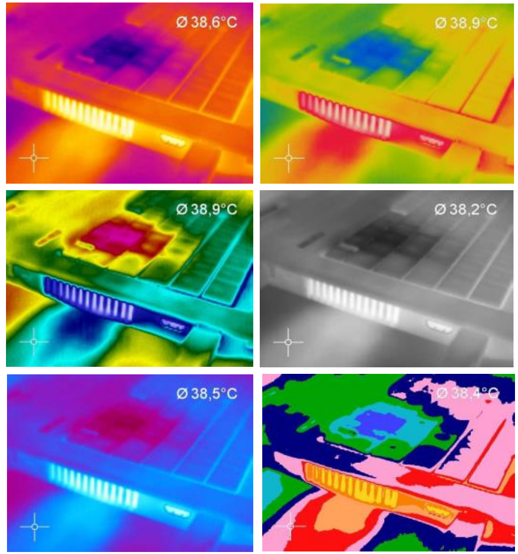
IR

160/ 200/ 230/ 400/ 450

Thermal Imager



Operators manual

CE - Conformity

The product complies with the following standards:

EMC:	EN 61326-1:2006 (Basic requirements) EN 61326-2-3:2006
Safety regulations:	EN 61010-1:2001

The product accomplishes the requirements of the EMC Directive 2004/108/EG and of the Low Voltage Directive 2006/95/EG.
This product is in conformity with Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

Note
Read the manual carefully before the initial start-up. The producer reserves the right to change the herein described specifications in case of technical advance of the product.

Content

1. Welcome!

Thank you for choosing the IR thermal imager!

The IR calculates the surface temperature based on the emitted infrared energy of objects [► Basics of Infrared Thermometry]. The two-dimensional detector (FPA - focal plain array) allows a measurement of an area and will be shown as thermal image using standardized palettes.
The radiometric processing of the picture data enables the user to do a comfortable detailed analysis with the software IR Connect.

Please take care of the following notes:

Notes

- The IR is a precise instrument and contains a sensitive infrared detector and a high-quality lens. The alignment of the camera to intensive energy sources (high power laser or reflections of such equipment, e.g.) can have effect on the accuracy of the measurement or can cause an irreparable defect of the infrared detector.
- The mounting should be made only via the mounting threads or tripod connection the housing is providing.
- Avoid static electricity, arc welders, and induction heaters. Keep away from very strong EMF (electromagnetic fields).
- Avoid abrupt changes of the ambient temperature.
- In case of problems or questions which may arise when you use the infrared camera, please contact our service department.

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2. Scope of Supply

Standard version

- IR160, IR200, IR230, IR400 or IR450 incl. 1 lens
- USB cable (1 m[1])
- Table tripod
- Process interface cable incl. terminal block (1 m)
- Software package IR Connect
- Operators manual
- Aluminum case
- IR200/ 230 only: focusing tool for VIS camera

Thermal Analysis Kit

- IR160 or IR200
- 3 lenses (23°, 6° and 41°, incl. calibration certificate)
- USB cable (1 m[1] and 10 m)
- Tripod (20 - 63 cm)
- Process interface cable incl. terminal block (1 m)
- Software package IR Connect
- Operators manual
- Aluminum case
- IR200/ 230 only: focusing tool for VIS camera

[1] The camera plug of USB cable (1 m) does not feature an IP67 protection class. For industrial applications there are cables with IP67 available starting at 5 m.

3. Maintenance

Lens cleaning

Blow off loose particles using clean compressed air. The lens surface can be cleaned with a soft, humid tissue moistened with water or a water based glass cleaner.

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

4. Technical Data

Factory Default Settings

The unit has the following presetting 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

General Specifications

Environmental rating	IP67 (NEMA-4)
Ambient temperature	0...50 °C
Storage temperature	-20...70 °C
Relative humidity	10...95 %, non condensing
Material (housing)	aluminum, anodized
Dimensions	IR160 / IR200 / IR230: 45 x 45 x 62 - 65 mm (depending on lens) IR400/ 450: 46 x 56 x 86 - 90 mm (depending on lens)
Weight (incl. lens)	IR160: 195 g, IR200/ 230: 215 g, IR400 / IR450: 320 g
Cable length (USB 2.0)	1 m (Standard), 5 m, 10 m, 20 m
Vibration	IEC 68-2-6: 3G, 11 – 200Hz, any axis
Shock	IEC 68-2-27: 50G, 11ms, any axis

Electrical Specifications

Power Supply	5 VDC (powered via USB 2.0 interface)
Current draw	max. 500 mA
Output Process Interface (PIF out)	0-10 V (T_{Obj}, T_{Int}, flag status or alarm status)
Input Process Interface (PIF in)	0-10 V (Emissivity, Ambient temperature, Reference temperature, Flag control, triggered video or triggered snapshots)
Digital Input Process Interface	Flag control, triggered video or triggered snapshots)
Digital interface	USB 2.0 [► Appendix F: PIF]

Measurement Specifications

Temperature ranges	-20...100 °C; 0...250 °C; 120...900 °C; option: 200…1500°C[1)]
Detector	IR160 / IR200 / IR230: UFPA, 160 x 120 pixels IR400 / IR450: UFPA, 382 x 288 pixels
Spectral range	7.5...13 µm
Lenses (FOV)	IR160 / IR200 / IR230[2)]: 23° x 17°; 6° x 5°; 41° x 31°; 72° x 52° IR400 / IR450: 38° x 29°; 62° x 49°; 13° x 10°
System accuracy[3)]	±2 °C or ±2 %

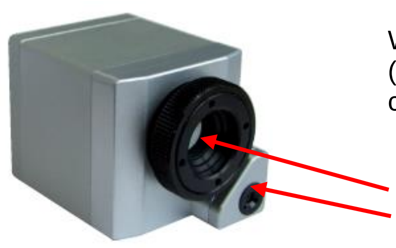
[1)] The additional measurement range of 200…1500°C is not available for the model IR450 as well as for camera version IR160 / IR200 featuring 72° HFOV optics
[2)] For an ideal combination of IR and VIS image we recommend the 41° lens for IR200 and the 23° lens for IR230
[3)] At ambient temperature 23±5 °C; whichever is greater

Temperature resolution (NETD)	IR160 / IR200 / IR230: 0.08 K with 23°; 0.3 K with 6°; 0.1 K with 41° and 72° IR400[1)]: 0.08 K with 38° and 62°; 0.1 K with 13° IR450[1)]: 0.04 K with 38° and 62°; 0.06 K with 13°
Frame rate	IR160: 120 Hz IR200 / IR230: 128 Hz[2)] IR400 / IR450: 80 Hz
Warm-up time	10 min
Emissivity	0.100…1.000 (adjustable via software)
Visual camera (IR200 only)	640 x 480 pixels, 32 Hz, 54° x 40° FOV[2)]
Visual camera (IR230 only)	640 x 480 pixels, 32 Hz, 30° x 23° FOV[2)]
Software	IR Connect

[1)] Value is valid at 40 Hz and 25°C room temperature
[2)] The following options can be set: Option 1 (IR with 96 Hz at 160 x 120 px; VIS with 32 Hz at 640 x 480 px); Option 2 (IR with 128 Hz at 160 x 120 px; VIS with 32 Hz at 596 x 447 px)

5. Optical Data

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. 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 (please see tables at the end of this section).



With the help of BI-SPECTRAL technology at IR200/ 230, a visual image (VIS) can be combined with a thermal image (IR). Both can be finally captured time synchronously:

IR channel

VIS channel

Focusing tool for VIS camera

Note

Please make sure that the focus of thermal channel and visual channel (IR200/ 230 only) is adjusted correctly. For focusing the thermal camera please turn the lens, for focusing the visual camera please use the focusing tool supplied in the scope of delivery.

IR 160 / 200 160 x 120 px	Focal length	Angle	Minimum distance*	Distance to object [m]												
					0.02	0.1	0.2	0.3	0.5	1	2	4	6	10	30	100
O23 Standard lens	10 mm	23°	0.2 m	HFOV [m]	0.008	0.04	0.08	0.12	0.20	0.40	0.81	1.61	2.42	4.0	12.1	40.3
		17°		VFOV [m]	0.006	0.03	0.06	0.09	0.15	0.30	0.60	1.20	1.79	3.0	9.0	29.9
		29°		DFOV [m]	0.010	0.05	0.10	0.15	0.26	0.51	1.02	2.04	3.06	5.1	15.3	51.1
		2.52 mrad		IFOV [mm]	0.050	0.25	0.50	0.76	1.26	2.52	5.04	10.08	15.12	25.2	75.6	252.0
O6 Tele lens	35.5 mm	6°	0.5 m	HFOV [m]					0.06	0.11	0.23	0.45	0.68	1.1	3.4	11.3
		5°		VFOV [m]					0.04	0.08	0.17	0.34	0.50	0.8	2.5	8.4
		8°		DFOV [m]					0.07	0.14	0.28	0.56	0.84	1.4	4.2	14.1
		0.71 mrad		IFOV [mm]					0.35	0.71	1.41	2.82	4.23	7.1	21.2	70.5
O48 Wide angle lens	5.7 mm	41°	0.2 m	HFOV [m]	0.015	0.08	0.15	0.23	0.38	0.76	1.51	3.02	4.53	7.6	22.7	75.6
		31°		VFOV [m]	0.011	0.05	0.11	0.16	0.27	0.55	1.09	2.19	3.28	5.5	16.4	54.7
		52°		DFOV [m]	0.019	0.10	0.19	0.29	0.49	0.97	1.95	3.90	5.85	9.7	29.2	97.5
		4.72 mrad		IFOV [mm]	0.094	0.47	0.94	1.42	2.36	4.72	9.45	18.89	28.34	47.2	141.7	472.3
O72 Wide angle lens	3.3 mm	72°	0.2 m	HFOV [m]	0.029	0.15	0.29	0.44	0.73	1.45	2.91	5.81	8.72	14.5	43.6	145.3
		52°		VFOV [m]	0.020	0.10	0.20	0.29	0.49	0.98	1.95	3.90	5.85	9.80	29.3	97.5
		95°		DFOV [m]	0.043	0.22	0.43	0.65	1.09	2.17	4.34	8.68	13.02	21.7	65.1	217.0
		9.08 mrad		IFOV [mm]	0.182	0.91	1.82	2.72	4.54	9.08	18.16	36.33	54.49	90.8	272.5	908.2

Table 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 PIConnect contains an algorithm which corrects this distortion.

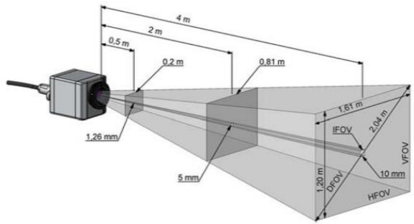
**Note: The accuracy of measurement can be outside of the specifications for distances below the defined minimum distance.*

IR 400 / 450 382 x 288 px	Focal length	Angle	Minimum distance*	Distance to object [m]												
					0.02	0.1	0.2	0.3	0.5	1	2	4	6	10	30	100
O38 Standard lens	15 mm	38°	0.2 m	HFOV [m]	0.014	0.07	0.14	0.21	0.35	0.69	1.39	2.77	4.16	6.9	20.8	69.3
		29°		VFOV [m]	0.010	0.05	0.10	0.15	0.25	0.51	1.02	2.03	3.05	5.1	15.2	50.8
		49°		DFOV [m]	0.018	0.09	0.18	0.28	0.46	0.92	1.84	3.68	5.52	9.2	27.6	92.0
		1.81 mrad		IFOV [mm]	0.036	0.18	0.36	0.54	0.91	1.81	3.63	7.25	10.88	18.1	54.4	181.3
O13 Tele lens	41 mm	13°	0.5 m	HFOV [m]					0.12	0.23	0.47	0.94	1.40	2.3	7.0	23.4
		10°		VFOV [m]					0.09	0.17	0.35	0.70	1.05	1.7	5.2	17.5
		17°		DFOV [m]					0.15	0.29	0.58	1.17	1.75	2.9	8.8	29.2
		0.61 mrad		IFOV [mm]					0.31	0.61	1.22	2.45	3.67	6.1	18.4	61.2
O62 Wide angle lens	8 mm	62°	0.5 m	HFOV [m]	0.024	0.12	0.24	0.36	0.60	1.20	2.40	4.80	7.20	12.0	36.0	119.9
		49°		VFOV [m]	0.018	0.09	0.18	0.27	0.45	0.90	1.80	3.60	5.41	9.0	27.0	90.1
		74°		DFOV [m]	0.030	0.15	0.30	0.45	0.75	1.50	3.00	6.00	8.99	15.0	45.0	149.9
		3.14 mrad		IFOV [mm]	0.063	0.31	0.63	0.94	1.57	3.14	6.28	12.56	18.84	31.4	94.2	314.0

Table 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 PIConnect contains an algorithm which corrects this distortion.

**Note: The accuracy of measurement can be outside of the specifications for distances below the defined minimum distance.*

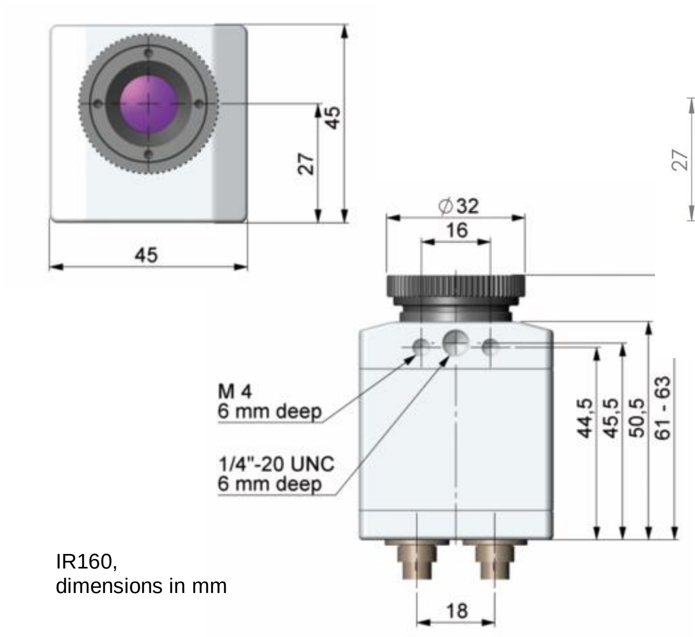
- **HFOV**: Horizontal enlargement of the total measuring field at object level
- **VFOV**: Vertical enlargement of the total measuring field at object level
- **IFOV**: Size of the single pixel at object level
- **DFOV:** Diagonal dimension of the total measuring field at the object level
- **MFOV**: Recommended, smallest measured object size of 3 x 3 pixel



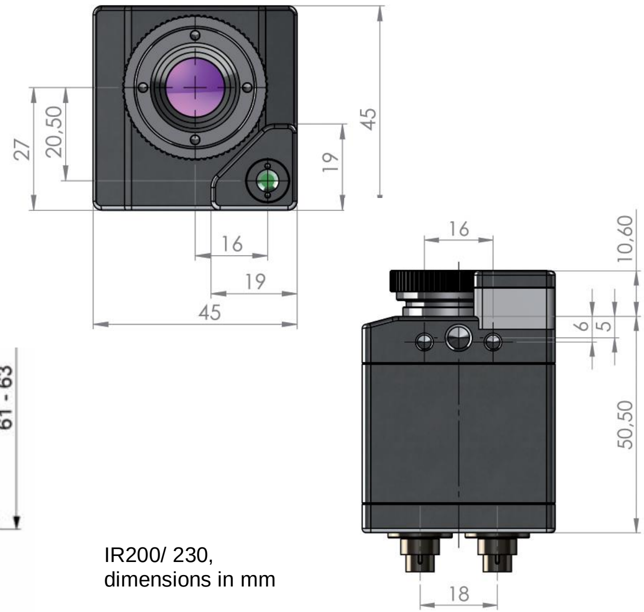
Measurement field of the IR
representing the 23° x 17° lens

6. Mechanical Installation

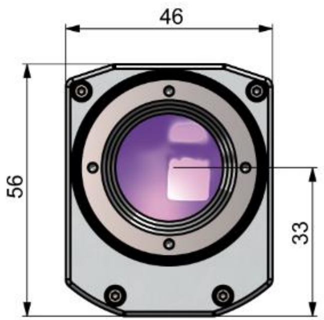
The IR is equipped with two metric M4 thread holes on the bottom side (6 mm depth) and can be installed either directly via these threads or with help of the tripod mount (also on bottom side).

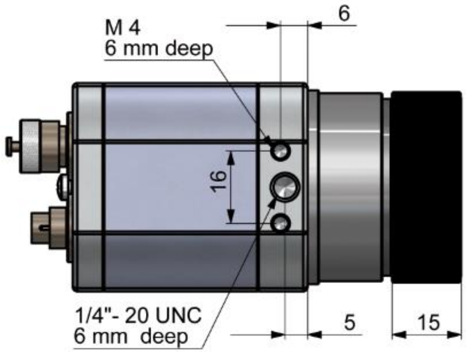


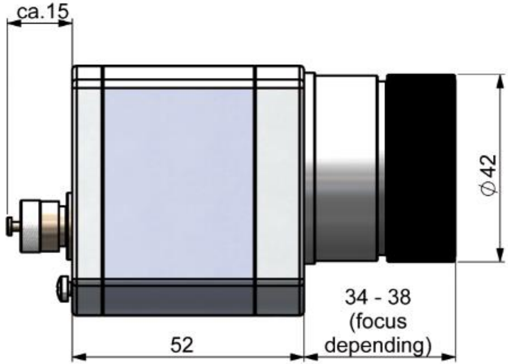
IR160,
dimensions in mm



IR200/ 230,
dimensions in mm

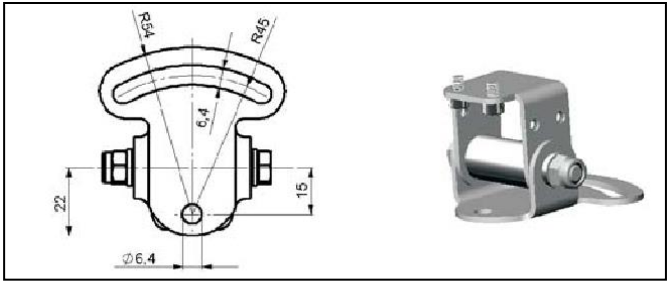




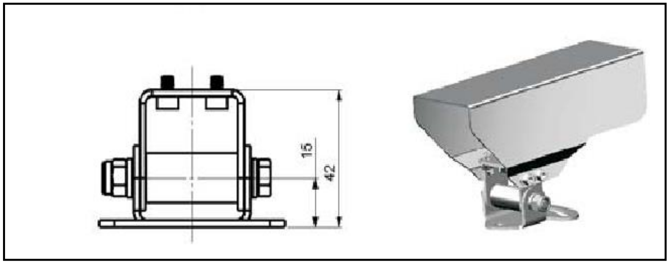


IR400 / IR450,
dimensions in mm

Mounting accessories (optional)



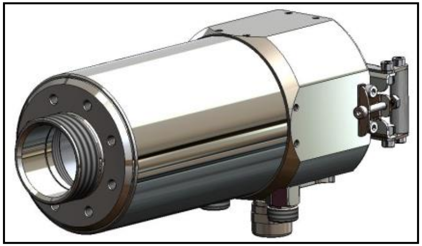
Mounting base, stainless steel,
adjustable in 2 axes
Product code: XACPIMB



Protective housing, stainless steel,
Incl. Mounting base
Product code: XACPIPH

High temperature accessories (optional for IR160 only)

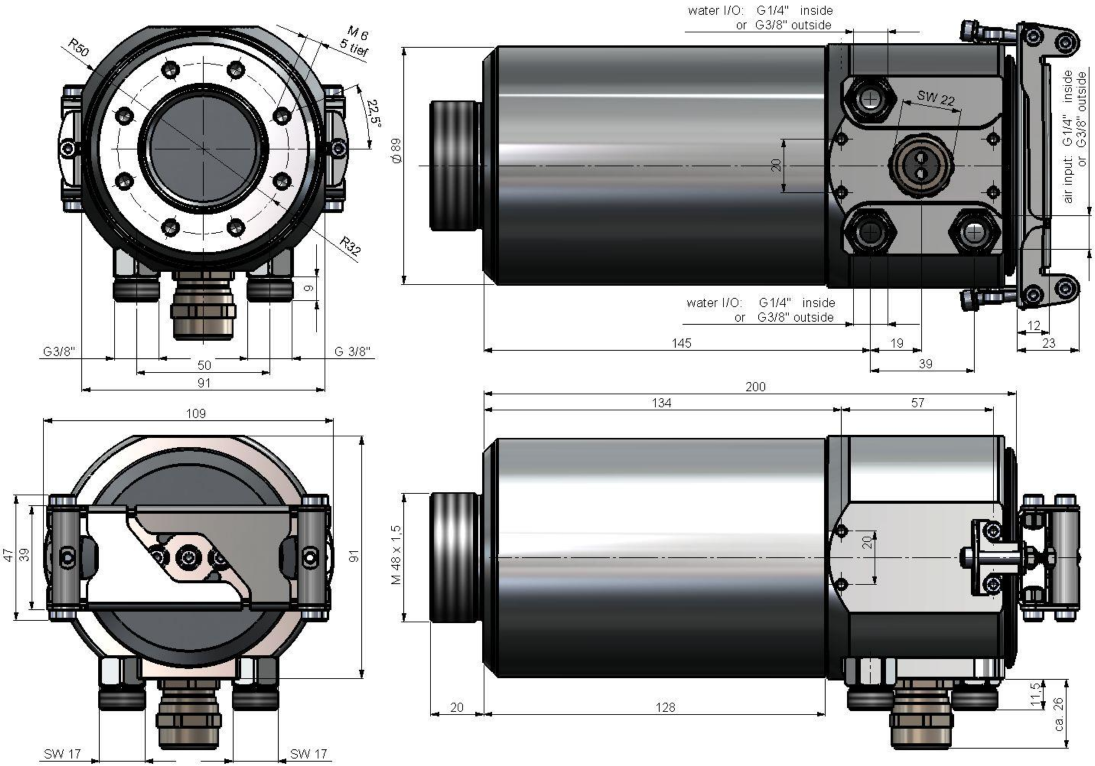
The imager IR160 can be used at ambient temperature up to 50°C
At higher temperatures (up to 240°C) the cooling jacket should be used.



Cooling jacket for IR
Product code: XACCJPI

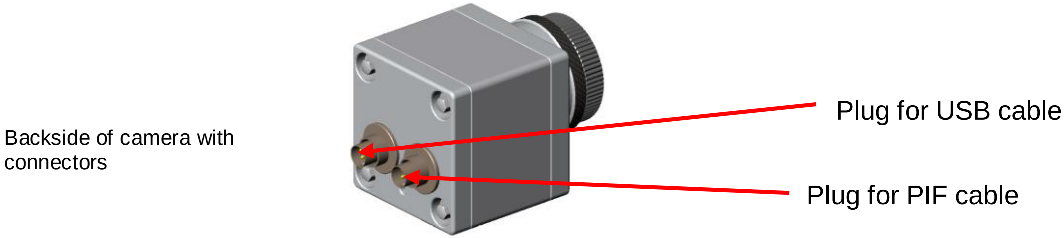
Mounting bracket for cooling jacket,
adjustable in two axes
Product code: XACCJAB

Cooling jacket dimensions:



7. Electrical Installation

At the back side of the IR you will find two connector plugs. Please connect the supplied USB cable with the left plug. The right connector plug is only used for the process interface.



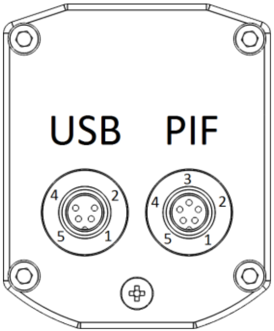
Process Interface

The IR 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.

Note

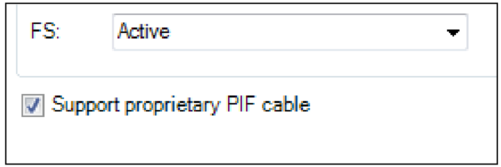
Please make sure that the process interface (electronics within cable as well as industrial interface) is powered separately (5-24 VDC). Please connect at first the PIF cable on the camera before powering it.

PIN Allocation



Rear side of camera

PIF	**1**	**INT**
	2	**SDA (I²C)**
	3	**SCL (I²C)**
	4	**DGND**
	5	**3,3V (Out)**
USB	**1**	**VCC**
	2	**GND**
	4	**D-**
	5	**D+**



In case you would like to connect the process interface of the camera directly to external hardware [1)] (without using the supplied PIF cable) you should activate the field „Support proprietary PIF cable" in the menu **Tools/ Configuration/ Device (PIF)** in the IRConnect software.

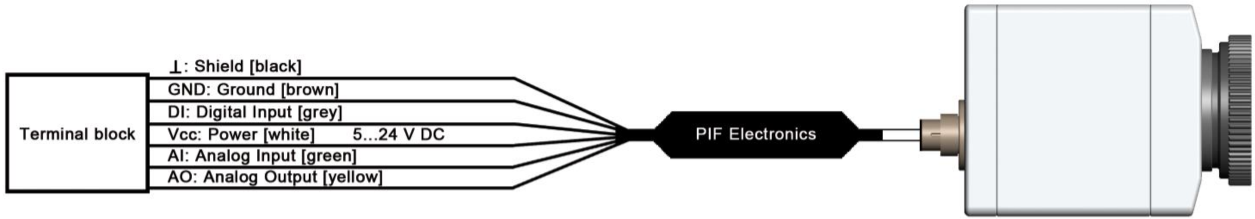
Note

In case of working with a direct PIF connection the input of the PIF is not protected!
A voltage > 3V on the INT pin will destroy the device!

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

The process interface can be activated choosing the following options:

Analog Input (AI):	Emissivity, ambient temperature, reference temperature, flag control, triggered recording, triggered snapshots, triggered linescanner, uncommitted value
Analog Output (AO):	Main area temperature, internal temperature, flag status, alarm
Digital Input (DI):	flag control, triggered recording, triggered snapshots, triggered linescanner



Configuration Standard Process Interface (PIF)

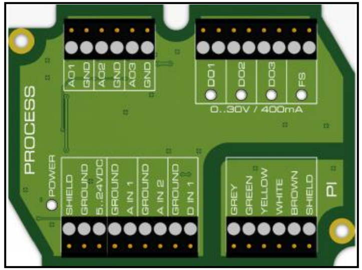
The standard process interface offers the following inputs and outputs:

Name	Description	max. range [1)]/ status
AI	analog input	0-10 V
DI	digital input	24 V
AO	analog output	0-10 V
	alarm output	0/ 10 V

[1)] depending on supply voltage

Industrial Process Interface (optional)

For use in industrial environment an industrial process interface with 500 VAC_{RMS} isolation voltage between IR and process is available (connection box with IP65, 5m, 10m or 20m standard or high temp cable for camera connection, terminal for process integration).
[► Appendix F: PIF]



Connections of the industrial process interface

Pin assignment PIF cable (industrial process interface)

GREY	Interrupt
GREEN	SCL (I²C)
YELLOW	SDA (I²C)
WHITE	3,3 V
BROWN	GND
SHIELD	GND

The industrial process interface offers the following inputs and outputs:

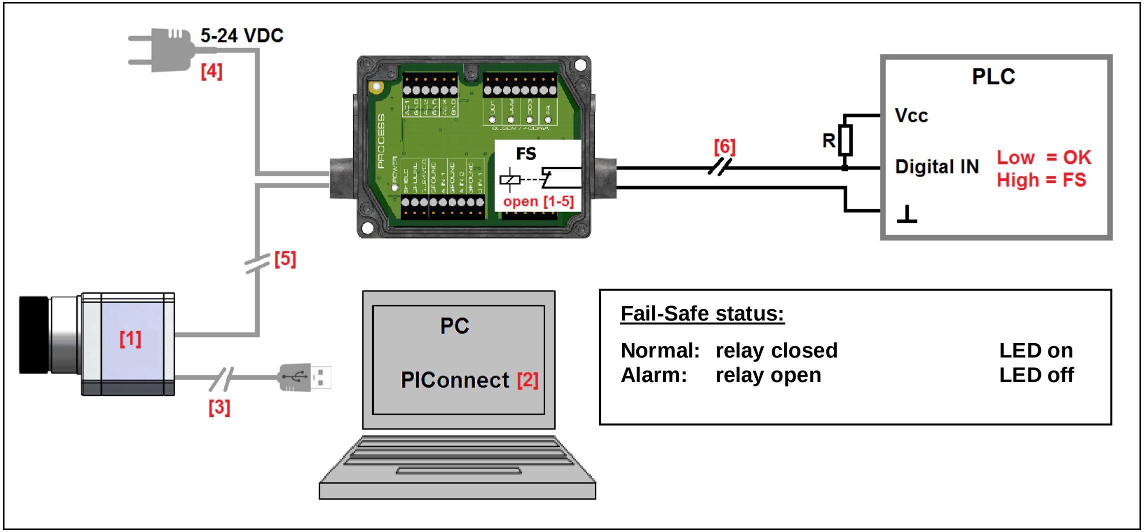
Name	Description	max. range [1)]/ status
A IN 1 / 2	analog input 1 and 2	0-10 V
D IN 1	digital input	24 V
AO1 / 2 / 3	analog output 1, 2 and 3	0-10 V
	alarm output 1, 2 and 3	0/ 10 V
DO1 / 2/ 3	relay output 1, 2 and 3 [2)]	open/ closed (red LED on) / 0...30 V, 400 mA
FS	fail-safe relay	open/ closed (green LED on)/ 0...30 V, 400 mA

1) depending on supply voltage
2) active if AO1, 2 or 3 is/ are programmed as alarm output

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.

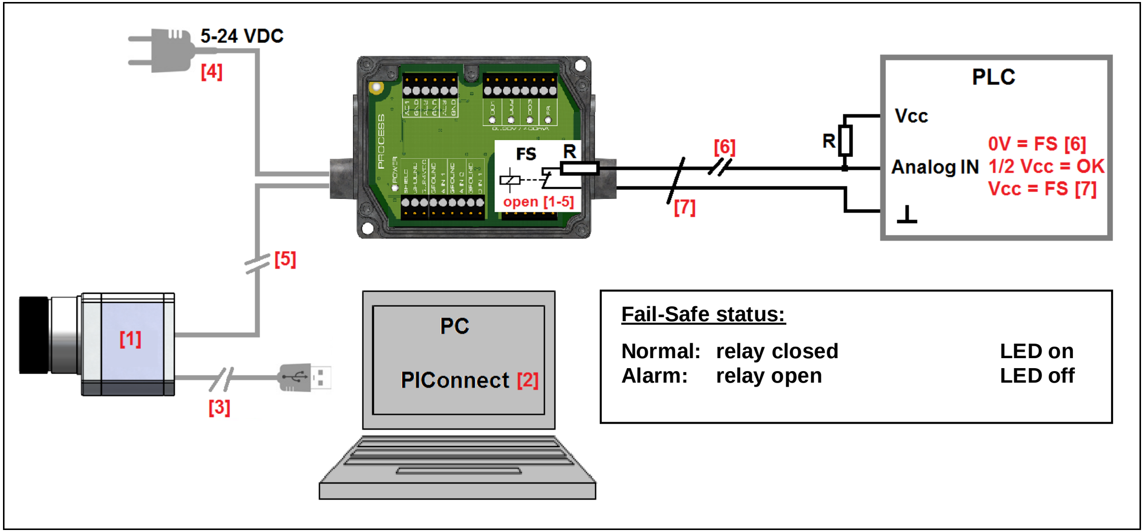
Controlled conditions on camera and software	**Standard Process interface ACPIPIF**	**Industrial Process interface ACPIPIF500V2CBxx**
Interruption USB cable to camera	√	√
Interruption data cable camera - PIF	√	√
Interruption power supply PIF	√	√
Shut-down of PIConnect software	√	√
Crash of PIConnect software	-	√
Fail-Safe output	0V at analog output (AO)	open contact (fail-safe relay)/ green LED off

Examples for a Fail-Safe monitoring of the IR with a PLC



Fail-Safe monitoring states

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

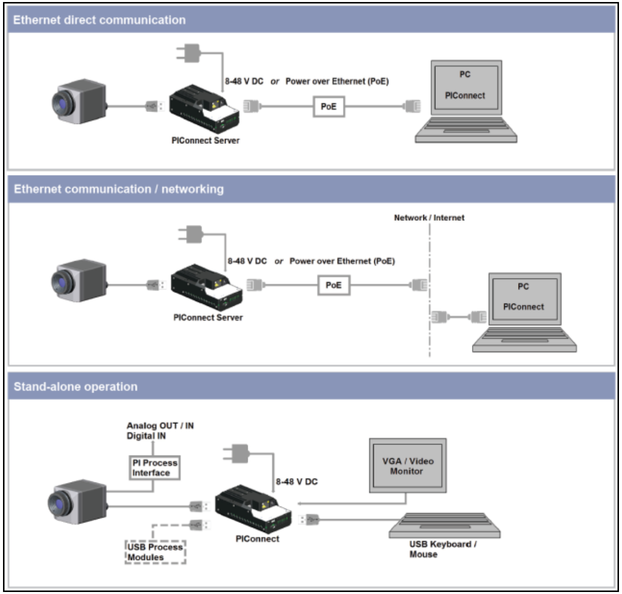


Fail-Safe monitoring states

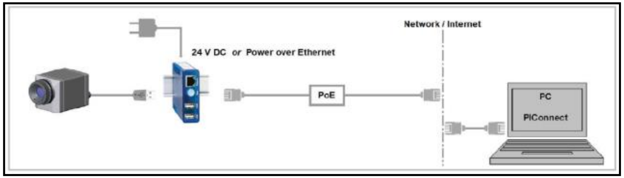
[1] Malfunction of IR
[2] Malfunction of IRConnect software
[3] Breakdown of IR power supply/ Interruption of USB cable
[4] Breakdown of PIF power supply
[5] Interruption of cable IR-PIF
[6] Cable break of fail-safe cable
[7] Short circuit of fail-safe cable

USB Cable Extensions

The maximum USB cable length is 20m. For greater distances between IR and computer or for stand-alone solutions you should use the optional IR NetBox or the USB-Server Industry Isochron:



IR NetBox



USB-Server Industry Isochron

8. Initial start-up

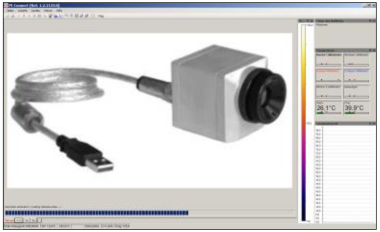
Please install at first the software IR Connect from the CD.

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

Now you can connect the infrared imager into an USB port (USB 2.0) of your PC.

Note
If connecting the imager and the computer please plug at first the USB cable into the camera and then into the computer.
If disconnecting the imager and the computer please remove at first the USB cable from the computer and then from the camera.

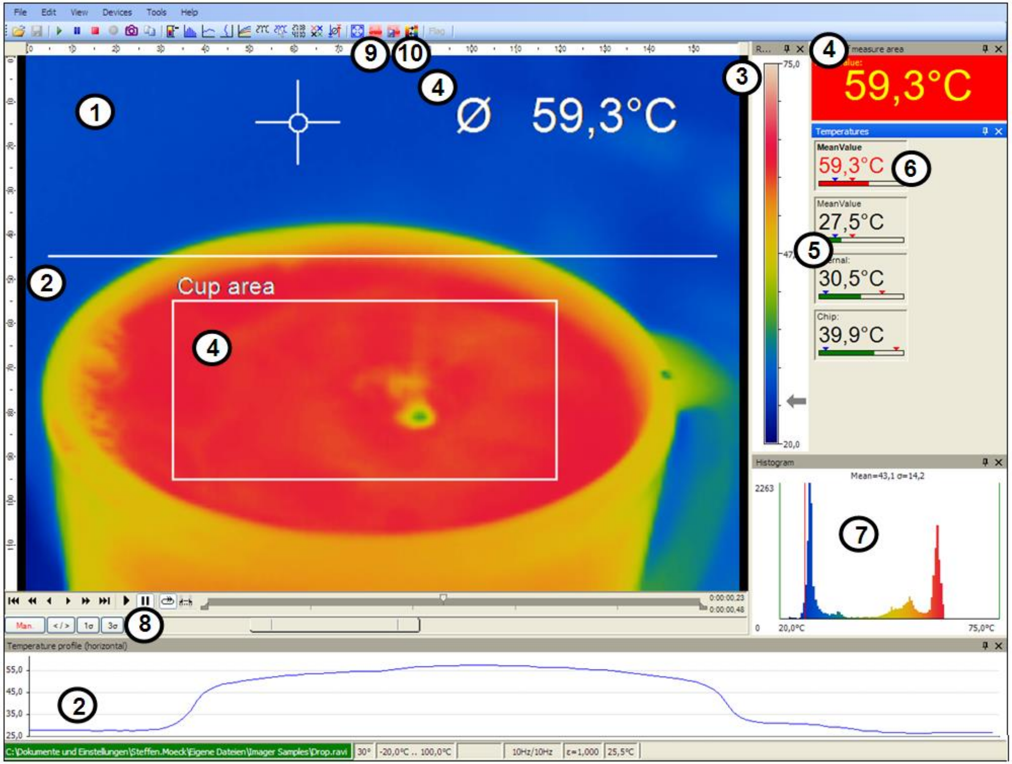
After the software has been started, you should see the live image from the camera inside a window on your PC screen.



Note
At first start of software you will be asked to install the calibration data of camera (supplied on the CD).

The sharpness of the image can be adjusted by turning the exterior lens ring at the camera.

9. Software IRConnect

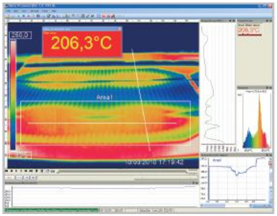
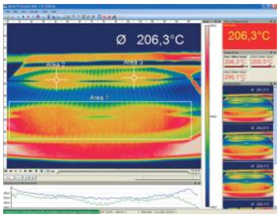


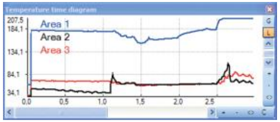
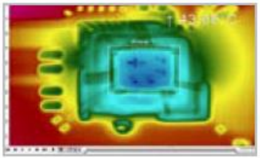
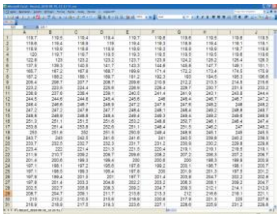
Example of software layout

Note
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	Reference bar: Shows the scaling of temperature within the color palette.
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	Control displays: Displays all temperature values in the defined measure areas like Cold Spots, Hot Spots, temperature at cursor, internal temperature and chip temperature.
6	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 temperature above the high alarm value) and to blue (when temperature below the low alarm value).
7	Histogram: Shows the statistic distribution of single temperature values.
8	Automatic / manual scaling of the palette (displayed temperature range): Man., </> (min, max), 1**σ** : 1 Sigma, 3**σ** : 3 Sigma
9	Icon for quick access to Image Subtraction function
10	Icon enabling switching between color palettes

Basic features of software IRConnect

	Extensive infrared camera software • No additional costs • 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 and 8
	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 • BI-SPECTRAL video analysis (IR and VIS) in order to highlight critical temperatures • 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 • BI-SPECTRAL process monitoring (IR and VIS) for easy orientation at point of measurement • Definition of visual or acoustic alarms and analog data output • Analog and digital signal input (process parameter) • External communication of software via Comports and DLL • 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 programs DLL or Comport interfaces

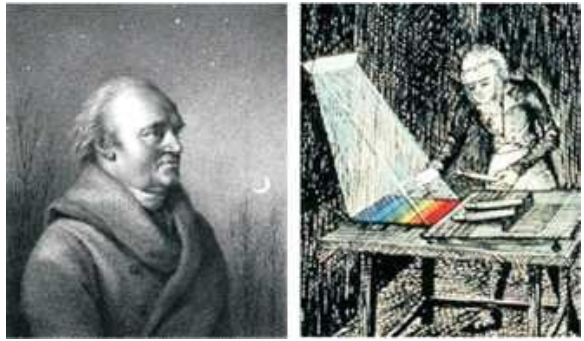
10. Basics of Infrared Thermometry

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

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

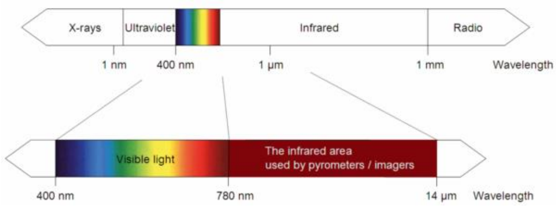
He blackened the peak of a sensitive mercury thermometer. This thermometer, a glass prism that led sun rays onto a table made his measuring arrangement.

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”.



William Herschel (1738 - 1822)

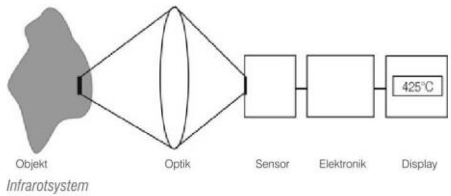
For the measurement of “thermal radiation” infrared thermometry uses a wave-length ranging between 1 µ and 20 µm.
The intensity of the emitted radiation depends on the material. This material contingent constant is described with the help of the emissivity which is a known value for most materials (see enclosed table emissivity).



The electromagnetic spectrum and the area used for temperature measurement

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

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

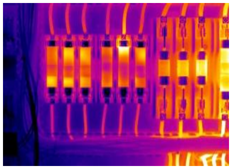


The specifications of the lens decisively determine the optical path of the infrared thermometer, which is characterized by the ratio Distance to Spot size. The spectral filter selects the wavelength range, which is relevant for the temperature measurement. The detector in cooperation with the processing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

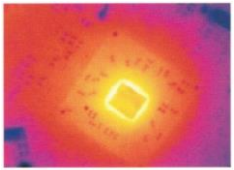
The advantages of non-contact temperature measurement are clear - it supports:

- 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

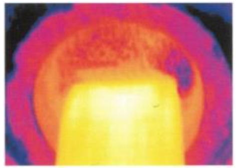
Application examples:



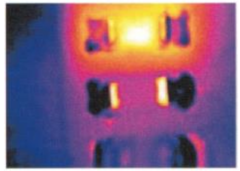
Monitoring of electronic cabinets



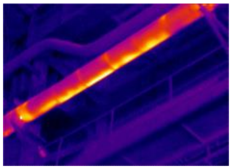
R&D of electronics



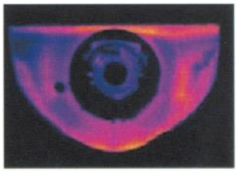
Process control extruding plastic parts



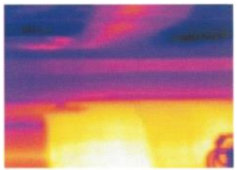
R&D of electronic parts



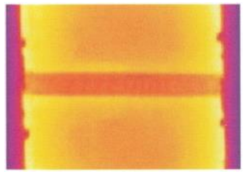
Monitoring of cables



R&D of mechanical parts



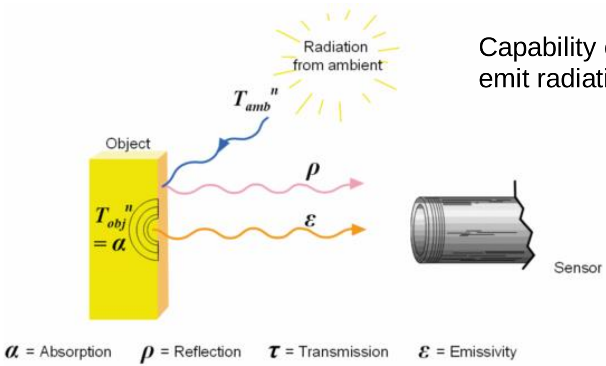
Process control at calendering



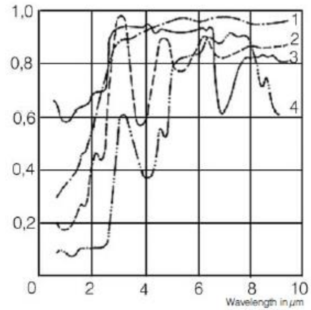
Process control manufacturing solar modules

Emissivity

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.



Capability of an object to emit radiation

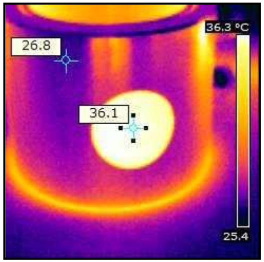


Spectral emissivity of some materials
1 Enamel, 2 Plaster, 3 Concrete, 4

Determination of unknown emissivity

► First, determine the actual temperature of the measuring object with a thermocouple or contact sensor. Second, measure the temperature with the infrared thermometer and modify the emissivity until the displayed result corresponds to the actual temperature.

► If you monitor temperatures of up to 380°C you may place a special plastic sticker (emissivity dots – part number: XACLSED) onto the measuring object, which covers it completely. Now set the emissivity to 0,95 and take the temperature of the sticker. Afterwards, determine the temperature of the adjacent area on the measuring object and adjust the emissivity according to the value of the temperature of the sticker.



Plastic sticker at metal surface

► 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. 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.

Shiny metal surface

Blackened metal surface

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

Characteristic Emissivity

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

- temperature
- measuring angle
- geometry of the surface
- thickness of the material
- constitution of the surface (polished, oxidized, rough, sandblast)
- spectral range of the measurement
- transmissivity (e.g. with thin films)

Appendix A – Emissivity Table Metals

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

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

Appendix B – Emissivity Table Non Metals

Material		typical Emissivity
Asbestos		0,95
Asphalt		0,95
Basalt		0,7
Carbon	non oxidized	0,8-0,9
	graphite	0,7-0,8
Carborundum		0,9
Ceramic		0,95
Concrete		0,95
Glass		0,85
Grit		0,95
Gypsum		0,8-0,95
Ice		0,98
Limestone		0,98
Paint	non alkaline	0,9-0,95
Paper	any color	0,95
Plastic > 50 µm	non transparent	0,95
Rubber		0,95
Sand		0,9
Snow		0,9
Soil		0,9-0,98
Textiles		0,95
Water		0,93
Wood	natural	0,9-0,95

Appendix C - Serial Communication (a brief overview)

Introduction

One of the features of the IR 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 IR connect software is installed.

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.

Command list

You will find the command list on the CD provided.

Appendix D – Interprocess Communication (IPC)

The communication to the process imager device is handled by the IR Connect software (Imager.exe) only. A dynamic link library (ImagerIPC2.dll) serves 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 ImagerIPC.dll are designed for Windows XP/Vista/7 only. The application must support call-back functions.

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

Note
The description of the init procedure as well as the necessary command list you will find on the CD provided.

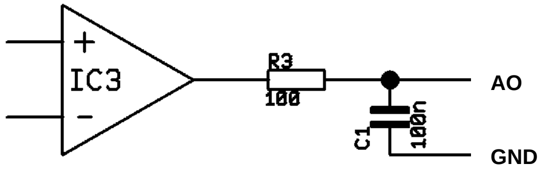
Appendix E – IR Connect Resource Translator

IR 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 (e.g.: 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 IR Connect application we have developed the small tool "Resource Translator". This tool helps to translate any visible text within the IR Connect application.

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

Appendix F – Process Interface

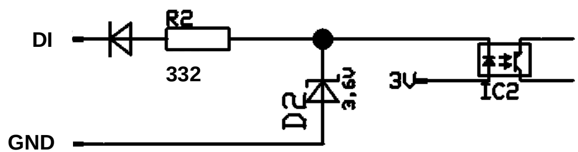
Analog Output:



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

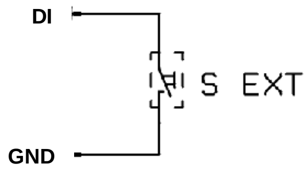
The analog output can be used as a digital output. The voltage for “no alarm” and “alarm on” can be set within the software. The analog output (0 … 10V) has a 100 Ohm resistor in raw. With a maximum current of 10ma the voltage drop is 1V.
Having an alarm LED with a forward voltage of 2V the analog output value for “alarm on” should be 3V as maximum

Digital Input:

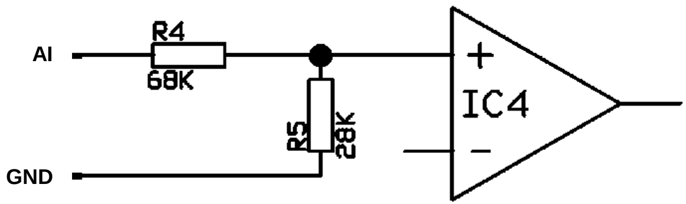


The digital input can be activated with a button to the IR GND or with a low level CMOS/TTL signal:
Low level 0…0.6 V; high level 2…24 V

Example button:



Analog Input:



Useable voltage range: 0 … 10 V

Relay output on Industrial process interface [XACPIPIF500V2CBxx]

The analog output has to be set to „Alarm".
The voltage level for AO1-AO3 can be set in the software (no alarm: 0V / alarm: 2-10V)

REL1-3 (DO1-DO3): Umax = 30VDC
Imax = 400mA