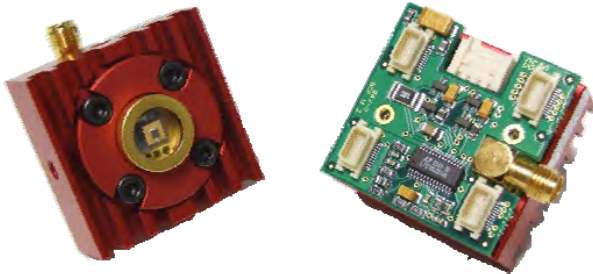


Overview



The SPMMini is the first solid state alternative to the long established Photomultiplier Tube (PMT). It combines the high gain (10^6) and high quantum efficiency of the PMT with the well appreciated benefits of silicon including size, low operating voltage, robustness, reliability, magnetic field insensitivity, tolerance of excess/ambient light, and suitability for miniaturization. In addition, the detector has high signal to noise and fast timing properties.

The detector consists of an array of Geiger mode Avalanche Photodiodes (APDs), each individually coupled to integrated quench electronics, and is a type of detector commonly referred to as a Silicon Photomultiplier (SPM). The Geiger mode APD microcells have extremely high internal amplification that allows single photon sensitivity at room temperature. The output of a Geiger mode APD is an identical, fixed charge or current pulse for each single photon detected. By connecting an array of Geiger mode APDs in parallel, the summed output becomes proportional to the number of Geiger mode pulses and hence proportional to the incident photon flux.

The uniform high gain across the array allows the single photoelectron peaks to be clearly resolved permitting both single photon detection and accurate calibration of the photon number. The SPMMini has add-on modules available to enhance functionality, including a Peltier cooler driver circuit to enable cooling to -20°C and a variety of amplifier circuits, including a transimpedance option for CW applications, and pulse amplifier circuits for pulsed applications and applications where it is desirable to see the individual photon peaks, an integrated power supply and an enclosure for CE certification.

The detector die is mounted on a Peltier cooler and housed in a hermetically sealed TO8 can. During normal operation the SPMMini is cooled to -20°C . This allows even greater performance over room temperature operation as the dark rate is typically reduced by an order of magnitude. It is available with an active area of $1\times 1\text{mm}^2$ or $3\times 3\text{mm}^2$. Two microcell sizes are offered, $20\mu\text{m}$ and $35\mu\text{m}$, to match the detection efficiency and dynamic range requirements of your application.

The features and applications for the SPMMini detectors are summarized below. Whether you are an OEM or a researcher, and your application is a portable/miniature instrument, a large area radiation detection application or a high tier laboratory analysis instrument, the SPMMini will provide significant benefit over existing detector platforms.

Features

- High gain (10^6)
- Low bias voltages (30V)
- Fast rise time ($\sim 5\text{ns}$)
- Low dark count rate ($< 1\text{MHz}/\text{mm}^2$)
- High S/N
- Not damaged by excess/ambient light
- Large area up to 9mm^2
- Minimal electronics requirement
- Compact, rugged, and stable
- Insensitive to magnetic fields
- Integrated Cooling (Option)
- Transimpedance or Pulse Amplifiers (Option)
- Integrated Power Supply (Option)
- Mechanical enclosure making the complete unit CE compliant (Option)

Applications

- Fluorescence Lifetime Measurement
- Biological Sensors
- Scanning Microarrays
- DNA Biochips/Sequencing
- Proteomics/Protein Biochips
- Point-of-Use Biological Agent Detection
- Confocal Microscopy
- Nuclear Medicine
- Environmental Monitoring
- Nuclear Radiation Detection
- Homeland Security
- High Energy Physics
- Flow Cytometry
- Capillary Electrophoresis
- Range Finding

https://web.archive.org/web/20071117030155/http://www.sensl.com/pdfs/Datasheets/SPMMini_Datasheet.pdf

General Specifications

Parameter	Min	Typical	Max	Units	Test Conditions
INPUTS					
Input Voltage 1 (+5V)	4.9	5.0	5.1	V	Typical current 50mA
Input Voltage 2 (-5V)	-4.9	-5.0	-5.1	V	Typical current 50mA
Input Voltage 3 - Detector Operating	26.8	28.8	30.8	V	Typical current 0.05mA; @ 20°C
Breakdown Voltage (V_{br})	26.3	26.8	27.3	V	At -20°C
OTHER					
Spectral range	400	500	1100	nm	Peak $\lambda = 520\text{nm}$
Operating Temperature	-20	-	40	°C	
Storage Temperature	-30	-	85	°C	
Input Voltage 1 (5V)	4.9	5.0	5.1	V	Cooling Board Option (typical currents) 200mA at normal operation, 700mA at startup
Cooling Time		10		s	Cooling Board Option (from room temperature)
Temperature Setpoint Stability	-20.1	-20	-19.9	°C	Cooling Board Option

Module Specifications

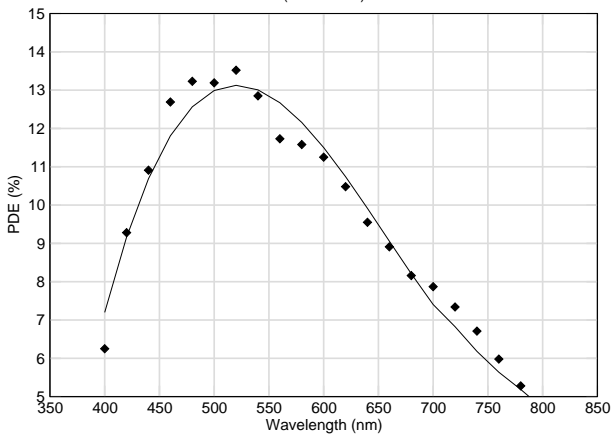
Typical Values	Part Number								Units	Test Conditions
	SPMMini 1000X03A1	SPMMini 1000X03A3	SPMMini 1000X06A1	SPMMini 1000X06A3	SPMMini 3000X03A1	SPMMini 3000X03A3	SPMMini 3000X06A1	SPMMini 3000X06A3		
Chip Area	1.14x1.14	1.14x1.14	1.4x1.4	1.4x1.4	3x3	3x3	3x3	3x3	mm ²	-
Active Area	1x1	1x1	1x1		2.85x2.85	2.85x2.85	2.85x2.85	2.85x2.85	mm ²	-
Operating Voltage (typical)	28.8	28.8	28.8	28.8	28.5	28.5	28.5	28.5	V	+2V above V_{br} , $\lambda = 520\text{nm}$; @ -20°C
Detector Responsivity (typical)	40K	-	-	-	35K	-	-	-	A/W	+2V above V_{br} , $\lambda = 520\text{nm}$; @ -20°C
Microcell Gain	1×10^6	1×10^6	$>1 \times 10^6$	$>1 \times 10^6$	1×10^6	1×10^6	$>1 \times 10^6$	$>1 \times 10^6$	-	-
Preamplifier Board Gain	470	20	470	20	470	20	470	20	-	50Ω load
Max Output Voltage	2	2	2	2	2	2	2	2	V	50Ω load
NEP	6.5×10^{-15}	6.5×10^{-15}	-	-	5.84×10^{-14}	5.84×10^{-14}	-	-	WHz ^{-1/2}	+4V above V_{br} , $\lambda = 520\text{nm}$
Dynamic Range	10^3	10^3	10^3	10^3	$>10^3$	$>10^3$	$>10^3$	$>10^3$	-	-
Linear Range	10^2	10^2	10^2	10^2	10^2	10^2	10^2	10^2	-	-
Cut-Off Frequency	1	10	1	10	1	10	1	10	MHz	-
Output Capacitance	130	130	130	130	130	130	130	130	pf	source
Output Impedance	50	50	50	50	50	50	50	50	Ω	-
Number of Microcells	1144	1144	520	520	8640	8640	3640	3640	-	-
Photon Detection Probability	21	21	21	21	21	21	21	21	%	+2V above V_{br} , $\lambda = 520\text{nm}$
Geometric Efficiency (F)	43	43	60	60	43	43	60	60	%	-
Photon Detection Efficiency	9-21	9-21	13-30	13-30	9-21	9-21	13-30	13-30	%	$\lambda = 520\text{nm}$, @ +1V to @ +4V range
Temp. Dependence of V_{br}	23	23	23	23	23	23	23	23	mV/°C	-
Single Photon Pulse	-	5	-	10	-	15	-	20	ns	Leading Edge (typ.)
Single Photon Pulse	-	20	-	40	-	50	-	100	ns	Falling Edge (typ.)

https://web.archive.org/web/20071117030155/http://www.sensl.com/pdfs/Datasheets/SPMMini_Datasheet.pdf

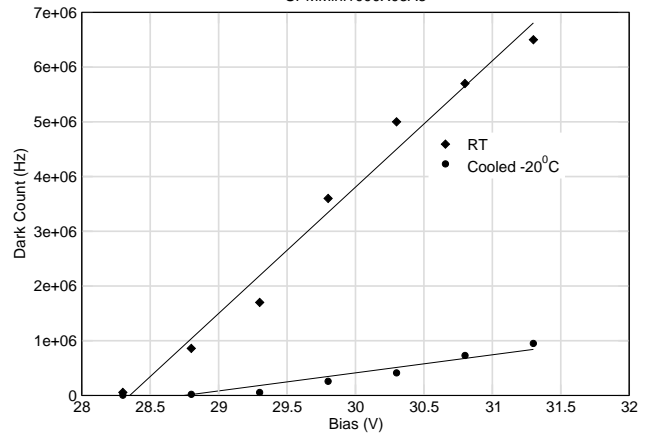
Technical Information (SPMMini1000X03A1 and A3)

For a full explanation of the effects of the different parameters on the detector's performance, see [SPM Technical and Application Notes](#) on our website.

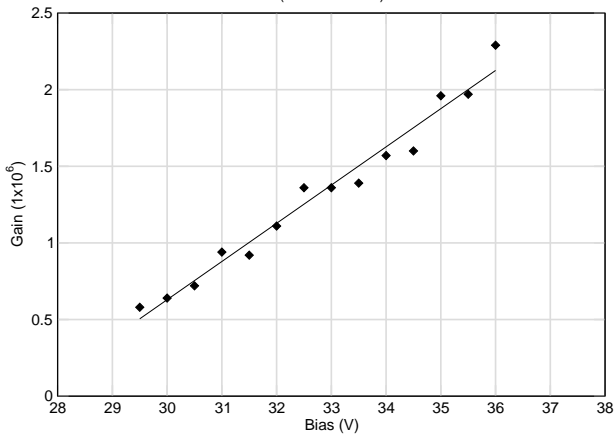
PDE vs. Wavelength
($\lambda = 520\text{nm}$)



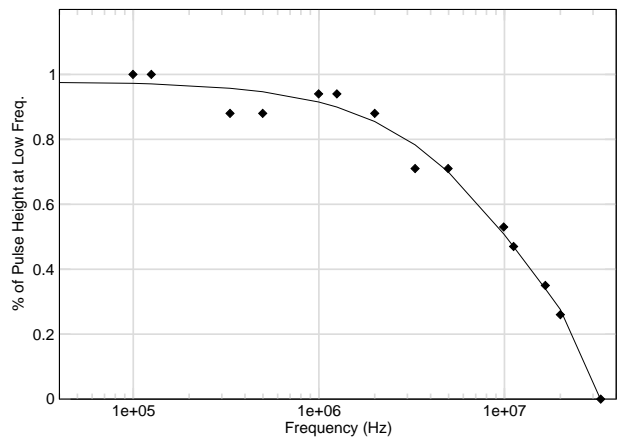
Dark Rate vs. Bias
SPMMini1000X03A3



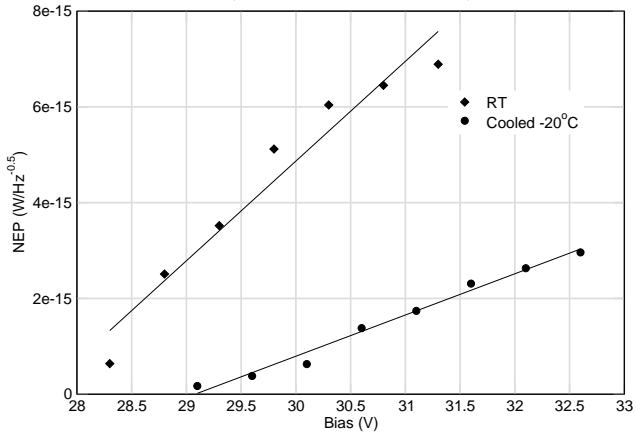
Gain vs. Bias Voltage
(SPMMini1000)



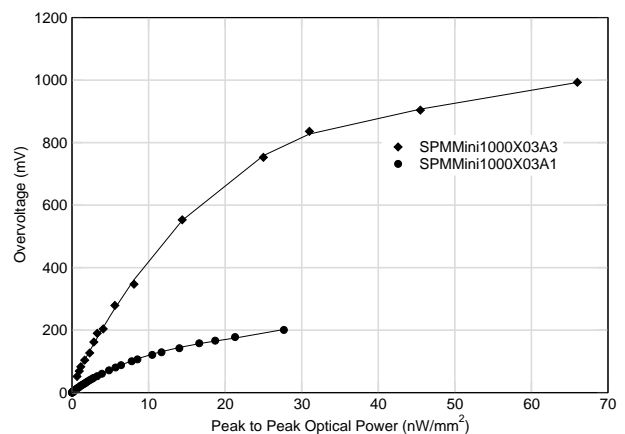
Bandwidth SPMMini1000
($\lambda = 520\text{nm}$; overbias +3V)



NEP vs. Bias
(SPMMini1000X03A03; $\lambda = 520\text{nm}$)



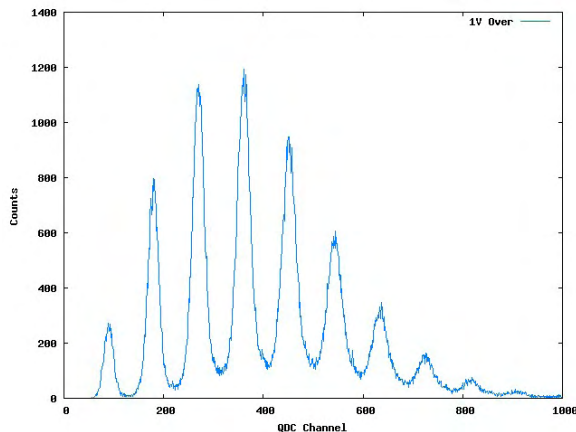
Dynamic Range vs. Optical Power



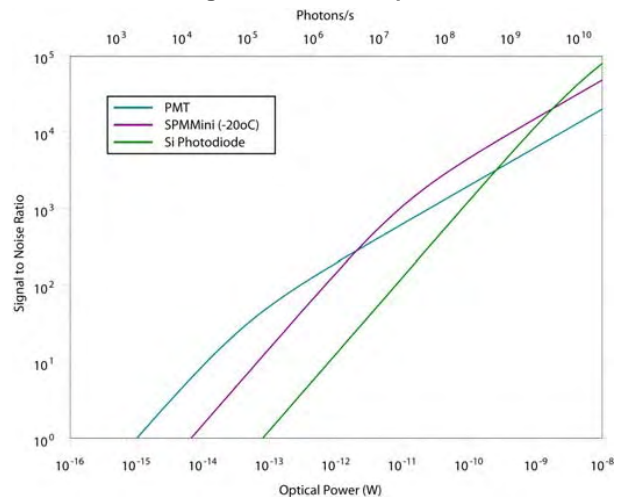
https://web.archive.org/web/20071117030155/http://www.sensl.com/pdfs/Datasheets/SPMMini_Datasheet.pdf

Technical Information

Single Photoelectron Spectrum



Signal to Noise Comparison



Technical Information: Preamplifier Options

To benefit from the high gain responsivity it is necessary to use circuitry which can convert the current flowing through the array into a voltage which can be readily processed with standard electronics. Given the high gain inherent in the SPM, it is possible to use pre-amplifier boards of either current or voltage amplification. This has resulted in two different preamplifier configurations available from SensL.

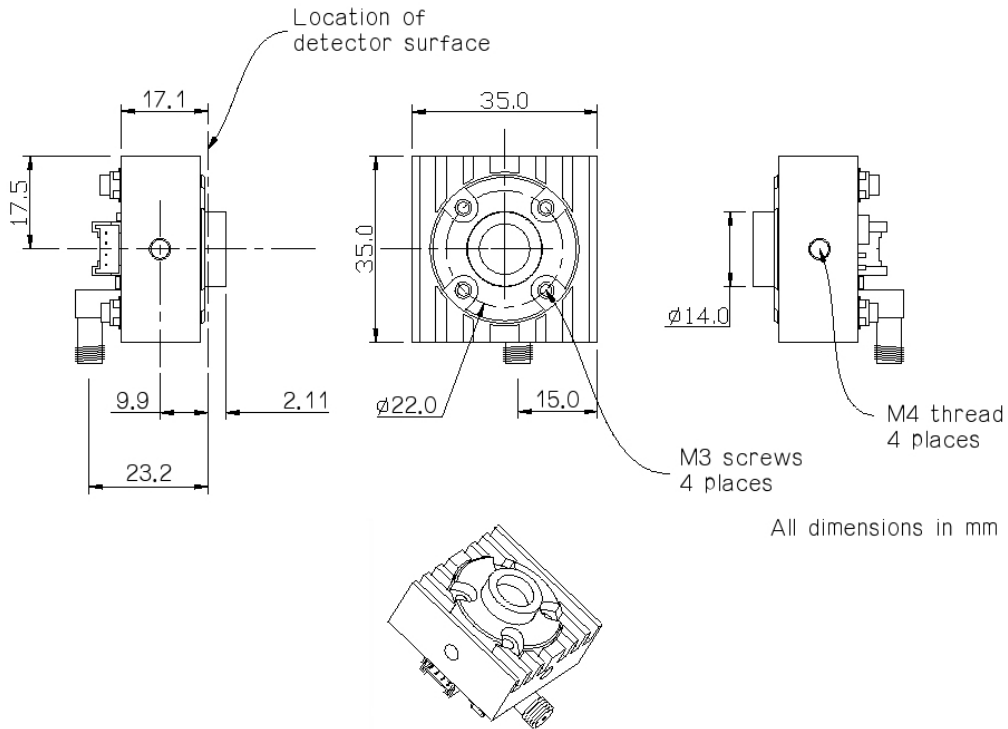
Transimpedance Amplifier (TIA)

The transimpedance preamplifier can convert the raw current from the SPM into a voltage. The typical gain for a SensL transimpedance amplifier is 470V/A. This board is ideal for applications that require detection of continuous signals where integration of the signal is done over time. One application is cell imaging or DNA micro-arrays where it is desired to integrate the optical signal from a sample for periods from 1 μ s to 1ms in time. This can be accomplished easily with the SensL transimpedance preamplifier.

Pulse Amplifier (Pulse)

In situations where the signal is a pulse input, such as ranging applications or scintillation experiments, SensL has developed the pulse amplification preamplifier. This allows the fast rise time of the detector to be exploited and provides the simplest way to accurately bring pulse information to the user. The SensL SPM is coupled to a high-speed pulse preamplifier that uses an internal gain of 20. This signal is then output to the user via a DC blocking capacitor to convey pulse information originating in the SPM.

Mechanical Information



Ordering Information

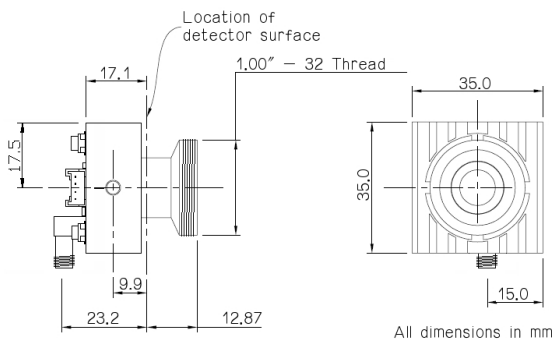
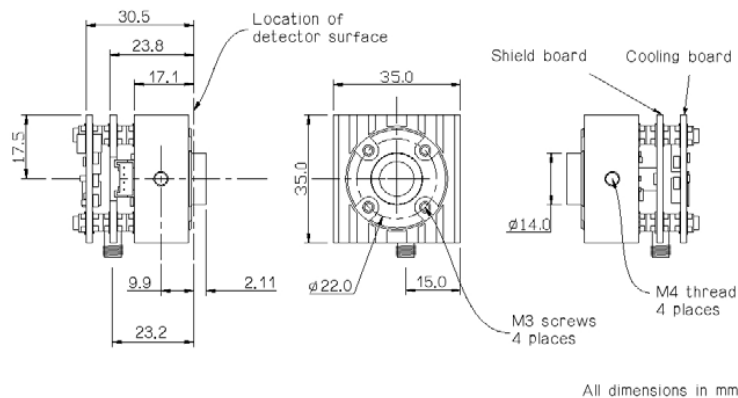
PRODUCT NUMBER	DESCRIPTION
SPMMini1000X03A1	Module Base: TIA amplifier, 1mm ² sensor, 20 μ m microcell in T08 Can (with Peltier cooler)
SPMMini1000X03A3	Module Base: Pulse amplifier, 1mm ² sensor, 20 μ m microcell in T08 Can (with Peltier cooler)
SPMMini3000X03A1	Module Base: TIA amplifier, 9mm ² sensor, 20 μ m microcell in T08 Can (with Peltier cooler)
SPMMini3000X03A3	Module Base: Pulse amplifier, 9mm ² sensor, 20 μ m microcell in T08 Can (with Peltier cooler)
SPMMini1000X06A1	Module Base: TIA amplifier, 1mm ² sensor, 35 μ m microcell in T08 Can (with Peltier cooler)
SPMMini1000X06A3	Module Base: Pulse amplifier, 1mm ² sensor, 35 μ m microcell in T08 Can (with Peltier cooler)
SPMMini3000X06A1	Module Base: TIA amplifier, 9mm ² sensor, 35 μ m microcell in T08 Can (with Peltier cooler)
SPMMini3000X06A3	Module Base: Pulse amplifier, 9mm ² sensor, 35 μ m microcell in T08 Can (with Peltier cooler)
SPMMiniC1	Option: Cooling Board
SPMMiniM1	Option: C Mount Adapter
SPMMiniF1	Option: Fiber Coupler
SPMMiniP1	Option: Power Supply
SPMMiniE1	Option: EM Compliant Module

https://web.archive.org/web/20071117030155/http://www.sensl.com/pdfs/Datasheets/SPMMini_Datasheet.pdf

Option 1: Cooling Board

The SPMMini has a cooling option for reducing the temperature of the sensor to -20°C . Cooling is achieved with a two-stage TEC Peltier cooler controlled by the add-on board which connects directly onto the SPMMini or main module. A pulse width modulator is used to maintain a stabilized temperature to within 0.1°C based upon feedback from a thermistor situated beside the SPMMini in the hermetically sealed TO8 can. The module features current soft-start for controlled start-up to prevent high current in-rush and an output slew rate limiter to reduce system noise.

The cooling board snaps onto the main module quench board. The drawing shows the dimensions of the main module combined with the cooling board. The addition of the cooling board increases the current drawn on the main 5V power supply. See the table on Page 2 for full details.



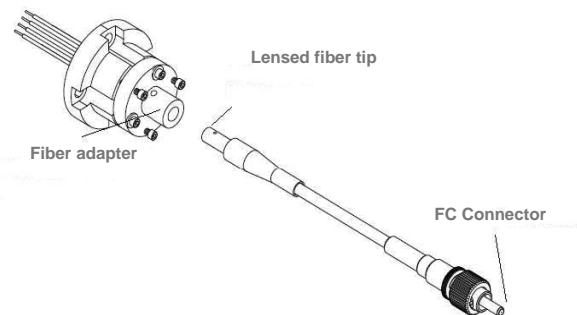
Option 2: C Mount Adapter

A C Mount Adapter option is available that attaches to the collar around the TO8 can and facilitates the attachment of various standard C Mount fittings, including filters and lenses. This is an ideal solution for attaching light collection lenses.

Option 3: Fiber Coupler

SensL offers the following pigtail lens style photodiode to multi-mode (MM) fiber coupler to couple light signals from a source via MM glass fiber to SPMMini1000X03A1 and SPMMini1000X03A3 modules.

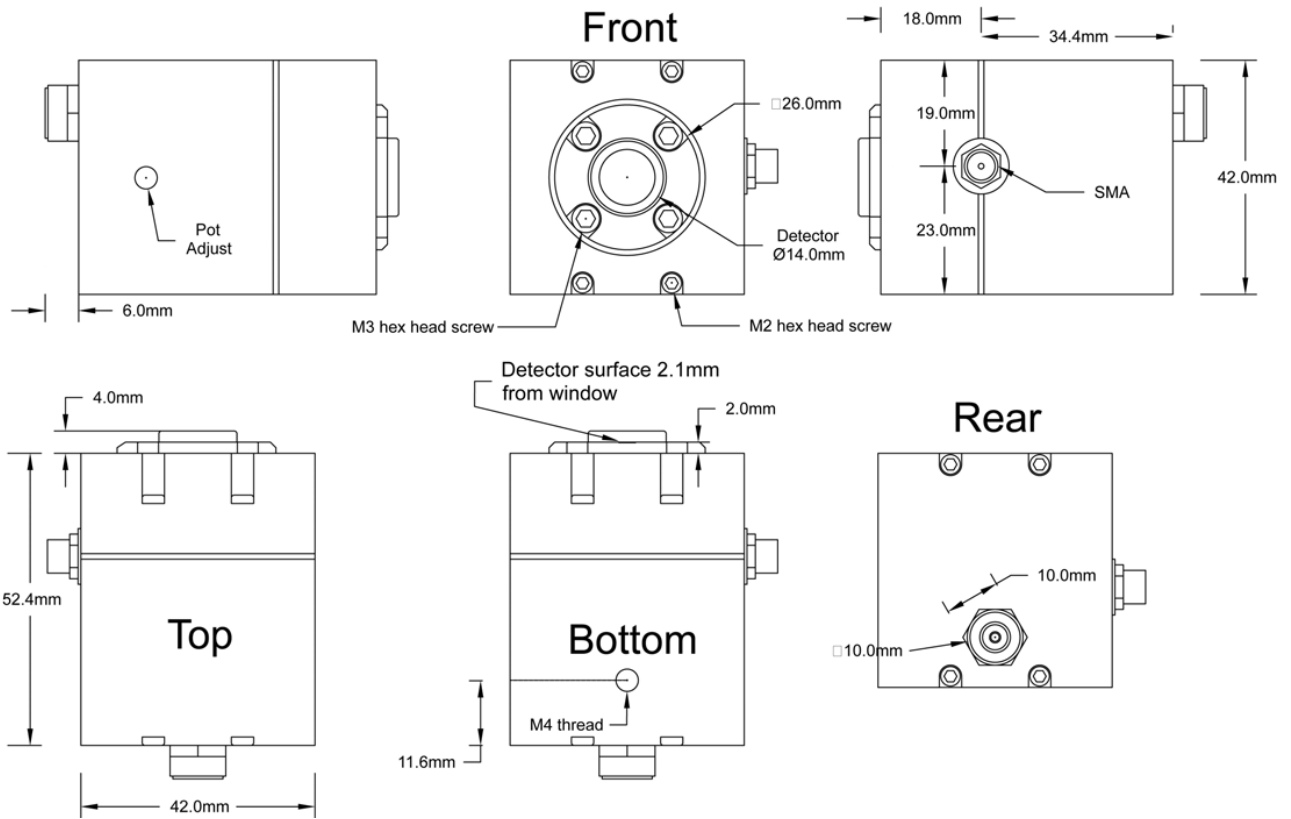
A universal receptacle is mounted onto the collar of the SPM module which allows different fiber types and specifications depending on the application requirements. The fiber output facet to the detector is tipped with a focusing lens for optimal coupling onto detector. This approach offers a "plug and play" solution for any fiber type, which can be specified when placing your order. Details of current fiber specifications are available on our website under [Product Options](#).



https://web.archive.org/web/20071117030155/http://www.sensl.com/pdfs/Datasheets/SPMMini_Datasheet.pdf

Enclosure Option

The SPMMini is available with an aluminum enclosure option to provide extra electromagnetic screening, robustness and ease of mounting to optical equipment. The dimensions of the enclosure are shown in the figure below.



About SensL

SensL's vision is to become the brand and partner of choice for users (particularly OEMs) of low light detectors and imaging systems. Our disruptive products facilitate the improvement in the performance of our customers' systems and enable new applications by overcoming the limitations of existing low light detector technologies. This is particularly relevant when compared to the vacuum based Photomultiplier Tube (PMT).

This breakthrough in low light detection solutions has been achieved by leveraging our core Geiger Mode Photodiode technology to create three distinct low light detector platforms. Our Photon Counting, Silicon Photomultiplier and Low Light Imager products enable the development of new systems for applications such as Bio-Diagnostics, Medical Imaging, LIDAR, Environmental Monitoring, and High Energy Physics.

Sales Channels and Partners

Europe, Middle East, Africa

Belgium

Laser 2000 BeNeLux S.A.
Rue du Moulin 18
5650 Fraire
tel: +32 / 71 61 06 40
email: sales@laser2000.be
web: www.laser2000.be

France

Laser 2000 S.A.S.
Parc d'Affaires, 3 rue de la Plaine
78860 Saint-Nom la Bretèche
tel: +33 / 1 / 30 80 00 60
email: info@laser2000.fr
web: www.laser2000.fr

Germany

Laser 2000 GmbH
Argelsrieder Feld 14
D-82234 Wessling, München
tel: +49 8153 405 0
email: contact@laser2000.de
web: www.laser2000.de

Israel

Lahat Technologies Ltd.
Teradion Industrial Zone
Misgav 20179
tel: +972 4 9990151
email: sales@lahat.co.il
web: www.lahat.co.il

Italy

UNIFIBRE s.r.l.
Via Salvemini 17
20019 Settimo Milanese (MI)
tel: +39 02 33 55 501
email: uniteam@unifibre.it
web: www.unifibre.it

Netherlands

Laser 2000 BeNeLux C.V.
Voorbancken 13a, PO Box 20
3645 ZJ Vinkeveen
tel: +31 / 297 / 266 191
email: info@laser2000.nl
web: www.laser2000.nl

Spain

LASERTechnology, S.L.
Poligono Industrial "LaBaileta", CalleB
Nave 8—08348 Cabrils, Barcelona
tel: +34 93 750 0121
email: info@laser-technology.com
web: www.laser-technology.com

Sweden

Laser 2000 AB
Box 799
601 17 Norrköping
tel: +46 11 369681
email: info@laser2000.se
web: www.laser2000.se

Switzerland

GMP SA
Av. Des Baumettes 17
CH-1020 Renens
tel: +41 21 633 21 21
email: info@gmp.ch
web: www.gmp.ch

United Kingdom

Laser 2000 (UK) LTD
Britannia House, Denford Road
Ringstead, Kettering, NN14 4DF
tel: +44 (0)1933 461 666
email: sales@laser2000.co.uk
web: www.laser2000.co.uk

Asia-Pacific

China

Shanghai Weining Technology Development Co., Ltd.
1138 Changan Road, Suite 24D
Chongfang East China Tower, Shanghai, 200070
tel: +86 21 5106 8395
email: jamesxu2005@126.com
web: www.weiningtech.com

Japan

Tokyo Instruments, Inc.
6-18-14 Nishi-Kasai, Edogawa-Ku
Tokyo 134-0088
tel: +81 3 3686 4711
email: sales@tokyoinst.co.jp
web: www.tokyoinst.co.jp

Korea

SeongKyeong Photonics.
Ma-220, 399-8, Daeduk Hi-tech B/D, Doryong-dong
Yuseong-gu, Daejeon, 305-340
tel: +82 42 867-2227
email: yoona@skphotonics.com
web: www.skphotonics.com

North America

Canada

Gamble Technologies Ltd.
6535 Millcreek Drive, Unit #71
Mississauga, ON L5N 2M2
tel: +1 905 812 9200
email: info@gtl.ca
web: www.gtl.ca

USA

SensL USA
415 Barcelona Court
Mountain View, CA 94040
tel: +1 650 210 9110 (ext. 2)
email: sales@SensL.com
web: www.SensL.com