



### PROBE TIPS #3

#### A Technical Bulletin for Probing Applications

#### Measurement Accuracy and Kelvin Probing

Four point Kelvin measurement is the most accurate way to measure a low value, tight tolerance resistor. The term “Kelvin Type Measurement” simply defines a four wire measurement system which provides for power (FORCE) to be delivered through one pair of wires, and for the measurement (sense) to be made through a second pair of sensing wires.

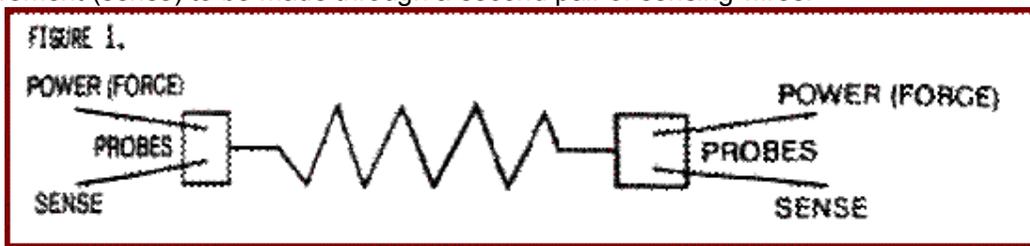


FIGURE 1.

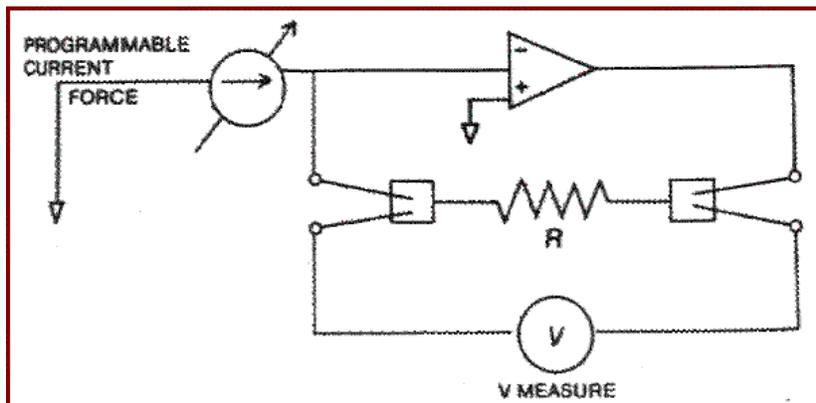
Kelvin measurements are routinely used when the point of measurement is physically a long distance from the actual measurement instrument and small values are to be measured.

#### FORCE I (CURRENT), MEASURE V (VOLTAGE)

Laser trim applications where individual resistors are measured and adjusted provide a good illustration of how force and sense techniques apply. Resistor values increase as they are trimmed. The amount of the force current can be initially set for the final resistor, defined by the programmed current range, establishes the stop trim threshold.

The diagram below illustrates a typical simple circuit.

FIGURE 2.



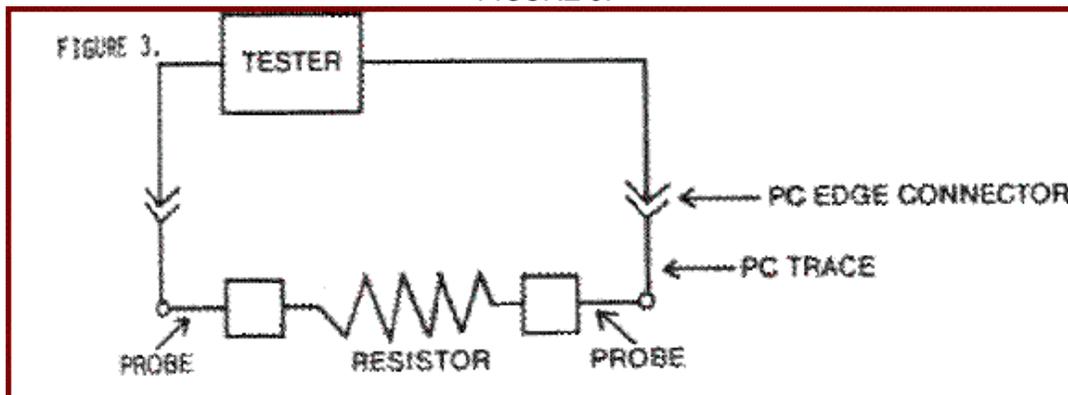
Operational amplifier theory provides that the net current into the summing junction must equal zero. Therefore current through R, the resistor under measurement, is forced to be equal and opposite to the programmed force current. The final desired value of R defines the programmed current range and the voltage across R is measured in the process to determine the resistance value within the current range. The high impedance voltmeter leads become the sense wires and feedback path around the operational amplifiers provides the force path.

Essentially, Kelvin measurement techniques allow precision measurement and provide a method to compensate for conductor path irregularities such as unequal cable lengths and PC traces and contact resistance in connectors, solder joints and probe tips.

## LEVELS OF MEASUREMENT ACCURACY

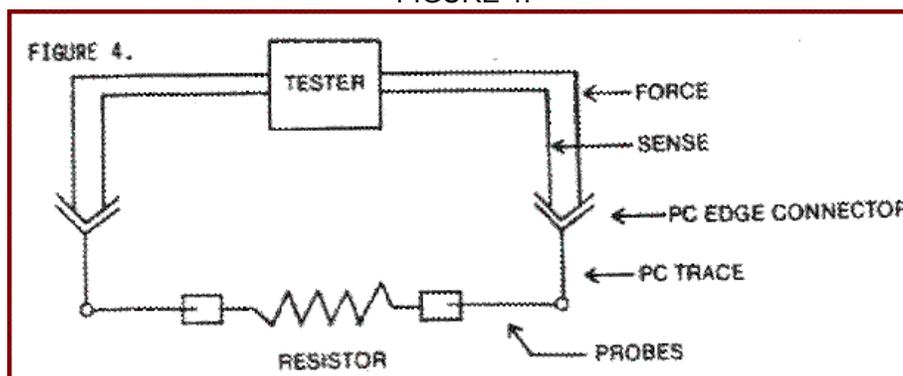
From the perspective of the probe card assembly the simplest and least accurate measurement is where single conductor paths connect from the tester to the device pads as shown in the illustration below.

FIGURE 3.



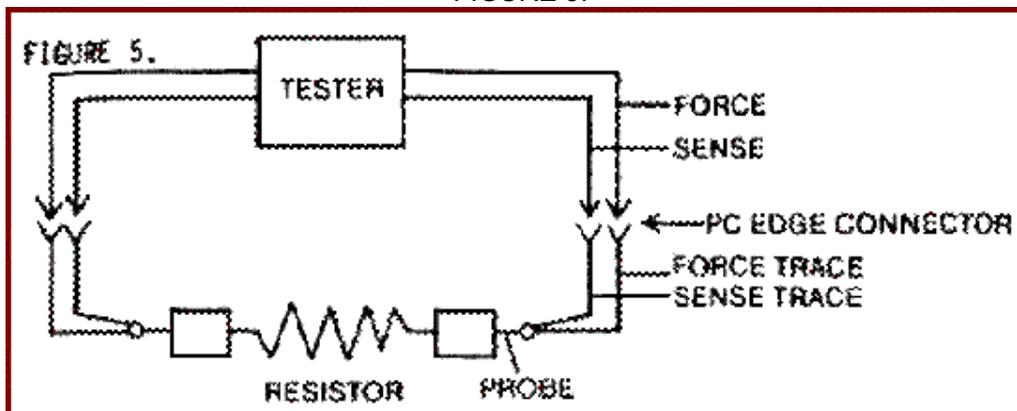
The next level of accuracy involves bringing Kelvin measurement capability to the card edge connector, which allows the measurement system to compensate for unequal conductor path resistance in the test cable.

FIGURE 4.



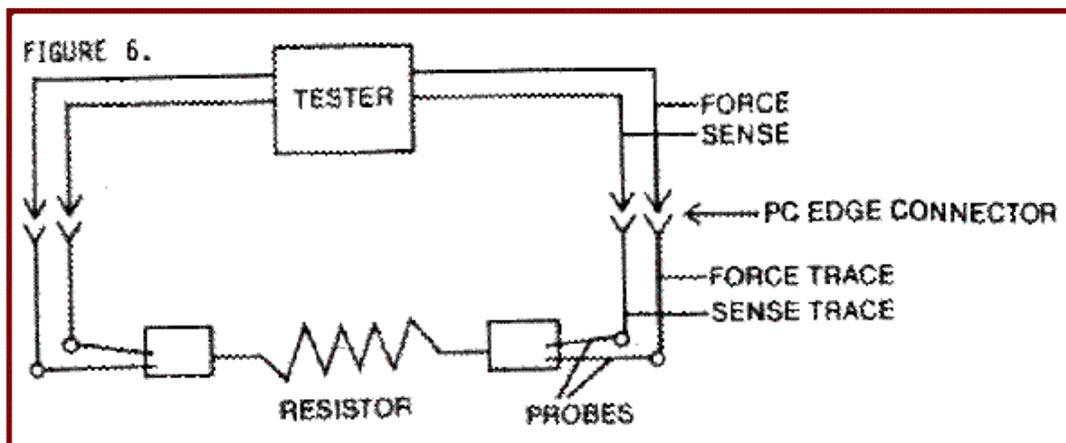
The third level of measurement accuracy involves the continuation of force and sense lines through the PC edge connector and terminating Kelvin at the probe land. This allows the measurement system to compensate for unequal trace resistance in addition to test cable variances.

FIGURE 5.



The best level of measurement accuracy is known as full four point Kelvin measurement. This level requires force and sense lines to be brought directly to the test pads of the device thereby requiring two electronically independent probe needles to contact the test pad.

FIGURE 6.



## PROBES AND PROBE CARDS

In order to implement full four point Kelvin probing, two probes are required for each test pad. Where space is limited a special Kelvin probe assembly consisting of a single probe body and two needles mounted to a ceramic needle carrier allow for Kelvin contact in place of two separate probe assemblies.

These Kelvin probes are particularly useful of tight device geometry and heavy probe density.

Innovative probe card designs provide for full Kelvin capability by designing in the larger edge connectors, dual traces and cuttable etches to provide for wiring flexibility. Accuprobe SK Series probe cards are an excellent example of this kind of forward thinking and design.

These cards with dual traces also offer another uncommon benefit. If full Kelvin is not required on all lines, the unused traces can be used to provide “AC GUARD” by shielding a signal line with adjacent traces terminated to ground. Ultimately, custom probe cards can be created to accommodate a variety of needs for increasing testing complexity.

Note:

1. Figure 2 and related text adapted from information provided by Chicago Laser Systems.

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