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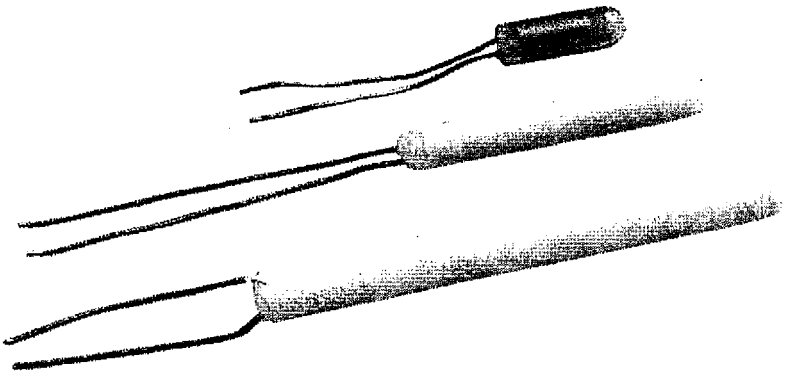
PT-100 Series

Platinum Resistance Sensors



INSTRUCTION SHEET

M3567/0200

The PT-102, PT-103, and PT-111, are wire wound thermometers and normally used as secondary standards. However, these thermometers should be treated in the same manner as any precision instrument. It is recommended that they not be subjected to any unnecessary shock or rough mechanical treatment.

In reading the thermometer, it is important to use the proper measuring current. An excessively high current will cause joule heating (I^2R), thus giving erroneous reading. a maximum power dissipation (joule heating) of 10 microwatts is recommended; the same as used in calibration. The recommended measuring currents to avoid joule heating are as follows:

1 Ω to 12 Ω	1 mA
10 Ω to 120 Ω	100 μA
100 Ω to 1200 Ω	10 μA

There are three aspects of using a cryogenic temperature sensor which are critical to its optimum performance. The first involves the proper mounting of the sensor package, the second relates the proper joining of sensor lead wires and connecting wires. The final concern is the thermal anchoring of the lead wires. Although the sequence in which these areas should be addressed is not fixed, all elements covered under each aspect should be adhered to for maximum operating capabilities of the sensor.

SENSOR MOUNTING

1. Mounting area should be prepared and cleaned with a solvent such as Acetone followed by an isopropyl alcohol rinse. Allow time for the solvents to evaporate before sensor mounting.

2. The list below provides brief instructions on mounting a sensor using a number of different methods. The constraints of your application should dictate the most appropriate mounting method to follow.

   Apiezon® N Grease – Is best used as a thermal conductor when the sensor is mounted in a hole or recess and when the sensor is intended to be removed. The sensor should be surrounded with thermal grease and placed into the mounting position. When the temperature is lowered the thermal grease will harden, giving good support and thermal contact.
   NOTE: Use Apiezon® H Grease for high temperature applications (up to 500 K).

   IMI 7031 Varnish – Prepare varnish and apply a thin layer on the mounting surface. Press the sensor firmly against the varnish during curing to ensure a thin bond layer and good thermal contact. Varnish will air dry in 5 – 10 minutes. Sufficient time must be allowed for the solvents in the varnish to evaporate. There is a small probability of ionic shunting across the sensor during the full cure period of the varnish (typically 12 – 24 hours).

   Stycast ® 2850FT Epoxy – Prepare epoxy and apply a thin layer on the mounting surface. Press the sensor firmly into the epoxy during curing to ensure a thin bond layer and good thermal contact. Epoxy will cure in 12 hours at 25 °C or in 2 hours at 66 °C.

   NOTE: Varnish, epoxies, and other adhesives should be considered permanent mounts and only be used if the sensor is not intended for removal.

3. Follow manufacturers instructions for adhesives curing schedules.

LEAD ATTACHMENT

1. Although the platinum sensors are a two-lead device, measurements should preferably be made using a four-wire configuration to avoid uncertainties associated with lead resistance.

   Two-Lead Measurement Scheme – The leads used to measure the voltage are also the current carrying leads. The resultant voltage measured at the instrument is the sum of the temperature sensor voltage and the voltage drop across the two leads. (See Figure 1A.)

   Four-Lead Measurement Scheme – The current is confined to one pair of current leads with the sensor voltage measured across the voltage leads. (See Figure 1B.)

2. Lead Polarity: None.

3. Strip the insulation from the connecting wires by delicately scraping with a razor blade, fine sand paper, or steel wool. Phosphor-bronze or Manganin wire, in sizes 32 or 36 AWG, is commonly used as the connecting lead wire. These wires have low thermal conductivity and high resistivity which help minimize the heat flow through the leads. Typical wire insulation is Polyvinyl Formal (Formvar™) or Polyimide (ML). Formvar™ insulation has better mechanical properties such as abrasion resistance and flexibility. Polyimide insulation has better resistance to chemical solvents and burnout.

Figure 1. Two-Lead Versus Four-Lead Measurements

4. Platinum sensor leads can easily be soldered if a flux is used. One suitable flux is "Stay Clean Solder and Tinning Flux" (J.W. Harris Company, Cincinnati, Ohio). Use appropriate solder with respect to temperature (recommend Sn 60/Pb 40 for up to 400 K and Pb 90/Sn 10 for up to 500 K.)

5. The "Stay Clean Solder and Tinning Flux" is acidic. Hence, after soldering, clean off the residual flux with a solvent which is "basic" in nature. (For example, baking soda dissolved in water will also work.)

6. Join one sensor lead with two of the connector wires. Apply the soldering iron to the connector wire above the joint area until the solders melt, then remove the iron. Repeat for the other set of connector wires and the other sensor lead.

7. Avoid putting stress on the device leads and leave enough slack to allow for the thermal contractions that occur during cooling which could fracture a solder joint or lead. Some epoxies and shrink tubing can put enough stress on lead wires to break them.

HEAT SINKING/THERMAL ANCHORING

1. Since the area being measured is read through the body of the sensor, heat flow through the connecting leads can create an offset between the sensor and the true sample temperature. Thermal anchoring of the connecting wires is necessary to assure that the sensor and the leads are at the same temperature as the sample.

2. Connecting wires should be thermally anchored at several temperatures between room temperature and cryogenic temperatures to guarantee that heat is not being conducted through the leads to the sensor.

3. If connecting wires have a thin insulation such as Formvar™ or Polyimide, a simple thermal anchor can be made by winding the wires around a copper post, or other thermal mass. A minimum of five wraps around the thermal mass should provide sufficient thermal anchoring. However, if space permits, additional wraps are recommended for good measure. To maintain good electrical isolation over many thermal cycles, it is good practice to first varnish a single layer of cigarette paper to the anchored area then wrap the wire around the paper and bond in place with a thin layer of IMI 7031 Varnish. Formvar wiring insulation has a tendency to craze with the application of IMI varnish. If used, the wires cannot be disturbed until the varnish is fully cured and all solvents have evaporated (typically 12–24 hours).

4. A final thermal anchor at the sample itself is good practice to ensure thermal equilibrium between the sample and temperature sensor.

CRYOGENIC ACCESSORIES – Recommended for proper installation and use of Platinum sensors:

Stycast® Epoxy 2850FT (P/N: OB-CY20): Permanent attachment, excellent low temperature properties, poor electrical conductor, low cure shrinkage.

Apiezon® N Grease (P/N: CYAG): Low viscosity, easy to use, solidifies at cryogenic temperatures, excellent lubricant.

IMI 7031 Varnish (P/N:CYAV): Nonpermanent attachment, excellent thermal conductor, easy to apply and remove.

Indium Solder (P/N: CYIF): 99.99% pure, excellent electroplating material, foil form.

Phosphor-Bronze Wire (P/N:CYW4): Available in single, duo, and quad strands, no magnetic attraction, low thermal conduction.

Instruments: Omega Engineering sells a complete line of instrumentation used with the platinum sensors, such as: Current Sources, Temperature Controllers, Monitors and Thermometers, Temperature Scanners and Transmitters.

Temperature/Resistance Table for Platinum Sensors

°C	Ω	°C	Ω	°C	Ω	°C	Ω
–200	18.52	20	107.79	240	190.47	460	267.56
–195	20.68	25	109.73	245	192.29	465	269.25
–190	22.83	30	111.67	250	194.10	470	270.93
–185	24.97	35	113.61	255	195.91	475	272.61
–180	27.10	40	115.54	260	197.71	480	274.29
–175	29.22	45	117.47	265	199.51	485	275.97
–170	31.33	50	119.40	270	201.31	490	277.64
–165	33.44	55	121.32	275	203.11	495	279.31
–160	35.54	60	123.24	280	204.90	500	280.98
–155	37.64	65	125.16	285	206.70	505	282.64
–150	39.72	70	127.08	290	208.48	510	284.30
–145	41.80	75	128.99	295	210.27	515	285.96
–140	43.88	80	130.90	300	212.05	520	287.62
–135	45.94	85	132.80	305	213.83	525	289.27
–130	48.00	90	134.71	310	215.61	530	290.92
–125	50.06	95	136.61	315	217.38	535	292.56
–120	52.11	100	138.51	320	219.15	540	294.21
–115	54.15	105	140.40	325	220.92	545	295.85
–110	56.19	110	142.29	330	222.69	550	297.49
–105	58.23	115	144.18	335	224.45	555	299.12
–100	60.26	120	146.07	340	226.21	560	300.75
–95	62.28	125	147.95	345	227.96	565	302.38
–90	64.30	130	149.83	350	229.72	570	304.01
–85	66.31	135	151.71	355	231.47	575	305.63
–80	68.33	140	153.58	360	233.21	580	307.25
–75	70.33	145	155.46	365	234.96	585	308.87
–70	72.33	150	157.33	370	236.70	590	310.49
–65	74.33	155	159.19	375	238.44	595	312.10
–60	76.33	160	161.05	380	240.18	600	313.71
–55	78.32	165	162.91	385	241.91	605	315.31
–50	80.31	170	164.77	390	243.64	610	316.92
–45	82.29	175	166.63	395	245.37	615	318.52
–40	84.27	180	168.48	400	247.09	620	320.12
–35	86.25	185	170.33	405	248.81	625	321.71
–30	88.22	190	172.17	410	250.53	630	323.30
–25	90.19	195	174.02	415	252.25	635	324.89
–20	92.16	200	175.86	420	253.96	640	326.48
–15	94.12	205	177.69	425	255.67	645	328.06
–10	96.09	210	179.53	430	257.38	650	329.64
–5	98.04	215	181.36	435	259.08	655	331.22
0	100.00	220	183.19	440	260.78	660	332.79
5	101.95	225	185.01	445	262.48		
10	103.90	230	186.84	450	264.18		
15	105.85	235	188.66	455	265.87		

Permissible Deviations for Class A and Class B Platinum Sensors

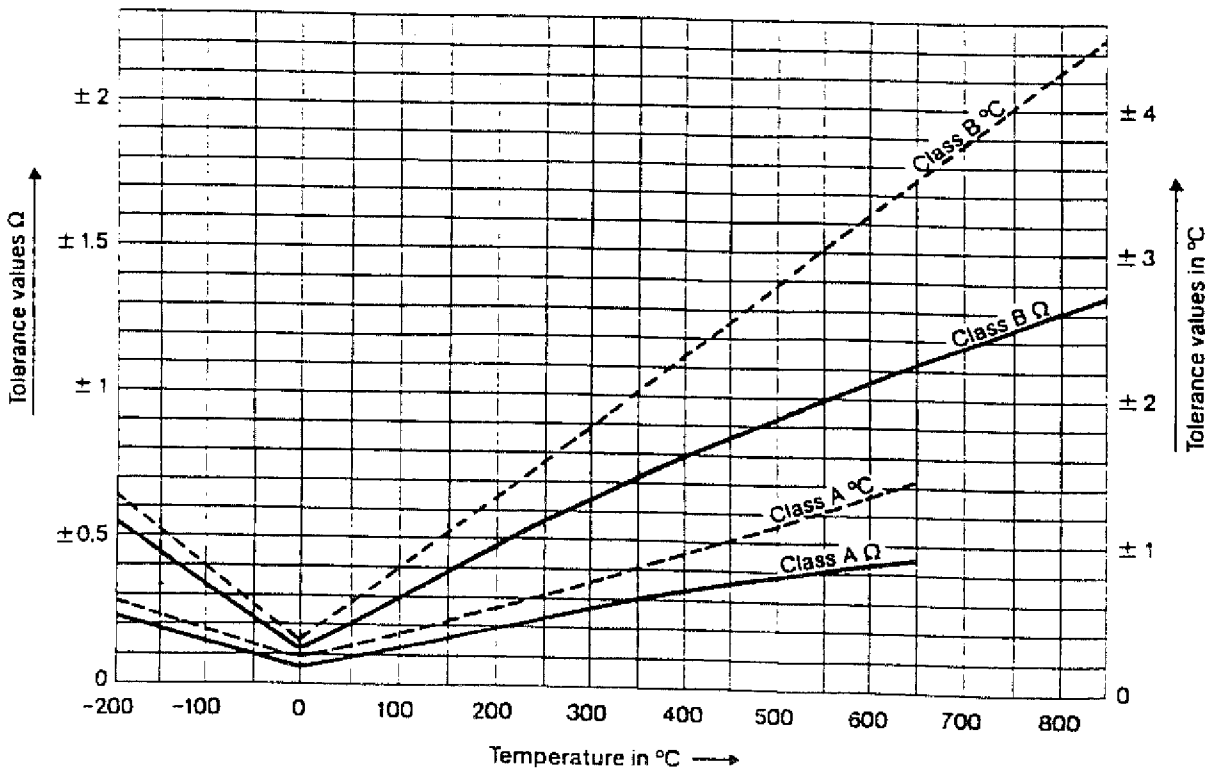
The permissible deviations for platinum resistance elements (uncalibrated) are determined by the following equations (in accordance with DIN IEC 751):

Permissible Deviation – Class A
°C = ±(0.15 + 0.002 [t]

Permissible Deviation – Class B
°C = ±(0.3 + 0.005 [t]

Where [t] is the temperature value in °C.

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



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If the unit malfunctions, it must be returned to the factory for evaluation. OMEGA's Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective, it will be repaired or replaced at no charge. OMEGA's WARRANTY does not apply to defects resulting from any action of the purchaser, including but not limited to mishandling, improper interfacing, operation outside of design limits, improper repair, or unauthorized modification. This WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of having been damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA's control. Components which wear are not warranted, including but not limited to contact points, fuses, and triacs.

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FOR **WARRANTY** RETURNS, please have the following information available BEFORE contacting OMEGA:

1. Purchase Order number under which the product was PURCHASED,
2. Model and serial number of the product under warranty, and
3. Repair instructions and/or specific problems relative to the product.

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1. Purchase Order number to cover the COST of the repair,
2. Model and serial number of the product, and
3. Repair instructions and/or specific problems relative to the product.

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