

---

**ROF Silicon free running single  
photon detector  
R-QCD300B-S-3  
User Manual**

---

# 1 Product Overview

## 1.1 Product Introduction

The R - QCD300B is a series of silicon free-running single photon detectors. The core component is an integrated cooling type silicon single photon avalanche diode. An AQAR chip is integrated inside, which has active quenching and active recovery functions and can operate in the free-running mode. This product has a USB communication interface and an external departmental control input interface, enabling it to flexibly support users in conducting various applications of single photon detectors based on this.

## 1.2 Product Appearance and Interface

- ◆ The product appearance view is shown in the following figure:

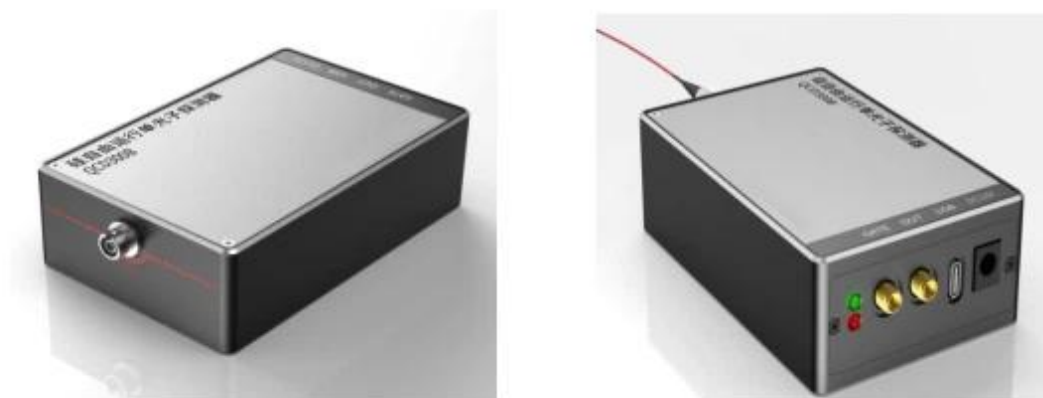


Figure 1 Appearance of the front and rear sides of the equipment

1. The outer casing and cover plates of the equipment are made of aluminum alloy, model 6061.
2. The surface of the equipment casing is treated with sandblasting and then colored and oxidized. The upper cover plate is silver-white (the original metal color), while the casing and the rear panel are black.

3. A barcode label is attached to the left side of the equipment: the serial number of the entire machine, including the production date and batch number.

◆ The device interface is as follows:

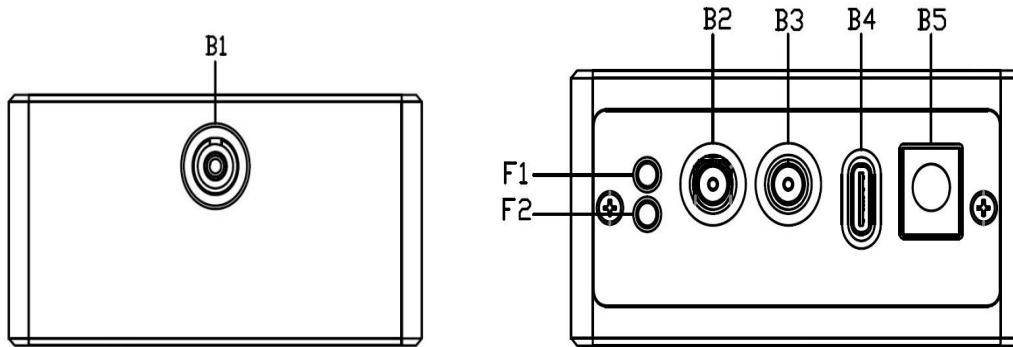


Figure 2 Equipment Interface Diagram

Table 1 Main Interface Description

N	Panel labeling	interface name	interface type	direction	Specifications	purpose
F1	/	Operation indicator LED light	Green LED	/	/	On: The device is powered on normally
F2	/	Fault indicator LED light	Red LED	/	/	Bright: Fault has occurred Extinguish: No malfunction occurs
B1	/	Fiber optic flange interface	/	IN	FC/UPC	Optical signal input
B2	GATE	gating signal	SMA	IN	/	External Gate Control Input
B3	DET	Detector output signal	SMA	OUT	/	Detecting pulse output

B4	USB	data communication	USB	IN/OUT	USB2.0 Type C	data communication
B5	DC-12V	power interface	DC-005	IN	DC-12V	DC power input (No switch)

### 1.3 Product Features

- Single photon detection: Capable of detecting single photon signals in the visible light band;
- USB communication: Supports communication with the host computer via the USB 2.0 protocol, enabling parameter configuration download, status reporting, data upload, and related debugging functions;
- High reliability: Maintains system performance stability in different working environment temperatures through active stabilization algorithms;
- Easy maintenance: Supports real-time monitoring and control of system status;

### 1.4 Technical indicators

Table 2 Main parameter indicators of R - QCD300B-S-3 silicon free running single photon detector

Project		R-QCD300B-S-3
parameter indicators	response wavelength	400 - 900nm
	number of channels	single channel
	Coupling method	62.5um/105um multimode fiber @ UPC interface
	Detection efficiency @ $\lambda=850\text{nm}$	Maximum 65%, typical value 60%
	Dark count rate	$\leq 100\text{cps}$
	Post pulse probability	$\leq 8\%$ @ 100ns dead time
	Time jitter	Minimum 350ps, typical value 500ps
	Dead time adjustment	0ns-63ns

	Saturation count rate	$\geq 8\text{Mcps}@100\text{ns}$ Death time
Specifications	size	Width 110mm, height 35mm, depth 72mm
	weight	Net weight approximately 300g
	power supply	DC 12V
	Maximum power consumption of the whole machine	$\leq 8\text{W}$
environmental adaptability	Operating Temperature	-10 ~ 55°C
	Storage temperature	-40 ~ 85°C
	Operating Humidity	10% ~ 90%RH
	storage humidity	10% ~ 90%RH

## 2 Installation and Deployment

### 2.1 Typical application scenarios

The application fields of the R - QCD300 series of silicon free-running single-photon detectors include: single-photon lidar, fluorescence lifetime detection, single-photon imaging, quantum communication, quantum optics, optical time-domain reflection, etc. Typical applications are shown in the following figure.

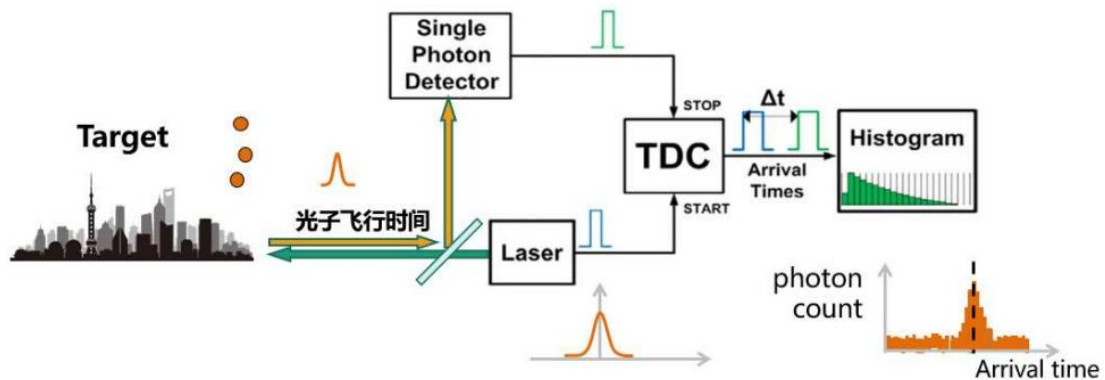


Figure 1 Schematic diagram of typical application scenarios of the product

In applications such as single-photon lidar and single-photon imaging, a pulsed laser beam is emitted from the laser to the target. The signal photons scatter or reflect when encountering molecules in the air or hard targets. After being collected at the laser emission point, the scattered or diffuse reflected echo photon signals are collected. These signals are

detected using single-photon detectors, and the detection signals are analyzed in conjunction with the laser emission signals using time digital converters to obtain the photon flight time. Finally, the distance of the target object is calculated using the speed of light. In atmospheric lidar applications, the backscattered laser from the atmosphere is detected to obtain physical information of the atmosphere. In three-dimensional imaging lidar applications, the distance information of each pixel is obtained through scanning, and then the three-dimensional image of the detected target is accurately reconstructed using imaging algorithms. Due to the inverse square relationship between the power of the echo signal received by the lidar and the detection distance, as the detection distance increases, the signal strength will sharply weaken. Moreover, because the laser is scattered and absorbed by the atmosphere during its round trip, the signal strength will further decrease. Compared to traditional photoelectric detectors, single-photon detectors have higher sensitivity and can respond to individual photon signals, enabling longer-distance detection and reducing the dependence on the laser emission power.

## 2.2 Typical Deployment Scenarios

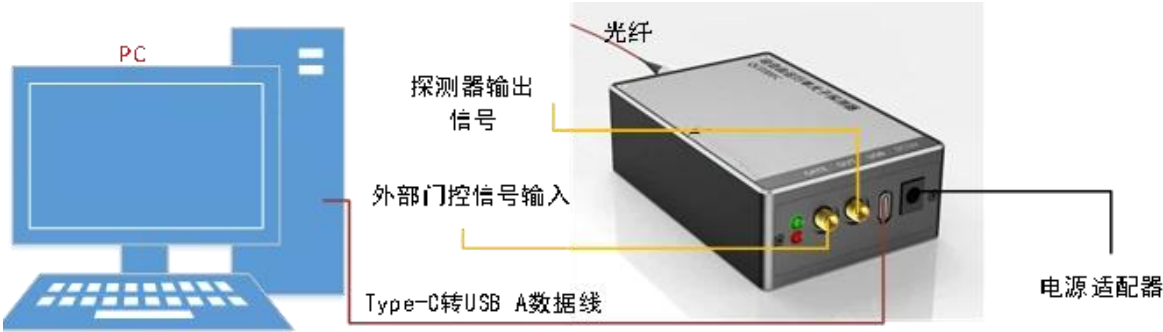


Figure 1 Deployment Connection Diagram

- 1) Connect the device as shown in Figure 2;
- 2) External input signals can be connected to devices through the GATE interface as gating input signals in gating mode;
- 3) External signals that need to be detected are connected to the fiber flange interface of

---

the product through optical fibers;

- 4) Connect the Type-C to USB A data cable via USB A to the PC end, and connect the Type-C to the USB interface on the back panel of the product;
- 5) After the connection is completed, the detector will be powered by a DC power adapter. After the detector is powered on, wait for 3 minutes (cold start time at room temperature) to work normally;
- 6) Open the free running single photon detector upper computer software on the PC end, connect the device to monitor the status of the detector.

## **2.3 Equipment Installation Instructions**

### **2.3.1 Equipment working environment**

It is recommended that users place anti-static pads on the countertop when using the device to avoid bottom wear and static interference.

- a) **Attention**
- b) **Ensure the stability and good grounding of the workbench;**
- c) **Leave a 10 cm heat dissipation space around the device;**
- d) **Do not place heavy objects on the device.**

### **2.3.2 Equipment Power Supply**

The R - QCD300B-S-3 product is powered by a power adapter. To ensure the safety of equipment and operation, reliable grounding is necessary.

#### **■ Power requirements:**

- a) The equipment is powered by a DC power supply;
- b) The input range of DC power supply voltage is  $12V \pm 20\%$ .

#### **■ Power connection:**

---

One end of the power adapter is connected to the power socket on the back panel of the device, and the other end is connected to an external power socket.

**Attention**

If the device is powered off, the power supply of the adapter should be disconnected first. It is forbidden to plug and unplug the power supply connector connected to the device end while it is live, in order to avoid damaging the internal components of the device.

### **2.3.3 Equipment pre power on inspection**

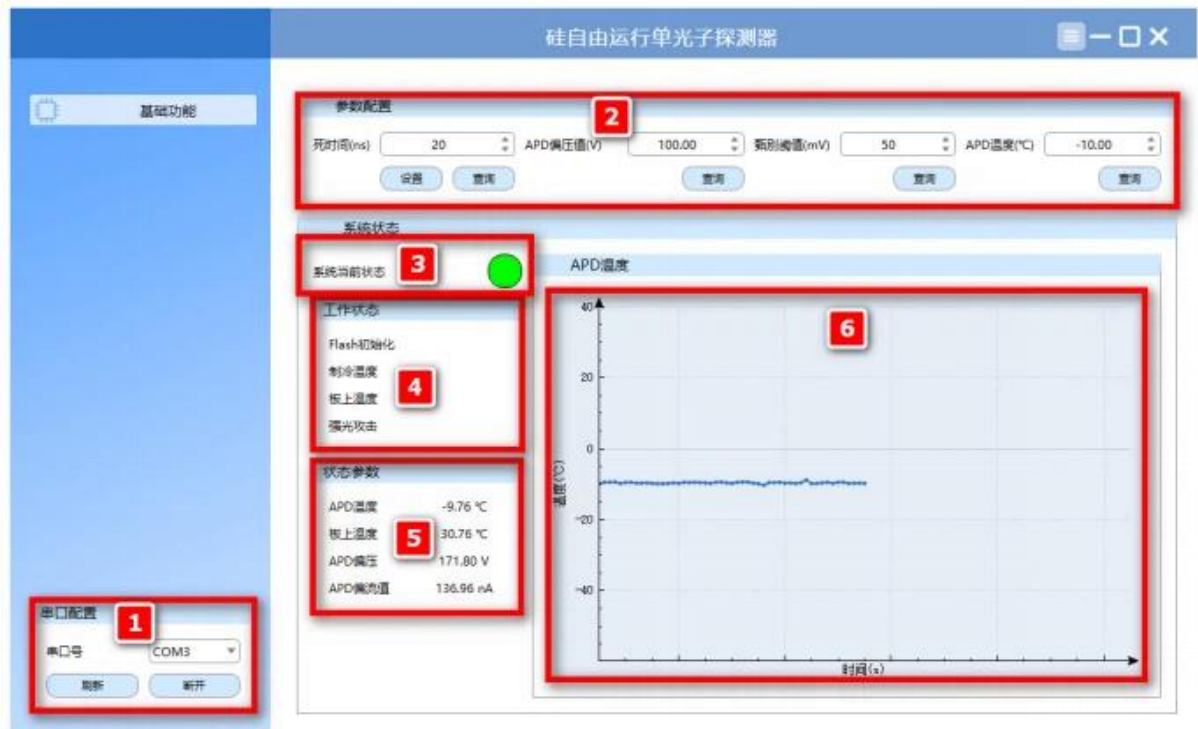
- 1) The equipment should be placed steadily or securely installed;
- 2) The device is not powered on;
- 3) The device cable is connected and correctly connected.

**Attention**

If there is outdoor wiring, please check if the AC power lightning protection plug and lightning arrester are connected.

## **3 Instructions for using supporting software**

The R - QCD300B-S-3 silicon free running single photon detector provides upper computer software, mainly used to monitor product operating parameters. The specific introduction is as follows:



- ① **Serial port configuration:** Open and close the connection between the current device and the upper computer.
- ② **Parameter configuration:** supports dead time query and setting; Support real-time query of APD bias voltage value, discrimination threshold, and APD temperature.
- ③ **System status:** Display the current device connection status (green: normal, red: fault, gray: not connected or APD cooling process).
- ④ **Working status:** When Flash initialization abnormality, cooling temperature abnormality, board temperature abnormality, or strong light attack abnormality occurs, a red icon will be displayed after the corresponding fault type.
- ⑤ **Status parameters:**
- ⑥ **APD temperature:** The device has a built-in temperature sensor that provides real-time feedback on the cooling temperature of the APD chip;
- ⑦ **On board temperature:** Real time monitoring of the temperature around the

**main control board or refrigeration module of the detector;**

- ⑧ **APD bias voltage: Real time display of APD reverse bias voltage;**
- ⑨ **APD bias current value: Real time detection of APD working current;**
- ⑩ **APD temperature: Real time monitoring of temperature during APD operation;**

## 4 Common problem explanations

This chapter mainly introduces some faults and their handling methods that occur in daily operations, as shown in the table below

Table 4 Troubleshooting and Solutions

N	Fault phenomenon	Cause of failure	Solution measures
1	The running indicator light is not illuminated	The power supply is not plugged in tightly	Power off the adapter, unplug and plug in the device power connector again
2		Power adapter mismatch	Check if the power supply of the power adapter meets the requirements. If it does not meet the requirements, replace it with a suitable power adapter
3	The fault indicator light is on	The upper computer displays Flash initialization exception	Power off and restart the device to see if it can be restored. If the fault cannot be eliminated, contact technical personnel for handling
4		The upper computer displays abnormal cooling temperature	Power off and restart the device to see if it can be restored. If the fault cannot be eliminated, contact technical personnel for handling.

5		The upper computer displays abnormal temperature of the single board	Check if the temperature of the upper computer board exceeds the threshold (80 °C). It is recommended to use an electric fan to cool down the detector to avoid abnormalities caused by high board temperature. If the fault cannot be eliminated, contact technical personnel for handling.
6		The upper computer displays abnormal strong light attack	Check if there is strong light entering the detector, remove the strong light source to see if it can be restored. If the fault cannot be eliminated, contact technical personnel for handling.
7	The detector has no output	Deployment environment issues	Check if all cable connections are functioning properly.
8	signal	hardware failure	Contact technical personnel for handling.

## 5 Appendix

### 4.1 Equipment packaging

#### Internal packaging:

- The device body is wrapped in anti-static foam, made of ixpe black material, and placed inside the foam mold to avoid shaking
- Accessories (power adapter, Type-C to USB data cable, USB flash drive, fiber optic jumper, etc.) are placed in the foam grooves.



**Special protection: Cover the optical interface (fiber flange) with a dust cap to prevent dust from entering.**

### 4.2 Supporting List

Table 5 Supporting List

N	Component Name	Quantity	Remark
---	----------------	----------	--------

1	QCD300B host	1 unit	Including pre installed fiber flange interface
2	12V power adapter	1 piece	Input 100-240V AC, output 12V DC
3	Type-C to USB A data cable	1 item	Length 0.5m, supports USB 2.0 communication
4	FC/PC multimode fiber optic jumper	1 item	62.5/105 $\mu$ m, Length 1m (optional)
5	USB drive	1 piece	Attached user upper computer software