Thermalert® 4.0 Series

Smart Integrated Infrared Sensors

Users Manual

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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.

The foregoing warranty is in lieu of all other warranties, expressed or implied, including but not limited to any implied warranty of merchantability, fitness, or adequacy for any particular purpose or use. The manufacturer shall not be liable for any special, incidental or consequential damages, whether in contract, tort, or otherwise.

Software Warranty

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

This manual is available in different languages. In case of differences between the language versions, the English manual is binding.

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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 Compliance
amended by Directive (EU) 2015/863

EC –   Directive 2014/34/EU – ATEX
valid for models: T40-xx-xx-xxx-x-IS

EC –   Directive Nr. 1907/2006 – REACH
amended by Directive (EU) 2020/2096

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)
EN 60079-0: 2019	Risk of explosion – part 0: general requirements (ATEX)
EN 60079-11: 2012	Risk of explosion – part 11: device protection by intrinsic safety "I" (ATEX)

Conforms to UK Conformity. Except for units with intrinsically-safe rating.

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.
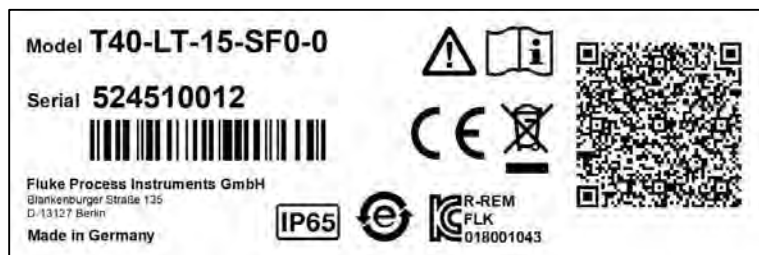
Exemplary product label for standard model

Exemplary product label for HART model

Exemplary product label for model with intrinsically-safe rating

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
	Disposal of old instruments should be handled according to professional and environmental regulations as electronic waste.
IP65	International Ingress Protection Marking
40	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:
  o Earth grounding of the cable shield
  o Installing the unit's metallic enclosure on an earth grounded mounting bracket or on any other grounded bases
  o Protect the operator from electrostatic discharge

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 2300°C (-40 to 4172°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
- Power over Ethernet (PoE)
- PROFINET IO, EtherNet/IP, or HART fieldbus communications
- Intrinsically safe rating for installation in hazardous areas (ATEX / IECEx)
- Dedicated models to detect flames and gases
- Rugged accessories for harsh industrial environments
- Software for remote configuration, monitoring and field calibration

The following Thermalert 4.0 model variants are available:

T40	–	**LT**	–	**07**	–	**SF0**	–	**0**	–	**IS**
Series:		Spectral:		Optics:		Focus:		Interface:		Rating
Thermalert 4.0		LT		04		SF0		0 = 2 wire		IS = intrinsically-safe
		LTB		07		SF2		1 = 6 wire		rating
		LTD		15		SF4		2 = 12 wire		(for interface variant -6
		MT		20		CF0		3 = Ethernet		only)
		HT		30		CF1		4 = EtherNet/IP		
		G5		50		CF2		5 = PROFINET IO		
		G7		60				6 = HART (2 wire)		
		CO		70						
		NOX		150						
		CO2								
		P3								
		P7								
		3M								
		2M								
		1ML								
		1MH								

Example: T40-LT-07-SF0-6-IS

Figure 1-1: Available Models

2-Wire
4 to 20 mA, Alarm, USB

4-Wire
Ethernet, EtherNet/IP, PROFINET IO

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)
LTB-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)
LTD-04	-20 to 500°C (-4 to 932°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)
CO-30	120 to 1650°C (248 to 3002°F)
NOX-30	120 to 1650°C (248 to 3002°F)
CO2-30	120 to 1650°C (248 to 3002°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)
3M-70	100 to 600°C (212 to 1112°F)
2M-150	250 to 1400°C (482 to 2552°F)
1ML-150	500 to 1650°C (932 to 3002°F)
1MH-150	650 to 2300°C (1202 to 4172°F)

Spectral Response

LT-07	8 to 14 µm
LT-15	8 to 14 µm
LT-30	8 to 14 µm
LTB-30	8 to 14 µm
LT-50	8 to 14 µm
LT-70	8 to 14 µm
LTD-04	8 to 14 µm
P7-30	7.9 µm
G7-70	7.9 µm
G5-30	5 µm
G5-70	5 µm
CO-30	4.64 µm
CO2-30	4.24 µm
NOX-30	4.47 µm

MT-30	3.9 µm
MT-70	3.9 µm
P3-20	3.43 µm
HT-60	2.2 µm
3M-70	2.3 µm
2M-150	1.6 µm
1ML-150	1 µm
1MH-150	1 µm

Response Time[1]

LT-07	150 ms
LT-15	150 ms
LT-30	30 ms
LTB-30	30 ms
LT-50	130 ms
LT-70	130 ms
LTD-04	150 ms
P7-30	130 ms
G7-70	130 ms
G5-30	60 ms
G5-70	60 ms
CO-30	130 ms
CO2-30	130 ms
NOX-30	130 ms
MT-30	130 ms
MT-70	130 ms
P3-20	130 ms[2]
HT-60	130 ms
3M-70	20 ms
2M-150	10 ms
1ML-150	10 ms
1MH-150	10 ms

System Accuracy[3]

P3	$\pm$ (3°C + 1% of reading) for T_{meas} > 75°C (167°F)
1M, 2M, 3M	$\pm$ (2°C + 0.5% of reading)
CO	$\pm$ 1% of reading or $\pm$ 5°C (10°F)
CO2	$\pm$ 1% of reading for T_{meas} > 700°C (1292°F) $\pm$ 2% of reading or $\pm$ 6°C (12°F) for T_{meas} ≤ 700°C (1292°F)
NOX	$\pm$ (2°C + 1% of reading)

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[1] 90% value
[2] 10 s for T_{meas} < 150°C (302°F)
[3] at ambient temperature 23°C ± 5°C (73°F ± 9°F), emissivity = 1.0 and calibration geometry

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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
Thermocouple output	± 1°C (2°F), in addition to the system accuracy

The system accuracy is valid for temperature values provided via the digital interface, the mA output and the V output. When using the thermocouple output, an additional measurement uncertainty must be considered.

Note
To maintain the specified accuracy, it is recommended to calibrate the instrument annually.

Repeatability[4]

P3	± 1°C (2°F) or 0.5% of reading, whichever is greater
1M, 2M, 3M	± (1°C + 0.25% of reading)
CO	± 0.5% of reading or ± 2.5°C (5°F)
CO2	± 0.5% of reading for T_{meas} > 700°C (1292°F)
	± 1% of reading or ± 3°C (12°F) for T_{meas} ≤ 700°C (1292°F)
NOX	± 0.5% of reading
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

4-, 6-, 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

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[4] at ambient temperature 23°C ± 5°C (73°F ± 9°F), emissivity = 1.0 and calibration geometry

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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
LTB-30	33:1	SF0, CF1, CF2
LT-50	50:1	SF0, CF2
LT-70	70:1	SF2, CF2
LTD-04	4:1	SF0
P7-30	33:1	SF0
G7-70	70:1	SF2
G5-30	33:1	SF0
G5-70	70:1	SF2
CO-30	33:1	SF0
CO2-30	33:1	SF0
NOX-30	33:1	SF0
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
3M-70	70:1	SF0, CF2
2M-150	150:1	SF0, CF2
1ML-150	150:1	SF0, CF2
1MH-150	150:1	SF0, 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 15.1 Optical Diagrams, page 108.

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

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Smallest Measurement Spot

LT-07-CF	7.1 mm (0.28 in)
LT-30-CF1	2.3 mm (0.09 in)
LT-30-CF2	6.1 mm (0.24 in)
LTB-30-CF1	2.3 mm (0.09 in)
LTB-30-CF2	6.1 mm (0.24 in)
LT-50-CF2	4 mm (0.16 in)
LT-70-SF2	17.9 mm (0.7 in)
LT-70-CF2	2.9 mm (0.11 in)
G7-70-SF2	17.9 mm (0.7 in)
G5-70-SF2	17.9 mm (0.7 in)
MT-30-CF1	2.3 mm (0.09 in)
MT-30-CF2	6.1 mm (0.24 in)
MT-70-SF2	17.9 mm (0.7 in)
MT-70-CF1	1.1 mm (0.04 in)
MT-70-CF2	2.9 mm (0.11 in)
HT-60-CF1	1.3 mm (0.05 in)
HT-60-CF2	3.3 mm (0.13 in)
1ML-150-SF0	10.1 mm (0.4 in)
1ML-150-CF2	1.3 mm (0.05 in)
1MH-150-SF0	10.1 mm (0.4 in)
1MH-150-CF2	1.3 mm (0.05 in)
2M-150-SF0	10.1 mm (0.4 in)
2M-150-CF2	1.3 mm (0.05 in)
3M-70-CF2	2.9 mm (0.11 in)

Laser

All models   laser available per standard
(except LT-07, LT-15, LTB-30, LTD-04, CO-30, NOX-30, CO2-30, P3 and HART models)

2-wire devices require an additional power supply via USB

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2.3 Electrical Specifications

2.3.1 Model 2-Wire

Voltage Supply	depending on loop impedance, see Table 5-3: Minimum Voltage Supply, page 40
Sensor voltage	12 to 24 VDC (+20%)
Residual ripple	≤ 100 mV (peak-to-peak)

Outputs

Analog	4 to 20 mA, loop impedance max. 750 Ω
Alarm	24 V / 150 mA
USB	version 2.0, micro-B connector (only for the setup of the instrument)

2.3.2 Model HART, 2-Wire

Voltage Supply	depending on loop impedance, see Table 5-3: Minimum Voltage Supply, page 40
Sensor voltage	12 to 24 VDC (+20%)

Outputs

Analog	4 to 20 mA, loop impedance max. 750 Ω
Alarm	24 V / 150 mA (deactivated for intrinsically-safe models -IS)
Digital	HART communication, 1200 Bit/s, 8 bits, odd parity for further information, see "HART Communication Protocol" manual

2.3.3 Model Fieldbus, 4-Wire

Power	Power over Ethernet IEEE 802.3af, pinout mode A, mixed DC & data

Ethernet

Connection	M12 socket, 4 wires (full duplex) 100 MBit/s, 100BASE-TX / IEEE 802.3u, Auto-Negotiation electrically isolated from power supply
Addressing	DHCP or fixed IP address
Protocols	UDP, default port 6363 TCP/IP version 4, default port 6363 http web server (port 80) PROFINET IO, see section 8 PROFINET IO, page 63 EtherNet/IP, see section 9 EthernNet/IP, page 66

Default Settings

IP Address	192.168.42.134
Subnet Mask	255.255.255.0
Gateway	192.168.42.1
BootP Request	disabled
DHCP Request	disabled
MAC address	see sticker on the sensor

The 4-wire version is not available for LTB-30 models.

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2.3.4 Model 6-Wire

Power	+ 24 VDC nominal (20 to 48 VDC), 100 mA @ 24 V
Residual ripple	≤ 100 mV (peak-to-peak)

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. 750 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.

2.3.5 Model 12-Wire

Power	+ 24 VDC nominal (20 to 48 VDC), 100 mA @ 24 V
Residual ripple	≤ 100 mV (peak-to-peak)

Outputs

Analog	0 to 20 mA (active), or
	4 to 20 mA (active), or
	0 to 10 V
	current loop impedance: max. 750 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
IS rated models	-20 to 80°C (-4 to 176°F) without cooling
Storage temperature	-20 to 85°C (-4 to 185°F)
Humidity	10% to 95% @ 30°C (86°F), non-condensing (operating and storage)
Shock	50 g, 11 ms, 3 axes, 3 times in each axis (IEC 60068-2-27)[6]
Vibration	3 g, 10 – 200 Hz, 3 axes, each axis for 2 h (IEC 60068-2-6)[7]
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)

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[6] at ambient temperature 23°C ± 5°C (73°F ± 9°F), humidity 25 to 75%
[7] at ambient temperature 23°C ± 5°C (73°F ± 9°F), humidity 25 to 75%

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2.5 Dimensions

2.5.1 Model 2-Wire / 6-Wire

Figure 2-1: Dimensions for the 2-Wire and 6-Wire Model
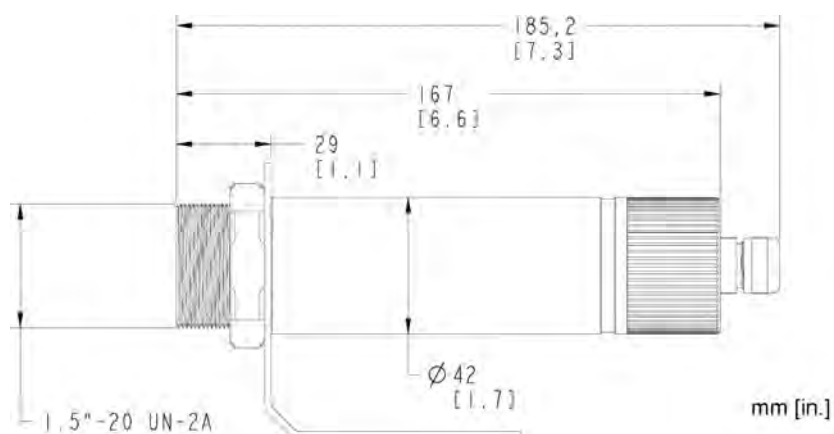
2.5.2 Model Fieldbus, 4-Wire

Figure 2-2: Dimensions for the 4-Wire Model, Fieldbus
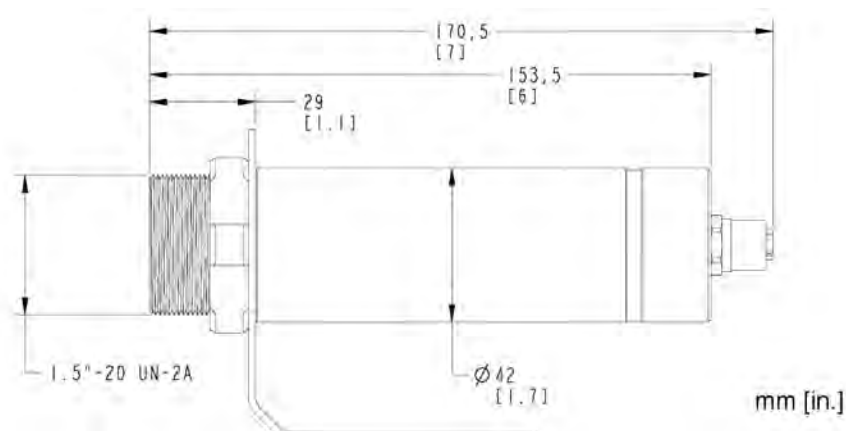
2.5.3 Model 12-Wire

Figure 2-3: Dimensions for the 12-Wire Model
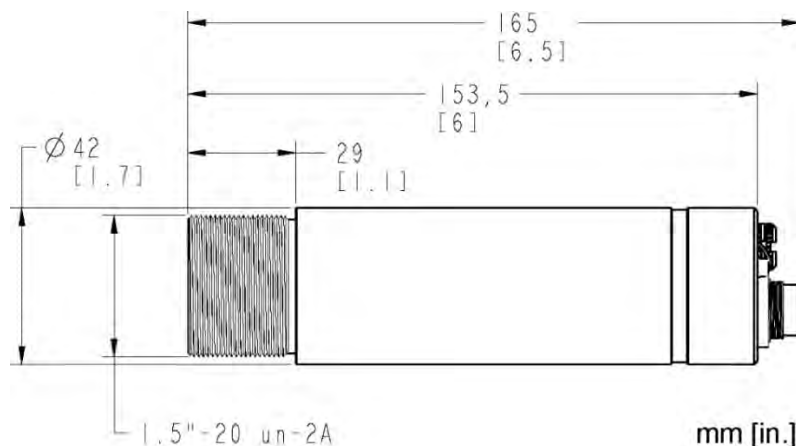
2.6 Scope of Delivery

The scope of delivery includes the following:

- Sensor
- Mounting nut (not for LTB model)
- Fixed bracket (not for LTB model)
- USB cable, only for the setup of the instrument (not for LTB and 4-wire models)
- Operator's manual (as pdf file on data carrier)
- Quick Start Guide (printed)
- PC Software (on data carrier)

- Air Purge (dedicated for LTD models only)

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 15.4 Typical Emissivity Values, page 125. 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.

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4 Environment

4.1 Ambient Temperature

In many cases there is a poor understanding of the actual temperatures at the site where the sensor is mounted. While process temperatures are typically very well monitored and controlled, there is ambient conditions around the process have no bearing on product throughput or quality and therefore remain unknown.

In all cases it is recommended to perform considerable testing. The external temperature can be measured at the surface of the instrument. For automated monitoring, the sensor also provides its internal temperatures via the PC software or via the digital interface. Alternatively, the sensor-internal alarm relay (if present) can be switched if the maximum permissible internal temperature is threatened to be exceeded.

Note
Without additional cooling, the maximum permitted internal operating temperature of the sensor of max.
85°C (185°F) must not be exceeded!

The internal operating temperature can be extended using cooling accessories. For the available extension stages of the cooling equipment, see section 2.4 Environmental Specifications, page 26.

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 13.2.9 Air Purge , page 100. 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)
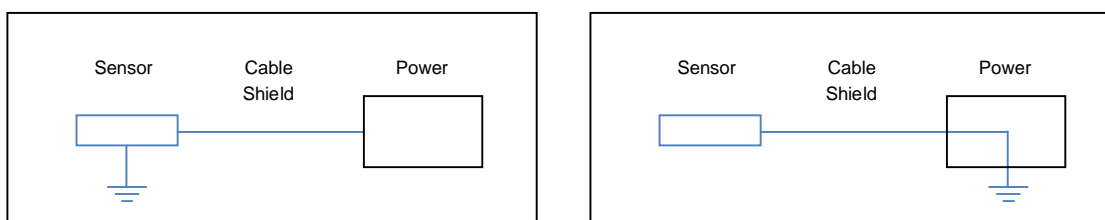
Note
The metal housing of the sensor is electrically connected to the shield of the sensor's cable.

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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

Isolation
+ VDC
GND
+ Analog Out
AGND
Isolation
RS485-A
RS485-B
Housing
Shield
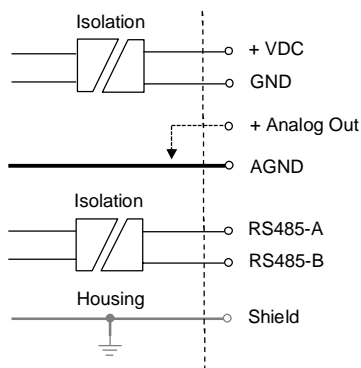
Figure 4-3: Principle of the Galvanic Isolation for the 12-Wire Model

Isolation
+ VDC (M)
GND (L)
Trigger (F)
+ Analog Out (J)
AGND (K)
FTC1 (C)
FTC2 (D)
Isolation
RS485-A (A)
RS485-B (B)
Isolation
Relay (G)
Relay (H)
Housing
Shield (E)
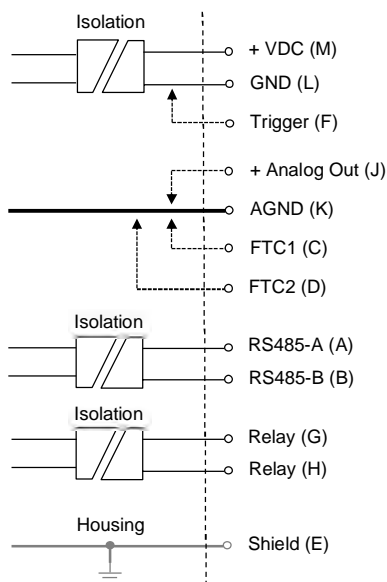
5 Installation

⚠️ **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 22. The manufacturer provides a tool for calculating spot sizes, see section 15.2 Spot Size Calculator, page 124.

Figure 5-1: Proper Sensor Placement
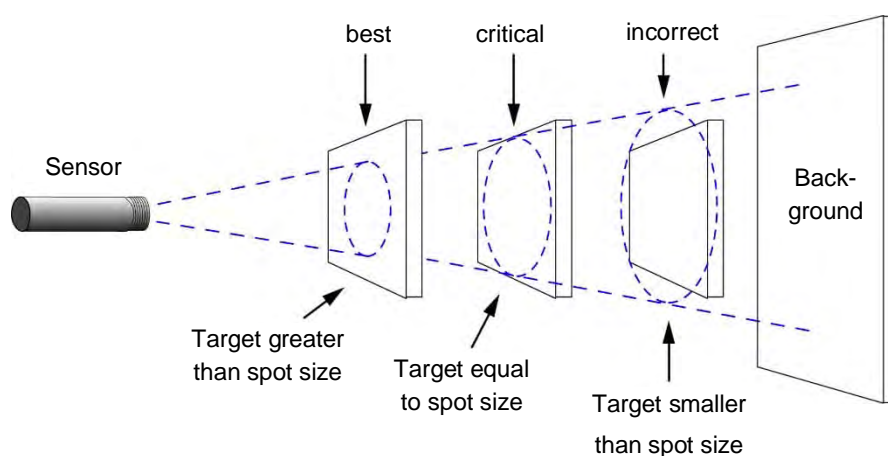
5.3 Viewing Angles

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

Figure 5-2: Acceptable Sensor Viewing Angles

Best
perpendicular
to target

Acceptable
Angles

Good
up to 45° to target

Bad
45° to 90° to target

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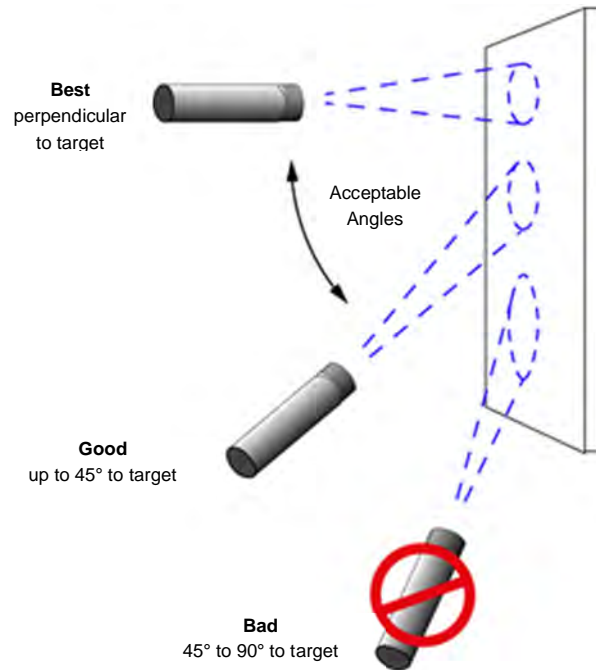
5.4 Model 2-Wire

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 and Emissivity Preset at 0.95
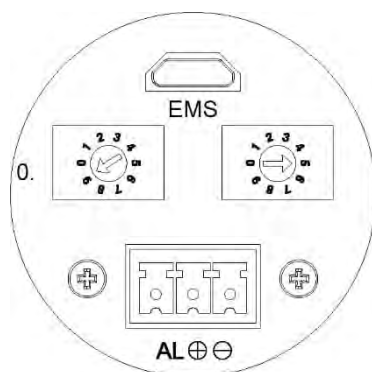
Table 5-1: Terminal Connections

Designation	Description
AL	alarm output
$\oplus$	positive signal (4 to 20 mA) and positive power supply
$\ominus$	negative signal (4 to 20 mA) and ground

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 0.95. The appendix lists typical emissivity values for common materials, see section 15.4 Typical Emissivity Values, page 125.

The smallest adjustable emissivity is 0.10. In the switch positions below 0.10, the device enters the test mode and provides the functions listed below.

Table 5-2: Test Modes

Emissivity Switch	Test Mode
0.01	Current output permanently provides 4 mA
0.02	Current output permanently provides 20 mA
0.03	Alarm relay permanently toggles between "open" and "closed"
0.04	Current output provides internal case temperature Scaling is fixed to -40 to 120°C (-40 to 248°F)
0.05	reserved
0.06	reserved
0.07	reserved
0.08	reserved
0.09	reserved

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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). Note that it might be necessary
to additionally seal the cable entry to allow IP65 with smaller cables!

Note
To improve the assembly ability, the threads of the end cap and sensor are greased with silicone.

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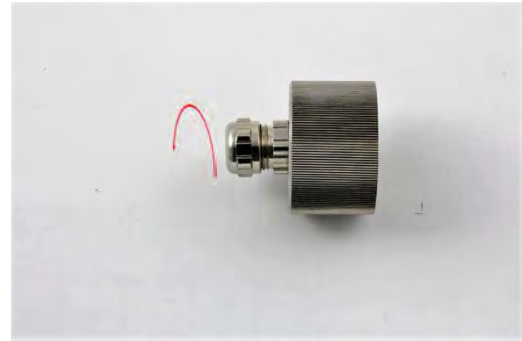
Step 3
The cable gland consists of a PG nut (1), a relief bushing (2)
and a metal cone ring (3).

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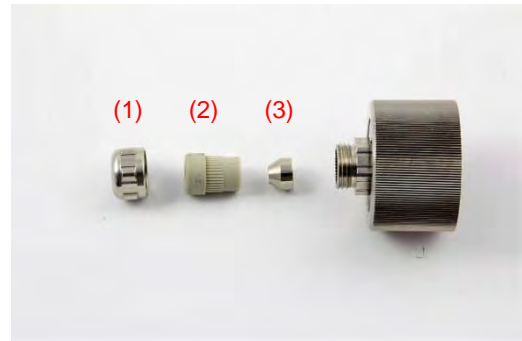
Step 4

Put the following on the cable: the PG nut (1) and the relief bushing (2).
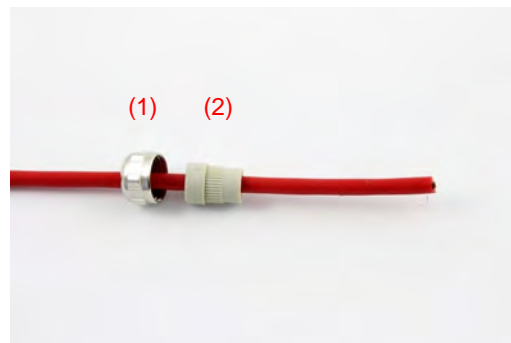
Step 5

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.
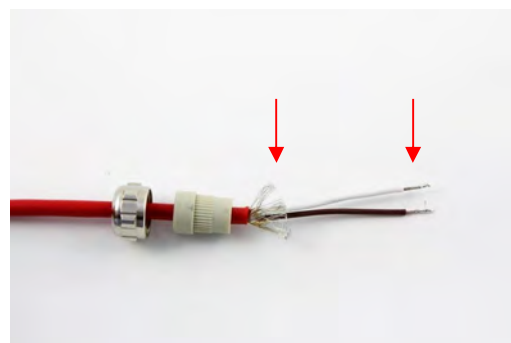
Step 6

Feed the prepared cable with the metal cone ring.
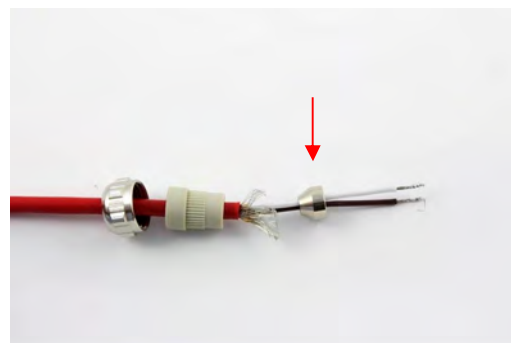
Step 7

Make sure to have a proper contact between the braided shield and the metal cone ring.
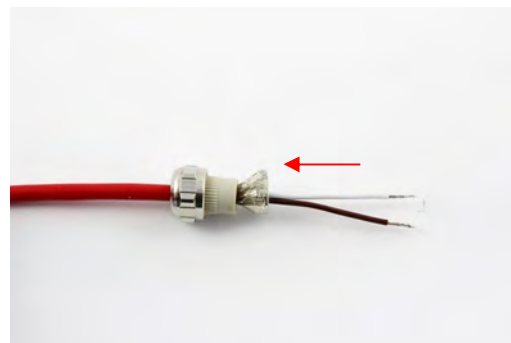
Step 8

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

Step 9

Connect the wires to terminal connector.
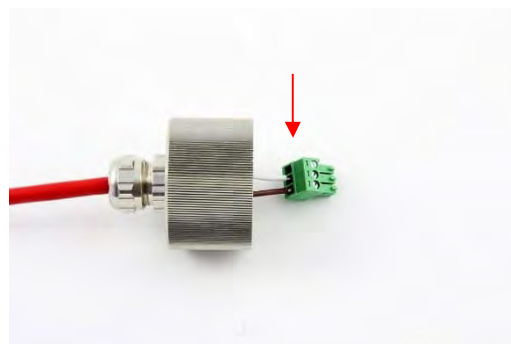
Step 10

Plug the terminal connector in the unit.
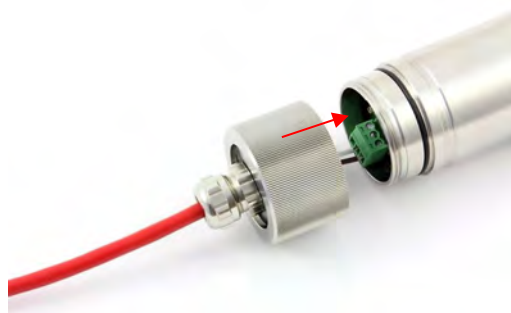
Step 11

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.
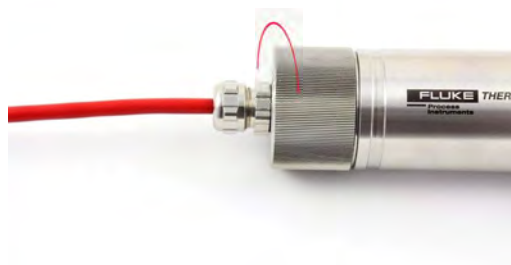
5.4.3 mA Single Loop

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
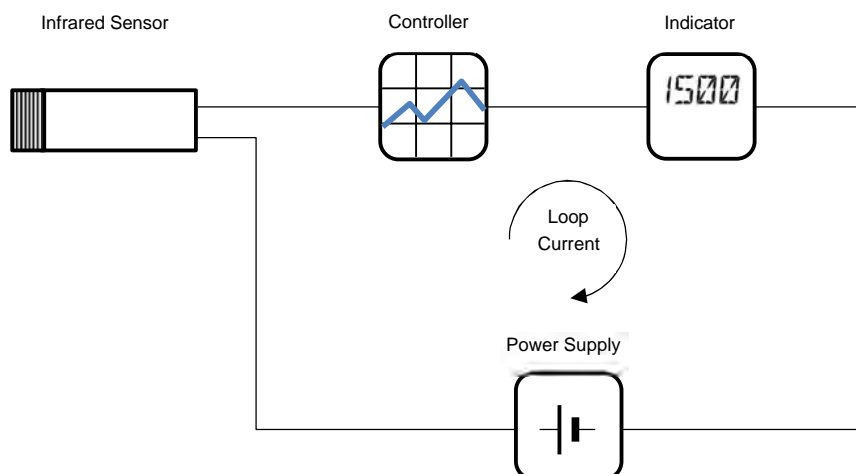
The infrared sensor operates at any supply voltage between 12 and 24 V direct current. For indicators, recorders, and other load elements, pay strict attention to the load resistance and, of course, the zero scale and full scale currents. Part of the power supply voltage is dropped across the load and 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
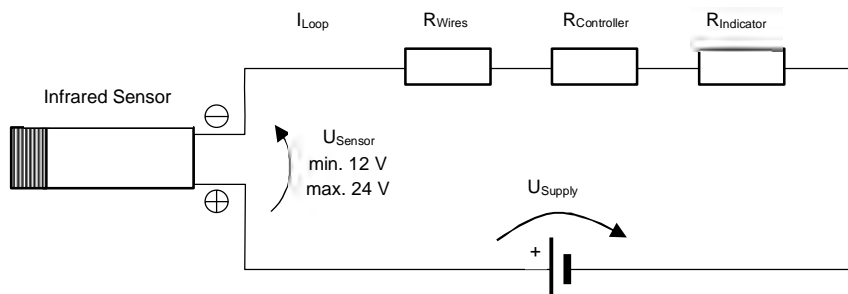
Assume the resistances are as follows:

$R_{Wires} = 3\Omega$

$R_{Controller} = 90\Omega$

$R_{Indicator} = 7\Omega$

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:

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

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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 the minimum voltage supply. Be sure to total up all load resistance in the loop and add cable resistance if it will have a noticeable effect on loop resistance.

Table 5-3: Minimum Voltage Supply

Total Load Resistance R_{Load}	Total Load Voltage at 20 mA U_{Load}	Minimum Voltage Supply U_{Supply}
0 Ω	0 V	12 V
50 Ω	1 V	13 V
100 Ω	2 V	14 V
200 Ω	4 V	16 V
300 Ω	6 V	18 V
400 Ω	8 V	20 V
500 Ω	10 V	22 V
600 Ω	12 V	24 V
750 Ω	15 V	27 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
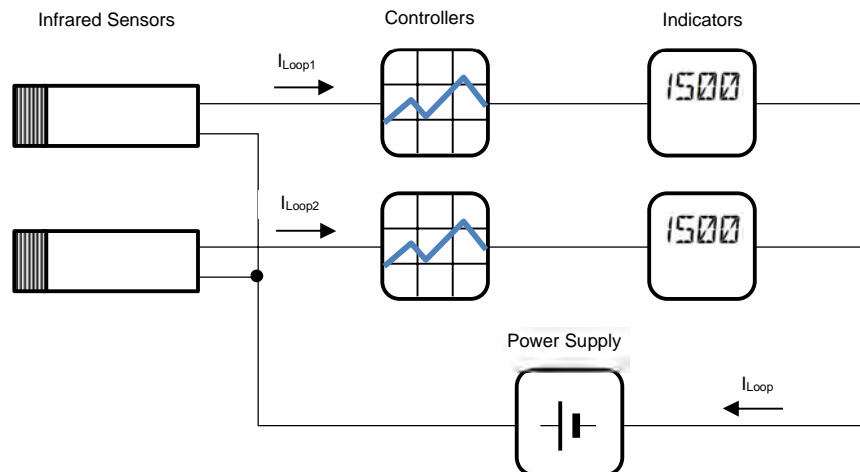
5.4.5 Alarm Output AL

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

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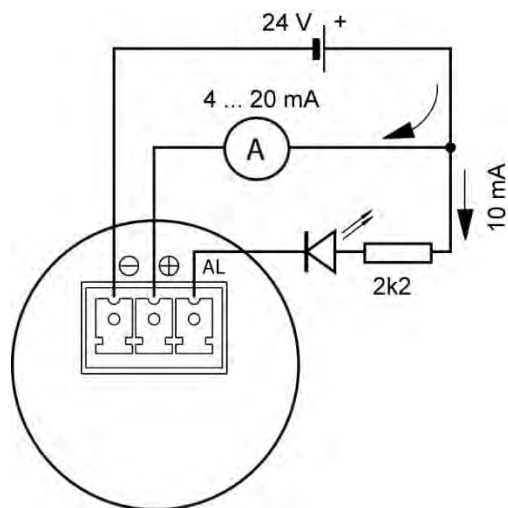
5.5 Model HART, 2-Wire

The HART model provides digital communication via a standard two-wire current loop output.

5.5.1 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 5-8: Rear Panel for the HART 2-Wire Model
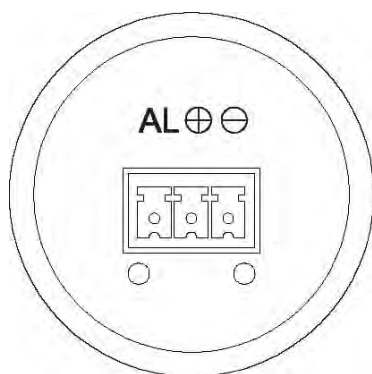
Table 5-4: Terminal Connections

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

5.5.2 Cable Connection

The sensor cable must be provided by the user. For the assembling steps, see section 5.4.2 Cable Connection, page 36.

5.5.3 mA Loop

For comprehensive descriptions on the mA current loop, see section 5.4.3 mA Single Loop, page 38 and section 5.4.4 mA Multiple Loops, page 40

5.5.4 Alarm Output AL

The HART mode, 2-wire, supports alarm functionality. For detailed information on the alarm output, see section 5.4.5 Alarm Output AL, page 41.

Note
The connection for the alarm output is also accessible for the intrinsically safe devices, but the alarm function is deactivated and therefore not available!

5.6 Model Fieldbus, 4-Wire

5.6.1 Wiring

The 4-wire model fieldbus supports a M12 plug-in connector, 4 pin D-coded, and a screw retention feature.

Figure 5-9: M12 Connector Socket and Pin Assignment

M12-Pin	
1	TX+
2	RX+
3	TX-
4	RX-

For appropriate cables, see section 13.1.3 Ethernet PoE Cable (A-CB-xx-M12-W04-xx), page 82.

The 4-wire fieldbus models are supplied with power via the PoE standard (Power over Ethernet). PoE allows a single cable to provide both data connection and electric power to the sensor. The following figure shows exemplarily the connection to a PC.

Figure 5-10: Sensor Connection to a PC using PoE
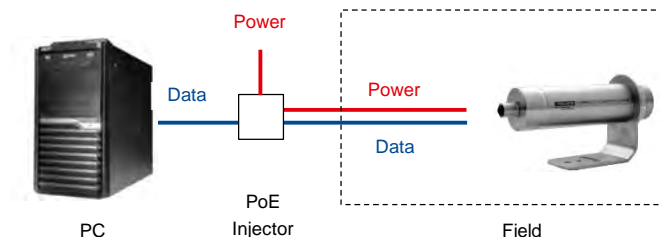
5.6.2 Sensor Address

The factory default IP address for the Thermalert 4.0 sensor is 192.168.42.134

The last valid address is 254.

The IP address for the sensor is not free of choice: It must be unique in the network meaning that no other device in the network including the PC network adapter may run at the same IP address.

Note
Ask your IT administrator for a free IP address to be used!

5.6.2.1 Advanced Addressing

Subnet Mask:

The Subnet Mask defines the interpretation of the IP address. The factory default setting is 255.255.255.0. The Subnet Mask can be changed using the ASCII command NM.

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Port:

In the case that the default port for the sensor should conflict with something else (it could be blocked by the firewall for example) it can be changed using the ASCII command PORT.

Gateway:

A gateway connects two subnets (which have a different subnet address). The IP address of the gateway is given with the ASCII command GW.

Note
To establish the Ethernet communication, the subnet addresses for both the Thermalert 4.0 sensor and the PC need to match! Appropriate changes can be applied either on the sensor side or on the PC network adapter!

Note
The current settings for the IP address and the netmask of the PC can be asked with the command <ipconfig> in a Command Prompt window!

Figure 5-11: Command Prompt Window
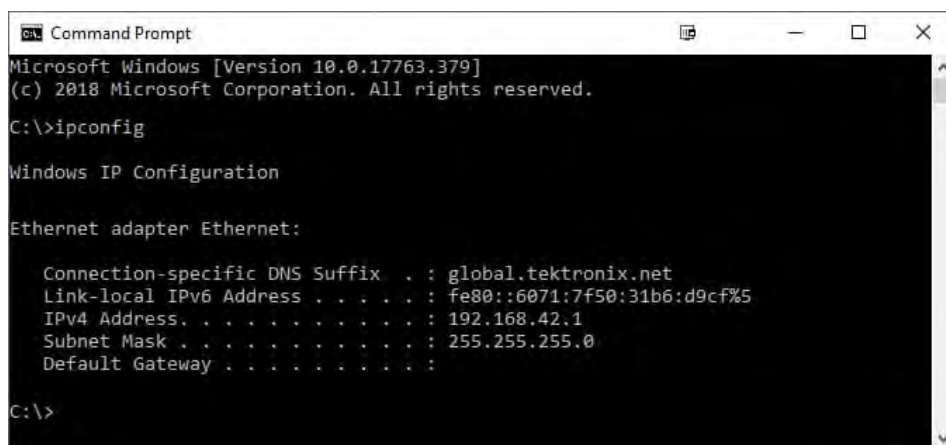
For the example above, the IP address of the PC is 192.168.42.1. The subnet address is 192.168.42, the host address is 1. The subnet address for the Thermalert 4.0 sensor must be 192.168.42 as well. The host address of the sensor must be in the range from 2 to 254 (address 1 is already used for the PC).

5.6.2.2 Reset Addressing

To reset the network settings of the sensor, power up the device for 12 s then power off. Repeat the on/off procedure three times.

The reset sets the following parameter back to factory default:

IP Address	192.168.42.134
Subnet Mask	255.255.255.0
Gateway	192.168.42.1

A new IP address can be assign using the IP command.

5.6.3 PC Network Adapter

The network adapter on the PC side can be configured as following:

1. Go to <Start> <Settings> <Network & Internet> <Change adapter options>

2. Click on <Properties>:
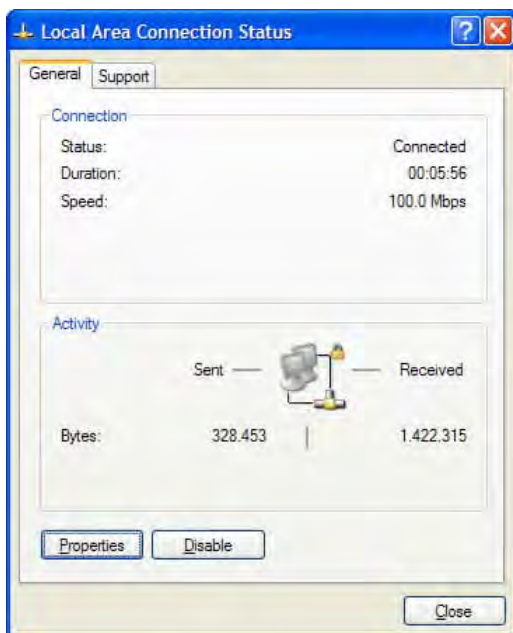
3. Under <This connection uses the following items> select <Internet Protocol (TCP/IPv4)> and click on <Properties>:
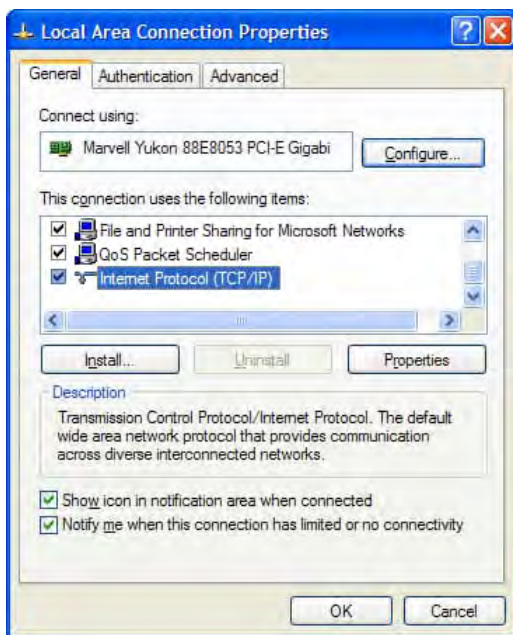
4. Activate the radio button <Use the following IP address> and make the following settings:
   IP address: 192.168.42.x
                                where x is an address between 0 and 255 except 134 which is already used by
                                the Thermalert 4.0 sensor by factory default
   Subnet mask: 255.255.255.0
   Default gateway: {empty}
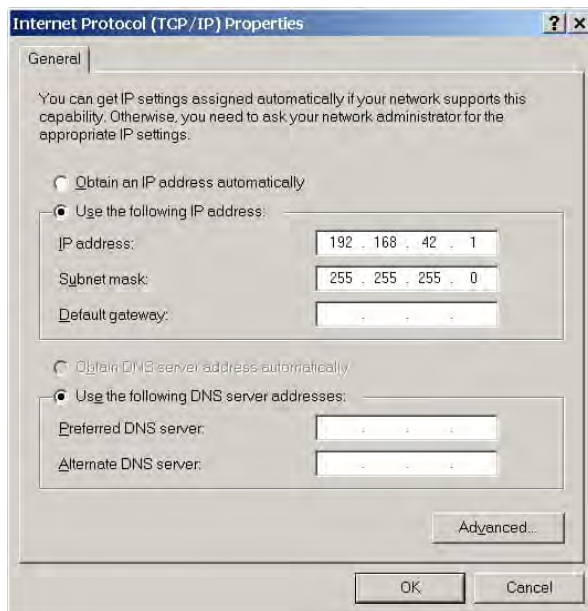
5.   Close all dialog boxes by pressing on <OK>.

5.6.4 ASCII Programming

For the programming details, see section 10 ASCII Programming, page 69.

5.6.5 http Server

The Thermalert 4.0 sensor with Ethernet provides a built-in http server for one or more client computers based on the http protocol within an Intranet. Several information is available – such as actual measured temperature and internal case temperature. For accessing the sensor's web interface, a standard web browser can be used. For that, you have to provide the current IP address of the sensor.

5.7 Model 6-Wire

5.7.1 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 5-12: Rear Panel for 6-Wire Sensor

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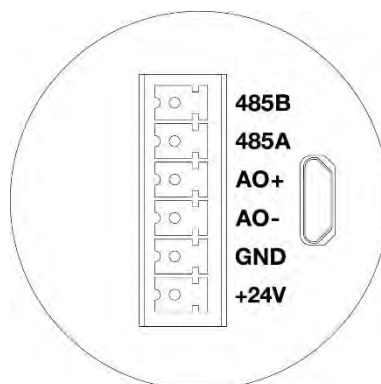
5.7.2 Cable Connection

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). Note that it might be necessary to additionally seal the cable entry to allow IP65 with smaller cables!

5.7.3 Terminal Strip

Table 5-5: 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

5.7.4 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.

5.7.4.1 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 750 Ω.

For the principle wiring, use the installation scheme below.

Figure 5-13: Wiring Analog Out as Current Output
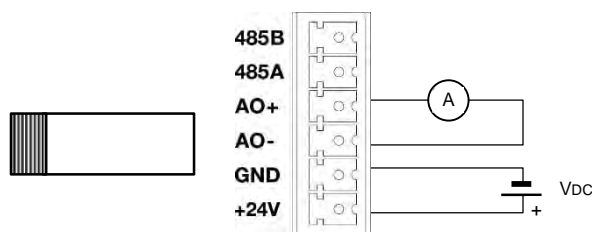
A specific feature for the testing or calibrating of connected equipment allows the current loop output to be set to specific values, under range or over range using a dedicated ASCII command. Via such functionality, you can force the instrument, operating in the 4-20 mA mode, to transmit an output current less than 4 mA (e.g. 3.5 mA) or above 20 mA (e.g. 21.0 mA).

5.7.4.2 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 5-14: Wiring Analog Out as Voltage Output
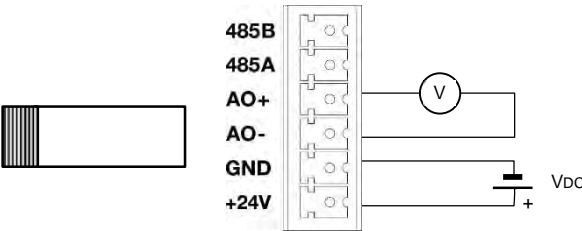
5.7.4.3 TC Output

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.

5.7.5 RS485 Communication

For detailed information on the RS485 communication see section 7 RS485, page 59.

5.8 Model 12-Wire

5.8.1 Back Panel

Figure 5-15: DIN Connector Pin Layout (pin side)
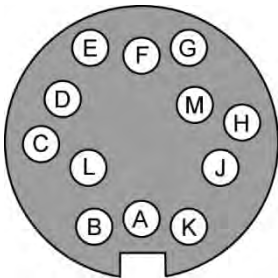
Table 5-6: Pin Assignment for DIN Connector

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

5.8.2 RS485 Communication

For detailed information on the RS485 communication, see section 7 RS485, page 59.

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5.8.3 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 5-7: Ratio between Analog Input Voltage and Emissivity (Example)

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

Use ASCII commands to configure the FTC1 input, see section 10.4.2 Emissivity Setting, page 71.

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 5-16: Adjustment of Emissivity at FTC1 Input (Example)
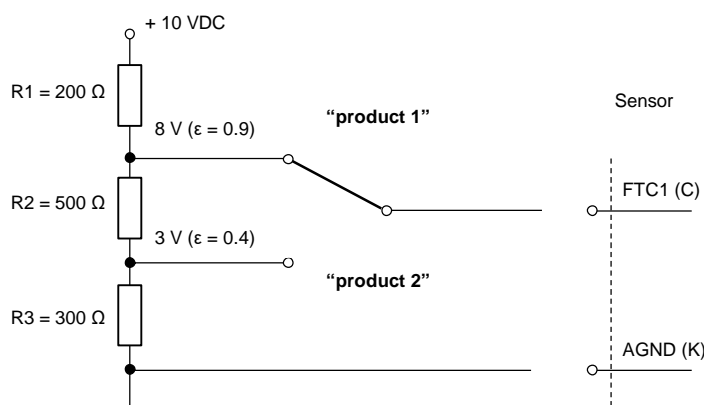
5.8.4 FTC2 – Background Temperature Compensation

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.

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- 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 5-17: Principle of Background Temperature Compensation
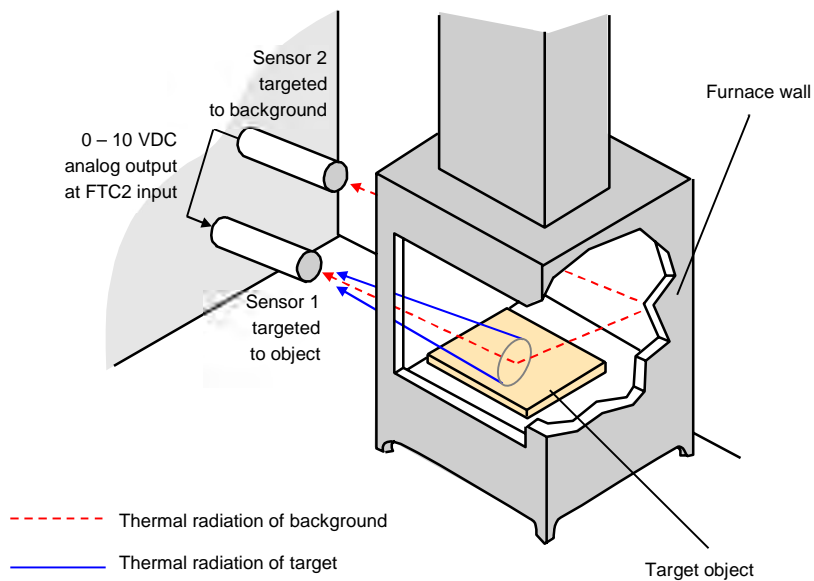
Figure 5-18: Adjustment of Background Temperature Compensation at FTC2 Input (Example)
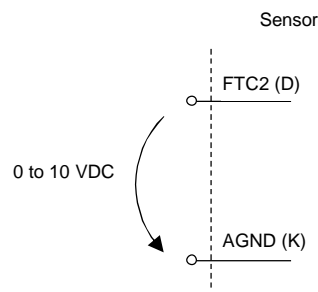
Use ASCII commands to configure the FTC2 input, see section 10.4.3 Background Temperature Compensation, page 71.

5.8.5 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.

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Figure 5-19: Wiring the Trigger Input

Sensor

Trigger (F)

GND (L)
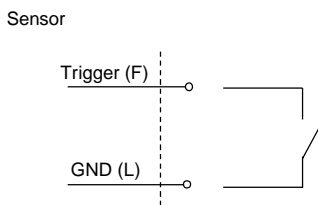
5.8.5.1 Reset

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

Figure 5-20: Resetting the Peak Hold Function

Temp.

Object temperature
Output temperature

Trigger

Time
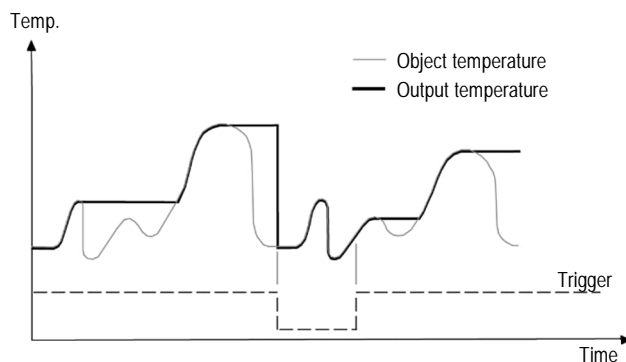
5.8.5.2 Hold

This mode acts as an externally generated hold function when the peak/valley function is active. A transition at the trigger input from logical high level toward logical low level will clear the hold value and 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 5-21: Holding the Output Temperature

Temp.

Object temperature
Output temperature

Trigger

Time
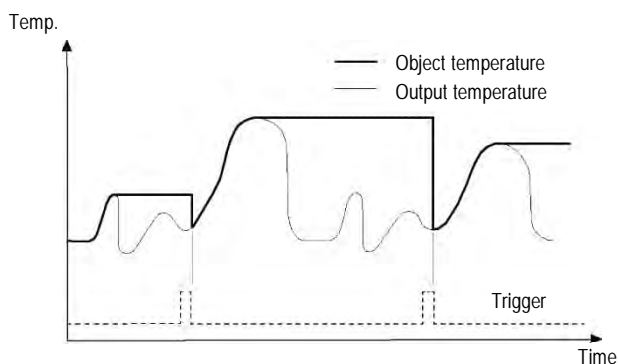
5.8.5.3 Laser

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.

5.8.6 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 5-22: Spike Voltage Limitation for the Alarm Relay
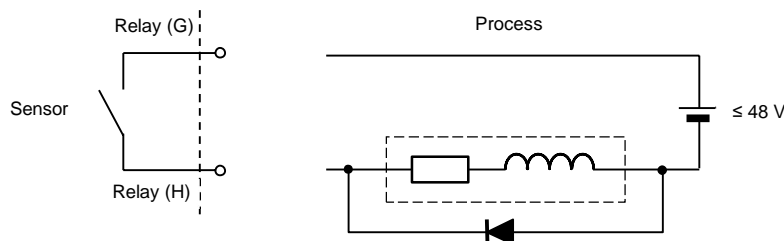
5.8.7 Analog Out

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.

5.8.7.1 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 750 Ω.

For the principle wiring, use the installation scheme below.

**Figure 5-23: Wiring Analog Out as Current Output**
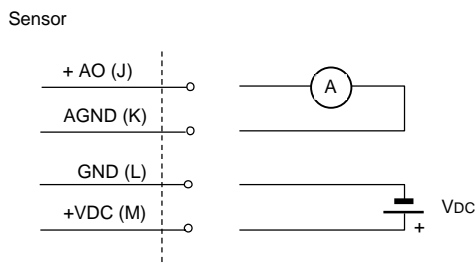
A specific feature for the testing or calibrating of connected equipment allows the current loop output to be set to specific values, under range or over range using a dedicated ASCII command. Via such functionality, you can force the instrument, operating in the 4-20 mA mode, to transmit an output current less than 4 mA (e.g., 3.5 mA) or above 20 mA (e.g., 21.0 mA).

5.8.7.2 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 5-24: Wiring Analog Out as Voltage Output
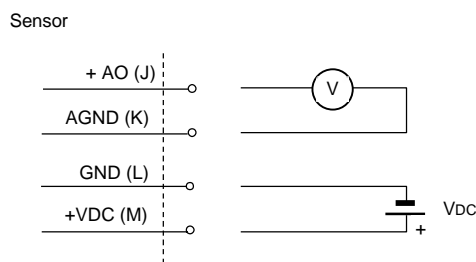
5.9 Model LTD-04

5.9.1 Assembly

The LTD-04 model consists of two components, the sensor itself and a special air purge. These two components are supplied separately in an unassembled state. Therefore, before installation, the LTD-04 model must be assembled as follows:

1. Make sure that the supplied mounting bracket - or an adequate mounting fixture - is attached to the sensor with the mounting nut.
2. There is a sticker with an arrow on the sensor body. For correct assembly, now screw the air purge onto the sensor only until the arrowhead is in line with the connection fitting for the air injection.

Figure 5-25: Assembly of the Air Purge
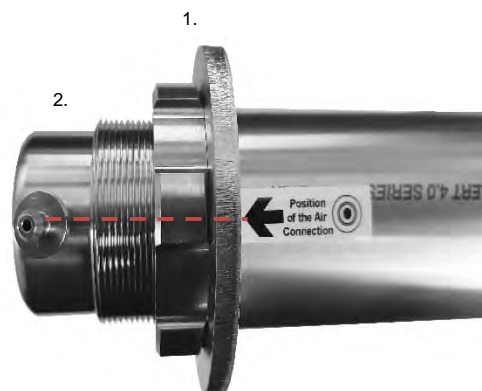
Note
The air purge is specially designed for the LTD-04 model. This air purge is not identical with the air purge according to section 13.2.9 Air Purge (A-AP), page 100.

Note
The sensor has been calibrated at the factory with the air purge installed. Deviations from the above assembly instructions may result in incorrect measurements.

Note
Each air purge is uniquely assigned to the sensor. The air purge must not be interchanged even within the LTD-04 model series.

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6 Operation

6.1 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 6-1: Laser Indication

Laser dot indicating
the spot center

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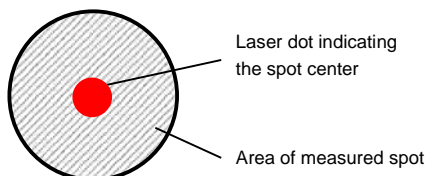
The laser is a Class II type laser with an output power less than 1 mW, and an output wavelength of 650 nm.

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!

	LASER 2	
λ = 650 nm, < 1 mW, IEC/EN 60825-1 :2014		
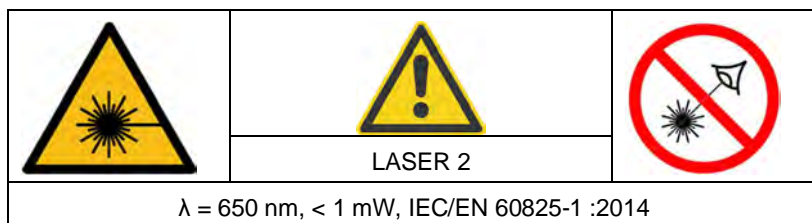
The laser automatically turns off above an internal case temperature of 50°C (122°F).

The laser is not available for the LT-07, LT-15, LTB-30, LTD-04, CO-30, NOX-30, CO2-30, P3 and HART 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.

6.2 Post Processing

6.2.1 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.

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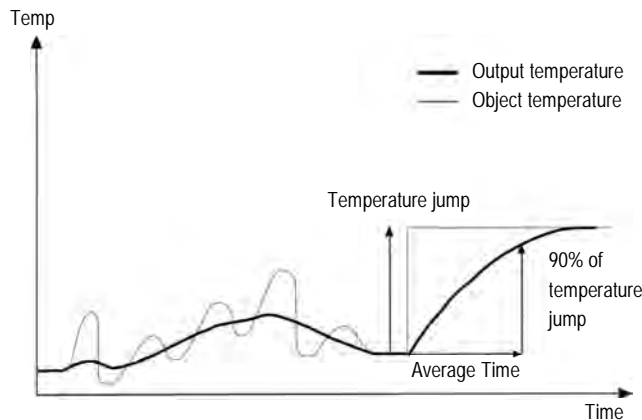
A low-level input (GND) at external trigger input will promptly interrupt the averaging and start the calculation again. For sensors without an external trigger input (2- and 6-wire models) the dedicated ASCII command should be used.

6.2.2 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 6-3: Peak Hold
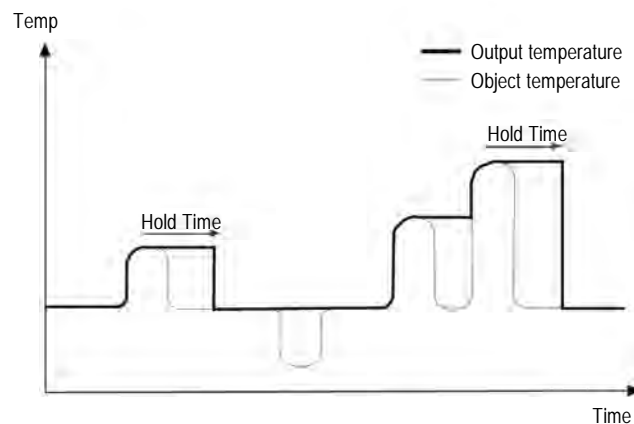
A defined hold time of 999 s will put the device into continuous peak detection mode.

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.

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6.2.3 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 6-4: Valley Hold
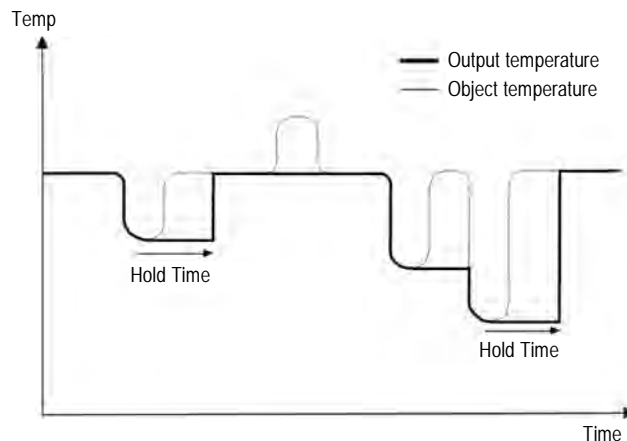
A defined hold time of 999 s will put the device into continuous valley detection mode.

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.

6.2.4 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 6-5: Advanced Peak Hold
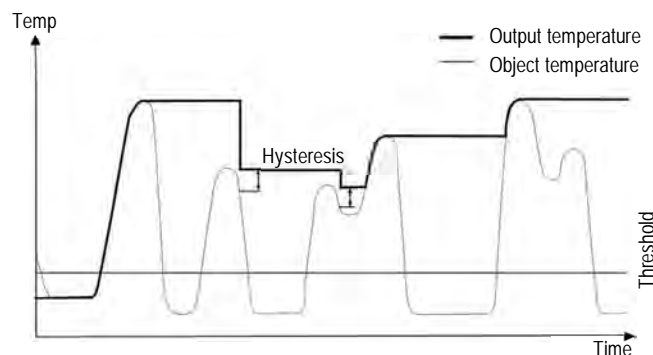
The advanced peak hold function requires the setting of the following ASCII commands:

Hysteresis XY > 0	// activates advanced peak hold
Advanced Hold Time AA = 0	// deactivates the averaging for advanced peak hold
Threshold C	// sets the value for the temperature threshold

6.2.5 Advanced Valley Hold

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

The advanced valley hold function requires the setting of the following ASCII commands:

Hysteresis XY < 0	// activates advanced valley hold
Advanced Hold Time AA = 0	// deactivates the averaging for advanced valley hold
Threshold C	// sets the value for the temperature threshold

6.2.6 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 6-6: Advanced Peak Hold with Averaging
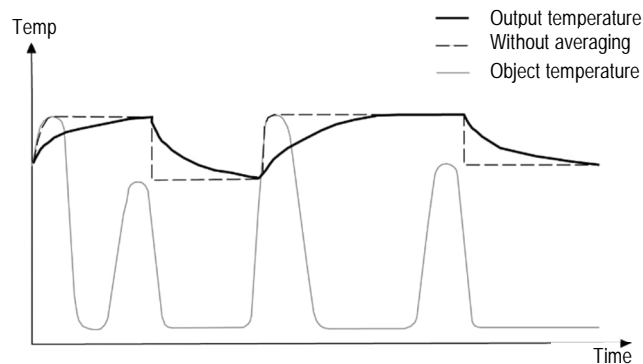
The advanced peak hold function with averaging requires the setting of the following ASCII commands:

Hysteresis XY > 0	// activates advanced peak hold
Advanced Hold Time AA > 0	// activates the averaging for advanced peak hold
Threshold C	// sets the value for the temperature threshold

6.2.7 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.

The advanced valley hold function with averaging requires the setting of the following ASCII commands:

Hysteresis XY < 0	// activates advanced valley hold
Advanced Hold Time AA > 0	// activates the averaging for advanced valley hold
Threshold C	// sets the value for the temperature threshold

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7 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 13.1.8 USB/RS485 Converter, page 88. The RS485 interface allows communication either via the standard Software or directly via dedicated ASCII commands, see section 10 ASCII Programming, page 69.

7.1 Specification

Technical Data:

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

7.2 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 7-1: Network in Linear Topology (daisy chain)
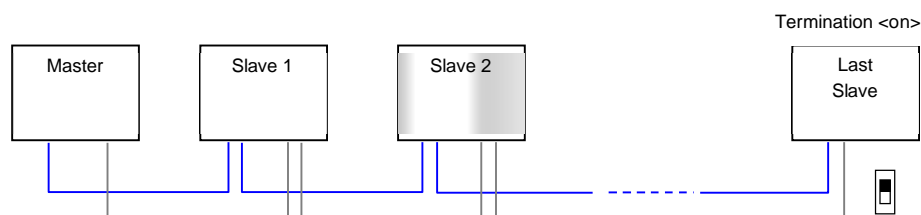
For implementing the termination, you must activate the sensor internal shunt resistor (120 Ω) for the physically last unit in the network. For doing so, use the accompanying software or the TR command via the serial communication (TR1 for termination "on", TR0 for termination "off").

7.3 Wiring

7.3.1 Model 6-Wire

Figure 7-2: RS485 Communication for 6-Wire Model
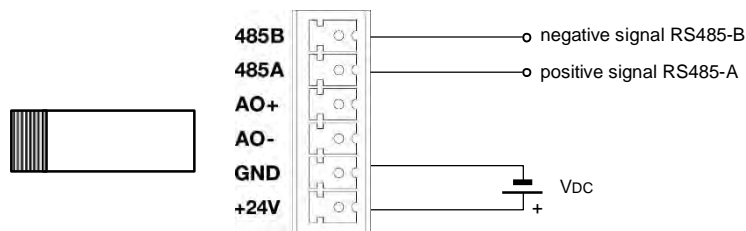
7.3.2 Model 12-Wire

Figure 7-3: RS485 Communication for 12-Wire Model
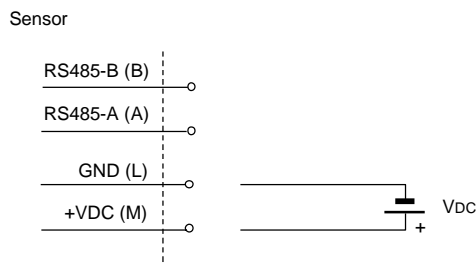
7.3.3 Computer Interfacing

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!

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Figure 7-4: Wiring the Sensor's RS485 Interface with USB/RS485 Converter in 2-Wire Mode
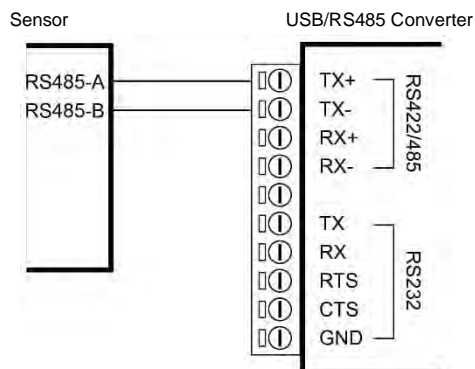
7.3.4 Multiple Sensors

For an installation of two or more 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.
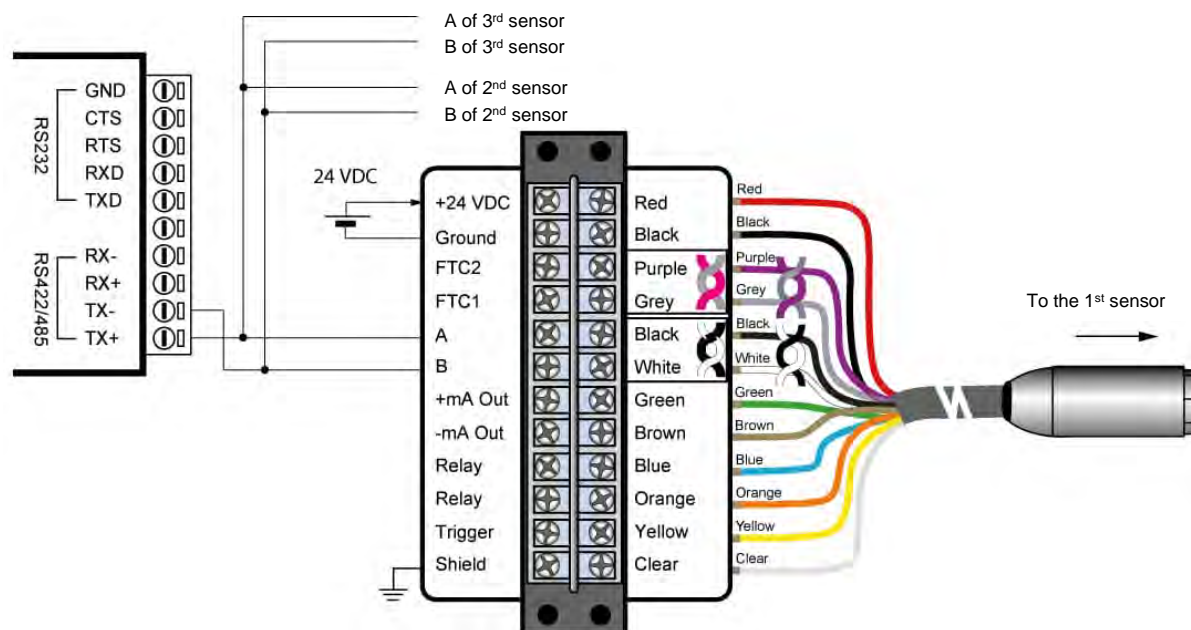
Figure 7-5: Wiring the Multiple Sensors via RS485 Interface with USB/RS485 Converter in 2-Wire Mode

7.4 ASCII Programming

For the programming details, see section 10 ASCII Programming, page 69.

8 PROFINET IO

The PROFINET IO maps the object temperature, internal temperature and the status of the pyrometer via PROFINET IO. Furthermore, PROFINET IO allows you to change a subset of sensor parameters in data exchange mode. In the initialization phase, the PROFINET module determines the physical structure of the node and creates a local process image with the pyrometer.

The diagnostics concept is based on channel specific diagnostic messages which are mapped to the respective alarms. Coding standard is according to IEC 61158 PROFINET IO.

Specification:

Type: PROFINET IO

Conformance class: A

Real-Time class: 1 (RT) and the Real-Time class UDP

I/O update cycle time: 1 ms

Configurable substitute value behavior in the event of error/failure

8.1 Configuration

The PROFINET IO takes over the task of the I/O device in PROFINET IO. Selecting the I/O module for the process data exchange and defining the time pattern happens during the I/O controller configuration.

Under PROFINET IO, the device manufacturer describes the device features in a GSD file, which is XML (Extensible Markup Language) coded and supplied to the end-user.

GSDML-V2.34-FPI-T40-xxxxxxxx

The I/O device is configured in accordance with the physical arrangement of the node (slot oriented).

Module slot 0 contains the PROFINET in its function as station substitute. It does not deliver process data itself, but provides the parameters required to perform communication settings of the I/O device (e.g. update cycle time).

Slot 1 (input module) and slot 2 (output module) reflect the physical arrangement of the pyrometer, that deliver a part of the process and diagnostics data. All specific information on the relevant module is contained in the associated GSD file.

8.2 Parameters

The parameter setting of a connected pyrometer happens via "record data" sets. The I/O module allows diagnostics message to be locked or released. Once all parameter settings are performed, the I/O device signals that it is ready to send cyclic productive data.

Table 8-1: Pyrometer Parameters

Parameter	Description	Setting
Temperature unit	Set the temperature unit	Celsius, Fahrenheit
Emissivity	*1000, in thousandths (0.9 → 900)	100…1100
Transmissivity	*1000, in thousandths (1.0 → 1000)	100…1100
Average Time	*0.1 s, in tenths (1 s → 10)	1 ... 9990
Peak hold Time	*0.1 s, in tenths (1 s → 10)	0 ... 9990
Valley hold Time	*0.1 s, in tenths (1 s → 10)	0 ... 9990
Laser control		off/on
Gain	Amplification adjustment for temperature value	0.8000 ~ 1.2000
Offset	Shift adjustment for temperature value	-200.0 ~ 200.0°C / -360.0 ~ 360.0°F In current unit (°C/°F)

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Certain pyrometer characteristics are parameterizable during the configuration. The parameters of the pyrometer substitute are used to set the overall settings of the PROFINET I/O node. Some of the setting are used in the module as default settings and can be optionally overwritten within the module configuration.

8.3 Messages

Table 8-2: Messages

Parameter	Description	Setting
Message diagnostics alarm	The diagnostics information of pyrometer is not transferred to the PROFINET IO controller	message inactive (default)
	is transferred to the PROFINET IO controller	message active
Message process alarm	The process alarm of pyrometer is not transferred to the PROFINET IO controller	message inactive (default)
	is transferred to the PROFINET IO controller	message active
Behavior on module fault		set process data to zero, set process data to last value

8.4 Input Data

Table 8-3: Input Data

Address without offset	Length	Format	Value
0	4 Byte	REAL (Big Endian, Motorola)	Target temperature
4	4 Byte	REAL (Big Endian, Motorola)	Internal temperature
8	4 Byte	DWORD	Error code

8.5 Output Data

The output data may be used to change the initialization of the device (which was set once at start-up) when the bus is in data exchange mode.

Table 8-4: Output Data

Address without offset	Length	Format	Value
0	1 Byte	BYTE	Type of parameter
1	4 Byte	REAL / DWORD	Parameter

The <Type of parameter> gives the meaning of the following parameters with the same format as described in section 8.2 Parameters, page 63.

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Table 8-5: Parameter Types

Type of parameter	Meaning	Format	Example
0	Do not change anything		
1	Emissivity	REAL	0.95
2	Transmissivity	REAL	0.89
3	Averaging time	REAL	5.5
4	Peak hold time	REAL	20.5
5	Valley hold time	REAL	20.5
6	Laser control	DWORD	1 ("on")

If <Type of parameter> is set to 0 then the output data gets ignored. As default, it should be set to 0 (zero).

8.6 Diagnostics

The diagnostics information of the fieldbus communicator can be read out acyclically using standard diagnostics data sets defined in the PROFINET IO specification.

Errors occurring when configuring and setting the parameters of the fieldbus communicator and the connected pyrometer as well as external errors are reported by the communicator via channel specific diagnostic.

In productive data exchange between the I/O controller and the fieldbus PROFINET IO, one byte IOPS process data qualifiers are available for each module providing information of the validity of the pyrometer module data (good/ bad). In the event of an error occurs during operation, the problem-indicator in APDU-Status is set by the communicator and a diagnostic alarm is additionally transmitted.

Table 8-6: Error Codes

Bit	Description
2	Internal temperature over range
3	Internal temperature under range
9	Object temperature under range
10	Object temperature over range
17	PROFINET not ready

9 EthernNet/IP

The EtherNet/IP module maps the object temperature, internal temperature, device status and other pyrometer data to its input assembly which is then sent onto the EtherNet/IP network using CIP. In the initialization phase, the device sends configuration data which is accessible for setup via the PLC programming software controller tags. Furthermore, EtherNet/IP allows you to change a subset of sensor parameters in data exchange mode using output data. For the device diagnostics, there is a special status register containing an error code, which is sent a part of the device's input data.

Specification:

- Device class: adapter device
- Device type: 06h (Photoelectric sensor)

9.1 Configuration

A manual configuration of the EtherNet/IP pyrometer is based on a generic Ethernet module. In this case, the assembly instance number and size must be typed in. The device settings are:

- Data type: SINT
- Input assembly instance 101, size 12 byte
- Output assembly instance 100, size 5 byte
- Configuration assembly instance 102, size 0

9.2 Parameters

All settable parameters of the Thermalert 4.0 pyrometer are available in the Configuration Data. Changing the parameters this way can only happen upon device initialization, i.e. when downloading the program to the PLC (default values are sent if no changes have been made). Once the parameter setting has been performed, the I/O device is ready to send cyclic productive data. While certain pyrometer characteristics are parameterizable only during the configuration, others can also be set in the data exchange mode using Output Data. The tables below contain all the parametrizable characteristics and are followed by a short implementation description.

The parameters included in the configuration data are accessible through controller tags in the PLC programming environment. Changing them in the controller tags will first have effect after downloading the program to the PLC. The programming software allows however for an easy saving of these tags so that the values can always be sent as default upon initialization.

Table 9-1: Pyrometer Parameters

Attribute ID	Name	Data type	Data value	Access rule
0x01	Temperature unit	USINT	0x43 ('C') – Celsius 0x46 ('F') - Fahrenheit	Read/Write
0x02	Emissivity	REAL	0.1 ... 1.1	Read/Write
0x03	Transmissivity	REAL	0.1 ... 1.1	Read/Write
0x04	Device Offset	REAL	-200 … 200	Read/Write
0x05	Device Gain	REAL	0.8 ... 1.2	Read/Write
0x06	Average Time	REAL	0.1 ... 999.0	Read/Write
0x07	Peak hold Time	REAL	0.0 ... 999.0	Read/Write
0x08	Valley hold Time	REAL	0.0 ... 999.0	Read/Write
0x09	Laser control	USINT	0 - off, 1 - on	Read/Write

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9.3 Input Data

Table 9-2: Input Data

Address without offset	Length	Format	Value
0	4 Byte	REAL (Big Endian, Motorola)	Target temperature
4	4 Byte	REAL (Big Endian, Motorola)	Internal temperature
8	4 Byte	DWORD	Error code

The data must be processed (copied) into especially created tags in a correct format in accordance to column "Format". For example, to obtain the internal temperature of the device, one should create a REAL tag and an instruction copying 4 bytes of the device's input data into this tag, beginning with byte 12.

9.4 Output Data

Once the pyrometer has been initialized and is running in the data exchange mode, only the below listed parameters can be changed, using the device's output data.

Table 9-3: Output Data

Address without offset	Length	Format	Value
0	1 Byte	SINT	Type of parameter
1	4 Byte	REAL / INT	Parameter

The <Type of parameter> gives the meaning of the following parameters with the same format as described in section 9.2 Parameters, page 66.

Table 9-4: Parameter Types

Type of parameter	Meaning	Format
0	Do not change anything	
1	Emissivity	REAL
2	Transmissivity	REAL
3	Averaging time	REAL
4	Peak hold time	REAL
5	Valley hold time	REAL
6	Laser control	INT

To send the parameters and their values to the device, they must be stored in the controller tags first and then copied to their destination register in the device. Please note, that most of the values of the parameters are REALs whereas the parameter for laser control uses UDINT format – at least this value must be stored in a separate tag.

9.5 Diagnostics

The EtherNet/IP device has a designated status register. The bits of this register make up for an error code, which is sent as a part of input data.

Address without offset	Length	Format	Value
8	4 Byte	DWORD	Error code

It can be translated using the table below.

Table 9-5: Error Codes

Bit	Description
2	Internal temperature over range
3	Internal temperature under range
9	Object temperature under range
10	Object temperature over range
17	EtherNet/IP not ready

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10 ASCII Programming

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><LF>   "?" 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><LF>   "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

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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)

A power off/on cycle requires the sensor to quit a running burst mode and to continue in poll mode if the device is supplied with power again.

10.3 Sensor Information

The sensor information is factory installed as read only values.

Table 10-1: 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"
?XRA	Analog firmware revision	"!XRA02.00.0719"
?XH	Maximum temperature of the sensor	"!XH0600.0"
?XB	Minimum temperature of the sensor	"!XB-020.0"

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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 71.
A=250	sets the ambient background temperature compensation according to the setting of "AC" command, see section 10.4.3 Background Temperature Compensation, page 71.
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 5.8.3 FTC1 – Emissivity Setting, page 49.
ES=S	sets emissivity by a rotary switch (2-wire model only)
?CE	asks for the current emissivity value
?E	asks for the internal 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 5.8.4 FTC2 – Background Temperature Compensation, page 49.

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 6.2 Post Processing, page 55.

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Table 10-2: 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 7 RS485, page 59. 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 ASCII Command List

For the ASCII command list, see section 15.5 ASCII Command List, page 129.

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11 HART Communication

2-wire sensing heads with HART communication transmit information in two directions. On the one hand, the sensing head provides analog measured values to the control room via the 4 to 20 mA current loop. On the other hand, the sensing head can be reprogrammed from the control room by means of bi-directional transmission of digital signals. The superposition of analog and digital signals is described by the HART protocol. Sensors which are programmable in this way are called HART sensors.

Figure 11-1: Typical Installation with HART Adapter
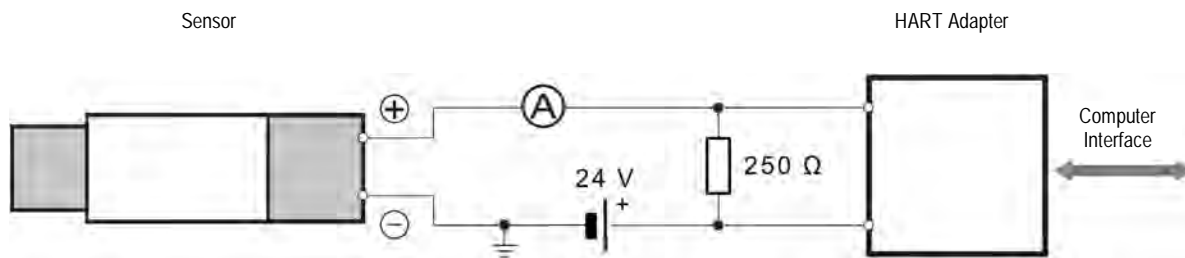
The manufacturer recommends using the following HART/USB adapter:

- Company ProComSol, model HM-USB-ISO

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12 Intrinsic Safety

The HART model for the Thermalert 4.0 series is available as intrinsic safety rated sensing head (-IS) intended for use in explosive atmospheres.

The model T40-xx-xx-xxx-6-IS follows the ATEX / IECEx certification in accordance to:

Certificate:	CSANe 20ATEX2254X	IECEx SIR 20.0047X
	II 2G Ex ib IIC T4 Gb	Ex ib IIC T4 Gb
	II 2D Ex ib IIIC T135°C Db	Ex ib IIIC T135°C Db

Details of certification can also be found in sections 15.6 ATEX Certificate of Conformity, page 133 and 15.7 IECEx Certificate of Conformity, page 135.

The ambient temperature range for these sensors is specified as follows:

-20 < $T_{Ambient}$ < 80°C (-4 to 176°F)

The intrinsically safe unit is available with air/water-cooled housing. That accessory can provide a cooler, more stable operating environment for the electronics but does not allow for approved intrinsically safe operation when external ambient conditions are above 80°C (176°F).

Note
The intrinsically safe model has neither USB support nor laser capability nor alarm output functionality. The intrinsically safe model is also not available for LTB models.

The metallic enclosure of the intrinsically safe unit is not 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**

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12.1 Power Supply Barrier

The intrinsically safe sensor requires a power supply barrier which must be ordered separately from a third-part vendor. The manufacturer recommends using the following power supply barrier:

- Company Pepperl+Fuchs, model KCD2-STC-EX1

**Figure 12-1: Intrinsic Safety Installation with Power Supply Barrier
from company Pepperl+Fuchs (example)**
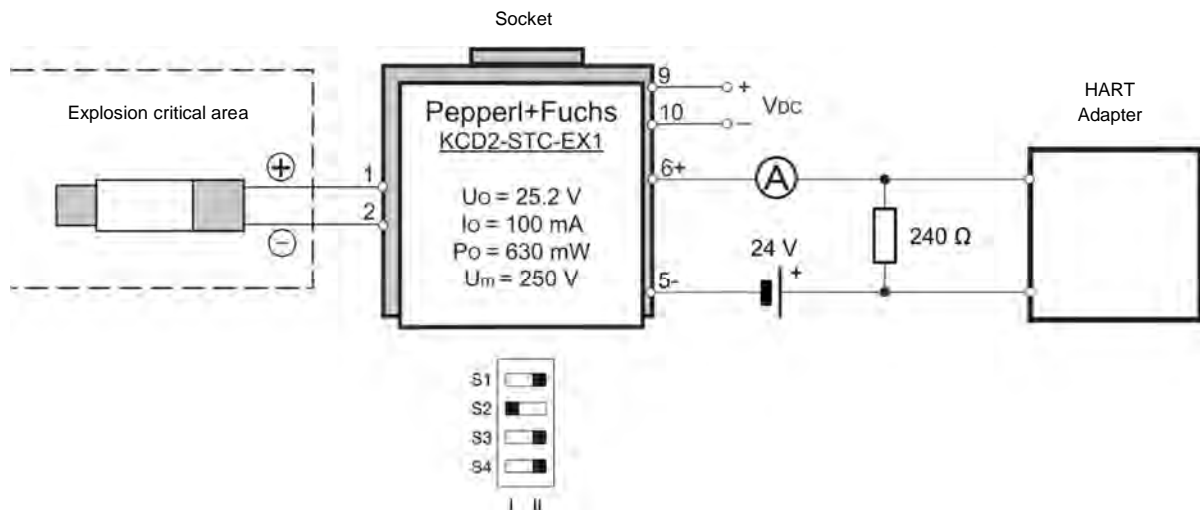
13 Accessories

13.1 Electrical Accessories

The following electrical accessories are available:

- 12-Wire Cable, High Temp (A-CB-HT-M16-W12-xx)
- 12-Wire Cable, Low Temp (A-CB-LT-M16-W12-xx)
- Ethernet PoE Cable (A-CB-xx-M12-W04-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)
- PoE Injector (A-POE)

13.1.1 12-Wire Cable, High Temp (A-CB-HT-M16-W12-xx)

Use the High Temp 12-wire cable for the sensor 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, all as tinned copper braid. The cable is equipped with a M16 DIN connector on one side and wire sleeves at the counter side. The outer diameter of the cable is 7 mm (0.28 in).

The cable withstands ambient temperatures up to 200°C (392°F) and is Teflon coated. 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 13-1: 12-Wire Cable, High Temp Version

Table 13-1: Cable Specification

P/N	Ambient Temperature	Length
A-CB-HT-M16-W12-04	-80 to 200°C (-112°F to 392°F)	4 m (13 ft)
A-CB-HT-M16-W12-08	-80 to 200°C (-112°F to 392°F)	8 m (26 ft)
A-CB-HT-M16-W12-15	-80 to 200°C (-112°F to 392°F)	15 m (49 ft)
A-CB-HT-M16-W12-30	-80 to 200°C (-112°F to 392°F)	30 m (98 ft)
A-CB-HT-M16-W12-60	-80 to 200°C (-112°F to 392°F)	60 m (197 ft)

Color	Number	Cross Section	Shield
black/red	2 wires	0.33 mm² (AWG 22)	none
black/white	1 twisted pair	0.22 mm² (AWG 24)	yes
purple/gray	1 twisted pair	0.22 mm² (AWG 24)	yes
green/brown/blue/orange/yellow/clear	6 wires	0.22 mm² (AWG 24)	none

Table 13-2: Color Assignment to DIN Connector

Color	Connector Pin	Description
Black	A	RS485-A
White	B	RS485-B
Gray	C	FTC1 (emissivity setting)
Purple	D	FTC2 (background temperature compensation)
White/drain	E	Shield
Yellow	F	Trigger– with GND
Orange	G	Relay contact (alarm)
Blue	H	Relay contact (alarm)
Green	J	+ Analog out (positive)
Brown	K	AGND (analog ground)
Black	L	GND (digital ground)
Red	M	+ VDC power supply

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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 sensor should not extend the 60 m (200 ft) limit.

13.1.2 12-Wire Cable, Low Temp (A-CB-LT-M16-W12-xx)

Use the Low Temp 12-wire cable for the sensor 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, all as tinned copper braid. The cable is equipped with a M16 DIN connector on one side and wire sleeves at the counter side. The outer diameter of the cable is 7.2 mm (0.28 in).

The cable withstands ambient temperatures up to 105°C (221°F) and is PUR (Polyurethane PUR- 11Y, Halogen free, Silicone free) coated. PUR coated cables are flexible and have good to excellent resistance to against oil, bases, and acids.

Figure 13-2: 12-Wire Cable, Low Temp Version

Table 13-3: Cable Specification

P/N	Ambient Temperature	Length
A-CB-LT-M16-W12-04	-40 to 105°C (-40 to 221°F)	4 m (13 ft)
A-CB-LT-M16-W12-08	-40 to 105°C (-40 to 221°F)	8 m (26 ft)
A-CB-LT-M16-W12-15	-40 to 105°C (-40 to 221°F)	15 m (49 ft)
A-CB-LT-M16-W12-30	-40 to 105°C (-40 to 221°F)	30 m (98 ft)
A-CB-LT-M16-W12-60	-40 to 105°C (-40 to 221°F)	60 m (197 ft)

Color	Number	Cross Section	Shield
black/red	2 wires	0.33 mm² (AWG 22)	none
black/white	1 twisted pair	0.22 mm² (AWG 24)	yes
purple/gray	1 twisted pair	0.22 mm² (AWG 24)	yes
green/brown/blue/orange/yellow/clear	6 wires	0.22 mm² (AWG 24)	none

Table 13-4: Color Assignment to DIN Connector

Color	Connector Pin	Description
Black	A	RS485-A
White	B	RS485-B
Gray	C	FTC1 (emissivity setting)
Purple	D	FTC2 (background temperature compensation)
White/drain	E	Shield
Yellow	F	Trigger– with GND
Orange	G	Relay contact (alarm)
Blue	H	Relay contact (alarm)
Green	J	+ Analog out (positive)
Brown	K	AGND (analog ground)
Black	L	GND (digital ground)
Red	M	+ VDC power supply

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Risk of Personal Injury

Polyurethane 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 sensor should not extend the 60 m (200 ft) limit.

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13.1.3 Ethernet PoE Cable (A-CB-xx-M12-W04-xx)

The Ethernet PoE cable comes with a four-pin male M12 D-coded connector, assigned to the sensors rear female M12 connector. The corresponding end of the Ethernet PoE cable is equipped with a general RJ45 snap-in connector.

The LT version of the cable is PUR coated and withstands ambient temperatures up to 80°C (176°F).

The HT version is Teflon coated and withstands ambient temperatures up to 180°C (356°F).

Figure 13-3: Ethernet PoE Cable
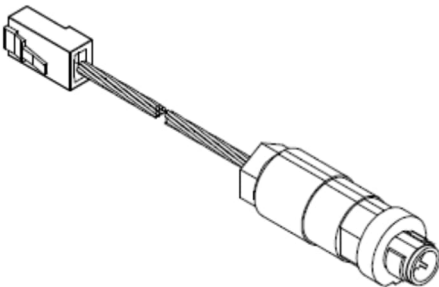
Figure 13-4: Pin Assignment (Front View)

RJ45 Plug   M12 Plug

M12-Pin	
1	TX+
2	RX+
3	TX-
4	RX-
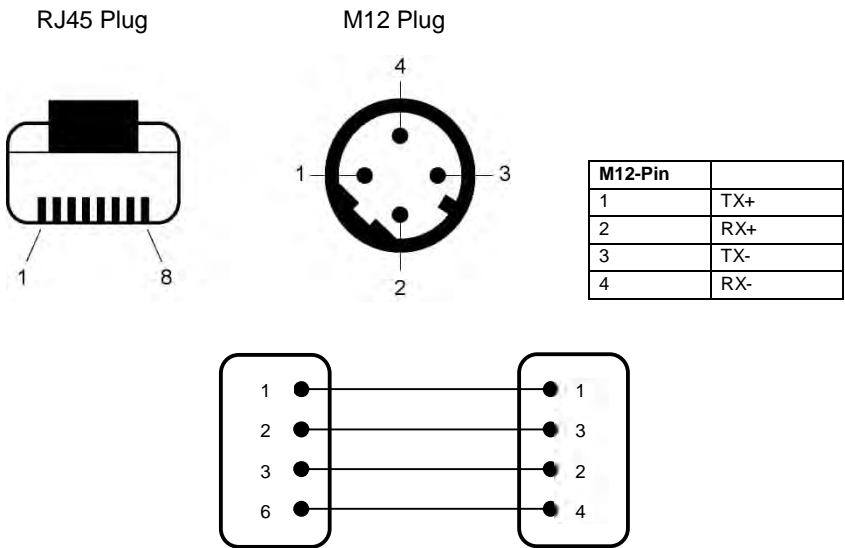
Table 13-5: Available Ethernet PoE Cables

P/N	Length	Ambient Temperature
A-CB-LT-M12-W04-07	7.5 m (25 ft)	80°C (176°F)
A-CB-LT-M12-W04-25	25 m (82 ft)	80°C (176°F)
A-CB-LT-M12-W04-50	50 m (164 ft)	80°C (176°F)
A-CB-HT-M12-W04-07	7.5 m (25 ft)	180°C (356°F)
A-CB-HT-M12-W04-10	10 m (33 ft)	180°C (356°F)

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13.1.4 Terminal Block (A-T40-TB)

The terminal block accessory is for the connection of the 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 13-5: Terminal Block with Wire Color Assignment

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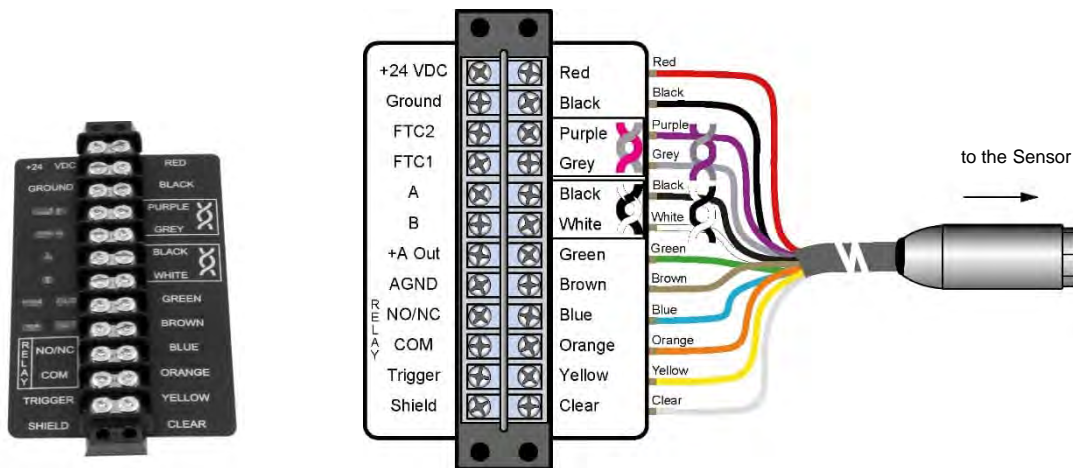
13.1.5 Terminal Block with Enclosure (A-T40-TB-ENC)

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 13-6: Terminal Block in an Enclosure

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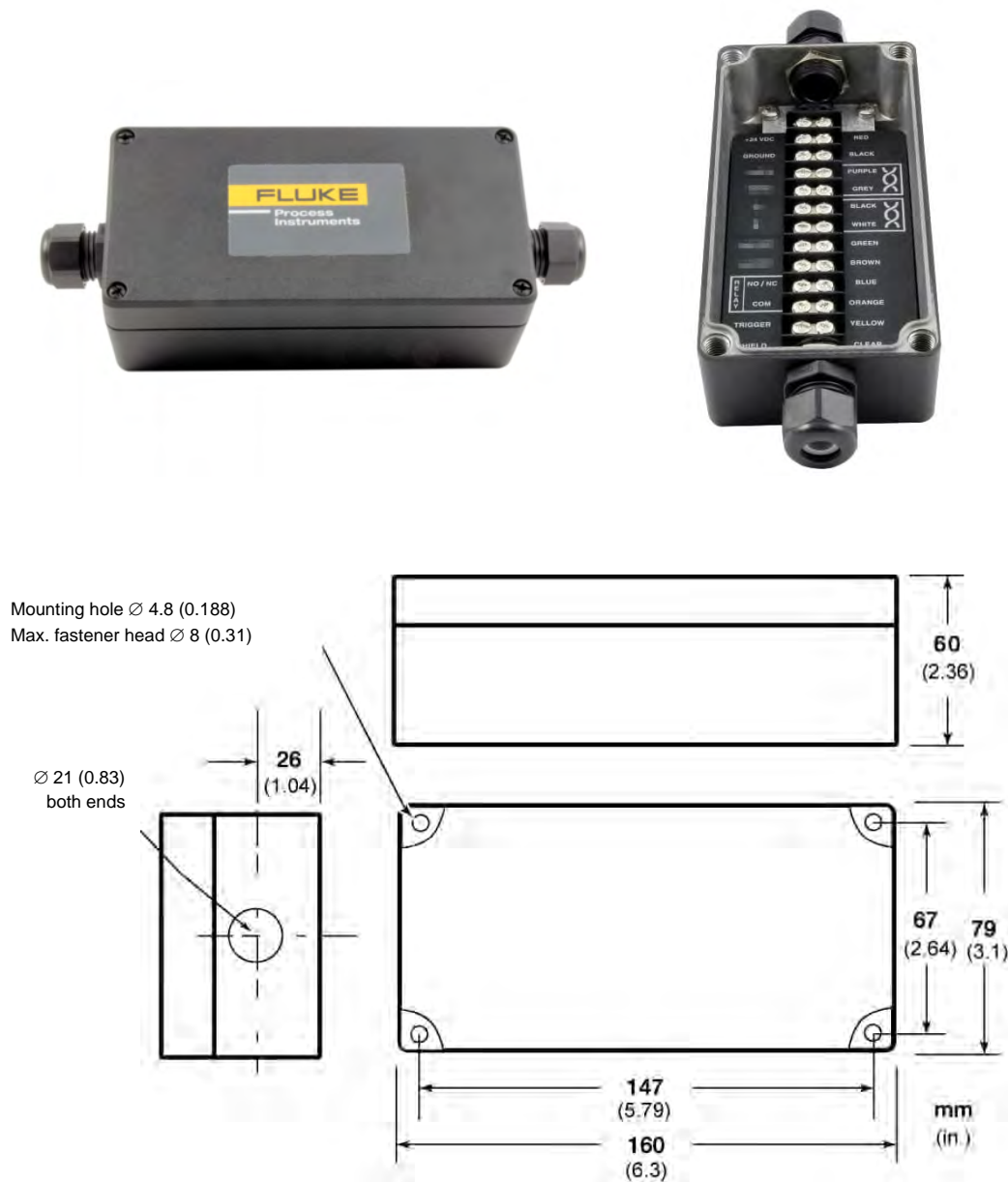
13.1.6 Power Supply DIN Rail (A-PS-DIN-24V)

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 13-7: Industrial Power Supply

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13.1.7 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 13.1.4 Terminal Block, page 83, 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 13-8: Power Supply with Terminal Box
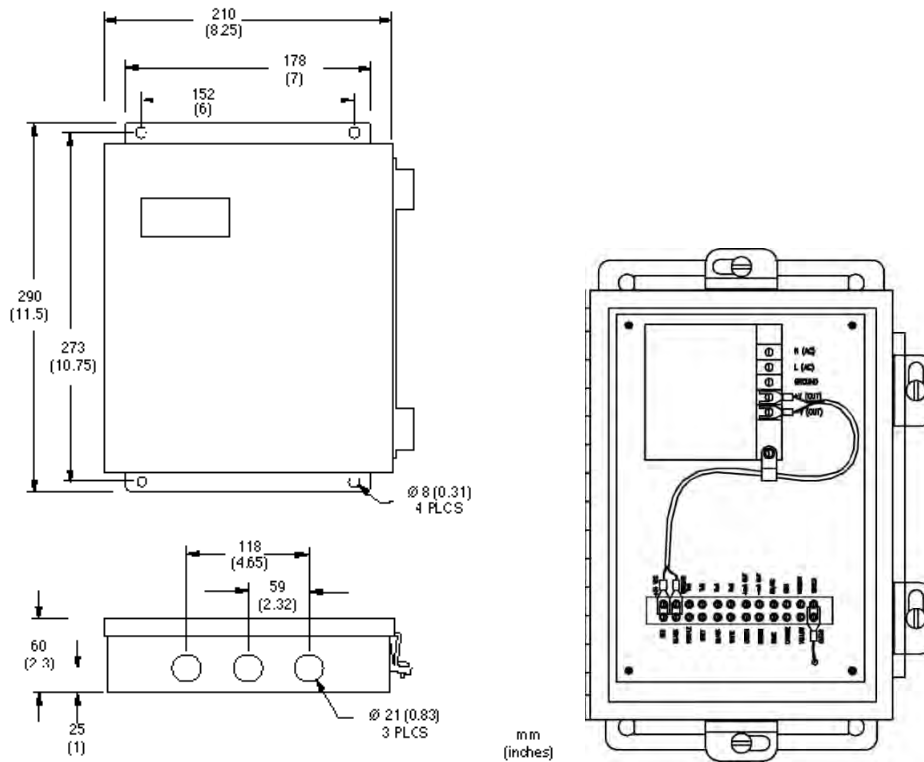
To ensure correct wiring, stick the enclosed sticker onto the carrier plate as shown below.
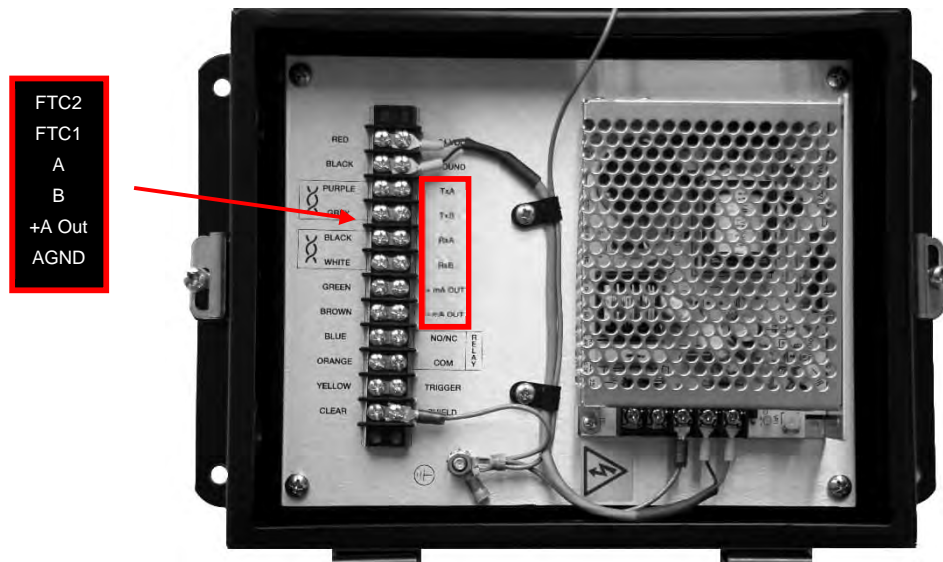
13.1.8 USB/RS485 Converter (A-CONV-USB485)

The USB/RS485 converter allows you to connect your 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) (the 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 13-9: USB/RS485 Converter

For more information, see section 7.3.3 Computer Interfacing, page 60.

13.1.9 PoE Injector (A-POE)

The PoE injector allows you to power the Thermalert 4.0 sensor over the Ethernet connection.

Technical Data

PoE standard	802.3af
PoE output power	15.4 W
PoE ports	1
Ethernet	100Base TX
Power supply	100 to 240 VAC / 50 to 60 Hz, 19 W
Operating temperature	0 to 50°C (32 to 122°F)
Humidity	10 to 90%, non-condensing
Dimensions L x W x H	146 x 64 x 42 mm (5.7 x 2.5 x 1.6 in)

Figure 13-10: PoE Injector

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13.2 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-T40-MF)

Figure 13-11: Overview to Mechanical Accessories
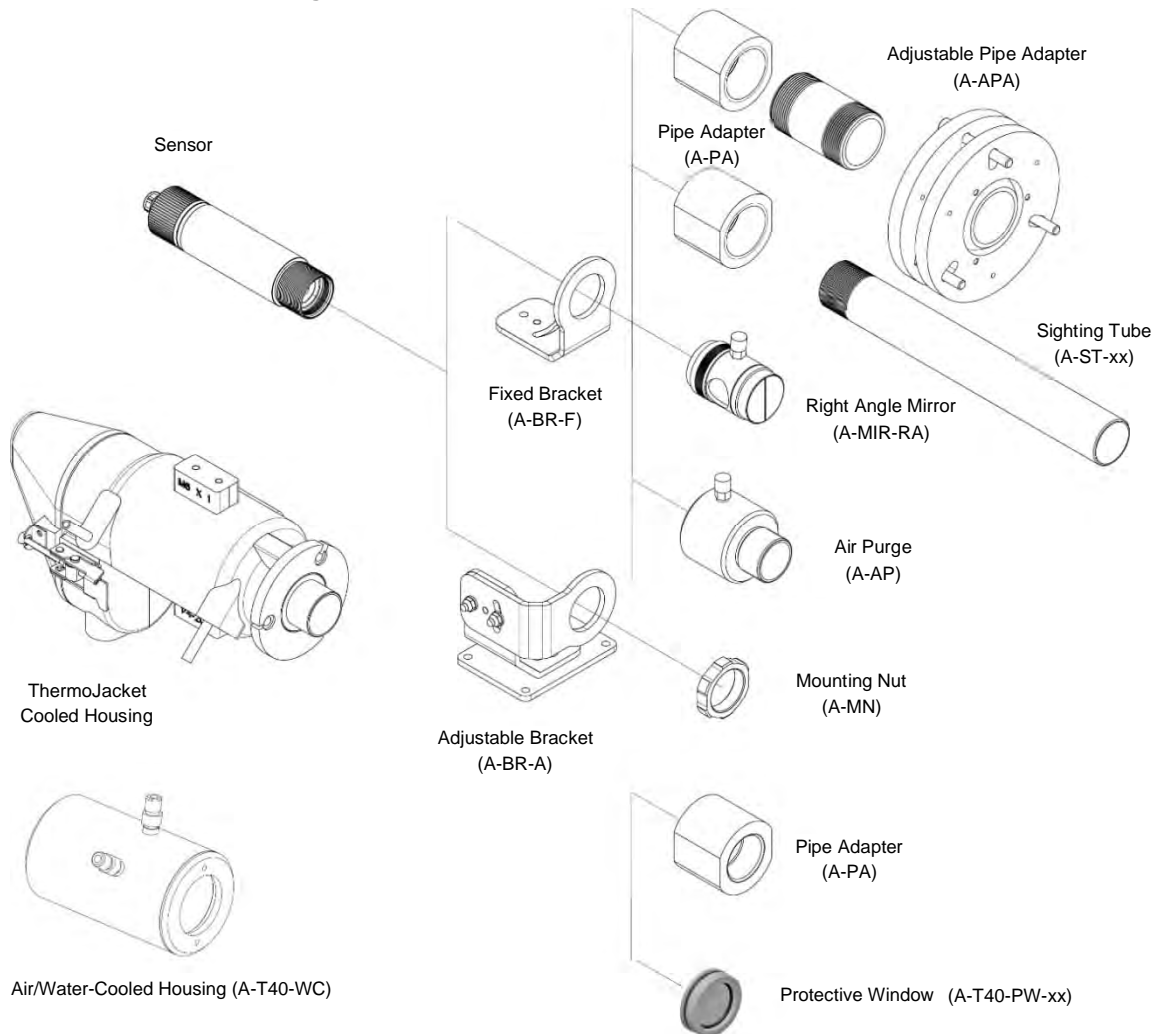
13.2.1 Mounting Nut (A-MN)

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 13-12: Mounting Nut

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13.2.2 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 13-13: Fixed Bracket

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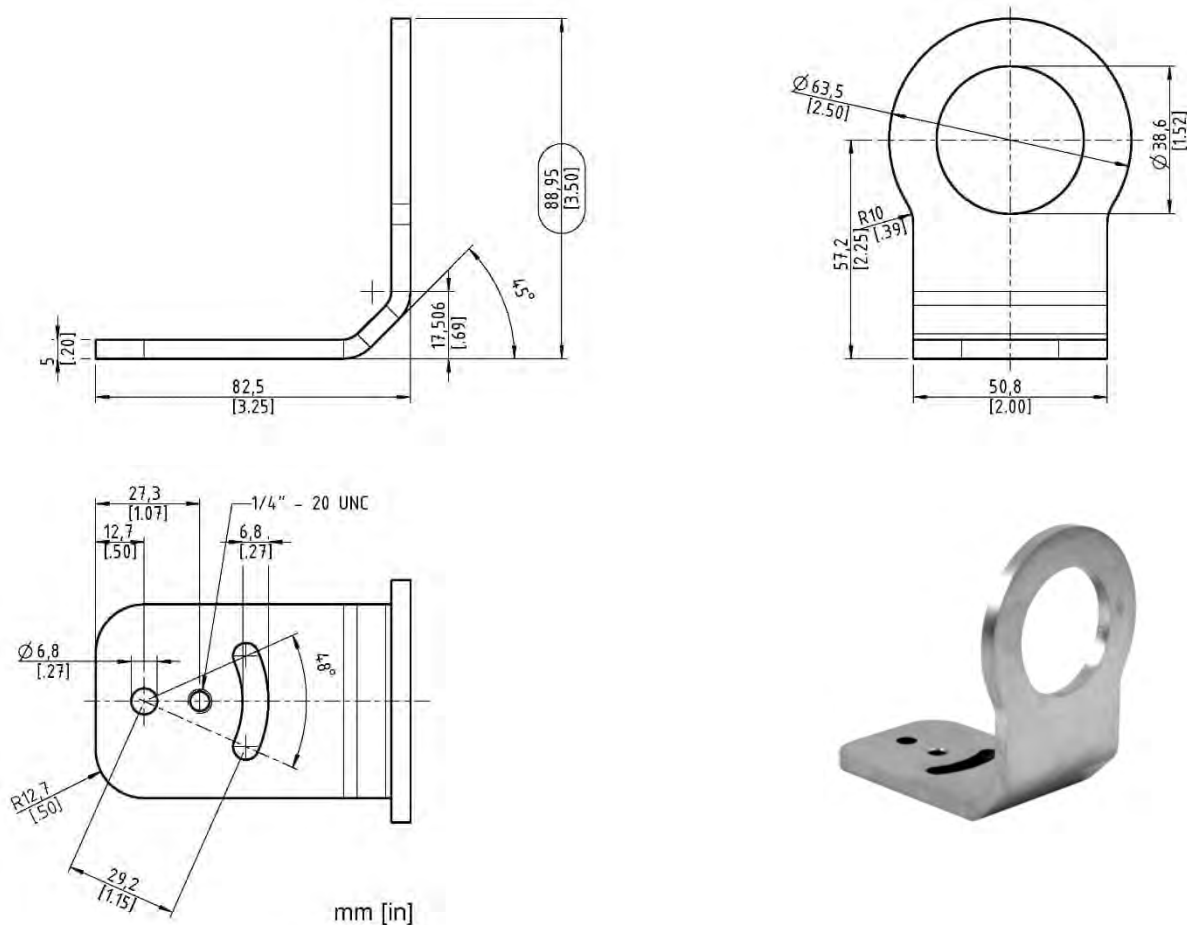
13.2.3 Adjustable Bracket (A-BR-A)

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 13-14: Adjustable Bracket
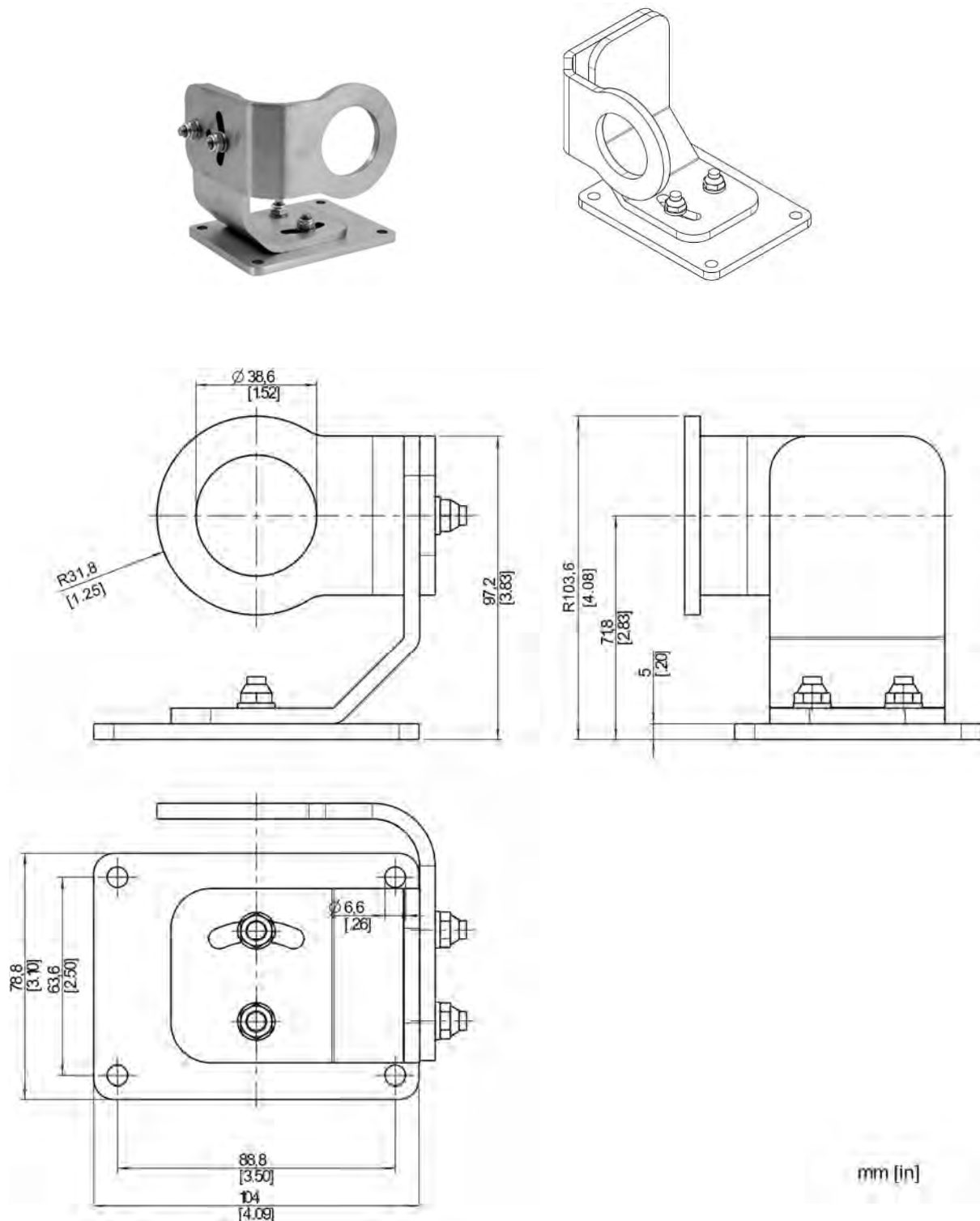
13.2.4 Swivel Bracket (A-BR-S)

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 13-15: Swivel Bracket

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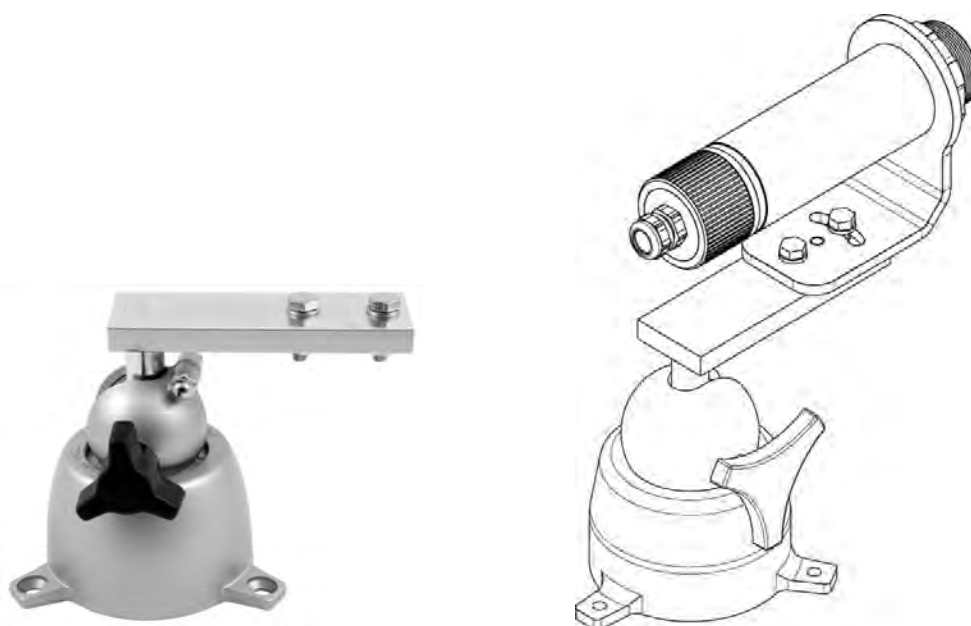
13.2.5 Sighting Tube (A-ST-xx)

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 13-16: Installation of the Sighting Tube

Sensor

Pipe Adapter
(A-PA)

Sighting Tube
(A-ST-xx)
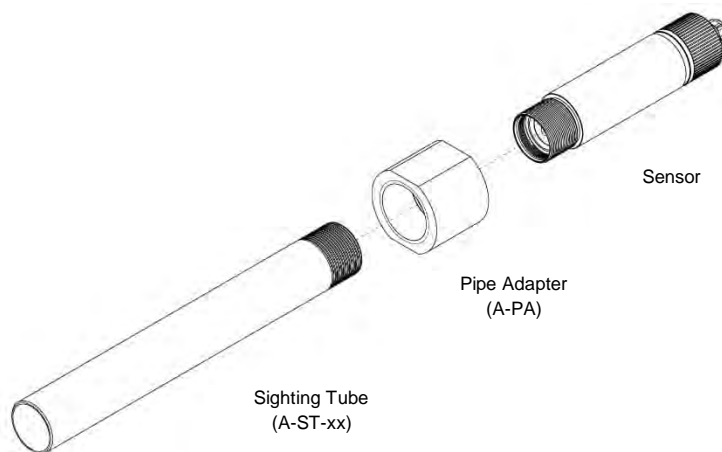
Figure 13-17: Dimensions for the Sighting Tube

305
(12)

Ø 48
(1.9)

1 1/2" NPT   mm (in.)
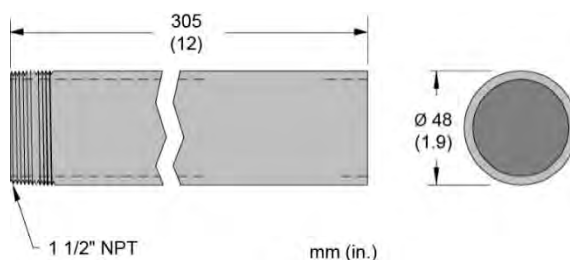
Available sighting tubes:

- 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 13-18: Available Sighting Tubes

Sighting Tube Ceramic (A-ST-CER)

Sighting Tube Stainless Steel (A-ST-SS)

Sighting Tube Carbon Steel (A-ST-CS-45)
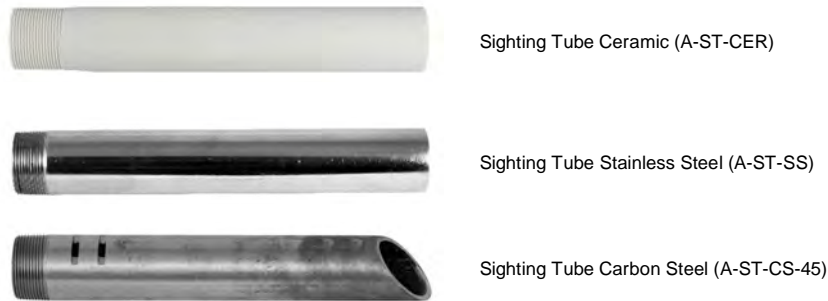
Note
When using a customer supplied sighting tube, use caution in specifying the inside diameter and length. Your sensing head determines what diameter/length combinations are possible without impeding the optical field of view!
For this reason, the Thermalert 4.0 sensors LT-07 and LT-15 cannot be combined 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.

13.2.6 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 13.2.5 Sighting Tube, page 95. 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 13-19: Pipe Adapter
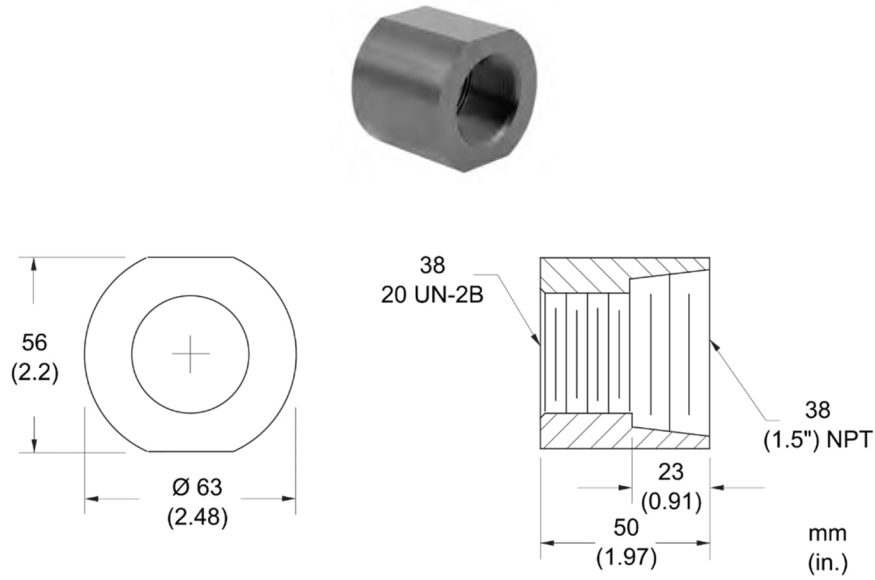
13.2.7 Protective Windows (A-T40-PW-xx)

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

Figure 13-20: 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 13-6: 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 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 MT-30-CF1 MT-30-CF2 MT-70-CF1 MT-70-CF2	0.85 ±0.05	yes
A-T40-PW-HT	3 red dots	Glass	HT-60	0.89 ±0.05	yes
			1ML-150	0.91 ±0.05	yes
			1MH-150	0.9 ±0.05	yes
			2M-150	0.92 ±0.05	yes
			3M-70	0.89 ±0.05	yes
A-T40-PW-G5G7P7	2 red dots	Calcium Fluoride	G5-30 G5-70 G7-70 P7-30	0.93 ±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.

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13.2.8 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 13-21: Right Angle Mirror
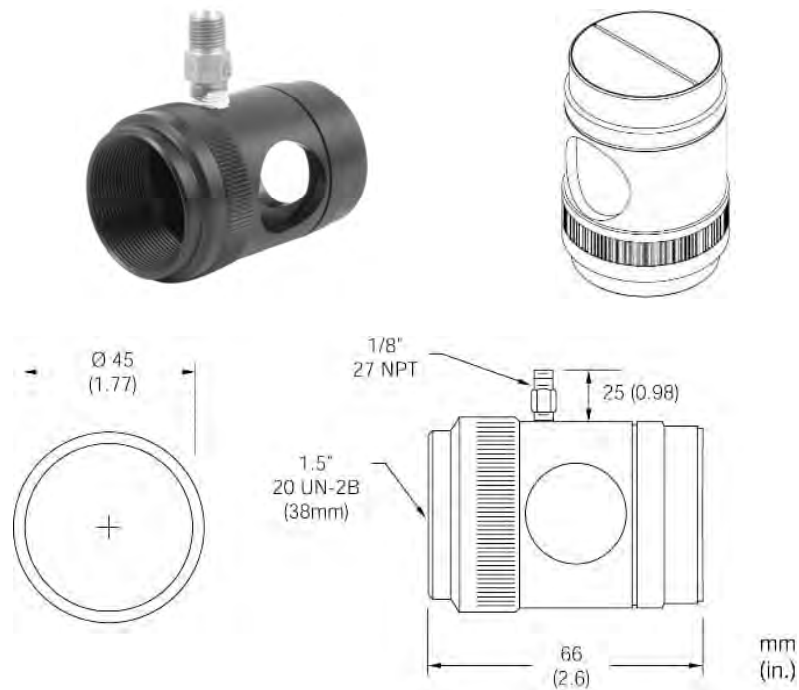
13.2.9 Air Purge (A-AP)

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 13-22: Air Purge
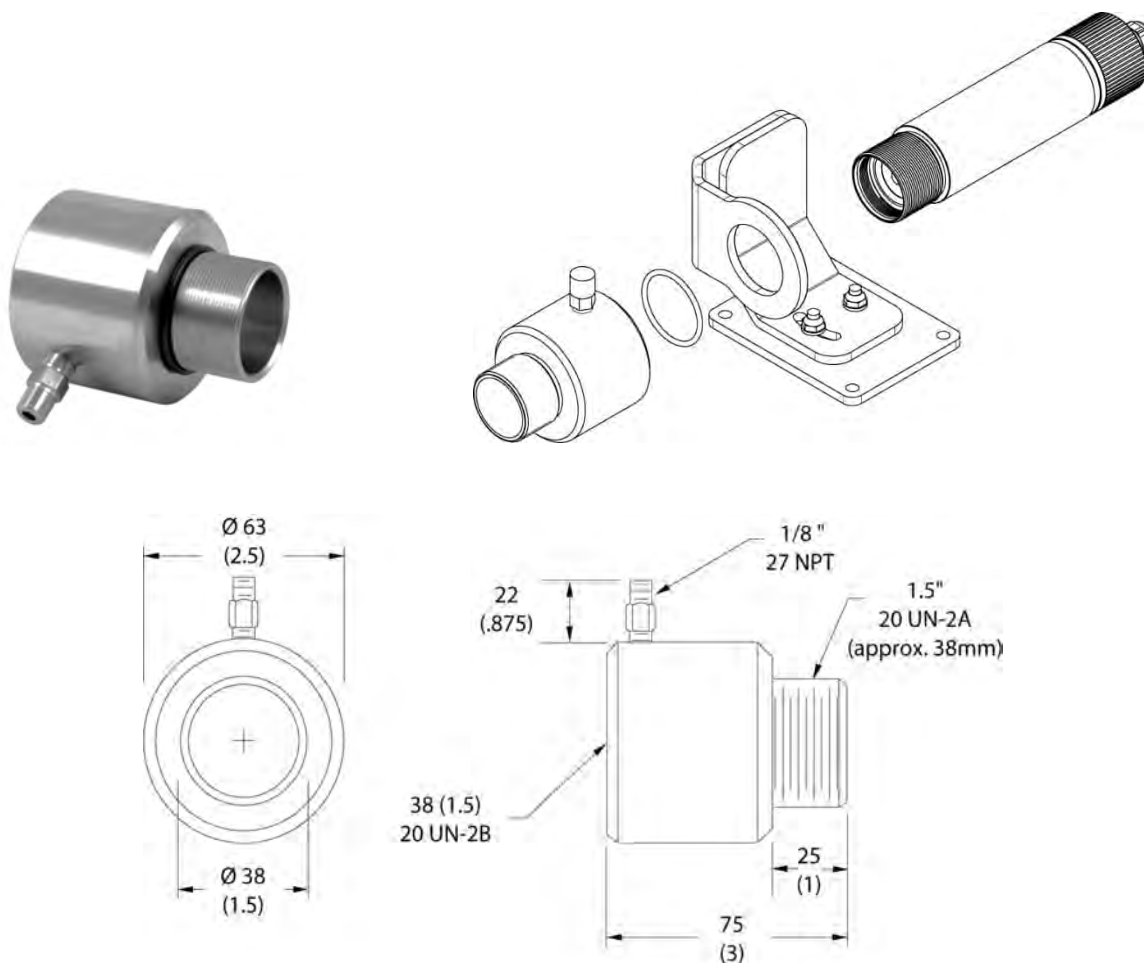
13.2.10 Air/Water-Cooled Housing (A-T40-WC)

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 and is delivered with air purge, see section 13.2.9 Air Purge (A-AP), page 100. The air purge should be always used to keep the lens dry.

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 13-23: Air/Water-Cooled Housing
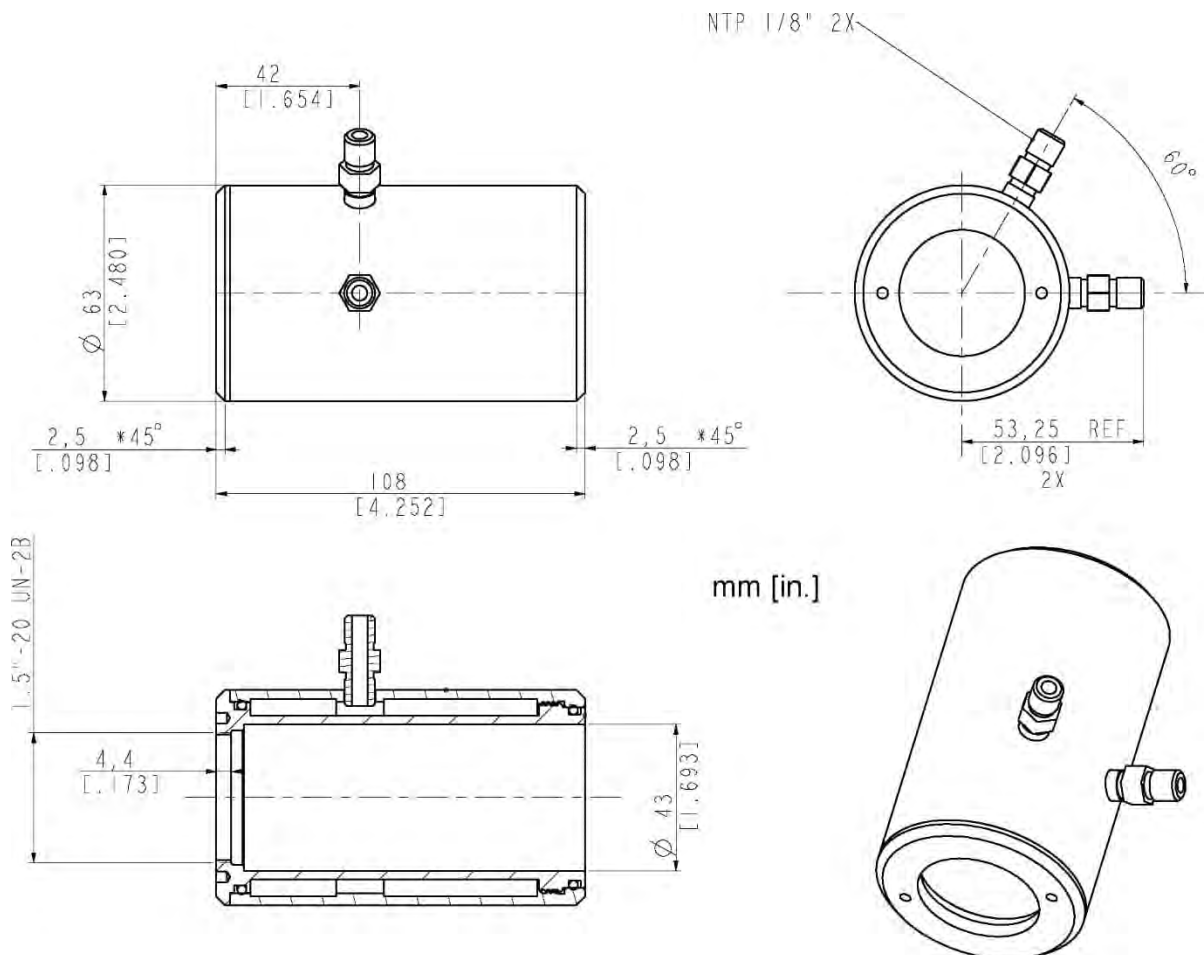
13.2.10.1 Avoidance of Condensation

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 13-7: Minimum device temperatures [°C/°F]

Relative Humidity [%]

Ambient Temperature [°C/°F] (rows) vs Relative Humidity [%] (columns)

	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!

13.2.11 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 13-24: Thread Adapter
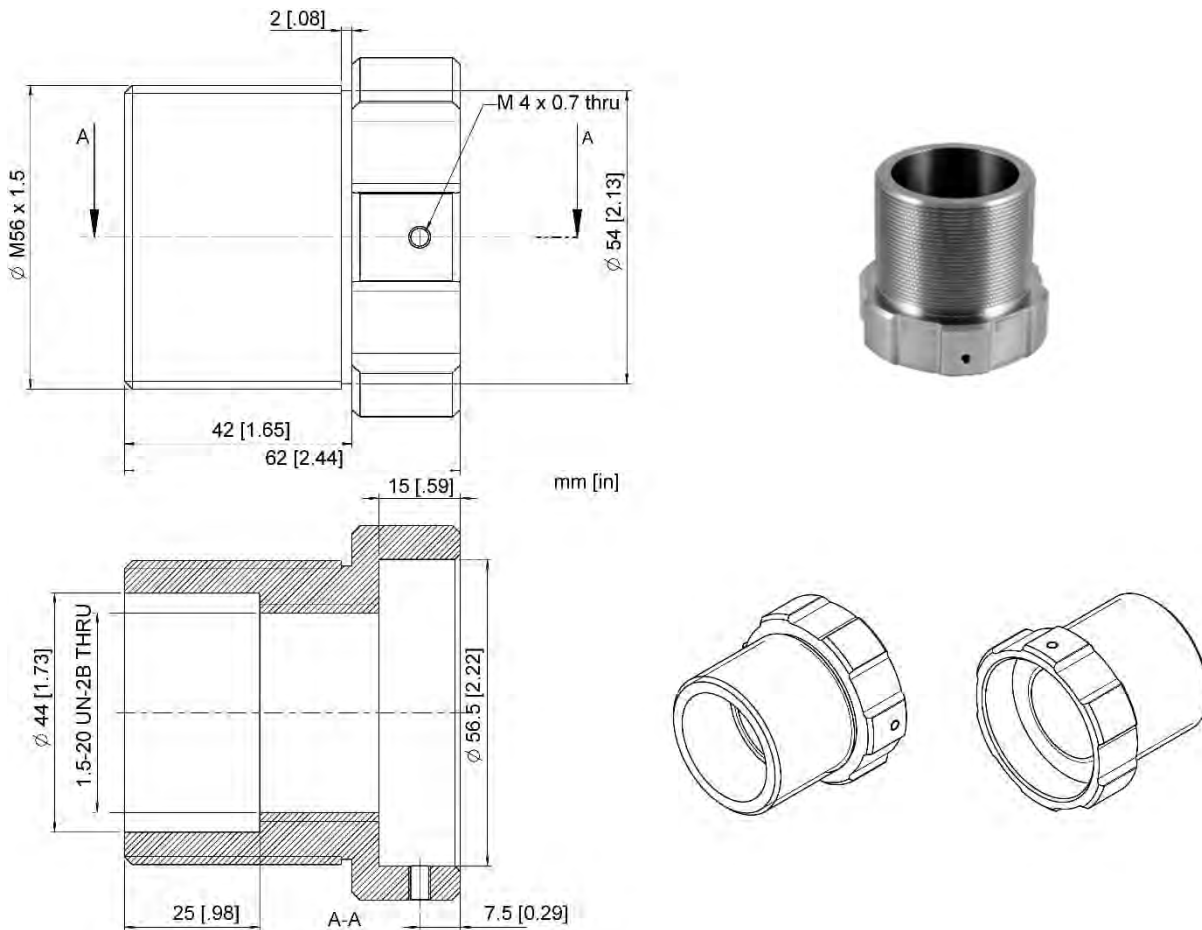
13.2.12 Mounting Flange (A-T40-MF)

The mounting flange provides a footprint to allow the Thermalert 4.0 sensor to be mounted into a legacy Ircon Modline flange mount installations.

Figure 13-25: Mounting Flange
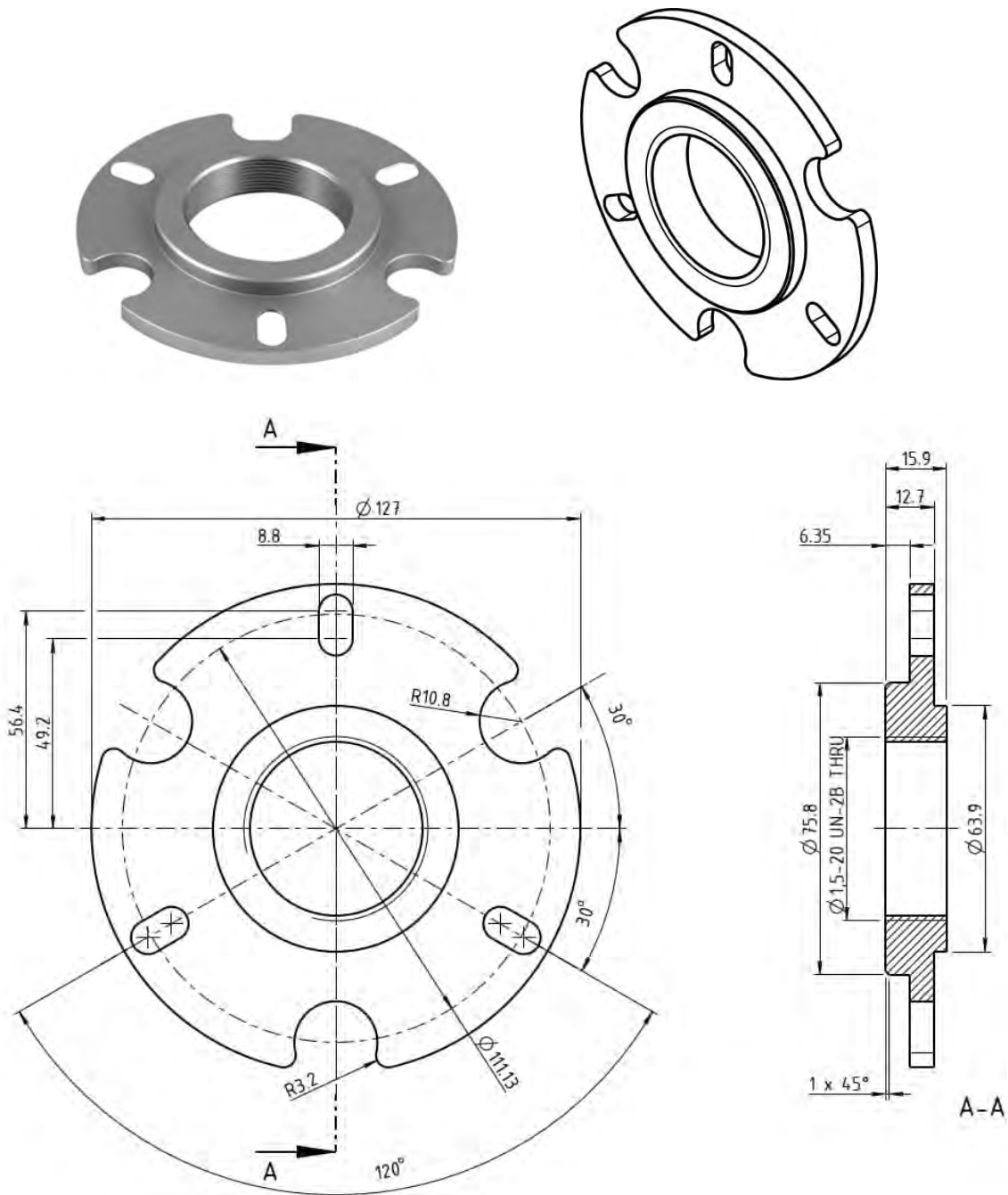
14 Maintenance

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.

14.1 Troubleshooting Minor Problems

Table 14-1: Troubleshooting

Symptom	Probable Cause	Solution
No output	No power to instrument	Check the power supply
Erroneous temperature	Faulty sensor cable	Verify cable continuity
Erroneous temperature	Field of view obstruction	Remove the obstruction
Erroneous temperature	Window 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

14.2 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 analog values and the error code transmitted over the digital communication.

Table 14-2: Error Codes for Outputs

Symptom	0 to 10 V	0 to 20 mA	4 to 20 mA	Relay
Measured temperature over range*	10 V	21 mA	21 mA	alarm state
Measured temperature under range*	0 V	0 mA	approx. 3.5 mA	alarm state

* related to zoomed temperature range

Table 14-3: Error Codes via Digital Communication

Output	Error Code Description
EHHH	Measured temperature over range
EUUU	Measured temperature under range
EIHH	Internal temperature over range
EIUU	Internal temperature under range

14.3 Cleaning the Lens

Always keep the lens clean. 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!

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15 Appendix

15.1 Optical Diagrams

15.1.1 LT-07 Models

Figure 15-1: Optical Diagrams LT-07 Models
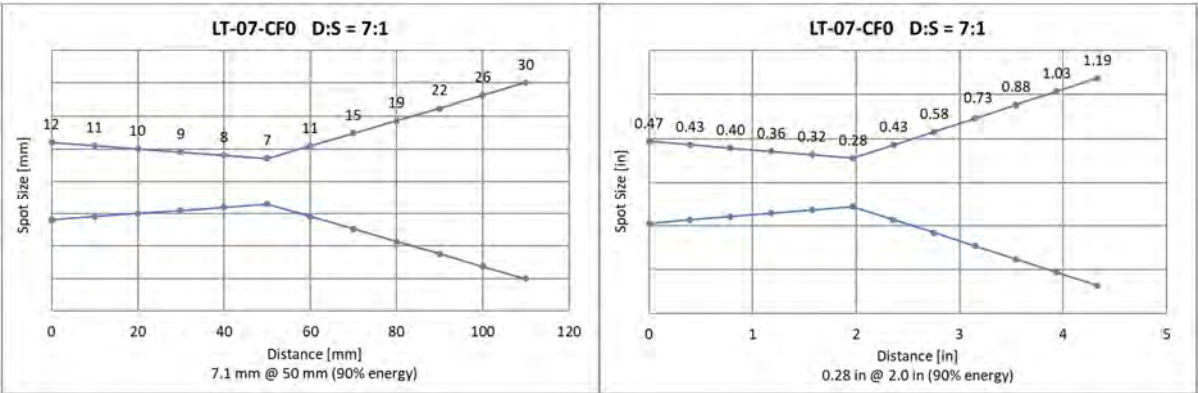
15.1.2 LT-15 Models

Figure 15-2: Optical Diagrams LT-15 Models
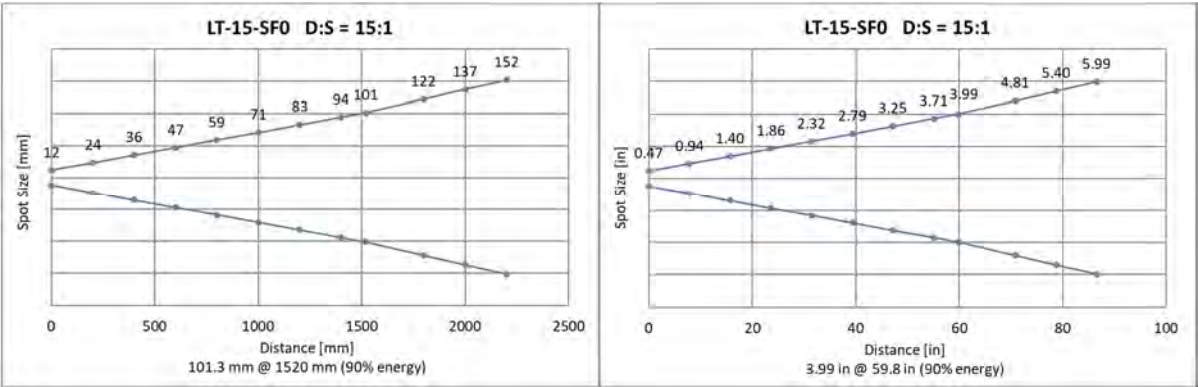
15.1.3 LT-30 Models

Figure 15-3: Optical Diagrams LT-30 Models

LT-30-SF0 D:S = 33:1
46.1 mm @ 1520 mm (90% energy)

LT-30-SF0 D:S = 33:1
1.81 in @ 59.8 in (90% energy)

LT-30-CF1 D:S = 33:1
2.3 mm @ 76 mm (90% energy)

LT-30-CF1 D:S = 33:1
0.09 in @ 3.0 in (90% energy)

LT-30-CF2 D:S = 33:1
6.1 mm @ 200 mm (90% energy)

LT-30-CF2 D:S = 33:1
0.24 in @ 7.9 in (90% energy)

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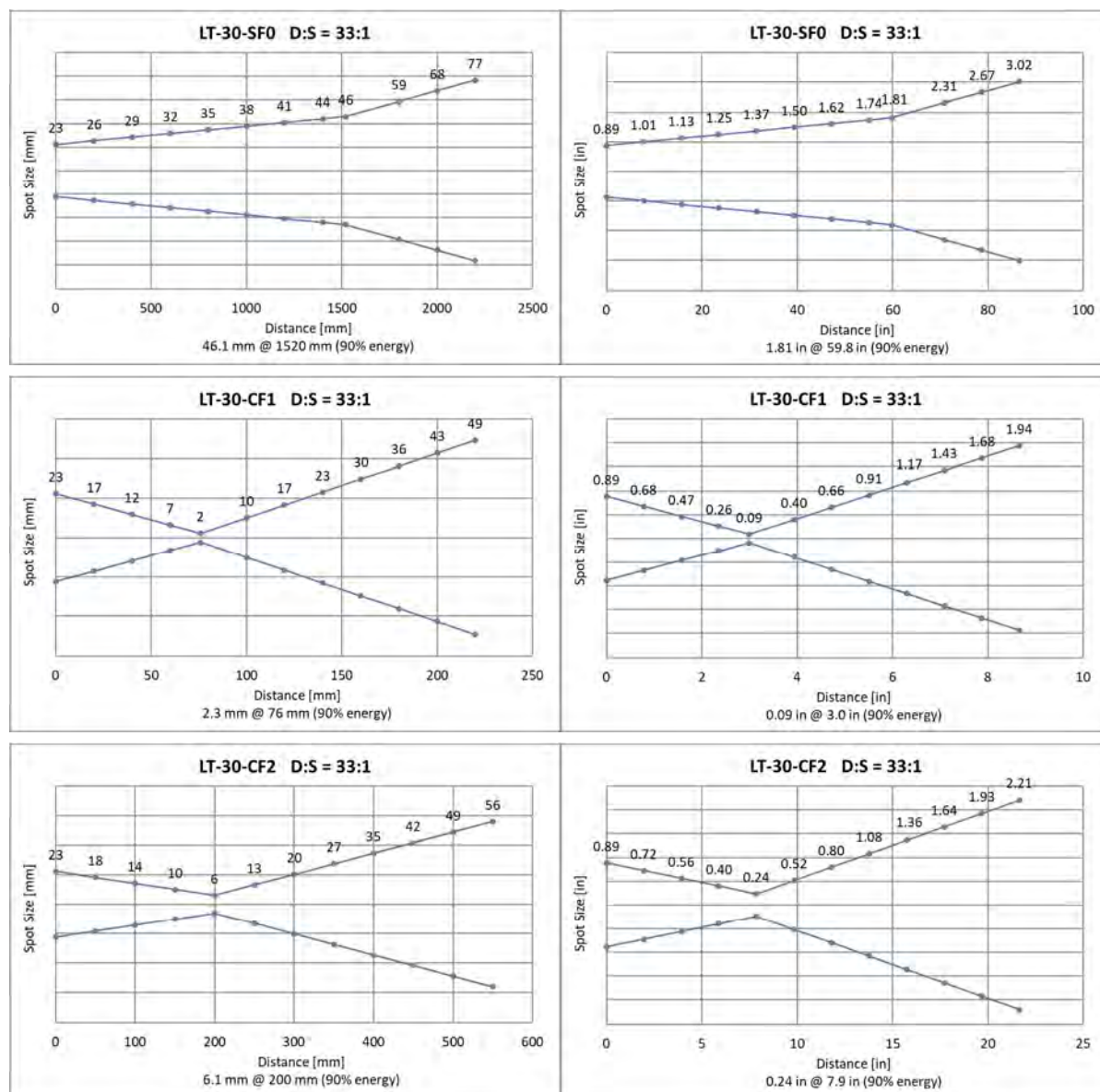
15.1.4 LTB-30 Models

Figure 15-4: Optical Diagrams LTB-30 Models
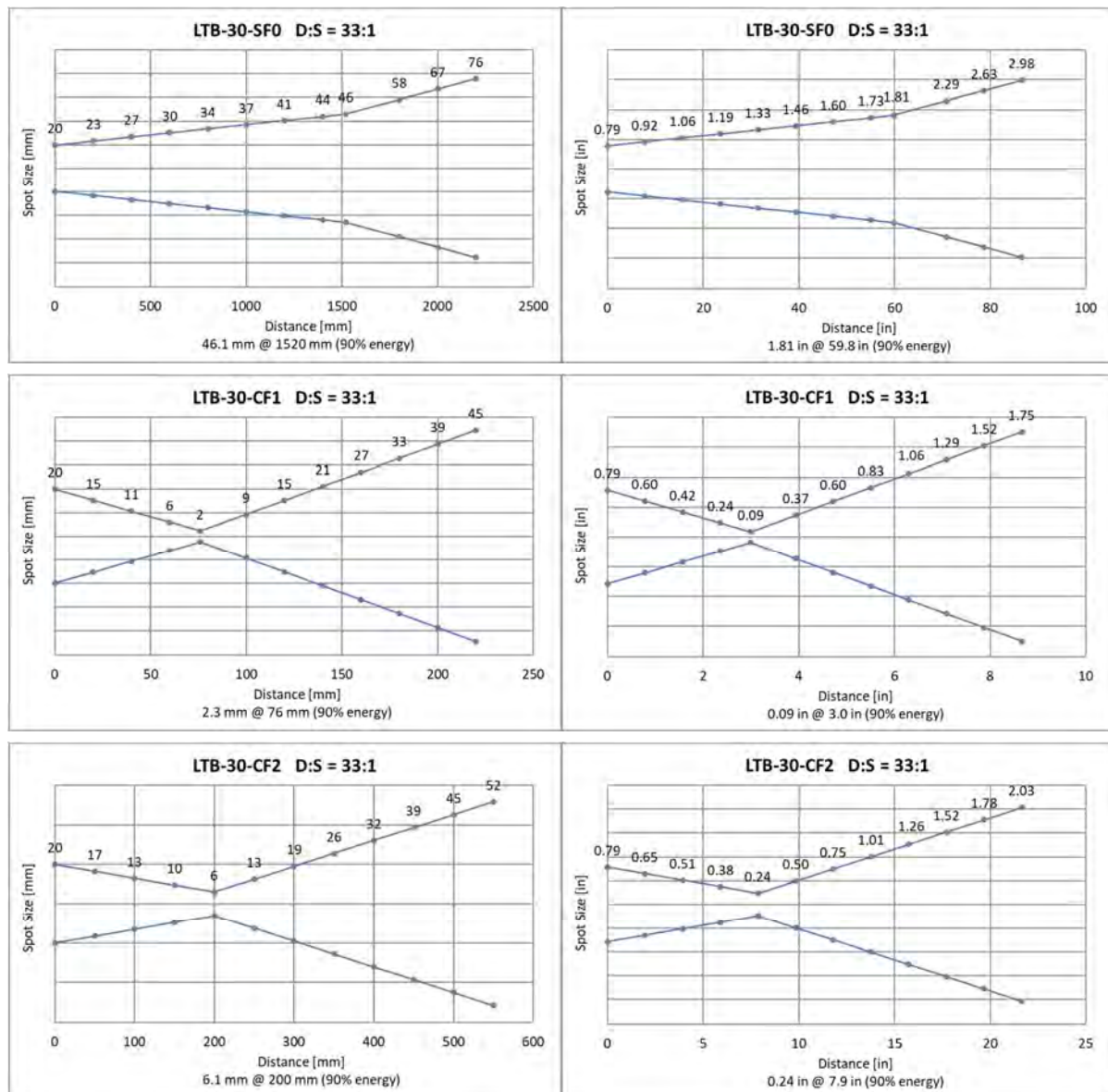
15.1.5 LT-50 Models

Figure 15-5: Optical Diagrams LT-50 Models
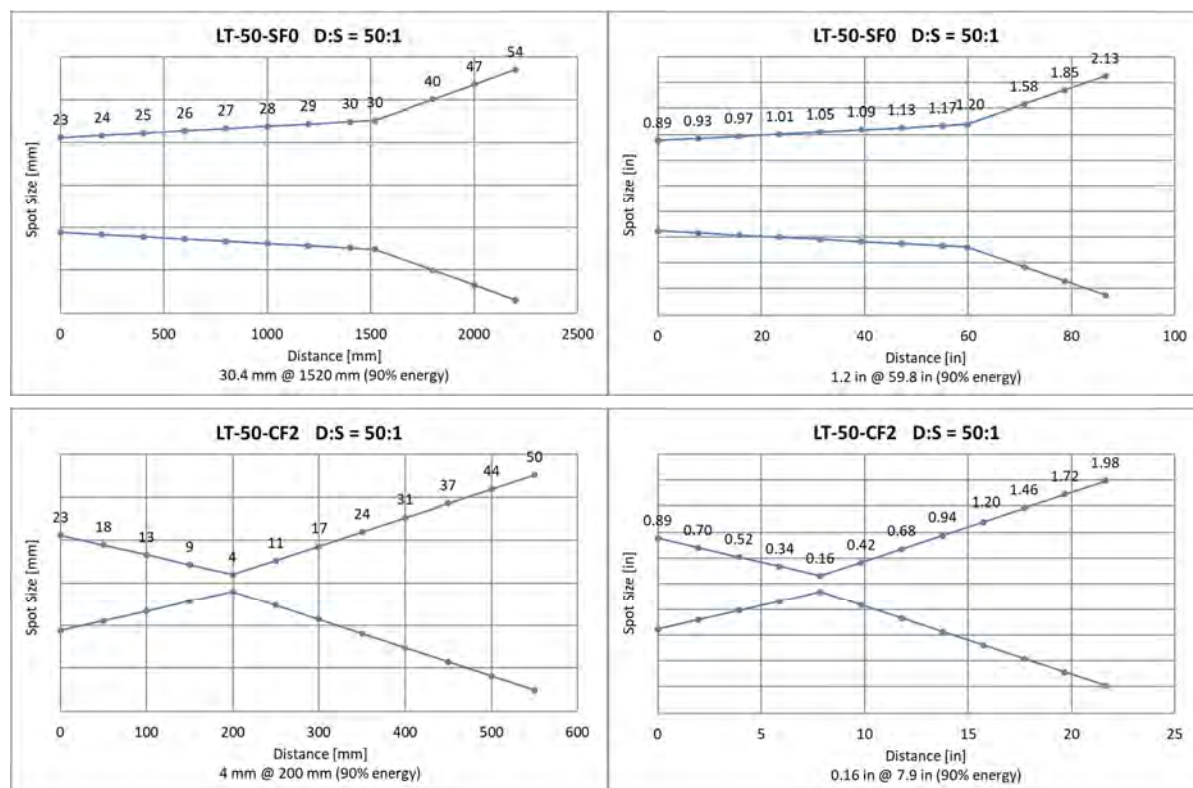
15.1.6 LT-70 Models

Figure 15-6: Optical Diagrams LT-70 Models
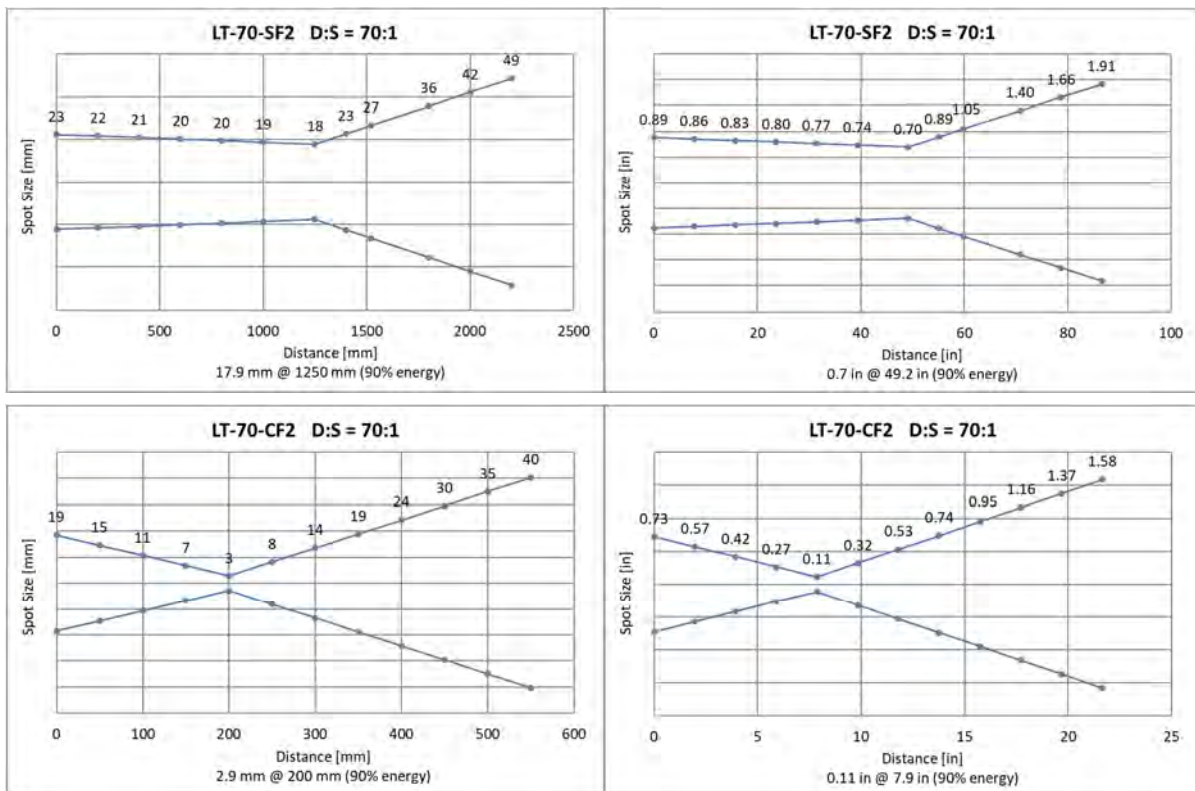
15.1.7 LTD-04 Models

Figure 15-7: Optical Diagrams LTD-04 Models
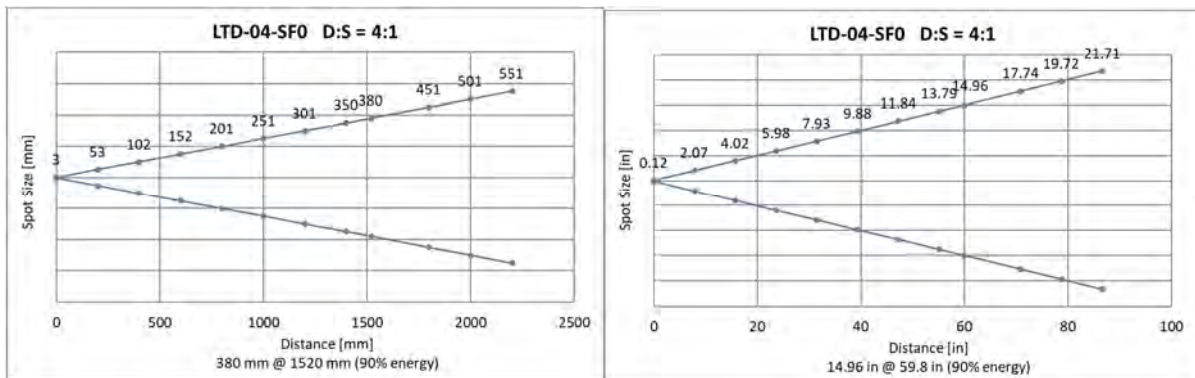
15.1.8 P7-30 Models

Figure 15-8: Optical Diagrams P7-30 Models
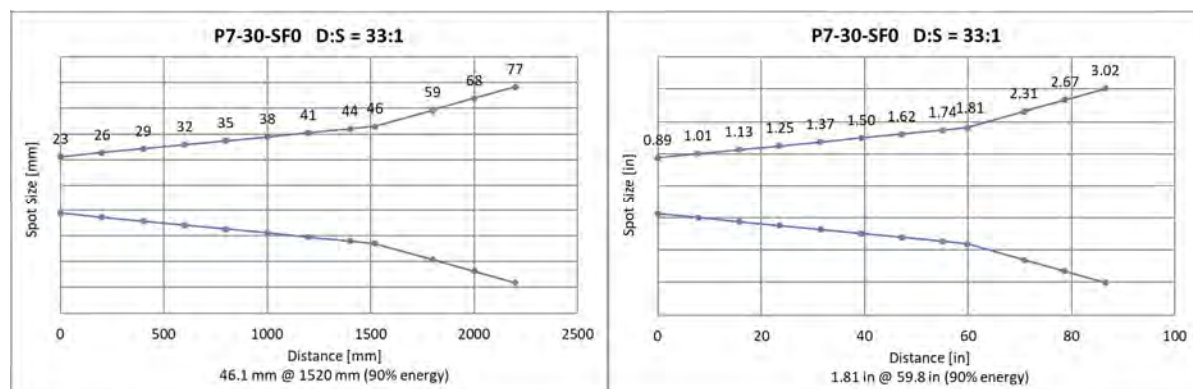
15.1.9 G7-70 Models

Figure 15-9: Optical Diagrams G7-70 Models
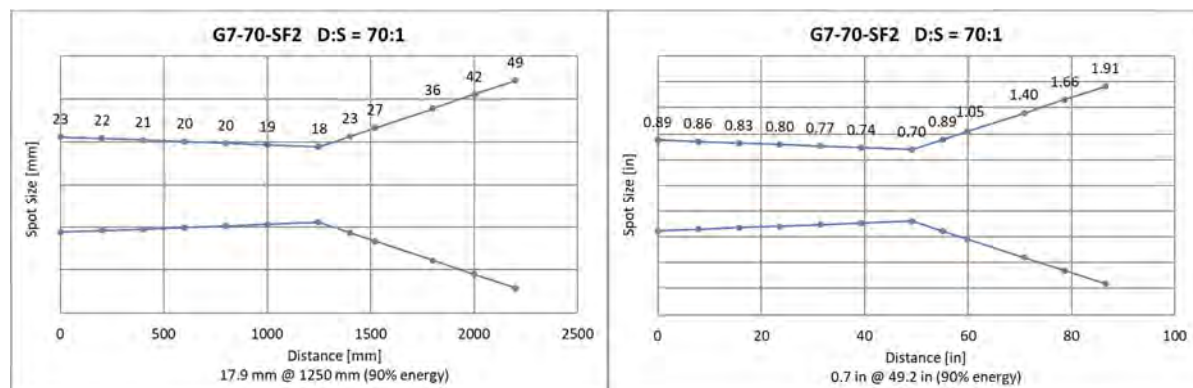
15.1.10 G5-30 Models

Figure 15-10: Optical Diagrams G5-30 Models

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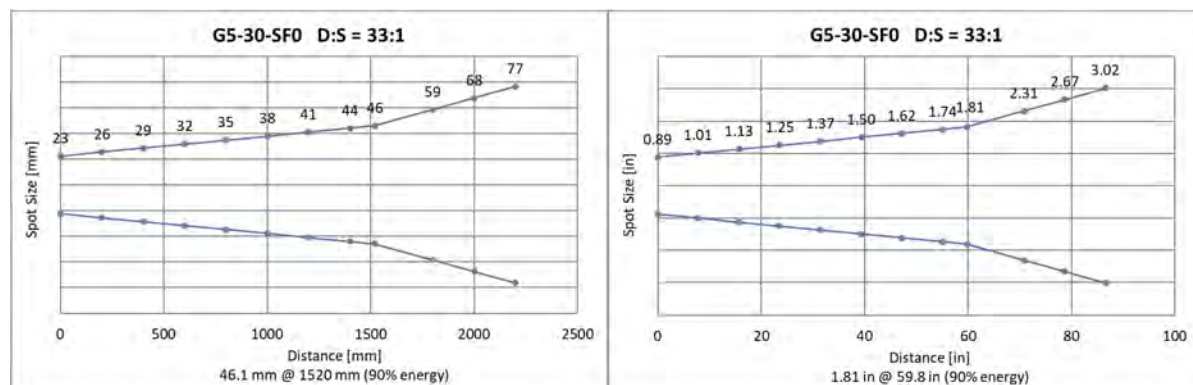
15.1.11 G5-70 Models

Figure 15-11: Optical Diagrams G5-70 Models
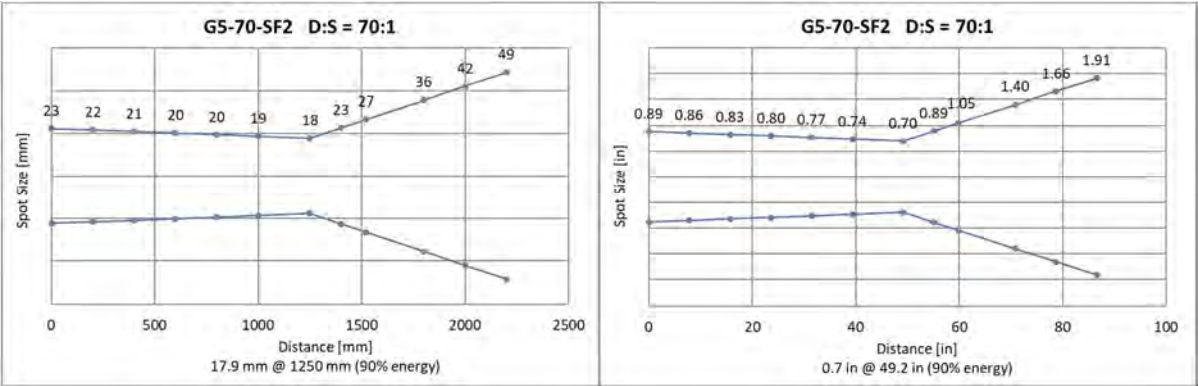
15.1.12 CO-30 Models

Figure 15-12: Optical Diagrams CO-30 Models
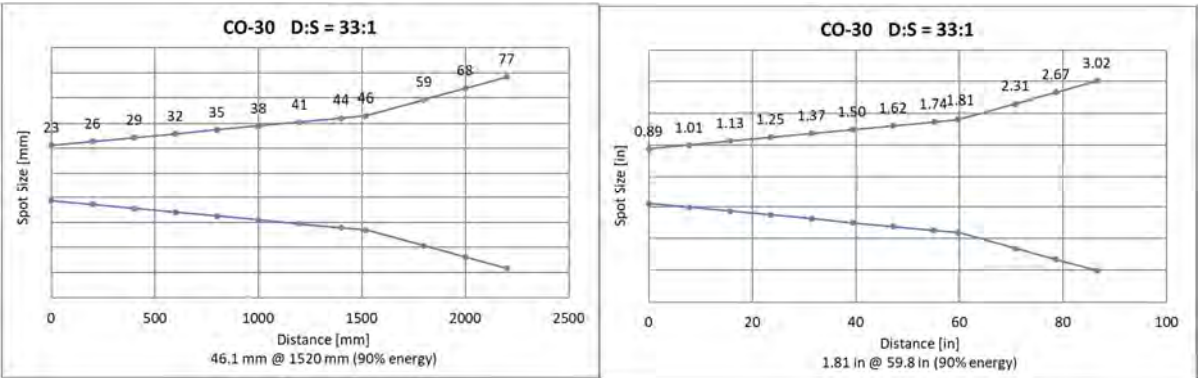
15.1.13 CO2-30 Models

Figure 15-13: Optical Diagrams CO2-30 Models
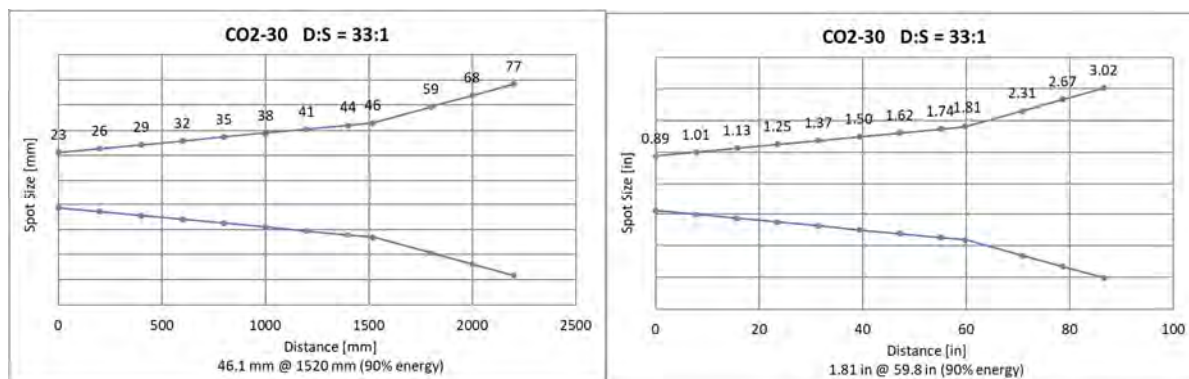
15.1.14 NOX-30 Models

Figure 15-14: Optical Diagrams NOX-30 Models
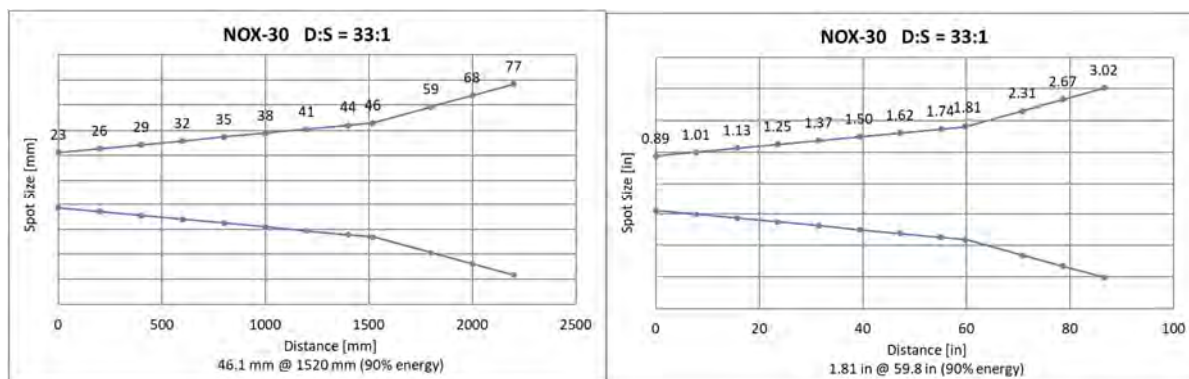
15.1.15 MT-30 Models

Figure 15-15: Optical Diagrams MT-30 Models
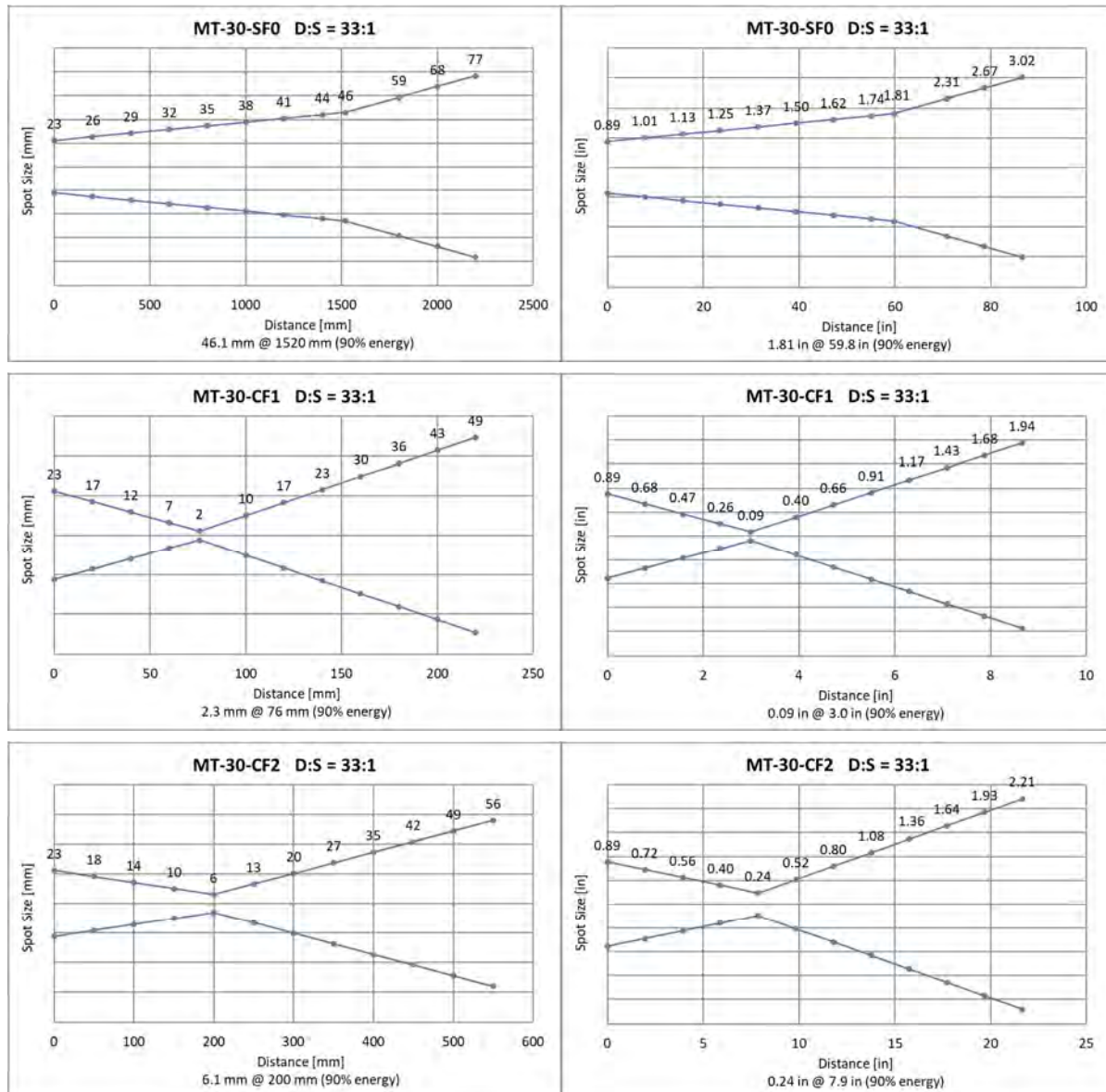
15.1.16 MT-70 Models

Figure 15-16: Optical Diagrams MT-70 Models
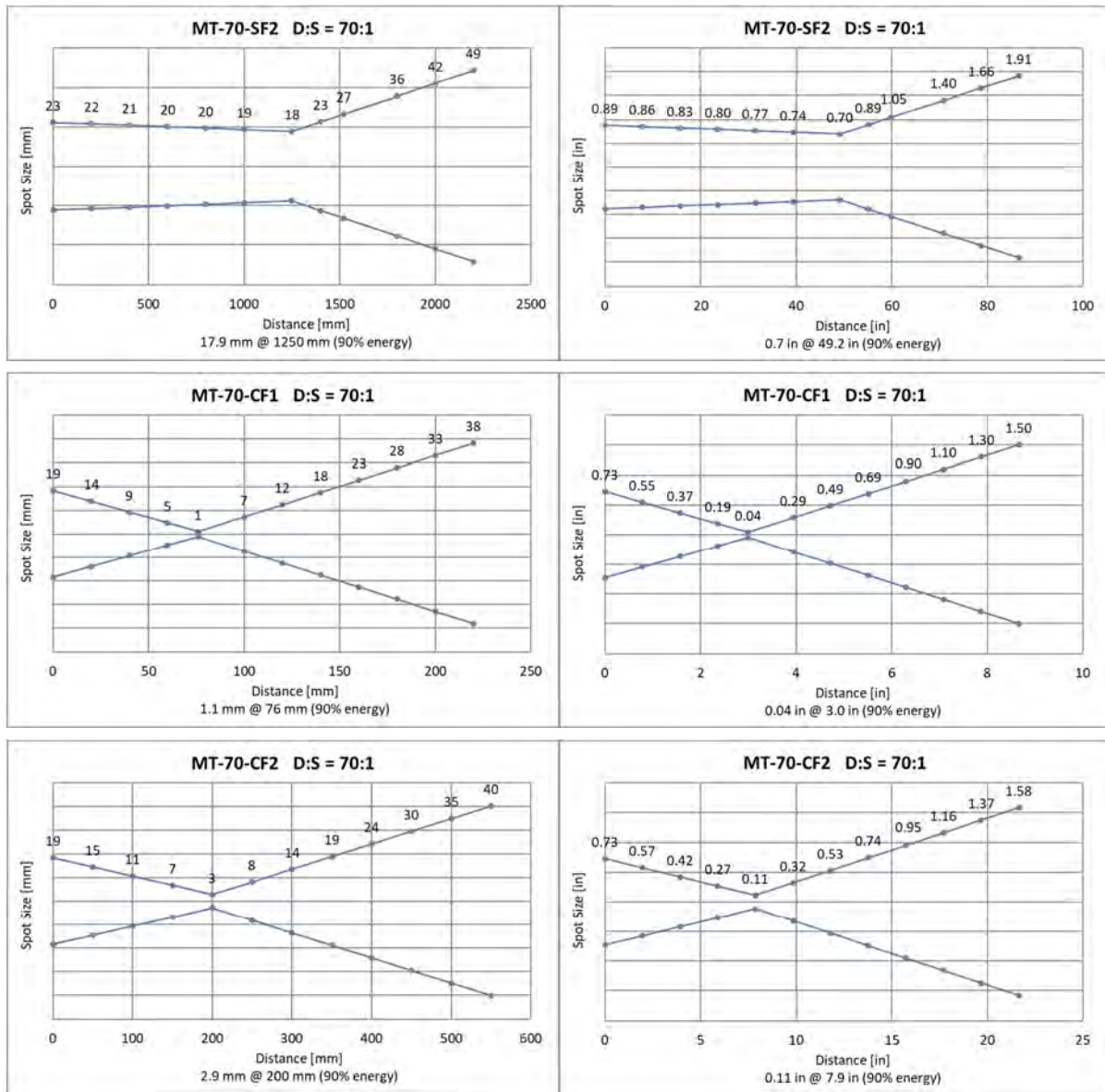
15.1.17 P3-20 Models

Figure 15-17: Optical Diagrams P3-20 Models
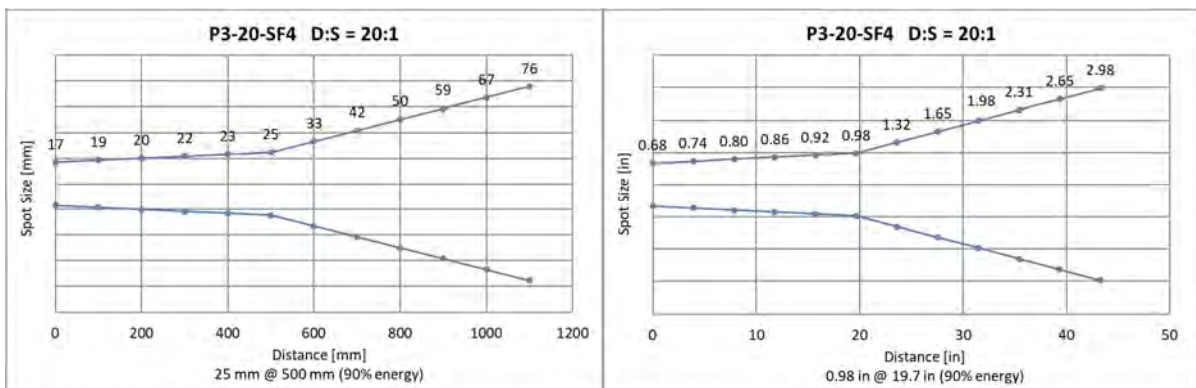
15.1.18 HT-60 Models

Figure 15-18: Optical Diagrams HT-60 Models
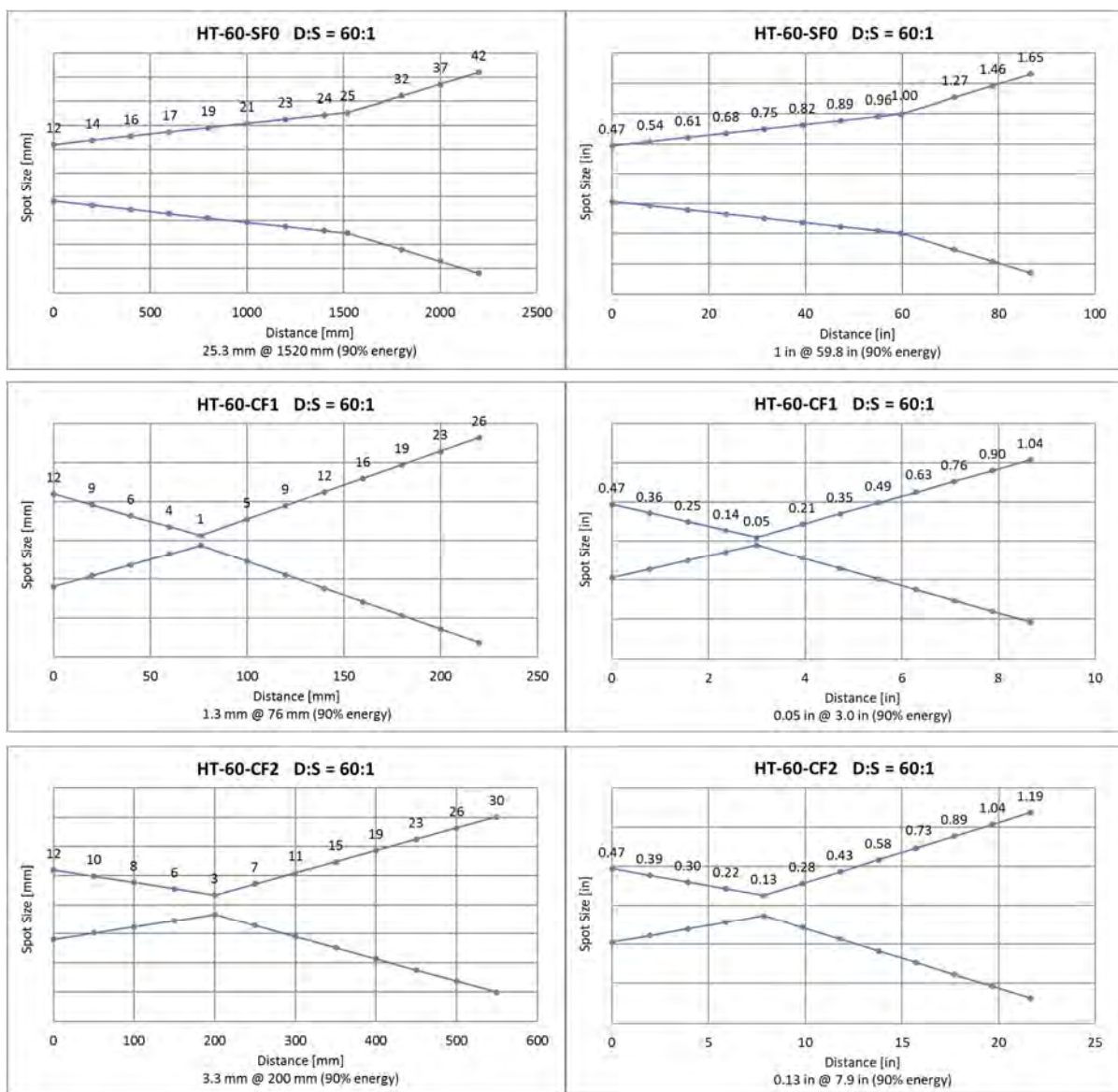
15.1.19 1M-150 Models

Figure 15-19: Optical Diagrams 1M-150 Models
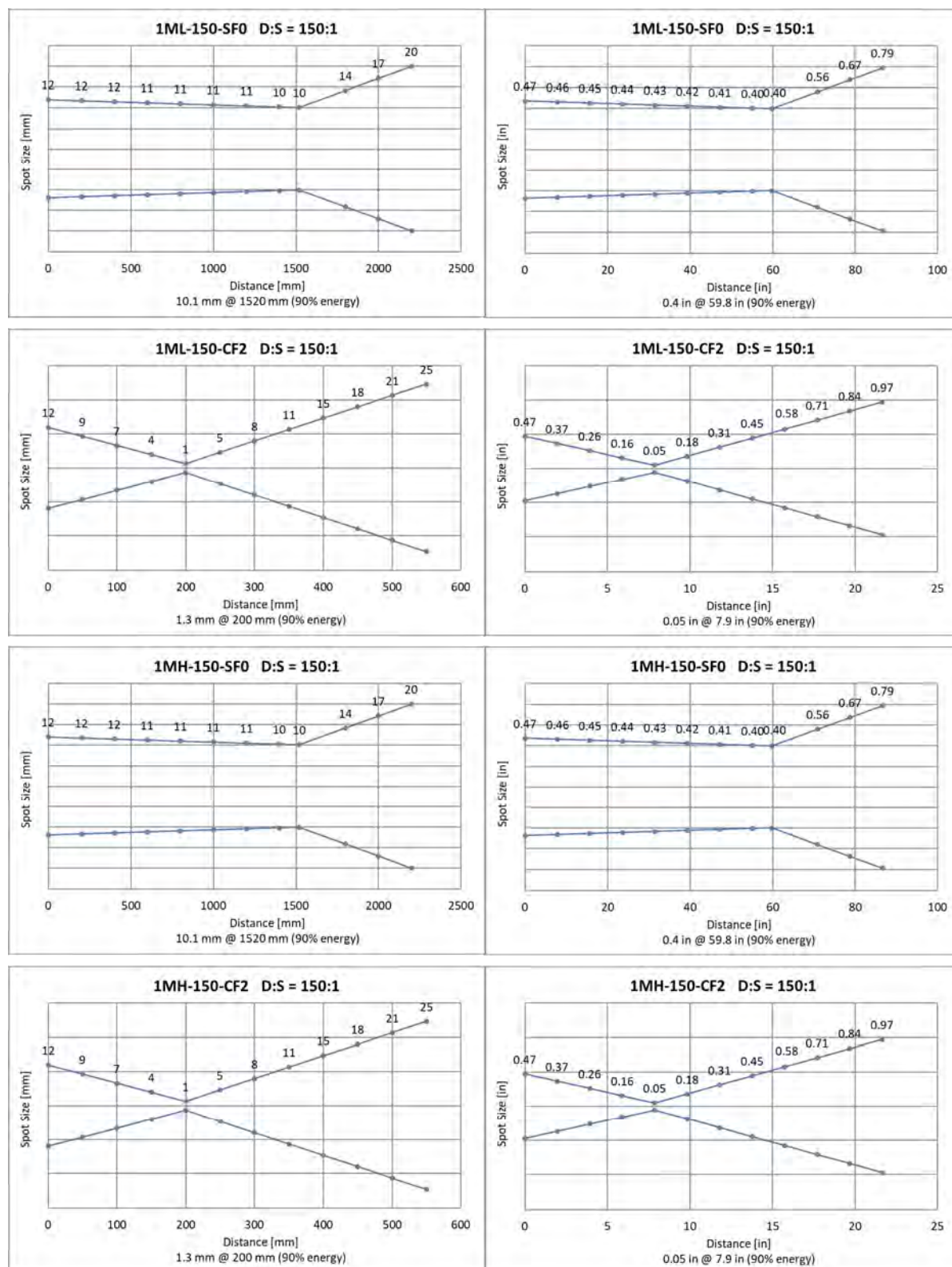
15.1.20 2M-150 Models

Figure 15-20: Optical Diagrams 2M-150 Models
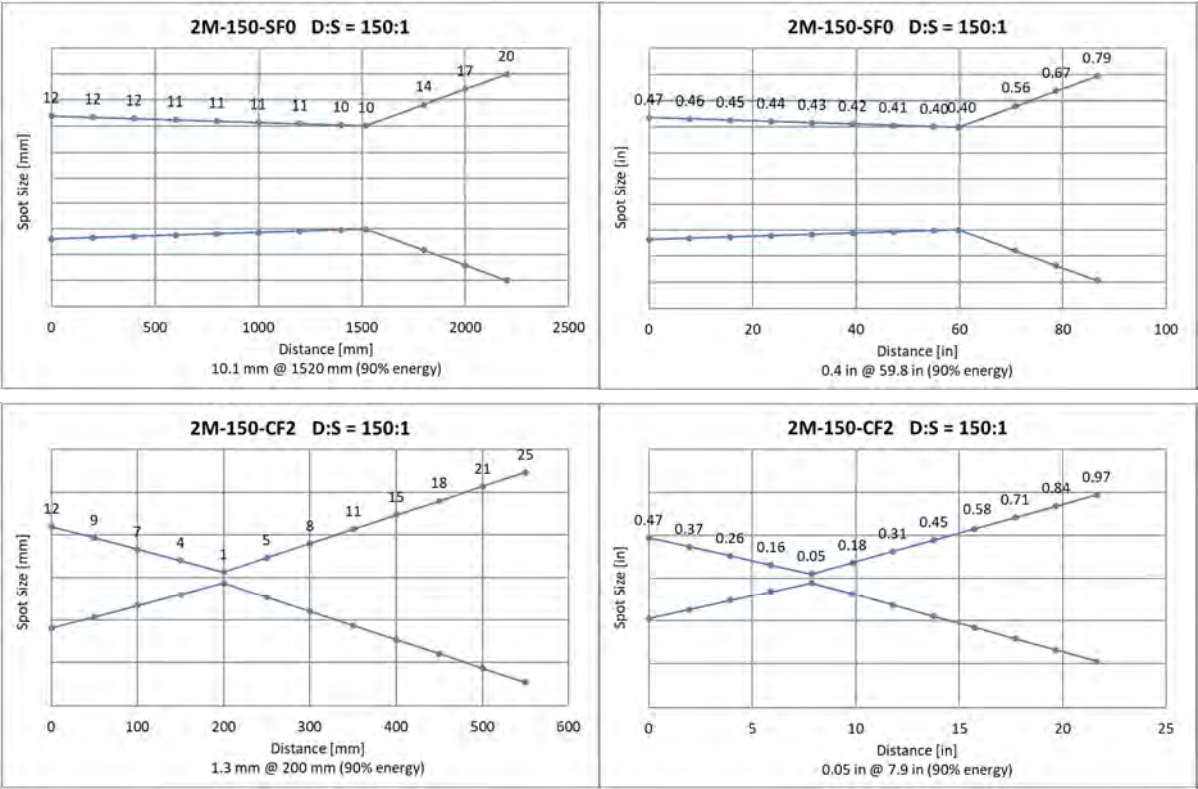
15.1.21 3M-70 Models

Figure 15-21: Optical Diagrams 3M-150 Models
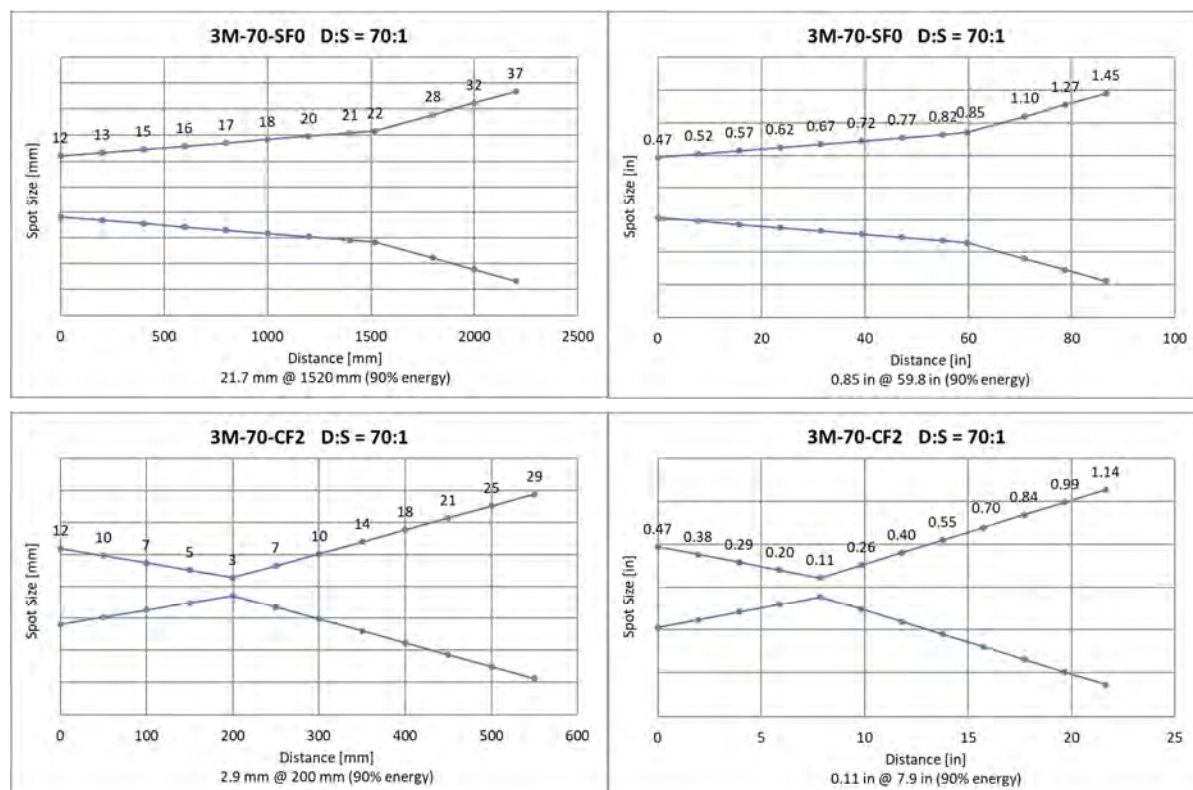
15.2 Spot Size Calculator

It is important that the sensor is mounted at a distance from the target, sufficient to be able to "see" the entire area of interest. For this reason, the manufacturer provides a field of view calculating software called "Spot Size Calculator", which allows the calculation of the resulting spot size for a given sensor model and based on a specific mounting distance.

Figure 15-22: Spot Size Calculator
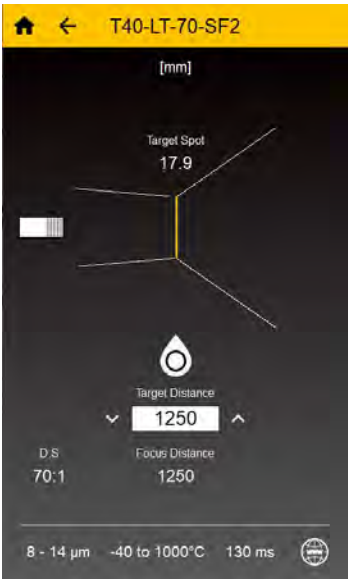
The "Spot Size Calculator" tool is available via the following stores and locations:

As app for Windows 10 based desktop computers, see Windows Store		
As app for Android mobiles, see Google Play Store		
As App for the iOS mobiles (iPhone and iPad), see App Store		

15.3 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.

15.4 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 45° from incidence.

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Table 15-1: Typical Emissivity Values for Metals

Material	1 µm	1.6 µm	2.3 µm	3.9 µm	5 µm	7.9 µm	8 – 14 µm
Metals Emissivity							
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

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Table 15-2: Typical Emissivity Values for Non-Metals

Material	1 µm	1.6 µm	2.3 µm	5 µm	7.9 µm	8 – 14 µm
			NON-METALS Emissivity			
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

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15.5 ASCII Command List

P ... Poll, B ... Burst, S ... Set, N ... Notification
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**	**4-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) U T I F G P CE EC XI XG (for 4-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	4-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	√	√	√	√
DHCP/BOOTP	DHCP	n	√		√	0 = OFF, 1 = DHCP ON 2 = BOOTP ON	0				√
Offset adjustment for temperature value	DO	nnnn.n	√		√	-200.0 ~ 200.0°C / -360.0 ~ 360.0°F 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	0.95	√	√	√	√
Error code	EC	nnnn	√			2W, 6W, 12W 0001 = Target temp. over range 0002 = Target temp. under range 0010 = Ambient temp. over range 0020 = Ambient temp. under range 0100 = Analog output over range 0200 = Analog output under range 4W: 00000004 = Ambient temp. over range 00000008 = Ambient temp. under range 00000200 = Target temp. over range 00000400 = Target temp. under range 00020000 = Profinet not ready		√	√	√	√
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	√	√	√	√
Gateway Address	GW	nnn.nnn.nnn.nnn	√		√	0.0.0.0 - 255.255.255.255	192.168.42.1				√
Temperature value responding to the top of current / voltage output range	H	nnnn.n	√	√	√	(Bottom temperature of current / voltage output range + 20°C) ~ Upper-limit of temperature range. In current unit (°C/°F)	Upper-limit of temperature range	√	√	√	

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COMMAND LIST											
Description	Char	Value Format	Poll	Burst	Set	Legal values	Factory default	2-W	6-W	12-W	4-W
Device ambient temperature	I	nnn.n	√	√		In current unit (°C/°F) EIHH over range EIUU under range		√	√	√	√
IP Address	IP	nnn.nnn.nnn.nnn	√		√	0.0.0.1 - 255.255.255.255	192.168.42.134				√
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	√		√	
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 - 20°C). In current unit (°C/°F)	Lower-limit of temperature range	√	√	√	
MAC Hardware Address	MAC	nnnnnnnnnnnn	√			e.g. 001d8d2aaa01	Set at factory calibration				√
Net Mask	NM	nnn.nnn.nnn.nnn	√		√	0.0.0.1 - 255.255.255.255	255.255.255.0				√
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	√	√	√	√
IP Port Address	PORT	n - nnnnn	√		√	1 – 65535	6363				√
Target energy value	Q	nnnnnn	√	√				√	√	√	√
Reset unit	RST				√			√	√	√	√
Target temperature value	T	nnnn.n	√	√		In current unit (°C/°F) EHHH over range EUUU under range		√	√	√	√
RS485 shunt resistor (120ohm) enable	TR	n	√		√	0 = deactivate the shunt resistor; 1 = activate the shunt resistor	0		√	√	
TCP/IP time out interval	TTI	n - nnn	√		√	0 =∞ , 1 – 240 s	0				√
Temperature unit	U	X	√	√	√	C/F	C	√	√	√	√
Poll or Burst mode selection	V	X	√		√	P = poll mode; B = burst mode	P		√	√	√
Web server ON/OFF	WS	n	√		√	0 = OFF, 1 = ON	0 = OFF				√
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 ~ 50.0°C / 1.8 ~ 90.0°F In current unit (°C/°F)	02.0 (unit: °C)	√		√	
Restore factory defaults	XF				√			√	√	√	√
Transmission rate	XG	n.nnn	√	√	√	0.100 ~ 1.000	1.000	√	√	√	√
Upper-limit of Device temperature range	XH	nnnn.n	√			In current unit (°C/°F)		√	√	√	√

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COMMAND LIST											
Description	**Char**	**Value Format**	**Poll**	**Burst**	**Set**	**Legal values**	**Factory default**	**2-W**	**6-W**	**12-W**	**4-W**
Device initialisation	XI	n	√	√	√	1 = after a reset 0 = no reset reset occurs after a power shut down		√	√	√	√
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		√	√	
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	√		√	
Main firmware revision	XR	nn.nn.nnnn	√			Examples: 6/12W: 01.01.1111 Ethernet, EtherNet/IP: 01.01.1111E PROFINET: 01.01.1111P			√	√	√
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	XXXXXXXXXX	√			e.g. STRLTH5SFCW		√	√	√	√
Device serial number	XV	nnnnnnnnn	√			e.g. 123456789		√	√	√	√
Advanced hold - hysteresis temperature value	XY	nnnn.n	√		√	-100.0 ~ 100.0°C / -180.0 ~ 180.0°F In current unit (°C/°F)	0000.0	√	√	√	√
Amb count + IR ADC count value	YA	nnnnn#nnnnnn	√					√	√	√	√
PSa value + Energy value	YB	nnnnnn#nnnnnn	√					√	√	√	

15.6 ATEX Certificate of Conformity

1 **EU-TYPE EXAMINATION CERTIFICATE**

2 Equipment intended for use in Potentially Explosive Atmospheres Directive 2014/34/EU

3 Certificate Number: **CSANE 20ATEX2254** Issue: **0**

4 Equipment: **Smart Integrated Infrared Sensors/Thermalert T4.0**

5 Applicant: **Fluke Process Instruments GmbH**

6 Address: Blankenburger Straße 135
13127 Berlin
Germany

7 This equipment and any acceptable variation thereto is specified in the schedule to this certificate and the documents therein referred to.

8 CSA Group Netherlands B.V., notified body number 2813 in accordance with Articles 17 and 21 of Directive 2014/34/EU of the European Parliament and of the Council, dated 26 February 2014, certifies that this equipment has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of equipment intended for use in potentially explosive atmospheres given in Annex II to the Directive.

The examination and test results are recorded in the confidential reports listed in Section 14.2.

9 Compliance with the Essential Health and Safety Requirements, with the exception of those listed in the schedule to this certificate, has been assured by compliance with the following documents:

EN IEC 60079-0:2018   EN 60079-11:2012

10 If the sign 'X' is placed after the certificate number, it indicates that the equipment is subject to Specific Conditions of Use identified in the schedule to this certificate.

11 This EU-Type Examination Certificate relates only to the design and construction of the specified equipment. If applicable, further requirements of this Directive apply to the manufacture and supply of this equipment.

12 The marking of the equipment shall include the following:

II 2G
Ex ib IIC T4 Gb
-20°C≤Ta≤+80°C

II 2D
Ex ib IIIC T135°C Db
-20°C≤Ta≤+80°C

Project Number   80075135

Signed: J A May

Title: Director of Operations

CSA Group Netherlands B.V.
Utrechtseweg 310, Building B42,
6812AR Arnhem, The Netherlands

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SCHEDULE

EU-TYPE EXAMINATION CERTIFICATE

CSANE 20ATEX2254
Issue 0

13 **DESCRIPTION OF EQUIPMENT**

Thermalert 4.0 series Smart Integrated Infrared Sensors are used for temperature measurement and they have many different spectral responses to be capable of covering a broad range of applications such as metal, glass and plastics. They are intended to be powered by an approved IS safety barrier and use Hart for communication.

The smart integrated Infrared Sensors are comprised of a stainless-steel housing that houses two PCBs, a terminal block and a temperature sensor.

The entity parameters are:
U_i= 27V, I_i= 100mA, P_i=0.63W, L_i=21.6µH, C_i=0µF

The thermalert 4.0 series utilizes a configurator style model coding system as defined below:

T40	-	AB	-	CD	-	EFG	-	6	-	IS
Thermalert 4.0		Stands for spectral (µm)		Stands for optics D:S		Stands for focus distance (mm)		Stands for interface: HART		Intrinsic safety

14 **DESCRIPTIVE DOCUMENTS**

14.1 **Drawings**

Refer to Certificate Annexe.

14.2 **Associated Reports and Certificate History**

Issue	Date	Report number	Comment
0	22 June 2021	R80075135A	The release of the prime certificate.

15 **SPECIFIC CONDITIONS OF USE** (denoted by X after the certificate number)

None

16 **ESSENTIAL HEALTH AND SAFETY REQUIREMENTS OF ANNEX II** (EHSRs)

The relevant EHSRs that are not addressed by the standards listed in this certificate have been identified and individually assessed in the reports listed in Section 14.2.

17 **CONDITIONS OF MANUFACTURE**

17.1 The use of this certificate is subject to the Regulations Applicable to Holders of Sira/CSA Certificates.

17.2 Holders of EU-Type Examination Certificates are required to comply with the conformity to type requirements defined in Article 13 of Directive 2014/34/EU.

CSA Group Netherlands B.V.
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6812AR Arnhem, The Netherlands

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15.7 IECEx Certificate of Conformity

IECEx Certificate of Conformity

INTERNATIONAL ELECTROTECHNICAL COMMISSION
IEC Certification System for Explosive Atmospheres
for rules and details of the IECEx Scheme visit www.iecex.com

Certificate No.	**IECEx SIR 20.0047**	Page 1 of 3	Certificate history:
Status	**Current**	Issue No: 0	
Date of Issue	2021-03-05		

Applicant: **Fluke Process Instruments GmbH**
Blankenburger Straße 135
Berlin 13127
Germany

Equipment: **Smart Integrated Infrared Sensors/Thermalert 4.0**

Optional accessory:

Type of Protection: **Intrinsically Safe ib**

Marking: Ex ib IIC T4 Gb
Ex ib IIIC T135°C Db
Ta -20°C≤Ta≤+80°C

Approved for issue on behalf of the IECEx
Certification Body: **Neil Jones**

Position   **Certification Manager**

Signature:
(for printed version)

Date

1. This certificate and schedule may only be reproduced in full.
2. This certificate is not transferable and remains the property of the issuing body.
3. The Status and authenticity of this certificate may be verified by visiting www.iecex.com or use of this QR Code.

Certificate issued by:

SIRA Certification Service
CSA Group
Unit 6, Hawarden Industrial Park
Hawarden, Deeside, CH5 3US
United Kingdom

IEC | **IECEx**

IECEx Certificate of Conformity

Certificate No.:	**IECEx SIR 20.0047**	Page 2 of 3	
Date of issue:	2021-03-05	Issue No: 0	

Manufacturer: **Fluke Process Instruments GmbH**
Blankenburger Straße 135
Berlin 13127
Germany

Additional manufacturing locations:

This certificate is issued as verification that a sample(s), representative of production, was assessed and tested and found to comply with the IEC Standard list below and that the manufacturer's quality system, relating to the Ex products covered by this certificate, was assessed and found to comply with the IECEx Quality system requirements. This certificate is granted subject to the conditions as set out in IECEx Scheme Rules, IECEx 02 and Operational Documents as amended.

STANDARDS
The equipment and any acceptable variations to it specified in the schedule of this certificate and the identified documents, was found to comply with the following standards

IEC 60079-0:2017 Explosive atmospheres - Part 0: Equipment - General requirements
Edition 7.0

IEC 60079-11:2011 Explosive atmospheres - Part 11: Equipment protection by intrinsic safety "i"
Edition 6.0

This Certificate **does not** indicate compliance with safety and performance requirements other than those expressly included in the Standards listed above.

TEST & ASSESSMENT REPORTS:
A sample(s) of the equipment listed has successfully met the examination and test requirements as recorded in:

Test Report:

GB/SIR/ExTR21.0040/00

Quality Assessment Report:

DE/EPS/QAR15.0003/07

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IECEx Certificate of Conformity

Certificate No.: **IECEx SIR 20.0047**	Page 3 of 3
Date of issue: 2021-03-05	Issue No: 0

EQUIPMENT:
Equipment and systems covered by this Certificate are as follows:

Thermalert 4.0 series Smart Integrated Infrared Sensors are used for temperature measurement and they have many different spectral responses to be capable of covering a broad range of applications such as metal, glass and plastics. They are intended to be powered by an approved IS safety barrier and use Hart for communication.

The smart integrated Infrared Sensors are comprised of a stainless steel housing that houses two PCBs, a terminal block and a temperature sensor.

The entity parameters are:

U_i= 27V, I_i= 100mA, P_i=0.63W, L_i=21.6µH, C_i=0µF

Refer to the Annexe for the configurator style model coding system

SPECIFIC CONDITIONS OF USE: NO

Annex:

IECEx SIR 20.0047 Annexe Issue 0.pdf

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Annexe to:	IECEx SIR 20.0047 Issue 0
Applicant:	Fluke Process Instruments GmbH
Apparatus:	Smart Integrated Infrared Sensors/Thermalert 4.0

Thermalert 4.0 series Smart Integrated Infrared Sensors are used for temperature measurement and they have many different spectral responses to be capable of covering a broad range of applications such as metal, glass and plastics. They are intended to be powered by an approved IS safety barrier and use Hart for communication.

The smart integrated Infrared Sensors are comprised of a stainless steel housing that houses two PCBs, a terminal block and a temperature sensor.

The entity parameters are:
Ui= 27V, Ii= 100mA, Pi=0.63W, Li=21.6µH, Ci=0µF

The thermalert 4.0 series utilizes a configurator style model coding system as defined below:

T40	-	AB	-	CD	-	EFG	-	6	-	IS
Thermalert 4.0		Stands for spectral (µm)		Stands for optics D:S		Stands for focus distance (mm)		Stands for interface: HART		Intrinsic safety