

# Instructions, CS Series Capacitance Temperature Sensor, Model CS-401 and CS-501

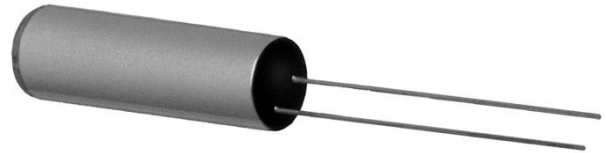


There are three aspects of using a temperature sensor which are critical to its optimum performance. The first involves the proper mounting of the sensor package, the second relates the proper joining of sensor lead wires and connecting wires. The final concern is the thermal anchoring of the lead wires. 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 CS-501 and CS-401GR-A incorporates ceramic sensing elements housed in a gold-plated copper can. The copper can is designed for mounting in a 3.2 mm (0.125 in) hole. The CS-401LG-B is designed for mounting in a 3.8 mm (0.15 in) hole.

1. For CS-501 and CS-401GR-A, a hole should be drilled 3.2 mm (0.125 in) diameter by 8.5 mm (0.335 in) deep minimum for the copper can. For the CS-401LG-B, a hole should be drilled 3.8 mm (0.15 in) diameter by 8.9 mm (0.35 in) deep minimum.
2. Surface area should be cleaned with a solvent such as acetone followed by an isopropyl alcohol rinse. Allow time for the solvents to evaporate before sensor positioning.
3. A small amount of Apiezon® N grease should be applied around the mounting surface and the sensor to enhance thermal contact.
4. Position the copper can so that it is fully submerged in the mounting hole.



**NOTE:** This package is designed for use up to 325 K (52 °C).

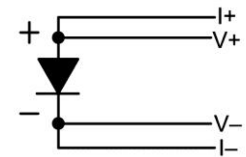
## LEAD CONFIGURATION

On all CS models, two leads are attached with epoxy strain relief at the sensor. Each is 32 AWG (0.20 mm) diameter phosphor bronze wire, insulated with heavy polyimide to an overall diameter of 0.24 mm (0.0095 in), and 15 mm (1 in) long. The thermal rating of the insulation is 220 °C.

## EXTRA LEAD ATTACHMENT

If extra leads need to be attached, it is recommended that a 4-lead measurement scheme be used with this sensor. Attaching four connecting wires to the sensor leads is recommended.

1. Prepare the sensor leads and connecting lead wires with a RMA (rosin mildly active) soldering flux, tin them with a minimal amount of 60% Sn/40% Pb solder. Use a low wattage soldering iron that will not exceed 200 °C. Clean off residual flux with rosin residue remover. The sensing element inside the package should be protected from excessive heat by putting a heat sink clip over the package.
2. Strip connecting wires insulation 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 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.
3. Prepare the connecting wire ends with a RMA (rosin mildly active) soldering flux, tin them with a minimal amount of 60% Sn 40% Pb solder. Use a low wattage soldering iron which will not exceed 200 °C.
4. Clean off residual flux with rosin residue remover. The sensor lead can be prepared in an identical manner.
5. Attach one sensor lead with two of the connector wires and apply the soldering iron above the joint area until the solders melt, then remove the iron immediately. Repeat for the other set of connector wires and the other sensor lead.
6. 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. This can be achieved with heat shrink tubing.



Recommended Wire Hook Up

## HEAT SINKING/THERMAL ANCHORING

1. Since the heat flow through the connecting leads can create an offset between the sensor element 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 sensing element.
3. If the connecting leads 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 enough of an anchor. 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. Once IMI varnish is applied, the wires cannot be disturbed until all solvents have evaporated and the varnish has fully cured (typically 12 to 24 h).
4. A final thermal anchor at the sample itself is a good practice to ensure thermal equilibrium between the sample and temperature sensor.

**CRYOGENIC ACCESSORIES** – Recommended for proper installation and use of CS501/CS401 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.

**RMA Soldering Flux** (P/N 9008): Variety of types, refer to Lake Shore Product Catalog for details.

**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 used with the CS501/CS401 sensors, such as 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 at (614) 891-2243, E-mail at [sales@lakeshore.com](mailto:sales@lakeshore.com), or visit our website at [www.lakeshore.com](http://www.lakeshore.com).