XL-Series Product Thermistor Linearization Supplemental Guide

1. INTRODUCTION

The following supplemental guide covers the 10kΩ thermistor configuration on the Horner XL-Series (XL4, XL7, EXL6, EXL10, and XL+) controllers in Cscape.

The thermistor support is available for the Model 2 (-10, -14), Model 3 (-10), and Model 4 (-10). It is recommended to refer to original product manual for all other information on the controller.

There are two options for thermistor support for Horner products. **Option "-10" is for 2 channels, and option "-14" is for 4 channels.** These are special build units that should be ordered with the dash numbers specified, for example: HE-XE102-10.

The -10 and -14 units supports Kele Engineering Precon Type III, 10 kΩ thermistors. It also directly supports the following: 10 kΩ (Beta=3574) thermistors from Yellow Springs Instruments (YSI).

Part Numbers	
44006	46006
44106	46031
44406	46041
44031	44907
45006	44908

Thermistors are measured using a half-bridge circuit that exhibits variable resolution and the associated increased measurement range. Refer to the table below:

Temperature, ° C	Resolution, ° C
-55	1.05
-35	0.36
-15	0.17
5	0.11
25	0.1
45	0.13
65	0.22
85	0.30
105	0.55
125	0.85
145	1.35

Best Resolution is at 25°C (77°F). With a constant 0.1°C resolution circuit, the measurement range would only extend from -26°C to +76°C.

## 2.	THERMISTOR CURVE

Thermistor Curve for PreCon TYPE III (Model 3)					
Temperature °F	Resistance	Temperature °F	Resistance	Temperature °F	Resistance
-35	203.6k	60	14.78k	155	2.098k
-30	173.6k	65	13.15k	160	1.920k
-25	148.3k	70	11.72k	165	1.759k
-20	127.1k	75	10.46k	170	1.614k
-15	109.2k	80	9.354k	175	1.482k
-10	94.07k	85	8.378k	180	1.362k
-5	81.23k	90	7.516k	185	1.254k
0	70.32k	95	6.754k	190	1.156k
5	61.02k	100	6.078k	195	1.066k
10	53.07k	105	5.479k	200	984.0
15	46.27k	110	4.947k	205	909.8
20	40.42k	115	4.472k	210	841.9
25	35.39k	120	4.049k	215	779.8
30	31.06k	125	3.671k	220	723.0
35	27.31k	130	3.333k	225	671.0
40	24.06k	135	3.031k	230	623.3
45	21.24k	140	2.759k	235	579.5
50	18.79k	145	2.515k	240	539.4
55	16.65k	150	2.296k		

3. CONFIGURATION AND PROGRAM LOGIC

Linearization must be performed by the user in the ladder application code, using 26 internal %R registers per channel. Refer to the **thermistor_linearization.csp** example file found in Cscape installation files or at www.hornerautomation.com and follow the following steps.

NOTE: Example images and samples may reflect different registers and values depending on application. Refer to example Cscape program for easy access to the following configuration.

3.1   Linearization

1) The following specific logic must be added to the program to properly scale the analog input signal from the Thermistor.

2) Make entries exactly as shown for either Celsius or Fahrenheit scaling. Use the Constant_Move element to enter the scaling constants. Any available block of %R registers can be used. Note where the Constant_Mov Destination address fits into the math expressions below.
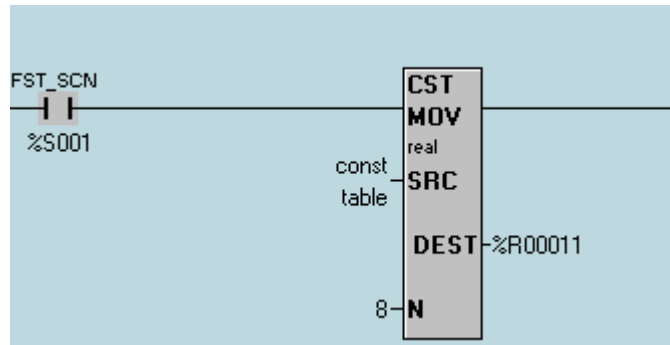

Figure 1 – Move Constant Block

3a)   Use the following scaling constants for temperature in degree **Celsius.**
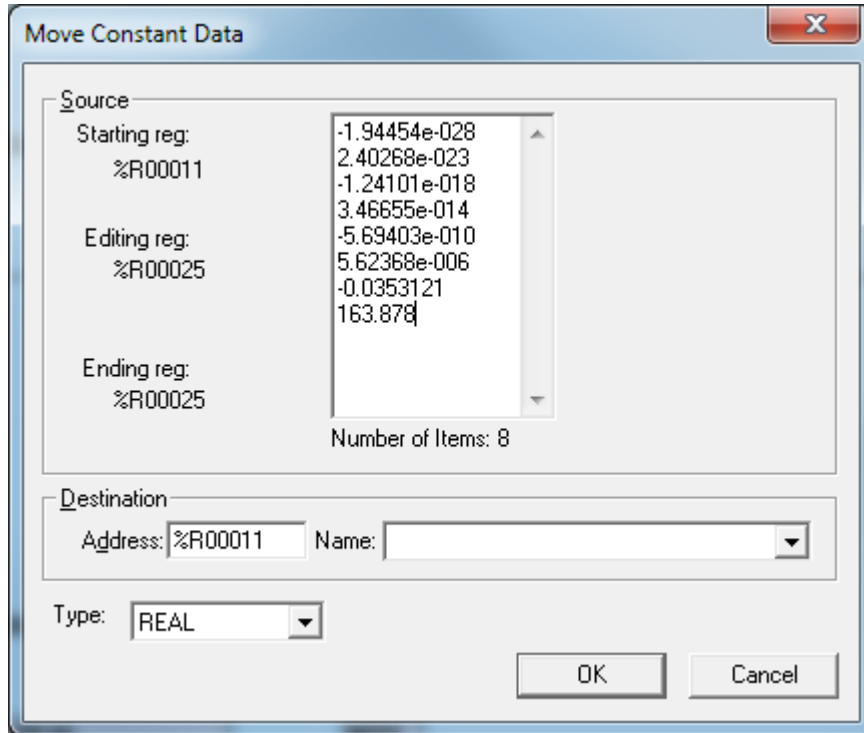

Figure 2 – Celsius Move Constant Data

3b)   Use the following scaling constants for temperature in degrees **Fahrenheit.**
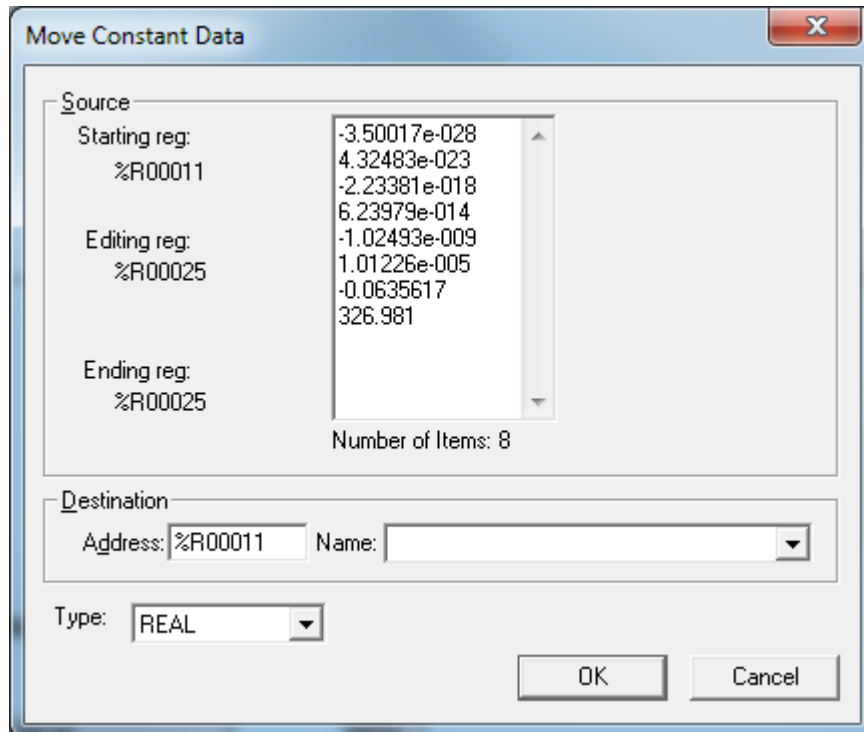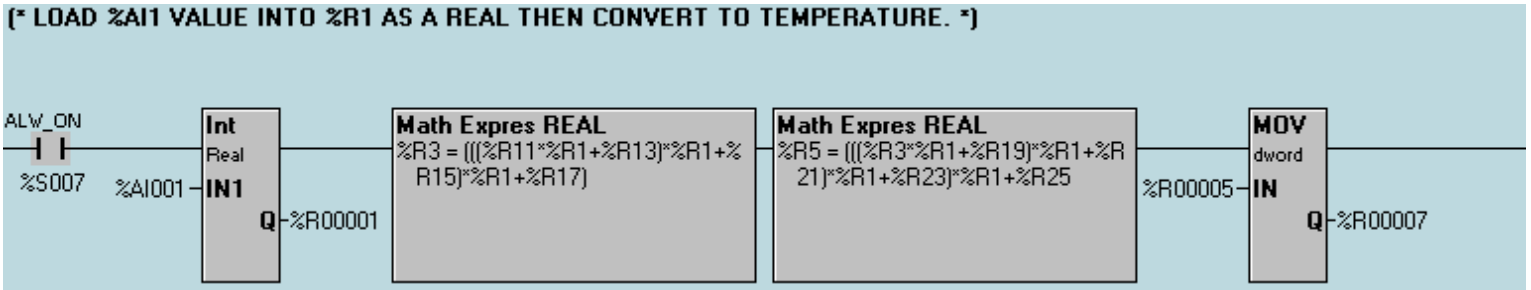

Figure 3 – Fahrenheit Move Constant Data

4) Convert %AI Value into %R1 as a Real.
5) Convert to Temperature using the expressions shown below.

[* LOAD %AI1 VALUE INTO %R1 AS A REAL THEN CONVERT TO TEMPERATURE. *]

ALW_ON
| |
%S007   %AI001 — IN1

Int
Real

Q — %R00001

Math Expres REAL
%R3 = (((%R11*%R1+%R13)*%R1+%
R15)*%R1+%R17)

Math Expres REAL
%R5 = (((%R3*%R1+%R19)*%R1+%R
21)*%R1+%R23)*%R1+%R25

%R00005 — IN

MOV
dword

Q — %R00007

1st math expression: %R3 = (((%R11*%R1+%R13)*%R1+%R15)*%R1+%R17)
2nd math expression: %R5 = (((%R3*%R1+%R19)*%R1+%R21)*%R1+%R23)*%R1+%R25)

The same rung can be used for subsequent channels by changing the first and last addresses.

[* LOAD %AI2 VALUE INTO %R1 AS A REAL THEN CONVERT TO TEMPERATURE. *]

ALW_ON
| |
%S007   %AI002 — IN1

Int
Real

Q — %R00001

Math Expres REAL
%R3 = (((%R11*%R1+%R13)*%R1+%
R15)*%R1+%R17)

Math Expres REAL
%R5 = (((%R3*%R1+%R19)*%R1+%R
21)*%R1+%R23)*%R1+%R25
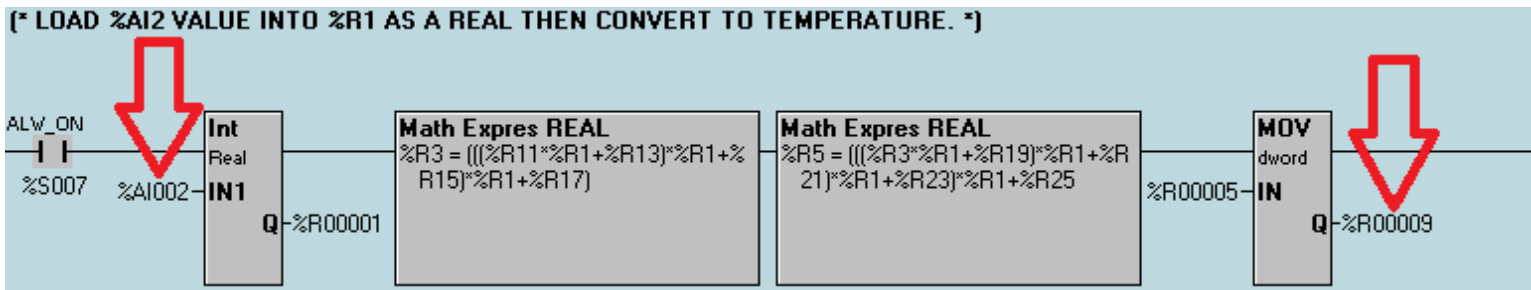
%R00005 — IN

MOV
dword

Q — %R00009

Figure 4 – Conversion from Real Numbers to Degrees

3.2 Voltage Configuration

The thermistors use 0 – 10V scale. In order to set up controller to operate within these parameters in Cscape:

1) Select **Controller→Hardware Configuration** from the top navigation bar.
2) Open **Local I/O** and select **Config** next to the corresponding image.
3) Click the **Module Setup** tab and open **Analog In**.
4) Set Channels used to **0..10V** and Filter Constant to **3**.
5) Click **OK.**

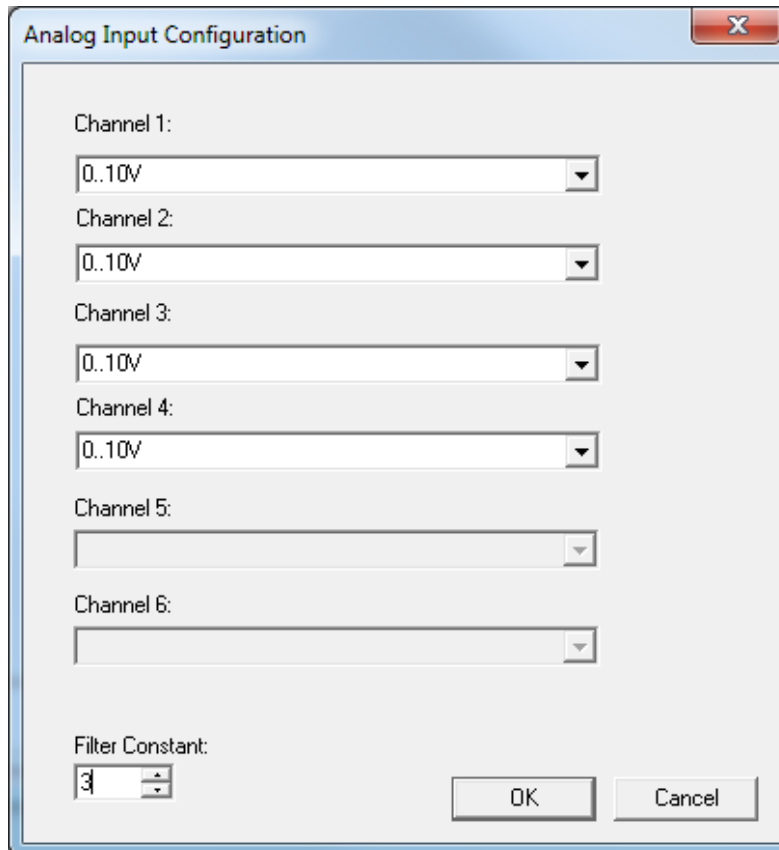**Analog Input Configuration**

Channel 1:
[0..10V]

Channel 2:
[0..10V]

Channel 3:
[0..10V]

Channel 4:
[0..10V]

Channel 5:
[ ]

Channel 6:
[ ]

Filter Constant:
[3]

[OK] [Cancel]

Figure 5 – Analog Input Voltage Configuration

4 TECHNICAL SUPPORT

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