MICRO-EPSILON

More Precision

thermoIMAGER TIM // Compact thermal imaging cameras

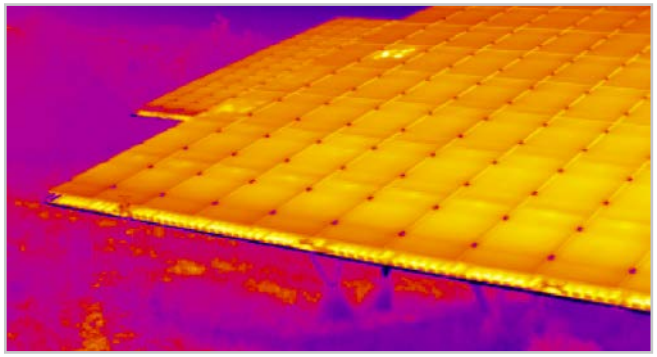
- *Temperature range from -20°C to 1800°C*
- *Compact cameras ideal for OEM applications*
- *Up to 1kHz for fast processes*
- *Resolution up to 764 x 480 pixels*
- *License-free analysis software and complete SDK included*

thermoIMAGER TIM - compact USB thermal imaging cameras for precise thermography

Non-contact measurements of temperature distribution using thermal imaging cameras enable to efficiently monitor and control temperature-criticial processes in various fields of application. The thermoIMAGER infrared cameras are ideal for stationary thermography providing an excellent price/performance ratio. The thermal imaging cameras are connected via USB 2.0 to a computer and are promptly ready for use. The license-free TIMConnect software visualises and records the detected temperature data as thermal images. Additionally, the software provides set up and configuration and enables to control the infrared cameras.

Functioning principle of Micro-Epsilon thermal imaging cameras

Thermal imaging cameras from Micro-Epsilon are designed to measure surface temperatures from -20°C to 1800°C. The infrared radiation emitted by a body is used for the measurement. As the measurement is a non-contact technology, the devices perform wear-free and can therefore be reliably used in the long term. Selectable models and optical systems enable to install the cameras in different distances from the surface. This enables measurements to the target from a safe distance in critical operation areas.

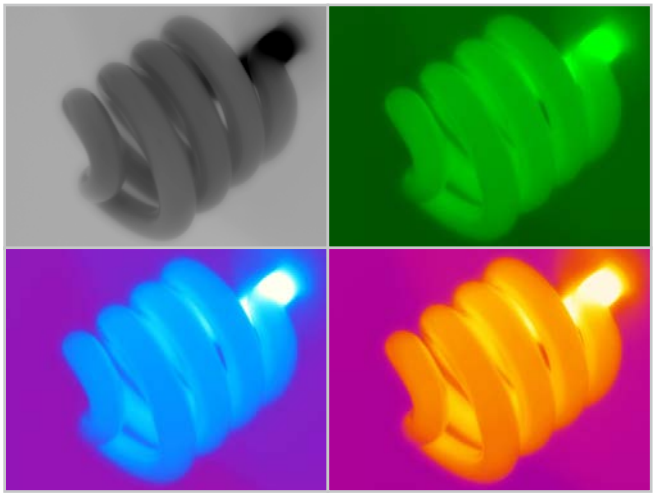


Fast temperature measurement even on large surfaces
Due to this non-contact technology, measurement objects can be detected precisely and wear-free. Large surfaces can be measured accurately at millisecond intervals. The camera can be operated in the line monitoring mode in order to continuously monitor the process.

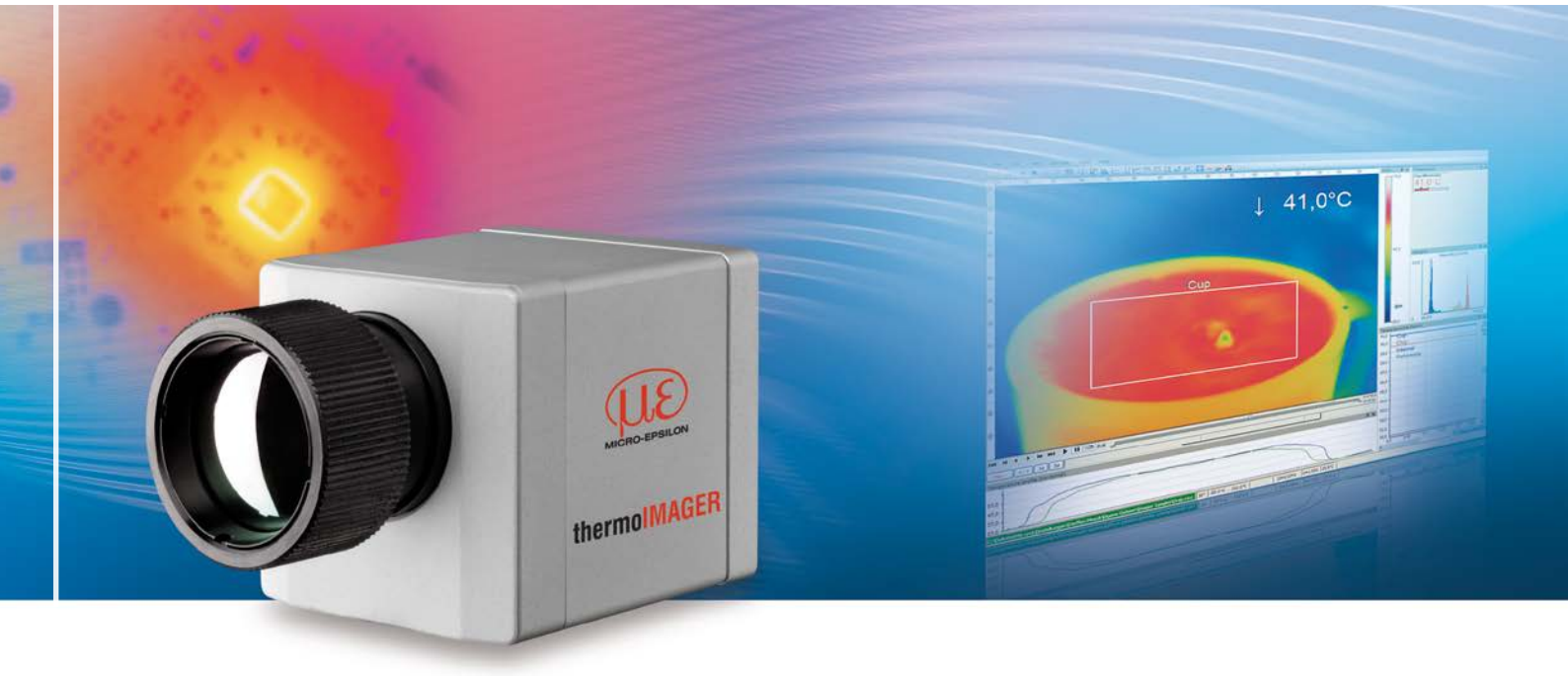
Compact design for mobile and stationary use
The thermoIMAGER cameras close the previous gap between portable infrared snapshot cameras and devices for stationary use.
Exemplary fields of applications:
- Process automation
- Test stations
- Research & Development
- Mobile measurement tasks

License-free software
- Automatic process and quality control
- Individual alarm threshold settings depending on the respective process
- Analogue and digital signal input
- External communication of software via COM-Ports, DLL and LabVIEW driver
- Compatible with Windows XP and Windows 7 / 10

Easy process integration via Advanced interfaces
- USB cable extension up to 100m (Ethernet)
- Process interface (PIF) as analogue or digital input/output
- Serial data communication via RS232



Large temperature measuring range
Thermal imaging cameras from Micro-Epsilon are suitable for use across a wide measuring range - from low temperatures prevalent in cooling chains or laboratories, to the highest temperatures in metal processing applications.



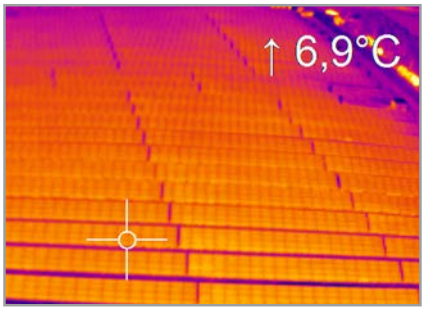
thermoIMAGER TIM 160

Miniaturised thermal imaging camera with USB interface

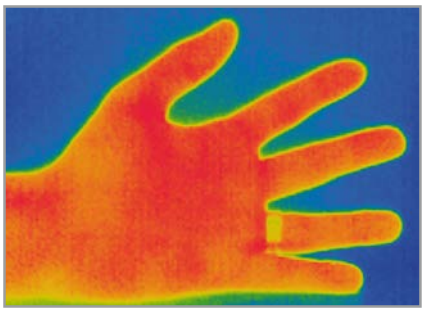
- Measuring range from -20°C to 900°C (special edition up to 1500°C)
- Excellent thermal sensitivity (NEDT) of 0.08K
- Exchangeable lenses with 6°/23°/48°FOV or 72°FOV
- Real-time thermography with 120Hz frame rate via USB 2.0 interface
- Power supply and data transfer via USB interface
- Extremely lightweight (195g) and robust (IP67)
- Extremely compact dimensions 45x45x62mm
- Analogue input and output, trigger interface
- Software Developer Kit and LabVIEW samples included

Software

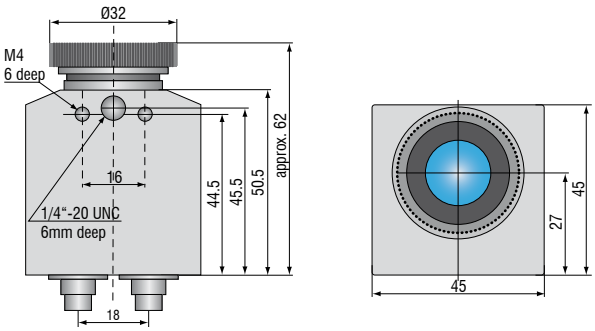
- Display of the thermal image in real time (120Hz) with recording function (video, snapshot)
- Complete set up of parameters and remote control of the camera
- Detailed analysis of fast, thermodynamic processes
- Output of analogue temperature or alert values via the process interface
- Digital communication via RS232 or DLL for software integration



Surface measurements in industrial applications



Suitable lenses for every measurement distance



Model	TIM 160
Optical resolution	160 x 120 pixels
Temperature ranges	-20°C to 100°C / 0°C to 250°C / 150°C to 900°C, optional range: 200°C to 1500°C
Spectral range	7.5 to 13µm
Frame rate	120Hz
System accuracy	±2°C or ±2%, whichever is greater
Resolution (Display)	0.1°C
Lenses	72° / f = 3.3mm (min. distance 20mm); 48° / f = 5.7mm (min. distance 20mm); 23° / f = 10mm (min. distance 20mm); 6° / f = 35.5mm (min. distance 500mm)
Emissivity	0.10 to 1.00 adjustable
Thermal sensitivity (NETD)	0.1K with 48° FOV and 72° FOV [1] / 0.08K with 23° FOV [1] / 0.3K with 6° FOV [2]
Detector	Focal Plane Array (FPA) - uncooled micro bolometer 25x25µm²
Measurement modes	Flexible spot with crosshair marking, measuring field with automatic display of maximum-, minimum- or average value
Colour palettes	Iron, rainbow, black-white, black-white inverted etc.
Operation and set up (via menu)	Measurement modes fully automatic or manual, colour palettes, emissivity, file management, date/time,°C/°F, language
Outputs/digital	USB 2.0 / optional GigE
Process interface (electrically isolated)	0-10V output, 0-10V input, trigger input
Digital communication	via RS232 of PC / DLL interface used
Cable length	1m (standard), 5m, 10 m, 20m
Power supply	USB powered
Tripod mount	¼-20 UNC
Protection class	IP67
Ambient temperature	0°C to 50°C (with cooling jacket up to 315°C)
Storage temperature	-40°C to 70°C
Relative humidity	20 to 80%, non-condensing
Vibration	IEC 60068-2-6 (sine-shaped) /IEC 60068-2-64 (broadband noise)
Shock	IEC 60068-2-27 (25g and 50g)
Weight	195g, incl. lens

PC requirements: minimum 1.5GHz, 1GB RAM, Windows XP SP 2 or Windows 7
[1] Please note: measurement accuracy can be out of specification with distances below 200mm
[2] Please note: measurement accuracy can be out of specification with distances below 500mm

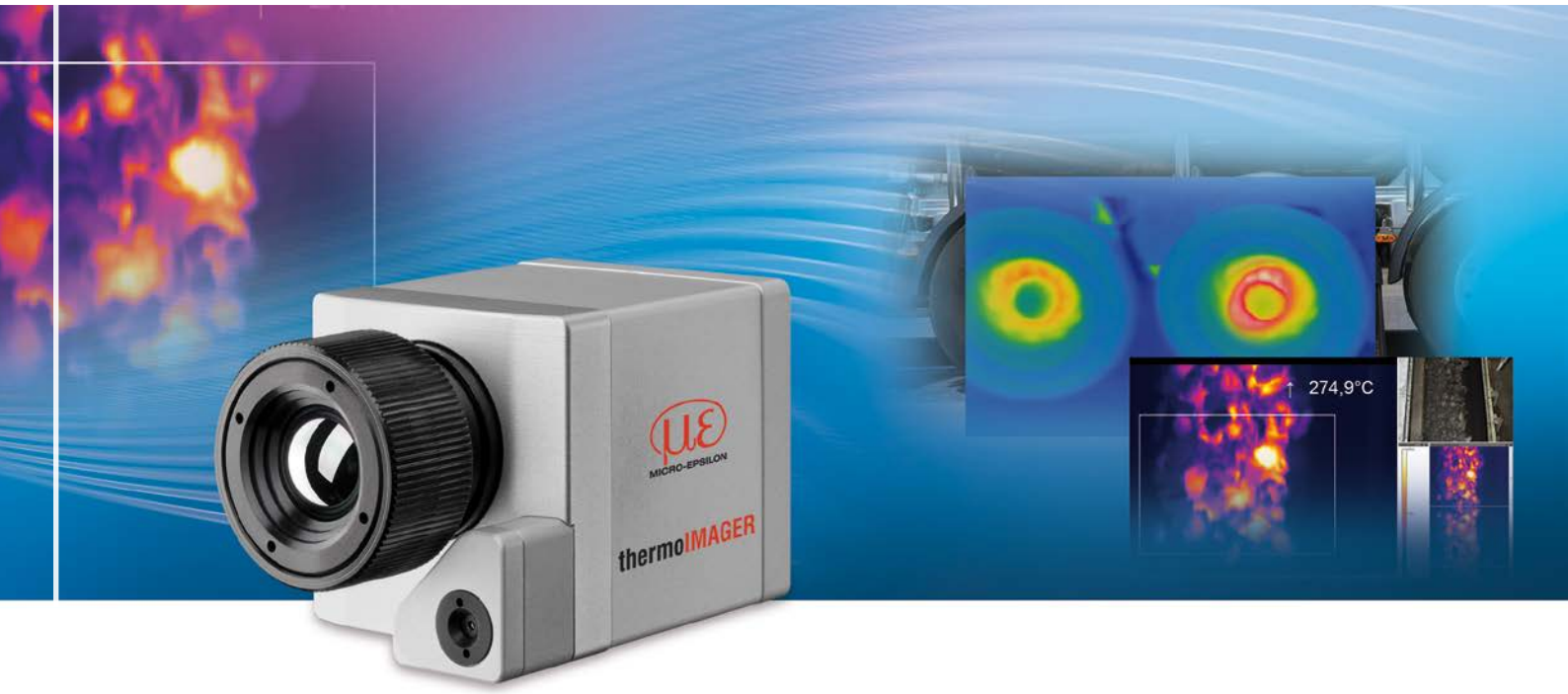
Scope of supply

TIM 160

- TIM process camera incl. a selectable lens
- Operation manual
- USB cable 1m
- Software for real-time processing and analysing thermal images
- Tripod mount
- PIF cable 1m
- Aluminium case

TIM 160/DK

- TIM process camera incl. three lenses 6°, 23°, 48°
- Certificate of calibration, adjusted to the included lenses
- Tripod mount 200 to 1000mm
- Aluminium case
- Operation manual
- USB cable 1m and 10m
- Software for real-time processing and analysing thermal images
- PIF cable 1m



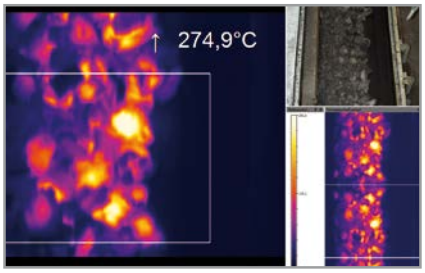
thermoIMAGER TIM 200/230

Thermal imager with BI-SPECTRAL technology

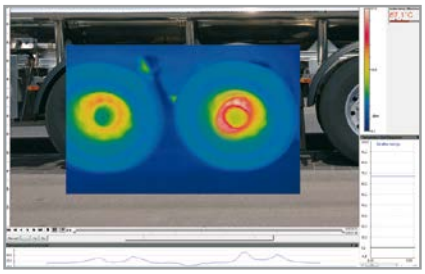
- Parallel detection in the IR field and the visual field
- Measuring range from -20°C to 900°C (special edition up to 1500°C)
- Excellent thermal sensitivity (NEDT) of 0.08K
- Exchangeable lenses with 6°/23°/48°FOV or 72°FOV
- Real-time thermography with 128Hz frame rate via USB 2.0 interface
- Time synchronous, real-time image recording (VIS) with 32Hz (640 x 480 pixels)
- Power supply and operation via USB interface
- Extremely lightweight (215g) and robust (IP67)
- Extremely compact dimensions 45x45x62mm
- Analogue input and output, trigger interface
- Software Developer Kit and LabVIEW samples included

Software

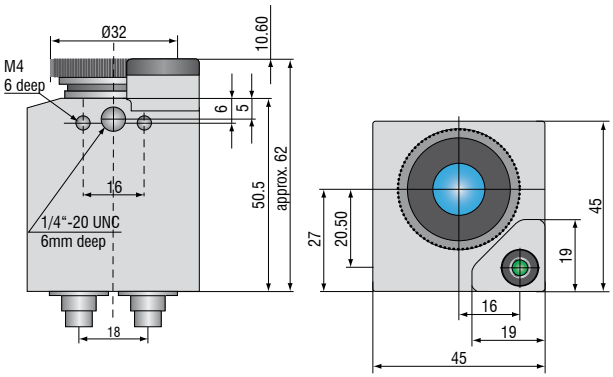
- Display of the thermal image (128Hz) and the real-time image (32Hz) in real time with recording function (video, snapshot)
- Complete set up of parameters and remote control of the camera
- Detailed analysis of fast, thermodynamic processes
- Output of analogue temperature or alert values via the process interface
- Digital communication via RS232 or DLL for software integration



Monitoring modus
Monitoring a coal conveyor belt



Cross-fading modus
Highlighting brake temperature by cross-fading



Model	TIM 200	TIM 230
Visual camera	Optical resolution: 640 x 480 pixels; frame rate: 32Hz	
	Lens (FOV): 54° x 40°	Lens (FOV): 30° x 23°
Optical resolution (IR)	160 x 120 pixels	
Temperature ranges	-20°C to 100°C / 0°C to 250°C / 150°C to 900°C, optional range: 200°C to 1500°C	
Spectral range	7.5 to 13µm	
Frame rate	128Hz	
System accuracy	±2°C or ±2%, whichever is greater	
Resolution (Display)	0.1°C	
Lenses	72° / f = 3.3mm (min. distance 20mm); 48° / f = 5.7mm (min. distance 20mm); 23° / f = 10mm (min. distance 20mm); 6° / f = 35.5mm (min. distance 500mm)	
Emissivity	0.10 to 1.00 adjustable	
Thermal sensitivity (NETD)	0.1K with 48° FOV and 72° FOV [1] / 0.08K with 23° FOV [1] / 0.3K with 6° FOV [2]	
Detector	Focal Plane Array (FPA) - uncooled micro bolometer 25x25µm²	
Measurement modes	Flexible spot with crosshair marking, measuring field with automatic display of maximum-, minimum- or average value	
Colour palettes	Iron, rainbow, black-white, black-white inverted etc.	
Operation and set up (via menu)	Measurement modes fully automatic or manual, colour palettes, emissivity, file management, date/time,°C/°F, language	
Outputs/digital	USB 2.0 / optional GigE	
Process interface (electrically isolated)	0-10V output, 0-10V input, trigger input	
Digital communication	via RS232 of PC / DLL interface used	
Cable length	1m (standard), 5m, 10 m, 20m	
Power supply	USB powered	
Tripod mount	¼-20 UNC	
Protection class	IP67	
Ambient temperature	0°C to 50°C (with cooling jacket up to 315°C)	
Storage temperature	-40°C to 70°C	
Relative humidity	20 to 80%, non-condensing	
Vibration	IEC 60068-2-6 (sine-shaped) /IEC 60068-2-64 (broadband noise)	
Shock	IEC 60068-2-27 (25g and 50g)	
Weight	215g, incl. lens	

PC requirements: minimum 1.5GHz, 1GB RAM, Windows XP SP 2 or Windows 7

[1] Please note: measurement accuracy can be out of specification with distances below 200mm

[2] Please note: measurement accuracy can be out of specification with distances below 500mm

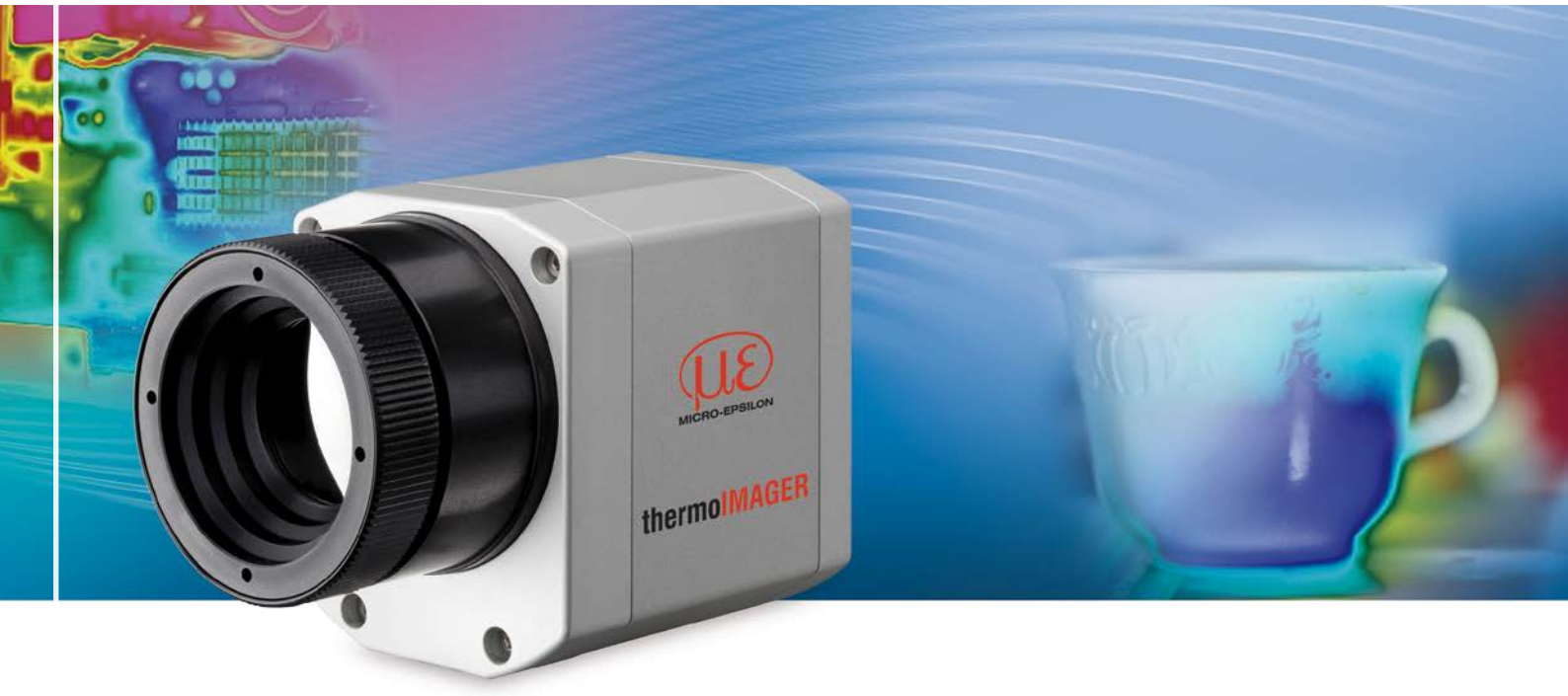
Scope of supply

TIM 200/230

- TIM process camera incl. a selectable lens
- Operation manual
- USB cable 1m
- Software for real-time processing and analysing thermal images
- Tripod mount
- PIF cable 1m
- Aluminium case

TIM 200/DK

- TIM process camera incl. three lenses 6°, 23°, 48°
- Certificate of calibration, adjusted to the included lenses
- Tripod mount 200 to 1000mm
- Aluminium case
- Operation manual
- USB cable 1m and 10m
- Software for real-time processing and analysing thermal images
- PIF cable 1m



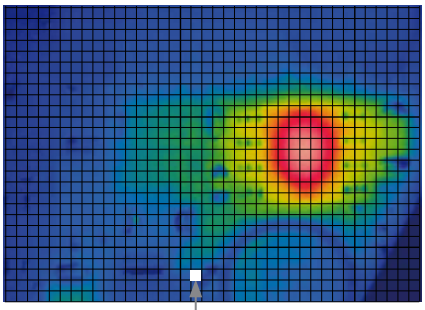
thermoIMAGER TIM 400/450

Thermal imaging camera with high resolution and sensitivity

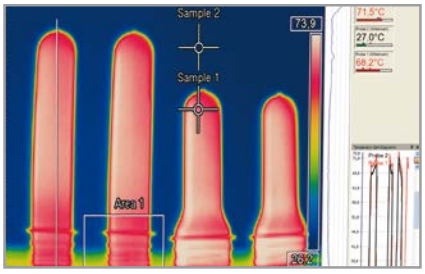
- Detector with 382 x 288 pixels
- Measuring range from -20°C to 900°C (special edition up to 1500°C)
- Fast, real-time thermal imager with up to 80Hz
- Very high thermal sensitivity with 80mK (TIM 400) and 40mK (TIM 450)
- Smallest camera in its class (46 x 56 x 90mm)
- Lightweight (320g incl. lens)
- Exchangeable lenses & industrial accessories
- Software TIMConnect included in the scope of supply
- Software Developer Kit and LabVIEW samples included

Software

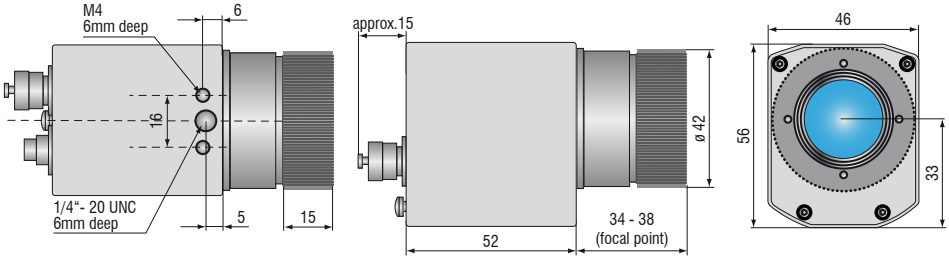
- Display of the thermal image in real time (80Hz) with recording function (video, snapshot)
- Complete set up of parameters and remote control of the camera
- Detailed analysis of fast, thermodynamic processes
- Output of analogue temperature or alert values via the process interface
- Digital communication via RS232 or DLL for software integration



SMD element as measurement object
Measuring field size: 240mm x 180mm,
pixel size: 0.63mm



80Hz imaging with full pixel resolution
Thermal image shots of preforms in PET bottle production



Model	TIM 400	TIM 450
Optical resolution	382 x 288 pixels	
Temperature ranges	-20°C to 100°C, 0°C to 250°C, 150°C to 900°C, optional range: 200°C to 1500°C (only for TIM 400)	
Spectral range	7.5 to 13µm	
Frame rate	80Hz	
System accuracy	±2°C or ±2%, whichever is greater	
Lenses	80° x 56° FOV / f = 7.7mm [1] or 38° x 29° FOV / f = 15mm [1] or 62° x 49° FOV / f = 8mm [1] or 13° x 10° FOV / f = 41mm [2]	
Thermal sensitivity (NETD)	**0.08K** with 80° x 56° FOV / F = 0.8 **0.08K** with 62° x 49° FOV / F = 0.8 **0.08K** with 38° x 29° FOV / F = 0.8 **0.1K** with 13° x 10° FOV / F = 1.0	**0.04K** with 80° x 56° FOV / F = 0.8 **0.04K** with 62° x 49° FOV / F = 0.8 **0.04K** with 38° x 29° FOV / F = 0.8 **0.06K** with 13° x 10° FOV / F = 1.0
Detector	FPA - uncooled micro bolometer 25x25µm²	
Outputs/digital	USB 2.0 / optional GigE	
Process interface (electrically isolated)	0-10V output, 0-10V input, trigger input	
Power supply	USB powered	
Tripod mount	¼-20 UNC	
Protection class	IP67	
Ambient temperature	0°C to 50°C	0°C to 70°C
Storage temperature	-40°C to 70°C	-40°C to 85°C
Relative humidity	20 to 80%, non-condensing	
Vibration	IEC 60068-2-6 (sine-shaped) /IEC 60068-2-64 (broadband noise)	
Shock	IEC 60068-2-27 (25g and 50g)	
Housing (size)	46mm x 56mm x 90mm	
Weight	320g; incl. lens	

PC requirements: minimum 1.5GHz, 1GB RAM, Windows XP SP 2 or Windows 7

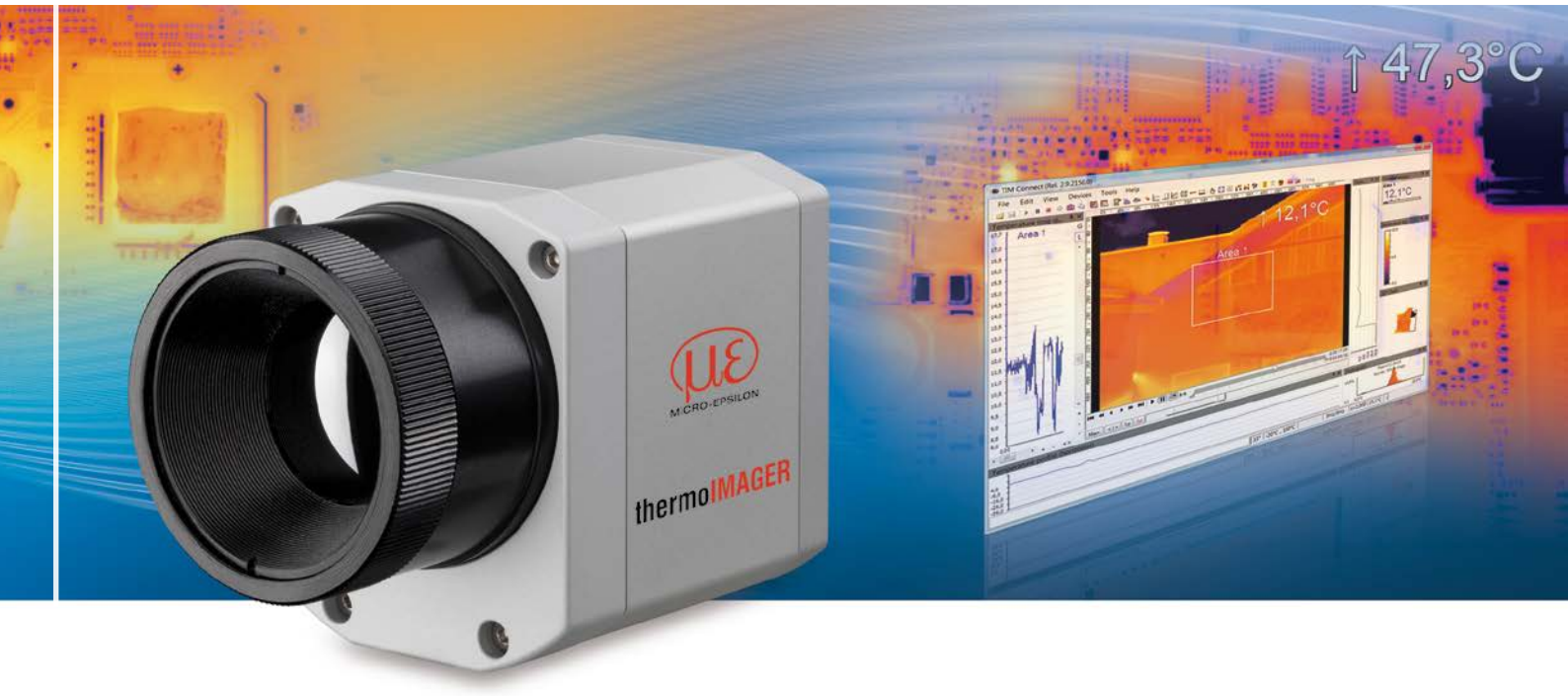
[1] Please note: measurement accuracy can be out of specification with distances below 200mm

[2] Please note: measurement accuracy can be out of specification with distances below 500mm

Scope of supply

TIM 400/450

- TIM process camera incl. a selectable lens
- Operation manual
- USB cable 1m
- Software for real-time processing and analysing thermal images
- Tripod mount
- PIF cable 1m
- Aluminium case



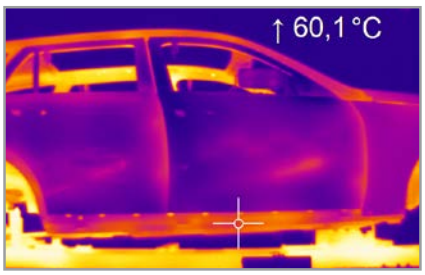
thermoIMAGER TIM 640

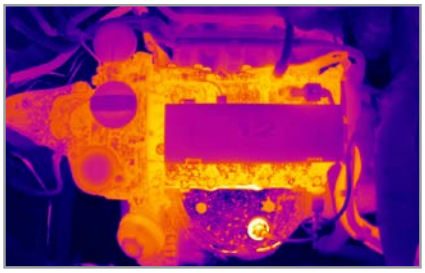
Thermal imaging camera with VGA resolutions

- Thermography in VGA resolution
- 640 x 480 pixels
- Measuring range from -20°C to 900°C
- Radiometric video recording with 32Hz
- Compact design (46 x 56 x 90mm) with USB interface
- Lightweight (320g incl. lens)
- Exchangeable lenses & industrial accessories
- Software TIMConnect included in the scope of supply
- Software Developer Kit and LabVIEW samples included

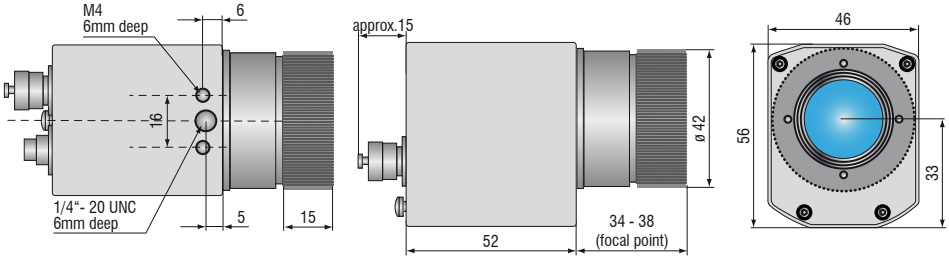
Software

- Display of the thermal images in real time (32Hz) with recording function (video, snapshot)
- Complete set up of parameters and remote control of the camera
- Detailed analysis of fast, thermodynamic processes
- Output of analogue temperature or alert values via the process interface
- Digital communication via RS232 or DLL for software integration





Razor-sharp infrared pictures and videos for process optimisation e.g. in the automotive industry



Model	TIM 640
Optical resolution	640 x 480 pixels
Temperature ranges	-20°C to 100°C, 0°C to 250°C, 150°C to 900°C
Spectral range	7.5 to 13µm
Frame rate	32Hz
System accuracy	±2°C or ±2%, whichever is greater
Lenses	15° x 11° FOV / f = 41.5mm or 33° x 25° FOV / f = 18.4mm or 60° x 45° FOV / f = 10.5mm or 90° x 66° FOV / f = 7.3mm [1)]
Thermal sensitivity (NETD)	75mK
Detector	FPA, uncooled (17µm x 17µm)
Outputs/digital	USB 2.0 / optional GigE
Standard process interface (PIF)	0 - 10V input, digital input (max. 24V), 0 - 10V output
Industry process interface (PIF)	2x 0 - 10V input, digital input (max. 24V), 3x 0 - 10V output, 3x relays (0 - 30V/ 400mA), fail safe relay
Cable length (USB)	1m (standard), 5m, 10m 5m and 10m also available as high temperature USB cable (180°C)
Power supply	USB
Tripod mount	¼-20 UNC
Protection class	IP67
Ambient temperature	0°C to 50°C
Storage temperature	-40°C to 70°C
Relative humidity	20 to 80%, non-condensing
Vibration	IEC 60068-2-6 (sine-shaped) /IEC 60068-2-64 (broadband noise)
Shock	IEC 60068-2-27 (25g and 50g)
Housing (size)	46mm x 56mm x 90mm
Weight	320g; incl. lens

PC requirements: minimum 1.5GHz, 1GB RAM, Windows XP SP 2 or Windows 7

[1)] Please note: measurement accuracy can be out of specification with distances below 200mm

Scope of supply

TIM 640

- TIM process camera
  incl. a selectable lens
- Operation manual
- USB cable 1m
- Software for real-time processing
  and analysing thermal images
- Tripod mount
- PIF cable incl. terminal block (1m)
- Transport case

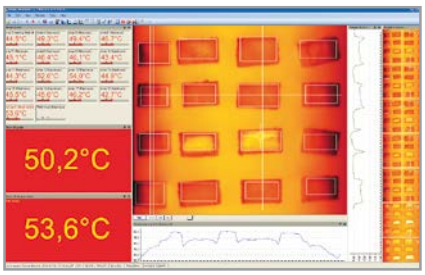
thermoIMAGER TIM G7

Thermal imaging camera with line scan feature for the glass industry

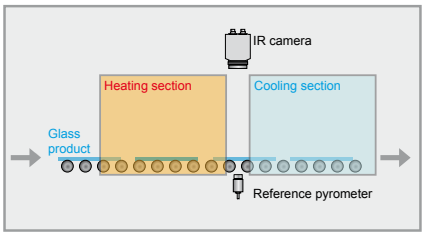
- Line scan feature via license-free TIMConnect analysis software
- Compact size of 46 x 56 x 90mm
- Frame rate of 80Hz
- Robust against ambient temperatures up to 70°C without requiring additional cooling, up to 315°C with cooling jacket
- Optional integration of a reference pyrometer for glass with a reflection coating
- Compact design (46 x 56 x 90mm) with USB interface
- Lightweight (320g incl. lens)
- Exchangeable lenses & industrial accessories
- Software TIMConnect included in the scope of supply
- Software Developer Kit and LabVIEW samples included

Software

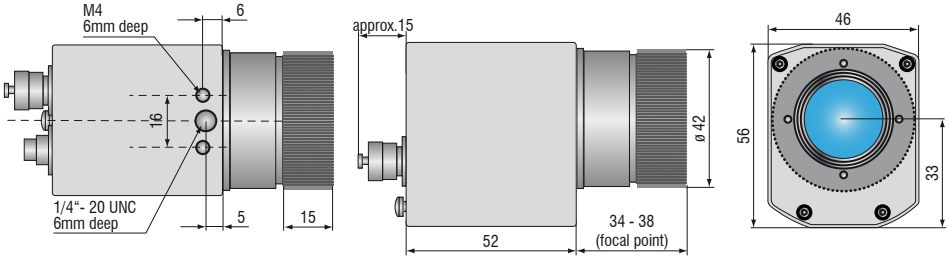
- Line scan camera feature
- Display of the thermal image in real time (80Hz) with recording function (video, snapshot)
- Complete set up of parameters and remote control of the camera
- Detailed analysis of fast, thermodynamic processe
- Output of analogue temperature or alert values via the process interface
- Digital communication via RS232 or DLL for software integration



Exact temperature measurement on moving glass surfaces due to line scan feature



Line scan camera feature measures the temperature distribution between the heating zone and the cooling zone e.g. when toughened or tempered safety glass is heat-treated.



Model	TIM G7
Optical resolution	382 x 288 pixels
Temperature ranges	200°C to 1500°C
Sighting range	0°C to 250°C (measurement is not possible)
Spectral range	7.9µm
Frame rate	switchable 80Hz or 27Hz
System accuracy	±2°C or ±2%, whichever is greater
Lenses	38° x 29° FOV / f = 15mm or 62° x 49° FOV / f = 8mm [1] or 80° x 56° FOV / f = 7.7mm [1]
Thermal sensitivity (NETD)	130mK
Detector	FPA, uncooled (17µm x 17µm)
Outputs/digital	USB 2.0 / optional GigE
Standard process interface (PIF)	0-10V input, digital input (max. 24V), 0-10V output
Industry process interface (PIF)	2x 0-10V input, digital input (max. 24V), 3x 0 - 10V output, 3x relays (0 - 30V/ 400mA), fail safe relay
Cable length (USB)	1m (standard), 5m, 10m 5m and 10m also available as high temperature USB cable (180°C)
Power supply	USB
Tripod mount	¼-20 UNC
Protection class	IP67
Ambient temperature	0°C to 70°C
Storage temperature	-40°C to 85°C
Relative humidity	20 to 80%, non-condensing
Vibration	IEC 60068-2-6 (sinus-shaped) / IEC 60068-2-64 (broadband noise)
Shock	IEC 60068-2-27 (25g and 50g)
Housing (size)	46mm x 56mm x 90mm
Weight	320g; incl. lens

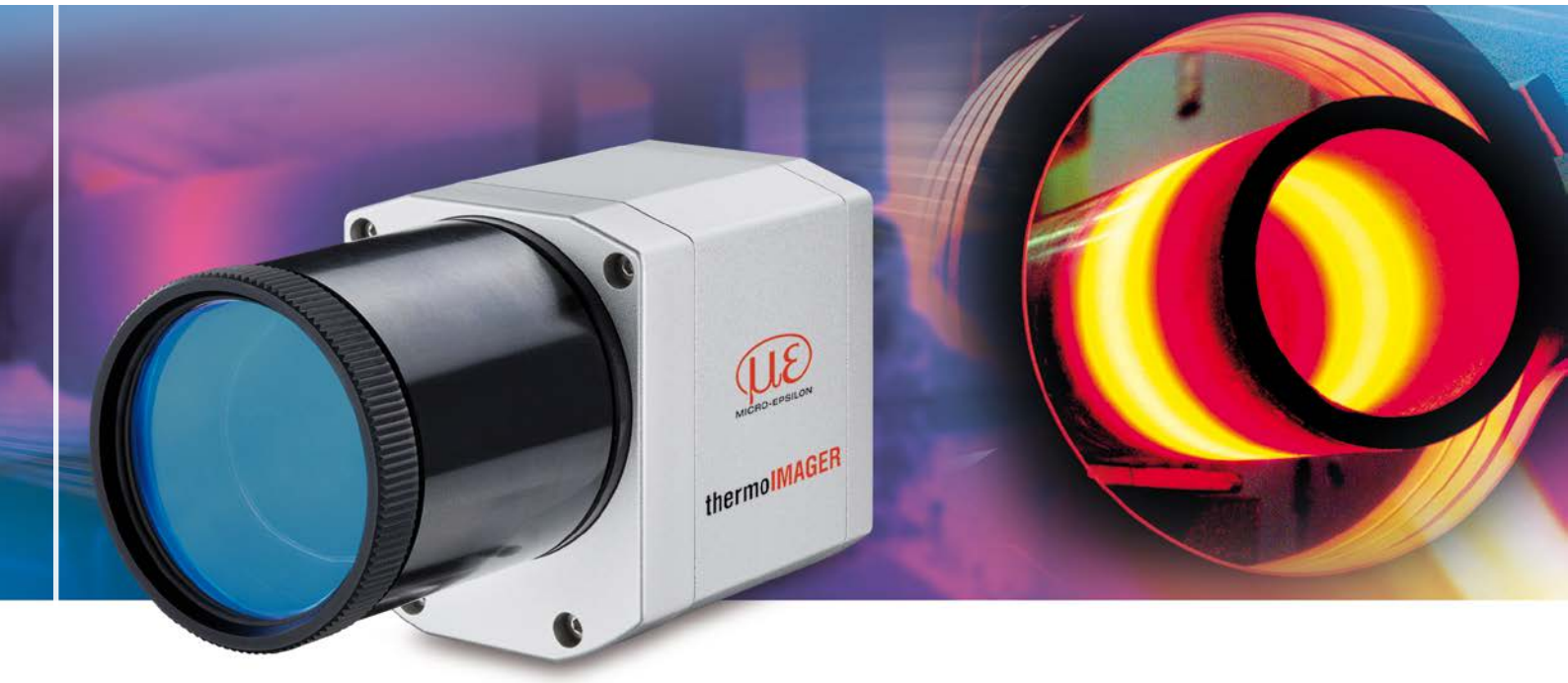
PC requirements: minimum 1.5GHz, 1GB RAM, Windows XP SP 2 or Windows 7

[1] Please note: measurement accuracy can be out of specification with distances below 200mm

Scope of supply

TIM G7

- TIM process camera
  incl. a selectable lens
- Operation manual
- USB cable 1m
- Software for real-time processing
  and analysing thermal images
- Tripod mount
- PIF cable incl. terminal block (1m)
- Aluminium case



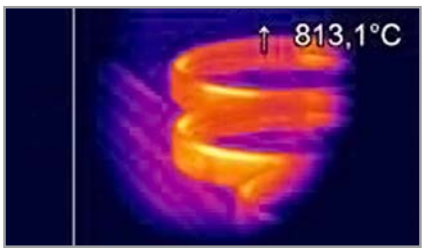
thermoIMAGER TIM M1

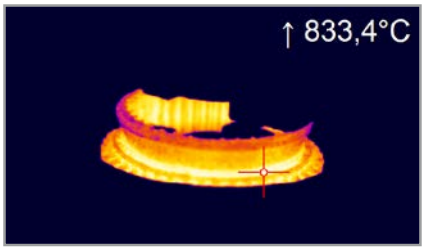
Short wavelength infrared camera for high temperature measurements of metal surfaces

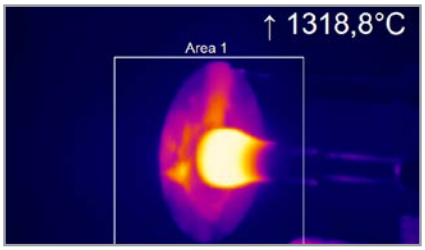
- Highly dynamic CMOS detector with optical resolution up to 764 x 480 pixels
- Very large temperature measuring range (without sub-ranges) from 450°C to 1800°C
- Frame rates up to 1kHz for fast processes
- Real time output of the centre pixel up to 1kHz via process interface (PIF)
- License-free analysis software and complete SDK included

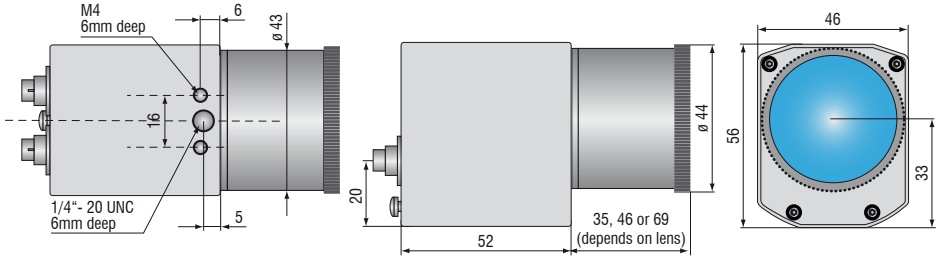
Software

- Display of the thermal image in real time with recording function (video, snapshot)
- Complete set up of parameters and remote control of the camera
- Detailed analysis of fast, thermodynamic processes
- Output of analogue temperature or alert values via the process interface
- Digital communication via RS232 or DLL for software integration









Model	TIM M1	
Optical resolution	764 x 480 pixels @ 32Hz | 382 x 288 pixels @ 80Hz (switchable to 27Hz) | 72 x 56 pixels @ 1kHz	
Temperature ranges	450°C to 1800°C (32 and 27Hz modes) | 500°C to 1800°C (80Hz mode) | 600°C to 1800°C (1kHz mode)	
Spectral range	0.92 to 1.1µm	
Frame rate	Up to 1kHz	
System accuracy	±2% of reading (object temperature < 1500°C)	
Lenses	**FOV @ 764 x 480 px:** 39° x 25° (f = 16mm) [1] 26° x 16° (f = 25mm) [2] 13° x 8° (f = 50mm) [3] 9° x 5° (f = 75mm) [4]	**FOV @ 382 x 288 px:** 20° x 15° (f = 16mm) [1] 13° x 10° (f = 25mm) [2] 7° x 5° (f = 50mm) [3] 4° x 3° (f = 75mm) [4]
Thermal sensitivity (NETD)	< 1K (700°C), < 2K (1000°C)	
Detector	CMOS (15µm x 15µm)	
Outputs/digital	USB 2.0 / optional GigE	
Standard process interface (PIF)	0-10V input, digital input (max. 24V), 0-10V output	
Industry process interface (PIF)	2x 0-10V input, digital input (max. 24V), 3x 0 - 10V output, 3x relays (0 - 30V/ 400mA), fail safe relay	
Cable length (USB)	1m (standard), 5m, 10m 5m and 10m also available as high temperature USB cable (180°C)	
Power supply	USB	
Tripod mount	¼-20 UNC	
Protection class	IP67	
Ambient temperature	0°C to 50°C	
Storage temperature	-40°C to 70°C	
Relative humidity	20 to 80%, non-condensing	
Vibration	IEC 60068-2-6 (sinus-shaped) / IEC 60068-2-64 (broadband noise)	
Shock	IEC 60068-2-27 (25g and 50g)	
Housing (size)	46mm x 56mm x 90mm	
Weight	320g; incl. lens	

PC requirements: minimum 1.5GHz, 1GB RAM, Windows XP SP 2 or Windows 7

[1] Please note: measurement accuracy can be out of specification with distances below 200mm

[2] Please note: measurement accuracy can be out of specification with distances below 500mm

[3] Please note: measurement accuracy can be out of specification with distances below 1500mm

[4] Please note: measurement accuracy can be out of specification with distances below 2000mm

Scope of supply

TIM M1

- TIM process camera
  incl. a selectable lens
- Operation manual
- USB cable 1m
- Software for real-time processing
  and analysing thermal images
- Tripod mount
- PIF cable incl. terminal block (1m)
- Aluminium case
- Optional:
  Cooling Jacket, high temperature cable

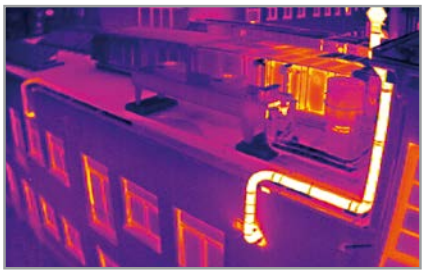
thermoIMAGER TIM LightWeight

Extra light thermoIMAGER mini PC for flight applications

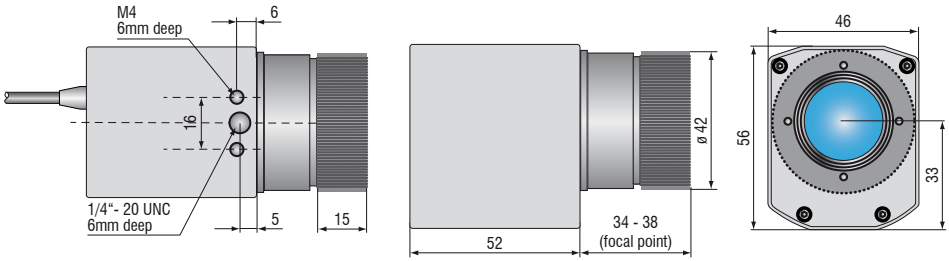
- Fully-radiometric IR inspection with up to 640x480 pixels
- 380g two-piece design: independent, additional use of the IR camera with any Windows PC or tablet PC
- Simultaneous video signal generation in real-time parallel to a 32Hz onboard radiometric recording in VGA resolution (125Hz in VGA sub-frame mode)
- GPS and GoPro support
- Extensive TIMConnect analysis software included
- Automatic transfer of flight videos (IR and GoPro) to USB flash drive

Photovoltaic thermography from the air
The 380-gramme thermal imaging camera can be mounted to a quadrocopter to carry out defect analysis on solar cells.

Possible extension with GoPro Hero camera,
GPS USB flash drive and 2.4 GHz flight control receiver



Temperature monitoring for building thermography



Model		TIM LightWeight
Optical resolution		640x480 pixels / 382x288 pixels
Temperature ranges		-20°C to 900°C
Spectral range		7.5 to 13µm
System accuracy		±2°C or ±2%, whichever is greater
Lens		13°... 90° HFOV
Thermal sensitivity (NETD)		40/ 80mK (depending on camera model)
Operating temperature		0...50 / 70°C (TIM 450)
Storage temperature		-20°C to 50°C
Relative humidity		10 to 95% (non-condensing)
Power supply		9.5...48V DC
Power consumption		6W
Cooling		Active (integrated fan)
Dimensions	TIM camera	46 x 56 x 90mm
	Miniature PC	96 x 67 x 47mm
Weight		380g (TIM camera + miniature PC)
Material (housing)		Aluminium
Module		Odroid XU4
Processor		Samsung Exynos/ 2GHz
Operating system		Linux
Memory		32GB eMMC, 2GB RAM (LPDDR3), SDHC card (32GB)
Ports		Ethernet (GigE/ 1000Mbit/ s), 2x USB 3.0/ 1x USB 2.0, 1x Mini-USB for GoPro Hero3+ (or better), 1x HDMI, 1x TVout, JR connectors
Terminals		+5V DC out, Video IN (VIS camera), TVout, 2x external switches
Control (via JR connectors or terminal)		Start/ Stop recording, Switch VIS/ IR camera
Additional functions		GPS support, 5 status LEDs

thermoIMAGER TIM LightWeight

Scope of supply

TIM 400/450

- TIM process camera incl. a selectable lens
- Operation manual
- USB cable 40 cm integrated
- Software
- Aluminium case
- Miniature PC

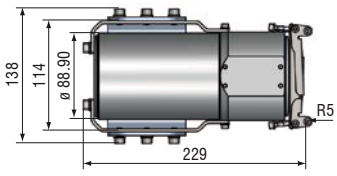
Cooling Jacket and Cooling Jacket Advanced
Universal cooling housing for infrared cameras up to 315°C

- Operation at ambient temperatures up to 315°C
- Also available as protection housing with cooling function up to 180°C
- Air/Water cooling with integrated air purging and optional protective windows
- Modular design for easy fitting of different devices and lenses
- Easy sensor removal on site due to quick-release chassis
- Integration of additional components like TIM NetBox, USB Server Gigabit and Industrial Process Interface (PIF) in the extended version

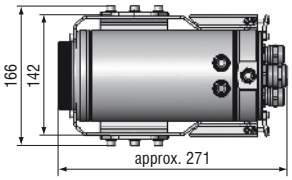
Model	Cooling Jacket	Cooling Jacket Advanced Standard	Cooling Jacket Advanced Extended
Protection class	IP 65	IP 65	IP 65
Ambient temperature	up to 180°C	up to 315°C[1)]	up to 315°C[1)]
Relative humidity	10 to 95% (non-condensing)	10 to 95% (non-condensing)	10 to 95% (non-condensing)
Material (housing)	V2A	V2A	V2A
Dimensions	237mm x 117mm x 138mm	271mm x 166mm x 182mm	426mm x 166mm x 182mm
Weight	4.5kg	5.7kg	7.8kg
Air purge collar	G1/4“ internal thread G3/8“ External thread	G1/4“ Internal thread G3/8“ External thread	G1/4“ Internal thread G3/8“ External thread
Cooling water fittings	G1/4“ Internal thread G3/8“ External thread	G1/4“ Internal thread G3/8“ External thread	G1/4“ Internal thread G3/8“ External thread
Cooling water pressure	max. 15 bar (217 psi)	max. 15 bar (217 psi)	max. 15 bar (217 psi)
Scope of supply	▪ Cooling Jacket, consisting of housing and chassis	▪ Cooling Jacket Advanced, consisting of casing with mounting angle, chassis ▪ Assembly instructions ▪ Focusing unit or front attachment [2)]	▪ Cooling Jacket Advanced, consisting of casing with mounting angle, chassis ▪ Mounting accessories for TIM NetBox or USB Server Gigabit and Industry PIF ▪ Assembly instructions ▪ Focusing unit or front attachment [2)]

[1)] Cable for up to 250°C ambient temperature as well as cable cooling for up to 315°C available.
[2)] Must be ordered separately.

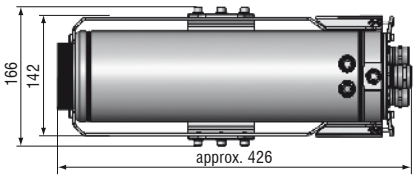
Cooling Jacket

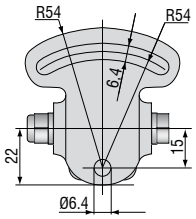


Cooling Jacket Advanced – Standard version

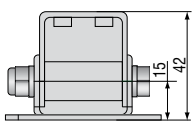


Cooling Jacket Advanced – Extended version





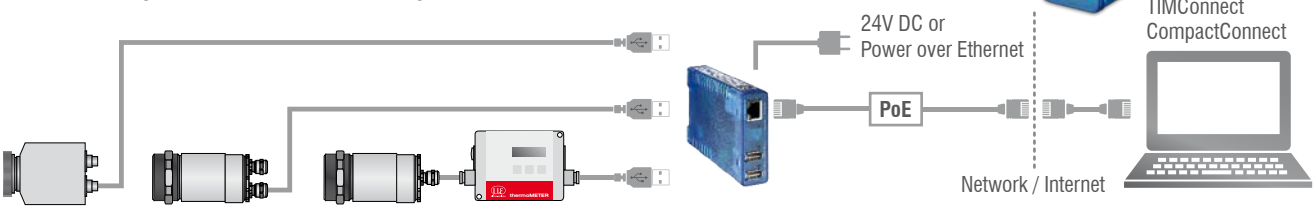
TM-MB-TIM Mounting base, adjustable



TM-PH-TIM Protective housing incl. mounting base

thermoIMAGER TIM USB Server Gigabit
Simple cable extension for the thermoIMAGER TIM series and pyrometers

- Fully compatible with USB 2.0, data transfer rate 1.5/ 12/ 480 mbps, USB transfer modes: Control, Bulk, Interrupt, Isochronous
- For all models in the thermoIMAGER TIM series 1x TIM640, 1x TIM4xx, 2x TIM160, 1x TIM200
- Full TCP/IP support incl. routing and DNS
- Galvanic isolation 500V_{RMS} (network connection)
- Remote configuration via web-based management

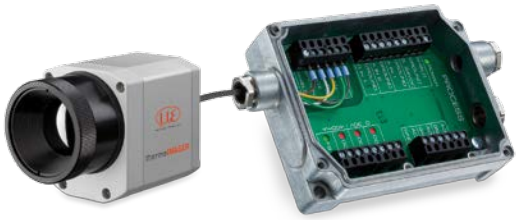


Model	TIM USB Server Gigabit
USB ports	Two independent USB ports
USB speed	480Mbit/s
Network	10/100/1000 BaseT (max. 1000Mbit/s)
Power supply	Power over Ethernet (PoE) class 3 (6.49 - 12.95W) or via screw terminal DC 24V ... 48V (±10%)
Power consumption	External power supply (24V DC) without USB devices: typ. 120mA External power supply (24V DC) with 2 USB devices each 2.5W: typ. 420mA
Ambient temperature	Storage: -40 ... 85°C | In operation, individually assembled: 0 ... 50°C
Permissible relative humidity	0 - 95% (non-condensing)
Housing	Compact plastic housing for DIN rail mount, 105 x 75 x 22mm
Weight	200g
Scope of supply	1 x USB Server Gigabit | 24 V DC wall plug transformer | Quick guide [1]
USB protocols	USB 1.0 / 1.1 / 2.0 Control / Bulk / Interrupt / Isochronous
Protocols for direct network connection	TCP/IP: Socket | Auxiliary protocols: ARP, DHCP, HTTP, PING Inventory keeping, group management

[1] TIMConnect CD or Compact Connect CD: USB redirector \| WuTility Management Tool \| Operating instructions (DE/EN)

Industrial process interface
Camera and process control for use in industrial environments

- Separate fail-safe relay output
- TIM hardware with all cable connections and the TIMConnect software are permanently monitored during operation



Model	Industrial process interface
Protection class	IP65 (NEMA-4)
Ambient temperature	-30°C to 85°C
Storage temperature	-30°C to 85°C
Relative humidity	10 to 95% (non-condensing)
Vibration resistance	IEC 60068-2-6 (non-condensing)/ IEC 60068-2-64 (broadband noise)
Shock	IEC 60068-2-27 (25g and 50g)
Weight	610g (with 5m cable)
Cable length	5m, optional 10m and 20m or HT cable (180° or 250°)
Power supply	5 – 24V DC
LED indicators	2 green LEDs for voltage and fail safe / 3 red LEDs for alarm relay status
Isolation	500V AC_{RMS} between TIM camera und process
Outputs	3 analogue/ alarm outputs | 3 alarm relays [1]
Inputs	2 analogue inputs |1 digital input
Ranges	0 – 10V (for AO 1 – 3) [2] | 0 – 30V / 400mA (for alarm relays DO1 – 3) | 0 – 10V (for AI 1 – 2) | 24V (for DI)
Analogue inputs	Emissivity setting | Ambient temperature compensation | Reference temperature | Uncommitted value Flag control | Triggered snapshots, triggered recordings, triggered line scan camera
Digital input	Flag control | Triggered snapshots, triggered recordings, triggered line scan camera
Analogue outputs	Main measuring range | Measuring range | Internal temperature | Flag status

[1] active when AO1, 2 or 3 is / are programmed as alarm output [2] dependent on supply voltage

thermoIMAGER TIM NetPC / NetPCQ
PC solution for thermoIMAGER TIM applications

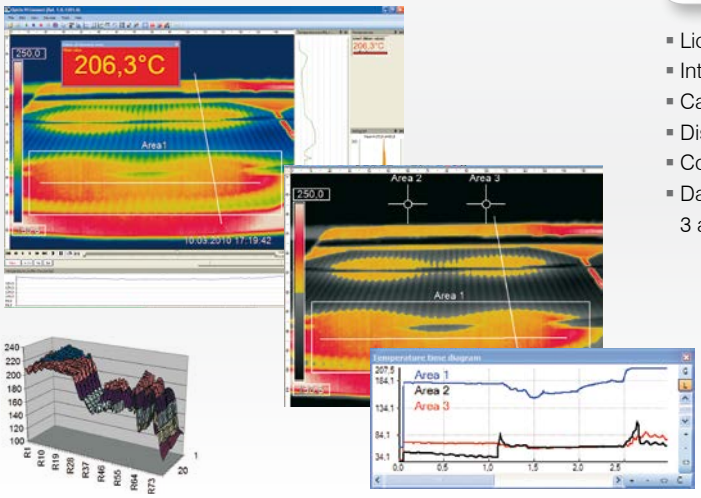
TIM NetPC is a professional, embedded industrial PC solution with a passive cooling (fanless) for thermoIMAGER applications and is suitable for top hat rail mounting. The NetPC and the TIM camera can be operated in combination as stand-alone system. Remote maintenance via Ethernet is possible. Data provided by the TIM camera can be stored directly on the NetPC where customer-specific software can also be installed. A recovery-stick is included in the scope of delivery.

thermoIMAGER TIM NetPC

- Supports all thermoIMAGER TIM models
- Supports 120Hz (TIM 160), up to 80Hz (TIM 4x0), up to 32Hz (TIM 640) frame rates
- Including TIMConnect software
- Monitor via VGA (analogue)
- Integrated watchdog feature
- Optional: up to 20m USB cable, high temperature USB cable, extendable up to 100m Ethernet cable (PoE)

Model	TIM NetPC	TIM NetPCQ
Ambient temperature	0 to 50°C	
Storage temperature	-20 to 60°C	
Relative humidity	10 to 95% (non-condensing)	
Dimensions	165 x 65 x 130mm (W x H x D)	
Material (housing)	Anodised aluminium	
Weight	1000g	
Vibration	IEC-2-6: 3G, 11 - 200Hz, each axis	
Shock	IEC-2-27: 50G, 11ms, each axis	
Operating system	Windows 7 embedded	
Power supply	12 - 24V DC	
Power consumption	approx. 9.5W without TIM [0.76A with 12V]	
Cooling	passive cooling (fanless)	
Processor	Intel® Atom™ 2600 @ 2x1.6GHz Dual	Intel® Atom™ J1900 @ 4x2.4GHz
Hard disc drive	integrated 64GB SSD	
RAM	2GB DDR3 RAM 800MHz	
Ports	1 Gbit/s (Gig E), 2 x RS 232, 4 x USB 2.0, VGA	1 Gig E, 2 x RS 232 / 485, 3 x USB 2.0, 1 x USB 3.0, VGA
Additional functions	1x status LED	

SOFTWARE FEATURES **TIMConnect**



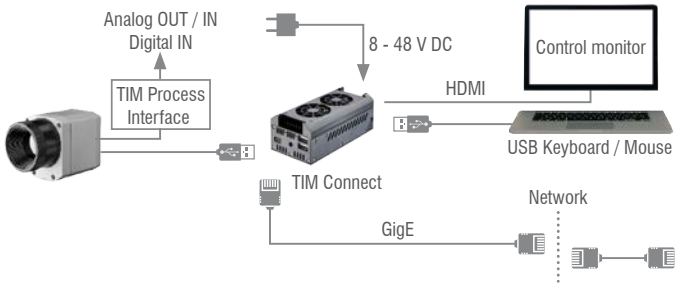
Comprehensive IR camera software

- License-free analysis software and complete SDK included
- Intuitive user interface
- Camera remote control via software
- Displays several camera images in different windows
- Compatible with Windows 7 and 8 and Linux (ubuntu)
- Data output via PIF hardware interface using up to 3 analogue channels

Windows 7 Windows 10

thermoIMAGER TIM NetBox
Miniature PC for thermoIMAGER TIM

- Can be integrated into CoolingJacket Advanced Extended
- Miniature PC for TIM 160/ 4x0 standalone mode or for cable extension
- Supports 120Hz (TIM 160) up to 70Hz (TIM 4x0) frame rate, 32Hz (TIM 640)
- Integrated hardware and software watchdog
- Optional: up to 20m USB cable, high temperature USB cable, extendable up to 100m Ethernet cable (PoE)

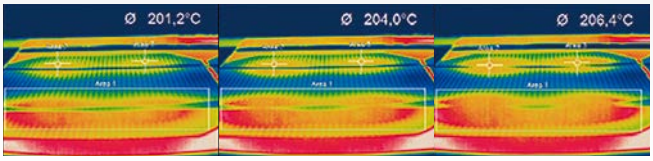


thermoIMAGER TIM NetBox

Model	TIM NetBox
Operating temperature	0 to 50°C
Storage temperature	-20 to 75°C
Relative humidity	10 to 95% (non-condensing)
Material (housing)	Anodised aluminium
Dimensions	113 x 57 x 39mm
Weight	385g
Vibration	IEC 60068-2-6 (sine-shaped) / IEC 60068-2-64 (broadband noise)
Shock	IEC 60068-2-27 (25g and 50g)
Operating system	Windows 7 Professional
Power supply	8 ... 48VDC or Power over Ethernet (PoE/ 1000BASE-T)
Power consumption	7.5W (+ additional 2.5W for TIM camera)
Cooling	Active via two integrated fans
Module	COM Express® mini embedded board
Processor	Intel® E3845 Quad Core, 1.91GHz
Hard disc drive	16GB SSD
RAM	2GB (DDR2, 533MHz)
Ports	2x USB 2.0, 1x USB 3.0, 1x Mini USB 2.0, Micro HDMI, Ethernet (Gigabit Ethernet)
Extensions	micro SDHC/ SDXC card
Additional functions	4x status LEDs

Online and offline data analysis

- Real time temperature information (°C or °F) in main window, as digital display or graphic display
- Detailed analysis using measuring fields, automatic hotspot/cold-spot search
- Logical linking of temperature information
- Slow-motion replay without connected camera
- Various colour palettes to highlight thermal contrasts



Video recording and snapshot feature (IR or BI-SPECTRAL)

- Recording of video sequences and individual images for later analysis or documentation
- Adjustable frame rate to reduce data volume
- Display of snapshot process for direct analysis

Temperature data analysis and documentation

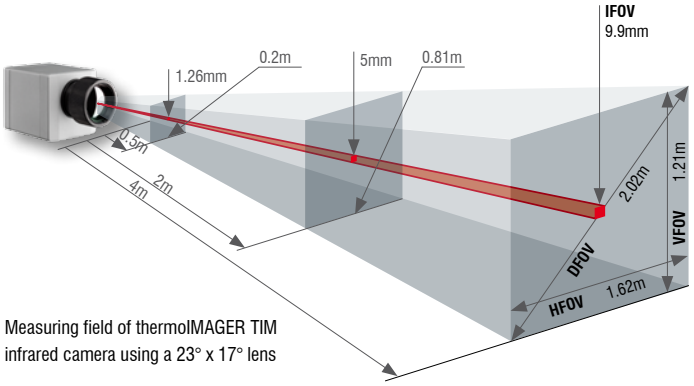
- Triggered data collection
- Radiometric video sequences (*.ravi) and snapshots (*.tiff)
- Thermal images as *.avi / *.tiff or text file *.csv, *.dat incl. complete temperature information
- Data transfer in real time to other software programs via DLL or COM port interfaces

TIM 160 / 200 160 x 120 px	Focal length [mm]	Angle	Minimum measurement distance*	Distance to measurement object [m]												
					0.02	0.1	0.2	0.3	0.5	1	2	4	6	10	30	100
23° Standard lens	10	23° 17° 29° 2.48 mrad	0.2m	HFOV [m] VFOV [m] DFOV [m] IFOV [mm]	0.012 0.009 0.015 0.1	0.043 0.032 0.054 0.3	0.08 0.06 0.10 0.5	0.12 0.09 0.16 0.8	0.21 0.15 0.26 1.3	0.41 0.30 0.51 2.5	0.81 0.60 1.01 5.0	1.62 1.21 2.02 9.9	2.44 1.81 3.03 14.9	4.1 3.0 5.1 24.8	12.2 9.0 15.2 74.4	40.6 30.1 50.5 248.0
6° Telephoto lens	35.5	6° 5° 8° 0.70 mrad	0.5m	HFOV [m] VFOV [m] DFOV [m] IFOV [mm]					0.06 0.04 0.07 0.4	0.11 0.09 0.14 0.7	0.23 0.17 0.28 1.4	0.45 0.34 0.57 2.8	0.68 0.51 0.85 4.2	1.1 0.8 1.4 7.0	3.4 2.5 4.2 21.1	11.3 8.5 14.2 70.4
48° Wide angle lens	5.7	41° 31° 51° 4.39 mrad	0.2m	HFOV [m] VFOV [m] DFOV [m] IFOV [mm]	0.022 0.016 0.027 0.1	0.082 0.059 0.101 0.4	0.16 0.11 0.19 0.9	0.23 0.17 0.29 1.3	0.38 0.28 0.47 2.2	0.76 0.55 0.94 4.4	1.51 1.10 1.86 8.8	3.00 2.19 3.72 17.5	4.50 3.28 5.57 26.3	7.5 5.5 9.3 43.9	22.5 16.4 27.8 131.6	74.9 54.5 92.7 438.6
72° Wide angle lens	3.3	72° 52° 89° 7.51 mrad	0.2m	HFOV [m] VFOV [m] DFOV [m] IFOV [mm]	0.039 0.027 0.048 0.2	0.152 0.106 0.186 0.8	0.29 0.20 0.36 1.5	0.43 0.30 0.53 2.3	0.72 0.50 0.87 3.8	1.42 0.99 1.74 7.5	2.84 1.98 3.46 15.0	5.66 3.95 6.91 30.0	8.49 5.92 10.35 45.0	14.1 9.9 17.2 75.1	42.4 29.6 51.7 225.2	141.4 98.6 172.3 750.8

TIM 400 / 450 / G7 382 x 288 px	Focal length [mm]	Angle	Minimum measurement distance*	Distance to measurement object [m]												
					0.02	0.1	0.2	0.3	0.5	1	2	4	6	10	30	100
38° Standard lens	15	38° 29° 48° 1.67 mrad	0.2m	HFOV [m] VFOV [m] DFOV [m] IFOV [mm]	0.024 0.018 0.030 0.1	0.079 0.060 0.099 0.2	0.15 0.11 0.18 0.4	0.21 0.16 0.27 0.5	0.35 0.26 0.44 0.9	0.70 0.52 0.87 1.7	1.39 1.04 1.73 3.4	2.76 2.07 3.46 6.7	4.14 3.11 5.18 10.0	6.9 5.2 8.6 16.7	20.7 15.5 25.9 50.0	68.9 51.7 86.2 166.7
13° Telephoto lens (not G7)	41	13° 10° 17° 0.61 mrad	0.5m	HFOV [m] VFOV [m] DFOV [m] IFOV [mm]					0.12 0.09 0.15 0.3	0.23 0.17 0.29 0.6	0.47 0.35 0.58 1.2	0.94 0.70 1.17 2.5	1.40 1.05 1.75 3.7	2.3 1.7 2.9 6.1	7.0 5.2 8.8 18.4	23.4 17.5 29.2 61.2
62° Wide angle lens	11	62° 49° 79° 2.27 mrad	0.5m	HFOV [m] VFOV [m] DFOV [m] IFOV [mm]	0.040 0.030 0.050 0.1	0.136 0.103 0.170 0.2	0.26 0.19 0.32 0.5	0.38 0.28 0.47 0.7	0.62 0.47 0.77 1.2	1.22 0.92 1.53 2.29	2.42 1.83 3.03 4.56	4.83 3.65 6.05 9.11	7.23 5.47 9.06 13.65	12.0 9.1 15.1 22.7	36.1 27.3 45.2 68.2	120.3 90.9 150.8 227.3
80° Wide angle lens	7.7	80° 56° 97° 3.25 mrad	0.2m	HFOV [m] VFOV [m] DFOV [m] IFOV [mm]		0.182 0.119 0.218 0.3	0.35 0.23 0.41 0.7	0.84 0.55 1.00 1.6	0.84 0.54 1.00 1.6	1.65 1.08 1.97 3.3	3.29 2.14 3.92 6.5	6.55 4.28 7.83 13.0	9.82 6.41 11.73 19.5	16.4 10.7 19.5 32.5	49.0 32.0 58.5 97.4	163.4 106.6 195.1 324.7

FOV = Field of view; HFOV = Horizontal field of view; VFOV = Vertical field of view; DFOV = Diagonal dimension of the total measuring field at the object level; IFOV = Indicated field of view
Table with examples showing which measuring field sizes and pixel sizes are reached at which distance. Various lenses are available for optimal configuration of the camera. Wide angle lenses have radial distortion due to the angle of their aperture. The TIMConnect software has an algorithm which corrects this distortion.

* Please note: The measurement accuracy of the camera may lie outside of the specifications for distances below the defined minimum measurement distance.



Measuring field of thermoIMAGER TIM infrared camera using a 23° x 17° lens

- Standard-, telephoto- and wide angle lenses for different applications
- High quality germanium lenses and special anti-reflective coating for excellent optics
- Factory-calibrated lenses for easy exchange of optical system without recalibration

Measuring field sizes can be calculated online at www.micro-epsilon.com/optikkalkulator.

TIM 640 640 x 480 px	Focal length [mm]	Angle	Minimum measurement distance*	Distance to measurement object [m]											
					0.1	0.2	0.3	0.5	1	2	4	6	10	30	100
33° Standard lens	18.7	33° 25° 41° 0.91 mrad	0.2m	HFOV [m] VFOV [m] DFOV [m] IFOV [mm]	0.068 0.051 0.085 0.1	0.13 0.09 0.16 0.2	0.19 0.14 0.23 0.3	0.31 0.23 0.38 0.5	0.60 0.45 0.75 0.9	1.20 0.89 1.49 1.8	2.38 1.77 2.97 3.6	3.57 2.65 4.45 5.5	5.9 4.4 7.4 9.1	17.8 13.2 22.2 27.3	59.3 44.2 74.0 90.9
15° Teleoptik	41.5	15° 11° 19° 0.41 mrad	0.5m	HFOV [m] VFOV [m] DFOV [m] IFOV [mm]				0.13 0.10 0.17 0.2	0.26 0.20 0.33 0.4	0.52 0.39 0.66 0.8	1.05 0.79 1.31 1.6	1.57 1.18 1.96 2.5	2.6 2.0 3.3 4.1	7.8 5.9 9.8 12.3	26.1 19.6 32.7 41.0
60° Weitwinkeloptik	10.5	60° 45° 75° 1.62 mrad	0.2m	HFOV [m] VFOV [m] DFOV [m] IFOV [mm]	0.128 0.091 0.157 0.2	0.25 0.18 0.30 0.3	0.36 0.26 0.44 0.5	0.59 0.42 0.72 0.8	1.17 0.83 1.43 1.6	2.32 1.66 2.85 3.2	4.63 3.31 5.69 6.5	6.94 4.96 8.52 9.7	11.6 8.3 14.2 16.2	34.6 24.7 42.6 48.6	115.4 82.4 141.8 161.9
90° Super wide angle lens	7.7	90° 64° 111° 2.21 mrad	0.2m	HFOV [m] VFOV [m] DFOV [m] IFOV [mm]	0.220 0.138 0.260 0.2	0.43 0.27 0.50 0.4	0.63 0.39 0.73 0.7	1.03 0.64 1.21 1.1	2.03 1.27 2.39 2.2	4.04 2.53 4.76 4.4	8.06 5.05 9.50 8.8	12.07 7.57 14.24 13.2	20.1 12.6 23.7 22.1	60.3 37.8 71.1 66.2	200.8 125.9 237.0 220.8

TIM M1 382 x 288 px	Focal length [mm]	Angle	Minimum measurement distance*	Distance to measurement object [m]											
					0.1	0.2	0.3	0.5	1	2	4	6	10	30	100
f=16mm Wide angle lens	16	20° 15° 25° 0.94 mrad	0.2m	HFOV [m] VFOV [m] DFOV [m] IFOV [mm]		0.07 0.05 0.09 0.2	0.11 0.08 0.13 0.3	0.18 0.14 0.22 0.5	0.36 0.27 0.45 0.9	0.72 0.54 0.90 1.9	1.43 1.08 1.79 3.8	2.15 1.62 2.69 5.6	3.6 2.7 4.5 9.4	10.7 8.1 13.5 28.1	35.8 27.0 44.9 93.8
f=25mm Standard lens	25	13° 10° 16° 0.60 mrad	0.5m	HFOV [m] VFOV [m] DFOV [m] IFOV [mm]	0.023 0.017 0.029 0.1	0.05 0.03 0.06 0.1	0.07 0.05 0.09 0.2	0.11 0.09 0.14 0.3	0.23 0.17 0.29 0.6	0.46 0.35 0.57 1.2	0.92 0.69 1.15 2.4	1.38 1.04 1.72 3.6	2.3 1.7 2.9 6.0	6.9 5.2 8.6 18.0	22.9 17.3 28.7 60.0
f=50mm Telephoto lens	50	7° 5° 8° 0.30 mrad	1.5m	HFOV [m] VFOV [m] DFOV [m] IFOV [mm]				0.06 0.04 0.07 0.2	0.11 0.09 0.14 0.3	0.23 0.17 0.29 0.6	0.46 0.35 0.57 1.2	0.69 0.52 0.86 1.8	1.1 0.9 1.4 3.0	3.4 2.6 4.3 9.0	11.5 8.6 14.4 30.0
f=75mm Super telephoto lens	75	4° 3° 5° 0.20 mrad	2.0m	HFOV [m] VFOV [m] DFOV [m] IFOV [mm]					0.08 0.06 0.10 0.2	0.15 0.12 0.19 0.4	0.31 0.23 0.38 0.8	0.46 0.35 0.57 1.2	0.8 0.6 1.0 2.0	2.3 1.7 2.9 6.0	7.6 5.8 9.6 20.0

Please note: the camera provides 382 x 288 px in the 80Hz mode

TIM M1 with VGA resolution 764 x 480 px	Focal length [mm]	Angle	Minimum measurement distance*	Distance to measurement object [m]											
					0.1	0.2	0.3	0.5	1	2	4	6	10	30	100
f=16mm Wide angle lens	16	39° 25° 46° 0.94 mrad	0.2m	HFOV [m] VFOV [m] DFOV [m] IFOV [mm]		0.14 0.09 0.17 0.2	0.21 0.14 0.25 0.3	0.36 0.23 0.42 0.5	0.72 0.45 0.85 0.9	1.43 0.90 1.69 1.9	2.87 1.80 3.38 3.8	4.30 2.70 5.08 5.6	7.2 4.5 8.5 9.4	21.5 13.5 25.4 28.1	71.6 45.0 84.6 93.8
f=25mm Standard lens	25	26° 16° 30° 0.60 mrad	0.5m	HFOV [m] VFOV [m] DFOV [m] IFOV [mm]	0.046 0.029 0.054 0.1	0.09 0.06 0.11 0.1	0.14 0.09 0.16 0.2	0.23 0.14 0.27 0.3	0.46 0.29 0.54 0.6	0.92 0.58 1.08 1.2	1.83 1.15 2.17 2.4	2.75 1.73 3.25 3.6	4.6 2.9 5.4 6.0	13.8 8.6 16.2 18.0	45.8 28.8 54.1 60.0
f=50mm Telephoto lens	50	13° 8° 15° 0.30 mrad	1.5m	HFOV [m] VFOV [m] DFOV [m] IFOV [mm]				0.11 0.07 0.14 0.2	0.23 0.14 0.27 0.3	0.46 0.29 0.54 0.6	0.92 0.58 1.08 1.2	1.38 0.86 1.62 1.8	2.3 1.4 2.7 3.0	6.9 4.3 8.1 9.0	22.9 14.4 27.1 30.0
f=75mm Super telephoto lens	75	9° 5° 10° 0.20 mrad	2.0m	HFOV [m] VFOV [m] DFOV [m] IFOV [mm]					0.15 0.10 0.18 0.2	0.31 0.19 0.36 0.4	0.61 0.38 0.72 0.8	0.92 0.58 1.08 1.2	1.5 1.0 1.8 2.0	4.6 2.9 5.4 6.0	15.3 9.6 18.0 20.0

Please note: the camera provides 764 x 480 px in the 32Hz mode

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