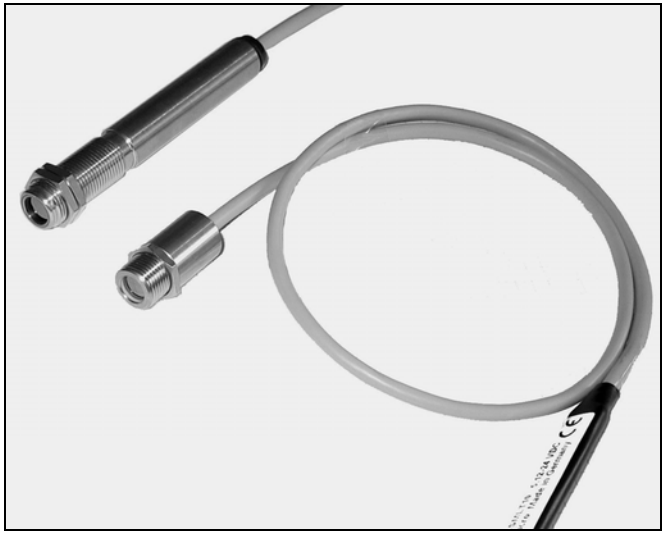
optris® CS/ CSmicro

Infrared Sensor



Operators manual

optris
infrared thermometers

CE-Conformity

The product complies with the following standards:

EMC: EN 61326-1
Safety Regulations: EN 61010-1:1993/ A2:1995

The product accomplishes the requirements of the EMC Directive 89/336/EEC and of the low-voltage directive 73/23/EEC.

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

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.

Content

	Page		Page
Description	**3**	**Basics of Infrared Thermometry**	**19**
Scope of Supply	3	**Emissivity**	**20**
Maintenance	3	Definition	20
Cautions	4	Determination of unknown Emissivities	20
Factory Default Settings	4	Characteristic Emissivities	21
Technical Data	**5**	**Appendix A – Emissivity Table Metals**	**22**
General Specifications	5	**Appendix B – Emissivity Table Non Metals**	**23**
Electrical Specifications	6		
Measurement Specifications	7		
Optical Charts	8		
Close Focus Optics	9		
Installation	**10**		
Mechanical Installation	10		
Mounting Accessories	11		
Air Purge Collars	12		
Further Accessories	13		
Electrical Installation	14		
Software CompactConnect	**17**		
Command List	**18**		

Description

The sensors of the optris CS and 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 CS is made of stainless steel (IP65/ NEMA-4 rating) and contains the complete sensor electronics. The sensing head of the optris CSmicro is also made of stainless steel (IP65/ NEMA-4 rating) – the sensor electronics is part of the connection cable in that case.
Both of the sensors have a fixed mounted connection cable.

The sensors CS/ 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).

Scope of Supply

- CS/ CSmicro incl. connection cable, mounting nut and 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 static electricity, arc welders, and induction heaters. Keep away from very strong EMF (electromagnetic fields). Avoid abrupt changes of the ambient temperature.
In case of problems or questions which may arise when you use the CS/ CSmicro, please contact our service department. The customer service staff will support you with questions concerning the optimization of the work with the infrared thermometer, calibration procedures or with repairs.

Factory Default Settings

The unit has the following presetting at time of delivery:

Temperature range:	**0...350 °C**
Output voltage:	**0...3,5 V**
Emissivity:	**0,950**
Transmission:	**1,000**
Average time:	**0,09 s**
Smart averaging:	**active**
Ambient temperature source:	**Head temperature**

If the unit is supplied together with the USB-kit (optional) the output will be set to digital communication (bidirectional).

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.

Technical Data

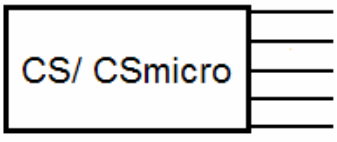
General Specifications

	CS	CSmicro
Environmental rating	IP65 (NEMA-4)	IP65 (NEMA-4)
Ambient temperature	-20...75 °C	-20...125 °C (sensing head) -20...75 °C (electronic in cable)
Storage temperature	-40...85 °C	-40...85 °C
Relative humidity	10...95 %, non condensing	10...95 %, non condensing
Material	stainless steel	stainless steel
Dimensions	M12x1, 85 mm long	28 mm x 14 mm (head)/ 70 mm x 12 mm (electronic)
Weight	58 g	42 g
Cable length	1 m (standard), 3 m, 8 m, 15 m	1 m (50 cm between head and electronics)
Cable diameter	4,3 mm	2,8 mm (head-electronic)/ 4,3 mm (electronic-end of cable)
Vibration	IEC 68-2-6: 3G, 11 – 200 Hz, any axis	IEC 68-2-6: 3G, 11 – 200 Hz, any axis
Shock	IEC 68-2-27: 50G, 11 ms, any axis	IEC 68-2-27: 50G, 11 ms, any axis
EMI	89/336/EWG	89/336/EWG

Electrical Specifications

	CS	CSmicro
Output [used pin]	only alternatively selectable	
Analog [OUT]	0-5 V[1] or 0-10 V[2]/ scalable	0-5 V[1] or 0-10 V[2]/ scalable
Serial digital[3] [OUT+IN]	uni- (burst mode) or bidirectional	uni- (burst mode) or bidirectional
Alarm [OUT]	output voltage adjustable; N/O or N/C	output voltage adjustable; N/O or N/C
Additional features	LED alarm indication/ LED aiming support	Programmable open collector output 24 VDC/ 50 mA [IN pin]
Output impedances	min. 10 kΩ load impedance	min. 10 kΩ load impedance
Input	programmable functional input on green IN pin for: ▪ external emissivity adjustment [0 V ► ε=0,1 | 5 V ► ε=1,1] ▪ ambient temperature compensation [0 V ► -20 °C | 5 V ► 350 °C] ▪ trigger (reset of hold functions) [5V at IN pin resets the selected hold function]	
Current draw	9 mA (12...28 VDC)/ 15 mA (5 VDC)	9 mA
Power supply	5...7 VDC or 12...28 VDC	5...28 VDC

[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



white	PS	Power supply
yellow	OUT	Analog output/ TxD (5 V)/ Alarm output
green	IN	Analog input/ RxD (5 V)/ Open collector output (CSmicro only)
brown	GND	Ground (⊥)
black	Shield	

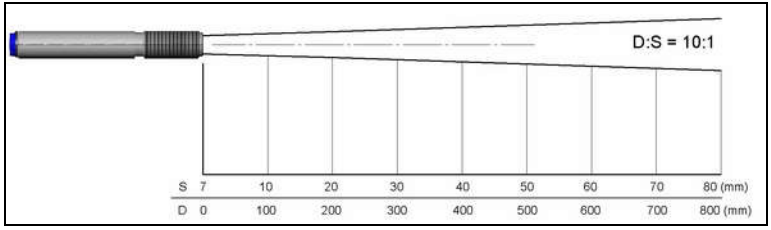
Measurement Specifications

Temperature range IR	-20...350 °C (scalable via software)
Spectral range	8...14 μm
Optical resolution	10:1
CF-lens (optional)	1,2 mm@ 10 mm
Accuracy[1)]	±1,5 °C or ±1,5 % of reading
Repeatability[1)]	±0,75 °C or ±0,75 % of reading
Temperature resolution[2)]	0,2 °C (NETD)
Response time	30 ms...2 s (95 % signal/ adjustable via software)
Warm-up time	10 min
Emissivity/ Gain	0,100...1,100 (adjustable via 0-5 VDC input or software)
Transmissivity	0,100...1,000 (adjustable via software)
Interface (optional)	USB programming interface
Signal processing	Average, Peak hold, Valley hold (adjustable via software)
Software (optional)	CompactConnect

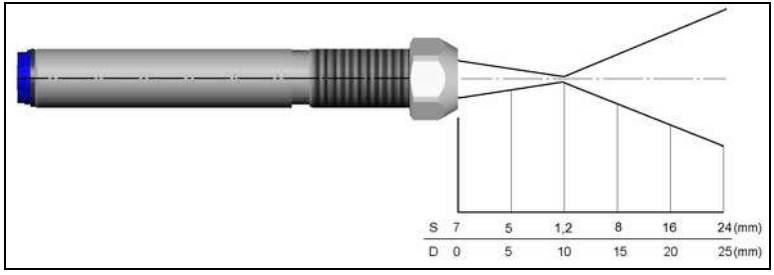
[1)] at ambient temperature 23±5 °C; whichever is greater
[2)] NETD at object temperatures >20 °C and time constant >0,2 s

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.



Optical chart CS/ CSmicro (10:1)

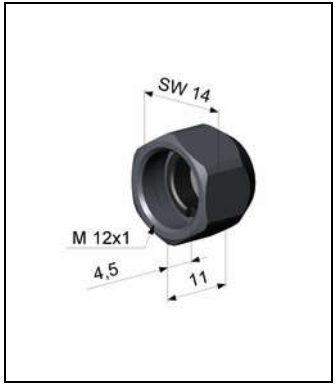


Optical chart CS/ CSmicro with CF-lens (1,2 mm@ 10 mm)

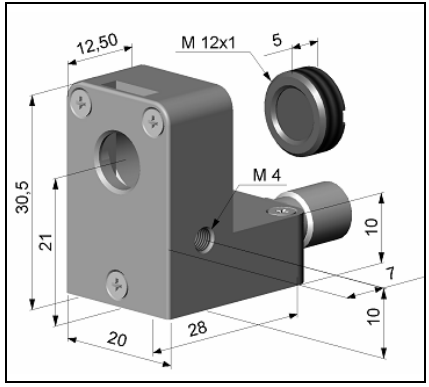
The size of the measuring object and the optical resolution of the infrared thermometer determine the maximum distance between sensing head and measuring object.
In order to prevent measuring errors the object should fill out the field of view of the optics completely.
Consequently, the spot should at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

Close Focus Optics

The optional CF-lens allows the measurement of small objects. The CF optics can also be combined with a laminar air purge:



CF-lens [ACCTCF]



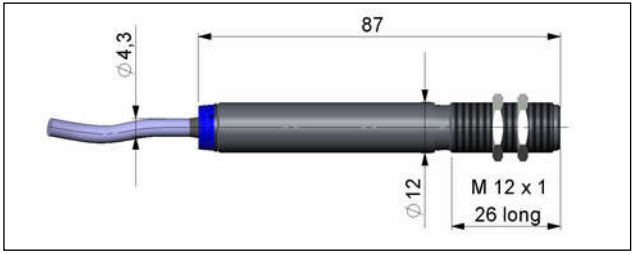
Laminar air purge with integrated CF-lens [ACCTAPLCF]

If the CF-lens is used, the transmission has to be set to 0,78.
To change this value the optional USB-Kit (including CompactConnect software) is necessary.

Installation

Mechanical Installation

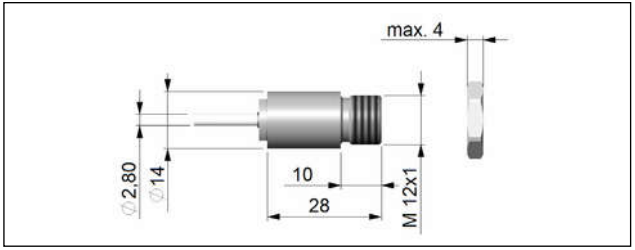
The **CS** is equipped with a metric M12x1 thread and can be installed either directly via the sensor thread or with the help of the both hex nuts (standard) to the mounting bracket available.



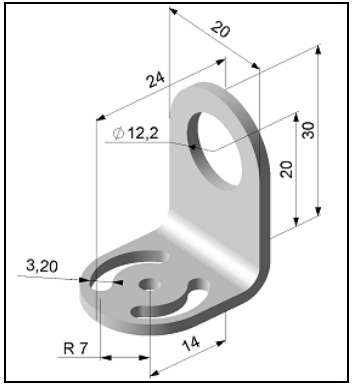
The LED aiming support helps to adjust the unit to an object which has a temperature different to the background. For this reason it might be necessary to adjust the alarm value with the CompactConnect software. With the factory default setting (alarm value: 100 °C) the LED (ring at the junction sensor housing – cable) will give blue light when the unit aims at a target with a temperature >100 °C.

The **CSmicro** is also 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.

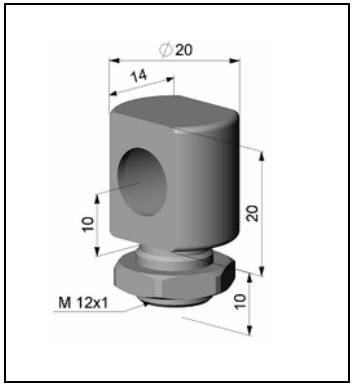
Various mounting accessories, fitting both CS and CSmicro, can be ordered additionally.



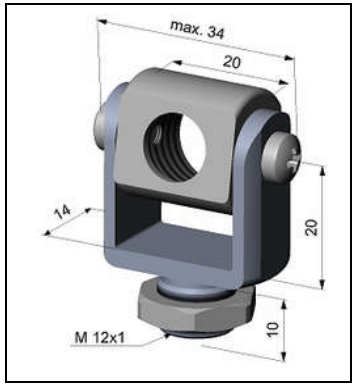
Mounting Accessories



Mounting bracket, adjustable in one axis [ACCTFB]



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



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

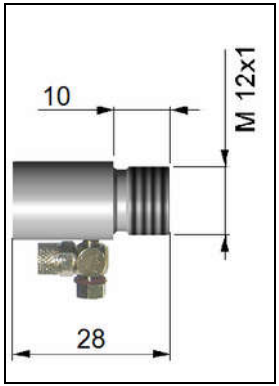


Mounting bracket, adjustable in two axes [ACCTAB]

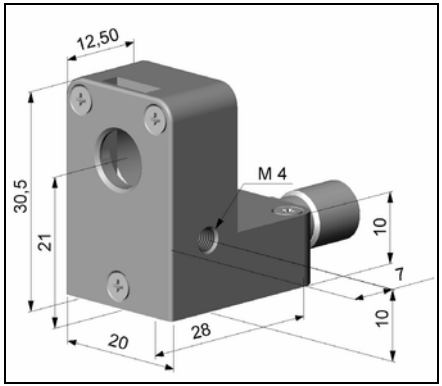
The **Mounting fork** can be combined with the **Mounting bracket [ACCTFB]** using the M12x1 thread.

Air Purge Collars

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



Standard air purge collar; fits to the mounting bracket; hose connection: 3x5 mm [ACCSAP]



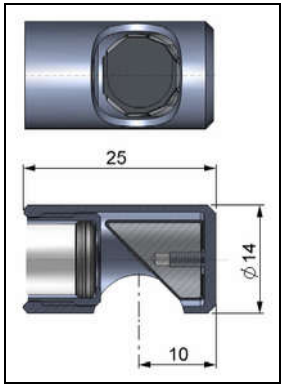
Laminar air purge collar – the side air outlet prevents a cooling down of the object in short distances; hose connection: 3x5 mm [ACCTAPL]



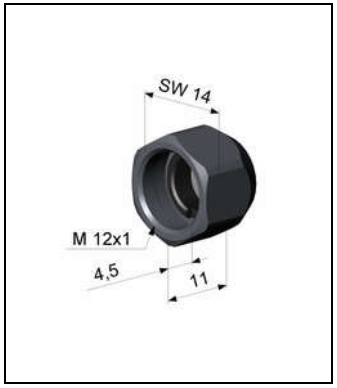
A combination of the **Laminar air purge collar** with the bottom section of the **Mounting fork** allows an adjustment in two axes. [ACCTAPL+ACCTMG]

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

Further Accessories



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



Protective window
same mechanical size
as CF lens
[ACCTPW]



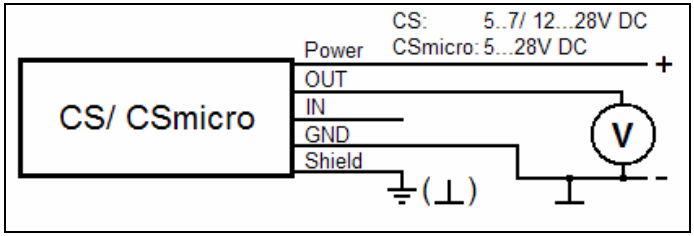
USB-Kit: USB programming adaptor
incl. terminal block and software CD
[ACCSUSBK]

If the protective window is used, the transmission has to be set to **0,83**.
To change this value the optional USB-Kit (including CompactConnect software) is necessary.

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

Electrical Installation

Analog device (mV output on OUT pin)

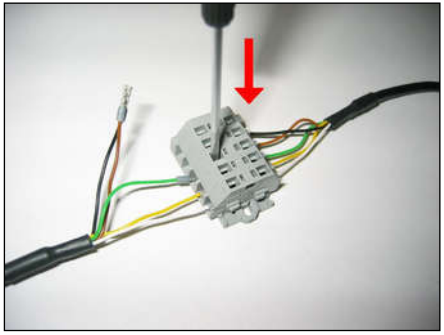


Wire colors	
Power	white
OUT	yellow
IN	green
GND	brown
Shield	black

The output impedance must be ≥ 10kΩ.

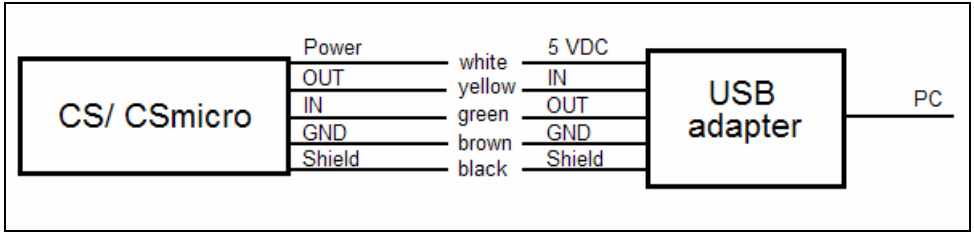
Digital communication

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.

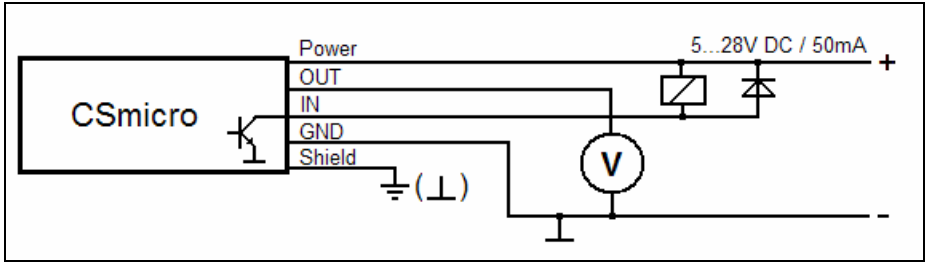


The sensor is offering two ways of digital communication:

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

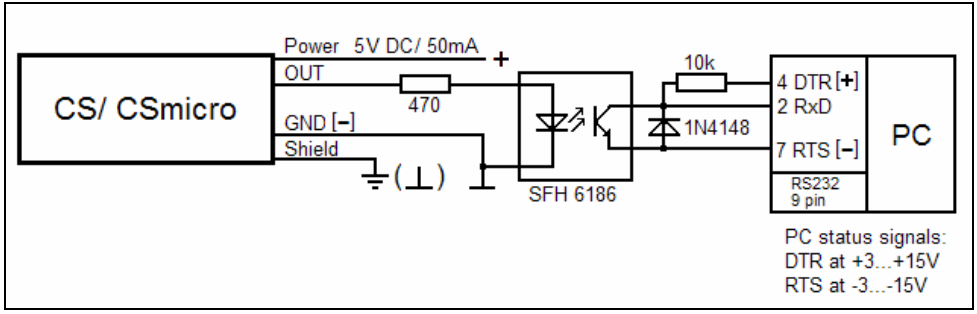


Open collector output (CSmicro only)



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

Direct connection to an RS232 interface on the computer



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.

Software CompactConnect

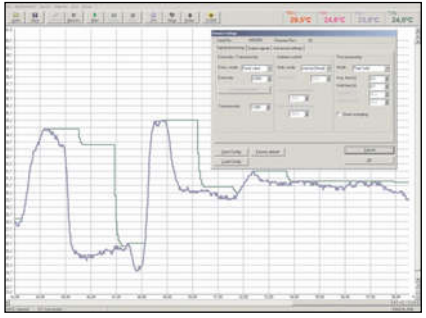
Installation

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.

System requirements:
- **Windows XP**
- **USB interface**
- **Hard disc with at least 30 MByte free space**
- **At least 128 MByte RAM**
- **CD-ROM drive**

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.

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

Command List (also available on CD CompactConnect)

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	**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	**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 target temperature" are the same				
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**	

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 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.

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
Aluminium	non oxidized	0,02-0,1
	polished	0,02-0,1
	roughened	0,1-0,3
	oxidized	0,2-0,4
Brass	polished	0,01-0,05
	roughened	0,3
	oxidized	0,5
Copper	polished	0,03
	roughened	0,05-0,1
	oxidized	0,4-0,8
Chrome		0,02-0,2
Gold		0,01-0,1
Haynes	alloy	0,3-0,8
Inconel	electro polished	0,15
	sandblast	0,3-0,6
	oxidized	0,7-0,95
Iron	non oxidized	0,05-0,2
	rusted	0,5-0,7
	oxidized	0,5-0,9
	forged, blunt	0,9
Iron, casted	non oxidized	0,2
	oxidized	0,6-0,95
Lead	polished	0,05-0,1

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

Appendix B – Emissivity Table Non Metals

Material		typical Emissivity
Asbestos		0,95
Asphalt		0,95
Basalt		0,7
Carbon	non oxidized	0,8-0,9
	graphite	0,7-0,8
Carborundum		0,9
Ceramic		0,95
Concrete		0,95
Glass		0,85
Grit		0,95
Gypsum		0,8-0,95
Ice		0,98
Limestone		0,98
Paint	non alkaline	0,9-0,95
Paper	any color	0,95
Plastic $>50\,\mu m$	non transparent	0,95
Rubber		0,95
Sand		0,9
Snow		0,9
Soil		0,9-0,98
Textiles		0,95
Water		0,93
Wood	natural	0,9-0,95