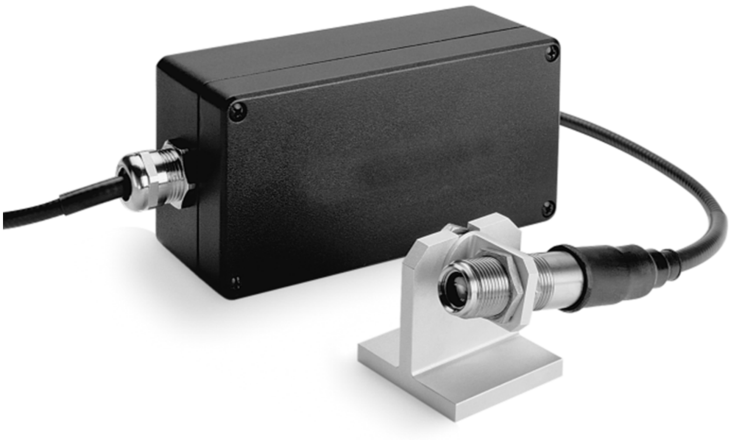
MARATHON
FA/FR Series

1-Color Fiber Optic Thermometer

2-Color Fiber Optic Thermometer



Operating Instructions

Raytek®
A Fluke Company

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53001

WARRANTY

The manufacturer warrants this instrument to be free from defects in material and workmanship under normal use and service for the period of two years from date of purchase. This warranty extends only to the original purchaser. This warranty shall not apply to fuses, batteries, or any product that has been subject to misuse, neglect, accident, or abnormal conditions of operation.

In the event of failure of a product covered by this warranty, the manufacturer will repair the instrument when it is returned by the purchaser, freight prepaid, to an authorized Service Facility within the applicable warranty period, provided manufacturer's examination discloses to its satisfaction that the product was defective. The manufacturer may, at its option, replace the product in lieu of repair. With regard to any covered product returned within the applicable warranty period, repairs or replacement will be made without charge and with return freight paid by the manufacturer, unless the failure was caused by misuse, neglect, accident, or abnormal conditions of operation or storage, in which case repairs will be billed at a reasonable cost. In such a case, an estimate will be submitted before work is started, if requested.

THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS, OR ADEQUACY FOR ANY PARTICULAR PURPOSE OR USE. THE MANUFACTURER SHALL NOT BE LIABLE FOR ANY SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES, WHETHER IN CONTRACT, TORT, OR OTHERWISE.

SOFTWARE WARRANTY

The manufacturer does not warrant that the software described herein will function properly in every hardware and software environment. This software may not work in combination with modified or emulated versions of Windows operating environments, memory-resident software, or on computers with inadequate memory. The manufacturer warrants that the program disk is free from defects in material and workmanship, assuming normal use, for a period of one year. Except for this warranty, the manufacturer makes no warranty or representation, either expressed or implied, with respect to this software or documentation, including its quality, performance, merchantability, or fitness for a particular purpose. As a result, this software and documentation are licensed "as is," and the licensee (i.e., the User) assumes the entire risk as to its quality and performance. The liability of the manufacturer under this warranty shall be limited to the amount paid by the User. In no event shall the manufacturer be liable for any costs including but not limited to those incurred as a result of lost profits or revenue, loss of use of the computer software, loss of data, the cost of substitute software, claims by third parties, or for other similar costs. The manufacturer's software and documentation are copyrighted with all rights reserved. It is illegal to make copies for another person.

Specifications subject to change without notice.

The device complies with the requirements of the European Directives.

EC – Directive 2004/108/EC (EMC)

Content

1 Safety Instructions

This document contains important information, which should be kept at all times with the instrument during its operational life. Other users of this instrument should be given these instructions with the instrument. Eventual updates to this information must be added to the original document. The instrument can only be operated by trained personnel in accordance with these instructions and local safety regulations.

Acceptable Operation

This instrument is intended only for the measurement of temperature. The instrument is appropriate for continuous use. The instrument operates reliably in demanding conditions, such as in high environmental temperatures, as long as the documented technical specifications for all instrument components are adhered to. Compliance with the operating instructions is necessary to ensure the expected results.

Unacceptable Operation

The instrument should not be used for medical diagnosis.

Replacement Parts and Accessories

Use only original parts and accessories approved by the manufacturer. The use of other products can compromise the operation safety and functionality of the instrument.

Instrument Disposal

Do not dispose of this product as unsorted municipal waste. Go to Fluke's website for recycling information.

Operating Instructions

The following symbols are used to highlight essential safety information in the operation instructions:

Helpful information regarding the optimal use of the instrument.

Risk of danger. Important information.

Warning – incorrect use of 110 / 230 V electrical systems can result in electrical hazards and personal injury. All instrument parts supplied with electricity must be covered to prevent physical contact and other hazards at all times.

The instrument is equipped with a Class 2 laser. Class 2 lasers shine only within the visible spectrum at an intensity of 1 mW. Looking directly into the laser beam can produce a slight, temporary blinding effect, but does not result in physical injury or damage to the eyes, even when the beam is magnified by optical aids. At any rate, closing the eye lids is encouraged when eye contact is made with the laser beam. Pay attention to possible reflections of the laser beam. The laser functions only to locate and mark surface measurement targets. Do not aim the laser at people or animals.

2 Product Description

The Marathon FA/FR fiber optic series of instruments are high-performance infrared thermometers. Each has a front end consisting of a small, fixed focus optical head coupled to a rugged fiber optic cable wrapped with a flexible stainless steel sheath. The fiber optic cable attaches to an electronics enclosure, which can be mounted away from the hot, hostile environment. The electronics enclosure can be connected to a computer with its two-way RS485 interface.

Temperature measurements can be taken using either of the following modes:

- **1-color mode** (FA and FR sensors) – for standard temperature measurements. The 1-color mode is best for measuring the temperature of targets in areas where no sighting obstructions, either solid or gaseous, exist. The 1-color mode is also best where the target completely fills the measurement spot and where the background or foreground are higher in temperature than the target.
- **2-color mode** (FR sensors only) – temperatures are determined from the ratio of two separate and overlapping infrared bands. The 2-color mode is best for measuring the temperature of targets that are partially obscured (either intermittently or permanently) by other objects, openings, screens, or viewing windows that reduce energy, and by dirt, smoke, or steam in the atmosphere. The 2-color mode can also be used on targets that do not completely fill the measurement spot, provided the background is much cooler than the target.

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

Model	Description
FA1A, FA1B, FA1C	1-color-sensor in spectral range of 1 µm different temperature ranges
FA1G	1-color-sensor specifically designed for measuring glass
FA2A, FA2B	1-color-sensor in spectral range of 1.6 µm different temperature ranges
FR1A, FR1B, FR1C	2-color-sensor in spectral range of 1 µm (nominal) different temperature ranges

Table 1: Models

2.1 Theory of Operation for 2-Color Sensors

Two-color ratio technology makes possible accurate and repeatable temperature measurements that are free from dependence on absolute radiated energy values. In use, a 2-color sensor determines temperature from the ratio of the radiated energies in two separate wavelength bands (colors). The benefits of 2-color sensors are that accurate measurements can be made under the following conditions:

- When the field of view to the target is partially blocked or obscured.
- When the target is smaller than the sensor’s field of view.
- When target emissivities are low or changing by the same factor in both wavelength bands.

Another benefit is that 2-color sensors measure closer to the highest temperature within the measured spot (spatial peak picking) instead of an average temperature. A 2-color sensor can be mounted farther away, even if the target does not fill the resulting spot size. The convenience is that you are not forced to install the sensor at some specific distance based upon target size and the sensor's optical resolution.

2.1.1 Partially Obscured Targets

The radiated energy from a target is, in most cases, equally reduced when objects or atmospheric materials block some portion of the optical field of view. It follows that the ratio of the energies is unaffected, and thus the measured temperatures remain accurate. A 2-color sensor is better than a 1-color sensor in the following conditions:

- Sighting paths are partially blocked (either intermittently or permanently).
- Dirt, smoke, or steam is in the atmosphere between the sensor and target.
- Measurements are made through items or areas that reduce emitted energy, such as grills, screens, small openings, or channels.
- Measurements are made through a viewing window that has unpredictable and changing infrared transmission due to accumulating dirt and/or moisture on the window surface.
- The sensor itself is subject to dirt and/or moisture accumulating on the lens surface.

1-color sensors see polluted atmosphere and dirty windows and lenses as a reduction in energy and give much lower than actual temperature readings!

2.1.2 Targets Smaller Than Field of View

When a target is not large enough to fill the field of view, or if the target is moving within the field of view, radiated energies are equally reduced, but the ratio of the energies is unaffected and measured temperatures remain accurate. This remains true as long as the background temperature is much lower than the target's. The following examples show where 2-color sensors can be used when targets are smaller than the field of view:

- Measuring wire or rod — often too narrow for field of view or moving or vibrating unpredictably. It is much easier to obtain accurate results because sighting is less critical with two-color sensors.
- Measuring molten glass streams — often narrow and difficult to sight consistently with single-wavelength sensors.

2.1.3 Low or Changing Emissivities

If the emissivities in both wavelengths (colors) were the same, as they would be for any blackbody (emissivity = 1.0) or graybody (emissivity < 1.0 but constant), then their ratio would be 1, and target emissivity would not be an influence. However, in nature there is no such thing as a greybody. The emissivity of all real objects changes with wavelength and temperature, at varying degrees, depending on the material.

When emissivity is uncertain or changing, a 2-color sensor can be more accurate than a 1-color instrument as long as the emissivity changes by the same factor in both wavelength bands. Note, however, that accurate measurement results are dependent on the application and the type of material being measured. To determine how to use 2-color sensors with your application when uncertain or changing emissivities are a factor, please contact your sales representative.

3 Technical Data

3.1 Measurement Specifications

3.1.1 FA Models

Temperature Range	
FA1A	475 to 900°C (887°F to 1652°F)
FA1B	800 to 1900°C (1472°F to 3452°F)
FA1C	1200 to 3000°C (2192°F to 5432°F)
FA1G	750 to 1675°C (1382°F to 3047°F)
FA2A	250 to 800°C (482°F to 1472°F)
FA2B	400 to 1700°C (752°F to 3092°F)
Spectral Response	
FA1	1.0 µm (Si detector)
FA2	1.6 µm (InGaAs detector)
System Accuracy[1]	
FA1/FA2	±(0.3% T_{meas} + 2°C), T_{meas} in °C
FA1G	±3°C
Repeatability	±1°C
Temperature Resolution	
Current Output	±0.05°C ±0.01°C for FA1G
Display and RS485	±1°C
Response Time	10 ms (95%), selectable to 10 s
Temperature Coefficient	±0.03% full scale change per 1°C change in ambient temperature
Noise Equivalent Temp. (NET)	1°C peak to peak, at target emissivity of 1.00
Emissivity	0.10 to 1.00, in 0.01 increments
Signal Processing	Peak Hold, valley hold, averaging Hold time 0 – 300 sec, in 0.1 sec increments

3.1.2 FR Models

Temperature Range	
FR1A	500 – 1100°C (930°F to 2010°F)
FR1B	700 – 1500°C (1290°F to 2730°F)
FR1C	1000 – 2500°C (1830°F to 4530°F)
Spectral Response	1.0 µm nominal (Si/Si sandwich detector)
System Accuracy[2]	
no signal attenuation	±(0.3% T_{meas}^{*} + 2°C)

[1] at ambient temperature 23°C ±5°C (73°F ±9°F)
[2] at ambient temperature 23°C ±5°C (73°F ±9°F)

up to 95% signal attenuation	±(1% T_{meas}* + 2°C) for FR1A/FR1B
up to 95% signal attenuation	±(1.3% T_{meas}* + 2°C) for FR1C * T_{meas} in °C see also appendix 11.4 and 11.5, pages 64 ff.
Repeatability	±1°C (±2°F)
Temperature Resolution	±1°C (±2°F)
Response Time	10 ms (95%), selectable to 10 s
Temperature Coefficient	±0.1% of reading at ambient temperature from 0 to 50°C
Emissivity (1-color)	0.10 to 1.00, in 0.01 increments
Slope (2-color)	0.850 to 1.150 in 0.001 increments
Max. Signal Reduction	95% at 600°C (1112°F), 50% at 500°C (932°F) for FR1A 95% at 875°C (1607°F), 50% at 700°C (1292°F) for FR1B 95% at 1300°C (2372°F), 50% at 1000°C (1832°F) for FR1C
Signal Processing	Peak Hold, averaging, hold time 0 – 299.9 sec, in 0.1 sec increments, 300.0 sec → holds with external trigger

3.2 General Specifications

Display	7-segment LED display, individual LED's indicate modes
Environmental Rating	NEMA-4 (IEC 529, IP 65) rated with conduit adapter and compression fitting (which prevents liquid from entering through the connector)
Ambient Temperature	
Head / Fiber Cable	0 to 200°C (32°F to 360°F)
Electronics Housing	0 to 50°C (32°F to 122°F), with cooling platform: 150°C (300°F)
Storage Temperature	
Electronics Housing	-20 to 70°C (-4°F to 158°F)
Fiber Cable	rated to 200°C (360°F), stainless steel armour, Viton coated, NEMA-4 (IP65) for a high temperature fiber cable, see section 7 Options, page 41.
Relative Humidity	10 to 95%, not condensing at 22°C to 43°C (72°F to 110°F)
Electromagnetic Interference	IEC 61326-1
Mechanical Shock	
Electronics Housing	MIL-STD-810D (IEC 68-2-27), 50 G, 11 ms duration, any axis
Vibrations	
Electronics Housing	MIL-STD-810D (IEC 68-2-6), 3 G, 11 to 200 Hz any axis
Warm up Period	15 minutes
Weight	
Optical Head	100 g (3.5 oz)
Electronics Housing	710 g (25 oz)

3.3 Electrical Specifications

Power Supply	24 VDC ±20%, 500 mA (max 100 mV peak to peak of ripple)
Power Consumption	max. 12 W
Outputs	
Analog	0/4 - 20 mA (active output) 16 bit resolution max current loop impedance: 500 Ω
Digital RS485	networkable to 32 sensors Baud rate: 300, 1200, 2400, 9600, 19200, 38400 (default) Adjustable baud rate only available through digital RS485. Data format: 8 bit, no parity, 1 stop bit, Software selectable 4-wire, full-duplex non-multidrop, point-to-point or 2-wire half duplex multidrop
Relay	Contacts max. 48 V, 300 mA, response time < 2 ms, (software programmable)
Input	
External Reset	TTL input, trigger for resetting peak or valley hold

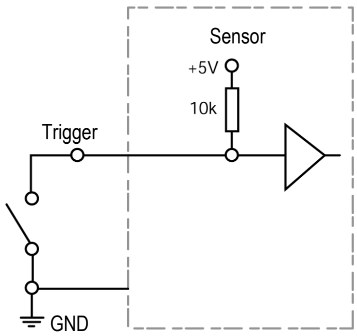
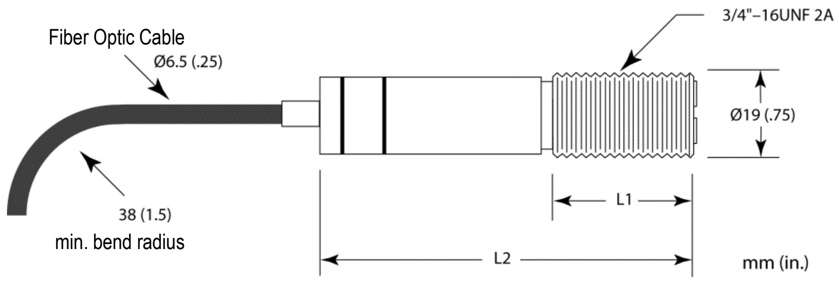


Figure 1: External Reset Wiring Diagram

3.4 Dimensions



Model	L1	L2
FA	25 mm (1.0 in.)	62 mm (2.46 in.)
FR1A	28 mm (1.1 in.)	69 mm (2.7 in.)
FR1B, FR1C	36 mm (1.4 in.)	79 mm (3.1 in.)

Figure 2: Dimensions of Optical Head

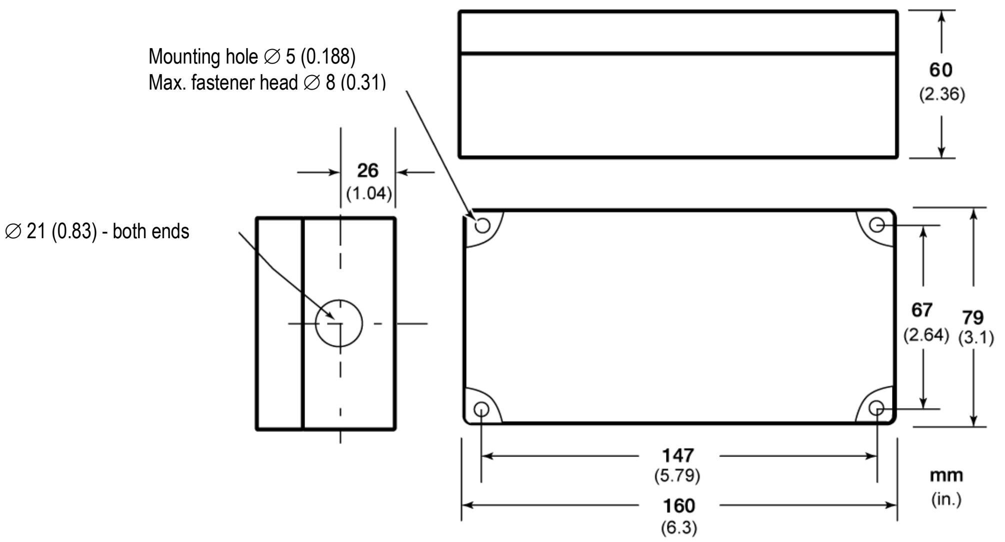


Figure 3: Dimensions of Electronics Housing

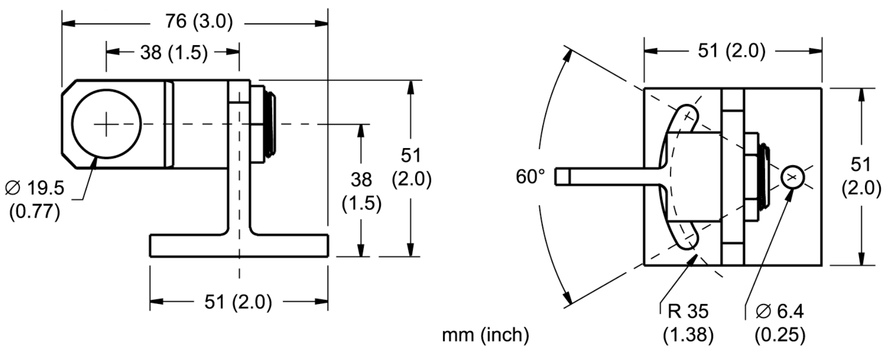


Figure 4: Adjustable Mounting Bracket for Optical Head

3.5 Optical Specifications

The sensor comes as a standard focus model or one of two close focus models, see following overview for available options. For one-color temperature measurements make sure the target completely fills the measurement spot.

3.5.1 FA Models

3.5.1.1 Standard Focus

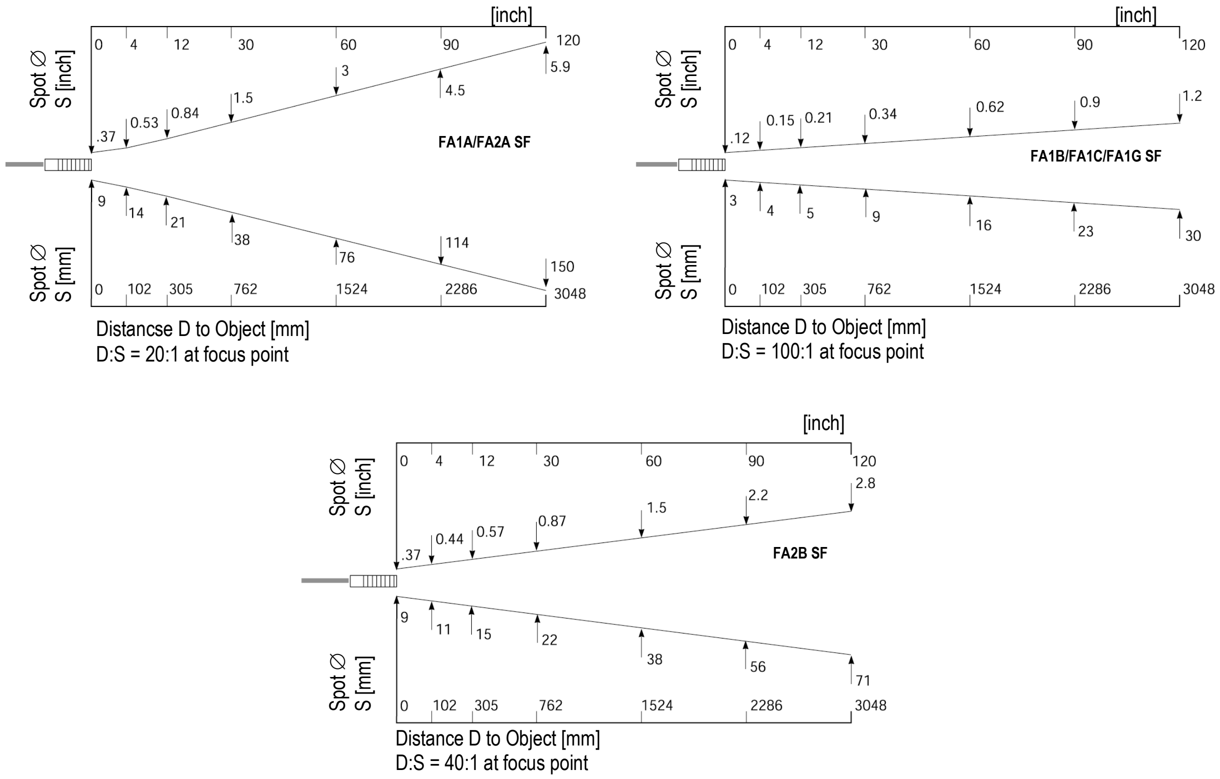


Figure 5: Standard Focus Spot Size Charts for FA models

3.5.1.2 Close Focus

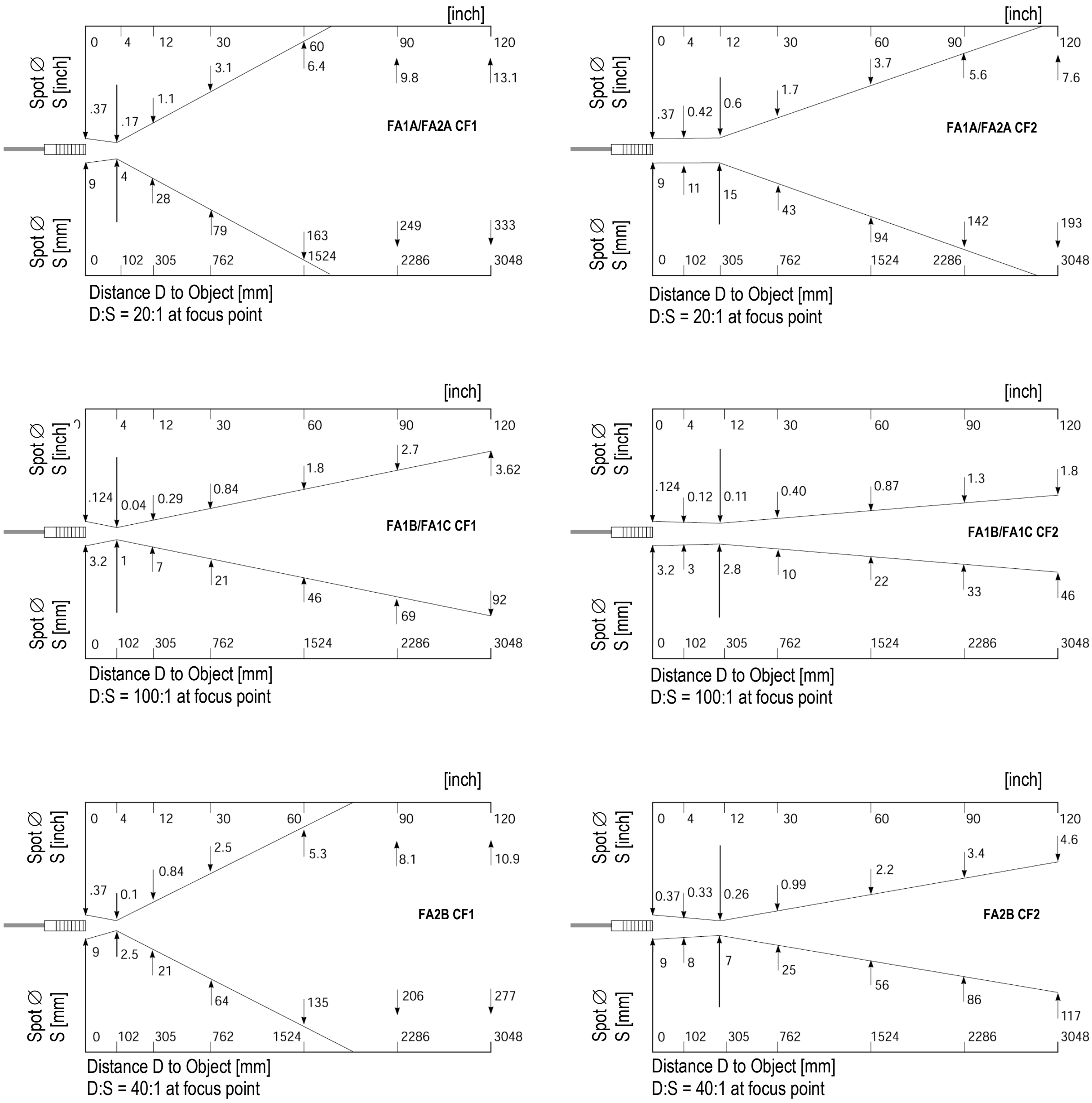


Figure 6: Close Focus Spot Size Charts for FA models

3.5.2 FR Models

3.5.2.1 Standard Focus

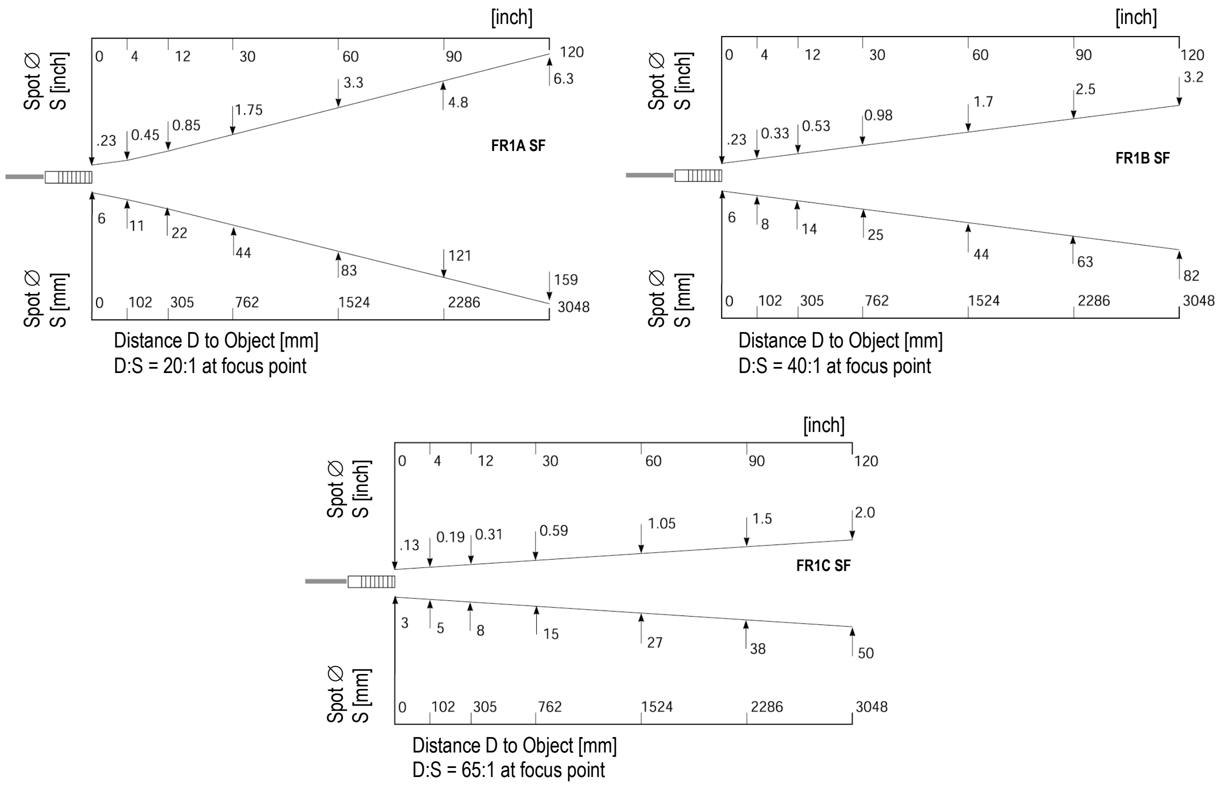


Figure 7: Standard Focus Spot Size Charts for FR models

3.5.2.2 Close Focus

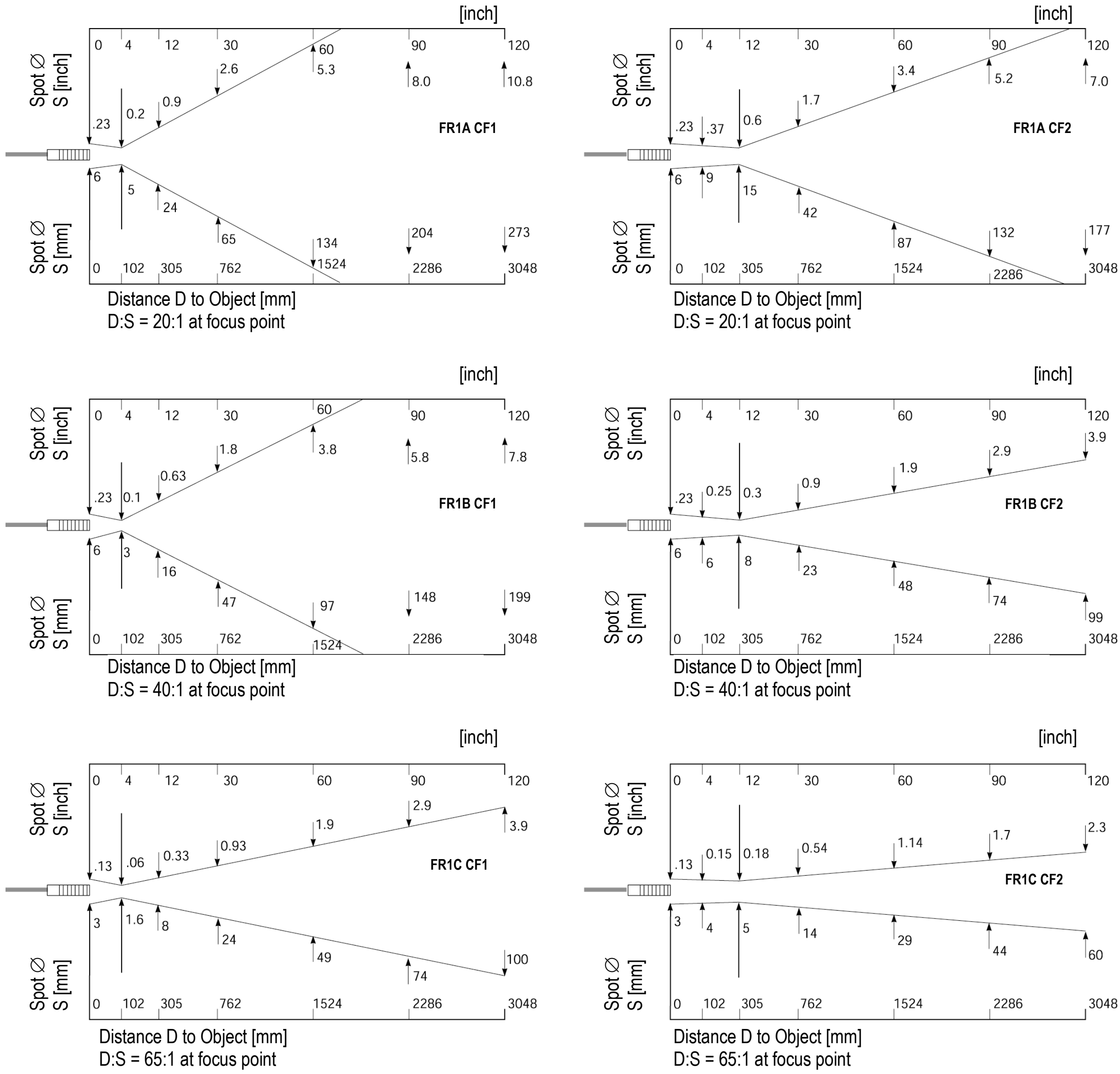


Figure 8: Close Focus Spot Size Charts for FR models

3.6 Scope of Delivery

The scope of delivery includes the following:

- Marathon FA/FR Documentation and Support CD
- Mounting nuts
- Adjustable mounting bracket (XXXFOMB)
- Two ferrite elements (FR models only)

4 Sensor Location

Sensor location and configuration depends on the application. Before deciding on a location, you need to be aware of the ambient temperature of the location, the atmospheric quality of the location (especially for 1-color temperature measurements), and the possible electromagnetic interference in that location (a consideration only for the electronics enclosure). If you plan to use air purging, you need to have an air connection available. Also, wiring and conduit runs must be considered, including computer wiring and connections, if used. The following subsections cover topics to consider before you install the sensor.

4.1 Ambient Temperature

The optical head is designed to operate in ambient temperatures up to 200°C (390°F). The electronics enclosure is designed to operate in ambient temperatures between 0°C (32°F) and 50°C (122°F). Internal temperatures outside this range will cause a failsafe error.

4.2 Atmospheric Quality

Smoke, fumes, dust, and other contaminants in the air, as well as a dirty lens are generally not a problem when using the 2-color mode (as long as the attenuation is equal in both spectral bands). However, if the lens gets too dirty, it cannot detect enough infrared energy to measure accurately, and the instrument will indicate a failure. 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 with the correct air pressure is installed before proceeding with the sensor installation.

4.3 Electrical Interference

To minimize electrical or electromagnetic interference or "noise" be aware of the following:

- Mount the electronics enclosure 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.
- Make sure the shield wire from the electronics to terminal block 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 for other equipment in the same conduit.

When installing the optical head, 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 a sensor to give erroneous readings.

4.4 Distance to Object

The requested spot size determines the maximum distance to the measurment object and the necessary focus of the optic. The Standard Focus is set at infinity. The Close Focus optical heads are focused at 100 mm (4 in) or 300 mm (12 in), see section 3.5 Optical Specifications, p. 14.

4.5 Sensor Placement (1-Color Mode)

Optical head placement for one-color temperature measurements is more critical than two-color measurements. The sensor must have a clear view of the target. There can be no obstructions on the lens, window, or in the atmosphere. The distance from the target can be anywhere beyond the minimum requirements, as long as the target completely fills the field of view. The following figure illustrates proper placement when using the one-color mode.

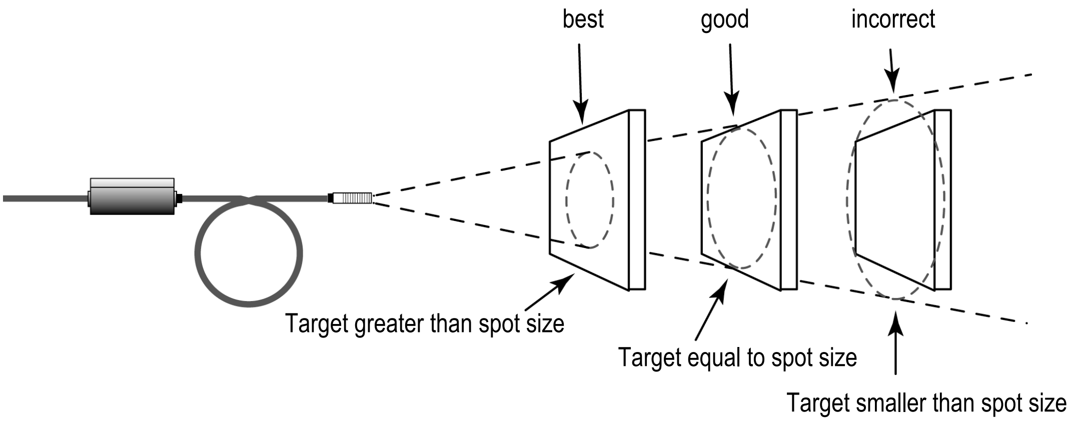


Figure 9: Proper Sensor Placement in 1-Color Mode

4.6 Sensor Placement (2-Color Mode)

The following figure shows head placement under various conditions where two-color temperature measurements can be taken. Note, however, that if the sensor signal is reduced more than 95% (including emissivity and obscuration of the target), the sensor accuracy also degrades.

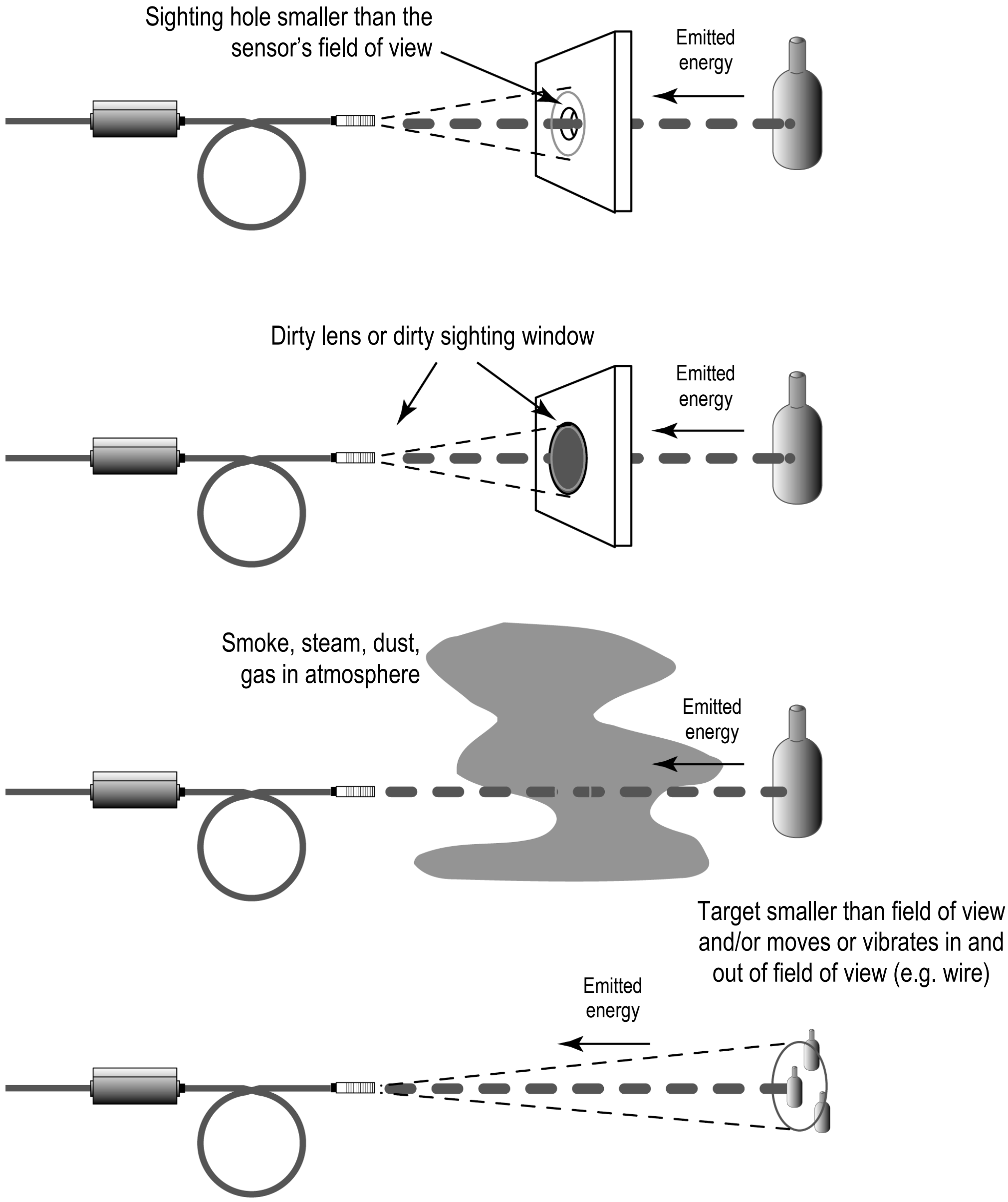


Figure 10: Sensor Placement in 2-Color Mode

4.7 Viewing Angles

The optical head can be placed at any angle from the target up to 30° for one-color mode, or 45° for two-color mode.

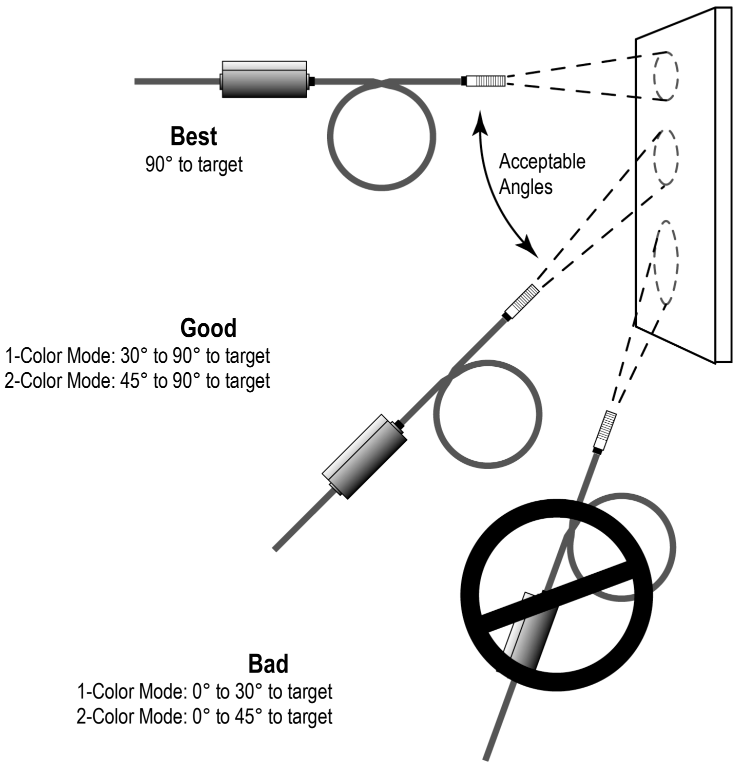


Figure 11: Acceptable Sensor Viewing Angles

5 Installation

5.1 Mounting the Sensor

After all preparations are complete according to section 4 Sensor Location, page 18 ff., you can install the sensor.
How and where you anchor the optical head and electronics enclosure depends on the type of surface and the type of bracket you are using. You can mount the optical head through a hole, on a bracket of your own design, or on the available bracket accessory.
You may need to "snake" the fiber optic cable through and around any obstacles, such as beams, walls, support columns, etc., or, if your installation requires, through conduit, before attaching the end to the electronics enclosure. (Do not attach until you aim the optical head.) The cable can be disconnected from the electronics box for aiming or threading through conduit during installation. The cable is keyed and can only be inserted one way into the electronics enclosure.

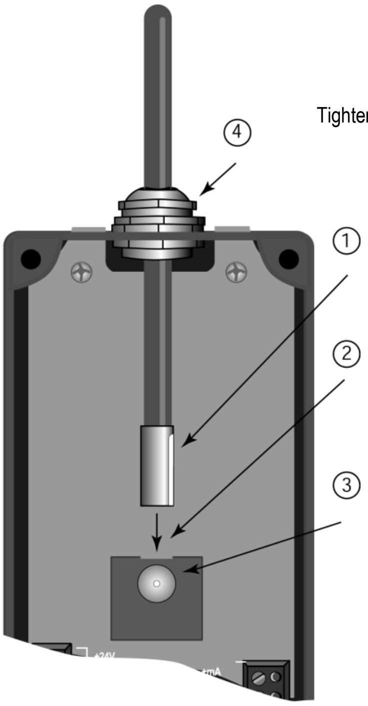


Figure 12: Connecting the Fiber Optic Cable

5.2 Mounting the Sensor (Laser units)

Sensors equipped with a sighting laser use a branched fiber optic cable. Insert the cable through the bushing and behind the laser module. Note: one branch is large (sensor) and one branch is small (sighting laser).

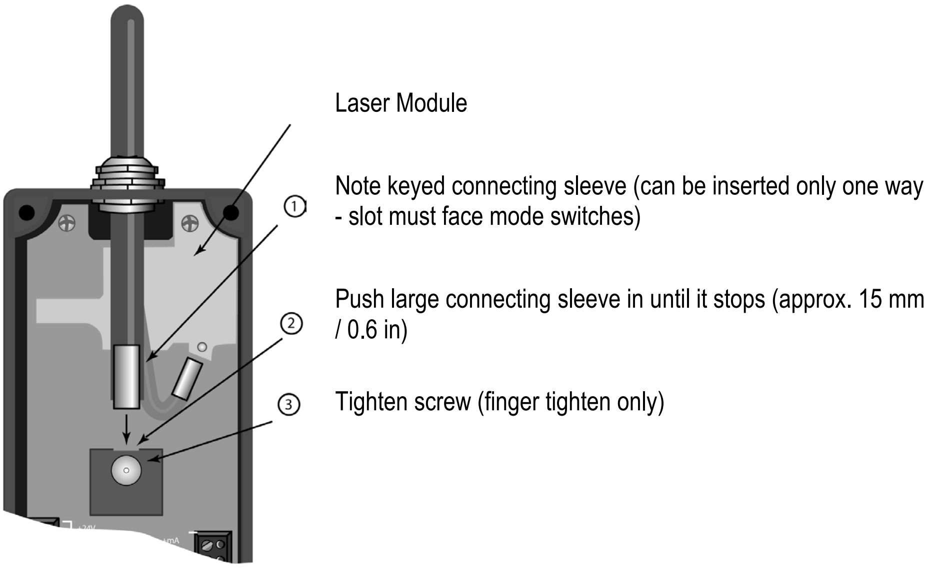


Figure 13: Connecting the Fiber Optic Cable

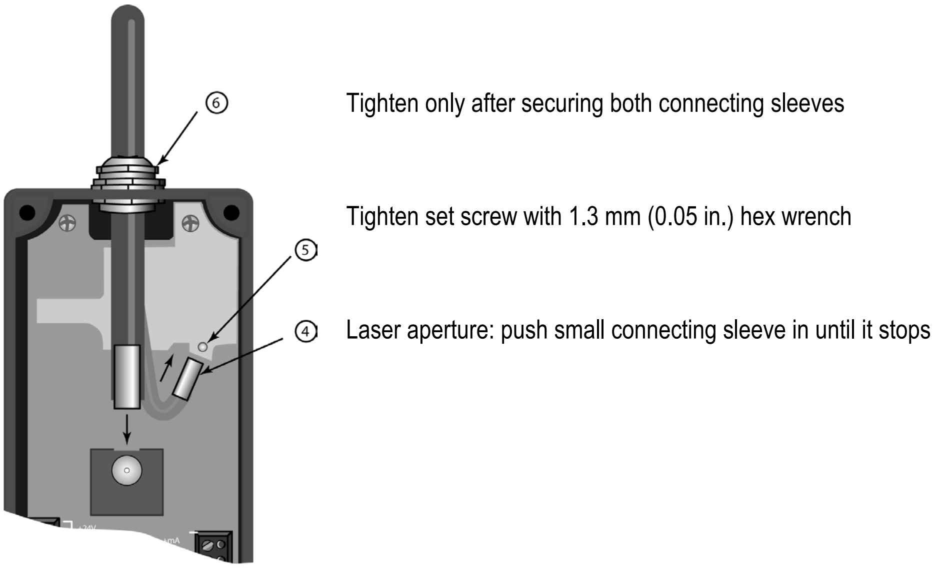
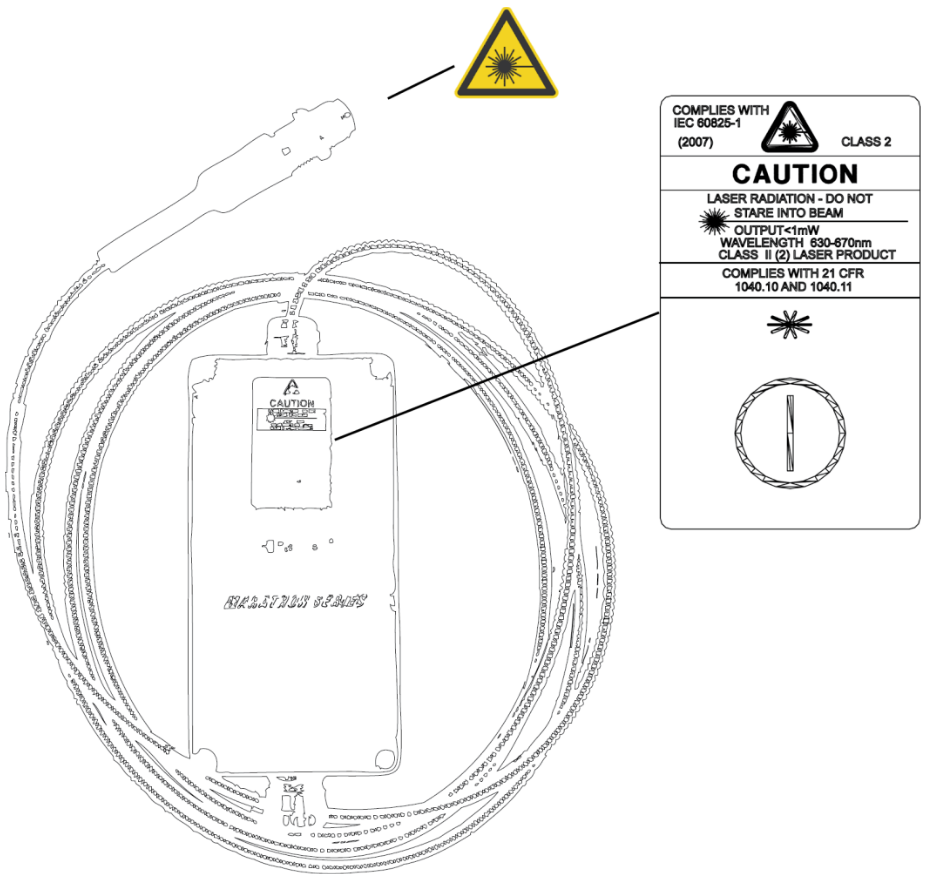


Figure 14: Connecting the Fiber Optic Cable



Ensure fiber optic cable is connected before turning on the laser!

5.3 Aiming

An effective aiming technique is to adjust the head until the highest reading is observed on the internal display. When the highest reading is reached, hold the unit in place and secure the mounting base. **Make sure that the sensor is in 1-color mode when using this aiming technique!**

Another aiming can be done by means of a battery powered aiming light. Simply loosen the compression sleeve holding the fiber optic cable, loosen the screw at the heater block, and pull the cable out of the heater block approximately 7 mm (0.25 in), see Figure 12, p. 22. Raise the fiber optic cable enough to slip the aiming light onto the end. Align the light beam on the target.

5.4 Fiber Optic Cable

Fiber optic cables and optical heads are able to withstand hot ambient temperatures up to 200°C (390°F), optional even up to 315°C (599°F). They can also operate in areas of high electromagnetic fields, which would render conventional instruments useless. The small optical head can be mounted in cramped locations. The fiber optic cable has a small bend radius (36 mm / 1.5 in minimum) and can be "snaked" around and through machinery, walls, and other obstacles. If the cable needs to be changed, it is field replaceable. A calibration program for replaced fiber cables is included with your sensor. Longer fiber optic cables allow the electronics enclosure to be well away from hostile environments.

The fiber optic cable is field replaceable, see section 10.4 Replacing the Fiber Optic Cable, p. 56. The fiber optic cable and head are one component. The cable can be disconnected from the electronics box for aiming or threading through conduit during installation. The cable is keyed and can only be inserted one way into the electronics enclosure.

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

Bend Radius of Fiber Bundle:	38 mm (1.5 in) minimum
Cable Diameter:	6.5 mm (0.25 in)
Ambient Temperature:	0 to 200°C (32°F to 392°F), optional up to 315°C (599°F)
Environmental Rating:	Water tightness as per NEMA-4 (IEC 529, IP 65) hose down test, rated attached and with protective sleeves, which prevents liquid from entering through the connectors. The given environmental rating is not valid for the 315°C (599°F) cables!

5.5 Installing the Electronics Housing

The distance between the electronics housing and a computer (via RS485 cable) can be up to 1200 m (4000 feet). This allows ample distance from the harsh environment where the sensing head is mounted to a control room or pulpit where the computer is located.

For reliable performance it is recommended that the power supply be no more than 60 m (200 feet) away!

Following you can see installation examples shown with two representative cable types. A 4-wire cable is used to wire the 24 VDC power supply and one output of the electronics housing. A coated 12-wire cable is used to wire all inputs and outputs of the electronics housing.
Sometimes in cable both sets of twisted-pair wires have drain wires inside their insulation. These drain wires must be assembled and connected to the terminal labeled SHIELD (bare). Also connect the earth ground to the SHIELD (bare) terminal. The following figure shows how to configure the drain wires of both 4- and 12-wire cables before connecting to the sensor and RS485/RS232 converter.

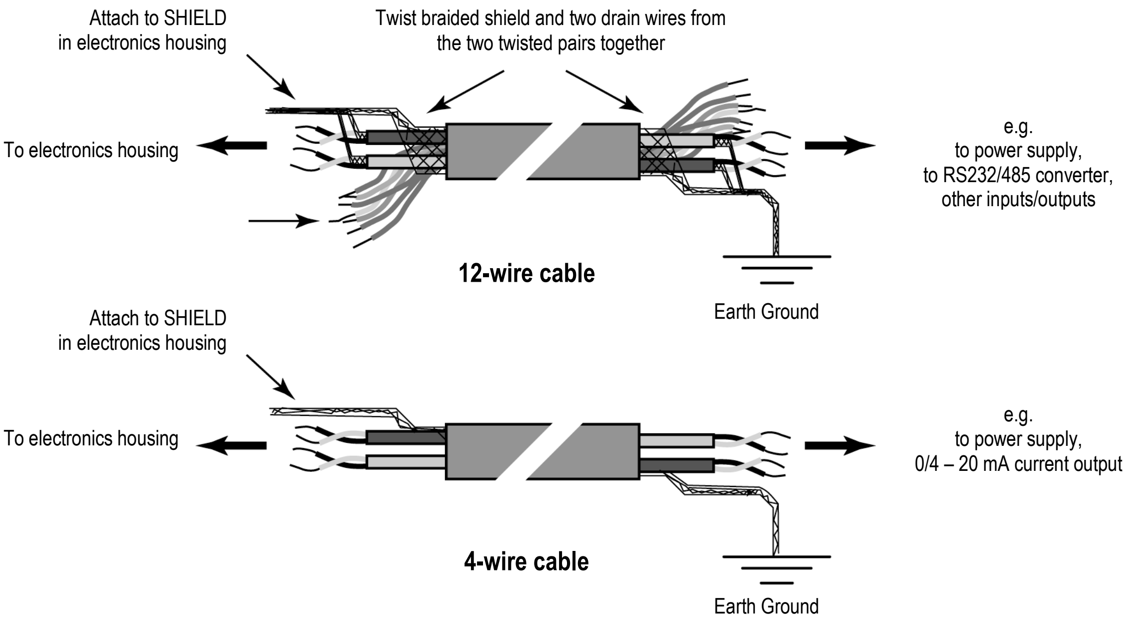


Figure 15: Configuring the Sensor Cable

The complete wiring must have only one common earth ground point!

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

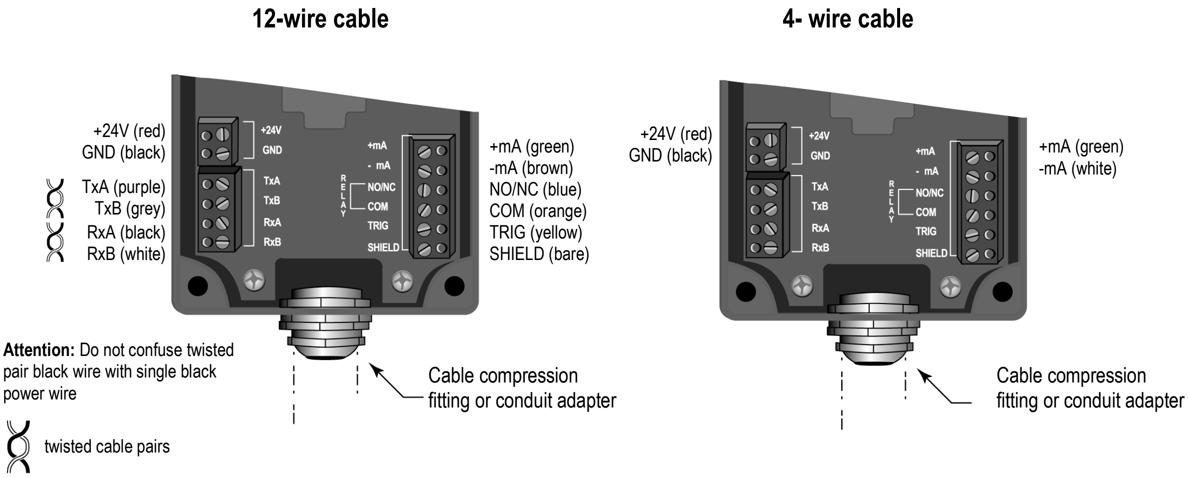


Figure 16: Electronics Housing Wiring

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

The following figure illustrates how to remove the terminal block.

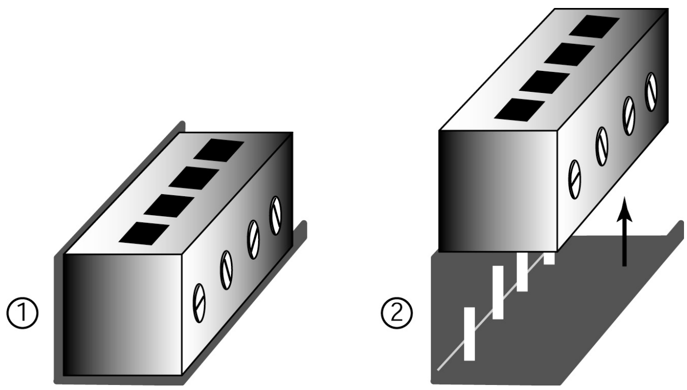


Figure 17: Removing the Terminal Block

The electronics box has two compression fittings to provide water sealing for the fiber optics cable and the electronics cable. The compression fitting must be tightened with a wrench around the cables to achieve water sealing. To achieve sealing for the fiber optics cable, hand tighten the compression fitting around the cable, and then use a wrench to tighten another 1 1/2 to 2 turns. If the cable is too thin then it may be necessary to add a bushing or heat shrink material to increase the cable diameter in order to ensure sealing. Hand tighten the compression fitting around the cable, and then use a wrench to tighten another 1½ to 2 turns.

5.5.1 Installing the Housings for FR Models

The FR model is supplied with two ferrite elements which should be applied to both the electrical and fiber optic cables during installation in order to assure full compliance with EMC requirements. In particularly "noisy" electrical environments these elements are necessary to achieve the highest performance from the instrument. After connecting the fiber optic and electrical cables to the box, simply clamp the supplied ferrite elements over the cables nearby where those cables enter the box.

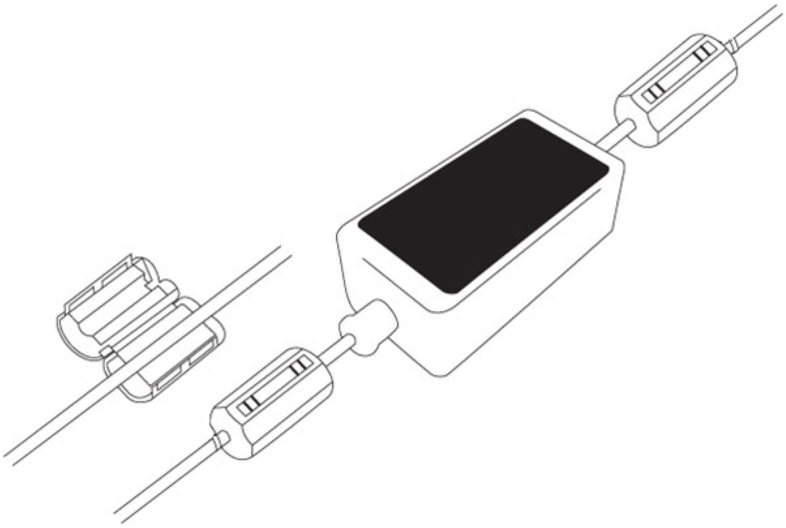


Figure 18: Installing the Ferrite Elements

5.6 Power Supply

Connections from a 24 VDC (500 mA or higher) power supply attach to the appropriate terminals on the electronic enclosure's terminal strip.

Isolated power is required, and this is provided by the appropriate manufacturer supplied power supply accessory. Beware of use of other power supplies which may not provide the necessary isolation and could cause instrument malfunction or damage!

5.7 Computer Interfacing

The distance between the sensor and a computer can be up to 1200 m (4000 ft.) via RS485 interface. This allows ample distance from the harsh environment where the sensing system is mounted to a control room or pulpit where the computer is located. The USB/RS485 Interface Converter allows you to connect your sensor to computers by using a USB interface.
With auto configuration the converter is able to automatically configure RS485 signals without external switch setting. The converter is equipped with 3000 VDC of isolation and internal surge-protection to protect the host computer and the converter against high voltage spikes, as well as ground potential difference. When the converter is connected the computer gets one virtual COM port.

Technical Data	
Power supply	5 VDC direct from USB port
Speed	max. 256 kBit/s
RS485	4 wire (full duplex) and 2 wire (half duplex)
Terminal screwed	accepts 0.05 to 3 mm² (AWG 13 to AWG 30)
USB connector	type B (supplied with type A to type B cable)
Ambient Temperature	0 to 60°C (32 to 140°F), 10-90% relative humidity, non-condensing
Storage Temperature	-20 to 70°C (-4 to 158°F), 10-90% relative humidity, non-condensing
Dimensions (L x W x H)	151 x 75 x 26 mm (5.9 x 2.9 x 1 in)

Figure 19: USB/RS485 Converter (XXXUSB485)

The factory default setting for the FA/FR sensor is the 4-Wire Mode!

To switch the sensor to the 2-wire mode, see section 11.6 2-Wire Mode, page 66.

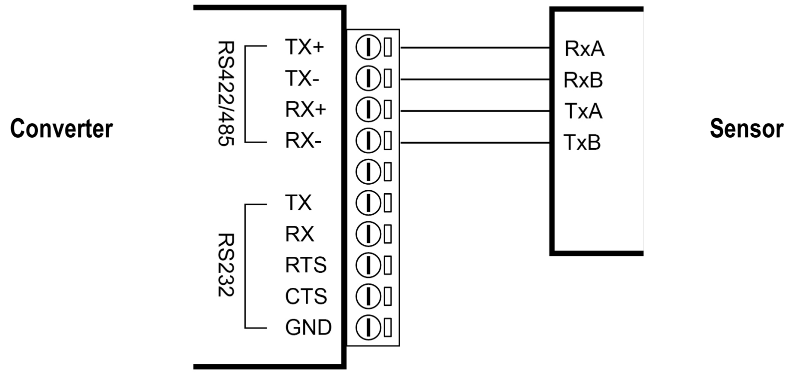


Figure 20: Wiring the Sensor's RS485 Interface with USB/RS485 Converter in 4-Wire Mode (factory default)

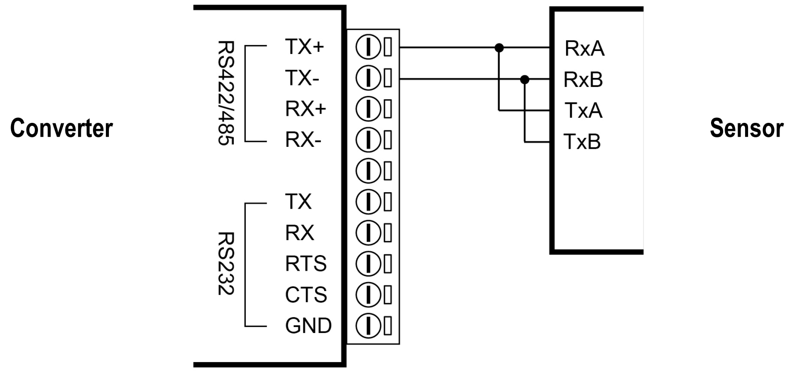


Figure 21: Wiring the Sensor's RS485 Interface with USB/RS485 Converter in 2-Wire Mode

5.8 Multiple Sensors in a Network

5.8.1 Wiring

For an installation of two or more sensors in a network, each sensor cable is wired to its own terminal block. The RS485 terminals on each terminal block are wired in parallel.
The following figures illustrate the wiring of sensors in a 4-wire and 2-wire multidrop installation.

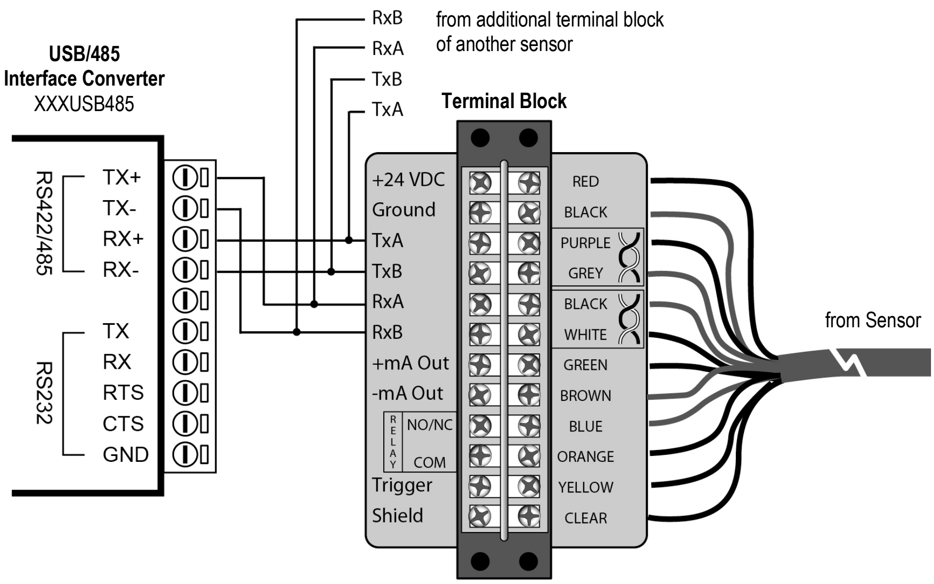


Figure 22: 4-Wire Multidrop Wiring in a Network

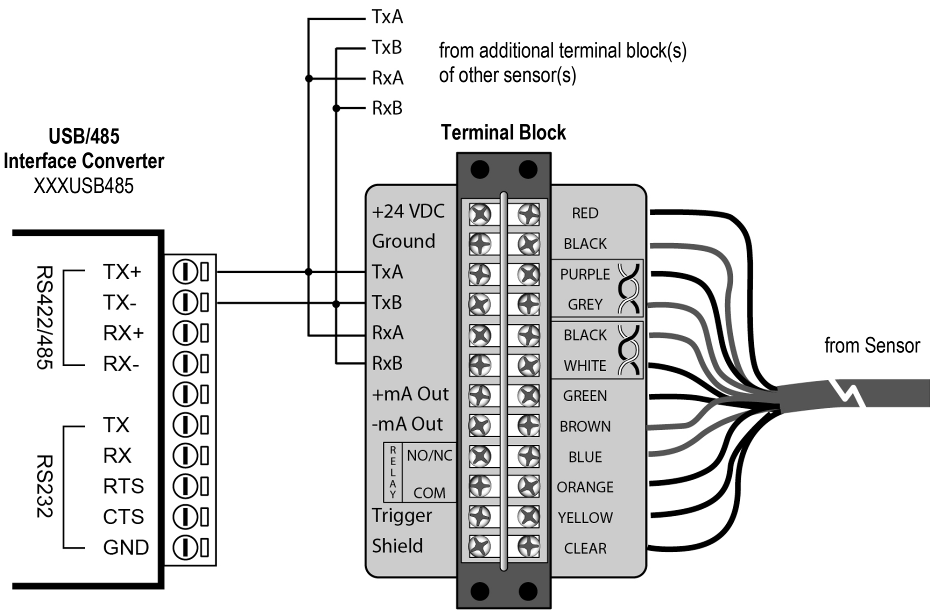


Figure 23: 2-Wire Multidrop Wiring in a Network

5.8.2 Addressing

The addressing of a sensor can be done by means of the Control Panel on the back of the sensor or the DataTemp Multidrop Software (Menu <Sensor Setup>) that came with your sensor. An alternative would be to use the specific interface commands of the sensor in conjunction with a standard terminal program (e.g. Windows HyperTerminal), see section 9.5 Command List, page 49.
If you are installing two or more sensors in a multi-drop configuration, please be aware of the following:

- Each sensor must have a unique address greater zero.
- Each sensor must be set to the same baud rate.

5.8.3 Configuration Procedure

1. Attach each unit individually to the computer.
2. Start the DataTemp Multidrop Software.
3. In the DataTemp Multidrop Startup Wizard, select the correct COM port and ASCII protocol, then <Scan All Baud Rates> for a <Single Sensor>. DataTemp Multidrop should find the single FA/FR unit connected to the computer serial port.
4. Once DataTemp Multidrop is running, go to the <Setup> menu and select <Sensor Setup>.
5. In the <Sensor Setup> menu select the <Advanced Setup> tab. This tab contains the Communications Interface menu. The Interface Menu allows you to set the <Polling Address>, <Baud Rate> and <RS485 Mode>. Each unit needs a unique address, but the same <Baud Rate> and <RS485 Mode> settings.
6. Once all the units are addressed, wire up the units in the either the 2-wire or 4-wire multidrop manner, keeping all TxA's, TxB's, RxA's and RxB's to be common.
7. Now you can run the DataTemp Multidrop Software and by selecting the baud rate that you set, the program will quickly identify all of the units attached on the network and you're up and running.

It is also possible to address each unit without the use of the DataTemp Multidrop Software. Once the unit is powered up, use the enter and mode buttons on the back panel operator interface and toggle to the Multidrop Address field, see section 6.2 Operation Modes, page 34. Use up and down buttons to select a unique address for each unit. The units may now be installed in a multidrop network.

6 Operation

Once you have the optical head and electronics housing positioned and connected properly, the system is ready for continuous operation.
The operation of the sensor can be done by means of the control panel in the electronics housing or by means of the software that came with your sensor.

6.1 Control Panel

The sensor is equipped with a control panel, 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. The buttons and LEDs are defined in the following sections.

Allow the electronics to warm up for 15 minutes before making control panel adjustments!

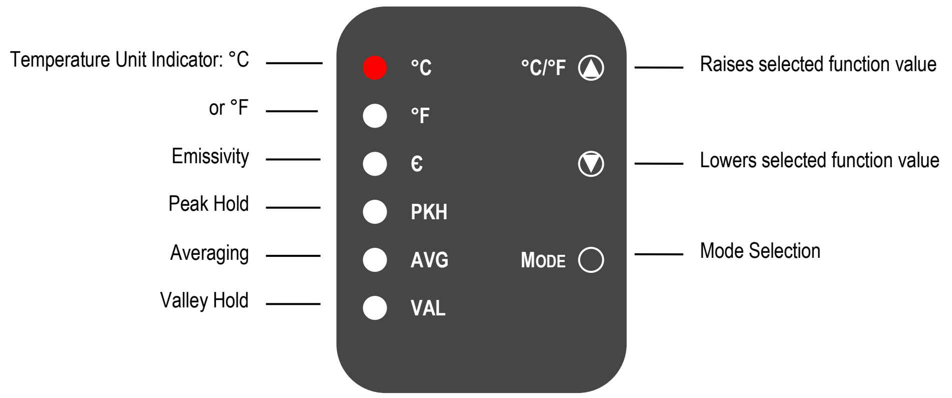


Figure 24: Operating the Control Panel for FA Model

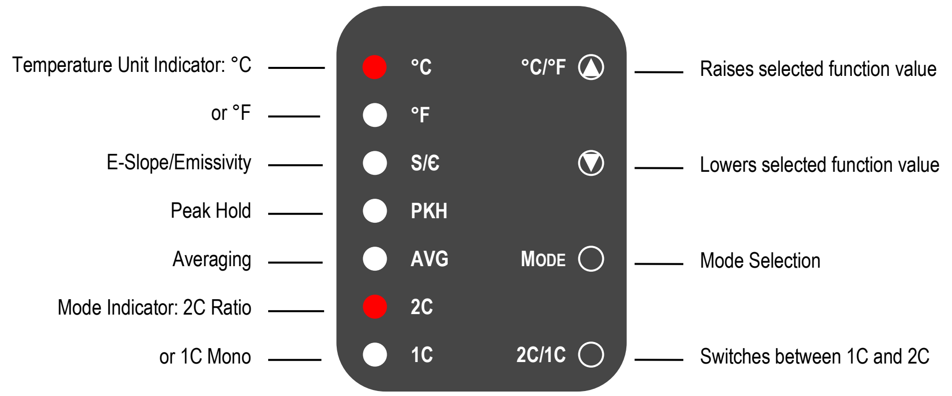


Figure 25: Operating the Control Panel for FR Model

The sensor has a remote locking feature that keeps the unit from being accidentally changed from the control panel (locked by default in multidrop mode). This lockout mode denies access to all the switches on the control panel. It is available through the RS485 connection and can be unlocked only by a command from the remote computer.

6.2 Operation Modes

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. The following figure illustrates the sequence of operation for the mode selector button when in current temperature mode.

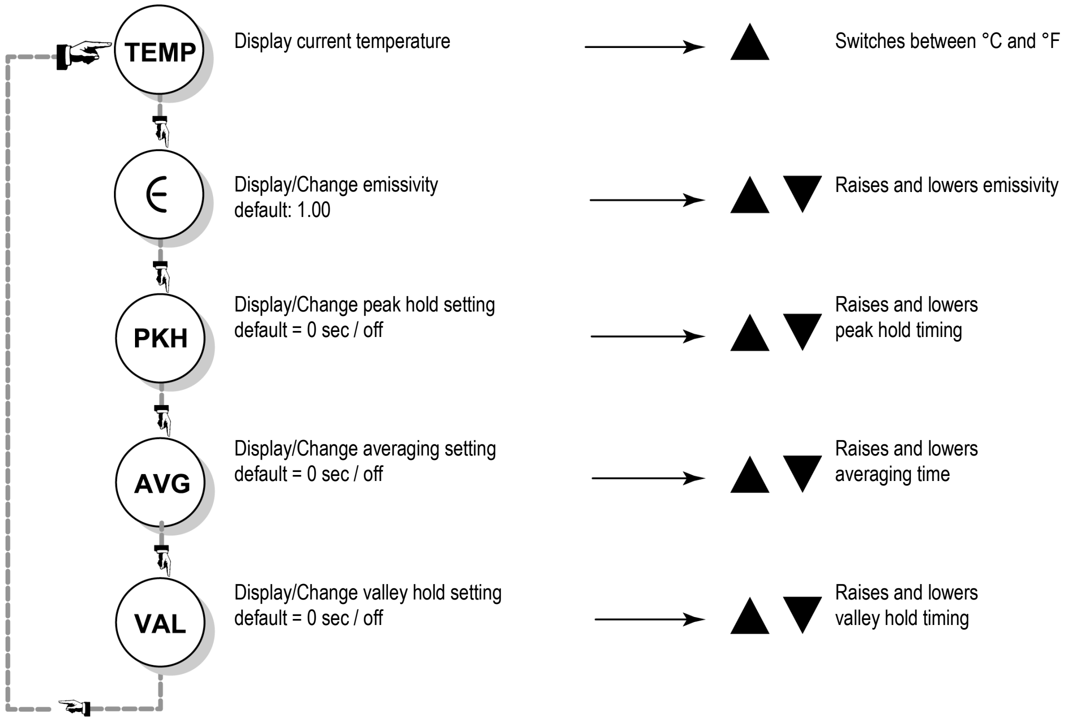


Figure 26: Mode Selector Button Sequence (FA Models)

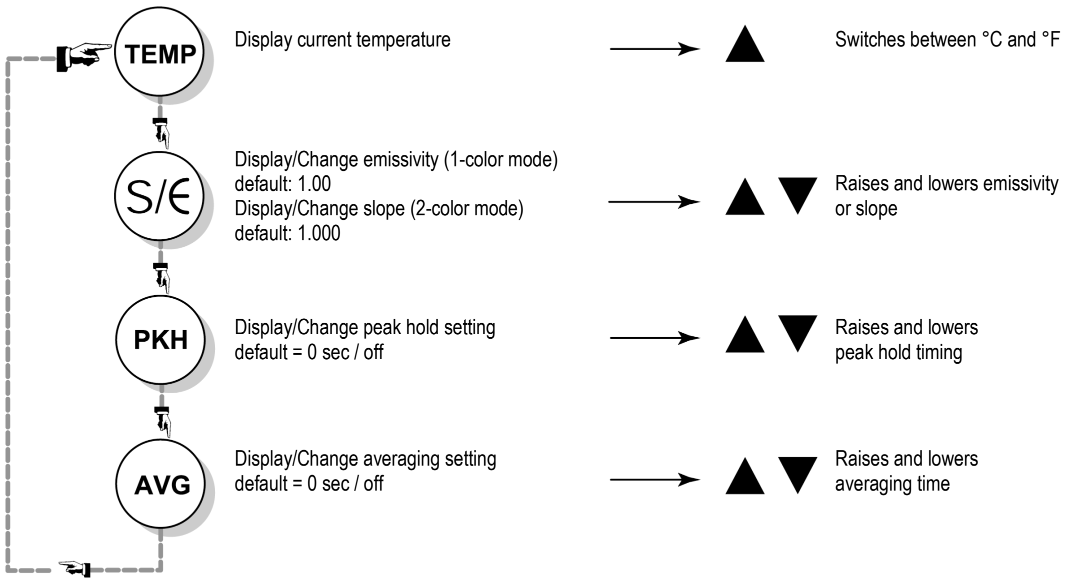


Figure 27: Mode Selector Button Sequence (FR Models)

6.2.1 Temperature Display

The temperature display can be set for either °C or °F by pressing the C/F selector button (▲ – up arrow), which also doubles as the Increase Value button for the other modes. 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 RS485 output for both target and internal temperatures.

6.2.2 Emissivity (1-Color)

You can set the unit up for either 1-color or 2-color measurements. The **1C/2C** selector button on the control panel switches between the two functions. One of the red LEDs, labeled 1C and 2C, will show what function is active.
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. For information on determining an unknown emissivity, and for sample emissivities, refer to section 11.1 Determination of Emissivity and 11.2 Typical Emissivity Values, p. 61f.

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

1. Make sure the **1C** LED is lit.
2. Press the Mode button until the **∈** LED is lit. The current emissivity value shows on the display.
3. Press the ▲ or ▼ button to change the value.
4. Press the Mode button several times until the **C** or **F** LED is lit. The displayed temperature will now be based on the new emissivity value.

6.2.3 Slope (2-Color)

The slope is the quotient of the emissivities based on the narrow and the wide spectral range (first and second wavelength). The slope is preset at the factory at 1.000.

The slope is the deciding parameter for measurements in 2-color mode! The emissivity affects only measurements in 1-color mode.

For information on determining an unknown slope, and for sample slopes, refer to section 11.3 Typical Slopes, p. 63.

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

1. Make sure the **2C** LED is lit.
2. Press the Mode button until the **Є** LED is lit. The current slope value shows on the display.
3. Press the ▲ or ▼ button to change the value.
4. Press the Mode button several times until the **C** or **F** LED is lit. The displayed temperature will now be based on the new slope value.

6.2.4 2C/1C Switch

To switch between 2-color and 1-color temperature measurement push the 2C/1C selector button. A lit LED indicates the active measurement method. Switching affects the LED display and analog out but not the RS485 out.

6.2.5 Peak Hold (PKH)

With Peak Hold, the respective last peak value is held for the duration of 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▲ button to both set and activate. The display reads in 0.1 seconds. Set Peak Hold from 0.1 to 299.9 seconds. If Peak Hold is set to 300.0 seconds, a hardware reset is needed to trigger another reading. If Peak Hold is set to 0.0 seconds, the function is deactivated.
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:

- The peak hold time runs out. In this case, the signal reverts to actual temperature.
- The actual temperature goes above the hold temperature. In this case, starts holding new peak.

Note that other hold functions (like Valley Hold or Averaging) cannot be used concurrently.
By means of the software other hold functions are adjustable (e.g. Advanced Peak Hold).

6.2.6 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.
The averaging algorithm simulates a first order low pass RC filter whose time constant can be adjusted to match the user's averaging needs. The following figure illustrates an averaging output signal.

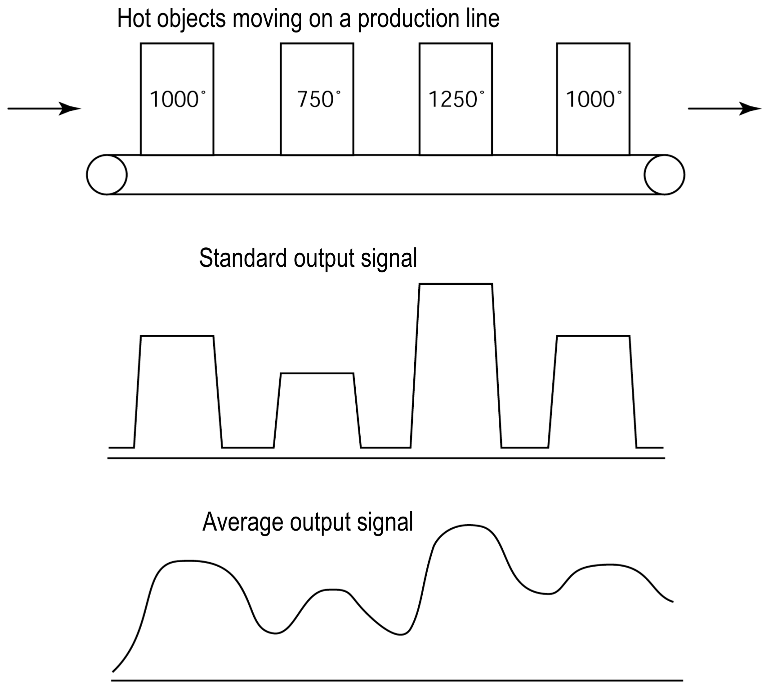


Figure 28: Averaging Example

To set and activate Averaging, do the following:

1. Press the Mode button until the **AVG** LED is lit.
2. Press the ▲ button to both set and activate. The display reads in 0.1 seconds. Set Average anywhere from 0.1 to 300.0 seconds. If Average is set to 0.0 seconds, the function is deactivated.
3. Press the Mode button until the **C** or **F** LED is lit. If Average has been activated, the **AVG** LED will stay lit.

Once Averaging is set above 0, it automatically activates. Note that other hold functions (like Peak Hold or Valley Hold) cannot be used concurrently.

6.2.7 Valley Hold (VAL)

With Valley Hold, the respective last valley value is held for the duration of Hold Time.
Function and setting for valley hold corresponds to the already described Peak Hold function, see section 6.2.5 Peak Hold (PKH), p. 36. The Valley Hold function is not available for 2-color units.

6.2.8 Overview to Hold Functions

The following table 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.
Please note, the setting of some commands is not possible by using of the control panel, these commands are only available by means of the software.

Hold Function	RESET by	Peak Time	Valley Time	Threshold	Hysteresis	Decay Rate
		Protocol code				
		P	F	C	XY	XE
none	none	000.0	000.0	-*	-*	-*
Peak Hold	timer	000.1-299.9	000.0	000.0	-*	000.0
Peak Hold	trigger	300.0**	000.0	000.0	-*	000.0
Peak Hold with decay	timer	000.1-299.9	000.0	000.0	-*	0001-9999

Advanced Peak Hold	trigger or threshold	300.0	000.0	0250-3000	-*	0000
Advanced Peak Hold	timer or threshold	000.1-299.9	000.0	0250-3000	-*	0000
Advanced Peak Hold with decay	timer or threshold	000.1-299.9	000.0	0250-3000	-*	0001-9999
Valley Hold***	timer	000.0	000.1-299.9	000.0	-*	000.0
Valley Hold***	trigger	000.0	300.0**	000.0	-*	000.0
Valley Hold with decay***	timer	000.0	000.1-299.9	000.0	-*	0001-9999
Advanced Valley Hold***	trigger or threshold	000.0	300.0	0250-3000	-*	0000
Advanced Valley Hold***	timer or threshold	000.0	000.1-299.9	0250-3000	-*	0000
Advanced Valley Hold with decay***	timer or threshold	000.0	000.1-299.9	0250-3000	-*	0001-9999

Table 2: Hold Functions

* Value does not affect the function type
** Holds indefinitely or until triggered
*** Function available only for FA Models

6.2.9 Setpoints

The two Setpoints are deactivated by default (alarm mode). Activating and adjusting the Setpoints is accomplished through software. Once one or both Setpoints are activated the relay changes state as the current temperature passes the setpoint temperature.

6.2.10 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 or F of Setpoint value. Adjusting to other values is accomplished through software. For information on the sensor's communication protocols, see section 9 Programming Guide, page 46. The following figure is an example of the Deadband around a Setpoint temperature of 960°C (1760°F).

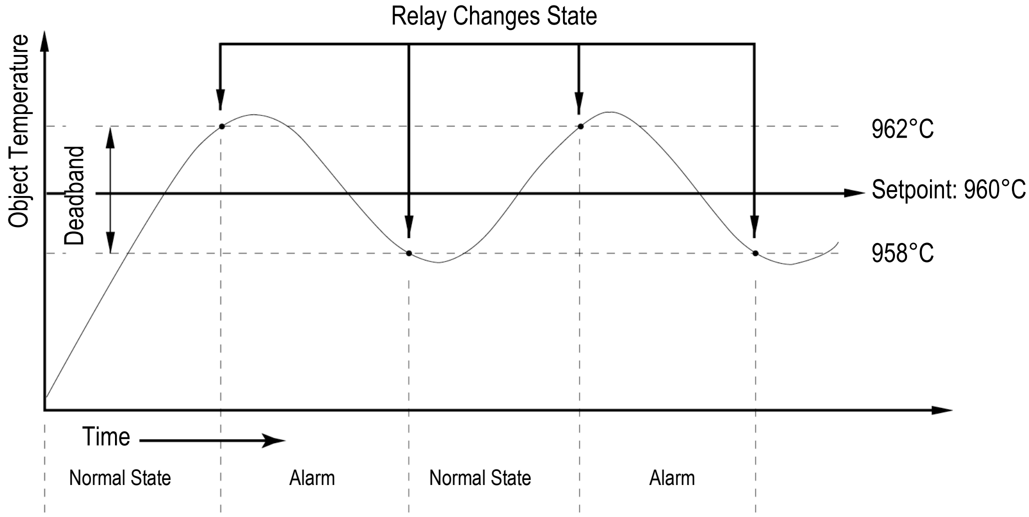


Figure 29: Deadband Example

6.2.11 Ambient Background Temperature Compensation (FA Models)

The FA model 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 enable the sensor with the background temperature feature via the DataTemp Software.

6.3 Inputs and Outputs

6.3.1 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 0.5°C or 1°F. The mA output can be forced to a specific value, underrange, or overrange with a 2- way RS485 command. This feature is useful for testing or calibrating connected equipment.

6.3.2 Relay Outputs

The relay output is used as an alarm for failsafe conditions or as a setpoint relay, refer to section 10.2 Fail-Safe Operation, p. 53. Relay outputs relate to the currently displayed temperature on the LED display. The relay output can be used to indicate an alarm state or to control external actions. The relay can be set to either NO (Normally Open) or NC (Normally Closed) with a 2- way RS485 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.

6.3.3 Trigger

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

6.4 Factory Defaults

To globally reset the unit to its factory default settings, press the ▲ and ▼ buttons at the same time for approximately 2 seconds. The baud rate will not change from the last value when this is done.

Parameter	FA (1-color unit)	FR (2-color unit)
Display mode	°C, TEMP- Display	2C, °C, TEMP- Display
Emissivity	1.00	1.00
Slope	-	1.000
PKH	0.0 s	0.0 s
AVG	0.0 s	0.0 s
VAL	0.0 s	-
Baud rate	38400	38400
Relay alarm output	controlled by unit	controlled by unit
Current Output	4 – 20 mA	4 – 20 mA
Temperature setting for 4 mA	FA1A: 475°C (887°F) FA1B: 800°C (1472°F) FA1C: 1200°C (2192°F) FA1G: 750°C (1382°F) FA2A: 250°C (482°F) FA2B: 400°C (752°F)	FR1A: 500°C (932°F) FR1B: 700°C (1290°F) FR1C: 1000°C (1830°F)
Temperature setting for 20 mA	FA1A: 900°C (1652°F) FA1B: 1900°C (3452°F) FA1C: 3000°C (5432°F) FA1G: 1675°C (3047°F) FA2A: 800°C (1472°F) FA2B: 1700°C (3092°F)	FR1A: 1100°C (2012°F) FR1B: 1500°C (2732°F) FR1C: 2500°C (4532°F)
Panel Control	unlocked	unlocked
Serial Communication	4-wire, non multidrop	4-wire, non multidrop
Transfer modus RS485	Burst-Modus	Burst-Modus
Output string (RS485)	UTEI = temperature unit, 1C temperature, emissivity, internal temperature	UTEI = temperature unit, 2C temperature, emissivity, internal temperature

Figure 30: Factory Defaults

7 Options

Options are items that are factory installed and must be specified at time of order. The following are available:

- Fiber optic cable lengths: 1, 3, 6, 10 m (3, 10, 20, 33 ft), 22 m (72 ft) for selected models
- ISO Calibration Certificate, based on NIST/DAkkS certified probes (XXXFR1CERT)
- High Temperature Fiber Cable (…H), rated to 315°C (600°F), not available on FA2 models
- Laser Sighting (…L) only on FA1A/FA2A and FR1A/FR1B models
- Cooling Platform for Electronics Housing (...W)

The High Temperature Fiber Cable excludes Viton coating and IP65 (NEMA-4) rating!

7.1 Cooling Platform for Electronics Housing

The cooling platform for the electronics housing can be used for ambient temperatures up to 150°C (302°F). For an efficient cooling a water flow of 2 l (0.53 gallons) per minute is recommended at a water temperature of 16°C (61°F).

Mounting hole: Ø 5 mm (0.188); max. fastener head: 8 mm (0.31)

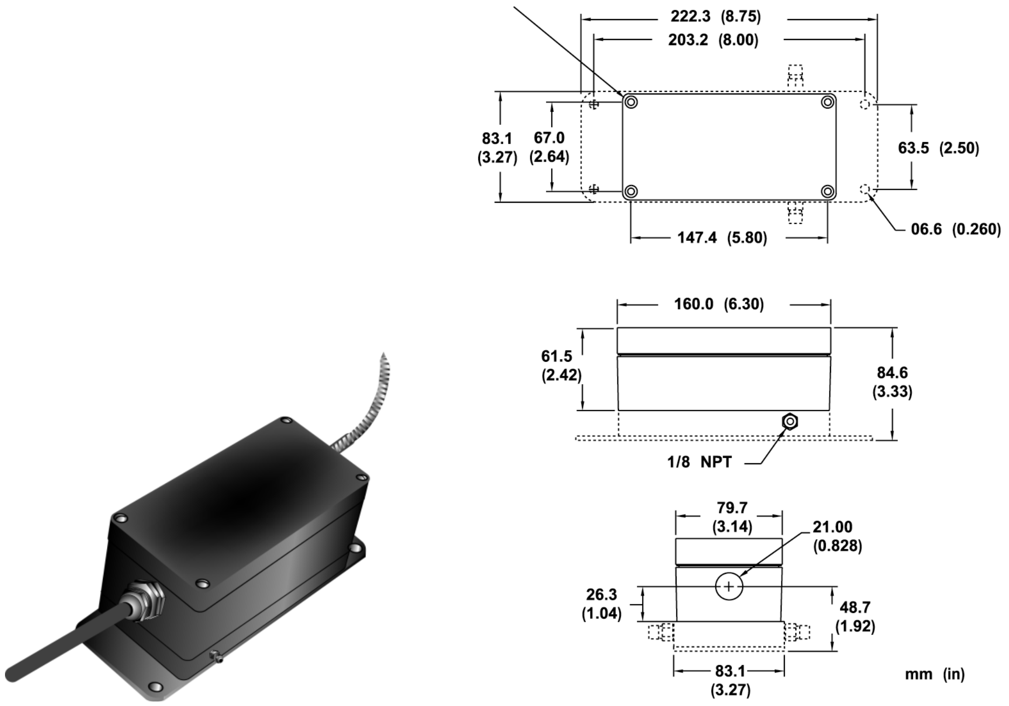


Figure 31: Cooling Platform for Electronics Housing

8 Accessories

8.1 Overview

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

- Air Purge Collar with protection tube for optical head (XXXFOHAPA)
- Protection Tube (XXXFOSTCA)
- Fitting System
- USB/RS485 Converter (XXXUSB485) see section 5.7, page 29
- Industrial Power Supply (XXXSYSPS)
- Terminal Block (XXX2CTB)
- Terminal Block including 24 VDC power supply and NEMA-4 (IP 65) rated housing (RAYMAPB)
- Aiming light, battery powered (XXXFAFAL)

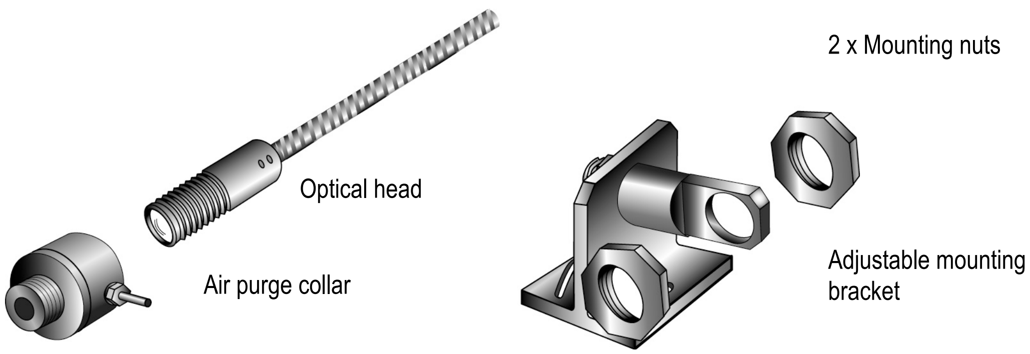


Table 3: Accessories (selection)

8.2 Air Purge Collar

The Air Purge Collar accessory is used to keep dust, moisture, airborne particles, and vapors away from the optical head's lens. It can be installed before or after the bracket. 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). Also provided is a stainless steel protection tube, 150 mm (6 inches) long by 25 mm (1 inch) diameter that threads onto the front of the air purge collar.

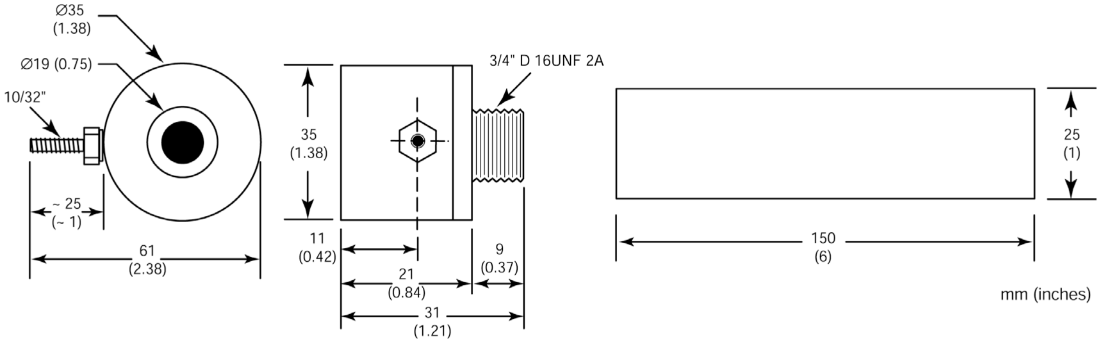


Figure 32: Air Purge Collar and Protection Tube (XXXFOHAPA)

8.3 Protection Tube

The protection tube is available as an accessory. It is 305 mm (12 in.) long and 32 mm (1.26 in.) in diameter and comes with ¾” NPT external thread at one end. The optical head is threaded with the protection tube. The use of the air purge collar in the same time is possible.

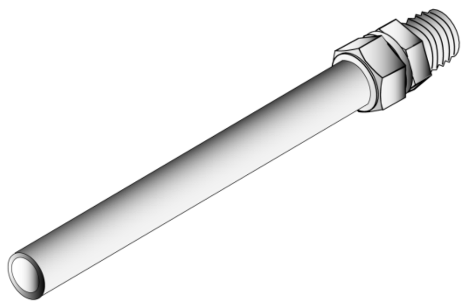


Figure 33: Protection Tube for Optical Head

8.4 Fitting System

Flexible accessory selections allow you to pick and choose the accessories you need.

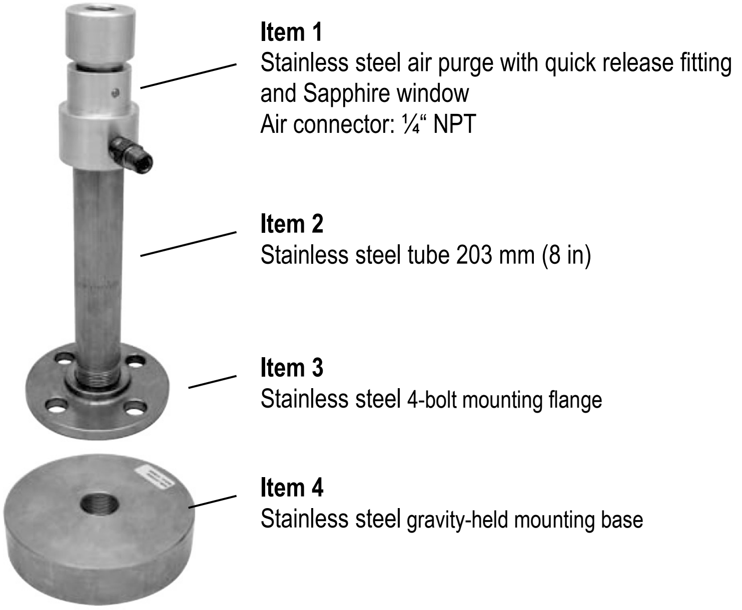


Figure 34: Flexible Fitting System

Part number	Description
XXXFORFQP	Item 1
XXXFORFAP	Item 1 + Item 2
XXXFORFMF	Item 1 + Item 2 + Item 3
XXXFORFMC	Item 1 + Item 2 + Item 4

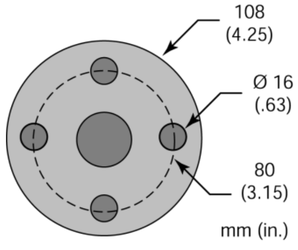


Figure 35: Dimension for 4-Bolt Mounting Flange

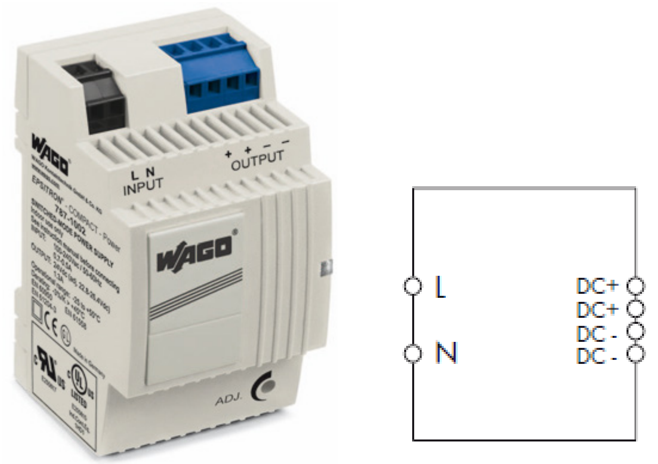
8.5 Industrial Power Supply

The DIN-rail mount industrial power supply delivers isolated dc power and provides short circuit and overload protection.

To prevent electrical shocks, the power supply must be used in protected environments (cabinets)!

Technical data:

Protection class	prepared for class II equipment
Environmental protection	IP20
Operating temperature range	-25°C to 55°C (-13°F to 131°F)
AC Input	100 – 240 VAC 44/66 Hz
DC Output	24 VDC / 1.3 A
Cross sections	input/output 0.08 to 2.5 mm² (AWG 28 to 12)



[1]

Figure 36: Industrial Power Supply (XXXSYSPS)

[1] Copyright Wago®

9 Programming Guide

This section explains the sensor's communication protocol. Use them when writing custom programs for your applications or when communicating with your sensor with a terminal program.

9.1 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. (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 set via the 2-way interface are retained in the sensor's nonvolatile memory.

i **When a unit is placed in multidrop mode its manual user interface is automatically locked! It can be unlocked with the command XXXJ=U <CR>, where XXX is the multidrop address.**

9.2 Command Structure

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. If the unit is in multidrop mode the 3-digit address can be sent out before the exclamation mark.
For a change in the setting of a parameter, the range of possible setting values is defined, and, if the host inputs a value outside the allowed range, an appropriate "error" response character shall be transmitted back by the sensor.

i **All commands must be entered in upper case (capital) letters. Also note that leading and trailing zeros are necessary!**

Example: Send E=0.90 instead of E=0.9; send P=001.2 instead of P=1.2

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. The response is faster at higher baud rates.

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 (unknown command)
- An "out-of-range" parameter value
- A value entered in the incorrect format (syntax error)
- Lower case character(s) entered (all characters must be upper case)

9.3 Transfer Modes

The protocol allows the use of two different modes: the Poll Mode and the Burst Mode

9.3.1 Poll Mode

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.

9.3.2 Burst Mode

The unit transmits the user-defined output string (continuously, at the selected baud rate), which may contain all of the parameters. Parameters may also be polled for while the instrument is in burst mode. The poll string will be inserted in the burst-mode stream.

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
2. Target temperature
3. Power
4. Emissivity
5. Peak hold time
6. Average time
7. Mode (Setup/Fast)
8. Internal temperature
9. Temperature setting for 20 mA
10. Temperature setting for 0 mA / 4 mA
11. Output current (specified values, in mA, or controlled by sensor)
12. Multidrop address
13. Trigger status
14. Multidrop address
15. Initialization flag

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

- Poll/Burst Mode
- Baud rate
- Manual Lockout/Unlock

- Sensor Model Type
- Sensor Serial Number
- Relay Control
- Laser status
- Setpoints
- Deadband
- Current Output Mode (0 - 20 mA or 4 - 20 mA)

The following items cannot be polled:

- Poll/Burst Mode
- Baud rate
- Relay control
- Set current output

An example string for command $=UTQEGH<CR>
The default string is as follows: C T1250 Q0400.023 E1.00 G005.5 H1400 <CR><LF>

9.4 Response Time in Setup Mode

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 RS485 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:

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

where:

t = average 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 and ambient (20 characters), the average digital response time would be the following:

$$t = 9.9 + \frac{20 \cdot 15000}{38400} = 17.7ms$$

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

9.5 Command List

In depending from the specific commands, the following characters are used:

- **?** ... host (e.g. PC) requests for a parameter value of the unit
- **!** ... unit acknowledges a valid parameter request and responses with the parameter value
- **=** ... host forces the unit to set a certain parameter
- **#** ... unit informs the host, a parameter was set on the control panel manually
- ***** ... unit's error response

Description	Char	Format (2)	P (1)	B (1)	S (1)	N (1)	Legal Values	Factory Default
Burst string format	$	(3)	√		√		(3)	UTSI
Ambient radiation correction (FA only)	A	nnnn	√		√		0000-3000°C	0000
Measured attenuation	B	nn	√	√			0 to 99	
Advanced Hold Threshold	C	nnnn	√		√		0000-3000°C	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 (FA only)	F	nnn.n	√		√	√		
Average time (4)	G	nnn.n	√	√	√		000.0-300.0 s	000.0
Top of mA range	H	nnnn	√	√	√	√	0000-9999 (°C/°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/°F)	(6)
Mode (FR only)	M	n	√	√	√	√	1 = 1-color, 2 = 2-color	2
Target temperature 1-color (FR only)	N	nnnn	√	√		√		
Output current	O	nn		√	√		00 = controlled by unit 02 = under range 21 = over range 00-20 = current in mA	00
Peak hold time (4)	P	nnn.n	√	√	√	√	000.0-300.0 s	0000.0

Table 4: Command List

(1) P = Poll Mode (Request for a parameters), B = Burst Mode (continuous sending of parameters in the burst string), S = Set (Command for setting a parameters), N = Notification (Acknowledgment for setting a parameter)
(2) n = number, X = uppercase letter
(3) see section 9.3.2 Burst Mode, p. 47
(4) Setting peak hold cancels average, and vice-versa. 300.0 means reset only with external trigger
(5) The sensor restarts after a baud rate change.

Description	Char	Format (2)	P (1)	B (1)	S (1)	N (1)	Legal Values	Factory Default
Wide Power	Q	nnnn.nnn	√	√			0000.000-9999.999	
Narrow Power (FR only)	R	nnnn.nnn	√	√			0000.000-9999.999	
Slope (FR only)	S	n.nnn	√	√	√	√	0.850-1.150	1.000
Target temperature FR series: 2-color	T	nnnn	√	√			(4)	
Temperature unit	U	X	√	√	√	√	C or F	USA: F, Foreign: C
Poll/Burst mode	V	X			√		P = Poll, B = Burst	Burst
Target temperature FR series: 2-color wide	W	nnnn	√	√			(4)	
Burst string contents (5)	X$		√					
Multidrop address	XA	nnn	√	√	√		000 to 032	000
Low temperature limit	XB	nnnn	√				0000-9999 (4)	set at factory calibration
Deadband (6)	XD	nn	√		√		01 - 55 in °C	02
Decay rate	XE	nnnn	√		√		0000-5555°C	0000
Restore factory defaults (8)	XF				√	√		
High temperature limit	XH	nnnn	√				0000-9999 (4)	set at factory calibration
Sensor initialization	XI	n	√	√	√	√	0 = Flag reset 1 = Flag set	1
Laser (optional)	XL	X	√		√	√	0 = off, 1 = on H = overheat (off) N = no laser built in	0
Sensor model type	XM	X	√				A, B, C	set at factory calibration
Output current	XO	n	√		√		0=0 - 20 mA, 4=4 - 20 mA	4
Second setpoint	XP	nnnn	√		√		0000 to 5432 (11)	0000
Sensor revision	XR	Xn	√					set at factory calibration
Setpoint / relay function	XS	nnnn	√		√		0000 to 5432 (9)	0000
Trigger	XT	n	√	√		√	XT0=inactive, XT1= active	
Identify unit	XU		√					!XUFR1A
Sensor serial number	XV	Xnnnnnn	√					set at factory calibration
Hysteresis Advanced Hold	XY	nnnn	√		√		0000-3000°C	0002
Attenuation to activate relay (10) (FR only)	Y	nn	√	√	√		0 to 95%	95%
Attenuation for failsafe (FR only)	Z	nn	√	√	√		0 to 99%	95%

Table 5: Command List (continued)

(4) in current scale (°C or °F)
(5) see section 9.3.2 Burst Mode, p. 47
(6) no effect if relay in alarm mode
(7) N = no laser built in
(8) Note that this command has a special effect on the "Bottom of mA range" parameter, as noted above in (6)
(9) 0000 places unit in alarm mode. Non-zero setpoint value puts unit in Setpoint mode. Setpoint is in current scale (°C or °F). Must be within unit's temperature range.
(10) Relay goes to abnormal, display and analog out continue to provide temperature.
(11) XP = 000 means only 1 setpoint or no setpoint is used. XS <> 0000 and XP <> 0000 means 2 setpoints are used. (XS defines the first setpoint. XP defines the second setpoint.)

9.6 Command Examples

	HOST	SENSOR	HOST	SENSOR	WHERE USED (1)			
Description	Query →	Answer	Set →	Notification	P	B	S	N
Burst string format	001?$	001!$UTSI	001$=UTSI		√		√	
Show list of commands	001?				√			
Measured attenuation	001?B	001!B12			√	√		
Baud rate		001!D384	001D=384				√	
Emissivity	001?E	001!E0.95	001E=0.95	001#E0.95	√	√	√	√
Average time	001?G	001!G001.2	001G=001.2	001#G001.2	√	√	√	√
Top of mA range	001?H	001!H2000	001H=2000	001#H2000	√	√	√	
Sensor internal ambient	001?I	001!I028			√	√		
Switch panel lock	001?J	001!JL	001J=L		√		√	
Relay alarm output control		001!K0	001K=0		√		√	
Bottom of mA range	001?L	001!L1200	001L=1200		√	√	√	
Mode – FR series	001?M	001!M1	001M=1	001#M1	√	√	√	√
Target temperature, 1-color narrow	001?N	001!N1158				√		
Output current		001!O10	001O=10		√	√	√	
Peak hold time	001?P	001!P005.6	001P=005.6	001#P005.6	√	√	√	√
Power	001?Q	001!Q0036.102			√	√		
Narrow Power	001?R	001!R0002.890			√	√		
Slope	001?S	001!S0.850	001S=0.850	001#S0.850	√	√	√	√
Target temperature, 2-color (FR only)	001?T	001!T1225			√	√		
Temperature units	001?U	001!UC	001U=C	001#UC	√	√	√	√
Poll/Burst mode		001!VP	001V=P				√	
Target temperature, 1-color wide	001?W	001!W1210			√	√		
Burst string contents	001?X$				√			
Multidrop address	001?XA	001!XA013	001XA=013		√	√	√	
Low temperature limit	001?XB	001!XB			√			
Deadband	001?XD	001!XD12	001XD=12		√		√	
Restore factory defaults		001!XF	XF	001#XF			√	√
High temperature limit	001?XH	001!XH1400			√			
Sensor initialization	001?XI	001!XI0	001XI=0	001#XI	√	√	√	√
Laser	001?XL	001!XL1	001XL=1	001#XL1	√		√	√
Sensor model type	001?XM	001!XR			√			
0-20 mA or 4 - 20 mA analog output	001?XO	001!XO4	001XO=4		√		√	
Second setpoint	001?XP	001!XP1234	001XP=1234		√		√	
Sensor revision	001?XR	001!XRF1			√			
Setpoint / relay function	001?XS	001!XS1234	001XS=1234		√		√	
Trigger	001?XT	001!XT0		001#XT0	√	√		√
Identify unit	001?XU	001!XUFR1			√			
Sensor serial number	001?XV	001!XVA099901			√			
Attenuation to activate relay	001?Y	001!Y95	001Y=95		√	√	√	
Attenuation for failsafe	001?Z	001!Z99	001Z=99		√	√	√	

Table 6: Command Examples

(1) P = Poll Mode (Request for a parameters), B = Burst Mode (continuous sending of parameters in the burst string), S = Set (Command for setting a parameters), N = Notification (Acknowledgment for setting a parameter)

The given examples are related to a unit in a network addressed with address 001. Stand-alone units are requested without having an address information in the command.

10 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 at the beginning of this document.

10.1 Troubleshooting Minor Problems

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 lens	Clean the lens
Erroneous temperature	Wrong slope or emissivity	Correct the setting
Temperature fluctuates	Wrong signal processing	Correct Peak/Valley Hold or Average settings

Table 7: Troubleshooting

10.2 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.

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. The following table shows the values displayed on the LED display and transmitted over the 2-way interface.

Symptom	Error Code	Priority
Heater control temperature over range	ECHH	1 (high)
Heater control temperature under range	ECUU	2
Internal temperature over range	EIHH	3
Internal temperature under range	EIUU	4
Temperature under range	EUUU	5
Temperature over range	EHHH	6 (low)

Table 8: Error Codes in 1-Color Mode (FA models)

Condition	2-Color	1-Color (wide band)**	1-Color* (narrow band)**	Priority
Heater control temperature over range	ECHH	ECHH	ECHH	1 (high)
Heater control temperature under range	ECUU	ECUU	ECUU	2
Internal temperature over range	EIHH	EIHH	EIHH	3
Internal temperature under range	EIUU	EIUU	EIUU	4
Wide band detector failure	EHHH	EHHH	<temperature>	5
Narrow band detector failure	EHHH	<temperature>	EHHH	6
Energy too low	EUUU	<temperature>	<temperature>	7
Attenuation too high (>98%)	EAAA	<temperature>	<temperature>	8
Attenuation too high >95% ("dirty lens", relay will go to “alarm” state)	<temperature>	<temperature>	<temperature>	9
2-color temperature under range	EUUU	<temperature>	<temperature>	10
2-color temperature over range	EHHH	<temperature>	<temperature>	11
1-color temperature (wide) under range	<temperature>	EUUU	<temperature>	12
1-color temperature (wide) over range	<temperature>	EHHH	<temperature>	13
1-color temperature (narrow) under range	<temperature>	<temperature>	EUUU	14
1-color temperature (narrow) over range	<temperature>	<temperature>	EHHH	15 (low)

* only available through RS485
** Wide and narrow band stands for the first and the second wavelength in 2-color mode

Table 9: Error Codes in 2-Color Mode (FR models)

The relay is controlled by the temperature selected on the display. If any failsafe code appears on the display, the relay changes to the "abnormal" state. The exception is the "dirty window" condition. This causes the relay to change state, leaving a normal numerical temperature output. The dirty window is detected in either 1-color or 2-color mode.

Error Code	0 – 20 mA Output	4 – 20 mA Output
no error	according to temperature	according to temperature
ECHH	21 to 24 mA	21 to 24 mA
ECUU	0 mA	2 to 3 mA
EIHH	21 to 24 mA	21 to 24 mA
EIUU	0 mA	2 to 3 mA
EUUU	0 mA	2 to 3 mA
EHHH	21 to 24 mA	21 to 24 mA
EAAA	0 mA	2 to 3 mA

Table 10: Current Output Values in accordance to an Error

If two errors occur simultaneously, the higher priority error is the one that is presented on the LED's digital and analog outputs. For example, in 2-color mode, if the internal ambient is too high and the attenuation is too high, the unit outputs EIHH on the LED's and digital output and 21 mA on the analog output. However, since 2-color wide band and narrow band temperatures may all be presented simultaneously through RS485, their over and under range conditions are independent.

Examples of failsafe conditions:

1. One-color temperature is selected for display on the LED's. Two-color temperature is transmitted in burst mode. Wide band temperature is under range. Two-color temperature is 999°C.

   Outputs:
   Display: EUUU
   RS485: C T0999
   Analog: 2 to 3 mA
   Relay: abnormal state

2. Two-color temperature is selected for display on LED's. All three temperatures are transmitted in burst mode. Two-color temperature is 1021°C. Wide band temperature is 703°C. Narrow band temperature is 685°C. Attenuation is above 95%, the "dirty window" threshold.

   Outputs:
   Display: 1021
   RS485: C T1021 W0703 N0685
   Analog: scaled to temperature, between 4 and 20 mA
   Relay: abnormal state

10.3 Cleaning the Lens

Keep the lens clean at all times. Any foreign matter on the window will affect 1-color measurement accuracy and may affect two-color accuracy. However, care should be taken when cleaning the lens. To clean the window, do the following:

1. Lightly blow off loose particles with "canned" air (used for cleaning computer equipment) or a small squeeze bellows (used for cleaning camera lenses).
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

Apply one of the above to the lens. 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.

Do not use any ammonia or any cleaners containing ammonia to clean the lens. This may result in permanent damage to the lens' surface!

10.4 Replacing the Fiber Optic Cable

FA fiber cable assemblies are not field "replaceable" without blackbody recalibration! As such, spare FA fiber cable assemblies are not available!

If the fiber optic cable ever needs to be removed or replaced, it can be removed from both the optical head and electronics enclosure without demounting them from their brackets.

Please be aware of the following when removing or installing cables:

- Make sure cable connectors at the sensing head and electronics enclosure are clean before removing and/or replacing the fiber optic cable.
- Replacement fiber optic cables of the same length can be recalibrated in the field by using the supplied Fiber Replacement Calibration software. Replacement fiber optic cables of different lengths require recalibration at the factory, or at a factory-authorized service center. Contact your sales representative for details.

Always clean the area around the fiber optic cable connectors before disconnecting. If any contaminants get into the open connectors, the sensor's accuracy will be compromised. After removing the cable, or before installing a new cable, the ends must be protected at all times until connected to the sensing head and electronics enclosure. Cables are shipped with protective end caps. Always save these caps for use whenever the fiber optic cable must be disconnected. Any contamination to the fiber optic cable ends will degrade performance. To replace the fiber optic cable, you will need to disconnect it from both the optical head and the electronics enclosure. The following instructions will guide you through the process.

10.4.1 Removing the Fiber Optic Cable

10.4.1.1 Removing the Fiber Optic Cable from the Optical Head

Complete the following steps to disconnect the fiber optic cable from the optical head:

1. Thoroughly clean the area around the optical head.
2. Insert a 1.3 mm (0.050”) hex wrench into the optical head's hex screw and turn counter clockwise until the cable is loose.
3. Draw the fiber optic cable out of the optical head.
4. **Important** – If you plan to reconnect the same cable, immediately cover the end with a slip-on end cap to prevent contamination. Do not use any adhesive tape over the cable end.

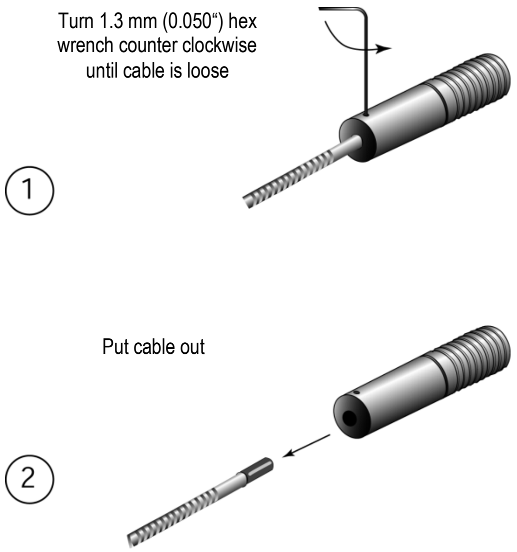


Figure 37: Removing the Fiber optic Cable from the Optical Head

10.4.1.2 Removing the Fiber Optic Cable from the Electronics Housing

Complete the following steps to disconnect the fiber optic cable from the electronics housing:

1. First loosen the cable connecting sleeve.
2. Loosen the cable receptacle screw to release the cable.
3. Pull cable from electronics enclosure, and immediately place a protective cap over the end of the fiber optic cable. Do not use adhesive tape on the cable end.

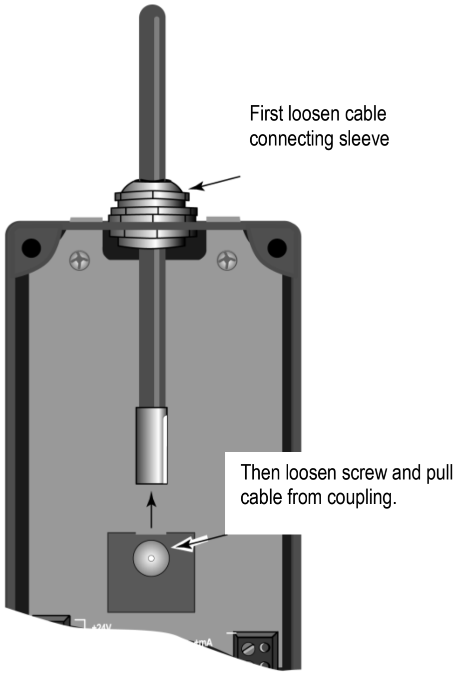


Figure 38: Removing the Fiber optic Cable from the Electronics Housing

10.4.2 Mounting the Fiber Optic Cable

10.4.2.1 Attaching the Fiber Optic Cable to the Optical Head

Complete the following steps to attach the fiber optic cable to the optical head:

1. The fiber optic cable ferrule has a key slot on its surface. Insert the ferrule into the rear of the optical head. Turn the head until the key on the ferrule's key slot engages the key pin inside the head.
2. Make sure cable is pushed in all the way before tightening hex screw! Tighten the hex screw with the 1.3 mm (0.050") hex wrench until snug. **Do not over tighten!**

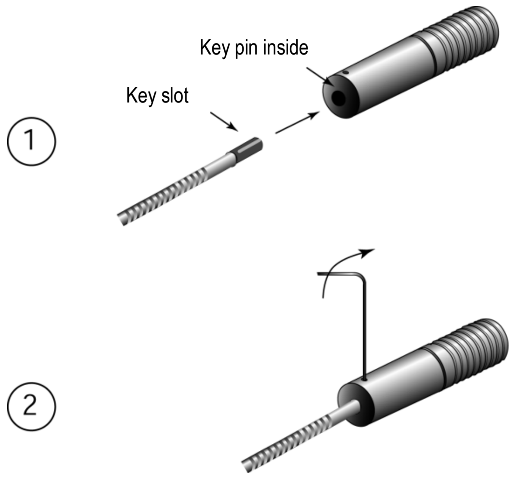


Figure 39: Attaching the Fiber optic Cable to the Optical Head

10.4.2.2 Attaching the Fiber Optic Cable to the Electronics Housing

Complete the following steps to attach the fiber optic cable to the electronics housing:

1. Insert the tip of the fiber optic cable into the mating receptacle on the electronics enclosure. The cable ferrule is keyed and can go in only one way.
2. Push connecting sleeve in until it stops (approx. 15 mm / 0.6 in), see Figure 12, page 22.
3. Tighten the screw (finger tighten only) on the mating receptacle.
4. Tighten the cable's compression fitting.

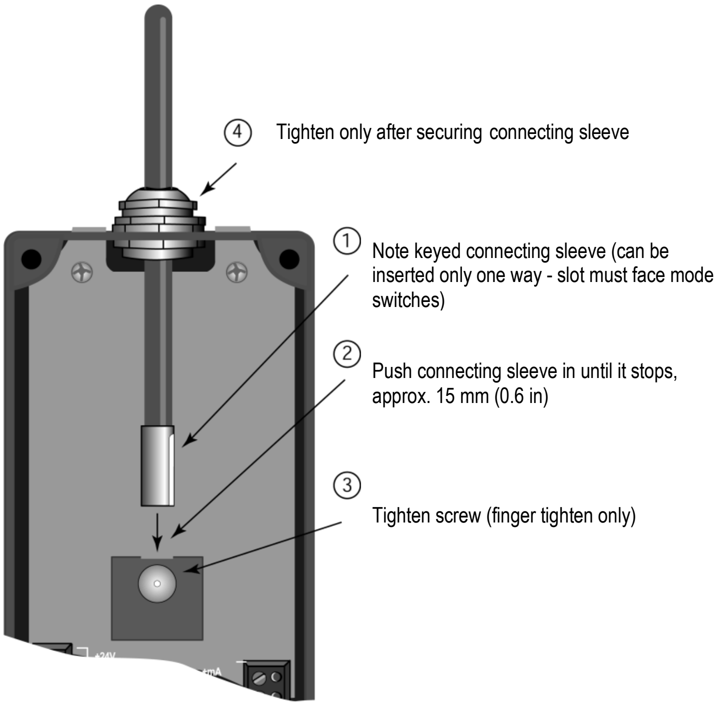


Figure 40: Attaching the Fiber Optic Cable to the Electronics Housing

10.4.3 Fiber Calibration

Each replacement fiber optic cable is calibrated at the factory before shipping. The calibration constants are sent along with a label mounted on the cable. So you have to enter them into the appropriate Fiber Calibration software program. This program sends the new calibration constants, through the RS485 connection, to the sensor's electronics.

The Fiber Calibration program comes with the other software programs you received. To run the program and enter new cable calibration constants, complete the following:

1. The program can not be launched from the CD. Thus you have to copy the file MARATHFC.EXE from the software CD to the hard disk of your computer, e.g. by means of the Windows Explorer.
2. For launching the program you have to select the file and to push the <Enter> button.
3. In the following dialog you are requested to select the right COM port with the plugged unit. For establishing the communication click on the <Done> button.
4. The main screen appears. Click on the <Fiber ID> button.
5. In the following dialog you are requested to input the calibration constants for the fiber cable. The dialog must be closed with clicking on the <Finish> button.
6. The transmission of the new calibration constants to the unit is initialized by clicking on the <Download Calibration Constants> button. Attention: Do not interrupt the data transmission!
7. The click on the <Exit> button completes the recalibration of the fiber cable.

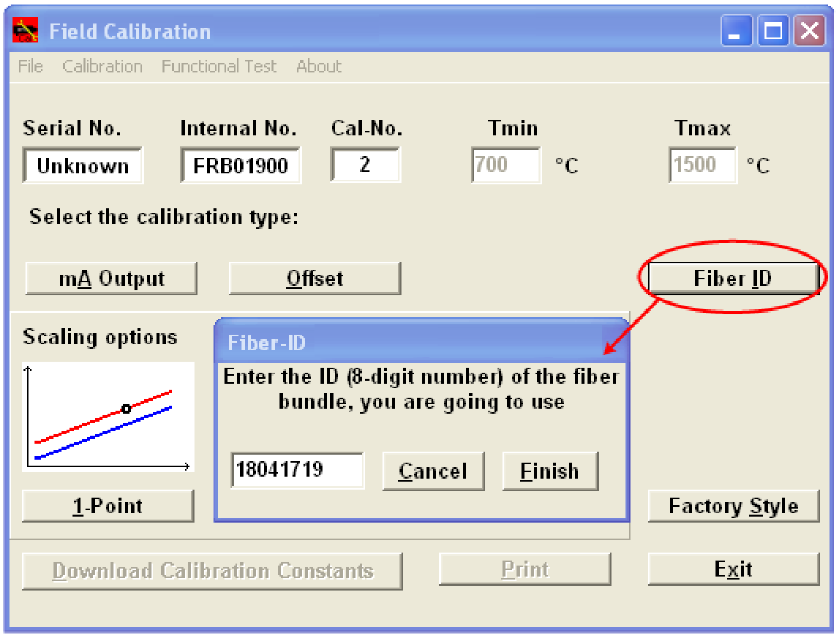


Figure 41: Dialog for the Calibration of the Fiber Cable

11 Appendix

11.1 Determination of Emissivity

Emissivity is a measure of an object's ability to absorb and emit infrared energy. It can have a value between 0 and 1.0. For example a mirror has an emissivity of 0.1, while the so-called "Blackbody" reaches an emissivity value of 1.0. If a higher than actual emissivity value is set, the output will read low, provided the target temperature is above its ambient temperature. For example, if you have set 0.95 and the actual emissivity is 0.9, the temperature reading will be lower than the true temperature.
An object's emissivity can be determined by one of the following methods:

1. Determine the actual temperature of the material using an RTD (PT100), a thermocouple, or any other suitable method. Next, measure the object's temperature and adjust emissivity setting until the correct temperature value is reached. This is the correct emissivity for the measured material.
2. If possible, apply flat black paint to a portion of the surface of the object. The emissivity of the paint must be above 0.98. Next, measure the temperature of the painted area using an emissivity setting of 0.98. Finally, measure the temperature of an adjacent area on the object and adjust the emissivity until the same temperature is reached. This is the correct emissivity for the measured material.

11.2 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 table are only approximate, since several parameters may affect the emissivity of a material. These include the following:

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

EMISSIVITY AT 1 μM FOR METALS				
Aluminum			Iron, cast	
unoxidized	0.1-0.2		oxidized	0.9
oxidized	0.4		unoxidized	0.35
roughened	0.2-0.8		molten	0.35
polished	0.1-0.2		Magnesium	0.3-0.8
Brass			Molybdenum	
polished	0.35		oxidized	0.5-0.9
Burnished	0.65		unoxidized	0.25-0.35
Chromium	0.4		Monel (Ni-Cu)	0.3
Copper			Nickel	
polished	0.05		oxidized	0.8-0.9
roughened	0.05-0.2		electrolytic	0.2-0.4
oxidized	0.2-0.8		Silver	0.04
Gold	0.3		Steel	
Haynes			cold rolled	0.8-0.9
Alloy	0.5-0.9		polished sheet	0.35
Inconel			molten	0.35
oxidized	0.4-0.9		oxidized	0.8-0.9
sandblasted	0.3-0.4		stainless	0.35
electropolished	0.2-0.5		Tin (unoxidized)	0.25
Iron			Titan	
oxidized	0.7-0.9		polished	0.5-0.75
unoxidized	0.35		Zinc	
rusted	0.35		oxidized	0.6
			polished	0.5

Table 11: Typical Emissivity Values (Metals)

EMISSIVITY AT 1 μM FOR NON-METALS	
Asbestos	0.9
Ceramic	0.4
Concrete	0.65
Carbon	
unoxidized	0.8-0.95
Graphite	0.8-0.9

Table 12: Typical Emissivity Values (Non-Metals)

11.3 Typical Slopes

The following slope settings are approximate and will vary depending on the metal alloy and surface finish, as well as the application. These are supplied here as examples.
Set the slope to approximately **1.000** for measuring the following metals with oxidized surfaces:

- Stainless Steel
- Iron
- Cobalt
- Nickel
- Steel

Set the slope to approximately **1.060** for measuring the following metals with smooth, clean, unoxidized surfaces:

- Iron
- Stainless Steel
- Cobalt
- Molybdenum
- Nickel
- Rhodium
- Steel
- Platinum
- Tantalum
- Tungsten

Molten iron also has an approximate slope setting of 1.060.

How to determine slope?

The most effective way to determine and adjust the slope is to take the temperature of the material using a probe sensor such as an RTD, thermocouple, or other suitable method. Once you determine the actual temperature, adjust the slope setting until the sensor's temperature reads the same as the actual temperature reading. This is the correct slope for the measured material.

11.4 Signal Reduction (FR Models)

The following figures show each sensor model's typical percentage of allowed signal reduction at all temperatures. Refer to these graphs to estimate what percentage of target area must be visible to the sensor at temperatures below the minimum temperature (95% attenuation).

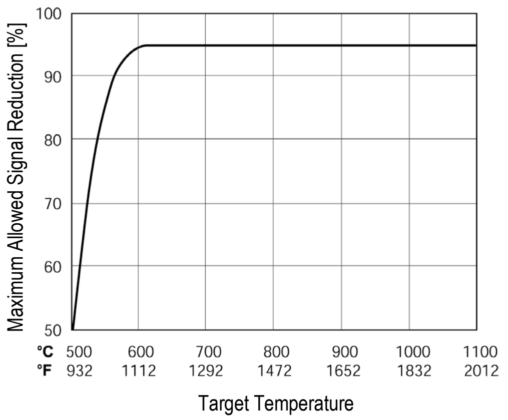


Figure 42: Typical Percentage of Allowed Signal Reduction (FR1A Models)

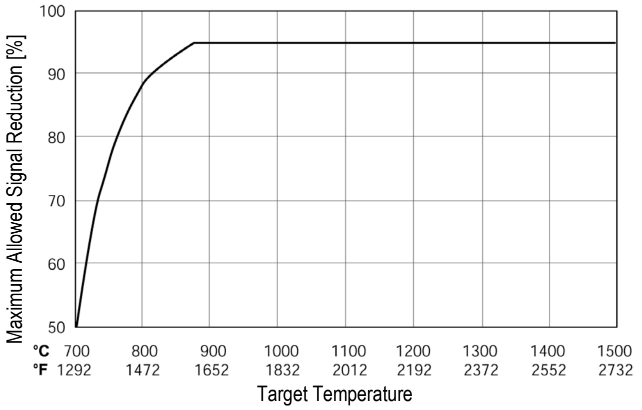


Figure 43: Typical Percentage of Allowed Signal Reduction (FR1B Models)

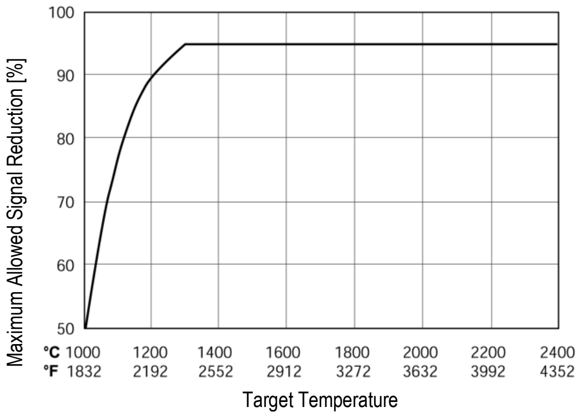


Figure 44: Typical Percentage of Allowed Signal Reduction (FR1C Models)

11.5 Attenuation Influence on Accuracy

The ability of the FR ratio instruments to accurately measure the temperature of targets smaller than the field-of-view (FOV) is a key feature. As the target size becomes smaller than the FOV (thus attenuating the signal) this may cause a slight inaccuracy in the reading. The following figure presents typical measured data for an FR1C unit showing how this degradation in reading accuracy depends upon both the amount of geometrical attenuation[1] and the target temperature. Notice that the worst inaccuracies occur at the highest target temperatures and the highest attenuations.

The worst inaccuracy (at the highest temperature and the highest geometrical attenuation) is the value guaranteed in our specifications. However, notice that the accuracy of the instrument is approximately a factor of two or more better than our specification over the majority of the usable temperature and attenuation combinations, i.e., for all geometrical attenuations less than approximately 80%! Thus, by choosing the sensor-to-target distance properly so that the target fills at least 20% of the FOV (attenuation < 80%) the sensor performance will be significantly improved.

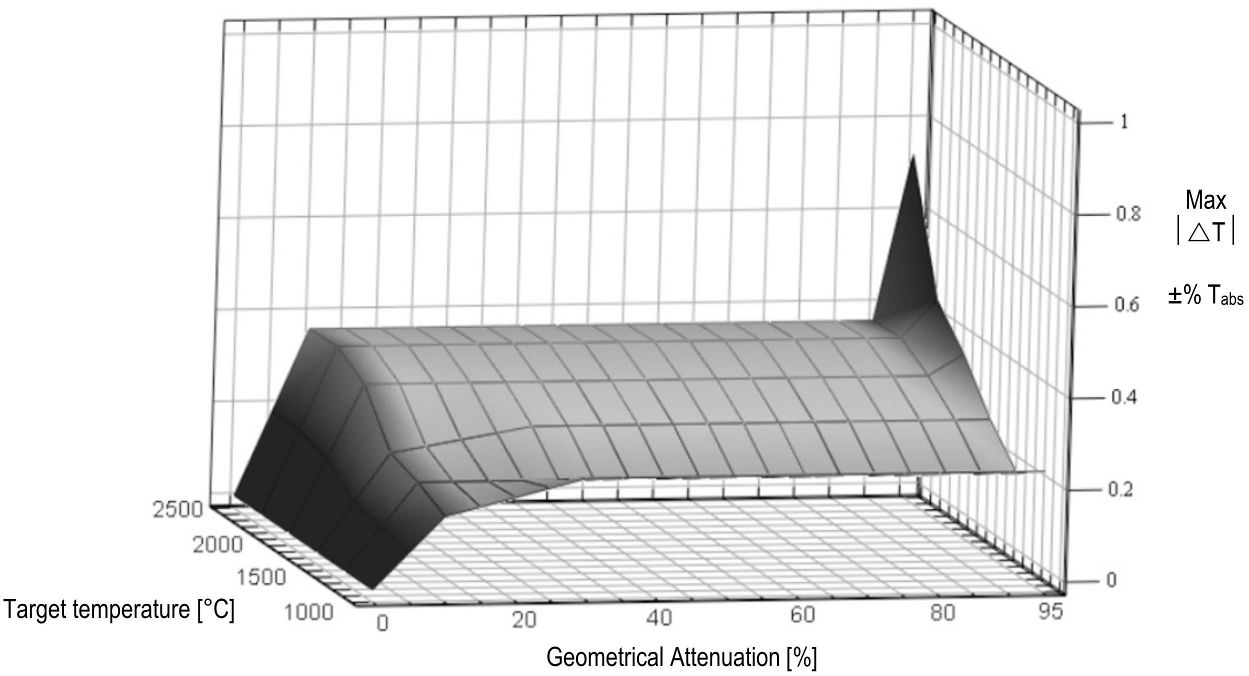


Figure 45: Maximum Error

[1] Geometrical Attenuation (%) is defined as [1 - (Small Target Signal / Target Signal when target fills FOV)] x 100. Thus, if the signal from the target is only 30% of the value when the target fills the FOV, then the Geometrical Attenuation = [1 - 0.3] x 100 = 70%.

11.6 2-Wire Mode

Using the 2-wire installation saves 2 wires in comparison to the 4-wire installation. The disadvantage is that the data transfer can be only in one direction at the same time. 2-wire communications is also available for network installations, in situations where other sensors are only able to communicate via 2 wires(e.g. MI3 sensor).
To switch the FA/FR sensor into the 2-wire mode, you need one of the Interface Converter accessories (see table below) and the proper RS232 cable. If your computer has an RS485 interface card, you can connect the sensor directly to its port (using the proper connector) with wiring from the electronic enclosure's terminal block.

Do not use other commercially available converters, they do not have the necessary features!

Order number	Model
XXX485CVT	25 pin to terminal strip interface converter, recommended for direct wiring between a serial interface and the terminal block
XXX485CVT1	XXX485CVT with 110 VAC power adapter
XXX485CVT2	XXX485CVT with 230 VAC power adapter
XXX485CV	25 pin to 25 pin interface converter
XXX485CV1	XXX485CV with 110 VAC power adapter
XXX485CV2	XXX485CV with 230 VAC power adapter

Table 13: Available RS232/485 Interface Converters

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.

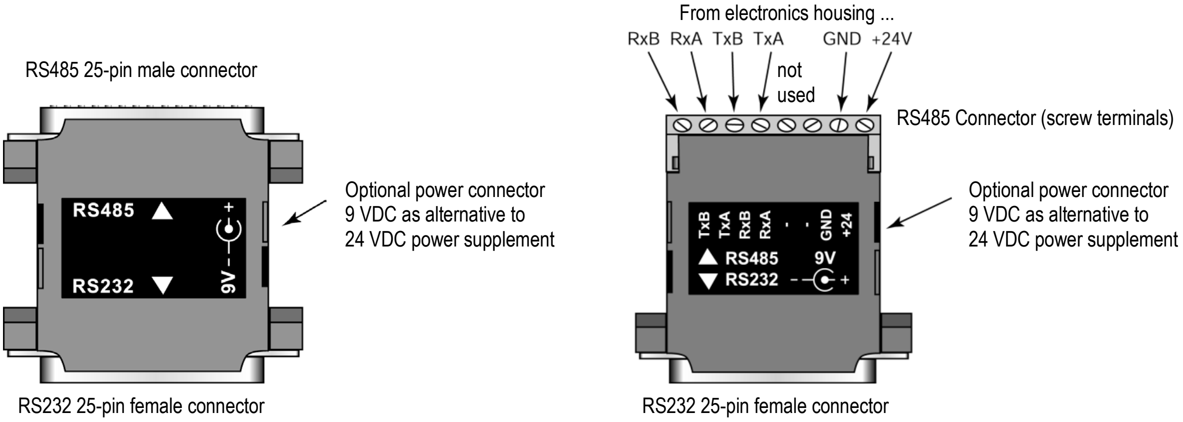


Figure 46: RS232/485 Interface Converter, with pins (left, XXX485CV…) or terminal (right, XXX485CVT…)

The RS485 output is as follows:

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

Note: Adjustable baud rate only available through 2-way RS485.

Data format: 8 bit, no parity, 1 stop bit

4-wire, full duplex, point-to-point

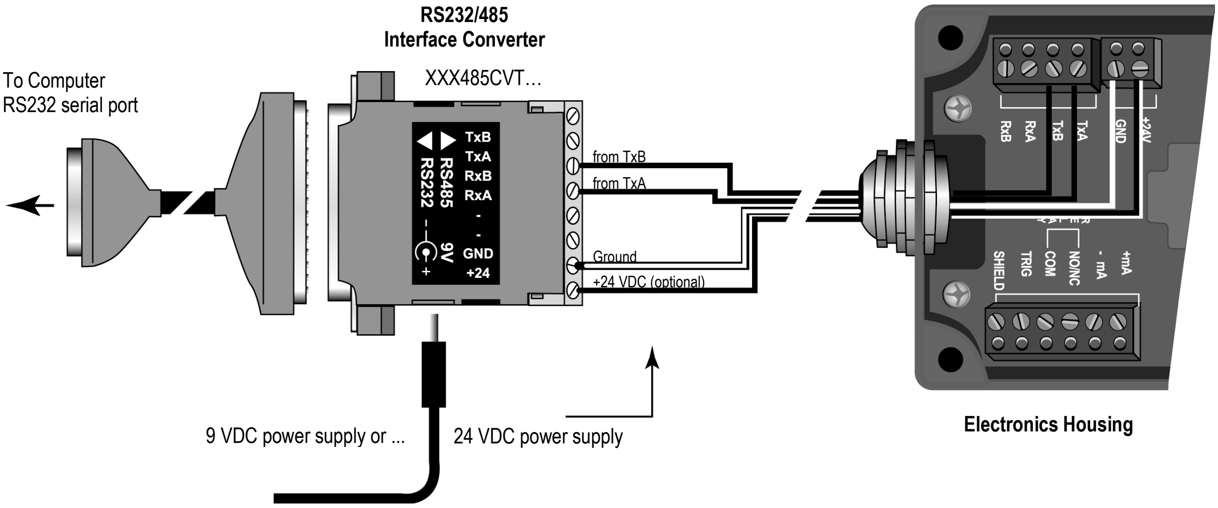


Figure 47: Wiring for 2-Wire Sensor Setup

To set up your computer to switch the sensor to the 2-wire mode, complete the following steps:

1. Remove power from the FA/FR sensor!
2. Install all electronics wiring!
3. Plug the RS485/RS232 interface converter into your computer's serial port, or attach it to a serial cable connected to the computer! Use 9 pin to 25 pin converter if necessary!
4. If the 9 VDC power supply is used, apply power to the RS485/RS232 converter!
5. Apply power to the FA/FR sensor!
6. Turn on your computer!
7. Launch the Network Communication Setup Software (COMSETUP.EXE), found on the software CD and following the wizard.

11.7 Traceability of Instrument Calibration