

Physical Property Measurement System (PPMS) – Resistivity (DC)

All users must receive specific training for the Resistivity option regardless of training on other options. Reserve all necessary time in Coral and enable and disable when starting and finishing your experiment. Fill out a log sheet for each use.

The Resistivity option is used for making basic DC resistance measurements by applying a current and measuring the resulting voltage. Resistance measurements can also be made using the AC Transport option. Which option is more appropriate depends on several factors, including whether an AC signal is desirable/acceptable, the resistance of the device(s) to be tested, and the number of devices to be tested. Consult the system documentation and/or facility staff to help determine which option is appropriate. The three “transport...” PDF documents on the PPMS computer desktop are a particularly useful resource for making electronic transport measurements.

Sample Preparation

The Resistivity option performs a 4-point resistance measurement on up to 3 channels at a time. The standard Resistivity puck (see right) includes pre-mapped pads for + and – current and voltage for Channels 1 – 3. The recessed area measures 11.6 mm x 13.6 mm (with rounded corners), so samples that fit within this area will work best. The base is conducting, so an insulating layer such as Kapton tape will be necessary for samples with conductive back sides. Electrical contact between the sample and the desired channel input pads can be made via wire bonding, soldered or silver-painted wires, spring-loaded press contacts (consult staff on use of these), or other methods. Alternatively, samples can be mounted on the user puck, which has a blank face and no pre-configured channel set-up. This can be useful for larger samples or if no Resistivity pucks are available. The pin-to-channel correspondence for the user puck is posted on the bulletin board. The Resistivity or user puck can be used in combination with the User Bridge (the red face plate corresponds to the Resistivity option channels) to test sample-to-puck connections in advance of insertion into the PPMS using a hand-held ohm meter or other device.



Activation

1. In the MultiVu software, de-activate any other active option, and physically remove the cables/hardware as necessary according to the respective SOP.
2. Attach the Resistivity LEMO connector to the back of the probe head.
3. Click `Utilities - Activate Option...` and select and activate the Resistivity option. The Resistivity Option control window should appear if the option has been successfully activated.
4. If not immediately inserting a sample, insert the baffle/flange rod and clamp it in place, then purge and seal the system. Or, go to step 3 under Measurement Procedure to install a sample.

Measurement Procedure

Refer to Chapter 3 of the Resistivity manual for information on performing measurements. Once the option is activated, the Resistivity Option control window contains most commands needed to set up and perform a measurement. To insert a sample:

1. Click the `Install/Remove...` button and follow the on-screen instructions.
2. When the system is vented, remove the baffle/flange rod.
3. Visually verify that there is not a puck in the system, and if there is, remove it.
4. Place the puck in the puck insertion tool:
 - a. Flip the switch on the handle up to open the collar.

- b. Put the puck into the bottom of the tool, sample side first.
 - c. Hold the puck in place while flipping the switch down to lock the puck in place.
5. Using the tool, slowly lower the puck into the probe. When it reaches the bottom, rotate it until the key aligns with the key slot (this happens with the key facing forward), then press down to engage the pins. Do not press too hard – if the pins are not engaging properly, there may be damage which could be worsened.
6. Flip the switch on the tool up and withdraw the tool.
7. Replace the baffle/flange rod and finish the install procedure in the software to purge and seal the system.
8. Place the puck insertion tool back on the wire shelving unit.
9. Under the Datafile header, click `Browse...` and set up a file location and name. Once this is defined, you will be prompted to enter sample info for any channels to be used. This includes the length and cross-sectional area to be used in the resistivity calculation. Default values are 1 mm and 1 mm² respectively, and these can be left equal to have resistance reported rather than true resistivity.

When the sample is inserted, real-time resistance readings can be seen via the bridge set-up, which must be defined by clicking the `Bridge Setup...` button. In the subsequent window, parameters for each of the three channels (plus Channel 4, which is not used) can be specified. See page 2-10 of the Resistivity manual for details. Note that Channel Set dictates whether the excitation current is being applied or not, and that the measurement can be limited by any one of current, power, or voltage depending on the specific limits specified and the sample characteristics (the graph on page 2-12 provides a nice illustration of this). Despite the “DC” designation, all measurement excitations are actually single-pulse measurements at 60 Hz (corresponding to the input line frequency), and Drive Mode dictates whether this is a single positive pulse (DC) or a full-cycle bi-polar pulse (AC, which is the default). The right side of the window gives the “Status” of each channel – the specified parameters are applied whenever the channel is on, and the current and resistance are displayed.

For data to be saved, a “measurement” (as opposed to a simple real-time indication) must be made, either in immediate mode or as part of a sequence.

- Immediate measurements can be made by clicking the `Measure...` button and using the Resistivity Quick Measure window. The channel(s) to be measured and the number of readings to average are specified. Note that the bridge needs to be defined again within the measurement window by clicking `Bridge Setup...`. Click `Measure` to begin the measurement. Results are displayed and can be saved to the specified file (see above) by clicking `Save`.
- For information on setting up and running sequences, refer to the PPMS general instructions. Resistivity measurement commands are listed under “Resistivity” (click the + to expand the list of choices) and are similar to immediate measurements. The Resistivity measurement definition window again allows the bridge set-up to be defined using the Bridge Configuration tab, and the Data Fields tab allows the user to select what parameters and results (from both the measurement and the system hardware) will be saved to the file.

To change samples, set the system temperature to 300 K and the magnetic field to 0 Oe (persistent); this should be done at the end of each sequence, but can be done manually if necessary. Use the sample change sequence as described above (with slight differences for puck removal). When finished, the Resistivity option can be left active in the system.

De-activation and Removal

1. Set the system temperature to 300 K and the magnetic field to 0 Oe (persistent).
2. Click `Utilities - Activate Option...` and select and de-activate the Resistivity option.
3. Remove the Resistivity LEMO connector from the back of the probe and hang the LEMO connector from one of the hooks on the wall.