



Single Photon Counting Module

SPCMxxA Quick Start



2020

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Contents

Foreword	2
1 General Information	3
1.1 Safety	3
2 Installation	4
2.1 Parts List	4
2.2 Getting Started	4
2.3 Installing Software	4
3 Operating Instructions	5
3.1 Operating Principle in brief	5
3.2 Connecting the SPCM	5
3.3 Graphic User Interface (GUI)	6
3.3.1 Operating Modes	7
3.3.2 Measurement Modes	8
3.3.3 Measurement Properties	8
3.3.4 Occurrences During Measurement	9
3.3.5 Measurement Result Display	9
4 Maintenance and Service	10
5 Appendix	11
5.1 Certifications and Compliances	11
5.2 Warranty	12
5.3 Exclusion of Liability and Copyright	12
5.4 Thorlabs Worldwide Contacts and WEEE Policy	13

We aim to develop and produce the best solution for your application in the field of optical measurement technique. To help us to live up to your expectations and constantly improve our products we need your ideas and suggestions. Therefore, please let us know about possible criticism or ideas. We and our international partners are looking forward to hearing from you.

Thorlabs GmbH

WARNING

Sections marked by this symbol explain dangers that might result in personal injury or death. Always read the associated information carefully, before performing the indicated procedure.

ATTENTION

Paragraphs preceded by this symbol explain hazards that could damage the instrument and the connected equipment or may cause loss of data.

NOTE

This manual also contains "NOTES" and "HINTS" written in this form.

Please read this advice carefully!

1 General Information

Thorlabs' Single Photon Counter Modules use a silicon avalanche photodiode to detect single photons. The SPCM counters are sensitive to photons emitted in the 350 to 900 nm range with the maximum sensitivity at 500 nm. They work by converting an incoming photon into a TTL pulse in the detector, which is counted by the internal 31-bit counter. An additional SMA connection offers a direct output pulse signal from the module that can be viewed on an oscilloscope or connected to an external counter.

An integrated Peltier element stabilizes the diode's temperature below the ambient temperature to reduce the dark count rate. The two available models, SPCM20A and SPCM50A, have low typical dark count rates of 25 and 150 counts per second, respectively, which allows them to detect power levels down to 0.14 fW.

The active quenching circuit integrated into the diode of the SPCM enables high count rates. Its high speed allows users to count a photon every 35 - 45 ns, depending on the model chosen. The SPCM20A provides an active area of $\text{\O}20\ \mu\text{m}$ and the SPCM50A offers $\text{\O}50\ \mu\text{m}$.

The SPCM includes a software package with GUI for out-of-the-box operation.

1.1 Safety

Attention

The safety of any system incorporating the equipment is the responsibility of the assembler of the system.

All statements regarding safety of operation and technical data in this instruction manual will only apply when the unit is operated correctly as it was designed for.

The SPCMxxA must not be operated in explosion endangered environments!

Do not remove covers!

Do not open the cabinet. There are no parts serviceable by the operator inside!

This precision device is only serviceable if properly packed into the complete original packaging including the plastic foam sleeves. If necessary, ask for replacement packaging.

Refer servicing to qualified personnel!

Only with written consent from Thorlabs may changes to single components be made or components not supplied by Thorlabs be used.

All modules must only be operated with proper shielded connection cables.

2 Installation

2.1 Parts List

Inspect the shipping container for damage.

If the shipping container seems to be damaged, keep it until you have inspected the contents and you have inspected the SPCMxxA mechanically and electrically.

Verify that you have received the following items within the package:

1. SPCM20A (~/M) or SPCM50A (~/M)
2. Wall plug adapter (power supply 100-240 VAC / 6 VDC / 1.5 A)
3. USB 2.0 cable, A to mini B
4. Quick Start
5. CD with operating software

2.2 Getting Started

NOTE

Take care for proper air ventilation in order to ensure normal operation of the SPCMxxA. Prior to connecting the SPCMxxA to a PC, please install software from the attached CD.

2.3 Installing Software

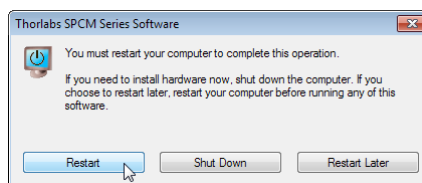
NOTE

The screenshots in this manual are related to a Windows® 7 Operating System.

Insert the CD into your CD or DVD drive. If the installation screen does not appear automatically, please execute

[CD Drive]:\Autorun\autorun.exe

After completing the installation you might be prompted to restart your PC.



3 Operating Instructions

3.1 Operating Principle in brief

The Thorlabs SPCMxxA uses a silicon avalanche photo diode (Si APD), operated in reverse direction and biased slightly beyond the avalanche threshold (Geiger mode). An incident photon generates charge carriers, which initiate a current pulse.

In order to enable the count of next incident photon, each current pulse must be “quenched” by lowering the bias voltage below the avalanche threshold for a short time. After quenching the bias increases again, this way enabling the APD for detection of the next photon. The Thorlabs SPCMxxA use an APD with integrated quenching circuit, providing a high counting accuracy. Photon initiated current pulses are counted. The counter is gated for a certain time (“bin”). Measurement can be repeated in order to count the number of incident photons in subsequent bins. For details, please refer to the full Operation Manual.

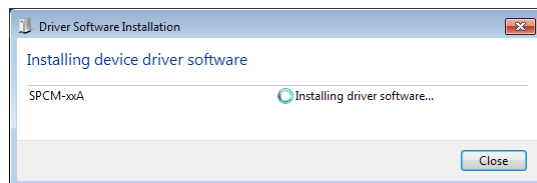
3.2 Connecting the SPCM

- Connect the wall plug adapter to mains outlet
- Connect the adapter’s DC output cable to the SPCMxxA
- Connect the SPCMxxA via the USB cable to your PC
- Switch on the single photon counter module. The green LED, located beside the DC power input of the SPCMxxA, lights up.

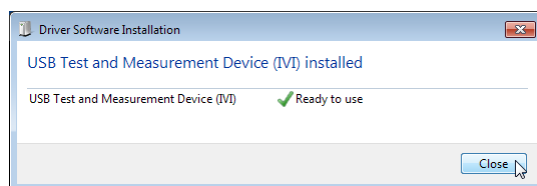
Note

During a measurement, the green status LED is switched off in order to avoid stray light.

- Your operating system will recognize a new hardware and automatically start the driver installation.




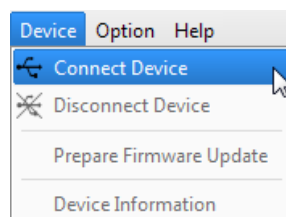
- After completing, a message will inform you that the new hardware is installed and ready to use.



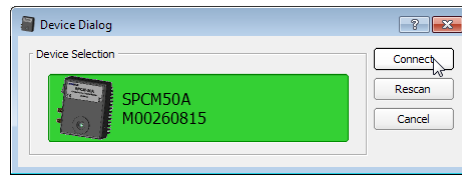
Start the software by clicking the appropriate  icon on the desktop; alternatively it can be started from Windows button - Programs - Thorlabs - SPCM Series Software - “SPCM”.

As a next step, the Single Photon Counter Module needs to be connected to software. There-

fore, click to the  icon in the toolbar or choose the appropriate function from the Device menu



A device selection dialog opens

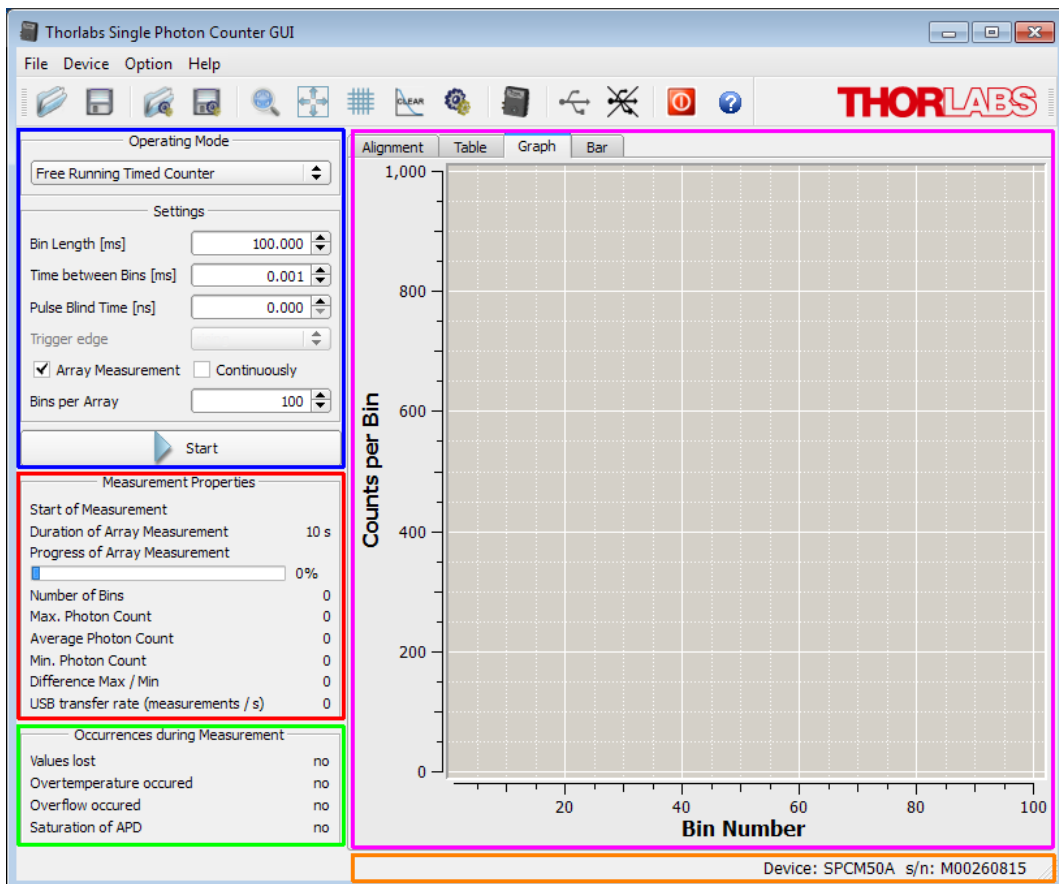


The selected device is shown on a colored background. Click "Connect" - the selected hardware is connected and the dialog window closes. If no device is shown to be selected, click "Refresh Device List" button. Select the recognized device and click "Connect".

Note

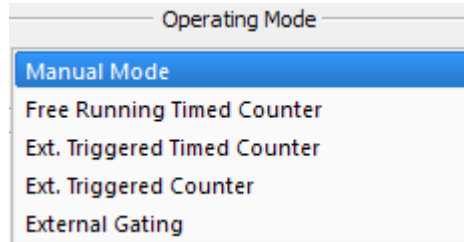
Multiple SPCM devices can be operated from a single PC by running a separate software instance. The Device Dialog panel will show all recognized SPCM devices, an already connected SPCM will be inactive (grayed out), so that only a free, available SPCM can be selected to connect.

3.3 Graphic User Interface (GUI)



3.3.1 Operating Modes

The SPCM software offers five operating modes to be selected from a drop-down list:

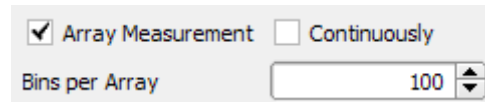


- **Manual Mode:** The APD is biased beyond breakdown voltage internally. The counter is started and stopped manually via the appropriate button in the software, at each "start" command the counter is reset. No settings except **Pulse Blind Time** can be made. The count result is updated 10 times per second and displayed numerically (Alignment display) and graphically (tabs Graph and Bar).
- **Free Running Timed Counter:** The APD is biased beyond breakdown voltage at any time. The counter is started / stopped by the internal timer. The timer is programmed via software, this way defining the **bin length** and the waiting **time between bins**. The sum of bin length and time between bins must not go below 0.020 ms. An additional **Pulse Blind Time** can be set. After pushing the Start button, the timer begins to control the counter and incident photons are counted into bins until the Stop button is pressed. The results are displayed graphically and numerically, see [Measurement Result Display](#)⁹.
- **Externally Triggered Timed Counter:** This operating mode is similar to the Free Running Timed Counter mode, with the difference that the timer is started by an external trigger signal. The sensitive **trigger edge** (rising or falling) can be selected. The APD is biased beyond breakdown voltage at any time. The counter is started / stopped by the internal timer. The **bin length** is programmed via software. After pushing the Start button, the trigger is armed and waits for the first pulse slope. When the selected trigger edge is detected, the timer is started and photons are counted for a time, defined by the set **bin length**. After finishing the bin, the counter stops. With the next trigger slope, the count starts again. This continues until the Stop button is pressed. The results are displayed graphically and numerically.
- **Externally Triggered Counter:** In this mode, the counter is not timed, but controlled (started and stopped) only by an external trigger signal. The sensitive **trigger edge** (rising or falling) can be selected. The APD is biased beyond breakdown voltage at any time. After pushing the Start button, the trigger is armed and waits for the first pulse slope. When the selected trigger edge is detected, the counter starts photon count until the next trigger pulse arrives. As for this reason, the trigger period T_p defines the **bin length** as well as the time between subsequent bins. This counting process continues until the Stop button is pressed. The results are displayed graphically and numerically.
- **External Gating:** The External Gating is similar to Externally Triggered Counter mode. The significant difference is that the APD is not always biased beyond breakdown voltage, but the APD bias is controlled by an external gating signal. The advantage of this active gating is a lower probability to miss a photon: In previously described modes, the APD is biased beyond breakdown voltage at any time. That means, it reacts on incident photons at any time. This reaction includes also the activity of the quenching circuit; during the quenching time (35 - 45ns) the APD is "blind" for incident photons. When the APD is gated actively, it is armed with the arrival of the gating signal so that the first incoming photon can be counted. In External Gating mode, the counter is not triggered on a selectable edge, but enabled

as long as a gating signal is present. The gating signal must be TTL level compatible, HI = active.

3.3.2 Measurement Modes

In all operation modes, except for Manual Mode, the number of bins to be counted can be limited. This measurement mode is called **Array Measurement**. Array measurement allows high measurement speed by limiting the number of bins; after completing the count is stopped (**Single Array**) or restarted (**Continuously**) by the GUI. Check the appropriate box and enter the number of bins to be counted.



In above example, the SPCM will count an array of 100 bins and the stop. If desired, the array count can be restarted automatically by checking the box "Continuously".

Array size: A max. of 10,000 bins can be measured. For fast measurements (Bin Length + Time between Bins < 0.020 ms), the max. array size is limited to 1,000.

3.3.3 Measurement Properties

Measurement Properties	
Start of Measurement	15:43:49
Duration of Array Measurement	10 s
Progress of Array Measurement	0%
Number of Bins	27
Max. Photon Count	958026
Average Photon Count	950891
Min. Photon Count	942695
Difference Max / Min	15331
USB transfer rate (measurements / s)	9

Beside the measurement status (start time; for array measurement - duration and progress), statistics of counted photons is displayed (number of bins, max. and min. photon count per bin, average photon count and the span between the minimum and maximum count).

Note

The minimum photon count serves also as an indicator for counter errors:

- values ≥ 0 are true, valid count results
- value = -1: During measurement, a counter overflow occurred (more than 2,147,483,647 photons counted)
- value = -2: During measurement, a bin was missed and could not be transferred to the GUI
- value = -3: Read error during loading data from a file

Finally, the current USB transfer rate is displayed.


3.3.4 Occurrences During Measurement

Occurrences during Measurement	
Values lost	no
Overtemperature occurred	no
Overflow occurred	no
Saturation of APD	no

Displays the history of occurred during measurement error, which may lead to incorrect photon count. In contrast to the display of the actual SPCM status in the status bar, in this child window single error events are recorded until a new measurement is started.

3.3.5 Measurement Result Display

Graphical and auxiliary displays are arranged in 4 tabs:

- **Alignment:** This display is useful to adjust the optical setup. Beside the actual photon count it brings up important information on the current measurement and device status.
- **Table:** This is a purely numeric display. The first two columns state bin number and the appropriate photon count. In column remarks are stated deviations from normal operation for the actual bin count (e.g., saturation level or over temperature).
- **Graph:** In this tab, the recent photon counts are displayed graphically. Areas of interest can be zoomed, using the cursor (marked red) by click and drag to the desired region. Alternatively, the zoom area can be selected numerically from the Zoom Dialog (click to the  icon).
- **Bar:** This display is similar to the Graph display, with the difference that each bin is displayed as a bar.

4 Maintenance and Service

Protect the SPCMxxA from adverse weather conditions. The SPCMxxA is not water resistant.

Attention

To avoid damage to the instrument, do not expose it to spray, liquids or solvents!

The unit does not need a regular maintenance by the user. It does not contain any modules and/or components that could be repaired by the user himself. If a malfunction occurs, please contact [Thorlabs](#)¹³ for return instructions.

Do not remove covers!

5 Appendix

5.1 Certifications and Compliances

Category	Standards or description
EC Declaration of Conformity - EMC	Meets intent of Directive 2004/108/EC ¹⁾ for Electromagnetic Compatibility. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Communities:
EN 61326:2006	EMC requirements for Class A electrical equipment for measurement, control and laboratory use, including Class A Radiated and Conducted Emissions ^{2,3,4)} and Immunity. ^{2,3,4)}
IEC 61000-4-2	Electrostatic Discharge Immunity (Performance criterion B)
IEC 61000-4-3	Radiated RF Electromagnetic Field Immunity (Performance criterion A)
IEC 61000-4-4	Electrical Fast Transient / Burst immunity (Performance criterion B)
FCC EMC Compliance	Emissions comply with the Class A Limits of FCC Code of Federal Regulations 47, Part 15, Subpart B ^{2,3,4)} .
EC Declaration of Conformity - LVD	Compliance was demonstrated to the following specification as listed in the Official Journal of the European Communities: Low Voltage Directive 2006/95/EC ⁵⁾
EN 61010-1:2001	Safety requirements for electrical equipment for measurement, control and laboratory use.
UL 61010-1 2 nd ed.	Safety requirements for electrical equipment for measurement, control and laboratory use.
CAN/CSA C22.2 No. 61010-1 2 nd ed.	Safety requirements for electrical equipment for measurement, control and laboratory use.
IEC 61010-1:2001	Safety requirements for electrical equipment for measurement, control and laboratory use.
Equipment Type	Test and measuring
Safety Class	Class I equipment (as defined in IEC 60950-1:2001)

¹⁾ Replaces 89/336/EEC

²⁾ Compliance demonstrated using high-quality shielded interface cables.

³⁾ Emissions, which exceed the levels required by these standards, may occur when this equipment is connected to a test object.

⁴⁾ Minimum Immunity Test requirement.

⁵⁾ Replaces 73/23/EEC, amended by 93/68/EEC.

5.2 Warranty

Thorlabs warrants material and production of the SPCMxxA for a period of 24 months starting with the date of shipment. During this warranty period Thorlabs will see to defaults by repair or by exchange if these are entitled to warranty.

For warranty repairs or service the unit must be sent back to Thorlabs. The customer will carry the shipping costs to Thorlabs, in case of warranty repairs Thorlabs will carry the shipping costs back to the customer.

If no warranty repair is applicable the customer also has to carry the costs for back shipment.

In case of shipment from outside EU duties, taxes etc. which should arise have to be carried by the customer.

Thorlabs warrants the hard- and/or software determined by Thorlabs for this unit to operate fault-free provided that they are handled according to our requirements. However, Thorlabs does not warrant a fault free and uninterrupted operation of the unit, of the software or firmware for special applications nor this instruction manual to be error free. Thorlabs is not liable for consequential damages.

Restriction of Warranty

The warranty mentioned before does not cover errors and defects being the result of improper treatment, software or interface not supplied by us, modification, misuse or operation outside the defined ambient stated by us or unauthorized maintenance.

Further claims will not be consented to and will not be acknowledged. Thorlabs does explicitly not warrant the usability or the economical use for certain cases of application.

Thorlabs reserves the right to change this instruction manual or the technical data of the described unit at any time.

5.3 Exclusion of Liability and Copyright

Thorlabs has taken every possible care in preparing this document. We however assume no liability for the content, completeness or quality of the information contained therein. The content of this document is regularly updated and adapted to reflect the current status of the hardware and/or software. We furthermore do not guarantee that this product will function without errors, even if the stated specifications are adhered to.

Under no circumstances can we guarantee that a particular objective can be achieved with the purchase of this product.

Insofar as permitted under statutory regulations, we assume no liability for direct damage, indirect damage or damages suffered by third parties resulting from the purchase of this product. In no event shall any liability exceed the purchase price of the product.

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5.4 Thorlabs Worldwide Contacts and WEEE Policy

For technical support or sales inquiries, please visit us at www.thorlabs.com/contact for our most up-to-date contact information.



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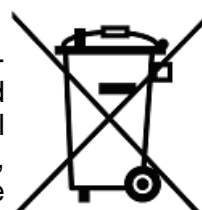
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Thorlabs 'End of Life' Policy (WEEE)

Thorlabs verifies our compliance with the WEEE (Waste Electrical and Electronic Equipment) directive of the European Community and the corresponding national laws. Accordingly, all end users in the EC may return “end of life” Annex I category electrical and electronic equipment sold after August 13, 2005 to Thorlabs, without incurring disposal charges. Eligible units are marked with the crossed out “wheelie bin” logo (see right), were sold to and are currently owned by a company or institute within the EC, and are not disassembled or contaminated. Contact Thorlabs for more information. Waste treatment is your own responsibility. “End of life” units must be returned to Thorlabs or handed to a company specializing in waste recovery. Do not dispose of the unit in a litter bin or at a public waste disposal site.





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