

sensL



SPMMatrix

Silicon Photomultiplier Large Array
Detector and Readout Electronics

Overview



**256 channel
Silicon Photomultiplier
large area using matrix
readout system**

The SensL Matrix detector (SPMMatrix) is the largest area, highest channel count, Silicon Photomultiplier detector on the market today. It consists of a 61.28mm x 61.28mm Silicon Photomultiplier detection area using SensL's SPMArray4 detectors mounted onto a matrix board which provides bias to each array. Two analog boards each containing 16 analog channels provide amplification, discrimination and energy sampling. The SPMMatrix is also supplied with an FPGA board which implements cross-wire logic time stamping and readout/buffering events to the USB or openPET bus. It also contains SensL's power board to provide the necessary bias to the arrays. The SPMMatrix is the ultimate large area SPM detection system on the market today and for easy portability, it is supplied in a handy travel briefcase.

Features and Benefits

- 61.28mm x 61.28mm Large Area Silicon Photomultiplier
- 256 Multichannel SPM detector
- 3mm x 3mm individual pixels
- Uses SensL's [SPMArray4](#)
- Detectors Socket Mount
- 3MHz max count rate
- Cross-wire readout
- 12 bit Energy sampling ADC
- 500ps precision time stamp
- Direct USB interface to PC/ openPET interface
- GUI software
- 2Mbyte Data Buffer
- Power by single +5V supply, <1A current consumption (supplied)
- Compatible with [OpenPET](#) Architecture
- Supplied in a briefcase for portability

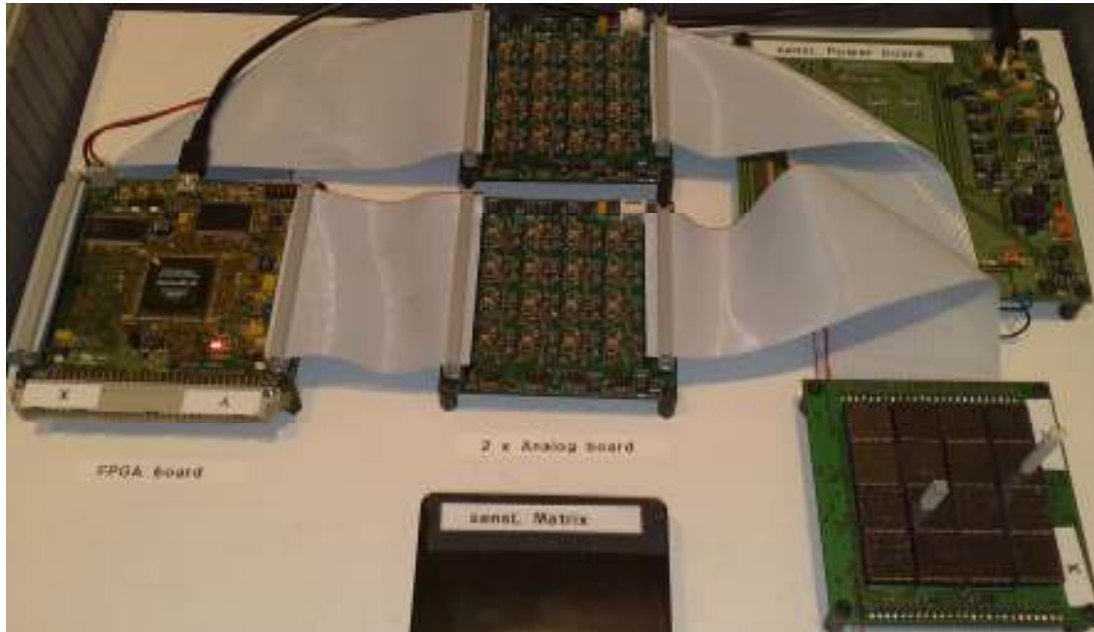
Applications

- PET Camera
- Radiation Imaging
- Nuclear & Particle Physics
- Mammography
- Gamma Camera
- SPECT
- X-Ray
- Scintillation Crystal Readout



SensL's [SPMArray4](#) - 16 element Silicon Photomultipliers
used in a 4x4 panel for SPMMatrix

Contents of the SPMMatrix



5 Boards

- Matrix Board
- Analog Board (x 2)
- FPGA Board
- Power Board

Matrix Board

The Matrix Readout System consists of the following:

- Matrix board with 16 x SensL SPMArray4 pixel arrays.
- 16-channel bias trimming DACs (1 per array), allowing individual bias trimming.
- 16 channels of row and 16 channels of column high-speed AC-coupled transimpedance preamplifiers providing effective transimpedance gain of 250ohm.
- Rows and columns summed in cross-wire readout scheme

Analog Board (x 2)

Two identical 16-channel boards are used to handle row and column signals.

- Each readout channel implements a fast/slow shaper architecture.
- The fast shaper implements a wideband amplifier with a gain of 2 providing the signal to the discriminator.
- The discriminator can be configured to have either positive or negative threshold thus enabling it to support either the row or column signals.
- The slow shaper provides CR-RC shaping of the signal with time constants of $CR=1\mu s$ and $RC=0.25\mu s$. Such shaping allows the system to obtain an energy estimate from a gamma interaction event in a fast scintillator such as LSO/LYSO.
- The output of the slow shaper is connected to energy sampling 12-bit, 3Msps serial ADC. To allow the analog board to be used on either the row or column side, the ADC's input baseline is maintained at the centre of the input range of the ADC. This allows sampling of positive or negative pulses.

Contents of the SPMMatrix (Continued)

FPGA Board

The FPGA board provides:

- Decoding of both the X and Y side discriminator signals
- Reading of ADC energy values
- FIFO interface, using 2 MB RAM for communication with a PC via a high speed USB port
- Additional OpenPET compatible interface operates simultaneously
- In addition, the FPGA board provides logic and PC interfacing for configuration control, allowing the host PC to set individual bias offsets for each SPM array and individual discriminator thresholds for each discriminator on both 'analog' boards.

Power

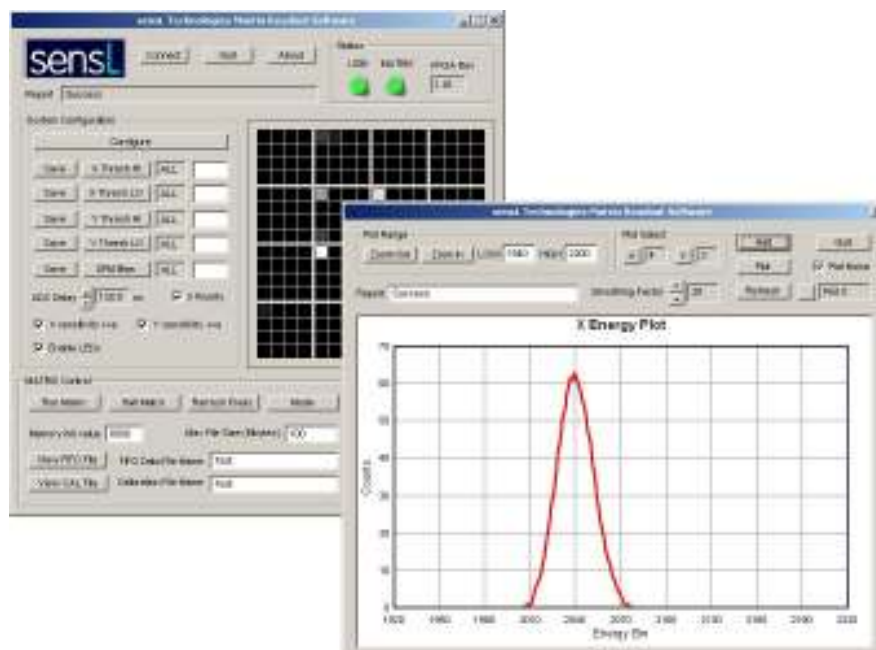
- The boards have to be provided with +5V, 1Amp power and additionally -30V, 10mA bias. In the Matrix Readout system pictured, the -30V bias is generated from +5V by sensL power board. These are supplied with the SPMMatrix.

Software

The support software package (**compatible with the [SPMArray4](#)**) includes a comprehensive set of DLL drivers plus an easy to use GUI*.

The GUI allows:

- Easy setup and storage of DAC values for bias and threshold settings.
- Streaming of event data to file.
- Real-time graphic representation of events and intensity of energy on the Matrix.
- Automatic calibration of background noise.
- Real-time energy histogramming of both row and column event signals



See image on Page 5

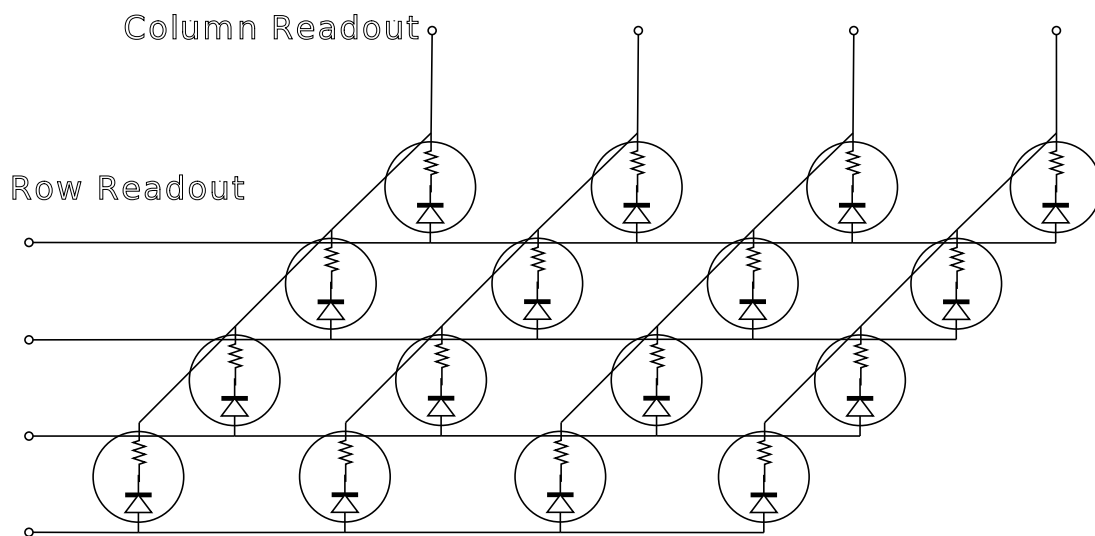
*Please note that the GUI is for demonstration purposes only. It is intended to demonstrate the SPMMatrix functionality. Users will want to write their own software to use the included DLLs.

Matrix Readout Principles

The matrix readout system (**compatible with the [SPMArray4](#)**) demonstrates how to reduce readout channels using a principle known as 'cross-wire' applied to an array of SPMs. This principle is used primarily in the readout of charged particle detectors (silicon micro-chip detectors) and gamma imaging.

To explain the principle, consider an NxN matrix of SPM detectors wired in such a way that:

- all anodes of the same column devices are united to form set of the column "row" outputs
- all cathodes of the same row devices are united to form set of the row "column" outputs.
- *An example of such wiring for 4x4 sensor matrix is presented in Figure*



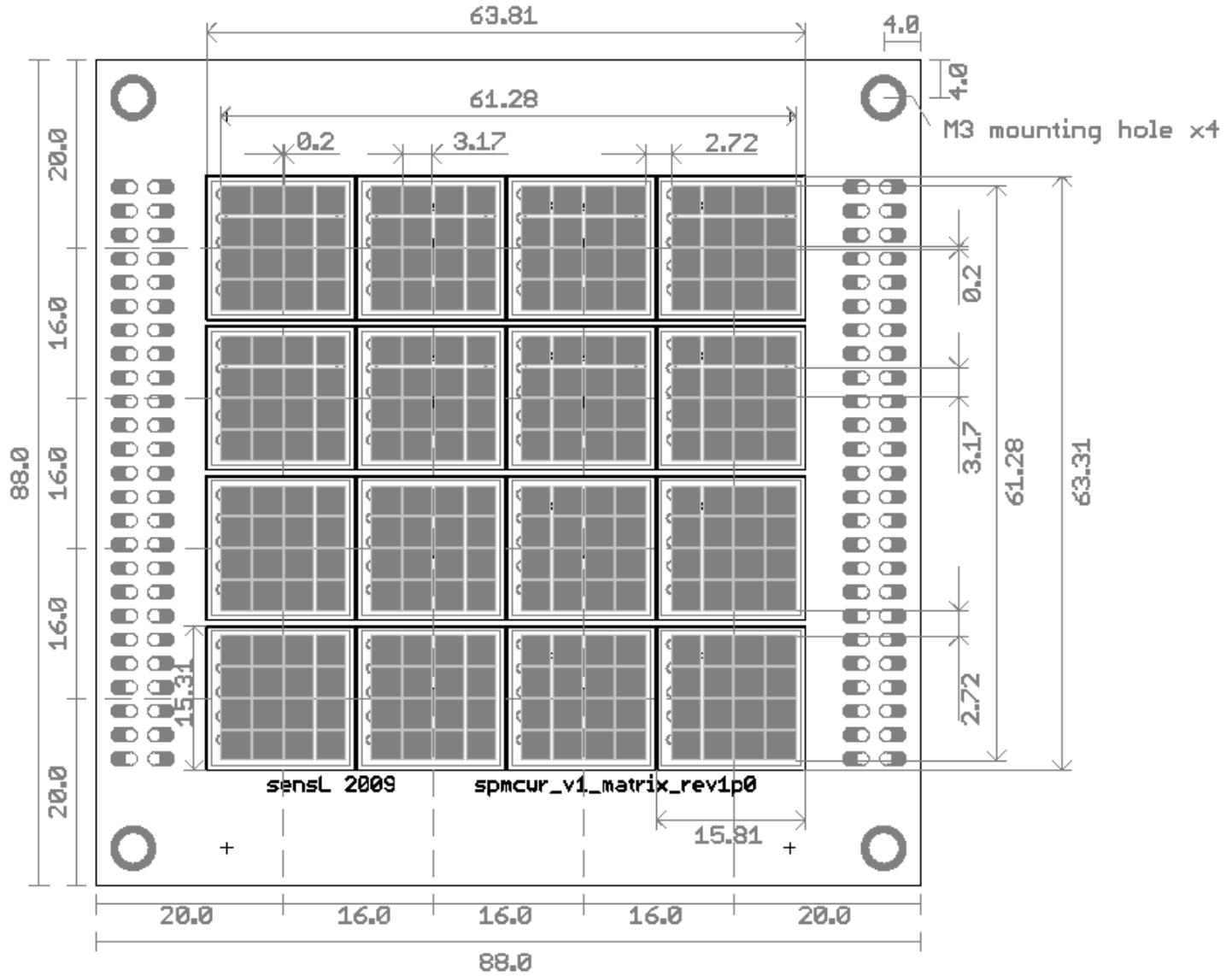
If one of the devices 'fires' in response to light applied to that device, it will generate a current pulse in one of corresponding row and column outputs. This allows the specific device to be determined unambiguously by its unique row. column signature.

The main reason for the use of the cross-wiring technique is to reduce the number of readout electronics channels. The reduction factor is $2 \cdot \sqrt{N}$ where N is the number of detectors in the array. For the SPMMatrix, only 32 readout channels are required for a 256 pixels array corresponding to a channel reduction factor of 8.

Ordering Information

Product Code	Description
SPMMatrix	4x4 array of SPMArray4 (256 channels) with cross wire row and column readout (pre-amp, comparator, analog to digital converter), FPGA digitization of signal (USB and openPET) with power supply board. Included in convenient carry case. GUI and DLL included.

SPMMatrix Detection Head Dimensions:



Dimensions in mm

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