Thermocouple Troubleshooting

Application Note #71, 1/15/2003

Below are several things to try if your thermocouple is not reading correctly:

GROUND TC AT ONE PLACE: Attach a wire from the thermocouple Vin- screw terminal to the GND screw terminal. If this wire is already attached, try disconnecting it at the Vin- screw terminal, and see if this effects the measurement. In general the tc should be grounded at one place. If left floating, it could radiate like an antenna. If grounded at more than 1 place, it could be in a ground loop, and have current flowing through it from one ground to the other (which might have a 5mVpp 10MHz sine between them).

THERMOCOUPLE SETUP
Make sure the channel is set up for Thermocouple Sensor Type, approx 0.016 Seconds integration, and a Range <= 80mV. If you are on the +/-80mV range, try the +/-10mV range.

INSTRUNET CALIBRATION & TEMPERATURE DRIFT ERRORS
Try pressing the instruNet CALIBRATE button in the NETWORK page. The reading on the computer screen might change slightly. This change represents the correction of the thermal drift within the instruNet voltage measuring system (i.e. an instruNet measurement error that is proportional to the temperature change of the instruNet PCB since the last calibration). instruNet can be set up to automatically calibrate every X minutes, or when it starts to digitize. This error can be several degrees C if the instruNet pcb temp has changed >10C since the last calibrate. For information on dealing with temperature drift and calibration, please see instruNet application note #67, with emphasis on discussions AUTO CAL RATE, CJC CAL RATE, CALIBRATING WHILE DIGITIZING, THERMOCOUPLE DRIFT ERROR. If your measured temperatures are drifting while the actual temperature is constant, this application note is important. In summary, it is strongly recommend that you work with version >= 1.4.1 of the instruNet software (available from www.instrunet.com/d), and that AUTO CAL RATE be set to approximately 5 and CJC CAL RATE be set to approximately 3 (in the Record page, press the Setup button, and then the Calibrate button to access these fields).

TEST INSTRUNET AMPLIFIER
Press the TEST tab and then the SEARCH button. This will give you the temperature of the instruNet device. Then short the Vin- to Vin+ screw terminals. The shorted channel temperature should be the same as the instruNet box temperature. If this is correct, then something is happening with the thermocouple being attached; otherwise, the channel is having difficulty in some way. Also, try turning the analog low pass filter OFF, and see if that fixes it. Also, try attaching the thermocouple to another measurement channel, to see if your channel amplifier is damaged in some way (e.g. due to static electricity).

DEBRIS & TC MATERIALS
Clean the screw terminal housing and wire with alcohal and visually inspect them for debris or discoloration. And make sure that your tc wiring and connectors are of the correct material. Any non-correct metals in the system will cause your tc to be inaccurate.

TEMPERATURE GRADIANT
Are your thermocouple wires at the measurement device hot or cold with respect to room temperature? If so, you might have a thermal gradient from the wires to the internal instruNet temperature sensor.

INSTRUNET NETWORK
Try disconnecting outbound instruNet devices, and see if this effects the measured temperature. Try measuring the instruNet 5/12/-12V power supply voltages at the instruNet screw terminals. They should be within 1V of their nominal values. If they are not, you might have a power supply problem. Make sure the instruNet cable thumbscrews are snug and the end of the network is terminated. Make sure you are not working with outdated instruNet software. Free updates are available at www.instrunet.com.

OSCILLATING TC: If touching your TC wires with a moist finger makes the computer reading change, then your added capacitance to ground might be stopping or changing an oscillation w.r.t. earth ground. To view the voltage vs. time waveform at the instruNet screw terminals, set integration to 0.0 and digitize 1 channel for 1000 pts at 100,000 samples per sec, 1 scan; and then look for a sine wave on the screen. If you see this (you might need to change the display min/max to better see the waveform shape), then your TC is raditating w.r.t. earth.

OSCILLATING instruNet: Gently touch your instruNet box with a moist finger and watch the reading on the computer screen. If it changes, this indicates that your boxes are radiating with respect to earth ground (i.e. there is a small high frequency sine wave voltage between earth and the instruNet ground). You might need a wire from instruNet GND to earth ground, or an optical isolator, #iNet-330.

RFI THROUGH TC WIRE: RFI going through a loop of wire (e.g. your tc wires) can induce a voltage such as 5mVpp sine wave at 10MHz (Refernence: Maxwell's equations). To test for this, please move your thermocouple wires around with a plastic pen. If the reading on the computer screen changes, this means that RFI is interacting with your wires since changing the EMF flux through the wire loop changes the voltage at the screw terminals. To fix this, one can add a 0.1uF capacitor (non polarized) between the Vin+ and Vin- screw terminals, add a wire between your Vin- and GND screw terminals, add a 1K (1% >= 1/8W) resistor between the Vin+ screw terminal and the + thermocouple lead, and add a 1K (1% >= 1/8W) resistor between the Vin- screw terminal and the - thermocouple lead (to build a 1.6KHz 1pole low pass RFI filter). Alternatively, one can try better shielding of your tc wires (long tc wires should be shielded, preferably with braid), try better grounding of your tc cable shield, try electrical isolation (#iNet-330), and try making sure your TC is grounded in one place. RFI tends to be more of a problem with long thermcouple wires and setups surrounded by high voltages and/or quickly changing voltages.

GROUND LOOPS: If your computer is at ground G1, and the instruNet device is at ground G2, and the sensor is at ground G3; and these 3 grounds vary by several milliVolts (AC or DC), then this can effect your 5uV accurate measurement. The ideal case is for the instruNet box and sensor to be at one ground (G2-3), and this is isolated from G1, which could be noisey due to the 15,000,000 transisitors on the computer motherboard that switch 200,000,000 times per second with a 0.000000003 second rise time (nasty!). The iNet-330 optical oscillator fascillitates this break, and is very useful with low level measurements that involve long wires. The instruNet devices themselves can be completely isolated from earth with the #iNet-330 along with 2-to-3 prong adaptors at the external power supply input connectors (i.e. the ohm meter should show >1Mohm between instruNet GND and Earth gnd). Then, one can attach the instruNet GND to the piece of equiptment that contains the sensors. This, along with placing the instruNet measuring system as close as possible to the sensors, is the most reliable and most accurate configuration.