Technical References

Resistance Characteristics

Principle of temperature measurement using Pt-RTD is based on the measurement of electrical resistance. Resistance value of Pt-RTD varies almost linearly as ambient temperature changes, resulting in a precise predetermined relationship between temperature and resistance. The relationship can be expressed exactly as an empirical mathematical equation:

$$R_T = R_0 [\, 1 + aT - bT^2 - cT^3 (T - 100) \,]$$

where

R_T resistance at a certain temperature T
R_0 resistance at 0°C
a, b, c coefficient (refer to the following tables)

Coefficient for TCR = 3850 PPM/°C(IEC751 Standard)

Temperature	a	b	c
$T < 0°C$	3.90830×10^{-3}	5.7750×10^{-7}	4.1830×10^{-12}
$T \geqq 0°C$	3.90830×10^{-3}	5.7750×10^{-7}	0

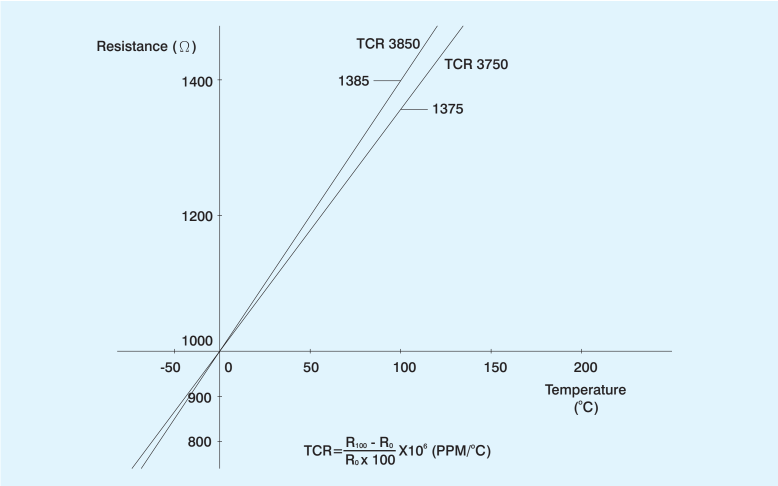
Coefficient for TCR = 3750 PPM/°C

Temperature	a	b	c
$T < 0°C$	3.81019×10^{-3}	6.01875×10^{-7}	6.14500×10^{-12}
$T \geqq 0°C$	3.81019×10^{-3}	6.01875×10^{-7}	0

Resistance at 0°C (Ω)	100	500	1000	
TCR (PPM/°C)	3850	3850	3850	3750
Temperature (°C)	Resistance (Ω)			
-50	80.31	401.53	803.06	807.87
0	100.00	500.00	1000.00	1000.00
50	119.40	596.99	1193.97	1189.00
100	138.51	692.53	1385.06	1375.00
150	157.33	786.63	1573.25	1557.99
200	175.86	879.28	1758.56	1737.96
250	194.10	970.49	1940.98	1914.93
300	212.05	1060.26	2120.52	2088.89
350	229.72	1148.58	2297.16	2259.84
400	247.09	1235.46	2470.92	2427.78
450	264.18	1320.90	2641.79	2592.71
500	280.98	1404.89	2809.78	2754.63
550	297.49	1487.44	2974.87	2913.54
600	313.71	1568.54	3137.08	3069.44
650	329.64	1648.20	3296.40	3222.33

Complete table of increment 1°C or 1°F is available on request

Temperature - Resistance Diagram



Temperature Coefficient of Resistance (TCR)

TCR indicates average resistance change rate per degree between 0°C and 100°C. TCR is defined as the following formula. We offer Pt-RTD with TCR both of 3850 PPM/°C and 3750 PPM/°C, where 3850 PPM/°C conforms to both IEC751 and DIN43760 standards.

$$TCR = \frac{R_{100} - R_0}{R_0 \times 100} \times 10^6 \ (PPM/^\circ C)$$

where

R_0 resistance at 0°C

R_{100} resistance at 100°C

Resistance Tolerance and Temperature Deviation

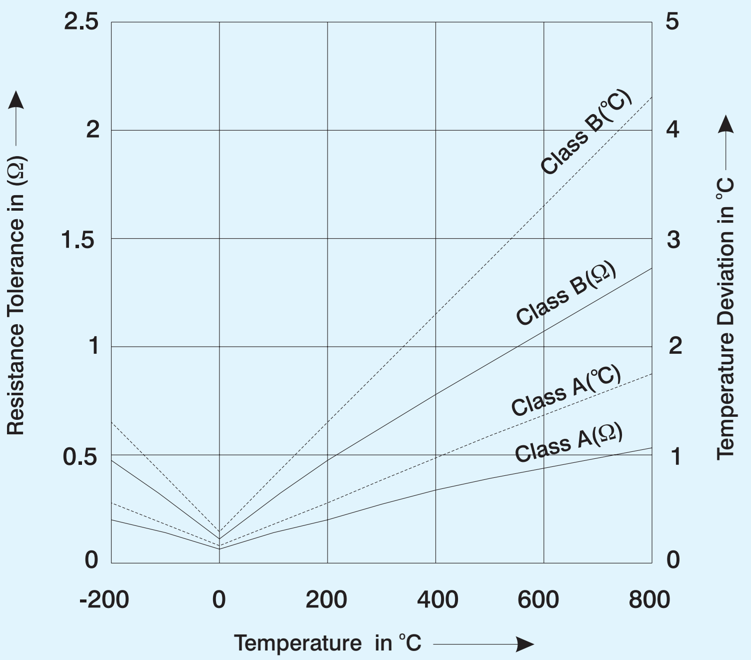
Pt-RTD can be categorized as class A or B, according to its resistance tolerance and temperature deviation. Resistance tolerance and temperature deviation in accordance with DIN43760 and IEC751 are listed in the following table.

Class	Resistance Tolerance(%) at 0°C	Temperature Deviation(°C)
A	±0.06	±(0.15 + 0.002 |T|)
B	±0.12	±(0.30 + 0.005 |T|)

Resistance Tolerance and Temperature Deviation Table of Pt-100

Temperature (℃)	Nominal Resistance (Ω)	class A		class B	
		Resistance Tolerance(Ω)	Temperature Deviation(℃)	Resistance Tolerance(Ω)	Temperature Deviation(℃)
-50	80.31	±0.10	±0.25	±0.22	±0.55
0	100.00	±0.06	±0.15	±0.12	±0.30
100	138.51	±0.13	±0.35	±0.30	±0.80
200	175.86	±0.20	±0.55	±0.48	±1.30
300	212.05	±0.27	±0.75	±0.64	±1.80
400	247.09	±0.33	±0.95	±0.79	±2.30
500	280.98	±0.38	±1.15	±0.93	±2.80
600	313.71	±0.43	±1.35	±1.06	±3.30

Resistance Tolerance and Temperature Deviation Table of Pt-100



Self-Heating Effect

Heat energy is generated while applying electric current through Pt-RTD. The self-heating effect might result in errors in temperature measuring. Self-heating effect is characterized as dissipation constant δ :

$$\delta = \frac{S\,(P_2 - P_1)}{(R_2 - R_1)} \quad (mW/^{\circ}C)$$

Where

δ Dissipation Contant (mW/°C)

R_1 resistance at lower power dissipation (Ω)

R_2 resistance at higher power dissipation (Ω)

S thermometer sensitivity (dR/dT) at the respective temperature (Ω/°C)

P_1 lower power dissipation (mW)

P_2 higher power dissipation (mW)

Measurement errors due to self-heating ($\triangle$T) can be calculated by the following formula:

$$\triangle T = \frac{P}{\delta} \quad (^{\circ}C)$$

where

$\triangle$T= Self-heating in °C

P= Electrical power dissipation in the resistance in mW

δ = Dissipation constant in mW/°C

Thermal Response Time

The thermal response time (t_{90}) is the time interval that Pt-RTD needs to respond 90% of temperature change. The response time is the time period, t_2 - t_1, where the following formula holds true:

$$t_{90} = t_2 - t_1 = \text{thermal response time (sec.)}$$

$$Rt_2 = Rt_1 + 0.9\ (Rt_3 - Rt_1)$$

where

Rt_i resistance at time t_i (i = 1, 2, 3)