Quantifying the 8-wire RTD Connection Errors in the 269Plus

GE Power Management No. GET-8421

DESCRIPTION

The increased current in final RTD return and compensation leads result in a measurement error. This error increases as more RTDs are added to the circuit.

The 269Plus measures the "hot" (V12) and "compensation" (V23) voltages on its inputs to calculate the voltage across the RTD 1.

The difference between V12 and V23 provides an accurate measurement of the RTD 1 voltage provided that all three leads are connected between RTD 1 and the 269Plus to effectively compensate for the voltage drop across the wire leads.

However, in the case of a 8-wire connection a measurement error is introduced.

RTD 1 ERROR

For RTD 1, the 269Plus injects a current of I = 8 mA from both Terminals 1 and 3. Similar currents are injected for the other five RTDs. Assume that the lead resistance (R) and the jumper resistance (R_j) are of equal magnitude.

Observe the current distribution in the following figure, neglecting the dotted internal connection resistances between the "return" terminals and assume that

$$R = R_{retn} + R_{comp} \quad \text{(EQ 1)}$$

The "hot" voltage between Terminals 1 and 2 for RTD 1 is:

$$\begin{aligned} V_{1\_2} &= IR + IR_{rtd} + 15IR_j + 5IR_{retrn} \\ &= IR_{rtd} + 6IR + 15IR_j \end{aligned} \quad \text{(EQ 2)}$$

The "compensation" voltage between Terminals 2 and 3 for RTD 1 is:

$$\begin{aligned} V_{2\_3} &= 5IR_{retrn} + 5IR_{comp} + 15IR_j \\ &= 10IR + 15IR_j \end{aligned} \quad \text{(EQ 3)}$$

The "hot" voltage minus the "compensation" voltage gives the RTD 1 voltage:

$$V_{RTD1} = V_{1\_2} - V_{2\_3} = (IR_{rtd} + 6IR + 15IR_j) - (10IR + 15IR_j)$$
$$= IR_{rtd} - 4IR \qquad \text{(EQ 4)}$$

Therefore, the error magnitude is $4IR$.

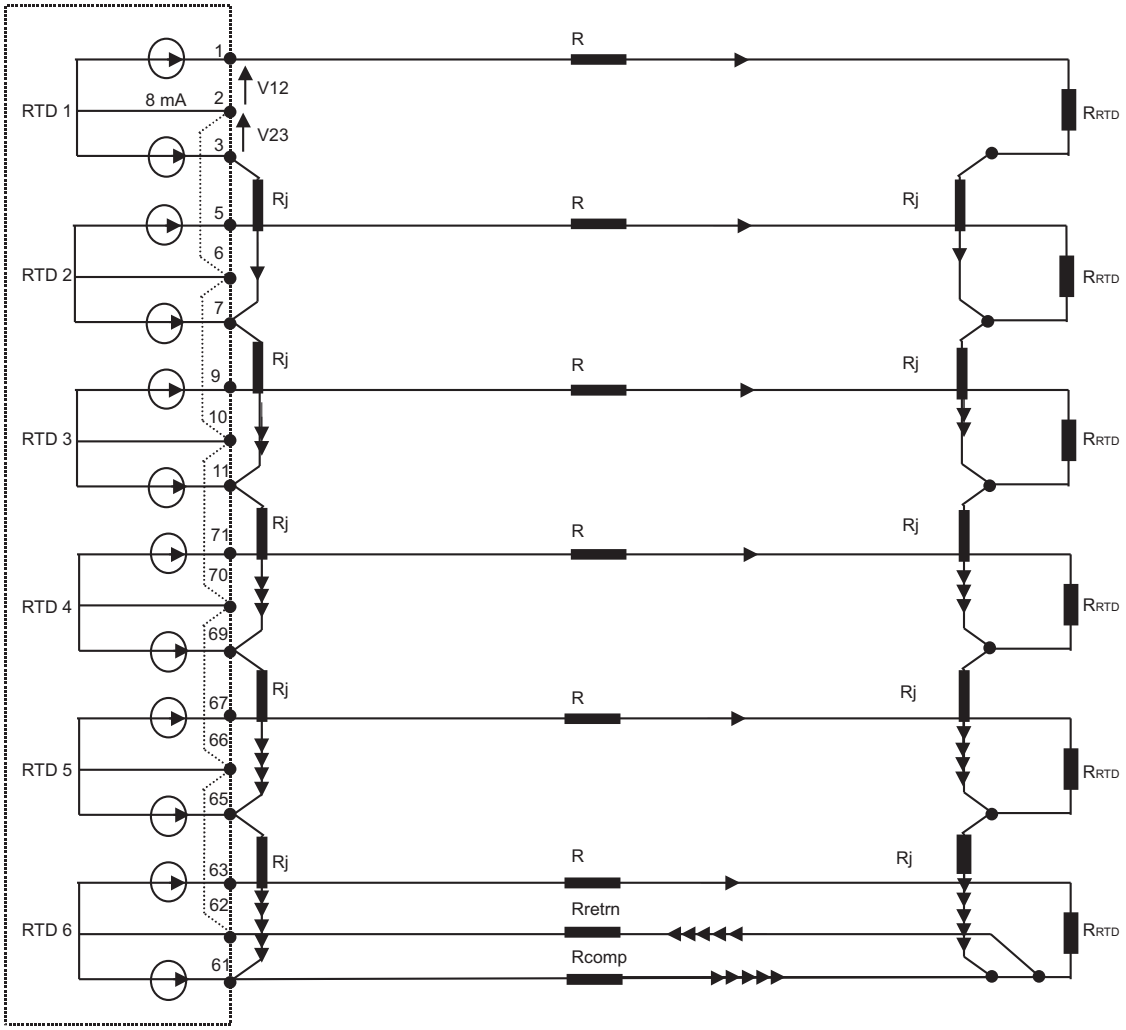

FIGURE 1. 8-wire RTD Connection

RTD 4 ERROR

Similarly for the RTD 4 inputs, the “hot” voltage between Terminals 71 and 70 is:

$$\begin{aligned} V_{71\_70} &= IR + IR_{rtd} + 9IR_j + 5IR_{retrn} \\ &= IR_{rtd} + 6IR + 9IR_j \end{aligned} \quad \text{(EQ 5)}$$

The “compensation voltage between Terminals 70 and 69 for RTD 4 is:

$$\begin{aligned} V_{70\_69} &= 5IR_{retrn} + 5IR_{comp} + 9IR_j \\ &= 10IR + 9IR_j \end{aligned} \quad \text{(EQ 6)}$$

The "hot" voltage minus the "compensation" voltage for RTD 4 gives the RTD 4 voltage:

$$\begin{aligned} V_{\text{RTD1}} &= V_{71\_70} - V_{70\_69} = (IR_{rtd} + 6IR + 9IR_j) - (10IR + 9IR_j) \\ &= IR_{rtd} - 4IR \end{aligned} \quad \text{(EQ 7)}$$

Therefore, the error magnitude for RTD 4 is also 4*IR*.

CONCLUSION

For all the RTDs, the error magnitude is 4*IR*, since:

$$V_{hot} - V_{comp} = IR_{rtd} - 4IR \quad \text{(EQ 8)}$$

The error tends to lower the resistance.

Since the single return wire connection introduces this error, it is generally not recommended. Rather, all three leads (hot, compensation, and return) should be connected.

For a single return-wire connection, the error can be minimized by reducing the lead resistance *R* and/or using less RTDs. As demonstrated above, the error magnitude is the same for all the RTDs.