User's manual
FLIR Ax5 series
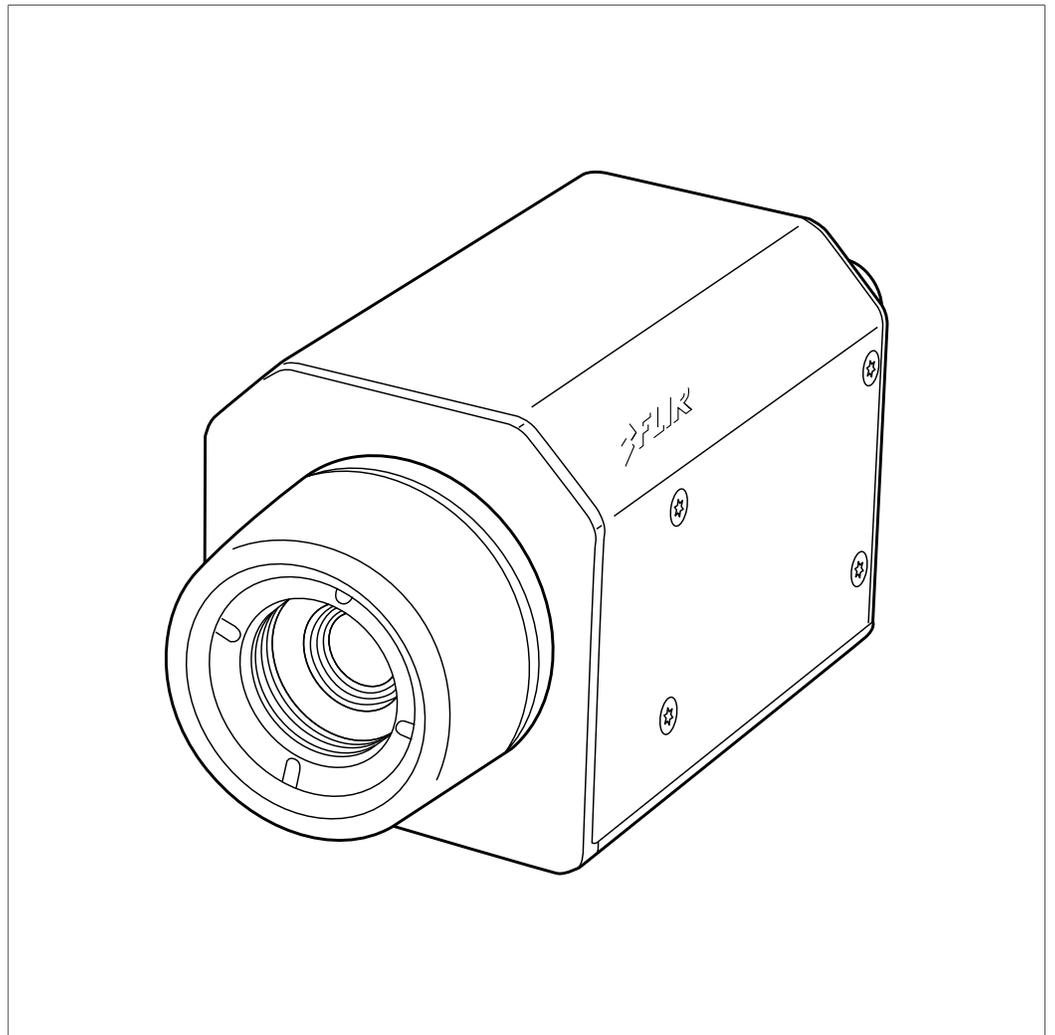
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1   Legal disclaimer

1.1   Legal disclaimer

All products manufactured by FLIR Systems are warranted against defective materials and workmanship for a period of one (1) year from the delivery date of the original purchase, provided such products have been under normal storage, use and service, and in accordance with FLIR Systems instruction.

Products which are not manufactured by FLIR Systems but included in systems delivered by FLIR Systems to the original purchaser, carry the warranty, if any, of the particular supplier only. FLIR Systems has no responsibility whatsoever for such products.

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In the case of a defect in a product covered by this warranty the product must not be further used in order to prevent additional damage. The purchaser shall promptly report any defect to FLIR Systems or this warranty will not apply.

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This warranty shall be governed by Swedish law.

Any dispute, controversy or claim arising out of or in connection with this warranty, shall be finally settled by arbitration in accordance with the Rules of the Arbitration Institute of the Stockholm Chamber of Commerce. The place of arbitration shall be Stockholm. The language to be used in the arbitral proceedings shall be English.

1.2   Usage statistics

FLIR Systems reserves the right to gather anonymous usage statistics to help maintain and improve the quality of our software and services.

1.3   Changes to registry

The registry entry HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Control\Lsa \LmCompatibilityLevel will be automatically changed to level 2 if the FLIR Camera Monitor service detects a FLIR camera connected to the computer with a USB cable. The modification will only be executed if the camera device implements a remote network service that supports network logons.

1.4   U.S. Government Regulations

This product may be subject to U.S. Export Regulations. Please send any inquiries to exportquestions@flir.com.

1.5   Copyright

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The Quality Management System under which these products are developed and manufactured has been certified in accordance with the ISO 9001 standard.

FLIR Systems is committed to a policy of continuous development; therefore we reserve the right to make changes and improvements on any of the products without prior notice.

1.7 Patents

One or several of the following patents and/or design patents may apply to the products and/or features. Additional pending patents and/or pending design patents may also apply.

000279476-0001; 000439161; 000499579-0001; 000653423; 000726344; 000859020; 001106306-0001; 001707738; 001707746; 001707787; 001776519; 001954074; 002021543; 002058180; 002249953; 002531178; 0600574-8; 1144833; 1182246; 1182620; 1285345; 1299699; 1325808; 1336775; 1391114; 1402918; 1404291; 1411581; 1415075; 1421497; 1458284; 1678485; 1732314; 2106017; 2107799; 2381417; 3006596; 3006597; 466540; 483782; 484155; 4889913; 5177595; 60122153.2; 602004011681.5-08; 6707044; 68657; 7034300; 7110035; 7154093; 7157705; 7237946; 7312822; 7332716; 7336823; 7544944; 7667198; 7809258 B2; 7826736; 8,153,971; 8,823,803; 8,853,631; 8018649 B2; 8212210 B2; 8289372; 8354639 B2; 8384783; 8520970; 8565547; 8595689; 8599262; 8654239; 8680468; 8803093; D540838; D549758; D579475; D584755; D599,392; D615,113; D664,580; D664,581; D665,004; D665,440; D677298; D710,424 S; D718801; DI6702302-9; DI6903617-9; DI7002221-6; DI7002891-5; DI7002892-3; DI7005799-0; DM/057692; DM/061609; EP 2115696 B1; EP2315433; SE 0700240-5; US 8340414 B2; ZL 201330267619.5; ZL01823221.3; ZL01823226.4; ZL02331553.9; ZL02331554.7; ZL200480034894.0; ZL200530120994.2; ZL200610088759.5; ZL200630130114.4; ZL200730151141.4; ZL200730339504.7; ZL200820105768.8; ZL200830128581.2; ZL200880105236.4; ZL200880105769.2; ZL200930190061.9; ZL201030176127.1; ZL201030176130.3; ZL201030176157.2; ZL201030595931.3; ZL201130442354.9; ZL201230471744.3; ZL201230620731.8.

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2 Safety information

> ⚠️ **WARNING**
>
> Make sure that you read all applicable MSDS (Material Safety Data Sheets) and warning labels on containers before you use a liquid. The liquids can be dangerous. Injury to persons can occur.

> ⚠️ **WARNING**
>
> **Applicability**: FLIR Ax5.
>
> Do not use screws that are too long. If you use screws that are too long, damage to the camera will occur. The maximum depth of the M3 holes is 4 mm (0.15 in.).

> ⚠️ **CAUTION**
>
> Do not point the infrared camera (with or without the lens cover) at strong energy sources, for example, devices that cause laser radiation, or the sun. This can have an unwanted effect on the accuracy of the camera. It can also cause damage to the detector in the camera.

> ⚠️ **CAUTION**
>
> Do not use the camera in temperatures more than +50°C (+122°F), unless other information is specified in the user documentation or technical data. High temperatures can cause damage to the camera.

> ⚠️ **CAUTION**
>
> Do not apply solvents or equivalent liquids to the camera, the cables, or other items. Damage to the battery and injury to persons can occur.

> ⚠️ **CAUTION**
>
> Be careful when you clean the infrared lens. The lens has an anti-reflective coating which is easily damaged. Damage to the infrared lens can occur.

> ⚠️ **CAUTION**
>
> Do not use too much force to clean the infrared lens. This can cause damage to the anti-reflective coating.

> ⚠️ **CAUTION**
>
> **Applicability**: Cameras with an automatic shutter that can be disabled.
>
> Do not disable the automatic shutter in the camera for a long time period (a maximum of 30 minutes is typical). If you disable the shutter for a longer time period, damage to the detector can occur.

> 📝 **NOTE**
>
> The encapsulation rating is only applicable when all the openings on the camera are sealed with their correct covers, hatches, or caps. This includes the compartments for data storage, batteries, and connectors.

> ⚠️ **CAUTION**
>
> **Applicability**: Cameras where you can remove the lens and expose the infrared detector.
>
> Do not use the pressurized air from the pneumatic air systems in a workshop when you remove dust from the detector. The air contains oil mist to lubricate the pneumatic tools and the pressure is too high. Damage to the detector can occur.

3   Notice to user

3.1   User-to-user forums

Exchange ideas, problems, and infrared solutions with fellow thermographers around the world in our user-to-user forums. To go to the forums, visit:

http://www.infraredtraining.com/community/boards/

3.2   Calibration

FLIR Systems recommends that you verify your calibration yearly. You can verify the calibration yourself or with the help of a FLIR Systems Partner. If preferred, FLIR Systems offers a calibration, adjustment, and general maintenance service.

3.3   Accuracy

For very accurate results, we recommend that you wait 5 minutes after you have started the camera before measuring a temperature.

3.4   Disposal of electronic waste

As with most electronic products, this equipment must be disposed of in an environmentally friendly way, and in accordance with existing regulations for electronic waste.

Please contact your FLIR Systems representative for more details.

3.5   Training

To read about infrared training, visit:

- http://www.infraredtraining.com
- http://www.irtraining.com
- http://www.irtraining.eu

3.6   Documentation updates

Our manuals are updated several times per year, and we also issue product-critical notifications of changes on a regular basis.

To access the latest manuals and notifications, go to the Download tab at:

http://support.flir.com

It only takes a few minutes to register online. In the download area you will also find the latest releases of manuals for our other products, as well as manuals for our historical and obsolete products.

3.7   Important note about this manual

FLIR Systems issues generic manuals that cover several cameras within a model line.

This means that this manual may contain descriptions and explanations that do not apply to your particular camera model.

3.8   Note about authoritative versions

The authoritative version of this publication is English. In the event of divergences due to translation errors, the English text has precedence.

Any late changes are first implemented in English.

4 Customer help

4.1 General

For customer help, visit:

http://support.flir.com

4.2 Submitting a question

To submit a question to the customer help team, you must be a registered user. It only takes a few minutes to register online. If you only want to search the knowledgebase for existing questions and answers, you do not need to be a registered user.

When you want to submit a question, make sure that you have the following information to hand:

- The camera model
- The camera serial number
- The communication protocol, or method, between the camera and your device (for example, HDMI, Ethernet, USB, or FireWire)

- Device type (PC/Mac/iPhone/iPad/Android device, etc.)
- Version of any programs from FLIR Systems
- Full name, publication number, and revision number of the manual

4.3   Downloads

On the customer help site you can also download the following, when applicable for the product:

- Firmware updates for your infrared camera.
- Program updates for your PC/Mac software.
- Freeware and evaluation versions of PC/Mac software.
- User documentation for current, obsolete, and historical products.
- Mechanical drawings (in *.dxf and *.pdf format).
- Cad data models (in *.stp format).
- Application stories.
- Technical datasheets.
- Product catalogs.

5   Introduction

The FLIR Ax5 cameras have features and functions that make them the natural choice for anyone who uses PC software to solve problems. Available resolutions include 80 × 64, 160 × 128, and 320 × 256 pixels.

Among their main features are GigE Vision and GenICam compliance, which makes them plug-and-play when used with software packages such as IMAQ Vision and Halcon.

Key features:

- Very affordable.
- Compact (40 × 43 × 106 mm/1.57 × 1.69 × 4.17 in.).
- GigE Vision and GenICam compliant.
- GigE Vision lockable connector.
- PoE (power over Ethernet).
- 8-bit monochrome image streaming.
- 14-bit radiometric image streaming.
- High frame rates (60 Hz).
- Synchronization between cameras possible.
- 1x+1x GPIO.
- Compliant with any software that supports GenICam, including National Instruments IMAQ Vision, Stemmers Common Vision Blox, and COGNEX Vision Pro.
- Lenses: 5°, 9°, 13°, 19°, and 25° (model-dependent).

Typical applications:

- Automation, thermal machine vision.
- Entry-level "high-speed" R&D.

6   System overview

6.1   Figure

1	RET_GB
2	PWR_GB
3	SYNC_OUT
4	SYNC_OUT_GND
5	SYNC_IN
6	SYNC_IN_GND
7	GPO+
8	GPO-
9	GPIO_PWR
10	GPIO_GND
11	GPI+
12	GPI-
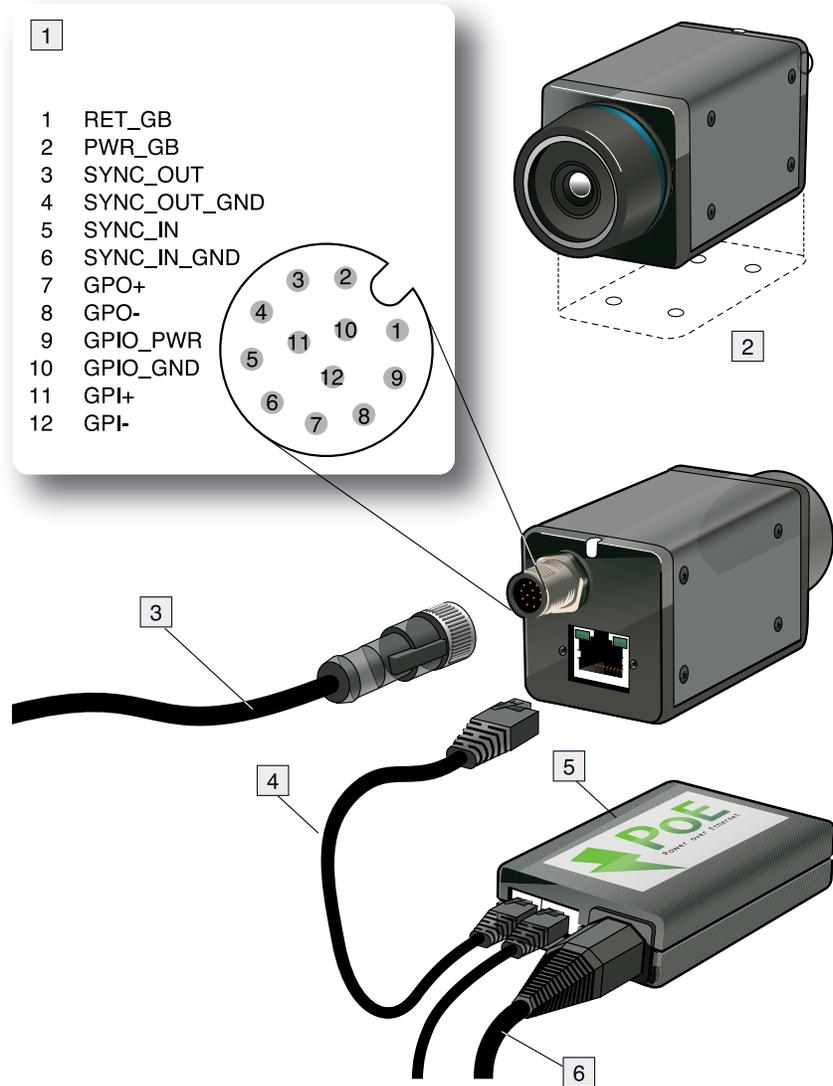
6.2   Explanation

1. Pin configuration in M12 connector. For more information, see section 16.1 *M12 connector pin configuration*, page 152.
2. 4x M3 threaded holes.
3. Cable M12 pigtail or Cable M12 sync.
4. Ethernet cable CAT6, 2 m/6.6 ft.
5. PoE injector.
6. Cable kit mains.

7   Quick start guide

Follow this procedure:

1. Download FLIR GEV Demo from http://support.flir.com/Ax5-software.
2. Install FLIR GEV Demo.
3. Connect the camera to power and to the computer, typically via a PoE injector connected to the Ethernet cable.
4. Start FLIR GEV Demo.
5. In FLIR GEV Demo, click the *Select/Connect* button.
6. In the GEV Device Selection window, identify the camera using the MAC address (printed on the camera). Select the camera in the list and click the *OK* button.
7. If the device is not visible, check the box "Show unreachable Network Devices" and then select the correct device and press "Set IP Address…". Then assign the correct IP address to your device.
8. FLIR GEV Demo can now be used to set up and control the camera. Click the *Play* button to start the image stream.

8 List of accessories

| Product name	Part number
Base support	T198349
Cable kit Mains (UK,EU,US)	T198348
Cable M12 Pigtail	T127605ACC
Cable M12 Sync	T127606ACC
Ethernet cable CAT6, 2 m/6.6 ft.	T951004ACC
FLIR IR Camera Player	DSW-10000
FLIR Tools	T198584
FLIR Tools+ (download card incl. license key)	T198583
Focus adjustment tool	T198342ACC
Gigabit PoE injector 16 W, with multi-plugs	T911183
Table stand kit	T198392
Transport case Ax5	T198594ACC

Note FLIR Systems reserves the right to discontinue models, parts or accessories, and other items, or to change specifications at any time without prior notice.

9 Mechanical installation

The camera unit has been designed to allow it to be mounted in any position. It has a mounting interface on the bottom with four metric M3 holes.

⚠	**WARNING**

Do not use screws that are too long. Using screws that are too long will damage the camera. The maximum depth of the M3 holes is 4 mm (0.15 in.).

Max. depth 4 mm (0.15 in.)
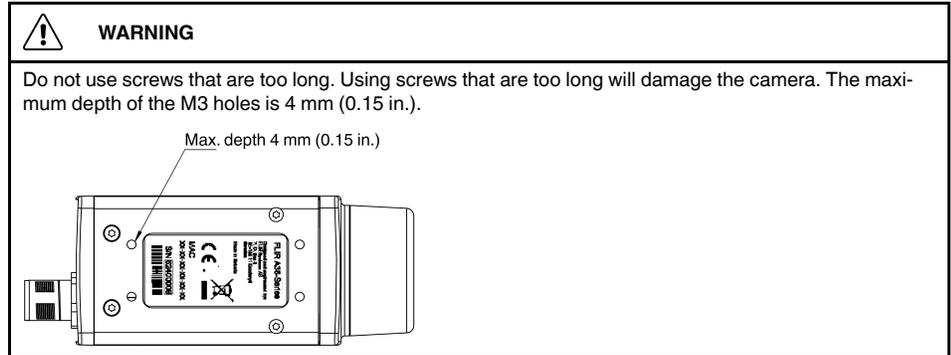
Note The camera generates a considerable amount of heat during operation. This is normal. In order to transfer this heat, it is recommended that the camera is mounted on a base support or a heat sink made of a material that has a high capacity to transfer heat, e. g., aluminum. FLIR Systems provides P/N T198349 (base support) for this purpose, but other base supports or heat sinks can be used.
The use of the base support is also strongly recommended in order to minimize temperature drift of the infrared detector in the camera.

If the camera unit is to be permanently mounted on the application site, certain steps have to be taken. The camera unit might need to be enclosed in a protective housing and, depending on the ambient conditions (e.g., temperature), the housing may need to be cooled by means of water or air. In very dusty conditions the installation might also need to have a stream of pressurized air directed at the lens, in order to prevent dust build-up.

When mounting the camera unit in harsh environments, every precaution should be taken when it comes to securing the unit. If the environment exposes the unit to severe vibrations, there may arise a need to secure the mounting screws by means of Loctite or another industrial brand of thread-locking liquid, as well as to dampen the vibrations by mounting the camera unit on a specially designed mounting base.

For further information regarding mounting recommendations and environmental enclosures, contact FLIR Systems.

The camera is typically powered using PoE (Power over Ethernet). A PoE injector and cable kit are available from FLIR Systems. See the part numbers below.

- T198348, Cable kit mains (UK, EU, US).
- T911112, PoE injector.
- T951004ACC, Ethernet cable CAT-6, 2 m/6.6 ft.

9.1   Table stand mounting

9.1.1   Figure
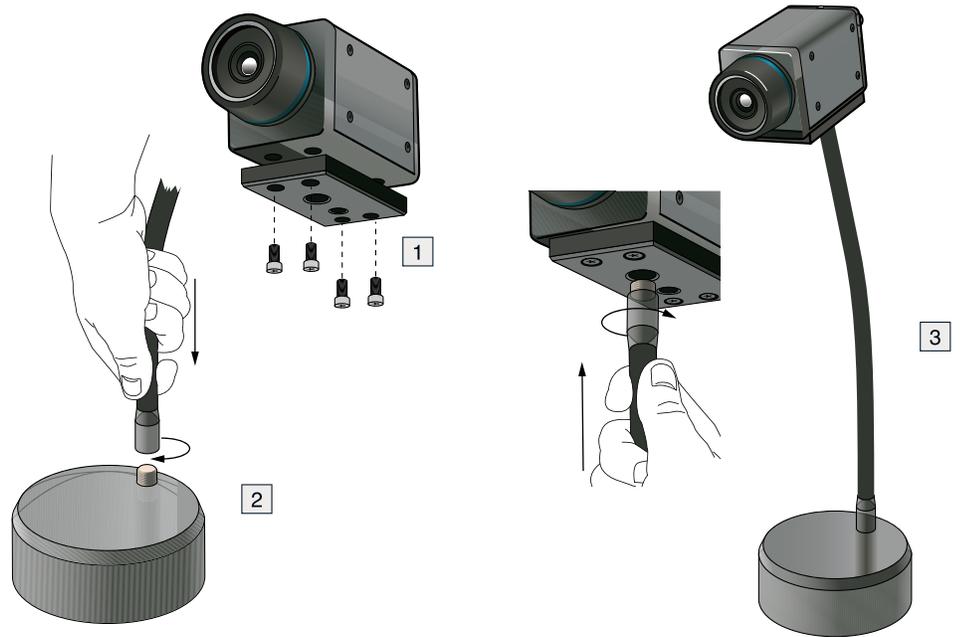
9.1.2   Explanation

1. Base support.
2. Table stand.
3. Gooseneck.

10.1   Focusing cameras with 5 to 19 mm lenses

10.1.1   Necessary tools

Focus adjustment tool (included in the package for cameras with 5 to 19 mm lenses).

10.1.2   Procedure

Follow this procedure:

1. Note the four pegs on the inside of the focus adjustment tool.
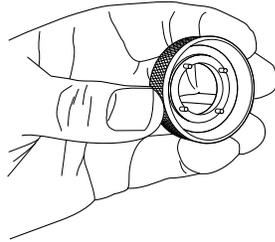
2. Align the four pegs with the corresponding slots on the front of the lens, and push the focus adjustment tool into position.
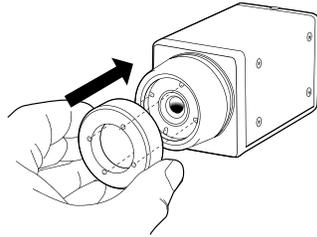
3. Rotate the lens.
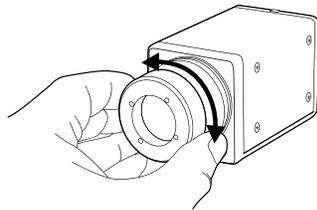
10.2   Focusing cameras with 25 to 100 mm lenses

⚠ CAUTION
Do not use the focus adjustment tool when focusing cameras with 25 to 100 mm lenses.

10.2.1   Necessary tools

Allen wrench, 1.5 mm.

10.2.2   Procedure

Follow this procedure:

1. Unlock the clamp by loosening the Allen screw.
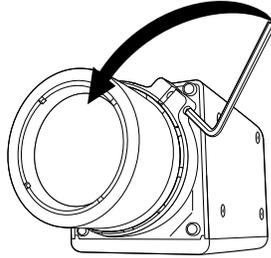
2. Focus the camera by rotating the lens.
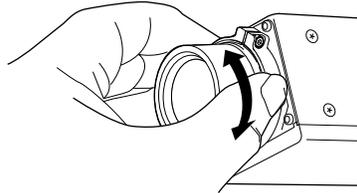
3. Lock the clamp by tightening the Allen screw.
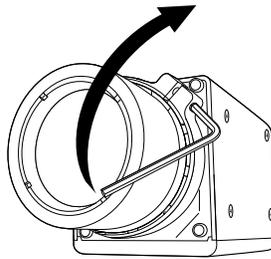
11   Downloads

The principal software used to configure and control the camera is FLIR GEV Demo 1.3.0. This software is based on the PleoraeBus SDK and the runtime Pleora GEVPlayer that comes with the SDK.

Downloads:

- http://support.flir.com/Ax5-software
- Link to download PureGEV SDK Sample (source code): http://support.flir.com/SwDownload/app/RssSWDownload.aspx?ID=133
- Link to download FLIR GEV Demo 1.3.0 (installer): http://support.flir.com/SwDownload/app/RssSWDownload.aspx?ID=155

The camera is compliant with the following standards. Additional software and documentation resources can be downloaded from these sites.

- GeniCAM: http:www.genicam.org
- Gigabit Ethernet: http://www.ieee802.org/3

12 About I/O, synchronization, and measurement

12.1 FLIR Ax5 General Purpose I/O

The FLIR Ax5 camera has one general-purpose input line and one output line that can be used in control applications.

Typical usage:

- The output line is asserted when an alarm condition is met.
- The input line is used to trigger an action, for example saving an image.

The output line GPO+ is controlled by the register *UserOutputValue*. Set this register to *True* to assert (level equal to GPIO_PWR) the GPO+ signal, and set to *False* to de-assert (level is equal to GPIO_GND).

You can monitor the input line by reading the *LineStatus* register on a regular basis. The *LineStatus* register will return*True* if the input level is asserted (level equal to GPIO_PWR voltage), and it will return*False* if the input line is de-asserted (level is equal to GPIO_GND).

Another option is to configure the camera to send a GigEVision event when the input line state is changed. In order to configure the camera for event transmission you need to modify the following registers:

PLC_Q7_Variable0	Enum	Set this register to PLC_I0 (enumeration value 2) to route the GPI signal
EventSelector	Enum	Set this register to PLC_Interrupt_FIFO0_Q7 (enumeration value 5)
EventNotification	Enum	Set this register to GigEVisionEvent (enumeration value 3)

To de-bounce the input signal you also might want to configure the *LineDebounceFactor* register. This register controls the width of the window during which spurious transitions from the input line are filtered out (in increments of ~480 ns). This register is 0 by default, which means that the de-bouncing is disabled. The maximum value for this register is 65535, which corresponds to a maximum holding time of ~31 ms.

The FLIR GEV Demo 1.3 sample illustrates how to setup the event transmission. C++ source code is available in PureGEV SDK Sample.

Applicable downloads:

- Link to download PureGEV SDK Sample (source code): http://support.flir.com/SwDownload/app/RssSWDownload.aspx?ID=133
- Link to download FLIR GEV Demo 1.3.0 (installer): http://support.flir.com/SwDownload/app/RssSWDownload.aspx?ID=155

12.2 FLIR Ax5 synchronization

The camera provides an external sync channel that can be used to synchronize the frame start between two cameras, one configured as the master and the other configured as the slave. It can also be used to synchronize the frame start of a camera with that of another product.

Stream 60 Hz

Sync out

SyncMode set to *SelfSyncMaster*

29.97 Hz

Sync cable (FLIR P/N: T127606)

Sync in

Stream 60 Hz

SyncMode set to *ExtSyncMaster*

Sync out

Sync cable (FLIR P/N: T127606)
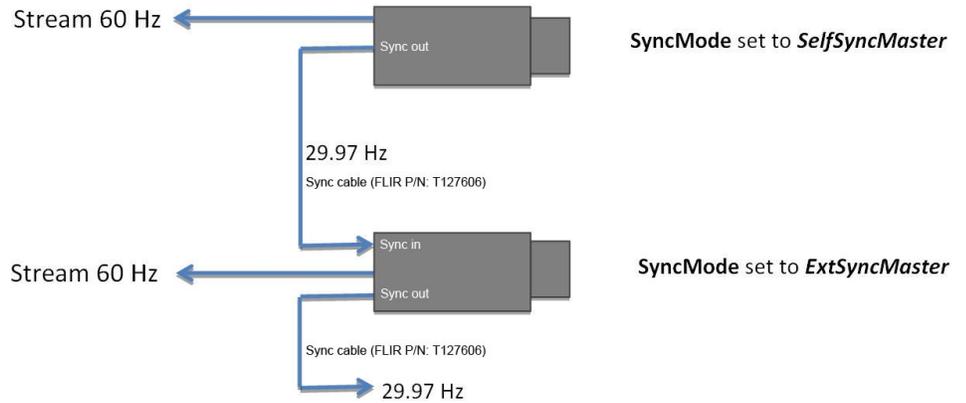
29.97 Hz

Figure 12.1 Master/slave synchronization between two FLIR Ax5 cameras (NTSC).

Note   External synchronization can be applied but only by using an input signal with a frequency of 29.97 Hz (NTSC).

• The signal voltage (relative to digital GND) is 3.3 V.
• The pulse width (minimum) is 100 ns (will be extended to 1 µs).

Note that the synchronization mode is not persistent. The camera will always return to *SyncMode Disabled* after reset or power cycling.

For slow configurations (9 Hz), the output frame rate is a fraction of the sync pulse rate. Because there is ambiguity as to which received pulse triggers the frame timing, FLIR does not recommend using the external sync interface with a slow-configured camera.

Note   The only difference between *ExtSyncMaster* and *SelfSyncSlave* mode is that the incoming sync signal is relayed to the SYNC_OUT port if set to *ExtSyncMaster*.

12.3   FLIR Ax5 measurement

The FLIR Ax5 camera has an option to output 14-bit digital video that is temperature linear.

Each count in the temperature-linear video corresponds to either 0.04 K or 0.4 K in 14-bit video, depending on the selected resolution.

Temperature-linear output is enabled or disabled with the feature register:

TemperatureLinearMode: On (1) or Off (0)

Temparture-linear resolution is determined with the feature register:

TemperatureLinearResolution: Low 0.4 K (0) or High 0.04 K (1)

If **TemperatureLinearMode** is On, the signal-to-temperature mapping is calculated using the equations

$T_{[K]} = 0.04 \times S$ (for high resolution)

$T_{[K]} = 0.4 \times S$ (for low resolution)

S corresponds to the 14-bit pixel value.

If the **TemperatureLinearMode** is Off, then the camera provides registers that can be used to convert signal values to temperature. For each measurement range (or gain mode) there is a set of register values that is used for this conversion.

The conversion from the corrected signal *S* to the temperature $T_{[K]}$ is performed using the external RBFO values for the selected lens and gain mode. The signal-to-temperature mapping is calculated using the equation

$$T_{[K]} = \frac{B}{\ln\left(\dfrac{R}{S-O} + F\right)}$$

ln(*x*) is the base-e logarithm of the *x* parameter, and *S* corresponds to the 14-bit pixel value.

Register name	Type
R	Integer
B	Float
F	Float
O	Float (handles only positive vales)
OInt	Integer (same as O but handles negative values)

Please note that these registers will be automatically updated when switching between the high gain mode and the low gain mode.

The FLIR GEV Demo sample illustrates how to use this conversion formula.

You also have the option to do your own one-point calibration by adjusting the offset value (register **OInt**) by pointing the camera at an accurately known temperature. Knowing the temperature, you can then calculate the offset value and update the **OInt** register.

$$OInt = S - \left(R \Big/ \left(\exp\left(B/T_{KNOWN}\right) - F\right)\right)$$

The FLIR GEV Demo sample illustrates how to perform this kind of calibration. Please note that you will need to save the current settings if you want the new offset value to be persistent. Use the command register **SensorSetDefaults** to set all current settings as power on defaults.

There are additional registers that also affect the temperature linear output. These registers are grouped together as Object Parameter registers. These registers only affect the transformation of detector signal values to temperature values when the camera is in temperature linear mode.

ReflectedTemperature: The estimated reflected background temperature for the target scene.

ObjectEmissivity: The target scene emissivity factor. The default value is 1.0.

WindowTransmission: The estimated transmission factor for the protective window. The default value is 1.0.

WindowTemperature: The external window temperature T_{win} (in kelvin).

AtmosphericTransmission: The estimated transmission factor for the atmosphere between the camera and the scene.

AtmosphericTemperature: The estimated temperature T_{atm} for the atmosphere between the camera and the scene.

The correction for scene parameters is extended to include the following parameters:
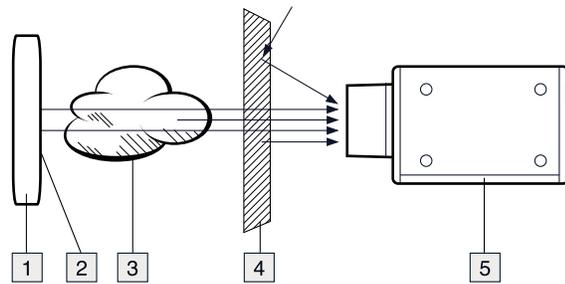
**Figure 12.2** 1: Scene, T_{scene}; 2: Reflected background temperature; 3: Atmosphere, T_{Atm}; 4: External window, T_{win}; 5: Infrared camera.

Note   The default values for the object parameters are set to values that will have no impact on the conversion between detector signal values and corrected signal values.

16 Pin configurations and schematics

16.1 M12 connector pin configuration

This section specifies the pin configuration for the M12 connector at the rear of the camera.
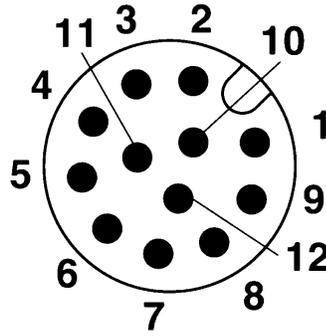

Figure 16.1 Pin assignment M12 male connector: 12 positions, male side view.

Table 16.1 Mapping table, pin to signal

Pin	Signal	Explanation
1	RET_GB	Camera PWR –
2	PWR_GB	Camera PWR +
3	SYNC_OUT	LVC Buffer @ 3.3 V, "0" = 24 MA max, "1" = –24 mA max.
4	SYNC_OUT_GND	= RET_GB = Camera PWR –
5	SYNC_IN	LVC Buffer @ 3.3 V, "0" < 0.8 V, "1" > 2.0 V
6	SYNC_IN_GND	= RET_GB = Camera PWR –
7	GPO+	1 × opto-isolated, 2–40 VDC, max. 185 mA
8	GPO–	= GP Input return
9	GPIO_PWR	GP Output PWR. 2–40 VDC, max. 200 mA
10	GPIO_GND	GP Ouput PWR return
11	GPI+	1 × opto-isolated, "0" < 2, "1" = 2–40 VDC
12	GPI-	GP Input return

Cables for the M12 connector are available from FLIR Systems. See the part numbers below.

- T127605, Cable M12 pigtail.
- T127606, Cable M12 sync.

16.2 Pig-tail end of cable

1 RET_GB
2 PWR_GB
3 SYNC_OUT
4 SYNC_OUT_GN
5 SYNC_IN
6 SYNC_IN_GND
7 GPO+
8 GPO-
9 GPIO_PWR
10 GPIO_GND
11 GPI+
12 GPI-

BLACK BROWN
BLACK RED
BLACK ORANGE
BLACK YELLOW
BLACK GREEN
BLACK BLUE

Figure 16.2 Mapping table, signal type to cable color.

16.3 SYNC input/output schematics
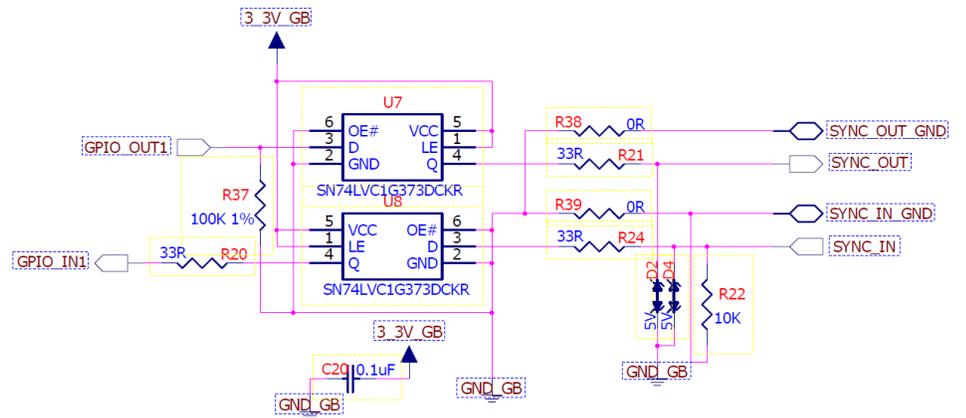
Figure 16.3 Schematics of SYNC input and output.

16.4   GP input/output schematics
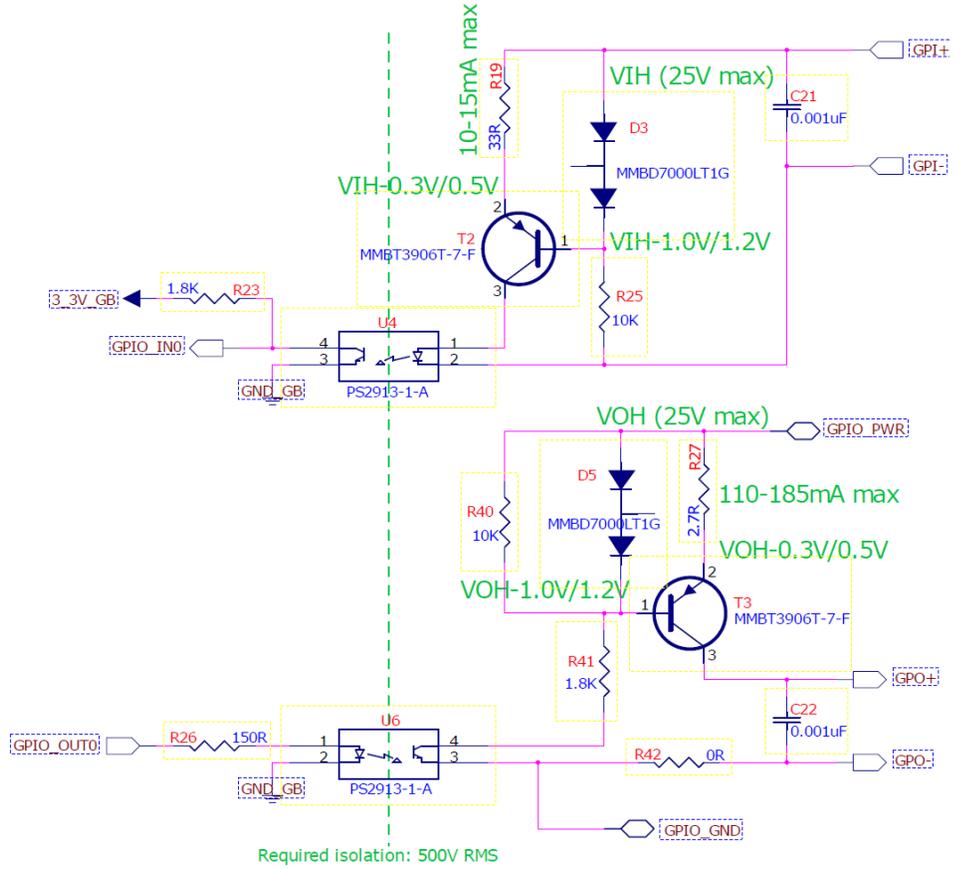

Figure 16.4   Schematics of GP input and output.

17   Cleaning the camera

17.1   Camera housing, cables, and other items

17.1.1   Liquids

Use one of these liquids:

• Warm water
• A weak detergent solution

17.1.2   Equipment

A soft cloth

17.1.3   Procedure

Follow this procedure:

1. Soak the cloth in the liquid.
2. Twist the cloth to remove excess liquid.
3. Clean the part with the cloth.

⚠ **CAUTION**

Do not apply solvents or similar liquids to the camera, the cables, or other items. This can cause damage.

17.2   Infrared lens

17.2.1   Liquids

Use one of these liquids:

• A commercial lens cleaning liquid with more than 30% isopropyl alcohol.
• 96% ethyl alcohol (C_2H_5OH).

17.2.2   Equipment

Cotton wool

17.2.3   Procedure

Follow this procedure:

1. Soak the cotton wool in the liquid.
2. Twist the cotton wool to remove excess liquid.
3. Clean the lens one time only and discard the cotton wool.

⚠ **WARNING**

Make sure that you read all applicable MSDS (Material Safety Data Sheets) and warning labels on containers before you use a liquid: the liquids can be dangerous.

⚠ **CAUTION**

• Be careful when you clean the infrared lens. The lens has a delicate anti-reflective coating.
• Do not clean the infrared lens too vigorously. This can damage the anti-reflective coating.