

SNAPSHOT SWIR



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This document is the original English user manual.

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1. Foreword

1.1 Foreword

Dear customer,

Thank you for choosing imec's hyperspectral imaging solutions.

Imec is an R&D hub for nano- and digital technologies and already developed various mature and groundbreaking applications across a multitude of industries such as healthcare, agriculture and industry 4.0. Explore what we offer at www.imec-int.com.

Our hyperspectral imaging division can provide you with a total solution thanks to our imaging software packages and a whole variety of cameras in both the visible and the infrared spectral range. There is even a range of ultra-mobile cameras available and in addition, thanks to our proprietary sensor (nano-)technology, we can offer customized solutions. See for details at www.imechyperspectral.com.

1.2 Target group

The purpose of this user manual is to provide all users of the appliance with all relevant information that ensures the safety of all operations with the appliance, work on the appliance and the condition of the appliance itself.

The user manual applies to all circumstances related to operations with the appliance or work on the appliance. These include: moving and storage, assembly and installation, commissioning, operation, adjustment, maintenance, decommissioning and disposal of the unit.

The target group is as follows:

- Carriers
- Mechanics and installers
- Maintenance technicians
- Persons who commission the appliance
- Persons responsible for the proper operation of the appliance, for example mounting, connecting to power and computer, storing, cleaning, etc.

The aforementioned persons must have sufficient demonstrable knowledge and/or level of experience for their specific tasks.

Users of the appliance must be at least 18 years old.

See also

[Intended use](#) on page 8

1.3 Symbols used

The symbols below are used in this user manual:

**TIP**

Gives the user suggestions and advice for carrying out a procedure more simply or easily.

**NOTE**

A general comment that could have an increased economic benefit.

**IMPORTANT**

Precautions to ensure proper operation of the unit or to avoid damaging it.

**ENVIRONMENT**

Guidelines that have to be followed when using hazardous substances and when recycling products and materials.

**CAUTION**

Indicates a hazardous situation, which, if the safety instructions are not followed, could lead to slight to moderate injury and/or damage to the machine or the surroundings.

**WARNING**

Indicates a hazardous situation, which, if the safety instructions are not followed, **could** lead to serious or fatal injury and/or serious damage to the machine or the surroundings.

**DANGER**

Indicates a hazardous situation which, if the safety instructions are not followed, **will** lead to serious or fatal injury.

See also

[Abbreviations and acronyms used](#) on page 6

1.4 Abbreviations and acronyms used

Abbreviation	Explanation
ATEX	(French: ATmosphère EXplosive): used in the context of intended use of equipment in explosive atmospheres.
AC	Alternating current
ADC	Analog-to-digital
DC	Direct current
DOF	Depth of field
EMI	Electromagnetic interference
ENVI	Commonly used binary file format. See the HSI Mosaic manual for more information.
ESD	Electrostatic discharge
FWHM	Full width at half maximum
GND	Ground (earth)
GUI	Graphic user interface
IO	Input/Output

Abbreviation	Explanation
PWR	Power
ROIC	Read-Out Integrated Circuit
SNR	Signal-to-noise-ratio
SWIR	Short-wave infrared
TTL	Transistor-to-Transistor Logic

See also

[Symbols used](#) on page 5

2. Introduction

2.1 Intended use

When you purchased the Snapshot SWIR camera, you filled out and signed the **Export Control Questionnaire for export of SWIR camera**.

As agreed in the questionnaire

- In paragraph **D. Declaration of commitment with regard to the Item**, the camera may only be used in the provided **description of the final end-use**
- In paragraph **C. Final destination**, the camera may only be used at the destination indicated or mentioned.



IMPORTANT

Also read imec's [Code of conduct](#).

The camera may be used by adults (18 years old or more) as long they have read this manual. They have to read all safety instructions or they have received instructions concerning the safe use of the appliance and thus understand the hazards associated with its use.

The camera and power supply are intended for use in regular industrial and scientific non-APEX environments with operation temperatures of 10 - 40 °C (50 - 104 °F) and humidity 20 - 80 % (with no condensation). Avoid dust and lint.

See also

[Forbidden use](#) on page 8

[Target group](#) on page 5

2.2 Forbidden use

The camera cannot be used for

- As agreed in paragraph **D. Declaration of commitment with regard to the Item** of the **Export Control Questionnaire for export of SWIR camera**, the camera will not be used or likely to be used, wholly or in part for or in connection with any of the following:
 - The design, development, production, handling, operation, maintenance, storage, detection, identification or dissemination of any nuclear, chemical or biological weapon, or the development, production, maintenance or storage of missiles which are capable of delivering any such weapon.
 - The design, development, production, maintenance or storage of systems that are capable of delivering such weapon (e.g., missiles, rockets or unmanned air vehicle system or
 - Human rights violation
- Legally unauthorized private or public observations

IMPORTANT

Also read imec's [Code of conduct](#).

Attaching parts to the appliance that are not approved by imec is forbidden. These can:

- Adversely affect the working of the appliance
- Compromise the safety of the user or other persons
- Reduce the service life of the appliance
- Cancel the compliance with guidelines.

The camera is not ATEX approved and can thus not be used in an explosive atmosphere. Examples of high-risk areas include gas and petrochemical plants, paint and chemical manufacturers and users, petrol stations, and workplaces handling fine organic dusts such as grain flour or wood.

Using the appliance for purposes other than those stated in the intended use is prohibited. Using the appliance for other than the intended purpose can compromise the safety of the user or other persons.

Children are not permitted to play with the appliance. Children are not permitted to clean the appliance or carry out any user maintenance without supervision.

See also

[Intended use](#) on page 8

2.3 Service life

The expected service life of the camera is 10 years, as long as it is used according to the intended use and the prescribed maintenance is carried out.

Regular inspection, and, if necessary, cleaning or replacement of worn, damaged or stained parts will improve the service life of the camera and its accessories.

2.4 Identification label

The identification label can be found at the back of the camera.

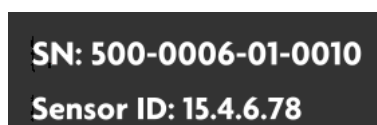


Figure 1: Identification label (example)

Item	Description
SN: xxx-xxxx-xx-xxxx	Serial number of the camera
Sensor ID: xx.x.x.xx	Sensor identification number

Table 1: Identification label items

3. Technical data

3.1 Mechanical camera specifications

Feature	Specification
Body size (H x W x L) (without Power + IO socket)	68 mm x 68 mm x 98 mm
Weight (without lens)	682 g
Lens mount	C-mount
Tripod socket (bottom)	1/4"-20 UNC Distance to the front of the camera: 30 mm
Mounting screw holes	Thread: M5 Center distance: • Top/bottom: 50 mm • Right/left: 25 mm Distance to the front of the camera: 8 mm
Sensor	VGA (640x480) total resolution Pixel size: 15 µm
Rejection filter	SWIR 9: below 1100 nm cut-off SWIR 16: below 1250 nm cut-off
USB port	Micro B USB 3.0
Power + IO socket	12 pin Hirose male socket • Power input: 6 V • Trigger I/O level: 5 V
Cooling	Camera housing: passive Sensor: active (thermoelectric)

Feature	Specification
USB3 led	Yellow (flashing quickly): proper operation of the camera Yellow (flashing): data traffic between camera and computer Green (solid): a USB 3.0 connection has been established Off: A USB 2.0 connection has been established
PWR led	Green: the camera is receiving power and the main firmware is being used Green and orange: the camera is receiving power. The USB cable might not be connected to the computer. Off: the camera is not receiving power

Table 2: Mechanical camera specifications

See also

[Electro-optical camera specifications](#) on page 11

3.2 Electro-optical camera specifications

Feature	Specification
Image acquisition	Real-time
Spatial resolution	640 × 512 pixels (raw sensor resolution)
Pixel size	15 µm
Spectral resolution	SWIR 9: 9 bands SWIR 16: 16 bands
Spectral range	SWIR 9: 1100 - 700 nm SWIR 16: 1250 - 1700 nm
FWHM (Full width at half maximum)	10 - 15 nm (collimated)
Bit depth	13 bit
Cube acquisition speed	Up to 150 cubes/s in imec's HSI Mosaic software
SNR (Signal-to-noise-ratio)	Up to 600/1
Dynamic Range	6500 [DN]

Feature	Specification
Noise	1.5 nA/cm ³ at 280 K
Digital output format	RAW or ENVI Standard (float)
Analog-to-Digital (ADC)	13 bit
Shutter speed	50 ms open/close time

Table 3: Elektro-optical specifications

See also

[Mechanical camera specifications](#) on page 10

3.3 Power supply unit specifications

Feature	Specification
Mains input	100-240 V AC - 0,8 A - 50/60 Hz C14 socket
Power/trigger-output plug	6 V DC - 3.0 A Female 12 pin Hirose plug
Triggering cable plug	See Trigger plug specifications on page 12
Separate mains cable	C13 plug Mains plug (type C or E/F (CEE 7/7) plug is delivered

Table 4: Power supply unit specifications

See also

[The power supply unit](#) on page 20

[Label of the power supply unit](#) on page 41

[Connect the camera to the power supply unit](#) on page 27

3.4 Trigger plug specifications

Feature	Specification
Connector type	Bulgin PXPTPU05FBF03ACL010PUR

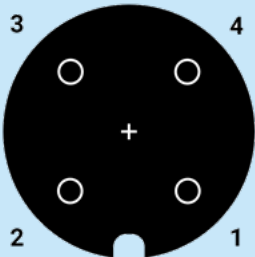
Pins 	• Pin 1: external triggering input (see below in this table) • Pin 2: not in use • Pin 3: external triggering output (see below in this table) • Pin 4: GND
Input (pin 1)	Type: Transistor-to-Transistor Logic (TTL) Electrical Isolation: No Low voltage threshold: < 1.5 V High voltage threshold: > 3.5 V Maximum delay: 8 ns Minimum voltage: -0.5 V (absolute) Maximum voltage: 6.5 V (absolute) ESD protection: up to class -4 (+/- 15 kV) EMI filtering: serial ferrite bead 120 Ω at 100 MHz
Output (pin 3)	Type: Transistor-to-Transistor Logic (TTL) Electrical isolation: No High level output current: +/-32 mA High minimum voltage: 3.8 V High maximum voltage: 5.3 V Low maximum voltage: 0.55 V Maximum delay: 6.4 ns ESD protection: up to class -4 (+/- 15 kV) EMI Filtering: serial ferrite bead 120 Ω at 100 MHz

Table 5: Triggering plug

See also

[External triggering](#) on page 34

[Connect/enable external triggering](#) on page 29

3.5 USB cable specifications

Feature	Specification
Camera plug	Micro B USB 3.0
Computer plug	USB A 3.0

Table 6: USB cable specifications

See also

[Connect the camera to the computer](#) on page 27

3.6 Lens compatibility and recommendations

Only lenses with the following specifications can be used:

- C-mount, maximum 5 mm protrusion depth



IMPORTANT

When the protrusion depth is more than 5 mm, the mount damages the rejection filter. You can use spacer rings between the lens and the camera to prevent this.

- Minimal chromatic aberrations in the 1100 - 1700 nm spectral range
- Achromatic/apochromatic (or similar)
- High transmission in the 1100 - 1700 nm spectral range
- Aperture range: f/2.8 - f/16
- (Near) image-side telecentric (entrance pupil at infinity)

See also

[The lens](#) on page 32

3.7 Environmental conditions

Parameter	Conditions
Temperature	• Operation: 10 - 40 °C (50 - 104 °C) • Storage/transport: 5 - 50 °C (41 - 122 °F)
Humidity	• Operation: 20 - 80 % (with no condensation) • Storage/transport: < 60 % (with no condensation)

Table 7: Temperature and humidity conditions

4. Description

4.1 Delivery scope

The camera and its accessories come in a protective carrying case.

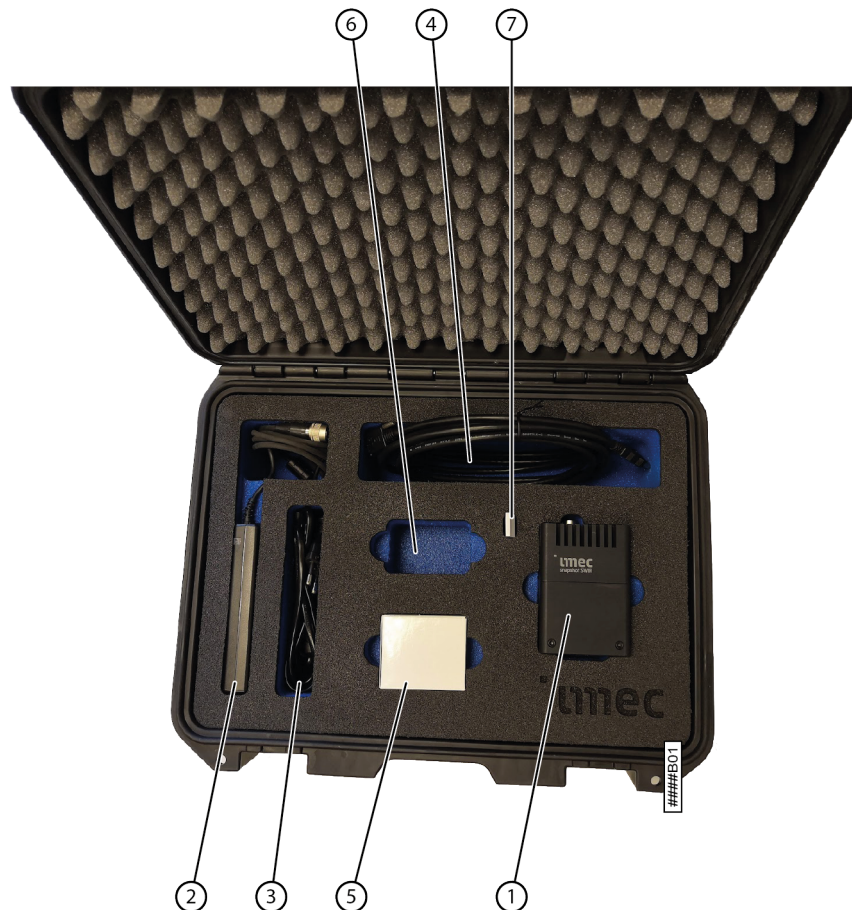


Figure 2: The carrying case

Standard in the case:

1. Camera (with attached lens mount cap)
2. Power supply unit with PWR + I/O connector
3. Mains power cable of the power supply unit
4. USB cable
5. Lens (Optional)
6. Lens compartment

7. USB-stick, containing:

- This Snapshot SWIR hardware user manual
- HSI Suite, software package containing:
 - HSI Mosaic: GUI software used to acquire, process and analyze hyperspectral cubes
 - HSI Studio: lightweight, standalone GUI software used to view and analyze hyperspectral cubes
 - Camera API: code library and documentation to access and acquire raw hyperspectral cubes from imec snapshot cameras
 - Mosaic API: code library and documentation to process acquired raw cubes from imec snapshot cameras. Available for C and Python languages in Windows
- The calibration file
- imec HSI Support registration form: please fill in this form and send it to hsisupport@imec.be
- Camera validation report: includes the test results for spectral and overall quality of this particular camera



NOTE

As a registered customer or partner, visit the support website <https://imechyperspectral.com/support> to download the latest support documents and materials.

When lenses are part of the purchase, maximum two lenses are included in the carrying case.

See also

[Options](#) on page 21

[Models](#) on page 16

[Camera authentication](#) on page 30

[Software](#) on page 35

4.2 Models

Two camera models are available.

- The Snapshot SWIR 9
- The Snapshot SWIR 16

Specifications	Snapshot SWIR 9	Snapshot SWIR 16
Spectral bands	9 bands	16 bands
Spectral range	1100 - 1700 nm	1250 - 1700 nm

Table 8: Models

4.3 Orientation and dimensions of the camera

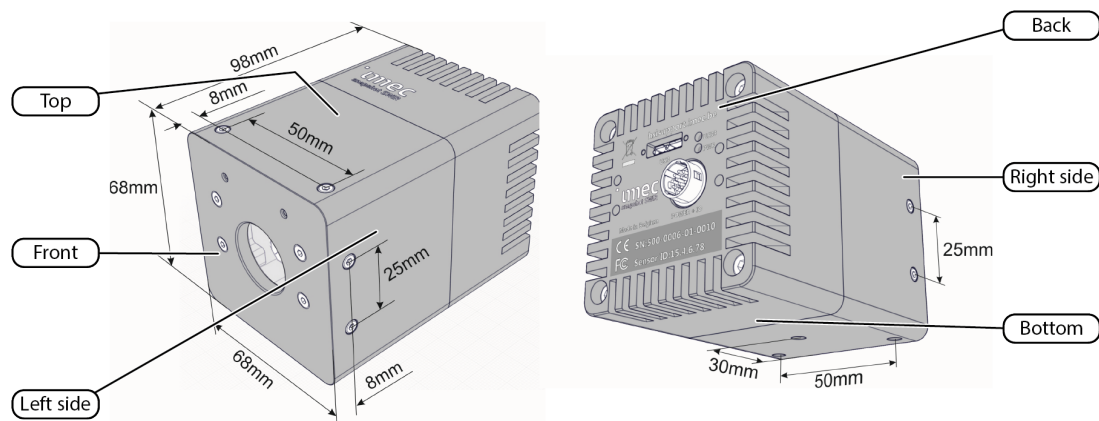


Figure 3: 3D orientation view

4.4 Camera parts and functions

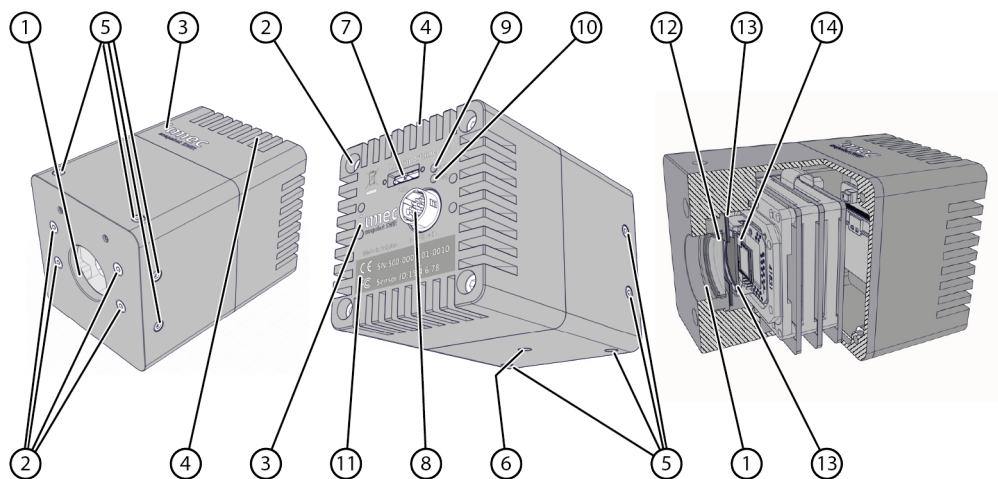


Figure 4: 3D-views

No.	Part	Function
1	Lens mount	Allows attaching the lens or lens mount cap. See Attach a lens to the camera on page 25.
2	Assembly screws	Fastens camera components. Never loosen assembly screws.
3	imec logo and product name	Identification of the product
4	Cooling fins	Prevents overheating by passive cooling. Do not cover the cooling fins while the camera is in use.

No.	Part	Function
5	Protective screws in mounting holes	To be unscrewed and removed to mount the camera in your measuring setup. See Mount the camera on page 26.
6	Tripod socket	Allows attaching the camera to a tripod. Only use an appropriate tripod screw. See Technical data on page 10.
7	USB connector	Connects the camera to the computer with the imaging software. See Connect the camera to the computer on page 27.
8	POWER + IO connector	Power/trigger input-connector. Connects the camera to the power supply unit and allows for external triggering. See The power supply unit on page 20, Connect the camera to the power supply unit on page 27, and Connect/enable external triggering on page 29.
9	USB3 led	Off: a USB 2.0 connection has been established. Green: a USB 3.0 connection has been established. Yellow - flashing quickly: the camera is operating properly. Yellow - flashing: indicates GenCP traffic between the camera and the host.
10	PWR led	Off: the camera is not receiving power. Green: the camera is receiving power and the main firmware load is being used. Green and orange: the camera is receiving power and the backup firmware is being used. It can also indicate that you have not connected the USB cable to the computer.
11	Identification label	Identifies the camera. See Identification label on page 9.
12	Rejection filter	Filters out wavelengths below 1100 nm and protects the sensor behind it.

No.	Part	Function
13	Mechanical shutter	Traveling curtains that open/close to allow/block the light from the scene towards the sensor.
14	Sensor	Captures light from the scene with pixels and converts it to electrical signals. Eventually, these signals are processed resulting in an image.

Table 9: Camera parts and functions

See also

[Orientation and dimensions of the camera](#) on page 16

[Mechanical camera specifications](#) on page 10

[Electro-optical camera specifications](#) on page 11

4.5 Lens parts and functions

For full specifications, images, parts and functions, please refer to the lens manufacturer documentation.



Figure 5: Lens parts

No.	Part	Function
1	Front element	The lens element exposed to the scene.
2	Aperture ring with f-number indications or fixed aperture indication (f-number)	Rotate to change the aperture /indicates the aperture of the lens.

No.	Part	Function
3	Manual focus ring	Rotate to focus.
4	C-mount	To attach the lens to the camera.

Table 10: Lens parts and functions

See also

The lens on page 32

4.6 The power supply unit



IMPORTANT

Before connecting the camera to the power supply unit, you have to connect the camera to the computer with the USB-cable. Before disconnecting the camera from the computer, disconnect the camera from the power supply. Thus, connect or disconnect the USB connection only when the camera is not powered.



WARNING

- Disconnect the power supply unit from the camera and the mains when the camera will not be used for an extended period.
- Only use the cables and the power supply unit that are delivered with the camera or as a spare part by imec or that are (written) recommended by imec.
- Only use the power supply unit in a dry location.

Failure to observe this precautions could result in fire, burns, other injuries or product malfunction.

The power supply unit provides low-voltage power to the camera and has a trigger-input connector that allows external triggering of the camera by, for example, a flash.

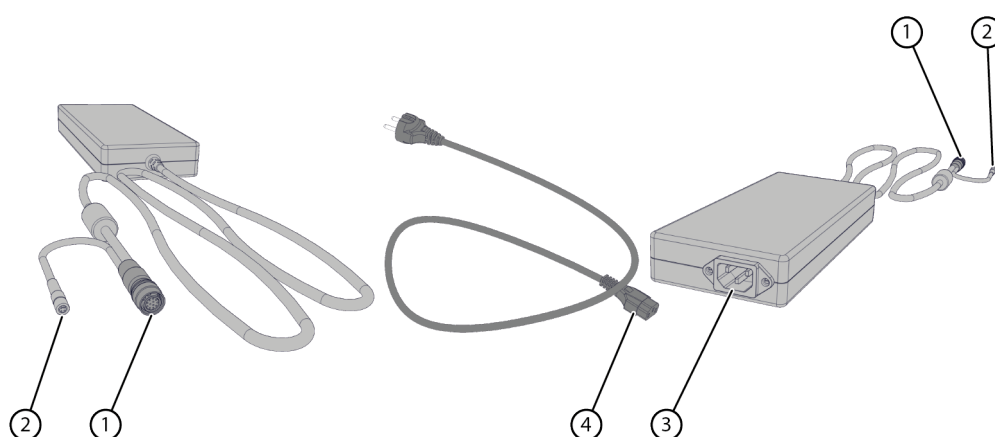


Figure 6: Power supply unit with power cable

No.	Part
1	Power + IO output plug
2	Trigger plug

No.	Part
3	Mains socket
4	Power supply unit plug - mains cable

Table 11: Parts of the power supply unit

See also

[Connect the camera to the power supply unit](#) on page 27

[Power supply unit specifications](#) on page 12

4.7 Options

- Lenses
- Lab measurement setup

5. Safety

5.1 Important safety instructions

 	Read this important information and the user manual carefully before you start using the camera. Save this information where all those who use the camera can consult it.
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WARNING

- Do not use the camera while walking or driving a vehicle. Do not engage in traffic while using the camera.
Failure to observe this precaution could result in accidents or other injury.
- Do not disassemble or modify the camera or its accessories, in particular the power supply.
Failure to observe this precaution could result in electric shock, exposure to hazardous products or other injury.
- Do not cover the cooling fins of the camera while it is in use.
Covering the cooling fins could result in overheating of the camera, fire, burns or other injury.
- Do not point lenses at direct sunlight or powerful light sources for an extended period of time.
Failure to observe this precaution could result in fire, burns or other injury.
- When you notice any abnormalities such as the camera or the accessories producing smoke, heat or unusual odors, immediately disconnect the mains cable from the power supply unit.
Continued operation could result in fire, burns or other injury.
- Do not handle the camera or the accessories with wet hands.
Handling with wet hands could result in fire or electrical shock.
- Do not use this product in the presence of flammable dust, gases or aerosols.
Failure to observe this precaution could result in explosion or fire.
- Disconnect the power supply unit from the camera and the mains when the camera will not be used for an extended period.
Failure to observe this precaution could result in fire or product malfunction.
- Do not expose the product to extremely high temperatures, for an extended period such as in an enclosed car or in direct sunlight.
Failure to observe this precaution could result in fire or product malfunction.

- *Only use the cables and the power supply unit that are delivered with the camera or as a spare part by imec or that are (written) recommended by imec.*

Failure to observe this precaution could result in fire, burns, other injuries or product malfunction.

- *Only use the power supply unit in a dry location.*

Failure to observe this precaution could result in fire, burns, other injuries or product malfunction.

CAUTION

- *Do not let your skin in prolonged contact with the camera or its accessories while it is on or plugged in.*

Prolonged skin contact could result in low-temperature burns.

Electromagnetic fields

This appliance complies with all applicable guidelines and standards concerning exposure to electromagnetic fields.

6. Transport and storage

6.1 Transporting and moving the camera

When moving the camera to another room or transporting it:

- Dismount the camera from the measurement setup.
- Dismount the lens.
- Attach the lens mount cap.
- Disconnect the cables.
- Fit the camera and its accessories in the carrying case and close it firmly.

NOTE

Do not expose your camera to temperatures above 50 °C (122 °F) or below 5 °C (41 °F) and humidity above 60 % during transport.

NOTE

Bring the necessary export/transport forms when exporting the camera.

See also

[Storing the camera for a longer period](#) on page 24

[Export restrictions](#) on page 40

[Export/travel license](#) on page 41

6.2 Storing the camera for a longer period

When storing the camera for extended periods:

- Dismount the camera from the measurement setup.
- Dismount the lens.
- Attach the lens mount cap.
- Disconnect the cables.
- Fit the completely dry camera and its dry accessories in the carrying case and close it firmly. When the camera is not dry, keep it first in a well-ventilated location.
- Store the case in a cool, dry, well-ventilated area.

NOTE

Do not store your camera and accessories in locations:

- *Where chemical products are handled since this may result in corrosion*
- *With naphta or camphor moth balls*
- *That are poorly ventilated or subject to humidities of over 60 %*
- *That are exposed to temperatures above 50 °C (122 °F) or below 5 °C (41 °F)*

See also

[Transporting and moving the camera](#) on page 24

7. Assembly and commissioning

7.1 Attach a lens to the camera

IMPORTANT

Only use lenses with the correct lens mount. Using an incorrect mount is grounds for voiding the warranty.

- A lens with the wrong mount will damage the screw thread.
- A lens with a too large protrusion depth will damage the rejection filter. You can use spacer rings between the lens and the camera to prevent this.
- Be careful to prevent dust or other dirt entering the camera.
- Attach the lens caps to the lens when the lenses are not in use.

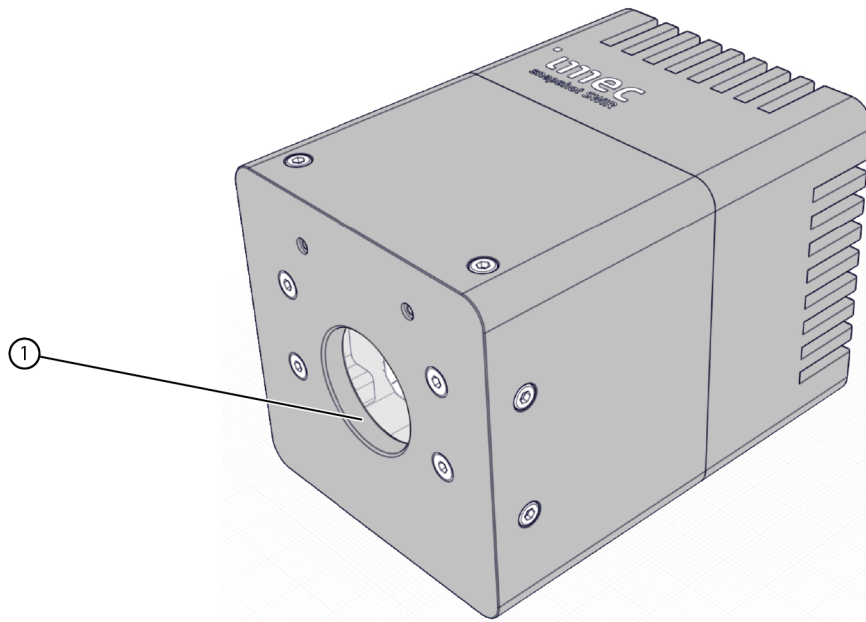


Figure 7: The lens mount

1. Unscrew the lens mount cap or another attached lens counterclockwise.
2. Align the male lens mount to the female body mount and gently screw the lens clockwise on the body. Do not overtighten the lens.

See also

[Lens parts and functions](#) on page 19

[The lens](#) on page 32

[Detach a lens from the camera](#) on page 25

[Lens compatibility and recommendations](#) on page 14

7.2 Detach a lens from the camera

Be careful to prevent dust or other dirt entering the camera. Attach the lens caps to the lens when the lenses are not in use.

1. Unscrew the lens counterclockwise and add the lens caps to protect it.
2. Attach a new lens or screw the lens mount cap to the body.
3. Attach the lens caps to both sides of the dismantled lens.

7.3 Mount the camera

CAUTION

Do not cover the cooling fins of the camera while it is in use.

Covering the cooling fins could result in overheating of the camera, fire, burns or other injury.

NOTE

All screw holes have an M5 thread except for the centered tripod screw hole on the bottom of the camera. Center distance between the screw holes is 25 mm (left and right side) or 50 mm (top and bottom). Distance to the front of the camera is 8 mm.

You can mount the camera in any direction. Only the image may need to be rotated via the software.

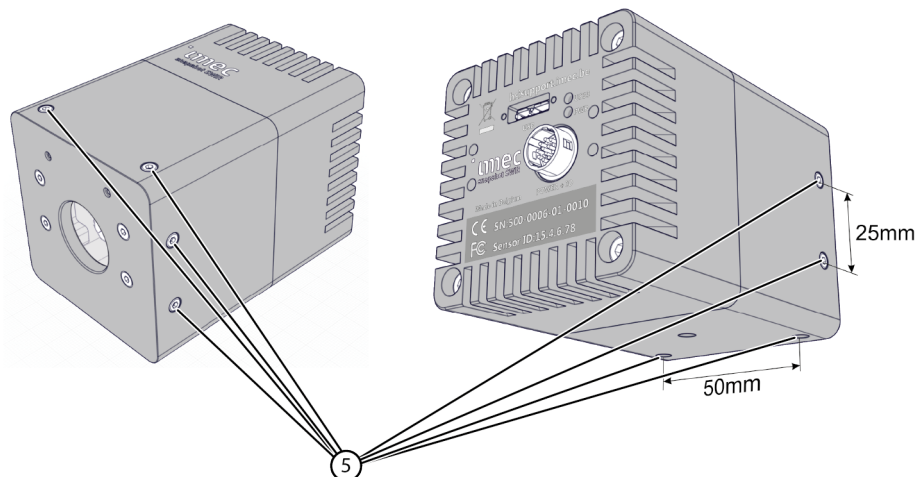


Figure 8: The M5 mounting holes

1. Unscrew the protective screws from the mounting holes that you want use. Make sure that you don't loosen assembly screws.
2. Use M5 mounting screws (minimum 2 recommended) to mount the camera. Do not overtighten the screws.

See also

[Attach the camera to a tripod](#) on page 26

7.4 Attach the camera to a tripod

IMPORTANT

Only use a tripod or a quick release tripod mount with a ¼"-20 UNC screw. All other mounting holes have a M5-thread.

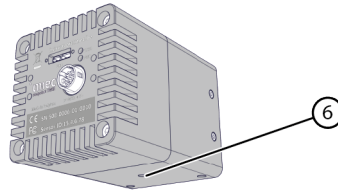


Figure 9: The tripod mount

Gently screw the tripod mount(or quick release tripod mount) clockwise on the centered tripod screw hole (6) at the bottom of the camera. Do not overtighten the screw.

See also

[Mount the camera](#) on page 26

7.5 Connect the camera to the computer

IMPORTANT

Before connecting the camera to the power supply unit, you have to connect the camera to the computer with the USB-cable. Before disconnecting the camera from the computer, disconnect the camera from the power supply. Thus, connect or disconnect the USB connection only when the camera is not powered.

TIP

*You can distinguish a USB A 3.0 port from a 2.0 port on your computer by the blue color of the 3.0 port or the SuperSpeed initials **SS** near the port.*

1. Plug the supplied USB-cable into the micro B USB 3.0 port (7) of the camera.

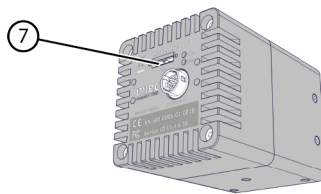


Figure 10: The micro B USB 3.0 port

2. Plug the other end of the USB-cable into a free USB A 3.0 port of the computer.
You can now [Connect the camera to the power supply unit](#) on page 27.

See also

[USB cable specifications](#) on page 13

7.6 Connect the camera to the power supply unit

❗ IMPORTANT

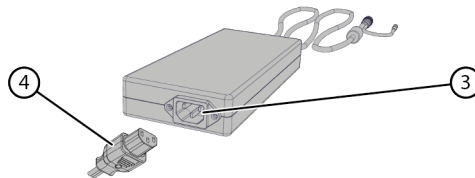
Before connecting the camera to the power supply unit, you have to connect the camera to the computer with the USB-cable. Before disconnecting the camera from the computer, disconnect the camera from the power supply. Thus, connect or disconnect the USB connection only when the camera is not powered.

⚠ CAUTION

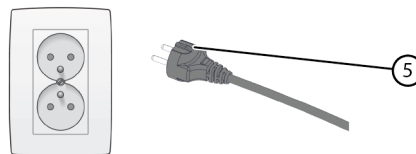
- Disconnect the power supply unit from the camera and the mains when the camera will not be used for an extended period.
- Only use the cables and the power supply unit that are delivered with the camera or as a spare part by imec or that are (written) recommended by imec.
- Use the power supply unit in a dry location.

Failure to observe this precautions could result in fire, burns, other injuries or product malfunction.

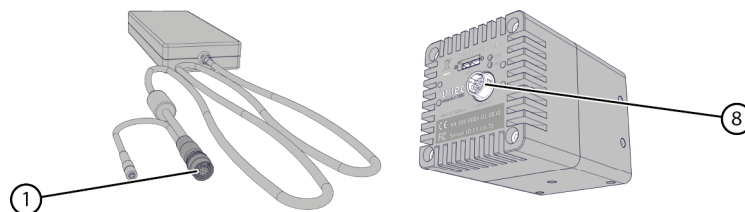
1. Plug the supplied unit mains cable (4) into the power supply unit's mains socket (3).



2. Plug the mains (5) cable into the wall socket.



3. Plug the power supply unit's power/trigger-output (1) cable into the camera's **POWER + IO** socket (8) until the plug locks up.



❗ NOTE

To disconnect the cable, pull back the slide ring to unlock the plug.

The camera is now turned on. The **PWR** led lights up green. If the camera is connected to the computer via USB 3.0, the **USB** led turns green. Once the camera is operational the led starts flashing yellow.

See also

[The power supply unit](#) on page 20

[Power supply unit specifications](#) on page 12

7.7 Connect/enable external triggering

The camera can be triggered externally. For example, a flash light can be an external trigger. Triggering will have to be enabled via the software, for example, via HSI Mosaic.

The actual input from the trigger is done through the trigger-input connector (2) of the power supply unit.

NOTE

Provide your own trigger connector for your device's triggering cable. See the technical data of the triggering cable of the power supply unit for more information.

The power supply unit forwards the trigger signal via its power/trigger-output connector to the camera's power/trigger-input connector.

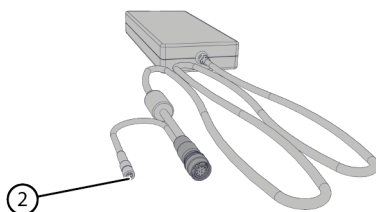


Figure 11: The trigger input connector

1. Connect the external trigger with the trigger-input connector of the power supply unit.
2. Enable external triggering in the software.

See also

[External triggering](#) on page 34

[Trigger plug specifications](#) on page 12

8. Operation

8.1 Camera authentication

Each sensor, and consequently each camera, is unique. To compensate for the data variation that thus arises, imec supplies a calibration file with the camera. This calibration file ensures that the imaging software (for example, HSI Mosaic) correctly interprets all data.

The calibration file name contains the serial number of the sensor, for example, the file name CDL640-SSM3x3-1100_1700-12.11.12.10 with 12.11.12.10 being the sensor serial number. Refer to **Camera authentication** in the HSI Mosaic software manual or your own API documentation for proper calibration.

See also

[The sensor](#) on page 30

8.2 The sensor

The Snapshot SWIR camera integrates a HSI sensor based on a Cardinal 640 640x512 15 μ m pixel pitch InGaAs Detector with digital SWIR ROIC image sensor.

Physically there are 9 (or 16) spectral bands implemented on this sensor. These bands are implemented as single pixels in a mosaic pattern. Each group of 3x3 (or 4x4) pixels have 9 (or 16) different filters and they are used to acquire the hyperspectral information of a single location. This multi-band information of a single location is called a voxel.

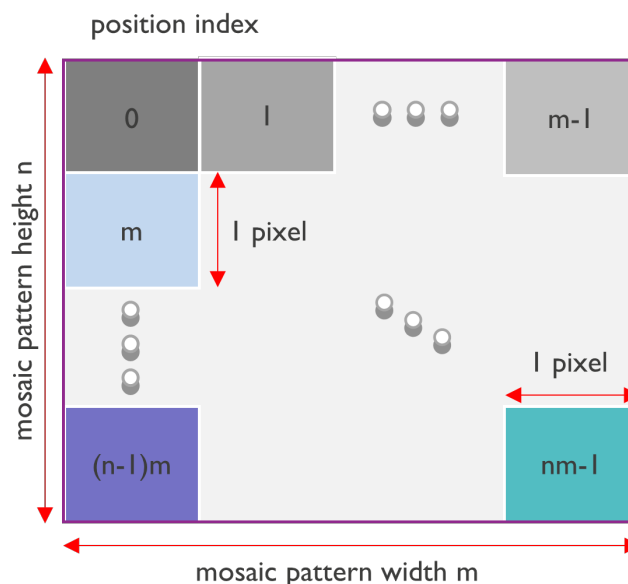


Figure 12: Mosaic pattern of pixel filters for a single voxel on a sensor

The active area of the sensor is covered by this mosaic structure. Thus, each location in the image has the information in 9 (or 16) bands. Grouping this information by bands results in 9

(or 16) versions of the same image carrying different wavelength information. The combination of these images is called a *hyperspectral cube*.

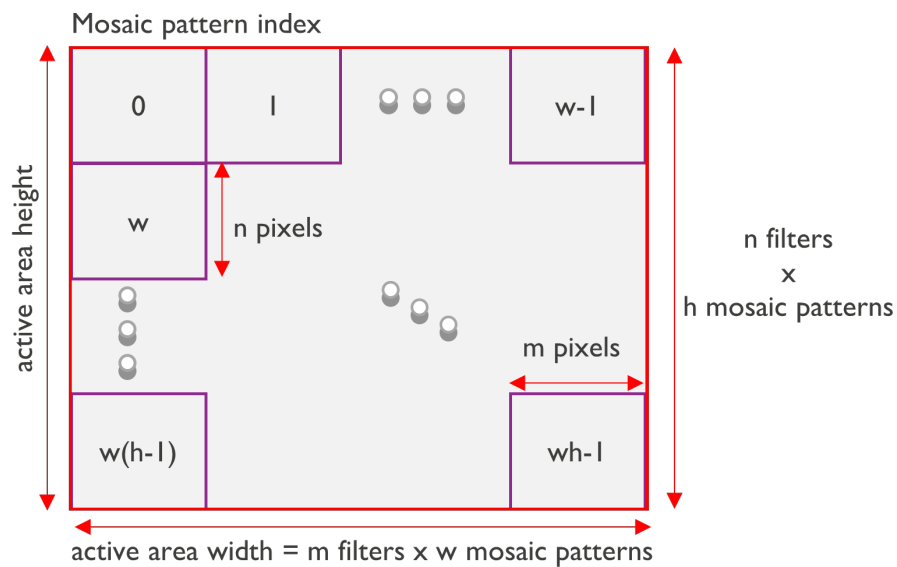


Figure 13: Voxels of $m \times n$ pixels forming the active region of the entire sensor.

Hyperspectral filters from imec are based on Fabry-Pérot structures. Fabry-Pérot structures have two reflective surfaces with a transparent cavity in between.

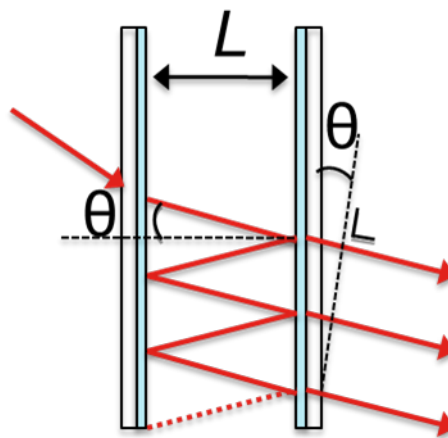


Figure 14: Fabry-Pérot structure

The filter only transmits wavelengths that complies with equation: $k\lambda = 2nL\cos\theta$

The angle of the incident light (θ) on the filter is introduced to the formula with a cosine. Because the cosine of a small angle is very close to 1, the angle of the incident light is insignificant when the light strikes the filter close to perpendicularity. If the light enters with a larger angle, the angularity effect must be considered in calculations.

The different filters in the mosaic structure are realized by varying the thickness (L) of the cavity layer from pixel to pixel.

Multiple harmonics can be transmitted through the filter, which is represented by the integer number (k). The filters in the mosaic structure are designed for the wavelengths where $k = 1$.

However, the filter also transmits second or third level harmonics, which are around the wavelengths determined by $k = 2$ and $k = 3$. These additional harmonics are outside the sensitive range of the sensor or are externally filtered.

See also

[Camera authentication](#) on page 30

[The rejection filter](#) on page 32

8.3 The rejection filter

The sensor is designed to be sensitive in a certain wavelength range but out of this range there are no guarantees for reliable measurement results.

To prevent unreliable results, the Snapshot SWIR camera is equipped with a rejection filter. This filter rejects all wavelengths below 1100 nm (Snapshot SWIR 9) or 1250 nm (Snapshot SWIR 16) before they reach the sensor and can contaminate the measurement results. The filter also blocks the second and third level harmonics outside the active range.

8.4 The lens

The lenses imec optionally offers are tested with the camera and well-suited for the its spectral range. However, there is a whole range of suitable lenses available from various manufacturers.

See also [Lens compatibility and recommendations](#) on page 14.

- The lens system determines the angularity of the incident light on the sensor. For the best performance, the angularity must be minimized (see [The sensor](#) on page 30). To minimize the angle of the light on the sensor Fabry-Pérot filters, use (near) image-side telecentric lenses. These lenses have infinite or close to infinite exit pupil distances.
- Use achromatic/apochromatic (or similar) lenses. When a lens has a large focus error across the entire bandwidth range (large chromatic aberrations), you cannot achieve a sharp focus across the full spectral range of the camera.
- The Snapshot SWIR camera has a rejection filter between the lens and the image sensor to reject light out of the sensor's spectral range. The inclusion of a long pass filter in the optical path, shifts the image plane slightly behind the focal plane array of the sensor. To accommodate the shift in the image plane due to the filter, the use of a lens with a large depth of focus (DOF) is recommended. The DOF information of a specific lens can be acquired from its manufacturer.

See also

[Lens parts and functions](#) on page 19

[f-number settings](#) on page 32

[Attach a lens to the camera](#) on page 25

[Lens compatibility and recommendations](#) on page 14

8.5 f-number settings

The aperture of an optical system is the opening that limits the amount of light that can pass through the system. The aperture of the system determines the cone angle of a bundle of rays that come to a focus in the image plane, for example, the sensor of your camera.

The size of the glass elements of your lens determines its maximum aperture. The larger the glass elements, the larger the maximum aperture.

Most lenses have a diaphragm, that functions like the iris of a human eye and that can block the light depending on the setting. The diameter D of the diaphragm opening now determines the amount of light passing through the lens, and the cone angle of the rays.

The f-number (N) is the ratio of the system's focal length (f) to the diameter (D) of the entrance pupil: $N = f/D$. It is commonly indicated as f/N , where N is the f-number. When you decrease the diaphragm diameter, the f-number increases and the sensor receives less light from the object. For example, an $f/16$ setting of your lens results in a much smaller opening than an $f/2.8$ setting.

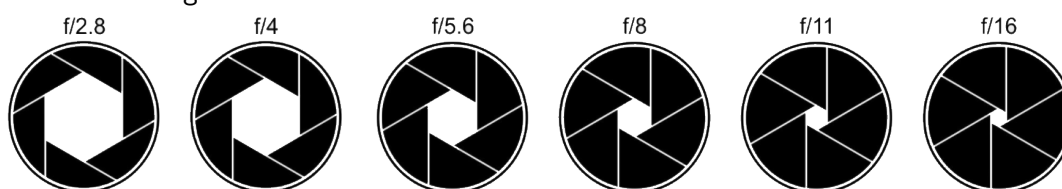


Figure 15: Diaphragm and f-numbers

The depth of field (DOF) is the distance between the nearest and the farthest objects that are in acceptably sharp focus in an image. The DOF gets wider as the cone angle gets narrower. When you increase the f-number, the diaphragm diameter decreases and the DOF gets wider.

f-number settings

- The lowest recommended f-number (maximum aperture) setting is $f/2.8$. Beyond that number, widening the opening impacts the filter performance as the cone angle increases.
- Start focusing at $f/2.8$.
- For a non-flat sample, start focusing in the middle of the sample and gradually increase the f-number (decrease the aperture and increase the DOF) until the sample part that matters is completely in focus.

See also

[The lens](#) on page 32

8.6 Focusing

To get the best accuracy and performance in acquisition, you have to focus the lens properly.

- Use objects that have sharp contrasts to focus on.
- Start focusing at $f/2.8$. For a non-flat sample, start focusing in the middle of the sample and gradually increase the f-number until the sample part that matters is completely in focus, see [f-number settings](#) on page 32.

- When the focusing object is different than the actual object that will be imaged, make sure that their features have a similar distance to the lens.
- When perfect focusing in all bands is not possible because the quality of the lens, you can try to:
 - Focus in the middle bands
 - Acquire multiple images in different bands, focusing for each image separately
- When you use the HSI Mosaic software, see the manual for software focus assistance.

See also

[f-number settings](#) on page 32

8.7 The mechanical shutter

The camera is provided with a mechanical shutter in front of the sensor. When the shutter is closed, it stops the light from the scene to go to the sensor.

8.8 Illumination

Illumination (lighting of your sample/scene) is critical in hyperspectral imaging. Different sources of illumination have different spectral profiles and thus different intensity levels at different wavelengths. The illumination source has a significant effect on the signal-to-noise ratio (SNR) of the measurement because the system's measurement sensitivity corresponds to the combined response of the illumination and the sensor.

To get good illumination you have to think of:

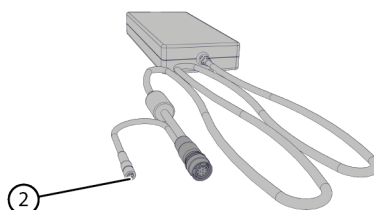
- The spectral reflectance of the target
- The quantum efficiency of the spectral filter bands of the sensor

Ideally, the illumination of your source gives an equivalent number of photons per spectral band after sampling by the camera.

The full lab setup of imec includes halogen lamps with a reflector that reflects all light to the scene and provides a relatively flat spectral profile. Halogen lamps are a cost-effective solution in the SWIR range because of their emission characteristics. To optimize the system performance, you can use illumination sources with a customized spectral profile to compensate for spectral variations in the application.

8.9 External triggering

The Snapshot SWIR camera can send receive external trigger pulses through the trigger plug (2).



- **External triggering input**

External triggering input can be used to start an acquisition. In some applications this functionality is used for syncing with an event or a light source. Use pin 1 of the trigger plug (2) to transmit the external triggering signal to the system.

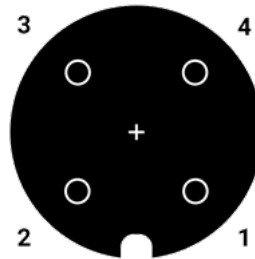


Figure 16: The trigger plug pins

Keep the signal at a low voltage when it is not used. To use the trigger, a high voltage pulse between 1 and 300 microseconds is necessary.

- **External triggering output**

External triggering output transmits a high signal pulse when an image is acquired. You can use this signal to sync with external devices. Use pin 3 of the trigger plug to receive an external triggering signal.

An external triggering pulse with high voltage is transmitted to pin 3 each time an external or internal trigger input pulse is transmitted to the system. This pulse starts 1 μ s after the start of the input pulse and continues for 1 μ s. When no pulse is transmitted, this pin is on low voltage.

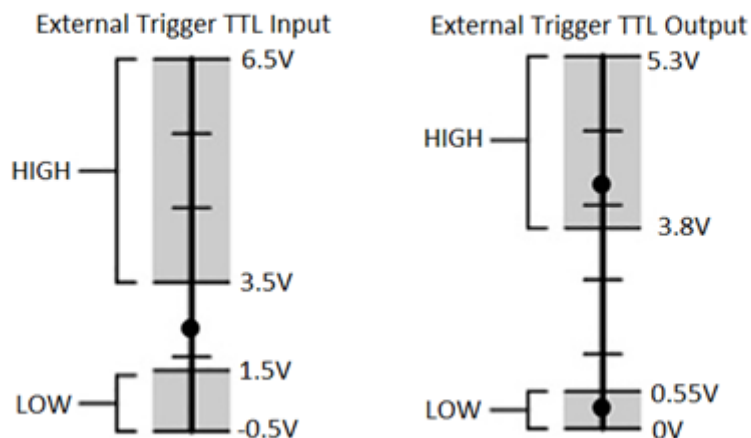


Figure 17: External trigger TTL voltage levels

See also

[Connect/enable external triggering](#) on page 29

[Trigger plug specifications](#) on page 12

8.10 Software

To control the camera you can use:

- **HSI Mosaic**

The HSI Mosaic software runs on a Windows PC and has a graphical user interface (GUI). With HSI Mosaic you can connect to the camera and acquire, process and view hyperspectral cubes. See the HSI Mosaic manual.

- **Application programming interface (API) packages**

The API packages are supplied with the HSI Suite for Windows in the languages Python and C:

- **Camera API:** to control the camera and acquire images
- **Mosaic API:** to process the acquired images

See the documentation in the API packages.

9. Maintenance

9.1 Cleaning

CAUTION

Never loosen the assembly screws of the camera. Tampering with the interior of the camera is grounds for voiding the warranty.

Applying other cleaning methods than mentioned below may void your warranty.

If the rejection filter or the lens is severely contaminated or damaged, contact imec or your lens supplier.

Exterior

Wipe gently with a soft cloth. If the camera is very dirty, soak the cloth in mild soapy water and wring well. Wipe the camera with the damp cloth and then dry it with another clean, dry, soft cloth.

Rejection filter and lens

When the lens and lens mount cap are removed, remove dust and lint from the rejection filter/lens with a commercial air blower. Do not use an aerosol blower or a blower brush, as the aerosol liquid or the bristles could damage the rejection filter or the lens.

Only clean fingerprints and mild stains gently with commercial available foam cleaning swabs and lens cleaner or urethane resin sticks suited for camera sensors and lenses. Do not use alcohol or other volatile chemicals.

10. Troubleshooting

10.1 Troubleshooting

Problem	Solution
Camera doesn't work	1. Use Task Manager in Windows to close all software that possibly tries to connect to the camera. 2. Remove the plug from the camera's Power + IO socket. 3. Remove the plug from the USB port. 4. Reboot the computer. 5. Connect the camera to the computer on page 27 6. Connect the camera to the power supply unit on page 27 7. Try to use the camera.
	Do a check on the USB3 and the PWR leds. See Mechanical camera specifications on page 10 When the leds do not behave normally, do a check on: • The connection of the USB3 cable to the camera and the computer • The condition of the USB3 cable. You can use a different USB3 cable to test the connection. • The correct working of the USB3 port of your computer with another USB3 device • The connections of the power supply unit with the camera and the mains • The status of the drivers of the USB hub of the computer. Update the drivers if necessary • The appearance of the camera in the Device Manager in Windows. The camera has to be identified in the Device Manager as a USB3 Vision Device without warnings or errors.
	Try to use the camera with a different computer.

Table 12: Troubleshooting

11. Decommissioning and disposal

11.1 Decommissioning and disposal of the camera



At the end of the life cycle of the camera:

- Dismount the camera from the measurement setup, disconnect all cables, dismount the lens and attach the lens mount cap.
- Pack the camera and transport/export forms in a sturdy box that you seal securely.
- Inform imec HSI support by emailing to support@imechyperspectral.com
- Send the parcel to imec:

IMEC

Snapshot SWIR

Kapeldreef 75

3001 Leuven

België

See also

[Disposal of the lens](#) on page 39

[Disposal of the accessories](#) on page 39

11.2 Disposal of the lens

Follow the disposal instructions from the lens manufacturer.

See also

[Decommissioning and disposal of the camera](#) on page 39

[Disposal of the accessories](#) on page 39

11.3 Disposal of the accessories

Follow the local disposal instructions for cables, power supply unit, (case) plastics, paper; packaging material, ...

See also

[Decommissioning and disposal of the camera](#) on page 39

[Disposal of the lens](#) on page 39

12. Appendices

12.1 EU declaration of conformity

We declare under sole responsibility that the camera, accessories, and options to which this declaration relates is in conformity with the below specifications. This declaration is valid for the European Economic Area (EEA) only.

- Product type: digital shortwave infrared camera
- Product name: Snapshot SWIR
- Accessories:
 - Lens mount cap (attached to the camera)
 - Power supply unit
 - Mains power cable of the power supply unit
 - USB cable
 - Case
- Options: lenses

EMC

The IEC 61326:2013 standard was followed.

See also

[USA declaration of conformity](#) on page 40

12.2 USA declaration of conformity

We declare under sole responsibility that the camera, accessories, and options to which this declaration relates, is in conformity with the below specifications. This declaration is valid for the U.S. only.

- Product type: digital shortwave infrared camera
- Product name: Snapshot SWIR
- Accessories:
 - Lens mount cap (attached to the camera)
 - Power supply unit
 - Mains power cable of the power supply
 - USB cable
 - Case
- Options: lenses

See also

[EU declaration of conformity](#) on page 40

12.3 Export restrictions

When purchasing the Snapshot SWIR camera, the **Export Control Questionnaire for export of SWIR camera** was filled out and signed.

IMPORTANT

Make sure to read the full questionnaire.

In section **D. Declaration of commitment with regard to the Item** of the questionnaire **Item** refers to the Snapshot SWIR and the following was certified:

- (iii) The Snapshot SWIR will remain in the country that was entered in the questionnaire at D (iii).
- (iv) The Snapshot SWIR will not be re-exported to other third countries without the consent of the Flemish department of Foreign affairs, Strategic Goods Control
- (v) The Snapshot SWIR will not be re-exported to a destination subject to UN or EU embargo where that act would be in breach of the terms of that embargo
- (vi) The Snapshot SWIR will not be exported, directly or indirectly, to the following countries: Belorussia, Bolivia, Cuba, Eritrea, Iran, Lebanon, Libya, Malaysia, Mauritania, Myanmar, Nicaragua, North Korea, Pakistan, PRC, Russia, Somalia, Sudan, Syria, Venezuela, Yemen, and Zimbabwe.

See also

[Export/travel license](#) on page 41

[Transporting and moving the camera](#) on page 24

12.4 Export/travel license

If you must travel with the camera, for example, for demonstration purposes, make sure that you comply with all export restrictions and/or contact imec by emailing to support@imechyperspectral.com.

See also

[Export restrictions](#) on page 40

[Transporting and moving the camera](#) on page 24

12.5 Label of the power supply unit



Figure 18: The power supply unit label

See also

[Power supply unit specifications](#) on page 12

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