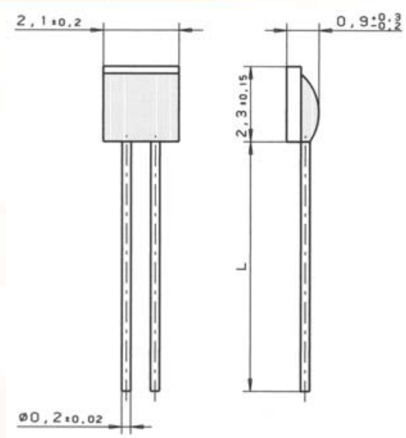
Platinum Resistance Temperature Detector 222

Mseries PRTDs are designed for large volume applications where long term stability, interchangeability and accuracy over a large temperature range are vital. Typical applications are Automotive, White goods, HVAC, Energy management, Medical and Industrial equipment.

Nominal Resistance R_0	Tolerance
100 Ohm at 0℃	DIN EN 60751, class B DIN EN 60751, class A DIN EN 60751, class 1/3 DIN
500 Ohm at 0℃	DIN EN 60751, class B
1000 Ohm at 0℃	DIN EN 60751, class B DIN EN 60751, class A DIN EN 60751, class 1/3 DIN

The measuring point for the nominal resistance is defined at 8 mm from the end of the sensor body.



Specification	DIN EN 60751 (according to IEC 751)
Temperature range	-70℃ to +500℃ (continuous operation) (temporary use to 550 ℃ possible) Tolerance class B: - 70 ℃ to + 500 ℃ Tolerance class A: - 50 ℃ to + 300 ℃ Tolerance class 1/3 DIN: 0 ℃ to + 150 ℃
Temperature coefficient	TCR = 3850 ppm/K
Leads	Pt clad Ni wire Recommend connection technology: Welding, Crimping and Brazing
Lead lengths (L)	10 mm +- 1 mm
Long-term stability	max. R_0-drift 0.04% after 1000 h at 500℃
Vibration resistance	at least 40 g acceleration at 10 to 2000 Hz, depends on installation
Shock resistance	at least 100 g acceleration with 8ms half sine wave, depends on installation
Environmental conditions	unhoused for dry environments only
Insulation resistance	> 100 MΩ at 20℃; > 2 M Ω at 500℃
Self heating	0.4 K/mW at 0℃
Response time	water current (v = 0.4 m/s): $t_{0.5}$ = 0.05 s, $t_{0.9}$ = 0.15 s air stream (v = 2 m/s): $t_{0.5}$ = 3.0 s, $t_{0.9}$ = 10.0 s
Measuring current	100 Ω: 0.3 to 1.0 mA 500 Ω: 0.1 to 0.7 mA 1000 Ω: 0.1 bis 0.3 mA (self heating has to be considered)
Note	Other tolerances, values of resistance and wire lengths are available on request.

We reserve the right to make alterations and technical data printed. All technical data serves as a guideline and does not guarantee particular properties to any products.

Platinum Thin-Film Sensors in Operation

The electrical resistance of a platinum measuring element changes exactly defined by the temperature so that this relationship can be utilized for thermometry.
The relationship is listed in the first table of basic values for Pt 100 (TC = 3850 ppm/K) and in the second table of basic values for Pt 200 (TC = 3770 ppm/K).

Described in more detail below are a few of the parameters influenced by platinum thin-film sensors during their operating time.

Measured currents and self-heating
The supply current heats the platinum thin-film sensor. The resulting temperature measuring error is given by:
$\Delta T = P*S$

with P, the power loss = I^2R and S, the self-heating coefficient in K/mW.

The self-heating coefficients are specified in the data sheets for the individual products. Self-heating is dependent on thermal contact between the platinum thin-film sensor and the surrounding medium. If the heat transfer to the environment is efficient, higher measured currents can be used.

Platinum thin-film sensors set no lower limits for measured currents. They depend to a great extent on the application. We recommend:

100 Ω:	0.3 to max 1.0 mA
500 Ω:	0.1 to max 0.7 mA
1000 Ω:	0.1 to max 0.3 mA
2000 Ω:	0.1 to max 0.3 mA
10.000 Ω:	0.1 to max 0.25 mA

Basic values for 100 Ω platinum temperature sensors as per DIN EN 60751 (TS90) TC = 3850 ppm/K

°C	Ω	Ω/°C	°C	Ω	Ω/°C	°C	Ω	Ω/°C	°C	Ω	Ω/°C
-200	18.52	0.432	70	127.08	0.383	340	226.21	0.352	610	316.92	0.320
-190	22.83	0.429	80	130.90	0.382	350	229.72	0.350	620	320.12	0.319
-180	27.10	0.425	90	134.71	0.380	360	233.21	0.349	630	323.30	0.318
-170	31.34	0.422	100	138.51	0.379	370	236.70	0.348	640	326.48	0.317
-160	35.34	0.419	110	142.29	0.378	380	240.18	0.347	650	329.64	0.316
-150	39.72	0.417	120	146.07	0.377	390	243.64	0.346	660	332.79	0.315
-140	43.88	0.414	130	149.83	0.376	400	247.09	0.345	670	335.93	0.313
-130	48.00	0.412	140	153.58	0.375	410	250.53	0.343	680	339.06	0.312
-120	52.11	0.409	150	157.33	0.374	420	253.96	0.342	690	342.18	0.311
-110	56.19	0.407	160	161.05	0.372	430	257.38	0.341	700	345.28	0.310
-100	60.26	0.405	170	164.77	0.371	440	260.78	0.340	710	348.38	0.309
-90	64.30	0.403	180	168.48	0.370	450	264.18	0.339	720	351.46	0.308
-80	68.33	0.402	190	172.17	0.369	460	267.56	0.338	730	354.53	0.307
-70	72.33	0.400	200	175.86	0.368	470	270.93	0.337	740	357.59	0.305
-60	76.33	0.399	210	179.53	0.367	480	274.29	0.335	750	360.64	0.304
-50	80.31	0.397	220	183.19	0.365	490	277.64	0.334	760	363.67	0.303
-40	84.27	0.396	230	186.84	0.364	500	280.98	0.333	770	366.70	0.302
-30	88.22	0.394	240	190.47	0.363	510	284.30	0.332	780	369.71	0.301
-20	92.16	0.393	250	194.10	0.362	520	287.62	0.331	790	372.71	0.300
-10	96.09	0.392	260	197.71	0.361	530	290.92	0.330	800	375.70	0.298
0	100.00	0.391	270	201.31	0.360	540	294.21	0.328	810	378.68	0.297
10	103.90	0.390	280	204.90	0.358	550	297.49	0.327	820	381.65	0.296
20	107.79	0.389	290	208.48	0.357	560	300.75	0.326	830	384.60	0.295
30	111.67	0.387	300	212.05	0.356	570	304.01	0.325	840	387.55	0.294
40	115.54	0.386	310	215.61	0.355	580	307.25	0.324	850	390.48	0.293
50	119.40	0.385	320	219.15	0.354	590	310.49	0.323			
60	123.24	0.384	330	222.68	0.353	600	313.71	0.322			

Basic values for 200 Ω Pt temperature sensors with special automotive TC = 3770 ppm/K

°C	Ω	°C	Ω	°C	Ω	°C	Ω	°C	Ω/°C
-40	169.18	170	326.79	380	474.07	590	611.04	800	737.68
-30	176.92	180	334.04	390	480.83	600	617.30	810	743.45
-20	184.64	190	341.26	400	487.56	610	623.54	820	749.20
-10	192.33	200	348.46	410	494.27	620	629.76	830	754.93
0	200.00	210	355.64	420	500.96	630	635.95	840	760.63
10	207.65	220	362.79	430	507.62	640	642.12	850	766.31
20	215.27	230	369.92	440	514.26	650	648.27	860	771.97
30	222.87	240	377.03	450	520.87	660	654.40	870	777.60
40	230.44	250	384.11	460	527.46	670	660.50	880	783.21
50	237.99	260	391.17	470	534.03	680	666.58	890	788.80
60	245.52	270	398.21	480	540.58	690	672.63	900	794.36
70	253.03	280	405.22	490	547.10	700	678.66	910	799.90
80	260.51	290	412.21	500	553.60	710	684.67	920	805.42
90	267.97	300	419.18	510	560.08	720	690.65	930	810.91
100	275.40	310	426.12	520	566.53	730	696.61	940	816.38
110	282.81	320	433.04	530	572.96	740	702.55	950	821.82
120	290.20	330	439.94	540	579.36	750	708.46	960	827.24
130	297.56	340	446.81	550	585.74	760	714.35	970	832.64
140	304.90	350	453.66	560	592.10	770	720.22	980	838.02
150	312.22	360	460.49	570	598.44	780	726.06	990	843.37
160	319.52	370	467.29	580	604.75	790	731.88	1000	848.70

Thermal response times
The thermal response time is the time required by a platinum thin-film sensor to react to a step temperature change with a change in resistance, which corresponds to a certain percentage of the temperature change.
DIN EN 60751 recommends the use of times for a 50% and 90% change, $t_{0.5}$ and $t_{0.9}$ are indicated in the data sheets for water and air flows of 0.4 or 2.0 m/s. Conversion to other media and speeds can be carried out with the aid of the VDI/VDE 3522 manual.

Thermo-electric effect
Platinum thin-film sensors generate practically no electromotive power.

Vibration and impact
Platinum thin-film sensors are solid components and as such extremely resistant to vibration and impact. The qualifying factor is normally the mounting method. Testing well mounted platinum thin-film sensors revealed:

Vibration resistance:	40 g over a range of 10 Hz up to 2 kHz
Shock resistance:	100 g, 8 ms half sine

General electrical parameters of the elementary sensors

Inductivity:	< 1µH
Capacity:	1 to 6 pF
Insulation:	> 10 MΩ at 20°C > 1 MΩ at 500°C
High-voltage strength:	> 1000 V at 20°C > 25 V at 500°C

Mechanical load capability
Platinum thin-film sensors are sensitive to mechanical loads that may, under extreme conditions, lead to a rupture or chipping of the glass cover or the ceramic substrate. Improper handling or unsuitable mounting processes may lead to permanent changes in the measuring signals.

During manufacture, the connection wires are subjected to pulling and tear resistance tests in accordance with MIL 833 and IEC 40046. In the case of nickel/platinum coated wires, the products are approved when $F_{axial} > 8$ N (without glass ceramic connection sealing).

Repeatability

Platinum thin-film sensors manufactured by Heraeus Sensor Technology are characterized by a high degree of repeatability of the signal.

Accuracy tolerance classification

Heraeus Sensor Technology supplies platinum thin-film sensors in accordance with DIN EN 60751 in the accuracy tolerance classifications B and in addition A and 1/3 DIN (see table of limit variations for 100 Ω platinum sensors).
Proportionally limited tolerances are calculated as

$\Delta T = \pm 1/a\ (0.3\,°C + 0.005\ |t|)$ with a = 1, 2 or 3

Platinum thin-film sensors can also be selected in tolerance groups with a maximum $\Delta T = 0.1$ K over a range of 0 °C to 100 °C. For applications with high price sensitivity, other accuracy tolerances are also available.

Limit variations for 100 Ω platinum sensors

Temp °C	Limit variations			
	Class A		Class B	
	°C	Ohm	°C	Ohm
–200	±0.55	±0.24	±1.3	±0.56
–100	±0.35	±0.14	±0.8	±0.32
0	±0.15	±0.06	±0.3	±0.12
100	±0.35	±0.13	±0.8	±0.30
200	±0.55	±0.20	±1.3	±0.48
300	±0.75	±0.27	±1.8	±0.64
400	±0.95	±0.33	±2.3	±0.79
500	±1.15	±0.38	±2.8	±0.93
600	±1.35	±0.43	±3.3	±1.06
650	±1.45	±0.46	±3.6	±1.13
700	-	-	±3.8	±1.17
800	-	-	±4.3	±1.28
850	-	-	±4.6	±1.34

Long-term stability

The ageing effects on thin-film sensors as a result of long-term operation or temperature shock may have a negative influence on the precision and reproducibility of the sensor signal. Long-term stability is therefore of the greatest importance.

Due to the chemical stability and homogeneity of the platinum used, platinum thin-film sensors are the most stable thin-film sensors. Depending on the operating conditions, the resistance changes after 5 years of operation at 200 °C are typically less than 0.04 %. The standard test conditions include 250 h, 500 h and 1000 h. However, shock tests and long-term tests can be adjusted to the customer's requirements.

Climate and humidity

A double glass layer and a glass of ceramic fixing drops protect the sensor element reliably from environmental influences. Measurements as per IEC 71 show that climatic and humidity variations do not have an impact on the measuring accuracy of sensor elements.

Circuit design

Platinum thin-film sensors are often fed with a continuous current, as standard in 2-lead circuitry. For energy-saving reasons (accumulator or battery operation), a switched measured current can also be used. The voltage output signal is a function of the R_t resistance. Because of the simple quadratic function of the platinum thin-film sensor characteristic curve as well as the possibility of a simple linear approximation, the linearization of the measuring symbols poses no problem.

Connection

Standard 2-lead circuits may result in a loss of precision. Therefore, 3 or 4-lead circuits are recommended:

- for longer cables, where the resistance and the temperature-dependent resistance of the cable may achieve significant values

- for platinum thin-film sensors with narrower tolerances

- if significant electromagnetic interference exist

Storage

Platinum thin-film sensors should not be subjected to caustic and corrosive media and atmospheres. The specific storage information for each type is to be followed.

Cleaning

Platinum thin-film sensors are cleaned before packing and further cleaning is normally not required. Should cleaning be required after mounting, most conventional industrial processes can be used, including immersion in a liquid or bath. We recommend that residue-free cleaning agents be used.

Handling

Platinum thin-film sensors are precision components, and should therefore be carefully handled during mounting. Metal holders, clamps or other rough gripping devices may not be used. Plastic tweezers are recommended for working with elementary sensors. The supply leads may not be bent near the body of the platinum thin-film sensor. Frequent repositioning of the supply leads should be avoided.

Connection technology

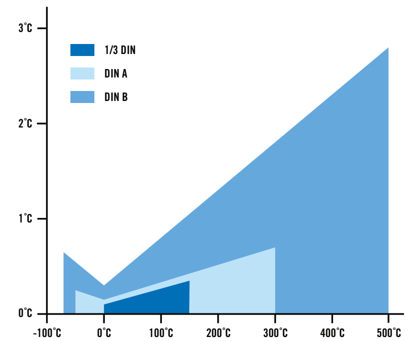
The best results are achieved with welding processes (resistance welding, laser welding etc.) or soldering (soft, hard solder). When using hard solder, it should be ensured that the platinum thin-film sensor body is not heated above its maximum nominal temperature. In general, the soldering times for hard solder should be less than three seconds. Shrinkage and ultrasonic sealing is also possible.

- When shrinkage is being carried out,it must be ensured that any electrical resistance is avoided at the connecting point.
- With ultrasonic sealing, the leads are to be bent out of the level of the platinum thin-film sensor, in order to exclude interior damage.
- For the SMD and TO92 series, we recommend automatic further processing with wave or reflow soldering processes.

Adhesion and embedding

When adhering, embedding, powdering or coating platinum thin-film sensors, it is important that the coefficients of thermal expansion of the different materials used agree, in order to avoid mechanical tensions that may affect the sensor signal.

The embedding materials should be chemically neutral and remain elastic after drying. The position of a connected platinum thin-film sensor should under no circumstances be subsequently corrected by sliding its body. Heraeus Sensor Technology's MR series is already recast in a ceramic casing. The TO92 serie is cast in plastic.



Tolerances of basic values for platinum temperature sensors are specified in DIN EN 60751. The following applies Class B: $\Delta T = \pm (0.3\,°C + 0.005\ |t|)$; Class A: $\Delta T = \pm (0.15\,°C + 0.002\ |t|)$ and according to our own definition: Class 1/3 DIN: $\Delta T = \pm 1/3\ (0.3\,°C + 0.005\ |t|)$, Class 2 B: $\Delta T = \pm 2\ (0.3\,°C + 0,005\ |t|)$