MPI TS150 Manual Probe Station


1. Introduction

Prober station are used for electrical testing of devices produced on wafers or dies. Prober is not suitable for sheet resistance measurement of unpatterning conducting layer. Probe station available in CMI is a very basic tool equipped with 4 tips, simple optics (binocular) and a DC parameter analyzer. This user manual explains how to operate the MPI TS150 probe station to perform electrical characterization of your wafer/chips with AGILENT 4155B parameter analyzer.

2. Login & System Preparation

- Login on “MPI TS150 – Manual prober” with CAE on zone 11 (BM+1) accounting computer
  Proper operation of XY stage –and microscope is enabled by your login
- Setup overview

New (from April 2021) prober station setup (older Süss PM8 removed from cleanroom):
Binocular optics with LED 4 segments illumination and CCD camera
New stable and precise MPI micromanipulators with W probes
• Switch on the Agilent 4155C parameter analyser and the light illumination.

Switch Agilent 4155C power on. Auto-calibration and test is started

After completion of the Agilent auto-calibration open Expert Graphical interface

• and load a workspace (see section 5)
• Select the public workspace named “setup_test” and click on continue…

Alternatively, TP-Micro can be used as a back-up.

3. Prepare prober for loading.

Before loading a sample on the chuck please check for:
  Check for the lever position to be set to “Up 3mm” and locked
  If not move platform to the upper level
  Check the z position of all manipulator.

Sample (or Chuck) vertical distance control on the left side shown at 3mm distance. Rotate lever to lock for safe loading operation.

For all micromanipulators check z-tip position to be upper the middle position marker as shown in this picture. (green area)
• Micro-manipulator and probes:
  Contact tips are mounted on precision XYZ micro-manipulator MP25. Up to 4 tips are available any time. For critical application, additional probes can be ordered online to be mounted on separate coaxial arm as a service (material will be shared free of charge for a limited period of time).

| Before loading a sample: Manipulator can be moved or slipped to a new position which fits your sample/contact position. Toggle the magnetic clamping Off/On to reduce the magnetic force for moving. | Load sample in the middle of the chuck and fix it (Chuck on) Move chuck and center your sample under the optics | Unlock the platform lever on the left side. Move lever in the middle position to leave tips about 300µm distance. Adjust z-tip distance to sample using the tips image mirrored by your sample. Keep gap open. |
- Move binocular optics and focus

Unlock the Scope and use handler at the back left-side of the optics to view the area of interest (AOI).

Lock the scope in position. Zoom and focus on the sample. Move chuck or tips with fine movement screws. Tip and tip image mirrored in the sample should be at focus together with sample. If not reduce gap distance.

- Probing (find contact)

Use probes only for clean of residues electrical contact.

Move down the lever position to “Contact” Tips should be closer to the surface. Move x-y micro-positioner or Chuck fine movement only if the mirrored image don’t merge with direct tip image. Move z micro-positioner until slight lateral movement of the tip is detected (landing on conducting pad).

Repeat landing operation for each contact. Do not forget to move platform lever to the middle position before moving the chuck! Moving the optics is safe. No need to to move the platform up.

Go to next step (section 4)
4. Probe Connection Set-up

The Agilent 4155C parameter analyser provides 4 Source/Measure Units (SMU) for signal input or output. These are labelled SMU1 to SMU4. A switching box with 6 positions is available to manage electrical connections between the probes and the SMUs, which allows rapid switching of predefined software configurations/applications. Probes arm and cable are coaxial (voltage follower outside – measurement central wire) and SMUs are triaxial (ground guard – voltage follower shield- measurement central wire). A connection box provides an easy and flexible transition from Triax (SMU standard) to Coax connectors (probes).

![Agilent 4155C Triaxial to BNC coaxial manual connection box.](image)

**Default connection for Easy Expert/Agilent 4155C (switch in position “IV”)**

<table>
<thead>
<tr>
<th>Triax</th>
<th>Coax</th>
<th>Assignment for RES2 program</th>
<th>Assignment for RES4 program</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMU1</td>
<td>BNC 9</td>
<td>Var 1 (High I)</td>
<td>Grounding (I low)</td>
</tr>
<tr>
<td>SMU2</td>
<td>BNC 7</td>
<td></td>
<td>Var 1 (High I)</td>
</tr>
<tr>
<td>SMU3</td>
<td>BNC 8</td>
<td>Low (grounding)</td>
<td>Low Pot</td>
</tr>
<tr>
<td>SMU4</td>
<td>BNC 11</td>
<td></td>
<td>High Pot</td>
</tr>
</tbody>
</table>

- Switch rotating knob to position “IV” for default assignment
- Connect probe’s cables in use to BNC connectors accordingly to the above configuration list. Pay attention to the color code at each end to identify probes or chuck contact.
- Assignment for current resistance measurement (quick test “2020” group) are listed in above configuration list.
Assignments for previous program version

Optional: Switching matrix table for compatibility with older measurement library
Rapid switching of predefined quick test “Old” preset group

Position I: Field effect transistor, with substrate contact on top (probe tip)

<table>
<thead>
<tr>
<th>FET</th>
<th>BNC7</th>
<th>BNC8</th>
<th>BNC9</th>
<th>BNC10</th>
<th>BNC11</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMU1</td>
<td></td>
<td></td>
<td>BNC9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMU2</td>
<td>Drain (Var1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMU3</td>
<td>Gate (Var2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMU4</td>
<td></td>
<td></td>
<td></td>
<td>SUB (Pot)</td>
<td></td>
</tr>
</tbody>
</table>

Position II: Field effect transistor, with substrate contact on the chuck (conductive substrate)

<table>
<thead>
<tr>
<th>FET</th>
<th>BNC7</th>
<th>BNC8</th>
<th>BNC9</th>
<th>BNC10</th>
<th>BNC11</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMU1</td>
<td></td>
<td></td>
<td>BNC9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMU2</td>
<td>Drain (Var1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMU3</td>
<td>Gate (Var2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMU4</td>
<td></td>
<td></td>
<td></td>
<td>SUB (Pot)</td>
<td></td>
</tr>
</tbody>
</table>

Position III: Diode VF-ID, 2-points resistance

<table>
<thead>
<tr>
<th>RES2</th>
<th>BNC7</th>
<th>BNC8</th>
<th>BNC9</th>
<th>BNC10</th>
<th>BNC11</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMU1</td>
<td>High (Var1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMU2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMU3</td>
<td></td>
<td>Low (Common)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMU4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Position IV: General 4-points measurement

<table>
<thead>
<tr>
<th>RES4</th>
<th>BNC7</th>
<th>BNC8</th>
<th>BNC9</th>
<th>BNC10</th>
<th>BNC11</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMU1</td>
<td></td>
<td>I low (Common)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMU2</td>
<td>I High (Var1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMU3</td>
<td>V Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMU4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>V High</td>
</tr>
</tbody>
</table>

Position V: Bipolar transistor, with substrate contact on the chuck (conductive substrate)

<table>
<thead>
<tr>
<th>BPT</th>
<th>BNC7</th>
<th>BNC8</th>
<th>BNC9</th>
<th>BNC10</th>
<th>BNC11</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMU1</td>
<td></td>
<td></td>
<td>Emitter (Common)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMU2</td>
<td>Base (Var2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMU3</td>
<td>Collector (Var1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMU4</td>
<td></td>
<td></td>
<td></td>
<td>SUB (Pot)</td>
<td></td>
</tr>
</tbody>
</table>

Position VI: Bipolar transistor, with substrate contact on top (probe tip)

<table>
<thead>
<tr>
<th>BPT</th>
<th>BNC7</th>
<th>BNC8</th>
<th>BNC9</th>
<th>BNC10</th>
<th>BNC11</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMU1</td>
<td></td>
<td></td>
<td>Emitter (Common)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMU2</td>
<td>Base (Var2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMU3</td>
<td>Collector (Var1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMU4</td>
<td></td>
<td></td>
<td></td>
<td>SUB (Pot)</td>
<td></td>
</tr>
</tbody>
</table>

Select the correct configuration with the knob in front of the switching box. Check the list above for available configurations.
5. EasyEXPERT Software Set-up

EasyExpert software is an application program to control Agilent 4155C. Benefit is easy set-up and automatic program and data transfer to the PV hard drive.

- Open Expert Graphical interface. If not yet started see section 2
  Both computer and analyzer must be turned power off in case Expert did not open for workspace selection.


Start-up screen.
- Select public workspace - Set-up or TP-Micro

Workspaces organisation at start-up.
- Quick test tab or “My Favorite setup” contains basic cleanroom programs

- Select preset group and program
- or Recall from Favorite
- The “Channel Setup” tab lets the user define each SMU's functionality. Simple applications are as follows:

**Application example:**

**2Pt_Res**

VAR 1 drives voltage.
SMU1 measures both VF and IF
COMMON CONST on SMU3 for device grounding
(V and I assigned but not used)

**Application example:**

**4Pt_Res**

VAR 1 drives voltage.
SMU2 measures both VF and IF
I CONST: create a voltage potential probe on SMU2 and 3
COMMON CONST on SMU1 for device grounding
(V and I assigned but not used)

- Next: Measurement Setup

**I/V Sweep**

- Define scan parameters
- Trust compliance protection
- Access to digital noise filter setup
“Function Setup” tab lets user defines additional functions for plots and records.

![Function Setup Tab](image)

Example of useful function definition. Alternatively dynamic resistance can be extracted using \( \text{diff}(V_F, I_F) \)

The “Display Setup” tab let user defines how to display the measurement's result.

![Display Setup Tab](image)

X-Y Graphic settings by new plot window creation (see next section). Further auto-scaling is available later after measurement.

List display control associated measurements recorded as a list for exporting results.

6. Taking & Saving Measurements

Once the parameter analyser is correctly set, the measurements are taken using the green “start” button:

![Start Button](image)

Alternatively, measurements can be appended to previous ones or ran continuously using the following buttons:

![Append & Continuous Buttons](image)
The measurement window will show up (on top of main window). Note in the main window the result table is updated at each single measurement with a new line. Count report for number of appended measurements in the same window.

Example:
Series of 2Pt_Res

Any plot can be loaded from result window for export or rework

Discover useful icon palette:
Auto scaling (first activate X/Ymode)
Marker to sweep into results simultaneously in plot window, list display and Index (using mouse or pointer)

Using Results list: Exporting with right clicking on the line and going to “Transport Data”.

Exported data should be transferred on cmi server (\lst1\files\cmi-transfert\your_folder).

Public workspace are purged for older measurements after 1 year.
7. **Logout**

- At the end of the measurement session, close the EasyEXPERT software.
- Move all micro-probe tips about 1mm up (above the medium z marker)
- Move probe platform at higher safety position.
- Slide chuck fully to front.
- Unload the wafer. Move chuck back under the optics.
- Turn off Agilent 4155C parameter analyzer and scope illumination.
- Logout off “MPI TS150 – Manual prober” with CAE on zone 11 (CMi+1) accounting computer.