



Btu transmitters and energy monitors by Badger Meter require two temperature sensors and a flow sensor to operate. The proper selection and placement of the temperature sensors is extremely important when operating Btu monitors. There are a number of options available to help maximize the efficiency of Btu monitoring. The following are a few tips to help fully take advantage of Badger Meter monitoring capabilities.

The temperature sensor is based on a 10kΩ thermistor. A thermistor is actually a resistor made of specific semiconductor material whose resistance decreases as the temperature around it increases. Thermistors should NOT be confused with thermo-couples, which are fabricated from two dissimilar conductors joined at the ends, as where the junction is heated, the voltage across it becomes proportional to the rise in temperature.

The actual resistance values for Badger Meter thermistors are based on all temperature sensors having 10kΩ resistance at 25° C. Twenty-five degrees Celsius is the industrial standard used as the main point of reference for most thermistor calibrations. The following chart references the change in resistance values relative to changes in temperature. Note that at 25° C (77° F), the resistance value is 10,000 ohms.

°C	°F	Resistance
0	32	32,654 Ω
10	50	19,903 Ω
20	68	12,493 Ω
25	77	10,000 Ω
30	86	8,056 Ω
40	104	5,325 Ω
50	122	3,602 Ω
60	140	2,488 Ω
70	158	1,753 Ω
80	176	1,257 Ω
90	194	917 Ω
100	212	679 Ω

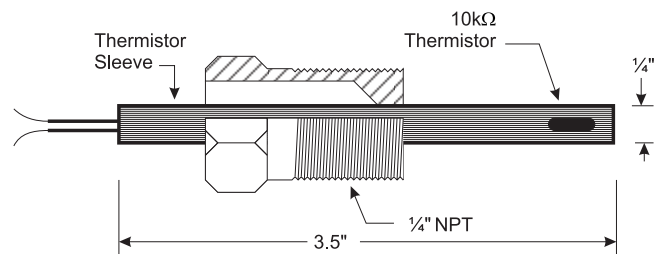
With an accuracy of ±0.2° C, Badger Meter thermistors can operate accurately from 0° C (32° F) to 70° C (158° F) with maximum temperature of 110° C (230° F), and are designed for use with liquid heating and cooling media. The maximum distance between a temperature sensor and any Badger Meter Btu monitor is 500 feet.

The simplest temperature sensor option is a ¼ inch tube, 3 ½ inch long with ½ inch NPT pipe connections. The thermistor is potted solid inside the tube fixture. The potting is used to eliminate any air pockets from forming around the temperature sensitive areas of the 10kΩ thermistor. If air is present, it will act as an insulation barrier to the thermistor, adversely affecting the heat transfer coefficients of the tubing wall, the potting material, and the semiconductor material itself. The quality built into the Badger Meter temperature sensors allows minimum variation from sensor to sensor. Each temperature sensor can be replaced without affecting either the other temperature sensor or the accuracy of Btu calculations. Individual circuit adjustments are NOT required when changing temperature sensors.

### PROTECTING TUBE CONFIGURATION

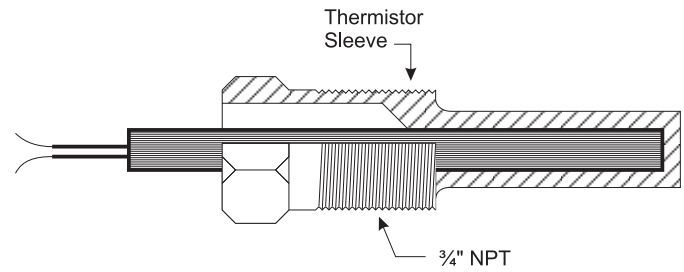
Badger Meter temperature sensors are available as a thermistor potted in protecting tube for direct insertion or for use with a thermowell. The T106 has an adjustable length and a ¼ inch process connection so it can be used in line sizes from ½ inch and up. The sensing portion of the probe is at the tip and must be mounted so that the tip is completely immersed in the direct flow stream. All sensors measure not only the fluid they are in, but also the mass and effect of their own body to the fluid stream.

For higher velocity or pressure systems or for industrial applications in larger pipe sizes, we suggest that thermowells be used. A thermowell is a sleeve assembly that protects the temperature sensing device from direct damage by higher velocities, and also allows ease in service or replacement of the thermistor elements without draining or shutting down of the fluid system.



## THERMOWELL STYLE

Thermowells also allow deeper sensor penetration into larger piping systems. A general rule is to allow the sensing area of the thermowell to be as close to the actual center of the pipe I.D. as practical. This helps make the response time of the thermistor faster and more representative of the actual fluid temperature. Badger Meter offers a number of optional thermowells. When the actual thermistor sleeve is mounted at the bottom of the thermowell, make sure some type of heat transfer material (silicone grease) is used to fill the area between the I.D. of the thermowell and the O.D. of the thermistor tubes. This material serves the same purpose as potting the actual thermistor element in the tube assembly previously discussed. The thermistor sleeve is held in the thermowell by a threaded retainer.



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