

Teledyne DALSA Rad-icon- 2329HS

GigE model

CD62M22

Detector User Manual

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About Teledyne DALSA

Teledyne DALSA is an international high performance semiconductor and electronics company that designs, develops, manufactures, and markets digital imaging products and solutions, in addition to providing semiconductor products and services. Teledyne DALSA's core competencies are in specialized integrated circuit and electronics technology, software, and highly engineered semiconductor wafer processing. Products and services include image sensor components; electronic digital cameras; X-ray detectors; vision processors; image processing software; and semiconductor wafer foundry services for use in MEMS, high-voltage semiconductors, image sensors and mixed-signal CMOS circuits.

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Safety and System Information

Safety Information

Definitions

User of the products as described in this manual is the Original Equipment Manufacturer (OEM) that is developing and producing an X-ray imaging device (or 'modality'), using the product as an component to capture image information;

End-User of the products as described in this manual is the professional operating the OEM equipment to perform a diagnostic imaging routine;

Intended Use

The products as described in this manual are components that are used enclosed inside a User's system to capture images in X-ray modalities. Typical applications include, but are not limited to, Non-Destructive Testing, Electronics Inspection and Computed Tomography (CT).

Installation Warning

The User is responsible for the safe and prudent installation of the detector in their system. All X-ray sources and controls, shielding, personnel safety monitoring devices, and personnel safety precautions and training involved in the use of this equipment are the responsibility of the User and/or the End-User.

For safety reasons, the on-time of the X-ray source should never be controlled directly by the detector synchronization output. Control of the X-ray source remains a system/host responsibility.

Safety Statement

The general safety precautions that follow must be observed during all phases of installation, operation, service, repair and disposal of this system. Failure to comply with these precautions, or with specific warnings noted in this manual, violates the safety standards of design, manufacture and the intended used of this system. Teledyne DALSA assumes no responsibility for the user's failure to comply with these requirements.



Warning: The product, when installed, is subject to exposure from X-rays during operation.

To ensure personnel safety, it is necessary that a radiation meter will be used to check for radiation leakage after installation of the digital camera in the end users system.

For safety reasons, the on-time of the X-ray source should never be controlled directly by the detector synchronization output. Control of the X-ray source remains a system/host responsibility.

Teledyne DALSA assumes no responsibility for proper installation of the detector, installation of X-ray shielding, X-ray shield enclosure testing, or safe and prudent operation of the camera system in the End-user's installation. It is the Users and End-users responsibility to ensure that local and federal guidelines regarding the installation and operation of X-ray sources are followed.

The power requirements of the product, especially the voltage specifications, must be strictly adhered to or warranty will be void.

No User Serviceable Components

There are no components in this system which need to be replaced, modified, or adjusted by the end user. Please contact Teledyne DALSA Support for assistance if needed.



Safety Warning: Tampering with this product voids the warranty and may degrade the detectors image quality, resulting in a possibly unsafe condition for (End-) Users or Patients.

The system has been designed to minimize the amount of interference it may generate in a medical installation. This equipment generates and can radiate radio frequency energy and, if not installed and operated in accordance with the instructions, may cause harmful interference to other devices in the area.

Stacking

Teledyne DALSA does not recommend that the user stack the product or use it in adjacent to other equipment. If this arrangement is unavoidable, then the (End-)user must ensure that there is adequate airflow around the detector and that normal operation conditions are maintained.







Disposal of Product

The detector contains lead, CsI and no batteries. Dispose the unit in accordance with local regulatory guidelines.





Labels

Symbols




On product label symbols:

	Serial number
	Manufacturer
	Electrical and Electronic Equipment (Do not dispose in household bin)
	Refer to instruction manual
	CE-marking
	UL recognized component mark

On product connector symbols:

	GigE Interface connector
	Functional earth connector
	Power DC supply connector
	Trigger connector

As used in this manual:

	Caution
	General warning sign
	General mandatory action sign

General safety instructions

- Read and follow the instructions before using the FPD to ensure safe and proper use.
- Wear an ESD wrist strap, ESD clothes, or ESD gloves when installing or maintaining the FPD.
- Use indoor and in dry location only.

- Do not install if visible damages are observed on the FPD. Inspect shipping containers for any signs of damage and contact Teledyne DALSA for assistance.
- Take care the FPD is handled only by gripping at the sides or backside. Avoid applying pressure on the carbon front cover.
- Lack of calibration can result in a lower image quality. The clinical parameters are under the X-ray system manufacturer's control. Periodical check is necessary to ensure that the FPD meets the requirements of targeted application.



EMC compliance

To ensure EMC compliance, follow these specific guidelines:

- Ensure that all cable shields have a 360° electrical connection to the connector.
- Tightly fasten and secure all connectors.

Warning

- The detector can influence the performance of very sensitive equipment.
- Strong EMC disturbances can influence the detectors performance.

System precautions

The following are precautions that must be taken in order to prevent possible damage to your Teledyne DALSA Detector system:



Warning:

The use of accessories, power supplies and cables other than those specified, with the exception of cables sold by Teledyne DALSA as replacement parts, may result in increased emission or decreased immunity of the Rad-icon Detector.

X-ray exposure should be limited only to the active image area (see chapter 5 mechanical drawing) in order not to cause damage to the electronic components of the device.



Static precautions

Observe proper ESD/static control procedures when handling system components. The use of properly grounded wrist strap is highly recommended.



Installation Precautions

Never connect or disconnect cables while power to the detector is on. Damage to the detector electronics might occur if the cables are connected and/or disconnected while the detectors power is on.



Enclosed Use

This equipment is designed for use in enclosed systems, with the enclosure sufficiently shielding the equipment against the influence of visible light. If used without enclosure and in bright environments, ambient light entering the detector may impact image quality or the effectiveness of calibrations. It is the customer's responsibility to take measures in the application to avoid ambient light entering the detector.



Service by Qualified Personnel Only

This equipment is to be installed by a qualified technician only. The system can only be used in conjunction with a properly installed X-ray source with the appropriate shielding and a properly configured computer workstation that meets the minimum system requirements discussed later in this manual.

Environmental Specifications

Temperature	
- Operating	+10..+40 °C
- Transport & Storage	0..+50 °C
Humidity (non-condensing)	
- Operating	20%..80%
- Transport & Storage	20%..80%
Shock	25G (6ms)
Vibration	1G (10-150Hz)
Ingress protection	IP50

Note: For transport and storage, the standard product packaging is assumed to be in place which includes a sealed anti-static shield bag.

Regulatory Compliance

The Rad-ikon-2329HS has been designed and manufactured in accordance with the applicable clauses of the international standards and legislations.

- EN 61000-6-3: Electromagnetic compatibility (EMC) – Generic standards. Emission standard for residential, commercial and light-industrial environments
- IEC/EN 61000-6-2: Electromagnetic compatibility (EMC) – Generic standards. Immunity standard for industrial environments
- EN 50581/EN IEC 63000: Technical documentations for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

Detector Maintenance

Before performing any of the following operations, make sure that the power to the detector is switched OFF.

Protecting the Detector Front Cover

The front cover of the detector and should be treated with care, as scratches or debris in this area may produce artifacts in the X-ray image. Manual contact is to be avoided.

Cleaning the Detector Body and Front Cover

The detector body and front cover can be cleaned with a mild, non-abrasive cleanser such as isopropyl alcohol. Place a small amount of cleanser on a soft cloth and rub gently over the detector body surface. Wipe off with a clean soft cloth. Do not use any harsh cleansers or solvents that may damage the paint or other finishes on the detector.

In the event of detector exposure to bio-hazardous materials, proper cleaning procedures should be undertaken prior to removal or maintenance of the detector.

Calibration

To have the best image performance, the raw image data generated by the detector should be corrected at the host by using a flat field (offset and gain) correction. As the offset (dark) calibration signal depends (amongst others) on ambient temperature conditions of the detector, it is commonly accepted good practice to generate these calibration images frequently at times that the X-ray source is switched off. It is recommended to re-calibrate the gain correction image at least once per year, at least when e.g. the X-ray tube is exchanged or anything changes in the X-ray imaging geometry (e.g. the distance between the X-ray source and the detector).

The following basic guidelines for periodic calibration are recommended:

- The frequency of calibration: at least 1/yr
- Minimum number of dark images: 16
- Minimum number of gain images: 32
- Exposure level of gain images: appr. 25% of the saturation level, 15000-20000 DN

As a reference TeledyneDalsa provides an Application Note describing general calibration guidelines for Teledyne DALSA CMOS X-ray detectors:

DNR-440-02-18001-06 Detector Calibration ApplicationNote 20180604

The detector can contain deviating pixels. To have the best possible image quality it is advised to perform a defect pixel correction in the host system. It is recommended to create a defect pixels calibration image at least every year, or more frequently in case of heavy use.

To verify if the detector still operates according specification it is advised to measure on regular base the following performance parameters of the detector: dark reference, noise performance, flat field reference, saturation dose and MTF performance.

Open Source Software Licenses

Teledyne DALSA X-ray detector firmware contains open source software provided under different open source software licenses.

Recycling

EU Waste Electrical and Electronic Equipment (WEEE) Directive



The European Union (EU) implemented the EU WEEE Directive 2012/19/EU requiring producers of electrical and electronic equipment (EEE) to manage and finance the collection, re-use and recycling of the products that producers placed on the EU market after 13 August 2005. The EU Commission adopted the Implementing Regulation (EU) 2019/290 establishing the format for registration and reporting of producers of EEE to

the register. The goal of this directive is to minimize the volume of EEE waste disposal and to encourage re-use and recycling at the end of life.

The WEEE symbol on the product indicates that the product cannot be disposed of with other household or municipal waste. Teledyne DALSA has labeled its products with the WEEE symbol to alert the customers that products bearing this label should not be disposed of in the landfill.

It is our customers' responsibility to dispose of their waste equipment (where Rad-icon detector is integrated on the medical system) separately from the municipal waste stream. The correct disposal of your equipment will help conserve the natural resources and ensure that the equipment is recycled in a manner that protects the environment and human health.

The Rad-icon-2329HS Detector

A full description of the features and functional specification of the Rad-icon-2329HS detector can be found in the latest product specification or datasheet.

Please contact sales.sensors@teledynedalsa.com or visit www.teledynedalsa.com for information on how to obtain the latest datasheet or other product documentation.

Detector Highlights

Key Features

- 49.5µm square 3T PPD, radiation-hard CMOS active pixel design
- Latest generation CMOS technology (6th generation) enables even lower noise and power consumption
- Highest sensitivity AND highest dynamic range over an extended dose range
- Unmatched diagnostic image quality at low dose levels
- 4608 x 5890 pixel resolution, 49.5µm pixel pitch, active area 228x291 mm²
- 16-bits Analog to Digital conversion
- Very low image lag
- Up to 20 frames per second at full resolution, full Field-of-View, 14 bit pixel data
- 10 GBase-T GigE data interface
- Gadox/CSI scintillators
- Offset, Gain and Defect Pixel Correction (Win10/11 64-bit library)
- Long life time with stable performance
- Software to support detector factory calibrations

Programmability

- Read out modes
- Exposure modes
- Trigger modes
- Integration time
- 1x1, 1x2 or 2x2 pixel binning

Description

The Rad-icon-2329HS CD62M22 CMOS X-ray detector is designed to address the most advanced and demanding X-ray industrial applications.

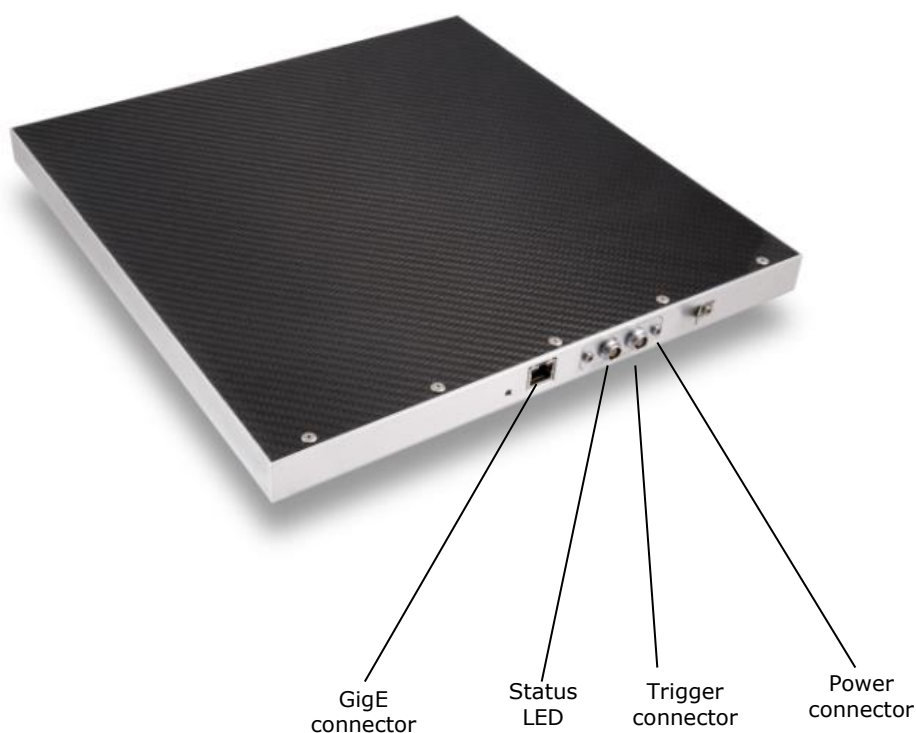
3

Setting up the Detector

Detector Connectors and Cables

This detector uses the following connectors.

- A RJ-45 connector for 5 GBASE-T Ethernet signals, data signals
- CAT6 shielded Ethernet cable (STP)
- One 2-pin Lemo connector for power
 - Lemo EEG.0B.302.CLL
 - Mating connector:
 - straight type: FGG.0B.302.CLAD52
 - elbow type: FHG.0B.302.CLAD52
- One 4-pin Lemo connector for triggering
 - Lemo EEG.0B.304.CLL
 - Mating connectors:
 - straight type: FGG.0B.304.CLAD52
 - elbow type: FPG.0B.304.CLAD52



Ethernet Connector

Ethernet Connection LED

Steady orange indicates that an Ethernet connection is successfully established.
The LED is switched off during normal operation.

Data Transmission LED

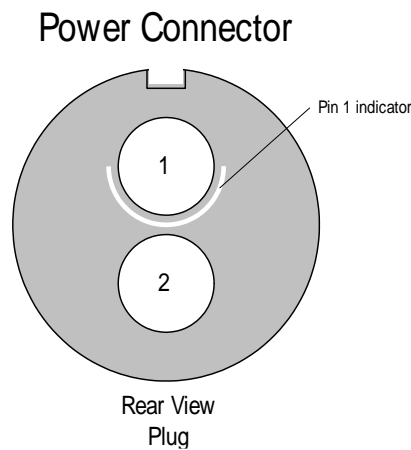
Flashing green indicates that the detector is transmitting or receiving data.

Detector Status LED

The detector is equipped with an orange/green LED used to display the status of the detector's operation. The table below summarizes the operating states of the detector and the corresponding LED states.

	Color Of Status LED	Meaning
1	Orange/red	Detector in startup phase
2	Off	Detector is either off or operational, the latter state is recognizable from the RJ-45 LEDs

Power Connector



	Description
1	Supply voltage (+12- 28V / 20W)
2	Ground

Shielding (chassis)

The detector requires a single voltage input (+12-28V / 20W). There is a protection for misconnection, via a resettable fuse. When the fuse has been activated (isolating), power cycling will return it to conductive state again thus restoring normal operation (assuming power has been properly applied).

WARNING: When setting up the detector power supplies follow these guidelines:



Apply the appropriate voltages.

The power supply must be able to deliver higher peak current of 3A during start up.

Keep leads as short as possible in order to reduce voltage drop. The voltage level at the product power connector should be within the range mentioned in the datasheet.

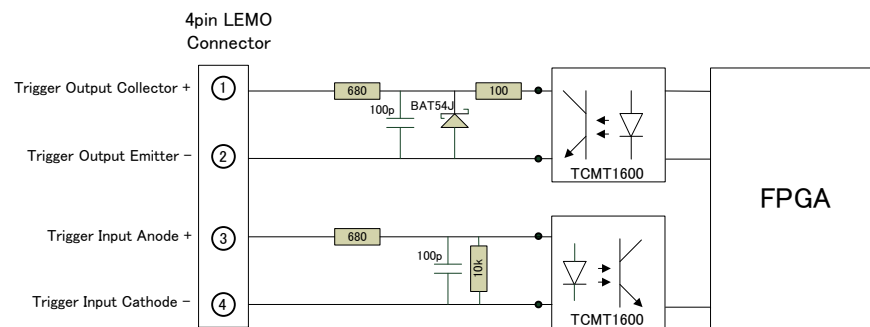
Use high-quality linear supplies of SELV type and EN 60601-1 compliant.

It is advised to use a shielded power cable. The shield is only to be connected to system chassis ground.

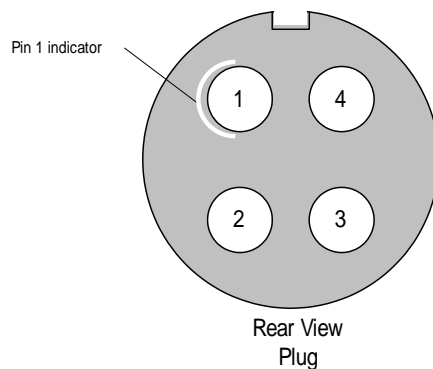
Note: If your power supply does not meet these requirements, the detector performance specifications cannot be guaranteed.

Trigger Connector

The trigger circuitry inside the detector is shown in the figure below.



I/O Connector



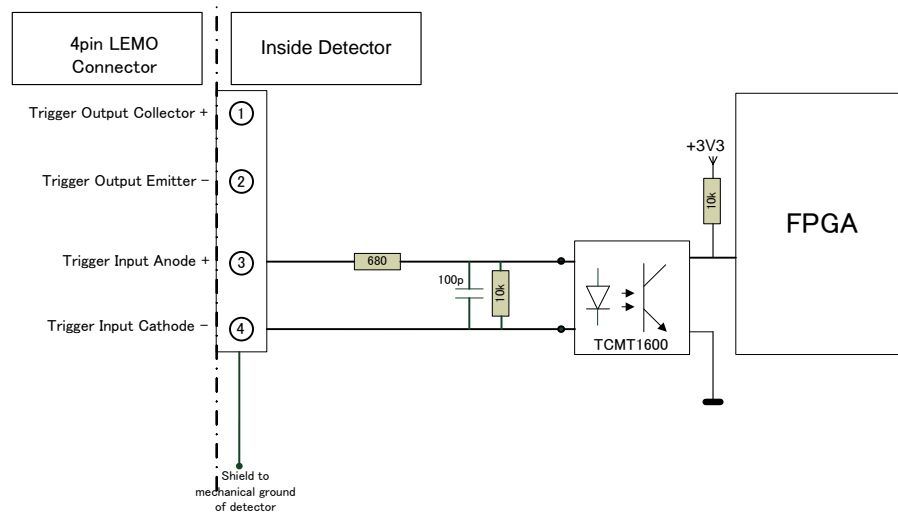
Description		
1	Out	Optocoupler collector with 680R +100R (+/- 2%) series resistor (note 1)
2	Out	Optocoupler emitter
3	In	Optocoupler anode with 680R (+/- 2%) series resistor (note 2)
4	In	Optocoupler cathode
Shielding (chassis)		

Note 1: maximum voltage across collector and emitter is 70V. Maximum reverse voltage (between emitter and collector) is 6V

Note 2: maximum reverse voltage across cathode and anode is 6V.

Description Input circuitry Trigger In

Inside the detector the connection for the input is as in below drawing:



Depending of the connection, the trigger input can be active high or active low:

For normal input operation:

“Trigger Input Anode +” is used as driving source and

“Trigger Input Cathode -” is connected to ground.

Then “Trigger in” is active high.

This is the situation which is referred to in this document.

For inversed input operation:

“Trigger Input Anode +” is connected to VCC and

“Trigger Input Cathode -” is used as driving source and then “Trigger in” is active low.

Voltage range of trigger input:

Active State:

The recommended photodiode forward current is 5mA. Absolute maximum input voltage is 10.0V. Do not apply an input voltage with reversed polarity. In the detector there is a series resistor of 680 Ohm. The maximum forward voltage of the photodiode is 1.35V.

Minimum voltage input:

When 2.4V input voltage is applied then the trigger will be active.

Forward voltage of optocoupler is maximum 1.35V.

The forward current will be $(2 - 1.35V)/680 \text{ Ohm} = 1.5\text{mA}$.

The optocoupler shall response correctly.

Maximum voltage input:

When 10V input voltage is applied then the trigger will be active.

Typical forward voltage of optocoupler is 1.35V.

The forward current will be $(10 - 1.35V)/680 \text{ Ohm} = 13\text{mA}$.

The maximum voltage is limited by internal dissipation of internal series resistor (which is 125mW). In this case the dissipation is 110mW.

By adding external series resistor the external voltage can be increased.

The forward current for the trigger input to the detector may not exceed 13mA.

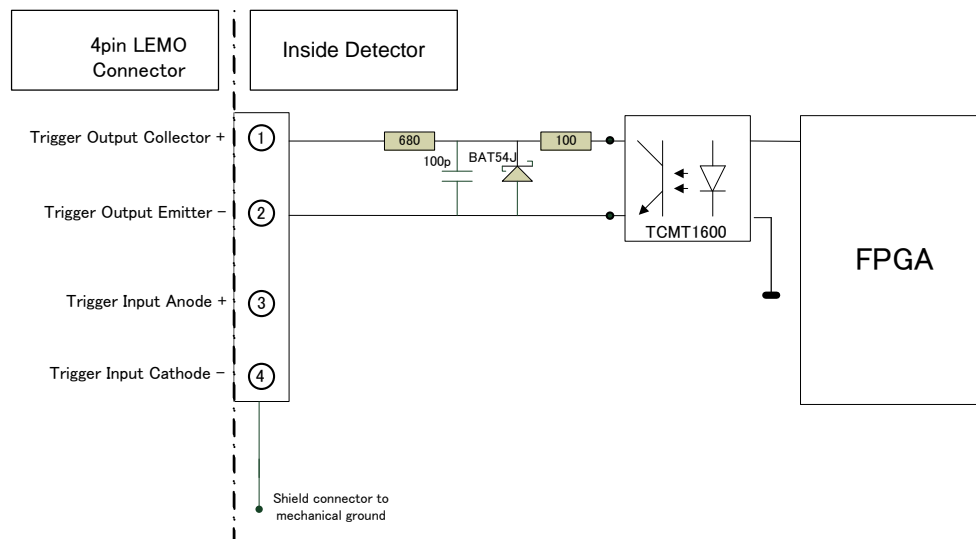
Then the optocoupler will respond correctly.

Voltage range active state: 2.4 ... 10V (with a corresponding current of 1,5 ... 13mA)

Passive state: Voltage range: <0.5V (with a corresponding current of < 0.1mA)

Description circuitry Trigger Out

Inside the detector the connection for the input is as in below drawing:



The optocoupler transistor output is able to sink 10mA current in non-saturated condition. Absolute maximum voltage is 24V. Do not apply a voltage with reversed polarity.

Depending of the connection the trigger output can be active high or active low.

When “**optocoupler collector connection**” is used:

“Trigger Output Collector” is pulled up with a resistor (of 10k) and

“Trigger Output Emitter” is connected to ground

Then “Trigger out” is active low (= integration state of detector).

When “**optocoupler emitter connection**” is used:

“Trigger Output Collector” is connected to VCC (supply) and

“Trigger Output Emitter” is pulled down with a resistor (of 10k)

Then “Trigger out” is active high (= integration state of detector).

In this document the state of “Trigger Out” is “active” (integrating) or “not active” (reading/reset of pixels).

Passive trigger output levels: 0...0.1mA@0..20V

Active trigger output levels:

Saturation voltage: <0.4V@ <10mA

Maximum allowed current: 10mA

Trigger & Power Cables (optional)

Teledyne DALSA can supply suitable 4-pin LEMO Trigger and 2-pin LEMO power cables as accessory to the detector. These cables have a length of 5 meters, with open-ended connections on one side.

External Trigger cable 5m

TDPI 3322 925 00761

Lemo UNS.0B.304.FGG.003

Connection side: open end

Trigger cable		
Pin	Color	Function
1	Black	Output; optocoupler collector
2	Brown	Output; optocoupler emitter
3	Red	Input; optocoupler anode
4	Orange	Input; optocoupler kathode



Solder/wire side

External Power Supply cable 5m

TPDI 3322 925 00751

Lemo UNS.0B.302.FGG.003

Connection side: 4mm plug

Power cable			
Pin	Color	Function	4mm plug
1	Black	+12V	Red
2	Brown	GND	Black



Solder/wire side

Setting up the Detector

Network Interface Card

A Network Interface Card (NIC) is required to acquire images and control the Rad-icon-2329HS detector. A NIC with Jumbo packet support up to 9014 bytes is required to receive streaming video, preferably with a PCI Express slot.

Teledyne DALSA advises to use the Asus XG-C100C 10G PCI-E Network Interface Card (NIC).

Make sure that the latest driver of the NIC manufacturer is installed. We advise to use 64-bit operating systems as the NIC drivers are better maintained.

Due to the high bandwidth used by the detector it is strongly advised to have a direct connection from the NIC to the detector.

Connect Trigger Cable

Connect the trigger cable to the detector when the trigger mode of the detector is set to Triggered, Snapshot, Snapshot Extended Exposure and Triggered Sequence modes.

Connect Ethernet Cable

Connect the CAT-6 STP Ethernet cable from the detector to the computer Ethernet jack. Secure the RJ-45 connector to the detector.

When the detector is connected to a host system it will be recognized in 30 to 65 seconds.

Connect Power Cable

Connect a power cable from the detector to a power supply with a supply voltage between 12-28V and capable of delivering at least 20W.

Software installation

Sapera LT SDK

Sapera LT is an image acquisition and control software development toolkit (SDK) for Teledyne DALSA'S cameras and frame grabbers. Hardware independent in nature, Sapera LT offers a rich development ecosystem for machine vision OEMs and system integrators. Sapera LT supports image acquisition from cameras and frame grabbers based on standards including GigE Vision™, CameraLink® and CameraLink HS™.

The latest version of the Sapera LT SDK can be downloaded from the Teledyne DALSA website: www.teledynedalsa.com/imaging/products/software/sapera/lt/
It is recommended to use Sapera LT version 8.65 or higher.

Sapera LT supports 64-bit/32-bit Windows 7/8/8.1/10/11 WoW64 and Linux.
For Linux OS, some conditions apply; contact Teledyne DALSA for more information.

Sapera CamExpert

Sapera CamExpert, part of Sapera LT, offers an intuitive graphical interface that allows configuring and setup of CameraLink, GigE Vision, CLHS, HSLink and GenCP compliant cameras and frame grabbers.

Sapera CamExpert includes live image acquisition with interactive parameter configuration capabilities. With live status windows and built-in serial communication terminal, Users can setup the camera and frame grabbers from a single window.

In addition, Sapera CamExpert offers software color conversion algorithms, horizontal and vertical line profiles, individual pixels inspection window, localized zoom, and image statistics (histogram, max, min, average values, etc.) to facilitate setup and diagnosis.

Optimizing Network Settings

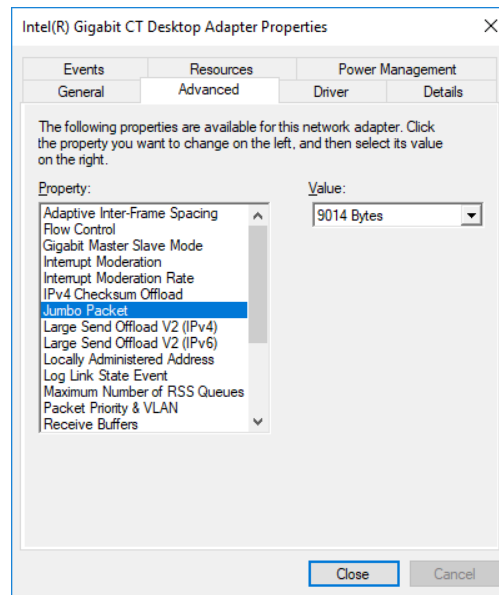
The performance of the gigabit Ethernet connection on the host computer generally can be improved by adjusting some settings in the NIC.

For a more detailed explanation please refer to "Network Optimization Guide (PDF)" and "Network Imaging User's Manual (PDF)" which is part of the Sapera LT software package.

To reduce the interrupt overhead in the host the following settings in the NIC are advised.

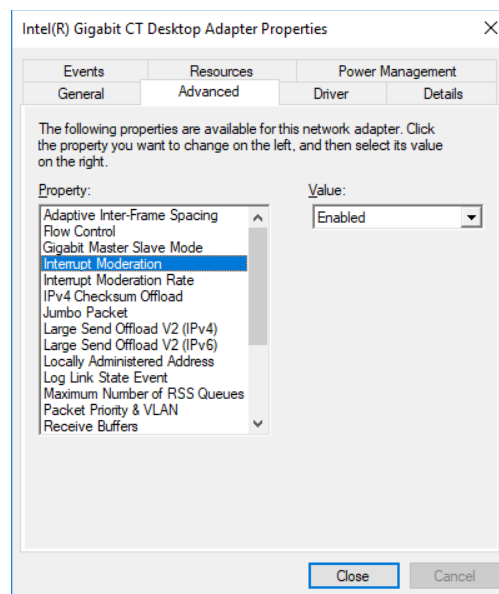
Packet Size

Set Jumbo Packet to the value: 9014 Bytes



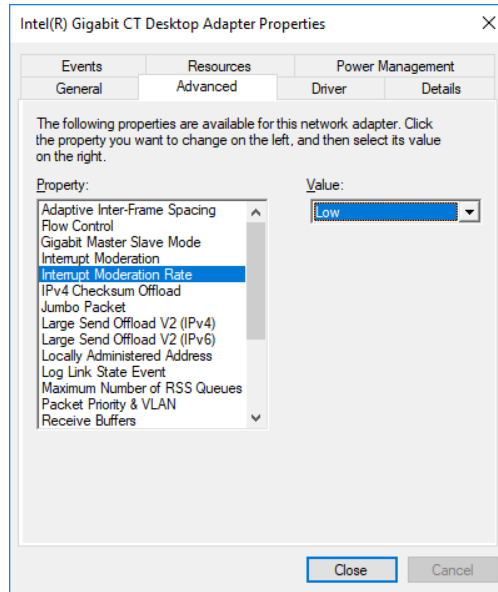
Interrupt Moderation

Set Interrupt Moderation to the value: Enabled.



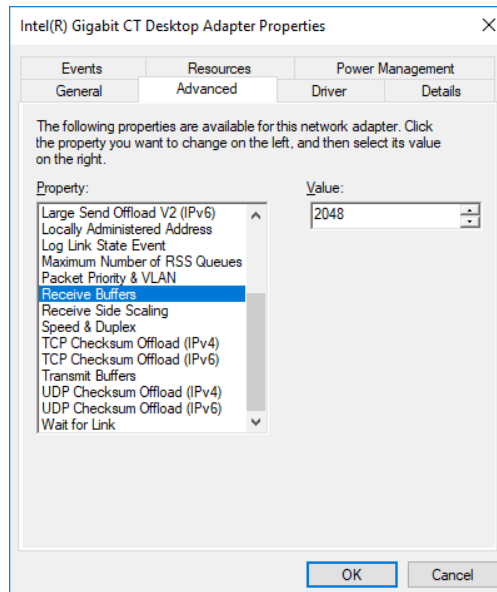
Interrupt Moderation rate

Set Interrupt Moderation Rate to the value: Low.



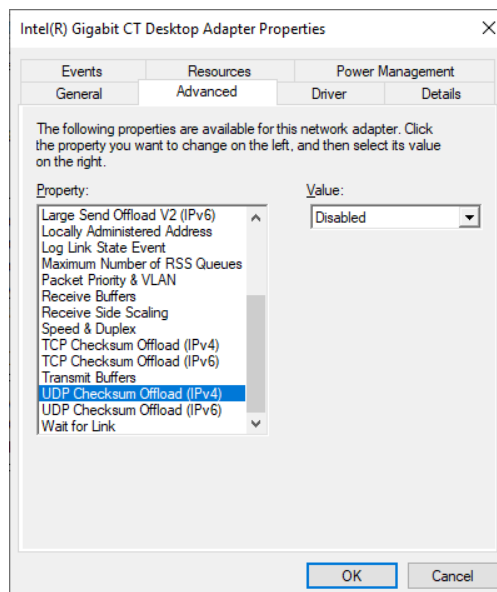
Receive Buffers

Set Receive Buffers to the value: 2048 (maximum).



UDP Checksum Offset (IPv4)

Disable UDP Checksum Offset (IPv4).



Connecting

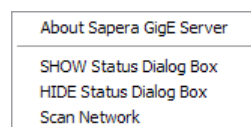
1. After the installation is complete, plug in the detector's communication cable.
2. Power up the detector.
3. After powering up the detector, the application automatically detects the detector. This may take 30 to 65 seconds. Wait until the detector connected indicator in the task bar (shown below) has confirmed that a connection has been established (the red cross over the camera icon disappears).



Checking detector status and information in Gigabit Ethernet

After the detector connection has been established, the status of the connection can be displayed by right clicking on the camera icon in the task bar and selecting "SHOW Status Dialog Box."

When you add or remove a detector from the network, it is automatically detected by the GigE server. A manual network scan can also be launched from this menu by selecting "Scan Network." This action will refresh the information of the device connected to the network. The "About Sapera GigE Server" option will display the version of the installed GigE driver.



Selecting the "SHOW Status Dialog Box" will open the device status window, which displays the basic information of the detector:

- Serial Number
- Model Name
- MAC Address
- Packet size, which should be 9000
- Firmware version which only indicates a build number
Refer to the "DeviceVersion" to see the actual firmware version (this can be seen in CamExpert)
- IP addresses of
 - o Detector
 - o Network Interface Card on host system to which the detector is connected

These settings can be changed by the Network Configuration which is included in the GigE Vision framework

The user can also view the detector and the host system IP addresses in this window.

Manufacturer	Model	Serial number	MAC address	Status	Camera IP	NIC IP	Filter driver	MaxPktSize	Firm ver	User name	ABI
Teledyne D...	Saperas 2329	Chassis M...	00:11:22:33:44:55	Connected	169.254.4.168	169.254.83.83	Enable	9000	2	<Empty>	0001

The default assigned detector IP address and other network settings can be modified using the Teledyne DALSA Network Configuration Tool, which is part of the installation package.

The detector is default set to DHCP/LLA mode. This mode does not need any adjustment in the detector. However, as DHCP service is default not available on the detector network, this will cause some initialization delay during power on or reconnect of the detector. If initialization time is critical one may choose to enable Teledyne Dalsa DHCP Server on the NIC the detector is connected to or choose for Persistent IP on the detector. This will shorten the initialization time with approx. 15 sec. For further details please refer to Teledyne DALSA/Sapera Network Imaging Package/Network Imaging User's Manual.

Quick Test with CamExpert

When a Rad-icon detector is connected to a Gigabit network adapter on a host computer, testing the installation with CamExpert is a straightforward procedure.

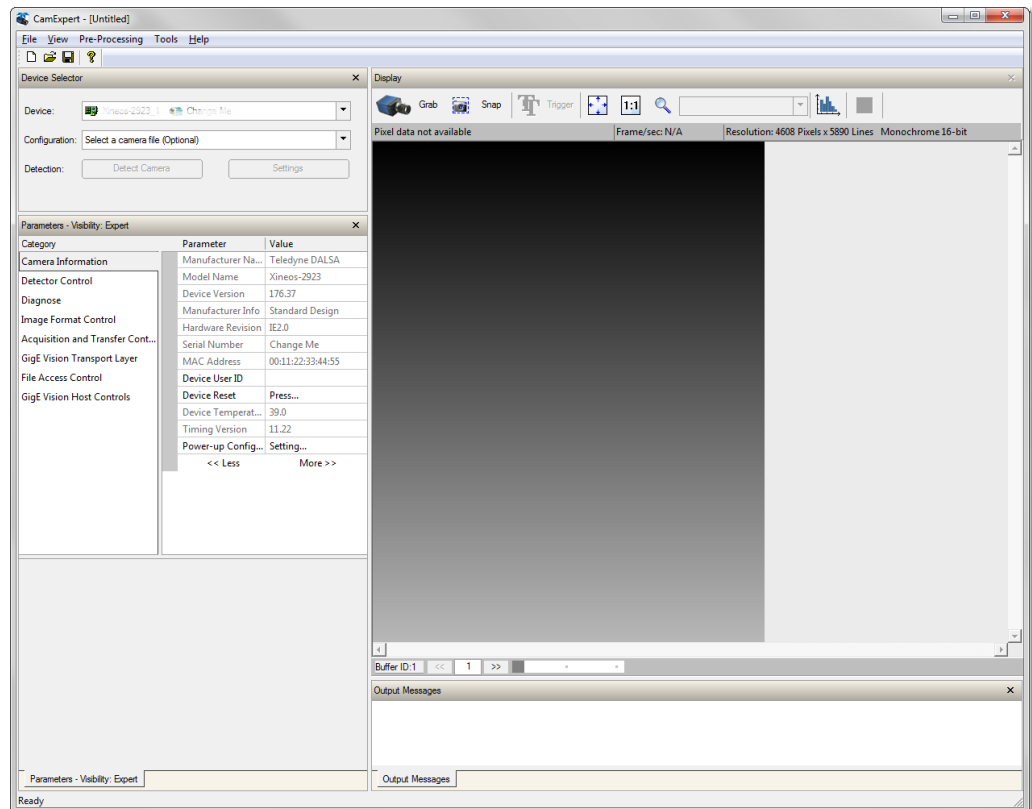
- Start Sapera CamExpert by double clicking the desktop icon created during the Sapera LT software installation.
- CamExpert will search for installed Sapera devices. In the Device list area on the left side, the connected Rad-icon detector is shown or will be listed in a few seconds after CamExpert completes the automatic device search (device discovery).
- Select the Rad-icon detector device by clicking on the camera user defined name. By default the Rad-icon detector is identified by its serial number.
- Click on the Grab button for live acquisition (the Rad-icon detector factory default is Free Running mode).
- See "Operational Reference" for information on CamExpert parameters with the Rad-icon detector.
- The Snap or Grab function of CamExpert can be used to acquire live image. By default this will be dark signal from the sensor from the parameters pane a digital test pattern can be selected for testing network/computer bandwidth issues.
- If error messages are shown in the Output Messages pane, first increase the value of the Interpacket Delay feature available from the GigE Vision TransportLayer Category group in CamExpert. An increase from default may correct errors with NIC interfaces that do not have adequate performance.
- Warning: If the detector is grabbing images, the ethernet cable to the detector should not be disconnected. When this is done by accident, the detector must be repowered before it becomes operational again after the ethernet has been reconnected.
- If error messages still remain, refer to the Teledyne DALSA Network Imaging package manual.

Acquiring Images

The CamExpert software can be started to acquire images.

Select the correct device from the Device Selection Menu.

The software will display all available device parameters of the specific detector type.



The user has the option to either snap an image or to grab continuously. Snapping an image produces a single frame, whereas the grabbing process generates multiple frames by operating in a continuous mode.

To snap an image:

Click the *Snap* button. The Detector has now snapped a single frame. The image appears in the GUI window.

To grab continuously:

Click the *Grab* button. The detector is now armed and ready to acquire images in continuous mode.

To stop a *Grab* process the user must press the *Freeze* button. After the *Freeze* button is pressed the detector ignores any additional triggers and no additional images are acquired.

5



Operational reference

Using CamExpert with Rad-icon Detector

The Sapera CamExpert tool is the interfacing tool for GigE Vision detectors and cameras, and is supported by the Sapera library and hardware. When used with a Rad-icon detector, CamExpert allows a user to test most of the operating modes. Additionally CamExpert saves the Rad-icon user settings configuration to the detector or saves multiple configurations as individual detector parameter files on the host system (*.ccf).

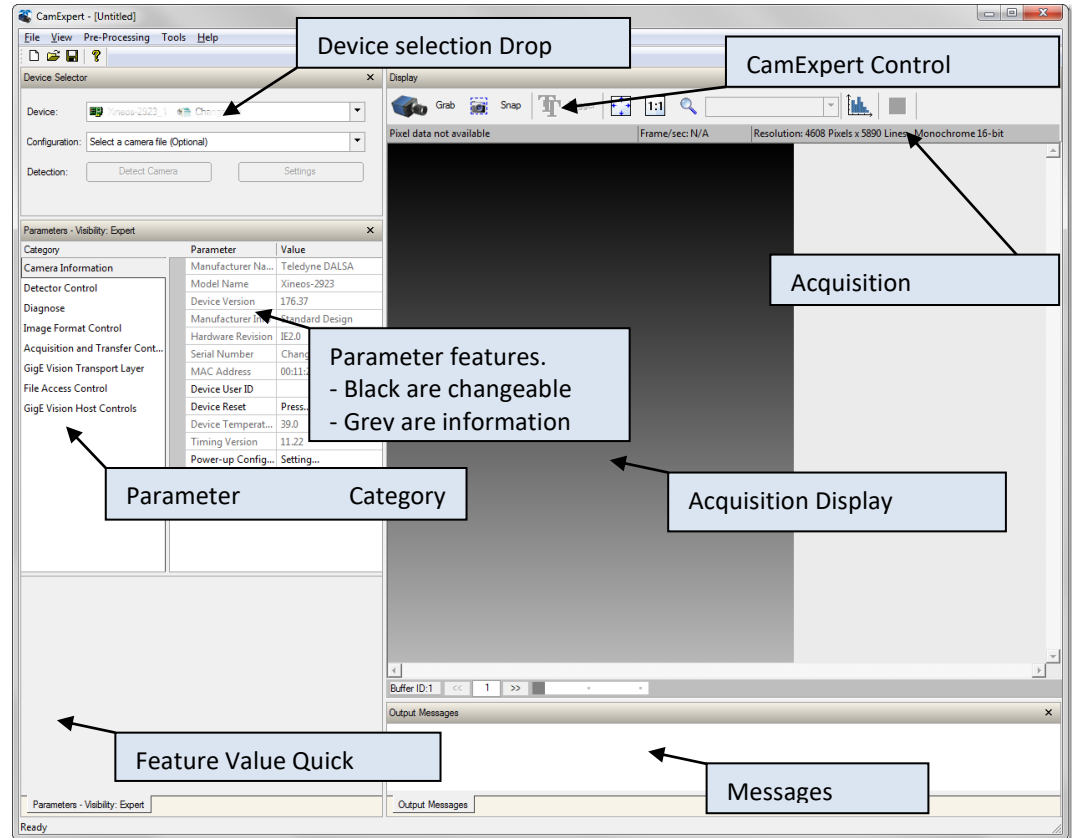
An important component of CamExpert is its live acquisition display window which allows immediate verification of timing or control parameters without the need to run a separate acquisition program.

Click on any parameter and a short description is displayed below the Category pane.

The same context sensitive help is available by clicking on the  button then click on a detector configuration parameter. Click on the  button to open the help file for more descriptive information on CamExpert.




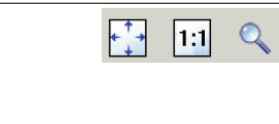

CamExpert Panes

The various areas of the CamExpert tool are described in the summary figure below. GigE Vision device Categories and Parameter features are displayed as per the device's XML description file. The number of parameters shown is dependent on the View mode selected (Beginner, Expert, Guru – see description below).



- **Device pane:** View and select from any installed GigE Vision or Spera acquisition device. After a device is selected CamExpert will only present parameters applicable to that device.
- **Parameters pane:** Allows viewing or changing all acquisition parameters supported by the acquisition device. CamExpert displays parameters only if those parameters are supported by the installed device. This avoids confusion by eliminating parameter choices when they do not apply to the hardware in use.
- **Display pane:** Provides a live or single frame acquisition display. Frame buffer parameters are shown in an information bar above the image window.

- **Control Buttons:** The Display pane includes CamExpert control buttons. These are:

	<p>Acquisition control button: Click once to start live grab, click again to stop.</p>
	<p>Single frame grab: Click to acquire one frame from device.</p>
	<p>Software trigger button: With the I/O control parameters set to Trigger Enabled / Software Trigger type, click to send a single software trigger command.</p>
	<p>CamExpert display controls: (these do not modify the frame buffer data) Stretch (or shrink) image to fit, set image display to original size, or zoom the image to any size and ratio. Note that under certain combinations of image resolution, acquisition frame rate, and host computer speed, the CamExpert screen display may not update completely due to the host CPU running at near 100%. This does not affect the acquisition.</p>
	<p>Histogram / Profile tool: Select to view a histogram or line/column profile during live acquisition.</p>

- **Output pane:** Displays messages from CamExpert or the GigE Vision driver.

CamExpert View Parameters Option

All detector features have a Visibility attribute which defines its requirement or complexity. The states vary from Beginner features required for basic operation of the device) to Guru (optional features required only for complex operations).

CamExpert presents detector features based on their visibility attribute. CamExpert provides quick Visibility level selection (Beginner/Expert/Guru) via controls below each Category Parameter list [<< Less More >>].

The user can also choose the Visibility level (Beginner/Expert/Guru) from the View - Parameters Options menu. In this user manual it is supposed the Visibility is set to Beginner.

Changing Modes and Settings



Changing modes and settings via commands or CamExpert software should not be done when the detector is busy. There should be enough pause for the detector to process the last frame from the previous operation. The pause duration required could be up to 500ms during summing modes. Please consult Teledyne Dalsa for more details on read out and trigger mode changing on the fly.

First image after Standby or Switching Modes



If the detector is switched into the trigger modes Triggered or Free Running, the first image from the detector may be affected by a preceding detector standstill. The first image might contain unwanted data from dark current accumulation or reset behavior. It is required to read and discard at least 1 image after an extended standby period that lasts more than 1 second.

Exposure Modes

When the Trigger Mode is set to Free Running, the frame period can be calculated for all read out modes by adding the Extended Exposure with the Sensor Readout Time.

Shuttering

The detector does not have a shuttering mechanism built into the detector. The detector can be operated with a continuous beam X-ray source, however there can be motion blur associated with continuous beam imaging. If pulsed X-ray operation is required, the X-ray source should not be active during read out. This might cause unwanted imaging artifacts.

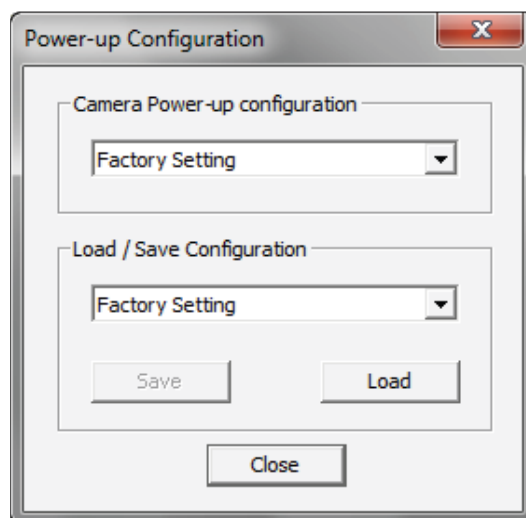
Camera Information

The following table describes the parameters Display Name as shown in CamExpert and their feature name, accessibility (RO=ReadOnly, RW=Read/Write, WO=WriteOnly) and description.

Display Name	Feature Name	Acc	Description
Manufacturer Name	DeviceVendorName	RO	Displays the device vendor name
Family Name	DeviceFamilyName	RO	Displays the device family name
Model Name	DeviceModelName	RO	Displays the device model name
Device Version	DeviceVersion	RO	Displays the device firmware version. This tag will also highlight if the firmware is a beta or custom design
Boot ID	BootID	RO	Displays the boot ID
Layout Revision	LayoutRevision	RO	Displays the Processing board hardware revision
BOM Revision	BOMRevision	RO	Displays the Bill of Materials revision
Timing Version	TimingVersion	RO	Displays the Detector internal timing revision
Reference Voltage Version	VoltRefVersion	RO	Displays the Detector internal voltage revision
Sensor Settings Version	SensorSettingsVersion	RO	Displays the Detector internal settings revision
Firmware Version	DeviceFirmwareVersion	RO	Displays the Detector firmware revision
MAC Address	DeviceMacAddress	RO	Displays the unique MAC (Media Access Control) address
Device User ID	DeviceUserID	RW	Feature to store a user-programmable identifier of up to 15 characters. The default factory settings is the Serial Number
Device Reset	DeviceReset	WO	Restarts the device.
Device Temperature Selector	DeviceTemperatureSelector	RW	Select a temperature sensor type if the detector (FPGA, PHY, Internal, MaxInternal)
Device Temperature	Detector Temperature	RO	The temperature reading of the selected temperature sensor in degrees Celcius
Power-up Configuration Selector	UserSetDefaultSelector	RW	Selects the camera configuration set to load and make active on camera power-up or reset. The camera configuration set is stored in camera non-volatile memory (RW)
<i>Factory Setting</i>	<i>FactorySetting</i>		<i>Load the factory default feature settings</i>
<i>UserSet1</i>	<i>UserSet1</i>		<i>Select the user defined configuration UserSet1 as the Power-up Configuration</i>

<i>UserSet2</i>	<i>UserSet2</i>		<i>Select the user defined configuration UserSet2 as the Power-up Configuration</i>
User Set Selector	UserSetSelector	RW	Selects the camera configuration set to load feature settings from or save current feature settings to. The Factory set contains default camera feature settings
<i>Factory Setting</i>	<i>FactorySetting</i>		<i>Select the default camera feature settings saved by the factory</i>
<i>UserSet1</i>	<i>UserSet1</i>		<i>Select the User Defined Configuration space UserSet1 to save to or load from features settings previously saved by the user</i>
<i>UserSet2</i>	<i>UserSet2</i>		<i>Select the User Defined Configuration space UserSet2 to save to or load from features settings previously saved by the user</i>
Load Configuration	UserSetLoad	WO	Loads the camera configuration set specified by the User Set Selector feature, to the camera and makes it active
Save Configuration	UserSetSave	WO	Saves the current camera configuration to the user set specified by the User Set Selector feature. The user sets are located on the camera in non-volatile memory

Camera Configuration Selection Dialog



CamExpert provides a dialog box which combines the features to select the detector power-up state and for the user to save or load a detector state from Rad-icon memory.

Camera (Detector) Power-up Configuration

The first drop list selects the detector configuration state to load on power-up (see feature UserSetDefaultSelector). The user chooses from one factory data set or one of two possible user saved states.

User Set Configuration

The second drop list allows the user to change the detector configuration anytime after a power-up (see feature UserSetSelector). To reset the detector to the factory configuration, select Factory Setting and click Load. To save a current detector configuration, select User Set 1 or 2 and click Save. Select a saved user set and click Load to restore a saved configuration.

Sensor Control

In this section the operation of the sensor part can be controlled.

Display Name	Feature Name	Acc	Description
Acquisition Frame Rate (in Hz)	AcquisitionFrameRate	RW	Sets the detector frame rate, if Exposure Mode = Frame Rate
Exposure Mode	ExposureMode	RW	Sets the operation mode for the detector exposure (or electronic shutter)
<i>Exposure</i>	<i>Exposure</i>		<i>The exposure duration time is set using the Exposure Time feature and the exposure starts with a FrameStart event</i>
<i>Frame Rate</i>	<i>FrameRate</i>		<i>The exposure duration time is set using the Acquisition Frame Rate feature and the exposure starts with a FrameStart event</i>
Exposure Alignment	exposureAlignment	RO	Exposure us synchronous to the internal timing of the sensor. The readout is concurrent to the exposure for the fastest possible frame rate.
Exposure Delay (in us)	exposureDelay	RO	Not in use
Exposure Time (in us)	ExposureTime	RW	Sets the exposure time when the Exposure Mode feature is set to Exposure
Actual Exposure Time (in us)	exposureTimeActual	RO	Actual detector trigger out exposure time
Sensor Readout Time (in us)	readoutTime	RO	Sensor readout time
Readout Direction Y	ReadoutDirectionY	RW	Set vertical readout direction
<i>Top to Bottom</i>	<i>ToptoBottom</i>		<i>Sets vertical readout direction to top to bottom</i>
<i>Bottom to Top</i>	<i>BottomtoTop</i>		<i>Sets vertical readout direction to bottom to top</i>
Readout Direction X	ReadoutDirectionX	RW	Set horizontal readout direction
<i>Left to Right</i>	<i>LefttoRight</i>		<i>Sets horizontal readout direction to top to bottom</i>
<i>Right to Left</i>	<i>RighttoLeft</i>		<i>Sets horizontal readout direction to bottom to top</i>
Offset	Offset	RW	Sensor dark ADC offset level; based on full scale of sensor.
<i>0%</i>	<i>Offset0pct</i>		<i>0</i>
<i>0.75%</i>	<i>Offset0pct75</i>		<i>0,75% of 65535 ADC full scale.</i>
<i>1.5%</i>	<i>Offset1pct5</i>		<i>1.5% of 65535 ADC full scale.</i>
<i>2.35%</i>	<i>Offset2pct35</i>		<i>2.35% of 65535 ADC full scale.</i>
Full Well Selection	FullWell	RW	Selects the full well type
<i>High Full Well</i>	<i>HighFullWell</i>		<i>High Full Well = low detector sensitivity</i>
<i>Low Full Well</i>	<i>LowFullWell</i>		<i>Low Full Well = high detector sensitivity</i>

I/O Controls (trigger)

In this section all settings concerning triggering and triggering modes can be controlled.

Display Name	Feature Name	Acc	Description
Trigger Selector	TriggerSelector	RO	Not in use, set to single frame trigger
Trigger Mode	TriggerMode	RW	Selection of trigger mode (see for more details below this table)
<i>Free running</i>	<i>Freerunning</i>		<i>The detector is master, triggers itself internally</i>
<i>Triggered</i>	<i>Triggered</i>		<i>The host is master, the detector triggers on the trigger input signal</i>
<i>Snapshot</i>	<i>Snapshot</i>		<i>Sensor reset occurs on rising edge and sensor read out occurs on falling-edge of trigger input.</i>
<i>SnapshotExtExp</i>	<i>SnapshotExtExp</i>		<i>Sensor reset occurs on rising edge of trigger and sensor read out occurs after extended exposure counter reaches its counter value.</i>
<i>TrigSequence</i>	<i>TrigSequence</i>		<i>Sensor reset occurs on rising edge of trigger and then records a number of exposed frames and offset frames.</i>
Trigger Edge Select	TriggerEdgeSelect	RW	Controls on which edge the trigger starts a detector readout
<i>Falling Edge</i>	<i>FallingEdge</i>		<i>Trigger starts on falling edge of trigger input signal</i>
<i>Rising Edge</i>	<i>RisingEdge</i>		<i>Trigger starts on rising edge of trigger input signal</i>
Invert Trigger Out	InvertTriggerOut	RW	Controls polarity of trigger out signal. Default is high.
<i>Off</i>	<i>Off</i>		<i>Trigger out active high</i>
<i>On</i>	<i>On</i>		<i>Trigger out active low</i>
Trigger Out Mode	TriggerOutMode	RW	Controls the trigger out signal. Default is pulsed.
<i>Off</i>	<i>Off</i>		<i>Trigger out signal is disabled</i>
<i>Pulsed</i>	<i>Pulsed</i>		<i>Trigger out signal is inactive during sensor readout</i>
<i>On</i>	<i>On</i>		<i>Trigger out signal is active until the last programmed frame readout starts</i>
Software Trigger	TriggerSoftware	RW	In all modes except Freerunning, pressing this field once generates 1 internal trigger
Pulse Width Control	PulseWidthControl	RW	Enable or disable (default) trigger pulse width control. When enabled, the detector sends out a frame only if the trigger pulse exceeds a threshold value. Valid only in triggered mode.
<i>Off</i>	<i>Off</i>		<i>No pulse width control</i>
<i>On</i>	<i>On</i>		<i>Pulse width control active</i>

Pulse Width Length (in us)	PulseWidthLength	RW	If Pulse Width Control is on, sets threshold value.
Pulse Active On	PulseActiveOn	RW	If Pulse Width Control is on, determines if a trigger pulse control needs to kick in after or before threshold value
<i>Long Pulse</i>	<i>Long Pulse</i>		<i>Kick in after threshold value</i>
<i>Short Pulse</i>	<i>Short Pulse</i>		<i>Kick in before threshold value</i>
Pulse Width Level Select	PulseWidthLevelSelect	RW	If Pulse Width Control is on, sets which level of an active trigger pulse is measured: high or low.
<i>High Time</i>	<i>HighTime</i>		<i>High time is used for pulse width measurement</i>
<i>Low Time</i>	<i>LowTime</i>		<i>Low time is used for pulse width measurement</i>
Pulse Control Latency	Pulse Control Latency	RW	Sets the amount of delay before starting Pulse Width control (Pulse Width Control must be on).
<i>1 Frame</i>	<i>OneFrame</i>		<i>Pulse width control is applied the 2nd frame and after</i>
<i>2 Frame</i>	<i>TwoFrame</i>		<i>Pulse width control is applied the 3rd frame and after</i>
Invalid Trigger Count	InvalidTriggerCount	RO	If Pulse Width Control is on, indicates the number of received invalid trigger pulses. This may happen when the trigger pulse is longer than the sensor readout time and Pulse Control Latency is set to 1 Frame.

Trigger Modes

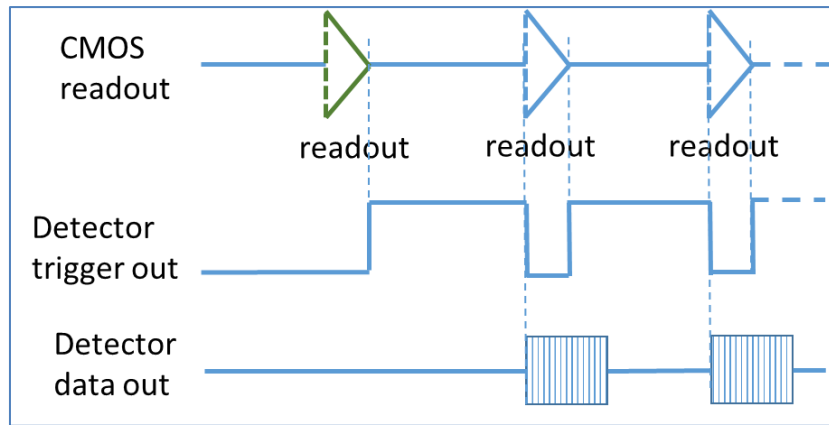
Free Running Mode

The detector is Master. In this mode the detector will run continuously on internal timing, no trigger input is required to initiate a frame read out.

The frame rate can be set using the Exposure Mode. If the setting Exposure is chosen the Exposure Time determines the frame rate, frame time is the sum of Sensor Readout Time and Exposure Time. If the setting Frame Rate is chosen the frame rate can directly be set using Acquisition Frame Rate.

The maximum frame rate is in Full FOV (1x1) mode 20 FPS. In Full FOV (1x2) and (2x2) modes the maximum frame rate is 40 FPS.

The trigger output indicates the X-ray active time. When a grab is started, the next integration period will be acquired and send to the host system. If a grab is started but the sensor is still in the integration period, this frame will be dropped and the following frame will be send to the host system; this to avoid changes to the sensor during the integration period (which can happen before acquiring images).



Timing diagram in Free Running mode

The sensor is read simultaneously from top and bottom to center. This read out method is called “butterfly read out”.

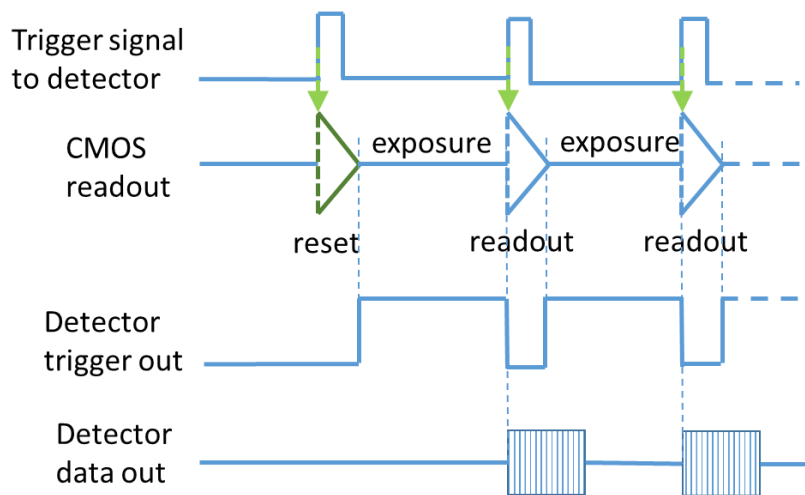
The readout time in full resolution is 50 msec.

In 2x2 binning mode and 1x2 binning mode the read out time is reduced by a factor of 2, thus 25 msec.

Triggered mode

The detector is in Slave mode. In this mode the detector acquire images at the moment trigger signals are applied to the detector.

The trigger output indicates the Exposure Time when no read out of the sensor occurs.



Timing diagram in Triggered mode

Some notes about the external trigger mode:

- When no external trigger signal is applied, the detector is accumulating dark signal
- Upon the first trigger the sensor will be reset, since the image would be invalid due to charge accumulation the image is not sent out
- The trigger frequency is limited by the maximum frame rate.

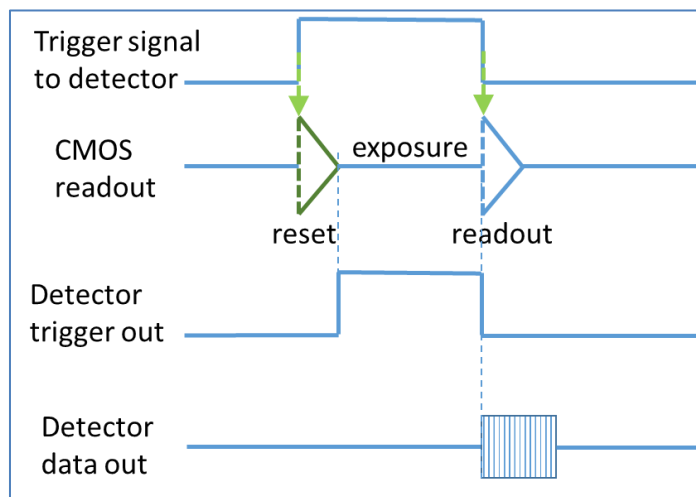
Snapshot mode

In this mode the detector will initiate a sensor reset at rising edge (default, can be changed) of the trigger input and successive to this it will read out the sensor at the falling edge.

The sensor reset is actually a normal read out of the sensor but the data is discarded.

The trigger output indicates the Exposure Time between finalization of the reset and start of the read out of the sensor.

To allow sufficient time for the sensor reset, the delay between rising edge of the trigger input and when the detector is exposed to x-ray should equal or higher to the reset or read out time of the sensor.

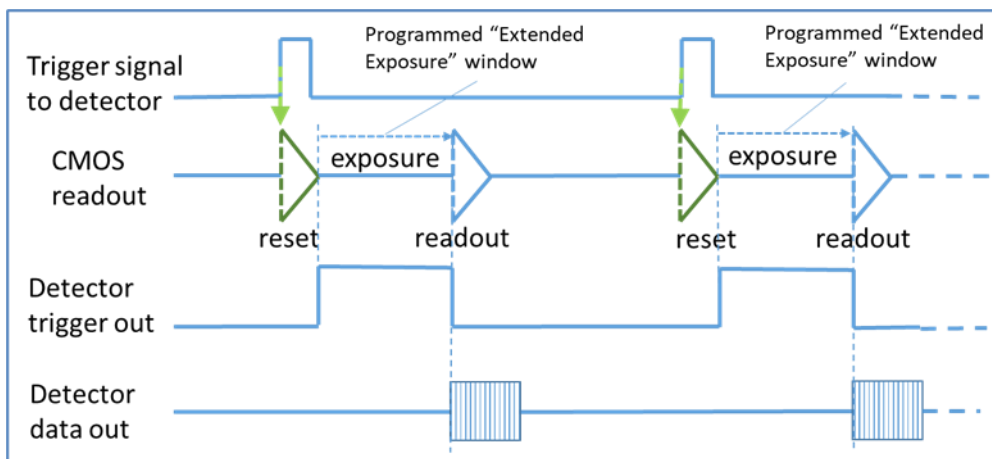


Timing diagram in Snapshot mode

	Full FOV 1x1	Full FOV 1x2	Full FOV 2x2
CMOS (detector) reset/read out	50ms	25ms	25ms
Detector trigger out time	Trigger pulse length – reset time	Trigger pulse length – reset time	Trigger pulse length – reset time
Minimum period time	50ms	25 ms	25 ms

Snapshot Extended Exposure Mode

This mode is very similar to the snapshot mode, with 1 difference: the start of Readout is not triggered by the falling (default) trigger input but by a preprogrammed time, in this case the set Exposure Time + Reset time.



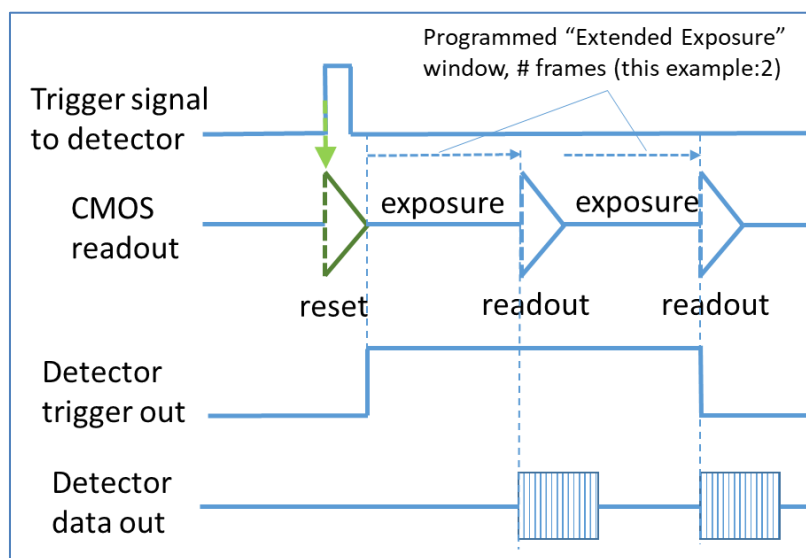
Timing diagram in Snapshot Extended Exposure mode

	Full FOV 1x1	Full FOV 1x2	Full FOV 2x2
Detector read out	50ms	25ms	25ms
Detector trigger out time	Exposure Time setting	Exposure Time setting	Exposure Time setting
Minimum period time	50ms	25 ms	25 ms

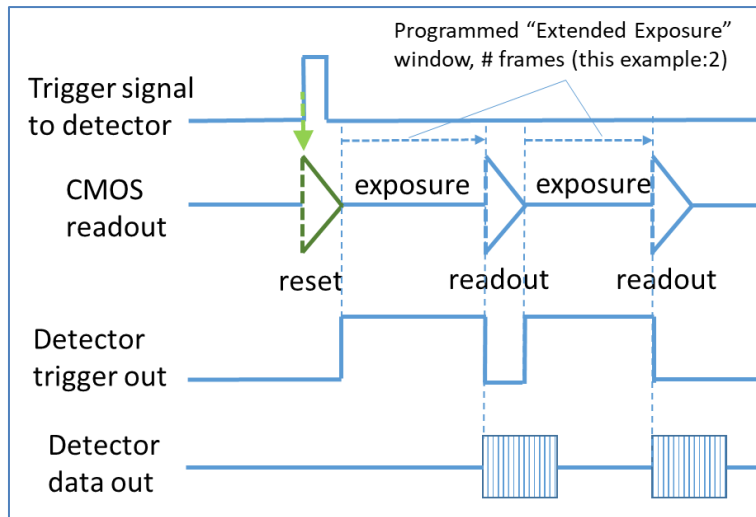
Offset images can be acquired by putting the detector in to free running mode with the same Exposure Time setting.

Triggered Sequence mode

In this mode the detector is slave. The detector waits for 1 external trigger signal to initiate the acquisition of a sequence of images, the number can be programmed via the SDK SW interface. If no value for this number is programmed, the detector will just continue grabbing images, it is like starting free running with 1 external trigger pulse.



Timing diagram Triggered sequence trigger mode with "trigger out mode" set to "on"



Timing diagram Triggered sequence trigger mode with “trigger out mode” set to “pulsed”

	Full FOV 1x1	Full FOV 1x2	Full FOV 2x2
CMOS (detector) reset/read out	50ms	25ms	25ms
Detector trigger out time	Exposure Time setting	Exposure Time setting	Exposure Time setting
Minimum period time	50ms	25 ms	25 ms

Image Format Controls

In this section all settings concerning the image format can be set.

Display Name	Feature Name	Acc	Description
Pixel Format	PixelFormat	RO	Number of bits and color. Set to monochrome 16 bit only.
Horizontal Offset	OffsetX	RO	Not in use
Vertical Offset	OffsetY	RO	Not in use
Width	Width	RO	Displays image width in #pixels
Height	Height	RO	Displays image height in #pixels
Binning List	binningSelector	RW	Select binning of detector
<i>Binning 1x1</i>	<i>Binning_1x1</i>		<i>Full Field-of-View image</i>
<i>Binning 1x2</i>	<i>Binning_1x2</i>		<i>Full Field-of-View image, 2x vertical pixel binning</i>
<i>Binning 2x2</i>	<i>Binning_2x2</i>		<i>Full Field-of-View image, 2x2 pixel binning</i>
Binning Mode	binningMode	RW	Choose summing or average calculation
<i>Average</i>	<i>Average</i>		<i>Average the 2 pixel values</i>
<i>Sum</i>	<i>Sum</i>		<i>Sum the 2 pixel values</i>
Binning Domain	binningDomain	RW	Choose where the binning is carried out
<i>In Digital Domain</i>	<i>InDigitalDomain</i>		<i>Summing or averaging is done in digital domain</i>
<i>In Sensor</i>	<i>InSensor</i>		<i>Summing or averaging is done in the sensor, in analog domain</i>
Binning Horizontal	BinningHorizontal	RO	Displays the number of horizontal pixels that are combined using the methods selected by Binning Mode and Binning Domain
Binning Vertical	BinningVertical	RO	Displays the number of vertical pixels that are combined using the methods selected by Binning Mode and Binning Domain
Factory/Customer Map Select		RW	Choose between factory or customer defect map
<i>Auto</i>	<i>Auto</i>		<i>If customer defect map exists then use customer else factory</i>
<i>Customer</i>	<i>Customer</i>		<i>Use customer defect map</i>
<i>Factory</i>	<i>Factory</i>		<i>Use factory defect map</i>
Test Pattern	TestPattern	RW	Not in use
Sensor Test Pattern Value	SensorTestPatternValue	RW	Not in use

Binning Modes

Full Resolution

In Full Field-of-View, full resolution of the sensor is read out and streamed to the host system. A butting gap is injected in vertical direction in the image to indicate at what position the two separate sensors are butted to each other, the pixel value of this butting gap is 1. Refer to chapter “Mechanical Interface” for the exact location.

The table below indicates the pixel values in one line and where the butting gap is located (shaded) in the columns in different modes.

Pixel	0	1	2	3...	2302	2303	2304	2305	2306	2307	2308			
Value	A	B	C	D	1	1	M	O	N	O	P			

The position of the vertical and horizontal butting gap locations for different modes is shown in the table below. The first pixel position is defined as (0,0).

MODE	Image Resolution	Vertical Butting Gap Locations	Horizontal Butting Gap Location
FullFOV 1x1	4608 x 5890	2302, 2303	2944, 2945
FullFOV 1x2	4608 x 2945	2302, 2303	1472
FullFOV 2x2	2304 x 2945	1151	1472

Note: the first and last 10 rows may be less sensitive and would need to be discarded.

Binning 2x2

The detector supports 2x2 pixel binning. The butting gap appears as a pixel with zero value.

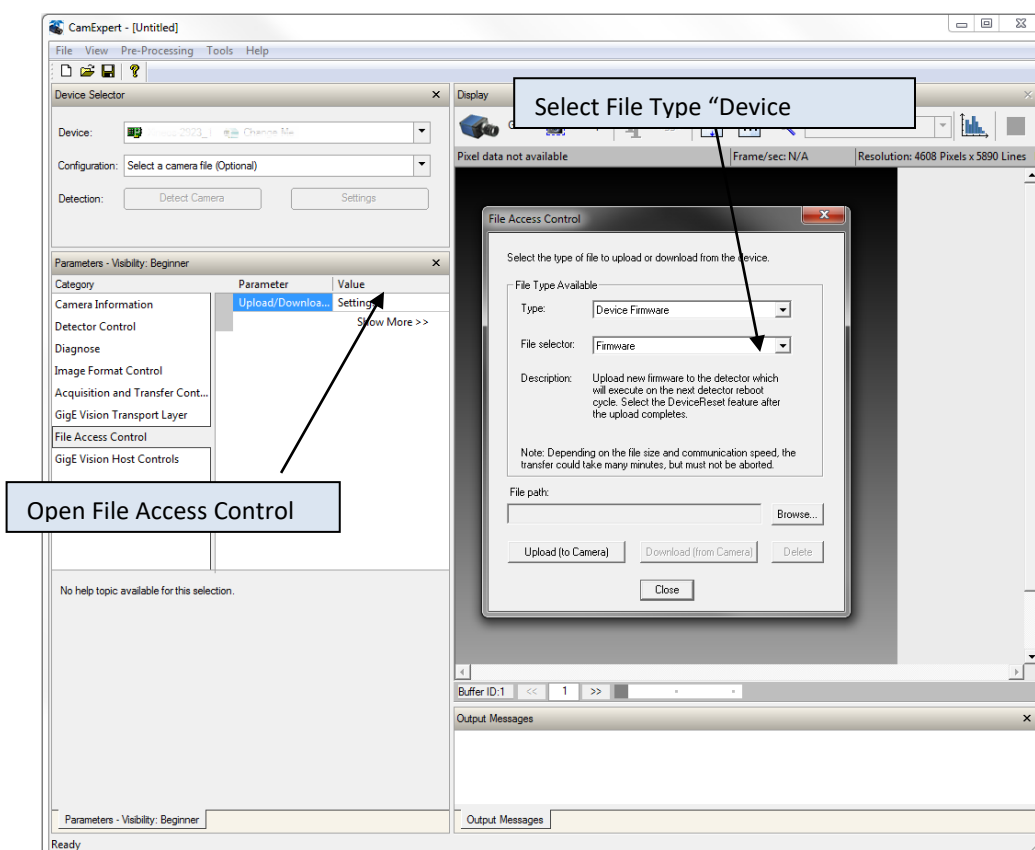
File Access Control

Uploading Firmware

Trough the file access control firmware update can be performed. Use the browse button to select a firmware file which has the extension CBF. The filename has the following format:

- MAJORFWVER_ MINORFWVER_ MODELNAME

The major firmware version (MAJORFWVER) and MODELNAME should be identical as the detector.



After uploading the file to the detector, CamExpert will request for a restart of the detector which is required to reboot with the new firmware.

Defect maps

Introduction

Defect pixel reference maps are stored in detector non-volatile memory. These maps contain information on the position of defective (or deviating) pixels, required for Defect Pixel Correction (DPC). These maps are detector-specific, and are generated during Teledyne DALSA factory calibration.

Separate defect pixel maps are available for different read out modes.

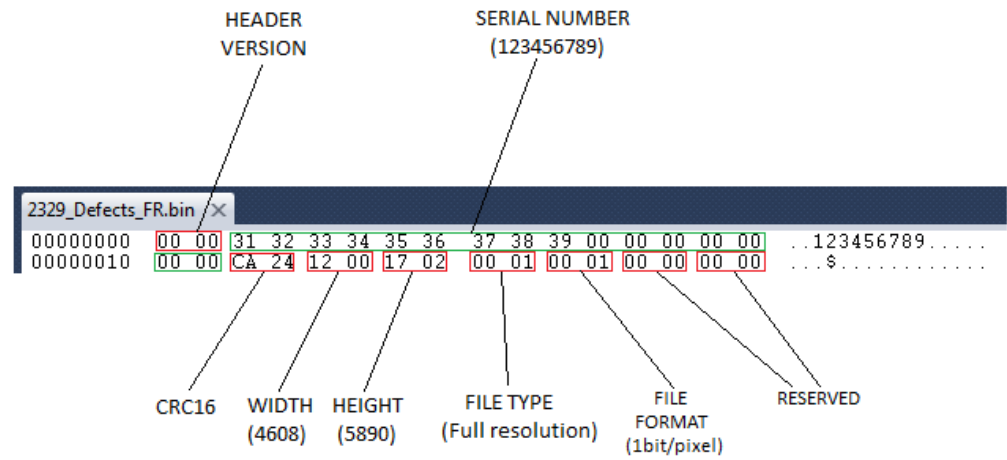
The defect map can be used by the host application to apply corrections for defect pixels in images captured from the detector. The host application may use the “Teledyne X-Ray Processing Library” functions to apply such corrections, or for the creation and uploading of new correction maps. This library and its API can be downloaded from the Teledyne DALSA FTP server ([ftp.teledynedalsa.com](ftp://ftp.teledynedalsa.com)); please refer to “Rad-icon Support Tools” chapter for FTP login details.

File Format

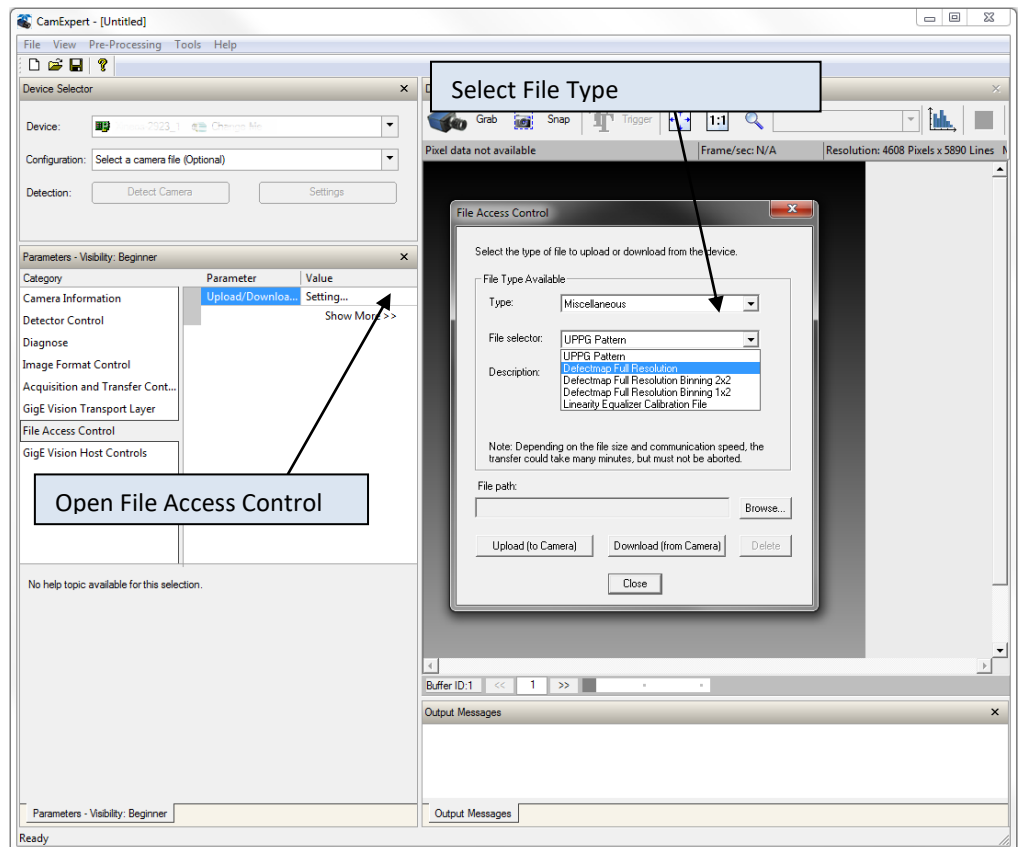
The file format of a defect map is as follows: a header indicates the specification of the defect map, and will be followed by a data block with the defect information per pixel. Only one bit per pixel is used to indicate the defect status (0 = no defect, 1 = defect). The defect status data per pixel is ordered row-by-row, left-to-right and top-to-bottom in an image displayed on a computer screen). The 32 bytes header format is described below:

Field	Description		Endian	Bytes
Header Version	0	Version number		2
Serial Number	Serial Number of detector			16
CRC	CRC16 of total data file without the header		Little	2
Width	Number of columns (of full resolution image)		Big	2
Height	Number of rows (of full resolution image)		Big	2
File Type	0 1 2 3	Full Resolution, High Full Well Full Resolution, Low Full Well Binning 2x2, High Full Well Binning 2x2, Low Full Well	Big	2
File Format	1	1 bit per pixel	Big	2
Extra1	Reserved		Big	2
Extra2	Reserved		Big	2

Example of defect map file header (hex format):



Up- and downloading



The File Access Control dialog box enables up- and downloading of defect map files.



Please download and archive the factory default maps, before attempting to upload new maps to the detector. In case a new map with wrong contents is uploaded to the detector, it will always be possible to upload and restore the factory default map.

To upload a defect map file from the host to the detector, select Type Miscellaneous in the first drop list and in the second drop list the appropriate Resolution/Binning mode. Press the **Browse...** button to select a Defect Map File on the host and press **Upload (to Camera)** to start the transfer to the detector. The upload will be confirmed with the message: **File Upload Completed**.

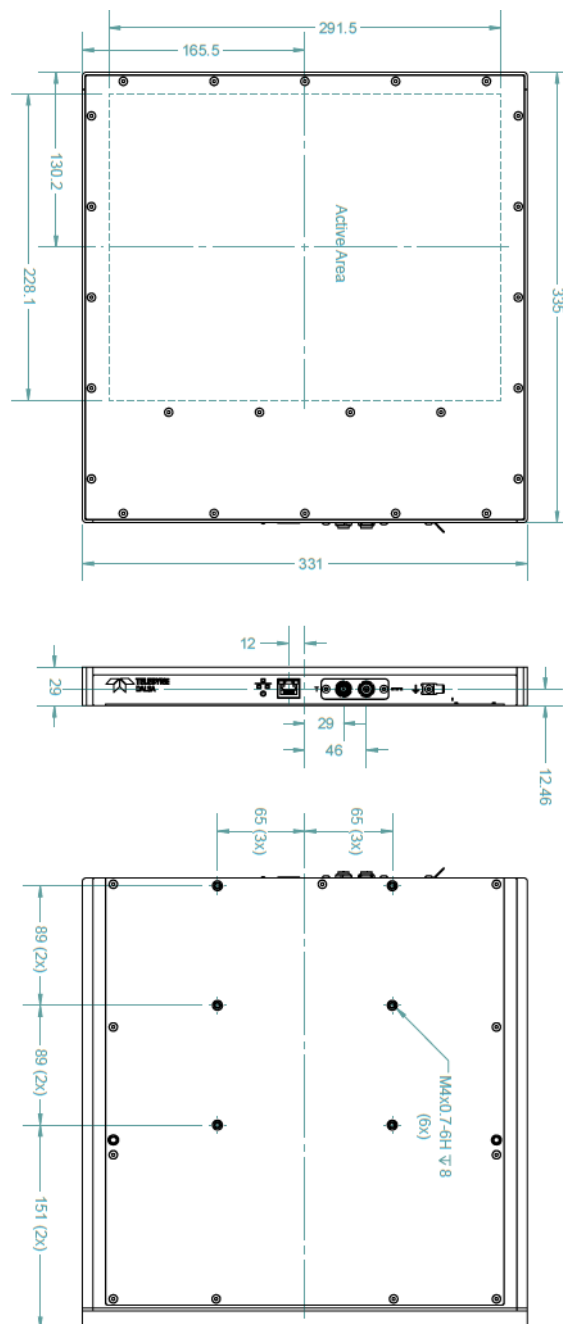
To transfer a defect map file from the detector to the host press the button: **Download (from Camera)**. A browse screen will be opened to select the **Save as...** location on the host. Pressing the **Save** button after selecting the correct name and location, the detector will start a transfer of the defect map file of the selected Resolution/Full Well mode to the host. The download will finish with **The file download completed successfully** message.

When attempting to upload a new defect pixel map, the detector will check the file header. In case the header is incorrect, uploading the file will be blocked with error message **The selected file write access to the device failed!**.

6

Mechanical Interface

Mechanical Dimensions



Appendix A

Revision History

Revision Number	Change Description	Revision Date
00	Draft	2023-05-15
01	First release	2023-12-05