MICRO-EPSILON

Instruction Manual
thermoMETER CSL

CSL-SF
CSLM-2

Infrared sensor

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Contents

1.   Safety

The handling of the system assumes knowledge of the instruction manual.

1.1   Symbols Used

The following symbols are used in the instruction manual:

| ⚠ CAUTION | Indicates a hazardous situation which, if not avoided, may result in minor or moderate injuries. |

| NOTICE | Indicates a situation which, if not avoided, may lead to property damage |

➡   Indicates a user action.

i   Indicates a user tip.

Measure   Indicates a hardware or a button/menu in the software

1.2   Warnings

⚠ CAUTION

Connect the power supply and the controller in accordance with the safety regulations for electrical equipment.
> Danger of injury

> Damage to or destruction of the sensor

NOTICE

Avoid shock and vibration to the sensor.
> Damage to or destruction of the sensor

The power supply must not exceed the specified limits.
> Damage to or destruction of the sensor

Protect the sensor cable against damage.
> Destruction of the sensor, Failure of the measuring device

No solvent-based cleaning agents may have an effect on the sensor (neither for the optics nor the housing)
> Damage to or destruction of the sensor

1.3   Notes on CE Identification

The following applies to the thermoMETER CSL:
- EU directive 2004/108/EC
- EU directive 2011/65/EU, "RoHS" category 9

Products which carry the CE mark satisfy the requirements of the quoted EU directives and the European standards (EN) listed therein. The EC declaration of conformity is kept available according to EC regulation, article 10 by the authorities responsible at

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The system is designed for use in industry and laboratory and satisfies the requirements.

1.4   Proper Use

- The thermoMETER CSL is designed for use in industrial and laboratory areas. It is used for non-contact temperature measurement.
- The system may only be operated within the limits specified in the technical data, see Chap. 2..
- Use the system in such a way that in case of malfunctions or failure personnel or machinery are not endangered.
- Take additional precautions for safety and damage prevention for safety-related applications.

1.5   Proper Environment

- Protection class: IP 65
- Operating temperature: -20 ... 85 °C (-4 ... +185 °F)

HINWEIS

Avoid abrupt changes of the operating temperature.
> Inaccurate measuring values

- Storage temperature: -40 ... 85 °C (-40 ... +185 °F)
- Humidity: 10 ... 95 %, non-condensing

2. Technical Data

2.1 Functional Principle

The sensors of the thermoMETER CSL series are non-contact measuring infrared temperature sensors. They calculate the surface temperature based on the emitted infrared energy of objects, see Chap. 11. An integrated double laser aiming marks the real measurement spot location and spot size at any distance on the object surface.
The sensor housing of the thermoMETER CSL is made from stainless steel (protection class IP 65).

$\underset{1}{\bullet}$ The thermoMETER CSL sensor is a sensitive optical system. Please only use the thread for mechanical installation.

NOTICE

Avoid mechanical violence on the sensor.
> Destruction of the system

2.2   Sensor Models

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

Model	Modal codes	Measuring range	Spectral response	Typical applications
CSL	SF	-50 to 975 °C	8 - 14 μm	Non-metallic surfaces
CSL M-2	M-2H	385 to 1600 °C	1.6 μm	Metals and ceramic surfaces

In the following chapters of this manual you will find only the short modal codes.

2.3   General Specifications

Protection class	IP 65
Operating temperature [1]	-20 ... 85 °C (-4 ... +185 °F)
Storage temperature	-40 ... 85 °C (-40 ... +185 °F)
Relative humidity	10 ... 95 %, non-condensing
Material	Stainless steel
Dimensions	100 mm x 50 mm, M48x1.5
Weight	600 g
Cable diameter	5 mm
Vibration	IEC 68-2-6: 3 g 11 - 200 Hz, any axis
Shock	IEC 68-2-27: 50 g, 11 ms, any axis

1) Laser will turn off automatically at ambient temperatures > 50 °C.

2.4 Electrical Specifications

Power supply	5 - 28 VDC
Current draw (laser)	45 mA @ 5 V 20 mA @ 12 V 12 mA @ 24 V
Aiming laser	635 nm, 1 mW, On/Off via external switch (needs to be installed by user before start-up) or software
Output/analog	4 - 20 mA current loop
Alarm output	Programmable open collector output at RxD pin (0 - 30 V/ 500 mA)
Output impedance	Max. loop resistance 1000 Ω (in dependence on supply voltage)
Output/digital	uni-/ bidirectional, 9.6 kBaud, 0/3 V digital level USB optional

2.5   Measurement Specifications

Model	SF	M-2H
Temperature range (scalable)	-50 ... 975 °C (-58 °F ... 1787 °F)	385 ... 1600 °C (725 ... 2912 °F)
Spectral range	8 ... 14 μm	1.6 μm
Optical resolution	50:1	300:1
System accuracy [1]	±1 °C or ±1 % [2]	±(0.3 % of reading +2 °C) [3]
Repeatability [1]	±0.5 °C or ±0.5 % [2]	±(0.1 % of reading +1 °C) [3]
Temperature resolution	0.1 °C [2]	0.1 °C
Response time (90 % signal)	150 ms	10 ms
Warm-up time	10 min	-
Emissivity/ gain	0.100 ... 1.100 (adjustable via switches on sensor or via software)	
IR window correction	0.100…1.000 (adjustable via software)	
Signal processing	Average, peak hold, valley hold, extended hold functions with threshold and hysteresis (adjustable via software)	

1) At operating temperature 23 ±5 °C; whichever is greater.
2) At object temperatures > 0 °C; ε = 1
3) ε = 1/ Response time 1 s

3. Delivery

3.1 Unpacking

1 thermoMETER CSL sensor

1 Mounting nut and mounting bracket (fixed)

1 Instruction Manual

➡ Check the delivery for completeness and shipping damage immediately after unpacking.

➡ In case of damage or missing parts, please contact the manufacturer or supplier.

You will find optional accessories in appendix, see Chap. A 1.

3.2 Storage

- Storage temperature: -40 ... 85 °C (-40 ... +185 °F)
- Humidity: 10 ... 95 % (non-condensing)

4.　　Optical Charts

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

i　The size of the measuring object and the optical resolution of the infrared thermometer determine the maximum distance between sensor 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 as the object or should be smaller than that.

D = Distance from the front of the sensor to the object

S = Spot size

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

SF
Optics: SF
D:S (focus distance) = 50:1
24 mm @ 1200 mm
D:S (far field) = 20:1

| S | 20 | 20,5 | 21 | 21,5 | 22 | 22,5 | 23 | 23,5 | 24 | 29,5 | 35 | 46 | 57 | 68 | (mm) |
| D | 0 | 150 | 300 | 450 | 600 | 750 | 900 | 1050 | 1200 | 1350 | 1500 | 1800 | 2100 | 2400 | (mm) |
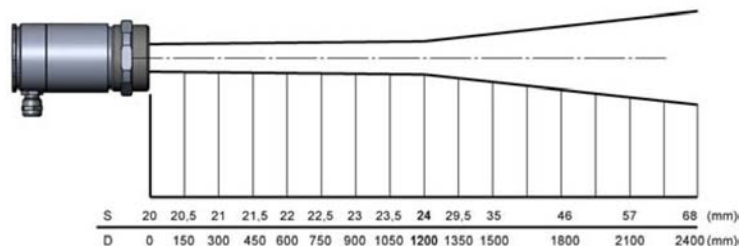
SF
Optik: CF1
D:S (focus distance) = 50:1
1.4 mm @ 70 mm
D:S (Fernfeld) = 1.5:1

S	20	10	**1,4**	11	26	41	57	72	103	133	164	194	225(mm)
D	0	40	**70**	100	150	200	250	300	400	500	600	700	800(mm)
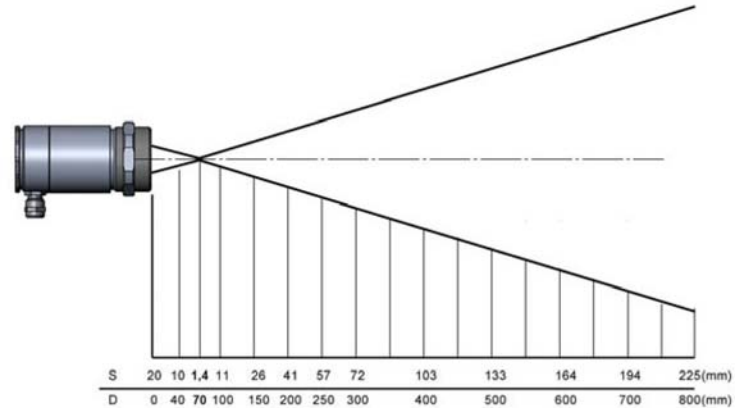
SF
Optik: CF2
D:S (focus distance) = 50:1
3 mm @ 150 mm
D:S (far field) = 6:1

S	20	15	9	**3**	11	19	26	42	57	72	88	103(mm)
D	0	50	100	**150**	200	250	300	400	500	600	700	800(mm)
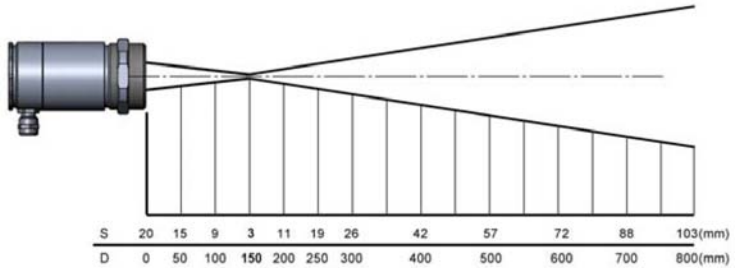
SF
Optik: CF3
D:S (focus distance) = 50:1
4 mm @ 200 mm
D:S (far field) = 8:1

S	20	16	12	8	4	10	16	28	40	52	64	76 (mm)
D	0	50	100	150	200	250	300	400	500	600	700	800(mm)
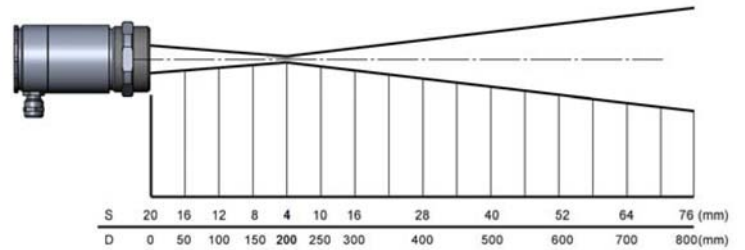
SF
Optik: CF4
D:S (focus distance) = 50:1
9 mm @ 450 mm
D:S (far field) = 16:1

S	20	19	18	16,5	15	14	13	11,5	10	9	12	19	25	32 (mm)
D	0	50	100	150	200	250	300	350	400	450	500	600	700	800(mm)
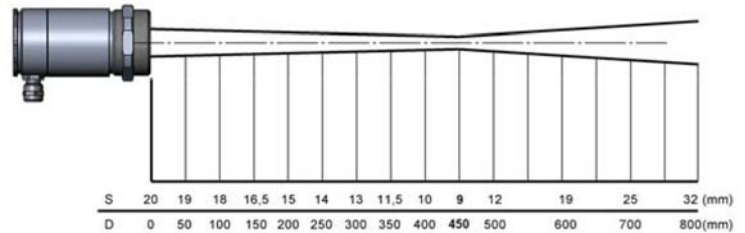
M-2H
Optik: FF
D:S (focus distance) = 300:1
12 mm @ 3600 mm
D:S (far field) = 115:1

S 20	19	18	17	16	15	14	13,4	12	16,5	24,4	33,4	40 (mm)
D 0	450	900	1350	1800	2250	2700	3000	3600	4000	5000	6000	6750 (mm)
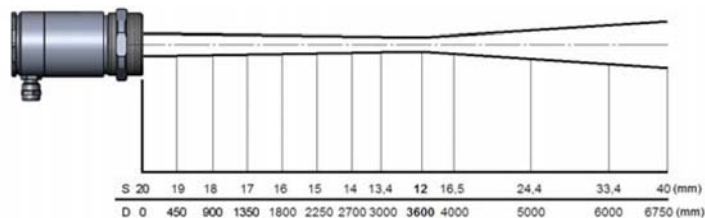
M-2H
Optik: SF
D:S (focus distance) = 300:1
3.7 mm @ 1100 mm
D:S (far field) = 48:1

S 20	17,8	15,6	13,4	11,2	8,9	6,7	5,2	3,7	5,9	9,1	12,4	17,7	27,4 (mm)
D 0	150	300	450	600	750	900	1000	1100	1200	1350	1500	1750	2200 (mm)
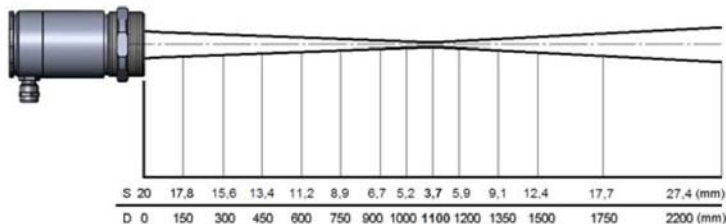
M-2H
Optik: CF2
D:S (focus distance) = 300:1
0.5 mm @ 150 mm
D:S (far field) = 7.5:1

S 20	13,5	7	0,5	7,4	14,2	21	34,7	48,4	62	75,7	89,4 (mm)
D 0	50	100	150	200	250	300	400	500	600	700	800 (mm)
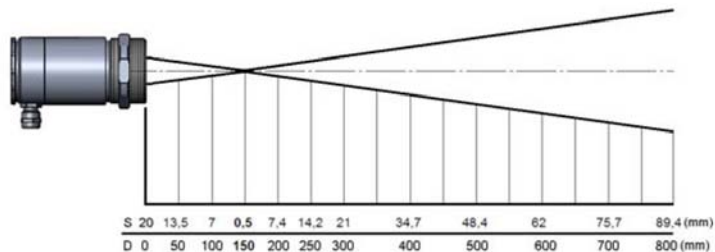
M-2H
Optik: CF3
D:S (focus distance) = 300:1
0.7 mm @ 200 mm
D:S (far field) = 10:1

S	20	15,2	10,3	5,6	0,7	5,9	11,1	21,4	31,8	42,1	52,5	62,8 (mm)
D	0	50	100	150	200	250	300	400	500	600	700	800 (mm)
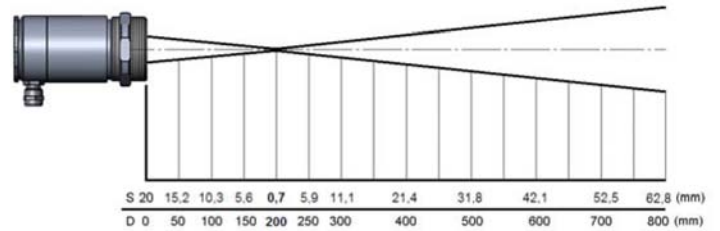
M-2H
Optik: CF4
D:S (focus distance) = 300:1
1.5 mm @ 450 mm
D:S (far field) = 22:1

S	20	18	16	13,9	11,8	9,8	7,7	5,6	3,6	1,5	3,9	8,7	13,5	18,3 (mm)
D	0	50	100	150	200	250	300	350	400	450	500	600	700	800 (mm)
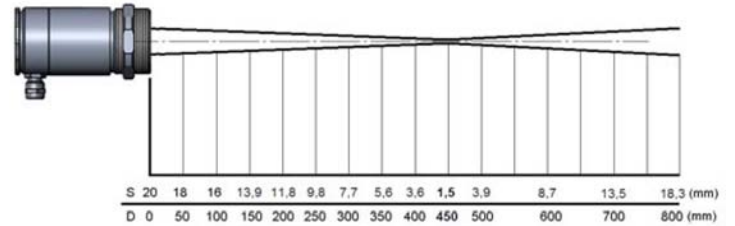
5.   Mechanical Installation

The thermoMETER CSLaser is equipped with a metric M48x1.5 thread and can be installed either directly via the sensor thread or with help of the supplied mounting nut (standard) and fixed mounting bracket (standard) to a mounting device available.
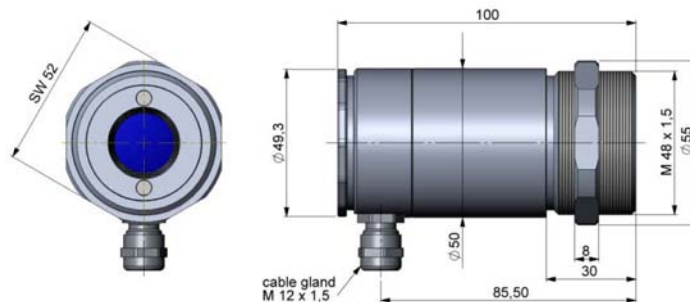

Fig. 1 thermoMETER CSL sensor, dimensions in mm, not to scale

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

6. Electrical Installation

6.1 Cable Connections

6.1.1 Basic Version

The basic version is supplied without connection cable.

▶ To connect the thermoMETER CSLaser please open at first the sensor backplane (4 screws).

▶ Use a 4-wire shielded cable which you have to conduct through the cable gland.

Fig. 2 View on sensor back side

i   During assembling please make sure the shield gets a safe electrical contact to the sensor housing.

For an easier connection the terminal block can be removed from the PCB by pulling off.

6.1.2 Power Supply

Use a power supply unit with an output voltage of 5 - 28 VDC, which can supply 100 mA.

6.1.3   Pin Assignment (Sensor Terminal Block)

RXD	Receive data (digital)
TXD	Transmit data (digital)
LOOP +	Current loop (+)
LOOP -	Current loop (-)
LASER -	Power supply laser (-)
LASER +	Power supply laser (+)

Fig. 3 Sensor back side with terminal block

Above the terminal block you will find two rotary switches for Emissivity Adjustment, see Chap. 7..
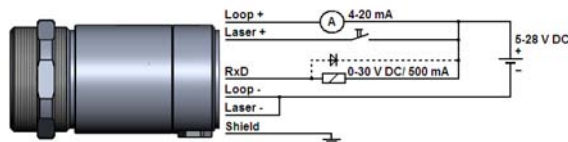
6.2   Analog Mode

Fig. 4 Analog Mode

If the thermoMETER CSLaser is used as analog device the sensor provides beside the 4 - 20 mA signal in addition an alarm output (open-collector) on the RxD pin. To activate the alarm output and set the alarm threshold value the software (optional) is needed. The supply line for the sighting laser must be led via a switch or button, which has to be installed max. 2 m away from installation site of the sensor.

6.3   Digital Mode
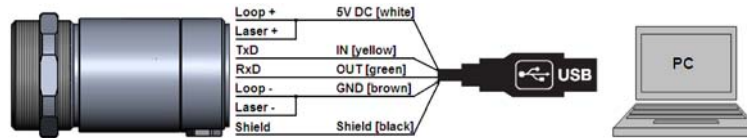
In the digital mode the sensor and the laser will be powered via the 5 V from USB interface. The activation/ deactivation of the laser has to be made via the software.

For a digital communication the optional USB programming kit is required.

➡ Please connect each wire of the USB adapter cable with the same colored wire of the sensor cable by using the terminal block.

➡ Press with a screw driver as shown in the picture to loose a contact.
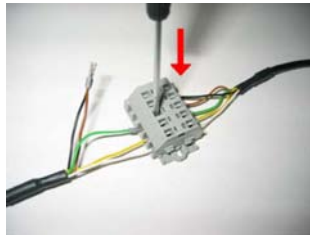
Fig. 5 Cable connection via terminal block

Alternatively the USB cable can also be connected directly on the sensor, see Chap. 6.1.

The sensor is offering two ways of digital communication:

- Bidirectional communication (sending and receiving data)
- Unidirectional communication (burst mode - the sensor is sending data only)

6.4   Digital and Analog Mode Combined
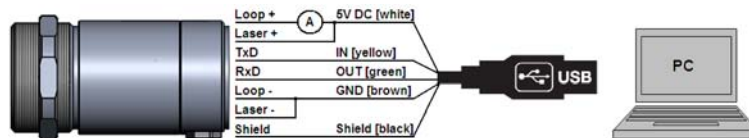

Fig. 6 Combination digital and analog mode

The thermoMETER CSLaser are able to work in the digital mode and simultaneously as analog device (4 - 20 mA).

In this case the sensor will be powered by the USB interface (5 V).

6.5   Maximum Loop Impedance

The maximum impedance of the current loop depends on the supply voltage level:
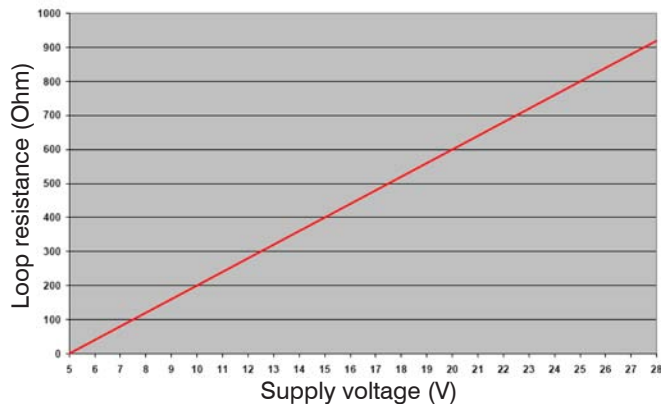
Fig. 7 Graph maximum loop resistance

7. Emissivity Setting

After opening of the sensor backplate, see Chap. 6.1, both of the emissivity switches are accessible.

Fig. 8 Emissivity switches

For an emissivity setting of 1.00 please turn both switches to 0. Values below 0.10 are not adjustable. For all other switch positions the following applies: 0, S1 S2.

Therefore the adjustment range is 0.10 ... 1.09.

Example: $\varepsilon = 0.84$ S1 = 8

S2 = 4

Fig. 9 View on emissivity setting

i If you use the software (optional), please consider that the emissivity switches can be activated/ deactivated in the software menu Device/ Device setup. At time of delivery the switches are active.

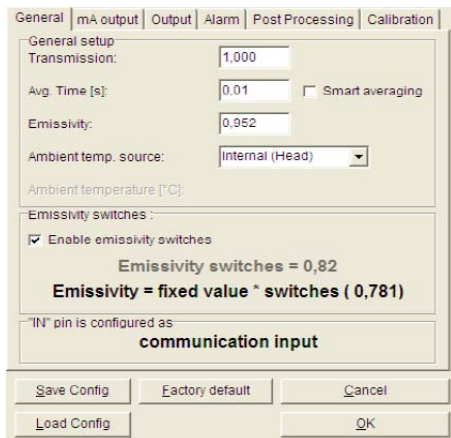The emissivity set in the software interacts as a factor to the emissivity set on the unit. Thus the adjustment range increases to 0.100 ... 1.199.

Example: $\varepsilon_{Software} = 0.952/ \varepsilon_{Sensor} = 0.82$ (S1 = 8/ S2 = 2)

Therefore the effective emissivity is: 0.781.

8.   Laser Sighting

The thermoMETER CSLaser has an integrated double laser aiming. Both of the laser beams are marking the exactly location and size of the measurement spot, independent from the distance. At the focus point of the according optics, see Chap. 4., both lasers are crossing and showing as one dot the minimum spot. This enables a perfect alignment of the sensor to the object.

⚠ CAUTION

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!

The supply line for the sighting laser must be led via a switch or button, which has to be installed max. 2 m away from installation site of the sensor.

The laser can be activated/ deactivated via this, by the user on site to be installed switch, or via the software.

At ambient temperatures > 50 °C the laser will switch off automatically.

During operation the pertinent regulations acc. to DIN EN 60825-1: 2007 on "radiation safety of laser equipment" must be fully observed at all times.

9. Instructions for Operation

9.1 Cleaning

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.

NOTICE

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

10.   CompactConnect Software

10.1   Installation

➡️ Insert the CompactConnect installation CD into the according drive on your computer.

If the auto run 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 CompactConnect software from your system, please use the `uninstall` icon in the start menu.

You will find detailed software manual on the CompactConnect CD.

10.2   System Requirements

- Windows XP, Windows Vista, Windows 7, 8 and 10
- At least 128 MByte RAM
- USB Interface
- CD-ROM drive
- Hard disc with at least 30 MByte free space

10.3   Main Features
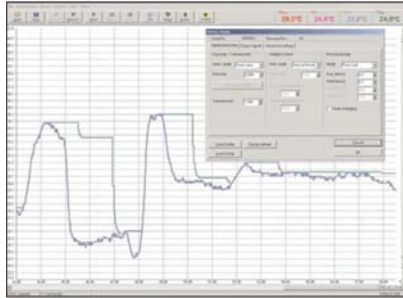
Fig. 10 Graphic display main features

- Graphical display for temperature measuring values 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

10.4   Communication Settings

10.4.1   Serial Interface

Baud rate:	9.6 kBaud
Data bits:	8
Parity:	none
Stop bits:	1
Flow control:	off

10.4.2   Protocol

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

To power the sensor the control signal DTR has to be set.

10.5   Digital Command Set

thermoMETER CSLaser commands							
Decimal	HEX	Binary / ASCII	Command	Data	Answer	Result	Unit
1	0x01	binary	READ Temp - Target	no	byte1byte2	= (byte1x256+byte2-1000)/10	
2	0x02	binary	READ Temp - Head	no	byte1byte2	= (byte1x256+byte2-1000)/10	°C
3	0x03	binary	READ actual Temp - Target	no	byte1byte2	= (byte1x256+byte2-1000)/10	°C
4	0x04	binary	READ Emissivity	no	byte1byte2	= (byte1x256+byte2)/1000	°C
5	0x05	binary	READ Transmission	no	byte1byte2	= (byte1x256+byte2)/1000	
9	0x09	binary	READ Processor Temperature	no	byte1	= (byte1x256+byte2)/1000	
14	0x0E	binary	READ Serial number	no	byte1byte2byte3	= (byte1x256+byte2-1000)/10	
15	0x0F	binary	READ FW Rev.	no	byte1byte2	= byte1x256+byte2	
16	0x10	binary	READ Laser status	no	byte1	0 = off/1 = on	
17	0x11	binary	READ Emissivity switch setting	no		HEX value (e.g. 0x58) = Switch setting (e.g. S1 = 5/S2 = 8 -> Eps. = 0.58)	
129	0x081	binary	SET DAC mA	byte1	byte1	byte1 = mAx10 (e.g. 4mA = 4x10 = 40)	°C
130	0x082	binary	RESET of DAC mA output				
132	0x084	binary	SET Emissivity	byte1byte2	byte1byte2	=(byte1x256+byte2)/ 1000	
133	0x085	binary	SET Transmission	byte1byte2	byte1byte2	=(byte1x256+byte2)/ 1000	
144	0x090	binary	SET Laser	byte1	byte1	0 = off/1 = on	

Temperature calculation at thermoMETER CSLaser: (byte1 x 256 +byte2 - 10000) / 100			
EXAMPLES (all bytes in HEX):			
Redout of object temperature			
Send	01	Command for readout of object temperature	
Receive	04 D3	Object temperature in tenth degree + 1000	04 D3 = dec. 1235 1235 - 1000 = 235 235 / 10 = 23.5 °C
Set of emissivity			
Send	84 03 B6		03B6 = dec. 950
Receive	03 B6		950 / 1000 = 0.950

11.   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 μm. The intensity of the emitted radiation depends on the material. This material contingent constant is described with the help of the emissivity (ε - Epsilon) which is a known value for most materials, see Chap. A 3, see Chap. A 4.

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
- Controller (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 Controller transforms the emitted infrared radiation into electrical signals.

12.   Emissivity

12.1   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.

12.2   Determination of Unknown Emissivity

- First of all, determine the current temperature of the measuring object with a thermocouple or contact sensor. The second step is to measure the temperature with the infrared thermometer and modify the emissivity until the displayed measuring value corresponds to the current temperature.
- If you monitor temperatures of up to 380 °C you may place a special plastic sticker (Part number: TM-ED-CT emissivity dots) 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.

- Cover 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.

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

12.3   Characteristic Emissivity

In the case that none of the methods mentioned above help to determine the emissivity you may use the emissivity tables, see Chap. A 3, see Chap. A 4. These are only average values. The actual emissivity of a material depends on the following factors:

- Temperature
- Measuring angle
- Geometry of the surface (smooth, convex, concave)
- Thickness of the material
- Constitution of the surface (polished, oxidized, rough, sandblast)
- Spectral range of the measurement
- Transmissivity (e.g. with thin films)

13.   Warranty

All components of the device have been checked and tested for perfect function in the factory. In the unlikely event that errors should occur despite our thorough quality control, this should be reported immediately to MICRO-EPSILON.

The warranty period lasts 12 months following the day of shipment. Defective parts, except wear parts, will be repaired or replaced free of charge within this period if you return the device free of cost to MICRO-EPSILON. This warranty does not apply to damage resulting from abuse of the equipment and devices, from forceful handling or installation of the devices or from repair or modifications performed by third parties.

No other claims, except as warranted, are accepted. The terms of the purchasing contract apply in full. MICRO-EPSILON will specifically not be responsible for eventual consequential damages. MICRO-EPSILON always strives to supply the customers with the finest and most advanced equipment. Development and refinement is therefore performed continuously and the right to design changes without prior notice is accordingly reserved.

For translations in other languages, the data and statements in the German language operation manual are to be taken as authoritative.

14.   Service, Repair

In the event of a defect on the sensor or the sensor cable please send us the affected parts for repair or exchange.

In the case of faults the cause of which is not clearly identifiable, the entire measuring system must be sent back to:

MICRO-EPSILON MESSTECHNIK
GmbH & Co. KG
Königbacher Str. 15
94496 Ortenburg / Germany

Tel. +49 (0) 8542/ 168-0
Fax +49 (0) 8542 / 168-90
info@micro-epsilon.de
www.micro-epsilon.com

For customers in USA applies:

Send the affected parts or the entire measuring system back to:

MICRO-EPSILON USA
8120 Brownleigh Dr.
Raleigh, NC 27617 /USA

Tel. +1 919 / 787-9707
Fax +1 919 / 787-9706
me-usa@micro-epsilon.com
www.micro-epsilon.com

For customers in Canada or South America applies:

Please contact your local distributor.

15.   Decommissioning, Disposal

➡ Disconnect the sensor cables.

➡ Do the disposal according to the legal regulations (see directive 2002/96/EC).

Appendix

A 1   Accessories

A 1.1   Mounting Brackets

Fig. 11 Mounting bracket, adjustable in one axis (TM-FB-CTL)

Dimensions in mm, not to scale

For an exact sensor alignment to the object please activate the integrated double laser, see Chap. 8.
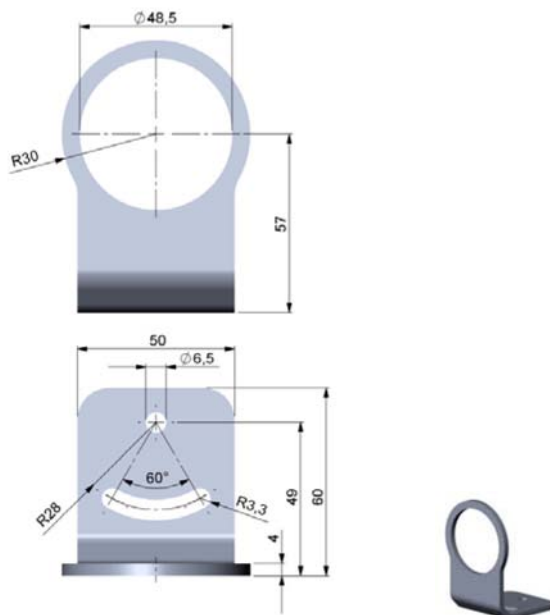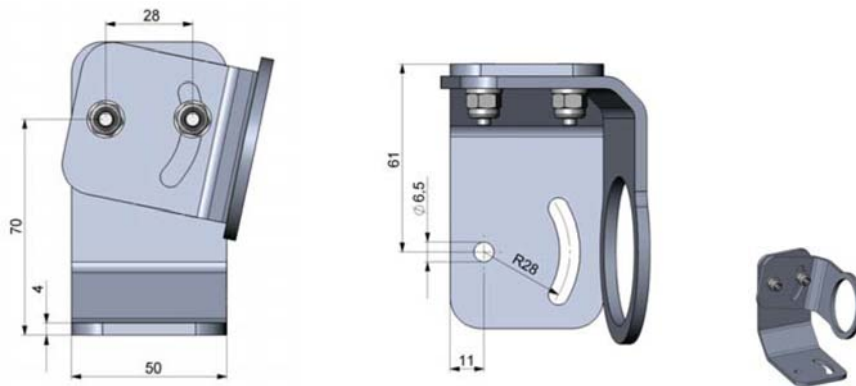
Fig. 12 Mounting bracket, adjustable in two axes (TM-AB-CTL)

Dimensions in mm, not to scale

For an exact sensor alignment to the object please activate the integrated double laser, see Chap. 8.

A 1.2 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.

i   Make sure to use oil-free, technically clean air, only.

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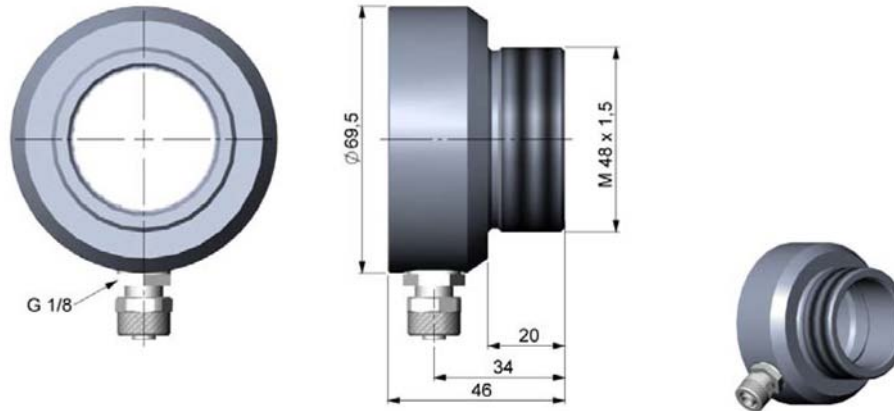

Fig. 13 Air purge collar (TM-AP-CTL), hose connection: 6x8 mm, thread (fitting): G 1/8 inch
Dimensions in mm, not to scale

A 1.3   Water Cooled Housing

The thermoMETER CSLaser can be used at ambient temperatures up to 85 °C without cooling. For applications, where the ambient temperature can reach higher values, the usage of the optional water cooled housing is recommended (operating temperature up to 175 °C). The sensor should be equipped with the optional high temperature cable (operating temperature up to 180 °C).

i   To avoid condensation on the optics an air purge collar, see Chap. A 1.2, is recommended.
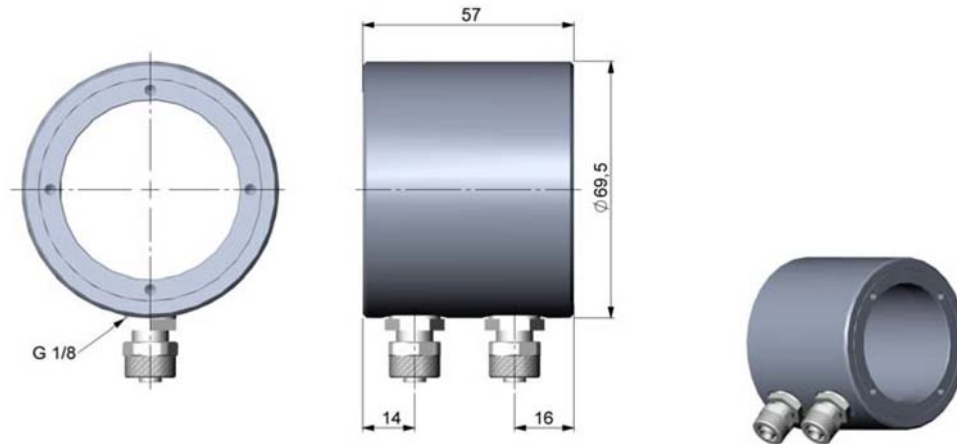

Fig. 14 Water cooled housing (TM-W-CTL), hose connection: 6x8 mm, thread (fitting): G 1/8 inch
Dimensions in mm, not to scale

A 2   Factory Settings

The devices have following precessing at time of delivery:

Models	SF	M-2H
Signal output object temperature	4 - 20 mA	
Emissivity (switches)	0.970	1.000
Emissivity (via software)	1.000	
Transmission	1.000	
Average time (AVG)	0.2 s	inactive
Smart Averaging	inactive	active
Peak hold (MAX)	inactive	
Valley hold (MIN)	inactive	
Lower limit temperature range	0	385
Upper limit temperature range	500	1600
Lower limit signal output	4 mA	
Upper limit signal output	20 mA	
Temperature unit	°C	
Ambient temperature compensation	internal sensor temperature probe	
Laser	inactive	

Smart Averaging means a dynamic average adaptation at high signal edges (activation via CompactConnect software only), see Chap. A 5.

A 3 Emissivity Table Metals

ℹ Please note that these are only approximate values, which were taken from various sources.

Material		Typical Emissivity			
Spectral response		1.0 μm	1.6 μm	5.1 μm	8 - 14 μm
Aluminum	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

Material		Typical Emissivity			
Spectral response		1.0 μm	1.6 μm	5.1 μm	8 - 14 μm
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
	Forget, 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
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

Material	Typical Emissivity			
Spectral response	1.0 μm	1.6 μm	5.1 μm	8 - 14 μm
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	0.9 - 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

A 4   Emissivity Table Non Metals

i   Please note that these are only approximate values which were taken from various sources.

Material		Typical Emissivity			
Spectral response		1.0 μm	2.2 μm	5.1 μm	8 - 14 μm
Asbest		0.9	0.8	0.9	0.95
Aphalt				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 - 0.9
Carborundum		0.4	0.8 - 0.95	0.8 - 0.95	0.95
Cement		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 alcaline				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	0.95

Material	Typical Emissivity			
Spectral response	1.0 μm	2.2 μm	5.1 μm	8 - 14 μm
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

A 5   Smart Averaging

The average function is generally used to smoothen the signal curves. 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.
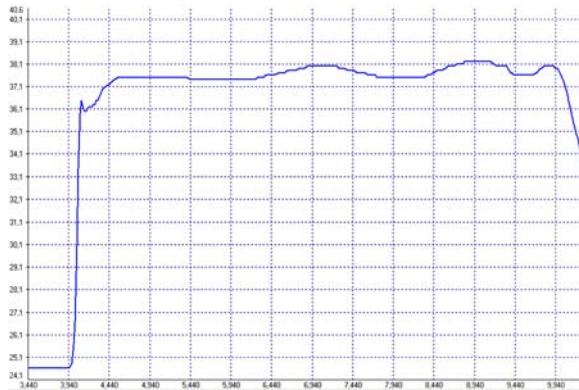

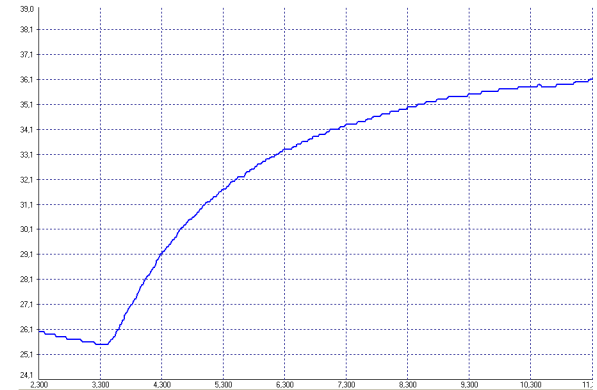*Fig. 15 Signal curve with Smart Averaging function*

Fig. 16 Signal curve without Smart Averaging function

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