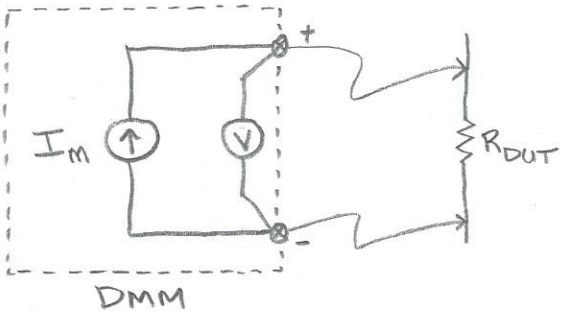
4-WIRE RESISTANCE MEASUREMENT
(KELVIN CONNECTION)

W2AEW

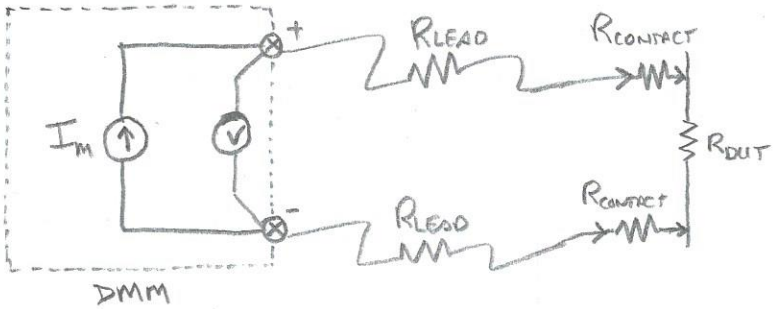
BACKGROUND

- HOW DMMs MAKE RESISTANCE MEASUREMENTS:



- INJECT KNOWN CURRENT (I_M) THROUGH DEVICE UNDER TEST (R_{DUT})
- MEASURE VOLTAGE
- CALCULATE $R = \frac{V}{I_M}$

- ERRORS / IN-ACCURACIES WHEN MEASURING LOW VALUES... (< FEW Ω)



- MEASURED RESISTANCE IS SUM $R_{DUT} + 2 \times R_{LEAD} + 2 \times R_{CONTACT}$
  - R_{LEAD} CAN BE ≈ 1Ω OR SO
  - $R_{CONTACT}$ CAN BE FEW HUNDRED mΩ AND CAN VARY WITH PRESSURE, CLEANLINESS, ETC.

- USING DELTA / ZERO / NULL...
  - CAN SUBTRACT $R_{LEAD} + R_{CONTACT}$ FROM MEASUREMENT... ... BUT $R_{CONTACT}$ CAN VARY
  - ACCURACY IS WORSE! HERE'S WHY...

GIVEN: $R_{LEAD} = 0.7\Omega$
$R_{CONTACT} = 0.2\Omega$
$R_{DUT} = 0.3\Omega$
DMM ACCURACY +/- 0.1%

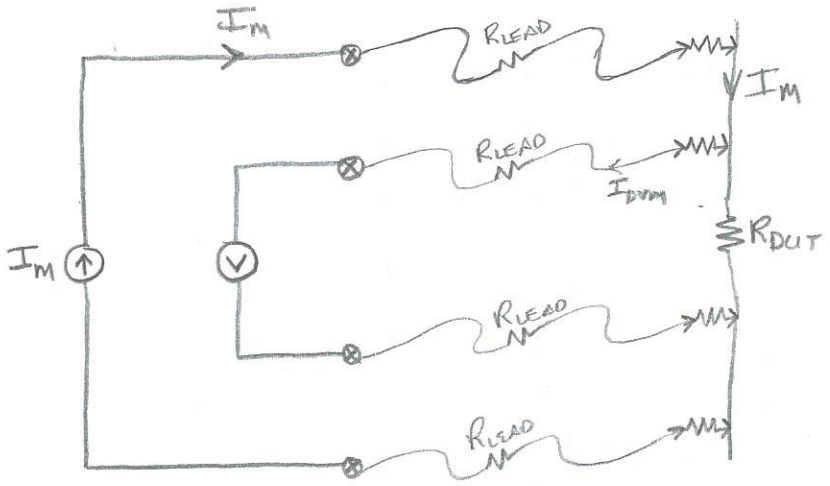
$R_{MEAS} = 2.1\Omega$ +/- 0.0021Ω

$R_{DUT} = 0.3\Omega$ +/- 0.0021Ω

+/- 0.7%

7x WORSE!

4-WIRE / KELVIN CONNECTION ELIMINATES LEAD & CONTACT R



- FOR LOW RESISTANCE, I_M IS TYPICALLY 1mA, 5mA, 10mA, ETC.
- $I_M \gg I_{DVM}$, THUS LEAD & CONTACT VOLTAGE DROPS ARE VERY SMALL

EXAMPLE: $I_M = 1mA$, $R_{DUT} = 0.3\Omega$

$$V_{R_{DUT}} = 0.3mV$$

$$I_{DVM} \cong \frac{0.3mV}{10M\Omega} = 30pA$$

∴ VOLTAGE DROP ON DVM LEADS IS VERY SMALL ... $< 1nV$