SUPPORT NOTE

SN-116

SelfCal Test Lead Set—P/N 16360

Introduction

Assuring the accuracy of Reedholm test systems is greatly simplified and improved through use of the Reedholm SelfCal Module (P/N 11038). However, accuracy of the SelfCal Module can be compromised by use of off-the-shelf test leads from even the best instrumentation suppliers. This support note describes a cable supplied by Reedholm that does not compromise accuracy.

Reedholm SelfCal Module

Reedholm's SelfCal module (SCM) provides a simple way to link accuracy of dc instrumentation in a Reedholm system to that of an external digital multimeter. If the accuracy of the digital multimeter (DMM) used to calibrate the SCM can be linked to a certified calibration laboratory, the accuracy of the Reedholm test system can thus be certified.

Measurements with External DMM

Under software control, the SCM outputs a series of voltages from ~250mV to ~100V that are measured by the external meter and then keyed into the software program. In order to make effective offset and gain corrections, the SCM outputs voltages in both polarities. In addition, the SCM has two precision resistors, 10kΩ and 10MΩ, that are used to convert voltage to current. Both need to be measured.

Voltage Accuracy Requirements

Proper operation of the Reedholm SelfCal correction software requires that the external DMM be calibrated within 0.01% of correct values for the SCM calibration points. Lead sets from companies that make precision DMM's do not compromise voltage measurement accuracy. However, they do compromise performance when measuring high resistance.

Minimizing Thermal EMF's

Thermally generated voltages are easily generated with lead sets if low-cost, electronic store components are used to make the cable. For both plugs and jacks, steel or nickel construction is favored with plating that reduces contact resistance. Unfortunately, such connectors can produce tens of microvolts of thermal emf just from normal handling. As a result, low voltage and low resistance measurements are often wrong and unstable. The only solution is to use material that has a low thermal emf relative to copper. That is why the Reedholm test lead set has banana jacks with a brass body and copper alloy springs, and why the alligator clips are made from copper.

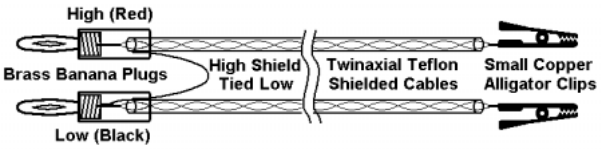

Figure 1 - Cable Construction Elements

Allowable Lead Set Resistance

In order to meet the accuracy requirements when measuring the 10kΩ SCM resistor, the lead set cannot have very high lead resistance. If one uses the rule of thumb that test lead resistance contribute <1/3 of the allowable error at 10kΩ, the lead resistance must be <0.0033% or <0.33Ω.

Resistance of the individual wires in the Reedholm twin-axial cables is 39Ω/1000' at 20°C. The twin-axial wires are connected in parallel, so the total resistance for the two 3' cables is:

$$R = [(39\Omega / 1000') / 2] \times 3' \times 2 = 0.117\Omega$$

Reedholm production limits require that the resistance measure <0.150Ω.

High Resistance Measurements

Most bench and system DMM's have good specifications for high resistance ranges, so measuring the SCM 10MΩ to adequate accuracy is not difficult. However, even the best standard DMM cables cause two problems measuring high resistance:

- Leakage resistance through the insulation between the leads is seldom $>10^9\Omega$, so 10MΩ measurements are often off by 1%, or more.
- Noise and capacitive pickup due to an unshielded high lead causes noisy and widely varying readings.

The figure below shows that the Reedholm test cable addressed the leakage resistance issue through use of Teflon insulated cables. Noise pickup due to the cable was eliminated through use of a shielded lead.

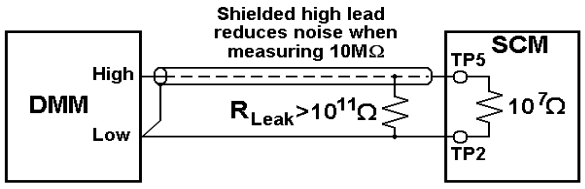

Figure 2 - Measuring 10MΩ Resistor

Reedholm Test Lead Set

The photograph below is of the 3' Reedholm Self-Cal Test Lead Set, P/N 16360.

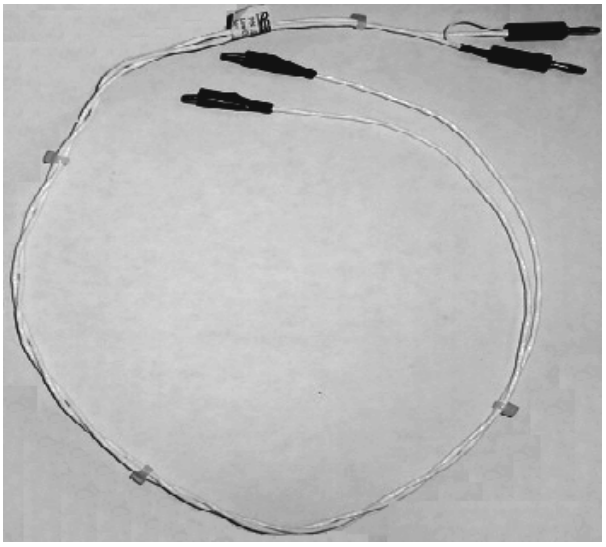

Figure 3 - SelfCal Cable