The Next Generation of True Kelvin Spring Probes

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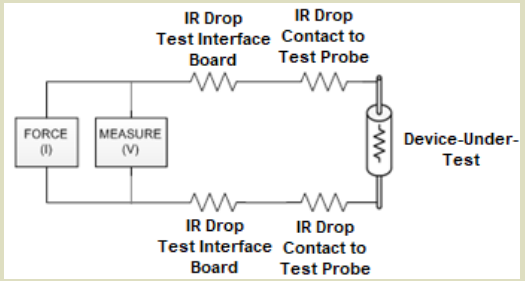
Contents

Need for Low Resistance Measurements

The Goal:

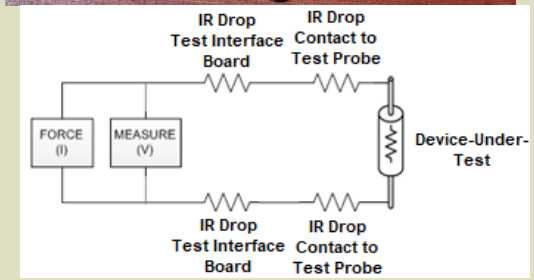
- Reduce errors caused by test interconnect resistance



- Four wire contacting is the most accurate method when measuring resistance below 1.0 Ω.

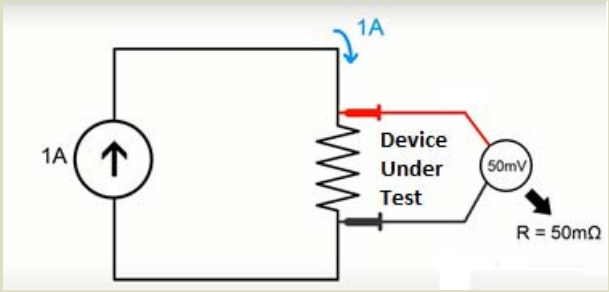
Four Wire Resistance Measure

- If you try to use your multimeter's resistance function, you will get a useless reading:
  - As shown, we have no idea what the resistance of the wire is. We do know that the resistance of the wire is a lot less than 0.4 Ω, 1.0 Ω, 0.3 Ω, 0.4 Ω
  - Recommended is the use of setups that minimize errors induced by the test interconnect resistance, load board trace resistance, and the resistance of the probe.
- Four Wire Kelvin is error reduction solution



Improved Measurement Accuracy

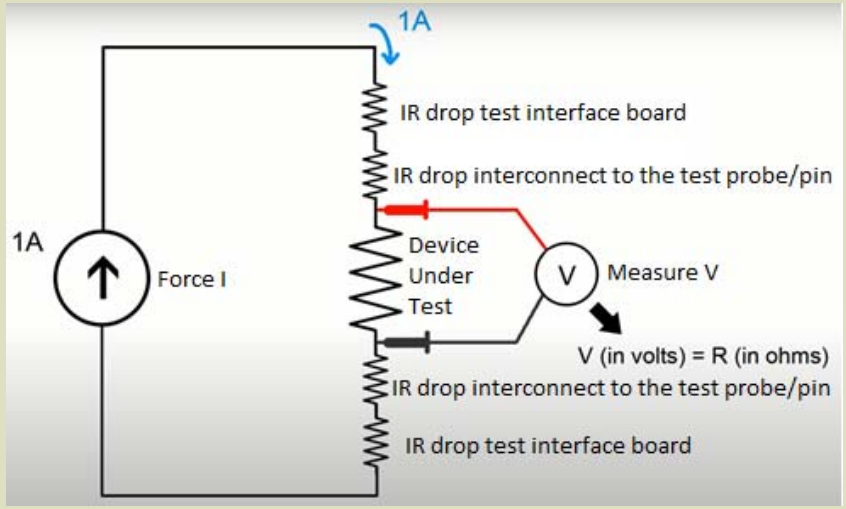
- Let's start with a constant current source of one ampere.
  - Since it is a constant current source, the amount of current flowing through the circuit will always be one ampere.
  - The measuring instrument has a high input impedance.
- For example, we measure 50 millivolts across R.
  - That means that the resistance of the wire is 0.050 Ω

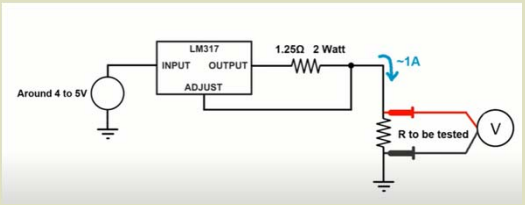


$$R = \frac{E}{I}$$

Circuit Traces, Test Cables, Wires, and Clips are not a Big Deal Anymore

- The input impedance of the Multimeter is so high, almost no current flows into the multimeter so the meter does not affect the circuit.

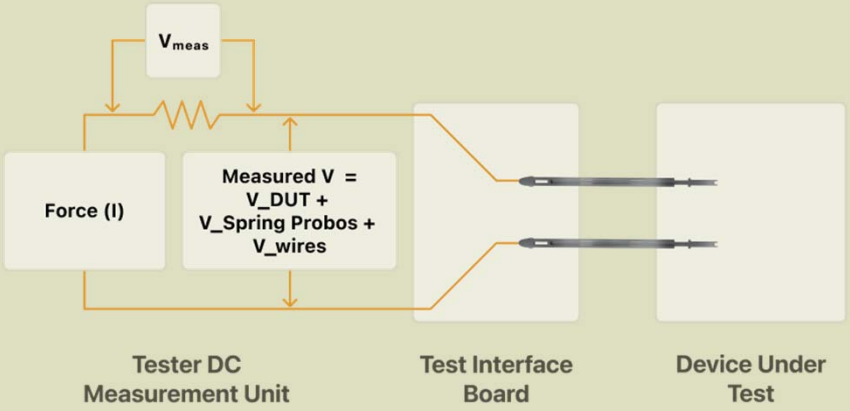




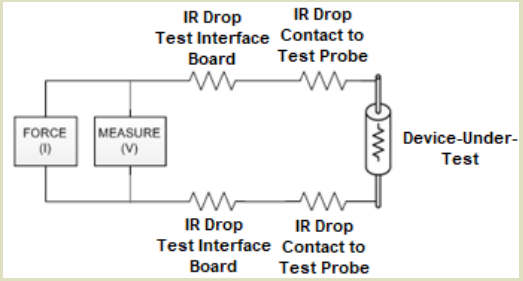
- 0-30 Volts, 0-3 Amps
- Constant Voltage, Constant Current
- Single Digital Meter with Switchable Volts or Amps Display
- Coarse and Fine Controls for Voltage and Current
- Light and Compact Design
- 0.01% Regulation
- Low Ripple and Noise
- Or you can build your own

Device-Under-Test
Traditional Two-Wire Interconnect

- Shown here is a basic block diagram of an automatic test equipment (ATE) measurement circuit with some of the interconnects to the device-under-test.
  - The current flowing through the device-under-test is in series with the current flowing through test system interconnects to the test interface board, the test interface board, and the contact probe. This is because there is only one series path for current to flow.

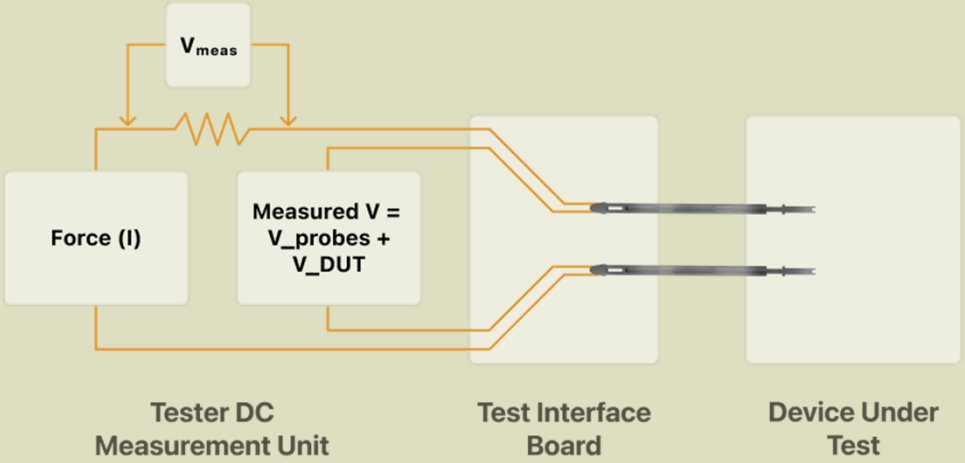


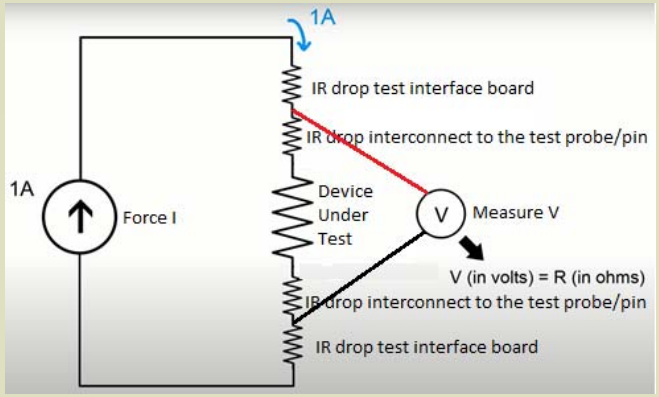
Traditional Two-Wire Interconnect Equivalent Circuit



Four-Wire Interconnect at the Test Contactor

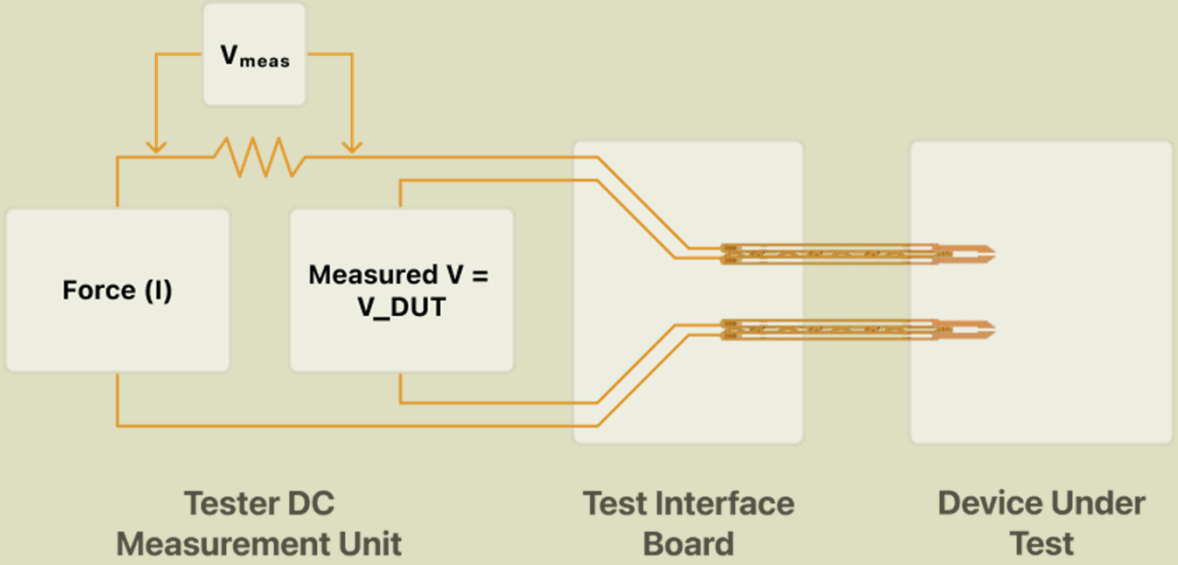
- Four wire connection at the contactor involves shorting the force and sense lines at spring probe the test interface board interconnect pad.
  - This method is used when an accurate measurement is desired, but Kelvin contacting at the device-under-test is not practically feasible.
- The four-wire sense measurement at the test interface board pad.
- This method of sensing provides the tester's measurement unit with the voltage level at the point where the contactor and the test interface board connect.

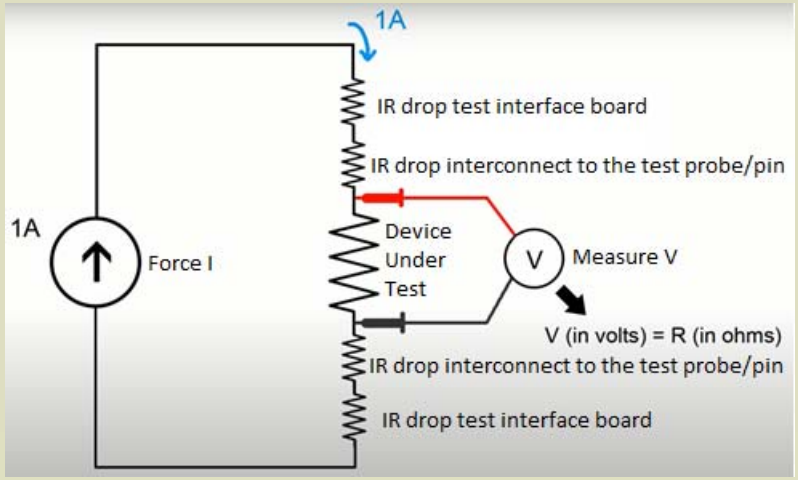




Four-Wire Interconnect at the Device-Under-Test

- Four wire connection at the Device-Under-Test

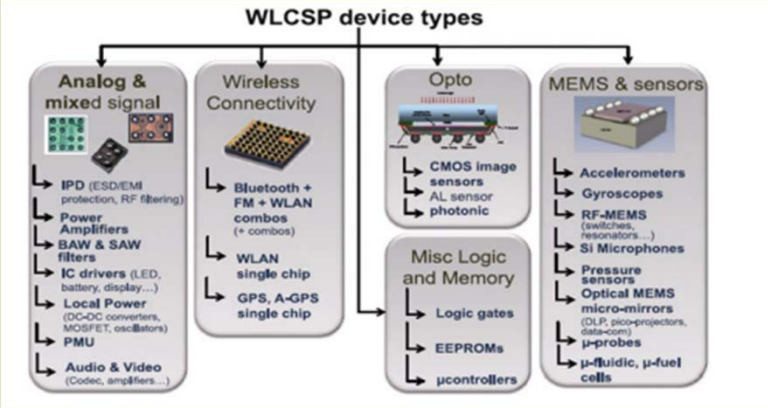




As shown, the sense path is a direct connect from the precision measurement unit all the way to the device-under-test. This is the best way to eliminate possible measurement errors caused by a voltage drop anywhere in the sense circuit.

The Next Generation of True Kelvin Spring Probes

- Needs driving a new generation of advanced package four-wire Kelvin contacting technology:
  - Increasing I/O density
    - Pitch shrink
    - Demand for full array Kelvin contacting at and below 400-micron pitch
  - Higher system integration
  - Smaller devices

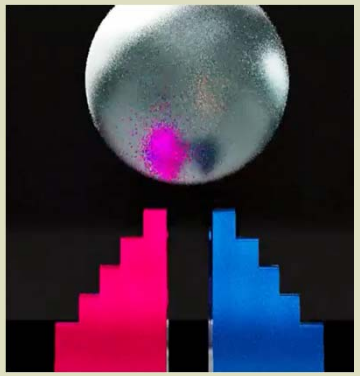


Yannou, J-M.: Market dynamics impact WLCSP adoption, 3D Packages, No. 22, Feb (2012)

I/O counts of less than 50 is considered by most to be mature.
There is plenty of activity underway in the industry to extend board level reliability of WLCSP to array size in more than 100 I/O counts with acceptable reliability.

WLCSP True Kelvin Requirements

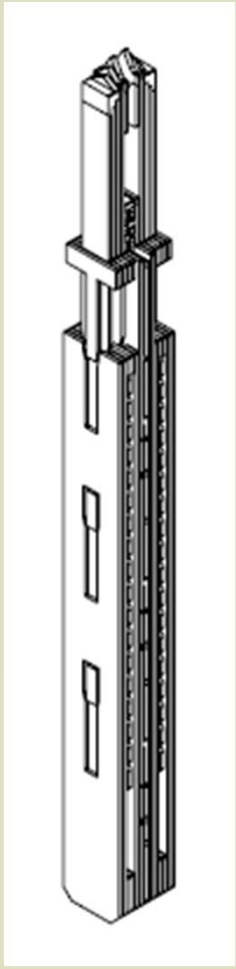
- True Four Wire Kelvin dual probe criteria.
  - Force and sense probe are electrically insulated.
  - Force and sense probes are mechanically isolated.
  - Probe tips most hit smaller targets.
  - Ball and bump diameters that are ≥ 200 microns.
  - Multiple and single site contacting.



- Force and sense probe are electrically isolated.
- Force and sense probes are mechanically isolated.
- 150 micron diameter ball

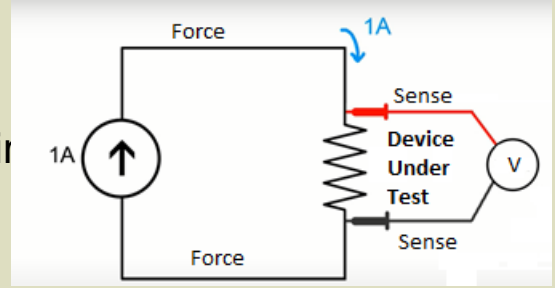
The Next Generation of True Kelvin Spring Probes

- Modular single probe dual probe construction
- Reduced forces = reduced contactor and probe head bowing
- One hole per dual Kelvin probes in the contactor body
  - Ease of field maintenance
  - Higher I/O density contacting



Summary

- The Goal: Reduce errors caused by test interconnect resistance
- Precision reliable connections all the way to the device under test.
- In low resistance measurements, the recommended method
  - Force through two wires
  - Measure (sense) through the other two wi
    - That is: four wire Kelvin



- Recommendation:
- Use four wire Kelvin interconnects when testing power controllers, voltage regulators, and mixed signal devices where precision is required.

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