AT-Automation Technology GmbH

IRSX User Manual

IRSX-I336, IRSX-I640

Content

General Notes

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Warranty Conditions

Only the manufacturer can accept the terms of the guarantee. If the manufacturer is not responsible for the malfunction, the warranty right is considered void. This is the case if the device has been changed electrically or mechanically. Especially when changing the wiring / soldering, or when the device is used for purposes not intended by the manufacturer, or if the external wiring of the device is faulty, or if the device is used outside the conditions specified in this manual.

Return Policy

Before returning a camera for repair (warranty or non-warranty) to AT – Automation Technology GmbH a Return Material Authorization (RMA) number has to be provided by AT. Please get in contact with the AT support to receive a RMA. If the camera was not purchased directly from AT, please contact your distributor to start the RMA process. Ship the sensor carefully packed in its original shipping box or an equivalent box

Contact

AT-Automation Technology GmbH
Hermann-Bössow-Str. 6-8
D-23843 Bad Oldesloe
Germany
Tel.: +49 4531 88011-0
Email: support@AutomationTechnology.de
www.AutomationTechnology.de

Symbols and Notes used in the Document

The following general safety rules must be taken into account during installation, operation and maintenance. Failure to do so may cause damage to the operator, the camera or the environment.

Warning

- Do not use the camera in adverse environmental conditions, such as in rooms with a high concentration of flammable gases, vapors or dust. The camera must not be operated under water.
- Make sure that all cables are routed without risk of tripping.
- Only connect the power cord to the mains voltage after finishing the installation of the camera.

Read the manual

- Read the operating instructions before using the camera.
- Make sure that the operating personnel have read the operating instructions and understood the contents!
- Observe the safety instructions.
- Observe the locally applicable safety and accident prevention regulations.
- In case of any uncertainty contact the manufacturer.

CE marking, see Declaration of conformity

RoHS RoHS mark, the system complies with RoHS Directive 2002/95 / EC

WEEE mark, the system is registered according to the WEEE directive under the WEEE-Reg.-No. DE 13042735

Safety information

General remark

Introduction

The temperature measuring infrared cameras of the IRSX series are specially designed for industrial applications. With their small size, the cameras can be used even in the tightest of space. The robust design, combined with their IP67 protection class, an extended ambient temperature range up to 60°C and an integrated air purge are additional features which often allow the installation in industrial environments without an additional protective housing. The installation effort is thereby significantly reduced.

Two variants of the infrared camera with different frame rates are available: A slow version and a fast variant.

The cameras are GigE Vision and GenICam compatible and can be connected to any GenICam compliant software. With its worldwide standardization, the Ethernet interface allows an easy integration even into existing networks. The maintenance-free design, based on uncooled microbolometer image sensors ensures a long and trouble-free operation.

Intended use

The image sensor of the camera is a highly sensitive electronic component. If the radiation from high power density sources (e.g., laser radiation or their reflections) hits the sensor, irreparable damage may result. This also applies if the camera is switched off. Damage of this kind is excluded from the warranty.

Do not use the camera at ambient temperatures above 60°C, unless otherwise specified in the technical specifications. Higher temperatures can damage the camera. For applications near ovens or other high temperature environments, the camera must be protected from radiant heat with a heat shield. Using it without a heat shield can damage the camera.

Calibration

The cameras are delivered with a radiometric calibration for accurate temperature measurements. To ensure high measurement accuracy, it is recommended to have the calibration checked every 2 years.

Accuracy

The IRSX series uses only uncooled infrared image sensors for temperature measurement. Rapid changes of the ambient temperature greater than 15°C can affect the accuracy of the measurement. To achieve the highest possible accuracy it is recommended to start with temperature measurements only 15 minutes after starting the camera or after a significant change of the ambient temperature.

Disposal

Like most electronic products, IRSX series cameras are subject to environmentally sound disposal regulations. Please contact the manufacturer for additional information.

Technical Specifications

General Specifications

Model	**IRSX-I-336**		**IRSX-I-640**	
Detector type	Focal Plane Array (FPA), non-cooled microbolometer			
Spectral range	7.5 to 13 µm			
Pixel size	17 x 17 µm			
Frame rate	Slow 9 Hz	Fast 30/60 Hz	Slow 9 Hz	Fast 30 Hz
Measurement				
Measurement ranges	High Gain		-20°C to 135°C	
	Low Gain		-40°C to 550°C	
Accuracy	±2°C (±3,6 °F) or ±2% of the measured value (+10 to +100°C @ +10 to +35°C amb)			
NETD	< 30 mK @ F/1.0			
Lenses with air purge (IP 67)				
7.5 mm (f/1.4, f/1.2)	42° x 32°		72° x 60°	
9 mm (f/1.4)	35° x 27°		62° x 52°	
13 mm (f/1.25)	25° x 19°		45° x 37°	
19 mm (f/1.25)	17° x 13°		32° x 26°	
35 mm (f/1.5)	9.3° x 7.1°		18° x 14°	
Lenses without air purge				
35 mm	9.3° x 7.1°		18° x 14°	
50 mm	6.5° x 5.0°		12° x 9.9°	
60 mm	5.5° x 4.2°		10° x 8.3°	
100 mm	3.3° x 2.5°		6.2° x 5.0°	
Zoom lenses				
35 mm – 105 mm **				

(*) Subject to dual use export regulations (for frame rates > 9 Hz)

(**) On request

Electrical Specifications and Interfaces

Electrical Specifications	
Input voltage range	+10 to +24 V (DC)
Power consumption	4.0W (IRSX-336S) 4.2W (IRSX-640S)
Interfaces	
Ethernet connector	8 Pin, A-coded M12
Ethernet type	10, 100, 1000 Mbit/s
Ethernet protocols	DHCP, DNS, GigE Vision
Communication protocol	GigE Vision with GeniCam
Ethernet image stream	16-Bit, 14-Bit, 12-Bit, 8-Bit
Analog video out	Available on request
Inputs / Outputs	
Digital Inputs	2x electrically isolated, 5 - 24 VDC (max. 27 VDC) VIL, logic "0" voltage < 1.5V VIH, logic "1" voltage > 3.5V Max. frequency: 450 kHz
Digital Outputs	2x electrically isolated, 5 - 24 V (DC) VOL, logic "0" voltage < 0,5V VOH, logic "1" voltage ≥ 3,8V IOH, logic "1" max. current 100 mA
Digital I/O, input voltage	4.5 - 30 V (DC), max. 100 mA
Encoder / Resolver Input	A+,A-, B+,B- High-Speed, Dual RS-422/RS-485 Receiver Max. input voltage 24V DC RS422-Mode, max. frequency: 15 MHz
Analog Output	0 - 5V DC
Analog Input	0 - 5V DC
Connector Type	17 pin, M12 connector (shared with external power)

Mechanical and Environmental Specifications

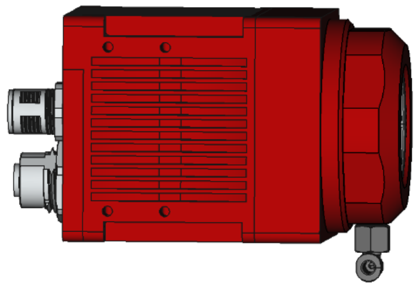
Mechanical specifications	
Dimensions	(55 x 55 x 61.5)mm (w/o lens, w/o connectors) (55 x 55 x 77)mm (w/o lens, w/ connectors)
Weight	270g (w/o lens)
Lens mount	M24 x 0,5 (lenses with air purge) M34 x 0,5 (lenses without air purge, zoom lens)
Mounting	4x M3 threaded holes (all sides)
Material	Aluminum
Environmental	
Protection class	IP 67 (IEC 60529)
Operating temperature range	-40°C to +60°C
Storage temperature range	-50°C to +80°C (IEC 68-2-1 and IEC 68-2-2)
Humidity	0 to 95% relative humidity, non-condensing (IEC 60068-2-30)
Bump	200g (IEC 60068-2-29)
Vibration	4.3g (IEC 60068-2-6)
RoHS	compliant

Installation and Connection

Mechanical Installation

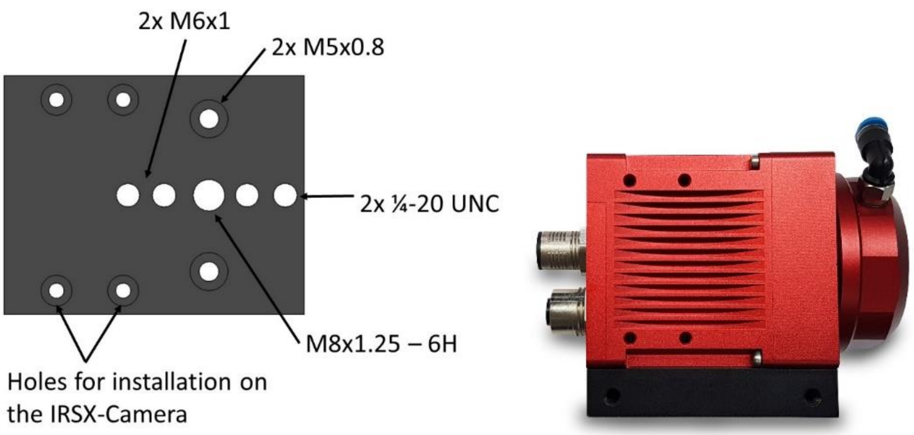
The camera can be mounted via four M3 mounting holes on each side of the housing.

Note: The tightening torque for the M3 screws must not exceed 1 Nm.



Mounting with Base-Adapter

Alternatively, the IRSX camera can be installed with the optional mounting adapter. The adapter provides a variety of threaded holes (metric and inches) and 4 holes for installation on the camera (see Figure 3 or Section 6.2.5).



Mounting with adjustable Pan-Tilt head

The mounting bracket allows installing the IRSX camera with an adjustable pan and tilting angle to the mounting point (e.g., aluminum profile).

Figure 1: IRSX with adjustable mounting bracket.

For the installation of the adjustable bracket the base adapter is required. The adjustable bracket can be connected to the adapter by an M8 screw. It is important to make sure that the pins at the adjustable bracket engage into the holes provided in the adapter.

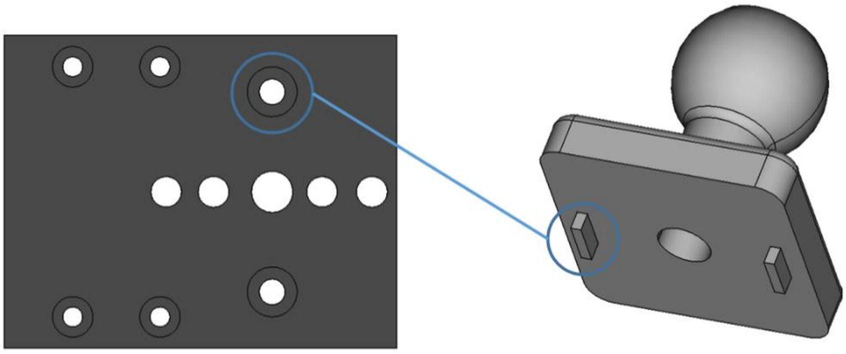
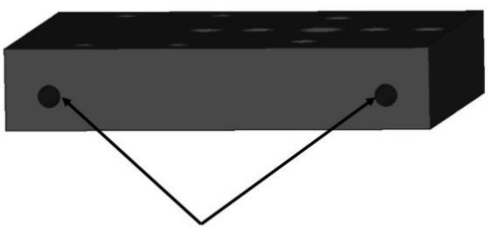


Figure 2: Installation of the adjustable mounting bracket to the base adapter.

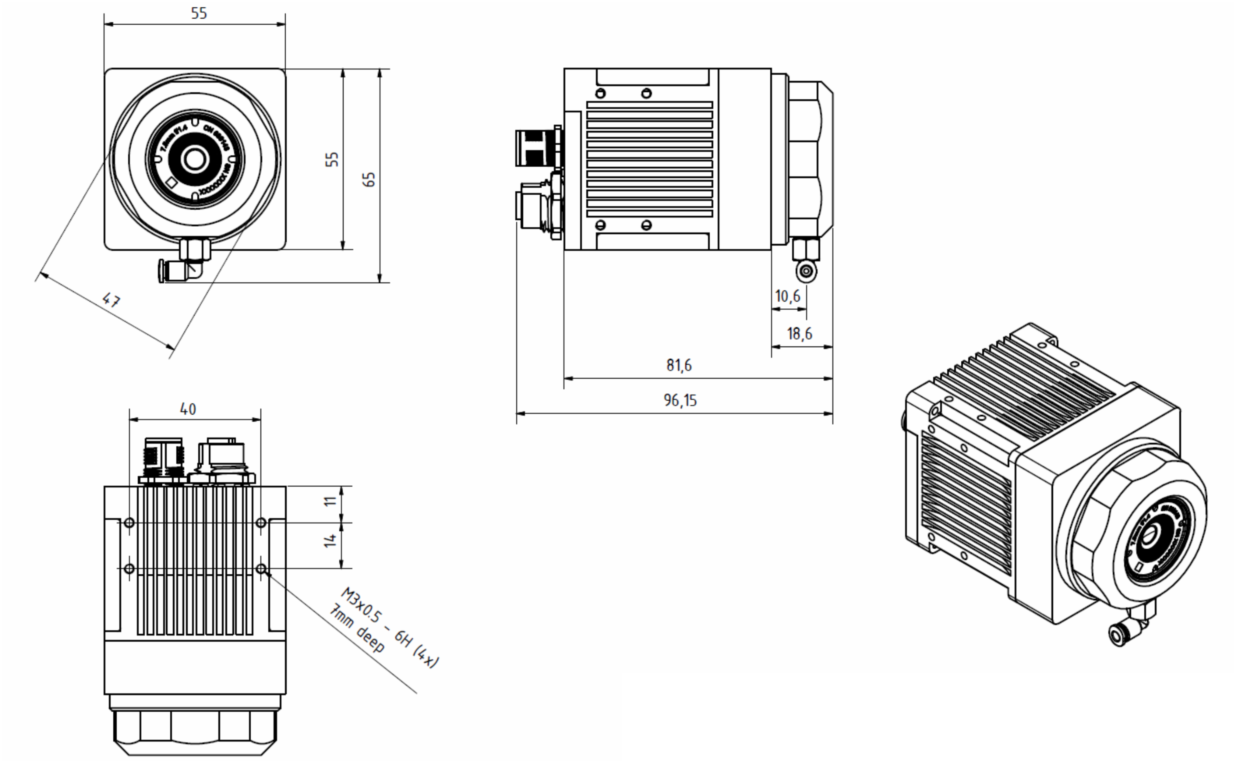
Mounting the Sunroof

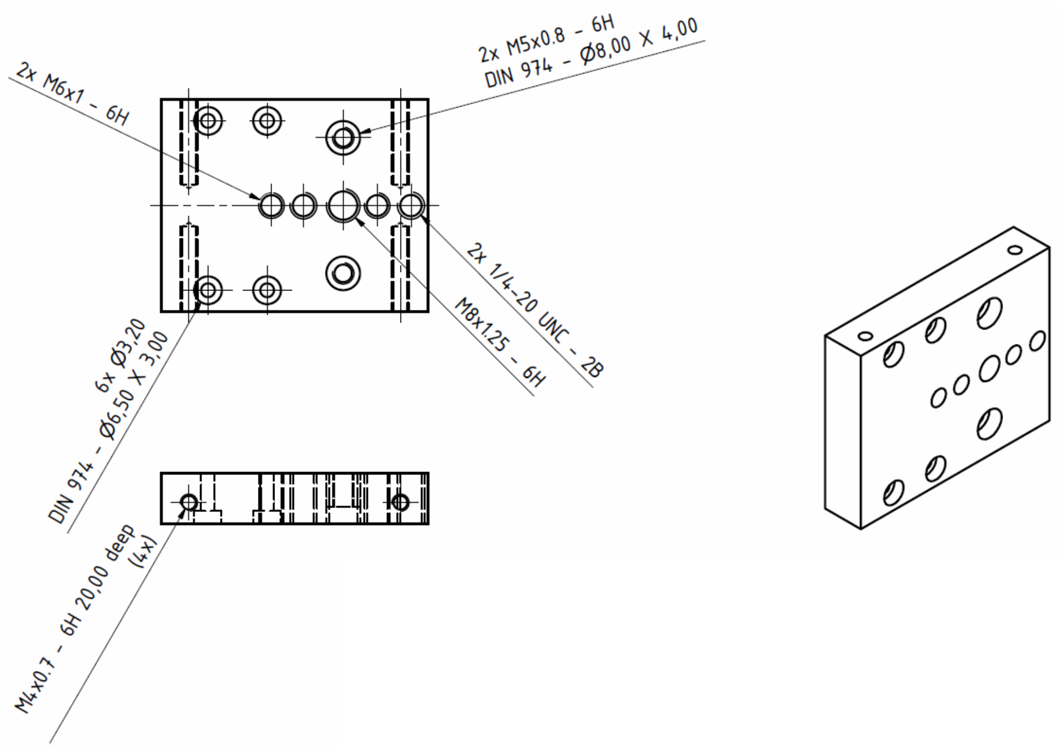
For protection against the weather and to reduce solar reflections, the IRSX can be equipped with a sunroof (the base adapter is required for mounting the sunroof).

The side tapped holes in the base adapter (M4 x 0.7, 20 mm deep) are used for mounting.



Drawings


55
55
65
47
40
11
14
M3x0.5 - 6H (4x)
7mm deep
10,6
18,6
81,6
96,15

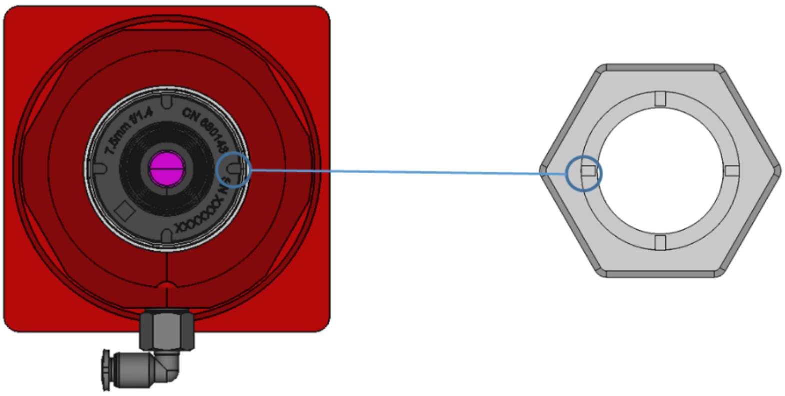

2x M6x1 - 6H
2x M5x0.8 - 6H
DIN 974 - Ø8,00 X 4,00
2x 1/4-20 UNC - 2B
M8x1.25 - 6H
6x Ø3,20
DIN 974 - Ø6,50 X 3,00
M4x0.7 - 6H 20,00 deep
(4x)

Focusing the Camera

Use the focusing tool delivered with the camera to adjust the lens to the working distance.

Never turn out the lens completely!

For focusing, place the focusing tool on the lens, so that the pins of the tool engage in the grooves of the optics and the tool lies flat on the lens. Turn the lens until the image is in focus. Turning to the left sets the focus to "near", turning to the right sets the focus to "far".

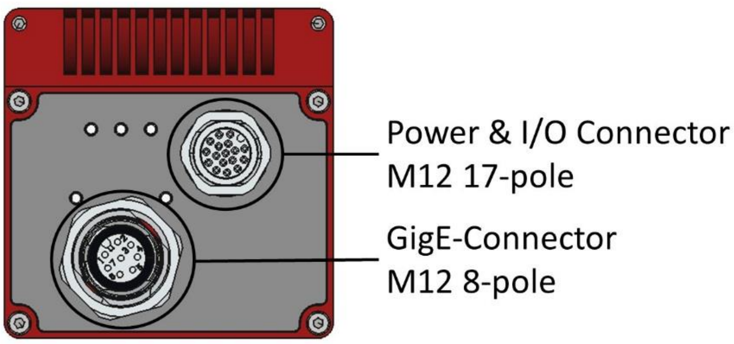


Electrical Installation

On the rear of the IRSX camera there are two M12 connectors. Connect the power connection cable to the Power & I / O connector (see Figure 10). Connect the Ethernet cable to the GigE connector. After the cables are connected to the camera, connect them to the power supply (10 - 24V DC) and to the PC.

Note the operating voltage range and the polarity!

The pin assignment of the I/O interface is described in section 6.5.1.



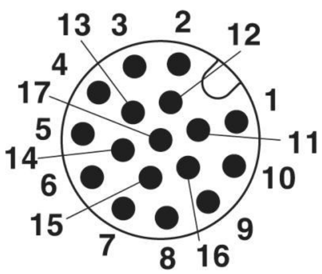
Power Supply and I/O Interface

The IRSX camera is compliant to the GenICam standard. This allows an easy access to the properties of the camera (e.g. gain mode, object parameters, etc.), as well as to functions available on the camera. Functionalities of the inputs / outputs can also be configured via this interface.

More information about the GenICam standard can be found at www.GenICam.org.

Table 1: Configurable interface elements.

	Configurable function
Encoder / Resolver	Trigger
Digital I/O	Trigger Input / Output



Numbering of the pins of the IRSX M12 connector

The following table shows the pin assignment of the interface.

Table 2: Pin assignment of the Power & I/O connector

Pin	Signal Name	Description
1	AI	Analog input
2	AO	Analog output
3	-	No function (do not connect)
4	ENC_B+	Encoder / Resolver Track B+
5	AX_GND	Ground for Analog Input and Output (AI, AO)
6	ENC_B-	Encoder / Resolver Track B -
7	ENC_A-	Encoder / Resolver Track A -
8	VCC	Power supply for the camera (10-24V DC)
9	GND	Ground for camera power supply
10	ENC_A+	Encoder / Resolver Track A+
11	ENC_GND	Encoder / Resolver Ground
12	OUT2	Digital Output 2, electrically isolated
13	IN1	Digital Input 1 (5-24V DC), electrically isolated
14	IN2	Digital Input 2 (5-24V DC), electrically isolated

15	I/O_Supply	Reference voltage for digital outputs (5-24V DC)
16	OUT1	Digital Output 1, electrically isolated
17	IO_GND	Ground for Digital Inputs / Outputs
Shield	SHIELD	Shield

Before connecting the camera, check whether the inputs and outputs are suitable for a voltage of 24V. The suitability can be found on the nameplate (IO: 24V).

The Status LEDs

Figure 3: Rear of the IRSX-Camera

The LEDs on the back of the IRSX indicate the different operating states of the camera. These are described in Table 5.

Table 3: Description of the status LEDs

LED	Description
1 - PWR	Green = Operating voltage applied and camera start completed Off = No operating voltage or camera start failed
2 - USR	After switching the camera on: Off = no network cable connected Green = network connected After connecting to the network: Green = CCP status connected Off = CCP status disconnected *Red = no network found, no network cable connected*
3 - MOD	Red = modulation is on

	Off = modulation is off
4 - ACT	Green blinking = network activity indicator
5 - LNK	Green = connection speed 1 Gbit Orange = connection speed 100 Mbit *Off = connection speed 10 Mbit or waiting for end of auto negotiation*

The IRSX-IO Panel

The IRSX-IO panel provides a user friendly way to connect the power supply and the input and output lines via terminal strips. With the DIN rail mounting bracket, the panel can be easily integrated into control cabinets. The power supply includes a reverse voltage protection and features a 2A (two ampere) micro-fuse.

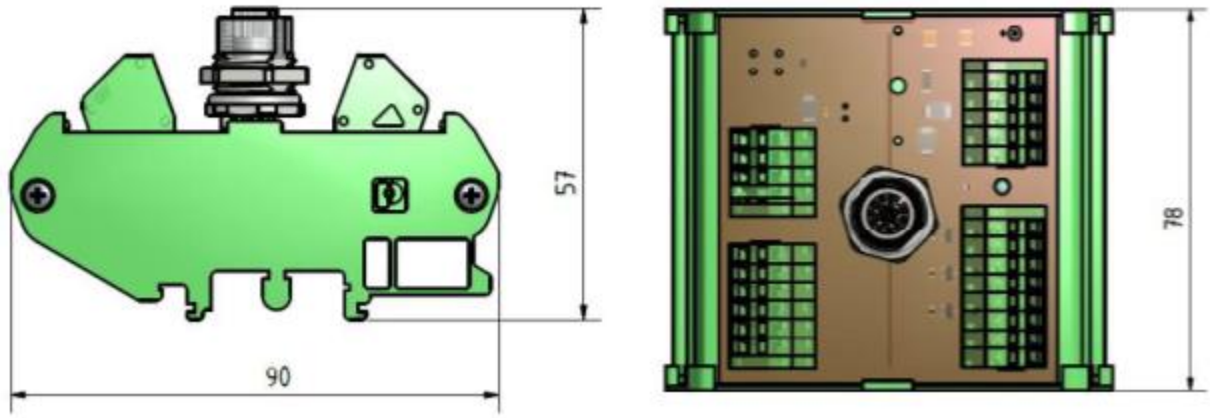


Figure 4: Dimensions of the IRSX-I/O panel

Note the electrical specifications of the IRSX-IO panel described in Table 6

Table 4: Electrical specifications of the IRSX-IO panel.

Identifier	Description
Operating voltage	10 - 24 V DC (max. 27 V DC), reverse polarity protected
Fuse	2 amp fuse, slow (20 mm x 6.3 mm)
Digital trigger input	2 inputs (electrically isolated), 5 - 24 VDC VIL, logic “0” voltage < 1.5 V VIH, logic “1“ voltage > 3.5 V
Digital outputs	2 outputs VOL, logic “0” voltage < 0.5 V VOH, logic “1” voltage ≥ 4.5 V IOH, logic “1” max. 100 mA IOL, logic “0” max. 100 mA
Resolver inputs	2 differential pairs Input voltage max. ± 24 V DC
Analog output	0 - 5.0 V Max. short circuit current 15 mA
Analog input	0 - 5.0 V No overvoltage protection

For protection, the panel has a replaceable micro-fuse. The green LED indicates the operating states of the panel (see Table 7).

Table 5: Jumper, LEDs and fuse of the panel

Identifier	Type	Description
JP4	Jumper	Jumper for connecting the camera ground to the shield
D2	LED	Green = operating voltage applied Off = no operating voltage applied or fuse defective
F1	Fuse	2 amps slow (20 mm x 6.3 mm)

Connect the cable for power supply and IO to the M12 socket on the panel. The power supply and the input and output signals can be connected via terminals. The assignment of the connections is shown in Table 8.

Table 6: Pin assignment IRSX-IO panel

Clamp No.	Signal Name	Description
J2/1	Shield	
J2/2	GND (-)	Camera Ground
J2/3	GND (-)	Camera Ground
J2/4	VCC (+)	Camera Supply Voltage (10 – 24 V DC)
J2/5	VCC (+)	Camera Supply Voltage (10 – 24 V DC)
J3/1	Z-	Not connected
J3/2	Z+	No function
J3/3	B-	Track 2 -
J3/4	B+	Track 2 +
J3/5	A-	Track 1 -
J3/6	B+	Track 1 +
J3/7	ENC_GND	Ground Encoder / Resolver
J3/8	Shield	
J4/1	I/O_GND	Ground Digital IO
J4/2	I/O_Supply	Supply Voltage IO
J4/3	OUT1	Digital Output 1

J4/4	OUT2	Digital Output 2
J4/5	IN1	Digital Input 1
J4/6	IN2	Digital Input 2
J5/1	IO_GND	Ground Digital IO
J5/2	AX_GND	Ground Analog IO
J5/3	AOUT	Analog Output
J5/4	AIN	Analog Input

The analog output ground is directly connected to the internal camera ground. The analog output is NOT electrically isolated from the device ground! Please take care for a correct operation.
Before connecting the camera, check whether the inputs and outputs are suitable for a voltage of 24V. The suitability can be found on the nameplate (IO: 24V).

Network Configuration

The camera supports the following link speeds: 10/100 or Gigabit Ethernet. To get the maximum performance, the camera should always be connected to a Gigabit Ethernet port.

Configuration of the Ethernet interface

Make sure your network card has been installed to the specifications of your network card manufacturer.

In the delivery state, the DHCP of the IRSX is activated; the camera obtains the IP automatically. The network adapter used must be set to "Obtain an IP address automatically".

Example of configuration procedure (Windows 10):

- Press the Windows key on your keyboard
- On your keyboard, type "Control Panel"
- In the open window, search for Network Status and Tasks
- Search on the left to change adapter settings
- After right-clicking on the relevant Ethernet port, select Properties
- In the newly opened window search for Internet Protocol version 4 (TCP / IPv4) and open it with a double-click

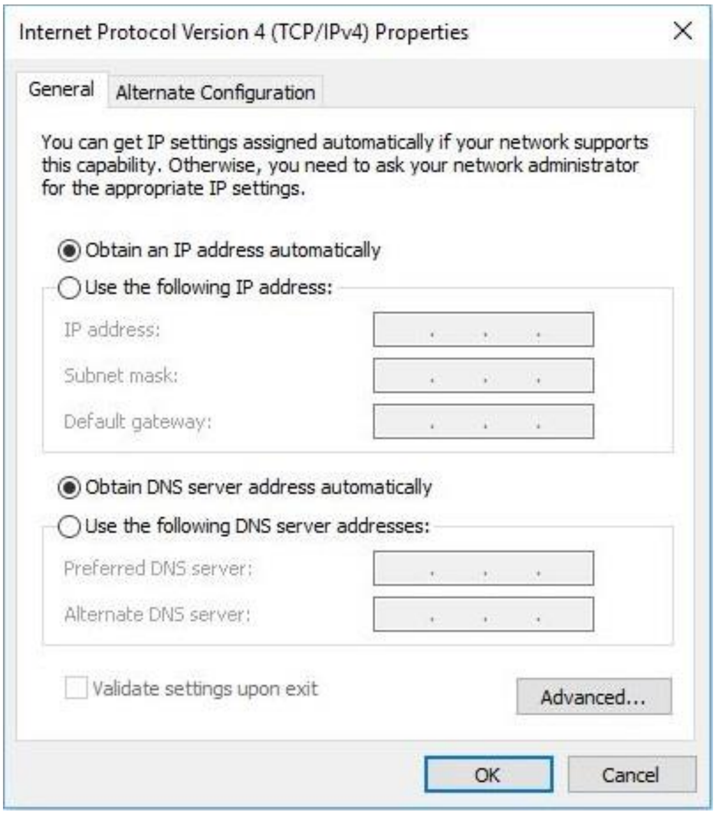


Figure 14: Settings of the network adapter (TCP/IPv4)

- Activate the checkbox "Obtain IP automatically" in the displayed window and confirm the setting with OK.

The following adapter settings are additionally recommended for the best possible performance:

- In the properties window of the Ethernet adapter, click on Configure
- In the new window, select “Advanced”
- Search for “Large Package” (Jumbo Packet) and select 9014 bytes (or the largest possible value)
- Search for Receive Descriptors and set the value as high as possible. (For example, 2048)
- Search for interrupt moderation and activate it.
- Find Interrupt Moderation Rate and set it to Extreme
- Click on OK and close all relevant windows

Maintenance Instructions

Cleaning the Camera

The camera is maintenance-free. This chapter is limited to cleaning the camera. Use only the following items:

- Water
- Residue-free, weak detergent solution
- Soft cloth
- Lens cleaner liquid or 96% ethyl alcohol
- Lens cleaning cloths

Clean the cameras with the wetted, non-dripping cloth. Never expose the camera to running liquids or immerse it. Clean the lens only when necessary and use only special lens cleaners and wipes.

The sensor of the camera is structurally protected by the optics and housing. If the sensor is dirty, it must only be cleaned by authorized specialist personnel. Unscrew the optics only when absolutely necessary and within a clean environment. Hold the camera with the sensor facing down.

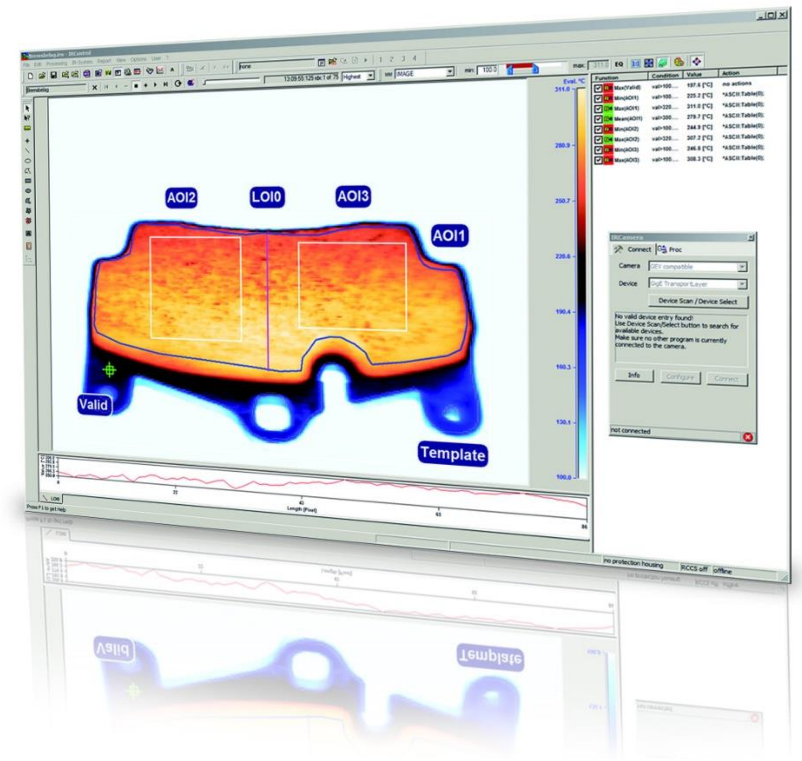
Never use solvents or similar liquids to clean the camera, cables or accessories. This can lead to damage!!

Software

The IRControl software comes with a 30-day trial license to operate the cameras. Each model of the IRSX series is compatible with GigE Vision and GenICam and can be run with any third-party software that supports these standards. A list of compatible software packages can be found on the following page.

Please note that the software IRControl cannot be started after the test period has expired. To purchase a permanent license, contact Automation Technology or local distributor.

IRControl



The IRControl software is used to analyze infrared images according to a user-defined measurement plan. It can output digital control signals or record image sequences and measurement data when certain user-defined temperature events occur. This functionality allows setting up controls for temperature-dependent industrial processes.

Depending on the type of camera and the hardware used, the program can also be used to analyze and control highly transient thermal processes. The program displays live images or saved images in a window with a selectable color palette. Images and image sequences can be saved to hard disk for subsequent analysis.

To create a measurement plan, the following analysis tools (AOI) are available: spotmeter, line, elliptical line, contour, rectangle, polygon, ellipse, mask and template. The analysis tools can be placed in any number in the infrared image and can be changed in size and shape, so that the evaluation of the temperature distribution is possible even on very complex objects.

For each analysis tool inserted into the image, the user can specify operations that calculate corresponding values from the temperature distribution within the AOI. The following operations are offered by the program: No operation, minimum, maximum, temperature range, mean, variance, standard deviation Center of Mass (CoM).

In addition, history functions (functions over time) are available. These are: No operation, minimum, maximum, mean, variance, standard deviation, difference between maximum and minimum, and a trend analysis based on the mean and maximum trends.

The results of the operations applied to two AOIs can be linked together, which considerably increases the possibilities for creating a measurement plan. The following combinations are available as linking options: No operation, determination of the minimum, maximum, mean, addition or subtraction of both values and calculation of the difference between the two values.

Third Party Software

For example, the IRSX camera series is compatible with the following third-party software:

Software	Provider	Remarks
Common Vision Blox Camera Suite	Stemmer Imaging	License integrated into camera
MATLAB	MathWorks	Incl. Image Acquisition Toolbox
LabView	National Instruments	incl. Vision Acquisition Software
HALCON	MVTec	
EyeVision	EVT	

Please observe the installation instructions of the manufacturer.

Automation Technology cannot provide support for third-party software.

Further information about GigE Vision and GenICam can be found at:

http://www.emva.org

Thermography and Radiometric Properties

Field of View and Temperature Measurement

Figure 11 shows the horizontal (HFOV) and vertical (VFOV) field of view. Depending on the distance of the camera to the observed scene, the maximum scene width increases. As the distance increases, the resolution on the object to be measured changes.

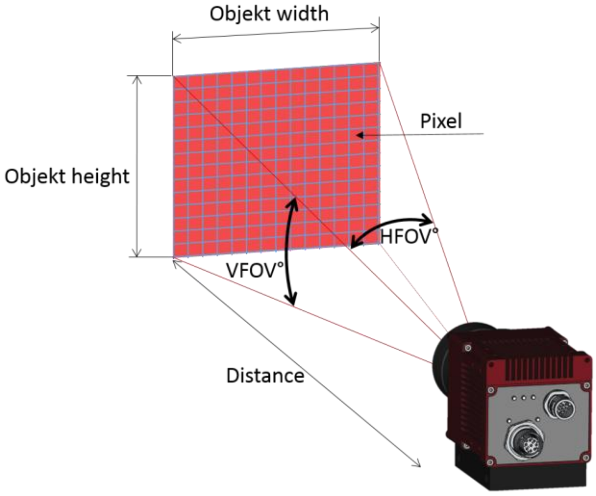


Figure 5: Field of view

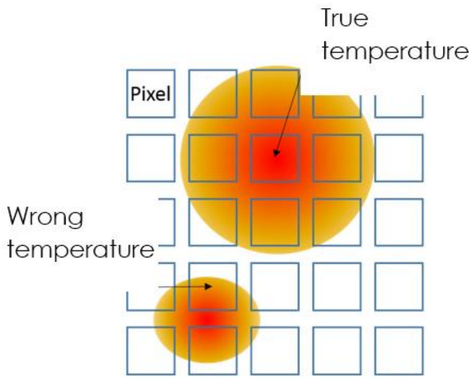


Figure 6: Resolution on the measured object

Since real optics produce an unavoidable blur, the object to be measured should be at least 3 pixels in size to obtain an accurate measurement result (see Figure 16).

Thermographic principles for radiometric temperature determination

This chapter is intended to provide a brief overview of the radiometric temperature measurement with infrared cameras. Prerequisite for a temperature measurement with the IRSX is that the camera has a calibration. This can be recognized by the GenICam Nodes Radiometric Control in the camera properties.

The camera series IRSX is exclusively equipped with thermal sensors. An essential feature of these sensors is the direct proportional relationship to the radiant energy incident from an object on the detector. The radiant energy depends nonlinearly on the object temperature and is influenced by environmental conditions as well as by object parameters.

In order to be able to measure the temperature of an object via its infrared radiation, it is essential to know some parameters of the measurement situation. The most important parameters are illustrated in the sketch below.

The emissivity depends on several object properties such as material, surface condition, viewing angle and also on the object temperature itself. Thus, this parameter is one of the most fundamental in thermographic temperature measurement. In practice values between 0.1 (e.g., polished metal surfaces) to 0.98 (e.g., human skin) are common.

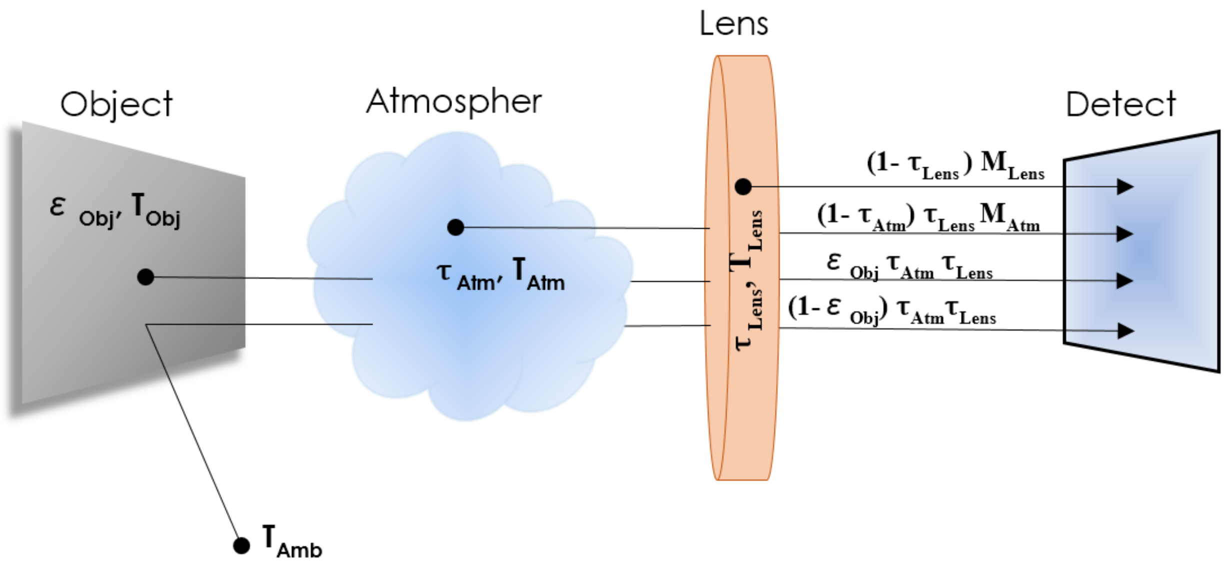


Figure 7: Emission and transmission parameters of a real measurement situation

Table 7: Parameters

Parameter	Description
T_{Amb}	Ambient Temperature
ε_{Obj}	Emissivity of the object
T_{Obj}	Temperature of the object
τ_{Atm}	Transmission of the atmosphere
T_{Atm}	Temperature of the atmosphere
τ_{Lens}	Transmission of the lens
T_{Lens}	Temperature of the lens
S_{Det}	Detector signal in counts
M(…)	Radiation (temperature-dependent)

The functional relationship between the object temperature and the signal S_{Det} of the camera, taking into account the viewing scene, is described by the following formula:

$$S(T_{Obj}) = \frac{S_{Det}}{\tau_{Atm}\tau_{Lens}\varepsilon} - \frac{(1-\tau_{Lens})\,S(T_{Lens})}{\tau_{Atm}\tau_{Lens}\varepsilon} - \frac{(1-\tau_{Atm})\,S(T_{Atm})}{\tau_{Atm}\varepsilon} - \frac{(1-\varepsilon)\,S(T_{Amb})}{\varepsilon}$$

In order to calculate the object temperature T_{Obj}, the camera signal S_{Det} has to be corrected with respect to the environmental influences.

Determination of the Emissivity

The emissivity of an object can be provisionally determined, for example, by the methods described below. The object must have a temperature that differs significantly from the ambient temperature. For your orientation, a table with typical values for the emissivity of different materials can be found in the appendix.

Measurement of the Object Temperature with a Thermocouple

A simple method for the provisional determination of the emissivity is obtained by measuring the object temperature at a point using a thermocouple. Now align the infrared camera to the same point on the object and adjust the emissivity until the temperature displayed by the camera matches the value measured with the thermocouple. The set value is then the emissivity of the object. With this procedure, however, it should be ensured that the temperature of the measurement object differs significantly from the temperature of the environment.

Using a Reference Material

In this method, a reference material with known emissivity is applied to the measurement object. For example this can be paint or a piece of tape. By adjusting the emissivity of the reference material on the camera and measuring the temperature of the ink / adhesive tape, the object temperature is first determined. The emissivity of the measurement object is obtained by looking at the object itself with the camera and adjusting the emissivity until you get the same temperature reading as on the reference material. Again with this method, the object temperature should be significantly different from the ambient temperature.

Temperature Calculation from camera signal

The non-linear relationship between camera signal and object temperature is described by the following formula:

$$S = \frac{R}{e^{\frac{B}{T}} - F} + O$$

The coefficients R, B, F are based on the physical Planck function. The coefficient O describes the signal offset (property of the detector). The determination of these coefficients is part of the factory calibration. The coefficients are found in the GenICam Nodes under the *Radiometric Control* group in the camera properties.

The exchange of the lens has an influence on these coefficients. If the lens must be replaced, a recalibration is recommended.

Most IRSX models can store two calibration sets. This allows a replacement of the lens without recalibration. The calibration sets belonging to the lenses can be selected in the GenICam Nodes under the camera property *Lens Selector* in the group *Lens Control*. When delivered without a replacement lens, the relevant calibration set is stored under Lens1 as standard. For each calibration set, you can switch between the high and low temperature measurement range using the *Temperature Range Selector* property.

In the temperature calculation, the external environmental influences such as ambient temperature, must be taken into account. The object temperature can be calculated according to the following formula:

$$T_{Obj} = \frac{B}{log\left(\frac{R}{S(T_{Obj}) - O} + F\right)}$$

In order to calculate a temperature value from the camera signal, the R, B, F, O parameters are be required. These can be read out of the camera. In addition, the environmental parameters must be known.

Table 8: Parameters

Parameter	Description
T_{Amb}	Ambient temperature [K]
ε_{Obj}	Emissivity of the object [0…1]
τ_{Atm}	Transmission of the atmosphere [0…1]
T_{Atm}	Temperature of the atmosphere [K]
τ_{Lens}	Transmission of the lens / of the protective window [0..1]
T_{Lens}	Temperature of the lens [K]
S	Camera Signal in Counts (LSB)

For the transmission of the atmosphere, τ_{Atm} = 1 can be assumed for short distances. If no protective window is installed, τ_{Lens} = 1 can be used. To calculate the temperature from the signal value, the following parameters must first be calculated.

Calculation of the emissivities:

$$\varepsilon_{\tau} = \varepsilon * \tau_{Atm}$$

$$\varepsilon_{\tau 2} = \varepsilon * \tau_{Lens} * \tau_{Atm}$$

Calculation of the radiation of the environment (I_{amb}), of the atmosphere (I_{Atm}) and of the protective window (S_{Atm}):

$$I_{Amb} = \frac{R}{\left(e^{\left(\frac{B}{T_{Amb}}\right)} - F\right)}$$

$$I_{Atm} = \frac{R}{\left(e^{\left(\frac{B}{T_{Atm}}\right)} - F\right)}$$

$$S_{Atm} = \frac{R}{\left(e^{\left(\frac{B}{T_{Lens}}\right)} - F\right)}$$

Calculation of the radiation components (K_1, K_2):

$$K_1 = \frac{1}{\varepsilon_{\tau 2}}$$

$$K_2 = \left(\frac{(1-\varepsilon)}{\varepsilon} * I_{Amb} + \frac{(1-\tau)}{\varepsilon_{\tau}} * I_{Atm} + \frac{(1-\tau_{Lens})}{\varepsilon_{\tau}} * S_{Atm}\right)$$

Calculation of the object signal (S_{Obj}):

$$S_{Obj} = K_1 * (S - O) - K_2$$

With the signal S_{Obj} and the parameters R, B and F, the object temperature can be calculated in Kelvin.

$$T_{Obj} = \frac{B}{\log\left(\frac{R}{S_{Obj}} + F\right)}$$

Temperature Calculation with Camera Temperature Linearization

The IRSX series allows to calculate the output signal directly proportional to the object temperature. There are two levels of accuracy, which differ in their dynamics. The function can be selected in the GenICam Nodes under *Radiometric Pixel Format* in the group *Radiometric Control*.

Figure 18 shows the selection of temperature linearization with the factor 0.04.

Figure 8: Radiometric Pixel Format.

Assuming the signal value in a pixel is 7600, the temperature is calculated as follows:

Temperature in Kelvin

$$T = Pixel\,Value * 0{,}04\,K = 7600 * 0{,}04\,K = 304\,K$$

Temperature in Celsius

$$T = 304\,K - 273{,}15\,K = 31\,°C$$

For measuring temperatures with this method, ambient properties such as emissivity, transmission and temperatures must be set in the camera. You will find these settings in the GenICam Nodes under *Radiometric Control*.

Emissivity Table

Material	Surface	Temperature [°C]	Emissivity
Aluminum	polished	20	0.04
	oxidized, strongly	20	0.83-0.94
Copper	polished	100	0.05
	oxidized, strongly	20	0.78
Iron	cast, oxidized	100	0.64
	sheet, heavy rusted	20	0.69-0.96
Nickel	polished	20	0.05
Stainless steel (18-8)	polished	20	0.16
	oxidized	60	0.85
Steel	polished	100	0.07
	oxidized	200	0.79
Brick	red	20	0.93
Carbon		20	0.93
Concrete	dry	35	0.95
Glass		35	0.97
Oil, lubricating		17	0.87
	0,03mm film	20	0.27
	0,13mm film	20	0.72
	Thick coating	20	0.82
Oil paint	Mix from 16 colors	20	0.94
Paper	white	20	0.07-0.90
Plaster		20	0.86-0.90
Rubber	black	20	0.95
Human skin		32	0.98
Soil	dry	20	0.92
	saturated with water	20	0.95
Water	distilled	20	0.96
	frost crystals	-10	0.98
	snow	-10	0.85

Trouble Shooting

Problems during power-on	Action
Problems during startup	A first indication whether the camera is supplied with power, is usually a multiple clicking sound of the shutter when starting the camera and the light up of the operating LED's on the back.
LED´s do not light up	There is no power supply to the camera. Check all cables and make sure that the supply voltage is connected to the camera. If no function of the camera is detectable despite connected supply voltage, contact our support team.
Problems in the data communication	**Action**
Camera is not detected in the network	Make sure all Ethernet settings are correct and the camera is powered up. Make sure that the camera and the connected device (computer) are in the same subnet (see section 6.6.1)
Camera is detected in the network, but does not provide images	Make sure your computer has the latest version of a GenICam compatible camera driver. Disable the firewall for the relevant Ethernet adapter.
Problems during operation	**Action**
Poor quality of the image	Check if the correct temperature measurement range is selected
The measured temperatures are not correct	Check if the correct calibration set has been loaded
The image is oversaturated	Check if the correct temperature measurement range is selected
The camera makes a clicking sound	The camera has an internal shutter, which is pushed in front of the sensor at certain intervals to perform an image correction

Field of view IRSX-I336 – compact body Lenses

IRSX-I336			Distance to the object [m]										
Focal length [mm]	**Angle [°]**	**MOD [mm]**	**FOV**	**0.1**	**0.2**	**0.5**	**1**	**2**	**4**	**6**	**10**	**30**	**100**
7.5	45	25	HFOV [m]	0.08	0.17	0.41	0.83	1.66	3.31	4.97	8.28	24.9	82.8
	35		VFOV [m]	0.06	0.13	0.32	0.63	1.26	2.52	3.78	6.31	18.9	63.1
	64.8		DFOV[m]	0.10	0.21	0.52	1.04	2.08	416	6.25	10.4	31.2	104
	2.3		IFOV [mm]	3.96	7.91	19.8	39.6	79.1	158	237	396	1187	3957
9	35	32	HFOV [m]	0.06	0.13	0.32	0.63	1.26	2.52	3.78	6.31	18.9	63.1
	27		VFOV [m]	0.05	0.10	0.24	0.48	0.96	1.92	2.88	4.80	14.4	48.0
	44.2		DFOV[m]	0.08	0.16	0.40	0.79	1.59	317	4.76	7.93	23.8	79.3
	0.055		IFOV [mm]	0.10	0.19	0.48	0.96	1.92	3.84	5.76	9.60	28.8	96.0
13	25	76	HFOV [m]	0.04	0.09	0.22	0.44	0.89	1.77	2.66	4.43	13.3	44.3
	19		VFOV [m]	0.03	0.07	0.17	0.33	0.67	134	2.01	3.35	10.0	33.5
	31.4		DFOV[m]	0.06	0.11	0.28	0.56	1.11	2.22	3.33	5.56	16.7	55.6
	0.04		IFOV [mm]	0.07	0.14	0.34	0.68	1.36	2.72	4.08	6.81	20.4	68.1
19	17	153	HFOV [m]	-	0.06	0.15	0.30	0.60	1.20	1.79	2.99	8.97	29.9
	13		VFOV [m]	-	0.05	0.11	0.23	0.46	0.91	1.37	2.28	6.84	22.8
	21.4		DFOV[m]	-	0.08	0.19	0.38	0.75	1.50	2.26	3.76	11.3	37.6

	0.027		IFOV [mm]	-	0.09	0.24	0.47	0.94	1.88	2.83	4.71	14.1	47.1
35	9.3	600	HFOV [m]	-	-	-	0.16	0.33	0.65	0.98	1.63	4.88	16.3
	71		VFOV [m]	-	-	-	0.12	0.25	0.50	0.74	1.24	3.72	12.4
	117		DFOV[m]	-	-	-	0.20	0.41	0.82	1.23	2.05	6.14	20.5
	0.015		IFOV [mm]	-	-	-	0.26	0.52	1.05	1.57	2.62	7.85	26.2

MOD = Minimum Object Distance, FOV = Field Of View [°], HFOV = Horizontal Field Of View [°], VFOV = Vertical Field Of View [°],
DFOV = Diagonal Field Of View [°], IFOV = Instantaneous Filed of View (field of view per pixel).

Field of view IRSX-I640 – compact body Lenses

IRSX-I640			**Distance to the object [m]**										
Focal length [mm]	**Angle [°]**	**MOD [mm]**	**FOV**	**0.1**	**0.2**	**0.5**	**1**	**2**	**4**	**6**	**10**	**30**	**100**
7.5	90	25	HFOV [m]	0.20	0.40	1.00	2.00	4.00	8.00	12.0	20.0	60.0	200
	69		VFOV [m]	0.14	0.27	0.69	1.37	2.75	5.50	8.25	13.7	41.2	137
	113.4		DFOV [m]	0.24	0.49	1.21	2.43	4.85	9.71	14.6	24.3	72.8	243
	0.141		IFOV [mm]	0.25	0.49	1.23	2.46	4.92	9.84	14.8	24.6	73.8	246
9	69	32	HFOV [m]	0.14	0.27	0.69	1.37	2.75	5.50	8.25	13.7	41.2	137
	56		VFOV [m]	0.11	0.21	0.53	1.06	2.13	4.25	6.38	10.6	31.9	106
	88.9		DFOV [m]	0.17	0.35	0.87	1.74	3.48	6.95	10.4	17.4	52.1	174
	0.108		IFOV [mm]	0.19	0.38	0.94	1.88	3.77	7.54	11.3	18.8	56.5	188
13	45	76	HFOV [m]	0.08	0.17	0.41	0.83	1.66	3.31	4.97	8.28	24.9	82.8
	37		VFOV [m]	0.07	0.13	0.33	0.67	1.34	2.68	4.02	6.69	20.1	66.9

	58.3		DFOV [m]	0.11	0.21	0.53	1.06	2.13	4.26	6.39	10.6	31.9	106
	0.07		IFOV [mm]	0.12	0.24	0.61	1.22	2.44	4.89	7.33	12.2	36.7	122
19	32	153	HFOV [m]	-	0.11	0.29	0.57	1.15	2.29	3.44	5.73	17.2	57.3
	26		VFOV [m]	-	0.09	0.23	0.46	0.92	1.85	2.77	4.62	13.9	46.2
	41.2		DFOV [m]	-	0.15	0.37	0.74	1.47	2.95	4.42	7.36	22.1	73.6
	0.05		IFOV [mm]	-	0.17	0.44	0.87	1.75	3.49	5.24	8.73	26.2	87.3
35	18	600	HFOV [m]	-	-	-	0.32	0.63	1.27	1.90	3.17	9.50	31.7
	14		VFOV [m]	-	-	-	0.25	0.49	0.98	1.47	2.46	7.37	24.6
	22.8		DFOV [m]	-	-	-	0.40	0.80	1.60	2.40	4.01	12.0	40.1
	0.028		IFOV [mm]	-	-	-	0.49	0.98	1.95	2.93	4.89	14.7	48.9

MOD = Minimum Object Distance, FOV = Field Of View [°], HFOV = Horizontal Field of View [°], VFOV = Vertical Field of View [°], DFOV = Diagonal Field Of View [°], IFOV = Instantaneous Field Of View (field of view per pixel.

Automation Technology GmbH

EG-Konformitätserklärung
EC Declaration of Conformity
Déclaration de Conformité CE

Hersteller **Manufacturer** **Fabricant**	AT-Automation Technology GmbH Hermann-Bössow-Str. 6-8 23843 Bad Oldesloe Germany

erklärt in alleiniger Verantwortung, dass das Produkt
declares in its sole reponsibiliity, that the product
déclare sous sa seule responsabilité, que le produit

Produktbezeichnung **product** **produit**	**Thermal Imaging Camera IRSX:** **IRS-168, IRS-320, IRS-324, IRS-336, IRS-384,** **IRS-640, IRSX-I336, IRSX-I640**

die Anforderungen der folgenden Richtlinien erfüllt
is in conformity to he following directive
est conforme aux directives suivantes

- Niederspannungsrichtlinie, Low Voltage Directive 2006/95/EG
- EMV-Richtlinie, EMC Directive 2004/108/EG

Die folgenden harmonisierte Normen wurden angewandt
The following harmonised standards were applied
Les normes harmonisées suivantes ont été appliquées

- EN 61010-1:2010
- EN 61326:2013 (Immunity)
- EN 61000-4-2 (Electrostatic Discharge- ESD)
- EN 61000-4-3 (Electromagnetic Fields)
- EN 61000-4-4 (Electrical Fast Transients – Burst)
- EN 61000-4-5 (High energy pulses – Surge)
- EN 61000-4-6 (Conducted RF Disturbance)
- EN 61000-4-8 (Power frequency magnetic field)
- EN 61000-4-11 (Voltage dips, short interruptions, and voltage variations)
- EN55011:2009 + A1:2010 Group 1, Class A

Environmental and Use Conditions : Electrical equipment for measurement, control, and laboratory use; intended for use in industrial locations.

Dr. Andrè Kasper, CEO

Bad Oldesloe, 03.02. 2017

Ort und Datum
Place and Date
Lieu et date

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