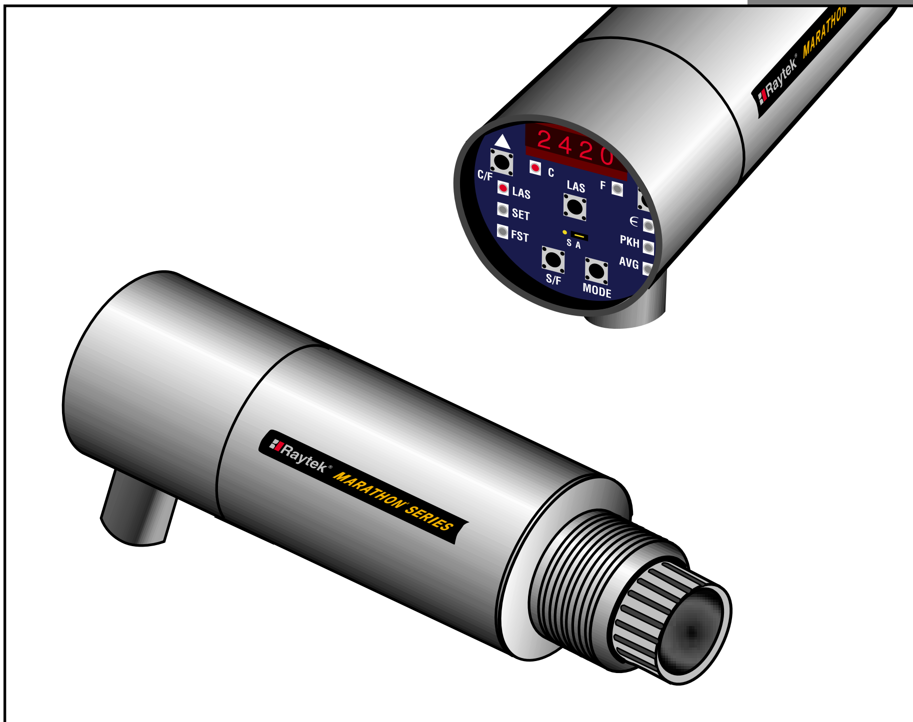
MA1S/MA2S

MARATHON SERIES



Marathon

Integrated High-Performance Infrared Thermometer

Operator's Manual

Raytek®

Rev. C 9/99
57204-1

ISO 9001 Certified

WARNING

Exposing Raytek products to temperatures in excess of their maximum rated ambient temperature specification may result in a health hazard.

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APPENDICES

Part 1 Introduction

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 non-multidrop or multidrop networked environment.

Topics include...

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

ABOUT THIS MANUAL

The *Marathon MA1S/MA2S 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 non-multidrop, 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 non-multidrop, 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 three supplied Marathon utility programs. Two programs can be used in any Marathon sensor environment, one program is for a multidrop network environment only.
- **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 Field Calibration Guide, which allows you to calibrate your sensor at its installed location; 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 / non-multidrop–Go to Part 2.
- Each Additional Sensor / Computer / non-multidrop–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 Marathon Series™ MA1S/MA2S infrared thermometers combine superior performance with state-of-the-art digital technology. These integrated units offer an advanced electro-optical design, which ensures high accuracy in the most difficult applications. They also inlcude smart digital electronics, which allow 2-way RS-485 communication and multidrop capabilities, and a built-in user interface–all housed in a rugged, compact enclosure. Each model (see Table 1-1) is optimized to yield excellent performance over a wide measurement and ambient temperature range.

Table 1-1: Models

MODEL	TEMPERATURE RANGE	OPTICAL RESOLUTION (NOMINAL)*	SPECTRAL RESPONSE
MA1SA	500 to 1400°C (932 to 2550°F)	≥ 80:1	1 micron
MA1SB	600 to 2000°C (1110 to 3630°F)	≥ 300:1	1 micron
MA1SC	750 to 3000°C (1382 to 5430°F)	≥ 300:1	1 micron
MA2SA	250 to 1000°C (482 to 1830°F)	≥ 80:1	1.6 micron
MA2SB	300 to 1400°C (572 to 2550°F)	≥ 200:1	1.6 micron
MA2SC	350 to 2000°C (662 to 3630°F)	≥ 300:1	1.6 micron

* Values indicate "worst case" limits at 95% energy.

All models consist of optical elements, spectral filters, detector, digital electronics and a NEMA-4 (IEC 529, IP 65) housing. Each is built to operate on a 100 percent duty cycle in industrial environments. Outputs consist of standardized current signals commonly available for use with computers, controllers, recorders, alarms, or A/D interfaces.

Models are available with standard focus or close focus optics. Standard Focus MA1S models can be focused from 600 mm (24 in) to infinity, and MA2S models can be focused from 650 mm (27 in) to infinity. MA1S models with the optional Close Focus optics can be focused from 280 mm (11 in) to 460 mm (18 in), MA2S Close Focus models can be focused from 300 mm (12 in) to 555 mm (22 in).

Each model is available with through-the-lens sighting or with a laser aiming option. 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:

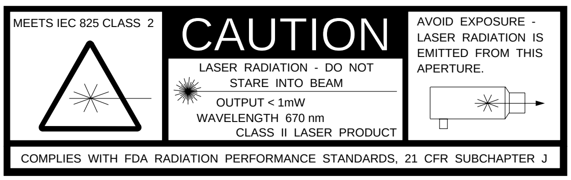
- Air purge collar
- Fixed bracket
- Adjustable bracket (included)
- Mounting nut (included)
- Swivel bracket
- Polarizing filter (for sighting head)
- Isolated 24 VDC power supply (110 or 220) or switching power supply with universal input (110/220)
- RS-485 to RS-232 interface converter (w/110V or 220V power supply)
- 4, 8, 15, 30, or 60 meter (13, 26, 50, 100, or 200 feet) cable (For cable longer than 60 meters (200 feet), contact your sales representative.)
- Marathon Software (supplied)
- Field Calibration Software (supplied)
- Terminal Block Accessory
- ThermoJacket™ protective housing and accessories
  - Mounting bracket
  - Mounting flange
  - Sighting tube mounting flange
  - Stainless steel sighting tube
  - Ceramic sighting tube
  - Adjustable pipe adapter
  - Blast gate
  - Focusing tool

Notes: Sensing heads 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 options are available:

- Air/Water-cooled housing
- NIST certification
- Glass window endcap (easy viewing of electronic enclosure LEDs) instead of standard endcap
- Laser aiming



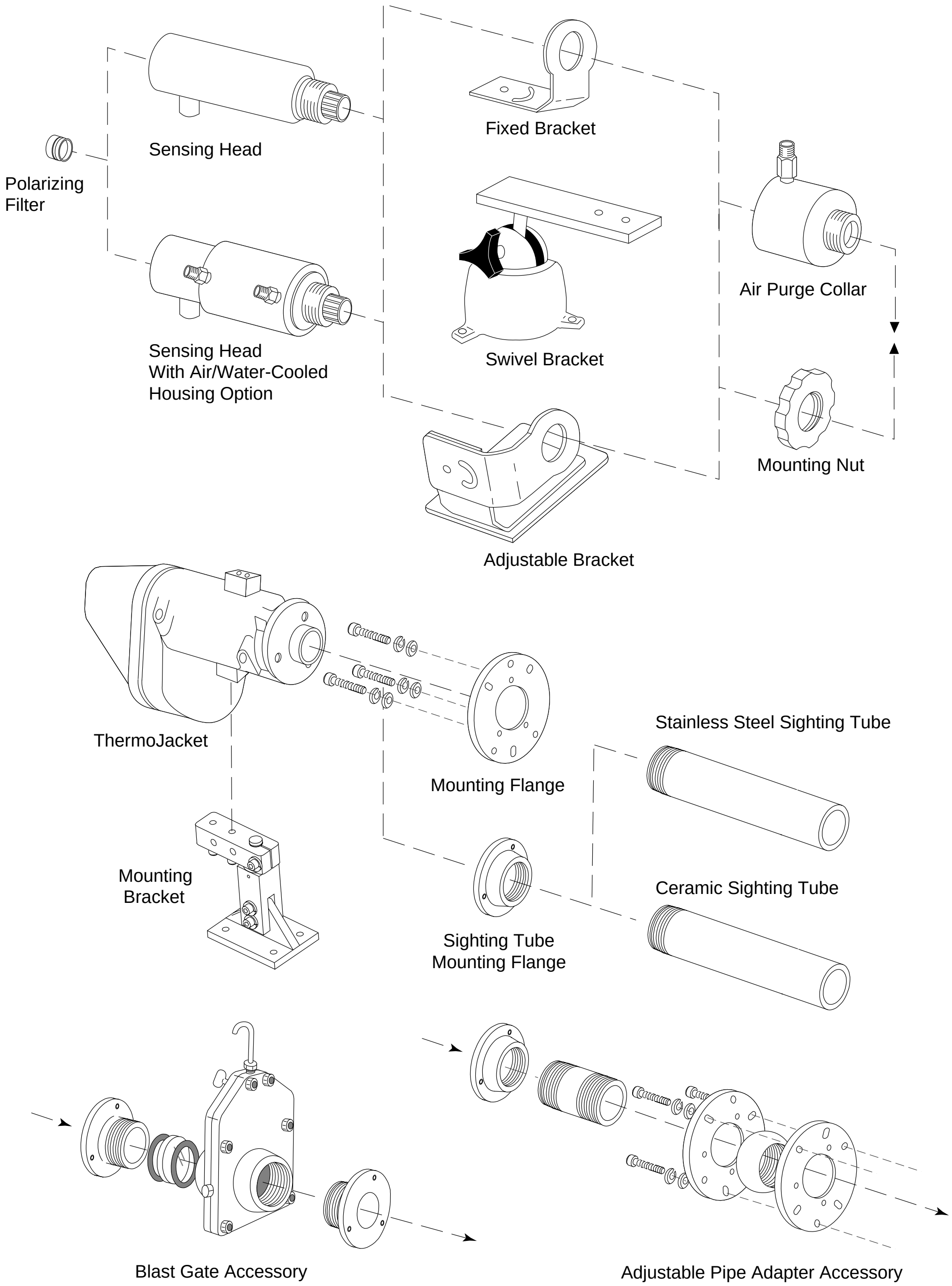


Figure 1-1: Accessories and Options

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

Because these sensors are available with through-the-lens sighting or with laser aiming, and come with with variable focus and parallax-free optics, they can be mounted almost anywhere. Standard Focus MA1S models can be focused from 600 mm (24 in) to infinity, and MA2S models can be focused from 650 mm (27 in) to infinity. MA1S models with the optional Close Focus optics can be focused from 280 mm (11 in) to 460 mm (18 in), MA2S Close Focus models can be focused from 300 mm (12 in) to 555 mm (22 in). In all cases, 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.

Divide the distance (D, in Figure 1-2) by your model's D:S number. For example, if a Model C unit (D:S = 300:1) is 2000 millimeters (80 inches) from the target, divide 2000 by 300 (80 by 300), which gives you a target spot size of approximately 7 mm (0.28 in). A Model A unit (D:S = 80:1) at 2000 mm (80 in) would measure a target spot of 25 mm (1 in). Divide 2000 by 80 (80 by 80).

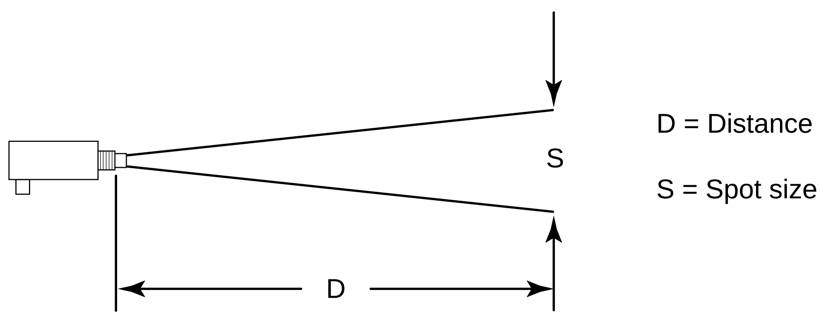


Figure 1-2: Spot Size Chart

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

Nominal Spectral Response:

MA1S:	1 µm
MA2S::	1.6 µm

Nominal Optical Resolution (D:S)

Model A	≥ 80:1
Model B	≥ 300:1 (MA1S) and ≥ 200:1 (MA2S)
Model C	≥ 300:1

Optical resolution assumes 95% energy at the focus point.

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

All Models: ± {0.3% T_{meas} + 1 °C}, "worst case" (or ± 3σ limit), T_{meas} in °K *(Assumes known emissivity value and blackbody calibration).*
Note: Applies to all models except the MA2SA, which has a 2° K offset in its accuracy expression.

System Repeatability

All Models: ± {0.01% T_{meas} + 0.1 °C}, "worst case" T_{meas} in °K *(This represents "short-term" repeatability on a 3-sigma basis, readings taken consecutively, one after the other.)*

Response Time (95% Response)

All Models: 10 ms for signal to reach 95% of final temperature
(1 ms in fast mode)

1.3.3 Operational

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

Detector:

1-micron model:	Si
1.6-micron model:	InGaAs

Temperature Resolution (Display and RS485)

All Models: 1°C or 1°F

Analog Output Resolution

All Models: 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, point-to-point or multidrop or 2-wire half-duplex multidrop.

Emissivity: 0.10 - 1.00, digitally adjustable in increments of 0.01

Peak Hold Range	0 to 299.9 seconds, digitally adjustable in increments of 0.1 secs. (Setting peak hold to 300.0 enables "reset by external trigger.")
Averaging 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, ± 20%, at 250 mA (Can tolerate up to 100 mV peak-to-peak of ripple)
Power Consumption	maximum of 6 watts
Outputs	0-20 mA / 4-20 mA, two-way RS-485, relay control for failsafe alarm or setpoint
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–(software programmable to NO (Normally Open) or NC (Normally Closed) Maximum rating: 48 V, 300 mA AC or DC
External Reset	Trigger input (TTL input–see Figure 1-3)

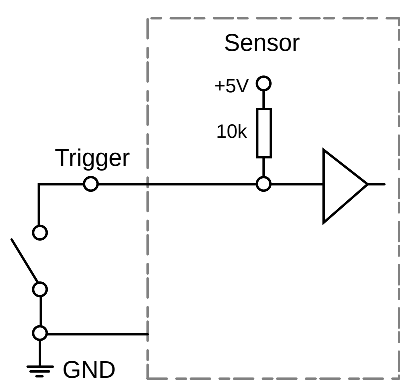


Figure 1-3: External Reset (Trigger Input) Wiring Diagram

1.3.5 Physical

Dimensions

Sensing Head	198mm (7.8 in) L x 57mm (2.2 in) Dia
with air / water-cooled housing	198mm (7.8 in) L x 76mm (3.0 in) Dia
with ThermoJacket	338mm (13.3 in) L x 125mm (4.93 in) W x 158mm (6.2 in) H

Weight

Sensing Head	0.56 kg (19 oz)
with air / water-cooled housing	0.8 kg (28 oz)
ThermoJacket (body only)	3.26 kg (7.2 lbs)

1.3.6 Environmental

Ambient Operating Range

No Cooling	10 to 65°C (50 to 150°F)
With Air Cooling	10 to 120°C (50 to 250°F)
With Water Cooling	10 to 175°C (50 to 350°F)
With ThermoJacket	10 to 315°C (50 to 600°F)

Ambient Temperature Effect / Ambient Compensation

Between 20°C (68°F) and 45°C (116°F) ambient temperature, a small accuracy shift 2°C (1.5°F) is allowed. Above 45°C (116°F) and below 20°C (68°F), there is an additional residual accuracy shift. Consult Raytek for further information.

Vibration	MIL-STD-810D (IEC 68-2-6) 3 Gs, 0 to 300 Hz, any axis
Mechanical Shock	MIL-STD-810D (IEC 68-2-27) 50 Gs, 11 msec duration, any axis
Thermal Shock	None
Relative Humidity	0% to 95% non-condensing at 22°C to 43°C (72°F to 110°F)
Storage Temperature	-20 to 70°C (-4 to 158°F)
Environmental Rating	NEMA-4 (IEC 529, IP 65) rated (hosedown test) with conduit adapter and compression fitting (which prevents liquid from entering through the connector)
Electromagnetic Interference	CE certification Emission Standard: EN50081-2 Immunity Standard: EN50082-2

1.4 MECHANICAL

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

1.4.1 Sensors

The following illustrations show dimensions of a standard sensor (Figure 2-3), a sensor with the air / water-cooled housing option (Figure 2-4), and the adjustable bracket (supplied–Figure 2-5). Dimensions are listed for your installation convenience.

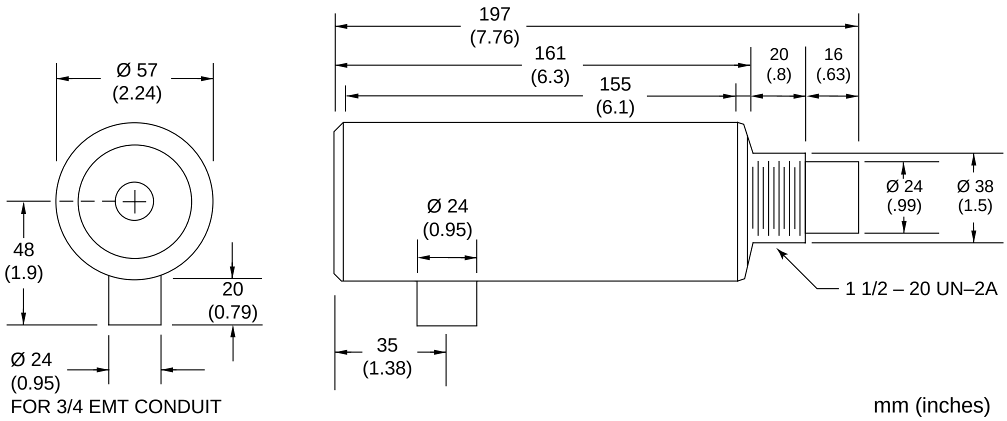


Figure 2-3: Sensing Head

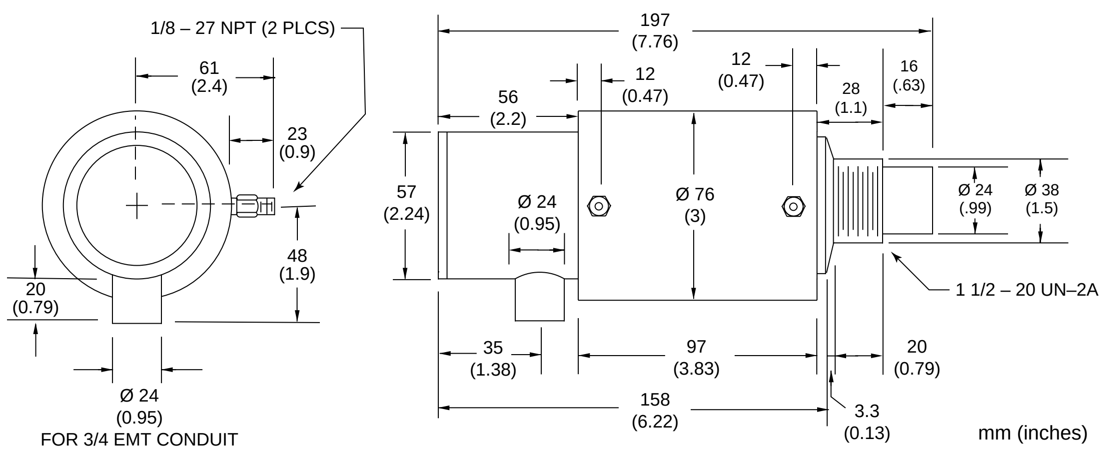


Figure 2-4: Sensing Head with Air / Water-Cooled Housing Option

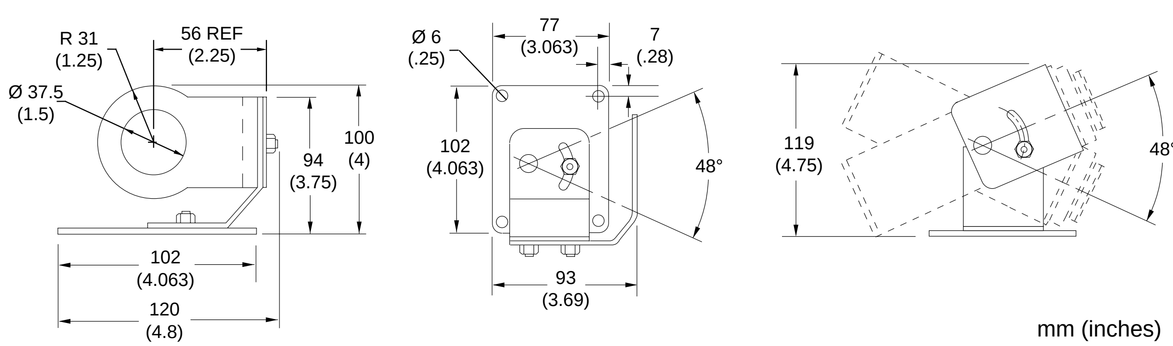


Figure 2-5: Adjustable Bracket

1.4.2 Accessories and Options

This section defines accessories and options, lists installation considerations, and shows the dimensions for each piece. Note that accessories can be purchased at any time and added to the sensor(s). Options must be ordered with the unit(s). For purchasing information, contact your sales representative.

1.4.2.1 Fixed Mounting Bracket

The Fixed Mounting Bracket accessory can be used if the sensor will always remain in a fixed location.

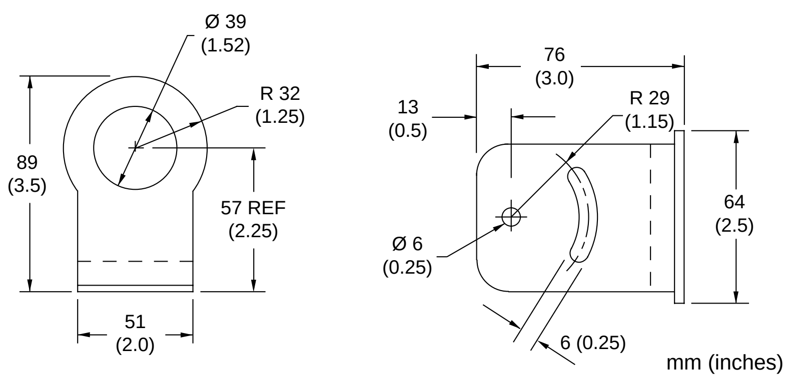


Figure 2-6: Fixed Mounting Bracket

1.4.2.2 Air Purge Collar

The Air Purge Collar accessory is used to keep dust, moisture, airborne particles, and vapors away from the 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).

IMPORTANT
Focus the instrument before attaching the air purge collar.

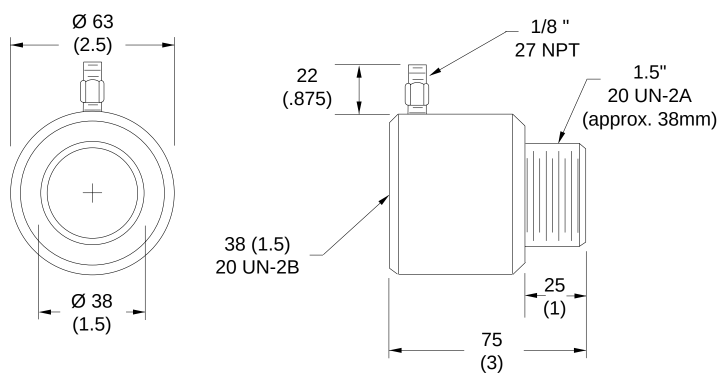


Figure 2-7: Air Purge Collar

1.4.2.3 Polarizing Filter

The Polarizing Filter (Figure 2-8) can be screwed into the viewing port to provide eye protection when sighting on bright, high temperature targets. The filter does not affect measured energy. It is solely for viewing comfort. Rotate the outer portion of the filter until you achieve the desired visual attenuation.

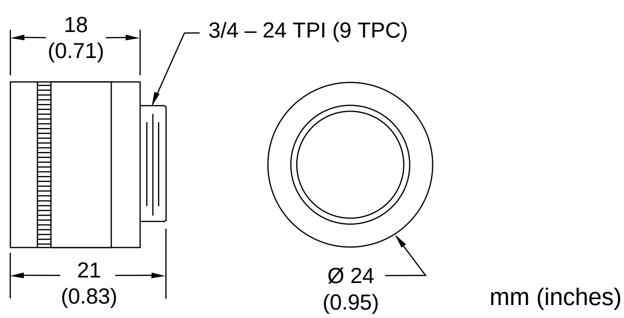


Figure 2-8: Polarizing Filter

1.4.2.4 ThermoJacket and Accessories

The ThermoJacket accessory allows use of sensing heads in ambient temperatures up to 315°C (600°F). The ThermoJacket's rugged cast aluminum housing completely encloses the head and provides water cooling and air purging in one unit. Sensing heads can be easily installed or removed from the ThermoJacket housing in its mounted position. See the *ThermoJacket Operator's Manual* for more information.

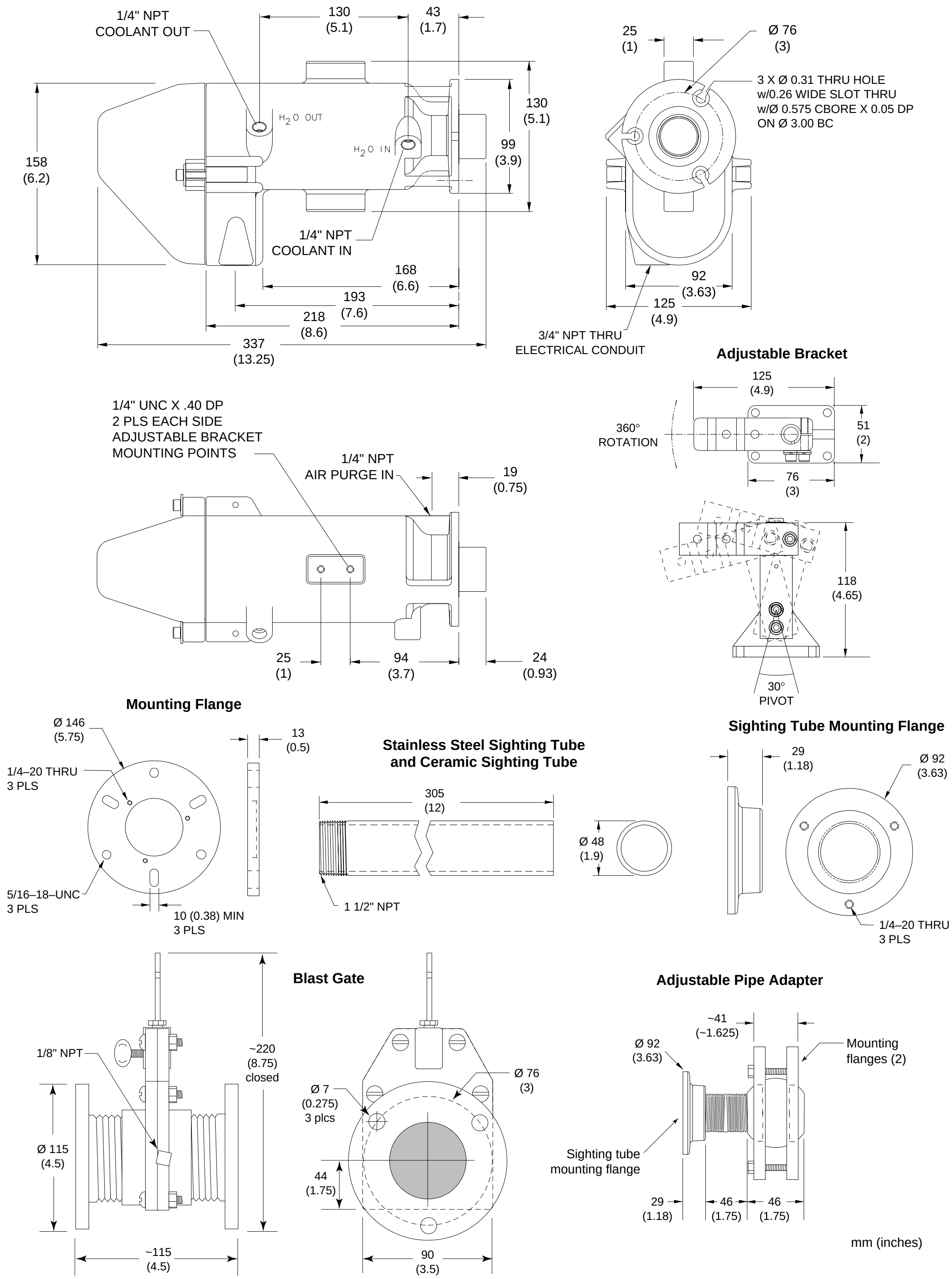


Figure 2-9: ThermoJacket and Accessories

1.4.3 Cables

The cable is 2 twisted pairs and 8 separate wires. The overall shield is aluminized mylar and 85% braided tinned copper. 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 / Clear)

Conductor:	AWG 24 / 7x32 tinned copper
Insulation:	FEP .006” wall
Shield:	None

Cable Diameter:	7 mm (0.256 in) nominal
Cable Length:	Customer selectable at time of order. (See Section 1.1, Accessories, for available cable lengths.)
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

If you cut the cable to shorten it, notice that both sets of twisted-pair wires have drain wires inside their insulation. These drain wires (and the white wire that is not part of the twisted pair) must be connected to the terminal labeled CLEAR. (Only necessary if you cut the cable.) Refer to Section 2.3 for terminal block wiring diagram.

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) 1B model: 800˚C (1472˚F) 1C model: 1200˚C (2192˚F) 1G model: 750˚C (1382˚F) 2A model: 250˚C (482˚F) 2B model: 400˚C (752˚F)
Temperature Setting for 20 mA **	1A model: 900˚C (1652˚F) 1B model: 1900˚C (3452˚F) 1C model: 3000˚C (5432˚F) 1G model: 1675˚C (3047˚F) 2A model: 800˚C (1472˚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.

Part 2 Non-multidrop Installation & Operation

This section explains the installation and operation of a Marathon infrared thermometer in a non-multidrop 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 and / or air or water cooling, you need to have air and water 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.

Note: All sensors, whether standard or with the air/water-cooled housing option, are supplied with an adjustable bracket and mounting nut. If necessary, the sensor can be mounted through a hole, or it can be mounted using a customer-supplied bracket or other accessories. (Refer to Part 1, Section 1.1 and 1.2, for an overview of the available accessories and options.)

2.1.1 Ambient Temperature

The sensing head is designed to operate in ambient temperatures between 10°C (50°F) and 65°C (150°F). The internal ambient temperature can vary from 2°C (35°F) to 68°C (154°F). Internal temperatures outside this range will cause a failsafe error. In ambient conditions above 65°C (150°F), an optional air / water-cooled housing is available to extend the operating range to 120°C (250°F) with air cooling, or 175°C (350°F) with water cooling. When using the water cooled housing, it is strongly recommended to also use the air purge collar to avoid condensation on the lens. In ambient conditions up to 315°C (600°F), the ThermoJacket accessory should be used.

IMPORTANT

Lasers in laser aiming units can operate with internal temperatures up to 48°C (119°F). The laser will turn off when the temperature exceeds 48°C (119°F). The sensor will continue to function normally unless the internal temperature goes above 68°C (154°F).

When using air or water cooling and air purging, make sure air and water supplies are installed before proceeding with the sensor installation.

Water and air temperatures for cooling should be 15-30°C (60-86°F) for best performance. Chilled water or air below 10°C (50°F) is not recommended. For air purging or air cooling, 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 too dirty, it cannot detect enough infrared energy to measure accurately, and the instrument will indicate a failure (see Section 4.2). 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.

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.
- 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 MA1S models can be focused from 600 mm (24 in) to infinity, and MA2S models can be focused from 650 mm (27 in) to infinity. MA1S models with the optional Close Focus optics can be focused from 280 mm (11 in) to 460 mm (18 in), MA2S Close Focus models can be focused from 300 mm (12 in) to 555 mm (22 in). Sensor placement can be varied to suit the application. The sensor must have a clear view of the target. There can be no obstructions on the lens, window, or in the atmosphere. Because you can focus the lens, the distance from the target is not a major consideration, as long as the target completely fills the field of view. Figure 2-1 shows proper sensor placement.

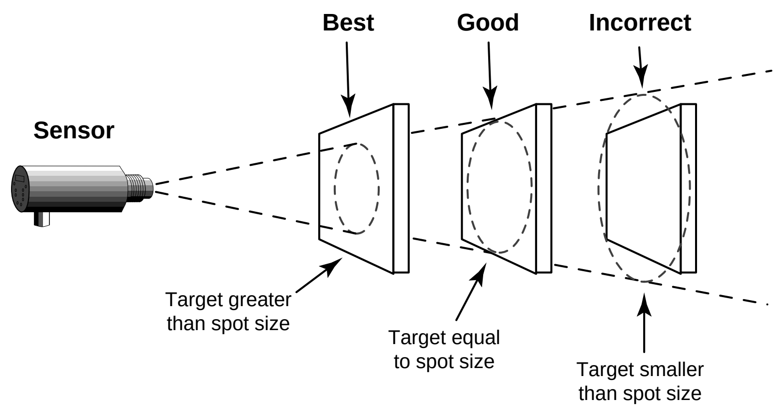


Figure 2-1: Proper Sensor Placement

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

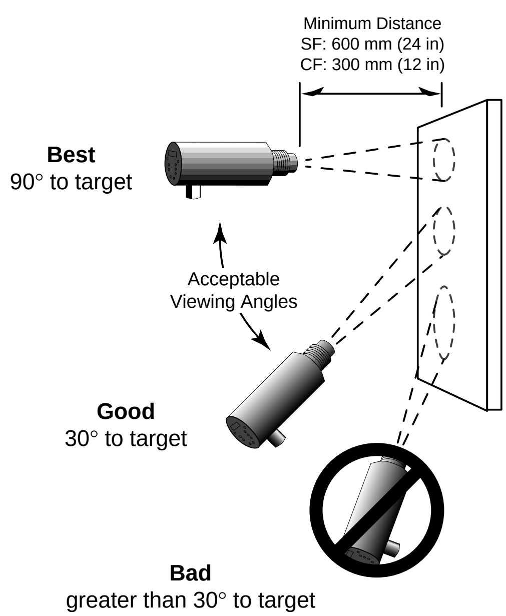


Figure 2-2: Acceptable Sensor Viewing Angles

2.2 MECHANICAL INSTALLATION

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

2.2.1 Mounting the Sensor

How you anchor the sensor depends on the type of surface and the type of bracket you are using. As noted before, all sensors, whether standard or with the air / water-cooled housing option, are supplied with an adjustable bracket and mounting nut. You can also mount the sensor through a hole, on a bracket of your own design, or on one of the other available mounting accessories (refer to Part 1). If you are installing the sensor in a ThermoJacket accessory, you should use the appropriate mounting device. (Refer to Part 1 for an overview of ThermoJacket accessories.) If you do not have the focusing tool accessory, the sensor must be focused before mounting inside a ThermoJacket or before attaching an air purge collar.

NOTICE

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 and Focusing

Once you have the sensor in place, you need to aim and focus it on the target. Refer to the appropriate section below for your particular model (through-the-lens aiming model or laser aiming model).

2.2.2.1 Through-the-lens Aiming

1. Loosen the nuts or bolts of the mounting base. (This can be either a factory-supplied accessory or customer-supplied base.)
2. Look through the eyepiece and position the sensor so the target is centered as much as possible in the middle of the reticle. (Note that the target appears upside down.) Tighten the mounting base nuts or bolts.
3. Turn the lens holder clockwise or counter-clockwise until the target is in focus.

   You can tell the lens is focused correctly by moving your eye from side to side while looking through the eyepiece. The target should not move with respect to the reticle. If it does, keep adjusting the focus until no apparent motion is observed.
4. Check once more to make sure the target is still centered, and make sure the mounting base is secure. Focusing is complete.

2.2.2.2 Laser Aiming

1. Loosen the nuts or bolts of the mounting base. (This can be either a factory-supplied accessory or customer-supplied base.)
2. Position the sensor so the laser beam hits in the center of your target, then tighten the mounting base nuts or bolts just enough so you can still move the sensor.
3. To complete laser aiming, go to Section 2.2.2.3, Peaking for Maximum Signal, and complete the steps.

2.2.2.3 Peaking for Maximum Signal

This focusing technique can be used on both the through-the-lens aiming and laser aiming models. The unit should have all electrical and electronics connections secure before using this technique.

1. If sensor is connected to a power source, turn the unit on.
2. Point the sensor at the target and gently move it around until the temperature signal reads the highest.
3. Hold the unit in place and secure the mounting base. Focusing is complete.

2.3 ELECTRICAL INSTALLATION

Sensor cables can be ordered in several lengths. They come with a 12-pin DIN plug on one end and bare wires on the other. An external terminal block is included with each sensor cable and is labeled as shown in Figure 2-3.

Note: The terminal block is susceptible to electrostatic discharge. You should mount it in a protective case.

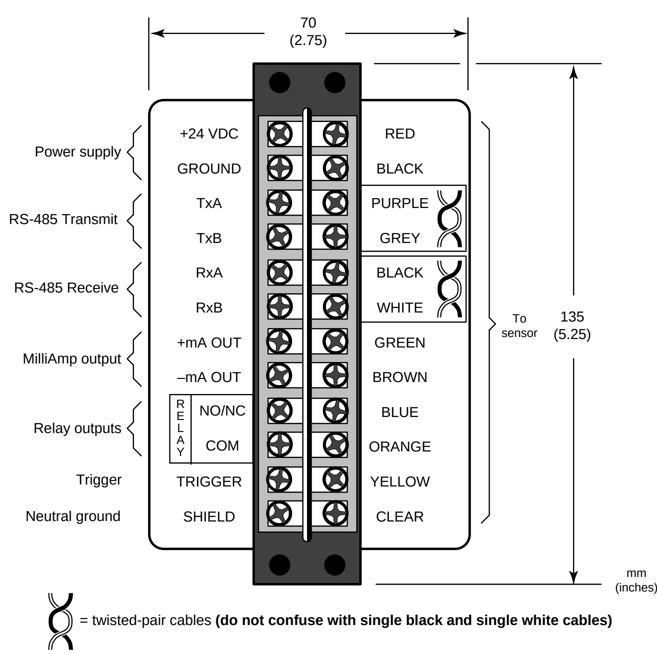


Figure 2-3: Terminal Block

Note that the wire between the terminal block and RS-485 / RS-232 converter is bare on each end. Both sets of twisted-pair wires have drain wires inside their insulation. These drain wires must be connected to the terminal labeled SHIELD. Also connect the earth ground to the SHIELD terminal. Figure 2-4 shows how to configure the drain wires before connecting to the terminal block and RS-485 / RS-232 converter.

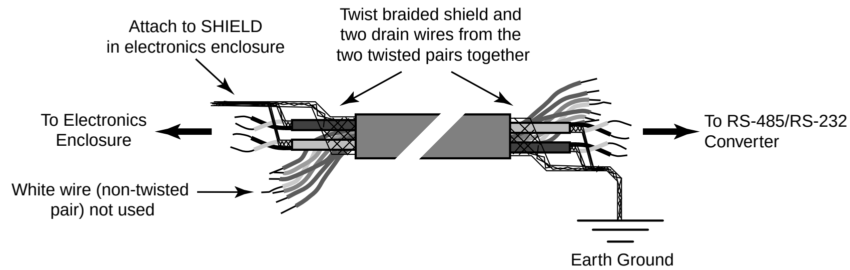


Figure 2-4: Terminal Block to RS-485 / RS-232 Converter Cable

2.3.1 Connecting Sensors

To connect the bare wires to the terminal block, attach the sensor cable wires to the color coded side of the terminal block. Match the wire's colors to the appropriately labeled terminals (use Figure 2-3 as a guide). The connections on the opposite side of the terminal are discussed in the following subsections. **If you cut the cable to shorten it, notice that both sets of twisted-pair wires have drain wires inside their insulation. These drain wires (and the white wire that is not part of the twisted pair) must be connected to the terminal labeled CLEAR. (Only necessary if you cut the cable.)**

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).

2.3.2 Power

Connections from a 24 VDC (250 mA or higher) power supply attach to the first two terminals on the terminal strip (as shown in Figure 2-3).

IMPORTANT

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

2.3.3 RS-485 Interface Converter

To connect to a computer's RS-232 port, you need one of the Interface Converter accessorie (Figure 2-5) and the proper RS-232 cable (refer back to Figure 2-4).   If your computer has an RS-485 interface card, you can connect directly to its port (using the proper connector) with the sensor cable or with wiring from the terminal block.

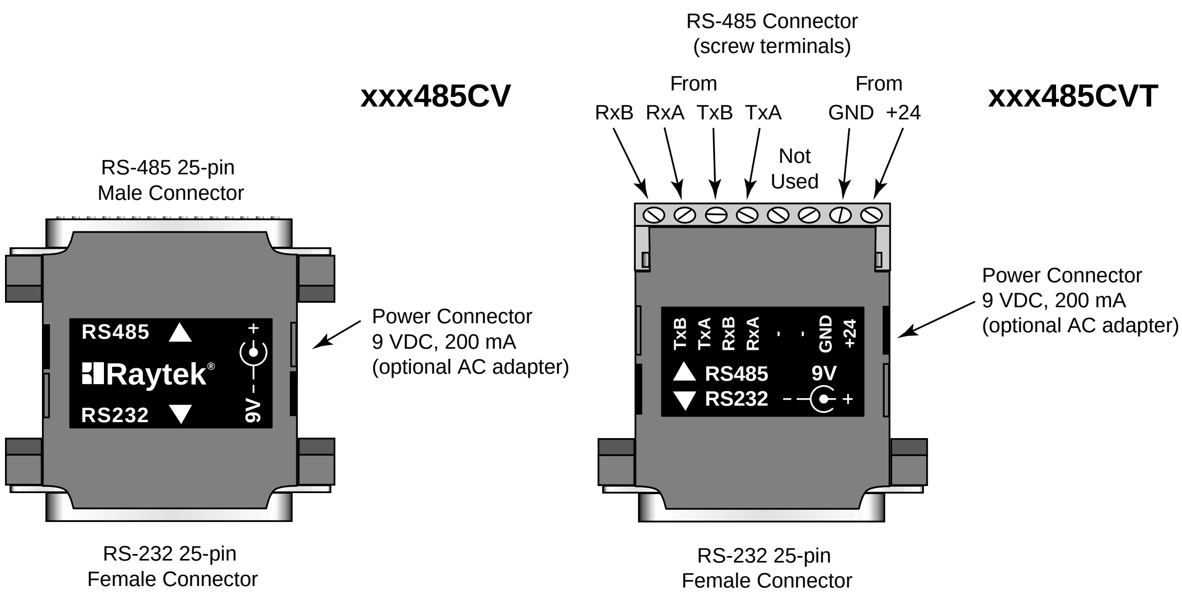


Figure 2-5: RS-485 to RS-232 Interface Converter

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 2-6 illustrates cable and converter connections between sensor and computer. You can wire directly from the elecronics 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.

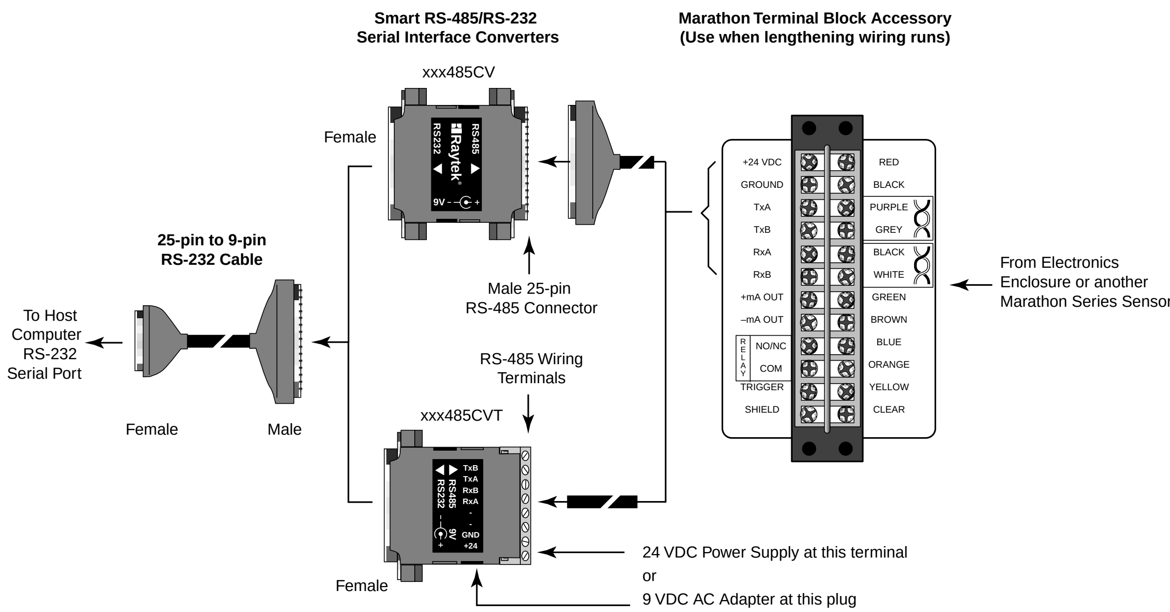


Figure 2-6: Connections from Sensor to Computer

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 COM2 is connected to an external modem (an internal modem can also be set to use COM2). It is possible for two devices to share a port (COM1/COM3 or COM2/COM4); however, they cannot be used at the same time.

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.

2.3.4 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 all models is 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.

2.3.5 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.

2.4 OPERATION

Once you have your sensor(s) positioned and connected properly, the system is ready for continuous operation. Operation is accomplished either through the back 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, water, 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 (Figure 2-6), 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 protected during operation by the supplied end cap. If your sensor is a through-the-lens aiming model, the sighting hole in the end cap is threaded to accept the polarizing filter accessory (used for sighting / focusing on very bright targets). An end cap with a larger window, which allows all control panel LEDs to be visible, is available as an option. (You cannot use the polarizing filter with this option.)

Figure 2-7 is an overview of both types of control panel (through-the-lens and laser). The buttons and LEDs are defined in the following sections.

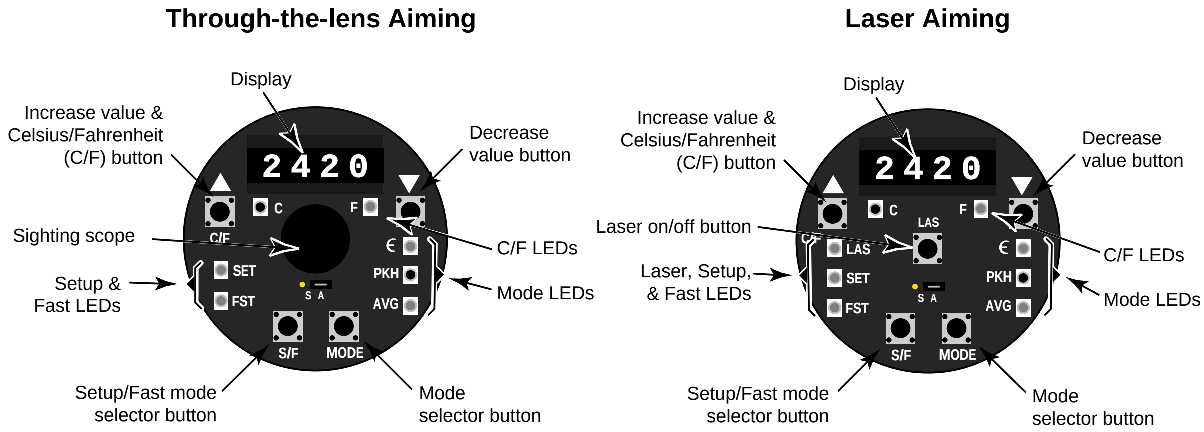
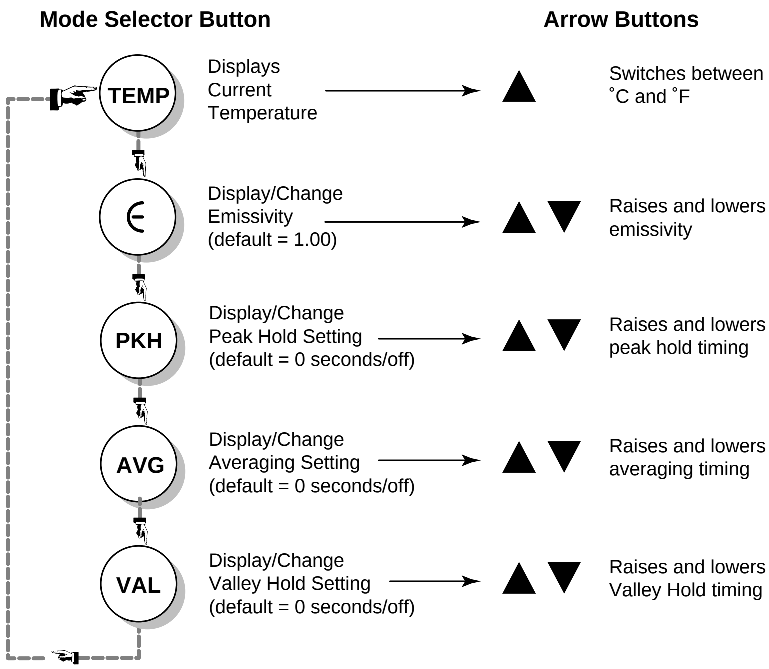


Figure 2-7: Control Panels

2.4.2 SET-UP

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.** (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 2-8 illustrates the sequence of operation for the mode selector button when in current temperature mode.



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.

To change the settings for each mode using the control panel is simple. 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 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.

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 2-9)

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.

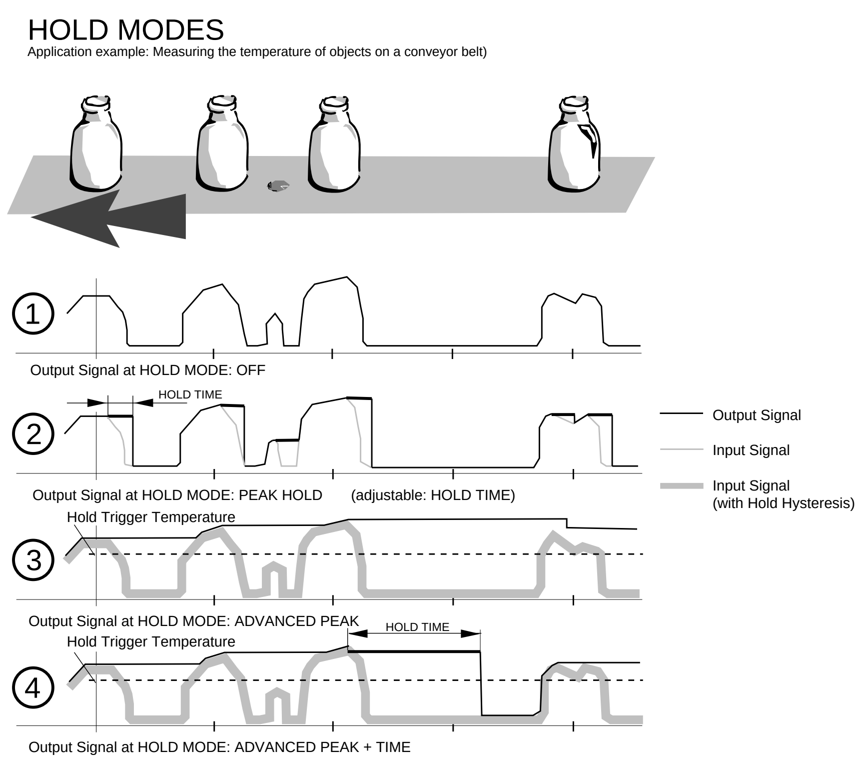


Figure 2-9: Peak Hold Output Signal Example

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 2-10):

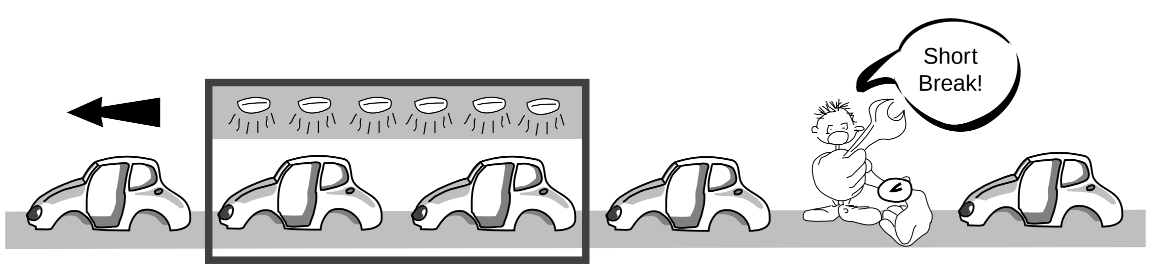


Figure 2-10: Peak Hold Example

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 2-11.)

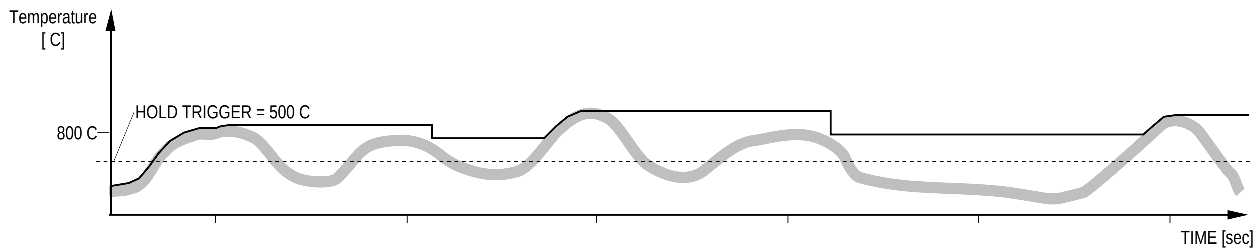


Figure 2-11: Advanced Peak Hold

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 2-12, the break has no end.)

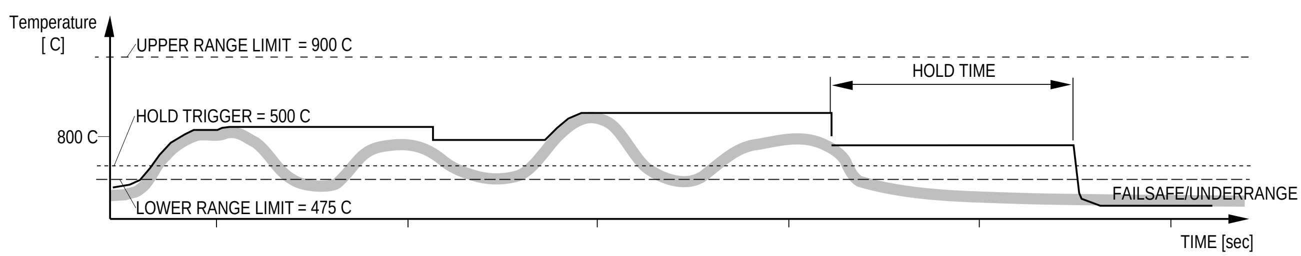


Figure 2-12: Advanced Peak Hold + Time

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 2-13 shows an example of continuous Peak Hold reset by the Trigger input.

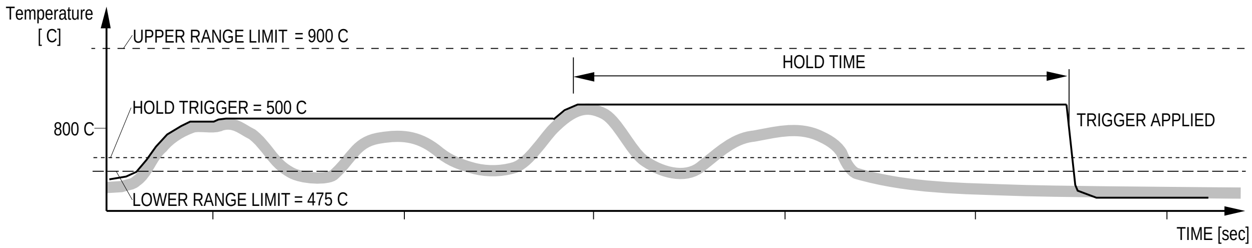


Figure 2-13: Continuous Peak Hold + Trigger

A decay time can be set to allow a slow reduction of the temperature until another peak is encountered. Figure 2-14 is an example of a Peak Hold with a set Decay Time.

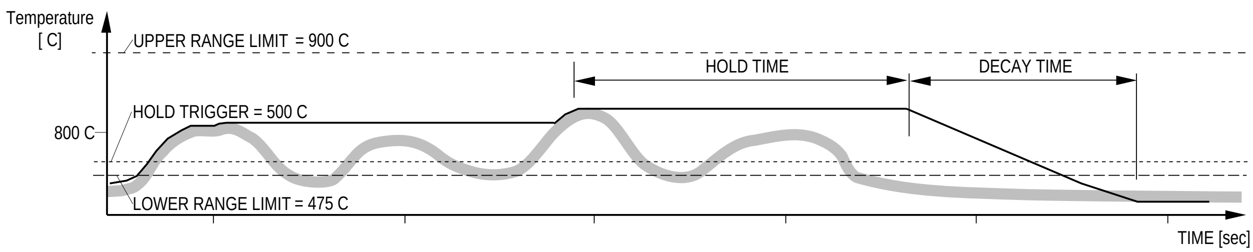


Figure 2-14: Peak Hold + Decay

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 2-10: No new car bodies enter.

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

   In the example in Figure 2-10: 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 2-10 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.

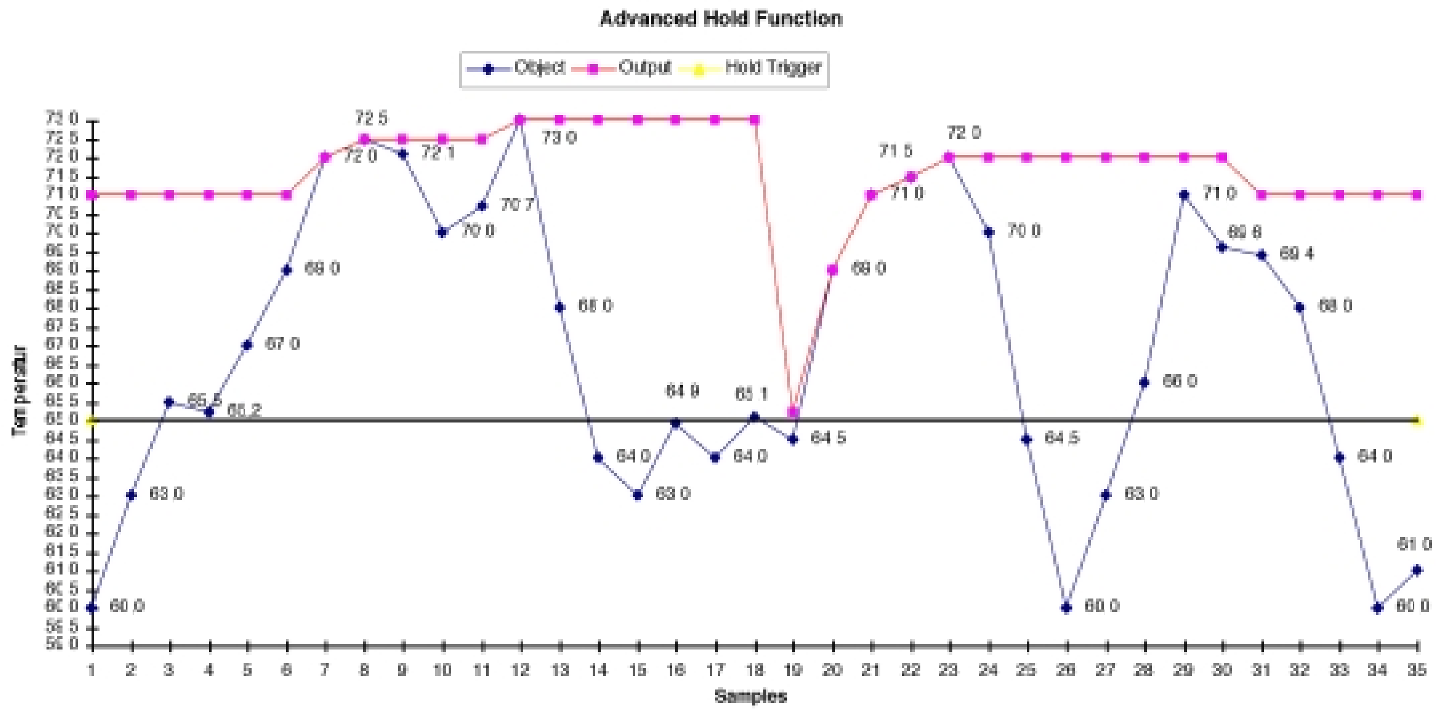


Figure 2-15: Advanced Hold Function

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 2-16 illustrates the Averaging output signal.

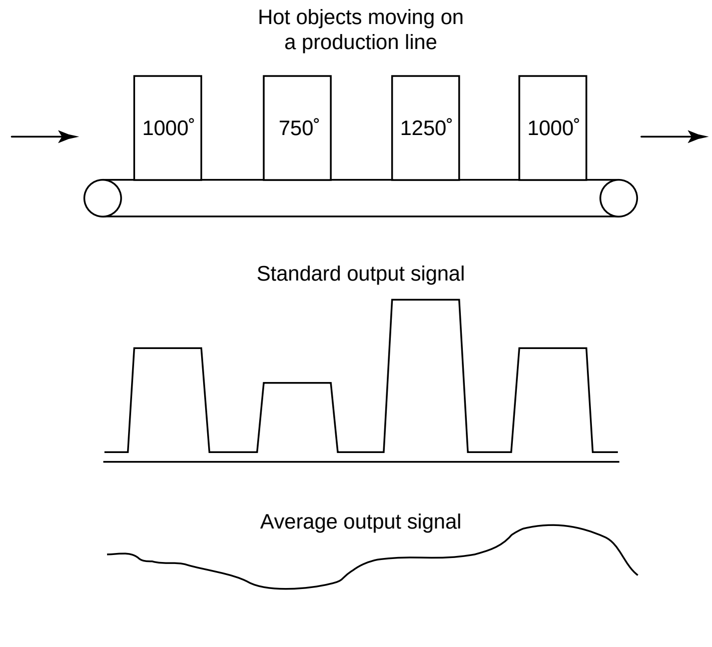


Figure 2-16: Averaging Example

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 2-17 illustrates the Valley Hold output signal.

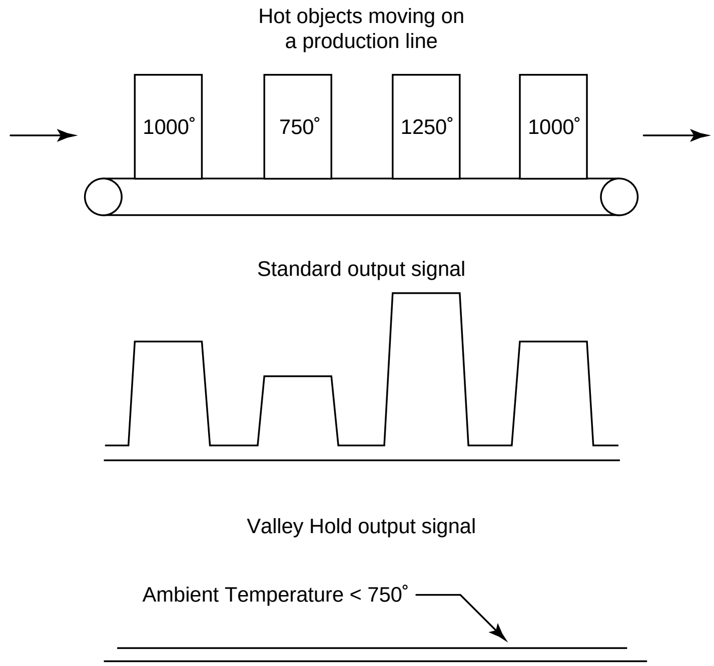


Figure 2-17: Valley Hold Example

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 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.

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 ± 2° C (±4° 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).

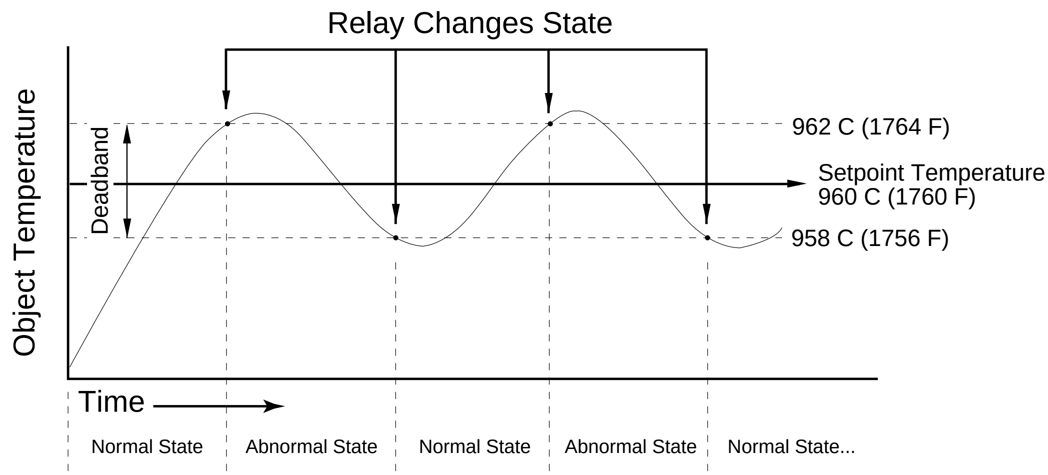


Figure 2-18: Deadband Example

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 permanentlly in the instrument.

The command A=0000 will turn this feature off.

2.4.2.6 Resetting Factory Defaults

To globally reset the unit to its factory default settings, make sure the unit is in Setup mode (SET LED is lit) and 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.

2.4.2.7 Laser On/Off

To turn the laser on or off (on sensors equipped with laser aiming), push the LAS button in the center of the control panel. When the laser is on, the LAS LED on the left side of the panel will be lit.

Note: You cannot use the laser in Fast Mode.

IMPORTANT

The laser must be turned off when measuring temperatures or the sensor's accuracy will be compromised.

2.4.3 Fast Mode

During normal operation the unit's response time is approximately 10 milliseconds. When using software to control the sensor you may notice response time on the digital output drop to slower rates. (The more data you want to log, the slower the response time.) For applications that require very fast response time, the unit can be switched, either manually or through software, to Fast Mode.

To manually switch to Fast Mode, you only need to press the S/F button so the FST LED is lit. The current settings are used (emissivity, peak hold, etc.).

Note: You cannot use the laser in Fast Mode.

IMPORTANT

In Fast Mode the only function available is Peak Hold. No other functions or modes, including Averaging, are available other than obtaining and displaying a temperature. If you need to reset functions, switch back to Setup Mode (the SET LED is lit), and make any necessary changes. These new changes will be in effect if you return to Fast Mode.

Part 3 Multidrop Installation & Operation

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 MULTI-DROP SENSOR INSTALLATION

The multi-drop 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 MULTI-DROP 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 and / or air or water cooling, you need to have air and water 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.

Note: All sensors, whether standard or with the air/water-cooled housing option, are supplied with an adjustable bracket and mounting nut. If necessary, the sensor can be mounted through a hole, or it can be mounted using a customer-supplied bracket or other accessories. (Refer to Part 1, Section 1.1 and 1.2 for an overview of the available accessories and options.)

3.1.1 Ambient Temperature

The sensing head is designed to operate in ambient temperatures between 10°C (50°F) and 65°C (150°F). The internal ambient temperature can vary from 2°C (50°F) to 68°C (154°F). Internal temperatures outside this range will cause a failsafe error. In ambient conditions above 65°C (150°F), an optional air / water-cooled housing is available to extend the operating range to 120°C (250°F) with air cooling, or 175°C (350°F) with water cooling. When using the water cooled housing, it is strongly recommended to also use the air purge collar to avoid condensation on the lens. In ambient conditions up to 315°C (600°F), the ThermoJacket accessory should be used.

IMPORTANT

Lasers in laser aiming units can operate with internal temperatures up to 48°C (119°F). The laser will turn off when the temperature exceeds 48°C (119°F). The sensor will continue to function normally unless the internal temperature goes above 68°C (154°F).

When using air or water cooling and air purging, make sure air and water supplies are installed before proceeding with the sensor installation.

Water and air temperatures for cooling should be 15-30°C (60-86°F) for best performance. Chilled water or air below 10°C (50°F) is not recommended. 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 too dirty, it cannot detect enough infrared energy to measure accurately, and the instrument will indicate a failure (see Section 4.2). 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.

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.

- 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.

3.1.4 Sensor Location

Standard Focus MA1S models can be focused from 600 mm (24 in) to infinity, and MA2S models can be focused from 650 mm (27 in) to infinity. MA1S models with the optional Close Focus optics can be focused from 280 mm (11 in) to 460 mm (18 in), MA2S Close Focus models can be focused from 300 mm (12 in) to 555 mm (22 in). Sensor placement can be varied to suit the application. The sensor must have a clear view of the target. There can be no obstructions on the lens, window, or in the atmosphere. Because you can focus the lens, the distance from the target is not a major consideration, as long as the target completely fills the field of view. Figure 3-1 shows proper sensor placement.

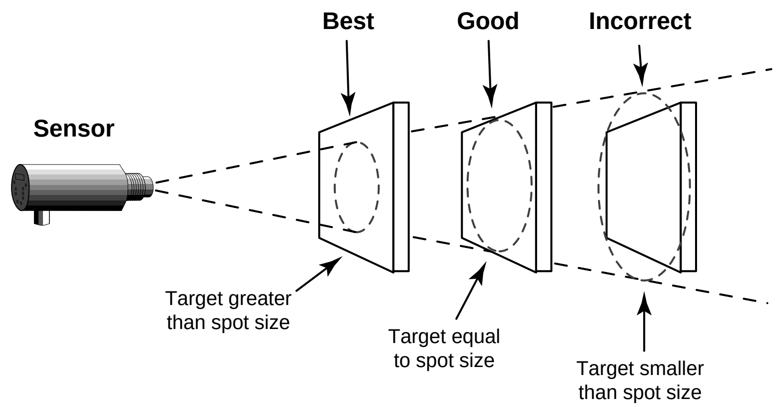


Figure 3-1: Proper Sensor Placement

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

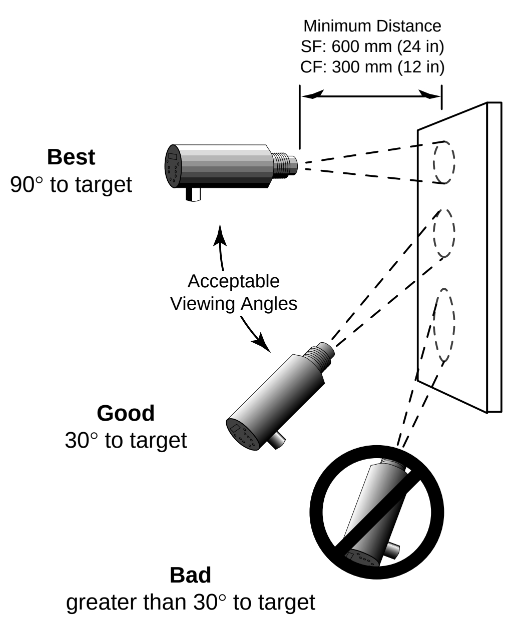


Figure 3-2: Acceptable Sensor Viewing Angles

3.1.5 Multi-drop Considerations

If you are installing two or more sensors in a multi-drop 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.

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.

3.2 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. Wire a sensor cable to the right side of a terminal block (supplied with each cable), and attach the appropriate power supply and RS-485 cables to the other side. (Refer to Section 2.3, Electrical Installation, for terminal block information.)
3. Plug the RS-485 to RS-232 converter into your computer's serial port, and plug in the AC power supply cable if used. (Use the supplied 25-pin to 9-pin adapter if necessary.)

   Note: This step is not necessary if your computer is equipped with an RS-485 interface card
4. Before turning on the computer, make sure the sensor and RS-485 to RS-232 adapter power supplies are plugged in.
5. Turn on your computer.

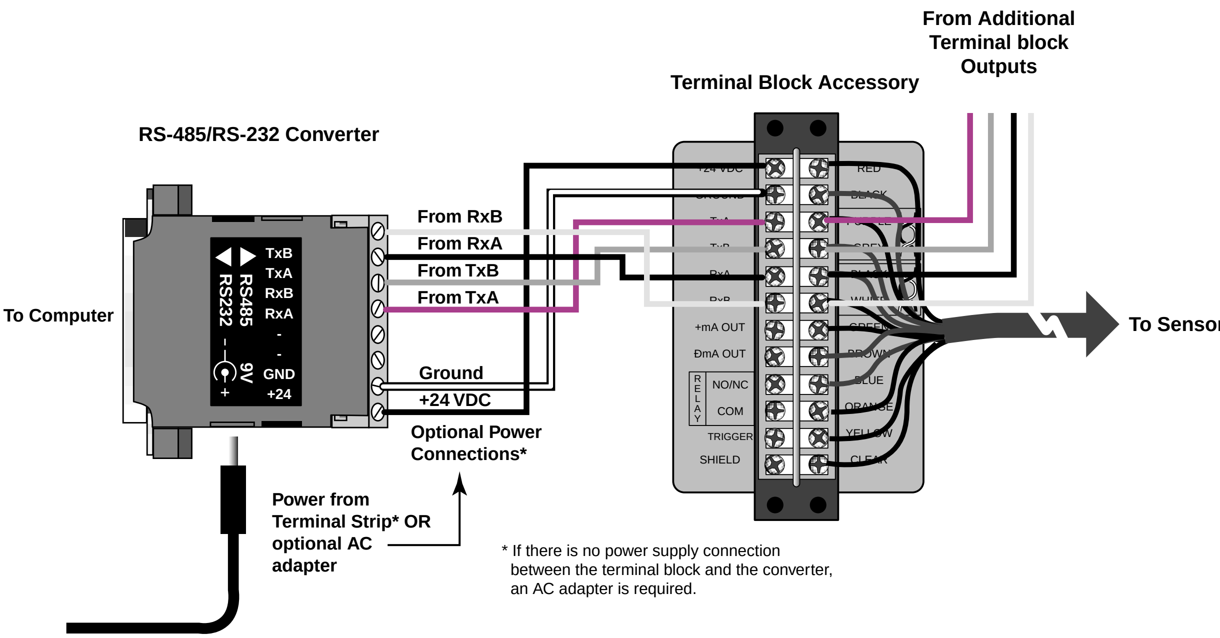


Figure 3-3: Wiring for 4-Wire Sensor Setup

VERY IMPORTANT

You must supply your own cable between the converter and terminal block. Purchase (from any computer parts supply store) a serial cable with a 25-pin female connector on one end and bare wires on the other. Make sure a wiring diagram is included with your purchase.

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.

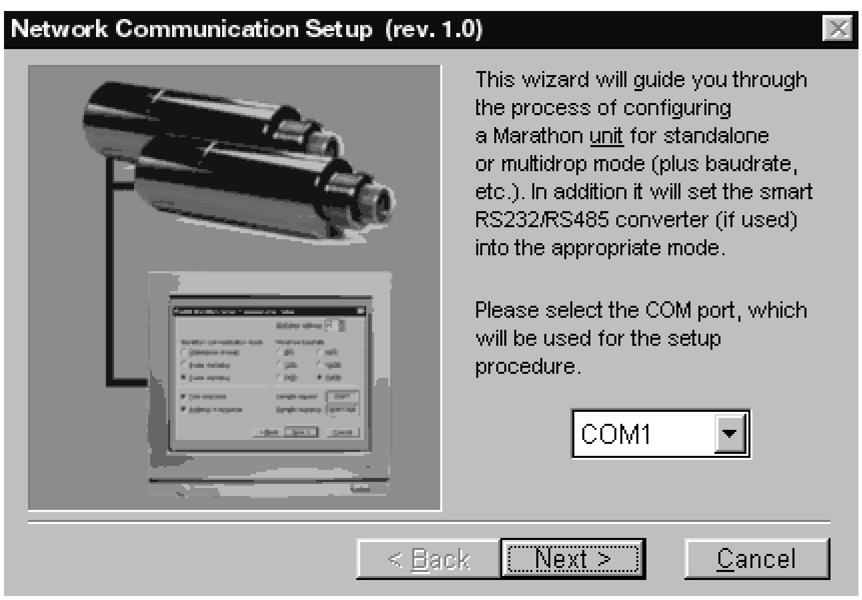


Figure 3-4: Communication Setup Screen

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

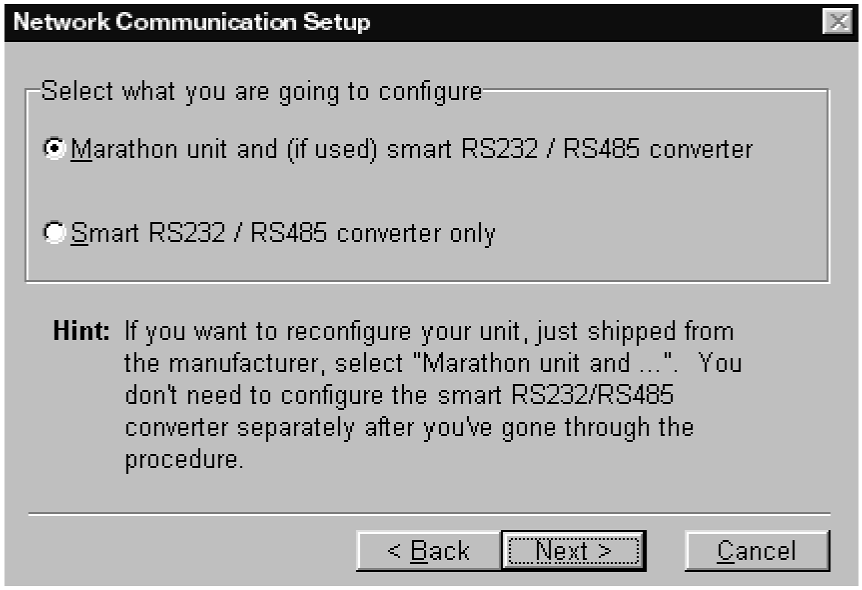


Figure 3-5: Communication Setup Screen 2

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.

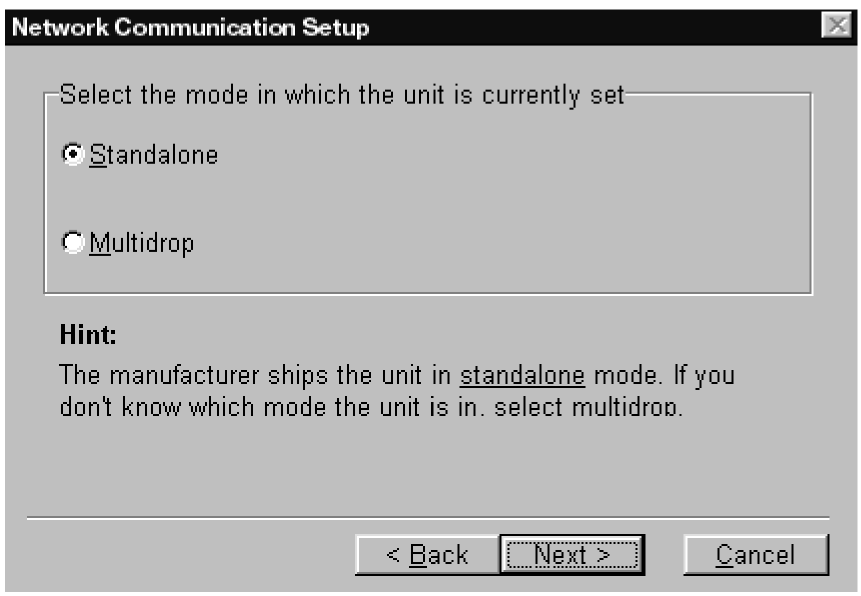


Figure 3-6: Standalone or Multidrop Selection Screen

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 Standalone, you will see a screen similar to Figure 3-7.

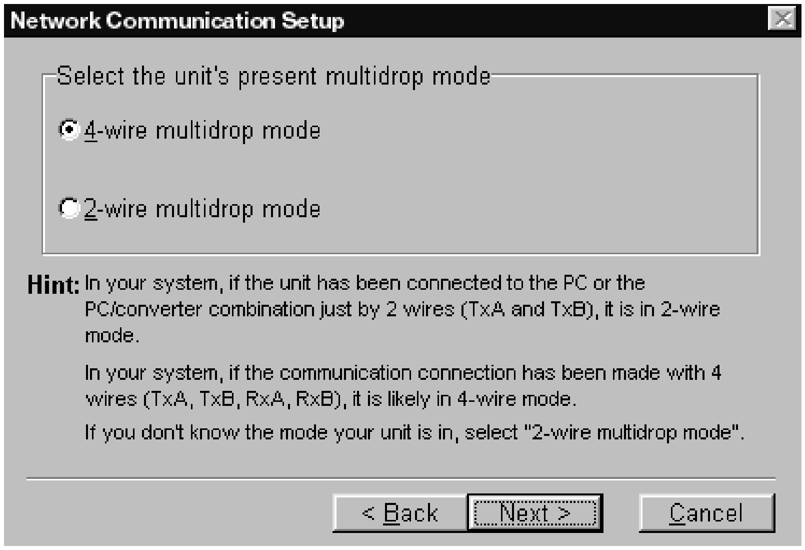


Figure 3-7: Multidrop Mode Screen

   Sensors are shipped in 4-wire mode. If the units are currently connected to the computer using 4 wires, select “4-wire mulitidrop 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.

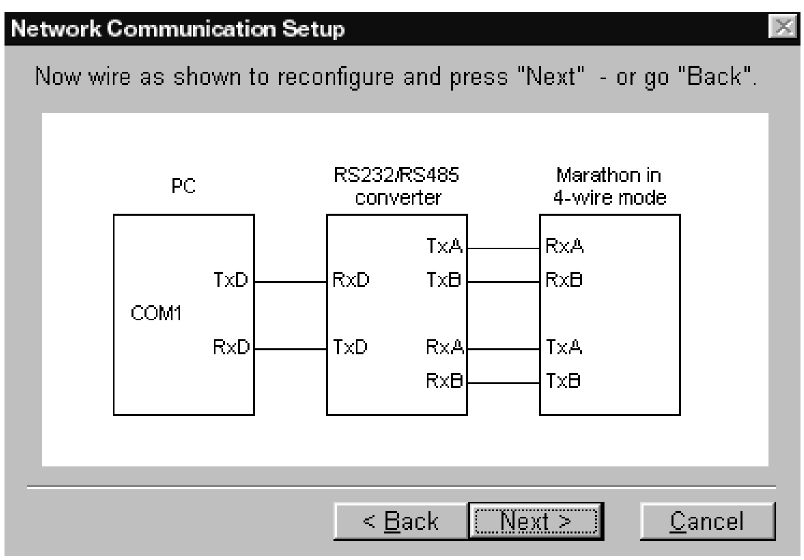


Figure 3-8: 4-Wire Wiring Diagram

6. On the sensor's back panel is a switch that is labeled "S" and "A." The next screen (Figure 3-9), prompts you to make sure the switch is in the "A" position, and to check once more that power and all connections are secure. If everything is correct, click the Next button.

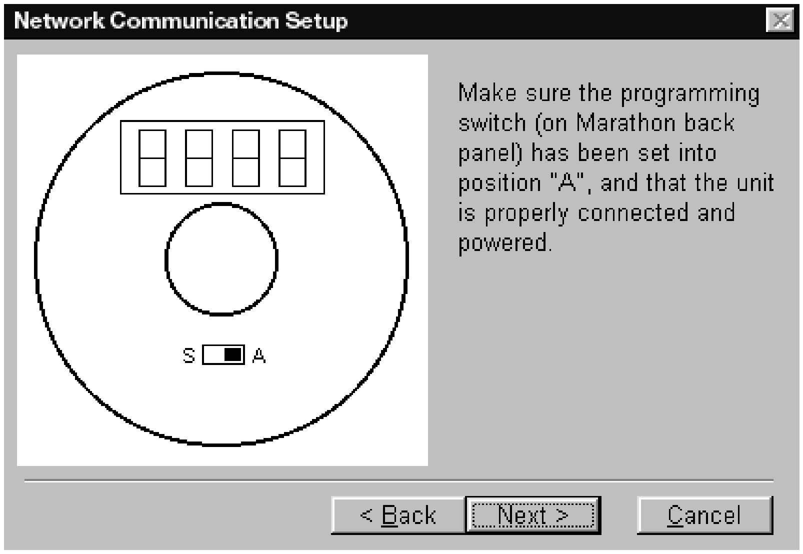


Figure 3-9: Switch Selection / Verification Screen

7. 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.

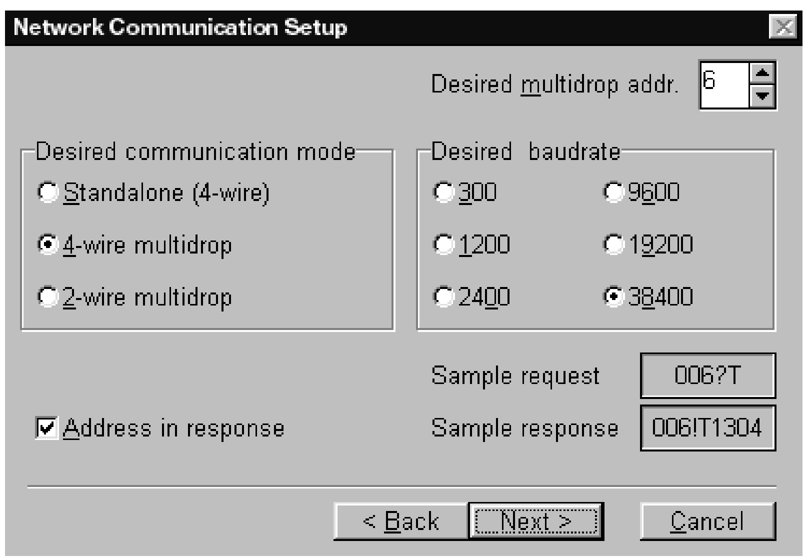


Figure 3-10: Address Selection Screen

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..

8. 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:

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

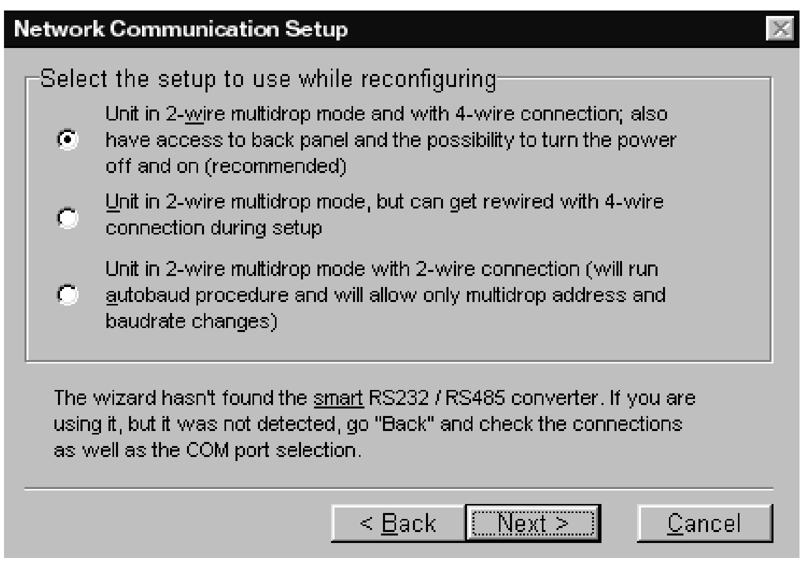


Figure 3-12: 2-Wire Setup Screen

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

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

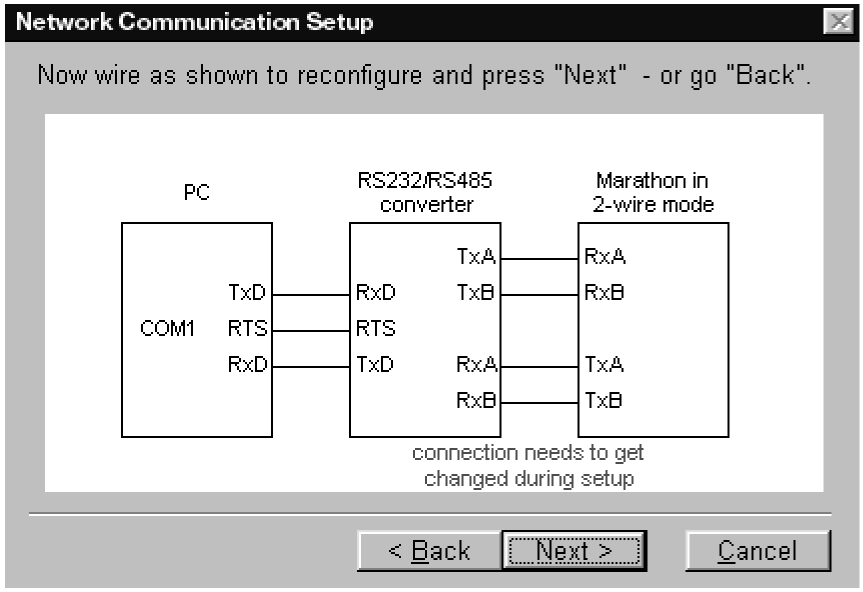


Figure 3-13: 2-Wire Setup Wiring Diagram Screen

3. 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 and each sensor is properly set up, mechanical installation can proceed. Be sure all appropriate communication, electrical, water, and air connections to each sensor are in place.

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

3.3.1 Mounting the Sensor

How you anchor the sensor depends on the type of surface and the type of bracket you are using. As noted before, all sensors, whether standard or with the air/water-cooled housing option, are supplied with an adjustable bracket and mounting nut. You can also mount the sensor through a hole, on a bracket of your own design, or on one of the other available mounting accessories (refer to Part 1). If you are installing the sensor in a ThermoJacket accessory, you should use the appropriate mounting device. (Refer to Part 1 for an overview of ThermoJacket accessories.) If you do not have the focusing tool accessory, the sensor must be focused before mounting inside a ThermoJacket or before attaching an air purge collar.

3.3.2 Aiming and Focusing

Once you have the sensor in place, you need to aim and focus it on the target. Refer to the appropriate section below for your particular model (through-the-lens aiming model or laser aiming model).

3.3.2.1 Through-the-lens Aiming

1. Loosen the nuts or bolts of the mounting base. (This can be either a factory-supplied accessory or customer-supplied base.)
2. Look through the eyepiece and position the sensor so the target is centered as much as possible in the middle of the reticle. (Note that the target appears upside down.) Tighten the mounting base nuts or bolts.
3. Turn the lens holder clockwise or counter-clockwise until the target is in focus.

   You can tell the lens is focused correctly by moving your eye from side to side while looking through the eyepiece. The target should not move with respect to the reticle. If it does, keep adjusting the focus until no apparent motion is observed.
4. Check once more to make sure the target is still centered, and make sure the mounting base is secure. Focusing is complete.

3.3.2.2 Laser Aiming

1. Loosen the nuts or bolts of the mounting base. (This can be either a factory-supplied accessory or customer-supplied base.)
2. Position the sensor so the laser beam hits in the center of your target, then tighten the mounting base nuts or bolts just enough so you can still move the sensor.
3. To complete laser aiming, go to Section 3.3.2.3, Peaking for Maximum Signal, and complete the steps.

3.3.2.3 Peaking for Maximum Signal

This focusing technique can be used on both the through-the-lens aiming and laser aiming models. The unit should have all electrical and electronics connections secure before using this technique.

1. If the sensor is connected to a power source, turn the unit on.
2. Point the sensor at the target and gently move it around until the temperature signal reads the highest.
3. Hold the unit in place and secure the mounting base.

This completes sensor focusing.

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. Only one RS-485 cable is necessary from the computer to the first terminal block.

Sensor cables can be ordered in several lengths. They come with a 12-pin DIN plug on one end and bare wires on the other. An external terminal block is included with each sensor cable and is labeled as shown in Figure 3-14.

Note: Terminal block is susceptible to electrostatic discharge. Mount it in a protective case.

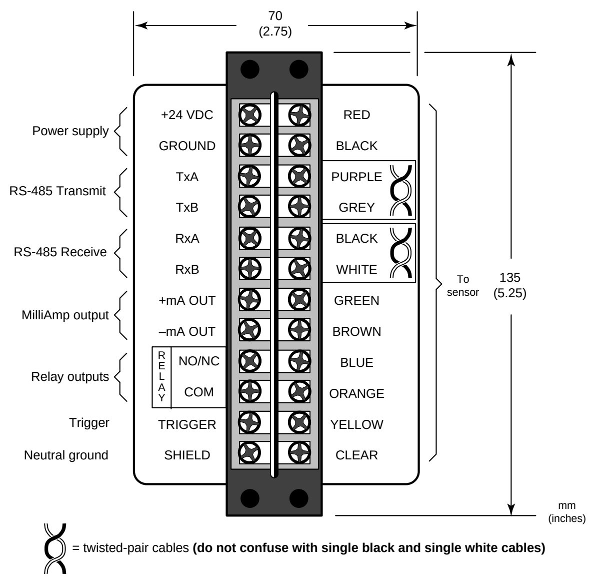


Figure 3-14: Terminal Block

Note that the wire between the terminal block and RS-485 / RS-232 converter is bare on each end. Both sets of twisted-pair wires have drain wires inside their insulation. These drain wires must be connected to the terminal labeled SHIELD. Also connect the earth ground to the SHIELD terminal. Figure 3-15 shows how to configure the drain wires before connecting to the terminal block and RS-485 / RS-232 converter.

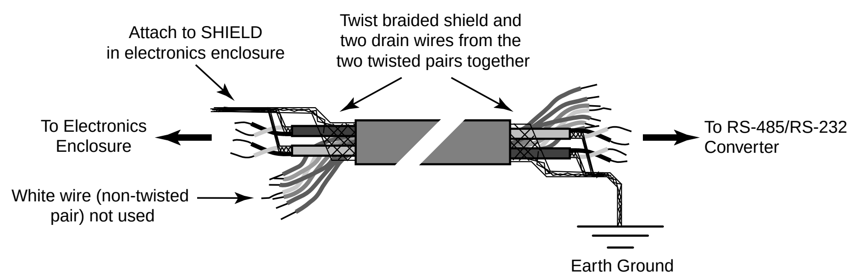


Figure 3-15: Terminal Block to RS-485 / RS-232 Converter Cable

3.4.1 Connecting Sensors

To connect the bare wires to the terminal block, attach the sensor cable wires to the color coded side of the terminal block. Match the wire's colors to the appropriately labeled terminals (use Figure 3-14 as a guide). The connections on the opposite side of the terminal are discussed in the following subsections. **If you cut the cable to shorten it, notice that both sets of twisted-pair wires have drain wires inside their insulation. These drain wires (and the white wire that is not part of the twisted pair) must be connected to the terminal labeled CLEAR. (Only necessary if you cut the cable.)**

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).

3.4.2 Power

Connections from a 24 VDC (250 mA or higher) power supply attach to the first two terminals on the terminal strip (as shown in Figure 3-14).

IMPORTANT

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

3.4.3 RS-485 Interface Converter

To connect to a computer's RS-232 port, you need one of the Interface Converter accessorie (Figure 3-16) and the proper RS-232 cable (refer back to Figure 3-15). If your computer has an RS-485 interface card, you can connect directly to its port (using the proper connector) with the sensor cable or with wiring from the terminal block.

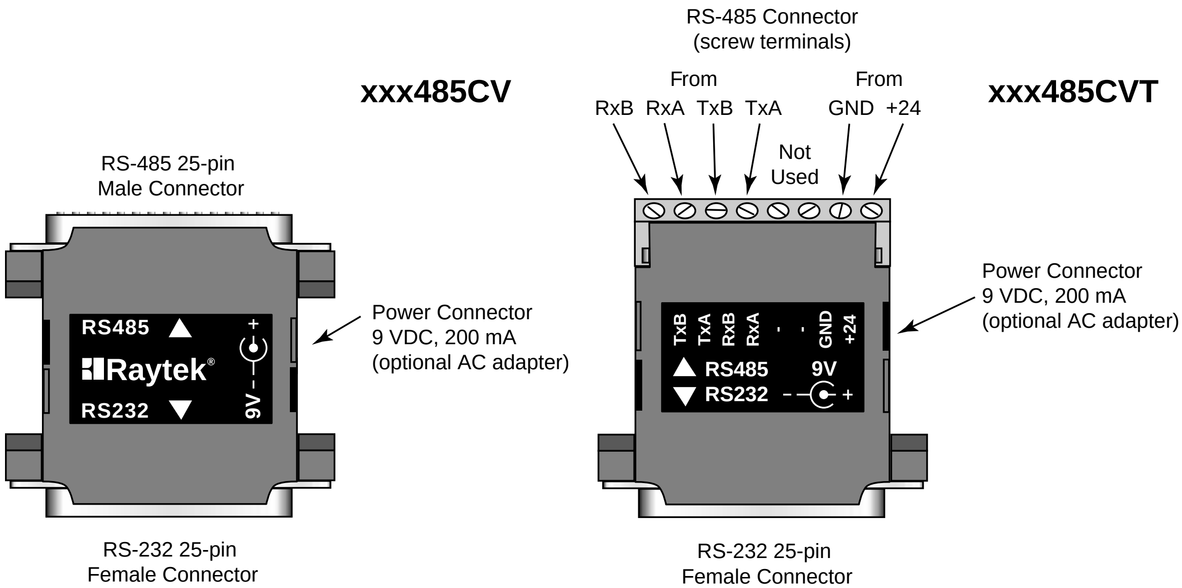


Figure 3-16: RS-485 to RS-232 Interface Converter

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 3-17 illustrates cable and converter connections between sensor and computer. You can wire directly from the elecronics 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.

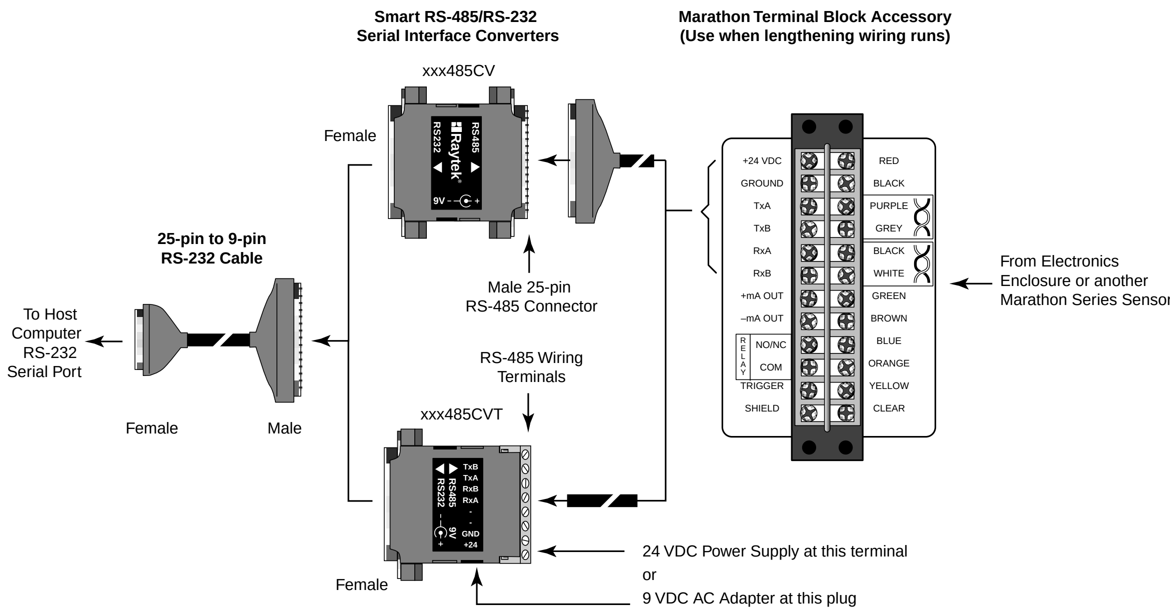


Figure 3-17: Connections from Sensor to Computer

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 COM2 is connected to an external modem (an internal modem can also be set to use COM2). It is possible for two devices to share a port (COM1/COM3 or COM2/COM4); however, they cannot be used at the same time.

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.

3.4.4 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 all models is 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.

3.4.5 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.

3.4.6 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 3-18, below.

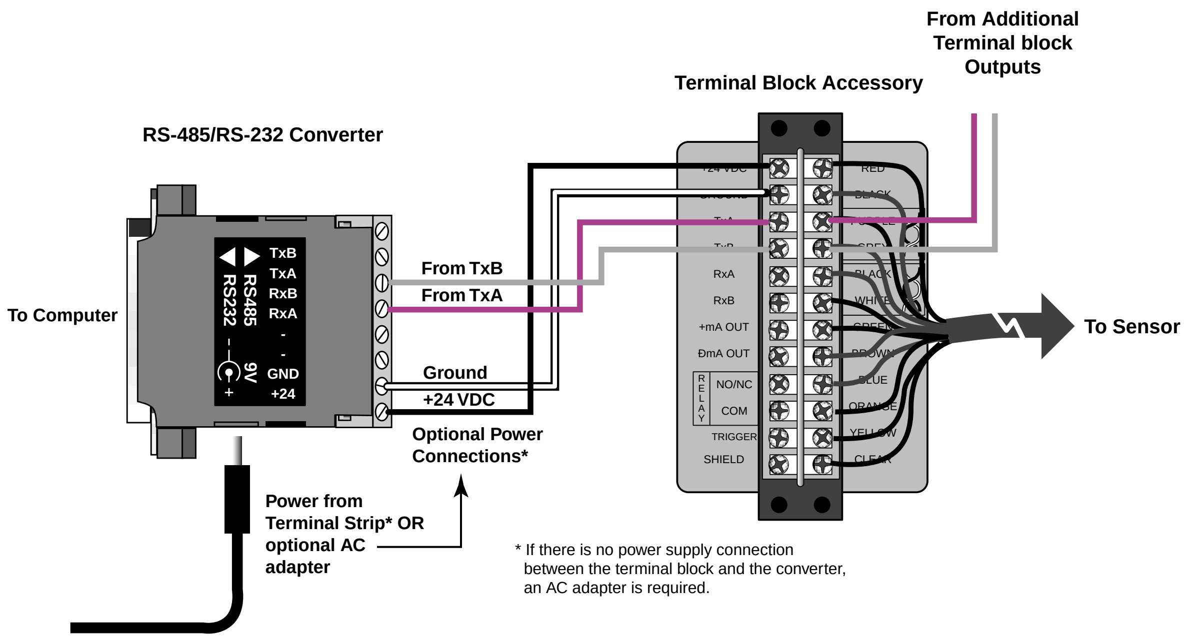


Figure 3-18: 2-Wire Multidrop Wiring

NOTICE

Be aware that you 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.)

3.4.7 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 3-19, below.

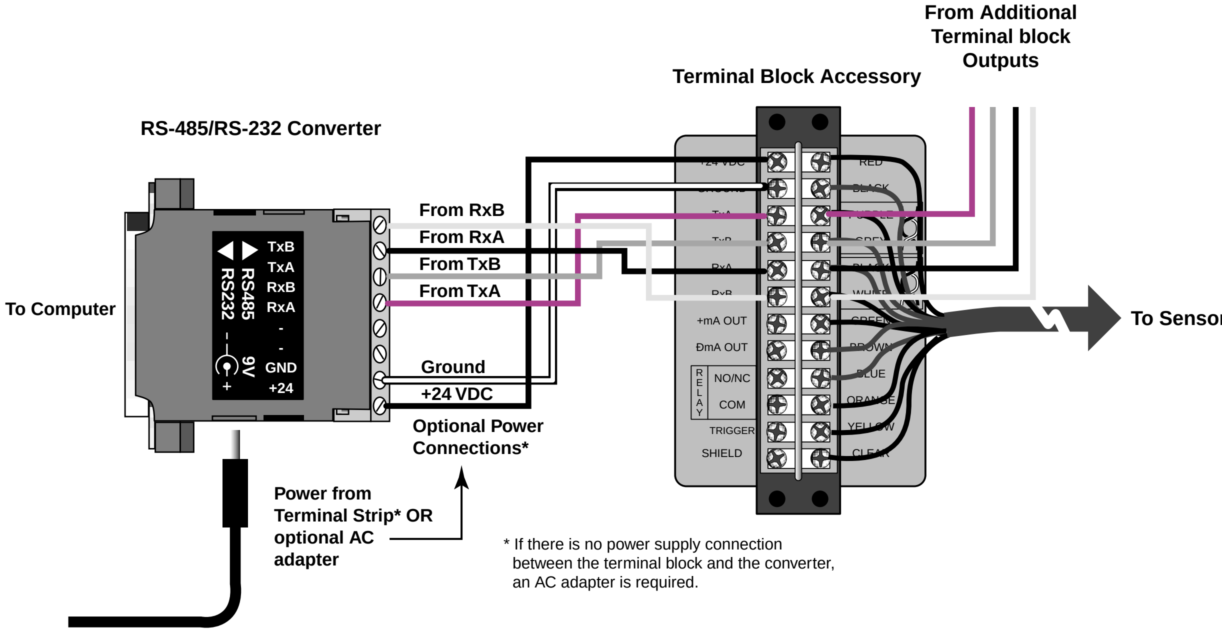


Figure 3-19: 4-Wire Multidrop Wiring

For setting up milliamp and relay outputs, refer to Sections 3.3.4 and 3.3.5.

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), a Chat program (for communicating directly to a sensor from your computer terminal), and a Field Calibration program. All but the Field Calibration program are described in Part 4 (Field Calibration is explained in Appendix D).

3.5 OPERATION

Once you have your sensor(s) positioned and connected properly, the system is ready for continuous operation. Operation is accomplished either through the back 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, water, 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.

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 (Figure 3-20), which has setting / controlling buttons and an LED display. The panel is normally locked when the sensor is in multidrop mode but can be unlocked through software. (Refer to Appendix B.) When the panel is locked in multidrop mode, pushing a button makes the unit display the mode and multidrop address. For example, 4.013 shows that the unit is in 4-wire multidrop mode and that the address is 13.

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 protected during operation by the supplied end cap. If your sensor is a through-the-lens aiming model, the sighting hole in the end cap is threaded to accept the polarizing filter accessory (used for sighting / focusing on very bright targets). An end cap with a larger window, which allows all control panel LEDs to be visible, is available as an option. (You cannot use the polarizing filter with this option.)

Figure 3-20 is an overview of both types of control panel (through-the-lens and laser). The buttons and LEDs are defined in the following sections.

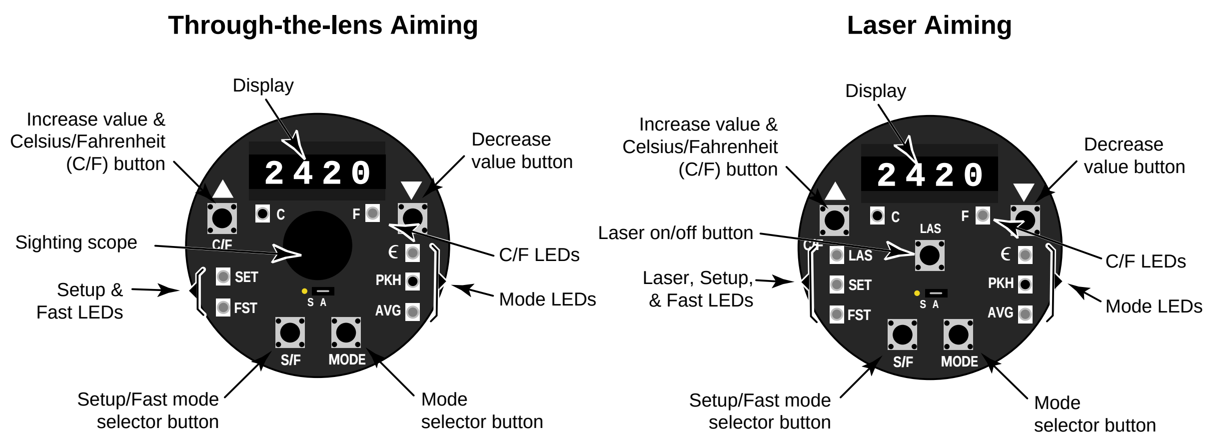


Figure 3-20: Control Panels

3.5.2 Set-Up

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.** (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 3-21 illustrates the sequence of operation for the mode selector button when in current temperature mode.

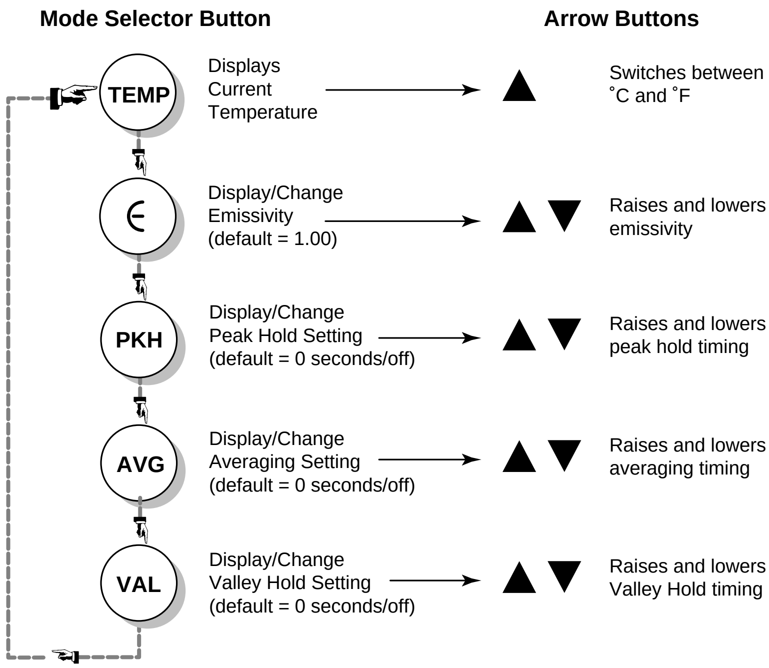


Figure 3-21: Mode Selector Button Sequence

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.

To change the settings for each mode using the control panel is simple. The following sections define each of the control panel's features and functions and explains sensor setup and use. Section 3.5.2.5 explains how to reset the factory defaults. Note that all modes can be changed from a computer using controlling software such as the supplied Utilities program.

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. When in multidrop mode the panel is locked by default. 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 3-21.

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 3-22)

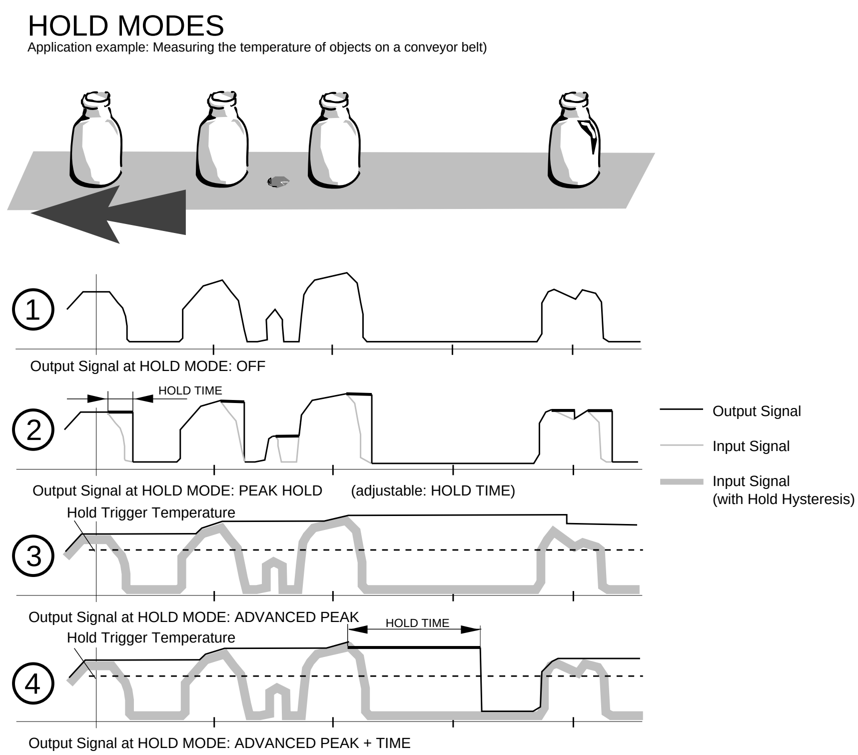


Figure 3-22: Peak Hold Output Signal Example

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.

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 3-23):

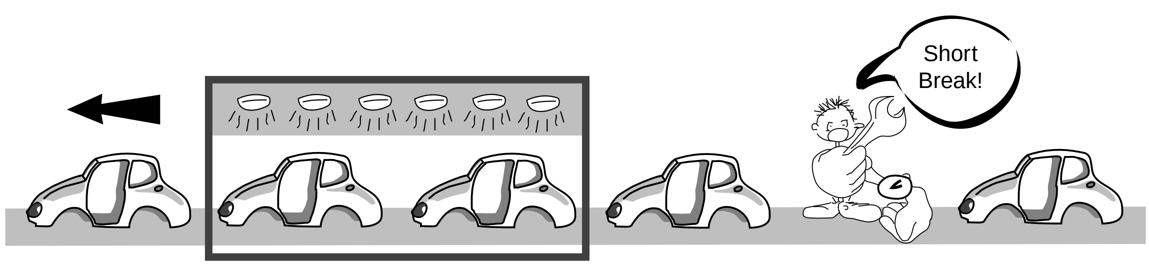


Figure 3-23: Peak Hold Example

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 3-24.)

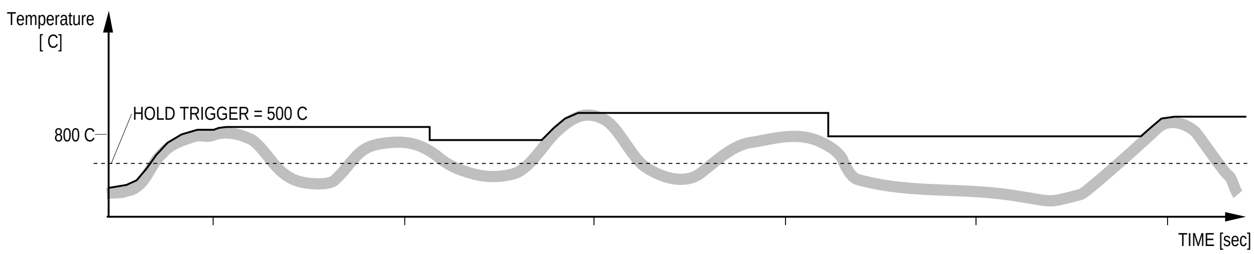


Figure 3-24: Advanced Peak Hold

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 3-25, the break has no end.)

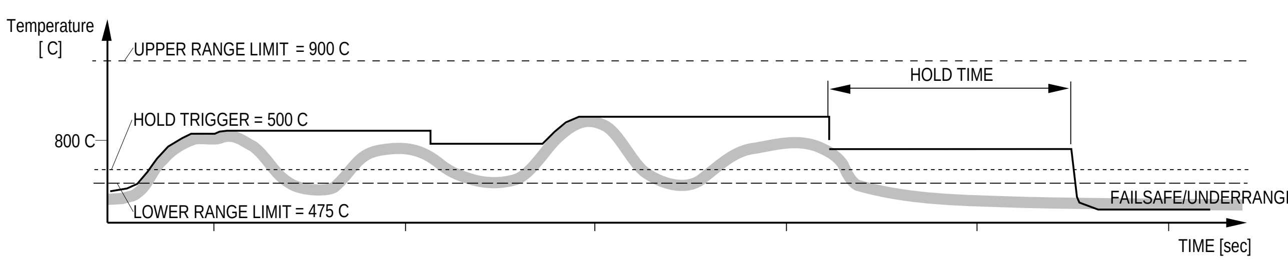


Figure 3-25: Advanced Peak Hold + Time

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 3-26 shows an example of continuous Peak Hold reset by the Trigger input.

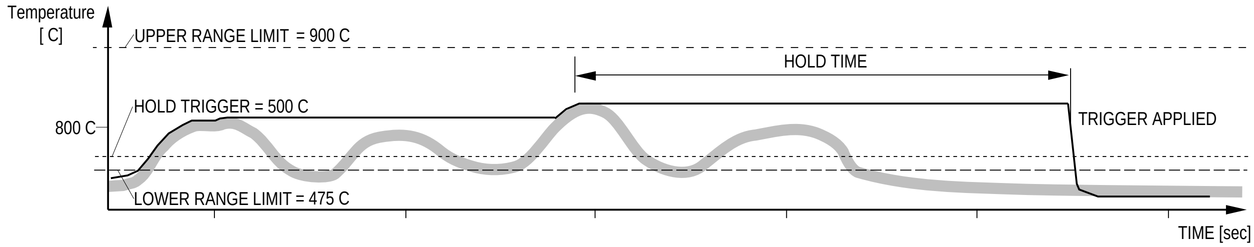


Figure 3-26: Continuous Peak Hold + Trigger

A decay time can be set to allow a slow reduction of the temperature until another peak is encountered. Figure 3-27 is an example of a Peak Hold with a set Decay Time.

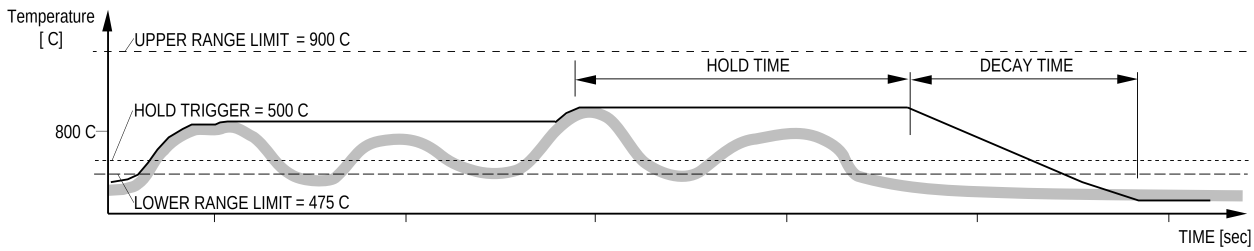


Figure 3-27: Peak Hold + Decay

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 3-23: No new car bodies enter.

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

   In the example in Figure 3-23: 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 3-23 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.

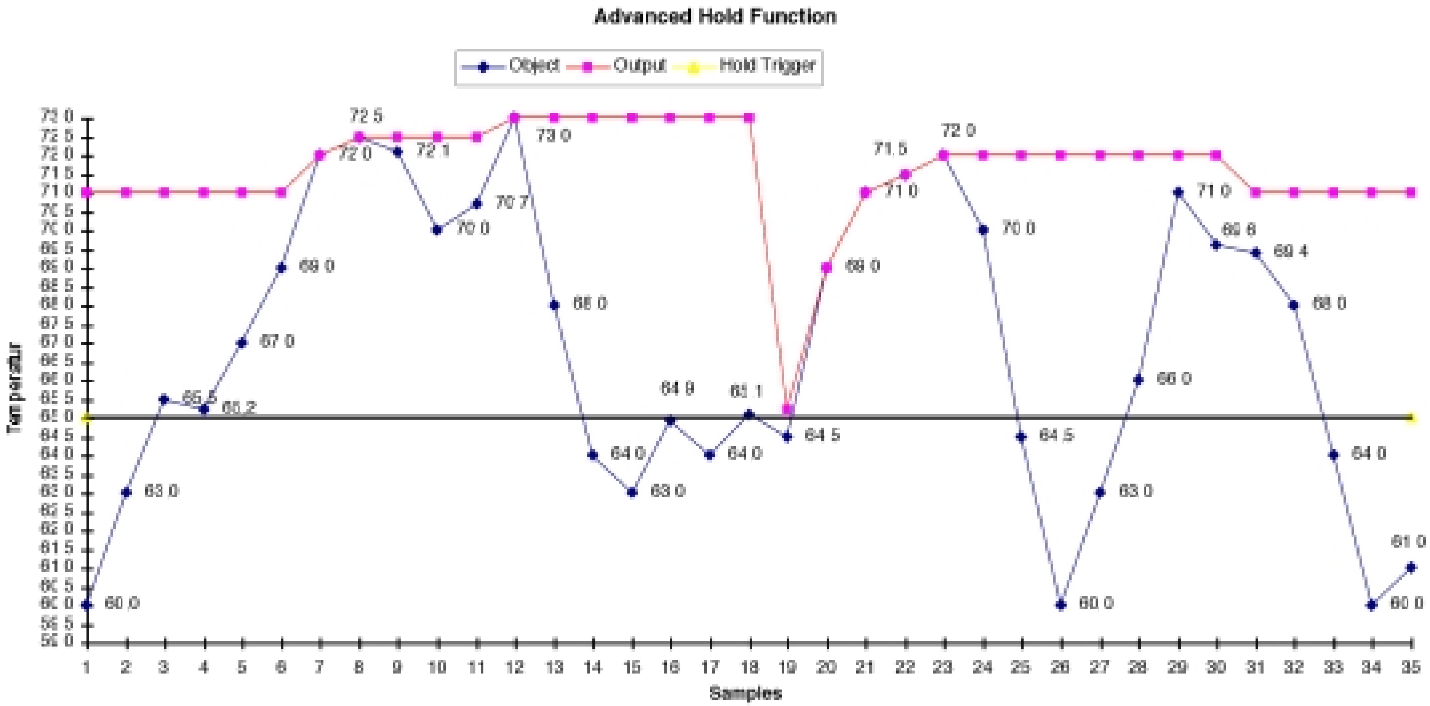


Figure 3-28: Advanced Hold Function

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 3-29 illustrates the Averaging output signal.

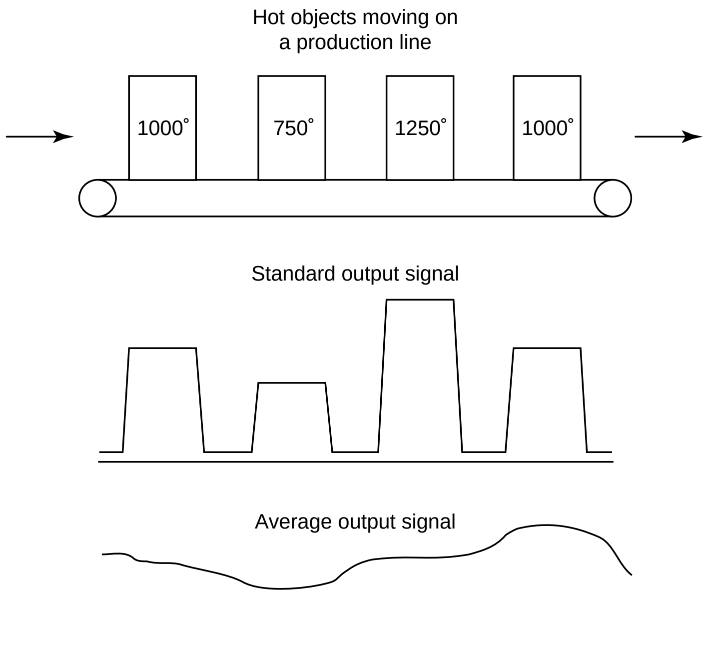


Figure 3-29: Averaging Example

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 3-30 illustrates the Valley Hold output signal.

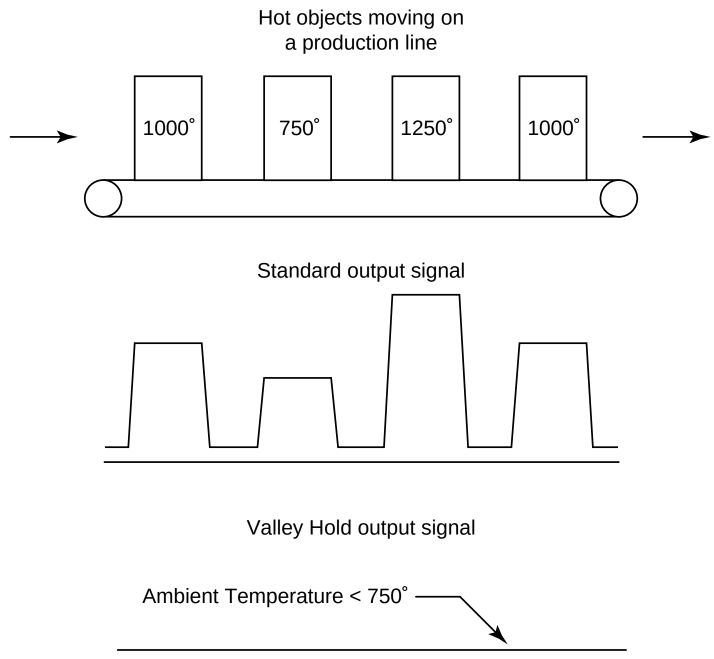


Figure 3-30: Valley Hold Example

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

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 ± 2° C (±4° 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).

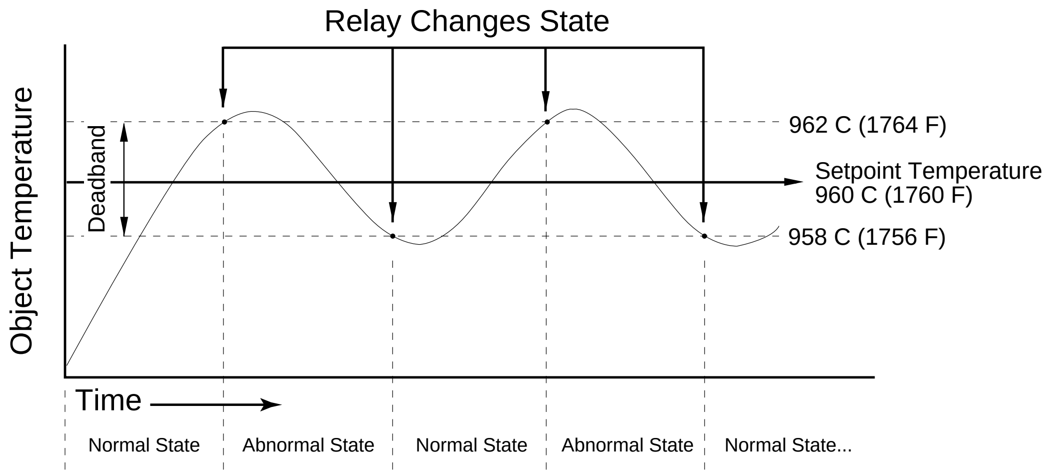


Figure 3-31: Deadband Example

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 permanentlly in the instrument.

The command A=0000 will turn this feature off.

3.5.2.6 Resetting Factory Defaults

To globally reset the unit to its factory default settings, make sure the unit is in Setup mode (SET LED is lit) and 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.

3.5.2.7 Laser On/Off

To turn the laser on or off (on sensors equipped with laser aiming), push the LAS button in the center of the control panel. When the laser is on, the LAS LED on the left side of the panel will be lit.

Note: You cannot use the laser in Fast Mode.

IMPORTANT

The laser must be turned off when measuring temperatures or the sensor's accuracy will be compromised.

3.5.3 FAST MODE

During normal operation the unit's response time is approximately 10 milliseconds. When using software to control the sensor you may notice response time on the digital output drop to slower rates. (The more data you want to log, the slower the response time.) For applications that require very fast response time, the unit can be switched, either manually or through software, to Fast Mode.

To manually switch to Fast Mode, you only need to press the S/F button so the FST LED is lit. The current settings are used (emissivity, peak hold, etc.).

Note: You cannot use the laser in Fast Mode.

IMPORTANT

In Fast Mode no other functions or modes, including Averaging, are available other than obtaining and displaying a temperature. If you need to reset functions, switch back to Setup Mode (the SET LED is lit), and make any necessary changes. These new changes will be in effect if you return to Fast Mode.

Part 4 Marathon Support Software Installation & User Guides

This section explains the installation and operation of the Marathon Support Software included with your sensors. Graphic Setup and Display, Sensor Network Setup and Display, and Chat can be used in multidrop sensor environments. The Graphic Setup and Display and Marathon Chat programs can also 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), 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 and Field Calibration programs described in Part 3 and Appendix D.

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.

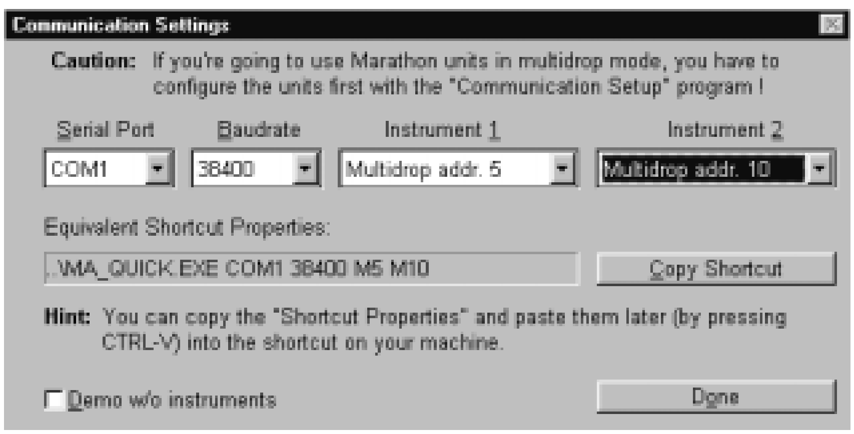


Figure 4-1: Communication Settings Screen

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 MA2S 1-color instrument on the right.

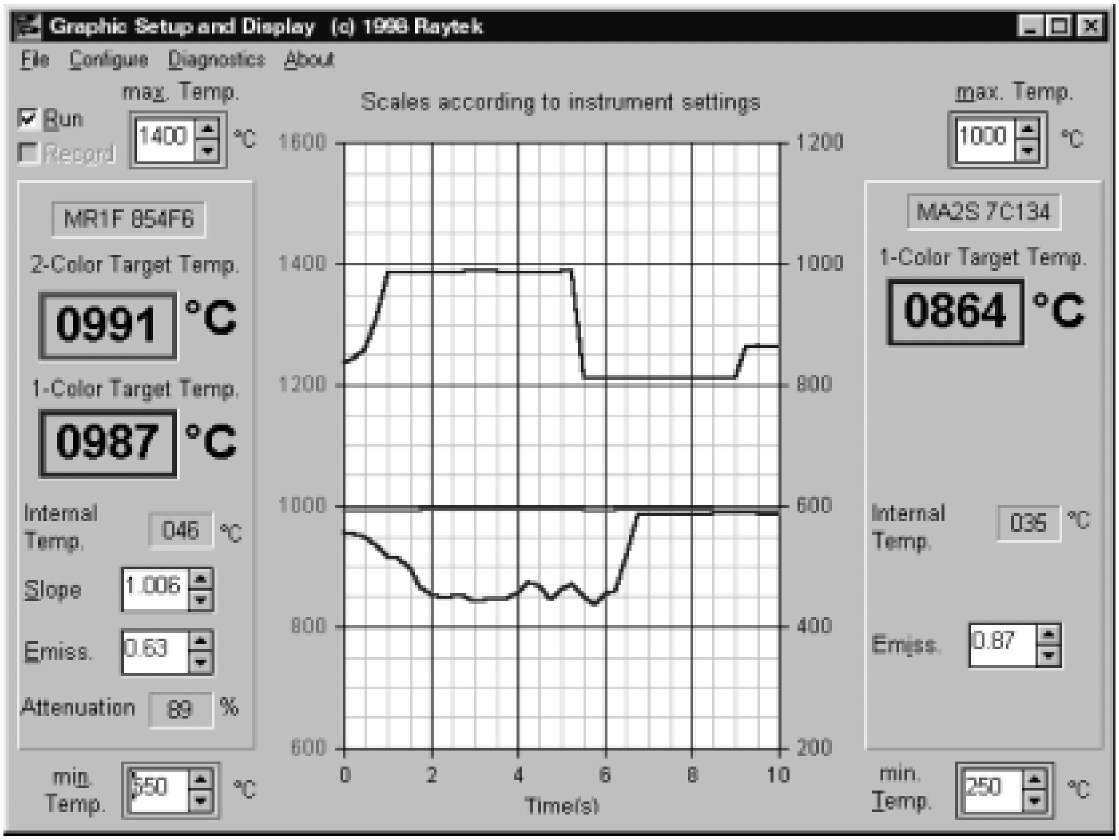


Figure 4-2: The Graphic Setup and Display Main Screen

The 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.

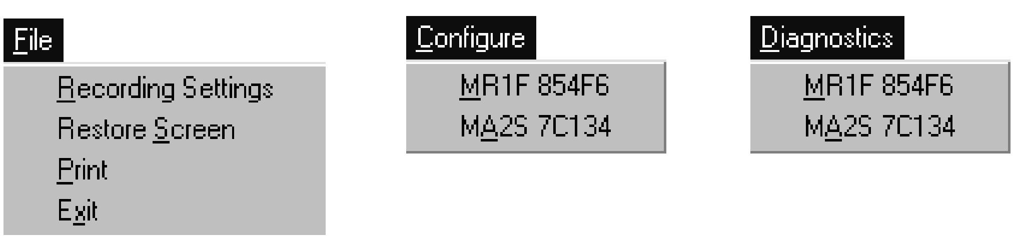


Figure 4-3: The Menus

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.

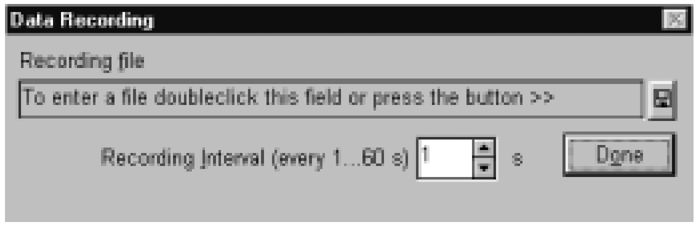


Figure 4-4: Data Recording

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.

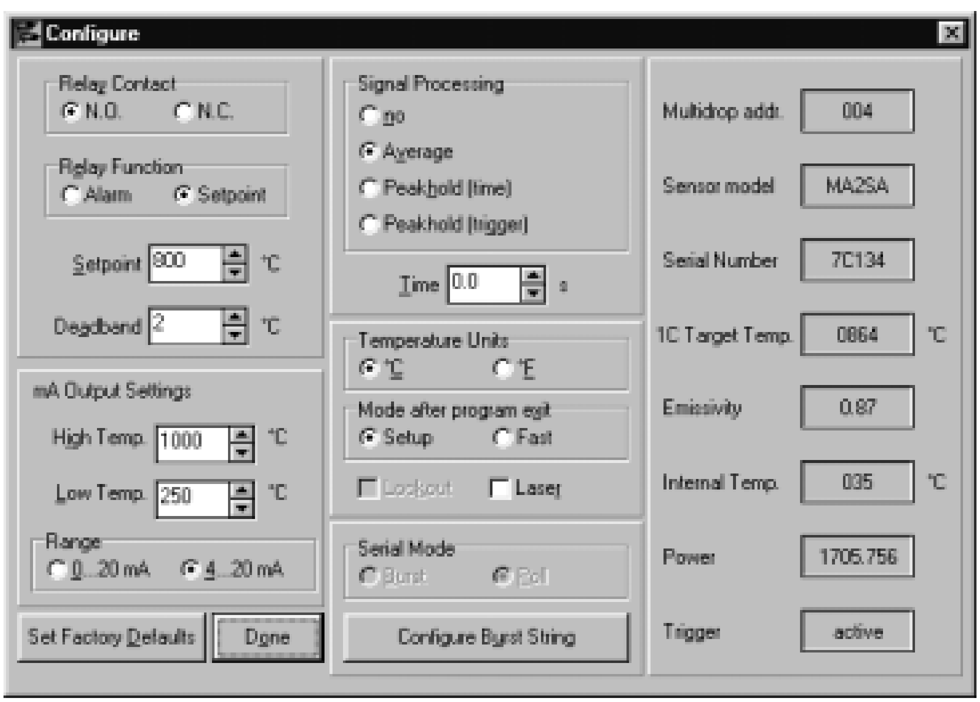


Figure 4-5: Sensor Configuration Screen

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. 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 beyond a deadband value, 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.

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.

Laser–turns the laser on or off. Use this when aligning or realigning a sensor on its target. This feature is available only for sensors with built-in laser sighting.

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.

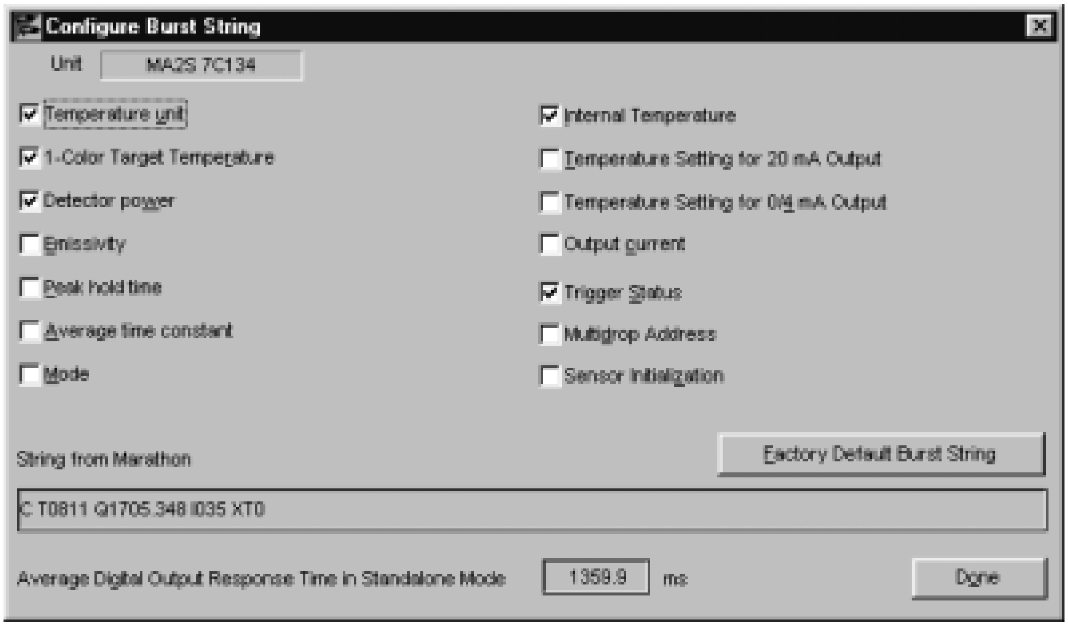


Figure 4-6: Configure Burst String Window

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.

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.

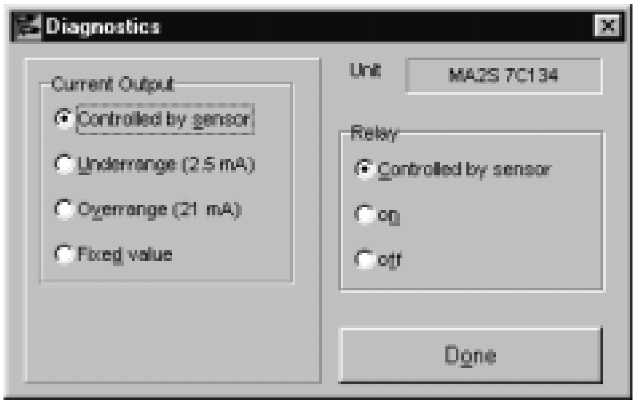


Figure 4-7: Diagnostics Window

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 that 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).

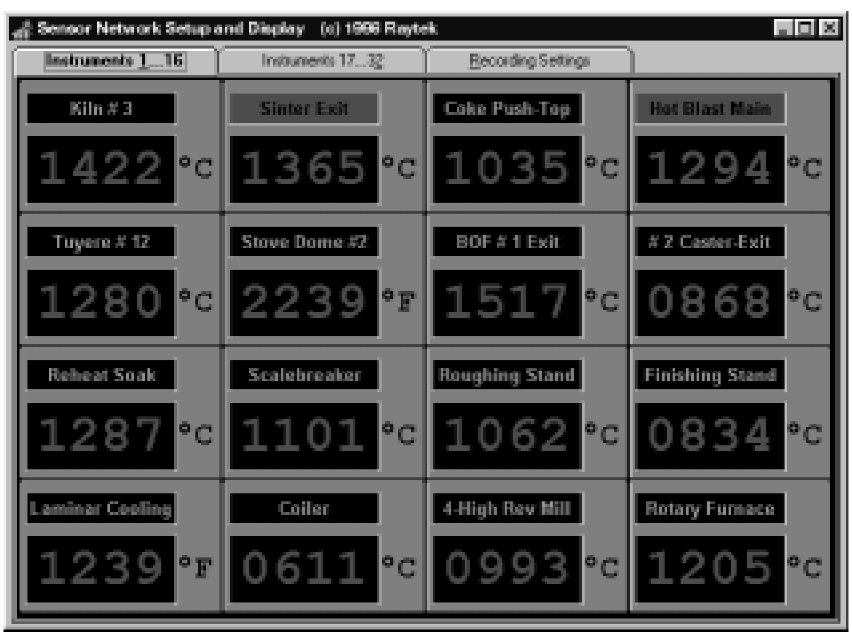


Figure 4-9: Sensor Network and Display Main Screen

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.)

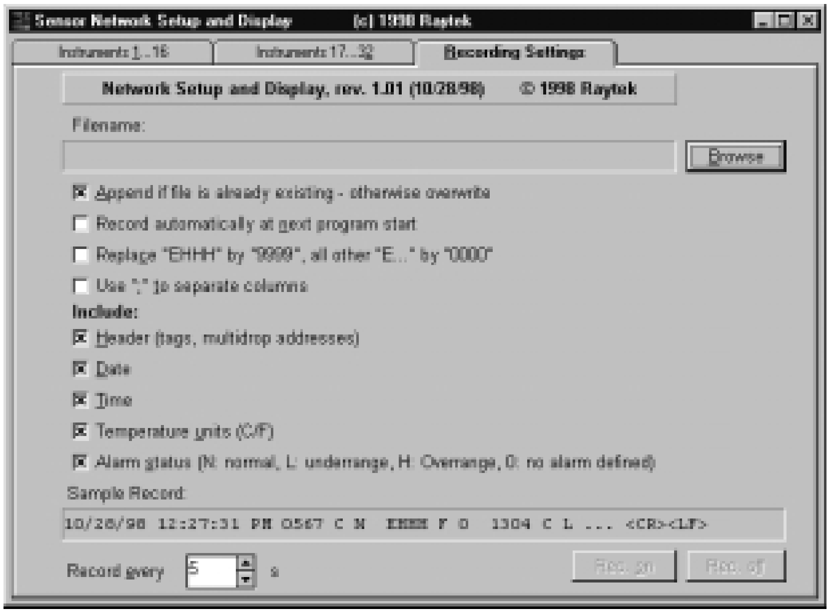
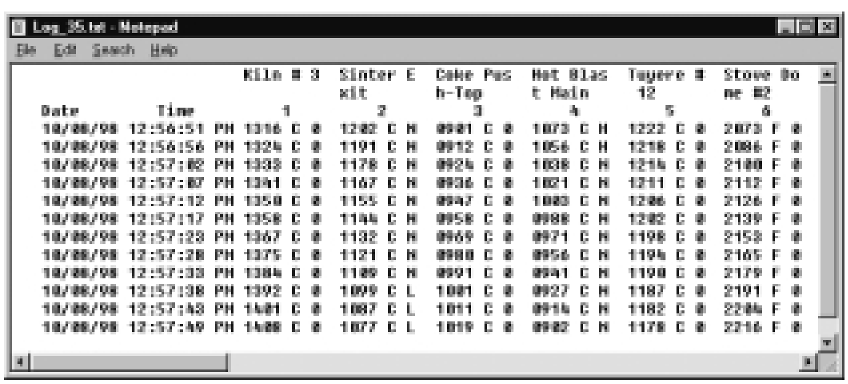


Figure 4-10: Recording Settings Screen

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.


Log_35.txt - Notepad
File Edit Search Help

```
                          Kiln # 3  Sinter E  Coke Pus  Hot Blas  Tuyere #  Stove Do
                                    xit       h-Top     t Main     12       me #2
 Date       Time             1         2         3         4         5         6
 10/08/98 12:56:51 PM 1316 C 0  1202 C H  0901 C 0  1073 C H  1222 C 0  2073 F 0
 10/08/98 12:56:56 PM 1324 C 0  1191 C H  0912 C 0  1056 C H  1210 C 0  2086 F 0
 10/08/98 12:57:02 PM 1333 C 0  1178 C H  0924 C 0  1038 C H  1214 C 0  2100 F 0
 10/08/98 12:57:07 PM 1341 C 0  1167 C H  0936 C 0  1021 C H  1211 C 0  2112 F 0
 10/08/98 12:57:12 PM 1350 C 0  1155 C H  0947 C 0  1003 C H  1206 C 0  2126 F 0
 10/08/98 12:57:17 PM 1358 C 0  1144 C H  0958 C 0  0986 C H  1202 C 0  2139 F 0
 10/08/98 12:57:23 PM 1367 C 0  1132 C H  0969 C 0  0971 C H  1198 C 0  2153 F 0
 10/08/98 12:57:28 PM 1375 C 0  1121 C H  0980 C 0  0956 C H  1194 C 0  2165 F 0
 10/08/98 12:57:33 PM 1384 C 0  1109 C H  0991 C 0  0941 C H  1190 C 0  2179 F 0
 10/08/98 12:57:38 PM 1392 C 0  1099 C L  1001 C 0  0927 C H  1187 C 0  2191 F 0
 10/08/98 12:57:43 PM 1401 C 0  1087 C L  1011 C 0  0914 C H  1182 C 0  2204 F 0
 10/08/98 12:57:49 PM 1408 C 0  1077 C L  1019 C 0  0902 C H  1178 C 0  2216 F 0
```

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.)

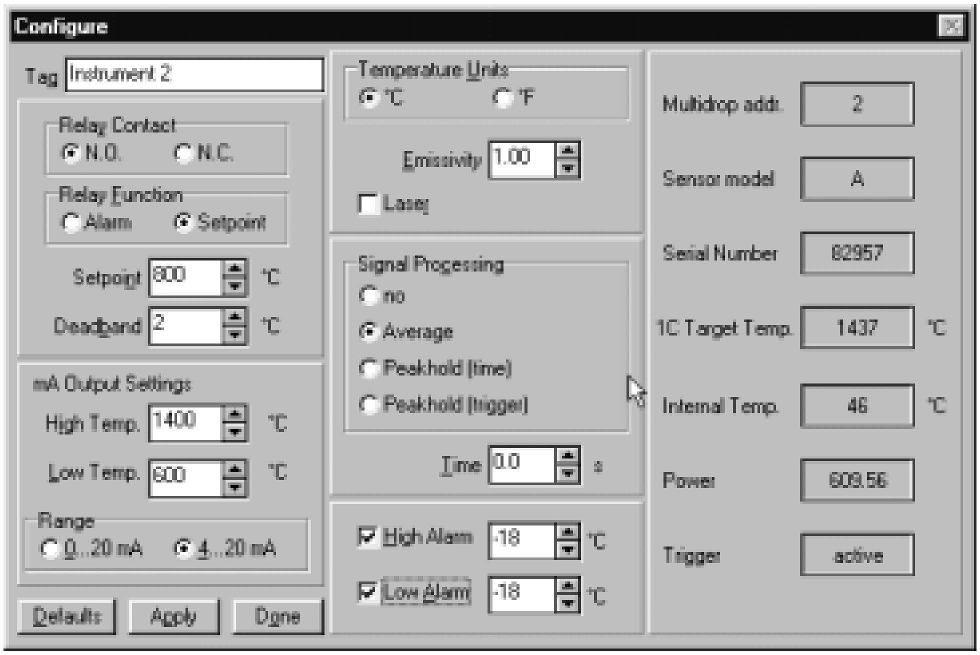


Figure 4-12: Configure Screen

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.

Laser–turns the laser on or off. Use this when aligning or realigning a sensor on its target. This feature is available only for sensors with built-in laser sighting.

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 C for sample emissivities for metals and non-metals.

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.

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.

After you make any configuration changes, click on the Apply or Done button. To switch the sensor back to its factory settings, click on the Default button.

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.

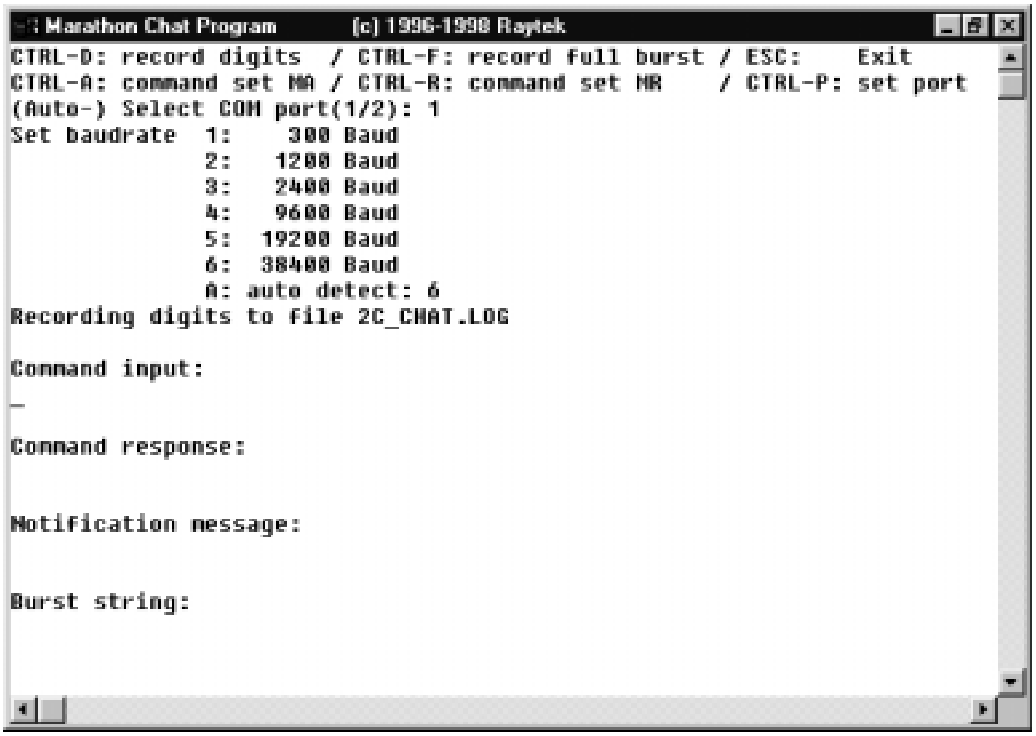


Figure 4-13: Chat Program Display

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 or R. 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.

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 is receives, but will only display command responses, reports of pushbutton activity, and lines containing transmission errors.

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
- Field Calibration Guide
- DIN Connector Wiring
- 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 temepratur 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.

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.

A.3 CLEANING THE WINDOW

Keep the window clean at all times. Any foreign matter on the window will affect measurement accuracy. However, care should be taken when cleaning the window. To clean the window, do the following:

1. Lightly blow off loose particles.
2. Gently brush off any remaining particles with a soft camel hair brush or a soft lens tissue (available from camera supply stores).
3. Clean remaining “dirt” using a cotton swab or soft lens tissue dampened in distilled water. Do not scratch the surface.

For finger prints or other grease, use any of the following:

- Denatured alcohol
- Ethanol
- Kodak® lens cleaner

Apply one of the above to the window. Wipe gently with a soft, clean cloth until you see colors on the surface, then allow to air dry. Do not wipe the surface dry, this may scratch the surface.

If silicones (used in hand creams) get on the window, gently wipe the surface with Hexane. Allow to air dry.

A.4 CHANGING THE WINDOW

Sometimes extremely harsh environments can cause damage to the window. Replacement windows are available from the manufacturer. To order replacement windows, contact your local sales representative or distributor.

To replace the sensor’s window, complete the following:

1. With a very small flat-bladed screw driver (e.g., a jeweler’s screwdriver), pry out the rubberized Buna-N 70 durometer O-ring. The O-ring is set in a groove in front of the window.

WARNING

If you use a fine-bladed knife to remove the O-ring, be careful not to cut or sever the ring.

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2. Turn the sensor face down (window pointing down), and the window should fall out.
3. Turn the sensor face up and insert the new window. (Make sure both sides of the window are clean.)
4. Replace the O-ring.

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.

Table B-1 (continued): Protocols

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 **P**olled for (queried), **B**urst string item, **S**et command, or **N**otification.
(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-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 **P**olled for (queried), **B**urst string item, **S**et command, or **N**otification.
(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:

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

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:

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

$$= 17.7 \text{ ms}$$

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	
	1.0µm	**1.6µm**
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: MA1S/MA2S FIELD CALIBRATION SOFTWARE

The field calibration and diagnostics software and hardware package allows convenient, reliable calibration of Marathon MA1S and MA2S infrared thermometers.

D.1 DESCRIPTION

The field calibration and diagnostics software is included in the software you installed in Part 4 (or Part 3 if working in a multidrop environment).

The field calibration hardware kit (sold separately) includes the following:

- A 4 meter (13 feet) cable (sensor to terminal block)
- RS-485 to RS-232 converter with power supply
- Adapter (25-pin to 9-pin serial connections)
- Terminal block
- Two 3 meter (10 ft) 4-conductor cables–one for power, one for RS-485
- Power supply (110V or 220V) and power cord (CE certified)
- Mounting nut and bracket

D.2 SYSTEM REQUIREMENTS

To operate the field calibration system and software, you need the following:

- DMM for measuring mA output (Fluke 85 or equivalent recommended)
  Specifications

Range:	400.0 µA to 40.0 mA
Accuracy (DC):	± 0.2% reading + 2 digits
Maximum Resolution:	0.1 µA in the 400 µA range

- Blackbody capable of achieving the required calibration temperatures (depends on sensor model and type of calibration). Should have at least a 25mm (1 in) diameter cavity.
- Laser power meter (for units with laser sighting)
- Stable tripod

IMPORTANT

Do not run the Field Calibration & Diagnostics Software on a network server or network workstation. Raytek cannot guarantee the product when used in this manner.

D.3 HARDWARE INSTALLATION

Note: ***Field Calibration cannot be performed in a multidrop configuration. If your sensor is in a multidrop network, you must disconnect it and connect it to a dedicated PC as described below.***

There are four unique calibrations you can perform: 1-point, 2-point, 3-point, and factory style. For each temperature calibration method, use a blackbody source capable of any temperature within the sensor's temperature range. For the three-point fixed temperature calibration method, use the calibration temperatures and distances shown in Table D-1 below.

When setting up and adjusting your blackbody source, you can set the temperature(s) to what relates best for your application.

Complete the following steps to install your field calibration system hardware (if needed, refer to the documentation accompanying your computer system and blackbodies):

1. Turn on your calibration source (blackbody), and set it to the appropriate temperature. Let the source stabilize before proceeding with the actual calibration.

   Note: For One Point Calibration, set the blackbody to your chosen calibration temperature. For Two Point Calibration and Three Point–Variable Calibration, set the blackbody to either the highest or lowest temperature (or middle temperature in a Three Point calibration) in your chosen temperature range. The sequence you calibrate in (high, low, or middle) does not matter. For Factory-style calibration, match calibration temperature given in Table D-1.

Table D-1: Calibration Temperatures and Distances

	FA1A	FA1B	FA1C	FA1G	FA2A	FA2B
Distance (all calibration types)	915 mm (36 in)	915 mm (36 in)	915 mm (36 in)	915 mm (36 in)	915 mm (36 in)	915 mm (36 in)
Factory Style Temperatures						
High Temp Cal Point	1227 C (2240 F)	1627 C (2960 F)	2627 C (4760 F)	827 C (1520 F)	1227 C (2240 F)	1727 C (3140 F)
Low Temp Cal Point	627 C (1160 F)	827 C (1520 F)	1027 C (1880 F)	327 C (620 F)	427 C (800 F)	527 C (980 F)

2. Place the sensor on a stable tripod the proper distance from the calibration source (see Table D-1). Blackbody target should completely fill the field of view. The calibration distance is measured from the front of the sensor to the front of the source cavity (see Figure D-1).

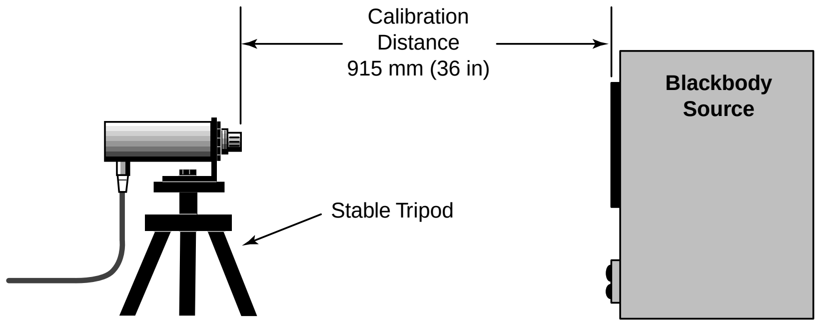

Figure D-1: Calibration Distance

3. Attach the sensor cable assembly's 12-pin connector to the sensor, and plug the AC adapter into the RS-485 to RS-232 converter (see Figure D-2).
4. Attach the RS-485 to RS-232 converter, if needed, to an available COM port on your computer. If necessary, use the supplied 25 to 9-pin serial adapter to connect to your computer.
5. Turn on the power to the sensor and let it warm up for 15 minutes.
6. Connect the Volt / Amp meter to the appropriate analog output terminals on the terminal block assembly (see Figure D-2).

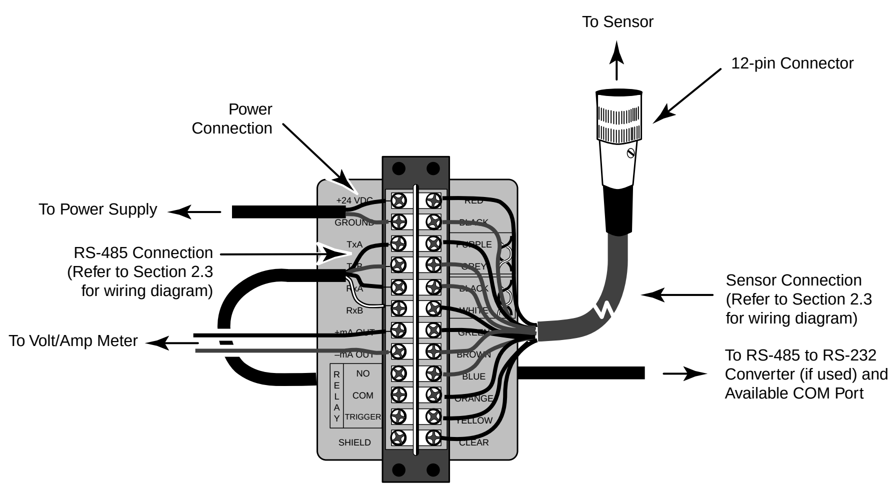

Figure D-2: Wiring Diagram

This completes the hardware installation. If the sensor has been set to multidrop mode, you must return it to non-multidrop 4-wire mode by running the Network Communication Setup program (see Section 3.2). Please note the sensor's multidrop address so you can restore it after field calibration is complete. To start calibrating the sensor, go to the next section.

D.4 OPERATION

The Field Calibration and Diagnostics program follows standard Windows conventions. The following sections assume you are familiar with using the Windows 95, Windows 98, or Windows NT operating environments. If you need Windows help when using this software, refer to your Windows manual.

The following sections define the functions of the user interface, calibrating your sensor (and why to use a particular calibration), and how and why to use the various utilities.

D.4.1 THE MAIN SCREEN

All calibration functions, as well as Downloading Calibration Constants and printing, are done from the Main Screen. To start the Field Calibration program and display the main screen, complete the following steps:

1. Select the **Start** button and **Programs**
2. Select the Raytek program group, and select MA Field Calibration.
3. Before the main screen appears, a dialog box like Figure D-3 displays. Click on the appropriate button then the main screen displays (Figure D-4).

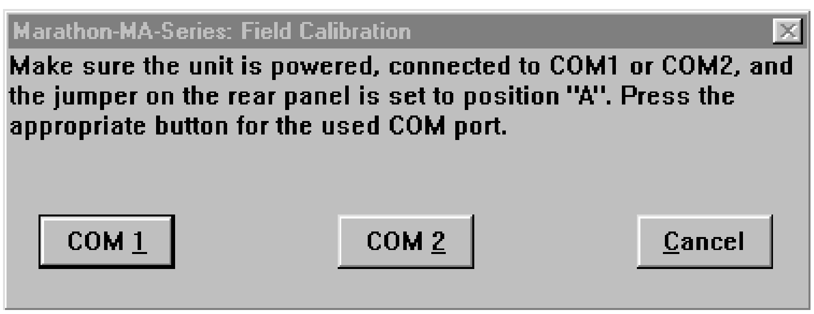

Figure D-3: Dialog Box

Notes: If you start a calibration procedure, you have to finish it before starting another procedure. Once a calibration is started, the program will disable some of the main screen buttons and menu selections. If you don't finish a calibration and exit the program, you will be prompted whether you would like to continue the already started calibration or to abandon it when you restart the program.

After finishing a calibration procedure, the Download Calibration Constants and Print buttons on the main screen (and in the File Menu) are active. (You must download the calibration constants to the sensor after performing a successful calibration.) If you need a calibration report for your records, click on the Print button (or select Print from the File Menu).

All necessary calibration functions are performed from this main screen. The main screen's buttons, as shown in Figure D-4, are duplicated in the Calibration menu. (Download Calibration Constants and Print are duplicated in the File menu.) The following sections cover the functions of the main screen buttons. The file menu functions are explained later in this section.

Note: Before you perform a 1-Point, 2-Point, 3-Point, or Factory Style calibration, an Offset calibration is recommended.

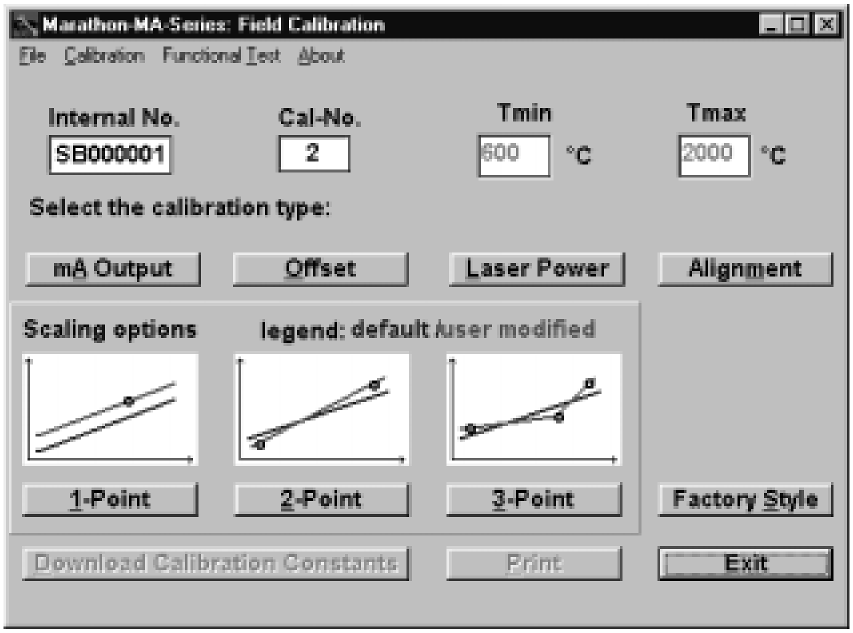

Figure D-4: The Main Screen

D.4.1.1 mA Output

To perform the mA Output calibration, complete the following steps:

1. Click on the mA Output button (or pull down the Calibration menu and select mA-Output Calibration). A dialog box displays the message "Please wait while testing communications channels."
2. The mA-Output Calibration screen displays (Figure D-5). Follow the directions.

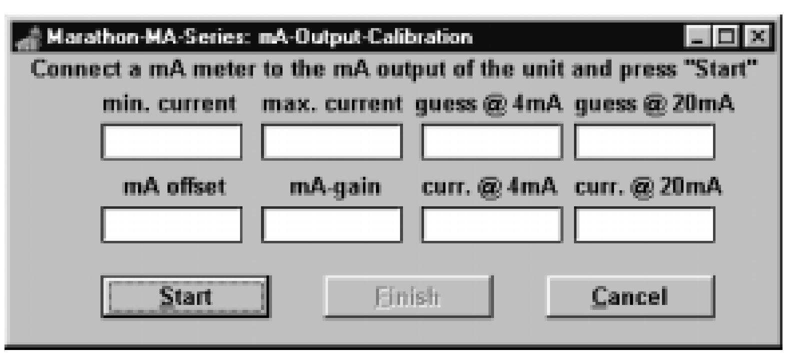

Figure D-5: The mA Output Calibration Screen

D.4.1.2 Offset

An Offset Calibration is recommended before performing a 1-Point, 2-Point, 3-Point, or Factory Style Calibration. To perform an Offset calibration, complete the following:

1. Click on the Offset button (or pull down the Calibration menu and select Offset Calibration). The first dialog box displays with the message "Please wait while testing communications channels." A second dialog box displays the message "Reloading offset trim for analog board–please wait."
2. When the Offset Calibration screen displays (Figure D-6), click on the Start button and follow the onscreen directions. Click on the Finish button when done.

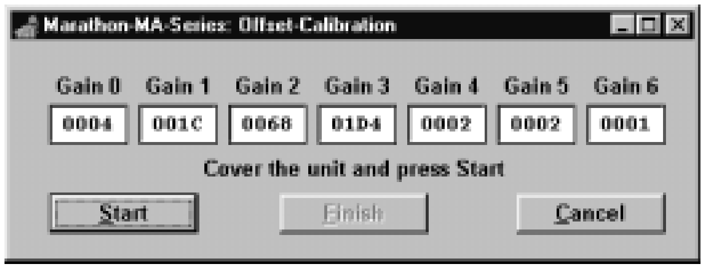

Figure D-6: Offset Calibration Screen

D.4.1.3 Laser Power

Laser Power calibration is available only if the attached MA1S or MA2S has laser sighting. Otherwise, the Laser Power button and the Laser Power Calibration selection in the Calibration menu are "greyed" out and inactive.

WARNING

Do not look directly into the laser beam.

To perform a Laser Power Calibration, complete the following steps:

1. Place a laser power meter in front of the sensor.
2. Using the arrow buttons (see Figure D-7), adjust the value until the laser power meter reads 0.95 mW.

WARNING

Do not exceed 1.00 mW or you can damage the laser diode.

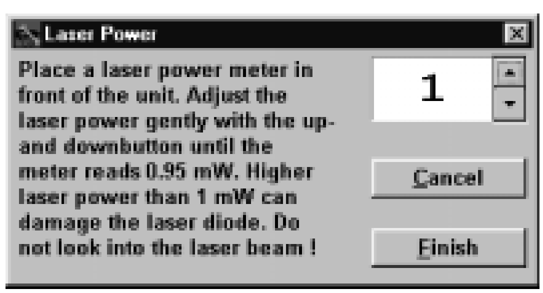

Figure D-7: Laser Power Calibration Screen

D.4.1.4 Alignment

1. Click on the Alignment button (or pull down the Calibration menu and select Alignment). A dialog box displays with the message “Preparing for alignment.”
2. The Alignment screen displays (Figure D-8). Follow the onscreen directions.

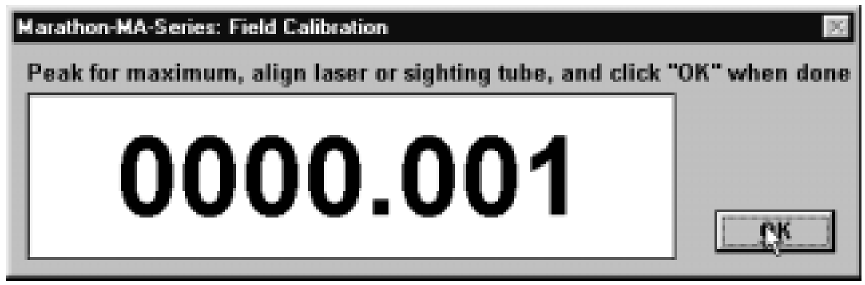

Figure D-8: Alignment Window

D.4.1.5 1-Point

If you are working with a single temperature in your process and you need to “offset” the reading at that temperature to make it match your “known temperature,” use the 1-Point Calibration. This offset will be applied to all temperatures throughout the entire temperature range. This calibration technique can also be used to match several sensors to each other at one temperature.

Figure D-9 illustrates the before and after of 1-Point Calibration (for MA1SA model). You can set the offset to any temperature within the sensor’s temperature range.

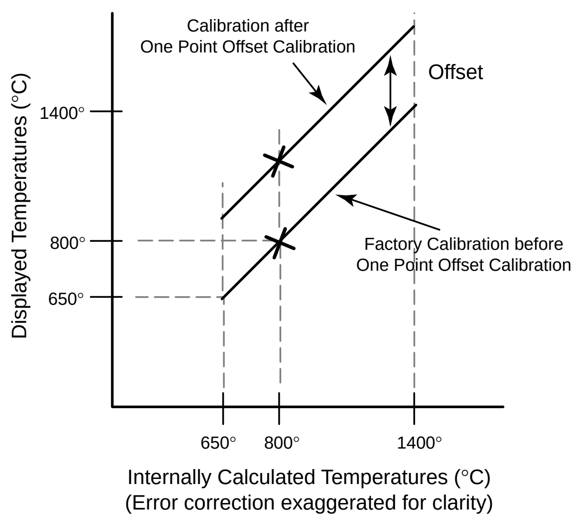

Figure D-9: 1-Point Calibration Example

To complete the 1-Point Calibration procedure, complete the following:

1. Click on the 1-Point button (or pull down the Calibration menu and select 1-Point Calibration). A dialog box displays with the message “Preparing for Calibration.”
2. The 1-Point Calibration screen displays (Figure D-10). Follow the onscreen directions.

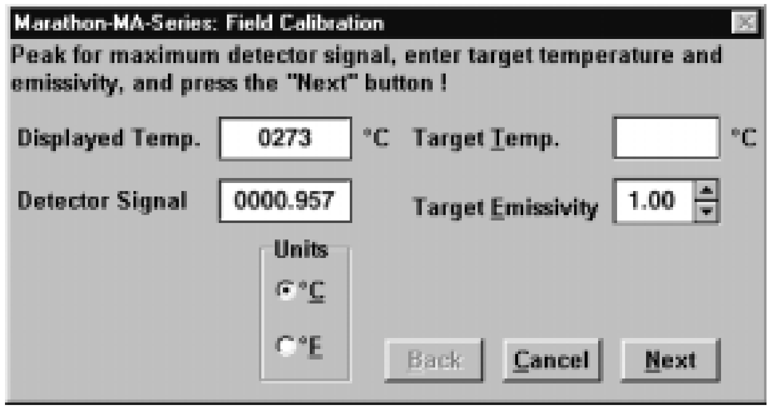

Figure D-10: 1-Point Calibration Screen

Note: After finishing the calibration procedure you must download the calibration constants to the sensor. If you need a calibration report for your records, click on the Print button (or select Print from the File Menu).

D.4.1.6 2-Point

If you need to match readings at two specific temperatures, use the 2-Point Calibration. This technique uses the calibration temperatures to calculate a gain and an offset. This gain and offset is applied to all temperatures throughout the entire temperature range.

Figure D-11 illustrates before and after of 2-Point Calibration (MA1SA model). Note that you can calibrate the temperatures in any order, highest first, lowest second, or vice versa. You can use any two temperatures within the sensor's temperature range.

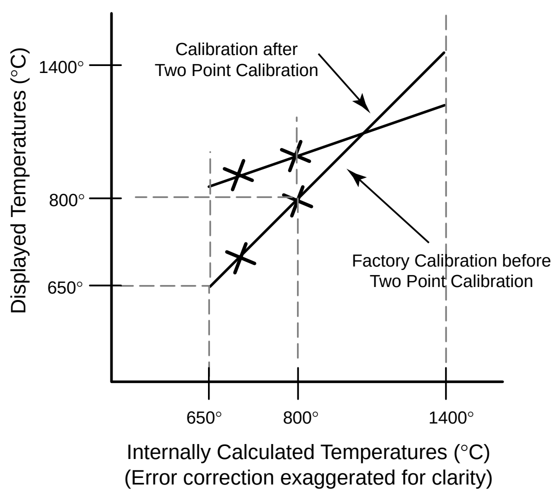

Figure D-11: 2-Point Calibration Example

To complete the 2-Point Calibration procedure, complete the following:

1. Click on the 2-Point button (or pull down the Calibration menu and select 2-Point Calibration). A dialog box displays with the message "Preparing for Calibration."

2. The first 2-Point Calibration screen displays (as shown in Figure D-11), then a second screen displays (Figure D-12). Follow the onscreen directions.

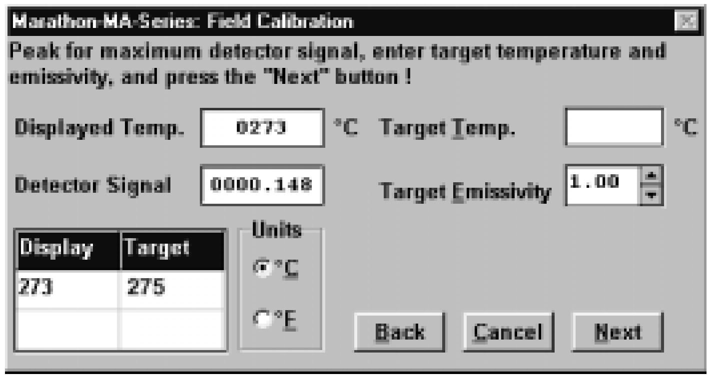

Figure D-12: The Second 2-Point Calibration Screen

Note: After finishing the calibration procedure you must download the calibration constants to the sensor. If you need a calibration report for your records, click on the Print button (or select Print from the File Menu).

If you have one point already entered in the 2-Point Calibration procedure and would like to repeat that point, click on the Back button.

If necessary, you can exit the program after taking one calibration point by clicking on the Cancel button then the Exit button and then restart the program at a later time. When you restart, the program asks you if you want to continue the interrupted calibration. If you answer Yes and press the 2-Point Calibration button on the main screen, the program will remember the first calibration point and prompt you for the second.

D.4.1.7 3-Point

If you are working with a wide range of temperatures in your process, and you need to match readings at three specific temperatures, use this calibration process. This technique uses the calibration temperatures to calculate two gains and two offsets. The first gain and offset is applied to all temperatures below a midpoint temperature chosen by you, and the second set of gain and offset is applied to all temperatures above the midpoint temperatures.

Figure D-13 illustrates the before and after of 3-Point calibration (for MA1SA model). You can use any temperatures within the sensor's temperature range, and you can calibrate the temperatures in any order, highest first, middle, and lowest last, or vice versa.
To complete the 3-Point Calibration procedure, complete the following:

1. Click on the 3-Point button (or pull down the Calibration menu and select 3-Point Calibration). A dialog box displays with the message "Preparing for Calibration."
2. The first and second 3-Point Calibration screens display (similar to Figure D-11), and then a third screen, similar to Figure D-14, displays. Follow the onscreen directions.

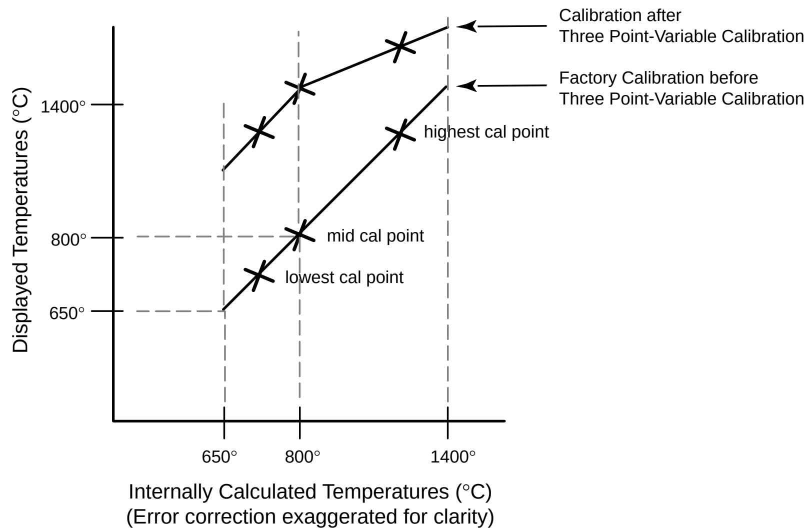

Figure D-13: 3-Point Calibration Example

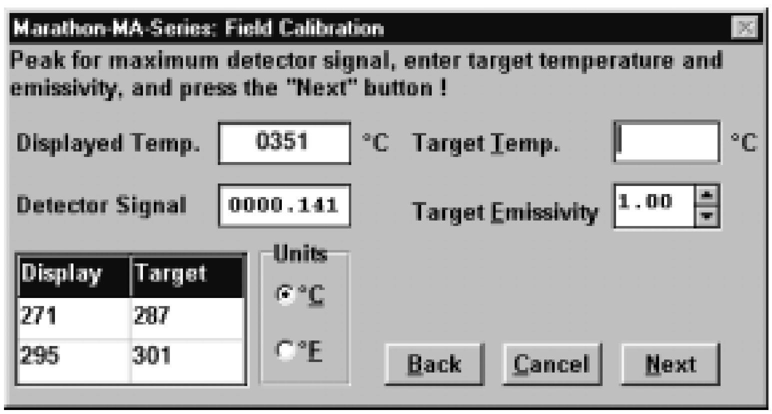

Figure D-14: The Third 3-Point Calibration Screen

Note: After finishing the calibration procedure you must download the calibration constants to the sensor. If you need a calibration report for your records, click on the Print button (or select Print from the File Menu).

If you have one or two points already entered in the 3-Point Calibration procedure and would like to repeat a point, click on the Back button.

If necessary, you can exit the program after taking one calibration point by clicking on the Cancel button then the Exit button and then restart the program at a later time. When you restart, the program asks you if you want to continue the interrupted calibration. If you answer Yes and press the 3-Point Calibration button on the main screen, the program will remember the previously taken calibration point and prompt you for the remaining ones.

D.4.1.8 Factory Style

This calibration technique is the same as that performed at the factory and yields the most accurate readings. It must, however, be done at the exact factory temperatures specified in Table D-1. The other three calibration techniques do not affect the internal factory calibration constants, they simply modify the final temperature calculations with the offset(s) and gain(s) calculated by the three calibration techniques.

NOTICE

This type of calibration modifies the original factory calibration constants. For this reason you must use the same fixed temperatures as those used at the factory. Note that small deviations of the calibration source temperature can be corrected by entering the true calibration temperature.

To complete the Factory-style Calibration procedure, complete the following:

1. Click on the Factory-style button (or pull down the Calibration menu and select Factory-style Calibration). One dialog box displays with the message "Please wait while testing communication channels," then another displays saying "Reloading offset trim for analog board–please wait."
2. A screen similar to Figure D-15, displays. Follow the onscreen directions.

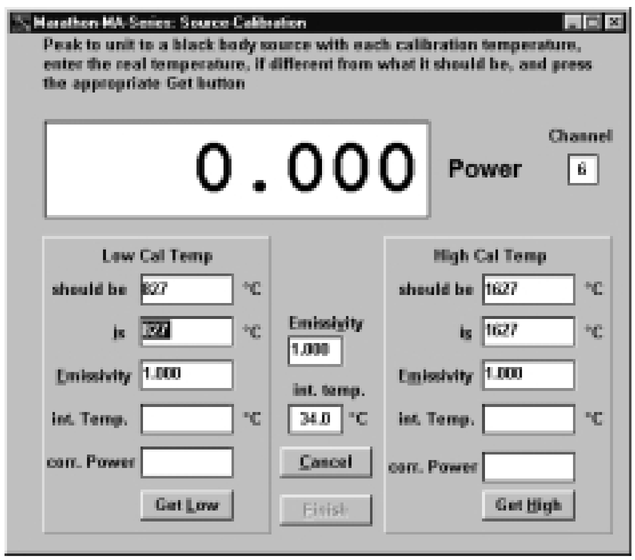

Figure D-15: Factory Style Calibration Screen

Note: After finishing the calibration procedure you must download the calibration constants to the sensor. If you need a calibration report for your records, click on the Print button (or select Print from the File Menu).

The low and high calibration points can be taken in any order and can be repeated, if necessary. If necessary, you can exit the program after taking one calibration point by clicking on the Cancel button then the Exit button and then restart the program at a later time. When you restart, the program asks you if you want to continue the interrupted calibration. If you answer Yes and press the Factory Style Calibration button on the main screen, the program will remember the first calibration point and prompt you for the second.

D.4.2 The Menus

The menu bar is made up of four pull-down menus: File, Calibration, Functional Test, and About. The buttons on the main screen duplicate some of the menu functions described in Section D.3.1. The following is a summary of the file menus:

File The File menu allows you to Initialize EEPROM, Download Cal Constants, Download DSK File, Restore Last Calibration, Restore Startup Code, Print, and Exit. These menu selections are defined and explained in Section D.3.2.1.

Calibration Opening the Calibration menu gives you the following choices: mA-Output Calibration, Offset Calibration, Laser Power Calibration (inactive if unit does not have a laser), Alignment, 1-Point Calibration, 2-Point Calibration, 3-Point Calibration, and Factory Style Calibration. The calibration procedures are explained fully in Section D.3.2.2.

Functional Test You can test various functions of MA series units by opening the Functional Test menu. It includes the following tests: Display, UART, Reset & Flash, EEPROM, Keyboard, Trigger, Relay, ADC, Power supply, and int. Temperature. These are defined and explained in Section D.3.2.3.

About The About menu displays the Field Calibration's software revision level.

IMPORTANT

Note that use of the file menu functions (excluding Print and exit) are only necessary if sensor data has been lost or corrupted. Use functional tests for preventative maintenance and sensor quality verification.

D.4.2.1 The File Menu

The file menu, as shown in Figure D-16, is where you can initialize the EEPROM, download constants and stored files, and restore the sensor's last or factory calibration and the startup code. The following sections explain the menu selections.

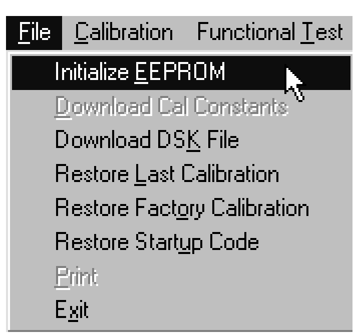

Figure D-16: The File Menu

Initialize EEPROM

With this function the Field Calibration program initializes the EEPROM with the factory defaults for emissivity, peak hold, average, relay, and 4 to 20mA settings. When you select Initialize EEPROM two message boxes display: “Please wait while testing communications channels,” and “Initializing EEPROM.”

Download Cal Constants

This function is a duplicate of the Download Calibration Constants button on the main screen and is active only after you perform a calibration procedure. It is necessary to download the new calibration constants after performing a mA, Laser, Offset, 1-Point, 2-Point, 3-Point, or Factory Style calibration.

Download DSK File

This function loads saved .DSK files to your sensor. If there was an error during calibration causing the sensor to read inaccurately, you can either restore your last calibration, or you can restore the original factory calibration. These files are named <serial number>.DSK (e.g., SB000001.DSK).

If the Flash ROM is totally corrupted and the calibration cannot be restored, you can obtain the original calibration file from the manufacturer and download it with this command. If necessary, you can also download the original or special firmware with this command. (Contact your sales or service representative for the appropriate files.)

To use the Download DSK File feature, select it from the File menu and follow the onscreen instructions.

Restore Last Calibration

This function loads the last calibration setup to your sensor. If there was an error during calibration (e.g., power failure or cable disconnection), you can restore your last calibration. If you feel your last calibration is not accurate, use the Restore Factory Calibration feature.

To use the Restore Factor Calibration feature, select it from the File menu and follow the onscreen instructions.

Restore Factory Calibration

This function loads the original calibration setup to your sensor. If there was an error during calibration (e.g., power failure or cable disconnection), you can restore the factory calibration or your last calibration.

IMPORTANT

If you cannot restore the original factory default calibration this way, please call your sales or service representative and request the proper .DSK file for your sensor.

To use the Restore Factor Calibration feature, select it from the File menu and follow the onscreen instructions.

Restore Startup Code

If there was an error during Alignment calibration or Reset and Flash testing, the firm-ware might not start after power up. Instead the instrument shows “HELP” on the display. Use Restore Startup Code to restore the original firmware into the Flash ROM.

Print

The Print function is a duplicate of the Print button on the main screen and is active only after performing one or more of the calibration procedures. Select Print if you need a hardcopy report for your records.

Exit

When you have finished using the MA1S/MA2S Field Calibration program, select Exit.

D.4.2.2 The Calibration Menu

All functions of the Calibration menu are the same as the buttons on the main screen. Refer to Section D.3.1 for information on the Calibration menu.

D.4.2.3 The Functional Test Menu

Functional tests are available to test the sensor's components. The following sections define each of the Functional Test selections.

Display

Use the Display test to make sure all control panel LEDs function properly. When you select Display, a dialog box appears saying "Please wait while testing communication channels." When a dialog box like Figure D-17 displays, the LEDs begin flashing one at a time, including the separate segments of the temperature display panel. Check the control panel to make sure all segments are working properly. If any segments are not working, contact your sales or service representative.

Figure D-17: The Display Test Screen

UART

The UART test checks the serial communications chip and interrupt behavior. When you select UART, a dialog box displays saying "Please wait while testing communications channels," then a screen like Figure D-18 displays. To test whether the UART echoes (returns the signal), click each character and check what gets received.

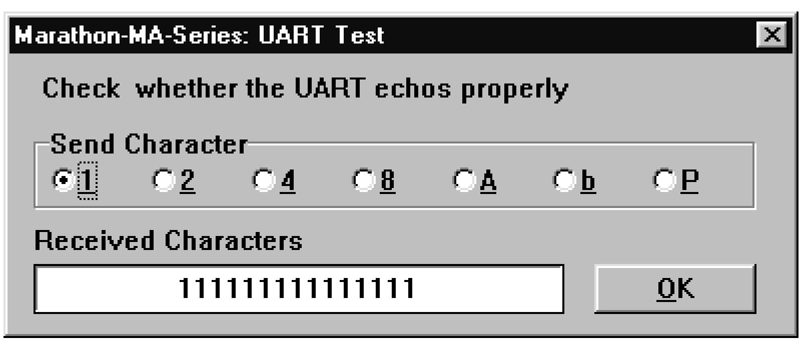

Figure D-18: The UART Test Screen

Reset & Flash

Reset & Flash tests the internal Flash ROM. When you select Reset & Flash, one dialog box displays “Please wait while testing communications channels,” then another displays “Writing to Address xxxx” (where xxxx is the sensor address number). At this point a screen similar to Figure D-19 displays. When the program completes, click the OK button.

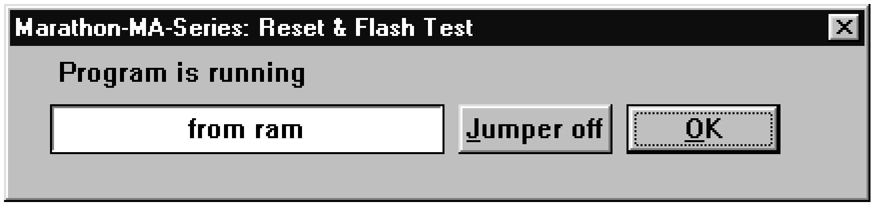

Figure D-19: The Reset & Flash Test Screen

If there was an error during this test, the unit may not start the firmware after it powers up and will show “HELP” on the display. If this is the case, use the Restore Startup Code feature and redo the test. If the problem persists, contact your service representative.

EEPROM

To test the EEPROM, choose this menu selection. When the test starts, a dialog box displays “Please wait while testing communications channels,” then a screen similar to Figure D-20 displays. If any errors are listed, contact your sales or service representative.

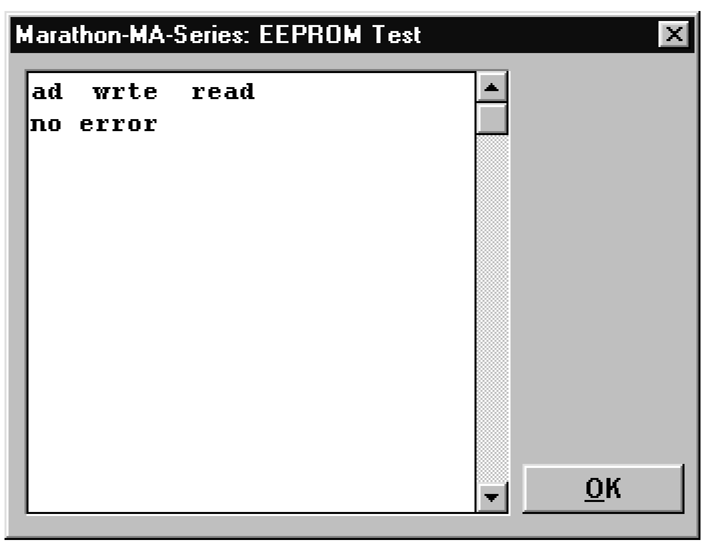

Figure D-20: The EEPROM Test Screen

Keyboard

Test the control panel's push buttons (keyboard) by selecting this function. When the test starts, a dialog box displays saying "Please wait while testing communications channels," then a screen similar to Figure D-21 displays. If you notice that one or more of the keys do not respond by displaying a check mark in the appropriate box, contact your sales or service representative. If there is no response for any of the buttons, check your connections before contacting service.

Figure D-21: Keyboard Test Screen

Trigger

You can test the external trigger by selecting this function. When the test starts, a dialog box displays saying "Please wait while testing communications channels," then a screen similar to Figure D-22 displays. You need to have a triggering device connected to the terminal block to perform this test (e.g., alarm, heating / cooling controller). If no signal is detected, first check the connections, then, if there is still no signal, contact your sales or service representative.

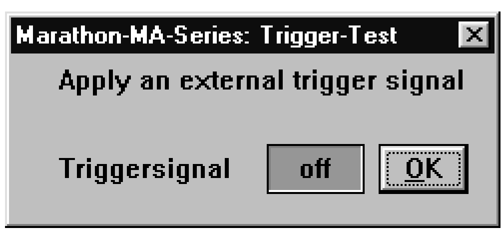

Figure D-22: Trigger Test Screen

Relay

To test the relay, select this function. Connect relay output to an alarm or other such device. When the test starts, a dialog box displays saying “Please wait while testing communications channels,” then a screen similar to Figure D-23 displays. Click the on and off buttons. Verify that the alarm changes state. You may also hear the relay “click” if you are in a quiet environment. (Note that the temperature display reads “help.” This is normal.)

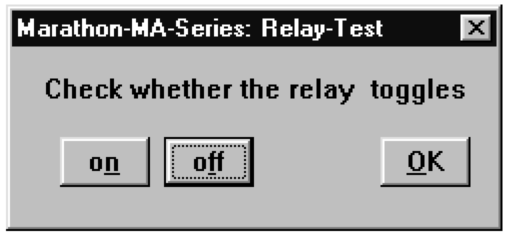

Figure D-23: The Relay Test Screen

ADC

To test the Analog to Digital Converter(ADC), select this function. When the test starts, a dialog box displays saying “Please wait while testing communications channels,” then a screen similar to Figure D-24 displays showing reference voltages.

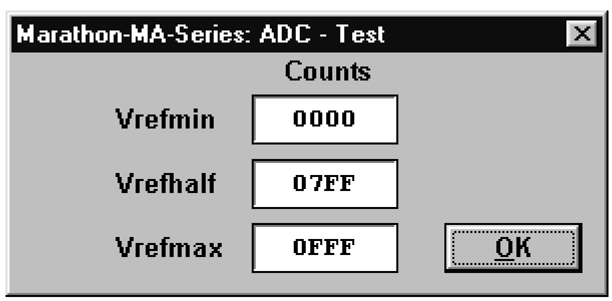

Figure D-24: The ADC Test Screen

Note: If any of these values are out of range, you will get an error message.

Power Supply

To test the power supply, select this function. When the test starts, a dialog box displays saying "Please wait while testing communications channels," then a screen similar to Figure D-25 displays. The dialog box shows the amount of voltage the sensor is receiving.

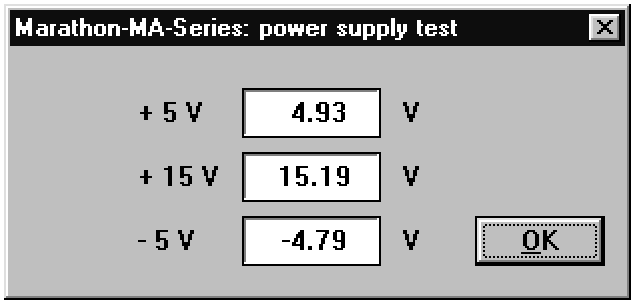

Figure D-25: The Power Supply Test Screen

Note: If any of these values are out of range, you will get an error message.

int. Temperature

To test the internal temperature of the sensor, select this function. When the test starts, a dialog box displays saying "Please wait while testing communications channels," then a screen similar to Figure D-26 displays. The dialog box gives you the current internal temperature of the unit in degrees C and the amount of noise (RFI, EMI) the unit has been receiving. Clicking on the Reset button resets the noise memory.

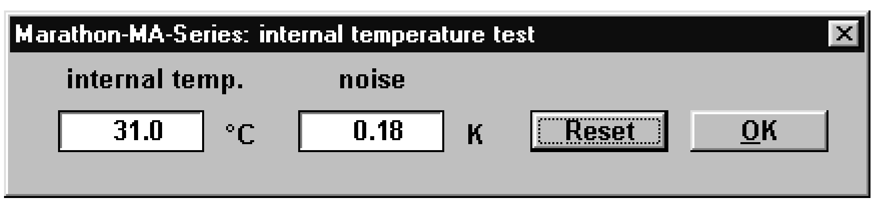

Figure D-26: The Internal Temperature Screen

Note: If any of these values are out of range, you will get an error message.

IMPORTANT

When field calibration is complete, and if you are returning the sensor to a multidrop network, you need to run the Network Communication Setup program once more to reconfigure the sensor. Refer to Section 3.2 for instructions.

APPENDIX E: DIN CONNECTOR WIRING

If you need to wire a new DIN connector or rewire the supplied connector, refer to the following illustration and table for the wiring layout.

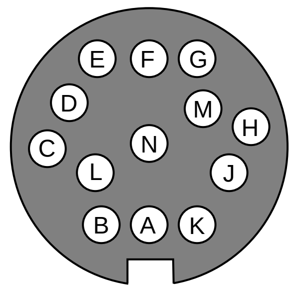

Figure E-1: DIN Connector Pin Layout (Pin Side)

Table E-1: DIN Connector Wiring

PIN	COLOR	DESCRIPTION
A	Black *	Rx A
B	White *	Rx B
C	Grey *	Tx B
D	Purple *	Tx A
E	White/Drain	Shield
F	Yellow	Trigger
G	Orange	Relay COM
H	Blue	Relay NO/NC
J	Green	+ mA Out
K	Brown	– mA Out
L	Black	Power Ground
M	Red	+ 24 VDC
N	No Connection	N/A

* Note: Twisted Pairs — Black & White
— Grey & Purple

APPENDIX F: 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.

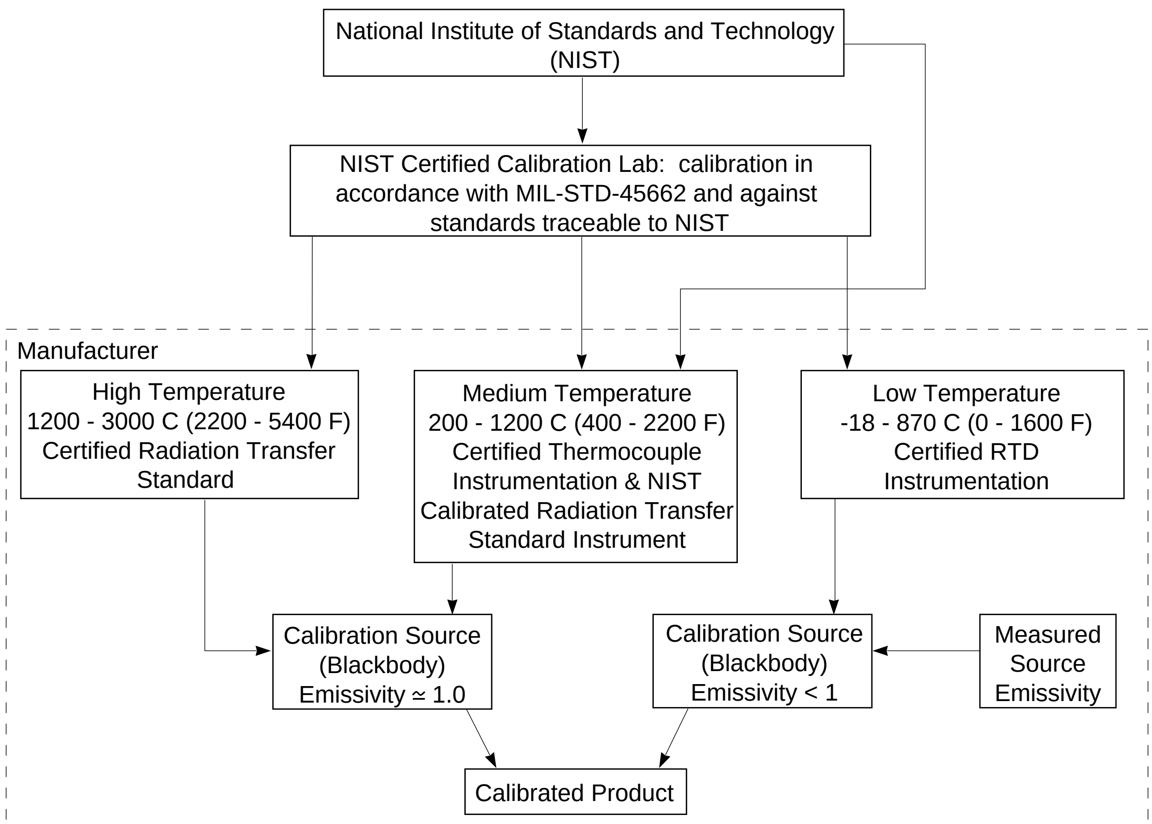

Figure F-1: Traceability of Temperature Instrumentation Calibration

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

APPENDIX G: 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 (±) 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 x 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 3-5µm and 8-14µm regions of the spectrum and require TE cooling in the 3-5 µm region and cryogenic cooling in the 8-14µm 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 NE^{3}T) — 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 or 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.

Photondetector 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 x 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 occurances: 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 two 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:

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)

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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