

User's Guide

Thermocouple Module

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Using Thermocouple Sensors

Thermocouple temperature sensors offer an extremely wide range of operation. They can also be inexpensive and easy to install. However, devices used in cryogenic applications are often difficult to apply because they exhibit poor sensitivity at low temperature and are generally constructed with metals that are difficult to use. In order to obtain the best possible measurement accuracy, the recommendations given here should be carefully applied.

Installing the Thermocouple Module

All thermocouple sensors require the use of an optional Cryo-con external thermocouple module (4039-004). This module plugs into any sensor input channel of a instrument. Up to four modules can be installed on a single instrument and they can easily be added or removed at any time. They are powered by the instrument and perform amplification, cold-junction compensation, open sensor detection and connection to copper.

Internal switches are used to select the cold junction compensation for specific types. Open the module and use the switches to select types K, E, T, AuFe 0.7% or off.



Figure 1: Thermocouple Module

Module Configuration

Before a thermocouple module can be used, the thermocouple type must be set into the module's internal switches. This selects the cold-junction compensation method.

To access the switches, remove the cover by removing the two screws from the plastic cover.

The type is set by the four switches shown here. Settings are E, K or T, AuFe 0.7% and OFF. The Off setting disables cold-junction compensation. Select the type by sliding the proper switch to the right. Ensure that there is only one type selected.

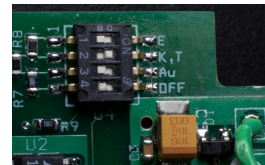


Figure 2: Thermocouple Switches

Next, replace the plastic cover on the module. The thermocouple module is now ready for use.

Instrument Setup

Instrument setup is performed as follows:

1. Connect the thermocouple module to any of the available input channels.
2. From the front panel, go to the Input Channel Configuration menu by pressing the appropriate **ChA**, **ChB** etc. key. Next, scroll down to the Sen: field and select the sensor by pressing the **Next** key. When the proper thermocouple type is displayed, press the **Enter** key.
3. Scroll down to the Input Config field and press the Enter key to display the Thermocouple Sensor Configuration Menu.
4. Optionally perform the offset calibration procedure described below.
5. Return to the Home screen by pressing the **Home** key several times.

Offset Calibration

Thermocouple devices can vary significantly from their standard curves, especially at cryogenic temperatures where their sensitivity is reduced. To accommodate these variations, the instrument allows an offset calibration for individual thermocouple devices. Note that device calibration do not affect the instrument's basic calibration.

Device calibration is performed by using the instrument's Input Configuration menu. An example is shown here. Alternatively, calibration may be performed by using remote commands.

ChA:Radiation Shield Thermocouple Sensor Configuration + 78.12K FS Input: 70mV Set Reading: 0.00K Return to ChA cfg

This menu is selected by pressing the ChA key and then setting the Sensor field to the desired thermocouple type. Next, select the Input Config field.

For cryogenic applications, an offset calibration is usually done at a low temperature reference point. Examples being liquid nitrogen or even liquid helium. The result of the calibration is that the controller will read the correct temperature when the sensor is held at that reference. Setting the Reading field to zero turns offset calibration OFF. This is useful to start a new calibration.

Since thermocouples lose sensitivity at low temperature, an offset calibration in that range will generally have little effect on the higher temperature accuracy.

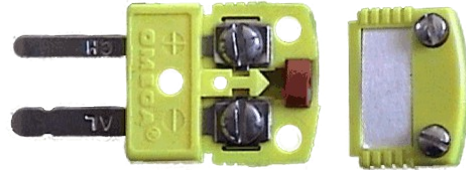
An offset calibration is done as follows:

1. Connect the controller as usual for thermocouple measurements. For best accuracy, be sure that ambient temperature doesn't vary.
2. Allow the instrument to warm up for at least ½ hour without moving or handling the sensor.
3. From the instrument front panel, first set the thermocouple sensor and then go to the input configuration menu.
4. Establish the thermocouple device at a precisely known temperature. When stable, enter the desired reading in the Set Reading field and press **Enter**. For example, if the sensor is immersed in liquid nitrogen, enter a value of 77.35K
5. The input temperature reading should now stabilize at the value entered.

Note that the Set Reading temperature is always in units of Kelvin.

Thermocouple Device Installation

The thermocouple device must first be connected to a standard thermocouple mini-spade connector of the proper type. Wires are attached using the screw terminals. Polarity is marked on the input connector and a summary of common thermocouple types is given in the table below. The input connector should have its plastic back-shell and rubber grommet installed in order to prevent local air currents from generating errors in the cold junction circuitry.



Type	Connector Color	(+) Terminal	(-)Terminal
E	Purple	Chrome Purple	Constantan Red
K	Yellow	Chrome Yellow	Aluminum Red
T	Blue	Copper Blue	Constantan Red
Chromel-AuFe	White	Chromel Silver	Gold Gold

Table 1: Thermocouple Polarities

Note that the Chromel-AuFe device is a special cryogenic device. The connector used is White, indicating a type U (unspecified) device.

Grounded vs. Floating Thermocouples

Electrically floating devices are always recommended because they provide generally lower noise operation and cannot facilitate ground-loop conditions. However, the thermocouple module inputs are differential and have a high impedance to ground. This will allow operation with grounded devices in most systems. Always ensure that there is no more than a 5V difference between the grounded thermocouple and the instrument's chassis ground.

Common Installation Issues

Cold Junction Compensation

Cold Junction Compensation in the Cryo-con thermocouple module is performed by a circuit that measures the temperature of the input connector pins. This reading is then used offset the device's output voltage. Errors can be minimized by reducing local air currents around the module.

Device Calibration Errors

Variation in the manufacture of thermocouple wire and its annealing over time can cause errors in temperature measurement.

Instruments that measure temperatures above about 0°C will usually allow the user to correct calibration errors by adjusting an offset in order to zero the error at room temperature. Unfortunately, in cryogenic applications, thermocouples lose sensitivity at low temperatures so a single offset voltage correction is insufficient.

Thermocouples used over a wide temperature range may need to be calibrated at two temperature extremes.

AC Power Line Noise Pickup

AC power noise pickup is indicated by temperature measurements that are significantly in error. In extreme cases, there may be no valid measurements at all.

When a grounded sensor is used, a poor quality ground may have sufficient AC voltage to exceed the input range of the module. This can often be corrected by running a copper connection from a point near the sensor ground and the chassis ground of the controller. Defective building wiring or insufficient grounding is usually the root cause.

General recommendations to minimize AC pickup include:

1. Minimize the length of the thermocouple wires. Connect the module as near as possible to the sensor so that thermocouple wires are converted to copper as soon as possible.
2. Twist the wires.
3. Avoid running sensor wires near, or parallel to AC power lines.