# XDAS-V3 0.4 MM PITCH

## DUAL ENERGY X-RAY DATA ACQUISITION SYSTEM

SENS - TECH

## KEY FEATURES

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

- Operation by external trigger
- 10 µs minimum integration time
- 43 µs minimum scan time for continuous operation
- 16 bit A/D conversion
- Up to 36000:1 SNR
- Programmable dynamic range from 1.875pC to 60pC in steps of 1.875 pC.
  * 30pC and 60pC using sub-samples
- Gain can be set for each DH 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
- Front-lit detectors
- Read back of status and configuration parameters
- Programmable integration time in steps of 1us
- Separate integration times for low and high energy
- USB 2.0, GigE or parallel interfaces to host
- X-ray energy range 5 keV to 160 keV
  * higher energy range is covered by suitable combination of photodiode and scintillator
- Software API supporting Windows and Linux

## 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 host interface board.

A single energy DH board has 128 detector channels. A dual energy system requires separate DH board for low and high energy. Detector boards can be butted end-to-end to form a continuous array over 5 metres in length.

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

DH boards with 0.8 mm, 1.6 mm and 2.5 mm detector pitch are also available. See separate data sheets.

## 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

## GENERAL SPECIFICATION

| | |
|---|---|
| **INTEGRATION TIME (SINGLE SAMPLE)**<br>10 µs to 50 ms | **INTEGRATION TIME (MULTIPLE SAMPLES)**<br>200 ms (max) |
| **SUB-SAMPLES**<br>1, 2 or 4 | **POWER SUPPLY INTERFACE BOARD**<br>12V (9V to 30V), 100 mVp-p ripple |
| **CROSS-TALK (BOARD TO BOARD)**<br><0.01% | **CURRENT (TYPICAL)**<br>DH: 125 mA to 150mA<br>SP: 200mA to 900mA<br>Interface board: 100mA to 500mA |
| **CROSS-TALK (CHANNEL TO CHANNEL)**<br><0.1% | |
| **DATA RATE (MAXIMUM)**<br>48 MB/s | **SNR* (ELECTRONIC)**<br>**3.75pC** 14500:1<br>**15pC** 19000:1<br>**60pC** 36000:1 |
| **NON-LINEARITY**<br><0.1% | |
| **A/D CONVERSION**<br>16 bits | **SNR* (<10PF DETECTOR CAPACITANCE)**<br>**3.75pC** 10000:1<br>**15pC** 18000:1<br>**60pC** 34000:1 |
| **DATA OUTPUT**<br>16 bits | |
| **DETECTOR PITCH (MM)**<br>0.4 mm | **NUMBER OF CHANNELS**<br>up to 21504 |
| **NUMBER OF SP BOARDS**<br>up to 7 | **NUMBER OF DH BOARDS**<br>up to 168 |

Note 1:Interface board steps down input supply to 6V (max 5A) for SP boards. SP boards provides power to DH boards.

Note 2: SNR is calculated for ADC full scale and bandwidth limiting enabled.

## ENVIRONMENTAL SPECIFICATION

| TEMPERATURE | |
|---|---|
| **Operating** | 0 to +60 °C |
| **Storage** | -40 °C to +70 °C |

| HUMIDITY (NON-CONDENSING) | |
|---|---|
| **Operating** | 30°C 93% |
| **Non-operating** | 40°C 93% |

## PRINCIPLES OF OPERATION

**See system configuration block diagrams, page 10**

Current from the photodiodes is integrated by an ASIC containing 128 charge sensitive amplifiers. **See detector head block diagram**. 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 µs 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 high and low energy channels.

Multiple sampling facility is available on the SP board. This enables 2 or 4 samples to be added providing a maximum dynamic range of 60 pC.

Integration time can be adjusted in 1µs steps. Low and high energy detectors can be set different integration times enabling fine tuning of the dynamic range for the two detectors.

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**.

## PRINCIPLES OF OPERATION

**See system configuration block diagrams, page 10**

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 3.0 to 48 MB/s. **See system block diagram**.

## DATA ACQUISITION RATE AND POWER

Signal integration time in a typical line scan application is as calculated using following formula:

**Integration time (ms) = pixel width (mm)/belt speed ( m/s)**

*Example: integration time setting for 0.4mm pixel width scanning at 1m/s belt speed shall be 0.4 / 1= 0.4 ms*

Speed of operation is normally limited by processing speed of an SP board. Two speeds are available. The SP board takes 42.7 µs at 3MSps and 85.4 µs at 1.5MSps to process a DH board. Minimum continuous integration time of a system can be calculated using following formula:

**3MSps: Tint (minimum) = 1.6µs + (num DH per SP x 42.7µs)**

**1.5MSps: Tint (minimum) = 3.2µs + (num DH per SP x 85.4µs)**

*Example: minimum integration time for a 9 DH board and 1SP board system shall be 1.6 + 9x42.7 = 386 µs*

Multiple SP boards process DH boards in parallel.

*Example: minimum integration time for a 18 DH board and 2 SP board system shall be 16 + $\frac{18}{2}$ x 42.7 = 386 µs*

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.

A total of 258 bytes is read out per DH board. This includes 2 bytes per pixel and 2 header bytes representing SP address and DH address. There are five host bus speed settings avail-able: 3, 6, 12, 24 and 48 MB/s. The host data rate setting must exceed the data being produced by the system. When integration time is longer than Tint (minimum), average host data rate can be calculated using following formula:

**Data rate (MB/s) = (258 x numSP X numDH per SP) / Tint (us)**

## DATA ACQUISITION RATE AND POWER

*Example: data rate for a system of 2 SP boards and 9 DH boards at 500us integration time shall be (258 x2x9) / 500 = 9.3MB/s. Therefore, host bus speed should be set to 12MHz.*

*Example: current requirement for a system of 2 SP boards, 18 DH boards and 1 interface board shall be: (2 x 900mA)+(18 x 150mA)+(1 x 500mA) = 5A.*

## 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 converter
- PCI7300 card, via an RS485 to TTL converter

**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 output and evaluation software. This is mounted in a test box (LINX type, see data sheet) to provide electrical and radiation screening.

Demonstration software is available via download link or 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 parameters is presented on page 14.

## ORDERING INFORMATION

### DETECTOR HEAD BOARDS

0.4 mm pitch standard width

| PART NUMBER | DESCRIPTION |
|---|---|
| XDAS-DH3-0610 | no detectors |
| XDAS-DH3-0611 | Gadox |
| XDAS-DH3-0614 | Silicon |

### SIGNAL PROCESSING BOARD

| PART NUMBER | DESCRIPTION |
|---|---|
| XDAS-SP3-01 | signal processing board (sandard) |
| XDAS-SP3-801 | signal processing board (narrow ) |

### TERMINATORS AND ADAPTORS

| PART NUMBER | DESCRIPTION |
|---|---|
| XDAS-TERMINATOR8 | Local bus (standard) |
| XDAS-TERMINATOR31 | Local bus (narrow) |
| XDAS-TERMINATOR3-01 | System bus |
| XDAS-ADAPTOR3-01 | DH3-8xx adaptor to XDAS-SP3-01 (DH1 to 12) |
| XDAS-ADAPTOR3-02 | DH3-8xx adaptor to XDAS-SP3-01 (DH13 to 24) |
| XDAS-INTERFACE-01 | Belt encoder processing board |

### INTERFACE OPTIONS

| PART NUMBER | DESCRIPTION |
|---|---|
| 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 |
| 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 (max 5A).

## ORDERING INFORMATION

### CABLES

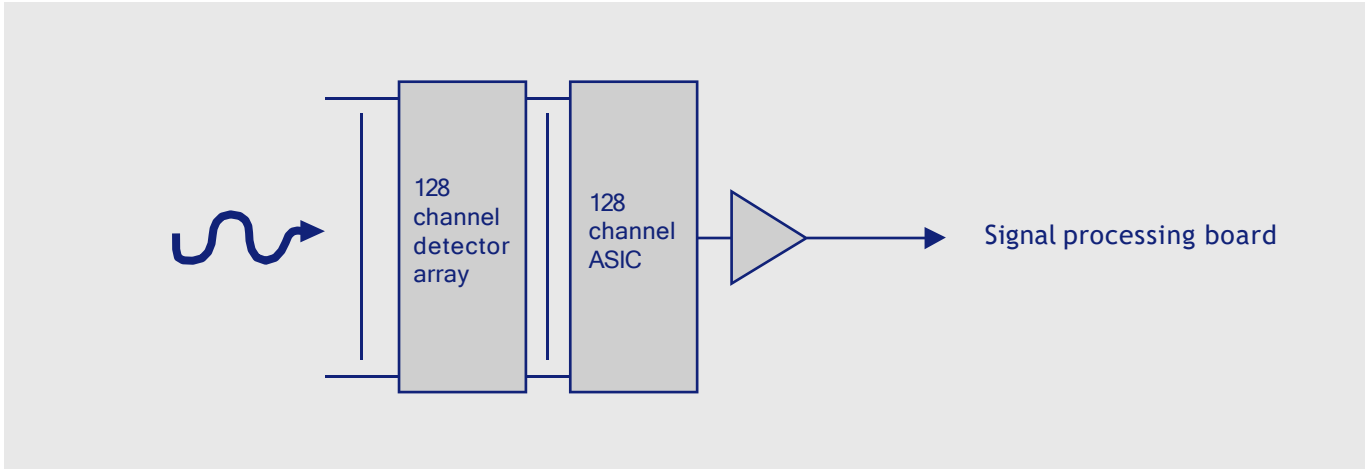
Note: see system configuration section or contact Sens-tech for cable part numbers

| PART NUMBER | DESCRIPTION | PART NUMBER | DESCRIPTION |
|---|---|---|---|
| **Detector board (standard)** | 50way 2mm pitch IDC | **Detector board (narrow)** | 50way 1.27mm pitch IDC |
| **CABLE-XDASPCBxx** | Data cable (specify length) | **Signal processing board** | 50way 1.27mm pitch IDC |
| **CABLE-XDASPCB21** | 48mm | **CABLE-XDASPCBxx** | Data cable (specify length) |
| **CABLE-XDASPCB22** | 75mm | **CABLE-XDASPCB24** | 100mm |
| **CABLE-XDASPCB17** | 100mm | **CABLE-XDASPCB25** | 175mm |
| **CABLE-XDASPCB23** | 110mm | **CABLE-XDASPCB26** | 200mm |
| **CABLE-XDASPCB18** | 200mm | **CABLE-XDASPWR2-xx** | Power cable from GIGE board to SP board (specify length) |
| **CABLE-XDASPCB19** | 300mm | | |
| **CABLE-XDASPCB20** | 400mm | **CABLE-XDASPWR2-02** | 500mm |
| **CABLE-XDASLED-01** | Bulkhead diagnostic LED | **CABLE-XDASPWR2-12** | 150mm |
| | | **CABLE-XDASPWR2-04** | 100mm |

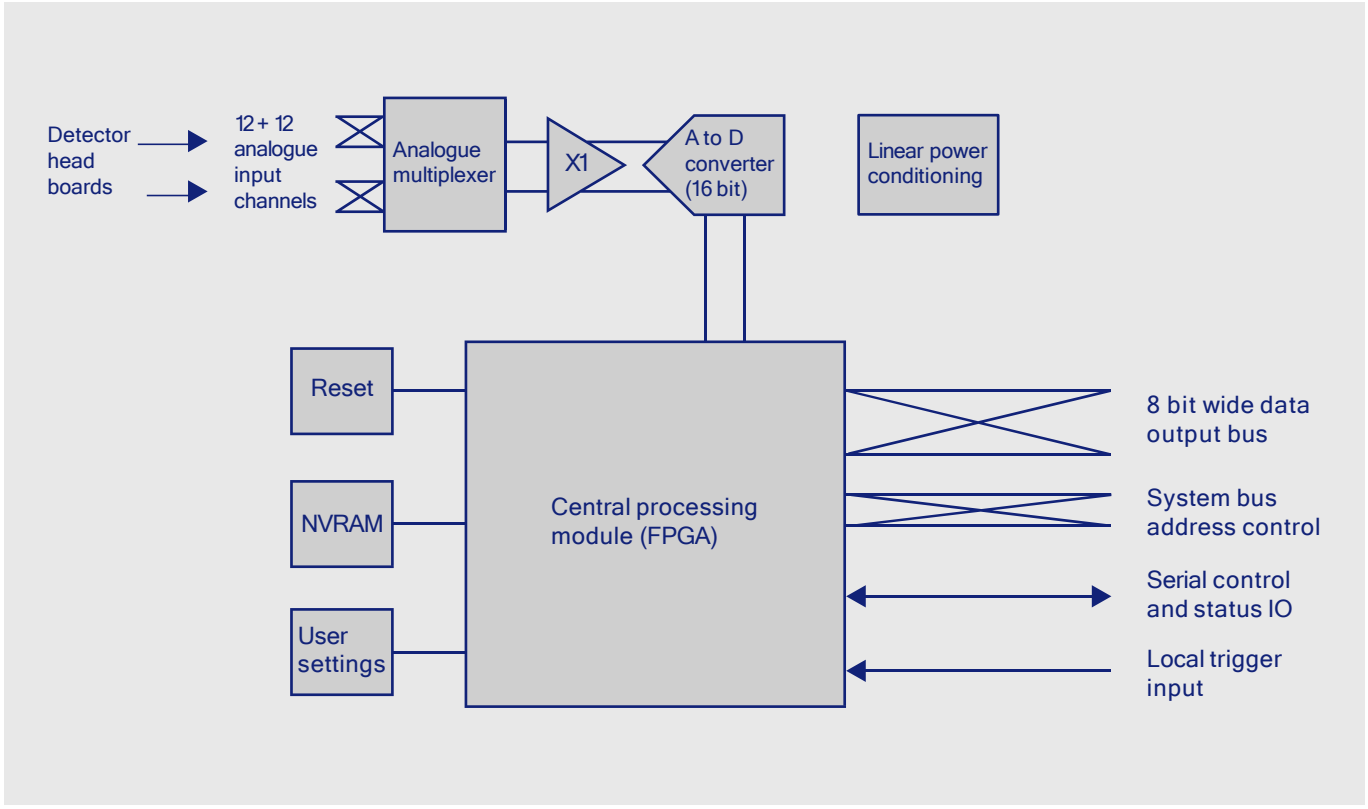
### SOFTWARE

| PART NUMBER | DESCRIPTION |
|---|---|
| **XDAS-SOFTWARE** | evaluation software and SDK |

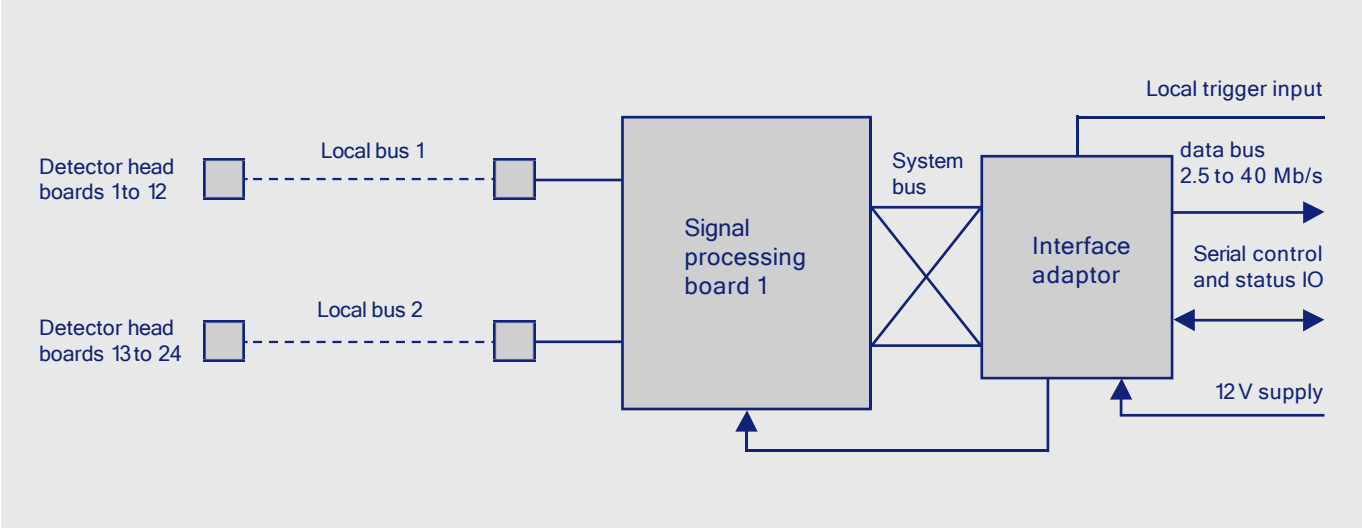
## DETECTOR HEAD BLOCK DIAGRAM




## SIGNAL PROCESSING BLOCK DIAGRAM

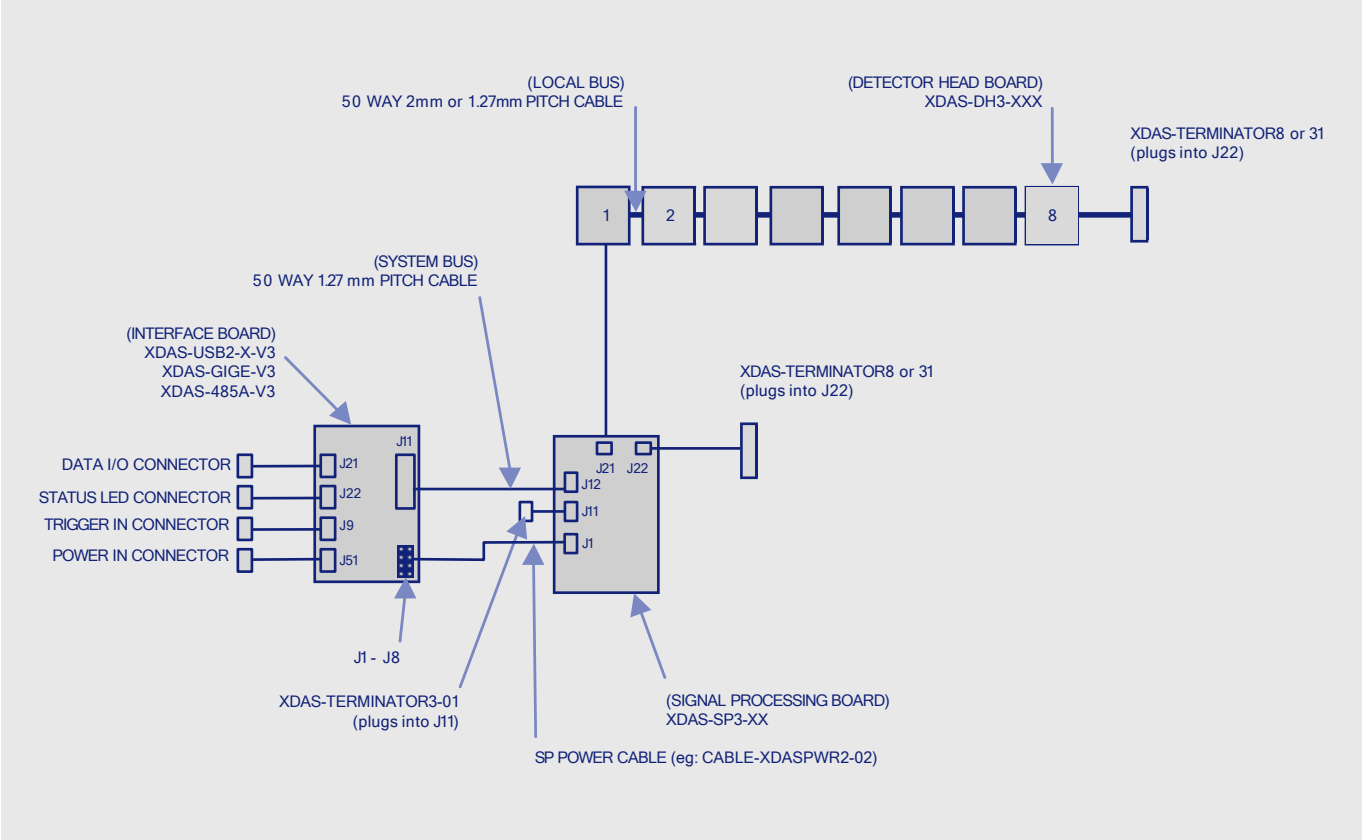


## SYSTEM BLOCK DIAGRAM



## SYSTEM CONFIGURATION

### SINGLE SP BOARD




Notes:-

1.Custom cable lengths available upon request

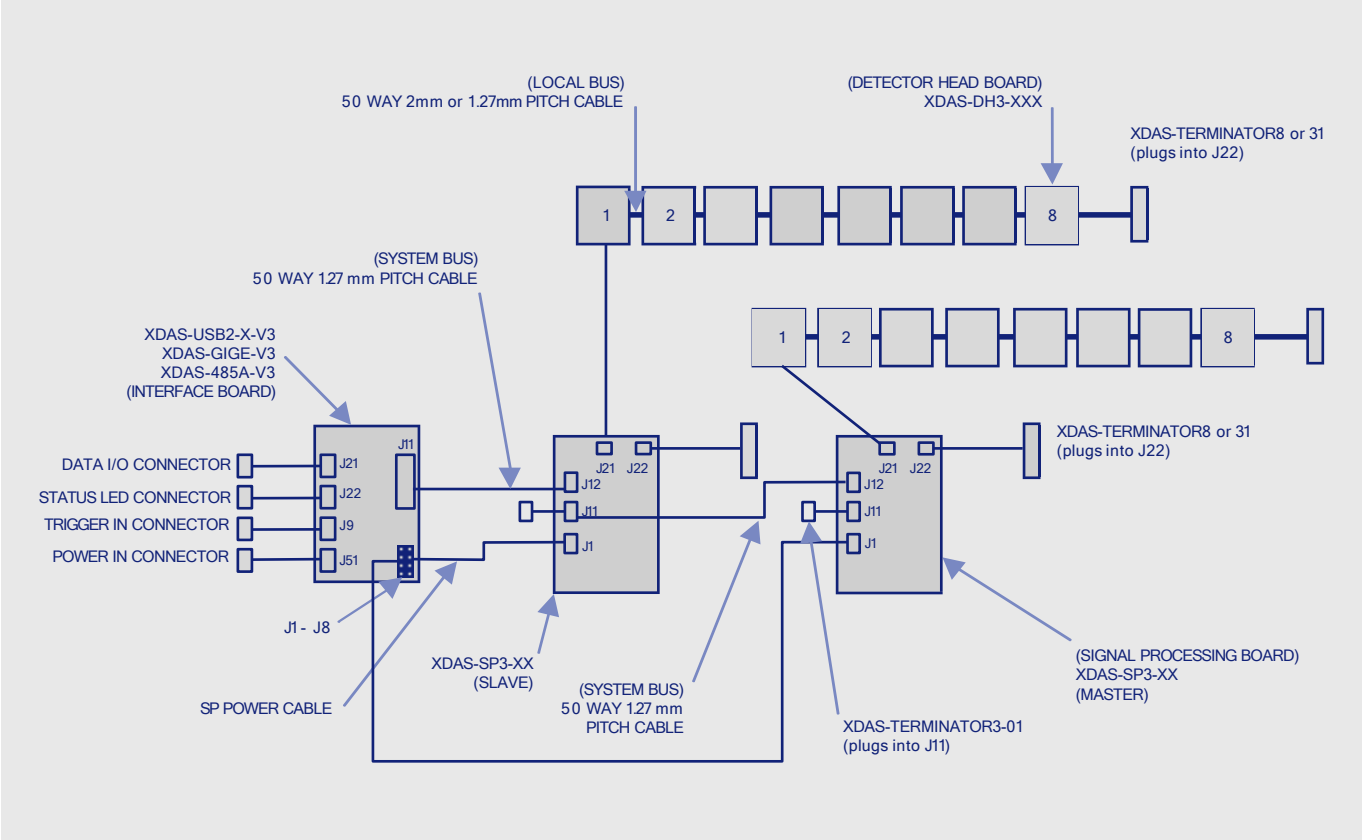
2. Narrow format boards use 1.27mm pitch connectors and 0.635 mm cable

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

## SYSTEM CONFIGURATION

### MULTIPLE SP BOARD




Notes:-

1.Custom cable lengths available upon request

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## DETECTORS

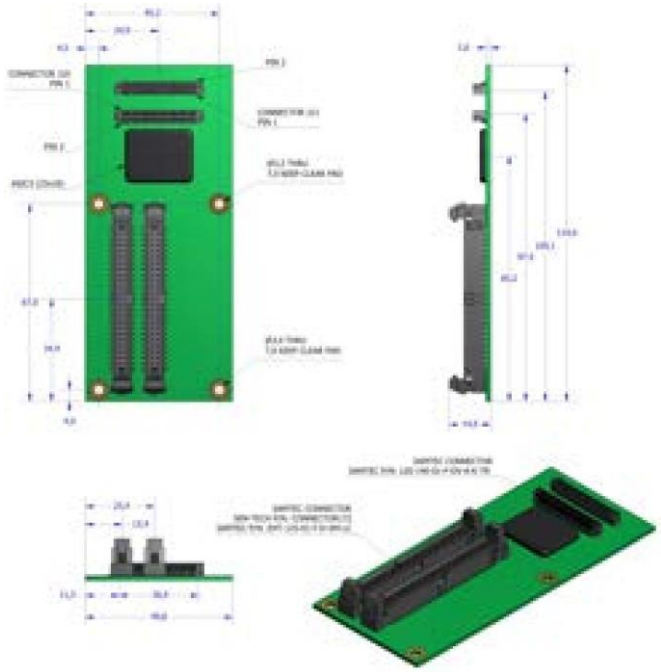
| TYPE OF SCINTILLATOR | THICKNESS | ENERGY RANGE | SIGNAL OUTPUT PER UNIT ENERGY | DECAY TIME CONSTANT | COMMENTS |
|---|---|---|---|---|---|
| Silicon | 0.30 mm | 5 - 30 keV | highest | 1 µs for unbiased diode | Direct conversion, no scintillator cost |
| Gadox (Tb) | 0.3 mm | 20 - 100 keV | similar to CSI | 2 - 3 ms | Phosphor strip, no pixellation required to prevent cross-talk |

Note 1:Thicknesses shown are of standard products. Other thicknesses are available on order which will cover wide energy ranges

## OUTLINE DRAWINGS

Note: Following drawings are for reference only. Contact Sens-tech for latest mechanical drawings and 3D CAD models.

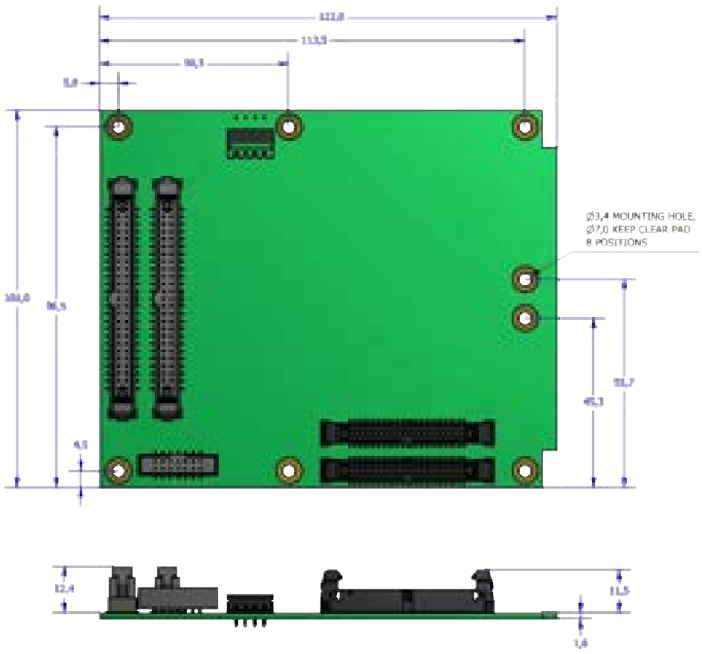
**XDAS-DH3-6x** **Standard footprint detector head board (mm)**



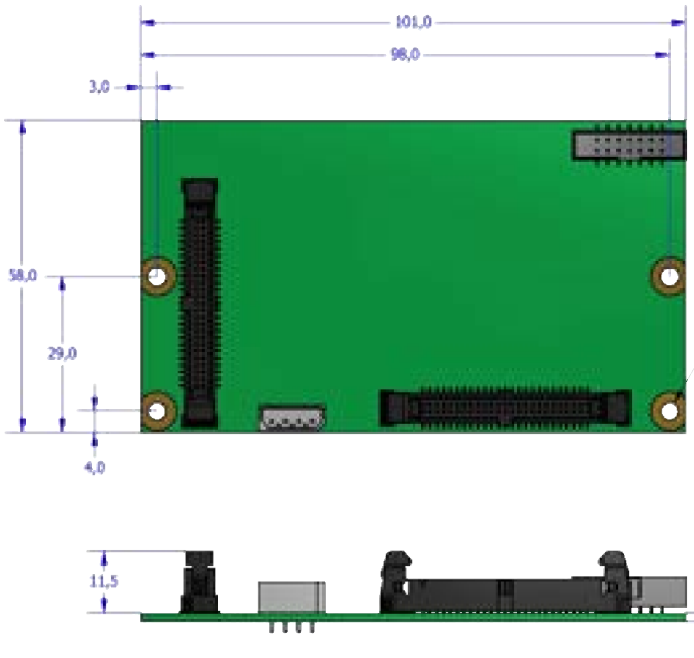
Note: Following drawings are for reference only. Contact Sens-tech for latest mechanical drawings and 3D CAD models.

## OUTLINE DRAWINGS CONTINUED...

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



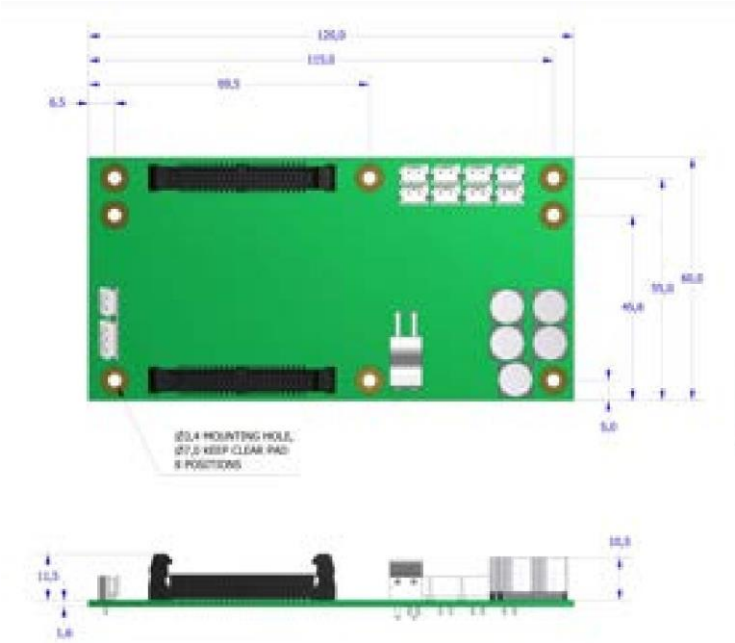

### XDAS-SP3-801 Small footprint signal processing board (mm)



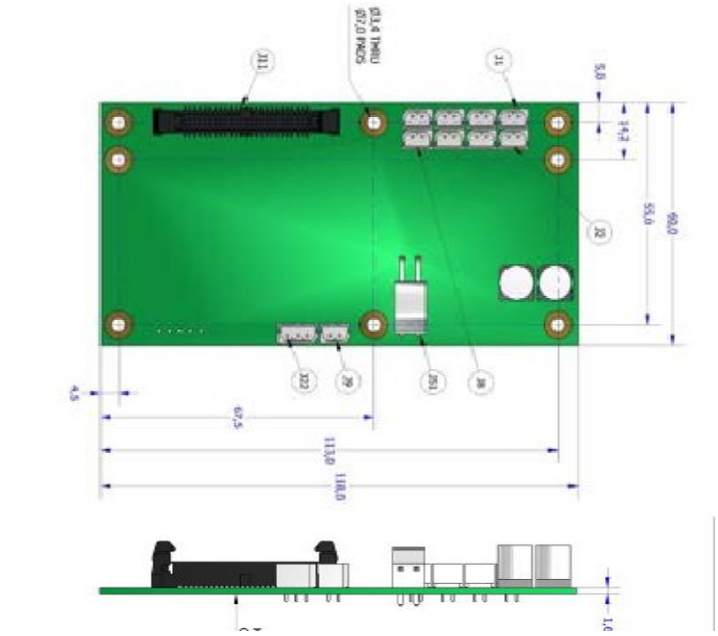

Note: Following drawings are for reference only. Contact Sens-tech for latest mechanical drawings and 3D CAD models.

## OUTLINE DRAWINGS CONTINUED...

### XDAS-485A-V3 Interface board



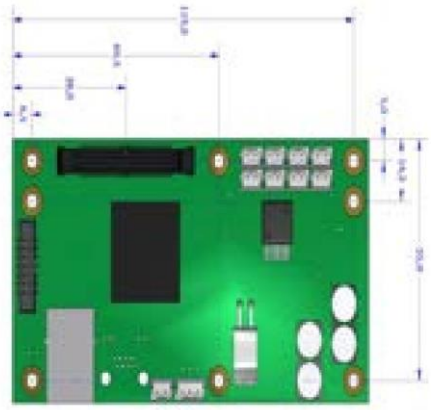
### XDAS-USB2-x-V3 Interface board



Note: Following drawings are for reference only. Contact Sens-tech for latest mechanical drawings and 3D CAD models.

## OUTLINE DRAWINGS CONTINUED...

### XDAS-GIGE-V3 Interface board



### LED STATUS MNEMONICS

| LED INDICATION | MEANING (USB) | MEANING (GIGE) |
|---|---|---|
| | Idle | Idle |
| | Acquiring data | Acquiring data |
| | Data buffer overflow. (Idle) | Connected to 100Mbps link. Not yet supported |
| | Data buffer overflow. (Acquiring) | Command received from host |
| | System under reset | System under reset |
| | Microcontroller not responding | Device fault. Contact support |
| | USB endpoint has stalled | Ethernet Link is not connected |
| | Could not enumerate as USB2.0 device | Ethernet link fault |
| | Power off, un-programmed or other fault | Power off, un-programmed or other fault |