
B1500A Semiconductor Device Analyzer

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This product has been designed and tested in accordance with accepted industry standards, and has been supplied in a safe condition. To review the Declaration of Conformity, go to <http://www.keysight.com/go/conformity>.

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Portions of the software are licensed by third parties, including open source terms and conditions.

To get the text of the license, use the Graphical Web Interface of the instrument.

You can also visit www.keysight.com and type the model number in the search field to get the text of the license.

Contact Keysight to obtain the source code. Keysight may charge for shipping.

Latest Information

To get the latest firmware/software/electronic manuals/specifications/support information, go to www.keysight.com and type in the product number in the Search field at the top of the page.

COMPLIANCE WITH GERMAN NOISE REQUIREMENTS

This is to declare that this product is in conformance with the German Regulation on Noise Declaration for Machines (Lärmangabe nach der Maschinenlärminformation-Verordnung -3.GSGV Deutschland).

- Herstellerbescheinigung
GERÄUSCHEMISSION
Lpa < 70 dB
am Arbeitsplatz
normaler Betrieb
nach DIN 45635 T. 19
- Manufacturer's Declaration
ACOUSTIC NOISE EMISSION
Lpa < 70dB
operator position
normal operation
per ISO 7779

South Korean Class A EMC declaration

This equipment is Class A suitable for professional use and is for use in electromagnetic environments outside of the home.

A급 기기

(업무용 방송통신기자재)

이 기기는 업무용(A급) 전자파적합기기로서 판매자 또는 사용자는 이 점을 주의하시기 바라며, 가정외의 지역에서 사용하는 것을 목적으로 합니다.

Safety Summary

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual may impair the protections provided by the instrument. In addition, it violates safety standards of design, manufacture, and intended use of the instrument. Keysight Technologies assumes no liability for customer's failure to comply with these requirements.

Product manuals may be provided on CD-ROM or in printed form. Printed manuals are an option for many products. Manuals may also be available on the Web. Go to www.keysight.com and type the product model number in the Search field at the top of the page.

NOTE

Do not use this instrument in any manner not specified by the manufacturer. The protective features of this instrument may be impaired if it is used in a manner not specified in the operation instructions.

This instrument is an INDOOR USE product.

This instrument complies with OVERVOLTAGE CATEGORY II for mains input and POLLUTION DEGREE 2 defined in IEC 61010-1.

If an instrument is marked CAT I (IEC Measurement Category I), or it is not marked with a measurement category, its measurement terminals must not be connected to line-voltage mains.

Safety of any system incorporating the equipment is the responsibility of the assembler of the system.

WARNING

Hazardous voltage, instrument maximum output voltage may appear at the measurement terminals (Force, Guard, and Sense) if Interlock terminal is closed. Open the Interlock terminal when the measurement terminals are accessible. Voltage applied to the terminals will be limited up to ± 42 V.

Do not work the interlock function intentionally in order to bring the output voltage to the safe level. While the high voltage indicator is lit, the dangerous voltage by the output voltage or the residual charge appears on the measurement terminal.

- DANGEROUS PROCEDURE WARNINGS

Warnings, such as WARNING on the previous page, shall be complied. Procedures throughout in this manual prevent you from potentially hazard. Their instructions contained in the warnings must be followed.

- BEFORE APPLYING POWER

Verify that all safety precautions are taken. Make all connections to the instrument before applying power. Note the instrument's external markings described under "Safety Symbols".

- GROUND THE INSTRUMENT

This is Safety Class I instrument. To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The power terminal and the power cord must meet International Electrotechnical Commission (IEC) safety standards.

- DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

- DO NOT REMOVE COVERS

No operator serviceable parts inside. Refer servicing to qualified personnel. To prevent electrical shock do not remove covers.

- IN CASE OF DAMAGE

Instruments that appear damaged or defective should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel. Return the instrument to a Keysight Technologies sales or service office for services and repair to ensure that safety features are maintained.

- USE ONLY THE SPECIFIC ACCESSORIES

Specific accessories satisfy the requirements for specific characteristics for using the instrument. Use the specific accessories, cables, adapters, and so on for safety reasons.

Safety Symbols

The general definitions of safety symbols used on equipment or in manuals are listed below.

- Direct current.
- ~ Alternating current.
- ⊕ Earth (ground) terminal.
- Protective conductor terminal. For protection against electrical shock in case of a fault. Used with field wiring terminals to indicate the terminal which must be connected to ground before operating equipment.
- △ Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.
- ⊥ Grounded terminal which indicates the earth potential.
- | On supply.
- Off supply.
- Standby supply. The equipment will be marked with this symbol if not completely disconnected from AC mains when power switch is in the standby position.
- In position of a bi-stable push switch.
- Out position of a bi-stable push switch.
- ⚡ Hazardous voltage and potential for electrical shock. Do not touch terminals that have this symbol when the equipment is on.
- ⚠ Hot surface. Avoid contact. Surfaces are hot and may cause personal injury if touched.
- ⚠ Caution, refer to accompanying documentation. The equipment will be marked with this symbol when it is necessary for the user to refer to the instruction manual.

WARNING

The warning sign denotes a hazard. It calls attention to a procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in injury or death to personal.

CAUTION

The caution sign denotes a hazard. It calls attention to an operating procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the equipment.



Read operator's manual. To indicate that the operator's manual or card should be read before continuing the operation.

CAT I IEC Measurement Category I



The CE mark shows that the product complies with all applicable European Directives.



The CSA mark is a registered trademark of the Canadian Standards Association.



The RCM mark is a registered trademark of the Australian Communications Authority. This signifies compliance with the Australian EMC Framework Regulations under the terms of the Radio communications Act.

This ISM device complies with Canadian ICES-001.

Cet appareil ISM est conforme à la norme NMB-001 du Canada.

CAN ICES/NMB-001(A)

This ISM device complies with Canadian ICES-001 Class A.

Cet appareil ISM est conforme à la norme NMB-001 classe A du Canada.

**ISM GROUP 1
CLASS A**

This is the symbol for an Industrial, Scientific and Medical, Group 1 Class A product. (CISPR 11)



The UKCA mark shows that the product complies with all applicable UK regulations.



Korea's safety and EMC mark



China RoHS - Environmentally Green Product Label



China RoHS - Product with Toxic Substance 40 yr EPU



The Chinese mark for paper-based packaging materials; Paperboard and Corrugated Fiberboard



Plastic Material Coding Identification



Low temperature or freezing conditions. Avoid contact. Surfaces are cold and may cause personal injury if touched.

Power Supply and Measurement Safety

- Power Supply Safety

This instrument can output high currents and voltages. Make sure that the load or device under test can safely handle the output current and voltage. Also, make sure that the connection leads can safely withstand the expected currents and are insulated for the expected voltages.

The instrument outputs may be connected so as to float relative to earth ground. Isolation or floating voltage ratings are indicated on the instrument, near the output terminal or the Circuit Common terminal. There is the danger of electric shock by touching the floated measurement terminals. Keep in mind it to protect yourself. And it is a reason of using the recommended accessories.

- Voltage/Current Measurement Safety

Multimeters and other instruments capable of measuring high voltages and currents are subject to specific safety concerns because of the circuits to which they may be connected. To safely use these instruments, you need to understand the markings on the instrument near the input terminals, which include the Protection Limits and the IEC Measurement Category.

- Protection Limits

Keysight multimeters and other voltage measurement instruments provide protection circuitry to prevent damage to the instrument and to protect against the danger of electric shock, provided the Protection Limits are not exceeded. To ensure safe operation of the instrument, do not exceed the Protection Limits shown on the input terminals.

- Source/Monitor Terminals

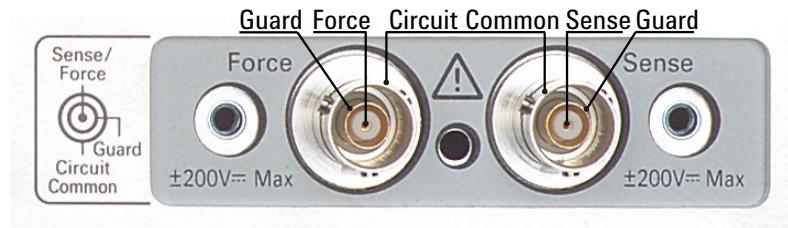
Source/monitor unit, SMU, can simultaneously perform DC voltage or current output and measurement. Typical SMU has the Force, Guard, Sense, and Circuit Common terminals as shown below. Normally the Force, Guard, and Sense terminals are the same potential. Voltage marked around the terminals indicates the Protection Limits.

Force and Sense must be connected to a terminal of a device under test for the Kelvin connection which is effective for high current measurement and low resistance measurement. For the non-Kelvin connection to ease the connections, connect Force only. Do not connect Sense. It must be opened.

Guard should be extended to around the device terminal for reducing leakage current caused by a coaxial cable used. Guard must be never connected to anything at the device side.

Circuit Common should be connected to shielding of the coaxial cable used.

The following image is the Kelvin triaxial connector of High Power SMU.





High Voltage Shock Hazard

Keysight B1500A can force dangerous voltages (± 200 V for HPSMU and ± 100 V for MPSMU/HRSMU) at the High, Force, Sense, and Guard terminals. To prevent electric shock hazard, the following safety precautions must be observed during the use of Keysight B1500A.

- Use a three-conductor AC power cord to appliance coupler (inlet) and the instrument to an electric ground (safety ground).
- Prepare shielding box which covers interface to a device under test and equipped with interlock circuit that opens when the door is opened.
- Before performing measurement, connect the interlock circuit to the Interlock terminal of this instrument.
- Confirm periodically that the interlock function works normally.
- Before touching the connections of the High/Force/Sense/Guard terminal, turn the instrument off and discharge any capacitors of the measurement path. If you do not turn the instrument off, complete "all" of the following items, regardless of any instrument's settings.
 - Terminate measurement by pressing the Stop key, confirm that the Measurement status indicator is not lit.
 - Confirm that the High Voltage indicator is not lit.
 - Open the shielding box access door (open the Interlock terminal).
 - Discharge any capacitors if the capacitance is connected to an SMU.
 - Warn workers in the vicinity of the instrument about hazardous conditions.



Gefahr durch Hochspannung

Von den Geräten Keysight B1500A können Spannungen an den Anschlüssen "High", "Force", "Sense" und "Guard" von bis zu 200 V ausgehen. Um elektrischem Schlag vorzubeugen, ist bei der Benützung der Geräte Keysight B1500A folgendes zu beachten.

- Verwenden Sie ein dreiphasiges AC-Stromkabel für die Gerätsteckvorrichtung (Eingang) und schließen Sie das Instrument an eine Erdung an (Sicheritserdung).
- Bereiten Sie das Abschirmungsgehäuse vor, dass die Oberfläche eines zu testenden Geräts abdeckt und mit einem Verriegelungsstromkreis ausgestattet ist, der bei geöffneter Tür unterbrochen wird.
- Vor der Messung verbinden Sie den Verriegelungsstromkreis mit dem Interlock-Anschluss dieses Instruments.
- Prüfen Sie in regelmäßigen Abständen, dass die Verriegelungsfunktion ordnungsgemäß funktioniert.
- Bevor Sie die Verbindungen zu den Anschlüssen "High", "Force", "Sense" und "Guard" berühren, schalten Sie das Instrument aus und entladen alle Kondensatoren des Messwegs. Wenn Sie das Instrument nicht ausschalten, führen Sie, unabhängig von den Instrumenteneinstellungen, alle folgenden Schritte durch.
 - Beenden Sie die Messung, indem Sie auf die Taste "Stop" drücken. Stellen Sie sicher, dass die Statusanzeige "Measurement" nicht leuchtet.
 - Stellen Sie sicher, dass die Anzeige "High Voltage" nicht leuchtet.
 - Öffnen Sie die Tür des Abschirmungsgehäuses (öffnen des Interlock-Anschlusses).
 - Entladen Sie alle Kondensatoren, wenn die Kapazität mit einer SMU verbunden ist.
- Warnen Sie Mitarbeiter in der Umgebung des Instruments vor den Gefahren.



Danger de choc dû à une haute tension

Une tension dangereuse (max. \pm pour HPSMU; 200 Vdc, max. \pm pour MPSMU/ HRSMU; 100 Vdc) émanant du dispositif Keysight B1500A peut être sortie aux bornes High, Force, Sense et Guard. Les précautions suivantes doivent être observées contre commotion électrique accidentelle.

- Utilisez un câble d'alimentation CA à trois conducteurs vers le coupleur secteur (entrée) et branchez l'instrument sur une mise électrique à la terre (prise de terre de sécurité).
- Préparez le boîtier de protection qui couvre l'interface avec le dispositif à tester et équipez-le d'un circuit de sécurité qui s'ouvre lors de l'ouverture d'une porte.
- Avant de procéder aux mesures, connectez le circuit de sécurité à la borne Interlock de l'instrument.
- Vérifiez régulièrement le bon fonctionnement de la fonction de sécurité.
- Avant de toucher les connexions des bornes High, Force, Sense et Guard, mettez l'instrument hors tension et déchargez tout condensateur du chemin de mesure. Si vous ne mettez pas l'instrument hors tension, effectuez « toutes » les opérations ci-dessous, quels soient les paramètres de l'instrument.
 - Terminez les mesures en appuyant sur la touche Stop ; vérifiez que l'indicateur d'état Measurement est éteint.
 - Vérifiez que le témoin High Voltage est éteint.
 - Ouvrez la trappe d'accès au boîtier de protection (ouvez la borne Interlock).
 - Déchargez les éventuels condensateurs si la capacité est connectée à une unité SMU.
 - Informez les personnes travaillant à proximité de l'instrument des conditions.



高電圧感電注意

Keysight B1500A の High/Force/Guard/Sense 端子には、危険電圧が出力されることがあります (HPSMU の場合は最大 ± 200 Vdc、 MPSMU/HRSMU の場合は最大 ± 100 Vdc)。感電事故防止のため、必ず以下の事柄を守ってください。

- ・ 3 極電源ケーブルを使用して本器を接地してください。
- ・ ドアを開くことによって開放されるインターロック回路を装備し、被測定デバイスとのインターフェースを覆うことのできるシールド・ボックスを用意してください。
- ・ 測定を開始する前にはインターロック回路を本器の Interlock 端子に接続してください。
- ・ インターロック機能が正常であることを定期的に確認してください。
- ・ High/Force/Guard/Sense 端子に繋がる接続部に触れる前には、本器の電源を切斷してください。また、測定系のキャパシタを放電してください。電源を切らない場合は、以下の事項を全て実施してください。
 - ・ Stop キーを押して測定を終了し、Measurement インジケータが消灯したことを見認めてください。
 - ・ 高電圧警告 (High Voltage) インジケータが消灯していることを確認してください。
 - ・ シールド・ボックスのドアを開けてください (Interlock 端子を開放してください)。
 - ・ キャパシタが SMU に接続されているならば、キャパシタを放電してください。
- ・ 周囲のほかの作業者に対しても、高電圧危険に対する注意を徹底してください。

Product Stewardship

- Waste Electrical and Electronic Equipment (WEEE)



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 <http://keysight.com/go/takeback> to understand your Trade in options with Keysight in addition to product takeback instructions.

- LCD Fluorescent Lamp

Certain products sold by Keysight contain a liquid crystal display (LCD); backlighting for the LCD is provided by a fluorescent lamp which contains mercury, and must be managed, recycled, and/or disposed in accordance with all applicable laws, ordinances and regulations.

For information on how to recycle or dispose of the fluorescent lamp contained in your own product, visit the following website.

http://about.keysight.com/en/quality/env_compliance.shtml

If you live in the U.S., also visit the following websites.

<http://www.lamprecycle.org>

<http://www.eiae.org>

If you have additional questions, please visit the following website.

<http://www.keysight.com/go/contactus>

- Perchlorate Information

Perchlorate Material - special handling may apply. Visit the following website.

<http://www.dtsc.ca.gov/hazardouswaste/perchlorate/>

Equipment's real-time clock battery or coin cell battery may contain perchlorate and may require special handling when recycled or disposed of in California.

Precautionary Statement

Keysight B1500A Semiconductor Device Analyzer operates in the Microsoft Windows environment. Keysight B1500A requires Keysight EasyEXPERT software, a specially-designed Windows application program.

- About guarantee and support for Keysight B1500A

Keysight Technologies guarantees and supports the performance of Keysight B1500A for the same condition as the preload condition when shipped from the factory.

- About updating Keysight EasyEXPERT and the Windows Update

Keysight Technologies confirms the operation of Keysight EasyEXPERT patch programs and important Windows security patches, and provides recommended update information. Visit Keysight B1500A support site, download the patches, and perform the software update.

- About Windows application programs and peripherals (including driver)

Using commercial products on Keysight B1500A is your responsibility. Keysight Technologies cannot provide compatibility information for commercial products.

- About servicing

Bench repair service is available at your nearest Keysight Technologies service center. Be aware that the B1500A configuration might be updated to the latest one without notice because of support issues.

The internal solid state drive (SSD) might be initialized during servicing. If peripherals are connected, they will be removed.

When Keysight B1500A is returned, the internal SSD might be initialized. Peripherals will be returned separately.

- Other notes

- Back up the internal SSD to prevent loss of data by accident or failure.

- Protect Keysight B1500A from computer viruses.

- If you connect Keysight B1500A to the network, take care to protect it from computer virus.

Working in Comfort

To optimize your comfort and productivity, it is important that you set up your work area correctly and use your instrument properly. With that in mind, we have developed some set-up and use recommendations for you to follow based on established ergonomic principles. Improper and prolonged use of keyboards and input devices are among those tasks that have been associated with repetitive strain injury (RSI) to soft tissues in the hands and arms. If you experience discomfort or pain while using the instrument, discontinue use immediately and consult your physician as soon as possible. For more information on RSI you may wish to consult the About Repetitive Strain Injury section. Please study the recommendations described below. Included there are references to relevant parts of international standards, regulations and guidelines, such as ISO 9241 and the European Community Display Screen Equipment directive. You may also wish to consult your employer's human resources department or other relevant departments for guidance specific to your company.

About Repetitive Strain Injury

Because your comfort and safety are our primary concern, we strongly recommend that you use the instrument in accordance with established ergonomic principles and recommendations. Scientific literature suggests that there may be a relationship between injury to soft tissues -especially in the hands and arms- and prolonged improper use of keyboards or other equipment requiring repeated motions of the hands and forearms. This literature also suggests that there are many other risk factors that may increase the chance of such injury, commonly called Repetitive Strain Injury.

What is RSI?

Repetitive Strain Injury (RSI -also known as cumulative trauma disorder or repetitive motion injury) is a type of injury where soft tissues in the body, such as muscles, nerves, or tendons, become irritated or inflamed. RSI has been a reported problem for those who perform repetitive tasks such as assembly line work, meatpacking, sewing, playing musical instruments, and computer work. RSI also has been observed in those who frequently engage in activities such as carpentry, knitting, housework, gardening, tennis, windsurfing and lifting children.

What causes RSI?

The specific causes of RSI have not been established. Nevertheless, the incidence of RSI has been associated with a variety of risk factors, including:

- Too many uninterrupted repetitions of an activity or motion.
- Performing an activity in an awkward or unnatural posture.

- Maintaining static posture for prolonged periods.
- Failing to take frequent short breaks.
- Other environmental and psychosocial factors.

In addition, there have been reports associating the occurrence of RSI with the use of keyboards, mice, and other input devices. Also, certain medical conditions, such as rheumatoid arthritis, obesity and diabetes, may predispose some people to this type of injury.

What if I experience discomfort?

If you are experiencing any discomfort, seek professional medical advice immediately. Typically, the earlier a problem is diagnosed and treated, the easier it is to resolve.

Mice and Other Input Devices

Various aspects of using mice and other input devices may increase your risk of discomfort or injury. Observing the following recommendations may reduce that risk.

- Try to keep your hand, wrist, and forearm in a neutral position while using your mouse or other input device.
- If you use your thumb to rotate the ball on a trackball or spaceball, keep it in a relaxed, natural shape, and maintain a neutral posture in your hand, wrist, and forearm.
- Hold the mouse gently by draping your fingers over it. Keep your hand relaxed and fingers loose. Do not grip the mouse tightly.
- It takes very little pressure or force from your fingers to activate the buttons or scroll wheel on your mouse, scrolling mouse, trackball, or other input device. Using too much force can place unnecessary stress on the tendons and muscles in your hands, wrists, and forearms.
- If you are using a scrolling mouse, be sure to keep your fingers and hand in a relaxed, neutral position when activating the scroll wheel. Also, this type of mouse features software that can minimize the number of mouse movements or button clicks.
- When using a mouse, trackball, or other input device, position it as close to the keyboard as possible, and keep it at the same level as you do not have to stretch while using it.
- Be sure to keep your mouse and trackball clean. Regular removal of accumulated dust and dirt helps ensure proper tracking and reduces unnecessary hand and wrist motions.

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:

<https://www.keysight.com/find/techsupport>

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:

<https://www.keysight.com/find/b1500a>

To receive the latest updates by email, subscribe to Keysight Email Updates at the following URL:

<https://support.keysight.com>

Information on preventing instrument damage can be found at:

<https://www.keysight.com/find/PreventingInstrumentDamage>

Product and Solution Cybersecurity

Keysight complies with multinational regulations for the cybersecurity of its own products and is committed to providing information to assist you in protecting your products and solutions from external cyber threats. For more information, see:

<https://www.keysight.com/us/en/about/quality-and-security/security/product-and-solution-cyber-security.html>

Keysight also recommends that you secure your IT environments using appropriate third-party tools. For instruments that run the Microsoft Windows operating system, Keysight concurs with Microsoft's recommendations for ensuring that the instrument is protected:

- Get the latest critical Windows updates
- For network-connected instruments, use an Internet firewall (in Keysight instruments, Windows Firewalls enabled by default)
- For network-connected instruments, use up-to-date antivirus and anti-spyware software

Responsible Disclosure Program

Keysight recommends that security researchers share the details of any suspected vulnerabilities across any asset owned, controlled, or operated by Keysight (or that would reasonably impact the security of Keysight and our users) using this form:

<https://www.keysight.com/us/en/contact/responsible-disclosure-program.html>

Report a Product Cybersecurity Issue

If you discover a cybersecurity issue that you suspect may involve Keysight's proprietary software, or third-party software supplied by Keysight as part of a product, or that may affect the operation of Keysight products, we encourage you to report it to us using this form:

<https://www.keysight.com/us/en/about/quality-and-security/security/product-and-solutions-on-cyber-security.html>

Disable and Reduce Unnecessary Access

The instrument comes configured to allow access for remote services which allows flexible measurement configurations and access to data.

You can disable these features if you don't use them.

Windows Firewall is automatically configured with open ports which can be closed, depending on your test application needs.

The following ports are open by default on the B150xA.

Port 5025: Used by EasyEXPERT SCPI Socket

Port 3389: Used by Windows Remote Desktop

Disable these port if you are not using these feature.

In This Manual

This manual describes the product overview and installation information of Keysight Technologies B1500A. This manual consists of the following chapters:

- [Chapter 1, Getting Started](#)

This chapter describes basic operations of Keysight B1500A.

- [Chapter 2, Introduction](#)

This chapter describes basic features of Keysight B1500A.

- [Chapter 3, Installation](#)

This chapter describes installation, device connection, and maintenance.

- [Chapter 4, Accessories and Options](#)

This chapter describes accessories and options of Keysight B1500A.

NOTE

For the specifications of the B1500A, see Data Sheet.

To get the latest Data Sheet, go to www.keysight.com/find/b1500a and click “Technical Support” and “Specifications”.

NOTE

The information is subject to change without notice due to the future enhancement.

The actual screen image on the B1500A may be different from the image shown in this manual.

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4. Accessories and Options

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1

Getting Started

This chapter describes the basic operations of Keysight B1500A. Before learning the product details, let's try to use the B1500A briefly. The operations need the B1500A, power cord, and USB keyboard only (USB mouse and stylus pen are optional). Keysight B1500A also requires Keysight EasyEXPERT software as its graphical user interface.

During the operations, you will not connect device under test. Open all measurement terminals.

This chapter consists of the following sections.

- “To Turn On/Off B1500A”
- “To Launch EasyEXPERT”
- “To Use Tracer Test Mode”
- “To Use Application Test Mode”
- “To Use Classic Test Mode”
- “To Perform Measurement”
- “To Use Analysis Tools”

NOTE

If you are using the B1500A for the first time

If this is the first time to turn Keysight B1500 on after the delivery, you need to perform the initial setup of the B1500. See “[Inspection and Installation](#)” on page [3-8](#). After the initial setup and if no users are added, you can automatically logon as “Keysight B1500 User” account without password.

To Turn On/Off B1500A

NOTE

When turning the B1500A on

Open the measurement terminals at the device side when turning the B1500A on. Also disconnect the device from the measurement terminals and open the measurement terminals after the test. If you leave the connection with the device, the device may be damaged by unexpected operations or charge-up of measurement cables.

NOTE

If the Start EasyEXPERT button is not displayed

Select All Programs > Start EasyEXPERT from the Start menu. The Start EasyEXPERT button will be displayed.

NOTE

Automatic start function

If the automatic start function is on, EasyEXPERT is launched within the B1500A boot up process. If the function is off, EasyEXPERT is not launched and the Start EasyEXPERT button is displayed.

To turn the automatic start function off, use the Start EasyEXPERT window displayed by the File > Exit menu on the EasyEXPERT main screen. And remove the check from the Option > Auto Start of EasyEXPERT menu.

NOTE

If EasyEXPERT does not run

Launch “Keysight Connection Expert” by using the icon on Windows taskbar. And check the USB0 connection status displayed in “Instrument I/O on this PC” area.

USB0 connection status display example:

```
USB0
+ B1500A(USB0::2391::1::0001::0::INSTR)
  + agb1500a
  + UsbDevice1
```

If “agb1500A” and “UsbDevice1” are not listed, add them by using a dialog box which is opened by right-clicking on B1500A(USB0::2391::1::0001::0::INSTR) and selecting “Add VISA Alias” from the menu. For more information, see *Connectivity Guide* opened from the Help menu on the Connection Expert window.

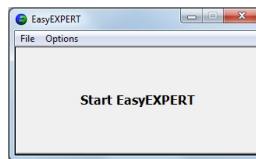
Getting Started

To Turn On/Off B1500A

To Turn B1500A On

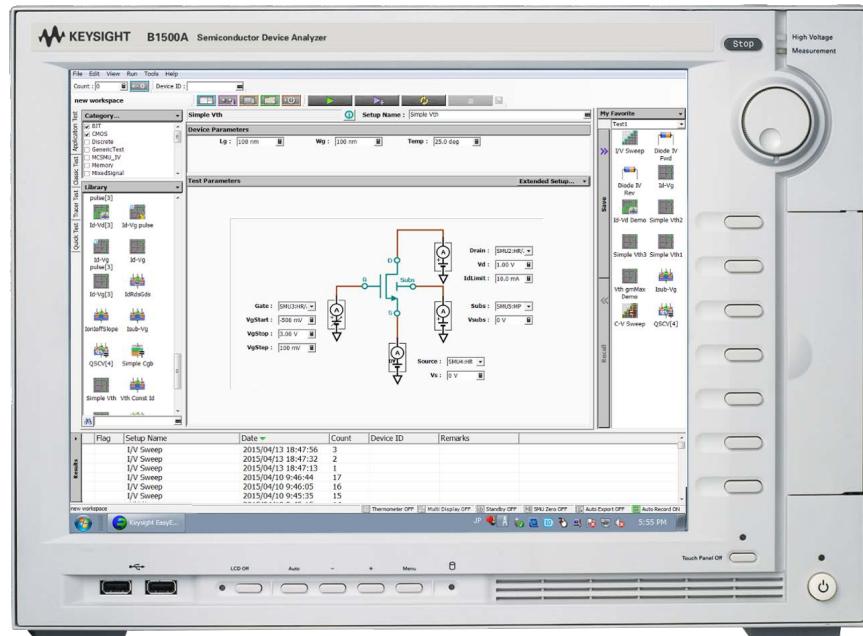
1. Connect the power cord from Keysight B1500A to an AC power outlet.
2. Connect the USB keyboard to the B1500A. Optionally, connect the USB mouse to the B1500A.
3. Press the Standby switch (lower right corner of the front panel). Windows, measurement module initialization, and self-calibration will start. For the Windows logon screen, log on Windows.

After logging on, the Start EasyEXPERT button will be displayed on the screen, or EasyEXPERT will be launched if the automatic start function is on.



To Turn B1500A Off

Press the Standby switch (lower right corner of the front panel). Windows will be shutdown and the B1500A will become the standby state.



NOTE

Keysight B1500A has the following front panel user interface.

- Stop
Stops the present measurement or source output immediately.
- Rotary knob
Rotating the knob moves the marker on the graph window, or increases/decreases/changes the value in the active entry field.
Pressing the knob sets or enters the value.
- Softkeys
Seven softkeys are available. Used to select one for the entry field specified or the dialog box. They are also used to recall the test definitions (pre-defined test setups).
- Touch Panel Off
Enables or disables the touch screen operation.
- Standby switch
Turns the B1500A on. Pressing the button in the ON state makes the B1500A in the standby state.
- LCD Off
Enables or disables the LCD panel. LED lights when the LCD is disabled.
- +, -, Set, Cancel
Four keys are available for adjusting brightness. Use + and – to adjust it and then press *Set* to fix it. Pressing *Cancel* instead of *Set* cancels the adjustment.

Keysight B1500A also requires Keysight EasyEXPERT software as its graphical user interface. You can operate Keysight EasyEXPERT by using the touch panel. Use your fingers, stylus pen, and so on for the touch panel operation. The USB keyboard and the USB mouse are also available for operating the EasyEXPERT.

To remove USB devices from the B1500A, use “Safely Remove Hardware” on Windows taskbar. If it is not used, the B1500A may cause the internal USB communication error. If the error occurs, turn the B1500A off and disconnect the power cord from the B1500A. Leave it about 30 seconds before rebooting the B1500A, and connect the power cord again, and then turn the B1500A on.

To Launch EasyEXPERT

1. If the automatic start function is off, the Start EasyEXPERT button is displayed. Click the button and wait until the EasyEXPERT main screen or workspace selection screen is displayed.



NOTE

Workspace is the space created in Keysight B1500A's internal solid state drive, and is used to store the test setup, test result data, and so on. The workspace can be created and allocated for each user.

2. If this is the first time to start the EasyEXPERT, or if no workspace exists, a workspace will be created automatically.

Skip to “[To Use Tracer Test Mode](#)” on page 1-10, “[To Use Application Test Mode](#)” on page 1-12, or “[To Use Classic Test Mode](#)” on page 1-14.

3. If only one workspace exists, the B1500A displays the screen as shown in [Figure 1-1](#).

Skip to “[If Only One Workspace Exists](#)” on page 1-7.

4. If two or more workspaces exist, the B1500A displays the screen as shown in [Figure 1-3](#).

Skip to “[To Select Workspace](#)” on page 1-9.

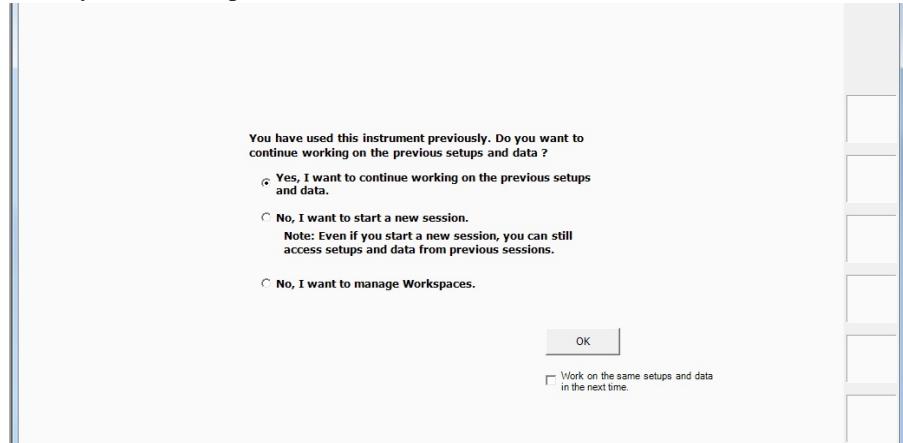
If Only One Workspace Exists

For the screen as shown in [Figure 1-1](#), perform the following steps.

- If you do not want to create a workspace, select the *Yes* radio button and click OK. Skip to [“To Use Tracer Test Mode” on page 1-10](#), [“To Use Application Test Mode” on page 1-12](#), or [“To Use Classic Test Mode” on page 1-14](#).
- If you want to create a workspace, select the *No, I want to start a new session* radio button and click Next. The B1500A displays the screen as shown in [Figure 1-2](#). Skip to [“To Create Workspace” on page 1-8](#).
- If you want to manage workspaces, select the *No, I want to manage Workspaces* radio button and click Next. The B1500A displays the screen as shown in [Figure 1-3](#). Skip to [“To Select Workspace” on page 1-9](#).

Figure 1-1

If Only One Workspace Exists



NOTE

Work on the same setups and data next time

If this check box is checked, the workspace selection screen will be skipped at the next startup and EasyEXPERT will be launched with the workspace used at the last operation. To perform this setup again, click the File > Close Workspace menu on the EasyEXPERT main screen.

To Create Workspace

For the screen as shown in [Figure 1-2](#), perform the following steps. To cancel creating workspace, click Prev.

1. Enter the name of the new workspace into the above-entry field.

Check *Allow other users to access this workspace* box if you want to create a public workspace that is opened for all users.

2. If you are the owner of the existing workspace, you can change the name of the existing workspace.

If you want to rename the existing workspace, enter the name into the below-entry field.

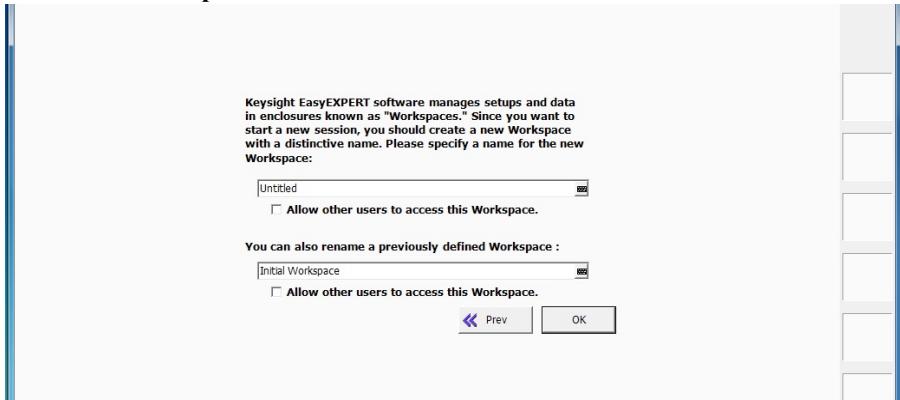
Check *Allow other users to access this workspace* box if you want to set it to a public workspace that is opened for all users.

3. Click OK.

Skip to “[To Use Tracer Test Mode](#)” on page 1-10, “[To Use Application Test Mode](#)” on page 1-12, or “[To Use Classic Test Mode](#)” on page 1-14.

Figure 1-2

To Create Workspace



To Select Workspace

For the screen as shown in [Figure 1-3](#), perform the following steps. This example selects the workspace named as *test* that is a private workspace.

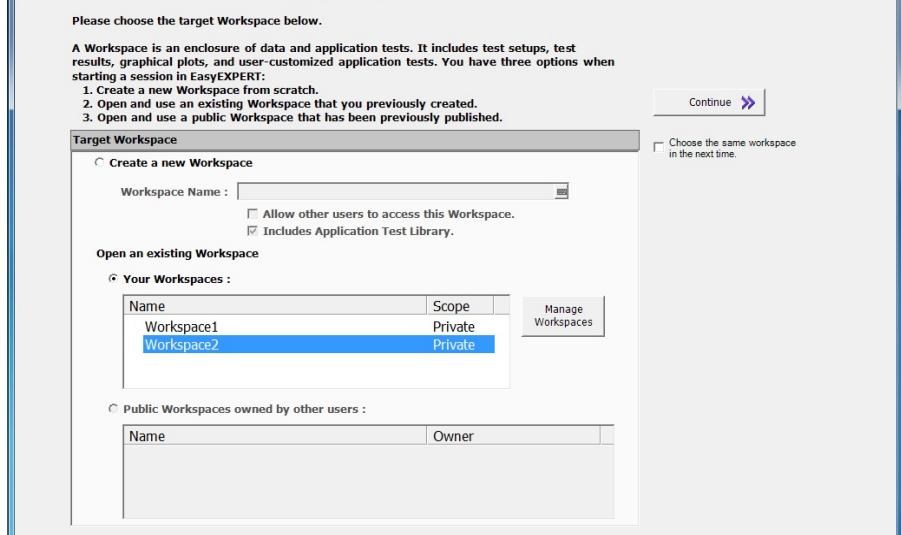
1. Select *Your Workspaces* radio button.
2. Select *test* and click Continue.

Skip to “[To Use Tracer Test Mode](#)” on page 1-10, “[To Use Application Test Mode](#)” on page 1-12, or “[To Use Classic Test Mode](#)” on page 1-14.

If you want to manage workspaces, click the *Manage Workspaces* button. See *Keysight EasyEXPERT User’s Guide*.

Figure 1-3

To Select Workspace



NOTE

Choose the same Workspace in the next time

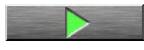
If this check box is checked, the workspace selection screen will be skipped at the next startup and EasyEXPERT will be launched with the workspace used at the last operation. To perform this setup again, click the *File > Close Workspace* menu on the EasyEXPERT main screen.

To Use Tracer Test Mode

The following procedure performs the tracer test setup.

1. Click the Tracer Test tab on the main screen. The tab is in the leftmost column on the screen. The I/V Trace screen is displayed. See [Figure 1-4](#).
2. Set the channels at the field below the graph as shown in [Table 1-1](#).
3. Set the measurement condition at the right field of the graph as shown in [Table 1-3](#).
4. Set the graph display condition at the field below the graph as shown in [Table 1-2](#).

To enter the value, use the USB keyboard or the screen/numeric keyboard opened by clicking the right button of the entry field.

To start measurement, click  for the single measurement or  for the repeat measurement.

If the Stop field is highlighted, the range of measurement and graph display can be changed by using the rotary knob during the repeat measurement.

Table 1-1
I/V Trace Channel Setup

Unit	V Name	I Name	Mode ^a	Function
SMU1	V1	I1	V	VAR1
SMU2	V2	I2	V	CONST

a. Channel output mode. Set I or IPULSE for the current output and voltage measurement. Set V or VPULSE for the voltage output and current measurement.

Table 1-2
I/V Trace Graph Setup

	Name	Scale			Name	Scale	
Y↑	I1	LIN	±	→ X	V1	LIN	±

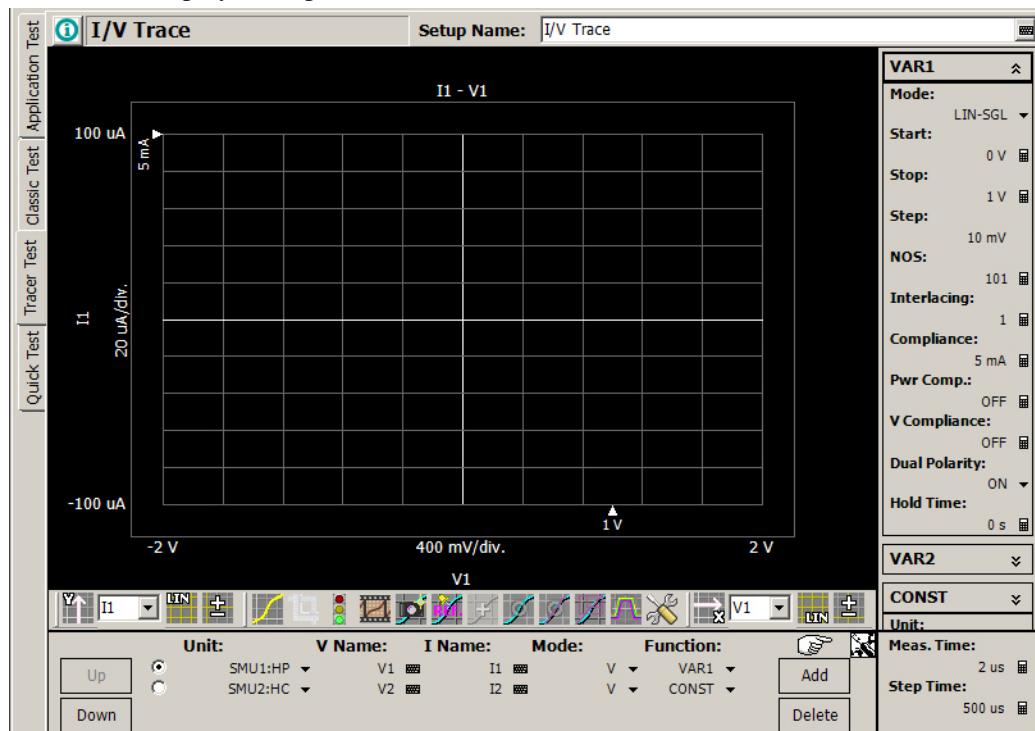
Table 1-3

I/V Trace Measurement Setup

VAR1		CONST	
Mode	LIN-SGL	Unit	SMU2
Start	0 V	Source	0 V
Stop	1 V	Compliance	5 mA
Step	10 mV		
NOS	101		
Interlacing	1		
Compliance	5 mA		
Pwr Comp.	OFF	Meas. Time	2 us
Dual Polarity	ON	Step Time	500 us

Figure 1-4

Display Example of I/V Trace Screen

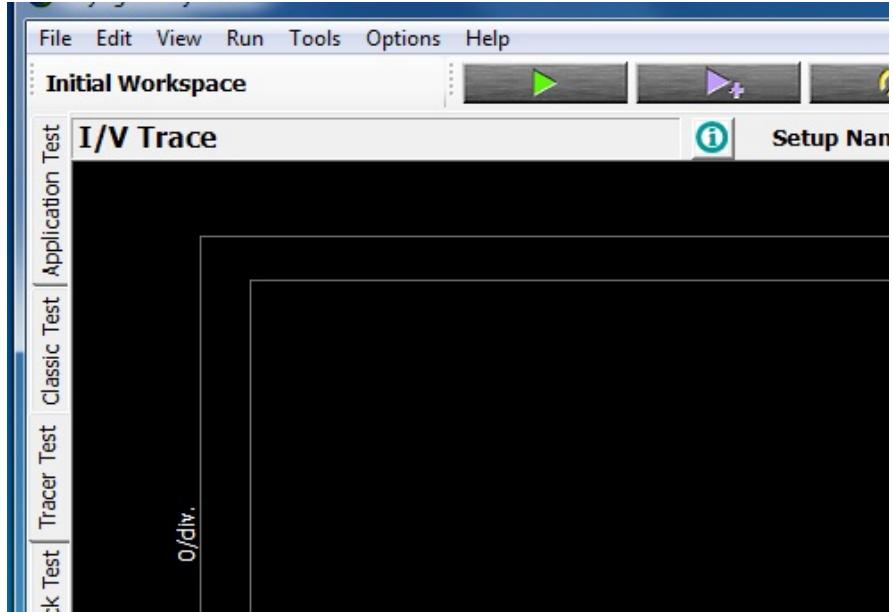


To Use Application Test Mode

For the screen as shown in [Figure 1-5](#), perform the following procedure.

Figure 1-5

Display Example of EasyEXPERT Main Screen



1. Click the Application Test tab on the main screen. The tab is in the leftmost column on the screen.
2. Set the Category field. For example, check the CMOS only. The Library field lists the test definitions.
3. Select a test definition at the Library field. For example, click the *Id-Vg* and *Select* button sequentially. The screen changes the display as shown in [Figure 1-6](#).
4. Change the measurement conditions at the Test Parameters field.
The following example changes the voltage sweep output.
 - a. Set VgStart to 0 V and VgStep to 0.2 V.
 - b. Set VsubStep to -1.0 V.

To enter the value, use the USB keyboard or the screen/numeric keyboard opened by clicking the right button of the entry field.

See “[To Perform Measurement](#)” on page 1-16 to start measurement.

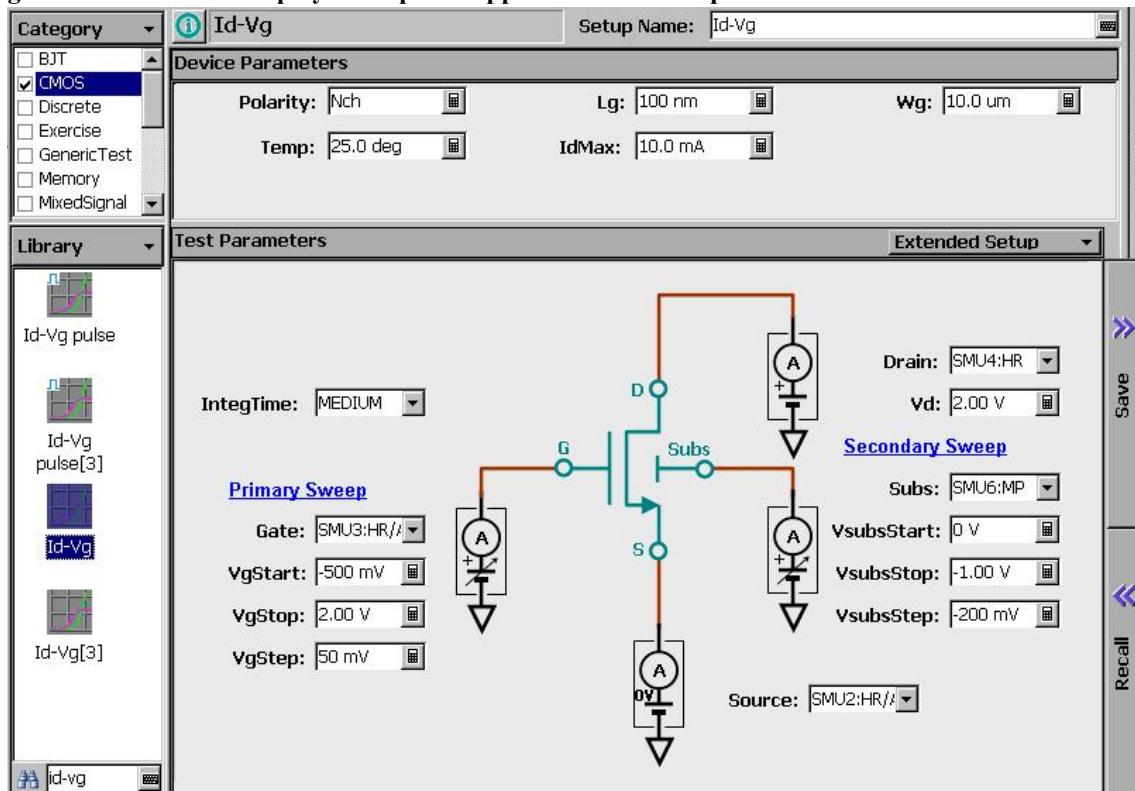
NOTE

Test Definitions

Test definitions are the built-in test setups that have been defined and stored in the EasyEXPERT as the application library. The EasyEXPERT contains more than two hundred test definitions. You can execute the test without modifications. Also you can create your own test setup/definition by making any changes. All furnished test definitions are just sample. Keysight Technologies is NOT LIABLE for any damages caused by the samples.

Figure 1-6

Display Example of Application Test Setup Screen



To Use Classic Test Mode

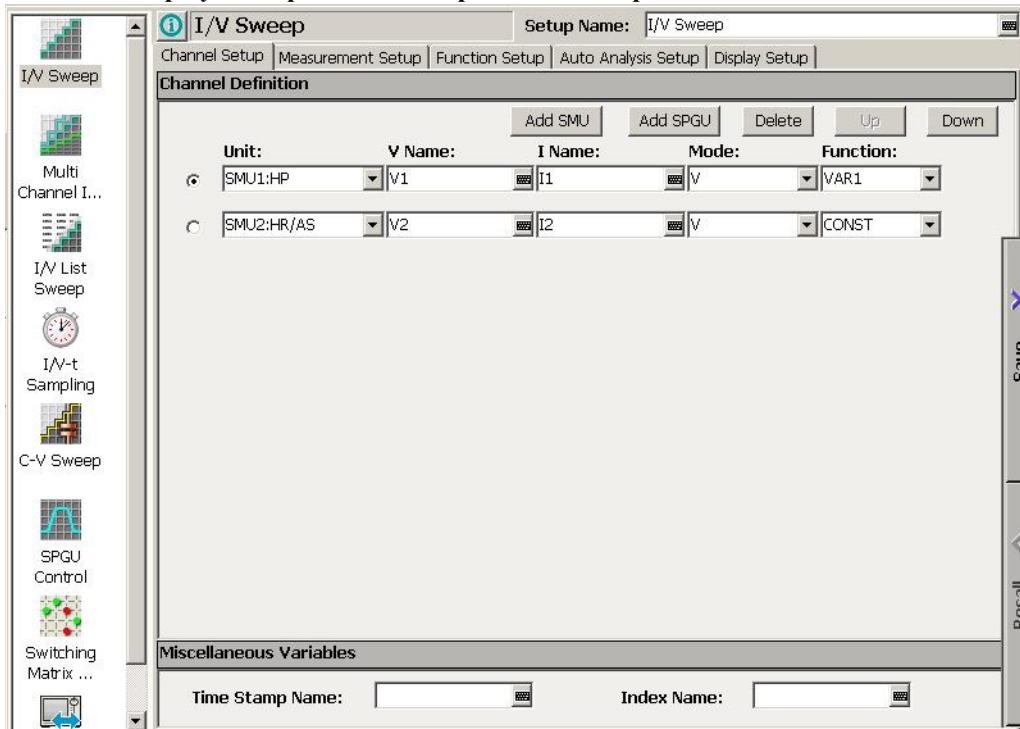
The following procedure performs the I/V Sweep classic test setup.

1. Click the Classic Test tab on the main screen. The tab is in the leftmost column on the screen.
2. Click I/V Sweep and Select button sequentially. The I/V Sweep Channel Setup screen is displayed. See [Figure 1-7](#).
3. Set the Channel Setup parameters as shown in [Table 1-4](#).
4. Click the Measurement Setup tab and set the parameters as shown in [Table 1-5](#).
5. Click the Display Setup tab and set the parameters as shown in [Table 1-6](#).

To enter the value, use the USB keyboard or the screen/numeric keyboard opened by clicking the right button of the entry field.

Figure 1-7

Display Example of I/V Sweep Channel Setup Screen



See “To Perform Measurement” on page 1-16 to start measurement.

Table 1-4

I/V Sweep Channel Setup

Unit	V Name	I Name	Mode ^a	Function
SMU1	V1	I1	V	VAR1
SMU2	V2	I2	V	CONST

a. Channel output mode. Set I or IPULSE for the current output and voltage measurement. Set V, VPULSE, or COMMON for the voltage output and current measurement.

Table 1-5

I/V Sweep Measurement Setup

VAR1		Timing		Constants	
Unit	SMU1	Hold	0 s	Unit	SMU2
Name	V1	Delay	0 s	V Name	V2
Direction	Single			I Name	I2
Linear/Log	LINEAR			Mode	V
Start	0 V			Source	0 V
Stop	1 V			Compliance	100 mA
Step	10 mV				
No of Step	101				
Compliance	100 mA				
Pwr Comp	OFF	Sweep	CONTINUE AT ANY		status

Table 1-6

I/V Sweep Display Setup

	Name	Sharing	Scale	Min	Max
X	V1	(None)	Linear	0 V	1 V
Y1	I1	(None)	Linear	-1 pA	1 pA

To Perform Measurement

1. Click the Single button (upper right on the main screen) to start measurement. This opens the Data Display window and starts a single sweep measurement.

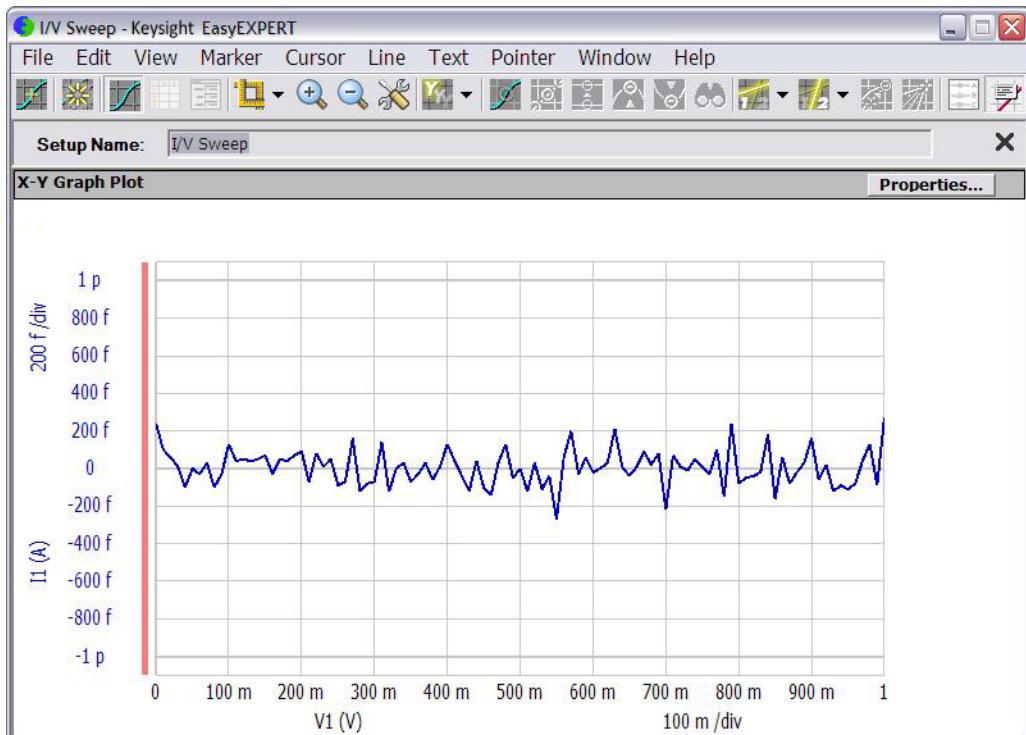


After the measurement, the measurement data is displayed on the Data Display window. For the measurement after performing “[To Use Classic Test Mode](#) on [page 1-14](#), you will have the test result as shown in [Figure 1-8](#). This is the leakage current measurement result because all measurement terminal is opened for performing the procedures described in this chapter.

2. If the automatic data record function has been set to ON (Auto Record ON), Test Result Editor appears on the lower area of the screen when the measurement is completed. See “[To Use Test Result Editor](#)” on [page 1-17](#).

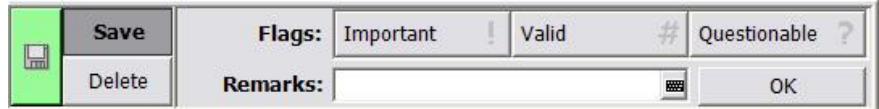
Figure 1-8

Display Example of Data Display Window



To Use Test Result Editor

The Test Result Editor provides the following GUI to set a flag and remarks to the test result record.



- Save button and Delete button

Divides test records into groups, Save and Delete.

Test records in Save-group are always listed in the lower area of the EasyEXPERT main screen.

Test records in Delete-group can be listed when Results > Filter > Show Deleted Data is checked.

- Flags buttons

The following buttons are available. You can set one of the following flags.

- Important ! button

Sets the important flag (!) to the test result record.

- Valid # button

Sets the valid flag (#) to the test result record.

- Questionable ? button

Sets the questionable flag (?) to the test result record.

- Remarks field

You can enter characters into this field. The characters will be recorded as the Remarks value of the test result record.

- OK button

Applies the setup on the Test Result Editor, and closes this dialog box.

To Use Analysis Tools

The Data Display window provides several analysis functions.

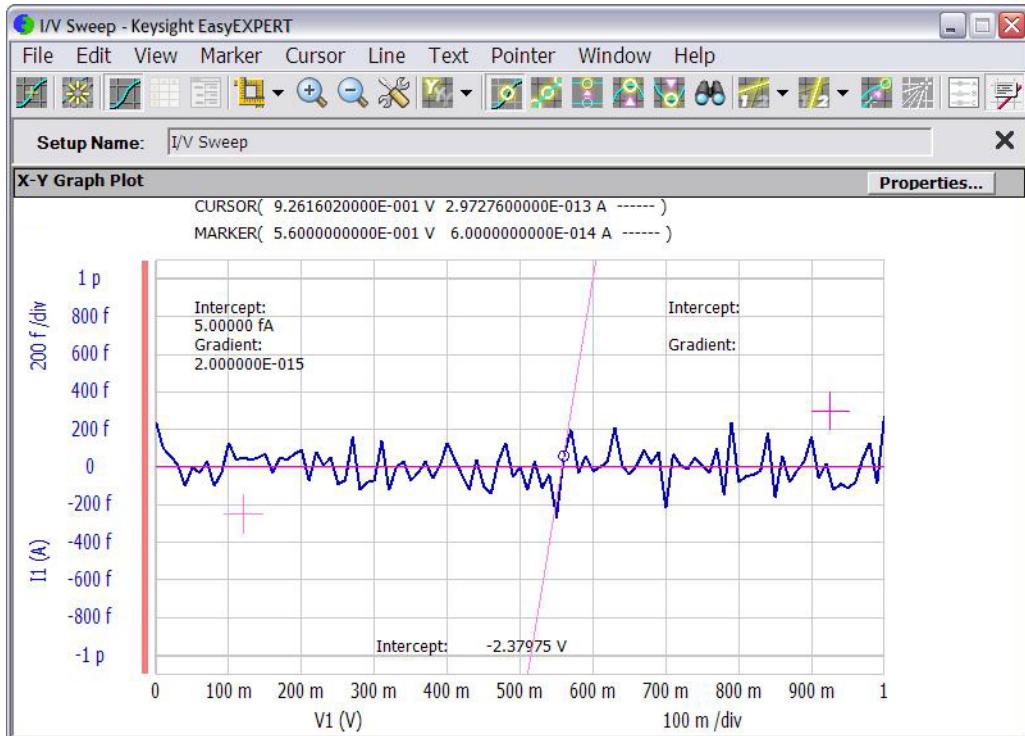
- View menu: used to adjust the graph scale.
- Marker menu: used to display and control the marker.
- Cursor menu: used to display and control the cursor.
- Line menu: used to display and control the lines.

When the marker, cursor, and lines are effective, their parameters are also displayed on the X-Y Graph Plot area.

Figure 1-9 is an example displaying marker, tangent line, and regression line on the test result graph shown in **Figure 1-8**. You can read position of the marker and the active cursor, and interrupt and gradient of the active line.

Figure 1-9

Display Example of Analysis Tools



2

Introduction

This chapter describes the basic functions and features of Keysight B1500A Semiconductor Device Analyzer, and consists of the following sections:

- “Overview”
- “Front View”
- “Rear View”
- “Measurement Modules”

NOTE

Application Library

Keysight B1500A has installed Keysight EasyEXPERT software as the user interface. The EasyEXPERT contains an application library that is a set of test definitions. The application test can be performed by selecting a test definition and setting the test condition for the actual DUT (device under test).

All test definitions are just sample. If the samples damage your devices, Keysight Technologies is NOT LIABLE for the damage.

NOTE

Furnished Sample Programs (Utility)

The following sample programs are stored in the following folder.

- <program folder>\Agilent\B1500\EasyEXPERT\Utilities\
Prober control programs
sleep.exe program
- <program folder>\Agilent\B1500\EasyEXPERT\415xC\Conversion\
4155/4156 setup file converter
- <program folder>\Agilent\B1500\EasyEXPERT\IC-CAP Support\MDM\
MDM file converter for IC-CAP users

Where, <program folder> is as follows. Then, <system drive> is the drive the EasyEXPERT has been installed.

For Windows 10/7 64 bit version, <system drive>:\Program Files (x86)

For Windows 10/7 32 bit version, Vista, or XP, <system drive>:\Program Files

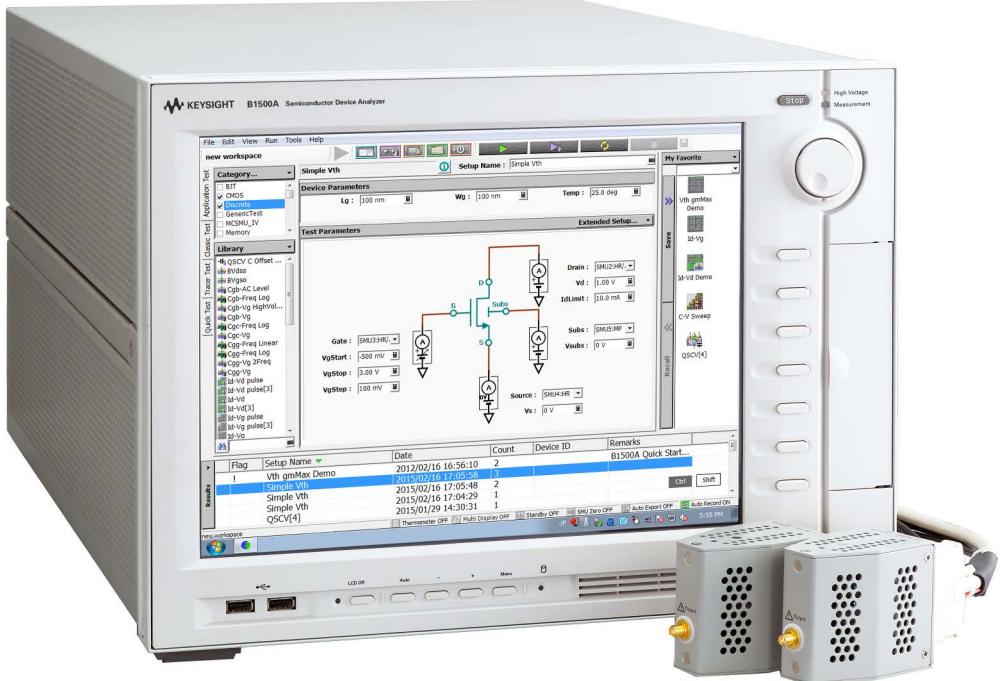
For more details of programs, see Keysight EasyEXPERT User’s Guide.

Overview

Keysight B1500A Semiconductor Device Analyzer is the new generation one box solution for the semiconductor device DC/AC parametric measurement and analysis application. Keysight B1500A provides the DC voltage/current output capability, DC voltage/current measurement capability, and AC signal output and impedance measurement capability. So you can perform a current-voltage sweep measurement and a capacitance-voltage sweep measurement for example by one instrument.

Keysight B1500A also provides an intuitive graphical user interface, touch screen LCD panel, keyboard, and mouse for easy and effective measurement and analysis on the Windows environment. You can analyze a measurement result characteristics graph for example by using several tools such as markers, cursors, and lines.

Also, in the GPIB remote control mode, you can control the B1500A from an external computer by using Keysight FLEX command set that is the common language for Keysight semiconductor DC measurement instruments. So you can reuse the measurement program created for Keysight 4155/4156/E5260/E5270.



- Keysight B1500A Semiconductor Device Analyzer

Mainframe that provides the ground unit (GNDU) and ten empty slots for the measurement facilities, and Keysight EasyEXPERT software for the operating environment. The EasyEXPERT is the GUI based measurement control and analysis software runs on the Windows.

This instrument is equipped with the 15 inch LCD with touch panel, solid state drive, DVD drive, and USB/LAN/GP-IB interfaces. This instrument is also furnished the USB keyboard, the USB mouse, and the stylus pen.

NOTE

The B1500A with serial number MY64320101 or later is not equipped with DVD drive.

- HRSMU module

High resolution source/monitor unit module. Occupies one slot. Needs Keysight E5288A ASU to perform atto level current measurement or automatic switching of the measurement resource connected to the device under test (DUT).

- HPSMU module

High power source/monitor unit module. Occupies two slots.

- MPSMU module

Medium power source/monitor unit module. Occupies one slot. Needs Keysight E5288A ASU to perform atto level current measurement or automatic switching of the measurement resource connected to the device under test (DUT). ASU is effective for the B1511B MPSMU. ASU cannot be connected to the B1511A MPSMU.

- MCSMU module

Medium current source/monitor unit module. Occupies one slot.

- MFCMU module

Multi frequency capacitance measurement unit module. Occupies one slot. Needs Keysight N1301A-100 SCUU to perform automatic switching of the measurement resource connected to the DUT.

- SPGU module

High voltage semiconductor pulse generator unit module. Occupies one slot. Up to five modules can be installed in one mainframe. One module provides two output channels. Needs Keysight 16440A (B1500A-A04) and 16445A to perform automatic switching of the measurement resource connected to the DUT.

- **WGFMU module and RSU**

Waveform generator/fast measurement unit module and the remote-sense and switch unit. Occupies one slot. Up to five modules can be installed in one mainframe. One module provides two channels. See Keysight B1530A *User's Guide* for using the WGFMU.

- **Keysight 16440A SMU/PGU pulse generator selector (B1500A-A04)**

Used to switch the measurement resource connected to the DUT. The measurement resource can be SPGU or SMU. Needs the 16445A adapter to use the selector. One selector provides two switching channels.

- **Keysight 16442B test fixture (B1500A-A5F)**

Test fixture for semiconductor parameter analyzers and device analyzers. Provides three Kelvin triaxial connectors (six non-Kelvin triaxial connectors) for connecting SMU, six BNC connectors for connecting SPGU, MFCMU, or other instruments, a GNDU connector, and an Intlk connector. Furnished with the dual-in-line package socket module, universal socket modules (two types), blank PTFE board, and connection wires for device connection.

- **Keysight 16445A selector adapter**

Used to connect the 16440A selector (B1500A-A04) to the B1500A. Two selectors can be connected.

- **Keysight E5288A ASU**

Atto sense and switch unit (ASU). Used to enable the 1 pA range for the atto level current measurement, also switch the measurement resource connected to the DUT. The measurement resource can be HRSMU/MPSMU (B1511B) or the instrument connected to the AUX terminal.

- **Keysight N1255A 2 channel connection box for MCSMU**

Connection box to make the MCSMU connection easy. Supports two MCSMU.

- **Keysight N1301A-100 SCUU**

SMU CMU unify unit (SCUU). Used to switch the measurement resource connected to the DUT. The measurement resource can be CMU or one of two HRSMU/MPSMU connected to the SCUU.

- **Keysight N1301A-200 GSWU**

Guard switch unit (GSWU). Needs the SCUU to use the GSWU. Effective for the accurate impedance measurements by connecting the guard lines between CMU high and low near the DUT.

Keysight EasyEXPERT Software

Keysight EasyEXPERT software is a specially-designed Windows application program for controlling Keysight B1500A. The EasyEXPERT provides the easy and effective measurement and analysis environment with intuitive graphical user interface (GUI), touch screen LCD panel, keyboard, and mouse. Some of the functions are listed below.

- Single measurement, repeat measurement, and append measurement
- Switching matrix control

Supported models:

- Keysight B2200A/B2201A switching matrix
- Keysight E5250A switching matrix with E5252A
- Measurement/setup data management by workspace
- Graph display and analysis with markers, cursors, and lines; and auto analysis
- Data import/export capability, data output by CSV/XML format, and graph output by EMF/BMP/GIF/PNG format
- Maintenance; self-test and self-calibration
- Remote control function from an external computer

The EasyEXPERT has the following measurement execution environments.

- Application test
- Classic test
- Tracer test
- Quick test

Application Test

The EasyEXPERT contains an application library that supports typical measurements for CMOS devices, TFT, BJT, memory, nanotechnology devices such as CNT FET, and so on. The application library includes more than two hundred test definitions.

You can perform measurements by choosing the best one for your device under test (DUT) from the application libraries, and modifying and executing it. Modification is really simple. For example, it will be completed by changing the output voltage only to DUT terminals. And the setup with your modifications can be saved and recalled as your setup (*My Favorite*).

Classic Test

You can perform measurements by using the user interface similar to the semiconductor parameter analyzers such as Keysight 4156C. The setup can be made by entering values into the setup tables used for the measurement module control. And it can be saved and recalled as your setup (*My Favorite*). This measurement environment provides the following functions.

- I/V Sweep
- Multi Channel I/V Sweep
- I/V List Sweep
- I/V-t Sampling
- C-V Sweep
- SPGU Control
- Switching Matrix Control
- Direct Control

The Direct Control test mode is used to control the measurement modules directly by using the B1500A GPIB control commands and perform measurement. For the control commands, see “Programming Guide”.

Tracer Test

Curve tracer test mode. This test allows you to perform the high speed I-V measurement on one screen. The Tracer Test screen provides GUI for selecting the used channels, setting the sweep output, and displaying the measurement result (tracing the I-V curve). Range of the sweep output and measurement can be changed by the rotary knob on the front panel.

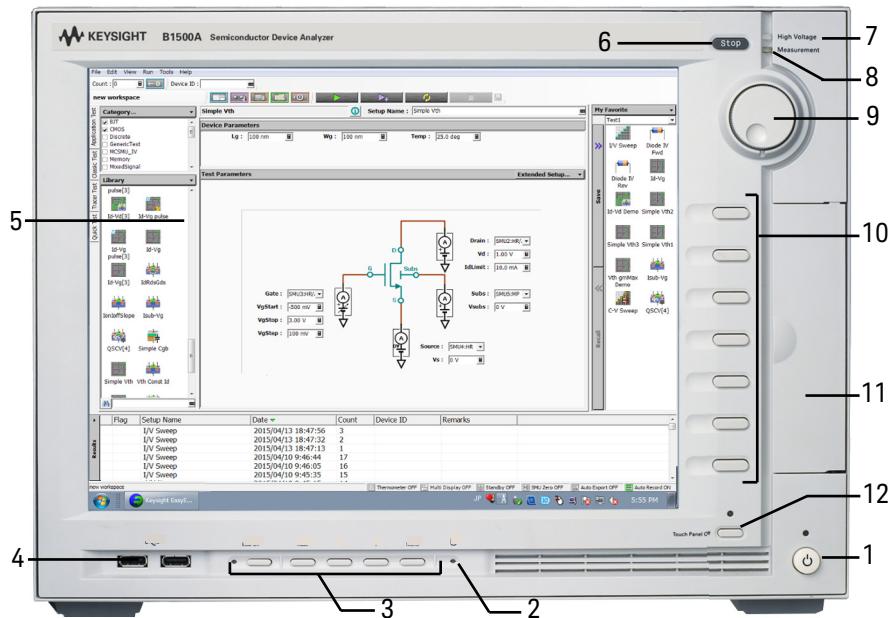
Tracer test also provides the oscilloscope view to display the pulse current or voltage output waveform of the MCSMU. You can verify output waveform over the I-V curve.

Quick Test

You can execute the test setups saved in a preset group (*My Favorite*) sequentially.

Front View

This section describes the front view of Keysight B1500A.



1. Standby switch

Turns the instrument on. Pressing the button in the ON state makes it in the standby state. The green LED lights when it is in the ON state.

NOTE

Before turning the B1500A on

Open the measurement terminals at the device side when turning the B1500A on. Also disconnect the device from the measurement terminals and open the measurement terminals after the measurement. If you leave the connection with the device, the device may be damaged by unexpected operations or charge-up of measurement cables.

2. SSD access indicator

This green LED lights in the access status of SSD or DVD drive. Do not turn the instrument off during this LED lights.

NOTE

The B1500A with serial number MY64320101 or later is not equipped with DVD drive.

3. LCD adjustment keys

LCD Off enables or disables the LCD panel. The green LED lights when the LCD is disabled.

Four keys are available for adjusting brightness. Use + and – to adjust it and then press *Set* to fix it. Pressing *Cancel* instead of *Set* cancels the adjustment.

4. USB interfaces

USB, 2 ports. For keyboard, mouse, and so on.

To remove USB devices from the instrument, use “Safely Remove Hardware” on Windows taskbar. If it is not used, the instrument may cause the internal USB communication error. If the error occurs, turn the instrument off and disconnect the power cord from it. Leave it about 30 seconds before rebooting it, and connect the power cord again, and then turn the instrument on.

5. LCD panel

15 inch TFT XGA display, 1024×768 resolution. Displays the Windows screen, Keysight EasyEXPERT software window, and so on. Touch screen operation is available when the Touch Panel Off indicator does not light.

To adjust the touch panel, use Microchip TSHARC Control Panel which is opened by selecting *Microchip TSHARC Control Panel* from the Start menu.

6. Stop key

Stops the present measurement or source output immediately.

7. High voltage status indicator

This red LED lights when a source channel applies more than ± 42 V.

8. Measurement status indicator

This green LED lights when a measurement channel performs measurement.

Introduction

Front View

9. Rotary knob

Works on Keysight EasyEXPERT environment. Rotating the knob moves the marker on the graph window, or increases/decreases/changes the value in the active entry field. Pressing the knob sets or enters the value.

10. Softkeys

Seven softkeys are available for Keysight EasyEXPERT environment. Used to select an alternative for the entry field specified or the dialog box.

11. DVD-R drive

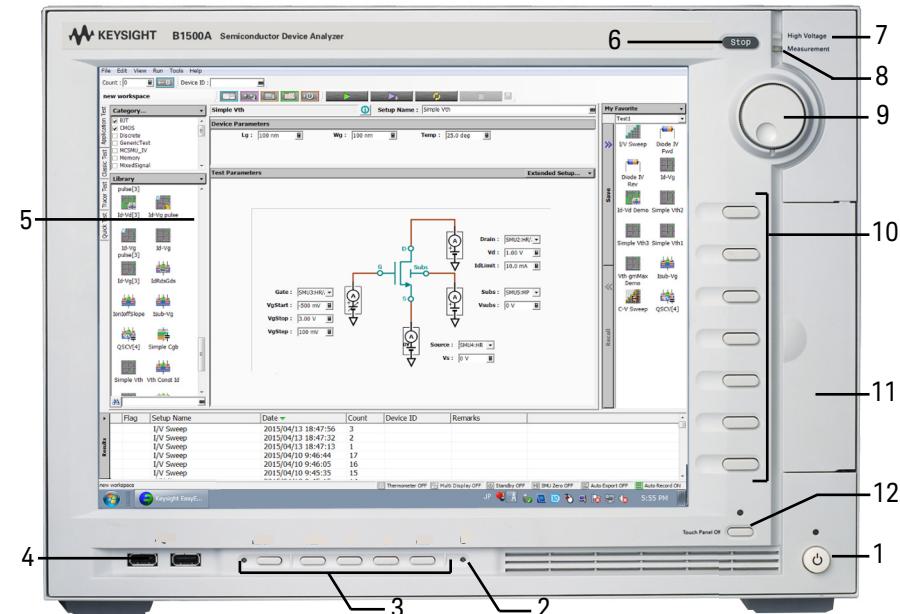
For data backup, software update, and so on.

NOTE

The B1500A with serial number MY64320101 or later is not equipped with DVD drive.

12. Touch Panel Off key

Works on the execution environment of EasyEXPERT software. Enables or disables the touch screen operation. The green LED lights when the touch screen is disabled.



Rear View

This section describes the rear view of Keysight B1500A.

WARNING



To avoid electrical shock and instrument damage, turn the all instruments off before connecting or disconnecting measurement cable.

Mettez la machine hors tension pour fixer le connecteur ou pour retirer le connecteur de l'unité centrale.

WARNING



There are potentially hazardous voltages (± 200 V for HPSMU, and ± 100 V for MPSMU/HRSMU) present at the High/Force/Guard/Sense terminal of this instrument. To prevent electrical shock, the following safety precautions must be observed during the use of the instrument.

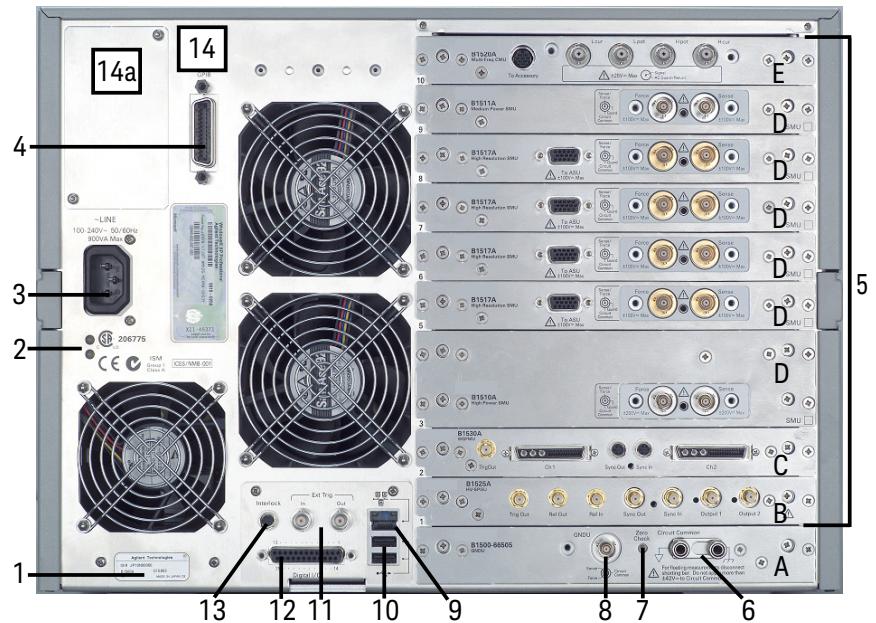
- Use a three-conductor AC power cord to connect the instrument to an electrical ground (safety ground).
- If an interlock circuit is not installed in your test fixture or connection interface, you must install and connect an interlock circuit that opens the Interlock terminal when the shielding box access door is opened.
- If you change the connection interface, test fixture, prober, and such, connect an interlock cable to the one actually used.
- Confirm periodically that the interlock function works normally.
- Before touching the connections on the High/Force/Guard/Sense terminal in the test fixture or the shielding box, turn the instrument off and discharge any capacitors. If you do *not* turn the instrument off, complete *all* of the following items, regardless of the instrument settings.
 - Terminate measurement by pressing the front panel Stop key, and confirm that the Measurement status indicator is not lit.
 - Confirm that the front panel High Voltage indicator is not lit.
 - Open the fixture cover or the shielding box access door (open Interlock).
 - Discharge any capacitors connected to a measurement resource.
 - Warn persons working around the instrument about dangerous conditions.

WARNING



Une tension dangereuse (max. \pm pour HPSMU; 200 Vdc, max. \pm pour MPSMU/ HRSMU; 100 Vdc) émanant du dispositif Keysight B1500A peut être sortie aux bornes High, Force, Guard et Sense. Les précautions suivantes doivent être observées contre commotion électrique accidentelle.

- Utilisez un cordon d'alimentation CA à trois connecteurs pour connecter la cabine (si utilisée) et l'instrument à la mise électrique à la terre (sol de sécurité).
- Si un circuit de sécurité n'est pas installé dans votre test d'installation ou dans votre interface de connexion, vous devez installer et connecter le circuit de sécurité qui ouvre la borne d'enclenchement lorsque la porte d'accès à la protection de la boîte est ouverte.
- Si vous changez l'interface de connexion, un test d'installation, la sonde, ou toute autre élément, connectez un cordon d'enclenchement à celui utilisé actuellement.
- Vérifiez régulièrement que la fonction de verrouillage fonctionne normalement.
- Avant de toucher les connexions des bornes High, Force, Guard et Sense, mettez l'instrument hors tension et déchargez tout condensateur du chemin de mesure. Si vous ne mettez pas l'instrument hors tension, effectuez « toutes » les opérations ci-dessous, quels que soient les paramètres de l'instrument.
 - Terminez les mesures en appuyant sur la touche Stop ; vérifiez que l'indicateur d'état Measurement est éteint.
 - Vérifiez que le témoin High Voltage est éteint.
 - Ouvrez le couvercle d'appareil ou la protection du boîtier de la porte d'accès (ouvez la borne Interlock).
 - Déchargez tous les condensateurs connectés au réseau.
- Informez les personnes se trouvant à proximité de l'appareil à propos des conditions dangereuses.



1. Serial number

You need this *serial number* when using Keysight Technologies telephone assistance program.

2. LED status indicator

For troubleshooting. Followings are some examples.

- Both LEDs turn off:

The instrument is in the standby state and Standby switch is OFF position.

- One LED turns green:

Power supply works normally.

- Both LEDs turn orange:

The instrument is in the standby state and Standby switch is ON position.

3. LINE input receptacle

AC power cord is connected to this receptacle.

4. GPIB interface

For the GPIB connection of this instrument, use an GPIB interface, Keysight 82350B/C (for PCI bus), Keysight 82351A/B (for PCIe bus), Keysight 82357A/B (USB/GPIB), or National Instrument GPIB-USB-HS.

For using an USB/GPIB interface, it is recommended to set the GPIB address of this instrument to an even number. The USB/GPIB interface might cause serial poll error intermittently due to the intrinsic communication scheme differences. It is reported that using an even GPIB address sometimes significantly decreases the chance of the error.

5. Module slot

Ten slots are available for installing the modules. Several kinds of module can be installed in the B1500A. However, the allowable number to install is different by the module type. See “[Measurement Modules](#)” on page 2-18. Also, there is a rule for the installation order by the module type. See [Chapter 3, “Installation.”](#)



6. Circuit Common () and Frame ground () terminals

Normally, connect the terminals together by using the shorting bar (Keysight part number 5000-4206). For floating measurement, remove the shorting bar.

WARNING



If the Circuit Common terminal is *not* connected to the frame ground terminal (for floating measurement), a potential shock hazard may present. Do not touch any of measurement circuit at any time while a floating measurement is in progress.

Si la borne Circuit Common *n'est pas* connectée à la borne de terre du cadre (pour des mesures de flotte), il peut y avoir un risque de choc électrique. Ne touchez aucun circuit de mesure à *n'importe quel moment quand la mesure de flotte est en cours.*

CAUTION

For floating measurement, do not apply dangerous voltage to the Circuit Common terminal. Failure to heed this caution may result in damage to the instrument.

7. Zero Check terminal

Ground reference point of the instrument.

CAUTION

The Zero Check terminal can be used for the service purpose only. For the normal operation, leave this terminal open and do not connect anything to this terminal. Connecting anything can damage the instrument.

8. GNDU terminal

0 V constant voltage source. Used for the reference of measurement ground.
Triaxial connector.

9. LAN interface

RJ45 connector.

10. USB interfaces

USB, 2 ports. For keyboard, mouse, or peripherals.

To remove USB devices from the instrument, use “Safely Remove Hardware” on Windows taskbar. If it is not used, the instrument may cause the internal USB communication error. If the error occurs, turn the instrument off and disconnect the power cord from it. Leave it about 30 seconds before rebooting it, and connect the power cord again, and then turn the instrument on.

11. Ext Trig terminals

Two BNC connectors, one for trigger input, and one for trigger output. For details about the trigger function, see *Programming Guide*.

12. Digital I/O terminal

DSUB 25 pin connector. Can be used for the trigger input/output terminals or an interface to control an external relay circuit and so on. For details, see *Programming Guide*. This connector is also used to connect Keysight 16445A selector adapter.

 13. Interlock terminal

Used in conjunction with the interlock function of the instrument. If the Interlock terminal is open, maximum SMU output is limited to ± 42 V. Be sure to connect this terminal to the interlock circuit of the 16442B test fixture (B1500A-A5F) or the prober station before performing measurement. For the interlock circuit, see “[To Make an Interlock Circuit](#)” on page 3-34.

To verify the interlock function, perform the Interlock Open/Close test on the Main Frame tab screen of the EasyEXPERT Configuration window.

WARNING



Dangerous voltage, instrument maximum output voltage may appear at Force, Guard, and Sense terminals if the Interlock terminal is closed.

Une tension dangereuse, une tension de sortie maximale de l'appareil peut apparaître aux bornes Force, Guard et Sense si la borne Interlock est fermée.

14. Video output terminal

VGA connector. For an external display. Signal to the built-in LCD is also applied to this terminal. For the B1500A manufactured before the video output terminal is supported, it is mounted on the position “14a” by upgrading the mainframe.

A. GNDU/ADC

Ground unit and A/D converter module. Always installed in the B1500A.

B. SPGU module

The semiconductor pulse generator unit (SPGU) has the Output 1 and Output 2 terminals and the following terminals to synchronize the operation between SPGUs or with an external equipment.

Ref Out/Sync Out: Connect to the Ref In/Sync In of the secondary SPGU.

Ref In/Sync In: Connect to the Ref Out/Sync Out of the primary SPGU.

Trig Out: Connect to the trigger input terminal of the equipment synchronized with the SPGU output.

CAUTION

Connect the Ref Out/In, Sync Out/In, and Trig Out terminals to the specified terminal properly. Connecting to the other terminal may result in damage to the SPGU.

In the EasyEXPERT operation mode, the SPGU outputs can be specified by the PG number. PG1 and PG2 are assigned to the Output 1 and Output 2 terminals of the SPGU at the lowest position. And the following PG numbers are assigned to the outputs of the upper SPGUs in sequence. Use the PG number label furnished with the B1500A or equivalent to identify the SPGU channel number.

C. WGFMU module

The waveform generator/fast measurement unit (WGFMU) has the Ch 1 and Ch 2 terminals and the following terminals to synchronize the operation between WGFMUs or with an external equipment.

Sync Out: Connect to the Sync In of the secondary WGFMU.

Sync In: Connect to the Sync Out of the primary WGFMU.

Trig Out: Connect to the trigger input terminal of the equipment synchronized with the WGFMU output.

CAUTION

Connect the Sync Out/In, and Trig Out terminals to the specified terminal properly. Connecting to the other terminal may result in damage to the WGFMU.

Connect the connection cable between the WGFMU and the RSU (remote-sense and switch unit) before turning the instrument on. Changing the cable connection in the power on state may damage them. See Keysight B1530A *User's Guide* for cable connection and usage.



D. SMU module

The source/monitor unit (SMU) has two triaxial connectors, force and sense, for the Kelvin connections.

The HRSMU (high resolution SMU) and MPSMU (B1511B medium power SMU) also have a D-sub connector (To ASU terminal) which is used to connect the ASU (atto sense and switch unit).

In the EasyEXPERT operation mode, the SMUs can be specified by the SMU number. SMU1 is assigned to the SMU at the lowest position. And the following SMU numbers are assigned to the upper SMUs in sequence. Use the SMU number label furnished with the B1500A or equivalent to identify the SMU number.

NOTE

Connect the connection cables between the SMU and the ASU before turning the instrument on. Changing the cable connection in the power on state may damage them. To connect the ASU, see “[To Connect ASU](#)” on page 3-19.



E. CMU module

The multi frequency capacitance measurement unit (MFCMU) has four coaxial connectors, Lcur, Lpot, Hpot, and Hcur, for the four-terminal pair connection. The Hcur and Hpot have to be connected together at a terminal of the device under test (DUT). Also the Lcur and Lpot have to be connected together at the other terminal of the DUT. Then, the guard lines of four-terminal pair must be connected together.

CAUTION

Do not apply voltage more than ± 25 V to the MFCMU input terminals. Failure to heed this caution may result in damage to the module.

Measurement Modules

Keysight B1500A can be equipped with the following measurement modules.

- “GNDU - Ground Unit”
- “HPSMU - High Power SMU”
- “MPSMU - Medium Power SMU”
- “MCSMU - Medium Current SMU”
- “HRSMU - High Resolution SMU”
- “MFCMU - Multi Frequency CMU”
- “HVSPGU - High Voltage SPGU”
- “WGFMU - Waveform Generator/Fast Measurement Unit”

See Keysight EasyEXPERT *User’s Guide* for the functions available for Keysight EasyEXPERT software. See *Programming Guide* for the functions available for the GPIB remote mode. See Keysight B1530A *User’s Guide* for using the WGFMU.

GNDU - Ground Unit

Keysight B1500A is equipped with the ground unit (GNDU). The GNDU is a 0 V constant voltage source, and used for the reference of measurement ground. Also the GNDU can sink up to ± 4.2 A, so it is effective for using the HPSMU (high power SMU). [Figure 2-1](#) is a simplified circuit diagram of GNDU.

Figure 2-1

Simplified GNDU Circuit Diagram



About SMU

Source/monitor unit (SMU) can apply DC voltage or current, and can measure DC current or voltage. [Figure 2-2](#) is a simplified SMU circuit diagram. The SMU can perform the following operations:

The HPSMU, MPSMU, and HRSMU can perform the following operations:

- Apply voltage and measures current or voltage
- Apply current and measures current or voltage

The MCSMU can perform the following operations:

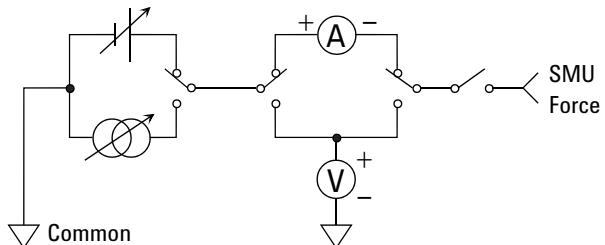
- Apply voltage and measures current and/or voltage
- Apply current and measures current and/or voltage

NOTE

To select the SMU operation mode in the GPIB remote condition, enter the CMM command.

Figure 2-2

Simplified SMU Circuit Diagram



Compliance

The SMU has a compliance feature that limits output voltage or current to prevent damage to the device under test. When the SMU applies voltage, you can specify current compliance. When the SMU applies current, you can specify voltage compliance. For details about the compliance, see *Keysight EasyEXPERT User's Guide*.

HPSMU - High Power SMU

This section describes typical specification of the high power source/monitor unit (HPSMU). Maximum four modules can be installed in one mainframe.

- Maximum voltage, current, output power: ± 200 V, ± 1 A, 20 W
- Minimum range: 2 V, 1 nA
- Output/measurement value and resolution: see [Table 2-1](#) to [Table 2-4](#).

Figure 2-3

HPSMU Output and Measurement Ranges

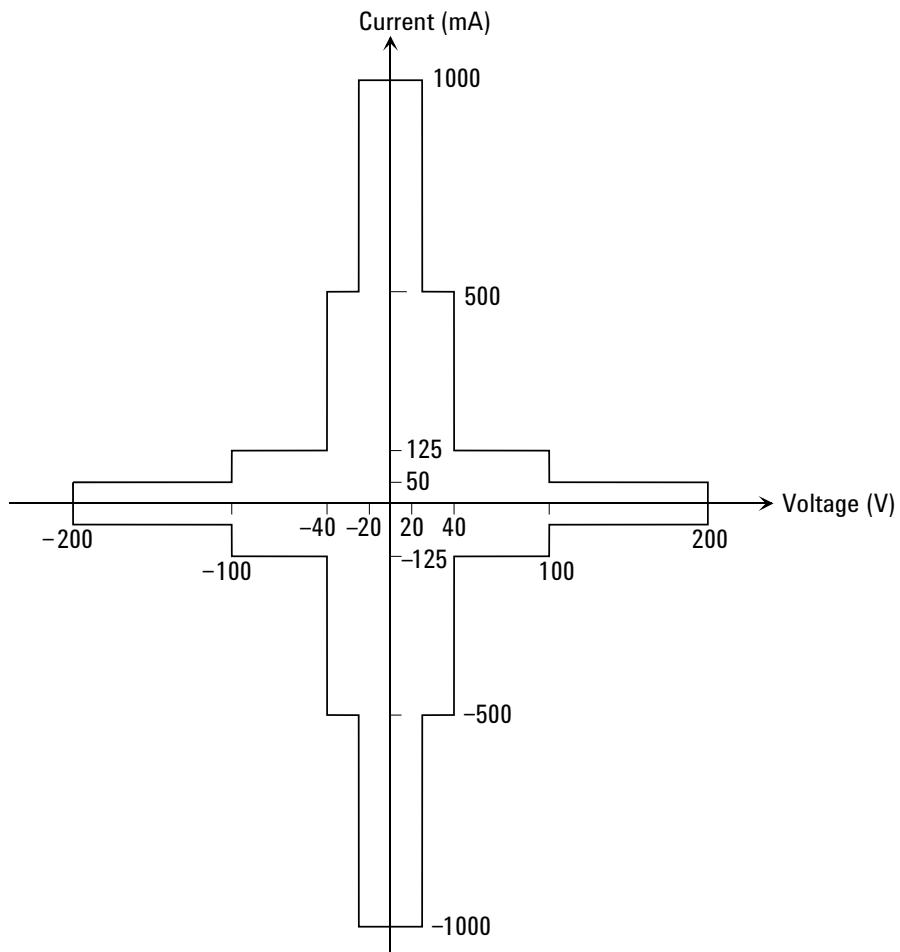


Table 2-1

HPSMU Output Voltage Ranges and Resolutions

Range	Output Value	Setting Resolution	Maximum Current
2 V	$0 \leq V \leq 2 \text{ V}$	100 μV	$\pm 1000 \text{ mA}$
20 V	$0 \leq V \leq 20 \text{ V}$	1 mV	$\pm 1000 \text{ mA}$
40 V	$0 \leq V \leq 40 \text{ V}$	2 mV	$\pm 500 \text{ mA}$
100 V	$0 \leq V \leq 100 \text{ V}$	5 mV	$\pm 125 \text{ mA}$
200 V	$0 \leq V \leq 200 \text{ V}$	10 mV	$\pm 50 \text{ mA}$

Table 2-2

HPSMU Output Current Ranges and Resolutions

Range	Output Value	Setting Resolution	Maximum Voltage
1 nA	$0 \leq I \leq 1.15 \text{ nA}$	50 fA	$\pm 200 \text{ V}$
10 nA	$0 \leq I \leq 11.5 \text{ nA}$	500 fA	$\pm 200 \text{ V}$
100 nA	$0 \leq I \leq 115 \text{ nA}$	5 pA	$\pm 200 \text{ V}$
1 μA	$0 \leq I \leq 1.15 \mu\text{A}$	50 pA	$\pm 200 \text{ V}$
10 μA	$0 \leq I \leq 11.5 \mu\text{A}$	500 pA	$\pm 200 \text{ V}$
100 μA	$0 \leq I \leq 115 \mu\text{A}$	5 nA	$\pm 200 \text{ V}$
1 mA	$0 \leq I \leq 1.15 \text{ mA}$	50 nA	$\pm 200 \text{ V}$
10 mA	$0 \leq I \leq 11.5 \text{ mA}$	500 nA	$\pm 200 \text{ V}$
100 mA	$0 \leq I \leq 50 \text{ mA}$	5 μA	$\pm 200 \text{ V}$
	$50 \text{ mA} < I \leq 115 \text{ mA}$	5 μA	$\pm 100 \text{ V}$
1 A	$0 \leq I \leq 50 \text{ mA}$	50 μA	$\pm 200 \text{ V}$
	$50 \text{ mA} < I \leq 125 \text{ mA}$	50 μA	$\pm 100 \text{ V}$
	$125 \text{ mA} < I \leq 500 \text{ mA}$	50 μA	$\pm 40 \text{ V}$
	$500 \text{ mA} < I \leq 1 \text{ A}$	50 μA	$\pm 20 \text{ V}$

Table 2-3

HPSMU Measurement Voltage Values and Resolutions

Range	Measurement Value ^a	Measurement Resolutions	
		High Speed ADC	High Resolution ADC
2 V	0 ≤ V ≤ 2.2 V	100 µV	2 µV
20 V	0 ≤ V ≤ 22 V	1 mV	20 µV
40 V	0 ≤ V ≤ 44 V	2 mV	40 µV
100 V	0 ≤ V ≤ 110 V	5 mV	100 µV
200 V	0 ≤ V ≤ 200 V	10 mV	200 µV

Table 2-4

HPSMU Measurement Current Values and Resolutions

Range	Measurement Value ^a	Measurement Resolutions	
		High Speed ADC	High Resolution ADC
1 nA	0 ≤ I ≤ 1.15 nA	50 fA	10 fA
10 nA	0 ≤ I ≤ 11.5 nA	500 fA	10 fA
100 nA	0 ≤ I ≤ 115 nA	5 pA	100 fA
1 µA	0 ≤ I ≤ 1.15 µA	50 pA	1 pA
10 µA	0 ≤ I ≤ 11.5 µA	500 pA	10 pA
100 µA	0 ≤ I ≤ 115 µA	5 nA	100 pA
1 mA	0 ≤ I ≤ 1.15 mA	50 nA	1 nA
10 mA	0 ≤ I ≤ 11.5 mA	500 nA	10 nA
100 mA	0 ≤ I ≤ 115 mA	5 µA	100 nA
1 A	0 ≤ I ≤ 1 A	50 µA	1 µA

a. This column is applied to the auto ranging or the limited auto ranging. For fixed ranging, maximum measurement value is **Range** column value.

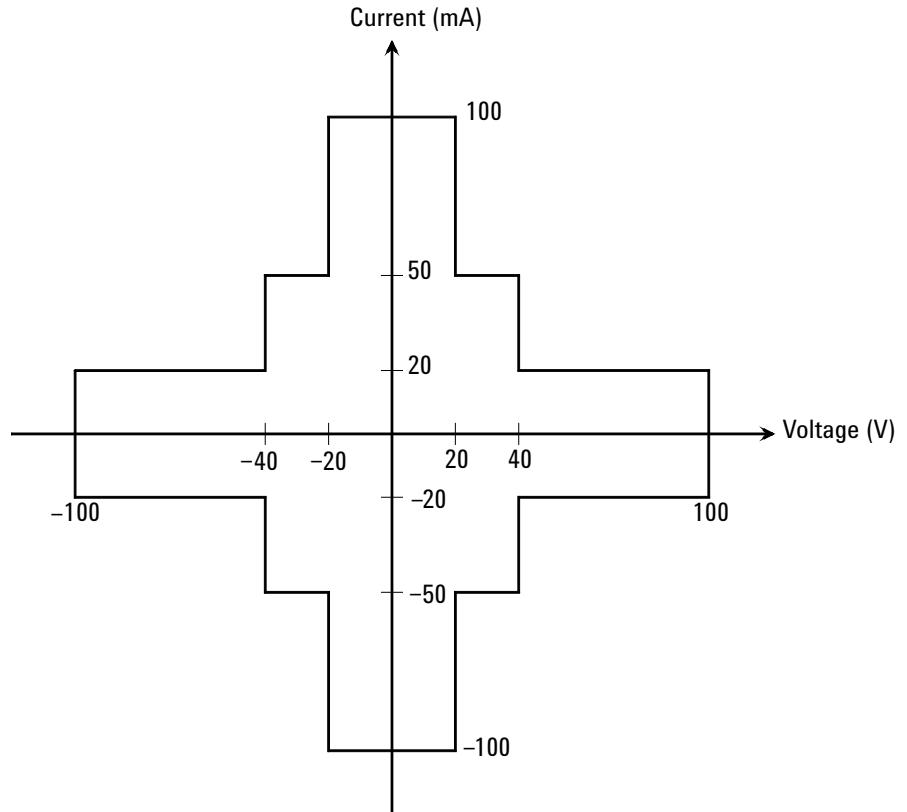
MPSMU - Medium Power SMU

This section describes typical specification of the medium power source/monitor unit (MPSMU). There is no restriction for the number of modules installed in one mainframe.

- Maximum voltage, current, output power: ± 100 V, ± 100 mA, 2 W
- Minimum range: 0.5 V, 1 nA (1 pA when the E5288A ASU is used)
- Output/measurement value and resolution: see [Table 2-5](#) to [Table 2-8](#).

Figure 2-4

MPSMU Output and Measurement Ranges



NOTE

The E5288A Atto Sense and Switch Unit (ASU) can be connected to the B1511B MPSMU, but it cannot be connected to the B1511A MPSMU.

Table 2-5

MPSMU Output Voltage Ranges and Resolutions

Range	Output Value	Setting Resolution	Maximum Current
0.5 V	$0 \leq V \leq 0.5$ V	25 μ V	± 100 mA
2 V	$0 \leq V \leq 2$ V	100 μ V	± 100 mA
5 V	$0 \leq V \leq 5$ V	250 μ V	± 100 mA
20 V	$0 \leq V \leq 20$ V	1 mV	± 100 mA
40 V	$0 \leq V \leq 20$ V	2 mV	± 100 mA
	$20 \text{ V} < V \leq 40 \text{ V}$	2 mV	± 50 mA
100 V	$0 \leq V \leq 20$ V	5 mV	± 100 mA
	$20 \text{ V} < V \leq 40 \text{ V}$	5 mV	± 50 mA
	$40 \text{ V} < V \leq 100 \text{ V}$	5 mV	± 20 mA

Table 2-6

MPSMU Output Current Ranges and Resolutions

Range	Output Value	Setting Resolution	Maximum Voltage
1 pA ^a	$0 \leq I \leq 1.15$ pA	1 fA	± 100 V
10 pA ^a	$0 \leq I \leq 11.5$ pA	5 fA	± 100 V
100 pA ^a	$0 \leq I \leq 115$ pA	5 fA	± 100 V
1 nA	$0 \leq I \leq 1.15$ nA	50 fA	± 100 V
10 nA	$0 \leq I \leq 11.5$ nA	500 fA	± 100 V
100 nA	$0 \leq I \leq 115$ nA	5 pA	± 100 V
1 μ A	$0 \leq I \leq 1.15$ μ A	50 pA	± 100 V
10 μ A	$0 \leq I \leq 11.5$ μ A	500 pA	± 100 V
100 μ A	$0 \leq I \leq 115$ μ A	5 nA	± 100 V
1 mA	$0 \leq I \leq 1.15$ mA	50 nA	± 100 V
10 mA	$0 \leq I \leq 11.5$ mA	500 nA	± 100 V
100 mA	$0 \leq I \leq 20$ mA	5 μ A	± 100 V
	$20 \text{ mA} < I \leq 50 \text{ mA}$	5 μ A	± 40 V
	$50 \text{ mA} < I \leq 100 \text{ mA}$	5 μ A	± 20 V

a. For B1511B MPSMU. Available when the ASU is used.

Table 2-7

MPSMU Measurement Voltage Values and Resolutions

Range	Measurement Value ^a	Measurement Resolutions	
		High Speed ADC	High Resolution ADC
0.5 V	$0 \leq V \leq 0.55$ V	25 μ V	0.5 μ V
2 V	$0 \leq V \leq 2.2$ V	100 μ V	2 μ V
5 V	$0 \leq V \leq 5.5$ V	250 μ V	5 μ V
20 V	$0 \leq V \leq 22$ V	1 mV	20 μ V
40 V	$0 \leq V \leq 44$ V	2 mV	40 μ V
100 V	$0 \leq V \leq 100$ V	5 mV	100 μ V

Table 2-8

MPSMU Measurement Current Values and Resolutions

Range	Measurement Value ^a	Measurement Resolutions	
		High Speed ADC	High Resolution ADC
1 pA ^b	$0 \leq I \leq 1.15$ pA	100 aA	100 aA
10 pA ^b	$0 \leq I \leq 11.5$ pA	1 fA	400 aA
100 pA ^b	$0 \leq I \leq 115$ pA	5 fA	500 aA
1 nA	$0 \leq I \leq 1.15$ nA	50 fA	10 fA
10 nA	$0 \leq I \leq 11.5$ nA	500 fA	10 fA
100 nA	$0 \leq I \leq 115$ nA	5 pA	100 fA
1 μ A	$0 \leq I \leq 1.15$ μ A	50 pA	1 pA
10 μ A	$0 \leq I \leq 11.5$ μ A	500 pA	10 pA
100 μ A	$0 \leq I \leq 115$ μ A	5 nA	100 pA
1 mA	$0 \leq I \leq 1.15$ mA	50 nA	1 nA
10 mA	$0 \leq I \leq 11.5$ mA	500 nA	10 nA
100 mA	$0 \leq I \leq 100$ mA	5 μ A	100 nA

a. This column is applied to the auto ranging or the limited auto ranging.

For fixed ranging, maximum measurement value is Range column value.

b. For B1511B MPSMU. Available when the ASU is used.

NOTE**To connect ASU**

To use the ASU, it must be connected to the SMU which is connected together when the calibration is performed. The specifications are satisfied and guaranteed in this condition only. So confirm the serial number of the ASU and connect it to the dedicated SMU properly.

To connect the ASU, see “[To Connect ASU](#)” on page 3-19.

To confirm the serial number, see *Keysight EasyEXPERT User’s Guide*.

NOTE**Before using 1 pA range**

The measurement channel connected to the ASU supports the 1 pA range. To use the 1 pA range, set the 1 pA fixed range or the 1 pA limited auto ranging.

The B1500A automatically performs the compensation of the data measured by the 1 pA range and returns the compensated data. You can use either the pre-stored offset data or the pre-measured offset data.

To measure the offset data, perform the self-calibration before starting the measurement for a DUT. This offset data is temporarily memorized until the B1500A is turned off.

MCSMU - Medium Current SMU

This section describes typical specification of the medium current source/monitor unit (MCSMU). Maximum four modules can be installed in one mainframe.

- Maximum current: ± 1 A (pulse), ± 0.1 A (DC)
- Maximum voltage: ± 30 V
- Maximum output power: 30 W (pulse), 3 W (DC)
- Minimum range: 0.2 V, 10 μ A
- Minimum pulse width: 10 μ s
- Output/measurement value and resolution: see [Table 2-9](#) and [Table 2-10](#).

Figure 2-5

MCSMU Output and Measurement Ranges

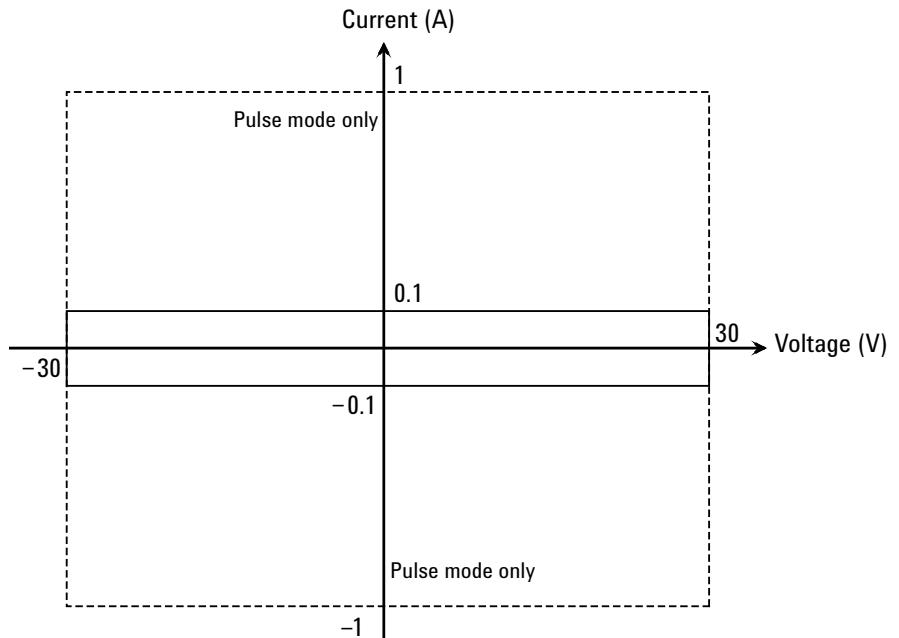


Table 2-9

MCSMU Voltage Ranges and Resolutions

Range	Output Value and Measurement Value	Setting/Measurement Resolution	Maximum Current	Maximum Pulse Base Value
0.2 V	$0 \leq V \leq 0.2 \text{ V}$	200 nV	100 mA, 1 A ^a	$\pm 0.2 \text{ V}$
2 V	$0 \leq V \leq 2 \text{ V}$	2 μV		$\pm 2 \text{ V}$
20 V	$0 \leq V \leq 20 \text{ V}$	20 μV		$\pm 20 \text{ V}$
40 V	$0 \leq V \leq 30 \text{ V}$	40 μV		$\pm 30 \text{ V}$

a. For pulse.

Table 2-10

MCSMU Current Ranges and Resolutions

Range	Output Value and Measurement Value	Setting/Measurement Resolution	Maximum Voltage	Maximum Pulse Base Value
10 μA	$0 \leq I \leq 11.5 \mu\text{A}$	10 pA	$\pm 30 \text{ V}$	$\pm 10 \mu\text{A}$
100 μA	$0 \leq I \leq 115 \mu\text{A}$	100 pA		$\pm 100 \mu\text{A}$
1 mA	$0 \leq I \leq 1.15 \text{ mA}$	1 nA		$\pm 1 \text{ mA}$
10 mA	$0 \leq I \leq 11.5 \text{ mA}$	10 nA		$\pm 10 \text{ mA}$
100 mA	$0 \leq I \leq 100 \text{ mA}$, $0 \leq I \leq 115 \text{ mA}^a$	100 nA		$\pm 100 \text{ mA}$
1 A ^b	$0 \leq I \leq 1 \text{ A}$	1 μA		$\pm 50 \text{ mA}$

a. For pulse.

b. For pulse. Maximum pulse width and duty cycle are 100 ms and 5 % respectively.

HRSMU - High Resolution SMU

This section describes typical specification of the high resolution source/monitor unit (HRSMU). There is no restriction for the number of modules installed in one mainframe.

- Maximum voltage, current, output power: ± 100 V, ± 100 mA, 2 W
- Minimum range: 0.5 V, 10 pA (1 pA when the E5288A ASU is used)
- Output/measurement value and resolution: see [Table 2-11](#) to [Table 2-14](#).

Figure 2-6

HRSMU Output and Measurement Ranges

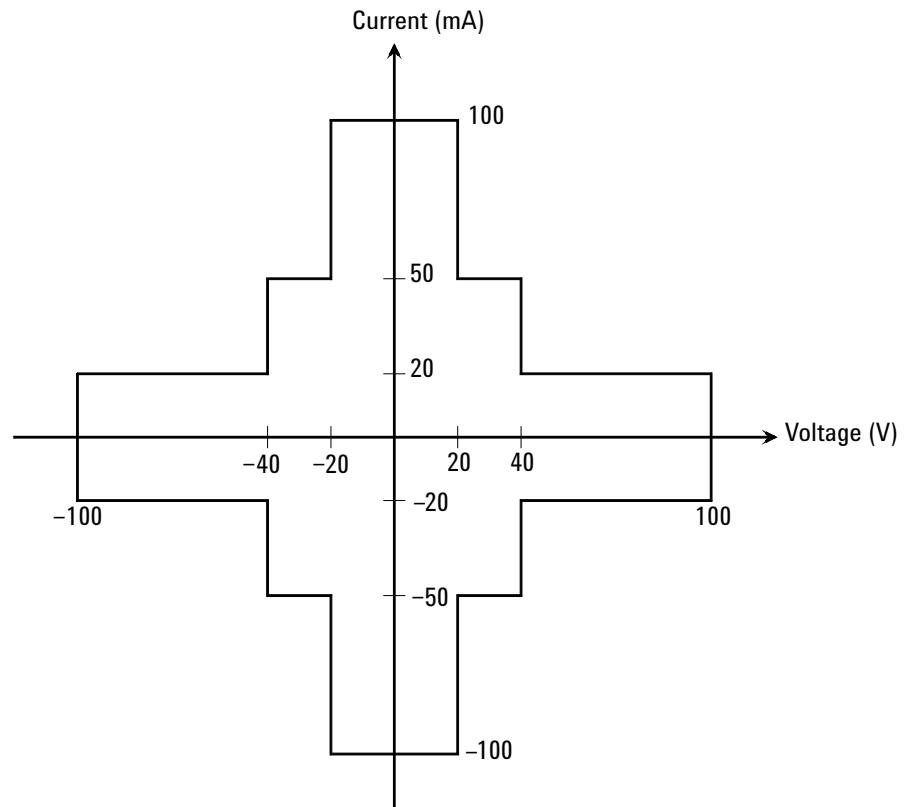


Table 2-11

HRSMU Output Voltage Ranges and Resolutions

Range	Output Value	Setting Resolution	Maximum Current
0.5 V	$0 \leq V \leq 0.5$ V	25 μ V	± 100 mA
2 V	$0 \leq V \leq 2$ V	100 μ V	± 100 mA
5 V	$0 \leq V \leq 5$ V	250 μ V	± 100 mA
20 V	$0 \leq V \leq 20$ V	1 mV	± 100 mA
40 V	$0 \leq V \leq 20$ V	2 mV	± 100 mA
	$20 \text{ V} < V \leq 40 \text{ V}$	2 mV	± 50 mA
100 V	$0 \leq V \leq 20$ V	5 mV	± 100 mA
	$20 \text{ V} < V \leq 40 \text{ V}$	5 mV	± 50 mA
	$40 \text{ V} < V \leq 100 \text{ V}$	5 mV	± 20 mA

Table 2-12

HRSMU Output Current Ranges and Resolutions

Range	Output Value	Setting Resolution	Maximum Voltage
1 pA ^a	$0 \leq I \leq 1.15$ pA	1 fA	± 100 V
10 pA	$0 \leq I \leq 11.5$ pA	5 fA	± 100 V
100 pA	$0 \leq I \leq 115$ pA	5 fA	± 100 V
1 nA	$0 \leq I \leq 1.15$ nA	50 fA	± 100 V
10 nA	$0 \leq I \leq 11.5$ nA	500 fA	± 100 V
100 nA	$0 \leq I \leq 115$ nA	5 pA	± 100 V
1 μ A	$0 \leq I \leq 1.15$ μ A	50 pA	± 100 V
10 μ A	$0 \leq I \leq 11.5$ μ A	500 pA	± 100 V
100 μ A	$0 \leq I \leq 115$ μ A	5 nA	± 100 V
1 mA	$0 \leq I \leq 1.15$ mA	50 nA	± 100 V
10 mA	$0 \leq I \leq 11.5$ mA	500 nA	± 100 V
100 mA	$0 \leq I \leq 20$ mA	5 μ A	± 100 V
	$20 \text{ mA} < I \leq 50 \text{ mA}$	5 μ A	± 40 V
	$50 \text{ mA} < I \leq 100 \text{ mA}$	5 μ A	± 20 V

a. Available when the ASU is used.

Table 2-13

HRSMU Measurement Voltage Values and Resolutions

Range	Measurement Value ^a	Measurement Resolutions	
		High Speed ADC	High Resolution ADC
0.5 V	$0 \leq V \leq 0.55$ V	25 μ V	0.5 μ V
2 V	$0 \leq V \leq 2.2$ V	100 μ V	2 μ V
5 V	$0 \leq V \leq 5.5$ V	250 μ V	5 μ V
20 V	$0 \leq V \leq 22$ V	1 mV	20 μ V
40 V	$0 \leq V \leq 44$ V	2 mV	40 μ V
100 V	$0 \leq V \leq 100$ V	5 mV	100 μ V

Table 2-14

HRSMU Measurement Current Values and Resolutions

Range	Measurement Value ^a	Measurement Resolutions	
		High Speed ADC	High Resolution ADC
1 pA ^b	$0 \leq I \leq 1.15$ pA	100 aA	100 aA
10 pA	$0 \leq I \leq 11.5$ pA	1 fA	1 fA / 400 aA ^b
100 pA	$0 \leq I \leq 115$ pA	5 fA	2 fA / 500 aA ^b
1 nA	$0 \leq I \leq 1.15$ nA	50 fA	10 fA
10 nA	$0 \leq I \leq 11.5$ nA	500 fA	10 fA
100 nA	$0 \leq I \leq 115$ nA	5 pA	100 fA
1 μ A	$0 \leq I \leq 1.15$ μ A	50 pA	1 pA
10 μ A	$0 \leq I \leq 11.5$ μ A	500 pA	10 pA
100 μ A	$0 \leq I \leq 115$ μ A	5 nA	100 pA
1 mA	$0 \leq I \leq 1.15$ mA	50 nA	1 nA
10 mA	$0 \leq I \leq 11.5$ mA	500 nA	10 nA
100 mA	$0 \leq I \leq 100$ mA	5 μ A	100 nA

a. This column is applied to the auto ranging or the limited auto ranging.
For fixed ranging, maximum measurement value is **Range** column value.
b. Available when the ASU is used.

NOTE**To connect ASU**

To use the ASU, it must be connected to the SMU which is connected together when the calibration is performed. The specifications are satisfied and guaranteed in this condition only. So confirm the serial number of the ASU and connect it to the dedicated SMU properly.

To connect the ASU, see “[To Connect ASU](#)” on page 3-19.

To confirm the serial number, see *Keysight EasyEXPERT User’s Guide*.

NOTE**Before using 1 pA range**

The measurement channel connected to the ASU supports the 1 pA range. To use the 1 pA range, set the 1 pA fixed range or the 1 pA limited auto ranging.

The B1500A automatically performs the compensation of the data measured by the 1 pA range and returns the compensated data. You can use either the pre-stored offset data or the pre-measured offset data.

To measure the offset data, perform the self-calibration before starting the measurement for a DUT. This offset data is temporarily memorized until the B1500A is turned off.

MFCMU - Multi Frequency CMU

This section describes typical specification of the multi frequency capacitance measurement unit (CMU). The CMU performs the impedance measurement and returns the specified measurement data such as Cp-G. Only one module can be installed in one mainframe.

- Measurement parameters: See [Table 2-15](#).

- AC signal, output frequency:

1 kHz to 5 MHz

Setting resolution: 1 mHz (1 kHz to), 10 mHz (10 kHz to), 0.1 Hz (100 kHz to), or 1 Hz (1 MHz to 5 MHz)

- AC signal, output level:

10 mVrms to 250 mVrms, 1 mV resolution

- DC bias:

0 to ± 25 V, using MFCMU internal DC bias

0 to ± 100 V, using SMU and SCUU (SMU CMU unify unit)

- Measurement range:

For the fixed ranging mode, measurement range (impedance range) must be specified to perform measurement. [Table 2-16](#) shows the available measurement ranges and the corresponding impedance value. And [Figure 2-7](#) shows the calculation example of the impedance vs frequency characteristics of a capacitive load. Use these information to decide the measurement range.

Impedance Z is calculated by the following formula.

$$Z = 1 / (2\pi f C)$$

where f is frequency (Hz) and C is capacitance (F).

Table 2-15

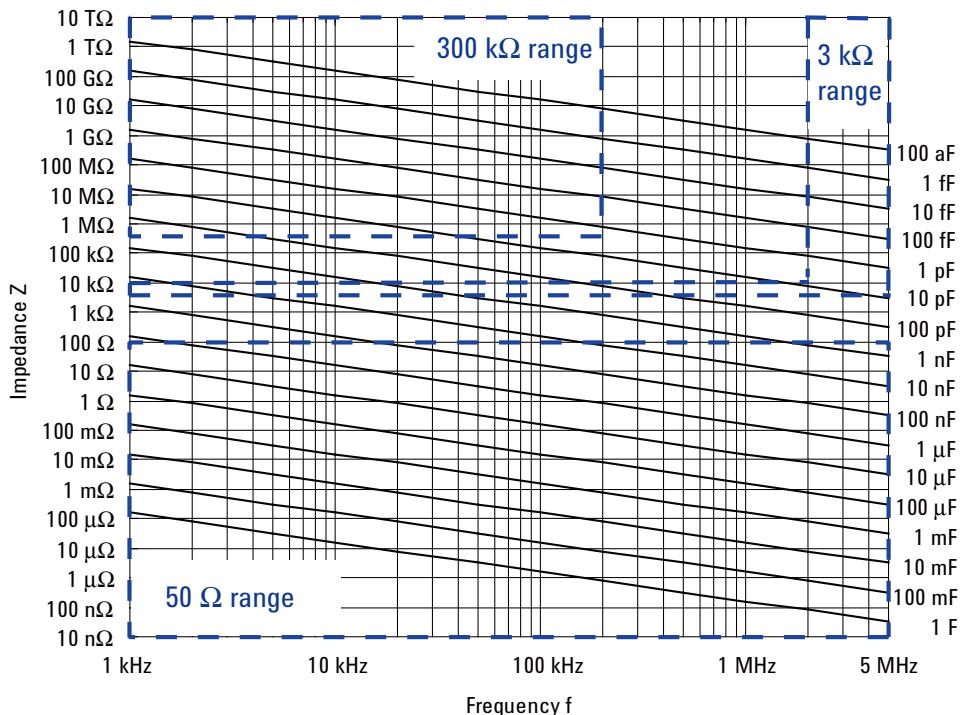
Measurement Parameters

Primary Parameter	Secondary Parameter
R (resistance, Ω)	X (reactance, Ω)
G (conductance, S)	B (susceptance, S)
Z (impedance, Ω)	θ (phase, radian)
Z (impedance, Ω)	θ (phase, degree)
Y (admittance, S)	θ (phase, radian)
Y (admittance, S)	θ (phase, degree)
C _p (parallel capacitance, F)	G (conductance, S)
C _p (parallel capacitance, F)	D (dissipation factor)
C _p (parallel capacitance, F)	Q (quality factor)
C _p (parallel capacitance, F)	R _p (parallel resistance, Ω)
C _s (series capacitance, F)	R _s (series resistance, Ω)
C _s (series capacitance, F)	D (dissipation factor)
C _s (series capacitance, F)	Q (quality factor)
L _p (parallel inductance, H)	G (conductance, S)
L _p (parallel inductance, H)	D (dissipation factor)
L _p (parallel inductance, H)	Q (quality factor)
L _p (parallel inductance, H)	R _p (parallel resistance, Ω)
L _s (series inductance, H)	R _s (series resistance, Ω)
L _s (series inductance, H)	D (dissipation factor)
L _s (series inductance, H)	Q (quality factor)

Table 2-16 Measurement Range for Fixed Ranging Mode

Impedance Z	Measurement range (impedance range)		
	$1 \text{ kHz} \leq f \leq 200 \text{ kHz}$	$200 \text{ kHz} < f \leq 2 \text{ MHz}$	$2 \text{ MHz} < f \leq 5 \text{ MHz}$
$0 \leq Z < 100 \Omega$	50 Ω	50 Ω	50 Ω
$100 \Omega \leq Z < 300 \Omega$	100 Ω	100 Ω	100 Ω
$300 \Omega \leq Z < 1 \text{ k}\Omega$	300 Ω	300 Ω	300 Ω
$1 \text{ k}\Omega \leq Z < 3 \text{ k}\Omega$	1 $\text{k}\Omega$	1 $\text{k}\Omega$	1 $\text{k}\Omega$
$3 \text{ k}\Omega \leq Z < 10 \text{ k}\Omega$	3 $\text{k}\Omega$	3 $\text{k}\Omega$	3 $\text{k}\Omega$
$10 \text{ k}\Omega \leq Z < 30 \text{ k}\Omega$	10 $\text{k}\Omega$	10 $\text{k}\Omega$	
$30 \text{ k}\Omega \leq Z < 100 \text{ k}\Omega$	30 $\text{k}\Omega$	30 $\text{k}\Omega$	
$100 \text{ k}\Omega \leq Z < 300 \text{ k}\Omega$	100 $\text{k}\Omega$		
$300 \text{ k}\Omega \leq Z$	300 $\text{k}\Omega$		

Figure 2-7 Impedance vs Frequency Characteristics of Capacitive Load, Calculation Example



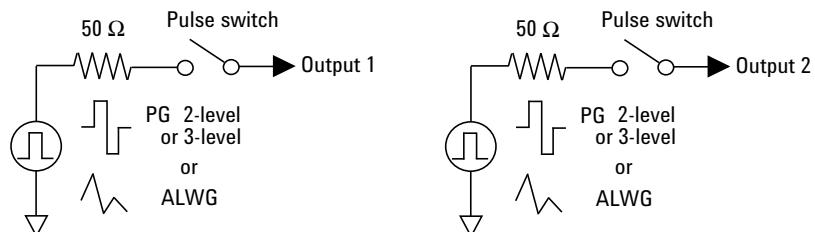
HVSPGU - High Voltage SPGU

This section describes key specification of the high voltage semiconductor pulse generator unit (SPGU). Maximum five modules can be installed in one mainframe.

- Number of output channels: 2 channels per module
- Output impedance: $50\ \Omega$
- Output level: 0 to $\pm 40\text{ V}$ (open load), $\pm 20\text{ V}$ ($50\ \Omega$ load), 1 mV resolution
- SPGU operation mode:
 - PG (pulse generator) or ALWG (arbitrary linear waveform generator)
- Channel output operation mode:
 - Free run, duration, or pulse count (PG mode)/sequence count (ALWG mode)
- PG output mode:
 - 2-level pulse or 3-level pulse, for each channel
- Pulse timing parameters: (programmable range)
 - Period: 20 ns to 10 s, 10 ns resolution
 - Width: 10 ns to period–10 ns, resolution 2.5 ns or 10 ns (transition time $> 8\ \mu\text{s}$)
 - Delay: 0 to period–20 ns, resolution 2.5 ns or 10 ns (transition time $> 8\ \mu\text{s}$)
 - Transition time (leading time or trailing time): 8 ns to 400 ms, resolution 2 ns or 8 ns (transition time $> 8\ \mu\text{s}$)
- Pulse switch, which is more durable than mechanical relays, and better suited for frequent switching applications.
- Automatic voltage level adjustment by specifying load impedance of DUT

Figure 2-8

SPGU Simplified Circuit Diagram



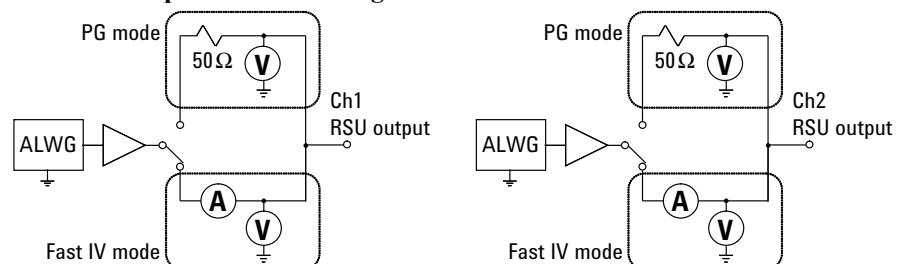
WGFMU - Waveform Generator/Fast Measurement Unit

This section describes typical specification of the waveform generator/fast measurement unit (WGFMU) and the remote-sense and switch unit (RSU). Maximum five modules can be installed in one mainframe.

- Number of channels: 2 channels per module
- Function:
 - Voltage output and current or voltage sampling measurement with minimum sampling interval of 5 ns
- Current measurement range: 1 μ A, 10 μ A, 100 μ A, 1 mA, or 10 mA
- Operation mode: PG mode, Fast IV mode, or DC mode
- PG mode:
 - ALWG (arbitrary linear waveform generator) voltage output and voltage measurement (VFVM).
 - Output level: -5 V to 5 V for open load or -2.5 V to 2.5 V for 50 Ω load
 - Minimum pulse width: 50 ns
- Fast IV mode:
 - ALWG voltage output and current or voltage measurement (VFIM or VFVM).
 - Output level: 0 to -10 V, 0 to 10 V, or -5 V to 5 V
 - Minimum pulse width (VFVM): 130 ns for 10 V output, 105 ns for 5 V output
- DC mode:
 - DC voltage output and current or voltage measurement (VFIM or VFVM).
 - Output level: 0 to -10 V, 0 to 10 V, or -5 V to 5 V

Figure 2-9

WGFMU Simplified Circuit Diagram



Introduction
Measurement Modules

3

Installation

This chapter describes how to install Keysight B1500A and accessories.

- “Requirements”
- “Inspection and Installation”
- “Installing Accessories”
- “Mounting Connectors”
- “Connecting Measurement Devices”
- “Capacitance Compensation When Using Switching Matrix”
- “Maintenance”
- “About Plug-in Modules”

To change the GPIB address of the B1500A, see “[To Change GPIB Address](#)” on [page 3-11](#). To control external GPIB devices from the B1500A/EasyEXPERT, see “[To Enable System Controller](#)” on [page 3-12](#).

WARNING

To avoid electrical shock and instrument damage, turn the instrument off before connecting or disconnecting measurement cable.

Mettez la machine hors tension pour fixer le connecteur ou pour retirer le connecteur de l'unité centrale.

WARNING

This instrument is heavy and requires a two person lift.

Cet instrument est lourd et nécessite deux personnes pour le soulever.

CAUTION

Do not grab the fixture cover when lifting the test fixture.

WARNING

There are potentially hazardous voltages (± 200 V for HPSMU, and ± 100 V for MPSMU/HRSMU) present at the High/Force/Sense/Guard terminal of this instrument. To prevent electrical shock, the following safety precautions must be observed during the use of the instrument.

- Use a three-conductor AC power cord to connect the instrument to an electrical ground (safety ground).
- If an interlock circuit is not installed in your test fixture or connection interface, you must install and connect an interlock circuit that opens the Interlock terminal when the shielding box access door is opened.
- If you change the connection interface, test fixture, prober, and such, connect an interlock cable to the one actually used.
- Confirm periodically that the interlock function works normally.
- Before touching the connections on the High/Force/Sense/Guard terminal in the test fixture or the shielding box, turn the instrument off and discharge any capacitors. If you do *not* turn the instrument off, complete *all* of the following items, regardless of the instrument settings.
 - Terminate measurement by pressing the front panel Stop key, and confirm that the Measurement status indicator is not lit.
 - Confirm that the front panel High Voltage indicator is not lit.
 - Open the fixture cover or the shielding box access door (open Interlock).
 - Discharge any capacitors connected to a measurement resource.
 - Warn persons working around the instrument about dangerous conditions.

WARNING



Une tension dangereuse (max. \pm pour HPSMU; 200 Vdc, max. \pm pour MPSMU/ HRSMU; 100 Vdc) émanant du dispositif Keysight B1500A peut être sortie aux bornes High, Force, Sense et Guard. Les précautions suivantes doivent être observées contre commotion électrique accidentelle.

- Utilisez un cordon d'alimentation CA à trois connecteurs pour connecter la cabine (si utilisée) et l'instrument à la mise électrique à la terre (sol de sécurité).
- Si un circuit de sécurité n'est pas installé dans votre test d'installation ou dans votre interface de connexion, vous devez installer et connecter le circuit de sécurité qui ouvre la borne d'enclenchement lorsque la porte d'accès à la protection de la boîte est ouverte.
- Si vous changez l'interface de connexion, un test d'installation, la sonde, ou toute autre élément, connectez un cordon d'enclenchement à celui utilisé actuellement.
- Vérifiez régulièrement que la fonction de verrouillage fonctionne normalement.
- Avant de toucher les connexions des bornes High, Force, Sense et Guard, mettez l'instrument hors tension et déchargez tout condensateur du chemin de mesure. Si vous ne mettez pas l'instrument hors tension, effectuez « toutes » les opérations ci-dessous, quels que soient les paramètres de l'instrument.
 - Terminez les mesures en appuyant sur la touche Stop ; vérifiez que l'indicateur d'état Measurement est éteint.
 - Vérifiez que le témoin High Voltage est éteint.
 - Ouvrez le couvercle d'appareil ou la protection du boîtier de la porte d'accès (ouvez la borne Interlock).
 - Déchargez tous les condensateurs connectés au réseau.
- Informez les personnes se trouvant à proximité de l'appareil à propos des conditions dangereuses.

Requirements

This section contains information on:

- “Power Requirements”
- “Operating Environment”
- “Storaging/Shipping Environment”
- “Installation Requirements”
- “Power Cord”

Power Requirements

This instrument can operate from any single-phase AC power source supplying 100-240 V ($\pm 10\%$) at 50/60 Hz. The maximum power consumption is 900 VA.

Operating Environment

This instrument is specified to operate within the following environmental conditions:

Temperature: 5 °C to 40 °C

Humidity: 20 % to 70 % RH, non-condensing

Altitude: 0 to 2,000 m (6,561 ft.)

Storaging/Shipping Environment

This instrument is specified to store/ship within the following environmental conditions:

Temperature: -20 °C to 60 °C

Humidity: 10 % to 90 % RH, non-condensing

Altitude: 0 to 4,600 m (15,092 ft.)

Installation Requirements

WARNING



Do not operate the instrument in dusty environment, or in the presence of flammable gases, corrosive gases, or fumes.

Ne pas utiliser l'appareil dans un endroit poussiéreux, ou en présence de gaz inflammables, corrosifs ou de fumée.

- Environmental conditions for this instrument are documented in “[Operating Environment](#)” on page 3-5. In principle, this instrument should only be operated indoors in a controlled environment.
- Install the instrument horizontal place then face the roof up.
- Fan cools the instrument by drawing air through the sides and exhausting it out the back. The instrument must be installed in a location that allows sufficient space at the sides and back of the instrument for adequate air circulation.

If the airflow is restricted, the internal operating temperature will be higher. This may reduce the instrument’s reliability, or cause the thermal-protection circuits to turn the instrument off.

- Make sure that there is enough space for connecting/disconnecting the power cord easily.

Power Cord

WARNING



FIRE HAZARD: Use only the power cord supplied with your instrument. Using other types of power cord may cause overheating of the power cord, resulting in fire.

SHOCK HAZARD: The power cord provides the chassis ground through a third conductor. Be sure to connect to a three-conductor type power outlet with the correct pin grounded.

RISQUE D'INCENDIE : utilisez uniquement le câble d'alimentation fourni avec votre appareil. L'utilisation d'autres types de câble d'alimentation peut provoquer une surchauffe du câble d'alimentation et provoquer un incendie.

RISQUE DE CHOC ÉLECTRIQUE: le câble d'alimentation fournit la masse du châssis par le biais d'un troisième conducteur. Assurez-vous de connecter la prise d'alimentation de type trois conducteurs avec la broche correcte mise à la terre.

NOTE

The detachable power cord may be used as an emergency disconnecting device. Removing the power cord will disconnect AC input power to the instrument.

Connect the power cord to the IEC 60320 connector on the rear of the instrument. If the wrong power cord was shipped with your instrument, contact your nearest Keysight Sales and Support Office.

The AC input on the back of your instrument is a universal AC input. It accepts nominal line voltages in the range of 100 to 240 VAC.

Inspection and Installation

This section describes what to do when you receive the instrument and accessories.

1. Inspect the shipment. See “[To Inspect B1500 and Accessories](#)”.
2. Verify the instrument operation and perform initial setup. See “[To Perform Initial Setup](#)”.
3. Install the instrument in the appropriate place. See “[Requirements](#)” on page 3-5.

To use the instrument briefly, see “[Getting Started](#)” on page 1-1.

To change the Windows logon setting, see “[To Change Windows Logon Setting](#)” on page 3-10.

To change the GPIB address of the instrument, see “[To Change GPIB Address](#)” on page 3-11.

To allow the B1500A/EasyEXPERT to control external GPIB devices, see “[To Enable System Controller](#)” on page 3-12.

To Inspect B1500 and Accessories

Perform the following inspections when the instrument and accessories arrive at your site.

1. Before unpacking any components, inspect all boxes for any signs of damage that might have occurred during shipment, such as:
 - dents
 - scratches
 - cuts
 - water marks

If you suspect any damage, notify your local Keysight Technologies sales or service office.

2. When you open the boxes that contain the instrument and accessories, check the components against the contents lists attached to the boxes.

If anything is missing, notify your local Keysight Technologies sales or service office.

To Perform Initial Setup

After you receive the instrument, perform the following setup.

For the users available just after the initial setup, see [Table 3-1](#).

1. Make sure that the Standby switch is set to off.
2. On the instrument rear panel, connect the Circuit Common terminal to the frame ground terminal by using a shorting-bar.
3. If you use Keysight 16444A-001 USB keyboard and/or the 16444A-002 USB mouse, connect it to an USB port of the instrument.
4. Connect the power cord from the instrument to an AC power outlet.
5. Open the measurement terminals and press the Standby switch to turn on the instrument.

If the instrument is operating correctly, the power-on self-test is automatically performed. If problems arise, see *Keysight EasyEXPERT User's Guide*.

6. Perform the initial Windows setup. The setup method may vary depending on the manufacturing period.
 - a. If the Windows Setup Wizard appears:

Follow the on-screen instructions to complete the setup.

 - Set the system display language to English. The language must be English.
 - If you use the 16444A-001 USB keyboard, the keyboard layout must be US.
 - Accept the End User License Agreement (EULA) when prompted during setup.
 - b. If the Windows Setup Wizard does not appear and Windows starts automatically:

Accept the End User License Agreement (EULA) when it is displayed after startup.

If the instrument has been already connected to your site LAN, you can proceed the network connection setup.

NOTE**Other Windows setups**

You can configure other Windows settings after the initial setup. This is your responsibility.

Table 3-1**Users Available Just After the Initial Setup**

User Account	Description
Keysight B1500 User	Account for automatic logon. Password is not set or Keysight4u!, depending on the manufacturing period. Set or change the password to something more secure (and less well-known).
keysightOnly	Account for Keysight service personnel. Do not delete this account. This account is password protected.
Administrator	Administrator. Password is not set or Keysight4u!, depending on the manufacturing period. Set or change the password to something more secure (and less well-known).

You can add users after the initial setup. Add users as you need.

To Change Windows Logon Setting

Keysight B1500A initially enables Windows automatic logon. If you want to change this setting, select *All Programs > Control Auto Logon* from the Start menu. Control Auto Logon is displayed on the browser. Then click one of the following buttons on the browser and follow the setup script.

- Enable Auto Logon
- Disable Auto Logon

NOTE

If you set a password for the user account *Keysight B1500 User*, disable the automatic logon.

To Change GPIB Address

When this instrument is shipped from the factory, the GPIB address is set to 17. To change the GPIB address, perform the following procedure.

1. If the EasyEXPERT software is running, terminate it as shown below:
 - a. Select the menu function *File > Exit* on the EasyEXPERT main screen.
 - b. Click [x] at the upper right corner of the Start EasyEXPERT button.
2. Select *All Programs > Keysight IO Libraries Suite > Keysight Connection Expert* from the Start menu. Keysight Connection Expert window appears.
3. At the *Instrument I/O on this PC* area, select GPIB0, and click the *Change Properties...* button. Keysight 82350 PCI GPIB Interface - GPIB0 window appears.
4. Change the GPIB Address value.
5. Remove the check from the *Auto-discover instruments connected to this interface* box.
6. Click the *OK* button on Keysight 82350 PCI GPIB Interface - GPIB0 window.
7. If the *Reboot Required* dialog box is displayed, click the *Reboot Now* button, and reboot the instrument.

NOTE

For the GPIB connection of this instrument, use an GPIB interface, Keysight 82350B/C (for PCI bus), Keysight 82351A/B (for PCIe bus), Keysight 82357A/B (USB/GPIB), or National Instrument GPIB-USB-HS.

For using an USB/GPIB interface, it is recommended to set the GPIB address of this instrument to an even number. The USB/GPIB interface might cause serial poll error intermittently due to the intrinsic communication scheme differences. It is reported that using an even GPIB address sometimes significantly decreases the chance of the error.

To Enable System Controller

To allow Keysight B1500A/EasyEXPERT to control external GPIB devices, perform the following procedure.

1. If the EasyEXPERT software is running, terminate it as shown below:
 - a. Select the menu function *File > Exit* on the EasyEXPERT main screen.
 - b. Click [x] at the upper right corner of the Start EasyEXPERT button.
2. Select *All Programs > Keysight IO Libraries Suite > Keysight Connection Expert* from the Start menu. Keysight Connection Expert window appears.
3. At the *Instrument I/O on this PC* area, select GPIB0, and click the *Change Properties...* button. Keysight 82350 PCI GPIB Interface - GPIB0 window appears.
4. Set the *GPIB Address* value to 21 that is the typical address number for the system controller.
5. Check the *System Controller* box.
6. Remove the check from the *Auto-discover instruments connected to this interface* box.

This disables the automatic device detection. So the Connection Expert cannot detect the instruments connected to the GPIB interface by itself.

7. Click the *OK* button on Keysight 82350 PCI GPIB Interface - GPIB0 window.
8. If the *Reboot Required* dialog box is displayed, click the *Reboot Now* button, and reboot the instrument.

NOTE

To Disable System Controller

If the B1500A is the system controller, you cannot control the B1500A by using an external computer. To disable the system controller, change the steps 4 and 5 for setting the *GPIB Address* value to *not* 21 and removing the check from the *System Controller* box, and perform the procedure to the step 8.

Installing Accessories

This section describes how to install the accessories.

- “To Connect 16442B Test Fixture (B1500A-A5F)”
- “To Connect Connector Plate”
- “To Connect ASU”
- “To Connect SCUU/GSWU”
- “To Connect GNDU Adapter”
- “To Connect MCSMU Connection Box”

WARNING



To avoid electrical shock and instrument damage, turn the instrument off before connecting or disconnecting measurement cable.

Mettez la machine hors tension pour fixer le connecteur ou pour retirer le connecteur de l'unité centrale.

WARNING



There are potentially hazardous voltages (± 200 V for HPSMU, and ± 100 V for MPSMU/HRSMU) present at the Force, Sense, and Guard terminals. To prevent electrical shock, do *not* expose these lines.

Une tension dangereuse (max. \pm pour HPSMU; 200 Vdc, max. \pm pour MPSMU/ HRSMU; 100 Vdc) émanant du dispositif Keysight B1500A peut être sortie aux bornes Force, Sense et Guard. Afin d'éviter toute décharge électrique, n'exposez pas ces lignes.

WARNING



This instrument supports the Interlock function to prevent you from receiving an electrical shock from high voltage (more than ± 42 V). If the Interlock terminal is open, this instrument *cannot* apply high voltage more than ± 42 V.

If you do not use the 16442A/B test fixture, install an interlock circuit (see page 3-34) and connect it to the Interlock terminal.

Cet instrument prend en charge la fonction de verrouillage afin d'éviter que vous ne receviez un choc électrique par haute tension (plus de ± 42 V). Si la borne de verrouillage est ouverte, cet instrument ne peut pas appliquer de haute tension à plus de ± 42 V.

Si vous n'utilisez pas l'équipement de test 16442A/B, installez un circuit de verrouillage (voir page 3-34) et connectez-le à la borne de verrouillage.

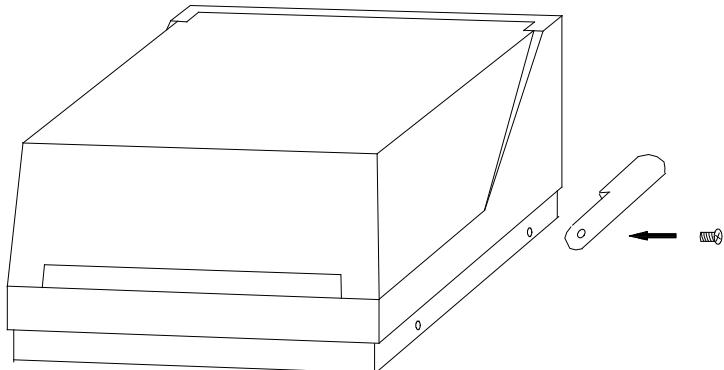
CAUTION	<p>The GNDU can sink current of up to 4.2 A. Use Keysight 16493L GNDU cable to connect the GNDU to a test fixture or a connector plate.</p> <p><i>Do not</i> use normal triaxial cable (Keysight 16494A) because the maximum current rating of the cable is 1 A.</p>
CAUTION	<p>Never connect the Guard terminal to any output, including circuit common, chassis ground, or any other guard terminal. Doing so will damage the SMU.</p>

To Connect 16442B Test Fixture (B1500A-A5F)

See this section if you use Keysight 16442B test fixture (B1500A-A5F). This section describes how to set up the 16442B and how to connect the B1500A to the 16442B.

To Set up 16442B (B1500A-A5F)

You can stabilize the 16442B (B1500A-A5F) as shown in the figure below.



1. Put a stabilizer on both sides of the test fixture.
2. Attach each stabilizer to the test fixture with a flathead screw.

To Connect 16442B (B1500A-A5F)

Use the cables shown in [Table 3-2](#) to connect from the B1500A connectors to the 16442B's relative connectors.

NOTE

Making non-Kelvin connection

The Force terminals can be used to force and measure DC voltage or current. If you want to simplify the cable connections, open the Sense terminals and connect the Force terminals only to the test fixture by using the triaxial cables.

If you make the Kelvin connection (remote sensing), use both Force and Sense terminals. Connecting the Force and Sense lines together at the terminal of the device under test minimizes the measurement error caused by the residual resistance of the connection cables. The Kelvin connection is effective for the low resistance measurement and the high current measurement.

Table 3-2 To Connect 16442B (B1500A-A5F)

Cables	16442B Terminals	B1500A Terminals	
Keysight 16493J Interlock Cable, 3 m or 1.5 m	Intlk	Interlock	
Keysight 16493L GNDU Cable, 3 m or 1.5 m	GNDU	GNDU	
Keysight 16493K Kelvin Triaxial Cable, 3 m or 1.5 m, for the Kelvin connection Up to 3 SMUs can be connected to the 16442B by the Kelvin connection.	SMU1	SMU	Force
	SMU2		Sense
	SMU3	SMU	Force
	SMU4		Sense
	SMU5	SMU	Force
	SMU6		Sense
Keysight 16494A Triaxial Cable, 3 m or 1.5 m, for the non-Kelvin connection	SMU1	SMU	Force
	SMU2	SMU	Force
	SMU3	SMU	Force
	SMU4	SMU	Force
	SMU5	SMU	Force
	SMU6	SMU	Force
Keysight 16493P SPGU Cable, 3 m or 1.5 m	PGU1	SPGU	Output 1
	PGU2		Output 2
Keysight N1300A CMU Cable ^a , 3 m or 1.5 m	PGU1	CMU	Hcur/Hpot
	PGU2		Lcur/Lpot

a. To extend the four-terminal pair (4TP) connection to the 16442B inputs, connect the Hcur and Hpot cables together and the Lcur and Lpot cables together by using the BNC T-type adapter (female-female-male, Keysight part number 1250-2405), then connect them to the 16442B inputs.

To extend the 4TP connection to the socket module inputs, connect the cables to the PGU1, PGU2, VSU1, VSU2, VMU1, or VMU2 connector individually, and connect the Hcur and Hpot terminals together and the Lcur and Lpot terminals together at the socket module inputs.

It is ok to leave open the ground wire extended from the CMU cable.

To Connect Connector Plate

The available connector plates are listed in [Table 3-3](#). Option 001 provides the through connectors except for the Interlock connector that provides the soldering patterns at the back side. For the option 002, the back of each connector is designed for soldering. For connector plate installation information, see [Keysight 16495 Installation Guide](#).

For the 16495H/J, the insulator is inserted between the panel and the outer conductor of Triax connectors/BNC connectors.

Use the cables shown in [Table 3-4](#) to connect from the B1500A connectors to the connector plate's relative connectors. For the cable connections from the connector plate to the DUT interface such as manipulator and probe card, see [“Mounting Connectors” on page 3-32](#) as reference.

NOTE**Making non-Kelvin connection**

The Force terminals can be used to force and measure DC voltage or current. If you want to simplify the cable connections, open the Sense terminals and connect the Force terminals only to the connector plate by using the triaxial cables.

If you make the Kelvin connection (remote sensing), use both Force and Sense terminals. Connecting the Force and Sense lines together at the terminal of the device under test minimizes the measurement error caused by the residual resistance of the connection cables. The Kelvin connection is effective for the low resistance measurement and the high current measurement.

Table 3-3 **Connector Plates**

Model	Option Item	Connectors
16495F	16495F-001	Triax. (f-f) ×12, GNDU (f-f) ×1, Interlock (f) ×1
	16495F-002	Triax. (f) ×12, GNDU (f) ×1, Interlock (f) ×1
16495G	16495G-001	Triax. (f-f) ×24, GNDU (f-f) ×1, Interlock (f) ×1
	16495G-002	Triax. (f) ×24, GNDU (f) ×1, Interlock (f) ×1
16495H	16495H-001	Triax. (f-f) ×6, Coax. (f-f) ×6, GNDU (f-f) ×1, Interlock (f) ×1
	16495H-002	Triax. (f) ×6, Coax. (f) ×6, GNDU (f) ×1, Interlock (f) ×1
16495J	16495J-001	Triax. (f-f) ×8, Coax. (f-f) ×4, GNDU (f-f) ×1, Interlock (f) ×1
	16495J-002	Triax. (f) ×8, Coax. (f) ×4, GNDU (f) ×1, Interlock (f) ×1
16495K	16495K-001	Connector plate, rubber holder

Table 3-4 To Connect Connector Plate

Cables	Connector Plate	B1500A Terminals	
Keysight 16493J Interlock Cable, 3 m or 1.5 m	Intlk	Interlock	
Keysight 16493L GNDU Cable, 3 m or 1.5 m	GNDU	GNDU	
Keysight 16493K ^a Kelvin Triaxial Cable, 3 m or 1.5 m, for the Kelvin connection 16495F provides the inputs 1 to 12 (6 Kelvin). 16495H provides the inputs 1 to 6 (3 Kelvin). 16495J provides the inputs 1 to 8 (4 Kelvin).	odd number	SMU	Force
	even number		Sense
	odd number or even number	SMU	Force
Keysight 16494A Triaxial Cable, 3 m or 1.5 m, for non-Kelvin connection 16495H provides the inputs 1 to 6. 16495J provides the inputs 1 to 8.	odd number or even number	SPGU	Output 1
	odd number or even number		Output 2
	odd number or even number	CMU	Hcur/Hpot Lcur/Lpot

- Use Keysight 16494B Kelvin Triaxial Cable to connect to Keysight E5250A Low Leakage Switch Mainframe or the connector plate for Keysight 4142B Modular DC Source/Monitor by the Kelvin connection.
- To extend the four-terminal pair (4TP) connection to the connector plate inputs, connect the Hcur and Hpot cables together and the Lcur and Lpot cables together by using the BNC T-type adapter (female-female-male, Keysight part number 1250-2405), then connect them to the connector plate inputs. To extend the 4TP connection to the DUT interface, connect the cables to the connector plates input connectors individually, and connect the Hcur and Hpot terminals together and the Lcur and Lpot terminals together on the DUT interface. See [Figure 3-20](#).

It is ok to leave open the ground wire extended from the CMU cable.

To Connect ASU

Keysight E5288A Atto Sense and Switch Unit (ASU) adds the following functions to the B1500A. To use the ASU, it must be connected to the SMU which is connected together when the calibration is performed.

- Atto ampere (aA) level current measurement capability
- Automatic switching of ASU input resource connected to ASU output

CAUTION

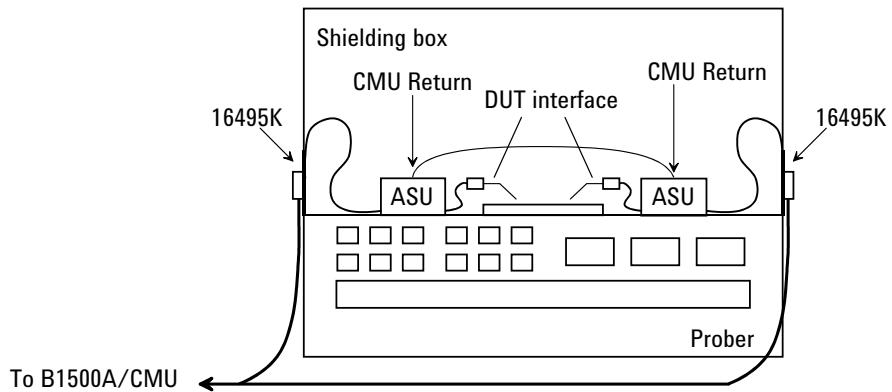
To prevent instrument damage, never connect or disconnect the ASU in the instrument power on state.

NOTE

For the installation of the ASU and the connection to the DUT interface (probe card, manipulators, and so on), contact your favorite prober vendor. The prober vendor will have the solutions. Dimensions of the ASU are 132 mm (W) × 88.5 mm (H) × 50 mm (D) excluding the connectors.

Figure 3-1

Image of ASU Installation



Required parts

- Keysight 16495K Connector plate
- Keysight 16493M ASU cable
- Keysight N1300A CMU cable or Keysight 16048D/E test leads
- Keysight N1254A-108 Magnet stand
- BNC cable, coaxial cable, manipulator, wire, and so on

To install 16495K

Fix the 16495 plate to the shielding box or something that will cover the DUT interface. See *Keysight 16495 Installation Guide*. The 16495K is the plate that has the mechanism to block the light from the cable hole used to pass the cables in the shielding box.

To install ASU

1. Fix the ASU in the shielding box. The ASU must be fixed to the best position for accessing its connectors. Keysight N1254A-108 Magnetic Stand will be useful for fixing the ASU.
2. Pass the 16493M (D-sub cable, triaxial cable), N1300A CMU cable, 16048D/E test leads, BNC cable and so on through the cable hole of the 16495K. They will be connected between the ASU and the instruments
3. Connect the D-sub cable to the ASU D-sub connector.
Connect the triaxial cable to the ASU Force terminal.
Connect the cable to the ASU CMU-cur/AUX In terminal. See [Figure 3-2](#).
 - For the MFCMU, connect the N1300A CMU cable.
 - For Keysight 4284A/E4980A LCR meter, connect Keysight 16048D/E test leads.
 - For the instrument other than the MFCMU or the 4284A/E4980A, connect the BNC cable to the CMU-cur/AUX In terminal. And open the CMU-pot terminal or cover it by using the BNC open cap.
4. Adjust the cable length in the shielding box, and catch in the cables by using the cover of the 16495K.
5. Connect the cable from the DUT interface to the ASU output terminal.

For the non Kelvin connection, open the Sense terminal or cover it by using the triaxial open cap.

**To connect
B1500A**

1. Turn the B1500A off.
2. Connect the D-sub cable from the ASU to the SMU D-sub connector.
3. Connect the triaxial cable from the ASU to the SMU Force terminal.

NOTE

To use the ASU, it must be connected to the SMU which is connected together when the calibration is performed. The specifications are satisfied and guaranteed in this condition only. So confirm the serial number of the ASU and connect it to the dedicated SMU properly. See Keysight EasyEXPERT *User's Guide* to confirm the serial number.

**To connect
MFCMU/4284A/
E4980A to AUX**

Perform the following procedure to connect the MFCMU or the 4284A/E4980A. See [Figure 3-2](#) and [Figure 3-3](#).

Prepare a shorting bar furnished with the ASU. The shorting bar is effective for reducing the offset capacitance caused by connecting a measurement terminal to the chuck of a wafer prober.

1. Turn the instrument off.
2. Prepare two ASUs (#1 and #2) and two shorting bar. And perform the following procedure for each ASU.
 - a. Disconnect the triaxial cable from the ASU if it is connected to the ASU Force terminal.
 - b. Face the concave side of the shorting bar to front.
 - c. Slide the shorting bar from the right side of the connectors.
3. Connect the cable to the instrument. For the MFCMU, use the N1300A CMU cable. For the 4284A/E4980A, use the 16048D/E test leads. It is ok to leave open the ground wire extended from the cable.
4. Connect the high potential (Hp) cable of the test leads to the ASU #1 CMU-pot terminal.
5. Connect the high current (Hc) cable to the ASU #1 CMU-cur/AUX In terminal. The shorting bar is fixed to the ASU #1 by the step 5 and 6.
6. Connect the triaxial cable from the SMU #1 Force terminal to the ASU #1 Force terminal.
7. Connect the low potential (Lp) cable to the ASU #2 CMU-pot terminal.
8. Connect the low current (Lc) cable to the ASU #2 CMU-cur/AUX In terminal. The shorting bar is fixed to the ASU #2 by the step 8 and 9.
9. Connect the triaxial cable from the SMU #2 Force terminal to the ASU #2 Force terminal.
10. Prepare the connection wire (both pin terminals) furnished with the ASU and connect it between the CMU Return terminals of the ASU #1 and ASU #2 together.

NOTE

About ASU output cables

To perform capacitance measurements accurately, the cable length between DUT and the ASU output must be as short as possible.

Figure 3-2

To Connect ASU

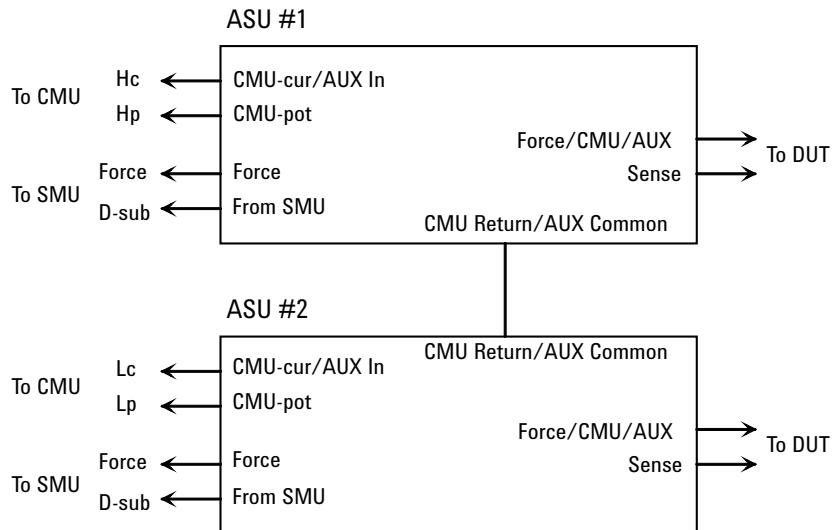
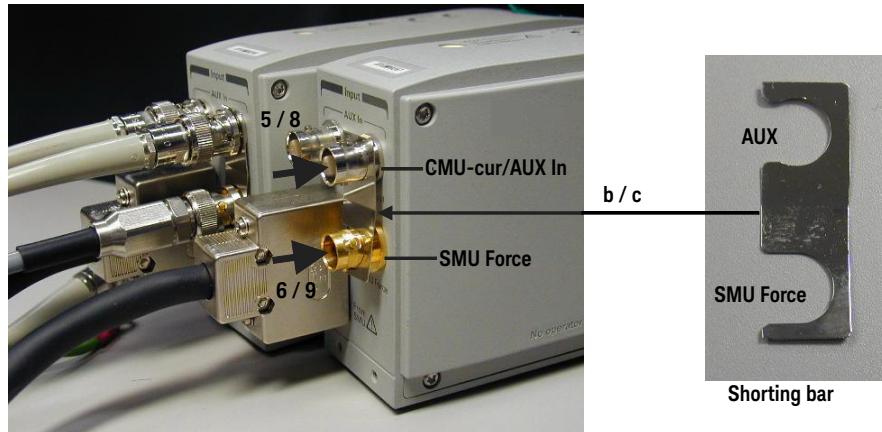


Figure 3-3

To Set Shorting Bar



To connect other instrument to AUX

To connect the instrument other than the MFCMU or the 4284A/E4980A:

1. Turn the instrument off.
2. Connect the BNC cable from the ASU CMU-cur/AUX In terminal to the instrument. Prepare an adapter if the instrument's input/output connector is not BNC.

To Connect SCUU/GSWU

Keysight N1301A-100 SMU CMU Unify Unit (SCUU) is used to switch the measurement resource (CMU or SMU) to be connected to the DUT.

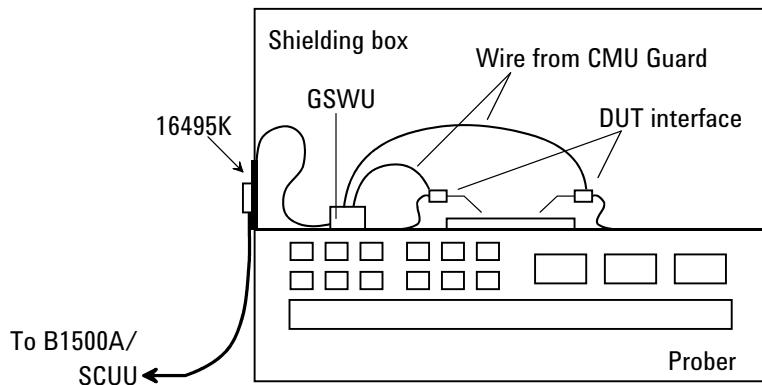
Keysight N1301A-200 Guard Switch Unit (GSWU) is used to connect the CMU high and low guard lines together near the DUT. The connection is broken when the SCUU is in the SMU connection state. The GSWU is effective for the accurate impedance measurement.

NOTE

For the installation of the SCUU/GSWU and the connection to the DUT interface (probe card, manipulators, and so on), contact your favorite prober vender. The prober vender will have the solutions. Dimensions of the SCUU are 148 mm (W) × 75 mm (H) × 70 mm (D). Dimensions of the GSWU are 33.2 mm (W) × 41.5 mm (H) × 32.8 mm (D).

Figure 3-4

Image of GSWU Installation

**Required parts**

- Keysight 16495K Connector plate
- Keysight N1301A-201/202 GSWU cable (if GSWU is used)
- Keysight N1301A-102 SCUU cable (if SCUU is not attached to the MFCMU)
- Keysight N1301A-110 Magnet stand (if GSWU is used)
- BNC cable, coaxial cable, manipulator, wire, and so on

To install 16495K

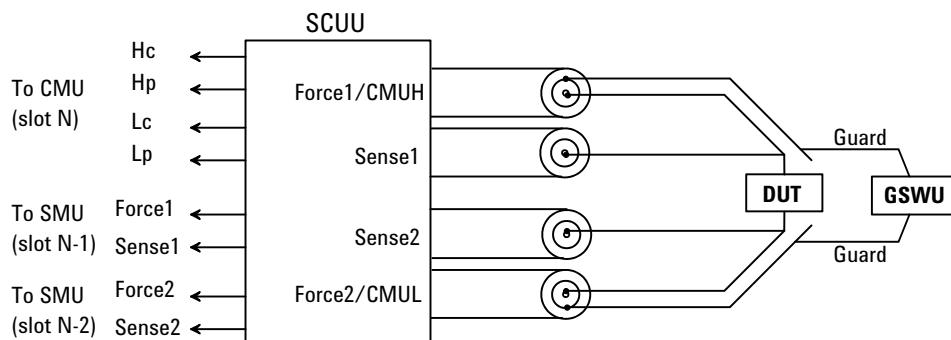
Fix your necessary 16495 connector plates to the shielding box or something that will cover the DUT interface. See *Keysight 16495 Installation Guide*. For the GSWU installation, the 16495K is required. It is the plate that has the mechanism to block the light from the cable hole used to pass the cables in the shielding box.

Before starting

1. GSWU is furnished with wires (2 ea.) for the connection between the GSWU and the DUT interface Guard terminal. If it is too short to connect them, prepare additional wire.
2. Turn the B1500A off.

Figure 3-5

To Connect SCUU/GSWU



**To connect
SCUU/GSWU 1**

To attach the SCUU to the B1500A:

1. Attach the SCUU to the B1500A rear panel connectors for the MFCMU in the slot N and two SMUs in the slots N-1 and N-2 (N: integer, 3 to 10).
Connection will be easy by bringing the control connectors together before bringing the BNC connectors.
2. Fix the GSWU in the shielding box. The GSWU must be fixed to the best position for accessing its connectors.
3. Pass the GSWU cable (Keysight N1301A-201/202) through the cable hole of the 16495K. And connect it between the SCUU and the GSWU.
4. Adjust the cable length in the shielding box, and catch in the cables by using the cover of the 16495K.
5. Connect the proper cables from Force1/CMUH and Force2/CMUL to the 16495 connector plates or the DUT interface. See [Figure 3-5](#).

For the Kelvin connections, also connect the proper cables from Sense1 and Sense2 to the 16495 connector plates or the DUT interface.

6. Connect the wires (furnished, 2 ea.) to the GSWU.
7. Connect one of the wires to the Guard terminal extended from CMUH of SCUU. Then the wire should contact the Guard terminal as close to the device as possible.
8. Connect another one to the Guard terminal extended from CMUL of SCUU. Then the wire should contact the Guard terminal as close to the device as possible.

NOTE

About SCUU output cables

To perform capacitance measurements accurately, the cable length between DUT and the SCUU output must be as short as possible.

**To connect
SCUU/GSWU 2**

1. Attach an end of the SCUU cable (Keysight N1301A-102) to the SCUU.

Connection will be easy by putting the SCUU and the cable connection box on the flat table, and bringing the control connectors together before bringing the BNC connectors.

If the SCUU is fixed inside the shielding box, pass the SCUU cable through the cable hole of the 16495K.

2. Fix the SCUU inside or outside the shielding box. The SCUU must be fixed to the best position for accessing its connectors. Keysight N1301A-110 Magnetic Stand will be useful for fixing the SCUU.
3. Attach the other end of the SCUU cable to the B1500A rear panel connectors for the MFCMU in the slot N and two SMUs in the slots N-1 and N-2 (N: integer, 3 to 10).

Connection will be easy by bringing the control connectors together before bringing the BNC connectors.

4. Fix the GSWU in the shielding box. The GSWU must be fixed to the best position for accessing its connectors.
5. Connect the GSWU cable (Keysight N1301A-201/202) between the SCUU and the GSWU.

If the SCUU is fixed outside the shielding box, pass the GSWU cable through the cable hole of the 16495K.

6. Adjust the cable length in the shielding box, and catch in the cables by using the cover of the 16495K.
7. Connect the proper cables from Force1/CMUH and Force2/CMUL to the 16495 connector plates or the DUT interface. See [Figure 3-5](#).

For the Kelvin connections, also connect the proper cables from Sense1 and Sense2 to the 16495 connector plates or the DUT interface.

8. Connect the wires (furnished, 2 ea.) to the GSWU.
9. Connect one of the wires to the Guard terminal extended from CMUH of SCUU. Then the wire should contact the Guard terminal as close to the device as possible.
10. Connect another one to the Guard terminal extended from CMUL of SCUU. Then the wire should contact the Guard terminal as close to the device as possible.

NOTE**About SCUU output cables**

To perform capacitance measurements accurately, the cable length between DUT and the SCUU output must be as short as possible.

To Connect GNDU Adapter

The ground unit (GNDU) output is the single triaxial connector. To change it to the dual triaxial connector, use Keysight N1254A-100 GNDU to Kelvin Adapter. The adapter and cables are furnished with the B1500A.

Attach the adapter directly to the rear panel as shown below.

1. Face the adapter's GNDU connector and banana jack to the B1500A's GNDU connector and Circuit Common terminal respectively.
2. Push the adapter toward the B1500A.
3. Rotate the GNDU connector handle of the adapter to fix it to the B1500A.

Use the following cables to extend the GNDU Force and Sense terminals

- 16493L GNDU cable, for Force
- 16494A Triaxial cable, for Sense

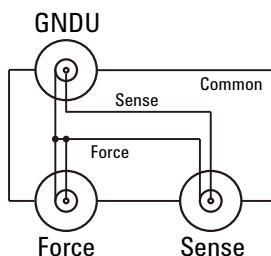
Figure 3-6

GNDU to Kelvin Adapter



Figure 3-7

GNDU to Kelvin Adapter Internal Connections



To Connect MCSMU Connection Box

Keysight N1255A connection box is used to make the connection of MCSMU easy. Input panel provides six triaxial connectors for connecting two MCSMU and one GNDU or SMU. Output panel provides six triaxial connectors for the High1, High2, and Low terminals. See [Figure 3-10](#) for image of the Input panel and the Output panel. Also see [Figure 3-8](#) for the connection image. And see [Figure 3-9](#) for the internal connection.

Use the following cables to connect the N1255A to the MCSMU.

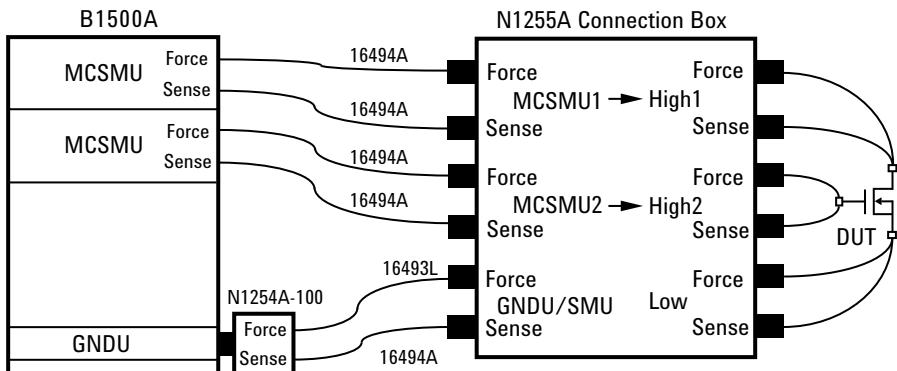
- 16494A Triaxial cable, 2 ea. per one MCSMU

Use the following cables and adapter to connect the N1255A to the GNDU.

- N1254A-100 GNDU to Kelvin adapter, 1 ea.
- 16493L GNDU cable, 1 ea.
- 16494A Triaxial cable, 1 ea.

Figure 3-8

N1255A Connection Example



NOTE



N1255A Input and Output terminals

If a MP/HP/HRSMU is connected instead of the GNDU, use the following cable. Also, do not use the SMU current range less than 100 mA.

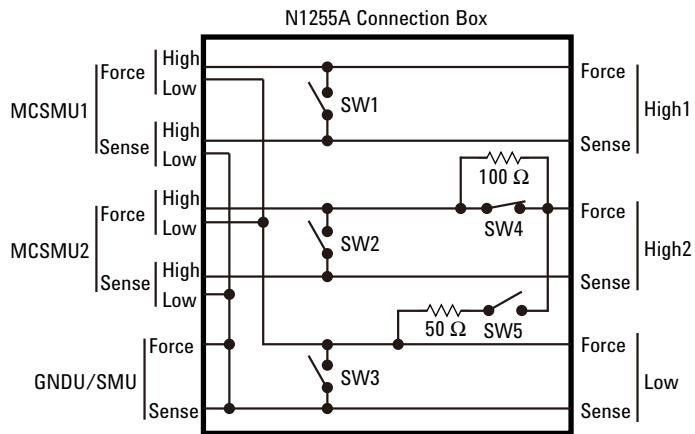
- 16494A Triaxial cable, 2 ea.

Voltage rating of terminal is indicated near connector on the Input or Output panel.

The N1255A cannot be used for measurement of the IEC Measurement Category II, III, or IV.

Figure 3-9

N1255A Internal Connections



- SW1: Kelvin/Non-Kelvin selection switch for High1
- SW2: Kelvin/Non-Kelvin selection switch for High2
- SW3: Kelvin/Non-Kelvin selection switch for Low
- SW4: 0 Ω/100 Ω series resistor selection switch for High2 Force
- SW5: Open/50 Ω shunt resistor selection switch between High2 and Low, Force

NOTE



Selection switch SW2 and SW4

The SW4 switches the series resistance 0 Ω/100 Ω on the High2 Force line. The resistor is not mounted on the High2 Sense line.

Set the SW4 to “0 Ω” if the SW2 is set to “Kelvin”.

Set the SW2 to “Non-Kelvin” if the SW4 is set to “100 Ω”.

NOTE



Selection switch SW1/SW2/SW3 and Sense connector on Output panel

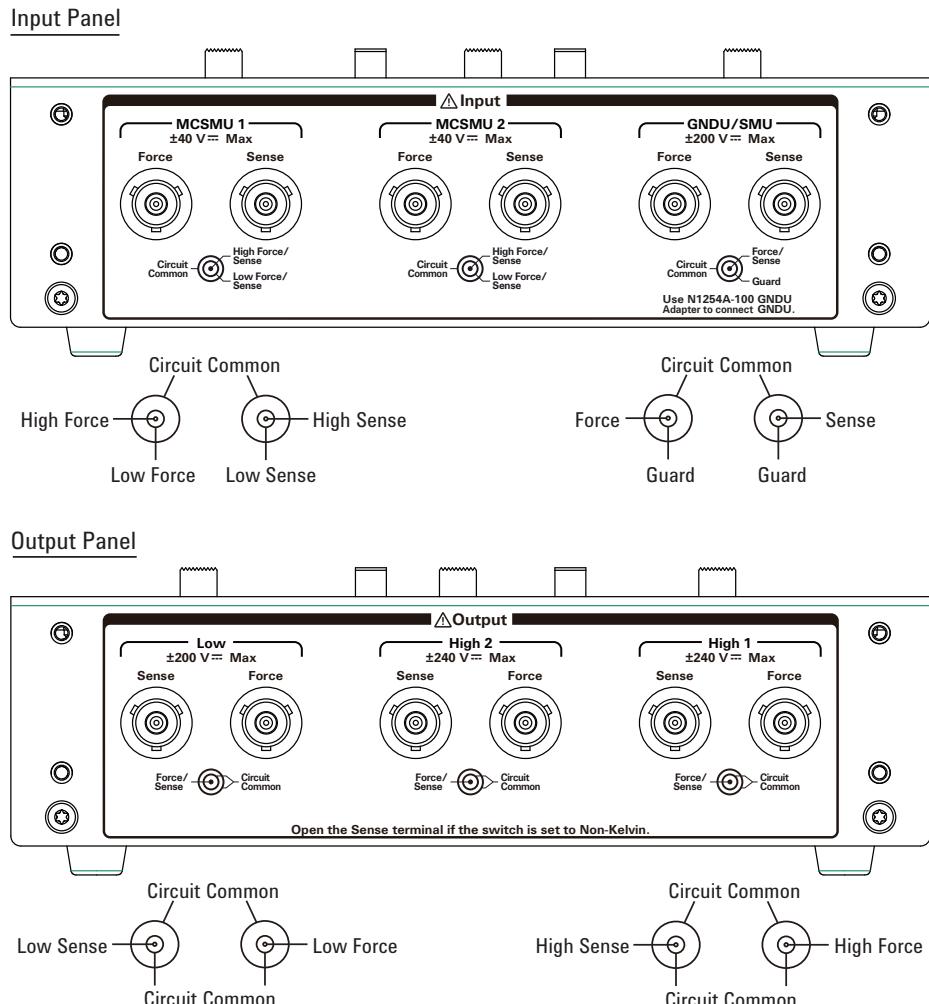
The switch is used to make or break the connection between Force and Sense in the N1255A. Setting it to “Non-Kelvin” makes this internal connection to enable the non-Kelvin connection. And setting it to “Kelvin” breaks this internal connection to enable the Kelvin connection.

If the switch is set to “Non-Kelvin”, do not extend the Sense output corresponding to it. Voltage on the Force line also appears on the Sense line. So, open the Sense connector on the Output panel.

NOTE**Series Resistor and Shunt Resistor**

The series resistor and the shunt resistor can be used for preventing MCSMU from oscillation. If the MCSMU oscillates, insert either $100\ \Omega$ series resistor or $50\ \Omega$ shunt resistor.

If it does not stop the oscillation, prepare the resistor of the other value and insert it between the Output High and the device under test (DUT).

Figure 3-10**N1255A Input Panel and Output Panel**

Mounting Connectors

Previous sections described how to install the available accessories, and *Keysight 16495 Installation Guide* provides the information on how to install connector plates on the shielding box. However, you may choose to mount connectors directly on your own connector plate or test fixture.

To do this, you will need to make connector holes and mount the connectors yourself. This section contains information on connector hole dimensions.

To mount connectors:

1. Select and prepare the appropriate parts for your application. See [Table 3-5](#).
2. Make the holes and mount the connectors. See [Table 3-6](#).

For Kelvin connections (remote sensing), use Keysight 16493K Kelvin triaxial cable. The Kelvin triaxial cable requires a Kelvin triaxial connector, which has two connector holes and three screw holes.

3. Build the interlock circuit shown in “[To Make an Interlock Circuit](#)” on page [3-34](#).
4. Attach cables from the connectors to the DUT (device under test). See “[To Connect GNDU Output](#)” on page [3-37](#), “[To Connect SMU Output](#)” on page [3-38](#), and “[To Connect MFCMU Output](#)” on page [3-46](#).

WARNING



For safety, prepare and attach a shield cover to avoid touching the joints on the wiring side of connectors. And ground the cover.

Wrap an insulator around the naked conductors of coaxial cable to avoid touching it.

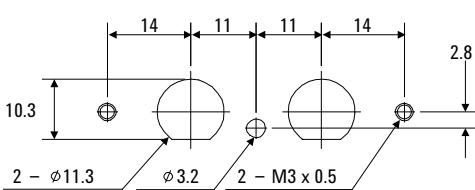
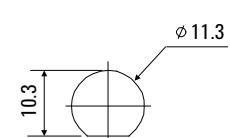
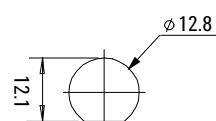
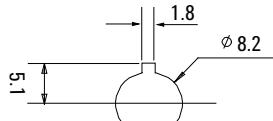
Pour des raisons de sécurité, préparez et fixez un couvercle protecteur pour éviter de toucher les joints du côté du câblage des connecteurs. Et mettez le couvercle à la terre.

Enroulez un isolant autour des conducteurs dénudés du câble coaxial afin d'éviter de les toucher.

Table 3-5
Recommended Parts

Usage	Keysight Part No.	Description
Making an interlock circuit	1252-1419	Interlock Connector (6 pin, female)
	N1254A-402	Switch
	1990-0486	LED ($V_F \approx 1.9$ V @ $I_F = 10$ mA)
	8150-5680	Wire (24 AWG, 600 V, 150 °C)
Connecting GNDU to DUT	1250-2457	Triaxial Connector (female)
	8121-1189 or 8150-2639	Coaxial Cable or Wire
Connecting SMU to DUT	1250-2457	Triaxial Connector (female)
	8121-1191	Low Noise Coaxial Cable
Connecting MFCMU to DUT	1250-0118	BNC Connector (female)
	8120-0367	Coaxial Cable (50 Ω)
	8150-0447	Wire

Table 3-6
Dimensions of Connector Holes

Kelvin Triaxial Connector (in mm)	Triaxial Connector (in mm)
	
BNC Connector (in mm)	Interlock Connector (in mm)
	

⚠ To Make an Interlock Circuit

The interlock circuit is designed to prevent electrical shock when a user touches the measurement terminals.

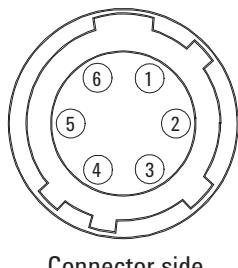
CAUTION

You must install an interlock circuit on a shielding box to prevent hazardous voltages when the door of the shielding box is open.

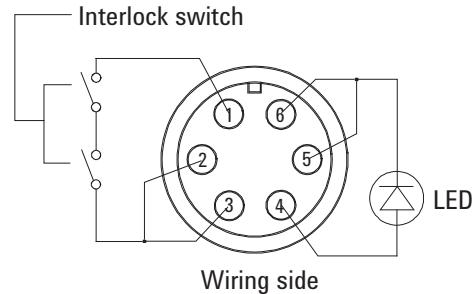
Figure 3-11 shows the pin assignments of the interlock connector that should be mounted on a connector plate or test fixture.

Figure 3-11

Interlock Connector Pin Assignments



Connector side



Wiring side

WARNING



Dangerous voltage, instrument maximum output voltage may appear at Force, Guard, and Sense terminals if the Interlock terminal is closed.

Une tension dangereuse, une tension de sortie maximale de l'appareil peut apparaître aux bornes Force, Guard et Sense si la borne Interlock est fermée.

Installing the interlock circuit

Install the interlock circuit as follows:

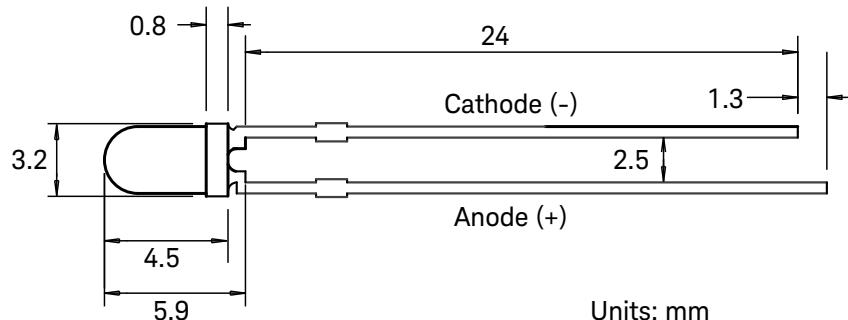
1. Mount two mechanical switches on your shielding box, so that the switches close when the door of the shielding box is closed, and open when the door is opened. For the dimensions of the switch, see [Figure 3-13](#).
2. Mount an LED on your shielding box. For the dimensions of the LED, see [Figure 3-12](#).
3. Use wire to connect the two switches in series between pin number 1 and 2 (or 3) of the interlock connector. See [Figure 3-11](#).
4. Use wire to connect the LED between pin number 4 and 5 (or 6) of the interlock connector. See [Figure 3-11](#).

If Keysight B1500A Interlock connector is connected to the interlock circuit, Keysight B1500A SMU *cannot* force more than ± 42 V when the door is open. When the door is closed, it can force more than ± 42 V.

When more than ± 42 V is forced from an SMU, the LED lights to indicate *high voltage output*.

Figure 3-12

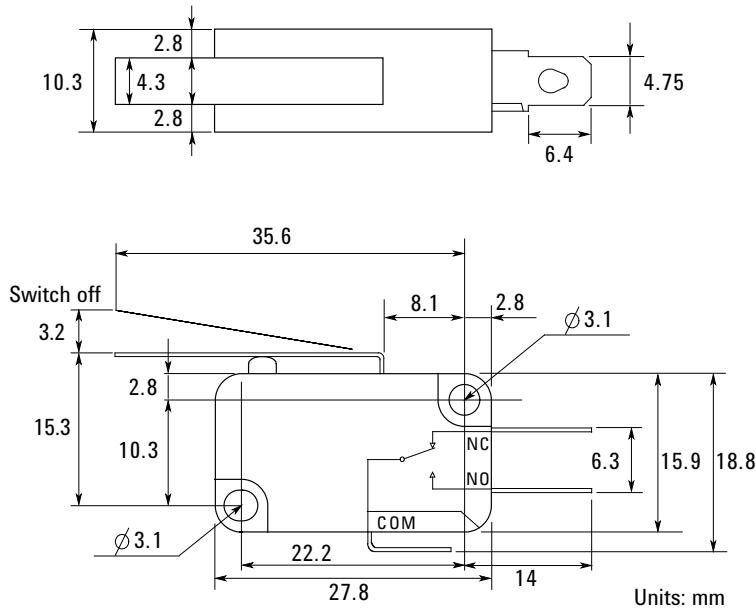
Dimensions of the LED (1990-0486)



Installation
Mounting Connectors

Figure 3-13

Dimensions of the Interlock Switch (N1254A-402)



To Connect GNDU Output

The GNDU output connection examples are shown in [Table 3-7](#).

Table 3-7 GNDU Output Connections

Kelvin connections (remote sensing)	non-Kelvin connections
<p>Use a low-noise coaxial cable (Keysight part number 8121-1189) from the connector to the prober, socket, or DUT as shown.</p> <p>To cancel the effects of cable resistance, connect the Sense line and Force line as close as possible to the terminal of the DUT.</p>	<p>Short the Sense and Force on the connector as shown below. Measurement data will include the residual resistance of the connection wire.</p> <p>Use AWG 22 single-strand insulated wire (Keysight part number 8150-2639) from the connector plate to the prober, socket, or DUT.</p> <p>For a quick connection where measurement accuracy is not critical, connect only Force to the DUT, without shorting the Sense and Force. With this connection, the measurement data will include residual resistance from the connection cable between the GNDU and the connector plate.</p>

CAUTION

Use Keysight 16493L GNDU cable to connect the GNDU to your connector plate or test fixture. Do *not* use the triaxial cable. The GNDU is rated for up to 4.2 A, while the maximum current rating of the triaxial cable is 1 A.

To Connect SMU Output

The SMU output connection examples are shown in [Table 3-8](#).

WARNING



There are potentially hazardous voltages (± 200 V for HPSMU, and ± 100 V for MPSMU/HRSMU) present at the Force, Sense, and Guard terminals.

To prevent electrical shock, do *not* expose these lines.

Before turning the instrument on, connect the Interlock terminal to an interlock circuit.

Before you touch any connections to these terminals, turn the instrument off, disconnect the power cord, and discharge any capacitors.

Il y a des tensions potentiellement dangereuses (± 200 V pour HPSMU, et ± 100 V pour MPSMU/HRSMU) au niveau des bornes Force, Sense et Guard.

Afin d'éviter toute décharge électrique, n'exposez pas ces lignes.

Avant de mettre l'instrument sous tension, connectez la borne de verrouillage à un circuit de verrouillage.

Avant de toucher toute connexion sur ces bornes, mettez l'appareil hors tension, débranchez le câble d'alimentation et déchargez tous les condensateurs.

CAUTION

Never connect the Guard terminal to any output, including circuit common, chassis ground, or any other guard terminal. Doing so will damage the SMU.

NOTE

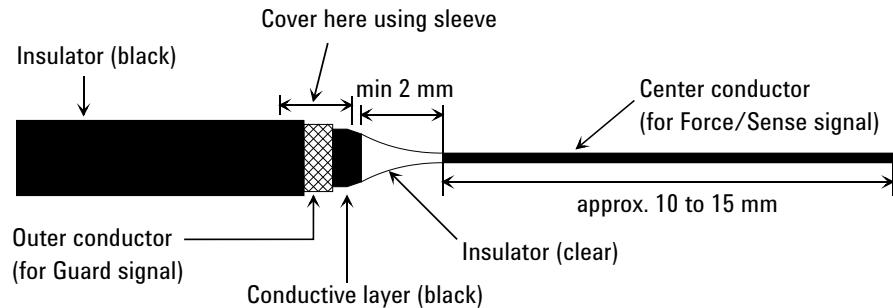
Low-Noise Coaxial Cable

For the extended measurement paths over the connector plate, use low-noise coaxial cable (Keysight part number 8121-1191). This cable can maximize the guard effects and minimize the impression of the external noise.

[Figure 3-14](#) shows the cutting example of this cable. Key point is the isolation between the conductive layer and the center conductor. So, cut and trim the end of the cable as shown in this figure by using a cutter and so on.

Figure 3-14

Coaxial Cable Cutting Example



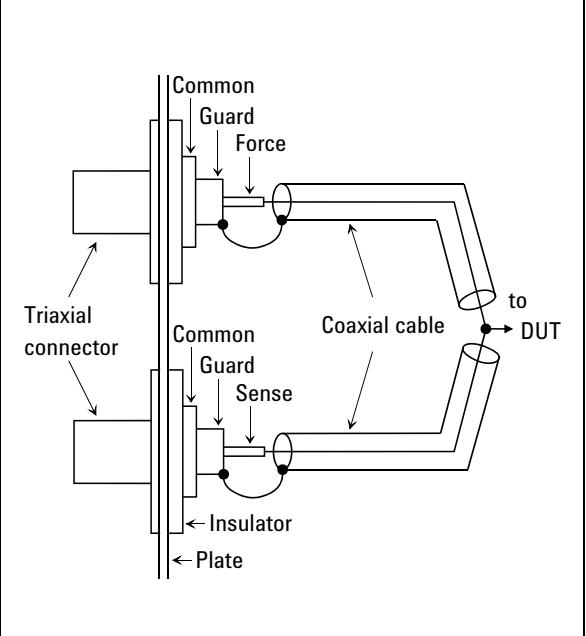
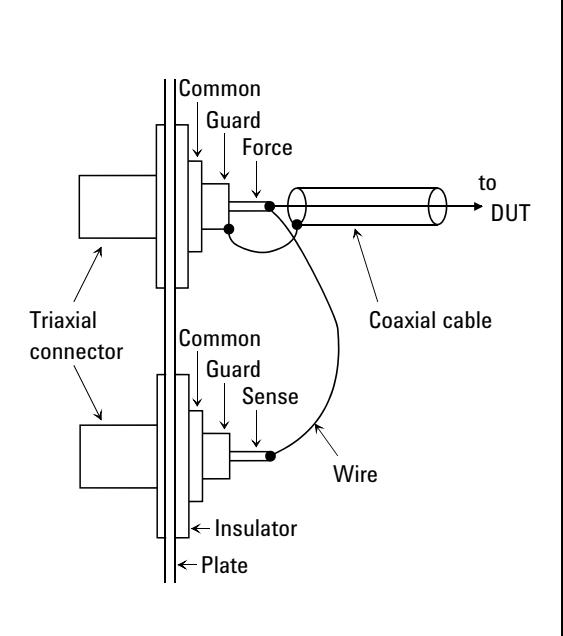
WARNING



Wrap an insulator around the naked conductors of coaxial cable to avoid touching it.

Enroulez un isolant autour des conducteurs dénudés du câble coaxial afin d'éviter de les toucher.

Table 3-8 **SMU Output Connections**

Kelvin connections (remote sensing)	non-Kelvin connections
<p>Use low-noise coaxial cable (Keysight part number 8121-1191) from the connector to the prober, socket, or DUT as shown.</p> <p>See Figure 3-15 and Figure 3-17 for the ASU and SCUU connections respectively.</p> <p>To cancel the effects of cable resistance, connect the Sense line and Force line as close as possible to the DUT terminal.</p> <p>To prevent oscillations, do not use cables longer than 1.5 m.</p>	<p>Use low-noise coaxial cable (Keysight part number 8121-1191). The following figure is for the connection using Kelvin triaxial cable.</p> <p>For the connection using triaxial cable, connect the cable to the Force terminal only.</p> <p>In this connection, measurement data will include residual resistance from the connection cable.</p> <p>See Figure 3-16 and Figure 3-18 for the ASU and SCUU connections respectively.</p>
	

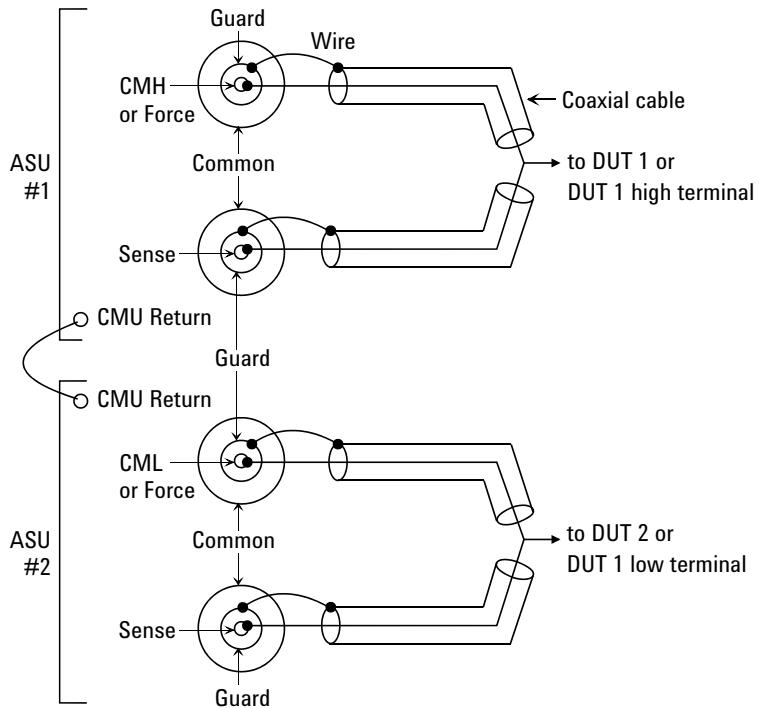
NOTE

To Minimize Leakage Current

For the highly accurate current forcing and measurements, surround all force and sense lines by a guard as far as possible, and physically stabilize the cables with tape.

Figure 3-15

ASU Output Kelvin Connection (Remote Sensing)



The ASU inputs can be connected to the instruments by using a control cable, a triaxial cable, and two coaxial cables. The cables can be connected to the ASU inside the shielding box through the 16495K plate.

The ASU outputs should be connected to the DUT by using coaxial cables and wires as shown above.

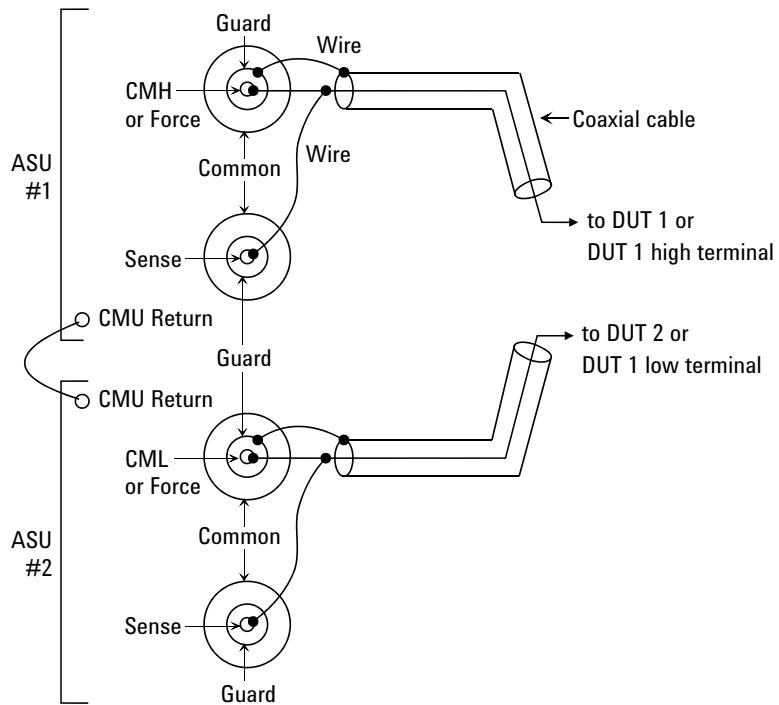
When a SMU is used for the measurements, the Kelvin paths will work as same as [Table 3-8](#).

When a four-terminal pair (4TP) instrument is used, the sense lines can be ignored. And a Kelvin path is used for the high signal, and the other one is used for the low signal. For the accurate impedance measurements, a wire must be connected between the ASU#1 CMU Return and the ASU#2 CMU Return.

If the 4TP instrument is not used, you can ignore the CMH, CML, CMU Return, and the DUT1 high and low terminals.

Figure 3-16

ASU Output non-Kelvin Connection



The ASU inputs can be connected to the instruments by using a control cable, a triaxial cable, and two coaxial cables. The cables can be connected to the ASU inside the shielding box through the 16495K plate.

The ASU outputs should be connected to the DUT by using coaxial cables and wires as shown above.

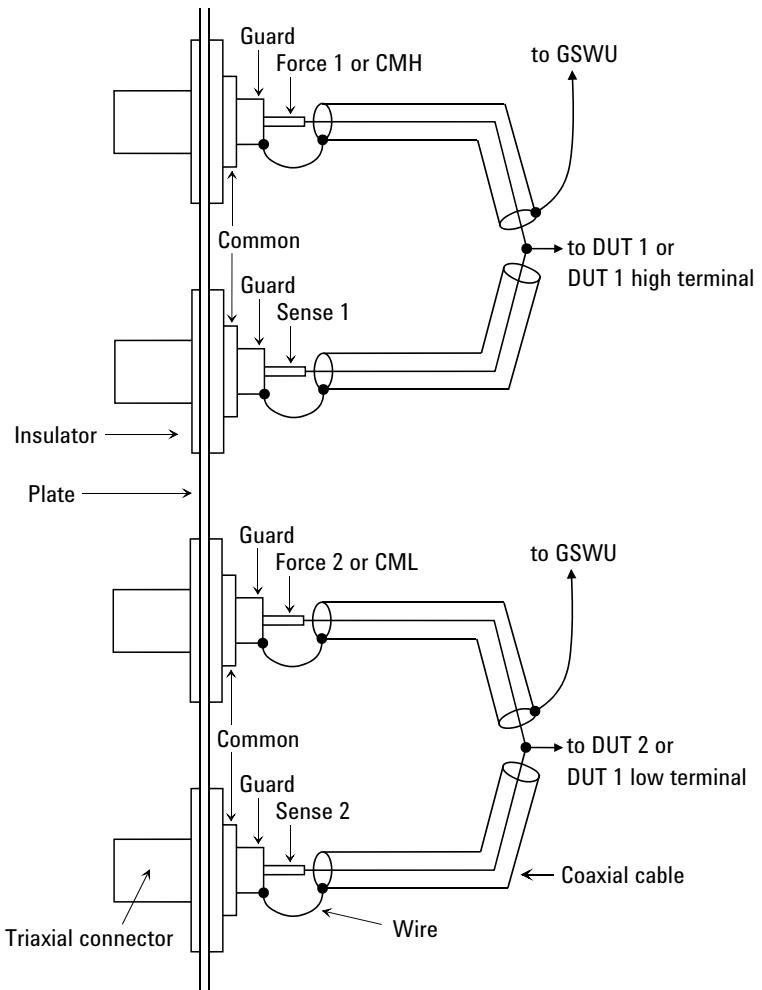
When a SMU is used for the measurements, the Kelvin paths/force lines will work as same as [Table 3-8](#). Then the sense line is not extended to the DUT.

When a four-terminal pair (4TP) instrument is used, the sense lines can be ignored. And a force line is used for the high signal, and the other one is used for the low signal. For the accurate impedance measurements, a wire must be connected between the ASU#1 CMU Return and the ASU#2 CMU Return.

If the 4TP instrument is not used, you can ignore the CMH, CML, CMU Return, and the DUT1 high and low terminals shown above.

Figure 3-17

SCUU Output Kelvin Connection (Remote Sensing)



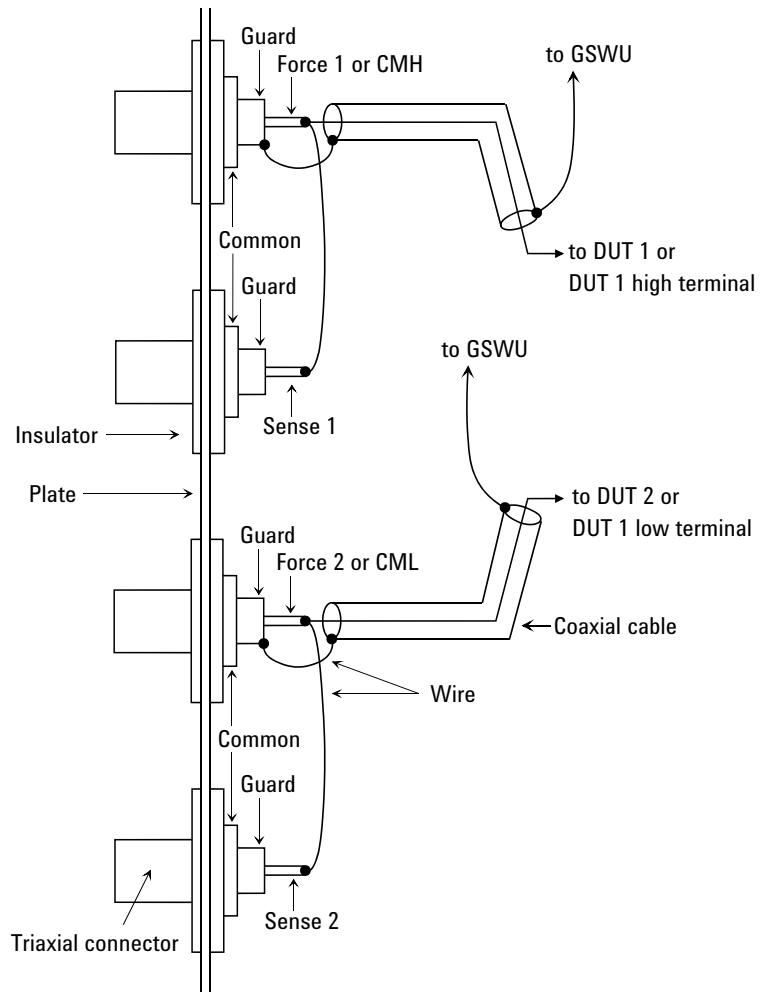
The SCUU should be connected to the DUT by using coaxial cables and wires as shown above. Also the SCUU should be connected to the GSWU inside the shielding box by using a control cable through the 16495K plate.

When a SMU is used for the measurements, the Kelvin paths will work as same as [Table 3-8](#).

When the MFCMU is used, the sense lines can be ignored. And a Kelvin path is used for the CMU high, and the other one is used for the CMU low. For the accurate impedance measurements, wires must be connected to the GSWU from the CMH guard and the CML guard as near as possible to the DUT.

Figure 3-18

SCUU Output non-Kelvin Connection



The SCUU should be connected to the DUT by using coaxial cables and wires as shown above. Also the SCUU should be connected to the GSWU inside the shielding box by using a control cable through the 16495K plate.

When a SMU is used for the measurements, the Kelvin paths/force lines will work as same as [Table 3-8](#). Then the sense line is not extended to the DUT.

When the MFCMU is used, the sense lines can be ignored. And a force line is used for the CMU high signal, and the other one is used for the CMU low signal. For the accurate impedance measurements, wires must be connected to the GSWU from the CMH guard and the CML guard as near as possible to the DUT.

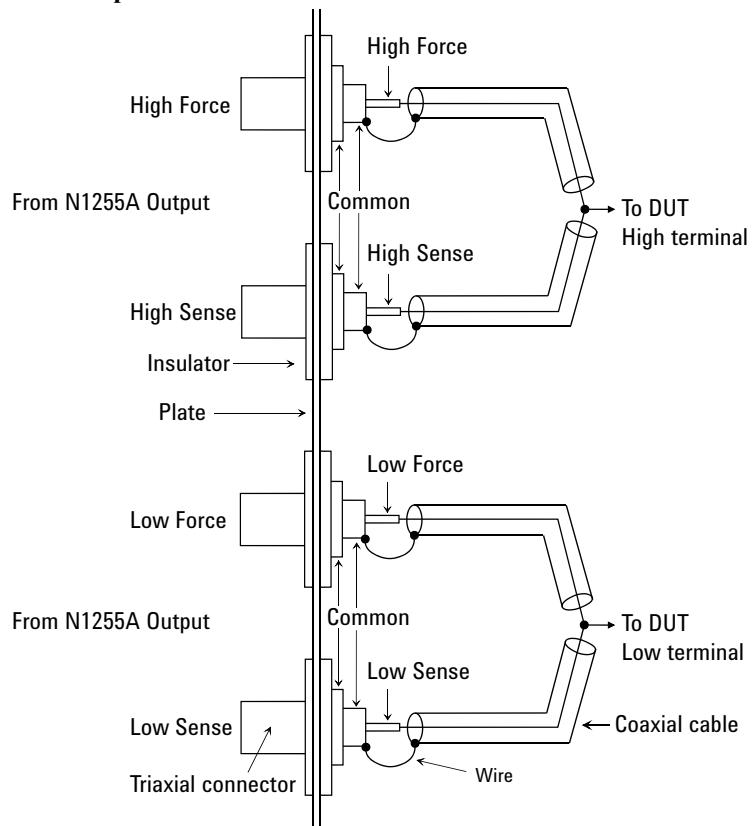
To Connect MCSMU Output

The MCSMU output connection example is shown in [Figure 3-19](#).

For the connection of the MCSMU, the N1255A connection box is required. See [“To Connect MCSMU Connection Box” on page 3-29](#) to connect the MCSMU to the N1255A Input terminals. To connect the N1255A Output terminals to the connectors as shown in [Figure 3-19](#), use the 16494A triaxial cable.

Figure 3-19

MCSMU Output Connection



The High Force/High Sense/Low Force/Low Sense lines should be connected to the DUT as shown above. Wiring shown in [“To Connect SMU Output” on page 3-38](#) can be used. To simplify the connections, omit the wiring of the Common.

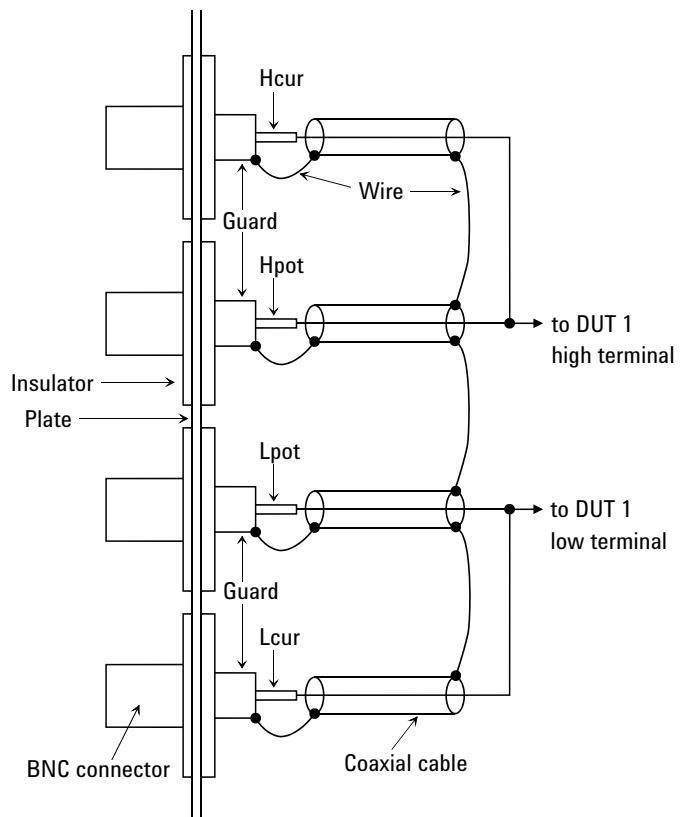
For the non-Kelvin connection, use the High Force and the Low Force only. Omit the wiring of the High Sense and the Low Sense.

To Connect MFCMU Output

The MFCMU output connection example is shown in [Figure 3-20](#). This connection is for the MFCMU without the SCUU. Then Keysight N1300A-001/002 CMU cable should be used for the connection between the MFCMU and the connectors you mount. It is ok to leave open the ground wire extended from the CMU cable.

Figure 3-20

MFCMU Output Connection



The Hcur/Hpot/Lcur/Lpot lines should be connected to the DUT as shown above.

Use a $50\ \Omega$ coaxial cable (Keysight part number: 8120-0367) for the Hcur/Hpot/Lcur/Lpot lines connection. Use a wire for the guard connection.

Connecting Measurement Devices

This section describes how to connect device under test (DUT) to the 16442B test fixture (B1500A-A5F), and how to connect cables to the connector plate.

If you use a wafer prober, see wafer prober manuals.

Note that you must set the module output off when connecting or disconnecting DUTs. If not, the DUTs may be damaged.

To set the module output off, press the **Stop** key.

This section has the following descriptions:

- “[Using Test Fixture](#)”
- “[Using Connector Plate](#)”

NOTE

Kelvin connection and non-Kelvin connection

To make the Kelvin connection (remote sensing), use both Force and Sense terminals. Connecting the Force and Sense lines together at the terminal of the DUT (device under test) minimizes the measurement error caused by the residual resistance of the connection cables. The Kelvin connection is effective for the low resistance measurement and the high current measurement.

If you want to simplify the cable connections, open the Sense terminals and use the Force terminals only. This is the non-Kelvin connection. The Force terminals can be used to force and measure dc voltage or current.

NOTE

Generally, environmental conditions, such as electromagnetic environment, have a negative impact on the performance of the instrument. Use coaxial cables and shielding technique to minimize the impact.

Using Test Fixture

1. Press the **Stop** key to set the output off.
2. Select a proper socket module for your DUT, then set the socket module on the test fixture.
3. Mount your DUT on the socket module.
4. Connect between the socket module and the test fixture by using the proper test leads.
5. Close the fixture cover.

To force more than ± 42 V, close the fixture cover. Otherwise, the interlock function will stop Keysight B1500A output.

To connect between the socket module and the test fixture, you can use test leads that have the following terminals:

- Miniature banana-to-miniature banana
- Miniature banana-to-pin plug
- Miniature banana-to-miniature clip

WARNING

Set the instrument output off before connecting or disconnecting connection wire.

Press the B1500A front panel Stop key to set the output off. And confirm that the B1500A front panel High Voltage indicator is not lit.

Désactivez la sortie de l'appareil avant de brancher ou de débrancher un câble de connexion.

Appuyez sur la touche Stop du panneau avant du B1500A pour désactiver la sortie. Et confirmez que l'indicateur de tension High du panneau avant du B1500A n'est pas allumé.

WARNING

Make sure that the cover is closed properly before starting measurement. Do not perform the measurement when a wire is protruding from the fixture cover.

Assurez-vous que le couvercle est fermé correctement avant de commencer la mesure. Ne pas effectuer la mesure lorsqu'un câble dépasse du couvercle de l'appareil.

CAUTION

Do not touch the terminals of the test leads. Oil, perspiration, and dirt prevent good electrical contact, deteriorate insulation, and degrade measurement accuracy.

WARNING



To prevent electrical shock and DUT damage, do not connect or disconnect the DUT while the instrument is applying voltage or current.

When you touch the DUT after measurement, devise a countermeasure of residual charge and heat to prevent electrical shock and burn. Use glove and any tool. Also have enough time for discharge and radiation.

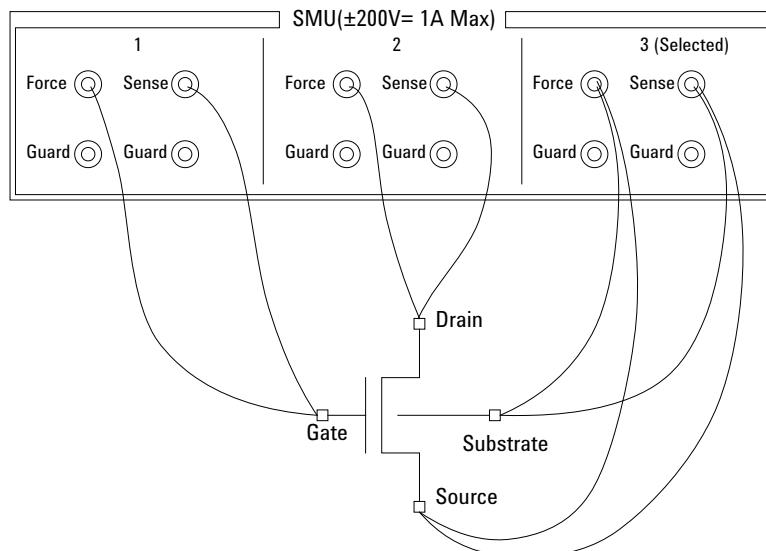
Afin d'éviter toute décharge électrique et dommage MST, ne branchez ou débranchez pas la sortie MST alors que l'appareil envoie de la tension ou du courant.

Lorsque vous touchez le MST après la mesure, élaborez une contre-mesure de la charge résiduelle et du chauffage afin d'éviter tout choc électrique et toute brûlure. Utilisez des gants et des outils. Prévoyez également du temps pour la décharge et la radiation.

Connections for High Current Measurements

When you force or measure a large current, you may want to use a Kelvin connection (4-wire, remote sensing) to eliminate the residual resistance effects of test leads and contacts. For example, you can use the following connections as Kelvin connections on the test fixture.

Examples: Kelvin Connection



To cancel the effects of the residual resistance, test leads must be connected as close as possible to the DUT.

Using Connector Plate

This section provides the information useful for connecting cables and probing needles to a connector plate.

- “To Reduce Leakage Current”
- “To Measure Low Resistance”

To Reduce Leakage Current

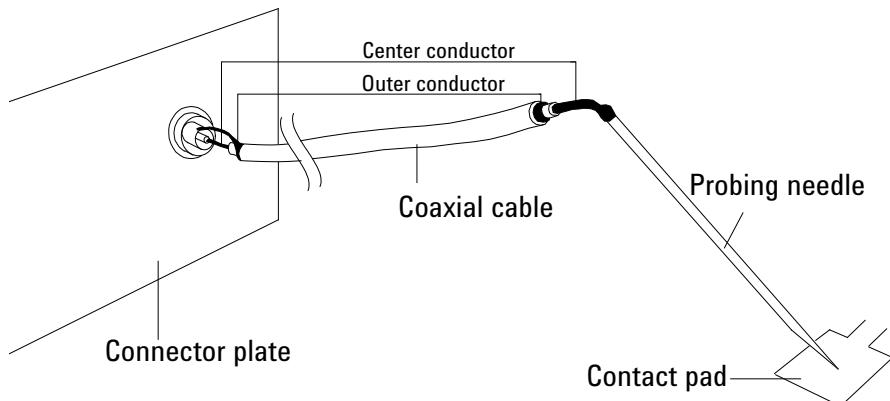
To reduce the leakage current caused by connection cables, the guard technique is effective. Connect the probing needles to the terminals of the connector plate by using coaxial cables as shown below:

1. At end of cable, connect coaxial center conductor to force terminal of connector plate, and connect coaxial outer conductor to guard terminal of connector plate.
2. At another end, connect coaxial center conductor to tail of the probing needle. Never connect the outer conductor at this cable end.

Extend the outer conductor as close as possible to the probing needle.

Example

The following example connection can be used to reduce the leakage current. Extend the outer conductor as close as possible to the probing needle. This also reduces the induced noise.



WARNING



For safety, prepare and attach a shield cover to the connector plate to avoid touching the joints on the wiring side of connectors. And ground the cover.

Wrap an insulator around the naked conductors of coaxial cable to avoid touching it.

Pour des raisons de sécurité, préparez et fixez un couvercle protecteur à la plaque de raccord pour éviter de toucher les joints du côté du câblage des connecteurs. Et mettez le couvercle à la terre.

Enroulez un isolant autour des conducteurs dénudés du câble coaxial afin d'éviter de les toucher.

WARNING



To prevent electrical shock and DUT damage, do not connect or disconnect the DUT while the instrument is applying voltage or current.

When you touch the DUT after measurement, devise a countermeasure of residual charge and heat to prevent electrical shock and burn. Use glove and any tool. Also have enough time for discharge and radiation.

Afin d'éviter toute décharge électrique et dommage MST, ne branchez ou débranchez pas la sortie MST alors que l'appareil envoie de la tension ou du courant.

Lorsque vous touchez le MST après la mesure, élaborez une contre-mesure de la charge résiduelle et du chauffage afin d'éviter tout choc électrique et toute brûlure. Utilisez des gants et des outils. Prévoyez également du temps pour la décharge et la radiation.

WARNING



Do not touch the guard terminal with bare hands because you may be shocked by high voltage. The potential of the guard terminal is equal to the output voltage.

Ne touchez pas à mains nues la borne de protection car vous risquez de subir une électrocution à haute tension. Le potentiel de la borne de protection est égal à la tension de sortie.

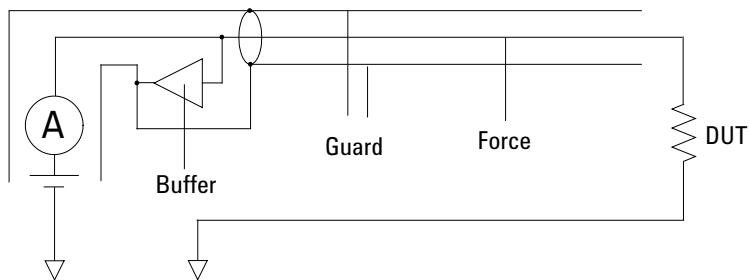
CAUTION

Never connect the guard terminal to any other output, including circuit common, frame ground, or the terminals of any other measurement resource. Doing so may damage it.

Guarding

Guarding reduces the leakage current between the measurement points and instrument. This is important when you measure low current.

The following figure shows the theory of guarding. The buffer amplifier ($\times 1$) keeps the potential of the guard conductor at the same potential as the force conductor, so current does not flow between the force and guard conductors. Therefore, the current measured by SMU is same as current at measurement point because no current is leaked.



To Measure Low Resistance

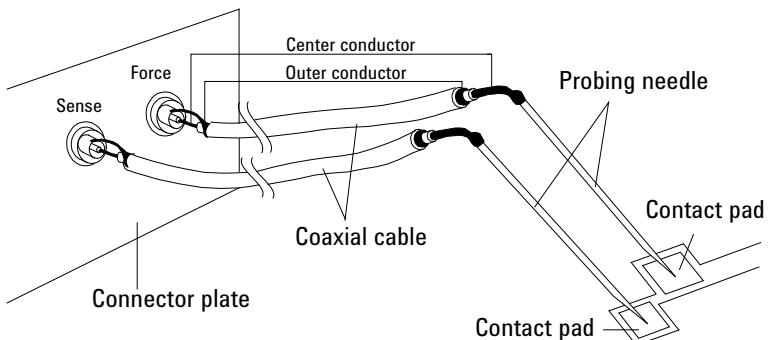
When you measure a low resistance, high current flows through the DUT. This high current increases the measurement error caused by the residual resistance of cables. To cancel the effect of this resistance, you can use Kelvin connections (4-wire, remote sensing), which means the force and sense lines are extended separately to the DUT.

Connect the probing needles to the terminals of the connector plate by using test leads or coaxial cables. Following instruction uses the coaxial cables:

1. At end of cable, connect coaxial center conductor to force terminal of connector plate, and connect coaxial outer conductor to guard terminal of connector plate.
2. At another end, connect coaxial center conductor to tail of the probing needle. Never connect the outer conductor at this cable end.
Extend the outer conductor as close as possible to the probing needle.
3. Repeat 1 and 2 for the sense terminal of connector plate.
4. Contact the probing needles from force and sense terminals as close as possible to the DUT.

Example

The following example connection can be used to measure low resistance. The sense line is extended to the probing pad, and contacts the force line through the pad, so the voltage drop due to the residual resistance caused by cables and test leads is canceled. To reduce the leakage current, use coaxial cables.



WARNING



For safety, prepare and attach a shield cover to the connector plate to avoid touching the joints on the wiring side of connectors. And ground the cover.

Wrap an insulator around the naked conductors of coaxial cable to avoid touching it.

Pour des raisons de sécurité, préparez et fixez un couvercle protecteur à la plaque de raccord pour éviter de toucher les joints du côté du câblage des connecteurs. Et mettez le couvercle à la terre.

Enroulez un isolant autour des conducteurs dénudés du câble coaxial afin d'éviter de les toucher.

WARNING



To prevent electrical shock and DUT damage, do not connect or disconnect the DUT while the instrument is applying voltage or current.

When you touch the DUT after measurement, devise a countermeasure of residual charge and heat to prevent electrical shock and burn. Use glove and any tool. Also have enough time for discharge and radiation.

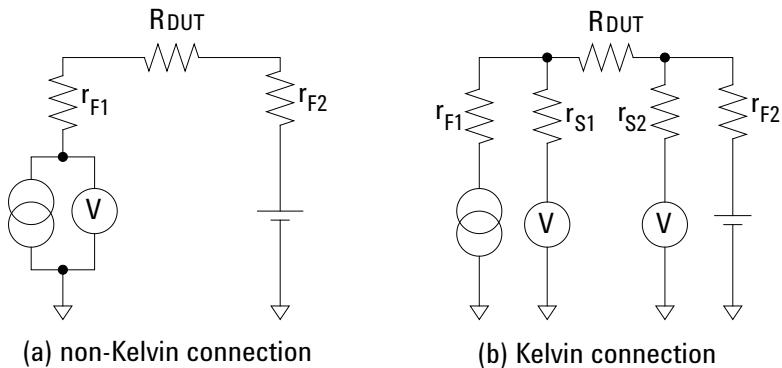
Afin d'éviter toute décharge électrique et dommage MST, ne branchez ou débranchez pas la sortie MST alors que l'appareil envoie de la tension ou du courant.

Lorsque vous touchez le MST après la mesure, élaborez une contre-mesure de la charge résiduelle et du chauffage afin d'éviter tout choc électrique et toute brûlure. Utilisez des gants et des outils. Prévoyez également du temps pour la décharge et la radiation.

Kelvin Connection (Remote Sensing)

Kelvin connections give good measurement results when you force high-current. The following figure shows the equivalent circuits for Kelvin and non-Kelvin connections.

- For the non-Kelvin connection, the voltmeter measures the voltage drop of resistances r_{F1} , R_{DUT} , and r_{F2} .
- For the Kelvin connection, the voltmeter measures the voltage drop of resistance R_{DUT} only. The impedance of the voltmeter is very high, so the voltage drop of resistances r_{S1} and r_{S2} can be ignored.



The Kelvin connection is effective even when forcing voltage. The voltage drop due to the residual resistance of the force line wiring is fed back to the voltage source via a comparator in the sense line. The input impedance of comparator is high, and current flow into the sense line is very low. So output error is not significant if the sense line wiring has a residual resistance of 10Ω or less. Therefore, the specified voltage appears at the sense point (point where sense line contacts force line)

Capacitance Compensation When Using Switching Matrix

When the capacitance/conductance measurement is performed through Keysight B2200A/B2201A/E5250A switching matrix, Keysight B1500A measures the capacitance/ conductance of the path including a DUT (device under test), matrix switches, extension cables and so on. So, the data measured by the B1500A is far from the DUT's capacitance/conductance.

Keysight EasyEXPERT provides the functions used to compensate the data measured in the environments described in [“Required Conditions” on page 3-56](#). This section explains how to perform compensation.

- [“Required Conditions”](#)
- [“To Create Compensation Data File”](#)

NOTE

Corrected data by the function is not guaranteed. But typical data (supplemental data) is as follows.

Capacitance measurement accuracy (typical): $\pm 1\% \pm 0.5\text{ pF}$

This typical data is for the following measurement conditions:

Measurement frequency: 1 kHz to 5 MHz

Measurement range: Maximum 1000 pF

Measurement terminal: At the end of Keysight 16494A/B/C cable connected to the switch module output terminals.

The typical data does not apply to anything extended from the 16494A/B/C cable. The conditions described in [“Required Conditions” on page 3-56](#) must be satisfied.

Required Conditions

The following conditions must be satisfied to use the capacitance compensation function. For the instrument connections, see [Figure 3-21](#).

- Setting of the MFCMU
 - Range of the measurement frequency: 1 kHz to 5 MHz
 - Measurement function: Cp-G, Cp-D, Cs-Rs, or Z-Th. There is no limitation.
 - Calibration
 - Perform the MFCMU open calibration at the end of the measurement paths in front of the switching matrix inputs. If you also perform the short calibration (optional), prepare the BNC thru adapter (Keysight part number 1250-0080, 1 ea.).
 - Total cable length of both Hc-Hp side and Lc-Lp side must be the same.
- Switching matrix input ports

Use Keysight N1300A CMU cable to connect the MFCMU. The BNC-T adapters (2 ea., Keysight part number 1250-2405 for each) are required to connect between the Hc and Hp terminals and between the Lc and Lp terminals. Connect the Hc-Hp cable and the Lc-Lp cable as follows. It is ok to leave open the ground wire extended from the CMU cable.

Hc-Hp: Input 13 (B2200A/B2201A) or AUX INPUT CV1 (E5250A)

Lc-Lp: Input 14 (B2200A/B2201A) or AUX INPUT CV2 (E5250A)

- Switching matrix output terminals

Use the Keysight 16494A triaxial cable to extend the outputs to the connector plate or the Keysight B2220A probe card interface (only for B2200A/B2201A). For the Kelvin connection, use the Keysight 16494B/C Kelvin triaxial cable.

- Ahead of the connector plate

Recommended cable: Keysight part number 8121-1191 Triaxial cable

You can also use another type of triaxial cable, coaxial cable, or combination of these.

To approximate the capacitance/conductance of the DUT, you need to obtain the appropriate compensation coefficients for your measurement environment, and create your compensation data file. See [Figure 3-21](#).

In Figure 3-21, C1 (DATA04), C2H (DATA05), C2L (DATA06), C3H (DATA07), C3L (DATA08) are the compensation coefficients defined in the compensation data file. where, CxH is for the path connected to the MFCMU Hc-Hp terminal, and CxL is for the path connected to the MFCMU Lc-Lp terminal.

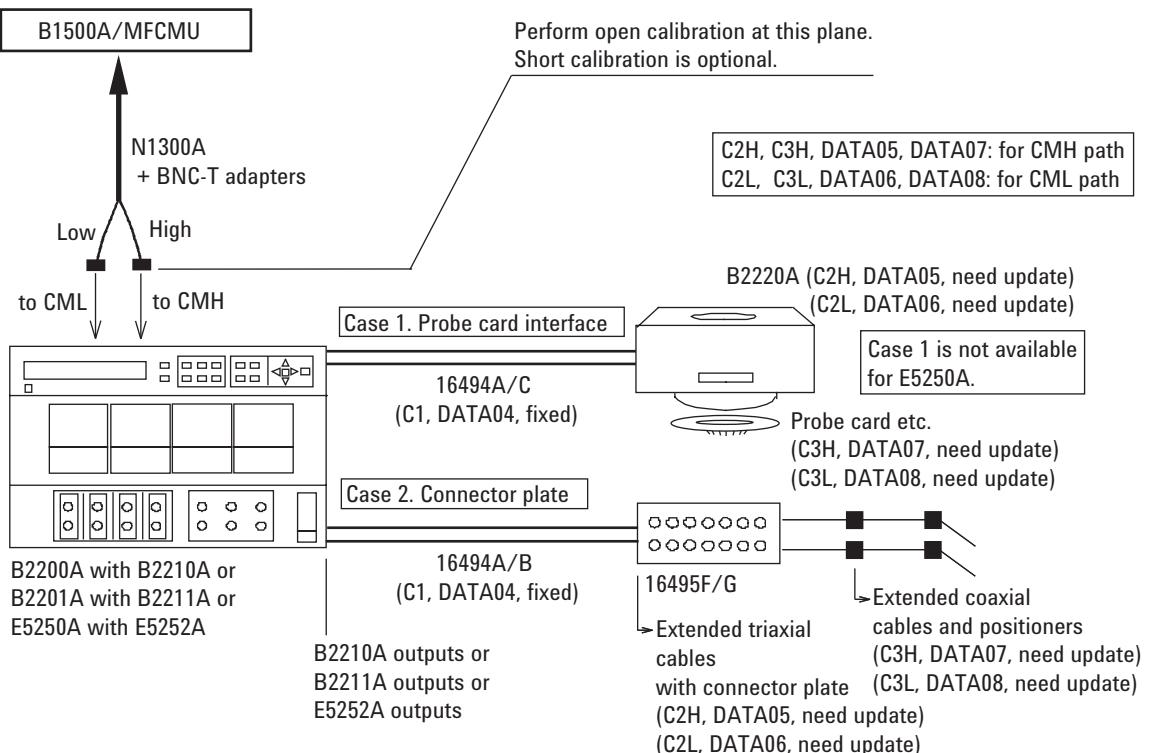
When Keysight B2220A probe card interface is used, obtain the coefficients for C3x, and create your compensation data file. In this case, probe card will be used for the C3x path.

When the connector plate is used, obtain the coefficients for C2x and C3x, and create your compensation data file. In this case, triaxial cable with connector plate will be used for the C2x path. And coaxial cable with positioner will be used for the C3x path.

For obtaining the compensation coefficients and creating the compensation data file, see “[To Create Compensation Data File](#)” on page 3-58.

Figure 3-21

Extension Cables and Compensation Coefficients



To Create Compensation Data File

This section explains how to create the compensation data file. To perform the capacitance compensation, enter the file name of the compensation data file to the User Compensation Data File field of the Extended Configuration dialog box opened from the Switching Matrix tab screen of the Configuration window.

1. Create a text file (e.g. C:\temp\c_data.txt) that contains the information as shown below.

- For B2200A/B2201A:

```

#
# Compensation data file for B2210A/Cable connection/3m triax cable
#
#
# MB      Mother Board
# MH     Matrix Path High
# ML     Matrix Path Low
# C1      Triax Cable
# C2H     Probe card I/F or User Triax cable High
# C2L     Probe card I/F or User Triax cable Low
# C3H     Probe card or User Coax cable High
# C3L     Probe card or User Coax cable Low
#
format version 1.0
B2210A
CABLE
#
#      R[Ohm]          L[H]          C[F]
#-----
MB  0.000000e+00  5.250000e-08  2.940000e-11
MH  2.430000e+00  6.310000e-07  1.930000e-10
ML  2.490000e+00  5.970000e-07  1.920000e-10
C1  6.300000e-01  1.250000e-06  1.600000e-10
C2H 1.007000e-01  4.000000e-07  8.000000e-11
C2L 1.007000e-01  4.000000e-07  8.000000e-11
C3H 1.140000e-01  5.440000e-07  1.300000e-10
C3L 1.140000e-01  5.440000e-07  1.300000e-10

```

The 15th line specifies the used switch module, B2210A or B2211A.

The 16th line specifies the DUT interface, PCIF or CABLE. PCIF indicates that Keysight B2220A probe card interface is used. CABLE indicates that the connector plate is used.

The lines C2H to C3L should be modified for each measurement environment. See [Table 3-9](#). Do not modify the other lines.

NOTE

EasyEXPERT provides the template of the compensation data file for the B2200A/B2201A. See [Table 3-11](#). Select and use the template suitable for your measurement environment.

- For E5250A:

```

# E5250A  C Compensation coefficient data table
#
#  CAUTION : Do not add or delete "REVISION" line and "DATAx" line.
#              Change the value for R,L,C of DATA05,06,07 or 08.
#
REVISION      A.03.00
#              R [ohm]    L [H]      C [F]
DATA00        74.65E-3  140.00E-9  58.44E-12  # Frame Path 1
DATA01        75.41E-3  90.00E-9   67.13E-12  # Frame Path 2
DATA02        231.41E-3 450.00E-9  178.85E-12 # Card Path High
DATA03        177.56E-3 390.00E-9  135.45E-12 # Card Path Low
DATA04        100.70E-3 400.00E-9  80.00E-12   # Triax Cable    [/m]
DATA05        100.70E-3 400.00E-9  80.00E-12   # User Triax Cbl H [/m]
DATA06        100.70E-3 400.00E-9  80.00E-12   # User Triax Cbl L [/m]
DATA07        114.00E-3 544.00E-9  130.00E-12 # User Coax Cbl H [/m]
DATA08        114.00E-3 544.00E-9  130.00E-12 # User Coax Cbl L [/m]
DATA09        0.00E-3   0.00E-9   1.20E-12   # Stray Capacitance
# END of Data

```

The lines DATA05 to DATA08 should be modified for each measurement environment. See [Table 3-9](#). Do not modify the other lines.

Table 3-9 Compensation Coefficients and Modifications

Compensation coefficients	Modifications of data file
C2H (DATA05) C2L (DATA06)	For the connector plate, change the R, L, C values in the lines. The value must be changed to the R, L, C values of the C2H (DATA05) path and the C2L (DATA06) path (triaxial cable with connector plate) shown in Figure 3-21 . For Keysight B2220A probe card interface, do not modify the lines.
C3H (DATA07) C3L (DATA08)	Change the R, L, C values in the lines. The value must be changed to the R, L, C values of the C3H (DATA07) path and the C3L (DATA08) path shown in Figure 3-21 . For the connector plate, the coaxial cable with positioner will be the appropriate path. For Keysight B2220A probe card interface, the probe card will be the appropriate path.

- Measure the R, L, C values of the for C2H (DATA05), C2L (DATA06), C3H (DATA07), and C3L (DATA08) by using the MFCMU. See “[To obtain compensation coefficients](#)” on page 3-61.

After the measurements, calculate the per meter value of the R, L, C, and record them into the following table.

Compensation coefficients	Explanation		
	R (Ω)	L (H)	C (F)
C2H (DATA05)			
C2L (DATA06)			
C3H (DATA07)			
C3L (DATA08)			

- Launch a text editor and open the compensation data file created at step 1.

Change the R, L, C values of the C2H (DATA05), C2L (DATA06), C3H (DATA07), and C3L (DATA08) lines to the values recorded at step 2. Do not change any other lines.

- Save the file as your compensation data file (e.g. C:\temp\my_env_1.txt).

To perform the capacitance compensation, enter the file name of the compensation data file to the User Compensation Data File field of the Extended Configuration dialog box, and execute the measurement.

Before starting measurement, perform the CMU calibration. For details, see *Keysight EasyEXPERT User’s Guide*.

To obtain compensation coefficients

Obtain the compensation coefficients as shown below.

1. Select the measurement frequency (Fmeas) used for the capacitance measurement of a device under test (DUT), and set it to the MFCMU. The coefficients must be measured at the same frequency.
2. Perform the MFCMU open calibration at the measurement terminal. Optionally, perform short calibration if you want.
3. See [Table 3-10](#) and [Figure 3-22](#), and set the MFCMU.
4. Connect the path/cable corresponding to C3H (DATA07) shown in [Figure 3-21](#) to the MFCMU. Then measure and record the R, L, and C values.
5. Connect the path/cable corresponding to C3L (DATA08) to the MFCMU. Then measure and record the R, L, and C values.
6. If you use the connector plate, perform the following procedure.
 - a. Connect the path/cable corresponding to C2H (DATA05) to the MFCMU. Then measure and record the R, L, and C values.
 - b. Connect the path/cable corresponding to C2L (DATA06) to the MFCMU. Then measure and record the R, L, and C values.

Table 3-10

R, L, C Measurement Conditions

Parameter	Frequency	Function	Terminals
R	1 kHz to 5 MHz ^a	—	A and B
L		SERIES	see note ^b
C		PARALLEL	A and C

- a. R, L, C of all coefficients must be measured with the same frequency setting.
- b. For triaxial cable, connect B to F directly, and measure L between A and E. For coaxial cable, ignore E and F, and connect B to D directly, and measure L between A and C.

Figure 3-22

Compensation Coefficient Measurement Terminals of Extended Cables

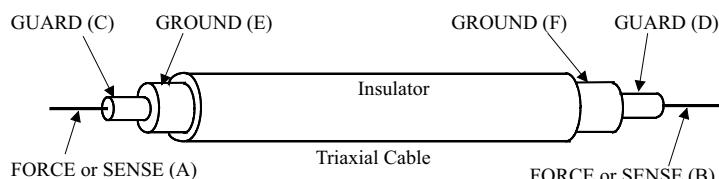


Table 3-11 **Template Compensation Data Files for B2200A/B2201A**

File name ^a	Measurement environment that template targets			
	Switch module	Cable ^b	DUT interface ^c	Coefficients to be modified
<path>\b2210a\pcif\triax\3m.data	B2210A	16494A-002	B2220A	C3H and C3L
<path>\b2210a\pcif\triax\4m.data		16494A-005		
<path>\b2210a\pcif\kelvin\3m.data		16494C-002		
<path>\b2210a\pcif\kelvin\4m.data		16494C-005		
<path>\b2210a\cable\triax\1_5m.data		16494A-001		C2H, C2L, C3H, and C3L
<path>\b2210a\cable\triax\3m.data		16494A-002		
<path>\b2210a\cable\triax\4m.data		16494A-005		
<path>\b2210a\cable\kelvin\1_5m.data		16494B-001		
<path>\b2210a\cable\kelvin\3m.data		16494B-002		
<path>\b2210a\cable\kelvin\4m.data		16494C-005		
<path>\b2211a\pcif\triax\3m.data	B2211A	16494A-002	B2220A	C3H and C3L
<path>\b2211a\pcif\triax\4m.data		16494A-005		
<path>\b2211a\pcif\kelvin\3m.data		16494C-002		
<path>\b2211a\pcif\kelvin\4m.data		16494C-005		
<path>\b2211a\cable\triax\1_5m.data		16494A-001		C2H, C2L, C3H, and C3L
<path>\b2211a\cable\triax\3m.data		16494A-002		
<path>\b2211a\cable\triax\4m.data		16494A-005		
<path>\b2211a\cable\kelvin\1_5m.data		16494B-001		
<path>\b2211a\cable\kelvin\3m.data		16494B-002		
<path>\b2211a\cable\kelvin\4m.data		16494C-005		

a. <path>: \Program Files\Agilent\B1500\EasyEXPERT\B220xA\ccdata

b. Model number of the cable connected between the switch module and the DUT interface.

c. Keysight B2220A probe card interface or Keysight 16495F/G connector plate.

Maintenance

Maintenance should be performed periodically to keep the instrument in good condition.

Cleaning

Before performing cleaning, turn off the instrument, and disconnect power cord from the rear panel. Use a dry cloth to clean the external case parts.

To prevent electrical shock, do not perform cleaning when the instrument is turned on, and do not use a wet cloth.

Self-test and Diagnostics

This instrument provides the following functions to check the operation. Perform the following functions as necessary. Open the measurement terminals to perform self-test, self-calibration, or diagnostics.

- Self-test
- Self-calibration
- Diagnostics

If problems arise, contact Keysight Technologies. For details, see Keysight EasyEXPERT *User's Guide*.

WARNING



Interlock Open/Close test and High Voltage LED test

Interlock function limits the maximum output voltage to ± 42 V when the measurement terminal is touchable. For safety, this function must be checked before using the B1500A after power on at least once a day by performing the diagnosis.

Test d'ouverture/de fermeture Interlock et test High Voltage LED

La fonction de verrouillage limite la tension de sortie maximale à ± 42 V lorsque la borne de mesure peut être touchée. Pour des raisons de sécurité, cette fonction doit être vérifiée avant d'utiliser le B1500A après la mise sous tension, au moins une fois par jour en effectuant le diagnostic.

Calibration

Calibration and adjustments must be performed periodically so that the instruments satisfy the specifications, and keep a good condition. It is recommended to perform the calibration once a year at least. For the calibration and adjustments, contact Keysight Technologies. Trained service personnel will perform the calibration and adjustments. Also see Keysight *EasyEXPERT User's Guide*.

About Plug-in Modules

This section describes the following notices about plug-in modules.

- “Module Type and Locations”
- “To Interconnect SPGUs”
- “To Interconnect WGFMUs”
- “About Module Installation”

Module Type and Locations

Module locations when the B1500A is shipped from the factory are shown in [Table 3-12](#). This table shows the relative locations by the module types.

If the SPGUs are installed, the SPGUs must be installed in the slots from the slot number 1. And if the SPGU and the WGFMU are not installed and the HPSMUs are installed, the HPSMUs must be installed in the slots from the slot number 1. Then the same type of modules must be installed in the contiguous slots.

For example, if the module configuration is two HPSMU, two MPSMU, and one CMU, the B1500A will be shipped with the HPSMUs of the slots 1 to 4, the MPSMUs of the slots 5 to 6, the CMU of the slot 7, and the blank panels of the slots 8 to 10.

Table 3-12

Module Installation Rule

Slot Number and Location	Module Type
10	B1514A Medium Current SMU (MCSMU)
:	B1520A Multi Frequency CMU
:	B1511A Medium Power SMU (MPSMU)
:	B1511B Medium Power SMU (MPSMU)
:	B1517A High Resolution SMU (HRSMU)
:	B1510A High Power SMU (HPSMU)
:	B1530A WGFMU
1	B1525A High Voltage SPGU
0	GNDU/ADC (always installed)

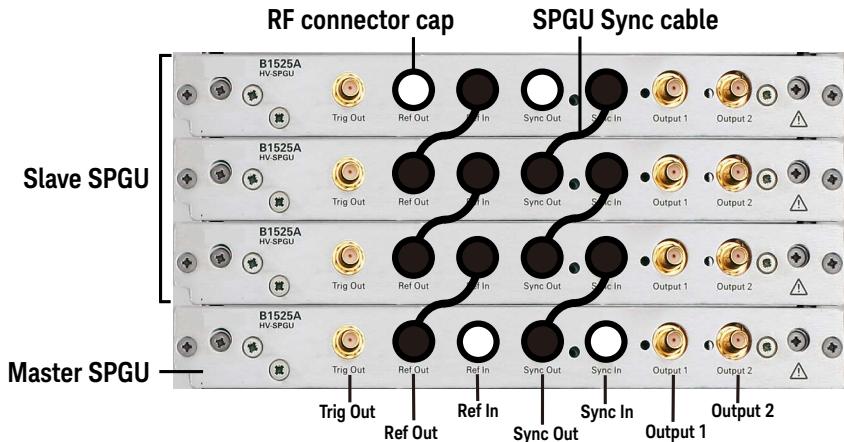
To Interconnect SPGUs

If multiple SPGUs have been installed, connect the SPGUs by using the following parts furnished with the SPGU. See [Figure 3-23](#).

- SPGU Sync cable, 16493Q-001, (number of SPGUs – 1)×2 ea.
- RF connector cap, 1253-7431, 4 ea.

Figure 3-23

SPGU Module Connection Example, Four Modules



If multiple SPGUs have been installed, connect the SPGUs as shown in [Figure 3-23](#). This connection makes it possible to perform the synchronous output by the multiple SPGU channels. In this figure, the primary SPGU is the module which outputs the reference signal and the secondary SPGUs are the modules which follow to the reference signal.

Connect the RF connector cap to the Ref In and Sync In connectors on the primary SPGU and the Ref Out and Sync Out connectors on the last secondary SPGU.

The Trig Out terminal must be connected to the trigger input terminal of the external equipment to make the synchronized operation of it.

CAUTION

Connect the Ref Out/In, Sync Out/In, and Trig Out terminals to the specified terminal properly. Connecting to the other terminal may result in damage to the SPGU.

NOTE

The B1500A does not support the synchronized operation between SPGU and WGFMU.

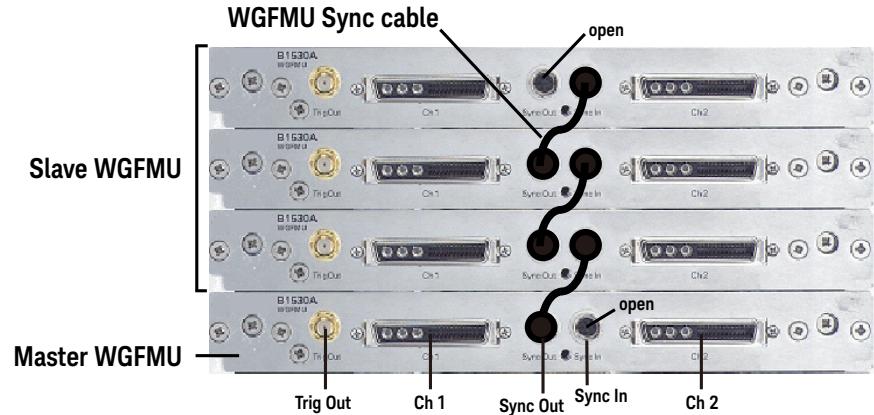
To Interconnect WGFMUs

If multiple WGFMUs have been installed, connect the WGFMUs by using the following cable furnished with the WGFMU. See [Figure 3-24](#).

- WGFMU Sync cable, 16493R-803, number of WGFMUs – 1 ea.

Figure 3-24

WGFMU Module Connection Example, Four Modules



If multiple WGFMUs have been installed, connect the WGFMUs as shown in [Figure 3-24](#). This connection makes it possible to perform the synchronous output by the multiple WGFMU channels. In this figure, the primary WGFMU is the module which outputs the reference signal and the secondary WGFMUs are the modules which follow to the reference signal.

Open the Sync In connector on the primary WGFMU and the Sync Out connector on the last secondary WGFMU.

The Trig Out terminal must be connected to the trigger input terminal of the external equipment to make the synchronized operation of it.

CAUTION

Connect the Sync Out/In, and Trig Out terminals to the specified terminal properly. Connecting to the other terminal may result in damage to the WGFMU.

NOTE

The B1500A does not support the synchronized operation between SPGU and WGFMU.

About Module Installation

Module installation must be carried out at a Keysight Technologies service center. Contact Keysight Technologies for the module installation. Then send the following equipment and accessories to Keysight Technologies.

- B1500A
- Plug-in modules to be installed
- ASU, for installing the exclusive SMU or retrofitting ASU only
- Connection cable between ASU and SMU, for installing the exclusive SMU or retrofitting ASU only
- RSU, for installing WGFMU
- Connection cable between RSU and WGFMU, for installing WGFMU

For returning ASU or RSU, do not forget to notify the combination of the unit, connection cable, and module channel.

WARNING

To prevent electrical shock, turn the instrument off and remove the power cord before removing the connection cables.

Afin d'éviter toute décharge électrique, mettez l'appareil hors tension et débranchez le cordon d'alimentation avant de retirer les câbles de connexion.

NOTE**About B1500A which supports SPGU and WGFMU**

SPGU and WGFMU are supported by the B1500A serial numbered JP40Nxxxx and later. The other B1500A needs the mainframe upgrade to support the module. Contact Keysight Technologies to upgrade the B1500A.

NOTE**Module locations after servicing**

After the module installation, upgrade, and so on, the B1500A will be returned with the module configuration decided by the rule shown in [Table 3-12](#). If you want to change the module locations, consult the service personnel before servicing.

Furnished accessories, available accessories, and available options of Keysight B1500A Semiconductor Device Analyzer are described in this chapter.

Table 4-1**Furnished Accessories**

Description	Quantity
USB keyboard	1
USB mouse	1
Stylus pen	1
Interlock cable, 1.5 m or 3.0 m	1
GNDU cable, 1.5 m or 3.0 m	1
GNDU Kelvin adapter ^a	1
Triaxial cable ^a , 1.5 m or 3.0 m	1
SMU number label, only for the B1500A installed with SMU	1
PG number label, only for the B1500A installed with SPGU	1
Power cord	1
License-to-use for EasyEXPERT	

a. GNDU Kelvin adapter must be directly connected to the B1500A GNDU connector for taking out the GNDU Force and Sense to the individual connectors. Then the GNDU cable must be used for extending the GNDU Force. And the triaxial cable must be used for the Sense.

Cable length 1.5 m or 3.0 m is specified by the option B1500A-015 or B1500A-030.

Table 4-2 Options

Option Item	Description
B1500A-015	1.5 m length of bundled cables
B1500A-030	3.0 m length of bundled cables
B1500A-050	50 Hz power line frequency
B1500A-060	60 Hz power line frequency
B1500A-A00	Empty package for custom solution, contains no measurement module
B1500A-A01	Standard package, contains four MPSMU and eight triaxial cables
B1500A-A02	High resolution package, contains four HRSMU and eight triaxial cables
B1500A-A03	High power package, contains two HPSMU, two MPSMU, and eight triaxial cables
B1500A-A04	Flash memory cell measurement basic package, see Table 4-3
B1500A-A10	HPSMU add-on package, adds one HPSMU and two triaxial cables
B1500A-A11	MPSMU add-on package, adds one MPSMU and two triaxial cables
B1500A-A17	HRSMU add-on package, adds one HRSMU and two triaxial cables
B1500A-A1A	Add-on package, adds one MCSMU, two triaxial cables, and one N1255A
B1500A-A1B	Add-on package, adds two MCSMU, four triaxial cables, and one N1255A
B1500A-A20	Capacitance measurement add-on package, adds the MFCMU and one CMU cable
B1500A-A25	HVSPGU add-on package, adds one HVSPGU and two SPGU cables
B1500A-A28	Add-on package for HRSMU, adds one ASU, one D-sub cable, and one triaxial cable
B1500A-A29	Add-on package for MPSMU, adds one ASU, one D-sub cable, and one triaxial cable
B1500A-A30	WGFMU add-on package, adds one WGFMU, two RSU, and two RSU cables
B1500A-A31	WGFMU add-on package with connector adapters, see Table 4-4
B1500A-A3P	WGFMU probe cable kit, see Table 4-5
B1500A-A5F	Test fixture for package device measurement, adds one 16442B, see Table 4-6
B1500A-A6J	ANSI Z540 compliant calibration
B1500A-UK6	Commercial calibration certificate with test data

Table 4-3**B1500A-A04 Basic Flash Memory Cell Package**

Description	Quantity
Medium power source/monitor unit (MPSMU)	2
High resolution source/monitor unit (HRSMU)	2
High voltage semiconductor pulse generator unit (HVSPGU)	1
SPGU cable, 1.5 m or 3.0 m	2
16440A SMU/PGU pulse generator selector	1
16445A selector adapter for 16440A	1
Control cable, 1.5 m, between B1500A and 16445A	1
Control cable, 40 cm, between 16445A and 16440A	1
Triaxial cable, 1.5 m, between B1500A and 16440A	2
Triaxial cable, 1.5 m or 3.0 m	8

Table 4-4**B1500A-A31¹ WGFMU Add-on Package with Connector Adapter**

Description	Quantity
Waveform generator/fast measurement unit (WGFMU)	1
Remote-sense and switch unit (RSU)	2
RSU cable, 2.4 m, between WGFMU and connector adapter	2
RSU cable, 0.6 m, between RSU and connector adapter	2
16493R-801 connector adapter (female-female)	2

1. The option B1500A-A31 cannot be selected with the option B1500A-015.

Table 4-5**B1500A-A3P WGFMU Probe Cable Kit**

Description	Quantity
16493R-101 SSMC short-open cable for current return path, 50 mm	2
16493R-102 SSMC short-open cable for current return path, 75 mm	2
16493R-202 SMA-SSMC cable between RSU and DC probe, 200 mm	2
16493R-302 SMA-SMA cable between RSU and RF probe, 200 mm	2

Table 4-6**B1500A-A5F¹ Test Fixture for Package Device Measurement**

Description	Quantity
16442B test fixture	1
Accessory case	1
Blank PTFE board for DUT stage	1
28-pin DIP (dual-in-line) package socket module	1
Universal socket module, 0.075 inch pitch	1
Universal socket module, 0.05 inch pitch	1
Connection pin set for universal socket module	10
Connection wire, mini banana to pin plug	4/color
Connection wire, pin plug to pin plug	3/color
Connection wire, mini banana to mini clip	3/color
Connection wire, mini banana to mini banana	3/color

1. Contains four types of the connection wire. There are three colors for each connection wire, black, red, and blue.

Table 4-7 Available Accessories

Model Number	Option Item	Description
16440A		SMU/PGU pulse generator selector
	16440A-001	Control cable, 1.5 m
	16440A-002	Control cable, 3.0 m
	16440A-003	Control cable, 40 cm for second selector
16442B		Test fixture
	16442B-010	Add triaxial cables, 1.5 m, 4 ea.
	16442B-011	Add triaxial cables, 3 m, 4 ea.
	16442B-800	Extra blank PTFE board
	16442B-801	Universal socket module, 0.1 inch pitch, with 10 pins
	16442B-802	Universal socket module, 0.075 inch pitch, with 10 pins
	16442B-803	Universal socket module, 0.05 inch pitch, with 10 pins
	16442B-810	Extra pin set (for universal socket module, 10 pins.)
	16442B-811	Extra wire set (mini banana to pin plug, 6 ea.)
	16442B-812	Extra wire set (pin plug to pin plug, 6 ea.)
	16442B-813	Extra wire set (mini banana to mini clip, 6 ea.)
	16442B-814	Extra wire set (mini banana to mini banana, 6 ea.)
	16442B-821	Socket module, 4-pin TO package
	16442B-822	Socket module, 18-pin DIP package
	16442B-823	Extra socket module, 28-pin DIP package
	16442B-890	Extra accessory case
16444A		Accessories for B1500A
	16444A-001	USB keyboard
	16444A-002	USB mouse
	16444A-003	Stylus pen

Model Number	Option Item	Description
16445A		Selector adapter for 16440A
	16445A-001	Control cable (B1500 to 16445A), 1.5 m
	16445A-002	Control cable (B1500 to 16445A), 3.0 m
16493G		Digital I/O connection cable
	16493G-001	1.5 m length
	16493G-002	3 m length
16493J		Interlock cable
	16493J-001	1.5 m length
	16493J-002	3 m length
	16493J-003	5 m length
16493K		Kelvin triaxial cable (B1500 to B1500)
	16493K-001	1.5 m length
	16493K-002	3 m length
16493L		GNDU cable
	16493L-001	1.5 m length
	16493L-002	3 m length
	16493L-003	5 m length
16493M		Triaxial and D-sub cables for ASU
	16493M-001	1.5 m length
	16493M-002	3 m length
16493N		GNDU cable for B2200 Kelvin input
	16493N-001	2 m length
16493P		SPGU output connection cable (SMA to BNC)
	16493P-001	1.5 m length
	16493P-002	3 m length

Model Number	Option Item	Description
16493Q		SPGU-SPGU connection cable (SMA to SMA)
	16493Q-001	8 cm length
16493R		WGFMU Cables and Accessories
	16493R-001	WGFMU-to-RSU cable, 0.6 m
	16493R-002	WGFMU-to-RSU cable, 2.4 m
	16493R-003	WGFMU-to-RSU cable, 3 m
	16493R-004	WGFMU-to-RSU cable, 5 m
	16493R-005	WGFMU-to-RSU cable, 4.4 m
	16493R-006	WGFMU-to-RSU cable, 1.5 m
	16493R-101	SSMC short-open cable for current return path, 50 mm
	16493R-102	SSMC short-open cable for current return path, 75 mm
	16493R-202	SMA-SSMC cable between RSU and DC probe, 200 mm
	16493R-302	SMA-SMA cable between RSU and RF probe, 200 mm
	16493R-801	WGFMU connector adapter (female-female)
	16493R-802	Magnet stand for RSU
	16493R-803	Sync terminal connection cable
16494A		Triaxial cable
	16494A-001	1.5 m length
	16494A-002	3 m length
	16494A-003	80 cm length
	16494A-004	40 cm length
	16494A-005	4 m length
16494B		Kelvin triaxial cable (B1500 to E5250)
	16494B-001	1.5 m length
	16494B-002	3 m length
	16494B-003	80 cm length

Model Number	Option Item	Description
16495F		Connector plate w/ 12×triax., Interlock, GNDU
	16495F-001	Bulkhead feedthrough connectors (female to female)
	16495F-002	Connectors to contacts for soldering
16495G		Connector plate w/ 24×triax., Interlock, GNDU
	16495G-001	Bulkhead feedthrough connectors (female to female)
	16495G-002	Connectors to contacts for soldering
16495H		Connector plate w/ 6×triax., 6×coax., Interlock, GNDU
	16495H-001	Bulkhead feedthrough connectors (female to female)
	16495H-002	Connectors to contacts for soldering
16495J		Connector plate w/ 8×triax., 4×coax., Interlock, GNDU
	16495J-001	Bulkhead feedthrough connectors (female to female)
	16495J-002	Connectors to contacts for soldering
16495K		Connector plate with universal cable holder
	16495K-001	Connector plate with rubber holder
B1510A		High Power Source/Monitor Unit module (HPSMU)
B1511B		Medium Power Source/Monitor Unit module (MPSMU)
B1514A		Medium Current Source/Monitor Unit module (MCSMU)
B1517A		High Resolution Source/Monitor Unit module (HRSMU)
B1520A		Multi Frequency Capacitance Measurement Unit module (MFCMU)
B1525A		Semiconductor Pulse Generator Unit module (SPGU)
B1530A		Waveform Generator/Fast Measurement Unit (WGFMU)
	B1530A-0KN	Self-paced sample program learning kit
B1531A		Remote-sense and Switch Unit (RSU)
E5288A		Atto Sense and Switch Unit (ASU)
	E5288A-001	Add triaxial and D-sub cables, 1.5 m
	E5288A-002	Add triaxial and D-sub cables, 3 m

Model Number	Option Item	Description
N1253A		Accessories for Digital I/O
	N1253A-100	Digital I/O T-cable
	N1253A-200	Digital I/O BNC Box
N1254A		Accessories
	N1254A-100	GNDU Kelvin Adapter
	N1254A-108	ASU Magnetic Stand
N1255A		2 Channels Connection Box for MCSMU
N1300A		CMU cable
	N1300A-001	1.5 m length
	N1300A-002	3 m length
N1301A		Accessories for CMU
	N1301A-100	SMU CMU Unify Unit (SCUU)
	N1301A-102	SCUU cable, 3 m
	N1301A-110	SCUU magnetic stand
	N1301A-200	Guard Switch Unit (GSWU)
	N1301A-201	GSWU cable, 1.5 m
	N1301A-202	GSWU cable, 3 m

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