Van Der Pauw Setup

The Van Der Pauw technique of four-point probe measurements allows measurements of samples of arbitrary shape. See Philips Research Reports, February 1958; "*A Method of Measuring Specific Resistivity and Hell Effects of Discs of Arbitrary Shape*." Using the Cryostat as a four-point probe one can calculate the majority charge carrier density—n_s—and mobility—μ—of a semi-conducting sample as a function of temperature.

Equipment

Electromagnet
Cryostat
Rotary Pump
Current Controlled Current Source: HP6633A
Digital Multimeter: HP3457A
Switching Unit: HP3488A
Polarity Switch Unit for Electromagnet
2 Power Supply in Series for Magnet: HP6681A
Temperature Controller: LakeShore 331

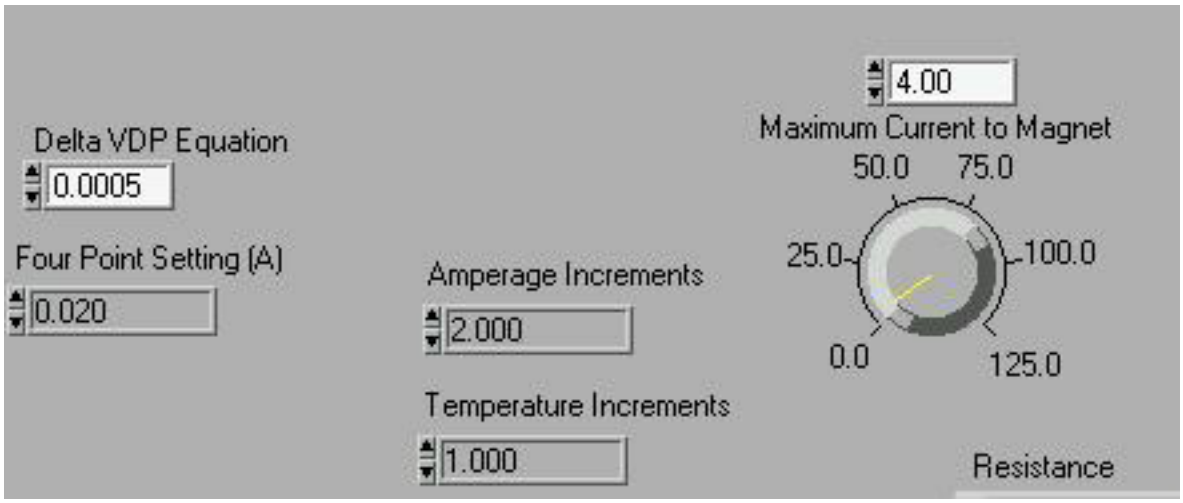
Procedure

1. Mount sample to cold head (see sample mounting)

2. Rotate Cryostate into electromagnet

3. Execute c:\\..\\VanDerPauw.VI

4. Define settings

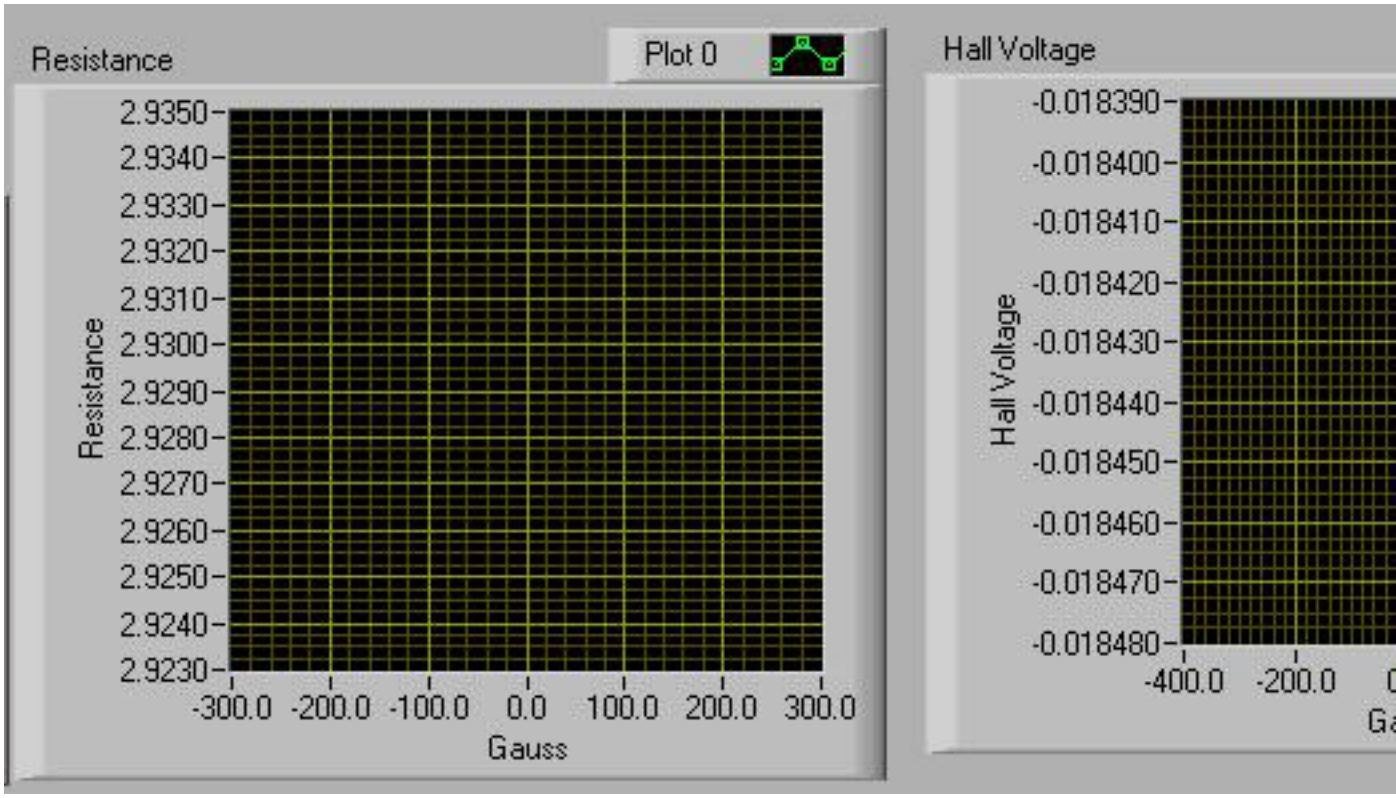


Note: Delta VDP is the minimum error used in the numeric solution for the Van Der Paw equation (see (12) in "*A Method of Measuring Specific Resistivity and Hell Effects of Discs of Arbitrary Shape*."). Maximum Current to Magnet define the range of current to the electromagnet, i.e. 4.00 defines the interval (-4.00 amps , 4.00 amps) of discrete steps defined by Amperage Increments.

A For-While loop in VanDerPauw.VI waits for the Starting Temperature before executing the program and steps by the Temperature Increments. To achieve low temperatures run roughing pump to the order of millitorrs.

The Switching Unit: HP3488A, defines the four-point probe settings (see Four-Point configurations using the HP3488A and Switching Unit Arrangments)

The program will graph the Hall Voltage measurements and the Resistance measurements for each temperature reading.



5. When the program ends, it will ask you to save the data to a spreadsheet. Apply the data to the Hall Measurement Worksheet and calculate the majority charge carrier density—n_s—and mobility—μ

Sample Mounting to Cold Head

1) Sample
2) Wire – 36 gauge(.005) Phosphor Bronze HML Green
3) CircuitWriter Silver Pen for Ohmic contacts
4) Apiezon Cryo-High Vacuum grease (-269 C – 30 C)

Disconnect cold head from cryostat

Clean Sample and cold head

Apply a liberal amount of grease such that the sample is not shorted to the terminals or the cold head

Apply a small amount of silver to one corner of the sample and allow 4 minutes to partially dry.

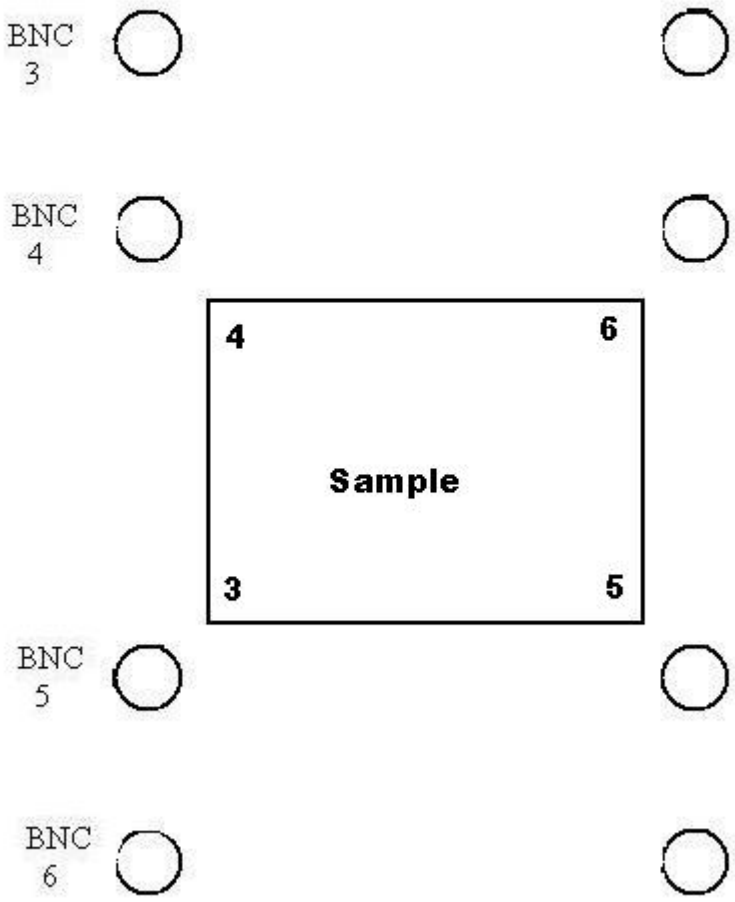
The silver will be somewhat sticky. Attach the appropriate wire to the corner (see cold head wiring diagram) and apply another small amount of silver and allow 6 minutes to dry.

Since this is tedious, I recommend doing only one corner at a time

Using a handheld multimeter check the four terminal to ensure there is not a short to another terminal or the cold head itself. Write down the resistance measurements to have a general idea of the resistance of the sample.

After mounting the cold back to the cryostat, remove the BNC connections from the cryostat and test each terminal for continuity and to ensure there is not a short. I use the diode test on the hand held multimeter. Since the sample is connected there will be a drop across all four BNC connection for each cold head terminal. However the terminal that corresponds to the BNC connection will have a larger drop than the other three.

Cold Head Wiring Diagram



Four Point Probe Configurations using the HP 3488A

		BNC 3	BNC 4	BNC 5	BNC 6
Hall Voltage Settings	**5**	I-	V-	V+	I+
	6	I+	V-	V+	I-
	7	I-	V+	V-	I+
	8	I+	V+	V-	I-
	13	V-	I-	I+	V+
	14	V-	I+	I-	V+
	15	V+	I-	I+	V-
	16	V+	I+	I-	V-
R1 Settings	**1**	V+	I+	V-	I-
	2	V+	I-	V-	I+
	3	V-	I+	V+	I-
	4	V-	I-	V+	I+
	9	I+	V+	I-	V-
	10	I-	V+	I+	V-
	11	I+	V-	I-	V+
	12	I-	V-	I+	V+
R2 Settings	**21**	V+	V-	I+	I-
	22	V+	V-	I-	I+
	23	V-	V+	I+	I-
	24	V-	V+	I-	I+
	25	I-	I+	V+	V-
	26	I+	I-	V+	V-
	27	I-	I+	V-	V+
	28	I+	I-	V-	V+

Manual Setting for #5 (I-, V-, V+, I+)

Close 101 BNC 5 = V+

Close 112 BNC 4 = V-

Close 303 BNC 6 = I+

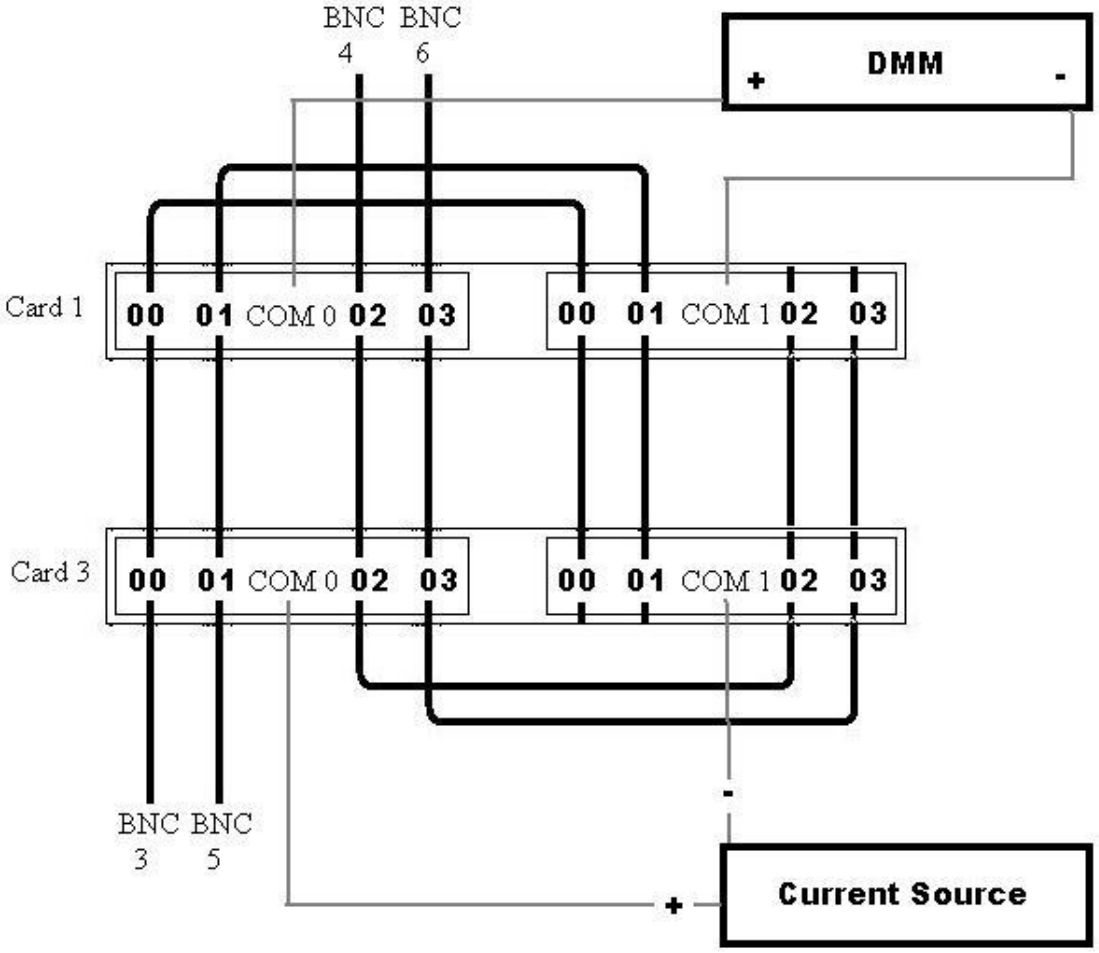
Close 310 BNC 3 = I-

CARD MON 1 **1: ,1 , , , , ,2 ,**

CARD MON 3 **3: , , ,3 , 0, , ,**

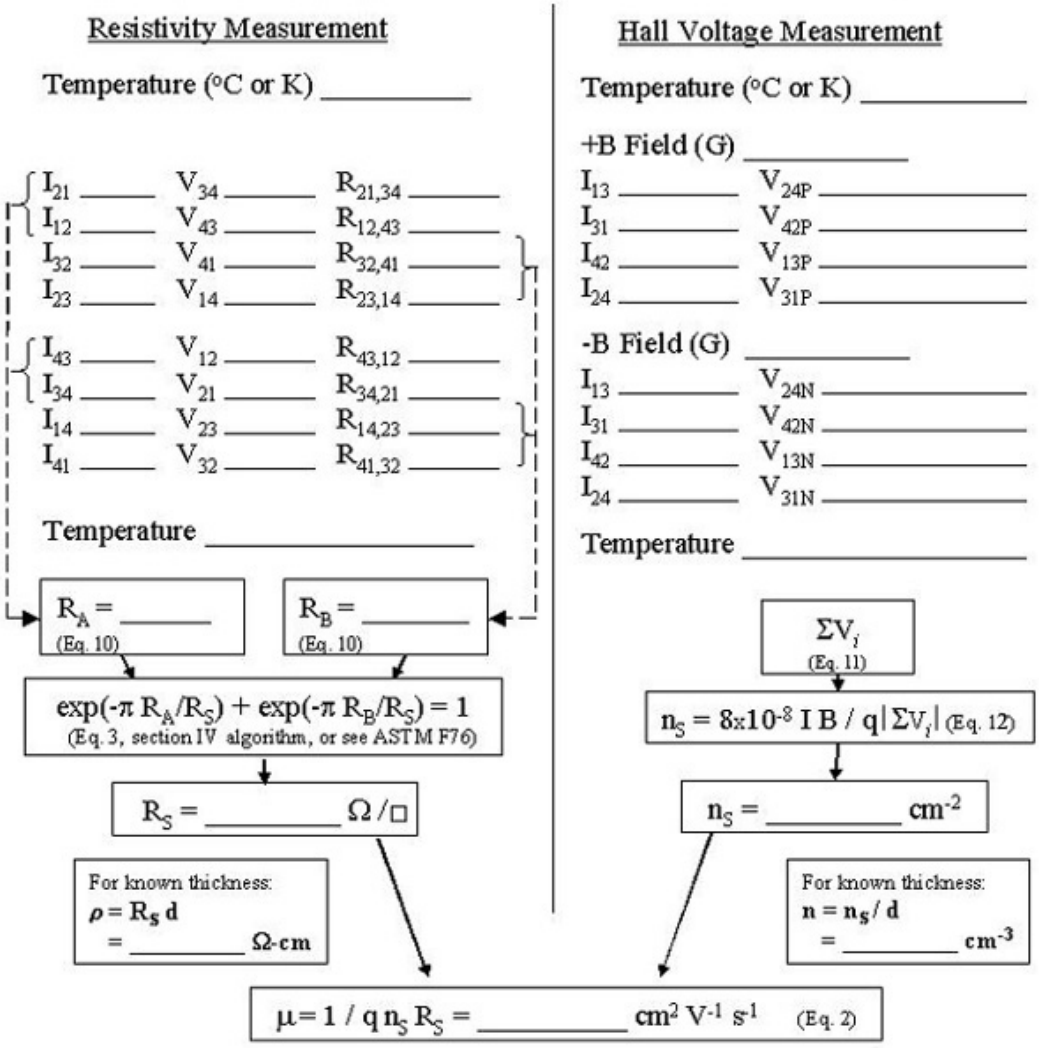
Note: C:\..\\HP3488a\HallChannelSettings.VI configures the listed settings and assigns a RECALL number

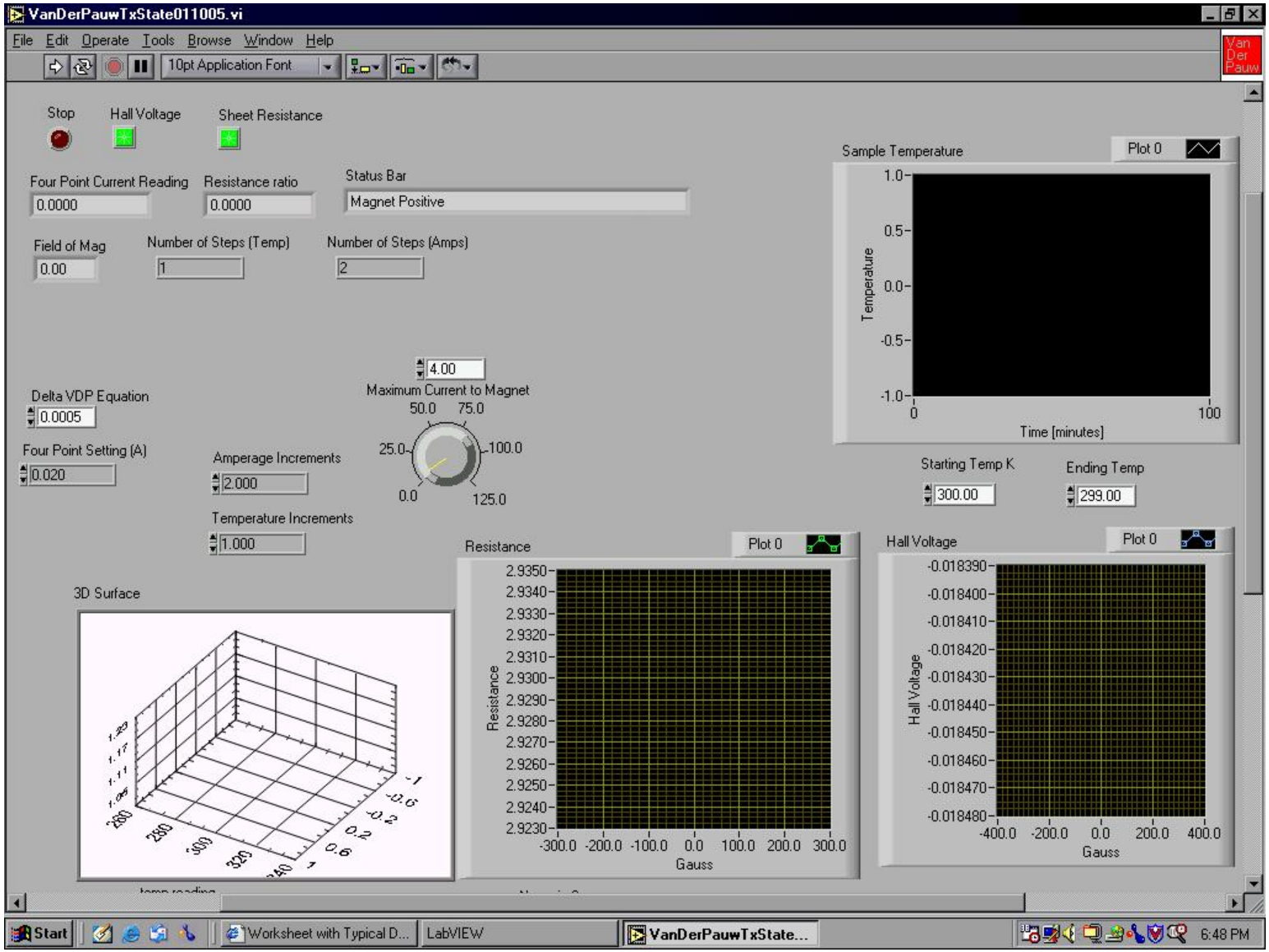
Switching Unit Arrangement



Van der Pauw Hall Measurement Worksheet

Sample Identification _____
Thickness if known (cm) _____ Dimensions _____
Date _____ Lab _____ Operator _____
Chemical Pretreatment (if any) _____
Contact Metal _____ Contact Process _____
Comments _____




VanDerPauwTxState011005.vi
File Edit Operate Tools Browse Window Help
10pt Application Font
Van Der Pauw
Stop
Hall Voltage
Sheet Resistance
Four Point Current Reading
0.0000
Resistance ratio
0.0000
Status Bar
Magnet Positive
Field of Mag
0.00
Number of Steps (Temp)
1
Number of Steps (Amps)
2
Sample Temperature
Plot 0
Temperature
Time [minutes]
4.00
Maximum Current to Magnet
50.0 75.0 25.0 100.0 0.0 125.0
Delta VDP Equation
0.0005
Four Point Setting (A)
0.020
Amperage Increments
2.000
Temperature Increments
1.000
Starting Temp K
300.00
Ending Temp
299.00
3D Surface
Resistance
Plot 0
Resistance
Gauss
Hall Voltage
Plot 0
Hall Voltage
Gauss
Start
Worksheet with Typical D...
LabVIEW
VanDerPauwTxState...
6:48 PM

http://www.physics.utoronto.ca/~phy325/exp13/vanderpauw.pdf