

Agile-Link™

2.4 GHz Wireless Nodes



Using Thermocouples with V-Link®

Overview

MicroStrain's 2.4 GHz V-Link® will support thermocouples on channels 1, 2, 3 and 4.

- This technical note assumes use of MicroStrain's Agile-Link™ software with 1 thermocouple and that the user has a general working knowledge of the software.
- Reference is made to the thermocouple wiring diagram in the 2.4 GHz V-Link® Quick Start Guide where in the case of channel 1:
 - the negative(-) lead of the thermocouple is attached to pin 13 referred to as Channel 1 Sensor Differential Amplifier Input +;
 - the positive(+) lead of the thermocouple is attached to pin 15 referred to as Channel 1 Sensor Differential Amplifier Input -;
 - a jumper is run from the positive(+) lead of the thermocouple to pin 17 referred to as Ground.
- As a first step the user should bring the thermocouple to ambient temperature and establish normal communication with the thermocouple properly connected to the V-Link®.
- Following this, the user should enable channel 8 only (internal temperature channel) with Graph as Temp(°C) enabled, stream the node and carefully note the internal temperature of the V-Link®. We will give this temperature reading the designator **Tc**.
- Following this, the user should enable channel 1 only (the channel where we have applied the thermocouple), apply the default hardware gain (210) and mid-scale balance channel 1. A stream should be run to insure that the stream runs at around mid-scale or about 2048 bits.
- As we find in the Quick Start Guide, the bits can be converted to volts using the formula: Volts = Bits * (3 Volts / 4096 Bits). The user can convert the bits to volts in post-processing or use the Custom Formula plugin to stream Volts. If the Custom Formula is used, the formula resolves to a Gain of 0.000732 Volts/Bit and an Offset of 0. Try the Custom Formula to further familiarize yourself. A stream should be run to insure that the stream runs at around mid-scale or about 1.5 Volts. We will give this temperature reading the designator **Voutput**.

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Approach 1

This approach describes the use of an ice-water/ice cube bath to create a 0°C environment and a boiling water bath to create a 100°C environment leading to a linear slope calibration.

- Place the thermocouple into the ice bath, allow it to come to temperature and stream the V-Link[®]. Note carefully the median volt reading. We will give this temperature reading the designator **V0**.
- Place the thermocouple into the boiling bath, allow it to come to temperature and stream the V-Link[®]. Note carefully the median volt reading. We will give this temperature reading the designator **V100**.
- Now continue on into your actual testing environment and make temperature measurements using the following formula:
 - $\text{Temp}^{\circ}\text{C} = (\text{Voutput} - \text{V0}) * \text{TempSlope}$
 - where $\text{TempSlope} = 100 / (\text{V100} - \text{V0})$
- Note: This method assumes a linear response for thermocouples, which may be valid for a small thermocouple range, depending on thermocouple type.

Approach 2

This approach describes a method where the offset is determined by shorting the input of the V-Link[®] and the gain of the amplifier is used to calculate predicted volts out of the thermocouple.

- Prior to connecting your thermocouple to channel 1, connect a straight jumper wire between pins 13, 15 and 17 so that all have the jumper in common.
- Following this, the user should enable channel 1 only (the channel where we have applied the jumper), apply the default hardware gain (210) and mid-scale balance channel 1. A stream should be run to insure that the stream runs at around mid-scale or about 2048 bits. By applying the Bits-to-Volts formula in the Custom Formula plugin described above, we should see a stream that runs about 1.5 Volts.
- Note carefully the median volt reading. We will give this volt reading the designator **InputOffset**.

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- Following this, the user should now remove the jumper, bring the thermocouple to ambient temperature and establish normal communication with the thermocouple properly connected to the V-Link[®].
- Now continue on into your actual testing environment and make temperature measurements using the following formula:
 - Thermocouple Volts Out = (Voutput – InputOffset) / Hardware Gain
- Temp^{°C} is calculated using the specific thermocouple's polynomial scaling as provided by the manufacturer.

Cold Junction Compensation

Cold Junction Compensation (CJC) may be added to either approach 1 or 2 by using the internal temperature sensor of the V-Link[®].

- We will designate **TemperatureCalculated** as the temperature arrived at in either approach 1 or 2.
- Operationally, the user should:
 - enable channel 1 (the channel where we have applied the thermocouple), apply the default hardware gain (210), mid-scale balance channel 1 and set its Channel Action to the Custom Formula described above;
 - enable channel 8 set with Graph as Temp(°C) checked.
- We will give this channel 8 temperature reading the designator **Tb**.
- Note: The units displayed in the Agile-Link[™] software will be Volts on channel 1 and Temperature on channel 8.
- Now continue on into your actual testing environment and make CJC temperature measurements using the following formula:
 - Temp^{°C} (at thermocouple tip) = TemperatureCalculated + (Tb-Tc)

Other discussion

One should also consider that a range can be calibrated which is supported by the V-Link[®]'s native 4096 bits resolution. If in fact the thermocouples measure outside the calibrated range, the V-Link[®] output will be railed against either end of the 0-4096 bits range and the output will be clipped.