 과열, 폭발 또는 점화가 유발될 수 있는 안전 및 보호 장치가 포함되어 있습니다.
경고	배터리를 직사광선에 노출시켜서는 안 되며 더운 날씨에 배터리를 자동차 안에서 사용하거나 자동차 안에 보관하지 마십시오. 이 점에 주의하지 않으면 배터리가 과열 또는 폭발하거나 점화될 수 있습니다. 또한 배터리 성능이 저하되고 기대 수명이 짧아질 수 있습니다.
경고	배터리를 잘못 교체하면 폭발의 위험이 있습니다. 동일하거나 유사한 유형의 배터리로만 교체할 것을 권장합니다. 다 쓴 배터리는 제조업체의 지침에 따라 폐기하십시오.
경고	실내에서 배터리를 충전할 경우에는 FieldFox 전원이 꺼졌더라도 FieldFox가 뜨거워질 수 있습니다. 적절하게 환기되도록 하십시오.
경고	FieldFox 또는 외부 배터리 충전기(N9910X-872)를 제외한 다른 장치를 사용하여 배터리를 방전시키지 마십시오. 지정된 것 이외의 장치에서 배터리를 사용하면 배터리가 손상되거나 배터리 수명이 줄어들 수 있습니다. 장치가 비정상적인 전류 흐름을 유발할 경우, 배터리가 뜨거워지거나 폭발하거나 점화될 수 있으며 심각한 부상을 초래할 수 있습니다.
경고	한국어 배터리 안전 고려 사항 번역본은 부록 D:, "한국어 배터리 안전 번역본"을 참조하십시오.
경고	러시아어 배터리 안전 고려 사항 번역본은 부록 E:, "러시아어 배터리 안전 번역본"을 참조하십시오.

배터리 보호 기능

이 섹션에는 다음과 같은 내용이 포함됩니다.

– “배터리 보호 기능 (N9910X-876)”
– “배터리 보호 기능(N9910X-870)”, 페이지 533

배터리 보호 기능(N9910X-876)

FieldFox에 사용된 리튬-이온 충전식 배터리 시스템에는 다음과 같은 보호 기능이 내장되어 있습니다.

보호 기능은 능동과 수동의 두 범주로 나뉠 수 있습니다. 능동 보호는 적어도 2개의 보호 장치가 함께 동작하는 유형의 보호를 의미하며, 수동 보호는 다른 보호 장치와 별개로 항상 활성화되는 보호 유형을 의미합니다.

능동 보호

기본 과충전 전압: 이 기능은 셀의 전압이 셀당 약 4.35 V를 초과할 경우 배터리의 충전을 방지합니다. 과전압 보호 기능이 작동하면 각 셀의 전압이 약 4.10 V 미만으로 떨어져야 하며, 이때 보호 기능이 리셋되고 충전이 가능해집니다.

과방전 전압: 셀의 전압이 약 2.5 V 미만으로 떨어지면 배터리가 방전되지 않도록 방지합니다. 과방전 전압 보호가 작동하면 각 셀의 전압이 약 3 V로 충전되어야 하며, 이때 보호 기능이 리셋되고 방전이 가능해집니다.

기본 과충전 전류: 이 기능은 평균 충전 전류가 3.3A에 도달하거나 이 값을 초과할 경우 5초 이상 배터리의 충전을 중지시킵니다.

기본 과방전 전류: 이 기능은 배터리의 평균 전류가 7A에 도달하거나 이 값을 초과할 경우 5초 이상 배터리의 방전을 중지시킵니다. 이 보호 기능은 부하를 제거하여 리셋할 수 있습니다.

단락 회로 보호: 이 기능은 배터리 전류가 33.3A에 도달하거나 이 값을 초과할 경우 274.5마이크로초 동안 배터리의 충전 또는 방전을 중지시켜 데이터가 손상이나 손실되지 않도록 보호합니다. 이 보호 기능은 부하를 제거하여 리셋할 수 있습니다.

과온 충전: 셀 온도가 섭씨 48도를 초과할 경우 시스템 마이크로컨트롤러가 배터리의 충전을 중지시킵니다. 과온 충전 보호 기능이 작동하면 셀 온도가 섭씨 43도 미만으로 떨어져야 하며, 이때 보호 기능이 리셋되고 충전이 가능해집니다.

안전 고려 사항
배터리 보호 기능

과온 방전: 셀 온도가 섭씨 67도를 초과할 경우 시스템 마이크로컨트롤러가 배터리 방전을 중지시킵니다. 과온 방전 보호 기능이 작동하면 배터리가 자동으로 차단되며 계측기 또한 꺼지게 됩니다.

수동 보호

리버스 충전: 리버스 보호 다이오드가 배터리 단자에 적용되는 리버스 충전 극성으로 인한 손상 또는 데이터 손실을 방지합니다.

기본 과온: 이 퓨즈의 최대 작동 온도는 섭씨 85도입니다. 과온 컷아웃은 복구 없이 섭씨 85도에서 영구적으로 열립니다.

보조 과온: 고전류가 되면 각 리튬-이온 셀에 내장된 보조 PTC 폴리퓨즈가 개방되어 전류 흐름이 제한됩니다.

3차 과온: 개별 셀의 내부 압력이 너무 높으면 각 리튬-이온 셀 내의 CID(current interrupt device)가 영구적으로 개방됩니다. 각 셀 퓨즈가 영구적으로 중단되므로 전반적인 배터리 성능이 심각하게 저하되어 배터리를 못쓰게 될 수도 있습니다.

안전 고려 사항
배터리 보호 기능

배터리 보호 기능(N9910X-870)

FieldFox에 사용된 리튬-이온 충전식 배터리 시스템에는 다음과 같은 보호 기능이 내장되어 있습니다.

보호 기능은 능동과 수동의 두 범주로 나뉠 수 있습니다. 능동 보호는 적어도 2개의 보호 장치가 함께 동작하는 유형의 보호를 의미하며, 수동 보호는 다른 보호 장치와 별개로 항상 활성화되는 보호 유형을 의미합니다.

능동 보호

기본 과충전 전압: 이 기능은 셀의 전압이 셀당 약 4.35 V를 초과할 경우 배터리가 충전되지 않도록 방지합니다. 과전압 보호 기능이 작동하면 각 셀의 전압이 약 4.15 V 미만으로 떨어져야 하며, 이때 보호 기능이 리셋되고 충전이 가능해집니다.

보조 과충전 전압: 이 기능은 셀의 전압이 약 4.45 V를 초과할 때 작동하는 1회용 영구 보호 조치입니다. 이 보호 기능이 작동하면 배터리를 더 이상 사용할 수 없으며 교체가 필요합니다.

과방전 전압: 셀의 전압이 약 2.6 V 미만으로 떨어지면 배터리가 방전되지 않도록 방지합니다. 과방전 전압 보호가 작동하면 각 셀의 전압이 약 3 V로 충전되어야 하며, 이때 보호 기능이 리셋되고 방전이 가능해집니다.

기본 과충전 전류: 이 기능은 평균 충전 전류가 3.5A에 도달하거나 이 값을 초과할 경우 120초 이상 배터리의 충전을 중지시킵니다.

보조 과충전 전류: 이 기능은 충전 전류가 4A+/−20%에 도달하거나 이 값을 초과할 경우 20밀리초 이상 배터리의 충전을 중지시킵니다.

기본 과방전 전류: 이 기능은 배터리의 평균 전류가 5 A에 도달하거나 이 값을 초과할 경우 120초 이상 배터리의 방전을 중지시킵니다. 이 보호 기능은 부하를 제거하여 리셋할 수 있습니다.

보조 과충전 전류: 이 기능은 배터리 전류가 6A에 도달하거나 이 값을 초과할 경우 20밀리초 이상 배터리의 방전을 중지시킵니다. 이 보호 기능은 부하를 제거하여 리셋할 수 있습니다.

단락 회로 보호: 이 기능은 배터리 전류가 12.5A에 도달하거나 이 값을 초과하면 183마이크로초 동안 배터리의 충전 또는 방전을 중지시켜 데이터가 손상이나 손실되지 않도록 보호합니다. 이 보호 기능은 부하를 제거하여 리셋할 수 있습니다.

안전 고려 사항
배터리: 안전한 취급과 폐기

과온 충전: 셀 온도가 섭씨 46도를 초과할 경우 시스템 마이크로컨트롤러가 배터리 충전을 중지시킵니다. 과온 충전 보호 기능이 작동하면 셀 온도가 섭씨 45도 미만으로 떨어져야 하며, 이때 보호 기능이 리셋되고 충전이 가능해집니다.

과온 방전: 셀 온도가 섭씨 65도를 초과할 경우 시스템 마이크로컨트롤러가 배터리 방전을 중지시킵니다. 과온 방전 보호 기능이 작동하면 배터리가 자동으로 차단되며 계측기 또한 꺼지게 됩니다.

수동 보호

리버스 충전: 리버스 보호 다이오드가 배터리 단자에 적용되는 리버스 충전 극성으로 인한 손상 또는 데이터 손실을 방지합니다.

기본 과온: 고전류가 되면 리튬-이온 셀들과 충전 및 방전 트랜지스터 간에 직렬로 연결된 PTC(positive temperature coefficient) 폴리퓨즈가 개방되며 배터리 단자로의 전류 흐름이 제한됩니다. 이 보호 기능은 과도한 스트레스 조건이 사라지면 리셋 가능합니다.

보조 과온: 고전류가 되면 각 리튬-이온 셀에 내장된 보조 PTC 폴리퓨즈가 개방되어 전류 흐름이 제한됩니다.

3차 과온: 개별 셀의 내부 압력이 너무 높으면 각 리튬-이온 셀 내의 CID(current interrupt device)가 영구적으로 개방됩니다. 각 셀 퓨즈가 영구적으로 중단되므로 전반적인 배터리 성능이 심각하게 저하되어 배터리를 못쓰게 될 수도 있습니다.

과전류 퓨즈: 정격 전류가 12A인 일회용 파열 퓨즈입니다.

배터리: 안전한 취급과 폐기

안전한 취급 및 폐기 방법은 배터리 제조업체의 안전 데이터 시트(SDS)를 참조하십시오. 배터리 SDS는 https://regulations.about.keysight.com/msds/default.htm에서 확인할 수 있습니다.

배터리 운반

배터리에는 일반적으로 운반 규제가 적용됩니다. 운반에 필요한 요건은 배터리 안전 데이터 시트(SDS)를 참조하고 배송 부서에 문의하십시오.

안전 고려 사항
배터리 표식

배터리 표식

CE 마크는 제품이 유럽의 모든 관련 법적 지시문을 준수하다는 것을 보여줍니다(연도가 표시된 경우 설계가 입증된 시기를 의미함).

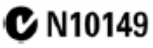
배터리 부품은 재활용이 가능합니다. 현지 규제를 확인하십시오.

올바른 방법으로 폐기하십시오. 배터리를 함부로 버리면 안 되며 소형 화학 폐기물로 수거해야 합니다.

다 쓴 배터리는 적절히 재활용하십시오. 현지의 폐기 관련 규제를 확인하시기 바랍니다.

배터리가 과도한 열에 노출되지 않도록 하십시오. 태워서 폐기하면 안 됩니다.

캐나다와 미국에서 UL 인증.



C-Tick Mark는 Australian Spectrum Management Agency의 등록 상표입니다.

RCM Mark는 Australian Communications and Media Authority의 등록 상표입니다.

한국 인증(KC) 마크; 다음 형식을 따르는 마크 식별자 코드를 포함합니다: KCC-REM-YYY-ZZZZZZZZZZZZ 또는 MSIP-REM-YYY-ZZZZZZZZZZZZ

안전 고려 사항
배터리 표식

등록을 위한 BIS(Bureau of Indian Standards) 표준 마크.

정상적인 사용 중 위험 물질 성분이나 독성 물질 성분이 누출되거나 악화될 것으로 예상되는 기간을 나타냅니다. 제품의 예상 유효 수명은 10년입니다.

이 기호는 제품의 독성 물질 및 중국 RoHS 요건에 대한 환경 보호 사용 기간(EPUP)을 나타냅니다.

E: Russian Battery Safety Translation

Меры безопасности для внешнего зарядного устройства батареи (N9910X-872)

Для аккумуляторной батареи

При неправильном использовании литий-ионные аккумуляторные батареи могут нагреться, воспламениться или взорваться, что может привести к серьезным травмам.

Данный раздел включает следующую информацию:

– «Литий-ионная аккумуляторная батарея большой емкости (N9910X-876)»

– «Аккумуляторная батарея стандартной емкости (N9910X-870)»

Литий-ионная аккумуляторная батарея большой емкости (N9910X-876)

Литий-ионная аккумуляторная батарея (большой емкости): N9910X-876 (номер батареи по каталогу Keysight: 1420-0937) используется для питания портативных измерительных приборов СВЧ-диапазона, выпускаемых компанией Keysight Technologies. Обязательно соблюдайте следующие требования техники безопасности:

Внешняя батарея, соответствующая требованиям Федеральной комиссии по связи (FCC) США	Хранение аккумуляторной батареи: Единственным регламентируемым параметром, связанным с хранением изделия, является температура. – Среднемесячная температура: от –20°C до +45°C – Средняя температура за полгода: от –20°C до +40°C – Среднегодовая температура: от –20°C до +35°C
Rating:	10,8 В; 6400 мА·ч; 70 Вт·ч

Меры безопасности при использовании аккумуляторной батареи

ОСТОРОЖНО	Литий-ионные аккумуляторные батареи: – запрещается подвергать воздействию высокой температуры (более +70°C) или открытого огня; – следует хранить в недоступном для детей месте; – запрещается замыкать накоротко полюса батареи; – следует заменять только литий-ионными батареями, рекомендованными компанией Keysight; – в случае неправильной замены или зарядки батареи существует опасность взрыва аккумулятора.
ОСТОРОЖНО	Запрещается замыкать положительный и отрицательный контакты батареи какими-либо металлическими предметами (например, проводами).
ОСТОРОЖНО	Запрещается носить или хранить батарею рядом с цепочками, заколками для волос и другими металлическими предметами.
ОСТОРОЖНО	Запрещается пробивать батарею острыми предметами (например, гвоздями), бить по ней молотком, наступать на батарею или подвергать ее каким-либо другим сильным механическим воздействиям.
ОСТОРОЖНО	Запрещается припаивать что-либо непосредственно к батарее.
ОСТОРОЖНО	Запрещается погружать батарею в пресную или соленую воду, а также допускать попадание влаги на батарею.
ОСТОРОЖНО	Запрещается разбирать батарею или изменять ее конструкцию. Батарея оснащена предохранительными устройствами и схемой защиты, повреждение которых может привести к нагреву, воспламенению или взрыву батареи.
ОСТОРОЖНО	Запрещается подвергать батарею воздействию прямых солнечных лучей или хранить ее внутри автомобиля в жаркую погоду. Это может привести к нагреву, воспламенению или взрыву батареи. Использование батареи подобным образом также может повлечь за собой ухудшение ее характеристик и сокращение срока службы.
ОСТОРОЖНО	В случае неправильной замены существует опасность взрыва батареи. Для замены используйте батарею того же типа или совместимую батарею, рекомендованную производителем прибора. Утилизация батареи должна осуществляться в соответствии с инструкциями изготовителя.
ОСТОРОЖНО	При зарядке аккумуляторной батареи внутри анализатора FieldFox, прибор может нагреться, даже если перед этим выключить его питание. Рекомендуется обеспечить надлежащую вентиляцию. Запрещается работать с анализатором FieldFox, если он находится в сумке для переноски или его вентиляционные отверстия перекрыты.

Руководство по эксплуатации Keysight N9938-90003

Меры безопасности
Для батареи

ОСТОРОЖНО	Запрещается разряжать батарею с помощью любого устройства, кроме анализатора FieldFox или внешнего зарядного устройства N9910X-872. Использование батареи в других устройствах может привести к ее повреждению или сокращению срока ее службы. Протекание через устройство аномально высокого тока может вызвать нагрев, воспламенение или взрыв аккумулятора и стать причиной серьезной травмы. Внешнее зарядное устройство разряжает батарею во время перекалибровки.
ОСТОРОЖНО	Перевод правил техники безопасности при обращении с батареей на корейский язык приведен в Приложении D «Правила техники безопасности при обращении с батарей (перевод на корейский язык)».
ОСТОРОЖНО	Перевод правил техники безопасности при обращении с батареей на русский язык приведен в Приложении E «Правила техники безопасности при обращении с батарей (перевод на русский язык)».
ОСТОРОЖНО	Внешняя аккумуляторная батарея не предназначена для эксплуатации в местах с повышенной влажностью. Запрещается использовать внешнюю батарею в местах с повышенной влажностью.

Аккумуляторная батарея стандартной емкости (N9910X-870)

ОСТОРОЖНО	Литий-ионные аккумуляторные батареи: – запрещается подвергать воздействию высокой температуры (более +70°C) или открытого огня; – следует хранить в недоступном для детей месте; – запрещается замыкать накоротко полюса батареи; – следует заменять только литий-ионными батареями, рекомендованными компанией Keysight; – в случае неправильной замены или зарядки батареи существует опасность взрыва аккумулятора.
ОСТОРОЖНО	Запрещается замыкать положительный и отрицательный контакты батареи какими-либо металлическими предметами (например, проводами).
ОСТОРОЖНО	Запрещается носить или хранить батарею рядом с цепочками, заколками для волос и другими металлическими предметами.
ОСТОРОЖНО	Запрещается пробивать батарею острыми предметами (например, гвоздями), бить по ней молотком, наступать на батарею или подвергать ее каким-либо другим сильным механическим воздействиям.
ОСТОРОЖНО	Запрещается припаивать что-либо непосредственно к батарее.
ОСТОРОЖНО	Запрещается погружать батарею в пресную или соленую воду, а также допускать попадание влаги на батарею.

Руководство по эксплуатации Keysight N9938-90003

Меры безопасности при использовании аккумуляторной батареи

ОСТОРОЖНО	Запрещается разбирать батарею или изменять ее конструкцию. Батарея оснащена предохранительными устройствами и схемой защиты, повреждение которых может привести к нагреву, воспламенению или взрыву батареи.
ОСТОРОЖНО	Запрещается подвергать батарею воздействию прямых солнечных лучей или хранить ее внутри автомобиля в жаркую погоду. Это может привести к нагреву, воспламенению или взрыву батареи. Использование батареи подобным образом также может повлечь за собой ухудшение ее характеристик и сокращение срока службы.
ОСТОРОЖНО	В случае неправильной замены существует опасность взрыва батареи. Для замены используйте батарею того же типа или совместимую батарею, рекомендованную производителем прибора. Утилизация батареи должна осуществляться в соответствии с инструкциями изготовителя.
ОСТОРОЖНО	При зарядке аккумуляторной батареи внутри анализатора FieldFox, прибор может нагреться, даже если перед этим выключить его питание. Рекомендуется обеспечить надлежащую вентиляцию.
ОСТОРОЖНО	Запрещается разряжать батарею с помощью любого устройства, кроме анализатора FieldFox или внешнего зарядного устройства N9910X-872. Использование батареи в других устройствах может привести к ее повреждению или сокращению срока ее службы. Протекание через устройство аномально высокого тока может вызвать нагрев, воспламенение или взрыв аккумулятора и стать причиной серьезной травмы.
ОСТОРОЖНО	Перевод правил техники безопасности при обращении с батареей на корейский язык приведен в Приложении D «Правила техники безопасности при обращении с батарей (перевод на корейский язык)».
ОСТОРОЖНО	Перевод правил техники безопасности при обращении с батареей на русский язык приведен в Приложении E «Правила техники безопасности при обращении с батарей (перевод на русский язык)».

Руководство по эксплуатации Keysight N9938-90003

Защитные функции аккумуляторной батареи

Данный раздел включает следующую информацию:

– «Защитные функции аккумуляторной батареи (N9910X-876)»

– «Защитные функции аккумуляторной батареи (N9910X-870)» на стр. 533

Защитные функции батареи (N9910X-876)

Литий-ионная аккумуляторная батарея анализатора FieldFox оснащена следующими встроенными защитными функциями.

Защитные функции могут быть разделены на два вида: активные и пассивные. Функции активной защиты зависят от двух или более защитных устройств, работающих вместе для обеспечения защиты. Функции пассивной защиты всегда работают независимо от любых других защитных устройств.

Функции активной защиты

Первичная защита от чрезмерного заряда по напряжению. Прекращает дальнейший заряд батареи, если напряжение на любом из элементов аккумуляторной батареи превышает приблизительно 4,25 В. После срабатывания защиты от чрезмерного заряда напряжение на каждом элементе аккумулятора должно снизиться примерно до 4,10 В, чтобы схема защиты вернулась в исходное состояние и вновь разрешила заряд аккумулятора.

Защита от чрезмерного разряда по напряжению. Прекращает дальнейший разряд батареи, если напряжение на любом из элементов аккумуляторной батареи падает ниже примерно 2,5 В. После срабатывания защиты от чрезмерного разряда напряжение на каждом элементе аккумулятора должно увеличить примерно до 3 В, чтобы схема защиты вернулась в исходное состояние и вновь разрешила разряд аккумулятора.

Первичная защита от чрезмерного заряда по току. Прекращает дальнейший заряд батареи, если среднее значение тока заряда достигает или превышает 3,3 А в течение 5 с или более.

Первичная защита от чрезмерного тока разряда. Прекращает дальнейший разряд батареи, если среднее значение тока разряда достигает или превышает 7 А в течение 5 с или более. Схема защиты может быть возвращена в исходное состояние путем отключения нагрузки.

Защита от короткого замыкания. Прекращает дальнейший заряд или разряд батареи и не допускает повреждения оборудования и потери данных, если ток батареи (входной или выходной) достигает или превышает 33,3 А в течение 274,5 мкс или более. Схема защиты может быть возвращена в исходное состояние путем отключения нагрузки.

Защита от перегрева при заряде. Системный микроконтроллер останавливает заряд батареи, если температура элементов аккумулятора превышает +48°C. После срабатывания защиты от перегрева температура элементов аккумулятора должна снизиться до +43°C и ниже, чтобы схема защиты вернулась в исходное состояние и вновь разрешила заряд аккумулятора.

Меры безопасности
Защитные функции аккумуляторной батареи

Защита от перегрева при разряде. Системный микроконтроллер останавливает разряд батареи, если температура элементов аккумулятора превышает +67°C. После срабатывания защиты от перегрева батарея автоматически отключается, что, в свою очередь, приводит к выключению прибора.

Функции пассивной защиты

Защита от включения с обратной полярностью при заряде. Защитный диод предотвращает повреждение прибора и потерю данных при подаче на клеммы аккумуляторной батареи напряжения заряда с обратной полярностью.

Первичная защита от перегрева. Максимальная рабочая температура этого предохранителя составляет +85°C. При температуре свыше +85°C происходит необратимое срабатывание предохранителя.

Вторичная защита от перегрева. Второй самовосстанавливающийся предохранитель с положительным температурным коэффициентом, встроенный в каждый элемент литий-ионной аккумуляторной батареи, разрывает цепь и ограничивает протекание тока при очень высоких значениях температуры.

Третичная защита от перегрева. Устройство прерывания тока (CID) в каждом элементе литий-ионной аккумуляторной батареи необратимо разрывает цепь при чрезмерно высоком давлении внутри элемента. Поскольку при срабатывании защиты предохранитель в каждом элементе аккумулятора разомкнут необратимо, характеристики батареи значительно ухудшаются, вплоть до полной потери работоспособности аккумулятора.

Руководство по эксплуатации Keysight N9938-90003

Меры безопасности
Защитные функции аккумуляторной батареи

Защитные функции аккумуляторной батареи (N9910X-870)

Литий-ионная аккумуляторная батарея анализатора FieldFox оснащена следующими встроенными защитными функциями.

Защитные функции могут быть разделены на два вида: активные и пассивные. Функции активной защиты зависят от двух или более защитных устройств, работающих вместе для обеспечения защиты. Функции пассивной защиты всегда работают независимо от любых других защитных устройств.

Функции активной защиты

Первичная защита от чрезмерного заряда по напряжению. Прекращает дальнейший заряд батареи, если напряжение на любом из элементов аккумуляторной батареи превышает приблизительно 4,35 В. После срабатывания защиты от чрезмерного заряда напряжение на каждом элементе аккумулятора должно снизиться примерно до 4,15 В, чтобы схема защиты вернулась в исходное состояние и вновь разрешила заряд аккумулятора.

Вторичная защита от чрезмерного заряда по напряжению. Эта функция защиты срабатывает однократно, когда напряжение на любом из элементов аккумуляторной батареи превысит примерно 4,45 В. После срабатывания этой функции защиты пользоваться батарей запрещается и ее следует заменить.

Защита от чрезмерного разряда по напряжению. Предотвращает дальнейший разряд батареи, если напряжение на любом из элементов аккумуляторной батареи падает ниже примерно 2,6 В. После срабатывания защиты от чрезмерного разряда напряжение на каждом элементе аккумулятора должно увеличить примерно до 3 В, чтобы схема защиты вернулась в исходное состояние и вновь разрешила разряд аккумулятора.

Первичная защита от чрезмерного заряда по току. Прекращает дальнейший заряд батареи, если среднее значение тока заряда достигает или превышает 3,5 А в течение 120 с или более.

Вторичная защита от чрезмерного заряда по току. Прекращает дальнейший заряд батареи, если значение тока заряда достигает или превышает 4 А ± 20% в течение 20 мс или более.

Первичная защита от чрезмерного тока разряда. Прекращает дальнейший разрядбатареи, если среднее значение тока разряда достигает или превышает 5 А в течение 120 с или более. Схема защиты может быть возвращена в исходное состояние путем отключения нагрузки.

Вторичная защита от чрезмерного тока разряда. Прекращает дальнейший разряд батареи, если значение тока разряда достигает или превышает 6 А в течение 20 мс или более. Схема защиты может быть возвращена в исходное состояние путем отключения нагрузки.

Защита от короткого замыкания. Прекращает дальнейший заряд или разряд батареи и не допускает повреждения оборудования и потери данных, если ток батареи (входной или выходной) достигает или превышает 12,5 А в течение 183 мкс или более. Схема защиты может быть возвращена в исходное состояние путем отключения нагрузки.

Защита от перегрева при заряде. Системный микроконтроллер останавливает заряд батареи, если температура элементов аккумулятора превышает +46°C. После срабатывания защиты от перегрева температура элементов аккумулятора должна снизиться до +45°C и ниже, чтобы схема защиты вернулась в исходное состояние и вновь разрешила заряд аккумулятора.

Защита от перегрева при разряде. Системный микроконтроллер останавливает разряд батареи, если температура элементов аккумулятора превышает +65°C. После срабатывания защиты от перегрева батарея автоматически отключается, что, в свою очередь, приводит к выключению прибора.

Функции пассивной защиты

Защита от включения с обратной полярностью при заряде. Защитный диод предотвращает повреждение прибора и потерю данных при подаче на клеммы аккумуляторной батареи напряжения заряда с обратной полярностью.

Первичная защита от перегрева. Самовосстанавливающийся предохранитель с положительным температурным коэффициентом, включенный последовательно между элементами литий-ионной аккумуляторной батареи и транзисторами цепей заряда и разряда, разрывает цепь и ограничивает протекание тока к полюсам батареи при очень высоких значениях температуры. Схема защиты может быть возвращена в исходное состояние только при устранении условий, вызвавших ее срабатывание.

Вторичная защита от перегрева. Второй самовосстанавливающийся предохранитель с положительным температурным коэффициентом, встроенный в каждый элемент литий-ионной аккумуляторной батареи, разрывает цепь и ограничивает протекание тока при очень высоких значениях температуры.

Третичная защита от перегрева. Устройство прерывания тока (CID) в каждом элементе литий-ионной аккумуляторной батареи навсегда необратимо без возможности восстановления разрывает цепь, когда температура достигает +95°C. Поскольку при срабатывании защиты предохранитель в каждом элементе аккумулятора разомкнут необратимо, характеристики батареи значительно ухудшаются, вплоть до полной потери работоспособности аккумулятора.

Предохранитель для защиты от перегрузки по току. Одноразовый плавкий предохранитель с номинальным током 12 А.

Правила безопасного обращения с аккумуляторными батареями и их утилизации

Информация о безопасном обращении с аккумуляторными батареями и их утилизации приведена в паспорте безопасности производителя батареи (SDS). С паспортами безопасности аккумуляторных батарей можно ознакомиться по адресу: https://regulations.about.keysight.com/msds/default.htm

Транспортировка аккумуляторных батарей

На аккумуляторные батареи обычно распространяются особые правила транспортировки, указанные в паспорте безопасности (SDS). Кроме того, получить информацию о требованиях к транспортировке аккумуляторных батарей можно в транспортном отделе.

Меры безопасности
Маркировка аккумуляторных батарей

Маркировка аккумуляторных батарей

Знак CE указывает на то, что изделие отвечает требованиям всех применимых директив ЕС (если рядом со знаком приведен год, то это означает год, в который изделие прошло соответствующие испытания).

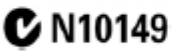
Детали аккумуляторных батарей могут подлежать вторичной переработке. Ознакомьтесь с региональным и национальным законодательством по этому вопросу.

Утилизируйте их надлежащим образом. Выбрасывать аккумуляторные батареи запрещается. Они подлежат сбору как незначительные химические отходы.

Утилизируйте отслужившие аккумуляторные батареи надлежащим образом. Ознакомьтесь с региональным и национальным законодательством по этому вопросу.

Храните аккумуляторные батареи вдали от источников чрезмерного нагрева. Запрещается утилизировать отслужившие аккумуляторные батареи путем сжигания.

Сертификаты UL действительны в США и Канаде.



Знак C-Tick является зарегистрированной торговой маркой Australian Spectrum Management Agency.

Знак RCM является зарегистрированной торговой маркой Australian Communications and Media Authority.

Знак корейской сертификации KC включает в себя идентификационный код следующего формата:
KCC-REM-YYY-ZZZZZZZZZZZZZZ или
MSIP-REM-YYY-ZZZZZZZZZZZZZZ

Руководство по эксплуатации Keysight N9938-90003

Меры безопасности
Маркировка аккумуляторных батарей

Стандартный регистрационный знак Индийского бюро стандартов (Bureau of Indian Standards, BIS).

В этом символе указывается период времени, в течение которого при условии нормальной эксплуатации прибор не станет источником опасных или токсических веществ. Ожидаемый срок службы изделия составляет 10 лет.

Этот символ обозначает срок экологически безопасного использования (EPUP) содержащего токсичные вещества изделия в соответствии с требованиями нормативных документов КНР по ограничению использования опасных веществ (RoHS).

F: Keysight Software End-User Licensing Agreement (EULA)

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