KEITHLEY

Model 8681 Miniature RTD Surface Probe

Description

The Model 8681 Miniature RTD Surface Probe is a 100Ω, platinum-type, 4-conductor, resistive temperature detector. The RTD tip offers a flat surface with minimal surface area to facilitate critical surface temperature measurements.

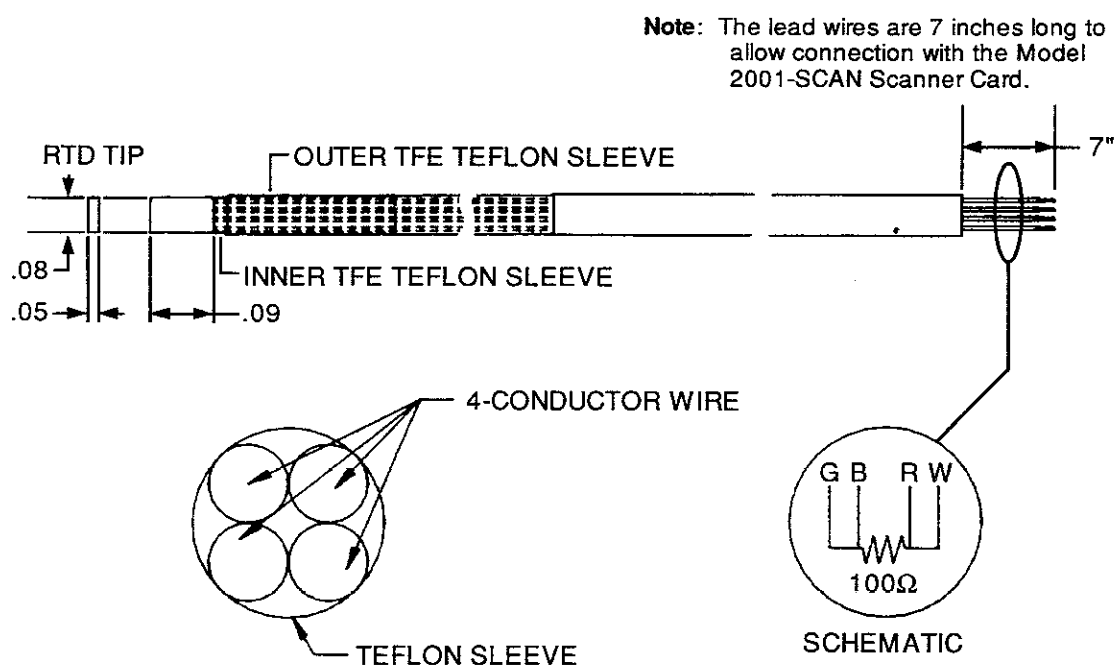

Figure 1. Model 8681 RTD probe

Table 1. Kit components

Qty.	Keithley part no.	Description
1	CA-105	RTD cable and probe

WARNING

To avoid a shock hazard and possible instrument damage, do not use this product to measure voltages exceeding 30V RMS, 42.4V peak.

Specifications

Total length:	39.37" (1.0m)
Lead wire type:	26 AWG, stranded. 0.25" stripped and tinned ends
Wire insulation and sleeve:	Teflon®
Maximum voltage*:	42V DC or AC peak
RTD type:	Thin-film platinum, 4-wire, PT385
Nominal resistance:	100Ω at 0°C
Tip dimensions:	0.05" × 0.08" × 0.09" (1.27mm × 2.03mm × 2.28mm)
Temperature range (RTD):	-200 to +600°C
Temperature range (wire):	-65 to +200°C
Current	0.1 to 2mA
Self-heating coefficient - (°C/mW):	Water flowing @: 0.2M/sec...0.005
	Air flowing @: 1M/sec...0.2
Response time in seconds - T to 0.5 step:	Water flowing @: 0.2M/sec...0.15
(Step = 10°C)	Air flowing @: 1M/sec...5.5

*Common mode to RTD substrate.

Model 8681 Error terms

Model 2001 RTD temperature readings are based on the 4-wire resistance measurements of platinum (resistance temperature detectors). As the temperature rises, its resistance increases as well, although not in a linear manner.

There are various error terms that must be added to the basic accuracy specifications of an RTD in close tolerance applications. Among them are the tolerance of the RTD, its self-heating characteristics, and thermal offset voltages introduced by connections to the detector.

RTD tolerance

Tolerance of the Model 8681 meets or exceeds the following specifications:

BS 1904:1984 Class A
DIN 43760-1980 Class A
IEC 751:1983 Class A
JIS C1604-1981 0.2

In accordance with DIN IEC 751, the permissible deviations for platinum resistance elements (tolerance grade Class A) are determined by the following equation:

Permissible deviation in °C = $\pm(0.15 + 0.002\ |t|)$

where $|t|$ is the absolute temperature in °C. Table 2 shows the permissible deviation in ohms and °C.

Table 2. Permissible deviations

Measuring temperature °C	Permissible deviation (Class A)	
	Ω	°C
-200	±0.24	±0.55
-100	±0.14	±0.35
0	±0.06	±0.15
100	±0.13	±0.35
200	±0.20	±0.55

Self-heating

An additional error term is due to self-heating of the RTD. Since a current must be sourced through the device to provide a voltage that can be measured, the current causes I^2R heating within the RTD, changing its temperature. Self-heating effects are described by the following equation:

Self-heating error = $I^2 \times R \times EK$

where: I is the source current
R is the resistance of the detector at a given temperature
EK is the self-heating coefficient in °C/mW

For example, the Model 2001 Multimeter sources about 0.6mA RMS in 4-wire, normal speed, with auto zero on. The Model 8681 has a self-heating coefficient of 0.2°C/mW in air flowing at 1m/sec. With this probe, the temperature rise due to self-heating at 0°C would be:

$$\begin{aligned} \text{Self-heating error} &= I^2 \times R \times EK \\ &= (0.6\text{mA})^2 \times 100\Omega \times 0.2°\text{C/mW} \\ &= 0.0072°\text{C} \end{aligned}$$

Note that when the Model 2001 is measuring temperature with an RTD, the resolution is 0.01°C, so this error term value could show up as one count.

Thermal offset voltages

Thermal offset voltages are generated by temperature differences at the junction of dissimilar metals. These voltages are introduced by the platinum-to-copper connections that are made when the RTD is measured.

The the Model 2001, 4-wire resistance measurements of RTDs are made in the normal manner, but during the measurement process, thermal voltages are cancelled out with the offset compensated ohms feature. This cancellation is achieved by making two measurements:

- The first measurement is the voltage across the SENSE Ω4-WIRE HI and LO terminals with current flowing through the RTD probe.
- The second measurement is made with the no current flowing through the probe.

The voltage measurements are then used by the Model 2001 to calculate the temperature. Because the RTD has an on/off cycle, the off cycle allows thermal voltages to be measured. Also, probe heating is reduced.

Figure 2 shows a schematic of the offset voltages sources when using a Model 8681 RTD probe. V_1 through V_4 represents thermal contact voltages generated by dissimilar metals. V_{RTD} is the voltage developed across the probe when current I is flowing.

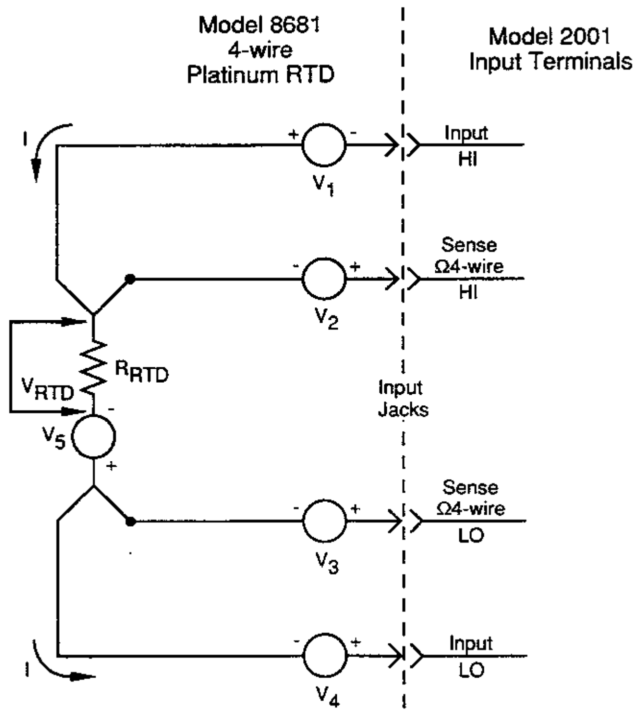

Figure 2. Offset voltage sources of RTD resistance measurement

When current is flowing through the RTD probe, the voltage, as seen by the SENSE Ω4-WIRE HI and LO terminals is:

$V_{HI} - V_{LO} = V_2 + V_{RTD} + V_5 + V_3$

With no current flowing, the voltage between these two terminals is:

$V_{HI} - V_{LO} = V_2 + V_5 + V_3$

Since the voltage is measured at the SENSE Ω4-WIRE terminals, V_1 and V_4 are insignificant.

The resistance of the probe can then be calculated as follows:

$R_{RTD} = R_{REF} \times V_{RTD} / (V_{REF\,HI} - V_{REF\,LO})$