dataTaker

Training Note

TR-07RD

Thermistor temperature sensors

Introduction

Thermistors are a high accuracy resistance based temperature sensor usually made from Ceramic or polymer.

The DT80 range loggers support Negative Temperature Curve (NTC) thermistors.

For thermistors with resistance of greater then 10 kOhms a resistor can be placed in parallel with the thermistor to reduce the circuit resistance and there for increase the measurable temperature range. By entering the value of the parallel resistor as the channel factor the DT80 will calculate the actual temperature value.

For thermistors not supported by a specific dataTaker channel types the DT80 can read the resistance and then apply thermistor scaling using the Steinhart-Hart equation with the A, B and C for the specific thermistor type.

Prerequisite

This worked example assumes basic knowledge of;

1. *dEX interface or DeTransfer*
2. *dataTaker* programming language. (When using DeTransfer)
3. Connecting and programming thermistors temperature sensors.

Requirements

Hardware;

1. DT80 Range *dataTaker* data logger. Version 8.06.0001 firmware or later.
2. Thermistor. (MEAS 44005 used in this example)

Software;

1. *dEX interface*.

or

2. *DeTransfer*.

Manuals;

1. *DT80* User manual Version UM-0085-B1 or later
2. Thermistor data sheet.

Quick start

Thermistor temperature sensors will typically have a two wire configurations.

Sampling the Thermistor.

1. Connect the thermistor to the * and # terminals of a *dataTaker* analog channel.

Note: Cable shielding is to be connected to either the Digital Ground or the ground screw terminal.

2. When using dEX web based configuration interface

a. Open your web browser and enter the TCP/IP address of your DT80 series GeoLogger.

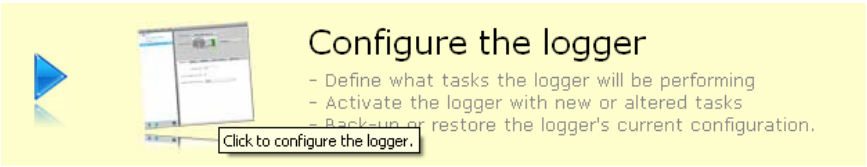

Figure 1 Accessing dEX configuration builder

b. In the Menu tree select Schedule_1 then click on “Add” in the menu bar

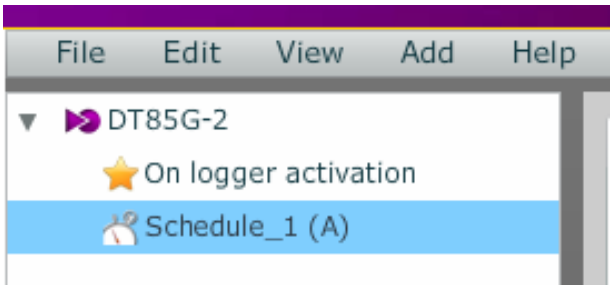

Figure 2 Adding a measurement

c. Expand out the add menu following the path Measurement -> Temperature and click on YSI, Meas thermistor.

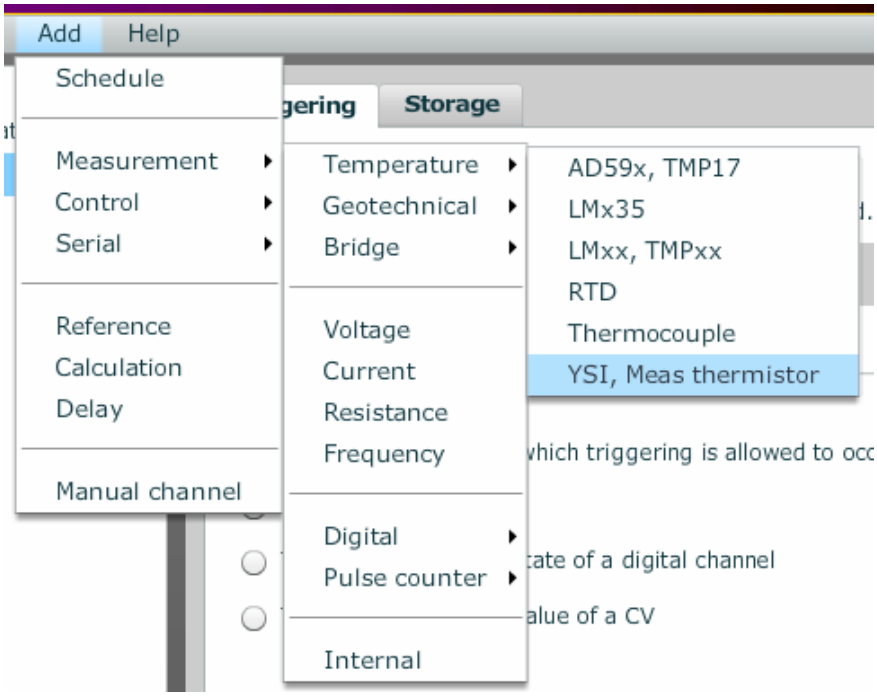

Figure 3 Adding a thermistor channel type

d. In the tree view give the channel a unique and meaningful name. To accept the name click on the tick. Note: This name will be referred to in later calculations.

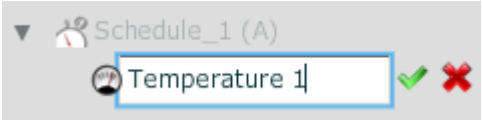

Figure 4 Naming the channel

e. In the view pane, click on “Select wiring” and select the first wiring option.

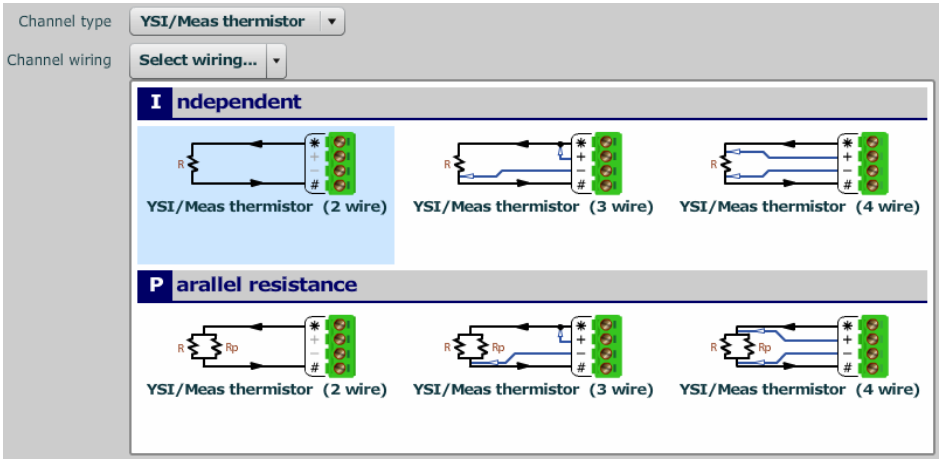

Figure 5 Selecting wiring type

f. In the view pane, click on the channel selector and select the analog channel number the Thermistor sensor is physically connected to.

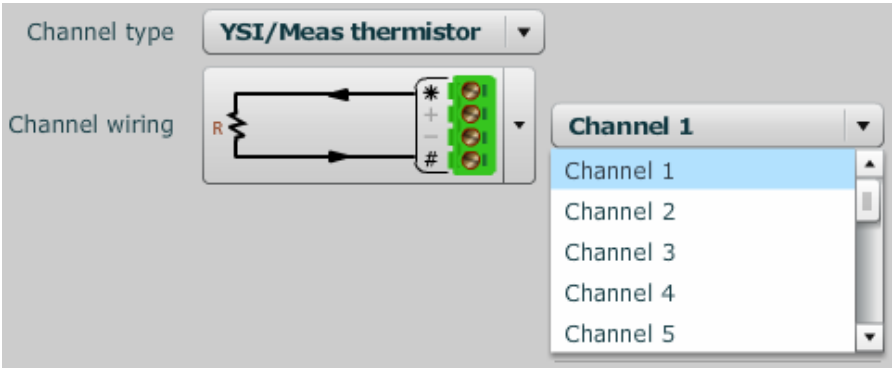

Figure 6 Selecting analog channel number

g. Click on the dialog next to Thermistor model and select the thermistor type from the list

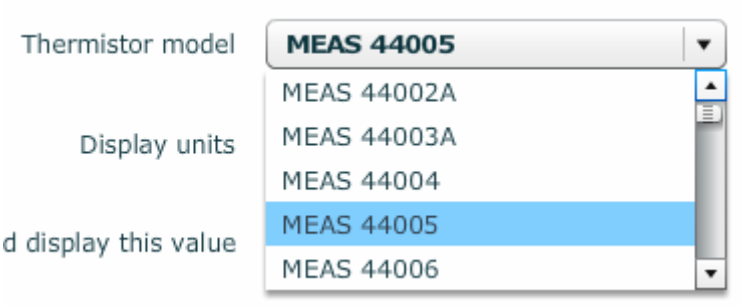

Figure 7 Selecting thermistor type

h. To send the configuration to the logger, on the menu bar, Click on “File” -> “Save to logger”

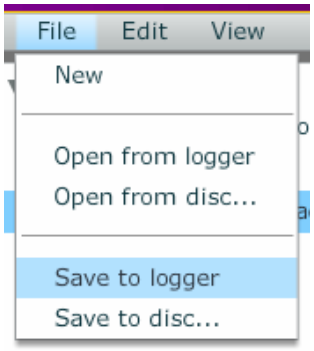

Figure 8 Sending configuration to logger

3. When using the dEX command window or *DeTransfer*.

a. Connect to the *DT80* range logger.

b. In the send window type the command nYSmm. Where n is the analog channel number the thermistor is connected to and mm is the appropriate dataTaker thermistor channel type. This will cause the *DT80* to take a single reading from the thermistor.

c. Sample result will be returned to the receive window.

Thermistor Support in detail

The dataTaker data loggers support several types of the Measurement Specialist Inc. range of thermistors. While other manufacturer's thermistors are not directly supported the resistance can be measures and the resistance can be converted to temperature by applying the Steinhart-Hart equation. (Thermistor scaling)

The thermistor is a thermo-resistive device, which changes resistance with changes in temperature. The thermistors have a negative temperature coefficient, such that the resistance of the device decreases as temperature increases. The dataTaker accurately measures the changes in resistance of the element, and linearizes the measured resistance to units of temperature.

Measuring low temperatures

Thermistors have a negative temperature coefficient, in that the resistance of the device decreases as temperature increases. The resistance of thermistors is highest at lower temperatures. Therefore the minimum temperatures which can be measured using thermistors with the DT80 is limited by the maximum resistance that the logger can measure. The dataTaker can measure resistance up to 10000 Ohms.

This maximum resistance that can be measured translates to a different minimum temperature for the different types of Measurement Specialist Inc. thermistors supported. The minimum temperatures which can be measured using the dataTaker for the different types of Measurement Specialist Inc. thermistors supported are summarized in appendix 1.

In contrast the maximum temperatures that can be measured using the Measurement Specialist Inc. thermistors with the dataTaker are limited only by the manufacturer's specification.

The lower temperature can be extended by wiring a known resistor in parallel with the resistance being measured. This will, however, reduce the resolution of the high end temperature measurements.

The required value of the parallel resistor *Rp* is given by:

$$R_p = \frac{10000 \times R_{Max}}{R_{Max} - 10000}$$

Where

R_p = Parallel resistor value

R_{Max} = Resistance to be measured

10000 = Maximum resistance that can be measured

Figure 9 Calculation of Rp value

A table of possible Rp values for different thermistor types is given in appendix 2. The value of Rp is entered as the channel factor for thermistor channel type. If an Rp value is entered then the DT80 will do the necessary calculations to return the corrected temperature value.

To configure the DT80 for using a parallel resistor select one of the wiring sequences that shows Rp. e.g. Two wire parallel resistor (Figure 10)

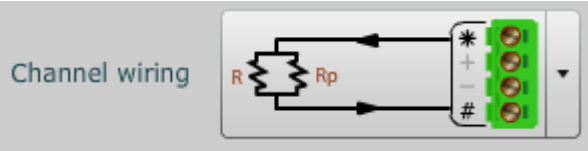

Figure 10 Two wire parallel resistor configuration

And add the value of the parallel resistor in the dialog box.

Figure 11 Entering Parallel resistor value

For further details on using parallel resistors to extend the measurement range please refer to the DT80 range user manual, Part N - Sensors and Channels, Analog Channels, Resistance section R5.

Measuring high temperatures

As mentioned above, thermistors have a negative temperature coefficient, in that the resistance of the device decreases as temperature increases but is also means the resistance decreases as the temperature increases.
When measuring low resistance values care needs to be taken to compensate for lead length resistances.

While a two wiring configuration will increase the number of thermistors that can be connected it will not compensate for lead length resistance where as a three or 4 wire configuration will compensate for lead length resistance which can, in some cases, greatly increase the accuracy of the temperature reading.

Example 1
MEAS. 44001 thermistor measuring a temperature of 100 Deg C.

Given;
1. 14.3 Sensor resistance at 100 Deg C
2. Two wire configuration
3. 30 AWG copper wire (approx 0.354 Ohms per meter)
4. 10 m lead wire length

As a two wires measurement will include the lead wire resistance then the measured resistance will be 14.3 + 2 x 10 x 0.354 = 21.38 Ohms which corresponds to a temperature of 82 Deg C. In this case a three or 4 wire configuration should be used.

An alternative is to use a higher resistance thermistor.

Example 2
MEAS. 44006 thermistor measuring a temperature of 100 Deg C.
Given the same wiring as in example 1 and having a sensor resistance of 816.6 Ohms at 100 deg C then the error is a two wire configuration is 816.8 + 2 x 10 x 0.354 = 346.68 Ohms which corresponds to a temperature of 99.74 Deg C an error of 0.26. While a 3 or 4 wire configuration will reduce the error there is limited benefit in the extra cost of wiring and reduced channel density.

Non MEAS. thermistors.

The dEX programming interface does not support thermistor scaling. It is possible how ever to use the manual channel type to enter the Steinhart-Hart equation A, B and C coefficients into the thermistor scaling then apply the thermistor scaling to a resistance measurement. Please refer to the DT80 User manual for further details.

Programming the DT80 data logger

DeTransfer / *WEB UI example (Differential Inputs).*

Enter the following *dataTaker* code into the send window of *DeTransfer* or the data logger WEB UI command send pane and send to the data logger.

Code example 1:

```
BEGIN"YS05"
'Sample of MEAS. 44005 thermistor measurement.

RA"Schedule_1"("b:",ALARMS:OV:100KB:W60,DATA:OV:1MB)5S LOGONA
 1*YS05     'Two wire thermistor measurement
 2YS05      'Three wire thermistor measurement
 3YS05(4W) 'Four wire thermistor measurement
END
```

Appendix 1

Supported thermistor types:

Channel type	YSI/MEAS type	Resistance @25 Deg C	Max. Temp Deg C	Min. Temp Without Rp Deg C	Min. Temp With Rp Deg C
YS01	44001A	100 Ω	100	-74	-80
	44101A	100 Ω	100	-74	-80
YS02	44002A	300 Ω	100	-51	-80
	44102A	300 Ω	100	-51	-80
YS03	44003A	1,000 Ω	100	-27	-80
	44103A	1,000 Ω	100	-27	-80
	44035	1,000 Ω	100	-27	-80
YS04	44004	2,252 Ω	150	-6	-55
	44104	2,252 Ω	150	-6	-55
	44033	2,252 Ω	75	-6	-55
	45004	2,252 Ω	200	-6	-55
	46004	2,252 Ω	200	-6	-55
	46033	2,252 Ω	200	-6	-55
	46043	2,252 Ω	200	-6	-55
	44901	2,252 Ω	90	-6	-55
	44902	2,252 Ω	70	-6	-55
YS05	44005	3,000 Ω	150	0	-55
	44105	3,000 Ω	150	0	-55
	44030	3,000 Ω	75	0	-55
	45005	3,000 Ω	200	0	-55
	46005	3,000 Ω	200	0	-55
	46030	3,000 Ω	200	0	-55
	46040	3,000 Ω	200	0	-55
	44903	3,000 Ω	90	0	-55
	44904	3,000 Ω	70	0	-55
YS06	44006	10,000 Ω	90	25	-55
	44106	10,000 Ω	90	25	-55
	44031	10,000 Ω	75	25	-55
	45006	10,000 Ω	250	25	-55
	46006	10,000 Ω	200	25	-55
	46031	10,000 Ω	200	25	-55
	46041	10,000 Ω	200	25	-55
	46046	10,000 Ω	200	25	-55
	44907	10,000 Ω	90	25	-55
	44908	10,000 Ω	70	25	-55

Supported thermistor types continued:

Channel type	YSI/MEAS type	Resistance @25 Deg C	Max. Temp Deg C	Min. Temp Without Rp Deg C	Min. Temp With Rp Deg C
YS07	44007	5,000 Ω	150	10	-55
	44017	5,000 Ω	150	10	-55
	44034	5,000 Ω	75	10	-55
	45007	5,000 Ω	250	10	-55
	46007	5,000 Ω	250	10	-55
	46034	5,000 Ω	250	10	-55
	46044	5,000 Ω	250	10	-55
	44905	5,000 Ω	90	10	-55
	44906	5,000 Ω	70	10	-55
YS16	44016	10,000 Ω	150	25	-55
	44116	10,000 Ω	150	25	-55
	44036	10,000 Ω	75	25	-55
	46036	10,000 Ω	200	25	-55
YS17	44017	6,000 Ω	150	14	-55
	44117	6,000 Ω	150	14	-55
	45017	6,000 Ω	250	14	-55
	46017	6,000 Ω	200	14	-55
	46037	6,000 Ω	200	14	-50
	46047	6,000 Ω	200	14	-55

Appendix 2

Rp Values.

Channel type	Minimum Temperature	Minimum Temp Resistance	Calculated Rp Value	Standard Rp Value.
YS01	-80 Deg C	14,470 Ω	32,371 Ω	30,000 Ω
YS02	-80 Deg C	67,660 Ω	11,734 Ω	11,000 Ω
YS03	-80 Deg C	278,800 Ω	10,372 Ω	10,000 Ω
YS05	-80 Deg C	2,211,000 Ω	10,045 Ω	10,000 Ω
YS06	-80 Deg C	3,558,000 Ω	10,028 Ω	10,000 Ω
YS07	-80 Deg C	3,685,000 Ω	10,027 Ω	10,000 Ω
YS16	-80 Deg C	7,371,000 Ω	10,013 Ω	10,000 Ω
YS17	-80 Deg C	4,423,000 Ω	10,022 Ω	10,000 Ω