

# X-ray data acquisition single & dual energy XDAS-V3 0.8 mm pitch



## 1 key features

The XDAS-V3 system is the latest version of Sens-Tech X-ray data acquisition systems. New features include:

- 16 bit A/D conversion
- SNR 36000:1
- Programmable dynamic range in steps of 1.875 pC up to 15 pC
- Gain can be set for each board in the system
- Gain for low energy and high energy channels can be set independently
- Programmable bandwidth limiting to reduce noise
- In-system programmable Xilinx FPGA
- Detectors use new back-lit silicon photodiode arrays
- Read back of all status and configuration parameters
- 50  $\mu$ s minimum scan time for continuous operation
- 10  $\mu$ s scan time for non-continuous operation
- USB 2.0 and GigE interfaces to host
- X-ray energy range 5 keV to 250 keV



## 2 description

XDAS-V3 is a modular system of boards for data acquisition in X-ray line-scan, multi-view and CT systems. It consists of detector head (DH) boards, signal processing (SP) boards and data interface board.

A single energy DH 0.8mm pitch board has 128 single energy detector channels. A dual energy system requires separate DH boards for low and high energy. Detector boards can be butted end-to-end to form a continuous array over 10 metres in length.

An optional low energy filter is used for enhanced low and high energy separation.

DH boards with 0.4 mm, 1.6 mm and 2.5 mm detector pitch are also available. See separate data sheets.

## 3 applications

- security inspection
- CT Imaging
- multi-view imaging
- non-destructive testing
- food inspection
- thickness measurement
- foreign particle detection
- bone densitometry
- industrial process control
- mineral sorting
- waste sorting

## 4 general specification

integration time (single sample)	10 $\mu$ s to 50 ms
sub-samples	1, 2 or 4
integration time (multiple samples)	200 ms (max)
SNR (electronic)	
1.875pC	11000:1
15pC	18000:1
60pC	36000:1
SNR (<30pF detector capacitance)	
1.875pC	6000:1
15pC	17000:1
60pC	34000:1
cross-talk (board to board)	<0.01%
cross-talk (channel to channel)	<0.1%
maximum read out rate	40 MB/s
non-linearity	<0.1%
A/D conversion	16 bit
data output	16 bits per pixel
detector pitch	0.8 mm
maximum number of signal processing boards	7
maximum number of data head boards	168
maximum number of channels	21504
power supply (to interface board)	9 V to 30 V, 100 mVp-p ripple
current	200 to 900 mA (typical per SP) 125 mA (typical per DH) 100 to 500 mA (per interface board)

*Interface board steps down input supply to 6V for DH boards and SP boards*

## 5 environmental specification

operating temperature	+ 5 to + 35 $^{\circ}$ C
storage temperature	-40 to +70 $^{\circ}$ C
humidity (non-condensing)	
operating	30 $^{\circ}$ C 93%
non-operating	40 $^{\circ}$ C 93%

## 6 principles of operation

See system configuration block diagrams, page 4

Current from the photodiodes is integrated by an ASIC containing 128 charge sensitive amplifiers. See detector head block diagram, section 11. Correlated double sampling is used to minimise low frequency noise and reject offset error. The microcircuit provides a multiplexed serial analogue output to the signal processing board where data is converted into 16-bit format. Operation is continuous with one set of data being read out whilst the next set is acquired. Dead time is 1.6  $\mu$ s at full bandwidth.

The dynamic range of the system is programmable for each DH board and is determined by the storage capacitors within the ASIC. These can be set from 1.25 pF to 10 pF in steps of 1.25 pF, providing charge storage of 1.875 pC to 15 pC in 1.875 pC steps. The dynamic range can be set separately for each board in a system.

A multiple sampling facility is provided on the SP board. This enables 2 or 4 samples to be added and the result stored in a 16-bit image store. This provides a maximum dynamic range of 60 pC.

The integration time can be adjusted in 1  $\mu$ s steps, enabling fine tuning of the dynamic range for high and low energy channels

The operation of the system is controlled by a gate array which provides central intelligence and control signals for signal processing. Control settings are transmitted to the SP board via a serial interface. All settings can be stored in non-volatile RAM such that on power-on, the system is initiated in the last mode saved. See signal processing block diagram, section 12.

A system is assembled by interconnecting multiple DH and SP boards and connecting to a processor via an interface adaptor board. The system data rate (host speed) is programmable from 2.5 to 40 MB/s. See system block diagram, section 13.

## 7 host data interface

Four types are available, providing the following interfaces.

1. Parallel RS485 output using up to 50 metre SCSI cable connecting to:
  - USB 2.0 remote converter adaptor
  - PCI7300 card, via an RS485 to TTL converter adaptor
2. Local USB 2.0 output connecting to:
  - laptop, PC or a single board computer
  - high speed USB 2.0 extender using fibre optic or CAT5 cable
3. Local GIGE output connecting to laptop, PC or a single board computer
  - UDP protocol
  - 1000 BASE-T Gigabit data rate
4. Channel Link
  - 2.2 Gb/s data rate
  - Interface to Active Silicon AS-PHX-D48CL-PE4 frame grabber
  - 1000 BASE-T Gigabit data rate

## 8 data acquisition rate

The signal integration time in a typical linescan application is as follows:

$$\text{Integration time (ms)} = \text{pixel width (mm)} / \text{belt speed (m/s)}.$$

The speed of operation is normally limited by the A/D sample rate. Two speeds of ADC rate are available, 3.0 MSps and 1.5 MSps.

At 3.0 MSps, conversion of one board with 128 channels takes 42.7  $\mu$ s. At 1.5 MSps, it takes 85.4  $\mu$ s. Multiple SP boards process DH boards simultaneously, permitting a shorter integration time.

$$\text{Tint (min)} = (\text{numDH} / \text{numSP}) \times 42.7 \mu\text{s}$$

A shorter integration time setting will switch electronics to a non-continuous mode. The SP board increases dead time to allow for ADC conversion to complete before starting the next integration cycle.

For systems using five or more SP boards, output data rate can be a limiting factor. There are five host bus speed settings available, 2.5, 5, 10, 20 and 40 MB/s.

A total of 258 bytes is read out per DH board. This includes 2 bytes per pixel and 2 header bytes. The host data rate setting must exceed the data being produced by the system:

$$\text{Data rate (MB/s)} = (\text{numSP} \times \text{numDH per SP} / \text{Tint}) \times 258$$

## 9 evaluation system

An evaluation system is available, consisting of a detector head board, detectors, signal processing board, USB output and evaluation software. This is mounted in a test box (LINUX type, see data sheet) to provide electrical and radiation screening.

The software is available on a CD or download link and can be loaded on to a Windows PC (Pentium 4 or later) to provide the basic functionality of the system. A high speed USB 2.0 port is required for the XDAS-USB2 interface. The software enables integration time and number of sub-samples to be set and single lines of data to be acquired.

Data can be logged into a spreadsheet and can be displayed in graphical form. Gain and offset correction can be applied via the software.

Imaging Application is available, contact Sens-Tech for details

## 10 ordering information

### Detectors

Detector selection is an important part of system design. Parameters are stopping power, light output and signal decay time. Fast decay time is particularly important in CT systems.

An overview of typical scintillation materials with the main parameters is presented in **section 15**.

### 0.8 mm pitch detector head boards

part number	description
XDAS-DH3-x20	no detectors
XDAS-DH3-x21	Gadox
XDAS-DH3-x22	Csl
XDAS-DH3-x23	CdWO4
XDAS-DH3-x24	Bare Silicon

### standard footprint board

XDAS-DH3-72x

### small footprint board

XDAS-DH3-82x

### Signal Processing Board

part number	description
XDAS-SP3-01	signal processing board
XDAS-SP3-801	signal processing board narrow format

### XDAS-DH3-72x Terminators

part number	description
XDAS-TERMINATOR8	Local bus
XDAS-TERMINATOR3-01	System bus

### XDAS-DH3-82x Adaptors & Terminators

part number	description
XDAS-TERMINATOR31	Local bus
XDAS-TERMINATOR3-01	System bus
XDAS-ADAPTOR3-01	DH3-82x cable adaptors
XDAS-ADAPTOR3-02	Interface to XDAS-SP3-01

High density 50 way DH-DH cables are required for DH3-82x systems (see system configuration section 14)

### Interface Options

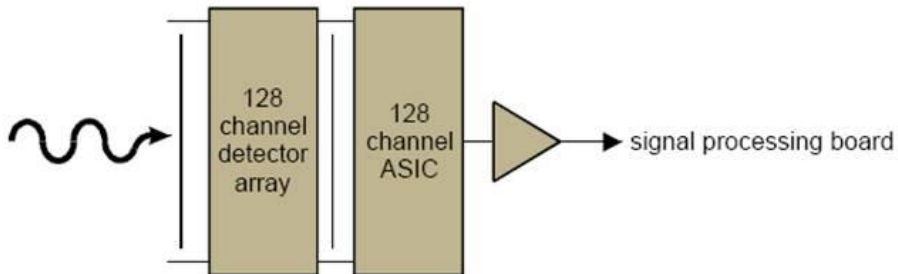
part number	description
XDAS-485A-V3	interface module for remote applications with 50 way SCSI cable
XDAS-USB2-1-V3	local USB2 interface, up to 5 metres (up to 100 meters with extender) includes all cables, connectors and LED
XDAS-USB2-2-V3	as above but with no leads, connectors or LED
XDAS-USB2-3-V3	as above but with USB2 connector and LED only
XDAS-GIGE-V3	local Ethernet interface (up to 100 meters)

The above parts include power supply conditioning.

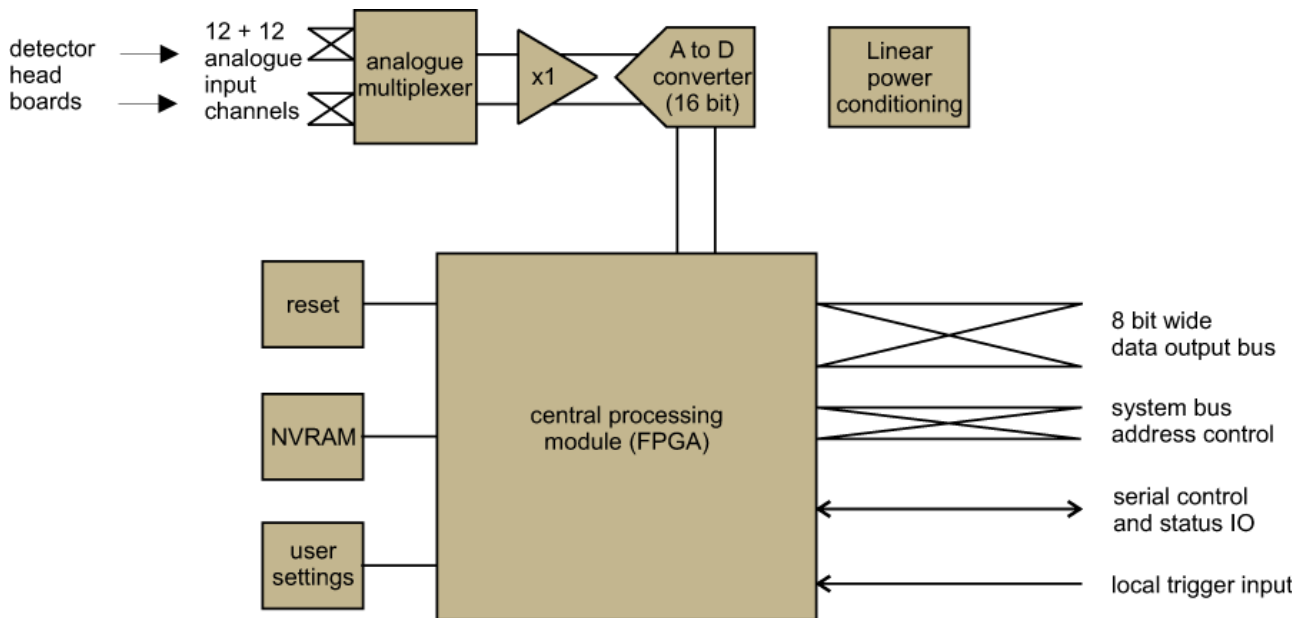
### Software

part number	description
XDAS-SOFTWARE	evaluation software and SDK

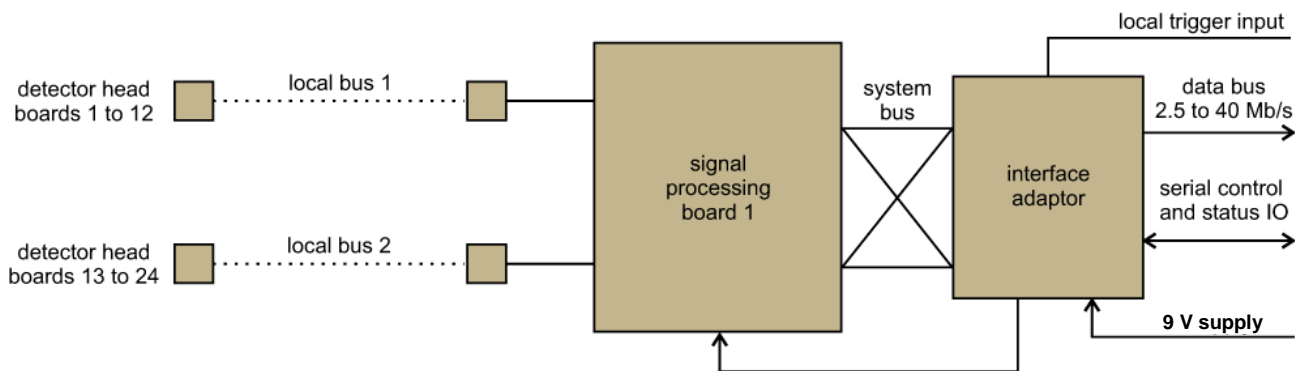
**11 detector head block diagram**



**12 signal processing block diagram**

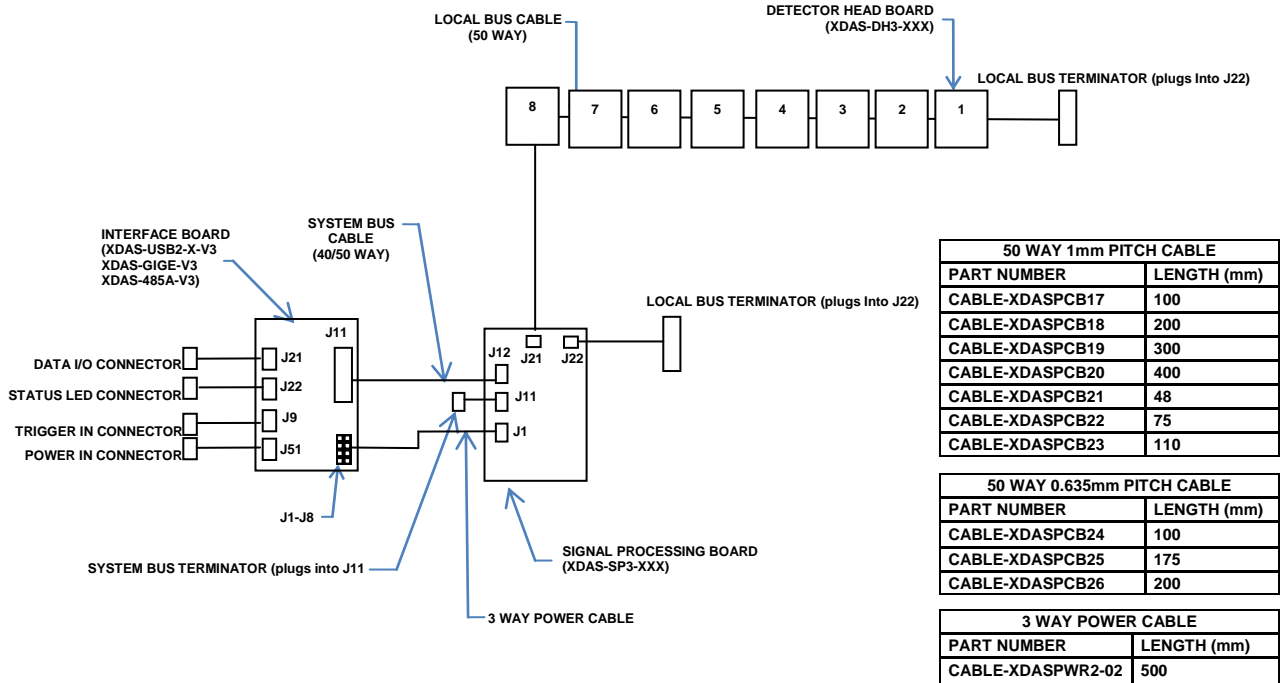


**13 system block diagram**



## 14 system configuration

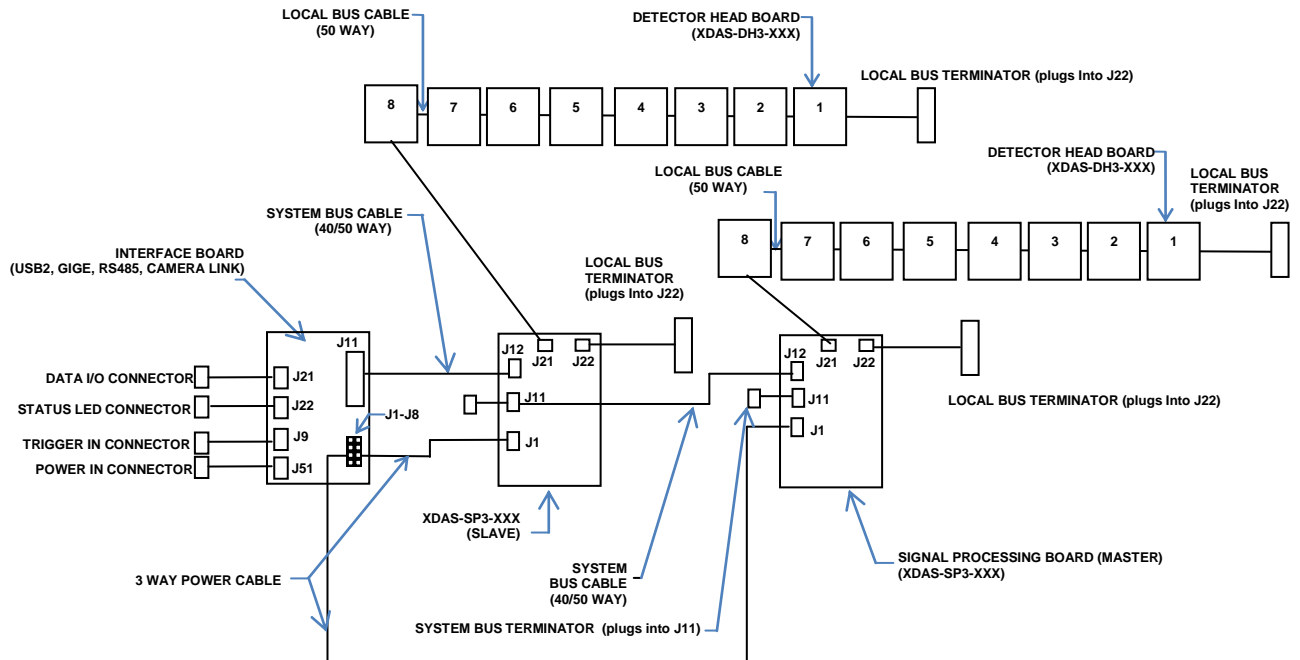
### single SP board



notes:-

1. CUSTOM CABLE LENGTHS AVAILABLE ON REQUEST
2. SHORT FORM BOARDS USE 1.27MM PITCH CONNECTORS AND 0.635MM FOR LOCAL BUS
3. INTERFACE BOARDS ARE SUPPLIED WITH CONNECTORS IF REQUIRED
4. FOR MULTIPLIER SIGNAL PROCESSING (SP) BOARD SYSTEMS, THE XDAS-TERMINATOR3-01 IS CONNECTED TO THE MASTER SP BOARD

### multiple SP boards



## 15 detectors

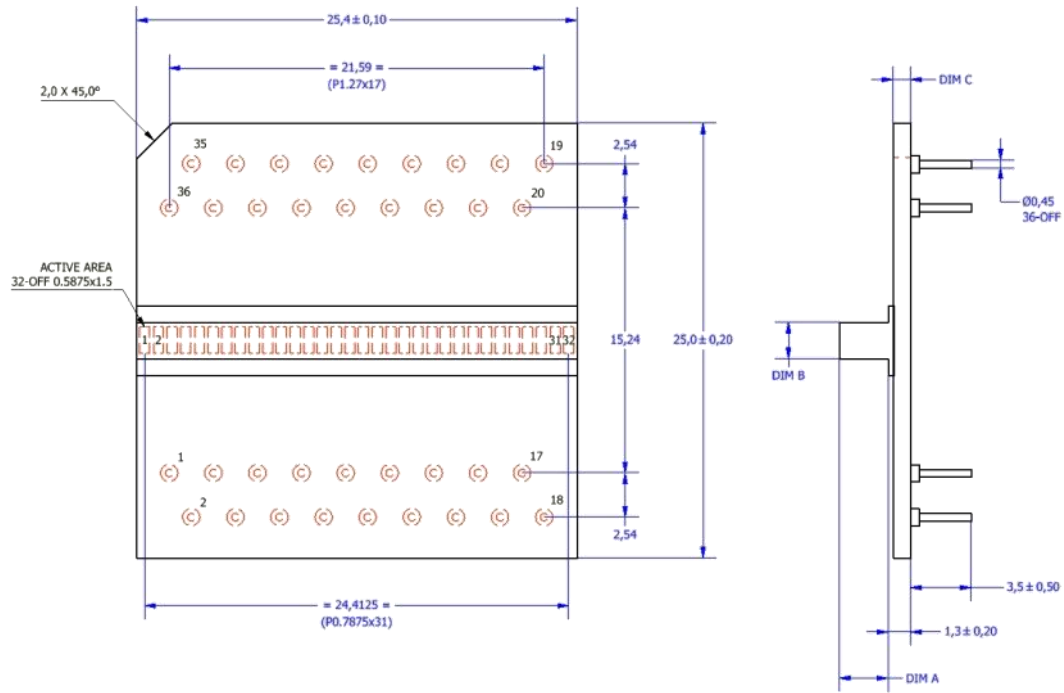
material	thickness	energy range	signal output per unit energy	signal decay time constant	comment
Silicon	300 $\mu$ m	5 – 30 keV	Highest, direct conversion	1 $\mu$ s for unbiased diode	Photodiode detects directly, no extra cost of scintillator
Gadox (Tb)	0.31 mm	20 – 100 keV	Similar to CsI	2 - 3 ms	Phosphor strip, no pixellation required to prevent cross-talk
Gadox A	0.2 mm	20 – 100 keV	20% lower	<1 ms	
Gadox B	0.4 mm	20 – 100 keV	10% higher	<1 ms	
CsI (TI)	2.5 mm	40 – 160 keV	Best light output	2 components of decay, slow decay of secondary component (seconds)	Arrays are pixellated to reduce cross talk
CdWO4	2.5 mm	150 – 250keV	25% of CsI	20 $\mu$ s	Arrays are pixellated to reduce cross talk, highest cost material

The thicknesses shown are for standard product but materials of different thicknesses can be made to special order.

scintillator part no.	type of scintillator	pitch	thickness	format	DIM A (mm) see page 7	DIM B (mm) see page 7	DIM C (mm) see page 7
DETECTORARRAY21	CsI	0.8 mm	2.5 mm	Standard	2.8	2.1	1.0 (+/- 0.15)
DETECTORARRAY22	Gadox	0.8 mm	0.3 mm	Standard	0.7	2.5	1.0 (+/- 0.15)
DETECTORARRAY22A	Gadox	0.8 mm	0.2mm	Standard	0.6	2.5	1.0 (+/- 0.15)
DETECTORARRAY22B	Gadox	0.8 mm	0.4mm	Standard	0.6	2.5	1.0 (+/- 0.15)
DETECTORARRAY23	CdWO4	0.8 mm	2.5 mm	Standard	2.6	1.9	1.6 (+/- 0.15)
DETECTORARRAY24	Bare Si	0.8 mm		Standard	0	1.5	1.0 (+/- 0.15)

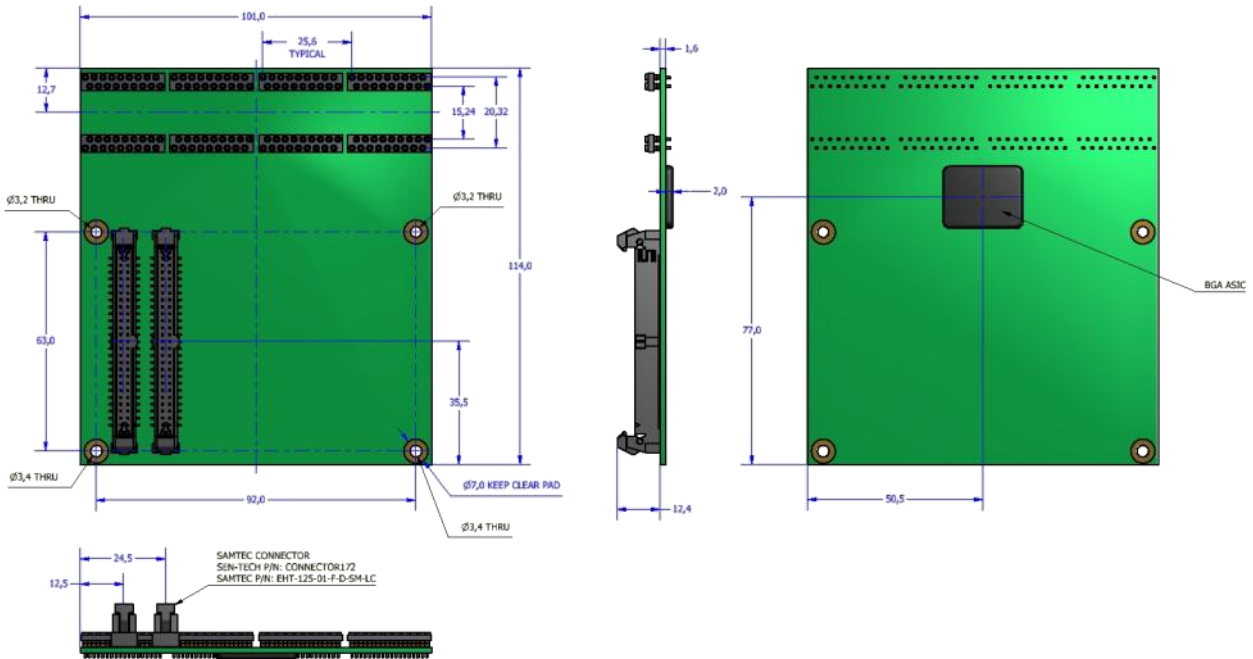
## 16 detector outline drawings (mm) see table in Section 15

standard format

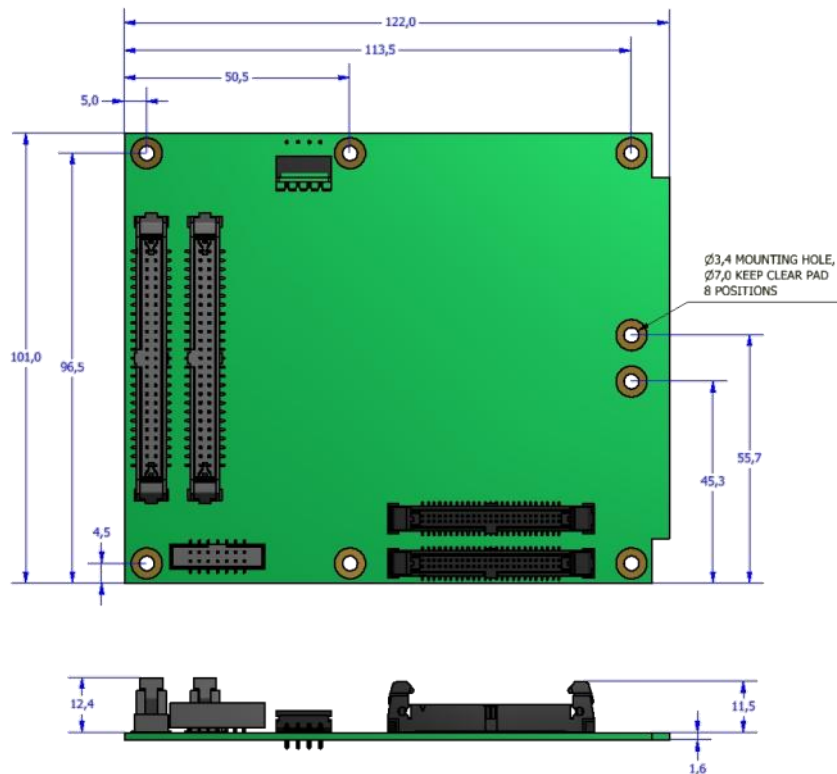


### 17 outline drawings

**XDAS-DH3-72x standard footprint detector head board (mm)**

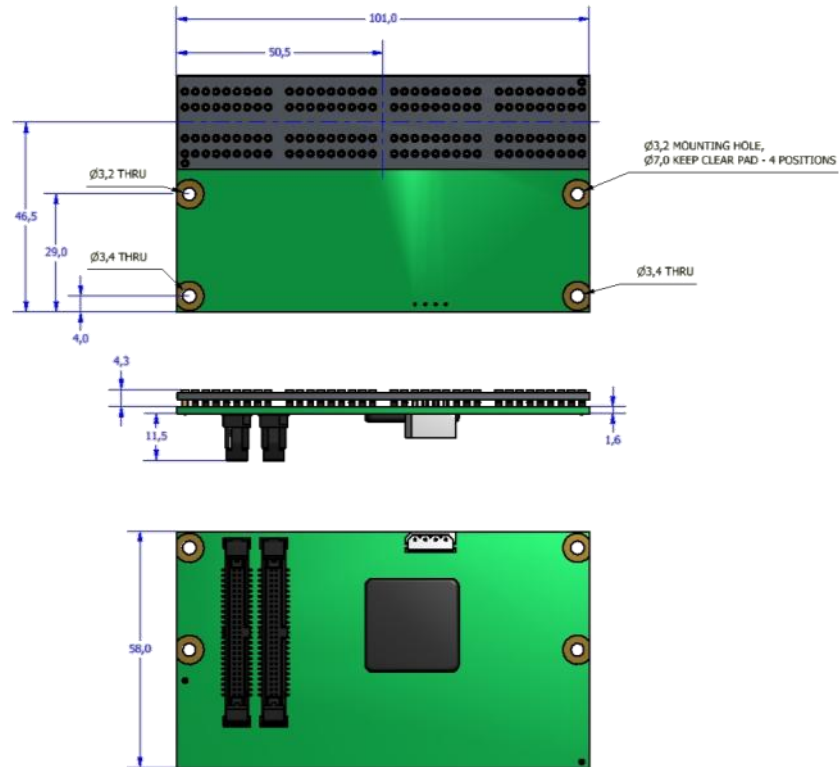


**XDAS-SP3-01 standard footprint signal processing board (mm)**

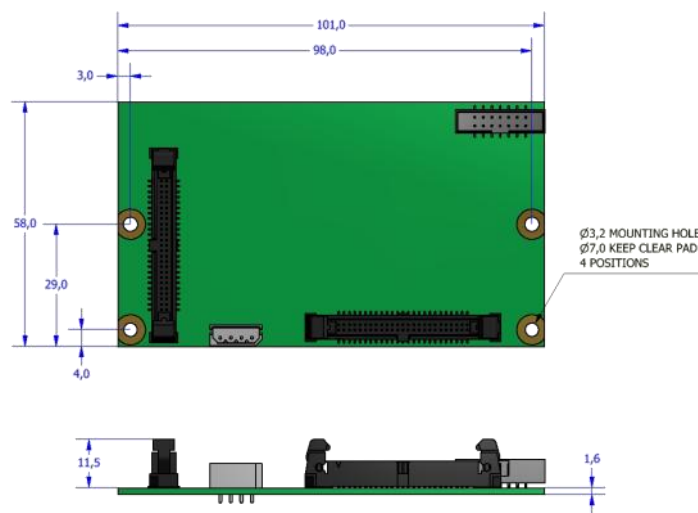




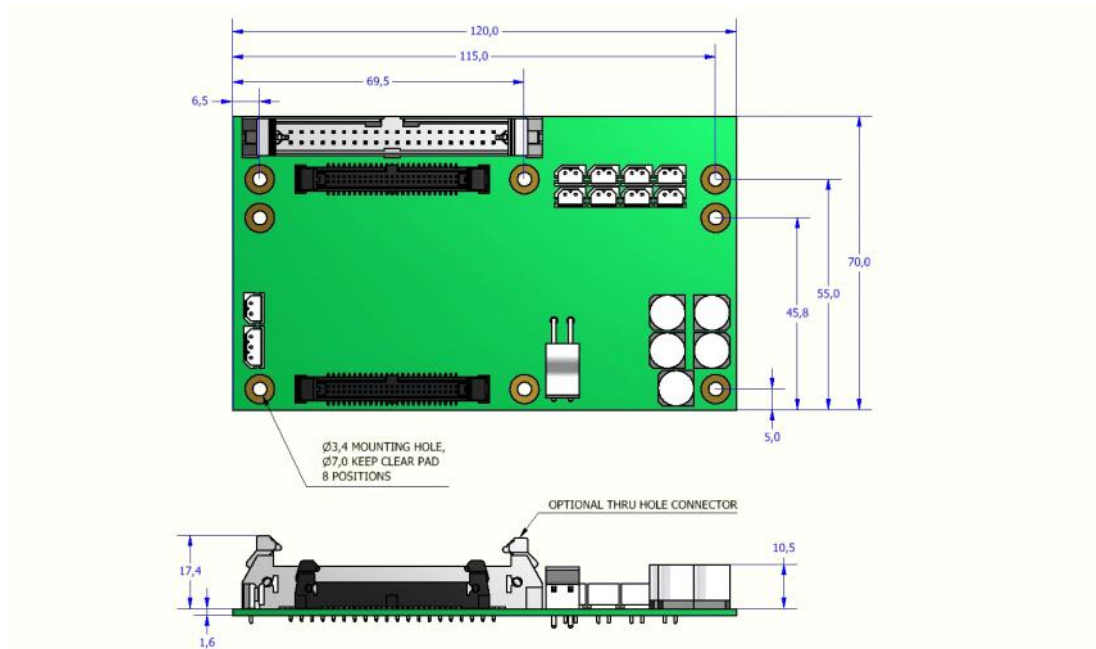
**XDAS-DH3-82x small footprint detector head board (mm)**



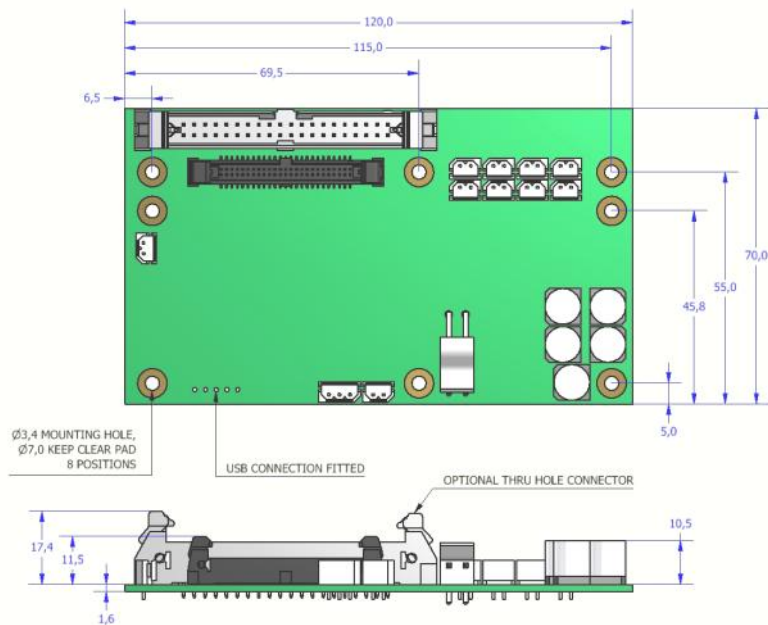
**XDAS-SP3-801 small footprint signal processing board (mm)**



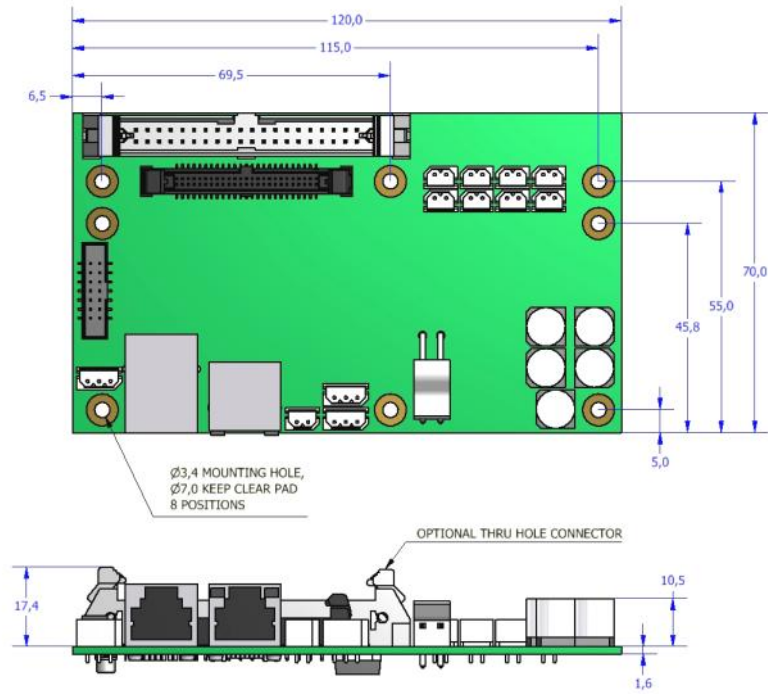
**XDAS-485A-V3 interface board**



**XDAS-USB2-2-V3 interface board**

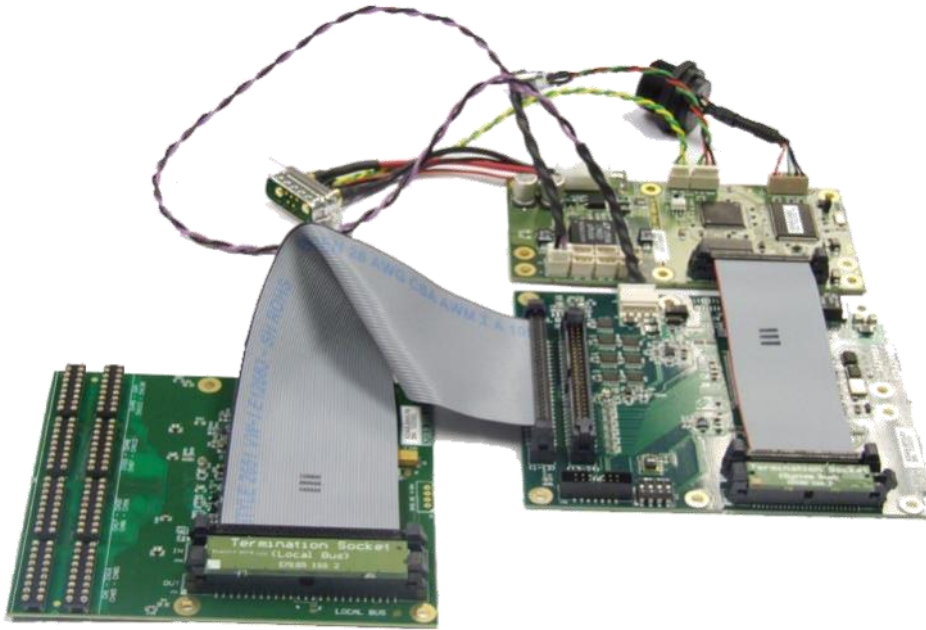


XDAS-GIGE-V3 gigabit ethernet interface board



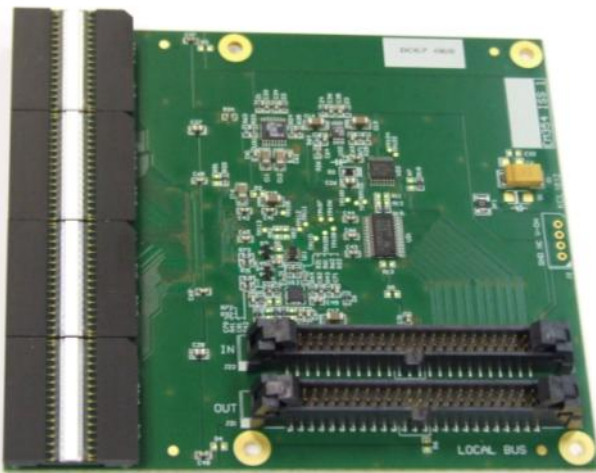
## 18 examples of XDAS boards

XDAS DH3-721, XDAS-SP3-01, XDAS-USB2-1-V3

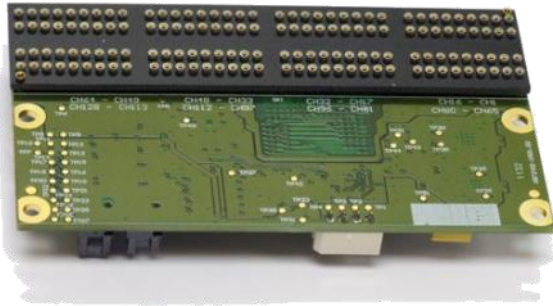


XDAS-DH3-721 detector head board

XDAS-SP3-01 signal processing board



XDAS-DH3-82x detector head board



XDAS-DH3-82x detector head board (reverse side)



XDAS-SP3-801 signal processing board



XDAS-GIGE-V3



XDAS-485A-V3



XDAS-USB2-1-V3



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You may also be interested in ...

## linear X-ray sensors and alternative pitch detector head boards

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### 1 LINX X-ray line scanner

The LINX x-ray line scanner provides an easy-to-use solution to inspect objects transported on a conveyor belt.

The LINX unit is housed in an aluminium box with additional lead screening to protect the electronic components from radiation damage. The unit has a collimator with a graphite window, so that only a narrow X-ray beam can reach the detector, reducing scattering and improving image quality. [Click here for further information](#)



### 2 XSYS X-ray line scanner

XSYS scanners are designed for applications such as the measurement of the thickness of hot steel strip during the rolling process. The electronic read-out system provides a much greater dynamic range than the V3 system making the unit suitable for large pitch detectors and high X-ray currents. The system architecture is also suitable for use with high energy pulsed sources.

Contact us for further information on this product

### 3 Alternative pitch XDAS-DH3 boards



DH boards with 2.5mm, 1.6 mm and 0.4mm pitch are also available, see separate data sheets.

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