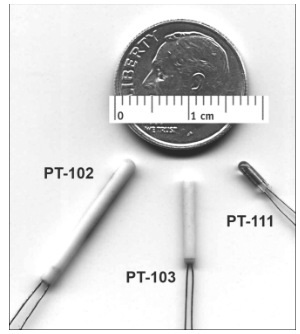
Instructions,
Platinum Resistance Thermometer Installation

Model PT-102, PT-103, and PT-111



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. Lake Shore recommends a maximum power dissipation (joule heating) of 10 µW: the same as used in calibration. The recommended measuring currents to avoid joule heating are as follows:

0 Ω to 200 Ω	0.5 mA
200 Ω to 1200 Ω	0.1 mA

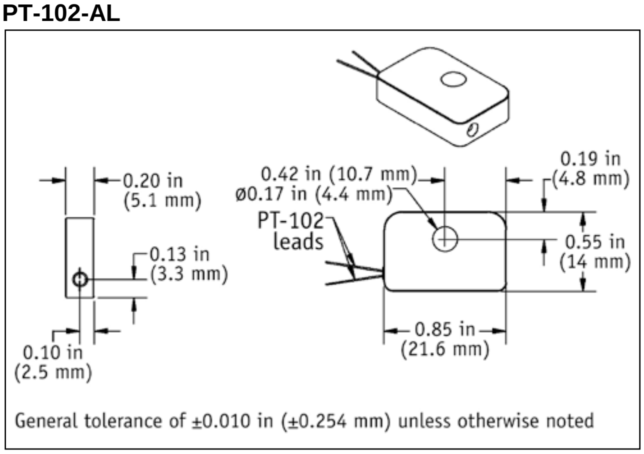
There are three aspects of using a cryogenic temperature sensor which are critical to its optimum performance: 1) proper mounting of the sensor package, 2) proper joining of sensor lead wires and connecting wires, and 3) proper thermal anchoring of the connecting wires. Although the sequence in which these concerns should be addressed is not fixed, all elements covered under each aspect should be adhered to for maximum operating capabilities of the sensor.

MOUNTING ADAPTERS

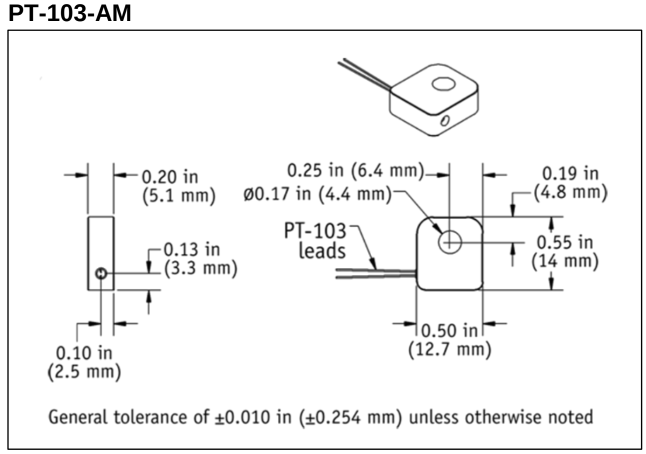
PT-102-AL and PT-103-AM each include a platinum RTD sensor mounted into a flat aluminum block. They can be mounted to any flat surface with a 6-32 or M3 screw (not included) and Inconel® Belleville washer (included).

Adapter material: 6061 Al block (PT mounted to adapter using Cotronics Durabond® 950 Al-based adhesive)
AL leads: Two 0.010-inch diameter: 10.160 ±1.270 mm (0.400 ±0.050 in) long
AM leads: Two 0.010-inch diameter: 15.240 ±1.270 mm (0.600 ±0.050 in) long
Lead material: Platinum
Mass: PT-102-AL: 3.8 g, PT-103-AM: 2.1 g
Limitation: The aluminum alloy limits the upper useful temperature of these configurations to 800 K

PT-102-AL



PT-103-AM



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. Follow manufacturer's instructions for mixing and curing adhesives. Carefully note temperature range limitations of the greases, varnishes, and epoxies to be used.

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 — Best used as a thermal conductor for temperatures under room temperature when the sensor is mounted in a hole or recess and when the sensor needs to be removable. 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. The use of grease is not recommended for use in high temperature applications above 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 to 10 min. 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 cure period of the varnish (typically 12 to 24 h).

   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 h at 25 °C or in 2 h 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.

   Aluminum mounting adapter — The sensor has been mounted to this adapter using Cotronics' Durabond™ 950 aluminum-based adhesive. This adhesive is well matched to the temperature expansion coefficient of the aluminum adapter. Attach the sensor adapter using a 6-32 or M3 screw along with an Inconel® Belleville washer. The washer is provided. Do not over tighten the screw. The Belleville washer should not be flattened.

3. Follow manufacturers' instructions for adhesive curing schedules. Carefully note the temperature range of use for greases, varnishes, and epoxies. Grease is not recommended to fill voids when the sensor will be used above 500 K.

LEAD ATTACHMENT

1. Although the platinum sensors are 2-lead devices, measurements should preferably be made using a 4-wire configuration to avoid uncertainties associated with the resistance of the connecting leads.

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

   4-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. For use up to 500 K, phosphor bronze or Manganin® wire in 32 or 36 AWG is commonly used as the connecting lead wire. These wires have low thermal conductivity and high resistivity, which helps 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. Formvar has a temperature rating of 373 K while polyimide has a temperature rating of 505 K.

4. For use above 500 K, use high temperature connecting wire (e.g., nickel) with high temperature insulation (e.g., wrap-around, ceramic tube, or ceramic beaded). Connection should be made by spot welding or brazing.

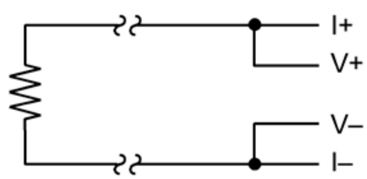
5. Platinum sensor leads can easily be soldered if a flux is used. One suitable flux is Stay Clean® Solder and Tinning Flux (J.W. Harris Company, Cincinnati, Ohio). Use appropriate solder with respect to temperature (recommend Sn 60/Pb 40 for up to 400 K and Pb 90/Sn 10 for up to 500 K.)

6. Stay Clean® Solder and Tinning Flux is acidic. Hence, after soldering, clean off the residual flux with a solvent that is "basic" in nature (i.e., baking soda dissolved in water will also work).

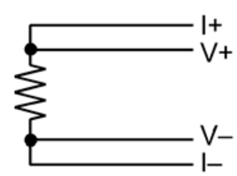
7. Join one sensor lead with two of the connector wires. Apply the soldering iron to the connector wire above the joint area until the solders melt, then remove the iron. Repeat for the other set of connector wires and the other sensor lead.

8. 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.

9. If the sensor is to be used above 500 K, it is recommended to either braze or spot weld appropriate lead wires (e.g., nickel wire).



A. 2-Lead Measurement Scheme



B. 4-Lead Measurement Scheme

Figure 1. 2-Lead Versus 4-Lead Measurements

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 ensure 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. Two different sizes of copper bobbins are available from Lake Shore for heat sinking connecting leads: P/N 9007-900 (large) and 9007-901 (small).
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, bobbin, 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, and 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 to 24 h).
4. A final thermal anchor at the sample itself is good practice to ensure thermal equilibrium between the sample and temperature sensor.

CALIBRATED SENSORS

As a 2-lead device, the resistance of a platinum sensor's leads is included in the measured resistance during calibration. Cutting the leads to a shorter length, tinning a greater portion of the lead length with solder, or otherwise changing the point of lead attachment will affect the overall measurement even if a 4-lead measurement is made to the point of connection with the sensor leads. Additionally, the lead material is not pure platinum, but rather an alloy or coated wire used to increase solderability and provide a more robust lead. The lead material is Pt-Rh (5%) alloy wire for the PT-103, platinum-coated palladium wire for the PT-102, and platinum-coated nickel wire for the PT-111. During calibration at Lake Shore, contact to each lead is made within 1 mm of the lead end. An estimate of the calibration shift for each 1 mm lead length change is given below for each of the three models. For the PT-103 sensor (which shows a relatively significant lead error below 30 K), the two sensor leads are branched into four leads prior to calibration, and the sensor is delivered with the four leads attached. The extensions are bare nickel wire brazed to the sensor leads using Fusion Inc. LHK-1235-701 silver brazing paste.

	Calibration shift (mK) per 1 mm lead length change	
Temperature (K)	PT-102 or PT-111	PT-103
295	8.9	9.5
77	2.1	5.4
20	0.5	24

CRYOGENIC ACCESSORIES — Recommended for proper installation and use of platinum sensors

Stycast® Epoxy 2850FT (P/N 9003-020, 9003-021): Permanent attachment, excellent low temperature properties, poor electrical conductor, low cure shrinkage.

Apiezon® N Grease (P/N 9004-020): Low viscosity, easy to use, solidifies at cryogenic temperatures, excellent lubricant.

IMI 7031 Varnish (P/N 9009-002): Nonpermanent attachment, excellent thermal conductor, easy to apply and remove.

Indium Solder (P/N 9007-002-05): 99.99% pure, excellent electroplating material, foil form.

90% Pb 10% Sn Solder (P/N 9008-001): Greater lead content for higher temperature applications no greater than 200 °C.

Phosphor Bronze Wire (P/N 9001-00X): Available in single, duo, and quad strands, no magnetic attraction, low thermal conduction.

Manganin® Wire (P/N 9001-00X): Low thermal conductivity, high resistivity, no magnetic attraction.

Heat Sink Bobbin (P/N 9007-900 large, 9007-901 small): Gold-plated oxygen-free high-conductivity (OFHC) copper bobbins.

Instruments: Lake Shore sells a complete line of instrumentation for use with platinum sensors, including current sources, cryopump monitors, temperature controllers, monitors and thermometers, temperature scanners and transmitters.

For complete product description and detailed specifications on the above accessories and instruments, consult the Lake Shore Temperature Measurement and Control Catalog, call (614) 891-2243, e-mail sales@lakeshore.com, or visit our website at www.lakeshore.com.