DIGITAL IMAGING

REFERENCE MANUAL

XRD 1621 xN ES
Digital X-Ray Detector

PerkinElmer
For the Better

www.perkinelmer.com

FOR YOUR SAFETY

Protection against ionizing Radiation

- Exposure of any part of the human body to X-rays or gamma-rays can be highly injurious to health. Whenever X-Ray equipment or radioactive sources are in use, appropriate legal requirements must be applied.
- Local or national or international safety precautions when ionizing radiation shall be strictly applied.
- The detector does not contain primary barrier for X-Ray and Gamma Ray. The system provider must provide the necessary protection based on intended use.
- The system is intended for use by qualified personnel who are trained and qualified in the operation of X-Ray equipment.

Warning

- Read the manual and all accompanying papers carefully before operating the **XRD 1621 xN ES** system to avoid any damage and personal injury.
- The system is intended for use by qualified personnel who are familiar with the operation of electrical equipment (considering safety precautions to avoid possible injuries).
- The system must only be installed by qualified personnel who are familiar with the installation of electrical equipment (considering safety precautions to avoid possible injuries and damage to the system).
- The X-Ray Detector is intended to operate from a power source that will not apply more than 240 Volts RMS between the supply conductors or between supply conductor and ground. Other system components listed below have to be grounded through the protection earth conductors in the power cords:
  - Computer connected with the detector
  - Monitor
- The required potential equalization has to be managed through the labeled connectors at the detector and if applicable also for the **XRD EPS** power supply.
- The socket outlet shall be installed near the power supply and shall be easily accessible.
- To avoid risk of electric shock, this equipment must only be connected to supply mains with protective earth.
- To avoid electrical shock, plug the power cords into a properly wired receptacle before performing all other connections. For proper performance do not use receptacles which are not properly grounded.
- Exercise extreme care to select a low noise, ripple free ground connection for the whole system. Ground terminals of wall receptacles are not suitable to ground the detector housing due to high noise and ripple input into the system.
- If the protective-ground connection is lost, all accessible conductive parts can render an electric shock, including the parts which appear to be isolated.
- Use only the original power cords. Inspect power cords and connectors regularly. Cord and connector repairs should only be serviced by qualified personnel.
- Be sure to operate the X-Ray Detector with the specified power supply. Use of an incorrect power supply will cause system failure and create a hazard.
- If any abnormal phenomena are evident such as smoke, strange sounds or fumes, unplug the Power Supply and contact your dealer, distributor or PerkinElmer subsidiaries immediately. Further use may be dangerous.
- Removing the housing of the X-Ray Detector or of the Power-Supply may cause electrical shock and/or irreparable damage of highly sensitive components and void the product warranty.
- In case of an accident or malfunction, unplug the power supply immediately and contact your dealer, distributor or PerkinElmer subsidiaries. Using the X-Ray Detector or the power supply any longer may cause fire, electrical shock or other damage.

- Install the X-Ray Detector horizontally on a flat, stable surface. If the detector is placed vertically or in any tilted position, the detector must be securely fastened in position. The X-Ray Detector may cause an injury if it falls or is dropped.
- Place the unit in a safe environment in a way that non-qualified personnel cannot touch the detector, power supply or cable.
- Do not place the X-Ray Detector or other components on or near other devices.
- Do not modify this equipment without authorization of PerkinElmer. Unauthorized modification of the equipment will void the product warranty.

Caution

- Do not operate the system in or around flammable gases or liquids.
- Environmental conditions that are not in compliance with Section 7.1.3 of this manual may cause fire, electrical shock, reduce the lifetime and/or irreparably damage the X-Ray Detector and void the product warranty.
- Disconnect the cables prior to moving the **XRD 1621 xN ES**, turn off the power supply and unplug all cables. Disconnect the cables by pulling on the connector and not the cable itself as stressing the cable may cause fire or electrical shock.
- Do not touch the connector with wet hands.
  Pulling or inserting the connector with wet hands may cause electrical shock.
- Do not touch the **XRD 1621 xN ES** or the power supply and the patient at the same time.
- Do not use more than 25 VAC and/or 60VDC at SIP/SOP.

EMC Safety

- Imaging Devices are in need of special precautions concerning EMC and should be installed and operated as written in the accompanying documentation.
- High electromagnetic fields near the X-Ray Detector or the data cables may result in erroneous readings.
- Mobile RF-communication devices near the X-Ray Detector or the data cables may result in erroneous readings.
- Only original components should be used, and no modifications and/or alterations to the product or any portion thereof should be performed without obtaining the prior written authorization of PerkinElmer. Unauthorized modification of the equipment will void the product warranty.
- External Equipment intended for connection to signal input, signal output or other connectors shall comply with relevant IEC standard (e.g. IEC 60950 for IT equipment and IEC 60601 series for medical electric equipment). In addition, all such combinations shall comply with the standard IEC 60601-1-1, Safety requirements for medical electrical systems. Equipment not complying with IEC 60601-1 shall be kept outside the patient environment, as defined in the standard.
- Any person who connects external equipment to signal input, signal output or other connectors has formed a system and is therefore responsible for the system to comply with the requirements of IEC 60601-1-1. If in doubt, contact qualified medical technician or your local representative.

ESD Safety

- Shut down the power supply before connecting or disconnecting any cables.
- Only original components should be used, and no modifications and/or alterations to the product or any portion thereof should be performed without obtaining the prior written authorization of PerkinElmer. Unauthorized modification of the equipment will void the product warranty.
- The system must be grounded through the grounding conductors of the power cords and in addition a potential equalization is required for the X-Ray Detector **XRD 1621 xN ES**, and if applicable also for the **XRD EPS** power supply.
- Proper Electrostatic Discharge protection must be used prior to handling electrical connections to the X-Ray Detector

Cleaning

- Only cloth lightly moistened with a mild detergent solvent and afterwards a soft dry cloth should be used.
- For safety reasons, turn off and unplug the power supply before cleaning.
- Never use any of the following strong solvents as damage to the X-Ray Detector and accessories may occur.
  - Thinner
  - Benzine
  - Acetone
  - Abrasive cleaner
  - Wax
  - Acid or Alkaline solvent
  - Spray-type cleaner

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1 Scope

This document describes design elements and respective interfaces for the **XRD 1621 xN ES** detector family. Applicable mechanical, electronic, and software interfaces are addressed. PerkinElmer digital X-Ray Flat Panel Detectors and accessories are designed to be integrated into a complete X-Ray system by imaging system manufactures. Manufactures are responsible for qualifying, validating, certifying their intended use on their specific application and meeting all applicable regulatory requirements established by local or national government authorities.

2 Intended Use

2.1 Medical Usage

The detector is a component of a digital imaging system. Properly integrated into a completed X-Ray system, the detector enables the digital X-Ray imaging intended for medical, dental and veterinary applications. The detector is capable of supporting image acquisition in digital X-Ray systems used for diagnostic and therapy. The detector does not have life supporting functions. Final application is based on the completed X-Ray system design. It is the responsibility of the final device manufacturer to confirm the efficacy of the system for its intended use.

2.2 Industrial and Security Usage

The detector is a component of a digital imaging system. Properly integrated into a completed X-ray system, the detector enables the digital X-ray imaging intended for general X-ray imaging such as Industrial Non Destructive Testing and Security applications. Final application is based on the completed X-ray system design. It is the responsibility of the final device manufacturer to confirm the efficacy of the system for its intended use and when necessary appropriate certification and or compliance to applicable regulations.

3 Abbreviations

ADU	Analogue Digital Unit (Grey Level)
COB	Chip on Board
D³	Data Delivery on Demand
FoV	Field of view
FPGA	Field Programmable Gate Array
fps	Frames per second
FSR	Full scale range
I/F	Interface
IP	Internet Protocol
LED	Light Emitting Diode
LVDS	Low Voltage Differential Signal
MSps	Mega Samples per second
PROM	Programmable Read Only Memory
PCB	Printed Circuit Board
RoHS	Restriction of Hazardous Substance
TTL	Transistor to Transistor Logic
SIP/SOP	Signal Input/Signal Output Part
VCT	Volts center tapped
XRD 1621 xN ES	**x** is used as a synonym for the two housing versions (x = A or C)

Table 1 Abbreviations

4 Definition of Symbols

Symbol	Description
	This way up
	Handle with care
	Keep Dry
	Reusable
	Disposal (WEEE)
	Read the manual
	D.C. Voltage
	Temperature limitation
	Potential equalization
	Protection class I
	Protection class II
	EMC sensitive component

Table 2 Symbols

5 Regulatory Requirements

The assembly of the X-Ray Detector **XRD 1621 xN ES** is designed to be compliant with the requirements detailed in the table below.
All regulatory certificates are valid only if the original accessories as listed in Table 12 are used.
All regulatory certificates and warranty are rendered void if any modification and/or alteration to the product is made, or any portion thereof, without obtaining the prior written authorization of PerkinElmer.

Standard	Description
UL 60950-1:2003	Information Technology Equipment - Safety - Part 1: General Requirements
IEC/EN 60950-1:2006	Safety of information technology equipment including electrical business equipment and associated equipment, with a rated voltage not exceeding 600V.
UL[1] 60601-1:2003	General Requirements for Safety for Medical Electrical Equipment (US)
IEC 60601-1:1988, EN 60601-1:1990	General Requirements for Safety for Medical Electrical Equipment
IEC/EN 60601-1-2:2001	Medical electrical equipment, Part 1-2: General requirements for safety - Collateral standard: Electromagnetic compatibility

Table 3 Regulatory Requirements

6 Description of the XRD 1621 xN ES

6.1 Principle of the XRD 1621 xN ES

The detector **XRD 1621 xN ES** works as a complete X-ray detector with the sensor and its electronics housed in one package. In order to increase the durability of the device in MeV source applications, the electronics are placed on the perimeter of the active sensor, out of the direct path of the beam.

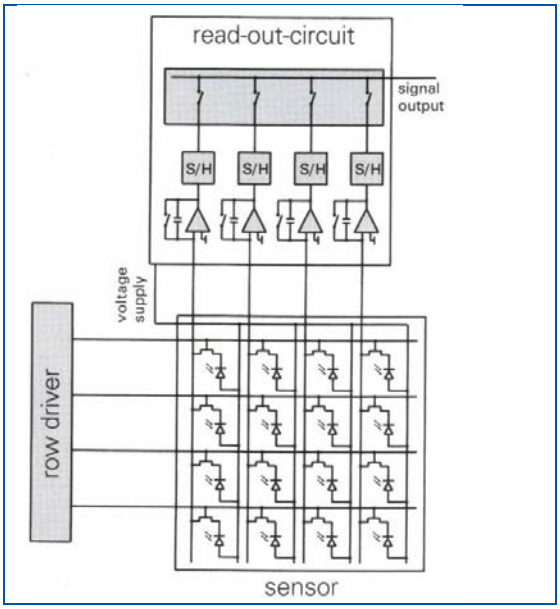


Figure 1 Principle electronic arrangement of XRD 1621 xN ES

Any portion of the housing outside of the active region has to be shielded externally to protect the electronic components from radiation damage.
The flat panel sensor of the **XRD 1621 xN ES** is fabricated using thin film technology based on amorphous silicon technology. Electronically, the sensors are much like conventional photodiode arrays. Each pixel in the array consists of a light-sensing photodiode and a switching Thin Film Transistor (TFT) in the same electronic circuit. Amorphous silicon photodiodes are sensitive to visible light, with a response curve roughly comparable to human vision. The sensitivity of

[1] For XRD EPS power supply Volts center tapped (VCT) is required

amorphous silicon photodiodes peaks in green wavelengths, well matched to Scintillators such as CsI:Tl or Gd_2O_2S:Tb. The response has the excellent linearity of a charge-integrating biased photodiode.

These sensors are of special interest primarily from the advantage of the size. The **XRD 1621 xN ES** sensor is based on a single panel. This means that no optical reduction is needed when recording large images, as from conventional X-ray cameras. The panel provides a very large improvement in the capture of optical photons from the Szintillator when compared to a fiber optic taper or reducing lens.

The incident X-rays are converted by the Szintillator material to visible light which generates electron hole pairs in the biased photodiode. The charge carriers are stored in the capacity of the photodiode. By turning on the gates of a TFT line within the matrix, the charges of all columns are transferred in parallel to the signal outputs. All signals of the columns are amplified in custom readout multiplexers for further processing (see Fig 1).

6.2 Electronic control and readout

Charge amplifiers for readout of the sensor, and row drivers for addressing the rows are placed on chip on board (COB) modules contacting the pads at the edges of the sensor. The COBs for control and readout are connected to A/D conversion PCB board. The analog part of the electronics is placed beside the sensor and includes sophisticated FPGA control of the detector. Numerous features are realized to minimize noise, as well as shaping and timing of the control pulses and isolation of digital and analog sections.

6.3 Structure of the XRD 1621 xN ES

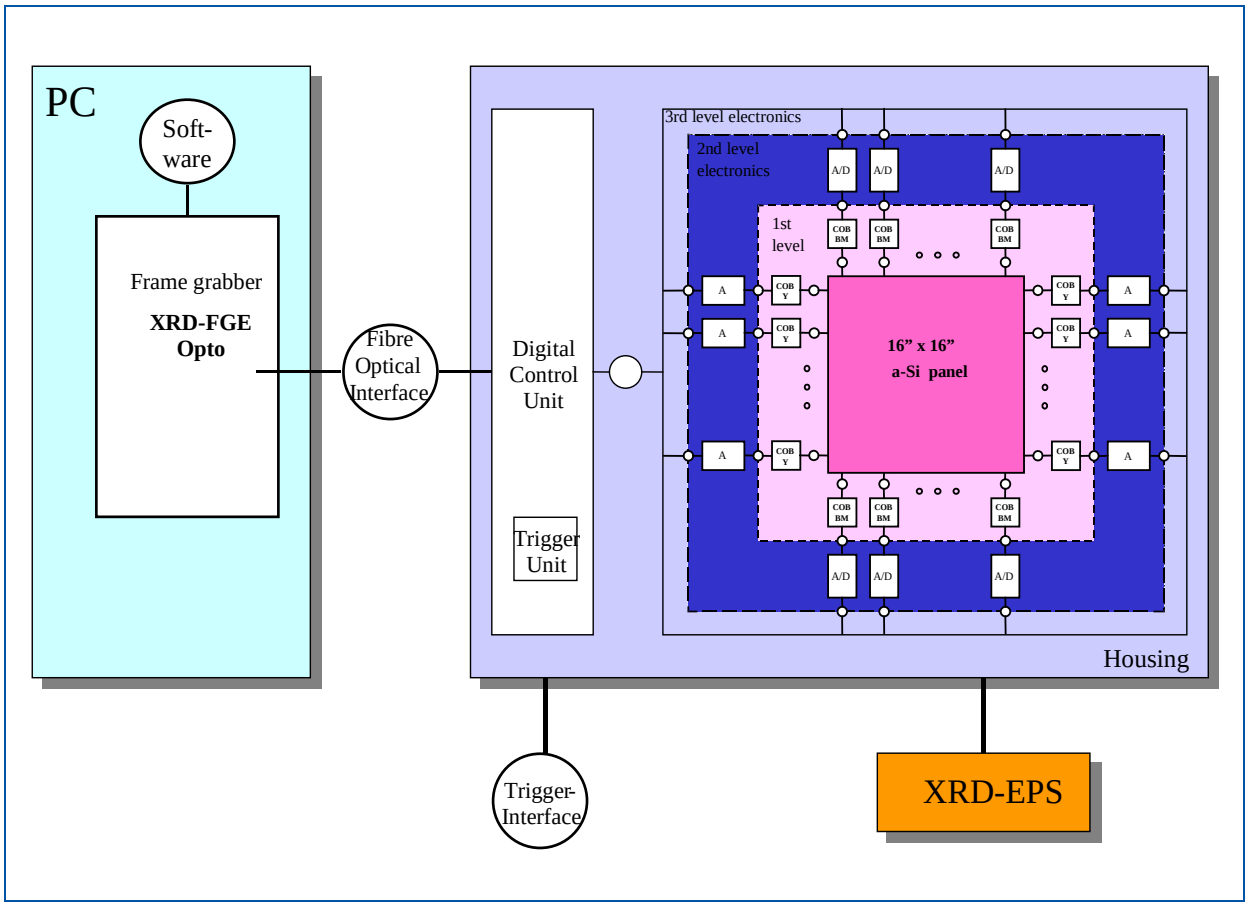


Figure 2 Structure of the XRD 1621 xN ES

6.4 Detector Overview

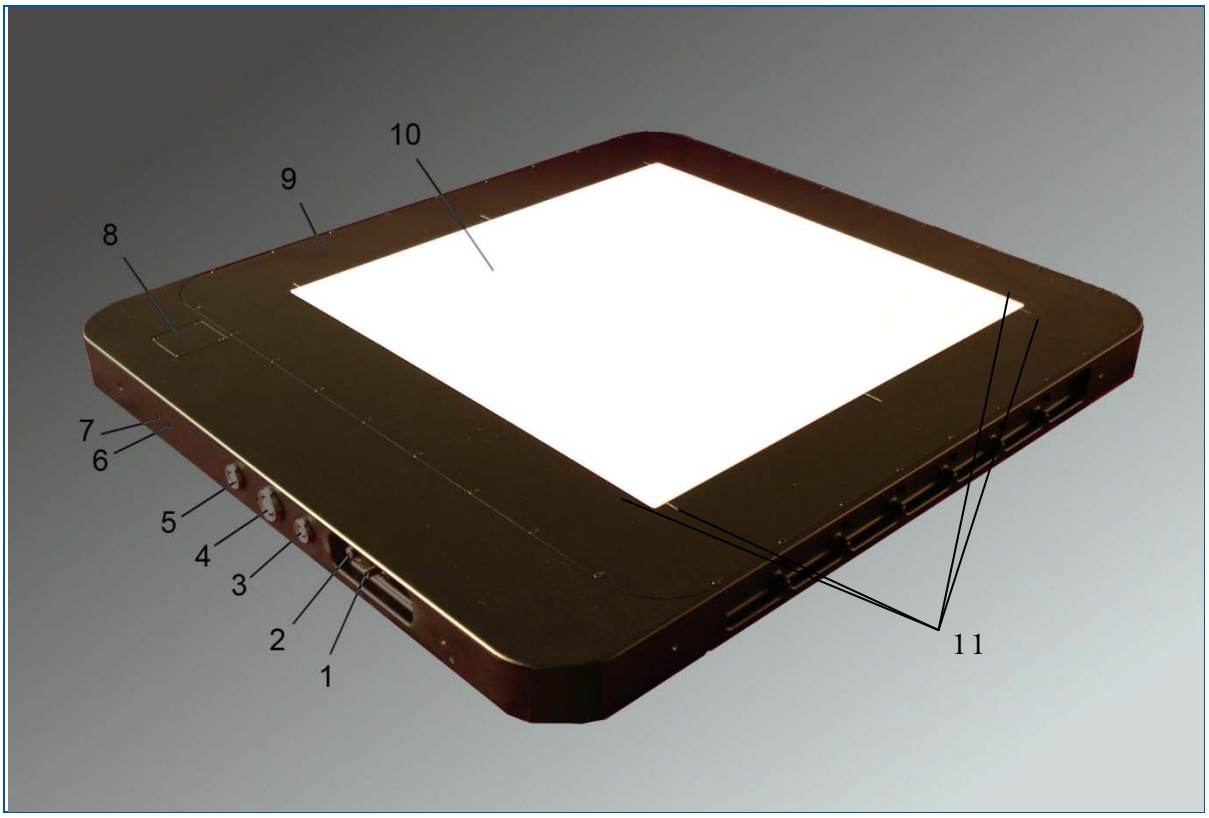


Figure 3 Detector Overview (a) Front Side (b) Back Side

1	Potential Equalization	
2	Ground Connection	
3	Trigger Input (page 16)	
4	Power Input (page 16)	
5	XRD Fibre Optical Interface Bus	
6	Detector Mode and Frame Rate	
	Green	Free Running (flashing)
	Yellow	Trigger Mode (flashing)
	Orange	During Boot-up and Self test
7	Power On and Detector Status	
	Green	Power ON
	Orange	During Boot-up and Self test
	Red	Self Test Failed
6 + 7	All Lights On during Self Inspection (Power-ON)	
7	Electronics (This Area needs to be shielded e.g. with the optional shielding cassette)	
8	PROM Holder	
9	Electronics (This Area needs to be shielded see 11)	
10	Active Area	
11	Markers to indicate the active area. All area outside the active area need to be shielded	

Table 4 Detector Overview

7 XRD 1621 xN ES Specification

7.1 Technical data of the XRD 1621 xN ES

7.1.1 Mechanical specification

Size:	672 mm x 599 mm x 44 mm
Weight:	25 kg.
Connectors:	Fibre Optical connector; 10-pole power supply connector; 7-pole trigger connector; Plug for Potential Equalization; M4 screw for grounding;
Construction:	
Detector:	
Sensor:	single glass substrate;
Contacts:	heat sealing contacts (including bias voltages);
Szintillator:	Gd_2O_2S:Tb optional: CsI:Tl needles directly deposited on the aSi photodiodes
Top plate:	aluminum plate for protection of sensor/Szintillator Thickness (0.75 ± 0.1) mm. optional: Carbon fiber plate Thickness (0.75 ± 0.1) mm.
Shielding:	Radiation shielding to the readout modules is not provided by the basic housing. The FOV (Field of view) and the X-ray exposure of the detector is restricted to the maximum of 409.6 x 409.6 mm ² active area, otherwise radiation damage to electronics might occur at any X-ray energy. **Depending on the application, electronics outside the active area need to be shielded by an appropriate shielding.**

Table 5 Mechanical specification

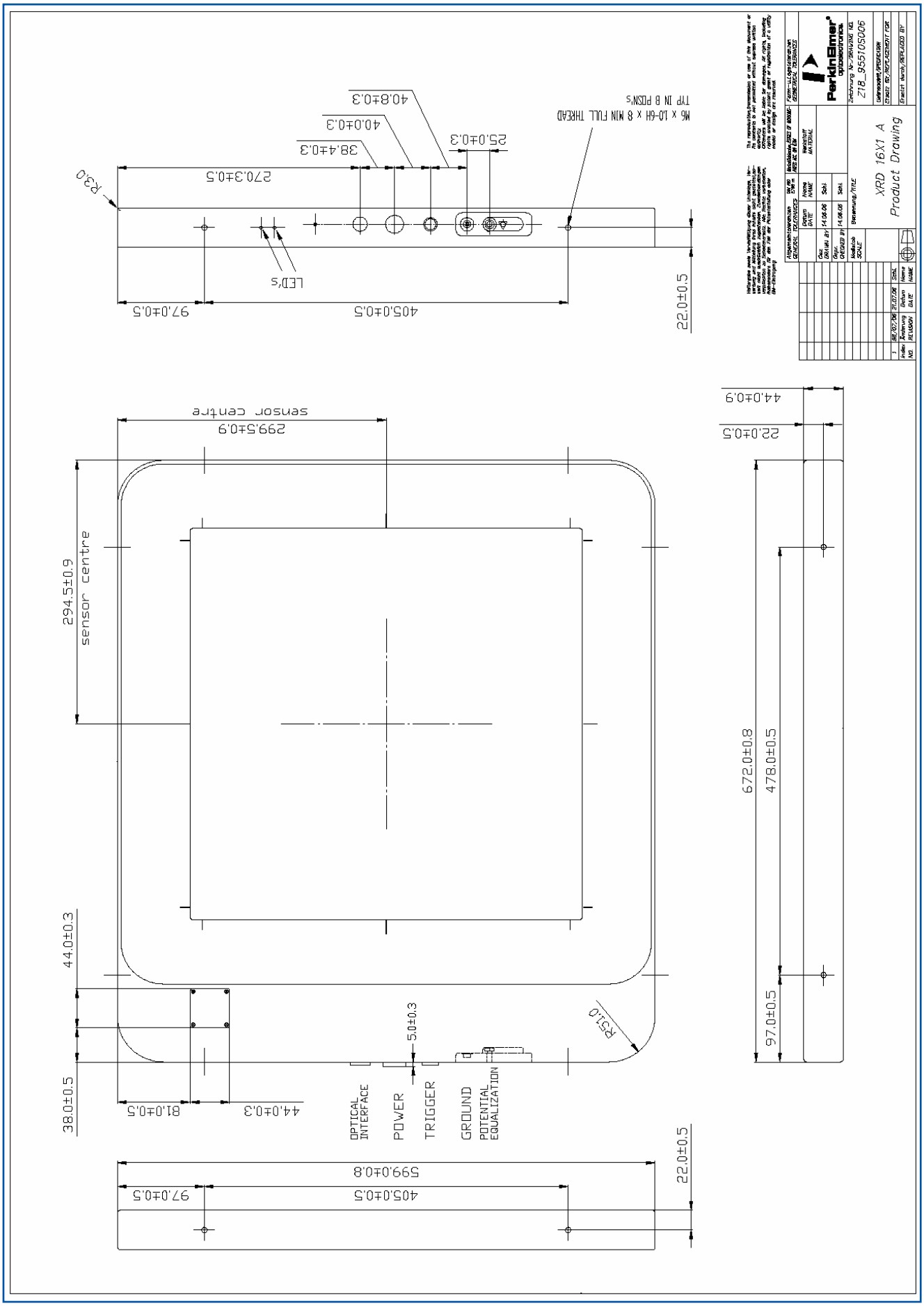


Figure 4 Mechanical drawing of the XRD 1621 xN ES

7.1.2 Readout Specification

Sensor:	
Total pixel number	2048 x 2048
Active pixel number	2024 x 2024
Pitch	200 µm 400 µm with 2x2 Binning
Total area	409.6 x 409,6 mm^2
Electronics:	
Charge amplifier	32 x 128 channel ASIC
ADC	16bit, 2MSps
Gain:	0.25pF, 0.5pF, 1pF, 2pF, 4pF, 4pF, 8pF
Integration time (minimum)	66.6 ms @ 200µm 33.2 ms @ 400µm (2x2 Binning)
Detector:	
Dynamic range*[1]	> 88 dB
Maximum frame rate	15 fps @ 200µm 30 fps @ 400µm (2x2 Binning)
Szintillator Optional	Gd_2O_2S:Tb CsI:Tl (direct deposition on aSi photodiodes)
Radiation energy*[2]	40 keV – 15 MeV (A-Housing) 20 keV – 15MeV (C-Housing)

*[1]Readout Specification accomplished at max. frame rate, 200µm, 4pF capacitor and all image corrections applied
*[2]Returned detectors to PerkinElmer Inc. shall have activation less than 0.2µSv/h

Table 6 Readout Specification

7.1.3 Environmental Considerations

Environmental Conditions outside the specification below may cause fire, electrical shock, reduce the lifetime and may irreparably damage the Product.

	Transportation / Storage*[1]	**Operation**
Ambient temperature (30d / 365d)	-10° to +55°C*[2] / 0° to +50°C *[2]	+15° to +35°C
Relative humidity*[3]	5% to 90%	30% to 70%
Atmospheric pressure	700 to 1250 hPa	800 to 1250 hPa
Vibration*[4] (EN60068-2-6)	2g (10 Hz to 150 Hz)	0.5g (10Hz to 150Hz)
Shock*[4] (EN 60068-2-27)	20g (duration 11 ms)	2g (duration 11ms)

Note:
*[1] In original transport container for 365 days
*[2] Temp. Gradient: max 4.5 K/hour
*[3] No condensation
*[4] Image quality cannot be guarantied

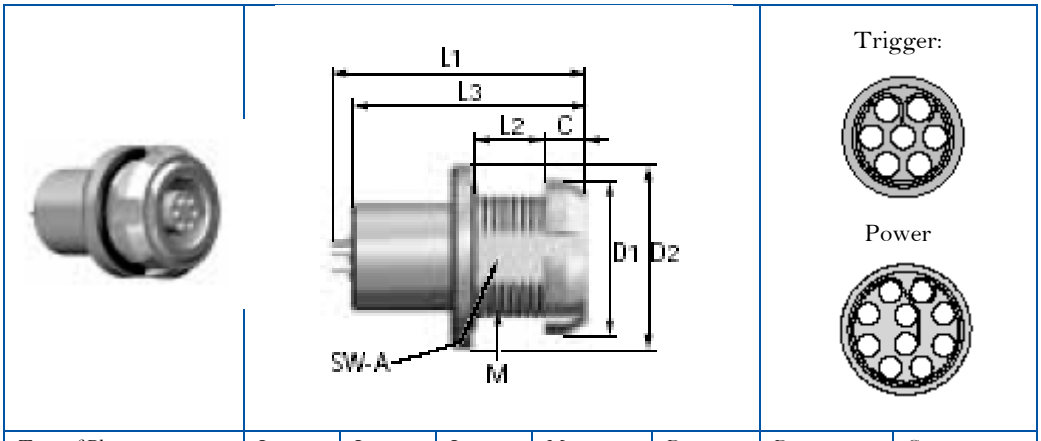
Table 7 Environmental Considerations

7.1.4 Connectors of the XRD 1621 xN ES

One edge of the housing contains the connectors for the XRD Interface Bus, the power supply XRD-EP, the housing ground and the trigger input.

Trigger input: ODU Series G8B1 (Male)

Power supply: ODU Series G83B (Male)



Type of Plug	L1	L2	L3	M	D1	D2	C
Trigger	26	4	22.5	14x1	18	4	12
Power	33	6	26.5	20x1	25	26	6

Figure 5 Drawing of the connectors for Power and Trigger (front view, female)

PIN	Colour	Connection
1	Black	TRIGIN_+
2	Brown	TRIG_IN_-
3	Red	TRIGOUT_+
4	Orange	TRIGOUT_-
5	Yellow	FGND
6	Blue	5PF
7	Magenta	

Table 8 PIN assignment of Trigger signal (LVDS Signals)

7.2 Detector Acquisition Modes

The detector can acquire images in a "Free Running" mode or in a "Trigger" Mode. In addition there are three different modes of triggering called: "External Trigger", "Software Trigger" and "Internal Trigger".

- The free running mode means that the detector sends out frames continuously.
- The external triggered mode means that the detector is synchronized by an external trigger source. The detector ignores all other incoming trigger pulses until the selected frame time has elapsed. After that the detector can be triggered by a new pulse.
- The internal triggered mode means that each frame time can be selected between the free running timing and 5 seconds. This mode is a combination of the free running and the external trigger modes.
- The Software triggered mode means that the detector is synchronized by a trigger pulse which is initiated by the Application Software. The detector ignores all other incoming trigger pulses until the selected frame time has elapsed. After that the detector can be triggered by a new pulse.

7.2.1 Trigger Modes

Triggering the detector attempts to synchronize the detector to other devices e.g. X-ray sources having specific schemes of radiating X-ray pulses. If there is no synchronization between e.g. pulsed X-ray source and the detector image artifacts can occur which are not correctable.
The **XRD 1621 xN ES** detector family supports different trigger methods like frame-wise and data delivered on demand triggered mode. Depending on the selected trigger method the detector finishes the regime of the selected method, like readout of the complete frame (frame-wise) until accepting a new trigger pulse. If a trigger signal is sent during the regime, it is ignored and the trigger lost flag will be set in the image header.
If no trigger signals are applied from external source or Software to the detector in a frame time of 20s, the detector will go into an idle mode. To reset the detector into trigger mode, a new trigger signal has to be sent. After this, the detector is ready for the next trigger pulses.

7.2.1.1 External Trigger

The external triggered mode means that the detector is synchronized by an external pulse.
The detector requires a 20 µs wide low active trigger pulse (TTL-signal) to be transmitted to the device. The trigger signal has to be generated externally and can then be connected to the 7-pin round connector, (/TRIG_IN) located directly at the detector device. Prior to this, the detector has to be set by command into the external trigger mode. The period of the trigger waveform determines the frame time. The /TRIG_OUT signal indicates the start of a new frame and can be used to synchronize the X-ray source.

7.2.1.2 Internal Trigger

The internal trigger mode combines the advantages of the free running mode and the external trigger mode with all different trigger modes. The detector is synchronized by itself (self-triggering) and the frame time can be selected between the fastest free running mode T0 and 5 seconds, in steps of 1 ms.

7.2.1.3 Software Trigger

The Software trigger mode works in the same way as the external trigger mode and supports all trigger methods. This means that the detector is synchronized by a software function and the trigger signal is generated by the detector itself.

7.2.2 Trigger Methods

7.2.2.1 Frame-wise (default) readout

The frame wise trigger readout regime is the default and most general one. Once the detector has been set to trigger mode the detector will synchronize to trigger events and perform a complete frame scan. The frame wise trigger method allows the operator to take control of the integration time of the detector. Trigger events during the scan process are ignored and the trigger lost flag will be set. Thus, the shortest possible frame time is equivalent to the frame time of the fastest mode in free running T0.

7.2.2.2 Data Delivered on Demand (D^3) triggered mode

The Date Delivered on Demand (D^3) triggered method is recommended for applications where single shots at a precise time or image sequences with longer interrupts have to be performed. This mode has the option to define the exposure time (no active scan) between zero and 4048ms. The default time in this mode is 400ms. The complete frame time is the selected Timing T0, T1..T7 plus the selected exposure time.

The regime of D^3 mode is shown in Figure 6 and works in the following way: The detector is running in a "silent" mode, like free running mode but without transferring image data. If the user application (external, internal or software trigger) sends a triggers signal to the detector, the detector accomplishes the current frame. The next frame (clearance scan) is processed also with the fastest integration time. After that the detector waits until a customer defined time has elapsed (delay time). During this time the detector shall be exposed in case of pulsed or shuttered radiation. When this time has elapsed the detector performs the image scan and transfers the desired data. After this the detector returns to the silent mode until the next trigger pulse is sent.
Note:
If desired, the clearance scan can be skipped (see XIS Reference Manual).

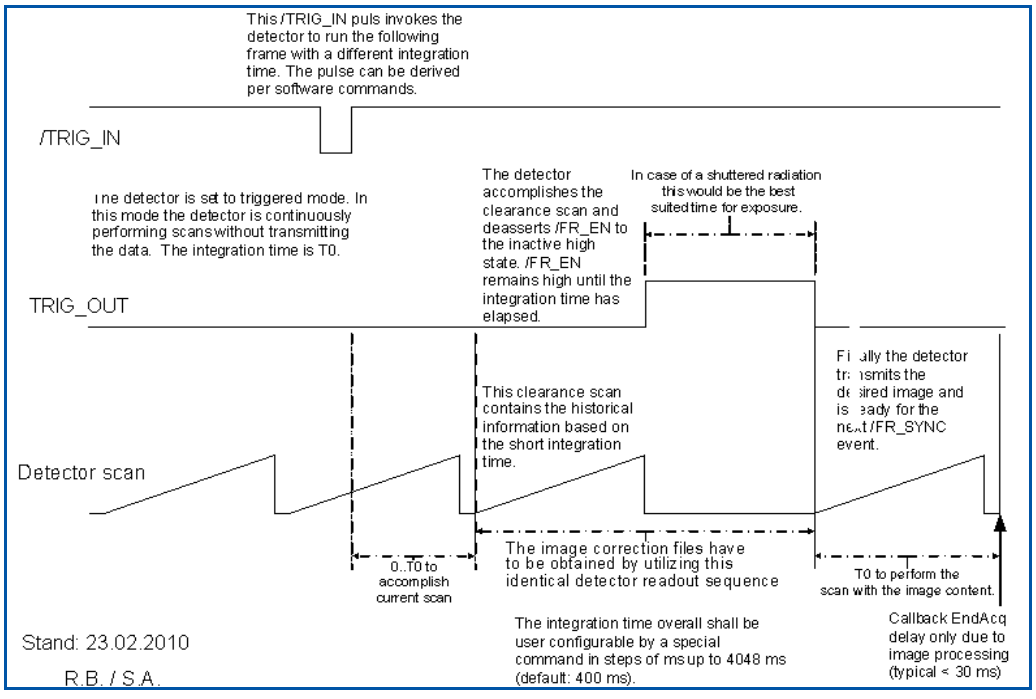


Figure 6 Timing diagram for 'Data Delivered on Demand' triggered regime

7.2.3 Trig Out Options

The **XRD 1621 xN ES** supports different trigger output signals at the trigger connector. These trigger output signals can be modified to perform an optimum synchronization between the detector and other devices e.g. x-ray sources having specific schemes of radiating x-ray pulses. The following trigger output options are available and are described in detail in the X-Ray Imaging Software manual.

- Exposure Pulse Width (FRM_EN_PWM)
- Defined Exposure Pulse in a Sequence (EP)
- Data Delivered on Demand Pulse
- Constant Ground (GND)
- Constant High (VCC)

7.2.4 Examples of the trigger modes

Once the **XRD 1621 xN ES** detector is powered up, it starts in the free running acquisition mode in Timing mode T0, which is in most cases the fastest frame rate of the detector. When the detector is set to one of the trigger modes it is waiting for the next trigger signal to transmit the data to the computer. **XRD 1621 xN ES** has a time out of 20s if no trigger signals are applied and will go into an idle mode. To reset the detector into trigger mode, a new trigger signal has to be sent. After this, the detector is ready for the next trigger pulses.
A detailed description of the software implementation can be found in the XIS reference Manual.

7.2.4.1 How to use the internal trigger mode

The following method describes how the internal trigger can be used to implement customized frame times:

1) The detector is set to the internal trigger mode using the Detector Mode menu
   XISL:
   Acquisition_SetFrameSyncMode(*hAcqDesc*,HIS_SYNCMODE_INTERNAL_TIMER).
   -> The detector aborts the current frame and waits for a trigger signal.
   -> The shortest repeat time of a trigger pulse is the selected timing (readout time).
2) Select the frame rate (readout plus delay time) in the appearing dialog (T0 … 5s)
   XISL: Acquisition_SetTimerSync(*hAcqDesc*, *frame_rate*).
3) The detector is running in its self-triggered mode in the selected frame rate.
   -> The detector runs "continuously" with the selected frame rate.
4) Start the acquisition
   XISL: Acquisition_AquireImage(*hAcqDesc*, *frames*, …)
   -> The data are transferred via Ethernet to the computer

7.2.4.2 How to use the (D^3) regime with the Software Trigger Mode

The following method describes how the (D^3) regime and the Software trigger can be implemented. The detector starts in the first timing and in free running mode when the power is switched on.

1) The detector is set to the (D^3) triggered method using the Detector Options menu
   XISL: Acquisition_SetCameraTriggerMode (hAcqDesc,1)
   -> The detector runs continuously (silence mode) in the fastest frame rate.
2) The delay time of the (D^3) regime is set in the detector option menu.
   XISL: Acquisition_SetFrameSyncTimeMode(hAcqDesc,0,1000);
   -> The delay time is set to 1000 ms
3) The detector is set to the Software trigger mode using the Detector Mode menu
   XISL: Acquisition_SetFrameSyncMode(*hAcqDesc*,
   HIS_SYNCMODE_SOFT_TRIGGER).
   -> The detector aborts the current frame and waits for a trigger signal.
   -> The shortest repeat time of a trigger pulse is the selected timing (readout time).

4) Start the acquisition
XISL: Acquisition_AquireImage(*hAcqDesc*, *frames*, …)
5) Call the SoftTrigger in the Acquisition menu
XISL: Acquisition_SetFrameSync(hAcqDesc);
-> The data are transferred via Ethernet to the computer.

7.3 How to use the detector gain setting

This paragraph describes how to change the detector gain setting. The **XRD 1621 xN ES** detector supports 6 different gain settings respectively (Table 9). The detector is starting with the 1pF capacity when it is powered on. The detector gain will be set bitwise by the **XIS** dialog **Options/Detector Options** or by the library function Acquisition_SetCameraGain(*hAcqDesc*, *wGain)*. The Table 9 gives an overview of the gain settings. It is very important for the image quality that the correction files are obtained in the same gain setting as in the current working operating mode.

Selected Value	Capacity
0	0.25 pF
1	0.5 pF
2	1 pF
3	2 pF
4	4 pF
5	8 pF

Table 9 Overview of the Detector Gain Settings

7.4 How to use the detector binning setting

This paragraph describes the detector binning modes. The **XRD 1621 xN ES** detector series supports different binning modes. When the detector is powered on, it runs without binning (default mode). The detector binning will be set by the **XIS** dialog **Options/Detector Options** or by the library function Acquisition_SetCameraBinningMode(..). The following table describes the different binning modes. It is very important for the image quality that the correction files are obtained in the same binning mode, gain setting and integration time as for the measurements.

Active bits	Value	Binning mode
0	1	No binning
1	2	2 x 2 binning
8	256	Averaged binning (2 x 2)
9	512	Accumulated binning (2 x 2)

Table 10 Overview of the detector binning modes

7.4.1 Sorting schemes overview

The XISL sorts the data in an internal buffer with highly optimized routines written in machine code. Figure 7 shows the read out scheme of the **XRD 1621** sensor.

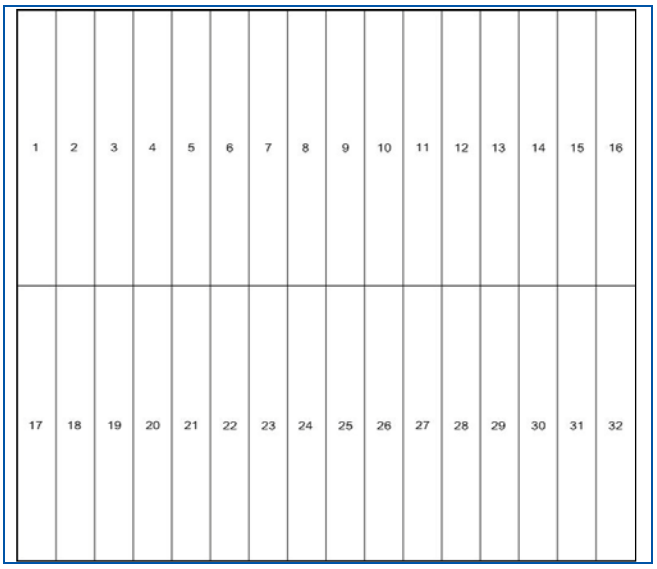


Figure 7 Sorting scheme of the XRD 1621

The sensor is divided into an upper and a lower part. Both sections are electrically separated. The data of each section is transferred by 32 "read out groups" (ROG). Each ROG has 128 channels for the detector. The upper groups scan the sensor columns from left to right. The lower groups scan from right to left. The upper groups are transferred first, followed by the lower groups. The upper groups start read out from the upper row. The lower groups start read out from the last row.
The following Table 11 displays the data stream for **XRD 1621**:

data stream no.	sensor pixel (row, column)	ROG no.
1	(1,1)	1
2	(1,129)	2
3	(1,257)	3
4	(1,385)	4
5	(1,513)	5
6	…	
15	(1,1793)	15
16	(1,1921)	16
17	(2048, 128)	18
18	(2048, 256)	17
19	(2048, 384)	20
20	(2048, 512)	19
…	…	…

Table 11 Sorting scheme of the XRD 1621

7.5 Accessories

For safety reasons, the **XRD 1621 xN ES** shall only be used with the **XRD EPS** power supply and its approved OEM cables and connectors. All regulatory certificates and warranty terms are rendered void if any modification and/or alteration to the Product is made, or any portion thereof, without the prior written authorization of PerkinElmer

PerkinElmer Art. No.	Description
95510354H	Power Supply XRD-EPS 215W (indoor & outdoor usage)
95510581H	XRD-EPS DC Cable 25FT / 7.6M
95510582H	XRD-EPS DC Cable 50 FT / 15,25M
95510583H	XRD-EPS DC Cable 100 FT / 30.5 M
95510331H	XRD-EP AC Cable EP – Germany
95510332H	XRD-EP AC Cable EP – US*
95510333H	XRD-EP AC Cable EP – JP
95510334H	XRD-EP AC Cable EP – UK
95510336H	XRD-EP AC Cable EP – IEC
95510544H	XRD-EP AC Cable EP – CN
95510592H	LVDS Trigger Cable 7.6m/25ft
95510593H	LVDS Trigger Cable 15,25m/50ft
95510594H	LVDS Trigger Cable 30,5m/100ft
95510595H	LVDS Trigger Cable 91,5m/300ft
95510598H	Trigger Adapter TTL to LVDS-Detector
95510215H	PCI-X Interface Frame Grabber XRD-FGX Opto
95510216H	PCI-Express Interface Frame Grabber XRD-FGE Opto
95510570	XRD-FGX Optical PC Connection Cable 7.6m/25ft
95510571	XRD-FGX Optical Extension Cable 7.6m/25ft
95510572	XRD-FGX Optical Extension Cable 15.25m/50ft
95510573	XRD-FGX Optical Extension Cable 30.5m/100ft
95510574	XRD-FGX Optical Extension Cable 91.5m/300ft

*mains plug has a Hospital Grade; 125 VAC / 13 A and VCT is required

Table 12 Accessories for the XRD 1621 xN ES

7.6 Power supply XRD EPS

The enhanced power supply **XRD EPS** is a stand-alone unit designed to support the **XRD 1621 xN ES** series detectors for indoor and outdoor usage. The power supply belongs to the protection class I and supports 100 V to 240 V at 50/60 Hz. An LED Display indicates the status of the device. In case of "overload", the power supply must be switched off and can be switched on after a few minutes. To isolate the equipment electrically from supply mains on all poles simultaneously, the supply mains switch has to be used. The required potential equalization has to be managed through the labeled connector at the power supply.

Figure 8 Image of the Power Supply XRD-EPS

Specifications	
Physical Dimension (L,W,H)*	250 mm x 83 mm x 127 mm
Weight	3.1 kg
Input	100 V – 240 V AC 50/60 Hz 2,7 - 1.1 A max; 215 W
Output	5,4 V / 5 A DC 12,5 V / 10 A DC -12,5 V / 5 A DC
Internal Fuse	6.3 Ampere / 250 Volts
Protection Class	⏚ protection class I

*without handle

Table 13 Electrical and Mechanical Specification of the XRD-EPS

Light	**Status**
Overload	The Power Supply is overloaded. The power Supply has to be switched OFF.
DC-Output	The DC-Output is ON.

Table 14 Status Lights of the XRD-EPS

	Transportation / Storage	**Operation**
Ambient temperature	-10° to +70°C	+0° to +70°C Derating > 40°C: 2.5%/K
Relative humidity	5% to 90%	5% to 90%

Note: No condensation

Table 15 Environmental Considerations for the Power Supply XRD-EPS

7.7 Frame Grabber Board

The **XRD 1621 xN ES** can be directly operated by the PCI-X Frame Grabber **XRD-FGX Opto** or the PCIe Frame Grabber **XRD-FGE Opto** over the **XRD Fibre Optical Interface Bus**. Both Frame Grabbers utilizes direct image acquisition into the PC's main memory and detector control functions. Main memory is used as a flexible frame buffer of virtual size. The XISL (X-Ray Imaging Software Library) integrates the frame grabber drivers for Microsoft Windows®XP, Vista and Windows®7 and is used to set internal DLL parameters to drive and read-out the **XRD 1621 xN ES** detectors (Table 20).

7.7.1 The optical Interface boards XRD FGX Opto and XRD FGE Opto

The **XRD-FGX Opto** designed for the PCI-X bus and the **XRD-FGE Opto** for the PCI-Express bus with 4 Lanes. The **Opto** frame grabbers contain sophisticated bus-master DMA controllers for data transfer into memory, using scatter-gather DMA for linear storage even of image sequences. The **XRD-FGX Opto** and **XRD-FGE Opto** provide a FPGAs and 256 MB RAM to perform on-board corrections including Multiple Gain Correction at 10 signal levels. The optical interface provides the advantage of synchronization between the detector and x-ray source or manipulator by using an external trigger signal or by using the internal trigger function of the frame grabber (Table 18).

Figure 9 Images of the optical Frame Grabbers a) XRD-FGX Opto and b) XRD FGE Opto

Specifications	XRD-FGX	XRD-FGe
Physical Dimension	195 mm x 107 mm	195 mm x 107 mm
PCI-X Compliant	PCI–X 2.0	PCIe 2.0
PCI-Bus	133 MHz / 64 Bit	4-Lane
Memory	256 MB	256 MB
Operation System	Windows™ XP Professional (32bit)	Windows™ XP Professional (32bit), Vista (32bit/64bit), Win 7 (32bit/64bit)

Table 16 Specification of XRD FGX Opto and XRD FGE Opto

	Transportation / Storage	Operation
Ambient temperature	-10° to +60°C	+0° to +40°C (2 m/s forced air cooling)
Relative humidity	5% to 90%	5% to 80%

Note: No condensation

Table 17 Environmental Considerations for the optical Frame Grabber

7.7.2 Connectors of the Frame Grabber

The connectors of the Frame Grabber interface boards link the **XRD 1621 xN ES** detector to the personal computer. The fibre optical connector on the module can be used to plug in the Interface cable. The module allows data acquisition via the fibre optical interface, detector mode control via the serial configuration bus and generation of external triggering.

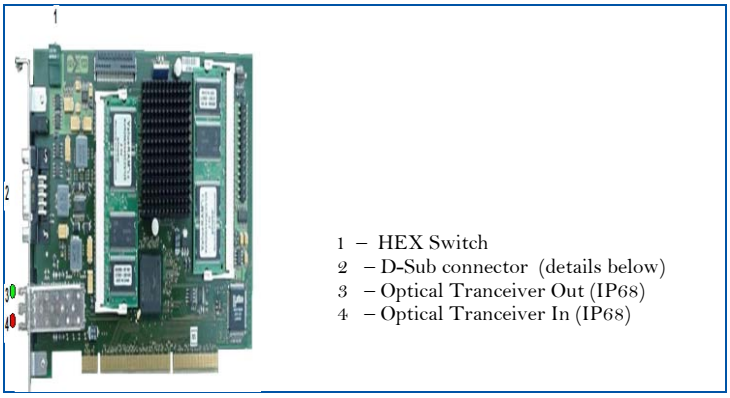


Figure 10 Connectors of the Optical Frame Grabbers

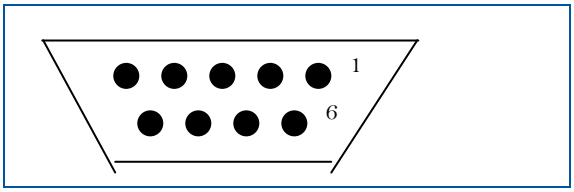


Figure 11 D-Sub connector front view:

PIN	DESCRIPTION	
1	GP_OUT0+	frame enable
2	GP_OUT1+	frame sync
3	GP_IN0+	trigger in
4	GP_IN1+	na
5	GND	
6	GP_OUT0-	frame enable
7	GP_OUT1-	frame sync
8	GP_IN0-	trigger in
9	GP_IN1-	na

Table 18 Frame Grabber D-Sub connector description

7.7.3 Installation of the Frame Grabber

To install the frame grabber the computer should be shut down, and the power supply unplugged. Failure to do so may cause severe damage to both the motherboard and frame grabber. In most cases the mainboard has an onboard LED which shows the power OFF mode or the soft-off mode (Power is still on). Hold the grabber by the edges and do not to touch the chips, leads or connectors. Please place the frame grabber on a grounded antistatic pad whenever the grabbers are separated from the system.
An exclusive IRQ port should be used, please consult the mainboard manual provided by the PC manufacture for more information. If more than one frame grabber has to be used in the system the switch on the left side of the grabber must be set to a unique number for every board.
Please read the readme.txt on the installation CD for the latest information before installing the frame grabber driver and the application software.

7.7.3.1 Hardware Installation

1) Shut down the computer
2) Unplug the power supply and remove the computer system cover
3) Turn the switch of the grabber to a unique number for every board
4) Carefully align the frame grabber's connectors and press firmly
5) Secure the card(s) on the slot with the screw
6) Replace the computer system's cover
7) Restart the computer system
8) Log on to Windows using the administrator account

7.7.3.2 Installation of the driver on Windows®XP, Vista, Win7

1) After LOG ON the Hardware Wizard notice the new frame grabber as an multimedia device
2) Plug in the XIS Installation CD-ROM
3) Follow the wizard to install the **XRD-FGX Opto / XRD-FGE Opto** as a new device
4) After installation of the **XRD-FGX Opto / XRD-FGE Opto** and XISL drivers by the Wizard start the XIS setup from the appearing menu or if the Setup does not start automatically start the START.EXE in the root directory of the CD
5) The XIS SETUP program will lead you through the installation process
6) Restart the computer system
7) The XIS is now ready to start
8) If the initialization of the frame grabber and the detector is successful if a corresponding message appears in the status bar.

7.7.4 Optical Interface

The robust glass fibre optical interface provides galvanic isolation between detector and frame grabber and IP68 proofed plugs at the detector side and on both sides of the extension cable. Up to four frame grabbers, each using its own detector can be connected to one PC.

Optical Interface Specification	
Bending radius:	
Dynamic	105 mm
Static:	70 mm
Traction:	
Temporary:	2000 N
Long-term::	800 N
Lateral Pressure Resistance:	
Temporary:	2500 N/dm
Long-term:	1000 N/dm
Cable Weight	approx. 55kg/km
Temperature:	
Transport and Storage	- 25°C to + 70°C
Laying:	- 5°C to + 50°C
Operation:	- 5°C to + 50°C

Table 19 Optical Interface Specification

7.8 X-Ray Imaging Software Library (XISL)

The **X**-Ray **I**maging **S**oftware **L**ibrary (**XISL**) allows implementation and use of all required detector functions into specific image acquisition and processing software programs. The list below describes a selection of important software functions of the Software Development Kit (SDK). The functions can be easily integrated in any modular programmed software. Their specific use is described in the XIS Reference Book.

Group	Function Name	Description
Init	**Acquisition Descriptor**	Basic structure for data acquisition used by XISL.
	Acquisition_EnumSensors	Enumerates all connected sensors
	Acquisition_GetNextSensor	Iterates through all recognized sensors.
	Acquisition_Init	Initializes driver and frame grabber.
	Acquisition_GetConfiguration	Retrieves the current configuration setting of the XISL.
	Acquisition_GetIntTimes	Routine to detect the actual frame time automatically.
	Acquisition_GetHwHeaderInfo	Returns the contents of the detector's hardware header in an info structure.
	Acquisition_GetHwHeaderInfoEx	Acquire Header and Extended Header if available
	Acquisition_Close	Closes driver and hardware of the specified camera.
Init GbIF	**Acquisition_GbIF_Init**	Initializes driver and GbIF device.
	Acquisition_GbIF_GetDeviceCnt	Retrieves the number of GBIF devices found by network broadcast
	Acquisition_GbIF_GetDeviceList	Retrieves additional info for each found device
	Acquisition_GbIF_GetDevice	Retrieves single devices by MAC-Address, IP-Address or device name
	Acquisition_GbIF_GetDeviceParams	Retrieves device-parameters of a GigE Detector
	Acquisition_GbIF_SetConnectionSettings	Set boot parameter of network connection
	Acquisition_GbIF_GetConnectionSettings	Retrieves boot parameter of network connection
	Acquisition_GbIF_SetPacketDelay	Set Inter-Packet Delay value
	Acquisition_GbIF_GetPacketDelay	Retrieves Inter-Packet Delay value
	Acquisition_GbIF_ForceIP	Assign temporary IP for initial connection
	Acquisition_GbIF_GetDetectorProperties	Retrieves the detector production data
Acquire / correct	**Acquisition_Acquire_Image**	Acquires images from the detector.
	Acquisition_Acquire_GainImage	Acquires a gain correction image.
	Acquisition_Acquire_OffsetImage	Acquires an offset correction image.
	Acquisition_DoOffsetCorrection	Performs an offset correction on an acquired image.
	Acquisition_DoGainCorrection	Performs a gain correction on an acquired image.
	Acquisition_DoOffsetGainCorrection	Performs offset and gain correction on an acquired image.
	Acquisition_DoPixelCorrection	Performs a pixel correction on an acquired image.
	Acquisition_DefineDestBuffers	Definition of the destination buffers for image capturing.
	Acquisition_CreatePixelMap	Creates a list for a mean correction of defective pixels.
	Acquisition_GetLatestFrameHeader	Retrieve Last Frame Header and Extended Header if available
	Acquisition_Acquire_Image_PreloadCorr	Acquire Image w/o setting correction data
	Acquisition_Acquire_GainImage_ PreloadCorr	Acquire Gain Image w/o setting correction data
	Acquisition_Acquire_OffsetImage_ PreloadCorr	Acquire Offset Image w/o setting correction data
	Acquisition_ Acquire_GainImage_EX_ROI	Acquire Gain Image with defined Region of interest
	Acquisition_Acquire_GainImage_Ex_ ROI_PreloadCorr	Acquire Gain Image (ROI) w/o setting correction data
	Acquisition_IsAcquiringData	Checks if an Acquisition Thread is running sensor is about to acquire data.
	Acquisition_CreateGainMap	Create a List of Median values for the Gain-Sequence correction
	Acquisition_Acquire_Image_Ex	Acquires images from the detector.
	Acquisition_SetCorrData_Ex	This function switches the correction buffers during a running acquisition.
	Acquisition_GetCorrData_Ex	This function retrieves the correction buffers during a running acquisition
	Acquisition_DoOffsetGainCorrection_Ex	Performs offset and gain-sequence correction on an acquired image.
	Acquisition_SetAcqData	Sets a 32 bit value / pointer that can be extracted by Acqusition_GetAcqData during acquisition time.
	Acquisition_Abort	Aborts a running acquisition.
	Acquisition_AbortCurrentFrame	Aborts the transmission of the current frame and immediately starts a new transfer.
Detector settings	**Acquisition_SetCameraMode**	Allows setting of detector frame time.
	Acquisition_SetCameraGain	Set Detector Gain (not available for all detectors)
	Acquisition_SetCameraBinningMode	Set binning Mode (not available for all detectors)

	Acquisition_GetCameraBinningMode	Retrieve actual binning Mode.
	Acquisition_SetCameraTriggerMode	Set trigger Mode (not available for all detectors)
	Acquisition_GetCameraTriggerMode	Retrieve actual trigger Mode.
	Acquisition_ResetFrameCnt	Reset detector Frame counter (not for all detectors)
	Acquisition_SetFrameSyncTimeMode	Set Parameters for 'Data Delivered on Demand' trigger mode
	Acquisition_SetTimerSync	Set Internal Trigger Time
	Acquisition_SetTriggerOutSignalOptions	This function defines the behavior of the '/TrigOut' - signal of the detector trigger connector
	Acquisition_SetCameraROI	This function enables a selectable Regions of Interest for Readout
	Acquisition_GetCameraROI	This function returns the current activated Region of Interest for Readout
	Acquisition_ActivateServiceMode	This function activates the Service Mode
CallBack	**Acquisition_GetReady**	Informs the user if image processing is flagged as ready.
	Acquisition_SetReady	Informs the XISL that the user image processing is ready.
	Acquisition_IsAcquiringData	Checks if an Acquisition Thread is running
	Acquisition_GetWinHandle	Returns the handle of the current acquisition window.
	Acquisition_GetAcqData	Extracts a 32 bit value / pointer at acquisition time that was set by Acqusition_SetAcqData.
	Acquisition_GetActFrame	Retrieves the nr of the current frame in the ring buffer.
Error Handling	**Acquisition_GetErrorCode**	Returns extended information if an error occurred.

Table 20 List of XISL modules

7.9 Description of Hardware Header

The Hardware Header is transferred at the beginning of each frame. Table 21 shows the structure of the header, where BYTE is an unsigned character, USHORT an unsigned 16 bit integer. HeaderID is the type of the header and if this number is zero then the whole hardware header is invalid.

WORD	**wHeaderID**	**identifies the used header version (>=14)**
WORD	**wPROMID**	**identifies the detector's PROM set**
WORD	**wResolutionX**	**detectors pixel resolution in x direction**
WORD	**wResolutionY**	**detectors pixel resolution in y direction**
WORD	**wNrRows**	**number of sensor rows**
WORD	**wNrColumns**	**number of sensor columns**
WORD	**wZoomULRow**	**row of the upper left edge of zoom region**
WORD	**wZoomULColumn**	**column of the upper left edge of zoom region**
WORD	**wZoomBRRow**	**row of bottom right edge of zoom region**
WORD	**wZoomBRColumn**	**column of bottom right edge of zoom region**
WORD	**wFrmNrRows**	**Number of rows that are used to synthesize the frame scheme of the detector. It results from the number of sensor rows plus the number of rows in which the sensor only integrates charge but doesn't transfer data to the frame grabber.**
WORD	**wFrmRowType**	**Identifies the implemented Row scheme**
WORD	**wRowTime**	**detector row time in 32MHz Ticks (6bit shifted to the left)**
WORD	**wClock**	**detector row time in MHz (6bit shifted to the left)**
WORD	**wDataSorting**	**see sorting**
WORD	**wTiming;**	**selected integration time**
WORD	**wGain;**	**Selected detector gain**
WORD	**wLeakRows;**	**Number of rows without driven gates**
WORD	**wAccess;**	**Access mode**
WORD	**wBias;**	**selected detector Bias mode**
WORD	**wUgComp;**	**selected detector compensation**
WORD	**wCameratype;**	**Detector type (1 support Binning, 2 supports Binning and special TriggerModes)**
WORD	**wFrameCnt;**	**Internal Frame counter of the detector**
WORD	**wBinningMode;**	**selected detector binning mode (Chapter 6.3)**
WORD	**wRealInttime_milliSec;**	**measured integration time of actual frame (millisec)**
WORD	**wRealInttime_microSec;**	**measured integration time of actual frame (millisec)**
WORD	**wStatus;**	**detector status word:** **Bit 0: 0 - OK 1 – Trigger lost** **Bit 1-3 Trigger mode : Value** **0: Data Delivered on Demand** **1: Data Delivered on Demand with clearance scan** **2: reserved** **3: Frame wise (default)** **Bit 4: reserved** **Bit 5: DAC Error Code Bit 0**

		Bit 6: DAC Error Code Bit 1 **Bit 7: DAC Error Code Bit 2** **Bit 8: Trigger Switch Current Setting 0 internal / 1 external**

Table 21 Image Header of the XRD 1621 xN ES

7.10 Description of file header

The file header allows the use of specific information which can be implemented into any software.

Information	Description
File header	68 byte
WORD FileType	File ID (0x700)
WORD HeaderSize	Size of this file header in bytes
WORD HeaderVersion	yy.y
ULONG FileSize	Size of the whole file in bytes
WORD ImageHeaderSize	Size of the image header in bytes
WORD ULX, ULY, BRX, BRY	bounding rectangle of the image
WORD NrOfFrames	Number of Frames
WORD Correction	0 = none, 1 = Offset, 2 = Offset+Gain
Double IntegrationTime	frame time in microseconds
WORD TypeOfNumbers	frame time in milliseconds
WORD TypeOfNumbers	short, long integer, float, signed/unsigned, inverted, fault map, Offset/Gain correction data, bad pixel correction data
BYTE x[WINRESTSIZE]	fill up to 68 byte

Table 22 File header description

8 Operational Functions

8.1 Getting Started - The first image

8.1.1 Introduction

This chapter describes the procedure necessary to obtain initial X-ray images. It explains how correction files are used with appropriate settings of the detector integration time and X-ray source parameters. In this example the Demo Software XIS is used to describe the mechanism. The XIS is intended to be used for demonstration purposes only and should not to be used for standard detector operation. Detailed information about the XIS and the XISL are provided in the XIS-Reference Book.

8.1.2 General considerations

In principal, the detector can produce images without any correction. These images contain the offset of the readout electronics, the individual offsets of each pixel (dark current) as well as the electronics and pixel gain differences, in additional to the X-ray source non-uniformities.
Each column is connected to one channel of the readout electronics with the specific channel offset resulting in a dark image with vertical stripes caused by the individual channel offsets. The dark image may also contain pixels which are brighter than the others caused by a higher dark current. The detector is arranged in groups of 128 readout channels. The groups can deviate in their gain such that one can distinguish blocks of 128 channels in a bright image caused by this gain difference. The panel itself may contain pixels and perhaps row or columns which are underperforming.
To eliminate these detector specific effects and obtain good quality results, each image will be 'offset' and 'gain' corrected, and if required, the underperforming pixels will also be corrected. The creation of the correction files is described in the chapter 'How to perform corrections'.

8.1.3 Connection of the XRD 1621 xN ES

Before starting the connection of the **XRD 1621 xN ES** ensure that the Frame Grabber driver and the X-Ray Imaging Software is installed as described in the chapter 7.7.3. If not please start with software installation. Figure 12 shows the connection of the **XRD 1621 xN ES** with the computer system and the **XRD EPS** power supply.

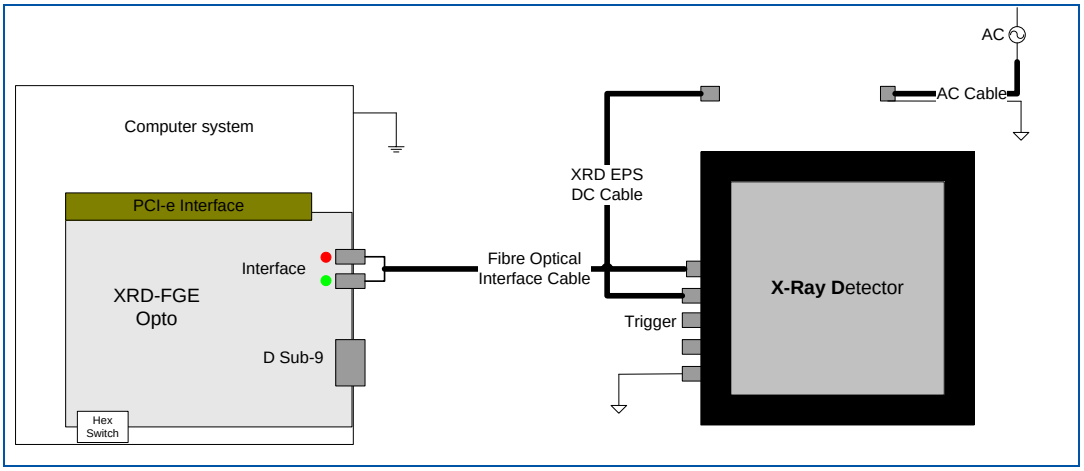


Figure 12 Connections of the XRD 1621 xN ES with the XRD EPS power supply

The computer with the monitor need to be grounded through the protection earth conductors within the power cords. For safety reasons, only original cables and connectors should be used. The socket-outlet shall be installed near the equipment and shall be easily accessible. The **XRD 1621 xN ES** should be connected with the XRD EPS as described in the following manner and as shown in Figure 12.

1) Connect the **XRD 1621** and the **XRD EPS** with potential equalization
2) **C**onnect the Computer and the **XRD 1621** via the Optical Interface Cable
3) Connect the **XRD EPS DC Cable** to the Power Connector of the **XRD 1621**
4) Connect the **XRD-EPS** and the **XRD EPS DC Cable**
5) Connect the **XRD-EPS** with the mains via **XRD EP AC Cable**[2]
6) Switch on the **Power Supply** at the supply mains switch
7) Switch on the Computer
8) Start the Application Software, e.g. XIS

8.1.4 The first image

The detector is directly connected to the host network adapter and powered on. During start of the XIS a dialog appears to select the working mode of the system. "**Yes**" enables the Interrupt Mode, "**No**" enables the Polling Mode. In both cases, the system attempts to initialize the direct connected detectors via Static IP, LLH and Frame grabbers. The "Cancel" button starts the program without initialization. The initialization can take some time depending on the number of connected detectors. If more than one detector is connected, a dialog appears that contains a list of all recognized detectors and an active detector has to be selected. All following actions correspond to that active sensor until a different one is selected.
The Acquire\Single Shot command acquires a single image. If the detector was not irradiated, only a dark image is displayed. The image can be enhanced by the brightness and contrast settings. As explained above, the uncorrected dark image contains vertical stripes caused by the electronics offset. By choosing the Continuous acquisition mode the image is refreshed on the display in the selected frame rate.
In the next step the detector should run in the continuous mode and the X-ray source should be switched on to irradiate the detector. The brightness and contrast should be set to default (F2-KEY: 0-65535). If a grey image is displayed, the parameters of the X-ray source and detector are within appropriate limits. If a white or a black image is displayed the X-ray source needs to be adjusted accordingly.

8.1.5 Stop the Operation of the Detector

To stop the detector operation, switch off the power supply switch which isolates the equipment electrically from supply mains on all poles simultaneously.
If the detector has to be disconnected, make sure that the XRD EPS power supply is switched off first. The cables have to be disconnected by the use of the connectors and not by the cable itself as stressing the cable will destroy the cable and may cause fire or electrical shock. Do not disassemble the detector system with wet hands.

8.2 How to perform corrections

After starting the XIS.EXE software, the detector is automatically initialized and provides images in the fastest setting (TIMING 0). The X-Ray Detector needs an Offset correction to account for the dark current of each pixel. Initially, during warm-up period, is measurements should not been taken since offset value may not be stable. The Warm-up of the detector takes a few minutes and can be reviewed by the stability of the offset values.
In general, a periodic refresh of the Offset Correction File is **required** during operation to meet the full performance specifications.
Additionally, a Gain correction is required to account differences in pixel sensitivities and to take into X-ray beam non-uniformities. It is therefore very important that the whole image area is illuminated homogenously. The Gain correction images should be applied under optimum dynamic range (70-80 % of the full scale range FSR) and in the dynamic ranges of interest. It is possible to use up to 10 different gain images. The use of an Offset corrected Gain calibration eliminates offset

[2] For US: Volts center tapped (VCT) is required

dependency and therefore any stored Gain correction can be used for a specific frame time for longer time periods.
The Pixel correction allows a 'software repair' of underperforming pixels to enhance image quality. Underperforming pixel values are replaced with the averaged value of the surrounding eight adjacent pixels where underperforming pixels are not used. The pixel correction is only performed on specific pixels, mapped in the file PXLMASK.HIS. Each detector is shipped from PerkinElmer with the PXLMASK.HIS file for that specific detector. The user can also generate a correction file.
Note: To fully meet all performance specifications, all corrections and the correction files must be acquired at the same readout mode, gain setting integration time and X-ray setting (e.g. energy and prefilter) as the images to be corrected

8.2.1 Use of the Offset Correction

The offset correction of images should be used to eliminate the effects of pixel dark currents on the acquired image.
To obtain an Offset correction file, the following steps are required:

1) Select the desired integration time, readout mode and gain setting.
2) Switch off the X-ray source so that the detector only transfers its "dark image".
3) Wait a few seconds until the detector achieves equilibrium.
4) Start the Get Offset Image. / Start All Offset Images.

   Select a number of frames.

   It is recommended to use between 20 to 100 frame cycles which will be averaged. The averaged image is qualified as the new Offset Image of the selected frame time and automatically linked to later acquired images.
5) Control the new acquired image using the Options/View command and/or Brightness, Contrast or Look up Table (LUT) range.
6) The Offset correction file can be saved if desired.

Note: A warning appears if the program is quit without saving new acquired Offset correction files.
The Offset correction should be repeated periodically in order to meet the full performance specifications. In particular, during the warming-up period of the system, the dark current of the pixels may change considerably.
To interrupt the procedure the <ESC> key can be used.
NOTE: If the item **Get All Offset Images** is used, step 4 is automatically performed for all available frame times. Please check the total time necessary before selecting the number of frames to avoid longer waiting periods.

8.2.2 Use of Single/Multiple Gain Correction

The Gain Correction is used to eliminate the effects of pixel sensitivities and the X-ray source on the acquired image.
To obtain a Multiple Gain Correction file the following steps are required:

1) Select the desired integration time, readout mode and gain setting
2) Acquire a new Offset correction image.
3) Switch on the X-ray source and adjust the brightness of the acquired image in the desired read out settings. The detector's acquired intensity should be in the dynamic range of the ROI. The whole image should be illuminated homogenously.
4) Start the Acquire Sequence
5) Select a number of frames and the average mode.
   20 to 100 frame cycles should be used which will be averaged.
6) Store the Offset corrected bright image
7) For Multiple Gain Correction repeat the steps 3-6 for all signal intensities of interest. Up to 10 gain images can be used for the Multi Gain Correction (MGC).

8) Create the Gain –Sequence of all Bright Images with Acquire=>Build Gain Sequence
9) Start a new acquisition.
10) Link the created Gain-Sequence file with Acquire=>Link Gain Sequence
11) Store the Gain correction file if desired.

8.2.3 Use and generation of the Pixel Correction

The Pixel Correction of images is used to eliminate the effects of underperforming pixels of the detector on acquired images.
To get a Pixel correction file the following steps have to be performed:

1) Select the desired frame time (see Timings menu).
2) Link correction files.
3) Switch on the X-ray source and start the continuous mode. The detector's acquired intensity should be about 70-80 % of its maximum signal.
4) Start an image acquisition as for the Get Gain/Offset Image (no sample in front of the detector).
5) Adjust the new acquired image by using the Options/View command and/or Brightness, Contrast or LUT range.
6) The window should show a homogenous corrected image. Intensity deviations are the result of marginal pixels.
7) Adjust the X-ray source that the detector's acquired intensity is about 30-40 % of its maximum signal.
8) Acquire an average image of 20-100 frames
9) Go to Select by Value in the Edit Menu.
10) Enter desired range of good pixels (e.g. +/- 10% around the selected grey value)
11) Select "Out of range" button. (All selected pixels are marked.)
12) Call Create Pixel Map in the Edit Menu.
13) The Pixel Map is created and can be stored as new PXLMASK.HIS.

NOTE: The new PXLMASK.HIS is automatically linked to new acquisitions and the acquired start-up image (see 4.) is also corrected.

8.2.4 Correct previously acquired images

It is possible to correct previously acquired uncorrected images by selecting the desired image by the Window Command and use one of the Link Commands (Link Offset Correction, Link Gain Correction or Link Pixel Correction). The active image is automatically corrected.
These settings are also used for the next acquisitions.

NOTE: It is not recommended to close linked correction files during a running acquisition. This can cause the application to close.

8.3 Maintenance

It is important that all correction files are regularly updated and used for image processing. In some applications it is advantageous to update the offset correction file directly before each image. Sensitivity, uniformity and noise behavior may change during aging and therefore the pixel correction files should be checked and compared regularly to determine any changes in underperforming pixels and clusters.
The power supply, the power cord, the DC cable and the data cable should be inspected periodically if there any damages.

8.4 Trouble Shooting

XISL Error 1:
If the function Acquisition_Acquire_Image returns 1, one possible reason can be the memory situation of the host system:
Please check your "boot.ini" file if the flag /3GB is set. If this is the case please remove this flag and try to acquire image data after rebooting the system.
However, if the function is not able to allocate enough memory for image acquisition (which at least is the size of the internal, 8 images comprising ring buffer) it also returns this error

No Connection to the detector:
Please ensure that the Firewall is disabled for the application or the required ports are not closed (details are described in the XIS manual)

XIS Error 2 // Eltec Error –41: Virtual device driver not present
No driver is loaded; please check if the driver for the frame grabber is loaded.

XIS Error 23: Hardware header invalid

1. Check the connections of the detector to the Computer.
2. Check if there are older libraries of an earlier installation.
3. Try the detector setup by the Option/Acquisition dialog.
   Write down the header information and contact your vendor.

9 After-Sales Service for PerkinElmer Products

Please contact your distributor for after-sales service (including warranty conditions) or any other information. In case information is not available, please contact one of PerkinElmer subsidiaries (regional service headquarters) listed below.
Field service is limited to replacement of detector, addition or replacement of approved accessories by authorized personnel. The detector and its accessories are not intended to be repaired in the field.
For product returns, please contact your distributor or PerkinElmer for shipping and packaging instructions. Please do not return products to PerkinElmer for repair or service without advance notification and include all required papers in the shipment.
If the detector or accessories have been contaminated with potentially harmful substances or activated by high energy X-rays, gamma rays or neutrons they cannot be accepted without written evidence of decontamination.

10 Disposal

This label on the product and its literature indicates that it shall not be disposed with other waste at the end of its working life. To prevent possible harm to the environment or human health from uncontrolled waste disposal, this product must be returned to PKI for disposal or properly disposed by qualified personnel in accordance with local regulatory requirements.
If the detector is activated by high energy X-rays, gamma rays or neutrons follow the local radiation protection regulation.
Please contact your supplier or distributor and check the terms of conditions of the purchase contract. This product should not mix with other commercial wastes for disposal.

11 Guidance and Manufacturer's Declaration

Guidance and Manufacturer's Declaration of Electromagnetic Emissions		
The X-Ray Detector is intended for use in the electromagnetic environment specified below. The customer or the user of the X-Ray Detector is responsible for the usage condition of the detector to be within such environment.		
Emissions test	Compliance	Electromagnetic Environment – Guidance
RF-emissions CISPR 11	Group 1	The X-Ray Detector uses RF energy only for its internal function. Therefore, its RF emissions are very low and are not likely to cause any interference in nearby electronic equipment.
RF-emissions CISPR 11	Class B	The X-Ray Detector is suitable for use in all environments.
Harmonic emissions IEC 61000-3-2	Class B	
Voltage fluctuations/ flicker emissions IEC 61000-3-3	Complies	

Table 23 Guidance and Manufacturer's Declaration of Electromagnetic Emissions

Guidance and Manufacturer's Declaration of Electromagnetic Immunity			
The X-Ray Detector is intended for use in the electromagnetic environment specified below. The customer or the user of the X-Ray Detector is responsible for the usage condition of the detector to be within such environment.			
Immunity Test	IEC 60601 Test	Compliance	Electromagnetic Environment – Guidance
Electrostatic Discharge (ESD) IEC 61000-4-2	Contact: 6 kV Air: 8 kV	Contact: 6 kV Air: 8 kV	Floors should be made of wood, concrete, or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%.
Electrical fast transients (Burst) IEC 61000-4-4	0.5 kV (AC) 1kV (DC)	0.5 kV (AC) 1kV (DC)	Mains power quality should be that of a typical commercial and/or hospital environment.
Transients-Surges IEC 61000-4-5	1 kV / 2 kV	1 kV / 2 kV	Mains power quality should be that of a typical commercial and/or hospital environment.
Power frequency magnetic field IEC 61000-4-8	3 A/m	3 A/m	Power frequency magnetic fields should be at levels characteristic of a typical location in a typical commercial and/or hospital environment.
Voltage dips and short interruptions IEC 61000-4-11	-95% / 10 ms -60% / 100 ms -30% / 500 ms >-95% / 5000 ms	-95% / 10 ms -60% / 100 ms -30% / 500ms >-95% / 5000 ms	Mains power quality should be that of a typical commercial or hospital environment. If the user of the X-Ray Detector requires continued operation during power mains interruptions, it is recommended that the X-Ray Detector be powered from an uninterruptible power supply or battery.

Table 24 Guidance and Manufacturer's Declaration of Electromagnetic Immunity

Recommended Separation Distance between Portable and Mobile RF-Communication Equipment and the X-Ray Detector			
The X-Ray Detector is intended for use in the electromagnetic environment specified below. The customer or the user of the X-Ray Detector should assure that it is used in such an environment.			
Rated Maximum Output Power of the Transmitter (W)	150 kHz to 80 MHz $d = \frac{3.5}{V_1}\sqrt{P}$	80 MHz to 800 MHz $d = \frac{3.5}{E_1}\sqrt{P}$	800 MHz to 2.5 GHz $d = \frac{7}{E_1}\sqrt{P}$
0,01	0.12	0.12	0.23
0,1	0.38	0.38	0.73
1	1.2	1.2	2.3
10	3.8	3.8	7.3
100	12	12	23
For transmitter rated at a maximum output power not listed above, the separation distance can be estimated using the equation in the corresponding column, where P is the maximum output (power rating of the transmitter in watt (W)) according to the transmitter manufacture and d as the recommended separation distance in meter (m). Note: This guideline may not apply in all situations. Electromagnetic propagation is absorption and reflection from structures, objects, and people.			

Table 25 Recommended Separation Distance between Portable and Mobile RF-Communication Equipment and the X-Ray Detector

Guidance and Manufacturer's Declaration of Electromagnetic Immunity			
The X-Ray Detector is intended for use in the electromagnetic environment specified below. The customer or the user of the X-Ray Detector should assure that it is used in such an environment.			
Immunity Test	IEC 60601 Test	Compliance	Electromagnetic Environment – Guidance
Conducted radio-frequency fields (CEF) IEC 61000-4-6	3 V 150 kHz to 80 MHz	[V_1] 3 V 150 kHz to 80 MHz	Portable and mobile RF-communication equipment should no closer to any part of the X-Ray Detector including the data cables, than the recommended separation distance calculated from the equation appropriate for the frequency of the transmitter $d = \frac{3.5}{V_1}\sqrt{P}$ $d = \frac{3.5}{E_1}\sqrt{P}$,for 80 MHz to 800 MHz $d = \frac{7}{E_1}\sqrt{P}$,for 800 MHz to 2.5 GHz Using P as the maximum output of the transmitter in watt (W) according to the transmitter manufacture and d as the recommended separation distance in meter (m).
Radiated electromagnetic field (REF) IEC 61000-4-3	3 V/m 80 MHz to 2.5 GHz	[E_1] 3 V/m 80 MHz to 2.5 GHz	Field strengths outside the shielded location from fixed RF transmitters, as determined by an electromagnetic site survey[a], should be less than 3 V/m. Interference may occur in the vicinity of equipment marked with the following symbol: 
NOTE 1 These guidelines may not apply all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people. NOTE 2 It is essential that the actual shielding effectiveness and filter attenuation of the shielded location be verified to assure that they meet the minimum specification.			
[a] Field strengths from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radios, armature radio, AM and FM radio broadcast and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the X-Ray Detector is used exceeds the applicable RF compliance level above, the XRD should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as re-orienting or relocating the X-Ray Detector.			

Table 26 Guidance and Manufacturer's Declaration of Electromagnetic Immunity (Portable Equipment)

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