Resistance Temperature Detectors

SPECIFICATIONS

Unless otherwise specified, Durex's RTD assemblies include photo-lithographically structured, high-purity platinum thin-film elements laser trimmed to precise resistance values. These sensors feature brief response times, excellent long term stability, low self heating and excellent resistance to vibration and temperature shocks.

Thermal Response Time

The response time $T_{0.63}$ is the time the sensors need to respond to 63% of the change in temperature.
The response time depends on the sheath dimensions, but can be as low as 1.2 seconds.

Long Term Stability

The change of ohmage after 1,000 hours at maximum operating temperature amounts to less than 0.03%.

Self Heating

To measure the resistance, an electric current has to flow through the element, which will generate heat energy resulting in errors of measurement. To minimize error, the testing current should be kept low (approximately 1mA for Pt-100).

Temperature error $\Delta T = RI^2/E$ with:

E = self-heating coefficient in mW/K
R = resistance in kΩ
I = measuring current in mA

The self-heating coefficient (E) for the standard elements used in Durex RTD assemblies is 4 mW/K in air and 40 mW/K in water.

Measuring Current

Measurement current causes heating of the platinum thin-film sensor. The resulting temperature error is given by: $\Delta T = P/E$ with the power loss $P = I^2R$, and the self-heating coefficient E in mW/K.

The amount of thermal transfer from the sensor in the application determines how much measuring current can be applied. There is no bottom limit of the measurement current with platinum thin-film. The measurement current depends highly on the application in use.

We recommend at:

100Ω: typically 1mA, maximum 5mA

500Ω: typically 0.5mA, maximum 3mA

1000Ω: typically 0.3mA, maximum 2mA

2000Ω: typically 0.2mA, maximum 1mA

Nominal Values

The nominal or rated value of the sensor is the target value of the sensor resistance at 0°C. The temperature coefficient α is defined as $\alpha = \frac{R_{100} - R_0}{100 - R_0}$ (K^{-1}) and has the numerical value of 0.00385 K^{-1} according to DIN IEC 751.

In practice, a value multiplied by 10^6 is often entered: $TCR = 10^6 \times \frac{R_{100} - R_0}{100 - R_0} \times$ (ppm/K)

In this case, the numerical value is 3850 ppm/K.

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Temperature Characteristic Curve

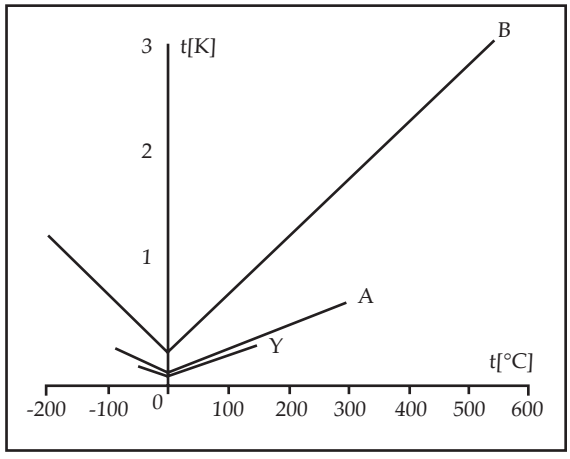
The temperature characteristic curve determines the dependence of the electrical resistivity on the temperature. The following definition of the temperature curve according to DIN EN 60751 standard applies:

-200 to 0°C	$R(t) = R_0[1+(A*t)+(B*t^2)+C(t-100)t^3]$
0 to 250°C	$R(t) = R_0[1+(A*t)+(B*t^2)]$

Platinum (3850 ppm/K):
$A = 3.9083 * 10^{-3}$ [°C^{-1}]
$B = -5.775 * 10^{-7}$ [°C^{-2}]
$C = -4.183 * 10^{-12}$ [°C^{-4}]

Platinum (3750 ppm/K):
$A = 3.9083 * 10^{-3}$ [°C^{-1}]
$B = -6.01888 * 10^{-7}$ [°C^{-2}]
$C = -6 * 10^{-12}$ [°C^{-4}]

R_0 = Resistance value in ohm at 0°C
t = temperature in accordance with ITS 90



Tolerance Field

Tolerance Classes

The temperature sensors are divided into classes according to their limit deviations:

Class	± limit deviations in °C (K)	IST AG designation	Temperature range
DIN 60751, class B	0.30 + 0.005 x |T|	B	-200°C to 850°C
DIN 60751, class A	0.15 + 0.002 x |T|	A	-90°C to 300°C
⅓ DIN 60751, class B	0.10 + 0.0017 x |T|	Y	-50°C to 150°C

|T| is the numerical value of the temperature °C without taking into account either negative or positive signs.

Special selection of sensors upon request (pairings, groupings, special tolerances).

Calibration Services

Durex RTD calibrations are fully traceable to the National Institute of Standards and Technology (NIST) and are useful for defining the exact temperature coefficient of the sensor. For sensor applications below 32°F (0°C), a cryogenic range calibration is recommended. Certificates are supplied with all calibrations. Printed tables of interpolated values are only supplied with cryogenic range calibrations.

RTD Assembly Temperature Ranges

Style: R1L, R2L, R3L, R4L — The maximum rated temperature for these four styles is 500°F. Typically they are constructed with Teflon leads and the lead end is protected with an epoxy seal. This epoxy seal provides a moisture resistant barrier.

Style: R1M, R2M, R3M, R4M — The maximum rated temperature for these next four styles is 900°F. They are constructed with high temperature fiberglass insulated conductors. The lead end is sealed and protected with a high temperature cement.

Style: R1P, R2P, R3P, R4P — The maximum rated temperature for these last four styles is 1200°F. Their construction features highly compacted magnesium oxide insulation. Nickel conductors provide for extended temperature ratings and harsh environments.

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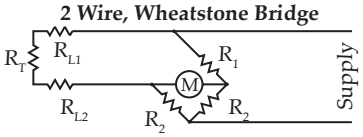
Available RTD Elements

Code	Element Type	Temperature Coefficient	Tolerance at 0°C
A	100 ohm Platinum	.00385	.1%
B	100 ohm Platinum	.00385	.06%
C	100 ohm Platinum	.00385	.03%
D	500 ohm Platinum	.00385	.1%
E	1000 ohm Platinum	.00385	.1%
F	2000 ohm Platinum	.00385	.1%
G	100 ohm Platinum	.00392	.1%
H	100 ohm Platinum	.00392	.03%
J	120 ohm Nickel	.00672	.5%
K	604 ohm Nickel Iron	.00520	.5%

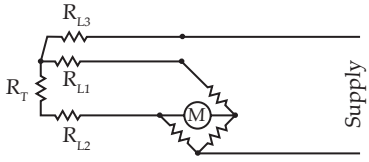
Wiring Diagrams

2 Wire, Wheatstone Bridge



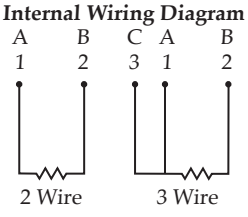
The meter reads R_T + the two lead resistances R_{L1} and R_{L2}

3 Wire, Wheatstone Bridge

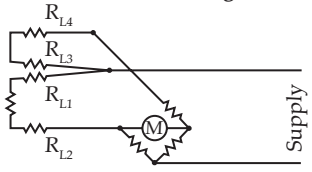


One lead resistance is included in each of the two arms of the bridge. The errors reduce to R_{L1} - R_{L2}

Internal Wiring Diagram

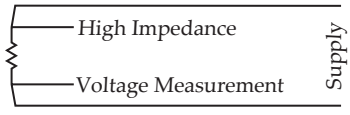


4 Wire, Compensated Wheatstone Bridge

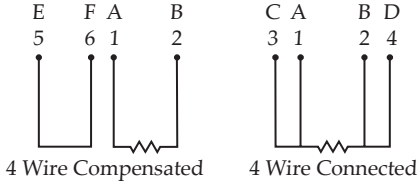


In this type R_{L3} and R_{L4} appear in one arm of the bridge. R_{L1} and R_{L2} appear in the other. Errors are $R_{L1}+R_{L2}-R_{L3}-R_{L4}$

4 Wire, Connected



Errors can be made negligible by having a very high input impedance amplifier.



Code Definitions

"L" Dimensions				"B" Dimensions				"A" Dimensions		Fractional Dimension Letter Code			
"L" dimensions are specified in whole inches and a single alpha character which represents a fraction. Enter the three digit code as follows:				"B" dimensions are specified in fractions from ⅛" to 1". Use the single alpha character to indicate the tip length. Enter the code as follows:				"A" dimensions are specified in whole inches only. Enter the three digit code as follows:		1/16"	A	11/16"	L
										⅛"	B	¾"	M
										3/16"	C	13/16"	N
										¼"	D	7/8"	P
										5/16"	E	15/16"	R
3"	030	10 5/8"	10K							⅜"	F	1"	S
4 ½"	04H	12"	120	⅛"	B	⅝"	K	9"	009	7/16"	G	0	No
6 ¼"	06D	15 ⅜"	15F	¼"	D	¾"	M	12"	012	½"	H	Fraction	
7 ⅞"	07P	17 ¾"	17M	⅜"	F	⅞"	P	36"	036	9/16"	J		
9 5/8"	09K	22 ⅛"	22B	½"	H	1"	S	144"	144	5/8"	K		

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