Van der Pauw/DLTS/IVT setup.

This setup contains three different setups. The Van der Pauw setup is not compatible with the other two setups, so if one uses the DLTS or IV features make sure to remove the van der Pauw GPIB cable from the GBIB interface in the back of the computer.

Van der Pauw measurements:

Connections:
1. Remove the Semetrol GPIB cable from the GPIB interface in the back of the computer and replace it with the Van der Pauw GPIB cable.
2. *Remove the semetrol bnc cables from the cryostat and replace them with the van der Pau bnc cables that come from the van der Pauw breakout box. Match cable number with connector number. The van der Pauw setup uses low noise guarded triax cables that run from the Hall-card in the switching unit to the break-out box. Please use gloves when you handle the connectors on those triax cables (do not touch them with your bare hands as oils will contaminate the connectors and might create leakage paths for the current, and use the yellow cabs if the cables are disconnected). The cryostat has DAMAGED female triax connectors on its electrical feedthrough port. To make good electrical connections we need to insert bnc cables in the triax connectors on the cryostat (a triax cable has a signal pin with a smaller diameter and would not make very good electrical contact). The breakout box converts from triax to bnc cables. Please do not put bnc cables in the triax connectors on the breakout box as that would damage them.*
3. The wiring in the cryostat consists of four different stages:
   a. Wiring from the electrical feed-throughs to the 2nd stage of the cryostat.
   b. Wiring from the 2nd stage of the cryostat to the extended sample-holder.
   c. Wiring from the extended sample-holder to the sample-holder pins.
   d. Wiring from the sample-holder pins to the sample.

   For each new sample the d-wires need to be replaced. Thin copper or gold wires are normally used. Depending on the type of sample, they can be attached by a wrapping tool or by soldering. For high temperature measurements use a wrapping tool or a high-temperature solder.

   When doing a series of van der Pauw measurements on different samples, the c-wires and b-wires are normally not replaced. When switching between the three modes, i.e. van der Pauw, DLTS, and IVT, it might be necessary to replace the c-wires and the d-wires. Please consult with Kevin Doyle, Wim Geerts, or Anup Bandyopadhyay. IVT and van der Pauw measurements require twisted pairs, to reduce the EMF picked up by the wires. DLTS requires separate wires to reduce the parasitic capacitance. Two different sets of b-wires that are terminated by small connectors are available. When installing the right wires for your experiment use gloves and use the yellow tape to make sure that the wires make thermal contact with the 2nd stage of the cryostat and the extended sample-holder. The tape can also be used to keep the wires and connectors away from the radiation shield as this would cause thermal leaks and will limit the lowest temperature that can be reached with the setup. The a-wiring is only replaced if it is damaged and make the connection between the connectors on the feed-through of the cryostat and the 2nd stage of the cryostat. Two of the connections are made by coax cables (connector x and y) and

should be used for DLTS measurements. The other four connections are made by twisted pairs and should be used for IVT or van der Pauw measurements (connector z, h, j, k). All six wires are terminated by miniature connectors.

Hardware:
1. To do van der Pauw measurements switch on the Keithley-6514 electrometer, the Keithley-2182 nanovoltmeter, the Keithley-7001 switching box (includes Keithley-7065 Hall card), the Keithley-6221 current source, the two HP-668A power supplies for the electromagnet, the HP3488A switching box, and custom design Relay unit (will switch the magnet field).
2. Furthermore open up the cooling water vents for the system.
   The van der Pauw setup is based upon the Keithley-7065 Hall card that is inserted in the Keithley 7001 switching unit. The schematics of the card is shown in the figure below. At the bottom of the diagram from left to right we see, a current meter (in our setup a Keithley-6514), a current source (in our setup a Keithley-6221), the sample, and a voltmeter (in our setup the Keithley-2182). The part in the rectangle is contained in the Keithley-7001 switching unit. The open circles represent relays that can be opened or closed to make a connection between an interconnect column and an interconnect row. The sample itself is hardwired, i.e. the black dots are permanent closed connections. The total switching matrix contains 8 relays on the left side that connect the current source to the sample and 12 relays on the right side that connect the sample to the voltmeter. Each of the relays can be programmed by the Keithley switching unit. The buffer amplifiers in the middle can be used for high-resistive samples. They have a large input impedance (>100TOhm) and can lower the load the voltmeter has on the sample (input impedance Keithley-2182 nanovoltmeter is 10 GOhm). The buffers can be inserted in the measurement circuit by closing the HI-R switches via the Keithley-7001 switching unit or via the software (high resistance mode enabled). Only for high resistive samples (resistance larger than 1 Gohm) one would like to insert those buffers as they would increase the required measurement time constant and can increase noise for low resistive samples.
   The Hall card has a maximum voltage rating of 8 volt and a maximum current of 100 mA. The software will automatically set the compliance of the current source to the 8 Volt value, and the maximum current you can set by the software is 100 mA. Higher voltages than 8 volt or large currents than 100 mA can not be used with the system.
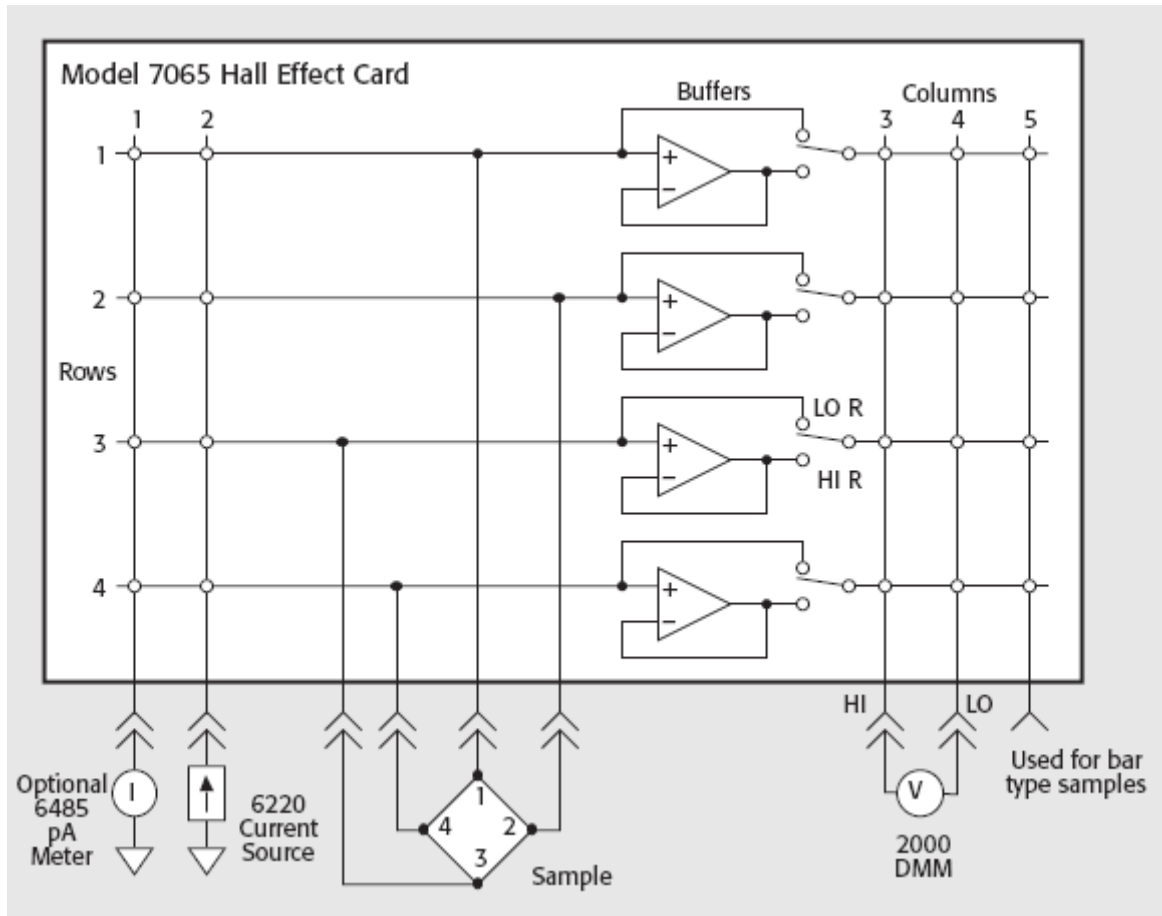
Software:
1. Log-in on the student account (password: physics).
2. Double click the VanDerPauw HardwareControl icon on the desktop. This will start Labview and load the program. To start the program in Labview push the arrow on the menubar of the Labview program. After starting up the program will first initialize all equipment. This will take some time. After it is done with the initialization it will show the message "Waiting for command" in the command box. This means that the program is ready to accept user commands.
3. This program will allow you to set the current, to set the magnetic field, to do a four point measurement using all switching configurations, to do a four point measurement using only four measurement configurations, to set the measurement time constant, to set the number of measurements for each data point, and to choose a particular measurement configuration for a single measurement. Other options are: (1) high resistance mode which is recommendable for resistors larger than 1 GOhm; (2) electrometer enabled, which allows you to measure the real current rather than the current set in the current source. Help for each GUI option can be obtained by switching on the context help option in Labview by selecting Help from the menubar and making sure that the context help option is checked. Moving with the mouse over a controller or indicator provides a help text in the context help window.