Thermalert® 4.0 Series

Smart Integrated Infrared Sensors

Users Manual

PN 4968276, English, Rev. 1.4, Jan 2019

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 which 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.

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Compliance Statement

The device complies with the requirements of the European Directives:

EC – Directive 2014/30/EU – EMC

EC – Directive 2011/65/EU – RoHS II

EN 61326-1: 2013	Electrical measurement, control and laboratory devices - Electromagnetic susceptibility (EMC)
EN 50581: 2012	Technical documentation for the evaluation of electrical products with respect to restriction of hazardous substances (RoHS)

Electromagnetic Compatibility Applies to use in Korea only. Class A Equipment (Industrial Broadcasting & Communication Equipment)
This product meets requirements for industrial (Class A) electromagnetic wave equipment and the seller or user should take notice of it. This equipment is intended for use in business environments and is not to be used in homes.

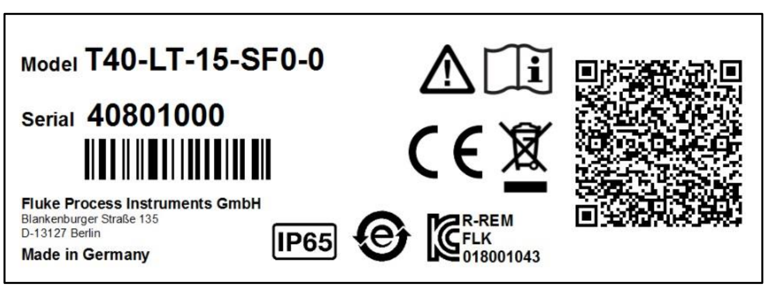
Safety Information

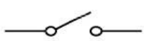
This document contains important information, which should be kept at all times with the instrument during its operational life. Other users of this instrument should be given these instructions with the instrument. Eventual updates to this information must be added to the original document. The instrument 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.



Safety Symbol	Description
	Read all safety information before in the handbook
	Hazardous voltage. Risk of electrical shock.
	Warning. Risk of danger. Important information. See manual.
	Laser warning
	Earth (ground) terminal
	Protective conductor terminal
	Switch or relay contact
	DC power supply
	Conforms to European Union directive.
	Disposal of old instruments should be handled according to professional and environmental regulations as electronic waste.
	Conforms to relevant South Korean EMC Standards.
IP65	International Ingress Protection Marking
	China RoHS

To prevent possible electrical shock, fire, or personal injury follow these guidelines:

- Read all safety information before you use the product.
- Use the product only as specified, or the protection supplied by the product can be compromised.
- Do not use the product around explosive gases, vapor, or in damp or wet environments.
- Carefully read all instructions.
- Do not use and disable the product if it is damaged.
- Do not use the product if it operates incorrectly.
- Do not apply more than the rated voltage between the terminals or each terminal and earth ground.
- Do not look directly into the laser with optical tools (for example, binoculars, telescopes, microscopes). Optical tools can focus the laser and be dangerous to the eye.
- Do not look into the laser. Do not point laser directly at persons or animals or indirectly off reflective surfaces.
- Do not use laser viewing glasses as laser protection glasses. Laser viewing glasses are used only for better visibility of the laser in bright light.
- Use the product only as specified or hazardous laser radiation exposure can occur.
- Incorrect wiring can damage the sensor and void the warranty. Before applying power, make sure all connections are correct and secure!
- To prevent possible electrical shock, fire, or personal injury make sure that the sensor is grounded before use.
- Have an approved technician repair the product.
- The metallic enclosure of the sensor is not necessarily earthed by installation. At least one of the following safety measures must be met to minimize the danger of electrostatic charges:
  - Earth grounding of the cable shield
  - Installing the unit’s metallic enclosure on an earth grounded mounting bracket or on any other grounded bases
  - Protect the operator from electrostatic discharge

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Worldwide Service
Fluke Process Instruments offers services, including repair and calibration.
For more information, contact your local office.

www.flukeprocessinstruments.com

1 Description

The Thermalert 4.0 sensor is an infrared thermometer that differs in spectral responses to be capable of covering a broad range of applications such as metal, glass, and plastics.

The Thermalert 4.0 Series introduces improved temperature measurement specifications, an extended operating ambient temperature range, multiple user interfaces and various network communications. Everything is packaged in a sealed stainless steel housing rated IP65 (NEMA 4).

The Thermalert 4.0 Series comes with the following features:

- Wide temperature range from -40 to 2250°C (-40 to 4082°F)
- Multiple spectral models for any kind of application
- Wide choice of optics
- Fast response time down to 10 ms
- Laser sighting
- Compact, rugged design in stainless steel
- Galvanic isolated outputs
- Real-time ambient background temperature compensation
- Simple, two-wire installation or digital communications RS485
- Rugged accessories for harsh industrial environments
- Software for remote configuration, monitoring and field calibration

The following Thermalert 4.0 model variants are available:

T40	–	**XX**	–	**XX**	–	**XXX**	–	**X**
Series		Spectral:		Optics:		Focus:		Interface:
		LT		07		SF0		0 (2 wire)
		LTB		15		SF2		1 (6 wire)
		MT		20		SF4		2 (12 wire)
		HT		30		CF0		
		G5		50		CF1		
		G7		60		CF2		
		P3		70				
		P7						

Example: T40-LT-15-SF0-0

Figure 1-1: Available Models

2-Wire
4 to 20 mA, Alarm, USB

6-Wire
Analog Out, RS485, USB

12-Wire
Analog In/Out, Alarm, Trigger, RS485, USB

2 Technical Data

2.1 Measurement Specification

Temperature Range

LT-07	-20 to 600°C (-4 to 1112°F)
LT-15	-20 to 600°C (-4 to 1112°F)
LT-30	-20 to 600°C (-4 to 1112°F)
LT-50	-40 to 1000°C (-40 to 1832°F)
LT-70	-40 to 1000°C (-40 to 1832°F)
LTB-30	-20 to 600°C (-4 to 1112°F)
P7-30	10 to 360°C (50 to 680°F)
G7-70	300 to 900°C (572 to 1652°F)
G5-30	250 to 1650°C (482 to 3002°F)
G5-70	450 to 2250°C (842 to 4082°F)
MT-30	200 to 1000°C (392 to 1832°F)
MT-70	450 to 2250°C (842 to 4082°F)
P3-20	25 to 450°C (77 to 842°F)
HT-60	500 to 2000°C (932 to 3632°F)

Spectral Response

LT-07	8 to 14 µm
LT-15	8 to 14 µm
LT-30	8 to 14 µm
LT-50	8 to 14 µm
LT-70	8 to 14 µm
LTB-30	8 to 14 µm
P7-30	7.9 µm
G7-70	7.9 µm
G5-30	5 µm
G5-70	5 µm
MT-30	3.9 µm
MT-70	3.9 µm
P3-20	3.43 µm
HT-60	2.2 µm

Response Time[1]

LT-07	150 ms
LT-15	150 ms
LT-30	30 ms
LT-50	130 ms
LT-70	130 ms
LTB-30	30 ms

[1] 90% value

P7-30	130 ms
G7-70	130 ms
G5-30	60 ms
G5-70	60 ms
MT-30	130 ms
MT-70	130 ms
P3-20	130 ms[2]
HT-60	130 ms

System Accuracy[3]

P3	± (3°C + 1% of reading) for T_{meas} > 75°C (167°F)
All other	± 1% of reading or ± 1.0°C (2.0°F) for T_{meas} > 0°C (32°F)
	for T_{meas} ≤ 0°C (32°F): ± [1.0°C + 0.1*(0°C – T_{meas})] with T_{meas} in °C ± [2.0°F + 0.1*(32°F – T_{meas})] with T_{meas} in °F

Repeatability[4]

P3	± 1°C (2°F) or 0.5% of reading, whichever is greater
All other	± 0.3°C (0.6°F) or 0.3% of reading, whichever is greater

Temperature Resolution

Digital output	0.1°C (0.1°F)
Analog output	14 bit

Emissivity

6-wire / 12-wire models	0.100 to 1.100, in 0.001 increments
2-wire models	0.10 to 1.00, in 0.01 increments

Signal Processing

All models	Averaging, peak hold, valley hold, advanced peak hold, advanced valley hold, ambient background temperature compensation

[2] 10 s for T_{target} < 150°C (302°F)
[3] at ambient temperature 23°C ± 5°C (73°F ± 9°F), emissivity = 1.0 and calibration geometry
[4] at ambient temperature 23°C ± 5°C (73°F ± 9°F), emissivity = 1.0 and calibration geometry

2.2 Optical Specifications

Optical Resolution	D:S[5]	Focus Distances
LT-07	7:1	CF0 (plastic lens)
LT-15	15:1	SF0 (plastic lens)
LT-30	33:1	SF0, CF1, CF2
LT-50	50:1	SF0, CF2
LT-70	70:1	SF2, CF2
LTB-30	33:1	SF0, CF1, CF2
P7-30	33:1	SF0
G7-70	70:1	SF2
G5-30	33:1	SF0
G5-70	70:1	SF2
MT-30	33:1	SF0, CF1, CF2
MT-70	70:1	SF2, CF1, CF2
P3-20	20:1	SF4
HT-60	60:1	SF0, CF1, CF2

Focus Distances

SF0	1520 mm (60 in)
SF2	1250 mm (49 in)
SF4	500 mm (20 in)
CF0	50 mm (2 in)
CF1	76 mm (3 in)
CF2	200 mm (7.9 in)

Note
The focus distance is measured from the lens of the sensor.
*For units with **air/water-cooled housing,** you have to subtract 70 mm (2.8 in) from the focus distance.*
*For units with **ThermoJacket,** you have to subtract 55 mm (2.2 in) from the focus distance.*
These considerations are very important, especially for sensors with close focus optic!

For detailed optical charts, see section 11.1 Optical Diagrams, page 86.

Laser

All models	laser available per standard (except LT-07, LT-15, LTB-30, and P3 models)
	2-wire devices require an additional power supply via USB

[5] at 90% energy, specified D:S ratio at focus point only

2.3 Electrical Specifications

2.3.1 Model 2-Wire

Power	12 to 24 VDC
Outputs	
Analog	4 to 20 mA, loop impedance max. 500 Ω
Alarm	24 V / 150 mA
Digital	USB: version 2.0, micro-B connector (only for the setup of the instrument)

2.3.2 Model 6-Wire

Power	+ 24 VDC nominal (20 to 48 VDC), 100 mA @ 24 V
Outputs	
Analog	0 to 20 mA (active), or 4 to 20 mA (active), or 0 to 10 V, or J thermocouple, or K thermocouple current loop impedance: max. 500 Ω voltage load impedance: min. 10 kΩ electrically isolated from power supply
Digital	USB: version 2.0, micro-B connector (only for the setup of the instrument) RS485: networkable to 32 sensors, baud rate: 4800, 9600, 19200, 38400, 57600, 115200 Bit/s (default: 9600 Bit/s)

The 6-wire version is not available for LTB-30 models.

2.3.3 Model 12-Wire

Power	+ 24 VDC nominal (20 to 48 VDC), 100 mA @ 24 V
Outputs	
Analog	0 to 20 mA (active), or 4 to 20 mA (active), or 0 to 10 V current loop impedance: max. 500 Ω voltage load impedance: min. 10 kΩ electrically isolated from power supply
Alarm	48 V / 300 mA 1 potential-free relay output with wear-free contacts (solid state relay), electrically isolated from power supply
Input	
Analog	0 to 10 V emissivity setting, or background temperature compensation
Digital	trigger input (closing contact)
Digital	USB: version 2.0, micro-B connector (only for the setup of the instrument) RS485: networkable to 32 sensors, baud rate: 4800, 9600, 19200, 38400, 57600, 115200 Bit/s (default: 9600 Bit/s)

The 12-wire version is not available for LTB-30 models.

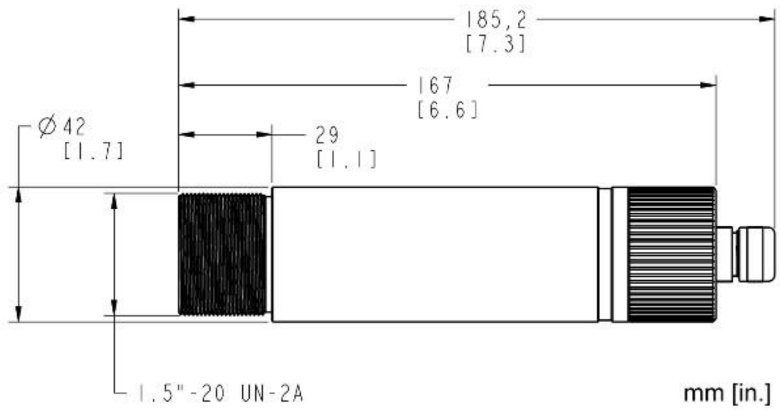
2.4 Environmental Specifications

Ingress Protection	IP65 / IEC 60529 (NEMA-4)
Operating temperature	-20 to 85°C (-4 to 185°F) without cooling 10 to 120°C (50 to 250°F) with air cooling 10 to 175°C (50 to 350°F) with water cooling 10 to 315°C (50 to 600°F) water cooled by ThermoJacket
Storage temperature	-20 to 85°C (-4 to 185°F)
Humidity	10% to 95% @ 30°C (86°F), non-condensing (operating and storage)
Vibration and shock	IEC 60068-2-27 (mechanical shock): 50 g, 6 ms, 3 axes IEC 60068-2-26 (sinusoidal vibration): 3 g, 11 – 200 Hz, 3 axes
EMC	EN 61326-1:2013 industrial
KCC	Electromagnetic Compatibility - applies to use in Korea only. Class A Equipment (Industrial Broadcasting & Communication Equipment) This product meets requirements for industrial (Class A) electromagnetic wave equipment and the seller or user should take notice of it. This equipment is intended for use in business environments and is not to be used in homes.
Warm up Period	30 min.
Material	Stainless steel (housing)
Weight	500 g (18 oz)
Altitude	operating: 2 000 m (6562 ft) storage: 12 000 m (40 000 ft)

2.5 Dimensions

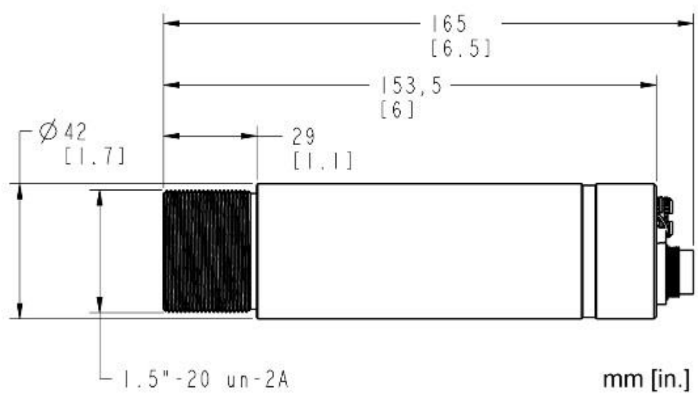
2.5.1 Model 2-Wire / 6-Wire

Figure 2-1: Dimensions for the 2-Wire and 6-Wire Model



2.5.2 Model 12-Wire

Figure 2-2: Dimensions for the 12-Wire Model



2.6 Scope of Delivery

The scope of delivery includes the following:

- Sensor
- Mounting nut
- Fixed bracket
- USB cable (only for the setup of the instrument)
- Operator's manual (as pdf file on data carrier)
- Quick Start Guide (printed)
- PC Software (on data carrier)

Note

For metrological reasons, the P7 and G7 sensors are delivered with a protective window. Please note that these sensors have been calibrated with that specific protective window. To comply with the metrological specifications, the protective window must not be removed.

3 Basics

3.1 Measurement of Infrared Temperature

All surfaces emit infrared radiation. The intensity of this infrared radiation changes according to the temperature of the object. Depending on the material and surface properties, the emitted radiation lies in a wavelength spectrum of approximately 1 to 20 µm. The intensity of the infrared radiation (heat radiation) is dependent on the material. For many substances, this material-dependent constant is known. This constant is referred to as the *emissivity value*.

Infrared thermometers are optical-electronic sensors. These sensors are sensitive to the emitted radiation. Infrared thermometers are made up of a lens, a spectral filter, a sensor, and an electronic signal processing unit. The task of the spectral filter is to select the wavelength spectrum of interest. The sensor converts the infrared radiation into an electrical signal. The signal processing electronics analyze the electrical signal and convert it into a temperature measurement. As the intensity of the emitted infrared radiation is dependent on the material, the required emissivity can be selected on the sensor.

The biggest advantage of the infrared thermometer is its ability to measure temperature without touching an object. Consequently, surface temperatures of moving or hard to reach objects can easily be measured.

3.2 Emissivity of Target Object

To determine the emissivity of the target object, see section 11.3 Typical Emissivity Values, page 97. If emissivity is low, measured results could be falsified by interfering infrared radiation from background objects (such as heating systems, flames, fireclay bricks, etc. located close beside or behind the target object). This type of problem can occur when measuring reflective surfaces and very thin materials, such as plastic film and glass.

This measurement error can be reduced to a minimum, if particular care is taken during installation and the sensing head is shielded from these reflecting radiation sources.

4 Environment

4.1 Ambient Temperature

The sensor is suited for a maximal operating temperature, see section 2.4 Environmental Specifications, page 21. The operating temperature can be extended by using the air/water-cooled housing accessory, see section 8.2.10 Air/Water-Cooled Housing, page 70.

4.2 Atmospheric Quality

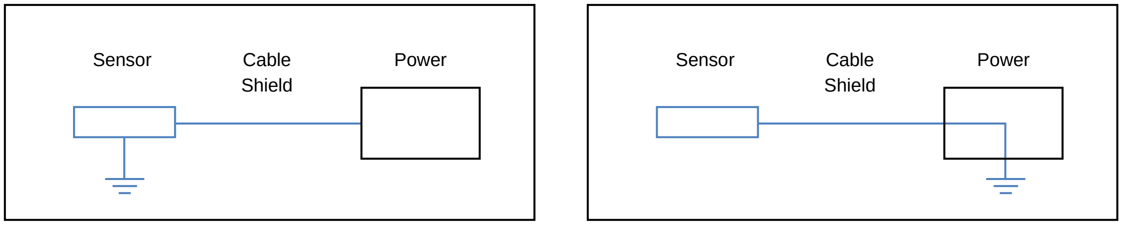
If the lens gets dirty, infrared energy will be blocked and the sensor will not measure accurately. It is good practice to always keep the lens clean. The air purge collar accessory helps keep contaminants from building up on the lens, see section 8.2.9 Air Purge , page 69. If you use air purging, make sure a filtered air supply with clean, dry air at the correct air pressure is installed before proceeding with the sensor installation.

4.3 Electrical Interference

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

- Mount the instrument as far away as possible from potential sources of electrical interference, such as motorized equipment, which can produce large step load changes.
- Use shielded wire for all input and output connections.
- 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 in the same conduit as the sensor signal wiring.
- To avoid ground loops, make sure that only ONE POINT is earth grounded, either at the instrument or at the power supply.

Figure 4-1: One Earth Ground at the Sensor (left) or at the Power Supply (right)



Note
The metal housing of the sensor is electrically connected to the shield of the sensor's cable.

Note
All inputs and outputs are electrically NOT connected to the power supply (except the alarm output for the 2-wire model).

Figure 4-2: Principle of the Galvanic Isolation for the 6-Wire Model

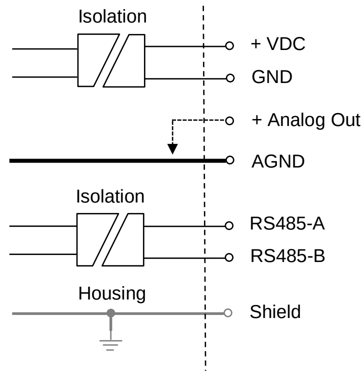
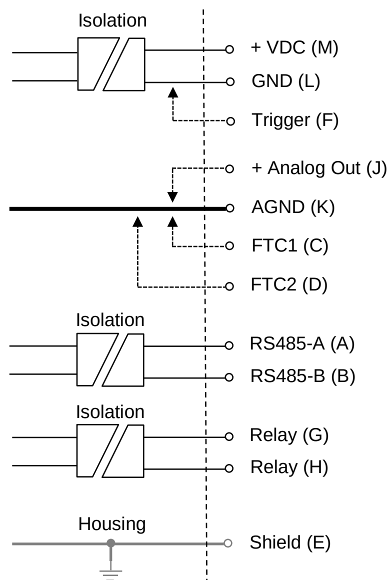


Figure 4-3: Principle of the Galvanic Isolation for the 12-Wire Model



5 Installation

Risk of Personal Injury

When this instrument is being used in a critical process that could cause property damage and personal injury, the user should provide a redundant device or system that will initiate a safe process shutdown in the event that this instrument should fail.

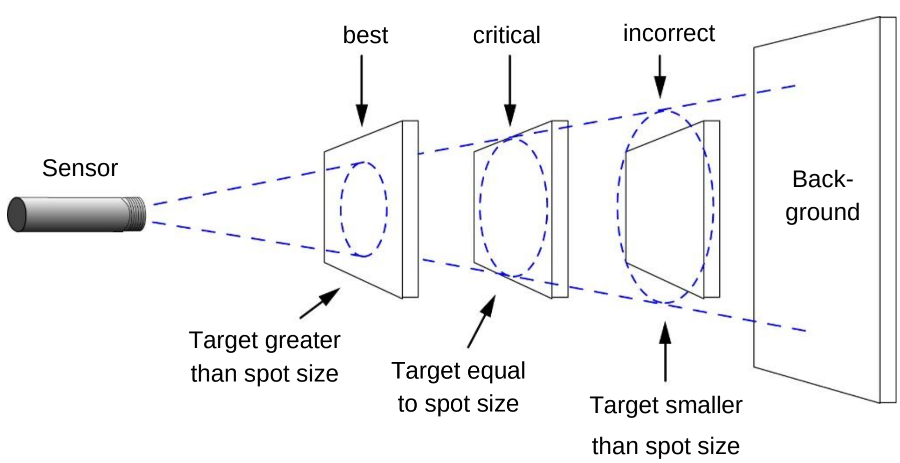
5.1 Positioning

Sensor location 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, and the possible electromagnetic interference in that location. If you plan to use air purging, you need to have an air connection available. Wiring and conduit runs must be considered, including computer wiring and connections, if used.

5.2 Distance to Object

The desired spot size on the target will determine the maximum measurement distance. To avoid erroneous readings, the target spot size must completely fill the entire field of view of the sensor. Consequently, the sensor must be positioned so the field of view is the same as or smaller than the desired target size. For a list indicating the available optics, see section 2.2 Optical Specifications, page 19.

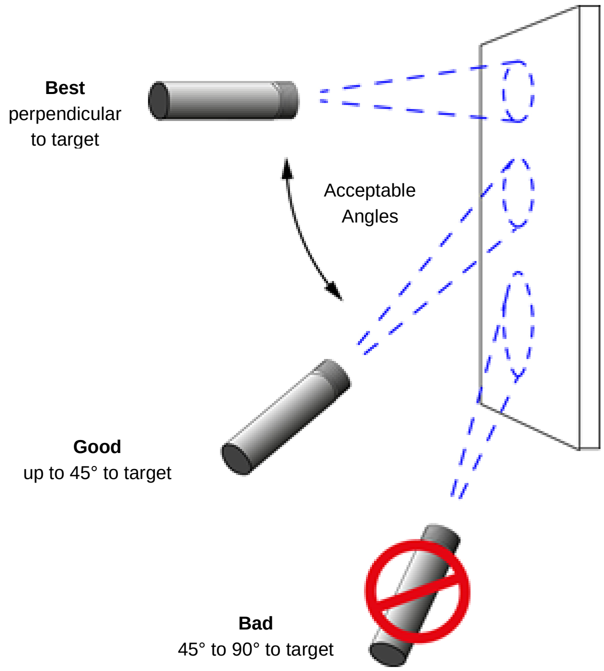
Figure 5-1: Proper Sensor Placement



5.3 Viewing Angles

The sensor head can be placed at any angle from the target less than 45°.

Figure 5-2: Acceptable Sensor Viewing Angles



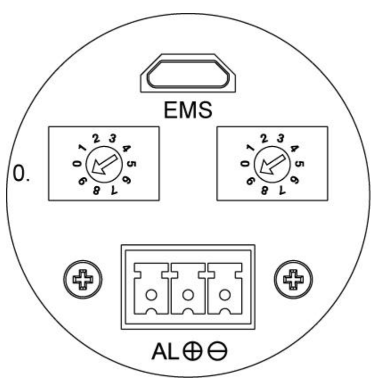
5.4 Model 2-Wire

The 2-wire model provides a standard two-wire current loop output and USB communications.

5.4.1 Back Panel

The rear panel supports a 3-pin terminal for connecting the alarm output (AL) and the 4 to 20 mA current loop. The polarity is indicated on the panel.

Figure 5-3: Rear Panel for 2-Wire Sensor



Above the terminal there are two rotary switches (EMS) for emissivity setting. Emissivity is changeable in tenths (left switch) and hundredths (right switch). The preset for the rotary switches at the factory default is 0.00, which is equivalent to an emissivity value of 1.00. The appendix lists typical emissivity values for common materials, see section 11.3 Typical Emissivity Values, page 97.

Table 5-1: Terminal Connections

Designation	Description
AL	alarm output
⊕	positive signal (4 to 20 mA) and positive power supply
⊖	negative signal (4 to 20 mA) and ground

5.4.2 Cable Connection

The sensor cable must be provided by the user.

Note

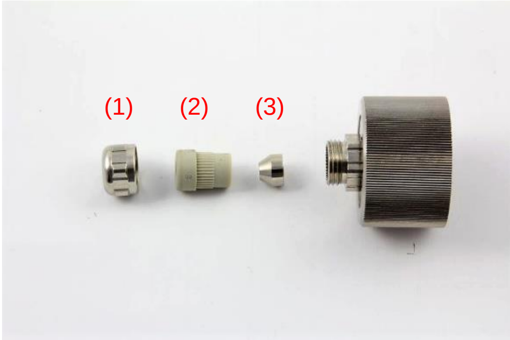
The cable must include shielded wires. The screwed cable gland described below is not a strain relief! Consequently, the cable must be clamped accordingly during the installation. The outside diameter of the connecting cables (round cable) should lie between 4 to 6.5 mm (0.16 to 0.26 in, AWG 6 to AWG 4). Note that it might be necessary to additionally seal the cable entry to allow IP65 with smaller cables!

To connect the cable to the sensor you should proceed with the following example for the 2-wire model:

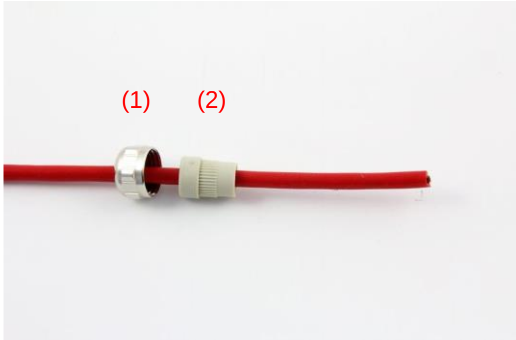
Step 1
Unscrew the end-cap until it can be pulled away from the sensor body.

Step 2
Open the PG threaded cable gland.

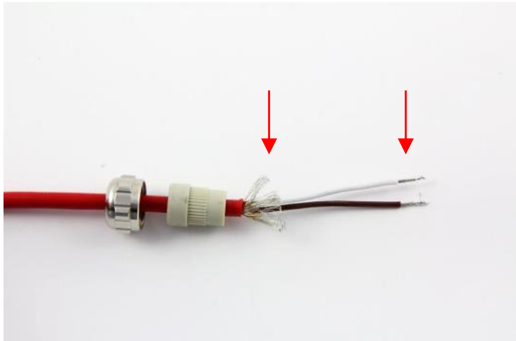
Step 3
The cable gland consists of a PG nut (1), a relief bushing (2) and a metal cone ring (3).



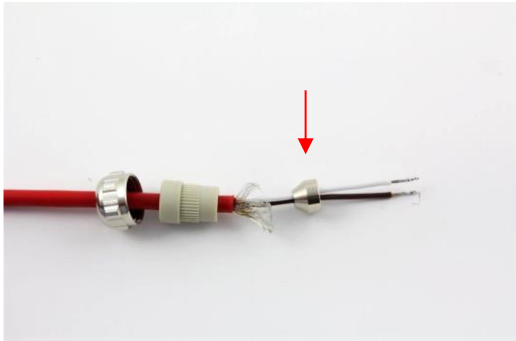
Step 4
Put the following on the cable: the PG nut (1) and the relief bushing (2).



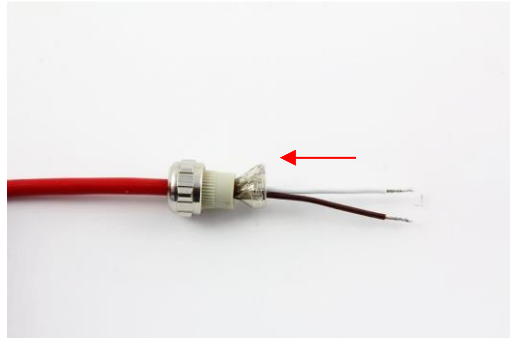
Step 5
Prepare the cable. Remove about 6 cm (2.36 in) of the insulation.
Shorten the shield to about 1 cm (0.4 in).
Tin-coat the connecting leads if not done yet.



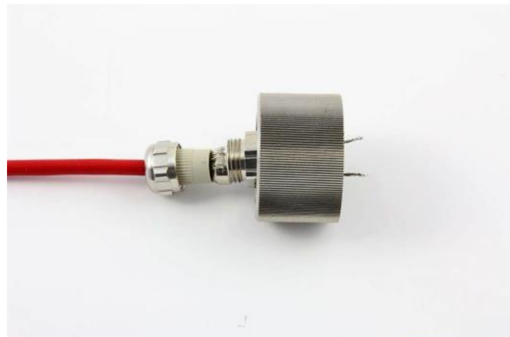
Step 6
Feed the prepared cable with the metal cone ring.



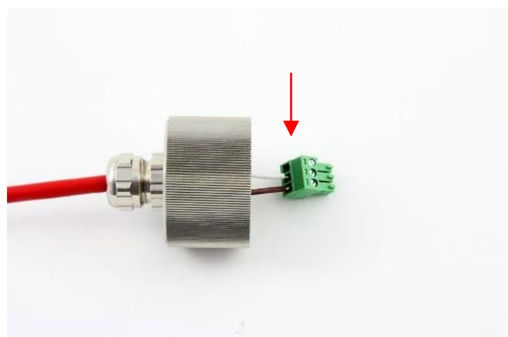
Step 7
Make sure to have a proper contact between the braided shield and the metal cone ring.



Step 8
Place the PG screwed cable gland back into the outer cap. Tighten the PG nut firmly.



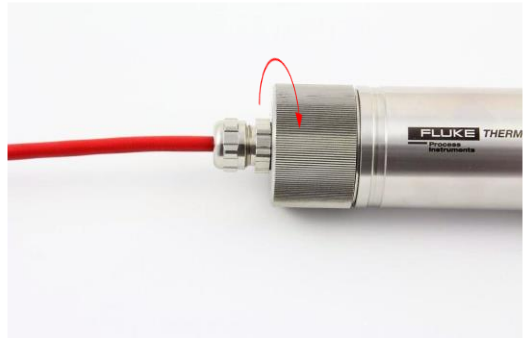
Step 9
Connect the wires to terminal connector.



Step 10
Plug the terminal connector in the unit.

Step 11
Screw the end-cap firmly onto the sensor until it is tight. Keep the cable don't revolve with the end-cap.

Important: Neither the end-cap nor the cable gland should have any play after tightening.

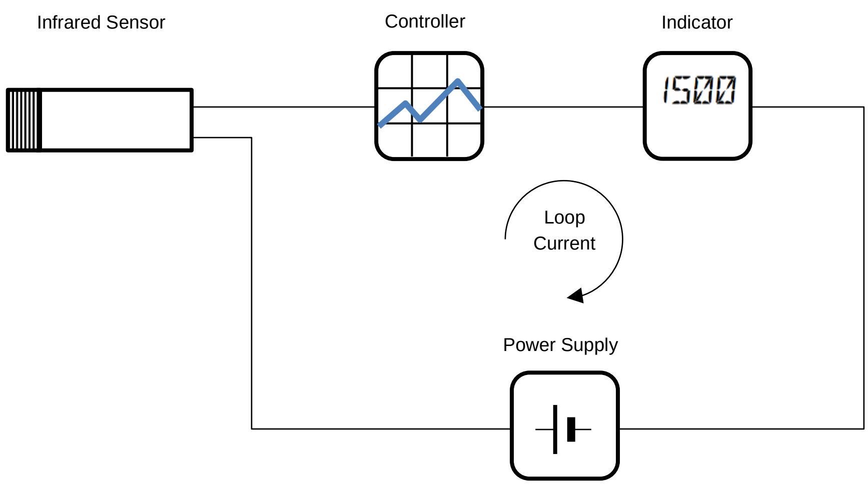


5.4.3 mA Single Loop

The 2-wire model of the Thermalert 4.0 Series is an infrared thermometer with a built-in two-wire transmitter. Power it up with an appropriate direct current source and you get a 4 to 20 mA current. The current varies with target temperature over the full temperature span of the instrument. For example, an instrument with a temperature span of 500 to 1500"C will have a 4 mA output when viewing a 500°C target. The output increases to 20 mA when viewing a 1500"C target. The output is a linear 16 mA span, from 4 to 20 mA.

You can use this current to operate a 4 to 20 mA indicator, recorder, controller or data logger – or a combination of devices in the series. The following figure illustrates a simple system consisting of the infrared sensor, a digital meter and a power supply. These components form a continuous current loop.

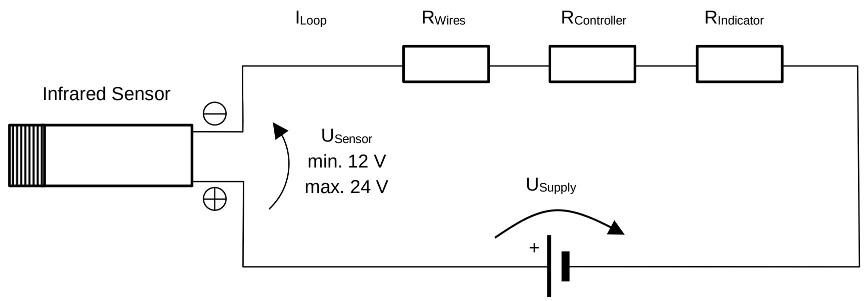
Figure 5-4: Principle Circuit Diagram: Infrared Sensor with Multiple Loads



The infrared sensor operates at any supply voltage between 12 and 24 V direct current. For indicators, recorders, and other load elements, pay strict attention to the load resistance and, of course, the zero scale and full scale currents. Part of the power supply voltage is dropped across the load and is not available for the infrared sensor.

In the following figure, a controller and an indicator are connected in a series in the loop. The 4-20 mA current determined by the infrared sensor flows through these load elements, producing voltage drops proportional to the resistance of each load element. The total load voltage is the sum of these voltage drops plus the drop across the connecting wires.

Figure 5-5: Equivalent Circuit Diagram: Infrared Sensor with Multiple Loads



Assume the resistances are as follows:

$R_{Wires} = 3\Omega$

$R_{Controller} = 90\Omega$

$R_{Indicator} = 7\Omega$

This adds up a total load resistance of:

$R_{Load} = R_{Wires} + R_{Controller} + R_{Indicator} = 3\Omega + 90\Omega + 7\Omega = 100\Omega$

With a total load voltage at 20 mA maximum current:

$U_{Load} = R_{Load} \times I_{Loop} = 100\Omega \times 0.02\text{A} = 2\text{V}$

With 2 V dropped across the load elements and cables, a supply voltage of at least 14 V is needed to ensure the required 12 V minimum for the infrared sensor:

$U_{Supply} = U_{Sensor} + U_{Load} = 12V + 2V = 14V$

Use the following table as a guide in selecting your power supply. Be sure to total up all load resistance in your loop and add cable resistance if it will have a noticeable effect on loop resistance.

Table 5-2: Power Supply Requirements for Multiple Loads

Total Load Resistance R_{Load}	Minimum Power Supply Voltage at 20 mA min. U_{Supply}	Maximum Power Supply Voltage at 4 mA max. U_{Supply}
50 Ω	13 V	26 V
100 Ω	14 V	26 V
200 Ω	16 V	26 V
300 Ω	18 V	26 V
400 Ω	20 V	26 V
500 Ω	22 V	26 V
600 Ω	24 V	26 V
700 Ω	26 V	26 V

Note
Connecting the USB cable when the power supply voltage is applied can cause a short-term fault at the mA output.

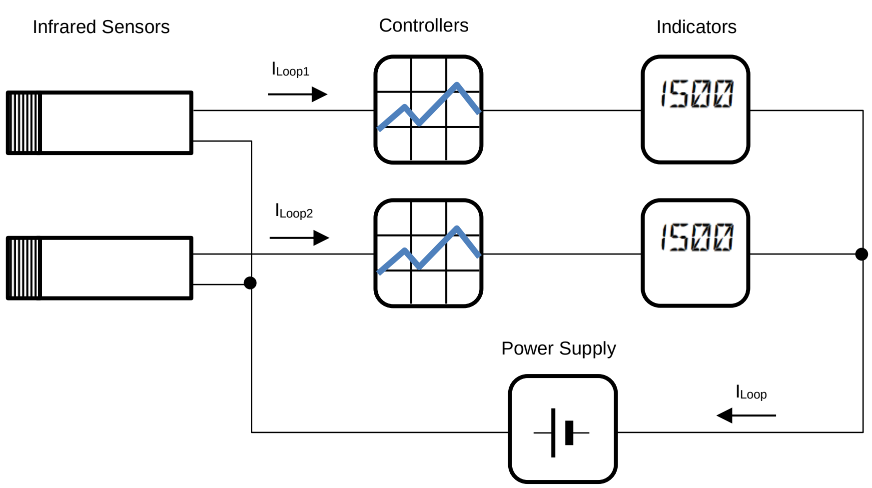
5.4.4 mA Multiple Loops

The following figure is an example of a multiple loop system. Two loops are operated from a single power supply. An arrangement of this type is suitable for measuring temperatures at two or more stations with an independent readout for each station. The advantage is the economy of a single power supply for all loops.

An important consideration in this system is the current capacity of the power supply. For example, if both loops are measuring full-scale temperature, the total supply current is calculated as follows:

$I_{Loop} = I_{Loop1} + I_{Loop2} = 20mA + 20mA = 40mA$

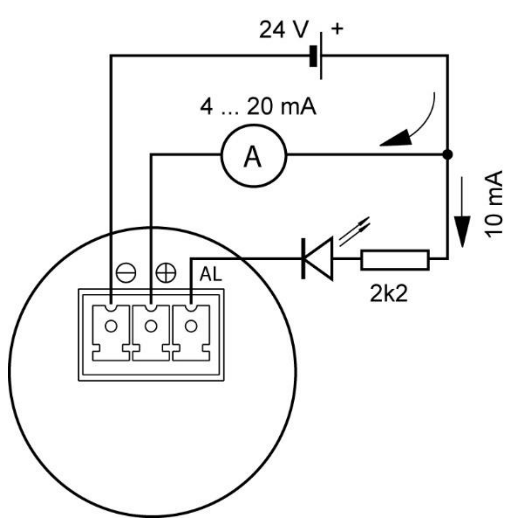
Figure 5-6: Principle Circuit Diagram: Infrared Sensor with Multiple Loads



5.4.5 Alarm Output AL

The maximum current carrying capacity for the alarm output is 150 mA. Use the circuit diagram below. The alarm output AL of the instrument is not electrically isolated from the power supply.

Figure 5-7: Exemplary Wiring the Alarm Output AL for the 2-Wire Sensor

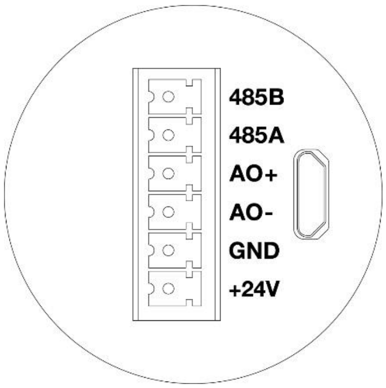


5.5 Model 6-Wire

5.5.1 Back Panel

The rear panel supports a 6-pin terminal for connecting the power supply, the analog output (AO) and RS485 communications (485). The polarity is indicated on the panel.

Figure 5-8: Rear Panel for 6-Wire Sensor



5.5.2 Cable Connection

The sensor cable must be provided by the user.

Note

The cable must include shielded wires. The screwed cable gland described below is not a strain relief! Consequently, the cable must be clamped accordingly during the installation. The outside diameter of the connecting cables (round cable) should lie between 6.5 to 9.5 mm (0.26 to 0.37 in, AWG 2 to AWG 1/0). Note that it might be necessary to additionally seal the cable entry to allow IP65 with smaller cables!

5.5.3 Terminal Strip

Table 5-3: Pin Assignment for Terminal Strip

Pin	Description
485B	RS485-B negative signal
485A	RS485-A positive signal
AO+	+ Analog Out (positive)
AO-	AGND (analog ground)
GND	GND (digital ground)
+24V	+ VDC power supply

5.5.4 Analog Out

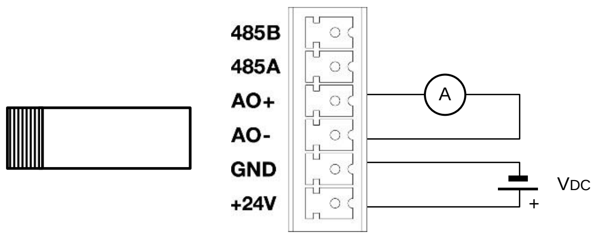
The 6-wire model of the Thermalert 4.0 Series is an infrared thermometer with a built-in analog output to drive analog devices. The output can be configured to output mA, V, or TC by means of software or a dedicated ASCII command. The output is short circuit resistant.

5.5.4.1 mA Output

The Analog Out can be set to 0-20 mA or 4-20 mA output current range. Direct connection to a recording device (e.g., chart recorder, PLC, or controller) is possible. The total analog output circuit impedance is limited to 500 Ω.

For the principle wiring, use the installation scheme below.

Figure 5-9: Wiring Analog Out as Current Output

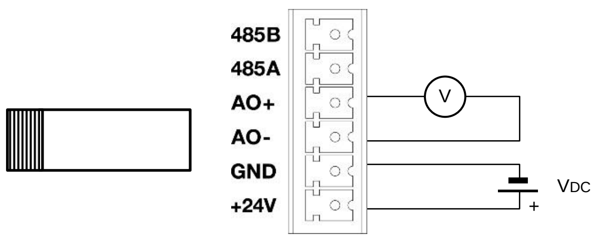


A specific feature for the testing or calibrating of connected equipment allows the current loop output to bet set to specific values, under range or over range using a dedicated ASCII command. Via such functionality, you can force the instrument, operating in the 4-20 mA mode, to transmit an output current less than 4 mA (e.g. 3.5 mA) or above 20 mA (e.g. 21.0 mA).

5.5.4.2 V Output

The Analog Out configured as voltage output covers a range between 0 to 10 V. The minimum load impedance for the voltage output must be 10 kΩ.

Figure 5-10: Wiring Analog Out as Voltage Output



5.5.4.3 TC Output

The output can be configured as thermocouple output type J or K. For a TC output, you must install a dedicated compensation cable. The output impedance is 50 Ω.

5.5.5 RS485 Communication

For detailed information on the RS485 communication see section 6 RS485, page 42.

5.6 Model 12-Wire

5.6.1 Back Panel

Figure 5-11: DIN Connector Pin Layout (pin side)

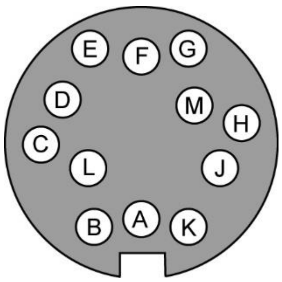


Table 5-4: Pin Assignment for DIN Connector

Pin	Description
A	RS485-A
B	RS485-B
C	FTC1 (emissivity setting)
D	FTC2 (background temperature compensation)
E	Shield
F	Trigger– with GND
G	Relay contact (alarm)
H	Relay contact (alarm)
J	+ Analog out (positive)
K	AGND (analog ground)
L	GND (digital ground)
M	+ VDC power supply

5.6.2 RS485 Communication

For detailed information on the RS485 communication, see section 6 RS485, page 42.

5.6.3 FTC1 – Emissivity Setting

The FTC1 input can be configured to accept an analog voltage signal (0 to 10 VDC) to provide real time emissivity setting. The following table shows the relationship between input voltage and emissivity:

Table 5-5: Ratio between Analog Input Voltage and Emissivity

U in V	0.0	1	…	9	10.0
Emissivity	0.1	0.2	…	1.0	1.1

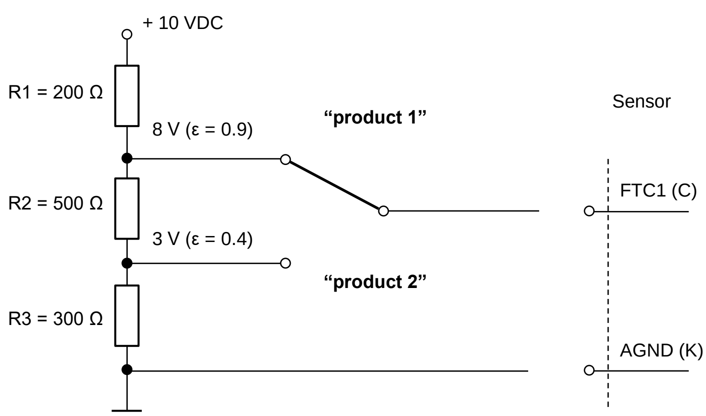
Example:

This process requires setting the emissivity:

- for product 1: 0.90
- for product 2: 0.40

Following the example below, the operator needs only to switch to position “product 1” or “product 2”.

Figure 5-12: Adjustment of Emissivity at FTC1 Input (Example)



5.6.4 FTC2 – Background Temperature Compensation

The sensor can improve the accuracy of target temperature measurements by considering the ambient or background temperature. This feature is useful when the target emissivity is below 1.0 and the background temperature is significantly hotter than the target temperature. For instance, the higher temperature of a furnace wall could lead to hotter temperatures being measured, especially for low emissivity targets.

Background temperature compensation allows for the impact of reflected radiation in accordance with the reflective behavior of the target. Due to the surface structure of the target, some amount of ambient radiation will be reflected and therefore, added to the thermal radiation collected by the sensor. The ambient background temperature compensation adjusts the result by subtracting the amount of ambient radiation measured from the sum of thermal radiation the sensor is exposed to.

Note
The ambient background temperature compensation should always be activated in case of low-emissivity targets measured in hot environments or when heat sources are near the target!

Three possibilities for ambient background temperature compensation are available:

- The **internal sensing head temperature** is utilized for compensation if the background temperature is more or less represented by the internal sensing head temperature. This is the default setting.
- If the background temperature is known and constant, the user may give the known background temperature as a **constant temperature value**.
- Background temperature compensation from a **second temperature sensor** (infrared or contact temperature sensor) ensures extremely accurate results. For example, a second infrared sensor, configured to provide a 0 to 10 Volt output scaled for the same temperature range as the first sensor can be connected to input FTC2 to provide real-time background temperature compensation.

Figure 5-13: Principle of Background Temperature Compensation

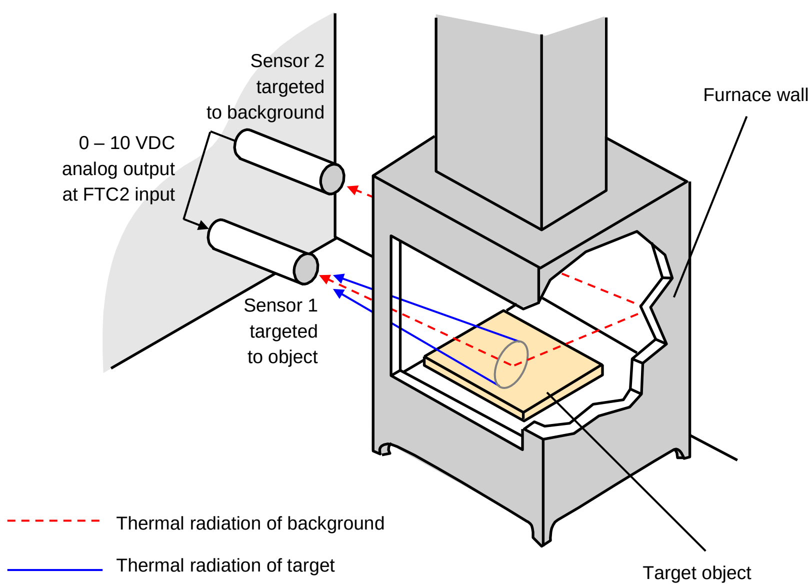
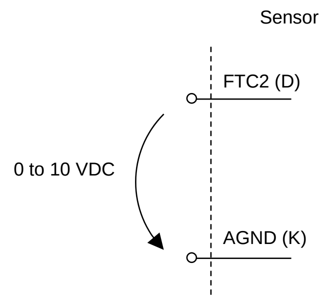


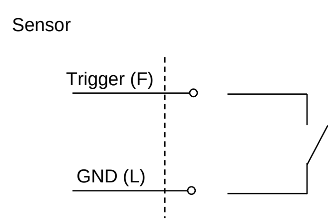
Figure 5-14: Adjustment of Background Temperature Compensation at FTC2 Input (Example)



5.6.5 Trigger Input

The trigger input can be used either as **Reset** or **Hold**, or as **Laser** switch. The trigger function is activated by shorting the external input to digital ground (pin GND). The shorting can be done with an external switch, relay, transistor, or TTL gate. The trigger function is set by means of the ASCII command XN.

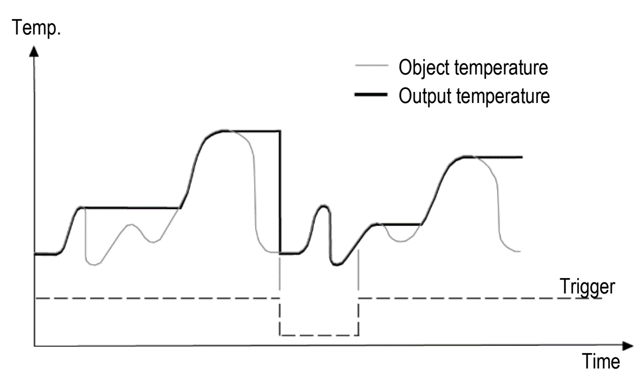
Figure 5-15: Wiring the Trigger Input



5.6.5.1 Reset

A logical low signal at the trigger input will reset the peak or valley hold function. As long as the input is kept at logical low level, the software will transfer the actual object temperatures toward the output. At the next logical high level, the hold function will be restarted.

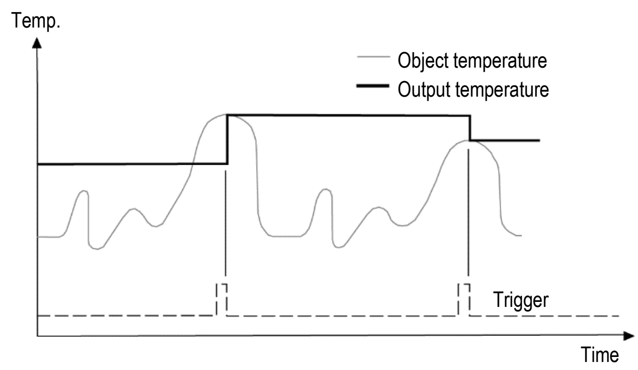
Figure 5-16: Resetting the Peak Hold Function



5.6.5.2 Hold

This mode acts as an externally generated hold function. A transition at the trigger input from logical high level toward logical low level will transfer the current temperature toward the output. This temperature will be written to the output until a new transition from high to low occurs at the trigger input.

Figure 5-17: Holding the Output Temperature



5.6.5.3 Laser

This mode acts as external triggered laser switch. A transition at the trigger input from logical high level toward logical low level will turn on or off the laser.

5.6.6 Relay Output

The relay output is used as an alarm for failsafe conditions or as a setpoint relay. The relay output can be used to indicate an alarm state or to control external actions. The relay functionality can either be set to:

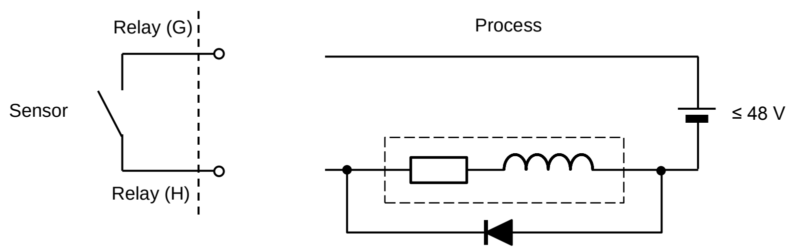
- NO (normally open), NC (normally close)
- PO (permanently open), PC (permanently close)

by the appropriate ASCII command. The relay PO and PC state can be used to detect wiring problems between the sensor and the process environment.

The alarm output can be controlled by the target object temperature or the internal case temperature of the sensor. In case of an alarm, the output switches the potential free contacts from a solid-state relay. The maximum load for this output is 48 V / 300 mA.

If a spike voltage exceeding the absolute maximum rated value is generated between the output terminals, insert a clamping diode in parallel to the inductive load as shown in the following circuit diagram to limit the spike voltage.

Figure 5-18: Spike Voltage Limitation for the Alarm Relay



5.6.7 Analog Out

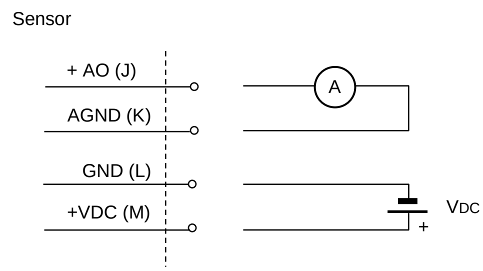
The 12-wire model of the Thermalert 4.0 Series is an infrared thermometer with a built-in analog output to drive analog devices. The output can be configured to output mA or V by means of software or a dedicated ASCII command. The output is short circuit resistant.

5.6.7.1 mA Output

The Analog Out can be set to 0-20 mA or 4-20 mA output current range. Direct connection to a recording device (e.g., chart recorder, PLC, or controller) is possible. The total analog output circuit impedance is limited to 500 Ω.

For the principle wiring, use the installation scheme below.

Figure 5-19: Wiring Analog Out as Current Output

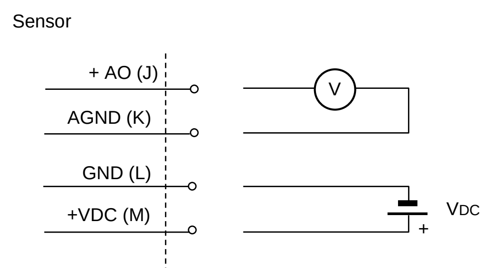


A specific feature for the testing or calibrating of connected equipment allows the current loop output to be set to specific values, under range or over range using a dedicated ASCII command. Via such functionality, you can force the instrument, operating in the 4-20 mA mode, to transmit an output current less than 4 mA (e.g., 3.5 mA) or above 20 mA (e.g., 21.0 mA).

5.6.7.2 V Output

The Analog Out configured as voltage output covers a range between 0 to 10 V. The minimum load impedance for the voltage output must be 10 kΩ.

Figure 5-20: Wiring Analog Out as Voltage Output



6 RS485

The RS485 serial interface is used for networked sensors or for long distances up to 1200 m (4000 ft). 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.

To connect the RS485 interface to a standard computer you should use a dedicated converter, see section 8.1.7 USB/RS485 Converter, page 58. The RS485 interface allows communication either via the standard Software or directly via dedicated ASCII commands, see section 10 Programming Guide, page 77.

6.1 Specification

Technical Data for Thermalert 4.0 Sensor:

Physical layer:	RS485, 2-wire, half-duplex, electrically isolated
Baud rate:	4800, 9600, 19200, 38400, 57600, 115200 Bit/s
Settings:	8 data bits, 1 stop bit, no parity, no flow control
Address range:	1 to 32 0 for stand-alone unit or broadcast transmission

6.2 Installation

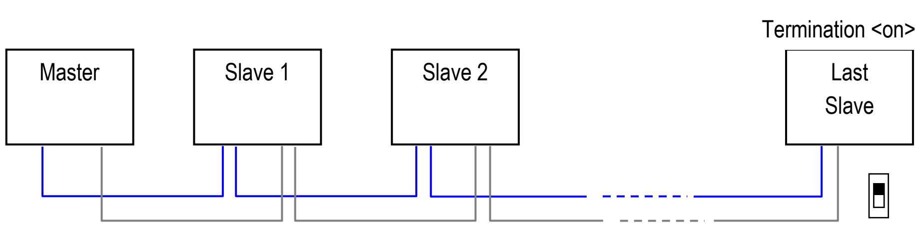
Note
A simultaneous communication via USB and fieldbus (e.g., RS485) is not allowed!

Note
Each slave in the network must have a unique nonzero address and must run at the same baud rate!

The recommended way to add more instruments into a network is connecting each instrument in series to the next in a linear topology (daisy chain). Use only one power supply for all instruments in the network to avoid ground loops!

Note
It is strongly recommended to use shielded and pair twisted cables (e.g. CAT.5)!!

Figure 6-1: Network in Linear Topology (daisy chain)

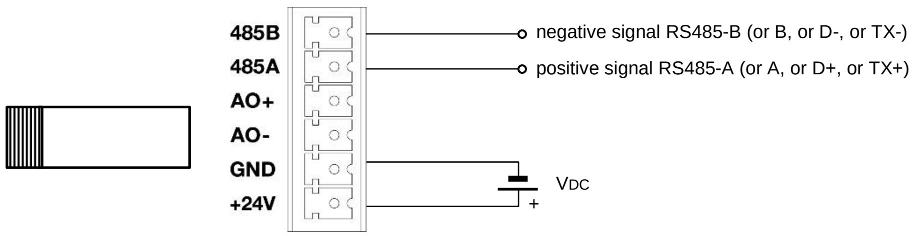


For implementing the termination, you must activate the sensor internal shunt resistor (120 Ω) for the physically last unit in the network. For doing so, use the accompanying software or the <TR> command via the serial communication (TR1 for termination “on”, TR0 for termination “off”).

6.3 Wiring

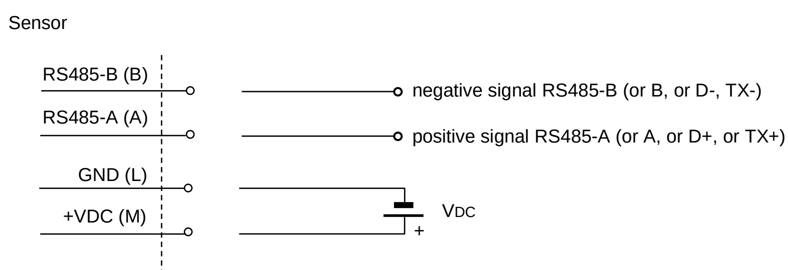
6.3.1 Model 6-Wire

Figure 6-2: Wiring RS485 Communication for 6-Wire Model



6.3.2 Model 12-Wire

Figure 6-3: Wiring RS485 Communication for 12-Wire Model



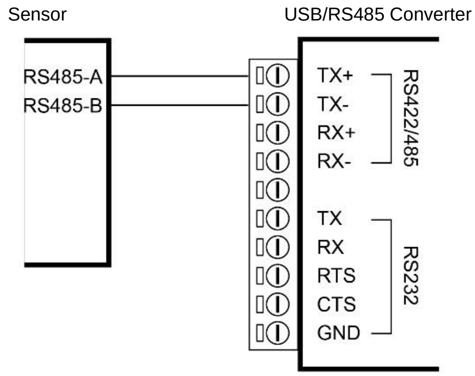
6.3.3 Computer Interfacing

The USB/RS485 Interface Converter (A-CONV-USB485) allows you to connect your sensor to computers by using a USB interface.

With auto configuration, the converter can 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.

Note
In serial RS485 communication, the Thermalert 4.0 sensors support the 2-wire / half duplex mode only!

Figure 6-4: Wiring the Sensor's RS485 Interface with USB/RS485 Converter in 2-Wire Mode



6.3.4 Multiple Sensors

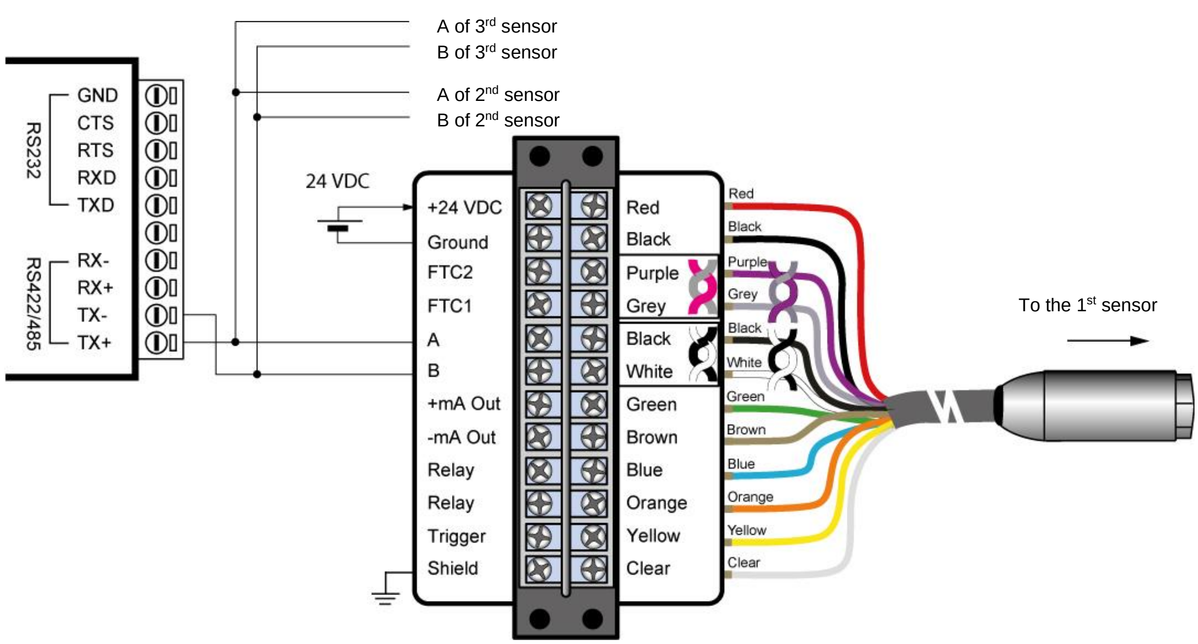
For an installation of two or more Thermalert 4.0 sensors in a RS485 network (2-wire, half duplex), each sensor needs its specific RS485 network address (1 - 32). Once all the units are addressed, wire up the units in the 2-wire multidrop manner, whereas all A and B signals must be connected to common lines. The common A signals must be routed to the TX+ and the common B signals to TX- terminal at the USB/RS485 converter given below.

Addressing

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 (1 - 32).
- Each sensor must be set to the same baud rate (default is 9.6 kBaud).
- Once all the units are addressed, wire up the units in the 2-wire multidrop manner, keeping all A & B to be common.
- Now you can run the supplied software, as well as written communication software or an individual terminal program to access the sensor for issuing commands and receive the responses.

Figure 6-5: Wiring the Multiple Sensors via RS485 Interface with USB/RS485 Converter in 2-Wire Mode

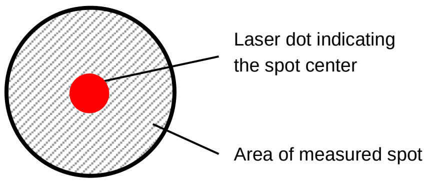


7 Operation

7.1 Laser

The laser sighting allows fast and precise aiming at small, rapidly moving targets, or targets passing at irregular intervals. The laser is specially aligned with the sensor's lens to provide accurate, non-parallax pinpointing of targets. The laser comes as a small, bright red spot indicating the center of the area being measured.

Figure 7-1: Laser Indication



The laser is a Class II type laser with an output power less than 1 mW, and an output wavelength of 650 nm.

Note

To preserve laser longevity, the laser automatically turns off after approximately 10 minutes of constant use!

Risk of Personal Injury

Avoid exposure to laser light! Eye damage can result.
Use extreme caution when operating!
Never look direct into the laser beam!
Never point directly at another person!

The laser automatically turns off above an internal case temperature of 50°C (122°F).

The laser is not available for the LT-07, LT-15, LTB-30, and P3 models.

2-wire devices require an additional power supply via USB. For this purpose, the end cap must be removed so that the device loses its IP65 ingress protection.

7.2 Post Processing

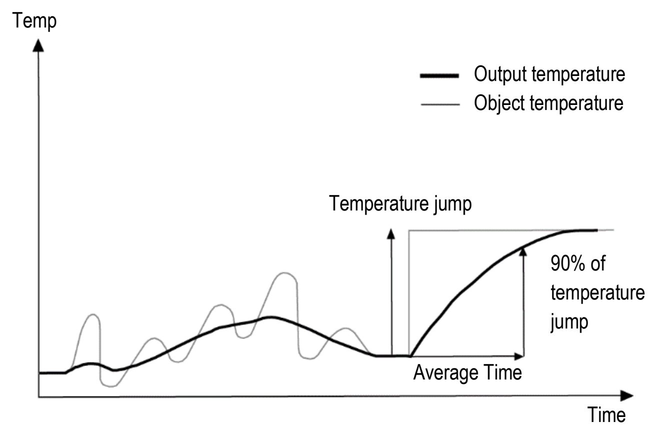
7.2.1 Averaging

Averaging is used to smooth the output signal. The signal is smoothed depending on the defined time basis. The output signal tracks the detector signal with significant time delay but noise and short peaks are damped. Use a longer average time for more accurate damping behavior. The average time is the amount of time the output signal needs to reach 90% magnitude of an object temperature jump.

Note

The disadvantage of averaging is the time delay of the output signal. If the temperature jumps at the input (hot object), the output signal reaches only 90% magnitude of the actual object temperature after the defined average time.

Figure 7-2: Averaging

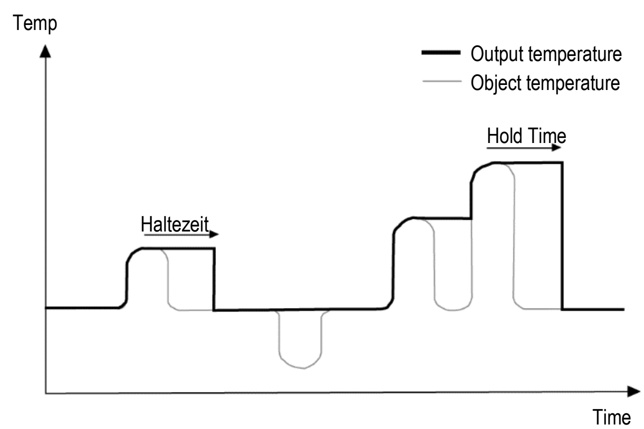


A low-level input (GND) at external trigger input will promptly interrupt the averaging and start the calculation again. For sensors without an external trigger input (2- and 6-wire models) the dedicated ASCII command should be used.

7.2.2 Peak Hold

The output signal follows the object temperature until a maximum is reached. The output will „hold“ the maximum value for the selected duration of the hold time. Once the hold time is exceeded, the peak hold function will reset and the output will resume tracking the object temperature until a new peak is reached. The range for the hold time is 0.1 to 998.9 s.

Figure 7-3: Peak Hold



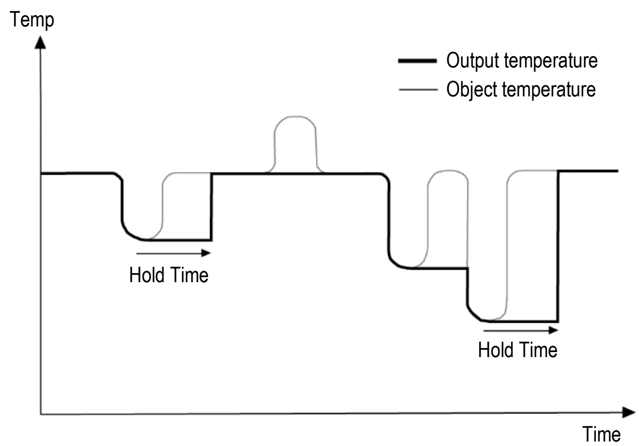
A defined hold time of 999 s will put the device into continuous peak detection mode.

A low-level input (GND) at trigger input will promptly interrupt the hold time and will start the maximum detection again. For sensors without an external trigger input (2- and 6-wire models) the dedicated ASCII command should be used.

7.2.3 Valley Hold

The output signal follows the object temperature until a minimum is reached. The output will „hold“ the minimum value for the selected duration of the hold time. Once the hold time is exceeded, the valley hold function will reset and the output will resume tracking the object temperature until a new valley is reached. The range for the hold time is 0.1 to 998.9 s

Figure 7-4: Valley Hold



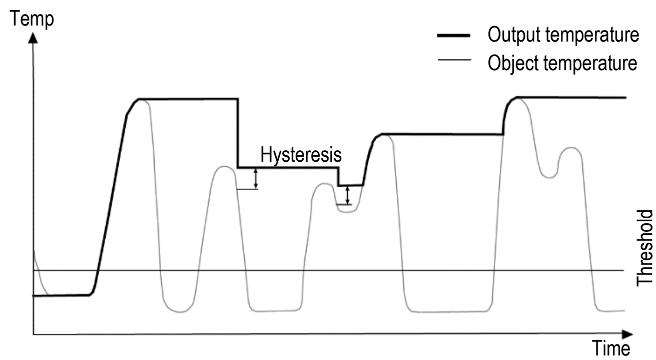
A defined hold time of 999 s will put the device into continuous valley detection mode.

A low-level input (GND) at trigger input will promptly interrupt the hold time and will start the minimum detection again. For sensors without an external trigger input (2- and 6-wire models), the dedicated ASCII command should be used.

7.2.4 Advanced Peak Hold

This function searches the sensor signal for a local maximum (peak) and writes this value to the output until a new local maximum is found. Before the algorithm restarts its search for a local maximum, the object temperature must drop below a predefined threshold. If the object temperature rises above the held value, which has been written to the output so far, the output signal follows the object temperature again. If the algorithm detects a local maximum while the object temperature is currently below the predefined threshold, the output signal jumps to the new maximum temperature of this local maximum. Once the actual temperature has passed a maximum above a certain magnitude, a new local maximum is found. This magnitude is called hysteresis.

Figure 7-5: Advanced Peak Hold



The advanced peak hold function is only adjustable by means of the PC Software.

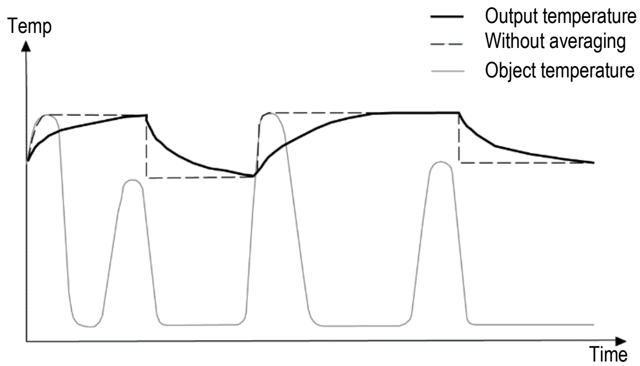
7.2.5 Advanced Valley Hold

This function works like the advanced peak hold function, except that it will search the signal for a local minimum.

7.2.6 Advanced Peak Hold with Averaging

The output signal delivered by the advanced peak hold functions tends to jump up and down. This is due to the fact that only maximum points of the otherwise homogenous trace will be shown. The user may combine the functionality of the peak hold function with the averaging function by choosing an average time, thus smoothing the output signal for convenient tracing.

Figure 7-6: Advanced Peak Hold with Averaging



The advanced peak hold function with averaging is only adjustable by means of the PC Software.

7.2.7 Advanced Valley Hold with Averaging

This function works like the advanced peak hold function with averaging, except it will search the signal for a local minimum.

8 Accessories

8.1 Electrical Accessories

The following electrical accessories are available:

- High Temp Cable 12-Wire (A-CB-HT-M16-W12-xx)
- Low Temp Cable 12-Wire (A-CB-LT-M16-W12-xx)
- Terminal Block (A-T40-TB)
- Terminal Block with Enclosure (A-T40-TB-ENC)
- Power Supply DIN Rail (A-PS-DIN-24V)
- Power Supply with Terminal Box (A-PS-ENC-24V)
- USB/RS485 Converter (A-CONV-USB485)

8.1.1 High Temp Cable 12-Wire (A-CB-HT-M16-W12-xx)

For wiring the 12-wire model for the Thermalert 4.0 sensor, use the 12-wire cable to support power supply, all inputs, outputs, and the RS485 interface. The cable described below is a shielded 12-conductor cable, made of two twisted pairs plus 8 separate wires, equipped with a M16 DIN connector on one side and wire sleeves at the counter side. The high temp cable is Teflon coated and withstands ambient temperatures up to 200°C (392°F). Teflon coated 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.

Figure 8-1: High Temp Cable (12-Wire)

Table 8-6: Available Cable Lengths

P/N	Description
A-CBHT-M16W12-04	12-Wire Cable, High Temp (200°C / 392°F), 4 m (13 ft)
A-CBHT-M16W12-08	12-Wire Cable, High Temp (200°C / 392°F), 8 m (26 ft)
A-CBHT-M16W12-15	12-Wire Cable, High Temp (200°C / 392°F), 15 m (49 ft)
A-CBHT-M16W12-30	12-Wire Cable, High Temp (200°C / 392°F), 30 m (98 ft)
A-CBHT-M16W12-60	12-Wire Cable, High Temp (200°C / 392°F), 60 m (197 ft)

Technical data:

Temperature:	UL-rated at -80 to 200°C (-112°F to 392°F)
Cable material	Teflon
Cable diameter:	7 mm (0.275 in) nominal
Conductors:	
Power supply	2 wires (black/red)
Conductor:	0.3 mm² (AWG 22), tinned copper
Isolation:	FEP 0.15 mm wall (0.006 in)
Shield:	none
RS485 interface	1 twisted pair (red/black)
Conductor:	0.22 mm² (AWG 24), tinned copper
Isolation:	FEP 0.15 mm wall (0.006 in)
Shield:	Aluminized Mylar with drain wire
FTC1/FTC2 inputs	1 twisted pair (purple/gray)
Conductor:	0.22 mm² (AWG 24), tinned copper
Isolation:	FEP 0.15 mm wall (0.006 in)
Shield:	Aluminized Mylar with drain wire
Outputs and Ground	6 wires (green/brown/blue/orange/yellow/clear)
Conductor:	0.22 mm² (AWG 24), tinned copper
Isolation:	FEP 0.15 mm wall (0.006 in)
Shield:	none

Risk of Personal Injury
Teflon develops poisonous gasses when it is exposed to flames!

Note
An ordered cable does ***not*** *include a terminal block!*

Note
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.

Note
If you purchase your own cable, use wire with the same specifications as herein mentioned. Maximum RS485 cable length is 1.200 m (4000 ft). Power supply feed in distance to the Thermalert 4.0 sensor should not extend the 60 m (200 ft) limit.

8.1.2 Low Temp Cable 12-Wire (A-CB-LT-M16-W12-xx)

For wiring the 12-wire model for the Thermalert 4.0 sensor, use the 12-wire cable to support power supply, all inputs, outputs, and the RS485 interface. The cable described below is a shielded 12-conductor cable, made of two twisted pairs plus 8 separate wires, equipped with a M16 DIN connector on one side and wire sleeves at the counter side. The cable is PUR (Polyurethane) coated and withstands ambient temperatures up to 105°C (221°F). PUR coated cables are flexible and have good to excellent resistance to against oil, bases, and acids.

Figure 8-2: Low Temp Cable (12-Wire)

Table 8-7: Available Cable Lengths

P/N	Description
A-CBLT-M16W12-04	12-Wire Cable, Low Temp (105°C / 221°F), 4 m (13 ft)
A-CBLT-M16W12-08	12-Wire Cable, Low Temp (105°C / 221°F), 8 m (26 ft)
A-CBLT-M16W12-15	12-Wire Cable, Low Temp (105°C / 221°F), 15 m (49 ft)
A-CBLT-M16W12-30	12-Wire Cable, Low Temp (105°C / 221°F), 30 m (98 ft)
A-CBLT-M16W12-60	12-Wire Cable, Low Temp (105°C / 221°F), 60 m (197 ft)

Technical data:

Temperature:	-40 to 105°C (-40 to 221°F)
Cable material	PUR- 11Y (Polyurethane), Halogen free, Silicone free
Cable diameter:	7.2 mm (0.283 in) nominal
Conductors:	
Power supply	2 wires (black/red)
Conductor:	0.2 mm² (AWG 24), tinned copper
Isolation:	PE- 2YI1
Shield:	none
RS485 interface	1 twisted pair (red/black)
Conductor:	0.2 mm² (AWG 24), tinned copper
Isolation:	PE- 2YI1
Shield:	CDV-15, 85% covered
FTC1/FTC2 inputs	1 twisted pair (purple/gray)
Conductor:	0.2 mm² (AWG 24), tinned copper
Isolation:	PE- 2YI1
Shield:	CDV-15, 85% covered

Outputs and Ground	6 wires (green/brown/blue/orange/yellow/clear)
Conductor:	0.2 mm^2 (AWG 24), tinned copper
Isolation:	PE- 2YI1
Shield:	none

Risk of Personal Injury

Polyurethane (Isocyanate) may cause allergy and possibly cancer!

Note

*An ordered cable does **not** include a terminal block!*

Note

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.

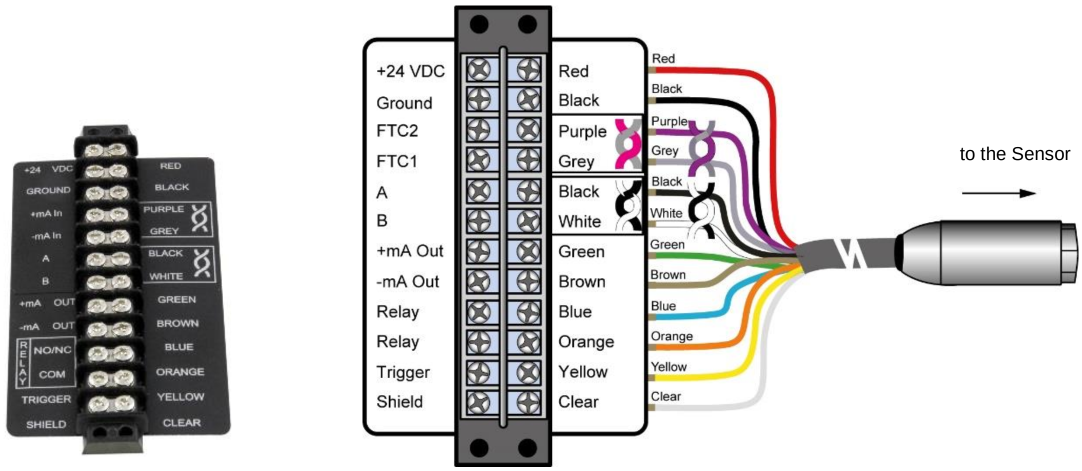
Note

If you purchase your own cable, use wire with the same specifications as herein mentioned. Maximum RS485 cable length is 1.200 m (4000 ft). Power supply feed in distance to the Thermalert 4.0 sensor should not extend the 60 m (200 ft) limit.

8.1.3 Terminal Block (A-T40-TB)

The terminal block accessory is for the connection of the Thermalert 4.0 sensor to the customer's industrial environment. It lists all different conductor colors on one side and the related signal names on the other side.

Figure 8-3: Terminal Block with Wire Color Assignment

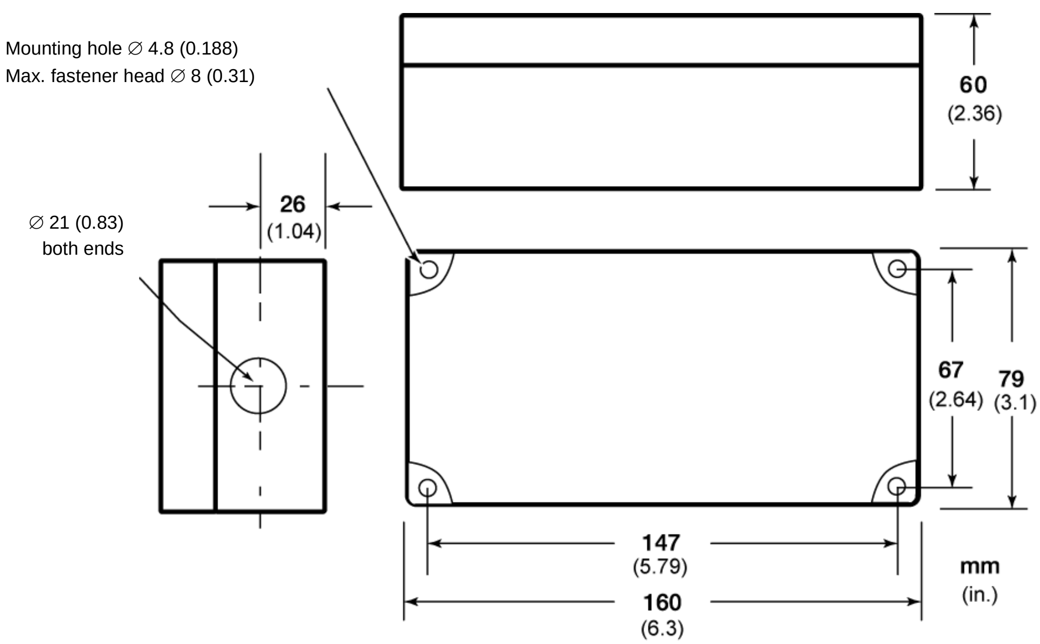


8.1.4 Terminal Block with Enclosure (A-T40-TB-ENC)

The terminal block accessory in an enclosure is for the connection of the Thermalert 4.0 sensor to the customer's industrial environment. The enclosure is IP67 (NEMA 4) protected, and the terminal block inside is identical to part A-T40-TB.

Figure 8-4: Terminal Block in an Enclosure

Figure 8-5: Dimensions of Enclosure



8.1.5 Power Supply DIN Rail (A-PS-DIN-24V)

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

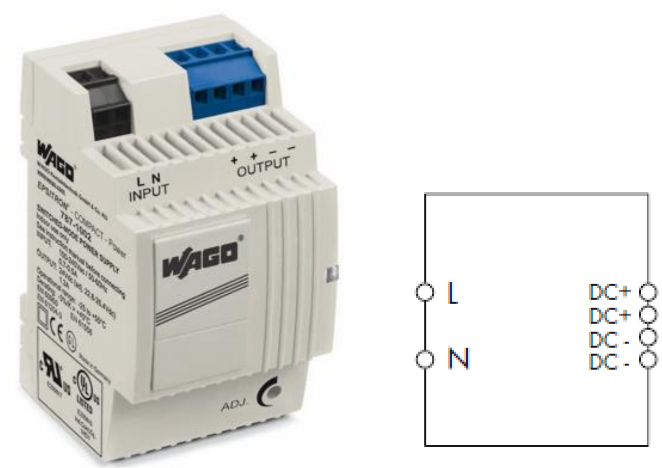
Risk of Personal Injury

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)

Figure 8-6: Industrial Power Supply



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[6] Copyright Wago®

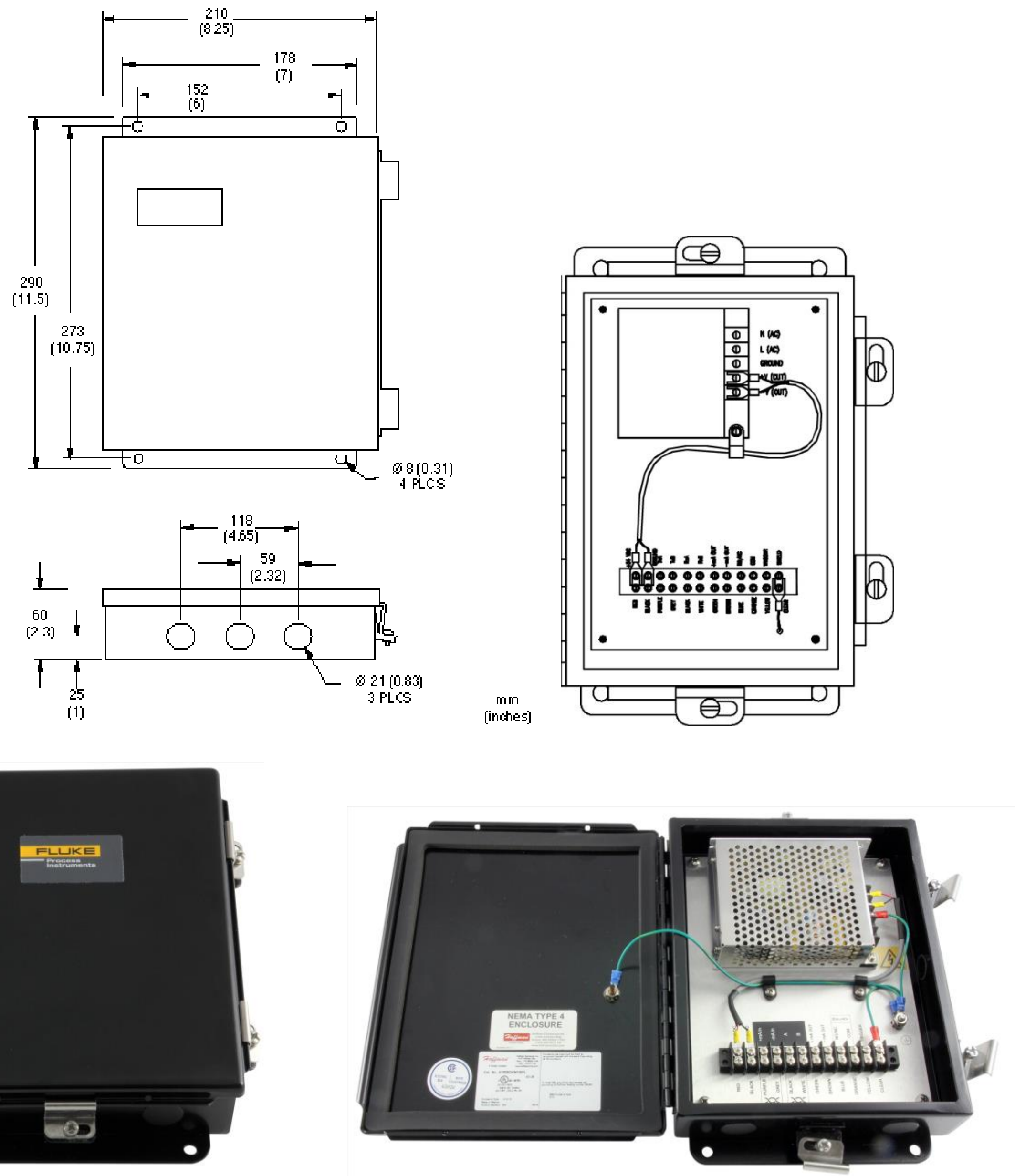
8.1.6 Power Supply with Terminal Box (A-PS-ENC-24V)

The terminal box for the power supply is designed to provide IP65 (NEMA-4) protection to the terminal block, see section 8.1.3 Terminal Block, page 54, and a power supply for the sensor. The terminal box should be surface mounted using the flanges and holes provided. It should be mounted in such a manner to allow the free flow of air around the unit. Ambient temperatures for the terminal box should be kept within the range of 0 to 50°C (32 to 120°F), and humidity between 20 to 90%, non-condensing.

Technical data for the power supply:

AC input	100 – 240 VAC 50/60 Hz
DC output	24 VDC / 1.1 A

Figure 8-7: Power Supply with Terminal Box



8.1.7 USB/RS485 Converter (A-CONV-USB485)

The USB/RS485 converter allows you to connect your Thermalert 4.0 sensor to computers by using an USB interface.

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) (Thermalert 4.0 sensor supports 2-wire only)
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 8-8: USB/RS485 Converter

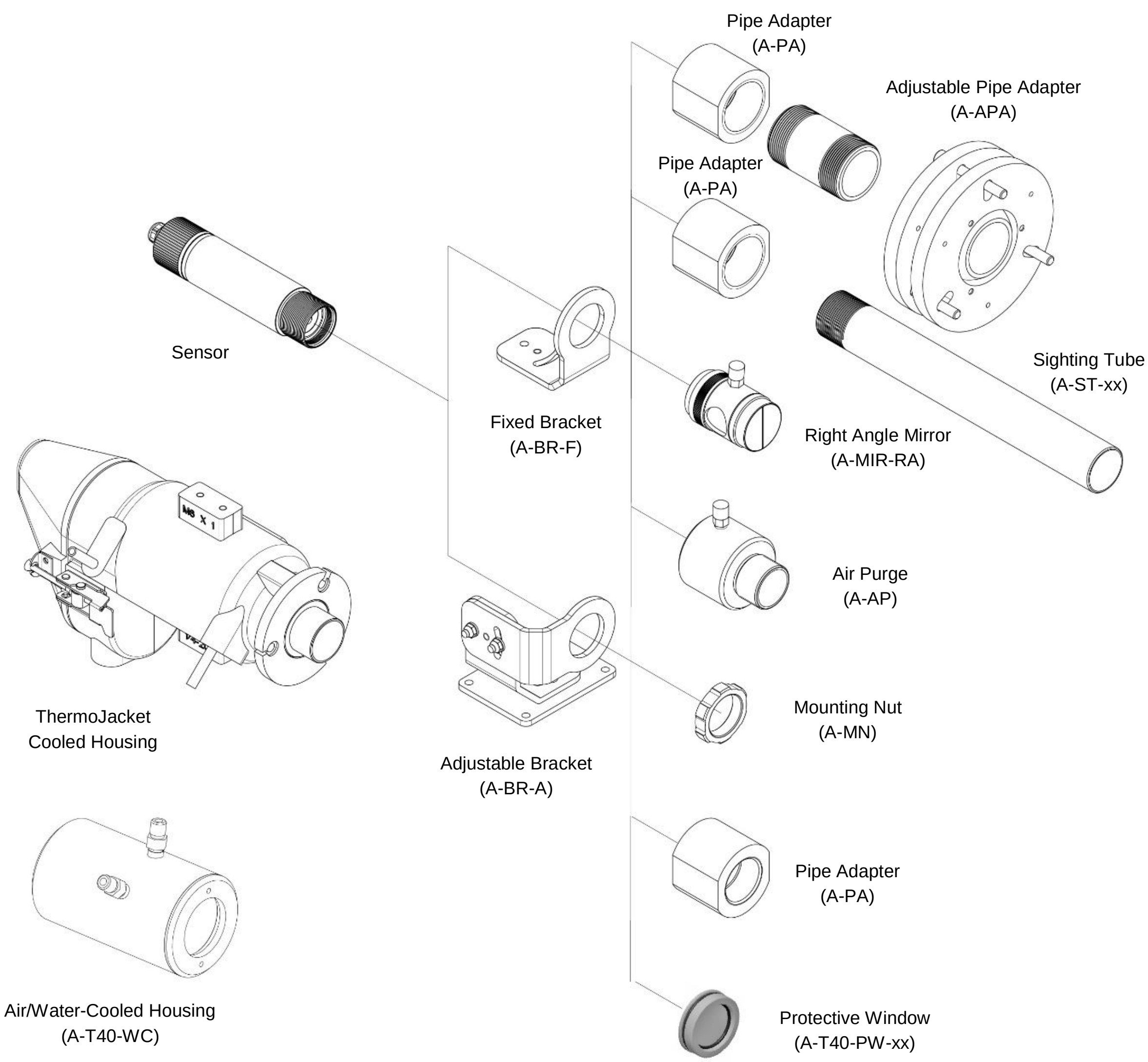
For more information, see section 6.3.3 Computer Interfacing, page 43.

8.2 Mechanical Accessories

The following mechanical accessories are available:

- Mounting Nut (A-MN)
- Fixed Bracket (A-BR-F)
- Adjustable Bracket (A-BR-A)
- Swivel Bracket (A-BR-S)
- Sighting Tube (A-ST-xx)
- Pipe Adapter (A-PA)
- Protective Windows (A-T40-PW-xx)
- Right Angle Mirror (A-MIR-RA)
- Air Purge (A-AP)
- Air/Water-Cooled Housing (A-T40-WC)
- Air/Water-Cooled Housing with Air Purge (A-T40-WCAP)
- Thread Adapter (A-TA-M56)
- Mounting Flange (A-MF-MOD)

Figure 8-9: Overview to Mechanical Accessories



8.2.1 Mounting Nut (A-MN)

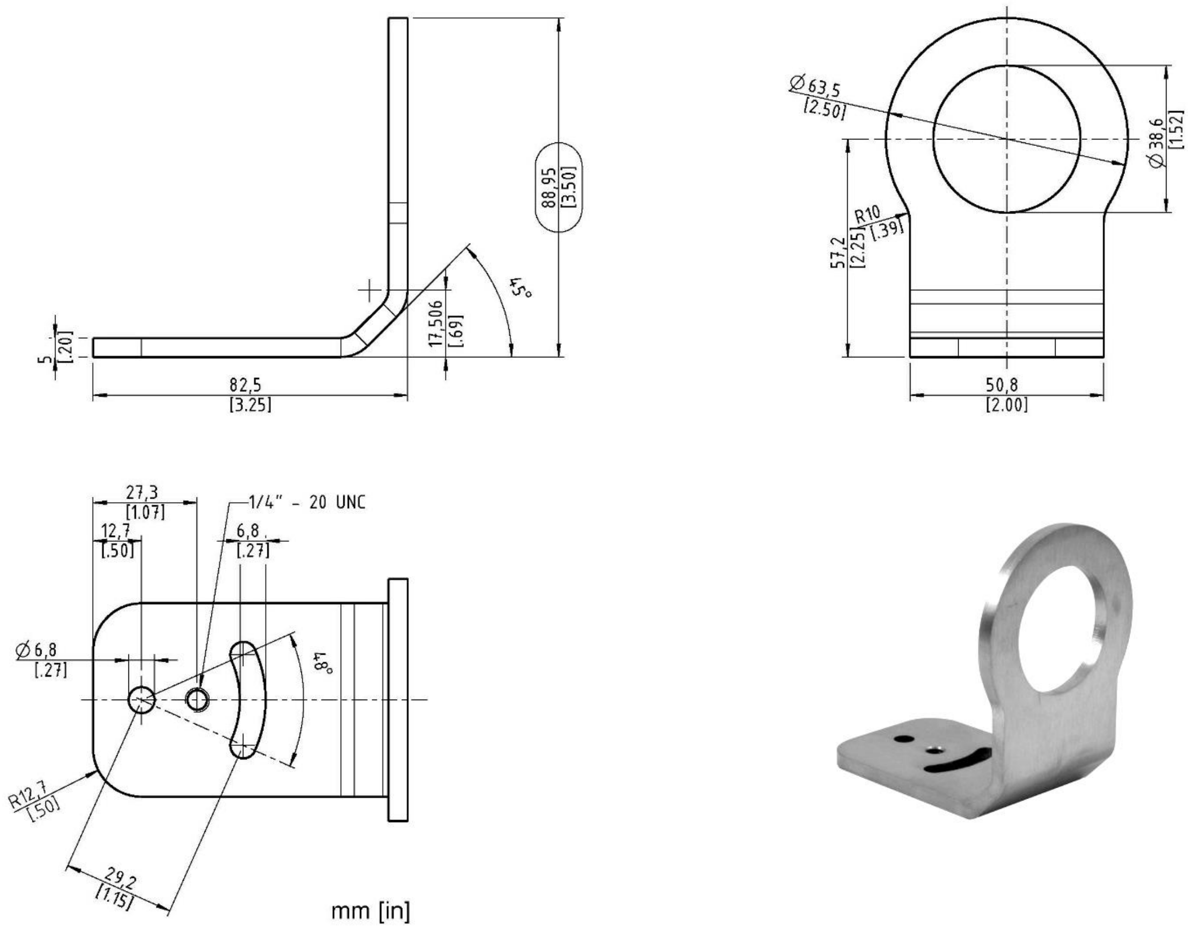
See below for the standard mounting nut with an inner thread of 1.5" UNC to fix and secure the Thermalert 4.0 sensor to any kind of mounting brackets.

Figure 8-10: Mounting Nut

8.2.2 Fixed Bracket (A-BR-F)

The fixed bracket enables the Thermalert 4.0 sensor to be mounted in a fixed location. For a correct horizontal sensor orientation, a swivel range within 45° is available.

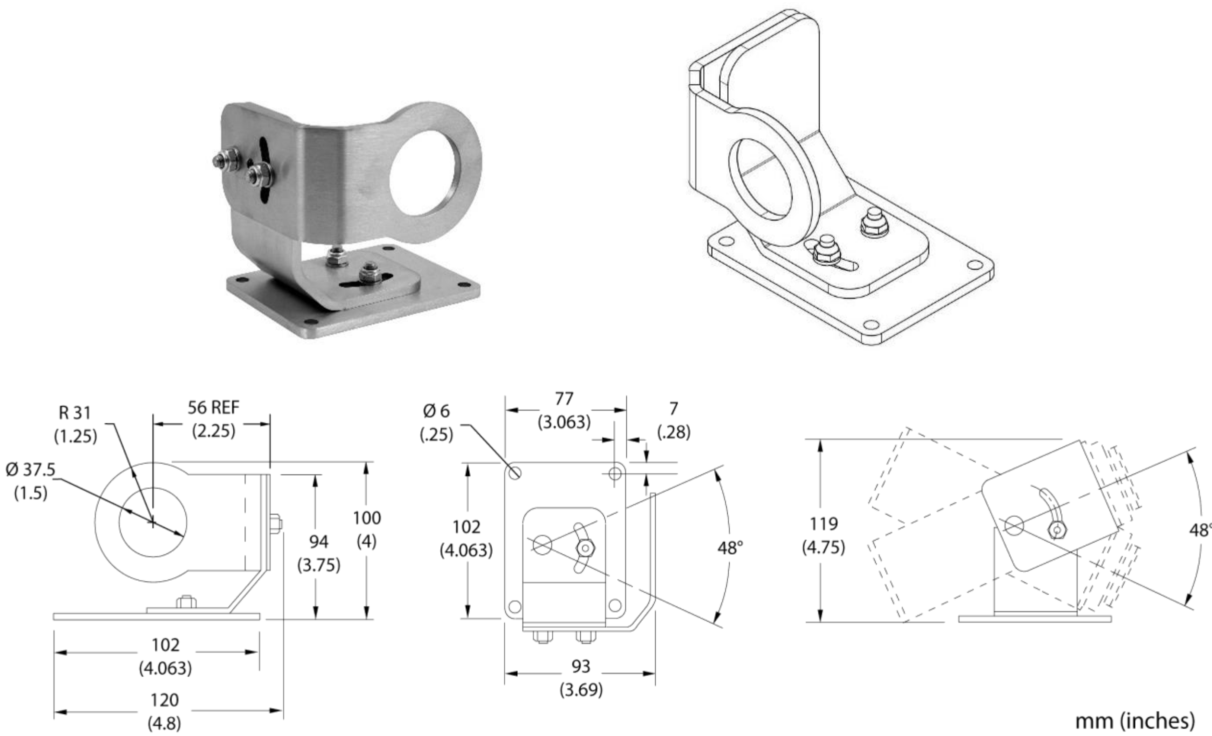
Figure 8-11: Fixed Bracket



8.2.3 Adjustable Bracket (A-BR-A)

The adjustable bracket enables the Thermalert 4.0 sensor to be mounted in a movable location. For a correct sensor orientation, you can pitch and swivel the sensor sighting axis in a range of about 45° per axis.

Figure 8-12: Adjustable Bracket



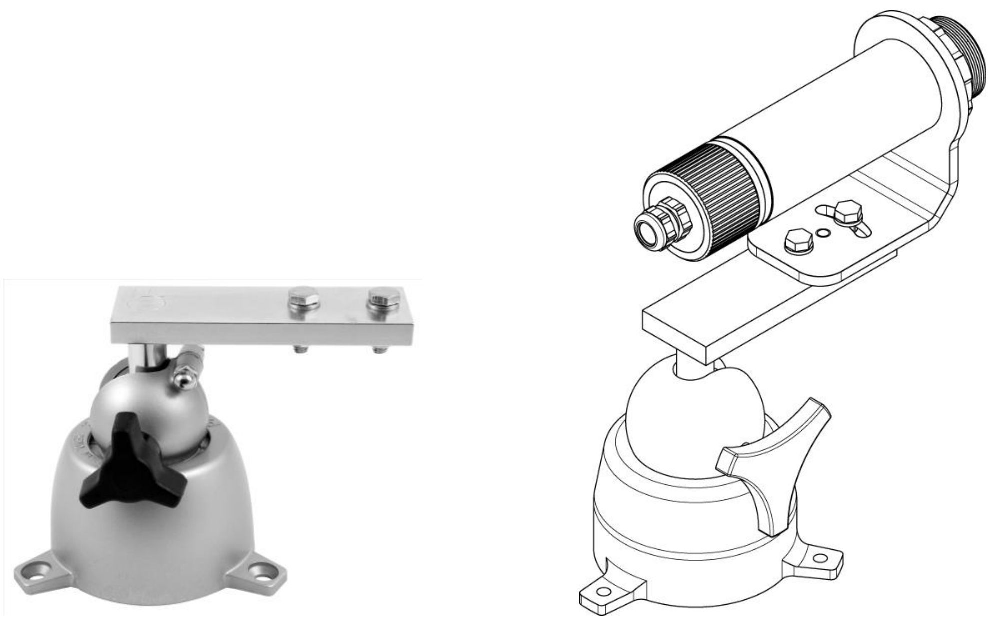
8.2.4 Swivel Bracket (A-BR-S)

The swivel bracket enables the Thermalert 4.0 sensor to be mounted in a movable position, to correct in an easy way the pitch and yaw orientation of the sensor. For a correct sensor orientation, you are able to pitch (0° – 90°) and to swivel (0° - 360°) the sensor-sighting axis. The base has a single control knob and a split-ball lock, to hold the specific head mount firmly in place.

Technical Data:

Circle diameter for three countersunk bolts:	109.5 mm (4.3 in)
Countersunk bolts:	6.3 mm (1/4") flat-head screws (not included)
Height (without instrument):	120 mm (4.7 in)
Weight (without instrument):	1.07 kg (2.4 lb)

Figure 8-13: Swivel Bracket



8.2.5 Sighting Tube (A-ST-xx)

The sighting tube is used in environmental conditions where reflected energy is a problem. Fix the pipe adapter (A-PA) directly to the sensor and screw the sighting tube into the pipe adapter.

Figure 8-14: Installation of the Sighting Tube

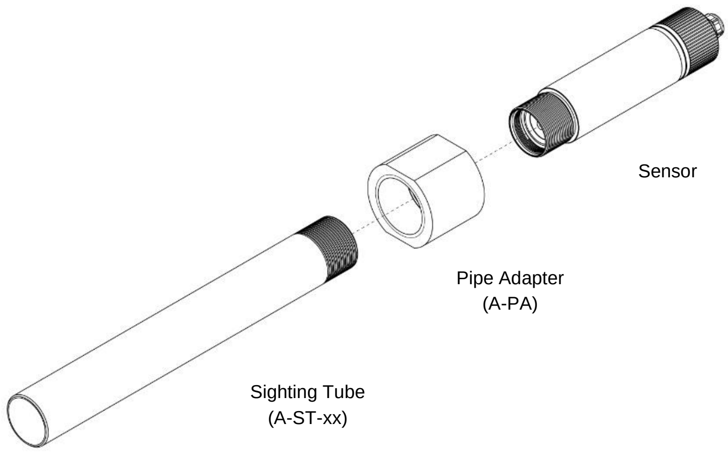
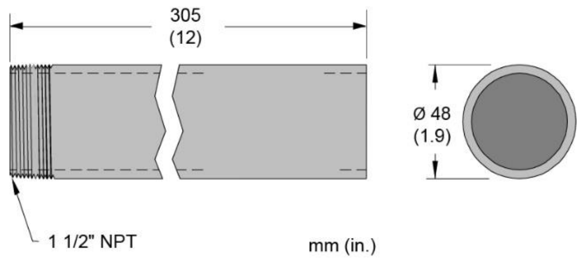


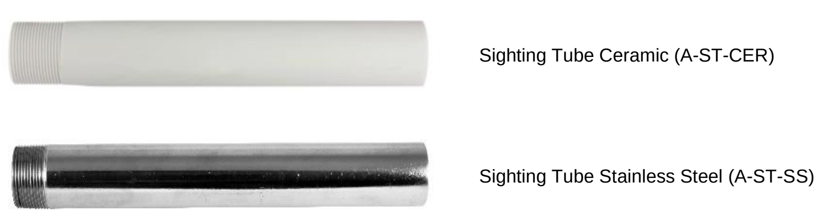
Figure 8-15: Dimensions for the Sighting Tube



Available sighting tubes:

- Sighting tube made of ceramic (A-ST-CER), resistible up to 1500°C (2732°F)
- Sighting tube made of stainless steel (A-ST-SS), resistible up to 800°C (1472°F)
- Sighting tube made of carbon steel (A-ST-CS-45), resistible up to 800°C (1472°F), with 45° cut and condensate outlet

Figure 8-16: Available Sighting Tubes



Sighting Tube Carbon Steel (A-ST-CS-45)

Note

When using a customer supplied sighting tube, use caution in specifying the inside diameter and length. Your sensing head determines what diameter/length combinations are possible without impeding the optical field of view!

For this reason, the Thermalert 4.0 sensors LT-07 and LT-15 cannot be combined with the above sighting tubes in its standard length of 300 mm (12 in). Shorten the sighting tube if needed to ensure that the sensor's spot diameter is half of the inside diameter of the tube (or less) everywhere along the tube length.

8.2.6 Pipe Adapter (A-PA)

The pipe adapter is used to adapt the sighting tube (A-ST-xx) to the Thermalert 4.0 sensor, see section 8.2.5 Sighting Tube, page 64. The adapter has two inner threads to adapt the outer thread of the instrument (1.5" UNC) to the outer thread of the sighting tube (1.5" NPT).

Figure 8-17: Pipe Adapter

8.2.7 Protective Windows (A-T40-PW-xx)

Protective windows can be used to protect the sensor's optics against dust and other contamination.

Figure 8-18: Protective Window

The following table provides an overview of the available protective windows recommended for the spectral models. All protective windows have a transmission below 100%.

Table 8-8: Protective Windows

Part number	Designation	Material	For model	Transmissivity	Transmissibility for Laser
A-T40-PW-LT	none (stainless steel)	Zinc Sulfide	**LT-30-SF0** **LTB-30-SF0** **LT-50-SF0** **LT-70-SF2**	0.62 ±0.05	yes
			LT-07-CF0 LT-15-SF0 LT-30-CF1 LT-30-CF2 LTB-30-CF1 LTB-30-CF2 LT-50-CF2 LT-70-CF2	0.71 ±0.05	yes
A-T40-PW-PF	none (stainless steel)	Polyethylene foil for food applications, non-poisonous, non-fragile	LT-30-SF0 LT-50-SF0 LT-70-SF2	0.67 ±0.05	no
			LT-07CF0 LT-15-SF0 LT-30-CF1 LT-30-CF2 LT-50-CF2 LT-70-CF2	0.75 ±0.05	no
A-T40-PW-MTP3	4 red dots	Sapphire	MT-30-SF0 MT-70-SF2 P3-20-SF4	0.7 ±0.05	yes
			MT-30-CF1 MT-30-CF2 MT-70-CF1 MT-70-CF2	0.77 ±0.05	yes
A-T40-PW-HT	3 red dots	Glass	HT-60	0.89 ±0.05	yes
A-T40-PW-G5G7P7	2 red dots	Calcium Fluoride	G5-30 G5-70 G7-70 P7-30	0.81 ±0.05	yes

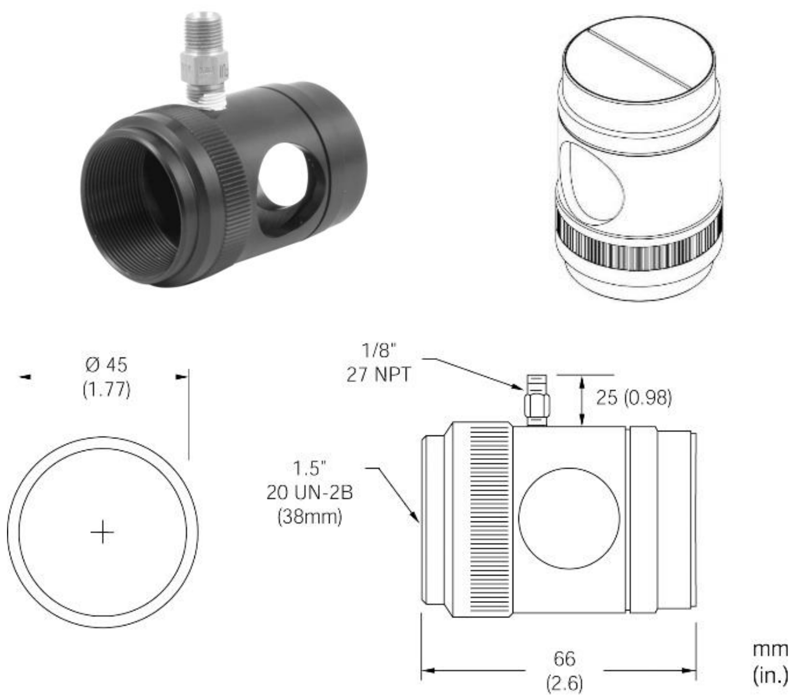
Note

To avoid erroneous readings, ensure that the transmission for the appropriate protective window must be set in the sensor via software.

8.2.8 Right Angle Mirror (A-MIR-RA)

The right angle mirror is to redirect the measured object temperature spot at an angle of 90°. This allows placing the Thermalert 4.0 sensor closer to the object to measure or in a more protected domain. To keep the inserted mirror dust and dirt clean, the right angle mirror has an air-purge adapter and needs to be supplied by air.

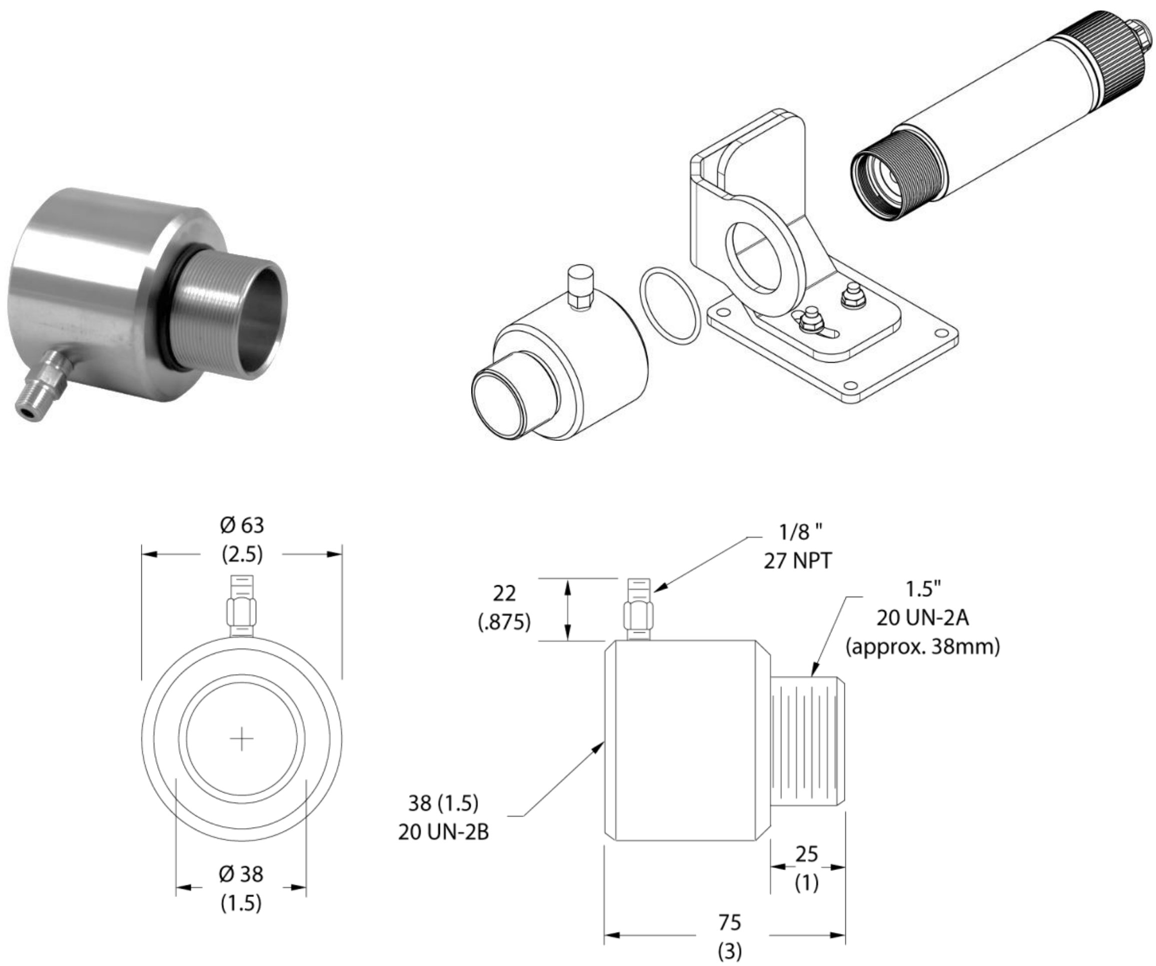
Figure 8-19: Right Angle Mirror



8.2.9 Air Purge (A-AP)

The air purge is used to keep dust, moisture, airborne particles, and vapors away from the lens. It can be mounted before or after the bracket. It must be screwed in fully. Air flows into the 1/8” NPT fitting and out the front aperture. Airflow should be a maximum of 0.5 to 1.5 l/s (0.13 to 0.4 gallons/s). 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).

Figure 8-20: Air Purge



8.2.10 Air/Water-Cooled Housing (A-T40-WC)

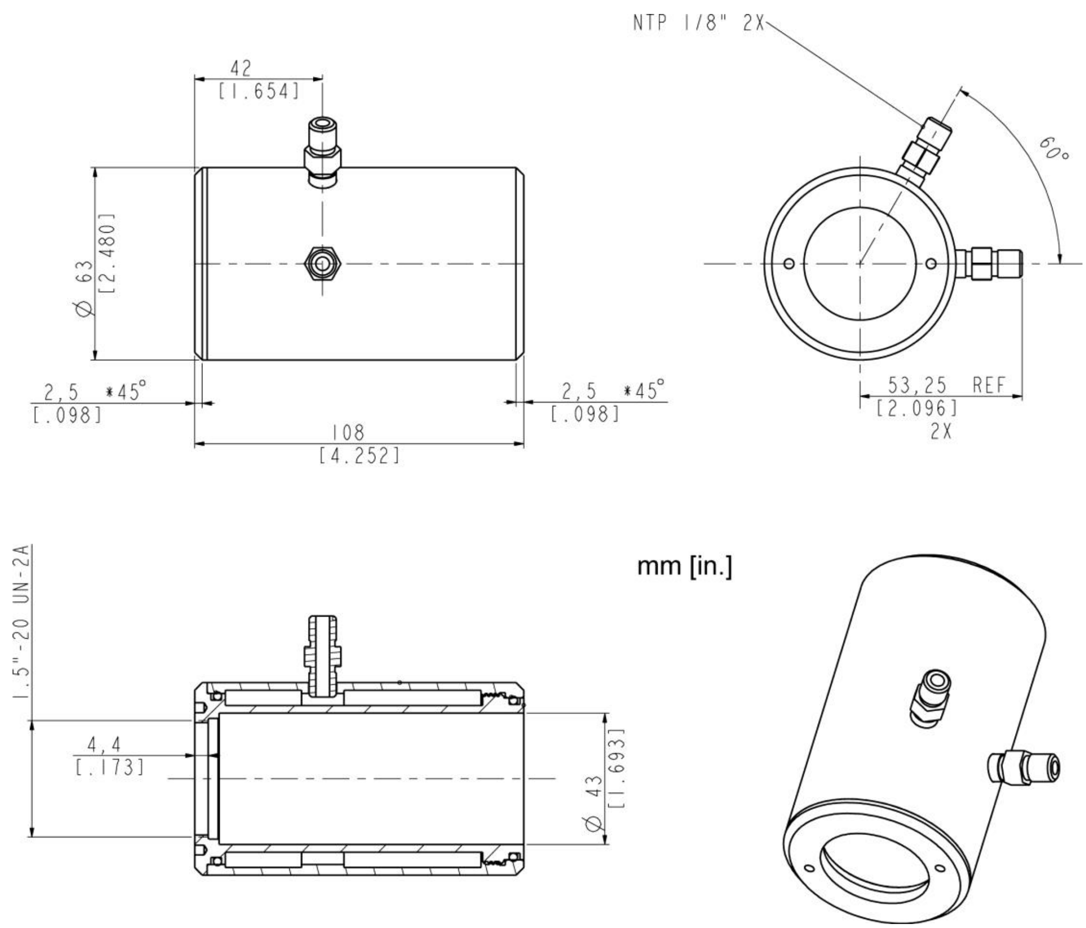
The air/water-cooled housing allows the sensor to be used in ambient temperatures up to 120°C (250°F) with air cooling, and 180°C (356°F) with water cooling. The cooling media should be connected using 1/8" NPT fittings requiring 6 mm (0.24 in) inner diameter and 8 mm (0.31 in) outer diameter for the tube. Airflow should be 1.4 to 2.5 l/s (0.37 to 0.66 gallons/s) at an air temperature of 25°C (77°F). Water flow should be approximately 1.0 to 2.0 l/min (0.26 to 0.52 gallons/min) at a water temperature between 10 and 27°C (50 to 80.6°F). Chilled water below 10°C (50°F) is not recommended.

The Air/Water-Cooled Housing is made from stainless steel. To keep the lens dry the Air/Water-Cooled Housing should be always used with air purge, see section 8.2.9 Air Purge (A-AP), page 69.

Note

For ambient temperatures exceeding 175°C (350°F), the ThermoJacket can be used. This accessory allows operation at ambient temperatures up to 315°C (600°F)!

Figure 8-21: Air/Water-Cooled Housing



8.2.10.1 Avoidance of Condensation

If environmental conditions make water cooling necessary, it is strictly recommended to check whether condensation will be a real problem or not. Water-cooling also causes a cooling of the air in the inner part of the sensor, thereby decreasing the capability of the air to hold water. The relative humidity increases and can reach 100% very quickly. In case of a further cooling, the surplus water vapor will condense out as water. The water will condense on the lenses and the electronics, resulting in possible damage to the sensor. Condensation can even happen on an IP65 sealed housing.

Note
There is no warranty repair possible in case of condensation within the housing!

To avoid condensation, the temperature of the cooling media and the flow rate must be selected to ensure a minimum device temperature. The minimum sensor temperature depends on the ambient temperature and the relative humidity. Please consider the following table.

Table 8-9: Minimum device temperatures [°C/°F]

Relative Humidity [%]

Ambient Temperature [°C/°F]

	10	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**
0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32
5/ 41	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	5/ 41
10/ 50	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	5/ 41	5/ 41	5/ 41	5/ 41	5/ 41	10/ 50
15/ 59	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	5/ 41	5/ 41	5/ 41	5/ 41	10/ 50	10/ 50	10/ 50	10/ 50	10/ 50	15/ 59
20/ 68	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	0/ 32	5/ 41	5/ 41	5/ 41	10/ 50	10/ 50	10/ 50	10/ 50	15/ 59	15/ 59	15/ 59	15/ 59	15/ 59	20/ 68
25/ 77	0/ 32	0/ 32	0/ 32	0/ 32	5/ 41	5/ 41	10/ 50	10/ 50	10/ 50	10/ 50	15/ 59	15/ 59	15/ 59	20/ 68	20/ 68	20/ 68	20/ 68	20/ 68	25/ 77
30/ 86	0/ 32	0/ 32	0/ 32	5/ 41	5/ 41	10/ 50	10/ 50	15/ 59	15/ 59	15/ 59	20/ 68	20/ 68	20/ 68	20/ 68	25/ 77	25/ 77	25/ 77	25/ 77	30/ 86
35/ 95	0/ 32	0/ 32	5/ 41	10/ 50	10/ 50	15/ 59	15/ 59	20/ 68	20/ 68	20/ 68	25/ 77	25/ 77	25/ 77	25/ 77	30/ 86	30/ 86	30/ 86	30/ 86	35/ 95
40/ 104	0/ 32	5/ 41	10/ 50	10/ 50	15/ 59	20/ 68	20/ 68	20/ 68	25/ 77	25/ 77	25/ 77	30/ 86	30/ 86	30/ 86	35/ 95	35/ 95	35/ 95	35/ 95	40/ 104
45/ 113	0/ 32	10/ 50	15/ 59	15/ 59	20/ 68	25/ 77	25/ 77	25/ 77	30/ 86	30/ 86	35/ 95	35/ 95	35/ 95	35/ 95	40/ 104	40/ 104	40/ 104	40/ 104	45/ 113
50/ 122	5/ 41	10/ 50	15/ 59	20/ 68	25/ 77	25/ 77	**30**/ 86	30/ 86	35/ 95	35/ 95	35/ 95	40/ 104	40/ 104	40/ 104	45/ 113	45/ 113	45/ 113	45/ 113	50/ 122
60/ 140	15/ 59	20/ 68	25/ 77	30/ 86	30/ 86	35/ 95	40/ 104	40/ 104	40/ 104	45/ 113	45/ 113	50/ 122	50/ 122	50/ 122	50/ 122	50/ 122	50/ 122	50/ 122	60/ 140
70/ 158	20/ 68	25/ 77	35/ 95	35/ 95	40/ 104	45/ 113	45/ 113	50/ 122	50/ 122	50/ 122	50/ 122	50/ 122	60/ 140	60/ 140	60/ 140	60/ 140	60/ 140	60/ 140	
80/ 176	25/ 77	35/ 95	40/ 104	45/ 113	50/ 122	50/ 122	50/ 122	60/ 140	60/ 140	60/ 140	60/ 140	60/ 140							
90/ 194	35/ 95	40/ 104	50/ 122	50/ 122	50/ 122	60/ 140	60/ 140	60/ 140											
100/ 212	40/ 104	50/ 122	50/ 122	60/ 140	60/ 140														

Example:

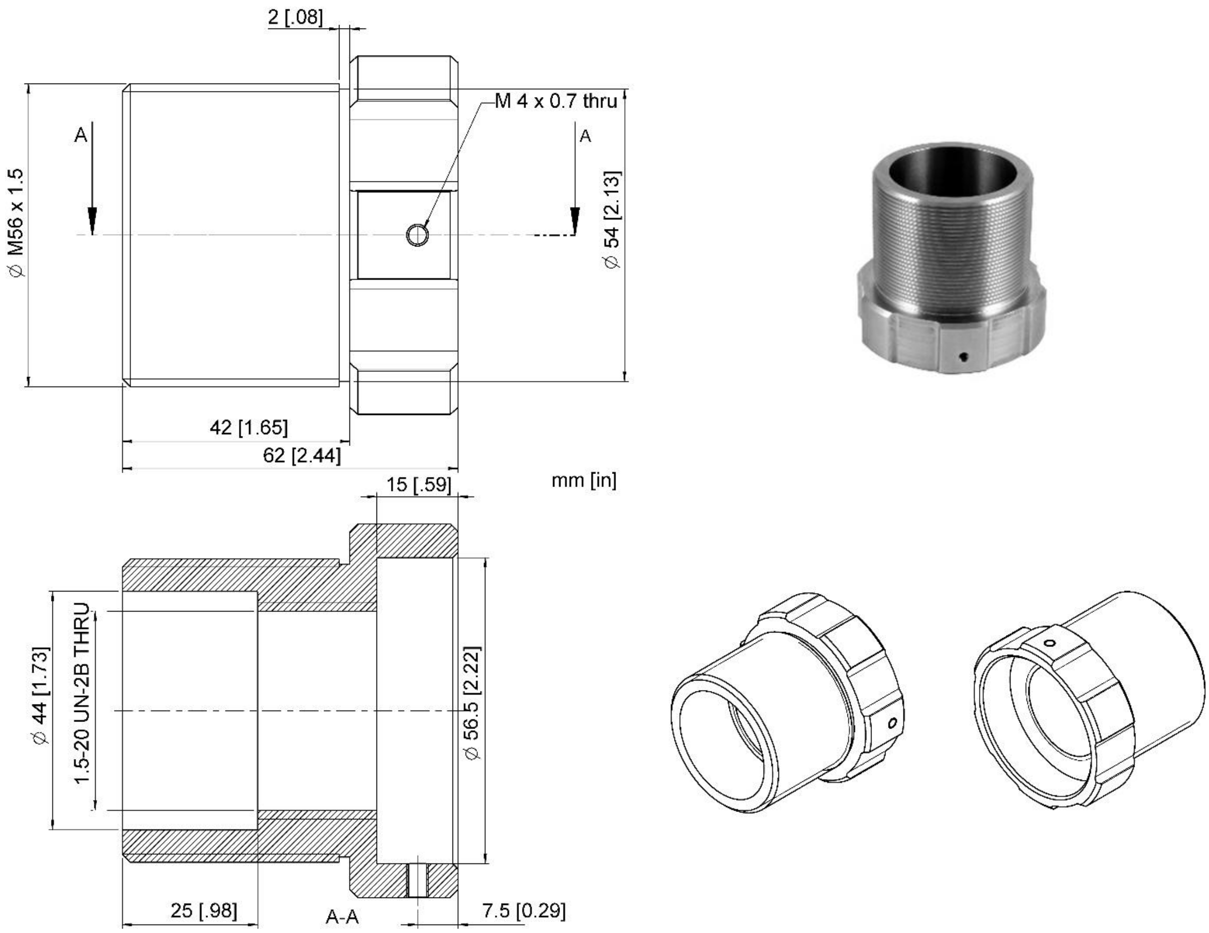
Ambient temperature = 50°C
Relative humidity = 40 %
Minimum device temperature = 30°C

The use of lower temperatures is at your own risk!

8.2.11 Thread Adapter (A-TA-M56)

The thread adapter is secured to the front of the Thermalert 4.0 sensor. It provides an outer M56 thread to fit to legacy Marathon MM installations. The thread adapter is also used to hold the mounting flange (A-MF-MOD) for use in existing Ircon flange mount installations.

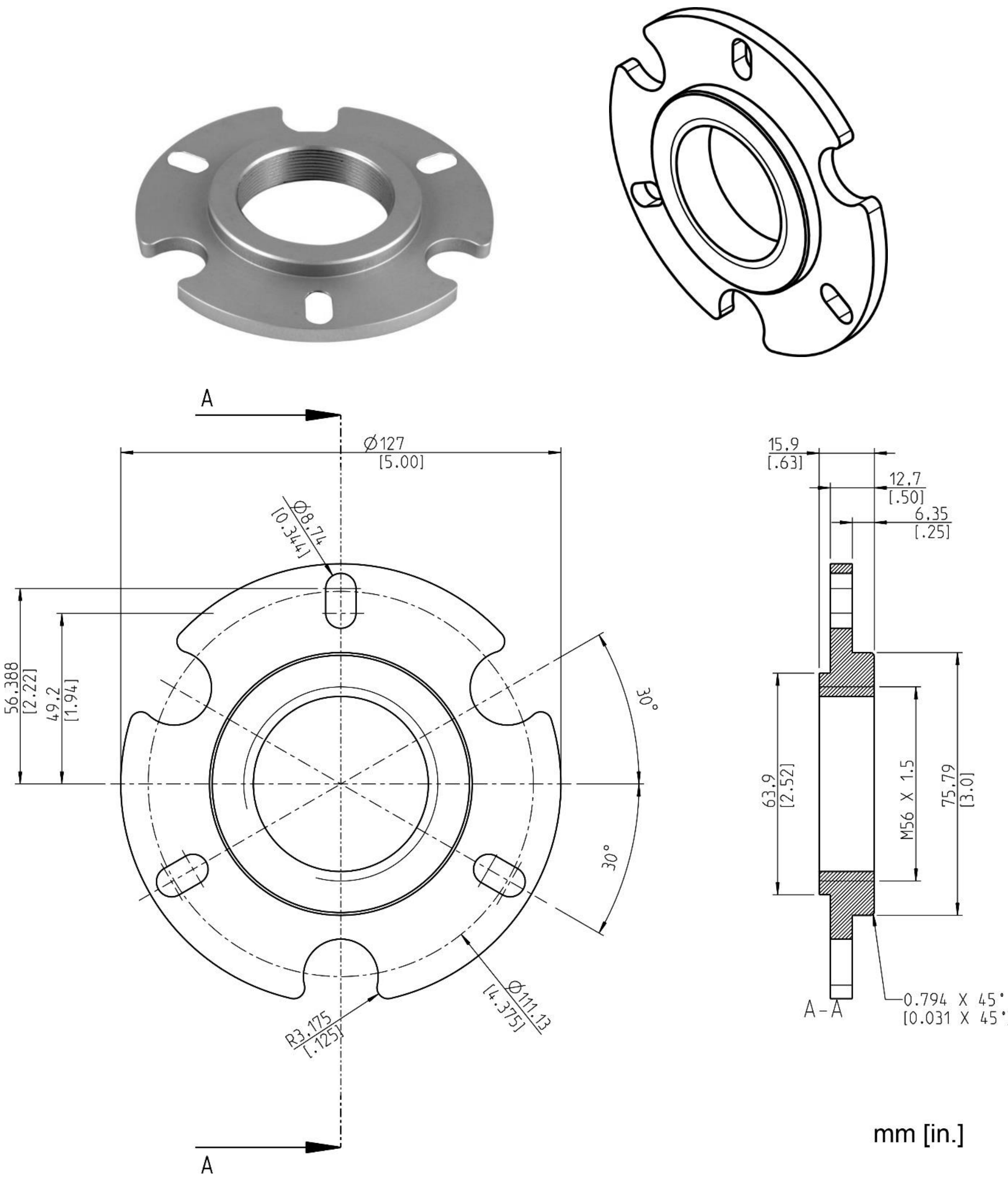
Figure 8-22: Thread Adapter



8.2.12 Mounting Flange (A-MF-MOD)

The mounting flange provides a footprint to allow the Thermalert 4.0 sensor to be mounted into a legacy Ircon Modline flange mount installations. Please note that this accessory needs to be used in conjunction with the thread adapter (A-TA-M56) to adapt the outer thread of the Thermalert 4.0 to the inner thread of the flange.

Figure 8-23: Mounting Flange



9 Maintenance

Our sales representatives and customer service staff are always at your disposal for questions regarding applications, 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.

9.1 Troubleshooting Minor Problems

Table 9-10: 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 lens	Clean the lens
Erroneous temperature	Wrong emissivity	Correct the setting
Temperature fluctuates	Wrong signal processing	Correct Peak/Valley Hold or Average settings
Temperature fluctuates	No ground for the instrument	Check wiring / grounding

9.2 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 shut down the process in the event of a set-up error, system error, or a failure in the sensor electronics.

Warning

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 output circuits automatically adjust to the lowest or highest preset level. The following table shows the corresponding values and the error code transmitted over the RS485 interface.

Table 9-11: Error Codes for Analog Output

Symptom	0 to 10 V	0 to 20 mA	4 to 20 mA
Temperature over range*	10 V	21 mA	21 mA
Temperature under range*	0 V	0 mA	approx. 3.5 mA

* related to zoomed temperature range

Table 9-12: Error Codes via Field Bus

Output	Error Code Description
T>>>>>>	Temperature over range
T<<<<<<	Temperature under range

9.3 Cleaning the Lens

Keep the lens at all times. Care should be taken when cleaning the lens. To clean the lens, 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 fingerprints or other grease, use any of the following:

- Denatured alcohol
- Ethanol
- Kodak lens cleaner

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, as 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.

Note
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 Programming Guide

This section explains the sensor's communication protocol. A protocol is the set of commands that define all possible communications with the sensor. The commands are described along with their associated ASCII command characters and related message format information. Use them when writing custom programs for your applications or when communicating with your sensor with a terminal program.

10.1 Command Structure

After transmitting one command, it is obligatory to wait for the response from the sensor before sending another. Make sure that a command sent was completely transmitted from the sender before the next command can be sent.

Note
All commands must be entered in upper case (capital) letters!

10.1.1 Requesting a Parameter (Poll Mode)

?E<CR>	"?" is the command for "request"
	"E" is the parameter requested
	<CR> carriage return ($0D_{hex}$) is closing the request

10.1.2 Setting a Parameter (Poll Mode)

E=0.975<CR>	"E" is the parameter to be set
	"=" is the command for "set a parameter"
	"0.975" is the value for the parameter
	<CR> carriage return ($0D_{hex}$) is closing the setting

10.1.3 Sensor Response

!E0.975<CR><LF>	"!" is the parameter for "answer"
	"E" is the parameter
	"0.975" is the value for the parameter
	<CR> <LF> ($0D_{hex}$ $0A_{hex}$) is closing the answer

For processing the received commands, the device typically needs about 200 ms. For certain commands, this time can be even longer.

10.1.4 Sensor Notification

With a notification the sensor informs the host, that the sensor or the firmware was reset.

#XI<CR><LF>	"#" is the parameter for "Notification"
	"XI" is the value for the notification (e.g. "XI" firmware reset)
	<CR> <LF> ($0D_{hex}$ $0A_{hex}$) is closing the notification
!XL<CR><LF>	"!" is the parameter for "Notification"
	"XL1" is the value for the notification (e.g. "XL1" laser switched on)
	<CR> <LF> ($0D_{hex}$ $0A_{hex}$) is closing the notification

10.1.5 Error Messages

An asterisk * will be transmitted back to the host in the event of an "illegal" instruction. An illegal instruction can be caused by a syntax error with the following response:

- "*Syntax Error" – a value entered in an incorrect format

10.2 Transfer Modes

There are two possible transfer modes for the serial interface.

Poll Mode: The current value of any individual parameter can be requested by the host. The sensor responds once with the value at the selected baud rate.

Burst Mode: A pre-defined data string, a so-called "burst string", will be transferred continuously as long as the burst mode is activated.

V=P	"P" starts the poll mode
V=B	"B" starts the burst mode
$=UTIEEC	"$" sets the content of the burst string
	"U" for temperature unit
	"T" for target temperature
	"I" for internal case temperature of the sensor
	"E" for emissivity value
	"EC" for error code
?$	gives the burst string parameters while in poll mode, e.g. "UTIE"
?X$	gives the burst string content while in poll mode, e.g. "UC T0150.3 I0027.1 E0.950"

Return from burst mode to poll mode

V=P	„V=P" to be sent (it could be necessary to send the command more than one times)

10.3 Sensor Information

The sensor information is factory installed as read only values.

Table 10-13: Sensor Information

Command	Description	Answer (example)
?XU	Name of the sensor	"!XUTHLT"
?DS	Additional remark, e.g. for special numbers	"!DSFPI"
?XV	Serial number of the sensor	"!XV2C027"
?XR	Firmware revision number	"!XR2.08"
?XH	Maximum temperature of the sensor	"!XH0600.0"
?XB	Minimum temperature of the sensor	"!XB-020.0"

10.4 Sensor Setup

10.4.1 General Settings

U=C	sets the physical unit for the temperature value (C or F). In case of a changed physical unit all temperature related parameters (e.g., thresholds) are converted automatically.
E=0.950	sets the emissivity according to the setting of "ES" command, see section 10.4.2 Emissivity Setting, page 79.
A=250	sets the ambient background temperature compensation according to the setting of "AC" command, see section 10.4.3 Background Temperature Compensation, page 79.
XG=1.000	sets the transmission
?T	asks for the target temperature

?I	asks for the internal temperature of the sensor
?Q	asks for the energy value of the target temperature

10.4.2 Emissivity Setting

The emissivity setting is selected by means of the "ES" command.

ES=I	sets emissivity by a constant number
ES=E	sets the emissivity by an analog voltage on the external input FTC1 (12-wire model only). For more information see section 5.6.3 FTC1 – Emissivity Setting, page 37.
ES=S	sets emissivity by a rotary switch (2-wire model only)
?E	asks for the current emissivity value

10.4.3 Background Temperature Compensation

In case the background temperature is not represented by the internal sensor case temperature, you must set the ambient background temperature values as follows:

A=250.0	current background temperature according to the setting of "AC" command
AC=0	no compensation (internal sensor case temperature equal to background temperature)
AC=1	compensation with a constant temperature value set with command "A"
AC=2	compensation with an analog voltage signal at the external input, 0 – 10 VDC corresponds to the temperature range of the sensor. Resulting temperature is read out by command "A". For more information see section 5.6.4 FTC2 – Background Temperature Compensation, page 37.

10.4.4 Temperature Hold Functions

The following table lists the various temperature hold functions along with their resets and timing values. Use this table as a guide for programming your sensor and adjusting the hold times. For further information see section 7.2 Post Processing, page 45.

Table 10-14: Overview to Temperature Hold Functions

Hold Function	RESET by	Peak Time	Valley Time	Threshold	Hystersis
		Protocol code			
		P	F	C	XY
None	none	000.0	000.0		
Peak Hold	timer	000.0-998.9	000.0	000.0	
Peak Hold	trigger	Holds infinitely or until triggered	000.0	000.0	
Advanced Peak Hold	trigger or threshold	Holds infinitely or until triggered	000.0	Temp. range	-100°C to 100°C (-180°F to 180°F)
Advanced Peak Hold	timer or threshold	000.0-998.9	000.0	Temp. range	-100°C to 100°C (-180°F to 180°F)
Valley Hold	timer	000.0	000.0-998.9	000.0	
Valley Hold	trigger	000.0	Holds infinitely or until triggered	000.0	
Advanced Valley Hold	trigger or threshold	000.0	Holds infinitely or until triggered	Temp. range	-100°C to 100°C (-180°F to 180°F)
Advanced Valley Hold	timer or threshold	000.0	000.0-998.9	Temp. range	-100°C to 100°C (-180°F to 180°F)

10.5 Sensor Control

10.5.1 Analog Output

The current output corresponds to the target temperature value. Depending on the considered sensor model, the output can be set to current, voltage, or thermocouple.

XO=4	sets the current output range to 4-20 mA
H=500	sets the temperature for the top analog output value to 500 (in current scale) e.g., the top current output value of 20 mA shall represent 500°C
L=0	sets the temperature for the bottom analog output value to 0 (in current scale) e.g., the bottom current output value of 4 mA shall represent 0°C

The minimum temperature span between “H” and “L” command values is 20 K.

For testing purposes the output can be forced to provide a constant value.

O=50	percentage of full output range, example given with 50%
O=255	switches back to the target temperature controlled output

10.5.2 Relay Output

If existing, the relay output can be triggered as follows:

- by target temperature
- by internal sensor temperature
- manually (command controlled)

The alarm output can be set either to N.C. (normally closed: relay contacts are closed while in the home position) or N.O. (normally open: relay contacts are open while in the home position).

K=0	relay contacts permanently open
K=1	relay contacts permanently closed
K=2	alarm output triggered by target temperature, N.O. normally open
K=3	alarm output triggered by target temperature, N.C. normally closed
K=4	alarm output triggered by internal sensor case temperature, N.O. normally open
K=5	alarm output triggered by internal sensor case temperature, N.C. normally closed
XS=125.3	sets the upper alarm threshold to 125.3 in current scale. The alarm threshold is used for the target temperature only (see command XS).

10.6 RS485 Communication

The serial RS485 communication is in 2-wire mode.

For setting the baud rate, the following command must be used.

D=0576	sets the baud rate to 57600, baud rate must be given with 4 numbers (0048, 0096, 0192, 0384, 0576, 1152).

10.7 Multidrop Mode

Up to 32 devices can be connected within an RS485 multidrop network, see section 6 RS485, page 42. To direct a command to one sensor among the 32 possible, it is necessary to “address” a command. Therefore, a 3-digit number is set prior the command. The 3-digit number is determined between 001 and 032. A unit with the address 000 is a single unit and not in multidrop mode.

XA=024	sets the device to address 24

Changing an address:

(e.g., the address is to be changed from 17 to 24)

Command	Answer	
“017?E”	“017E0.950”	*// asking one sensor on address 17*
“017XA=024”	“017XA024”	*// setting of a new address*
“024?E”	“024E0.950”	*// asking same sensor now on address 24*

If a command is transferred, starting with the 3-digit number 000, all units (with addresses from 001 to 032) connected will get this command - without to send an answer.

Command	Answer
“024?E”	“024E0.950”
“000E=0.5”	will be executed from all sensors, no answer
“024?E”	“024E0.500”
“012?E”	“012E0.500”

10.8 Command List

P ... Poll, B ... Burst, S ... Set, N ... Notification

(1) n = number, X = uppercase letter

Notes:

- USB virtual serial interface settings: 9600 bps Baudrate, 8 data bits, 1 stop bit, no parity, no flow control
- RS485 serial interface settings refer to command 'D' on the command list below.
- A sent command should be closed with 0x0D or 0x0D,0x0A; response command is closed with 0x0D, 0x0A.

COMMAND FORMAT

Description	Char	Format	Poll	Burst	Set	Legal values
Send Command Format						
Poll parameter	?	?X / ?XX	√			?T
Set parameter	=	X= / XX=			√	E=0.95
Multidrop addressing		001?E	√		√	
Response Format						
Acknowledge message	!					!E0.95
Error message	*					*Syntax Error

COMMAND LIST										
Description	**Char**	**Value Format**	**Poll**	**Burst**	**Set**	**Legal values**	**Factory default**	**2-W**	**6-W**	**12-W**
Device PCA(MCU) UID	%UID	XX…XX	√			e.g. abcdef1234567890		√	√	√
Burst mode string format	$	XX…XX	√		√	U T Q E F P G I H L XG XI XJ CE EC(for all); CK CS XT (only for 12-wire)	UTICE		√	√
Background temperature compensation	A	nnnn.n	√		√	Within device measurement range. In current unit (°C/°F)	Lower-limit of temperature range	√	√	√
Advanced hold - average time	AA	nnn.n	√		√	0 = no averaging; 0.1 ~ 999.0 secs	000.0	√	√	√
Ambient compensation control	AC	n	√		√	0 = no compensations; 1 = with compensation by command "A"; 2 = external input (for 12-wire)	0	√	√	√
Advanced hold - threshold temperature value	C	nnnn.n	√		√	Within device measurement range. In current unit (°C/°F)	Lower-limit of temperature range	√	√	√
Current calculated emissivity	CE	n.nnn	√	√				√	√	√
Current lower threshold value for Relay function	CK	nnnn.n	√	√		In current unit (°C/°F)		√		√
Current upper threshold value for Relay function	CS	nnnn.n	√	√		In current unit (°C/°F)		√		√

COMMAND LIST										
Description	**Char**	**Value Format**	**Poll**	**Burst**	**Set**	**Legal values**	**Factory default**	**2-W**	**6-W**	**12-W**
Adjustable baud rate for RS485	D	nnnn	√		√	0048 = 4800 baud rate 0096 = 9600 baud rate 0192 = 19200 baud rate 0384 = 38400 baud rate 0576 = 57600 baud rate 1152 = 115200 baud rate	0096		√	√
Gain adjustment for temperature value	DG	n.nnnn	√		√	0.8000 ~ 1.2000	1.0000	√	√	√
Offset adjustment for temperature value	DO	nnnn.n	√		√	-200.0 ~ 200.0oC / -360.0 ~ 360.0oF In current unit (°C/°F)	0000.0	√	√	√
Device special information (remark)	DS	XXX	√			e.g. FPI-RAYTEK		√	√	√
Emissivity internal	E	n.nnn	√	√	√	0.100 ~ 1.100	1.000	√	√	√
Error code	EC	nnnn	√			0001 = Target temperature over range; 0002 = Target temperature under range; 0010 = Ambient temperature over range; 0020 = Ambient temperature under range 0100 = Analog output over range; 0200 = Analog output under range;		√	√	√
Emissivity source selection: Constant / Analog input / / Rotary switch	ES	X	√		√	I = set by a constant number according to the command "E"; E = set by the input voltage on FTC1 (only for 12-wire); S = set by the rotary switch (only for 2-Wire)	I S for 2-wire sensor	√	√	√
Valley hold time	F	nnn.n	√	√	√	000.0 ~ 998.9 secs; 999.0 = infinite	000.0	√	√	√
Average time	G	nnn.n	√	√	√	0 = no averaging; 0.1 ~ 999.0 secs	000.0	√	√	√
Temperature value responding to the top of current / voltage output range	H	nnnn.n	√	√	√	(Bottom temperature of current / voltage output range + 20oC) ~ Upper-limit of temperature range. In current unit (°C/°F)	Upper-limit of temperature range	√	√	√
Device ambient temperature	I	nnn.n	√	√		In current unit (°C/°F)		√	√	√
Relay alarm output control	K	X	√		√	0 = open; 1 = closed; 2 = targert norm. open; 3 = target norm. closed; 4 = head norm. open; 5 = head norm. closed; N = no relay built in	0	√		√

COMMAND LIST										
Description	**Char**	**Value Format**	**Poll**	**Burst**	**Set**	**Legal values**	**Factory default**	**2-W**	**6-W**	**12-W**
Temperature value responding to the bottom of current / voltage output range	L	nnnn.n	√	√	√	Lower-limit of temperature range ~ (Top temperature of current / voltage output range - 20oC). In current unit (°C/°F)	Lower-limit of temperature range	√	√	√
Current / voltage output control: Percentage / Targrt temperature	O	nnn	√		√	0 ~ 100 = % of full range; 255 = controlled by target temperature	255	√	√	√
Peak hold time	P	nnn.n	√	√	√	000.0 ~ 998.9 secs; 999.0 = infinite	000.0	√	√	√
Target power value	Q	nnnnnn	√	√				√	√	√
Target temperature value	T	nnnn.n	√	√		In current unit (°C/°F)		√	√	√
RS485 shunt resistor (120ohm) enable	TR	n	√		√	0 = deactivate the shunt resistor; 1 = activate the shunt resistor	0		√	√
Temperature unit	U	X	√	√	√	C/F	C	√	√	√
Poll or Burst mode selection	V	X	√		√	P = poll mode; B = burst mode	P		√	√
Burst mode string contents	X$		√						√	√
Multiple devices' address	XA	0nn	√		√	000 = single device mode; 001 ~ 032 = multiple devices mode	000		√	√
Lower-limit of Device temperature range	XB	nnnn.n	√			In current unit (°C/°F)		√	√	√
Deadband value for Relay function	XD	nn.n	√		√	1.0 ~ 50.0oC / 1.8 ~ 90.0oF In current unit (°C/°F)	02.0 (unit: oC)	√		√
Restore factory defaults	XF				√			√	√	√
Transmission	XG	n.nnn	√	√	√	0.100 ~ 1.000	1.000	√	√	√
Upper-limit of Device temperature range	XH	nnnn.n	√			In current unit (°C/°F)		√	√	√
Device initialisation	XI	n	√	√	√	1 after RESET; 0 if XI =0		√	√	√
Connector/Box temperature	XJ	nnn.n	√	√		In current unit (°C/°F)		√	√	√
Laser control	XL	X	√		√	0 = OFF; 1 = ON; H = overheat(OFF); N = no laser built in	0	√	√	√
FTC3 function selection: Trigger / Hold / Laser control	XN	X	√		√	N = no function; T = trigger; H = hold; L = laser	N			√
Analog output mode selection	XO	n	√		√	0 = 0-20mA; 4 = 4-20mA; 5 = TCJ (only for 6-wire); 6 = TCK(only for 6-wire); 9 = mV	9		√	√

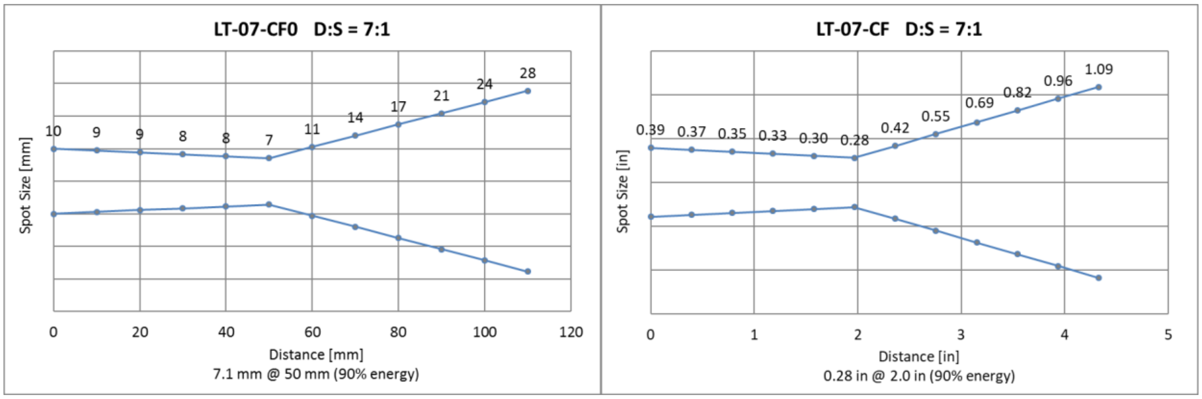
COMMAND LIST										
Description	**Char**	**Value Format**	**Poll**	**Burst**	**Set**	**Legal values**	**Factory default**	**2-W**	**6-W**	**12-W**
Lower threshold value for Relay function	XP	nnnn.n	√		√	Lower-limit of temperature range ~ (Upper threshold value for Relay function - 2 * Deadband). In current unit (°C/°F)	Lower-limit of temperature range	√		√
Firmware revision	XR	nn.nn.nnnn	√			e.g. 01.01.1111		√	√	√
Analog Firmware revision	XRA	nn.nn.nnnn	√			e.g. 01.01.1111			√	√
Upper threshold value for Relay function	XS	nnnn.n	√		√	(Lower threshold value for Relay function + 2 * Deadband) ~ Upper-limit of temperature range. In current unit (°C/°F)	Upper-limit of temperature range	√		√
Trigger status	XT	n	√	√		0 = inactive; 1 = active	0			√
Device identification (model name)	XU	XXXXXXXXXXX	√			e.g. STRLTH5SFCW		√	√	√
Device serial number	XV	nnnnnnnnn	√			e.g. 123456789		√	√	√
Advanced hold - hysteresis temperature value	XY	nnnn.n	√		√	-100.0 ~ 100.0oC / -180.0 ~ 180.0oF In current unit (°C/°F)	0000.0	√	√	√

11 Appendix

11.1 Optical Diagrams

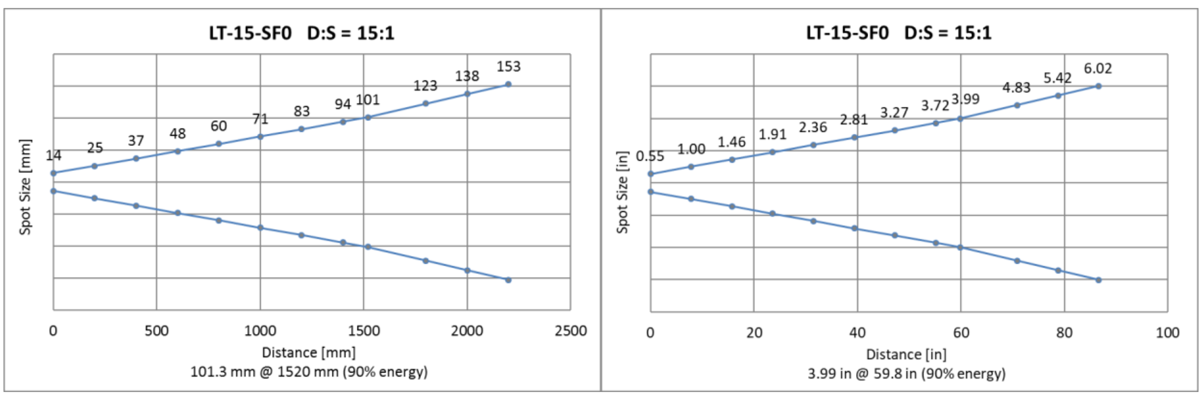
11.1.1 LT-07 Models

Figure 11-1: Optical Diagrams LT-07 Models



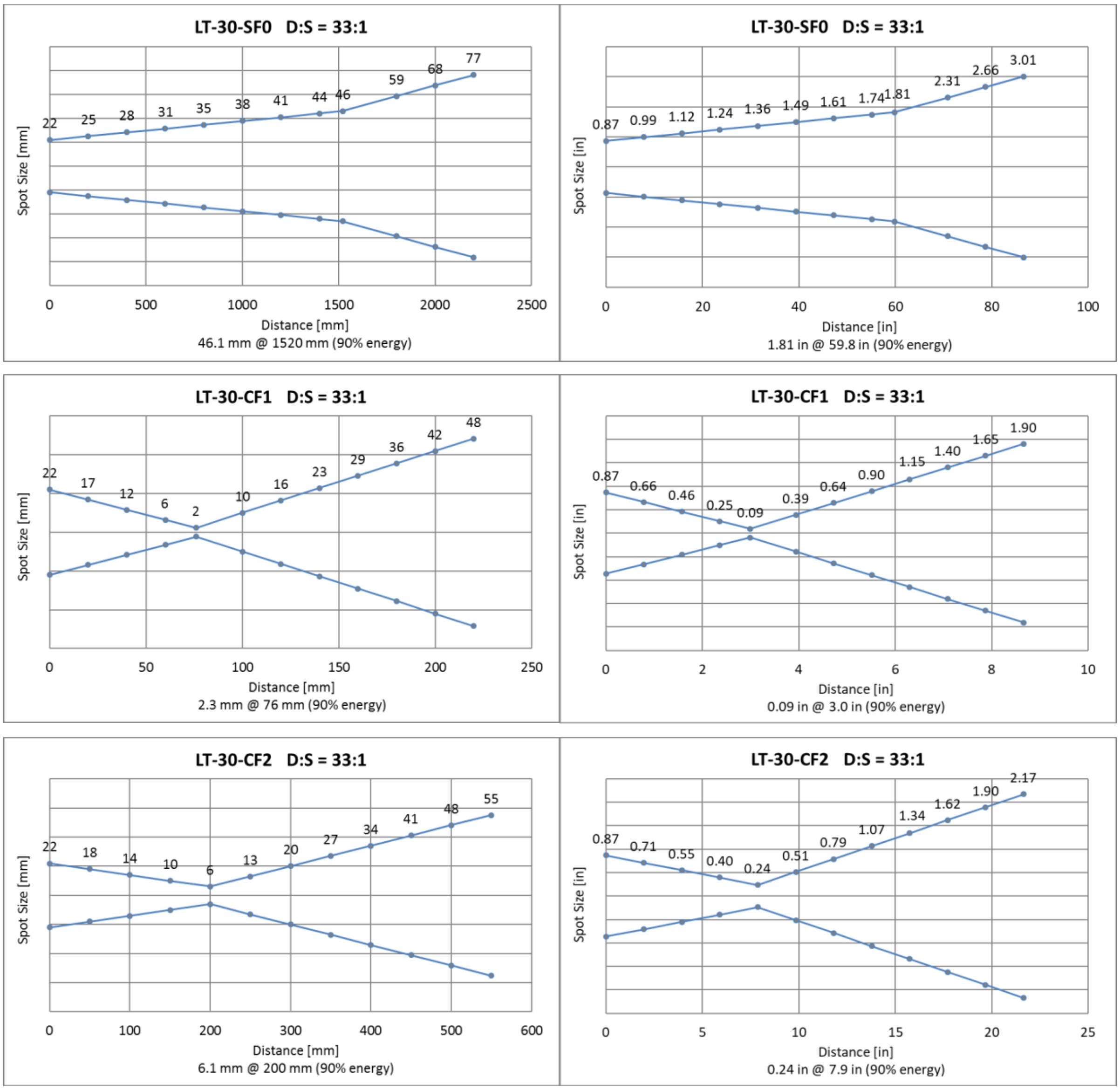
11.1.2 LT-15 Models

Figure 11-2: Optical Diagrams LT-15 Models



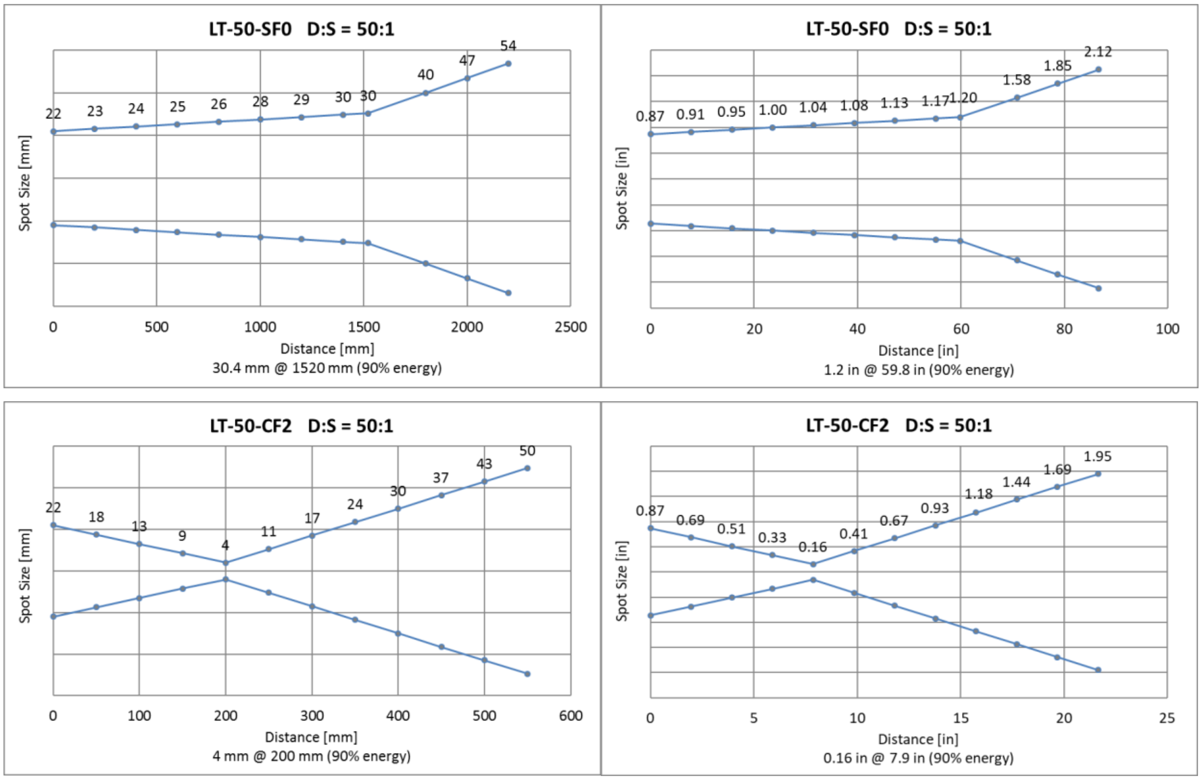
11.1.3 LT-30 Models

Figure 11-3: Optical Diagrams LT-30 Models



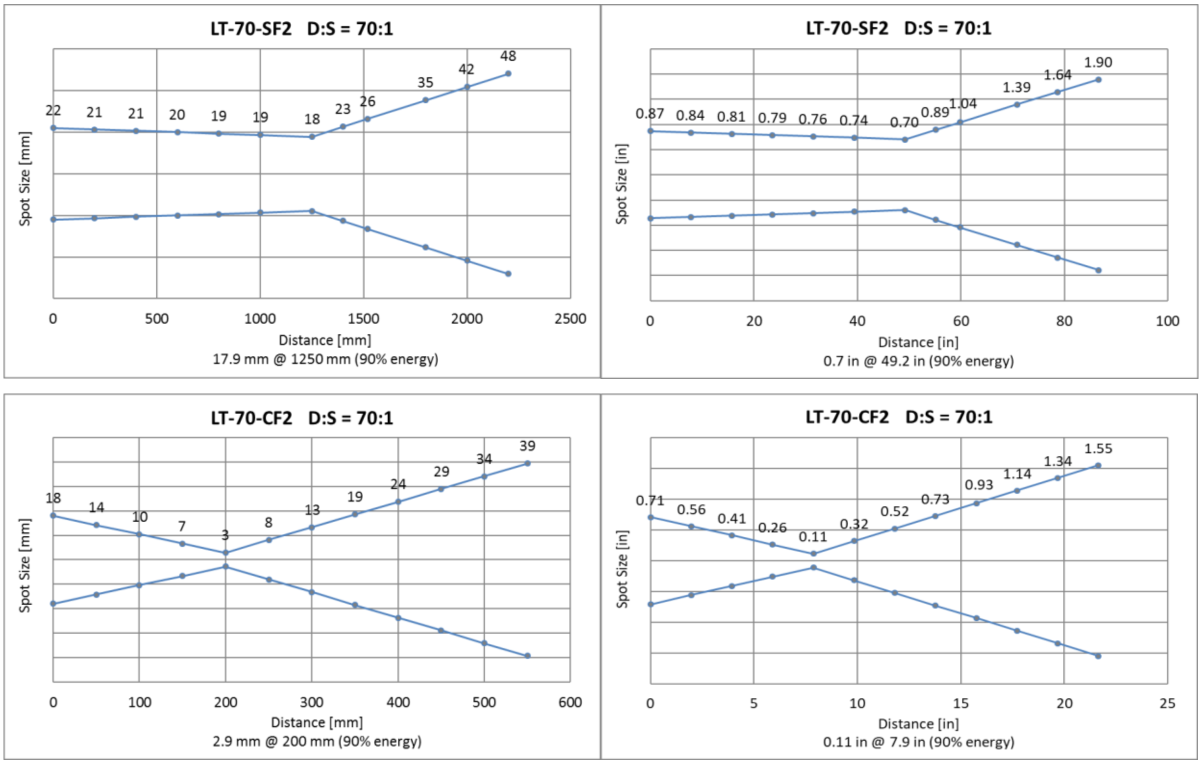
11.1.4 LT-50 Models

Figure 11-4: Optical Diagrams LT-50 Models



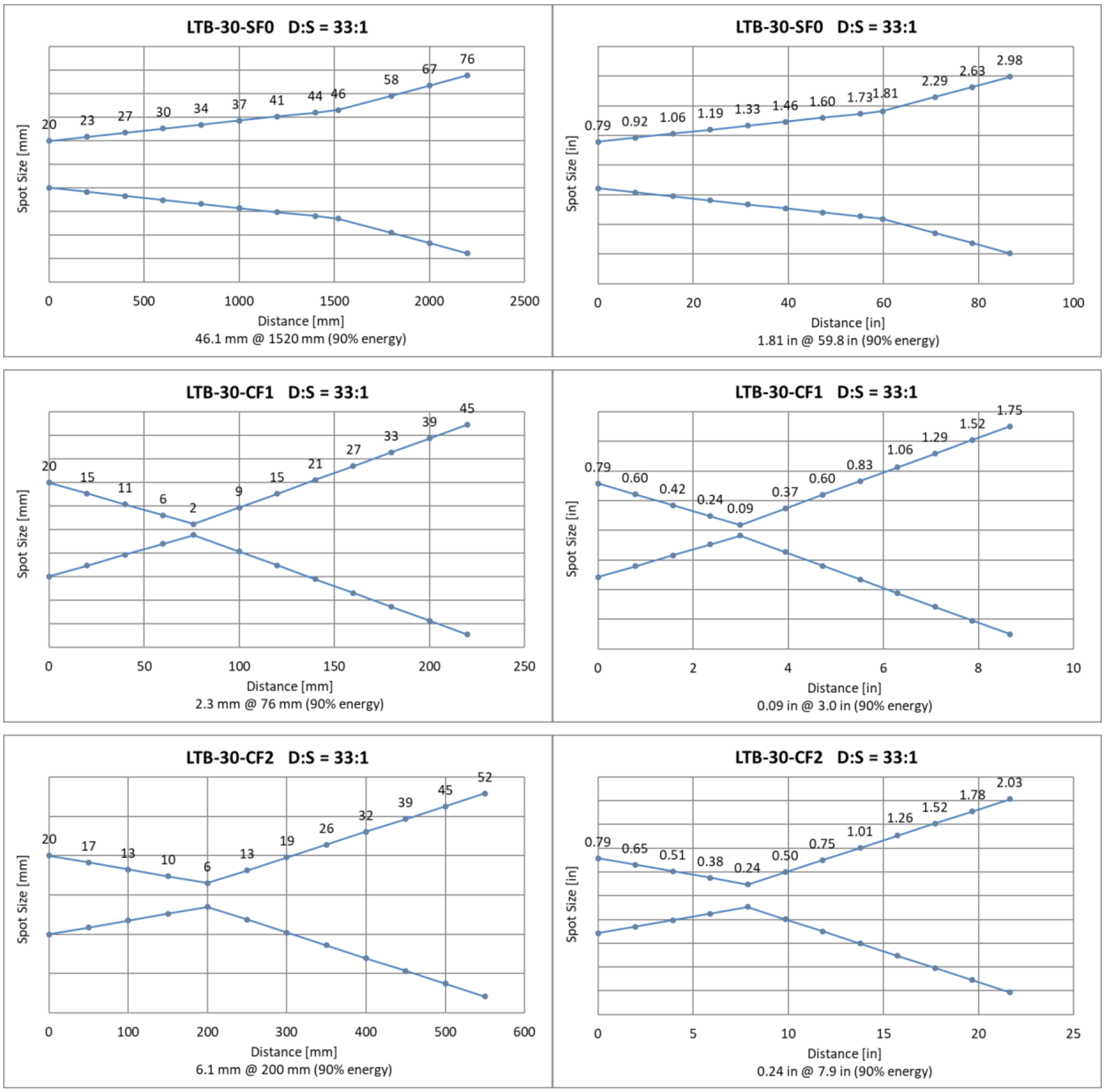
11.1.5 LT-70 Models

Figure 11-5: Optical Diagrams LT-70 Models



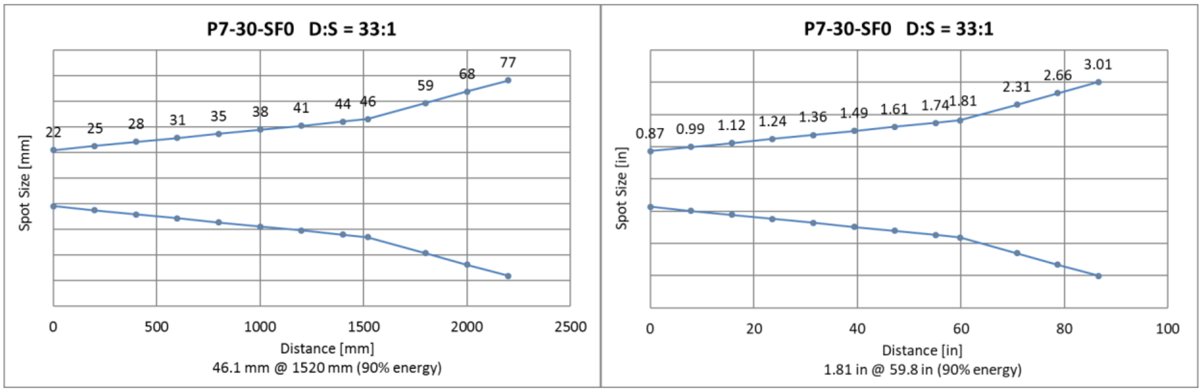
11.1.6 LTB-30 Models

Figure 11-6: Optical Diagrams LTB-30 Models



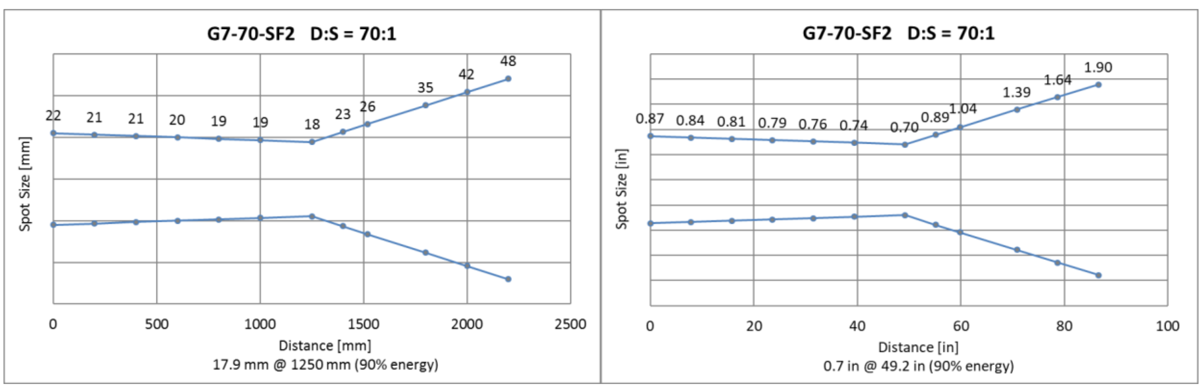
11.1.7 P7-30 Models

Figure 11-7: Optical Diagrams P7-30 Models



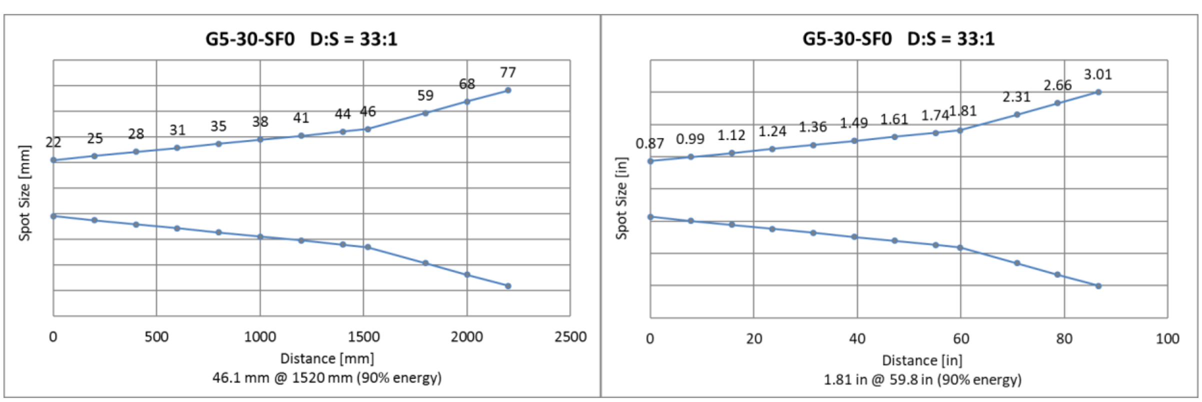
11.1.8 G7-70 Models

Figure 11-8: Optical Diagrams G7-70 Models



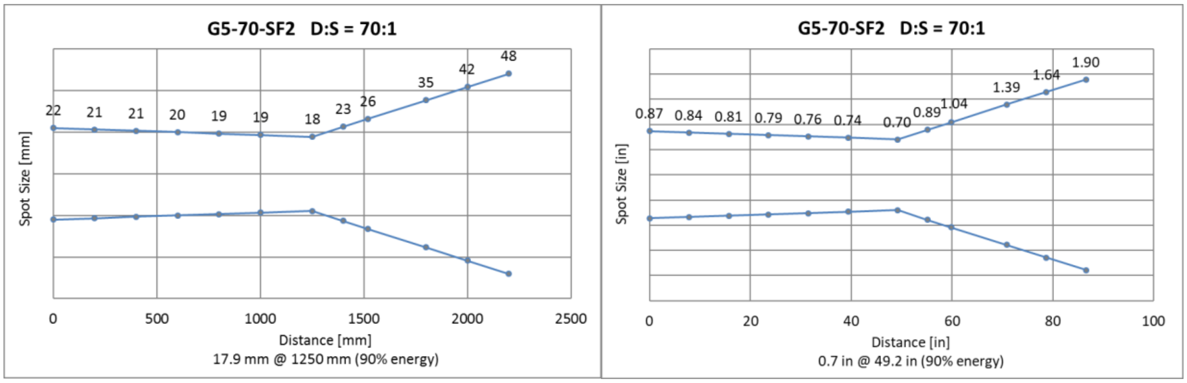
11.1.9 G5-30 Models

Figure 11-9: Optical Diagrams G5-30 Models



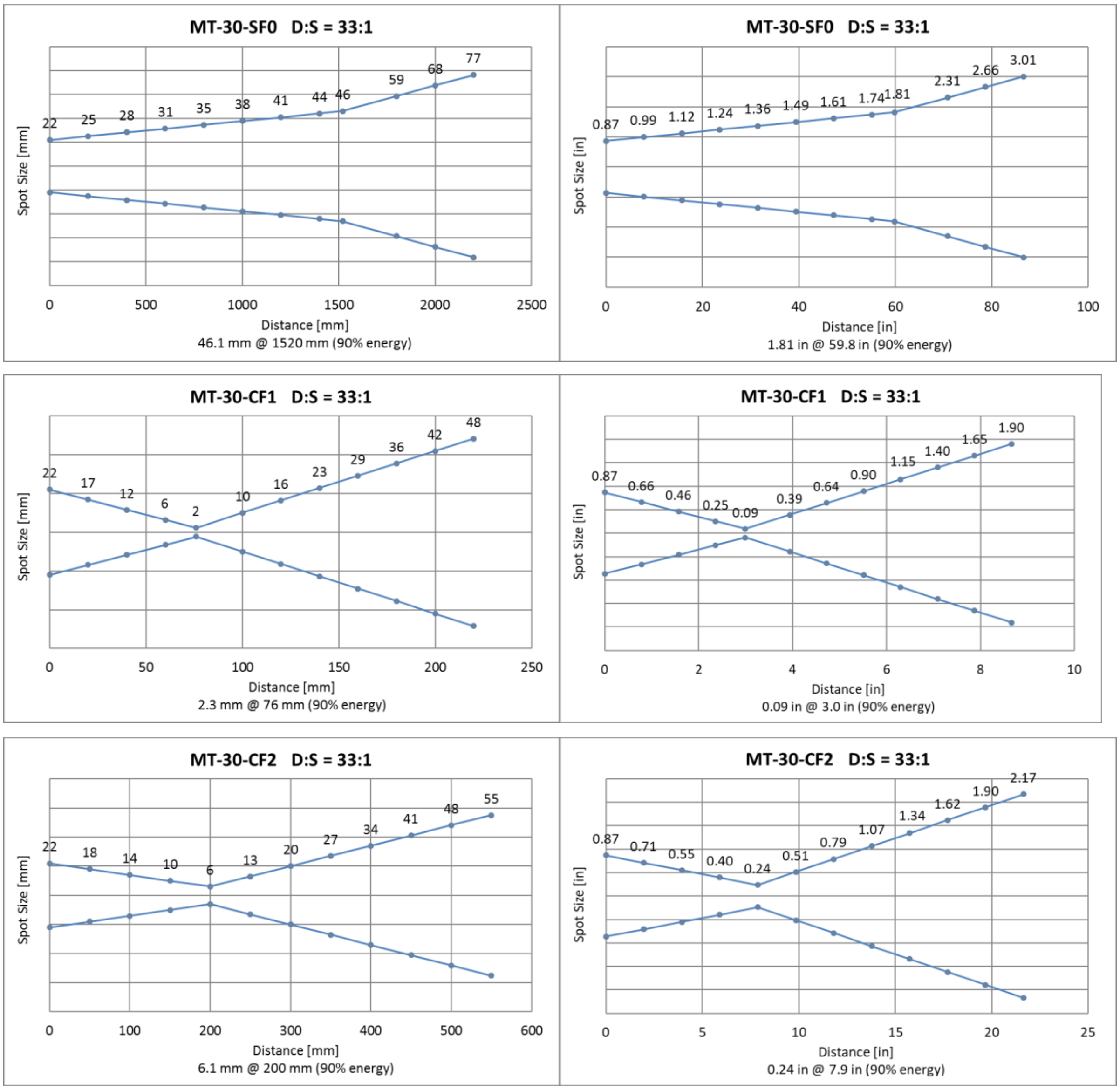
11.1.10 G5-70 Models

Figure 11-10: Optical Diagrams G5-70 Models



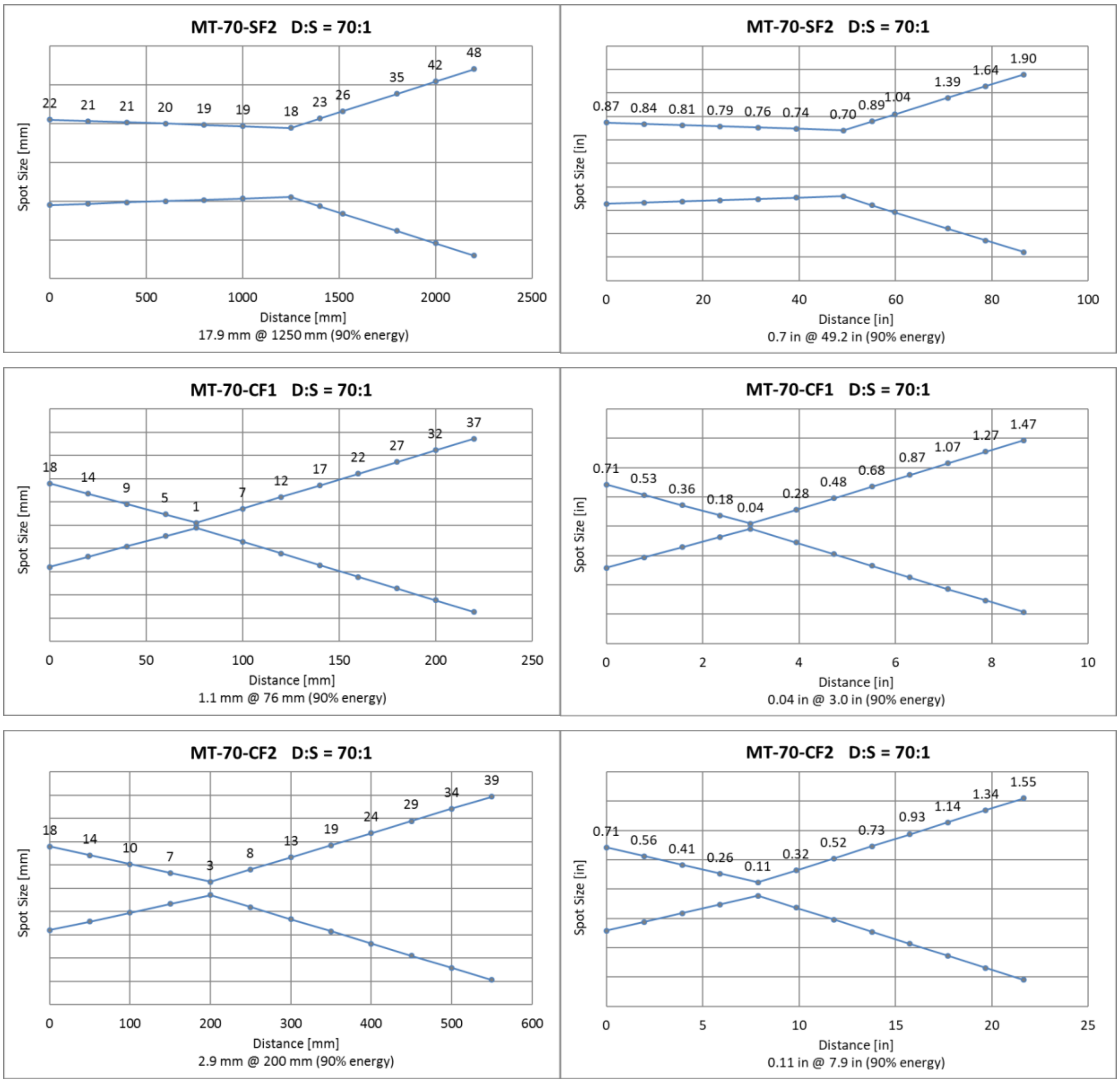
11.1.11 MT-30 Models

Figure 11-11: Optical Diagrams MT-30 Models



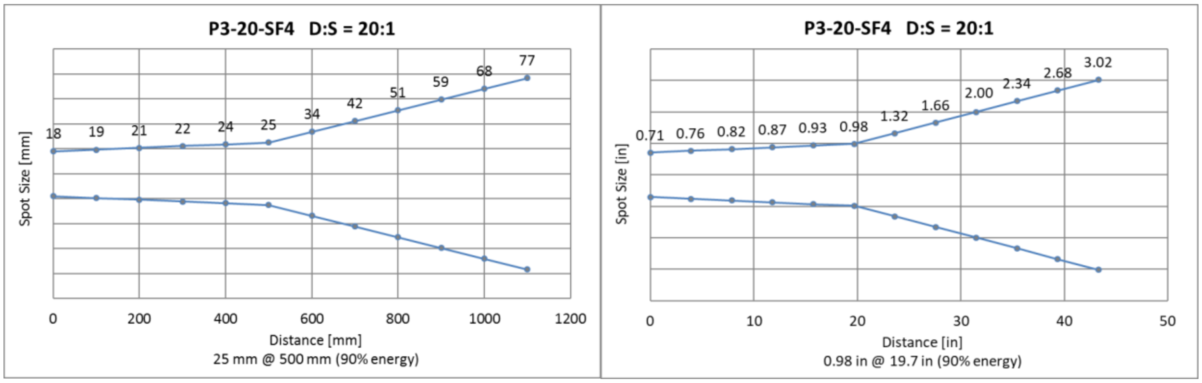
11.1.12 MT-70 Models

Figure 11-12: Optical Diagrams MT-70 Models



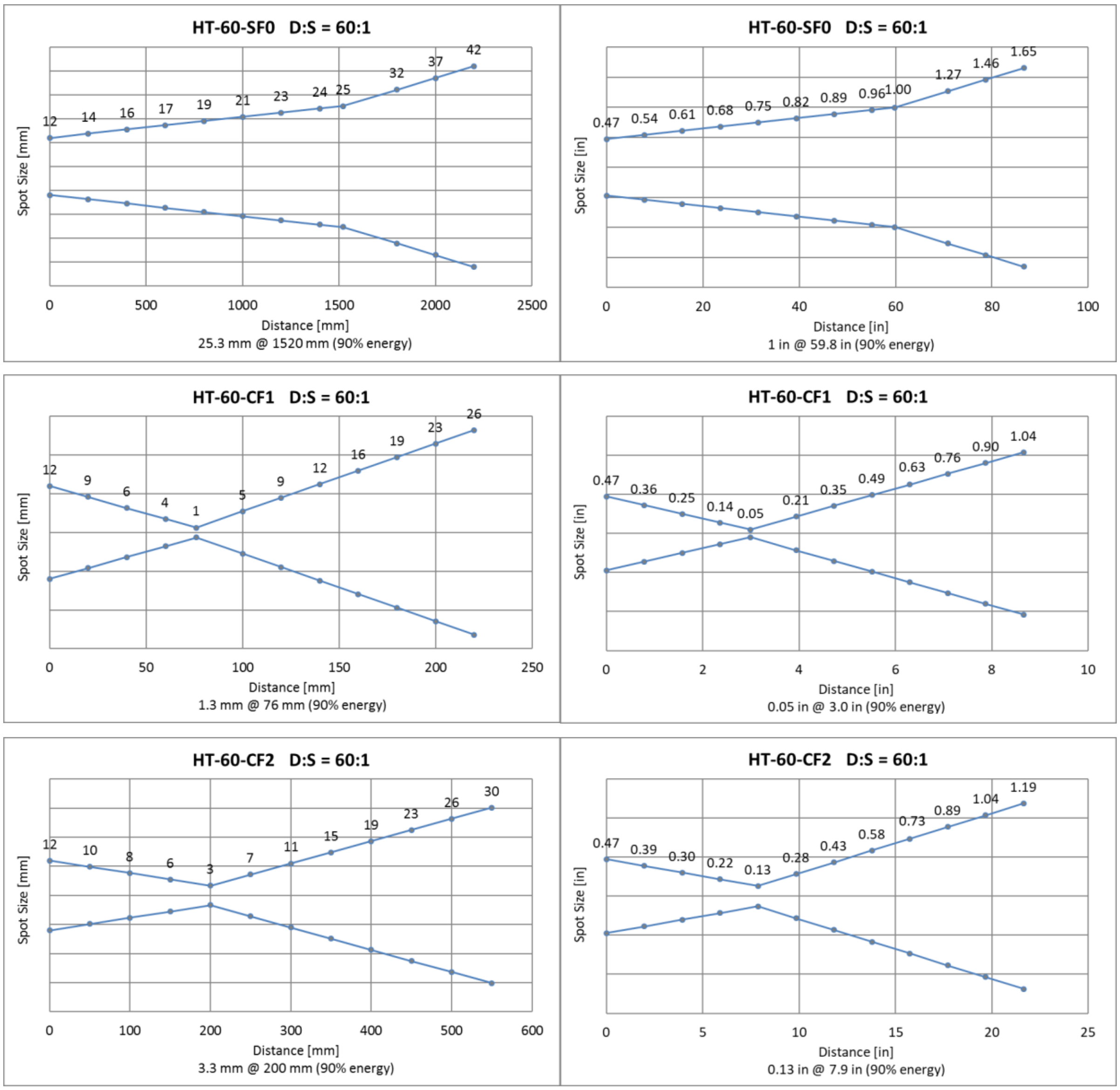
11.1.13 P3-20 Models

Figure 11-13: Optical Diagrams P3-20 Models



11.1.14 HT-60 Models

Figure 11-14: Optical Diagrams HT-60 Models



11.2 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:

- Determine the actual temperature of the material using an RTD (PT100), a thermocouple, or any other suitable contact temperature 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.
- For relatively low temperatures (up to 260°C / 500°F) place a plastic sticker on the object to be measured. This sticker should be large enough to cover the target spot. Next, measure the sticker's temperature using an emissivity setting of 0.95. Finally, measure the temperature of 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.
- If possible, apply flat black paint to a portion of the surface of the object. The emissivity of the paint is 0.95. Next, measure the temperature of the painted area using an emissivity setting of 0.95. 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.

11.3 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:

- Temperature
- Angle of measurement
- Geometry (plane, concave, convex)
- Thickness
- Surface quality (polished, rough, oxidized, sandblasted)
- Spectral range of measurement
- Transmission (e.g. thin films plastics)

To optimize surface temperature measurements, consider the following guidelines:

- Determine the object's emissivity using the instrument, which is also to be used for temperature measurements.
- Avoid reflections by shielding the object from surrounding temperature sources.
- For higher temperature objects, use instruments with the shortest wavelength possible.
- For translucent materials such as plastic foils or glass, ensure that the background is uniform and lower in temperature than the object.
- Mount the instrument perpendicular to the surface, if possible. In all cases, do not exceed angles more than 30° from incidence.

Table 11-1: Typical Emissivity Values for Metals

				Metals			
				Emissivity			
Material	**1 µm**	**1.6 µm**	**2.3 µm**	**3.9 µm**	**5 µm**	**7.9 µm**	**8 – 14 µm**
Aluminum							
Unoxidized	0.1-0.2	0.02-0.2	0.02-0.2	0.02-0.2	0.02-0.2	0.03-0.15	0.02-0.1
Oxidized	0.4	0.4	0.2-0.4	0.2-0.4	0.2-0.4	0.20-0.55	0.2-0.4
Alloy A3003, Oxidized		0.4	0.4	0.4	0.4		0.3
Roughened	0.2-0.8	0.2-0.6	0.2-0.6	0.1-0.4	0.1-0.4		0.1-0.3
Polished	0.1-0.2	0.02-0.1	0.02-0.1	0.02-0.1	0.02-0.1		0.02-0.1
Brass							
Polished	0.1-0.3	0.01-0.05	0.01-0.05	0.01-0.05	0.01-0.05	0.03-0.15	0.01-0.05
Burnished			0.4	0.3	0.3		0.3
Oxidized	0.6	0.6	0.6	0.5	0.5		0.5
Chromium	0.4	0.4	0.05-0.3	0.03-0.3	0.03-0.3	0.10-0.20	0.02-0.2
Oxidized						0.60-0.85	
Copper							
Polished		0.03	0.03	0.03	0.03	0.03-0.15	0.03
Roughened		0.05-0.2	0.05-0.2	0.05-0.15	0.05-0.15		0.05-0.1
Oxidized	0.2-0.8	0.2-0.9	0.7-0.9	0.5-0.8	0.5-0.8	0.40-0.80	0.4-0.8
Gold	0.3	0.01-0.1	0.01-0.1	0.01-0.1	0.01-0.1	0.02-0.15	0.01-0.1
Haynes							
Alloy	0.5-0.9	0.6-0.9	0.6-0.9	0.3-0.8	0.3-0.8		0.3-0.8
Inconel							
Oxidized	0.4-0.9	0.6-0.9	0.6-0.9	0.6-0.9	0.6-0.9	0.80-0.90	0.7-0.95
Sandblasted	0.3-0.4	0.3-0.6	0.3-0.6	0.3-0.6	0.3-0.6		0.3-0.6
polished	0.2-0.5	0.25	0.25	0.15	0.15	0.10-0.25	0.15
Iron							
Oxidized	0.4-0.8	0.5-0.8	0.7-0.9	0.6-0.9	0.6-0.9	0.80-0.95	0.5-0.9
Unoxidized	0.35	0.1-0.3	0.1-0.3	0.05-0.25	0.05-0.25		0.05-0.2
Rusted		0.6-0.9	0.6-0.9	0.5-0.8	0.5-0.8		0.5-0.7
Molten	0.35	0.4-0.6	0.4-0.6				
Iron, Cast							
Oxidized	0.7-0.9	0.7-0.9	0.7-0.9	0.65-0.95	0.65-0.95	0.10-0.95	0.6-0.95
Unoxidized	0.35	0.3	0.1-0.3	0.25	0.25	0.10-0.15	0.2
Molten	0.35	0.3-0.4	0.3-0.4	0.2-0.3	0.2-0.3		0.2-0.3
Iron, Wrought							
Dull	0.9	0.9	0.95	0.9	0.9		0.9
Lead							
Polished	0.35	0.05-0.2	0.05-0.2	0.05-0.2	0.05-0.2		0.05-0.1
Rough	0.65	0.6	0.5	0.4	0.4		0.4
Oxidized		0.3-0.7	0.3-0.7	0.2-0.7	0.2-0.7		0.2-0.6
Magnesium	0.3-0.8	0.05-0.3	0.05-0.2	0.03-0.15	0.03-0.15		0.02-0.1
Mercury		0.05-0.15	0.05-0.15	0.05-0.15	0.05-0.15		0.05-0.15
Molybdenum							
Oxidized	0.5-0.9	0.4-0.9	0.4-0.9	0.3-0.7	0.3-0.7		0.2-0.6
Unoxidized	0.25-0.35	0.1-0.35	0.1-0.3	0.1-0.15	0.1-0.15	0.10-0.25	0.1

Metals

Emissivity

Material	**1 µm**	**1.6 µm**	**2.3 µm**	**3.9 µm**	**5 µm**	**7.9 µm**	**8 – 14 µm**
Monel (Ni-Cu)	0.3	0.2-0.6	0.2-0.6	0.1-0.5	0.1-0.5	0.10-0.25	0.1-0.14
Oxidized						0.60-0.85	0.7-0.9
Nickel							
Oxidized	0.8-0.9	0.4-0.7	0.4-0.7	0.3-0.6	0.3-0.6	0.80-0.95	0.2-0.5
Electrolytic	0.2-0.4	0.1-0.3	0.1-0.2	0.1-0.15	0.1-0.15		0.05-0.15
Platinum							
Black		0.95	0.95	0.9	0.9		0.9
Silver		0.02	0.02	0.02	0.02	0.03-0.15	0.02
Steel							
Cold-Rolled	0.8-0.9	0.8-0.9		0.8-0.9	0.8-0.9		0.7-0.9
Ground Sheet			0.6-0.7	0.5-0.7	0.5-0.7		0.4-0.6
Polished Sheet	0.35	0.25	0.2	0.1	0.1	0.10-0.25	0.1
Molten	0.35	0.25-0.4	0.25-0.4	0.1-0.2	0.1-0.2		
Oxidized	0.8-0.9	0.8-0.9	0.8-0.9	0.7-0.9	0.7-0.9	0.80-0.95	0.7-0.9
Stainless	0.35	0.2-0.9	0.2-0.9	0.15-0.8	0.15-0.8	0.10-0.25	0.1-0.8
Tin (Unoxidized)	0.25	0.1-0.3	0.1-0.3	0.05	0.05		0.05
Titanium							
Polished	0.5-0.75	0.3-0.5	0.2-0.5	0.1-0.3	0.1-0.3		0.05-0.2
Oxidized		0.6-0.8	0.6-0.8	0.5-0.7	0.5-0.7		0.5-0.6
Tungsten			0.1-0.6	0.05-0.5	0.05-0.5		0.03
Polished	0.35-0.4	0.1-0.3	0.1-0.3	0.05-0.25	0.05-0.25	0.05-0.20	0.03-0.1
Zinc							
Oxidized	0.6	0.15	0.15	0.1	0.1		0.1
Polished	0.5	0.05	0.05	0.03	0.03	0.15-0.25	0.02

Table 11-2: Typical Emissivity Values for Non-Metals

	NON-METALS					
	Emissivity					
Material	**1 µm**	**1.6 µm**	**2.3 µm**	**5 µm**	**7.9 µm**	**8 – 14 µm**
Asbestos	0.9		0.8	0.9		0.95
Asphalt				0.95	0.95-1.00	0.95
Basalt				0.7		0.7
Carbon						
Unoxidized	0.8-0.95		0,8-0,9	0.8-0.9		0.8-0.9
Graphite	0.8-0.9		0.8-0.9	0.7-0.9	0.45-0.70	0.7-0.8
Carborundum			0.95	0.9		0.9
Ceramic	0.4		0.8-0.95	0.8-0.95		0.95
Clay			0.8-0.95	0.85-0.95		0.95
Coke	0.95-1.00	0.95-1.00	0.95-1.00	0.95-1.00	0.95-1.00	0.95-1.00
Concrete	0.65		0.9	0.9		0.95
Cloth				0.95		0.95
Glass						
Plate			0.2	0.98	0.98	0.85
“Gob”			0.4-0.9	0.9		
Gravel				0.95		0.95
Gypsum				0.4-0.97		0.8-0.95
Ice						0.98
Limestone				0.4-0.98		0.98
Paint (non-al.)					0.90-1.00	0.9-0.95
Paper (any color)				0.95	0.90-1.00	0.95
Plastic, opaque at 500 µm thickness (20 mils)				0.95		0.95
Rubber				0.9	0.95-1.00	0.95
Sand				0.9		0.9
Snow						0.9
Soil						0.9-0.98
Water						0.93
Wood, Natural				0.9-0.95	0.90-1.00	0.9-0.95