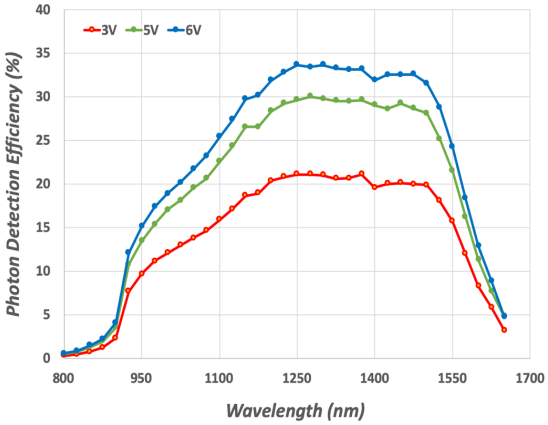
PDM-IR

900 nm – 1700 nm Infrared Photon Detection Module



The PDM-IR is based on a cooled InGaAs/InP SPAD for the detection of near-infrared single photons up to 1700 nm. The module includes a pulse generator for gating the detector, a front-end circuit for avalanche sensing and a fast circuitry for detector quenching and resetting.

High Photon Detection Efficiency
Higher than **35%** at 7 V excess bias (V_{EX})

Best-in class Timing Accuracy
As low as **50 ps** FWHM

Free Running and Gated Mode
free running, free gate and gated mode with fine adjustable gate width operations

Very Low DCR
As low as **400 c/s**

MODULE FEATURES

- SMF-28 and MMF GI 50 µm fibre-pigtailed versions
- Sensitivity from 900 nm to 1700 nm
- Adjustable PDE and DCR
- Gate width from 1 ns to 10 us
- Int. or Async Ext. trigger up to 100 MHz,
- Aux In for advance trigger mode
- User selectable outputs (TTL and NIM)
- Integrated counters
- Timing output

BIOMEDICAL APPLICATION

- Confocal Microscopy
- Single Molecule Spectroscopy
- Ultra-Sensitive Fluorescence
- Time-correlated single photon counting
- Single Molecule Detection

INDUSTRIAL APPLICATION

- Optical Testing of integrated circuits
- Metrology by Time of Flight measurements
- Fiber optics characterization

QUANTUM APPLICATION

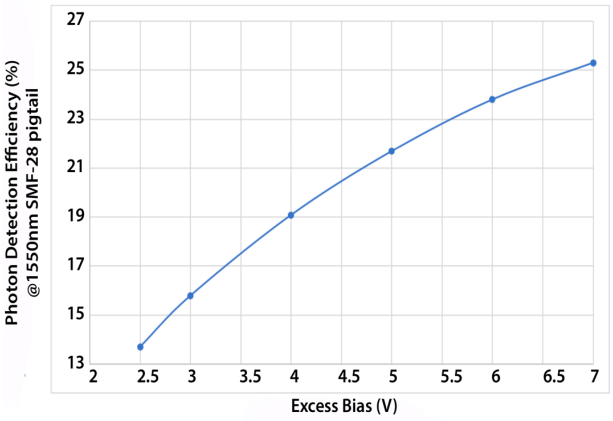
- Quantum Cryptography
- Quantum Optics
- Single-photon source characterisation

ASTRONOMY APPLICATION

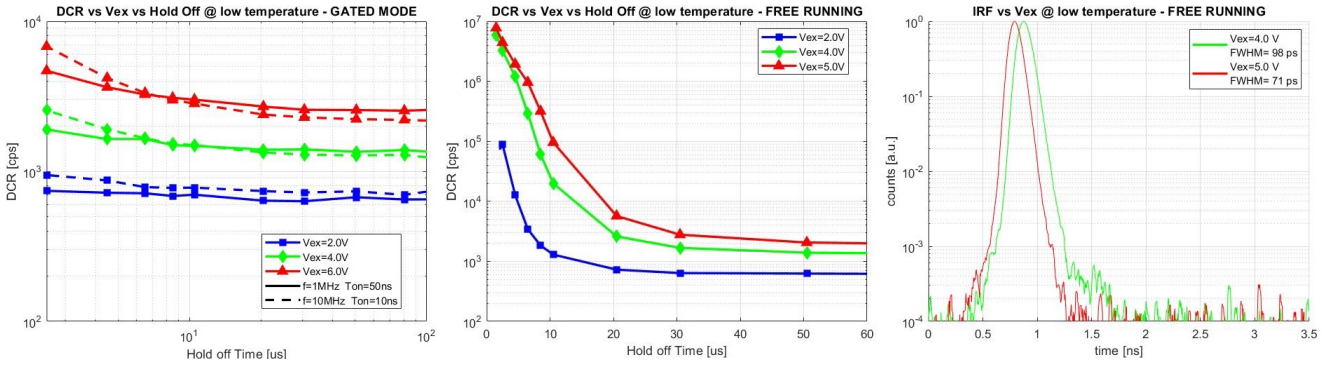
- Optical Range Finding, LIDAR & LADAR
- Astronomy Observations & Adaptive Optics

Overview

The PDM-IR is a photon counting module based on an InGaAs/InP Single-Photon Avalanche Diode (SPAD) for the detection of near-infrared single photons up to 1700 nm (see PDE graphs). The module includes a programmable frequency and pulse generator for gating the detector, a front-end circuit for SPAD's avalanche sensing, a fast circuit for detector's avalanche current quenching and operative bias voltage resetting and some sub-circuits for signal conditioning. All the main parameters and delay paths are adjustable by the user through the software interface, in order to match requirements of different applications. The system can be conveniently used both for counting and timing



measurements, since the high-performance electronics guarantees a clean temporal response even with fast gate transitions (see typical IRF curves displayed here below). PDM-IR can work either in free-running or in gated mode and the optical interface can be chosen between a free space and a pigtailed version. Here below typical DCR vs Hold-Off are shown for both gated and free-running modes.



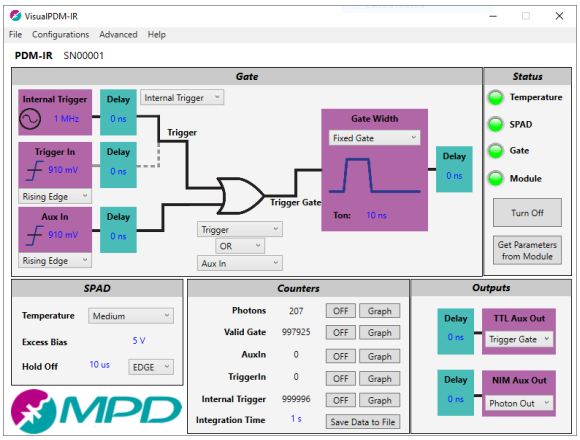
Principle of operation

The PDM-IR can be used either in gated or in free-running mode. Both modes of operations can be optimized using several user selectable parameters, all controllable from a computer using either the delivered SDK library or the provided Windows® PC software. When used in gated, the TRIGGER GATE signal, for GATE frequency generation, can be provided either using an INTERNAL TRIGGER or through an external signal fed into the TRIGGER IN input. Complex external trigger patterns can be also fed to the TRIGGER IN input, since it accepts not only periodic but also aperiodic signals. Additionally, it is possible to create even more complex TRIGGER GATE patterns for GATE generation, by combining the auxiliary input AUX IN signal with the INTERNAL TRIGGER or the TRIGGER IN, and by using the provided user-selectable logic. Finally, GATE signal can be generated either by exactly replicating TRIGGER GATE or by creating a new signal, synchronized with the rising edge of TRIGGER GATE and with a programmable fixed gated-ON width. All main signal paths have also a programmable delay, designed to help the user in synchronizing the various signals between them and with the external instruments. Independently on the chosen PDM-IR mode of operation, the module has also internal counters that continuously monitor the following signals: TRIGGER IN, AUX IN, INTERNAL TRIGGER, PHOTON OUT and VALID GATE. Concerning the outputs: PHOTON OUT is the low timing jitter output signal, precisely marking the photon detection time; NIM AUX OUT and TTL AUX OUT, instead, are auxiliary programmable outputs that can route out, at user choice TRIGGER GATE, INTERNAL TRIGGER, VALID GATE, PHOTON OUT and HOLD OFF signals. When used in free running mode the SPAD is always on until a SPAD avalanche is initiated. In this case, the avalanche current is first quenched and then, after a well-defined programmable hold-off, the detector is immediately enabled.

The SMF-28 fiber-pigtailed version of PDM-IR module is offered with 2 different mechanical enclosures: a Desktop Instrument version (DI) and a Small Form Factor one (SFF). The DI version has an additional thermal control loop for cooling even the SPAD package, whose black body radiation could increase detector dark counting rate. Additionally, the fiber pigtail is totally protected inside the case and can be only accessed through a FC/PC barrel mounted on the front panel. The SFF version has the fiber pigtail (not light tight) totally exposed, i.e., extra attention is needed to avoid damaging it, and does not have the additional thermal control loop. For this reason, and since the SPAD package is in very good thermal contact with both the hot side of the Peltier cooling the SPAD chip and the module case, the SFF module DCR will depend on case temperature. MPD team is available to provide further details at request.

PDM-IR control

The PDM-IR module is controlled through a PC software interface or the SDK library. With the user-friendly software, it is possible to set all the programmable parameters, like gate settings, SPAD settings, outputs, and get the counters value. The software can save and load up to 10 configurations and set one of them as power up configuration. The power up configuration is automatically applied and the SPAD is turned on after few seconds from the powering time. Concerning the SPAD parameters Hold-OFF time, excess bias voltage and SPAD temperature, they are all user selectable to get the best results from the measurement.



Specifications[1]

Parameter	Notes		Min	Typ	Max	Units
Fibre Pigtail Type	FC/PC – uses 10 µm SPAD			SMF-28[2]		
	FC/PC – uses 25 µm SPAD			MMF 50 µm GI NA=0.2		
Photon Detection Efficiency	Vex = 7V, λ=1550 nm			25		%
timing jitter (FWHM)	At VEX = 4 V (all working modes)		90	130		ps
	At VEX = 7 V (Fixed Gate mode only)		50	70		ps
Minimum wavelength for IRF with SHORT TAIL	Below 975 nm photons are absorbed in the top InP layer only			975		nm
DCR (dark counting rate)	At V_{EX} = 2 V, Temperature set to "*Low*", module in free running mode, Hold-off time = 100 µs. In case of the SFF module, case temperature was kept at 25°C	SMF-28 SFF		0.6	1.5	kcps
		SMF-28 DI		0.5	1	kcps
		MMF-50GI DI		2.6	5	kcps
SPAD Temperature	SW Selectable		225		243	K
Gate rise time	(20% - 80%)			2		ns
Excess Bias range	Free Gate and Free Running		2		5	V
	Fixed Gate		2		7	V
Hold-off time	SW selectable @ 10 ns step		1		3000	µs
Gate width	SW selectable @ 1 ns step		1 n		1.5 m	s
Gate repetition frequency					100	MHz
Internal Trigger Frequency	SW selectable @ 1 Hz step		100		100 M	Hz
Delay path	SW selectable @ 1 ns step		0		100	ns
Counter Integration Time	SW selectable @ 20 ms step		0.1		60	s
PHOTON OUT, NIM OUT	NIM output		-800		0	mV
	Required Load (DC)			50		Ω
PHOTON OUT	Pulse width			10		ns
TRIGGER IN, AUX IN	Amplitude		-2		2.5	V
	Load Impedance (DC)			50		Ω
	Pulse width		800			ps
TTL OUT	Output levels		0		2.7	V
	Required Load (DC)			50		Ω
Power Supply	Power				60	VA
	DC INPUT Voltage		22.8	24	25.2	V
Operating range	Ambient temperature		15		35	°C

[1]See the user-manual for the full list of module's specifications. Module designed and built compliant with the European Union Directive 2011/65/CE.

[2]Exposed fibre of SFF module version is not light-tight thus any measurement (including DCR characterisation) should ensure a proper and complete fibre shielding.

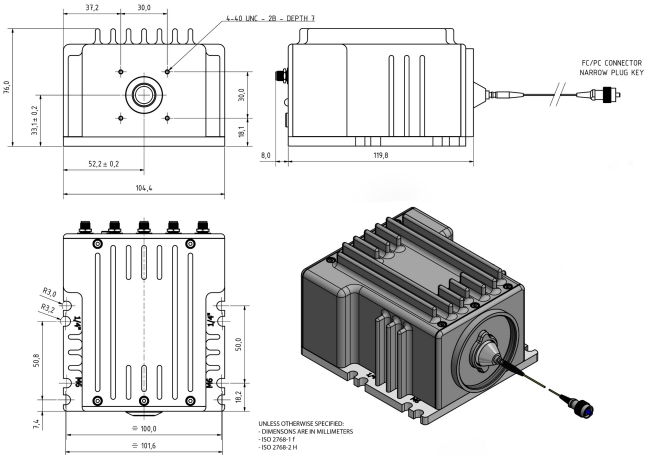
System requirements (software and SDK)

- Host computer (minimum requirements): USB 2.0 interface, 1 GHz processor and 512 MiB of RAM
- Supported operating systems
  - VisualPDM-IR
    - Microsoft 7, 8,10, 32- or 64-bit versions
  - SDK:
    - Microsoft 7, 8,10, 32- or 64-bit versions
    - Linux Ubuntu 12.04 LTS, Fedora Core 15 or compatible distributions, 32- or 64-bit versions
    - Mac OS X 10.7.5 and above

Mechanical Dimensions

Desktop Instrument

Small Form Factor Instrument



Ordering Information

The PDM-IR can be ordered directly from Micro Photon Devices or its representatives. For a complete list of representatives, visit our website at www.micro-photon-devices.com. The ordering codes for purchasing the PDM-IR are:

$PI-010-SM	(PDM-IR / SMF28	Fiberpigtailed Detector - Small Form Factor Instrument)
$PI-010-SM-DI	(PDM-IR / SMF28	Fiberpigtailed Detector - Desktop Instrument)
$PI-025-MM-DI	(PDM-IR / MMF50GI	Fiberpigtailed Detector - Desktop Instrument)

Included with the module are the following items/accessories: the module's power supply, a USB cable, a cleaning tool for the ferrule end face inside the FC fibre connector, a USB key containing the installation software, the user manual in PDF® format and module's test report.

Warranty

A standard legal warranty according to local legislation applies following shipment. Any warranty is null and void if the module case has been opened or if the absolute maximum ratings are exceeded. Specifications are subject to change without any notice. Document version v1.1.6 – March 2022

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