

optris[®] CT XL

LT/ 3M

Infrared Sensor



Operators manual

CE-Conformity

The product complies with the following standards:

EMC:	EN 61326-1:2006 (Basic requirements)
Safety Regulations:	EN 61326-2-3:2006 EN 61010-1:2001

The product accomplishes the requirements of the EMC Directive 2004/108/EG and of the Low Voltage Directive 2006/95/EG. This product is in conformity with Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.



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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. References to other chapters are marked as [► ...].

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.

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Description

The sensors of the optris CT XL series are noncontact infrared temperature sensors. They calculate the surface temperature based on the emitted infrared energy of objects [**► Basics of Infrared Thermometry**]. The sensor housing of the CT XL 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 CT XL sensing head is a sensitive optical system. Please use only the thread for mechanical installation.
Avoid mechanical violence on the head – this may destroy the system (expiry of warranty).**

Scope of Supply

- CT XL sensing head with connection cable and electronic box
- Mounting nut
- Operators manual

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 water based glass cleaner.

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

Cautions

Avoid abrupt changes of the ambient temperature. In case of problems or questions which may arise when you use the CT XL, please contact our service department.

Model Overview

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

Model	Model codes	Measurement range	spectral response	typical applications
CT XL LT	LT	-50 to 975 °C	8-14 µm	non-metallic surfaces
CT XL 3M	3ML	50 to 400 °C	2,3 µm	metallic surfaces
	3MH	100 to 600 °C	2,3 µm	metallic surfaces
	3MH1	150 to 1000 °C	2,3 µm	metallic surfaces
	3MH2	200 to 1500 °C	2,3 µm	metallic surfaces
	3MH3	250 to 1800 °C	2,3 µm	metallic surfaces

Factory Default Settings

The unit has the following presetting at time of delivery:

Signal output object temperature	0-5 V					
Emissivity	0,970 [LT] 1,000 [3M]					
Transmissivity	1,000					
Averaging (AVG)	0,2 s [LT] inactive [3M]					
Smart Averaging	inactive [LT], active [3M]					
Peak hold	inactive					
Valley hold	inactive					
	<u>LT</u>	<u>3ML</u>	<u>3MH</u>	<u>3MH1</u>	<u>3MH2</u>	<u>3MH3</u>
Lower limit temperature range [°C] 0	485	50	100	150	200	250
Upper limit temperature range [°C] 500	1050	400	600	1000	1500	1800
Lower alarm limit [°C] (normally closed)	30	100	250	350	550	600
Upper alarm limit [°C] (normally open)	100	300	500	600	1000	1400
Lower limit signal output	0 V					
Upper limit signal output	5 V					
Temperature unit	°C					
Ambient temperature compensation (on LT output at OUT-AMB as 0-5 V signal)	internal head temperature probe					
Baud rate [kBaud]	115					

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

Technical Data

General Specifications

	Sensing head	Electronic box
Environmental rating	IP65 (NEMA-4)	IP65 (NEMA-4)
Ambient Temperature	-20...85 °C	-40...85 °C ¹⁾
Storage temperature	-40...85 °C	-40...85 °C
Relative humidity	10...95%, non condensing	10...95%, non condensing
Material	stainless steel	die casting zinc
Dimensions	112 mm x 32 mm, M30x1	89 mm x 70 mm x 30 mm
Weight	120 g	420 g
Cable length	3 m (standard), 8 m, 15 m (8 and 15 m only available at LT)	
Cable diameter	2,8 mm	
Ambient temperature cable	180 °C max.	
Vibration	IEC 68-2-6: 3G, 11 – 200Hz, any axis	
Shock	IEC 68-2-27: 50G, 11ms, any axis	
Software (optional)	CompactConnect	

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

Electrical Specifications

Power Supply	8–36 VDC
Current draw	max. 100 mA
Outputs/ analog	
Channel 1	selectable: 0/ 4–20 mA, 0–5/ 10 V, thermocouple (J or K) or alarm output (Signal source: object temperature)
Channel 2 [LT only]	Head temperature [-20...180 °C] 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 at Pin AL2 [24 V/ 50 mA]
Output impedances	
mA	max. loop resistance 500 Ω (at 8-36 VDC),
mV	min. 100 K Ω load impedance
Thermocouple	20 Ω
Digital interfaces	USB, RS232, RS485, CAN, Profibus DP, Ethernet (optional plug-in modules)
Relay outputs	2 x 60 VDC/ 42 VAC _{RMS} , 0,4 A; optically isolated (optional plug-in module)
Functional inputs	F1-F3; software programmable for the following functions: - external emissivity adjustment, - ambient temperature compensation, - trigger (reset of hold functions)

Measurement Specifications [LT model]

LT

Temperature range (scalable)	-50...975 °C
Spectral range	8...14 µm
Optical resolution	75:1
System accuracy ^{1) 2)}	±1°C or ±1% ³⁾
Repeatability ¹⁾	±0,5°C or ±0,5% ³⁾
Temperature resolution (NETD)	0,1 °C ^{3) 4)}
Response time (90 % signal)	120 ms
Warm-up time	10 min
Emissivity/ Gain	0,100...1,100 (adjustable via programming keys or software)
Transmissivity	0,100...1,000 (adjustable via programming keys or software)
Signal processing	Average, peak hold, valley hold (adjustable via programming keys or software)

¹⁾ at ambient temperature 23±5 °C; whichever is greater

²⁾ Accuracy for thermocouple output: ±2,5°C or ±1%

³⁾ at object temperatures >0 °C, $\epsilon = 1$

⁴⁾ at time constant 100ms and an object temperature of 25 °C

Measurement Specifications [3M models]

	3ML	3MH
Temperature range (scalable)	50...375 °C ¹⁾	100...600 °C ¹⁾
Spectral range	2,3 µm	2,3 µm
Optical resolution	60:1	100:1
System accuracy ^{2) 3)}	±(0,3 % of reading +2 °C) ⁴⁾	±(0,3 % of reading +2 °C) ⁴⁾
Repeatability ²⁾	±(0,1 % of reading +1 °C) ⁴⁾	±(0,1 % of reading +1 °C) ⁴⁾
Temperature resolution	0,1 °C ⁴⁾	0,1 °C ⁴⁾
Response time (90 % signal)	1 ms ⁵⁾	1 ms ⁵⁾
Emissivity/ Gain	0,100...1,100 (adjustable via programming keys or software)	
Transmissivity	0,100...1,000 (adjustable via programming keys or software)	
Signal processing	Average, Peak hold, Valley hold, (adjustable via programming keys or software)	

¹⁾ T_{Object} > T_{Head}+25 °C

²⁾ at ambient temperature 23±5 °C

³⁾ Accuracy for thermocouple output: ±2,5°C or ±1%

⁴⁾ ε = 1/ Response time 1s

⁵⁾ with dynamic adaptation at low signal levels

Measurement Specifications [3M models]

	3MH1	3MH2	3MH3
Temperature range (scalable)	150...1000 °C	200...1500 °C	250...1800 °C
Spectral range	2,3 µm	2,3 µm	2,3 µm
Optical resolution	300:1	300:1	300:1
System accuracy ^{2) 3)}	±(0,3 % of reading +2 °C) ⁴⁾		
Repeatability ²⁾	±(0,1 % of reading +1 °C) ⁴⁾		
Temperature resolution	0,1 °C ⁴⁾	0,1 °C ⁴⁾	0,1 °C ⁵⁾
Response time (90 % signal)	1 ms ⁶⁾	1 ms ⁶⁾	1 ms ⁶⁾
Emissivity/ Gain	0,100...1,100 (adjustable via programming keys or software)		
Transmissivity	0,100...1,000 (adjustable via programming keys or software)		
Signal processing	Average, Peak hold, Valley hold, (adjustable via programming keys or software)		

¹⁾ T_{Object} > T_{Head}+25 °C

²⁾ at ambient temperature 23±5 °C

³⁾ Accuracy for thermocouple output: ±2,5°C or ±1%

⁴⁾ ε = 1/ Response time 1s

⁵⁾ at object temperatures > 300 °C

⁶⁾ with dynamic adaptation at low signal levels

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.

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.

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

S = Spot size

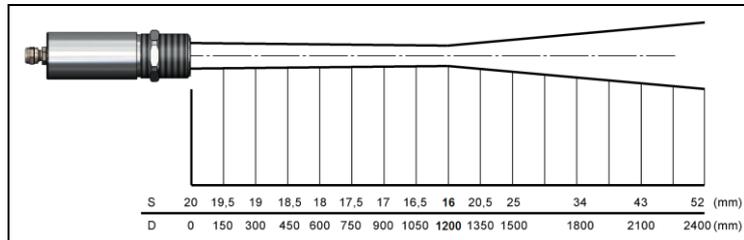
The D:S ratio is valid for the focus point.

LT

Optics: SF

D:S (focus distance) = 75:1/ 16mm@1200mm

D:S (far field) = 34:1

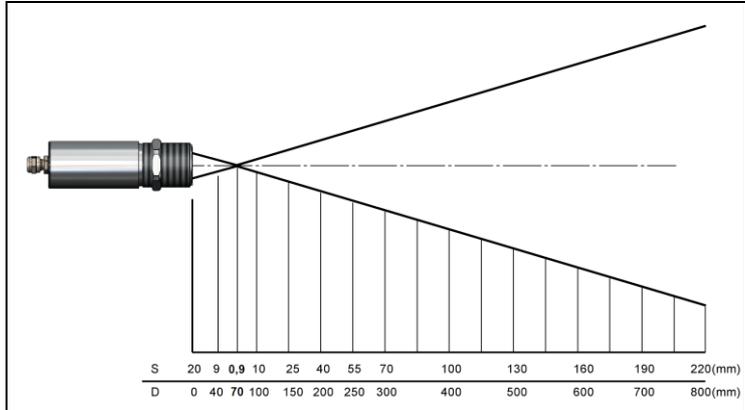




Optics: CF1

D:S (focus distance) = 75:1/ 0,9mm@70mm

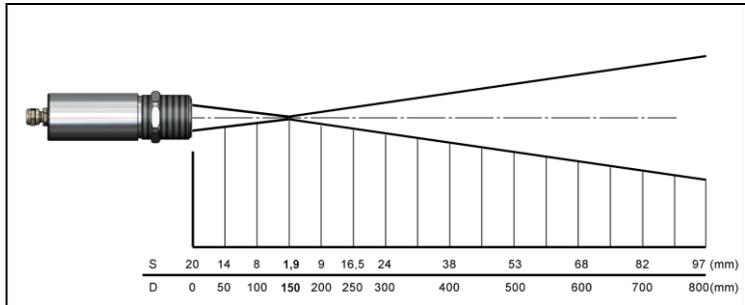
D:S (far field) = 3,5:1



Optics: CF2

D:S (focus distance) = 75:1/ 1,9mm@150mm

D:S (far field) = 7:1

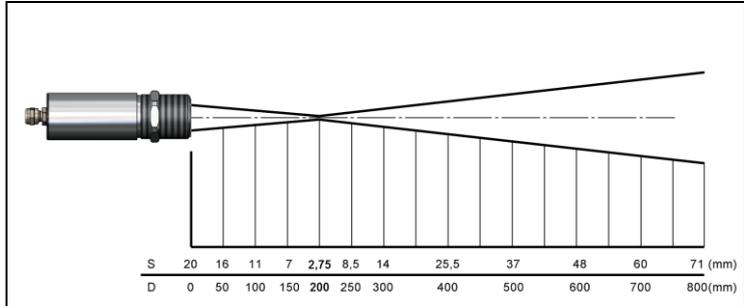




Optics: CF3

D:S (focus distance) = 75:1/ 2,75mm@200mm

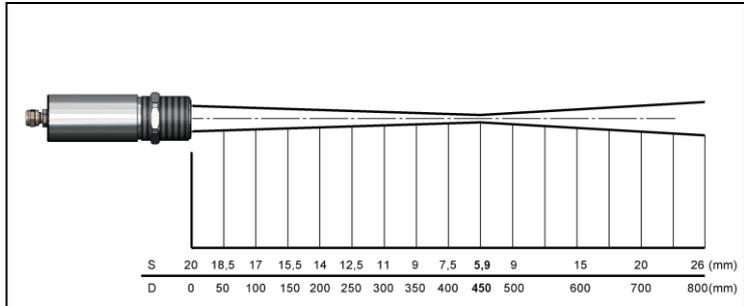
D:S (far field) = 9:1



Optics: CF4

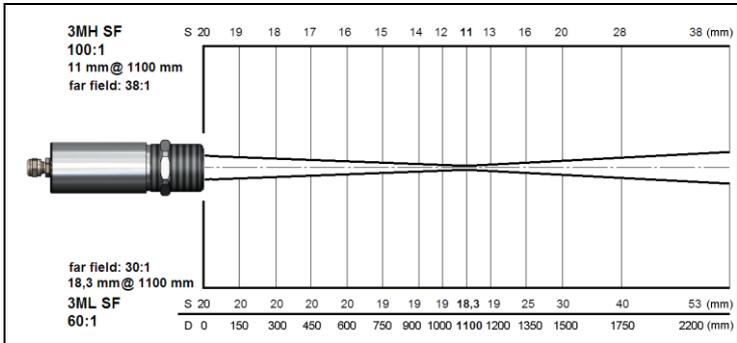
D:S (focus distance) = 75:1/ 5,9mm@450mm

D:S (far field) = 18:1



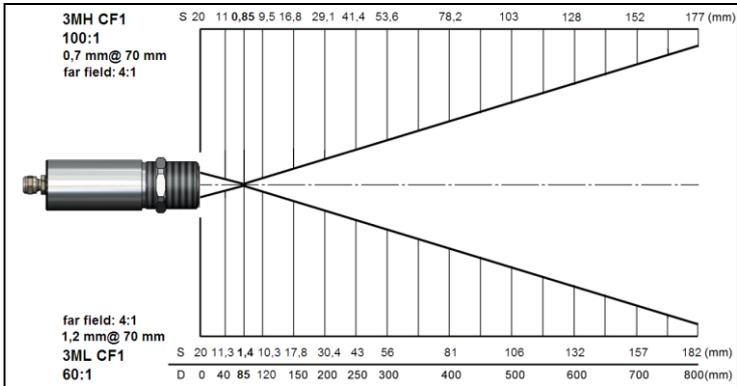
3MH Optics: SF
 D:S (focus distance) = 100:1
 11mm @ 1100mm
 D:S (far field) = 38:1

3ML Optics: SF
 D:S (focus distance) = 60:1
 18,3mm @ 1100mm
 D:S (far field) = 30:1



3MH Optics: CF1
 D:S (focus distance) = 100:1
 0,85mm @ 85mm
 D:S (far field) = 3:1

3ML Optics: CF1
 D:S (focus distance) = 60:1
 1,4mm @ 85mm
 D:S (far field) = 3:1



3MH

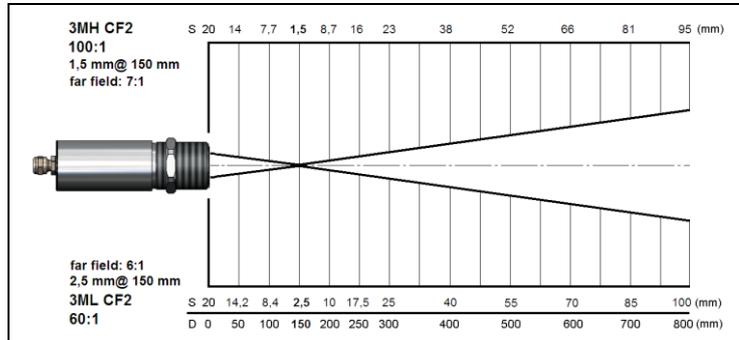
Optics: CF2

D:S (focus distance) = 100:1
 1,5mm @ 150mm
 D:S (far field) = 7:1

3ML

Optics: CF2

D:S (focus distance) = 60:1
 2,5mm @ 150mm
 D:S (far field) = 6:1

**3MH**

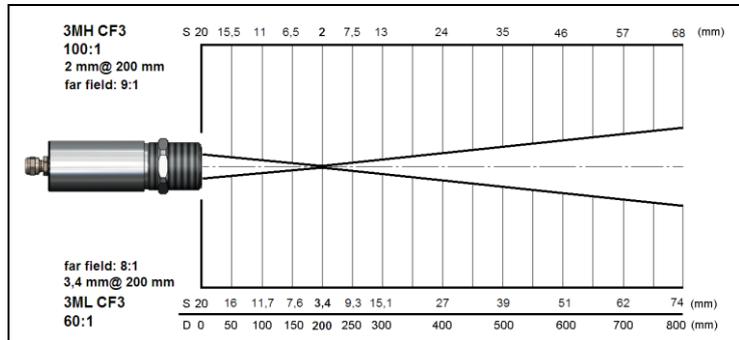
Optics: CF3

D:S (focus distance) = 100:1
 2mm @ 200mm
 D:S (far field) = 9:1

3ML

Optics: CF3

D:S (focus distance) = 60:1
 3,4mm @ 200mm
 D:S (far field) = 8:1



3MH

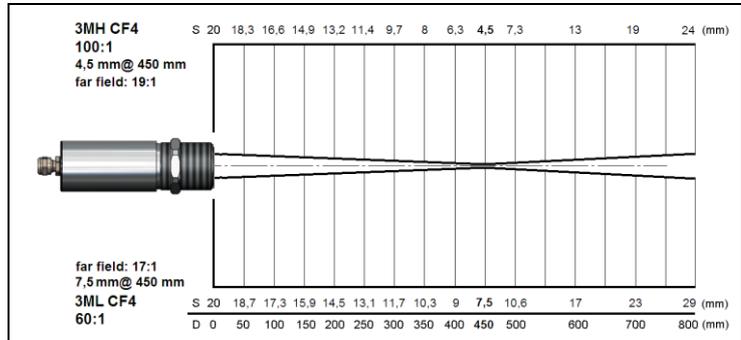
Optics: CF4

D:S (focus distance) = 100:1
4,5mm @ 450mm
D:S (far field) = 19:1

3ML

Optics: CF4

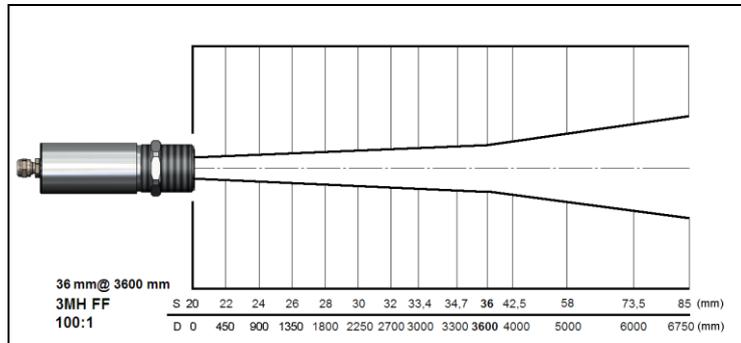
D:S (focus distance) = 60:1
7,5mm @ 450mm
D:S (far field) = 17:1



3MH

Optics: FF

D:S (focus distance) = 100:1
36mm @ 3600mm



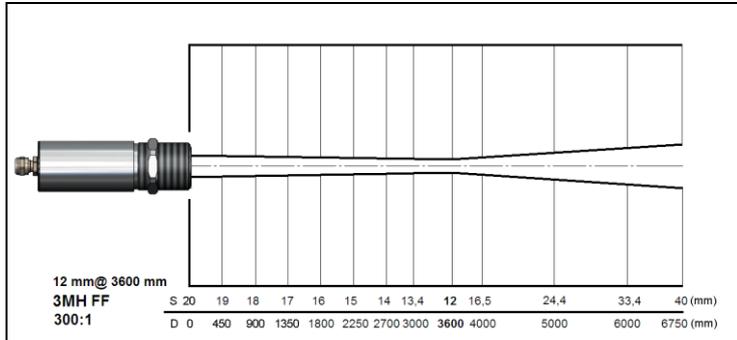
3MH1 - 3MH3

Optics: FF

D:S (focus distance) = 300:1

12mm @ 3600mm

D:S (far field) = 115:1

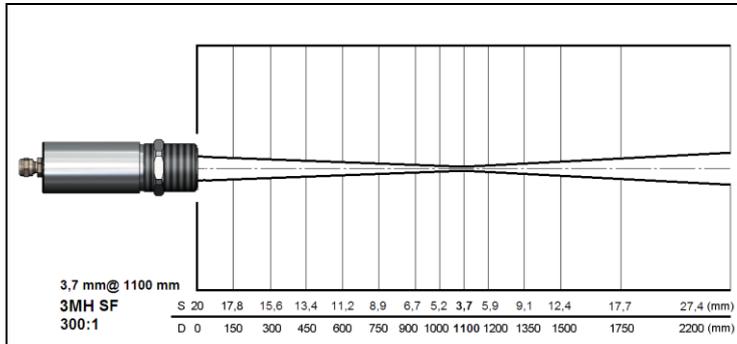
**3MH1 - 3MH3**

Optics: SF

D:S (focus distance) = 300:1

3,7mm @ 1100mm

D:S (far field) = 48:1



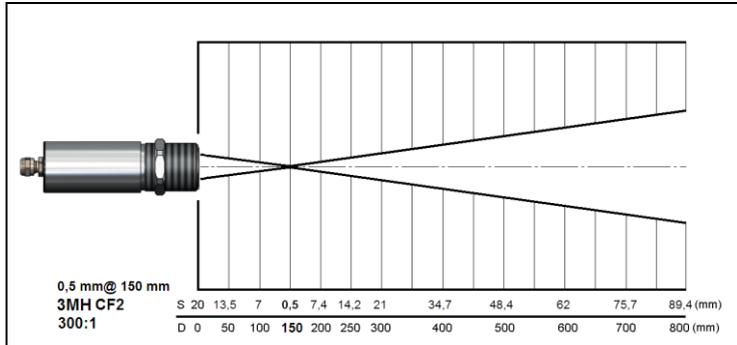
3MH1 - 3MH3

Optics: CF2

D:S (focus distance) = 300:1

0,5mm @ 150mm

D:S (far field) = 7,5:1

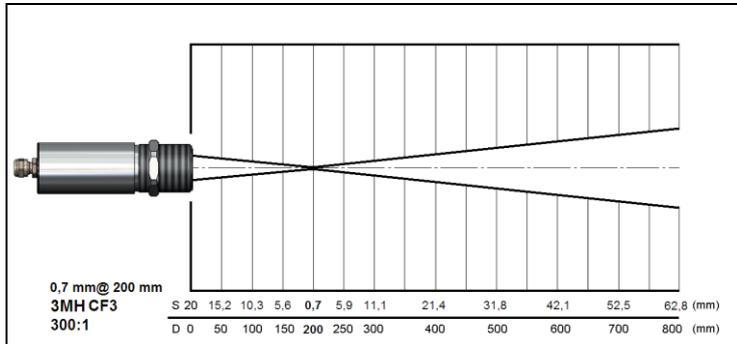
**3MH1 - 3MH3**

Optics: CF3

D:S (focus distance) = 300:1

0,7mm @ 200mm

D:S (far field) = 10:1



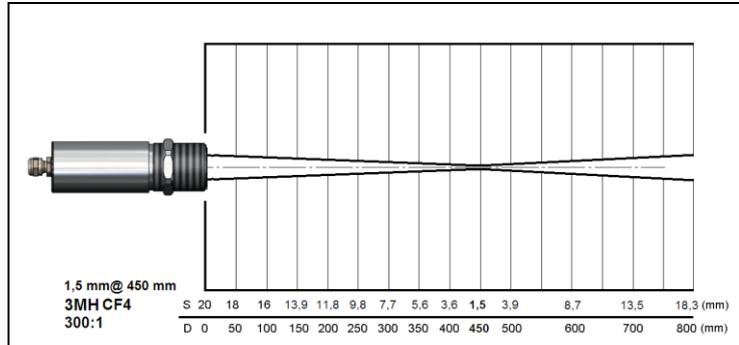
3MH1 - 3MH3

Optics: CF4

D:S (focus distance) = 300:1

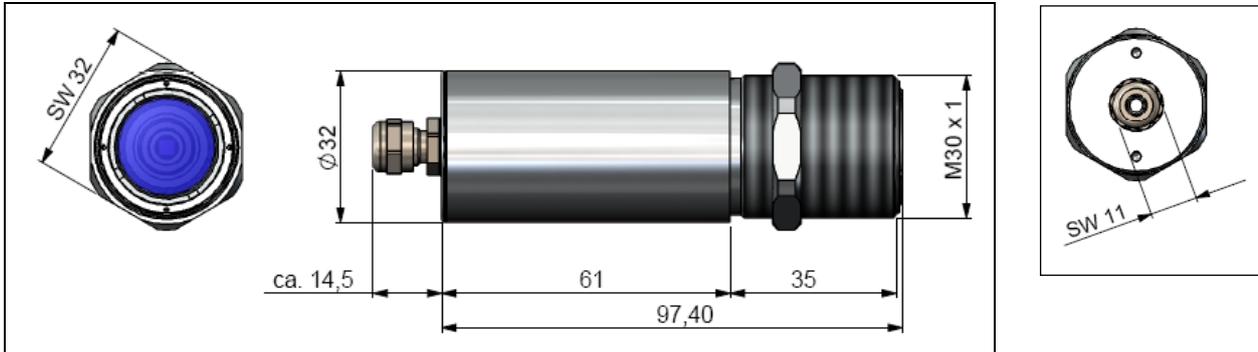
1,5mm @ 450mm

D:S (far field) = 22:1



Mechanical Installation

The CT XL sensing heads are equipped with a metrical M30x1-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.



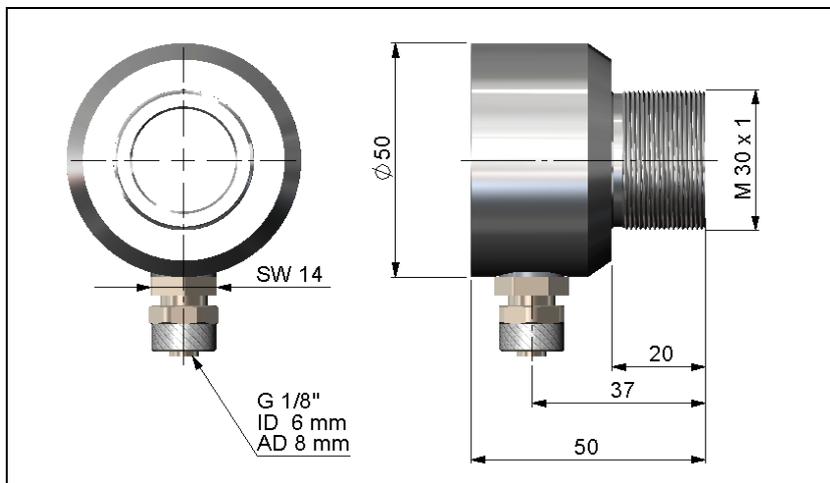
CT XL – Sensing head

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

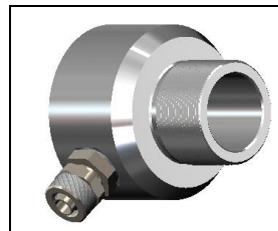
Accessories

Air Purge Collar

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.



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

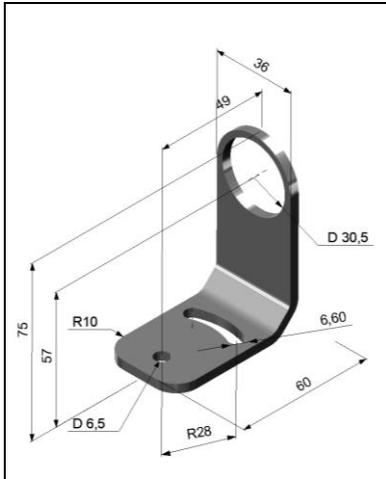


Air purge collar [ACCTXLAP]

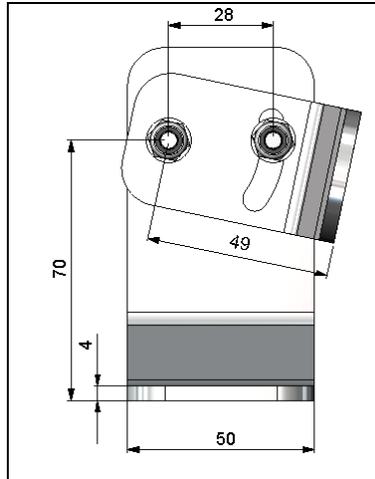
Hose connection: 6x8 mm

Thread (Fitting): G 1/8 inch

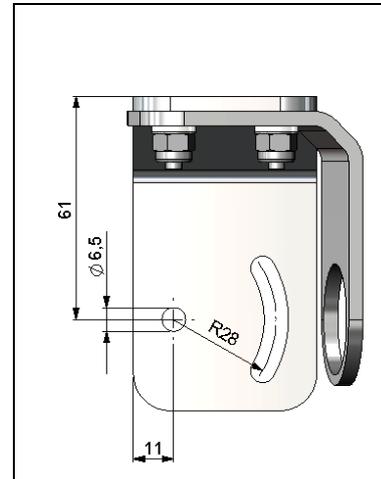
Mounting Brackets



**Mounting bracket, adjustable
in one axis [ACCTXLFB]**



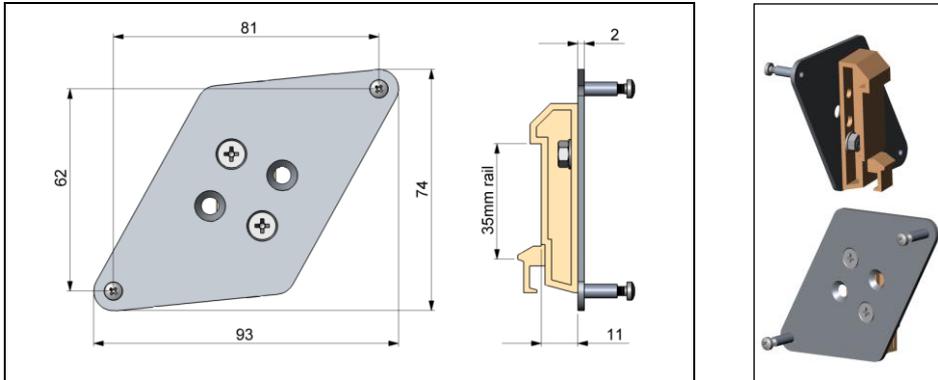
**Mounting bracket, adjustable in
two axes [ACCTXLAB]**



With the help of this bracket the sensing head can be adjusted in two axes.

Rail Mount Adapter for Electronic box

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



Rail Mount Adapter [ACCTRAIL]

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

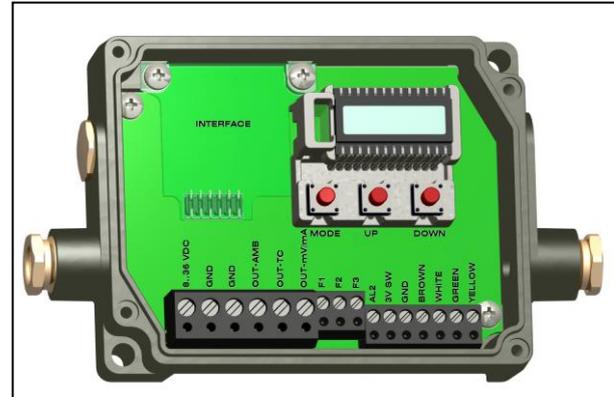
Electrical Installation

Cable Connections

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

Designation [model LT]

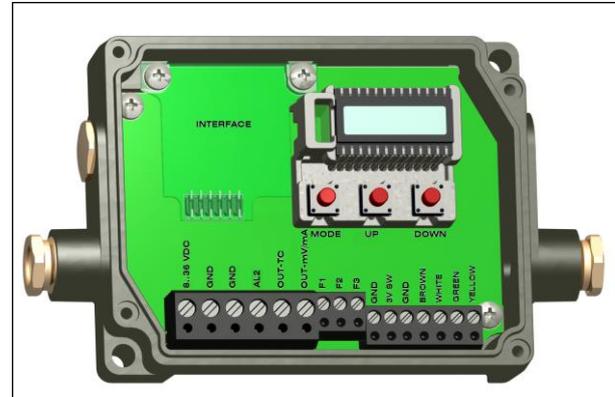
+8...36 VDC	Power supply
GND	Ground (0 V) of power supply
GND	Ground (0 V) of internal in- and outputs
OUT-AMB	Analog output head temperature (mV)
OUT-TC	Analog output thermocouple (J or K)
OUT-mV/mA	Analog output object temperature (mV or mA)
F1-F3	Functional inputs
AL2	Alarm 2 (Open collector output)
3V SW	3 VDC, switchable, for laser-sightingtool
GND	Ground (0 V) for laser-sightingtool
BROWN	Temperature probe head
WHITE	Temperature probe head
GREEN	Detector signal (-)
YELLOW	Detector signal (+)



**Opened LT electronic box
with terminal connections**

Designation [model 3M]

+8..36VDC	Power supply
GND	Ground (0V) of power supply
GND	Ground (0V) of internal in- and outputs
AL2	Alarm 2 (Open collector output)
OUT-TC	Analog output thermocouple (J or K)
OUT-mV/mA	Analog output object temperature (mV or mA)
F1-F3	Functional inputs
GND	Ground (0V)
3V SW	3 VDC, switchable, for laser-sightingtool
GND	Ground (0 V) for laser-sightingtool
BROWN	Temperature probe head (NTC)
WHITE	Head ground
GREEN	Head power
YELLOW	Detector signal



Opened 3M electronic box
with terminal connections

Power supply

Please use a power supply unit with an output voltage of **8–36 VDC** which can supply **100 mA**. The ripple should be max. **200 mV**.

CAUTION: Please do never connect a supply voltage to the analog outputs as this will destroy the output!

The CT XL is not a 2-wire sensor!

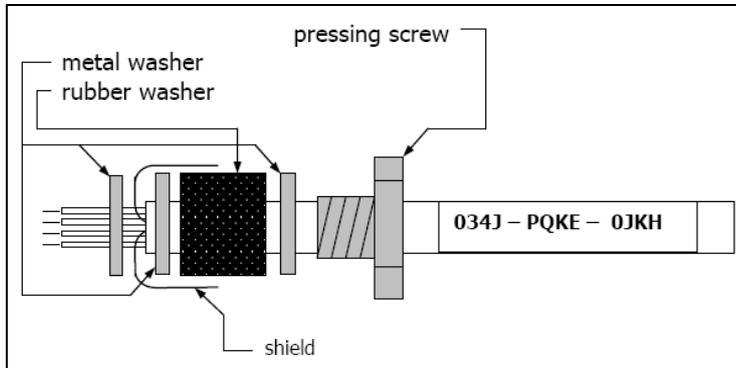
Cable Assembling

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.



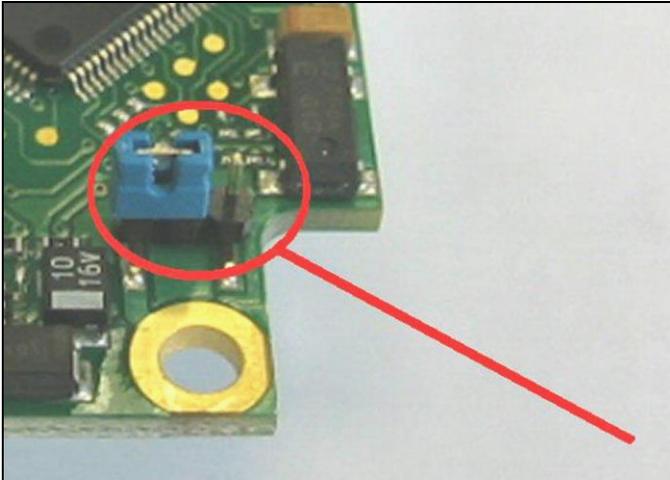
Use shielded cables only. The sensor shield has to be grounded.

Ground Connection [LT models]

At the bottom side of the mainboard PCB you will find a connector (jumper) which has been placed from factory side as shown in the picture [left and middle pin connected]. In this position the ground connections (GND power supply/ outputs) are connected 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. To do this please put the jumper in the other position [**middle** and **right** pin connected].

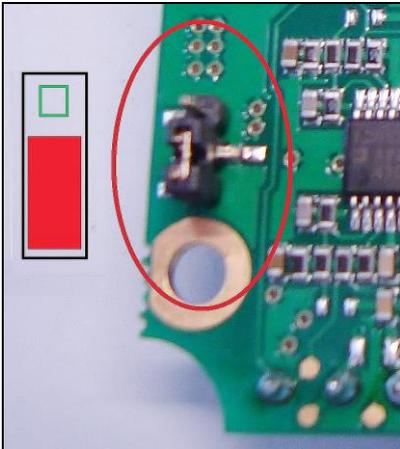
If the thermocouple output is used the connection GND – housing should be interrupted generally.



Ground Connection [3M models]

At the bottom side of the mainboard PCB you will find a connector (jumper) which has been placed from factory side as shown in the picture [**bottom** and **middle** pin connected]. In this position the ground connections (GND power supply/ outputs) are connected 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. To do this please put the jumper in the opposite position [**middle** and **top** pin connected].

If the thermocouple output is used the connection GND – housing should be interrupted generally.



Outputs and Inputs

Analog Outputs

The CT XL has two analog output channels.

CAUTION: Please do never connect a supply voltage to the analog outputs as this will destroy the output.
The CT XL is not a 2-wire sensor!

Output channel 1

This output is used for the object temperature. The selection of the output signal can be done via the programming keys [► **Operating**]. The software allows the programming of output channel 1 as an alarm output.

Output signal	Range	Connection pin on CT XL board
Voltage	0 ... 5 V	OUT-mV/mA
Voltage	0 ... 10 V	OUT-mV/mA
Current	0 ... 20 mA	OUT-mV/mA
Current	4 ... 20 mA	OUT-mV/mA
Thermocouple	TC J	OUT-TC
Thermocouple	TC K	OUT-TC

According to the chosen output signal different connection pins on the mainboard are used.
(OUT-mV/mA or OUT-TC).

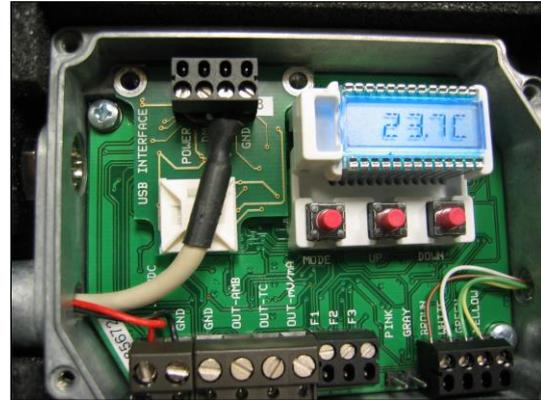
Output channel 2 [LT only]

The connection pin OUT-AMB is used for output of the head temperature [-20-180 °C as 0–5 V or 0–10 V signal]. The software allows the programming of output channel 2 as an alarm output. Instead of the head temperature **THead** also the object temperature **TObj** or electronic box temperature **TBox** can be selected as alarm source.

Digital Interfaces

CT XL sensors can be optionally equipped with an USB-, RS232-, RS485-, CAN Bus-, Profibus DP- or Ethernet-interface.

If you want to install an interface, plug the interface board into the place provided, which is located beside the display. 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 Ethernet interface requires at minimum 12 V supply voltage.
Please pay attention to the notes on the according interface manuals.**

Relay Outputs

The CT XL 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 [**► Alarms/ Visual Alarms**].

The alarm values are set according to the **► Factory Default Settings**.

To make advanced settings (change of low- and high alarm) a digital interface (USB, RS232) and the software is needed.

Functional Inputs

The three functional inputs F1 – F3 can be programmed with the software only.

F1 (digital): trigger (a 0 V level on F1 resets the hold functions)

F2 (analog): external emissivity adjustment [**0–10 V: 0 V ► $\epsilon=0,1$; 9 V ► $\epsilon=1$; 10 V ► $\epsilon=1,1$**]

F3 (analog): external compensation of ambient temperature/ the range is scalable via software
[0–10 V ► -40–900 °C / preset range: -20–200 °C]

F1-F3 (digital): emissivity (digital choice via table)

A non connected input represents:

F1=High | F2, F3=Low.

[High level: $\geq +3 \text{ V} \dots +36 \text{ V}$ | Low level: $\leq +0,4 \text{ V} \dots -36 \text{ V}$]

Alarms

The CT XL has the following Alarm features:

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

Output channel 1 and 2 [channel 2 on LT only]

To activate the according output channel has to be switched into digital mode. For this purpose the software CompactConnect is required.

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 [**24V/ 50mA**].

From factory side the alarms are defined as follows:

Alarm 1	Norm. closed/ Low-Alarm
Alarm 2	Norm. open/ High-Alarm

Both of these alarms will have effect on the LCD color:

BLUE:	alarm 1 active
RED:	alarm 2 active
GREEN:	no alarm active

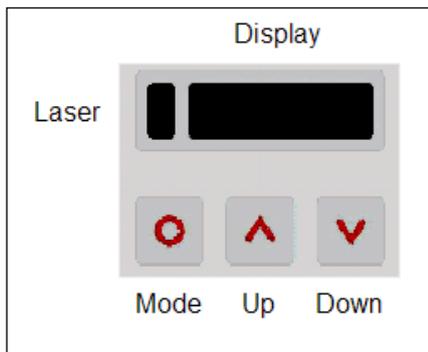
For extended setup like definition as low or high alarm [**via change of normally open/ closed**], selection of the signal source [**TObj, THead, TBox**] a digital interface (e.g. USB, RS232) including the software CompactConnect is needed.

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 [**► Alarms/ Visual Alarms**].

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 CT XL 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]	Adjustment Range
142.3C	Object temperature (after signal processing) [142,3 °C]	fixed
127CH	Head temperature [127 °C]	fixed
25CB	Box temperature [25 °C]	fixed
142CA	Current object temperature [142 °C]	fixed
<input type="checkbox"/> MV5	Signal output channel 1 [0-5 V]	<input type="checkbox"/> 0-20 = 0–20 mA/ <input type="checkbox"/> 4-20 = 4–20 mA/ <input type="checkbox"/> MV5 = 0–5 V/ <input type="checkbox"/> MV10 = 0-10 V/ <input type="checkbox"/> TCJ = thermocouple type J/ <input type="checkbox"/> TCK = thermocouple type K
E0.970	Emissivity [0,970]	0,100 ... 1,100
T1.000	Transmissivity [1,000]	0,100 ... 1,100
A 0.2	Signal output Average [0,2 s]	A---- = inactive/ 0,1 ... 999,9 s
P----	Signal output Peak hold [inactive]	P---- = inactive/ 0,1 ... 999,9 s / P oo oo oo oo = infinite
V----	Signal output Valley hold [inactive]	V---- = inactive/ 0,1 ... 999,9 s / V oo oo oo oo = infinite
u 0.0	Lower limit temperature range [0 °C]	depending on model / inactive at TCJ- and TCK-output
n 500.0	Upper limit temperature range [500 °C]	depending on model / inactive at TCJ- and TCK-output
[0.00	Lower limit signal output [0 V]	according to the range of the selected output signal
] 5.00	Upper limit signal output [5 V]	according to the range of the selected output signal
U °C	Temperature unit [°C]	°C/ °F
 30.0	Lower alarm limit [30 °C]	depending on model
 100.0	Upper alarm limit [100 °C]	depending on model
XHEAD	Ambient temperature compensation [head temperature]	XHEAD = head temperature/ -40,0 ... 900,0 °C (for LT) as fixed value for compensation/ returning to XHEAD (head temperature) by pressing Up and Down together
M 01	Multidrop adress [1] (only with RS485 interface)	01 ... 32
B 9.6	Baud rate in kBaud [9,6]	9,6/ 19,2/ 38,4/ 57,6/ 115,2 kBaud
S ON	Laser Sighting (3 VDC switch to connection pin 3V SW)	ON/ OFF This menu item appears on first position on 1M/ 2M/ 3M models.

MV5

Selection of the **Output signal**. By pressing **Up** or **Down** the different output signals can be selected [**► Outputs and Inputs**].

E0.970

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 [**► Emissivity**].

T1.000

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).

A 0.2

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. On 3M models the shortest value is 0,001 s (other models: 0,1 s) and can be increased/ decreased only by values of the power series of 2 (0,002, 0,004, 0,008, 0,016, 0,032, ...).
If the value is set to **0.0** the display will show --- (function deactivated).

P----

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).

u 0.0

Setup of the **Lower limit of temperature range**. The minimum difference between lower and upper limit is **20 K**. If you set the lower limit to a value \geq upper limit the upper limit will be adjusted to **[lower limit + 20 K]** automatically.

n 500.0

Setup of the **Upper limit of the temperature range**. The minimum difference between upper and lower limit is **20 K**. The upper limit can only be set to a value = lower limit + 20 K.

l 0.00

Setup of the **Lower limit of the signal output**. This setting allows an assignment of a certain signal output level to the lower limit of the temperature range. The adjustment range corresponds to the selected output mode (e.g. 0-5 V).

l 5.00

Setup of the **Upper limit of the signal output**. This setting allows an assignment of a certain signal output level to the upper limit of the temperature range. The adjustment range corresponds to the selected output mode (e.g. 0-5 V).

U °C

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

30.0

Setup of the **Lower alarm limit**. This value corresponds to Alarm 1 [**► Alarms/ Visual Alarms**] and is also used as threshold value for relay 1 (if the optional relay board is used).

11 100.0

Setup of the **Upper alarm limit**. This value corresponds to Alarm 2 [**► Alarms/ Visual Alarms**] and is also used as threshold value for relay 2 (if the optional relay board is used).

XHEAD

Setup of the **Ambient temperature compensation**. In dependence on the emissivity value of the object a certain amount of ambient radiation will be reflected from the object surface.

To compensate this impact, this function allows the setup of a fixed value which represents the ambient radiation.

If **XHEAD** is shown the ambient temperature value will be taken from the head-internal probe.

To return to **XHEAD** please press **Up** and **Down** together.

Especially if there is a big difference between the ambient temperature at the object and the head temperature the use of **Ambient temperature compensation** is recommended.

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.

B 9.6

Setup of the **Baud rate** for digital data transfer.

S ON

Activating (**ON**) and Deactivating (**OFF**) of an optional **Sighting Laser**

[► **Further Accessories**]. By pressing **Up** or **Down** a voltage of 3 VDC will be switched to the **3V SW** connection pin on the mainboard.

Error messages

The display of the sensor can show the following error messages:

LT models:

OVER	Object temperature too high
UNDER	Object temperature too low
^^CH	Head temperature too high
vvvCH	Head temperature too low

3M models:

1. Digit:

0x	No error
1x	Head temperature probe short circuit to GND
2x	Box temperature too low
4x	Box temperature too high
6x	Box temperature probe disconnected
8x	Box temperature probe short circuit to GND

2. Digit:

x0	No error
x2	Object temperature too high
x4	Head temperature too low
x8	Head temperature too high
xC	Head temperature probe disconnected

Software CompactConnect

Installation

Insert the installation CD into the according drive on your computer. If the autorun option is activated the installation wizard will start automatically.

Otherwise please start **CDsetup.exe** from the CD-ROM. Follow the instructions of the wizard until the installation is finished.

The installation wizard will place a launch icon on the desktop and in the start menu:

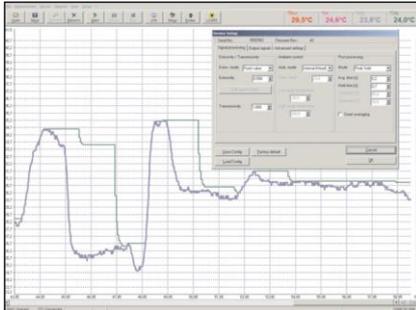
[Start]\Programs\CompactConnect.

If you want to uninstall the software from your system please use the **uninstall icon** in the start menu.

Minimum system requirements:

- Windows XP, Vista, 7, 8
- USB interface
- Hard disc with at least 30 MByte free space
- At least 128 MByte RAM
- CD-ROM drive

You will find a detailed software manual on the CD.



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

Communication Settings

Serial Interface

Baud rate: 9,6...115,2 kBaud (adjustable on the unit or via software)
Data bits: 8
Parity: none
Stop bits: 1
Flow control: off

Protocol

All sensors of the CT XL series are using a binary protocol. Alternatively they can be switched to an ASCII protocol. To get a fast communication the protocol has no additional overhead with CR, LR or ACK bytes.

ASCII protocol

To switch to the ASCII protocol you can use also the following command:

Decimal: 131
HEX: 0x83
Data, Answer: byte 1
Result: 0 – Binary protocol
 1 – ASCII protocol

Saving of parameter settings

After power on of the CT XL sensor the flash mode is active. It means, changed parameter settings will be saved in the CT XL-internal Flash-EEPROM and will be kept also after the sensor is switched off.

In case settings should be changed quite often or continuously the flash mode can be switched off by using the following command:

Decimal:	112
HEX:	0x70
Data, Answer:	byte 1
Result:	1 – Data will not be written into the flash memory 2 – Data will be written into the flash memory

If the flash mode is deactivated, all settings will only be kept as long as the unit is powered. If the unit is switched off and powered on again all previous settings are lost.

The command 0x71 will poll the current status.

You will find a detailed protocol and command description on the software CD CompactConnect in the directory: **\Commands**.

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 μ and 20 μ m.

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 (see enclosed table 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 **D**istance to **S**pot 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.

Emissivity

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.

Determination of unknown Emissivities

- ▶ 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 colored surface. Afterwards, determine the temperature of a directly adjacent area and modify the emissivity until the measured value corresponds to the temperature of the colored surface.

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

Characteristic Emissivities

In case none of the methods mentioned above help to determine the emissivity you may use the emissivity tables ► **Appendix A and B**. 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 – Emissivity Table 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

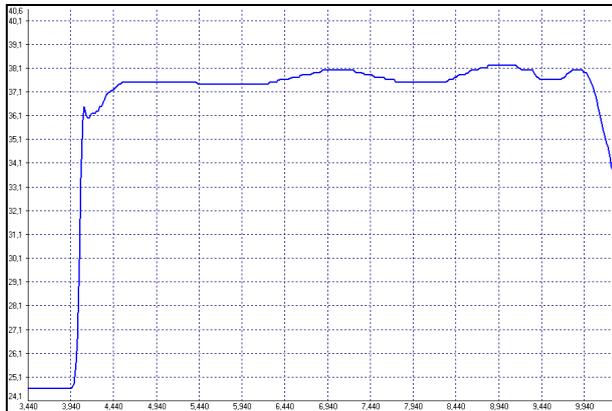
Appendix B – Emissivity Table Non Metals

Material		typical Emissivity			
		1,0 μm	2,2 μm	5,1 μm	8-14 μm
Spectral response					
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

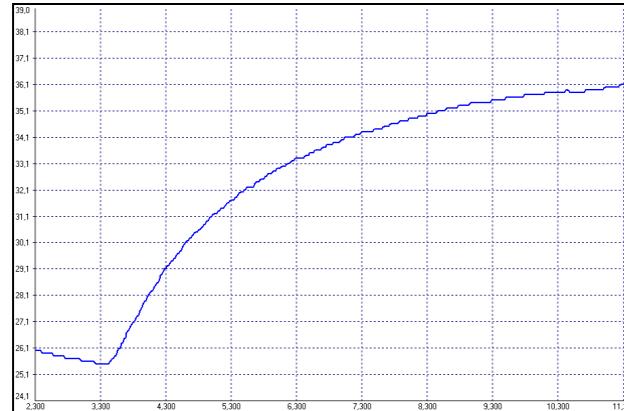
Appendix C – Smart Averaging

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.



Signal graph with Smart Averaging function



Signal graph without Smart Averaging function