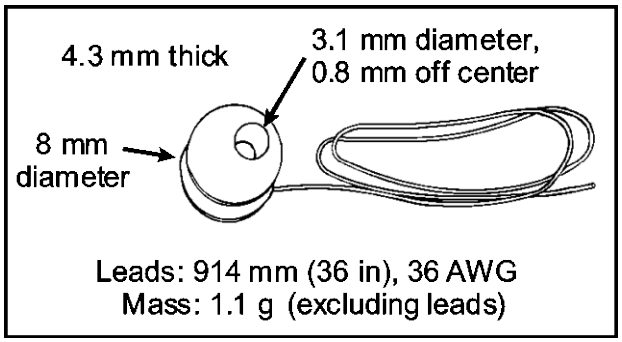
Instructions, Silicon Diode and GaAlAs Diode Temperature Sensor Installation, Model DT-470, 471, 670, and 671 CU and DI Packages, and TG-120-CU Package

CAUTION: This temperature sensor is sensitive to Electrostatic Discharge (ESD). Use ESD precautionary procedures when handling, or when making mechanical or electrical connections to this device in order to avoid performance degradation or loss of functionality.

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 set in stone, all elements covered under each aspect should be adhered to for maximum operating capabilities of the sensor.

SENSOR MOUNTING

The DT-470/471/670/671 CU, DI, and TG-120-CU packages combine a standard SD sensor with a gold-plated copper mounting bobbin to form the CU or DI package. The mounting bobbin of this package contains a 3.1 mm (0.122 inch) diameter hole (0.03 inch off center) designed for mounting with a #4-40 or M3 screw.



1. A threaded hole in your mounting surface is necessary for mounting the sensor package. The hole in the sensor package will accommodate a #4-40 or M3 screw. A brass screw is recommended due to the thermal contractions/expansions of the final assembly.
2. The threaded hole and surrounding surface should be cleaned with a solvent such as Acetone followed by an Isopropyl Alcohol rinse. Allow time for the solvents to evaporate before sensor mounting.
3. Apply a small amount of Apiezon® N grease to the threads of the screw. To ensure good thermal contact between the sensor and mounting surface, use an indium washer/preform or a thin layer of Apiezon® N grease between the mounting surface and the sensor package.
   NOTE: An overabundance of grease will increase the thermal barrier. Keep the thickness to 0.05 mm or less.
4. Insert screw through sensor mounting bobbin and tighten screw firmly enough to hold sensor in place. Avoid over tightening (torque of 30 to 50 in-oz [0.21 to 0.35 Nm] should be sufficient).

   NOTE: This package is designed for use up to 420 K (146 °C), subjecting sensor to temperature in excess of this will cause a shift in the sensor values.

LEAD ATTACHMENT

The SD sensor has been attached to the mounting bobbin and encapsulated in Stycast® epoxy. The 0.91 meter (36 inch) Polymide (ML) or Polyvinal Formal (Formvar™) insulated sensor leads are 36 AWG, phosphor bronze wire which are thermally anchored to the bobbin. Teflon® tubing is used as a strain relief to reinforce the leads at the bobbin assembly. The difference between the CU package and the DI package is the connecting lead configuration. Standard lead configuration for the CU is a four lead device [Red (I–), Green (V–), Black or Dark Blue (V+), Clear (I+)] with polyimide (ML) insulation while standard lead configuration for the DI package is a two lead device [Green = Cathode (–), Clear = Anode (+)] with Polyvinal Formal (Formvar™) insulation.

- **DI Package** - *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 within the two current leads. (See Figure 1A.). For wire separation, the polyvinyl butaryl bonding film is dissolvable by either isopropyl or denatured alcohol. The Formvar insulation is not affected by either.
- **CU Package** - *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.). Wire separation is explained in the next section.

A. Two-Lead Measurement Scheme (DI Package)

B. Four-Lead Measurement Scheme (CU Package)

Figure 1. Two-Lead Versus Four-Lead Measurements

Thirty-six inches of lead wire is attached during the production process. If additional connection wire is required, use the following instructions.

1. Prepare the sensor leads with a RMA (rosin mildly active) soldering flux, tin them with a minimal amount of 60% Pb 40% Sn solder. Use a low wattage soldering iron that will not exceed 200 °C. Clean off residual flux with rosin residue remover.
2. 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 which help minimize the heat flow through the leads. Typical wire insulation is 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.) Follow the same procedure in step 1 for preparing connecting wires.
3. *DI package* - Join one sensor lead with two of the connector wires. Apply the soldering iron above the joint area until the solders melt, then remove the iron immediately. Repeat for the other connecting wires and the other sensor lead.

   CU package - Identify lead polarities and apply the soldering iron above the joint area until the solders melt, then remove the iron immediately. Leave enough slack to allow for the thermal contractions that occur during cooling which could fracture a solder joint or lead. Insulating the soldering joint is recommended to prevent shorts. Use heat shrink tubing.

   NOTE: This package is designed for use up to 420 K (146°C), subjecting sensor to temperature in excess of this will cause a shift in the sensor values.

SEPARATION OF QUAD-LEAD™ WIRES

The Quad-Lead™ wire is formed into a "ribbon cable" using Bond Coat 999 bonding film. This bonding agent will soften above 160-180°C and the ribbon wire is designed to be separated into individual wires using heat.

CAUTION: Do not separate the wires using any kind of sharp blade, as damage will result.
CAUTION: Do not heat wire above 220 °C.

Separation using heat

A hot plate or soldering iron is the best tool for heating the wire. Hot-air guns are not recommended.

Set a hot plate or soldering iron to between 160-200°C. DO NOT heat the wire above 220°C.

If using a hot plate:

1. Take the section of the ribbon wire to be separated and place it on the hot surface.
2. Using a pair of fine tweezers, gently push the individual wires apart. They should come apart very easily; however, it may be necessary to bend them or fan them out slightly to prevent them from touching or re-bonding when removed from the heat.

If using a soldering iron:

1. Using a fine tip, run the tip in-between the sections of wire to be separated.
2. Use the tip at the same time to push and separate the wire(s) from the ribbon.
   - Any wire touching a hot surface may separate; be careful when handling the wire during this process
   - If the wires are not fully separated from each other while hot, they may re-bond when heat is removed. Take care with wires that did not fully separate, as pulling them apart may tear the insulation.

Mechanical separation
While heat is strongly recommended as the method to use, it is possible to separate wires by first removing the insulation from the end, then slowly and gently pulling the individual wires apart to the length desired. Removing the insulation from the end requires a rotary-abrasion mechanical stripper. It is also possible to separate a small section using heat, then continue the separation by gently pulling the individual wires apart.

CAUTION: There is a chance for damage to the ribbon wire in the form of the (colored) insulation being torn and/or coming completely off when the wires are mechanically pulled apart. This is due to the design of the bonding agent and wire. The more force used to pull the wires apart, the greater the chance for damage. Application of heat is recommended.

CAUTION: DO NOT attempt to separate the wires using any kind of blade or other similar tool, sharp or dull, or damage will result.

CAUTION: DO NOT attempt to remove the bonding agent or insulation with any kind of blade or other similar tool, sharp or dull, prior to separation. This will increase the chance of the insulation tearing, and/or coming completely off. Use only a rotary-abrasion mechanical stripper to remove insulation prior to separation.

HEAT SINKING/THERMAL ANCHORING
Depending on the application, sufficient heat sinking of the leads may already exist in the bobbin. Use the following procedure if additional heat sinking is recommended.

For additional heat sinking/thermal anchoring:
1. 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 sensing element.

2. 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 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 cured and all solvents have evaporated (typically 12–24 hours).

CRYOGENIC ACCESSORIES – Recommended for proper installation and use of DT-470/471/670/671 CU, DI, and TG-120-CU sensors:

Apiezon® Type N and H Grease. P/N GAN-25 and GAH-25 – 25 g tube. Low viscosity, easy to use, solidifies at cryogenic temperatures, excellent lubricant. Difference is melting point: Type N is 316 K, Type H is 523 K.

Heat Sink Bobbins. P/N HSB-40 Large, HSB-8 Small. Gold-plated copper bobbins. Large bobbin holds up to 40 wires, small bobbin holds up to 8 wires, depending on wire gauge and number of turns.

High-Temperature Solder. P/N SLT-10 – 3 meters (10 feet). Greater lead content (90% Pb 10% Sn) for soldering in applications up to 500 K.

Indium Foil/Solder. P/N IF-5 for 5 foil sheets (2" square × 0.005" thick), ID-10-31/ID-10-56 for 10 disks, 0.31" or 0.56" diameter × 0.005" thick respectively. Indium is 99.99% pure, exceptional pressure seal, extremely malleable.

Ostalloy® 158 Solder. P/N SOSY-16 – 16 oz. Reusable eutectic alloy with sharply defined melting point of 343.16 K (70 °C).

Stycast® Epoxy 2850FT, Catalyst 9. P/N ES-2-20 – 20 packets, 2 g each. Permanent attachment, excellent low temperature properties, poor electrical conductor, low cure shrinkage. [Requires Hazardous shipping.]

VGE-7031 Varnish. P/N VGE-7031 – 0.5 liter (1 pint) can. Nonpermanent attachment, excellent thermal conductor, easy to apply and remove. [Requires Hazardous shipping.]

Instruments: Lake Shore sells a complete line of instrumentation used with your sensor, such as: Current Sources, Temperature Controllers, Monitors and Thermometers, Temperature Scanners and Transmitters.

Wire. Lake Shore offers numerous types of wires for various applications, including phosphor-bronze wires: Single Strand, Duo-Twist™, Quad-Twist™, and Quad-Lead™, Nichrome heater wire, non-magnetic Manganin wire, and more.

Cable. Lake Shore offers ultra-miniature coaxial cable (Type C, SC, and SS), semi-rigid coaxial cable (Type SR), and a robust 4-wire CryoCable™ (Type CYRC).

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