Operator‘s Manual

optris
infrared measurements

optris® CSvision

R1M / R2M

Ratio thermometer with motorized focus, crosshair laser and video sighting

Optris GmbH & Co. KG
Ferdinand-Buisson-Str. 14
13127 Berlin
Germany

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

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

optris
infrared measurements

Table of Contents

Table of Contents **3**

1 General Information **7**

1.1 Description 7

1.2 Warranty 8

1.2.1 End of Line Test 9

1.3 Scope of Supply 9

1.4 Maintenance 10

1.5 Model Overview 10

1.6 Factory Default Settings 11

2 Technical Data **12**

2.1 General Specifications 12

2.2 Electrical Specifications 13

2.3 Measurement Specifications 14

2.4 Optics 15

3 Mechanical Installation 18

3.1 Laser Sighting 19

3.2 Focusing and Video Sighting 20

3.2.1 Function LED 21

3.2.2 Automatic Snapshots 22

3.2.3 IRmobile App 23

4 Accessories 24

4.1 Mounting Brackets 24

4.2 Air Purge Collar 25

4.3 Water Cooled Housing 26

4.3.1 Technical Mounting Instructions 27

5 Electrical Installation 30

5.1 Cable Connections 30

5.2 Power supply ... 31

6 Outputs and Inputs ... 32

6.1 Analog Output ... 32

6.2 Digital Communication ... 33

6.3 I/O pin ... 34

6.4 Alarms ... 35

7 IRmobile app ... 36

8 Software CompactPlus Connect ... 38

8.1 Installation ... 38

8.2 Communication Settings ... 40

8.2.1 Serial Interface ... 40

8.2.2 Protocol ... 40

9 Basics of Infrared Thermometry ... 41

9.1 The Ratio Principle ... 42

10 Emissivity 44

10.1 Definition 44

10.2 Determination of unknown Emissivity 44

10.3 Characteristic Emissivity 45

10.4 Characteristic Slope Values 46

10.5 Determination of unknown Slope values 46

10.6 Attenuation 46

Appendix A – Emissivity Table Metals 51

Appendix B – Emissivity Table Non Metals 53

Appendix C – Smart Averaging 54

Appendix D – EU Declaration of Conformity 55

Appendix D – UKCA Declaration of Conformity 56

1 General Information

1.1 Description

Thank you for choosing the **optris® CSvision** infrared video thermometer.
The sensors of the optris CSvision series are noncontact infrared temperature sensors.
They calculate the surface temperature based on the emitted infrared energy of objects. The aligning can be easily done with the crosshair laser and the integrated video sighting with a spot circle and switchable two-step brightness reduction filter. The CSvision can work in the 1-color-mode as well as in the ratio- or 2-color-mode **[►9 Basics of Infrared Thermometry]**. The housing of the CSvision is made of stainless steel (IP65/ NEMA-4 rating).

1-color-mode [1C]
The 1-color-mode is best for measuring the temperature of objects in areas where no sighting obstructions (solid, gases or dust) exist. The measurement object must fill completely the measurement spot, if the 1-color-mode is used.

2-color-mode [2C]
In this mode the object temperature will be determined from the ratio of the signal of two separate and overlapping infrared bands. The 2-color-mode is best for measuring the temperature of objects which are partially obscured by other objects, openings or viewing windows that reduce energy and by dirt, smoke, or steam in the atmosphere. Another benefit of the 2-color-mode is that the measurement object can be smaller than the measurement spot, provided the background is cooler than the target **[►9.1 The Ratio Principle]**.

The CSvision sensing head is a sensitive optical system. Please use only the thread for mechanical installation.

- Avoid abrupt changes of the ambient temperature.
- Avoid mechanical violence on the head – this may destroy the system (expiry of warranty).
- If you have any problems or questions, please contact our service department.

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.

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

1.2 Warranty

Each single product passes through a quality process. Nevertheless, if failures occur please contact the customer service at once. The warranty period covers 24 months starting on the delivery date. After the warranty is expired the manufacturer guarantees additional 6 months warranty for all repaired or substituted product components. Warranty does not apply to damages, which result from misuse or neglect. The warranty also expires if you open the product. The manufacturer is not liable for consequential damage or in case of a non-intended use of the product.

If a failure occurs during the warranty period the product will be replaced, calibrated or repaired without further charges. The freight costs will be paid by the sender. The manufacturer reserves the right to exchange components of the product instead of repairing it. If the failure results from misuse or neglect the user has to pay for the repair. In that case you may ask for a cost estimate beforehand.

1.2.1 End of Line Test

All Optris infrared measurement systems undergo a comprehensive end-of-line test before delivery. This final quality control ensures that every product meets our stringent performance and reliability standards. By rigorously testing each unit, we guarantee accurate and dependable operation in accordance with Optris' specifications.

1.3 Scope of Supply

- CSvision sensing head
- 1,5 m USB-C cable (USB-A adapter included)
- 3 m 7 pin connector cable with terminal block
- 1 mounting nut
- Mounting bracket, adjustable in one axis
- Operator's Manual
- USB stick with software package CompactPlus Connect

1.4 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 lens cleaner (e.g. Purosol or B+W Lens Cleaner).

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

1.5 Model Overview

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

Model	Model code	Measurement range	Spectral range	Typical applications
CSvision R1M	R1ML	600 to 1800 °C	0.8 – 1.1 µm	Metals and ceramic surfaces
	R1MH	1000 to 3000 °C		
	R1MH1	1000 to 3500 °C		Metals and ceramic surfaces
CSvision R2M	R2ML	300 to 1400 °C	1.35 – 1.75 µm	Metals and ceramic surfaces

1.6 Factory Default Settings

The unit has the following presetting at time of delivery:

Output 1	Analog: TProc/ max. temperature range (according to model) = 4-20 mA			
Output 2	Analog: Attenuation/ 0-100 % = 0-20 mA			
Emissivity	1,000			
Slope	1,000			
Averaging (AVG)	0,02 s			
Smart Averaging	inactive			
Hold mode (Peak/Valley hold)	inactive			
	R1ML	**R1MH**	**R1MH1**	**R2ML**
Lower limit temperature range [°C]	600	1000	1000	300
Upper limit temperature range [°C]	1800	3000	3500	1400
Max. attenuation	95 %			80 %
LED function/ color	Attenuation: green 0-95%; red > 95%			Attenuation: green 0-80%; red > 80%
Temperature unit	°C			
Baud rate [kBaud]	115			
Main Display Source	TProc			

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

2 Technical Data

2.1 General Specifications

Environmental rating	IP65 (NEMA-4)
Ambient temperature [1)]	-20 ... 65 °C (50 °C with laser ON) for R1M | -20 ... 60 °C (50 °C with laser ON) for R2M
Storage temperature	-40...85 °C
Relative humidity	10...95 %, non-condensing
Material	stainless steel
Dimensions	125,6 mm x 50 mm, M48x1,5
Weight	518 g
Cable length (analog+alarm)	3 m (incl.), 8 m, 15 m
Cable length (USB)	1,5 m (incl.), up to 20 m
Ambient temperature cable	80 °C max. [High temperature cable (optional): 180 °C]
Vibration	IEC 68-2-6: 3G, 11 – 200 Hz, any axis
Shock	IEC 68-2-27: 50G, 11 ms, any axis
Software	CompactPlus Connect, IRmobile app

[1)] The lasers will turn off automatically at ambient temperatures >50 °C.

2.2 Electrical Specifications

Power Supply	8–30 VDC or USB powered
Power	4 W
Aiming laser	635 nm, <1 mW, On/ Off by software or app
Outputs/ analog	2x 0/ 4–20 mA
Digital I/O pin	Programmable in-/output: selectable as alarm output (open collector 24 V/ 1 A), input for triggered signal output and peak hold function or as analog input for external emissivity or slope adjustment, Laser switch 8-30V, Uncommitted value
Output impedance	max. loop resistance 500 Ω (at 8-30 VDC)
Digital interface	USB, RS485, Modbus RTU, Modbus TCP, Ethernet TCP, EtherNet/IP, Profinet

2.3 Measurement Specifications

	R1ML	R1MH	R1MH1	2ML
Temperature range (scalable) [C°]	1 color: 550...1800 2 color: 600...1800	1 color: 900...3000 2 color: 1000...3000	1 color: 900...3500 2 color: 1000...3500	1 color: 250...1400 2 color: 300...1400
Spectral range	0.8 – 1.1 µm			1.35 – 1.75 µm
Optical resolution	100:1	150:1		75:1
Vario focus	180-350mm (CFV); 350 mm to infinity (SFV), infinitely adjustable			
System accuracy [1), 2), 3)]	±(0,5 % of reading +2 °C)			
Repeatability [1), 2), 3)]	±0,3 % of reading			
Temperature resolution	0,1 K			
Response time (90 % signal) [4)]	1 ms			
Emissivity	0,050…1,100 (adjustable via software or analog input)			
Slope	0,700…1,300 (adjustable via software or analog input)			
Signal processing	1-color / 2-color mode/ attenuation monitoring/ alarms/ peak hold, valley hold, average/ extended hold function with threshold and hysteresis			
±1% Accuracy @ attenuation (e.g. dirty window)	95% for Tobj>1000 °C	95% for Tobj>1500 °C		80% for Tobj>440°C

[1)] Measurements within specification over 5-95% of range
[2)] at ambient temperature 23±5 °C
[3)] ε = 1/ Response time 1 s
[4)] with dynamic adaptation at low signal levels

2.4 Optics

The vario optics of the CSvision allows a smooth focusing of the optics to the desired distance.

Optics	Focus adjustable in the range
SFV	350 mm till infinity
CFV	200 to 400 mm

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 sensing head.

As an alternative to the optical diagrams, the spot size calculator can also be used on the Optris website (https://optris.com/optris-calculator/) or via the Optris calculator app. The app can be downloaded for free from the Google Play Store (see QR code).

D = Distance from front of the sensing head to the object
S = Spot size

R1ML CFV (D:S =100:1)						
Spot size	mm	2.0	2.5	3.0	3.5	4.0
Measurement distance	mm	200	250	300	350	400

R1MH & R1MH1 CFV (D:S =150:1)						
Spot size	mm	1.3	1.7	2.0	2.3	2.7
Measurement distance	mm	200	250	300	350	400

R1ML SFV (D:S = 100:1)									
Spot size	mm	3.5	5	7,5	10	15	20	25	50
Measurement distance	mm	350	500	750	1000	1500	2000	2500	5000

R1MH & R1MH1 SFV (D:S = 150:1)									
Spot size	mm	2.3	3.3	5.0	6.7	10	13.3	16.7	33.3
Measurement distance	mm	350	500	750	1000	1500	2000	2500	5000

R2ML CFV (D:S = 75:1)						
Spot size	mm	2.7	3.3	4.0	4.7	5.3
Measurement distance	mm	200	250	300	350	400

R2ML SFV (D:S = 75:1)									
Spot size	mm	4.7	6.7	10	13.3	20	26.7	33.3	66.7
Measurement distance	mm	350	500	750	1000	1500	2000	2500	5000

Sensor placement [1C mode]

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.

Sensor placement [2C mode]

In the 2-color-mode the sensing head can be placed under various conditions, like:

- **Measurement through holes smaller than the spot size**
- **Measurement through dust, smoke or steam in the atmosphere**
- **Measurement of objects smaller than the measurement spot**
- **Measurement through a dirty lens or dirty sighting window**

[►9.1 The Ratio Principle]

CSvision
Unboxing video
https://youtu.be/cqCgl5yMU-E

How-to video
Particle chamber experiment
https://optris.com/support-service/videos/experiments/ctratio-particle-chamber-experiment/

How-to video
Grid structure experiment
https://optris.com/support-service/videos/experiments/ctratio-grid-structure-experiment/

3 Mechanical Installation

The CSvision 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. A small label at the back indicates the orientation of the video signal and marks the upper side of the sensing head. The CSvision is equipped with a protective membrane to avoid getting condensate within the sensing head, if used in extremely humid conditions.

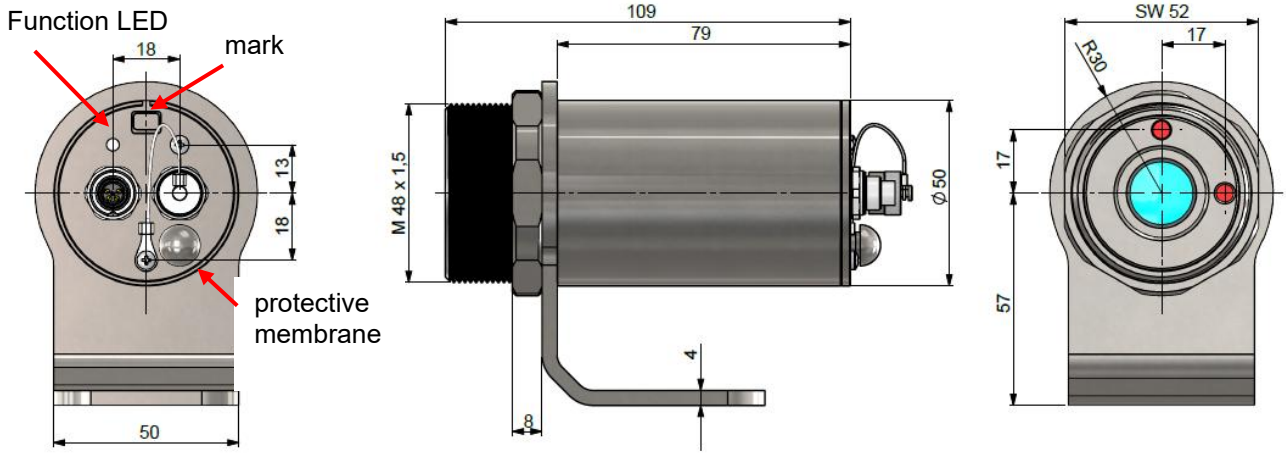
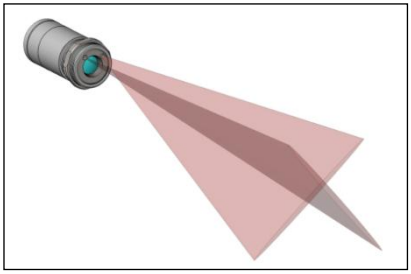
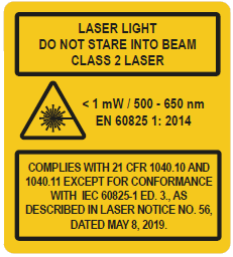


Figure 1: CSvision sensing head

3.1 Laser Sighting

The CSvision 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 centre of the measurement spot at any distance. The combination of video and laser sighting enables a perfect alignment of the sensor to the object.





WARNING: 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 laser can be activated/ deactivated via software CompactPlus Connect or IRmobile app. If the laser is controlled via the I/O pin, it cannot be switched using the software.
At ambient temperatures >50 °C the laser will be switched off automatically.

The laser should only be used for sighting and positioning of the sensor. A permanent use of the laser can reduce the lifetime of the laser diodes and the measurement accuracy can be affected.

3.2 Focusing and Video Sighting

To set the focus to the desired measurement distance you must connect the sensor with a PC, a mobile phone or a tablet using the USB cable. Please start the CompactPlus Connect software or IRmobile app. 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. Change the focus by click and drop the ***Focusing bar***. If the object appears too bright, you can use the two steps brightness filter by clicking on the video with right mouse button and click on **Video parameters**. A new window will appear (see Fehler! Verweisquelle konnte nicht gefunden werden.), and you can choose between **No filter**, **Dimmed** and **Max filter**. In additional you can use the ***Brightness bar*** to change the brightness digitally.

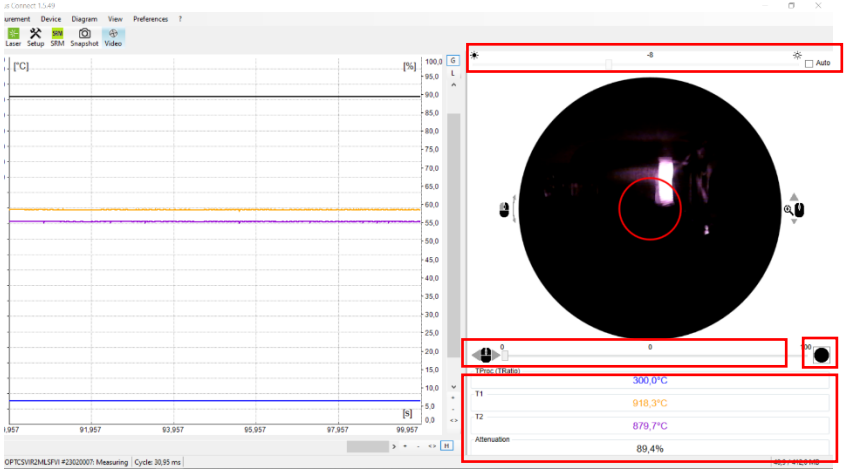


Figure 2: CompactPlus Connect

There is also a possibility to rotate and zoom the video screen, by click and rotate the video signal view with the left mouse button and spin mouse wheel in the CompactPlus Connect.

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

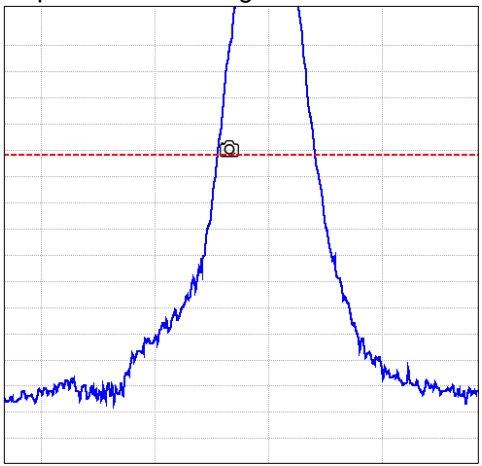
3.2.1 Function LED

The LED on the back of the sensor serves as a status indicator, displaying both normal operation and error conditions.
Normal Operation:
Continuous steady light (color can be programmed based on the indicator type).

Error Condition:
In case of a fault, the LED blinks at specific intervals to indicate different error types:
400 ms fast blink interval: Focus motor error
1s blink interval: Filter motor error
2s blink interval: Position sensor error

3.2.2 Automatic Snapshots

You can have temperature-triggered snapshots of the video signal created automatically. To do this, go to **Measurement/ Automatic snapshots** and set the check mark under Enable snapshot trigger. Now you can make the settings for triggered snapshots. In addition, you can have the trigger threshold shown in the diagram.
If a trigger event has happened and a triggered photo has been taken, an icon of a camera is shown in the temperature-time diagram.



Further settings can be made under **Preferences/ Video snapshot Setup.** The description of the snapshot with information on the date, time, serial number of the sensor and other measuring point information can be made, and the file storage location for the snapshots can be changed.

3.2.3 IRmobile App

In the IRmobile app you can zoom and rotate the video screen with your fingers. Also you can switch the **Laser** on and off. Over the **Menu** button you will get access to the menu, where you can set the emissivity, the slope or save and load data. With the **Brightness reduction filter** button, you can switch the brightness reduction filter in two steps. For adjusting the focus, use the **focusing bar**. With the **Anti flicker** button you avoid flickering video signals due to the interference to the frequency of the light source

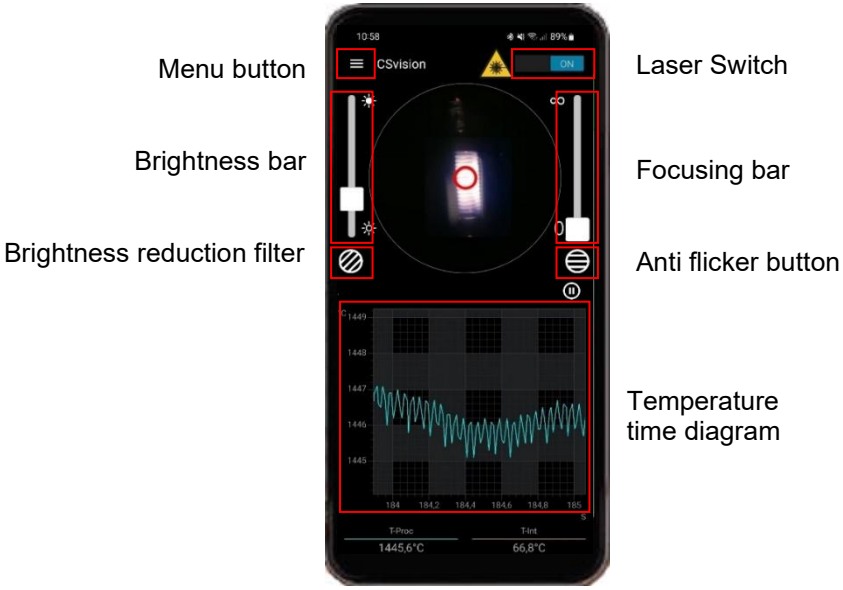


Figure 3: IRmobile App

4 Accessories

4.1 Mounting Brackets

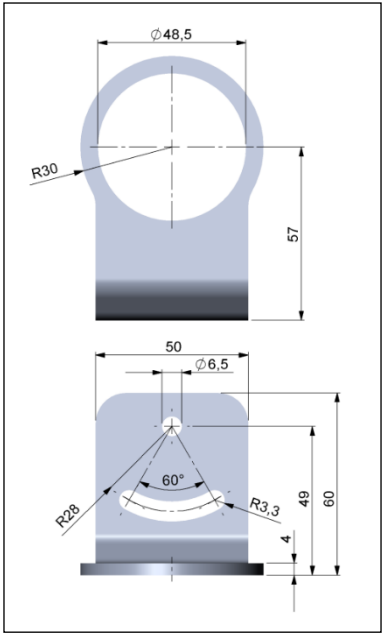


Figure 4: Mounting bracket, adjustable in one axis [ACCTLFB]

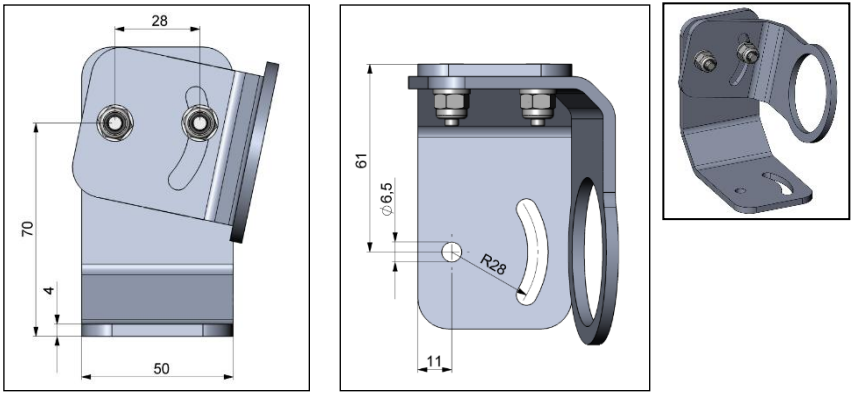


Figure 5: Mounting bracket, adjustable in two axes [ACCTLAB]

For an exact sensor alignment to the object please activate the integrated video and/ or cross laser sighting, see **3.2 Focusing and Video Sighting**

4.2 Air Purge Collar

The lens must be always kept clean 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.

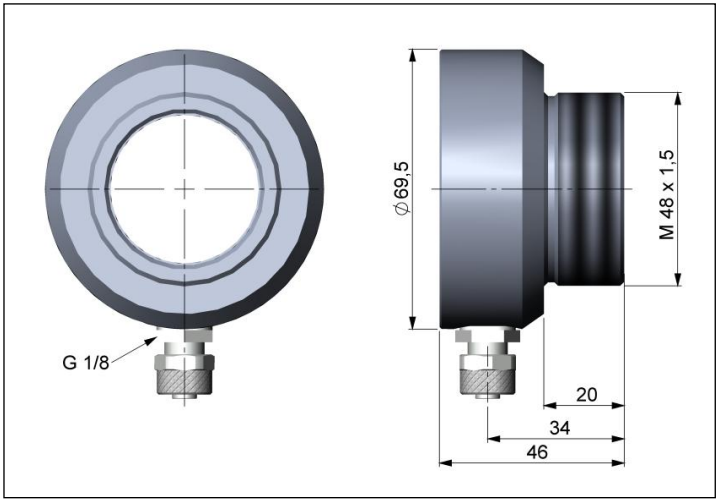


Figure 6: Air purge collar [ACCTLAP] Hose connection: 6x8 mm Thread (fitting): G 1/8 inch

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

4.3 Water Cooled Housing

The CSvision can be used at ambient temperatures up to 65 °C (R2M up to 60°C) without cooling. For applications, where the ambient temperature can reach higher values, the usage of the optional water-cooled housing [Part number: ACCSVIWA] is recommended (operating temperature up to 250 °C).

Figure 7: Water Cooled Housing [ACCSVIWA]

The sensor should be equipped with the optional high temperature cables (operating temperature up to 180 °C).

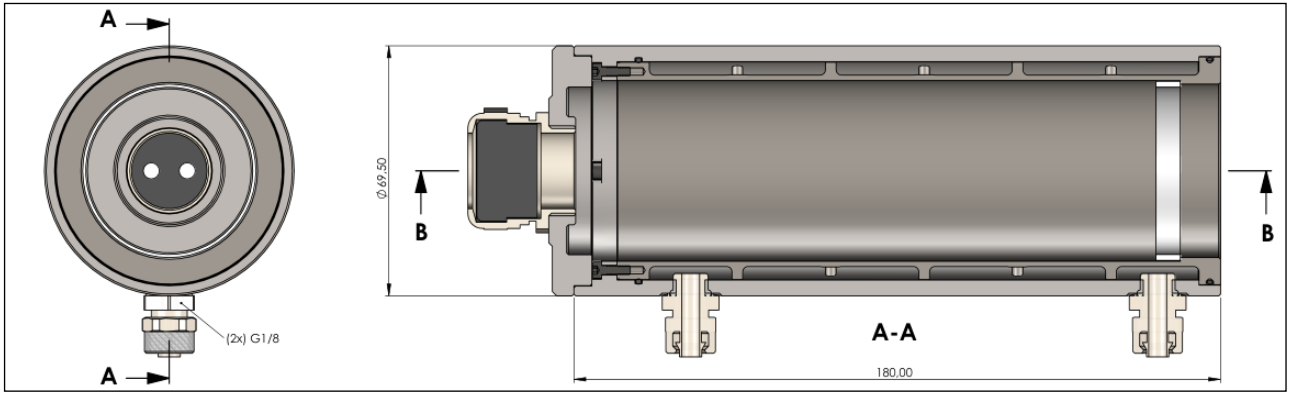


Figure 8: Water cooled housing [ACCSVIWA] Hose connection: 6x8 mm Thread (fitting): G 1/8 inch

To avoid condensation on the optics an air purge collar is recommended. The cooling water should not exceed 30 °C. The recommended flow rate is 2 l/min.

4.3.1 Technical Mounting Instructions

There are two ways to use the cooling housing: Option 1 with an Airpurge and Option 2 without an Airpurge. Please see **Figure 9**.

Option 1: Mounting with Air Purge (Recommended)
This configuration provides a thermal protection and prevents dust/liquid contamination on the lens.

Step 1: Remove the four screws of the rear cover 1 of the water-cooled housing. Remove the rear cable gland from the cover. Carefully feed the pyrometer's connection cables 2 through the cable gland, then through the rear opening of the housing 3. Connect the cables 2 to the corresponding terminals or connectors on the pyrometer 3.
Step 2: Slide the pyrometer into the rear opening of the water-cooled housing 5, guiding it forward until the M48 thread comes out of the front of the cooled housing.
Step 3: Take the air purge 6 and screw it onto the M48 thread of the pyrometer.
Step 4: Position the mounting bracket 7 and screw the M48 8 nut onto the housing thread
Step 5: Place the rear cover 1 back onto the rear of the housing, ensuring the cables are routed cleanly through the holes. Reinstall retaining screws.
Step 6: Screw the cable gland into the threaded hole on the rear cover 1.

Option 2: Direct Mounting (without Air Purge – not recommended). If this configuration is chosen, a spacer ring 4 (in scope of supply) is required.

Optris does not recommend this configuration. Operating the water-cooled housing without an air purge increases the risk of condensation, which will lead to inaccurate measurements and potential long-term damage to the optics.

Follow the **Step 1** of **Option 1**. Additional step before **Step 2** has to be done: Place the provided spacer ring 4 into the front bore of the water-cooled housing 5, before you insert the pyrometer into the housing. Follow **Step 2** and **Steps 4-6** of **Option 1**.

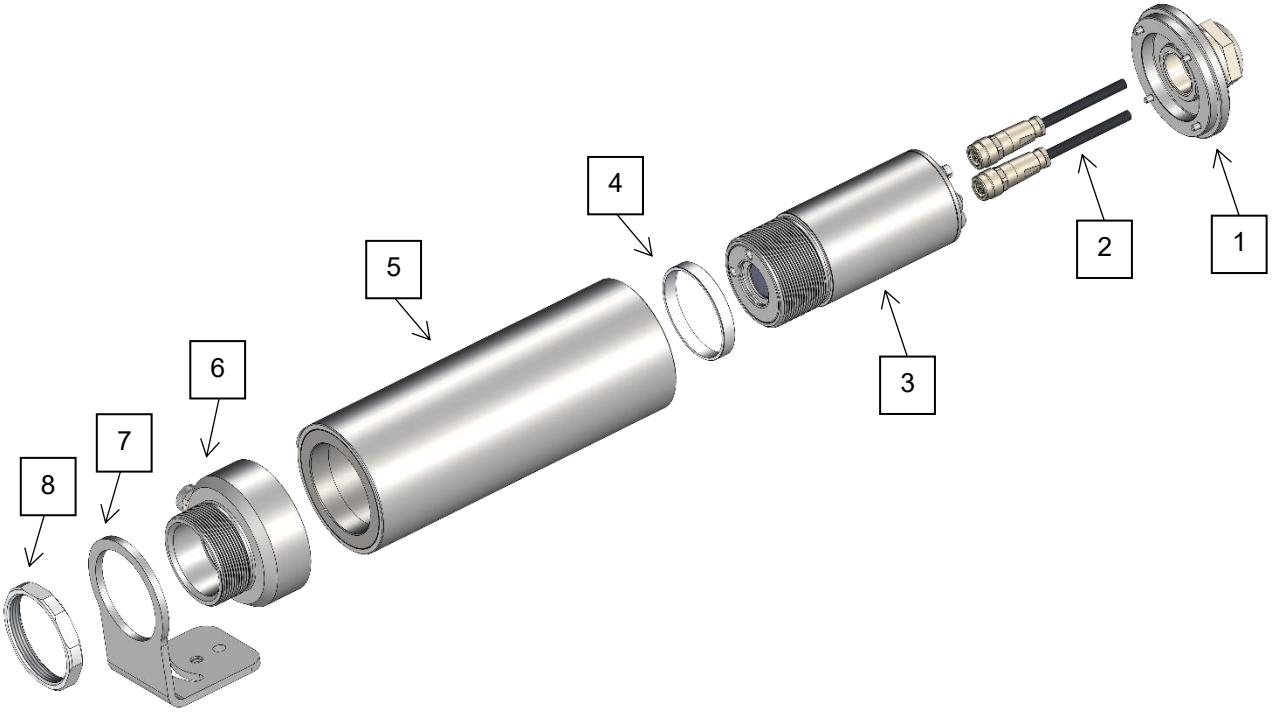


Figure 9: Assembling of the water cooled housing and CSvision with Airpurge

5 Electrical Installation

5.1 Cable Connections

The CSvision has two connector plugs integrated in the sensor backplane (see **Figure 10**). Therefore, an opening of the sensor for cable assembling is not necessary. For connection to a PC, mobile phone, or a tablet you can use the supplied 1,5 m USB cable with a 4-pin sensor connector (lengths up to 20 m are optional available).

Figure 10: sensor connectors

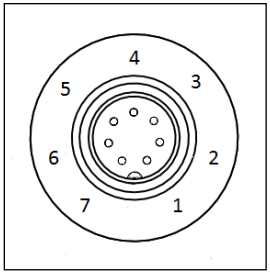
For the signal (2x mA OUT/, I/O Pin/ RS485) a cable with a 7-pin plug is needed, length of 3m is supplied (lengths up to 15 m are available). Please use the original ready-made, fitting connection cables.

5.2 Power supply

Please use a separate, stabilized power supply unit with an output voltage of **8–30 VDC**, the power consumption is **4W.** The ripple should be max. **200 mV.** Please use shielded cables only for all power and data lines.
The sensor shield must be grounded.

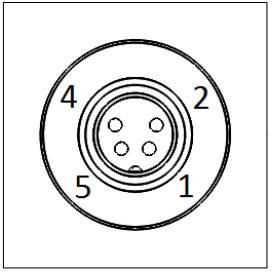
Pin assignment of 7-pin connector (current loop/ alarm/ laser)

PIN	Designation	wire color (original sensor cable)
-	Shield	black
1	Vcc (>8V)	yellow
2	GND	brown
3	I/O Pin	white
4	mA Output 1	green
5	mA Output 2	grey
6	RS485 A	pink
7	RS485 B	blue



Pin assignment of 4-pin connector (USB)

PIN	Designation
1	VCC
2	GND
4	D-
5	D+



6 Outputs and Inputs

The CSvision has two analog outputs and one I/O pin (programmable as in- or output).

6.1 Analog Output

The selection of the signal on output channel 1 and 2 (0/4-20 mA) can be done via the software CompactPlus Connect **[►8 Software CompactPlus Connect]** or the IRmobile app **[►7 IRmobile app]**.

Please do never connect a supply voltage to the analog outputs as this can damage the output.
The CSvision is not a 2-wire sensor!

The following signal sources can be selected for output channel 1 and 2:

Tproc	Process temperature
Tratio	Ratio temperature
T1	1C temperature – detector 1
T2	1C temperature – detector 2
Attenuation	Signal attenuation in %
Tdet	Detector temperature

6.2 Digital Communication

The CSvision has one A pin and one B pin for digital communication.

For network communication via RS485 and Modbus RTU please use the 7-pin cable (in scope of supply).

For network communication via EtherNet/IP [Part number: ACXICSVIEIPK], Ethernet TCP/IP and Modbus TCP [Part number: ACXICSVIENMBTCPK], or Profinet [Part number: ACXICSVIPFNK], use the optional adapter with the correspond part number.

The command list and the description for the setup you will find on the Optris website.

6.3 I/O pin

The CSvision has one I/O pin which can be programmed as output (digital) or as input (digital or analog) using the CompactPlus Connect software. The following functions are available:

Function	I/O pin acts as	Description
Alarm	output digital	Open collector output/ definition as High- or Low alarm via normally open/ normally close options in software dialog.
Valid Low	input digital	The output follows the object temperature as long as there is a Low level at the I/O pin. After discontinuation of the Low level the last value will be held.
Valid High	input digital	The output follows the object temperature as long as there is a High level at the I/O pin. After discontinuation of the High level the last value will be held.
Hold Low-High	input digital	The last value will be held if there is a signal with a rising edge on the I/O pin.
Hold High-Low	input digital	The last value will be held if there is a signal with a falling edge on the I/O pin.
Hold Reset Low	input digital	Reset of Peak or valley hold (High-Low signal)
Hold Reset High	input digital	Reset of Peak or valley hold (Low-High signal)
Slope external	input analog	The slope value can be adjusted via a 0-10 V signal on the I/O pin (scaling possible via software).
Emissivity external	input analog	The emissivity value can be adjusted via a 0-10 V signal on the I/O pin (scaling possible via software).
Uncommitted value	Input analog	Display of a uncommitted value
Laser on Low	Input digital	Turning on the laser (Low signal)
Laser on High	Input digital	Turning on the laser (High signal)

High-level or Low-level is to be set in the software CompactPlus Connect

6.4 Alarms

The CSvision has following Alarm features:

Digital Alarm

The I/O pin can be programmed as alarm output. In this case the pin acts as an open collector output (24 V/ 1 A).

The following signal sources can be selected:

TProc/ TRatio/ T1/ T2/ Attenuation/ TDet

For a setup of the alarm values, selection of the signal sources and definition as high or low alarm (via change of normally open/ closed) the programming interface (USB) including the software is needed.

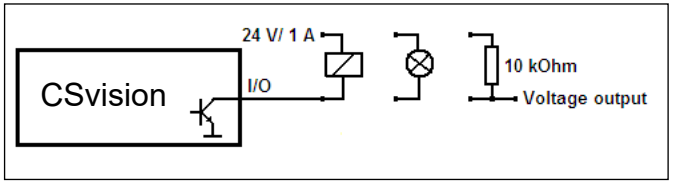
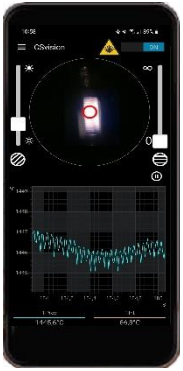


Figure 11: Different wirings of the open collector output

7 IRmobile app

The CSvision sensor has a direct connection to an Android smartphone or tablet. All you have to do is download the IRmobile app for free in the Google Play store. This can also be done via the QR code. The supplied USB cables can be used for connection to the device.

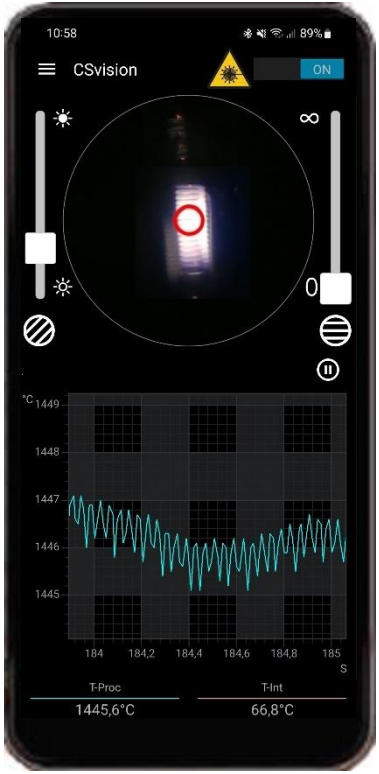


GET IT ON Google Play

With IRmobile you are able to monitor and analyze your infrared temperature measurement on a connected smartphone or tablet. This app works on most Android devices running 5.0 or higher with a micro USB or USB-C port supporting USB-OTG (On The Go). It is easy to operate: after you plug your CSvision device to your phone or tablet, the app will start automatically. The device is powered by your phone. Different digital temperature values can be displayed in the temperature time diagram. You can easily zoom-in the diagram to see more details and small signal changes. Also, you can save the data and analyze the data on your PC using CompactPlus Connect.

IRmobile app features:

- Video and temperature signal on one screen
- Focus control, laser switch, brightness filter control
- Temperature time diagram with zoom function
- Digital temperature values
- Setup of emissivity, transmissivity and other parameters
- Scaling of the analog output and setting of the alarm output
- Change of temperature unit: Celsius or Fahrenheit
- Saving/loading of configurations and T/t diagrams
- Restore factory default sensor settings
- Integrated simulator



Supported for:

- Optris pyrometers: Compact series, high performance series and video thermometers
- Optris IR cameras: PI and Xi series
- For android devices running 5.0 or higher with a micro USB or USB-C port supporting USB-OTG (On The Go)

8 Software CompactPlus Connect

8.1 Installation

The software is located on the included USB stick. Please start **Setup.exe** and follow the instructions of the wizard until the installation is finished.

Minimum system requirements:

- Windows 10, 11
- USB interface
- Hard disc with at least 30 MByte free space
- At least 128 MByte RAM

The software can also be downloaded via the Optris website under the following link: https://optris.com/software/compactplus-connect/

The installation wizard will place a launch icon on the desktop and in the start menu:
[Start]\Programs\ CompactPlus Connect.
If you want to uninstall the software from your system please use the **uninstall icon** in the start menu.

A detailed description of the software is provided in the documentation folder.

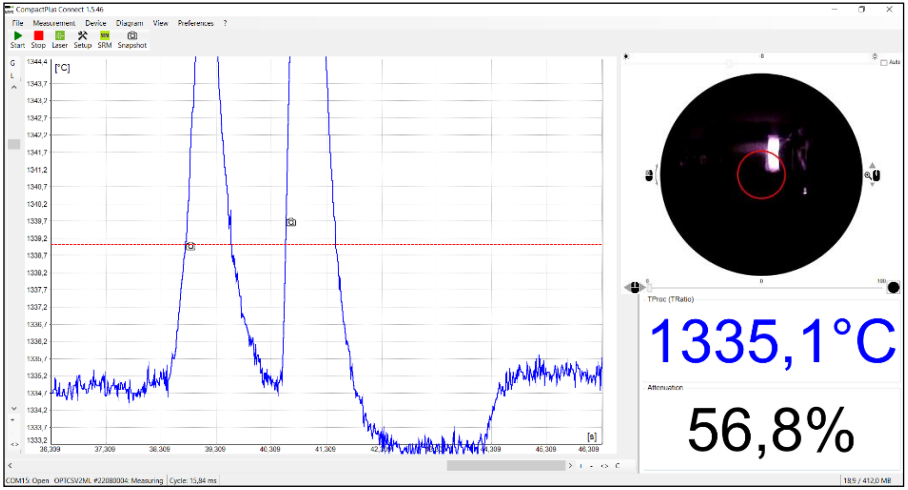


Figure 12: CompactPlus Connect with CSvision

Main Features:

- Video signal for exact aligning your measuring spot
- Control brightness filter
- Turning on/off the aligning laser
- Rotate and zoom the video screen
- 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

8.2 Communication Settings

8.2.1 Serial Interface

Baudrate:	115,2 / 921,6 kBaud (factory default: 115,2)
Data bits:	8
Parity:	none
Stop bits:	1
Flow control:	off

8.2.2 Protocol

All sensors of the CSvision series are using a binary protocol. Checksum is needed for set commands but not for read commands. The protocol has no additional overhead with CR, LR or ACK bytes. This makes the communication fast.
To get the current object temperature the user must send a simple 01hex byte and the CSvision will respond with the two byte temperature. To get the temperature as a floating value subtract 1000 and divide by 10. For more information, please refer to the Optris CSvision communication interface.

9 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 µm 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 (►**10 Emissivity**).

Infrared thermometers are optoelectronic sensors. They calculate the surface temperature on the basis of the emitted infrared radiation from an object. The most important feature of infrared thermometers is that they enable the user to measure objects contactless. Consequently, these products help to measure the temperature of inaccessible or moving objects without difficulties. Infrared thermometers basically consist of the following components:

- lens
- spectral filter
- detector
- electronics (amplifier/ linearization/ signal processing)

The specifications of the lens decisively determine the optical path of the infrared thermometer, which is characterized by the ratio **D**istance to **S**pot size.
The spectral filter selects the wavelength range, which is relevant for the temperature measurement. The detector in cooperation with the processing electronics transforms the emitted infrared radiation into electrical signals.

9.1 The Ratio Principle

The 2-color ratio technology makes possible accurate and repeatable temperature measurements that are free from dependence on absolute radiated energy values. In use, a 2-color sensor determines temperature from the ratio of the radiated energies in two separate wavelength bands (colors). The benefits of 2-color sensors are that accurate measurements can be made under the following conditions:

- ► When the field of view to the target is partially blocked or obscured.
- ► When the target is smaller than the sensor's field of view.
- ► When target emissivity are low or changing by the same factor in both wavelength bands.

Another benefit is that 2-color sensors measure closer to the highest temperature within the measured spot (spatial peak picking) instead of an average temperature. A 2-color sensor can be mounted farther away, even if the target does not fill the resulting spot size. The convenience is that you are not forced to install the sensor at some specific distance based upon target size and the sensor's optical resolution.

Partially Obscured Targets

The radiated energy from a target is, in most cases, equally reduced when objects or atmospheric materials block some portion of the optical field of view. It follows that the ratio of the energies is unaffected, and thus the measured temperatures remain accurate.

A 2-color sensor is better than a 1-color sensor in the following conditions:

- ► Sighting paths are partially blocked (either intermittently or permanently).
- ► Dirt, smoke, or steam is in the atmosphere between the sensor and target.
- ► Measurements are made through items or areas that reduce emitted energy, such as grills, screens, channels or small openings.

1-color sensors see polluted atmosphere and dirty windows and lenses as a reduction in energy and give much lower than actual temperature readings.

Targets Smaller Than Field of View

When a target is not large enough to fill the field of view, or if the target is moving within the field of view, radiated energies are equally reduced, but the ratio of the energies is unaffected and measured temperatures remain accurate. This remains true as long as the background temperature is much lower than the target temperature.

Example:

- ► Measuring of wire or rod — often too narrow for field of view or moving or vibrating unpredictably. It is much easier to obtain accurate results because sighting is less critical with 2-color sensors.

Low or Changing Emissivity

If the emissivity in both wavelengths (colors) were the same, as they would be for any blackbody (emissivity = 1.0) or greybody (emissivity < 1.0 but constant), then their ratio would be 1, and target emissivity would not be an influence. However, in nature there is no such thing as a greybody. The emissivity of all real objects changes with wavelength and temperature, at varying degrees, depending on the material.

When emissivity is uncertain or changing, a 2-color sensor can be more accurate than a 1-color instrument as long as the emissivity changes by the same factor in both wavelength bands. Note, however, that accurate measurement results are dependent on the application and the type of material being measured. To determine how to use 2-color sensors with your application when uncertain or changing emissivity are a factor, please contact your sales representative.

10 Emissivity

10.1 Definition

The intensity of infrared radiation, which is emitted by each body, depends on the temperature as well as on the radiation features of the surface material of the measuring object. The emissivity (ε – Epsilon) is used as a material constant factor to describe the ability of the body to emit infrared energy. It can range between 0 and 100 %. A “blackbody” is the ideal radiation source with an emissivity of 1,0 whereas a mirror shows an emissivity of 0,1.
If the emissivity chosen is too high, the infrared thermometer may display a temperature value which is much lower than the real temperature – assuming the measuring object is warmer than its surroundings. A low emissivity (reflective surfaces) carries the risk of inaccurate measuring results by interfering infrared radiation emitted by background objects (flames, heating systems, chamottes). To minimize measuring errors in such cases, the handling should be performed very carefully and the unit should be protected against reflecting radiation sources.

10.2 Determination of unknown Emissivity

► 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.

10.3 Characteristic Emissivity

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

10.4 Characteristic Slope Values

The slope is the quotient of the emissivity of both overlapping wavelength bands. The factory default value for the slope is 1,000. The following slopes are typical reference values. The real slope can vary depending on the metal alloy and surface finish.

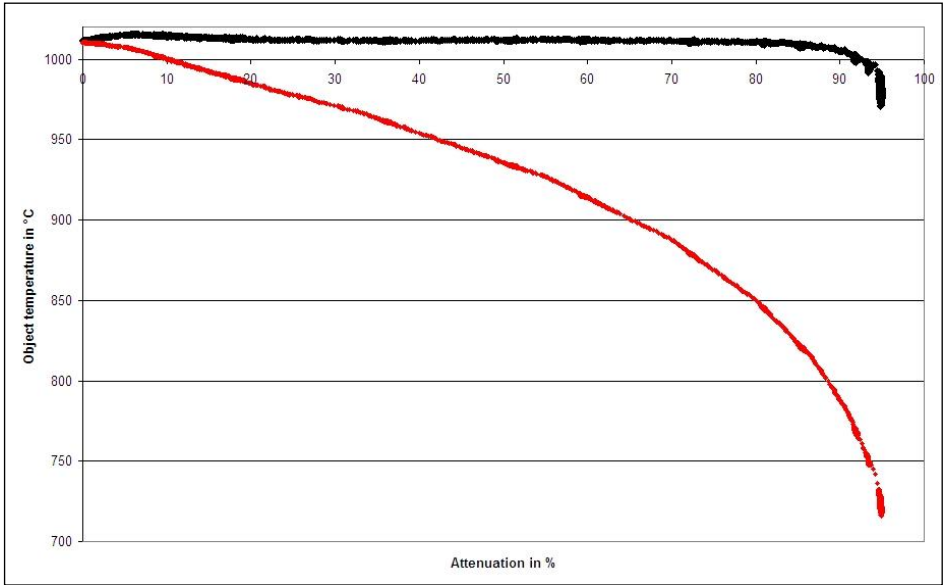
Cobalt, Iron, Nickel, Stainless steel, Steel	► oxidized surfaces	**Slope: 1,000**
Cobalt, Iron (solid, molten), Molybdenum, Nickel, Platinum, Rhodium, Stainless steel, Steel, Tantalum, Tungsten, Wolfram	► non-oxidized surfaces	**Slope: 1,060**

10.5 Determination of unknown Slope values

Basically you can use the same methods to determine an unknown slope as described under **►10.2 Determination of unknown Emissivity**. As the CSvision is dedicated for high temperature applications, only the first method may be practically applicable (use of a t/c or other contact probe).

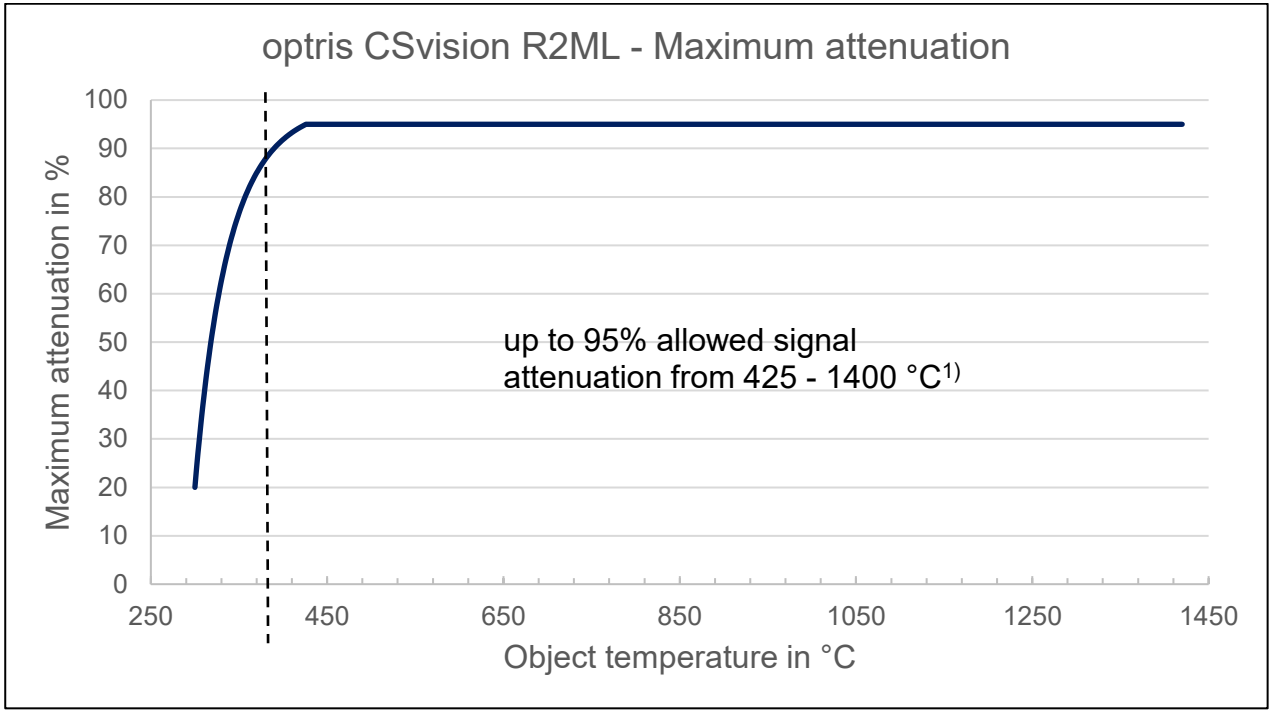
10.6 Attenuation

The CSvision is able to measure the temperature of targets smaller than the field of view (FOV). If the target size is smaller than the FOV (and thus attenuating the signal) this may cause a small inaccuracy of the reading. The inaccuracy is dependent on the object temperature and value of attenuation. The higher the object temperature and attenuation the higher the inaccuracy of the sensor.

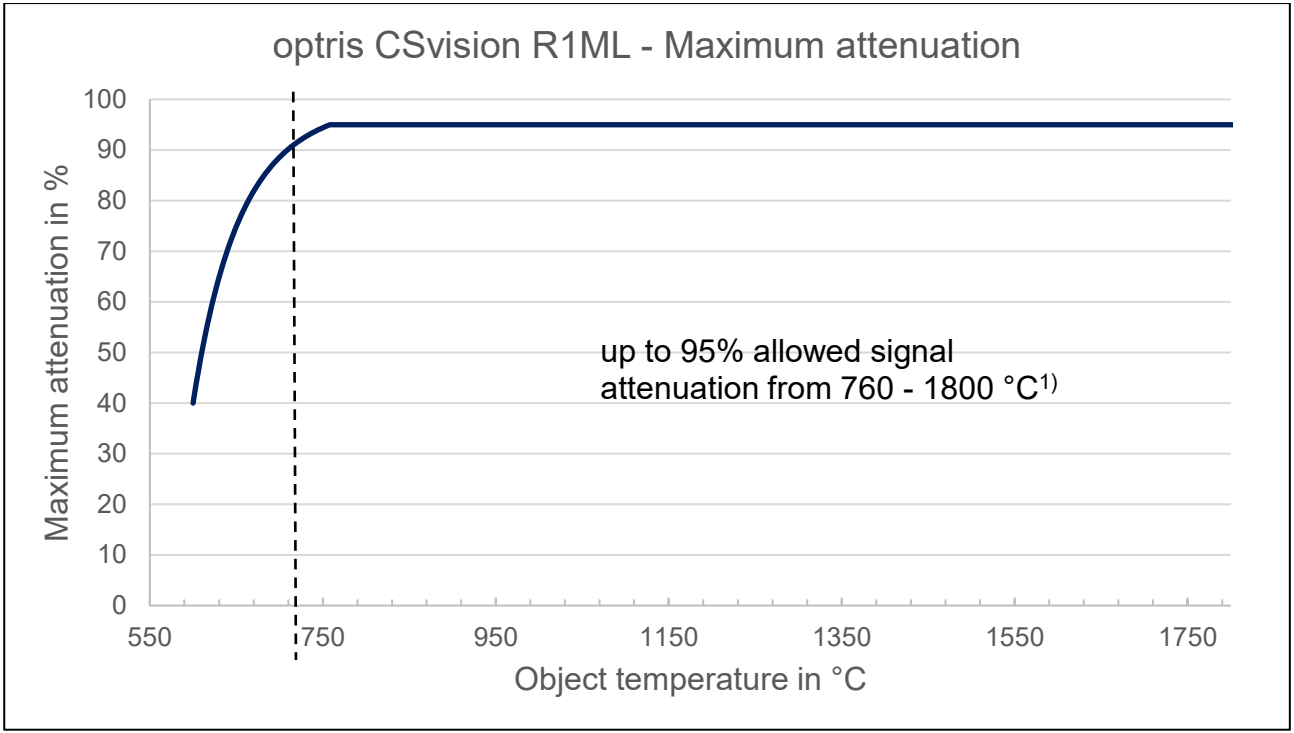


This figure is showing the typical temperature reading of a ratio thermometer optris CSvision in both the 1-color- (red curve) and the 2-color-mode (black curve) depending on increasing contamination of the optical transmission path in-between the target and the ratio thermometer. Due to the ratio principle the 2-color signal stays very stable over a wide range of attenuation up to over 90 %. The signal of the 1 color mode acting like in a standard pyrometer with one measuring wavelength only, is decreasing rapidly with the contamination of the transmission path.

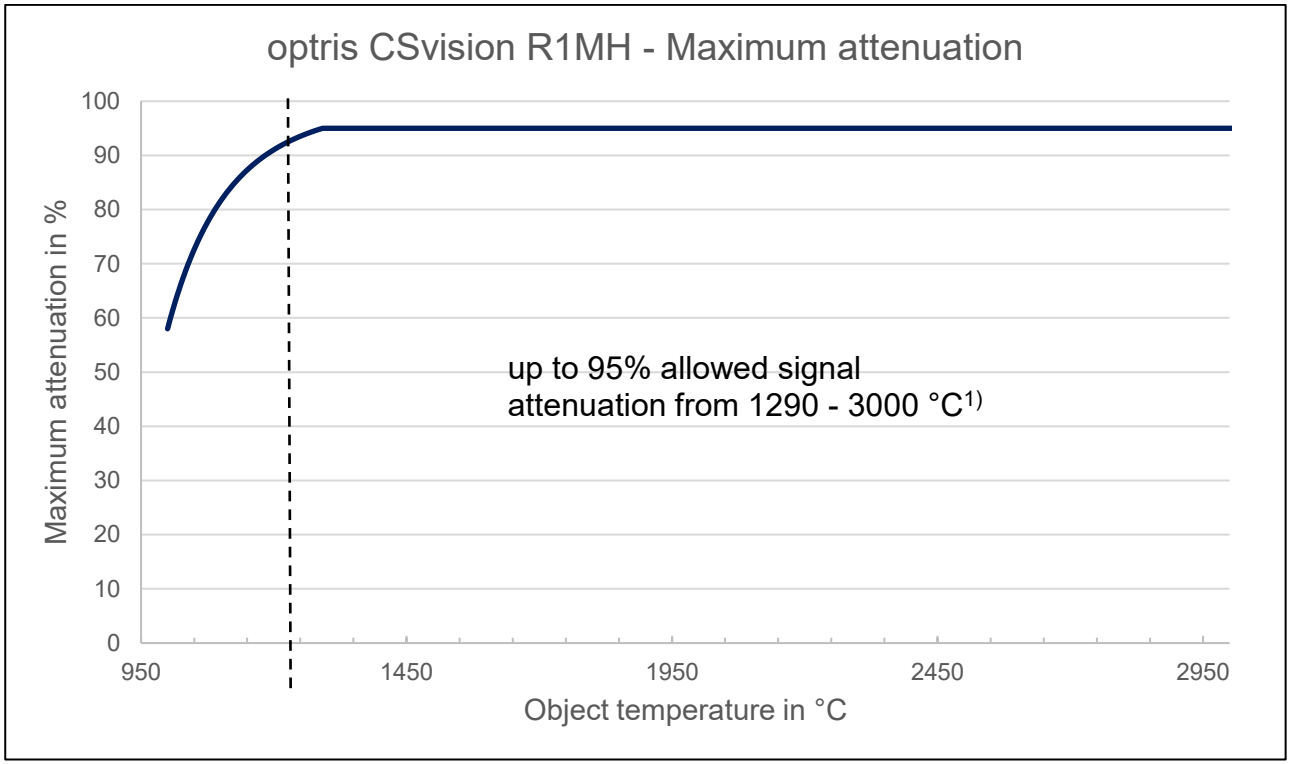
The following figures show allowed signal reduction depending on measuring temperatures. Refer to these graphs to estimate what percentage of target area must be visible to the sensor at temperatures below the minimum temperature (95% attenuation).



1) Valid only for a spectral neutral attenuation (gray) directly on or close to the sensor optics



1) Valid only for a spectral neutral attenuation (gray) directly on or close to the sensor optics



1) Valid only for a spectral neutral attenuation (gray) directly on or close to the sensor optics

Appendix A – Emissivity Table Metals

Material		typical Emissivity			
Spectral response		**1,0 µm**	**1,6 µm**	**5,1 µm**	**8-14 µm**
Aluminium	non oxidized	0,1-0,2	0,02-0,2	0,02-0,2	0,02-0,1
	polished	0,1-0,2	0,02-0,1	0,02-0,1	0,02-0,1
	roughened	0,2-0,8	0,2-0,6	0,1-0,4	0,1-0,3
	oxidized	0,4	0,4	0,2-0,4	0,2-0,4
Brass	polished	0,35	0,01-0,05	0,01-0,05	0,01-0,05
	roughened	0,65	0,4	0,3	0,3
	oxidized	0,6	0,6	0,5	0,5
Copper	polished	0,05	0,03	0,03	0,03
	roughened	0,05-0,2	0,05-0,2	0,05-0,15	0,05-0,1
	oxidized	0,2-0,8	0,2-0,9	0,5-0,8	0,4-0,8
Chrome		0,4	0,4	0,03-0,3	0,02-0,2
Gold		0,3	0,01-0,1	0,01-0,1	0,01-0,1
Haynes	alloy	0,5-0,9	0,6-0,9	0,3-0,8	0,3-0,8
Inconel	electro polished	0,2-0,5	0,25	0,15	0,15
	sandblast	0,3-0,4	0,3-0,6	0,3-0,6	0,3-0,6
	oxidized	0,4-0,9	0,6-0,9	0,6-0,9	0,7-0,95
Iron	non oxidized	0,35	0,1-0,3	0,05-0,25	0,05-0,2
	rusted		0,6-0,9	0,5-0,8	0,5-0,7
	oxidized	0,7-0,9	0,5-0,9	0,6-0,9	0,5-0,9
	forged, blunt	0,9	0,9	0,9	0,9
	molten	0,35	0,4-0,6		
Iron, casted	non oxidized	0,35	0,3	0,25	0,2
	oxidized	0,9	0,7-0,9	0,65-0,95	0,6-0,95

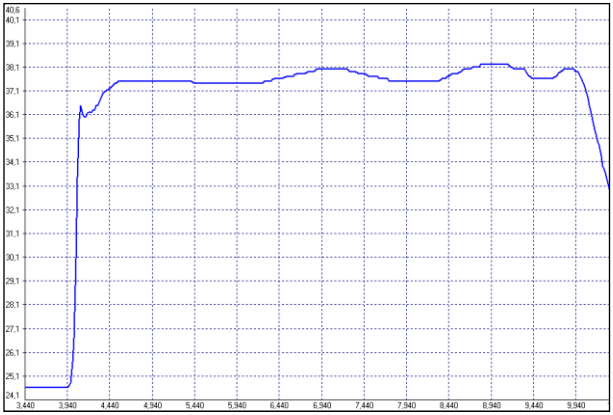
Material		typical Emissivity			
Spectral response		**1,0 µm**	**1,6 µm**	**5,1 µm**	**8-14 µm**
Lead	polished	0,35	0,05-0,2	0,05-0,2	0,05-0,1
	roughened	0,65	0,6	0,4	0,4
	oxidized		0,3-0,7	0,2-0,7	0,2-0,6
Magnesium		0,3-0,8	0,05-0,3	0,03-0,15	0,02-0,1
Mercury			0,05-0,15	0,05-0,15	0,05-0,15
Molybdenum	non oxidized	0,25-0,35	0,1-0,3	0,1-0,15	0,1
	oxidized	0,5-0,9	0,4-0,9	0,3-0,7	0,2-0,6
Monel (Ni-Cu)		0,3	0,2-0,6	0,1-0,5	0,1-0,14
Nickel	electrolytic	0,2-0,4	0,1-0,3	0,1-0,15	0,05-0,15
	oxidized	0,8-0,9	0,4-0,7	0,3-0,6	0,2-0,5
Platinum	black		0,95	0,9	0,9
Silver		0,04	0,02	0,02	0,02
Steel	polished plate	0,35	0,25	0,1	0,1
	rustless	0,35	0,2-0,9	0,15-0,8	0,1-0,8
	heavy plate			0,5-0,7	0,4-0,6
	cold-rolled	0,8-0,9	0,8-0,9	0,8-0,9	0,7-0,9
	oxidized	0,8-0,9	0,8-0,9	0,7-0,9	0,7-0,9
Tin	non oxidized	0,25	0,1-0,3	0,05	0,05
Titanium	polished	0,5-0,75	0,3-0,5	0,1-0,3	0,05-0,2
	oxidized		0,6-0,8	0,5-0,7	0,5-0,6
Wolfram	polished	0,35-0,4	0,1-0,3	0,05-0,25	0,03-0,1
Zinc	polished	0,5	0,05	0,03	0,02
	oxidized	0,6	0,15	0,1	0,1

Appendix B – Emissivity Table Non Metals

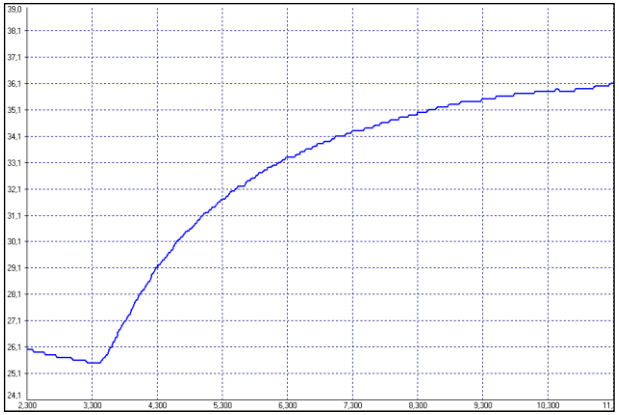
Material		typical Emissivity			
Spectral response		**1,0 µm**	**2,2 µm**	**5,1 µm**	**8-14 µm**
Asbestos		0,9	0,8	0,9	0,95
Asphalt				0,95	0,95
Basalt				0,7	0,7
Carbon	non oxidized		0,8-0,9	0,8-0,9	0,8-0,9
	graphite		0,8-0,9	0,7-0,9	0,7-0,8
Carborundum			0,95	0,9	0,9
Ceramic		0,4	0,8-0,95	0,8-0,95	0,95
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

Appendix D – EU Declaration of Conformity

EG-Konformitätserklärung
EU Declaration of Conformity

optris
infrared measurements

Wir / We

Optris GmbH
Ferdinand Buisson Str. 14
D-13127 Berlin

erklären in alleiniger Verantwortung, dass
declare on our own responsibility that

die Produktserie optris CSvision
the product group optris CSvision

den Anforderungen der EMV-Richtlinie **2014/30/EU** und der allgemeinen Produktsicherheits-richtlinie **2001/95/EG** entspricht.
meets the provisions of the EMC Directive **2014/30/EU** and the General Product Safety Directive **2001/95/EC**.

Dieses Produkt erfüllt die Vorschriften der Richtlinie **2015/863/EU** (RoHS) des Europäischen Parlaments und des Rates vom 4. Juni 2015 zur Beschränkung der Verwendung bestimmter gefährlicher Stoffe in Elektro- und Elektronikgeräten.
This product is in conformity with Directive **2015/863/EU** (RoHS) of the European Parliament and of the Council of 4 June 2015 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

Angewandte harmonisierte Normen / Applied harmonized standards:

EMV Anforderungen / EMC General Requirements:

EN 61326-1:2013 (Grundlegende Prüfanforderungen / Basic requirements)
EN 61326-2-3:2013

Gerätesicherheit von Messgeräten / Safety of measurement devices:

EN 61010-1:2010
EN 60825-1:2014 (Lasersicherheit / Laser safety)

Beschränkung gefährlicher Stoffe / Restriction of hazardous substances:

EN IEC 63000:2018

Berlin, 07.10.2022

Ort, Datum / place, date

Dr. Ulrich Kienitz
Geschäftsführer / General Manager

Appendix D – UKCA Declaration of Conformity

UKCA Declaration of Conformity

optris
infrared measurements

We

Optris GmbH
Ferdinand Buisson Str. 14
D-13127 Berlin

declare on our own responsibility that

the product group optris CSvision

meets the provisions of the UK Electromagnetic Compatibility Regulation 2016 and the Electrical Equipment (Safety) Regulations 2016.

Applied harmonized standards:

EMC General Requirements:

EN 61326-1:2021 (Basic requirements)
EN 61326-2-3:2021

Safety of measurement devices:

EN 61010-1:2010
EN 60825-1:2014 + AC:2017 + A11:2021 + A11:2021/AC:2022 (Laser safety)

Restriction of hazardous substances:

EN IEC 63000:2018

This product is in conformity with Directive 2015/863/EU (RoHS) of the European Parliament and of the Council of 4 June 2015 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

Berlin, 08.11.2022
place, date

Dr. Ulrich Kienitz
General Manager

optris CSvision-MA-E2026-08-A