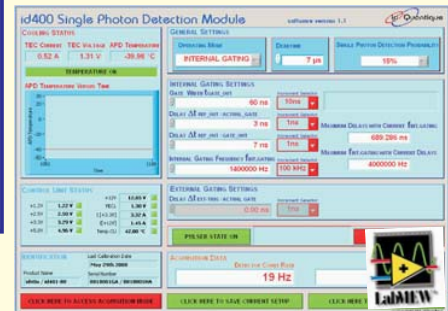


id400

Single Photon Detection Module for 1064nm



Labview Interface !



**Detection Probability
up to 30% !**

**Free-running
or
Gated Modes !**

A complete system for your photon counting needs

The id400 single photon detection module consists of a detection head and a control unit. The detection head contains a cooled InGaAsP/InP avalanche photodiode (APD) optimised for 1064nm single photon detection and a fast sensing and quenching electronic circuit. The control unit is intended for APD temperature control and regulation, power supply, gate generation and dead time setting. It also provides BNC connectors for input-output signals and a USB interface for Labview communication. During operation, the detection head must be connected to the control unit with two coaxial and a DB9 cables provided in a common slit harness wrap. A +12V power supply that must be connected to the mains is provided with the module. Besides counting photons, the id400 offers truly invaluable functionalities:

- internal counters for detection and effective gate rates
- Labview interface
- TTL reference output, TTL gate output
- TTL detection output signal
- adjustable delays between reference signal and gate output and between reference signal and actual detector gate.

The most versatile photon counter

The id400 is by far the most versatile photon counter on the market:

- Adjustable single photon detection probability:
 - 7.5%, 15% and 30% at 1064nm

Free-running or gating modes

Internal or external gating modes

- Adjustable dead time:
 - from 1 to 100us
 - by step of 1us

- Adjustable gate width (for internal gating mode):
 - from 500ps to 2us
 - by step of 10ps

- Adjustable internal gating frequency:
 - from 1Hz to 4MHz

- Adjustable delays:
 - up to 1us
 - by step of 50ps

Ease of use and connectivity

The Labview Virtual Instrument provided with the id400 offers a well-thought design with intuitive menus. All parameters can be adjusted via the VI. The detector and effective gate rates can be saved in a text file. Measurement setups can be save and reload later. They can also be stored by the control unit for operation without PC.

The id400 detection head is equipped with a machined plate for easy mounting on most post assemblies and translation stages.

Applications

- Free-space optical communications for space mission
- Satellite laser ranging
- Atmospheric research and meteorology
- Laser range-finder
- Free-space quantum cryptography
- Spectroscopy

Ordering information

id400-80-1064

Single photon detection module including:

- 1 x detection head (80 μ m effective optical diameter avalanche photodiode) with mounting plate
- 1 x control unit
- 2 x BNC-SMB 2m cables and 1 x DB9-DB9 2m cable in a common slit harness wrap
- 1 x USB 4.5m cable
- 1 x +12V/2.5A power supply with primary adapter corresponding to the country of destination
- 1 x CD-Rom including: User Guide: id400_User_Guide.pdf, LabVIEW Run-time Engine Version 7.0, installer for the LabVIEW application

For further information on this or other products, please contact *id Quantique* by phone: +41 (0)22 301 83 71 or email: sales@idquantique.com.



Block Diagram

The id400 is a complete single photon counting system based on a cooled InGaAsP/InP avalanche photodiode (APD) optimised for 1064nm. The APD temperature is set to -40°C upon assembly to optimise the id400 overall performance. A temperature variation of less than 0.1°C is achieved through a thermoelectric cooler (TEC) integrated in the package of the APD and the control unit that provides the TEC power supply and ensures temperature regulation.

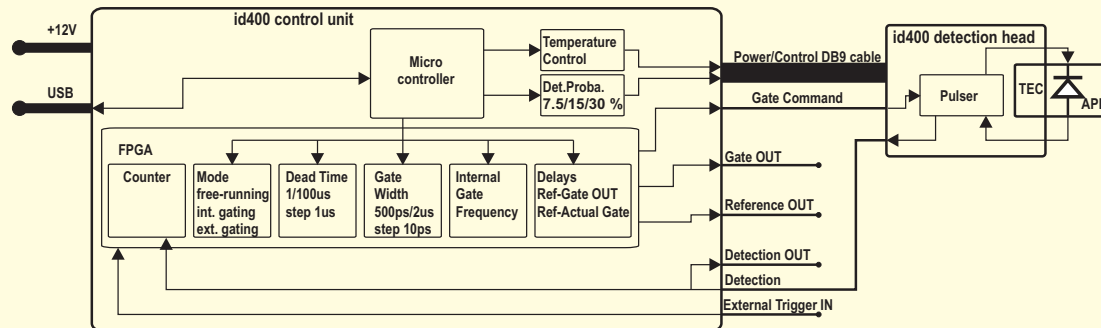
The id400 offers advanced functionalities, including:

Free-running, internal gating or external gating modes:

- **In free-running or asynchronous mode**, the APD is biased above the breakdown voltage in the so-called Geiger mode. Upon a photon arrival (or a dark count generation), an avalanche takes place in the APD. The avalanche is sensed by the id400 and reflected at *Detection OUT* by the rising edge of a TTL pulse. The id400 pulser provides a fast avalanche quenching required to limit the afterpulsing rate. The operating voltage is then restored at the end of the dead time and the id400 is ready to detect a subsequent photon.
- **In gating or synchronous mode**, a voltage pulse is applied to raise the bias above APD breakdown voltage upon triggering. The gating can be either internal or external. The APD is sensitive only during the gates. The gating mode is used in applications where the arrival time of the photon is known. It allows a reduction of the dark count rate.

An adjustable single photon detection probability level.

In any avalanche photodiode, the single photon detection probability increases with the excess bias voltage (difference between operating and breakdown voltages). The timing resolution is also improved at high excess bias voltages. On the other hand, the dark count and afterpulsing rates increase with the excess bias voltage. Whatever the operating modes (free-running or gating), the id400 provides three levels of single photon detection probability of 7.5%, 15% and 30% (measured at 1064nm). The user can thus find the best setting for its application.



An adjustable dead time. At high gating frequencies or when operated in free-running mode, afterpulsing may significantly deteriorate the id400 performance. To suppress detrimental afterpulsing effects, the id400 allows one to set a dead time after a detection. The dead time duration can be chosen between $1\mu\text{s}$ to $100\mu\text{s}$ by step of $1\mu\text{s}$. When this mode is enabled, the module will ignore trigger signals during a time equal to the deadtime after each registered avalanche event. When a dead time is applied, the id400 Labview Virtual Instrument displays the effective gate rate.

A gate generator (for internal gating mode) produce gates with adjustable duration and frequency. Using the Labview Virtual Instrument, the gate width is adjustable from 500ps to $2\mu\text{s}$ by step of 10ps . The internal gating frequency is adjustable to levels ranging from 1Hz to 4MHz .

two delay functions (for internal gating mode), providing a delay between the Reference OUT (clock signal) and the Gate OUT and a delay between the Reference OUT (clock signal) and the actual detector gate. This allows the user to synchronize the actual detector gate and the incoming optical signals.

Internal counters, whose results are displayed on the Labview Virtual Instrument to monitor the detection and the effective gate rates. For each detection, the module also produces a TTL pulse available on the id400 control unit front panel BNC connector. This pulse can, for example, be registered by an external counter or sent to a processing unit, such as a time-to-amplitude converter (TAC) or time-to-digital converter (TDC).

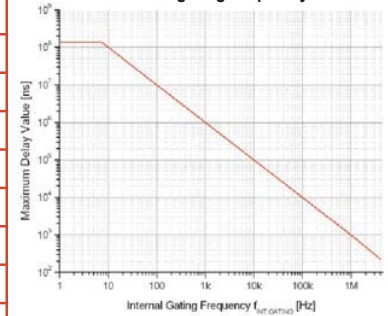
All the user-adjustable parameters can be easily entered from the Labview Virtual Instrument. They can also be stored by the control unit for operation without PC.

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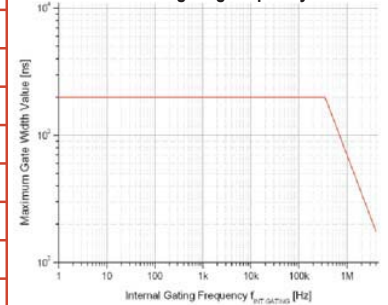


General Specifications						Applicable Mode		
						internal gating	external gating	free running
Features	Conditions	Min.	Typ.	Max.	Unit			
Wavelength range			900-1150		nm	✓	✓	✓
Effective optical diameter			80		μm	✓	✓	✓
Single photon detection probability (SPDE) 1			7.5, 15, 30		%	✓	✓	✓
Timing resolution at 7.5% SPDE 2					ps	✓	✓	✓
Timing resolution at 15% SPDE 2					ps	✓	✓	✓
Timing resolution at 30% SPDE 2					ps	✓	✓	✓
Dark count rate at 7.5% SPDE	with 20 μsdead time			150	Hz			✓
Dark count rate at 15% SPDE	with 20 μsdead time			400	Hz			✓
Dark count rate at 30% SPDE	with 20 μsdead time			1500	Hz			✓
Adjustable deadtime step			1		μs	✓	✓	✓
Adjustable deadtime range		1		100	μs	✓	✓	✓
f_{INT_GATING} frequency 3 4 5		1		4×10^6	Hz	✓		
t_{GATE_OUT} gate duration 4		5		2000	ns	✓		
t_{GATE_OUT} adjustable gate duration step			10		ps	✓		
$\Delta t_{REF_OUT/GATE_OUT}$ adjustable delay range		0		3		✓		
$\Delta t_{REF_OUT/GATE_OUT}$ adjustable delay step			50		ps	✓		
$\Delta t_{REF_OUT/ACTUAL_GATE}$ adjustable delay range		0		3		✓		
$\Delta t_{REF_OUT/ACTUAL_GATE}$ adjustable delay step			50		ps	✓		
t_{REF_OUT} Reference OUT pulse width		8		10	ns	✓		
Reference OUT pulse amplitude in 50Ω load		2.3		3.3	V	✓		
t_{DET_OUT} Detection OUT pulse width		100		130	ns		✓	✓
t_{DET_OUT} Detection OUT pulse width		90		6	ns	✓		
Detection OUT pulse amplitude in 50Ω load		2.3		3.3	V	✓	✓	✓
Gate OUT pulse amplitude in 50Ω load		2.3		3.3	V	✓		✓
t_{EXT_GATING} external trigger IN pulse width				7	ns		✓	
f_{EXT_GATING} external trigger IN frequency 7		1		4×10^6	Hz		✓	
$\Delta t_{EXT_GATE/ACTUAL_GATE}$ adjustable delay range		0		10	ns		✓	
$\Delta t_{EXT_GATE/ACTUAL_GATE}$ adjustable delay step			50		ps		✓	
External Trigger IN amplitude		1.6		3.0	V		✓	
External Trigger IN input impedance			50		Ω		✓	
Cooling time	at 25°C room temperature			5	min	✓	✓	✓
Electronic connectors			BNC			✓	✓	✓
Detection head dimension L x W x H			97x90x36		mm	✓	✓	✓
Control unit dimension L x W x H			225x170x50		mm	✓	✓	✓
Detection head weight			290		g	✓	✓	✓
Control unit weight			1180		g	✓	✓	✓
Operating temperature		0		25	°C	✓	✓	✓
Storage temperature		0		40	°C	✓	✓	✓

- 1 Calibrated at 1064 nm wavelength.
- 2 Please contact us to check availability.
- 3 Find below the maximum delay values versus internal gating frequency:



- 4 Find below the maximum gate width value versus internal gating frequency:



- 5 The uncertainty on the internal frequency is given by $(f_{INT_GATING})^2 / 1.2 \times 10^8$. For instance, if the frequency is set to 1MHz, the uncertainty is 8.333kHz.
- 6 In internal gating mode, the output pulse width t_{DET_OUT} depends on the time of photon arrival in the gate. In any case, the output pulse width is shorter than the gating period $1/f_{INT_GATING}$.
- 7 The duty cycle $(t_{ON} / t_{ON} + t_{OFF})$ of the external gating signal must be less than 70%.

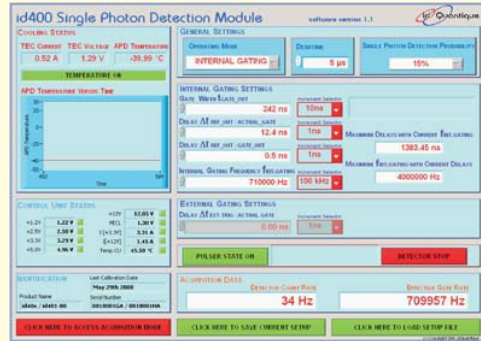
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LabVIEW application

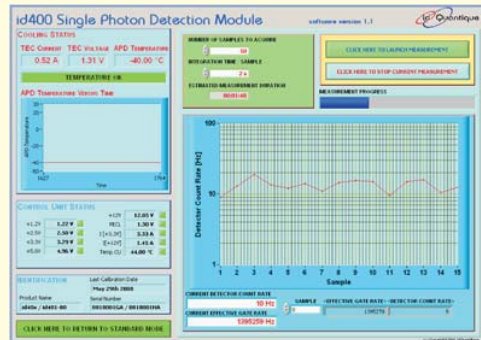
Supported Operating Systems:
Windows XP, Windows Vista 32 bits

Your id400 comes with a id400.exe LabVIEW application installed on your computer in a few clicks. It provides two different modes:

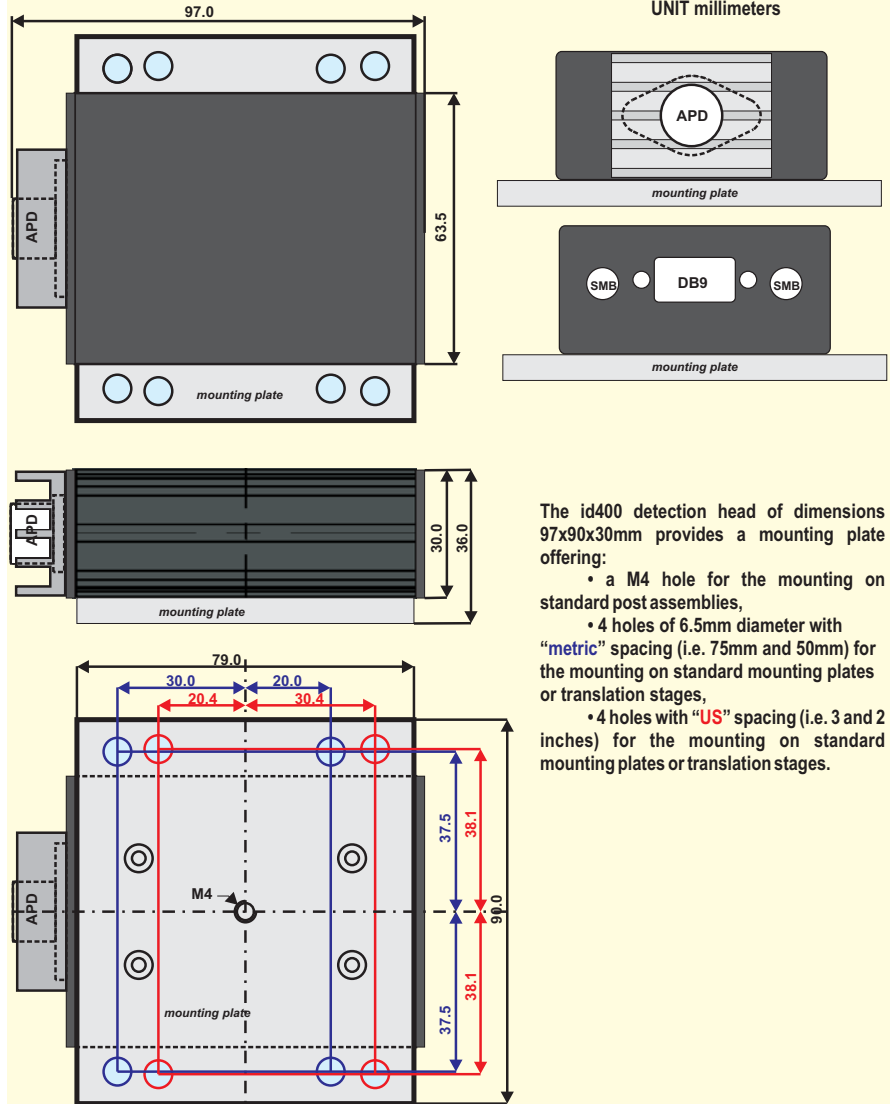
- in **standard mode**, the parameters can be set by the user: mode (internal gating, external gating or free-running), dead time, single photon detection probability level, gating frequency, gate width and delay values. The detector count rate and effective gate rate are continuously displayed on the front panel. Note that a setup can be save in a text file and reload later.



- in **acquisition mode**, the user can set the number of samples to acquire and the integration time / sample in seconds. A plot of the mean detector count rate over the integration time is displayed. The data can be saved in a text file.



Detection Head Dimensional Outline



The id400 detection head of dimensions 97x90x30mm provides a mounting plate offering:

- a M4 hole for the mounting on standard post assemblies,
- 4 holes of 6.5mm diameter with "metric" spacing (i.e. 75mm and 50mm) for the mounting on standard mounting plates or translation stages,
- 4 holes with "US" spacing (i.e. 3 and 2 inches) for the mounting on standard mounting plates or translation stages.

Other Products (please visit our website <http://www.idquantique.com>)

- id100 Single photon counting module for the visible spectral range
- id201 Single photon counting module for the IR spectral range
- id300 Short pulse laser source
- Quantis Quantum Random Number Generator
- Clavis² Quantum Key Distribution System for R&D
- Cerberis Layer 2 encryptor with Quantum Key Distribution
- Centauris Layer 2 encryptor