TM-100 Temperature Sensor

Technical Note

TM-100

Overview

The TM-100 Temperature Sensor is a sensor that can monitor temperatures between 15°C above and 15°C below room temperature. The TM-100 is capable of responding to changes in temperature within a few seconds because of its small size (1mm x 3mm) and mass. The TM-100 is suitable for monitoring the temperature of nasal airflow, changes in skin temperature that indicate evaporative cooling, and changes in atmospheric temperature and temperature in environmental chambers. Since the sensor element is water-resistant, the tip of the TM-100 can be immersed in aqueous solutions, including saline solutions, for a few hours.

How It Works

The sensor element in the TM-100 that responds to temperature changes is a thermistor, which is a type of resistor that changes resistance with changes in temperature. The thermistor in the TM-100 has a negative temperature coefficient (NTC) which means that the resistance of the thermistor decreases as the temperature goes up. Thermistors with positive temperature coefficients also exist. Table 1 at the end of this Technical Note shows the resistances of the thermistor in the TM-100 over a range of temperatures from 0°C to 50°C.

The thermistor in the TM-100 is wired into the circuit of the sensor as one leg of a Wheatstone bridge. On the other three legs of the bridge circuit, selected resistors are used to give the TM-100 a linear output over a range that is 15°C above and below room temperature.

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How to Use the TM-100

Equipment Setup

1) Insert the DIN8 connector of the TM-100 temperature sensor into a DIN8 extension cable.
2) Insert the other end of the DIN8 extension cable into a DIN8 transducer input on an iWorx data acquisition unit or amplifier.

Start the Software

1) Open LabScribe by clicking on the LabScribe desktop icon.
2) When the program opens, select **Preferences** from the **Edit** menu (or from the **LabScribe** menu on a Macintosh computer).
3) Select the **Channel** preferences dialog window. Name the channel to which the TM-100 is connected. Set the **Mode/Function** for this channel to **DIN8**. Also, set the sampling rate and display time. Click **OK**.

Calibration of the TM-100 Temperature Sensor

1) Prepare two beakers of water, one at 10°C, and the other at 40°C. Measure the temperature of the cold water with a thermometer just before the TM-100 temperature sensor is placed in the beaker.
2) Place the tip of the TM-100 temperature sensor in the center of the beaker of cold water.
3) Click the **Start** button on the **Main window** of the LabScribe software and begin recording. Type "**Calibration at <Cold Water Temperature>**" on the comment line to the right of the **Mark** button.
4) After about twenty seconds in the cold water, the output of the TM-100 temperature sensor displayed on the recording channel should reach a stable level. Press the Enter key on the keyboard to mark the recording. Continue recording.
5) Measure the temperature of the warm water with a thermometer just before the TM-100 temperature sensor is placed in the beaker. Type "**Calibration at <Warm Water Temperature>**" on the comment line.
6) Continue recording as the temperature sensor is moved from the cold water to the warm water.
7) After about twenty seconds in the warm water, the output of the TM-100 temperature sensor displayed on the recording channel should reach a stable level. Press the Enter key on the keyboard to mark the recording. Click **Stop** to halt the recording.
8) Select **Save As** in the **File** menu, and type a name for the file. Choose a destination on the computer in which to save the file. Click on **Save** to save the file.

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9) Compress the data from the calibration recording onto the same computer screen by clicking on the **Double Display Time** icon on the LabScribe toolbar. The output of the sensor at the two temperatures should be positioned on the same screen.

10) Click the **2-Cursor** icon and position the first cursor on the plateau of the first temperature (~10°C) and the second cursor on the plateau of the second temperature (~40°C).

11) Right-click in the recording window of the temperature channel. Select **Units** from the right-click menu and **Simple** from the **Units** submenu.

- In the **Units Conversion** dialog window, select **2 point cal** from the pull-down menu in the upper-left corner of the window.
- Put a check mark in the box next to **Apply Units to All Blocks**.
- Notice that the voltages from the positions of the cursors are automatically entered into the value equations.
- Enter the cold water temperature in the corresponding box to the right of the voltage recorded when the sensor was in the cold water. Enter the warm water temperature in the corresponding box to the right of the voltage recorded when the sensor was in the warm water.
- Enter the name of the units, **°C**, in the box below the temperatures. Click **OK** to activate the unit conversion.

Operating the TM-100 Temperature Sensor

- Once the TM-100 temperature sensor is calibrated, it can be immersed in aqueous solutions, including saline solutions, for a few hours. **The TM-100 is not designed for long-term immersion or chronic implantation.**
- The rugged Teflon jacket over the sensor can also be attached with tape or glue to a surface to be measured.
- The TM-100 is a low impedance (~10kΩ) sensor, so its cable can be extended to nearly any length without signal degradation.

Do not attempt to measure temperatures above 125°C. Temperatures above this limit will damage the sensor.

Experiments

LabScribe experiments that use the TM-100 include:

- **Experiment HE-1: Metabolic and Thermal Response to Exercise** (found in the **Human Exercise** category of the LabScribe **Settings** menu as **MetabolicThermalResponse-Exercise**)

Care of the TM-100 Temperature Sensor

Since the jacket covering the element and the insulation on the wires are made of Teflon, they may be cleaned with just about any cleaner.

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Table 1: Resistances of the Thermistor Used in the TM-100 Temperature Sensor at Different Temperatures

Temp (°C)	Resistance (Ω)	Temp (°C)	Resistance (Ω)	Temp (°C)	Resistance (Ω)
0	32650.5	17	14321.6	34	6808.36
1	31032.1	18	13679.8	35	6531.31
2	29499.9	19	13070.4	36	6265.75
3	28052.4	20	12491.6	37	6016.47
4	26684.6	21	11941.6	38	5776.05
5	25391.2	22	11418.9	39	5546.53
6	24168.2	23	10922.0	40	5327.34
7	23011.2	24	10449.5	41	5117.97
8	21916.3	25	10000.0	42	4917.94
9	20879.8	26	9572.32	43	4726.77
10	19898.3	27	9165.29	44	4543.91
11	18968.6	28	8777.79	45	4369.33
12	18087.6	29	8408.68	46	4200.84
13	17252.6	30	8057.31	47	4040.81
14	16460.9	31	7722.43	48	3889.51
15	15710.0	32	7403.29	49	3743.17
16	14997.7	33	7098.42	50	3603.10

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