Foil Temperature Sensors

Resistance thermometry is a widely employed method of measuring temperature, and is based on using a material whose resistivity changes as a function of temperature. Resistance Temperature Detectors (RTD's) have fast response times, provide absolute temperature measurement (no reference junctions are involved), and are very accurate. Measurement circuits are relatively simple, and the sensors, when properly installed, are stable over years of use.

Micro-Measurements resistance temperature sensors are constructed much like wide-temperature-range strain gage sensors. The standard sensors utilize nickel or nickel/manganin rolled foil grids, although special-purpose sensors are also available in Balco® alloy or copper foil grids. These temperature sensors are bonded to structures using standard strain gage installation techniques, and can measure surface temperatures from –452° to approximately +500°F (–269° to +260°C). Because of their extremely low thermal mass and the large bonded area, the sensors follow temperature changes in the structural mounting surface with negligible time lag.

Balco is a trademark of the W.B. Driver Company

TG TEMPERATURE SENSORS

TG Temperature Sensors are normally selected for measurements from –320° to +500°F (–195° to +260°C). The sensing grid utilizes a high purity nickel. Three basic constructions are offered:

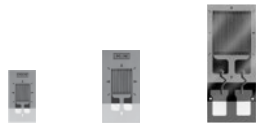
ETG Sensors have a polyimide carrier for flexibility. It is available as an encapsulated gage with exposed solder tabs (Option E), or with integral printed-circuit terminals (Option W).

The WTG Sensor incorporates integral leadwires and a high-temperature epoxy-phenolic matrix (reinforced with glass fiber) which fully encapsulates the grid.

The WWT-TG Sensor is a slightly larger version of the WTG, but preattached to a 0.005-in (0.13-mm) thick stainless steel shim. This gage can be welded or bonded to a structure.

The resistance at +75°F (+23.9°C) is 50Ω ±0.3% for the ETG and WTG Sensors; and 50Ω ±0.4% for the WWT-TG Sensors.

Maximum operating temperature for ETG Sensors with Option E is +450°F (+230°C), and +350°F (+175°C) for Option W. All other types are +500°F (+260°C).

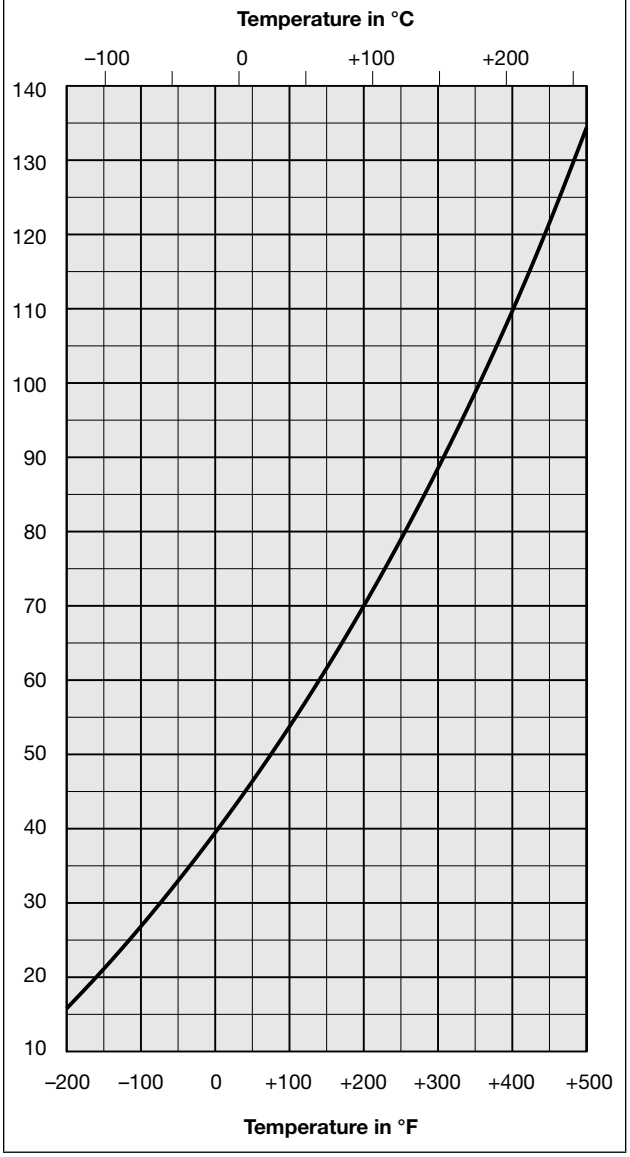
TG TEMPERATURE SENSORS GAGE PATTERN AND DESIGNATION Approximate Size Shown See Note 1		DIMENSIONS Legend: SL = Shim Length; SW = Shim Width inch / millimeter					
		GAGE LENGTH	OVERALL LENGTH	GRID WIDTH	OVERALL WIDTH	MATRIX Length	MATRIX Width
ETG-50A/Option E ETG-50A/Option W	 50A/E 50B/E Opt W Feature	0.060	0.148	0.100	0.100	0.28	0.20
		1.52	3.76	2.54	2.54	7.0	4.8
ETG-50B/Option E ETG-50B/Option W		0.125	0.235	0.125	0.125	0.33	0.19
		3.18	5.97	3.18	3.18	8.3	4.7
WTG-50A **WTG-50A/Option W**	 50A 50B Opt W Feature	0.060	0.148	0.100	0.100	0.28	0.20
		1.52	3.76	2.54	2.54	7.0	4.8
WTG-50B **WTG-50B/Option W**		0.125	0.235	0.125	0.125	0.33	0.19
		3.18	5.97	3.18	3.18	8.3	4.7
WWT-TG-W200B-050 For Weldable Temperature Sensor, see appropriate datasheet.		0.20	0.71 SL	0.200	0.43 SW	0.52	0.26
		5.08	18.03 SL	5.08	10.92 SW	13.1	6.6

Note 1: Products with designations and options shown in bold are not RoHS compliant.

In addition to the standard line of temperature sensors described above, Micro-Measurements can furnish almost any type of sensor pattern desired, in a wide range of resistances. Contact our Applications Engineering Department for details.

Foil Temperature Sensors

TYPICAL DATA FOR 50 Ω NICKEL SENSOR

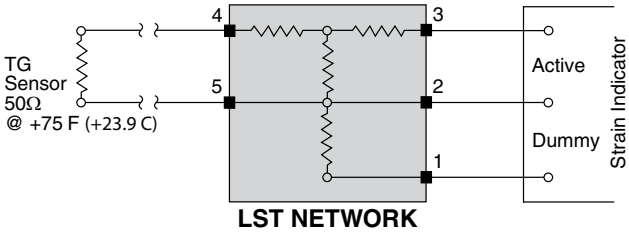


TG LST MATCHING NETWORKS

As indicated in the graph, the temperature coefficient of resistance for nickel sensors is quite large and nonlinear. The sensor resistance can be measured directly and converted to temperature with the charts supplied in Tech Note TN-506, but since TG Sensors are commonly used along with strain gages, special matching networks have been developed to use with strain gage instrumentation.

LST Matching Networks are small passive devices encapsulated in a molded epoxy case. These networks are connected between TG Temperature Sensors and strain gage instrumentation to perform the following three functions:

1. Linearize the nickel sensor resistance change with temperature.
2. Attenuate the resistance change slope to the equivalent of 10 or 100 microstrain per degree F or C for a gage factor setting of 2.000 on the strain indicator.
3. Present a balanced 350-ohm half-bridge circuit to the strain indicator.



LST NETWORK

To optimize performance, separate network designs are available for select temperature ranges covering cyrogenic to +500°F. The environmental temperature range for LST networks is –65° to +250°F (–55° to +125°C). Standard strain gage instrumentation, such as the Micro-Measurements Model P3, is ideal for use with these sensors, eliminating the need to purchase separate readout devices.

LOW TEMPERATURE RANGE		
NETWORK DESIGNATION	**OUTPUT SLOPE**	**SENSOR TEMPERATURE RANGE**
LST-10F-350C	10 microstrain/°F	–320° to +100°F
LST-10C-350C	10 microstrain/°C	–200° to +25°C
LST-100F-350C	100 microstrain/°F	–320° to +100°F
LST-100C-350C	100 microstrain/°C	–200° to +25°C

NORMAL TEMPERATURE RANGE		
NETWORK DESIGNATION	**OUTPUT SLOPE**	**SENSOR TEMPERATURE RANGE**
LST-10F-350D	10 microstrain/°F	–200° to +500°F
LST-10C-350D	10 microstrain/°C	–150° to +260°C
LST-100F-350D	100 microstrain/°F	–200° to +500°F
LST-100C-350D	100 microstrain/°C	–150° to +260°C

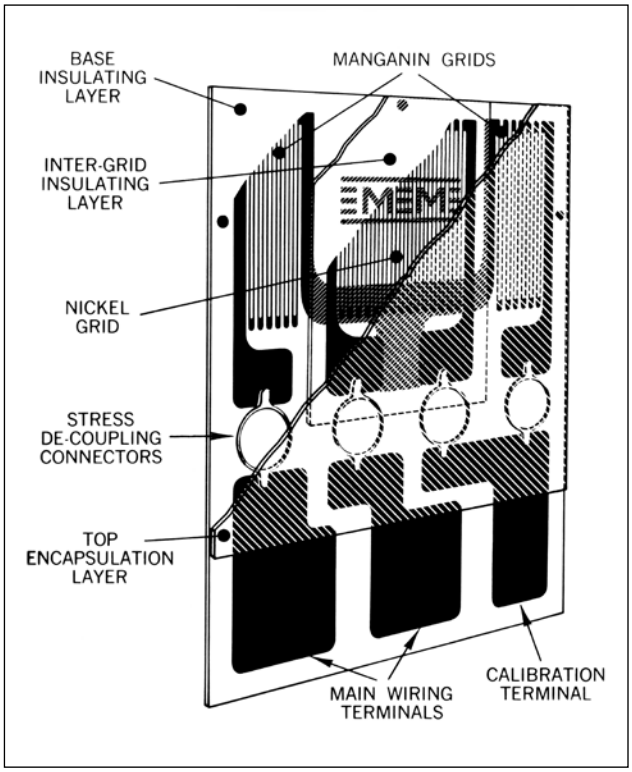
Foil Temperature Sensors

CLTS-2B TEMPERATURE SENSORS

The Cryogenic Linear Temperature Sensor (CLTS) is recommended for best accuracy over the temperature range of –452° to +100°F (–269° to +40°C). The CLTS-2B is a small surface thermometer consisting of two thin foil sensing grids laminated into a glass-fiber-reinforced epoxy-phenolic matrix, and electrically wired in series. The two alloys are special grades of nickel and manganin that are processed for equal and opposite nonlinearities in resistance versus temperature characteristics. The CLTS-2B is fabricated with integral printed-circuit terminals to provide strong, convenient attachment points for the leadwires. Gage construction is illustrated at right.

Because of its low thermal mass and thin construction, the CLTS-2B responds quickly and accurately to temperature changes in the surface to which it is bonded. Special design features protect the sensor from damage due to thermal shock, even during plunges from room temperature directly into liquefied gases, including LHe at –452°F (–269°C).

Avoid prolonged exposure of the CLTS-2B to temperatures above +150°F (+65°C) as this may adversely affect characteristics of the manganin material. The maximum recommended curing temperature of the bonding adhesive is two hours at +200°F (+95°C).

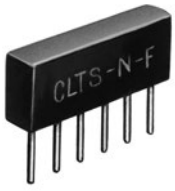


CLTS-2B SENSITIVITY

The nominal resistance of the CLTS-2B is 290.0 ohms ±0.5% at +75°F (+23.9°C). The resistance decreases linearly with temperature, reaching a nominal value of 220.0 ohms at –452°F (–269°C). This represents a change of 70 ohms for 527°F, or a slope of 0.1328 ohms per degree F; the corresponding slope on the Celsius scale is 0.2391 ohms per degree C. With proper instrumentation a resolution of 0.01° can be easily achieved. Data readout can be accomplished by directly monitoring resistance change with an appropriate resistance measuring instrument.

GAGE PATTERN AND DESIGNATION Actual size shown	DIMENSIONS (inch / millimeter)					
	GAGE LENGTH	OVERALL LENGTH	GRID WIDTH	OVERALL WIDTH	MATRIX Length	MATRIX Width
CLTS-2B 	0.130 ES	0.205	0.280 ES	0.280	0.43	0.31
	3.30 ES	5.21	7.11 ES	7.11	10.9	7.9

CLTS MATCHING NETWORKS



When used in a test program that includes strain gage instrumentation, it is convenient to modify the CLTS output with a simple, passive resistance network as described for LST networks and TG Sensors.

When using the CLTS Matching Network, the sensitivity can be adjusted to 10 microstrain per degree F (CLTS-N-F) or C (CLTS-N-C); with a resolution of 0.1° for most strain indicators. This type of network also provides a high degree of leadwire compensation. Environmental temperature limits for CLTS Networks are –65° to +250°F (–55° to +125°C).

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