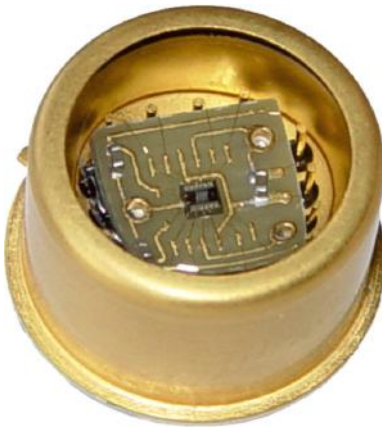
Redefining Measurement

ID150 Visible 8 Channel SPAD

Miniature 8-Channel Photon Counter for OEM Applications



The ID150-1x8 is the only multichannel solid-state single-photon detector on the market. It consists of a CMOS silicon chip packaged in a standard TO8-16 pin header with a transparent window cap. The chip combines 8 in-line single-photon avalanche diodes that can be accessed simultaneously for parallel processing. The square diodes are 40x40µm in area with a center-to-center pitch of 60 µm. A fast active quenching circuit is integrated within each pixel in order to operate each diode in photon counting regime. The chip is mounted on a printed circuit board on top of a single-stage thermoelectric cooler (TEC). A thermistor can be used to measure the temperature of the chip. Two power supplies (+5 V and -25 V) are sufficient for operation in photon counting mode. The fast active quenching circuit leads to a dead time of less than 50ns per channel. An outstanding timing resolution of less than 60 ps allows high accuracy measurements. The ID150-1x8 can be mounted on a printed circuit board and integrated in apparatus such as spectrometers or microscopes. The module is used in biological/chemical instrumentation, quantum optics, aerospace and defense applications. The small detector size is ideal for portable device applications.
Contrary to legacy photomultiplier tubes (PMTs) and other silicon-based counters manufactured with non-standard custom process, the ID150-1x8 is fabricated using a qualified commercial CMOS process, which guarantees high reliability.

Key Features

- 1x8 linear array with independent outputs
- Pixel active area of 40x40 µm^2
- Center-to-center pitch of 60 µm
- Best-in-class timing resolution (40 ps)
- Low dead time (45 ns) and dark count rate
- Peak photon detection at λ = 500 nm
- No crosstalk
- Not damaged by strong illumination

Applications

- High-throughput single molecule detection
- Parallel DNA sequencing
- Multi-Channel TCSPC
- Fluorescence and luminescence detection
- Decay and multiple decay time measurements
- Fluorescence correlation spectroscopy
- Flow cytometry, spectrophotometry
- Quantum optics

ID QUANTIQUE SA
Chemin de la Marbrerie 3
1227 Carouge/Geneva
Switzerland
T +41 22 301 83 71
F +41 22 301 89 79
info@idquantique.com
www.idquantique.com

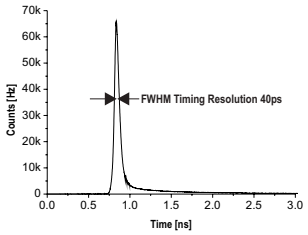
VISIBLE 8 CHANNEL SPAD

Specifications

Parameter	Min	Typical	Max	Units
Wavelength range	350		900	nm
Pixel active area		40x40		µm
Center-to-center pitch		60		µm
Timing resolution [FWHM] 1		40	60	ps
Single-photon detection probability (SPDE) 2 3				
at 400 nm	15	18		%
at 500 nm	30	35		%
at 600 nm	20	25		%
at 700 nm	15	18		%
at 800 nm	5	7		%
at 900 nm	3	4		%
Dark count rate (DCR) 1				
DCR / channel			15	kHz
Mean DCR over the 8 channels			3.5	kHz
Afterpulsing probability 4			3	%
Output pulse width	40	45	50	ns
Output pulse amplitude (in high impedance)		VDD		V
Output driver capability		4		mA
Deadtime			50	ns
VDD supply voltage	4.8	5.0	5.2	V
VOP supply voltage	-24		-26	V
Storage temperature	-40		70	°C

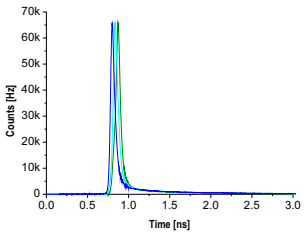
1 Measured at 273 K with V_{OP} = -25.5 V

1 Timing Resolution



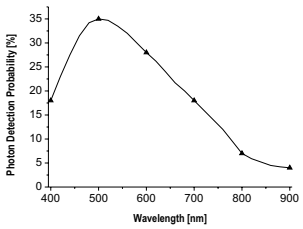
Optimal timing resolution is obtained when incoming photons are focused on the photosensitive area.

2 IRF Shift with Output Count Rate

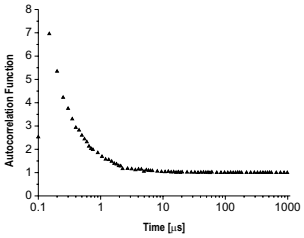


Extremely low shift of instrument response function with output count rate (less than 70 ps from 10 kHz to 8 MHz).

3 Photon Detection Probability versus λ



4 Afterpulsing



Typical autocorrelation function of a constant laser signal, recorded at a count rate of 10 kHz.

ID QUANTIQUE SA
Chemin de la Marbrerie 3
1227 Carouge/Geneva
Switzerland
T +41 22 301 83 71
F +41 22 301 89 79
info@idquantique.com
www.idquantique.com

VISIBLE 8 CHANNEL SPAD

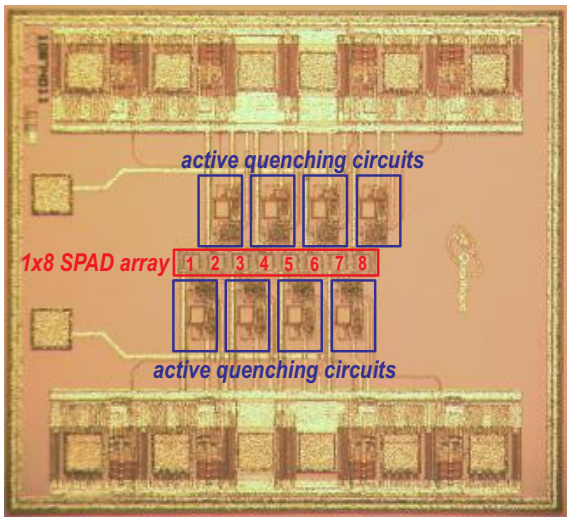
Principle of Operation

The ID150-1x8 is based on a 1.2x1.4 mm^2 CMOS silicon chip containing 8 in-line independent single-photon detectors. Each pixel combines a square avalanche photodiode of 40x40 µm^2 area and its active quenching circuit. The pixel center-to-center pitch is 60 µm (fill factor exceeds 75%).

To operate in the Geiger mode, each diode anode is biased with a negative voltage. In the ID150-1x8, the cathode of pixels 1, 3, 5 and 7 are connected together to V_{op1} pad, while the cathode of pixels 2, 4, 6 and 8 are connected to V_{op2} pad. Each cathode is linked to VDD through a polysilicon resistor R_q. Prior to the detection of a photon on a pixel, the switch is open (non-conducting) and the cathode is at VDD. When a photon strikes the diode, the voltage drop induced on the cathode is sensed by the active quenching circuit. The corresponding output pin OUT_i switches to *VDD*. The feedback circuit closes the switch: the diode is biased below its breakdown voltage resulting in the avalanche quenching. The diode is then kept below breakdown and the recharge takes place with the opening of the switch. The full cycle is defined as the pixel dead time.

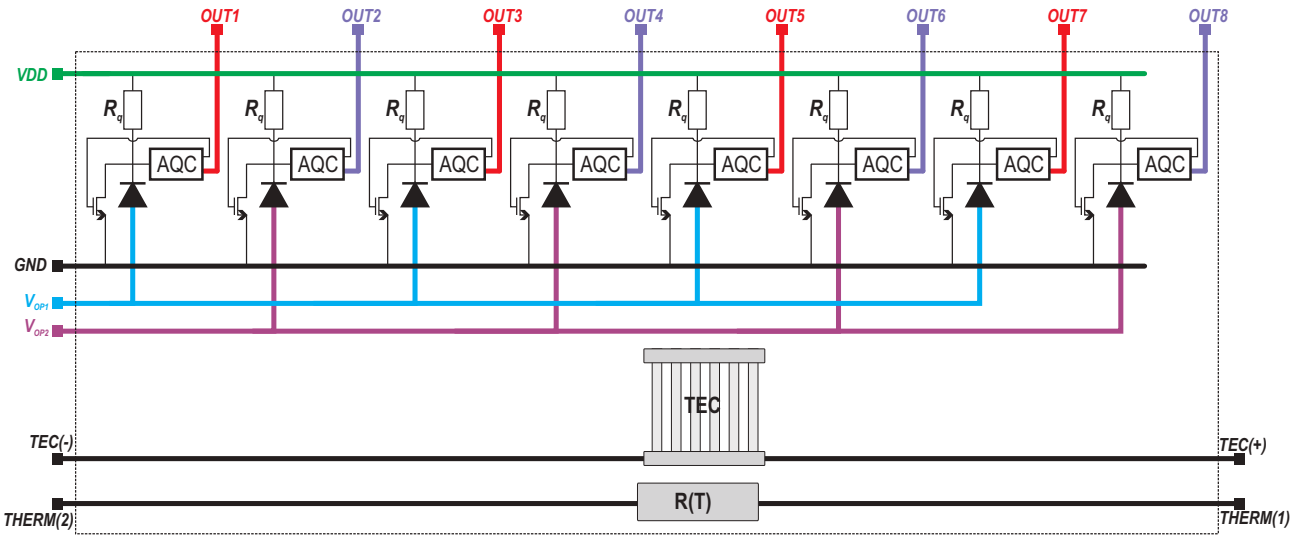
In any single-photon avalanche diode, thermally generated carriers induce false counts, called dark counts. A single-stage thermoelectric cooler (TEC) allows one to cool the device to reduce the dark count rate. Furthermore, the photon detection probability in a single-photon avalanche diode depends on the excess bias voltage.

Linear Array Picture



The breakdown voltage being temperature dependent, it is often crucial to keep the sensor at a constant temperature. The thermistor included in the ID150-1x8 allows one to implement a temperature control circuit. For efficient cooling, an additional heat-sink combined with a air fan must be added by the user. The heat-sink can either surround the TO8 header or be fixed using the UNC 4-40 thread.

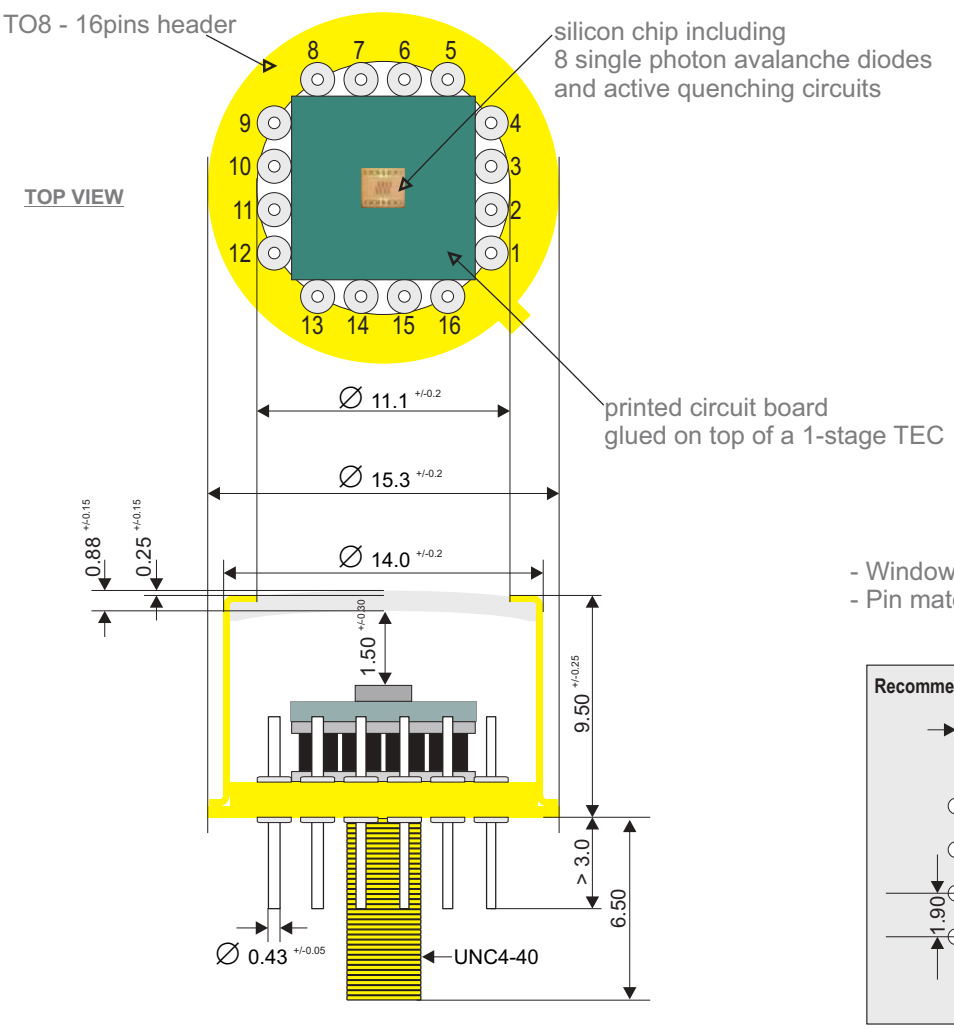
Block Diagram



ID QUANTIQUE SA
Chemin de la Marbrerie 3
1227 Carouge/Geneva
Switzerland
T +41 22 301 83 71
F +41 22 301 89 79
info@idquantique.com
www.idquantique.com

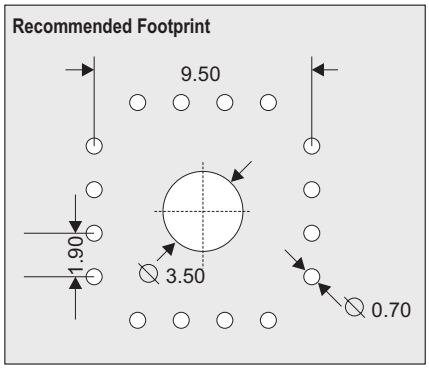
VISIBLE 8 CHANNEL SPAD

Dimensional Outline (in mm) and Pinout



pin #	connexion
1	TEC(-)
2	thermistor
3	thermistor
4	TEC(+)
5	OUT8
6	OUT6
7	OUT4
8	OUT2
9	V_{OP2}
10	VDD
11	GND
12	V_{OP1}
13	OUT1
14	OUT3
15	OUT5
16	OUT7

- Window material: glass
- Pin material: gold plated



Thermoelectric Cooler Specifications

Parameter	Unit	Value (conditions)
Maximum Current I_{max}	A	1.15 +/- 0.02 (at ΔT_{max})
Maximum Voltage Drop U_{max}	V	2.90 +/- 0.07 (at ΔT_{max})
Maximum Delta-T Δt_{max}	K	69.0 +/- 2.0 (Vacuum, Q=0, T_r=300 K)
Maximum Cooling Capacity Q_{max}	W	1.85 +/- 0.01 (at ΔT=0)

Thermosensor Specifications

Parameter	Unit	Value (conditions)
Resistance R0	kΩ	2.2 +/- 0.16 at 293 K
Beta Constant β	K-1	2918.9 +/- 5%

The thermistor resistance can be calculated by:

$$R_T = R_{293K} * \exp(\beta(293-T)/(293*T))$$

Mounting Details

TEC mounting	soldering, 117°C
Thermosensor mounting	epoxy glue
Wire mounting	soldering, 183°C

ID QUANTIQUE SA
Chemin de la Marbrerie 3
1227 Carouge/Geneva
Switzerland
T +41 22 301 83 71
F +41 22 301 89 79
info@idquantique.com
www.idquantique.com

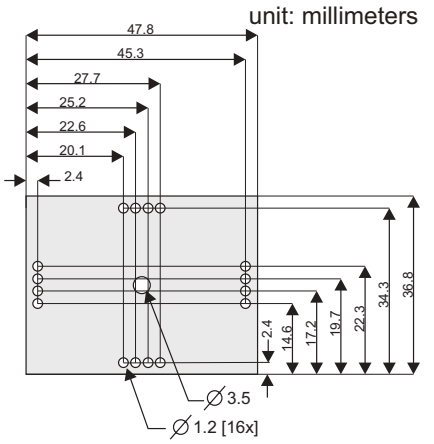
VISIBLE 8 CHANNEL SPAD

Accessories

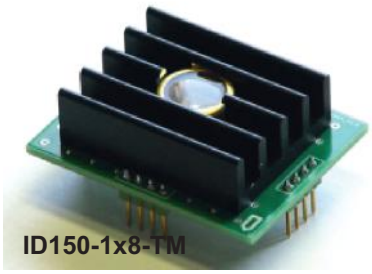
To accelerate integration of the ID150-1x8 in an optical set-up, the following accessories are available.

- ID150-1x8-TM option:

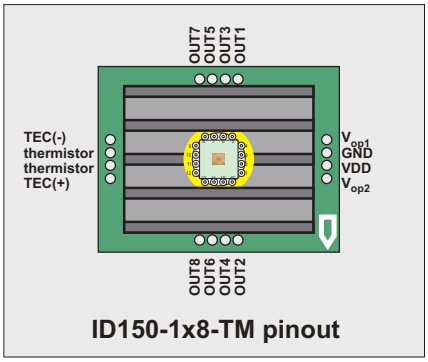
The ID150-1x8-TM consists of a ID150-1x8 welded on a 47.8mmx36.8mm printed circuit board. Required decoupling capacitances are mounted on the PCB bottom side, close to ID150-1x8 pins. A heat sink is glued around the ID150-1x8 TO8 package. Electrical connections are provided by 4 straight pin headers. Each 4-poles header consists of 0.63mmx0.63mm gold-plated pins with 2.54 mm pitch. The recommended footprint and pinout are given below.



ID150-1x8-TM recommended footprint



ID150-1x8-TM



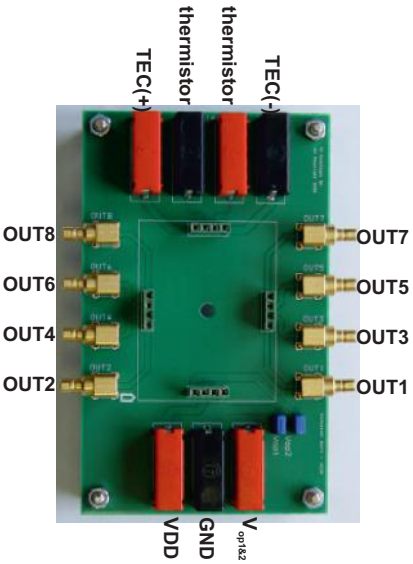
ID150-1x8-TM pinout

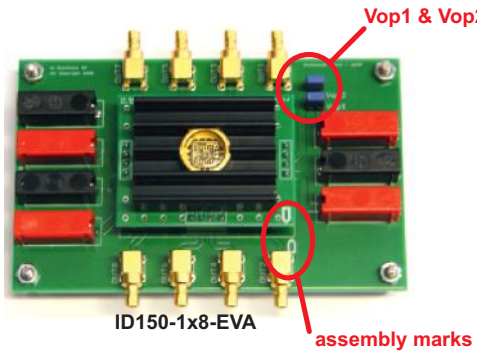
- ID150-1x8-EVA option:

The ID150-1x8-TM is provided with the ID150-1x8-EVA evaluation board of 66x107 mm in size. The ID150-1x8-TM is inserted on the ID150-1x8-EVA board using four 4-poles sockets. Assembly marks ensure a proper insertion.

The outputs are provided at SMB-type connectors. For Vop, GND, VDD, TEC(+), TEC(-) and thermistor, 4 mm banana connectors are used.

The bias voltages V_{op1} and V_{op2} can be disconnected by removing the corresponding jumpers.





Ordering Information

- ID150-1x8:TO8 head including 8 independent single-photon detectors with 40x40 µm² active area and 60 µm center-to-center pitch.
- ID150-1x8-TM: ID150-1x8 mounted on a printed circuit board including heat-sink and decoupling capacitances.
- ID150-1x8-EVA: ID150-1x8-TM and evaluation electronic board with connectors.

ID QUANTIQUE SA
Chemin de la Marbrerie 3
1227 Carouge/Geneva
Switzerland
T +41 22 301 83 71
F +41 22 301 89 79
info@idquantique.com
www.idquantique.com