

id 201

Single-Photon
Detection Module

Operating Guide

Version 4.0

id Quantique

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2 *Getting started*

2.1 **Accessories supplied and Available**

2.1.1 **Accessories Supplied**

- Power cord

The type of power cord supplied with each unit is determined according to the country of destination.

- SMF or MMF, 1 meter optical fiber patchcord
- Fiber cleaner

2.1.2 **Supplied Manuals**

- Operating guide – this guide

2.1.3 **Additional accessories if supplied with RS232 interface**

- Programming guide
- RS232 cable
- CD

2.2 **Preparation for use and Safety**

Before starting to use the id-201 Single-Photon Detection Module (SPDM), it must be unpacked and connected to a suitable power supply line. Refer to Specifications for a description of such a power supply line. A power cord is supplied with the id-201 SPDM.

When properly connected to a power supply line, the id-201 SPDM can be switched on using the front panel ON/OFF switch. When switched ON, the id-201 SPDM will start cooling the avalanche photodiode. The assigned temperature will be normally reached in a few minutes. During this phase, the message “Detector Cooling” is displayed on the front panel LCD display. The front panel keys are inactive. Once the assigned temperature is reached, the id-201 SPDM is enabled. The module is now ready for operation.

Before connecting cables to the front panel connectors, always make sure that the signal does not exceed the damage levels.

The insertion loss and reflection at an optical fibre connector is extremely dependent on its cleanliness. The fibre patchcord ends connected to the id-201 SPDM optical input port must be kept clean at all times.

IMPORTANT

The input connector of the id-201 SPDM cannot be cleaned or repolished by the user. In order to ensure minimum insertion losses, it is recommended to connect before the first use of the detector an optical fibre patchcord to the id-201 SPDM optical input port. This patchcord should then be used for all connections of the module to a device under test. In case of inappropriate insertion losses, the connector of this patchcord can be easily cleaned or repolished by the user.

2.3 The front panel at a glance

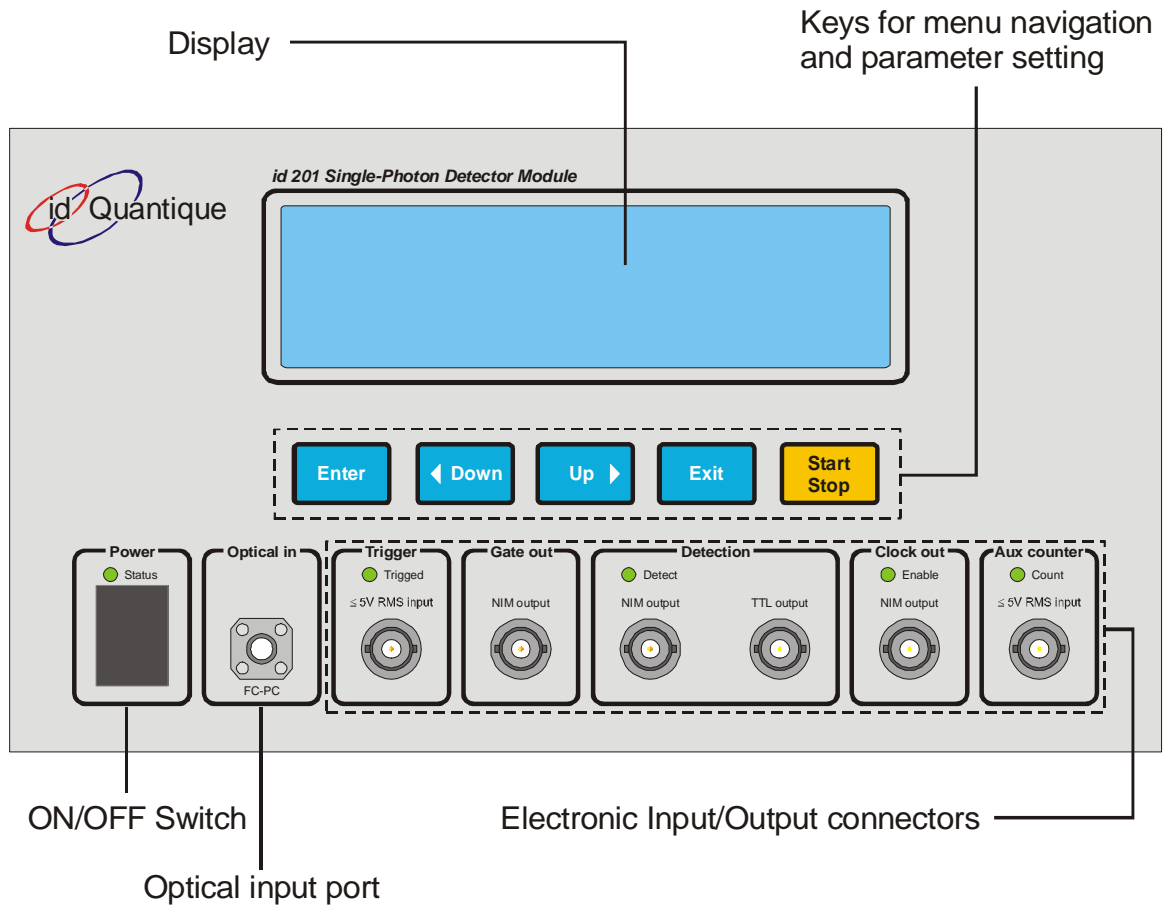


Figure 2.1 Front panel

Note: Your id-201 SPDM may slightly differ from this illustration.

2.4 The front panel indicators at a glance

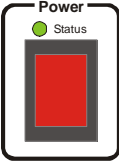
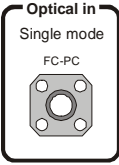
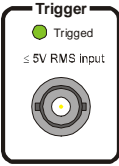
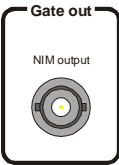
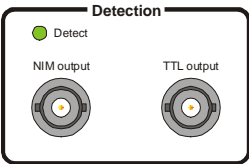
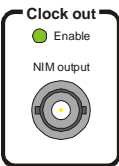
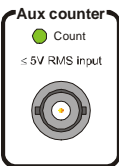
	<p><i>Power:</i> ON / OFF switch</p> <p><i>Status LED</i> On Green → ok</p>
	<p><i>Optical in:</i> FC/PC optical connector</p> <p><i>Note:</i> The type of fiber to be used is mentioned above the connector. We strongly recommend to connect the supplied patchcord and to avoid removing it.</p>
	<p><i>Trigger:</i> Input BNC connector for <i>trigger</i> signal</p> <p><i>Triggered LED</i> Flashes upon valid triggering</p>
	<p><i>Gate out:</i> Output BNC connector for <i>gate out</i> signal</p> <p>The delayed trigger signal is available on this front panel connector. Its duration is equal to the gate duration.</p>
	<p><i>Detection:</i> Output BNC connectors for <i>Detection</i> signals (NIM and TTL)</p> <p><i>Detect LED</i> Flashes upon valid detection</p>
	<p><i>Clock out:</i> Output BNC connector for <i>clock out</i> signal</p> <p><i>Enable LED</i> On when <i>clock out</i> signal enabled</p>
	<p><i>Aux counter:</i> Input BNC connector for external counter signal</p> <p><i>Count LED</i> Flashes upon valid counting</p>

Figure 2.2 Front panel indicators

2.5 The rear panel at a glance

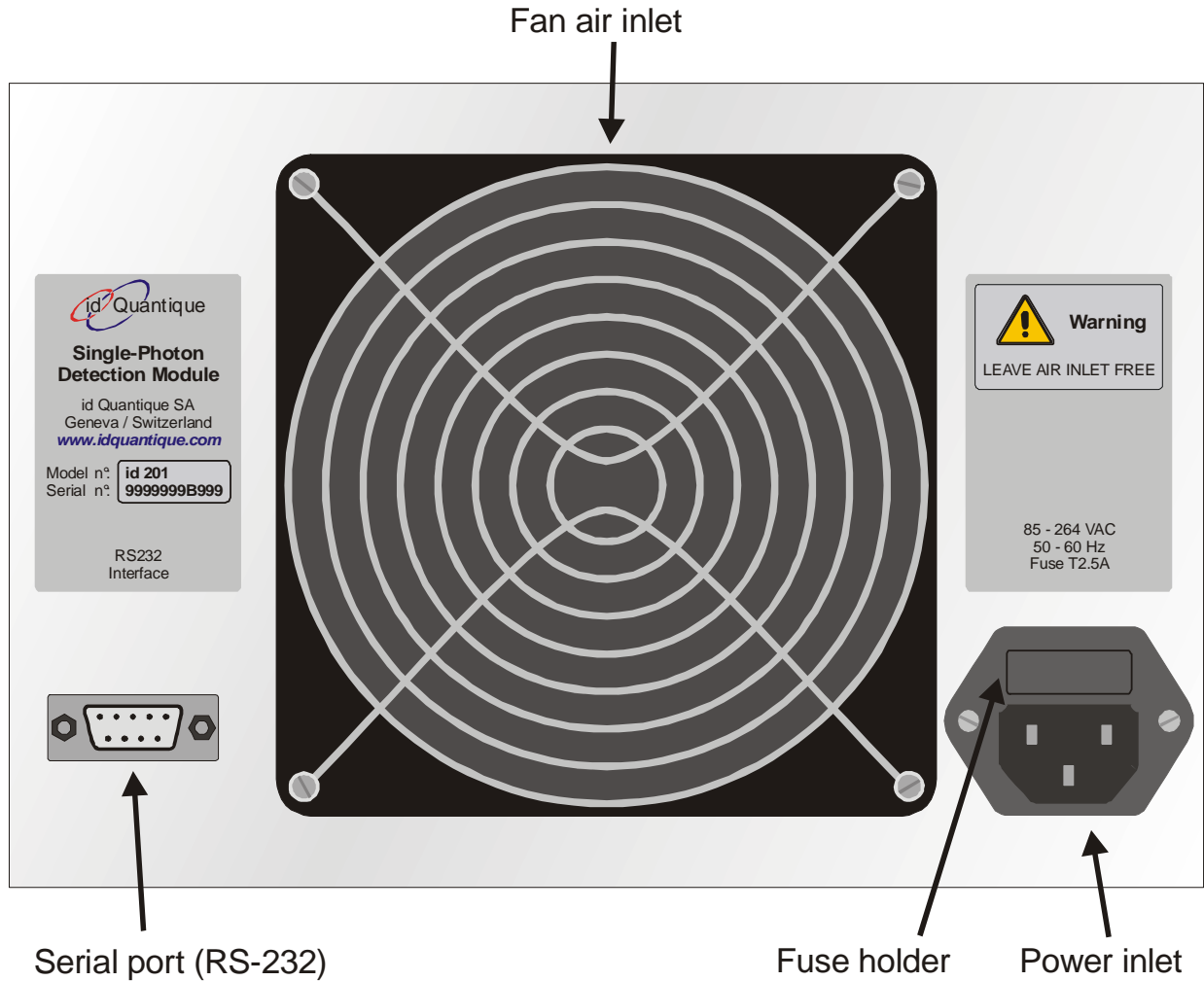


Figure 2.3 Rear panel

Note: Your id-201 SPDM may slightly differ from this illustration.

2.6 Block diagram of the id-201 SPDM

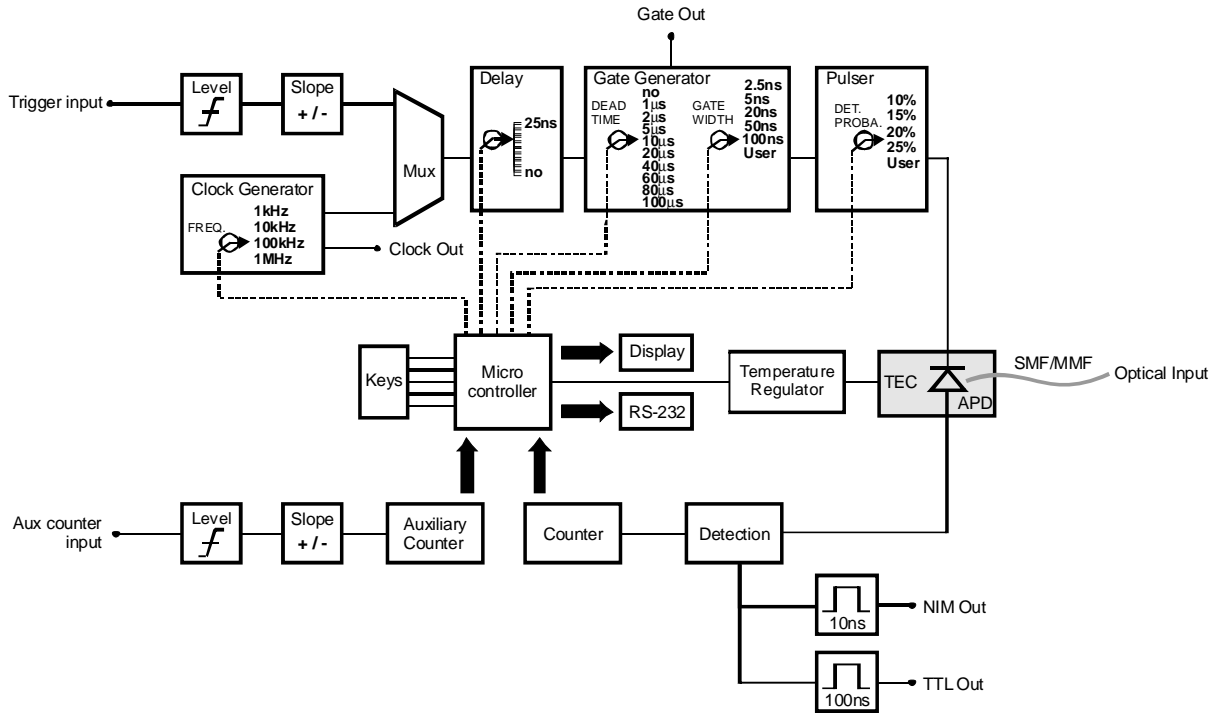


Figure 2.4 Block diagram of the id-201 SPDM

3 Operation

In this chapter, the operation of the id-201 Single-Photon Detection Module (SPDM) is presented. After an introduction where the general characteristics of the id-201 SPDM and its block diagram are presented, the procedure to configure the id-201 SPDM and perform a measurement is described. In this section, menus of the id-201 SPDM and navigation through their various levels are described.

3.1 Introduction

The id-201 SPDM consists of a cooled avalanche photodiode (APD) with temperature control, as well as biasing, quenching and sensing circuits. Figure 2.4 shows the block diagram describing the operation of the id-201 SPDM.

The operation temperature is set upon assembly to optimize the performance. It cannot be adjusted by the user. The APD is operated in so-called gated mode, where a voltage pulse is applied to raise the bias above breakdown upon triggering. The duration of the gate pulse can be adjusted by the user with the front panel keypad. The amplitude of the pulse can be adjusted with the Photon Detection Probability. It is selected, along with the temperature, to yield a given quantum detection efficiency and dark count probability. A trigger signal is necessary to define the time when a gate is applied onto the APD. Such a signal can be provided by an external device (External Trigger Mode). It can also be generated by the internal clock generator. In this case, the signal is also available on a front panel connector for synchronization of other devices (e.g. pulsed laser source). The frequency of the internal clock generator is obtained by frequency division of an internal time base and can be adjusted by the user.

Whether coming from an external source or from the internal clock generator, the trigger signal can be electronically delayed before generating the gate signal. This allows the user to synchronize the gate and the optical signal. Coarse synchronization should be done using cables and optical fibers, while fine adjustment can be obtained with the internal adjustable delay line. The delayed trigger signal is available on a front panel connector.

Note: When synchronizing the id-201 SPDM gate with an optical signal, it is useful to remember that the propagation delay induced by one meter of coaxial cable or one meter of single-mode optical fibre is approximately 5 ns.

A variable deadtime can be selected to reduce afterpulse occurrences. When this mode is enabled, the module will ignore trigger signals during a time equal to the deadtime after each registered avalanche.

The module features an internal counter, which can be displayed on the front panel to monitor the detection signal. For each detection, the module also produces an electronic pulse available on front panel connectors. These pulses can, for example, be registered by an external counter or sent to a processing unit, such as a time-to-amplitude converter.

The id-201 SPDM also offers the possibility to count external signals. These can then be displayed on the front panel LCD display.

For demanding photon-counting applications, where every sources of stray light can induce noise, it is possible to dim the id201 front panel back illumination and LED's indicators. This option is useful when visible spectrum photon counting detectors are used in combination with the id-201 SPDM.

The id-201 SPDM is also equipped with a RS-232C connector located on its back panel. This connector allows interfacing the module with a computer for parameter setting and data acquisition. This functionality is offered as an option. Please contact *id Quantique* for more information. This port is also used to update the embedded software. Refer to the detailed instructions provided by *id Quantique* along with the Embedded Software Update for guidelines.

Please refer to *id Quantique's* Single-Photon Detection Module Application Notes for more information about single-photon detection at telecommunication wavelengths with avalanche photodiodes.

3.2 Making a measurement

In this section, the measurement and configuration procedures of the id-201 SPDM are outlined.

3.2.1 Switching on the id-201 SPDM

Please refer to the "Getting Started" chapter for a description of the preparation for use and of the safety precautions. Make sure that the power supply line is compatible with the specifications of the id-201 SPDM. Attach the power cord and switch on the id-201 SPDM by pressing the front panel switch.

Cooling of the avalanche photodiode

The temperature of the avalanche photodiode is critical to obtain satisfying photon counting performance. Immediately after being switched on, the id-201 SPDM will start to cool the avalanche photodiode to its operation temperature. This normally takes a few minutes. During this phase, the message "Detector Cooling" is displayed on the front panel LCD display. The front panel keys are inactive. Once the assigned temperature is reached, the id-201 SPDM is enabled. The module is now ready for operation.

Note: The operation temperature cannot be reached if the message "Detector Cooling" changed to "Fatal error" on the front panel display. Please check that the environment temperature is not higher than the maximum operation temperature specified. Make also sure that the fan opening is not blocked.

3.2.2 Navigating the menus

The id-201 SPDM has five keys, which can be efficiently used to navigate through the various menu levels to configure the module and perform measurements.



Enter: When pressing this key in counting mode, the main **Setup** menu is displayed. When a menu is displayed, pressing this key will select the highlighted item. In a value list, pressing this key will validate the value and bring the user one level up.



Down / Up: These keys are used to navigate through menus and value lists. In normal operation mode, those keys can also be used to change the display mode.



Exit: This key is used to close a menu and go back up one level. In a value list, pressing this key will validate the value and bring the user one level up.



Start/Stop: This key is used to start and stop measurements.

3.2.3 Menu structure

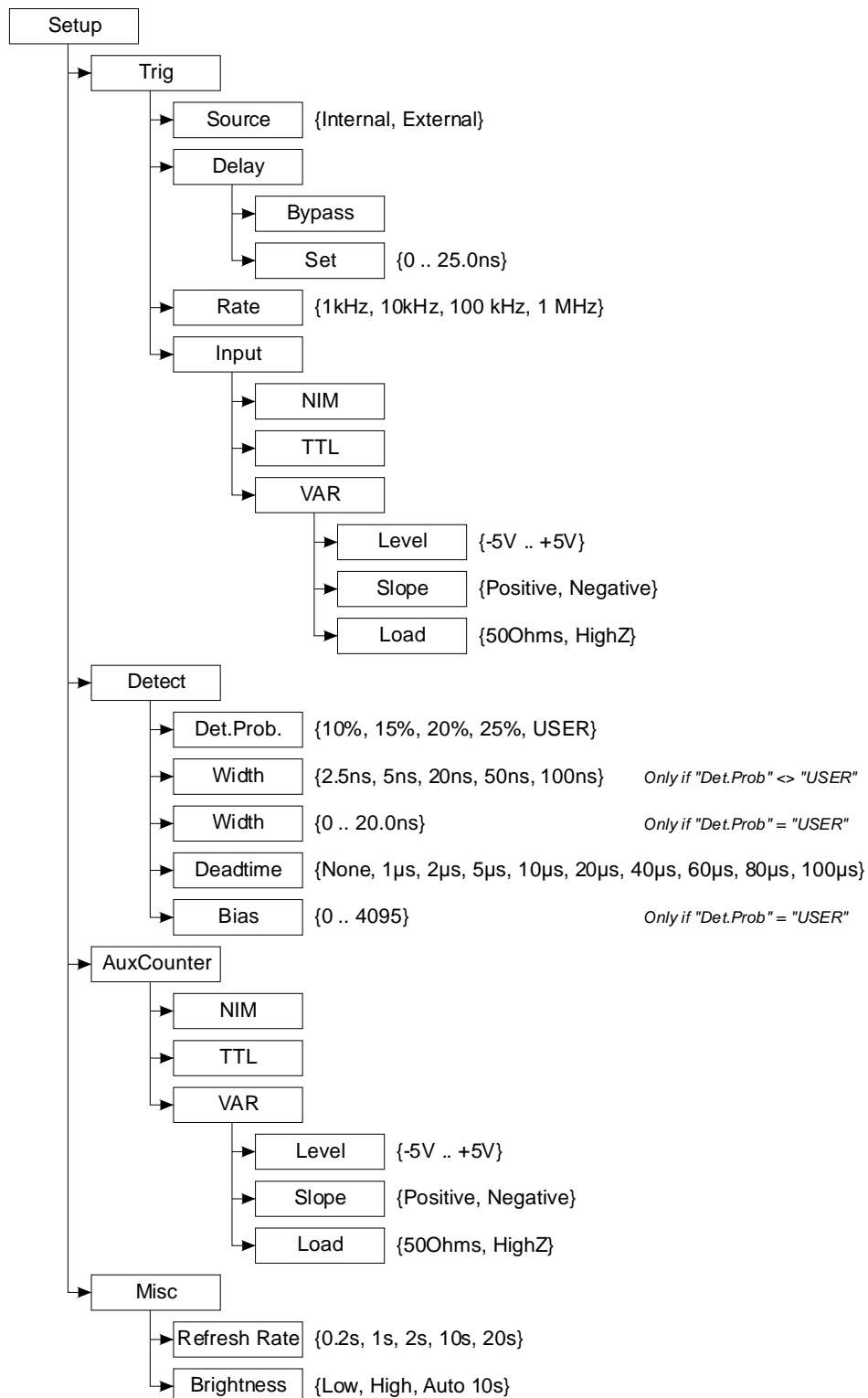


Figure 3.1 Menu structure

3.2.4 Source of trigger

The first step is to select the trigger source, which will provide the timing signal for the gate generation to the id-201 SPDM. We will first consider that this signal is provided by an external source. From the normal operation mode, press the **Enter** key to display the **Setup** menu. When the **Setup** menu is displayed, use the **Up** and **Down** keys to navigate through the items. Select the **Trig** item by pressing the **Enter** key.

External trigger selection

In the **Trigger** menu, use the **Up** and **Down** keys to navigate through the items. Highlight the **Source** item, and press the **Enter** key. This will open the **Source** Submenu. Navigate through the sub items using the **Up**, **Down** and **Enter** keys. It is now possible to select between **Internal** and **External** trigger sources. Highlight the **External** item, and press the **Enter** key.

Input type

The input type must now be set. In the **Trigger** menu, use the **Up**, and **Down** keys to highlight the **Input** item. Press the **Enter** key. It is now possible to choose between **NIM**, **TTL** and **Var** types. The first two items (**NIM** and **TTL**) are internally preset. If the third type (**Var**) is selected, three parameters can be set. One navigates through them with the **Up**, **Down** and **Enter** keys. The first option is the trigger level. When **Level** is highlighted and the **Enter** key pressed, the level value in volts can be scanned using the **Up** and **Down** keys. The second option is the **Slope**. The **Up** and **Down** keys are used to toggle between the **Positive** and **Negative** items. Finally, the third option is the **Load**. The **Up** and **Down** keys are used to toggle between the **50ohms** and **HighZ** items.

Highlighting one value of a list automatically validates it. One can then move one level up by pressing the **Enter** or **Exit** key.

Delay

Now that the external trigger type is selected, it is also possible to adjust the trigger delay. From the **Trigger** menu, select the **Delay** item using the **Up**, **Down** and **Enter** keys. The **External Trigger Delay** menu offers two options. The first one (**Bypass**) allows bypassing the internal delay line in order to minimize the jitter. It is validated by highlighting it. The second option (**Set**) allows setting the internal delay line value by scanning it using the **Up** and **Down** keys. When adjusting this value, the internal counter can also be displayed (see Display Modes Toggling below), in order to allow the user to monitor the measured counts.

3.2.5 Detector Configuration

Now that a suitable external trigger source has been selected, one must configure the detector parameters. From the counting mode, press the **Enter** key to display the **Setup** menu. Select the **Detect** item. This will display the **Detector** submenu. Browse through the items with the **Up** and **Down** keys and select one with the **Enter** key.

Photon Counting Probability

The first parameter that must be selected is the photon counting probability. It is selected by highlighting the **Det.Prob.** item and pressing the **Enter** key. One can then navigate through a list using the **Up** and **Down** keys. Highlighting one value of the list automatically validates it. One can then move one level up by pressing the **Enter** or **Exit** key.

Note: If the **USER** item is chosen then the bias value has to be set in the **Bias** menu.

Bias Pulse Duration (gate width)

The bias pulse duration is selected by highlighting the **Width** item and pressing the **Enter** key. One can then navigate through a list using the **Up** and **Down** keys. Highlighting one value of the list automatically validates it. One can then move one level up by pressing the **Enter** or **Exit** key.

If the **USER** item has been chosen under the **Det.Prob.** menu, then the gate width has to be "user defined" within the range from 0 up to 20ns.

Note: To obtain the best performance, the shortest bias pulse duration possible should always be selected.

Note: The bias pulse value listed corresponds to the full width at half maximum of the gate pulse. The actual Geiger mode width may differ from this value.

Deadtime

The deadtime option is useful in reducing noise counts generated by afterpulses. It causes the id-201 SPDM to skip bias pulses occurring during a certain time after an avalanche. Selecting this item with the **Enter** key, will display a list.

Note: Selecting **None** turns the deadtime off. When editing the deadtime value, the internal counter can be displayed in order to allow the user to monitor the measured counts.

User defined Photon Counting Probability

If the item **USER** has been chosen under the Photon Detection Probability then the user can define his own photon detection probability. The bias value is selected by highlighting the **Bias** item and pressing the **Enter** key

Note: The bias value is dependent on the gate width and dependent on the photon detection probability.

Note: The calibrated bias value can be seen in the General info display mode. Fig. 3.6, § 3.2.7, shows how to get this information.

Note: The bias internal parameter is not calibrated in voltage unit. It represents the internal value of a register.

Note: The bias must not be set too high in order not to damage the InGaAs diode

3.2.6 Internal Counter Configuration

Next, the counters refresh rate must be configured. From the **Setup** menu, select the **Misc** item with the **Up**, **Down** and **Enter** keys. Highlight then the **Refresh Rate** item, and press the **Enter** key. A list of values for the refresh rate of the counter will be displayed. Highlighting one value of the list automatically validates it. One can then move one level up by pressing the **Enter** or **Exit** key.

3.2.7 Display Mode Toggling

The id-201 SPDM offers several display modes. These can be selected from the counting mode. One can cycle through the various possibilities by pressing the **Up** and **Down** keys.

Frequency meters

The first possibility is to display the values of the internal and auxiliary counters as frequencies. The internal counter is displayed in the upper half of the screen, while the auxiliary counter appears in the lower half. The number of counts accumulated during a refresh period is divided by this time. Pressing the **Start/Stop** key can be used to start counting or alternatively freeze the value. When the id-201 SPDM counters are running, **RUN** is displayed in the upper right corner of the LCD display. When they are frozen, **Hold** is displayed.

Counters

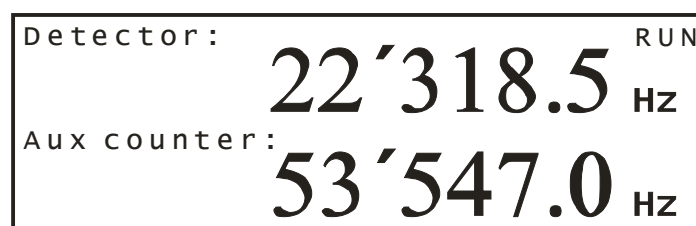


Figure 3.2: Frequency meters display mode

The second possibility is to display the number of counts of the internal and the auxiliary counters. The internal counter is displayed in the upper half of the screen, while the auxiliary counter appears in the lower half. Pressing the **Start/Stop** key can be used to start and stop the counters. A chronometer is displayed in the upper right corner of the LCD display. When the **Start/Stop** key is first pressed the counters are started and the chronometers starts running. Pressing this key a second time will freeze the counters values and stop the chronometer. Finally pressing it again will

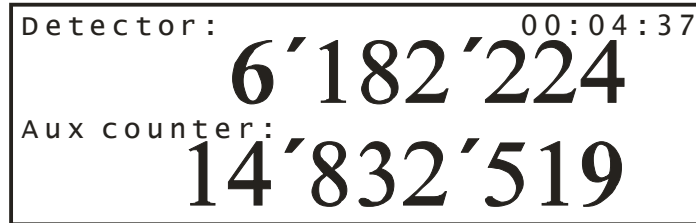


Figure 3.3: Counters display mode

reset the counters and the chronometers and restart them.

Trigger and internal counter frequency meters

The third possibility is to display the trigger rate and the internal counter as frequencies. This mode can be used to verify that the trigger rate. The **Start/Stop** key can be used to start and stop the counters.

Detection ratio mode

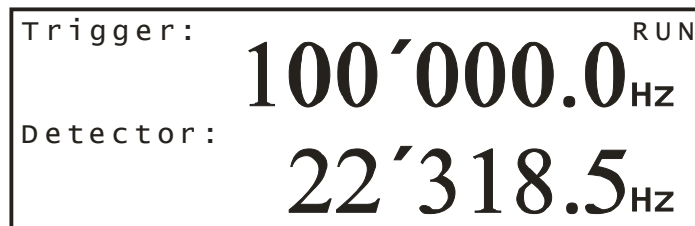


Figure 3.4: Trigger and internal counter frequency meters display mode

The fourth possibility is to display the ratio of the internal counter over the trigger counter in the upper half of the screen and the auxiliary counter frequency in the lower half.

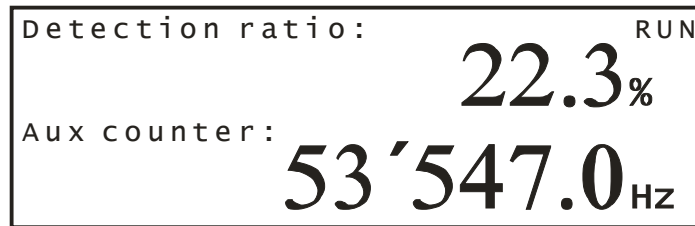


Figure 3.5: Detection ratio display mode

General info display mode

The last possibility is to display all the important detector parameters.

Note: The bias value is dependent on the gate width and dependent on the photon detection probability.

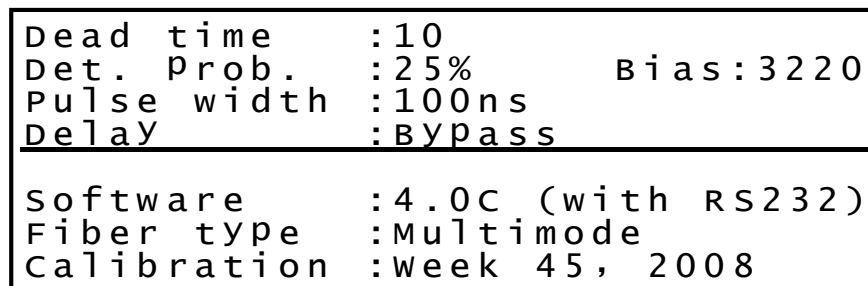


Figure 3.6: General info display mode

Note

In all of these modes, whenever the menus are displayed by pressing the Enter key, the counter displayed in the upper half of the LCD display remains visible, while the lower half is used for the menus.



Figure 3.7: Example of Menu display

3.2.8 Making a simple photon-counting measurement

Now that the different parameters necessary to ensure proper operation of the id-201 SPDM have been defined, the procedure for making a simple photon counting measurement will be outlined. A properly attenuated laser pulse is detected with the id-201 SPDM. Please refer to Figure 3.8 for a schematic view of the set-up.

We will assume that an external time base is providing the synchronization electronic signal to the id-201 SPDM and a pulsed laser source.

Note: Such a measurement can be used to calibrate the id-201 SPDM module. One should attenuate the laser pulses to a suitable level (typically 1 photon per pulse). By measuring the detection probability with and without blocking the optical path to the detector, one can measure the signal counting probability and the dark count probability. These quantities can then be used to evaluate the detection efficiency using the following formula:

$$\eta = \frac{1}{n} \ln \frac{p_{dc} - 1}{p_{dc} + p_{sig} - 1}$$

where

- η quantum detection efficiency
- n average photon number per pulse
- p_{dc} dark count probability per gate
- p_{sig} signal count probability per gate.

Connecting a trigger signal

Connect an electronic trigger signal to the trigger input. Make sure that the trigger parameters are properly set. Please also check that the electronic signal is suitable and does not exceed the damage values.

When a valid trigger signal is recorded by the id-201 SPDM, the front panel **Triggered** green LED flashes.

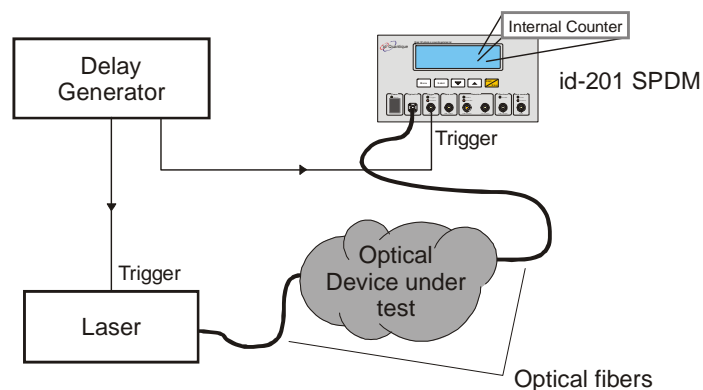


Figure 3.8 Simple photon-counting measurement set-up.

Connecting an optical signal

Cautiously clean the optical connector and connect it to the optical input of the id-201 SPDM.

Important

Before connecting an optical fibre to the id-201 SPDM, make sure that the optical level does not exceed the damage level.

Starting the measurement

Make sure that the id-201 SPDM is in counting mode. Press the **Start /Stop** key to start counting. The module will start displaying the measurement results of the counters. Select one of the display modes by pressing the **Up** or **Down** keys.

When a count is recorded by the id-201 SPDM, the front panel **Detect** green LED flashes.

Synchronizing the optical signal with the electronic gate

In order to be properly detected, the photons should reach the active junction of the avalanche photodiode during a bias pulse. It is thus important to synchronize the optical signal and the bias pulse. Coarse synchronization should be done using cables and optical fiber patch cords with an accuracy better than 20 ns, which corresponds to 4 meters of optical fiber or coaxial cable. Fine synchronization can then be achieved using the trigger delay. This delay can be scanned over 20 ns. Adjust this delay to maximize the counting rate.

Note: The delay induced by one meter of cable or one meter of single-mode optical fiber is approximately 5 ns.

3.2.9 Auxiliary Counter

The id-201 SPDM also features an auxiliary – or external – counter to measure signal coming from an external device.

The external counter parameters must be configured. From the **Setup** menu, select the **AuxCounter** item with the **Up**, **Down** and **Enter** keys. When selecting the **AuxCounter** item, the auxiliary counter is displayed in the upper half of the front panel display to allow the user to see the effect of the parameter he selects.

Auxiliary Counter Input

The input type of the auxiliary counter must be set. In the **Trigger** menu, use the **Up**, and **Down** keys to highlight the **Input** item. Press the **Enter** key. It is now possible to choose between **NIM**, **TTL** and **Var** types. The first two items (**NIM** and **TTL**) are internally preset. If the third type (**Var**) is selected, three parameters can be set. One navigates through them with the **Up**, **Down** and **Enter** keys. The first option is the trigger level. When **Level** is highlighted and the **Enter** key pressed, the level value in volts can be scanned using the **Up** and **Down** keys. The second option is the **Slope**. The **Up** and **Down** keys are used to toggle between the **Positive** and **Negative** items. Finally, the third option is the **Load**. The **Up** and **Down** keys are used to toggle between the **50ohms** and **HighZ** items.

Highlighting one value of a list automatically validates it. One can then move one level up by pressing the **Enter** or **Exit** key.

Note: When a count is recorded by the auxiliary counter of the id-201 SPDM, the front panel **Count** green LED flashes. The front panel **Overflow** red LED flashes, when the time between subsequent counts is smaller than 100ns, corresponding to a frequency of 10 MHz.

3.2.10 LCD Brightness

The id-201 SPDM also offers the possibility to adjust the brightness of the LCD screen. Select the **Misc** menu and highlight the **Brightness** item. This menu offers three possibilities. The first two choices are **Low** for a low brightness mode and **High** for a high – normal – brightness mode. With the third choice – **Auto 10s** – the brightness of the display will be automatically switched to low when no keys are pressed during ten seconds. The next time a key is pressed, the brightness will be reversed to bright for a duration of ten seconds. This option is useful in demanding measurements, when an id-201 SPDM is used in combination with a visible spectrum photon counting detector.

3.2.11 Operation with the internal time base

The id-201 SPDM is also equipped with an internal clock generator, which can be used to trigger the bias pulse applied to the detector. An electronic signal coincident with this

timing signal is present on the clock out connector. It can be used to trigger an external device such as a pulsed laser.

Entering the Internal trigger menu

In order to adjust the parameters of the clock generator, one must first enter the **Setup** menu. Select the **Trig** item and then the **Internal** item. This switches the id-201 SPDM to the internal trigger mode and turns the clock generator on. The front panel Clock out enable green LED indicates this choice. It is possible to set the trigger rate and the internal trigger delay.

Trigger rate

From the **Trigger** menu, select the **Rate** item. A list of possible rates will be displayed. Select a suitable value using the **Up**, **Down**, and **Enter** or **Exit** keys.

Delay

Just like in the case of the external trigger, an adjustable delay can be used to delay the bias pulse in order to synchronize it with the optical signal. This delay can be edited by selecting the **Delay** item in the **Trigger** menu. The **Internal trigger delay** menu offers two options. The first one (**Bypass**) allows bypassing the internal delay line in order to minimize the jitter. It is validated by highlighting it. The second option (**Set**) allows setting the internal delay line value by scanning it using the **Up** and **Down** keys.

Note: In spite of the fact that the internal and external trigger delays are implemented using a single delay line (see the block diagram of the id-201 SPDM), the values are stored independently which allows to define a delay for each trigger type.

3.3 Troubleshooting

3.3.1 Detector cooling problems

When first turned on, the id-201 SPDM will start cooling the avalanche photodiode. During this phase, the front panel display shows the message "Detector Cooling". If this message remains displayed, this means that the id-201 SPDM cannot cool the avalanche photodiode to the set temperature.

In this case, check that the room temperature is not higher than the maximum operation temperature specified.

Make also sure that the fan opening is not obstructed.

4 Maintenance

4.1 Transportation and Storage

Maintain a temperature range within specifications when transporting or storing the unit. Transportation damage can occur from improper handling. The following steps are recommended to minimize the possibility of damage:

- Pack the unit in the original packing material when shipping.
- Store unit at room temperature in a clean and dry area.
- Avoid high humidity or large temperature fluctuations.
- Keep the unit out of direct sunlight.
- Avoid unnecessary shock and vibration.

4.1.1 Safety Precautions

While manipulating optical fibres, laser radiation may be encountered at source output ports and at fibre ends. Avoid long-term exposure to laser radiation.

Warning

Never look directly into a live optical fibre and ensure that your eyes are protected at all times.

The following safety precautions must be observed during the operation and servicing of the unit. Failure to comply with these precautions or with specific indications elsewhere in this manual violates safety standards of intended use of the unit. *id Quantique* assumes no liability for the user's failure to comply with these requirements.

- This unit is intended for indoor use only.
- Unit covers cannot be removed during operation.
- Before powering on the unit, all grounding terminals, extension cords, and devices connected to it should be connected to a protective ground via a ground socket. Any interruption of the protective grounding is a potential shock hazard and may cause personal injury.
- Whenever the ground protection is impaired, the unit is not to be used and must be secured against any accidental or unintended operation.
- Only fuses with the required rated currents and specified type (T2.5A) may be used for replacement. Do not use repaired fuses or short-circuited fuse holders.
- Any adjustments, maintenance, and repair of opened unit under voltage should be avoided and carried out only by skilled personnel aware of the hazards involved. Do not attempt internal service or adjustment unless another person qualified in first aid is present. Do not replace any components while power cable is connected.
- Operation of any electrical instrument around flammable gases or fumes constitutes a major safety hazard.
- Installation of replacement parts or modification of the unit should be carried out by authorized personnel only.
- Certain components inside the unit – e.g. capacitors – may be charged even if the unit has been disconnected from its electrical supply.

4.1.2 AC Requirements

The id-201 SPDM can operate from any single-phase AC power source between 85 V and 264 V (50/60 Hz). The maximum input current is 2,5 A.

4.1.3 Power Cable

This unit uses an international safety standard three-wire power cable. This cable serves as a ground when connected to an appropriate AC power receptacle. The type of power cable supplied with each unit is determined according to the country of destination.

Only qualified electricians should connect a new plug if needed. The colour coding used in the electric cable depends on the cable. New plugs should meet the local safety requirements and include the following features:

- adequate load-carrying capacity
- ground connection
- cable clamp

Warning

To avoid electrical shock, do not operate the unit if there are signs of damage to any part of the outer surface (covers, panels, etc.).

To avoid serious injury, the following precautions must be observed before powering on the unit.

- **If the unit is to be powered via an auto-transformer for voltage reduction, the common terminal must be connected to the grounded power source pole.**
- **Insert the plug into a power outlet with a protective ground contact. Do not use an extension cord without a protective conductor.**
- **Before powering on the unit, the protective ground terminal of the unit must be connected to a protective conductor using the unit power cord.**
- **Do not tamper with the protective ground terminal.**

4.2 General Maintenance

There are no user-serviceable components in the id-201 SPDM, notwithstanding the procedure described in this section. The id-201 SPDM has been designed to require minimum maintenance and to provide reliable operation for many years to come.

Important

When the module is not being used, the protective cap should be fitted over the detector port.

To help ensure long, trouble-free operation,

- Keep the id-201 SPDM free of dust
- Do not spill liquids on or into the unit. If the unit does get wet, turn off the power immediately and let the unit dry completely
- Clean the id-201 SPDM casing with a slightly damp (with water) cloth.

4.3 Cleaning the Fibre Ends

The patchcord fibre ends connected to the id-201 SPDM optical input port must be kept clean at all times to ensure minimum loss and to reduce reflection.

1. Gently wipe the fibre end with a lint-free swab dipped in isopropyl alcohol (98% pure or better).
2. Dry using clean compressed air.

4.4 Cleaning the Detector Port

To ensure optimum performance, the optical port should be kept as clean as possible. It is recommended to connect before the first use of the detector an optical fibre patchcord to the id-201 SPDM optical input port. This patchcord should then be used for all connections of the module to a device under test. In case of inappropriate insertion losses, the end connector of this patchcord can be easily cleaned by the user.

Nevertheless, if the optical port needs to be cleaned,

1. Remove the protective cap
2. Insert a lint-free stick dipped in isopropyl alcohol and gently wipe the receptacle
3. Dry using a dry lint-free stick.

4.5 Fuse Replacement

The id-201 SPDM contains two fuses of type T2.5A. The fuse holder is located at the back of the id-201 SPDM, just beside the power inlet.

To replace the fuses,

1. Unplug the power cord from the id-201 SPDM.
2. Pull the fuse holder out of the id-201 SPDM.
3. Verify and replace one or both fuses if necessary.
4. Make sure the fuses are firmly in the holder prior to reinsertion.
5. Firmly push the holder into place.

4.6 Recalibration

To ensure that the single-photon detection module remains within the published specifications, *id Quantique* recommends that an annual calibration be performed. Please contact *id Quantique* for further information regarding calibration of the id-201 SPDM. The last calibration date can be seen in the General info display mode.

5 Warranty

5.1 General information

id Quantique warrants this equipment against defect in material and workmanship for a period of twelve months from the date of original shipment. *id Quantique* also warrants that this equipment will meet applicable specifications under normal use.

During the warranty period, *id Quantique* will, at its discretion, repair, replace, or issue credit for any defective product. This warranty also covers recalibration during twelve months if the equipment is repaired or if the original calibration is erroneous.

Important

The warranty can become void if

- the equipment has been tampered with, repaired, or worked upon by unauthorized individuals or non-*id Quantique* personnel,
- the warranty sticker has been removed,
- case screws, other than those specified in this manual, have been removed,
- the case has been opened, other than as explained in this manual,
- the equipment serial number has been altered, erased, or removed,
- the equipment has been misused, neglected, or damaged by accident.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES EXPRESSED, IMPLIED OR STATUTORY, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL *id Quantique* BE LIABLE FOR SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

5.2 Liability

id Quantique shall not be liable for damages resulting from the use of the purchased product, nor shall be responsible for any failure in the performance of other items to which the purchased product is connected or the operation of any system of which the purchased product may be a part.

5.3 Exclusions

id Quantique reserves the right to make changes in the design or construction of any of its products at any time without incurring any obligation to make changes whatsoever on units purchased. Accessories, including but not limited to the fuses, pilot lamps and batteries used with *id Quantique's* products are not covered by this warranty.

5.4 Certification

id Quantique certifies that this equipment met its published specifications at the time of shipment from the factory.

6 Specifications

6.1 Parameters lists

6.1.1 Internal Trigger Rate value list

1 kHz, 10 kHz, 100 kHz, 1 MHz

6.1.2 Detector Pulse Width value list

2.5 ns, 5 ns, 20 ns, 50 ns, 100 ns (or 0..20ns in USER mode)

6.1.3 Detector efficiency value list

10%, 15%, 20%, 25%, USER

6.1.4 Detector Deadtime value list

None, 1 μ s, 2 μ s, 5 μ s, 10 μ s, 20 μ s, 40 μ s, 60 μ s, 80 μ s, 100 μ s

6.1.5 Counters Refresh Rate value list

0.2 s, 1 s, 2 s, 10 s, 20 s, USER

6.2 Module

Dimensions (HxWxD):	150 x 250 x 300 mm
Weight :	6 kg
Power supply line:	85 – 246 VAC, 50 / 60 Hz
AC Line voltage selection:	Automatic
Power requirements:	90 W maximum, 30 W typical
Operating environment:	10°C to 30 °C
Storage environment:	-40°C to 60°C
Remote interface:	RS-232C
Connector:	The rear panel RS-232 connector is a 9-pin connector (DB-9, male)

6.3 Inputs

6.3.1 Trigger Specifications

Connector Type:	BNC
Maximum Frequency:	8 MHz
Minimum Pulse Width:	1 ns
Maximum counts:	4'294'967'295, ($2^{32}-1$)
Trigger level	
Range:	± 5 V
Resolution:	± 200 mV
Slope:	Positive or Negative
Input characteristics	
Impedance:	1 M Ω or 50 Ω
Coupling:	DC
Damage level:	> 5 V RMS

6.3.2 Aux counter specifications

Connector Type:	BNC
Maximum Frequency:	19 MHz
Minimum Pulse Width:	1 ns
Maximum counts:	$4'294'967'295 (2^{32}-1)$
Trigger level	
Range:	$\pm 5 \text{ V}$
Resolution:	$\pm 200 \text{ mV}$
Slope:	Positive or Negative
Input characteristics	
Impedance:	1 M Ω or 50 Ω
Coupling:	DC

6.3.3 Optical input

Optical connector type:	FC-PC
Type:	Single-mode fiber SMF28
Damage level:	> 10 dBm

6.4 Outputs

6.4.1 Detection Output

Connector Type:	BNC
TTL Output	
Pulse duration:	$100 \pm 10 \text{ ns}$
NIM Output	
Pulse duration:	$10 \pm 1 \text{ ns}$

6.4.2 Clock Out

Type:	NIM
Duty cycle:	50%
Active edge:	Falling edge

6.4.3 Gate Out

Type:	NIM
Pulse duration:	Set gate width

6.5 Internal Time Base

6.5.1 Stability

Frequency stability:	$\pm 50 \text{ ppm}$
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6.6 Adjustable Delay

Range:	0 – 25 ns
Jitter:	< 250 ps
Resolution:	100 ps
Stability (over 1 hour):	< 10^{-6}

6.7 Internal Signal Propagation Times

All signals are measured on the front panel of the id-201 SPDM.

Accuracy: ± 1.0 ns

6.7.1 External Trigger mode

Measured with adjustable delay set to *bypass*.

Trigger setting NIM

<i>Trigger – Gate out</i> delay :	9 ns
<i>Trigger – Rising edge of the APD gate</i> :	13 ns
<i>Trigger – Detection Nim Output</i> delay:	19 ns
<i>Trigger – Detection TTL Output</i> delay:	28 ns

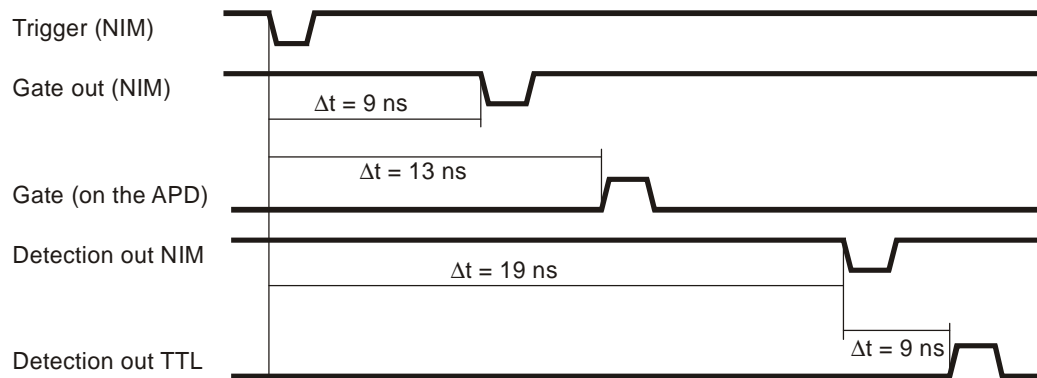


Figure 6.1: Internal signal propagation time in external trigger mode with NIM trigger setting.

Trigger setting TTL

<i>Trigger – Gate out</i> delay :	8 ns
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Figure 6.2: Internal signal propagation time in external trigger mode with TTL trigger setting.

6.7.2 Internal Trigger mode

Clock out – Gate out delay

Adjustable delay = bypass :	25 ns
Adjustable delay = 0 ns :	39 ns
Adjustable delay = 25 ns :	64 ns



Figure 6.3: Internal signal propagation time in internal trigger mode.

6.8 Detector

6.8.1 Cooling system

Temperature:	$-50 \pm 2.0 \text{ }^\circ\text{C}$
Stability (over 1 hour):	$< 0.1^\circ\text{C}$

6.8.2 Single-photon detector performance

The single photon detector performances are dependent of id201 different models.

The Dark count probability in function of the gate width and at a photon detection probability of 10% and 25% can be seen in the individual test report delivered with the id201.

The timing jitter in function at a photon detection probability of 10% and 25% can be seen in the individual test report delivered with the id201.

6.9 Counters

6.9.1 Internal counter

Maximum frequency:	8 MHz
Maximum counts:	$4'294'967'295 (2^{32}-1)$

6.9.2 Auxilliary counter

Maximum frequency:	19 MHz
Maximum counts:	$4'294'967'295 (2^{32}-1)$