optris
infrared measurements

Operator's Manual

optris® CTi

LT/LT hot

Infrared Industrial Pyrometer

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1 General Information

1.1 Description

Thank you for choosing the **optris® CTí** infrared thermometer.
The sensors of the optris CTi series are noncontact infrared temperature sensors.
They calculate the surface temperature based on the emitted infrared energy of objects **[►9 Basics of Infrared Thermometry]**. The sensor housing of the CTi head is made of stainless steel (IP65/ NEMA-4 rating) – the sensor electronics is placed in a separate box made of die casting zinc.

The CTi sensing head is a sensitive optical system. Please use only the thread for mechanical installation.

- Avoid abrupt changes of the ambient temperature.
- Avoid mechanical violence on the head – this may destroy the system (expiry of warranty).
- If you have any problems or questions, please contact our service department.

Read the manual carefully before the initial start-up. The producer reserves the right to change the herein described specifications in case of technical advance of the product.

► All accessories can be ordered according to the referred part numbers in brackets [ ].

1.2 Warranty

Each single product passes through a quality process. Nevertheless, if failures occur, please contact the customer service at once. The warranty period covers 24 months starting on the delivery date. After the warranty is expired the manufacturer guarantees additional 6 months warranty for all repaired or substituted product components. Warranty does not apply to damages, which result from misuse or neglect. The warranty also expires if you open the product. The manufacturer is not liable for consequential damage or in case of a non-intended use of the product.
If a failure occurs during the warranty period the product will be replaced, calibrated or repaired without further charges. The freight costs will be paid by the sender. The manufacturer reserves the right to exchange components of the product instead of repairing it. If the failure results from misuse or neglect the user has to pay for the repair. In that case you may ask for a cost estimate beforehand.

1.3 Scope of Supply

- CTi sensing head with connection cable and electronic box
- Mounting nut
- 1.5 m USB-C cable with USB-C to USB-A adaptor
- Quick Start Guide

1.4 Maintenance

Lens cleaning: Blow off loose particles using clean compressed air. The lens surface can be cleaned with a soft, humid tissue (moistened with water) or a lens cleaner (e.g. Purosol or B+W Lens Cleaner).

Never use cleaning compounds which contain solvents (neither for the lens nor for the housing).

1.5 Model Overview

The sensors of the CTi series are available in the following basic versions:

Model	Model codes	Measurement range	Spectral response	Typical applications
CTi LT	LT02	-50 to 650 °C	8-14 µm	non-metallic surfaces
	LT15	-50 to 800 °C		
	LT22	-50 to 1050 °C		
CTi hot	LT02H	-50 to 1050 °C		high ambient temperatures (up to 250 °C)
	LT10H			

1.6 Factory Default Settings

The unit has the following presetting at time of delivery:

Signal output 1 - object temperature	0 – 10 V = -50 – 500 °C
Signal output 2 - Internal head temperature	0 – 10 V = -50 – 500 °C
Emissivity	1,000
Transmissivity	1,000
Averaging (AVG)	0,2 s
Smart Averaging	inactive
Peak hold	inactive
Valley hold	inactive
Lower limit temperature range [°C]	0
Upper limit temperature range [°C]	500
Lower alarm limit [°C] (normally closed)	30
Upper alarm limit [°C] (normally open)	100

Smart Averaging means a dynamic average adaptation at high signal edges. [Activation via software only]. ►**Appendix C – Smart Averaging**

2 Technical Data

2.1 General Specifications

	Sensing head	Electronic box
Environmental rating	IP65 (NEMA-4)	IP65 (NEMA-4)
Operating Temperature	see: Measurement Specifications	-20...85 °C [1)]
Storage temperature	see: Measurement Specifications	-40...85 °C
Relative humidity	10...95 %, non-condensing	
Material	stainless steel	die casting zinc
Dimensions	28 mm x 14 mm (SF Optics) or 32 mm x 14 mm (CF Optics), M12x1	89 mm x 70 mm x 30 mm
	55 mm x 29,5 mm, M18x1 (with massive housing)	
Weight	40 g (205g with massive housing)	420 g
Cable length	1 m (standard for LT versions) 3 m (standard for LT hot versions) 8 m 15 m	
Cable diameter	2,8 mm	
Ambient temperature cable	max. 180 °C (High temperature cable for CTi LT hot: 250 °C)	
Vibration / Shock	IEC 68-2-6: 3G, 11 – 200 Hz, any axis / IEC 68-2-27: 50G, 11 ms, any axis	
Pressure resistance (head)	8 bar	
Software / App (optional)	CompactPlus Connect / IRmobile	

[1)] The functionality of the LCD display can be limited at ambient temperatures below 0 °C

2.2 Electrical Specifications

Power Supply	8-30 VDC / 5 V USB (built-in) / max. 1,2 W
Outputs/ analog	Output 1 and 2 are freely selectable: Analog mA/mV, Alarm mA/mV, TCK selectable: 0/ 4–20 mA, 0–5/ 10 V, thermocouple (type K) or alarm output (Signal source: object temperature) Head temperature as 0–5 V or 0–10 V output or alarm output (Signal source switchable to object temperature or electronic box temperature if used as alarm output)
Alarm output	Open collector output (NPN type) at Pin AL2 [24 V/ 50 mA]
Output impedances	
mA	max. loop resistance 500 Ω
mV	min. 100 kΩ load impedance
Thermocouple	20 Ω
Digital interfaces	USB, RS232, RS485, Modbus RTU, Ethernet TCP, Modbus TCP, EtherNet/IP, Profinet (optional plug-in modules)
Relay outputs	2 x 60 VDC/ 42 VAC_{RMS}, 0,4 A; optically isolated (optional plug-in module)
Functional inputs / I/O Pins	I/O 1-3 pins freely selectable via software

2.3 Measurement Specifications according to IEC/TS 62492-2 (2013-04)

	LT02	LT15	LT22	LT02H	LT10H
Temperature range (scalable)	-50...650 °C	-50...800 °C	-50...1050 °C	-50 … 1050 °C	-50 … 1050 °C
Operating temperature (head)[1)]	-20...130 °C	-20...180 °C		-20...250 °C	-20...250 °C
Storage temperature (head)	-40...130 °C	-40...180 °C		-40...250 °C	-40...250 °C
Spectral range	8...14 µm				
Optical resolution	2:1	15:1	22:1	2:1	10:1
System uncertainty [2) 3) 4) 5) 7)]	±1,0 °C or ± 1,0 %			±1,5 °C or ± 1,0 %	
Repeatability [2) 3) 4) 5) 7)]	±0,2 °C or ± 0,1 %	±0,1 °C or ± 0,1 %	±0,15 °C or ± 0,1 %	±0,13 °C or ± 0,1 %	±0,16 °C or ± 0,1 %
Temperature coefficient [5)]	±0,05 K/ K or ±0,02 %/ K	±0,05 K/ K	±0,05 K/ K	±0,1 K/ K	±0,04 K/ K
NETD [4) 5) 6) 7)] (typically)	25 mK	25 mK	35 mK	37 mK	45 mK
Short-term stability [4), 5), 7), 8)] (typically=	0.13 K/h	0.08 K/h	0.08 K/h	0.24 K/h	0.3 K/h
Response time (90 % signal)	40 ms	115 ms	115 ms	45 ms	40 ms
Warm-up time	10 min				
Emissivity/ Gain	0,050...1,100 (adjustable via programming keys or software)				
Transmissivity	0,050...1,100 (adjustable via programming keys or software)				
Signal processing	Average, peak hold, valley hold (adjustable via programming keys or software)				

1) The LCD displays capacity may be limited at ambient temperatures below 0 °C
2) Whichever is greater
3) T obj >0 °C
4) ε = 1
5) Response time = 200ms
6) T obj = 25 °C
7) at ambient temperature 23 ± 5 °C
8) Tobj = 100 °C

On the CTi LT hot models [LT02/ LT02H/ LT10H] the head cable must not be moved during the measurement.

2.4 Optical Charts

The following optical charts show the diameter of the measuring spot in dependence on the distance between measuring object and sensing head. The spot size refers to **90 % of the radiation energy**.
The distance is always measured from the front edge of the sensing head.

As an alternative to the optical diagrams, the spot size calculator can also be used on the Optris website or via the Optris calculator app. The app can be downloaded for free from the Google Play store (see QR code).

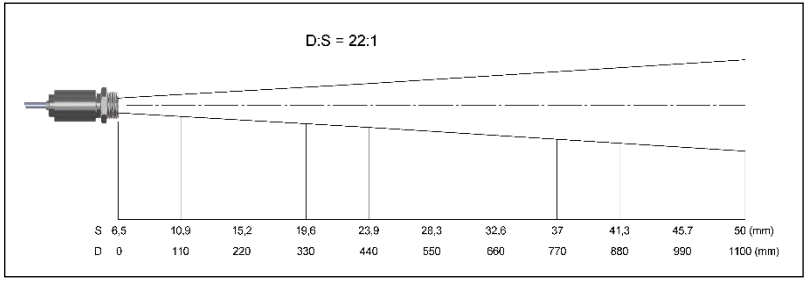
D = Distance from front of the sensing head to the object

S = Spot size

The size of the measuring object and the optical resolution of the infrared thermometer determine the maximum distance between sensing head and measuring object.
In order to prevent measuring errors the object should fill out the field of view of the optics completely.
Consequently, the spot should at all times have at least **the same size** like the object or should be **smaller than** that.

LT22

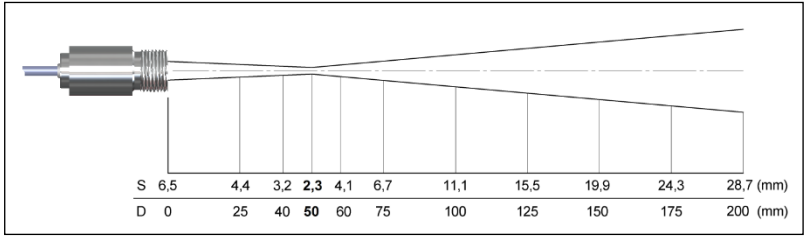
Optics: SF
D:S: 22:1



LT22

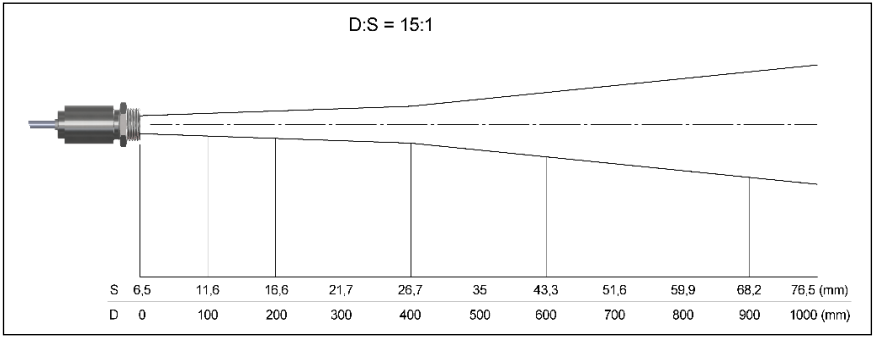
Optics: CF
D:S: 22:1

2,3mm@ 50mm
D:S (Far Field) = 6:1



LT15

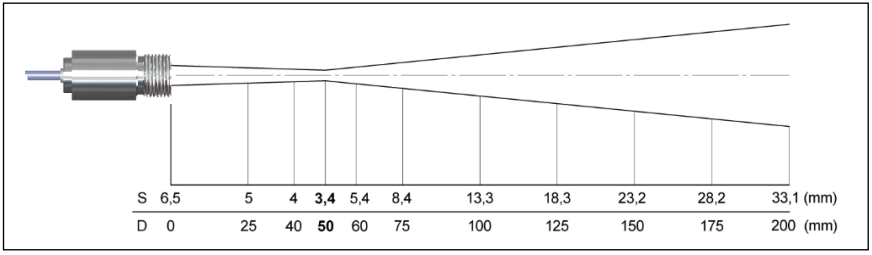
Optics: SF
D:S: 15:1



LT15

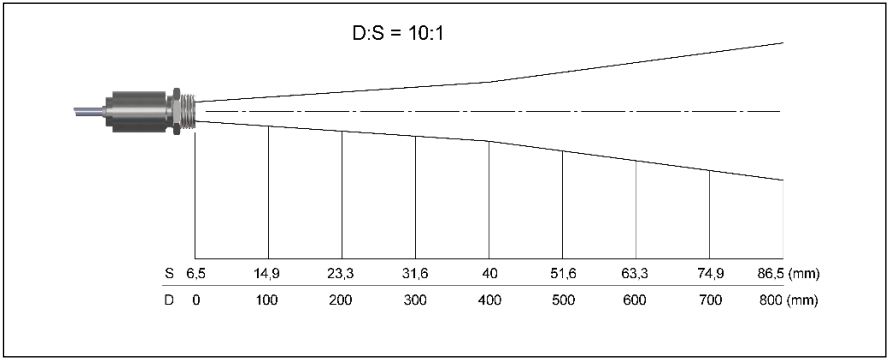
Optics: CF
D:S: 15:1

3,0mm@ 50mm
D:S (Far Field) = 5:1



LT10H

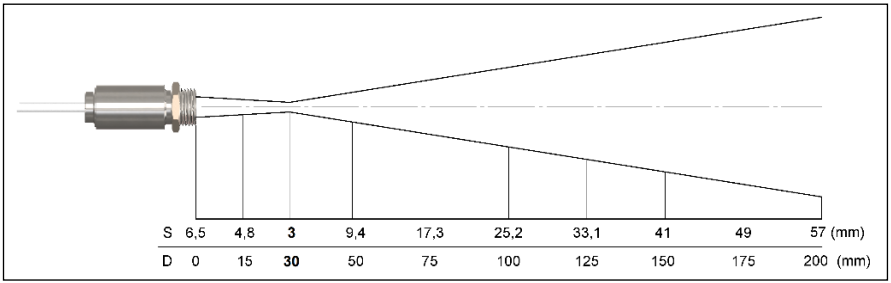
Optics: SF
D:S: 10:1



LT10H

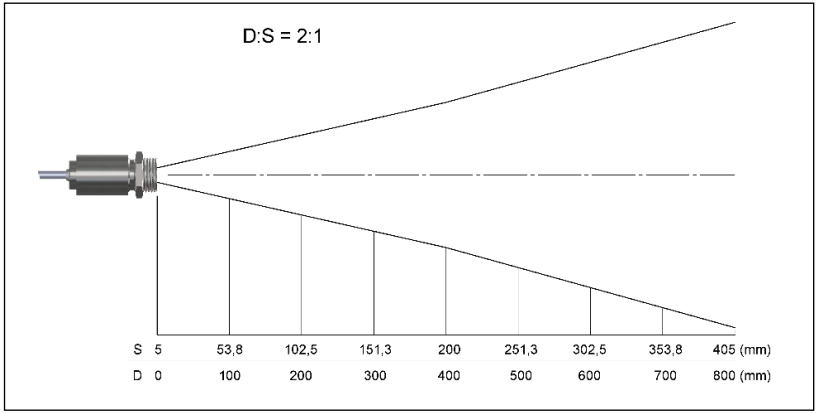
Optik: CF1
D:S: 10:1

3,0mm@ 30mm
D:S (Far Field) = 3:1



LT02 **LT02H**

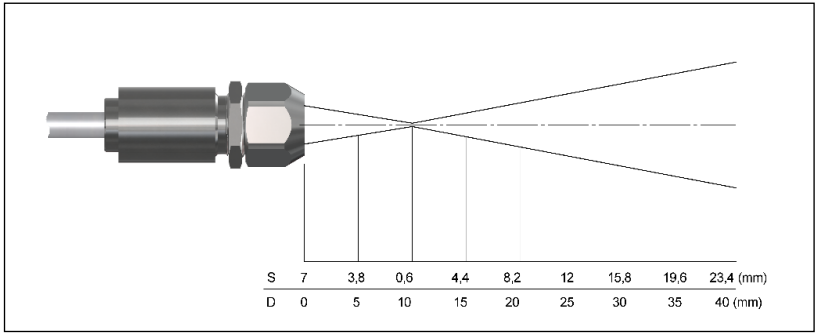
Optics: SF
D:S: 2:1



LT22 + CF lens

0,6 mm@ 10 mm
0,6 mm@ 8 mm [ACCTAPLCF]

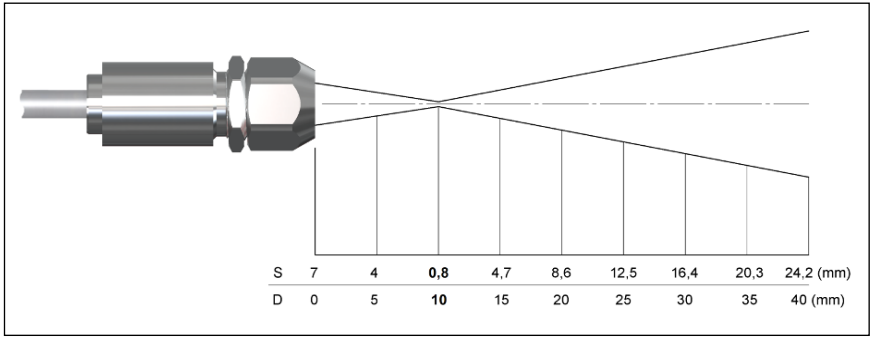
D:S (Far Field) = 1,5:1



LT15 + CF lens

0,8 mm@ 10 mm
0,8 mm@ 8 mm [ACCTAPLCF]

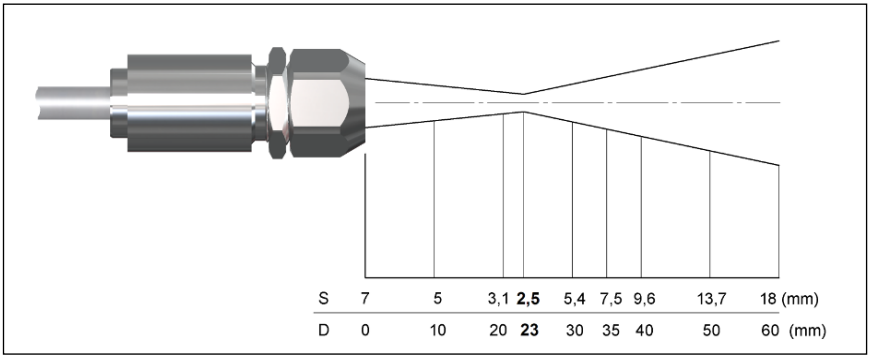
D:S (Far Field) = 1,5:1



LT02 + CF lens

2,5 mm@ 23 mm
2,5 mm@ 21 mm [ACCTAPLCF]

D:S (Far Field) = 2,5:1



2.5 CF Lens and Protective Window

The optional Close Focus lens (CF) allows the measurement of very small objects and can be used in combination with all LT models. The minimum spot size depends on the used sensing head. The distance is always measured from the front edge of the CF lens holder or laminar air purge collar.

Typical Transmission values* if the CF lens is used (average values): 0,78

The installation on the sensing head will be done by turning the CF lens until end stop. To combine it with the massive housing please use the version with external thread M12x1.

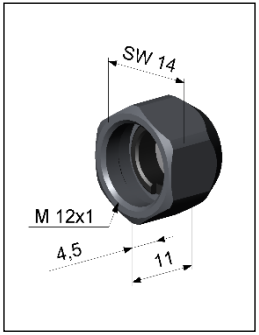
Versions Overview:

ACCTCF	**CF lens for installation on sensing head [LT]**
ACCTCFE	**CF lens with external thread for installation in massive housing [LT]**

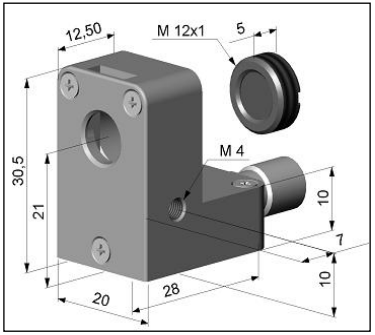
For protection of the sensing head optics a protective window is available. The mechanical dimensions are equal to the CF lens. It is available in the following versions:

ACCTPW	**Protective window for installation on sensing head [LT]**
ACCTPWE	**Protective window with external thread for installation in the massive housing [LT]**

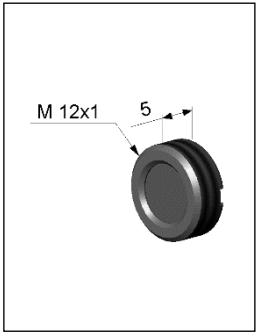
Typical Transmission values* if the protective window is used (average values): 0,83



CF lens:
ACCTCF/ ACCTCFHT
Protective window:
ACCTPWHT



Laminar air purge with integrated CF lens:
ACCTAPLCF/ ACCTAPLCFHT

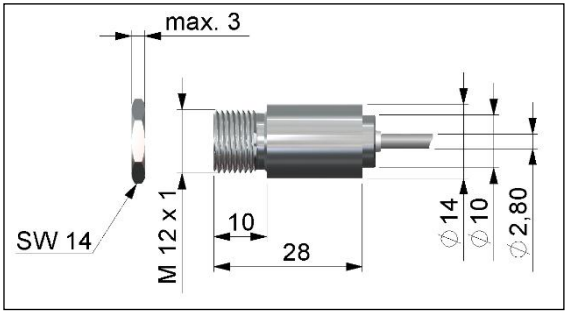


CF lens with external thread:
ACCTCFE/ ACCTCFHTE
Protective window with external thread: ACCTPWE/ ACCTPWHTE

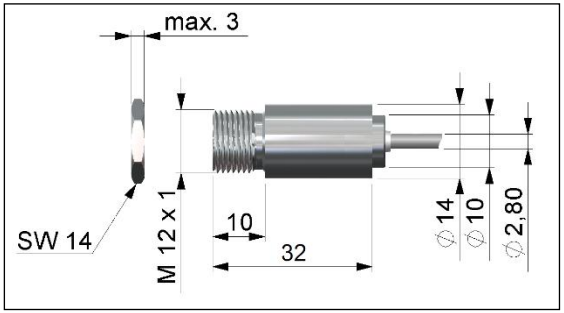
3 Mechanical Installation

The CTi sensing heads are equipped with a metrical M12x1-thread and can be installed either directly via the sensor thread or with help of the hex nut (included in scope of supply) to the mounting bracket available. Various mounting brackets, which make the adjustment of the sensing head easier, can be additionally ordered as accessories.

All accessories can be ordered using the according part numbers in brackets [ ].

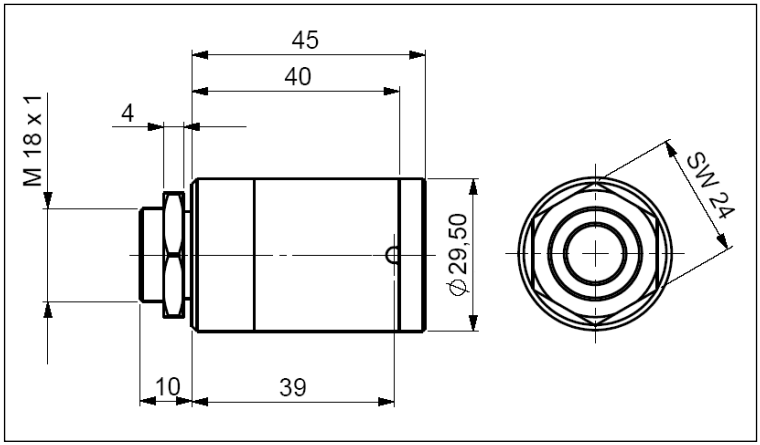


Sensing head



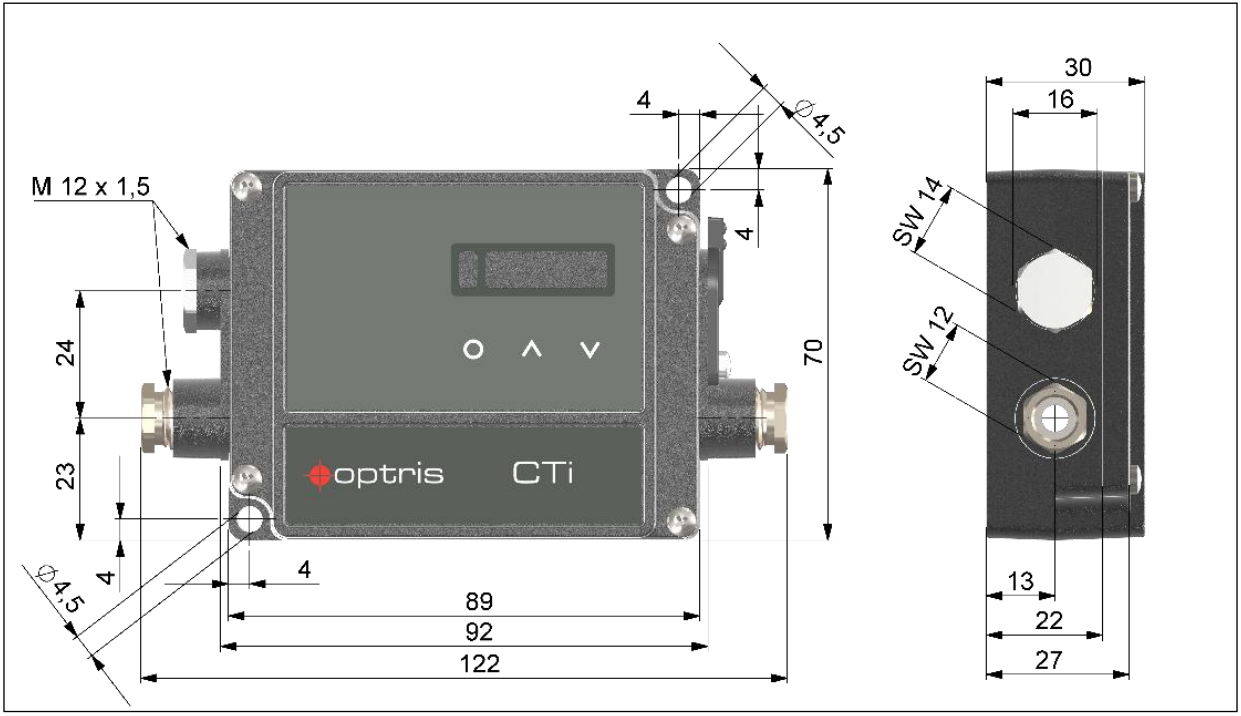
Sensing head LT15CF/ LT22CF

The CTi hot-sensors will be delivered with the massive housing and can be installed via the M18x1-thread.



Massiv housing (Standard for CTi hot)

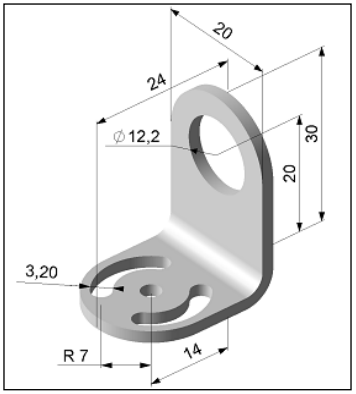
Make sure to keep the optical path clear of any obstacles.



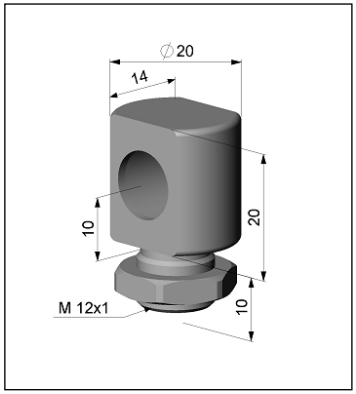
Electronic box

The electronic box is also available with closed cover (display and programming keys with no access from outside) [ACCTCOV].

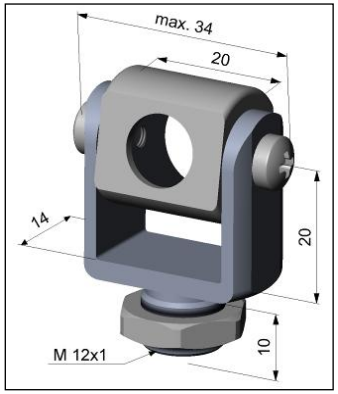
3.1 Mounting Accessories



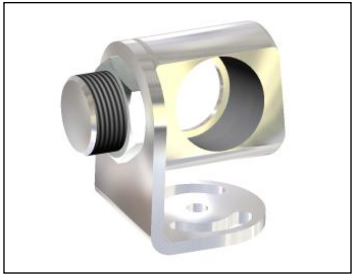
Mounting bracket, adjustable in one axis [ACCTFB]



Mounting bolt with M12x1 thread, adjustable in one axis [ACCTMB]

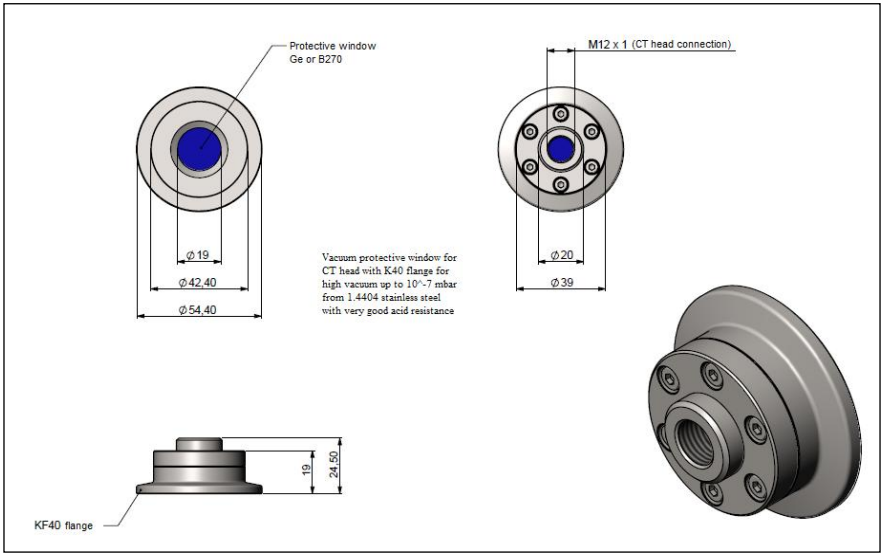


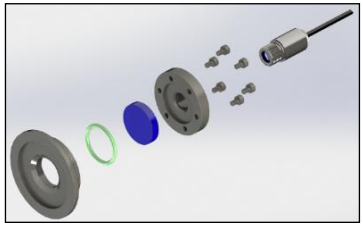
Mounting fork with M12x1 thread, adjustable in 2 axes [ACCTMG]



Mounting bracket, adjustable in two axes [ACCTAB] consisting of: ACCTFB and ACCTMB

The Mounting fork can be combined with the Mounting bracket [ACCTFB] using the M12x1 thread.



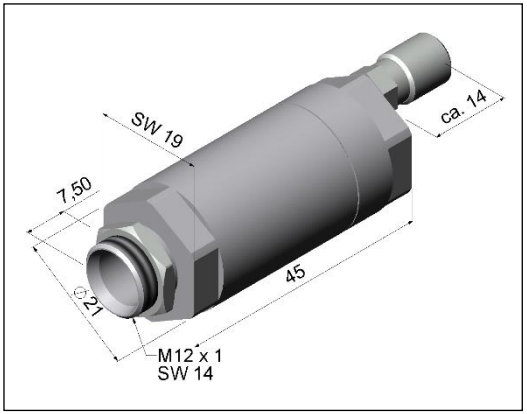


K40 flange [ACCTKF40GE] for CTiLT with Ge window

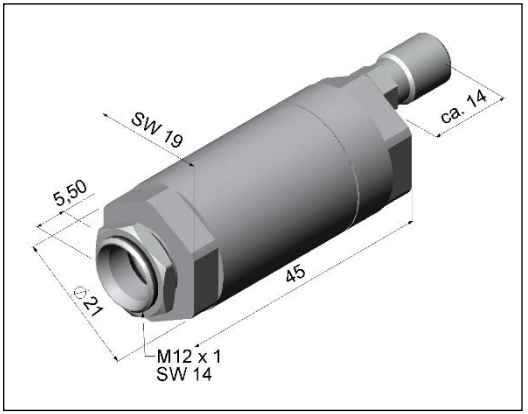
- When changing the windows, the screws must be tightened with a tightening torque of 1 Nm.
- Transmission: Ge ≈ 0,91 and B270 ≈ 0,92 (Deviations possible)

3.2 Air Purge Collars

The lens must be kept clean at all times from dust, smoke, fumes and other contaminants in order to avoid reading errors. These effects can be reduced by using an air purge collar. Make sure to use oil-free, technically clean air, only.

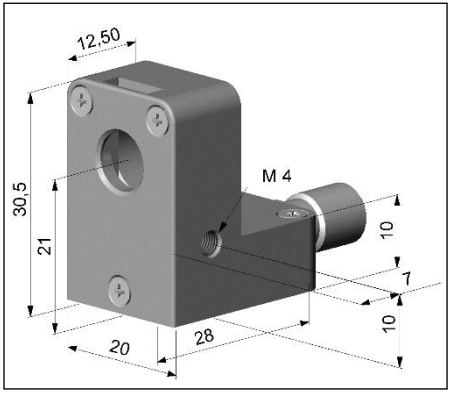


Standard air purge collar [ACCTAP] for optics with a D:S ≥ 10:1 (not for sensing heads with 32 mm length), fits to the mounting bracket
Hose connection: 3x5 mm
Thread (fitting): M5



Standard air purge collar [ACCTAP2] for optics with a D:S ≤ 2:1 (not for sensing heads with 32 mm length), fits to the mounting bracket
Hose connection: 3x5 mm
Thread (fitting): M5

The needed amount of air (approx. 2...10 l/ min.) depends on the application and the installation conditions on-site.

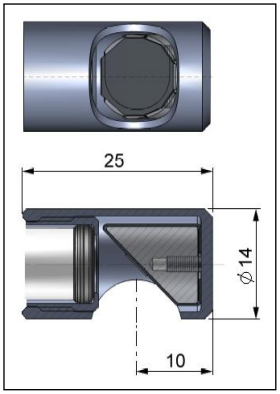


Laminar air purge collar [ACCTAPL]
The sideward air outlet prevents a cooling down of the object in short distances.
Hose connection: 3x5 mm
Thread (fitting): M5

Laminar air purge collar with mounting fork [ACCTAPLMF], adjustable in 2 axes

- The needed amount of air (approx. 2...10 l/ min.) depends on the application and the installation conditions on-site.
- The maximum ambient temperature for the **[ACCTAPL]** is 150°C.

3.3 Further Accessories



Right Angle Mirror [ACCTRAM]
for optics with a D:S ≥ 10:1;
enables measurements with 90° angle to sensor axis.

The mirror has a reflexion of 96% in combination with a LT22 and LT15 head. If the mirror is used this value has to be multiplied by the emissivity value of the measurement object.

Example: LT22 and object with emissivity = 0,85
0,85 x 0,96 = 0,816
Thus, the emissivity in the CTi has to be set to the resulting value of 0,816.

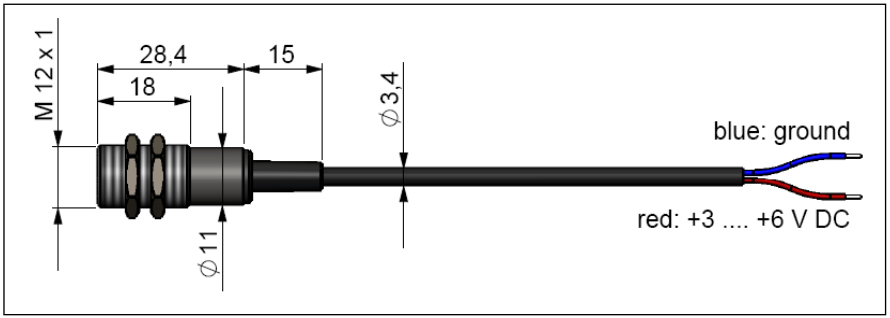
Laser-Sighting tool [D08ACCTLST]
battery powered (2x Alcaline AA), for alignment of CTi sensing heads. The laser head has the same mechanical dimensions as the CTi sensing head.

WARNING: Do not point the laser directly at the eyes of persons or animals! Do not stare into the laser beam. Avoid indirect exposure via reflective surfaces!

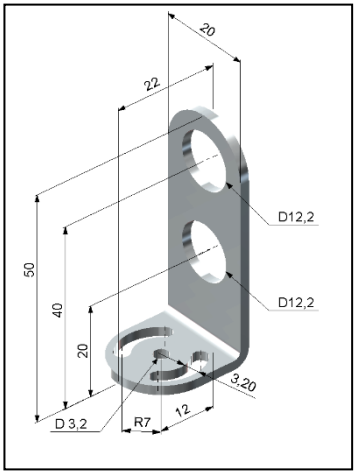
OEM-Laser-Sightingtool

The OEM-Laser-Sighting tool is available with 3,5 m **[ACCTOEMLST]** and 8 m connection cable **[ACCTOEMLSTCB8]**. The laser can be connected to the pins **3V SW** or **PINK** and **GND [►4 Electrical Installation]** and switched on and off via the programming keys or via the software.

The special double-hole mounting bracket **[ACCTFB2]** allows a simultaneous mounting of the CTi sensing head and the laser head.

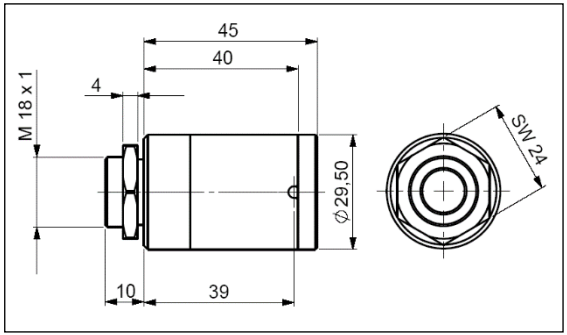


OEM-Laser-Sighting tool [ACCTOEMLST or ACCTOEMLSTCB8]

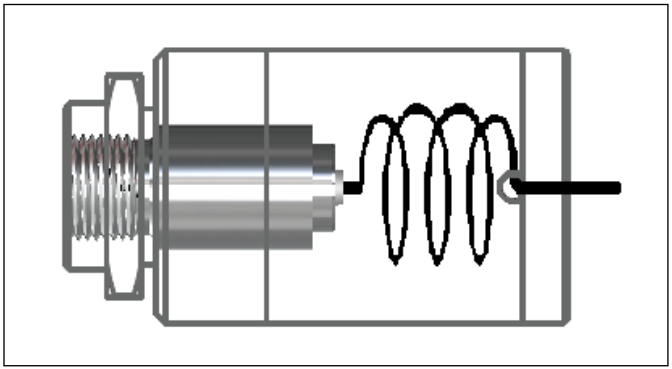


Mounting bracket [ACCTFB2]

Massive Housing



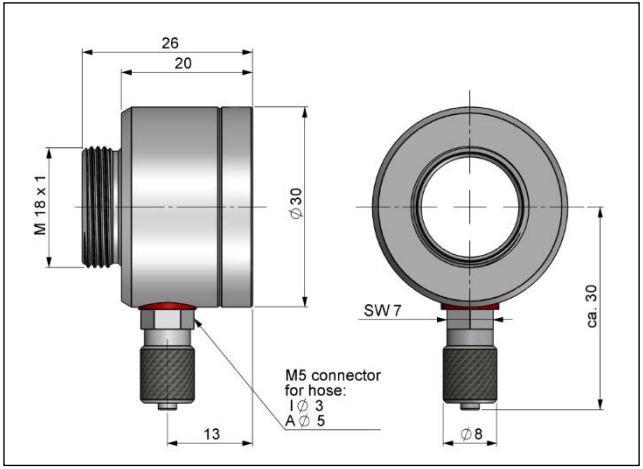
Massive housing, stainless steel [D06ACCTMHS] – also available in aluminum (anodized) or brass



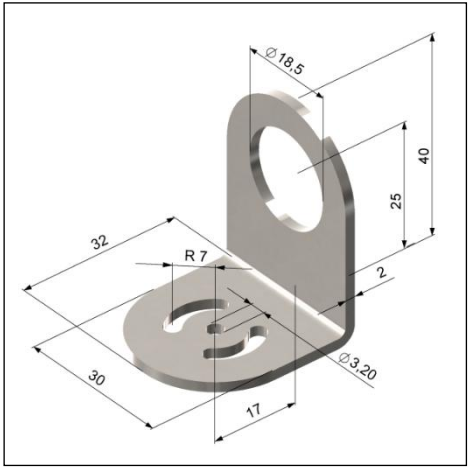
The Massive housing allows reproducible and stable measurements on applications with significant and short-term variation in ambient temperatures. It can be combined with the CF lens **[ACCTCFE]** or with the protective window **[ACCTPWE]**.

IMPORTANT: For an optimum function of the massive housing 10 cm of the head cable must be installed in loops inside the housing.

Accessories for Massive Housing



Air purge collar for massive housing (thread M18x1) [ACCTAPMH]



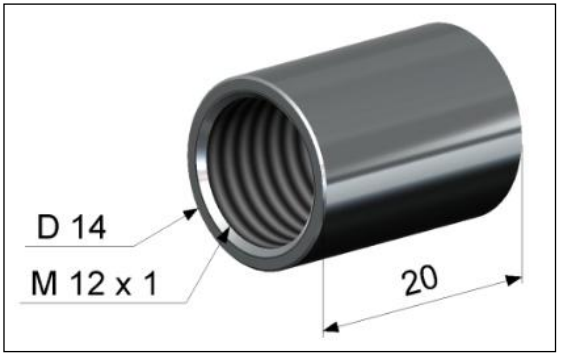
Mounting bracket for massive housing, adjustable in one axis [ACCTFBMH]

The needed amount of air (approx. 2...10 l/ min.) depends on the application and the installation conditions on-site.

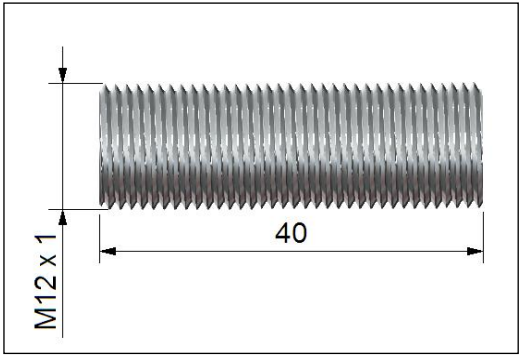
Pipe Adapter and Sighting Tubes

The pipe adapter **[ACCTPA]** allows an assembling of sighting tubes directly on the CTi head. The sighting tubes are available in 3 different lengths:

ACCTST20 20 mm
ACCTST40 40 mm
ACCTST88 88 mm



Pipe adapter [ACCTPA]

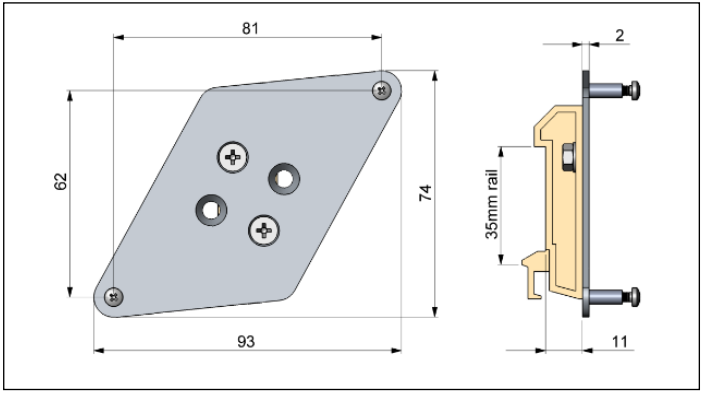


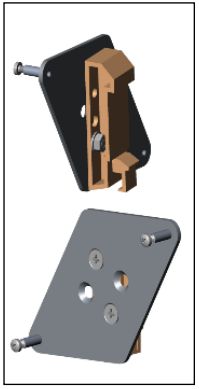
Sighting tube [ACCTST40]

The sighting tubes can only be used for sensing heads with a distance-to-spot ratio (D:S) of **≥ 15:1**.

Rail Mount Adapter for Electronic box

With the rail mount adapter, the CTi electronics can be mounted easily on a DIN rail (TS35) according EN50022.

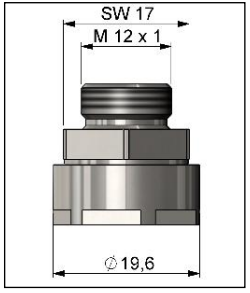


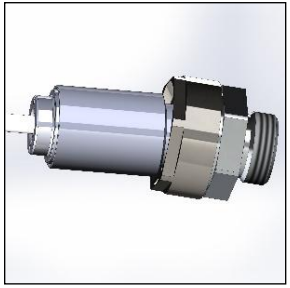


Rail Mount Adapter [ACCTRAIL]

Tilt Assembly for CTi heads

With this mounting accessory a fine adjustment of the CTi head with an off-axis angle +/- 6,5° is possible.





Tilt assembly [ACCTTAS]

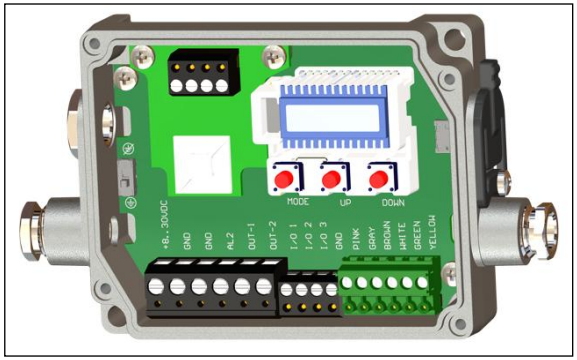
4 Electrical Installation

4.1 Cable Connections

For the electrical installation of the CTi please open at first the cover of the electronic box (4 screws). Below the display are the screw terminals for the cable connection.

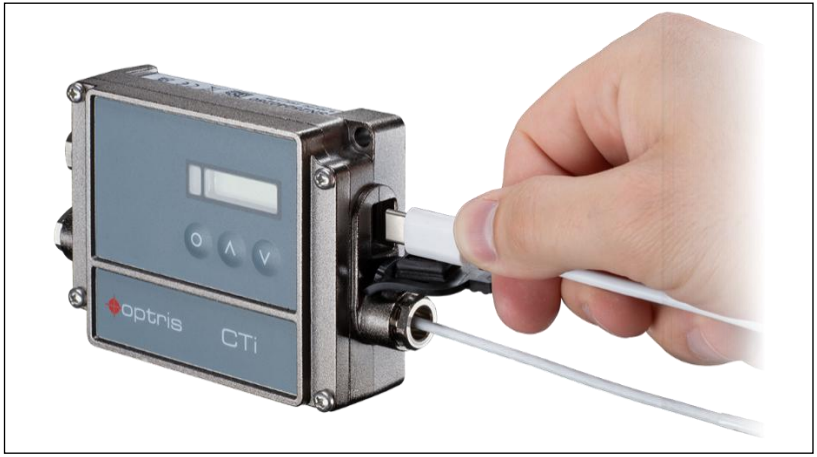
4.1.1 Designation

+8…30 VDC	**Power supply**
GND	**Ground (0 V) of power supply**
GND	**Ground (0 V) of internal in- and outputs**
AL2	**Alarm 2 (Open collector output)**
OUT-1	**Analog output mA, mV, TCK**
OUT-2	**Analog output mA, mV, TCK**
I/O1-I/O3	**In- and outputs**
GND	**Ground (0 V)**
Pink	**3 VDC, switchable, for laser-sighting tool**
Gray	**Ground of PIN pink**
BROWN	**Temperature probe head (NTC)**
WHITE	**Head ground**
GREEN	**Head power**
YELLOW	**Detector signal**



Opened electronic box with terminal connections

The supplied USB cable can be connected to the side of the electronics box. The device can be operated directly via the CompactPlus Connect software or the IRmobile app.



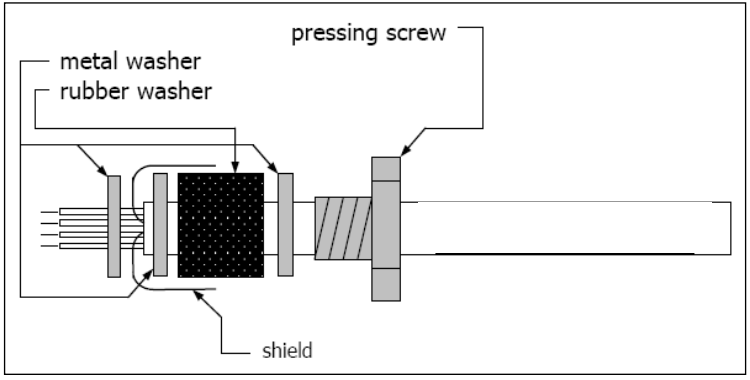
The USB socket on the side is only intended for setup and service and not for continuous use.

4.1.2 Power supply

Please use a stabilized power supply unit with an output voltage in the range of **8–30 VDC** which can supply **100 mA**. The ripple should be max. **200 mV**.

Cable Assembling

The cable gland M12x1,5 allows the use of cables with a diameter of 3 to 5 mm.
Remove the isolation from the cable (40 mm power supply, 50 mm signal outputs, 60 mm functional inputs). Cut the shield down to approximately 5 mm and spread the strands out. Extract about 4 mm of the wire isolation and tin the wire ends.
Place the pressing screw, the rubber washer and the metal washers of the cable gland one after the other onto the prepared cable end. Spread the strands and fix the shield between two of the metal washers. Insert the cable into the cable gland until the limit stop. Screw the cap tight.
Every single wire may be connected to the according screw clamps according to their colors.



Use shielded cables only. The sensor shield has to be grounded.

4.2 Ground Connection

On the left side of the mainboard PCB, you will find a black switch which connects factory-default the ground connections (GND power supply/ outputs) with the ground of the electronics housing.

To avoid ground loops and related signal interferences in industrial environments it might be necessary to interrupt this connection. For this purpose, the switch must be changed.

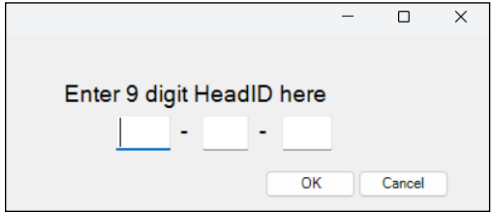
4.3 Exchange of the Sensing Head

From factory side the sensing head has already been connected to the electronics and the Head ID with its unique calibration data has been entered. Inside a certain model group any exchange of sensing heads and electronics is possible.

After exchanging a head the Head ID of the new head must be entered into the electronics.

4.3.1 Entering of the Head ID

Every head has a specific Head ID with its calibration data. The Head ID has a unique database association with the actual calibration data. An internet connection and our software (CompactPlus Connect or IRmobile) are mandatory to download the calibration data from our server. For a correct temperature measurement and functionality of the sensor this Head ID must be stored into the electronic box.



The Head ID consists of **3 blocks** with 3 **characters** each.

The entering of a new Head ID via the CompactPlus Connect software: Go to **Device** and **HeadID change** and enter the 9 digits of the cable in the fields.

You will find the Head ID on a label fixed on the head cable (near the electronics). Please do not remove this label or make sure the Head ID is noted anywhere. The Head ID is needed if the electronics has to be exchanged or in case of a necessary recalibration of the sensor.

After you have modified the Head ID a reset is necessary to activate the change.
[►6 Operating]

4.3.2 Sensing Head cable – shortening

There is the possibility to change different sensing heads and different cable length. The sensing head cable can be shortened if necessary.
Shortening of the head cable will cause an additional measuring error of about 0,1 K/ m.

5 Outputs and Inputs

5.1 Analog Outputs

The two analog outputs – OUT-1 and OUT-2 of the CTi are freely selectable. There is the possibility to choose between different Output channels, see **5.1.1**.

5.1.1 Output channels

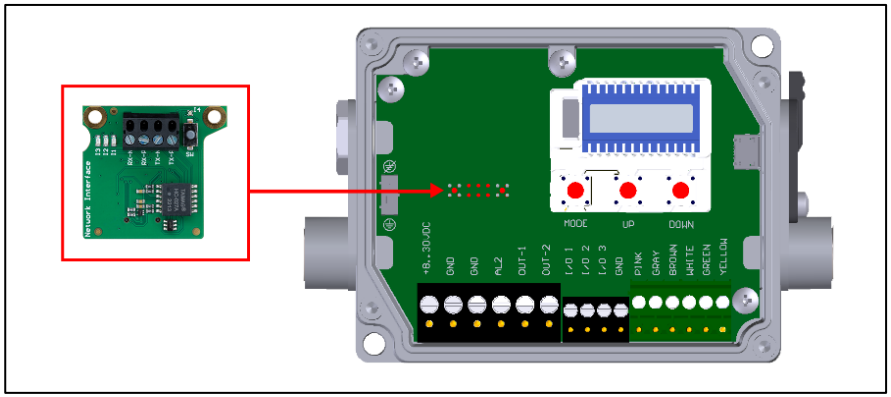
The outputs can be is used for the object temperature, internal temperature (head) and temperature of the electronic box. The selection of the output signal can be done via software.

Output signal	Range	Connection pin on CTi board
Voltage	0 ... (5)10 V	OUT-1 or OUT-2
Current	0 (4)... 20 mA	OUT-1 or OUT-2
Thermocouple	TC K	OUT-1 or OUT-2
Alarm Voltage	On/Off scalable	OUT-1 or OUT-2
Alarm Current	On/Off scalable	OUT-1 or OUT-2

5.2 Digital Interfaces

CTi sensors can be optionally equipped with an IP67 USB-, RS232-, RS485-, Modbus RTU, Modbus TCP, Ethernet TCP, Profinet, or EtherNet/IP interface.

If you want to install an interface, plug the interface board into the place provided, which is located beside the display (see picture below). In the correct position the holes of the interface match with the thread holes of the electronic box. Now press the board down to connect it and use both M3x5 screws for fixing it. Plug the preassembled interface cable with the terminal block into the male connector of the interface board.



The digital communication with the interface board will be interrupted while build-in USB cable is connected to the PC. The communication will be established again after unplugging the built-in USB cable.

5.3 Relay Outputs

The CTi can be optionally equipped with a relay output. The relay board will be installed the same way as the digital interfaces. **A simultaneous installation of a digital interface and the relay outputs is not possible.**
The relay board provides two fully isolated switches, which have the capability to switch
max. 60 VDC/ 42 VAC_{RMS}, 0,4 A DC/AC. A red LED shows the closed switch.

The switching thresholds are in accordance with the values for alarm 1 and 2 [►**5.5 Alarms**].
The alarm values are set according to the ►**1.6 Factory Default Settings**.
To make advanced settings (change of low- and high alarm) a digital interface (USB, RS232) and the software is needed.

5.4 I/O pins

The CTi has three digital pins which can be programmed as outputs (digital) or as inputs (digital or analog) using the CompactPlus Connect software. The following functions are available:

Function	I/O pin acts as	Description
Alarm	Output digital	Open collector output/ definition as High- or Low alarm via norm. open/ norm. close options in software dialog.
Valid Low	Input digital	The output follows the object temperature as long as there is a Low level at the I/O pin. After discontinuation of the Low level the last value will be held.
Valid High	Input digital	The output follows the object temperature as long as there is a High level at the I/O pin. After discontinuation of the High level the last value will be held.
Hold Low-High	Input digital	The last value will be held if there is a signal with a rising edge on the I/O pin.
Hold High-Low	Input digital	The last value will be held if there is a signal with a falling edge on the I/O pin.
Hold Reset Low	Input digital	Reset of Peak or valley hold (High-Low signal)
Hold Reset High	Input digital	Reset of Peak or valley hold (Low-High signal)
Emissivity external	Input analog	The emissivity value can be adjusted via a 0-10 V signal on the I/O pin (scaling possible via software).
Uncommitted value	Input analog	Display of a uncommitted value
Laser on Low	Input digital	Turning on the laser (Low signal)
Laser on High	Input digital	Turning on the laser (High signal)
External Ambient Compensation	Input analog	The ambient temperature will be determined by a voltage on the I/O-pin [0–10 V; range scalable].
External Transmitted Radiation	Input analog	The transmitted ambient temperature will be determined by a voltage on the I/O-pin [0–10 V; range scalable].

Low/High-level: **Via software**

5.5 Alarms

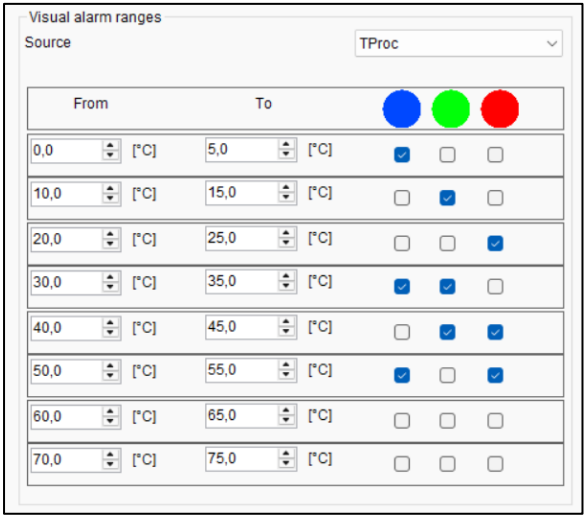
The CTi has the following Alarm features:

All alarms (alarm 1, alarm 2, output channel 1 and 2 if used as alarm output) have a fixed **hysterese of 2 K**

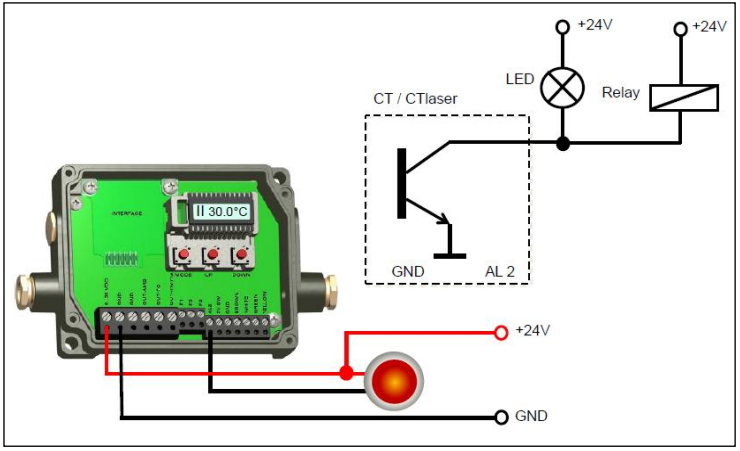
Visual Alarms

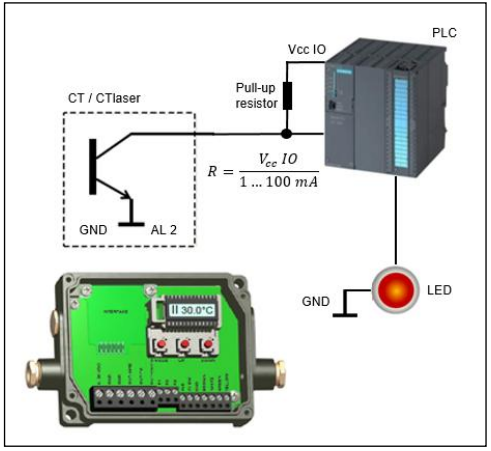
These alarms will cause a change of the color of the LCD display and will also change the status of the optional relays interface. In addition, the Alarm 2 can be used as open collector output at pin **AL2** on the mainboard **[24 V/ 50 mA]**.

For extended setup like definition as low or high alarm **[via change of normally open/ closed]**, selection of the signal source **[T_{Proc}, T_{Head}, T_{Box}]** in the software CompactPlus Connect is needed. The visual alarms are independent of the alarm settings. In the CompactPlus Connect software these can be defined as desired.



5.5.1 Open collector output / AL2:





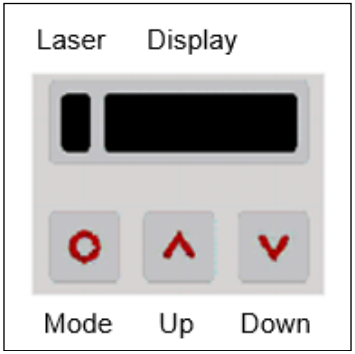
- The transistor acts as a switch. In case of alarm, the contact is closed.
- A load/consumer (Relay, LED or a resistor) must always be connected.
- The alarm voltage (here 24 V) must not be connected directly to the alarm output (short circuit).

6 Operating

After power up the unit the sensor starts an initializing routine for some seconds. During this time the display will show **INIT**. After this procedure the object temperature is shown in the display. The display backlight color changes according to the alarm settings **[►5.5 Alarms]**.

6.1 Sensor Setup

The programming keys **Mode**, **Up** and **Down** enable the user to set the sensor on-site. The current measuring value or the chosen feature is displayed. With **Mode** the operator obtains the chosen feature, with **Up** and **Down** the functional parameters can be selected **– a change of parameters will have immediate effect.** If no key is pressed for more than 10 seconds the display automatically shows the calculated object temperature (according to the signal processing).



Pressing the Mode button again recalls the last called function on the display. The signal processing features **Peak hold** and **Valley hold** cannot be selected simultaneously.

Factory Default Setting
To set the CTi back to the factory default settings, please press at first the **Down**-key and then the **Mode**-key and keep both pressed for approx. 3 seconds.
The display will show **RESET** for confirmation.

Display	Mode [Sample]	Display
TPROC 320.9	Process temperature (after signal processing) [320,9 °C]	fixed
T INT 50.1	Detector Temperature [50,1 °C]	fixed
T BOX 38.6	Electronic box Temperature [38,6 °C]	fixed
EMISS 1.000	Emissivity [1,000]	**0,050 ... 1,100**
TRANS 1.000	Transmission [1,000]	**0,050... 1,100**
AVG 0.020	Signal output Average [0,020 s]	**AVG 0.000** = inactive/ **0,1 … 65** s
HOLD **H TIM** **H TH** **H HY**	OFF PEAK/ VALL APEAK/ AVALL APEAK/ AVALL	**OFF/ PEAK/ VALL/ APEAK/ AVALL** **0…65 s** (65 = infinity) Starting temperature…end temperature Hysteresis setting in °C/°F
U °C	Temperature unit [°C]	**°C/ °F**
M 01	Multidrop address [1] (only with RS485 interface) RS422 mode	**01 … 32** **RS422** (Press Down button on M01)
BAUD 115.2K	Baud rate in kBaud [115]	**115.2 / 921.6 kBaud**
S ON	Laser Sighting	**ON/ OFF**

EMISS 1.000 Setup of **Emissivity**. Pressing **Up** increases the value, **Down** decreases the value (also valid for all further functions). The emissivity is a material constant factor to describe the ability of the body to emit infrared energy **[►10 Emissivity]**.

TRANS 1.000 Setup of **Transmissivity**. This function is used if an optical component (protective window, additional optics e.g.) is mounted between sensor and object. The standard setting is 1.000 = 100 % (if no protective window etc. is used).

AVG 0.020 Setup of **Average time**. In this mode an arithmetic algorithm will be performed to smoothen the signal. The set time is the time constant. This function can be combined with all other post processing functions. The shortest value is 0,001 s. If the value is set to **0.0** the function is deactivated.

HOLD Setup of **signal processing**. By pressing `Up` or `Down` the mode can be selected.

PEAK: Setup of **Peak hold**. In this mode the sensor is waiting for descending signals. If the signal descends the algorithm maintains the previous signal peak for the specified time.
After the hold time the signal will drop down to the second highest value or will descend by 1/8 of the difference between the previous peak and the minimum value during the hold time. This value will be held again for the specified time. After this the signal will drop down with slow time constant and will follow the current object temperature.
If the value is set to **0.0** the display will show **---** (function deactivated).

VALL: Setup of **Valley hold**. In this mode the sensor waits for ascending signals. The definition of the algorithm is according to the peak hold algorithm (inverted).
If the value is set to **0.0** the function deactivated.

APEAK (Advanced Peak Hold): In this mode the sensor waits for local peak values. Peak values which are lower than their predecessors will only be taken over if the temperature has fallen below the **Threshold** value beforehand. If **Hysteresis** is activated a peak in addition must decrease by the value of the hysteresis before the algorithm takes it as a new peak value.

AVALL (Advanced Valley Hold): This mode is the inverted function of Advanced Peak hold. The sensor waits for local minima. Minimum values which are higher than their predecessors will only be taken over if the temperature has exceeded the **Threshold** value beforehand. If **Hysteresis** is activated a minima in addition must increase by the value of the hysteresis before the algorithm takes it as a new minimum value.

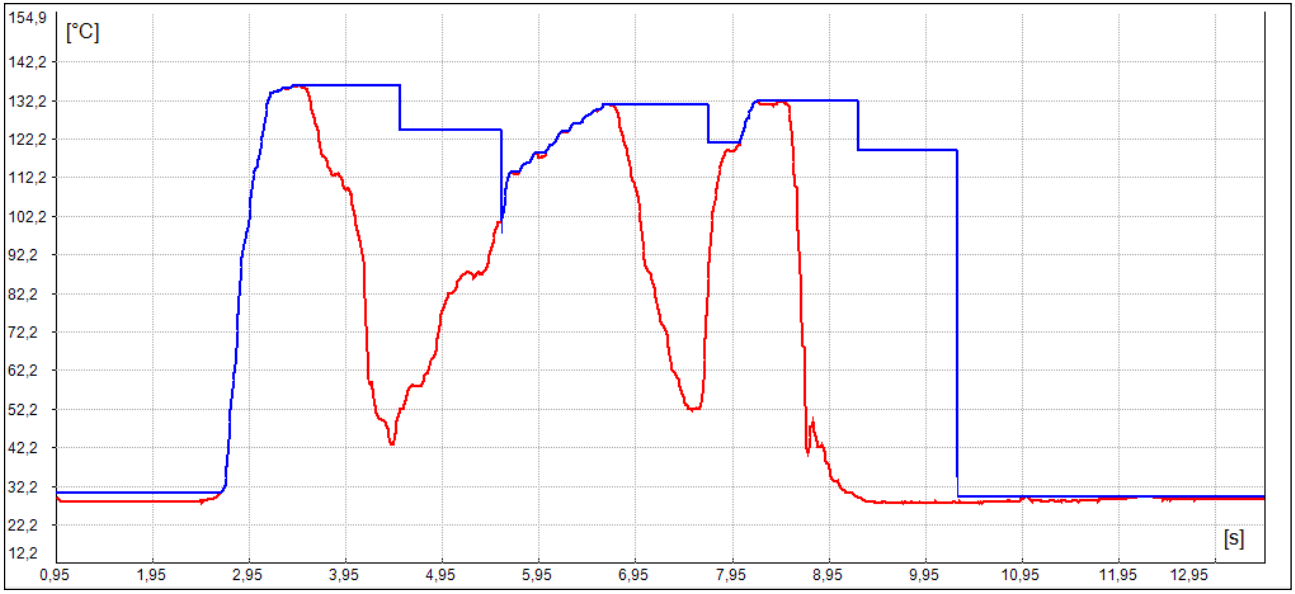
U °C Setup of the **Temperature unit** [°C or °F].

M 01	Setup of the **Multidrop address**. In a **RS485** network each sensor will need a specific address. This menu item will only be shown if a RS485 interface board is plugged in. For using the **RS422** mode, press once the down button on M01.
BAUD 115.2K	Setup of the **Baud rate** for digital data transfer.
S OFF	Activating (**ON**) and Deactivating (**OFF**) of an optional **Sighting Laser [►3.3 Further Accessories]**. By pressing **Up** or **Down** a voltage of 3 VDC will be switched to the **PINK** connection pin on the mainboard.

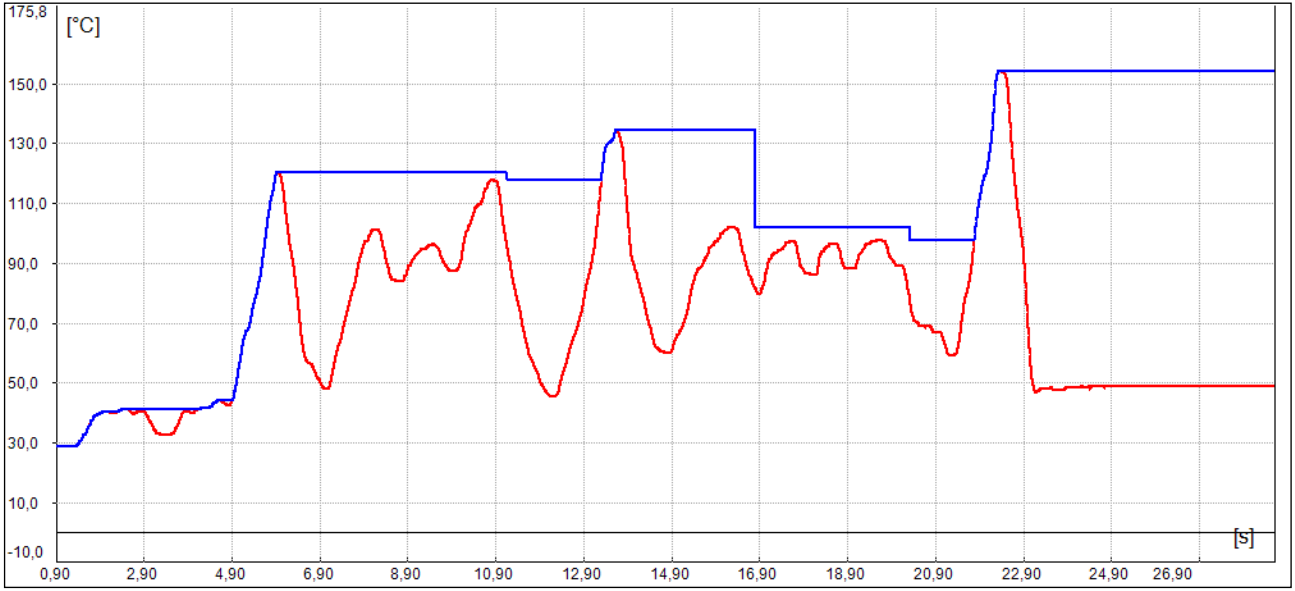
Peak picking function

You can display the process temperature TProc (with post processing) and also the current average temperature TAvg (without any post processing) in the diagram. In this way the result and functionality of the selected post processing features can easily be traced and controlled.

Signal Graphs



— T_{Proc} with Peak Hold (Hold time = 1s)
— T_{Avg} without post processing



— T_{Proc} with Advanced peak hold (Threshold = 80 °C/ Hysteresis = 20 °C)
— T_{Avg} without post processing

7 IRmobile app

The CTi sensor has a direct connection to an Android smartphone or tablet. All you have to do is download the IRmobile app for free in the Google Play store. This can also be done via the QR code. The supplied USB cable can be directly used.

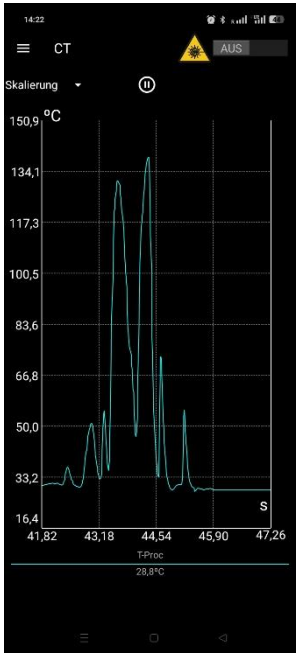
GET IT ON Google Play

optris

With IRmobile you are able to monitor and analyse your infrared temperature measurement on a connected smartphone or tablet. This app works on most Android devices running 5.0 or higher with a micro USB or USB-C port supporting USB-OTG (On The Go). It is easy to operate: after you plug your CT device to your phone or tablet, the app will start automatically. The device is powered by your phone. Different digital temperature values can be displayed in the temperature time diagram. You can easily zoom-in the diagram to see more details and small signal changes.

IRmobile app features:

- Temperature time diagram with zoom function
- Digital temperature values
- Setup of emissivity, transmissivity and other parameters
- Scaling of the analog output and setting of the alarm output
- Change of temperature unit: Celsius or Fahrenheit
- Saving/loading of configurations and T/t diagrams
- Restore factory default sensor settings
- Integrated simulator



Supported for:

- Optris pyrometers: Compact series, high performance series and video thermometers
- Optris IR cameras: PI and Xi series
- For android devices running 5.0 or higher with a micro USB or USB-C port supporting USB-OTG (On The Go)

8 Software CompactPlus Connect

8.1 Installation

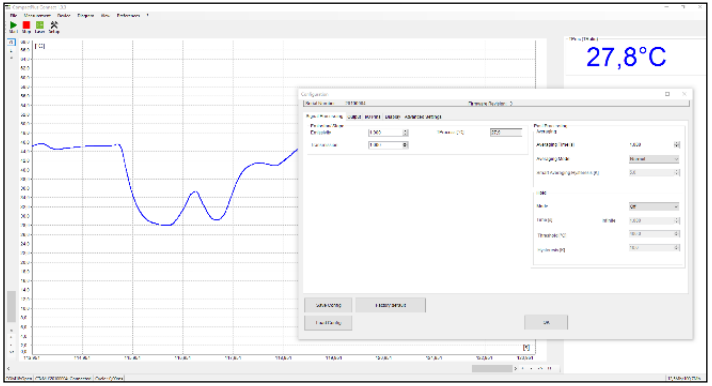
The software can be downloaded under https://optris.com/software/compactplus-connect/. Unzip and open the program and start the S**etup.exe**. Follow the instructions of the wizard until the installation is finished.

Minimum system requirements:

- Windows 8, 10, 11
- USB interface
- Hard disc with at least 60 MByte free space
- At least 128 MByte RAM

The installation wizard will place a launch icon on the desktop and in the start menu:
[Start]\Programs\CompactPlus Connect.
If you want to uninstall the software from your system, please use the **uninstall icon** in the start menu.

- A detailed description is provided on the downloaded software package.
- Software CompactPlus Connect



Main Features:

- Graphic display for temperature trends and automatic data logging for analysis and documentation
- Complete sensor setup and remote controlling
- Adjustment of signal processing functions
- Programming of outputs and functional inputs

8.2 Communication Settings

8.2.1 Serial Interface

Baudrate:	115,2 or 921,6 kBaud (adjustable on the unit or via software)
Data bits:	8
Parity:	none
Stop bits:	1
Flow controll:	off

8.2.2 Protocol

All sensors of the CTi series are using a binary protocol. To get a fast communication the protocol has no additional overhead with CR, LR or ACK bytes.

9 Basics of Infrared Thermometry

Depending on the temperature each object emits a certain amount of infrared radiation. A change in the temperature of the object is accompanied by a change in the intensity of the radiation. For the measurement of “thermal radiation” infrared thermometry uses a wave-length ranging between 1 µm and 20 µm.
The intensity of the emitted radiation depends on the material. This material contingent constant is described with the help of the emissivity which is a known value for most materials (►**10 Emissivity**).

Infrared thermometers are optoelectronic sensors. They calculate the surface temperature on the basis of the emitted infrared radiation from an object. The most important feature of infrared thermometers is that they enable the user to measure objects contactless. Consequently, these products help to measure the temperature of inaccessible or moving objects without difficulties. Infrared thermometers basically consist of the following components:

- lens
- spectral filter
- detector
- electronics (amplifier/ linearization/ signal processing)

The specifications of the lens decisively determine the optical path of the infrared thermometer, which is characterized by the ratio Distance to Spot size.
The spectral filter selects the wavelength range, which is relevant for the temperature measurement. The detector in cooperation with the processing electronics transforms the emitted infrared radiation into electrical signals.

10 Emissivity

10.1 Definition

The intensity of infrared radiation, which is emitted by each body, depends on the temperature as well as on the radiation features of the surface material of the measuring object. The emissivity (ε – Epsilon) is used as a material constant factor to describe the ability of the body to emit infrared energy. It can range between 0 and 100 %. A “blackbody” is the ideal radiation source with an emissivity of 1,0 whereas a mirror shows an emissivity of 0,1.
If the emissivity chosen is too high, the infrared thermometer may display a temperature value which is much lower than the real temperature – assuming the measuring object is warmer than its surroundings. A low emissivity (reflective surfaces) carries the risk of inaccurate measuring results by interfering infrared radiation emitted by background objects (flames, heating systems, chamottes). To minimize measuring errors in such cases, the handling should be performed very carefully and the unit should be protected against reflecting radiation sources.

10.2 Determination of unknown Emissivity

► First, determine the actual temperature of the measuring object with a thermocouple or contact sensor. Second, measure the temperature with the infrared thermometer and modify the emissivity until the displayed result corresponds to the actual temperature.

► If you monitor temperatures of up to 380 °C you may place a special plastic sticker (emissivity dots – part number: ACLSED) onto the measuring object, which covers it completely. Now set the emissivity to 0,95

and take the temperature of the sticker. Afterwards, determine the temperature of the adjacent area on the measuring object and adjust the emissivity according to the value of the temperature of the sticker.

► Cove a part of the surface of the measuring object with a black, flat paint with an emissivity of 0,98. Adjust the emissivity of your infrared thermometer to 0,98 and take the temperature of the coloured surface. Afterwards, determine the temperature of a directly adjacent area and modify the emissivity until the measured value corresponds to the temperature of the coloured surface.

CAUTION: On all three methods the object temperature must be different from ambient temperature.

10.3 Characteristic Emissivity

In case none of the methods mentioned above help to determine the emissivity you may use the emissivity tables ►**Appendix A – Table of Emissivity for metals** and **Appendix B – Table of Emissivity for non-metals**. These are average values, only. The actual emissivity of a material depends on the following factors:

- temperature
- measuring angle
- geometry of the surface
- thickness of the material
- constitution of the surface (polished, oxidized, rough, sandblast)
- spectral range of the measurement
- transmissivity (e.g. with thin films)

Appendix A – Table of Emissivity for metals

Material		typical Emissivity			
Spectral response		1,0 µm	1,6 µm	5,1 µm	8-14 µm
Aluminium	non oxidized	0,1-0,2	0,02-0,2	0,02-0,2	0,02-0,1
	polished	0,1-0,2	0,02-0,1	0,02-0,1	0,02-0,1
	roughened	0,2-0,8	0,2-0,6	0,1-0,4	0,1-0,3
	oxidized	0,4	0,4	0,2-0,4	0,2-0,4
Brass	polished	0,35	0,01-0,05	0,01-0,05	0,01-0,05
	roughened	0,65	0,4	0,3	0,3
	oxidized	0,6	0,6	0,5	0,5
Copper	polished	0,05	0,03	0,03	0,03
	roughened	0,05-0,2	0,05-0,2	0,05-0,15	0,05-0,1
	oxidized	0,2-0,8	0,2-0,9	0,5-0,8	0,4-0,8
Chrome		0,4	0,4	0,03-0,3	0,02-0,2
Gold		0,3	0,01-0,1	0,01-0,1	0,01-0,1
Haynes	alloy	0,5-0,9	0,6-0,9	0,3-0,8	0,3-0,8
Inconel	electro polished	0,2-0,5	0,25	0,15	0,15
	sandblast	0,3-0,4	0,3-0,6	0,3-0,6	0,3-0,6
	oxidized	0,4-0,9	0,6-0,9	0,6-0,9	0,7-0,95
Iron	non oxidized	0,35	0,1-0,3	0,05-0,25	0,05-0,2
	rusted		0,6-0,9	0,5-0,8	0,5-0,7
	oxidized	0,7-0,9	0,5-0,9	0,6-0,9	0,5-0,9
	forged, blunt	0,9	0,9	0,9	0,9
	molten	0,35	0,4-0,6		
Iron, casted	non oxidized	0,35	0,3	0,25	0,2
	oxidized	0,9	0,7-0,9	0,65-0,95	0,6-0,95

Material		typical Emissivity			
Spectral response		**1,0 µm**	**1,6 µm**	**5,1 µm**	**8-14 µm**
Lead	polished	0,35	0,05-0,2	0,05-0,2	0,05-0,1
	roughened	0,65	0,6	0,4	0,4
	oxidized		0,3-0,7	0,2-0,7	0,2-0,6
Magnesium		0,3-0,8	0,05-0,3	0,03-0,15	0,02-0,1
Mercury			0,05-0,15	0,05-0,15	0,05-0,15
Molybdenum	non oxidized	0,25-0,35	0,1-0,3	0,1-0,15	0,1
	oxidized	0,5-0,9	0,4-0,9	0,3-0,7	0,2-0,6
Monel (Ni-Cu)		0,3	0,2-0,6	0,1-0,5	0,1-0,14
Nickel	electrolytic	0,2-0,4	0,1-0,3	0,1-0,15	0,05-0,15
	oxidized	0,8-0,9	0,4-0,7	0,3-0,6	0,2-0,5
Platinum	black		0,95	0,9	0,9
Silver		0,04	0,02	0,02	0,02
Steel	polished plate	0,35	0,25	0,1	0,1
	rustless	0,35	0,2-0,9	0,15-0,8	0,1-0,8
	heavy plate			0,5-0,7	0,4-0,6
	cold-rolled	0,8-0,9	0,8-0,9	0,8-0,9	0,7-0,9
	oxidized	0,8-0,9	0,8-0,9	0,7-0,9	0,7-0,9
Tin	non oxidized	0,25	0,1-0,3	0,05	0,05
Titanium	polished	0,5-0,75	0,3-0,5	0,1-0,3	0,05-0,2
	oxidized		0,6-0,8	0,5-0,7	0,5-0,6
Wolfram	polished	0,35-0,4	0,1-0,3	0,05-0,25	0,03-0,1
Zinc	polished	0,5	0,05	0,03	0,02
	oxidized	0,6	0,15	0,1	0,1

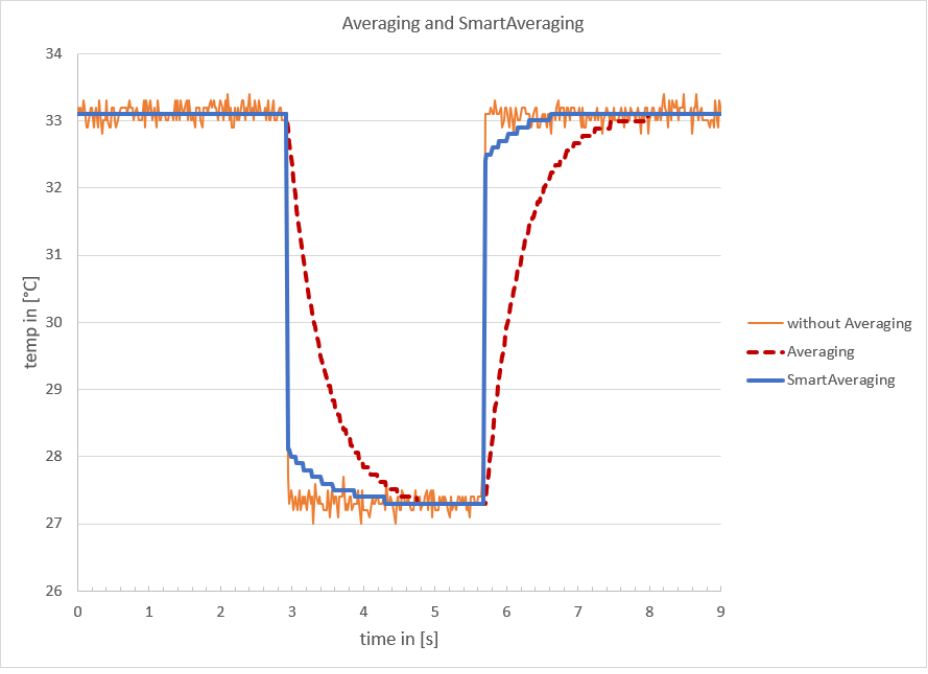
Appendix B – Table of Emissivity for non-metals

Material		typical Emissivity			
Spectral response		**1,0 µm**	**2,2 µm**	**5,1 µm**	**8-14 µm**
Asbestos		0,9	0,8	0,9	0,95
Asphalt				0,95	0,95
Basalt				0,7	0,7
Carbon	non oxidized		0,8-0,9	0,8-0,9	0,8-0,9
	graphite		0,8-0,9	0,7-0,9	0,7-0,8
Carborundum			0,95	0,9	0,9
Ceramic		0,4	0,8-0,95	0,8-0,95	0,95
Concrete		0,65	0,9	0,9	0,95
Glass	plate		0,2	0,98	0,85
	melt		0,4-0,9	0,9	
Grit				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 alkaline				0,9-0,95
Paper	any color			0,95	0,95
Plastic >50 µm	non transparent			0,95	0,95
Rubber				0,9	0,95
Sand				0,9	0,9
Snow					0,9
Soil					0,9-0,98
Textiles				0,95	0,95
Water					0,93
Wood	natural			0,9-0,95	0,9-0,95

Appendix C – Smart Averaging

The average function is generally used to smoothen the output signal. With the adjustable parameter time this function can be optimal adjusted to the respective application. One disadvantage of the average function is that fast temperature peaks which are caused by dynamic events are subjected to the same averaging time. Therefore, those peaks can only be seen with a delay on the signal output.

The function **Smart Averaging** eliminates this disadvantage by passing those fast events without averaging directly through to the signal output.



Appendix D – Declaration of Conformity

EG-Konformitätserklärung
EU Declaration of Conformity

optris
Infrared measurements

Wir / We

Optris GmbH & Co. KG
Ferdinand Buisson Str. 14
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erklären in alleiniger Verantwortung, dass / declare on our own responsibility that

die Produktserie optris CTi / the product group optris CTi

den Anforderungen der EMV-Richtlinie **2014/30/EU** und der Niederspannungsrichtlinie **2014/35/EU** entspricht.

meets the provisions of the EMC Directive **2014/30/EU** and the Low Voltage Directive **2014/35/EU**.

Angewandte harmonisierte Normen: / Applied harmonized standards:

EMV Anforderungen / EMC General Requirements:
EN 61326-1:2021 (Grundlegende Prüfanforderungen / Basic requirements)
EN 61326-2-3:2021

Gerätesicherheit von Messgeräten / Safety of measurement devices:
EN 61010-1:2010/A1:2019/AC:2019-04
EN 60825-1:2014 + AC:2017 + A11:2021 + A11:2021/AC:2022 (Lasersicherheit / Laser safety)

Beschränkung gefährlicher Stoffe / Restriction of hazardous substances:
EN IEC 63000:2018

Umgebungseinflüsse / Environmental testing
IEC 60068-2-27:2008 (Prüfung Ea und Leitfaden: Schocken / Test Ea and guidance: Shock)
IEC 60068-2-6:2008 (Schwingen, sinusförmig / Vibration (sinusoidal)
IEC 60068-2-64:2008 (Schwingen, Breitbandrauschen und Leitfaden / Vibration, broadband random and guidance)

Dieses Produkt erfüllt die Vorschriften der Richtlinie **2015/863/EU** (RoHS) des Europäischen Parlaments und des Rates vom 4. Juni 2015 zur Beschränkung der Verwendung bestimmter gefährlicher Stoffe in Elektro- und Elektronikgeräten.
This product is in conformity with Directive **2015/863/EU** (RoHS) of the European Parliament and of the Council of 4 June 2015 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

Berlin, 29.04.2025
Ort, Datum / place, date

Dr. Ulrich Kienitz
CEO

optris CTi-MA-E2025-07-A