

HM21 Test Unit

PORTABLE COMBINED CONSTANT CURRENT SOURCE AND VOLTMETER

Jandel Engineering offers the HM21 Test Unit for use in making four point probe measurements. The HM21 has six constant current settings between 100nA and 10mA, and can be used to measure voltages from 0.01mV to 1250mV.

The quoted measurement range of the HM21 is from 1 ohm/square to 10 Megohms/square (sheet resistance), from 0.01 ohm.cm to 10 Kohm.cm (bulk resistivity).*

Measurements can be displayed as mV values or directly in sheet resistance values. Up to 50 readings can be stored in onboard non-volatile memory for downloading to a PC using the free software included. The software can also be used to operate the unit directly from a PC, and to output results as sheet resistance, bulk resistivity, or 'bulk resistivity for wafer' values.

The HM21 enables current to be passed in a forward and reverse direction to verify good contacts and measurements.

Overall accuracy is 0.5%, highest accuracy is in the mid-range of measurements.

Connection to a computer can be made via USB connection, and the unit can be operated standalone, via a graphical interface in the free software provided, or by computer keyboard commands.

The HM21 can be powered using the supplied adapter or using four size AA rechargeable batteries (supplied).



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* measurements outside this range are possible depending on sample type and possible reduced accuracy

The Jandel HM21

The Jandel HM21 is a portable meter designed for use with a four point probe to make resistivity measurements. 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.

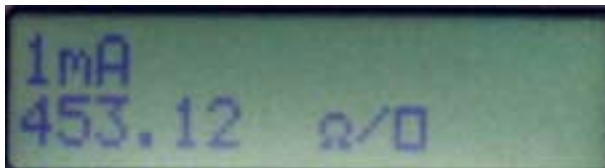
Unpacking

When you unpack the HM21 you should find:

1. A power lead incorporating a 9V AC adapter
2. A set of four AA rechargeable batteries
3. A 100 ohm test resistor
4. A Jandel HM21

Getting to know the HM21

On the HM21 you will find the display:



(A typical reading on the HM21)

and there are also 9 buttons...



When pressed the 'FWD' button allows current flow in a 'forward' direction



When pressed the 'STBY' button puts the unit in 'Standby' mode



When pressed the 'REV' button allows current flow in the 'reverse' direction



When pressed the 'INC' button increases the current by one level (10mA max.)



When pressed the 'DEC' button decreases the current by one level (100nA min.)



When pressed the ' Ω / \square ' button changes the display from mV to ohms/square. Pressing the button again reverts to a mV display.



When pressed the 'Hi' button switches the unit to 'High' resolution



When pressed the 'Low' button changes the unit to 'Low' resolution



When pressed the 'On/Off' button switches the unit on or off

Getting Started

Begin by inserting the batteries. Remove the back cover and place the 4 supplied rechargeable batteries in with the poles facing as indicated inside the unit. To give maximum length of service the batteries should be charged for 24-48 hours. The batteries charge slowly to give maximum lifetime and charge. Plug the AC adapter into the HM21 and connect the lead to the mains. A green light on the adapter indicates that the power is on.

When fully charged the unit can be in used heavily for up to 14 days or lightly used for up to several months. If the highest currents are used the charge lifetime may be reduced slightly.

When the battery power is running low the unit will display 'Battery Low'. The warning will first be noted at the higher current levels or when changing from Reverse to Standby.

The unit can be operated via the adapter whether the batteries are inserted or not. The batteries will charge when the adapter is in use whether the unit is switched on or not.

First operation of the HM21.

Switch the unit on using the On/Off button. The unit will self calibrate and then display "Jandel HM21" along with the version number (currently 1.2). It will indicate that the unit is in Standby and will show 'H' indicating 'high' resolution.

Plug in the 100 ohm test resistor so that the unit will believe it is measuring a sample.

Pressing 'Inc' or 'Dec' will increase / decrease the current. Use these buttons to set the unit at 1mA.

Press 'FWD'. The unit is now passing a current through the resistor and measuring the voltage. As $V=IR$ you can expect a reading of 100mV. The unit's accuracy is quoted at 0.5% so the reading should be between 99.50mV and 100.50mV. In

practice, particularly above 1mV the accuracy is better than 0.5% so it would not be unusual to find that you are within 0.2% of the expected value.

Press 'REV'. The HM21 is now passing current in the reverse direction. Again you should receive a reading of 100mV, but this time with a minus figure.

Press the ' Ω / \square ' button. For thin samples the most commonly used measurement is sheet resistance. This is measured in ohms per square. As the size of the square is not relevant to the measurement there are no units such as 'square centimetre' or 'square metre'. The formula for sheet resistance is quite complicated but can be resolved to $4.5324 \times V/I$. Therefore when using a 100 ohm resistor you can expect the reading to be approx 453.24 ohms/square.

Press the ' Ω / \square ' button again and the unit will once again show the reading in mV. Note that the ohms/square value is absolute and therefore does not have a positive or negative sign.

Sometimes the voltage readings can be slightly offset. This offset can be eliminated by 'zeroing' the HM21. With the unit already in Standby, press the Standby button. The unit will display 'Zeroing...' and after a few seconds return to standby mode. When making measurements if you have different forward and reverse readings it is worth zeroing the HM2) to make sure that it is not being caused by an offset. If you still obtain readings which are very different in forward and reverse this can indicate a poor contact or invalid measurement site.

The range of measurement in high resolution is 0-150mV. In Low resolution it is 0-1250mV. Where practicable the high resolution should be used and a mV reading of 50-100mV is ideal.

Use the 'INC' button to increase the current to 10mA. With a 100 ohm resistor we will expect a reading of 1000mV. Press 'FWD'. You should encounter an error message as 1000mV is outside of the high resolution range. The unit will display 'Out of Range'. Press 'Low' and you should obtain the reading of 1000mV.

With the unit back in Standby remove the resistor. Attempt to make a reading by pressing the 'FWD' key. This will cause an error and the message "Contact Limit" will be displayed. By removing the resistor we have made it so that the HM21 can't drive the current – you can therefore equate this to a four point probe being on a sample but the HM21 having a problem driving the current through. This could be because the sample is too insulating, because the current needles are not in proper contact with the sample, or simply that a lead is disconnected! Using a lower

current will sometimes prevent a 'Contact Limit' error – this is in situations where the sample has become damaged due to excessive current.

Press the 'On/Off' button to switch the HM21 off. Note that it can take up to 5 seconds for the unit to switch off – the button only needs pressing once!

This has now summarized the functions of the HM21 and you are ready to make some measurements!

General Information

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' button. 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.

Warning messages:

'Contact Limit' means that you should try reducing the current or improving the contact on the sample.

'Out of Range' means that you are exceeding the voltage input of the DVM, reduce the current or try Low sensitivity if the current is already at its minimum.

'Battery Low' means the unit needs to be charged. It is detected when changing to Standby and will occur first during reverse or at higher currents.

The unit is designed to charge the batteries with a trickle charge to give long life so recharge time can be up to 48 hours. However fully charged you can expect a very long usage time - if used continuously charging will only be required every week or two. With occasional or light usage several months operation is possible. The unit can be operated while connected to the mains at any time whether batteries are present in the unit or not. The USB charge feature can be used to keep the unit topped up but can't be used to charge the unit when the batteries are very low. The batteries must always be rechargeable AA Nickel Metal Hydride or similar type. The unit will completely turn off after 30 minutes if left in the Standby mode. The unit can also be switched off using the On/Off button - it should be noted that the On/Off button need only be pressed once to turn the unit off - there may be several seconds delay before the unit closes down.

Measurement range is:

1 ohm/square to 10 Megohms/square (in practice you can measure down to around 0.01 ohms/square but the accuracy may be compromised slightly)

This equates to a range of approx. 0.01 ohm.cm to 100 Kohm.cm

Remote control is available via USB.

Command is via simple single character commands. Data Output data is in the form of comma separated variables (CSV). Sending an "o" to the HM21 causes it to Send or Output the set Current and the Voltage Reading displayed at that time.

The USB Port utilizes an FTDI device, and drivers are available on the web site:

<http://www.ftdichip.com/> or

<http://www.ftdichip.com/FTDrivers.htm> (FT232BM)

Once the driver is correctly installed, connecting the HM21 will add a com port to your PC, and you can configure your PC to control or receive data over the port.

The com port number will vary depending on your PC configuration. For laptops the com port is usually 2 and for desktops without a modem it is often 3, but these are only a general guide and you will need to determine this yourself.

The com port settings are 9600 baud, 8 bit, no parity, 1 stop bit. Hardware and X on/off handshaking are not used.

It should be possible to build and send small macros to set the current and zero the reading etc from the PC.

Data output from the RM3 is in CSV format. This is the most basic format understood by databases and spreadsheets. Some means of capturing the data into a file on the PC will need to be used. At the most basic level, data can be captured in hyperterminal. Save it as a text file, change the files extensions to .csv, and it can then be opened in excel.

Even without special software, using hyperterminal it is possible to control the HM21 and cause it to output data remotely. The remote control commands simply mimic the operation of the keypad. They are:

“f” sets forward current

“r” sets reverse current

“s” puts the HM21 in standby mode

“z” zeros the reading

“h” sets high sensitivity mode (either 2 or more decimal places max +/- 150mV)

“l” low sensitivity (1 decimal places max +/- 1250mv)

“q” changes display from ohms/sq to mV

“o” output data through the serial or USB port

“p” decreases current

“i” increases current

“A” to “F” select the current in an absolute way as presets. It is capital letters (case sensitive.)

5 Pin “Din” Plug

- | | |
|---------------------|--------|
| 1. Current source – | RED |
| 2. Earth | |
| 3. Current source – | BLUE |
| 4. DVM – | GREEN |
| 5. DVM - | YELLOW |

“Screen” is earth