RTD Lead Wire Error: 2-Wire, 3-Wire and 4-Wire

Temperature error that lead wire resistance adds to a Pt100 or Pt1000 reading in 2-wire, 3-wire and 4-wire connections, from cable length and resistance.

Method: IEC 60751 Callendar–Van Dusen slope

Input parameters

Unit system: SI

Parameter	Value	Unit
RTD resistance at 0 °C (100 or 1000)	100.00	Ω
Measured temperature	200.00	°C
Connection	2-wire	
Resistance of one conductor per km From the cable data sheet at the cable's temperature.	13.000	Ω/km
Cable length, sensor to instrument (one way)	100.00	m
Mismatch between the leads, 3-wire (share of one lead)	5.0000	%

Calculated results

Parameter	Value	Unit
Resistance of one lead	1.3000	Ω
Resistance added to the reading	2.6000	Ω
RTD sensitivity at the temperature (Ω per K)	0.36773	
Temperature error (reads high)	7.0704	K

Notes for this case

- Lead resistance also changes with cable temperature; 3-wire cancels only matched leads, 4-wire cancels them fully.

Formula and method

$$R_L = rL$$

$$\Delta R = 2R_L \ (2-\text{wire}),\ mR_L \ (3-\text{wire}),\ 0 \ (4-\text{wire})$$

$$\Delta T = \frac{\Delta R}{dR/dT}, \quad dR/dT = R_0\left[A + 2Bt + C(4t^3 - 300t^2)\right] \quad (C = 0 \text{ for } t \geq 0\ ^\circ\text{C})$$

Variables

R_0	resistance at 0 °C	Ω
T	measured temperature	K
t	temperature in °C	°C
wiring	connection	-
r	resistance of one conductor per km	Ω/m
L	cable length, one way	m
m	lead mismatch (3-wire)	-
A, B, C	IEC 60751 coefficients	1/°C, 1/°C², 1/°C⁴
R_L	resistance of one lead	Ω
ΔR	added resistance	Ω
dR/dT	sensitivity	Ω/K
ΔT	temperature error	K

Method and standards

The added resistance of the leads reads as extra temperature; dividing by the RTD's sensitivity (the slope of the IEC 60751 curve, with the C term below 0 °C) gives the error.

Assumptions and limits

- Steady current; cable resistance at its actual temperature.
- The sensitivity dR/dT is shown in Ω per K in every unit system.

References

- IEC 60751 Callendar–Van Dusen slope

Report details

Report reference	FCC-629M-RYAH (the same inputs always give the same reference)
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Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/instrumentation/temperature/rtd-lead-wire-error

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.