

Pyrometers

METIS M311 / M322

METIS H311 / H322

With 12-pin connector, LED or OLED display and push button device configuration.
Versions with integrated optics, fiber optics, PID controller, Profibus / Profinet / Ethernet.

Operating Manual



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1 General

1.1 Information to this Manual

This manual enables the safe and efficient use with the device. The manual is part of the instrument that needs to be kept in a location where users have access to.

Read this manual carefully before operating. For secure operation all security notes and operation procedures in this manual need to be followed.

Additionally, the local accident prevention regulations and common safety regulations of the instruments installation area must be followed.

Illustrations in this manual are for basic understanding and can differ from the actual construction.

1.2 CE Conformity

The product conforms to the following EU directives:

2011/65/EU RoHS

2014/30/EU Electromagnetic Compatibility

DIN EN 60825-1:2015, laser class 2 (only devices equipped with laser targeting light)



1.3 Limitation of Liability

All information and notes in this manual are made under consideration of valid standards and rules, state of technology and our expert knowledge for many years.

The producer assumes no liability for damages due to:

- Non-observance of this manual
- Usage out of intended use
- Assignment of unskilled personnel
- Unauthorized modifications
- Technical modifications
- Usage of spare parts that are not approved.

1.4 Terms of Warranty

Our general terms and conditions apply as well as the legal regulations valid at the time of the conclusion of the contract.

A warranty period is 24 months from date of shipment form the Sensortherm facility. The seller will repair or replace the device at its own discretion. Further claims of the buyer against the seller or its agents are excluded, especially claims for damages that are not incurred in the delivery itself. This shall not apply in cases of intent, gross negligence, or the absence of assured properties. Damage or misuse of the product will be determined and void the warranty coverage. Repairs paid by the customer will include a 180 days warranty from date of shipment. Transportation costs are to be paid by the customer. Any claims for damage caused by misuse, neglect or tampering with the sensor are excluded.

Sensortherm does not guarantee that the software is free from programming errors.

1.5 Devices with PID controller

The PID controller is designed for temperature control in a variety of applications and has been tested in these applications over a long period for our satisfaction, especially in fast processes. However, Sensortherm doesn't guarantee that the temperature control meets all the desired requirements over all processes. Sensortherm excludes process responsibility.

1.6 Copyright

This manual is protected by copyrights and is intended solely for internal purposes.
It is not permitted to transfer these instructions to third parties, duplication in any kind and form - including excerpts - as well as recovery and / or notification of contents without written permission of the manufacturer, except for internal purposes.
Contraventions are liable for damages. All other rights reserved.

1.7 Customer Service / Spare Parts

For technical information contact our customer service.
It is recommended to purchase spare parts and accessories direct from Sensortherm (manufacturer).
In addition, our employees are always interested in new information and experiences arising from the application and can be valuable for improvement of our products.

1.8 Returning Goods

An **RMA number** must be requested for each device to be sent in. You will find an RMA application form on our website <https://www.sensortherm.de/en/repair-service/>, which can be provided with your address, the device data and a reason for sending it in. However, you can also contact us directly and we will then receive an RMA form that must be filled out and sent to us by e-mail. Once we have received the data and entered it into our system, you will receive a confirmation e-mail from us with your data and the RMA number. Print out this e-mail and enclose it with the shipment.

Shipments that arrive with us freight collect and shipments without an RMA number cannot be processed.

Please return items in suitable packaging to avoid damage in transit.

1.9 Disposal

Do not dispose of the product in the household waste (WEEE Directive).
Dispose of the product properly when it is no longer usable: pyrometers include electrical and electronic waste and have to be recycled or disposed environmentally friendly or to send to the manufacturer for disposal.



2 Safety

2.1 Use of the Manual

- Any person who is going to work with the device must have read and understood the operating manual before beginning.
- Operation and maintenance of the system is only to be performed by trained personnel.
- This operating manual is to be kept and handed over when passed on.

2.2 Supplementary Information about the Operation

The following symbol is used to simplify the search for useful information:

INFO indicates useful tips, recommendations and information for efficient and trouble-free operation.

2.3 Warning Notes

The following symbols are used in this manual and, if applicable, on the device as a mark for information, restrictions, preventive measures and security notes. This information indicates risks and how they can be avoided.

Please pay attention to these symbols for safety reasons.

CAUTION The hazard symbol with the signal word CAUTION on a yellow background indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE indicates a potentially hazardous situation that can lead to property and environmental damage if not avoided.

SAFETY INSTRUCTIONS indicate specific safety-related instructions or procedures.

2.4 Safety Labels / Symbols

Additionally to the warning notes used in this manual, the following warning symbols are used. Warning symbols are also to find on the device. Follow all measures marked with the label to avoid injury.



Indicates **general hazards**.



Indicates the **hazard for the eyes** from **optical radiation**.



Indicates the **hazard for the eyes** due to a class 2 **laser targeting light**.



Indicates the **hazard of automatic startup** of machine parts.

2.5 Device Labels

On the top of the device there is the type-label (nameplate) as well as a warning sticker for devices with a laser targeting light.

- Mount the device in a manner that the labels are still clearly visible after installation.
- Keep the warning signs in legible condition.
- Replace damaged labels.

2.6 Identification Label

The identification label on top of the device shows information to:

- Manufacturing company
- Series / order number (for breakdown see chap. [9.2](#))
- Temperature range, serial number and power supply
- CE sign and crossed-out waste container product mark (see [1.9 Disposal](#))
- Country of manufacture, manufacturing company and address.

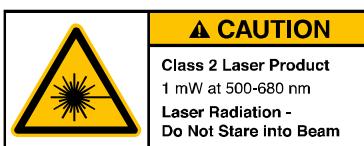


2.7 Laser Targeting Light

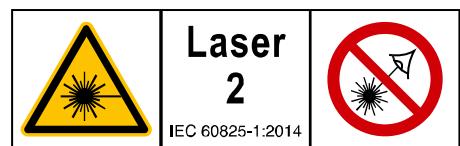
For easy alignment, the pyrometers may be equipped with a laser targeting light, laser class 2 (according to IEC 60825-1). The laser emits a visible red light with a wavelength around 650 nm or a green light with a wavelength around 515 nm and a maximum power of 1 mW.

Laser warning label on the device (depending on the country of delivery):

US sticker



EU sticker



2.8 Through-lens Sighting

Devices with through-lens sighting and temperature range above 1400°C are equipped with an adjustable eye protection filter in the eyepiece to reduce glare at high measurement temperatures. The unprotected look at temperatures >1400°C can damage the eyes function permanently.

SAFETY INSTRUCTIONS

- Never look into the direct or reflected laser beam.
- Do not point the laser to anyone.
- If laser radiation hits the eye, avert one's eyes immediately.

- Only look with darkened eyepiece at objects with temperatures above 1400°C / 2552°F to protect the eyes against glare at high radiation temperatures.
- Before looking at the high temperatures, always first adjust the eyepiece by turning it to the darkest position.

2.9 Electrical Connection

When connecting or when working on the mains voltage, the general safety guidelines must be observed, e.g. when connecting power transformers. Supply voltage can be lethal when touching. Improper installation can cause serious injury or physical damage. Only qualified personnel are allowed to work with mains voltage.

Our recommendation is the use of our wiring box accessory, this is a fully assembled connection set for Sensortherm pyrometers.

2.10 Responsibility of the Operators / Process Responsibility

If the device is used in the commercial sector the operator is subject to the legal responsibilities for workplace safety.

In addition to the safety instructions in this manual, follow the regulations of safety, accident prevention and environmental protection. If the device is integrated into a system, the safety of the system in which the device is integrated is in the responsibility of the installer of the system.

Sensortherm does not guarantee that the temperature control in all processes will meet the desired requirements. Sensortherm excludes the process responsibility.

3 Overview

3.1 Intended Use

The here described 2-color pyrometers METIS M3 and H3 are devices for non-contact temperature measurement. With its short-wave spectral range they are suitable for measurements on metals, ceramics, graphite etc. with temperature ranges depending on the model execution between 300 and 3300°C (M3) or 350 and 3300°C (H3). M3 models have a response time of < 1 ms, H3 high-speed models have a response time < 80 µs.

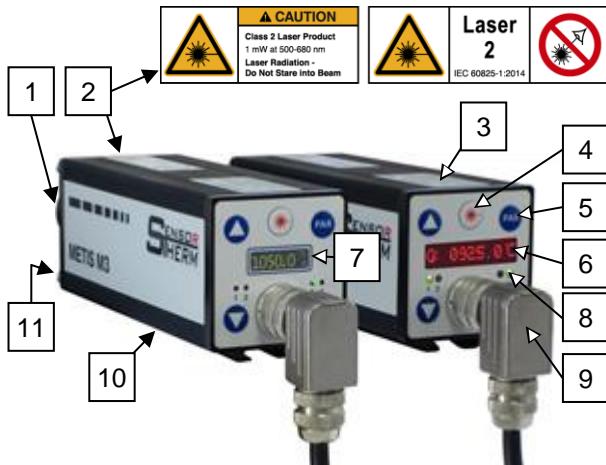
3.2 Scope of Delivery

Pyrometer with works certificate. Operating manual and *SensorTools* control and evaluation software is available from the download area <https://www.sensortherm.de/en/downloads/> on our website. (connection cables are not included in scope of delivery and need to be ordered separately).

3.3 Model Designs

- 1 Optics
- 2 Laser warning label (depending on the country of delivery); only devices with laser targeting light
- 3 Device identification label
- 4 Depending on sighting:
 - Eyepiece (models with view finder)
 - Laser targeting light push button
 - Connector for TV connection
- 5 Keypad
- 6 Red LED display (devices up to ca. 10/2020)
- 7 Green-yellow OLED display (devices from ca. 10/2020)
- 8 LEDs to indicate system ready and active switching outputs
- 9 Connectors for power supply, 2 linear analog current outputs, a serial interface (M3: RS232 / RS485 switchable; H3: RS485) and 3 configurable inputs / outputs
- 10 Mounting rail
- 11 Mounting thread (M5) for front mounting the pyrometer or accessory
- 12 Fiber optics with adjustable focus distance
- 13 Optical fiber for transporting the temperature radiation to the pyrometer
- 14 Tube to protect the optical fiber connection
- 15 Profibus / Profinet or Ethernet connectors
- 16 LEDs for monitoring the network activities (devices with Profibus, Profinet or Ethernet)

Standard models:



Differences in models with fiber optics:



Additionally at models with Profibus / Profinet / Ethernet:



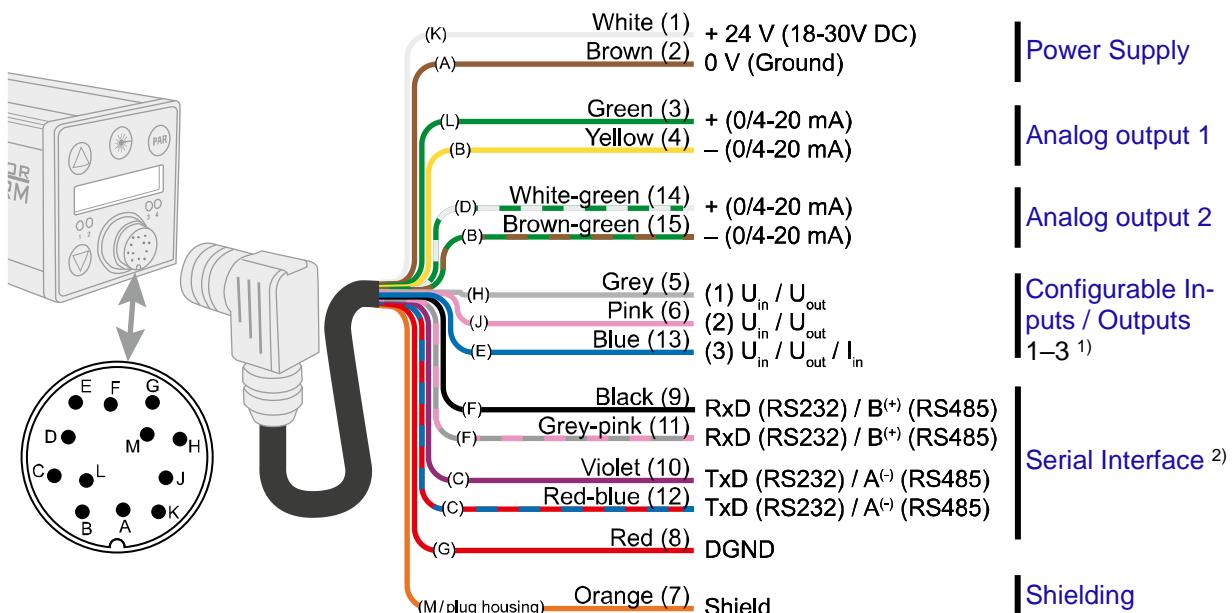
3.4 Device / Software Features

All functions described require the latest firmware on the pyrometer. If something is missing or is described differently than on your device, we recommend updating to the latest firmware (see **8 SensorFlash Software (firmware update)**).

4 Electrical Connection

4.1 Cable Colors and Pin Assignment (14-wire connection cables)

The electrical connection of the pyrometer (supply voltage and measuring signal) will be done via the connector on the rear panel. For this purpose, pre-assembled connection cables are available as accessories (see **9.3 Accessories**). To prevent accidental short circuits, not used cable wires need to be placed, for example to the supplied screw terminals.



¹⁾ Reference potential 0 V, brown
²⁾ H3 models only RS485

NOTICE We generally recommend the use of the current 14-wire connection cables. Precaution when using 12-wire connection cables that were delivered before 2015:

Connection cable for the previous models METIS and SIRIUS cannot be connected without restrictions on a M3 / H3 pyrometer!

Old connection cables are bridged in the cable connector to pins E-C and D-F. Connecting such a cable to a M3 pyrometer, serial interface and analog output 2 and digital input / output 3 are connected and the galvanic isolation between the outputs is bypassing. Thereby the pyrometer is not destroyed, but the functions are no longer available. Using such a cable only analog output 1 is available as output.

Cable colors old Sensortherm cable	Function	Pins
White	Power supply +24 V DC	K
Brown	Power supply 0 V DC (ground)	A
Green	+ Analog output (0/4–20 mA)	L
Yellow	- Analog output (0/4–20 mA)	B
Grey	Targeting light, external switch (bridge to K)	H
Pink	Maximum value storage, external clearing (bridge to K)	J
Orange	Screen	M
Red	DGND (Ground for interface)	G
Black	RxD (RS232) or B1 (RS485)	F
Violet	TxD (RS232) or A1 (RS485)	C
Grey / pink	RxD (RS232) or B2 (RS485) (bridge to F)	D
Red / blue	TxD (RS232) or A2 (RS485) (bridge to C)	E

Connector pins
cable socket
(solder side)

4.1.1 Factory Settings

Parameters	Factory Settings
Display	2-color temperature
Temperature sub range	Corresponds to basic range
Response time t_{90}	Min (corresponds to: M3: <1 ms; H3: <80 μ s)
Emissivity slope	1.000
Switch-off limit.....	10%, hysteresis: 2%
Switch-off verification.....	0 ms
Emissivity ϵ (channel 1 and 2)	1.00 (corresponds to 100%)
Transmittance	100%
Spot size fill factor.....	100%
Serial interface RS232 / 485	RS485
Data transmission speed (baud rate).....	115.2 kBd
Buffer mode	off (at "on": buffer interval: 100 ms, single reading)
Upscale Burnout function.....	off
Device address	00
Interface delay	00 (for RS232 and RS485)
Maximum value storage.....	off
Laser targeting switch-off time.....	180 s
Analog output 1	4–20 mA, output temperature: measured temperature
Analog output 2.....	4–20 mA, output temperature: no temperature output
Digital input / output 1	set to input: external switching on / off targeting light
Digital input / output 2	set to input: maximum value storage external clearing
Digital input / output 3 / Analog in	set to input: no function
Input debounce time	100 ms
Output activation time	0 ms
Output hold time.....	10 ms
Limit switch:	center of temp. range °C / °F; hysteresis: 10°C / 20°F
Device over temperature:.....	50°C / 120°F; hysteresis: 2°C / 5°F

With integrated PID controller:

Analog output 2	0-20 mA, output set to control output	P-zsc.....	100%
Digital input / output 2.....	Digital input: controller start	P-max	100%
Setpoint	Center of temp. range	P-min	0%
Proportional band Xp.....	1%	P-Dyn.....	100%
Derivative time Td.....	0 ms	AutoTune	at each start (AutoTune power: 50%)
Integral time Ti.....	10 ms	Ramp time	0 ms
Sampling time.....	10 ms	Hold time	0 ms
Ramp time	0 ms		

[INFO] to baud rate: The factory setting of the baud rate is set to 115 kBd to ensure also at longer interface cables a working data transfer. For data transmissions with the highest speed, baud rate and buffer mode must be adjusted (see [7.1.5.12](#)).

With integrated Profibus-DP / Profinet:

Field bus mode: Fixed standard format M3 series
Address 126 (delivery address)

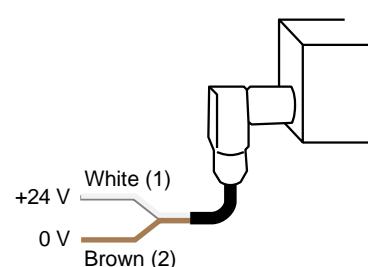
With integrated Ethernet:

Network mode: DHCP

4.1.2 Power Supply

With connection to the supply voltage (standard is 24 V DC, possible range 18–30 V) the unit is ready for operation with the factory settings.

H3 devices are thermostatically compensated and need a period of time to be ready for operation, until that time the display shows "warm-up", and the software shows "Wait". By connecting the power supply, the current firmware version is displayed for a few seconds on the display. Interrupt the power supply to turn off the pyrometer, e.g., by disconnecting the connector.



Electrical Connection

4.1.2.1 Displays on the Device

LED 4: operating status:

- **Orange:** self-test phase (M3 ca. 2 s; H3 during the initialization and thermostatic phase for ≤ 3 min.)
- **Green:** Pyrometer is ready for operation.
- **Red:** a device error occurred (see [10.3 Troubleshooting](#))

Main display:

- **Measured temperature with temperature unit °C or °F.**

Additional displays:

2C: 2-color temperature

C1: 1-color temperature channel 1

C2: 1-color temperature channel 2

Special displays:

----- Measuring temp. below beginning of temperature range

OVER Measuring temperature above end of temp. range

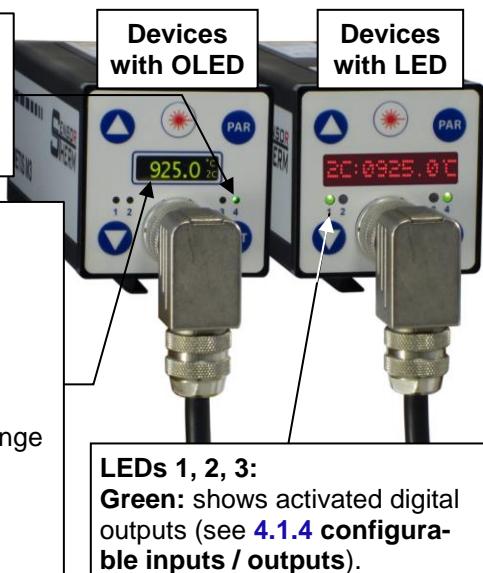
Device display set to „Suppressed“ in section [7.1.5](#)):

----- devices with LED display

No display devices with OLED display

- **Device menu / parameters** (see [6.2](#))

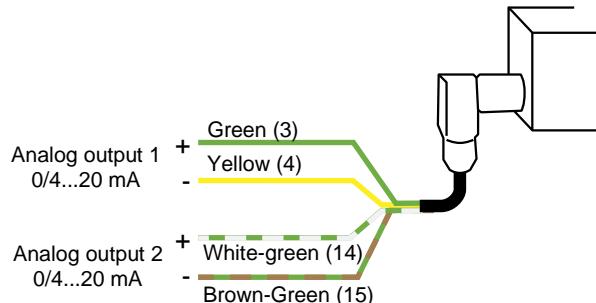
- **Focus distance** (displayed briefly) at devices with a motorized focus optics when the arrow keys are pressed.



4.1.3 Analog Outputs

2 analog outputs are available (e.g. for an external temperature display device):

- adjustable to **0–20 mA** or **4–20 mA**
- **Analog output 1** always provides the measured temperature (always the temperature displayed on the device display or the [control window](#) or [Devices Tab](#) in [SensorTools](#)).
- **Analog output 2** can be assigned to provide different signals:
 - **2-color temperature**
 - **1-color temperature**, optional channel 1 or 2
 - **Control output** (= manipulated variable) when equipped with a PID controller
 - **Device temperature**



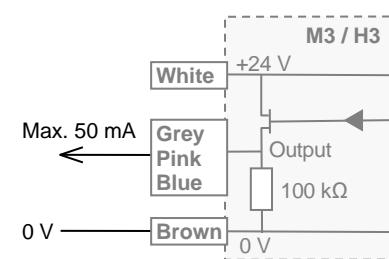
The outputs are galvanically isolated from the supply voltage

INFO on older models: If the same settings are possible on analog output 1 as on analog output 2, the device has an older firmware version. A firmware update to the latest version eliminates this possibility and thus prevents the analog output 1 from accidentally providing a different temperature signal than is displayed (Firmware update see section [8](#)).

4.1.4 Configurable Inputs / Outputs

3 ports are each available as:

- **Digital output** provides a switching signal:
 - **Device ready to operate** (device ready and error-free after self-test)
 - **Material detection** (only M3): turns on when exceeding the beginning of temperature range
 - **Limit switch** when a certain temperature threshold is exceeded or falling below
 - Exceeding the maximum allowed **internal device temperature**

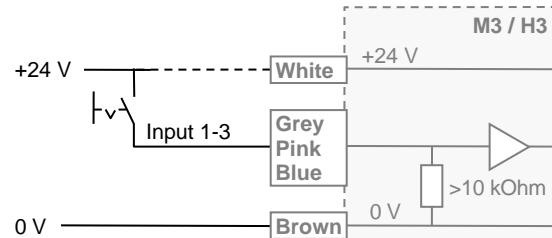


- **Signal strength too low** (for use as pollution monitoring: allows to detect the degree of contamination of the pyrometer's optics or of a viewing window or to identify interferences (dust ...) in the IR sensor's sight path and trigger an alarm if necessary).
- When equipped with PID controller: **controller activity, control within definable setpoint limits, control completed successfully, hold time finished.**

INFO The maximum output current is limited to 50 mA.

INFO The logic of the signal can be inverted (see [7.1.5 Device configuration → Logic NO / NC](#))

- **Digital input** for activating functions via voltage pulse (external button) or continuous voltage (switch).



Note: The input is safely detected as "high" at a voltage > 15.5 V and safely detected as "low" at a voltage < 3.0 V.

- **Clearing the peak picker** by voltage pulse.
- **Start controller** by voltage pulse (only devices with PID controller).
- **Activate controller** as long as voltage is present at the connection (only devices with PID controller).
- **Load pyrometer configuration (Setups)** by voltage pulse (digital input "parameter selector").
- **Switch on / off laser targeting light** (when equipped with a laser targeting light) (the targeting light will automatically switch off after 3 minutes if it is not switched off manually. The switch-off time is adjustable via software under [7.1.5 Device configuration → Laser targeting light settings](#)).



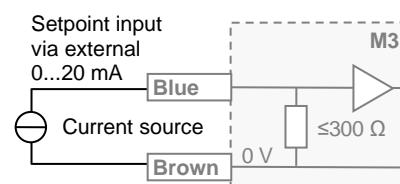
CAUTION Laser radiation, laser class 2, do not look into the beam.

SAFETY INSTRUCTIONS

- Never look into the direct or reflected laser beam.
- Do not point the laser to anyone.
- If laser radiation hits the eye, avert one's eyes immediately.

INFO A **debounce time** can be selected, that is, a period the signal at least must be present at an input so that it can be recognized and processed by the system (3 ms are specified by the pyrometer hardware). Values between immediately (0) to 1 s can be set.

- **Analog input** (only M3 and on port 3) for external adjustment of some parameters between their smallest and largest setting value.
 - **Emissivity slope** (0 mA = 0.8; 20 mA = 1.2)
 - **Emissivity** for every channel (0 mA = 0.05; 20 mA = 1.2)
 - **Setpoint** at devices with PID controller (0 mA = zero scale temperature, 20 mA = full scale temp.)
 - **Focus distance** at M3 devices with motorized focus (0 mA = shortest distance, 20 mA = widest distance)



INFO The analog input requires a current source of 0-20 mA and can be generated, for example, via a setpoint generator.

For activation, input 3 must be activated via the *SensorTools* software in the device configuration (see [7.1.5](#))

4.1.5 Serial Interface RS232 / RS485 (M3: switchable RS232 / RS485; H3: only RS485)

The serial interface is used for digital communication of the pyrometer with another computer, for example a PC for data transmission to the *SensorTools* software. Via interface always all temperatures are transferred (2-color and one channel temperatures) as well as device information and parameters.

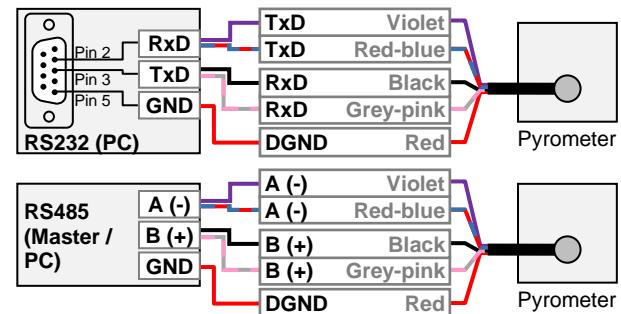
The maximum transmission speed (Baud rate) is limited by the cable length; it is halved with each doubling of the transmission path.

- **RS232:** about 7 m cable length with 19.2 kBd. Adjustable are values from 4.8 to 115.2 kBd.
- **RS485:** about 2 km with 19.2 kBd. Adjustable are values from 4.8 to 921.6 kBd.

Connecting one pyrometer via RS232 or RS485:

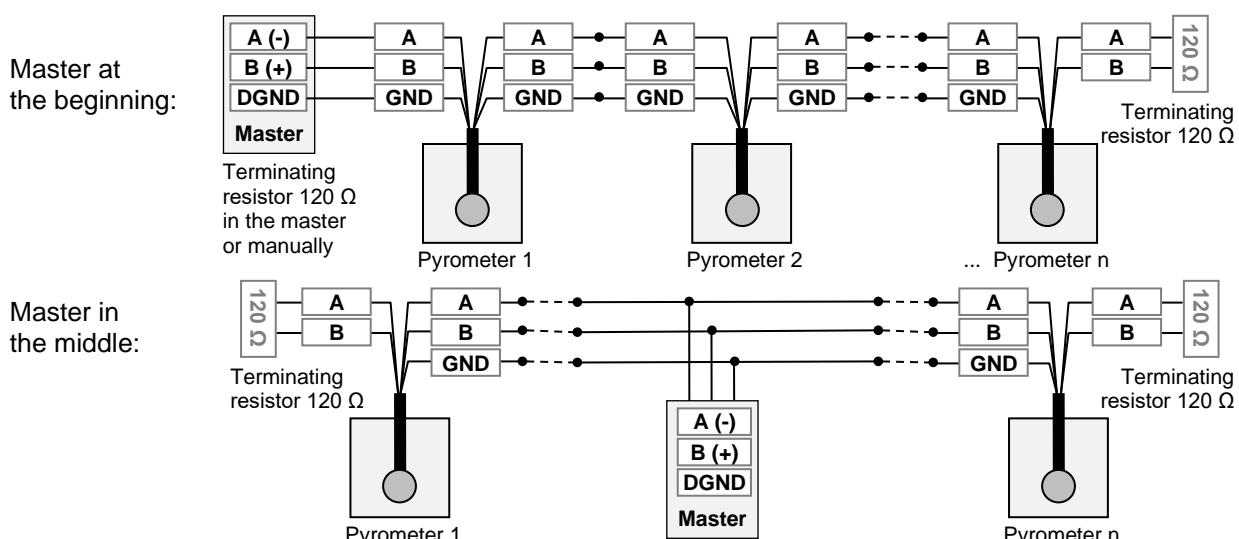
In a short RS232 or RS485 connection to the master (computer receiving the data), the pyrometer is connected directly as a point-to-point connection with the master.

It is advantageous to connect all interface cables in order to avoid reflections.



Connecting several pyrometers via RS485:

For a reflection-free operation with longer cables, pay attention to the correct cable termination. Termination at the physical bus is on front and rear.

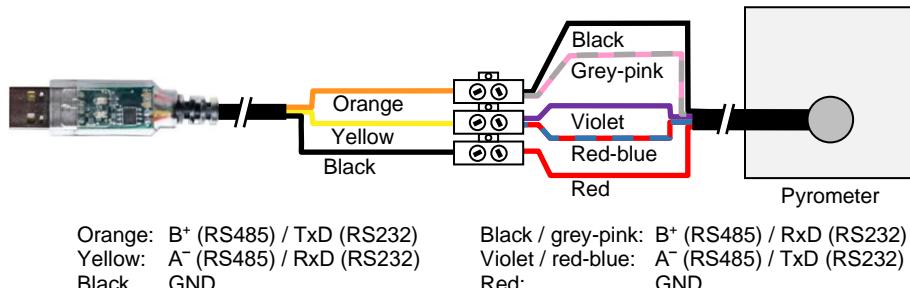


When operating multiple devices (up to 32 are possible), each device needs to assign its own address (directly on the device or via software *SensorTools*), under which it can be addressed later. For this purpose, initially, each device must be connected individually and provided with an address (00-97). After that, all devices can be connected.

If specific parameters for all devices should be changed simultaneously, the global address 98 is used (there is no response from the device). If the address of a device is unknown, you can address each device independently of the set address with the global address 99 (connect only one device).

4.1.5.1 Interface Converter (Accessory)

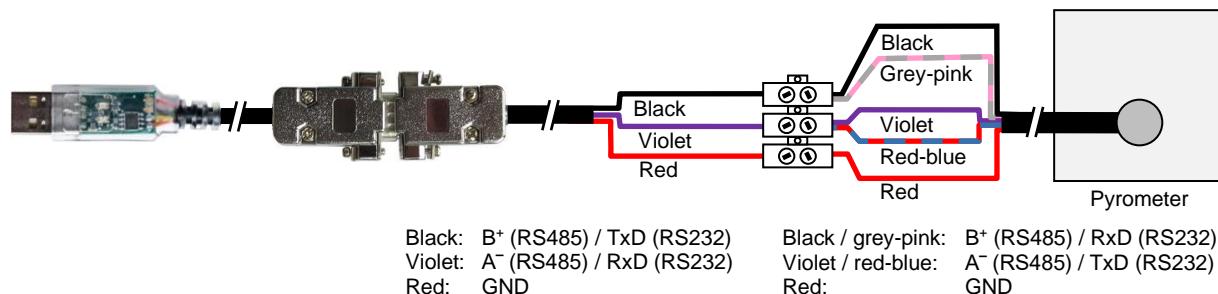
A quick and easy way to connect the pyrometer to a PC is to use an interface converter or a connecting cable with integrated interface converter (see **9.3 Accessories**).



- Interface converter **DK5485**: RS485 to USB for baud rates up to 921.6 kBd (recommended)
- Interface converter **DK5232**: RS232 to USB for baud rates up to 115.2 kBd (slower data transfer)

A suitable driver must be installed so that the interface converter is recognized by *SensorTools*. After installing *SensorTools*, the driver can be found in the installation directory in the "Driver" subfolder or can be downloaded from the FTDI homepage: www.ftdichip.com/Drivers/VCP.htm.

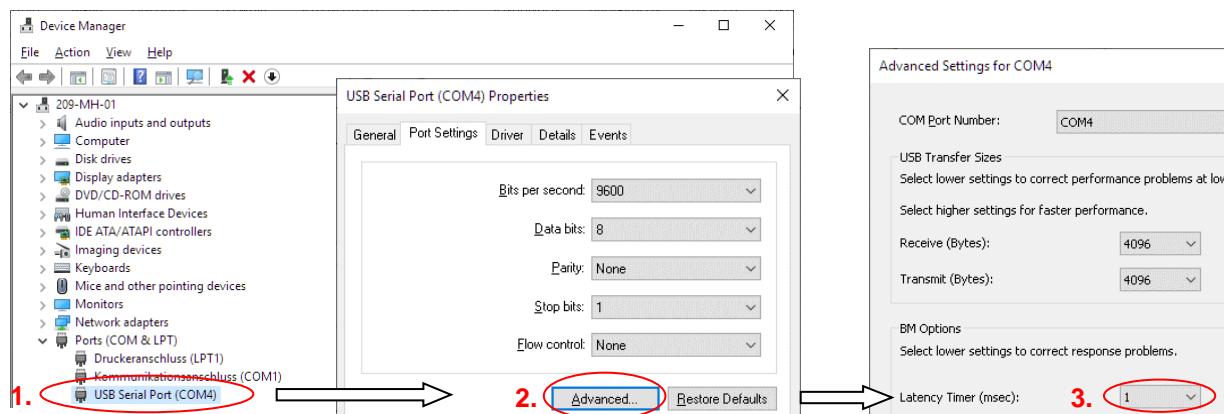
Alternatively, the interface converters are available with a 9-pin Sub-D connector instead of open connection wires. This can be used if a type of AM pyrometer connection cable has been ordered. This includes a 1 m cable with Sub-D socket, which can be used to flexibly connect the interface converter.



- Interface converter **DK4000**: RS485 to USB for baud rates up to 921.6 kBd (recommended)
- Interface converter **DK3000**: RS232 to USB for baud rates up to 115.2 kBd (slower data transfer)

4.1.5.2 Maximum Transfer Speed

To achieve the maximum transfer speed, it is necessary to change the latency time in the advanced port settings from the default 16 ms to 1 ms (administrator rights required):



1. Open Device Manager (right-click on the Windows Start button ()) and select "Device Manager" in the menu).
2. Double click on "Ports (COM and LPT)" → USB Serial Port (COMx) of the interface converter.
3. Select the tab "Port settings" and then click on "Advanced".
4. Set the latency timer to 1 ms (in "BM Options").

4.1.6 Shielding / Avoidance of Cable-Related Interferences

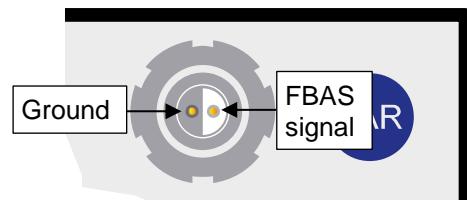
For trouble-free signal transmission between the pyrometer and evaluation devices such as external displays or PC / PLC, the connection via cable with electromagnetic shielding is necessary. Our connection cables have a shield that is connected in the connector housing and connected to the pyrometer housing via the pyrometer connector. On the connection side, the screen is led out via the orange wire.

To prevent interference from electromagnetic fields, potential differences or compensating currents, the shielding should only be connected on one side:

- Connect the pyrometer housing to the system ground (via one of the M5 screws on the front of the optics) and do not connect the shielding (orange wire at the end of the cable) (but connect it for example to one of the screw terminals supplied, to avoid accidental short circuits). The pyrometer housing is anodized and is therefore not suitable for connecting an earth connection.
- Mount the pyrometer ungrounded (insulated attachment, ensure, the pyrometer does not have an electrical connection to the system at any point) on the system and connect the shielding (orange wire at the end of the cable) to the ground of the PC or PLC.

4.1.7 Camera Module

Pyrometers with a camera module as an alignment method are equipped with an additional connector on the rear of the device for the output of the camera signal (CVBS signal). The connection to a monitor or video grabber with video input is made using the AK50 connection cable (accessory, length can be ordered in 5 m increments up to 30 m, with cinch connection on the opposite end).



4.2 Devices with additional Profibus-DP or Profinet Connection

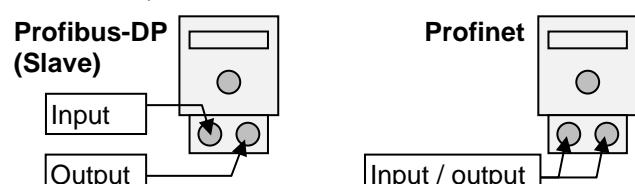
The Profibus or Profinet interface is used for the digital communication of one or more pyrometers with a PLC. It is available in addition to the serial RS232 or RS485 interface.

The connection is made in accordance with the applicable bus specifications.

The maximum possible transmission speed is limited by the cable length:

- **Profibus:** 9.6–93.75kb/s → 1200 m up to 3-12Mb/s → 100m
- **Profinet:** According to Ethernet standard (Cat5 / Cat6 cable) → 100 m

For the typical connection in succession, there are 2 connections on each device as input and output.



General Station Description (GSD): The device description file, which must be integrated into the configuration of the master (PLC) and can be found in the *SensorTools* installation directory under C:\Programs\Sensortherm GmbH\SensorTools in the subfolders ProfibusGSDs or ProfiNetXMLs or can be downloaded from our website https://www.sensortherm.de/en/downloads/#anleitungen_software.

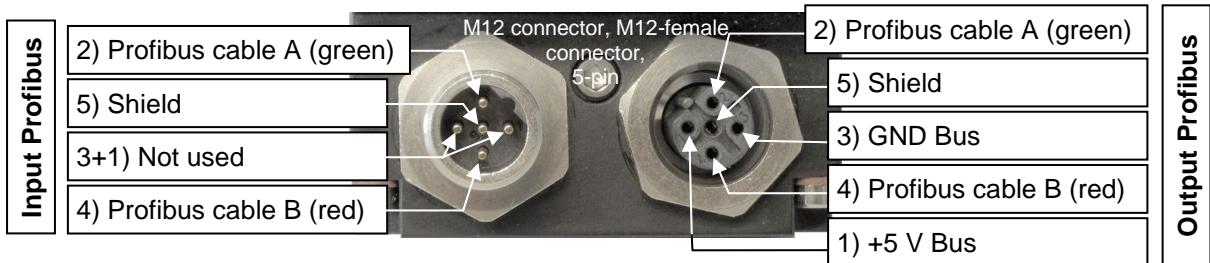
INFO about the GSD file of old METIS Profibus devices: If old METIS devices are replaced by new METIS 3 devices, the correct GSD file must also be included.

3 different transmission modes are available to receive the data packets:

- A fixed M3 standard mode (factory setting),
- a backward compatible to old METIS devices
- a variable format in which the data to be transmitted can be selected.

The modes can be selected on the device menu or via *SensorTools* software. The variable format must be configured via *SensorTools* (settings under → Device configuration → Field bus mode, also see [7.5](#)).

4.2.1 Pinout Profibus-DP

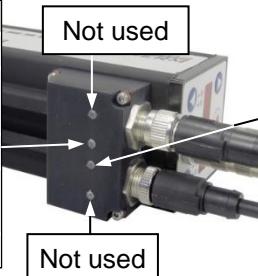


Profibus terminating resistor: If no other Profibus device is connected to the output, the output must be terminated with resistors. The terminating resistor plug AK81 is used for this purpose (accessory, see 9.3). The internal wiring is shown on the right.



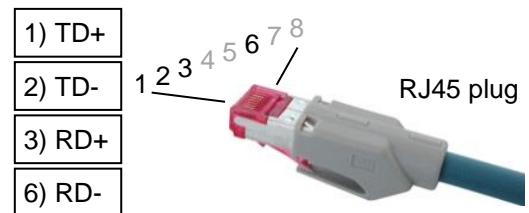
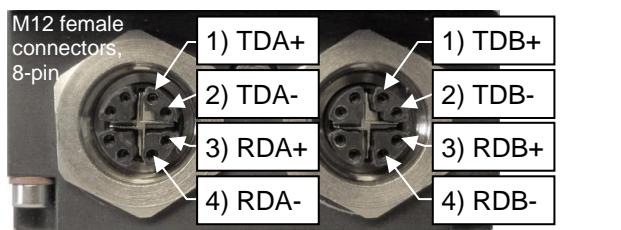
4.2.1.1 Status LEDs Profibus-DP

mode	Meaning
Off	Offline
Green	Online, data exchange
Green flashing	Online, clear
Red flashing, 1x	Parameterization error
Red flashing, 2x	Configuration error



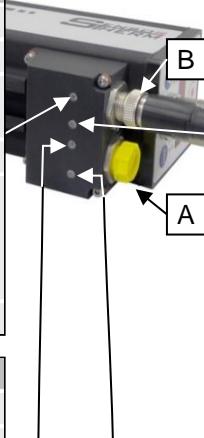
Module status	Meaning
Off	Not initialized
Green	Initialized
Green flashing	Initialized, diagnostic event(s) present
Red	Exception error

4.2.2 Pinout Profinet



4.2.2.1 Status LEDs Profinet

Module status	Description
Off	Not Initialized
Green	Normal operation
Green flashing, 1x	Diagnostic event(s)
Red	Exception error
Red	(combined with red network status LED) Fatal event
Alternating red / green	Firmware update



Network status	Description
Off	Offline
Green	Online (run)
Green flashing, 1x	Online (stop)
Green flashing	Blink
Red	(combined with red module status LED) Fatal event
Red flashing, 1x	Station name error
Red flashing, 2x	IP address error
Red flashing, 3x	Configuration error

Link / activity for A	Description
Off	No link
Green	Link
Green, flickering	Activity

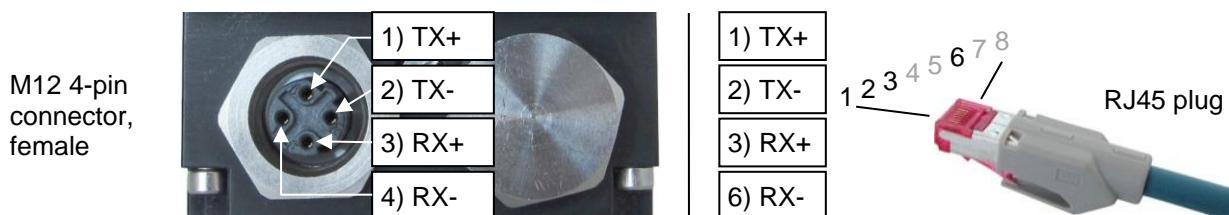
Link / activity for B	Description
Off	No link
Green	Link
Green, flickering	Activity

4.3 Devices with additional Ethernet Connection

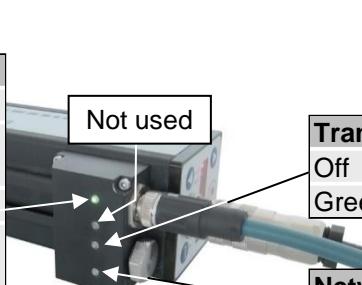
The Ethernet interface is used for the digital communication of one or more pyrometers over the network. It is available in addition to the serial RS232 or RS485 interface. The connection is made in accordance with the applicable bus specifications.

The maximum possible transmission speed is limited by the cable length:

- 100 m according to Ethernet standard (Cat5 / Cat6 cable).

4.3.1 Pinout Ethernet**4.3.1.1 Status LEDs Ethernet**

Operating mode	Description
Green	DHCP
Green flashing	DHCP + active socket connection
Orange	Fixed IP address
Orange flashing	Fixed IP address + active socket connection
Red flashing	IP error



Transfer rate	Description
Off	10 Mbit
Green	100 Mbit

Network status	Description
Green flashing	Network traffic

5 Mechanical Installation

5.1 Mounting

- The **mounting rail** on the bottom case is for the stable take-up of for example of a ball and socket mounting (for fiber optics devices a mounting angle is recommended, see [9.3 Accessories](#)).
- Front M5 **threaded screws** can also be used for mounting (all 4 threads has to be used for fixing).
- The slightest deviation from the optical axis is achieved with the **optics adapter / holder** of motor focus devices.
- Note that the **installation** of the pyrometer is free of vibrations, if necessary, helps the use of rubber absorbers when mounting.
- To keep the **optical fiber** ready for use as long as possible, it should be exposed as little as possible to permanent movement and mechanical stress. Lay the optical fiber as possible with a large bending radius, especially if it is carried along moving parts.



Example.: METIS with swivel mounting base, cooling plate and air purge unit

INFO Through manufacturing tolerances the optical and mechanical axis are not running 100% in the same direction. The pyrometer should be realigned if it is installed again and twisted in the same holder (see [5.4 Alignment onto the measuring object](#)).

5.2 Mounting Optical Fiber / Optics (only devices with optical fiber)

5.2.1 Bending Radius of Optical Fiber

The color code on the optical fiber identifies the optic diameter and minimum bending radius associated.

Color marking optical fiber	blue	red
Fiber diameter	0.4 mm	0.2 mm
Minimum bending radius	150 mm	75 mm

When laying the optical fiber, it is to observe the minimum bending radius. A bending radius smaller than specified can cause a stretched or broken optical fiber.

5.2.2 Winding and Unwinding the Optical Fiber

During winding and unwinding the optical fiber must be able to move easily and should not be twisted. Ideally, one hand winds up the light guide carefully, while the other hand guides the cable roll. For torsion-free winding only one side of the optical fiber should be connected, then the other can be moved freely.



NOTICE Avoid strong tensile and torsional forces during installation, optical fiber could break.

5.2.3 Mounting the Optical Fiber

Assignment fiber to pyrometer and optics: Each fiber is uniquely associated to a pyrometer and optics. For identification, all three components are tagged with the same device number. The measurement accuracy can only be guaranteed with proper assignment.

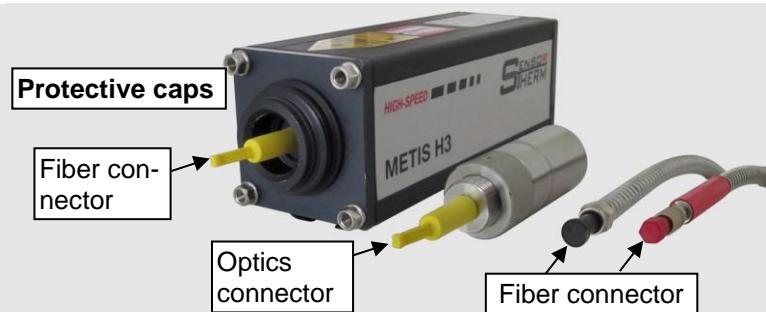


Mechanical Installation

INFO To meet the high accuracy, the instrument should be recalibrated when replacing an optics or the fiber optic cable.

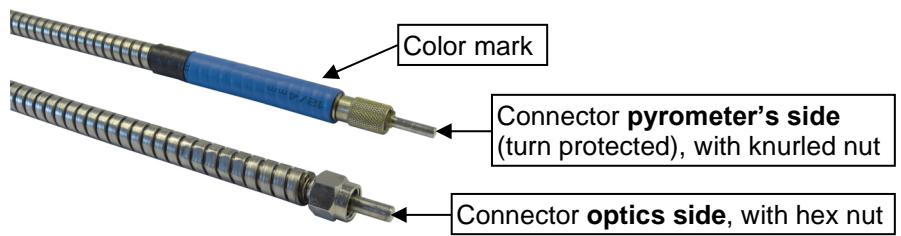
NOTICE Only remove the protective caps from the pyrometer and optics and fiber directly before assembly to prevent dirt from getting in and scratching the fiber connections during assembly.

Keep the protective caps to ensure protection again in the event of later disassembly or storage.

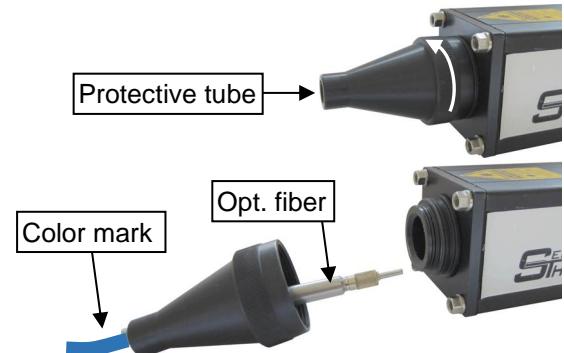


The optical fiber has to be mounted true-sided:

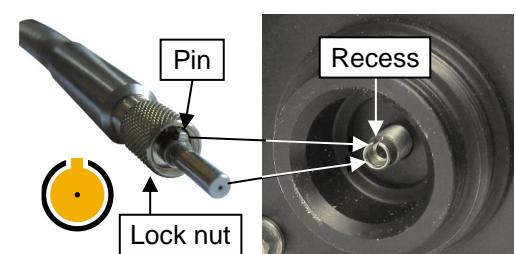
- The colored heat shrink tube marker matches to the pyrometer side.
- The optics fit on the side without marking.
- Unscrew the optical fiber protective tube from the pyrometer's housing.



- Pull the protective tube a little about the optical fiber on the colored side to avoid pulling it over the complete fiber after fiber assembly.

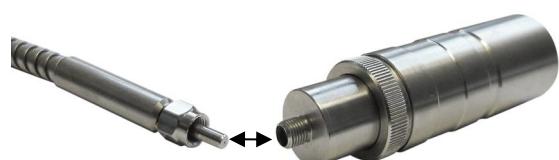


- Remove the protective caps from the pyrometer and optical fiber, insert the side with the turn protected fiber connector to the pyrometer, and make sure that pin and recess snap together.
- Tighten lock nut hand-tight (do not use a tool, otherwise the screw or optical fiber can be damaged).
- Finally screw the protective tube back on the pyrometer housing.



5.2.4 Connect the Optics

- The fiber-optic connectors on the side of the optics does not require special adjustment and is just plugged and screwed.
- Tighten lock nut hand-tight (do not use a tool, otherwise the screw or optical fiber can be damaged).



5.3 Ambient Temperature

- **M311** and **M322** pyrometers are designed for ambient temperatures between 0 and 80°C / 32 and 176°F.
- **H3 models** for ambient temperatures between 0 and 60°C / 32 and 140°F.
- **Fiber optics and optical fiber of fiber optic devices** can be exposed to ambient temperatures between -20 and 250°C (-4 to 482°F) on the optics side and up to 120°C (248°F) on the housing side. The temperatures for the housing are the same as for the standard devices.

[INFO] to avoid overheating of the laser targeting light or camera module:

- The laser targeting light is deactivated at an internal device temperature above 65°C / 149°F (M3 devices) or above 60°C / 140°F (H3 devices).
- The camera module is deactivated at an internal device temperature above 55°C / 131°F.

[INFO] to avoid premature aging of the OLED display:

- If no key is pressed for 10 minutes, the OLED display is darkened.
- The OLED display is darkened from an internal device temperature of 60°C / 140°F.
- The OLED display is switched off from an internal device temperature of 75°C / 167°F.

Below these temperatures, the sighting can be used again, or the OLED works with its full brightness.

Operation outside this temperature leads to incorrect measurements and may damage the device.

To comply with the permitted ambient temperature, sufficient distance from the (hot) measuring object is to observe. With radiant heat from the front, the pyrometer can be protected by a cooling plate, the use of the pyrometer in ambient temperatures outside the permissible pyrometer ambient temperature is possible with an additional cooling housing (accessory).

- The internal device temperature can be read out in the connection area or in the [control window](#) of the *SensorTools* software.
- It is possible to configure one of the switching outputs so that a corresponding signal is switched when the maximum temperature is exceeded (see [4.1.4 Configurable Inputs / Outputs](#) and under [7.1.5 → Configurable Inputs / Outputs](#)).



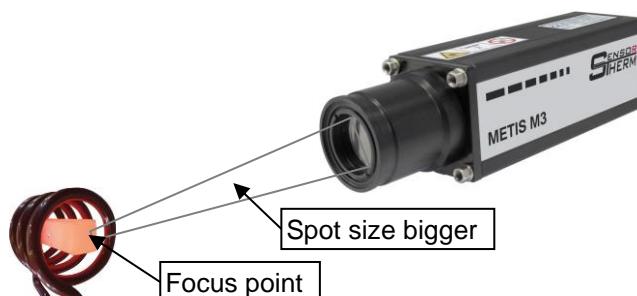
5.4 Ratio Technology / Alignment onto the Measuring Object

In opposition to radiation pyrometers, 2-color pyrometer measure in two spectral ranges simultaneously (two separate detectors at two adjacent narrow-band wavelengths) and determine the temperature by forming the radiation ratio (quotient).

In this method it is not necessary to know the emissivity of the target material. It cancels out because the radiation ratio remains constant at a neutral attenuation of infrared radiation (by dust, smoke ...). However, this reduction will only be successful if signal attenuation occurs homogeneously on both wavelength ranges. If the emissivity change in the two wavelengths e.g. with increasing temperature, also the relationship changes which results in measurement errors.

Via the Software *SensorTools* the 2-color temperature and the temperatures of the individual channels can be shown simultaneously to identify possible wavelength dependence (see [6.2.3 Emissivity slope](#)).

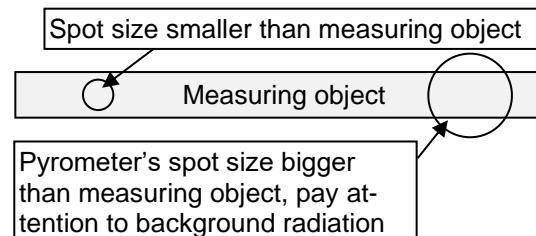
To detect the temperature correctly, the pyrometer must be properly aligned to the measuring object. In the focus point of the optics (focus distance) the spot size diameter is the smallest. Also, measurements in the defocused area can be done to determine the average temperature of a bigger spot.



To get a correct measurement result, the following requirements must be observed:

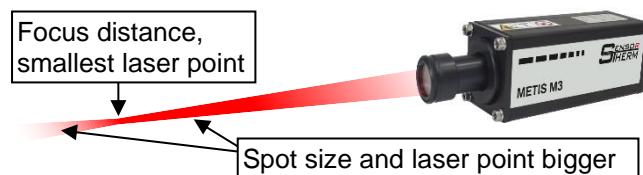
- For measurements through window, the window material has to be observed. If the transmission properties are not uniform (e.g. quartz glass), the corresponding emissivity slope has to be entered.

- A viewing window between pyrometer and the measured object must have constant transmission properties in the spectral range of the pyrometer (e.g. quartz glass or BK7 crown glass).
- The distance to the measured object must be in the range of focusable measurement distance of the optics, if a precise measurement is to be made.
- If the target is smaller than the spot size diameter, a warm background temperature effects the measurement. But this effect is not below about 300°C.
- If the target is smaller than the spot size, less signal strength arises to the pyrometer. If this falls below 2%, a measurement is no longer possible (see **6.2.4 Switch-off Level**).
- Entering a fill factor that indicates how much percent of the measuring field is filled, has no influence if using the 2-color measuring mode. In 1-color mode, measurements can be performed of measuring objects that are smaller than the spot size. Requirement is a cold background temperature, otherwise background temperature will be influenced the measurement result.



5.4.1 Alignment with the Laser Targeting Light

The laser targeting light is a conical red laser beam with the largest diameter directly at the lens and the smallest and sharpest in the focused distance, i.e. at the point where the measuring field is the smallest (= focus distance in the [Spot Size Tables](#)).



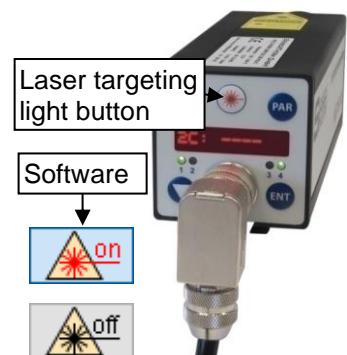
CAUTION **Laser radiation, laser class 2, do not look into the beam.**

SAFETY INSTRUCTIONS

- Never look into the direct or reflected laser beam.
- Do not point the laser to anyone.
- If laser radiation hits the eye, avert one's eyes immediately.

Turn on / off: Via the targeting light button on the devices rear panel or via software *SensorTools* (in the [Connection Window](#) or [control window](#)).

The targeting light will automatically switch off after 3 minutes (if it is not switched off manually). The switch-off time is adjustable via software (see under [7.1.5 Device Configuration → Laser targeting light settings](#)).



INFO **The laser targeting light is turned off at a device temperature above 65°C (M3 devices) or 60°C (H3 devices).**

If the targeting light does not turn on, probably the device's internal temperature is too high. In this case, the place of installation of the pyrometer should be checked (excessive heat radiated from the measuring object). If the temperature falls below the switch-off value, the laser will work again.

INFO **to the spot size:** The size of the laser point does not match to the spot size; spot sizes are given in the [Spot Size Tables](#).

INFO **to M311:** The laser targeting light is pulsed in these devices, i.e. the laser is alternately on or a measurement is taking place. This is necessary because the spectral range of the pyrometer and the red laser targeting light influence each other. For certain measuring tasks, such as when using the peak picker, this must be taken into account by using the laser targeting light only for alignment; the measurement itself should then only be carried out with the laser targeting light switched off.

5.4.2 Alignment with the Through-Lens View Finder Sighting

The view finder provides upright imagery so that the target under measurement can be viewed visually. A target circle shows the measuring spot when the target is in focus.

INFO The size of the target circle does not match to the spot size; spot sizes are given in the [Spot Size Tables](#).



Devices with temperature range above 1400°C are equipped with a continuously adjustable eye protection filter in the eyepiece to reduce glare at high measurement temperatures. Rotating the eyepiece will change the brightness.



CAUTION at measurement temperatures above 1400°C / 2552°F, risk of eye damage.

SAFETY INSTRUCTIONS

- Sight objects with temperatures above 1400°C / 2552°F only with the eyepiece darkened to protect the eyes from glare at high radiation temperatures.
- Before looking at the high temperatures, always first adjust the eyepiece by turning it to the darkest position.

5.4.3 Alignment with the Camera Module

Pyrometers with a color camera module provide a composite video output that can be connected to a TV or monitor or PC via converter. For example, analog to HDMI converters are commercially available. The pyrometer is focused and aligned via a target circle on the TV screen.



About the field of view of approximately 3.6% x 2.7% of the measured distance also the measurement events can be observed. About the PC software, image overlays and monitor settings can be configured (in the [Connection Window](#) or [control window](#) → [monitor settings](#)).

INFO about the target circle size: The size of the target circle does not match to the spot size; spot sizes are given in the [Spot Size Tables](#).

INFO The camera module is turned off at a device temperature above 55°C.

If the camera module does not turn on, probably the device's internal temperature is too high. In this case, the place of installation of the pyrometer should be checked (excessive heat radiated from the measuring object). When temperature falls below 55°C the camera module is working again.

5.5 Adjusting the Measuring / Focus Distance

The focus distance is the distance at which the lens has the smallest spot size. In most cases, this distance is also the required measuring distance.

- With focusable optics the focus distance can be changed continuously within a predetermined range, so the smallest possible spot size is always achieved.

5.5.1 Manually Focusable Optics

- Release optics turn counterclockwise.
- Move optics in or out until the measured distance is found (see [5.4 Alignment onto the measuring object](#) or via the optics pull-out in the [spot size tables](#), see section [5.6](#)).
 - Pulled optics: short measuring distance
 - Inserted optics: long distance measurement
- Lock optics turn clockwise (hand-screwed, without tools).

1. Release
2. Adjust
3. Lock

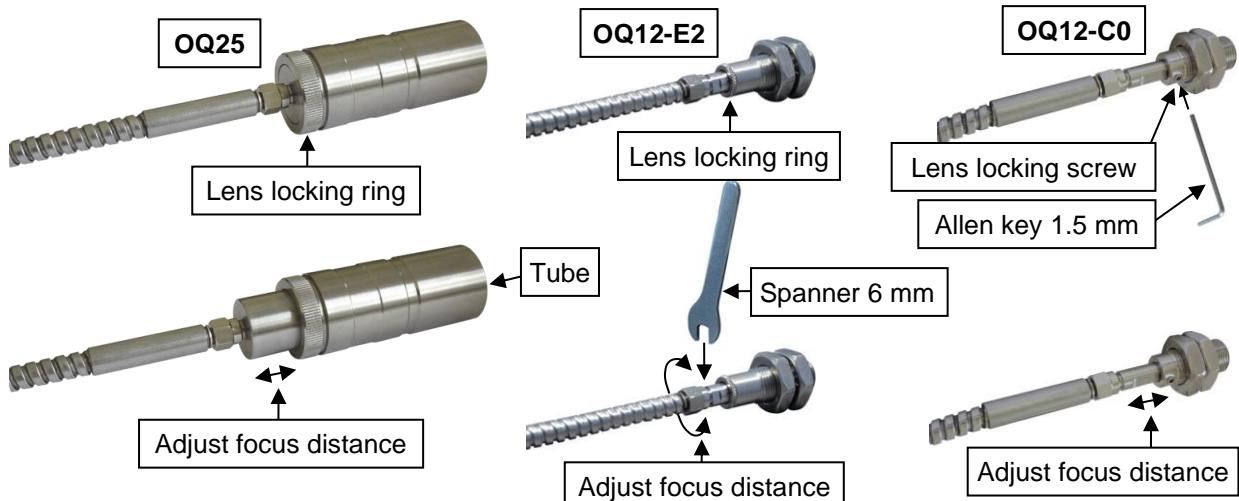


5.5.2 Motorized Focus Optics (only M3)

- Set the measuring distance with the arrow push buttons  on the device, the set distance is displayed on the device display for a few seconds, then will return to the measurement temperature.
- The distance also can be set via software (see **7, SensorTools Software**).



5.5.3 Manually Focusing Fiber Optic Lenses



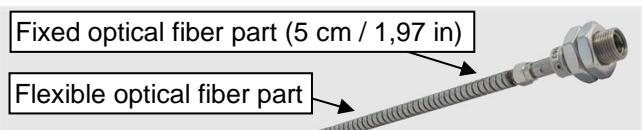
- OQ25 and OQ12-E2:** Loosen the locking ring a little by hand.
- OQ12-C0:** Loosen the locking screw a little with a 1.5 mm allen key.
- Adjust the focus distance:**
 - OQ25 and OQ12-C0:** Pull or push the rear part of the optics out of the tube by hand.
 - OQ12-E2:** Screw the rear part of the optics in or out.
- Tighten the locking ring or locking screw hand-tight.

INFO to the laser point size: In the focus distance, the laser point shows the smallest diameter.

INFO to optics position:

- Optics fully extended: shortest focus distance.
- Optics fully inserted: divergent focus distance.
- Optics in between: focus distance according to the **spot size tables** of the **Focusable Fiber-Optic Lenses**.

NOTICE Only pull on the fixed part of the optical fiber directly on the connector **to focus**, never on the flexible part, otherwise the fiber could tear.

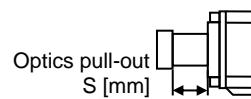


5.6 Spot Size Tables

The following tables show the optical data of the different device types. The values in the tables are exemplary, intermediate measurement distances must be determined by interpolation. If the measuring distance differs from the adjusted or specified focus distance, a measurement is also possible, but the spot size changes (usually it is larger, see **5.6.3 Calculation of the spot size diameter outside the focused distance**).

Focus distances at manually focused optics are specified from lens front, at motorized optics from the protection window.

The specification of the spot size diameter refers to the area from which 90% of the thermal radiation is recorded by the pyrometer.



5.6.1 Manually Adjusted or Motorized Focus Optics

Optics	Model Temperature ranges [°C]		M322: 300-1000°C H311: FSC <1500°C H322: FSC <1200°C	M311/ M322: all other temp. ranges H311: FSC ≥1500°C H322: FSC ≥1200°C
	Meas. distance a [mm]	Optics pull-out S [mm]		
M311 / H311: OQ11-A1	340	26	1.4	0.8
	400	20.7	1.8	1
	500	15.5	2.7	1.2
	600	11.7	3	1.5
	800	7.7	4.3	2.2
	1000	5.5	5.6	2.8
	1500	2.7	7.7	4.4
	2000	1.3	10	5.8
	2500	0.5	12.5	6.9
	3000	0	15	8
M311: OQ11-F1	1000	7.5	5.6	2.8
	2000	3.3	10	5.8
	3000	1.9	14	7.8
	4000	1.2	19	11
	5000	0.8	24	14
	10000	0	51	29
M322: OQ22-F2	1000	7.5	5.6	2.8
	2000	3.3	10	5.8
	3000	1.9	14	7.8
	4000	1.2	19	11
	5000	0.8	24	14
	10000	0	51	29

FSC = Full scale temperature

Aperture diameter D: Full scale temperature value ≤ 1400 °C: 14-16 mm; > 1400 °C: 7-8 mm
(D is dependent on the optics pull-out: optics pulled out: higher value, optics inserted: smaller value)

5.6.2 Focusable Fiber-Optic Lenses

25 mm Optics	Model Temperature ranges [°C]		M322: 300-1000°C H311: FSC <1500°C H322: FSC <1200°C	M311/ M322: all other temp. ranges H311: FSC ≥1500°C H322: FSC ≥1200°C
	Meas. distance a [mm]	Spot size diameter M [mm]		
M311 / H311: OQ25-B1	240	2	1	
	300	2.5	1.5	
	400	3	2	
	500	3.7	2.5	
	600	4.5	3	
	700	5.2	3.5	
	800	6	4	
	1000	7.7	5	
	1500	11.5	7.5	
	2000	15.4	10	
M322 / H322: OQ25-B2	2500	19.2	12.5	
	3000	23	15	

Aperture diameter D: 10-13 mm Fiber Ø 0.4 mm Fiber Ø 0.2 mm
(D is dependent on the optics pull-out: optics pulled out: higher value, optics inserted: smaller value)

12 mm Optics	Meas. distance a [mm]	Spot size diameter M [mm]	
OQ12-C0 OQ12-E2	120	2.2	1.2
	150	2.8	1.5
	200	3.8	2
	250	5	2.5
	300	6.3	3.4
	350	7.5	4
	400	9	4.7
	500	12	6
	Aperture diameter D: 5-7 mm		Fiber Ø 0.4 mm
		Fiber Ø 0.2 mm	

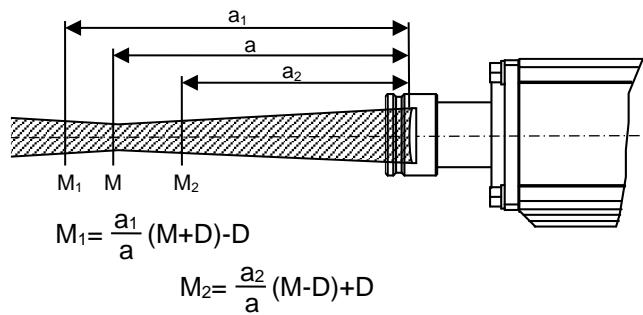
FSC = Full scale temperature

(D is dependent on the optics pull-out: optics pulled out: higher value, optics inserted: smaller value)

5.6.3 Calculation of the Spot Size Diameter Outside the Focused Distance

The spot size calculator integrated in *SensorTools* (see [7.7](#)) can be used to calculate spot size diameters in front of and behind the focus distance, or the one on our website <https://www.sensor-therm.de/en/pyrometers-infrared-switches/#messfeldrechner> or the following formula can be used:

- a Focused distance
- M Spot size diameter in the focused measuring distance
- a_1 Measuring distance longer than focused measuring distance
- M_1 Resulting spot size on measuring distance a_1
- a_2 Measuring distance shorter than focused measuring distance
- M_2 Resulting spot size on measuring distance a_2
- D Aperture (specifies the spot size directly on the optics lens, it differs depending on the optics pull-out. The largest value applies at a fully extended optics, the lowest value is with inserted optics)



6 Configuring the Pyrometer

Basic pyrometer settings can be made using the setting buttons on the back of the device in order to adapt it to the measuring task:

- Measurement parameters
- Analog outputs
- Interface

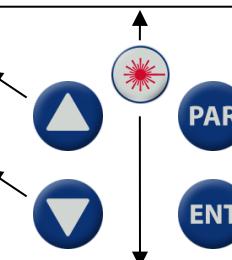
When connected to a PC, these and other settings can be made using the SensorTools software supplied (see Chapter 7) or via interface commands (see Chapter 11).

- Scaling the analog outputs (see 7.1.5.6)
- Set the configurable inputs / outputs (see 7.1.5.8)
- Send test signals to the analog and digital inputs/outputs (see 7.1.5.9)
- Define measurement parameter sets for activation via digital inputs (see 7.1.5.8.1.1 Setups)
- Perform single-point adjustment to match the measurement through windows (see 7.1.5.13)

6.1 Key Functions

Arrow keys: Settings can be done with the arrow keys. Keep the button pressed to change the values faster, reasonable for example when changing a temperature value. A changed value is shown by a blinking display and will only be saved when pressing "Enter", pressing PAR calls the next parameter point. If 60 seconds of inactivity have been made, the display jumps back to the measurement display without taking over any modified values.

Laser targeting light (depending on configuration): Turns on and off the laser targeting light.



Parameter: Press the button repeated to get access to all settings sequentially (see 6.2). If a subcategory is found, this is indicated with a > (e.g. MEASPARA.>). Pressing ENTer the subcategories are called.

Enter: opens a parameter category or takes over a modified parameter value.



CAUTION Laser radiation, laser class 2, do not look into the beam.

SAFETY INSTRUCTIONS

- Never look into the direct or reflected laser beam.
- Do not point the laser to anyone.
- If laser radiation hits the eye, avert one's eyes immediately.



Channel switching: When pressing an arrow key while holding down the ENTer key, the unit will cycle through the channels 2C (2-color measurement) / C1 (1-color measurement in channel 1) / C2 (1-color measurement in channel 2).



Key lock: Press the arrow keys and the ENTer key simultaneously for approx. 3 seconds to activate or deactivate the key lock. With locked keys, no parameters can be called and changed.

6.2 Parameters / Settings

The table shows the adjustable parameters in order they appear on the pyrometer, detailed description in the next chapters.

Parameters	Meaning	Settings
DISPLAY>	Measuring temperature on the device display: 2-color temperature (2C), temperature channel 1 (C1, longer range), channel 2 (C2, shorter range)	2C, C1, C2
MEASPARA.>	Measurement parameters	–
T90	Response time t_{90}	MIN / 01 ms–10.0 s
STMOD	Storage mode peak picker: peak picker off, with time clear (TIME, time settings under CLR), extern cleared (EXT), automatic cleared (AUTO), with trigger function (TRIG)	OFF / TIME / EXT. / AUTO / TRIG
CLR	Clear time settings with STMODE set to time clear (only if STMODE set to TIME)	OFF / 01 ms–25.0 s
SLO	Emissivity slope $\varepsilon_2/\varepsilon_1$	0.800–1.200
SW.OFF	Switch-off limit	2.0–90.0%
ε_1	Emissivity channel 1	0.050–1.200
TR1	Transmittance channel 1	5.0–100.0%
ε_2	Emissivity channel 2	0.050–1.200
TR2	Transmittance channel 2	5.0–100.0%
FF	Spot size filling (fill factor)	5.0–100.0%
ZSC	Zero scale temperature (beginning of temp. sub range)	e.g. 0400°C
FSC	Full scale temperature (end of temperature sub range)	e.g. 1300°C
TU	Temperature unit °C / °F	Celsius / Fahrenheit
OUTPUTS>	Analog outputs	–
ANALOG>	Settings of analog output	–
A1	Analog output 1, current output	0–20 mA / 4–20 mA
A1TST	Test current (10 mA at 0–20 mA, 12 mA at 4–20 mA) (not available if A1OUT is set to OFF)	OFF / 10 mA or 12 mA
A2	Analog output 2, current output	0–20 mA / 4–20 mA
A2OUT	Analog output 2 signal: off, 2-color temperature (2C), temperature channel 1 (C1), temp. channel 2 (C2), control output (only devices with PID controller), device temperature (DTMP)	OFF / 2C / C1 / C2 / CTR. / DTMP
A2TST	Test current (10 mA at 0–20 mA, 12 mA at 4–20 mA) (not available if A2OUT is set to OFF)	OFF / 10 mA or 12 mA
INTERFACE>	Serial interface	–
RSTYP	Interface type (only M3)	232 / 485
BD	Baud rate	4.8–115.2 kBd (RS232) 4.8–921.6 kBd (RS485)
ADD	Address	00–97
DELY	Delay	00–20
FB.ADR	Fieldbus address (at Profibus devices)	00–127
FB.MODE	Fieldbus mode (at Profibus- / Profinet devices)	0–2
MISC>	Miscellaneous settings	–
LG	Language	ENGLISH / DEUTSCH
N.PIN	Set (new) pin for push button lock	OFF / 0000–9999
FACT.SET	Reset to factory default settings	N / Y

INFO These settings are available with the latest firmware. Missing settings in your device can be added by updating the device firmware. By connecting the power supply, the current firmware version is displayed for a few seconds, a firmware update is possible with the **SensorFlash** software (see 8).

6.2.1 Response Time t_{90}

The response time t_{90} specifies the time that the pyrometer requires to track 90% of a sudden temperature change on the signal output.

The response time depends on the requirements of the respective measuring task and can be adjusted.

- If a short response time is selected, the temperature measurement follows the actual temperature curve accurately. Short setting thus allowing the detection of briefly occurring temperature peaks, which occur especially in fast heating processes or fast moving targets.
- At longer response times, the measurement signal is smoothed and average values for temperature fluctuations are formed caused by the inertial measurement.

6.2.1.1 Dynamic Adaptation at Low Signal Levels

All pyrometers have low signal levels at the beginning of the temperature range. At the highest measuring speed this would lead to signal noise and thus the risk of measurement uncertainties. To prevent this, the devices measure a little more slowly in the first 10-15% of its temperature range. How much slower differs depending on the temperature range of the models and is also dynamically adjusted, the higher the beginning of the temperature range is. As soon as this 10-15% is exceeded, the devices measure with their full response time.

6.2.2 Peak Picker Storage Mode / Clear Time

The peak picker always records the highest value during a measurement and holds it until it is deleted manually or automatically:

Off: The peak picker storage is off and the instantaneous value is measured.

Clear externally: The maximum value is cleared manually by an external button or machine contact (connection see [4.1.4 Configurable Inputs / Outputs](#)). The external clearing also can be carried out with the command **Ix** (see [11, Communication via Serial Interface / Interface Commands](#)).

Automatically: The maximum value is cleared, if after a "cold break" a new hot measuring object appears in the measuring beam. "Cold break" means that the measuring temperature must be below of the beginning of the temperature range. The "cold break" must correspond to at least the length of the set response time.

Time 0.01...25 s: Clears the maximum value after the specified time.

INFO If clear times are too long, important temperature information can be lost at sinking temperatures).

Trigger: The maximum value is manually generated via an external button or machine contact, as long as the trigger contact is active. The maximum value display appears after releasing the button.

6.2.3 Emissivity Slope

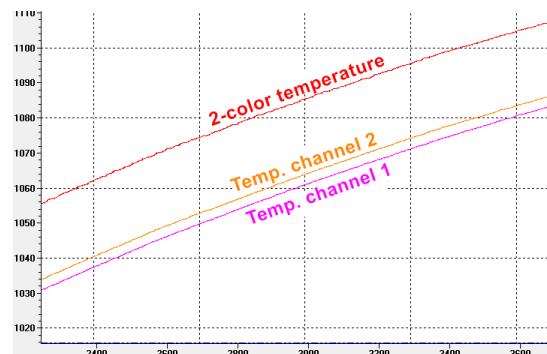
Measuring objects that emit the same on the two wavelengths of a 2-color pyrometer are often referred to as "Gray bodies" (e.g. well oxidized iron or steel surfaces). They can be measured accurately with the setting 1.00 for the emissivity slope without correction.

Measuring objects whose emissivity is different on the two wavelengths of the pyrometer (e.g. shiny un-oxidized metal surfaces) need for accurate temperature measurement a correction setting, the so-called emissivity slope $\varepsilon_2 / \varepsilon_1$. The value can be larger or less than 1, depending on whether the emissivity of channel 1 or 2 is higher.

- 0.800–1.000: gain, temperature display will be higher
- 1.000–1.200: Attenuation, temperature display will be lower

Configuring the Pyrometer

Regardless of emissivity slope 1 or above or below is used to measure, the ratio must remain constant in the required temperature range. In the software *SensorTools* the 2-color temperature and those of the two channels can be displayed at the same time. A 2-color measurement is possible if the curves of the two channels in the required measuring range run uniformly parallel, so the ratio is constant. If the temperature values of the curves are identical (at the same emissivity setting), then the emissivity slope is 1. Do they run parallel, so the correct value for the emissivity ratio must be found, such by comparative measurement with a thermocouple and subsequent ratio setting until the temperatures match.



6.2.4 Switch-off Level / Signal Strength / Dirty Window Monitoring

2-color pyrometers measure even with reduced signal strength, such as those occur in a partially filled measuring field, or dust, smoke, steam, or a window in the beam path between pyrometer and the measuring object. If the signal strength is too low for a reliable measurement, the measurement is switched off to avoid measurement errors. In this case, the beginning of the temperature range is set to the outputs, i.e. 0 or 4 mA depending on the setting.

The switch-off limit can be set between 2 and 90%, recommended for a reliable measurement is a minimum value of 10%.

Furthermore, a digital output can be set using the *SensorTools* software, which is activated when the signal strength falls below a certain value. This e.g. can be used as contamination or dirty window monitoring.

INFO The lower the signal strength, the more likely it can affect the measurement of ambient light and reflections.

6.2.4.1 Switch-off Verification (only via *SensorTools* software)

If signal strength is below minimum and a switch-off occurs, a time can be entered that defines when this switching-off actually takes effect.

6.2.5 Emissivity ϵ (when used in 1-color mode)

The pyrometer also can be used in 1-color mode, the measurement corresponds to that of a conventional radiation pyrometer. In this measuring mode the input of an emissivity is necessary.

The emissivity indicates the radiation capacity of an object to be measured relative to a Blackbody Source with the same temperature. To obtain correct readings, the emissivity must be taken into account in the measurement and adapted for the respective measuring material on the pyrometer.

Each material has a max. emissivity of 1.00 which can be set, an adjustment of up to 1.20 can be used. The emissivity adjustment above 1.00 allows for temperature corrections due to higher background reflection.

Measuring object	Emissivity ϵ (Epsilon)	
	M311/H311 0.7-1.1 μm	M322/H322 1.45-1.8 μm
Blackbody Source	1	1
Aluminum, shiny	n.s.	0.05-0.2
Aluminum, oxidized	n.s.	0.3-0.4
Aluminum, sandblasted, rough	n.s.	0.4-0.5
Aluminum, black anodized	n.s.	0.9
Lead oxidized	n.s.	n.s.
Bronze	0.2-0.4	0.2-0.4
Iron, liquid	0.15-0.3	0.1-0.25
Iron, shiny	0.3-0.4	n.s.
Iron, oxidized	0.7-0.9	0.65-0.85
Graphite	0.8-0.92	0.8-0.9
Gold, shiny	0.02-0.05	0.02-0.05
Inconel, shiny	0.35-0.45	0.4
Inconel, oxidized	0.65-0.75	0.6-0.7
Copper, shiny	0.10	0.05-0.1

In principle applies: to measure metals in a short-wavelength spectral range as possible, as here the emissivity is higher than in the long-wave range.

The specified values are guide values, which were determined in the laboratory and confirmed in application-oriented measurements. They can vary due to material-dependent conditions, as in metals additionally to the surface texture alloy components play an important role for the emissivity.

- Is a range given, this is related to differences in the nature of the surface from smooth to rough, rough surfaces have higher emissivities (for determining the correct emissivity also a comparison measurement can be performed with a thermocouple).
- "n.s." (not specified) means that no values exist for this wavelength range e.g. because a reasonable measurement in this wavelength or temperature range is not possible.
- The emissivities with "shiny" refer to applications that are performed under an inert gas or in a vacuum.

Copper, oxidized	0.3-0.7	0.2-0.8
Magnesium, shiny	n.s.	0.15-0.2
Magnesium, oxidized	n.s.	0.3-0.5
Brass, shiny	0.5-0.7	0.5-0.7
Brass, oxidized	0.6-0.8	0.6-0.7
Molybdenum, oxidized	0.7-0.9	0.7-0.85
Nickel	0.22	0.15-0.2
Porcelain, glazed	0.6	0.6
Porcelain, rough	0.8-0.9	0.8-0.9
Platinum	0.4	0.35
Soot	0.95	0.95
Chamotte	0.45-0.6	0.45-0.6
Slag	0.85	0.8-0.85
Silver, shiny	n.s.	n.s.
Silver, oxidized	0.1-0.2	0.05-0.2
Steel, shiny	0.4-0.55	0.3-0.45
Steel, oxidized	0.8-0.9	0.7-0.9
Steel, rolled	0.8-0.9	0.8-0.9
Stoneware, glazed	0.86-0.9	0.8-0.9
Stainless steel	0.4-0.9	0.4-0.9
Titanium, shiny	0.35-0.45	0.3-0.4
Titanium, oxidized	0.55-0.85	0.55-0.85
Tungsten, shiny	0.3-0.4	0.3-0.4
Tungsten, oxidized	0.7-0.9	0.7-0.85
Brick	0.85-0.9	0.8-0.9
Zinc	0.45-0.58	0.45-0.55

Measurement deviations at a 10% false set emissivity	+10%	-6.5°C	-10.5°C
at a temperature of 700°C:	-10%	+7°C	+11.5°C

Materials has a maximum emissivity of 1 (100%). However, a setting of up to 1.2 can be used to compensate for temperature corrections due to higher background reflection.

To determine the correct emissivity, also a comparative measurement with a thermocouple can be performed.

INFO Emissivity, transmittance and spot size fill factor are directly related to each other, the result of the multiplication of the 3 parameters has to be minimum 5%.

6.2.6 Window Transmittance

If there is a sight glass between the measuring object and the pyrometer, there is a reduction in the signal, that is compensated by using the ratio measurement technique. In the case of measurements in 1-color mode, this signal weakening leads to a reduced temperature display, which can be compensated by entering the transmittance of the sight glass.

Settings:

- 5%-100%

INFO Emissivity, transmittance and spot size fill factor are directly related to each other, the result of the multiplication of the 3 parameters has to be minimum 5%.

6.2.7 Spot Size Fill Factor

Entering a fill factor that indicates how much percent of the measuring field is filled, has no influence if using the 2-color measuring mode (see also [5.4 Alignment to the Measuring Object](#)).

In 1-color mode: Measurements of objects that are smaller than the pyrometer's spot size can be performed when measuring hot objects in front of a cold background. In this case the fill factor specifies how much percent of the measuring field is filled.

INFO Emissivity, transmittance and spot size fill factor are directly related to each other, the result of the multiplication of the 3 parameters has to be minimum 5%.

6.2.8 Temperature Sub Range

The temperature range can be scaled down to a temperature sub range in order to adapt it to specific measurement conditions (minimum range 51°C), e.g. to configure the automatic clear function of the [Peak Picker](#) function. A modified temperature range also can be set for the analog outputs to increase the resolution even further.

6.2.9 Temperature Unit

The temperature display can optionally be displayed in °C or °F.

6.2.10 Analog Outputs

The 2 analog outputs can be set separately:

- Depending on the connected devices to **0–20 mA** or **4–20 mA**
- **Analog output 1** always provides the measured temperature (the temperature displayed on the device and in the [control window](#) or [Devices Tab](#) of [SensorTools](#)).

INFO With older firmware versions, the same settings are possible as at analog output 2. A firmware update to the latest version eliminates this possibility and prevents, that the output of analog output 1 is accidentally different to the displayed temperature signal. Firmware update see section [8](#).

- **Analog output 2** can be assigned to provide different signals:
 - 2-color temperature: 2-color temperature output
 - Temperature channel 1: Channel 1 temperature output
 - Temperature channel 2: Channel 2 temperature output
 - Device temperature: Internal device temperature output
 - Control output: Manipulated variable on models with PID controller
 - No output No signal is on the output

6.2.10.1 Test Current

On the device itself and via software a test current can be set to the output. Via software this current is adjustable, on the pyrometer the current is fixed to 10 mA (at 0–20 mA) or 12 mA (at 4–20 mA).

6.2.10.2 Upscale-Burnout (only via [SensorTools](#) software)

In case of sudden shadowing of the pyrometer's visual field, the output current is set to 20 mA instead of usually the lowest.

- **Disabled upscale-burnout** (standard): The analog output at sudden shadowing of the pyrometer's view field is the lowest current (0 or 4 mA).
- With **enabled upscale-burnout** function, the analog output at sudden shadowing of the pyrometer's view field is set to the maximum current of 20 mA. This can be desirable, for example, in a furnace monitoring when the controller otherwise would recognize a cold oven and heat up fully and possibly burn out the oven.

6.2.10.3 Scaling Analog Outputs (only via SensorTools software)

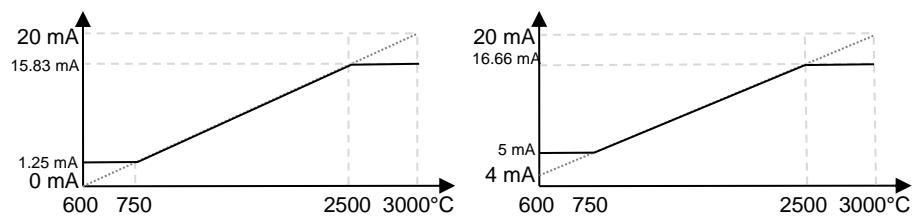
The analog outputs can be scaled to suit special circumstances, e.g. for replacement with a device with a larger measuring range.

- **Increasing the temperature range** beyond that of the pyrometer scales the analog output accordingly. It should be noted that the pyrometer cannot measure outside of its measuring range and behaves differently there, depending on the firmware version:
 - **M3 devices from firmware 01-2023 are switchable in the initial behavior:**
It can be set what happens below the beginning of the temperature range, either 0 or 4 mA is provided to the output, or the current that corresponds to that of the enlarged temperature range is provided to the output constantly (as with all older firmware versions).
 - H3 units always operate according to the “Scaled current under ZSC” function.**
 - At the end of the pyrometer temperature range, the current that corresponds to the increased temperature range is always provided to the output.
- **Decreasing the scope of the temperature range** can be made to increase the resolution of the output.

Example of increasing the scope of the temperature range: A pyrometer with temperature range 750–2500°C should be adapted to the range 600–3000°C. In the range of 600–750°C, the pyrometer cannot measure yet; it shows – – – or in the software “Under”.

- Analog option **Scaled current below ZSC** selected:

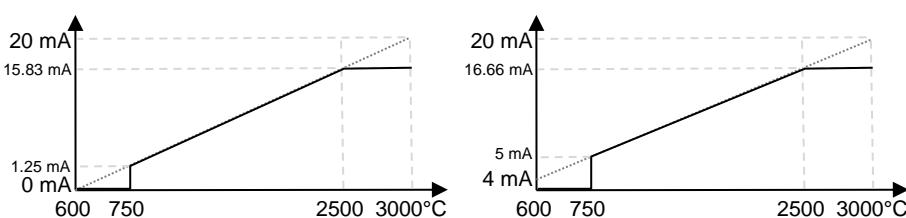
At the analog output set to 0-20 mA, a constant 1.25 mA is providing to the output until 750°C is reached, with 4-20 mA a constant 5 mA is providing to the output until 750°C is reached.



From 2500°C the same current is providing to the output as a 600-3000°C device would provide to the output at 2500°C, in the example this would be 15.83 mA at 0-20 mA and 16.66 mA at 4- 20mA.

- Analog option **0/4mA below ZSC** selected:

At the analog output set to 0-20 mA, 0 mA is providing to the output until 750°C is reached, with 4-20 mA corresponding 4 mA. From 750°C the current then jumps to that of the scaled output of 1.25 mA at 0-20 mA or 5 mA at 4-20 mA.



From 2500°C the same current is providing to the output as a 600-3000°C device would provide to the output at 2500°C, in the example this would be 15.83 mA at 0-20 mA and 16.66 mA at 4- 20mA.

6.2.11 Interface (only M3 devices)

Provides the interface to RS232 or RS485 (see [4.1.5 Serial Interface RS232 / RS485](#)).

6.2.11.1 Interface Baud Rate (only M3 devices)

The baud rate is adjustable: RS232: 4.8 to 115.2 kBd; RS485: 4.8 to 921.6 kBd

6.2.12 Address

In bus operation with RS485 a device address between 00 and 97 can be assigned (see [4.1.5 Serial Interface RS232 / RS485](#)).

Device addresses from 00 to 97 are valid. Addresses 98 and 99 are with special functions. The global address 99 can be used to communicate with every controller, independent of the set device address. This allows communication with devices with unknown addresses. The address 98 is a group address used for RS485 devices in bus operation. With this address devices do not answer, useful to change parameters of all connected devices at the same time.

6.2.12.1 Interface Delay / Answer Delay

During operation of the pyrometer via RS485, it may happen that the connection is not fast enough to detect the response of pyrometer time to a command from the master, e.g. because the line is still busy with sending before receiving. This sometimes occurs in older PCs or interface adapters or by slow switching times of interface adapters and manifests itself in transmission errors of interface commands, so errors when parameters are changed or of measured values transmission.

In this case, a delay for delaying the data transfer can be entered, the value specifies the main circulating time and can be set from 00-20. The transmission of commands to the pyrometer is thus somewhat delayed, but it can work with existing peripherals.

6.2.13 Key Lock

Changing the parameters (PAR key) on the device can be deactivated or protected by entering a 4-digit pin (settings on the device (from firmware 2017_01), see [6.1 Key Functions](#) or via software, see [7.1.5, Device Configuration](#); only available at devices from firmware version 2016_18; update firmware see section [8](#)). If activated, this pin must be entered before parameters with the PAR button can be changed on the device.

7 SensorTools Software

▪ Possibilities:

- carry out all device settings
- Configure signal inputs / outputs (not possible directly on the device)
- Display measured values, numerically or as a graph
- Display the internal device temperature
- Record measurement curves (incl. measurement parameters)
- Display measurement curves using the *SensorTools* Viewer software included in the program package

▪ Installation

- The current setup program can be downloaded from our website in the download area: https://www.sensortherm.de/en/downloads/#anleitungen_software. In addition to the software, the latest version of these instructions and, if necessary, other device-specific files are also available there.
- For the download, the model and serial number must be entered, which can be found on the device nameplate.

- **Min. system requirement:** Pentium IV processor with min. 1.6 GHz and 2 GB RAM
20 MB hard drive capacity for the program
RS232 or RS485 interface or USB2 (use of an RS232 or RS485 to USB interface converter is required)

With the minimum requirements devices can be connect and configured. When capturing or recording data, the performance is potentially impaired, that is errors or interruptions in data transfer can occur.

- **Recommended:**
i7 multi-core processor with 3 GHz and 16 GB RAM
Screen resolution: min. 1024x768
Operation systems: Windows 7, 8, 8.1, 10

With the recommended requirements all software features should be fully available.

- To install, start the setup program and follow the on-screen instructions. If the program is installed under a different admin account, it is recommended not to start the program directly with the installer, otherwise the program file paths will also point to this and not to the current user.

INFO There are regularly provided software and firmware upgrades available that add functionality or fix bugs. It is recommended always to install the latest software and firmware.

In *SensorTools* can be checked to a new version of firmware or *SensorTools* program version is available, see [7.1.5.10 Service functions](#) and [7.6 Communication / Options](#).

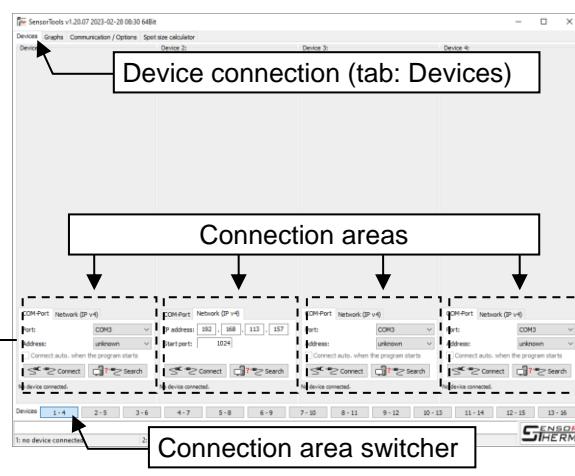
7.1 Program Start / Connecting the Pyrometer

The device connection takes place in the "Devices" tab, up to 16 devices connected to the PC can be connected in the software here.

The number of visible connection areas depends on the window width. The connection areas can be switched using the lower connection area switcher.

INFO The more devices are connected, the more powerful the PC has to be in order to be able to display all the graphs.

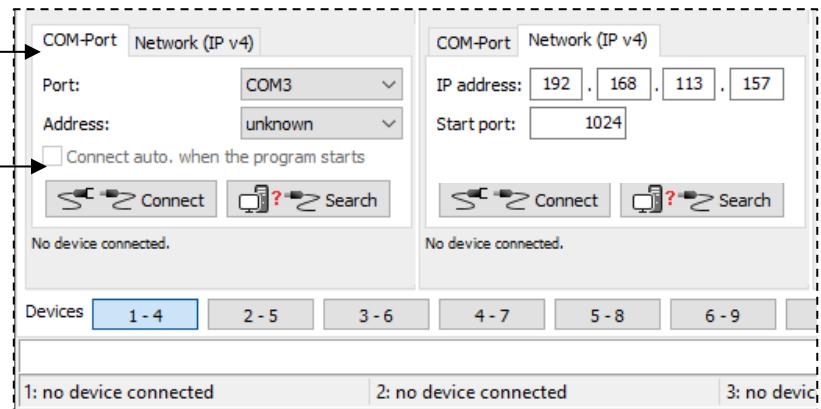
Proceed as follows to connect a device in one of the windows:



Select tab:

- **COM port**, if the pyrometer is connected via the RS232 or RS485 interface.
- **Network (IP v4)**: if the pyrometer is connected via a network.

The pyrometer is preset to a DHCP network and can be found using the "Search" function. If only a fixed IP can be used, the pyrometer must first be connected via a serial interface so that the [network settings](#) can be adjusted accordingly.

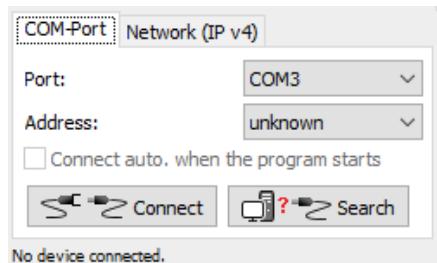


Connect automatically, when the program starts connects the last connected device automatically the next time the program starts (only for COM port, not available for network).

- The function is only active once a device has been successfully connected.
- The automatic connection only works with an entered device address (00-97, not "unknown").

7.1.1 Connect via COM Port

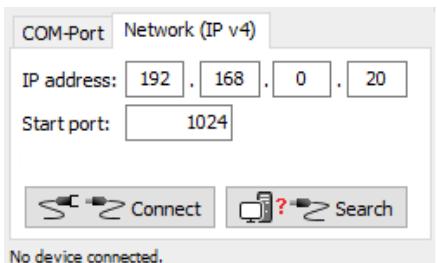
- Select the **COM port** or **USB port** to which the pyrometer is connected (if known, otherwise try all available ports one after the other).
- Enter the **device address** (if known, in "Unknown", the software automatically searches).
- **"Connect"** connects the pyrometer to the set port.
- If the port and device address are unknown, **"Search"** searches through all PC ports one after the other and then connects a device that is found automatically.



INFO It is not possible to connect 2 devices with the same device address.

7.1.2 Connect via Network

- Enter the **IP address** (only IPv4 addresses are supported) and **network port**, if these have been assigned.
- **"Connect"** connects the pyrometer with the IP address via the set port. All pyrometer settings are read out and displayed in the software.



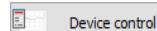
- **"New Search"** searches a DHCP network for Sensortherm devices (searches on port 30303). A DHCP network is searched as well as devices with a fixed IP if the subnet mask of the PC and the device match.

When finished, all devices found are displayed. After selecting a device, the connection with *SensorTools* is established via "Connect".

Supported network devices:					
Device type	Serial number	IP address	Start port	MAC address	IP version
M309	9480	192.168.113.69	4096	E8:EB:1B:D3:47:6A	4

Buttons at the bottom include 'Connect', 'New search', and 'Cancel'.

INFO It is not possible to connect 2 devices with the same IP address.

Define network settings:


Network settings can be adjusted in the device configuration, e.g. if no DHCP server is to be used, but separate configurations are required for the connection. The configuration can be carried out with an existing network connection or a connection via the serial interface.

- With DHCP, the network configuration is assigned by a server; the currently assigned data is displayed.
- The start port is the network port the device communicates with.

Network:
 DHCP Enabled Start port: 5000 Enter and activate
 IP address: 192 . 168 . 113 . 69 Netmask: 255 . 255 . 252 . 0 Gateway: 192 . 168 . 115 . 9
 MAC address: E8-EB-1B-D3-47-6A

[Service functions](#) [Interface settings](#) [Data collection](#) [Single](#)

- Without DHCP selected, the fields for manual IP configuration are accessible. The values for fixed IP currently stored in the device are displayed.
- The start port is the network port the device communicates with.

Network:
 DHCP Enabled Start port: 5000 Enter and activate
 IP address: 192 . 168 . 113 . 170 Netmask: 255 . 255 . 253 . 0 Gateway: 11 . 255 . 255 . 255
 MAC address: E8-EB-1B-D3-47-6A

[Service functions](#) [Interface settings](#) [Data collection](#) [Single](#)

Changes are accepted by clicking on "Enter and activate".
 If the pyrometer is connected via network, activation leads to a device restart and the pyrometer is disconnected from *SensorTools*.

7.1.3 Connection Window / Devices Tab

When the device is connected, all **pyrometer settings** as well as the current **measurement temperature** (2-color or 1-color) and **internal device temperature** are read out and displayed.

INFO for settings on the device: a pyrometer connected to the software has blocked push buttons. "KEY LOCK" appears when pressing a key.

2C: 2-color measuring temperature,
C1: 1-color meas. temp. channel 1,
C2: 1-color meas. temp. channel 2,
("Under" or "Over" when falling below
or exceeding the beginning / end of
the temperature range)

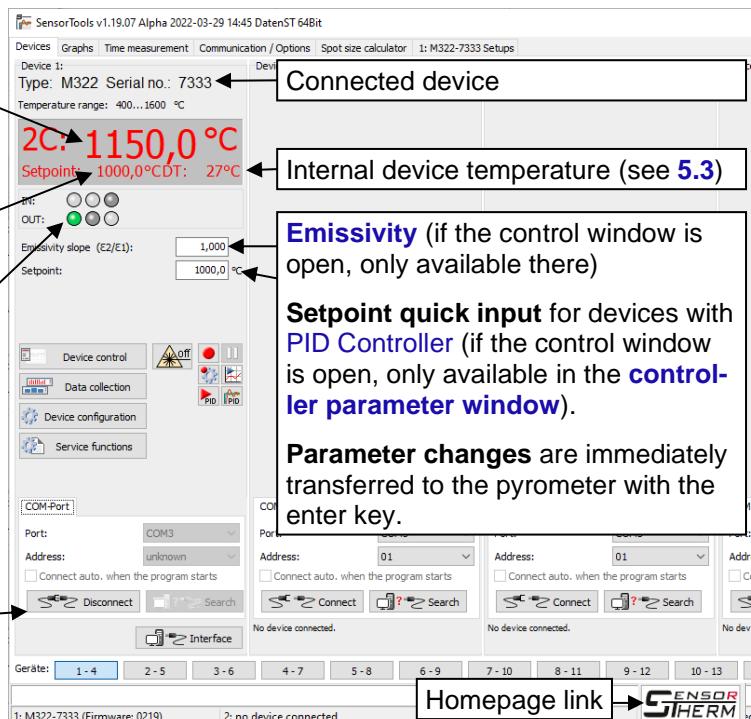
Large setpoint display for devices with
PID Controller

LED symbols for **status of the digital inputs / outputs:**

- Input (IN) or output (OUT) active
- Input (IN) or output (OUT) inactive
- Input (IN) or output (OUT) not activated (no function)

When devices are connected, the button changes to "Disconnect". This disconnects the connection to *SensorTools*. An icon shows the current connection status:

- | | |
|--|----------------------|
| | No device connected; |
| | Device connected |



Separate **control window**

Data Collection: Controlling the transfer of the measurement data from the pyrometer to the PC

Device Configuration

Service Functions: Backup, print or restore device parameters or create service files for remote diagnosis of problems

Device and firmware version

laser targeting light on / off
or **camera module** settings

Measurement Data Recording
Data Recording Settings
Measurement Data Playback

Only devices with **PID Controller**:
Start PID control
Control parameters window

Serial interface baud rate, delay, device address

- At devices with a **laser targeting light** this can be switched on and off (/)



CAUTION Laser radiation, laser class 2, do not look into the beam.

SAFETY INSTRUCTIONS

- Never look into the direct or reflected laser beam.
- Do not point the laser to anyone.
- If laser radiation hits the eye, avert one's eyes immediately.

7.1.4 Control Window



A separate control window also provides all available measurement-related functions and settings.

It is helpful when switching to another tab (e.g. to the graph display).

2C: 2-color measuring temperature,
C1: 1-color meas. temp. channel 1,
C2: 1-color meas. temp. channel 2,
("Under" or "Over" when falling below
or exceeding the beginning / end of
the temperature range)

Large setpoint display for devices
with PID controller

LED symbols for status of the digi-
tal inputs / outputs

Expand to display rarely used
settings, such as **window transmis-**
tance and **spot size filling**.

Parameter slider from active input
field (click first)

The screenshot shows the Control Window interface with the following details:

- Main Display:** Shows the text "2C: 1150,0 °C" in large red font, with "Setpoint: 1000,0°C DT: 30°C" below it.
- Top Bar:** Shows "1: M322-7333" and standard window controls.
- Left Sidebar:** Buttons for "IN: 1 2 3", "OUT: 1 2 3", "Measured temp.: 2-color temp.", "Response time: minimum", and "Storage mode: Off".
- Central Area:**
 - Emissivity slope E2/E1:** Set to 1,000.
 - Switch-off limit:** Set to 2,0 %.
 - Switch-off verification:** Set to 0,0 ms.
 - Emissivity channel 1 (E1):** Set to 1,000.
 - Window transmittance:** Set to 100,0 %.
 - Spot size filling:** Set to 100,0 %.
 - Emissivity channel 2 (E2):** Set to 1,000.
 - Window transmittance:** Set to 100,0 %.
 - Spot size filling:** Set to 100,0 %.
- Bottom Buttons:** Icons for "off", "Device configuration", "PID", and "Controller parameters".

Internal device temperature (see 5.3)

Measurement mode (2C, C1, C2)

response time (measurement speed)

Peak Picker on/off

Measurement parameters

Emissivity Slope,
Switch-off Level,
Switch-off Verification,
Emissivity of each single channel
and **transmittance**
and spot size **fill factor**.

Parameter changes are immedi-
ately transferred to the pyrometer
with the enter key.

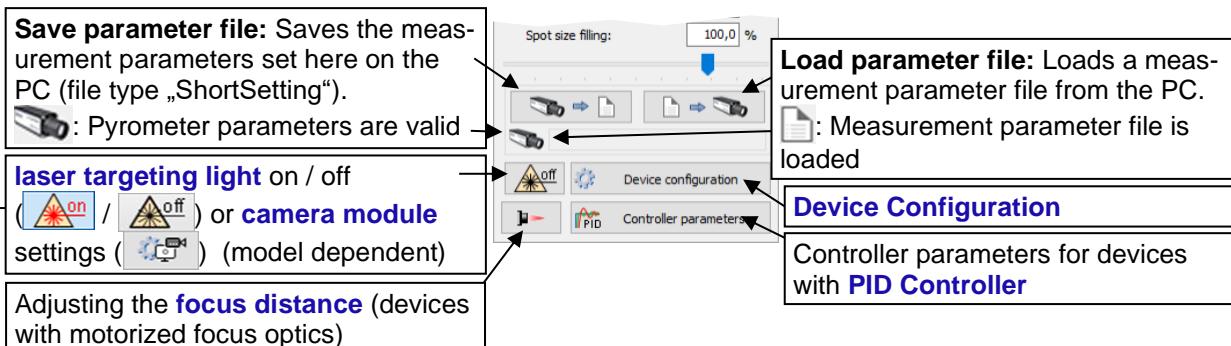
INFO on the **emissivity shown in red**: Emissivity, transmittance and spot size fill factor are directly related to each other, the result of the multiplication of the 3 parameters has to be minimum 5%. If the multiplication of the 3 parameters falls below 5%, the values are displayed in red.

Emissivity channel 1 (E1):	0,099
Window transmittance:	50,0 %
Spot size filling:	100,0 %

INFO on the **emissivity displayed in violet**: indicates that something is misaligned in the lower (possibly col-
lapsed) area.

Emissivity channel 1 (E1):	1,000
----------------------------	-------

Emissivity channel 1 (E1):	1,000
Window transmittance:	50,0 %
Spot size filling:	100,0 %



- At devices with a **laser targeting light** this can be switched off (/)

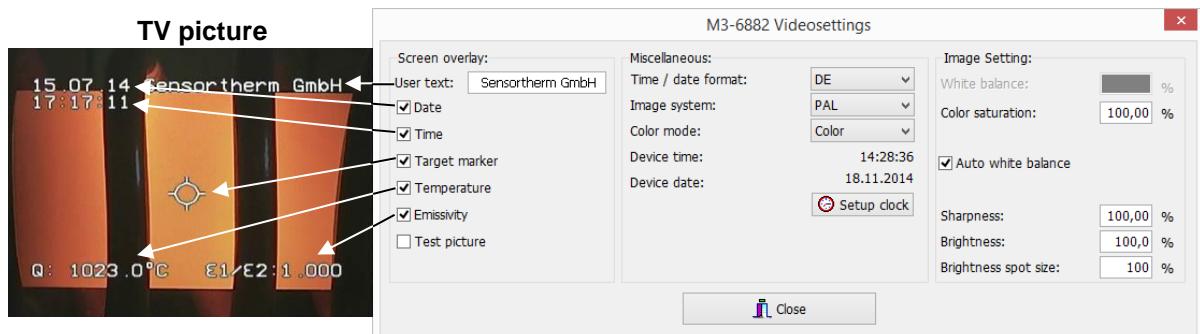


CAUTION Laser radiation, laser class 2, do not look into the beam.

SAFETY INSTRUCTIONS

- Never look into the direct or reflected laser beam.
- Do not point the laser to anyone.
- If laser radiation hits the eye, avert one's eyes immediately.

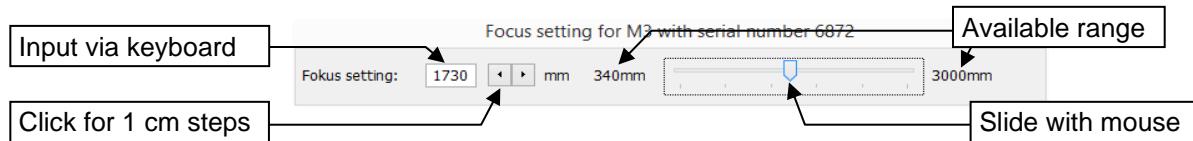
- With **camera module** () the monitor settings can be configured:



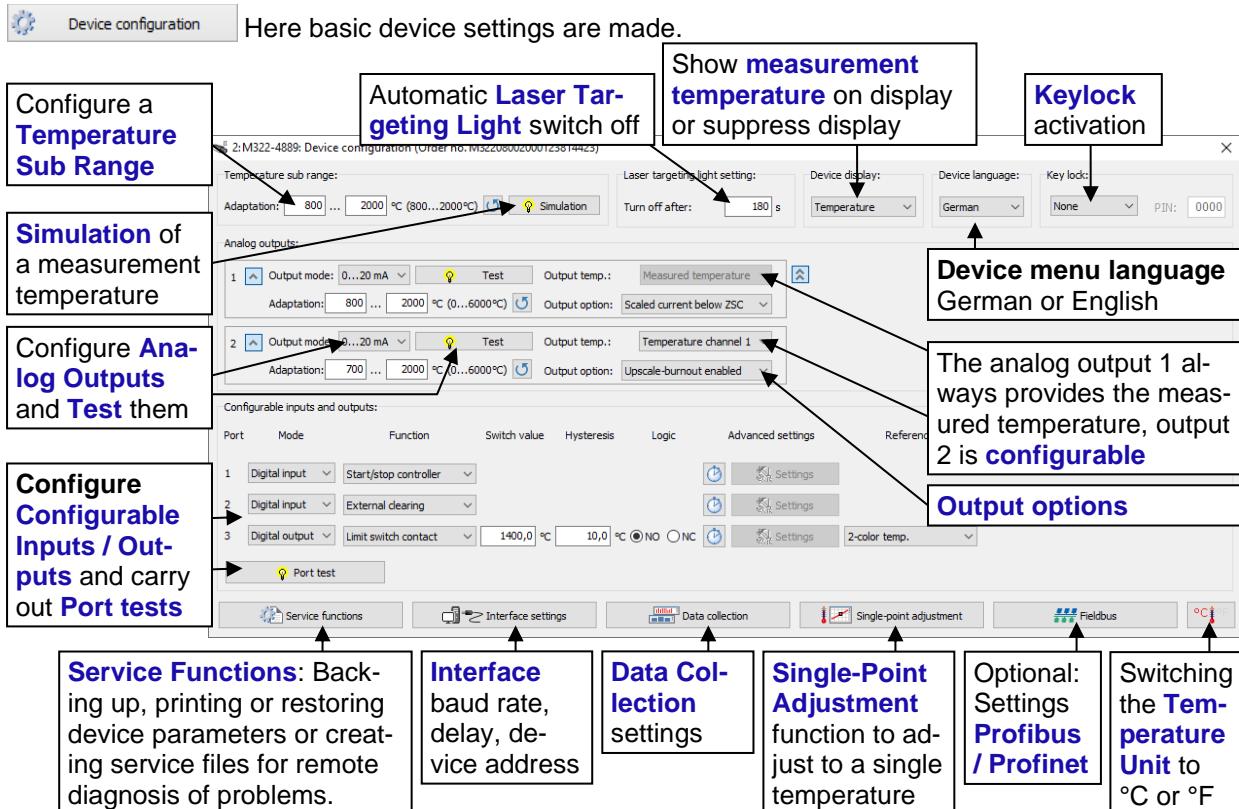
- Screen overlay:** select the desired overlays.
 - User text:** A text with max. 16 characters can be displayed on top right.
 - Emissivity:** shows depending on the measuring mode the emissivity or the emissivity slope.
 - Test picture:** Shows a test image instead of the camera picture.
- Miscellaneous**
 - Date / time format:** US (American time format): month, day, year
DE (German time format): day, month, year
 - Image system:** PAL (720 x 576 Pixel) / NTSC (720 x 480 Pixel)
 - Color mode:** Color or black and white.
 - Device time / device date:** Time and date by the pyrometer.
 - Setup clock:** Transfers the PC time to the device clock of the pyrometer.
- Image settings**
 - White balance** (active only when auto white balance off): Input 0 to 100% of the window area, calculated centrally on the monitor center.
 - Color saturation:** Sets the quality of the color
 - Auto white balance:** Executes the white balance automatically. Possibly with disabled function the result is better because the function reacts slowly to changes in color.
 - Sharpness:** Input 0 to 100%, with values below 100%, the image is softened.
 - Brightness:** For manual brightness adjustment.
 - Brightness spot size:** window size that should be used for the automatic brightness adjustment. Enter 5 to 100% of the window area, calculated centrally on the monitor center.

INFO To prevent image over-modulation, the measured object should be in the middle (in the target mark) and the brightness spot size as large as the measuring object.

- Adjusting the **focus distance** for pyrometers with a motor focus:
For adjusting the focus distance to the measuring object (**spot size tables** see [5.6](#)).



7.1.5 Device Configuration



7.1.5.1 Temperature Sub Range

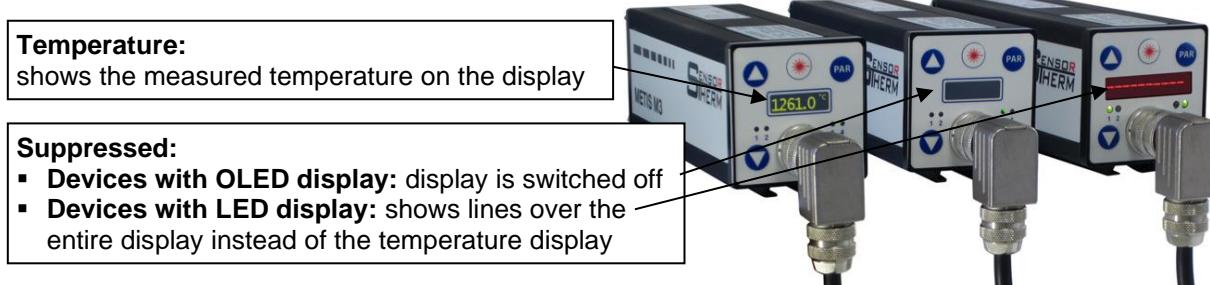
- **Adaptation:** The temperature range can be reduced to adapt it to special measuring conditions (minimum temperature span 51°C). resets the temperature range to the adjacent total temperature range.
- **Simulation** simulates a measured temperature at the outputs (see [7.1.5.9 Test functions](#)).

7.1.5.2 Laser Targeting Light Settings

The time can be entered here when a switched-on laser targeting light switches off automatically.
Times: between 5 and 900 s (15 min).

7.1.5.3 Device Display

Enables or disables the measurement temperature display.



7.1.5.4 Device Language

Changes the language of the parameter menu on the device to English or German.

7.1.5.5 Keylock

To lock or unlock the key functions on the device (enabling on the device, see [6.1](#)).

- None:** All functions can be changed using the buttons on the unit.
- Active:** The buttons on the unit are disabled.
- Menu lock:** activates an input field for a 4-digit PIN code, which enables to protect changing of parameters (PAR key) on the device. If activated, this code must be entered on the device before parameters with the PAR button can be changed.

7.1.5.6 Analog Outputs

- Output mode** sets the output current to **0...20 mA** or **4...20 mA**.
- Output temperature**
 - Analog output 1 always provides the measured temperature, which is shown on the device display or in the [SensorTools control window](#) or [Devices Tab](#).
 - Analog output 2 (will be displayed after expansion with) is configurable, here at **output temperature** you can select which output signal should be provided:
 - The **ratio temperature** or that of **each channel** can be set assigned to the output.
 - Device temperature** is the internal pyrometer temperature (scaled from 0 to 100°C).
 - Controller output:** The **manipulated variable** at devices with a PID controller is set here as standard.
 - "**No output**" disables the analog output.
- Test** can be used to set a test current at the respective output (see [7.1.5.9 Test functions](#)).

Further adjustments can be made by extending the setting range.

- Adaptation:** The analog outputs can be scaled between 0 and 6000°C to adapt them to special circumstances, e.g. to replace for a device with a larger temperature range or to obtain a higher output resolution (see [6.2.10.3](#)).

With the reset button, the temperature range is set to the adjusted temperature sub range.

- Output options**
 - If the beginning of the temperature range is reduced under "Adaptation" in order to scale the analog output, a decision must be made what should happen below the beginning of the pyrometer temperature range, since the pyrometer cannot measure from the lowered beginning value to the beginning of the pyrometer temperature range.
 - Scaled current below ZSC** outputs a constant current equal to that of the extended temperature range until the pyrometer's lower range value is reached.
 - 0/4mA below ZSC** (only available with M3, not with H3) outputs 0 mA or 4 mA until the beginning of the pyrometer temperature range is reached, depending on whether the output is set to 0-20 mA or 4-20 mA is.

- **Upscale burnout:** when the pyrometer field of view is suddenly obscured, the output is set to the maximum current of 20 mA instead of the standard 0 or 4 mA output. This function can, for example, be desirable for furnace monitoring if the control would otherwise detect a cold furnace and heat it up fully, possibly burning it out.

If the upscale burnout function is used together with a reduced beginning of temperature range (under "Adaptation"), this means that 20 mA are set to the output, before the pyrometer's beginning of temperature range is reached, not 0 or 4 mA.

7.1.5.7 Temperature Unit



The temperature can be displayed and entered in °C or °F. Changing the mode will not change the entered values, no conversion will be done.

7.1.5.8 Configurable Inputs / Outputs

The 3 inputs / outputs can be set as a digital output or input or port 3 as an analog input and assigned a function (for connection see also [4.1.4 Configurable Inputs / Outputs](#)).

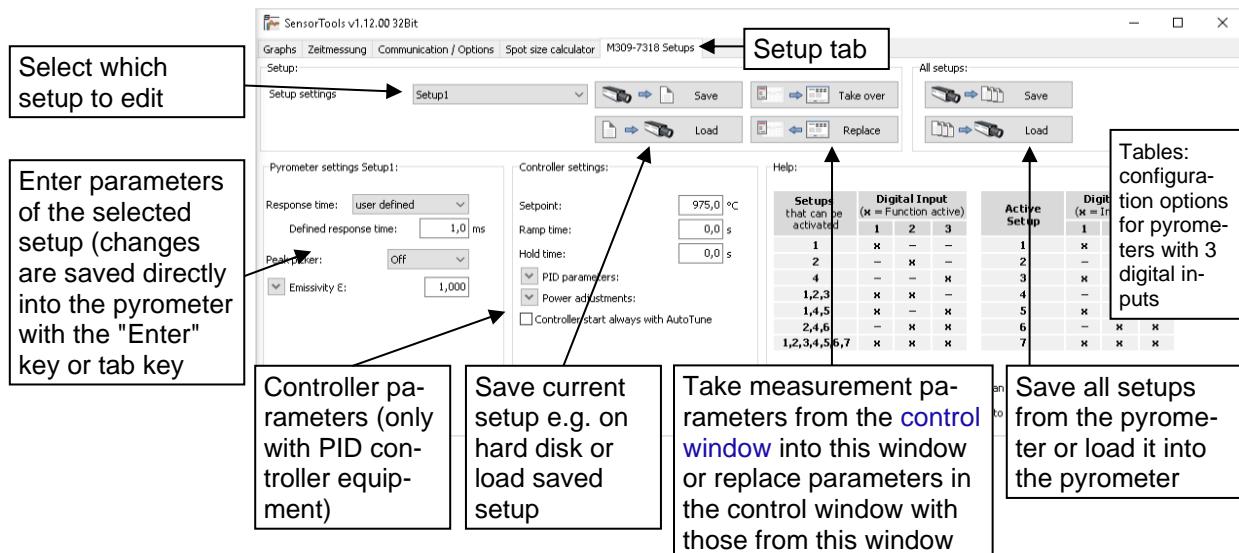
7.1.5.8.1 Digital Input Mode

for calling up pyrometer functions externally.

Functions	Description / switching trigger																																				
No function	A switching signal at the input has no effect.																																				
External clearing	Resets the maximum value of the maximum value memory by contact.																																				
Targeting light on/off	(devices with laser targeting light only) Turns the targeting light on or off.																																				
Activate controller	(only devices with PID controller) Activates the control as long as voltage is present at the connection.																																				
Start/stop controller	(only devices with PID controller) Starts or stops the controller with each pulse (alternately).																																				
Parameter selector	<p>To call up and activate up to 7 pyrometer configurations (incl. control parameters for devices with PID controller). The inputs are binary coded, i.e.</p> <ul style="list-style-type: none"> ▪ with one digital input only one Setup can be activated ▪ with 2 digital inputs there are 3 Setups available ▪ using all 3 inputs, 7 Setups can be accessed and activated <table border="1" style="margin-top: 10px; width: 100%;"> <thead> <tr> <th></th> <th colspan="3">Inputs to be activated</th> </tr> <tr> <th></th> <th>Input 1</th> <th>Input 2</th> <th>Input 3</th> </tr> </thead> <tbody> <tr> <td>Setup 1</td> <td>x</td> <td>-</td> <td>-</td> </tr> <tr> <td>Setup 2</td> <td>-</td> <td>x</td> <td>-</td> </tr> <tr> <td>Setup 3</td> <td>x</td> <td>x</td> <td>-</td> </tr> <tr> <td>Setup 4</td> <td>-</td> <td>-</td> <td>x</td> </tr> <tr> <td>Setup 5</td> <td>x</td> <td>-</td> <td>x</td> </tr> <tr> <td>Setup 6</td> <td>-</td> <td>x</td> <td>x</td> </tr> <tr> <td>Setup 7</td> <td>x</td> <td>x</td> <td>x</td> </tr> </tbody> </table>		Inputs to be activated				Input 1	Input 2	Input 3	Setup 1	x	-	-	Setup 2	-	x	-	Setup 3	x	x	-	Setup 4	-	-	x	Setup 5	x	-	x	Setup 6	-	x	x	Setup 7	x	x	x
	Inputs to be activated																																				
	Input 1	Input 2	Input 3																																		
Setup 1	x	-	-																																		
Setup 2	-	x	-																																		
Setup 3	x	x	-																																		
Setup 4	-	-	x																																		
Setup 5	x	-	x																																		
Setup 6	-	x	x																																		
Setup 7	x	x	x																																		
Time settings	<p>A debounce time can be selected, that is, a period the signal at least must be present at an input so that it can be recognized and processed by the system (3 ms are specified by the pyrometer hardware). Values: "immediately" (0) to 1 s.</p> <div style="display: flex; align-items: center;"> M322-7333: Input 2: 0,100 ↓ ↑ s </div>																																				

7.1.5.8.1.1 Setups

Setups are a set of stored measurement parameters that can be activated via the digital inputs. "Parameter selector" must be selected as the digital input in the device configuration. Activation takes place via a voltage pulse (for connection see [4.1.4 Configurable inputs / outputs](#)).



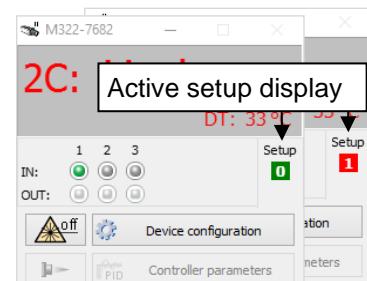
The parameters for the selected setup can be entered directly in this window using the keyboard, with Enter or the Tab key they are transferred to the pyrometer.

Setups can be saved individually or as a complete list to the PC and loaded from there.

INFO when values are hidden in the control window: With an active Setup, the pyrometer operates using the setup values, all adjustment possibilities in the control window are hidden.

Active setups are displayed:

- Setup **0** At least 1 digital input is set to "Parameter selector", but no input is activated (inputs to "low").
- Setup **1** At least 1 digital input is set to "Parameter selector" and at least 1 input is active ("high").



7.1.5.8.2 Digital Output Mode

for the output of a switching signal.

Functions	Description
No function	The output is deactivated.
Contact ready to use	Device readiness: device ready and error-free after self-test.
Material contact	(only M3) To detect whether a hot part is in the measuring field: Switches if the beginning of the temperature range is exceeded by 1% of the temperature range span (the clear time of the peak picker has to be set to ≥ 1 s or to Auto).
Limit switch contact	Switches when the entered switching value is exceeded.
Signal strength contact	Signal strength too low (for use as dirty window alarm: identifies the degree of contamination of the optics or a window or detects interferences (dust ...) in the beam path and trigger an alarm if activated).
Device temperature	Switches when a defined (internal) device temperature is exceeded.

Setpoint limit 1 / Setpoint limit 2:	(only devices with PID controller) The setpoint limit is a limit temperature above or below the setpoint temperature that should not exceed or to be below. Two setpoints can be defined. The output is activated if the measured value exceeds the defined setpoint value. The output is also activated if the measured value falls below the defined value. Entry of the setpoint value has to be done relative to the setpoint, positive or negative, e.g. 20°C if the setpoint value is 800°C and the output should be active at 820°C. Values will be entered in the PID controller form (see 7.4).	
Setpoint band	(only devices with PID controller) The setpoint band is composed of the 2 setpoint limits and defines a range within the temperature has to be. The output is activated if the measured value is outside the defined value.	
Controller active	(only devices with PID controller) Output is active when the controller is active.	
Successful control	(only devices with PID controller) Output is active when a control process is terminated (a possibly hold time has elapsed).	
Switch value Hysteresis <input type="text" value="500,0"/> °C <input type="text" value="10,0"/> °C	<ul style="list-style-type: none"> ▪ Switching value: Activates the output at the entered value. ▪ Hysteresis: The hysteresis indicates by how many degrees below the entered switching value it is switched back again. 	
Logic <input checked="" type="radio"/> NO <input type="radio"/> NC	<p>Switching logic of the outputs:</p> <p>NO (Normally Open): Outputs have in</p> <ul style="list-style-type: none"> ▪ active state 24 V ▪ inactive state 0 V <p>NC (Normally Closed): Outputs have in</p> <ul style="list-style-type: none"> ▪ active state 0 V ▪ inactive state 24 V 	
Time settings	<p>Activation time:</p> <ul style="list-style-type: none"> ▪ "immediately" (0) activates the output immediately when the event occurs. ▪ Time specification (0.001 – 65.534 s): Activation is delayed accordingly. <p>Hold time:</p> <ul style="list-style-type: none"> ▪ None: Signal is only active during the function. ▪ Time entry (1–65534 ms): For the entered time the output is kept longer active than the original signal. 	
Reference (with material contact, limit switch contact, setpoint limit 1, setpoint limit 2 and setpoint band)	The 2-color temperature or that of a channel can be used to activate the output. If the measurement temperature is selected, the selected temperature is always used as the reference.	

7.1.5.8.3 Analog Input Mode

for external adjustment of some parameters between their smallest and largest setting value.

Functions	Description
No Function	A current signal at the input has no effect.
$\varepsilon_2 / \varepsilon_1$, Emissivity ε	The emissivity slope or the emissivity for 1-color measurements can be adjusted externally.

	Under "Reference" it is specified more precisely whether the emissivity ratio or the emissivity should be set. If ϵ from measuring temperature is selected, the currently selected temperature is always used as the reference.	E2/E1 (emissivity slope) ϵ of channel 1 ϵ of channel 2 ϵ of Measured temp.
Setpoint value  Time settings	(only devices with PID controller) The setpoint can be adjusted With a response time, the input signal can be averaged to reduce interferences on the electric line. The longer the time, the slower the adjustments, but also more effective (values: 0-1000 ms).	M322-7333: Input 3: Response time: <input type="button" value="100,0"/> ms

7.1.5.9 Test Functions



CAUTION Using the test function with connected systems activates the selected outputs and can thus lead to an automatic startup of these systems.
Always observe all safety instructions of these systems!

-  **Simulation** simulates a measured temperature that is shown on the device display and in the software, as well as controls the interface and analog output and thus also has an effect on set limit contacts, for example.

1: M322-9396 Temperature simulation:

Activate simulation On Simulation temperature: °C

250 °C  1000 °C

Enter the simulation temperature or change it using the slider

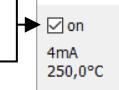
The temperature to be simulated can be changed using the slider or entered in the temperature input field and accepted with "Enter" on the keyboard. Click the hook "On" to activate the simulation and switch from normal measurement to simulation.

-  **Test** emits a **test current** at the **analog output**.

By moving the slider or by entering a value the corresponding current is set to the output.
The output is only activated when the hook "on" is set.

M322-9396 Simulate analog output 1:

Activate simulation on Simulation value: °C Output value: mA

4mA 250,0°C  20mA 1000,0°C

Enter the simulation temperature or current or change it using the slider

-  **Port test** is used to **test activated digital outputs**.

Outputs can only be tested if they have previously been set in the device configuration.
They can then be activated and deactivated under "Output Control" with the ON-OFF switches.

Digital inputs are recognized as active and displayed if they are set in the device configuration and the necessary voltage is present at the input.

Port test 1: M322-9396:

Status of the outputs:

Digital inputs:	1	2	3
Digital outputs:			
Output control:	<input type="button" value="ON"/>	<input type="button" value="OFF"/>	<input type="button" value="ON"/>

ON: Output activated OFF: Output inactive

Output 1 activated  Output 2 inactive 

The status of the digital inputs / outputs is indicated by an LED symbol:

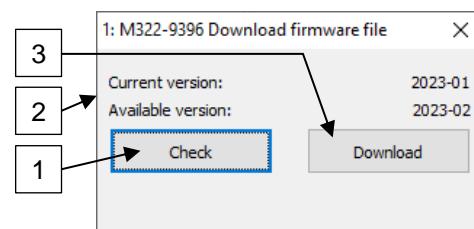
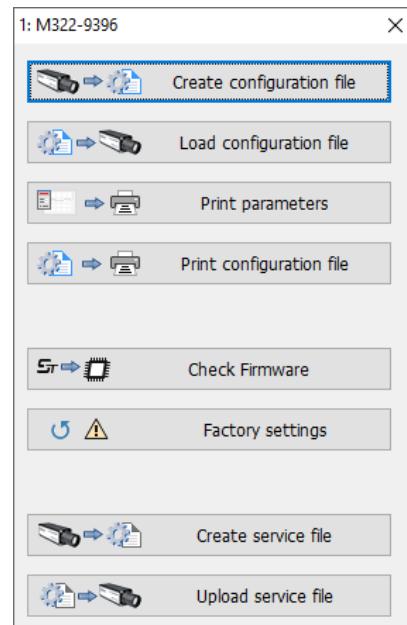
-  Input (IN) or output (OUT) active
-  Input (IN) or output (OUT) inactive
-  Input (IN) or output (OUT) not activated (no function)

7.1.5.10 Service Functions

- Service functions** To back-up, for printing or restore device parameters or create service files for remote diagnosis of problems.
- **Create configuration file:** A configuration file (data format *.r2p) contains all pyrometer data and device settings that have been made. This can be used e.g. to setup a new pyrometer with the same values and settings or to save the current status in case of a device replacement.
 - **Load configuration file:** load a previously saved configuration data in the pyrometer.
 - **Print parameters:** Prints the parameters of the currently connected device.
 - **Print configuration file:** Prints a saved file.
 - **Factory settings:** Resets the device to its factory defaults.
 - **Create service file:** A service file includes all device data and all software settings made by user. Creating such a file can be useful if a problem can't be solved and help from our service could be useful.
 - **Upload service file:** Transmitting a (possibly modified) file to the device it was created from.
 - **Check firmware:** Opens a window to check and download a current firmware file, the current version is displayed.

1. Clicking on "Check" checks whether a newer firmware than that in the pyrometer is available.
2. If there is a newer version than the current version, this is displayed as the available version.
3. If a newer version is available than the one installed in the device, the "Download" button will be activated.
Click on it to automatically load the file with the .bin extension into the Windows Downloads directory, it is about 700 KB in size.

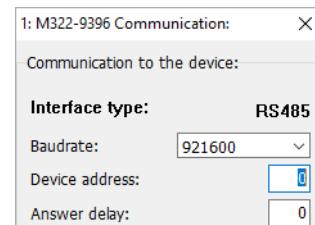
The installation is carried out via the **SensorFlash** update software. In the "**Communication / Options**" tab, click on **Flash firmware H3 / M3 / DI / DS** to start the software.



7.1.5.11 Interface

- Interface settings** For setting the **Baud rate** (can also be changed via the settings in **Data mode**), **device address** and **Interface Delay / Answer Delay**.

The **interface type** RS232 or RS485 is only displayed, but cannot be changed via software, since a currently connected interface converter would no longer work after the change. However, the interface can be changed directly on the device (select menu item RSTYP → 232 or 485) or via the interface command „if“ in the **Terminal field** of SensorTools. The device is then disconnected from the software and a corresponding interface converter is required for further communication.



7.1.5.12 Data Collection (Buffer Mode / ASCII Mode)

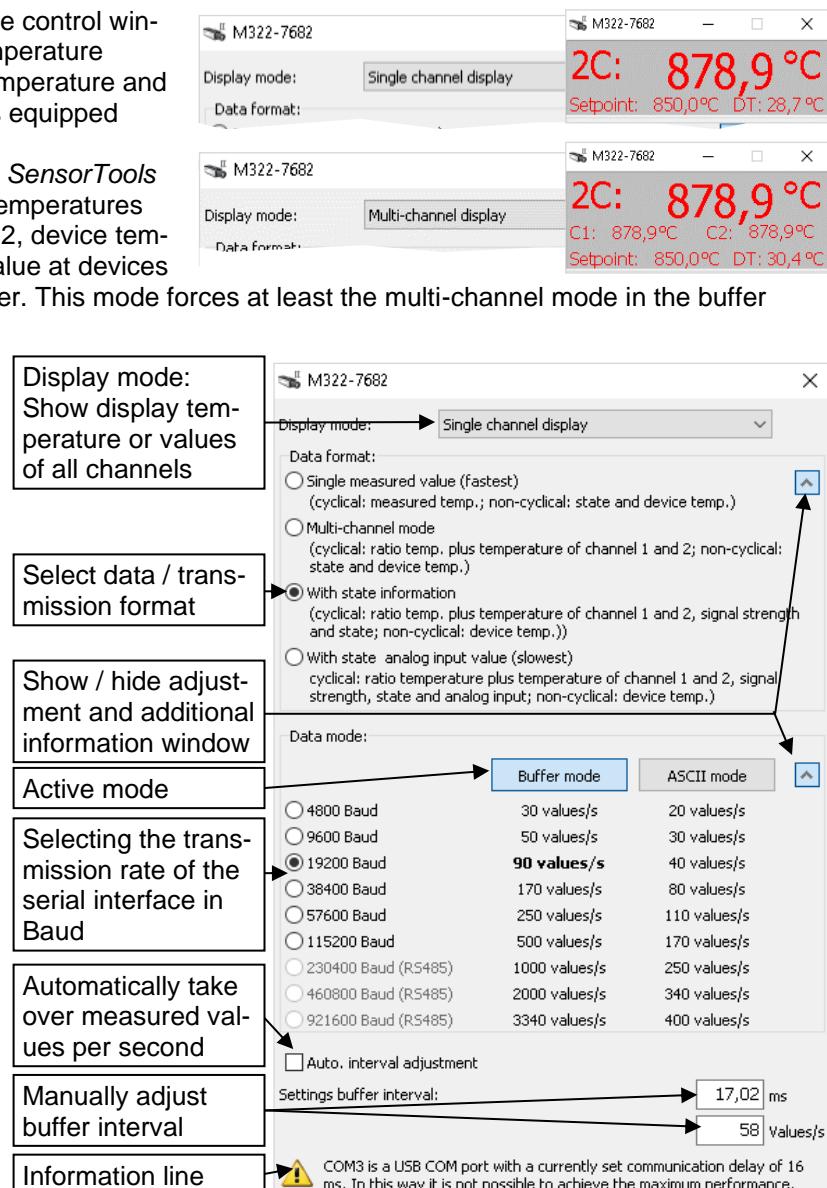
 **Data collection** The measurement data transfer from pyrometer to the PC can vary depending on the requirements and computing power. Speed and transferable amount of data are dependent on the baud rate and the data mode. In the data collection window, the amount of measured values are shown, determined by calculation for each baud rate and each mode. When set to "Auto. interval adjustment", the corresponding values of baud rate selection will be entered automatically in the field on bottom right. When required, they still can be adjusted manually, for example, if the calculated values still give problems.

- **Display mode** switches between:

- **Single channel display:** The control window displays the current temperature measurement, the device temperature and the setpoint value at devices equipped with a PID controller.
- **Multi-channel display:** The *SensorTools* control window displays all temperatures (2-color, channel 1, channel 2, device temperature) and the setpoint value at devices equipped with a PID controller. This mode forces at least the multi-channel mode in the buffer mode setting.

- **Data format:** When measurement data are transmitted, the amount of transmitted information can be selected. The selection affects the speed.

- **Single measured value (fastest):** Saves and transmits the temperature value shown on the display. Is used with M3 and H3 models together with the buffer mode at 921.6 kBd to ensure error-free high-speed communication.
- **Multi-channel mode:** Transmits the temperatures of all channels simultaneously and displays them in the software.
- **With state information:** Multi-channel mode plus control information (I/O states, laser targeting active,...). Devices with PID controller have this mode set by force.
- **With state information and analog input value (slowest):** multi-channel mode plus status information including analog input information.



INFO to display multiple channels in the **Graphs** tab of the software:

To select and view multiple temperature channels, at least the multi-channel mode must be set in the data collection settings. For additional indication of the setpoint at devices with PID controller, preferably the multi-channel mode with status information should be selected.

- **Data mode:**

- **ASCII mode:** The pyrometer always transfers separate readings to the software and shows each in the graph as a pixel. In addition to the transmission of measured values, also regularly status values are transmitted (limit contacts or active laser targeting light...), so that measured values do not always arrive at the same time interval.

For most applications this speed is sufficient, a modern PC can transmit every 5 ms a value at 921 Kbits.

- **Buffer mode:** Measurement data are temporarily stored in the internal pyrometer-buffer and periodically transferred to the software in blocks. The buffer interval defines how fast the internal FIFO buffer of the pyrometer is filled. The shorter the time, the more data per communication block will be transferred.

An interval time set too fast in relation to the baud rate and computing power leads to buffer overflows, which are represented by vertical bars in the graph. A modern PC reaches intervals of about 0.3 ms at 921.6 Kbits without buffer overflow, at 57 Kbits intervals of approximately 3.6 ms. If buffer overflows occur, the interval time can be increased, the baud rate can be increased, or unnecessary programs and background services be stopped. A minor impact also has the reduction of the **Maximum data sets in memory** in the **Data Recording Settings**).

7.1.5.13 Single-Point Adjustment Function

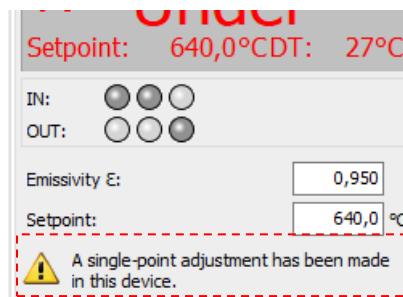
The single-point adjustment function is used to readjust the pyrometer to a mainly used measuring temperature.

The function can be used, e.g. to compensate optical losses in measurements through windows or lenses with unknown transmittance (for example, when coupling the pyrometer into a laser beam delivery system).

For this purpose, the pyrometer has to be aligned to a calibration source with this required temperature or a portable calibration source is positioned at the measuring point and the adjustment function is carried out.

NOTICE This function adjusts the pyrometer to one specific temperature and ensures accurate measurements in the range around this temperature.

INFO to identify a pyrometer that has performed a single-point adjustment: The pyrometer itself does not show whether the factory adjustment is running or whether a single-point adjustment has been carried out. However, a hazard symbol with the text "A single-point adjustment has been made in this device" can be seen in the **Devices Tab** when a single-point adjustment has been carried out. This can also be seen in the manual adjustment window, where the adjustment values of M3 devices differ from 0.0% (see [7.1.5.13.2](#)). H3 devices have a fixed value of mostly 5.9% for K1 and K2.



Preparation: Align the pyrometer with the required temperature to a calibration source or position a portable calibration source at the measuring point and perform the calibration function.

7.1.5.13.1 Automatic Single-Point Adjustment

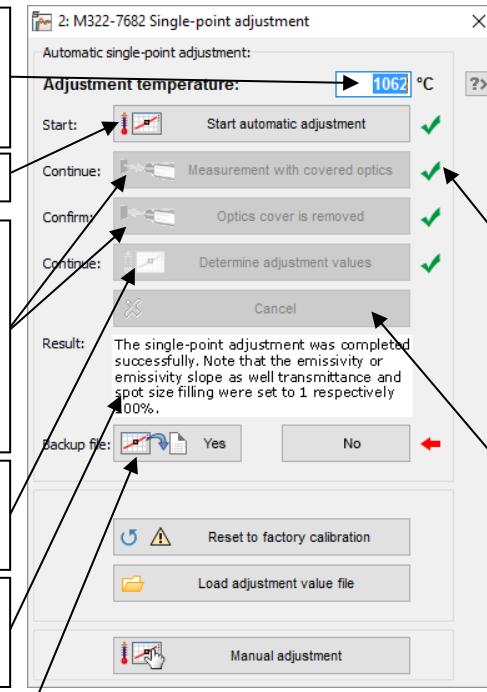
1. Enter the calibration temperature
(must be at least 20% of the total temperature range above the beginning of the measuring range).

2. Start adjustment

3. Measurement with covered optics (only M3 models): Cover the lens so it is opaque and start the measurement. Leave the lens covered until the green tick appears on the right and the next step is active (can take up to 20 seconds).

4. Determine adjustment values continues the automatic adjustment in front of the calibration source.

5. Result: After finishing the adjustment of the success or failure will be displayed in text form.



Open help text

Current step that requires a user's action.

Current processing step.

Successfully completed step.

With "Cancel" the device is reset to factory calibration.

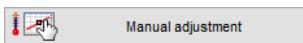
Backup file: Saved adjustment values can be written back to the same device at any time via "Load adjustment file", e.g. to load different adjustment files or if the instrument has been reset to factory calibration.

INFO The single-point adjustment sets the emissivity slope to 1 and the emissivity of channel 1 and channel 2 to 1 (100%), switches off the peak picker and sets the response time to 5 ms. These values are not automatically set to the previous used values and have to be readjusted as required.

INFO Each single-point adjustment deletes an existing one and replaces it with the new one.

- **Reset to factory calibration** resets all single-point adjustment values so that it measures again with the original complete adjustment.
- **Load adjustment value file** loads adjustment values from a saved file into the pyrometer.

7.1.5.13.2 Manual Adjustment



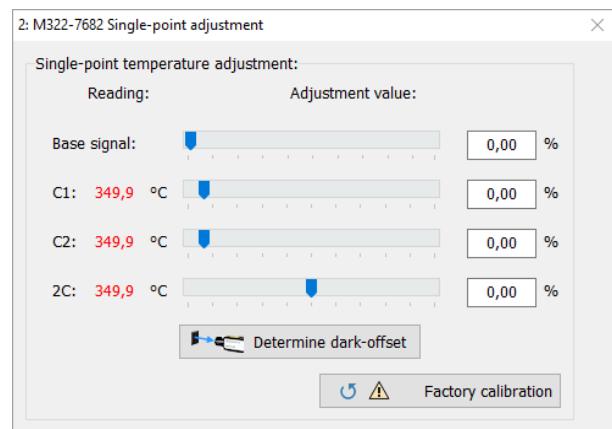
The single-point adjustment function also can be performed manually with sliding controllers. In this case the numerical value of the adjustment can be observed.

- **Preparation:** First, the parameters emissivity slope, emissivity of channel 1 and channel 2, transmittance and spot size filling should be set to 100%, as well as switch off the maximum value storage and set the response time to 5-10 ms.

- **M3 models:**

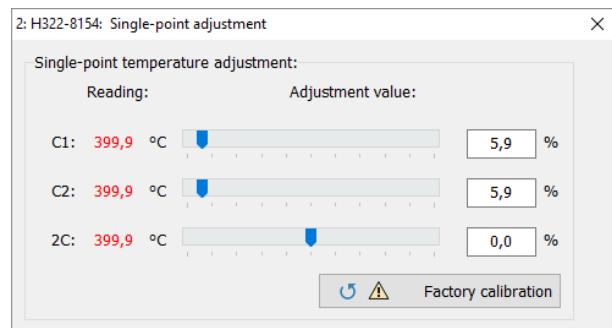
Move the sliders one by one:

1. **Base signal:** Move until the higher value of C1 or C2 has reached the target temperature.
2. In the determination of the so-called **dark-offset**, a measurement with completely darkened optics is carried out, which can increase the accuracy outside the adjusted temperature: Cover the lens opaque (for example, press the hand in front of the optics) and keep it covered during the operation (can take up to 20 seconds).
3. **C1 or C2:** Then readjust the other channel (C1 or C2) to the target temperature. When determining the dark-offset, under circumstances the values of C1 or C2 can be slightly misaligned. In this case C1 and C2 must be readjusted to the desired value. Deviates the temperature after dark-offset by several degrees, this indicates the lens was not darkened 100% and ambient light has penetrated. Then repeat the step.
4. **2C:** Finally, adjust the 2-color temperature until the temperature value of the calibration source is shown correctly.



- **H3 models:**

- Move the sliders one by one for channel 1 (C1), channel 2 (C2) and finally for the ratio temperature (2C) until the temperature value of the calibration source is measured correctly.



- : The process takes between one and two minutes. If anything goes wrong, for example the calibration source does not work smoothly, nevertheless calibration values are written into the pyrometer. In this case the process should be performed again or the device should be reset to factory settings, this sets all calibration values back to 0.0%.

7.2 Graphical Measurement Representation

Graphs tab:
Displays temperature curves graphically.

Scaling scale:

with a mouse click (upper and lower scale range)
by entering
Hold down mouse and drag to shift beginning and ending or the entire area.

 adjusts the measurement temperature scale to the pyrometer temp. range (+10°C above the maximum value and -10°C below the minimum value).

 automatically adjusts the measurement temperature scale when the current reading runs out of the display window.

T-Sample (sampling time): Time between the last two received measured values.
T-Slope (slope time): Time between a start and an end temperature (tab "Time measurement")
T-Contr. (only devices with PID controller): Time how long a control process has lasted

Model and serial number of connected device(s):

 **Data Recording**

 **Data Recording Settings**

 Start the **Viewer** and transfer temporarily stored data

 Start control process (only devices with **PID Controller**)

 Specify control parameters

SensorTools v1.19.07
Devices Graphs Time measurement Communication / Options Spot size calculator 1: M322-7333 Setups 2: M323-9109 Setups

M322-7333: Destination file: M322-7333_2.r2b (File incl: Destination file: M323-9109_2.r2b (File index mode))

File name according to according to **File options**

Measuring-tem-
perature graphs
Measuring-tem-
perature scale

Select graph
or deselect.
Change color display: right-click for color selection

390°C
10:30:37,000 10:30:47,000 10:30:57,000 10:31:07,000 10:31:17,000 10:31:27,000 10:31:37,000

Viewer
Copy data file
Start empty Viewer

Time in which the window is filled with measured values. Changing the time rebuilds the graph from the center of the window.
 **Time** manually rebuilds the graph from the left.

"Copy data file" allows you to quickly copy one or more files to another folder. Select the file(s) and then the target directory. If there are several files, the file names can be automatically preceded by a designation. This function opens the data storage path directly, which can be changed in the "**Communication / Options**" tab, if necessary.

1: M322-7333
T-Sample:
T-Contr.:
T-Slope:
18,00ms off

2: M323-9109
T-Sample:
T-Contr.:
T-Slope:
17,00ms off

All graphs

Measured temp.
 Setpoint temp.
 2-color temp.
 Temp. channel 1
 Temp. channel 2
 Signal strength
 Control output
 Device temp.

   **Time / Stopwatch:**

sets the displayed time at the current graph position to 0

    **Recording**
for all connected devices simultaneously start / stop / pause / replay after pause

INFO to temporarily stored data: As soon as a device is connected in SensorTools, measurement data is continuously saved (buffered). The amount of data is defined under "**Maximum data sets in memory**" in the **Data Recording Settings** and can be adjusted there:

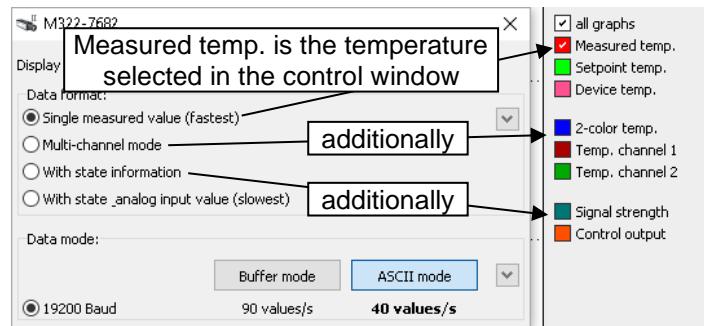
- for an error-free **display of the graph**. If the amount of data is set too high for the computer's performance, buffer overflows occur, which are shown as continuous vertical lines.
- for **passing to the SensorTools Viewer**. The measurement data can be displayed in the viewer by clicking the playback button (). There they can be evaluated more precisely and, if necessary, saved permanently as a file.

Note: Only the set amount of data is transferred, not the complete measurement data since a device is connected. With very fast baud rate and 10000 data sets in memory it could be that just around 0.5 seconds is in memory temporarily stored and transferred to the Viewer. Not very much, so if more values are required, the Data Recording function must be used (red button).

- for the "Back-time recording" function, also in the **Data Recording Settings** (blue button). If a recording is started, the measurement data file can also be preceded by the measurement data from the buffer.

- **Select display graphs:** Depending on the data collection settings (see **7.1.5.12 Data Collection (Buffer / ASCII Mode)**), different graphs can be shown or hidden.

- To select and view **multiple temperature channels** (e.g. 2-color temperature + 1-color temperature), at least the multi-channel mode must be set.
- To display the **signal strength**, the multi-channel mode with status information must be selected.
- For **displaying the setpoint** at devices with **PID controller**, the multi-channel mode with status information should preferably be selected.



7.2.1 Data Recording

The direct storage of all measured value data is possible via the **recording function**. The amount of data that can be stored is only limited by the hard disk capacity. Here, also the amount of data and thus the file size is directly related to the baud rate and the **Data Collection** settings. Saved files can be displayed in the **Viewer** (see **Viewer**).

The **recording button** is available in the devices tab or the graphs tab. Every mouse click starts and stops the data recording. When recording is active, the button (red button) flashes, pause (grey button) interrupts it. If the **Post-record of recording** function is activated, the button flashes correspondingly longer after stopping.

- The **File name** is displayed above the graph, according to the **File options** in the **Data Recording Settings**.
- The **storage path** of the data file created is shown in the **Communication / Options** tab at the bottom and can also be set individually there, if required.
- The data recording can be extended with the "Back-time recording" function or the **Post-record of recording** function at the beginning or the end.
- In the **Data mode**, the type of measured value transmission is specified together with the baud rate. The setting also affects the transmission speed.
 - The higher the **baud rate**, the more measured values per second can be transmitted.
 - The **ASCII mode** always transmits individual measured values and displays them. Depending on the baud rate, between 10 and 400 measured values per second can be displayed.
 - The **buffer mode** is faster, here the measurement data is transferred in blocks. Depending on the baud rate, between 20 and 3330 measured values per second can be displayed, but the PC must be more powerful for this.
- In addition to the measurement temperature, the emissivity slope or the emissivity, device temperature and status information, such as active inputs or outputs, are also saved. The **Data format** is used to set whether additional information is to be displayed, such as the setpoint for devices with a PID controller or the status of a set analog input. However, more information may slow down the transmission.

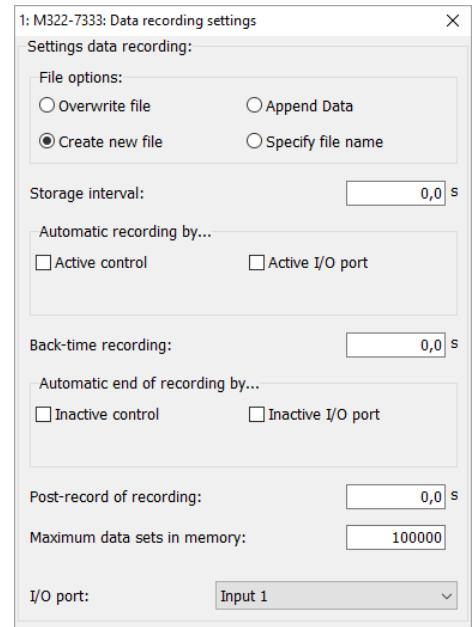
INFO for devices with PID controller: The recording can take place at the same time as the controller starts if this is activated accordingly in the **Data Recording Settings** (blue button) ("Automatic recording by: Active control" and, if applicable, "Automatic end of recording by: Inactive control").

7.2.1.1 Data Recording Settings



button to find in the **Devices Tab** or the **Graphs** tab.

- **File options:** the chosen option is displayed in the graphs tab above the graph with model and serial number as well as a colored target **File name** and sequential number.
 - **Overwrite File (red):** Overrides the same file with each new recording.
 - **Create new file (orange):** creates a separate file for each recording.
 - **Append data (green):** With each new recording, the new values are appended to the previous one.
 - **Specify file name (violet):** Each time a recording is started, first a window opens in which memory name and location must be entered.
 - **Storage interval:** Writes a reading in the file with the set storage interval. At 0.0 s the storage is done as fast as possible (depending on **Data mode** and baud rate).
 - **Automatic recording by:**
 - **Active control** (shows only effect when equipped with a PID controller): Starts recording automatically when a controller-start takes place (also at an external start).
 - **Active I/O port:** Starts recording when a digital input or output is active. The port selection will be done at I/O port at the bottom of the window.
 - **Back-time recording:** If the record button is pushed (or recording is activated by active I/O port and setting "automatic recording by active I/O port" is checked), values are stored retroactively for the entered time but only as many, as entered under "Maximum data sets in memory".
 - **Automatic end of recording by:**
 - **Inactive control** (shows only effect when equipped with a PID controller): Stops recording when a control process is stopped (even with automatic or external stop, error, etc.).
 - **Inactive I/O port:** Stops recording when a digital input or output is disabled.
 - **Post-record of recording:** recording can be continued for a while if control process is stopped, e.g. to record a cool down process.
 - **Maximum data sets in memory:** Number of measured value data sets that are buffered for display in the graph window or for back-time recording or when the *SensorTool* Viewer is opened. In addition to the measuring temperature, a measured value dataset also contains emissivity, device temperature and possibly more (depending on buffer mode settings, see [7.1.5.12](#)).
- Between 500 and 10 million records can be set. Higher values mean that e.g. in the graph window, when switching the time scale setting of the x-axis, more values can be displayed again. Even if post-record of recording is activated, more data can be stored retroactively. Also, the number of values that are transferred to the Viewer by pressing the play button () is affected.



INFO As soon as the data amount has reached the set value and new measured values are added continuously, the oldest ones are also continuously deleted. The higher the set value, the higher the power demanded by the PC. If the computer is not able to perform this task, buffer overflows occur, which are represented in the graph window by continuously redrawn vertical bars. Then the value must be set lower until the display works correctly.

- As **I/O port** a digital input as well as output can be selected.

INFO If an output is used, the assigned function can be used for controlling the automatic recording, for example for automatic recording when a certain temperature is exceeded (limit switch activated).

7.2.1.2 Settings for the Fastest Possible Measurement Data Recording

SensorTools can record very fast processes with recording intervals from approx. 50 µs (H3) or 300 ms (M3), if the corresponding settings have been made:

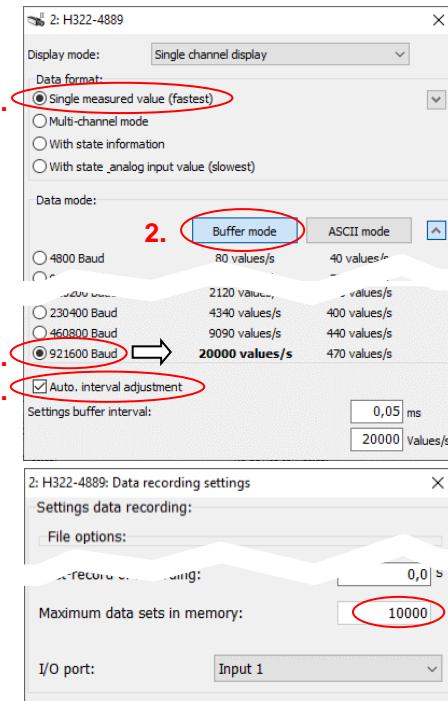
- Use pyrometer with RS485 interface and interface converter RS485 to USB if necessary.
- Set the latency time to 1 ms in the Windows Device Manager for the USB interface used (see [4.1.5.2](#)).

Make settings for the fastest data transfer in the data collection window (in the device connecting tab or in the control window via "Device configuration"):

1. Data format: Single measured value (fastest).
2. Data mode: Buffer mode.
3. Baud rate: 921600 Baud.
4. Activate "Automatic interval adjustment".

- Adjust data recording settings (in the device connection area or in the graph window):

Set the value under "Maximum data sets in memory" to 10000 and take over with the "Enter" key.



INFO The value has been determined experimentally and can be set higher or lower depending on the PC configuration (setting range between 500 and approx. 10 million). With higher values, buffer overflows may occur, which are shown in the graph window after a short time by vertical bars. Then the value should be set lower (also see the description "[Maximum data sets in memory](#)" in the [Data Recording Settings](#)).

7.3 SensorTools Viewer: Graphical Measurement Data Playback

The *SensorTools* Viewer is an independent program for graphic display and evaluation of measured value data. It opens in the language set in *SensorTools*.

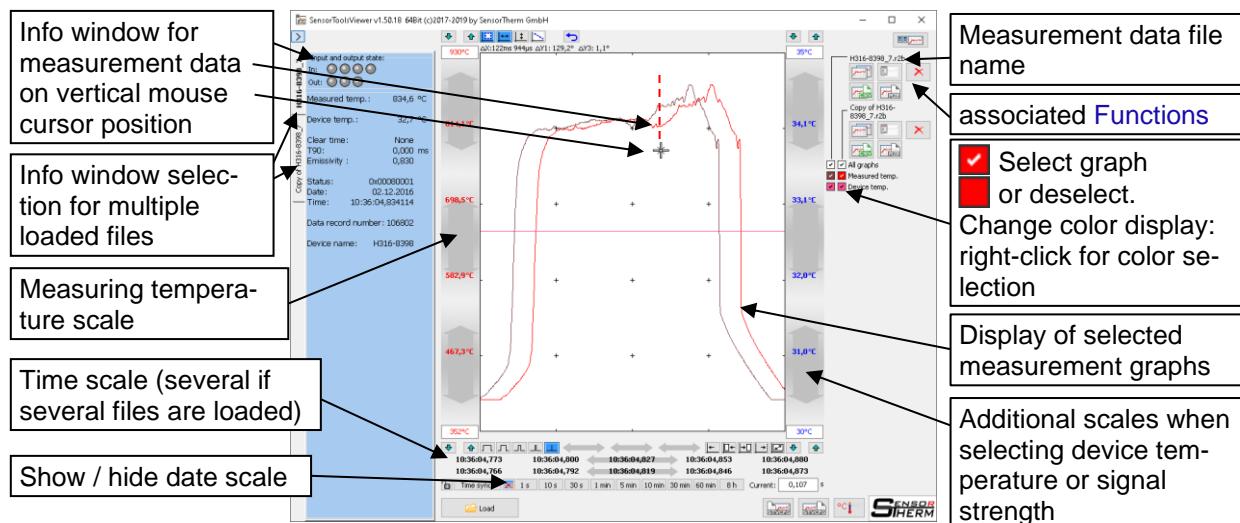
7.3.1 Load / Open Measurement Data File(s)

- Up to **four measurement data files** can be loaded and displayed in a viewer window, in addition to it several viewer instances can be opened:
 - The viewer opens without file content via the **playback symbol** in the graphs tab.
 - via the small **playback symbols** in the *SensorTools* connection area or the graphs tab the [temporarily stored data](#) will be passed to the *SensorTools* Viewer, that are those that have been recorded since the device was connected to the software. However, these are only as many as set in the "Maximum data sets in memory" in the [Data Recording Settings](#).
To be noted: This data is not stored automatically!
 - (directly in the viewer): **opens from the last opened file path**.
 - key + : opens from **standard working directory** (standard working directories can be set in *SensorTools* in the "Communication / Options" tab, also see [7.6](#)).
 - Via **drag-and-drop**, e.g. from the Windows Explorer files can be dragged directly into the viewer.
 - **Double-clicking** on a measurement data file opens its own viewer window and displays all measurement data in the window.

- The following **file types** can be selected:
 - **SensorTools data file (*.r2b**, file icon: ): The standard data format for recording measurement data in SensorTools.
 - **SensorTools Viewer view file (*.stvcfg**, file icon: ): workspace files store a view of multiple data files, e.g. to be sent as a comparative detail view. When saving a workspace file, you can choose in a selection window whether a folder should be created automatically in which the selected data files are saved as r2b so that they can be sent easily or if the original file path should be used.

INFO Loading an stvcfg file deletes already loaded and displayed r2b files from the Viewer.

7.3.2 Overview



7.3.3 Customize Views / Measurement Data Evaluating

Draw selection rectangle with the mouse + horizontal zoom / vertical zoom activated	Hide (integrated) info window	Open a separate information window for each measurement file and distribute it evenly and as large as possible with the main window on the monitor	Show separate info windows individually
Draw with the mouse for Time / difference temperature measurement	<p>Restore last view</p> <p>SensorToolsViewer v1.50.10 64Bit (c)2017-2019 by SensorTherm GmbH</p> <p>H316-8398_7.r2b</p> <p>C322-10311-H0000-2000129</p> <p>C322-10311-B12b</p> <p>Measured temp.: 849,6 °C (2-color temp.)</p> <p>2-color temp.: 849,6 °C 1-color temp.: 849,3 °C</p> <p>Device temp.: 25,0 °C</p> <p>Av 2C temp.: 849,1 °C Min. temp.: 845,5 °C Max 2C temp.: 850,8 °C</p> <p>Emissivity slope: 1,000 Switch-off: 10 % Signal length: 99,1 %</p> <p>Block type: Single data Storage mode: 4</p> <p>Storage interval: 1,0s Interval pause: 1,0s</p> <p>Status: 0x010004 Device status: 0x000000</p> <p>Date: 29.01.2020 Time: 12:25:04,190</p> <p>Device name: C322-10311</p> <p>Device record number: 5966</p> <p>Device name: C322-10311</p> <p>Clear time: None T90: 0,000 ms EV: 1,000 Emissivity E: 1,000</p> <p>Signal strength: 98,3 % Status: 0x00480000 Date: 29.01.2020 Time: 12:25:13,851999 Data record number: 5966 Device name: C322-10311</p>		
Shift the graph with the mouse, with several files for each measurement data file individually	<p>Select temperature unit °C / °F</p>		
Adjust scaling by mouse drag, by entering or mouse click	<p>Jump to the beginning</p> <p>A display window to the left</p> <p>A display window to the right</p> <p>Jump to the end</p> <p>Fit all measured value data in window</p>		
Enable / disable single graph shift	Scale time axis to fixed time (rebuids the graph from the middle)	<p>Mouseover help: if the mouse pointer is held over a button, a short description usually appears. Above a time axis at a plurality of files loaded, the associated file is displayed in bold, above one of the vertical scales the associated measured value graph is displayed.</p>	
Align all graphs to the left			
Steps of the horizontal axis shifts when dragging the mouse and when changing the display window (/ can be selected between: very rough (1/2 screen) and very fine (1/32 screen)			
Time / difference temperature measurement: ΔX: timeline, ΔY1/2/3: vertical axes from left to right			

Shortcuts: Moving the X or Y axes while pressing keys.

Temperature axis:	without key: Alt Ctrl +	10° steps	Time axis:	without key: Alt Ctrl +	as elected
	key: 	1° steps		key: 	1 pixel
	key: 	25° steps		key: 	1/8 screen
	key: 	50° steps		key: 	1/4 screen
	key: +	100° steps		key: +	1/2 screen

7.3.3.1 Copy, Save, Print, Export...

Functions for each measurement data file (top right):

- Creates a copy of the current view
- Opens a separate information window
- Closes the respective file
- Saves the current view as .r2b
- Exports the current view as .csv

General (below):

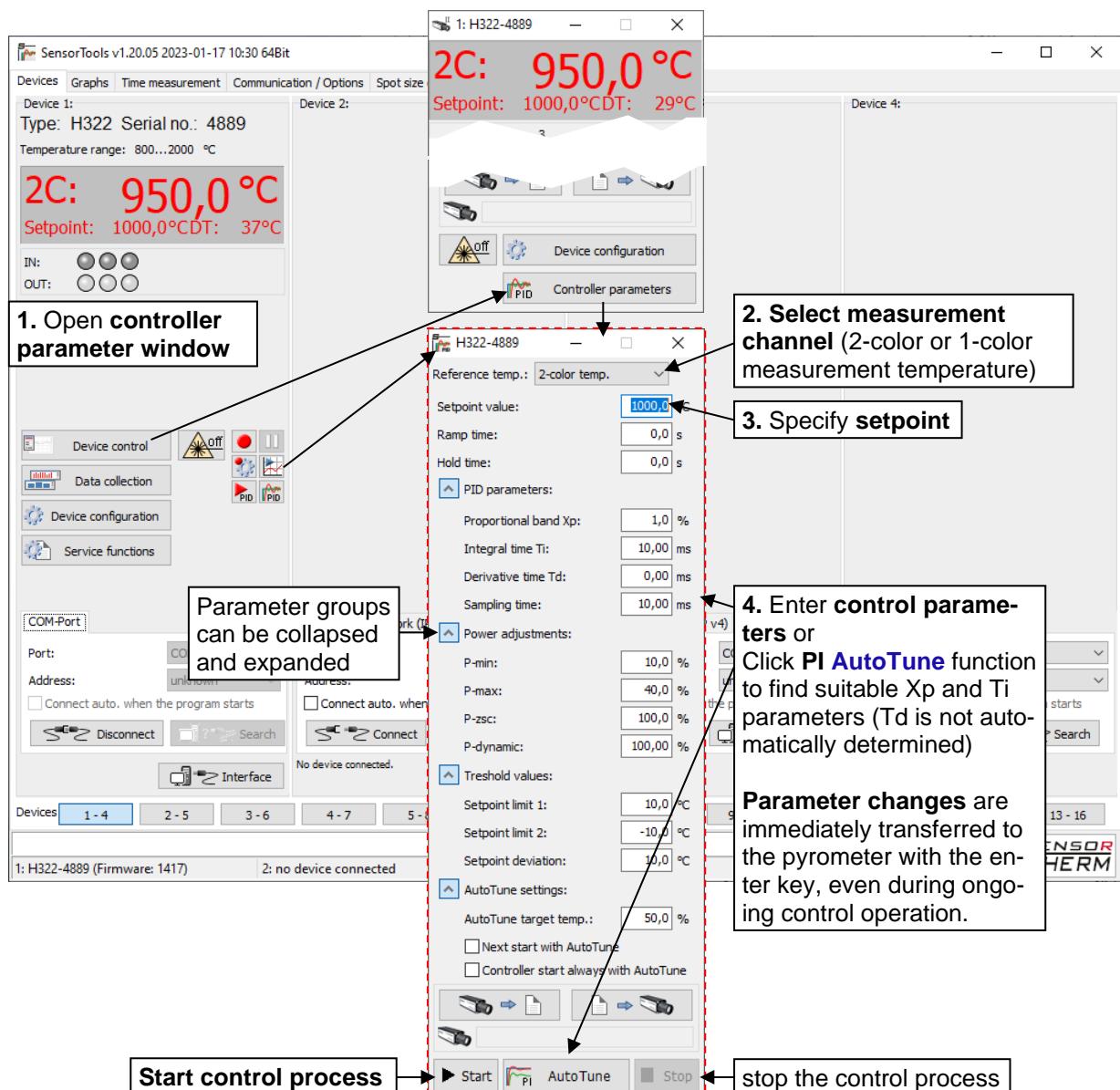
- View of multiple files
- Loading multiple files simultaneously
- Saves the current view of multiple files as .stvcfg.
- Prints the current screen view.

7.4 PID Controller Equipment

M3 and H3 pyrometers can optionally be equipped with an integrated PID controller. With this, the temperature signal is converted into a manipulated variable signal via a PID software controller. A setpoint value and the necessary PID parameters are set to trigger a corresponding control value output. At the analog output 2, the manipulated variable is provided, via display and analog output 1 the current temperature reading is available.

An integrated PID controller is automatically recognized by the software and activates

- the buttons for the controller setting window ( Controller parameters) in the control window and  in the devices tab).
- the control start / stop buttons ( Start /  Stop) in the controller setting window and  in the devices tab).
- additional functions of the [Configurable Inputs / Outputs](#).



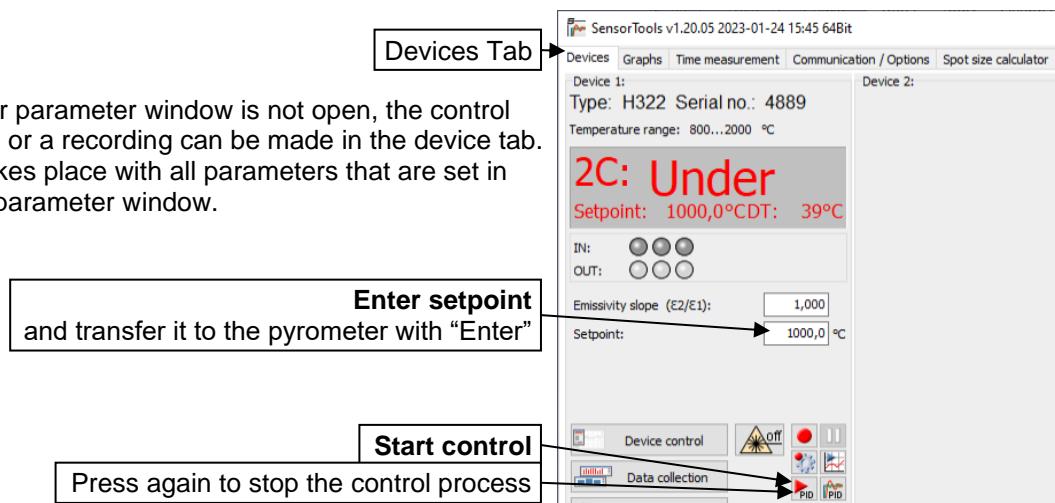
The control process is carried out until it is stopped manually or stops automatically if a hold time has been entered that runs from the time the setpoint is reached.

[INFO] if the controller start does not work: If a digital input "Activate controller" is activated, the controller process can only be started if 24 V are present at the input.

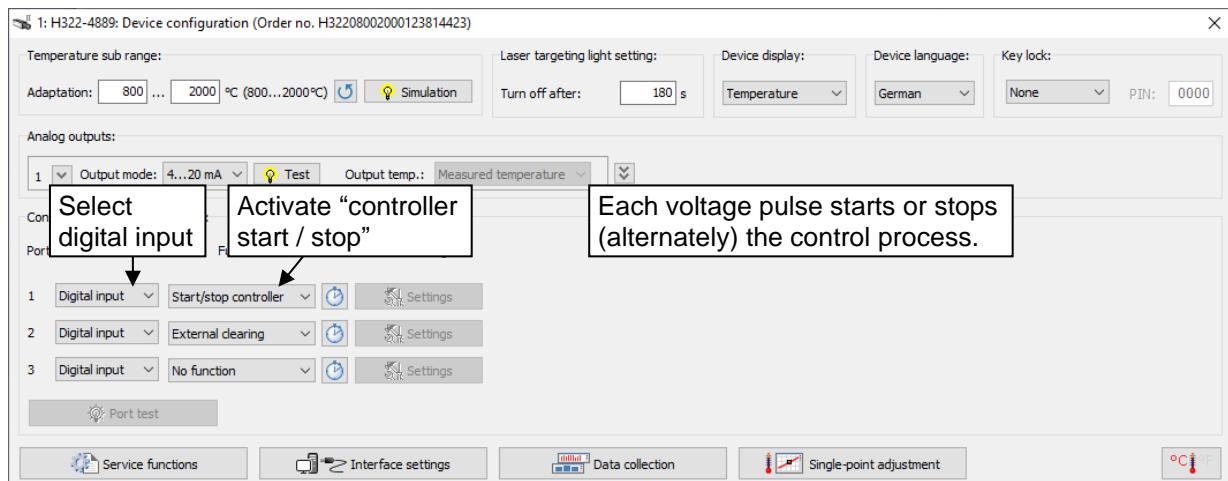
[INFO] in processes where the temperature is to be controlled from a value higher than the setpoint to a lower value, the controller cannot actively control anything, since reaching the temperature depends on the cooling speed of the material.

7.4.1 Start / Stop from the Devices Tab

If the controller parameter window is not open, the control can be started or a recording can be made in the device tab. The control takes place with all parameters that are set in the controller parameter window.



7.4.2 Start / stop via the Digital Input "Controller Start / Stop"



7.4.3 Control Parameters

- **Always visible parameters:**

- **Reference temperature:** selects the temperature that is displayed in the control window (same function as in the control window)
- **Setpoint value:** Setpoint specification
- **Ramp time** (in 100 ms): The setpoint temperature will be approached by increasing the temperature with a uniform gradient of the temperature within the entered time (the setpoint temperature in the grey field above can show updated ramp temperatures if the buffer mode settings in the data collection settings (see 7.1.5.12) are set to "with state information").
- **Hold time:** when reaching the desired value, the setpoint value can be maintained at the current value. The control process stops automatically after the hold time is elapsed.

 Click the **expand icon** to open the control parameters sorted into groups.

▪ **PID parameters:**

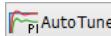
- **Proportional band Xp:** The proportional band represents the reciprocal of the gain of the controller (Entering 0.1-1000%, 0.1 = highest gain, 1000 = lowest gain).
- **Integral time Ti:** The integral time constant represents a kind of smoothing or delay.
INFO Ti is a multiple of the sampling time. Therefore, changes in the sample have an impact on this value.
- **Derivative time Td:** The derivative time constant slowdowns the rapid rise to prevent overshooting (if, for example, the actual value has almost reached the target value but still strong increases, Td slows a further increasing to prevent an overshoot).
INFO Td is a multiple of the sampling time. Therefore, changes in the sample have an impact on this value.
- **Sampling time:** Select how quick temperature values will be read out of the sensor. Select the parameter depending on the inertia of the heating process
INFO Ti and Td are a multiple of the sampling time. Therefore, changes in the sampling effect changes in Ti and Td.

▪ **Power adaptation:**

- **P-min:** The minimum control output power defines the power set to the control output at least.
- **P-max:** The maximum control output limits the power to the entered value.
- **P-zsc:** Limits the control output power as long as the beginning of the pyrometer's temperature range is reached. This is useful to avoid a too fast start of a heating process because the object temperature is out of the pyrometer's temperature range.
- **P-dynamic:** Limits the power, the control output can control suddenly (standard 100%).

▪ **Other functions:**

- **Setpoint limit 1 and 2:** Activates every selected "setpoint limit" output (see [4.1.4 Configurable Inputs / Outputs](#) and under [7.1.5 → Configurable Inputs / Outputs](#)) if set temperature is exceeded or falls below. The required temperature has to be set relative to the setpoint temperature (in the control parameter field), not as absolute value.
- **Setpoint deviation:** defines the maximum permissible deviation between setpoint and actual value. Used to detect if a ramp is within tolerance and then initiate the subsequent hold time.

▪  The **AutoTune** function enables to detect automatically useful values for the proportional Xp and integral time constant Ti. The function tries to find the values Xp and Ti without overshooting the setpoint temperature.

- The **AutoTune target temperature** defines the temperature that is used for Xp and Ti determination. The entry occurs in % and defines the difference between setpoint and actual value (example: setpoint is 1000°C, the measurement object is cold which means the actual value is the pyrometer's beginning of temperature range and thus, for example, 500°C, then the target temperature is 750°C at 50% factory setting). Only a value below 100% prevents a temperature exceeding during P-I-determination and thus a possibly material destruction due to overheating.
- **Next start with AutoTune:** Check this box to activate the AutoTune function with the next controller start. Starting the controller with "Start" will start first the AutoTune process followed by the programmed control process. This also works for an external control start. The function is only active for one controller start and will be unchecked with the next start.
- **Controller start always with AutoTune:** Starts every time the AutoTune function when the controller is started.

INFO The AutoTune process always starts from the current actual value (measured value). At a restart any residual heat of the object can thus potentially lead to unusable values.

7.4.3.1 Short help for finding the control parameters P, I and D

Basically, in a thermal process, different control parameters will be determined for different temperatures.

- **Proportional band X_p:**

X_p is a dimensionless number representing the reciprocal of the gain of the controller.

At X_p = 100% the controller gain is 1.

at X_p = 0.1% the gain is 1000, at X_p = 1000% the gain is only one tenth.

This amplification simply increases the control output (manipulated variable) without delay, the further apart the setpoint and actual value are. If you select X_p too small (=gain too high), it may be that the controller tends to oscillate. If X_p is too large (= gain too small), the control output may not be modulated high enough at all.

With proportional control alone, the actual value of the temperature always remains below the set-point (if no oscillation occurs), because if the control deviation is 0, the control output would also be set to 0 and no further heating energy would be supplied. A permanent control deviation is thus obtained.

- **Integral time K_i:**

K_i is specified in units of time (e.g. in seconds). It represents a kind of smoothing or delay time and integrates control deviations to correct the control output so that no remaining control deviation remains.

Basic rule:

K_i must be at least as large as the (thermal) time constant of the heating circuit.

For example, for a ceramic black body, K_i must typically be in the range of minutes, while fractions of a second may be sufficient for a filament.

Increasing the time K_i makes the control process slower but also more stable.

Decreasing K_i can result in overshoot or even continuous oscillation.

- **Derivative time K_d:**

K_d is also given in units of time. It represents the look-ahead component of the controller. For example, if the setpoint has almost reached the actual value but is still rising sharply, K_d "brakes" the rapid increase and prevents overshoot.

Method:

Start with K_d = 0, then set K_d = K_i/4 and see if the transient effect goes better.

7.5 Profibus / Profinet Equipment

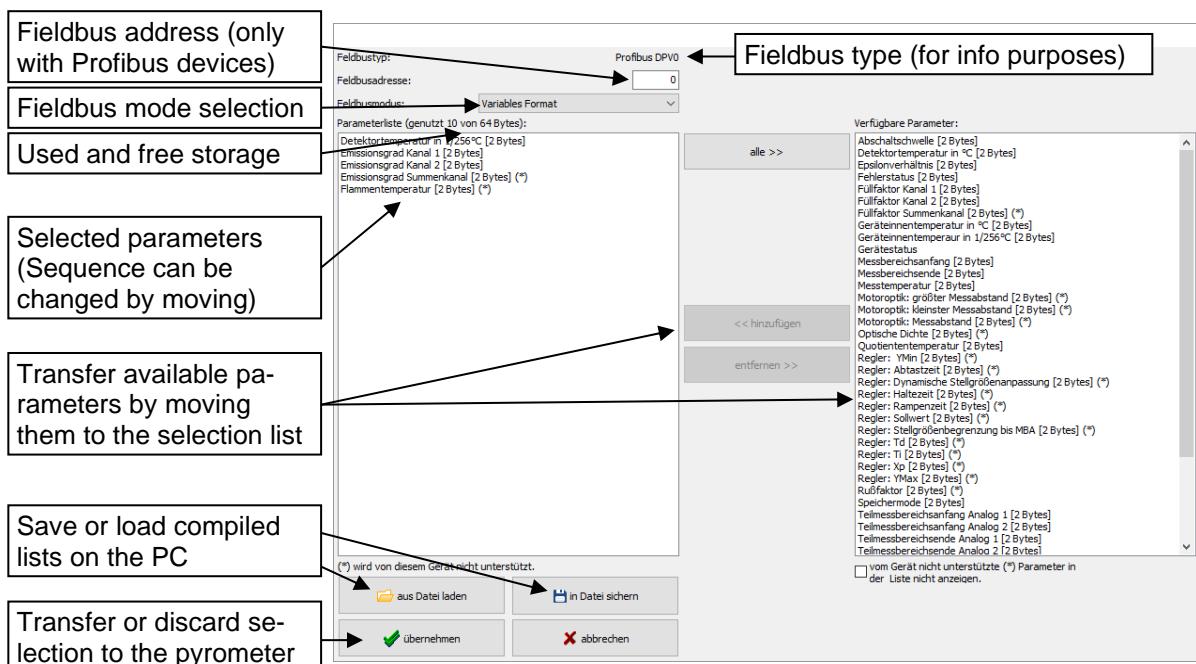
7.5.1 Fieldbus Mode Selection for Reading the Pyrometer Data

To read out the measured temperature and measurement relevant parameters, a fieldbus mode must be selected. There are 3 available, the setting is made via →  Device configuration →  Fieldbus.

Definition: The input data is the data that is sent cyclically from the pyrometer to the master. The output data is the data (commands) that is sent from the master to the pyrometer to possibly change parameters in the pyrometer.

Modes: The first two modes list the transmitted data, they are for information and can not be changed. In user-defined mode, the data to be transferred can be compiled from a list of all available data and the order can be determined.

- **Mode 0: Downward compatible to METIS series:** Provides a non-modifiable parameter list that is compatible with older pyrometer models MS / MI / MQ etc., it is used to substitute an M3 for these devices.
- **Mode 1: Fixed format M3 series** with the most frequently used parameters: Provides a non-modifiable parameter list that includes the most commonly used parameters of a fully featured pyrometer.
- **Mode 2: Custom format M3 series:** In this mode, the required parameters can be individually selected to create own profiles.



INFO about parameters listed with (*): These parameters are not supported by the device. For compatibility purposes to 2-color devices, they can be transmitted as an empty area, in the event that 1- and 2-color devices are to be used together. By placing the hook below the list, these parameters can be hidden from the list.

Mode 0 (Data packet size 32 Input Bytes): Sequence and Meaning

Byte	Meaning
1-2	Measured 2-color temperature (in 1/10 degree); special case: F0 00h = invalid measured value (overflow)
3-4	Measured 1-color temperature of channel 1 (1/10 degree). special case: F0 00h = invalid measured value (overflow)
5-6	Measured 1-color temperature of channel 2 (1/10 degree). special case: F0 00h = invalid measured value (overflow)
7-8	Measured 1-color temperature of sum channel 1+2 (1/10 degree). special case: F0 00h = invalid measured value (overflow)
9-10	Emissivity slope (in %) 1000 (03E8h) = 1.00
11-12	Emissivity channel 1 (in %) 1000 (03E8h) = 100%
13-14	Emissivity channel 2 (in %) 1000 (03E8h) = 100%
15-16	Emissivity of sum channel (in %) 1000 (03E8h) = 100%
17	Bit 7- Bit 4 = Response time (0...6) 0 = Intrinsic time constant of the device 1 = 0.01 s 2 = 0.05 s 3 = 0.25 s 4 = 1 s 5 = 3 s 6 = 10 s Bit 3 - Bit 0 = Clear settings of peak picker (0...8) 0 = off 1=0.01 s 2=0.05 s 3=0.25 s 4=1 s 5=5 s 6=25 s 7=external clear 8=automatic clear
18	Analog output (hex.; 00h, 10h): 00h = 0–20 mA; 10h = 4–20mA
19	Internal device temperature (in 1/256°C or 1/256°F)
20	Error status (see 11 , Interface commands: fs command)
21-23	Device status (internal purpose)
24-25	Beginning of device temperature range (in 1/10 degree)
26-27	End of device temperature range (in 1/10 degree)
28-29	Beginning of temperature sub range (in 1/10 degree)
30-31	End of temperature sub range (in 1/10 degree)
32	Unused

Mode 1 (Data packet size 64 Input Bytes): Sequence and Meaning

Byte	Meaning																																													
1-2	Measured 2-color temperature (in 1/10 degree); special case: F0 00h = invalid measured value (overflow)																																													
3-4	Measured 1-color temperature of channel 1 (1/10 degree). special case: F0 00h = invalid measured value (overflow)																																													
5-6	Measured 1-color temperature of channel 2 (1/10 degree). special case: F0 00h = invalid measured value (overflow)																																													
7-8	Emissivity slope (in %) 1000 (03E8h) = 1.00																																													
9-10	Emissivity channel 1 (in %) 1000 (03E8h) = 100%																																													
11-12	Emissivity channel 2 (in %) 1000 (03E8h) = 100%																																													
13	Unused																																													
14	Clear settings of peak picker / storage mode (0...4) 0 = No storage; 1 = time clear; 2 = external clear; 3 = automatic clear; 4 = pouring stream mode (optional)																																													
15-18	Response time (0...25 s); in steps of 10 µs (00000000h-0003d090h)																																													
19-22	Clear time (0...10 s); in steps of 10 µs (00000000h-000186a0h)																																													
23-24	Analog outputs (Byte 1= analog output 1, Byte 2=analog output 2) Bit 7-Bit 4 = 0–20 mA, 4–20 mA; Bit 3-Bit 0= Output temperature, controller, etc.																																													
25-26	Internal device temperature (in steps of 1/256°)																																													
27-28	Error status (see 11 , Interface commands: fs command)																																													
29-32	Status bytes																																													
	<table border="1"> <thead> <tr> <th>Bit</th> <th>Status byte 0</th> <th>Status byte 1</th> <th>Status byte 2</th> <th>Status byte 3</th> </tr> </thead> <tbody> <tr> <td>Bit0 (lsb)</td> <td>Fahrenheit active</td> <td>Controlling active</td> <td>Setup0</td> <td>Display 0</td> </tr> <tr> <td>Bit1</td> <td>Status dig. output 1</td> <td>AutoTune active</td> <td>Setup1</td> <td>Display 1</td> </tr> <tr> <td>Bit2</td> <td>Status dig. output 2</td> <td>AutoTune at controller start</td> <td>Setup2</td> <td>Display 2</td> </tr> <tr> <td>Bit3</td> <td>Status dig. output 3</td> <td>Device ready</td> <td>Unused</td> <td>Unused</td> </tr> <tr> <td>Bit4</td> <td>Status dig. input 1</td> <td>Device hardware error</td> <td>Unused</td> <td>Unused</td> </tr> <tr> <td>Bit5</td> <td>Status dig. input 2</td> <td>Controller finished (successful)</td> <td>Unused</td> <td>Unused</td> </tr> <tr> <td>Bit6</td> <td>Status dig. input 3</td> <td>Targeting light active</td> <td>Unused</td> <td>Unused</td> </tr> <tr> <td>Bit7 (msb)</td> <td>Status dig. input 4</td> <td>Unused</td> <td>Unused</td> <td>Unused</td> </tr> </tbody> </table>	Bit	Status byte 0	Status byte 1	Status byte 2	Status byte 3	Bit0 (lsb)	Fahrenheit active	Controlling active	Setup0	Display 0	Bit1	Status dig. output 1	AutoTune active	Setup1	Display 1	Bit2	Status dig. output 2	AutoTune at controller start	Setup2	Display 2	Bit3	Status dig. output 3	Device ready	Unused	Unused	Bit4	Status dig. input 1	Device hardware error	Unused	Unused	Bit5	Status dig. input 2	Controller finished (successful)	Unused	Unused	Bit6	Status dig. input 3	Targeting light active	Unused	Unused	Bit7 (msb)	Status dig. input 4	Unused	Unused	Unused
Bit	Status byte 0	Status byte 1	Status byte 2	Status byte 3																																										
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Bit4	Status dig. input 1	Device hardware error	Unused	Unused																																										
Bit5	Status dig. input 2	Controller finished (successful)	Unused	Unused																																										
Bit6	Status dig. input 3	Targeting light active	Unused	Unused																																										
Bit7 (msb)	Status dig. input 4	Unused	Unused	Unused																																										

33-34	Beginning of device temperature range (in 1/10 degree)
35-36	End of device temperature range (in 1/10 degree)
37-38	Devices with controller: setpoint value (in 1/10 Grad)
39-40	Devices with controller: proportional band Xp (0...10000) in 0.1%
41-42	Devices with controller: integral time Ti (0...65535) Factor × sampling time
34-44	Devices with controller: derivative tme Td (0...65535) Factor × sampling time
45-46	Devices with controller: minimum controller output power P-Min (0...999) in 0.1%
47-48	Devices with controller: maximum controller output power P-Max (1...1000) in 0.1%
49-50	Devices with controller: output power limitation up to the beginning of the temp. range P-zsc (0...1000) in 0.1%
51-52	Devices with controller: controller output power limitation P-dynamic (0...10000) in 0.01%
53-54	Devices with controller: ramp time (0...65535) in 100 ms
55-56	Devices with controller: hold time (0...65535) in 100 ms
57-58	Devices with controller: sampling time (100...2500) in 10 µs
59-60	Devices with motorized optics: smallest possible measuring distance (in mm)
61-62	Devices with motorized optics: largest possible measuring distance (in mm)
63-64	Devices with motorized optics: current set measuring distance (in mm)

Mode 2 (Data packet size 64 Input Bytes): available and freely selectable pyrometer data

Byte Length	Meaning	Byte Length	Meaning
2	Measured temperature (in 1/10 degree)	2	End of temperature sub range analog 1 (in degree)
2	2-color temperature (in 1/10 degree)	2	Beginning of temperature sub range analog 2 (in degree)
2	Temperature channel 1 (in 1/10 degree)	2	End of temperature sub range analog 2 (in degree)
2	Temperature channel 2 (in 1/10 degree)	2	Devices with controller: Setpoint value (in 1/10 degree)
2	Temperature sum channel (in 1/10 degree)	2	Devices with controller: Proportional band Xp (0...10000) in 0.1%
2	Flame temperature (in 1/10 degree)	2	Devices with controller: Integral time Ti (0...65535) Factor × sampling time
2	Emissivity slope (in 1/10 degree)	2	Devices with controller: Derivative time Td (0...65535) Factor × sampling time
2	Emissivity channel 1 (50...1200)	2	Devices with controller: Minimum controller output power P-Min (0...999) in 0.1%
2	Emissivity channel 2 (50...1200)	2	Devices with controller: Maximum controller output power P-Max (0...999) in 0.1%
2	Emissivity sum channel (50...1200)	2	Devices with controller: output power limitation up to the beginning of the temp. range P-zsc (0...1000) in 0.1%
2	Transmittance channel 1 (50...1000)	2	Devices with controller: Controller power limitation P dynamic (0...10000) in 0.01%
2	Transmittance channel 2 (50...1000)	2	Devices with controller: Ramp time (0...65535) in 100 ms
2	Transmittance sum channel (50...1000)	2	Devices with controller: Hold time (0...65535) in 100 ms
2	Fill factor channel 1 (50...1000)	2	Devices with controller: Sampling time (100...2500) in 10 µs
2	Fill factor channel 2 (50...1000)	2	Devices with motorized optics: smallest possible measuring distance (in mm)
2	Fill factor sum channel (50...1000)	2	Devices with motorized optics: largest possible measuring distance (in mm)
2	Switch-off level (20...900)	2	Devices with motorized optics: Current set measuring distance (in mm)
2	Soot factor (50...250) (Flame)	-	End mark
2	Optical density (0...10000) (Flame)		
2	Storage mode (0...4)		
4	Clear time (0...250000, 0...25 s)		
4	Response time (0...100000, 0...10 s)		
2	Analog output 1+2		
2	Error status (0...255)		
2	Internal device temperature (00...100, in 1°C)		
2	Int. device temp. (00...25600, in 1/256°C)		
2	Detector temperature (00...100, in 1°C)		
2	Detector temperature (00...25600, in 1/256°C)		
2	Beginning of device temp. range (in degree)		
2	End of device temp. range (in degree)		
2	Beginning of temperature sub range analog 1 (in degree)		

7.5.2 Writing the Output Data (changing pyrometer parameters)

To write parameters to the pyrometer, the interface commands are used (see [11, Interface commands](#)) as used on the RS232 / 485 serial interface.

Byte assignment (16 Bytes):

- The first 15 bytes contain the same interface command (in ASCII, without the device address) + <CR> (up to 15 bytes possible, unused bytes remain at 00h)
- The 16th byte is set to:
 - 03h: The command is sent to the pyrometer, and the pyrometer sends a corresponding response in the input data with a <CR> at the end if the command has been accepted. This response is output in the input data as long as the byte is set to 03h. Therefore, pyrometer data is no longer displayed cyclically during this time. Only when the 16th byte is set back to 00h can the master cyclically receive all measured values and parameters again.
 - 01h: the command is sent to the pyrometer, there is no response from the pyrometer.

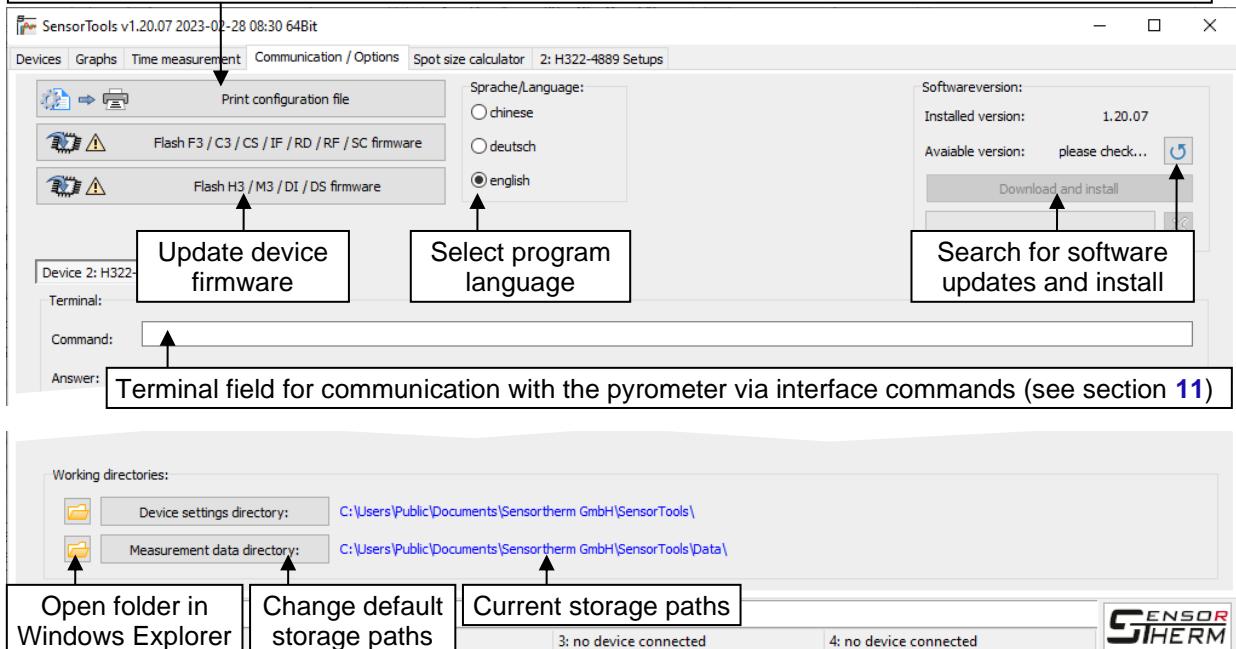
Example: Ia1 + <CR> (switch on laser targeting light, also see [11, Interface commands](#) → Ia)

Byte	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Command	I	a	1	<CR>	*	*	*	*	*	*	*	*	*	*	*	01h

* filled with 00, not relevant

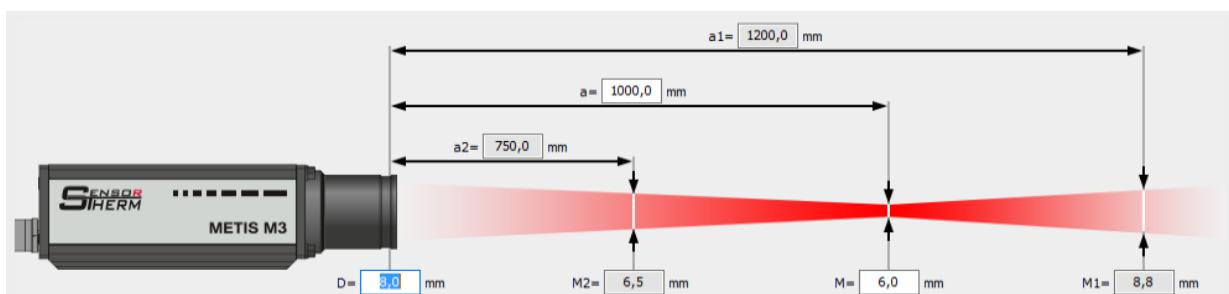
7.6 Communication / Options

Prints a saved device configuration file (data format *.r2p). To create the file, use the service function "Create configuration file" (see [7.1.5.10 Service functions](#)) while a pyrometer is connected.



- **Flash H3 / M3 / DI / DS firmware** starts the **SensorFlash** software to update the firmware of the pyrometer. A corresponding firmware file is required for this. It can be downloaded using the "Check firmware" service function (see [7.1.5.10 Service functions](#)) if the check shows that a more recent version than the one installed in the device is available.
To be able to connect the pyrometer to **SensorFlash**, it must first be disconnected from **SensorTools** in the Devices tab, the appropriate COM port must then be selected in **SensorFlash**, and the device connected again.
- The **working directories** specify the device settings locations (all software-internal and device-specific data such as **Service Functions** or **ShortSetting** files stored via the **Control Window**) and for measurement recording.
The storage paths can only be changed if no device is connected.

7.7 Spot Size Calculator



The spot size calculator is used to calculate the spot size diameter in front of and behind the focus distance. To do this, first enter the white fields with the focus distance, the associated spot size diameter and the aperture according to the **Spot Size Tables**. A measuring distance or spot size diameter can then be entered in a gray field and confirmed with the Enter key, the corresponding equivalent value in the associated gray field is calculated directly.

8 SensorFlash Software (Firmware Update)

The SensorFlash software is used to update the firmware of Sensortherm pyrometers. Press **Flash H3 / M3 / DI / DS firmware** in the Communication / Options tab (see [7.6](#)) to start the software, an updated firmware file can be downloaded via the **Service Functions**.

1. Select the interface that the pyrometer is connected to.
2. Press "Connect".
3. Detected device
4. Click on "Open Flash File".
5. Call up the "Downloads" directory of the previously downloaded firmware file.
6. Select and open the appropriate bin file. It consists of the series name, the year of publication and a consecutive year number.
7. Click on the "Flash" button that is now available.
8. Confirm security query.
9. The firmware is now transferred to the device. Wait for the progress bar to run out and the confirmation message (Congratulation) to appear.
10. After pressing "OK", the device is automatically disconnected from SensorFlash.
For further use with SensorTools, the pyrometer must be reconnected (see [7.1 Program Start / Pyrometer Connection](#)).

NOTICE **Do not interrupt the power supply during the process, the device could be destroyed!**

9 Technical Data

Device-specific M3

Model	M311	M322		
Temperature ranges	600–1400°C 650–1500°C 750–1800°C	900–2500°C 1000–3000°C *) 1100–3300°C *)	300–1000°C 350–1300°C 400–1600°C 500–1800°C	600–2300°C 800–3000°C **) 1000–3300°C **)
Spectral range	Channel 1: 0.93–1.1 µm / channel 2: 0.75–0.93 µm *) Channel 1: 0.99 µm / channel 2: 0.87 µm		Channel 1: 1.65–1.8 µm / channel 2: 1.45–1.65 µm **) Channel 1: 1.64 µm / channel 2: 1.4 µm	
Detector	2 x Silicon	2 x InGaAs		
Response time t ₉₀	< 1 ms (with dynamical adaptation at low signal levels), adjustable up to 10 s			
Exposure time	< 0.5 ms			
Uncertainty (ε = 1, t ₉₀ = 1s, T _A = 23°C)	Full-scale temperature up to 2500°C: 0.3% of reading in °C + 2 K Full-scale temperature above 2500°C: 0.5% of reading in °C (The measurement uncertainty is reached after a warm-up phase of min. 20 minutes; device must be connected to the power supply)			
Repeatability (ε = 1, t ₉₀ = 1s, T _A = 23°C)	0.1% of reading in °C + 1 K			
Temperature coefficient (deviations to 23°C)	From 10 to 60°C: 0.04%/K From 0 to 10°C and 60 to 80°C: 0.06%/K			
Serial interface	RS232 (4.8 to 115.2 kBd) or RS485 (4.8 to 921.6 kBd), switchable. Resolution 0.1°C or 0.1°F			
Optics (optional)	Manual focusable or motorized focus or fixed focus optics			
Power consumption	max. 6 VA (all outputs unconnected)			
Ambient temperature	0–80°C (32 to 176°F), fiber optic and optics on optics side: -20 to 250°C (-4 to 482°F) (to prevent its overheating, the laser targeting light is deactivated at a device temperature from 60°C / 140°F, the camera module from 55°C / 131°F)			

Device-specific H3

Model	H311	H322		
Temperature ranges	600–1100°C 650–1300°C 750–1400°C 900–1800°C	1000–2000°C 1100–2200°C 1300–2500°C 1600–3300°C *)	350–800°C 400–1200°C 500–1300°C 550–1400°C	800–2000°C 1000–2500°C 1300–3000°C **)
Spectral range	Channel 1: 0.93–1.1 µm / channel 2: 0.75–0.93 µm *) Channel 1: 0.99 µm / channel 2: 0.87 µm		Channel 1: 1.65–1.8 µm / channel 2: 1.45–1.65 µm **) Channel 1: 1.64 µm / channel 2: 1.4 µm	
Detector	2 x Silicon	2 x InGaAs		
Response time t ₉₀	< 80 µs, adjustable up to 10 s			
Exposure time	< 40 µs			
Uncertainty (ε = 1, t ₉₀ = 1s, T _A = 23°C)	0.5% of reading in °C			
Repeatability (ε = 1, t ₉₀ = 1s, T _A = 23°C)	0.2% of reading in °C + 1 K			
Serial interface	RS485 (4.8 to 921.6 kBd). Resolution 0.1°C or 0.1°F			
Optics (optional)	Manual focusable optics (built-in or as fiber optics version)			
Power consumption	max. 12 VA (all outputs unconnected)			
Ambient temperature	0 to 60°C (32 to 149°F), fiber optic and optics on optics side: -20 to 250°C (-4 to 482°F) (to prevent its overheating, the laser targeting light is deactivated at a device temperature from 60°C / 140°F)			

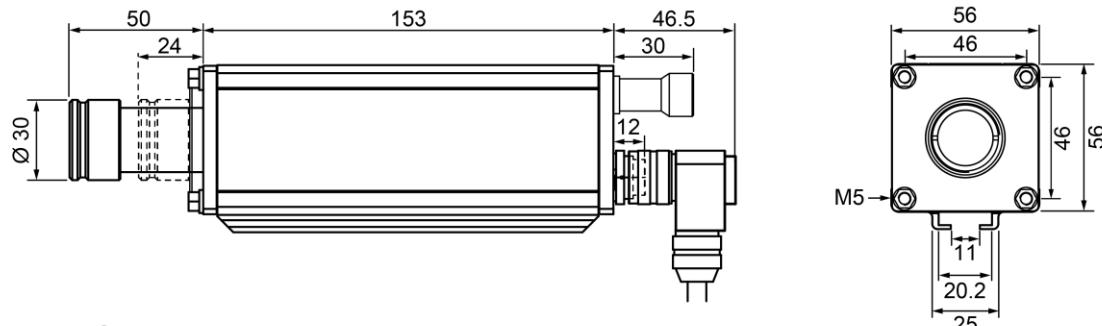
Common Data

Temp. sub ranges	Any range adjustable within the temperature range (minimum span 50°C)
Emissivity slope	0.800–1.200
Emissivity ϵ	0.050–1.200 (corresponds 5–120% in 0.1% steps)
Transmittance	5–100% in 0.1% steps
Spot size fill factor	5–100% in 0.1% steps
Switch-off level	2–90%
Analog output signal	2 scalable analog outputs 0 or 4–20 mA, switchable, max. load: 500 Ω . Resolution 0.0015% of the adjusted sub range temperature (16 Bit). User selectable: 2-color temperature, 1-color channel 1 or channel 2 temperature, device temperature or control output (when equipped with a controller)
3 configurable Inputs / outputs	<ul style="list-style-type: none"> ▪ Digital inputs (max. 3 inputs, protected against reverse polarity): laser targeting light on/off, clearing of peak picker, controller start (when equipped with PID controller), load pyrometer configuration, trigger input for start / stop of measured value recording. ▪ Digital outputs (max. 3 outputs, max. 50 mA, protected against short circuit): limit switch, exceeding the beginning of temperature range (for material recognition), device ready after self-test, device over-temperature, signal strength too low. When equipped with PID controller: controller active, control process within limits, control process finished. ▪ Analog input (0–20 mA, protected against reverse polarity and incorrect connection): analog adjustment of the emissivity, measuring distance at motor focus or setpoint for PID controller (devices with PID controller).
PROFIBUS	Supports PROFIBUS DP-V0 (and DP-V1) according to IEC61158 type 3
PROFINET	Supports PROFINET-RT and IRT according to specification 2.3. Pre-certified, supports class A, B and C functionalities.
Ethernet	Compliant with IEEE802.3/802.3u (Fast Ethernet) und Compliant with ISO 802-3/IEEE 802.3 (10BASE-T).
Maximum value storage / peak picker	Automatic hold mode or manual time settings to clear (reset) or external clear (via configurable input).
Display	Devices with LED: 10-digit LED display (5 mm high) for temperature display or device settings Devices with LED: Dot matrix, green-yellow, 128 x 32 dots (5.6 mm high) for temperature display or device settings (to avoid premature aging of the OLED display, it is darkened if no button is pressed for 10 minutes and from an internal temperature of 60°C (140°F). The display is switched off from an internal device temperature of 75°C (167°F)) Resolution 0.1°C / °F
Parameter settings	Push buttons on the device, serial interface, PC software <i>SensorTools</i> or via self-compiled communication program: Slope/ratio, switch-off limit for measurement, switch-off limit for dirty window alarm, emissivity, transmission, fill factor, temperature sub range, settings for max. value storage, device address, baud rate, response time, selecting analog outputs 0/4–20 mA, interface RS232/RS485 (selection on device only), °C/F, language (English / German), measuring distance with motorized focus optics.
Power supply	24 V DC (18–30 V DC), protected against reverse polarity.
Isolation	Voltage supply, analog and digital output are galvanically isolated from each other
Sighting methods (optional)	<ul style="list-style-type: none"> ▪ Through-lens sighting with adjustable attenuation filter. ▪ Laser targeting light (red, $\lambda=650$ nm or green, $\lambda=515$ nm, $P<1$ mW, laser class 2 acc. to IEC 60825-1) ▪ Color CCD camera, field of view: ca. 3.6 x 2.7% of measuring distance output signal: FBAS signal ca. 1 V_{PP}, 75 Ω, CCIR, NTSC / PAL switchable Resolution: NTSC: 720 x 480 Pixels; PAL: 720 x 576 Pixels frame rate: NTSC: 60 Hz, PAL: 50 Hz.
Storage	Storage temperature: -20 to 85°C (-4 to 185°F); relative humidity: max. 95%, non-condensing conditions, do not store outdoors, protect from direct sunlight, store dry and dust-free, do not expose to corrosive media and avoid mechanical vibrations.
Relative humidity	Non-condensing conditions.
Housing / protection class	Aluminum / IP65 (when the connector is plugged in).
Weight	Min. 660 g (1.46 lbs)
CE label	According to EU directives

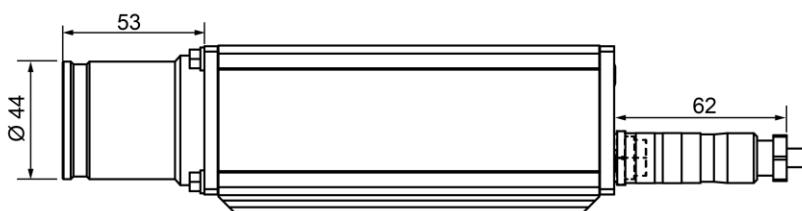
9.1 Dimensions

The case dimensions are the same for all models and differ in the mounting parts:

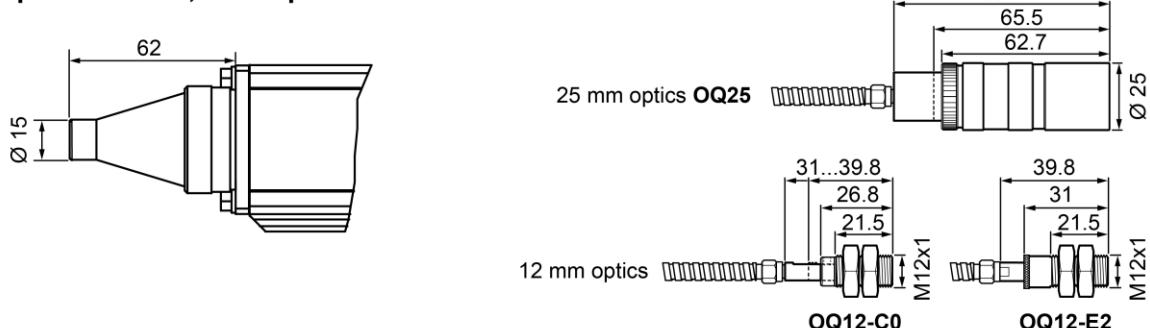
Manual focusable optics



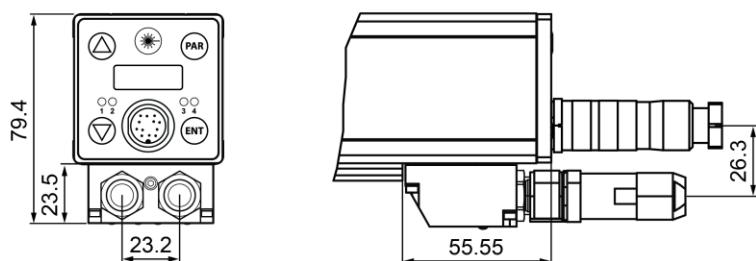
Motor focus optics



Fiber optics devices, fiber optics



Devices with Profibus, Profinet or Ethernet



9.2 Composition of the Type Number

The equipment version of the pyrometer is encoded in the 22-digit model number as follows
 (Example type number M311 with 600–1300°C; laser targeting light, motorized focus, optics):

Digit	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22
Expl.:	M	3	1	1	0	6	0	0	1	3	0	0	1	5	8	1	3	0	4	2	3	A

Digit	Indication of the various points	Code	Meaning / Example
01-02	Series M3	M3	METIS M3
	Series H3	H3	METIS H3
03-04	Spectral range	11	0.75–1.1 µm (2 x Si) 0.78 + 0.99 µm (2 x Si)
		22	1.45–1.8 µm (2 x InGaS) or 1.4+1.64 µm (2 x InGaS)
05-08	Beginning of temperature range [°C]	0600	600°C
09-12	End of temperature range [°C]	1300	1300°C
13	Sighting	1	Laser targeting light
		2	View finder
		4	TV color camera
14	Serial interface	5	RS232 / RS485 (switchable)
		3	Profinet integrated
		4	Profibus integrated
		6	Ethernet integrated
15	Lens type	1	Fixed focus optics
		2	Focusable optics
		3	Fiber optic cable 0.2 mm Ø with focusable optics
		4	Fiber optic cable 0.4 mm Ø with focusable optics
		8	Motorized focus
		B	Heavy-duty stainless-steel sensor head for 0.2 mm fiber with OQ25
		C	Heavy-duty stainless-steel sensor head for 0.4 mm fiber with OQ25
16-17	Minimum response time	13	< 1 ms (M3 version)
		81	< 80 µs (H3 version)
18	Configuration	0	Standard (12 pin connector, display, push buttons, 3 digital inputs / outputs)
		4	Standard + PID controller
19	Digital display	4	With display (12 pin connector)
20	Analog outputs	2	2 analog outputs
21	Digital input / digital output	3	3 digital inputs / outputs / 1 analog input 0–20 mA (with 12 pin connector)
22	Measuring distance / optics	A	Optics A (340-3000 mm, integrated optics)
		B	Optics B (240-3000 mm, optical fiber)
		C	Optics C (120-500 mm, optical fiber)
		X	Special optics

9.3 Accessories

Order no.	Meaning
AL11-XX ¹⁾	Connection cable with right angled connector
AL43-XX ¹⁾	Connection cable with straight connector
AL17- XX ¹⁾	Connection cable with right angled connector + 0.5 m SC10 cable
AM11-XX ¹⁾	Connection cable with right angled connector + 1 m interface cable with SUB-D plug
AM43-XX ¹⁾	Connection cable with straight connector + 1 m interface cable with SUB-D plug
AM17- XX ¹⁾	Connection cable with right angled connector + 0.5 m SC10 cable + 1 m interface cable with SUB-D plug
AU11-XX ¹⁾	Connection cable with right angled connector + RS232↔USB interface converter
AU43-XX ¹⁾	Connection cable with straight connector + RS232↔USB interface converter
AU17- XX ¹⁾	Connection cable with right angled connector + 0.5 m SC10 cable + RS232↔USB- interface converter
AV11-XX ¹⁾	Connection cable with right angled connector + RS485↔USB interface converter
AV43-XX ¹⁾	Connection cable with straight connector + RS485↔USB interface converter
AV17- XX ¹⁾	Connection cable with right angled connector + 0.5 m SC10 cable + RS485↔USB interface converter
AK50-05	Connection cable for camera output, 5 m cable
DK5485	Interface converter RS485↔USB, 1.7 m cable, open wire ends
DK4000	Interface converter RS485↔USB, 1.7 m cable, 9-pin Sub-D-connector
DK5232	Interface converter RS232↔USB, 1.7 m cable, open wire ends
DK3000	Interface converter RS232↔USB, 1.7 m cable, 9-pin Sub-D-connector
AK72-XX ²⁾	Profibus input connection cable (straight female connector and connection wires)
AK73-XX ²⁾	Profibus output connection cable (straight male connector and connection wires)
AK76-XX ²⁾	Profibus input / output connection cable (straight male and female connectors) for connecting 2 Profibus devices
AK81-00	Profibus terminating resistor with male connector M12 x 1
AK54-XX ¹⁾	Profinet or Ethernet connection cable
NG12-00	Din-rail power supply 24 V DC, 1.6 A
NG15-00	Desktop power supply 24 V DC, 2.5 A
IF0000	LED digital indicator for panel mounting
Regulus RD	PID program controller as bench top model
Regulus RF	PID program controller for panel mounting
KG10-00	Cooling jacket for ambient temperatures up to 200°C
KG20-00	Cooling plate for devices with focusable optics
KG31-00	Cooling hood for devices with focusable optics
BL10-00	Air purge accessory for devices with fixed focus optics
BL11-00	Air purge accessory for devices with focusable optics
BL12-00	Freiblaseinrichtung für Scanadapter SC10, Festobjektive, Motorfokus-Objektiv
BL13-00	Air purge accessory for fiber optic cable lens assembly OQ12
BL14-00	Air purge accessory for fiber optic cable lens assembly OQ25
HA10-00	Mounting bracket
HA14-00	Adjustable mounting bracket for fiber optics OQ25
HA15-00	Adjustable mounting bracket for fiber optics OQ12
HA20-00	Swivel mounting base
HA21-00	Swivel mounting base for METIS with SC10 scan adapter
HA22-00	Swivel mounting base for cooling jacket
SC10-41	Scan adapter SC10
GALAXY SC7x	Line scanner with air purge unit. x= Number of measurement regions analog outputs
GALAXY SC8x	Line scanner without air purge unit. x= Number of measurement regions analog outputs

¹⁾ XX Specify length in meters (available in 5 m steps)

²⁾ XX Specify length in meters (XX= 2, 5, 10, 15 m)

10 Maintenance



CAUTION **Switch off supply voltage.** Before beginning any maintenance, switch off power supply or pull connector on the pyrometer to prevent injury by accidentally activated laser targeting light!

10.1 Cleaning

Clean the lens with a soft cloth and a bit of ethanol.

Do NOT

- clean the optics with solvents that contain acid
- immerse the optics in water or other liquids to clean

10.2 Pyrometer Calibration / Adjustment

To obtain the measurement accuracy, we recommend to re-calibrate the pyrometer periodically (annually) with the help of calibration sources and optionally adjustment at Sensortherm.

- Fiber-optic pyrometers must always be calibrated together with the associated optics and the optical fiber cable.
- A recalibration is also necessary if (for fiber optic pyrometers) the optics OQ12 is replaced by OQ25 or vice versa and / or a new fiber optic cable should be used.

10.3 Troubleshooting

Before sending the pyrometer in for repair, check whether the fault can be identified and eliminated using the list.

- **Lens or protective window that is soiled with an oily film**, that weakens the signal differently in the two measurement wavelength ranges will change the emissivity ratio and cause measurement errors.
→ Clean the lens or protective window lens with a soft cloth and some ethanol.
- **Optical fiber connection broken** directly on the optics (caused e.g. by pulling the optical fiber while the optics is fixed, a measurement is no longer possible here) or **connector scratched** (caused by laying the fiber without protective connector cap, temperature display too low) or **minimum bending radius undershot** (causes a strong weakening of the signal with corresponding measurement errors).
→ Get a new fiber optic.
- **Emissivity slope** (or emissivity with 1-color measurements) **is set too high** (temperature reading too low) or **emissivity slope** (or emissivity with 1-color measurements) **is set too low** (temperature reading too high).
→ Correct the emissivity slope or emissivity according to the material.
- **Measurement error due to HF interference**, e.g. pyrometer too close to an inductor.
→ Shield incorrectly connected. Connect according to chapter **4.1.6**.
- **The measurement is influenced by reflections from hot system parts** (temperature display too high).
→ Shield interference radiation, e.g. with a mechanical device such as a sight tube.



- **Device malfunction**, indicated by a red operating status LED (right LED 4). This may be a data transmission error or a firmware problem.
→ If the interface is not affected, the error can be read out via the **fs** command (in the [Terminal field](#), see [7.6](#)). For interpretation of the answer please contact us so that we can find a solution of the problem.
To further limit the possibilities, a **service file** can be created via the software *SensorTools* (see under [7.1.5.10 Service Functions](#)) that can be sent to Sensortherm for further support.



11 Communication via Interface Commands

Interface commands are used to communicate directly with the pyrometer via the serial interface. Commands can be used to write an own access control or can be entered in the terminal field of the software *SensorTools* (see [7.6 Communication / Options](#)) or entered via a terminal software.

- Data is exchanged in ASCII format with the following transmission parameters:
8 bit, 1 stop bit, even parity (8,1,e)
- Command sequence to write parameters:
2-digit **device address** → **command** → **parameter** → <CR> (Carriage Return)
- Command sequence to read out the current set parameters:
2-digit **device address** → **command** → <CR> (Carriage Return)

INFO

- **Device address** (also see in [6.2.12](#)): In factory setting the device address is 00 but can be changed directly at the pyrometer (under INTERFACE> → ADD).
In the [Terminal field](#) of the *SensorTools* software no address is required.
- **Parameters** are encoded in hexadecimal unless specified otherwise.
- When writing with **valid parameters**, the response will be **ok + <CR>**
- When writing with **invalid parameters**, the response will be **no + <CR>**
- Deviating reading commands are in parentheses at the respective commands.

Example:

Input in terminal programs with device address 00:

0ar1<CR> sets the 2nd analog output to 4-20 mA
00ar<CR> reads out how the analog output is set

Input in the Terminal field of SensorTools without device address

ar1<CR> sets the 2nd analog output to 4-20 mA
ar<CR> reads out how the analog output is set

INFO The following commands are valid with the newest firmware version.

Command	Parameter	Description / Settings
aa (aaX)	XY	Output of the adjustable analog output 2 (X=2 = analog output 2) Y = 0...8, output temperature or controller Y = 0 = No output Y = 1 = 2-color temperature Y = 2 = Temperature channel 1 Y = 3 = Temperature channel 2 Y = 6 = manipulated variable (devices with PID controller) Y = 8 = Device temperature
an	X	Measured temperature (for temperature reading also see mw command) X = 0 = 2C channel; 1 = channel 1; 2 = channel 2
ar	X	Output mode: analog output 2 X = 0 = 0–20mA; 1 = 4–20mA
as	X	Output mode: analog output 1 X = 0 = 0–20mA; 1 = 4–20mA
ax	XXXX	Switch-off level in 1/10% XXXX = 0x0014...0x0384 (corresponds to 2.0 to 90.0%)
az	XXXXXX	Response time of the shutdown (in steps of 100 µs to 10 s) XXXXXX = 0x000000...0x0186A0
bn		Reference number pyrometer (18-digit ASCII)
bn1		Reference number pyrometer (21-digit ASCII)
bum	XX	Buffer mode selection (XX = 00...03)
bup		Transmission of measured data: Reading the buffer data (only one current packet!) Buffer mode 00: answer: AAAA AAAA = Measured temperature (0xF001 => Overflow) Buffer mode 01: answer: AAAABBBBCCCC AAAA = 2-color temperature (0xF001 => Overflow) BBBB = 1-color temperature channel 1 (0xF001 => Overflow) CCCC = 1-color temperature channel 2 (0xF001 => Overflow) Buffer mode 02: answer: AAAABBBBCCCCDDDDEEEEFFFFGGHHIIJJ AAAA = 2-color temperature (0xF001 => Overflow) BBBB = 1-color temperature channel 1 (0xF001 => Overflow) CCCC = 1-color temperature channel 2 (0xF001 => Overflow) DDDD = Setpoint value at ramp function (current ramp setpoint value!) EEEE = (Analog) controller manipulated variable (0-1000) in % (0.0-100.0%) FFFF = Signal strength (0-1000) in % (0.0-100.0%) GG = Data status byte 0 HH = Data status byte 1 II = Data status byte 2 JJ = Data status byte 3 Buffer mode 03: answer: AAAABBBBCCCCDDDDEEEEFFFFGGHHIIJJ AAAA = 2-color temperature (0xF001 => Overflow) BBBB = 1-color temperature channel 1 (0xF001 => Overflow) CCCC = 1-color temperature channel 2 (0xF001 => Overflow) DDDD = Setpoint value at ramp function (current ramp setpoint value!) EEEE = (Analog) controller manipulated variable (0-1000) in % (0.0-100.0%) FFFF = Signal strength (0-1000) in % (0.0-100.0%) GG = Data status byte 0 HH = Data status byte 1 II = Data status byte 2 JJ = Data status byte 3 KKKK = Analog input in Bit (0x0000–0xFFFF)

LLLL = unused (0xFFFF)
 NNNN = Measured temperature (0xF001 => Overflow)
 MMMM = unused (0xFFFF)

Data status bytes:

Bit	GG	HH	II	JJ
Bit0 (lsb)	Fahrenheit active	Controlling active	Setup0	Display 0
Bit1	Status digital output 1	AutoTune active	Setup1	Display 1
Bit2	Status digital output 2	AutoTune at controller start	Setup2	Display 2
Bit3	Status digital output 3	Device ready	unused	unused
Bit4	Status digital input 1	Device hardware error	unused	unused
Bit5	Status digital input 2	Controller finished successful	unused	unused
Bit6	Status digital input 3	Targeting light active	unused	unused
Bit7 (msb)	unused	unused	unused	unused

br	X	Baud rate of serial interface X=2...6,8..9,a,b 2 = 4800 Baud 5 = 38400 Baud 9 = 230400 Baud 3 = 9600 Baud 6 = 57600 Baud a = 460800 Baud 4 = 19200 Baud 8 = 115200 Baud b = 921600 Baud
eg	YYYYY	Emissivity / emissivity slope X = 0...2; YYYYY = 0x0050-1200 (corresponds 5 to 120%; in 0.1% steps) eg0 = emissivity slope = 0x0320...04b0 (0800-1200) eg1 = emissivity slope channel 1 = 0x0032...04b0 (0050-1200) eg2 = emissivity slope channel 2 = 0x0032...04b0 (0050-1200)
et	XXXXXX	Response time (in steps of 100 µs) XXXXXX = 0x000000-0186A0 (corresponds to 0 to 10 s)
fh	X	Celsius/Fahrenheit selection X = 0 = Celsius; 1 = Fahrenheit
ff	YYYYY	Fill factor (spot size filling) X = 1, 2; YYYYY = 0050-1000 (corresponds 5%-100%) in 0.1% steps ff1 – Fill factor channel 1 = 0x0032...03e8 (0050-1000) ff2 – Fill factor channel 2 = 0x0032...03e8 (0050-1000)
fs		Read error status: Bit 0 = Error A/D converter Bit 4 = error device temperature over Bit 1 = I2C error (video module) Bit 5 = error Eeprom Bit 2 = error device temperature Bit 6 = error motorized optics Bit 3 = error detector temperature Bit 7 = unused
ga	XX	Device address XX = 00...97 (2-digit dec.)
gh (ghX)	YYYYY	Hysteresis for limit switch X (X = 1...3) to value YYYYY (in 1/10 degree)
gk (gkX)	YYYYY	Threshold for limit switch X (X = 1...3) to value YYYYY (in 1/10 degree)
ia (iaX)	YYYYY	Debounce time for digital input X (X = 1...3) Debounce time: YYYYY = 0x0000...03E8 (0-1000 ms)
if	X	Serial interface (only M3) X = 0 = RS232; 1 = RS485 (that followed a baud rate of 19.2 KBd!)
io	XX	Configure digital inputs/outputs Bit 0 =1 => inputs 1 active / output 1 inactive, otherwise reversed; Bit 1 =1 => inputs 2 active / output 2 inactive, otherwise reversed; Bit 2 =1 => inputs 3 active / output 3 inactive, otherwise reversed.
in (inX)	XYY	Configure input X = 1...3; YY = 00...05 YY = 00 – No function YY = 01 – External clearing peak picker YY = 02 – Targeting light on (devices with targeting light) YY = 03 – Activate controller (devices with controller) YY = 04 – Controller start / stop (devices with controller) YY = 05 – Setup 0
la	X	State of targeting light; X = 0 =Targeting light off; 1 = Targeting light on; 2 = Targeting light toggle

lg	X	Language X = 0 = English; 1 = German
lm	X	Set storage mode (peak picker) X = 0 = peak picker off (no storage); 1 = Time delete (then it applies) 2 = External clearing of peak picker 3 = Automatic clearing of peak picker
lt	XXXXXX	Clear time of peak picker (in 100 µs steps) XXXXXX = 0x000000...03d090 (0 to 25 s)
lx		External clearing of peak picker
mb		(Read) temperature range XXXX = Beginning of temp. range; YYYY = end of temp. range in °C/°F
me	XXXXYYYY	Temperature sub range of pyrometer (superordinate to the analog outputs) XXXX = Beginning of temp. range; YYYY = end of temp. range in °C/°F
me (meX)	YYYYYZZZ	Scale analog output temperature range X (X = 1, 2) (0...6553.5 °C/°F) YYYY = Beginning of temp. range; YYYY = end of temp. range in °C/°F
mwX		Read measured temperature (current value) (4-digit hex.) mw0 = current 2-color reading mw1 = current channel 1 reading mw2 = current channel 2 reading
oa (oaX)	YYYYY	Activation time of the digital outputs X (X=1...3) YYYY=0x0000...ffff (corresponds to 0-65535 ms)
oc (ocX)	XYY	Reference temperature for activating a digital output (X=1...3) YY = 00 = 2-color, 01 = channel 1, 02 = channel 2
od	XX	Output inversion (logic NO to NC) Bit0 = 0 (digital output 1 = NO), Bit0 = 1 (digital output 1 = NC), Bit1 = 0 (digital output 2 = NO), Bit1 = 1 (digital output 2 = NC), Bit2 = 0 (digital output 3 = NO), Bit2 = 1 (digital output 3 = NC)
oh (ohX)	YYYYY	Hold time digital output X (X = 1...3) Hold time: YYYY (0x0000...fffe) 0-65534 ms
op (opX)	XYY	Outputs (digital output X, X=1...3) YY=0x00...0A YY=00 – no output YY=04 – unused YY=01 – device ready contact YY=05 – Over temperature YY=08 – Setpoint band YY=02 – Material contact YY=06 – Setpoint limit 1 YY=09 – Controller active YY=03 – limit switch contact YY=07 – Setpoint limit 2 YY=0A – Control successful
pia	XXXX	Automatic targeting light switch off XXXX = 0x0000...ffff (0 to 65535 s) X = 0 => targeting light never turns off; X = 1...65535 => switches off after X seconds
re (re0)		Device reset
sl		Read signal strength (answer: 4-digit hex in 1/10%)
sh	YYYYY	Hysteresis for signal strength contact X = 1...3 (digital output) to value YYYY (hex in 1/10%)
sk	YYYYY	Switching value for signal strength contact for X = 1...3 (digital output / signal strength contact) to value YYYY (hex in 1/10%)
sn		Read serial number (5-digit dec.)
tg	YYYYY	Transmittance X = 1, 2; YYYY = 0050-1000 (corresponds to 5%-100%) in 0.1% steps tg1 – Transmittance channel 1 = 0x0032...03e8 (0050-1000) tg2 – Transmittance channel 2 = 0x0032...03e8 (0050-1000)
to	XXXX	Output test: Bit0 = 0 (digital output 1 = inactive), Bit0 = 1 (digital output 1 = active) Bit1 = 0 (digital output 2 = inactive), Bit1 = 1 (digital output 2 = active) Bit2 = 0 (digital output 3 = inactive), Bit2 = 1 (digital output 3 = active) Special function: xxxx => deactivate test!
tsc / tsf	X	Read temperature sensor (in °C/°F) (4-digit hex) tsc0 = Device temperature in 1/256°C tsc1 = Detector temperature in 1/256°C

		tsf0 = Device temperature in 1/256°F tsf1 = Detector temperature in 1/256°F
tw	XX	Interface delay XX
uh (uhX)	YYYYYY	Hysteresis for over-temperature contact (X = digital output 1...3) to value YYYY (1/256°C)
uk (ukX)	YYYYYY	Device over-temperature threshold at digital output X X = 1...3 to value YYYY (in 1/256°C)
ve	XXYYZZ	Read device identifier and date of firmware XX = 55 ≤ M3 2-color types, XX = 29 ≤ H3 2-color types, YY = consecutive firmware number, ZZ = last 2 numbers of year

In addition, for devices with built-in camera module

oe	X	Show / hide emissivity X = 0 = Hide emissivity; 1 = Show emissivity
of	X	Set the time format X = 0 = German time format; 1 = US time format
oj	X	Show / hide date X = 0 = Hide date; 1 = Show date
oj	DDMMYY	Set date (6-digit ASCII) DD = day, MM = month, YY = year
ojus	MMDDYY	Set date US (6-digit ASCII) MM = month, DD = day, YY = year
om	X	Show / hide target marker X = 0 = hide marker; 1 = Show marker
os		Read camera status (answer: XX; 2-digit hex) Bit 0 = 1 Time displayed Bit 5 = US-Format Bit 10 = Autoexposure Bit 1 = 1 Date displayed Bit 6 = PAL Bit 11 = Autowhitebalance Bit 2 = 1 Emissivity displayed Bit 7 = NTSC Bit 12 = Videomodule active Bit 3 = 1 Temperature displayed Bit 8 = Test image active Bit 13-15 = Unused Bit 4 = 1 Marker displayed Bit 9 = Monochrome
ot	X	Show / hide time X = 0 = Hide time; 1=Show time
ot / otus	HHMMSS	Set time (6-digit ASCII), ot = German time, otus = US time HH = hour, MM = minute, SS = second
ov	X	Show / hide temperature X = 0 = Hide temperature; 1 = Show temperature
ox	TT...TT	Write own user text: TT...TT = Text (max. 16 ASCII characters)
vb	XX	White balance / automatic white balance XX = 0x00...64 (= 0...100% of the window area, calculated centric to the image center) or ff (= automatic white balance)
vc	XX	Color saturation XX = 0x00...ff (= level 0-255)
vd (only M3)	X	Camera module (power) on/off X = 0 = off; 1 = on
vh	XX	Sharpness of the image XX = 0x00...ff (= level 0 to 255)
vi (vh)	XX	Brightness (AEC) XX = 0x00...ff (= Level 0 to 255)
vm	X	Color transmission system camera module X = 0 = NTSC; 1 = PAL
vq	X	Image setting color / monochrome X = 0 = color image; 1 = monochrome image
vt (vm)	X	Test image: X = 0 = normal image; 1 = test image

In addition, for devices with built-in motorized focus

moa	XXXX	Focus distance XXXX in mm (may be rounded up or down in 10 mm resolution!)
-----	------	---

In addition, for devices with built-in PID controller

hz	XXXX	Hold time: XXXX = 0x0000...ffff (in ms)
ob	XXXX	Next controller start with AutoTune XXXX = 0x00C8...03E8 (20.0 to 100.0% in 0.1% steps)
rg	X	Controller handle X = 0 = Stop controller 1 = Start controller 3 = Controller with AutoTune
ro	XX	Controller options: Bit 0 = Clear of Ti (sets the integration sum of the PID control to 0 to prevent an undershoot if a control process is done from a higher to a lower value), Bit 4 = AutoTune optimization at every control start
r0 (ro0)	X	Controller options (not memory-resistant) bit0 = next controller start with AutoTune
rz	XXXX	Ramp time in ms XXXX = 0x0000...ffff
sg1	XXXX	Temperature deviation from setpoint value $\pm 3000^\circ$ for limit value 1 XXXX = 0x8AD0...7530 (in two's complement, 1/10 degree)
sg2	XXXX	Temperature deviation from setpoint value $\pm 3000^\circ$ for limit value 2 XXXX = 0x8AD0...7530 (in two's complement, 1/10 degree)
sw	XXXX	Setpoint value (XXXX in 1/10 degree)
td	XXXXXX	Derivative time constant Td (in sampling times) XXXXXX = 0x000000...00ffff
ti	XXXXXX	Integral time constant Ti (in sampling times) XXXXXX = 0x000000...00ffff
xa	XXXX	Sampling time in 10 μ s steps M3: XXXX = 0x0064...09C4 (1 ms to 25 ms), H3: XXXX = 0x000A...09C4 (0.1 ms to 25 ms)
xb	XXXX	Setpoint deviation (in 1/10 degree)
xl	XXXX	P dynamic XXXX = 0x0000...2710 (0.01 to 100.00%; 0.01% steps)
xp	XXXX	Proportional band Xp XXXX = 0x0000...2710 (0.1 to 1000.0%; 0.1% steps)
ym	XXXX	Minimum control output power Pmin XXXX = 0x0000...03E7 (0.0 to 99.9%; 0.1% steps)
ys	XXXX	P-zs XXXX = 0x0000...03E8 (0.0 to 100.0%; 0.1% steps)
yx	XXXX	P-max XXXX = 0001...03E8 (0.1 to 100.0%; 0.1% steps)

In addition, for devices with Profibus / Profinet

fpa	XX	Fieldbus address: 00...7fh (only Profibus)
fbm		Fieldbus mode (00, 01, 02) Mode 0 = old Profibus mode (as formerly MS09/MQ11, depending on the device) Mode 1 = new M3 format (default, like fbx-codes) Mode 2 = flexible format (see fbd codes)
fbr		Reset fieldbus (always apply if format change)
fbd	XXXXXX32x	Fieldbus codes 32 bytes of data 32xYY (for mode 2)
fbd	XXYY	Write fieldbus byte YY (address: XX = 00.1fh) (for mode 2)
fbx		Read fieldbus codes 32 bytes of data 32xYY (default for mode 1)

In addition, for devices with Ethernet

fs2		Read error status 2: Bit0 = IP error; Bit 1 = video error
ipa	AABBCCDD	Write IP address: AA = Address byte 1 (hex.) BB = Address byte 2 (hex.) CC = Address byte 3 (hex.) DD = Address byte 4 (hex.)
ipa		Read IP address: AABBCCDDEEFFGGHH AABBCCDD = set address (by command) EEFFGGHH = active address
ipc		Read MAC address: Answer: AABBCCDDEEFF (hex.)
ipf	XX	Read IP flag: XX = 00; 01 hex Bit 0: DHCP active
ipg	AABBCCDD	Write gateway address AA = Address byte 1 (hex.) BB = Address byte 2 (hex.) CC = Address byte 3 (hex.) DD = Address byte 4 (hex.)
ipg		Read gateway address: AABBCCDDEEFFGGHH AABBCCDD = set address (by command) EEFFGGHH = active address
ipm	AABBCCDD	Write mask address: AA = Address byte 1 (hex.) BB = Address byte 2 (hex.) CC = Address byte 3 (hex.) DD = Address byte 4 (hex.)
ipm		Read MAC address: AABBCCDDEEFFGGHH AABBCCDD = set address (by command) EEFFGGHH = active address
ips		Setting the set IP parameters (ipa, ipg, ipm, ipf) without a full reset.

Old commands: to standardize the command structure, some old commands with numeric parameters are replaced with new ones with hexadecimal coded. The old commands still work, but should no longer used in reprogramming:

ms (Read temperature value, 5-digit. dec.)	→ mw	em (Emissivity, 2-digit. dec.)	→ eg1
kt1 (Read temperature channel 1)	→ mw1	en1 (Emissivity channel 1, 2-digit. dec.)	→ eg1
kt2 (Read temperature channel 2)	→ mw2	en2 (Emissivity channel 2, 2-digit. dec.)	→ eg2
qt (Read 2-color temperature, 5-digit. dec.)	→ mw0	ev (Emissivity slope, 4-digit. dec.)	→ eg0
ez (Response time, 1-digit. dec.)	→ et	aw (Switch-off level, 2-digit. dec.)	→ ax
lz (Max. value, 1-digit. dec.)	→ lm in combination with lt	gt (Device temperature, 2-digit. dec.)	→ ts

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