

4-Side Scalable Silicon Photomultiplier Array

SensL introduces its 16-element Silicon Photomultiplier Array. It is based upon a 4x4 arrangement of 3mm SPM pixels which are mounted in a low profile ceramic package. The ArraySL-4 permits close packing on all four sides allowing for a detection area that can be as large or small as required by the specific application. It is the first commercially available detector of its kind and will be of particular interest to developers of imaging systems for PET, gamma cameras, nuclear hazard and threat detection and fluorescence measurements.

The ArraySL-4 utilizes a non-magnetic sensitive package that has been developed using Ni free processing and low magnetic susceptible materials. A 20-pin grid array (PGA) is employed for electrical I/O's to the user's printed circuit board or to a standard test socket connector which is available as an optional extra. The pixel array is over-molded with epoxy to completely encapsulate the pixels, bondwires and substrate bondpads. The pixel bias and readout configuration has been designed to allow for both differential and single channel readout electronics to optimize signal-to-noise ratios for PET applications.

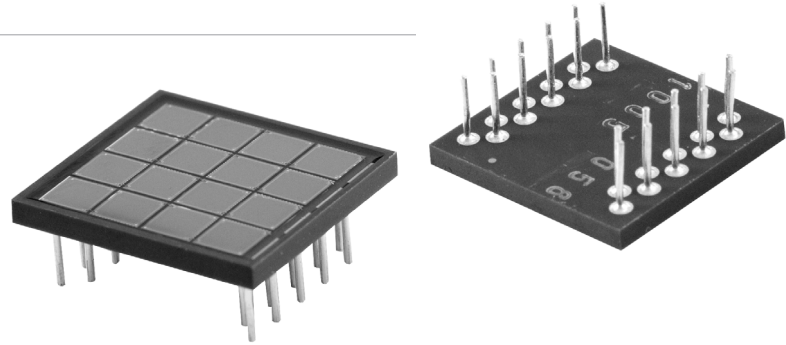
The performance characteristics and specification of each pixel in the array are identical to SensL's standard range of 3mm MicroSL SPMs. The ArraySL-4 is sensitive to visible light in the range of 400nm to 850nm and is suited to applications requiring either direct light detection or radiation detection via scintillators. Whether the application requires a 1D array for spectrometry or a 2D array for imaging, the ArraySL-4 is an attractive solution and an ideal replacement for MCPs, multi-anode PMTs, APDs, and existing discrete SPM products.

PIXEL CHARACTERISTICS

Pixel chip area	3.16 x 3.16 mm ²
Pixel active area	3.05 x 3.05 mm ²
Operating voltage (typical)	29.5V
Peak wavelength	500nm
Signal rise time	<2ns
Microcell recovery time	131ns
Pixel gain*	2.4x10 ⁶
Number of microcells per pixel	4774
Photon detection efficiency* [†]	14%
Dark current*	3μA

*At the typical operating voltage and room temperature

[†] Includes the effects of crosstalk and afterpulsing



FEATURES AND BENEFITS

- **Form Factor** – Smallest form factor package on market today using a unique low profile, ceramic package with minimal deadspace on all four sides.
- **Pixel Array Fill Factor** – Best fill factor in market today with 200 micron deadspace between pixels
- **Proven Performance** – 14% energy resolution at 511keV using L(Y)SO for nuclear medicine applications
- **Uniformity** – Superior uniformity compared to a PMT
- **Flexible** - The ArraySL-4 design is compatible with both pixellated and summed readout and can be configured with single ended, differential and X-Y differential preamplification electronics.
- **Magnetic Free Package Design** – Magnetic free materials used in package. Ni free processing and Cu pin Alumina ceramic package not visible to MRI systems at 1.5 and 3 Tesla.
- **External Cooling** – Package has been designed so that an external TEC controller can be placed under the package for moderate cooling applications, i.e reduced temperature operation (5-10°C) and/or temperature stabilization.
- **Interface Connections** – Pin compatible package design with standard test sockets available on market today.

ARRAY CHARACTERISTICS

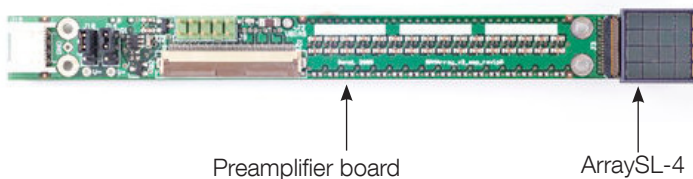
Array layout	4 x 4 pixels
Total array active area	13.4 x 13.4 mm ²
Pixel to pixel spacing	200µm
Pixel pitch	3.36mm
Pixel thickness	450 ± 25µm
Ceramic type	Alumina Al ₂ O ₃
Ceramic color	Black
Ceramic base	500µm
Ceramic package size	15.81 x 15.31 mm ²
Ceramic package height	1.5mm
Electrical I/Os	Cu Pin Grid Array (PGA)
Frame height	1000µm
Pin spacing	1.27mm
Epoxy encapsulant	Epotek 301-2FL
Epoxy thickness	<500µm
Epoxy refractive index ¹	1.569
Epoxy spectral transmission ²	>98%
Upper and lower limit of epoxy w.r.t package edge	+100µm convex, -200µm concave
Surface flatness range	300µm

¹ At 543nm, cured epoxy as measured by J. Va'vra, DIRC Note #140

² At 550 - 900nm, from Epotek datasheet

PREAMPLIFICATION BOARD

The ArraySL-4 can be ordered with the option of a 16-channel preamplifier board (Array4-EVB-PreAmp) that provides differential voltage outputs for each of the pixels in the array. The preamplifiers are implemented using Analog Device's AD8132 chips. Use of a differential output amplifier allows use of the compact FFC cable reducing channel-to-channel crosstalk and sensitivity to ground potential variations across the system compared with a single ended amplification system. It also incorporates a regulator that takes a nominal input voltage and steps it down to provide the optimal bias voltage for the array.

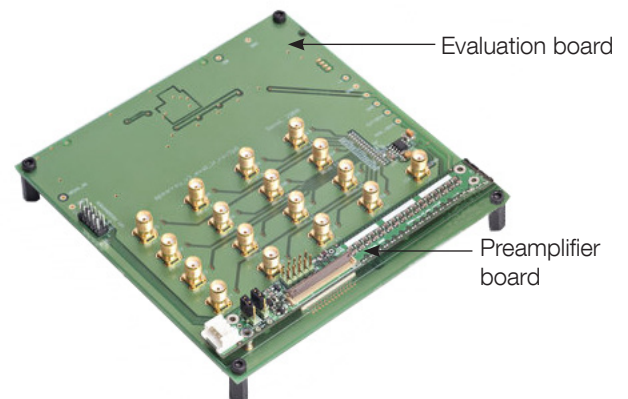


PREAMPLIFICATION BOARD CHARACTERISTICS

PCB area	13.6 x 147.6mm ²
Preamp chip	AD8132
Output type	differential
Power supply (default): (min/max):	+/- 3.3V +/-2.7V to +/-5V
Output connectors	- 50-way FFC - 80-way board-to-board connector
Power input	- FFC - 4-pin Sherlock connector - Board-to-board connector
Bias input range	+34V to +40V (50mA max)

EVALUATION BOARD

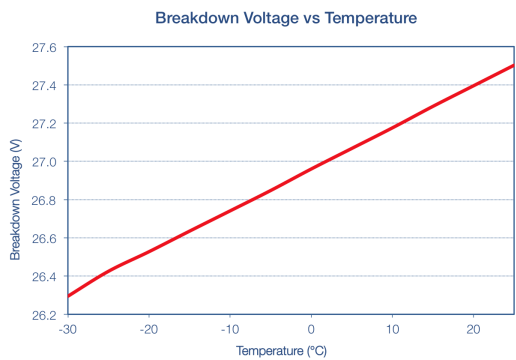
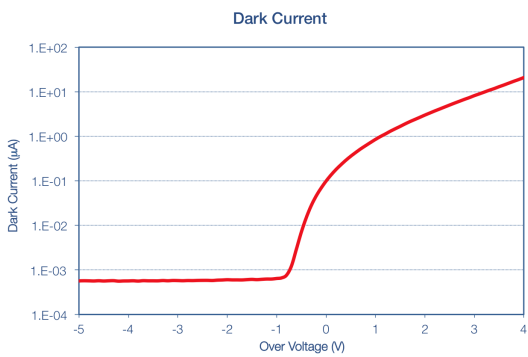
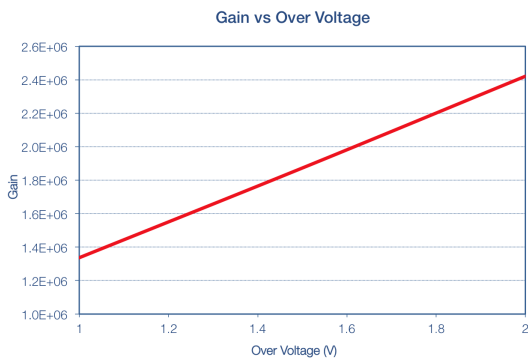
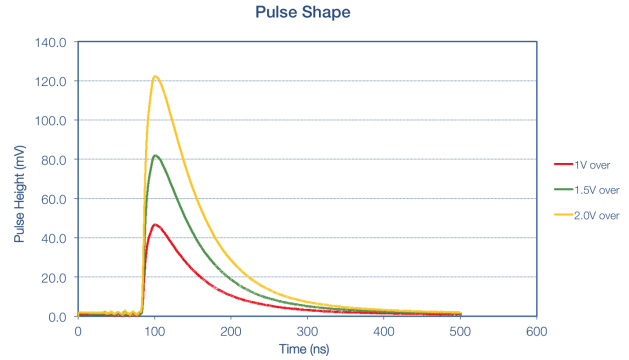
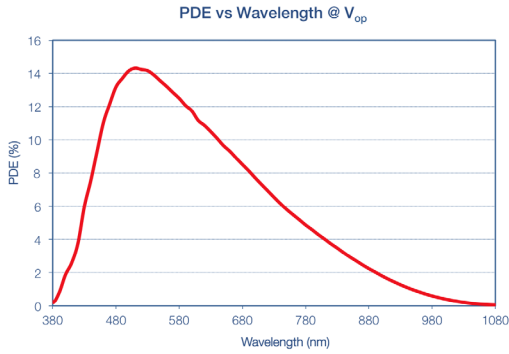
An additional option available for the ArraySL-4 is the evaluation board (Array4-EVB-PixOut). It connects to the preamplifier described above via the 80-way board-to-board connector then makes the output signals available via SMA connectors for fast and easy evaluation, e.g. via oscilloscope. It has the additional benefit of being able to extract either a single, summed signal or all of the 16 pixel signals individually. In this way, the evaluation board allows the ArraySL-4 to function as either a single channel or multi-pixel device respectively. There is on board regulation to provide the +/-3.3V and +36V for the preamplifier board power and bias.



EVALUATION BOARD CHARACTERISTICS

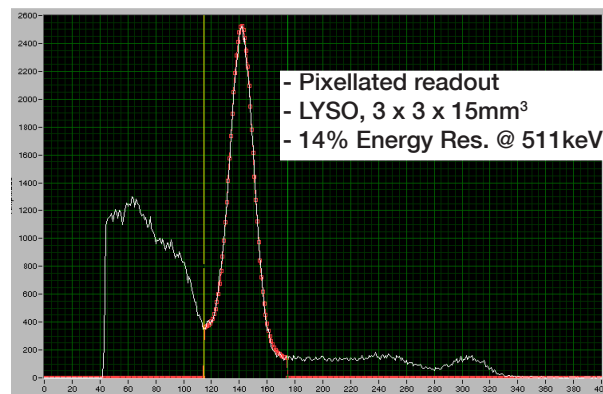
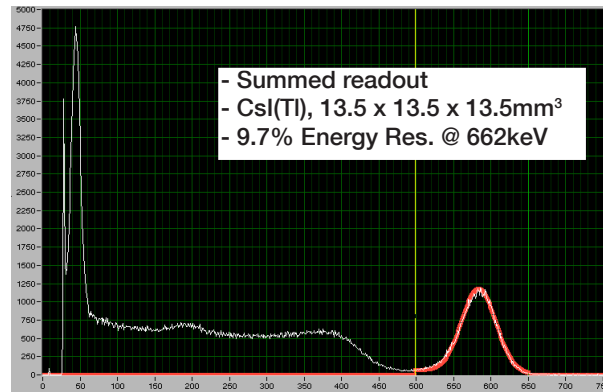
PCB area	130 x 123.7 mm ²
Connection to preamp. board	80-way board-to-board connector
Power supply	6V DC from AC adapter
Output connectors	SMA

PERFORMANCE PLOTS

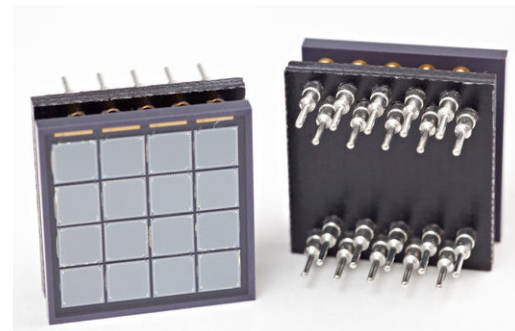
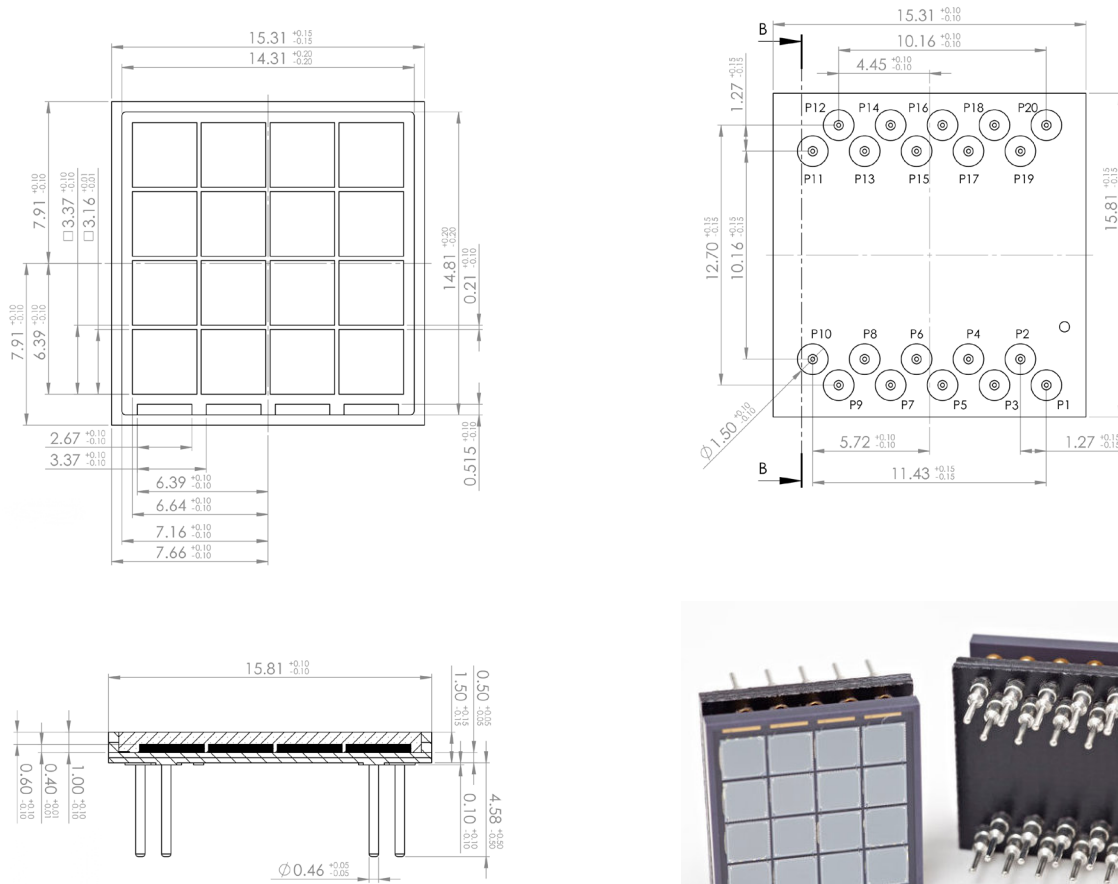


GAMMA RAY SPECTRA WITH SCINTILLATORS

Below are energy loss spectra obtained by coupling scintillation crystals to the ArraySL-4 for the purpose of gamma ray spectroscopy.



SCHEMATICS (All Dimensions in mm)



The image above shows the ArraySL-4 connected to the **Array-Opt-PGA20P** socket option.

ORDERING INFORMATION

Product Code	Description
ArraySL-4-30035-CER	4X4 element array of 3mm SPMs (type MicroSL-30035) mounted in 20-pin ceramic package
Array4-EVB-PreAmp	16-channel preamplifier board for ArraySL-4
Array4-EVB-PixOut	Evaluation board for ArraySL-4 for pixellated or summed signal output
Array-Opt-PGA20P	20-pin straight terminal SMT socket