Using WaferPro Express with B2200A Switch Matrix

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KEYSIGHT TECHNOLOGIES

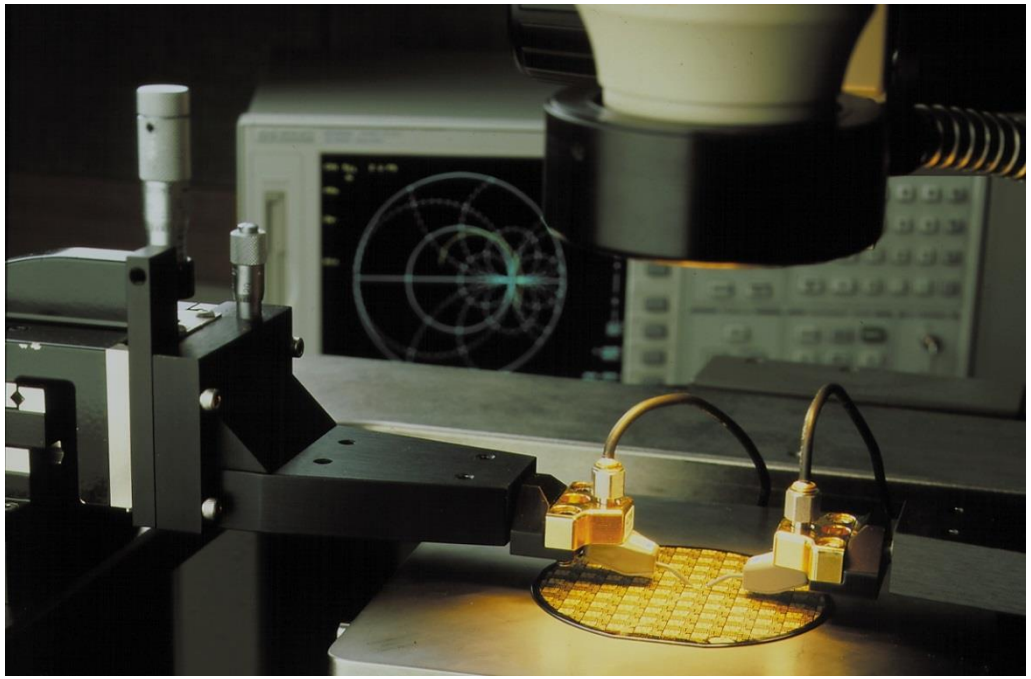
Different Types of Measurements

DC IV or DC CV Measurements

- Majority of foundries use these measurements for baseband modeling
- Typically 4-5 systems in a lab

DC IV + RF S-parameter Measurements

- For high-frequency modeling
- Typically 1 system in a silicon foundry lab
- For GaAs foundry, main application focus is RF



E5270B Precision IV Analyzer / 8 Slot Precision Measurement Mainframe

Applying or measure current or voltage to devices under test

B2200A fA Leakage Switch Mainframe

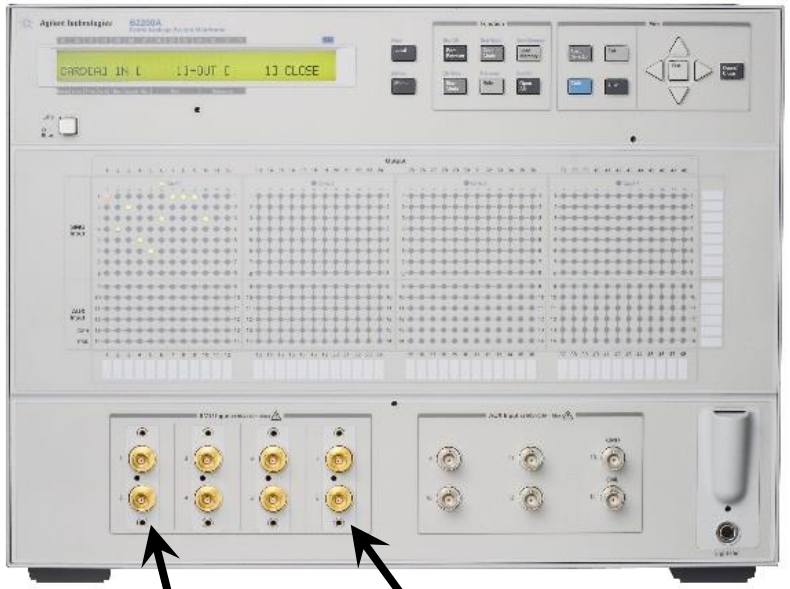
Reuse hardware to visit many sites

- in multi-pin package
- on probe card

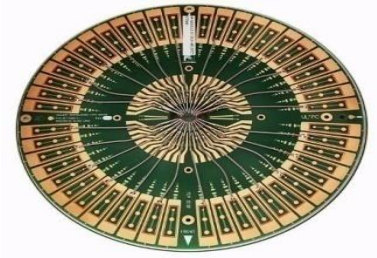
KEYSIGHT TECHNOLOGIES

Switch matrix applications

Switch Matrix



pins



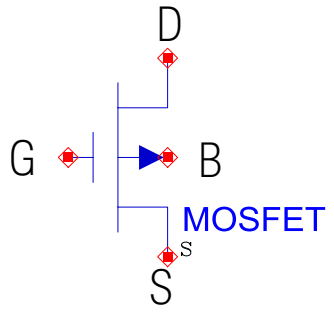
Probe Card
or...

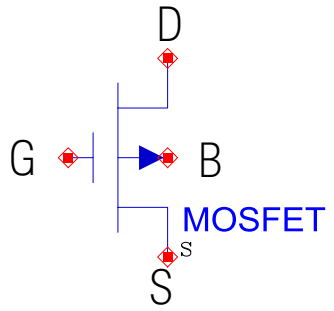
Packaged Group
of Parts

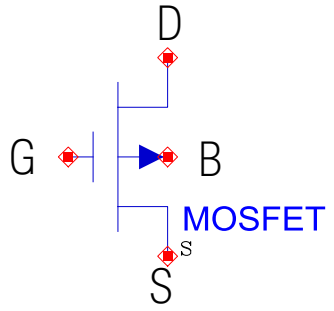
DC-IV

Capacitance

ports

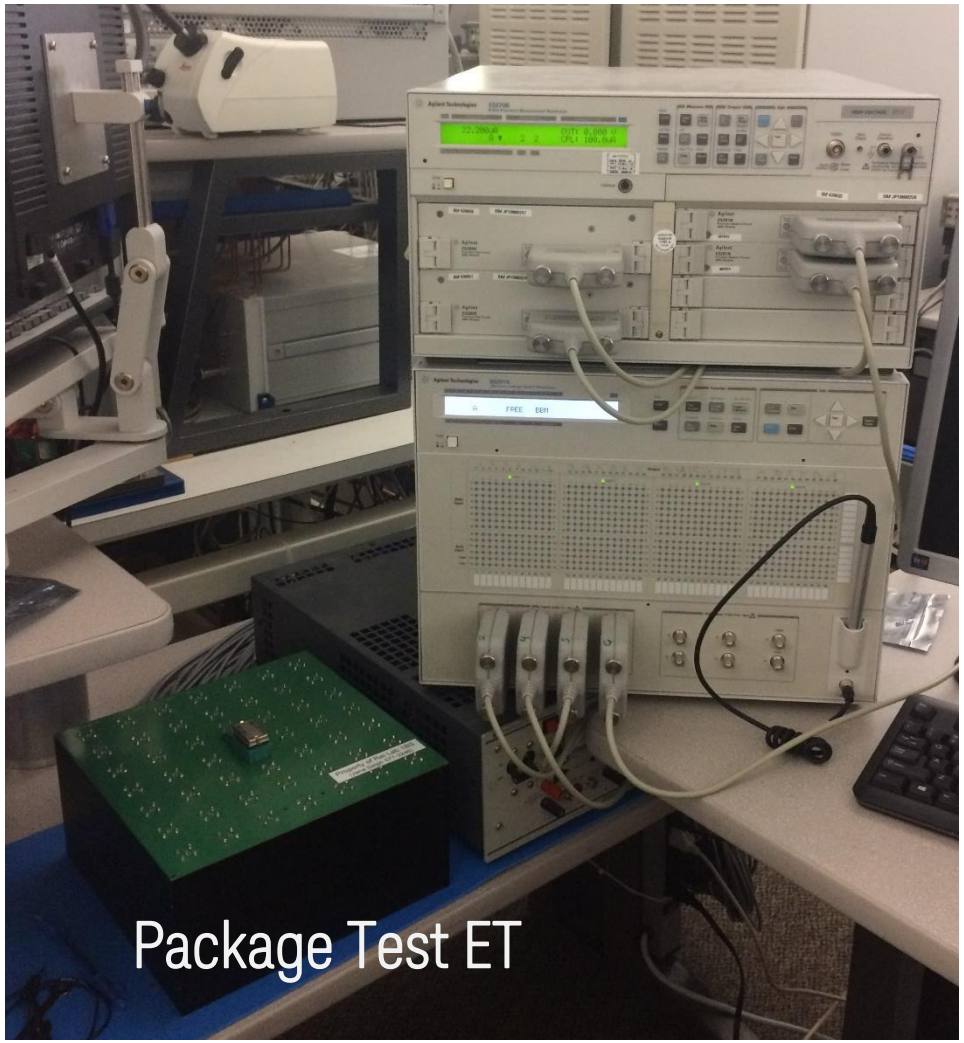






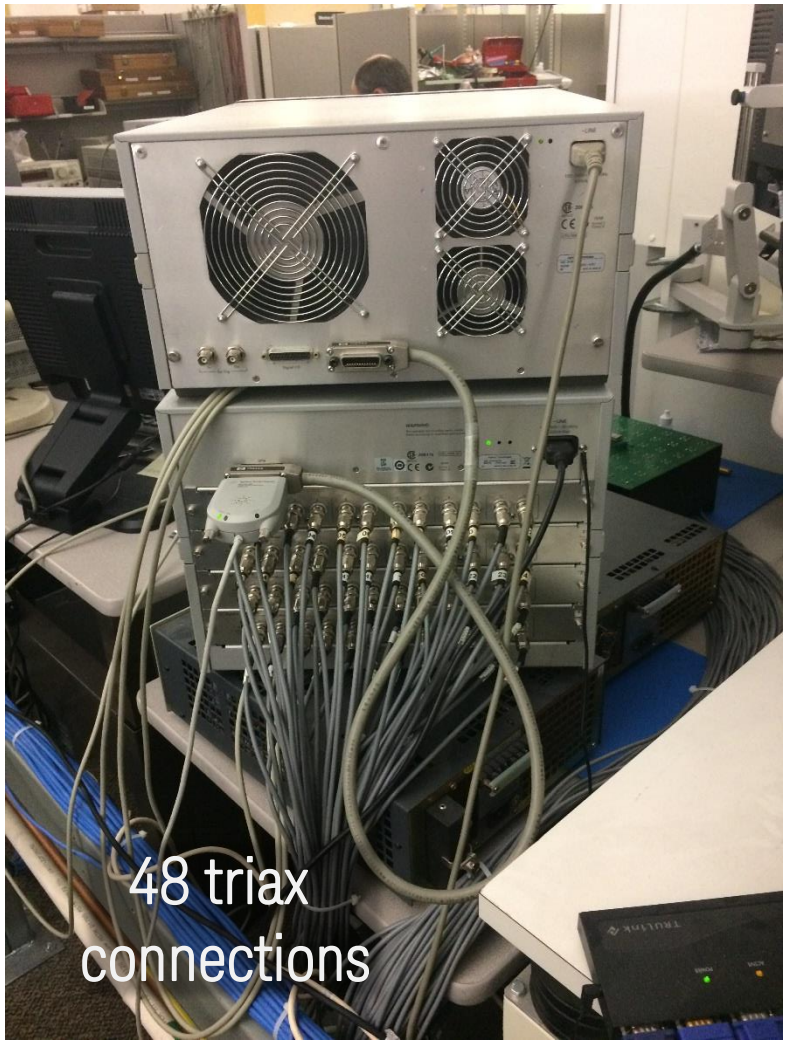
KEYSIGHT TECHNOLOGIES

Hardware Setup



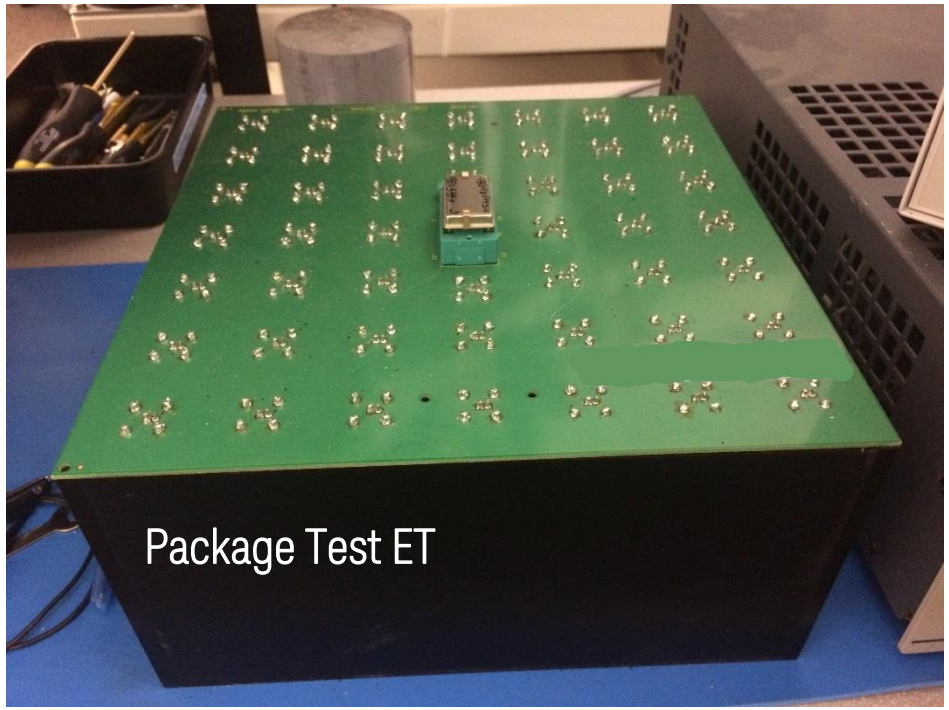
E5270B

B2200A



KEYSIGHT TECHNOLOGIES

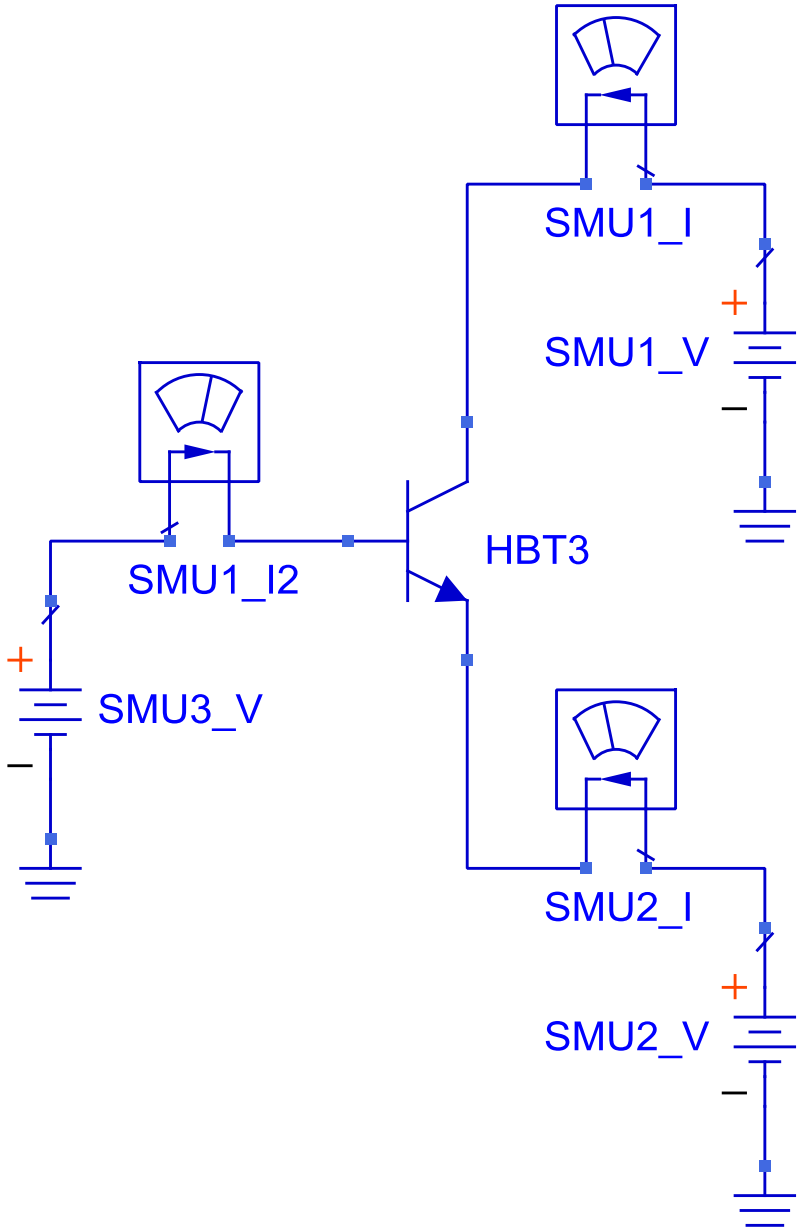
Package Test ET

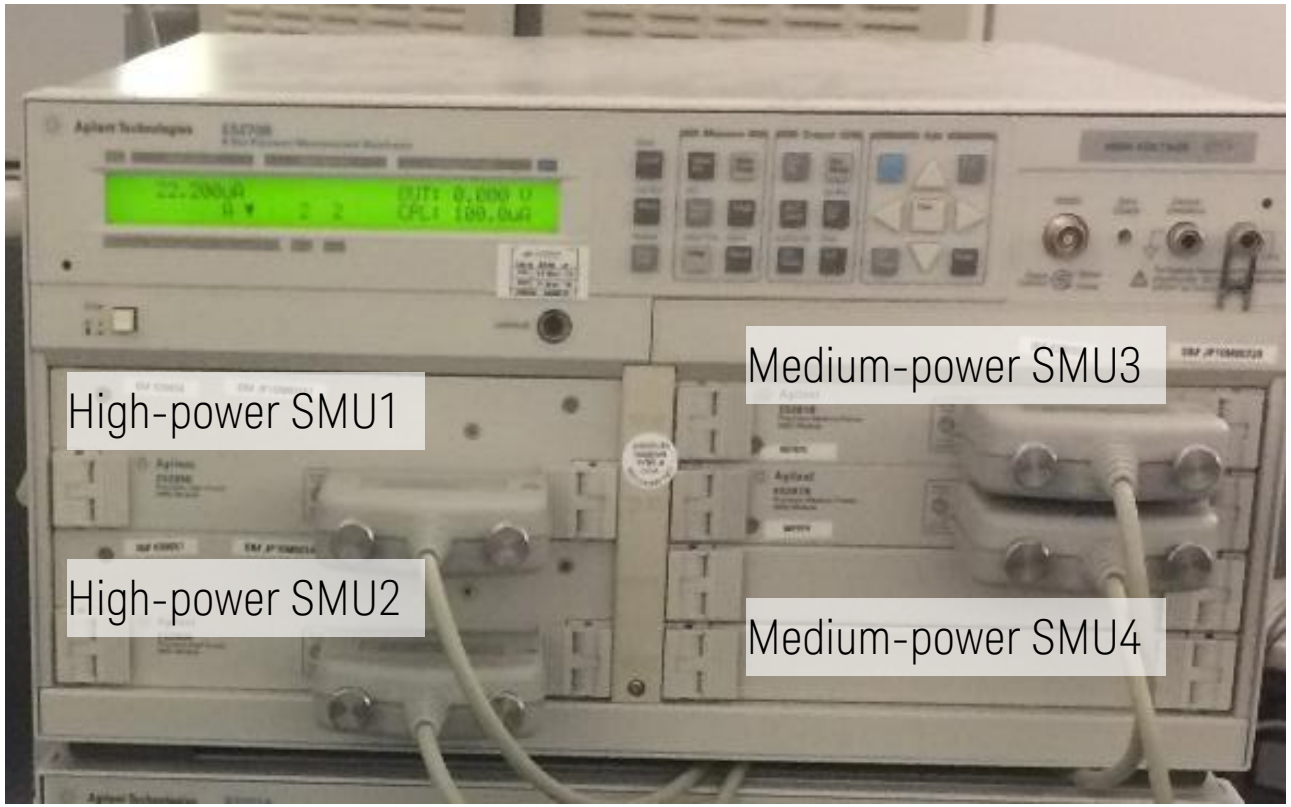


48 triax connector board mated to 24 pin socket

Force and sense connect just before socket

Guard = open





Instrument Settings

KeysightE5270

Interface: gpib0

Address: 1

Unit Table

Unit	Unit Alias
HPSMU2	SMU1
HPSMU4	SMU2
MPSMU5	SMU3
MPSMU6	SMU4

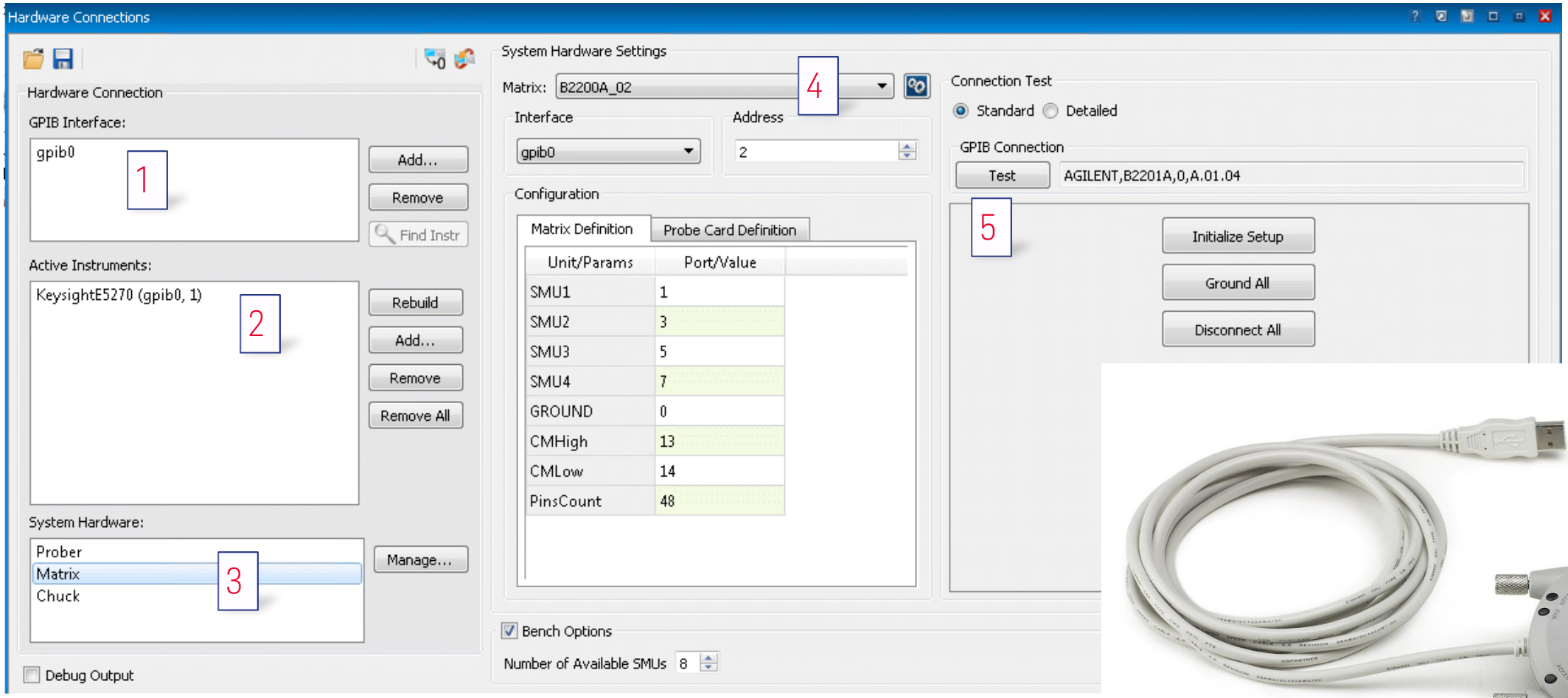
GPIB Connection

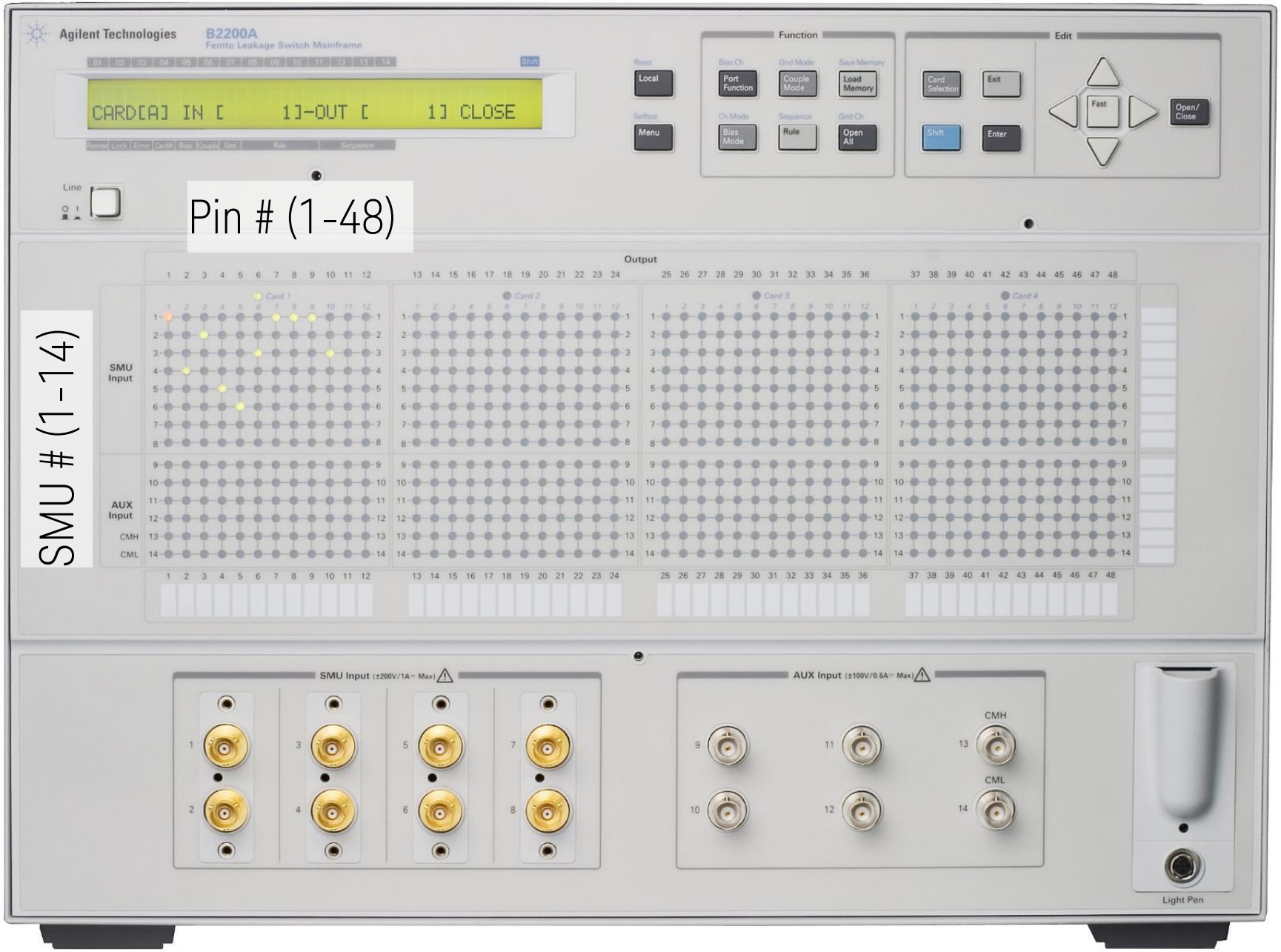
Test

Agilent Technologies,E5270B,0,B.01.01

KEYSIGHT TECHNOLOGIES

WaferPro Express GPIB Connections





KEYSIGHT TECHNOLOGIES

Force

Sense

Configuration

Matrix Definition | Probe Card Definition

Unit/Params	Port/Value
SMU1	1
SMU2	3
SMU3	5
SMU4	7
GROUND	0
CMHigh	13
CMLow	14
PinsCount	48

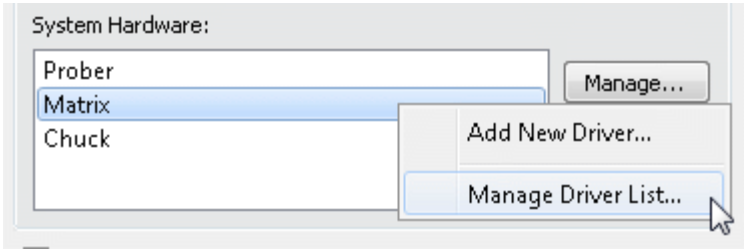
{WPE_Home}\hpeesof\waferpro_2016_04\instr\B2200A_02.matrix

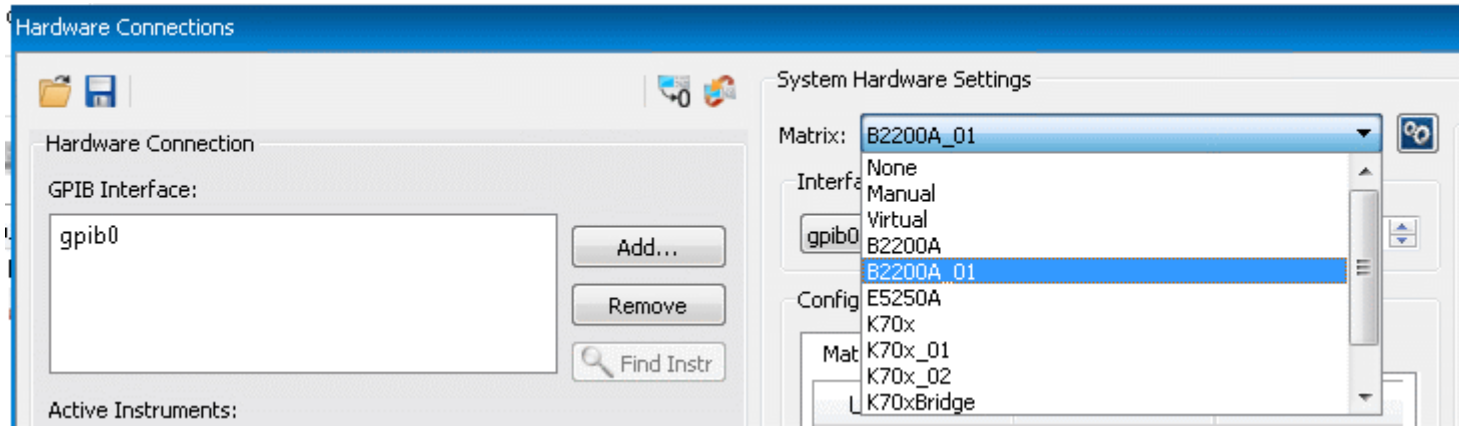
Where to look at Switch Matrix drivers

… and define your own!

In C:\Keysight\WAFERPROXP_2016_04_HF1\waferpro\config\DriverLibs

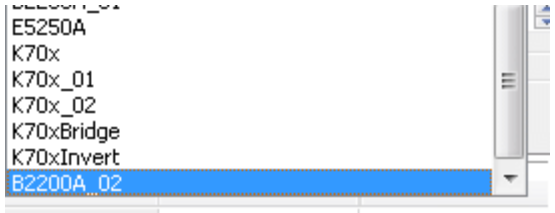
Driver~Matrix~B2200A.set — For set V only, standard approach
Driver~Matrix~B2200A_01.set — For force and sense (Kelvin Connection)



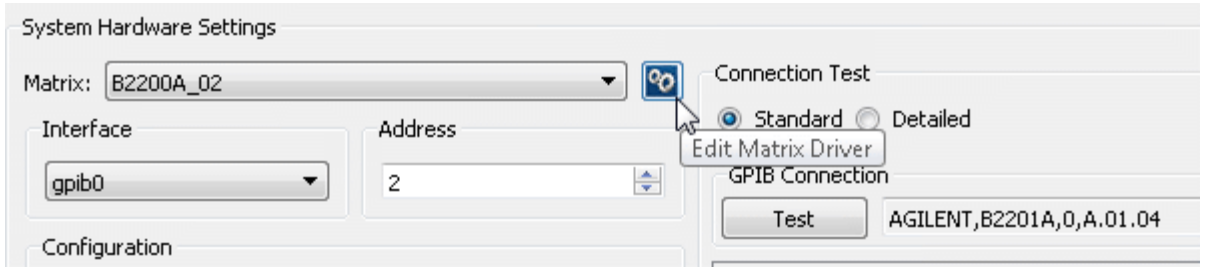


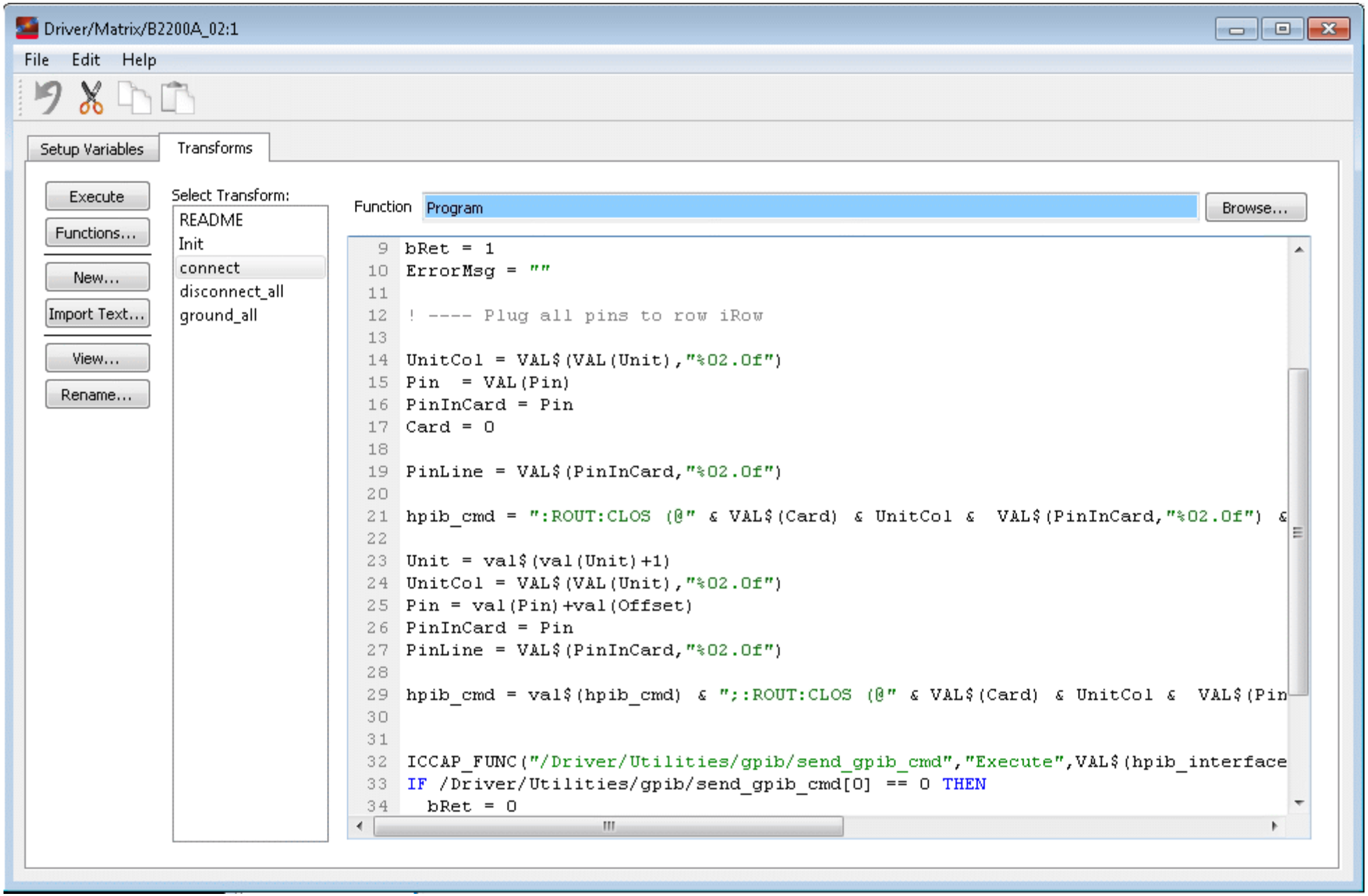
If you make a copy of this to edit it and call it B2200A_02, it will be saved here: {WPE_Home}\hpeesof\waferpro_2016_04\config\DriverLibs

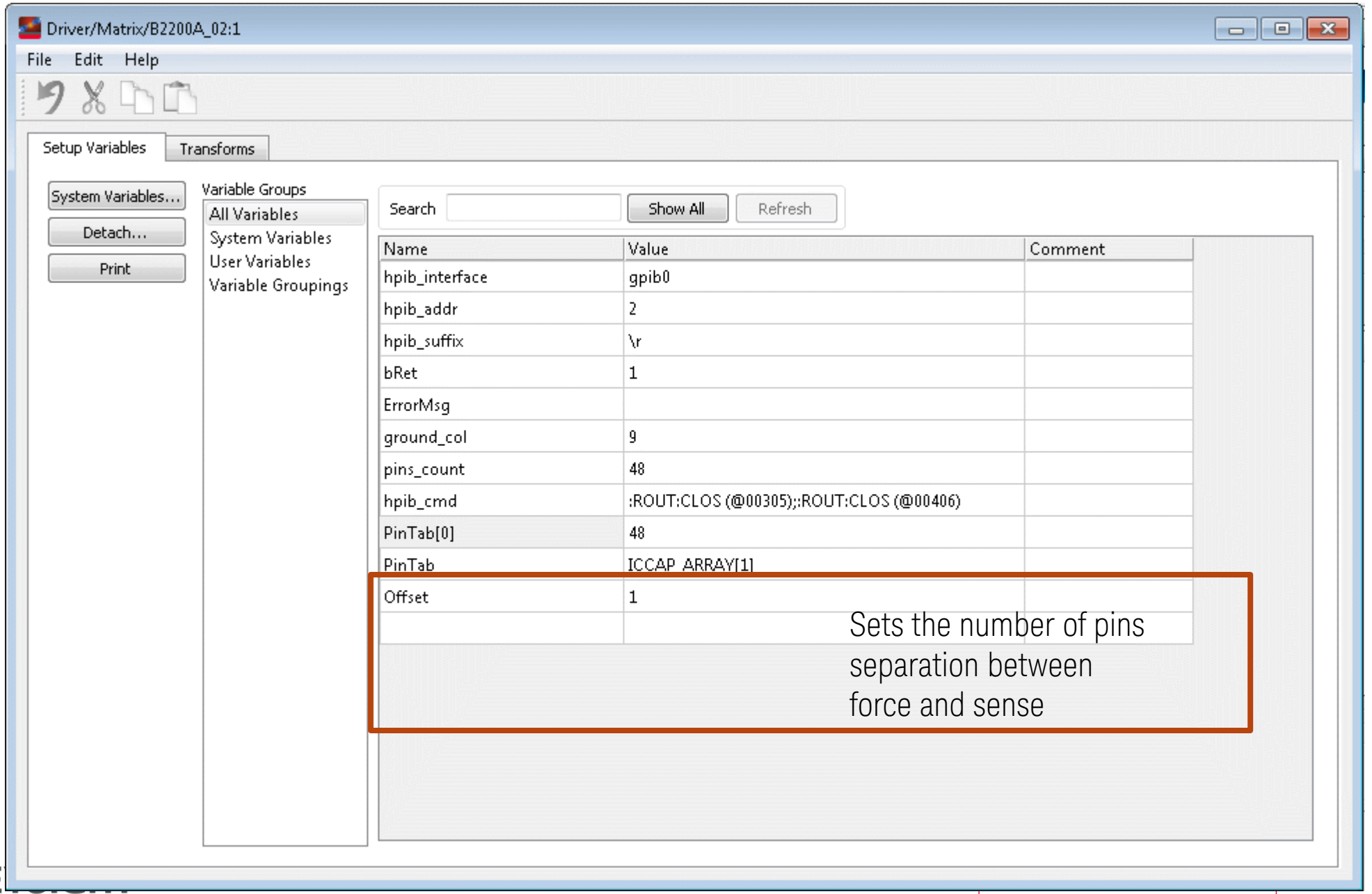
Now it shows up here:

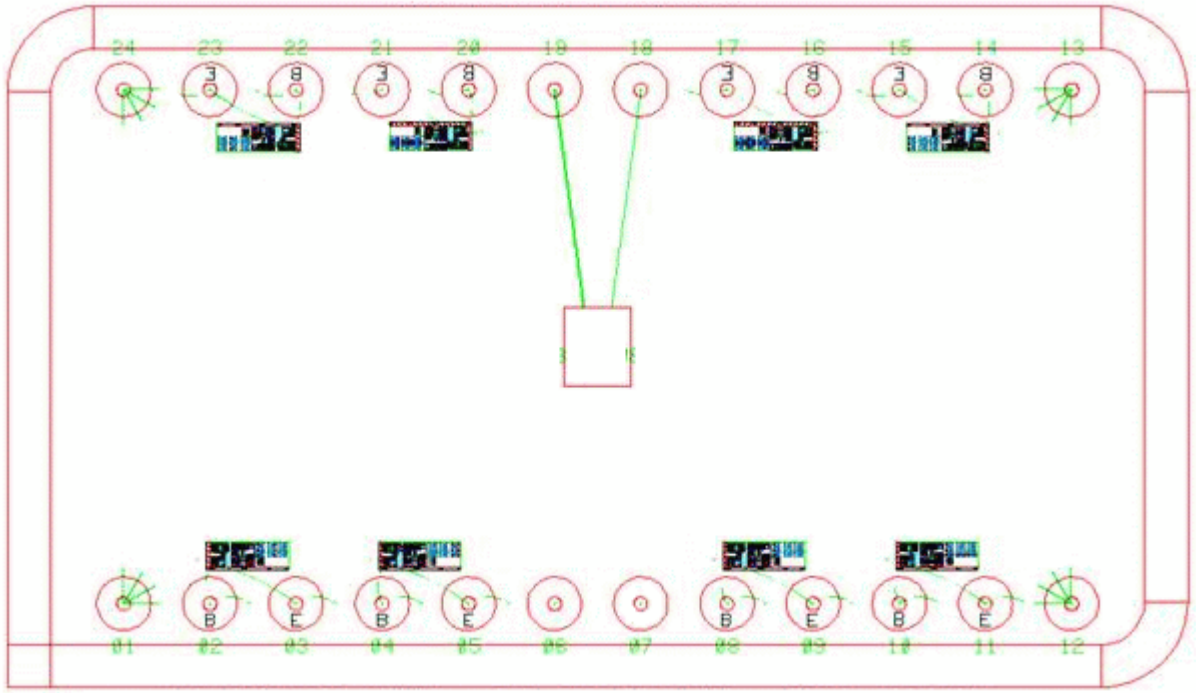


let’s look at the switch matrix driver

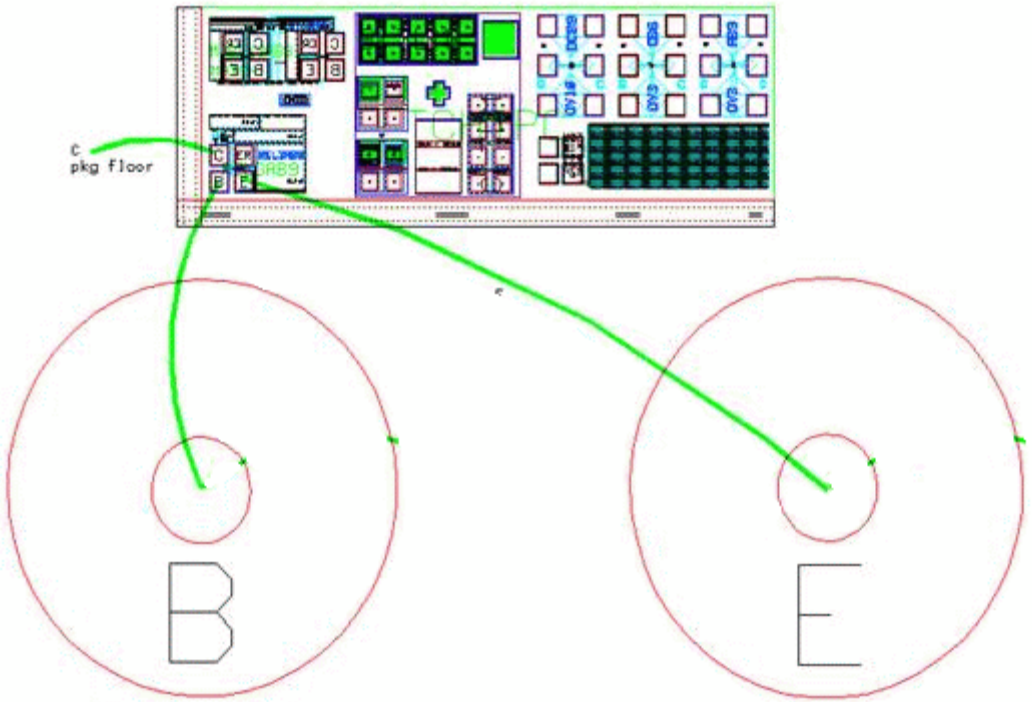



Driver/Matrix/B2200A_02:1
File
Edit
Help
Setup Variables
Transforms
Execute
Functions...
New...
Import Text...
View...
Rename...
Select Transform:
README
Init
connect
disconnect_all
ground_all
Function
Program
Browse...
9 bRet = 1
10 ErrorMsg = ""
11
12 ! ---- Plug all pins to row iRow
13
14 UnitCol = VAL$(VAL(Unit),"%02.0f")
15 Pin = VAL(Pin)
16 PinInCard = Pin
17 Card = 0
18
19 PinLine = VAL$(PinInCard,"%02.0f")
20
21 hpib_cmd = ":ROUT:CLOS (@" & VAL$(Card) & UnitCol & VAL$(PinInCard,"%02.0f") &
22
23 Unit = val$(val(Unit)+1)
24 UnitCol = VAL$(VAL(Unit),"%02.0f")
25 Pin = val(Pin)+val(Offset)
26 PinInCard = Pin
27 PinLine = VAL$(PinInCard,"%02.0f")
28
29 hpib_cmd = val$(hpib_cmd) & ";:ROUT:CLOS (@" & VAL$(Card) & UnitCol & VAL$(Pin
30
31
32 ICCAP_FUNC("/Driver/Utilities/gpib/send_gpib_cmd","Execute",VAL$(hpib_interface
33 IF /Driver/Utilities/gpib/send_gpib_cmd[0] == 0 THEN
34 bRet = 0


Driver/Matrix/B2200A_02:1
File Edit Help
Setup Variables
Transforms
System Variables...
Detach...
Print
Variable Groups
All Variables
System Variables
User Variables
Variable Groupings
Search
Show All
Refresh
Name
Value
Comment
hpib_interface
gpib0
hpib_addr
2
hpib_suffix
\r
bRet
1
ErrorMsg
ground_col
9
pins_count
48
hpib_cmd
:ROUT:CLOS (@00305);:ROUT:CLOS (@00406)
PinTab[0]
48
PinTab
ICCAP_ARRAY[1]
Offset
1
Sets the number of pins separation between force and sense

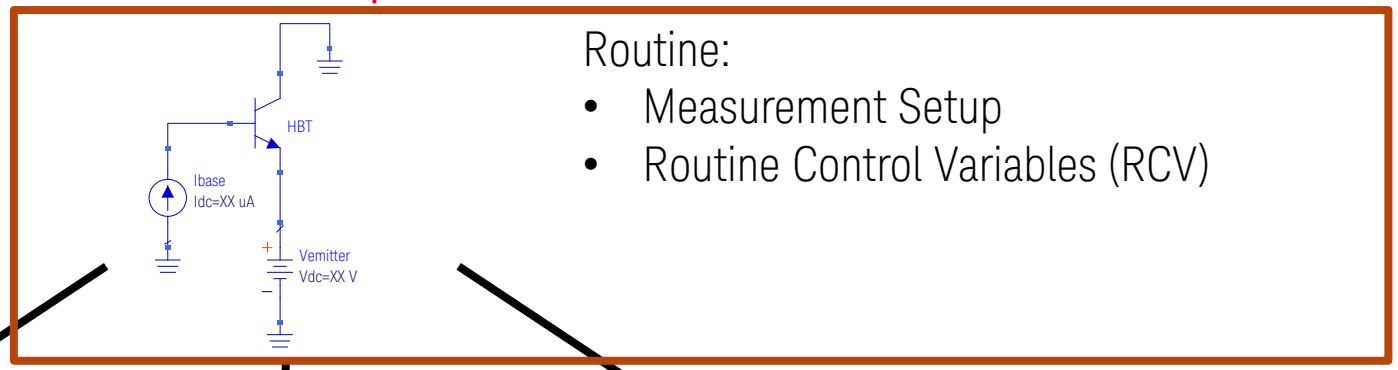


8 HBT devices bonded out to different pins



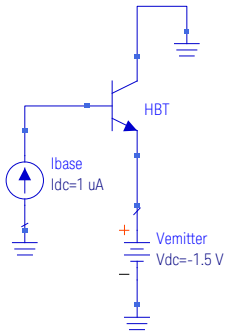
Collector = Package Ground
Base to pin
Emitter to pin
(no ESD wire)

Routine vs Measurement Group

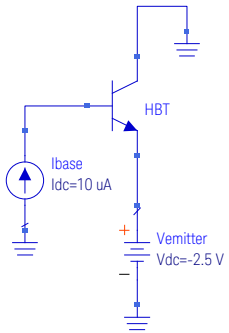


Routine:

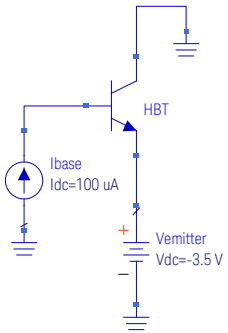
- Measurement Setup
- Routine Control Variables (RCV)



Low Bias – small device



Medium Bias – medium device

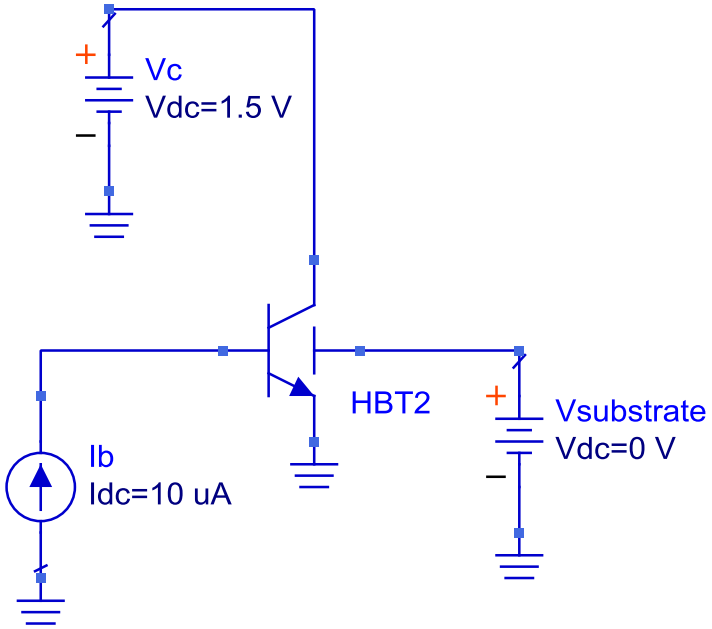


High Bias – big device

Measurement Groups:

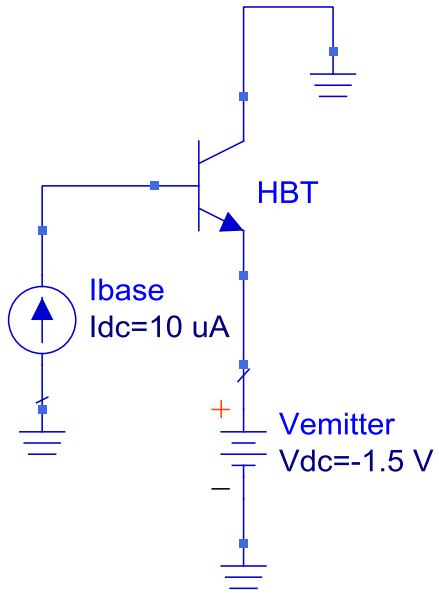
- Sets of RCV's

a measurement group instantiates your routine with particular bias conditions



Factory Provided Biasing Scheme
BJT/DC/Wpro_BJT_DC/Output

Assumes 4 Terminals

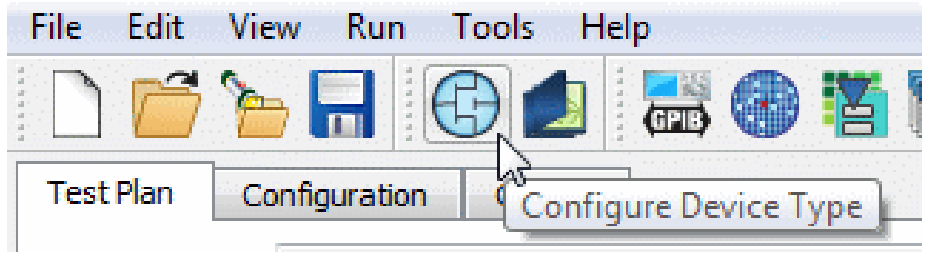


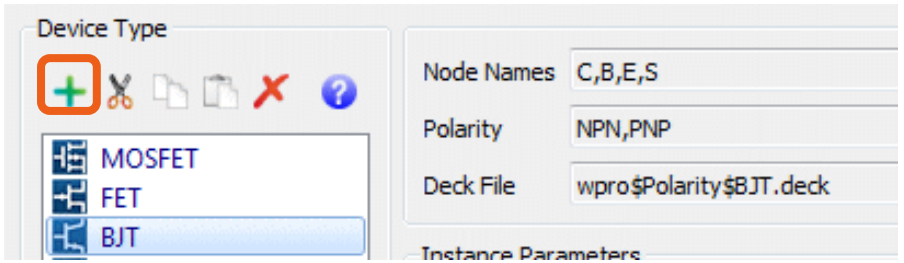
Desired Biasing Scheme

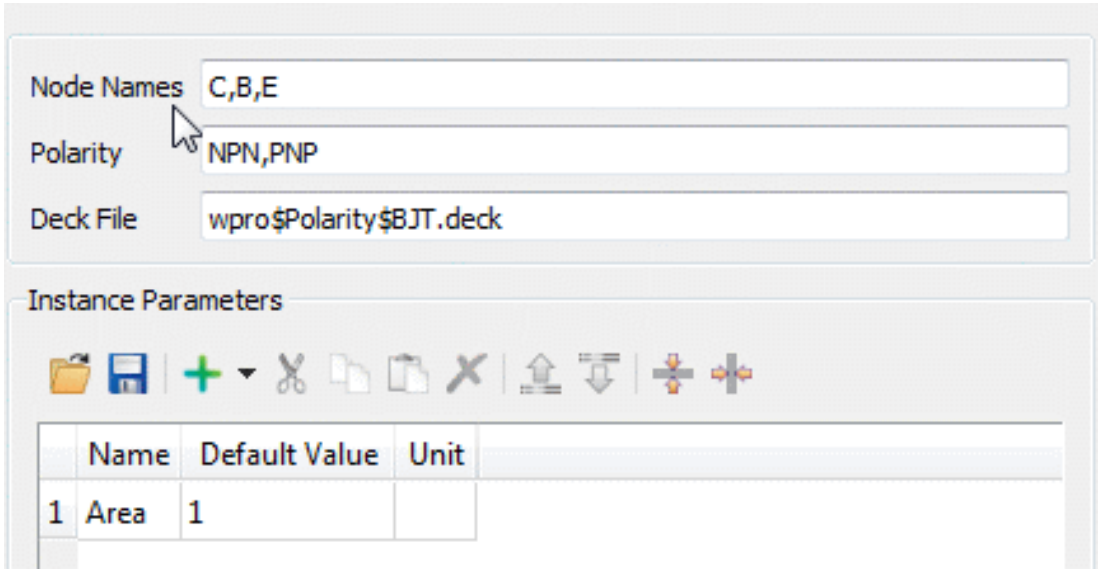
3 Terminals

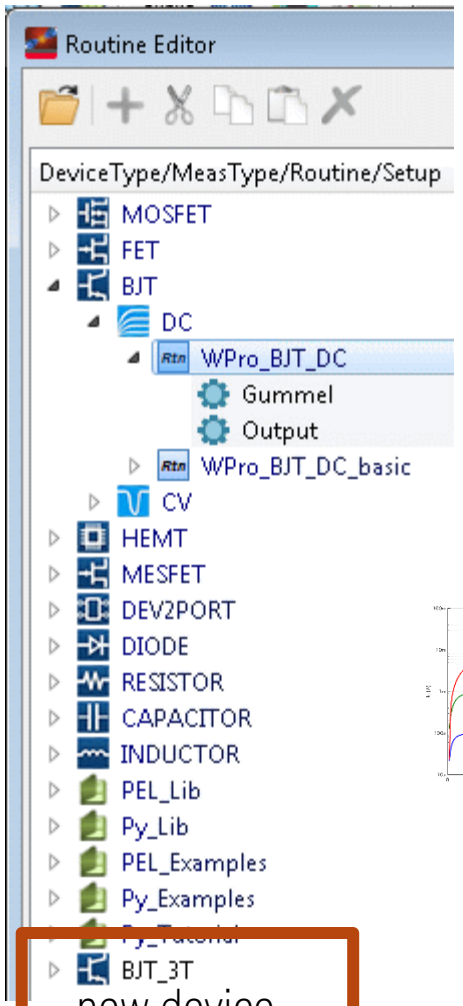
Lets create a new type of device:

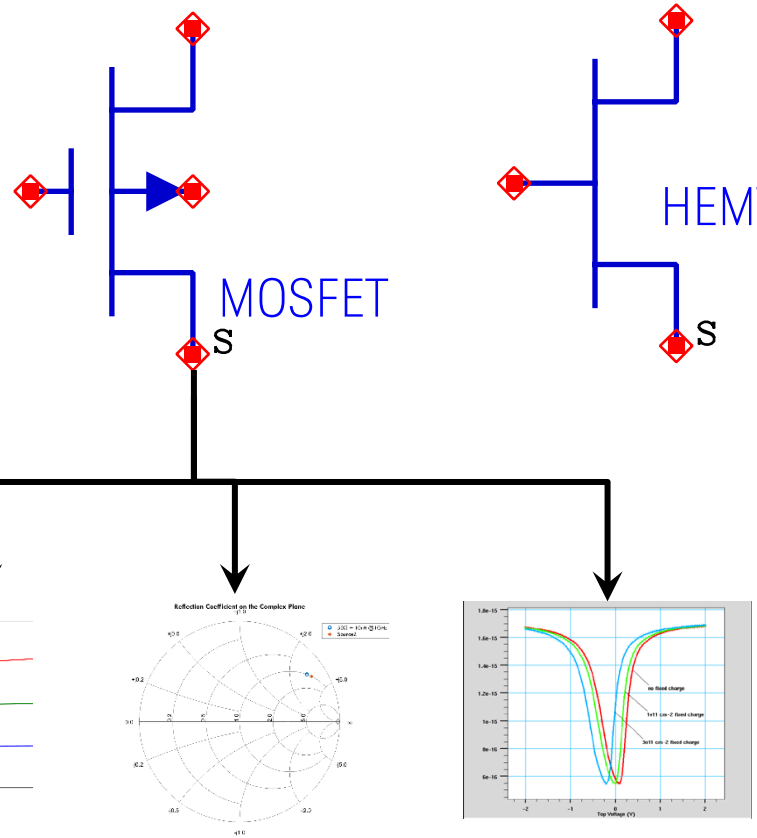
BJT_3T

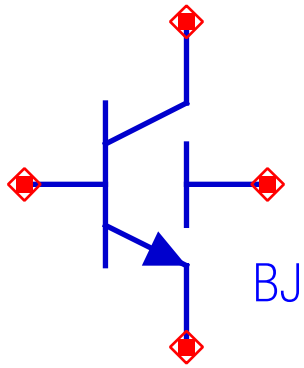












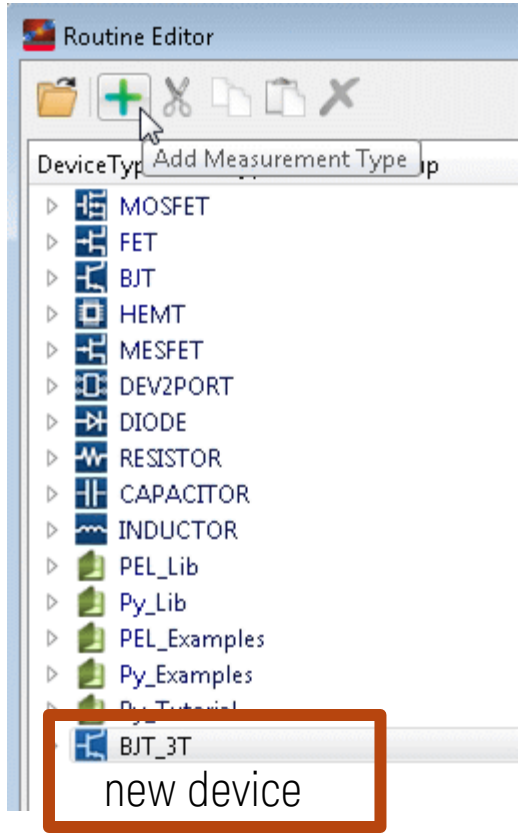
Device Type

Measurement Type

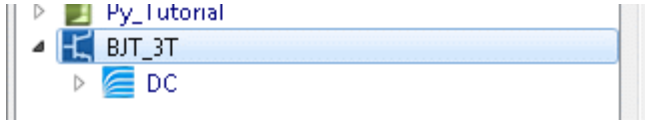
- WPro_MOSFET_DC
- WPro_MOSFET_DC_basic
- WPro_MOSFET_DC_basic2
- WPro_MOSFET_DC_basic2_py
- WPro_MOSFET_DC_basic3
- WPro_MOSFET_DC_basic_py

Routines (Factory Defined)

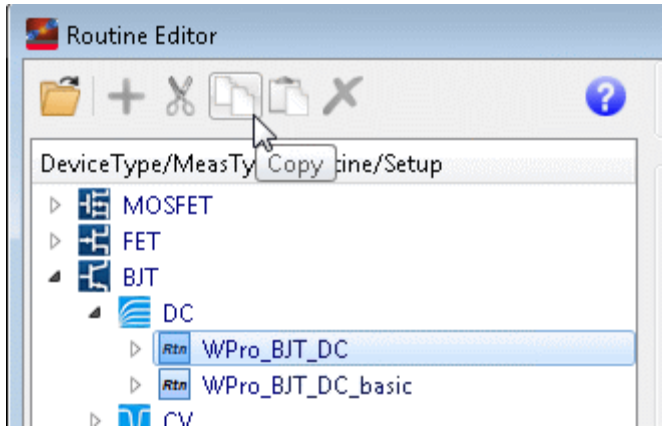
Let's create a routine for our new device that makes sense for a 3 port device



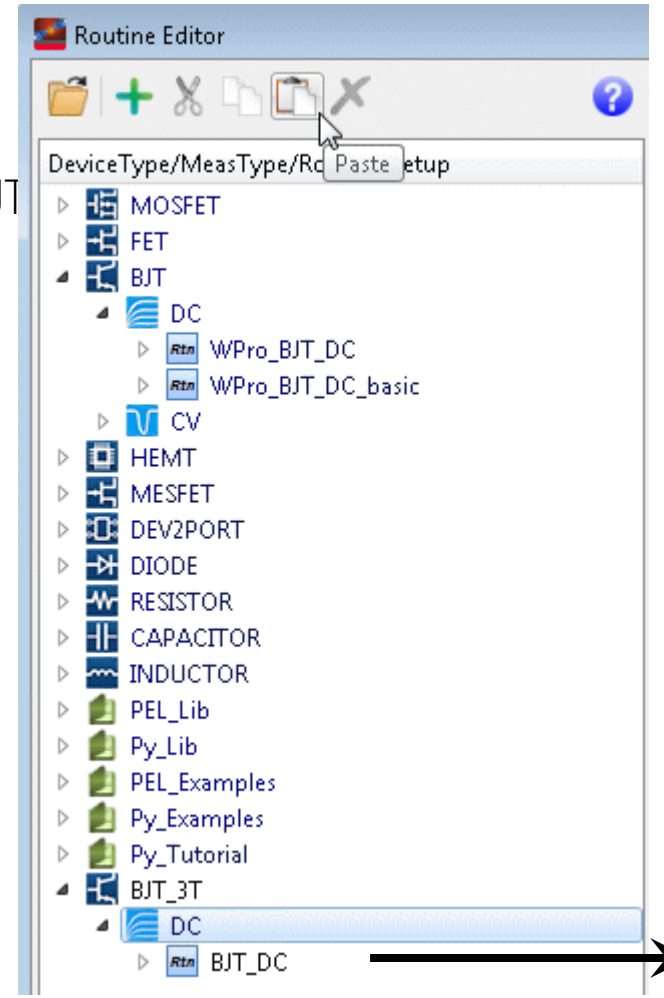
Add a new measurement type
Choose "DC"



Copy a routine from factory provided BJT routines



paste it into BJT_3T/DC

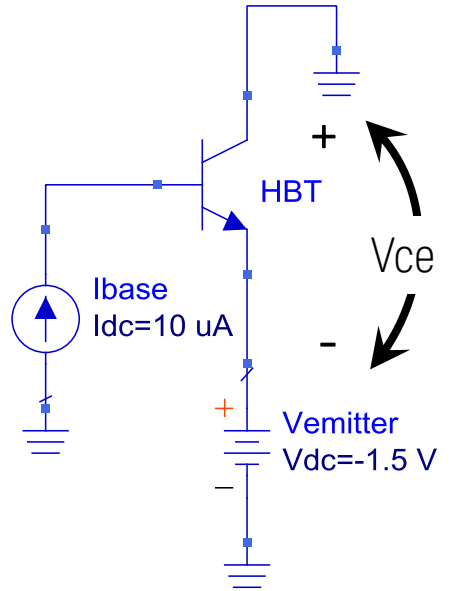


now customize this routine

Routine Control Variables

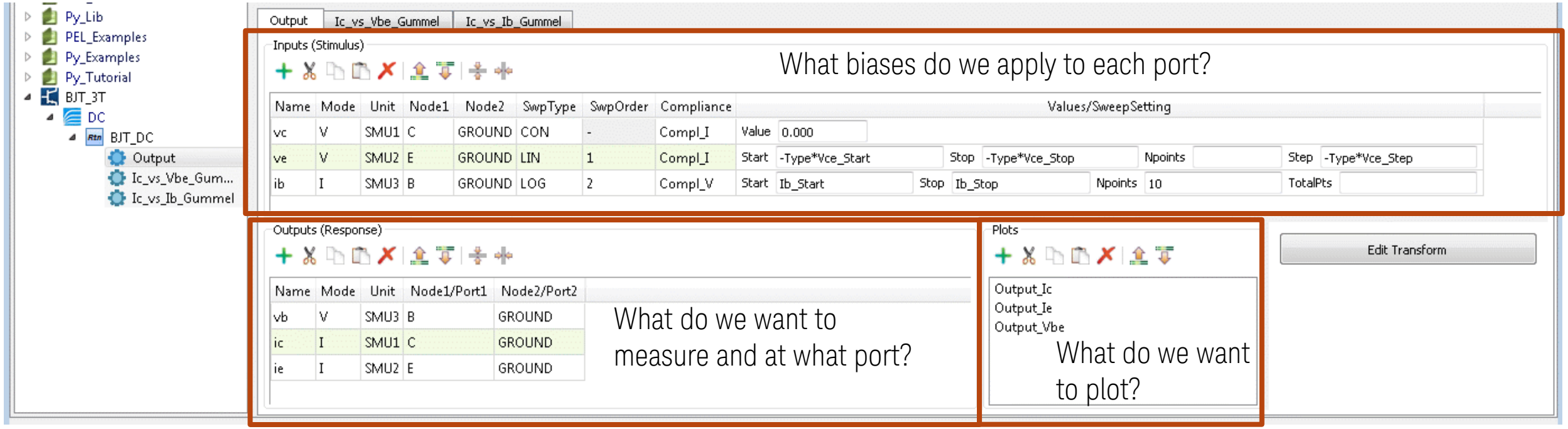
Routine Control Variables (Measurement Condition Table Definition)

	Name	Default Value	Unit	Description
1	Name	(MC1)		Measurement Condition Name (used by the system)
2	Compl_I	5m	A	Current Compliance
3	Compl_V	1.5	V	Voltage Compliance
4	Gummel_MNL	C,E		[C,E] Measurement Node List for Gummel measurement
5	Ib_Start	0.1u	A	Base current bias start value
6	Ib_Stop	100u	A	Base current bias stop value
7	Ib_Step	10u	A	Base current bias step value
8	VCB	0	V	Collector to Base bias
9	Output_MNL	C,B,E		[C,B,E] Measurement Node List for Output Characteristics measurement
10	Vce_Nom	1.5	V	For Gummel plot
11	Vce_Start	0	V	Collector to Emitter bias start value
12	Vce_Stop	2	V	Collector to Emitter bias stop value
13	Vce_Step	0.05	V	Collector to Emitter bias step value

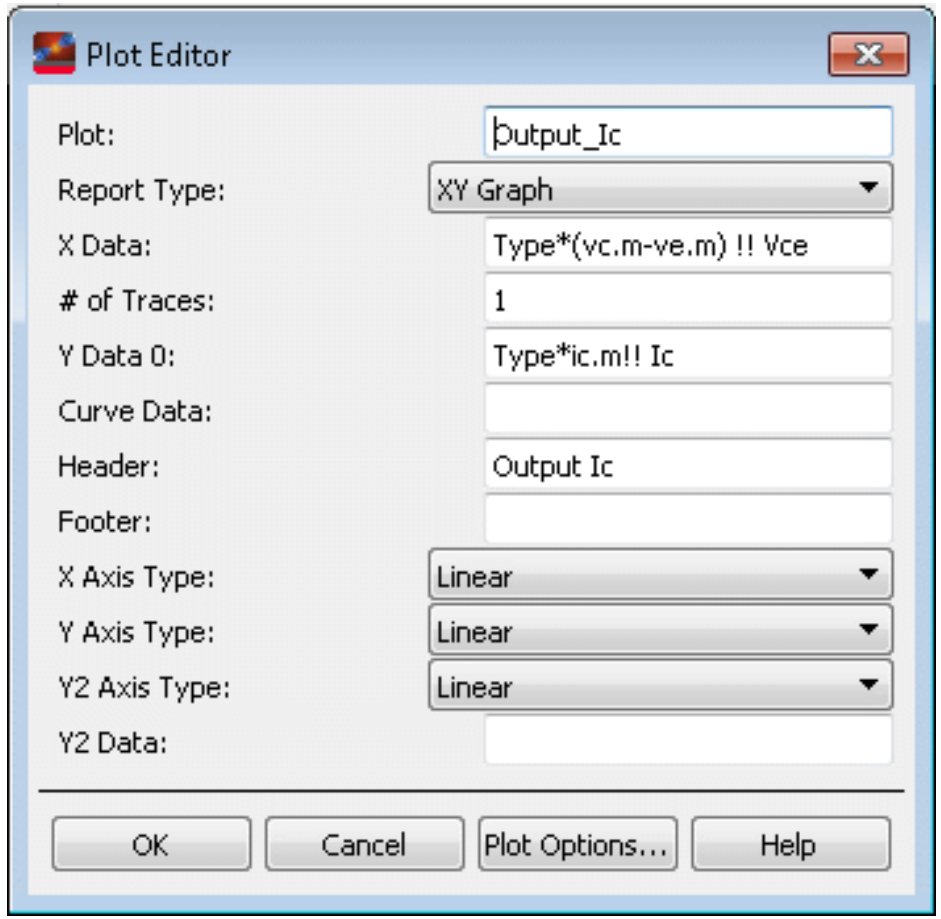


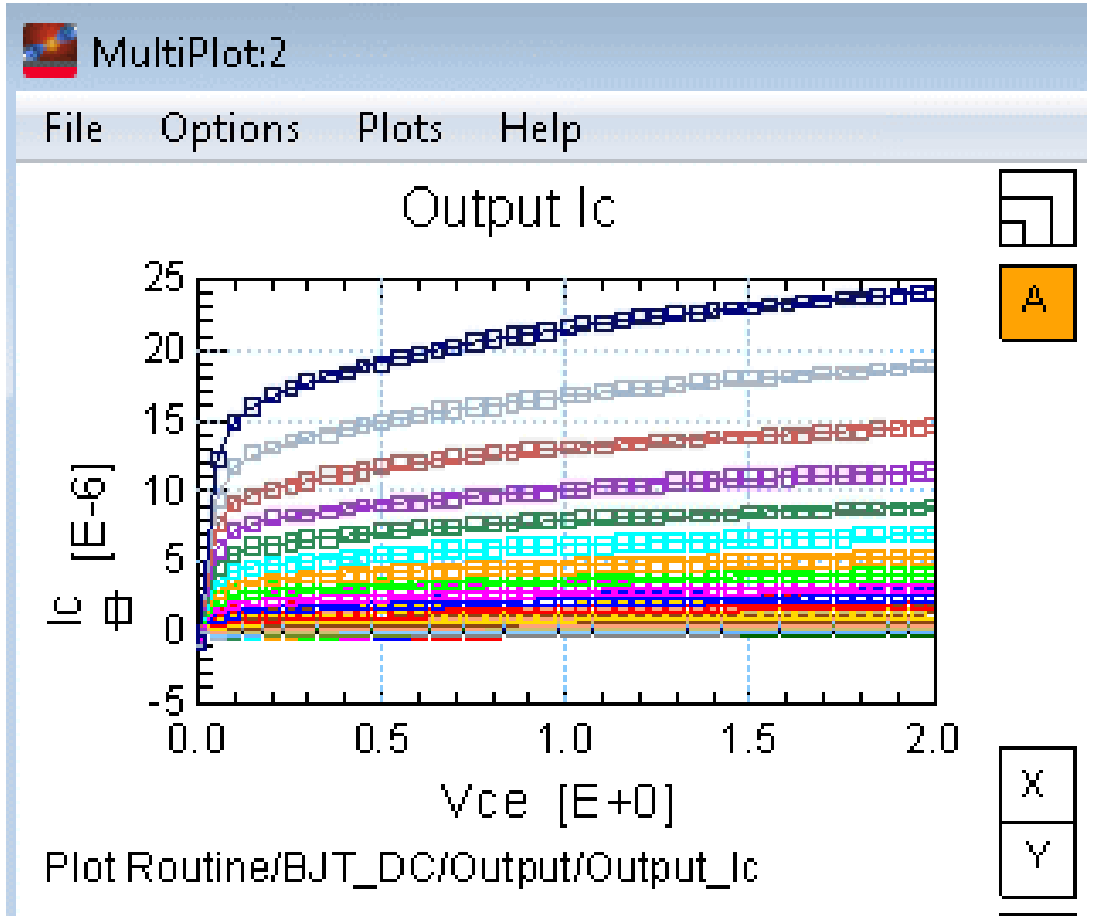
These are just variable names, with default values and descriptions.

Set voltages, measure currents, etc.

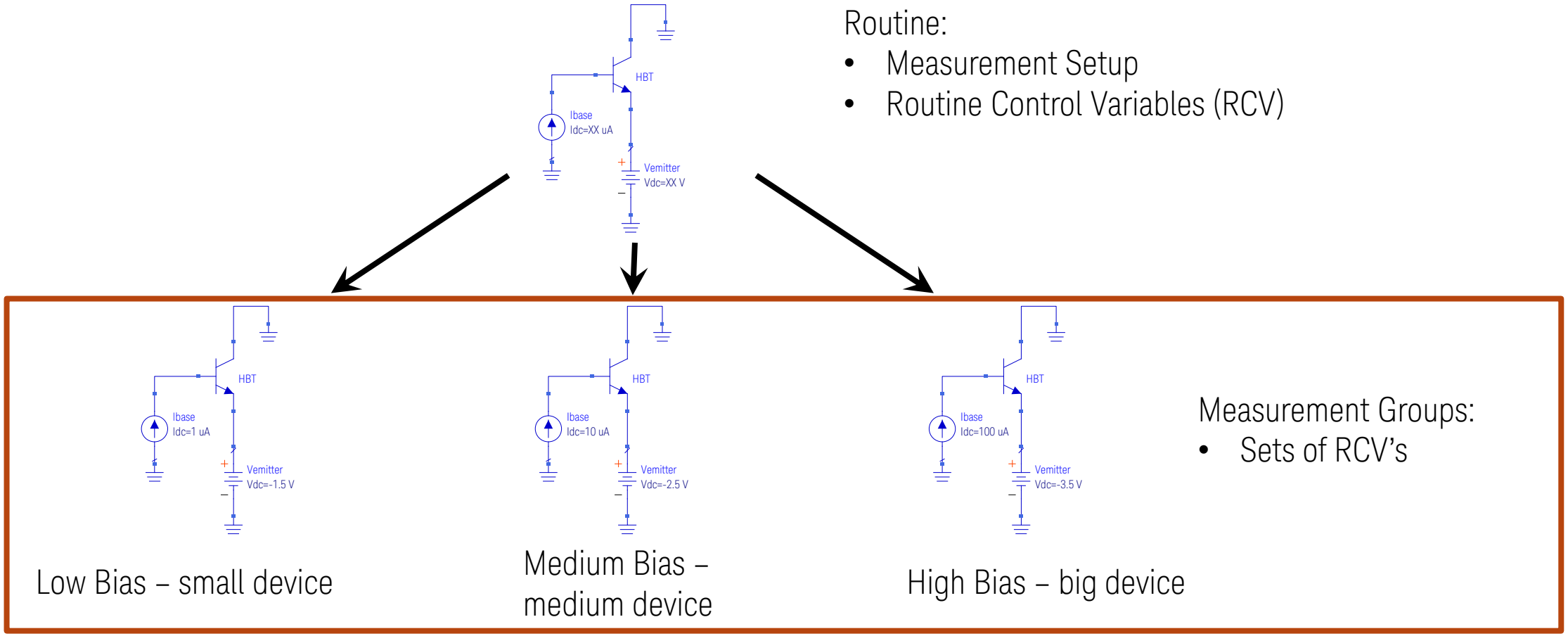


What do we want to plot?





Routine vs Measurement Group - Revisited



Routine:

- Measurement Setup
- Routine Control Variables (RCV)

Measurement Groups:

- Sets of RCV's

Low Bias – small device

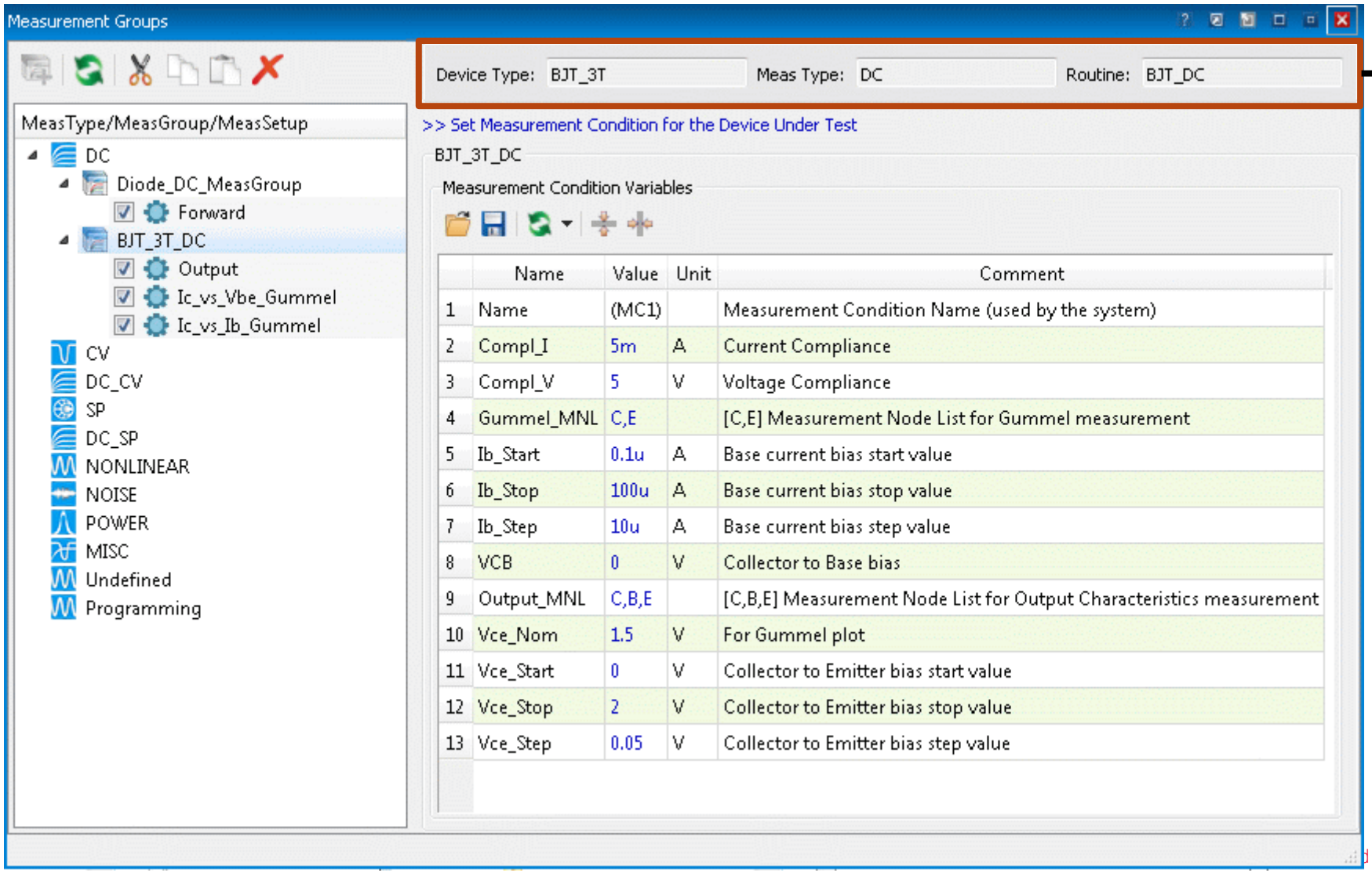
Medium Bias – medium device

High Bias – big device

a measurement group instantiates your routine with particular bias conditions

Measurement Group

… instantiates a routine with specific variable settings



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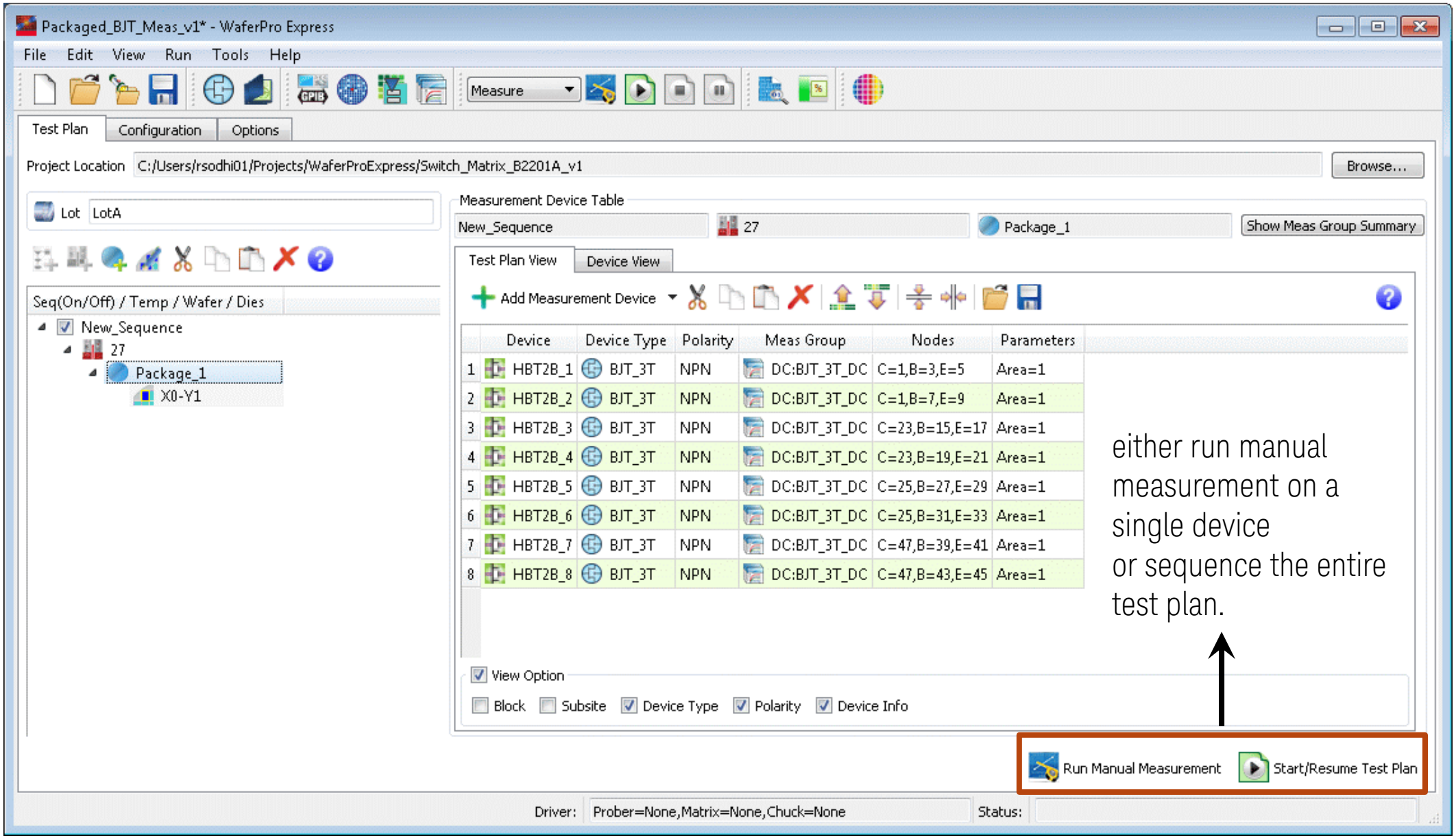
1	Name	(MC1)		Measurement Condition Name (used by the system)
2	Compl_I	5m	A	Current Compliance
3	Compl_V	5	V	Voltage Compliance
4	Gummel_MNL	C,E		[C,E] Measurement Node List for Gummel measurement
5	Ib_Start	0.1u	A	Base current bias start value
6	Ib_Stop	100u	A	Base current bias stop value
7	Ib_Step	10u	A	Base current bias step value
8	VCB	0	V	Collector to Base bias
9	Output_MNL	C,B,E		[C,B,E] Measurement Node List for Output Characteristics measurement
10	Vce_Nom	1.5	V	For Gummel plot
11	Vce_Start	0	V	Collector to Emitter bias start value
12	Vce_Stop	2	V	Collector to Emitter bias stop value
13	Vce_Step	0.05	V	Collector to Emitter bias step value

Only valid for Device “BJT_3T”

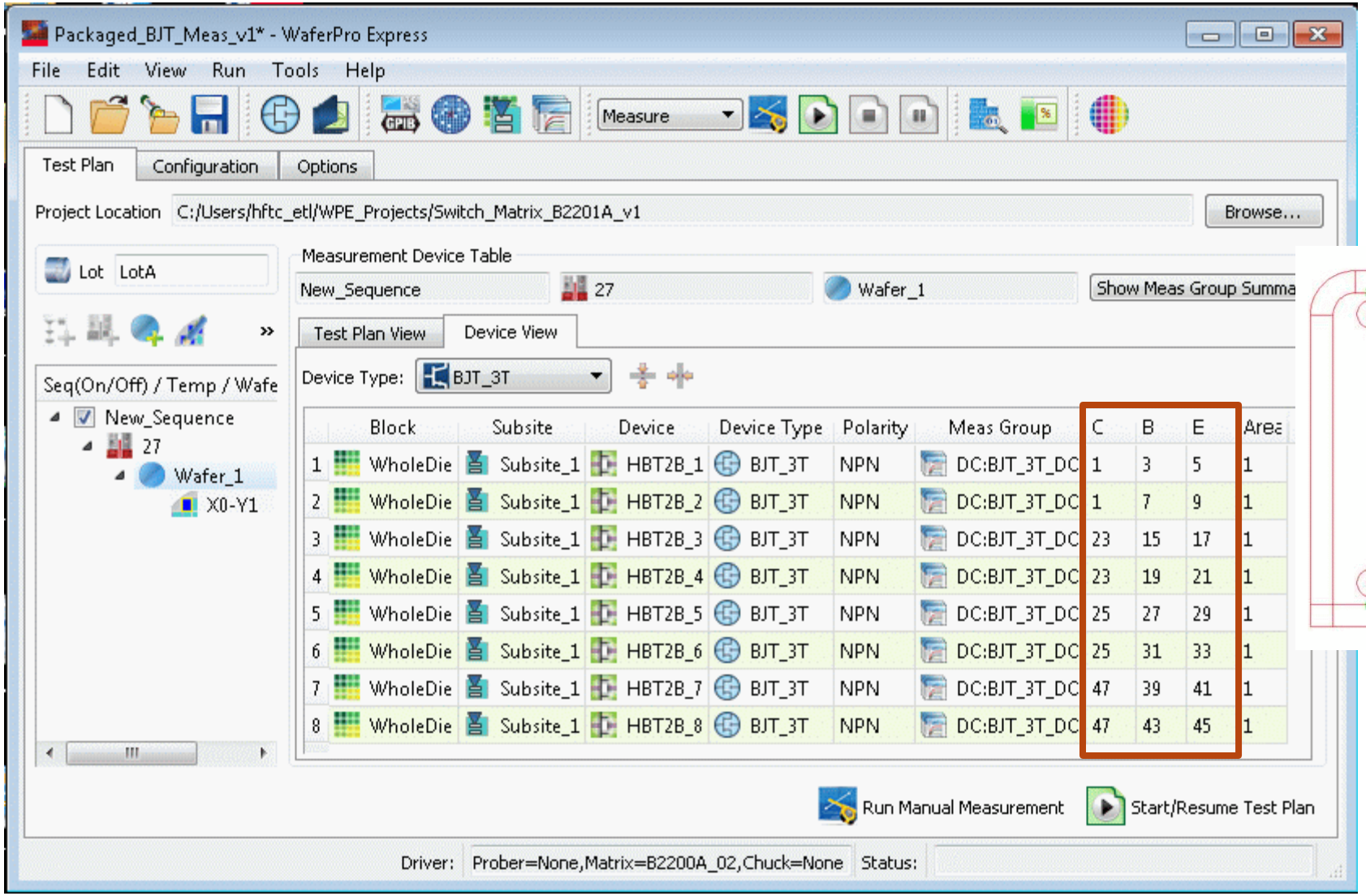
Points to our newly created routine “BJT_DC”

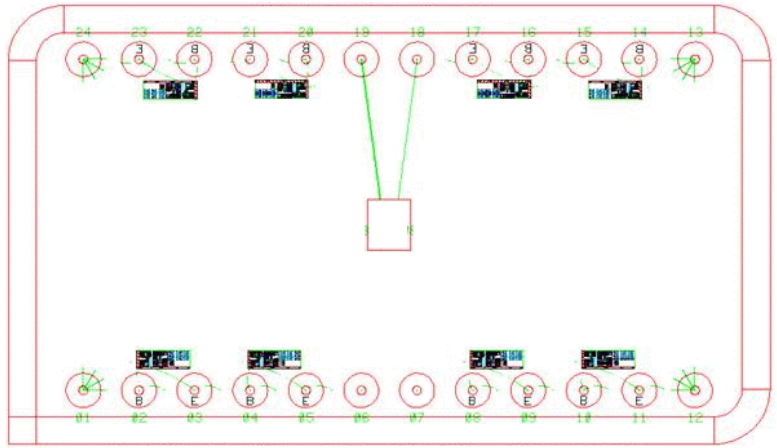
Measurement Group name = “BJT_3T_DC”

… will be called out in the test plan.



either run manual measurement on a single device or sequence the entire test plan.

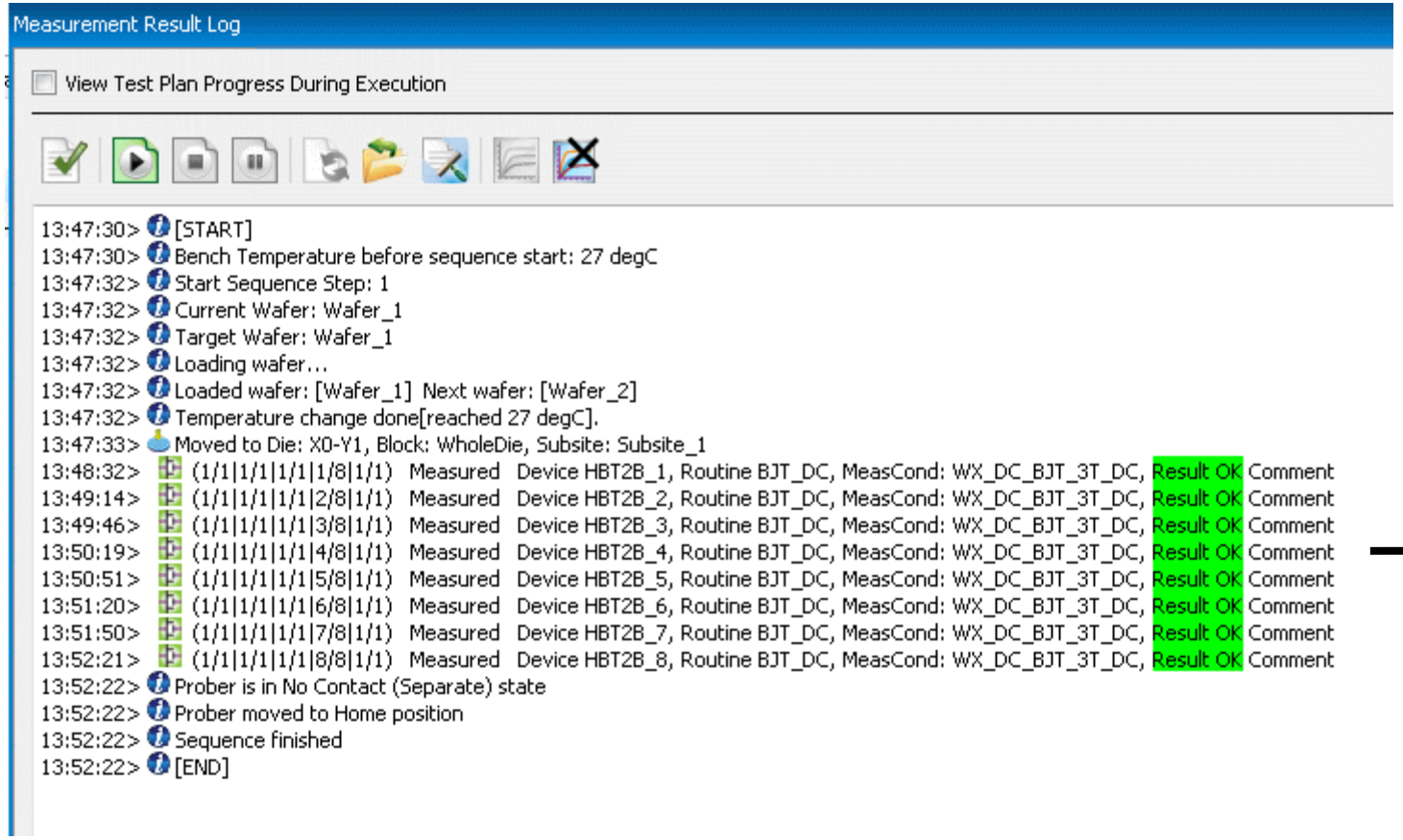




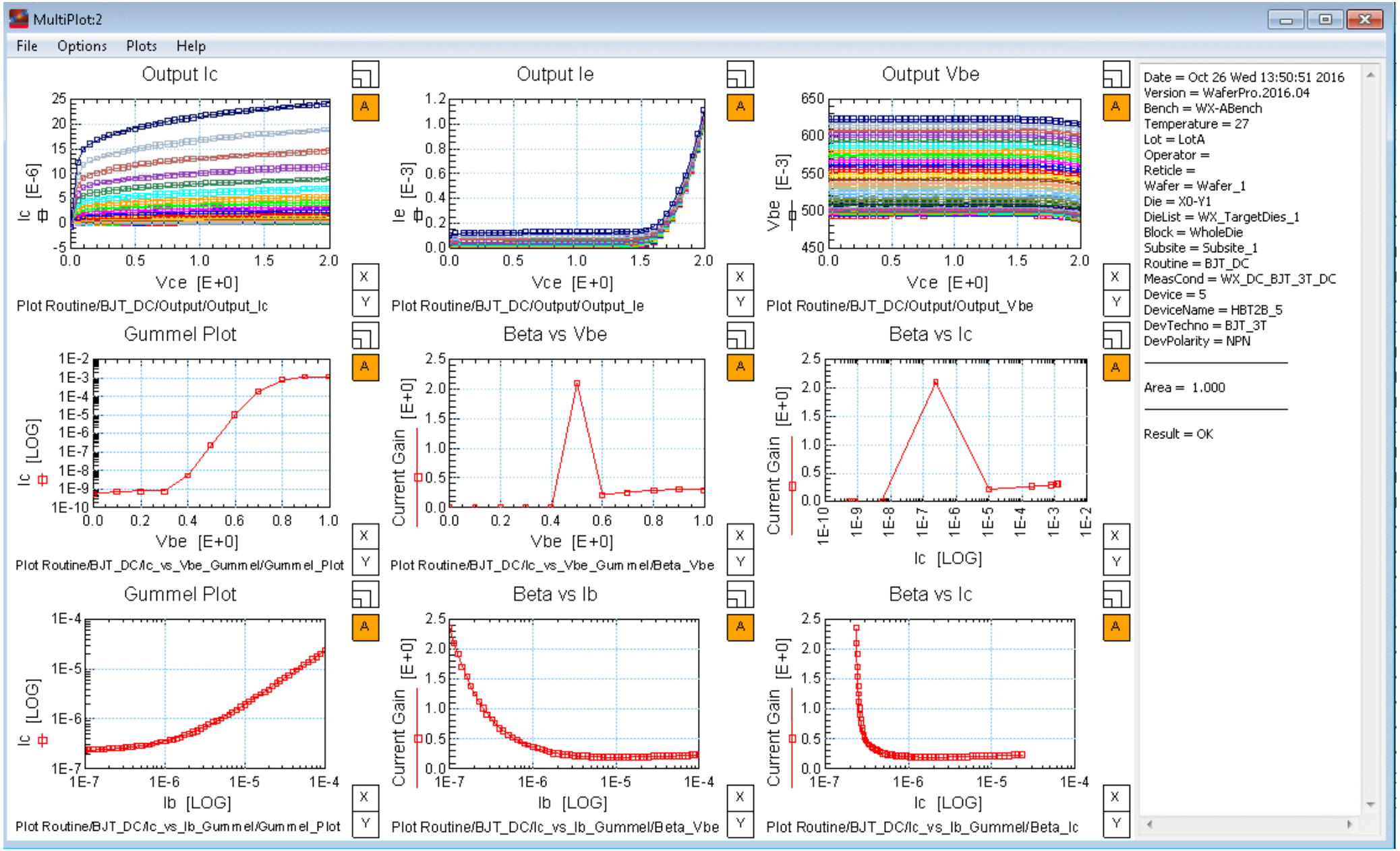
Force Pin = 2*Package Pin – 1

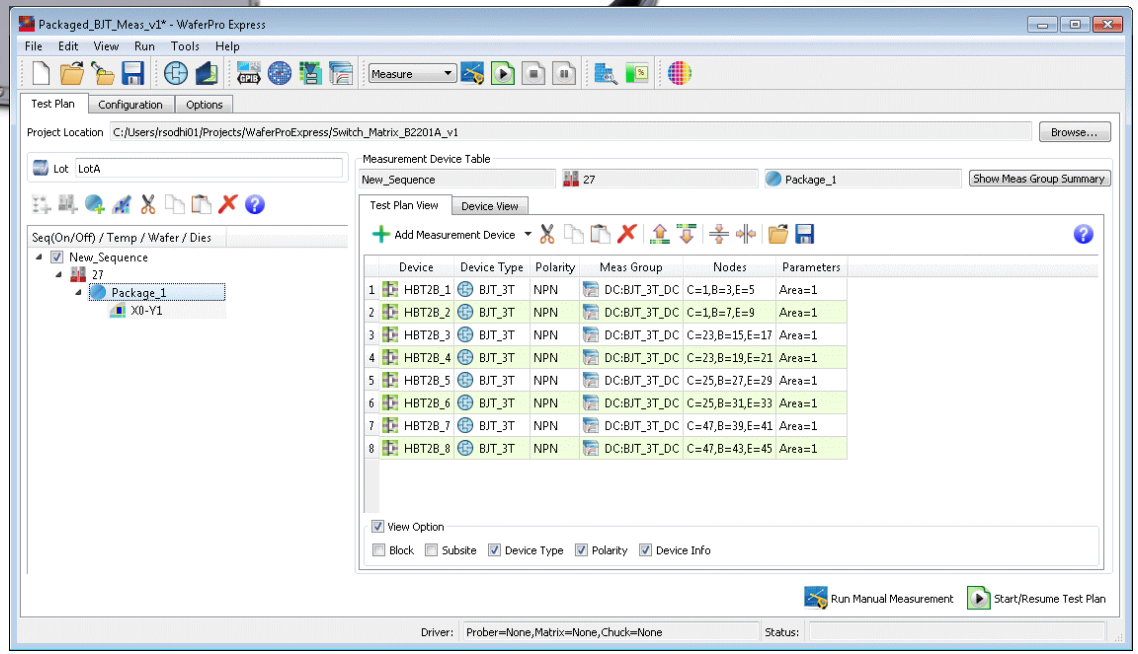
Sense Pin = Force Pin + Offset
(where Offset = 1)

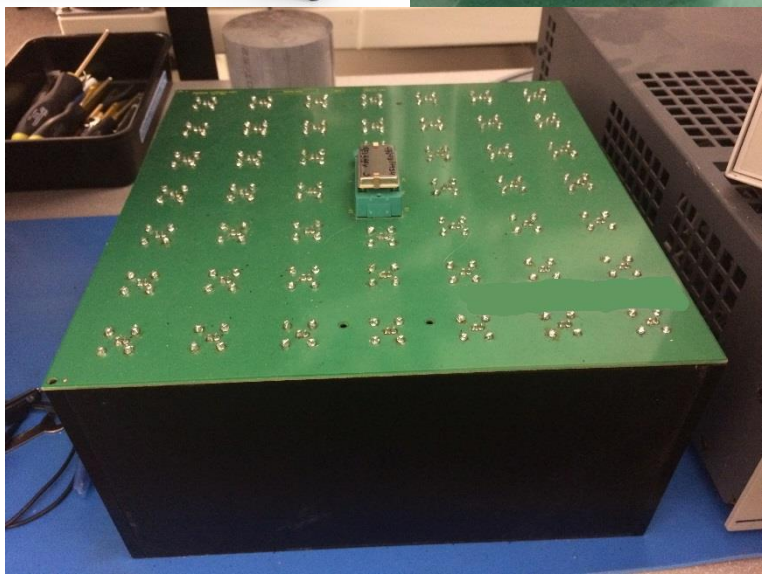
Measurement Log



→ double-click any one of these to get all of the plots for that device


MultiPlot:2
File
Options
Plots
Help
Output Ic
Ic [E-6]
Vce [E+0]
Plot Routine/BJT_DC/Output/Output_Ic
Output Ie
Ie [E-3]
Vce [E+0]
Plot Routine/BJT_DC/Output/Output_Ie
Output Vbe
Vbe [E-3]
Vce [E+0]
Plot Routine/BJT_DC/Output/Output_Vbe
Gummel Plot
Ic [LOG]
Vbe [E+0]
Plot Routine/BJT_DC/Ic_vs_Vbe_Gummel/Gummel_Plot
Beta vs Vbe
Current Gain [E+0]
Vbe [E+0]
Plot Routine/BJT_DC/Ic_vs_Vbe_Gummel/Beta_Vbe
Beta vs Ic
Current Gain [E+0]
Ic [LOG]
Gummel Plot
Ic [LOG]
Ib [LOG]
Plot Routine/BJT_DC/Ic_vs_Ib_Gummel/Gummel_Plot
Beta vs Ib
Current Gain [E+0]
Ib [LOG]
Plot Routine/BJT_DC/Ic_vs_Ib_Gummel/Beta_Vbe
Beta vs Ic
Current Gain [E+0]
Ic [LOG]
Plot Routine/BJT_DC/Ic_vs_Ib_Gummel/Beta_Ic
Date = Oct 26 Wed 13:50:51 2016
Version = WaferPro.2016.04
Bench = WX-ABench
Temperature = 27
Lot = LotA
Operator =
Reticle =
Wafer = Wafer_1
Die = X0-Y1
DieList = WX_TargetDies_1
Block = WholeDie
Subsite = Subsite_1
Routine = BJT_DC
MeasCond = WX_DC_BJT_3T_DC
Device = 5
DeviceName = HBT2B_5
DevTechno = BJT_3T
DevPolarity = NPN
Area = 1.000
Result = OK





KEYSIGHT TECHNOLOGIES

Where to Learn More

Keysight.com, Videos, Knowledge Center, etc.

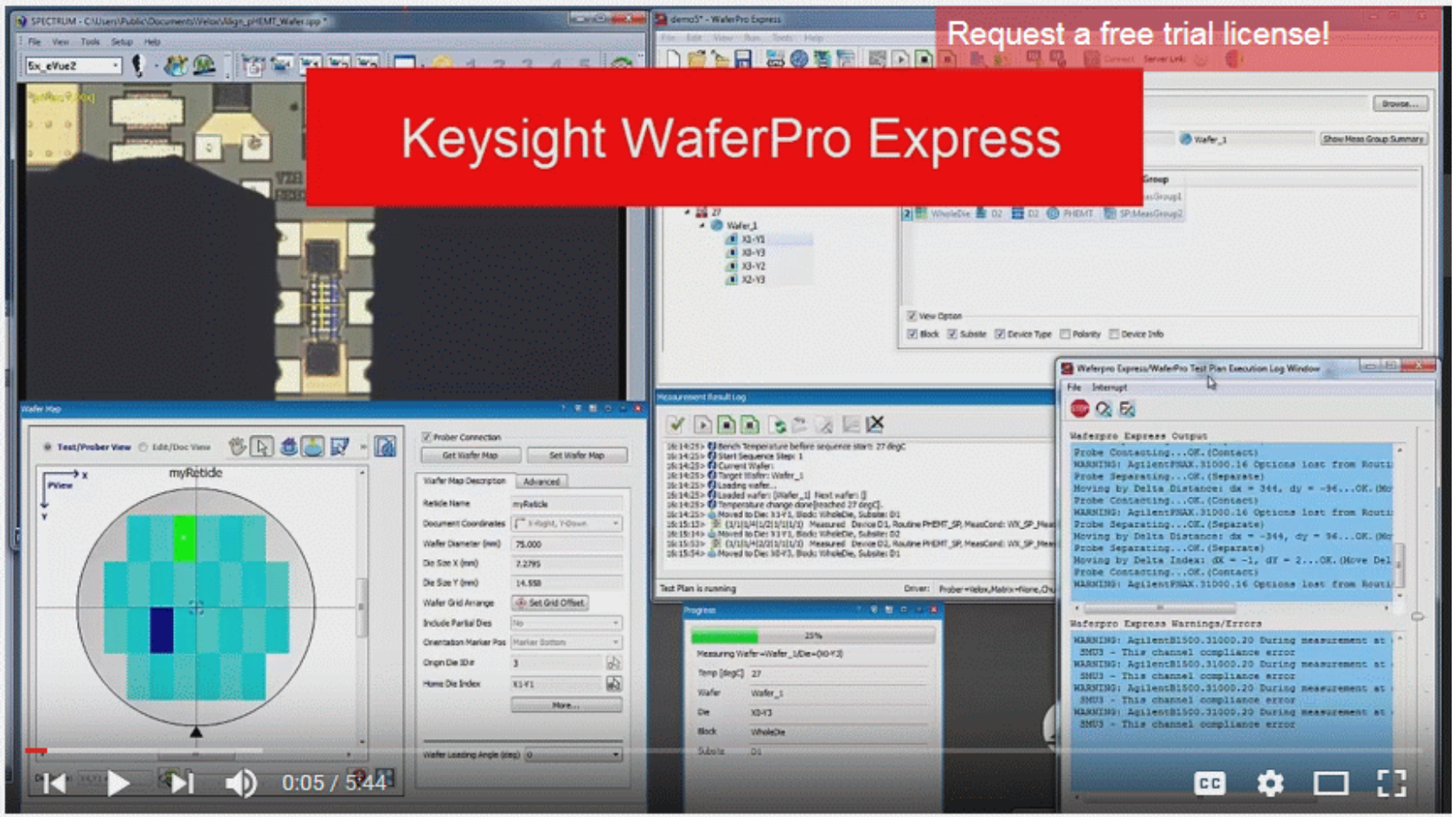
WaferPro Express

Knowledge Center

For questions, call:

Keysight Support

+1 800 829-4444



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