Experiment BI-8: Multipoint Calibration of the Temperature Sensor

Equipment Required

PC or Mac Computer

IX-TA data acquisition unit and power supply

USB cable

TM-220 temperature sensor

Beakers - optional

Thermometers - optional

The Equipment Setup

1. Connect the TM-220 to channel A7 on the front of the IXTA.

Figure BI-8-S1: The temperature sensor plugged into A7 on the from of the IX-TA

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Procedure:

Exercise 1: Creating a Calibration Channel

The TM-220 is a temperature sensor that uses a thermistor. A thermistor is a semiconductor device that changes its electrical resistance in response to temperature variations. The TM-220 is an NTC thermistor, and its resistance decreases as temperature increases.

The resistance to temperature calibration data for the TM-220 is below:

OHMS	°C
32650.5	0
31032.1	1
29499.9	2
28052.4	3
26684.6	4
25391.2	5
24168.2	6
23011.2	7
21916.3	8
20879.8	9
19898.3	10
18968.6	11
18087.6	12
17252.6	13
16460.9	14
15710	15
14997.7	16
14321.6	17
13679.8	18
13070.4	19
12491.6	20
11941.6	21
11418.9	22
10922	23
10449.5	24
10000	25
9572.32	26
9165.29	27
8777.79	28
8408.68	29
8057.31	30
7722.43	31
7403.29	32
7098.42	33
6808.36	34
6531.31	35

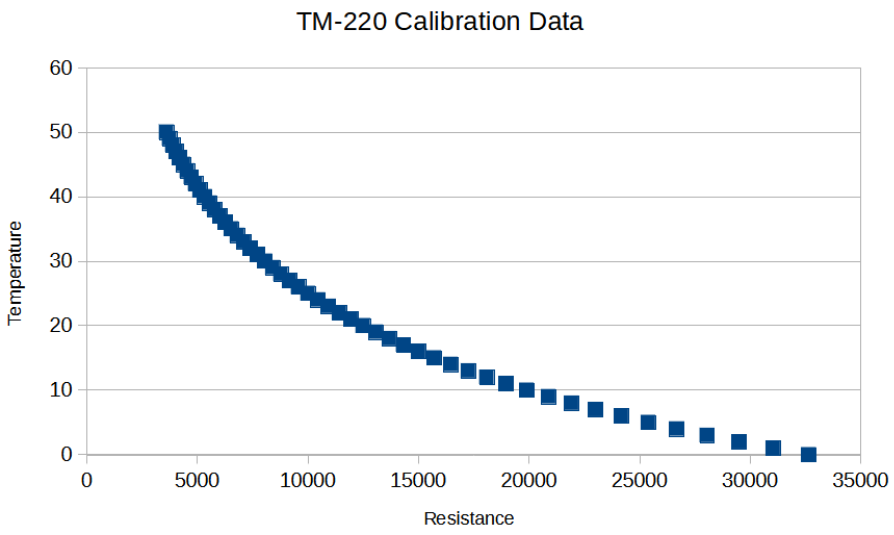

Figure BI-8-L1: Calibration curve and resistance data.

6265.75	36
6016.47	37
5776.05	38
5546.53	39
5327.34	40
5117.97	41
4917.94	42
4726.77	43
4543.91	44
4369.33	45
4200.84	46
4040.81	47
3889.51	48
3743.17	49
3603.1	50

As you can see the resistance to temperature curve is not linear. So you cannot use a linear units conversion to convert the resistance to temperature. LabScribe has a Multipoint Calibration function that can be used to perform a linear interpolation, to convert the resistance values measure to temperature. The temperature port on the TA and the TA-ROAM can measure the resistance. We will be using that to measure the resistance of the TM-220 temperature sensor.

LabScribe has built-in functions to convert the resistance data from the TM-220 to temperature. If the TM-220 input mode is selected, LabScribe will convert the resistance value measured from the sensor to temperature and display the temperature. We will be recording the raw resistance value from the TM-220 and then convert it to Temperature using the Multipoint Calibration function.

We are going to create 3 calculated channels to calculate the temperature,
MPCAL_10 Deg: uses the resistance to temperature data every 10 degrees.
MPCAL_5 Deg: uses the resistance to temperature data every 5 degrees.
MPCAL_2 Deg: uses the resistance to temperature data every 2 degrees.

We created the calculated channels for every 10 deg C and 5 deg C.

Create the calculated channel for every 2 deg C

1. Click the Fx button on the Resistance channel
2. Click Multipoint Calibration. A new window will open.
   - 1 – Click the drop down menu “ohm” and change it to deg C
   - 2 – Click the equation m*x + C; eq. drop down menu and change to Linear Interpolation
   - 3 – Click Import Table and navigate to the csv file for MPCAL_2 Deg in the LabScribe Complete Settings folder – BioInstrumentation
   - 4 – Click Fit
   - Click OK

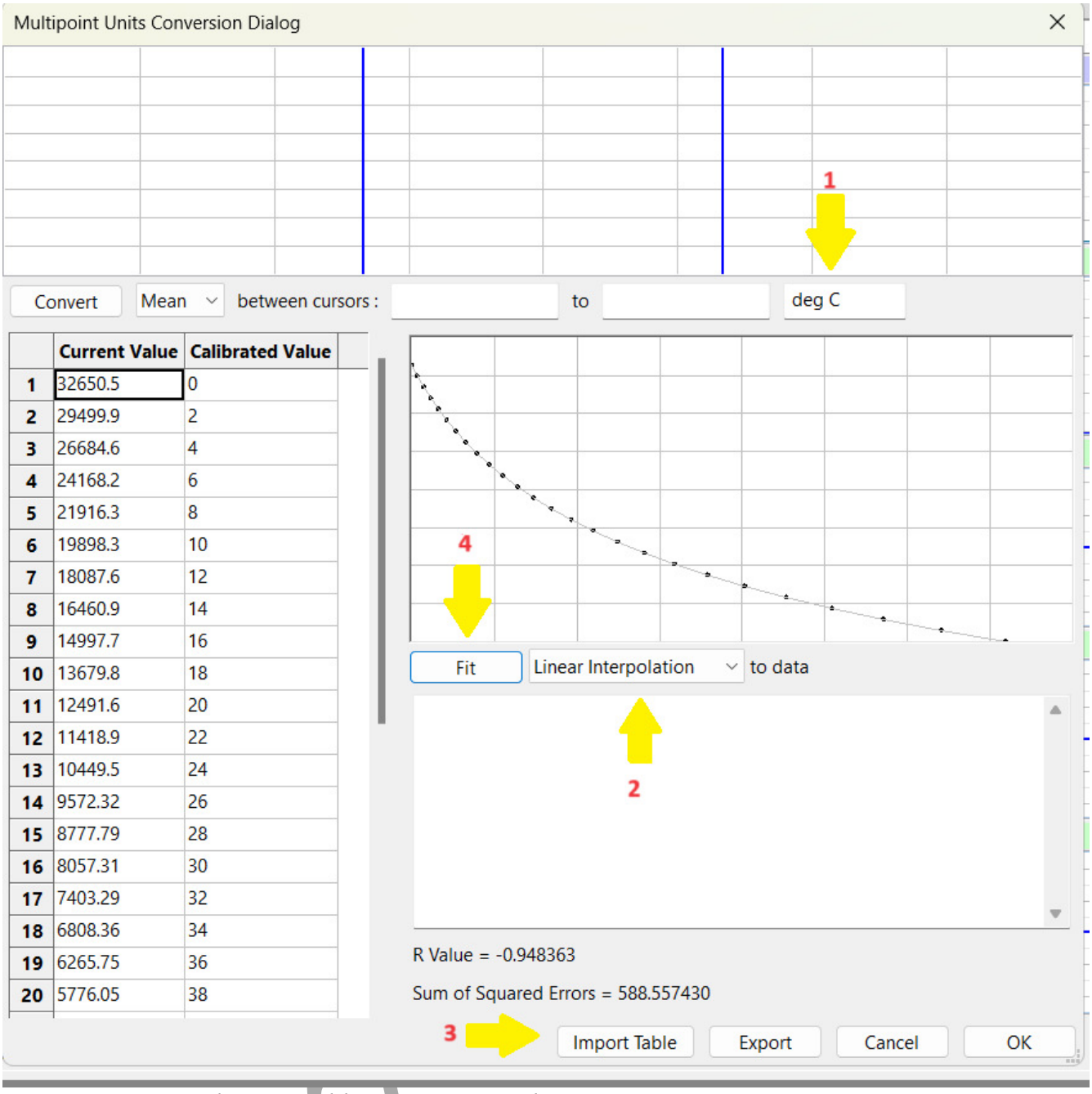

Figure BI-8-L2: Multipoint Calibration setup window.

3. A new channel will be created for the calibration every 2 deg C.
4. Name the channel MPCal-2Deg by clicking on the channel name and changing it.

Exercise 2: Comparing Different Temperatures to Known Resistance Values

We can see how using different calibration curves will affect the calculated temperature.

- Record the room temperature,
- Record the skin temperatures
- Record other temperatures between 0 deg and 50 deg.
  - Use ice water and take temperatures at different time periods
  - Use very warm water (no greater than 40 deg C) and do the same thing

Use the table to calculate the temperature from the raw resistance value, then compare this calculated value to the value on the 3 calculated channels. See how they compare.

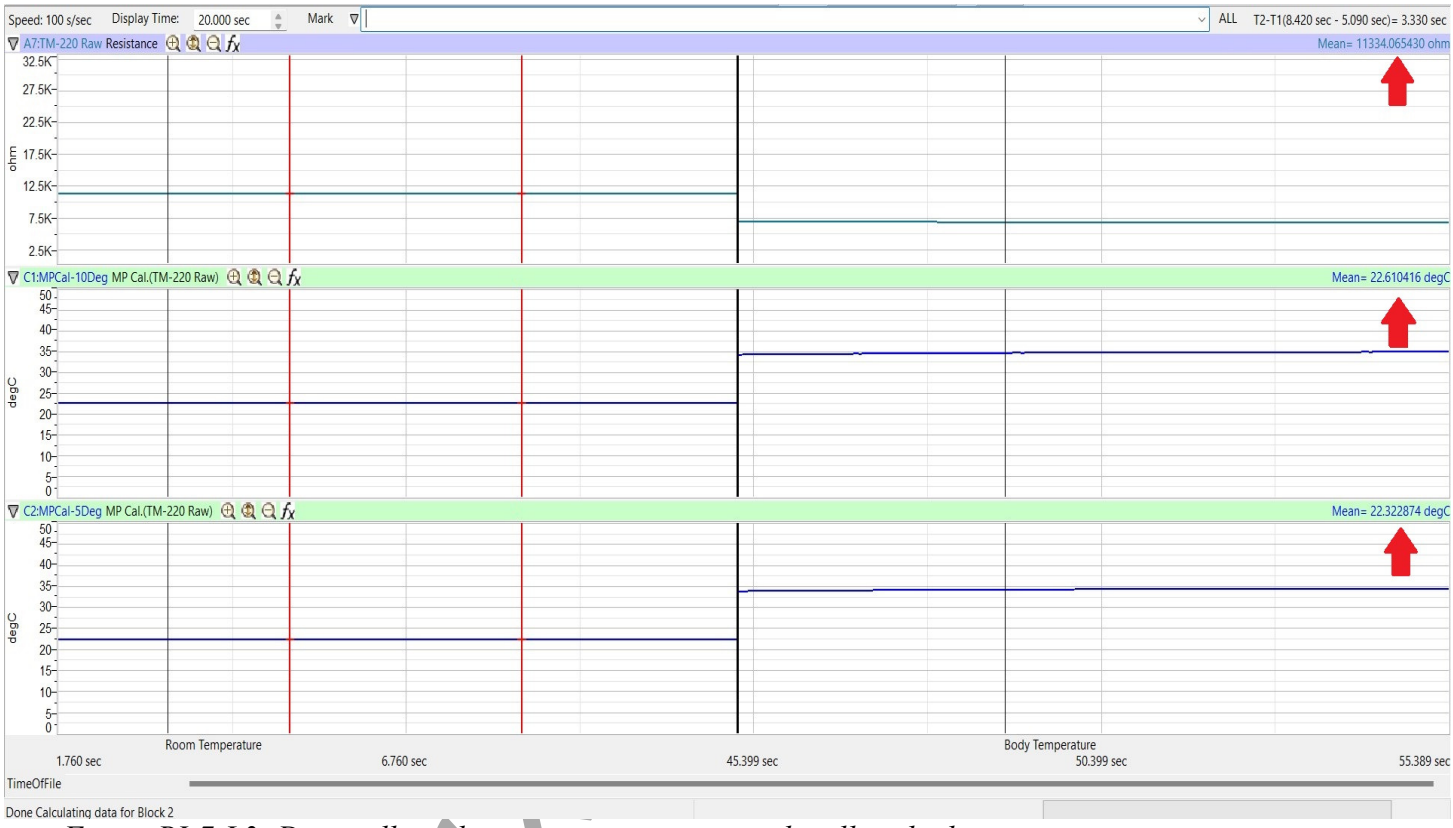

Figure BI-7-L3: Data collected at room temperature and axillary body temperature.

1. Record data at a known temperature, ie: room or body temperature, for approximately 10-15 seconds.
2. Mark the recording by typing "*X* Temperature" in the mark box and clicking the Mark button.
3. Click Stop and Save your data.
4. Record data at a 2nd known temperature for approximately 10-15 seconds. Mark the recording appropriately. Click Stop.
5. Save your data.

Data Analysis:

1. Place both cursors on the data collected at the first known temperature.
2. Read the mean values on all the channels.
   - Write down the resistance value and the temperatures shown on each channel
3. Compare the resistance value in the Resistance table on page 1 and see if it matches the temperatures on the calibration channels.
4. Repeat this procedure with the 2nd known temperature.

Optional Exercise:

1. Get a beaker of ice water. Place the temperature probe in the beaker and record data for about 15 seconds. Mark the recording "0 Deg C". Click Stop and Save your data.
2. Place the beaker on a hot plate set on low to slowly melt the ice and heat up the water. Record data while the ice is melting. Place a thermometer in the beaker and mark the recording at different temperature values.

   BE CAREFUL. Heat the beaker slowly. Do not heat the beaker over 40 deg C or you will damage the temperature probe.

3. Continuously record data until the ice has melted and the water has warmed to approximately body temperature.
4. Place the cursors at the various marked locations on the recording and compare the resistance values to the known temperature values.