



Instruction Manual
thermoMETER CSVideo

CSVM-2L
CSVM-2H

Infrared sensor

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Certified acc. to DIN EN ISO 9001: 2008

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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:



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



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



Indicates a user action.



Indicates a user tip.

Measure

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

1.2 Warnings



Connect the power supply and the display/output device in accordance with the safety regulations for electrical equipment.

- > Danger of injury
- > Damage to or destruction of the infrared sensor



Avoid shock and vibration to the infrared sensor.

- > Damage to or destruction of the infrared sensor

The power supply must not exceed the specified limits.

- > Damage to or destruction of the infrared sensor

Protect the USB cable against damage.

- > Damage to the infrared 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 infrared sensor

Avoid static electricity, arc welders and induction heaters. Keep away from very strong EMF (electromagnetic fields).
> Damage to or destruction of the infrared sensor

Avoid abrupt changes in operating temperature.
> Faulty measurement

Avoid that the measurement object fills the field of optics completely.
> Faulty measurement

Never connect a supply voltage.
> Destruction of the output

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

1.3 Notes on CE Identification

The following applies to the thermoMETER CSVideo:

- EU directive 2004/108/EC
- EU directive 2011/65/EC, "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 of the standards

- EN 61326-1: 2006
- EN 61326-2-3: 2006
- EN 61010-1: 2001

The system satisfies the requirements if they comply with the regulations described in the instruction manual for installation and operation.

1.4 Proper Use

- The thermoMETER CSVideo 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:
 - Sensor: -20 ... 70 °C (-4 ... +158 °F) ¹
 - Controller: 0 ... 85 °C (+32 ... +185 °F)
 - Cable sensor - controller: max. 80 °C (+176 °F) ²
- Storage temperature: -40 ... 85 °C (-40 ... +185 °F)
- Humidity: 10 - 95 %, non-condensing
- EMC acc. to: EN 61326-1: 2006
EN 61326-2-3: 2006
EN 61010-1: 2001

NOTICE

Avoid abrupt changes in operating temperature.
> Faulty measurement

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

2) Optional: High temperature cable: 180 °C (+356 °F), see Chap. A 1.4

2. Technical Data

2.1 Functional Principle

The sensors of the thermoMETER CSVideo are noncontact infrared temperature sensors.

They calculate the surface temperature based on the emitted infrared energy of objects, see Chap. 10.. The alignment of the sensor can be done with the integrated video sighting and crosshair laser aiming.

The sensor housing of the thermoMETER CSVideo sensor is made of stainless steel (IP 65/ NEMA-4 rating) – the controller is placed in a separate box made of die casting zinc.

• **i** The thermoMETER CSVideo sensor is a sensitive optical system. Please use only the thread for mechanical installation.

NOTICE

Avoid mechanical violence on the sensor.

> Destruction of the system

2.2 Sensor Models

Model	Measuring range	Spectral response	Typical applications
CSVM-2L	250 up to 800 °C	1.6 μ m	Metals and ceramic surfaces
CSVM-2H	385 up to 1600 °C		

2.3 General Specification

	Sensor
Protection class	IP 65
Operating temperature ¹	-20 ... 70 °C
Storage temperature	-40 ... 85 °C
Relative humidity	10 ... 95 %, non condensing
Material	Stainless steel
Dimensions	118.5 mm x 50 mm, M48x1.5
Weight	600 g
Cable length	analog and alarm
	USB
	3 m, 5 m, 10 m
	5 m (inclusive), 10 m, 20 m
Cable diameter	5 mm
Operating temperature cable	max. 80 °C ²
Vibration	IEC 68-2-6: 3 G, 11 – 200 Hz, any axis
Shock	IEC 68-2-27: 50 G, 11 ms, any axis
Software	inclusive

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

2) Optional: high temperature cable: 180 °C, see Chap. [A 1.4](#)

2.4 Electrical Specification

Power supply	5 - 28 VDC
Current draw (laser)	45 mA @ 5 V
	20 mA @ 12 V
	12 mA @ 24 V
Aiming laser	Crosshair laser, 635 nm, 1 mW, On/Off via external switch (needs to be installed by user before start-up) or software
Video sighting	Digital (USB 2.0), 640 x 480 px, FOV 3.1 ° x 2.4 °
Output/ analog	4 – 20 mA current loop
Alarm output	Programmable open collector output at RxD pin (0 - 30 V/ 500 mA)
Output impedances	max. loop resistance 1000 Ω (in dependence on supply voltage)
Output digital	USB 2.0

2.5 Measurement Specification

Model	CSVM-2L	CSVM-2H
Temperature range (scalable)	250 ... 800 °C	385 ... 1600 °C
Spectral range	1.6 μm	1.6 μm
Optical resolution	150:1	300:1
System accuracy ¹	±(0.3 % of reading +2 °C) ²	
Repeatability ¹	±(0.1 % of reading +1 °C) ²	
Temperature resolution	0.1 °C	
Exposure time (90 % signal)	10 ms	
Emissivity / Gain	0,100 ... 1,100 (adjustable via switches on sensor or via software)	
IR window correction	0,100 ... 1,100 (adjustable via software)	
Signal processing	Average, peak hold, valley hold, extended hold functions with threshold and hysteresis (adjustable via software)	


1) At operating temperature $23 \pm 5 \text{ °C}$


3) $\varepsilon = 1$ / Response time 1 s

3. Delivery

3.1 Unpacking

- 1 thermoMETER CSVideo infrared sensor
- 1 Mounting nut and mounting bracket (fixed)
- 1 USB interface cable
- 1 CompactConnect Software-CD
- 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 immediately.

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. Optics

The vario optics of the thermoMETER CSVideo allows a smooth focusing of the optics to the desired distance. The sensors are available in two optic versions:

Optics	Focus adjustable in the range
SF	200 mm until infinity
CF	90 mm until 250 mm

The size of the measuring object and the optical resolution of the infrared thermometer determine the maximum distance between sensor and measuring object.

Avoid that the measurement object fills the field of optics completely.

> Measurement error

NOTICE

Consequently, the spot should at all times have at least the same size like the object or should be smaller than that. The following tables show the diameter of the measuring spot for some selected distances. The spot size refers to 90 % of the radiation energy.

The distance is always measured from the front edge of the sensor.

2L: SF optics (D:S = 150:1)

Spot size	mm	1.3	2.0	3	4.7	7.3	10.7	16.7	33.3
Measurement distance	mm	200	300	450	700	1100	1600	2500	5000

2L: CF optics (D:S = 150:1)

Spot size	mm	0.6	0.8	1.0	1.2	1.4	1.7
Measurement distance	mm	90	120	150	180	210	250

2H: SF optics (D:S = 300:1)

Spot size	mm	0.7	1.0	1.5	2.3	3.7	5.3	8.3	16.7
Measurement distance	mm	200	300	450	700	1100	1600	2500	5000

2H: CF optics (D:S = 300:1)

Spot size	mm	0.3	0.4	0.5	0.6	0.7	0.8
Measurement distance	mm	90	120	150	180	210	250

5. Mechanical Installation

The thermoMETER CSVideo 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.

NOTICE

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

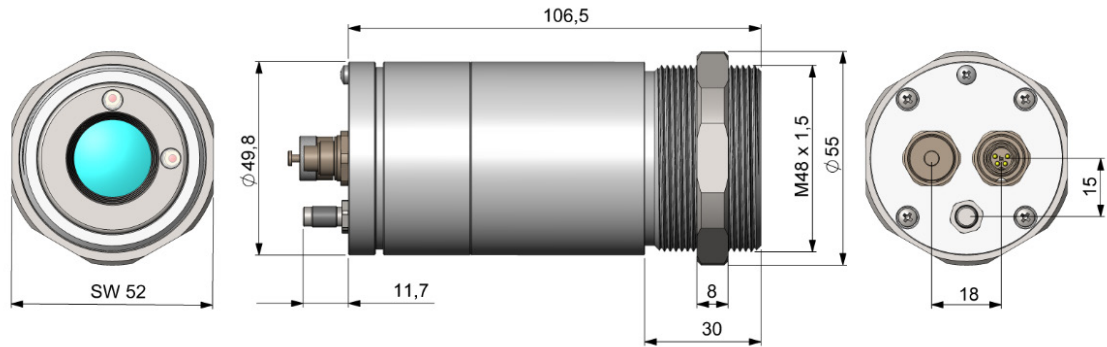


Fig. 1 Dimensional drawing thermoMETER CSVideo sensor

Dimensions in mm, not to scale

NOTICE

Make sure to keep the optical path clear of any objects.
> Faulty measurement

6. Electrical Installation

6.1 Cable Connections

The thermoMETER CSVideo has two connector plugs integrated in the sensor backplane, see [Fig. 2](#).



Fig. 2 Connectors

Therefore an opening of the sensor for cable assembling is not necessary.

For connection to a PC you can use the supplied 5 m USB cable with a 4-pin sensor connector (lengths of 10 m and 20 m are optional available).

For the analog connection (4 - 20 mA current loop, alarm, laser) a cable with a 7-pin plug is needed. This cable is not included in the scope of supply and has to be ordered separately.

Lengths of 3, 8 and 15 m are available. Please use the original ready-made, fitting connection cables.

6.2 Power Supply

Please use a separate, stabilized power supply unit with an output voltage of 5 - 28 VDC which can supply 100 mA. The ripple should be max. 200 mV.

Please use shielded cables only for all power and data lines.

The sensor shield has to be grounded.

6.3 Pin Assignment

6.3.1 7-pin Connector (Current Loop/ Alarm/ Laser)

Pin	Designation	Color (original sensor cable)
1	-	yellow
2	LOOP -	brown
3	LOOP +	white
4	Alarm	green
5	LASER -	gray
6	LASER +	pink
7	-	

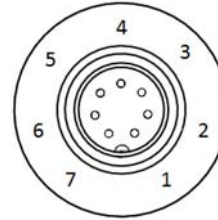


Fig. 3 7-pin round connector, view from outside

6.3.2 4-pin Connector (USB)

Pin	Designation	Color (original sensor cable)
1	VCC	yellow
2	GND	brown
3	D-	white
4	D+	green

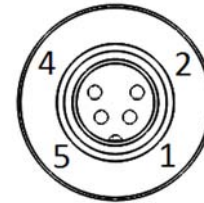
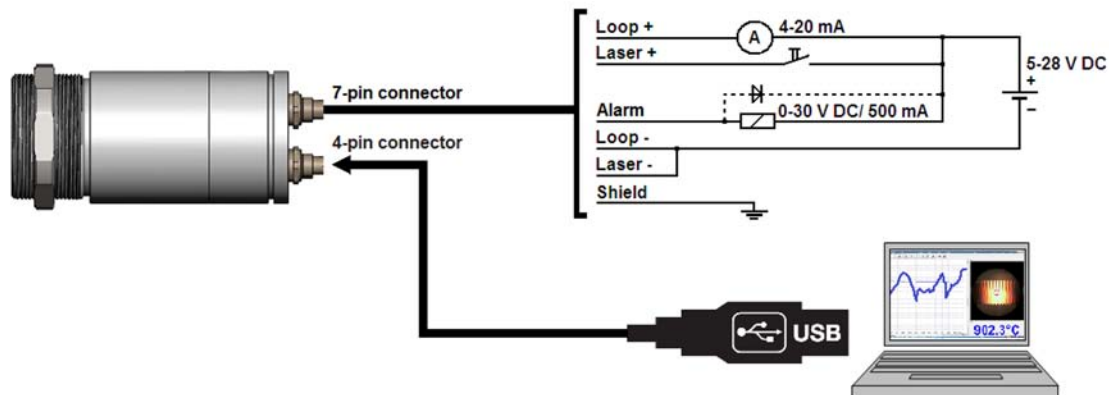


Fig. 4 4-pin round connector, view from outside

6.4 Analog Mode

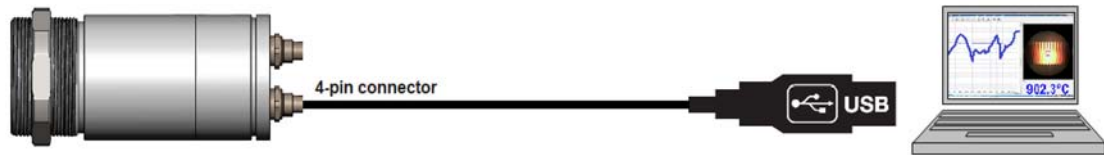


If the thermoMETER CSVideo is used as analog device the sensor provides beside the 4 - 20 mA signal in addition an alarm output (open-collector). To activate the alarm output and set the alarm threshold value the software is needed.

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

The sensor configuration and adjustment can be done on site with a laptop or tablet PC. The USB cable can be connected to the sensor during operation of the sensor (hot plug & play).

6.5 Digital Mode



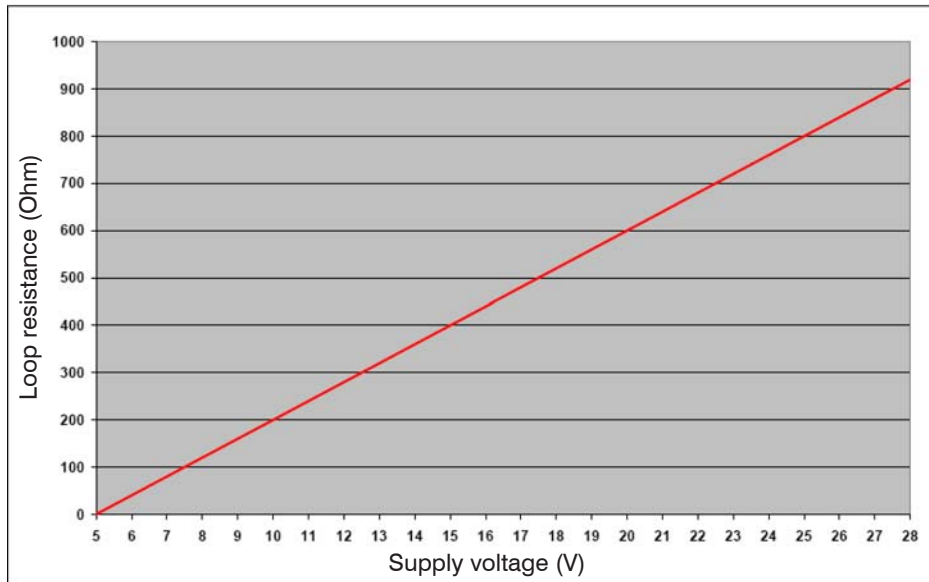
In the digital mode the sensor and the laser will be powered via the 5 V from USB interface. The activation/deactivation of the laser has to be made via the software.

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)

6.6 Maximal Loop Impedance

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



6.7 Options

The thermoMETER CSVideo has an integrated video camera which is using the same optical channel than the IR detector. In addition the sensor has a cross laser aiming which marks the center of the measurement spot at any distance. The combination of video and laser sighting enables a perfect alignment of the sensor to the object.

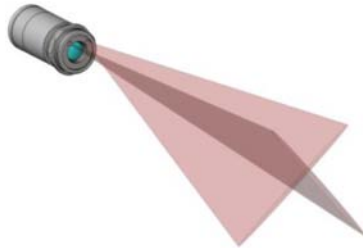


Fig. 5 Double laser cross aiming of thermoMETER CSVideo

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 pushbutton, which has to be installed max. 2 m away from installation site of the sensor.

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

NOTICE

The laser can be activated/ deactivated via the programming keys on the unit or via the software.

At operating temperatures $> 50\text{ }^{\circ}\text{C}$ the laser will switch off automatically.

The laser should only be used for sighting and positioning of the sensor.

> Reducing the lifetime of the laser diodes at high operating temperatures.

6.8 Focusing and Video Sighting

On the back plane of the sensor you will find a rotary button for focusing of the optics, see [Fig. 6](#).

➡ To set the focus to the desired measurement distance you have to connect the sensor with a PC using the USB cable. Please start the software.

You will see the video beside the temperature-time diagram. The position of the measurement spot is indicated by a circle inside the video picture. The size of this circle is equivalent to the IR spot size.

By turning the rotary button clockwise you will change the focus in direction far. By turning counterclockwise you will change the focus in direction close.

Focusing rotary button

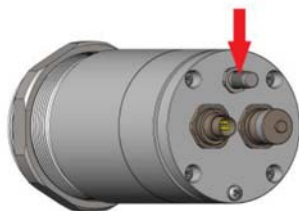


Fig. 6 Focusing with the focusing rotary button

➡ After a successful focusing please enter the measurement distance (distance sensor front – object) in the according field in the software (underneath the video picture, see [Fig. 7](#)).

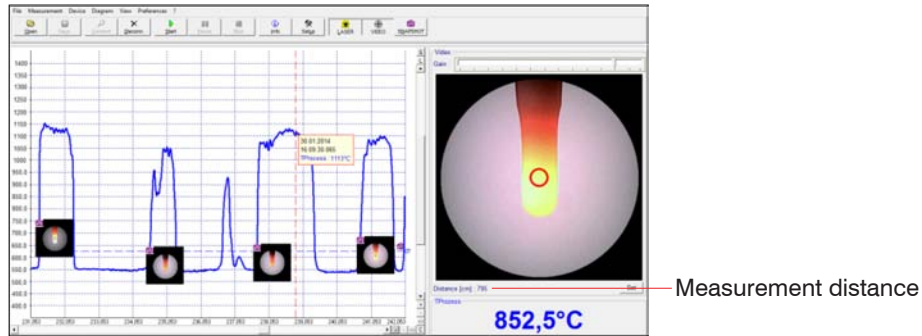


Fig. 7 View video presentation

You will find a detailed description of the video settings in the software description which you can call via the menu ? / Help...

7. Instructions for Operation

7.1 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.

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

> Destruction of the sensor and/or the controller

NOTICE

8. Software

8.1 Installation

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

If the autorun option is activated the installation wizard will start automatically.

➡ Otherwise please start CDsetup.exe from the CDROM.

➡ Follow the instructions of the wizard until the installation is finished.

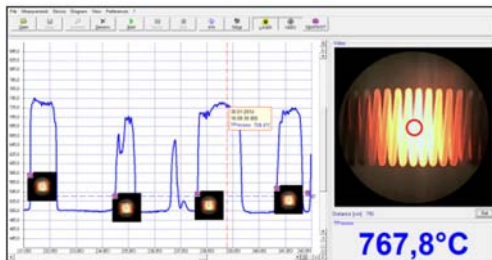
The installation wizard will place a launch icon on the desktop and in the start menu.

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.

8.2 System Requirements

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

8.3 Main Features



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

Fig. 8 Graphic display main features

9. Communication Settings

9.1 Serial Interface

Baud rate: 9600 baud

Data bits: 8


Parity: none

Stop bits: 1

Flow control: off

9.2 Protocol

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

 Set the control signal `DTR` to power the sensor.

9.3 Digital Command Set

13014thermoMETER CSVideo command list							
Decimal	HEX	Binary / ASCII	Command	Data	Answer	Result	Unit
1	0x01	Binary	READ Temp - Target	no	byte 1 byte 2	$= (\text{byte1} \times 256 + \text{byte 2} - 1000) / 10$	° C
2	0x02	Binary	READ Temp - Head	no	byte 1 byte 2	$= (\text{byte1} \times 256 + \text{byte 2} - 1000) / 10$	° C
3	0x03	Binary	READ current Temp - Target	no	byte 1 byte 2	$= (\text{byte1} \times 256 + \text{byte 2} - 1000) / 10$	° C
4	0x04	Binary	READ Emissivity	no	byte 1 byte 2	$= (\text{byte1} \times 256 + \text{byte 2}) / 10$	
5	0x05	Binary	READ Transmission	no	byte 1 byte 2	$= (\text{byte1} \times 256 + \text{byte 2}) / 10$	
9	0x09	Binary	READ Processor Temperature	no	byte 1	$= (\text{byte1} \times 256 + \text{byte 2} - 1000) / 10$	
14	0x0E	Binary	READ Serial number	no	byte 1 byte 2 byte 3	$= (\text{byte1} \times 65536 + \text{byte 2} \times 256 + \text{byte3})$	
15	0x0F	Binary	READ FW. Rev.	no	byte 1 byte 2	$\text{byte1} \times 256 + \text{byte2}$	
16	0x10	Binary	READ Laser status	no	byte 1	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	0x81	Binary	SET DAC mA	byte1	byte 1	$\text{byte1} = \text{mA} \times 10$ (z.B. 4 mA = $4 \times 10 = 40$)	° C
130	0x82	Binary	RESET of DAC mA output				
132	0x84	Binary	SET Emissivity	byte1 byte2	byte 1 byte 2	$= (\text{byte1} \times 256 + \text{byte 2}) / 10$	
133	0x85	Binary	SET Transmission	byte1 byte2	byte 1 byte 2	$= (\text{byte1} \times 256 + \text{byte 2}) / 10$	
144	0x90	Binary	SET Laser	byte 1	byte 1	0 = on/ 1 = off	

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 = dez. 1235
			1235 - 1000 = 235
			235 / 10 = 23.5 °C

Set of emissivity			
Send:	84 03 B6		03B6 = dez. 950
Receive:	03 B6		950 / 1000 = 0.950

10. Basics of Infrared Thermometry

Depending on 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 $1\ \mu$ and $20\ \mu\text{m}$. 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 Chap. 11.

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 processing electronics transforms the emitted infrared radiation into electrical signals.

11. Emissivity

11.1 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, chamotte). To minimize measuring errors in such cases, the handling should be performed very carefully and the unit should be protected against reflecting radiation sources.

11.2 Determination of Unknown Emissivity

- First, determine the actual temperature of the measuring object with a thermocouple or contact sensor. Secondly, 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 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 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 operating temperature.

11.3 Characteristic Emissivities

In case 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 average values, only. The actual emissivity of a material depends on the following factors:

- Temperature
- Measuring angle
- Geometry of the surface (flat, 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)

12. 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.

13. Service, Repair

In the event of a defect on the infrared sensor, 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:

For customers in USA applies:

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

For customers in Canada or South America applies:

Please contact your local distributor.

14. Decommissioning, Disposal

➡ Disconnect the USB cable from the infrared sensor.

The thermoMETER CSVideo is produced according to the directive 2011/65/EU, "RoHS".

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

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Appendix

A 1 Accessories

A 1.1 Mounting Bracket

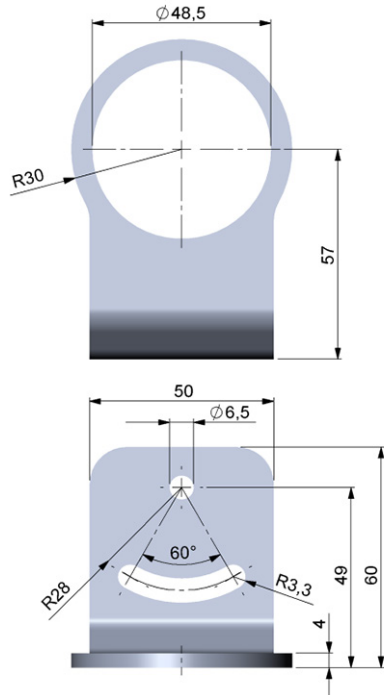


Fig. 9 Mounting bracket, adjustable in one axis (TM-FB-CTL)

Dimensions in mm, not to scale



Fig. 10 Mounting bracket, adjustable in one axes (TM-AB-CTL)

This adjustable mounting bracket allows an adjustment of the sensor in one axis.

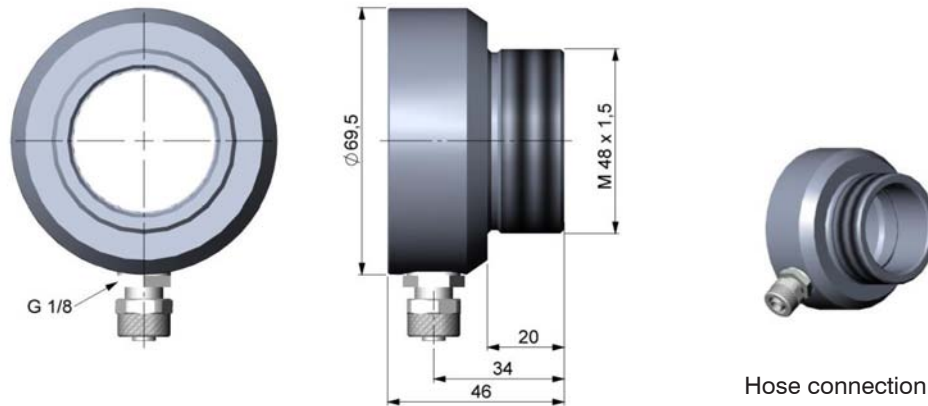
Please activate the integrated video and/or cross laser sighting for an exact sensor alignment to the object, see Chap. 6.7.

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.



Hose connection: 6 x 8 mm
Thread (Fitting): G 1/8 inch

Fig. 11 Air purge collar (TM-AP-CTL)

Dimensions in mm, not to scale

A 1.3 Water Cooled Housing

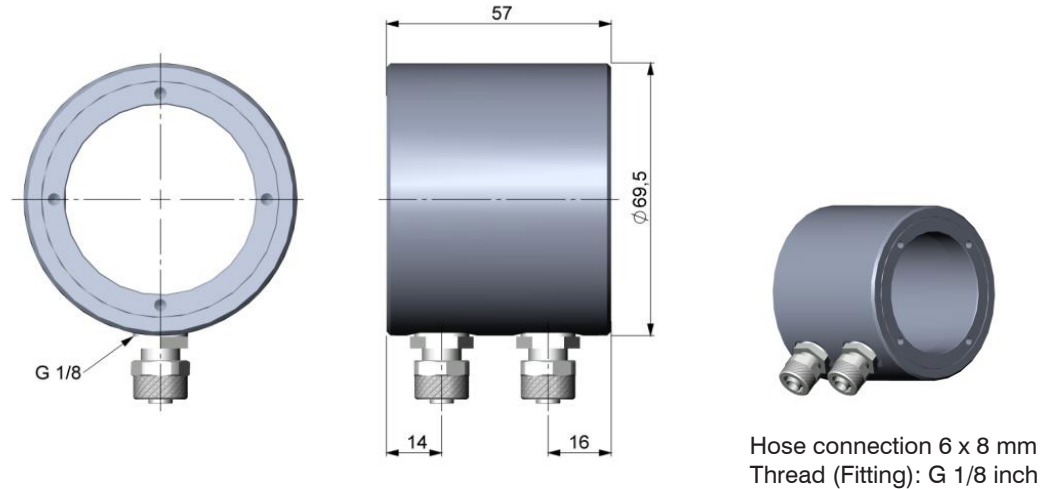


Fig. 12 Water cooled housing (TM-W-CTL)

Dimensions in mm, not to scale

i To avoid condensation on the optics an air purge collar is recommended.

The thermoMETER CSVideo sensor can be used at operating temperatures up to 70 °C without cooling. For applications, where the operating 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 cables (operating temperature up to 180 °C), see Chap. [A 1.4](#).

A 1.4 High Temperature Cable

For applications, where the ambient temperature can reach higher values, the usage of an optional high temperature cable is also recommended (operating temperature up to 180 °C).

A 2 Factory Default Settings

The thermoMETER CSVideo has the following presetting at time of delivery:

Signal output object temperature	4 - 20 mA
Emissivity	1,000
Transmission	1,000
Average time (AVG)	0.1 s
Smart Averaging	active
Peak hold (MAX)	inactive
Valley hold (MIN)	inactive

Smart Averaging means a dynamic average adaptation at high signal edges (Activation via software only, see Chap. 8.).

Model	M-2L	M-2H
Lower limit temperature range (°C)	250	385
Upper limit temperature range (°C)	800	1600
Lower limit signal output	4 mA	
Upper limit signal output	20 mA	
Temperature unit	°C	
Ambient temperature compensation	Internal sensor temperature probe	
Laser	active	

A 3 Emissivity Table Metals

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

Material		Typical emissivity			
		1.0 μm	1.6 μm	5.1 μm	8 - 14 μm
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			
		1.0 μm	1.6 μm	5.1 μm	8 - 14 μm
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
	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
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	0.8 - 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
	Polished	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			
	1.0 μm	2.3 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
	Graphite		0.8 - 0.9	0.7 - 0.9
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
	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

Material	Typical emissivity			
	1.0 μm	2.3 μm	5.1 μm	8 - 14 μm
Spectral response				
Plastic > 50 μm Non transparent			0.95	0.95
Rubber			0.9	0.59
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

A 5 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.

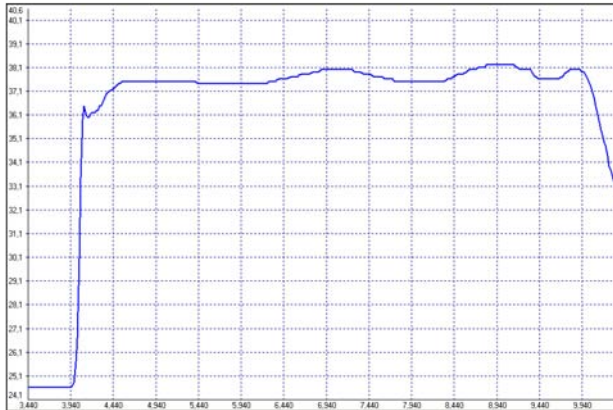


Fig. 13 Signal graph with Smart Averaging function

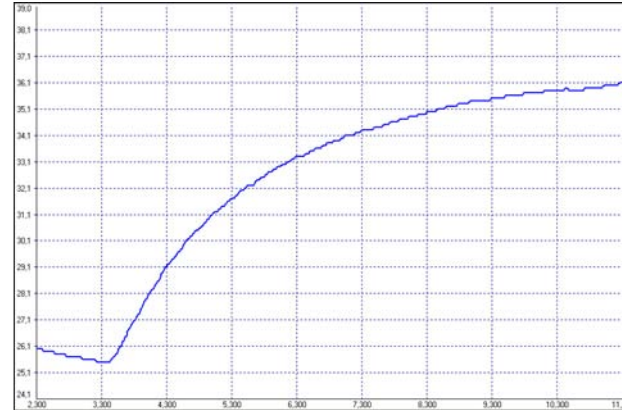


Fig. 14 Signal graph without Smart Averaging function



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