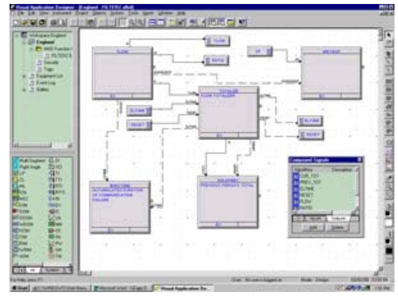
Temperature values are not accurate with B type T/C if CJC is used in MOD 30ML/Modcell

MOD 30ML and Modcell have Analog Output Module Error



Problem Description:

The configuration involves a Thermocouple input on the MOD 30ML/Modcell. The controller is configured with a TIM module/ AIN block configured as T/C and TI block with CJC. The TIM/AIN block is configured as a B type thermocouple. The compensation works properly at some temperatures, but not at others. This problem is seen only with the B type thermocouple configuration. The type of CJC selected (internal, built-in or modular) does not have any effect on this.

Applies to:

MOD 30ML/Modcell configured from Application Builder software or Visual Application Designer ViZapp Software. This also applies to MOD 30ML configured from front face.

Explanation:

It appears that the compensation for a Type B thermocouple is not working, due to an incomplete table in the instrument's firmware. The table that converts from millivolts to degrees and the reverse, has values for the range of 200 to 1820 degrees C. This range may be fine for converting a process signal from millivolts to degrees C.

The problem appears when the instrument tries to inverse calculate a millivolt value from room temperature for compensation. There are no table values to support this low value, and an invalid value is produced.

With a constant temperature at the terminal block, the number of degrees of compensation varies, depending on where the process temperature is on thermocouple's curve. It is not simply a matter of adding the reference temperature to the calculated thermocouple temperature.

It is noted that even though the range of a Type B thermocouple is 0 to 1700 degrees C, its useful range begins above 800 degrees C.

Because its linearization curve is nearly flat below this point, there are no accuracy specifications below that point.

Dynamic Compensation: Since this Type of thermocouple has a curve that produces almost no signal a room temperature, dynamic compensation really is not necessary. The millivolt value in a Type B curve that corresponds to 23 degrees C is -0.003 mV. At normal operating temperatures (above 800 degrees C), this relates to about 1/3 of a degree offset. Adding a fixed compensation value is all that is necessary for this type of thermocouple.

Using dynamic compensation may not help since the Type B tables indicate that the mV signal will fluctuate between 0.000 and -0.003 for any temperature under 45 degrees C.

Solution:

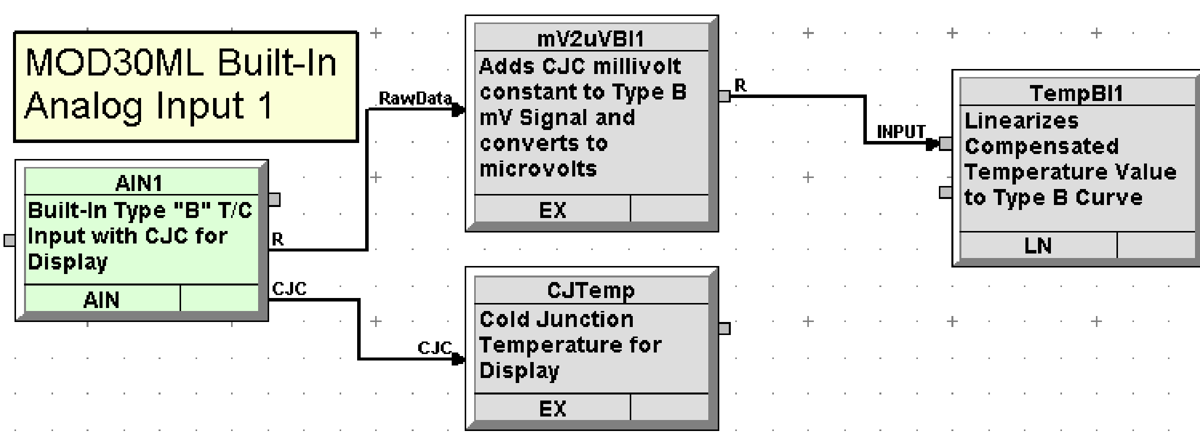
The solution to this problem is to perform the linearization manually with other blocks. We will use an EX (expression) block and a LN (linearization) block to this. This is explained below with configuration in ViZapp. If you use Application Builder, you can still follow the steps below. If you configured the controller from the front face, consider configuring it from the ViZapp or Application Builder software as the fix involves EX and LN blocks. The solution is different for Built-in inputs and Module inputs. Both types are discusseed below. The following 3 schemes are discussed in this Technote:

1. Built-In input 1 in MOD 30ML configured as B type thermocouple
2. Built-In input 2 in MOD 30ML configured as B type thermocouple
3. Thermocouple module 2013A configured as B type thermocouple in MOD 30ML or Modcell

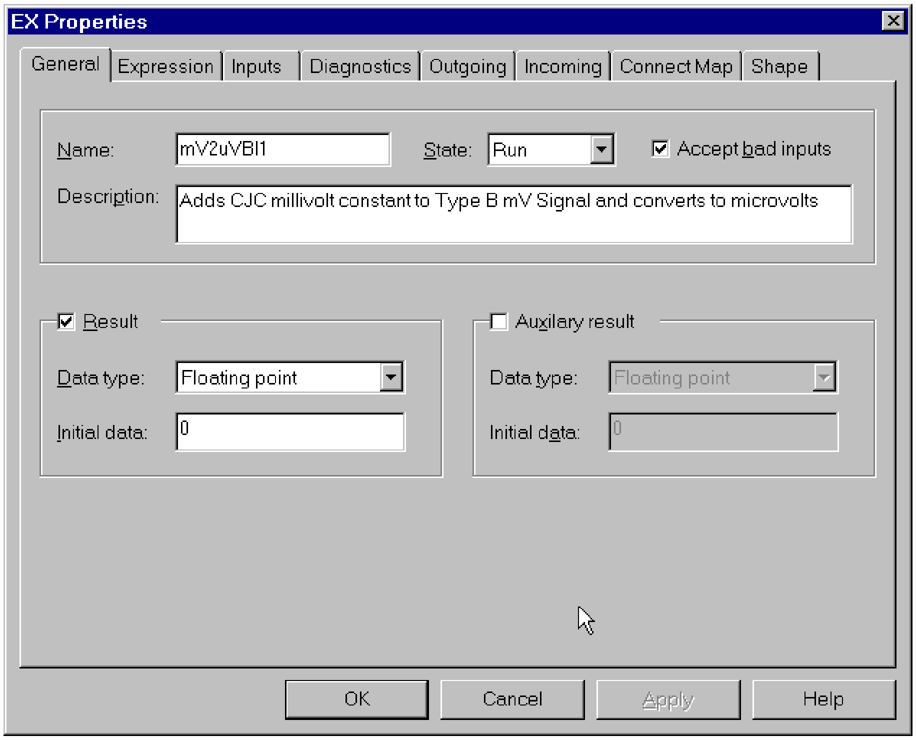
Note: The Default Gallary in VIZapp includes these schemes as compounds. You can also simply load the compound and use it.

Built-In Input 1 configured as B type T/C:

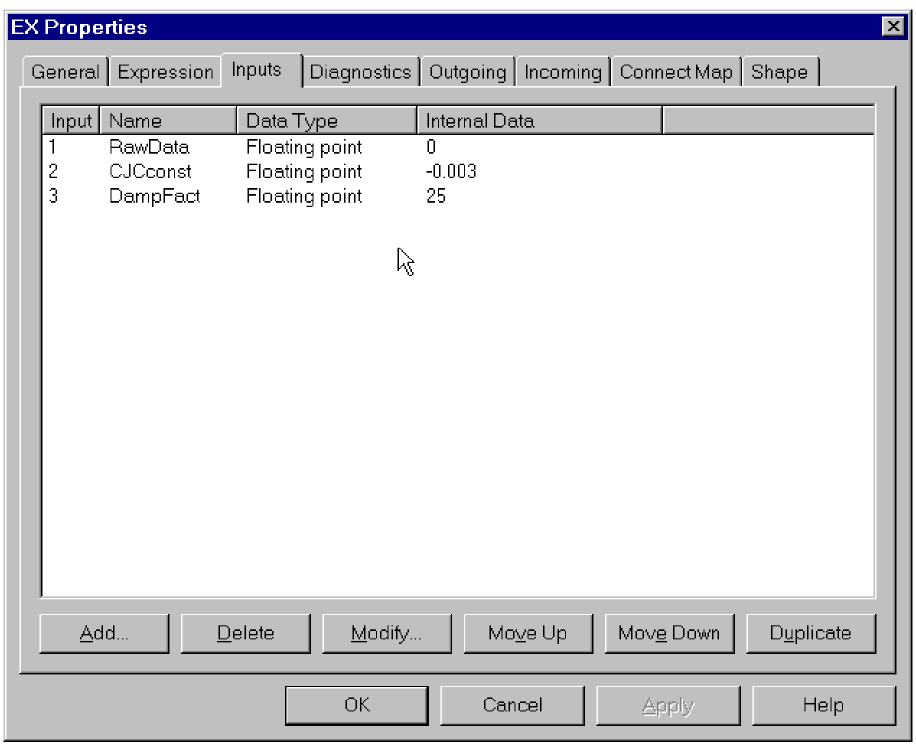
1. This scheme requires an AIN block, EX blocks and a LN block in your control strategy as shown in the next figure



2. Configure the AIN block for B type thermocouple and the desired Temperature scale.
3. Configure the first EX block's (mV2uVBI1) General tab as shown in the figure below: (Tag names and descriptions are optional).

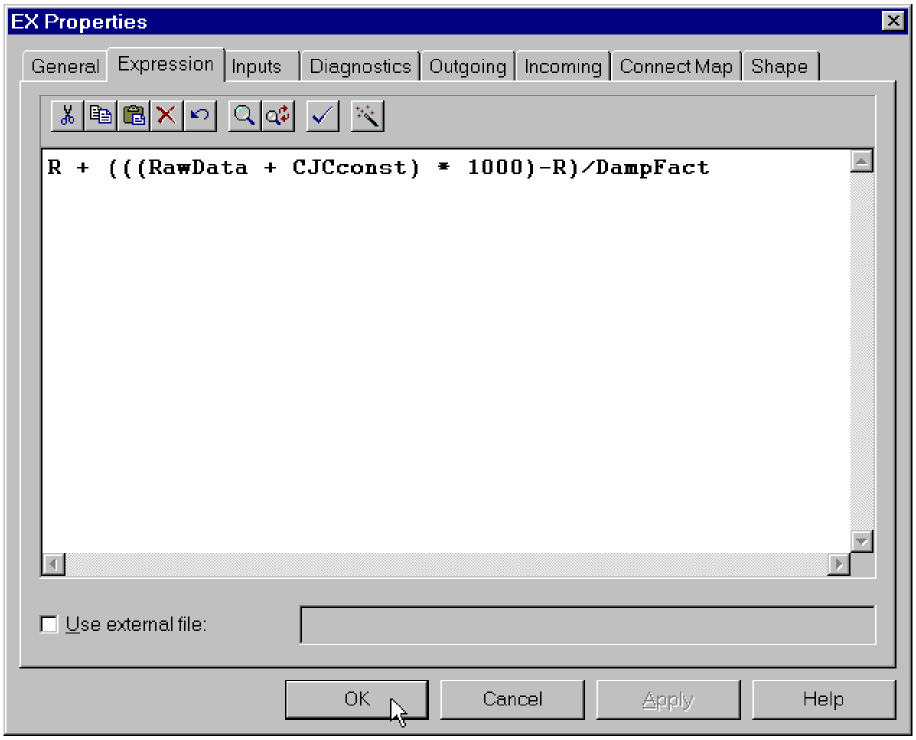


4. Add 3 inputs: **RawData** (Floating point), **CJConst** (Floating point with internal data value of –0.003) and **Dampfact** (Floating point with internal data value of 25) in the Inputs tab of this EX block as shown in the next figure:

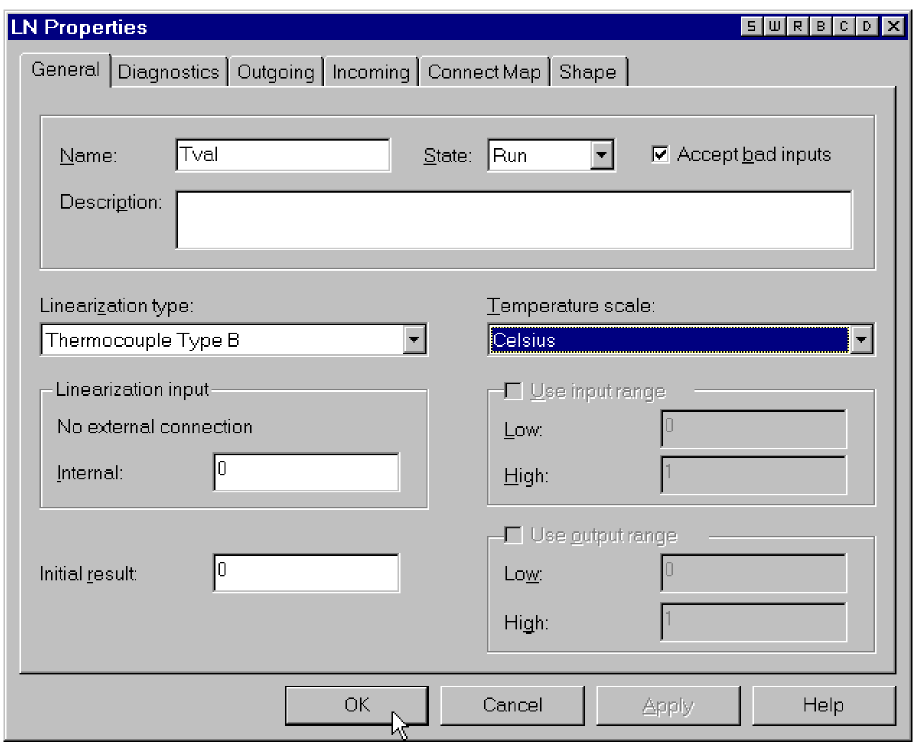


5. Configure the Expression tab of this EX block by typing the expression:

R + (((RawData + CJCconst) * 1000)-R)/DampFact



6. Click on OK.
7. Configure the LIN block with the Linearization type as **Thermocouple Type B** as shown in the next figure: Choose the appropriate Temperature scale:



8. Click on OK and connect the blocks as below: (Refer to the figure on the second page).

Connect **R** form the **TIM** block to the input **RawData** of the **EX** block.

Connect the **R** of the EX block to the **INPUT** of the LN block.

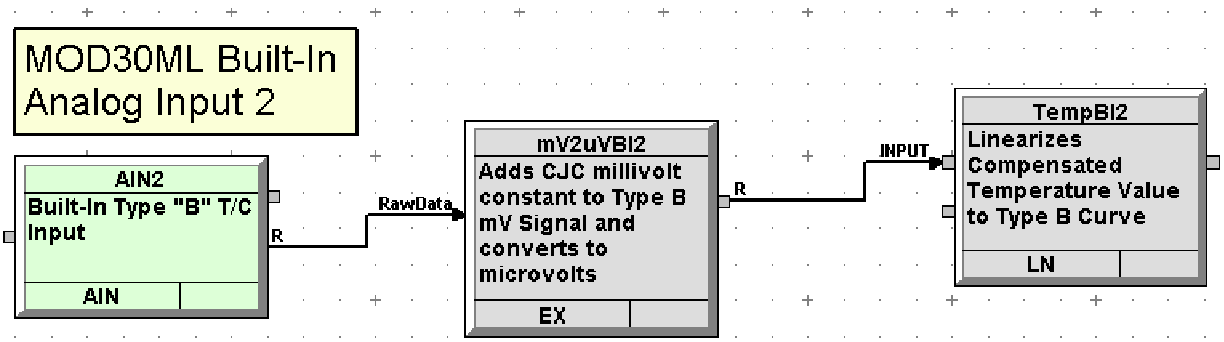
9. **Optional:** Add another EX block (tag name: CJTemp in the figure) to display the value of the temperature at the terminals. This EX block will have inputs CJC (Floating point) and DampFact (Floating point with internal data value of 2.0). The Expression for this EX block will be:

    R + (CJC-R)/DampFact

    The Result type is default (Floating point) for this EX block. Connect the **CJC** attribute from the TIM block to the **CJC** input of this EX block as shown on the figure on the second page. This EX block's result can be connected to a display block to display the value of the temperature at the terminals. As mentioned, this EX block is optional only and does not partcipate in the temperature calculation for the B type T/C.
10. Compile your database.

Built-In Input 2 configured as B type T/C:

1. This scheme requires an AIN block, EX block and a LN block in your control strategy as shown in the next figure:



2. The AIN block is configured as input number 2 and type as Thermocouple Type B.
3. Configure the desired Temperature scale.
4. Configure the EX block's (mV2uVBI2). Add 3 inputs: **RawData** (Floating point), **CJConst** (Floating point with internal data value of –0.003) and **Dampfact** (Floating point with internal data value of 25) in the Inputs tab of this EX block.
5. Configure the Expression tab of this EX block by typing the expression:

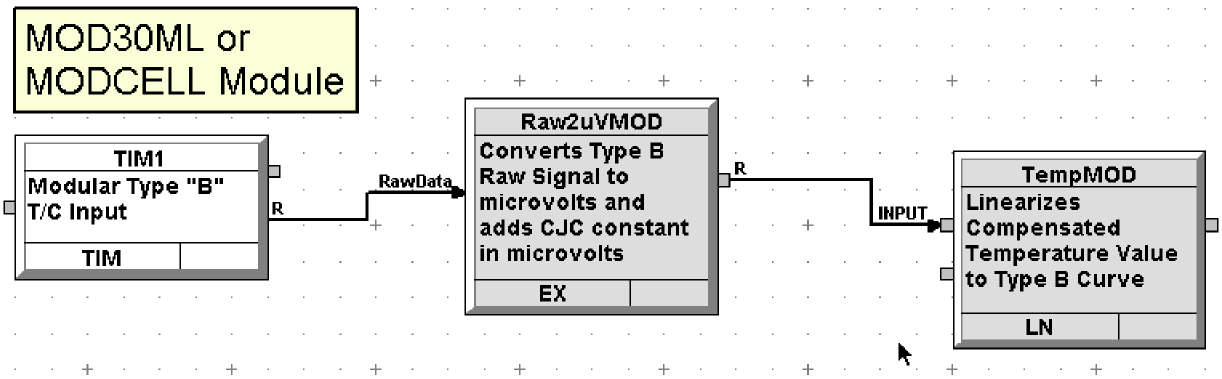
    R + (((RawData + CJCconst) * 1000)-R)/DampFact
6. Click on OK.
7. Configure the LIN block with the Linearization type as **Thermocouple Type B.** Choose the appropriate Temperature scale.

8. Click on OK and connect the blocks as below: (Refer to the figure above). Connect **R** form the **TIM** block to the input **RawData** of the **EX** block. Connect the **R** of the EX block to the **INPUT** of the LN block.

9. Compile the database.

TIM module block configured as B type T/C:

1. This scheme requires a TIM block, EX block and a LN block in your control strategy as shown in the next figure:



2. The TIM block is configured as Thermocouple Type B.
3. Configure the desired Temperature scale.
4. Configure the EX block's (mV2uVMOD). Add 3 inputs: **RawData** (Floating point), **CJConst** (Floating point with internal data value of –3.0) and **Dampfact** (Floating point with internal data value of 25) in the Inputs tab of this EX block.

10. Configure the Expression tab of this EX block by typing the expression:

    R + ((4.0 * RawData + CJCconst) - R)/DampFact

11. Click on OK.
12. Configure the LIN block with the Linearization type as **Thermocouple Type B.** Choose the appropriate Temperature scale.

13. Click on OK and connect the blocks as below: (Refer to the figure above). Connect **R** form the **TIM** block to the input **RawData** of the **EX** block. Connect the **R** of the EX block to the **INPUT** of the LN block.

14. Compile the database.