MICRO-EPSILON

Operating Instructions

thermoMETER TIM 8
thermoIMAGER TIM 40

Spot finder IR camera

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1. Safety

System operation assumes knowledge of the operating instructions.

1.1 Symbols Used

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.
`Measure`	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 camera

NOTICE

Avoid the alignment of the camera to intensive energy sources (e.g. devices which emit laser radiation or reflections of such equipment). This is also valid if the camera is switched off.
> Effect on the accuracy of the measurement

> Irreparable defect of the infrared detector

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

Avoid shocks, impacts and vibration to the camera.
> Damage to or destruction of the camera

The supply voltage must not exceed the specified limits.
> Damage to or destruction of the camera

No solvent-based cleaning agents may have an effect on the camera (neither for the optics nor the housing).
> Damage to or destruction of the camera

Avoid abrupt changes of the ambient temperature.
> Incorrect display of the device

Protect the USB cable against damage.
> Failure of the camera

1.3 Notes on CE Marking

The following apply to the thermoIMAGER TIM:

- EU Directive 2014/30/EU
- EU Directive 2011/65/EU, “RoHS” category 9

Products which carry the CE mark satisfy the requirements of the EU directives cited and the European harmonized standards (EN) listed therein. The EU Declaration of Conformity is available to the responsible authorities according to EU Directive, article 10, at:

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The measuring system is designed for use in industrial and laboratory environments and meets the requirements.

1.4 Intended Use

- The thermoIMAGER TIM is designed for use in industrial and laboratory areas. It is used for measuring the surface temperature based on the emitted energy of objects, see 10.
- The system must only be operated within the limits specified in the technical data, see 2.
- The system must be used in such a way that no persons are endangered or machines and other material goods are damaged in the event of malfunction or total failure of the controller.
- Take additional precautions for safety and damage prevention in case of safety-related applications.

1.5 Proper Environment

- Protection class: IP 67 (NEMA-4)
- Operating temperature: 0 ... 50 °C (+32 ... +122 °F)
- Storage temperature: -40 ... 70 °C (-40 ... +158 °F)
- Relative humidity: 10 ... 95 %, non-condensing

NOTICE

Avoid abrupt changes of the ambient temperature.
> Incorrect display of the device

2. Technical Data

2.1 Functional Principle

The thermoMETER TIM 8 and the thermoIMAGER TIM 40 calculates the surface temperature based on the emitted infrared energy of objects, see 10. The two-dimensional detector (FPA - focal plain array) allows a measurement of an area and will be shown as thermographic image using standardized palettes. The radiometric processing of the picture data enables the user to do a comfortable detailed analysis with the software TIM Connect.

2.2 Model Overview

The cameras of the TIM series are available in the following basic versions:

Model	Type	Temperature range	Spectral range	Frame rate	Typical applications
thermoMETER TIM 8	IR	-20 to 900 °C	7.5 - 13 µm	50 Hz	Surface measurements in industrial application, autonomous operation with automatic spot finder
thermoIMAGER TIM 40	IR	-20 to 900 °C	7.5 - 13 µm	80 Hz/ 27 Hz	Real-time thermographic images in high speed; Detection of smallest temperature differences

2.3 General Specifications

Model		thermoMETER TIM 8	thermoIMAGER TIM 40
Protection class		IP 67 (NEMA-4) [1]	
Operating temperature		0 ... 50 °C (+32 ... +122 °F)	
Storage temperature		-40 ... 70 °C (-40 ... +158 °F)	
Relative humidity		10 ... 95 %, non-condensing	
Material (housing)		Stainless steel	
Dimensions		36 x 90 mm / M30	36 x 100 mm / M30
Weight (inclusive lens)		185 g	200 g
Cable length (USB)	USB	1 m (Standard), 3 m, 5 m, 10 m, 20 m	
	Ethernet/ RS485	100 m	-
Vibration [1]		IEC 68-2-6: (sinus shaped), see 2.4 IEC 60068-2-64 (broadband noise), see 2.4	
Shock [1]		IEC 68-2-27: 25 g and 50 g, see 2.4	

1) Used standards for vibration and shock

2.4 Vibration / Shock

2.4.1 Used Standards

IEC EN 60068-1: 1995-03	Environmental testing - Part 1: General and guidance
IEC 60068-2-6: 2008-10	Environmental testing - Part 2-6: Tests - Test Fc: Vibration (sinusoidal)
IEC 60068-2-27: 2010-02	Environmental testing - Part 2-27: Test Ea and guidance: Shock
IEC 60068-2-47: 2006-03	Environmental testing - Part 2-47: Mounting of specimens for vibration, impact and similar dynamic tests
IEC 60068-2-64: 2009-04	Environmental testing - Part 2-64: Tests - Tests Fh: Vibration, broadband random and guidance

2.4.2 Stress Program (Camera in Operation)

Shock, half sinus 25 g – testing Ea 25 g (acc. IEC 60068-2-27)		
Acceleration	245 m/s²	(25 g)
Pulse duration	11 ms	
Number of directions	6	(3 axes with 2 directions each)
Duration	600 shocks	(100 shocks each direction)
Shock, half sinus 50 g – testing Ea 50 g (acc. IEC 60068-2-27)		
Acceleration	490 m/s²	(50 g)
Pulse duration	11 ms	
Number of directions	6	(3 axes with 2 directions each)
Duration	18 shocks	(3 shocks each direction)

Vibration, sinus shaped – testing Fc (acc. IEC60068-2-6)			
Frequency range	10 - 500 Hz		
Acceleration	29.42 m/s^2	(3 g)	
Frequency change	1 octave/ min		
Number of axes	3		
Duration	1:30 h	(3 x 0.30 h)	
Vibration, broadband noise – testing Fh (acc. IEC60068-2-64)			
Frequency change	10 - 2000 Hz		
Acceleration, effective	39.3 m/s^2	(4.01 g_{RMS})	
Frequency spectrum	10 - 106 Hz	0.9610 $(m/s^2)^2/Hz$	(0.010 g^2 /Hz)
	106 - 150 Hz	+6 dB/ octave	
	150 - 500 Hz	1.9230 $(m/s^2)^2/Hz$	(0.020 g^2 /Hz)
	500 - 2000 Hz	-6 dB/ octave	
	2000 Hz	0.1245 $(m/s^2)^2/Hz$	(0.00126 g^2 /Hz)
Number of axes	3		
Duration	3 h	(3 x 1 h)	

2.5 Electrical Specifications

Model	thermoMETER TIM 8	thermoIMAGER TIM 40
Power supply	USB/ PoE/ 5 - 30 VDC	USB
Current draw	max. 500 mA	
AO: Output Process Interface (PIF out)	0/4 - 20 mA	0 - 10 V
	(Main measure area, measure area, internal temperature, flag status, alarm, frame sync, fail-safe, external communication), see A 12.	
AI: Input Process Interface (PIF in)	0 - 10 V (Emissivity, ambient temperature, reference temperature, uncommitted value, flag control, triggered recording, triggered snapshots, triggered line-scanner, triggered event grabber, reset peak-/valley-hold), see A 12.	
DI: Digital Input Process Interface	Flag control, triggered recording, triggered snapshots, triggered line-scanner, triggered event grabber, reset peak-/valley-hold	
DO: Digital Output Process Interface	Flag Status, alarm, frame sync, fail-safe, external communication	
Digital interface	USB 2.0/ Ethernet/ RS485	USB 2.0/ optional USB to GigE (PoE) conversion

2.7 Measurement Specification

Model	thermoMETER TIM 8	thermoIMAGER TIM 40
Temperature ranges (scalable)	-20 ... 100 °C; 0 ... 250 °C; (20) 150 ... 900 °C [1]	
Spectral range	7.5 - 13 µm	
Detector	UFPA, 80 x 80 Pixel@50 Hz	UFPA, 382 x 288 Pixel@80 Hz/27 Hz
Lenses (FOV)	12° x 12°; 30° x 30°; 55° x 55°; 80° x 80°	18° x 14°; 29° x 22°; 53° x 38°; 80° x 54°
Optical resolution (D:S)	190:1 (12° optic)	390:1 (18° optic)
System accuracy [2]	±2°C or ±2 %	
Temperature resolution (NETD)	100 mK	80 mK
Warm-up time	10 min	
Emissivity	0.100 ... 1.100	
Software	TIMConnect	

1) Accuracy statement effective from 150 °C
2) At ambient temperature 23±5 °C; whichever is greater.

3. Delivery

3.1 Unpacking, Included in Delivery

1 thermoMETER TIM 8 or thermoIMAGER TIM 40

1 USB cable (1 m [1])

1 Mounting nut and mounting bracket (adjustable in one axis, tripod thread)

1 Process interface cable inclusive terminal block (1 m)

1 Software package TIM Connect

1 Assembly instructions

- 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.
- In case of damage or missing parts, please contact the manufacturer or supplier.

Optional accessories are available in the appendix, see A 1.

3.2 Storage

- Storage temperature: -40 ... 70 °C (-40 ... +158 °F)
- Relative humidity: 10 ... 95 %, non-condensing

1) The camera plug of USB cable (1 m) does not feature an IP 67 protection class. For industrial applications there are cables with 1 m, 3 m, 10 m and 20 m with IP 67 available.

4. Optical Charts

Make sure that the focus of thermal channel is adjusted correctly.

The cameras have a motorized focus, which can be adjusted in the TIM Connect Software via Menu `View > Windows > Distance` or over the icon .

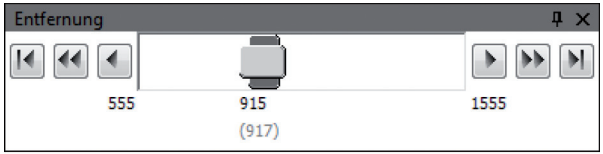


Fig. 1 Motorized focus settings in TIM Connect software

The variety of different lenses offers the possibility to precisely measure objects in different distances. We offer lenses for close, standard distances and large distances.

Please note that the TIM camera has a fixed optic. A change of optics is not possible.

Different parameters are important if using infrared cameras. They display the connection between the distance of the measured object and the size of the pixel, see Fig. 3, see Fig. 4.

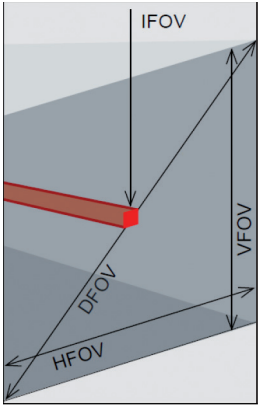


Fig. 2 Dependency between field of view (FOV) and distance

HFOV	Horizontal enlargement of the total measuring at object level
VFOV	Vertical enlargement of the total measuring at object level
IFOV	Size at the single pixel at object level
DFOV	Diagonal dimension of the total measuring field at object level
MFOV	Recommended, smallest measured object size of 3 x 3 Pixel (thermoIMAGER TIM 40) and 2 x 2 (thermoMETER TIM 8), not shown in the drawing above, see Fig. 2.

The following tables with examples showing what spot sizes and pixel sizes will be reached in which distance. For individual configuration there are different lenses available. Wide angle lenses have a radial distortion due to their large opening angle; the software TIM Connect has an algorithm which corrects this distortion. As an alternative to the tables below, the optics calculator can also be used. You will find the latest software at:
https://www.micro-epsilon.com/temperature-sensors/thermoIMAGER/optics/

TIM 8 (80 x 80 px)	Focal length	Minimum distance [1]	Distance to object (Measuring field in m, pixel in mm)											
				0.05	0.1	0.2	0.3	0.5	1	2	4	6	10	30	100
30 ° x 30 ° Standard	5 mm	0.2 m	HFOV (m)	0.028	0.056	0.111	0.167	0.279	0.557	1.115	2.230	3.346	5.6	16.7	55.8
			VFOV (m)	0.028	0.056	0.111	0.167	0.279	0.557	1.115	2.230	3.346	5.6	16.7	55.8
			IFOV (mm)	0.33	0.67	1.33	2.0	3.33	6.67	13.33	26.67	40.00	66.67	200.00	666.67
12 ° x 12 ° Telephoto	13 mm	0.3 m	HFOV (m)		0.022	0.043	0.065	0.11	0.21	0.43	0.45	0.68	1.1	3.4	11.3
			VFOV (m)		0.022	0.043	0.065	0.11	0.21	0.43	0.34	0.51	0.8	2.5	8.5
			IFOV (mm)		0.3	0.5	0.8	1.3	2.7	5.3	2.8	4.2	7.0	21.1	70.4
55 ° x 55 ° White angle	3 mm	0.2 m	HFOV (m)	0.057	0.110	0.218	0.325	0.539	1.07	2.14	4.27	6.41	10.7	32.0	106.7
			VFOV (m)	0.057	0.110	0.218	0.325	0.539	1.07	2.14	4.27	6.41	10.7	32.0	106.7
			IFOV (mm)	0.6	1.2	2.3	3.4	5.6	11.2	22.4	44.6	66.9	111.5	334.5	1114.8

HFOV: Horizontal enlargement of the total measuring field at object level
VFOV: Vertical enlargement of the total measuring field at object level
IFOV: Size of the single pixel at object level

1) The accuracy of measurement can be outside of the specifications for distances below the defined minimum distance.

TIM 8 (80 x 80 px)	Focal length	Minimum distance [1]	Distance to object (Measuring field in m, pixel in mm)											
				0.05	0.1	0.2	0.3	0.5	1	2	4	6	10	30	100
80 ° x 80 ° Wide angle	2 mm	0.2 m	HFOV (m)	0.090	0.174	0.343	0.509	0.884	1.682	3.357	6.708	10.058	16.8	50.3	167.5
			VFOV (m)	0.090	0.174	0.343	0.509	0.88	1.682	3.357	6.708	10.058	16.8	50.3	167.5
			IFOV (mm)	0.08	1.6	3.2	4.7	7.8	15.5	31.0	61.9	92.8	154.6	463.7	1545.5

Fig. 3 Table with examples (TIM 8) showing what spot sizes and pixel sizes will be reached in which distance

HFOV: Horizontal enlargement of the total measuring field at object level
VFOV: Vertical enlargement of the total measuring field at object level
IFOV: Size of the single pixel at object level

1) The accuracy of measurement can be outside of the specifications for distances below the defined minimum distance.

TIM 40 (382 x 288 px)	Focal length	Minimum distance [1]	Distance to object (Measuring field in m, pixel in mm)											
				0.05	0.1	0.2	0.3	0.5	1	2	4	6	10	30	100
29 ° x 22 ° Standard	13 mm	0.2 m	HFOV (m)	0.025	0.051	0.104	0.16	0.26	0.53	1.06	2.11	3.17	5.3	15.9	52.9
			VFOV (m)	0.019	0.038	0.78	0.12	0.20	0.39	0.79	1.58	2.36	3.9	11.8	39.4
			IFOV (mm)	0.1	0.1	1.263	0.4	0.7	1.3	2.7	5.4	8..1	13.4	40.3	134.4
18 ° x 14 ° Telephoto	20 mm	0.3 m	HFOV (m)			0.068	0.101	0.17	0.33	0.66	1.31	1.97	3.3	9.8	32.7
			VFOV (m)			0.051	0.076	0.13	0.25	0.49	0.99	1.48	2.5	7.4	24.6
			IFOV (mm)			0.170	0.26	0.4	0.9	1.7	3.4	5.1	8.5	25.5	85.0
53 ° x 38 ° White angle	8 mm	0.2 m	HFOV (m)		0.107	0.21	0.31	0.51	1.01	2.00	4.00	6.00	10.0	29.9	100.0
			VFOV (m)		0.076	0.15	0.22	0.35	0.70	1.39	2.78	4.17	6.9	20.8	69.5
			IFOV (mm)		0.3	0.5	0.7	1.1	2.2	4.4	8.8	13.2	22.0	66.0	220.0

HFOV: Horizontal enlargement of the total measuring field at object level
VFOV: Vertical enlargement of the total measuring field at object level
IFOV: Size of the single pixel at object level

1) The accuracy of measurement can be outside of the specifications for distances below the defined minimum distance.

TIM 40 (382 x 288 px)	Focal length	Minimum distance [1]	Distance to object (Measuring field in m, pixel in mm)											
				0,05	0,1	0,2	0,3	0,5	1	2	4	6	10	30	100
80 ° x 54 ° Wide angle	6 mm	0.2 m	HFOV (m)	0.069	0.149	0.30	0.46	0.78	1.57	3.14	6.29	9.43	15.7	47.3	157.7
			VFOV (m)	0.047	0.098	0.20	0.30	0.51	1.01	2.03	4.06	6.10	10.2	30.5	101.7
			IFOV (mm)	0.2	0.3	0.6	0.9	1.5	3.0	6.0	12.0	18.1	30.1	90.3	300.9

Fig. 4 Table with examples (thermoIMAGER TIM 40) showing what spot sizes and pixel sizes will be reached in which distance

HFOV: Horizontal enlargement of the total measuring field at object level
VFOV: Vertical enlargement of the total measuring field at object level
IFOV: Size of the single pixel at object level

1) The accuracy of measurement can be outside of the specifications for distances below the defined minimum distance.

5. Mechanical Installation

The thermoMETER TIM 8 and the thermoIMAGER TIM 40 are equipped with a tripod thread and can be installed either directly via the sensor thread or with help of the supplied mounting nut (standard) and adjustable mounting bracket (standard) to a mounting device available, see Fig. 9.

5.1 Dimensional Drawings

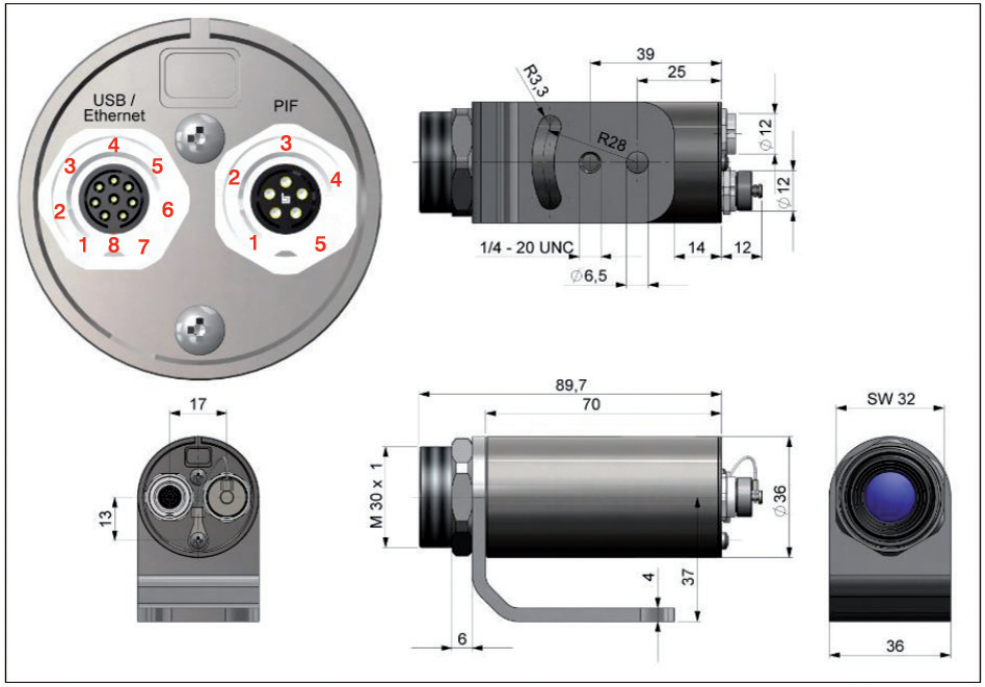


Fig. 5 Dimensional drawing thermoMETER TIM 8, dimensions in mm (inches), not to scale

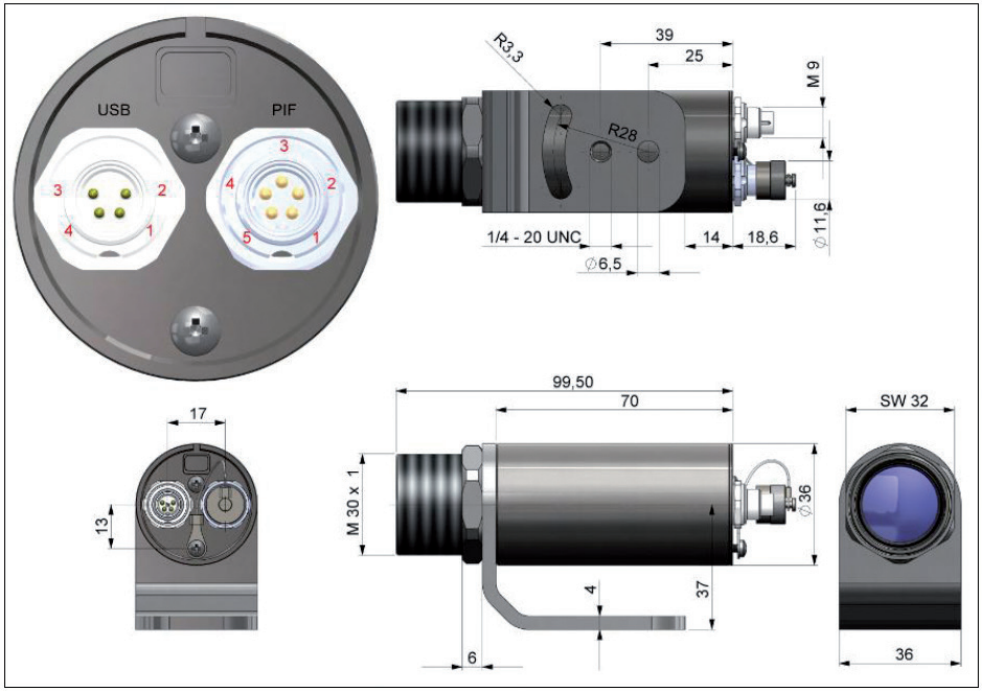


Fig. 6 Dimensional drawing thermoIMAGER TIM 40, dimensions in mm (inches), not to scale

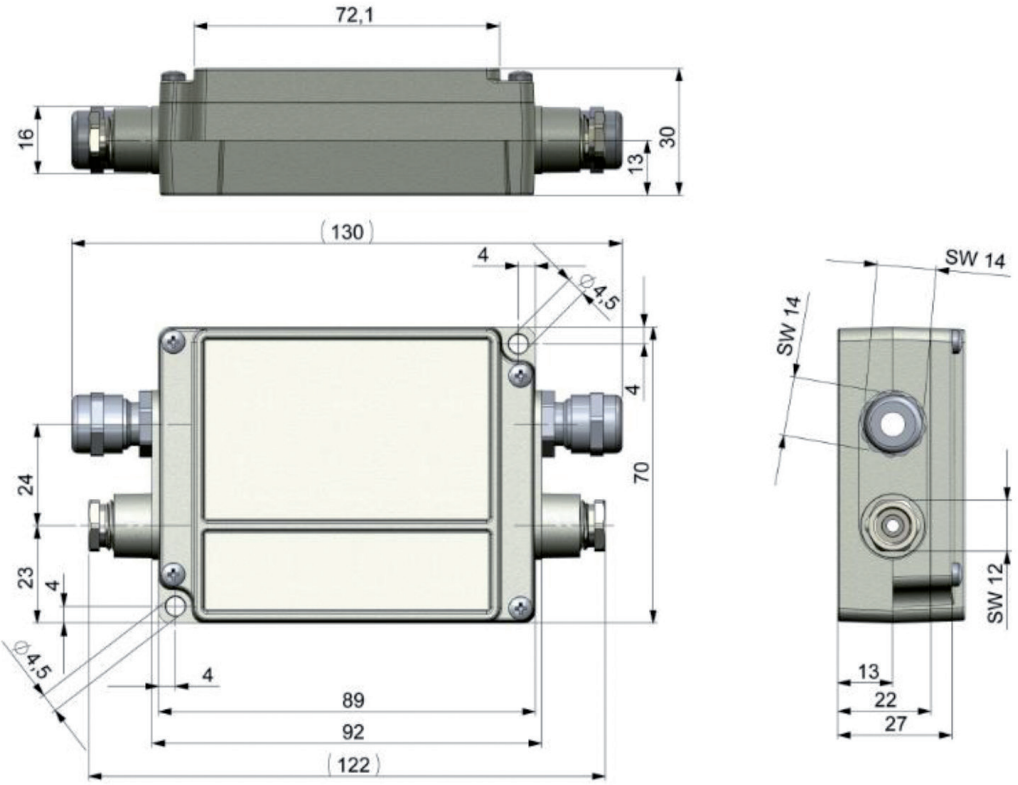


Fig. 7 Industrial/stackable PIF (Process Interface) - electronic box, control box shutter, dimensions in mm, not to scale

Fig. 8 thermoMETER TIM 8 / thermoIMAGER TIM 40 with mounting bracket

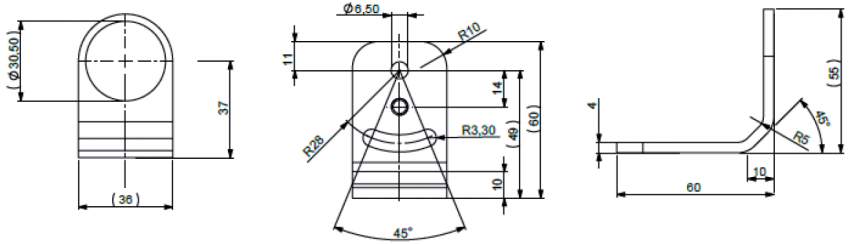


Fig. 9 Mounting bracket, adjustable in one axis, with tripod thread (TM-FB-TIM)

6. Electrical Installation

At the back side of the thermoMETER TIM 8 and the thermoIMAGER TIM 40 cameras there are the two connector plugs, see Fig. 10, see Fig. 11.

Fig. 10 Back side of the thermoMETER TIM 8 with connectors

1 Plug for USB/ Ethernet [1] / PoE cable

2 Plug for in- and outputs or RS485

Fig. 11 Back side of the thermoIMAGER TIM 40 with connectors

1 Plug for USB cable

2 Plug for PIF cable

1) When using the Ethernet connector, a 5 ... 30 V DC power supply must be ensured via the terminal block.

6.1 Process Interface

6.2 Process Interface TIM 8

The thermoMETER TIM 8 is equipped with an integrated process interface (cable with terminal block included in scope of supply), which can be programmed via the software as an direct analog input (AI) / digital input, as an direct analog output (AO) in order to control the process or as an RS485 interface [1)]. The signal level is 0 - 10 V for AI, 24 V for DI and 0/4 - 20 mA for AO.

The process interface can be activated choosing the following options:

Analog Input (AI)	Emissivity, ambient temperature, reference temperature, uncommitted value, flag control, triggered recording, triggered snapshots, triggered line-scanner, triggered event grabber, reset peak-/valley-hold
Analog Output (AO)	Main measure area, measure area, internal temperature, flag status, alarm, frame sync, fail-safe, external communication

1) Power supply only necessary when using the Ethernet connection (without PoE) or self-sufficient operation.

Fig. 12 Configuration terminal block thermoMETER TIM 8

Designation		Description	Color
⏚		Shield	Black
GND	0 V	Ground	Brown
VCC	5 - 30 V	Power supply [1)]	White
IN	A	Analog/Digital Input or RS485 (A)	Green
OUT	B	Analog output or RS485 (B)	Yellow
GND	ISO	Isolated Ground for IN and OUT	Gray

1) Power supply only necessary when using the Ethernet connection (without PoE) or self-sufficient operation (minimum voltage when using the Ethernet connection: 12 V)

The thermoMETER TIM 8 provides the following direct inputs and outputs:

Designation	**Description**	**max range / status**
AI	Analog input	0 - 10 V [1]
or DI	Digital input (Low-active = 0 ... 0.6 V)	24 V
AO	Analog output Alarm output	0/4 - 20 mA 0/4 - 20 mA

In addition to the above direct in- and outputs, the TIM 8 has an RS485 interface. This interface can be used to control the external industrial PIF.

1) The AI is designed for max. 24 V, the voltage level above 10 V is not interpreted.

6.3 Process Interface thermoIMAGER TIM 40

The process interface (electronics within cable as well as industrial interface) must be powered separately (5 - 24 VDC).

➪ Connect the PIF cable to the camera before switching on the power.

The TIM is equipped with a process interface (cable with integrated electronics and terminal block), which can be programmed via the software as an Analog Input (AI) and Digital Input (DI) in order to control the camera or as an Analog Output (AO) in order to control the process. The signal level is always 0 - 10 V (DI = 24 V).

The process interface can be activated choosing the following options:

Analog input (AI)	Emissivity, ambient temperature, reference temperature, uncommitted value, flag control, triggered recording, triggered snapshots, triggered line-scanner, triggered event grabber, reset peak-/valley-hold
Analog output (AO)	Main measure area, measure area, internal temperature, flag status, alarm, frame sync, fail-safe, external communication
Digital input (DI)	Flag control, triggered recording, triggered snapshots, triggered line-scanner, triggered event grabber, reset peak-/valley-hold

Fig. 13 Configuration terminal block thermoIMAGER TIM 40

Designation	Description	Color
⏚	Shield	Black
GND	Ground	Brown
DI	Digital input	Gray
Vcc	Power supply, 5 … 24 V DC	White
AI	Analog input	Green
AO	Analog output	Yellow

The standard process interface can be activated choosing the following options:

Designation	Description	max range [1] / status
AI	Analog input	0 - 10 V [2]
DI	Digital input (Low-active = 0 ... 0.6 V)	24 V
AO	Analog output Alarm output	0 - 10 V 0/ 10 V

1) Depending on supply voltage; for 0 - 10 V on the AO the PIF has to be powered with min. 12 V.
2) The AI is designed for max. 24 V, the voltage level above 10 V is not interpreted.

6.4 Pin Assignment thermoMETER TIM 8

Pin	USB	Ethernet	PIF
1	VCC		VCC
2	D+		RS485 or AO
3	D-		RS485 or AI
4		Tx+	GND
5		Tx-	GND-ISO
6		Rx+	
7		Rx-	
8	GND		

Fig. 14 Rear side thermoMETER TIM 8 connector

6.5 Pin Assignment thermoIMAGER TIM 40

Pin	USB	PIF
1	VCC	INT
2	GND	SDA (I^2C)
3	D-	SCL (I^2C)
4	D+	DGND
5	-	3.3 V (Out)

Fig. 15 Rear side thermoIMAGER TIM 40 connector

If the process interface of the camera is directly connected to external hardware [1] (without using the supplied PIF cable) an activation of the field `Support proprietary PIF cable` in the menu `Tools > Configuration > Device (PIF)` in the TIM Connect software is necessary.

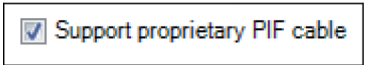


Fig. 16 Support proprietary PIF cable

i Consider that the input of the PIF is not protected if there is a direct PIF connection!

CAUTION

In this case, avoid a voltage > 3 V at INT pin.
> Destruction of the camera

1) We recommend using only a switching contact between INT and DGND as external hardware (button, relay).

7. Commissioning

➡ Please install at first the software TIM Connect from the delivered CD, see 9.2.

i Further information regarding software installation as well as software features you will find in the instruction manual supplied on the CD.

➡ Now you can connect the thermoIMAGER TIM camera into an USB port (USB 2.0) of your PC.

➡ If connecting the thermoIMAGER TIM camera and the computer please plug at first the USB cable into the camera and then into the computer.

NOTICE

If disconnecting the thermoIMAGER TIM camera and the computer please remove at first the USB cable from the computer and then from the camera.
> Damage to or destruction of the camera

After the software has been started, you should see the live image from the camera inside a window on your PC screen, see Fig. 17.

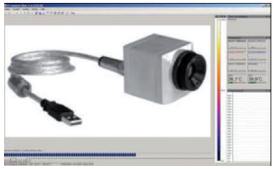


Fig. 17 Live image of camera

At first start of software you will be asked to install the calibration data of camera. You will find them on the supplied CD or can be accessed online via the Internet.

➡ Adjust the focus of the image by using the distance function in the software (`menu View > Windows > Distance` or over the icon :

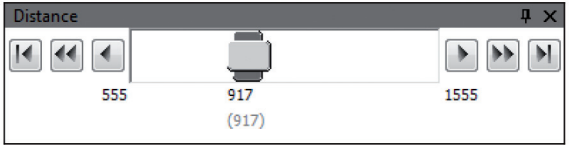


Fig. 18 Window distance

8. Instructions for Operation

8.1 Cleaning

Lens cleaning: Blow off loose particles using clean compressed air. The lens surface can be cleaned with a soft, humid tissue moistened with water or a lens cleaner (e.g. Purosol or B+W Lens Cleaner).

NOTICE

Never use cleaning compounds which contain solvents (neither for the lens nor for the housing).
> Destruction of the sensor and/or the controller

9. Software TIM Connect

9.1 Minimum System Requirements

- Windows Vista, Windows 7, Windows 8, Windows 10
- USB interface
- Hard disc with at least 30 MByte of free space
- At least 128 MByte RAM
- CD-ROM drive

A detailed description is provided in the software manual on the software CD. See also `Help` menu in the TIM Connect software under `Help` > `Documentation`.

9.2 Installation and Initial Operation

i All drivers are booted via Windows OS automatically. A driver installation is not necessary. By default the program starts automatically in the installed language.

➪ Insert the installation CD into the according drive on your computer.

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

➪ Otherwise start `setup.exe` from the CD-ROM. Follow the instructions of the wizard until the installation is finished.

The installation wizard places a launch icon on the desktop and in the start menu:

`Start > Programs > MICRO-EPSILON GmbH > TIM Connect.`

➪ To connect the camera to the PC, plug the USB cable to the camera first.

i Afterwards connect it with the PC. To disconnect the camera and the computer remove the USB cable from the computer first and then disconnect it from the camera.

➪ Start the software.

At the initial start the software asks for the calibrations files which are available via internet or on the CD (only for thermoIMAGER TIM 40). With the thermoMETER TIM 8, the calibration files are already included in the device.

➡ Install the calibration files at first start of the software (only necessary for thermoIMAGER TIM 40).

After the calibration files have been installed the live image from the camera is shown inside a window on your PC screen.

➡ Choose the desired language in the menu `Tools > Language`.

➡ Adjust the focus of the image by using the distance function in the software (`menu View > Windows > Distance` or over the icon :

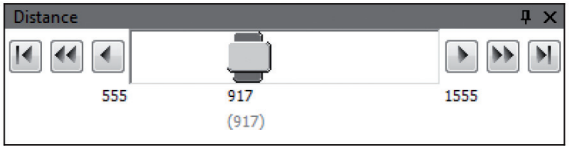


Fig. 19 Window distance

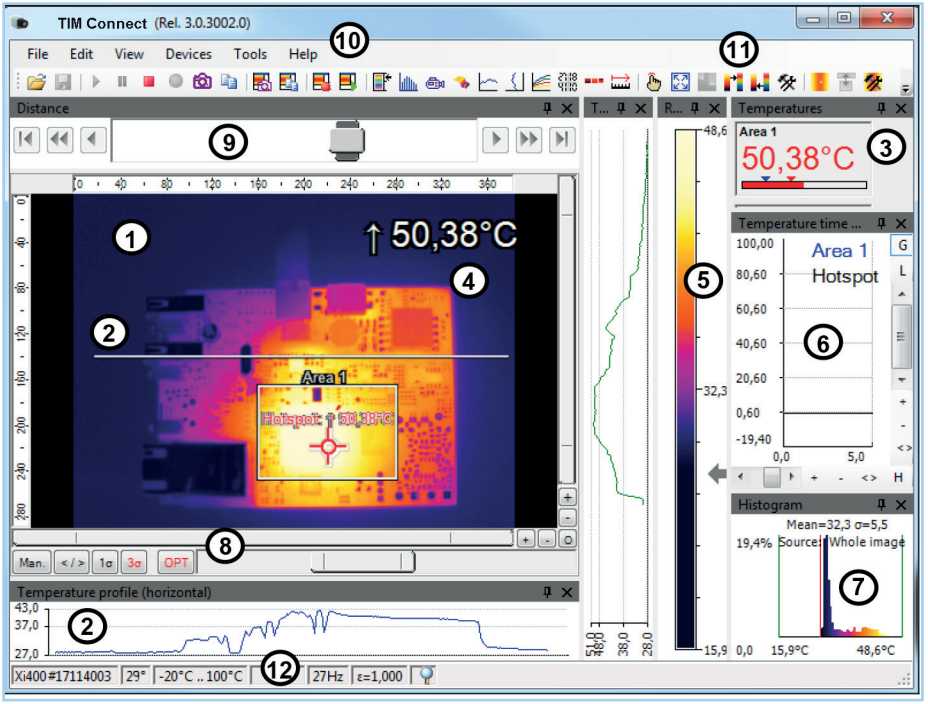


Fig. 20 Software window

i Further information regarding software installation as well as software features you will find in the manual supplied on the CD.

1	IR image from the camera
2	Temperature profile: Shows the temperatures along max. 2 lines at any size and position in the image.
3	Control displays: Displays all temperature values in the defined measure areas like Cold Spots, Hot Spots, temperature at cursor, internal temperature and chip temperature. Alarm settings: Bar showing the defined temperature thresholds for low alarm value (blue arrow) and high alarm value (red arrow). The color of numbers within control displays changes to red (when temp. above the high alarm value) and to blue (when temp. below the low alarm value).
4	Temperature of measure area: Analyses the temperature according to the selected shape, e.g. average temperature of the rectangle. The value is shown inside the IR image and the control displays.
5	Reference bar: Shows the scaling of temperature within the color palette.
6	Temperature time diagram: Shows the temperature curves over time for selectable region of interest (ROI)
7	Histogram: Shows the statistic distribution of single temperature values.
8	Automatic / manual scaling of the palette (displayed temperature range): Man., </> (min, max), 1σ : 1 Sigma, 3σ : 3 Sigma, OPT: Palette optimization
9	Distance function: Adjustment of the motor focus to focus the IR picture
10	Menu and Toolbar (Icons)
11	Icon enabling switching between color palettes
12	Status bar: Serial number, optic, temperature range, cursor position, device framerate/ display framerate, emissivity, ambient temperature, flag status

Further details to the software are in the enclosed CD.

9.3 Autonomous Operation thermoMETER TIM 8

A special feature of the thermoMETER TIM 8 is the autonomous operation. There is no need for a permanent connection to the TIM Connect software. Only a few settings must be set in advance in the software.

- To do this, connect the PIF and USB cables to the device.
- Then connect the thermoMETER TIM 8 to your PC and start the TIM Connect software, see 9.
- Position and focus, see 4, the camera so that your object to be measured is perfectly visible in the image.
- First define the desired measurement area with the corresponding mode you want to output.

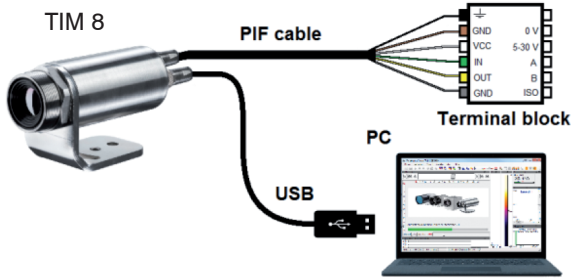


Fig. 21 Connection thermoMETER TIM 8 to PC via USB

- Now go to the configuration menu on Device (PIF).
- There you first select the PIF type (in this case: Internal PIF). Then select under Analog Outputs (AO) the function that is to be output autonomously.
- Then press *Setup*, make your settings and make sure that the checkbox is set to using autonomously by device.

By pressing the OK button an @ sign can be found in the configuration menu Devices (PIF), which indicates the autonomous operation.

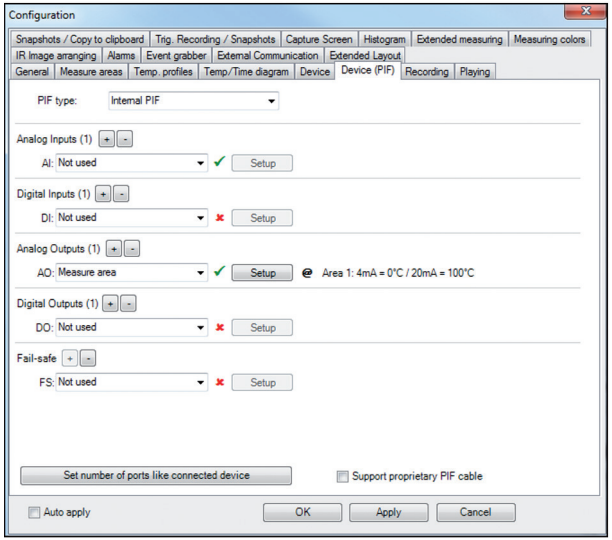


Fig. 22 Configurations menu Device (PIF)

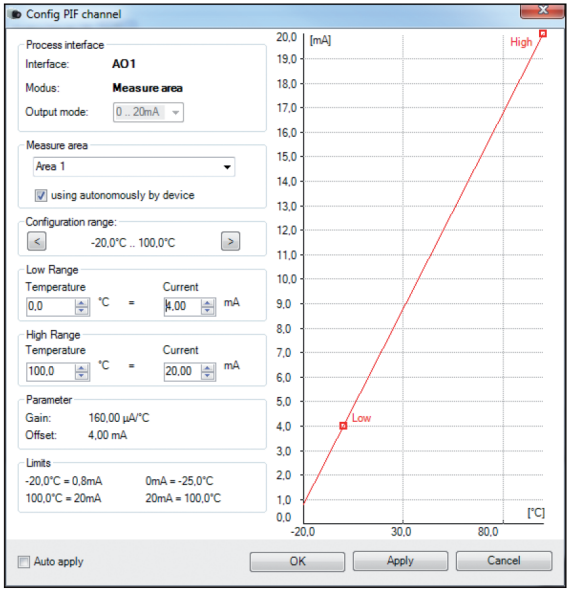


Fig. 23 Setup

In general these are all the settings that must be set in the TIM Connect software in order to operate the device autonomously. You can now close the software and then disconnect the USB cable. In order to start up the device autonomously, a 5 - 30 V power supply must be connected to the terminal block. Now the used input/output has to be connected. The resulting value can be displayed for example on a multimeter, see Fig. 23.

When using this variant, it can last for about half a minute until the device is ready for use in autonomous mode.

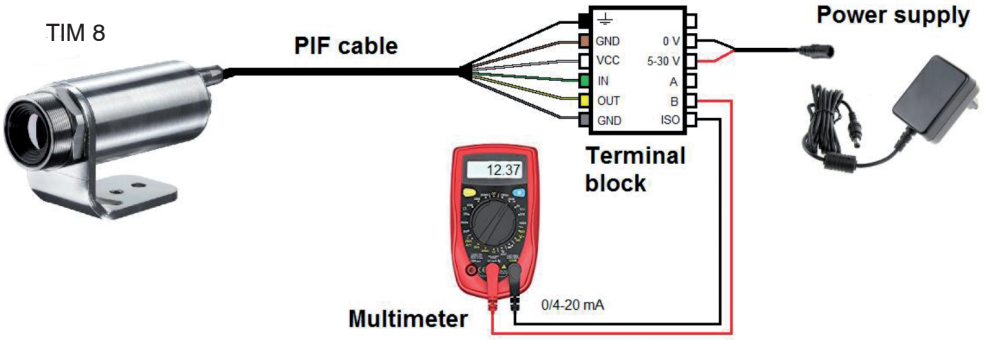


Fig. 24 Electrical installation for autonomous operation of thermoMETER TIM 8

- Autonomous operation also works via the industrial PIF of the thermoMETER TIM 8. The device is powered by the power supply of the PIF.
- Up to 9 measure areas can be output autonomously (firmware 3013 or higher required). The use of three stackable PIFs is required. Three analog outputs are possible per stackable PIF.
  Note: The first three measurement areas 1 - 3 have a response time of 20 ms, the measurement areas 4 - 6 a response time of 40 ms and the measurement areas 7 - 9 a response time of 60 ms.
- Autonomous mode cannot be set using the `Main measure area` function. To output a measure area autonomously, the function `Measure area` must be used.

Hot-/Coldspot Function in Autonomous Operation

The setting for a hot- or coldspot in autonomous mode differs from the general procedure. It is not enough to mark a measuring area as hot- or coldspot. Instead, a `User defined rectangle` must be selected under the tab `measure areas` of the configuration dialog. In addition, under `Mode`, you must set whether the `maximum` (for hotspot) or `minimum` (for coldspot) should be output.

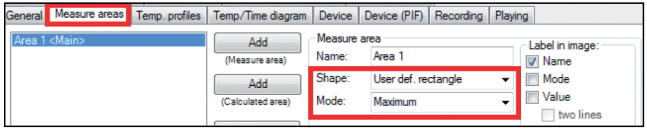


Fig. 25 Setting a hotspot for autonomous operation

For a hot- or coldspot output in the full field of view of the camera, the user defined rectangle must also fill out this size.

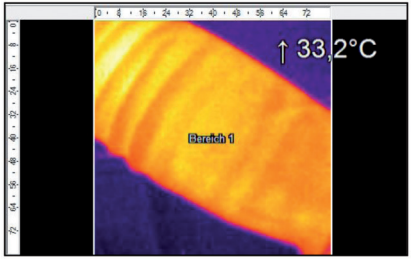


Fig. 26 Measure area over entire field of view

9.4 Ethernet thermoMETER TIM 8

The thermoMETER TIM 8 has a direct Ethernet interface. The advantage is cable lengths of up to 100 m. For example, a switch can be used to extend the distances.
The associated Ethernet cable (Order No.: TM-ETCx-TIM8) must be ordered separately. Ethernet is supported from software version Rel. 3.2.3020.0 and firmware 3008.

Using the Ethernet connection, the device must be supplied with power. This can be done either via the internal PIF cable via the terminal block (12 - 30 V), via the stackable PIF (12 - 28 V, Order No.: TM-PIFCx-TIM8) or via PoE (Power over Ethernet). For the PoE variant, a PoE adapter (Order No.: TM-ETPOEC1-TIM8) and a PoE injector (Order No.: TM-POE-TIM) or PoE switch (e.g. Netgear GS110TP) are also required.

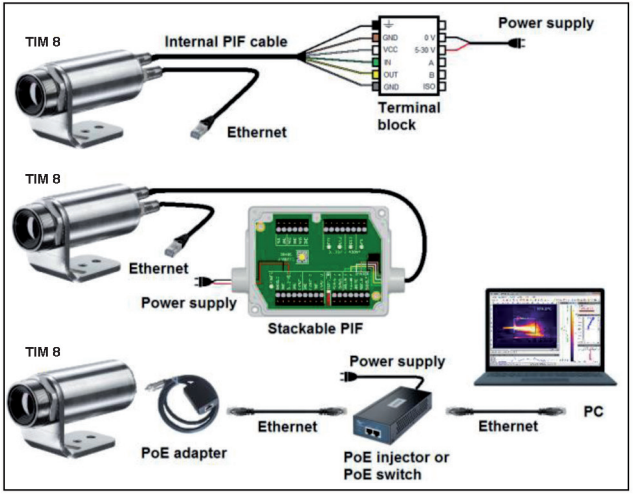
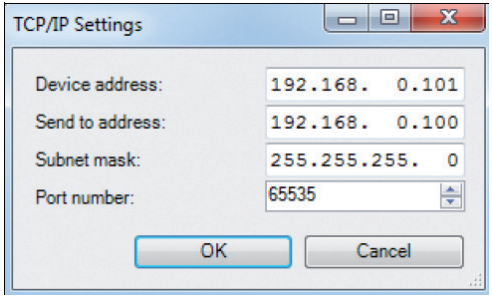


Fig. 27 Possibilities of power supply for thermoMETER TIM 8 via Ethernet connection

Ethernet Setup Software and PC (Point-to-Point-Connection)

➡ To make the appropriate address settings go to `Tools`, `Extended` and `TCP/IP Settings`.

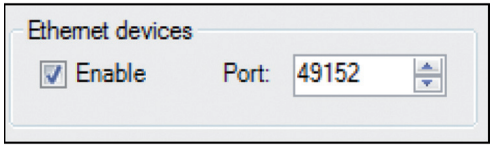
This setup is done via the camera's USB connection.



The address for the device is assigned under `Device address`. This must have a different address (last block) to the other participant (e.g., PC) (`Send to address`). It is important that the network part (first three blocks) must be identical for both addresses. The address range of the individual blocks can be between 0 and 255.

When using more than one Xi 80 in the same network a separate port number must be additionally configured (Firmware 3015 and software version Rel. 3.5.3032.0 or higher necessary). The selected number can be between 1 and 65535.

Furthermore, the Ethernet function has to be activated. This is done under `Tools`, `Extended` and `Options`.

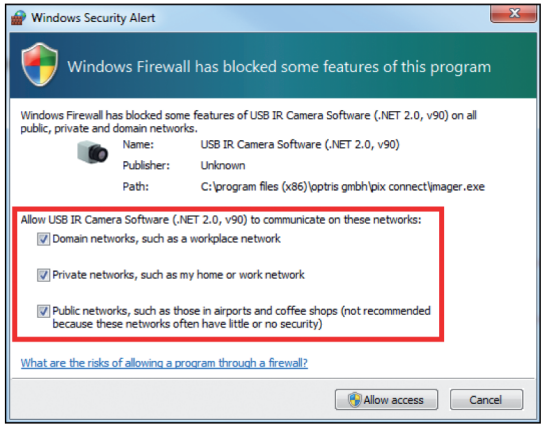


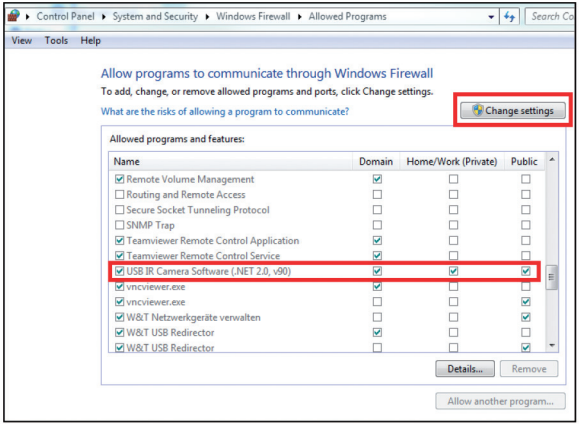
i When using more than one TIM 8 in the same network a separate `Port` has to be configured. This number has to be identical with the port number in TCP/IP Settings.

The port range used should be between `49152 ... 65535`. When using other ports it could be that they are already reserved or assigned.

After pressing `OK`, a Windows Firewall window appears.

Make sure to select allow all three networks parts (domain, private, public) to allow the communication with the device:

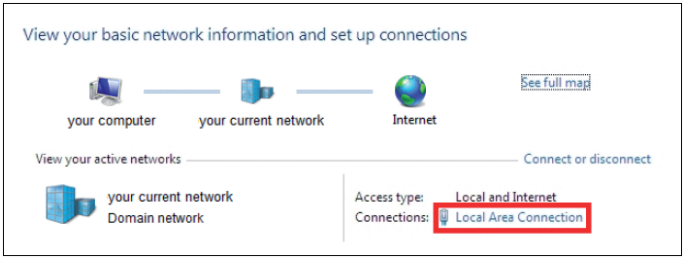


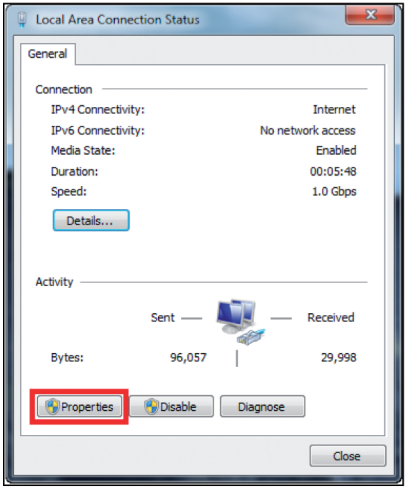


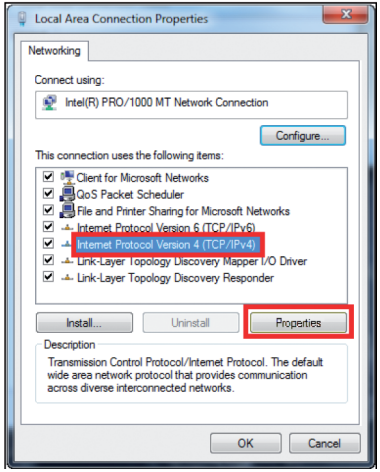
The approval of programs can also be activated afterwards in the Windows Firewall settings of the PC (under `Windows Firewall` and `Allow a program or feature through Windows Firewall`).

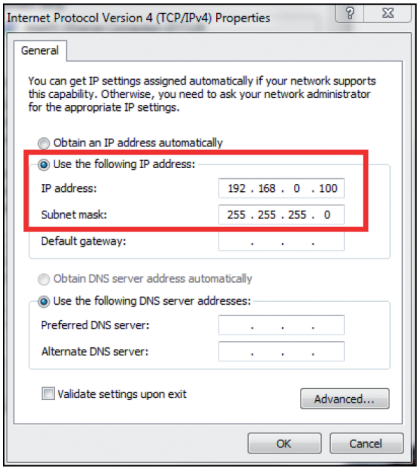
Then you can close the software and disconnect the USB connection to the computer.

- Replace the USB cable with a Ethernet cable.
- Now you have to set up the network address of the PC. To do this, go to `Control Panel` and open the `Network and Sharing Center`.
- Go on `LAN connection`.









➡ Click on `Properties`.

➡ Mark `Internet protocol Version 4 (TCP/IPv4)` and go to `Properties` again

➡ In the register card `General` enable the checkbox `Use the following IP address`.

➡ Now enter a user defined IP address for your PC (e.g. 192.168.0.100).

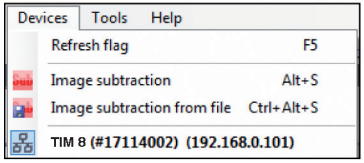
This must be identical to the address set in the TIM Connect software.

➡ Then close the windows with `OK`.

The Ethernet setup is finished.

➡ Start again the TIM Connect software.

The existing Ethernet connection can be found in the menu under `Devices` and is identified by a network symbol and the network address of the device.

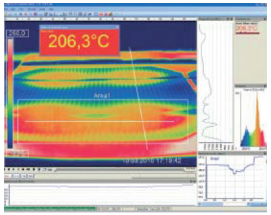
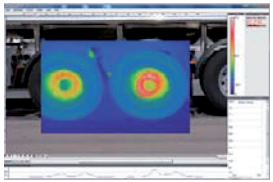


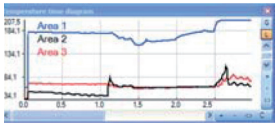
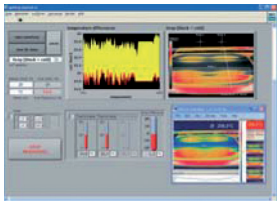
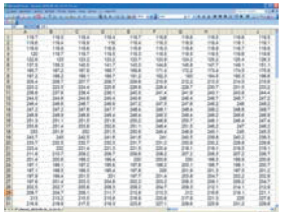
The device is now running via the Ethernet connection.

When using multiple TIM 8 cameras in a network, consider to the data rate:
- Switch with 100 Mbps: approx. 17 devices
- Switch with 1000 Mbps: approx. 170 devices

In addition to the data rate also make sure the power performance of the PC is high enough! Each device used requires its own instance.

9.5 Basic Features of Software TIM Connect

Extensive infrared camera software	
LabVIEW Windows xp Windows Vista Windows 7	- No restrictions in licensing - Modern software with intuitive user interface - Remote control of camera via software - Display of multiple camera images in different windows - Compatible with Windows XP, Vista, 7, 8, 10 sowie LabVIEW
High level of individualization for customer specific display	
	- Various language option including a translation tool - Temperature display in °C or °F - Different layout options for an individual setup (arrangement of windows, toolbar) - Range of individual measurement parameter fitting for each application - Adaption of thermal image (mirror, rotate) - Individual start options (full screen, hidden, etc.)
Video recording and snapshot function (IR or BI-SPECTRAL)	
	- Recording of video sequences and detailed frames for further analysis or documentation - Adjustment of recording frequency to reduce data volume - Display of snapshot history for immediate analysis

Extensive online and offline data analysis	
	- Analysis supported by measurement fields, hot and cold spot searching, image subtraction - Real time temperature information within main window as digital or graphic display (line profile, temperature time diagram) - Slow motion repeat of radiometric files and analysis without camera being connected - Editing of sequences such as cutting and saving of individual images - Various color palettes to highlight thermal contrasts
Automatic process control	
	- Individual setup of alarm levels depending on the process - Definition of visual or acoustic alarms and analog data output - Analog and digital signal input (process parameter) - External communication of software via Comports, DLL and LabVIEW - Adjustment of thermal image via reference values
Temperature data analysis and documentation	
	- Triggered data collection - Radiometric video sequences (*.ravi) radiometric snapshots (*.jpg,*.tiff) - Text files including temp. information for analysis in Excel (*.csv, *.dat) - Data with color information for standard programmes such as Photoshop or Windows Media Player (*.avi, *.jpg, *.tiff) - Data transfer in real time to other software programmes via LabVIEW, DLL or Comport interfaces

10. Basics of Infrared Thermometry

10.1 Introduction

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

Searching for new optical material William Herschel by chance found the infrared radiation in 1800.

He blackened the peak of a sensitive mercury thermometer. This thermometer, a glass prism that led sun rays onto a table made his measuring arrangement.

With this, he tested the heating of different colors of the spectrum. Slowly moving the peak of the blackened thermometer through the colors of the spectrum, he noticed the increasing temperature from violet to red.

The temperature rose even more in the area behind the red end of the spectrum. Finally he found the maximum temperature far behind the red area.

Nowadays this area is called infrared wavelength area.

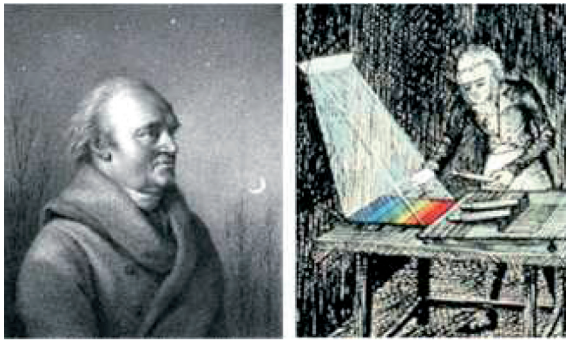


Fig. 28 William Herschel (1738 – 1822)

For the measurement of “thermal radiation” infrared thermometry uses a wave-length ranging between 1 μ and 20 μm.

The intensity of the emitted radiation depends on the material. This material contingent constant is described with the help of the emissivity which is a known value for most materials, see 11.

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

Infrared thermometers basically consist of the following components:

- Lens
- Spectral filter
- Detector (sensor)
- Electronics (amplifier/ linearization/ signal processing)

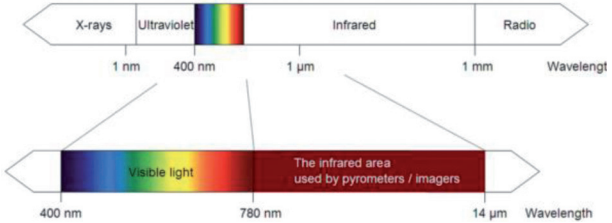
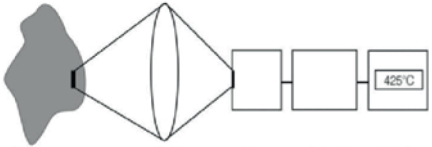


Fig. 29 The electromagnetic spectrum and the area used for temperature measurement

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



Object Lens Sensor Electronics Display
Infrared system

Fig. 30 Optical path

The advantages of non-contact temperature measurement are clear - it supports:

- temperature measurements of moving or overheated
- objects and of objects in hazardous surroundings
- very fast response and exposure times
- measurement without inter-reaction, no influence on the
- measuring object
- non-destructive measurement
- long lasting measurement, no mechanical wear

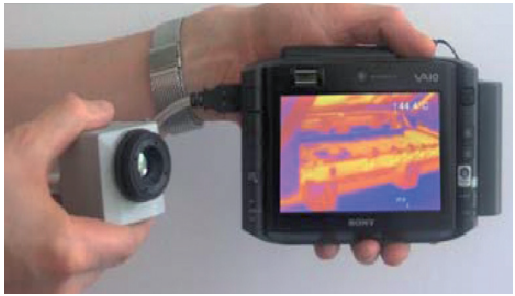
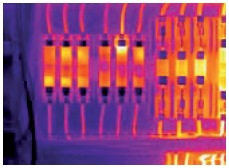
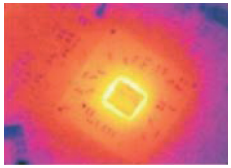


Fig. 31 TIM with tablet PC

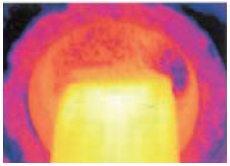
10.2 Application Examples



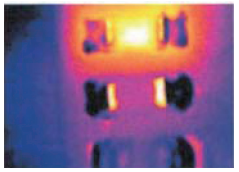
Monitoring of electronic cabinets



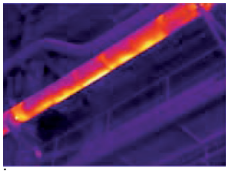
Electronic development



Process control extruding plastic parts

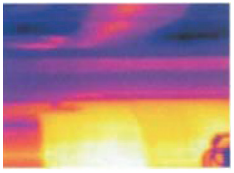


Development of electronic components

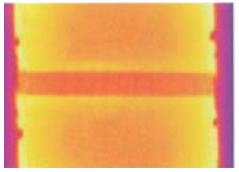


Monitoring of cables

Development of mechanical parts



Process control at calendering



Process control in solar cell production

11. Emissivity

11.1 Definition

The intensity of infrared radiation, which is emitted by each body, depends on the temperature as well as on the radiation features of the surface material of the measuring object. The emissivity (ε – Epsilon) is used as a material constant factor to describe the ability of the body to emit infrared energy. It can range between 0 and 100 %. A “blackbody” is the ideal radiation source with an emissivity of 1.0 whereas a mirror shows an emissivity of 0.1.

If the emissivity chosen is too high, the infrared thermometer may display a temperature value which is much lower than the real temperature – assuming the measuring object is warmer than its surroundings. A low emissivity (reflective surfaces) carries the risk of inaccurate measuring results by interfering infrared radiation emitted by background objects (flames, heating systems, chamottes). To minimize measuring errors in such cases, the handling should be performed very carefully and the unit should be protected against reflecting radiation sources.

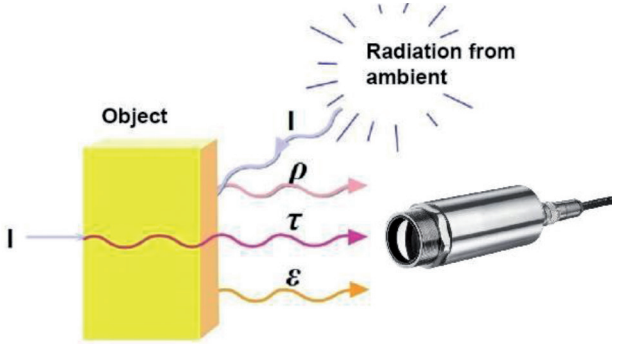


Fig. 32 Composition of IR radiation

I	IR radiation	ρ	Reflection
ε	Emission	τ	Transmission

$$\varepsilon + \rho + \tau = 1$$

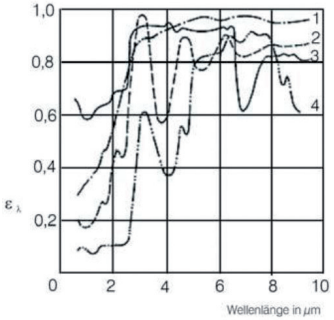


Fig. 33 Spectral emissivity of several materials

1	Enamel	3	Concrete
2	Plaster	4	Chamotte

11.2 Determination of Unknown Emissivity

There are 3 methods:

1. First of all, determine the current temperature of the measuring object with a thermocouple or contact sensor. The second step is to measure the temperature with the infrared thermometer and modify the emissivity until the displayed measuring value corresponds to the current temperature.
2. If you monitor temperatures of up to 380 °C you may place a special plastic sticker (Part number: TM-ED-LS emissivity dots) onto the measuring object, which covers it completely.

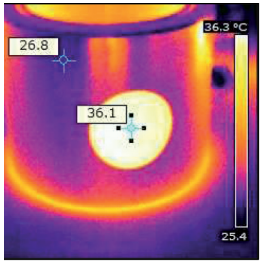


Fig. 34 Plastic sticker at metal surface

- Now set the emissivity to 0.95 and take the temperature of the sticker.
- Afterwards, determine the temperature of the adjacent area on the measuring object and adjust the emissivity according to the value of the temperature of the sticker.

3

- Cover a part of the surface of the measuring object with a black, flat paint with an emissivity of 0.98.
- Adjust the emissivity of your infrared thermometer to 0.98 and take the temperature of the colored surface.

Fig. 35 Shiny metal surface

Fig. 36 Blackened metal surface

- Afterwards, determine the temperature of a directly adjacent area and modify the emissivity until the measured value corresponds to the temperature of the colored surface.

i On all three methods the object temperature must be different from ambient temperature.

11.3 Characteristic Emissivity

In the case that none of the methods mentioned above help to determine the emissivity you may use the emissivity tables, see A 3, see A 4. These are only average values. The actual emissivity of a material depends on the following factors:

- Temperature
- Measuring angle
- Geometry of the surface (smooth, convex, concave)
- Thickness of the material
- Constitution of the surface (polished, oxidized, rough, sandblast)
- Spectral range of the measurement
- Transmissivity (e.g. with thin films)

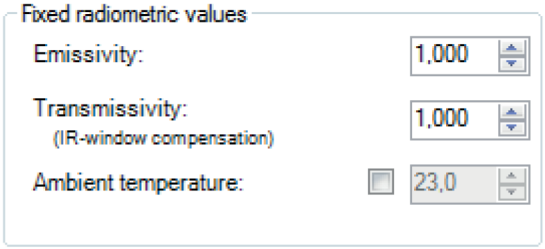


Fig. 37 Adjustment of the emissivity in the software TIM Connect under the menu item Tools / Configuration / Device

12. Liability for Material Defects

All components of the device have been checked and tested for functionality at the factory. However, if defects occur despite our careful quality control, MICRO-EPSILON or your dealer must be notified immediately.

The liability for material defects is 12 months from delivery. Within this period, defective parts, except for wearing parts, will be repaired or replaced free of charge, if the device is returned to MICRO-EPSILON with shipping costs prepaid. Any damage that is caused by improper handling, the use of force or by repairs or modifications by third parties is not covered by the liability for material defects. Repairs are carried out exclusively by MICRO-EPSILON.

Further claims can not be made. Claims arising from the purchase contract remain unaffected. In particular, MICRO-EPSILON shall not be liable for any consequential, special, indirect or incidental damage. In the interest of further development, MICRO-EPSILON reserves the right to make design changes without notification.

For translations into other languages, the German version shall prevail.

13. Service, Repair

If the camera is defective, please send us the affected parts for repair or exchange.

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

MICRO-EPSILON MESSTECHNIK
GmbH & Co. KG
Königbacher Str. 15
94496 Ortenburg / Germany
Tel. +49 (0) 8542 / 168-0
Fax +49 (0) 8542 / 168-90
info@micro-epsilon.de
www.micro-epsilon.com

For customers in USA applies:

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

MICRO-EPSILON USA
8120 Brownleigh Dr.
Raleigh, NC 27617 /USA
Tel. +1 919 / 787-9707
Fax +1 919 / 787-9706
me-usa@micro-epsilon.com
www.micro-epsilon.com

For customers in Canada or South America applies:

Please contact your local distributor.

14. Decommissioning, Disposal

➡ Remove all cables from the thermoIMAGER TIM camera.

Incorrect disposal may cause harm to the environment.

➡ Dispose of the device, 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.

Appendix

A 1 Accessories

A 1.1 Air Purge Laminar

The lens must be kept clean at all times from dust, smoke, fumes and other contaminants in order to avoid reading errors. These effects can be reduced by using an air purge TM-APL.

i Make sure to use oil-free, technically clean air, only.
The needed amount of air (approx. 2 ... 10 l/min.) depends on the application and the installation conditions on-site.
The laminar air purge has a Si-protective window. Typical transmission value: 0.82 (deviations possible)
The corresponding mounting bracket TM-APLAB-TIM 8/40 is mandatory.

Air flow

The air purge can be mounted in four different positions.

i The direction of the airflow must always be clear.

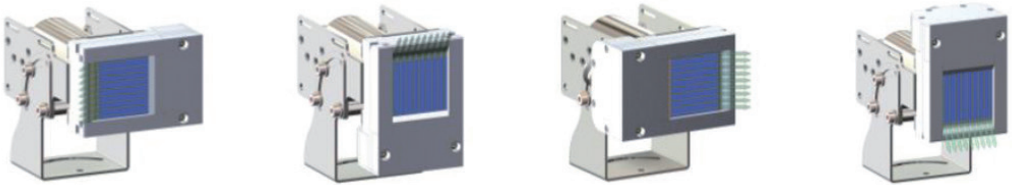


Fig. 38 Directions of airflow at different mounting positions

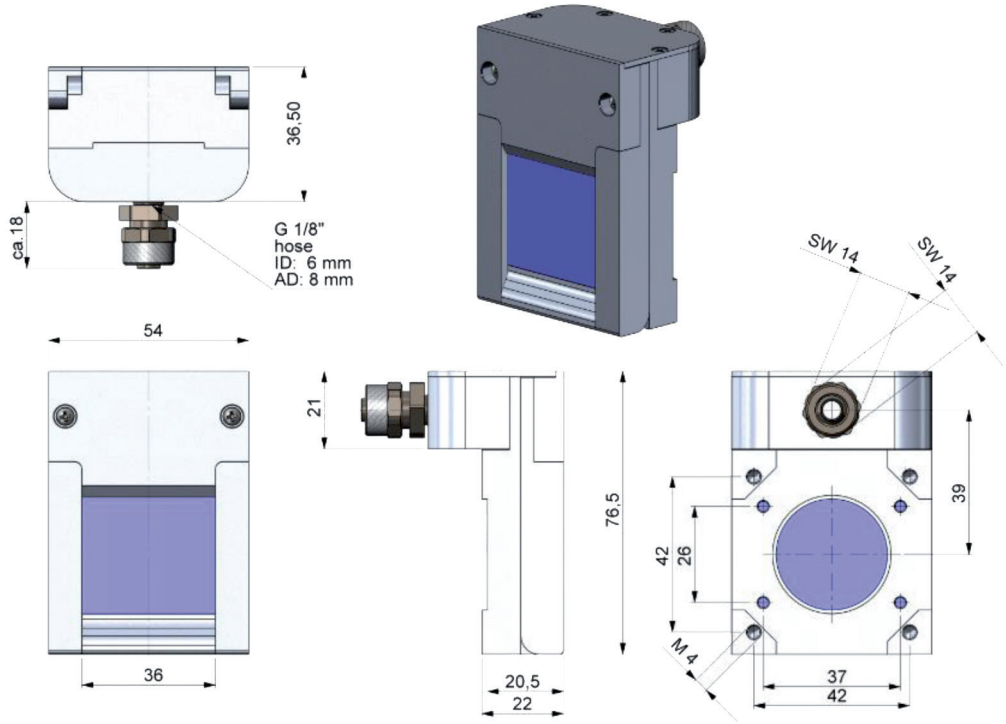


Fig. 39 Laminar air purge with SI protective window TM-APL-TIM8/40, dimensions in mm, not to scale

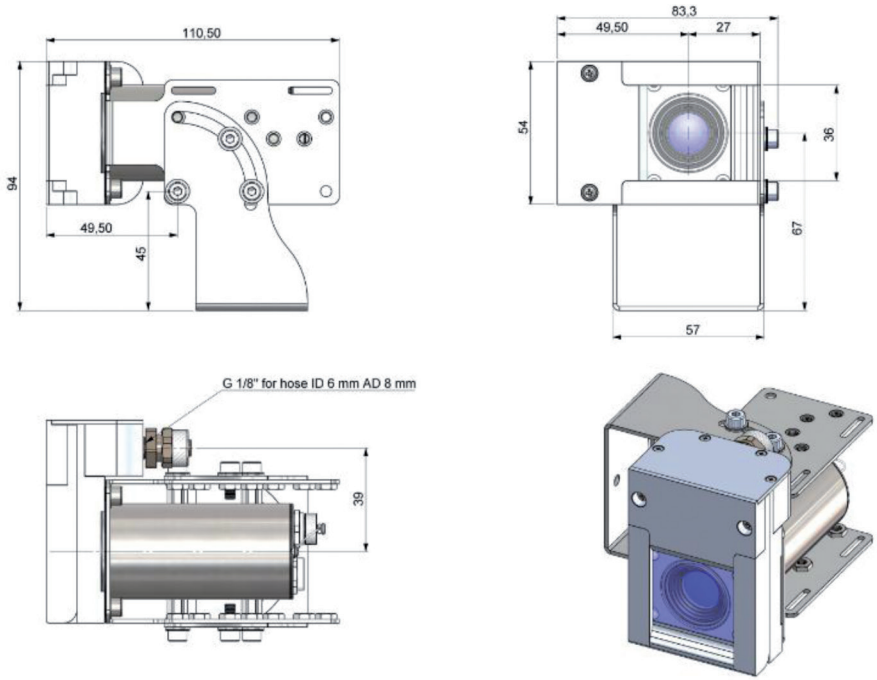


Fig. 40 Laminar air purge with SI protective window TM-APL and mounting bracket TM-APLAB, dimensions in mm (inches), not to scale

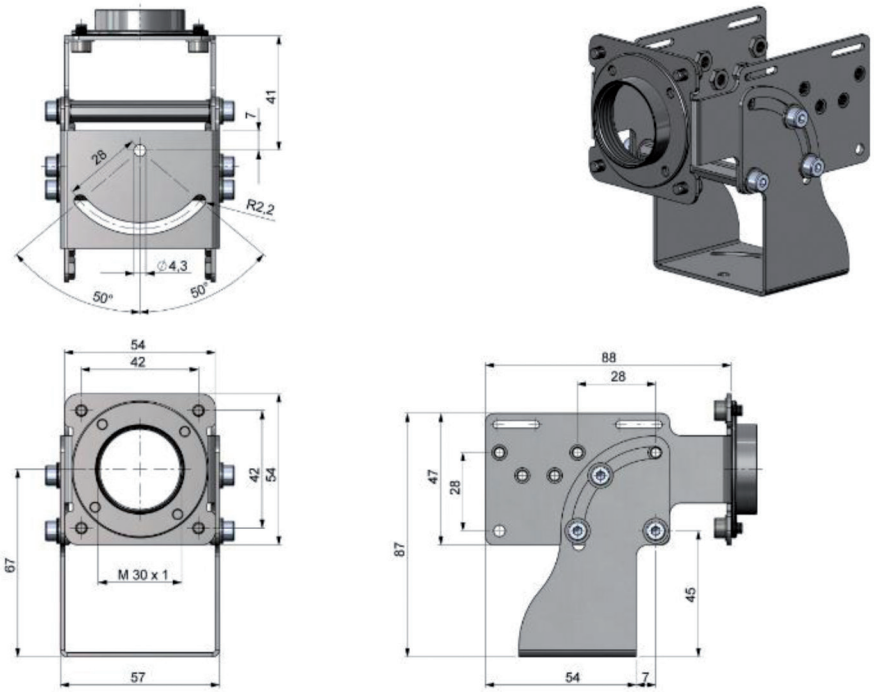
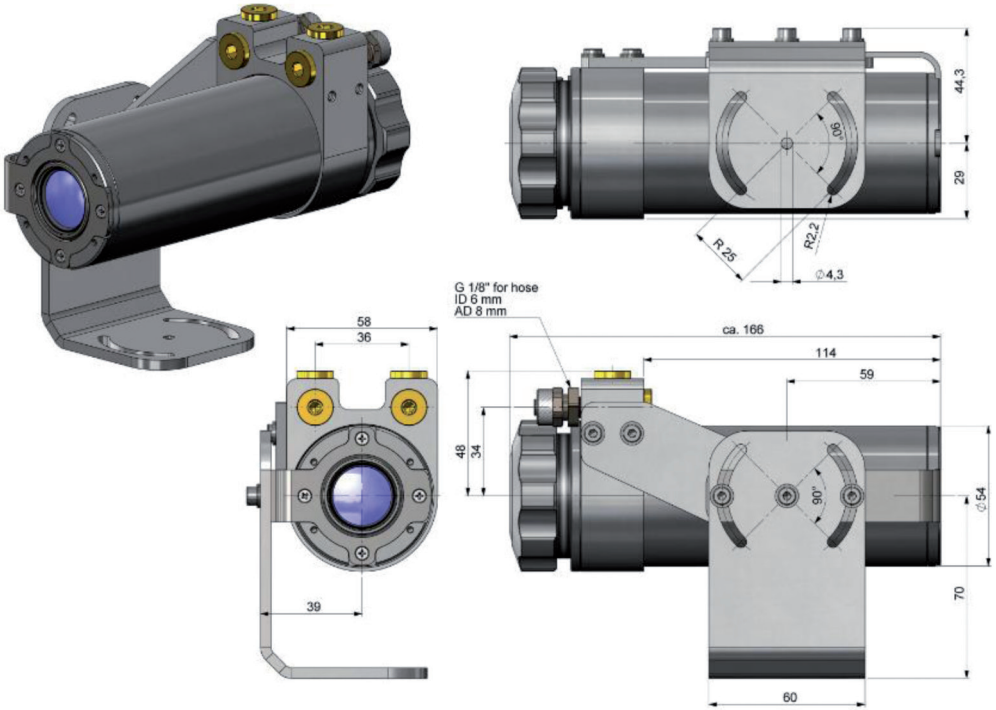


Fig. 41 Mounting bracket TM-APLAB, dimensions in mm (inches), not to scale

A 1.2 Water Cooling

The IR camera is for application at ambient temperatures up to 50 °C. For applications at higher ambient temperatures we recommend the usage of the optional water cooled housing (operating temperature up to 250 °C) and the optional high temperature cable (operating temperature up to 250 °C).

i Then using water cooling, a corresponding mounting kit (TM-WAKx-TIMxx) is required.
Water flow rate: approx. 2 l/ min (cooling water temperature should not exceed 30 °C)



Dimensions in mm (inches), not to scale

Fig. 42 Water cooling TM-W-TIM8/4 and mounting kit TM-WAK1-TIMxx

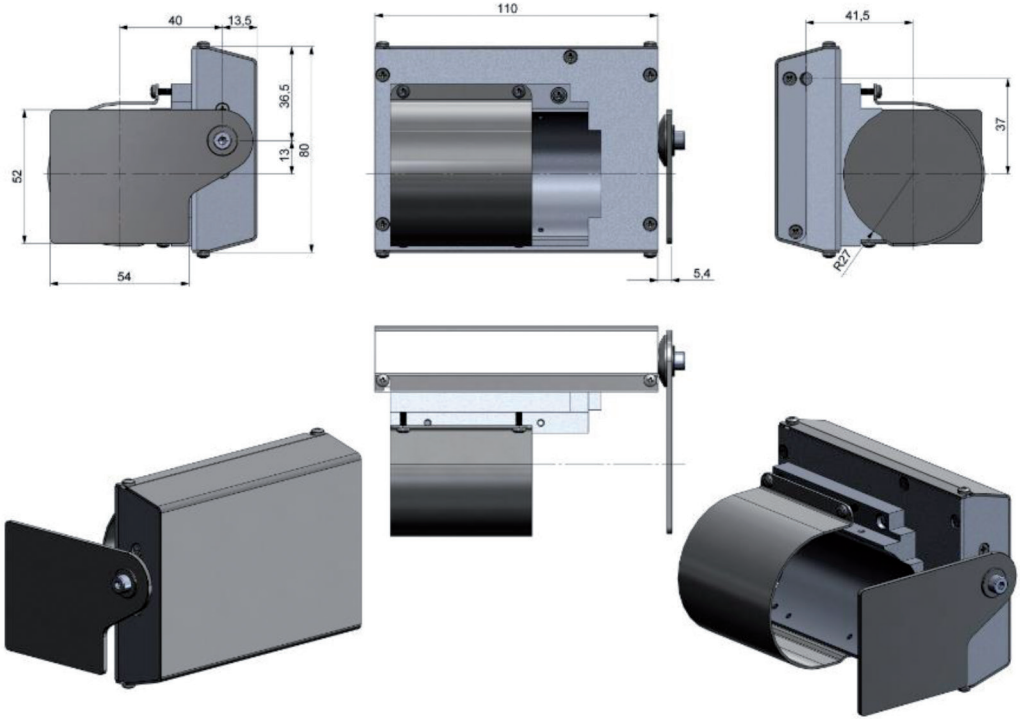


Fig. 43 Shutter for water cooling TM-SW-TIM8/40, dimensions in mm (inches), not to scale

A 1.3 Shutter

The shutter protects the optics of the camera. It is equipped with a servomotor that can open and close a mechanical lock as needed.

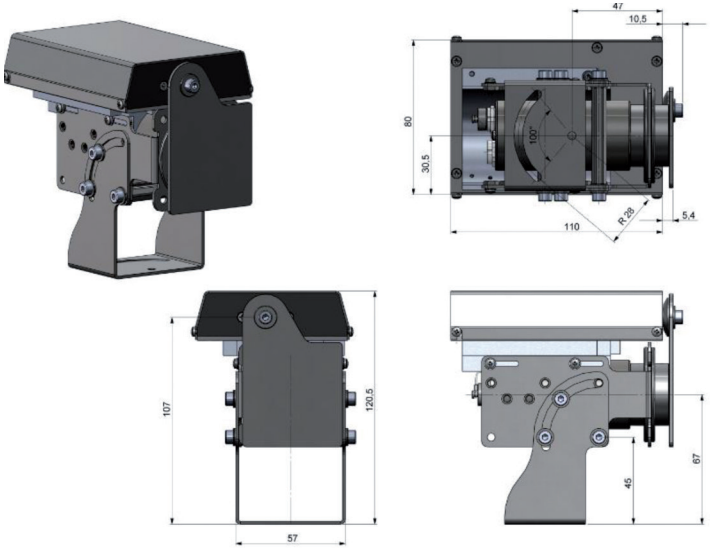


Fig. 44 Shutter TM-S-TIM8/40 with mounting bracket TM-SAB-TIM8/40, dimensions in mm, not to scale

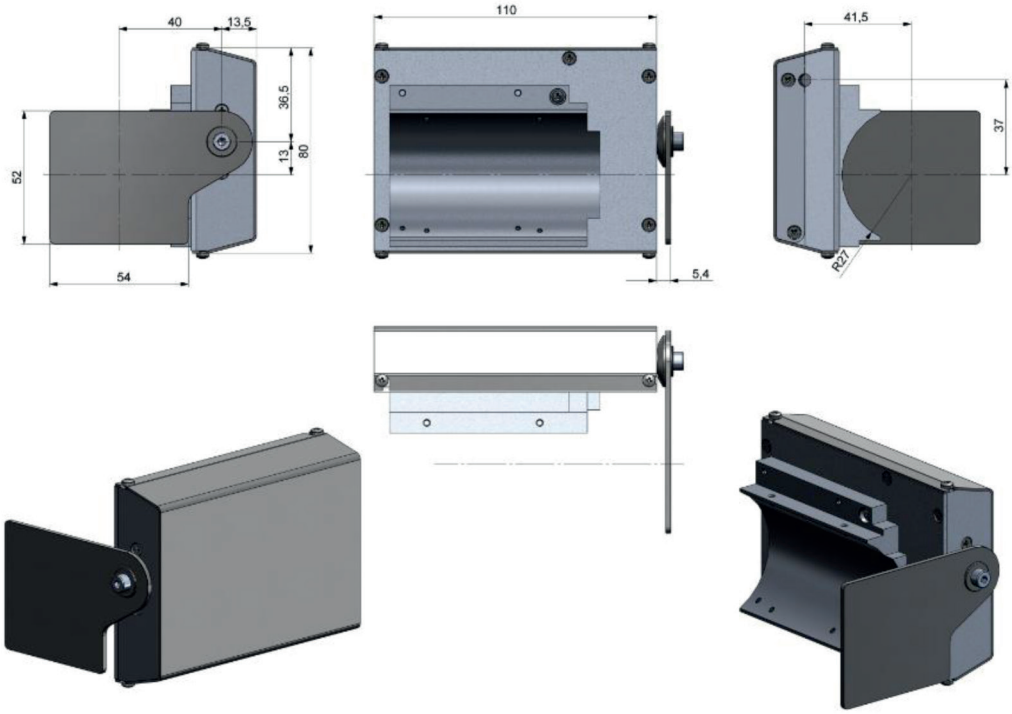


Fig. 45 Shutter TM-S-TIM8/40, dimensions in mm (inches), not to scale

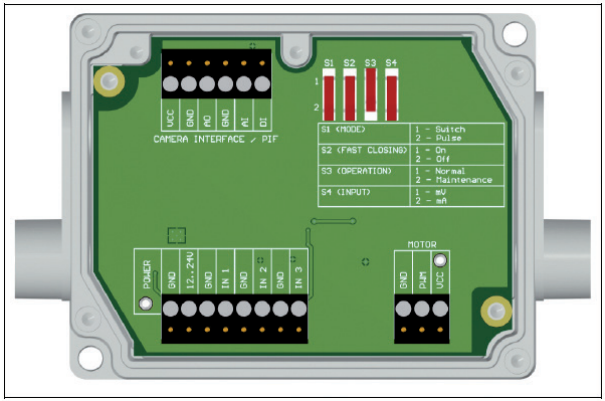


Fig. 46 Control box of shutter, dimensions, see Fig. 7

Power supply	12 - 24 V
Upper terminal screw	Connection for Process Interface (PIF)
Switch for different operation modes:	S1: Switching between switch operation and pulse operation
	S2: Activation/deactivation of fast-closing mode
	S3: Only for factory calibration (switch must be at normal)
	S4: Switching between mV or mA input
Lower screw terminal	Connection for power supply, inputs (Start/Stop signal) and motor
Inputs (Start/Stop signal, max. 24 V, input is active LOW (open input = HIGH))	IN 1: Trigger input for normal operation (S1)
	IN 2: Currently no usage
	IN 3: Trigger input for fast-closing mode (S2)

A 1.4 Combination of Air Purge, Water Cooling and Shutter

It is possible to combine all three components (air purge, water cooling and shutter) with each other. It should be noted that there are differences between the TIM 8 and TIM 40. Various mounting kits TM-WAKx-TIMxx are available in combination with water cooling. The mounting bracket is always required for the air purge TM-APLAB. For water cooling TM-W-TIM8/4, the mounting bracket is included and does not have to be ordered separately.

Article number / Combinations	TM-APL-TIM8/40	TM-APLAB-TIM8/40	TM-SAB-TIM8/40	TM-S-TIM8/40	TM-SW-TIM8/40	TM-W-TIM8/40	TM-WAK1-TIM8	TM-WAK2-TIM8	TM-WAK1-TIM40	TM-WAK2-TIM40
Air purge	√	√								
Water cooling TIM 8						√	√			
Water cooling TIM 40						√			√	
Shutter			√	√						
Air purge and water ccoling TIM 8	√					√		√		
Air purge and water ccoling TIM 40	√					√				√
Air purge and shutter	√	√		√						
Water cooling and shutter TIM 8					√	√	√			
Water cooling and shutter TIM 40					√	√			√	
Air purge, water cooling and shutter TIM 8	√				√	√		√		
Air purge, water cooling and shutter TIM 40	√				√	√				√

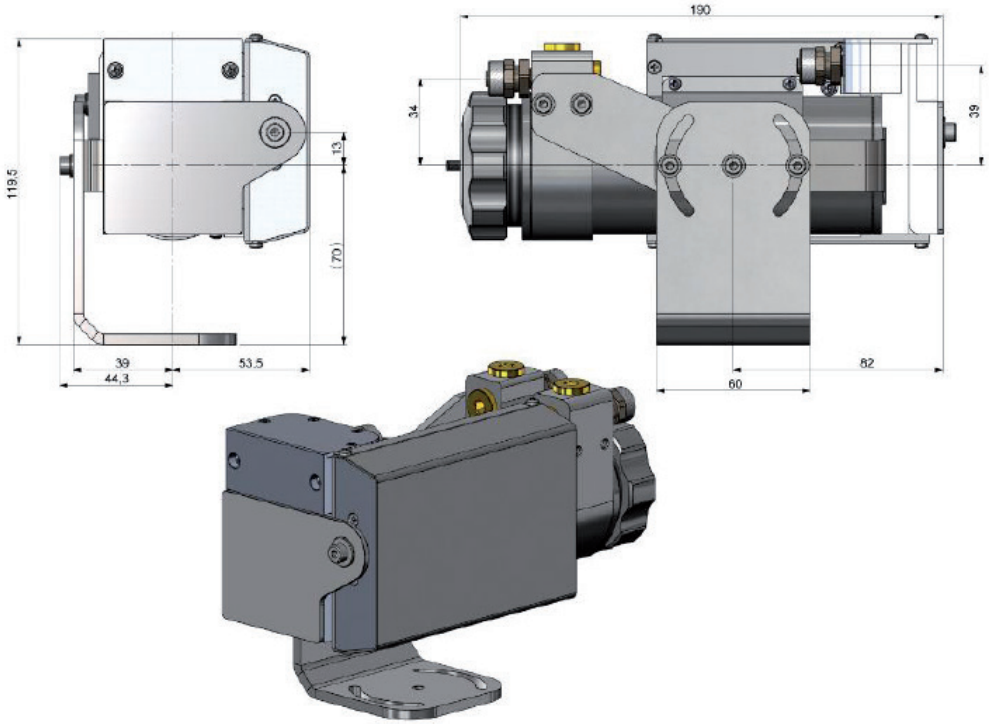


Fig. 47 Air purge TM-APL, water cooling TM-W-TIM8/40, shutter TM-SW-TIM8/40 and appropriate mounting kit TIM-WAKx-TIMxx, dimensions in mm (not to scale)

Components

- Air purge
- Water cooling
- Shutter
- Mounting kit

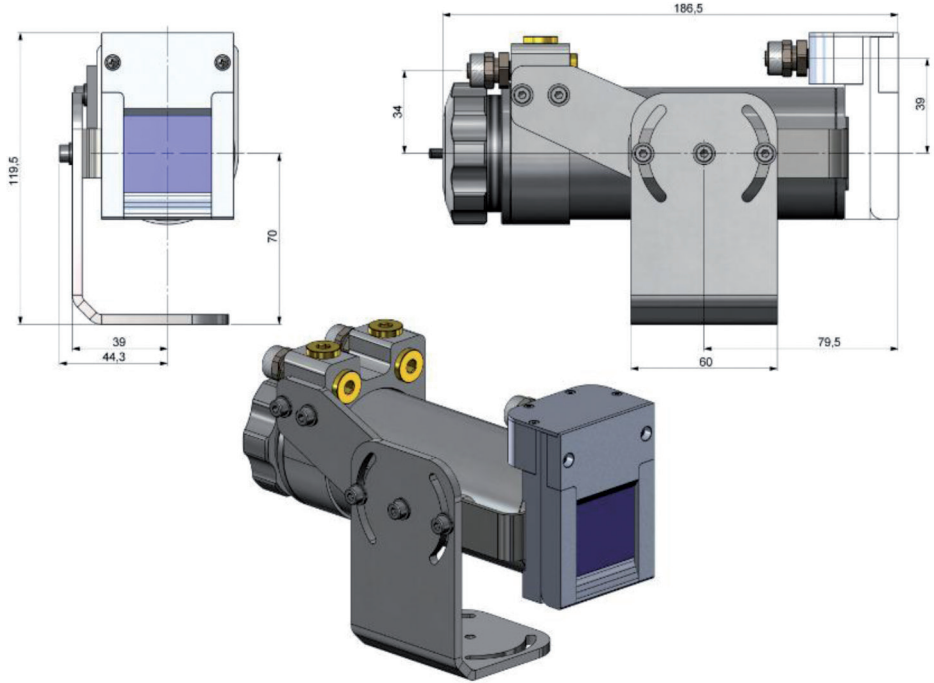


Fig. 48 Air purge TM-APL, water cooling TM-W-TIM8/40 and appropriate mounting kit TIM-WAKx-TIMxx, dimensions in mm (inches), not to scale

Components

- Air purge
- Water cooling
- Mounting kit

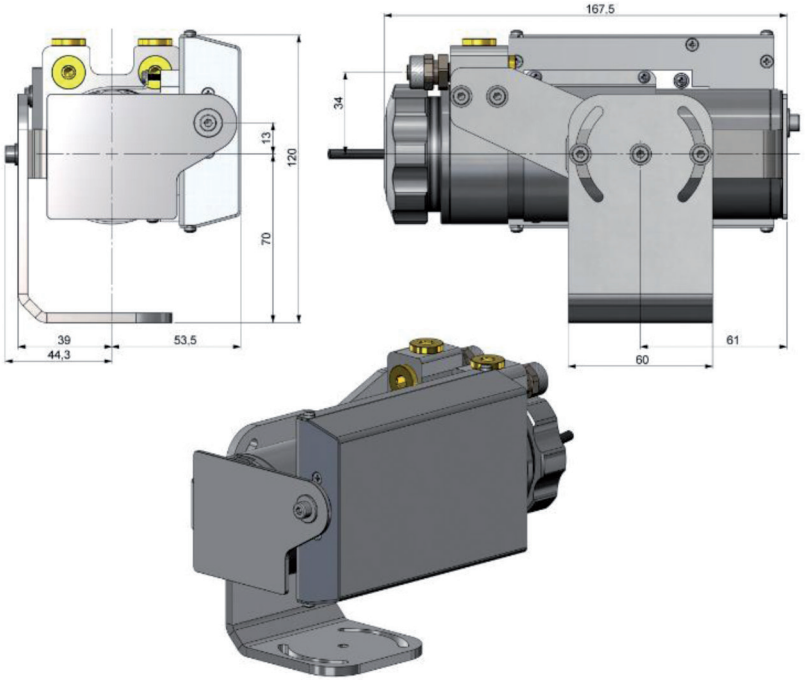


Fig. 49 Water cooling TM-W-TIM8/40L, shutter TM-SW-TIM8/40 and appropriate mounting kit TIM-WAKx-TIMxx, dimensions in mm (inches), not to scale

Components

- Water cooling
- Shutter
- Mounting kit

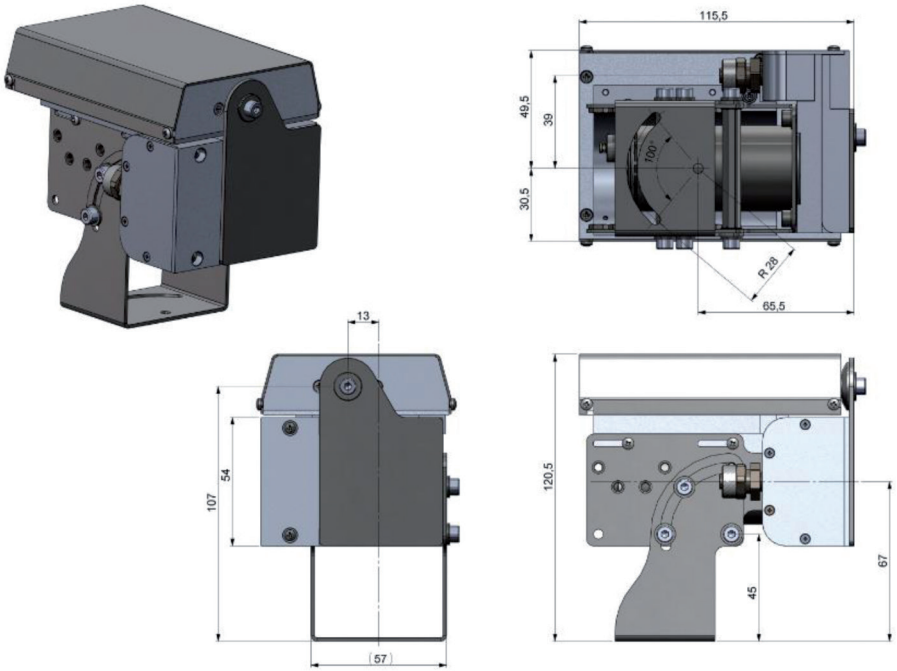


Fig. 50 Air purge TM-APL with mounting bracket TM-APL and shutter TM-S-TIM8/40, dimensions in mm (inches), not to scale

Components

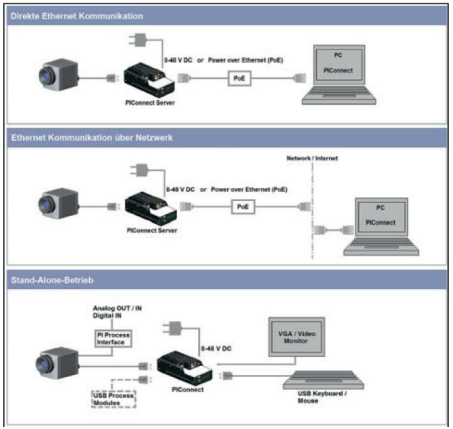
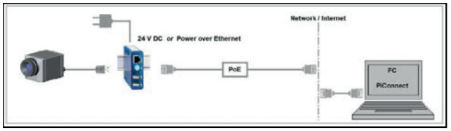
- Air purge
- Mounting bracket
- Shutter

A 1.5 Outdoor Protective Housing

The infrared camera TIM can also be used for outdoor applications by using the outdoor protective housing TM-OPH24-TIM8/40.
In addition, the industrial or stackable PIF TM-CJAPIF-TIM (thermoIMAGER TIM 40) or TM-PIFCx-TIM8 (thermoMETER TIM 8) can be installed as an accessory without housing and a USB Server TM-USB-SGB-TIM.

Fig. 51 Outdoor protective housing for TIM camera

A 1.6 Hardware and Software

TM-NETBox-TIM		Miniature PC for standalone installation of TIM systems
TM-USBSII-TIM		USB server for cable extension via Ethernet

A 2 Factory Settings

The devices have following presettings at time of delivery:

Temperature range	-20 ... 100 °C
Emissivity	1.000
Process interface (PIF)	inactive
Interprocess Communication (IPC)	inactive
Measurement function	Rectangle measure area

A 3 Emissivity Table Metals

Material		Typical Emissivity			
Spectral response		**1.0 µm**	**1.6 µm**	**5.1 µm**	**8 - 14 µm**
Aluminum	Non oxidized	0.1 - 0.2	0.02 - 0.2	0.02 - 0.2	0.02 - 0.1
	Polished	0.1 - 0.2	0.02 - 0.1	0.02 - 0.1	0.02 - 0.1
	Roughened	0.2 - 0.8	0.2 - 0.6	0.1 - 0.4	0.1 - 0.3
	Oxidized	0.4	0.4	0.2 - 0.4	0.2 - 0.4
Brass	Polished	0.35	0.01 - 0.05	0.01 - 0.05	0.01 - 0.05
	Roughened	0.65	0.4	0.3	0.3
	Oxidized	0.6	0.6	0.5	0.5
Copper	Polished	0.05	0.03	0.03	0.03
	Roughened	0.05 - 0.2	0.05 - 0.2	0.05 - 0.15	0.05 - 0.1
	Oxidized	0.2 - 0.8	0.2 - 0.9	0.5 - 0.8	0.4 - 0.8
Chrome		0.4	0.4	0.03 - 0.3	0.02 - 0.2
Gold		0.3	0.01 - 0.1	0.01 - 0.1	0.01 - 0.1
Haynes	Alloy	0.5 - 0.9	0.6 - 0.9	0.3 - 0.8	0.3 - 0.8
Inconel	Electro polished	0.2 - 0.5	0.25	0.15	0.15
	Sandblast	0.3 - 0.4	0.3 - 0.6	0.3 - 0.6	0.3 - 0.6
	Oxidized	0.4 - 0.9	0.6 - 0.9	0.6 - 0.9	0.7 - 0.95

Material		**Typical Emissivity**			
Spectral response		**1.0 µm**	**1.6 µm**	**5.1 µm**	**8 - 14 µm**
Iron	Non oxidized	0.35	0.1 - 0.3	0.05 - 0.25	0.05 - 0.2
	Rusted		0.6 - 0.9	0.5 - 0.8	0.5 - 0.7
	Oxidized	0.7 - 0.9	0.5 - 0.9	0.6 - 0.9	0.5 - 0.9
	Forget, blunt	0.9	0.9	0.9	0.9
	Molten	0.35	0.4 - 0.6		
Iron, casted	Non oxidized	0.35	0.3	0.25	0.2
	Oxidized	0.9	0.7 - 0.9	0.65 - 0.95	0.6 - 0.95
Lead	Polished	0.35	0.05 - 0.2	0.05 - 0.2	0.05 - 0.1
	Roughened	0.65	0.6	0.4	0.4
	Oxidized		0.3 - 0.7	0.2 - 0.7	0.2 - 0.6
Magnesium		0.3 - 0.8	0.05 - 0.3	0.03 - 0.15	0.02 - 0.1
Mercury			0.05 - 0.15	0.05 - 0.15	0.05 - 0.15
Molybdenum	Non oxidized	0.25 - 0.35	0.1 - 0.3	0.1 - 0.15	0.1
	Oxidized	0.5 - 0.9	0.4 - 0.9	0.3 - 0.7	0.2 - 0.6
Monel (Ni-CU)		0.3	0.2 - 0.6	0.1 - 0.5	0.1 - 0.14
Nickel	Electrolytic	0.2 - 0.4	0.1 - 0.3	0.1 - 0.15	0.05 - 0.15
	Oxidized	0.8 - 0.9	0.4 - 0.7	0.3 - 0.6	0.2 - 0.5
Platinum	Black		0.95	0.9	0.9
Silver		0.04	0.02	0.02	0.02

Material		**Typical Emissivity**			
Spectral response		**1.0 µm**	**1.6 µm**	**5.1 µm**	**8 - 14 µm**
Steel	Polished plate	0.35	0.25	0.1	0.1
	Rustless	0.35	0.2 - 0.9	0.15 - 0.8	0.1 - 0.8
	Heavy plate			0.5 - 0.7	0.4 - 0.6
	Cold-rolled	0.8 - 0.9	0.8 - 0.9	0.8 - 0.9	0.7 - 0.9
	Oxidized	0.8 - 0.9	0.9 - 0.9	0.7 -0.9	0.7 - 0.9
Tin	Non oxidized	0.25	0.1 - 0.3	0.05	0.05
Titanium	Polished	0.5 - 0.75	0.3 - 0.5	0.1 - 0.3	0.05 - 0.2
	Oxidized		0.6 - 0.8	0.5 - 0.7	0.5 - 0.6
Wolfram	Polished	0.35 - 0.4	0.1 - 0.3	0.05 - 0.25	0.03 - 0.1
Zinc	Polished	0.5	0.05	0.03	0.02
	Oxidized	0.6	0.15	0.1	0.1

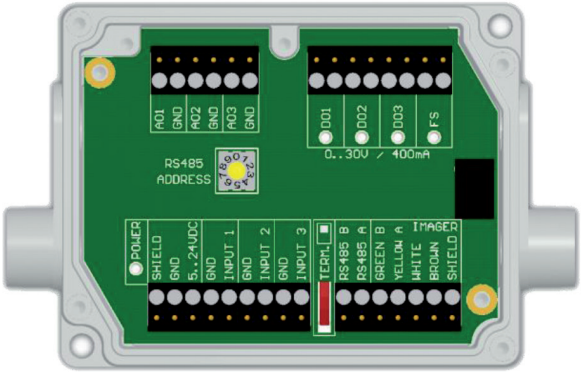
A 4 Emissivity Table Non Metals

Material		**Typical Emissivity**			
Spectral response		**1.0 µm**	**2.3 µm**	**5.1 µm**	**8 - 14 µm**
Asbest		0.9	0.8	0.9	0.95
Aphalt				0.95	0.95
Basalt				0.7	0.7
Carbon	Non oxidized		0.8 - 0.9	0.8 - 0.9	0.8 - 0.9
	Graphite		0.8 - 0.9	0.7 - 0.9	0.7 - 0.9
Carborundum		0.4	0.8 - 0.95	0.8 - 0.95	0.95
Cement		0.65	0.9	0.9	0.95
Ceramic		0.65	0.9	0.9	0.95
Glass	Plate		0.2	0.98	0.85
	Melt		0.4 - 0.9	0.9	
Grit				0.95	0.95
Gypsum				0.4 - 0.97	0.8 - 0.95
Ice					0.98
Limestone				0.4 - 0.98	0.98
Paint	Non alcaline				0.9 - 0.95
Paper	Any color			0.95	0.95
Plastic > 50 µm	Non transparent			0.95	0.95
Rubber				0.9	0.95

Material		**Typical Emissivity**			
Spectral response		**1.0 µm**	**2.3 µm**	**5.1 µm**	**8 - 14 µm**
Sand				0.9	0.95
Snow					0.9
Soil					0.9 - 0.98
Textiles				0.95	0.95
Water					0.93
Wood	Natural			0.9 - 0.95	0.9 - 0.95

A 5 Industrial Process Interface for thermoMETER TIM 8 (Optional)

For use in industrial environment the industrial process interface with 500 V AC RMS isolation voltage between thermoMETER TIM 8 and process is available (connection box with IP 65, 5 m, 10 m or 20 m standard or high temperature cable for camera connection, terminal for process integration), see A 12.



Color	Assignment
Green	RS485 B
Yellow	RS485 A
White	12 V
Brown	GND
Shield	GND

Fig. 52 Connections of the industrial Process Interfaces for thermoMETER TIM 8

The industrial process interface provides the following inputs and outputs:

Designation	**Description**	**max. range** [1] / **status**
INPUT 1/2/3	Analog- or digital input 1, 2, 3	0 - 10 V [2]
AO 1/2/3	Analog output 1, 2 and 3 Alarm output 1, 2 and 3	0 - 10 V 0/4 - 20 mA
DO 1/2/3	Relais output 1, 2 and 3 [3]	open/ closed (red LED on)/ 0 ... 30 V, 400 mA
FS	Fail-safe-relay	open/ closed (green LED on)/ 0 ... 30 V, 400 mA

The industrial PIF has a maximum of 3 analog outputs. To use more outputs, you can cascade up to three PIFs, allowing you to use up to 9 analog or alarm outputs in total.

1) Depending on supply voltage; for 0 - 10 V on the AO the PIF has to be powered with min. 12 V.
2) The AI is designed for max. 24 V, the voltage level above 10 V is not interpreted.
3) Active if AO1, 2 or 3 is/ are programmed as alarm output.

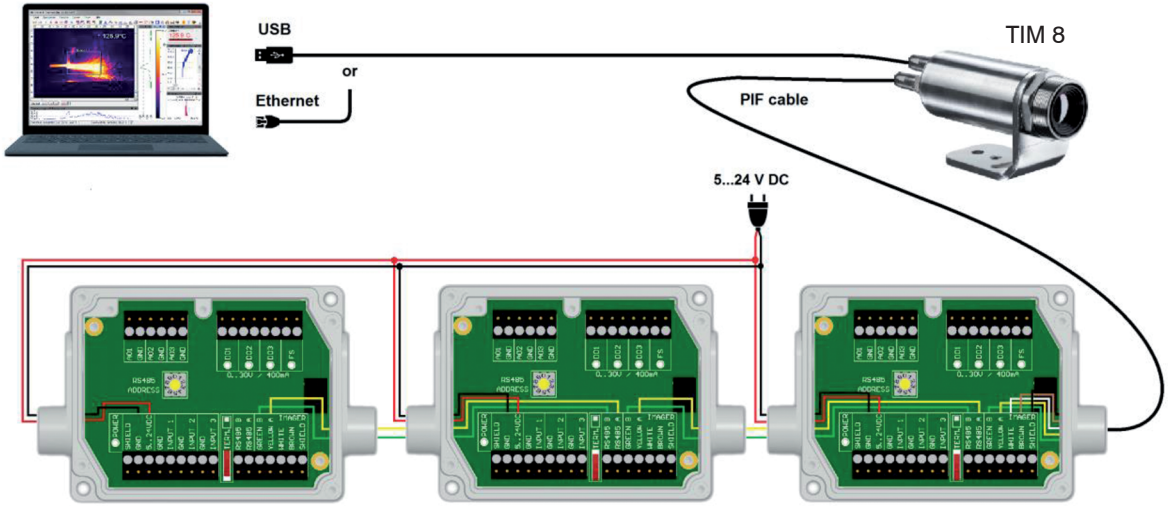


Fig. 53 Connection of 3 industrial PIFs via RS485

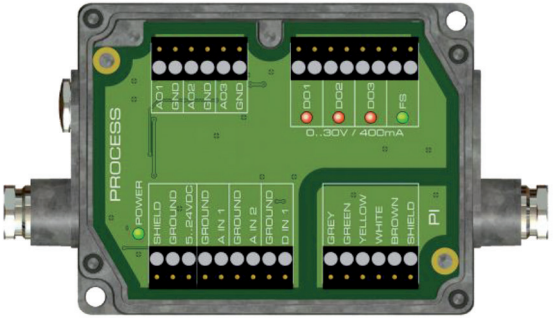
i Each stackable industrial PIF must have its own RS485 address. The address must be set directly on the board and in the software. For the PIF which is the furthest away the 120R switch (TERM.- Termination) has to be set.

The process interface has an integrated fail-safe mode. This allows to control conditions like interruption of cables, shut-down of the software etc. and to give out these conditions as an alarm.

Controlled conditions on camera and software	Standard Process interface TM-PIF-TIM8	Industrial Process interface TM-PIFCBx-TIM8
Interruption USB cable to camera	√	√
Interruption data cable camera - PIF	√	√
Interruption power supply PIF	√	√
Shut-down of TIM Connect software	√	√
Crash of TIM Connect software	-	√
Fail-Safe-Output	0 V at analog output (AO)	Open contact (fail-safe-relay)/ green LED off

A 6 Industrial Process Interface for thermoIMAGER TIM 40 (Optional)

For use in industrial environment the industrial process interface with 500 V AC_{RMS} isolation voltage between thermoIMAGER TIM 40 and process is available (connection box with IP 65, 5 m, 10 m or 20 m standard or high temperature cable for camera connection, terminal for process integration, see A 12.



Pin assignment	
Color	**Designation**
Grey	Interrupt
Green	SCL (I^2C)
Yellow	SCL (I^2C)
White	3.3 V
Brown	GND
Shield	GND

Fig. 54 Connections of the industrial Process Interfaces for thermoIMAGER TIM 40

The industrial process interface provides the following inputs and outputs:

Designation	Description	max. range [1] / status
A IN 1 / 2	Analog input 1 and 2	0 - 10 V [2]
D IN 1	Digital input (Low-active = 0…0.6 V)	24 V
AO 1 / 2 / 3	Analog output 1, 2 and 3 Alarm output 1, 2 and 3	0/4 - 20 mA 0/4 - 20 mA
DO 1 / 2 / 3	Relay output 1, 2 and 3 [3]	open/ closed (red LED on)/ 0 ... 30 V, 400 mA
FS	Fail-safe-relay	open/ closed (green LED on)/ 0 ... 30 V, 400 mA

1) Depending on supply voltage; for 0 - 20 mA on the AO the PIF has to be powered with min. 5 V < (1.5 + working resistance * 0.021) < 24 V. Working resistance = Load bzw. Measuring resistance;
Example: R_{Load} = 500 Ohm → U_{min} = 1.5 + 500 * 0.021 = 12 V,
R_{Load} = 100 Ohm → U_{min} = 1.5 + 100 * 0.021 = 3.6 V → min. 5 V
2) The AI is designed for max. 24 V, the voltage level above 10 V is not interpreted.
3) Active if AO1, 2 or 3 is/ are programmed as alarm output.

i The alarm output can be configured as a threshold between 0 - 4 mA for no alarm and between 10 - 20 mA as alarm. For values outside the respective range, the relay does not switch on the DO.

The process interface has an integrated fail-safe mode. This allows to control conditions like interruption of cables, shut-down of the software etc. and to give out these conditions as an alarm.

Controlled conditions on camera and software	Standard Process interface	Industrial Process interface TM-PIF500V2CBx-TIM
Interruption USB cable to camera	√	√
Interruption data cable camera - PIF	√	√
Interruption power supply PIF	√	√
Shut-down of TIM Connect software	√	√
Crash of TIM Connect software	-	√
Fail-Safe-Output	0 V at analog output (AO)	Open contact (fail-safe-relay)/ green LED off

A 7 Examples for a Fail-Safe Monitoring with a PLC

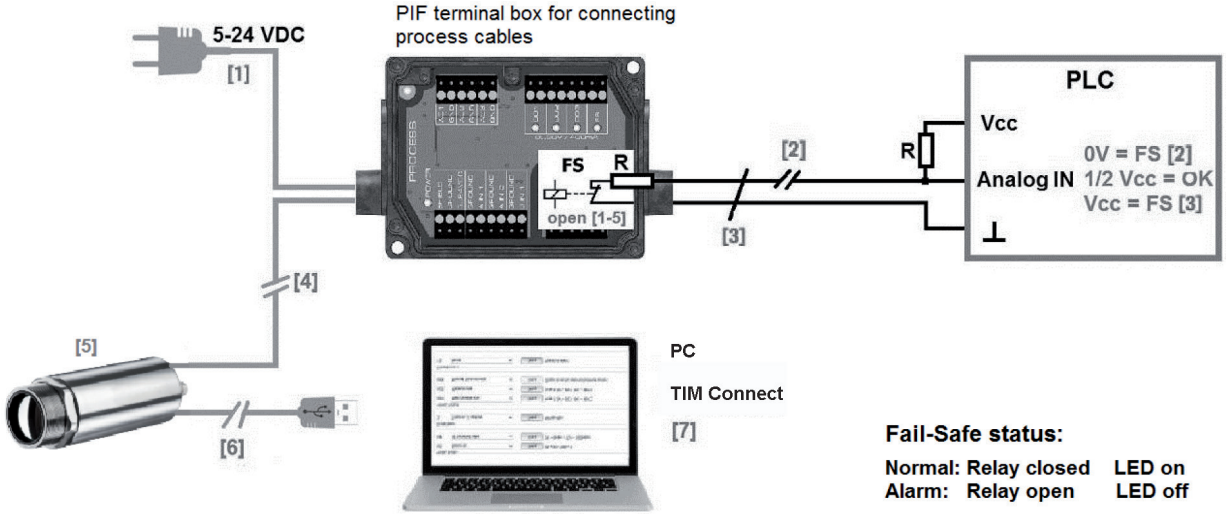


Fig. 55 Fail-Safe monitoring states

[1]	Breakdown of PIF power supply	[4]	Malfunction of camera
[2]	Cable break of fail-safe cable	[5]	Breakdown of TIM power supply/ Interruption of USB cable
[3]	Interruption of cable TIM-PIF	[6]	Malfunction of TIM Connect software

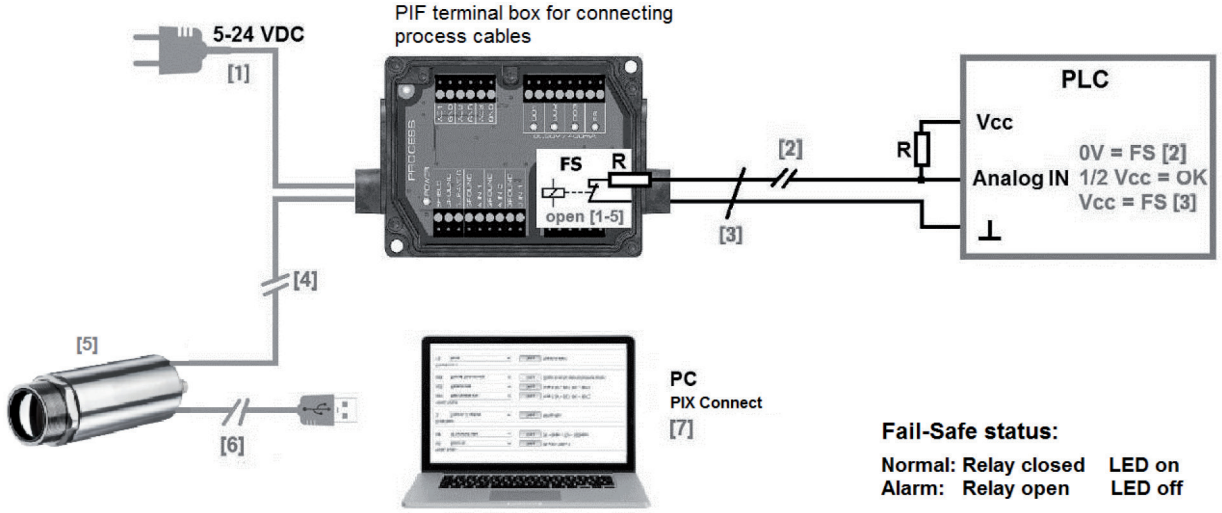


Fig. 56 Fail-Safe monitoring states

[1]	Breakdown of PIF power supply	[5]	Malfunction of TIM
[2]	Cable break of fail-safe cable	[6]	Breakdown of TIM power supply/ Interruption of USB cable
[3]	Short circuit of fail-safe cable	[7]	Malfunction of TIM Connect software
[4]	Interruption of cable TIM-PIF		

A 8 USB Cable Extension for thermoIMAGER TIM 40

The maximum USB cable length is 20 m. For greater distances between thermoIMAGER TIM 40 and computer or for stand-alone solutions the optional USB Server Gigabit is provided:

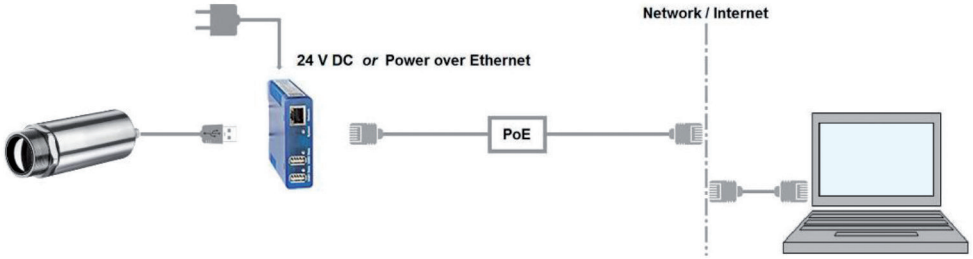


Fig. 57 USB-Server Gigabit

A 9 A Brief Overview to Serial Communication

A 9.1 Introduction

One of the features of the thermoIMAGER TIM Connect software is the ability to communicate via a serial comport interface. This can be a physical comport or a Virtual Comport (VCP). It must be available on the computer where the TIM connect software is installed.

A 9.2 Setup of the Interface

- To enable the software for the serial communication open the Options dialog and enter the tab `Extended Communication`.
- Choose the mode `Comport` and select the port you want to use.
- Also select the baud rate that matches the baud rate of the other communication device.

The other interface parameters are 8 data bits, no parity and one stop bit (8N1). This is mostly used on other communication devices too. The other station must support 8 bit data.

- Now you have to connect the computer with your other communication device.
- If this is a computer too you will have to use a null modem cable.

A 9.3 Command List

i You will find the command list on the CD provided and in the TIM Connect software (`Help` > `SDK`). Each command must end with a `CR / LF` (0x0D, 0x0A).

A 10 A Brief Overview to DLL Communication (IPC)

The description of the initialization procedure as well as the necessary command list is provided on the CD and in the TIM Connect software under `Help > SDK`.

2 SDK packages are available. These can be found on the included software CD:
- Connect SDK: requires the TIM Connect software
- Direct SDK: no TIM Connect software required, supports Linux and Windows

The communication to the process imager device is handled by the TIM Connect software (`Imager.exe`) only. A dynamic link library (`ImagerIPC2.dll`) provides the interprocess communication (IPC) for other attached processes. The DLL can be dynamically linked into the secondary application. Or it can be done static by a lib file too. Both `Imager.exe` and `ImagerIPC2.dll` are designed for Windows Vista/ 7/ 8/ 10 only. The application must support call-back functions and polling mode.

The ImagerIPC2.dll will export a bunch of functions that are responsible for initiating the communication, retrieving data and setting some control parameters.

The main difference to the former Version 1 (`ImagerIPC.dll)` is the support of more than one TIM cameras via multiple instances of TIM Connect.

A 11 thermoIMAGER TIM Connect Resource Translator

thermoIMAGER TIM Connect is a .Net Application. Therefore it is ready for localization. Localization as a Microsoft idiom means the complete adaption of resources to a given culture. If you want to learn more about the internationalization topics please consult Microsoft's developer documentation

http://msdn.microsoft.com/en-us/goglobal/bb688096.aspx.

If needed the localization process can be very detailed. Also the resizing of buttons or other visible resources and the support of right-to-left languages is supported. This can be a huge effort and should be done by experts who have the appropriate tools. To limit this effort and to enable anybody to translate the resources of the TIM Connect application

Micro-Epsilon has developed the small tool `Resource Translator`. This tool helps to translate any visible text within the thermoIMAGER TIM Connect application.

i You will find a detailed tutorial on the CD provided.

A 12 Process Interface for thermoIMAGER TIM 40

A 12.1 Analog Output

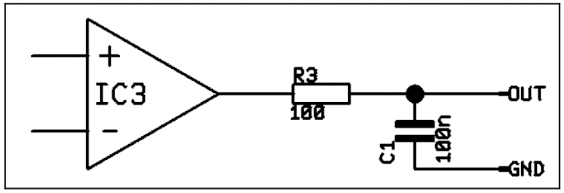


Fig. 58 Analog output

For voltage measurements the minimum load impedance should be 10 KOhm.

The analog output can be used as a digital output. The voltage for `no alarm` and `alarm on` can be set within the software. The analog output (0 … 10 V) has a 100 Ohm resistor in raw. With a maximum current of 10 mA the voltage drop is 1 V.

Having an alarm LED with a forward voltage of 2 V the analog output value for `alarm on` should be 3 V as maximum.

A 12.2 Digital Input

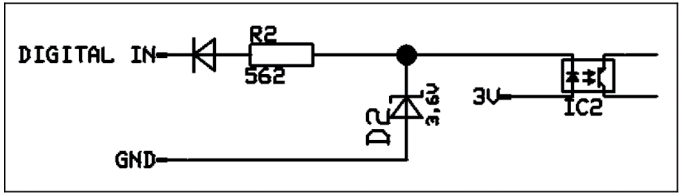


Fig. 59 Digital input

The digital input can be activated with a switch to the TIM GND or with a `Low` level CMOS/TTL signal:

- Low level 0 … 0.6 V
- High level 2 … 24 V

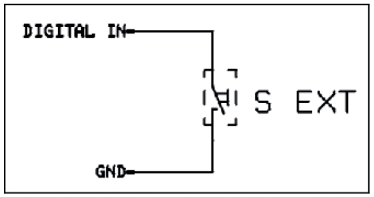


Fig. 60 Button

A 12.3 Analog Input

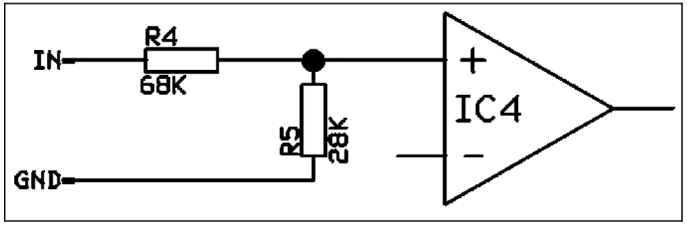


Fig. 61 Analog input

Useful voltage range: 0 ... 10 V

A 12.4 Relay Output on Industrial Interface

The analog output has to be set to `Alarm`.

The voltage level for AO1 - AO3 can be set in the software:

- no alarm: 0 V
- Alarm: 2 – 10 V

REL1-3 (D01-D03): U_{max} = 30 VDC
I_{max} = 400 mA

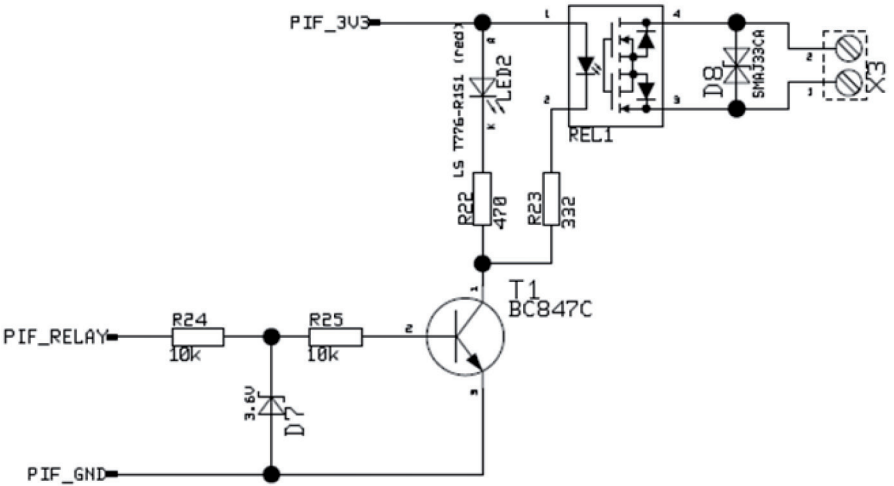


Fig. 62 Relay output

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