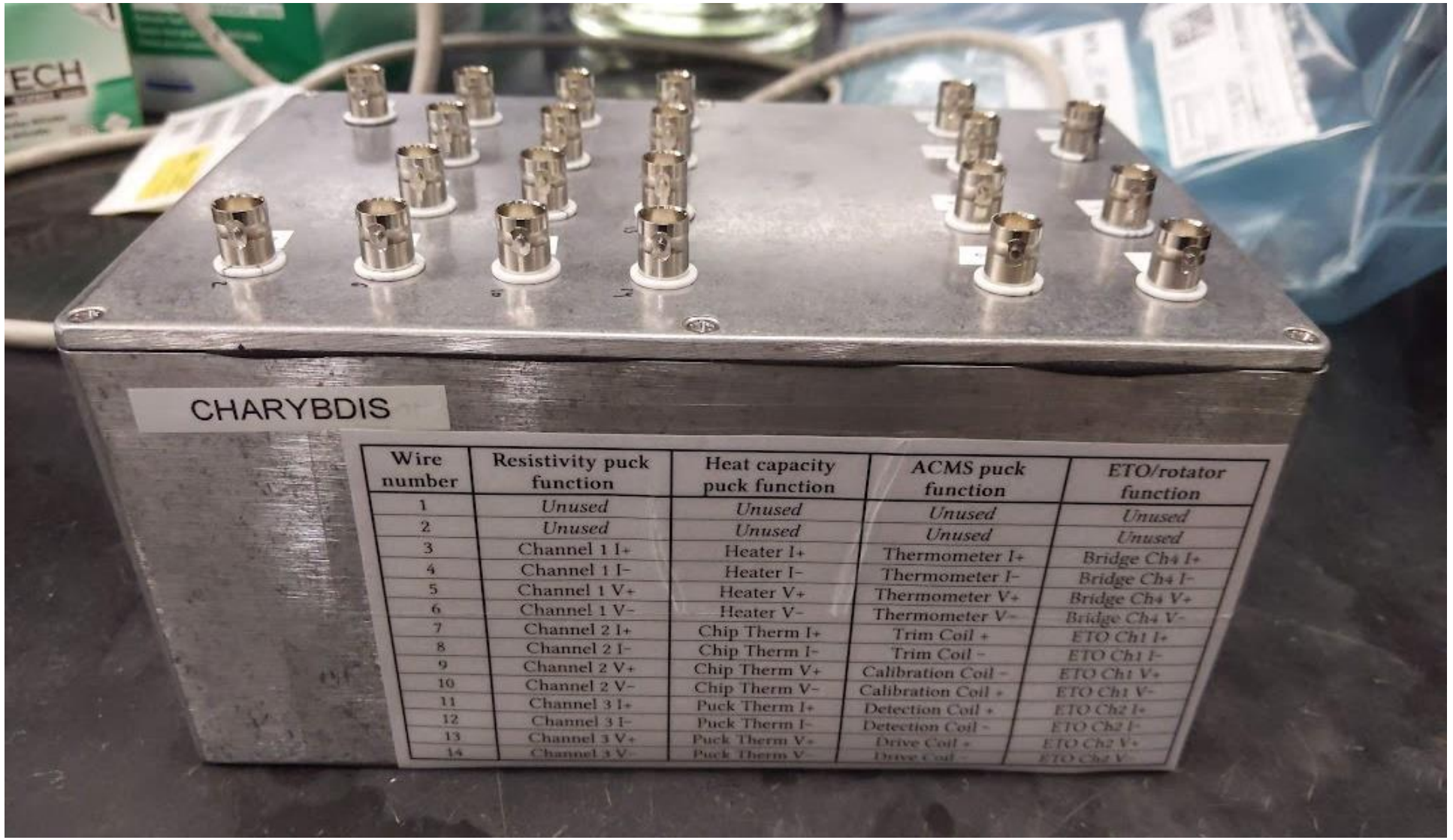
CHARYBDIS breakout box introduction

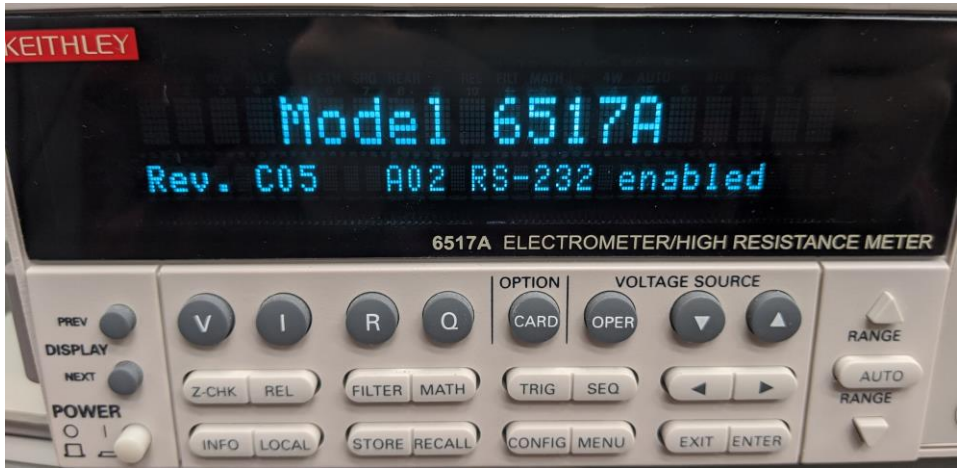
April 17, 2023


CHARYBDIS
Wire number | Resistivity puck function | Heat capacity puck function | ACMS puck function | ETO/rotator function
1 | Unused | Unused | Unused | Unused
2 | Unused | Unused | Unused | Unused
3 | Channel 1 I+ | Heater I+ | Thermometer I+ | Bridge Ch4 I+
4 | Channel 1 I− | Heater I− | Thermometer I− | Bridge Ch4 I−
5 | Channel 1 V+ | Heater V+ | Thermometer V+ | Bridge Ch4 V+
6 | Channel 1 V− | Heater V− | Thermometer V− | Bridge Ch4 V−
7 | Channel 2 I+ | Chip Therm I+ | Trim Coil + | ETO Ch1 I+
8 | Channel 2 I− | Chip Therm I− | Trim Coil − | ETO Ch1 I−
9 | Channel 2 V+ | Chip Therm V+ | Calibration Coil − | ETO Ch1 V+
10 | Channel 2 V− | Chip Therm V− | Calibration Coil + | ETO Ch1 V−
11 | Channel 3 I+ | Puck Therm I+ | Detection Coil + | ETO Ch2 I+
12 | Channel 3 I− | Puck Therm I− | Detection Coil − | ETO Ch2 I−
13 | Channel 3 V+ | Puck Therm V+ | Drive Coil + | ETO Ch2 V+
14 | Channel 3 V− | Puck Therm V− | Drive Coil − | ETO Ch2 V−

What is the function of CHARYBDIS?

It is a "breakout box" connecting the lab's Keithley model 6517A **electrometer** (SISYPHUS) and any Quantum Design **PPMS** (e.g., ZEUS).

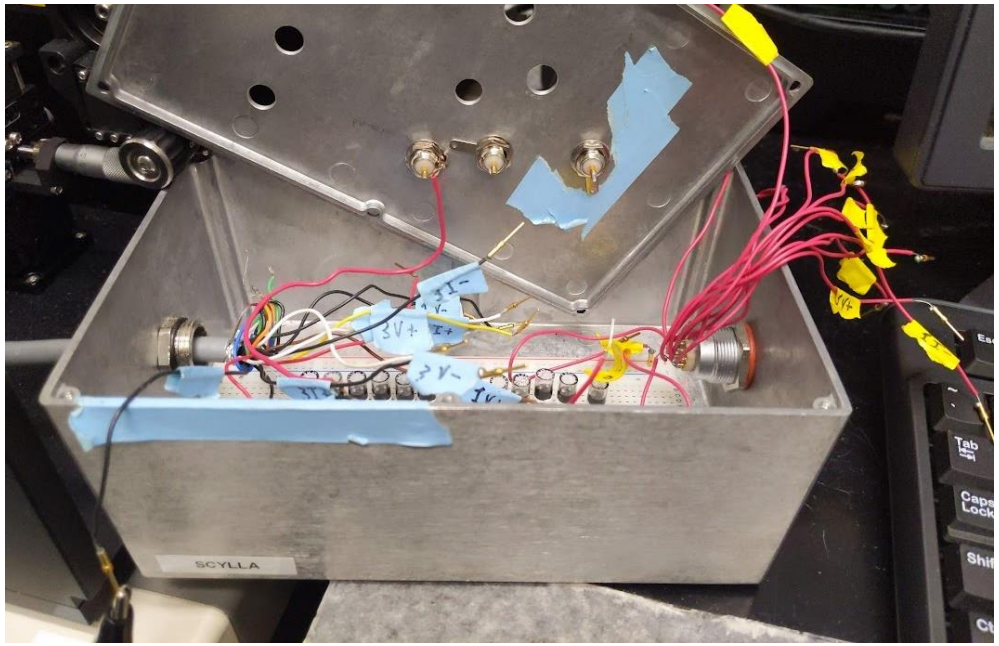
- CHARYBDIS enables the use of the PPMS as a **cryogenic chamber** for measurements using **external hardware**, such as SISYPHUS.
- It is an upgrade to SCYLLA for electrometer-specific use.



How is CHARYBDIS different from SCYLLA?

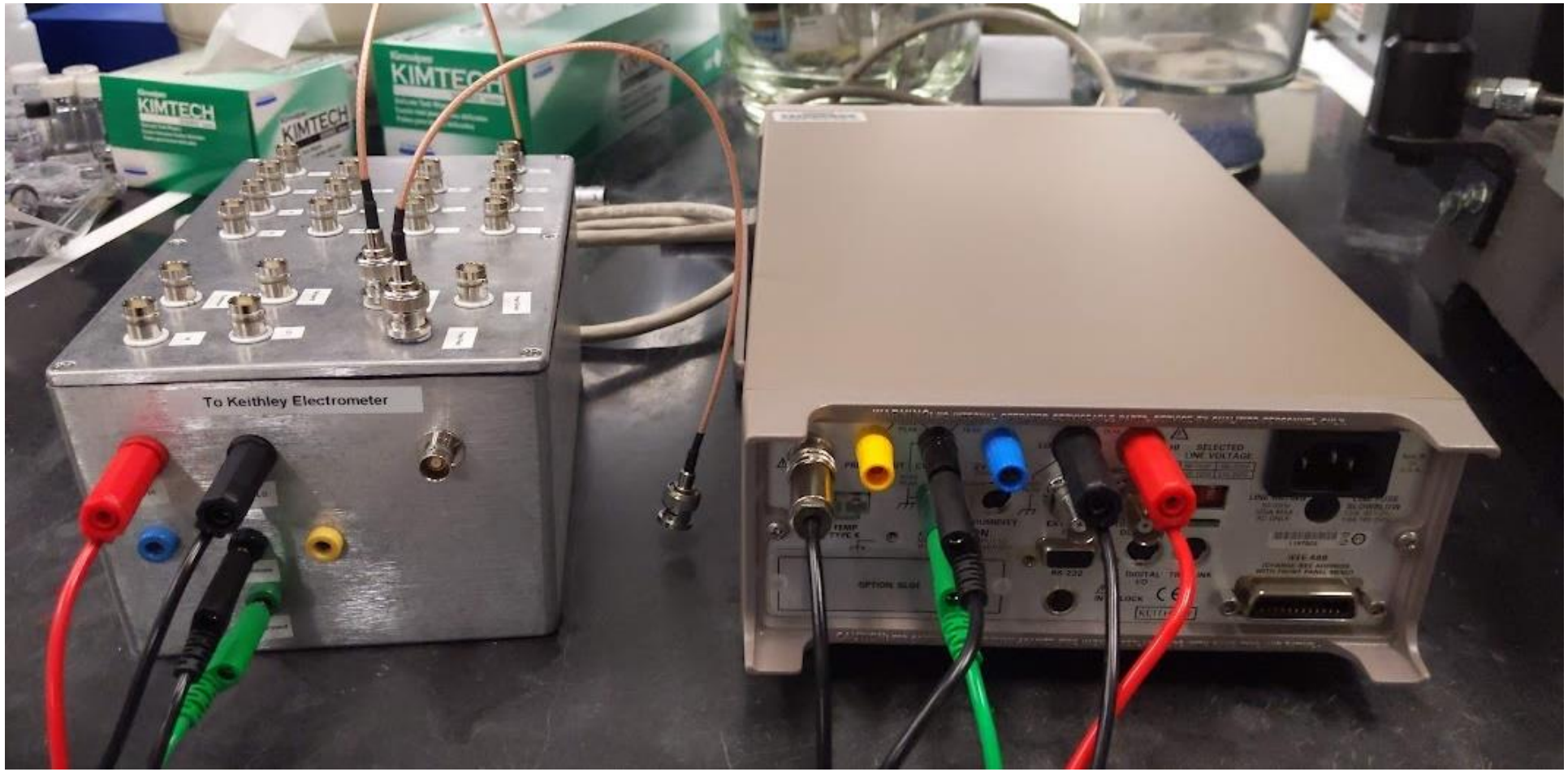
SCYLLA is the lab's previous breakout box, designed by former postdoc Thao for use with the **photoconductivity meter** (TANTALUS).

- SCYLLA can be used to connect ***any* external instrument** to the PPMS, but it is noisy due to physically loose and poorly shielded components.
- CHARYBDIS is designed to be lower noise but can be used *only* with the electrometer.



What are the steps to use CHARYBDIS?

1. Plug CHARYBDIS's LEMO cable (blue end) into the PPMS.
2. Insert your sample (mounted on a puck) into the PPMS.
3. Connect all relevant cables between CHARYBDIS and the electrometer.
   - At minimum, you will need the **triax-triax cable**.
4. Follow the pinout table to use **BNC cables** on the top of CHARYBDIS to connect to the PPMS puck.
5. (Optional) Connect the electrometer to a computer for data collection.


KIMTECH
KIMTECH
KIMTECH
To Keithley Electrometer


1
3
7
11
Triax Green
Triax Red
4
8
12
Triax Black
5
9
13
Ground
LO
2
6
10
14
Common
HI

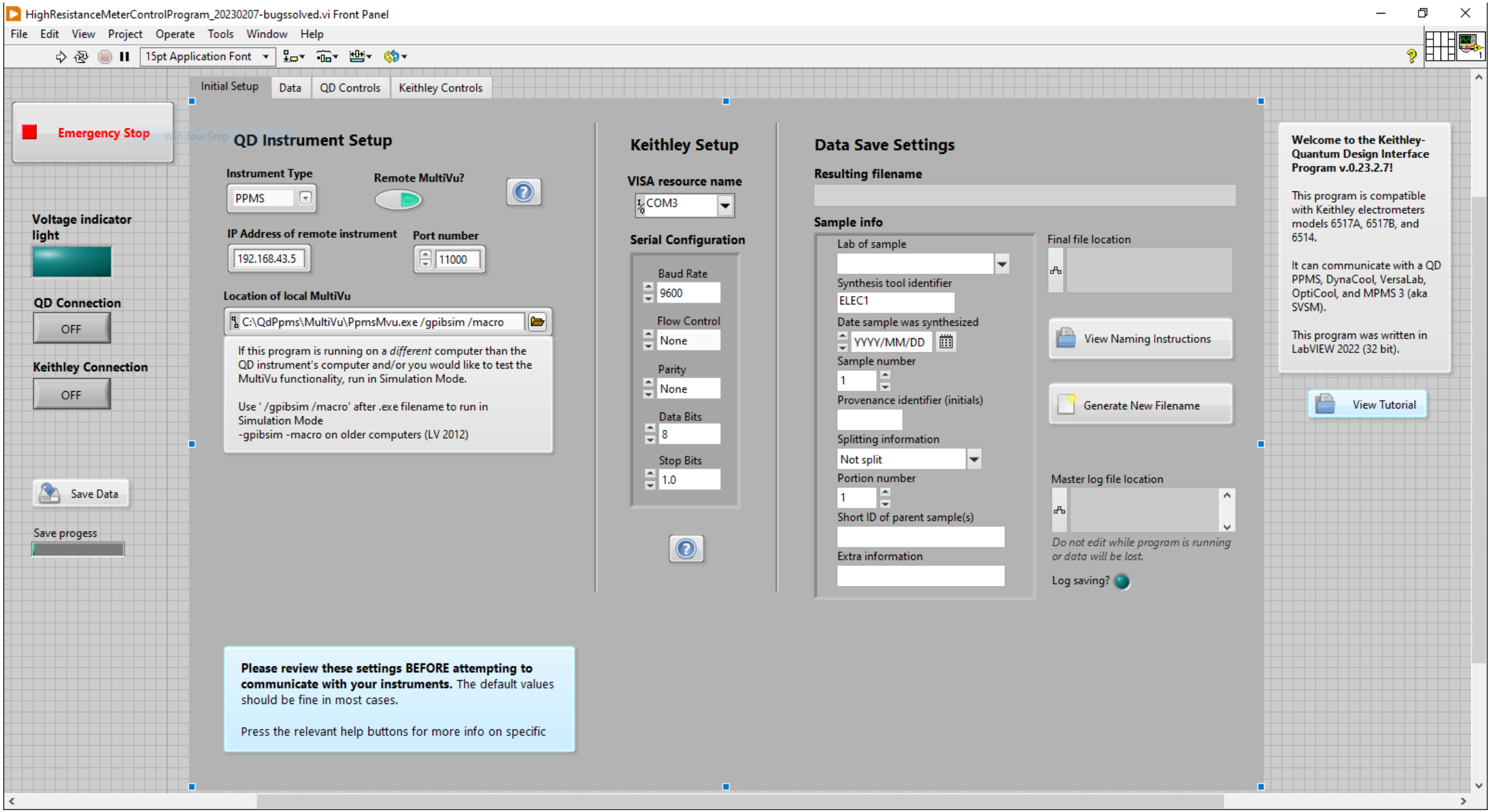
CHARYBDIS Pinout table

Wire number	Resistivity puck function	Heat capacity puck function	ACMS puck function	ETO/rotator function
1	Unused	Unused	Unused	Unused
2	Unused	Unused	Unused	Unused
3	Channel 1 I+	Heater I+	Thermometer I+	Bridge Ch4 I+
4	Channel 1 I–	Heater I–	Thermometer I–	Bridge Ch4 I–
5	Channel 1 V+	Heater V+	Thermometer V+	Bridge Ch4 V+
6	Channel 1 V–	Heater V–	Thermometer V–	Bridge Ch4 V–
7	Channel 2 I+	Chip Therm I+	Trim Coil +	ETO Ch1 I+
8	Channel 2 I–	Chip Therm I–	Trim Coil –	ETO Ch1 I–
9	Channel 2 V+	Chip Therm V+	Calibration Coil –	ETO Ch1 V+
10	Channel 2 V–	Chip Therm V–	Calibration Coil +	ETO Ch1 V–
11	Channel 3 I+	Puck Therm I+	Detection Coil +	ETO Ch2 I+
12	Channel 3 I–	Puck Therm I–	Detection Coil –	ETO Ch2 I–
13	Channel 3 V+	Puck Therm V+	Drive Coil +	ETO Ch2 V+
14	Channel 3 V–	Puck Therm V–	Drive Coil –	ETO Ch2 V–

Collecting data with CHARYBDIS

Once your sample is inside the PPMS, you can collect data with the PPMS as normal.

- **Use MultiVu** to control temperature, field, and vacuum using a sequence or the manual controls.
- If you would like to save electrometer data, run the most recent iteration of the **electrometer-PPMS interface program** on the photoconductivity PC.
  - You can choose to run the interface program in **remote mode** to automatically sync electrometer data with PPMS data. To do this, make sure **QD_Instrument_Server.exe** is running on the PPMS PC.

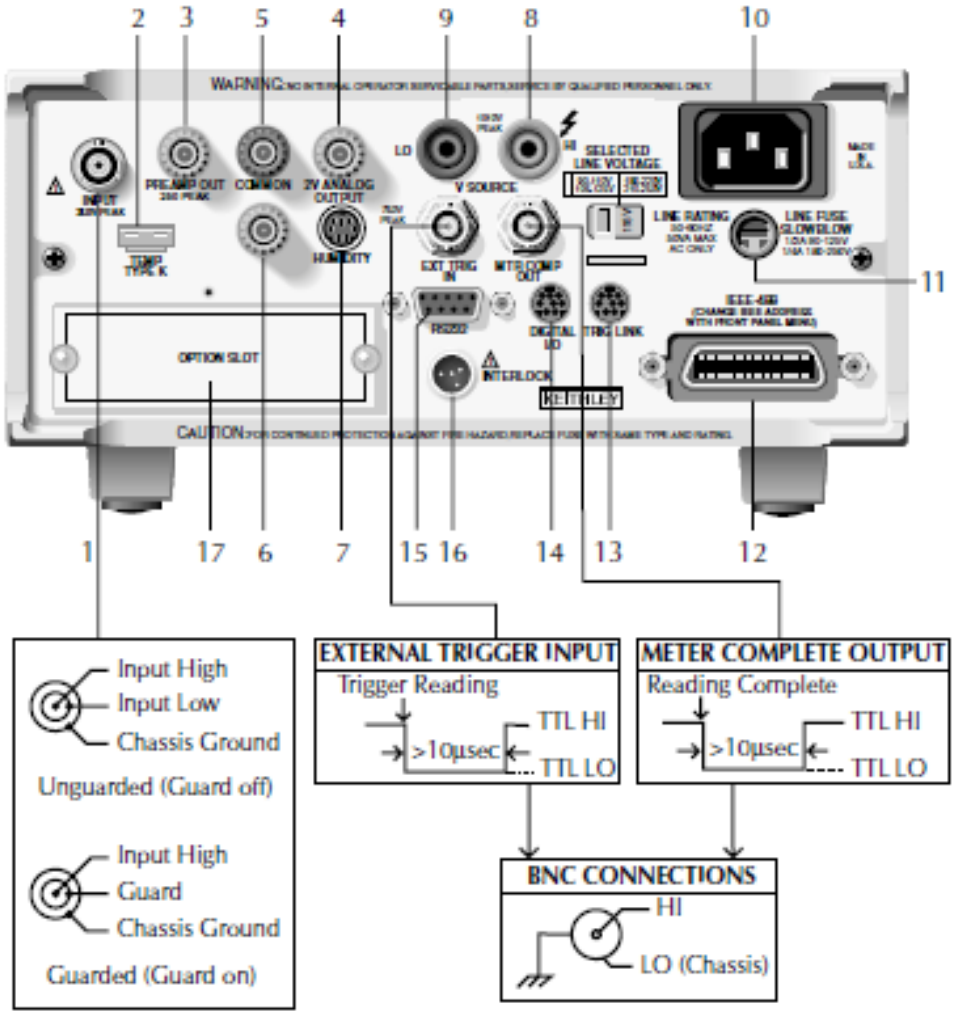

HighResistanceMeterControlProgram_20230207-bugssolved.vi Front Panel
File Edit View Project Operate Tools Window Help
15pt Application Font
Initial Setup
Data
QD Controls
Keithley Controls
Emergency Stop
QD Instrument Setup
Instrument Type
PPMS
Remote MultiVu?
IP Address of remote instrument
192.168.43.5
Port number
11000
Location of local MultiVu
C:\QdPpms\MultiVu\PpmsMvu.exe /gpibsim /macro
If this program is running on a different computer than the QD instrument's computer and/or you would like to test the MultiVu functionality, run in Simulation Mode.
Use ' /gpibsim /macro' after .exe filename to run in Simulation Mode
-gpibsim -macro on older computers (LV 2012)
Voltage indicator light
QD Connection
OFF
Keithley Connection
OFF
Save Data
Save progess
Keithley Setup
VISA resource name
COM3
Serial Configuration
Baud Rate
9600
Flow Control
None
Parity
None
Data Bits
8
Stop Bits
1.0
Data Save Settings
Resulting filename
Sample info
Lab of sample
Synthesis tool identifier
ELEC1
Date sample was synthesized
YYYY/MM/DD
Sample number
1
Provenance identifier (initials)
Splitting information
Not split
Portion number
1
Short ID of parent sample(s)
Extra information
Final file location
View Naming Instructions
Generate New Filename
Master log file location
Do not edit while program is running or data will be lost.
Log saving?
Welcome to the Keithley-Quantum Design Interface Program v.0.23.2.7!
This program is compatible with Keithley electrometers models 6517A, 6517B, and 6514.
It can communicate with a QD PPMS, DynaCool, VersaLab, OptiCool, and MPMS 3 (aka SVSM).
This program was written in LabVIEW 2022 (32 bit).
View Tutorial
Please review these settings BEFORE attempting to communicate with your instruments. The default values should be fine in most cases.
Press the relevant help buttons for more info on specific

What does the electrometer measure?

The electrometer (SISYPHUS) is essentially a **high-resolution multimeter**. It measures current, voltage, resistance/resistivity, and charge.

- The **connections differ** depending on the selected measurement mode. These are detailed in its "Getting Started" and full manuals.
  - You can leave all the cables plugged into CHARYBDIS and make these changes on the face of the breakout box.
- The electrometer can also apply D.C. voltage from ±0.005 V to 1000 V.

Model 6517A rear panel overview



1 **INPUT CONNECTOR (see Figure 1-2)**

Unguarded Configuration — Disable GUARD for amps, ohms, coulombs and unguarded volts measurements.
Guarded Configuration — Enable GUARD for guarded volts measurements.

2 **TEMP TYPE K** Connect the Model 6517-TP type K thermocouple for temperature measurements.

3 **PREAMP OUT** Follows the signal amplitude applied to the INPUT terminal. With GUARD on, PREAMP OUT is internally connected to the inner shell of the INPUT triax connector to configure the input for guarded volts measurements. Referenced to COMMON. See the Model 6517A User's Manual for more information.

4 **2V ANALOG OUTPUT** Binding post provides a scaled 0 to 2V output that is referenced to COMMON. Typically connected to a measuring device such as a chart recorder. See the Model 6517A User's Manual for more information.

5 **COMMON** Binding post that is internally connected to INPUT low through a 0.6Ω resistor.

6 **CHASSIS GROUND** Binding post that connects the chassis to ground through the power line cord. COMMON can be connected to chassis ground by installing the ground link. For floating measurements, make sure the ground link connection between COMMON and Chassis Ground is open.

7 **HUMIDITY** Connect the optional Model 6517-RH probe for relative humidity measurements.

8 **V-SOURCE HI and LO** Banana jacks for the voltage source.

9 **LINE VOLTAGE SWITCH** Two-position slide switch configures instrument for available line power voltage. A 90 to 125V line voltage requires the 115V setting, while a 180 to 250V line voltage requires the 230V setting.

10 **POWER LINE INPUT** Connect to power line (50 or 60Hz) grounded outlet using 3-wire power cord.

11 **LINE FUSE** For the 115V line voltage setting, use a ½A, 250V, slow blow, 5×20mm fuse. For the 230V setting, use a ¼A, 250V, slow blow, 5×20mm fuse.

12 **IEEE-488 CONNECTOR** Connects the instrument to the IEEE-488 (GPIB) bus. Use shielded IEEE-488 cables.

13 **TRIG LINK** An 8-pin micro DIN connector for sending and receiving trigger pulses to and from other instruments.

14 **DIGITAL I/O** An 8-pin micro DIN connector for the four TTL-compatible digital output lines.

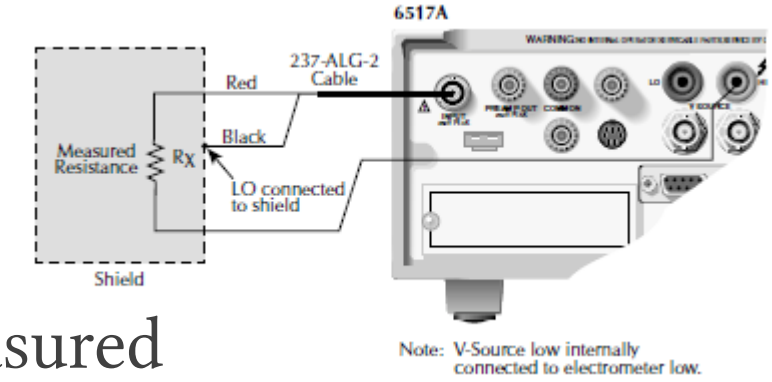
15 **RS-232** DB-9 connector for the RS-232 interface. Use a standard RS-232 cable.

16 **INTERLOCK** Connects the safety interlock to the Model 8009 Resistivity Test Fixture or the Model 8002A High Resistance Test Fixture using the appropriate cable.

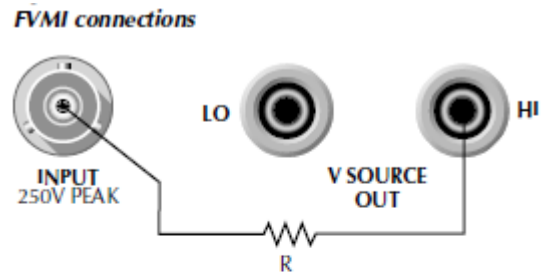
17 **OPTION SLOT** An option card, such as the Model 6521 or 6522 scanner card, installs in this slot.

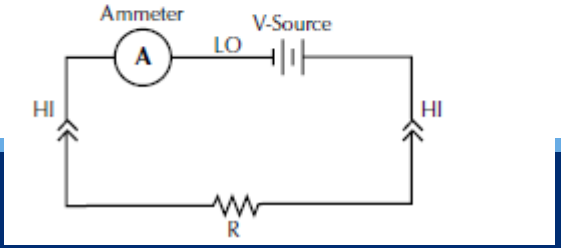
Resistance/resistivity measurements

By forcing a voltage to measure a current (FVMI), resistance $R = {}^{V}/_{I}$ can be calculated up to ~100 petaohms.



- In practice, the cap is closer to ~100 GΩ. Measured resistance is often voltage-dependent when ≤ 5 V.
  - The electrometer is usually the voltage source in these measurements. Its ammeter must be internally connected to the voltage source using a menu option.
- Resistivity is calculated from known sample dimensions input on the electrometer's face.

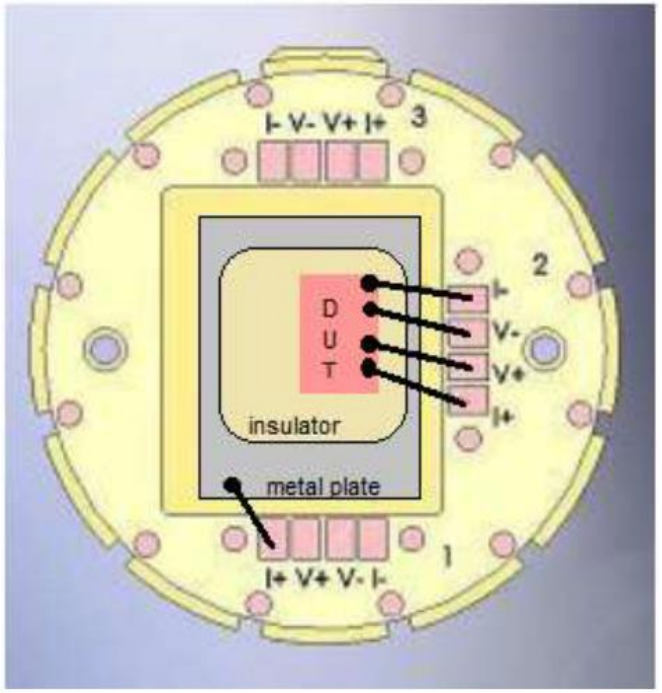




Resistance considerations

Above 1 GΩ, significant "leakage resistance" can cause your measurements to appear lower than expected.

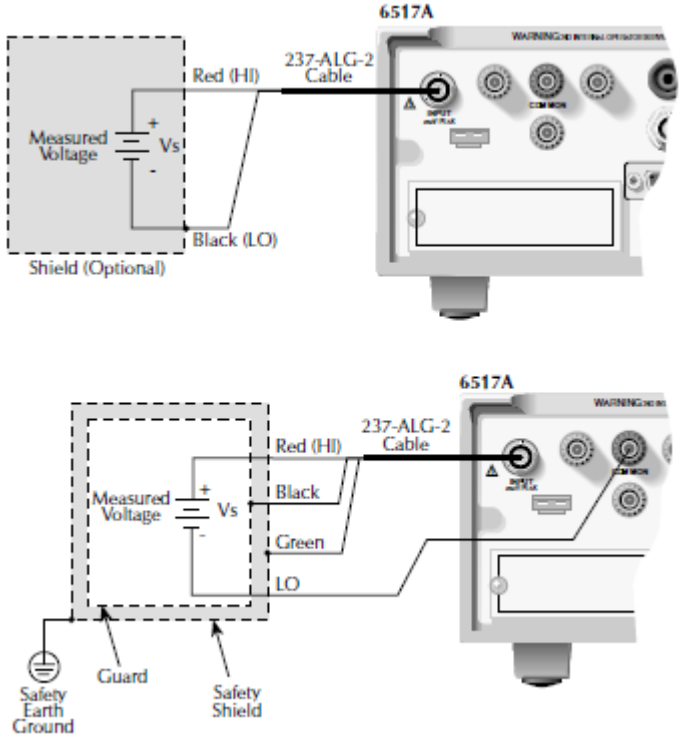
- This occurs when the insulation on the puck or cable is actually *lower* in resistance than your sample, so electrons preferentially travel through the insulation (the path of "least resistance").
- A Keithley "Low Current Measurements" article provides some ideas for how to get around this. The most important step is **guarding**; options are detailed in the electrometer manual.



Voltage measurements

The electrometer can measure voltages between 1 µV and 210 V.

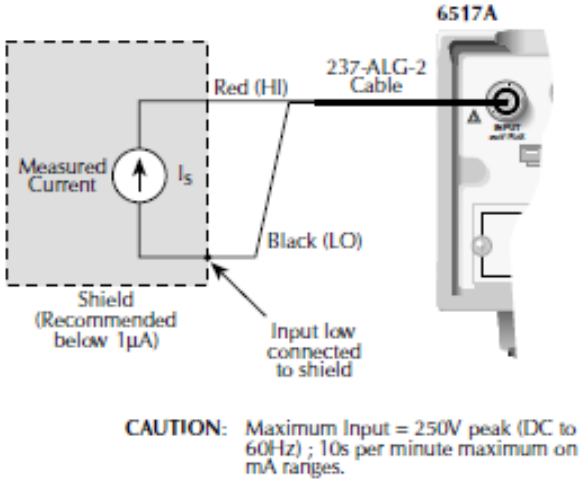
- Guarding may also be important for these types of measurements.
- The electrometer does *not* display the voltage it *applies* in this measurement mode – the voltage mode is for *read* voltage only.
- Please note the electrometer may also be used as an **independent voltage source** – this is also *not* the same as voltage measurement mode.



Current measurements

The electrometer can read from 10 aA to 21 mA.

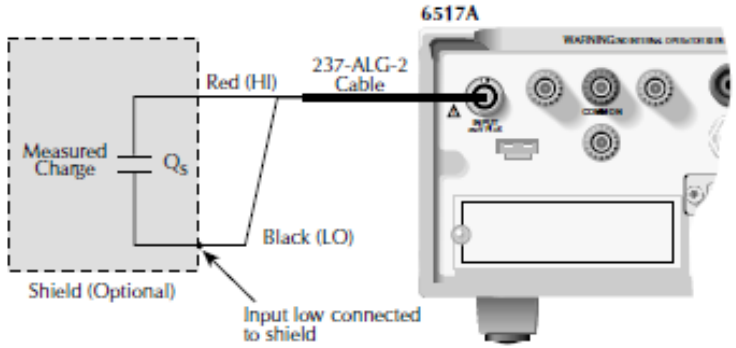
- Similarly to resistance, in practice the lowest current readable is somewhat higher than the stated minimum, in the picoamp range.
- You can also have the electrometer display the current it's reading in resistance mode, rather than swapping over to this mode.



Current measurements

The electrometer can read from 10 fC to 2.1 μC.

- Autoranging works slightly different in this mode because of time and charging considerations.



Other useful electrometer tools (to look up as needed)

- Manual vs. autoranging
- ZeroCheck and Rel for background subtraction
- Auto-discharge for charge measurements
- Use as an independent voltage source
- Pre-programmed test sequences
- Adjusting measurement speed and averaging features
- External triggering

Please Note:

The best source of information for...

...**the electrometer** and its measurement considerations is **its manual**.

...**a PPMS** and its measurement considerations is **its manual and operators**.

...**CHARYBDIS and the interface program** is this document or their designer Shannon Bernier.