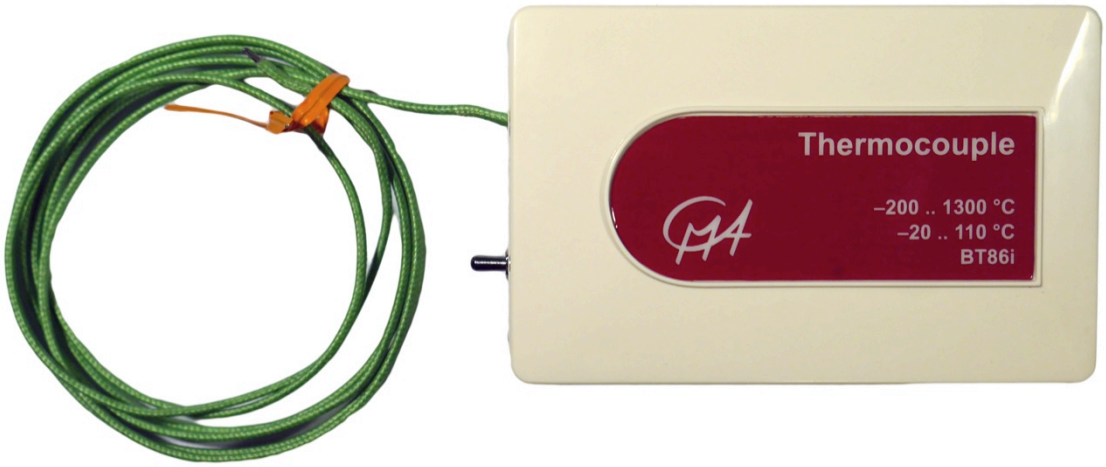
THERMOCOUPLE SENSOR BT86i

USER'S GUIDE



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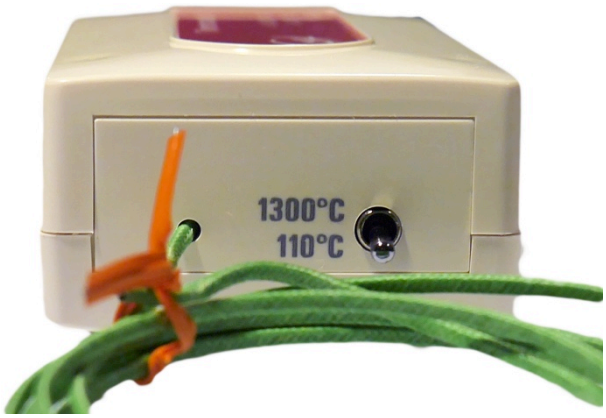
Short description

The CMA Thermocouple sensor BT86i measures temperatures in two ranges:

- -200 .. 1300 °C (wide range), and
- -20 .. 110 °C (narrow range).

These ranges are selected using the switch placed on the side of the sensor box, next to the thermocouple wire.

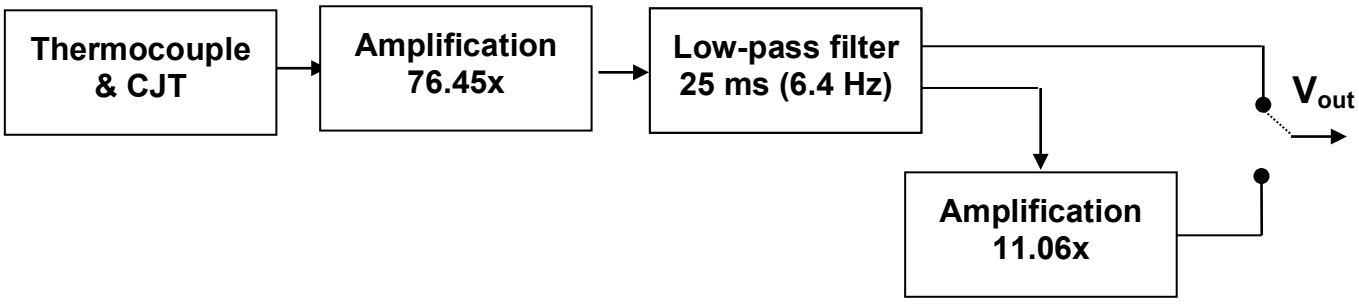


The sensor uses a thermocouple type K. The thermocouple consists of Chromega™ (Nickel - Chromium) and Alomega™ (Nickel - Aluminium) wires that are welded together at one end to form a measuring (hot) junction. The other ends of the wires form the so-called cold junction. Temperature at the measuring junction of a thermocouple is determined by measuring the voltage appearing at the thermocouple's cold junction. Since the voltage produced by the thermocouple is a function of the temperature difference between these two junctions, the cold junction temperature must be known in order to produce accurate temperature measurements.

The cold junction temperature is sensed by an on-board temperature sensor. The signal of this sensor is added to the thermocouple voltage signal. Such automatic cold-junction temperature (CJT) compensation is a method used to get accurate temperature readings measured by the thermocouple even when the temperature at the sensor box varies.

The thermal voltage varies between -5.9 mV at -200 °C and +52.4 mV at 1300 °C. This signal is amplified 76.45x and filtered with a low-pass filter (6 Hz). For the narrow temperature range (-20 .. 110 °C) the signal is again amplified 11.06x.

As result of the signal conditioning, the signal (V_{out}) will vary between approx. 0 V and approx. 4.9 V.



The Thermocouple sensor can be directly connected to analog BT inputs of CMA interfaces. The sensor cable BT - IEEE1394 needed to connect the sensor to an interface is not supplied with the sensor and has to be purchased separately (Order Code BTsc_1).

Sensor recognition

The Thermocouple sensor has a memory chip (EEPROM) with information about the sensor: its name, measured quantity, unit and calibration. Through a simple protocol this information is read by the CMA interfaces and the sensor is automatically recognized when it is connected to these interfaces.
Notice that for the Thermocouple each of its measurement ranges has its own EEPROM information. The selected sensor range, indicated by a switch, determines which information is used. For correct range detection first select the desired range of the sensor and then connect the sensor to your interface.
If your Thermocouple sensor is not automatically detected by an interface you have to manually set up your sensor by selecting it from the Coach Sensor Library.

Calibration

The CMA Thermocouple BT86i is supplied calibrated. The output of the sensor is approximately linear with respect to temperature. This means that the sensitivity of the thermocouple is almost constant. It varies slightly with temperature e.g. at 0 °C the sensitivity is 39.5 μV/°C, at 100 °C is 41.4 μV/°C and at 1000 °C is 38.9 μV/°C.

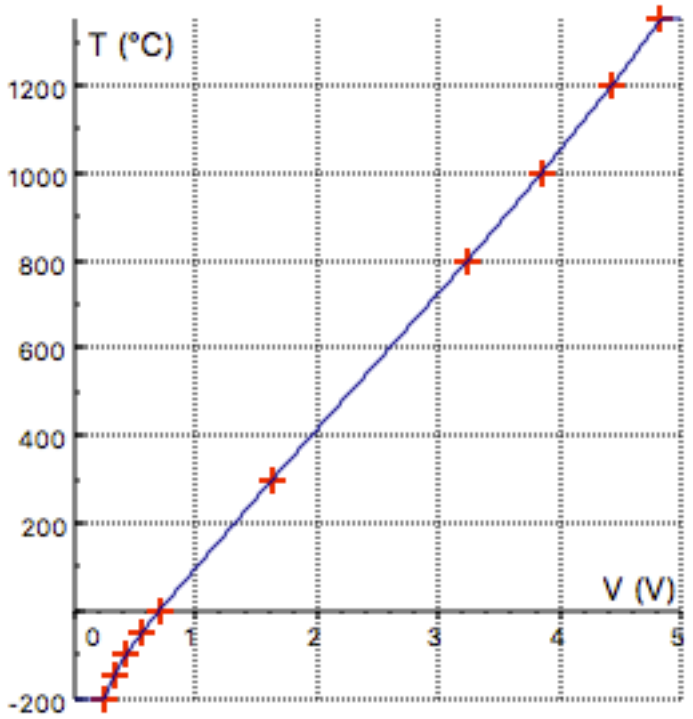
The supplied calibration functions are:

- Measurement range -200 .. 1300 °C: $T\,(°C) = 316.9 * V_{out}\,(V) - 221.0$
- Measurement range -20 .. 110 °C: $T(°C) = 29.093 * V_{out}\,(V) - 26.33$

The CMA Coach program allows selecting between the calibration supplied by the sensor memory (EEPROM) or the calibration stored in the Coach Sensor Library.

For the narrow temperature range (-20 .. 110 °C) the calibration in EEPROM and the calibration in the Coach Sensor Library are identical. The calibration is a linear function, which approximates the real calibration curve with an error of less than 1°C.
For the wide temperature range (-200 .. 1300 °C) the calibration in EEPROM is a linear function, which approximates the real calibration curve with an error of less than 7 °C in the range -60 .. 1100 °C. Outside of this temperature range the error shows a steep increase. The calibration in the Coach Sensor Library gives a very good approximation over the whole temperature range -200 .. 1300 °C. The error is always less than 3 °C.

Below the calibration graph and the calibration table of the point-to-point calibration (graph and table) used in the Coach Sensor Library is given.



V (V)	T (°C)
0.247	-200.0
0.322	-150.0
0.426	-100.0
0.553	-50.0
0.697	0.0
1.631	300.0
3.242	800.0
3.853	1000.0
4.430	1200.0
4.835	1350.0

Practical information

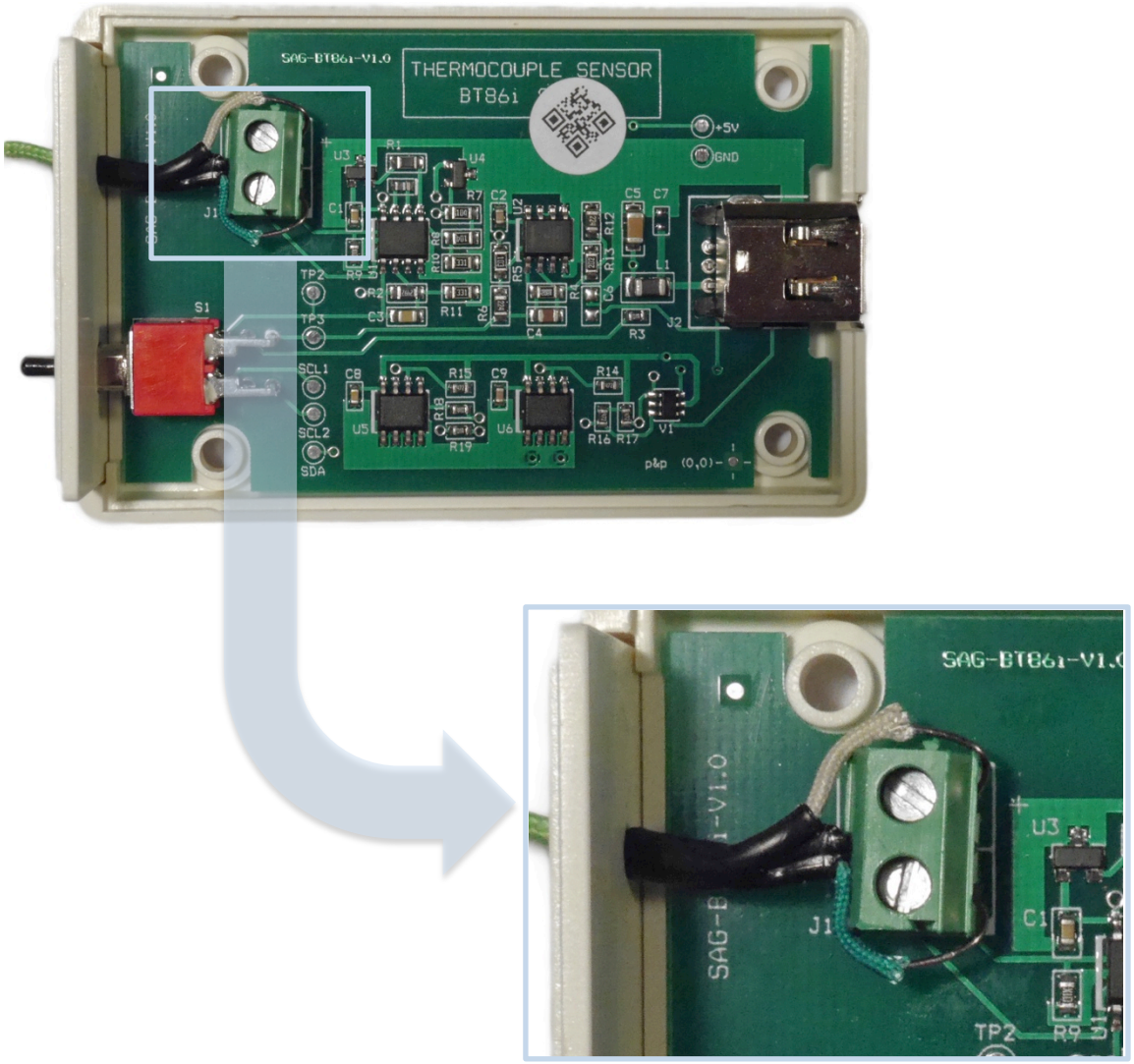
The thermocouple wire is insulated with glass braid. The wire is about one-meter long. The Chromega™ wire is in green insulation (positive), and the Alomega™ wire is in white insulation (negative). The thermocouple gives a positive potential difference when its temperature is higher than the cold junction temperature, which is usually room temperature.

The thermocouple has a typical range of -200 °C to 1250 °C.

For long measurements, the maximum temperature is limited to 870 °C. The insulation is damaged when working above 480 °C, but this does not normally detrimentally influence the operation of the thermocouple.

The thermocouple may be damaged if it is used in the presence of sulphur, or under reducing conditions.

The thermocouple wire is interchangeable. Screw terminals are placed inside the sensor box (see the photo below). The thermocouple calibration is independent of thermocouple length and thickness as long as it is a thermocouple Chromega™ /Alomega™ (type K).



Screw terminals for attaching the thermocouple wires.

Suggested experiments

The Thermocouple can be used for temperature measurements.
Examples of applications for the wide temperature range (-200 .. 1300 °C) are:

- Measurements of the temperature inside a Bunsen burner flame or candles
- Experimentally determine the melting point of copper, bismuth, or other solids.

Examples of applications for the narrow temperature range (-20 .. 110 °C) are:

- Measuring freezing and boiling points
- Specific heat experiments
- Measurement of breath.

Technical Specifications

Sensor kind	Analog, generates an output voltage between 0 and 4.9 V
Measuring ranges *Narrow* *Wide*	 -20 .. 110 °C -200 .. 1300 °C
Resolution using *12- bits 5V AD converter* *Narrow* *Wide*	 0.035 °C 0.39 °C
Calibration function *narrow range* *wide range in EEPROM* *wide range in the* *Coach Sensor Library*	 T (°C)= 29.093 * V_{out} (V) – 26.33 T (°C)= 316.9 * V_{out} (V) - 221 Point-to-point calibration, see page 4
Typical accuracy	± 5 °C
Speed	In air: 16 s as for a 63% change towards the temperature of the environment In liquid: 0.1 s as above
Limitations	Can be damaged when used in the presence of sulphur or under reducing conditions.
Insulation	Glass braid insulation
Chromega™/Alomega™ wire	Length = 95 cm Diameter = 0.51 mm
Filtering	Low-pass, at 6.4 Hz (τ = 25 ms)
Power	5 mA @ 5V DC
Connection	IEEE1394 connector for BT-IEEE1394 sensor cable. Sensor cable not delivered with the sensor.

Warranty:

The Thermocouple sensor BT86i is warranted to be free from defects in materials and workmanship for a period of 24 months from the date of purchase provided that it has been used under normal laboratory conditions. This warranty does not apply if the sensor has been damaged by accident or misuse.

Note: *This product is to be used for educational purposes only. It is not appropriate for industrial, medical, research, or commercial applications.*

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