

optris[®] CSmicro

LT/ 2WLT/ 2WLTH/ 2W2M/ 2WhsLT

Infrared Sensor



Operators manual

CentralAn 醇安
www.open17.com

 **optris**
infrared thermometers

CE-Conformity

The product complies with the following standards:

EMC:	EN 61326-1:2006 (Basic requirements) EN 61326-2-3:2006
Safety Regulations:	EN 61010-1:2001
Laser safety:	EN 60825-1:2007

The product accomplishes the requirements of the EMC Directive 2004/108/EG and of the Low Voltage Directive 2006/95/EG.



Optris GmbH
Ferdinand-Buisson-Str. 14
D – 13127 Berlin
GERMANY

Tel.: +49-30-500 197-0
Fax: +49-30-500 197-10

E-mail: info@optris.de
Internet: www.optris.com

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. 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 CSmicro 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 optris CSmicro is made of stainless steel (IP65/ NEMA-4 rating) – the sensor electronics is integrated inside the connection cable.

Scope of Supply

- CSmicro incl. connection cable
- 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 sensor, please contact our service department.

The sensors CSmicro are sensitive optical systems. Please use only the thread for mechanical installation. Avoid mechanical violence on the head – this may destroy the system (expiry of warranty).

Model Overview

The sensors of the CSmicro series are available in the following versions:

Series	Models	Measurement range	spectral response	Output/ Optics
LT	15	-40 to 1030 °C	8-14 µm	Voltage output 0-5/ 10 V/ 15:1 optics
	02	-40 to 1030 °C	8-14 µm	Voltage output 0-5/ 10 V/ 2:1 optics
2W	LT15	-40 to 1030 °C	8-14 µm	Two-wire sensor (4-20 mA)/ 15:1 optics
	LT15H	-40 to 1030 °C	8-14 µm	Two-wire sensor (4-20 mA)/ 15:1 optics/ max. ambient temperature 180 °C
	hsLT	-20 to 150 °C	8-14 µm	Two-wire sensor (4-20 mA)/ 15:1 optics/ Detection of smallest temperature differences (0,025 K)
	2M	385 to 1600 °C	1,6 µm	Two-wire sensor (4-20 mA)/ 75:1 optics

Factory Default Settings

The units have the following presetting at time of delivery:

	LT15/ LT02	2WLT15	2WLT15H	2W2M	2WhsLT
Temperature range:	0...350 °C	0...350 °C	0...500 °C	385...1600 °C	-20...150 °C
Output:	0...3,5 V	4...20 mA	4...20 mA	4...20 mA	4...20 mA
Emissivity:	0,950	0,950	0,950	1,000	0,950
Transmission:	1,000	1,000	1,000	1,000	1,000
Average time:	0,3 s	0,3 s	0,3 s	0,001 s	0,3 s
Smart averaging:	active	active	active	active	active
Smart Averaging hysteresis:	2 °C	2 °C	2 °C	2 °C	2 °C
Ambient temperature source:	internal (head)				
Status-LED function:	Self diagnostic				
Input (IN/ OUT/ green):	Communication input				
Output (OUT/ yellow):	mV output ----- Communication output -----				
Vcc adjust:	inactive				
Signal processing:	Hold mode: off				
Calibration:	Gain 1,000/ Offset 0,0				
Failsafe:	inactive				

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

For a usage of the CSmicro LT for online maintenance applications (in electrical cabinets e.g.) the following recommend settings are already included in the factory default setting (but not active):

OUT

At **3-state output** the following settings are default:

Pre-alarm difference: 2 °C
No alarm level: 8 V
Pre-alarm level: 5 V
Alarm level: 0 V
Service voltage: 10 V

IN/ OUT:

At **Alarm output (open collector)** the following settings are default:

Mode: normally closed
Temp code output: activated (for values above alarm level)
Range settings: 0 °C = 0 %/ 100 °C = 100 %

Vcc adjust:

If **activated** the following settings are default:

Output voltage range: 0-10 V
Difference mode: activated

Alarm level	Alarm value (IN/ OUT pin)	Vcc
1	40 °C	11 V
2	45 °C	12 V
3	50 °C	13 V
4	55 °C	14 V
5	60 °C	15 V
6	65 °C	16 V
7	70 °C	17 V
8	75 °C	18 V
9	80 °C	19 V
10	85 °C	20 V

Technical Data

General Specifications

Environmental rating	IP65 (NEMA-4)	
Ambient temperature	Sensing head:	see: Measurement Specifications
	Electronics (inside cable):	-20...80 °C [LT] -20...75 °C ¹⁾ [2W]
Storage temperature	-40...85 °C	
Relative humidity	10...95 %, non condensing	
Material	Stainless steel	
Dimensions	28 mm x 14 mm (head) [LT/ 2WLT15/ 2WLT15H/ 2W2M] 55 mm x 29,5 mm (head incl. massive housing) [2WwhsLT] 35 mm x 12 mm (electronics)	
Weight	42 g [LT/ 2WLT15/ 2WLT15H/ 2W2M] 200 g [2WwhsLT]	
Cable length	1 m standard/ 3,5 m optional [LT/ 2WLT15/ 2WLT15H/ 2W2M] 3,5 m [2WwhsLT]	
Position of electronics	50 cm after sensing head	
Cable diameter	2,8 mm (head – electronics) 4,3 mm (electronics – end of cable)	
Vibration	IEC 68-2-6: 3G, 11 – 200 Hz, any axis	
Shock	IEC 68-2-27: 50G, 11 ms, any axis	
Software (optional)	CompactConnect	

¹⁾ for Vcc (supply voltage) 5-12 VDC/ at Vcc > 12 VDC the max. ambient temperature of the electronics is 65 °C

Electrical Specifications

Used pin		Function	LT	2W
OUT	IN/ OUT			
x		Analog	0-5 V ¹⁾ or 0-10 V ²⁾ / scalable	4-20 mA/ scalable (current loop between Power and GND pin)
x		Alarm	output voltage adjustable; N/O or N/C	output current adjustable; N/O or N/C (current loop between Power and GND pin)
x		Alarm	3-state alarm output (three voltage level for no alarm, pre-alarm, alarm)	-
	x	Alarm	programmable open collector output [0-30 V DC/ 50 mA] ⁴⁾	programmable open collector output [0-30 V DC/ 500 mA]
	x	Temp. Code	Temp. Code Output (open collector) [0-30 V DC/ 50 mA] ⁴⁾	Temp. Code Output (open collector) [0-30 V DC/ 500 mA]
	x	Input	programmable functions: -external emissivity adjustment -ambient temperature compensation -triggered signal output and peak hold function ⁵⁾	programmable functions: -triggered signal output and peak hold function ⁵⁾
x	x	Serial digital ³⁾	uni- (burst mode) or bidirectional	uni- (burst mode) or bidirectional
Output impedances			min. 10 kΩ load impedance	max. 1000 Ω loop impedance
Current draw			9 mA	4-20 mA
Power supply			5...30 VDC	5...30 VDC

Status LED	green LED with programmable functions: <ul style="list-style-type: none">▪ alarm indication (threshold independent from alarm outputs)▪ automatic aiming support▪ self diagnostics▪ temperature code indication
Vcc adjust mode	10 adjustable emissivity and alarm values by variation of supply voltage/ Service mode for analog output [LT only]

¹⁾ 0...4,6 V at supply voltage 5 VDC; also valid for alarm output

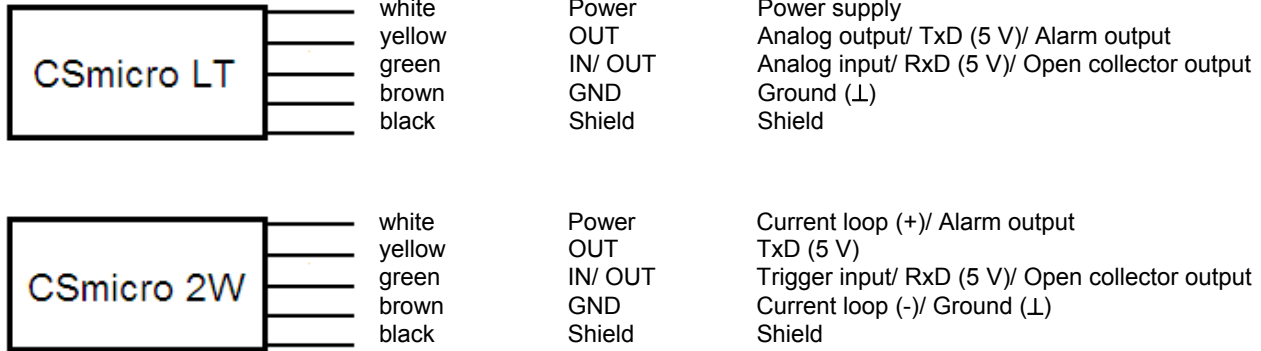
²⁾ only at supply voltage ≥ 11 V

³⁾ inverted RS232, TTL, 9,6 kBaud

⁴⁾ 500 mA if the mV output is not used

⁵⁾ High level: > 0,8 V/ Low level: < 0,8 V

Pin Configuration



You will find a detailed description of the different sensor connections in chapter ► **Electrical Installation**.

Measurement Specifications

	LT15/ LT02	2WLT15	2WLT15H
Temperature range IR (scalable via software)	-40...1030 °C	-40...1030 °C	-40...1030 °C
Ambient temperature (sensing head)	-20...120 °C	-20...120 °C	-20...180 °C
Spectral range	8...14 µm	8...14 µm	8...14 µm
Optical resolution	15:1/ 2:1	15:1	15:1
CF-lens (optional)	0,8 mm@ 10 mm/ 2,5 mm@ 23 mm	0,8 mm@ 10 mm	0,8 mm@ 10 mm
Accuracy ¹⁾	±1,5 °C or ±1,5 % ²⁾	±1,5 °C or ±1,0 % ²⁾	±1,5 °C or ±1,0 % ²⁾
Repeatability ¹⁾	±0,75 °C or ±0,75 % ²⁾	±0,75 °C or ±0,75 % ²⁾	±0,75 °C or ±0,75 % ²⁾
Temperature coefficient ³⁾	±0,05 K/ K or ±0,05 %/ K (whichever is greater)		
Temperature resolution	0,1 K	0,1 K	0,1 K
Response time	30 ms (90 % signal)	30 ms (90 % signal)	30 ms (90% signal)
Warm-up time	10 min	10 min	10 min
Emissivity/ Gain	0,100...1,100 (adjustable via software)		
Transmissivity	0,100...1,000 (adjustable via software)		
Interface (optional)	USB programming interface		
Signal processing	Average, Peak hold, Valley hold (adjustable via software)		

¹⁾ at ambient temperature 23±5 °C, whichever is greater; Epsilon = 1; Response time 1 s

²⁾ at object temperatures > 0 °C

³⁾ for ambient temperatures <18 °C and >28 °C

	2WhsLT	2W2M
Temperature range IR (scalable via software)	-20...150 °C	385...1600 °C
Ambient temperature (sensing head)	-20...75 °C	-20...125 °C
Spectral range	8-14 μm	1,6 μm
Optical resolution	15:1	75:1
Accuracy ¹⁾	±1 °C or ±1 % ³⁾	±(0,3 % of reading + 2 °C) ²⁾
Repeatability ¹⁾	±0,3 °C or ±0,3 % ³⁾	±(0,1 % of reading + 1 °C) ²⁾
Temperature coefficient ⁵⁾	±0,05 K/ K or ±0,05 %/ K (whichever is greater)	
Temperature resolution	0,025 K ³⁾⁴⁾	0,1 K
Response time	150 ms (90 % signal)	10 ms (95 % signal)
Warm-up time	10 min	-
Emissivity/ Gain	0,100...1,100 (adjustable via software)	
Transmissivity	0,100...1,000 (adjustable via software)	
Interface (optional)	USB programming interface	
Signal processing	Average, Peak hold, Valley hold (adjustable via software)	

¹⁾ at ambient temperature 23±5 °C; Epsilon = 1; Response time = 1 s

²⁾ at object temperatures > 450 °C

³⁾ at object temperatures > 20 °C

⁴⁾ at time constants > 0,2 s

⁵⁾ for ambient temperatures <18 °C and >28 °C

Optical Charts

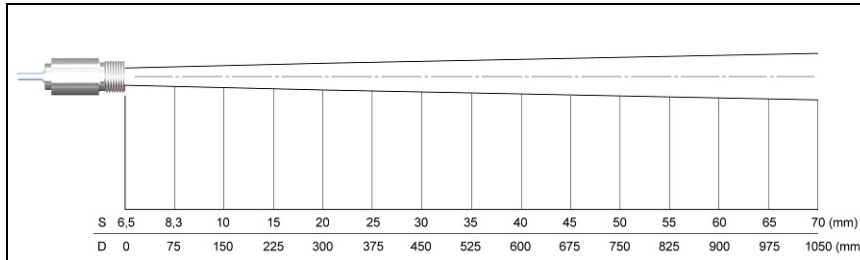
The following optical charts show the diameter of the measuring spot in dependence on the distance between measuring object and sensing head. The spot size refers to 90 % of the radiation energy. The distance is always measured from the front edge of the sensor housing/ CF-lens holder/ air purge.

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.

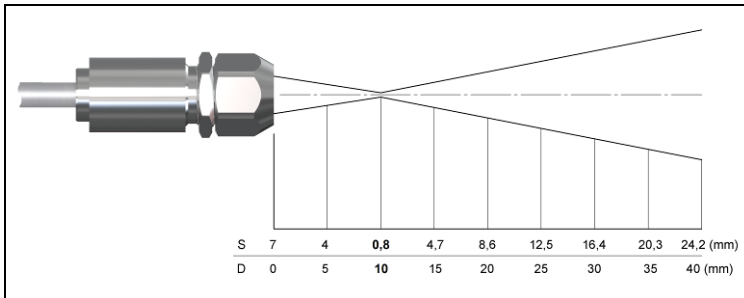
D = Distance from front of the sensing head to the object

S = Spot size

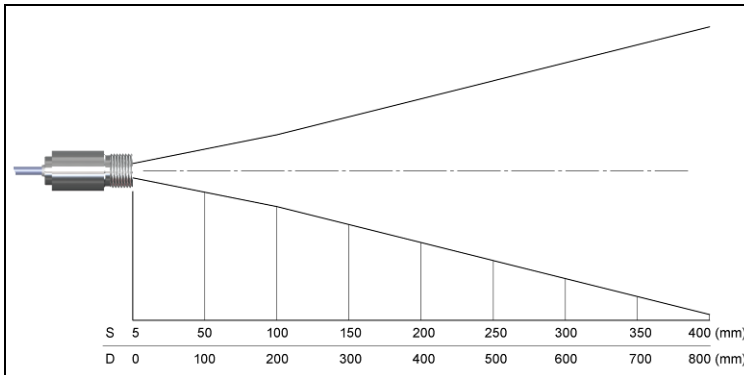
The D:S ratio is valid for the focus point.



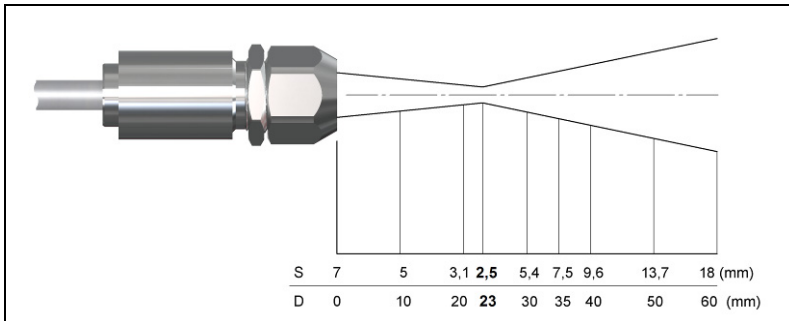
LT15/ 2WLT15/ 2WLT15H/ 2WhsLT D:S = 15:1



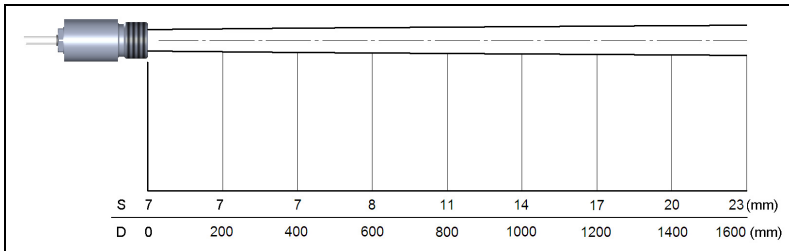
LT15/ 2WLT15/ 2WLT15H/ 2WhsLT with CF lens (0,8 mm@ 10 mm)



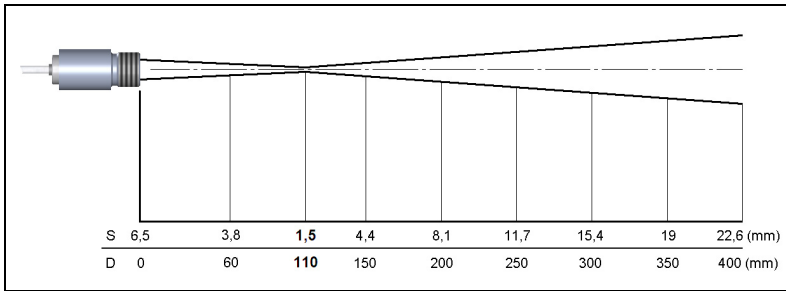
LT02 D:S = 2:1



LT02 with CF lens (2,5 mm@ 23 mm)



2W2M SF D:S = 75:1



2W2M CF D:S = 75:1/ D:S Far field = 14:1

If the CF lens (ACCTCFHT or ACCTCFHTE) is used in connection with 2W2M units (SF or CF optics) the focus is shifted to a distance of 11 mm.

CF Lens and Protective Window

The optional CF lens allows the measurement of very small objects. 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. The installation on the sensing head will be done by turning the CF lens until end stop. To combine it with the 2WhtLT model please use the version with external thread M12x1.

If the CF lens is used, the transmission has to be set to **0,78** [LT/ 2WLT].

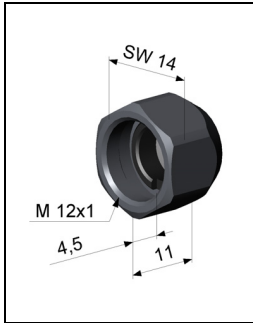
Versions Overview:

ACCTCF	CF lens for installation on sensing head [LT/ 2WLT]
ACCTCFHT	CF lens for installation on sensing head [2W2M]
ACCTCFE	CF lens with external thread for installation in massive housing [LT/ 2WLT]
ACCTCFHTE	CF lens with external thread for installation in massive housing [2W2M]

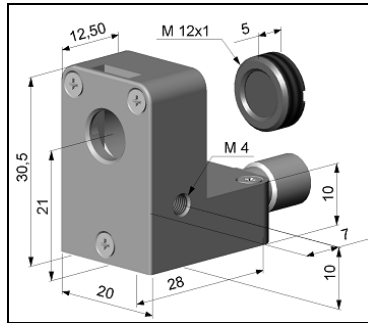
For protection of the sensing head optics a protective window is available. The mechanical dimensions are equal to the CF lens. It is available in the following versions:

ACCTPW	Protective window for installation on sensing head [LT/ 2WLT]
ACCTPWHT	Protective window for installation on sensing head [2W2M]
ACCTPWE	Protective window with external thread for installation in massive housing [LT/ 2WLT]
ACCTPWTE	Protective window with external thread for installation in massive housing [2W2M]

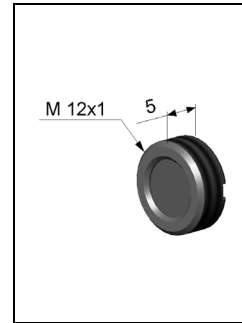
If the protective window is used, the transmission has to be set to **0,83** [LT/ 2WLT] or **0,93** [2W2M].



**CF lens:
ACCTCF/ ACCTCFHT
Protective window:
ACCTPW/ ACCTPWHT**



**Laminar air purge with integrated
CF lens:
ACCTAPLCF/ ACCTAPLCFHT**



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

To change the transmission value the optional USB-Kit (including software) is necessary.

LED Functions

The green LED can be programmed for the following functions. For the programming the **USB adapter cable incl. software (option)** is necessary. The factory default setting for the LED is self diagnostic.

LED Alarm	LED lights up if the object temperature exceeds or deceeds an alarm threshold
Automatic aiming support	Sighting feature for an accurate aiming of the CS to hot or cold objects
Self diagnostic	LED is indicating different states of the sensor
Temperature Code indication	Indication of the object temperature via the LED
Off	LED deactivated

Automatic Aiming Support

The automatic aiming support helps to adjust the unit to an object which has a temperature different to the background. If this function is activated via software the sensor is looking for the highest object temperature; means the threshold value for activating the LED will be automatically tuned.

This works also if the sensor is aimed at a new object (with probably colder temperature). After expiration of a certain reset time (default setting: 10s) the sensor will adjust the threshold level for activation of the LED new.

Self Diagnostic

With this function the current status of the sensor will be indicated by different flash modes of the LED.

If activated, the LED will show one out of five possible states of the sensor:

<u>Status</u>	<u>LED mode</u>	
Normal	intermittent off	- - - -
Sensor overheated	fast flash	-----
Out of measuring range	double flash	-- -- -- -- -- --
Not stable	intermittent on	====
Alarm fault	always on	=====

- Sensor overheated: The internal temperature probes have detected an invalid high internal temperature of the CSmicro.
- Out of measuring range: The object temperature is out of measuring range.
- Not stable: The internal temperature probes have detected an unequally internal temperature of the CSmicro.
- Alarm fault: Current through the switching transistor of the open-collector output is too high.

Temperature Code Indication

With this function the current measured object temperature will be indicated as percentage value by long and short flashing of the LED.

At a range setting of 0-100 °C → 0-100% the LED flashing indicates the temperature in °C.

Long flashing → first digit:	xx
Short flashing → second digit:	xx
10-times long flashing → first digit=0:	0x
10-times short flashing → second digit=0:	x0

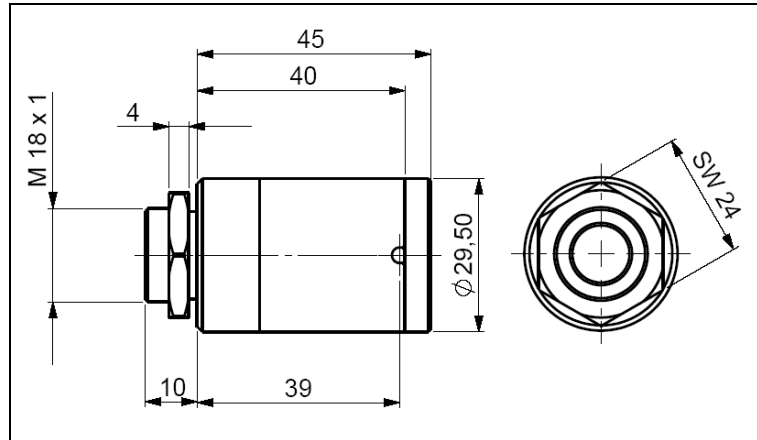
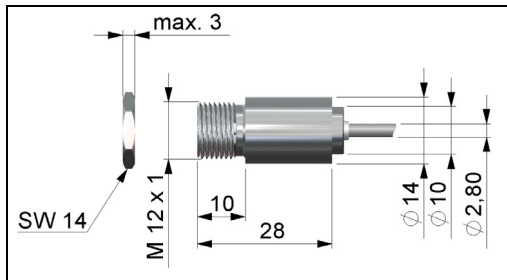
Examples

87 °C	8-times long flashing indicates	87
and afterwards	7-times short flashing indicates	87
31 °C	3-times long flashing indicates	31
and afterwards	1-time short flashing indicates	31
8 °C	10-times long flashing indicates	08
and afterwards	8-times short flashing indicates	08
20 °C	2-times long flashing indicates	20
and afterwards	10-times short flashing indicates	20

Mechanical Installation

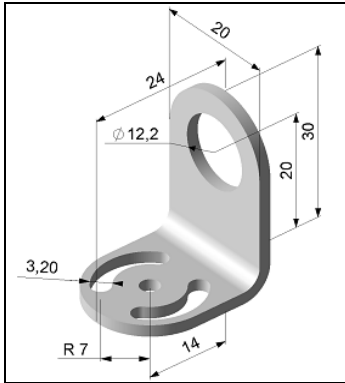
The CSmicro is equipped with a metric M12x1 thread and can be installed either directly via the sensor thread or with the help of the hex nut (standard) to the mounting bracket available. The CSmicro 2WhsLT will be delivered with the massive housing and can be installed via the M18x1-thread.

The sensors CSmicro are sensitive optical systems. Please use only the thread for mechanical installation. Avoid mechanical violence on the head – this may destroy the system (expiry of warranty).

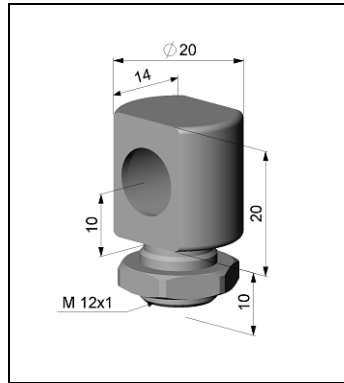


Sensing head [LT/ 2WLT15/ 2WLT15H/ 2W2M] **Sensing head [2WhsLT]**

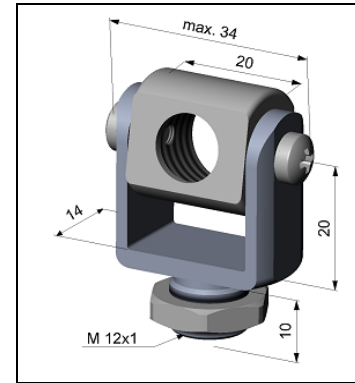
Mounting Accessories [LT/ 2WLT15/ 2WLT15H/ 2W2M]



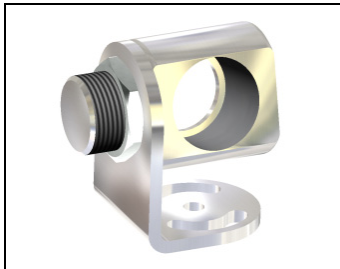
Mounting bracket, adjustable in one axis [ACCTFB]



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



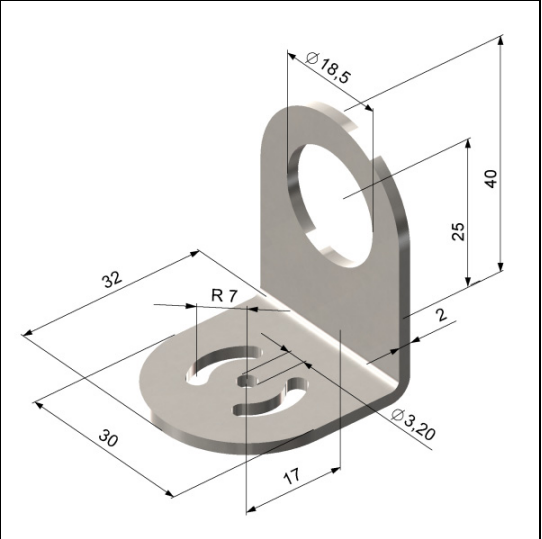
Mounting fork with M12x1 thread, adjustable in 2 axes [ACCTMG]



Mounting bracket, adjustable in two axes [ACCTAB]

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

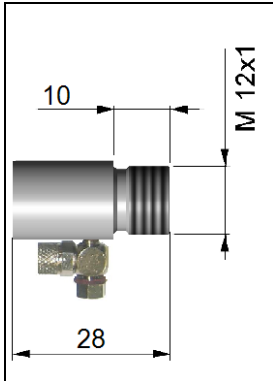
Mounting Accessories [2WhsLT]



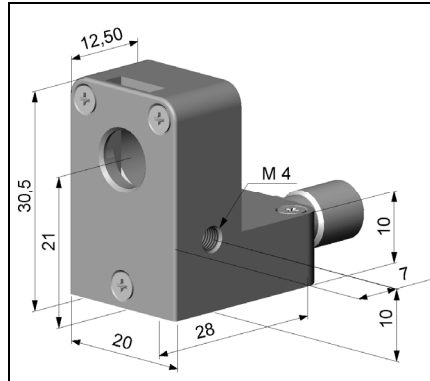
Mounting bracket, adjustable in one axis for 2WhsLT [ACCTFBMH]

Air Purge Collars [LT/ 2WLT15/ 2WLT15H/ 2W2M]

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;
fits to the mounting bracket;
hose connection: 3x5 mm
[ACCSAP]/ for heads with a
D:S ratio $\geq 10:1$



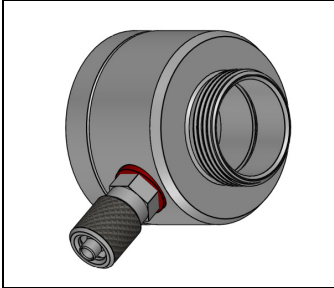
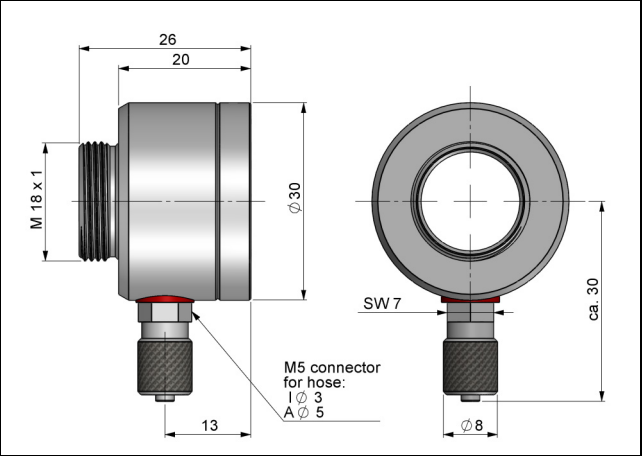
**Lamellar air purge collar – the sideward
air outlet prevents a cooling down of the object
in short distances; hose connection: 3x5 mm
[ACCTAPL]**



A combination of the
Lamellar air purge collar
with the bottom section of
the **Mounting fork** allows
an adjustment in two axes.
[ACCTAPL+ACCTMG]

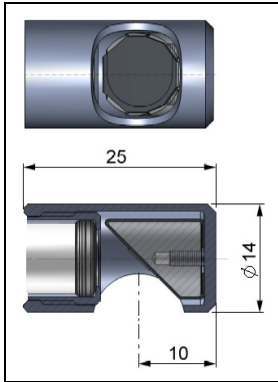
The needed amount of air (approx. 2...10 l/ min.) depends on the application and the installation conditions on-site.

Air Purge Collar [2WhsLT]



Air purge collar for 2WhsLT head [ACCTAPMH]

Further Accessories



Right angle mirror
Enables measurement
with 90° angle
[ACCTRAM]



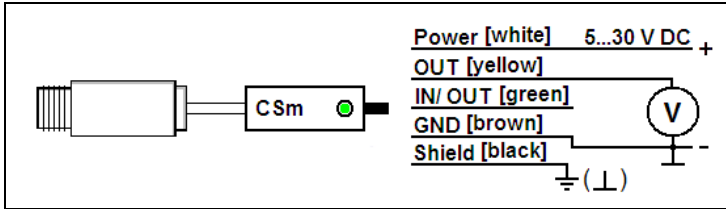
**USB-Kit: USB programming adaptor
incl. terminal block and software CD**
[ACCSUSBK]

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

Electrical Installation

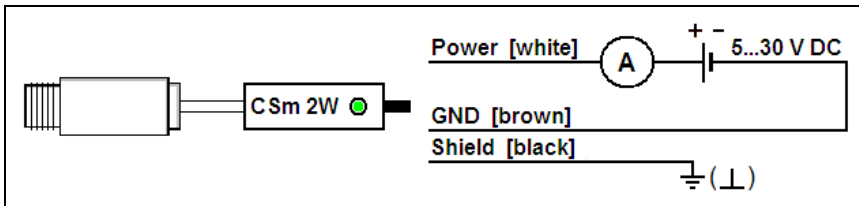
Analog Mode

CSmicro LT as analog device (mV output on OUT pin)



The output impedance must be $\geq 10\text{k}\Omega$.

CSmicro 2W as analog device (mA two-wire-output)



The maximum loop impedance is $1000\ \Omega$.

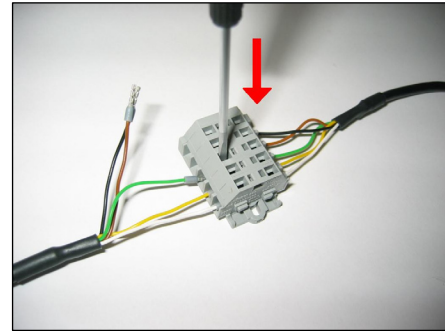
Maximum Loop Impedance [2W models]

The maximum impedance of the current loop depends on the supply voltage level:



Digital Mode

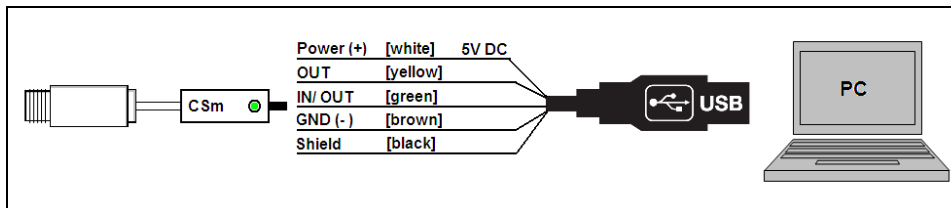
For a digital communication the optional USB programming kit is required. Please connect each wire of the USB adapter cable with the same coloured wire of the sensor cable by using the terminal block. Press with a screw driver as shown in the picture to loose a contact.



The sensor is offering two ways of digital communication:

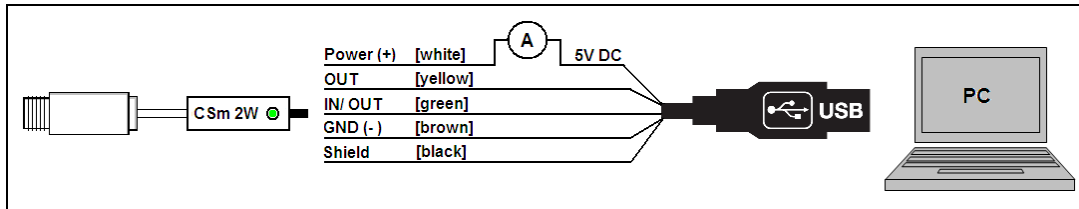
- bidirectional communication (sending and receiving data)
- unidirectional communication (burst mode – the sensor is sending data only)

Digital mode [LT]

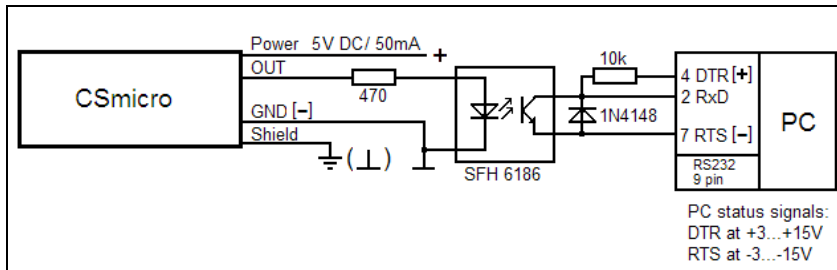


Analog + Digital mode combined [2W]

The two-wire models 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).



Direct connection to an RS232 interface on the computer [LT]

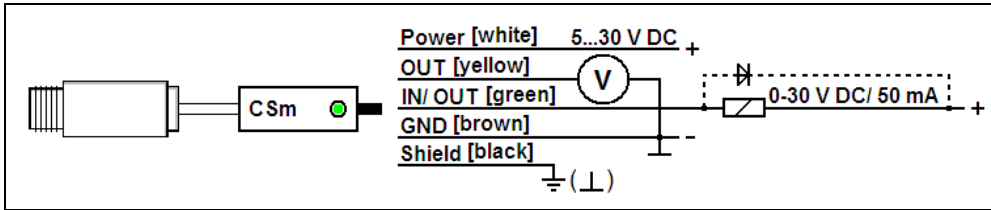


In the digital mode the sensor can be connected directly to a serial port (RS232) on your PC using this circuit.

This connection supports only the unidirectional communication mode.

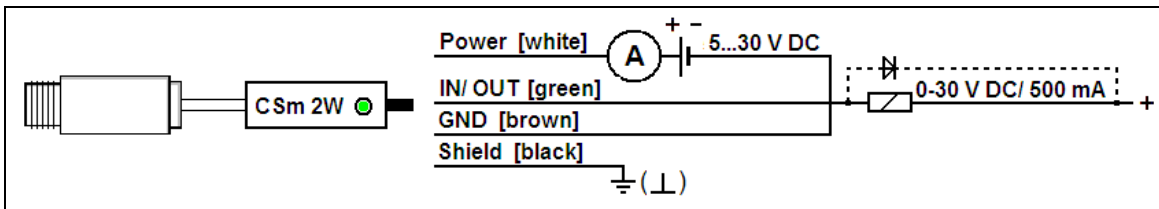
Alarm Output

Open collector output [LT]



The open collector output is an additional alarm output on the CSmicro and can control an external relay e.g. In addition the analog output can be used simultaneously.

Open collector output [2W]



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 setup.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:

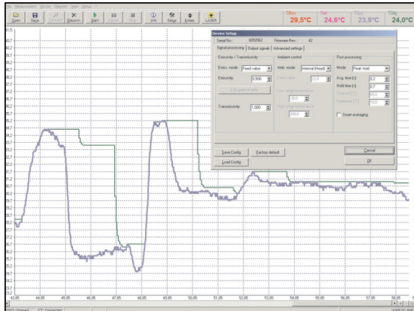
[Start]\Programs\CompactConnect.

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
- 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: 9600 baud
Data bits: 8
Parity: none
Stop bits: 1
Flow control: off

Protocol

All sensors of the CSmicro 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.

Digital Command Set [LT]

Communication mode (bidirectional)				
Read commands	Header bytes	Response	Conversion Response to Decimal value	Example
read process temperature ¹⁾	3E0200	word (hiByteLobyte)	process temp [°C] = (Hex ⇒ Dec(word)-1000)/10	[1]
read head temperature	3E0202	word (hiByteLobyte)	head temp [°C] = (Hex ⇒ Dec(word)-1000)/10	
read current target temperature ¹⁾	3E0204	word (hiByteLobyte)	current temp [°C] = (Hex ⇒ Dec(word)-1000)/10	
read current ambient temperature	3E0206	word (hiByteLobyte)	ambient temp [°C] = (Hex ⇒ Dec(word)-1000)/10	
read current emissivity	3E0208	word (hiByteLobyte)	emissivity = Hex ⇒ Dec(word)/1000	[2]
Set commands				
set emissivity	Header bytes	Set value	Generation of the set value	
set emissivity	3A0208	word (hiByteLobyte)	word = Dec ⇒ Hex (emissivity x 1000)	[3]
switch on loop maintenance mode	3D026190	-----	-----	[4]
set target temperature for maintenance	3A0212	word (hiByteLobyte)	word = Dec ⇒ Hex (target temperature [°C] x 10 +1000)	[5]
switch off loop maintenance mode	3D026180	-----	-----	[6]
Examples				
[1] read process temperature	Send	Receive	Comment	
[1] read process temperature	3E0200	0519	process temp [°C] = (Hex ⇒ Dec(0519)-1000)/10 = 30,5	
[2] read current emissivity	3E0208	036C	emissivity = (Hex ⇒ Dec(036C)/1000) = 0,876	
[3] set emissivity to 0,95	3A0208 03B6	-----	word = Dec ⇒ Hex(0,95 x 1000) = 03B6	
[4] switch on loop maintenance mode	3D026190	-----	-----	
[5] set analog output to 0 °C (permanent)	3A0212 03E8	-----	word = Dec ⇒ Hex (0 [°C] x 10 +1000) = 03E8	
[5] set analog output to 200 °C (permanent)	3A0212 0BB8	-----	word = Dec ⇒ Hex (200 [°C] x 10 +1000) = 0BB8	
[6] return to standard mode	3D026180	-----	-----	
¹⁾ if peak/ valley hold is activated the "process temperature" holds the detected peak or valley whereas the "current target temperature" shows the real process temperature (without post processing); in standard mode "process temperature" and "current ta				
Burstmode (unidirectional)				
After switch on a continuous serial signal will be created. The burst string can be configured with CompactConnect software.				
Burst string	Example	Complete burst string	Conversion to Decimal value	
2 synchronisation bytes: AAAA	-----		-----	
2 bytes for each output value (hi lo)	03B8	AAAA 03B8	process temp [°C] = (Hex ⇒ Dec(03B8)-1000)/10 = -4,8	

Digital Command Set [2W]

Commands CSmicro 2W/ 2Whs/ CX							
Decimal	HEX	Binary/ ASCII	Command	Data	Answer	Result	Unit
1	0x01	binary	READ Temp - Target	keine	byte1 byte2	= (byte1 x 256 + byte2 - 1000) / 10	°C
2	0x02	binary	READ Temp - Head	keine	byte1 byte2	= (byte1 x 256 + byte2 - 1000) / 10	°C
3	0x03	binary	READ current Temp - Target	keine	byte1 byte2	= (byte1 x 256 + byte2 - 1000) / 10	°C
4	0x04	binary	READ Emissivity	keine	byte1 byte2	= (byte1 x 256 + byte2) / 1000	
5	0x05	binary	READ Transmission	keine	byte1 byte2	= (byte1 x 256 + byte2) / 1000	
9	0x09	binary	READ Processor Temperature	keine	byte1	= (byte1 x 256 + byte2 - 1000) / 10	
14	0x0E	binary	READ Serial number	keine	byte1 byte2 byte3	= byte1 x 65536 + byte2 x 256 + byte3	
15	0x0F	binary	READ FW Rev.	keine	byte1 byte2	= byte1 x 256 + byte2	
129	0x81	binary	SET DAC mA	byte1	byte1	byte 1= mA x 10 (z.B. 4mA = 4 x 10=40)	°C
130	0x82	binary	RESET of DAC mA output				
132	0x84	binary	SET Emissivity	byte1 byte2	byte1 byte2	= (byte1 x 256 + byte2) / 1000	
133	0x85	binary	SET Transmission	byte1 byte2	byte1 byte2	= (byte1 x 256 + byte2) / 1000	

Temperature calculation at CSmicro hs: $(\text{byte1} \times 256 + \text{byte2} - 10000) / 100$

EXAMPLES (all bytes in HEX)

Readout 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**

Readout of object temperature (at CSmicro 2Whs)

Send: 01 Command for readout of object temperature
 Receive: 30 3E Object temperature in hundredth degree + 10000

30 3E = dec. 12350
 12350 - 10000 = 2350
 2350 / 100 = 23.50 °C

Set of emissivity

Send: 84 03 B6
 Receive: 03 B6

03B6 = dec. 950
 950 / 1000 = **0,950**

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 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.

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			
		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

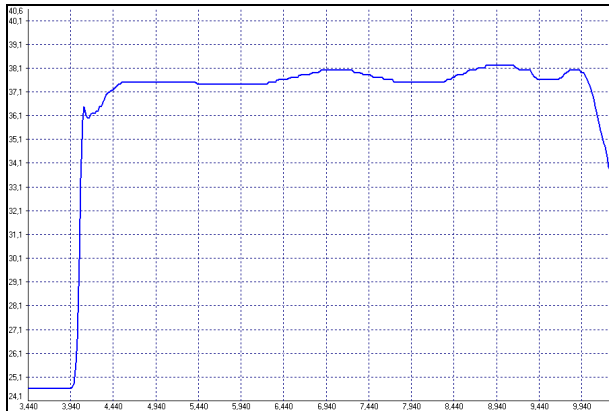
Appendix B – Emissivity Table Non Metals

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

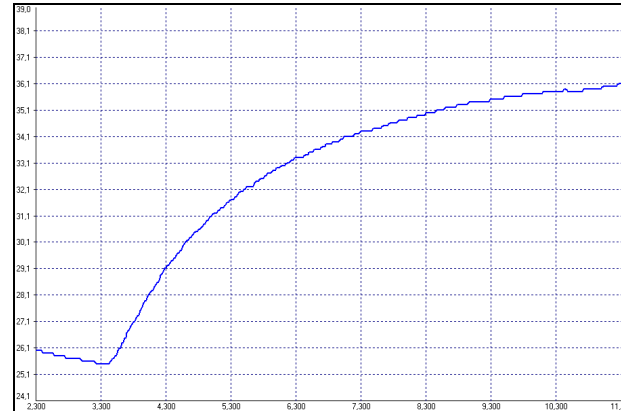
Appendix C – Smart Averaging

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