APPLICATION NOTE:
Titan Thermocouples

APN-1011

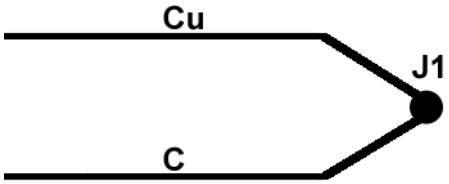
Mars Labs, LLC
29 C Street
Laurel, Maryland 20707
301.470.3278
www.marslabs.com

SUMMARY

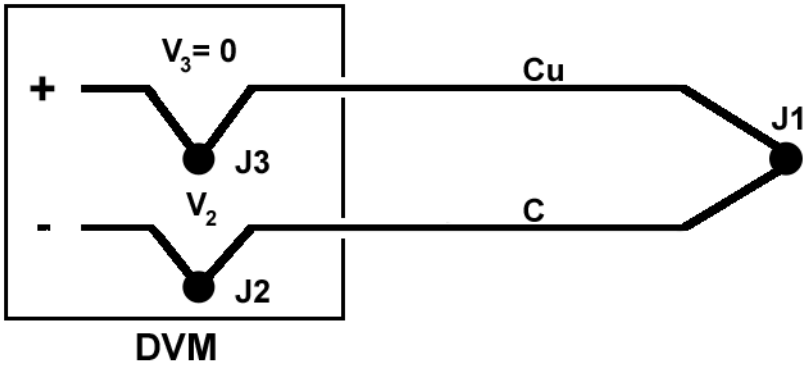
This applications note addresses the theory and operation of thermocouples in real-world applications.

DEFINITION

A thermocouple consists of a junction between two different metals that produces a voltage related to temperature. All dissimilar metal junctions exhibit this phenomenon, called the “Seebeck effect”. One common thermocouple is the T-Type, which is shown below:



The voltage on the Copper and Constantin (Cu and C, respectively) leads is related to the temperature of the junction J1 by a polynomial in general, and linearly when the temperature range is small. Connection of those Cu and C leads directly to a copper voltmeter results in one additional junction between the Constantin of the Thermocouple and Copper lead of the Meter, as seen below at junction J2 (J3 is Cu-Cu, which results in zero voltage):



EXTERNAL EFFECTS

The purpose of this discussion is to emphasize the sensitivity of the measurement to external effects. By extending the thermocouple with regular hookup wire, for instance, an additional junction is created between the thermocouple and the hookup wire. This will lead to an error in the measurement unless some compensation for the junction is made. Additionally, by placing the junction J1 in an environment that may affect its output voltage such as in an electrolytic solution, the thermocouple may report misleading values. Finally, connection of the thermocouple to some conductive surface may or may not be of concern. Should that surface have any electrical path back to the Titan Thermocouple device such as a common ground, voltage readings from the

thermocouple may be unreliable. **These concerns suggest that any and all electrical isolation (galvanic isolation) precautions should be taken when installing a thermocouple.** The material used to isolate the thermocouple should depend on the application. In most applications where temperatures are within –55 to 260 degrees C, non-conductive epoxy such as J-B Weld may be used. In more extreme temperatures, applications may call for specialty epoxy or cement. For example, if the temperature event under study is very fast the method of isolation must be very quick to change temperature. Omega Engineering sells thermally conductive cement called OmegaBond that is electrically isolating and suitable for such uses. Thin coats of this cement may be applied to thermocouples to isolate them electrically while allowing high thermal conductivity. This cement is suitable for high temperature applications. Information on OmegaBond can be found here:

http://www.omega.com/ppt/pptsc.asp?ref=OB_BOND_CHEM_SET&Nav=temf08

USING THERMOCOUPLES WITH TITAN INPUT DEVICES

Thermocouples are available in a number of variants supporting different temperature ranges. Titan Input Devices support J, K, and T-type thermocouples (only one type of thermocouple may be used at a time). The table below displays the temperature ranges and related connection information for the three supported thermocouple types.

Type	Temp Range (C)	Positive (+) Lead	Recommended TCS Gain *
K	-200 to +1372	Yellow	64
J	-210 to +1200	White	64
T	-200 to +400	Blue	64

***** When thermocouples are assigned to channels, Titan Control Software (TCS) will automatically set the gain to 64, but this can be manually reset to any desired value.

In summary, when using thermocouples:

1) Electrically isolate thermocouples from the environment in which they are used
2) Minimize isolation mass around thermocouple when concerned with high-speed temperature events
3) Use the appropriate thermocouple for the application
4) Use appropriate thermocouple hookup or extension cabling for the type of thermocouple in use
5) Always observe the polarity of connections

Note:
When using a thermocouple sensor in combination with other analog sensors, the additional load on the Titan device may result in a temperature offset on the thermocouple. The offset is the result of a temperature difference on the Titan device across the channel input and the temperature reference inside the device. The temperature reference is located under the channel 1 input on the device (Titan BMS & BSG Mini-Recorders). This means that channels physically closer to channel 1 (i.e. channels 2, 5 & 6) will be less subject to the offset while running than channels located further away.

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