JANDEL ENGINEERING LTD.

HM21-SRM Four Point Probe

Four Point Probing System for Measuring Silicon Pot Scrap, Ingots, and Remelt

HM21-SRM Hand Held Meter with SRM Probe Head

Shown with Optional coiled cable

The **HM21-SRM** is a portable system that can accurately measure silicon tops and tails, potscrap, and ingots. The key to the simplicity of this application is the fact that setting the input current to 1mA produces a read-out value in millivolts that is numerically equivalent to bulk resistivity expressed in ohms-cm. Two factors account for the ease in which the HM21-SRM can be used for this application, as follows:

1) **The HM21 four point probe electronics has a selection for setting the input current to 1 milliamp.** It actually has a total of six user selectable input current choices as follows: 100nA, 1uA, 10uA, 100uA, 1mA, and 10mA.

2) **The user can select to have the meter read-out in millivolts, which is equivalent to the ohms-cm value when the input current of 1mA is selected.** For example, you have pressed the "ohms/sq" button to toggle into the millivolt display mode instead of the sheet resistance mode. You have set the input current to 1mA and you are probing a chunk of silicon using the HM21-SRM. The display reads-out a voltage of 0.4mV. This tells you that the silicon chunk has a bulk resistivity of 0.4 ohms-cm.

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Why does this work?

Resistivity = 2 x pi x s x V/I (where s is the probe spacing in cm).

If one uses a probe head with tip spacing of 1.591mm (62.6 mils), since 1.591mm is 1/(2 x pi)cm, it cancels out to V/I

Resistivity = 1 x V/I

Therefore a unit current of 1mA will give a mV reading numerically equivalent to the resistivity in ohm-cm.

The HM21 only supplies currents in multiples of 10 - so it is a simple multiplication factor if the 1mA range is not suitable

For example, if the input current is set to 100uA (1/10 of 1mA) then the resulting mV value needs to be multiplied by 10 to give the correct resistivity. If an input current of 10mA is used (10 times 1mA), then the resulting mV value needs to be divided by 10 to give the correct resistivity.

If a probe head with tip spacing of 1.59mm (62.5mils) is used, then multiply the mV value displayed on the HM21 by these multipliers, based upon the input current, to arrive at the ohms-cm value:

If you use a probe head with 1.59mm (62.6 mils) spacing, then:	
If the input current is:	**Then multiply the mV by this to have the ohms-cm value:**
100nA	10000
1uA	1000
10uA	100
100uA	10
1mA	1 (when using 1mA input current, the millivolts displayed is equal to ohms-cm)
10mA	0.1

Make sure that you press the Ohms/Square button to toggle into the mV mode and out of the ohms-per-square mode. You need to be in the mode where the display shows mV values. To verify that an ohms-cm value is valid, drive the current foward and then reverse while probing the bulk material (press the FWD and REV buttons). The mV values should be similar, but with a minus sign displayed for the reverse value.

Alternately you can use the PC software that is included with the HM21 Hand Held Meter to convert the values to ohm-cm regardless of which input current is used. The data can then be saved on a computer. The software has pull down menus which allow you to input the tip spacing if you are measuring bulk materials such as ingots. If you are measuring bulk wafers, the wafer thickness must be input instead. The HM21 stores the last 50 measurements in memory so you can take it back to your PC and using the software, save the measurement data into a CSV file which opens in Excel.

About the HM21 Hand Held Meter
The Jandel HM21 Hand Held Meter is a battery powered four point probe meter which includes a universal AC power adaptor so that it does not have to run on batteries when portability is not important. The Jandel HM21 is a portable current source / meter specifically designed for the four point probe measurement.

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For successful measurements the HM21 supplies a constant current and displays either the resultant voltage or the sheet resistance in ohms/square depending which function has been chosen. The bulk resistivity measurement range is approximately 0.01 ohm.cm to 100 Kohm.cm. The current is changeable in 6 steps - 100nA, 1uA, 10uA, 100uA, 1mA, 10mA. The compliance voltage is above 8.5V but slightly reduces to 7.5V at 10mA, however 10mA would usually only be used with more conductive samples where the compliance voltage is not so critical. Overall accuracy is better than 0.5% where the DVM receives greater than 1mV. For the mid ranges the accuracy is better than 0.3% The DVM has two ranges - high sensitivity up to 150mV and low range up to 1.25V. The unit is push button operated. The current is increased with the 'INC' button and decreased with the 'DEC' button. Forward and reverse current can be selected using the 'FWD' and 'REV' buttons, which is a common way to check the validity of a measurement by checking the forward and reverse voltage values for consistancy. When the battery mode is used, the unit returns to standby automatically to save power and turns off altogether after some period of inactivity. The automatic time to return to standby is 70 seconds with low current and with the 3 highest currents 40 seconds. This is because the lower current ranges are used with higher impedance which can take longer to settle, and the higher currents drain the power faster. The unit can be zeroed to remove any offset by pressing the Standby button when the unit is already in Standby. The HM21 includes on-board non-volatile memory so that fifty measurements can be stored in the unit and then dowloaded to a PC later. When connected to a PC using the included software, the HM21 can save the data, or bulk resistivity values (ohms-cm) can be calculated. If the HM21 is connected to a PC using the software, the unit can be operated via the user interface which is an illustration of the HM21 on the computer screen. Clicking the "save" button on the computer screen saves the data to the PC. Files are stored in the CSV format which opens automatically in Excel. The HM21 reads-out directly in either millivolts or sheet resistance (ohms-per-square) without using a PC or the software.   The **instruction manual for the HM21 software** can be downloaded here:
http://www.fourpointprobes.com/hm20_software.pdf

The HM21 can be easily switched to measuring sheet resistance, such as thin films or homogeneous wafers by pressing the Ohms/SQ button to toggle the HM21 into the sheet resistance displaying mode.

About the SRM Probe
The SRM probe is a reasonably priced plastic bodied probe that is suitable for use in measuring silicon potscrap, chunks, ingots, etc. The connection to the probe head is made via a female RJ45 connector which is the same type of connector used for Ethernet connections. The HM21 is supplied with a cable that plugs directly into the SRM probe head.