

JANDEL ENGINEERING LTD. Universal Four Point Probe with RM3-AR Test Unit



shown with light shield closed

Applications:

- **4-Point Probe Measurement** of wafer sheet resistance
- **4-Point Probe Measurement** of epitaxial and diffused layer resistivity (where the layer is of the opposite conductivity type to the substrate, or the substrate is an insulator)
- **3-Point Spreading Resistance Measurement**
- An application titled, "**Pseudo-MOS Transistor in SOI Wafers: Operation, Parameter Extraction, and Applications**"

Principle Features of Universal Probe:

- Highly repeatable needle contact conditions owing to controlled velocity of descent
- Individually adjustable needle loadings with direct indication of set load
- Kinematic needle guidance system employing precision ruby ball guides and polished tungsten carbide rods
- Solid tungsten carbide needles with precision radiused tips
- Accuracy of needle spacing +/- 0.01mm, no side play
- Needles may be readily replaced without fear of derangement or loss of accuracy
- Fully visible contact area
- Micrometer controlled slice displacement for determination of resistivity gradient or junctions on a beveled slice.
- Hinged steel cover to eliminate effects of light and electrical interference during measurement

General Construction

The probe guidance system is kinematic and thus free of all lateral play. The needles are positioned by upper and lower jeweled guides, each needle being constrained by a spring-loaded ruby ball at each guide. The needles slide through their guides with minimum friction, and exchanging new needles for old or broken ones is a simple, quick operation. Changing needles does not affect the characteristics of the unit - provided that replacement needles are the same diameter - spacing and co-linearity will be retained. Variation in needle diameter do not introduce play.

Velocity Control

This device controls the velocity of the needle descent and the rate of applying load and thus offers uniform contact conditions from one measurement to the next. An air dashpot has been employed, since it's mechanism is vibration free and has a continuous motion. A spring is applied to the raising and lowering lever, tending to lower the needles. The dashpot is attached to the lever so that the lever is retarded by the piston.

Method of Operation

A cam shaft operated by a small lever projecting through the perspex cover sets the machine for either four probe operation (lever up) or three probe operation (lever down).

- i) During four probe operation all four needles rise and fall normally. The velocity control should be set as desired.
- ii) During three probe operation for spreading resistance measurements, the tension on the first probe should be reduced to zero and the lever pulled down. This lifts the first probe tension gauge finger so that it is inoperative. the central probe finger is raised slightly so that this probe contacts the specimen last. The velocity control knob should be set to give a probe descent rate of approximately 1mm per second.

More Information

Unlike the other probe models that Jandel offers which incorporate the [Cylindrical probe head](#), the Universal Probe has four individual needles which are held in a Guidance Unit. The Guidance Unit determines the tip spacing. Following is information which describes the differences, advantages, and disadvantages of the Universal Probe when compared to the other four point probing systems which Jandel offers which incorporate the Cylindrical probe head.

Limitations of the Universal Probe

- 1) Changing the probe tips is not something that you would want to do very often since the electrical contacts are soldered on. If you are measuring a wide range of materials and if you sometimes need to use sharp tips and sometimes need to use blunt tips, you will be better off with a system that uses a probe head since the probe heads can be quickly and easily interchanged. The Universal Probe is best used in an environment where the probe tip spring load may need to be changed often (it is easily adjustable between 0 to 100 grams per tip - each probe individually adjustable), but where the probe tip radii can remain the same.
- 2) The maximum spring load for the Universal Probe is 100 grams. Most materials can be measured with spring loads of 100 grams or less, however, some materials can require spring loads of up to 200 grams. Probing systems that use a probe head can be fitted with a probe head with spring loads up to 200 grams. The Universal probe is limited to 100 grams of load per tip, however, the use of sharper probe tips such as 25 micron radii tips can usually correct for this limitation.
- 3) The Universal Probe does not include the microswitch which prevents the current from flowing until the tips have made contact. The electronics should be put into the standby mode when making or breaking contact with the substrate.
- 4) The Universal Probe is only available with a linear tip array. A "probe head" can be configured with either a linear or square tip array.
- 5) The sample size is limited to 3" diameter or smaller samples since the system is equipped with a 3" wafer chuck with a vacuum hold-down facility.
- 6) The tip spacing options for the Universal Probe are 1.0mm, 1.27mm, or 1.59mm. The Cylindrical probe used in the other Jandel probe units can be built with tip spacings as close as 0.5mm, up to 1.59mm. Common probe tip spacings include 0.5mm, 0.635mm, 1.0mm, 1.27mm, and 1.59mm.

Continued

Advantages of the Universal Probe

1) The cost of probe tip replacement is lower on the Universal Probe. Other than the Universal Probe, all Jandel system incorporate the Cylindrical probe which costs a few times more than the price of a set of needles for the Universal Probe.

2) The spring loads for each needle on the Universal probe can be user adjusted in the range from 0 to 100 grams. The Cylindrical probe head used in the other Jandel systems is available in one of three user adjustable ranges, i.e., 10 to 30 grams per tip, 30 to 60 grams per tip, or 60 to 150 grams per tip. The factory sets the probe to one spring load setting within the selected range, and the user can adjust the probe tip pressure within the given range. The adjustment range for the Universal Probe is greater and the user can adjust each of the four tip pressures individually.

3) The needles on the Universal Probe are more visible (no obstruction from a probe head body), so it is easier to see the needles as they descend onto a target. This is desirable if you are trying to probe a relatively small geometry with accuracy.

4) The needles in the Universal probe are lowered onto the sample with pressure that is applied by each of the individually user adjustable tension gauges. So, even if the surface is slightly sloping or somewhat uneven, uniform spring pressure is still applied by each of the individual four probes.

5) The Universal Probe includes an integral light shield. Most of Jandel's other system do not include a light shield, which can be important when measuring photo-sensitive materials. Jandel offers a black cloth shroud and a nosepiece shroud which can be used with the systems that incorporate the Cylindrical probe head.

6) The Universal Probe can be used for making 3-point spreading resistance measurements. This is a somewhat arcane technique which we do not formally support, however, we do have some documentation about the technique. Some documentation regarding the 3-point spreading resistance measurement can be found in the following link, and additional documentation is available upon request:

http://www.fourpointprobes.com/3pt_spreadingres.html

7) In one particular application, the Universal Probe is used such that backside contact to the sample is required. In this case, Jandel supplies a polished brass chuck in addition to the standard chuck which is made from non-conducting hard anodized aluminum. We have found that customers who want the conductive chuck also require BNC connections (rather than the usual 9 pin D-sub connector). This requires a custom BNC connector mounting plate and an adjustment to the light shield. If you go to the BOTTOM of the following web page, you can see what the system configuration with the conductive chuck looks with the BNC connectors and the polished brass chuck:

<http://www.fourpointprobes.com/januniv.html>

If you would like a price quotation for the Universal Probe that includes the accessories for this application, please ask and the modifications to the Universal probe will be included at no additional charge. Standard parts which allow the Universal Probe to be used for the standard four point probe measurement will also be included. Our understanding is that the application that uses this special version of the Universal Probe is titled "***Pseudo-MOS Transistor in SOI Wafers: Operation, Parameter Extraction, and Applications***". Searching on Google for those key words will find further information.

RM3-AR Test Unit

The RM3-AR Test Unit is a specialty electronics instruments designed specifically for the four point probe measurement. It features high accuracy, an excellent range, and many features which simplify the four point probing measurement. The following are features of the RM3-AR Test Unit:

- The measurement range of the RM3-AR Test Unit is from 1 milliohm-per-square (10^{-3}) up to 5×10^8 ohms-per-square with 0.3% accuracy. The volume resistivity range is from 1 milliohm-cm (10^{-3}) up to 10^6 ohms-cm.
- The RM3-AR includes PC control software which can be used for data logging (storing data in the CSV format) and measurement conversion to ohms-per-square or ohms-cm.
- The RM3-AR reads-out directly in ohms-per-square (or toggle to millivolts) without requiring the use of the software or a PC.
- The RM3-AR has onboard non-volatile memory so that up to 50 measurements can be stored internally and then downloaded and saved all at one time using the software. Alternately, each measurement can be saved to a PC as it is made.
- The RM3-AR has an auto-range button that can be used to automatically determine the optimum input current for a given material without using the trial and error method.
- The RM3-AR has forward (FWD) and reverse (REV) buttons to reverse the direction of current flow. A common way to determine if a measurement is valid is to reverse the direction of current flow and then check to see if the forward and reverse voltage readings correlate well, i.e., the values should be similar, but with the reverse current voltage being a negative value.

RM3-AR Specifications:

- Superior Current Source
- 10nA to 100mA (99.999mA) current source selectable in steps to 5 decimal place resolution
- Current set numeric keypad
- 4 default preset current programs (user programmable) **Superior Inbuilt DVM**
- Input Impedance 1,000,000,000,000 ohms
- Input Bias current 4pA
- DVM 1300mV range and 130mV range
- 130mV accuracy
- 0.2% +/- 5uV resolution (10uV or 1uV) range
- 1300mV accuracy 0.2%+/-100uV resolution
- 100uV Ohms/Square
- Rapid Zeroing null function for DVM

Features

- 28 Key high quality Keypad
- 16x2 line LCD Display for simultaneous indication of Set Current and either Ohms/Sq or mV
- Auto-Ranging capability to determine the optimum input current based upon the material being measured.
- Intuitive operation
- Microprocessor controlled
- Reduced Footprint
- Robust Attractive ABS Case
- Accurately measures down to 10's of milliohms/square without external meter
- 4mm socket facility to connect an external meter
- RS232/USB connectivity for control and for collecting data in CSV format
- Automatic compliance voltage limit protects your sample which reduces maximum voltage as higher currents are set 5-40V
- Warning messages when compliance limit is reached, or DVM input exceeded
- Self test facility
- Flash upgradeable software
- CE Marked
- AD/DA converters and amplifiers for the DVM and setting the Current source and DVM, are Burr Brown 110V or 240V operation (selectable)

