



Marathon

FiberOptic
Infrared Thermometer

Operator's Manual



MARATHON SERIES

WORLDWIDE HEADQUARTERS

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This section covers manual layout and product information, and it points you in the right direction to install and operate your sensor or sensors in a standalone or multidrop networked environment.

Topics include...

- About this Manual
- Where to Start
- Product Description
- Product Specifications
- Accessories and Options

ABOUT THIS MANUAL

The *Marathon FA1/FA2 Operator's Manual* provides detailed information about Marathon Series™ infrared thermometers and supporting software. It is designed to be used as a reference tool in the installation and operation of your sensor or sensors.

This manual is organized according to the type of process environment you are installing into, whether it is a standalone, non-networked installation or a multidrop, networked installation.

- **Part 1** discusses manual usage, product descriptions and specifications, and what section of the manual, either Part 2 or Part 3, to go to for information on installation and operation for your particular environment.
- **Part 2** covers the installation and operation of Marathon sensors in a standalone, non-networked process environment. **If you are using Part 2 as an installation and operating guide, you do not need Part 3.**
- **Part 3** explains the installation, communication setup, and operation of one or up to 32 Marathon sensors in a multidrop network. **If you are using Part 3 as a guide, you do not need Part 2.**
- **Part 4** describes how to use the supplied Marathon utility programs.
- **Appendices** are made up of a Programming Guide, which lists the communications protocols for Marathon sensors; an Emissivity Guide, which shows examples of emissivity settings for various metals and non-metals; a DIN connector wiring chart; information on calibration traceability; and data on CE conformity for the European community.

WHERE TO START

Whether you are planning to install a single sensor, multiple sensors, or an interconnected sensor network, you must first prepare for installation. Use the following guide to go to the section that pertains to your type of installation:

- One Sensor/no Computer—Go to Part 2.
- One Sensor/Computer/standalone—Go to Part 2.
- Each Additional Sensor/Computer/standalone—Go to Part 2.
- One or More Sensors/Computer/future multidrop network—Go to Part 3.
- One or More Sensors/Computer/multidrop network—Go to Part 3.

1.0 PRODUCT DESCRIPTION

The Thermalert® Marathon FA1/FA2 fiber optic series of instruments are high-performance infrared thermometers. Each has a front end consisting of a small, fixed focus optical head coupled to a rugged fiber optic cable wrapped with a flexible stainless steel sheath. The fiber optic cable attaches to an electronics enclosure, which can be mounted away from the hot, hostile environment. The electronics enclosure can be connected to a computer with its two-way RS-485 interface.

Each model (Table 1-1) operates as a temperature measurement subsystem consisting of optical elements, spectral filters, detector, and digital electronics. All components are water-tight NEMA-4 (IEC 529, IP 65) rated and are built to operate on a 100 percent duty cycle in industrial environments. Simultaneous analog and digital outputs consist of standardized current signals commonly available for use with computers, controllers, recorders, alarms, or A/D interfaces.

Table 1-1: Models

MODEL	TEMPERATURE RANGE	SPECTRAL RESPONSE (NOMINAL)	OPTICAL RESOLUTION (@ 95% energy)
FA1A	475* to 900 C (885 to 1652°F)	0.73 - 1.22 μm	20:1
FA1B	800* to 1900 C (1472 to 3452°F)	0.73 - 1.22 μm	100:1
FA1C	1200* to 3000 C (2192 to 5432°F)	0.73 - 1.22 μm	100:1
FA1G	750 to 1675 C (1382 to 3047°F)	0.73 - 1.22 μm	100:1
FA2A	250 to 800 C (482 to 1472°F)	1.52 - 1.70 μm	20:1
FA2B	400 to 1700 C (752 to 3092°F)	1.52 - 1.70 μm	40:1

* Applies for fiber optic cable lengths up to 3 meters (10 feet).

Focal Point - Standard Focus: infinity; Optional Close Focus 300 mm (12 in) and 100 mm (4 in)

All Marathon sensors are addressable and can be used in multidrop environments. Setup, utility, and operating/monitoring software is included with your sensor(s).

1.1 ACCESSORIES

A full range of accessories for various applications and industrial environments are available (see Figure 1-1). Accessories include items that may be ordered at any time and added on-site. These include the following:

- Air purge collar for optical head
- Mounting bracket for optical head
- Aiming lights
- Isolated 24 VDC power supply (110 or 220) or switching power supply with universal input (110/220)
- Smart RS-485/RS-232 interface converters (required for PC communications)
- optional 110 VAC and 220 VAC adapters available for interface converters
- Electronics cable, 12-conductor (For cables longer than 60 meters (200 feet), contact your sales representative.)
- Fiber optic accessory kit
- Marathon Software (supplied)
- Field Calibration Software (supplied)
- Electronics Cable
- Terminal Block Accessory

Notes: Optical heads, fiber optic cables, and electronics enclosures are rated NEMA-4 (IEC 529, IP 65) with conduit adapter accessory and compression fitting (which prevents liquid from entering through the electronic enclosure's connector).

1.2 OPTIONS

Options are items that are factory installed and must be ordered with base model units. The following are available:

- Fiber optic cables, 1 or 3 meters (3.2 or 10 feet) long. Lengths up to 10 meters (30 feet) are available on a special order basis. (For longer lengths, consult your sales representative.)
- Protective Sapphire Window
- Focusing options SF, CF1, CF2
- NIST certification

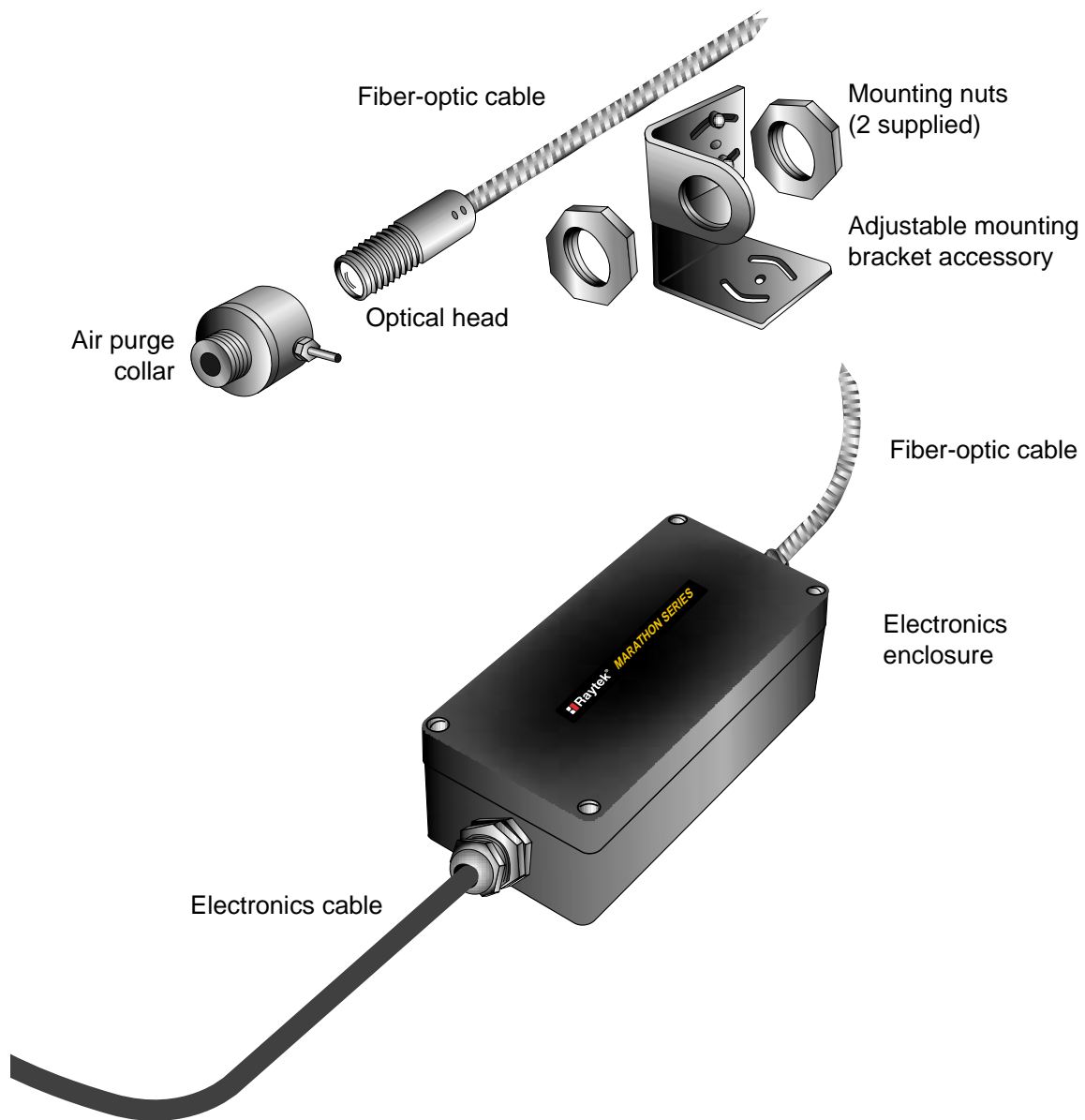


Figure 1-1: Accessories and Options

IMPORTANT

When reading this manual, look into exceptions that may result from customized features. Check with your sales representative whenever a parameter is critical or operation seems abnormal.

1.3 SPECIFICATIONS

The following sections cover optical, thermal, operational, electrical, and physical specifications for each model.

1.3.1 Optical

Standard focus models are focused at infinity, and the optional close-focus models are focused at 100 mm (4 in) and 300 mm (12 in). For accurate temperature measurements make sure the target completely fills the measurement spot. The spot size for any distance, when the unit is properly focused, can be figured by using the following formula and Figure 1-2. The charts in Figures 1-3 and 1-4 are examples of spot sizes at fixed distances from the target

Divide the distance (D, in Figure 1-2) by your model's D:S number. For example, if a Model C unit (D:S = 100:1) is 2000 millimeters (80 inches) from the target, divide 2000 by 100 (80 by 100), which gives you a target spot size of 20 mm (0.8 in). A Model A unit (D:S = 20:1) at 2000 mm (80 inches) from the target, divide 2000 by 20 (80 by 20), which gives you a target spot of 100 mm (4 in).

Note: D:S is a ratio and applies to either metric or standard measurements.

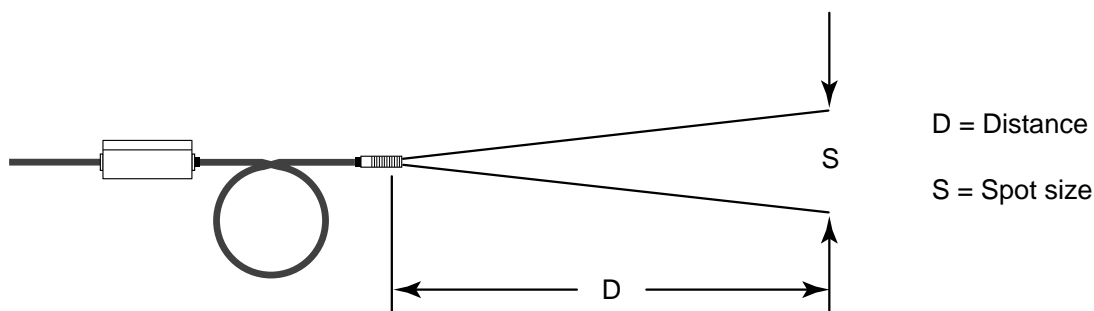


Figure 1-2: Spot Size Chart

The nominal spectral response for all models is as follows:

Model:

FA1: 0.73 to 1.22 μm

FA2: 1.52 to 1.70 μm

Typical Optical Resolution (D:S)

Model:

FA1A	20:1	FA2A	20:1
FA1B	100:1	FA2B	40:1
FA1C	100:1		
FA1G	100:1		

Optical resolution assumes 95% energy at the focus point.

The optical charts indicate the nominal target spot diameter at any given distance from the sensing head. Information in the top half of each chart is in inches or feet, the bottom half is in metric units. All the following optical charts assume 95% energy.

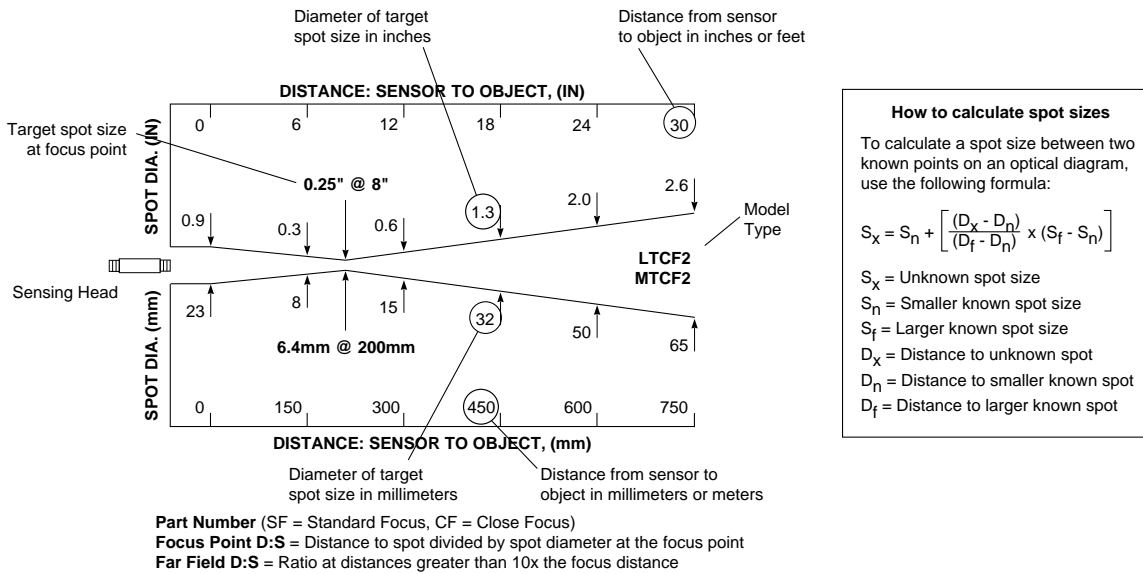


Figure 1-3: How to Read the Optical Charts

The following optic charts (Figure 1-4) are examples of standard focus focal points and their related spot sizes.

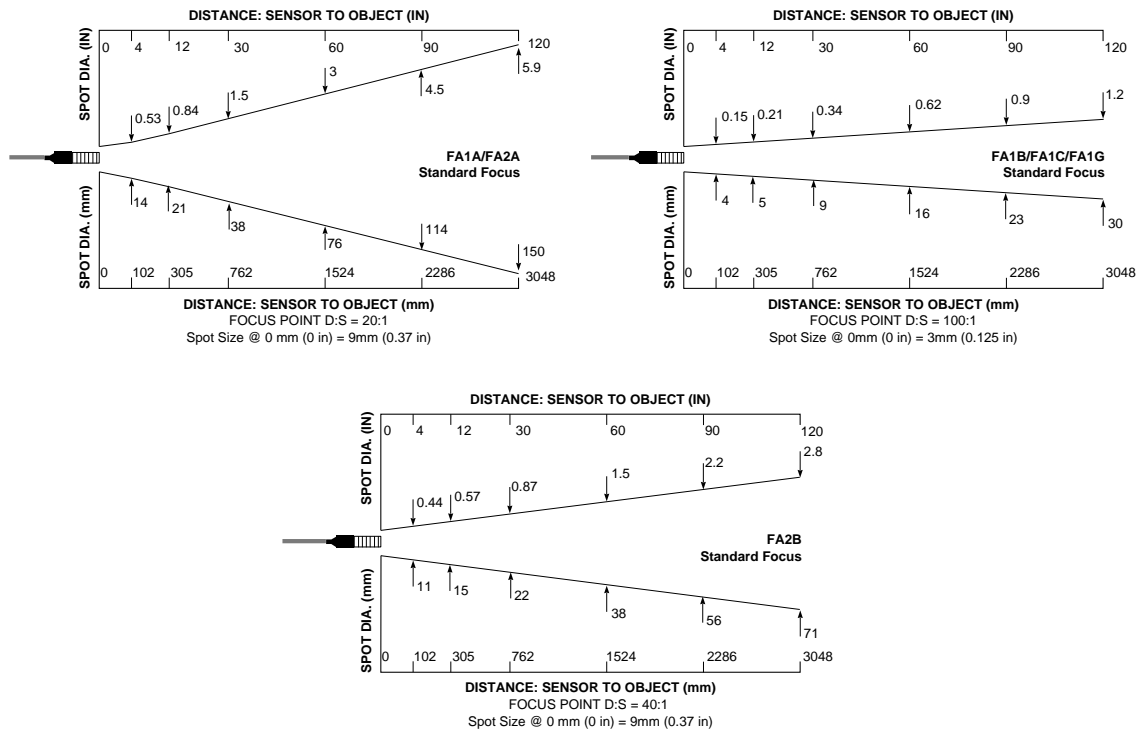


Figure 1-4: Standard Focus Optic Charts

The following optic charts (Figure 1-5) are examples of optional close focus focal points and their related spot sizes.

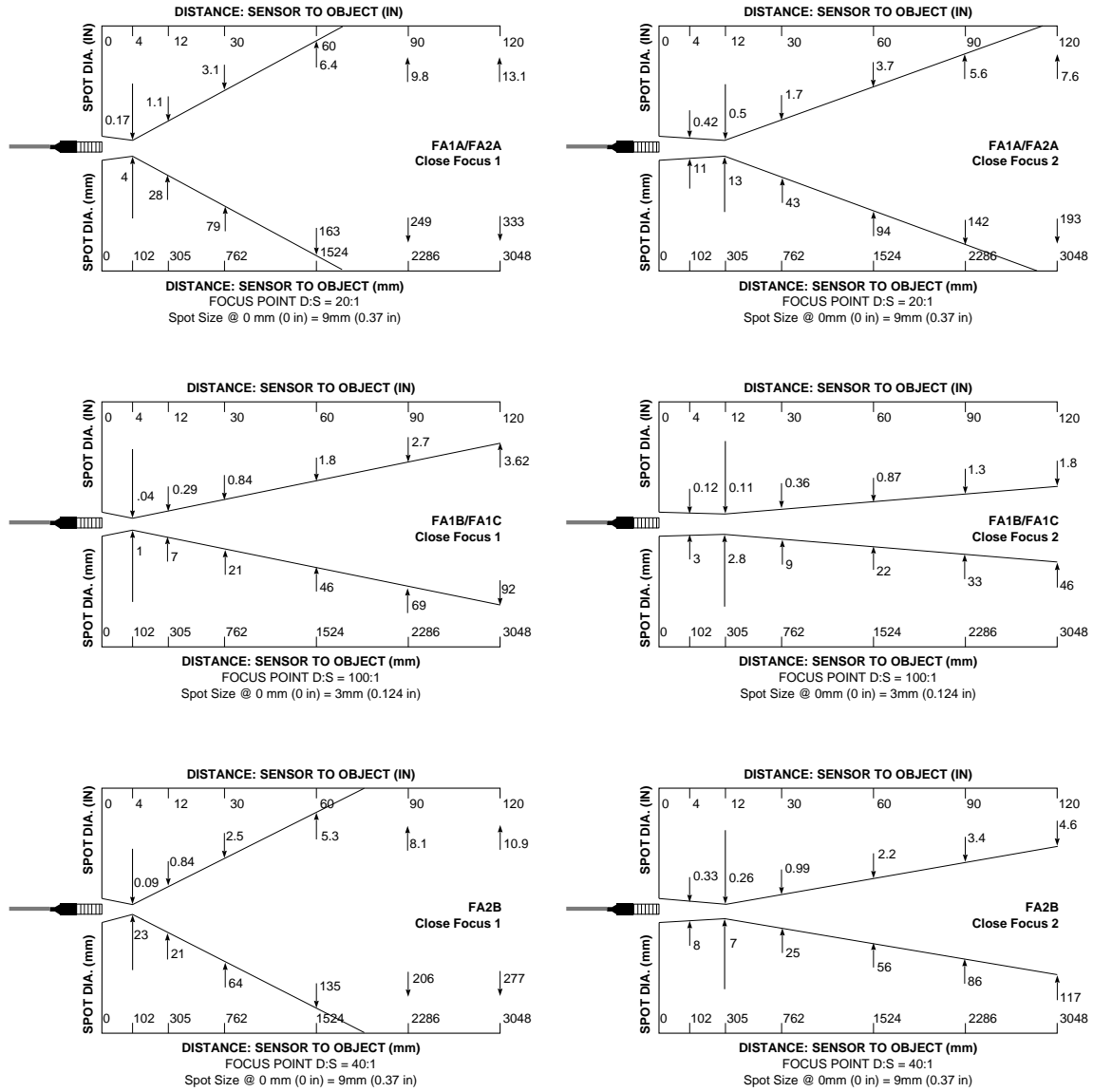


Figure 1-5: Close Focus Optic Charts

1.3.2 Thermal

This section lists specifications related to the sensors thermal characteristics. Refer to Table 1-1 for each model's overall temperature measurement range.

System Accuracy $\pm 0.3\% T_{\text{measured}} \pm 1^{\circ}\text{C}$; T_{measured} in K (all models except FA1G)
 $\pm 3^{\circ}\text{C}$ (FA1G)

System Repeatability $\pm 1^{\circ}\text{C}$

Response Time (95% Response)

 All Models 10 msec

Temperature Coefficient

 All Models 0.03% full scale change per 1°C change in ambient temperature

Noise Equivalent Temperature (NET)

 All Models 1°C peak to peak, target emissivity of 1.00

1.3.3 Operational

Display 7-segment LED display—shows temperature, emissivity, peak hold seconds, average seconds, valley seconds, and failsafe codes. Individual LEDs indicate modes and active functions (e.g., °C, °F, emissivity, peak hold, average, and valley)

Detector FA1: Si
FA2: InGaAs

Temperature Resolution (Display and RS485)

All Models 1°C or 1°F

Analog Output Resolution

FA1/FA2 0.5° C or 1°F
FA1G 0.05°C or 0.1°F

Two-Way RS-485 Output Description

All Models Baud Rate: 300, 1200, 2400, 9600, 19200, 38400 (default)
Note: Adjustable baud rate only available through 2-way RS-485.
Data Format: 8 bits, no parity, 1 stop bit
Software selectable 4-wire, full-duplex standalone or point-to-point or 2-wire, half-duplex multidrop.

Emissivity 0.1 - 1.00, digitally adjustable in increments of 0.01

Peak Hold Range 0 to 300 seconds, digitally adjustable in increments of 0.1 secs.

Averaging Range 0 to 300 seconds, digitally adjustable in increments of 0.1 secs.

Valley Hold Range 0 to 300 seconds, digitally adjustable in increments of 0.1 secs.

Warm Up Period 15 minutes

Fail-Safe Full or low scale, depending upon system failure (refer to Section 4.2)

1.3.4 Electrical

Power	24 VDC (18-36 VDC), at 500 mA (Can tolerate up to 100 mV peak to peak of ripple)
Power Consumption	maximum of 12 watts
Outputs	
Analog	0-20/4-20 mA, 16-bit resolution
Digital/Serial	Two-way RS-485 2-wire/4-wire, networkable to 32 sensors
Relay	Maximum rating: 48V, 300mA, response time <2msec
Output Isolation	500 V AC or DC provided by Raytek supplied power supply accessory
Max Current	
Loop Impedance	500 ohm
Dielectric	
Withstand Voltage	500 V
Relay Contacts	Type: SPDT contact closure (NO or NC, COM) software configurable
External Reset	Trigger input (TTL input--see Figure 1-6). Used to reset Peak Hold or Valley Hold. (It can also be used to reset AVG when ordered as a special.)

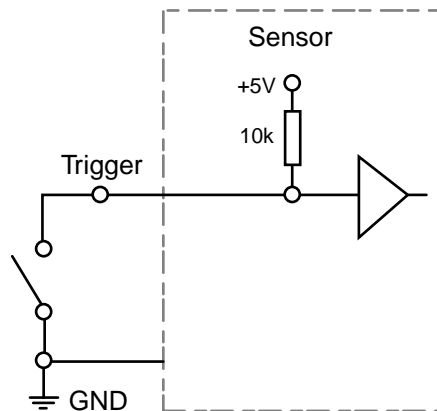


Figure 1-6: External Reset (Trigger Input) Wiring Diagram

1.3.5 Physical

Electronics Enclosure Aluminum alloy

Dimensions

Optical Head 75 mm (3 in) L x 19 mm (0.75 in) Dia
Electronics Enclosure 160 mm (6.3 in) x 79 mm (3.1 in) x
70 mm (2.75 in)

Weight

Optical Head 85 g (3.4 oz)
Electronics Enclosure 709 g (1 lb. 9 oz)

1.3.6 Environmental

Ambient Operating Range

Electronics Enclosure 0 to 60°C (32 to 140°F)
Fiber Cable/Optical Head 0 to 200°C (32 to 392°F)

Vibration (electronics enclosure) MIL-STD-810D (IEC 68-2-6)
3 Gs, 11 to 200 Hz, any axis

Mechanical Shock (electronics enclosure) MIL-STD-810D (IEC 68-2-27)
50 Gs, 11 msec duration, any axis

Thermal Shock None

Relative Humidity 10% to 95% non-condensing

Storage Temperature (electronics enclosure) -20 to 70°C (-4 to 158°F)

Environmental Rating Water tightness as per NEMA-4 (IEC 529, IP 65) hose-down test. Electronics enclosure-rated with compression fitting when fastened around the fiber optic cable and electronics cable. Optical head and fiber optic cable-rated connected to electronics enclosure with protective sleeves.

Electromagnetic Interference CE certification
Emission Standard: EN50081-2
Immunity Standard: EN50082-2

Cable Protection NEMA-4, stainless steel armor, Viton® coated, rated to 200°C

1.4 MECHANICAL

Mechanical specifications include measured drawings for the sensor and its accessories and options.

1.4.1 Sensors

The following illustrations show the dimensions of the optical head (Figure 1-3) and the electronics enclosure (Figure 1-4)

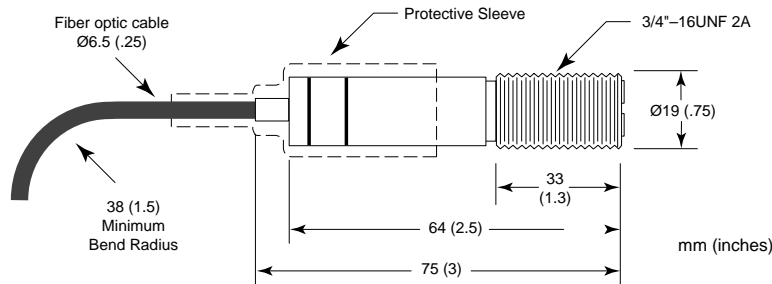


Figure 1-3: Optical Head and Fiber Optic Cable

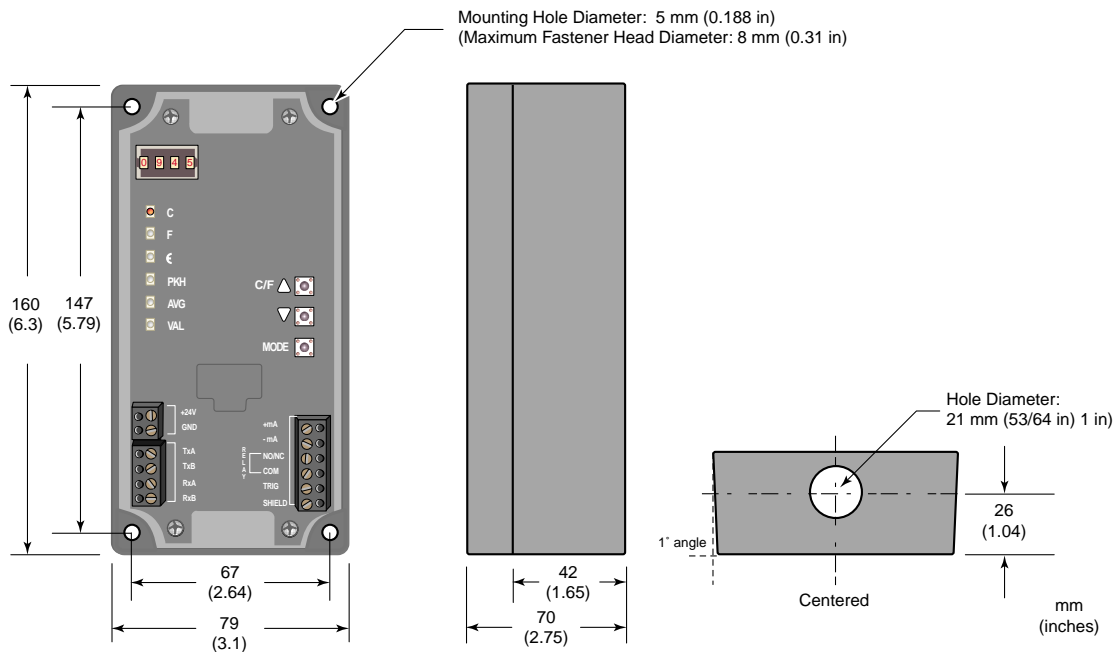


Figure 1-4: Electronics Enclosure

IMPORTANT

The electronics box has two compression fittings to provide water sealing for the fiber optics cable and the electronics cable. The compression fitting must be tightened with a wrench around the cables to achieve water sealing. To achieve sealing for the fiber optics cable, hand tighten the compression fitting around the cable, and then use a wrench to tighten another 1 1/2 to 2 turns. To achieve sealing for the electronics cable, shrink a 2" piece of 3/8" diameter heat shrink material on the cable in the area clamped by the compression fitting. Hand tighten the compression fitting around the cable, and then use a wrench to tighten another 1 1/2 to 2 turns.

Figures 1-5 shows the adjustable bracket for the sensing head .

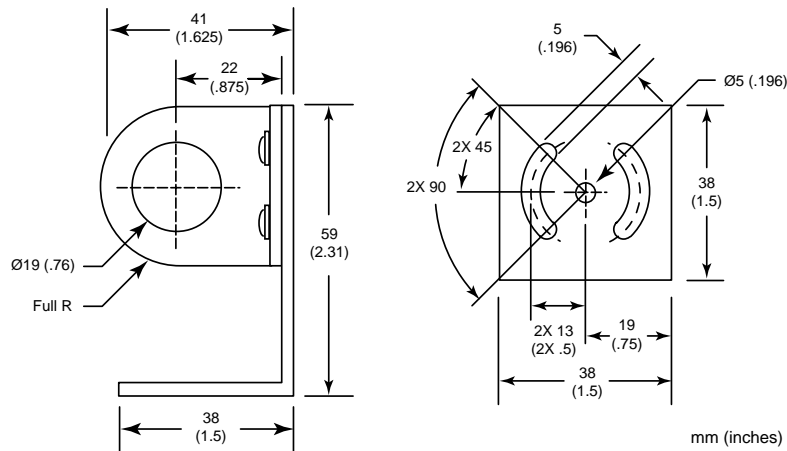


Figure 1-5: Adjustable Mounting Bracket for Sensing Head

1.4.2 Accessories and Options

This section defines accessories and options, lists installation considerations, and shows the dimensions for each piece.

1.4.2.1 Air Purge Collar

The Air Purge Collar accessory (Figure 1-6) is used to keep dust, moisture, airborne particles, and vapors away from the optical head’s lens. It can be installed before or after the bracket (see Figure 1-1, Accessories Overview). It must be screwed in fully. Air flows into the 1/8” NPT fitting and out the front aperture. Air flow should be a maximum of (0.5 - 1.5 liters/sec (1 - 3 cfm)). **Clean (filtered) or “instrument” air is recommended to avoid contaminants from settling on the lens.** Do not use chilled air below 10°C (50°F). Note that the Air Purge Collar cannot be used if the Protective Window Accessory is installed.

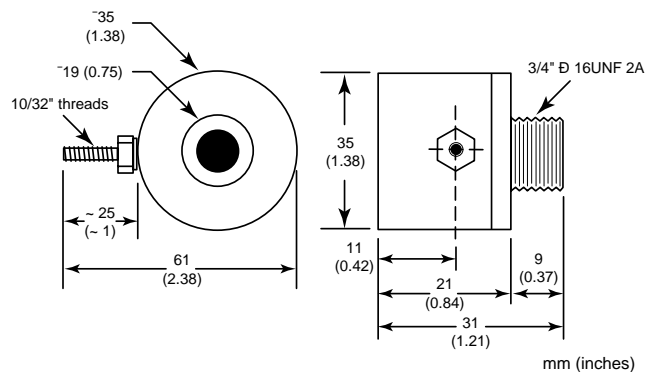


Figure 1-6: Air Purge Collar

IMPORTANT

Focus the instrument before attaching the air purge collar.

1.4.3 Electrical/Electronics Cable

The Raytek cable accessory has 2 twisted pairs and 8 separate wires. The overall shield is aluminized mylar and 85% braided tinned copper.

Note: Refer to the appropriate section of this manual for wiring instructions. A wiring label is also included inside the electronics enclosure lid.

The following are descriptions of the 12 wires:

- Power—2 wires (Black/Red)
 - Conductor: AWG 22/7x30 tinned copper
 - Insulation: FEP .006" wall
 - Shield: None

- RS-485—2 twisted pairs (Black/White and Purple/Gray)
 - Conductor: AWG 24/7x32 tinned copper
 - Insulation: FEP .006" wall
 - Shield: Aluminized mylar with drain wire

- Outputs and Ground—6 wires (Green/Brown/Blue/Orange/Yellow/bare)
 - Conductor: AWG 24/7x32 tinned copper
 - Insulation: FEP .006" wall
 - Shield: None

Cable Diameter: 7 mm (0.256 in) nominal

Temperature: UL rated at -80°C to 200°C (-112°F to 390°F)

High temperature cables have good to excellent resistance to oxidation, heat, weather, sun, ozone, flame, water, acid, alkalis, and alcohol, but poor resistance to gasoline, kerosene, and degreaser solvents.

Notes: If you purchase your own RS-485 cable, use wire with the same specifications as those listed above. Maximum RS-485 cable length is 1200 meters (4000 feet).

WARNING

Both sets of twisted-pair wires have bare drain wires inside their insulation. These drain wires and the bare cable shield wire must be connected to the terminal labeled SHIELD. Refer to Section 2.3 for the wiring diagram.

1.4.4 Fiber Optic Cable

The fiber optic cable is a sealed, stainless-steel armor sheath covering the fiber optic bundle.

Bend Radius of Fiber Bundle	24 mm (1 in) minimum bend radius
Cable Diameter	6.5 mm (0.25 in)
Temperature rating	0 to 200°C (32 to 390°F)
Environmental Rating	Water tightness as per NEMA-4 (IEC 529, IP 65) hosedown test, rated attached and with protective sleeves (which prevents liquid from entering through the connectors)

IMPORTANT

The fiber optic cable is not field replaceable. Note that the serial number on the fiber optic cable must match that on the electronics enclosure. The fiber optic cable and head are one component. The cable can be disconnected from the electronics box for aiming or threading through conduit during installation. The cable is keyed and can only be inserted one way into the electronics enclosure.

1.4.5 Protective Window Option

A Protective Window is available as an option and must be ordered at the time of sensor purchase. The protective window simply screws on the front of the optical head, but must be installed at the time of purchase because the factory must calibrate the sensor with the window in place. If you need to purchase the protective window at a later date, the sensor will need to be sent back to the factory for recalibration. Note that the Air Purge Collar cannot be used if the protective window is installed.

1.4.6 Aiming Lights

There are two Aiming Light accessories available: one is similar to a small flashlight, and is available for the A Temperature Range Model, and the other is a high intensity aiming light, available for B, C, and G Temperature Range Models. Both lights can be attached to the end of the fiber optic cable at the electronics enclosure. Simply loosen the compression sleeve holding the fiber optic cable, loosen the screw at the heater block, and pull the cable out of the heater block approximately 7mm (0.25 in). Raise the fiber optic cable enough to slip the aiming light onto the end.

WARNING

The high intensity aiming light can become very hot. Do not use for more than 15 minutes at a time or damage may occur to the fiber optic aiming accessory.

1.5 FACTORY DEFAULT VALUES

Table 1-2 lists the unit's default values as it is shipped from the factory.

Table 1-2: Parameters as Shipped and Factory Defaults

PARAMETER	FACTORY DEFAULT*
Display mode	Degrees C, TEMP display
Emissivity	1.00
AVG	0.0
PKH	0.0
VAL	0.0
Advanced Hold Hysteresis	0002
First (high) Setpoint	0000
Second (low) Setpoint	0000
Deadband	0002
Advanced Hold Threshold	0000
Decay Rate	0000
Ambient Radiation Correction	0000
Baud Rate	38400 baud
Temperature Setting for 4 mA **	1A model: 475°C (885°F) 1G model: 750°C (1382°F) 1B model: 800°C (1472°F) 2A model: 250°C (482°F) 1C model: 1200°C (2192°F) 2B model: 400°C (752°F)
Temperature Setting for 20 mA **	1A model: 900°C (1652°F) 1G model: 1675°C (3047°F) 1B model: 1900°C (3452°F) 2A model: 800°C (1472°F) 1C model: 3000°C (5432°F) 2B model: 1700°C (3092°F)
Serial Output Transmission Mode	Burst mode
Define Output String Format	Temp scale, Target Temp, Emissivity, Internal Ambient Temp
Relay Alarm Output Control	Controlled by unit
Set Output Current	Controlled by unit
Output Current Mode	4-20 mA
Lockout Switch Panel Access	Unlocked
Communication Mode	4-wire standalone

* Note that the factory default values can be loaded into the sensor by pressing the ▲ (up) and ▼ (down) buttons together for about 2 seconds or by two-way serial communication instructions. The baud rate will not change from the last value when this is done. Factory defaults can be installed with a two-way RS-485 command (XF). Refer to Appendix A for explanations and examples of RS-485 commands.

** These parameters can be adjusted both by a two-way RS-485 command or by the Field Calibration and Diagnostics software, which allows you to scale the high and low temperature points to suit your application.

This section explains the installation and operation of a Marathon infrared thermometer in a standalone environment. If you are installing one or more sensors using these directions, you do not need Part 3. However, if your future plans include setting up a multidrop sensor network, consider using Part 3 instead of Part 2 so your initial installation will be multidrop ready.

Topics include...

- Preparation
- Mechanical Installation
- Electrical Installation
- Operation

2.0 INSTALLATION

The installation process consists of the following:

- Preparation
- Mechanical Installation
- Electrical Installation

The most important part in the installation process is preparation. Please read Section 2.1 thoroughly before proceeding with the mechanical and electrical installations.

2.1 PREPARATION

Sensor location, the configuration, and/or the number of sensors depend on the application. Before installing any sensors you need to be aware of the ambient temperature of the location, the atmospheric quality of the location, and the possible electromagnetic interference in that location. If you plan to use air purging, you need to have air connections available. Also, wiring and conduit runs must be considered, including computer and controller wiring and connections, if used. The following subsections cover topics to consider before you install the sensor.

WARNING

Do not apply power to sensors, computer connections, if used, or RS-485/RS-232 converters, if used, until everything is securely connected. Turning power on before connections are complete can cause damage to sensor and/or converter electronics and void the warranty.

2.1.1 Ambient Temperature

The optical head is designed to operate in ambient temperatures up to 200°C (390°F). The electronics enclosure is designed to operate in ambient temperatures between 0°C (32°F) and 60°C (140°F). The internal ambient temperature can vary from 10°C (50°F) to 68°C (154°F). Internal temperatures outside this range will cause a failsafe error.

When using air purging, make sure air supplies are installed before proceeding with the sensor installation. Clean (filtered) or “instrument” air is recommended.

2.1.2 Atmospheric Quality

Smoke, fumes, dust, and other contaminants in the air, as well as a dirty lens can be a problem. If the lens gets dirty, the unit will read a lower than actual temperature. It is good practice to always keep the lens clean. The Air Purge Collar helps keep contaminants from building up on the lens.

If you use air purging, make sure an air supply is installed before proceeding with the sensor installation.

An optional Protective Window accessory can be ordered with the head to prevent damaging the lens by corrosive materials in the atmosphere. This option can also be used to prevent dirt from getting on the lens. Note that this option cannot be used in conjunction with the Air Purge Collar accessory.

2.1.3 Electrical Interference

To minimize electrical or electromagnetic interference or “noise,” be aware of the following:

- Mount the sensor as far away as possible from potential sources of electrical interference, such as motorized equipment producing large step load changes.
- Use shielded wire for all input and output connections (refer to Section 2.3, Electrical Installation for connecting information).
- Make sure the shield wire in the sensor cable is earth grounded and connected to the “Shield” terminal.
- For additional protection, use conduit for the external connections. Solid conduit is better than flexible conduit in high noise environments.
- Do not run AC power lines for other equipment in the same conduit.

IMPORTANT

When installing the sensor, check for any high-intensity discharge lamps or heaters that may be in the field of view (either background or reflected on a shiny target). Reflected heat sources can cause erroneous readings.

2.1.4 Sensor Location

Standard Focus FA1/FA2 models are focused at infinity. Models with the optional Close Focus optics are focused at 100 mm (4 in) or 300 mm (12 in). The sensor must have a clear view of the target, and the target must completely fill the field of view. There can be no obstructions on the lens, window, or in the atmosphere. Figure 2-1 shows proper sensor placement.

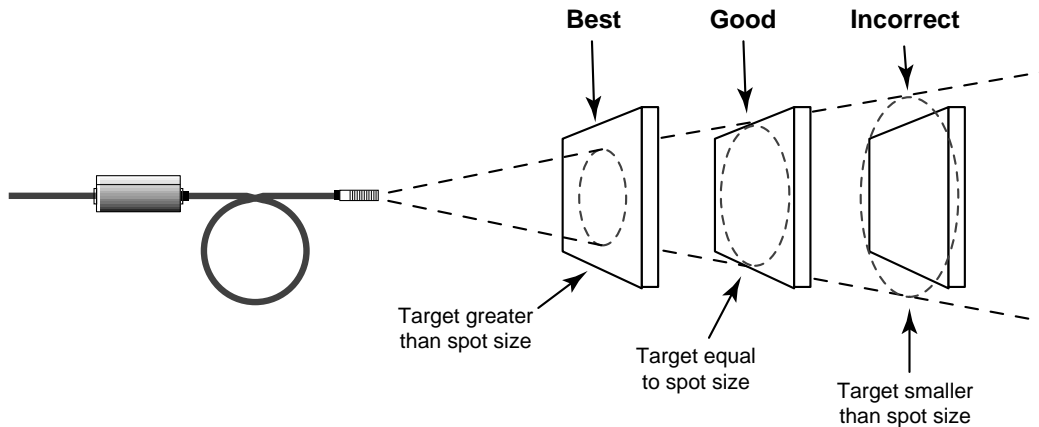


Figure 2-1: Proper Sensor Placement

The sensor can be placed at any angle from the target up to 30° (Figure 2-2).

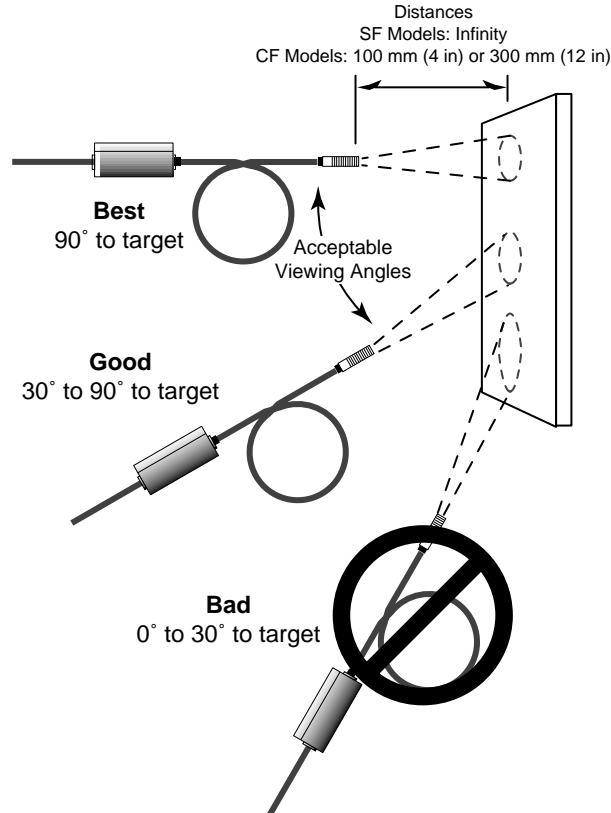


Figure 2-2: Acceptable Sensor Viewing Angles

2.2 MECHANICAL INSTALLATION

After all preparations are complete, you can install the sensor.

2.2.1 Mounting the Sensor

How and where you anchor the optical head and electronics enclosure depends on the type of surface and the type of bracket you are using. You can mount the optical head through a hole, on a bracket of your own design, or on the fixed bracket accessory. (Refer to Figure 1-1 for an overview of available mounting accessories.)

Another mounting consideration is the distance from the head to electronics enclosure and from the electronics enclosure to power and computer connections. The optical head has the fiber-optic cable attached and is factory calibrated with the length of fiber-optic cable ordered.

IMPORTANT

If you need to replace the fiber optic cable, the unit must be returned to the factory for installation and recalibration. Fiber optic cables are not field replaceable. The serial number on the fiber optic cable must match that on the electronics enclosure.

You may need to “snake” the fiber-optic cable through and around any obstacles, such as beams, walls, support columns, etc., or, if your installation requires, through conduit, before attaching the end to the electronics enclosure. (Do not attach until you aim the optical head.) The fiber optic cable and head are one component. The cable can be disconnected from the electronics box for aiming or threading through conduit during installation. The cable is keyed and can only be inserted one way into the electronics enclosure. Figure 2-3 shows how to connect the fiber optic cable to the electronics enclosure.

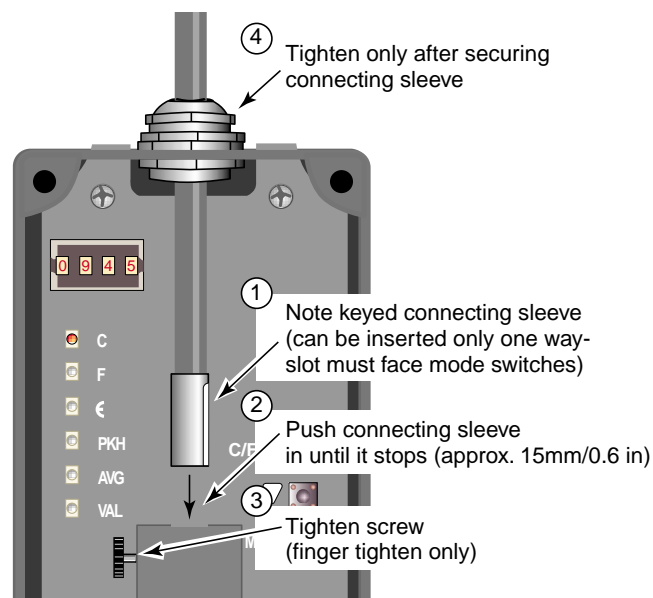


Figure 2-3: Connecting the Fiber Optic Cable

The distance between the electronics enclosure and a computer (via RS-485 cable) can be up to 1200 meters (4000 feet). This allows ample distance from the harsh environment where the sensing head is mounted to a control room or pulpit where the computer is located.

Power connections, however, must be no more than 60 meters (200 feet) from the electronics enclosure.

WARNING

The unit's electronics will not function if the power source is more than 60 meters (200 feet) away.

Note: If you are installing two or more sensors in a multi-drop configuration, or if you plan to add to or more sensors at a later date, refer to Part 3 for information on multi-drop installations.

2.2.2 Aiming

Aiming can be done with either the High Intensity Aiming "Flashlight," for "A" temperature range models, or the High Intensity AC Powered Aiming Light, for the "B", "C", and "G" temperature range models.

Simply loosen the compression sleeve holding the fiber optic cable, loosen the screw at the heater block, and pull the cable out of the heater block approximately 7mm (0.25 in). Raise the fiber optic cable enough to slip the aiming light or fiber optic light cable (depending on aiming light model) onto the end. Align the light beam on the target.

An effective aiming technique is to adjust the head until the highest reading is observed on the internal display. When the highest reading is reached, hold the unit in place and secure the mounting base.

To reconnect the fiber optic cable to the heater block in the electronics enclosure, follow the procedure in Figure 2-3 (previous page).

WARNING

The AC powered high intensity aiming light can become very hot. Do not use for more than 15 minutes at a time or damage may occur to the fiber optic aiming light cable.

2.3 CONNECTING SENSORS

Both sets of twisted-pair wires have drain wires inside their insulation. These drain wires must be connected to the terminal labeled SHIELD (bare). Also connect the earth ground to the SHIELD (bare) terminal. Figure 2-4 shows how to configure the drain wires before connecting to the sensor and RS-485/RS-232 converter.

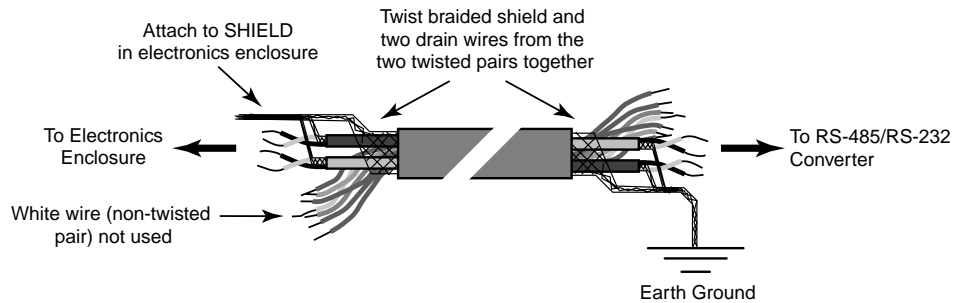


Figure 2-4: Configuring the Sensor Cable

Cables can be run to the electronics enclosure through conduit or fastened using the a compression fitting. Once you run the cable into the enclosure, attach the color-coded bare wires to the terminals. Use Figure 2-5 (or diagram on underside of lid) as a wiring guide. Note that the terminal blocks in the electronics enclosure can be “popped” out for easy wire connections. Figure 2-6 illustrates how to remove and replace the terminal blocks.

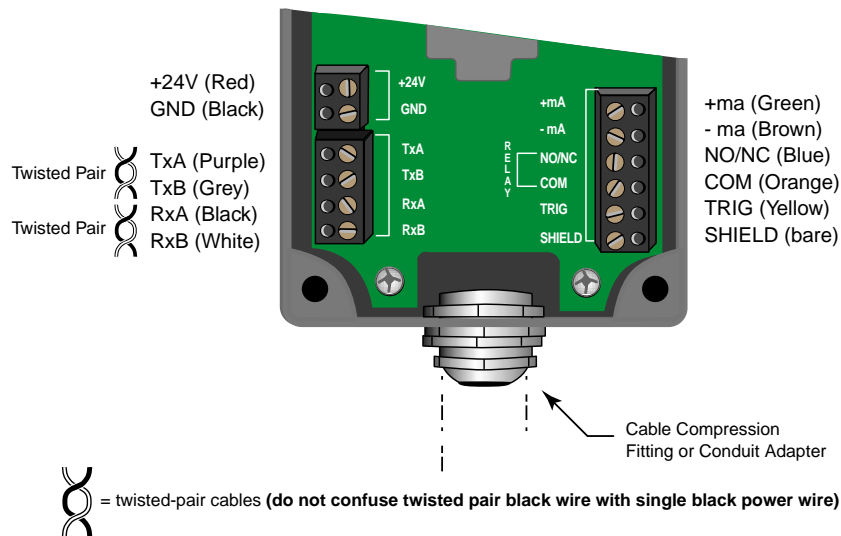


Figure 2-5: Electronics Enclosure Wiring

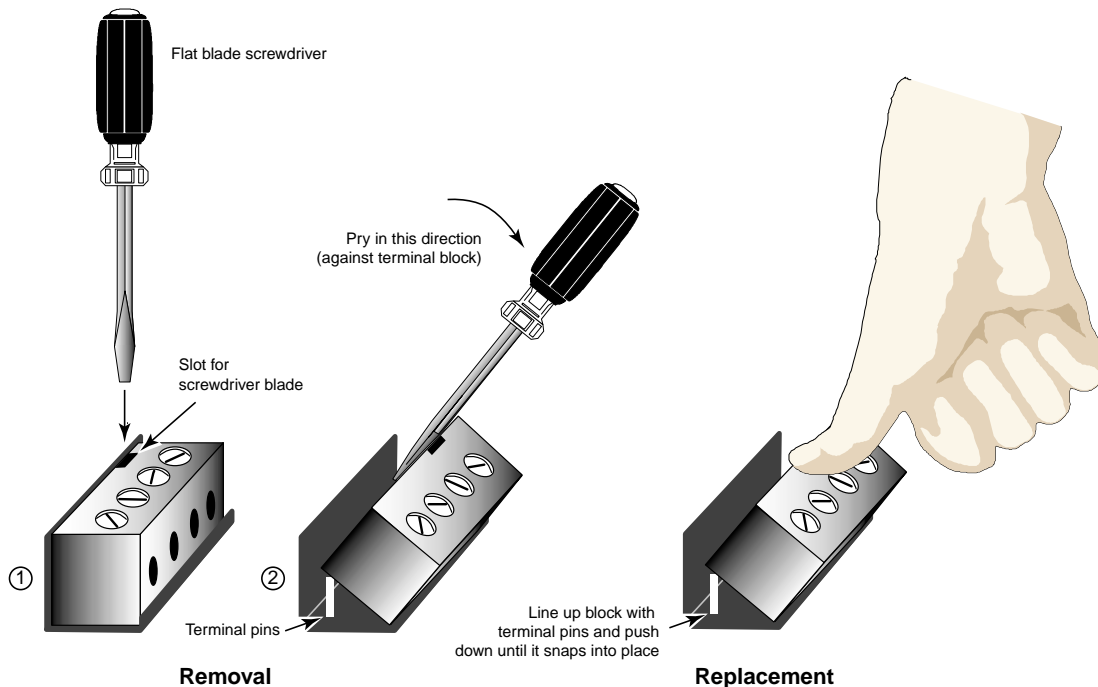


Figure 2-6: Removing and Replacing the Terminal Blocks

WARNING

Incorrect wiring can damage the sensor and void the warranty. Before applying power, make sure all connections are correct and secure.

The sensor cable may be shortened but not lengthened without the appropriate terminal block accessory. Longer cables are available from the factory. Limit power cables to 60 meters (200 feet) or less. RS-485 cables can be extended up to 1200 meters (4000 feet).

Avoid installing the sensor cable in noisy electrical environments such as around electrical motors, switch gear, or induction heaters. In these environments, it is recommended to install the cable in conduit. Note that the sensor head is designed to fit conduit directly.

Note: When using conduit for the cable, and when it has a compression fitting installed on the conduit connection, the sensor head is rated NEMA-4 (IEC 529, IP 65).

2.3.1 Power

Connections from a 24 VDC (500 mA or higher) power supply attach to the appropriate terminals on the electronic enclosure's terminal strip (as shown in Figure 2-5).

IMPORTANT

Isolation is provided only when used with the appropriate Raytek supplied power supply accessory.

2.3.2 RS-485 Interface Converters

To connect to a computer's RS-232 port, you need one of the Interface Converter accessories (similar to Figure 2-7) and the proper RS-232 cable. If your computer has an RS-485 interface card, you can connect the sensor directly to its port (using the proper connector) with wiring from the electronic enclosure's terminal block.

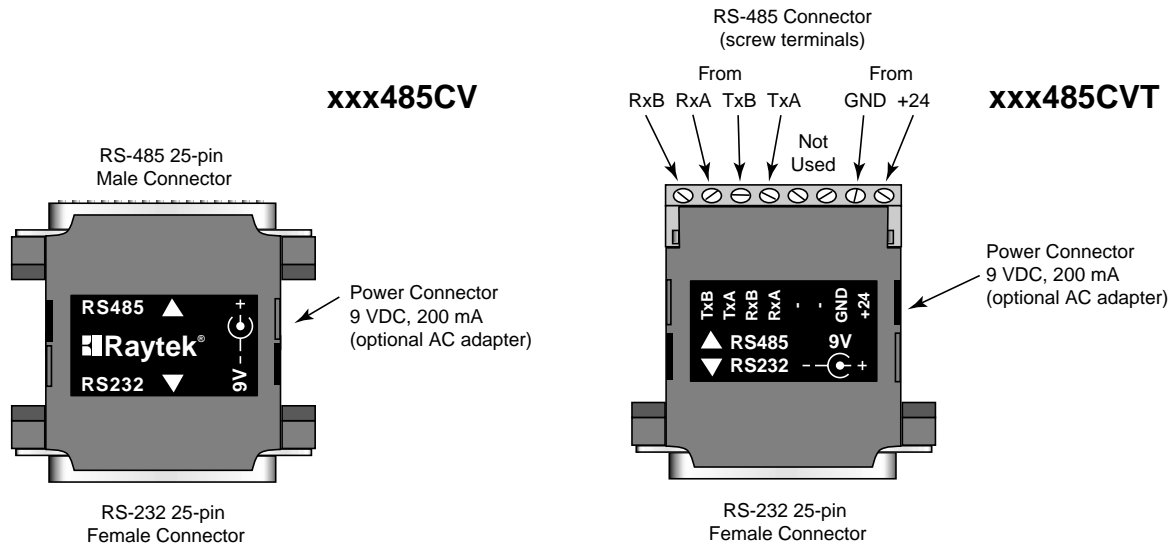


Figure 2-7: RS-485 to RS-232 Interface Converters

IMPORTANT

When wiring 2- or 4-wire connections from the electronics enclosure to the CVT RS-485 Interface Converter make sure wires going to the converter's RxA and RxB terminals come from the electronic enclosure's TxA and TxB terminals, and the converter's TxA and TxB terminals come from the electronic enclosure's RxA and RxB terminals.

Connect the interface converter to an available COM port on your computer, either directly or with an appropriate serial cable (available from computer supply stores). If your computer has a 9-pin serial connector, use the supplied 25-pin to 9-pin cable between the interface converter or cable and the computer.

The Interface Converter can be powered by either a 9 VDC AC adapter accessory or a 24 VDC Power Supply accessory.

WARNING

Always power up the Interface Converter before the sensor. Also, never change RS-485 or power connections while the instrument is powered. Doing so will damage the Interface Converter and void the warranty.

Figure 2-8 illustrates cable and converter connections between sensor and computer.

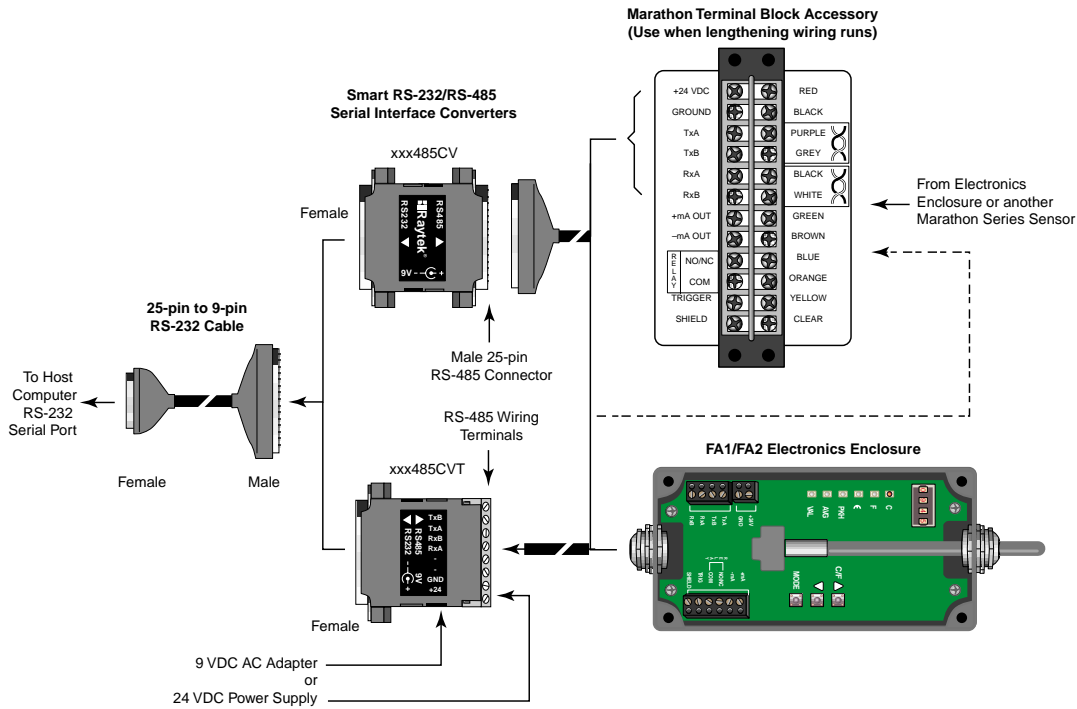


Figure 2-8: Connections from Sensor to Computer

You can wire directly from the electronics enclosure to the screw terminals on the xxx485CVT converter. If you need to extend the wiring, use the Terminal Block accessory. Make sure you connect the color-coded wires correctly.

Wires from the TxA and TxB terminals in the electronics enclosure and on the Terminal Block accessory must connect to the RxA and RxB terminals on the converter, and the RxA and RxB terminals in the enclosure and on the terminal block must connect to the TxA and TxB terminals on the converter.

IMPORTANT

On some computers the COM1 port is used by a pointing device (mouse, trackball, etc.), and sometimes the COM2 port is connected to an external modem or fax/modem (an internal modem can also be set to use COM2). It is possible for two devices to share an interrupt (COM1/COM3 or COM2/COM4); however, they cannot be used at the same time or your system might “crash.” You can connect the RS-232 cable to the same port as, for instance, your modem, but you need to make sure the modem is inactive while you use the sensor.

The RS-485 output is as follows:

Baud Rate: 300, 1200, 2400, 9600, 19200, 38400 (default)

Note: Adjustable baud rate only available through 2-way RS-485.

Data Format: 8 bits, no parity, 1 stop bit

Four-wire full duplex, point-to-point

For a full description of the RS-485 output string, see Appendix B.

WARNING

If you are using the converter's optional power adapter, note the following: After connecting the serial cables, attach the adapter plug into the converter BEFORE plugging the AC adapter into an AC outlet.

2.3.3 Milliamp Output

The milliamp output is an analog output you can connect directly to a recording device (e.g., chart recorder), PLC, or controller.

The analog output resolution for FA1/FA2 models is 0.5°C or 1°F. Analog output resolution for the FA1G is 0.05°C or 0.1°F.

The mA output can be forced to a specific value, underrange, or overrange with a 2-way RS-485 command. See Appendix B for details. This feature is useful for testing or calibrating connected equipment.

2.3.4 Relay Outputs

The relay output is used as an alarm for failsafe conditions or as a setpoint relay. (Refer to Section 4.2 for failsafe information.) Relay outputs relate to the currently displayed temperature on the LED display.

Note: Since the way you use the relay outputs depends on the application, check with your sales representative for the best way to use this feature.

The relay can be set to either NO (Normally Open) or NC (Normally Closed) with a 2-way RS-485 command (depending on the compatibility requirements of connected equipment). The relay can be forced on or off via the 2-way for testing connected equipment. See Appendix B for details.

2.3.5 Trigger

Peak Hold and Valley Hold can be Reset by shorting the Trigger input (labeled TRIG) to Ground (labeled GND) for a minimum of 10 msec. This can be done either with a momentary switch or a relay. Both Peak Hold and Valley Hold have to be set to 300.0 seconds to recognize this Reset. The Reset signal will cause the peak or valley reading that the sensor is holding to change immediately to the current target temperature. This feature is also available for the Average function as a special.

Note: Every change on the trigger input will cause a notification message (#XTx) on a unit in standalone mode, where x is "0" for an inactive trigger (open) and "1" for an active trigger signal (connected to ground). The status of the trigger signal can be queried by the ?XT command or put into the burst string (\$=XT...). This signal can be used by external software to start recording, special signal processing, or similar activities.

2.4 OPERATION

Once you have your sensor(s) positioned and connected properly, the system is ready for continuous operation. Operation is accomplished either through the electronic enclosure's internal panel or through controlling software. A Graphic Setup and Display program is supplied with your sensor and is covered in Part 4. You can also create custom programs using the communications protocols listed in Appendix B.

IMPORTANT

Make sure air, power, and computer connections are secure.

Avoid taking temperature measurements in bright sunlight. Also, be aware targets with low temperatures (below the sensor's range) and low emissivities may not register correctly.

2.4.1 The Control Panel

The sensor is equipped with a control panel in the electronic enclosure (Figure 2-9), which has setting/controlling buttons and an LED display. You can configure sensor settings with the control panel or with a computer. The panel is used primarily for setting up the instrument and is sealed during operation. The buttons and LEDs are defined in the following sections.

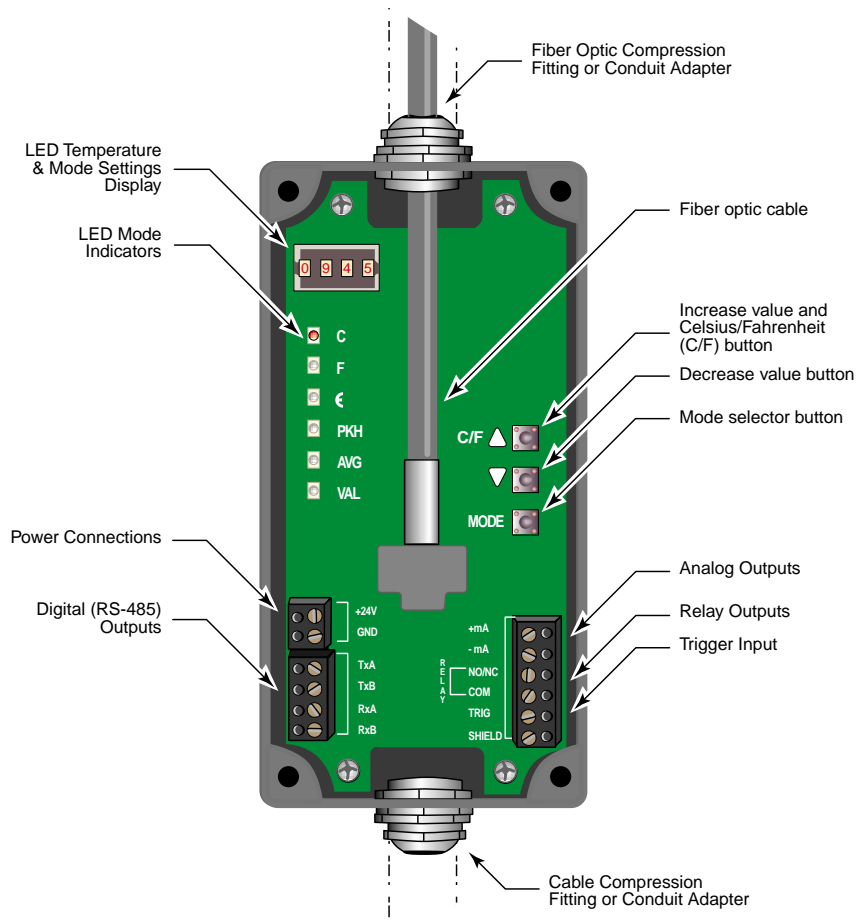


Figure 2-9: Control Panel

2.4.2 SET-UP

You can set up the sensor from the electronics enclosure panel or remotely through the 2-way RS-485 connection (refer to Appendix B). To begin setting up the sensor, first make sure all connections are secure, then turn on the power supply. **Allow the sensor to warm up for 15 minutes before making control panel adjustments.**

When you first turn the unit on, the display shows the current temperature. Pushing the mode selector button will change the figures on the display to the current setting for each particular mode. Figure 2-10 illustrates the sequence of operation for the mode selector button when in current temperature mode.

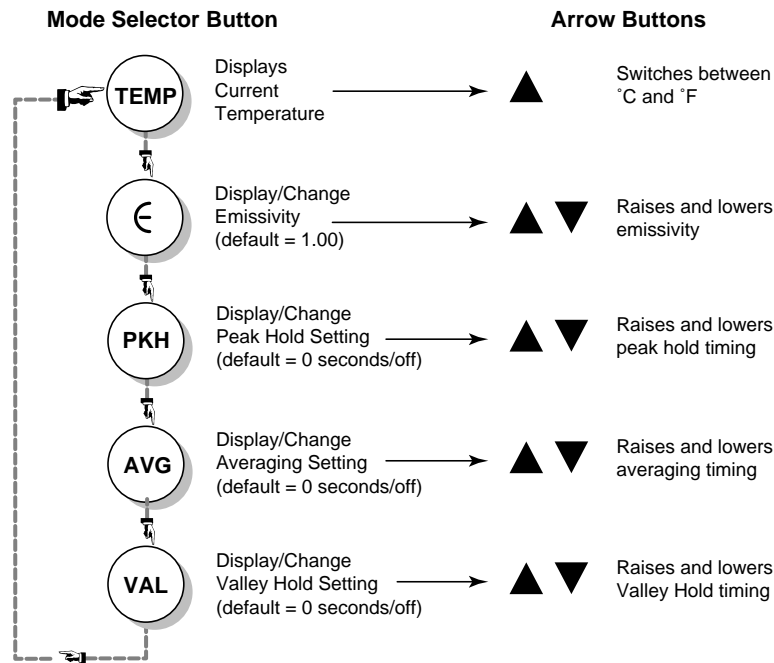


Figure 2-10: Mode Selector Button Sequence

Note: When the PKH mode is active (PKH LED lit), the Mode Selector cycle skips AVG and VAL (TEMP to E to PKH back to TEMP). When the AVG mode is active (AVG LED lit), the Mode Selector cycle skips PKH and VAL (TEMP to E to AVG back to TEMP). When the VAL mode is active (VAL LED lit), the Mode Selector cycle skips PKH and AVG (TEMP to E to VAL back to TEMP). If “AAAA” shows on the display when going through PKH and VAL, then an advanced function has been set, which can be changed or set via RS-485 only.

The following sections define each of the control panel’s features and functions and explains sensor setup and use. Section 2.4.2.5 explains how to reset the factory defaults. Note that all modes can be changed from a computer using controlling software such as those listed in Part 4.

WARNING

Do not connect, disconnect, or change wiring while the power is on.

2.4.2.1 Lockout Mode

The sensor has a remote locking feature that keeps the unit from being accidentally changed from the control panel. This lockout mode denies access to all the switches on the control panel. It is available through the RS-485 connection and can be unlocked only by a command from the remote computer. See Appendix B for details.

2.4.2.2 Modes

Pressing the mode selector button cycles you through the four operating modes as shown in Figure 2-7 (previous page).

Note: All parameters can be changed through controlling software such as those in Part 4.

Temperature

You can set the temperature display for either °C or °F by pressing the C/F selector button (▲–up arrow). The Decrease Value (▼–down arrow) button is inactive in this mode. A lit LED shows you whether the measured temperature is in °C or °F. Note that this setting influences the RS-485 output for both target and internal temperatures.

Emissivity

The emissivity is a calculated ratio of infrared energy emitted by an object to the energy emitted by a blackbody at the same temperature (a perfect radiator has an emissivity of 1.00). The emissivity is preset at 1.00. However, there are times when the surface characteristics of the object being measured will not return an accurate temperature measurement unless you change the sensor's emissivity setting. If you are unsure of the target's emissivity, refer to Appendix C for information on determining an unknown emissivity, and for sample emissivities of many metals and non-metals.

To change the unit's emissivity setting, complete the following:

1. **Press the Mode button until the ϵ LED is lit.**

The current emissivity value shows on the display.

2. **Press the ▲ or ▼ (UP or DOWN) button to change the value.**
3. **Press the Mode button several times until the temperature displays.**

The displayed temperature will now be based on the new emissivity value.

Note: The emissivity can also be adjusted with a 2-way RS-485 command. See Appendix B for details.

Peak Hold (PKH)

PKH as three modes: Peak Hold, Advanced Peak, and Advanced Peak + time. The following are definitions of some helpful terminology:

- Hold Temperature Output temperature, with peak hold mode applied.
- Hold Interval How long to hold the current peak.
- Hold Trigger Temperature threshold used in advanced modes.
- Hold Hysteresis Minimum temperature drop, used to filter out noise in advanced modes.

With Peak Hold, the respective last peak value is held for the duration of Hold Time. With the Advanced Peak setting (available only through software), every value above a threshold value (Hold Trigger Temperature) is held until a new peak value above the Hold Trigger Temperature is measured. It is accepted if the input temperature drops below the last determined peak value by Hold Hysteresis. With Advanced Peak + Time every maximum value is held above the Hold Trigger Temperature, but is limited to the duration of Hold Time. (Example shown in Figure 2-11.)

Hold Hysteresis: A tolerance range can be defined to suppress minor temperature variations (spurious peaks, noise). Thus a value of 5°C (9°F) for Hold Hysteresis means that the input signal can have a 5°C (9°F) tolerance without needing to activate one of the Advanced Peak functions.

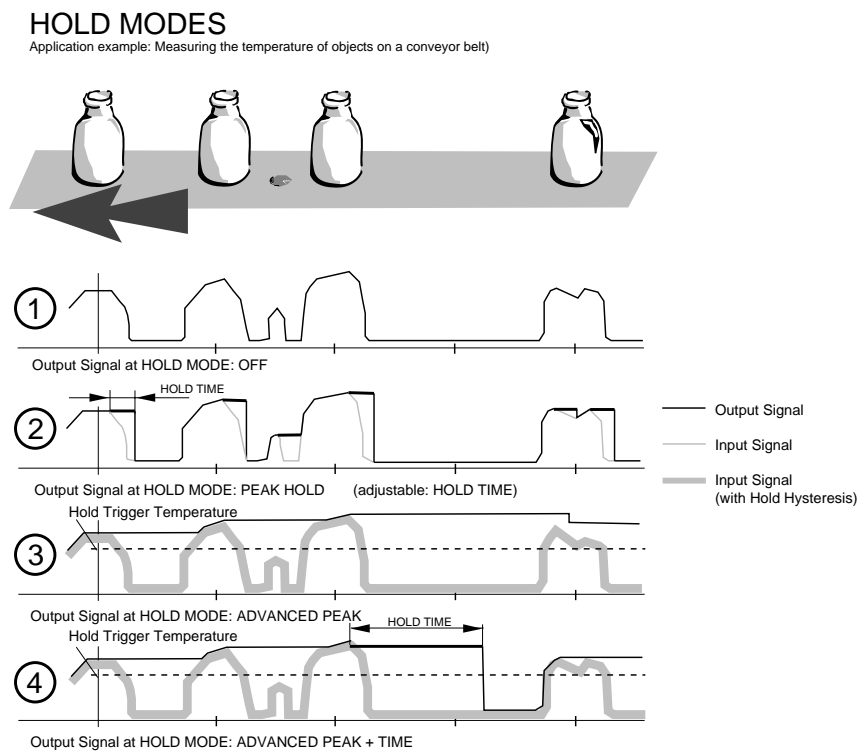


Figure 2-11: Peak Hold Output Signal Example

Simple Peak Hold

Simple Peak Hold is controlled by a single setting, the hold time. To set and activate Peak Hold, do the following:

1. **Press the Mode button until the PKH LED is lit.**
2. **Press the ▲ (UP) button to both set and activate.**

The display reads in 0.1 seconds. Set Peak Hold from 0 to 299.9 seconds. If Peak Hold is set to 300.0 seconds, a hardware reset is needed to trigger another reading. Refer to Section 2.3.5 for more information on the Trigger.

3. **Press the Mode button until the C or F LED is lit.**

If Peak Hold has been activated, the Peak LED will stay lit.

Once Peak Hold is set above 0, it automatically activates. The output signal remains the same until one of two things happens: (1) The peak hold time runs out. (In this case, the signal reverts to actual temperature.) (2) The actual temperature goes above the hold temperature. (In this case, starts holding new peak.) Note that Averaging (AVG) cannot be used concurrently. To deactivate Peak Hold, push the MODE button until only the PKH LED indicator is lit and reset to 0 by pushing the ▼ (DOWN) button.

Note: Peak Hold can also be adjusted with a 2-way RS-485 command. See Appendix B for details.

Advanced Peak Hold

The following is a practical application that explains the advanced Peak Hold functions (available only through software):

In a car plant, body parts are moved on a conveyor belt through a hardening oven to harden the metallic paint. Normally a new body passes through every two minutes. The temperature of the oven must be kept relatively constant, if possible, even if no new parts move into the oven for short periods (for breaks or for short technical stoppages). So practically speaking, we have the following case (Figure 2-12):

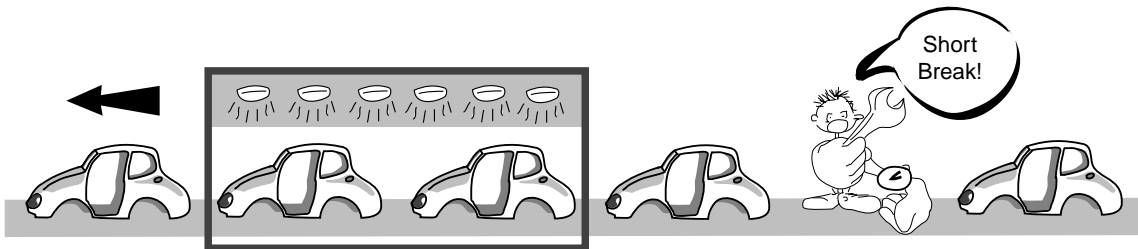


Figure 2-12: Peak Hold Example

Advanced peak mode is controlled by two settings: the Hold Trigger and the Hold Hysteresis. The Hold Interval is not used. If the actual temperature drops below the hold trigger, and then rises back above the trigger, the sensor begins looking for the new maximum. The new maximum is the highest temperature seen since it rose above the trigger. The sensor's output stays the same until one of two things happen:

1. The actual temperature drops below the new maximum, and the difference between the new maximum and the actual temperature is greater than the Hold Hysteresis. In this case, the sensor starts holding the new maximum.
2. The actual temperature goes above the hold temperature and starts holding the new peak and waits for the temperature to dip below the trigger.

In other words, the output signal will hold the respective last "Peak" (maximum value) until a new value above the HOLD TRIGGER TEMPERATURE occurs. The input signal may vary within the value for HOLD HYSTERESIS without causing an alteration of the output signal. (See Figure 2-13.)

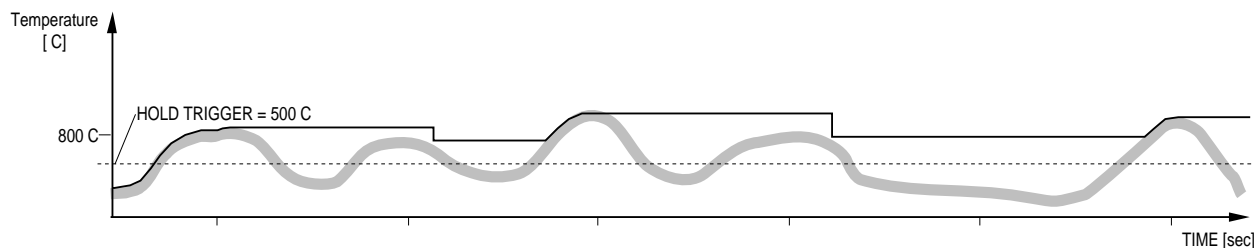


Figure 2-13: Advanced Peak Hold

Note: Advanced Peak Hold can be activated only through the RS-485 communications. Refer to Appendix B for information on programming and communications.

Advanced Peak + Time

Advanced Peak + Time mode is Advanced Peak with a hold interval. This is controlled by three settings: the hold interval, the hold trigger, and the hold hysteresis.

The output signal will hold the last "Peak" (maximum value) until a new value above the HOLD TRIGGER TEMPERATURE occurs, or until HOLD TIME is exceeded. This is important if, for example, the oven is to be switched off if no new parts pass through over a longer period. (In the curve illustrated in Figure 2-14, the break has no end.)

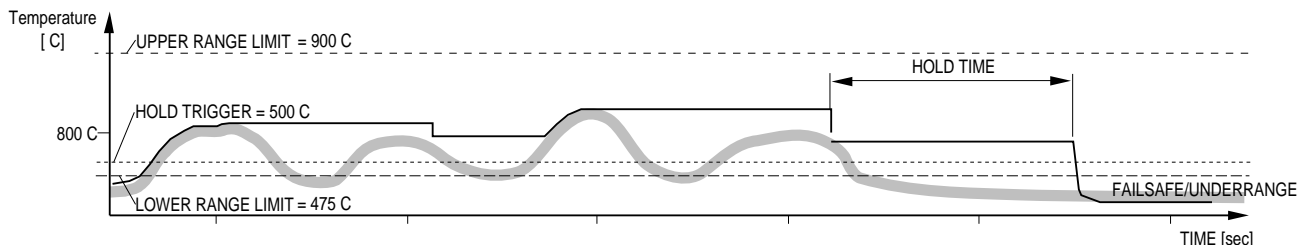


Figure 2-14: Advanced Peak Hold + Time

A continuous peak reading can be reset when Peak Hold Time is set to 300 seconds by shorting the Trigger input to Ground for a minimum of 10 msec. (Refer to Section 2.3.5 for more information on the Trigger.) Figure 2-15 shows an example of continuous Peak Hold reset by the Trigger input.

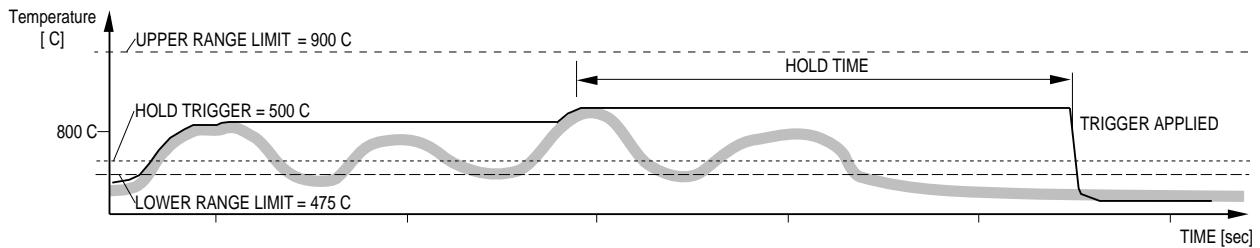


Figure 2-15: Continuous Peak Hold + Trigger

A decay time can be set to allow a slow reduction of the temperature until another peak is encountered. Figure 2-16 is an example of a Peak Hold with a set Decay Time.

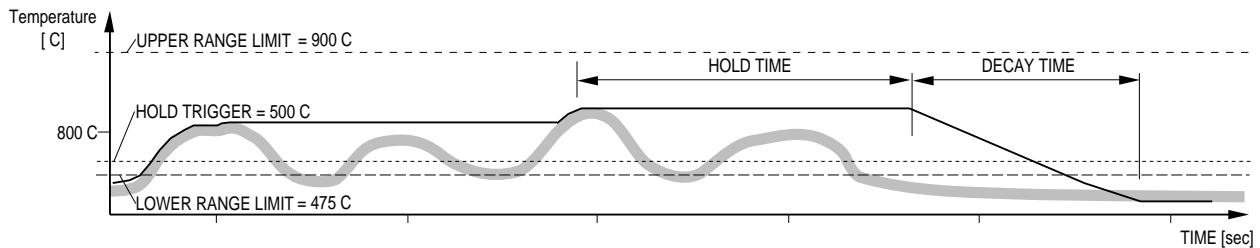


Figure 2-16: Peak Hold + Decay

Please note the following for the Advanced Peak Hold + Time function:

In Alarm Mode, the FAIL SAFE output signal is only set to underrange if two conditions are fulfilled simultaneously:

1. HOLD TIME, if any, was exceeded without a new value above HOLD TRIGGER TEMPERATURE being determined.

In the example in Figure 2-12: No new car bodies enter.

2. Value has fallen below the bottom of the temperature range.

In the example in Figure 2-12: the conveyor belt temperature is below the bottom of the temperature range. For example, 475°C for FA1A.

How to set ADVANCED PEAK HOLD + TIME:

- Set HOLD TRIGGER TEMPERATURE high enough that all "irrelevant" input values are suppressed. In the example in Figure 2-12 the bodywork parts have a higher temperature than the moving conveyor belt. HOLD TRIGGER TEMPERATURE was set above the conveyor belt temperature (2-way command "C").
- Set the Peak Hold time different from 0 (command "P").
- Set the hysteresis according to the expected noise in the process (command "XY").

An example of Advanced Hold is described in more detail on the following page.

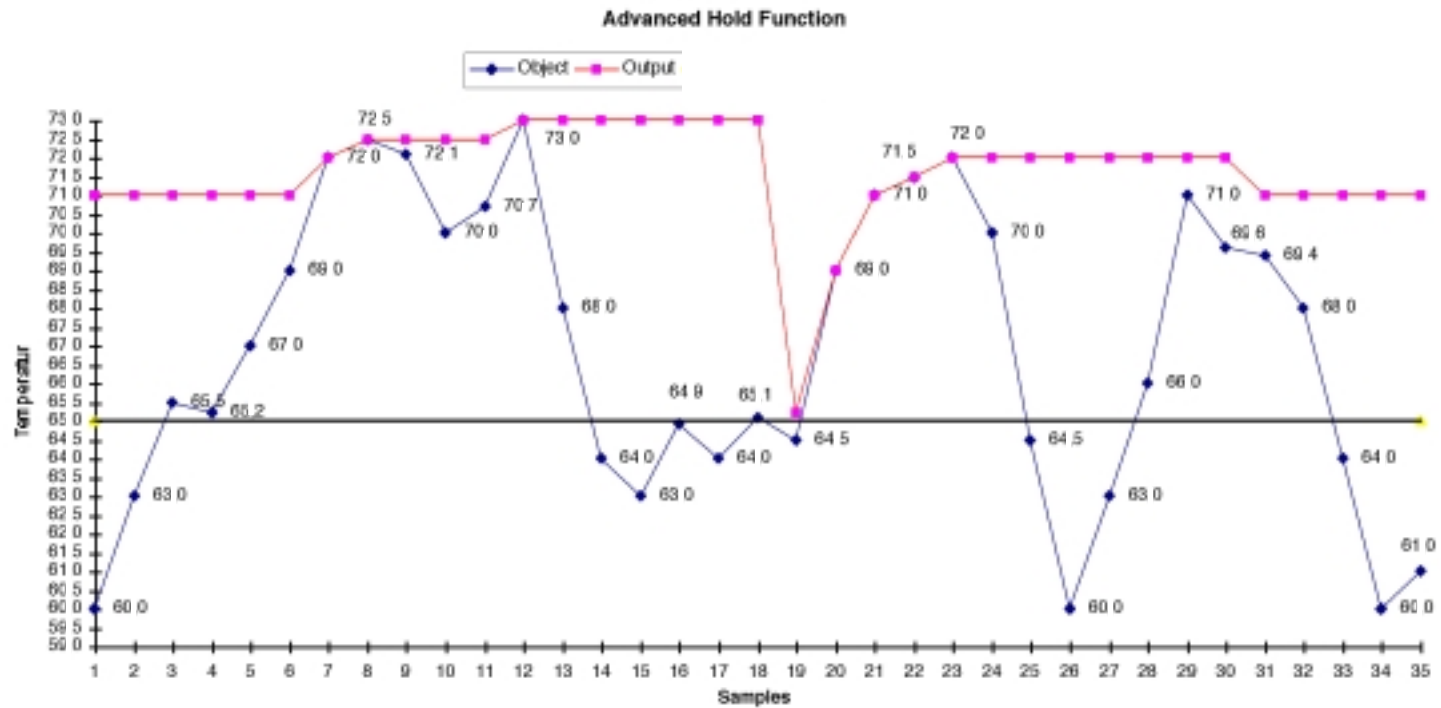


Figure 2-17: Advanced Hold Function

Samples 1 ... 6 : previous output value is held, local maximum at 3 is not evaluated, because hysteresis was not exceeded, timer runs

Samples 7, 8, 12 : because each new value is greater than held value, output is altered and timer is retriggered

Samples 9,10,11,13: previous output value is held, timer runs

Samples 14 ... 17 : previous output value is held, local maximum at 16 is not evaluated, because Hold Trigger was not exceeded, timer runs

Samples 18, 19 : local maximum at 18 is accepted at 19, because 18 is above Hold Trigger and hysteresis is exceeded, timer retriggered at 19

Samples 20 ... 23 : because each new value is greater than held value, output is altered and timer is retriggered

Samples 29 ... 31 : local maximum at 29 is accepted at 31, because hysteresis was not exceeded until 31, timer retriggered at 31

Averaging (AVG)

Averaging can be useful when an average temperature over a specific duration is desired, or when a smoothing of fluctuating temperatures is required. Figure 2-18 illustrates the Averaging output signal.

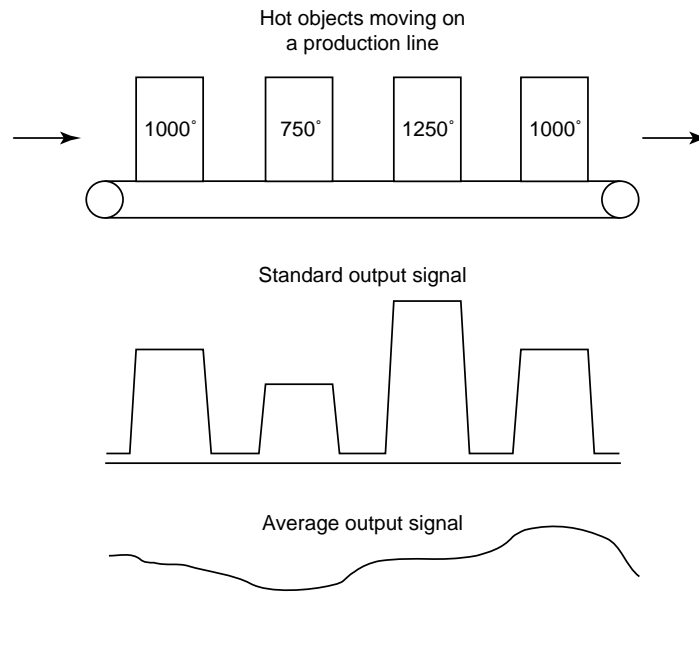


Figure 2-18: Averaging Example

The averaging algorithm simulates a first order low pass RC filter whose time constant can be adjusted to match the user's averaging needs.

To set and activate Average, do the following:

1. **Press the Mode button until the AVG LED is lit.**
2. **Press the ▲ (UP) button to both set and activate.**

The display reads in 0.1 seconds. Set Average anywhere from 0 to 300 seconds (to set the time constant of the first order, low-pass filtering).

3. **Press the Mode button until the C or F LED is lit.**

If Average has been activated, the Average LED will stay lit.

Once Average is set above 0, it is automatically activated. Peak and Valley Hold cannot be used concurrently with Average. To deactivate Average, push the MODE button until only the Average LED indicator is lit and reset to 0 by pushing the ▼ (DOWN) button.

Notes: Average can also be adjusted with a 2-way RS-485 command. See Appendix B.

With special software from the factory, the Average reading can be reset by shorting the Trigger input to Ground for a minimum of 10 msec. (Refer to Section 2.3.5 for more information on the Trigger.)

Valley Hold (VAL)

With Valley Hold activated, the unit monitors the minimum temperature seen over the pretermined time interval. The algorithm may be described as being exactly the reverse of that for the Peak Hold, in that it monitors the lowest rather than the highest temperature seen. The duration time is changed by the ▲ (UP) and ▼ (DOWN) buttons. Figure 2-19 illustrates the Valley Hold output signal.

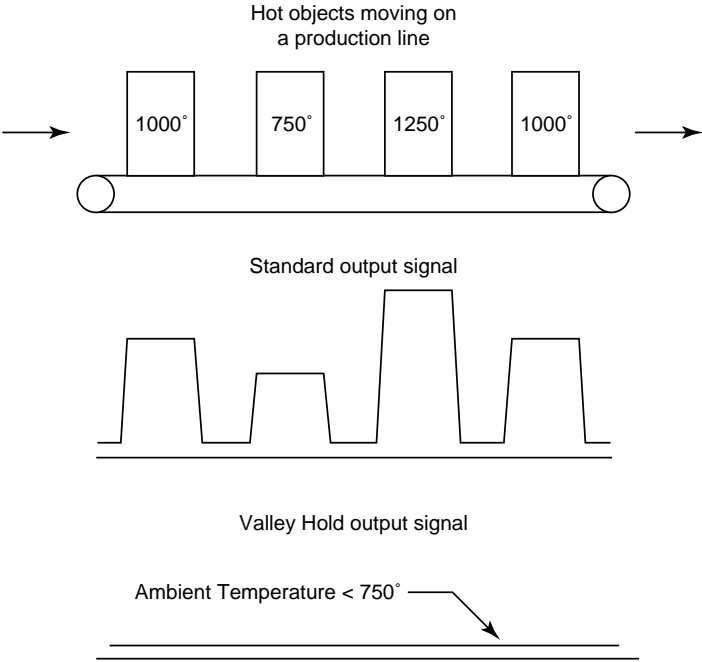


Figure 2-19: Valley Hold Example

The Valley reading can be reset when Valley Hold Time is set to 300 seconds by shorting the Trigger input to Ground for a minimum of 10 msec. (Refer to Section 2.3.5 for more information on the Trigger.)

The following table (Table 2-1) lists the various Hold functions along with their resets and timing values. Use this table as a guide for programming your sensor and adjusting the Hold times. Note that several of the program commands are not currently available through the Marathon Support Software and can only be used through the Chat program. Refer to Part 4 for information on the Marathon Chat Program, and Appendix B for the software protocols.

Table 2-1: Hold Functions

HOLD FUNCTION	HOLD RESET BY	PEAK TIME	VALLEY TIME	THRESHOLD	HYSTERESIS	DECAY RATE
Protocol Codes →		P	F	C	XY	XE
none	none	000.0	000.0	- *	- *	- *
simple peak	timer	000.1-299.9	000.0	000.0	- *	000.0
simple peak	trigger	300.0**	000.0	000.0	- *	000.0
simple peak w/decay	timer	000.1-299.9	000.0	000.0	- *	0001-9999
advanced peak	trigger or threshold	300.0	000.0	0250-3000	- *	0000
advanced peak	timer or threshold	000.1-299.9	000.0	0250-3000	- *	0000
advanced peak w/decay	timer or threshold	000.1-299.9	000.0	0250-3000	- *	0001-9999
simple valley	timer	000.0	000.1-299.9	000.0	- *	0000
simple valley	trigger	000.0	300.0	000.0	- *	0000
simple valley w/decay	timer	000.0	000.1-299.9	000.0	- *	0001-9999
advanced valley	trigger or threshold	000.0	300.0	0250-3000	- *	0000
advanced valley	timer or threshold	000.0	000.1-299.9	0250-3000	- *	0000
advanced valley w/decay	timer or threshold	000.0	000.1-299.9	0250-3000	- *	0001-9999

* Value does not affect the function type

** Holds indefinitely or until triggered

2.4.2.3 Resetting Factory Defaults

To reset the unit to the factory defaults, press the ▲ and ▼ buttons (up and down arrows) at the same time for approximately 2 seconds.

The factory defaults are listed in Part 1, Section 1.5.

Note: Resetting Factory Defaults can also be done with a 2-way RS-485 command. See Appendix B for details.

2.4.2.4 Deadband

Deadband is a zone of flexibility around the Setpoint. The alarm does not go abnormal until the temperature exceeds the Setpoint value by the number of set deadband degrees, then it does not go normal until the temperature is below the Setpoint by the number of set deadband degrees. The Deadband is factory preset to $\pm 2^{\circ}\text{C}$ ($\pm 4^{\circ}\text{F}$) of Setpoint value. Adjusting to other values is accomplished through software. Refer to Appendix B for information on the sensor's communication protocols. Figure 2-18 is an example of the Deadband around a Setpoint temperature of 960°C (1760°F).

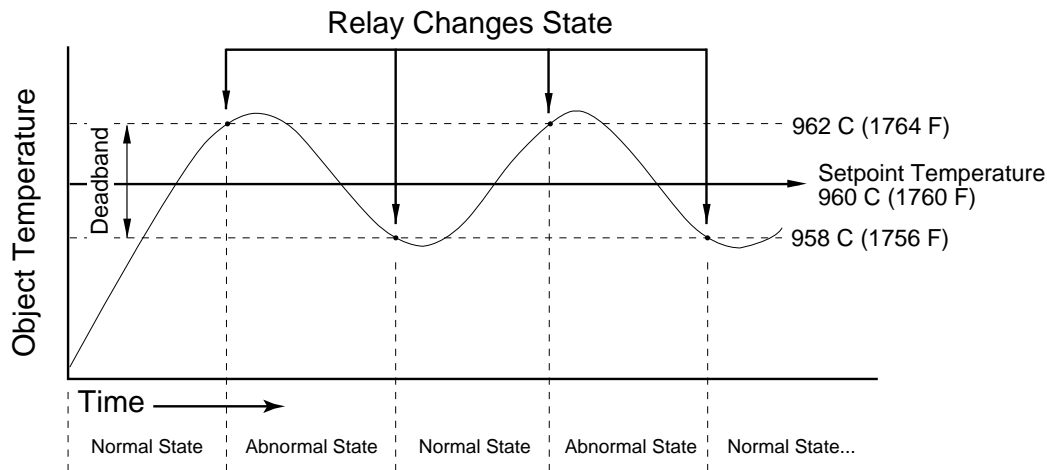


Figure 2-20: Deadband Example

2.4.2.5 Ambient Temperature Compensation

The instrument is capable of improving the accuracy of target temperature measurements by taking into account the ambient, or background, temperature. This feature is useful when the target emissivity is below 1.0 and the background temperature is not significantly lower than the target temperature. To utilize this feature, you must provide the instrument with the background temperature.

Two methods of providing background temperature information are available.

- You give the instrument a fixed temperature value with the command `A=xxxx`, where `xxxx` is the background temperature. This value will be stored in the instrument and applies even after cycling the power.
- Or you can frequently tell the system the background temperature information, allowing the system to track changes in the background temperature. The command format is different from other commands. After sending the command `A#xxxx` the instrument will take the background temperature into account, but will not store it permanently in the instrument.

The command `A=0000` will turn this feature off.

This section explains the installation and operation of one or more Marathon infrared thermometers in a multidrop sensor-network environment.

Topics include...

- Preparation
- Network Communication Setup
- Mechanical Installation
- Electrical Installation
- Operation

3.0 MULTIDROP SENSOR INSTALLATION

The multidrop sensor installation consists of the following:

- Preparation
- Communication Setup
- Mechanical Installation
- Electrical Installation

The most important part of the installation process is preparation. An additional preparation required for multidrop installations is the Network Communication Setup. Preparation and communications setup must be completed before proceeding to the mechanical installation.

3.1 MULTIDROP PREPARATION

Sensor location, sensor configuration, and/or the number of sensors depend on the application. Before installing your sensors, you need to be aware of the ambient temperature of the location, the atmospheric quality of the location, and the possible electromagnetic interference in that location. If you plan to use air purging, you need to have air connections available. Also, wiring and conduit runs must be considered, including computer and controller wiring and connections, if used. The following subsections cover topics to consider before you install the sensor.

3.1.1 Ambient Temperature

The optical head is designed to operate in ambient temperatures up to 200°C (390°F). The electronics enclosure is designed to operate in ambient temperatures between 0°C (32°F) and 60°C (140°F). The internal ambient temperature can vary from 10°C (50°F) to 68°C (154°F). Internal temperatures outside this range will cause a failsafe error.

When using air purging, make sure air supplies are installed before proceeding with the sensor installation. For air purging or air cooling, clean (filtered) or “instrument” air is recommended.

3.1.2 Atmospheric Quality

Smoke, fumes, dust, and other contaminants in the air, as well as a dirty lens can be a problem. If the lens gets dirty, the unit will read a lower than actual temperature. It is good practice to always keep the lens clean. The Air Purge Collar helps keep contaminants from building up on the lens.

If you use air purging, make sure an air supply is installed before proceeding with the sensor installation.

An optional Protective Window accessory can be ordered with the head to prevent damaging the lens by corrosive materials in the atmosphere. This option can also be used to prevent dirt from getting on the lens. Note that this option cannot be used in conjunction with the Air Purge Collar accessory.

3.1.3 Electrical Interference

To minimize electrical or electromagnetic interference or “noise,” be aware of the following:

- Mount the sensor as far away as possible from potential sources of electrical interference, such as motorized equipment producing large step load changes.
- Use shielded wire for all input and output connections (refer to Section 2.3, Electrical Installation for connecting information).
- Make sure the shield wire in the sensor cable is earth grounded and connected to the “Shield” terminal.
- For additional protection, use conduit for the external connections. Solid conduit is better than flexible conduit in high noise environments.
- Do not run AC power lines for other equipment in the same conduit.

IMPORTANT

When installing the sensor, check for any high-intensity discharge lamps or heaters that may be in the field of view (either background or reflected on a shiny target). Reflected heat sources can cause erroneous readings.

3.1.4 Sensor Location

Standard Focus FA1/FA2 models are focused at infinity. Models with the optional Close Focus optics are focused at 100 mm (4 in) or 300 mm (12 in). The sensor must have a clear view of the target, and the target must completely fill the field of view. There can be no obstructions on the lens, window, or in the atmosphere. Figure 3-1 shows proper sensor placement.

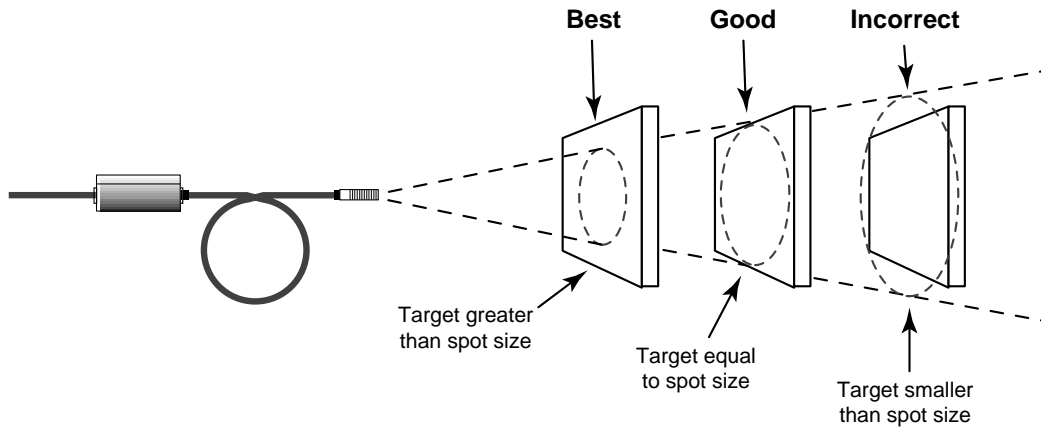


Figure 3-1: Proper Sensor Placement

The sensor can be placed at any angle from the target up to 30° (Figure 3-2).

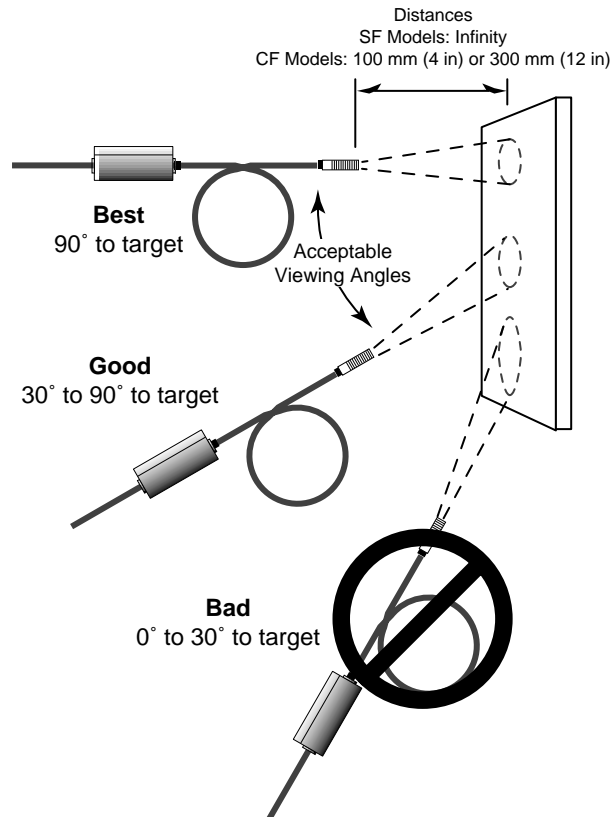


Figure 3-2: Acceptable Sensor Viewing Angles

3.1.5 Multidrop Considerations

If you are installing two or more sensors in a multidrop configuration, please be aware of the following:

- Each Marathon sensor must have a unique “address.”
- Sensor setup and addressing must be done before mounting sensor in permanent location.
- Each sensor must be set to the same baud rate.
- A 200 MHz or faster Pentium-class personal computer is suggested.
- If your computer does not have RS-485 communication capabilities, you will need to attach the RS-485 to RS-232 Converter accessory.

3.2 NETWORK COMMUNICATION SETUP

The following sections cover software installation, preparing your sensors, and how to use the software to give each sensor a unique address. These steps should be completed before installing the sensors in their permanent location.

3.2.1 Software Installation

The software that came with your Marathon sensor(s) consists of five separate programs. These include the Network Communications Setup (covered in this section), the Graphic Setup and Display (covered in Part 4), the Sensor Network Setup and Display (displays temperatures and alarms for up to 32 sensors—covered in Part 4), the Chat program (direct communications between the user and the sensor—Part 4), and the Field Calibration program (covered in Appendix D).

Note: You can create your own programs customized to your application by using the communications protocols listed in Appendix B.

To install the software on a personal computer running Windows 95, Windows 98, or Windows NT 4.0 (Service Pack 3), complete the following steps:

1. Put Disk 1 in your floppy drive.
2. Click on the Start Button and select Run.
3. Type A:\Install and press the Return/Enter key.
4. Follow the installation instructions.

All necessary programs are installed in the Raytek program group.

3.2.2 Preparing the Sensors for a 4-Wire Multidrop Installation

Before mounting the sensors in their permanent location, each one must be initialized with a unique address so communication to and from the sensors and the computer can occur without problems. To set up your computer to initialize the sensors, complete the following steps (use Figure 3-3 as a guide):

1. Turn off your computer.
2. Insert the appropriate cable into the electronics enclosure's compression fitting (as shown in Figure 3-3).
3. Connect the color-coded wires to the power and digital communication terminals on the left side of the electronics enclosure. Also connect any analog output or input wiring at this time.
4. Attach the power and digital communication wires on the other end of the cable to the appropriate terminals on the RS-485/RS-232 converter. Note that the RxA and RxB wires from the electronics enclosure connect to the TxA and TxB converter terminals, and the TxA and TxB wires from the enclosure connect to the RxA and RxB converter terminals.
5. Plug the RS-485/RS-232 converter into your computer's serial port, or attach it to a serial cable if a longer run to the computer is needed, and plug the AC power supply cable, if used, into the converter. (You may need to use the supplied 25-pin to 9-pin cable to connect to the computer.)
6. Before turning on the computer, make sure the sensor and RS-485 to RS-232 adapter power supplies are plugged in.
7. Turn on your computer.

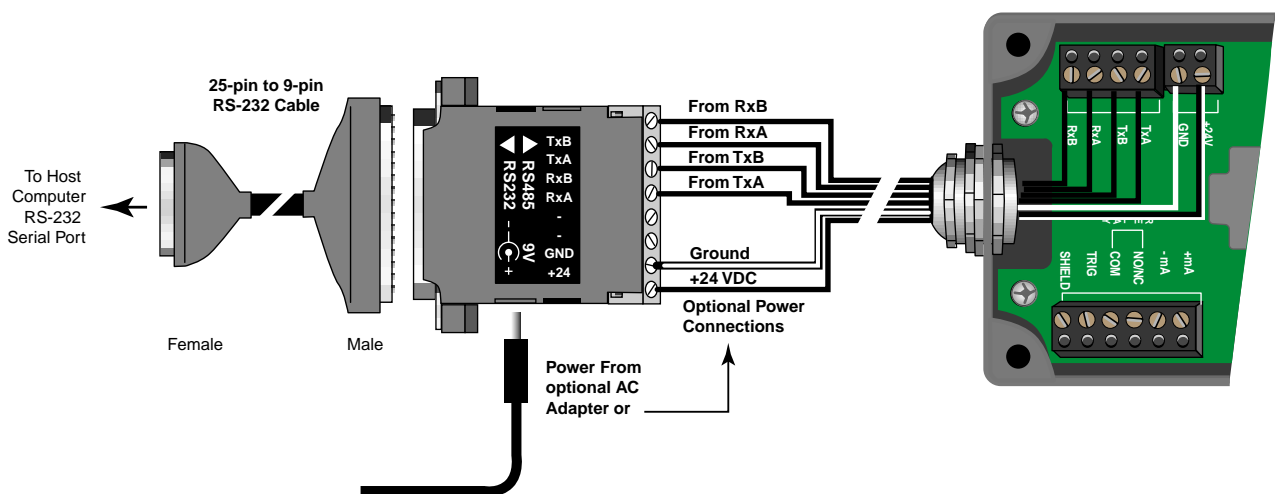


Figure 3-3: Wiring for 4-Wire Sensor Setup

VERY IMPORTANT

You must supply your own cable between the serial converter and terminal block inside the unit.

Note that the cable's RxA and RxB wires connect to the terminal block's TxA and TxB screws, and the cable's TxA and TxB wires connect to the terminal block's RxA and RxB screws.

After setting up your computer, complete the following steps to initialize and give each sensor a unique address:

1. Connect a sensor to the sensor cable.
2. Start the Network Communication Setup program. Click the Start button, select Programs, Raytek, and select Network Communication Setup. A screen similar to Figure 3-4 displays.

Note: For demonstration or training purposes, this program can be run without sensors connected. To do so, start the program by clicking the Start button, select Run, and type the path and file name for the program along with the word, Demo. For example, if the program file is at C:\Raytek, type on the command line, C:\Raytek\Comsetup.exe demo.



Figure 3-4: Communication Setup Screen

Select the appropriate COM port and click the Next button. The following screen displays (Figure 3-5).

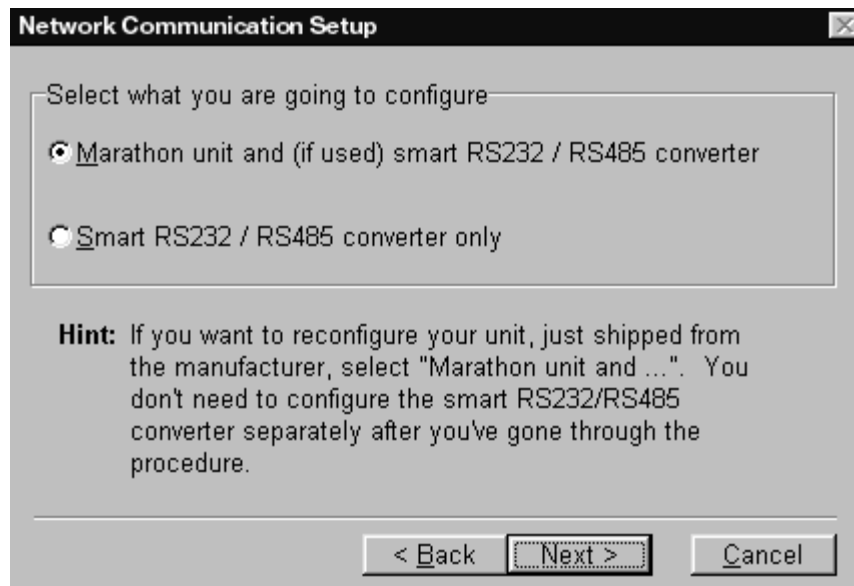


Figure 3-5: Communication Setup Screen 2

3. If you have a Marathon sensor attached, and you want to configure or reconfigure the unit, select “Marathon unit and (if used) smart RS-232/RS-485 converter.” Click the Next button and a screen like Figure 3-6 displays.

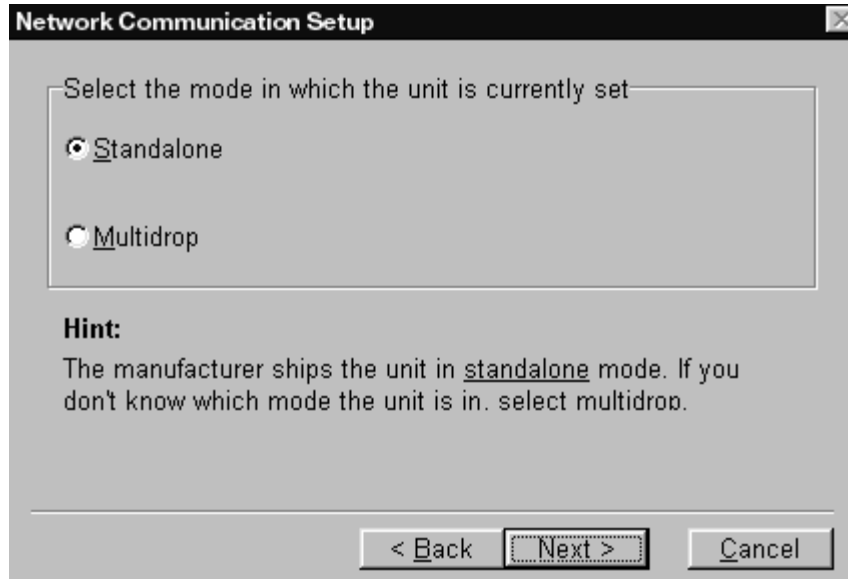


Figure 3-6: Standalone or Multidrop Selection Screen

If no sensor is connected and you have a smart RS-232/RS-485 converter attached, and you want to configure the connection, select “Smart RS-232/RS-485 converter only.” (After you click the Next button, follow the onscreen instructions to complete the configuration.)

As the “Hint” mentions, all units are shipped in Standalone mode.

4. Select the mode that your sensor is currently set to. If you are running this program for the first time, it will be Standalone. (If unsure, select Multidrop.) If you select Standalone, the program will display a screen similar to Figure 3-8. Please proceed to Step 5. If you select Multidrop, a screen similar to Figure 3-7 displays.

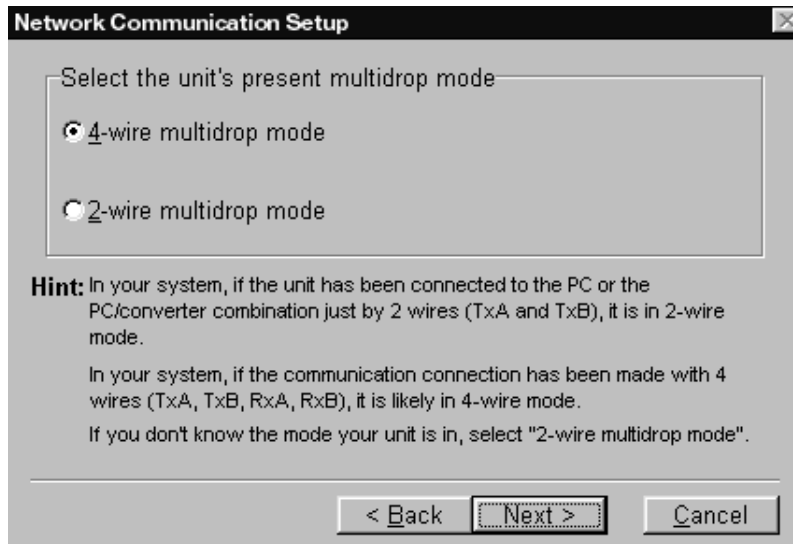


Figure 3-7: Multidrop Mode Screen

Sensors are shipped in 4-wire mode. If the units are currently connected to the computer using 4 wires, select “4-wire multidrop mode.” If they are connected with 2 wires, select “2-wire multidrop mode.” (To continue with a 2-wire multidrop installation, go to Section 3.2.3.) After you make your selection, click the Next button.

Note: Sensors in a 2-wire multidrop environment cannot be put in burst mode.

5. If you selected “4-wire multidrop mode,” you are shown a wiring diagram to verify the attached sensor is wired correctly (Figure 3-8). If this is correct, click Next.

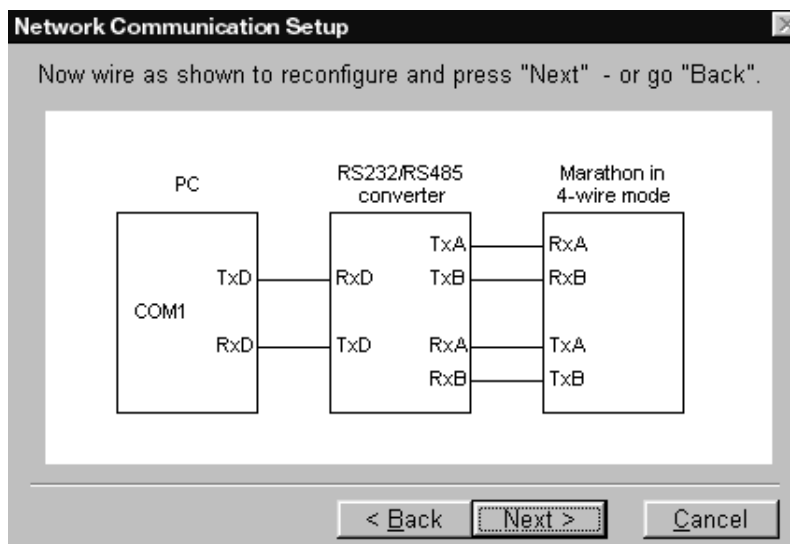


Figure 3-8: 4-Wire Wiring Diagram

- The next screen (Figure 3-9), prompts you to make sure the switch is in the “A” position. This does not apply to the FA sensors. However, do check once more that power and all connections are secure. If everything is correct, click Next.

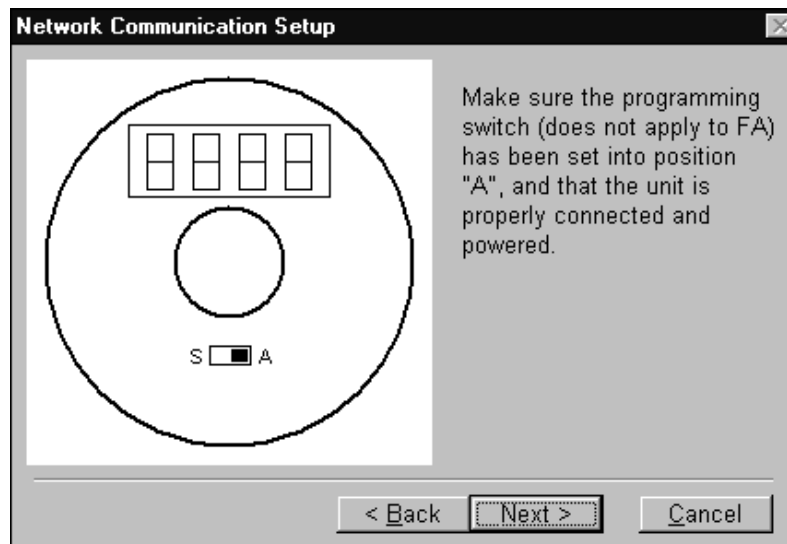


Figure 3-9: Switch Selection/Verification Screen

- Now you can set the attached sensor’s address (Figure 3-10). Select a number (one not used by another sensor on the multidrop network). Select the desired communication mode, the desired baud rate, and if you want the multidrop address in the response. The desired communications mode need not match the current setup. For example, you may connect a sensor to a 4-wire system, configure it to 2-wire mode, and then move it to the 2-wire system. Click the Next button.

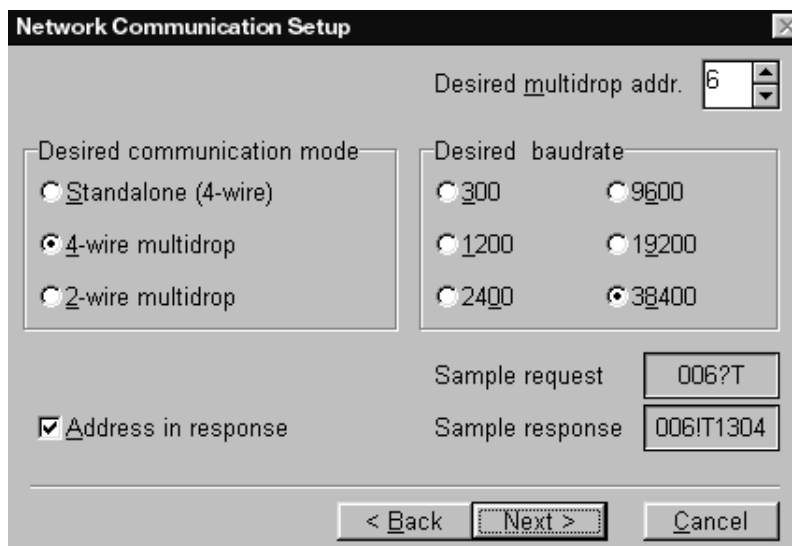


Figure 3-10: Address Selection Screen

Notes: If you check “Address in response,” the sensor’s multidrop address will be included in the data stream (see Sample response, above). This allows for easy checking of data in printouts or on the monitor when using custom monitoring programs.

- This complete the 4-wire multidrop setup procedure. If you have more sensors to configure, disconnect the sensor you just set up and connect the next one, then click on the Repeat button, as shown in Figure 3-11. Repeat the process in the order that displays.



Figure 3-11: Repeat or Exit Screen

3.2.3 Preparing the Sensors for a 2-Wire Multidrop Installation

If you chose “2-wire multidrop mode” in step 4 of Section 3.2.2, and you are not using the Smart RS-232/RS-485 converter, continue with the following instructions:

- After you click on the Next button a screen similar to Figure 3-12 displays.

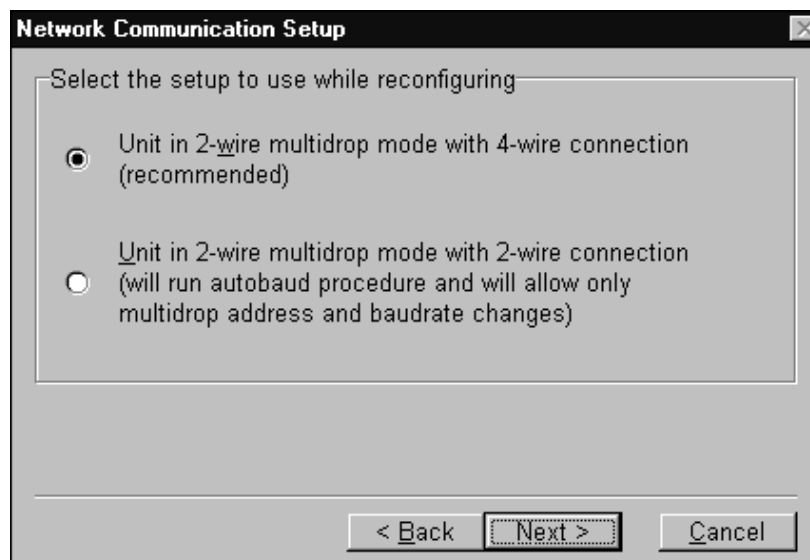


Figure 3-12: 2-Wire Setup Screen

Make a selection based on your current communication wiring setup and click the Next button.

- Depending on the selection you make, a screen showing how the wiring should be displayed (similar to Figure 3-13). Follow the directions and click the Next button.

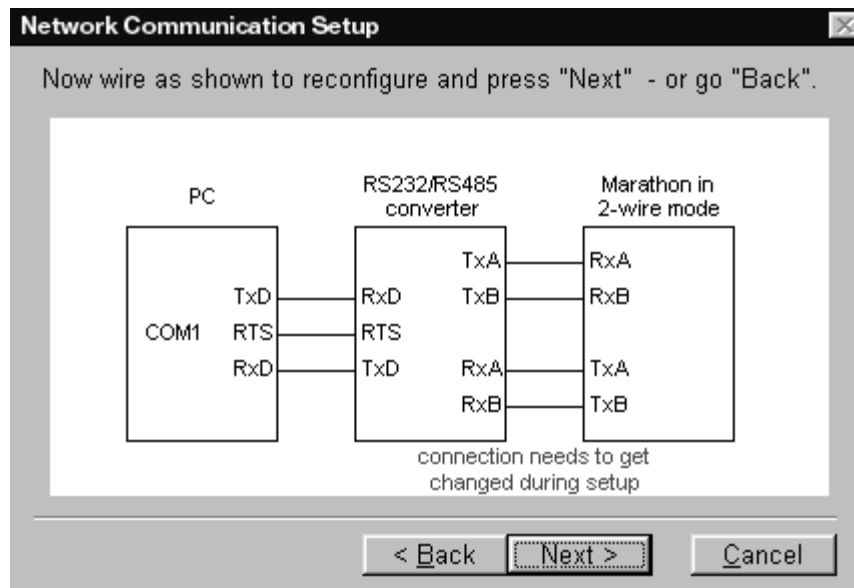


Figure 3-13: 2-Wire Setup Wiring Diagram Screen

- The remaining steps are similar to those listed in Section 3.2.2 (steps 6 through 8), and you will be returned to the “Repeat or Exit” screen (Figure 3-11).
Some additional steps may display if you selected “Unit in 2-wire multidrop mode with 2-wire connection.” The screens are self-explanatory. Complete those steps to return to the “Repeat or Exit” screen.

3.3 MULTIDROP MECHANICAL INSTALLATION

After all preparations are complete, you can install the sensor.

3.3.1 Mounting the Sensor

How and where you anchor the optical head and electronics enclosure depends on the type of surface and the type of bracket you are using. You can mount the optical head through a hole, on a bracket of your own design, or on the fixed bracket accessory. (Refer to Figure 1-1 for an overview of available mounting accessories.)

Another mounting consideration is the distance from the head to electronics enclosure and from the electronics enclosure to power and computer connections. The optical head has the fiber-optic cable attached and is factory calibrated with the length of fiber-optic cable ordered.

IMPORTANT

If you need to replace the fiber optic cable, the unit must be returned to the factory for installation and recalibration. Fiber optic cables are not field replaceable. The serial number on the fiber optic cable must match that on the electronics enclosure.

You may need to “snake” the fiber-optic cable through and around any obstacles, such as beams, walls, support columns, etc., or, if your installation requires, through conduit, before attaching the end to the electronics enclosure. (Do not attach until you aim the optical head.) The fiber optic cable and head are one component. The cable can be disconnected from the electronics box for aiming or threading through conduit during installation. The cable is keyed and can only be inserted one way into the electronics enclosure. Figure 3-14 shows how to connect the fiber optic cable to the electronics enclosure.

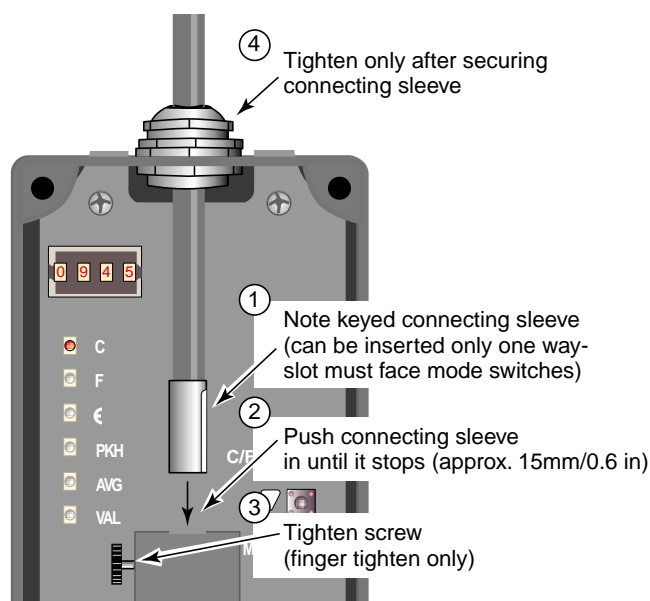


Figure 3-14: Connecting the Fiber Optic Cable

The distance between the electronics enclosure and a computer (via RS-485 cable) can be up to 1200 meters (4000 feet). This allows ample distance from the harsh environment where the sensing head is mounted to a control room or pulpit where the computer is located.

Power connections, however, must be no more than 60 meters (200 feet) from the electronics enclosure.

WARNING

The unit's electronics will not function if the power source is more than 60 meters (200 feet) away.

Note: If you are installing two or more sensors in a multi-drop configuration, or if you plan to add to or more sensors at a later date, refer to Part 3 for information on multi-drop installations.

3.3.2 Aiming

Aiming can be done with either the High Intensity Aiming "Flashlight," for "A" temperature range models, or the High Intensity AC Powered Aiming Light, for the "B", "C", and "G" temperature range models.

Simply loosen the compression sleeve holding the fiber optic cable, loosen the screw at the heater block, and pull the cable out of the heater block approximately 7mm (0.25 in). Raise the fiber optic cable enough to slip the aiming light or fiber optic light cable (depending on aiming light model) onto the end. Align the light beam on the target.

An effective aiming technique is to adjust the head until the highest reading is observed on the internal display. When the highest reading is reached, hold the unit in place and secure the mounting base.

To reconnect the fiber optic cable to the heater block in the electronics enclosure, follow the procedure in Figure 3-14 (previous page).

WARNING

The AC powered high intensity aiming light can become very hot. Do not use for more than 15 minutes at a time or damage may occur to the fiber optic aiming light cable.

3.4 MULTIDROP ELECTRICAL INSTALLATION

The following sections explain the terminal block, RS-232/RS-485 connections, power, communications, and sensor wiring for 2-wire and 4-wire multidrop installations.

IMPORTANT

Each sensor must have its own cable, terminal block (supplied with sensor cables), and power supply.

Both sets of twisted-pair wires have drain wires inside their insulation. These drain wires must be connected to the terminal labeled SHIELD (bare). Also connect the earth ground to the SHIELD (bare) terminal. Figure 3-15 shows how to configure the drain wires before connecting to the sensor and RS-485/RS-232 converter.

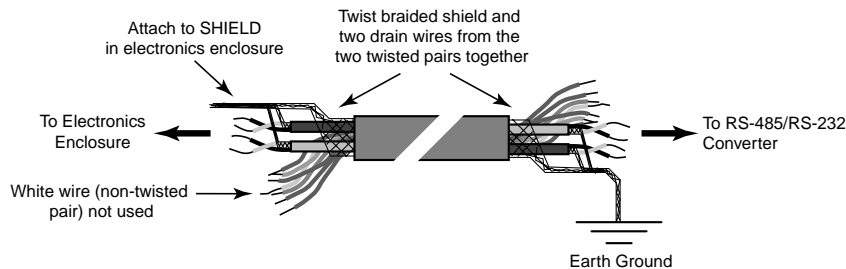


Figure 3-15: Configuring the Sensor Cable

Cables can be run to the electronics enclosure through conduit or fastened using the a compression fitting. Once you run the cable into the enclosure, attach the color-coded bare wires to the terminals. Use Figure 3-16 (or diagram on underside of lid) as a wiring guide. Note that the terminal blocks in the electronics enclosure can be “popped” out for easy wire connections. Figure 3-17 illustrates how to remove the terminal blocks.

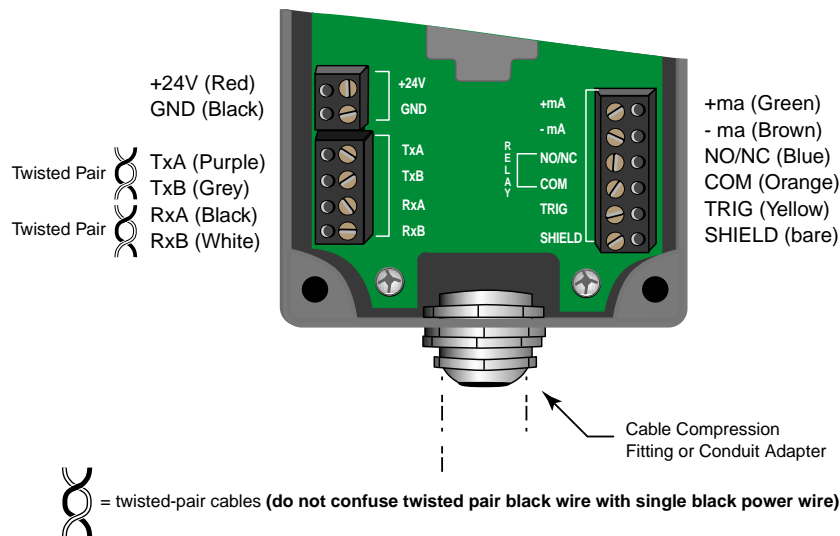


Figure 3-16: Electronics Enclosure Wiring

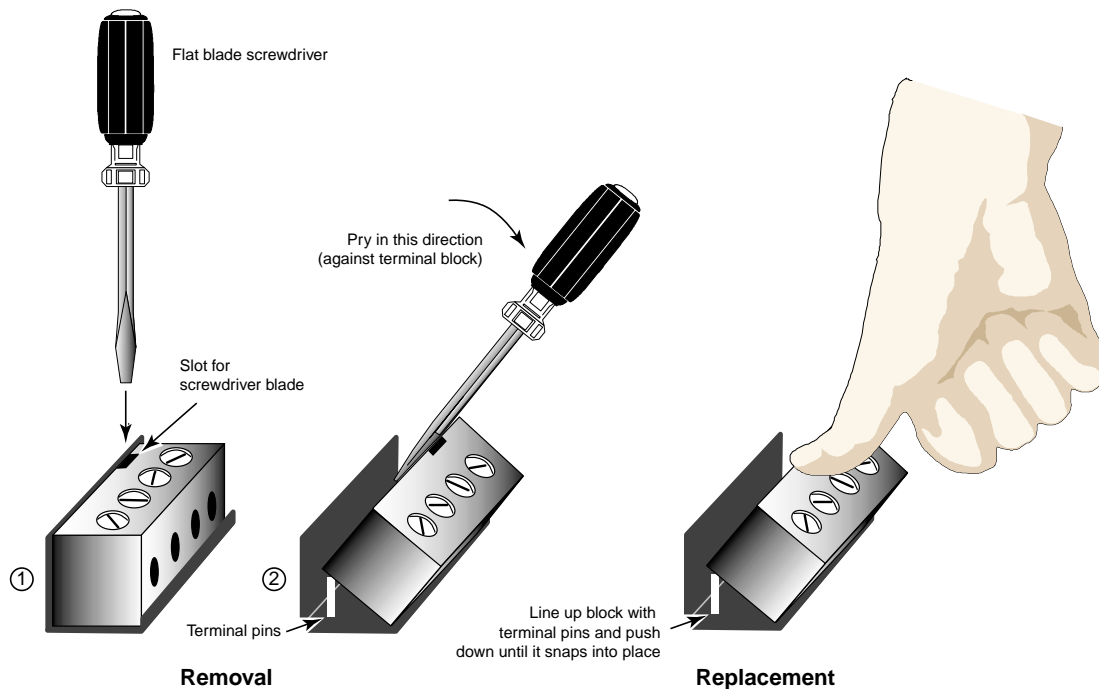


Figure 3-17: Removing the Terminal Blocks

WARNING

Incorrect wiring can damage the sensor and void the warranty. Before applying power, make sure all connections are correct and secure.

The sensor cable may be shortened but not lengthened without the appropriate terminal block accessory. Longer cables are available from the factory. Limit power cables to 60 meters (200 feet) or less. RS-485 cables can be extended up to 1200 meters (4000 feet).

Avoid installing the sensor cable in noisy electrical environments such as around electrical motors, switch gear, or induction heaters. In these environments, it is recommended to install the cable in conduit. Note that the sensor head is designed to fit conduit directly.

Note: When using conduit for the cable, and when it has a compression fitting installed on the conduit connection, the sensor head is rated NEMA-4 (IEC 529, IP 65).

3.4.1 Power

Connections from a 24 VDC (500 mA or higher) power supply attach to the first two terminals on the terminal strip (as shown in Figure 3-16).

IMPORTANT

Isolation is provided only when used with the appropriate Raytek supplied power supply accessory.

3.4.2 RS-485 Interface Converter

To connect to a computer's RS-232 port, you need one of the Interface Converter accessories (similar to Figure 3-18) and the proper RS-232 cable. If your computer has an RS-485 interface card, you can connect the sensor directly to its port (using the proper connector) with wiring from the electronic enclosure's terminal block.

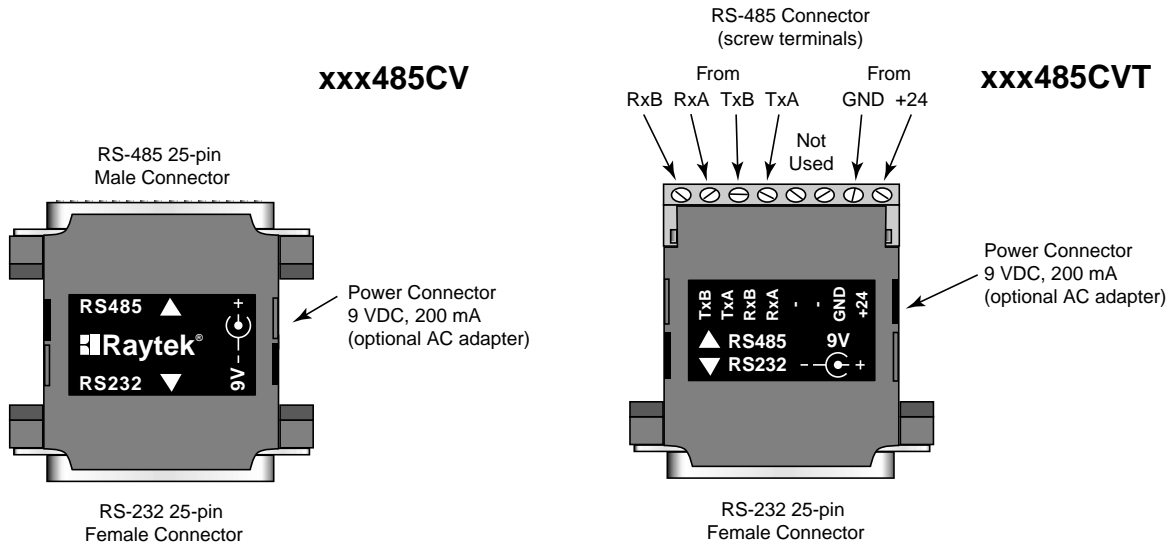


Figure 3-18: RS-485 to RS-232 Interface Converters

IMPORTANT

When wiring 2- or 4-wire connections from the electronics enclosure to the CVT RS-485 Interface Converter make sure wires going to the converter's RxA and RxB terminals come from the electronic enclosure's TxA and TxB terminals, and the converter's TxA and TxB terminals come from the electronic enclosure's RxA and RxB terminals.

Connect the interface converter to an available COM port on your computer, either directly or with an appropriate serial cable (available from computer supply stores). If your computer has a 9-pin serial connector, use the supplied 25-pin to 9-pin adapter between the interface converter or cable and the computer.

The Interface Converter can be powered by either a 9 VDC AC adapter accessory or a 24 VDC Power Supply accessory (shipped with sensor).

WARNING

Always power up the Interface Converter before the sensor. Also, never change RS-485 or power connections while the instrument is powered. Doing so will damage the Interface Converter and void the warranty.

Figure 3-19 illustrates cable and converter connections between sensor and computer.

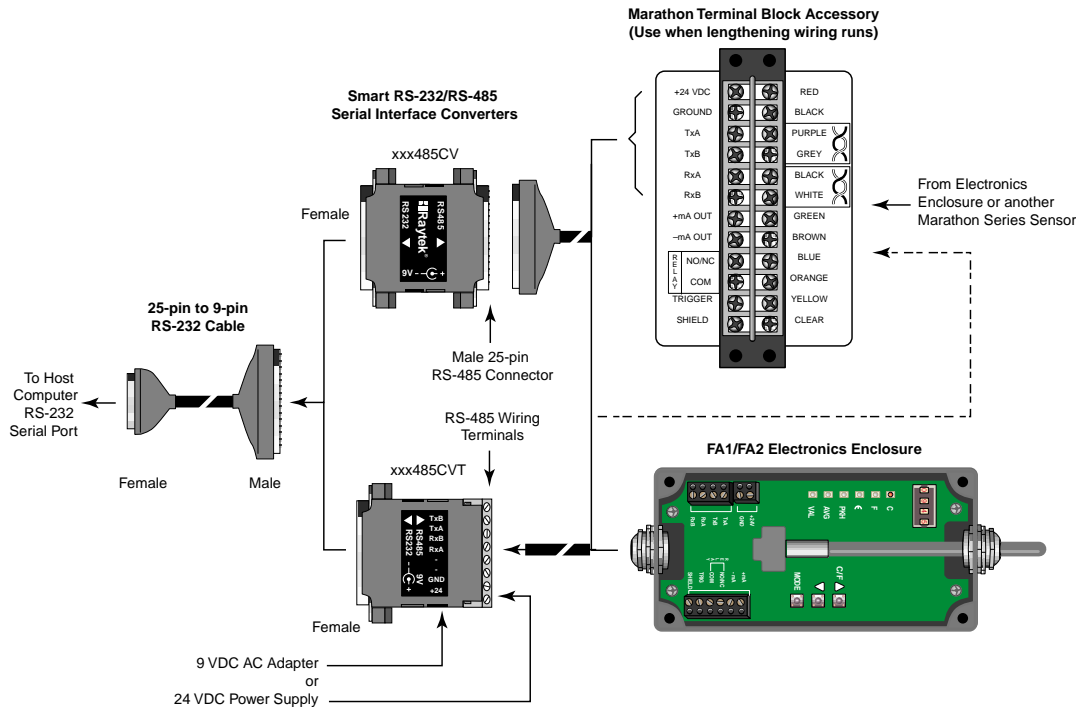


Figure 3-19: Connections from Sensor to Computer

You can wire directly from the electronics enclosure to the screw terminals on the xxx485CVT converter. If you need to extend the wiring, use the Terminal Block accessory. Make sure you connect the color-coded wires correctly.

Wires from the TxA and TxB terminals in the electronics enclosure and on the Terminal Block accessory must connect to the RxA and RxB terminals on the converter, and the RxA and RxB terminals in the enclosure and on the terminal block must connect to the TxA and TxB terminals on the converter.

IMPORTANT

On some computers the COM1 port is used by a pointing device (mouse, trackball, etc.), and sometimes the COM2 port is connected to an external modem or fax/modem (an internal modem can also be set to use COM2). It is possible for two devices to share an interrupt (COM1/COM3 or COM2/COM4); however, they cannot be used at the same time or your system might “crash.” You can connect the RS-232 cable to the same port as, for instance, your modem, but you need to make sure the modem is inactive while you use the sensor.

The RS-485 output is as follows:

Baud Rate: 300, 1200, 2400, 9600, 19200, 38400 (default)

Note: Adjustable baud rate only available through 2-way RS-485.

Data Format: 8 bits, no parity, 1 stop bit

Two-wire half-duplex or four-wire full duplex, point-to-point, or multidrop

For a full description of the RS-485 communications protocol, see Appendix B.

WARNING

If you are using the converter's optional power adapter, note the following: After connecting the serial cables, attach the adapter plug into the converter BEFORE plugging the AC adapter into an AC outlet.

3.4.3 Milliamp Output

The milliamp output is an analog output you can connect directly to a chart recording device (e.g., chart recorder), PLC, or controller.

The analog output resolution for FA1/FA2 models is 0.5°C or 1°F. Analog output resolution for the FA1G is 0.05°C or 0.1°F.

Note: The mA output can be forced to a specific value, underrange, or overrange with a 2-way RS-485 command. See Appendix B for details. This feature is useful for testing or calibrating connected equipment.

3.4.4 Relay Outputs

The relay output may be used as an alarm for failsafe conditions. (Refer to Section 4.2 for failsafe information.) This corresponds to the currently displayed temperature on the LED display.

Notes: Since the way you use the relay outputs depends on the application, check with your sales representative for the best way to use this feature.

The relay can be set to either NO (Normally Open) or NC (Normally Closed) with a 2-way RS-485 command depending on compatibility requirements of connected equipment. The relay can be forced on or off via 2-way RS-485 for testing connected equipment. See Appendix B for details.

3.4.5 2-Wire Electrical Installation

Each sensor cable is wired to its own terminal block. For multidrop installations the RS-485 terminals on each terminal block are wired together in parallel as shown in Figure 3-20, below.

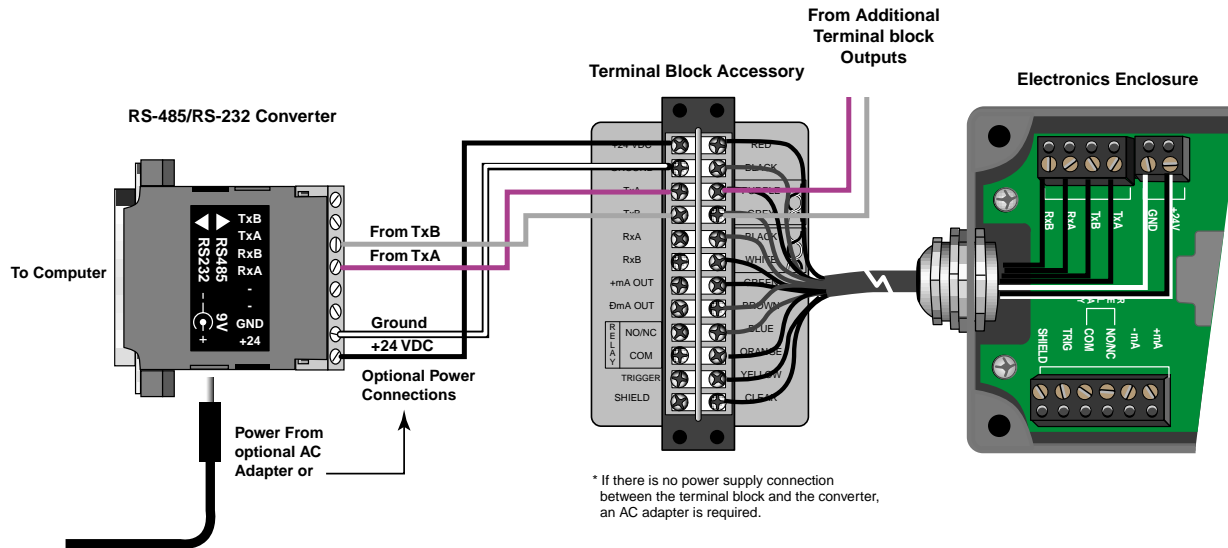


Figure 3-20: 2-Wire Multidrop Wiring

NOTICE

Be aware that you, the user, must supply your own RS-485 cable from the terminal block to the RS-485 to RS-232 converter.

Be sure to connect the correct wires to the terminal block's TxA and TxB screw terminals. (Make sure the cable you purchase includes a wiring diagram.)

3.4.6 4-Wire Electrical Installation

For a 4-wire multidrop installation, each sensor cable is wired to its own terminal block. The RS-485 terminals on each terminal block are wired in parallel as shown in Figure 3-21, below.

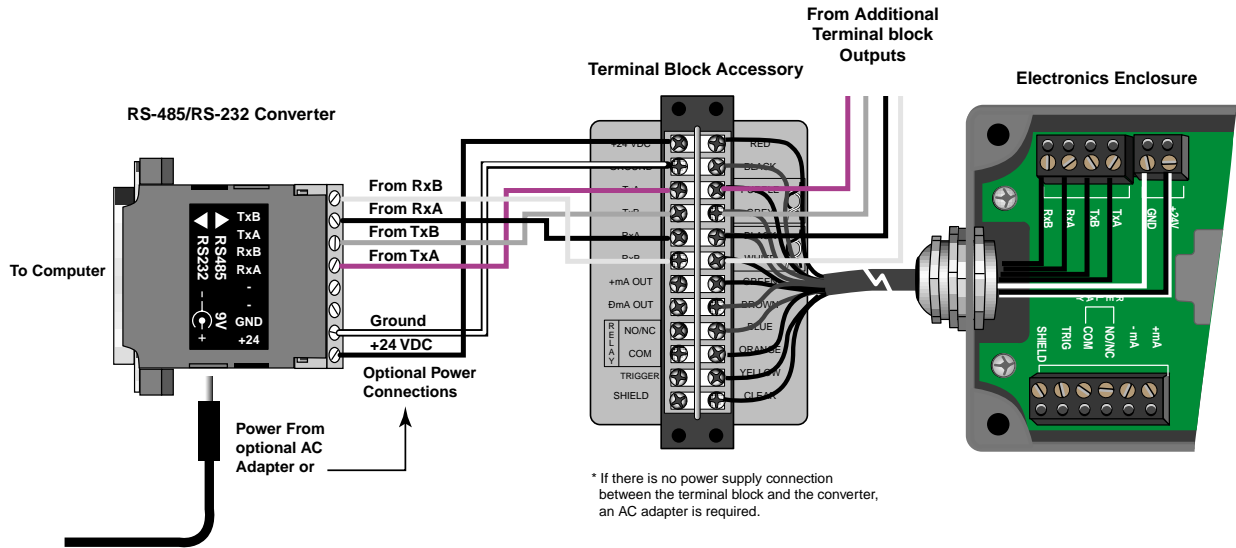


Figure 3-21: 4-Wire Multidrop Wiring

For setting up milliamp and relay outputs, refer to Sections 3.4.3 and 3.4.4.

The software you received with your sensor, besides the Network Communication Setup program described earlier in this section, includes a Sensor Network Setup and Display program (for monitoring temperatures of up to 32 sensors), a Graphic Setup and Display program (for configuring sensor parameters and monitoring processes for one or two sensors), and a Chat program (for communicating directly to a sensor from your computer terminal). All are described in Part 4.

3.5 OPERATION

Once you have the optical head and electronics enclosure positioned and connected properly, the system is ready for continuous operation.

IMPORTANT

Make sure power and necessary air and conduit connections are secure.
Avoid taking temperature measurements in bright sunlight. Also, be aware targets with low temperatures (below the sensor's range) and low emissivities may not register correctly.

3.5.1 The Control Panel

The control panel is normally locked in multidrop mode but may be unlocked through software. (Refer to Appendix B for software protocols.)

The sensor is equipped with a control panel in the electronic enclosure (Figure 3-22), which has setting/controlling buttons and an LED display. You can configure sensor settings with the control panel or with a computer. The panel is used primarily for setting up the instrument and is sealed during operation. The buttons and LEDs are defined in the following sections.

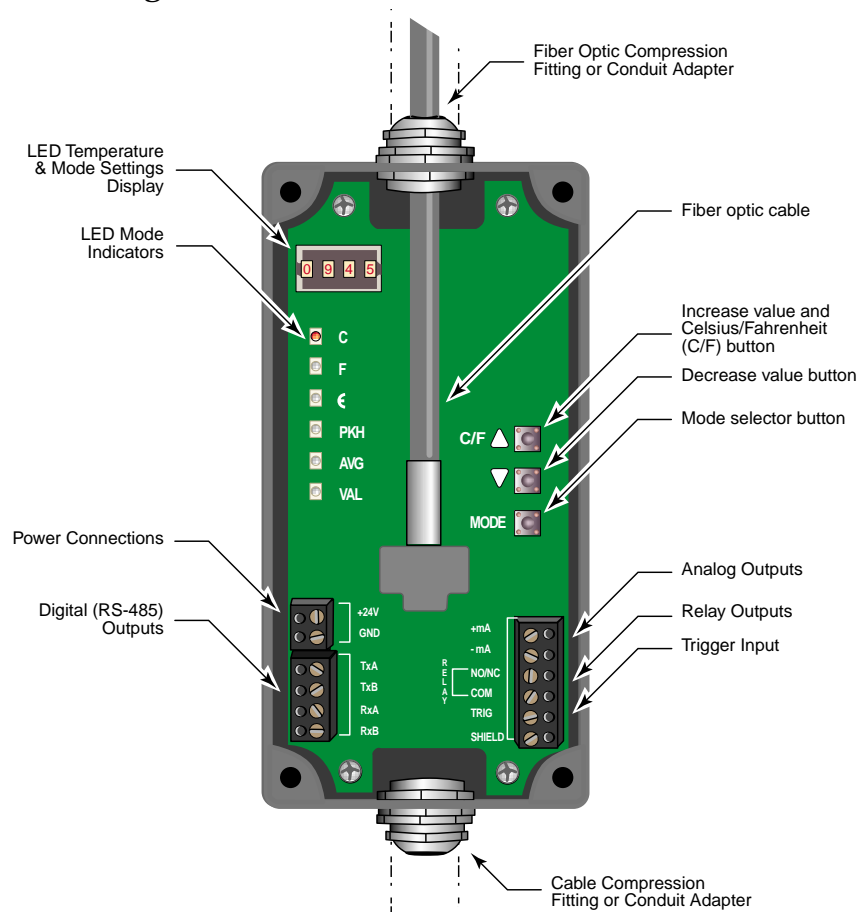


Figure 3-22: Control Panel

3.5.2 Set-Up

To begin setting up the unit, first make sure all connections are secure, then turn on the power supply. **Allow the electronics to warm up for 15 minutes before making control panel adjustments.** (You can also set up remotely through the 2-way RS-485 connection. Refer to Appendix B.)

When you first turn the unit on, the display shows the current temperature. Pushing the mode selector button will change the figures on the display to the current setting for each particular mode. Figure 3-23 illustrates the sequence of operation for the mode selector button when in current temperature mode.

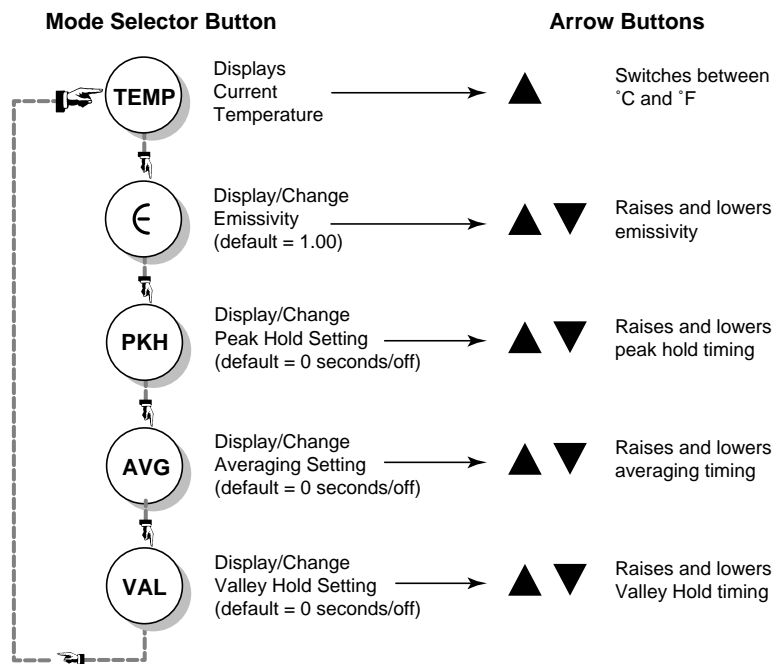


Figure 3-23: Mode Selector Button Sequence

Note: When the PKH mode is active (PKH LED lit), the Mode Selector cycle skips AVG and VAL (TEMP to E to PKH back to TEMP). When the AVG mode is active (AVG LED lit), the Mode Selector cycle skips PKH and VAL (TEMP to E to AVG back to TEMP). When the VAL mode is active (VAL LED lit), the Mode Selector cycle skips PKH and AVG (TEMP to E to VAL back to TEMP). If “AAAA” shows on the display when going through PKH and VAL, then an advanced function has been met, which can be changed or set via RS-485 only.

The following sections define each of the control panel’s features and functions and explains sensor setup and use. Section 2.4.2.5 explains how to reset the factory defaults. Note that all modes can be changed from a computer using controlling software such as those listed in Part 4.

WARNING

Do not connect, disconnect, or change wiring while the power is on.

3.5.2.1 Lockout Mode

The sensor has a remote locking feature that keeps the unit from being accidentally changed from the control panel. This lockout mode denies access to all the switches on the control panel. It is available through the RS-485 connection and can be unlocked only by a command from the remote computer. See Appendix B for details.

3.5.2.2 Modes

Pressing the mode selector button cycles you through the four operating modes as shown in Figure 3-19 (previous page).

Note: All parameters can be changed through controlling software such as those in Part 4.

Temperature

You can set the temperature display for either °C or °F by pressing the C/F selector button (▲–up arrow). The Decrease Value (▼–down arrow) button is inactive in this mode. A lit LED shows you whether the measured temperature is in °C or °F. Note that this setting influences the RS-485 output for both target and internal temperatures.

Emissivity

The emissivity is a calculated ratio of infrared energy emitted by an object to the energy emitted by a blackbody at the same temperature (a perfect radiator has an emissivity of 1.00). The emissivity is preset at 1.00. However, there are times when the surface characteristics of the object being measured will not return an accurate temperature measurement unless you change the sensor's emissivity setting. If you are unsure of the target's emissivity, refer to Appendix C for information on determining an unknown emissivity, and for sample emissivities of many metals and non-metals.

To change the unit's emissivity setting, complete the following:

1. **Press the Mode button until the ϵ LED is lit.**

The current emissivity value shows on the display.

2. **Press the ▲ or ▼ (UP or DOWN) button to change the value.**
3. **Press the Mode button several times until the temperature displays.**

The displayed temperature will now be based on the new emissivity value.

Note: The emissivity can also be adjusted with a 2-way RS-485 command. See Appendix B for details.

Peak Hold (PKH)

PKH as three modes: Peak Hold, Advanced Peak, and Advanced Peak + time. The following are definitions of some helpful terminology:

- **Hold Temperature** Output temperature, with peak hold mode applied.
- **Hold Interval** How long to hold the current peak.
- **Hold Trigger** Temperature threshold used in advanced modes.
- **Hold Hysteresis** Minimum temperature drop, used to filter out noise in advanced modes.

With Peak Hold, the respective last peak value is held for the duration of Hold Time. With the Advanced Peak setting (available only through software), every value above a threshold value (Hold Trigger Temperature) is held until a new peak value above the Hold Trigger Temperature is measured. It is accepted if the input temperature drops below the last determined peak value by Hold Hysteresis. With Advanced Peak + Time every maximum value is held above the Hold Trigger Temperature, but is limited to the duration of Hold Time. (Example shown in Figure 3-24.)

Hold Hysteresis: A tolerance range can be defined to suppress minor temperature variations (spurious peaks, noise). Thus a value of 5°C (9°F) for Hold Hysteresis means that the input signal can have a 5°C (9°F) tolerance without needing to activate one of the Advanced Peak functions.

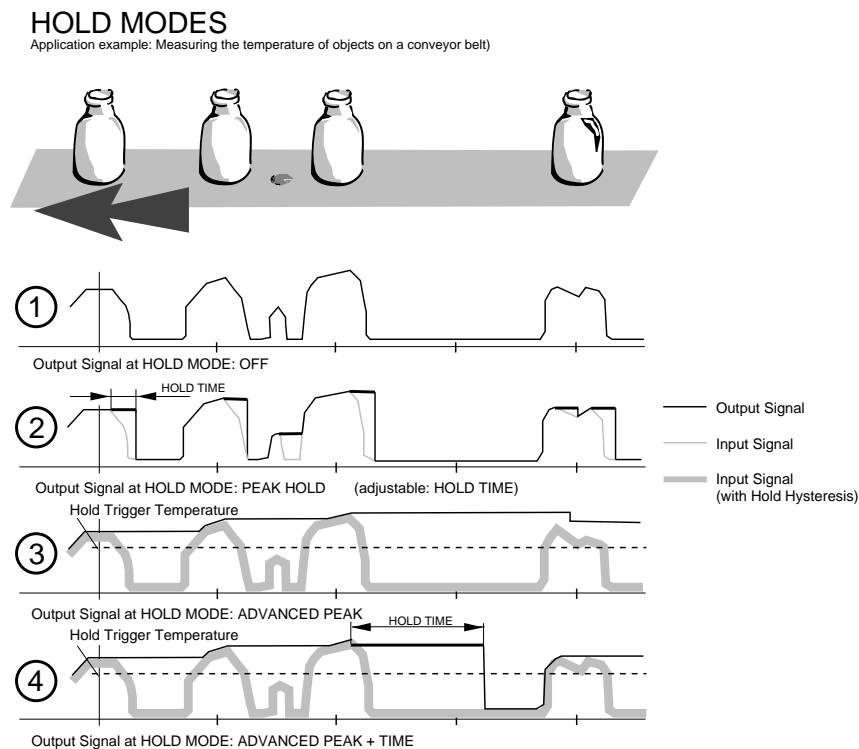


Figure 3-24: Peak Hold Output Signal Example

Simple Peak Hold

Simple Peak Hold is controlled by a single setting, the hold time. To set and activate Peak Hold, do the following:

1. **Press the Mode button until the PKH LED is lit.**
2. **Press the ▲ (UP) button to both set and activate.**

The display reads in 0.1 seconds. Set Peak Hold from 0 to 299.9 seconds. If Peak Hold is set to 300.0 seconds, a hardware reset is needed to trigger another reading. Refer to Section 2.3.5 for more information on the Trigger.

3. **Press the Mode button until the C or F LED is lit.**

If Peak Hold has been activated, the Peak LED will stay lit.

Once Peak Hold is set above 0, it automatically activates. The output signal remains the same until one of two things happens: (1) The peak hold time runs out. (In this case, the signal reverts to actual temperature.) (2) The actual temperature goes above the hold temperature. (In this case, starts holding new peak.) Note that Averaging (AVG) cannot be used concurrently. To deactivate Peak Hold, push the MODE button until only the PKH LED indicator is lit and reset to 0 by pushing the ▼ (DOWN) button.

Note: Peak Hold can also be adjusted with a 2-way RS-485 command. See Appendix B for details.

Advanced Peak Hold

The following is a practical application that explains the advanced Peak Hold functions (available only through software):

In a car plant, body parts are moved on a conveyor belt through a hardening oven to harden the metallic paint. Normally a new body passes through every two minutes. The temperature of the oven must be kept relatively constant, if possible, even if no new parts move into the oven for short periods (for breaks or for short technical stoppages). So practically speaking, we have the following case (Figure 3-25):

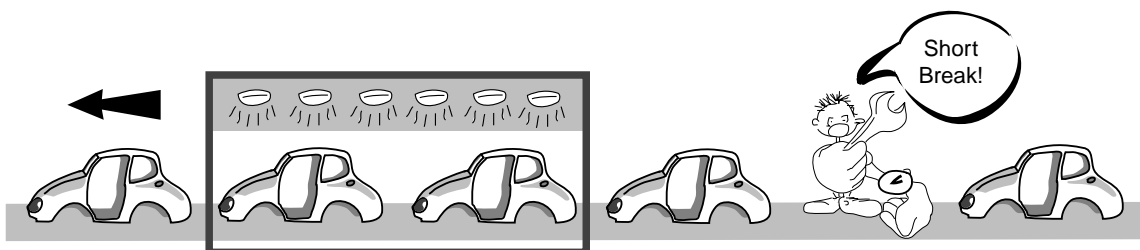


Figure 3-25: Peak Hold Example

Advanced peak mode is controlled by two settings: the Hold Trigger and the Hold Hysteresis. The Hold Interval is not used. If the actual temperature drops below the hold trigger, and then rises back above the trigger, the sensor begins looking for the new maximum. The new maximum is the highest temperature seen since it rose above the trigger. The sensor's output stays the same until one of two things happen:

1. The actual temperature drops below the new maximum, and the difference between the new maximum and the actual temperature is greater than the Hold Hysteresis. In this case, the sensor starts holding the new maximum.
2. The actual temperature goes above the hold temperature and starts holding the new peak and waits for the temperature to dip below the trigger.

In other words, the output signal will hold the respective last "Peak" (maximum value) until a new value above the HOLD TRIGGER TEMPERATURE occurs. The input signal may vary within the value for HOLD HYSTERESIS without causing an alteration of the output signal. (See Figure 3-26.)

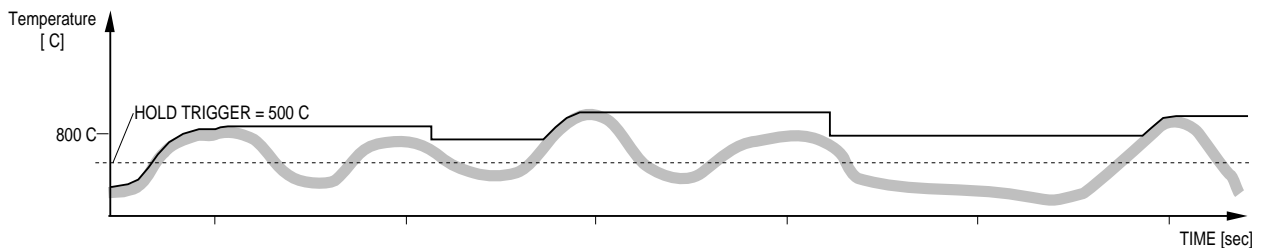


Figure 3-26: Advanced Peak Hold

Note: Advanced Peak Hold can be activated only through the RS-485 communications. Refer to Appendix B for information on programming and communications.

Advanced Peak + Time

Advanced Peak + Time mode is Advanced Peak with a hold interval. This is controlled by three settings: the hold interval, the hold trigger, and the hold hysteresis.

The output signal will hold the last "Peak" (maximum value) until a new value above the HOLD TRIGGER TEMPERATURE occurs, or until HOLD TIME is exceeded. This is important if, for example, the oven is to be switched off if no new parts pass through over a longer period. (In the curve illustrated in Figure 3-27, the break has no end.)

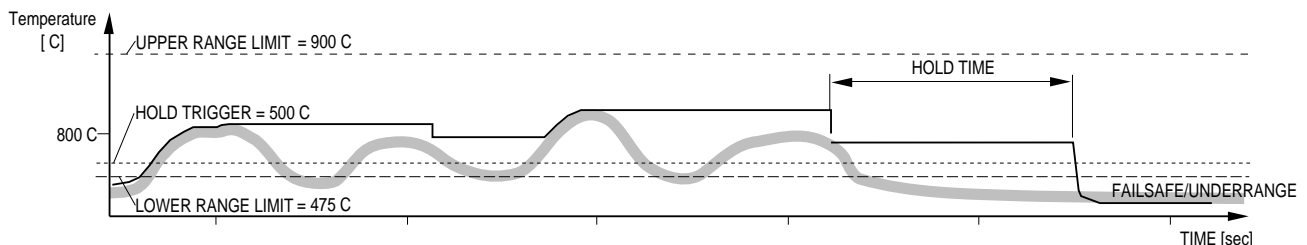


Figure 3-27: Advanced Peak Hold + Time

A continuous peak reading can be reset when Peak Hold Time is set to 300 seconds by shorting the Trigger input to Ground for a minimum of 10 msec. (Refer to Section 2.3.5 for more information on the Trigger.) Figure 3-28 shows an example of continuous Peak Hold reset by the Trigger input.

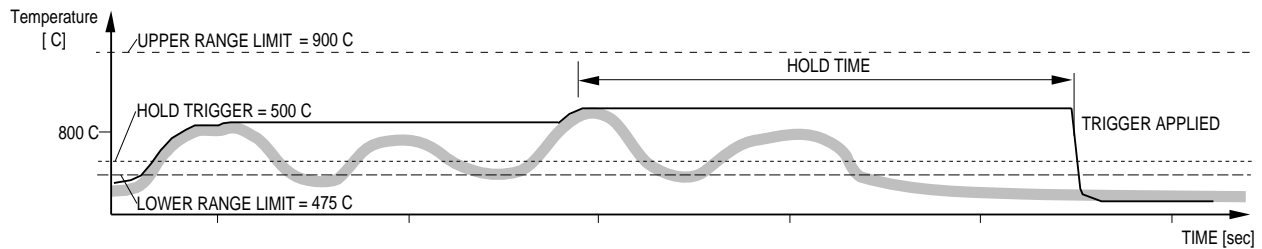


Figure 3-28: Continuous Peak Hold + Trigger

A decay time can be set to allow a slow reduction of the temperature until another peak is encountered. Figure 3-29 is an example of a Peak Hold with a set Decay Time.

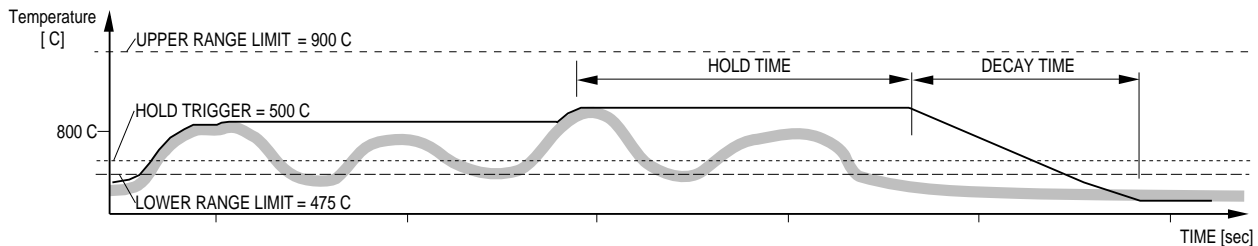


Figure 3-29: Peak Hold + Decay

Please note the following for the Advanced Peak Hold + Time function:

In Alarm Mode, the FAIL SAFE output signal is only set to underrange if two conditions are fulfilled simultaneously:

1. HOLD TIME, if any, was exceeded without a new value above HOLD TRIGGER TEMPERATURE being determined.

In the example in Figure 3-25: No new car bodies enter.

2. Value has fallen below the bottom of the temperature range.

In the example in Figure 3-25: the conveyor belt temperature is below the bottom of the temperature range. For example, 475°C for FA1A.

How to set ADVANCED PEAK HOLD + TIME:

- Set HOLD TRIGGER TEMPERATURE high enough that all "irrelevant" input values are suppressed. In the example in Figure 3-25 the bodywork parts have a higher temperature than the moving conveyor belt. HOLD TRIGGER TEMPERATURE was set above the conveyor belt temperature (2-way command "C").
- Set the Peak Hold time different from 0 (command "P").
- Set the hysteresis according to the expected noise in the process (command "XY").

An example of Advanced Hold is described in more detail on the following page.

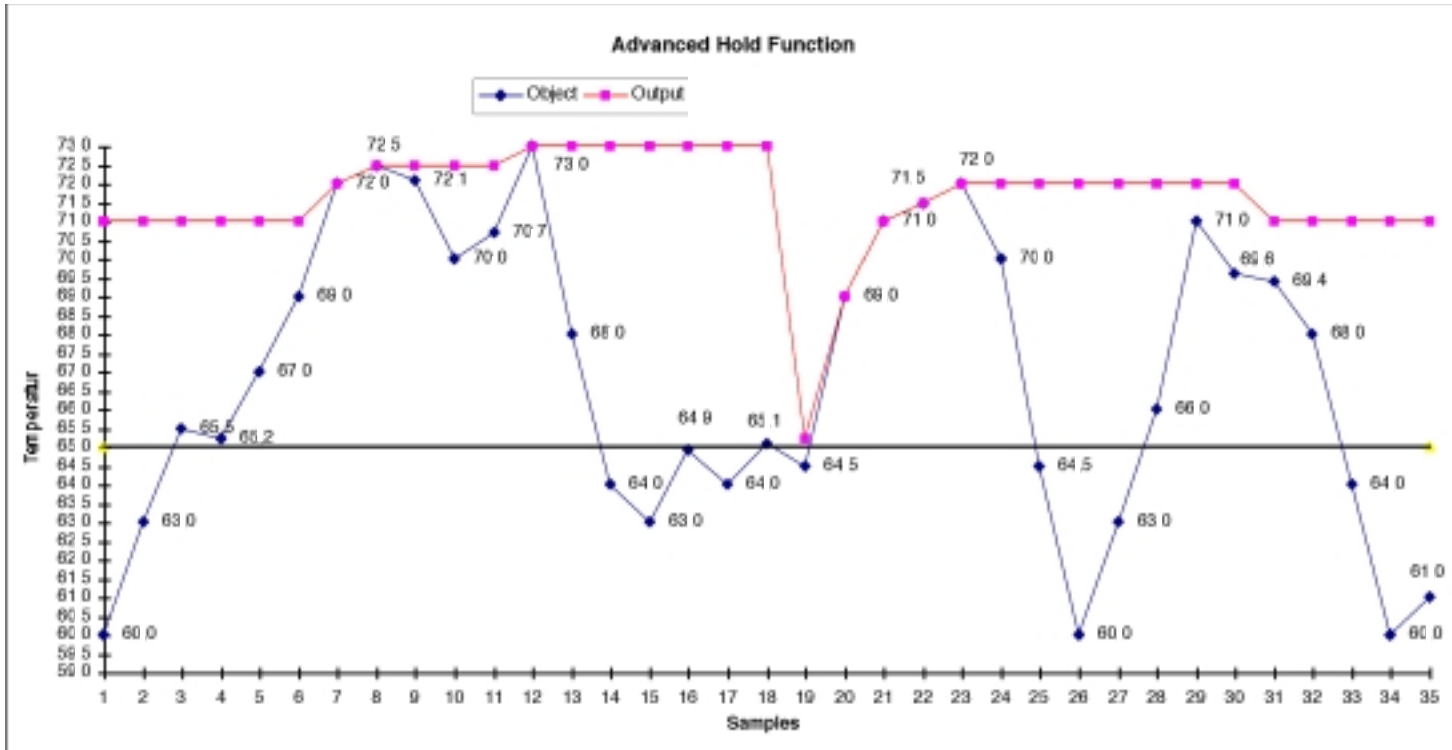


Figure 3-30: Advanced Hold Function

- Samples 1 ... 6 : previous output value is held, local maximum at 3 is not evaluated, because hysteresis was not exceeded, timer runs
- Samples 7, 8, 12 : because each new value is greater than held value, output is altered and timer is retriggered
- Samples 9,10,11,13: previous output value is held, timer runs
- Samples 14 ... 17 : previous output value is held, local maximum at 16 is not evaluated, because Hold Trigger was not exceeded, timer runs
- Samples 18, 19 : local maximum at 18 is accepted at 19, because 18 is above Hold Trigger and hysteresis is exceeded, timer retriggered at 19
- Samples 20 ... 23 : because each new value is greater than held value, output is altered and timer is retriggered
- Samples 29 ... 31 : local maximum at 29 is accepted at 31, because hysteresis was not exceeded until 31, timer retriggered at 31

Averaging (AVG)

Averaging can be useful when an average temperature over a specific duration is desired, or when a smoothing of fluctuating temperatures is required. Figure 3-31 illustrates the Averaging output signal.

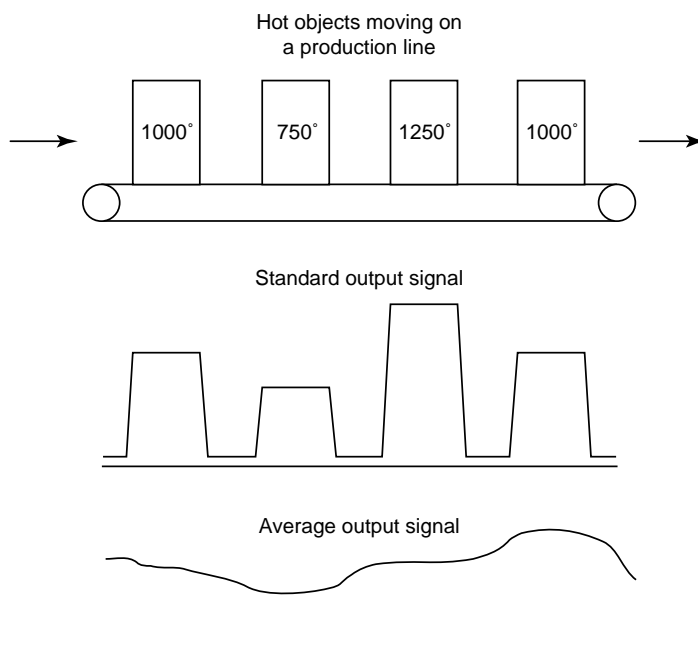


Figure 3-31: Averaging Example

The averaging algorithm simulates a first order low pass RC filter whose time constant can be adjusted to match the user's averaging needs.

To set and activate Average, do the following:

1. **Press the Mode button until the AVG LED is lit.**
2. **Press the ▲ (UP) button to both set and activate.**

The display reads in 0.1 seconds. Set Average anywhere from 0 to 300 seconds (to set the time constant of the first order, low-pass filtering).

3. **Press the Mode button until the C or F LED is lit.**

If Average has been activated, the Average LED will stay lit.

Once Average is set above 0, it is automatically activated. Peak hold cannot be used concurrently. To deactivate Average, push the MODE button until only the Average LED indicator is lit and reset to 0 by pushing the ▼ (DOWN) button.

Notes: Average can also be adjusted with a 2-way RS-485 command (only works in Setup mode). See Appendix B for details.

With special software from the factory, the Average reading can be reset by shorting the Trigger input to Ground for a minimum of 10 msec. (Refer to Section 2.3.5 for more information on the Trigger.)

Valley Hold (VAL)

With Valley Hold activated, the unit monitors the minimum temperature seen over the pretermined time interval. The algorithm may be described as being exactly the reverse of that for the Peak Hold, in that it monitors the lowest rather than the highest temperature seen. The duration time is changed by the ▲ (UP) and ▼ (DOWN) buttons. Figure 3-32 illustrates the Valley Hold output signal.

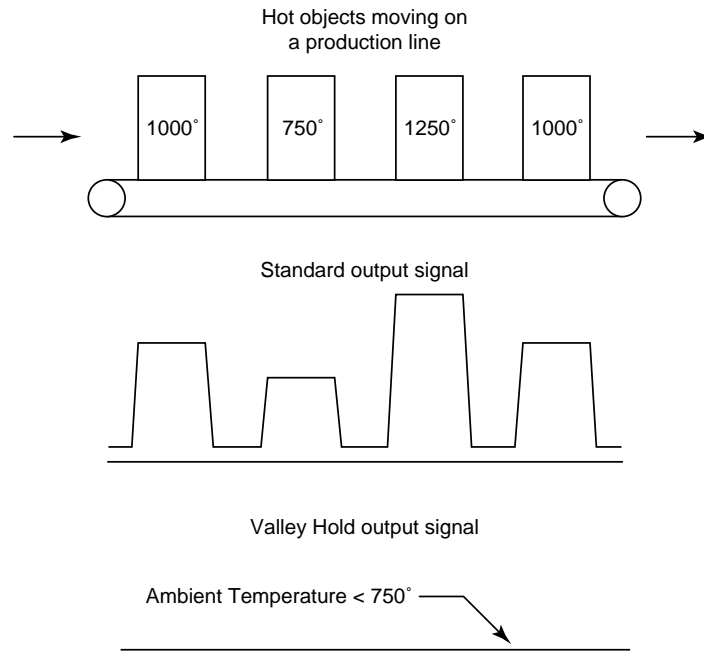


Figure 3-32: Valley Hold Example

The Valley reading can be reset when Valley Hold Time is set to 300 seconds by shorting the Trigger input to Ground for a minimum of 10 msec. (Refer to Section 2.3.5 for more information on the Trigger.)

The following table (Table 3-1) lists the various Hold functions along with their resets and timing values. Use this table as a guide for programming your sensor and adjusting the Hold times. Note that several of the program commands are not currently available through the Marathon Support Software and can only be used through the Chat program. Refer to Part 4 for information on the Marathon Chat Program, and Appendix B for the software protocols.

Table 3-1: Hold Functions

HOLD FUNCTION	HOLD RESET BY	PEAK TIME	VALLEY TIME	THRESHOLD	HYSTERESIS	DECAY RATE
Protocol Codes →		P	F	C	XY	XE
none	none	000.0	000.0	- *	- *	- *
simple peak	timer	000.1-299.9	000.0	000.0	- *	000.0
simple peak	trigger	300.0**	000.0	000.0	- *	000.0
simple peak w/decay	timer	000.1-299.9	000.0	000.0	- *	0001-9999
advanced peak	trigger or threshold	300.0	000.0	0250-3000	- *	0000
advanced peak	timer or threshold	000.1-299.9	000.0	0250-3000	- *	0000
advanced peak w/decay	timer or threshold	000.1-299.9	000.0	0250-3000	- *	0001-9999
simple valley	timer	000.0	000.1-299.9	000.0	- *	0000
simple valley	trigger	000.0	300.0	000.0	- *	0000
simple valley w/decay	timer	000.0	000.1-299.9	000.0	- *	0001-9999
advanced valley	trigger or threshold	000.0	300.0	0250-3000	- *	0000
advanced valley	timer or threshold	000.0	000.1-299.9	0250-3000	- *	0000
advanced valley w/decay	timer or threshold	000.0	000.1-299.9	0250-3000	- *	0001-9999

* Value does not affect the function type

** Holds indefinitely or until triggered

3.5.2.3 Setpoint

The Setpoint is deactivated by default (alarm mode). Activating and adjusting the Setpoint is accomplished through software. Refer to Appendix B for information on the sensor's communication protocols.

Once the Setpoint is activated the relay changes state as the current temperature passes the setpoint temperature.

3.5.2.4 Deadband

Deadband is a zone of flexibility around the Setpoint. The alarm does not go abnormal until the temperature exceeds the Setpoint value by the number of set deadband degrees. Thereafter, it does not go normal until the temperature is below the Setpoint by the number of set deadband degrees. The Deadband is factory preset to $\pm 2^\circ\text{C}$ ($\pm 4^\circ\text{F}$) of Setpoint value. Adjusting to other values is accomplished through software. Refer to Appendix B for information on the sensor's communication protocols. Figure 3-31 is an example of the Deadband around a Setpoint temperature of 960°C (1760°F).

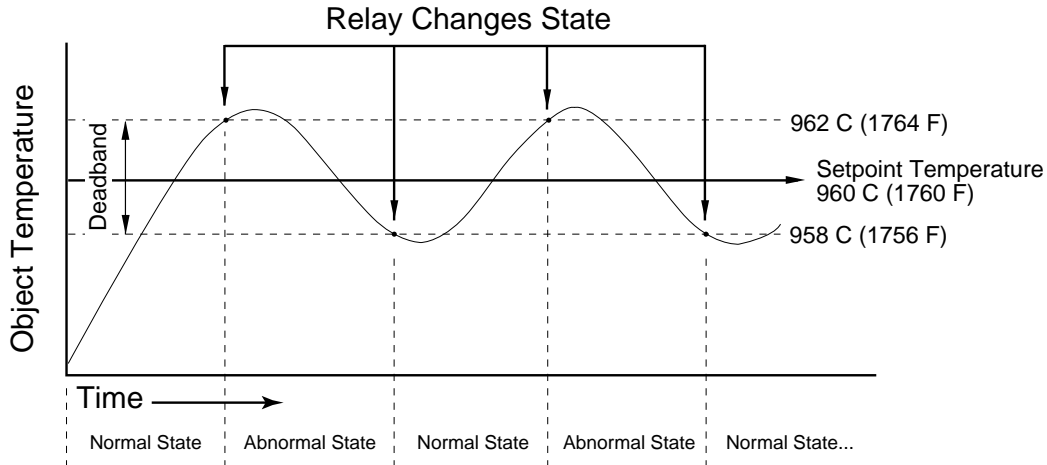


Figure 3-33: Deadband Example

3.5.2.5 Ambient Temperature Compensation

The instrument is capable of improving the accuracy of target temperature measurements by taking into account the ambient, or background, temperature. This feature is useful when the target emissivity is below 1.0 and the background temperature is not significantly lower than the target temperature. To utilize this feature, you must provide the instrument with the background temperature.

Two methods of providing background temperature information are available.

- You give the instrument a fixed temperature value with the command $A=xxxx$, where $xxxx$ is the background temperature. This value will be stored in the instrument and applies even after cycling the power.
- Or you can frequently tell the system the background temperature information, allowing the system to track changes in the background temperature. The command format is different from other commands. After sending the command $A\#xxxx$ the instrument will take the background temperature into account, but will not store it permanently in the instrument.

The command $A=0000$ will turn this feature off.

3.4.2.6 Resetting Factory Defaults

To reset the unit to the factory defaults, press the ▲ and ▼ buttons (up and down arrows) at the same time for approximately 2 seconds.

The factory defaults are listed in Part 1, Section 1.5.

Note: Resetting Factory Defaults can also be done with a 2-way RS-485 command. See Appendix B for details.

Part 4

Marathon Support Software Installation & User Guides

This section explains the installation and operation of the Marathon Support Software included with your sensors. The Graphic Setup and Display, Sensor Network Setup and Display, and Chat programs can be used in multidrop sensor environments. The Graphic Setup and Display and Marathon Chat programs can be used in non-multidrop environments.

Topics include...

- Installation
- Graphic Setup and Display User Guide
- Sensor Network Setup and Display User Guide
- Marathon Chat Program User Guide

SOFTWARE INSTALLATION

The software that came with your Marathon sensor(s) consists of five separate programs. These include the Network Communications Setup (multidrop only—covered in Part 3), the Graphic Setup and Display, the Sensor Network Setup and Display (displays temperatures and alarms for up to 32 sensors), the Chat program (direct communications between the user and the sensor), and the Field Calibration program (covered in Appendix D).

Note: You can also create your own custom programs for your application by using the communications protocols listed in Appendix B.

IMPORTANT

If you installed your sensors in a multidrop environment using Part 3 as a guide, you have already installed all necessary software. Skip the following steps.

To install the software on a personal computer running Windows 95, Windows 98, or Windows NT 4.0 (Service Pack 3 or 4), complete the following steps:

1. Put Disk 1 in your floppy drive.
2. Click on the Start Button and select Run.
3. Type A:\Install and press the Return/Enter key.
4. Follow the installation instructions.

All necessary programs are installed in the Raytek program group.

4.0 MARATHON SUPPORT SOFTWARE PROGRAMS

The following sections explain how to use the Graphic Setup and Display, Sensor Network Setup and Display, and Marathon Chat programs that are included in the software that came with your sensor. These programs are installed along with the Network Communication Setup program described in Part 3.

Note: For demonstration or training purposes, the Graphic Setup and Display and the Sensor Network Setup and Display programs can be run without sensors connected. This is described in the following sections.

4.1 GRAPHIC SETUP AND DISPLAY PROGRAM

The Graphic Setup and Display program allows you to change parameter values and to monitor, both digitally and graphically, one or two Marathon sensors.

To start the program, Click the Start menu, select Programs and the Raytek Program Group, then select Graphic Setup and Display from the list of files. When the program starts you first see a screen similar to Figure 4-1.

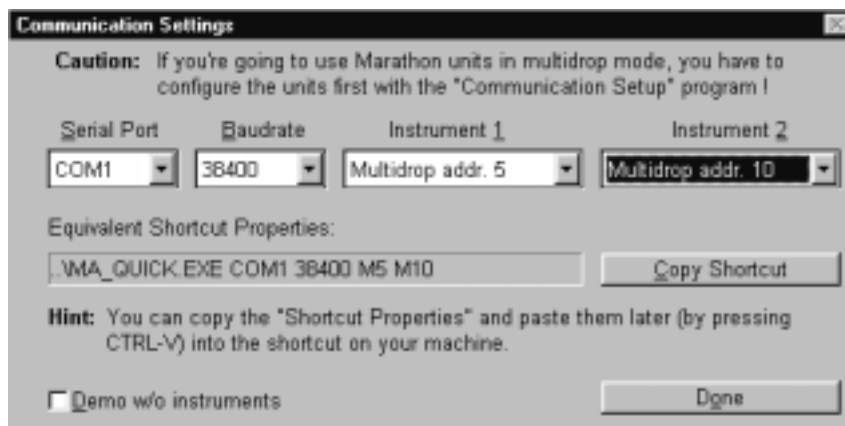


Figure 4-1: Communication Settings Screen

Choose the appropriate Serial Port and Baud rate, then select any one or two instruments attached to the sensor network. As the cautionary note states, using the sensors in multidrop mode requires them to have been preconfigured with the Network Communication Setup program as described in Part 3 (multidrop installations only).

For demonstration or training purposes when no sensors are attached, you can select the check box, Demo w/o instruments.

Click on the Done button when ready.

Note: If you don't plan to change settings, you can create a shortcut that will load the set configuration and proceed directly to the main screen (Figure 4-2). This will bypass the communication setup screen (Figure 4-1) and start the program faster. Use the Copy Shortcut button, then Paste the shortcut properties into the Graphdsp.exe file's properties (shortcut tab).

The main screen can display the parameters of one or two sensors (as shown in Figure 4-2). Any Marathon 1-color standard or 2-color ratio thermometer can be displayed concurrently as long as they are on the same sensor network. For example, Figure 4-2 shows an MR1F 2-color fiber optic ratio thermometer on the left and an FA1A 1-color instrument on the right.

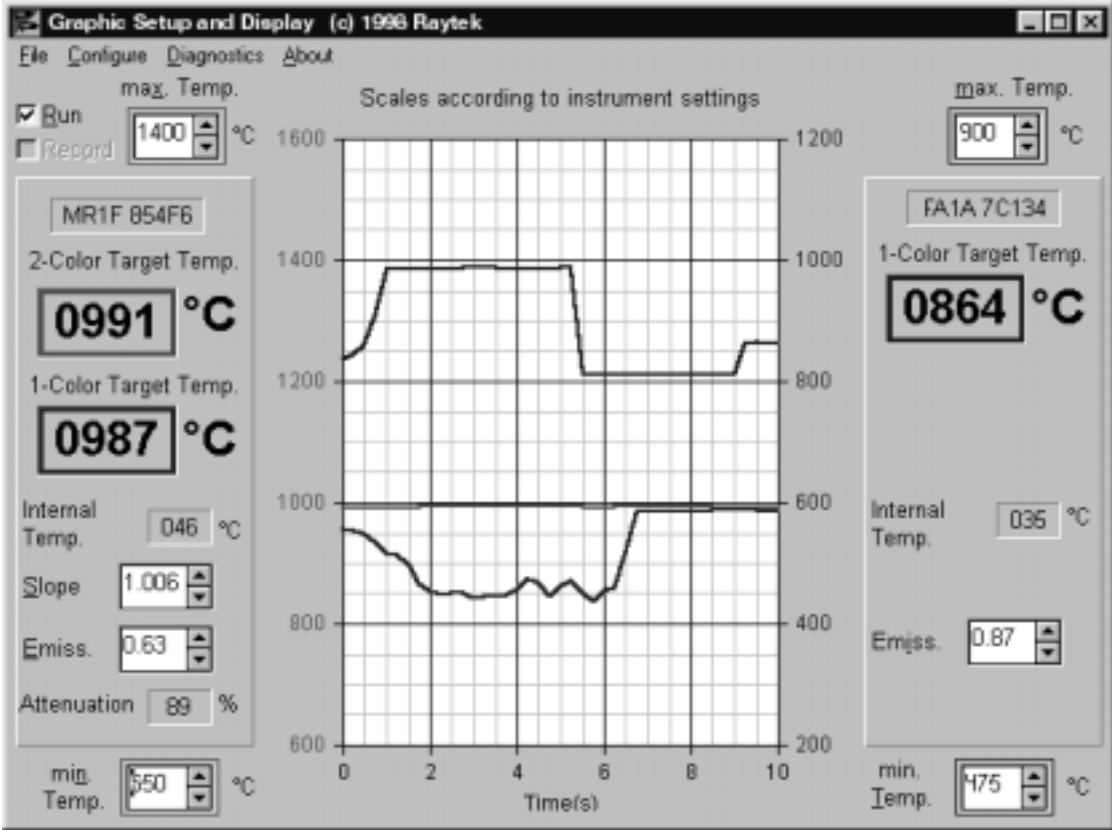


Figure 4-2: The Graphic Setup and Display Main Screen

Parameters you can change from the main screen include the maximum and minimum displayed temperatures and the emissivity and/or slope of each instrument.

The colored squares show the currently measured temperature, and the graph displays temperatures over a period of time.

The menus at the top of the screen include File, Configure, and Diagnostics, as shown in Figure 4-3, and About.

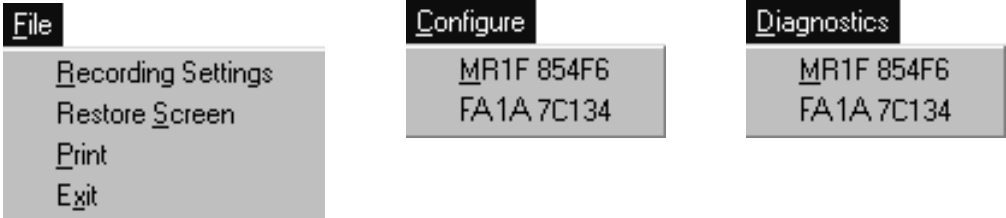


Figure 4-3: The Menus

The File menu is made up of the following:

Recording Settings—allows you to record the incoming data stream at an interval you select (Figure 4-4). Double clicking the large square or clicking the button brings up a standard Windows file menu listing where you can name a file to record to. When you have completed the necessary tasks, click on the Done button.

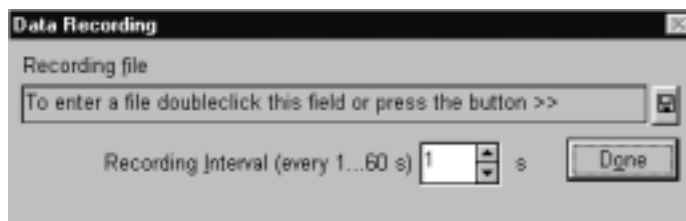


Figure 4-4: Data Recording

Restore Screen—lets you restore the screen to its original appearance after resizing.

Print—allows you to make a hardcopy printout of the display. The printouts can be used as records of parameter settings and/or temperature displays.

Exit—exits the program.

CONFIGURE

When you pull down the Configure menu, you will see one or two selections showing the sensor(s) being monitored by the Quick Start program. If you select one of the sensors, a screen similar to Figure 4-5 displays. Current sensor settings display on the right side of the screen.

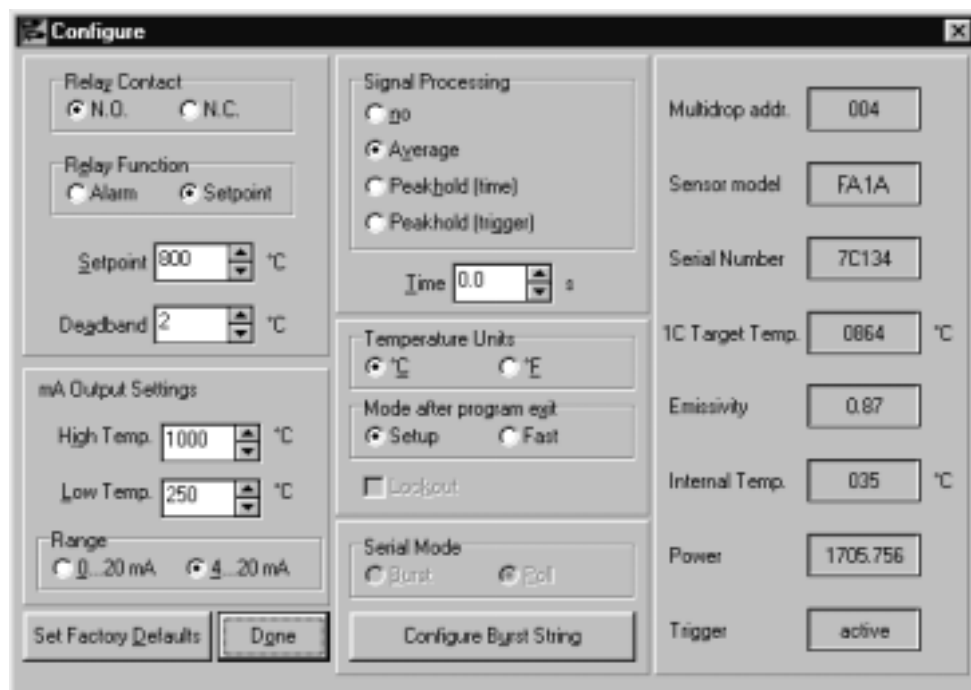


Figure 4-5: Sensor Configuration Screen

Relay Contact—You can set the relay contact to N.O. (Normally Open) or N.C. (Normally Closed). If it is set to N.O., when the relay is triggered (as with an alarm or setpoint), it will close. The opposite is true when set to N.C.

Relay Function—can be set to Alarm or Setpoint. In Alarm mode you can have an alarm alert you when the temperature goes above or below the maximum or minimum temperatures or for any other failsafe condition (as explained in Appendix A). When you select Setpoint two additional selection windows open where you can choose a setpoint temperature and a deadband range. The setpoint can be your optimum process temperature, and the deadband can be the allowable temperature range above and below the setpoint. If the temperature goes above the setpoint, the sensor can trip an external function and/or notify you through an external alarm. For more information on Setpoint and Deadband, refer to the appropriate sections in Part 2 or Part 3.

Temperature Units—allows you to set the unit and software to display °C or °F.

Display/Analog Output Mode—You only have this choice when using Marathon 2-color ratio thermometers, which can be switched between 1-color and 2-color temperature measurement modes.

Lockout—Select this box if you need to disable (lockout) the buttons on the sensor's control panel. With this selected, the sensor cannot be changed except through software. This makes sure no accidental changes are made to the sensor and that there is no chance of tampering while the instrument is on the process line. Sensors set up in a multidrop network are automatically locked. (It is recommended that you do not unlock multidropped sensors.) Note that this program doesn't allow you to unlock multidrop sensors. If you need to unlock them, use the CHAT program.

mA Output Settings—You can set the High Temp. (20 mA output) and/or Low Temp. (0 or 4 mA), if necessary, to temperatures appropriate for your process.

Range—allows you the choice of setting the sensor's mA output to select a range from 0 to 20 mA or 4 to 20 mA.

Signal Processing—lets you select no signal processing, averaging (which is timed), peak hold with a timer, or peak hold that is triggered. If you select Average or Peak hold (time) a time number box displays where you can set the averaging time constant or how long peak hold should be held. If you select Peak hold (trigger), an external trigger connected to the sensor is used to cut off peak hold. Note that the averaging time constant controls how fast the sensor responds to a fast change in target temperature.

Serial Mode—The interface has two modes of operation: Poll and Burst. These are defined in Appendix B, Section B.2.1. If you select Burst mode, you also have the ability to select sensor output parameters to display and/or record by clicking the Configure Burst String button. If you click the button, a screen similar to Figure 4-6 displays. Note that this screen’s contents vary depending on the sensor model.

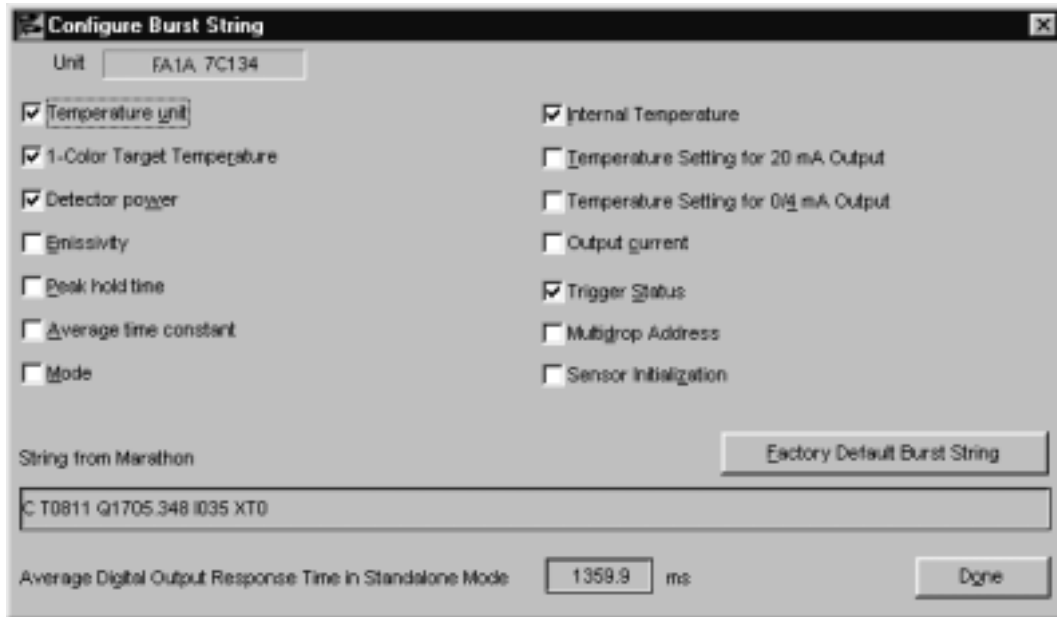


Figure 4-6: Configure Burst String Window

Each checked item adds to the burst string and displays in the space at the bottom of the window. Also displayed is the millisecond average response time of the digital output signal. This figure is an estimate and will vary depending on the baud rate.

After you make your selections, click on the Done button, and you will be returned to the Sensor Configuration Screen. To return to the factory settings, click the Factory Default Burst String button.

Set Factory Defaults—Any changes you have made to the Configure screen can be returned to the factory settings by clicking on the Set Factory Defaults button.

Note: The sensor can be returned to the “as shipped” values through a 2-way RS-485 command. Refer to Appendix B for details.

Done—After making changes, click on the Done button. You will be returned to the Main screen.

DIAGNOSTICS

When you pull down the Diagnostics menu, you will see one or two selections showing the sensor(s) being monitored by the Graphic Setup and Display program. If you select one of the sensors, a screen similar to Figure 4-7 displays. The diagnostics functions allow you to perform simple checks on the sensor's output and relay.

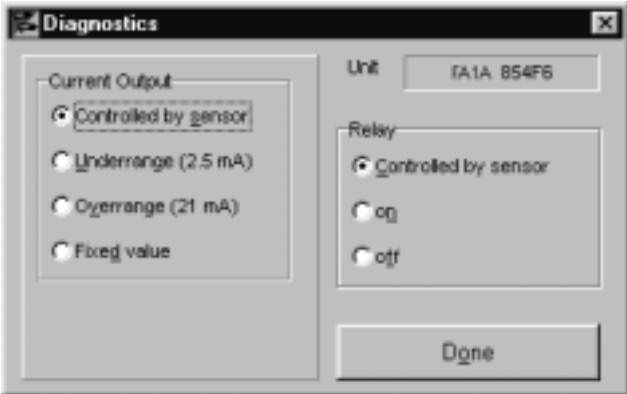


Figure 4-7: Diagnostics Window

4.2 SENSOR NETWORK SETUP AND DISPLAY PROGRAM

The Multidisplay program gives you the ability to setup and/or monitor up to 32 sensors, 16 to a screen. The program can be run two ways: supervisor mode and operator mode. Supervisor mode allows setup changes and operator mode allows only monitoring capabilities.

To start the program, Click the Start menu, select Programs and the Raytek Program Group, then select either Sensor Network Setup and Display (supervisor mode) or Sensor Network Display (operator mode) from the list of files. When the program starts you first see a communication setup screen similar to Figure 4-8.



Figure 4-8: Sensor Network Communication Setup

Select the appropriate com port and baudrate, and, if setting up for demonstration or training purposes, select Demo w/o inst, and click the Done button. A screen similar to Figure 4-9 displays (steel mill example).

Note: You can create a shortcut that will preload the connection parameters and proceed directly to the main screen, or you can run this program from the Start/Run command line. This will bypass the Sensor Network Setup and Display screen and start the program faster. Valid parameters are COM1, COM2, 300, 1200, 2400, 9600, 19200, or 38400, SETUP, and DEMO. For example, GRAPH.DSP COM1 19200 starts the program using COM 1 at 19200 baud. If you add SETUP on the command line, the program will run the initial setup screen. If you enter GRAPH.DSP DEMO, the program runs in demo mode (no sensors attached).

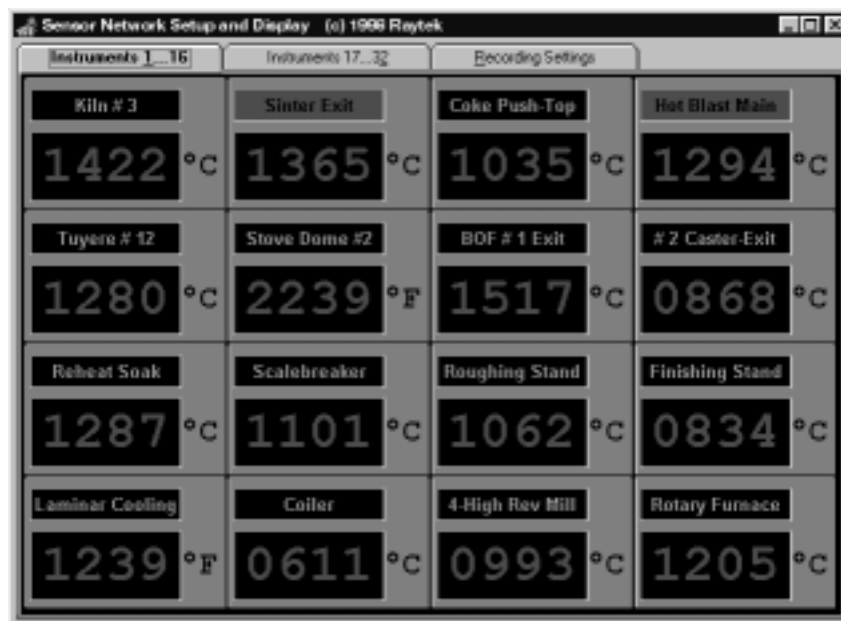


Figure 4-9: Sensor Network Setup and Display Main Screen

At the top of the 16 temperature displays are three tabs. By clicking on a tab, the screen associated with that tab displays. The first two tabs are for temperature displays, as shown in Figure 4-9 on the previous page, with up to 16 sensors on each page. The third tab is for recording settings. If you click on the Recording Settings tab, a screen similar to Figure 4-10 displays. (Disabled in operator mode.)

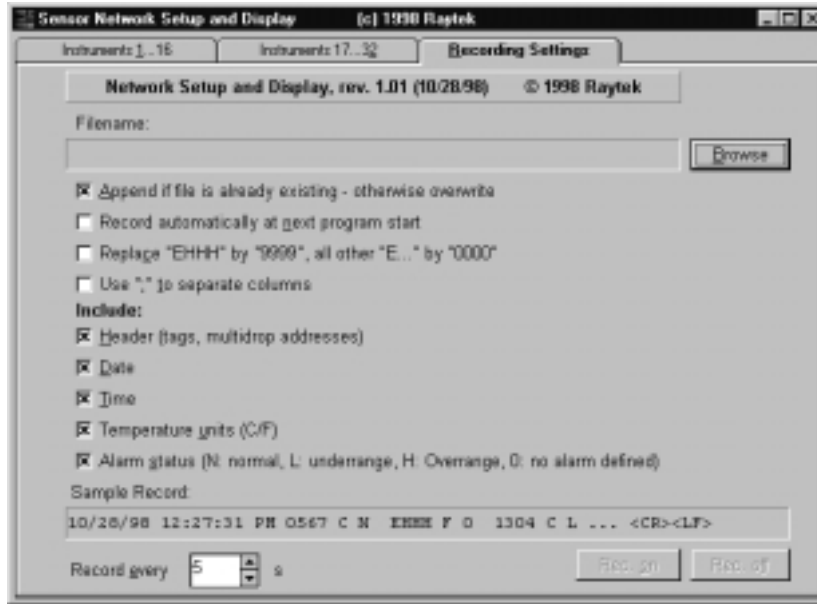


Figure 4-10: Recording Settings Screen

The program records all temperatures displayed on the first two screens. You may omit or include explanatory information (header, date and time, C or F, or alarm status) by clicking the appropriate check boxes. Use the Browse button to name the file and select a location to store it, and click on the Rec. on button to start recording. The recording function creates a standard ASCII text file that can be printed as is, using the Windows Notepad or another text editor, or you can import the text file into a spreadsheet program such as Excel™. To stop, click on the Rec. off button.

A sample text file, using the checked selections in Figure 4-10, would display like Figure 4-11.

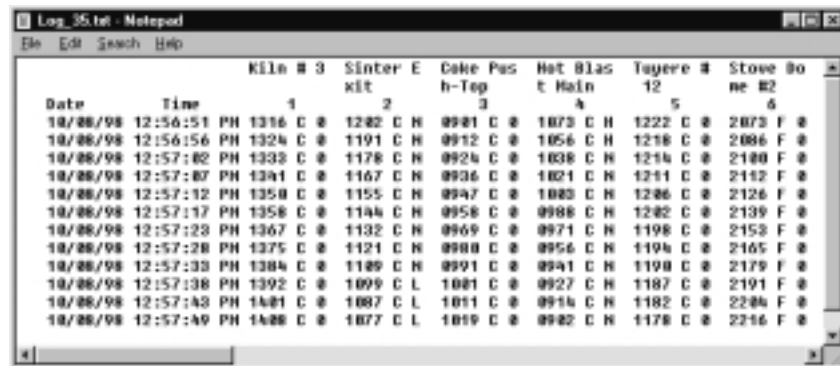


Figure 4-11: Recording Example

Any of the sensor displays under the Instruments tabs can be clicked on to open a Configure screen similar to Figure 4-12. (Disabled in operator mode.)

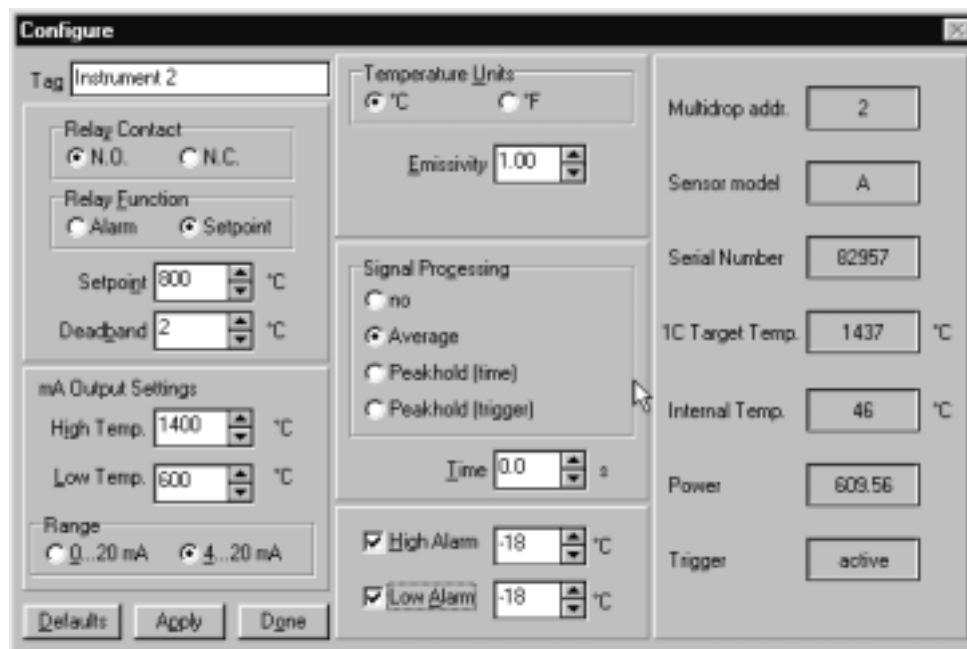


Figure 4-12: Configure Screen

Each sensor display shows only temperature, temperature unit, and, if alarms are set, they'll blink red or green to show if they are above or below the acceptable range ("soft" alarm, not a relay function). The Configure screen is made up of the following:

Tag—The tag is an area where you can name each sensor to help identify it. This is helpful if you have a number of sensors spread out through a plant or at different areas of a process.

Relay Contact—You can set the relay contact to N.O. (Normally Open) or N.C. (Normally Closed). If it is set to N.O., when the relay is triggered (as with an alarm or setpoint), it will close. The opposite is true when set to N.C.

Relay Function—can be set to Alarm or Setpoint. With an alarm you can have an alarm alert you when the temperature goes above or below the maximum or minimum temperatures or for any other failsafe condition (as explained in Appendix A). When you select Setpoint two additional selection windows open where you can choose a setpoint temperature and a deadband range. The setpoint can be your optimum process temperature, and the deadband can be the allowable temperature range above and below the setpoint. If the temperature goes above the setpoint, the sensor can trip an external function and/or notify you through an external alarm. For more information on Setpoint and Deadband, refer to the appropriate sections in Part 2 or Part 3.

Temperature Units—allows you to set the unit to display °C or °F.

Display/Analog Output Mode–You only have this choice when using Marathon 2-color ratio thermometers, which can be switched between 1-color and 2-color temperature measurement modes.

mA Output Settings–You can set the High Temp. (20 mA output) and/or Low Temp. (0 or 4 mA), if necessary, to temperatures appropriate for your process.

Range–allows you the choice of setting the sensor’s mA output to cover a range from 0 to 20 mA or 4 to 20 mA.

Emissivity–You can change the emissivity of an instrument by clicking on the up and down arrows or by entering a new number in the box. Changing these values are necessary only if the target being measured requires it. Refer to Appendix E for sample emissivities for metals and non-metals.

Signal Processing–lets you select no signal processing, averaging (timed), peak hold with a timer, peak hold that is triggered, or valley hold. If you select Average, Peak hold (time), or Valley hold a time number box displays where you can set the averaging time constant or how long peak hold should be held. If you select Peak hold (trigger), an external trigger connected to the sensor is used to cut off peak hold. Note that the averaging time controls how fast the sensor responds to a fast change in target temperature.

High Alarm/Low Alarm–Selecting one or both of these check boxes allows visual monitoring of each unit if it goes above or below an acceptable range. When you select a check box, a numeric control pops up allowing you to set the alarm level. This is independent of relay. The name (tag) on a temperature display will blink either red (over range) or blue (under range) depending on the condition. If there is an alarm condition on the second page of sensors, an alert (independent of relay alarm) pops up in the middle of the first page screen allowing you to immediately go the second page.

Defaults–The Defaults button resets the parameters to the “as shipped” settings. Note that the default settings can be reset through a 2-way RS-485 command. Refer to Appendix B for details.

DISPLAY INFORMATION

You can change the text and background colors for each temperature window, and the colors for the titles over each window (normal and flashing alarms) by clicking the right mouse button over the temperature display or text window.

4.3 MARATHON CHAT PROGRAM

The Chat program lets you control sensors through a command-line interface from your computer. You can enter data to change parameters for custom applications, and you can retrieve information for data analysis

To start the Chat program, Click the Start menu, select Programs and the Raytek Program Group, then select Marathon Chat from the list of files. When the program starts a screen similar to Figure 4-13 displays.

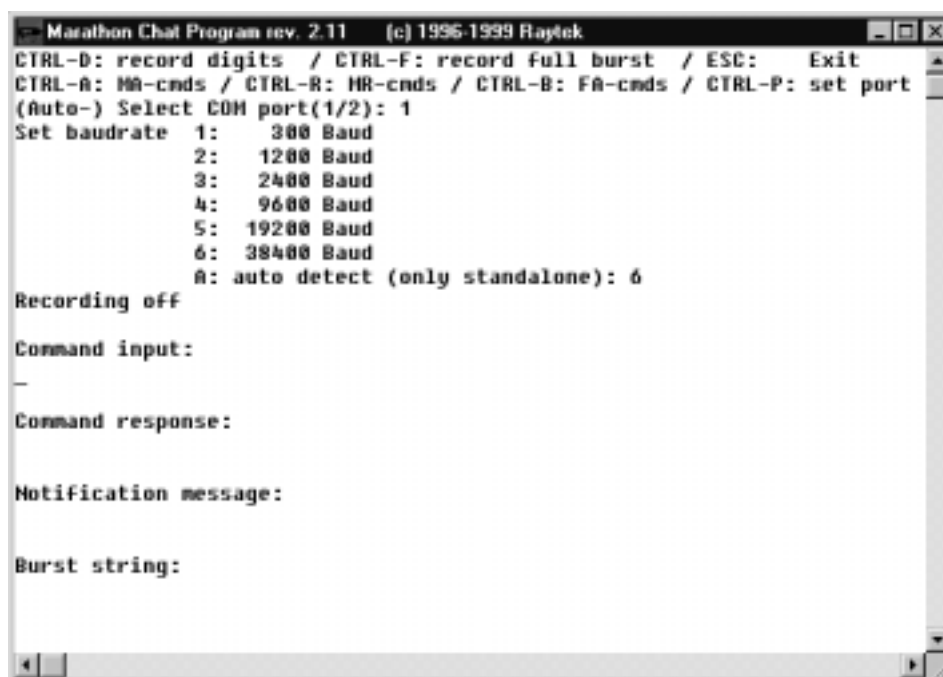


Figure 4-13: Chat Program Display

At the command line you can enter data to change the sensor's parameters. For a description and examples of the character set for command line entries, refer to Appendix B. You can also get a help screen listing of the character set by holding down the control key and typing A, R, or B. The A gives you the character set for the Marathon MA series 2-way command set. The R gives you the character set for the Marathon MR series 2-way command set. The B gives you the character set for the Marathon FA series 2-way command set.

This program can also log incoming data from the sensor. This data is stored as text in a .log file. The log text is space delimited and can be imported into a spreadsheet program for graphing and analysis. To start recording of digits (temperature data), hold down the control key and press D. To stop recording, do the same. To record the sensor's full burst (all data), hold down the control key and press F. To stop recording, do the same.

The program logs everything it receives, but will only display command responses, reports of pushbutton activity, and lines containing transmission errors.

If you are in burst mode, the current burst string displays under "Burst String:."

Appendices

The appendices consist of additional information to help you maintain and operate your Marathon infrared thermometer.

Topics include...

- Troubleshooting and Maintenance
- Programming Guide
- Object Emissivity
- Traceability of Instrument Calibration
- CE Conformity for European Community

APPENDIX A: TROUBLESHOOTING AND MAINTENANCE

Our sales representatives and customer service are always at your disposal for questions regarding application assistance, calibration, repair, and solutions to specific problems. Please contact your local sales representative if you need assistance. In many cases, problems can be solved over the telephone. If you need to return equipment for servicing, calibration, or repair, please contact our Service Department before shipping. Phone numbers are listed on the Warranty/Copyright page at the beginning of this manual.

A.1 TROUBLESHOOTING MINOR PROBLEMS

Table A-1 lists common symptoms, their causes, and possible solutions. If you are experiencing a problem that is not listed below, please call our Service Department.

Table A-1: Troubleshooting

SYMPTOM	PROBABLE CAUSE	SOLUTION
No output	No power to instrument	Check the power supply
Erroneous temperature	Faulty sensor cable	Verify cable continuity
Erroneous temperature	Field of view obstruction	Remove the obstruction
Erroneous temperature	Window dirty	Clean the window (see Section 4.3)
Erroneous temperature	Wrong emissivity	Correct the setting
Temperature fluctuates	Wrong signal processing	Correct Peak/Valley Hold or Average settings

A.2 FAIL-SAFE OPERATION

The Fail-Safe system is designed to alert the operator and provide a safe output in case of any system failure. Basically, it is designed to shutdown the process in the event of a set-up error, system error, or a failure in the sensor electronics.

IMPORTANT

The Fail-Safe circuit should never be relied on exclusively to protect critical heating processes. Other safety devices should also be used to supplement this function.

When an error or failure does occur, the display indicates the possible failure area, and the output circuits automatically adjust to their lowest or highest preset level. Table A-2 shows the values displayed on the LED display and transmitted over the 2-way interface.

Table A-2: Fail-safe Error Codes

CONDITION	ERROR CODE
Temperature over range	EHHH
Temperature under range	EUUU
Internal temperature over range	EIHH
Internal temperature under range	EIUU
Heater control temperature over range	ECHH
Heater control temperature under range	ECUU

Note: Relay will go to "alarm" state if not in Setpoint mode

When internal ambient temperature is requested, it is always transmitted, even if it is out of range. The analog output corresponds to the temperature displayed on the LEDs, as shown in Table A-3 (if set to “Controlled by Sensor,”--see Page 86).

Table A-3: Analog Outputs

SELECTED TEMPERATURE	0-20 mA ANALOG OUTPUT	4-20 mA ANALOG OUTPUT
Normal	Scaled to temperature	Scaled to temperature
EHHH	21 to 24 mA	21 to 24 mA
EUUU	0	2 to 3 mA
EIHH	21 to 24 mA	21 to 24 mA
EIUU	0	2 to 3 mA
ECHH	21 to 24 mA	21 to 24 mA
ECUU	0	2 to 3 mA

If any failsafe code appears on the display, the relay changes to the “abnormal” state.

Note: Relay won't reflect failsafe if in Setpoint mode or not “Controlled by Sensor.” See Page 86.)

Following are the priorities of the possible failsafe conditions:

1. Heater control temperature over range
2. Heater control temperature under range
3. Internal temperature over range
4. Internal temperature under range
5. Temperature under range
6. Temperature over range

If two errors occur simultaneously, the higher priority error is the one that is presented on the LED's digital and analog outputs.

APPENDIX B: PROGRAMMING GUIDE

This appendix explains the sensor's communication protocols. Use them when writing custom programs for your applications or when communicating with your sensor(s) with the Chat program.

B.1 INTRODUCTION

Protocols are the set of commands that define all possible communications with the sensor. The commands are described in the following sections along with their associated ASCII command characters and related message format information.

Types of commands include the following:

1. A request for the current value of a parameter
2. A change in the setting of a parameter
3. Defining the information contents of a string (either continuously output or periodically polled at the option of the user)

The sensor will respond to every command with either an "acknowledge" or a "not acknowledge" string. Acknowledge strings begin with the exclamation mark (!) and are either verification of a set command or a parameter value. See Table B-1.

Note: If the unit is in multidrop mode and you have checked the "Address in Response," the 3-digit address will be sent out before the exclamation mark.

An asterisk (*) will be transmitted back to the host in the event of an "illegal" instruction. An illegal instruction is considered to be one of the following:

- Any non-used or non-allowed character
- An "out-of-range" parameter value
- A value entered in the incorrect format (see Table B-1)
- Lower case character(s) entered (all characters must be upper case)

After transmitting one command, the host has to wait for the response from the unit before sending another. A response from the sensor is guaranteed within 4 seconds in Poll mode and 8 seconds in Burst mode at 300 baud (see the end of this appendix for information on Poll and Burst modes). The response is faster at higher baud rates. Contact your sales representative if you need further details for higher baud rates.

IMPORTANT

All commands must be entered in upper case (capital) letters. Also note that leading and trailing zeros are necessary. Examples: send E=0.90, not E=0.9; send P=001.2, not P=1.2.

B.2 PROTOCOLS DESCRIPTION

Table B-1 describes the commands available for 2-way communications.

Table B-1: Protocols

DESCRIPTION	CHAR	FORMAT (2)	P (1)	B (1)	S (1)	N (1)	LEGAL VALUES	FACTORY DEFAULT
Burst string format	\$	(3)	√		√		(3)	UTEI
Ambient radiation correction	A	nnnn	√		√		0000 to 3000°C 0000 to 5432°F	0000
Advanced Hold Function Threshold (7)	C	nnnn	√		√		0000 to 3000°C 0000 to 5432°F	0000 = no advanced hold
Baud rate (5)	D	nnn			√		003=300 baud 012=1200 baud 024=2400 baud 096=9600 baud 192=19200 baud 384=38400 baud	38400
Emissivity	E	n.nn	√	√	√		0.10-1.00	1.00
Valley hold time (6)	F	nnn.n	√		√	√	000.0-300.0 secs	000.0
Average time (4)	G	nnn.n	√	√	√	√	000.0-300.0 sec	000.0
Top of mA range	H	nnnn	√	√	√	√	0000-9999 (°C or °F)	High end of sensor range
Sensor internal ambient	I	nnn	√	√				
Switch panel lock	J	X	√		√		L=Locked U=Unlocked	Unlocked
Relay alarm output control	K	n			√		0=off 1=on 2=Normally Open 3=Normally Closed	2
Bottom of mA range	L	nnnn	√	√	√		0000-9999 (°C or °F)	Low end of sensor range
Output current	O	nn		√	√		00=controlled by unit 02=under range 21=over range 04-20=current in mA	00

Notes:

- (1) Commands may appear as **P**olled for (queried), **B**urst string item, **S**et command, or **N**otification.
- (2) n = number, X = uppercase letter.
- (3) See Section B.2.2.
- (4) Setting Average cancels PKH, VAL.
- (5) The sensor restarts after a baud rate change. (Command is not allowed in broadcast mode.)
- (6) Setting Valley cancels PKH, AVG. A value of 300 = advanced or trigger.
- (7) Must be within sensor's temperature range.

DESCRIPTION	CHAR	FORMAT (2)	P (1)	B (1)	S (1)	N (1)	LEGAL VALUES	FACTORY DEFAULT
Peak hold time (3)	P	nnn.n	√	√	√	√	000.0-300.0 sec	0000.0
Power	Q	nnnn.nnn	√	√			0000.000-9999.999	
Target Temperature	T	nnnn	√	√			(4)	
Temperature units (scale)	U	X	√	√	√	√	C or F	Foreign: C US: F
Poll/burst mode	V	X			√		P=Polled B=Burst	Burst
Burst string contents (5)	X\$		√					
Multidrop address	XA	nnn	√	√	√		000 to 032	000 = standalone
Low temperature limit	XB	nnnn	√				0000-9999 (4)	Set at factory calibration
Deadband (6)	XD	nn	√		√		01-55 in °C 01-99 in °F	02
Decay Rate	XE	nnnn	√		√		0000-5555 °C 0000-9999 °F	0000
Restore factory defaults	XF				√	√		
High temperature limit	XH	nnnn	√				0000-9999 (4)	Set at factory calibration
Sensor initialization	XI	n	√	√	√	√	0=flag reset 1=flag set or nothing	1
Laser	XL	X	√		√	√	0=off (7) 1=on H=overheat (off) N=no laser built in	0
Sensor model type	XM	X	√				A, B, C	Set at factory calibration

Notes:

- (1) Commands may appear as **Polled** for (queried), **Burst** string item, **Set** command, or **Notification**.
- (2) n = number, X = uppercase letter.
- (3) Setting Peak Hold cancels Average and VAL. 300.0 means advanced or trigger.
- (4) In current scale, °C or °F.
- (5) See Section B.2.2.
- (6) No effect if relay in alarm mode.

Table B-1 (continued): Protocols

DESCRIPTION	CHAR	FORMAT (2)	P (1)	B (1)	S (1)	N (1)	LEGAL VALUES	FACTORY DEFAULT
0-20 mA or 4-20 mA analog output	XO	n	√		√		0=0-20 mA 4=4-20 mA	4
Second (low) Setpoint (6)	XP	nnnn	√		√		0000-3000°C 0000-5432°F	0000
Sensor revision	XR	Xn	√					Set at factory calibration
Setpoint/Relay function	XS	nnnn	√		√		0000 to 5432 (3)	0000
Trigger	XT	n	√	√		√	XT0=inactive XT1=active	
Identify unit	XU	varies	√					!XUFA1, !XUFA2, etc.
Sensor serial number	XV	Xnnnnnn	√					Set at factory calibration
Advanced Hold Function Hysteresis (5)	XY	nnnn	√		√		0000-3000°C 0000-5432°F	0002

Notes:

- (1) Commands may appear as **P**olled for (queried), **B**urst string item, **S**et command, or **N**otification.
- (2) n = number, X = uppercase letter
- (3) 0000 places unit in alarm mode. Non-zero setpoint value puts unit in Setpoint mode and specifies upper limit. Setpoint is in current scale, °C or °F. Must be within unit's temperature range.
- (4) Relay goes to abnormal, display and analog out continue to provide temperature. See Appendix A.
- (5) No effect if not in advanced peak or valley mode.
- (6) Must be within sensor's temperature range.

Table B-1 (continued): Protocols

**Table B-2: Command Examples
(for units in multidrop mode)**

DESCRIPTION	EXAMPLES FROM HOST		EXAMPLES FROM UNIT		WHERE USED (1)			
	QUERY	SET	RESPONSE	NOTIFICATION	P	B	S	N
Burst string format	001?\$	001\$=UTSI	001!\$UTSI		√		√	
Baud rate		001D=384	001!D384				√	
Ambient radiation correction	001?A	001A=1234	001!A1234		√		√	
Adv. Hold Function Threshold	001?C	001C=1234	001!C1234		√		√	
Emissivity	001?E	001E=0.95	001!E0.95	001#E0.95	√	√	√	√
Valley Hold	001?F	001F=005.6	001!F005.6	001#F005.6	√		√	√
Average time	001?G	001G=001.2	001!G001.2	001#G001.2	√	√	√	√
Top of mA range	001?H	001H=2000	001!H2000		√	√	√	
Sensor internal ambient	001?I		001!I028		√	√		
Switch panel lock	001?J	001J=L	001!JL		√		√	
Relay alarm output control		001K=0	001!K0				√	
Bottom of mA range	001?L	001L=1200	001!L1200		√	√	√	
Output current		001O=10	001!O10		√		√	
Peak Hold time	001?P	001P=005.6	001!P005.6	001#P005.6	√	√	√	√
Power	001?Q		001!Q0036.102		√	√		
Target Temperature	001?T		001!T1225		√	√		
Temperature units	001?U	001U=C	001!UC	001#UC	√	√	√	√
Poll/Burst mode		001V=P	001!VP				√	
Burst string contents	001?X\$		(2)		√			
Multidrop address	001?XA	001XA=013	001!XA013		√	√	√	
Low temperature limit	001?XB		001!XB0300		√			
Deadband	001?XD	001XD=12	001!XD12		√		√	
Decay Rate	001?XE	001XE=1234	001!XE1234		√		√	
Restore factory defaults		001XF	001!XF	001#!XF			√	√
High temperature limit	001?XH		001!XH1400		√			
Sensor initialization	001?XI	001XI=0	001!XI0	001#XI	√	√	√	√
Sensor Model Type	001?XM		001!XMA		√			
0-20 mA or 4-20 mA	001?XO	001XO=4	001!XO4		√		√	
Second (low) Setpoint	001?XP	001XP=1234	001!XP1234		√		√	
Sensor revision	001?XR		001!XRF1		√			
Setpoint/Relay function	001?XS	001XS=1234	001!XS1234		√		√	
Trigger	001?XT		001!XT0	001#XT0	√	√		√
Identify unit	001?XU		001!XUFA1		√			
Sensor serial number	001?XV		001!XVA099901		√			
Adv. Hold Function Hysteresis	001?XY	001XY=0056	001!XY0056		√		√	

Notes:

- (1) Commands may appear as Polled for (queried), Burst string item, Set command, or Notification.
- (2) See Section B.2.2.

B.2.1 Poll Versus Burst Modes

The interface has two modes of operation: Poll and Burst. Either mode can be selected by the host.

Poll: The current value of any individual parameter can be requested by the host. The unit responds once with the value at the selected baud rate. Additionally, the user-defined output string can be polled.

Burst: The unit transmits the user-defined output string (continuously, at the selected baud rate), which may contain all of the parameters except for those noted in Section B.2.2. Parameters may also be polled for while the instrument is in burst mode. If a parameter is polled while the unit is in burst mode, it will transmit the response after the next burst string.

B.2.2 The Burst Mode

The sensor transmits the parameters in a fixed order, regardless of the order in which they are specified. This order is as follows:

1. Temperature unit (scale)
2. Target temperature
3. Power
4. Emissivity
5. Peak hold time
6. Average time
7. Internal temperature
8. Temperature setting for 20 mA
9. Temperature setting for 0/4 mA
10. Output current
11. Trigger status
12. Multidrop address
13. Initialization flag

The following items cannot be placed in the burst output string:

- Poll/Burst Mode
- Baud Rate
- Sensor Model Type
- Sensor Serial Number
- Relay Control
- Setpoint 1
- Setpoint 2
- Advanced Hold Threshold
- Hysteresis
- Valley Hold Time
- Decay Rate
- Deadband
- Current Output Mode (0–20 mA/4–20 mA)
- Ambient Correction
- Switch Panel Lock
- Low Temperature Limit
- High Temperature Limit
- Unit Identification
- Serial Number

The following items cannot be polled:

- Poll/Burst Mode
- Baud Rate
- Relay Control
- Output Current

An example string for command $\$=UTQEGH<CR>$:

```
C T1250 Q0400.023 E1.00 G005.5 H1400 <CR><LF>
```

The default string is as follows: `C T1234 E1.00 I025 <CR><LF>`

B.3 REMOTE VERSUS MANUAL CONSIDERATIONS

Since the sensor includes a local user interface, the possibility exists for a person to make manual changes to parameter settings. To resolve conflicts between inputs to the sensor, it observes the following rules:

- Command precedence: the most recent parameter change is valid, whether originating from manual or remote.
- If a manual parameter change is made, the sensor will transmit a “notification” string to the host. (See examples in Table B-2.) Note that notification strings are suppressed in multidrop mode.
- A manual lockout command is available in the protocols set so the host can render the user interface “display only,” if desired.

All parameters, except for Relay Control and Set Current Output, set via the 2-way interface are retained in the sensor's nonvolatile memory.

Note: When a unit is placed in multidrop mode its manual user interface is automatically locked.

B.4 RESPONSE TIME

The analog output response time is not guaranteed while a parameter value is being changed or if there is a continuous stream of commands from the host.

The digital response time specifies how quickly the unit can report a temperature change via RS-485 in burst mode. (Digital response time is not defined for polled mode.) The digital response time is defined as the time that elapses between a change in target temperature and the transmission of a burst string reporting the new temperature. Actual digital response time can vary from one reading to the next, so the digital response time is defined as the "average digital response time."

The average digital response time depends on the number of characters requested in the output string and with the baud rate. It may be computed as the following:

$$t = 9.9 + \frac{n \times 15000}{b}$$

where

t = average digital response time in ms

n = the number of characters in the string, including <CR> and <LF>

b = the baud rate

Example:

With a baud rate of 38400, and an output string containing temperature units, 2-color temperature, emissivity, and ambient (20 characters), the average digital response time would be the following:

$$t = 9.9 + \frac{20 \times 15000}{38400}$$

$$= 17.7 \text{ ms}$$

Note that the analog output response time is not affected by baud rate or the number of characters transmitted in the burst string.

APPENDIX C: OBJECT EMISSIVITY

C.1 HOW TO DETERMINE OBJECT EMISSIVITY

Emissivity is the measure of an object's ability to emit infrared energy. It can have a value from 0 (shiny mirror) to 1.0 (blackbody). If a higher than actual value of emissivity is set in a sensor, the output will read low, provided the target temperature is above ambient. For example, if 0.95 is set in and the actual emissivity is 0.9, the reading will be lower than the true temperature when the target temperature is above ambient.

The emissivity can be determined by one of the following methods, in order of preference:

1. Determine the actual temperature of the material using a sensor such as an RTD, thermocouple or another suitable method. Next, measure the object temperature and adjust the emissivity setting until the correct value is reached. This is the correct emissivity for the measured material.
2. For relatively low temperature (up to 500°F or 260°C) objects, place a piece of tape, such as electrical or masking, on the object - large enough to cover the field of view. Next, measure the tape temperature using an emissivity setting of 0.95. Finally, measure an adjacent area on the object and adjust the emissivity setting until the same temperature is reached. This is the correct emissivity for the measured material.
3. If a portion of the surface of the object can be coated, use a dull black paint, which will have an emissivity of about 0.98. Next, measure the painted area using an emissivity setting of 0.98. Finally, measure an adjacent area on the object and adjust the emissivity setting until the same temperature is reached. This is the correct emissivity for the measured material.

C.2 TYPICAL EMISSIVITY VALUES

The following table provides a brief reference guide for determining emissivity and can be used when one of the above methods is not practical. Emissivity values shown in the tables are only approximate, since several parameters may affect the emissivity of an object. These include the following:

1. Temperature
2. Angle of measurement
3. Geometry (plane, concave, convex, etc.)
4. Thickness
5. Surface quality (polished, rough, oxidized, sandblasted)
6. Spectral region of measurement
7. Transmissivity (i.e., thin film plastics)

Note: A material's emissivity differs when measured by sensors with different spectral responses (wavelengths). Select the appropriate column depending on your sensor model. (Refer to Table 1-1 for information on your sensor's spectral response.)

Table C-1: Metals

MATERIAL	EMISSIVITY	
	1.0μm	1.6μm
Aluminum		
Unoxidized	0.1-0.2	0.02-0.2
Oxidized	0.4	0.4
Alloy A3003,		
Oxidized	—	0.4
Roughened	0.2-0.8	0.2-0.6
Polished	0.1-0.2	0.02-0.1
Brass		
Polished	0.1-0.3	0.01-0.05
Burnished	—	—
Oxidized	0.6	0.6
Chromium	0.4	0.4
Copper		
Polished	—	0.03
Roughened	—	0.05-0.2
Oxidized	0.2-0.8	0.2-0.9
Gold	0.3	0.01-0.1
Haynes		
Alloy	0.5-0.9	0.6-0.9
Inconel		
Oxidized	0.4-0.9	0.6-0.9
Sandblasted	0.3-0.4	0.3-0.6
Electropolished	0.2-0.5	0.25
Iron		
Oxidized	0.4-0.8	0.5-0.9
Unoxidized	0.35	0.1-0.3
Rusted	—	0.6-0.9
Molten	0.35	0.4-0.6
Iron, Cast		
Oxidized	0.7-0.9	0.7-0.9
Unoxidized	0.35	0.3
Molten	0.35	0.3-0.4
Iron, Wrought		
Dull	0.9	0.9
Lead		
Polished	0.35	0.05-0.2
Rough	0.65	0.6
Oxidized	—	0.3-0.7

Table C-1 (continued): Metals

MATERIAL	EMISSIVITY	
	1.0 μ m	1.6 μ m
Magnesium	0.3-0.8	0.05-0.3
Mercury	—	0.05-0.15
Molybdenum		
Oxidized	0.5-0.9	0.4-0.9
Unoxidized	0.25-0.35	0.1-0.35
Monel (Ni-Cu)	0.3	0.2-0.6
Nickel		
Oxidized	0.8-0.9	0.4-0.7
Electrolytic	0.2-0.4	0.1-0.3
Platinum		
Black	—	0.95
Silver	—	0.02
Steel		
Cold-Rolled	0.8-0.9	0.8-0.9
Ground Sheet	—	—
Polished Sheet	0.35	0.25
Molten	0.35	0.25-0.4
Oxidized	0.8-0.9	0.8-0.9
Stainless	0.35	0.2-0.9
Tin (Unoxidized)	0.25	0.1-0.3
Titanium		
Polished	0.5-0.75	0.3-0.5
Oxidized	—	0.6-0.8
Tungsten	—	0.1-0.6
Polished	0.35-0.4	0.1-0.3
Zinc		
Oxidized	0.6	0.15
Polished	0.5	0.05

Table C-2: Non-Metals

MATERIAL	EMISSIVITY
	1.0μm
Asbestos	0.9
Asphalt	—
Basalt	—
Carbon	
Unoxidized	0.8-0.95
Graphite	0.8-0.9
Carborundum	—
Ceramic	0.4
Clay	—
Concrete	0.65
Cloth	—
Glass	
Plate	—
“Gob”	—
Gravel	—
Gypsum	—
Ice	—
Limestone	—
Paint (non-al.)	—
Paper (any color)	—
Plastic (opaque, over 20 mils)	—
Rubber	—
Sand	—
Snow	—
Soil	—
Water	—
Wood, Natural	—

To optimize surface temperature measurements consider the following guidelines:

1. Determine the object emissivity using the instrument used for the measurement.
2. Avoid reflections. Shield the object from surrounding high temperature sources.
3. For higher temperature objects, use shorter wavelength instruments whenever overlap occurs.
4. For semi-transparent materials such as plastic film and glass, assure that the background is uniform and lower in temperature than the object.
5. Mount the sensor perpendicular to a surface whenever emissivity is less than 0.9. In all cases, do not exceed angles more than 30 degrees from incidence.

APPENDIX D: TRACEABILITY OF INSTRUMENT CALIBRATION

The temperature sources (blackbodies) used to calibrate this instrument are traceable to the U.S. National Institute of Standards and Technology (NIST).

The calibration sources for this instrument were certified by a NIST certified calibration laboratory and are traceable to NIST primary standards. The certificate describes the equipment used for calibration and any corresponding NIST report numbers. In addition, the certificate lists test accuracy data and the next calibration date.

NIST certificates are available as an option (must be ordered with the instrument). Contact the manufacturer (not NIST) to order this option.

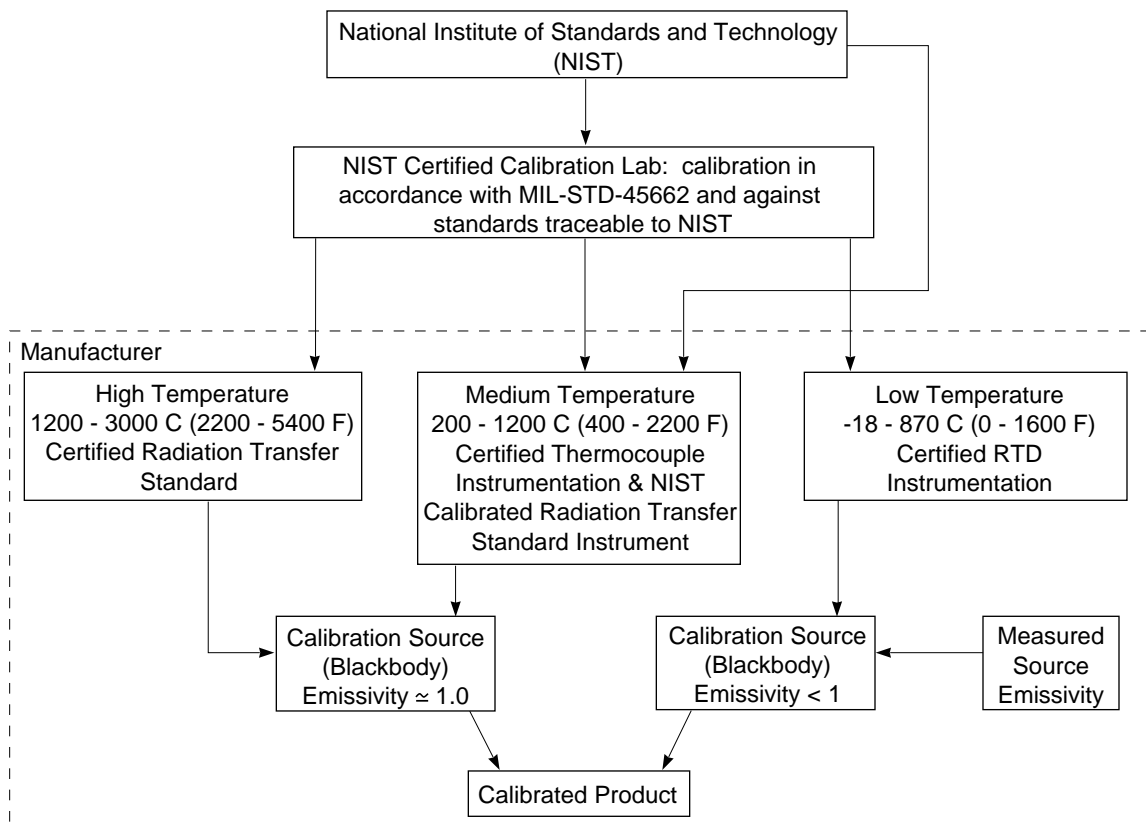


Figure D-1: Traceability of Temperature Instrumentation Calibration

Note: NIST certificates are currently only available for Si detector models.

**APPENDIX E: CE CONFORMITY FOR THE
EUROPEAN COMMUNITY**



This instrument conforms to the following standards:

- EN50081-2 Emission Standard
- EN50082-2 Immunity Standard

Glossary Of Terms

This glossary of terms defines vocabulary and nomenclature commonly used within Raytek manuals and literature and is a part of every online product manual. Raytek encourages feedback on items contained within the glossary. Please feel free to offer suggestions on additions, clarification, and/or deletions to this document.

Absolute Zero	The temperature of -273.16°C , -459.69°F , or 0°K ; thought to be the temperature at which molecular motion vanishes and a body would have no heat energy. [Ref.1]
Accuracy	The maximum deviation in a set of measurements between the temperature indicated by a radiation thermometer and the known temperature of a reference source, including the uncertainty of the reference temperature source. [Ref. 3] The accuracy can be expressed in a variety of ways including temperature, percentage of temperature reading, or percentage of full scale temperature of an instrument.
Ambient Derating	Derating or decrease in accuracy of an instrument due to changes in its ambient temperature from that at which it was calibrated. See also Temperature Coefficient.
Ambient Operating Range	Range in the ambient temperature over which the instrument is designed to operate.
Ambient Temperature	The temperature of the instrument. Can also refer to the temperature that gives rise to the background. See Background Radiation.
Ambient Temperature Compensation (TAMB)	See Reflected Energy Compensation.
ASTM	American Society for Testing and Materials.
ASTM E 1256	ASTM E1256 - 88, Standard Test Methods for Radiation Thermometers (Single Waveband Type). A standard by which Raytek products are tested and calibrated for accuracy, repeatability, resolution, target size, response time, warm-up time, and long-term drift.
Atmospheric Windows	The spectral bands in which the atmosphere least affects the transmission of radiant energy. The spectral bands are 0.4 to 1.8, 2 to 2.5, 3 to 5, and 8 to 14 micrometers.
Background Radiation	Radiation that enters an instrument from sources other than the intended target. Background radiation can enter due to reflections from the target or scattering within the instrument.
Blackbody	An ideal thermal radiator that absorbs all of the radiation incident thereon, and the radiant emission from which is quantified by Planck's Radiation Law. [Refs. 2,3]
Calibration Procedure	A procedure that is performed to determine and set the parameters affecting an instrument's performance in order to ensure its designed function within prescribed limits.
Calibration Source	A source for which the radiance temperature can be calibrated to within a known level of uncertainty in relation to some other parameter, and in which this relationship is sufficiently constant to enable it to be used for a reasonable period without calibration. [Ref. 4]

Carnot Cycle	An ideal heat engine that converts thermal energy to mechanical work with the greatest efficiency that can be achieved.
Celsius or C	The temperature scale in which the temperature in Celsius (T_C) is related to the temperature in Kelvin (T_K) by the formula; $T_C = T_K - 273.15$. The freezing point of water at standard atmospheric pressure is very nearly 0°C , and the corresponding boiling point is very nearly 100°C . Formerly known as centigrade temperature scale. [Ref. 1]
Color Temperature	The temperature of a black body from which the radiant energy has the same spectral distribution as that from a surface.
Colored Body or Non Gray Body	A source of thermal emission for which the emissivity depends on wavelength and is not constant.
Comparison Pyrometry	Method of radiation thermometry wherein the temperature of a calibrated source is changed until the radiation received from the source is the same as that from the target to determine the temperature of the target.
Current-Loop	A form of communications wherein a pair of wires is used to transmit the signal as a current. Levels of 4 to 20 mA are often used to indicate the minimum and maximum signal level, respectively. Sometimes, for digital applications, various magnitudes of mA current are used to indicate a logical 1 and 0. The current loop is often characterized by a maximum impedance of the device that is connected to the loop.
D:S	Optical resolution expressed as a ratio of the distance to the resolution spot divided by the diameter of the spot.
Deadband	Temperature band (\pm) about the set point, wherein an alarm output or relay cannot change state, thus providing hysteresis.
Detector	Transducer which produces a voltage or current proportional to the electromagnetic energy incident upon it. See also Thermopile, MCT, Thermoelectric Cooled, Pyroelectric, and Lead Selenide and Si detectors.
Dielectric Withstand Voltage (Breakdown Voltage)	The maximum voltage an insulator of electricity can endure without electrical conduction through the material.
Digital Data Bus	Two or more electrical conductors connecting several transmitters and receivers of digital data.
Digital Image Processing	Converting an image to digital form and changing the image to enhance it or prepare it for analysis by computer or human vision. In the case of an infrared image or thermogram, this could include temperature scaling, spot temperature measurements, thermal profiles, image addition, subtraction, averaging, filtering, and storage.
Digital Output Interval (DOI)	The time interval between transmission of packets of digital data containing temperature and system status information.
DIN	Deutsches Institut für Normung. The German standard for many instrumentation products.
Drift	The change in instrument indication over a period of time not caused by external influences on the device. [Ref. 3]

EMI/RFI	Electro-Magnetic Interference/Radio Frequency Interference, which affects the performance of electronic equipment.
Emissivity	At a given wavelength the ratio of infrared energy radiated by an object at a given temperature to that emitted by a blackbody at the same temperature. The emissivity of a blackbody is unity at all wavelengths.
Environmental Rating	A rating given (usually by agencies and regulatory bodies) to indicate the severity of the environment in which the unit will function reliably.
External Reset (Trigger)	Initialization of an instrument to its state at power up including signal conditioning features (Peak Hold, Valley Hold, Sample Hold, Average, 1-way RS232, etc.) via the external reset input.
Fahrenheit or F	Temperature measurement scale where, at standard atmospheric pressure, the freezing point of water is 32°F and the vaporization point of water is 212°F. To convert from Celsius, use $F = (C \times 1.8) + 32$.
Fail-Safe Operation	A feature designed to alert the operator via display, and to bring a process to a safe shutdown via output, in the event of a particular control system or process failure.
Far Field	A measurement distance sufficiently large (typically greater than 10 times the focal distance) whereby the spot size of an instrument is growing in direct proportion to the distance from the instrument, and the field of view is constant.
Field of View (FOV)	The area or solid angle viewed through an optical or infrared instrument. Typically expressed by giving the spot diameter of an instrument and the distance to that spot. Also expressed as the angular size of the spot at the focal point. See Optical or Infrared Resolution.
Focal Point or Distance	The point or distance from the instrument at which the object is focused onto the detector within the instrument. The focal point is the place or distance at which the optical or infrared resolution is greatest.
Full Scale Accuracy	The temperature measurement accuracy expressed as a percentage of the maximum possible reading of an instrument.
Gray Body	A source of radiant emissions for which the emissivity is less than 1 but constant and, therefore, independent of wavelength.
IEC	International Electrotechnical Commission. A European organization that coordinates and sets related standards among the European Community.
IEEE-488	A standard developed by Hewlett-Packard Corporation and adopted by the IEEE for digital interface between programmable instrumentation. It uses a 16-bit bus to interconnect up to 15 instruments. The standard comprises hardware and protocol options. It is also called the Hewlett-Packard Interface Bus (HPIB) or General Purpose Interface Bus (HPIB) or General Purpose Interface Bus (GPIB). The present standard is ANSI/IEEE-4881-1987.
IFOV (Instantaneous Field of View)	Instantaneous Field of View is the angular resolution of an imaging instrument that is determined by the size of the detector and the lens. For a point instrument the IFOV and FOV are the same.

Image Processing	Converting an image to a digital form and further enhancing the image to prepare it for computer or visual analysis. In the case of an infrared image or thermogram, this could include temperature scaling, spot temperature measurements, and thermal profiles, as well as image addition, subtraction, averaging, filtering, and storage.
Indium Antimonide (InSb)	A material used to construct photon detectors that are sensitive in the spectral region from 2.0 to 5.5 μm and used in infrared scanners and imagers. These detectors require cryogenic cooling.
Infrared Radiation (IR)	Radiation within the portion of the electromagnetic spectrum which extends from 0.75 to 1000 μm .
Infrared or Optical Filter	See Spectral Filter or Neutral Density Filter.
Infrared Thermometer	An instrument that determines the temperature of an object by means of detecting and quantifying the infrared radiation emitted therefrom. Types include total power, wide band, narrow band, and multiple wavelengths.
Insulation Resistance	The property of a material to resist the flow of electrical current and expressed in Megohms (M) as the ratio of an applied electrical potential divided by the flow of electrical current resulting therefrom.
Interchangeability (of heads)	The ability for a head sensor to be interchanged with another of the same type without the need to recalibrate the system (also referred to as Universal Electronics). Some monitors support the interchangeability of different types of heads.
Intrinsically Safe	A standard for preventing explosions in hazardous areas by limiting the electrical energy available to levels that are insufficient to cause ignition of explosive atmospheres during normal operation of an instrument.
IP Designation	Grades of intrinsic safety protection pertaining to enclosures per the British Standard 4752. The type of protection is defined by two digits, the first relating to accessibility and the second to environmental protection. The two numbers are preceded by the letters IP. [Ref. 6]
Isolated Inputs, Outputs or Power Supplies	Inputs, outputs and power supply lines that are electrically insulated from each other, whereby arbitrary grounding of these lines cannot affect the performance of the instrument such as generate ground-loops or short out internal resistors.
Isotherm	A continuous line (not necessarily straight or smooth) on a surface (or chart) comprising points of equal or constant temperature.
JIS	Japanese Industrial Standard. A technical governing body that sets standards for determining or establishing the accuracy of IR thermometers.
Kelvin or K	A temperature scale that is directly related to the heat energy within a body. Formally, a temperature scale in which the ratio of the temperatures of two reservoirs is equal to the ratio of the amount of heat absorbed from one of the them by a heat engine operating in a Carnot Cycle to the amount of heat rejected by this engine to the other reservoir. The temperature of the triple point of water (in this scale) is defined as 273.16° K. [Ref. 1] To convert from Celsius, $K=C+273.16$.
Lead Selenide (PbSe)	A material used to make photon detectors that are sensitive in the 3 to 5 μm spectral band. These detectors require thermoelectric cooling and are used in IR thermometers, scanners, and imagers.

Maximum Current Loop Impedance	Describes the size of a load that can be driven by an instrument with a mA output. For example a 500 ohm maximum loop impedance means that the instrument can supply 10 volts at 20 mA into this load.
MCT (Mercury Cadmium Telluride) or HgCdTe	A ternary alloy material used to build photon detectors that are sensitive in the 3-5 μ m and 8-14 μ m regions of the spectrum and require TE cooling in the 3-5 μ m region and cryogenic cooling in the 8-14 μ m region.
Minimum spot size	The diameter of the smallest object for which an instrument can meet its performance specifications.
NEMA	National Electrical Manufacturer's Association. Among its activities, sets US standards for housing enclosures, similar to IEC IP.
NET	See NETD.
NETD (or NE³T)	Noise Equivalent Temperature Difference or the change in temperature of a blackbody target that fills the radiometer FOV which results in a change in the radiometer signal equal to the rms noise of the instrument.
Neutral Density Filter	An optical or infrared filter for which the transmission is constant and not a function of wavelength.
NIST Traceability	Calibration in accordance with and against standards traceable to NIST (National Institute of Standards and Technology, USA). Traceability to NIST is a means of ensuring that reference standards remain valid and their calibration remains current.
Optical or Infrared Resolution	The ratio of the distance to the target divided by the diameter of the circular area (or spot) for which the energy received by the thermometer is a specified percentage of the total energy that would be collected by an instrument viewing a calibration source at the same temperature. The distance to the target is generally the focal distance of the instrument. The percentage energy is generally 90% to 95%.
Optical Pyrometer	A system that, by comparing a source whose temperature is to be measured to a standardized source of illumination (usually compared to the human eye), determines the temperature of the former source.
Output Impedance	Describes the impedance of the thermometer that is experienced by any device connected thereto. To achieve accurate readings, the input impedance of a device connected to the thermometer must be much greater than the output impedance of the thermometer.
Peak Hold	Output of the maximum temperature measurement indicated by an instrument during the time duration for which this display mode has been active.
Photodetector or Quantum Detector	A type of detector in which the photons or quanta of energy interact directly with the detector to generate a signal.
Pyroelectric Detector	Thermal detector that has a signal generated by means of the pyroelectric effect wherein changes in temperature of the detector generates an electrical signal.
Pyrometer	A broad class of temperature measuring devices. They were originally designed to measure high temperature, but some are now used in any temperature range. Includes radiation pyrometers, thermocouples, resistance pyrometers, and thermistors.

Radiance Temperature	The temperature of a black body which has a radiance equal to the radiance of the object at a particular wavelength or wavelength band. [Ref. 5]
Radiant Energy	The electromagnetic energy emitted by an object due to its temperature.
Radiation Thermometer	A device used to measure the temperature of an object by quantification of the electromagnetic radiation emitted therefrom. Also, a radiometer calibrated to indicate a blackbody's temperature. [Ref. 3]
Rankine or R	The absolute temperature scale related to Fahrenheit in the equivalent manner Kelvin is to Celsius. $R = 1.8 \times K$, or also $R = F + 459.67$.
Reference Junction or Cold Junction	Refers to the thermocouple junction that must be known in order to infer the temperature of the other or thermocouple measurement junction.
Reflectance	The ratio of the radiant energy reflected from a surface to that incident on the surface.
Reflected Energy Compensation	Feature used to achieve greater accuracy by compensating for background IR energy that is reflected off the target into the instrument. If the temperature of the background is known, the instrument reading can be corrected by using this feature.
Relative Humidity	The dimensionless ratio of the actual vapor pressure of the air to the saturation vapor pressure (abbreviated RH). Percent relative humidity is expressed as the product of RH and 100. For example an RH of 0.30 is a percent relative humidity of 30%. [Ref. 1]
Repeatability	The degree to which a single instrument gives the same reading on the same object over successive measures under the same ambient and target conditions. The ASTM standard E 1256 defines it as the sample standard deviation of twelve measurements of temperature at the center of the span of the instrument. Generally expressed as a temperature difference or a percent of full scale value, or both. [Ref. 3]
Resolution	See Temperature Resolution, Optical Resolution, or Spatial Resolution.
Response Time	The time for an instrument's output to change to 95% of its final value when subjected to an instantaneous change in target temperature corresponding to the maximum temperature the instrument can measure (per ASTM E 1256). The average time required for software computation within the processor is also included in this specification for Raytek products.
RS-232	Recommended Standard (RS) 232 is a standard developed by the Electronic Industries Association (EIA) that governs the serial communications interface between data processing and data communications equipment and is widely used to connect microcomputers to peripheral devices. [Ref. 1] The present revision is EIA-RS-232-D, which defines the interface between Data Terminal Equipment (DTE) and Data Communications Equipment (DCE) employing serial binary data interchange. The standard does not define the protocol or format of the binary stream. The standard comprises three parts: electrical characteristics, interface mechanical characteristics, and functional description of the interchange circuits. The equivalent international standard is Comite Consultatif International Telegraphique et Telephonique (CCITT) V.24.
RS-422	A recommended standard developed by EIA that defines a balanced interface and is an expansion of RS-423 that increases the data rate to 10 Mbps. see RS-423

RS-423	A recommended standard developed by EIA that defines an unbalanced interface and is an expansion of RS-232 and provides improvements included increased connecting cable lengths, increased data rates, and use of multiple receivers on line.
RS-485	A recommended standard developed by EIA that is an improvement over RS-422 in that it allows an increase in the number of receivers and transmitters permitted on the line.
RTD	Resistance Temperature Device. A contact measurement device whose resistance varies with temperature.
Sample Hold	A temperature taken from a target and displayed or held for a set period of time or until the next external reset occurs.
Scatter	Radiant energy reaching the detector of an instrument from the background other than that which is reflected from the target.
Set Point	Process or measurement variable setting which when crossed by the measured value will trigger an event and/or cause a relay to change state.
Shock Test	An impact test where an object or test unit is subjected to an impulsive force which is capable of exciting mechanical resonances of vibration.
Signal Processing	Manipulation of temperature data for purposes of enhancing the data. Examples of signal processing functions include Peak Hold, Valley Hold, and Averaging.
Silicon (Si) Detector	A photon detector used in measurement of high temperatures.
Size-of-Source Effect	The effect by which the energy collected by, and temperature reading of, an instrument continues to increase as the size of a target increases beyond the field-of-view of the instrument. It is caused by two occurrences: the remaining energy above the percentage used to define location and scattering of radiation as it enters the instrument such that energy from outside the FOV of the instrument enters it. The existence of this effect means that the accuracy of the instrument may be affected by targets that are too large as well as too small. This effect is also called Target Size Effect. [ASTM STP 895]
Slope	The ratio of the emissivities for the two spectral bands of a 2-color radiometer. The emissivity of the shorter wavelength band is divided by the emissivity of the longer wavelength band. Slope can be greater than, equal to, or less than unity. Slope accounts for materials where emissivity varies with wavelength.
Spectral Filter	An optical or infrared element used to spectrally limit the transmission of radiant energy reaching an instrument's detector.
Spectral Response	The wavelength region in which the IR Thermometer is sensitive.
Spot	The diameter of the area on the target where the temperature determination is made. The spot is defined by the circular aperture at the target which allows typically 90% of the IR energy from the target to be collected by the instrument. See also Size-of-Source Effect.

Stare or Lag	A saturation effect whereby the signal from an instrument endures beyond the response time after the target has been removed from the field of view. Can be caused by exposing the sensor to a target of high temperature for an extended period. The effect is expressed as the increase in response time required for the sensor to return to within 5% of the correct reading.										
Storage Temperature Range	The ambient temperature range an instrument can survive in a non-operating mode and perform within specifications when operated.										
Target	The object upon which the temperature is determined.										
Target Size Effect	See Size-of-Source Effect.										
Temperature	A property of an object which determines the direction of heat flow when the object is placed in thermal contact with another object (i.e., heat flows from a region of higher temperature to one of lower temperature). [Ref. 1]										
Temperature Coefficient	The change in accuracy of an instrument with changes in ambient temperature from that at which the instrument was calibrated. Usually expressed as the percent change in accuracy (or additional error in degrees) per change in ambient temperature. For a rapid change in ambient conditions, refer to Thermal Shock.										
Temperature Resolution	The minimum simulated or actual change in target temperature that gives a usable change in output and/or indication. [Ref. 3]										
Temporal Drift	The change in accuracy of an instrument over time. This effect may be due to aging of the instrument's components or calibration changes.										
Thermal Detector	Detector in which the photons of incident radiation are converted to heat and then into a signal from the detector. Thermal detectors include pyroelectric, bolometer, and thermopile types.										
Thermal Drift	See Temperature Coefficient.										
Thermal Radiator	An object that emits electromagnetic energy due to its temperature.										
Thermal Shock	An error due to a rapid change in the ambient temperature of an instrument. Expressed as a maximum error and the time required for performance to return to prescribed specifications.										
Thermistor	A semiconductor material whose resistivity changes with temperature.										
Thermocouple	A set of two junctions of two dissimilar metals used to measure temperature by means of the Peltier effect, whereby heat is liberated or absorbed by the flow of electrical current through a junction of two dissimilar metals such that an electrical potential develops between two such junctions in proportion to the difference in temperature of the junctions. A variety of types exist including: <table> <tr> <td>J (Fe / constantan)</td> <td>K (chromel / alumel)</td> </tr> <tr> <td>T (Cu / constantan)</td> <td>E (chromel / constantan)</td> </tr> <tr> <td>R (Pt / Pt - 30% Rh)</td> <td>S (Pt / Pt -10% Rh)</td> </tr> <tr> <td>B (Pt - 6% Rh / Pt - 30% Rh)</td> <td>G (W / W - 26% Re)</td> </tr> <tr> <td>C (W - 5% Re / W - 26% Re)</td> <td>D (W - 3% Re / W - 25% Re)</td> </tr> </table>	J (Fe / constantan)	K (chromel / alumel)	T (Cu / constantan)	E (chromel / constantan)	R (Pt / Pt - 30% Rh)	S (Pt / Pt -10% Rh)	B (Pt - 6% Rh / Pt - 30% Rh)	G (W / W - 26% Re)	C (W - 5% Re / W - 26% Re)	D (W - 3% Re / W - 25% Re)
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Thermoelectric (TE) Cooling	Cooling based on the Peltier effect. An electrical current is sent through two junctions of two dissimilar metals. One junction will grow hot while the other will grow cold. Heat from the hot junction is dissipated to the environment, and the cold from the other junction is used to cool. [Ref. 1]
Thermogram	A thermal photograph generated by scanning an object or scene. [Ref. 1]
Thermopile	A number of similar thermocouples connected in series, arranged so that alternate junctions are at the reference temperature and at the measured temperature, to increase the output for a given temperature difference between reference and measuring junctions. [Ref. 2]
Time Constant	The time it takes for a sensing element to respond to 63.2% of a step change at the target.
Transfer Standard	A precision radiometric measurement instrument with NIST traceable calibration in the USA (with other recognized standards available for international customers), used to calibrate radiation reference sources.
Transmittance	The ratio of IR radiant energy incident on an object to that exiting the object.
Triple Point	The condition of temperature and pressure under which the gaseous, liquid, and solid phases of a substance can exist in equilibrium. For water at atmospheric pressure, this is typically referred to as its freezing point.
Two-Color Thermometry	A technique that measures the energy in two different wavelength bands (colors) in order to determine temperature. The 2 color technique has been shown to be effective for correcting errors due to partial blockage of the target caused by dust particles.
Valley Hold	Output of the minimum temperature measurement indicated by an instrument during the time duration for which this display mode has been active.
Verification	Confirmation of a design with regard to performance within all prescribed specifications.
Vibration Test	A test where oscillatory or repetitive motion is induced in an object (as per MIL-STD-810 or IEC 68-2-6), which is specified as an acceleration in g's and power spectral density (PSD), after which the unit is tested for proper operation.
Warm-Up Time	Time, after turn on, until the instrument will function within specified repeatability. [Ref. 3]

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