MICRO-EPSILON

Operating Instructions

thermoMETER SE

SE-SF15-Sxx-U

SE-SF15-Sxx-I

Infrared sensor

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Contents

1 Safety

1.1 Symbols used

System operation assumes knowledge of the operating instructions.

The following symbols are used in these operating instructions:

⚠ CAUTION	Indicates a hazardous situation which, if not avoided, may result in minor or moderate injury.
NOTICE	Indicates a situation that may result in property damage if not avoided.
►	Indicates a user action.
i	Indicates a tip for users.
`Measurement`	Indicates hardware or a software button/menu.

1.2 Warnings

⚠ CAUTION

Connect the power supply and the display/output device according to the safety regulations for electrical equipment.

- Risk of injury
- Damage to or destruction of the sensor

NOTICE

The supply voltage must not exceed the specified limits.

- Damage to or destruction of the sensor

Avoid knocks and impacts to the sensor.

- Damage to or destruction of the sensor

Protect the sensor cable against damage.

- Destruction of the sensor
- Failure of the measuring device

Never fold the sensor cable and do not bend it in tight radii.
The minimum bending radius is 22 mm (static). Dynamic movement is not permitted.

- Damage to or destruction of the sensor cable
- Failure of the measuring device

Avoid exposure of sensor (both optics and housing) to cleaning agents that contain solvents.

- Damage to or destruction of the sensor

Avoid abrupt changes in ambient temperature.

- Inaccurate or incorrect measurements

1.3 Notes on product marking

1.3.1 CE marking

The following apply to the product:

- Directive 2014/30/EU ("EMC")
- Directive 2014/35/EU ("Low Voltage")
- Directive 2011/65/EU ("RoHS")

Products which carry the CE marking satisfy the requirements of the EU Directives cited and the relevant applicable harmonized European standards (EN).

The product is designed for use in industrial and laboratory environments.

The EU Declaration of Conformity and the technical documentation are available to the responsible authorities according to the EU Directives.

1.3.2 UKCA marking

The following apply to the product:

- SI 2016 No. 1091 ("EMC")
- SI 2016 No. 1101 ("Low Voltage")
- SI 2012 No. 3032 ("RoHS")

Products which carry the UKCA marking satisfy the requirements of the directives cited and the relevant applicable harmonized standards.

The product is designed for use in industrial and laboratory environments.

The UKCA Declaration of Conformity and the technical documentation are available to the responsible authorities according to the UKCA Directives.

1.4 Intended use

The sensor is designed for use in industrial and laboratory environments.

It is used for non-contact temperature measurement.

The sensor must only be operated within the values specified in the technical data, see Chap. 2.3.

The sensor must be used in such a way that no persons are endangered and no machines or other physical items of property are damaged in the event of malfunction or total failure of the sensor.

Take additional precautions for safety and damage prevention in case of safety-related applications.

1.5 Proper environment

Temperature range:	Sensor:	Storage:	-40 ... 85 °C
		Operation:	-20 ... 120 °C
	Controller:	Storage:	-40 ... 85 °C
		Operation:	-20 ... 80 °C
Humidity:			10 % RH ... 95 % RH (non-condensing)
Protection class (DIN EN 60529):	Sensor:		IP65
	Controller:		IP65

NOTICE
Avoid abrupt changes in the ambient temperature of both the sensor and the controller. ► Inaccurate or incorrect measurements

2 Functional principle, technical data

2.1 Functional principle

The sensors are non-contact infrared temperature measurement sensors. They measure the infrared radiation emitted by objects and calculate the surface temperature based on this.

The sensor housing is made of stainless steel (protection class IP65). The controller is integrated in the cable.

i The sensors are sensitive optical systems. It should therefore only be fitted using the existing thread.

NOTICE
Avoid rough mechanical force on the sensor. ► Destruction of the sensor

2.2 Sensor models

The sensors are available in the following versions:

Series	Model	Measuring range	Spectral range	Analog output	Optics
SF	SE-SF15-S05-C05-I	-40 °C up to 600 °C (1100 °C)	8 to 14 µm	Current	15:1
SF	SE-SF15-S05-C05-U	-40 °C up to 600 °C (1100 °C)	8 to 14 µm	Voltage	15:1
SF	SE-SF15-S05-C3-I	-40 °C up to 600 °C (1100 °C)	8 to 14 µm	Current	15:1
SF	SE-SF15-S3-C05-I	-40 °C up to 600 °C (1100 °C)	8 to 14 µm	Current	15:1
SF	SE-SF15-S3-C05-U	-40 °C up to 600 °C (1100 °C)	8 to 14 µm	Voltage	15:1
SF	SE-SF15-S3-C3-I	-40 °C up to 600 °C (1100 °C)	8 to 14 µm	Current	15:1
SF	SE-SF15-S3-C3-U	-40 °C up to 600 °C (1100 °C)	8 to 14 µm	Voltage	15:1
SF	SE-SF15-S6-C05-U	-40 °C up to 600 °C (1100 °C)	8 to 14 µm	Voltage	15:1
SF	SE-SF15-S6-C3-I	-40 °C up to 600 °C (1100 °C)	8 to 14 µm	Current	15:1
SF	SE-SF15-S6-C3-U	-40 °C up to 600 °C (1100 °C)	8 to 14 µm	Voltage	15:1
SF	SE-SF15-S15-C05-I	-40 °C up to 600 °C (1100 °C)	8 to 14 µm	Current	15:1
SF	SE-SF15-S15-C05-U	-40 °C up to 600 °C (1100 °C)	8 to 14 µm	Voltage	15:1

Tab. 2.1: thermoMETER SE sensor models

The sensors have a preconfigured current output (I) or voltage output (U), which can be switched via software and USB adapter.

2.3 Technical data

Model			SE-SF15
Optical resolution			15:1
Measuring range [1]			-40 °C up to 600 °C (1100 °C)
Spectral range			8 to 14 µm
System accuracy [2]			±1.0 % or ±1.0 °C
Repeatability [2]			±0.5 % or ±0.5 °C
Temperature resolution (NETD) [3]			50 mK
Response time [4]			20 ms
Emissivity			0.100 to 1.100
Transmittance			0.100 to 1.100
Signal processing			Intelligent averaging, Min/Max, Hold function with threshold/hysteresis (adjustable via software)
Supply voltage			5 … 30 VDC
Max. current consumption			≤ 4 mA (voltage output) / ≤ 20 mA (2-wire current output)
Digital interface			3.3V-LVTTL or USB via programming adapter
Analog output [5]			4 ... 20 mA (two-wire current output) / 0 ... 5 V; 0 ... 10 V (voltage output) freely scalable within the measuring range
Switching output			Open collector for alarm; 500 mA
Connection			Integrated cable with open ends (ferrules); standard length 0.5 m sensor and connection cable; optional sensor cable with 3 m, 6 m or 15 m and connection cable with 3 m available
Mounting		Sensor	Direct fastening via integrated M12x1 thread or fastening using the hexagon nut included in the scope of delivery
Temperature range	Sensor	Storage	-40 ... 85 °C
		Operation	-20 ... 120 °C
	Controller	Storage	-40 ... 85 °C
		Operation	-20 ... 80 °C
Humidity			10 % RH ... 95 % RH (non-condensing)
Shock (DIN EN 60068-2-27)			50g, 11 ms, each axis
Vibration (DIN EN 60068-2-6)			3g, 11 to 200 Hz, each axis
Protection class (DIN EN 60529)		Sensor	IP65
		Controller	IP65
Material		Sensor	Stainless steel (1.4404)
Weight			approx. 20 g (sensor only)
Control and indicator elements [6]			Sensor configuration optionally possible via sensorTOOL

[1] Measuring range can optionally be extended to 1100 °C

[2] At ambient temperature of 24±2 °C; whichever is greater (ε=1)

[3] With a time constant of 200 ms and an object temperature of 200 °C

[4] 0 - 90 % energy; adjustable via software

[5] Preconfigured for current or voltage on delivery; switchable via sensorTOOL (requires USB converter); voltage scaling depending on the supply voltage

[6] Access with sensorTOOL requires USB adapter (see accessories)

3 Delivery

3.1 Unpacking, included in delivery

- 1 Sensor
- 1 Mounting nut
- 1 Blue protective cap
- 1 Setup guide

► Carefully remove the components of the measuring system from the packaging and ensure that the goods are forwarded in such a way that no damage can occur.

► Check the delivery for completeness and shipping damage immediately after unpacking.

► If there is damage or parts are missing, immediately contact the manufacturer or supplier.

Optional accessories are listed in the appendix.

Return of packaging

Micro-Epsilon Messtechnik GmbH & Co. KG offers customers the opportunity to return the packaging of products purchased from Micro-Epsilon by prior arrangement so that it can be reused or recycled.

To arrange the return of packaging, for questions about the costs and / or the exact return procedure, please contact us directly at

info@micro-epsilon.com

3.2 Storage

Temperature range:	-40 ... 85 °C
Humidity:	10 % RH ... 95 % RH (non-condensing)

4 Optical tables

4.1 Description optical tables

The following optical tables show the diameter of the measurement spot dependent on the measurement distance. The measurement spot size refers to 90% of the radiation energy. The distance is measured from the front edge of the sensor / CF lens.

i The size of the object to be measured and the optical resolution of the IR thermometer determine the maximum distance between sensor and object. To avoid measuring errors, the measuring object should completely fill the field of vision of the sensor's optical system. This means, the measurement spot must always be at least as large as or smaller than the measuring object.

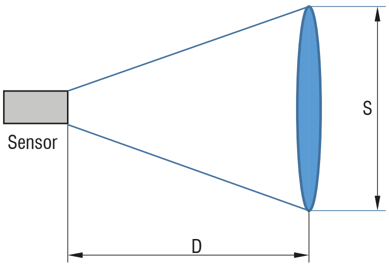


Fig. 4.1: Optical diagram

D = Distance

S = Spot size

4.2 Optical parameters

Standard Focus (in mm)								
SF15	15:1	6.5	11.5	14	18	23.5	29.5	35.5
Distance		0	100	200	300	400	500	600

Close Focus (when using the screwable CF lens, in mm)								
CF15	15:1	6.5	3.7	0.8	4.4	8.1	11.8	15.4
Distance		0	5	10	15	20	25	30

	= smallest spot size / focal point (mm)

The ratio D:S (example 15:1, see table) describes the ratio Distance (distance from the front edge of the sensor to the measuring object) to Spot size (measurement spot size).

5 Installation and assembly

5.1 Mechanical installation

The sensors have a metric M12x1-thread and can be attached to available mounting equipment either directly via this sensor thread or by means of the nut included.

Various mounting brackets and fixtures are available as accessories to facilitate the alignment of the sensor with the object.

i	Mount the sensor via the provided thread.

NOTICE
Avoid rough mechanical force on the sensor. ► Destruction of the sensor

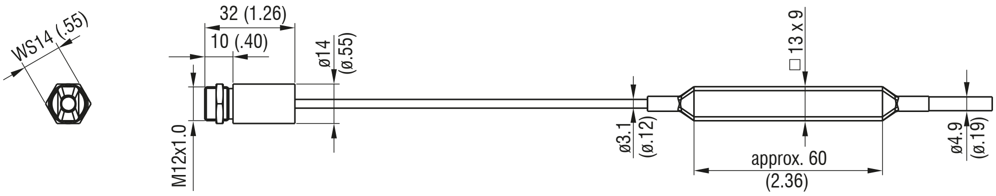


Fig. 5.1: Dimensional drawing thermoMETER SE-SF15-S05-C05, dimensions in mm (inches, rounded off)

5.2 Electrical connections

5.2.1 Connection possibilities

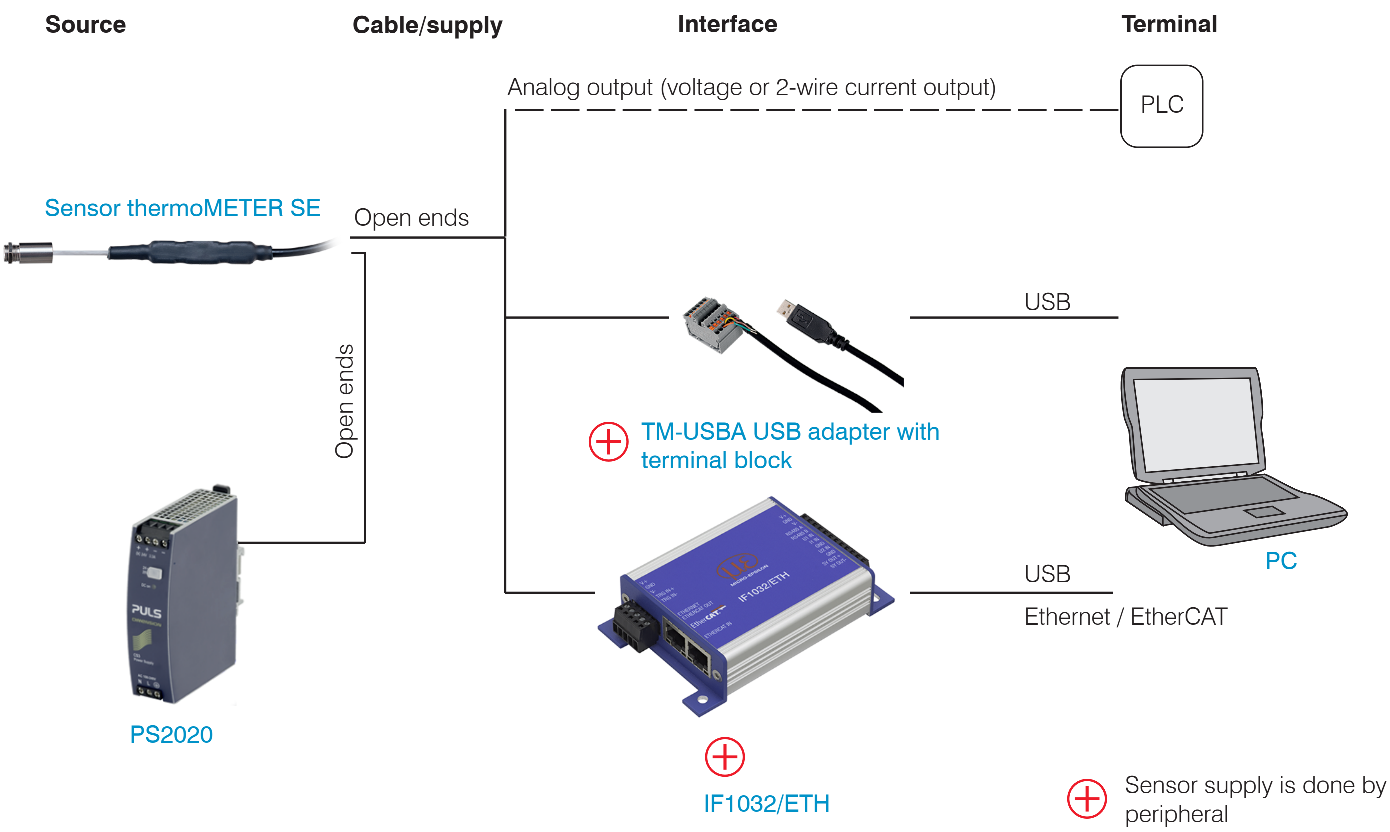


Fig. 5.2: Connection possibilities thermoMETER SE

5.2.2 General

i Use a power supply unit with a stabilized output voltage of 5 ... 30 VDC, which supplies a minimum current of 50 mA. Residual ripple should be no more than 200 mV.
Power the sensor either via USB or externally with a power supply unit, but not at the same time to prevent damage to a connected USB device.

i Only use shielded cables. The shield of the sensor is separated from the GND connection.
It is necessary that the shield is connected to ground or GND.

5.2.3 Pin assignment

The following table shows the color assignment and signal assignment of the connection cable.

Color	Signal	Description
Red	V_{CC}	Power supply
Green	V_{OUT}	Analog output Voltage
Black	GND	Ground
Yellow	Tx	Digital interface Output
Orange	Rx	Digital interface Input
Brown	OC	Open-collector output
Shield		Black cable with larger cross-section

Tab. 5.1: Pin assignment

The minimum bending radius of the connection cable is 40 mm (static). Dynamic movement is not permitted.

5.2.4 Analog output

5.2.4.1 Description

The sensor has the following preset analog outputs, which can be set using the `sensorTOOL` software:

- Voltage output
- Current output as two-wire sensor

i The digital interface is an LVTTL interface with a 3.3 V signal level.

NOTICE
Avoid using higher signal voltages.
► Damage to the input or output

5.2.4.2 Voltage output

The sensor has a voltage output at the V_{OUT} port. The shield of the sensor is separated from the GND connection.

i The output impedance must be ≥ 10 kΩ. It is necessary that the shield is connected to ground or GND.

NOTICE
Avoid a residual ripple of > 200 mV on the power supply unit used.
► Damage to or destruction of the controller

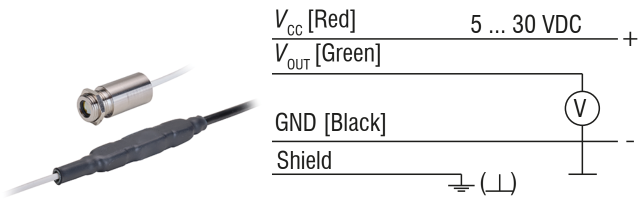


Fig. 5.3: Terminal assignment voltage output (mV)

5.2.4.3 Current output as 2-wire sensor

The sensor has a two-wire current output. The two wires are responsible for both the supply and the transmission of the measurement signal.

i	The maximum loop impedance is 1000 Ω.

The shield of the sensor is separated from the GND connection.

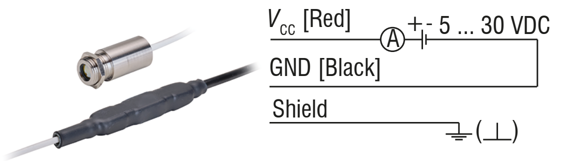


Fig. 5.4: Pin assignment current output as two-wire sensor

5.2.5 Maximum loop resistance

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

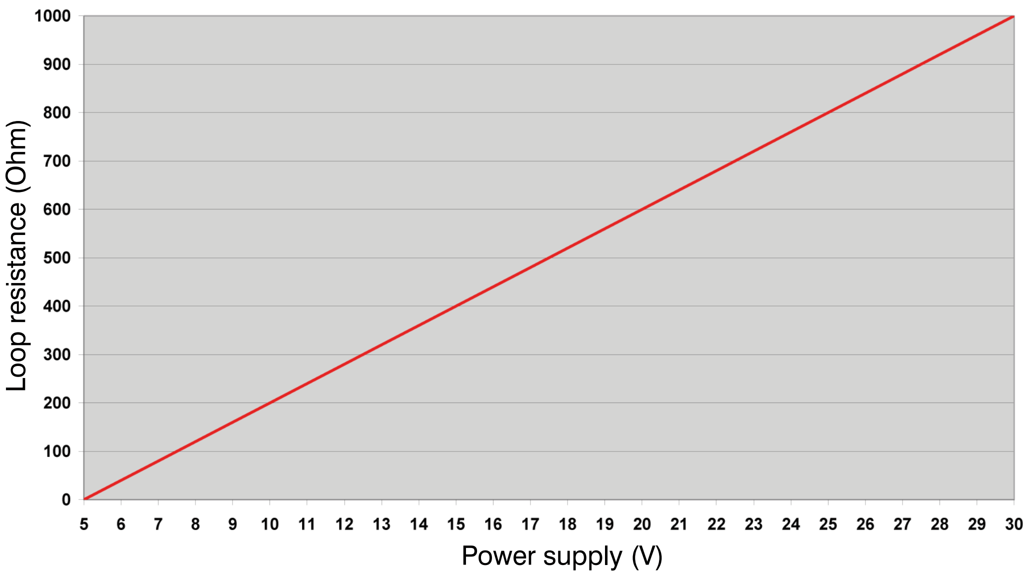


Fig. 5.5: thermoMETER SE Maximum loop resistance

5.2.6 Digital output

For digital communication, use the optionally available USB adapter and the `sensorTOOL` software.

► Connect the wire of the USB adapter indicated below to the wire of the same color of the sensor cable using a terminal block.

The sensor supports two communication protocols for digital communication:

- ME-Bus sensor protocol for complete parameterization and readout of the sensors
- Binary protocol for quick and easy reading of measured values with a limited range of functions

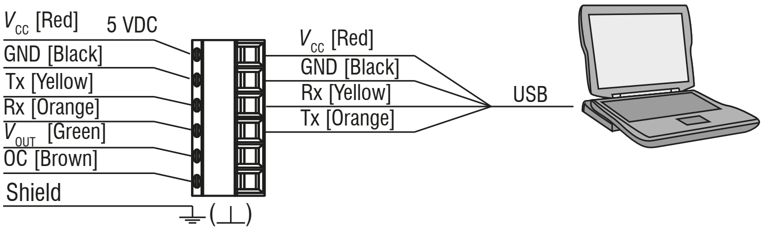


Fig. 5.6: Pin assignment digital output

5.2.7 Combination of analog output and digital output

The sensors can communicate digitally and be used as an analog device (current or voltage) at the same time.

In this case, power can be supplied via the USB interface (5 V).

The sensor can communicate in parallel in all operating modes (current or voltage output). The analog measurement signal can then be accessed either at the analog voltage output or in the supply voltage (current output as 2-wire sensor).

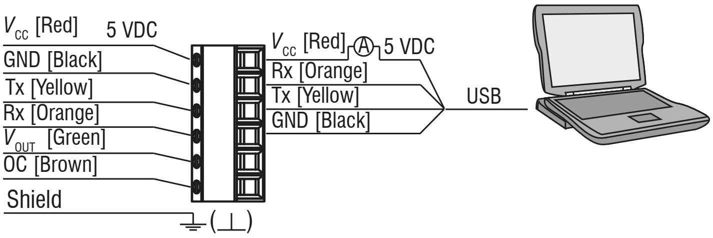


Fig. 5.7: thermoMETER SE Pin assignment analog (current) and digital

5.2.8 Open-collector output

The open-collector output is an additional alarm output on the sensor and can control an external relay, for example. In this case, the normal analog output is available at the same time.

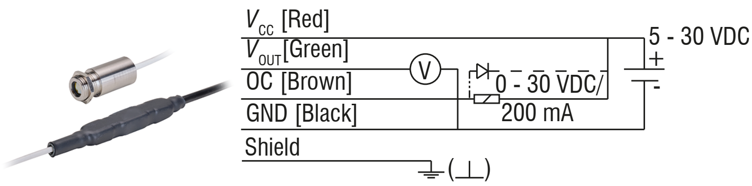


Fig. 5.8: Pin assignment of open-collector output

NOTICE
If a relay is used, a freewheeling or protective diode must be installed. ► Damage to the output

6 Operation via sensorTOOL software

6.1 Description

sensorTOOL by Micro-Epsilon is software that you can use to apply settings to the sensor and to view and document measurement data.

- ► Connect the sensor to a PC/notebook via the USB interface using the optionally available USB adapter from Micro-Epsilon.

The supply voltage for the sensor is supplied via the USB interface.

- ► Before using the USB adapter for the first time, install the corresponding driver TM-USBA-adapter-driver.
  You can find the current driver at https://www.micro-epsilon.com/fileadmin/download/software/tm-usba-adapter-driver.zip
- ► Start the sensorTOOL program.

i	Use a power supply unit with a stabilized output voltage of 5 ... 30 VDC, which supplies a minimum current of 50 mA. Residual ripple should be no more than 200 mV. Power the sensor either via USB or externally with a power supply unit, but not at the same time to prevent damage to a connected USB device.

- ► Start the sensorTOOL program.

You can find this program online at https://www.micro-epsilon.com/fileadmin/download/software/sensorTool.exe.

- ► Select thermoMETER from the Sensor group drop-down menu and thermoMETER SE from the Sensor type drop-down menu.

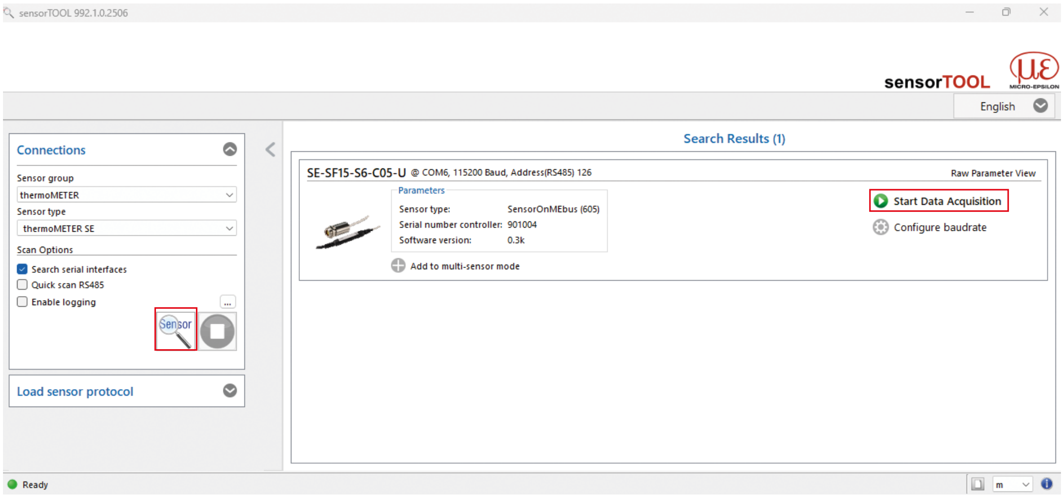


Fig. 6.1: First interactive site after calling the sensorTOOL

- ► Check the box Search serial interfaces.
- ► Click on the Sensor button with the magnifying glass icon in order to start the search.

All available channels will now be displayed in the Search Results (x) overview.

- ► Click on the Start Data Acquisition button or the Sensor icon to start the measurement.

6.2 Measurement menu

6.2.1 General

The recorded data is used to check the measurement. The measurement is influenced by the settings.

The following window appears:

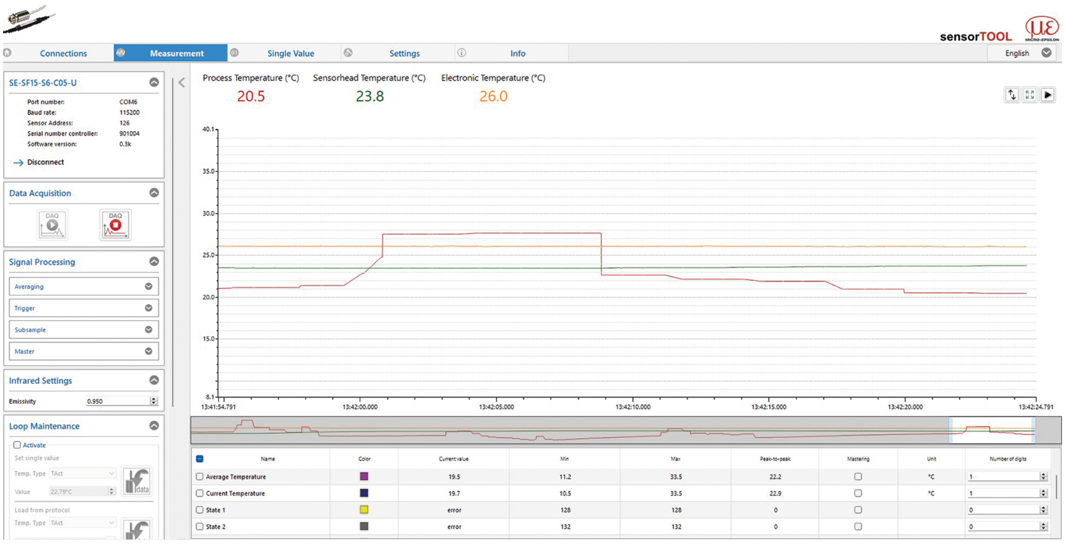


Fig. 6.2: View sensorTOOL thermoMETER SE Measurement menu

- Set your desired settings in the `Settings`, see Chap. 6.4 menu, before recording data for the first time.

Fig. 6.3: Data Acquisition Start / Stop buttons

	Recording is restarted when you press this button. The previously paused recording is lost.
	Recording is stopped when you click this button.

Tab. 6.1: Start / Stop buttons

> i You will find the `Signal Processing` selection in the side menu bar. Please ensure that all functions in this menu are set to `Disabled`. This function applies to other sensor models.

In the `Signal Processing` menu, you will find the functions for signal processing in the `sensorTOOL` and not in the sensor.

In the lower table of the menu you will find various options for showing or hiding:

Name	Signal curves of the sensors used can be hidden and shown.
Color	Change the color settings of the single signal curves.
Current value	Outputs the current measurement value
Min	Minimum measurement value
Max	Maximum measurement value

Peak-to-peak	Difference between Max and Min
Mastering	No function with this sensor series.
Unit	Selection of the output to be displayed. [7]
Decimal places	Selection from 0 to 12 possible.

Tab. 6.2: Overview data acquisition

Ending the measurement

► Once the measurement is complete, press the `Disconnect` button. You can then reconnect using the sensor search.

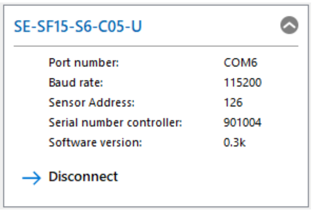


Fig. 6.4: View sensorTOOL thermoMETER SE Disconnect

6.2.2 Recording and saving measurements

During data acquisition, the measurement data is only displayed and not automatically saved on the PC. In the side menu under `CSV Output`, you can start transmitting data into a `*.CSV file` or only save the currently visible area from the time graph.

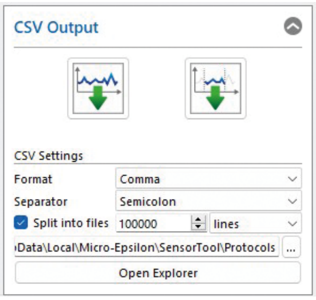


Fig. 6.5: View sensorTOOL CSV Output

	Data acquisition into a *CSV file is started when you press this button.
	The recording is saved when you press this button.

Tab. 6.3: Record and save measurement

You can make further settings under `Split into files`:

CSV Output	CSV Settings	*Format*	*Point / comma*	
		Separator	*Comma / semicolon / tab*	
		Split data	*Value*	*lines / MB / min / hourly / time point / DAQ-Start*

With `Open Explorer`, the previously selected path opens in Explorer, where you can view the recorded measurement results.

[7] Is set in the menu `Settings` > `General` > `Device Settings` > `Temperature Unit`.

6.2.3 Infrared settings

In the side menu under `Infrared Settings`, you can also change the `Emissivity` set in the `Settings` > `General` menu. The adjustment takes place simultaneously in both menus.

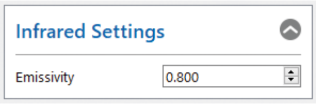


Fig. 6.6: View sensorTOOL Infrared Settings

6.2.4 Loop maintenance

In the side menu under `Loop Maintenance`, you can also change the `Loop Maintenance` set in the menu `Settings` > `Output`, see Chap. 6.4.2 and display the values.

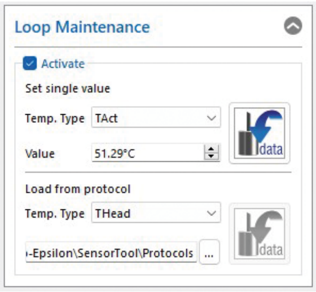


Fig. 6.7: View sensorTOOL Loop Maintenance

Loop Maintenance	Set single value	Temp. Type	*TAct / TBox / THead*
		Value (single)	*Value*
	Load from protocol	Temp. Type	*TAct / TBox / THead*

Set single value outputs a single value.

To output a protocol, first select the desired Explorer path. **Load from Protocol** loads data from protocol when the second button is clicked.

Tab. 6.4: Set single value and Load from protocol

6.3 Single value menu

In the `Single Value` menu, you can enlarge the display of up to 5 measured values.

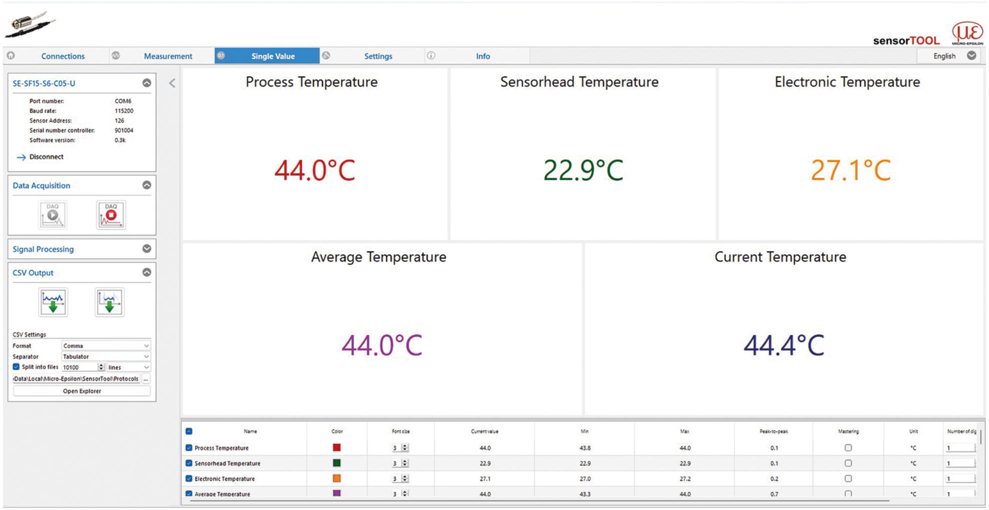


Fig. 6.8: View sensorTOOL thermoMETER SE Single Value

In the lower table of the `Single Value` menu, you will find various options for showing or hiding your settings selected under the menu `Settings` > `Signal Processing`, see Chap. 6.4.3. In addition, you can display the values, see Tab. 6.2.

6.4 Settings menu

6.4.1 Selection menu

► Start the settings by clicking on `Settings` in the menu bar.

There are 4 menus for setting your measured values:

- `General`
- `Signal Processing`
- `Output`
- `Alarms and Failsafe`

6.4.2 General menu

6.4.2.1 Overview

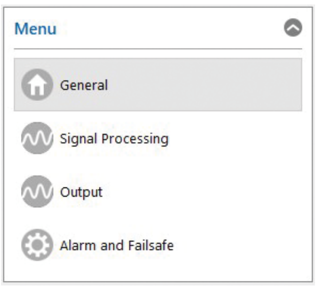


Fig. 6.9: View sensorTOOL - Settings menu - General

6.4.2.2 Device settings

Here you can set the `Temperature Unit` for the display and data output.

Device Settings	*Temperature Unit*	*°C*
		°F

6.4.2.3 Infrared settings

Setting the Emissivity and Transmissivity

The `Emissivity` (epsilon) is a material constant that describes the ability of a body to emit infrared energy.

The `Transmissivity` or transmittance compensates for the signal loss if a protective window or an additional lens is mounted between the sensor and the measuring object.

Infrared Settings	*Emissivity and Transmissivity*	*Emissivity*	*Value*	
		Transmissivity	*Value*	
	Advanced	*Ambient Temperature Mode*	*Automatic*	
			Fixed Value	*Value*
		Automatic Emissivity Calculation	*Process Temperature*	*Value*

Advanced Settings

Depending on the ambient temperature of the sensor head, this can falsify the measurement result. This influence can be compensated for via the `Ambient Temperature Mode`.

The `Ambient Temperature Mode` can be selected as follows:

- `Automatic`: The ambient temperature is determined by the temperature probe in the sensor.
- `Fixed Value`: The ambient temperature value is permanently set to the entered value.

6.4.2.4 Function automatic emissivity calculation

With the `Automatic Emissivity Calculation`, the pyrometer can determine an emissivity at a known object temperature. If a `Process Temperature` has been entered, the corresponding emissivity can be determined using the `Calculate` button.

6.4.3 Signal processing menu

6.4.3.1 Overview

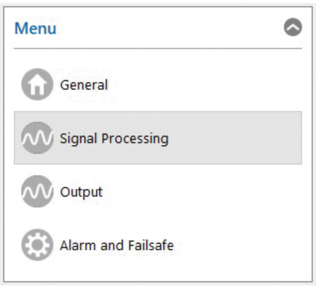


Fig. 6.10: View sensorTOOL - Settings menu - Signal Processing

6.4.3.2 Averaging

Depending on the selected function, an arithmetic mean value is calculated with the separately set time constant.

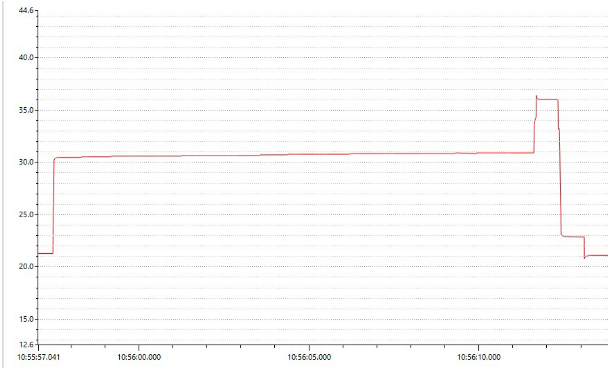
When using the `Normal` mode, an arithmetic mean value is calculated.

An intelligent algorithm is activated when `Hysteresis` mode is used. Rapid temperature rises are passed directly to the signal output if the set averaging hysteresis is exceeded, so that dynamic events can be recorded despite averaging.

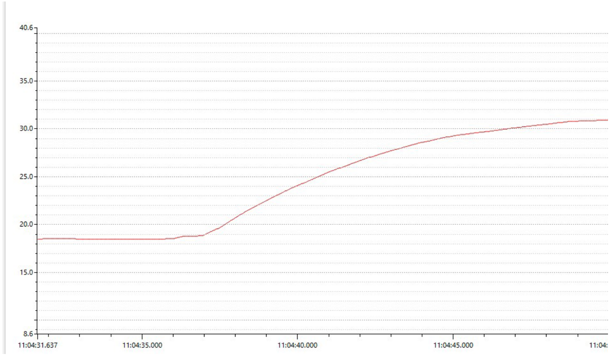
Averaging	*Normal*	*Averaging Time*	*Value*
	Hysteresis	*Averaging Time*	*Value*
		Averaging Hysteresis	*Value*

Intelligent averaging with Hysteresis

Averaging is generally used to smooth signal curves. This function can be optimally adapted to the respective application using the adjustable `Averaging Time` parameter. One disadvantage of averaging is that rapid temperature rises caused by dynamic events are subject to the same averaging time and are therefore only available at the signal output with a time delay. The `intelligent averaging function (Hysteresis)` eliminates this disadvantage by passing rapid temperature rises directly to the signal output without averaging.



Signal course with intelligent averaging (Hysteresis)



Signal course without intelligent averaging (Normal)

Tab. 6.5: Signal course with and without intelligent averaging (Hysteresis)

6.4.3.3 Minimum and maximum hold

Activating `Hold Mode` activates one of the following arithmetic algorithms:

- `Minimum Search`

  In this mode, the sensor waits for rising signals. When the signal rises, the algorithm holds the previous signal level for the specified hold time. The definition of the algorithm corresponds to the maximum search (inverted).
- `Maximum Search`

  In this mode, the sensor waits for descending signals. If the signal drops, the algorithm holds the previous signal peak for the specified hold time.
- `Extended Minimum Search`

  This mode is the reverse function of the extended maximum search. The sensor waits for local minima. Minimum values that are higher than their predecessors are only adopted if the temperature previously exceeded the threshold value.

  If `Hysteresis` is activated, a minimum value must also increase by the value of the hysteresis before the algorithm accepts the value as the new minimum value.
- `Extended Maximum Search`

  In this mode, the sensor waits for local peak values.

  Peak values that are lower than their predecessors are only accepted if the temperature has fallen below the threshold value.

  If `Hysteresis` is activated, a peak value must also decrease by the value of the hysteresis before the algorithm accepts it as the new peak value.

Minimum and Maximum Hold mode	Hold Mode	*Disabled*		
		Minimum Search	*Hold Time Minimum Search*	*Value*
		Maximum Search	*Hold Time Maximum Search*	*Value*
		Extended Minimum Search	*Hold Time Minimum Search*	*Value*
			Temperature Threshold	*Value*
			Temperature Hysteresis	*Value*
		Extended Maximum Search	*Hold Time Maximum Search*	*Value*
			Temperature Threshold	*Value*
			Temperature Hysteresis	*Value*

6.4.3.4 Signal selection (advanced)

The `Signal Selection` determines which and how many temperature values are permanently transmitted to the `sensorTOOL`.

This selection determines the data displayed in the graphical Measurement tab, see Chap. 6.2 , and the Single Value tab, see Chap. 6.3.

There are 5 different temperature types available for digital output:

Temperature Type	Meaning
`TProc`	Process temperature = temperature value with signal processing functions
`TAvg`	Averaged temperature = temperature value with averaging function
`TAct`	Temperature raw value = temperature value without signal processing functions
`TBox`	Temperature of the controller
`THead`	Temperature of the sensor

Tab. 6.6: Temperature types of signal selection

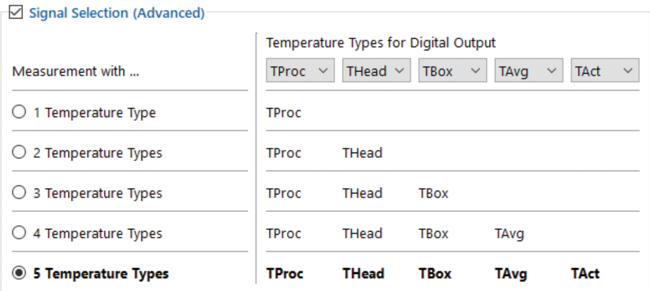


Fig. 6.11: Signal Selection (Advanced) with various options

6.4.4 Output menu

6.4.4.1 Overview

The number of transferred temperatures is defined by selecting the corresponding line. The measured value and the order in which the temperature values are output can be defined in the individual line.

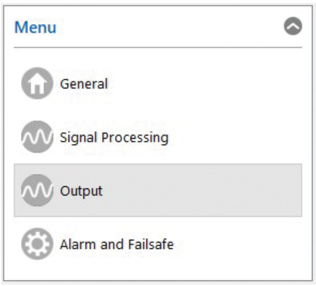


Fig. 6.12: View sensorTOOL - Settings menu - Output

6.4.4.2 Analog output settings

The `Output Mode` settings enables to activate the analog output `Voltage Output` or the `Current Output`.

If `Disabled` is selected, all available analog outputs are switched off.

Analog Output settings	*Output Mode*	*Disabled*		
Advanced		*Voltage Output / Current Output*	*Output Minimum Value*	*Value*
			Output Maximum Value	*Value*
			Temperature for Minimum Output	*Value*
			Temperature for Maximum Output	*Value*

The upper and lower limits for the output scaling of the analog output and the upper and lower temperature limits for the scaling are defined via the `Advanced` entry.

6.4.4.3 Loop maintenance (advanced)

`Loop Maintenance` makes it possible to simulate an output value to check the wiring or scaling of a connected PLC. As long as this mode is activated, the sensor does not output any measured values but only the set simulation values.

Loop Maintenance (Advanced)	*Loop Maintenance Status*	*Disabled*		
		Enabled	*Temperature Type*	*TAct / TBox / THead*
			Temperature value (Digital)	*Value*
			Temperature Value (Analog)	*Value*
			Voltage/Current Value (Analog)	*Value*
			Percentage Value (Analog)	*Value*

6.4.4.4 Calibration (advanced)

`Calibration` allows the user to specifically adjust the sensor using an offset and gain value, regardless of the factory settings.

Calibration (Advanced)	*Tweak Offset*	*Value in °C*
	Tweak Gain	*Value*

6.4.5 Alarm and failsafe menu

6.4.5.1 Overview

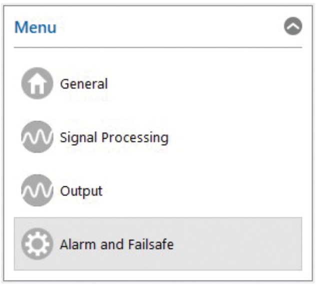


Fig. 6.13: View sensorTOOL - Settings menu - Alarm and Failsafe

6.4.5.2 Alarm settings

If you check `Advanced`, you can activate the alarm directly and set the `Alarm Switching Temperature` and the `Alarm Hysteresis`.

The `Alarm Source` is used to set the reference temperature of the alarm channel.

The entries are used to define the alarm source (temperature value) for the alarm output. The temperature determines when the alarm is triggered and the Open-collector alarm changes its switching state. `Off` deactivates alarm output.

Alarm 1	*Alarm source*	*TProc / TAvg / TAct / TBox / THead / Differenz /TAct / THead*	
	Extended	*Activate Alarm*	*Normal Open*
			Normal Closed

6.4.5.3 Failsafe settings (advanced)

`Failsafe Mode` enables to output values at the analog output that lie outside the specified analog scaling, depending on adjustable temperature values via assigned temperature limits. This makes it possible to signal error states via the analog output.

Failsafe Mode

Failsafe Mode	*Disabled*		
	Analog Out	Surveillance of	*TProc*
			THead
			TAct
			TBox

Analog Output Failsafe

If `Analog Out` is selected, the following settings are possible under `Analog Output Failsafe`:

Analog Output	Value
Voltage Output for T < Threshold	*Value*
Voltage Output for T > Threshold	*Value*
Current Output for T < Threshold	*Value*
Current Output for T > Threshold	*Value*

Tab. 6.7: Analog Output Failsafe

Temperature thresholds	*Minimum TProc*	*Value*
	Maximum TProc	*Value*
	Minimum TAct	*Value*
	Maximum TAct	*Value*
	Minimum THead	*Value*
	Maximum THead	*Value*
	Minimum TBox	*Value*
	Maximum TBox	*Value*

Tab. 6.8: Temperature thresholds

6.5 Info menu

► Switch to the `Info` menu.

This view gives you additional information about the connected system. In addition, the settings can be exported or imported, or copied to a clipboard, and the system can be reset to factory settings.

Clicking the Copy to clipboard button copies the information and settings for the selected sensor to the clipboard.

By confirming the Factory settings button, you can restore the factory state. All deactivated channels are reactivated, and the intensity adjustments and special channel-related settings are reset.
Confirm the dialog box that opens with Yes to reset the sensor.

Export Settings opens the Explorer and offers to save the sensor settings in a predefined *.csv file on the PC.

Import Settings opens the Explorer and offers to import the sensor settings from a predefined *.csv file on the PC.

When you click on the Disconnect button, the menu jumps back to the sensorTOOL start page.

6.6 Communication settings

Serial Interface	
Baud rate:	9600, 19200, 38400, 57600, 115200 (standard) [8] .
Data bits:	8
Parity:	even
Stop bits:	1
Flow control:	Off

Protocol

The sensors use the ME bus protocol as standard, which provides the full range of functions. In addition to this protocol, the sensor can also be converted to a simplified binary protocol using the sensorTOOL software. In this case, there is no additional overhead in order to achieve fast communication.

[8] Settings in the sensorTOOLsoftware

7 Cleaning

Lens cleaning:

Loose particles can be blown away with clean compressed air. The lens surface can be cleaned with a soft, damp cloth (moistened with water) or a lens cleaner (e.g. Zeiss Cleaning Fluid, Edmund Lens Cleaner).

NOTICE
Avoid exposure of sensor (both optics and housing) to cleaning agents that contain solvents. ► Damage to or destruction of the sensor

8 Principle of infrared temperature measurement

Depending on the temperature, every body emits a certain amount of infrared radiation. A change in the temperature of the object is accompanied by a change in the intensity of the radiation.

The wavelength range of this so-called "thermal radiation" used for infrared measurement technology is between approx. 1 µm and 20 µm. The intensity of the emitted radiation depends on the material.

The material-dependent constant is referred to as emissivity (ε - epsilon) and is known for most substances, see Chap. 9.4, see Chap. 9.5. Infrared pyrometers are optoelectronic sensors. They detect the infrared radiation emitted by a body and calculate the surface temperature based on this. Probably the most important feature of infrared pyrometers is the non-contact measurement technique, which allows the temperature of difficult-to-access or moving objects to be determined. Infrared pyrometers essentially consist of the following components:

- Lens
- Spectral filter
- Detector
- Controller

The properties of the lens largely determine the beam path of the infrared thermometer, which is characterized by the ratio of distance- to-spot-size. The filter is used to select the wavelength range that is relevant for the temperature measurement. Together with the controller, the detector converts the intensity of the emitted infrared radiation into electrical signals.

9 Emissivity

9.1 Definition

The intensity of the infrared heat radiation emitted by each body depends on both the temperature and the radiation properties of the material to be examined. The emissivity (ε - epsilon) is the corresponding material constant that describes the ability of a body to emit infrared energy. It can be between 0% and 100%. An ideally radiating body, a so-called "black body", has an emissivity of 1, while the emissivity of a gold mirror, for example, is < 0.1.

If the emissivity is set too high, the infrared thermometer determines a lower temperature than the real temperature, provided that the object being measured is warmer than the surroundings. With a low emissivity (reflective surfaces), there is a risk that interfering infrared radiation from background objects (flames, heating systems, fireclay, etc.) will distort the measurement result. To minimize the measurement error in this case, the device should be handled very carefully and shielded from reflective radiation sources.

9.2 Determination of an unknown emissivity

- The current temperature of the measuring object can be determined using a thermocouple, contact sensor or similar. The temperature can then be measured with the infrared temperature sensor. The emissivity can be changed until the displayed measurement value matches the actual temperature.
- For temperature measurements up to 380 °C, it is possible to attach a special plastic sticker to the measured object.
  - Set the emissivity to 0.95 and measure the temperature of the sticker.
  - Then determine the temperature of a directly adjacent surface on the measuring object and set the emissivity so that the value corresponds to the previously measured temperature of the plastic sticker.
- Apply matt black paint to part of the surface of the object to be measured.
  - Set the emissivity of your infrared thermometer to 0.98 and measure the temperature of the black-colored surface.
  - Then determine the temperature of a directly adjacent surface and change the emissivity setting until the measured temperature corresponds to that of the colored area.

i With all three methods, the object must have a different temperature from the room temperature.

9.3 Characteristic emissivities

If you do not wish to use any of the methods described above to determine your emissivity, you can use guide values from the following emissivity tables.

i Please note that the tables only show average values.

The actual emissivity of a material is influenced by the following factors, among others:

- Temperature
- Measuring angle
- Geometry of the surface (plane, convex, concave)
- Thickness of material
- Structure of the surface (polished, oxidized, rough, sandblasted)
- Spectral range of the measurement
- Transmission properties (e.g. with thin film)

9.4 Emissivity table for metals

Material		Typical emissivity			
Spectral sensitivity		1.0 µm	1.6 µm	5.1 µm	8 - 14 µm
Aluminum	Not oxidized	0.1 ... 0.2	0.02 ... 0.2	0.02 ... 0.2	0.02 ... 0.1
	Polished	0.1 ... 0.2	0.02 ... 0.1	0.02 ... 0.1	0.02 ... 0.1
	Roughened	0.2 ... 0.8	0.2 ... 0.6	0.1 ... 0.4	0.1 ... 0.3
	Oxidized	0.4	0.4	0.2 ... 0.4	0.2 ... 0.4

Material		Typical emissivity			
Lead	Polished	0.35	0.05 ... 0.2	0.05 ... 0.2	0.05 ... 0.1
	Roughened	0.65	0.6	0.4	0.4
	Oxidized		0.3 ... 0.7	0.2 ... 0.7	0.2 ... 0.6
Chrome		0.4	0.4	0.03 ... 0.3	0.02 ... 0.2
Iron	Not oxidized	0.35	0.1 ... 0.3	0.05 ... 0.25	0.05 ... 0.2
	Rusted		0.6 ... 0.9	0.5 ... 0.8	0.5 ... 0.7
	Oxidized	0.7 ... 0.9	0.5 ... 0.9	0.6 ... 0.9	0.5 ... 0.9
	Forged, blunt	0.9	0.9	0.9	0.9
	Molten	0.35	0.4 ... 0.6		
Iron, cast	Not oxidized	0.35	0.3	0.25	0.2
	Oxidized	0.9	0.7 ... 0.9	0.65 ... 0.95	0.6 ... 0.95
Gold		0.3	0.01 ... 0.1	0.01 ... 0.1	0.01 ... 0.1
Haynes	Alloy	0.5 ... 0.9	0.6 ... 0.9	0.3 ... 0.8	0.3 ... 0.8
Inconel	Electropolished	0.2 ... 0.5	0.25	0.15	0.15
	Sandblasted	0.3 ... 0.4	0.3 ... 0.6	0.3 ... 0.6	0.3 ... 0.6
	Oxidized	0.4 ... 0.9	0.6 ... 0.9	0.6 ... 0.9	0.7 ... 0.95
Copper	Polished	0.05	0.03	0.03	0.03
	Roughened	0.05 ... 0.2	0.05 ... 0.2	0.05 ... 0.15	0.05 ... 0.1
	Oxidized	0.2 ... 0.8	0.2 ... 0.9	0.5 ... 0.8	0.4 ... 0.8
Magnesium		0.3 ... 0.8	0.05 ... 0.3	0.03 ... 015	0.02 ... 0.1
Brass	Polished	0.35	0.01 ... 0.5	0.01 ... 0.5	0.01 ... 0.5
	Harshened	0.65	0.4	0.3	0.3
	Oxidized	0.6	0.6	0.5	0.1
Molybdenum	Not oxidized	0.25 ... 0.35	0.1 ... 0.3	0.1 ... 0.15	0.1
		0.5 ... 0.9	0.4 ... 0.9	0.3 ... 0.7	0.2 ... 0.6
Monel (Ni-Cu)		0.3	0.2 ... 0.6	0.1 ... 0.5	0.1 ... 0.14
Nickel	Electrolytic	0.2 ... 0.4	0.1 ... 0.3	0.1 ... 0.15	0.05 ... 0.15
	Oxidized	0.8 ... 0.9	0.4 ... 0.7	0.3 ... 0.6	0.2 ... 0.5
Platinum	Black		0.95	0.9	0.9
Mercury			0.05 ... 0.15	0.05 ... 0.15	0.05 ... 0.15
Silver		0.04	0.02	0.02	0.02
Steel	Polished pitch	0.35	0.25	0.1	0.1
	Stainless	0.35	0.2 ... 0.9	0.15 ... 0.8	0.1 ... 0.8
	Heavy plates			0.5 ... 0.7	0.4 ... 0.6
	Cold-milled	0.8 ... 0.9	0.8 ... 0.9	0.8 ... 0.9	0.8 ... 0.9
	Oxidized	0.8 ... 0.9	0.8 ... 0.9	0.7 ... 0.9	0.7 ... 0.9
Titanium	Polished	0.5 ... 0.75	0.3 ... 0.5	0.1 ... 0.3	0.05 ... 0.2
	Oxidized		0.6 ... 0.8	0.5 ... 0.7	0.5 ... 0.6
Tungsten	Polished	0.35 ... 0.4	0.1 ... 0.3	0.05 ... 0.25	0.03 ... 0.1
Zinc	Polished	0.5	0.05	0.03	0.02
	Oxidized	0.6	0.15	0.1	0.1
Tin	Not oxidized	0.25	0.1 ... 0.3	0.05	0.05

9.5 Emissivity table for non-metals

Material		Typical emissivity			
Spectral sensitivity		1.0 µm	2.3 µm	5.1 µm	8 - 14 µm
Asbestos		0.9	0.8	0.9	0.95
Asphalt				0.95	0.95
Basalt				0.7	0.7
Concrete		0.65	0.9	0.9	0.95
Ice					0.98
Soil					0.9 ... 0.98
Color	Not alkaline				0.9 ... 0.98
Gypsum				0.4 ... 0.97	0.8 ... 0.95
Glass	Washer		0.2	0.98	0.85
	Melting material		0.4 ... 0.9	0.9	
Rubber				0.9	0.95
Wood	Natural			0.9 ... 0.95	0.9 ... 0.95
Limestone				0.4 ... 0.98	0.98
Carborundum			0.95	0.9	0.9
Ceramics		0.4	0.8 ... 0.95	0.8 ... 0.95	0.95
Gravel				0.95	0.95
Carbon	Not oxidized		0.8 ... 0.9	0.8 ... 0.9	0.8 ... 0.9
	Graphite		0.8 ... 0.9	0.7 ... 0.9	0.7 ... 0.9
Plastics > 50 µm	Opaque			0.95	0.95
Paper	Any color			0.95	0.95
Sand				0.9	0.9
Snow					0.9
Textiles				0.95	0.95
Water					0.93

10 Disclaimer

All components of the device have been checked and tested for functionality in the factory. However, should any defects occur despite careful quality control, these shall be reported immediately to Micro-Epsilon or to your distributor / retailer.

Micro-Epsilon undertakes no liability whatsoever for damage, loss or costs caused by or related in any way to the product, in particular consequential damage, e.g., due to

- non-observance of these instructions/this manual,
- improper use or improper handling (in particular due to improper installation, commissioning, operation and maintenance) of the product,
- repairs or modifications by third parties,
- the use of force or other handling by unqualified persons.

This limitation of liability also applies to defects resulting from normal wear and tear (e.g., to wearing parts) and in the event of non-compliance with the specified maintenance intervals (if applicable).

Micro-Epsilon is exclusively responsible for repairs. It is not permitted to make unauthorized structural and / or technical modifications or alterations to the product. In the interest of further development, Micro-Epsilon reserves the right to modify the design.

In addition, the General Terms of Business of Micro-Epsilon shall apply, which can be accessed under

Legal details | Micro-Epsilon https://www.micro-epsilon.com/legal-details/.

11 Service, repair

If the measuring system is defect, please send in the affected parts for repair or replacement.

If the cause of a fault cannot be clearly identified, please send the entire system including cables to:

MICRO-EPSILON MESSTECHNIK
GmbH & Co. KG
Koenigbacher Str. 15
94496 Ortenburg / Germany

Tel: +49 (0) 8542 / 168-0
Fax: +49 (0) 8542 / 168-90
info@micro-epsilon.com
www.micro-epsilon.com/contact/worldwide/
https://www.micro-epsilon.com

12 Decommissioning, disposal

In order to avoid the release of environmentally harmful substances and to ensure the reuse of valuable raw materials, we draw your attention to the following regulations and obligations:

- Remove all cables from the sensor and/or controller.
- Dispose of the sensor and/or the controller, its components and accessories, as well as the packaging materials in compliance with the applicable country-specific waste treatment and disposal regulations of the region of use.
- You are obliged to comply with all relevant national laws and regulations.

For Germany / the EU, the following (disposal) instructions apply in particular:

- Waste equipment marked with a crossed garbage can must not be disposed of with normal industrial waste (e.g. residual waste can or the yellow recycling bin) and must be disposed of separately. This avoids hazards to the environment due to incorrect disposal and ensures proper recycling of the old appliances.

- A list of national laws and contacts in the EU member states can be found at https://ec.europa.eu/environment/topics/waste-and-recycling/waste-electrical-and-electronic-equipment-weee_en. Here you can inform yourself about the respective national collection and return points.

- Old devices can also be returned for disposal to Micro-Epsilon at the address given in the legal details at https://www.micro-epsilon.com/legal-details.

- We would like to point out that you are responsible for deleting the measurement-specific and personal data on the old devices to be disposed of.

- Under the registration number WEEE-Reg.-Nr. DE28605721, we are registered at the foundation Elektro-Altgeräte Register, Nordostpark 72, 90411 Nuremberg, as a manufacturer of electrical and/or electronic equipment.

13 Optional accessories

13.1 Mounting accessories

TM-MF-UC	Mounting fork	2970751
TM-FB	Mounting bracket	2970753
TM-AB-UC	Mounting bracket, adjustable in 2 axes	2970754
TM-MB-UC	Mounting bolt with M12x1 thread and nut	2970755
TM-TA	Pipe adapter	2970756
TM-T40	Reflection protection tube, length 40 mm; M12x1 external thread	2970757
TM-T88	Reflection protection tube, length 88 mm; M12x1 external thread	2970758
TM-T20	Reflection protection tube, length 20 mm; M12x1 external thread	2970759
TM-MH-UC	Massive housing made from stainless steel	2970760
TM-FBMH-UC	Mounting bracket for solid housing	2970761
TM-CF	Close Focus lens	2970763
TM-PW	Protective window	2970764
TM-MI	Right angle mirror	2970769
TM-DIN-UC	Rail mount adapter	2970750

The controller can be mounted on a DIN rail in accordance with EN50022 (TS35) using the rail mount adapter.

13.2 Air purge units

NOTICE
Avoid both deposit (dust, particles) and smoke, steam and high air humidity (condensation) on the lens. ► Erroneous measurements

These effects are avoided or reduced by using an air purge collar.

i Make sure you use oil-free, technically clean air.

The required air volume (approx. 2 ... 10 l/min.) depends on the application and the conditions at the installation site.

TM-AP	Air purge collar	2970767
TM-APL	Air purge collar with laminar air flow and air outlet offset by 90° to the measuring object	2970752
TM-AP8	Air purge collar with 8 mm hose connection	2970768
TM-APMH-UC	Air purge collar made from stainless steel for solid housing	2970762

There is an air outlet on the side of the laminar air purge collar. This prevents the measuring object from cooling down at small measuring distances.

13.3 CF ancillary lens

The CF ancillary lens enables the measurement of tiny objects. The minimum measurement spot depends on the sensor used. The distance is measured from the front edge of the CF lens holder or the laminar air purge collar. The ancillary lens is mounted by screwing it on the sensor up to the stop.

When using the CF ancillary lens (average values), the following transmission values must be set:

Model	Transmittance
SF15	0.85

Tab. 13.1: Model ancillary lens and transmission values

13.4 USB adapter

TM-USBA	USB adapter with terminal block	2970770

13.5 Protective window

A protective window is available to protect the sensor lens. It has the same mechanical dimensions as the CF lens and is available in the following variants:

When using the protective window (average values), the following transmission values must be set as a guide value:

Model	Transmittance
SF15	0.83

Tab. 13.2: Protective window model and transmission values

The optionally available USB adapter is required to change the transmission value.

14 Factory settings

The sensors have the following default settings on delivery:

	U- version [9]	I- version [10]
Temperature range	0 ... 600 °C	0 ... 600 °C
Output	0 ... 6 V	4 ... 20 mA
Emissivity	0.950	0.950
Transmission	1.000	1.000
Averaging Time (Normal and Hysteresis)	0.2 s	0.2 s
Averaging Hysteresis (Hysteresis)	2 °C	2 °C
Source of ambient temperature	Internal (sensor temperature)	Internal (sensor temperature)
Signal Processing	Hold mode: disabled	Hold mode: disabled
Calibration	Tweak Gain 1.000/Tweak Offset 0.0 °C	Tweak Gain 1.000/Tweak Offset 0.0 °C
Failsafe	Disabled	Disabled

The factory settings can be changed using the optional USB adapter and the `sensorTOOL`.

`Intelligent averaging (Hysteresis)` is a dynamic adaptation of the averaging to steep signal edges. Activation / deactivation is only possible via the `sensorTOOL` software.

[9] U = Voltage
[10] I = Current

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