

### KEY FEATURES

The XDAS-V3-HE system is the latest version of Sens-Tech X-ray data acquisition systems.

New features include:

- 10  $\mu$ s minimum integration time
- 43  $\mu$ s minimum scan time for continuous operation
- 24 bit output
- Up to 5ppm SNR
- Dynamic range from 15pC to 1920pC in steps of 15pC. (\* 960pC and 1920pC using sub-samples.)
- Gain can be set for each DH board in the system
- Separate gain setting for Low and High energy sources
- Programmable bandwidth limiting to reduce noise
- In-system programmable Xilinx FPGA
- Back-lit detectors maximising active area
- Read back of status and configuration parameters
- Programmable integration time in steps of 1 $\mu$ s
- USB 2.0, GigE or parallel interfaces to host
- Energy range up to 15 MeV
- Compatible with X-ray tubes and Gamma sources
- Compatible with LINAC's and Betatrons
- Diagnostic software and API for Windows and Linux
- Conformal coated electronics

### DESCRIPTION

XDAS-V3-HE is a modular system of boards for data acquisition in high energy imaging applications. The high energy detectors can be used for vehicle, train, container and cargo inspection using Linear accelerators, Betatrons, X-ray tubes or Gamma radiation sources such as Co60. It consists of detector head (DH) boards, signal processing (SP) boards and an interface board. DH and SP boards can be butted end-to-end to form a continuous array over 10

#### SP board

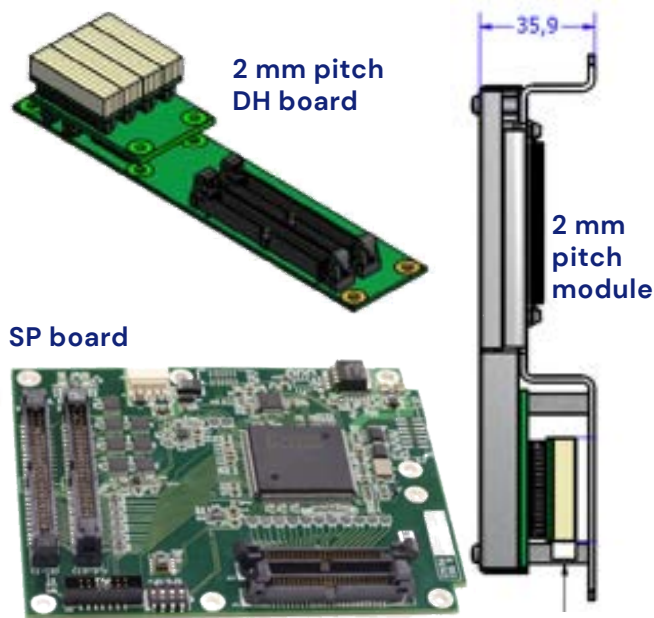


### DESCRIPTION CONTINUED...

metres in length. Maximum charge capacity using 4x sub-sampling is as follows:

Detector pitch	Charge capacity
2mm	480pC
4mm	960pC
8mm	1920pC

A fully assembled Detector module with mechanical mounting is recommended. Each module has 4 DH boards. 2mm, 4mm and 8mm are all available from a single standard module.



### APPLICATIONS

- Security inspection
- Vehicle inspection
- Train inspection
- Container inspection
- Cargo inspection
- Multi-view imaging
- Non-destructive testing
- Thickness measurement
- Foreign particle detection
- Industrial process control
- Mineral sorting
- Waste sorting

### GENERAL SPECIFICATION

<b>INTEGRATION TIME (SINGLE SAMPLE)</b> 10 $\mu$ s to 50 ms		<b>INTEGRATION TIME (MULTIPLE SAMPLES)</b> 200 ms (max)	
<b>SUB-SAMPLES- SNR (*ELECTRONIC)</b>		<b>SUB-SAMPLES- SNR (*WITH DETECTOR)</b>	
30pC	38000:1	30pC	22000:1
480pC	107000:1	480pC	89000:1
1920pC	215000:1	1920pC	178000:1

### GENERAL SPECIFICATION CONTINUED...

<b>CROSS-TALK (BOARD TO BOARD)</b> <0.01%	<b>CROSS-TALK (CHANNEL TO CHANNEL)</b> <0.1%
<b>DATA RATE (MAXIMUM)</b> 48 MB/s	<b>NON-LINEARITY</b> <0.1%
<b>DATA OUTPUT</b> 24 bits	<b>DETECTOR PITCH (MM)</b> 2, 4, and 8 mm
<b>NUMBER OF SP BOARDS</b> up to 7	<b>NUMBER OF DH BOARDS</b> up to 168
<b>NUMBER OF CHANNELS</b> up to 21504	<b>DETECTOR PITCH (MM)</b> 2, 4, and 8 mm
<b>POWER SUPPLY</b> <b>Interface board</b> 9V to 30V, 100 mVp-p ripple <b>Current (typical)</b> DH: 125 mA to 150mA SP: 200mA to 900mA Interface board: 100mA to 500mA	* for 2mm pitch detectors  <b>Note 1:</b> interface board steps down input supply to 6V for SP boards at 85% efficiency. SP provides power to DH boards.  <b>Note 2:</b> SNR is calculated for ADC full scale and bandwidth limiting enabled.

### ENVIRONMENTAL SPECIFICATION

<b>OPERATING TEMPERATURE</b> 0 to +60°C	<b>STORAGE TEMPERATURE</b> -40 to +70°C
<b>HUMIDITY (NON-CONDENSING) OPERATING</b> 30°C 93%	<b>HUMIDITY (NON-CONDENSING) NON-OPERATING</b> 40°C 93%



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## PRINCIPLES OF OPERATION

Current from the photodiodes is integrated by an ASIC containing charge sensitive amplifiers. **See detector head block diagram.** Correlated double sampling is used to minimise low frequency noise, reject offset error and minimise temperature effects. The microcircuit provides a multiplexed serial analogue output to the signal processing board where data is converted into digital 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 1.25pF to 10pF in steps of 1.25pF, providing charge storage of 15pC to 120pC in 15pC steps. The dynamic range can be set separately for high and low energy scans.

Multiple sampling facility is available on the SP board. This enables 2 or 4 samples to be added providing a maximum dynamic range of 480pC.

Integration time can be adjusted in 1 $\mu$ s steps.

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, USB or GIGE 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.**

A system is assembled by interconnecting multiple DH and SP boards and connecting to a processor via an interface adaptor board. **See system block diagram.**



### DATA ACQUISITION RATE

Signal integration time in a typical linescan application can be calculated using following formula:

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

**Example:** integration time setting for 2mm pixel width scanning at 1m/s belt speed shall be  $2 / 1 = 2 \text{ ms}$

Speed of operation is normally limited by processing speed of an SP board. The SP board takes 42.7  $\mu\text{s}$  to process a DH board. Minimum continuous integration time of a system can be calculated using following formulae:

$$\text{Tint (minimum)} = 1.6\mu\text{s} + (\text{num DH per SP} \times 42.7\mu\text{s})$$

**Example:** minimum integration time for a 9 DH board and 1 SP board system shall be  $1.6 + 9 \times 42.7 = 386 \mu\text{s}$

Multiple SP boards process DH boards in parallel.

**Example:** minimum integration time for a 18 DH board and 2 SP board system shall be  $1.6 + (18 / 2) \times 42.7 = 386 \mu\text{s}$

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 external triggering applications using non-continuous mode, the trigger time must exceed minimum integration time by at least 3.2 $\mu\text{s}$ .



### **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 converter
- GIGE convertor
- PCI7300A card, via an RS485 to TTL convertor

#### **2**

Local USB 2.0 output connecting to:

- Laptop, PC or a single board computer
- 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 over 1000 BASE-T data link

#### **4**

Channel Link (Camera Link):

- 2.2 Gb/s data rate
- Interface to Active Silicon AS-PHX-D48CL-PE4 frame grabber

### **EVALUATION SYSTEM**

An evaluation system is available, consisting of a detector head board, signal processing board, RS485/USB/GIGE out-put and evaluation software. This is mounted in a test box to provide electrical and radiation screening.

Demonstration software is available on a CD or download link and can be loaded on to a Windows PC (Pentium 4 or later) to check basic function of the system. A high speed USB 2.0 or

Gigabit Ethernet port is required for the host interface. The software enables setting of gain and integration time and single lines of data to be acquired.

Data can be logged to a csv file 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



## 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 pa-rameters is presented in the '**Detectors**' section.

PART NUMBER	DESCRIPTION
<b>DETECTOR HEAD BOARD</b>	
XDAS-DH3-H712	single energy 32mm*7mm CsI
XDAS-DH3-H713	single energy 32mm*7mm CdWO4
<b>DETECTOR MODULE (4 DH PER MODULE)</b>	
XDAS-HE3-H712	single energy 32mm*7mm CsI
XDAS-HE3-H713	single energy 32mm*7mm CdWO4
<b>SIGNAL PROCESSING BOARD</b>	
XDAS-SP3-O1	signal processing board (standard)
<b>INTERFACE OPTIONS</b>	
XDAS-485A-V3	parallel RS485 over 50 way SCSI cable, board only
XDAS-USB2-1-V3	USB2 interface with USB connector, power connector and LED
XDAS-USB2-2-V3	USB2 interface board only
XDAS-USB2-3-V3	USB2 interface with USB connector LED
XDAS-USB2-4-V3	USB2 interface with USB connector
XDAS-GIGE-V3	GIGE interface board only
XDAS-GIGE-V3-1	GIGE interface with RJ45 connector, power connector and LED
XDAS-GIGE-V3-3	GIGE interface with RJ45 and LED



### ORDERING INFORMATION CONTINUED...

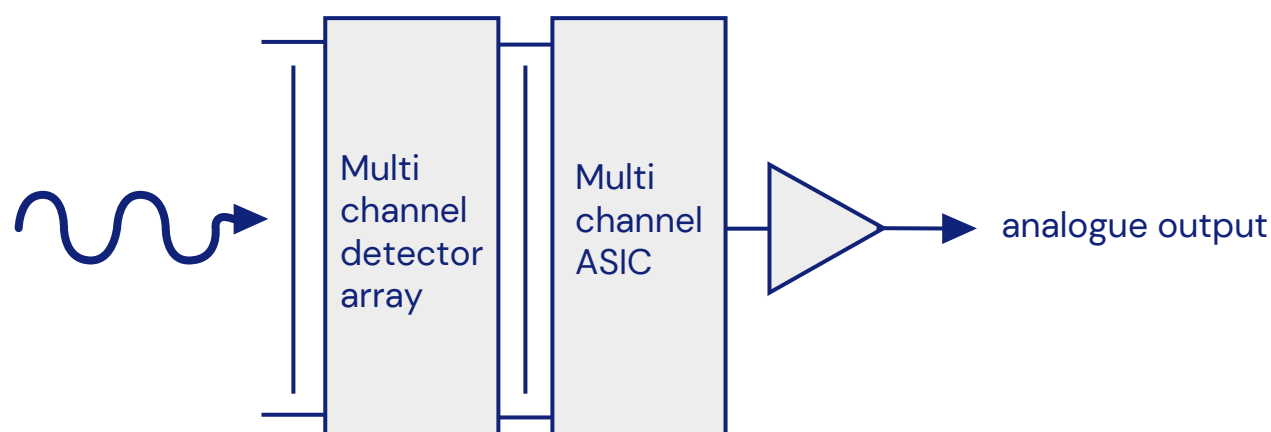
PART NUMBER	DESCRIPTION
<b>INTERFACE OPTIONS</b>	
XDAS-GIGE-V3-4	GIGE interface with RJ45 connector
XDAS-USB2	remote RS485 to USB converter
XDU-INT-SGI	remote RS485 to GIGE converter
note: interface boards step down input supply to 6V for supply to SP board.	
<b>TERMINATORS AND ADAPTORS</b>	
XDAS-TERMINATOR8	local bus terminator
XDAS-TERMINATOR3-01	system bus terminator
XDAS-INTERFACE-01	belt encoder processing board
<b>DETECTOR BOARD CABLES (50WAY 2MM PITCH IDC)</b>	
CABLE-XDASPCBxx	data cable (specify length)
CABLE-XDASPCB21	48mm
CABLE-XDASPCB22	75mm
CABLE-XDASPCB17	100mm
CABLE-XDASPCB23	110mm
CABLE-XDASPCB18	200mm
CABLE-XDASPCB19	300mm
CABLE-XDASPCB20	400mm
<b>SIGNAL PROCESSING BOARD CABLES (50WAY 1.27MM PITCH IDC)</b>	
CABLE-XDASPCBxx	data cable (specify length)
CABLE-XDASPCB24	100mm
CABLE-XDASPCB25	175mm
CABLE-XDASPCB26	200mm



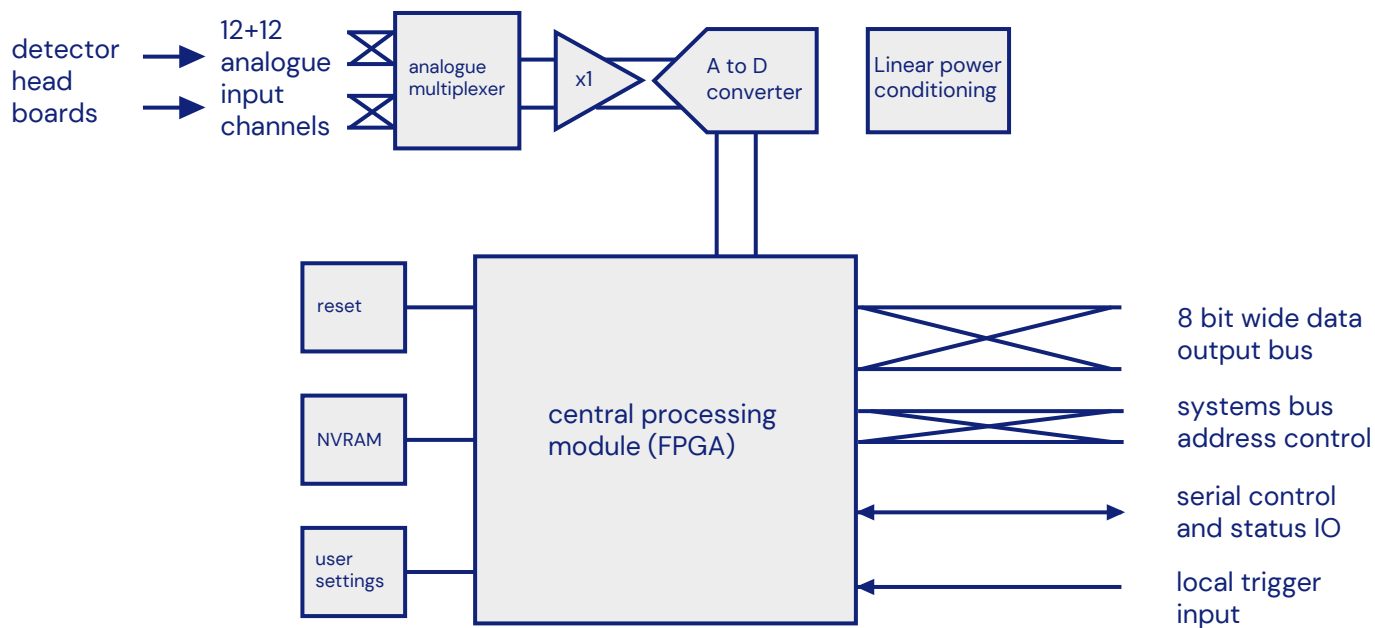
### ORDERING INFORMATION CONTINUED...

PART NUMBER	DESCRIPTION
POWER FROM INTERFACE TO SP (2.5MM PITCH MOLEX MICRO SPOX)	
CABLE-XDASPWR2-xx	Power cable (specify length)
CABLE-XDASPWR2-02	500mm
OTHER CABLES	
CABLE-XDASLED-01	Bulkhead diagnostic LED 20cm
SOFTWARE	
XDAS-SOFTWARE	evaluation software and SDK

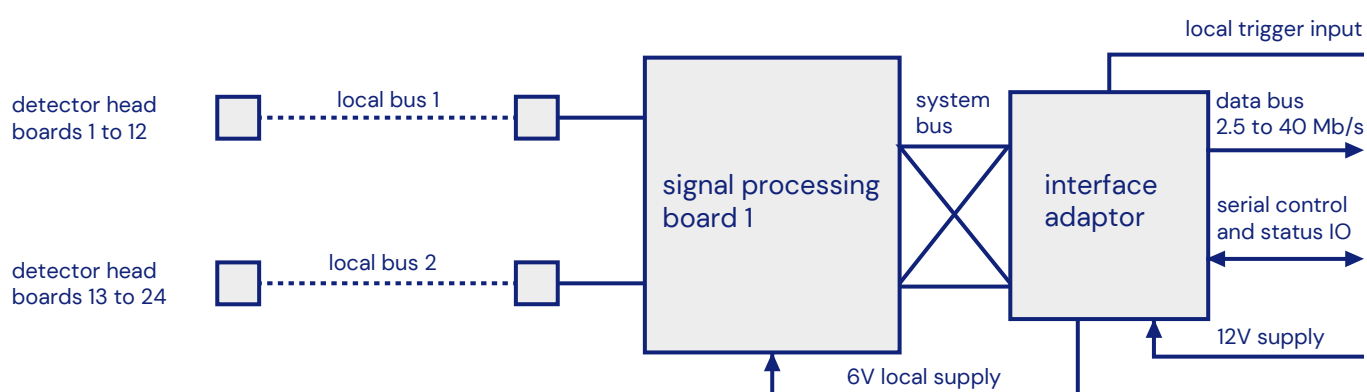
### DETECTOR HEAD BLOCK DIAGRAM



### SIGNAL PROCESSING BLOCK DIAGRAM

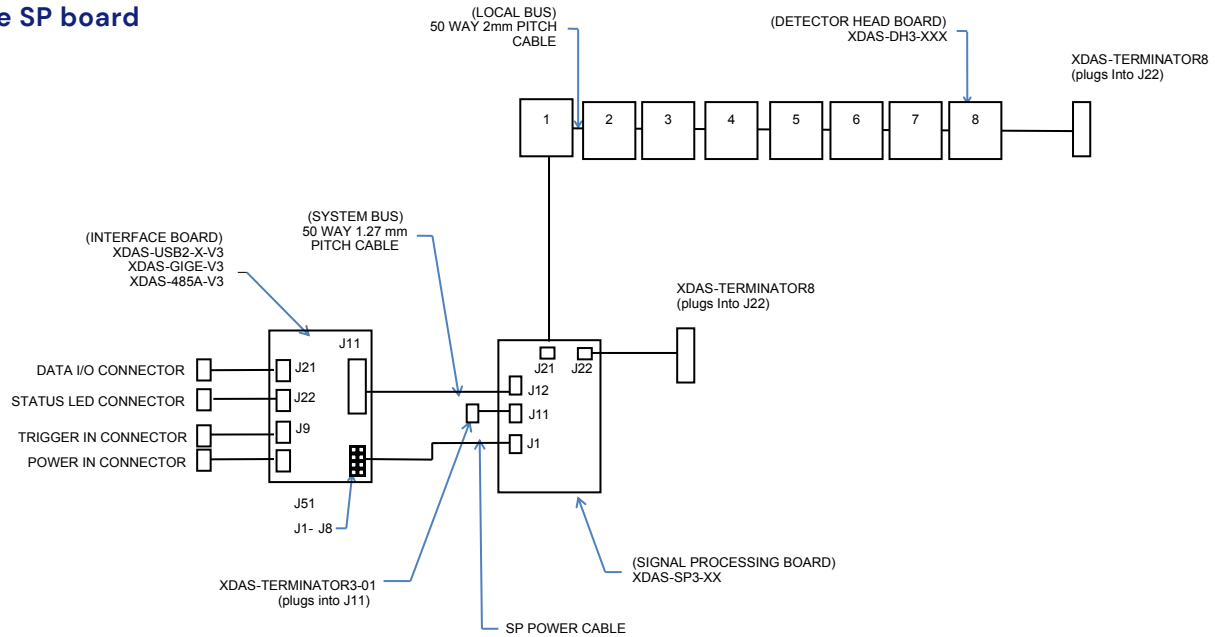


### SYSTEM BLOCK DIAGRAM



### SYSTEM CONFIGURATION

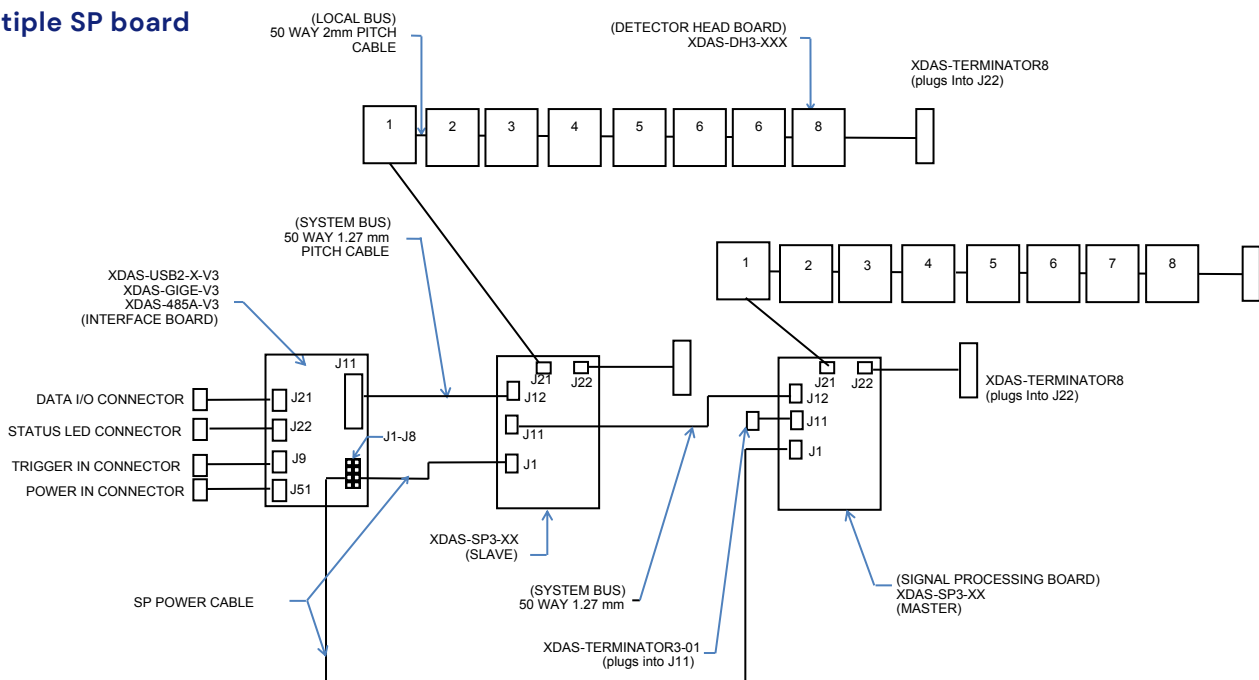
#### Single SP board



#### notes:

1. CUSTOM CABLE LENGTHS AVAILABLE UPON REQUEST
2. NARROW FORMAT BOARDS USE 1.27MM PITCH CONNECTORS AND 0.635 MM CABLE
3. INTERFACE BOARDS ARE SUPPLIED WITH CONNECTORS UPON REQUEST
4. XDAS-TERMINATOR3-01 IS CONNECTED TO MASTER SP BOARD FOR SYSTEMS WITH MULTIPLE SP BOARDS

#### Multiple SP board





### DETECTORS

TYPE OF SCINTILLATOR	DEPTH	ENERGY RANGE	SIGNAL OUTPUT PER UNIT OF ENERGY	DECAY TIME CONSTANT	COMMENTS	FORMAT
CsI (TI)	32 mm	450keV – 15MeV	best light output	2 components, slow decay of secondary component (seconds)	pixelated arrays to reduce crosstalk	2, 4, 8mm pitch 7, 15 mm tall
CsWO4	32 mm	450keV – 15MeV	25% of CSI	15 $\mu$ s	pixelated arrays, highest cost material	2, 4, 8mm pitch 7, 15 mm tall

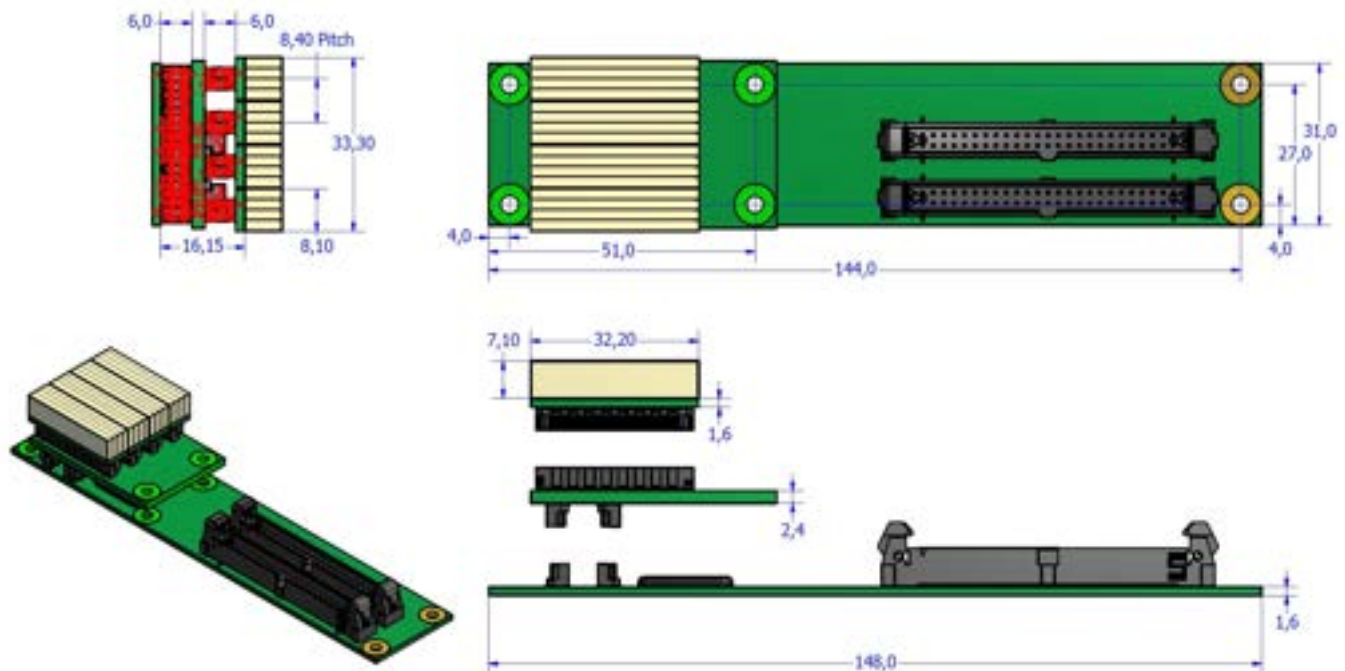
Note: Thicknesses shown are of standard products. Other thicknesses are available on order.

### OUTLINE DRAWINGS MM

Note: Following drawings are for reference only.

Contact Sens-tech for latest mechanical drawings and 3D CAD models.

#### XDAS-DH3-H71x detector head board (mm)

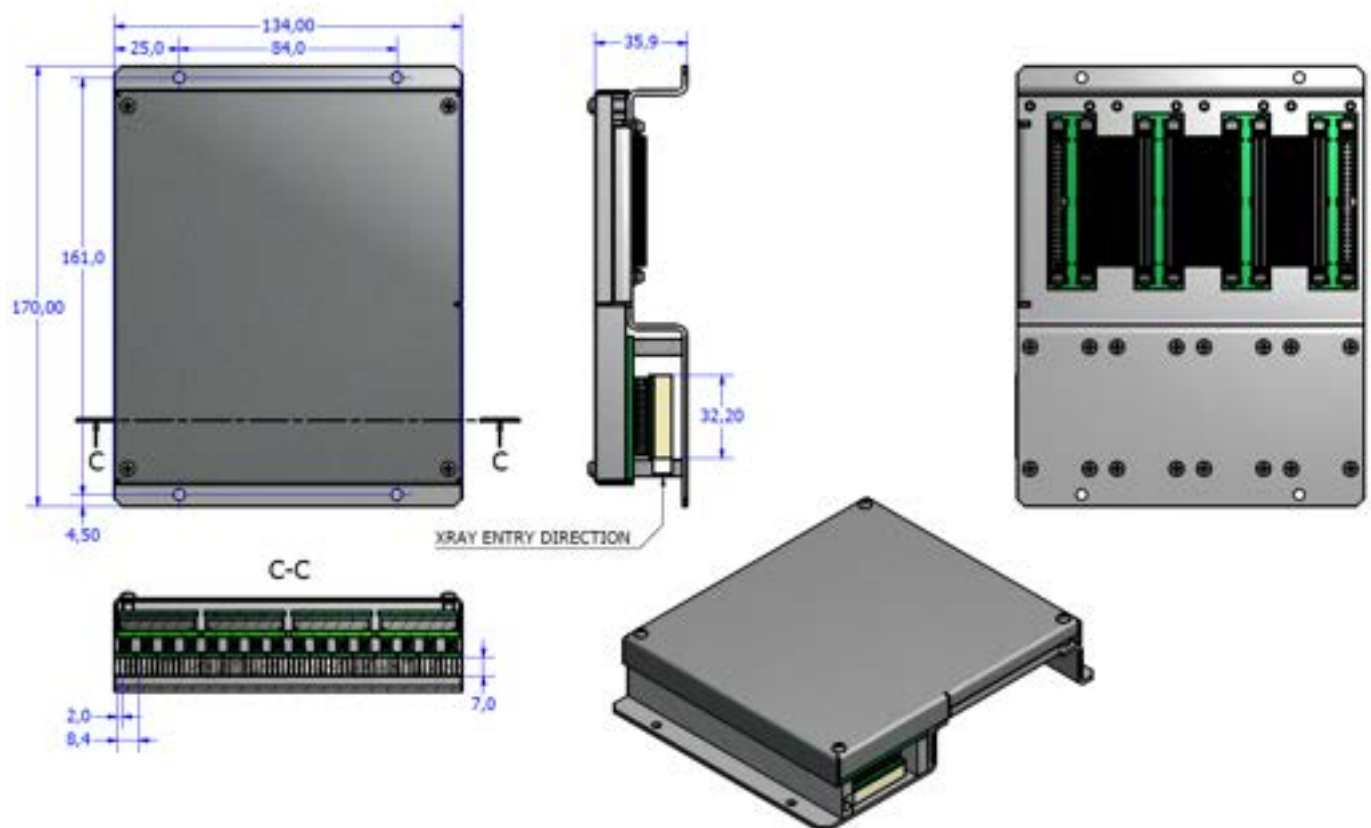


### OUTLINE DRAWINGS CONTINUED...

Note: Following drawings are for reference only.

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#### XDAS-DH3-H7xx detector module (mm)

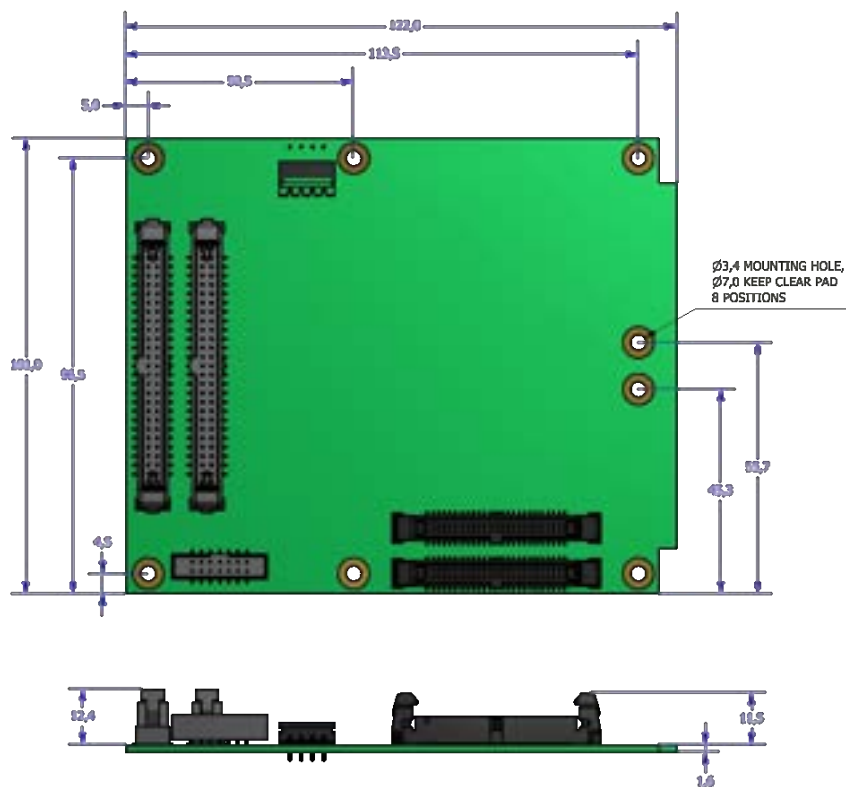


### OUTLINE DRAWINGS CONTINUED...

Note: Following drawings are for reference only.

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

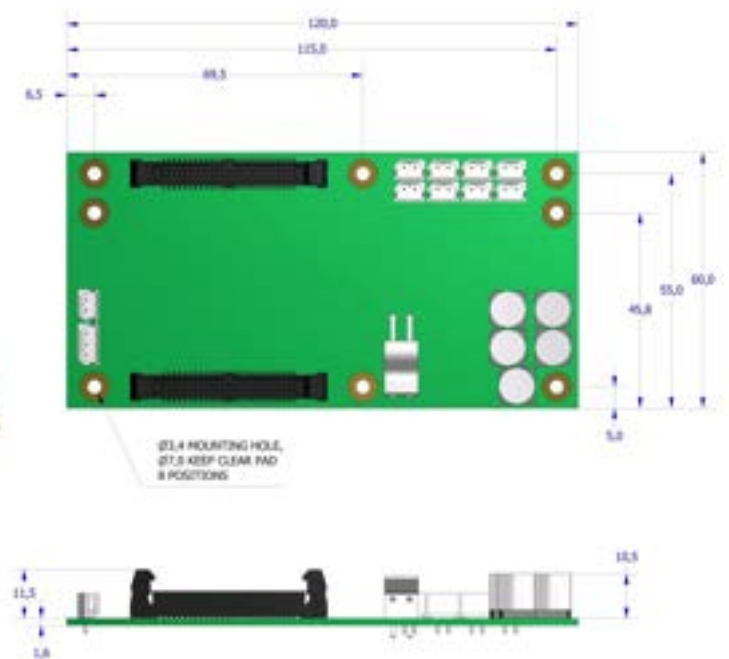


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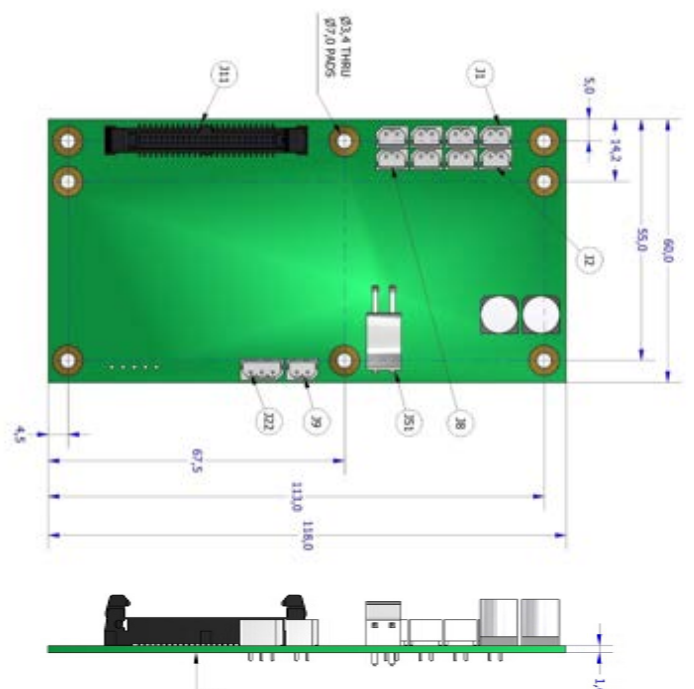
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XDAS-485A-V3 interface board



XDAS-USB2-x-V3 interface board



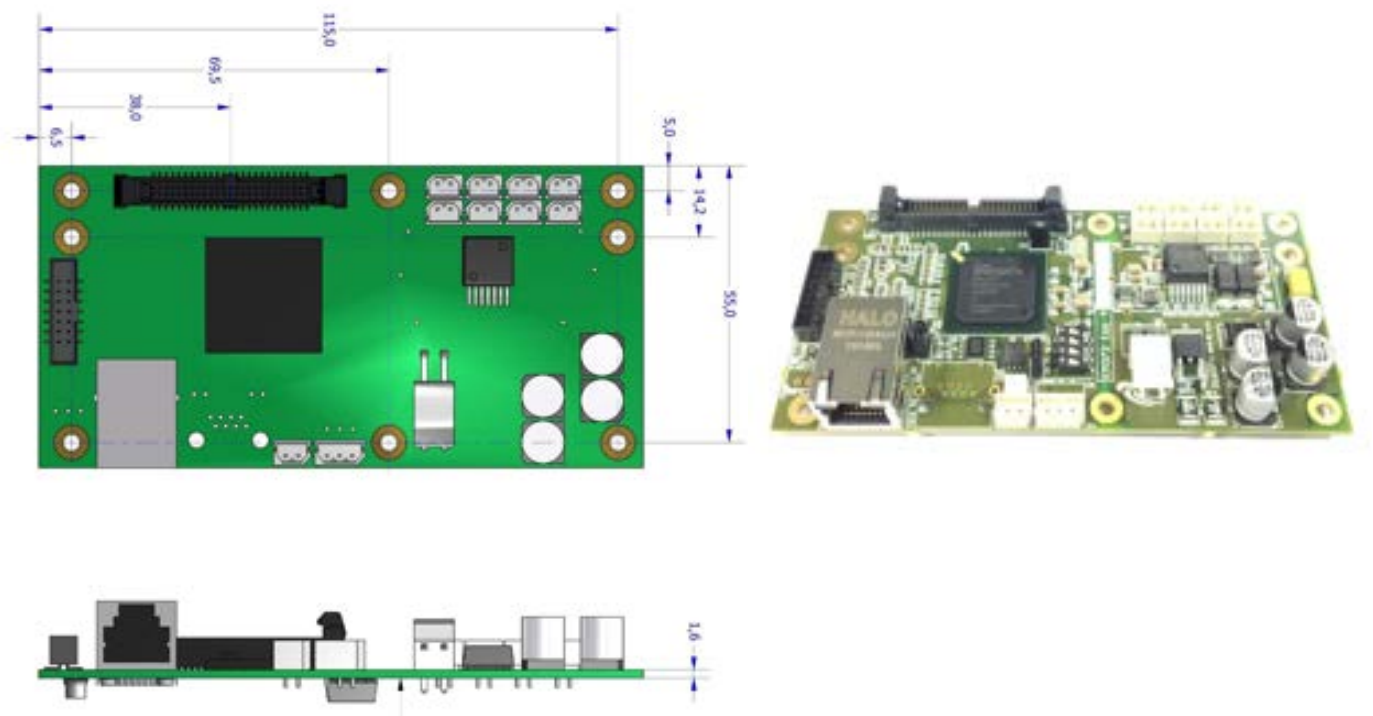


### OUTLINE DRAWINGS CONTINUED...






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#### XDAS-GIGE-V3 interface board



### LED STATUS MNEMONICS

LED INDICATION	MEANING (USB)	MEANING (GIGE)
 Green	Idle	Idle
 Green (Flashing)	Acquiring data	Acquiring data
 Amber	Data buffer overflow. (Idle)	Connected to 100Mbps link. Not yet supported
 Amber (Flashing)	Data buffer overflow. (Acquiring)	Command received from host
Red/Green (Alternating)	System under reset	System under reset
Red [1]	Microcontroller not responding	Device fault. Contact support
 Red [1] (Flashing ~1Hz)	USB endpoint has stalled	Ethernet Link is not connected
Red [1] (Flashing >4Hz)	Could not enumerate as USB2.0 device	Ethernet link fault
Off	Power off, un-programmed or other fault	Power off, un-programmed or other fault