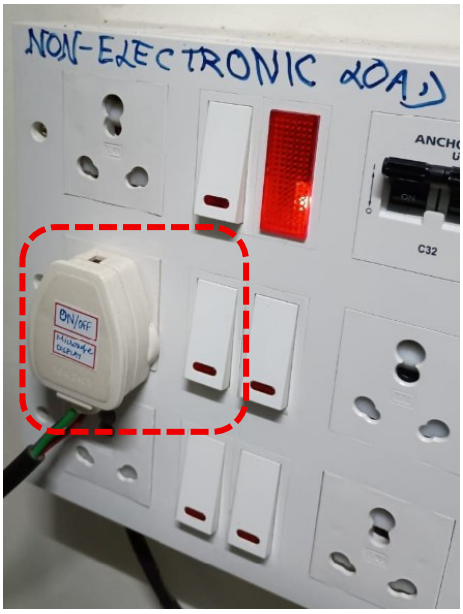
SOP for PDCS

(Power Device Characterization System)

Part 1: Device Characterization – On-Wafer Device Measurements

A) System Initialization

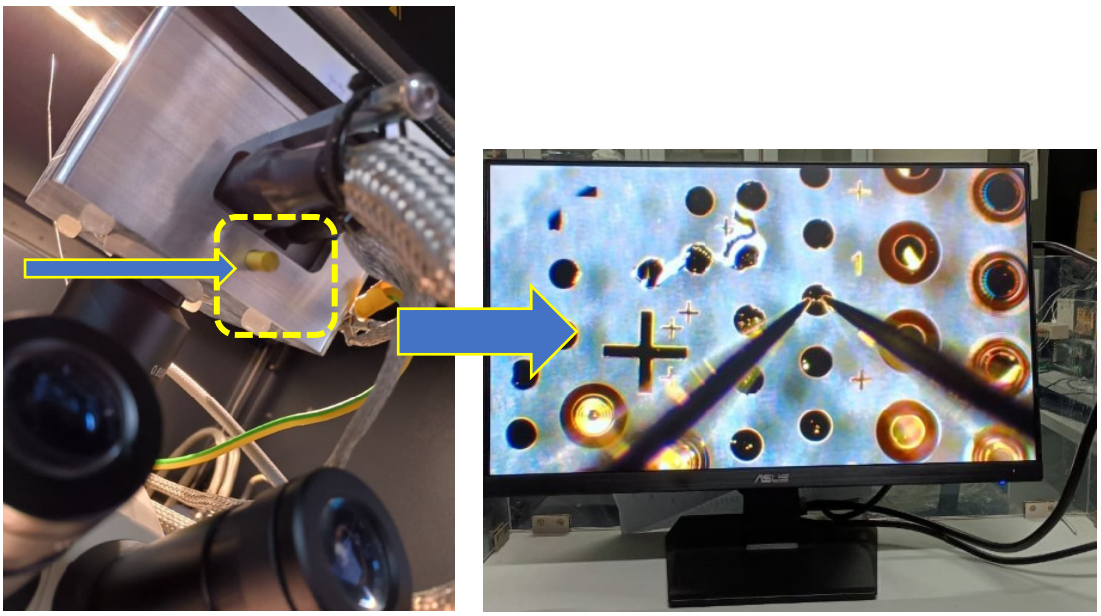
1. Switch ON/OFF the button on the *Non-Electronic Board* located behind the B1505.
    - This controls the microscope, illumination light, and vacuum pump used to hold the wafer on the chuck. (ref-IMG-1)



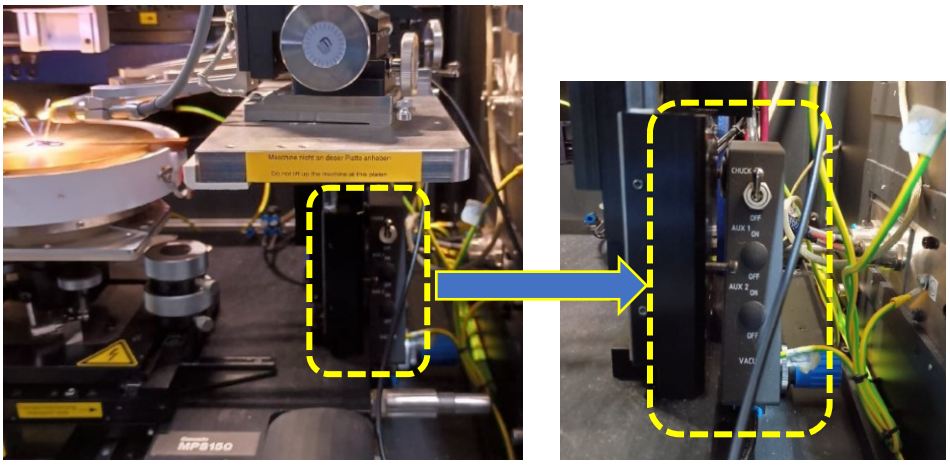
2. Operate the shutter using the knob labeled “Open <-> Close.”

3. Activate the display using the small yellow lever to visualize the probed devices on the monitor.
    - This allows probing independently of **direct microscope viewing**.

- To activate: press the yellow lid gently inward and pull back (located at the top of the microscope). (ref-IMG-2)



4. Check probe condition.
    - If probes are bent, replace them with spares available in the PDCS shelf (only if trained).
5. Place the sample at the centre of the chuck.
    - Use the appropriate vacuum button (out of three available) depending on the sample size. (ref-IMG-3)

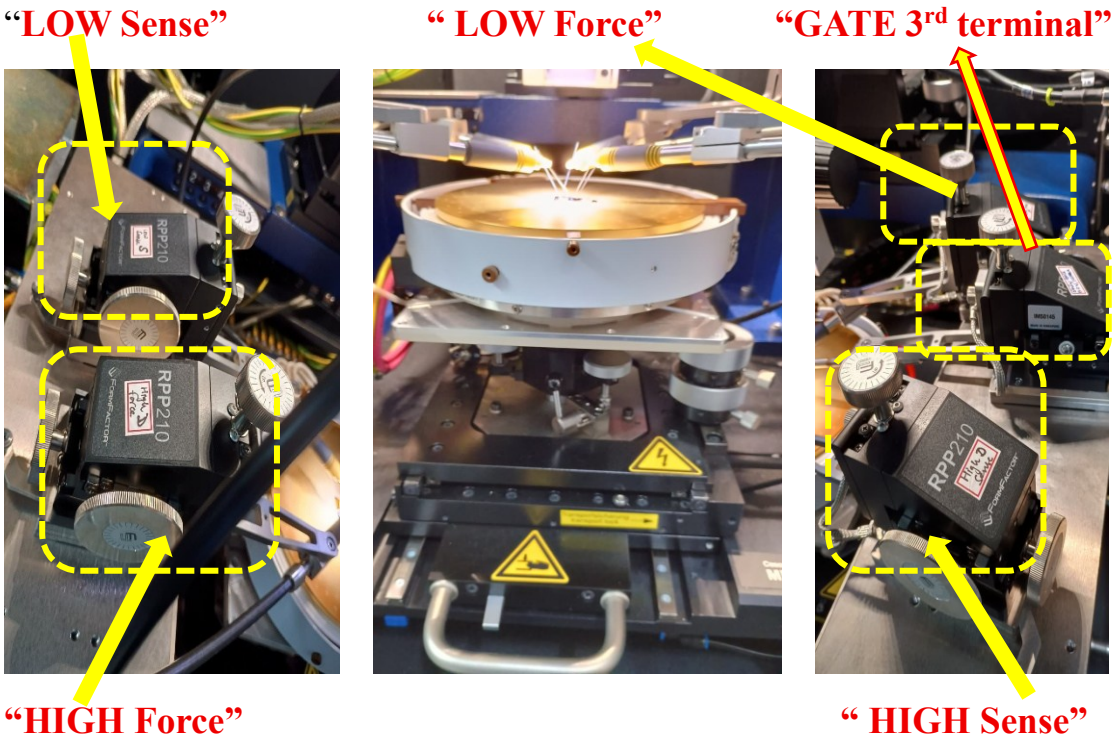


    - Note: Do not probe before performing system calibration (see Section B, Point i).

Important Notice 1

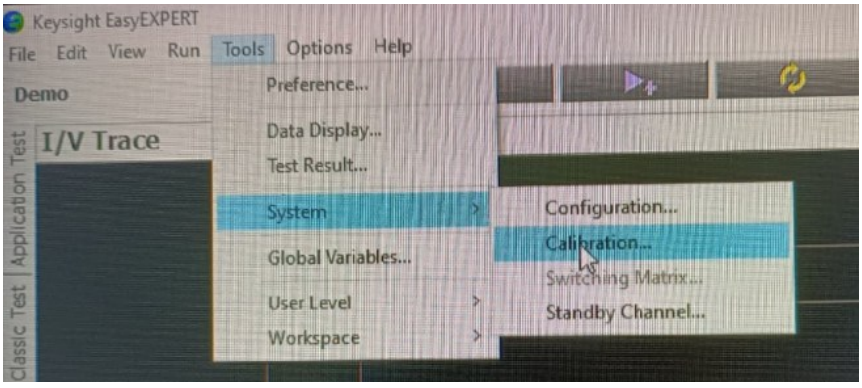
In PDCS, the FORCE and SENSE probes are separate, unlike Proxima and Polaris systems where a single probe integrates both.

- Two probes are required per contact.
- Thus, four probes are needed for two-terminal device measurements. (ref-IMG-4)

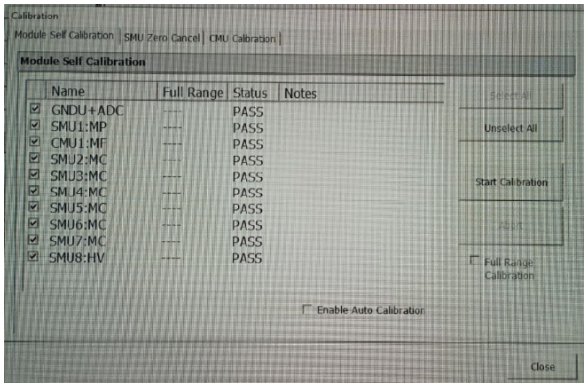


B) System Calibration & Open/Short Testing

1. Perform calibration using Keysight EasyEXPERT Tools → System Calibration Module.
    - Select Self-Calibration / CMU Calibration (for I–V and C–V measurements).



- Ensure PASS status for all SMUs, CMUs, and GNDs.



2. If any SMU fails calibration twice, restart the entire system as follows (**to be performed in the presence of the System Owner**):

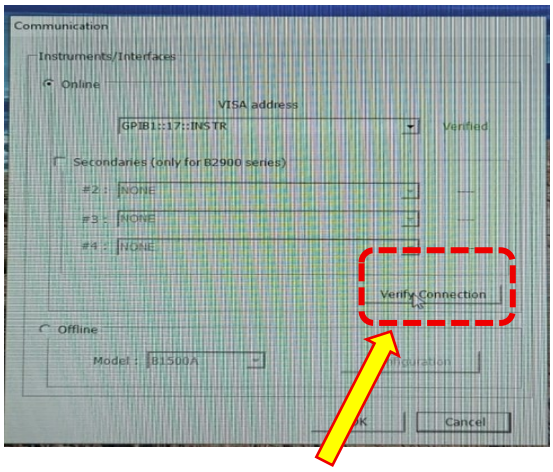
(a) On the PC: exit EasyEXPERT → B1505 System shutdown.

(b) On the B1505: shut down via front button → then switch OFF using the rear button.

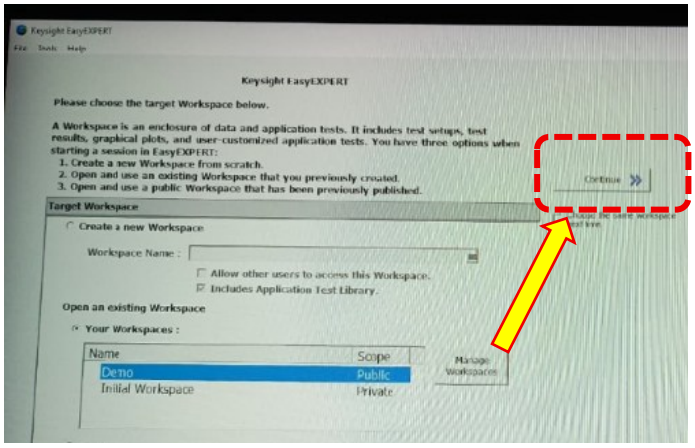
(c) Switch OFF the current and capacitance analyzers, followed by the *Electronic Board* and *Non-Electronic Board* (the latter controls only microscope, display, and illumination).

(d) Restart in reverse order:

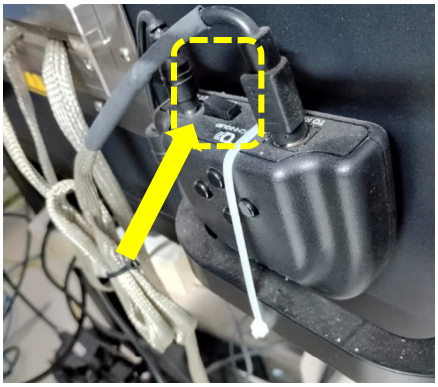
I. Switch ON the rear buttons → Power ON B1505 (front button).
II. Do not open EasyEXPERT from B1505; it launches automatically.
III. On the PC: verify GPIB connection (Options → Communication → GPIB → Verify connection should show **green** status).



IV. Start EasyEXPERT→ Continue, and wait for initialization. (ref-IMG-6)



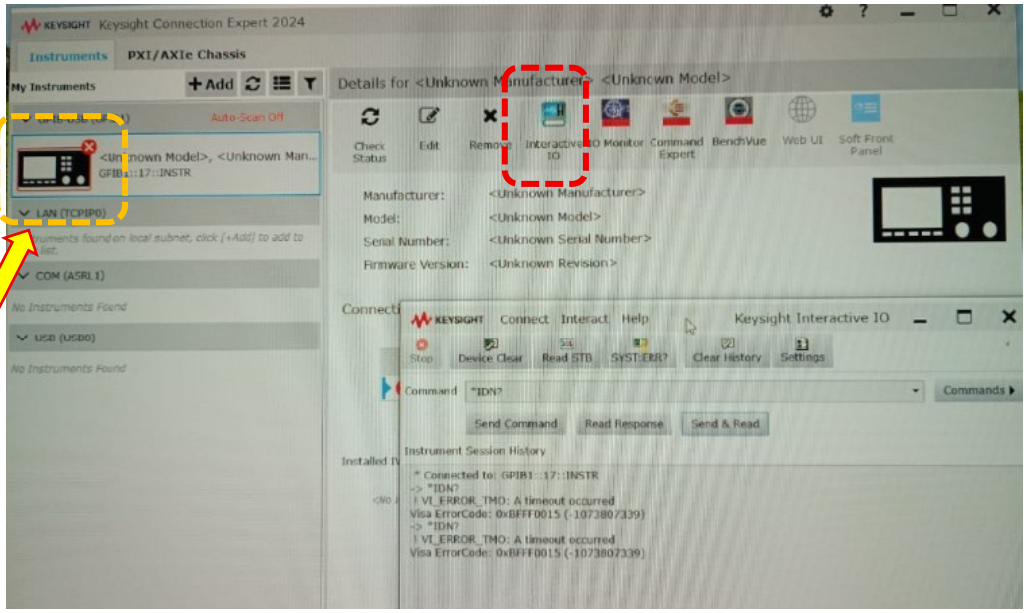
3. Open the I–V Sweep program.
    - Perform Open Circuit and Short Circuit checks.
    - Control illumination using the light button on the left-hand side of the probe station. (ref-IMG-7)



At this stage, the system is ready for measurements.

Troubleshooting GPIB Errors

- If GPIB error occurs:
    - Open Keysight Connection Expert (bottom-right system tray for hidden icons → **I/O** button).
    - Select Keysight **Interactive I/O** → click "**Send & Read**" until a green tick appears on GPIB-USB.
- If the issue persists:
    - Disconnect and reconnect the USB to the CPU.
    - Repeat the above procedure until communication is verified. (ref-IMG-8)



Measurements Setup (ref-IMG-9)

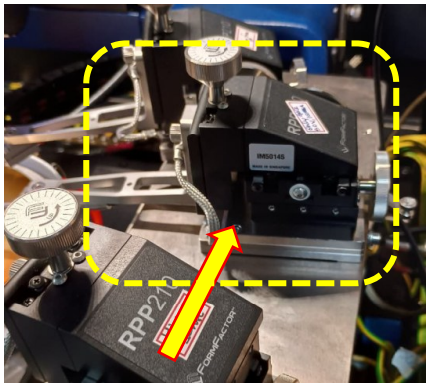
[Max. Reverse Voltage = 3 KV with 8 mA Compliance]

Current-voltage measurements

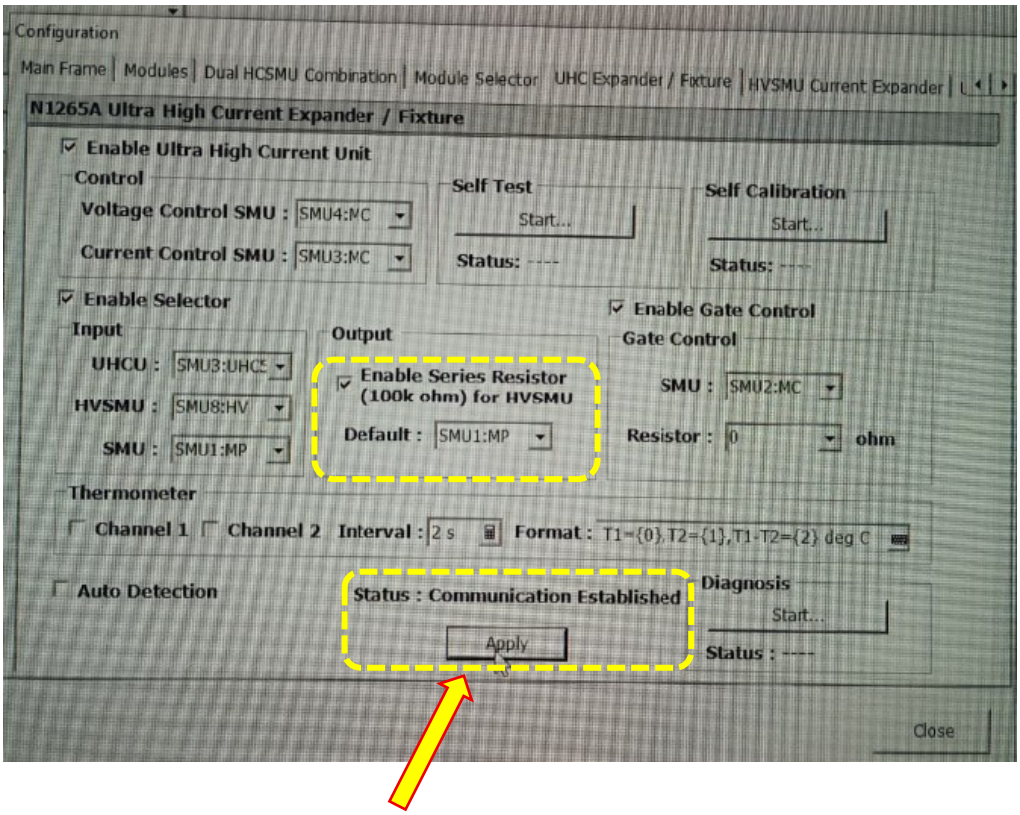
A1) For Lateral I–V measurements (Standard Connections, no need for SO presence):

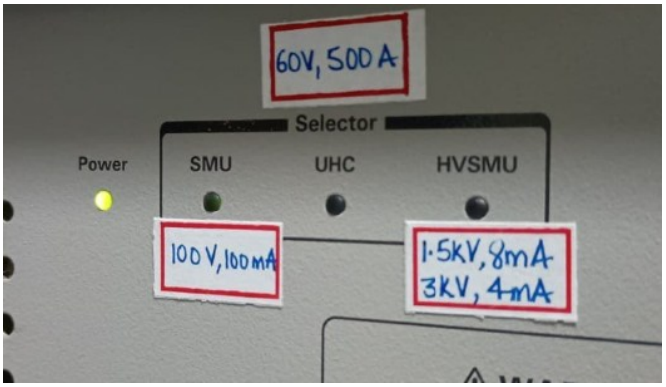
- Connect HIGH Force and HIGH Sense manipulators to the anode (top contact).
- Connect the LOW Force and the LOW Sense manipulators to the cathode (second contact).

2. For three-terminal devices (e.g., MOSFETs):
    - Use the GATE terminal (rated up to 50 V, 100 mA) as the third probe.



3. Open I–V Sweep mode for forward and reverse bias characterization.
4. Configure measurement units manually:
    - Forward bias: go to File → System → Configuration → UHC Expander/Fixture → select SMU1: MP (Medium Power) → Apply → wait for "Communication Established."





- Reverse bias: select SMU8: HP (High Power) → Apply → wait for confirmation.
- Note: Skipping this step may cause measurement issues. (ref-IMG-10)

5. Safety Requirement:

Keep probe station shutter closed during reverse bias measurement above 42 V.

Failure to do so will trigger an INTERLOCK error.

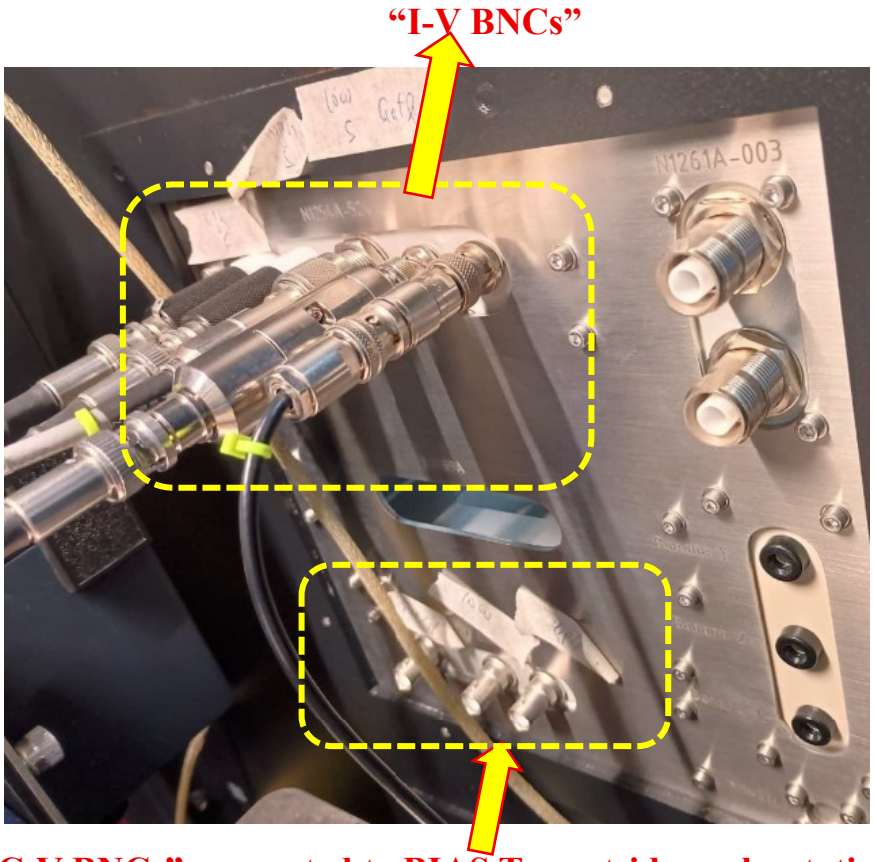
A2) For Vertical I–V measurements (Change of physical connections needed, Need for SO presence):

Chuck will be connected to the "SHV 5000 V/ 2A" setup box, where the red cable will be connected to the HIGH Force and HIGH Sense manipulators. The rest of the measurement is the same as lateral I-V measurements.

Capacitance-voltage measurements

B1) For Lateral C–V measurements (Change of physical connections needed, Need for SO presence):

1. Connect the "HIGH Force" manipulator to the HIGH of the C-V cable plugs on the RHS inside the probe station (ref-IMG-11).



2. Similarly, the "LOW force" manipulator to the LOW of the C-V cable plugs as shown in the picture via BNC connectors, known as "BIAS Tee".
3. Then proceed with the C-V measurement from the saved program "C-V Sweep"
4. Here, 2 options are there: a) With HMSMU, if needed SMU8
5. Here, 2 options are there: a) Connecting and, b) With HMSMU, If needed SMU8, which needs HVSMU cable to connect to Probe station by removing the "Ultra High Current Expander" (not recommended personally as the C-V generally happens at lower voltages)'

B2) For Vertical C–V measurements (Change of physical connections needed, Need for SO presence):

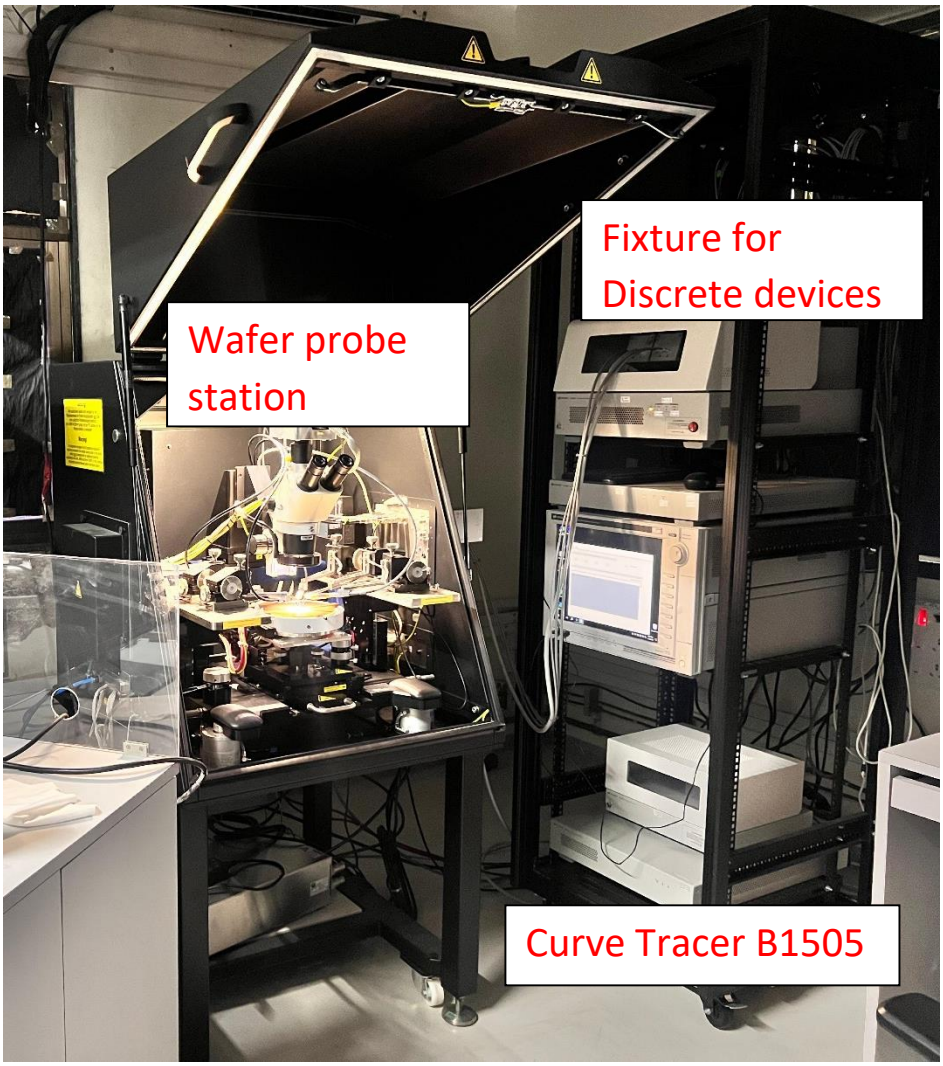
1. Connect the "HIGH and LOW Force" manipulators to the HIGH and LOW BNC connectors of the "BIAS Tee" for the C-V cable plugs on the RHS inside the probe station (as previously mentioned in ref-IMG-11).
2. Followed by the HVSMU cable from UH- Current Expander (N1265A) to Probe station via high-voltage BIAS Tee (N1260A).

Post-Measurement Protocol

- The Sample needs to be taken only after:
    - i) Unprobing the devices and keeping enough vertical and lateral distance between the probes
    - ii) The vacuum pump should be off locally (button is under the manipulator table)
    - iii) Sample chuck should not be done Up/Down, it needs to be in the Up position only (Just the probes height needs to be adjusted via manipulators).
    - iv) Take the sample out using the Stage movement given below the chuck holder on RHS with care and re-centre the chuck/stage back to it centre position.
- Close the switch on the non-electronic button using the turn ON/OFF button.
- Close the shutter carefully slowly.
- Send you data via email, do not use any CD/Pendrive in the system.
- After each measurement session, the user must update both the offline logbook and the online logbook with experiment details.
- If any error persists, please approach the System Owner (SO) before trying anything on your own. Also, mention the error in the Logbook.

Device Characterization: Discrete device measurements using Curve tracer

Setup:

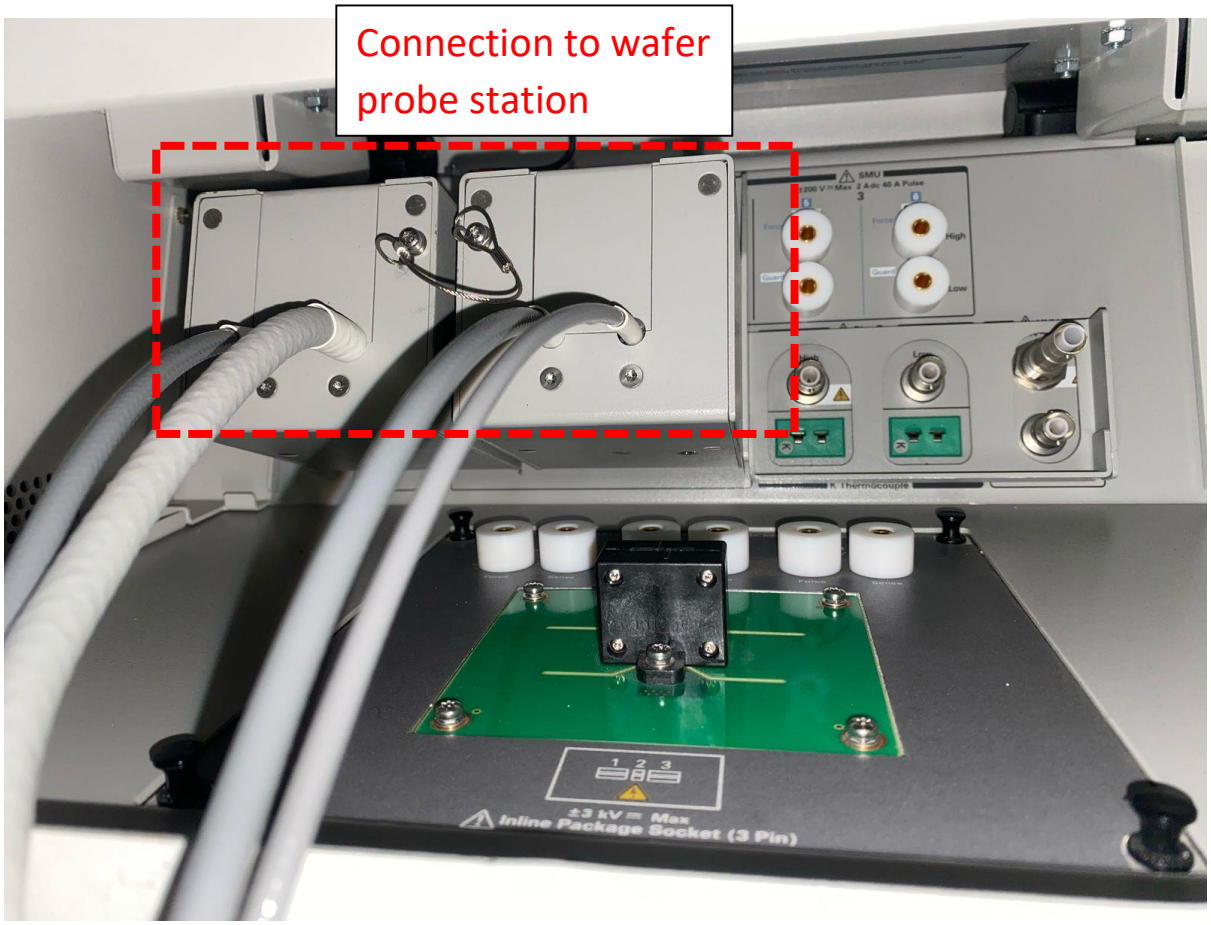


1. Curve Tracer B1505
2. Fixture for Discrete device characterization
3. Wafer probe station (for wafer characterization).

Note: Make the entry in the logbook before starting the measurements and revert back the any changes made before starting the measurements. If you see any error popup in measurement, please mention it in the logbook

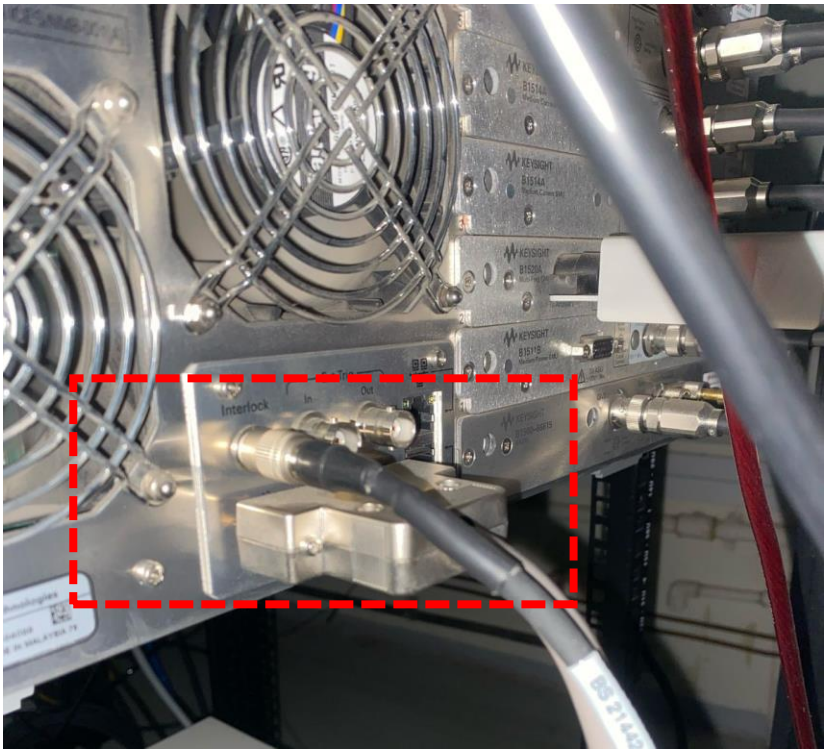
Required changes in setup for Discrete device:

1. Changes in Fixture Connection:
   Fixture is already connected for wafer measurements as shown below,

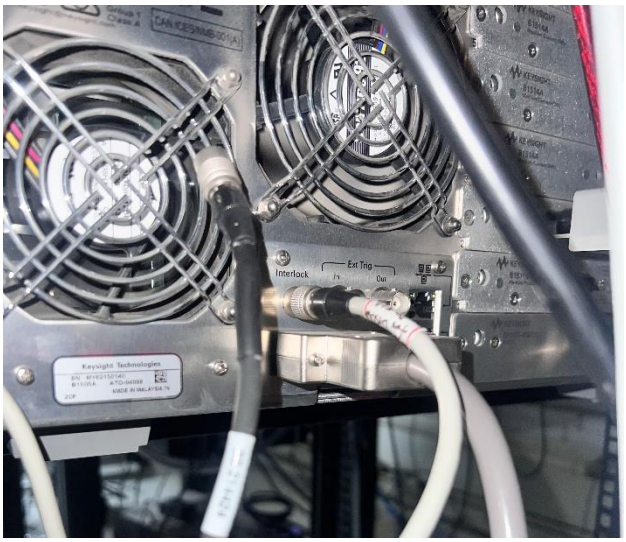


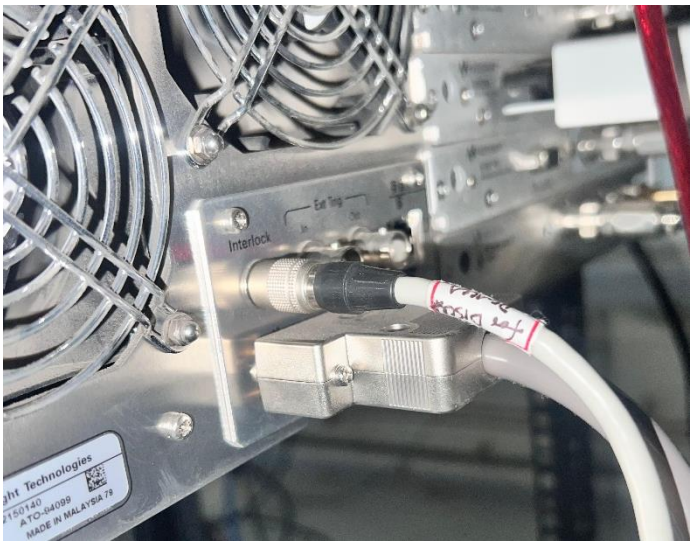
Setp 1. Using both hands remove the connections (shown in figure) of wafer probe station slowly and gently and keep it on the ground near to wafer probe station

Step 2. On the backside of Curve tracer, interlock connection for wafer station is connected as shown below,



Change the interlock connection for discrete device measurement as shown below,



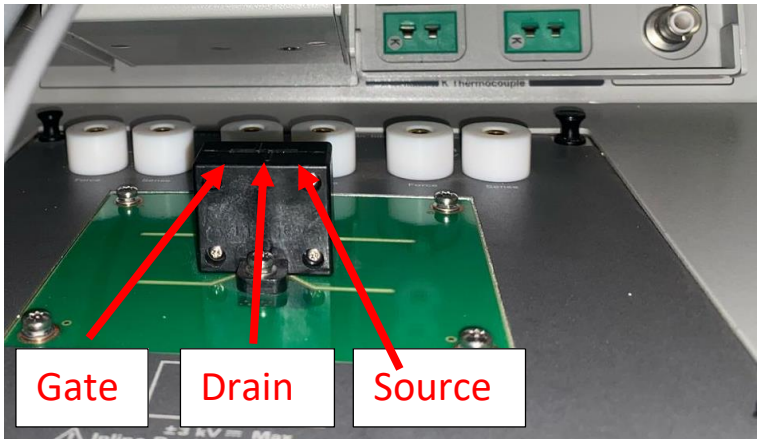


For Wafer Interlock: Black Cable

For Discrete interlock: White Cable (mentioned on sticker attached to cable)

Connections for Discrete devices (TO 247/TO 220)

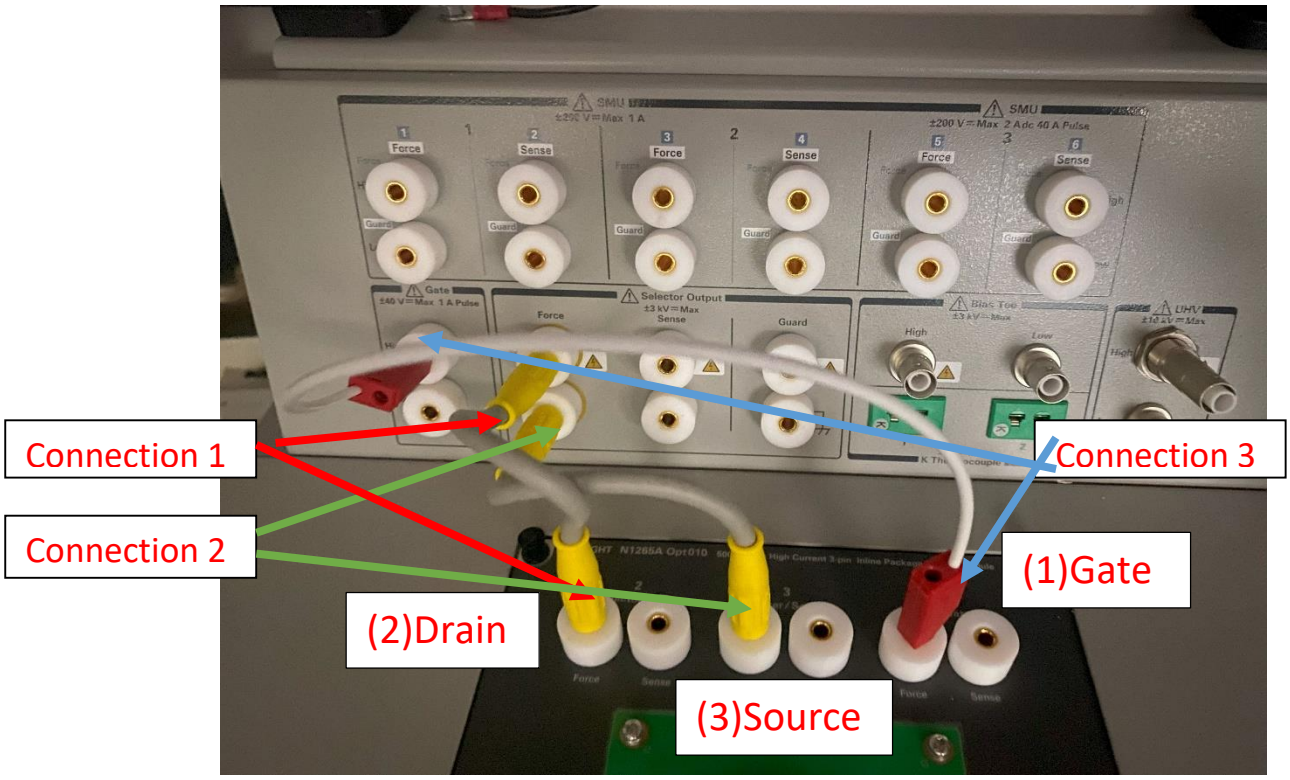
Discrete devices are connected to fixture as shown in figure below,



Terminals from Front View 1) Gate 2) Drain 3) Source

Steps to connect cables to curve tracer:

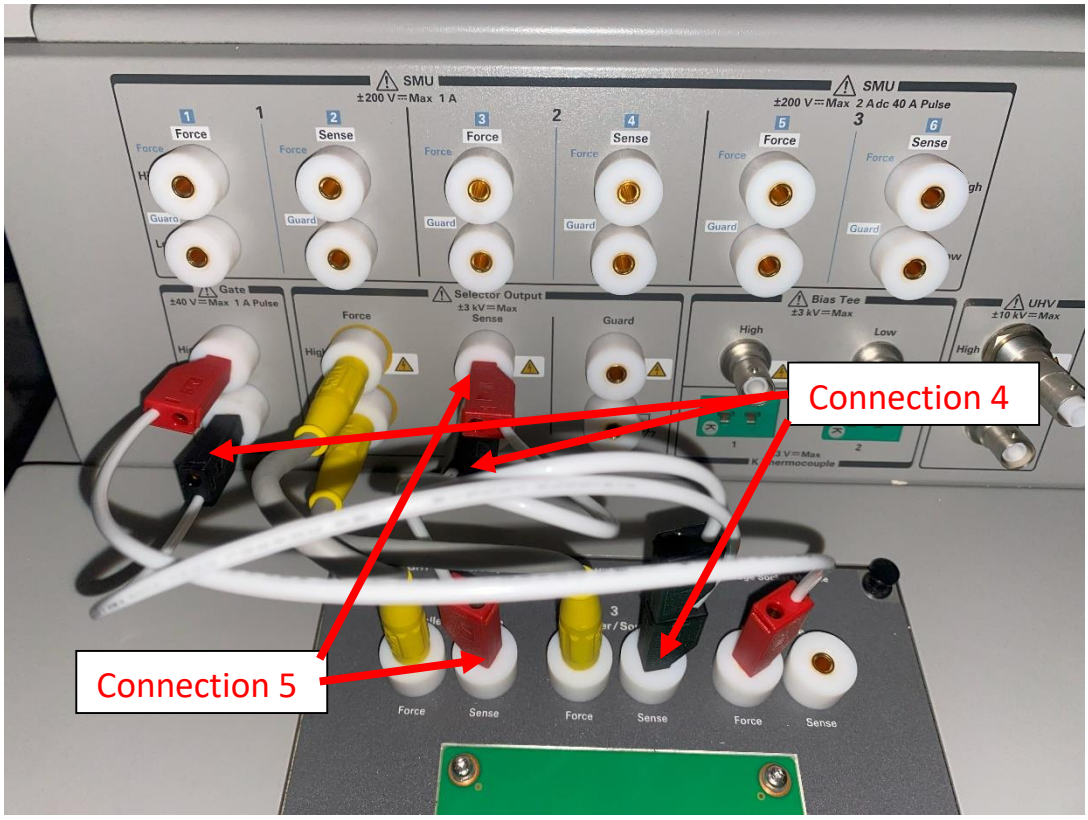
Step1:
Connection 1. Connect Drain to force high
Connection 2. Source to force low
Connection 3. Connect gate force to gate.



Connection 4: Connect Source sense (two cables) to →

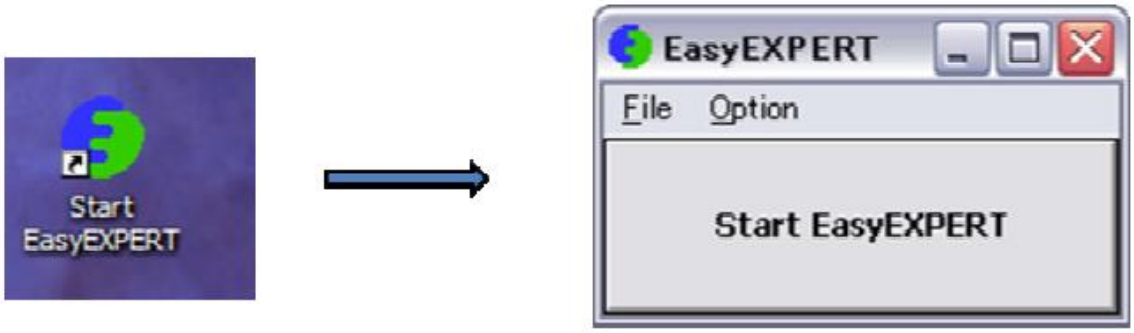
1) sense low and 2) Gate low

Connection 5: Connect Drain sense to Sense high



Using Easy Expert Software for measurements:

After connecting the cables, power on the B1505A. lick "Start EasyEXPERT" icon and then start the EasyEXPERT software by pressing the "Start EasyEXPERT" button.



Instruction for creating a new Workspace:

Follow the next steps for creating a new workspace:

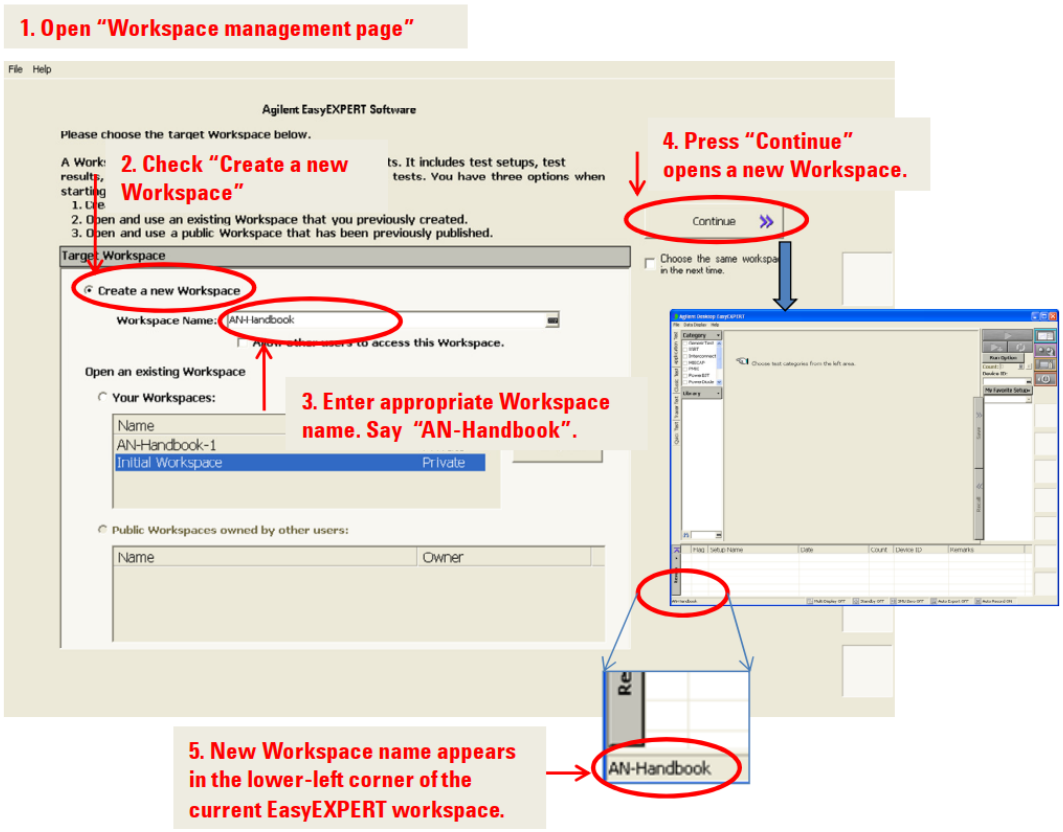
Step 1. Open the Workspace management window as shown in the figure below

Step 2. Check “Create a new Workspace”

Step 3. Enter appropriate Workspace name. Say “AN-Handbook”.

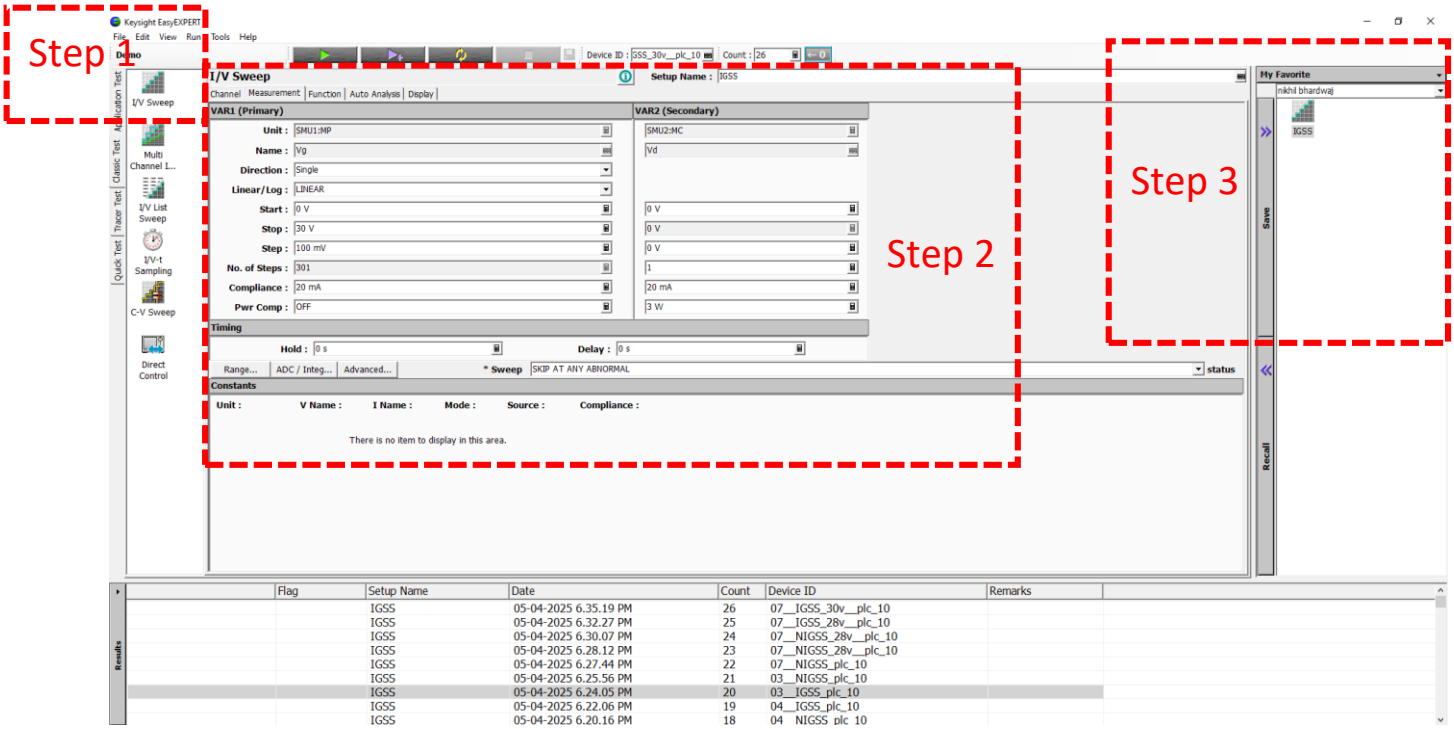
Step 4. Pressing “Continue” opens a new Workspace.

Step 5. New Workspace name appears in the lower-left corner of the current EasyEXPERT workspace.



General Idea of measurement using the EasyEXPERT software

1. IGSS measurement:

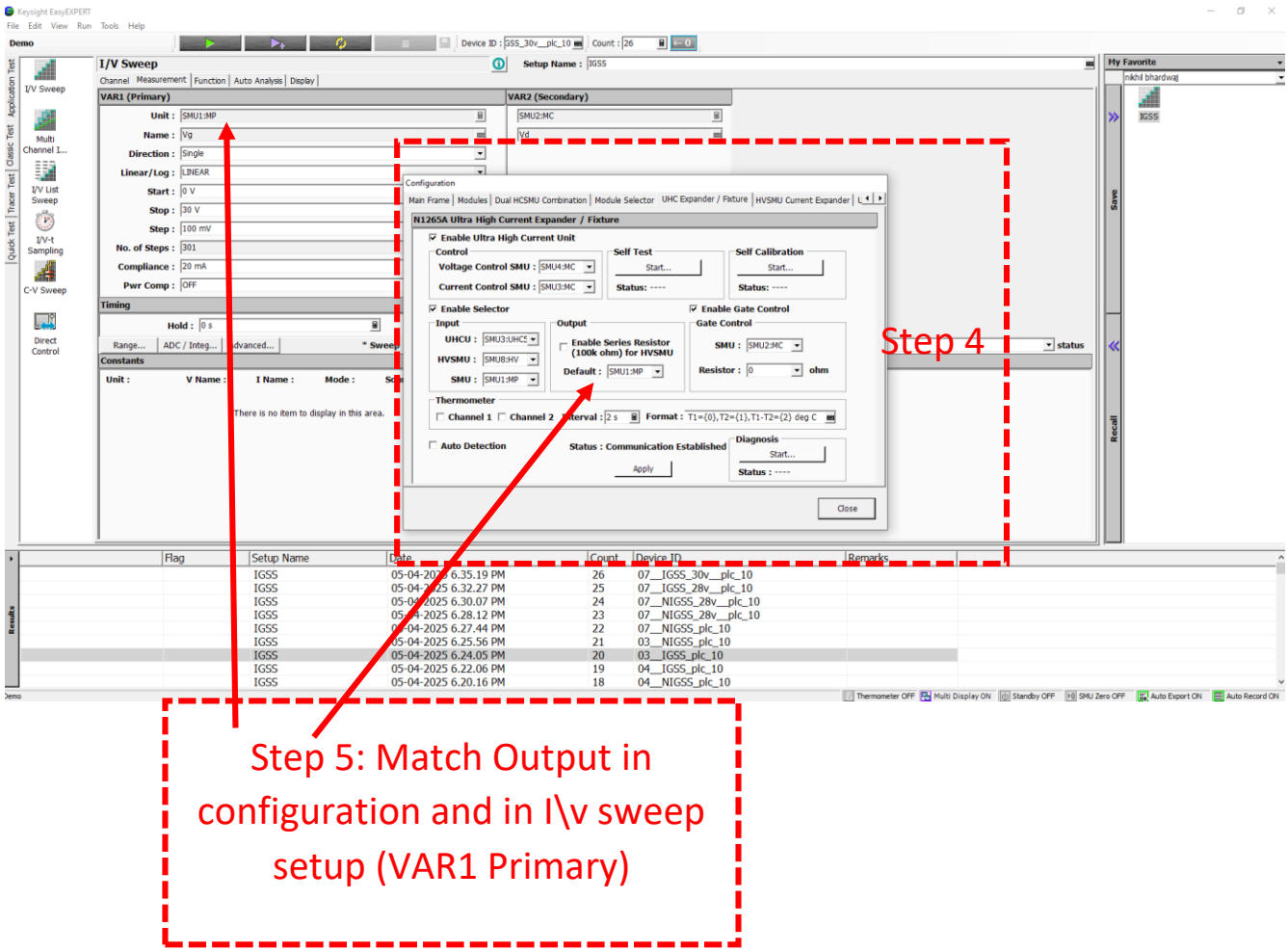


Step 1: From the Left side panel, and choose I\V sweep (for igss, idss, I\V)

Step 2: For IGSS measurement, define the parameters as mentioned in above figure

Step 3: To save the measurement setup, first make a new folder (right side bar : my favourite) and press Save option

Step 4: Configure the SMU setting, as shown in below figure,



Step 5: Match Output in configuration and in I\v sweep setup (VAR1 Primary)

Step 6: Set NPLC (averaging of igss) as shown in figure below

Step 7: run the measurement

Step 8: Save the file in the desired folder by exporting (right click and export the data)

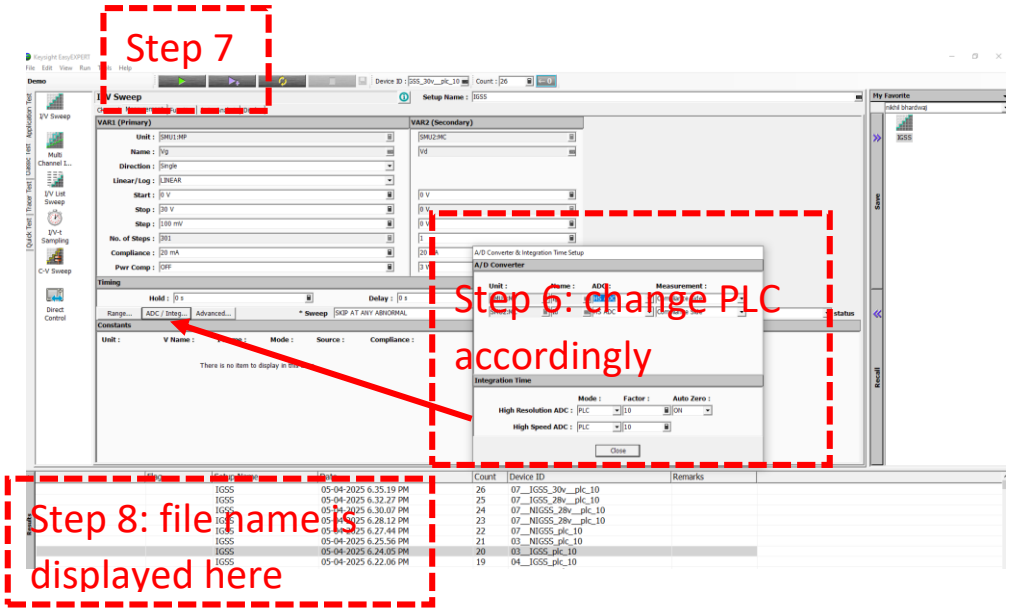
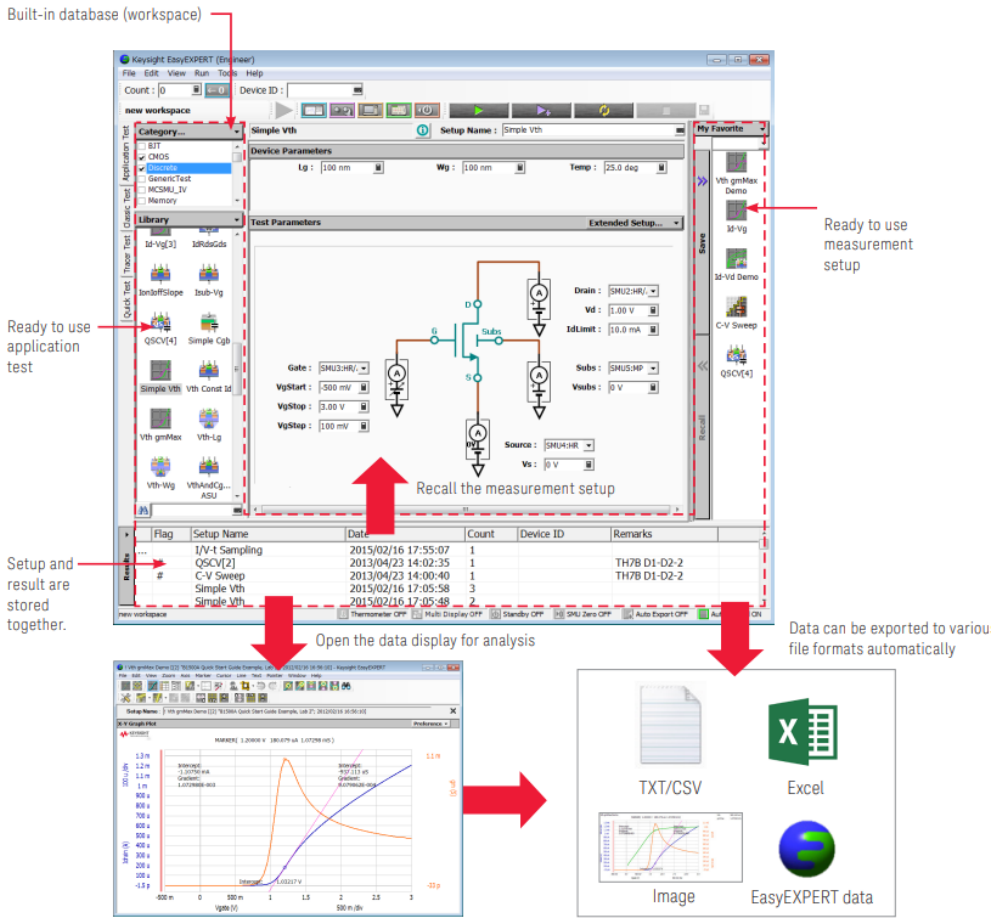


Figure below shows the overall setup (schematic) of IGSS measurement



Similarly other measurements can be done by configuring the setup(only change required is change in setup and configuration step)

I\V measurement: