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User Manual

Single Photon Detector SPD_A_M1



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1. Objectives & Applications

1.1. OBJECTIVES

The objectives of this document are to help the reader in the understanding and the correct use of the SPD_A_M1[™] equipment. This document gives all the information to the user of the SPD_A_M1[™] in order to:

- Understand all functionalities of the system.
- Proceed to overall installation.
- Turn up the system.
- Configure the equipment.
- Proceed to Single Photon Detection and counting.

This document gives a product overview with a general description of the product and a recommendation list of banned actions when using this system.

The configuration and use chapter gives to the reader all the details concerning the different functional mode of the equipment, how to configure and how to use it.

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1.2. APPLICATIONS

This document applies to all the persons who will use the SPD_A_M1[™] system. It is really important to read this manual completely before using the system.

This document can also be used by person who would like to get a useful description and an overview of the product.



2. Terminology

AC/DC	Alternative Current/Dirrect Current
APD	Avalanche PhotoDiode
CMOS	Complementary Metal Oxyd Semyconductor
DVD	Digital Versatile Disc
GUI	Graphical User Interface
LCD	Liquid Crystal Display
LED	Light-Emitting Diode
LDO	Low Drop Out
MMF	Multi Mode Fiber
PC	Personal Computer
RoHS	Restriction of the use of certain Hazardous Substances
SMF	Single Mode Fiber
TTL	Transistor to Transistor Logic
USB	Universal Serial Bus

Figure 1 : List of acronyms

3. Document conventions

This document uses the following typing conventions:

A reference to a menu of the front end interface is done through the quotation marks <> Example: <*Configuration*> describes the Configuration menu.

A reference to a terminal specific button on the front panel is done this way: **#Button** Example:

#Select stands for the Enter key:



#Up stands for the Up arrow key:





4. Product overview

4.1. INTRODUCTION

The SPD_A_MX[™] is a family of ultra low noise single photon detector. The SPD_A_M1[™] IR (near infraread) includes a Geiger-mode InGaAs avalanche photodiode and a thermo-electrical cooler that ensures: high Quantum Efficiency, low dark count, high speed, and low jitter. The SPD_A_M1[™] equipment is dedicated to high performance photon detection & counting especially in laboratory's environment.

The "product overview" chapter gives mechanical, functional and technical information upon the different features of the product. It also brings the user some useful information concerning the parameters to be set and the role of optical or electrical interfaces.

The product can be used directly as a plug and play system. The configuration and display of the information will in that case be controlled from the "front end". This mode is commonly called "Standalone mode".

The other mode is called "Remote control mode". In that case, the user must run the GUI on a PC and connect an USB cable to the SPD_A_M1[™].

4.2. FUNCTIONAL DESCRIPTION

In order to simplify the understanding, we can divide the system in 4 functional blocks.

- <u>Photon counting block</u>: This part consists in a mechanical holder for the diode, an electronic board and an avalanche photodiode (APD). The mechanical holder allows not only fixation but also cooling of the photodiode. The APD is used as a photon counter. The electronic board allows the control of the temperature cooling of the photodiode as well as the value of the avalanche voltage.
- <u>Parameters control block</u>: This block consists in 2 electronic boards. Its purposes are to set and monitor all the digital and analog parameters of the system. This block also gives an USB interface access to all the parameters of the system.
- <u>Front end setting and display block</u>: This part consists in an electronic board allowing the access from the front end to the parameters of the system. The electronic board integrates an LCD module, a keypad and a LED display module.
- <u>Power supply block</u>: This block consists in an electronic board coupled to cables and a transformer. The main supply is an AC/DC converter which will give 5V supply to the system. The power supply block will use a LDO regulator to convert 5V to 3,3V and also a voltage supervisor for safe use of the system.



The schematic below give a functional view of the system:



Figure 2 : Functional view of the system

4.3. DETECTION PROCESS

The detection process depends on 3 different parameters.

First the equipment must be synchronized by a "clock" signal. This "clock" signal will be used to generate the second parameter: a "gate". During the "gate" moment, the APD will be able to collect photons thus to count them.

A "delay" can also be applied to this gate in order to shift the beginning of the detection phase. To summarize, we have the following parameters that directly concern the detection process:

- "Clock"
- "Gate"
- "Delay"

"CLOCK" parameter:

Two clocking scheme are available in the system: internal clock and external clock, and should be selected by the user through the configuration process.

By default, the internal clock is selected.

The internal clock is generated by the SPD_A_M1[™] system in order to allow detection without any additional equipment. User could select between 13 pre-defined values from 1 kHz to 4 MHz.

A Clock signal generated by external equipment (clock generator) can also be used. In that case the external clock mode must be selected. The external clock signal must be connected to the input "**Clock in**" on the front panel of the SPD_A_M1TM.



Once generated, the clock signal (generated internally or externally) could be used to synchronize external equipment. The clock signal is derived to the "Clock out" output connector of the front panel.

- ⇒ When external clock mode is selected, output signal "Clock Out" is not identical to the signal connected to "Clock In" input.
- ⇒ When internal clock mode is selected, an output signal "Clock Out" is generated according to the value selected by the user (13 values available from 1 KHz to 4MHz).

"GATE" parameter:

An Avalanche PhotoDiode (APD) is used in Geiger Mode. In this mode a small positive voltage pulse is added to the bias voltage (Vb) of the photodiode in order to allow counting. Counting will be possible within the duration if this pulse. This pulse is also called the "Gate". This gate is derived from a trigger signal called clock. The gate is generated upon a positive Edge of the Clock signal.



----- : applied voltage to the photodiode versus time

Figure 3 : Electrical principle of an avalanche photodiode

In many applications, arrival time of the photon could not be known previously to the detection process. In order to maximize the chance to detect this event, the user can increase slightly the duration of the Gate by adjusting the "Gate Width" parameter.

"DELAY" parameter:

The Gate is generated few "ns" after the positive edge of the Clock signal. Duration between positive edge of the Clock and positive Edge of the Gate is called Gate Delay. The Gate delay combines two delays:

- fixed hardware delay of 10ns
- software delay adjustable from 0 to 127,5 ns.





Figure 4 : Gate generation timing diagram

4.4. TECHNICAL FEATURES AND CHARACTERISTICS

The technical features and ratings of the SPD_A_M1[™] are summarized in Annexe1 located at the end of this document.

4.5. MECHANICAL INFORMATION

4.5.1. General

The chassis characteristics of the SPD_A_M1[™] are:

- High : 70 mm
- Width : 250 mm
- Deep: 280 mm
- Weight : 4 kg

4.5.2. Front end

The front end of the SPD_A_M1[™] holds the optical interface as well as the clocking interfaces.





Figure 5 : Front end of the equipment

4.5.3. Rear end

The rear end of the SPD_A_M1TM holds the power supply interface.



Figure 6 : Rear end of the equipment



4.6. INTERFACES

4.6.1. Optical in

Description	Connector	Characteristics	Timing
Optical input.	Depending on customer purchase order (FC/PC type)	Δ The damage level for the APD is reach if the optical power is greater than - 45 dBm.	Not applicable

4.6.2. Clock in

Description	Connector	Characteristics*	Timing
Used as an external synchronization source for the counting process	SMA Impedance (High Z)	Input high voltage VIH 2.0V min. Input low voltage VIL 0,8V max. Input is 5V tolerant.	0-10MHz Max

* This means that the input is compatible with 3,3V/5V standard TTL and CMOS logics.

4.6.3. Clock out

Description	Connector	Characteristics*	Timing
Used to synchronize external equipment.	SMA Impedance (High Z)	Output high voltage VIH 2.0V min. Output low voltage VIL 0,5V max.	Max 10 MHz (13 values available for clocking mode: " internal ")

* This means that the output is compatible with 3,3V/5V standard TTL and CMOS logics.



4.6.4. Detection out

Description	Connector	Characteristics*	Timing
Signal generated after detection of an Event.	SMA Impedance (High Z)	Output high voltage VIH 2.0V min. Output low voltage VIL 0,5V max.	Pulse Width of 80ns.

* This means that the output is compatible with 3,3V/5V standard TTL and CMOS logics.

Minimum delay (fixed by hardware) between "Clock out" and "Detection out" is set to 10ns.



Figure 7: Timing diagram for Detection out signal

4.6.5. USB (Supervision)

There are two modes:

- The "*Standalone mode*": The product can be used directly as a plug and play system. The configuration and display of the information are in this case directly controlled by the front end panel. This mode is commonly called "Standalone mode".
- The "*Remote mode*": In this case, you must use the front end USB interface in order to connect the SPD_A_M1[™] to a PC.

Description	Connector	Characteristics	Timing
Used to connect a remote PC for supervision.	Mini USB type B.*	USB 1.0 & USB 2.0 compatible. Quality class: 1500 mating cycles.	USB 1.0 & USB 2.0 compatible.

* The USB connector on the SPD_A_M1[™] is type B (it is usually type A on remote PC)



4.6.6. Power Supply

Description	Connector	Characteristics	Timing
Used to supply a	2,5" jack	5V DC output	Not applicable.
DC voltage to the equipment.	+-50mV ripple noise.		
	+-5% of line and load regulation		
		4A maximum load	

5. Important recommandations & notices

Information furnished by Auréa Technology is believed to be accurate and reliable. However, no responsibility is assumed by Auréa Technology for its use, nor for any infringements of patents or their rights of third parties that may result from its use. Specifications are subject to change without notice. No license is granted by implication or otherwise under any patent or patent rights of Auréa Technology. Trademarks and registered trademarks are the property of their respective owners.

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Please read carefully the interfaces specifications before connecting the equipment. Stresses above those listed under the interfaces chapter may cause permanent damage to the equipment. Exposure to maximum rating conditions for extended period may affect equipment reliability. Operation above maximum operating condition may cause permanent damage to the SPD_A_M1[™].

Warranty is not applicable if the mechanical chassis have been opened by the customer. Technical intervention, maintenance and repairs should only be performed by Auréa Technology.



6. Configuration and use

6.1. INTRODUCTION: DIFFERENCES BETWEEN STANDALONE AND REMOTE MODE

The SPD_A_M1[™] could be used in 2 different modes:

- Standalone mode means that the equipment can be used as a plug and play system.
- Remote mode means that the equipment is remotely controlled by a PC.

The selection between both modes is done using the USB cable. If the USB cable is plugged on a powered computer, the remote mode is selected. If the USB cable is unplugged or the computer is not powered, then the standalone mode is selected.

In remote mode, the interface (Keypad + screen display) located on the front end is no more available to the user.

Counting is available in both modes. Modifications must be saved in non volatile memory of the system to be used during power on sequence.

- In standalone mode: Modifications are saved in non volatile memory of the system when "save all" menu from the front end interface is used.
 - In remote mode: Modifications are saved in non volatile memory of the system when menu "Equipment" option "Save parameters on board" from GUI is used.
 - In remote mode: Modifications are save in a .txt file and not in non volatile memory when menu "File" option "Save" from GUI is used.



6.2. STANDALONE MODE

6.2.1. Connecting the equipment

Step 1: Auréa Technology power supply cord assembly

The first phase consists in plugging the power supply cord in the AC/DC converter.



Figure 8 : Connecting the power supply module in standalone mode

Step 2: Optical connection of the system

Single photon optical signal to be detected should be connected to the optical input of the system (**Optical in**) through a dedicated optical fiber for single mode or multi mode version.

This optical fiber links optical output from the user's application device to the optical input of the SPD_A_M1[™].



For SPD_A_M1[™] multi-mode version, Single mode or multi-mode fiber should be used.



Optical power of the signal to be detected should not be higher than - 45 dBm

Optical signal will be detected via the Avalanche Photodiode (APD) connected inside the system to Optical in connector.

Step 4: Connection of the clock input (not mandatory for internal clocking mode)

If the user wants to use an external clock, he must follow this step. Please connect the clock output of the external equipment to the Clock in input of the SPD_A_M1[™] using a SMA to SMA cable.



6.2.2. Power On

 \Rightarrow Turn ON (pushed position) the ON/OFF button located on the front panel :



- ⇒ The Led "Power" located on the left side (top end) of the LCD screen turns green.
- ⇒ The LCD screen located on the front panel will be highlighted and the message "Press V to start" is displayed on the screen.



⇒ Press "Enter" on the keypad :



- ⇒ "Cooling" appears on the screen during the cooling process. (< 2 min)
- \Rightarrow The "Main Menu" appears. The device is ready.

The system checks the parameters during the « Turn On » process. When all the parameters are verified, the "Main Menu" window is displayed on the screen.



6.2.3. Front end interface

6.2.3.1. FRONT END KEYPAD DESCRIPTION

Once the system is powered up, the control with the front panel keypad is available.



Directional arrows are used to select the menu or sub-menu. The green V button stands for validate or select. The red cross button stands for cancel or back to previous menu.

The character "•" on the left side of the LCD screen, in front of a stream, indicates that this item has been selected.

The character "←" : "press enter to select "



6.2.3.2. TREE MENU

The following schematic gives the tree menu that is displayed on the LCD screen of the front end:



Figure 10 : Tree menu on front end display



6.2.3.3. CLOCK SELECTION

From Main Menu:

- Select the Menu < 1-Settings >
- Select the Menu < 1-Clock >
- Select the Menu < 2-Clocking Mode >
- Select the Menu < 1-Set >
- Choose the mode « Internal » or « External »
- Validate the choice (**#Select** Button).

If you work with an external clock generator then select the "External" mode.

If you work with the internal clock generator located inside the system, then select the "Internal" mode.

In case of "Internal mode" selection, the frequency of the clock must be defined:

- Select the Menu < 1-Settings >
- Select the Menu < 1-Clock >
- Select the Menu < 1-Clock Frequency >
- Select the Menu <1-Set >
- Choose the frequency.
- Validate the choice (**#Select** Button).

7.2.3.4. EFFICIENCY SELECTION

This menu allows you to configure the Detection Efficiency of the detector.

From Main Menu:

- Select the Menu < 1-Settings >
- Select the Menu < 2-Efficiency >
- Select the Menu < 1-Set >
- Choose the efficiency
- Validate the choice (**#Select** Button).
- \Rightarrow The message "Apply setting ..." is displayed on the screen.

6.2.3.5. COUNTING MODE SELECTION

This menu allows you to Enable or Disable the counting function of the system. Select "**Enable**" if you want to use the SPD_A_M1[™] to make counting. Select "**Disable**" if you are using an external counting board to count the photon detection Event.

From Main Menu:

- Select the Menu < 1-Settings >
- Select the Menu < 3-Counting Mode >
- Select the Menu < 1-Set >
- Choose "Enable" or "Disable"
- Validate the choice (**#Select** Button).
- ⇒ The value of the Detected photon per second is displayed on SPD_A_M1[™] LCD screen if "**Enable**" is selected.
- ⇒ The message "Disabled" is displayed on SPD_A_M1[™] LCD screen if "**Disable**" is selected.
- ⇒ The message "No Clock" is displayed on SPD_A_M1[™] Manager window in case of "External" Clocking Mode and when no clock has been connected to the Clock in port on the front panel..

6.2.3.6. GATE WIDTH SELECTION

This menu allows you to configure the duration of the Gate

From Main Menu:

- Select the Menu < 1-Settings >
- Select the Menu < 4-Gate Width >
- Select the Menu < 1-Set >
- Select a value with the directional pad. **#Up** or **#Down** to increase or decrease a digit. **#Right** and **#Left** to change digit.
- Validate the choice (**#Select** Button).
- \Rightarrow The message "Apply setting ..." is displayed on the screen.

6.2.3.7. DELAY CONTROL

This menu allows you to configure the duration of the Delay

From Main Menu:

- Select the Menu < 1-Settings >
- Select the Menu < 5-Delay control >
- Select the Menu < 1-Set >
- Select a value with the directional pad. **#Up** or **#Down** to increase or decrease a digit. **#Right** and **#Left** to change digit.
- Validate the choice (**#Select** Button).

6.2.3.8. SAVE ALL OPTION

Once all the parameters have been selected and the system configured you can save all the parameters.

From Main Menu:

- Select the Menu < 1-Settings >
- Select the Menu < 6-Save All >
- \Rightarrow A confirmation message is displayed on the screen.
- Press **#Select** to save all parameters
- Press **#Back** to exit Menu without saving

6.2.3.9. FACTORY SETTING OPTION

This menu allows the user to come back to a factory configuration of the system. The factory values are listed below:

Parameter	Factory value
Efficiency	5%
Delay	20 ns
Gate width	20 ns
Counting mode	Disable
Clocking mode	Internal
Clock frequency	~976Hz

Figure 11 : Factory value for parameters

From Main Menu:

- Select the Menu < 1-Settings >
- Select the Menu < 7- Factory Setting>
- \Rightarrow A confirmation message is displayed on the screen.
- Press **#Select** to save all parameters
- Press #Back to exit Menu without saving



6.2.3.10. DETAILS SELECTION

This menu allows you to display the clock count and detection count on a per second basis.

From Main Menu:

- Select the Menu < 2-Measurements >
- Select the Menu < 1-Details >

 \Rightarrow The following information are displayed on the screen:

clock : "Value" (Corresponds to clock count per second)

count : "Value" (Corresponds to detected photon per second)

6.2.3.11. ALARMS/STATUS MENU

This menu allows you to display the alarms and their status.

From Main Menu:

- Select the Menu < 3-System info >
- Select the Menu < 1-Alarms/Status >
- ⇒ Information concerning the alarms and status of the system are then displayed on the screen.

Name of the alarm	Status	Description
GateWidth-wr-err	"0" non active, "1" active	Error writing gate width command
Enable-MCP-wr-err	"0" non active, "1" active	Error in enabling optical system
APD-Volt-wr-err	"0" non active, "1" active	Error writing APD voltage command
APD-Volt-rd-oor	"0" non active, "1" active	APD voltage is out of range
APD-Temp-wr-err	"0" non active, "1" active	Error writing APD temperature command
APD-Temp-rd-oor	"0" non active, "1" active	APD temperature is out of range
Threshold-wr-err	"0" non active, "1" active	Error writing threshold commmand
Effi-GateWidth-NA	"0" non active, "1" active	Efficiency does not exist for current Gate Width
Delay-Freq-NA	"0" non active, "1" active	Delay is not applicable for current clock frequency

The table below gives the list of alarms of the SPD_A_M1[™]:

Figure 12 : List of the alarms and description in standalone mode



6.2.3.12. VERSION MENU

This menu allows you to display the version information of the SPD_A_M1[™].

From Main Menu:

- Select the Menu < 3-System info >
- Select the Menu < 2-Version >
- ➡ Informations concerning the version of the system are then displayed on the screen. These informations are the Serial Number, The Part Number and the version of the embedded software.
- 6.2.3.13. COUNTING DISPLAY

The counting value is displayed for almost each menu on the last line of the LCD screen: count : "value"

The only thing to do is to set internal counting enable.

If internal counting is disable, the following message will appear: count : Disabled

The counting value is available from the < Main Menu > and each menu of < 1-Settings >.

6.2.4. Front end indications

6.2.4.1. LOCATION OF THE LEDS

The front panel of the SPD_A_M1[™] has 4 LEDs located on the left side of the LCD screen which give indication concerning the system.



Figure 13 : Front end LEDs position



6.2.4.2 INITIALISATION STATE

The initialisation state can be related to power on.

Color	Possible Meanings
GREEN	The system is powered.
SWITCH OFF	Initialisation in progress
RED	System is not ready
GREEN	No alarm set

Figure 14 : LED color during initialisation state

6.2.4.3. POWER LED

Color	Possible Meanings
	System is un-powered or
SWITCH OFF	LED is out of order.
	The system is powered.
GREEN	

Figure 15 : Power LED description

6.2.4.4 CONTROL LED

Color	Possible Meanings
	System is un-powered or
SWITCH OFF	System in initialisation state or
	LED is out of order.
	Standalone mode selected
GREEN	
	Remote mode selected (USB cable is plugged)
ORANGE	

Figure 16 : Control LED description



6.2.4.5 STATUS LED

Color	Possible Meanings
	System is un-powered or
SWITCH OFF	System in initialisation state or
	LED is out of order.
	System is ready
GREEN	
0	System is not ready
RED	

Figure 77 : Status LED description

6.2.4.6 ALARM LED

Color	Possible Meanings
	- System is un-powered or
SWITCH OFF	- System in initialisation state or
	- LED is out of order.
	- No alarm set
GREEN	
	- Alarm(s) set (refer to 7.2.3.11 for further information on possible alarm).
RED	

Figure 18 : Alarm LED description



6.2.5. How to make a measure

In standalone mode, the system is configured to be used as a plug and play system.

<u>Step 1:</u>

The first phase consists in connecting the system. For further information concerning this part please refer to 6.2.1.

<u>Step 2:</u>

The second phase is the power on phase as described in 6.2.2.

<u>Step 3:</u>

The third phase is the verification phase. It is very important to check that there is no alarm. Please refer to table in 6.2.4 for further information.

<u>Step 4:</u>

The default parameters are as follows:

Efficiency = 5% Delay current = 20 ns Gate width = 20 ns Counting mode = Disable Clocking mode = Internal Clock frequency = ~976 Hz

If needed, to modify these parameters, please refer to 7.2.3.

<u>Step 5:</u>

The system is therefore ready to use. Several display and measure information are available through the front end as described in 7.2.3.



6.3. REMOTE MODE

6.3.1. Connecting the equipment

Step 5: USB connection of the system

In the remote mode, the SPD_A_M1[™] is controlled through the PC. Thus an USB cable must be connected between the SPD_A_M1[™] and the remote computer.



Figure 19 : USB connection for remote mode



It is recommended to connect the USB cable after the start procedure. After, you can plug and deplug the cable at any time.

6.3.2. USB connection

- \Rightarrow .After the start of the single photon detector, you can plug the usb cable.
- ⇒ The led "Control" located on the left side (second from top end) of the LCD screen turns orange.
- ⇒ The following message is displayed on the screen "**Remote Mode**"



At this point the use of the front end keypad is not available.

N.B: If the USB cable is plugged, the message "Remote Mode" is displayed on the front end screen. When the cable is unplugged, the front end screen displays the "Main Menu" even if the latest menu used in standalone mode was different.



6.3.3. How to use Auréa Technology GUI

6.3.3.1. INSTALLING AURÉA TECHNOLOGY GUI

<u>Step 1:</u>

Auréa Technology GUI can only be used in Remote Mode. Please refer to 7.3.1 for further information on the connecting process.

The SPD_A_M1[™] Manager installation package is included in the DVDrom "User software and documentation" delivered with the system. This package is composed of :

> 1 Folder with the software Auréa and DLL associed.

> 1 Driver : You must install this required driver at the first connection of the Single photon Counter on the PC.

The Manager is fully compatible with the following operating systems:

- Windows 7
- Windows Vista
- Windows XP

<u>Step 2:</u>

At the first connection of the Single photon Counter on the PC. You must install the driver "mchpcdc" ask by Windows.

<u>Step 3:</u>

From the DVD "User software and documentation", copy the folder "Aurea" on your PC and inside this file, double click on "**Aurea.exe**".

6.3.3.2. GUI MAIN WINDOW

The main window of the GUI is given below:







Figure 8 : Main window of the remote control GUI

The chapters here under give a description on how to use the GUI. The use of this GUI is really intuitive.

6.3.3.3 THE "MENU BAR" OF THE MAIN WINDOW

The menu bar of the main window is given below:

🐴 Aurea Tech				
File	Device	Equipment	Help	
٩,				

The menu bar is divided in 4 parts. Each part is described here after.

"File" scrolling menu:



ÅA	urea Te	ch	
File	Device	Equipment	Help
a 2	5ave		
ء 🎺	Settings		
© (Quit		

The "Save" option is used to save the configuration of the GUI in a "name.txt" file.



This option only saves the GUI parameter. At this point the parameters are not saved on board.

The "Settings" option is used to set the graphic parameters.

🗖 Dialog		? 🛛
Graphic Option	5	
Title:	1	
Y label	Count	
X label	Time	
Y max	100 🗘	
Y min	0	
Ploted points:	210	
	ОК	Cancel

The "Quit" option is used to close the GUI.

"Device" scrolling menu:



Å A	urea Teo	ch	
File	Device	Equipment	Help
٩	🌖 Find	portName t	
Gr	Stop)	

This menu is used to:

- > Find the port name for carried out the communication between the software and the PC.
- > Start or Stop the application Auréa

"Equipment" scrolling menu:



The "**Restore Factory Parameters**" allows saving on board the factory parameters. The factory parameters are:

Efficiency = 5% Delay.current = 20 ns Gate width. = 20 ns Counting mode. = Disable Clocking mode. = Internal Clock frequency. = ~976 Hz

"Save parameters on board" allows saving to board the parameters of the GUI.



Using this option means that each time you will turn on the SPD_A_M1TM, the saved parameters will be used.

"Clocking Mode" allows choosing between Internal or External clock.



"Clock Frequency" is only available if you choose Internal clocking mode. Several values can be selected.

"Internal counting" allows to Enable or Disable the counting.

"Active log" gives the current alarm set in the system. The alarm can be:

Name of the alarm	Description
GateWidth-wr-err	Error writing gate width command
Enable-MCP-wr-err	Error in enabling optical system
APD-Volt-wr-err	Error writing APD voltage command
APD-Volt-rd-oor	APD voltage is out of range
APD-Temp-wr-err	Error writing APD temperature command
APD-Temp-rd-oor	APD temperature is out of range
Threshold-wr-err	Error writing threshold commmand
Effi-GateWidth-NA	Efficiency does not exist for current Gate Width
Delay-Freq-NA	Delay is not applicable for current clock frequency

Figure 9 : List of the alarms and description in remote mode

"Alarms log" display a log file for the alarm of the system:

<u>"Help" scrolling menu:</u>

It gives information about the GUI.

6.3.3.5 THE "CONTROL" PART OF THE MAIN WINDOW

This part is located at the top right end of the GUI. A capture of this part is given below:



Gate width	20,00	\$ ns
Delay	20,00	\$ ns
- Claimer		
Efficiency	(%)	
• 5 () 10	
0 15 (20	

Figure 22 : Control window of the remote control GUI

With this window it is possible to select 3 parameters:

- Gate width from 2.5 ns to 100 ns (step of 0,5 ns)
- Delay from **0** to **127,5 ns** (Step of 0,5 ns)
- Efficiency with different values available (5% / 10% / 15% and 20%)
- Current clock get the clock frequency.

6.3.3.6 THE "GRAPHICAL" PART OF THE MAIN WINDOW



Figure 23 : Graphical part for the main window of the remote control GUI

To see any graphic, the counting must be enabled.

The text box in high right corner is used to display current value of the detected photon (it is done on a per second basis).

To set the parameter of the graph (number of point etc...), see the "file" menu in "settings" option.

6.3.4. How to launch the Auréa Technology GUI

Step 1 : Launch the file Aurea.exe

Step 2 : Click on the "File" menu and choose the "find the portName" option.



Step 3: In "Connection Settings" click on "Scan" button to search the serial port and click on "**OK**" to validate the connection with the single photon detector.



Note: If the application do not find automatically the used serial port, you can choose the used port in the proposed list.

Connection	n Settings 🛛 🛛 🔀	
Serial Port :	N.\COM4 Scan	
Baud Rate :	BAUD19200 firs	t
Data Bits :	DATA_8	
Parity :	PAR_NONE	
Stop Bits :	STOP_1	
Flow Control :	FLOW_OFF	
Level 1	Default Cancel	
n secondly		









6.4 UPGRADE PROCEDURE

Not available in this version

7. Warnings

7.1. RECYCLABLE PRODUCT

The information provided in this chapter represents Auréa Technology's knowledge and belief. Auréa Technology bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties (declaration of conformity). Auréa Technology has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals.

The SPD_A_M1[™] is ROHS compliant.

For Auréa Technology "ROHS compliant" term mean the equipment is compatible with the current ROHS requirements for all 6 substances.



7.2. STORAGE CONDITIONS

Equipment should be stored at room temperature from -40°C to 65°C. Atmosphere must be dry and wet.

7.3. OPERATING CONDITIONS

For best performance and reliable results the equipment should be used at ambient temperature from 0°C to 25°C.

7.4. MAINTENANCE

Auréa Technology should be the only interface in case of problems with the equipment. Performance and accuracy of the equipment may directly be impacted if a calibration process is not performed every year.

Upgrade is not mandatory except if clearly expressed by Auréa Technology.





8. Annexes

8.1. TECHNICAL FEATURES AND CHARACTERISTICS

Technical features

Features	Description
Optical detection	Single Photon Detection : SPD_A
	Wavelength Range : 900-1700 nm
Detection efficiency	Single-mode version :
	Detection Efficiency : 5%, 10%, 15% or 20% (signal @1550nm)
	Multi-mode version :
	Detection Efficiency : 5%, 10%, 15% or 20% (signal @1550nm)
External Clock (to be connected to "Clock in" and selected by "external clocking mode")	0-10 MHz Max, TTL signal.
Internal Clock (selected by "internal clocking mode")	0-4 MHz with 13 values available.
External synchronization possibility	"Clock out" is directly derived from Clock in for synchronization purposes.
Gate width	Gate control by software from 2.5ns to 100ns, 0.5ns step
Delay control	0-128 ns / 0.5ns step
Internal counting mode	0-6 MHz with enabling or disabling possibility.
Front panel control (Standalone mode)	It is possible through a 4 lines / 20 characters LCD, 4 indication LEDs and a directional keypad with a select and cancel button.
Remote control from a computer (Remote mode)	Performed through an USB connection, a graphical user interface and a software library.

Figure 24 : Technical features



The tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. For detailed measures, please refer to the characterization sheet delivered with the system.



Absolute maximum rating

Description	Rating
Operating temperature	From 0° to 30° C
Storage temperature	From -40° C to 65° C
Cooling time for APD	< 2 min @ 25°C
Total power dissipation	14 Watts
Jitter	< 600 ps (10% efficiency)

Figure 25 : Absolute maximum rating

Optical characteristics

Description	characteristic
Maximum input optical power	- 45 dBm
Dark Count	< 8.10 ⁻⁶ for 1 ns gate (10% efficiency) for monomode version.
	< 2.10 ⁻⁵ for 1 ns gate (10% efficiency) for multimode version.
After Pulsing	< 1% @ 200 KHz (10ns gate -10% efficiency)

Figure 106 : Optical characteristics

8.2. MEASUREMENTS WITH EXTERNAL TRIGGER AND INTERNAL COUNTING

8.2.1 Set-up

In this case, an external system should be used to "clock" the SPD_A_M1[™] system. Connect the external clock (from 1 KHz to 10 MHz) to the input "Clock in" of the SPD_A_M1[™].

Connect the optical signal to be measured to the input "Optical in" of the SPD_A_M1[™].

8.2.2 Equipment Configuration

- Select the mode « External » clock.
- Choose the desired **Efficiency**.
- Select the internal counting mode.
- ⇒ The value of the Detected photon per second is displayed on SPD_A_M1[™] LCD screen if "**Enable**" is selected.

Adjust the Gate and the Delay to optimize detection

8.3. MEASUREMENTS WITH INTERNAL TRIGGER AND INTERNAL COUNTING

8.3.1. Set-up

In this case the SPD_A_M1[™] system is clocked by a signal generated by the SPD_A_M1[™] itself. Connect the optical signal to be measured to the input "Optical in" of the SPD_A_M1[™].

8.3.2. Equipment Configuration

- Select the mode « Internal » clock.
- Select the internal clock **frequency**.
- Choose the desired **Efficiency**.
- Select the internal counting mode.
- ⇒ The value of the Detected photon per second is displayed on SPD_A_M1[™] LCD screen if "**Enable**" is selected.

Adjust the **Gate** and the **Delay** to optimize detection