ThermoSpyder™

8-Channel
Thermocouple Monitor

Revision A (07/2007)

Warranty

General Terms

Magna Systems, L.L.C. warrants this product to be free from defects in material and workmanship for a period of one year from the date of shipment. If this product is found to be defective during the warranty period, the product will either be repaired or replaced at Magna Systems' sole option.

To Use This Warranty

To exercise this warranty, write or telephone your local Magna Systems representative or contact Magna Systems headquarters in California. Detailed contact information may be found on the Magna Systems web site, www.magnasystems.net . You will receive prompt assistance and return instructions. Send the product, shipping prepaid, to the indicated service facility. The repaired or replacement product will be returned to you with shipping prepaid. The repaired or replaced product will be warranted for the remainder of the original warranty term or ninety days whichever is longer.

Limitation of Warranty

This warranty does not apply to defects or malfunctions resulting from modification or misuse of any product or part. This warranty does not apply to fuses or other circuit protection components, to batteries, damage from battery leakage or damage resulting from improper battery installation.

Entire Warranty

This warranty is the complete warranty and stands in lieu of any or all other warranties, expressed or implied, including any implied warranty of merchantability or suitability for a particular use. Magna Systems, L.L.C. shall not be liable for any indirect, special or consequential damages.

Symbols Used in This Manual

CAUTION Indicates potential for equipment damage. Refer to procedures or instructions.

CAUTION Indicates potential risk of electrical shock. Take suitable precautions.

Regulatory Statements

Industry Canada Notice to Users

Operation is subject to the following two conditions: (1) This device may not cause interference and (2) This device must accept any interference, including interference that may cause undesired operation of the device. See RSS-GEN 7.1.5

FCC Notice to Users

Magna Systems has not approved any changes or modifications to the ThermoSpyder made by the user. Antenna modification, antenna replacement or use of an antenna not approved by Magna Systems is not authorized. Any changes or modifications could void the user's authority to operate this equipment.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio / TV technician for help.

Battery Disposal

Please do not throw batteries in the trash. Used batteries must be disposed of in accordance with local regulation. For information about how to recycle batteries in your area, visit the Rechargeable Battery Recycling Corporation (RBRC©) at www.rbrc.org.

Important Safety Information

Electrical Shock Hazard

There are no hazardous voltages present in the ThermoSpyder, however the American National Standards Institute (ANSI) states that a shock hazard exists when probes or sensors are exposed to voltages greater than 42 VDC or 42 V peak AC. In some applications thermocouples may be attached to objects or surfaces between which voltages in excess of the ANSI shock hazard standard exist. Despite the electrical isolation designed into the thermocouple assemblies, conditions may exist such that hazardous voltages could be present at the dual row connector of the thermocouple assembly. In such cases, users must handle the dual row connector of the thermocouple assembly in a manner consistent with the presence of hazardous voltages.

Exposure to Radio Frequency (RF) Energy

The ThermoSpyder contains a radio transmitter and receiver. Whenever powered, the ThermoSpyder will receive and emit radio frequency energy.
The ThermoSpyder is designed to comply with local regulatory requirements including those concerned with the exposure of human beings to RF energy.

Use of Rechargeable Batteries

Under conditions of heavy use it may be advantageous to use rechargeable batteries to power the ThermoSpyder. Most rechargeable batteries, due to the chemical recombination process within the batteries, will vent non-corrosive gases to the ambient atmosphere. Ensure that the ThermoSpyder is used with adequate ventilation when rechargeable batteries are used.

Explosive Environments

DO NOT USE THE ThermoSpyder IN EXPLOSIVE ENVIRONMENTS.
Areas with potentially explosive atmospheres are often, but not always, posted. Such areas may include, but are not limited to, fueling areas, enclosed areas where fumes may accumulate (such as below decks on boats or areas near poorly ventilated gas powered appliances), chemical transfer or storage areas, laboratories, and areas when there are airborne particulates such as grain, dust, aerosolized paints or fine metal powders. DO NOT USE THE ThermoSpyder IN SUCH AREAS. The installation or removal of batteries may cause sparks which could cause an explosion or fire.

Not Vacuum Compatible

The ThermoSpyder is not vacuum compatible. Do not use the ThermoSpyder in vacuum as this could damage the ThermoSpyder and / or contaminate your vacuum chamber and associated hardware.

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Care of Your New ThermoSpyder

DO NOT EXPOSE YOUR ThermoSpyder TO ANY OF THE FOLLOWING-

Liquids
Don't expose your ThermoSpyder to water, rain, extreme humidity, cleaning solvents, fuels, or other liquids.

Extreme Heat or Cold
Avoid temperatures outside of the operating range of 0ºC to 80ºC (32ºF to 176ºF).

Microwaves or Intense RF Energy
Do not place your ThermoSpyder in a microwave oven or expose it to direct radio frequency (RF) energy such as from a RF power transmitter.

Extreme Dust or Dirt
Don't expose your ThermoSpyder to extreme dust, dirt, sand, or environments containing metal particles.

Shock
Do not expose your ThermoSpyder to mechanical shock in excess of a three (3) foot drop or vibration in excess of 10 g's.

Cleaning
Dirt and dust can be removed from the outside of the ThermoSpyder by wiping with a damp cloth. Do not use solvents to clean the ThermoSpyder.

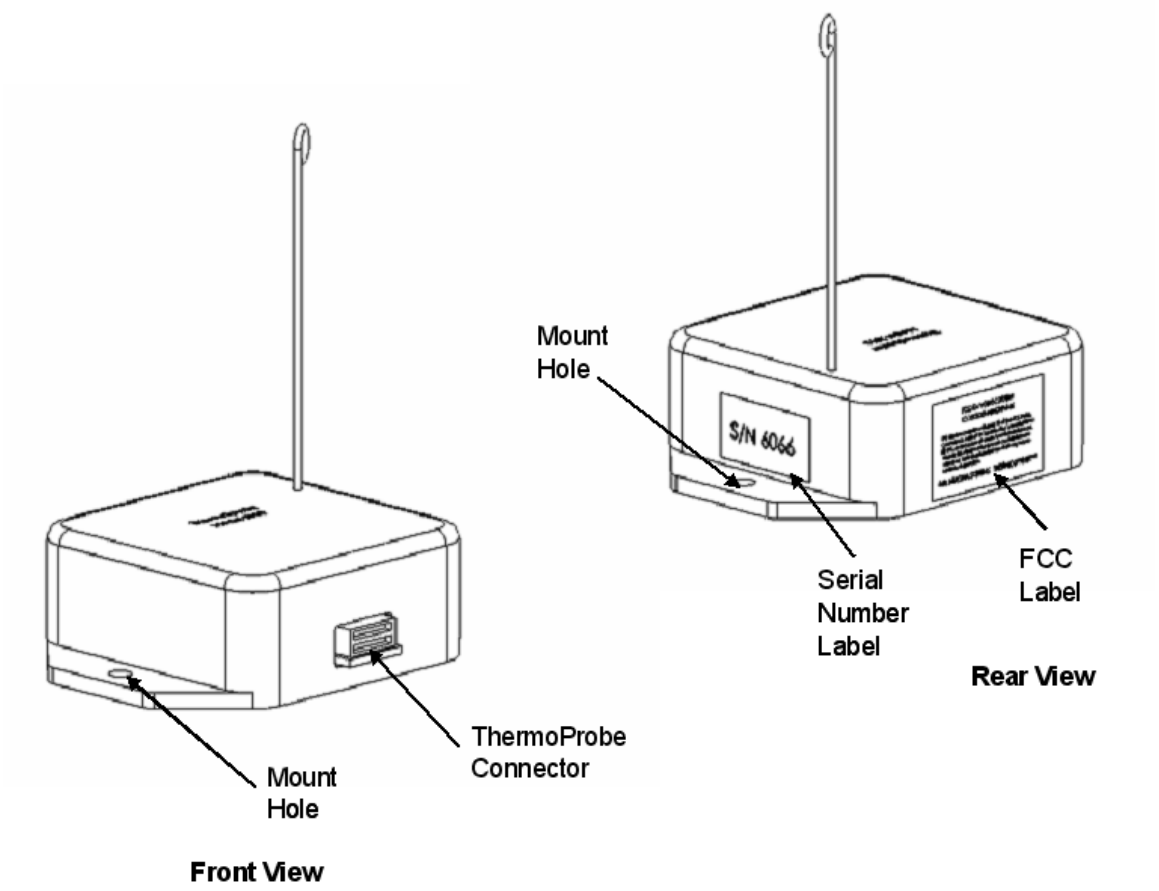
Calibration
Your ThermoSpyder comes factory calibrated and does not require any initial calibration before use. The ThermoSpyder has an automatic re-calibration alert which will be displayed through the DataLink software when re-calibration is required. Should the re-calibration message appear, please follow the instructions displayed.

Maintenance & Service
The only user maintenance operation is battery installation or replacement which is described in the Getting Started section of this manual. The ThermoSpyder should always be used with its cover installed. The ThermoSpyder has no user serviceable parts and does not require any adjustment by the user.

Getting Started

The figure below shows a front and rear view of your new ThermoSpyder. Your ThermoSpyder has been designed to provide accurate thermocouple based temperature measurements while requiring almost no user intervention.

Users typically perform three types of operations while using the ThermoSpyder, namely, battery installation, mounting, and connection of thermocouple assemblies, each described below.

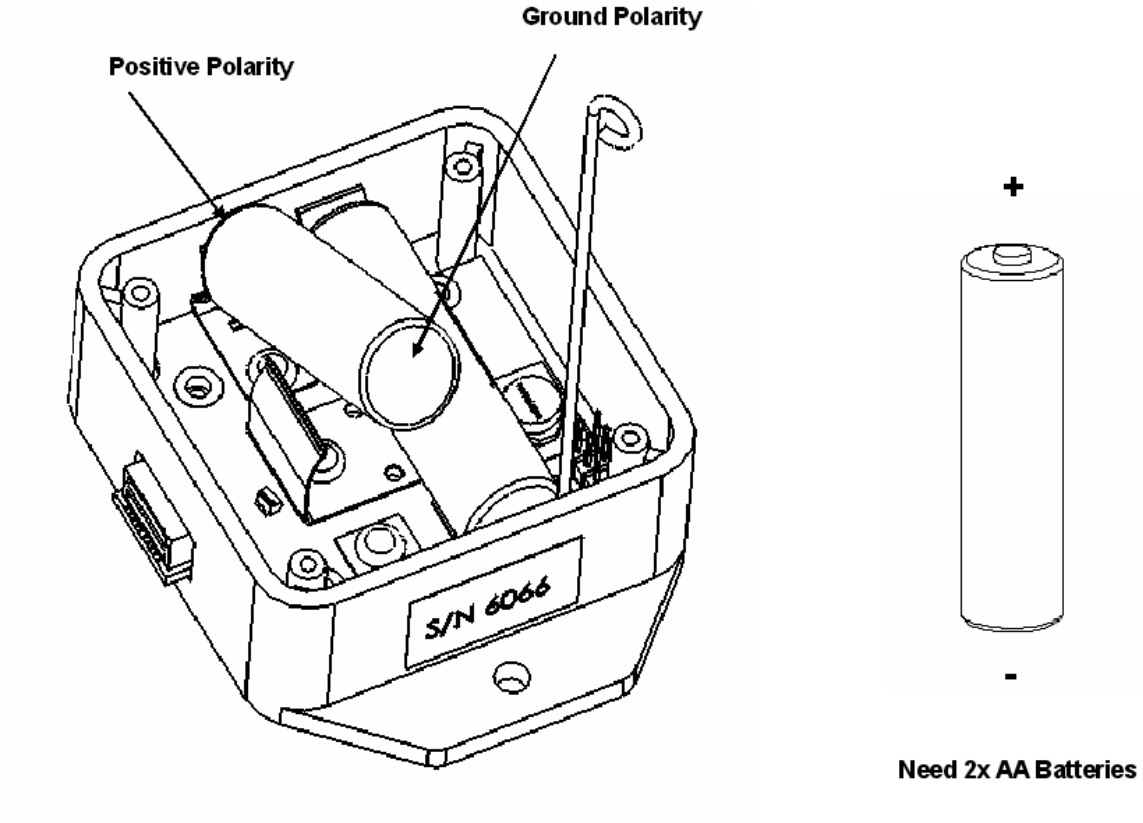


Turning the ThermoSpyder ON

The ThermoSpyder is powered by two (2) AA type batteries which are installed in the battery clip area. THERE IS NO ON / OFF SWITCH. To turn the ThermoSpyder ON, simply install the batteries as shown in the diagram using the procedure below.

CAUTION

Installing batteries in the wrong direction will damage the ThermoSpyder. Please double check the orientation of the batteries during the installation process.



Battery Installation Procedure-

BATTERY INSTALLATION PROCEDURE

1. Remove the four screws that secure the cover to the base as indicated in the diagram.
2. Separate the cover from the base and rotate it about the antenna so that the battery area is clearly visible.
3. Inspect the battery clip area and note the battery orientation indicated.

NOTE: BOTH BATTERIES ARE INSTALLED IN THE SAME ORIENTATION

4. Place the positive end of the first battery against the positive contact and rotate it down into place.

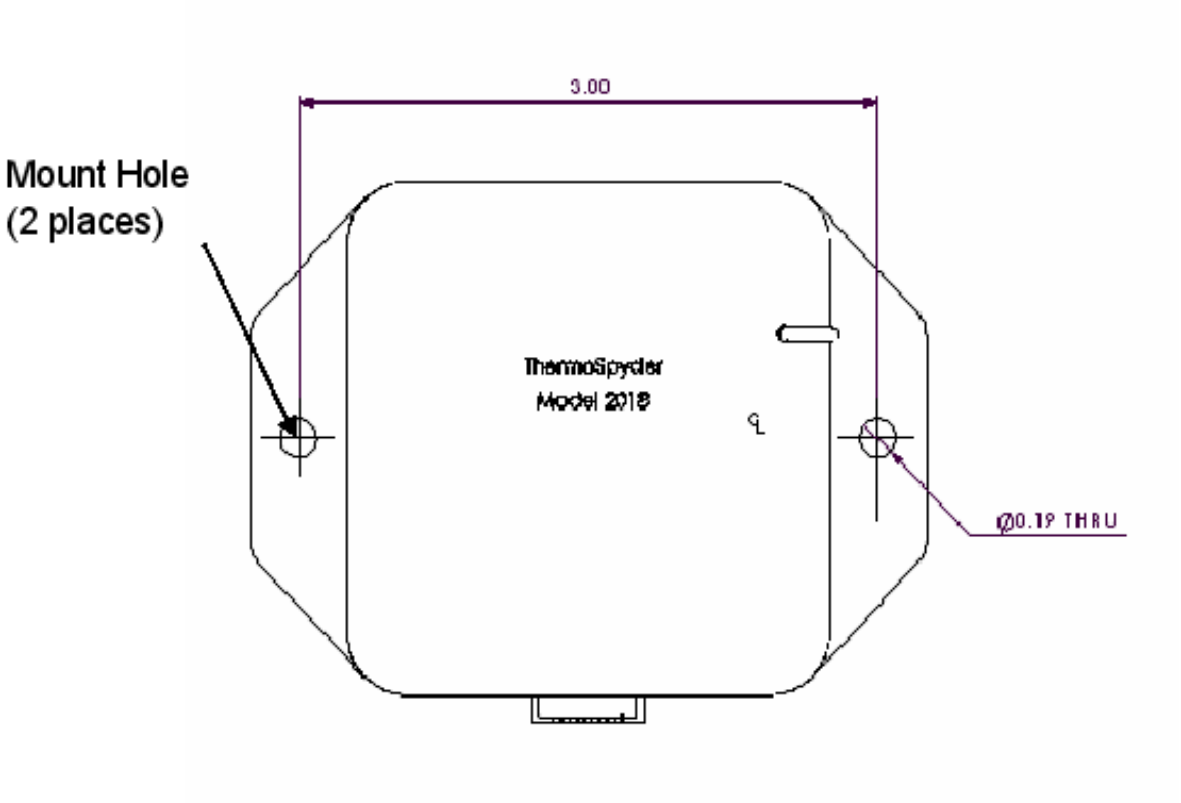
5. Place the positive end of the second battery against the remaining positive contact and rotate the battery into position. The second battery will “click” into position; however no sound may be heard.
6. Reposition the cover over the base such that it aligns again and press the cover into the recess in the base.
7. Re-secure the cover to the base using the four (4) screws that were previously removed.

TIP: *You can extend the life of the ThermoSpyder by carefully reinstalling the screws. To be sure that the screws are rethreaded into the threads already cut in the plastic base, rotate the screws counterclockwise until you feel the screw drop into the previously established threads, then turn the screw clockwise to tighten it and secure the cover.*

Once the batteries and ThermoProbes are installed, the ThermoSpyder is ready to take measurements using the GateWay Network Access Point and your DataLink software.

Mounting the ThermoSpyder

In many applications it is desirable to mount the ThermoSpyder close to the locations at which you wish to measure temperature data. The ThermoSpyder has mounting flanges with through holes on two sides of the base to facilitate mounting. These holes are located 3.0 inches (76.2 mm) apart and have a diameter of 0.190 inches (4.8 mm). The holes will accommodate #8 size English screws or M5 metric screws. The figure below may be used as a drill template to arrange for mounting the ThermoSpyder.



Installing the Thermocouple Assembly

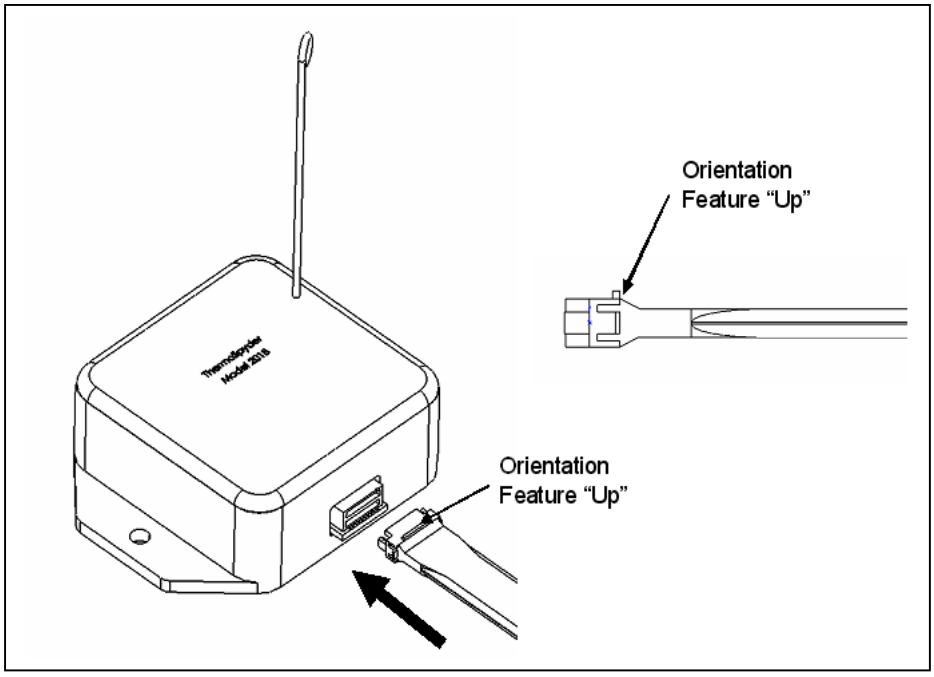
CAUTION !

DESPITE THE ELECTRICAL ISOLATION PROVIDED BY DESIGN, IF THE THERMOCOUPLES ARE ATTACHED TO OBJECTS WHICH HAVE HIGH VOLTAGES PRESENT THE THERMOCOUPLE CONNECTOR MAY PRESENT A SHOCK HAZARD. HANDLE THE CONNECTOR IN A MANNER CONSISTENT WITH THE PRESENCE OF A SHOCK HAZARD.

To measure temperature each ThermoSpyder uses a ThermoProbe assembly or ThermoAdapter / thermocouple assembly. In either case, connection is made to the ThermoSpyder with a POLARIZED dual row 1mm pitch latching connector. To install the assembly, simply grasp the connector body with the orientation feature “up” (as illustrated in the Figure below) and gently insert it into the mating header on the ThermoSpyder base until a latching “click” is felt.

CAUTION

The thermocouple assembly connector is POLARIZED. If gentle insertion does not work, check to be sure that the orientation feature is “up” or away from the ThermoSpyder mounting surface (refer to the Figure below). If the connector still does not engage, inspect the connector and header for physical damage.



TIP: *To make network initialization easier, install the ThermoProbe or ThermoAdapter / thermocouple assembly before starting to test. During network initialization, DataLink checks for open thermocouples so having the thermocouples connected to the ThermoSpyder speeds the initialization step.*

Once the ThermoSpyder is powered, mounted, and thermocouples have been connected the ThermoSpyder is ready to record temperature data.

Turning the ThermoSpyder OFF / Replacing the Batteries
During routine use it should not be necessary to turn the ThermoSpyder OFF and so THERE IS NO ON / OFF SWITCH. However, if it is anticipated that the ThermoSpyder will not be used for an extended period, it may be desirable to remove the batteries from the ThermoSpyder. To remove or replace the batteries, please use the same steps found in the battery installation procedure.

Making Accurate Temperature Measurements

It seems that making accurate temperature measurements should be simple, but experience tells a different story. Accurate temperature measurements are made by understanding the factors that can effect the measurement and controlling or eliminating them.

One of the most important factors in making accurate temperature measurements is good thermal contact. To make an accurate measurement, the thermocouple needs to be in intimate thermal contact with the measurement point. In achieving intimate thermal contact air is your enemy. Air is a very good thermal insulator and even a small air gap between the measurement point and the thermocouple can lead to significant error. Air can be excluded from the region between the thermocouple and the measurement point by using a thermally conductive adhesive or by using appropriately designed attachments.

It is also important to consider the effect that the measurement set up has on the accuracy of the measurement. For example, the addition of thermal mass to the measurement point will slow its thermal response, while the addition of thermally insulating material which impedes convective or radiative heat transfer will lead to inaccuracies too. In other cases, when measuring at low temperatures, even the thermal conductivity of the thermocouple itself can lead to an inaccurate measurement by introducing a heat source into the low temperature system.

In other measurement configurations, chemical corrosion and time may conspire to thwart a previously accurate measurement. At elevated temperatures chemical reactions proceed more quickly and since thermocouples depend on the properties of the dissimilar metals comprising the thermocouple, the corrosion of one or more thermocouple wires can give rise to inaccurate measurements.

So by understanding and controlling these and any other factors that affect your measurement you can make simple, robust and accurate temperature measurements. By allowing the selection of thermocouple material, insulation type, wire gauge and termination style, Magna Systems' ThermoProbes enable you to optimize your measurement and avoid problems.

We hope that Magna Systems has furnished the tools you need to achieve your measurement goals and that our products provide value through simplicity, ease of use and accuracy.

Setting Up For Accurate Measurements
The ThermoSpyder is designed to easily make accurate and repeatable temperature measurements utilizing up to eight (8) thermocouples manufactured and tested by Magna Systems. Magna Systems manufactures thermocouples with three different termination types:

- Standard termination- designed for use in immersion applications
- Bare termination- used for surface temperature measurements
- Ring-Lug termination- designed for attachment using threaded fasteners

The design of these termination types has taken into account several factors that affect measurement accuracy. Among these factors are electrical isolation of the thermocouple itself, addition of minimal thermal mass, ensuring good thermal contact with the measurement point, maintaining good thermal conductivity between the measurement point and the thermocouple, and minimizing the insulating effect of thermocouple attachment.

The Standard termination will provide optimal results for immersion measurements. Immersion measurements are those in which the probe is immersed in the measurement environment. Typical examples of immersion measurements are:

- Measuring the temperature of the air flowing past a cooling fan
- Measuring the air temperature above a heatsink
- Measuring the temperature of a container of water by immersing the probe
- Measuring the temperature of a metal block by embedding a thermocouple probe in a hole in the block

The Standard termination is simply a thermocouple junction that has been encapsulated in a thin layer of Teflon® to provide electrical isolation, mechanical toughness, and make the thermocouple more chemically inert.

The Bare termination is the traditional bare wire thermocouple end. Bare termination is useful when thermocouples are soldered in place or when measuring the temperature of a surface.

CAUTION

Bare termination users should be aware that, because the ThermoSpyder uses all solid state electronics, either all measurement points must be at the same electrical potential (voltage) or some sort of electrical insulation must be used to provide isolation between the channels.

To illustrate the use of the Bare termination, consider two typical applications, measurement of temperature on a sample printed circuit board (PCB) and temperature measurement on an electrically “live” heatsink where Kapton® tape is used to provide electrical isolation.

In the first case we are interested in measuring the temperature profile of a PCB sample during heating. To measure the temperature at various points on the bare board, we decide to use a high temperature solder to attach Bare ThermoProbe tips to the board. In this case, the board does not have any active components attached and all the ThermoProbe points are near ground potential.

In this case, the high temperature solder provides good thermal conductivity and fills any voids, thus eliminating any air pockets.

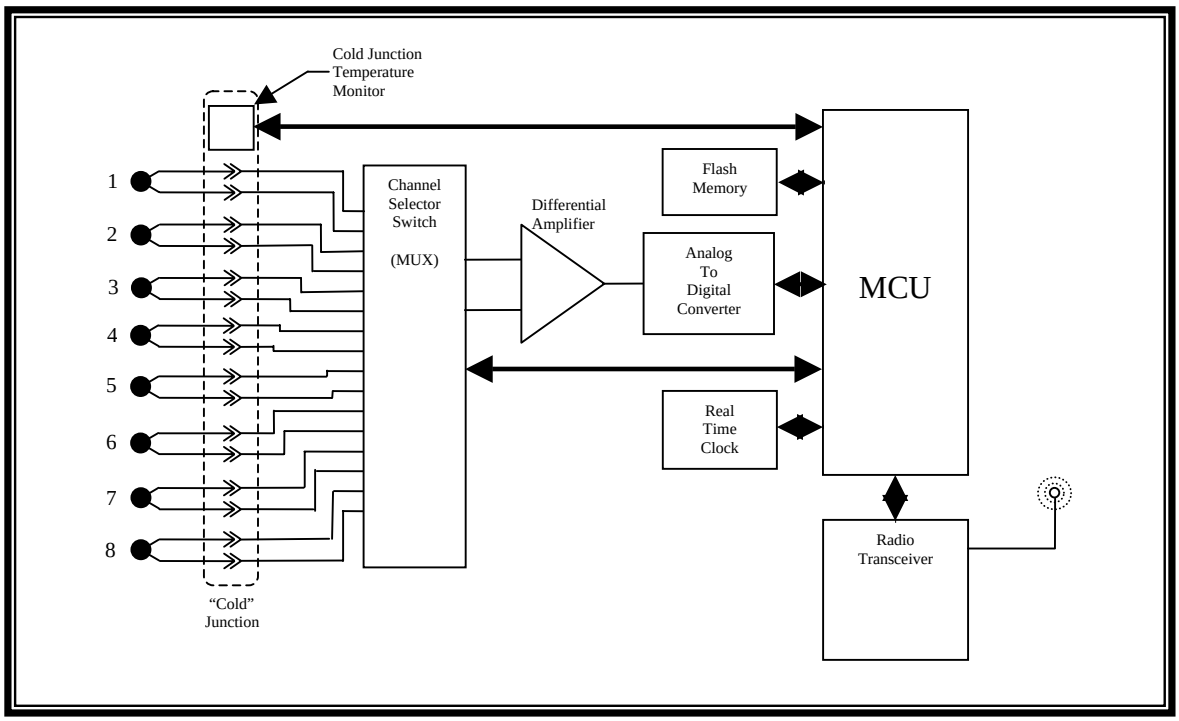
In the second case, we are interested in measuring the temperature distribution across the surface of a heatsink. The heatsink happens to be attached to a live component that is holding the heatsink at an elevated voltage. To be sure that there are no voltage differences between the ThermoProbe tips we choose to place a small piece of Kapton® tape onto the heatsink at each of the measurement locations, then we place the Bare termination ThermoProbe end and secure it to the heatsink with another piece of Kapton® tape. After placing the Kapton® tape over the Bare termination we are careful to press on the contact point to make sure that the tip is actually in contact with the heatsink / Kapton® tape and to remove as much air as possible from between the two layers of Kapton® tape.

The Ring-Lug termination is designed to meet the need to attach a thermocouple to a location where a threaded fastener is available. Typical applications of this type of termination include measurement of the temperature of a bolt-on style heatsink, measurement of the temperature of a motor and other applications where a temperature measurement at a fixed location is desired. In making this termination available, Magna Systems hopes to eliminate the frustration experienced when a bare thermocouple is clamped under the head of bolt and the pressure beaks the thermocouple or the thermocouple slips from under the head of the bolt. The Ring-Lug termination is comprised of a Standard termination that has been affixed in a specially selected ring lug. This construction allows the electrical isolation of the thermocouple while ensuring a good thermal connection to the measurement point.

Thermocouple assemblies having custom lengths or configurations are available either through the Magna Systems web site (www.MagnaSystems.net) or by contacting Sales at Magna Systems.

How the ThermoSpyder Works

A simplified block diagram of the ThermoSpyder with a thermocouple assembly attached is shown below.



To make a measurement, the microcontroller unit selects the desired thermocouple by sending control signals to the channel selector switch. The switch connects the selected thermocouple across the inputs of the differential amplifier. This low-noise, zero-drift amplifier magnifies the relatively small thermocouple voltage such that an effective measurement can be made. The amplified voltage is presented to the input of the analog to digital converter where it is converted to a digital code. The digital code is read by the microcontroller unit and stored in memory. In order to interpret the digital code representing the thermocouple temperature correctly, the "cold" junction voltage must be compensated. The ThermoSpyder uses an integrated circuit temperature sensor to accurately measure the "cold" junction temperature and the microcontroller then performs software based compensation. The microcontroller then selects the next channel to be measured and the process is repeated as required. The radio transceiver is used to periodically transfer acquired temperature data to DataLink using the GateWay network access node. If, for any reason, the data is not transferred to DataLink, the ThermoSpyder stores the data in the flash memory and transmits the data later. The ability to store over 20,000 data points and report them later means that no measurement data will be lost.

Judging the Accuracy of Your Results

Making good measurements isn't hard, but occasionally an unexpected result will crop up and it is useful to know how to judge the accuracy of your results.

Different errors can occur depending on the type of measurement attempted. Temperature measurements almost always involve temperature and time; in some cases a measurement of the "steady-state" temperature is important while in other cases we are interested in temperature transients.

The accuracy of a "steady-state" temperature measurement is essentially determined by good thermal contact and calibration. Calibration is handled by the processes we use at Magna Systems to provide ThermoSpyder units that meet specification. We take care in the design and maintenance of our processes so that you may be confident that by using a ThermoSpyder you are capable of making excellent and accurate measurements. The most likely issue then becomes the existence of intimate thermal contact at the measurement point. This can be checked by introducing a heat impulse near the measurement point and ascertaining that the thermocouple response is sufficiently rapid. A slow response or a response of insufficient amplitude indicates a lack of thermal conductivity between the measurement point and the thermocouple. This is often easily remedied by thermocouple reattachment.

When making measurements of thermal transients the most common worry is the thermocouple response time; is the thermocouple response fast enough to provide an accurate measurement of temperature versus time? To judge this, again a heat impulse may be used. By applying a thermal impulse or step function one can assess the thermocouple response time. This is most easily done by rapidly immersing the thermocouple in an environment at a different temperature while taking temperature data. The trace of temperature versus time for such a step function transient will give a good sense of the thermocouple thermal response time. When performing this test one must remember that the environment must be uniform such that the thermal mass of the thermocouple is insignificant. For example, if a thermocouple is suddenly immersed in hot water, it is important to move the thermocouple such that the water is stirred and that the water which is initially near the thermocouple is replaced with water at the elevated temperature. When using the temperature versus time trace to measure thermal response time, bear in mind that the initial transient will provide a more accurate measure of the response time than the later portions of the curve.

Troubleshooting

Symptom: ThermoSpyder does not appear during network initialization.

Possible Problem- ThermoSpyder may have depleted batteries.

Solution- Check to be sure the batteries in the ThermoSpyder are still charged and replace as required.

Symptom: ThermoSpyder does not read temperatures correctly.

Possible Problem- Wrong type of thermocouple specified in DataLink

Solution- Check thermocouple specification in the node configuration used for network initialization and revise as required.

Possible Problem- + / - Thermocouple leads swapped

Solution- For the malfunctioning thermocouple, check to be sure that the wire with blue insulation is at the side with the orientation feature. If not, please contact Magna Systems for a replacement thermocouple assembly.

Possible Problem- Thermocouple could be broken

Solution- Use the ThermoCouple continuity test feature in DataLink to test the thermocouple. If DataLink indicates that the thermocouple is broken, please contact Magna Systems for a replacement thermocouple.

Possible Problem- Temperature data is outside of the ThermoSpyder's rated temperature range.

Solution- Use the thermocouple within the rated temperature range. If an extended temperature range is required, please contact Magna Systems for an extended range ThermoSpyder.

Symptom: ThermoSpyder drops out during data collection.

Possible Problem- ThermoSpyder is too far from the GateWay or there is significant radio frequency interference.

Solution- Reposition the ThermoSpyder closer to the GateWay.

Possible Problem- Sampling rate is too high.

Solution- Cancel test and set sampling rate to a longer interval (slower rate).

Possible Problem- Weak battery condition.

Solution- Cancel test and replace batteries.

Technical Specifications

Thermocouple Inputs -

Number of Channels: 8

Thermocouple Types: E, J, K, R, S & T

Cold Junction Compensation: Automatic, software based

Thermocouple Input: Latching, Dual Row 20 pin Header (JST SM20B-SHLDS-G)

Thermocouple Temperature Range: -40ºC to +250ºC

Thermocouple Characteristics:

	Accuracy*	Resolution
Types E, J, K, T	± 0.5ºC	0.1 ºC
Types R, S	± 1.0ºC	0.3 ºC

*Errors are for the ThermoSpyder only and do not include the thermocouple error

Monitoring & Data Recording -

Sampling rate user settable from days to 5 samples / second

All samples time stamped at acquisition

Programmable start time or start on command

Programmable test end time or end on command

Measurements stored or relayed in real-time

General Specifications -

Operating Environment: 0 to 80ºC (32 to 176ºF)
5% to 95% Relative Humidity (non-condensing)

Vibration: 10 g (rms 20 Hz to 2000 Hz)

Shock: 3 foot drop

Power: Two AA style batteries

Battery Life: 1.5 yrs at 1 sample / min.

Time Accuracy: ± 1 min / month

Communications Interface: ISM band radio (868 / 915 MHz)
+5 dBm maximum TX power
RX sensitivity better than -100 dBm

Storage Temperature Range: -40 to 120 ºC

Weight:

ThermoSpyder only: 75 gm (2.65 oz)

ThermoSpyder with batteries: 125 gm (4.41 oz)

Enclosure: Flame Retardant ABS plastic (Best UL flame rating of 94-5VA)

Dimensions: