Near-Infrared Single-Photon Detector - IRSPD1
by S-Fifteen Instruments

1 Features

- 10% Photon detection efficiency
- Single-photon sensitivity from 1020 nm to 1650 nm
- Free-running
- Dark counts below 20 000 s^{-1}
- Detection timing jitter below 300 ps
- User-adjustable diode parameters (temperature, threshold, hold-off time, reverse-bias voltage)
- Integrated detection events counter

Applications: LIDAR & LADAR, Rangefinding, Optical communications, Ultra-sensitive fluorescence measurements, Environmental analysis, Biomedical devices, Quantum key distribution

2 General Description

The IRSPD1 is a single-photon detector module sensitive to the near-infrared spectrum. The photodetection is performed by a passively quenched InGaAs/InP avalanche photodiode in Geiger mode. A monolithically integrated quenching resistor provides a stable high-gain single-photon response and low dark counts.

3 Specifications

Table 1: Device Specifications

Diode Properties – Cooled Negative Feedback Avalanche Diode	
Photon Detection Efficiency	10% @ 1320 nm, -40°C device temperature
Spectral Response Range	1020 nm to 1650 nm
Dark Count (DC) Rate	<20 000 DC/s, typical 15 000 DC/s
Diode Temperature	Min. -50°C with the device case at 25°C, Software controllable
Breakdown Voltage V_B	70 V − 85 V
Temperature Coefficient of V_B	0.1 V/K
Available Reverse-bias Range	0 − 100 V, Software controllable
Quenching Mechanism	Passive
Hold-off Time	0 − 1 μs, Software controllable
Fiber Pigtail	SMF28 FC/UPC
Software Interface	
Physical Port	USB 2.0, Type B
Communication	Serial communication via virtual COM port / USB CDC ACM class
Electrical Specifications	
Output Pulse	NIM (Negative True -0.8 V, False 0 V, 50 Ω Load) or
	TTL (Positive True 2 V, False 0 V, 50 Ω Load), Software controllable
Pulse Rise/Fall Time	<2 ns (20% to 80%)
Timing jitter	<300 ps
Connector	LEMO 00 (NIM-CAMAC CD/N 549) or SMA, Selectable at product purchase
Power supply	4 W, 12 V DC, 2.1 mm Barrel socket
Physical Dimensions	
Size (W x L x H)	107 mm x 160 mm x 58 mm
Weight	500 g
Ambient Temperature Operating Range	15 − 35°C

4   Detection Time Accuracy

A time-correlation measurement between an InGaAs-APD and a reference superconducting nanowire single-photon detector (SNSPD) shows a jitter feature with a full-width at half-maximum of 196 ps. This characterization uses time-correlated photon pairs derived from down-conversion in a non-linear crystal. The timing uncertainty is mainly due to the InGaAs-APD as the SNSPD jitter <4 ps and photon pair timing uncertainty <1 ps do not contribute significantly. The feature is modeled with 2 Gaussian distributions (black line in Fig.1).

Figure 1: Observed timing jitter
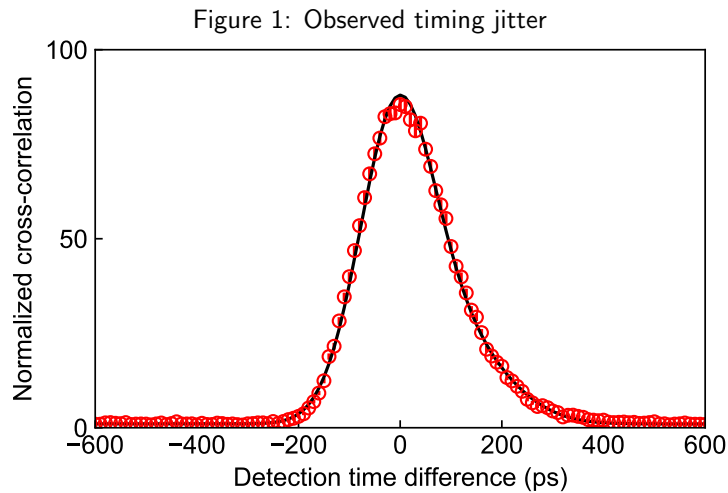
5   Software Control Commands

Send plain-text commands terminated/separated by newline/cr or semicolon via the virtual COM port. An eventual reply comes terminated with cr+lf. The commands are case-insensitive.

Table 2: List of serial commands/queries available on the detector

Command	Description
*IDN?	Returns device identifier
*RST	Resets device
TEMP?	Returns the current diode temperature
HVOLT <value>	Sets the diode reverse bias to <value> Volt.
HVOLT?	Returns the current voltage setting
PVOLT <value>	Sets the Peltier element to <value>Volt.
SETTEMP <value>	Sets the APD temperature to <value> Celsius.
SETTEMP?	Returns the set temperature.
CONSTP <value>	Sets the P loop constants in V/K.
CONSTI <value>	Sets the I loop constants in V/s/K.
CONSTD <value>	Sets the D loop constants in Vs/K.
LOOP <s>	Sets the temp loop status <s>. **1: on, 0: off**
LOOP?	Returns the temperature loop status.
THRESHVOLT <value>	Sets the threshold to <value> Volt. Can be both polarities.
THRESHVOLT?	Returns current threshold voltage.
TIME <t>	Sets the counter integration time to <t> millisec.
TIME?	Returns the counter integration time in millisec.
COUNTS?	Returns the events counted in an integration time.
CONFIG 3	NIM output pulse
CONFIG 8	TTL output pulse
DELAY <value>	Sets the hold-off time to <value> $\times$ 5 ns.
SAVE	Saves the current settings.
HELP	Print help text.

5.1 Python Library for S-Fifteen Instruments

A python class encapsulating all serial commands can be found on `https://github.com/s-fifteen-instruments/pyS15`. To install the library follow the instructions on GitHub.

Here a code example to count photon detections for 1 second:

```python
from S15lib.instruments import SinglePhotonDetector
detector = SinglePhotonDetector('/dev/tty.usbmodemISPD_0101')
detection_events = detector.counts(1)
```