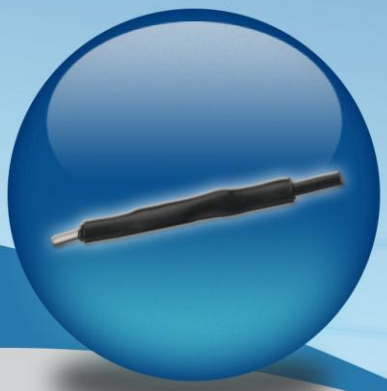
Science Division
Thought Technology Ltd



TEMPERATURE SENSOR SA9310M

Measure **More**
Sense **Better**

Technical Note Series

TEMPERATURE SENSOR (SA9310M)

- Type BF Equipment
- Internally powered equipment
- Continuous operation

WARNING

- If the sensor is interfaced to non-Thought Technology devices without the use of a TT Sensor Isolator SE9405AM, an elevated risk of electrical shock may be present. In particular, if a client-connected sensor is connected to any line powered device(s) or equipment(s), it will be the responsibility of the qualified user to ensure the electrical safety in the setup.
- Explosion Hazard; Do not use in the presence of a flammable anesthetic mixture with air, or with Oxygen or Nitrous Oxide.
- Not to be immersed in water.

CAUTION

- Connection of customer supplied circuits to Thought Technology sensor products has the potential to damage the sensor. Such damage is not covered by warranty.

ATTENTION

- For research only. Not for use in diagnostic procedures.
- To prevent voiding warranty by breaking connector pins, carefully align white guiding dot on sensor plug with slot on sensor input.

MAINTENANCE AND CALIBRATION

- Wipe with a clean cloth
- Factory testing and calibration ensure equipment accuracy and frequency response.
- No preventative inspections required;

STORAGE

- Temperature -23C – +60C
- Humidity (non-condensing) 10% – 90%
- Atmospheric pressure 700 – 1060 KPa

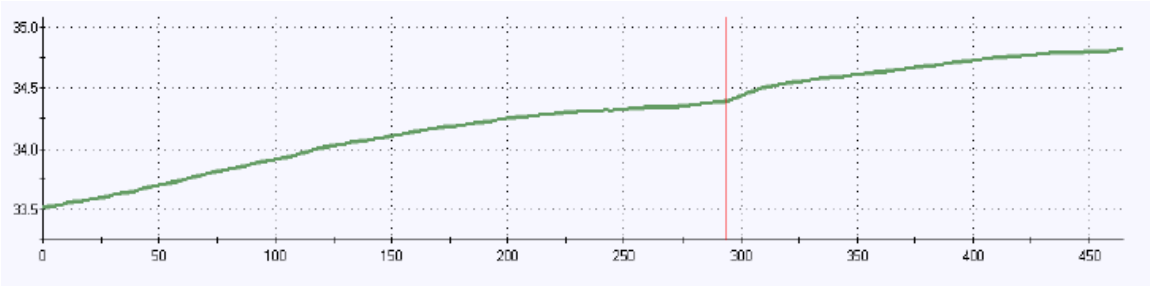
TRANSPORTATION

- Temperature -23C – +60C
- Humidity (non-condensing) 10% – 90%
- Atmospheric pressure 700 – 1060 KPa

PRODUCT OVERVIEW

The Temperature sensor measures skin surface temperature between 10°C – 45°C (50°F - 115°F). It is a thermistor, which detects very small changes in skin warmth and converts them in an electrical signal.

Peripheral temperature is an index of sympathetic arousal as it affects vasoconstriction in the extremities. Sympathetic nervous system (SNS) arousal causes an increase in peripheral vasoconstriction, which decreases the perfusion of blood in the tissues and causes a cooling down of the skin. This is part of the normal fight or flight response to stress.

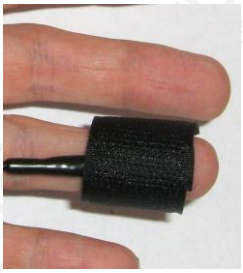


SENSOR PLACEMENT

A hook and loop fastener is provided with the sensor.

Ensure that the end of the temperature sensor makes solid contact with the finger. Any finger can be used.

Shown here is the ring finger.



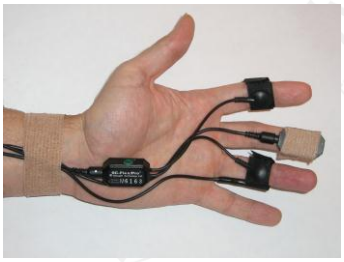
With hook and loop fastener

As an alternative, Coban self-adhesive tape (3M) can be used to provide a more secure fit attachment.

With Coban tape

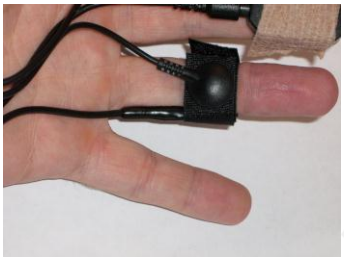
Using multiple sensors together:

This configuration is suggested for placing skin conductance, BVP and temperature sensors on the same hand. In this configuration, the temperature sensor is tucked under the ring finger strap of the skin conductance sensor.



This is a practical way to combine these sensors, but care must be taken to ensure that the end of the temperature sensor is secured firmly against the skin.

Also note that the cables are all directed inwards and Coban tape is used to secure the cables to the wrist.



Close up view of temperature sensor and skin conductance finger strap.

TECHNICAL SPECIFICATIONS

Length (approx.)	152cm (60”)
Weight	10g (0.33oz)
Temperature range	10°C - 45°C (50°F – 115°F)
Accuracy	±1.0°C (±1.8°F) 20°C – 40°C (68°F – 104°F) (assuming simplified transfer function)

INTERFACING WITH 3RD PARTY DATA ACQUISITION SYSTEM

Recommended Connectivity for Electrical Safety

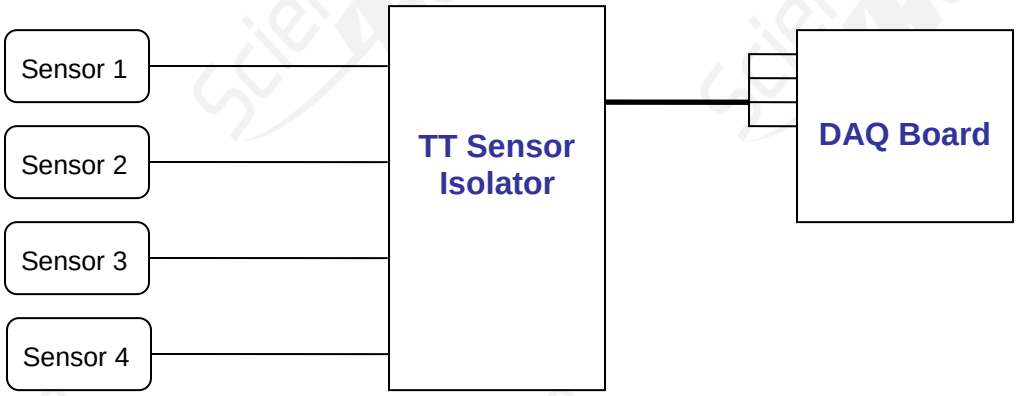
To ensure electrical safety in the user setup, Thought Technology recommends the use of TT Sensor Isolator SE9405AM when interfacing client connected sensor(s) to line powered equipment(s) or devices.

The TT Sensor Isolator SE9405AM is an interface device providing medical grade electrical isolation between the client connected sensors and the acquisition system. It provides the equivalent of Two Means of Client Protection under IEC 60601-1, and supplies battery power to the sensors. Using this device ensures Thought Technology sensors are safely interfaced to the analog inputs of line-powered systems such as computers with DAQ cards.

Note that this device isolates only between sensors and the DAQ interface, not between different sensor channels.

The TT Sensor Isolator can interface up to 4 sensors to a DAQ card. TT Sensor Isolator can be connected to the DAQ card in two ways:

- via two stereo jacks, or
- via a DB-15 connector; a BNC interface cable (SA9409BNC) or a pigtail cable (SA9409PGT) can be provided with the unit.



For more detailed information on the Sensor Isolator 4∞, consult the Thought Technology Science Division website or contact the sales department or an authorized distributor.

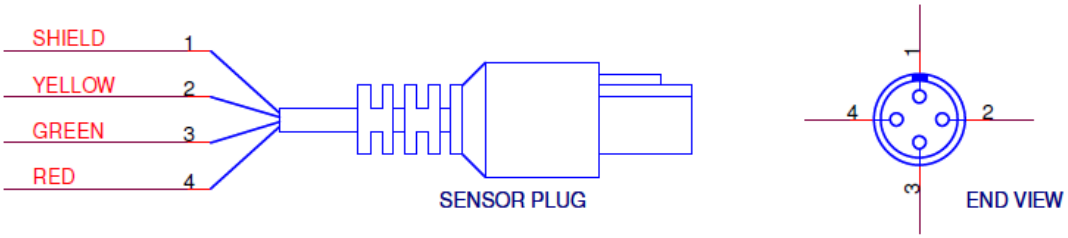
Direct Connectivity for Electrically Isolated Systems

The following notes are provided for qualified users to directly interface Thought Technology sensors with external systems.

WARNING: If the sensor is interfaced to non-Thought Technology devices without the use of a TT Sensor Isolator SE9405AM, an elevated risk of electrical shock may be present. In particular, if a client-connected sensor is connected to any line powered device(s) or equipment(s), it will be the responsibility of the qualified user to ensure the electrical safety in the setup and to ensure that the device or equipment provides sufficient isolation.

To interface with a sensor, a single sensor cable may be cut in half. Both sides can then be used to make custom interfacing cables by stripping the outer insulation of each required conductor. The sensor cable contains 4 color coded conductors. The table below shows the color coding and pin connector assignment.

Pin	Color code	Function	Note
1	metal (shield)	ground	Signal and power ground, connection required.
2	yellow	auxiliary (sensor ID)	No connection required.
3	green	signal	Sensor output signal
4	red	sensor power	Supply voltage, +7.26V referenced to ground. Note: sensor performance may be sensitive to supply voltage.



Notes:

1. The nominal supply voltage for this sensor is 7.26V. The sensor can safely be used with a supply voltage of up to 9V. However, as the sensor is calibrated with a 7.26V supply voltage level, changes in gain and offset will be expected when operating at a different supply voltage.

Recommended Specifications for DAQ Hardware

- Recommended resolution of 0.15mV (16-bit ADC over 10V span) or better
- Minimum input range:
  - If connected via SE9405AM Sensor Isolator, choose 0-5V (unipolar) or ±5V (bipolar)
  - If directly connected to DAQ, choose ±5V (bipolar).

Simplified Transfer Function

$V_{out} = 0.04685T_C + 1.503$	Temperature in Celsius to output voltage in volts
$T_C = 21.341V_{out} - 32.085$	Voltage [V] conversion to temperature [ºC]
$T_F = 38.415V_{out} - 25.754$	Voltage [V] conversion to temperature [ºF]

The simplified transfer function assumes the sensor is used with the Sensor Isolator, or the supply voltage provided by the user setup is 7.26V nominal.

Additional notes:
For applications requiring better accuracy, solving the equations below will provide the user with an accuracy of ±0.3ºC (±0.54°F) over 20°C – 40°C (68°F – 104°F), based on the component tolerances.

Rt = R2 * (Vsupply – Vout) / (Vout - Vgnd) – R1
T (deg C) = 1 / (A + B*ln Rt + C*(ln Rt)^3) - 273.16 (Steinhart-Hart equation)

Where:

A = 1.09114881E-03
B = 2.40311395E-04
C = 6.33157678E-08
Vsupply = 7.26V nominal (if used with TT Sensor Isolator, otherwise depends on user setup).
Vgnd = 0V nominal (if used with TT Sensor Isolator, otherwise depends on user setup).
Vout = Output voltage as measured on sensor output relative to Vgnd.
R1 = 4750
R2 = 8660
Rt = thermistor value