K29-B60467e

HAMAMATSU

MPPC Module

C10507 series, C10751 series

INSTRUCTION MANUAL

Doc Version 0.3

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SOLID STATE DIVISION

Introduction

Thank you for purchasing a HAMAMATSU MPPC Module (also called "this product").
This instruction manual explains how you can use this product and how to install, connect and operate it. To use this product safely and correctly, read this manual carefully before use and comply with the instructions.

This product is RoHS (Directive 2002/95/EC) compliant.
C10751 series conforms to EU EMC directive (applicable standards: EN 61326 class B).

Before using the MPPC Module

■ When using this product please be sure to stay within the maximum ratings and comply with all caution items to avoid possible trouble or accidents. We are constantly making every effort to improve product quality and reliability but this does not guarantee complete safety when using this product. In particular, when this product is to be used in equipment or systems which might cause personal injury, fatal accident or damage to property if handled improperly, be sure to implement safety measures that take potential problems fully into account. In such applications, we bear no responsibility for problems or damage arising from use of this product.

■ After unpacking, first check that all items are included (see the list below). If an item is missing or damaged, contact us immediately without using this product.

■ The contents of this manual are subject to change without prior notice due to product improvement, etc.

■ If this manual is lost or damaged, immediately contact our sales office to ask for an additional copy.

This product is supplied with the following items

MPCC Module main unit	1
CD-ROM	1
USB cable	1
Quick start guide	1

WARNING

■Stop using if an abnormal condition occurs.

If smoke, unusual odors, abnormal noise or heat are noticed while operating this product, immediately stop using it. Continuous operation under such abnormal conditions may cause fire or electrical shock. Immediately turn off the PC connected to this product and then unplug the USB cable. After making sure that no abnormal condition has disappeared, contact our sales office.
Never attempt to repair on your own since it is dangerous.

■High voltage hazard!

This module includes a high-voltage power supply needed to operate the MPPC. The high-voltage power supply is coated with silicone resin to prevent electrical shock. Do not remove the coating material or touch internal parts of this product.

■Do not apply vibrations or shocks to this product.

Excessive shocks or vibrations may damage the internal components or adversely affect their adjustments, causing fire or electrical shock.

■Always connect this product to a USB port.

This product is designed to connect to a USB port on a PC. Fire or electrical shock may result if used at a voltage higher than the USB voltage.

■Do not disassemble.

Do not disassemble any part of this module. Changing the adjustment or modifying this module may cause malfunctions and lead to fire or electrical shock.

■Keep away from water or any liquid.

Electrical shock or damage may occur if the module gets wet.

■Handle the cables properly.

Avoid placing any heavy objects on the cable or bringing a heater close to the cable. Do not pull on the cable itself when disconnecting it. Doing so might damage the cable and cause fire or electrical shock.

Table of contents

Handling precautions

Before using this product, be sure to read the following precautions to ensure correct and safe use.

- **Do not use organic solvent such as thinner and acetone for cleaning.** Use a soft dry cloth to wipe the surface of this product clean.

- **Ceramics Series (-xxxC) Cleaning.**
  Since the window of this product is made with soft resin, don't push nor touch the window surface by the hard or tip object.
  If the window needs to be cleaned, use ethyl alcohol and wipe off the window gently.

- Install the evaluation software in your PC only after you accept the terms in the **"Software license agreement". Do not connect this product to the PC before installing the evaluation software.** Otherwise, the software installation may fail. (See the description in "Setup" for how to install the software.)

- Power to this product is supplied from the USB port on the PC.

- Due to the USB specifications, the maximum power that can be supplied from one USB port is limited to 5 V, 500mA. Avoid connecting two or more units to one USB port through a hub.

	Current consumption[mA]
MPPC Module	200

- Power saving function and screensaver.
  Depending on the PC model, the power supplied from the USB port might be interrupted when the power saving function or screensaver is activated. In this case, this product also stops operation and might create problems when the PC returns from power saving or screensaver mode.
  If power to your PC is interrupted in this same way while connected to this product, disable the power saving function and screensaver. (For PC functions and settings, see the PC operation manual.)

Overview

The MPPC module is a semiconductor photo detector capable of detecting very low light levels. It has an MPPC (multi-pixel photon counter) device which consists of multiple APD pixels operable in Geiger mode with high gain (10^5 to 10^6). The MPPC module is made up of an MPPC, current-to-voltage conversion circuit, high-speed comparator circuit, high-voltage power supply circuit, temperature-compensation circuit, counter circuit, and microcomputer. Handling the MPPC module is very easy, since it operates on USB bus power and no external power supply is required. Three kinds of outputs are available: analog output, comparator output, and counter output (via USB), which are selectable according to the application. The threshold level of the counter can also be changed by USB communication. Operating the MPPC module requires high-precision voltage control because the MPPC is used in Geiger mode where the gain greatly depends on changes in bias voltage and also because the usable bias voltage range is narrower than that for normal APD devices. This module uses a microcomputer to control the bias voltage with high accuracy, allowing stable MPPC operation.
The MPPC module is expected to open up new applications in the photon counting region, including fluorescence lifetime measurement, flow cytometry, drug discovery, scientific research, various measurement, chemical analysis, and many more fields.

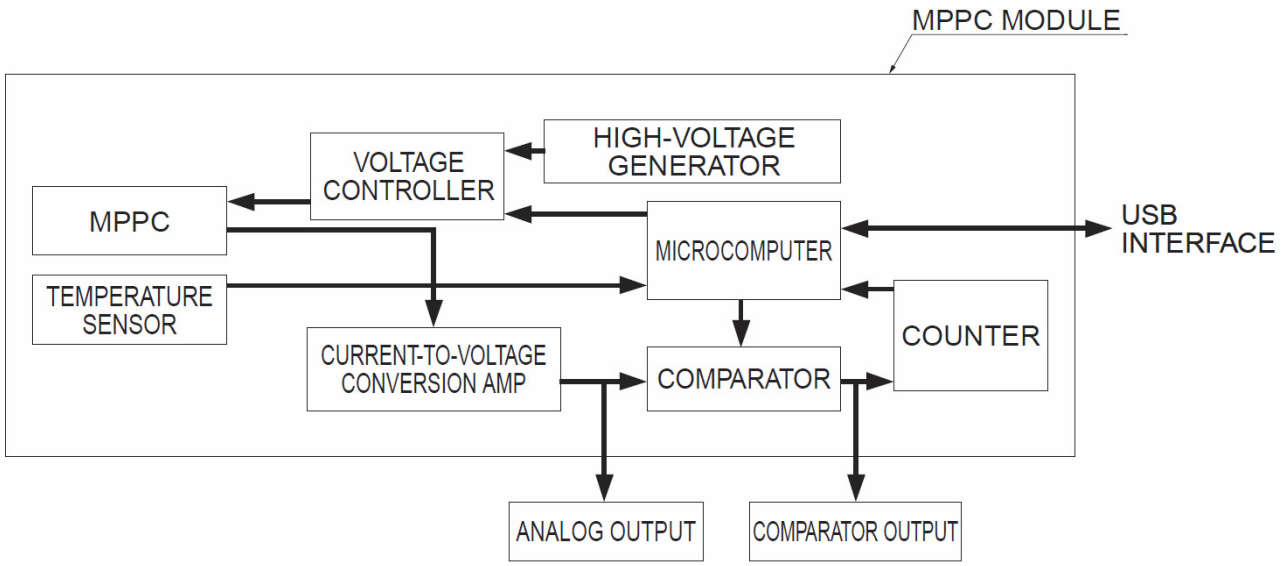
■Features

- ♦Integrates a signal readout circuit ideal for MPPC
- ♦Built-in high-voltage circuit and temperature-compensated circuit
- ♦Three types of output: analog, comparator and pulse calculation value
- ♦USB interface for easy handling: driven by USB bus power
- ♦Compact and lightweight

■Applications

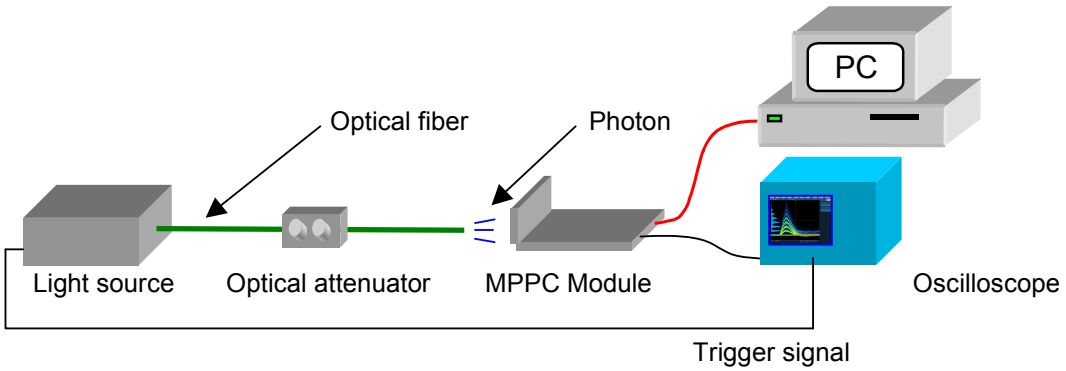
- ♦Fluorescence lifetime measurement
- ♦Biological flow cytometry
- ♦Bioluminescence analysis
- ♦Ultra low light detection
- ♦Analysis equipment

■Block diagram

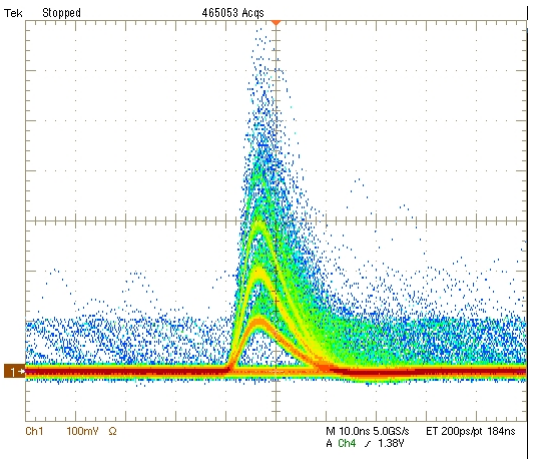


Basic configuration and description of terms

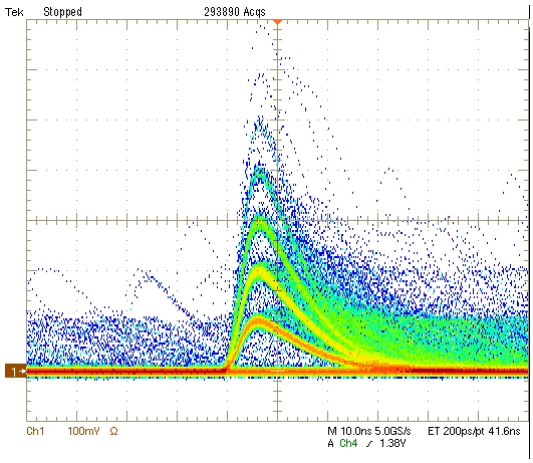
■ Measurement setup for MPPC module evaluation



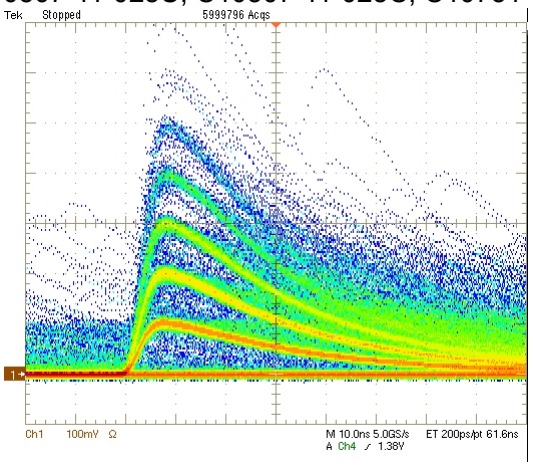
Power is supplied from the PC to the MPPC module via the USB cable. The PC also makes various settings and monitors the counter value.
The counter value can also be obtained by connecting the comparator output to a frequency counter, etc.
Connecting the analog signal to an oscilloscope allows monitoring the signal.



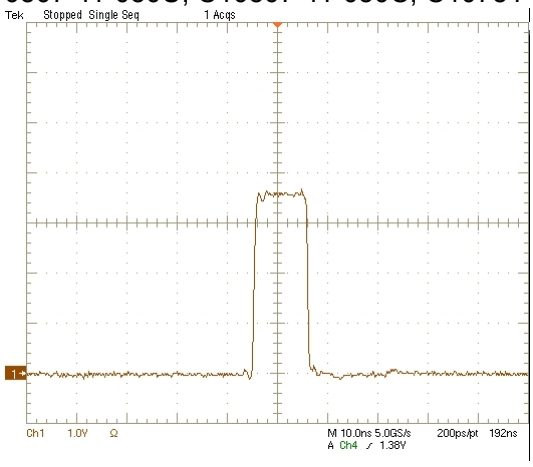
Analog output waveform
C10507-11-025U, C10507-11-025C, C10751-01



Analog output waveform
C10507-11-050U, C10507-11-050C, C10751-02



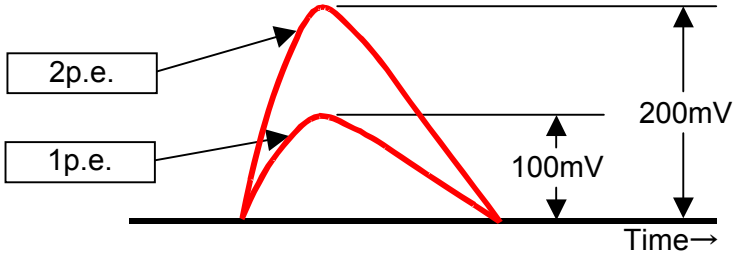
Analog output waveform
C10507-11-100U, C10507-11-100C, C10751-03



Comparator output waveform

■ Analog output

The analog output waveform from the MPPC module is adjusted so that a pulse of 100 mV is obtained at 1 p.e. (equivalent to detecting 1 photon). If two or more photons are detected at the same timing, then the pulses pile up for output.



MPPC module output waveform measured by oscilloscope

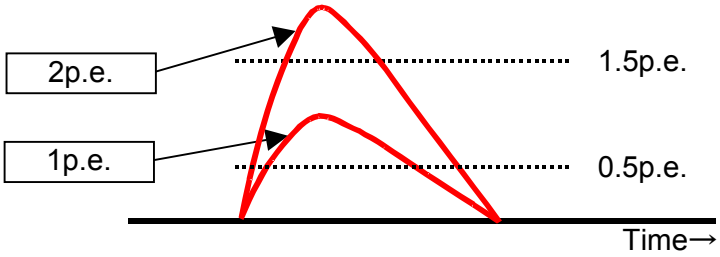
■ Gate time

This is a time width during which the number of input counts is integrated within the MPPC module.

Gate time is adjustable from a minimum of 1 ms to a maximum of 100 ms.

■ Threshold level

Setting the threshold level to one-half (0.5 p.e.) the height of the 1 p.e. pulse and then using a frequency counter to count the number of pulses exceeding this threshold level allows measuring the number of detected photons. The threshold level can be selected from 5 different settings (0.5 p.e. / 1.5 p.e. / 2.5 p.e. / 3.5 p.e. / Disable) on the evaluation software.



MPPC module output waveform measured by oscilloscope

■ Dark count

On the MPPC module, the dark count is defined as the number of counts measured with no light incident on the MPPC and with the threshold level set at 0.5 p.e.

Connecting and disconnecting the units

Procedures for connecting and disconnecting the units are explained below.

The MPPC module outputs a count of pulses that exceeded the preset threshold level, to the PC via the USB cable. Power to the MPPC module is supplied from the PC, so no additional power supply is needed at this point.

■ To connect

* Never connect the MPPC module to the PC before installing the software in the PC. Otherwise the software might not be installed correctly. (See the section "Installing the software".)

(1) Connect the USB-A plug of the USB cable (supplied with unit) to the USB port on the PC.

(2) Connect the USB mini-B plug of the USB cable (supplied with unit) to the USB connector on the MPPC module.

■ To disconnect

(3) First, quit the MPPC software (evaluation software installed from the CD-ROM).

(4) Remove the USB cable from the USB connector on the MPPC module.

(5) Remove the USB cable from the USB port on the PC.

Evaluation software

What is the sample software?

To use the MPPC module, it must first be connected to a PC through a USB 1.1 interface. Various MPPC operations are performed on the PC, and the measured data is transferred to the PC.
The sample software is free evaluation software that comes with the MPPC module. It is designed to easily perform basic MPPC module operations. Using the sample software allows you to make measurements on the MPPC module right after the setup. Basic functions of the sample software are acquiring data, displaying measurement data graphs, and saving data.

System requirements

Evaluation software operation has been verified on the following systems. Operation on other systems is not guaranteed.

Microsoft Windows 2000 Professional SP4
Microsoft Windows XP Professional SP2

To operate the sample software, you must use a PC that meets the above system requirements. Although there are no other special requirements, we recommend using a PC with a high-performance CPU and a large capacity memory. A high-performance CPU and large memory are especially important when operating two or more MPPC modules simultaneously.

Limit on number of connectable modules

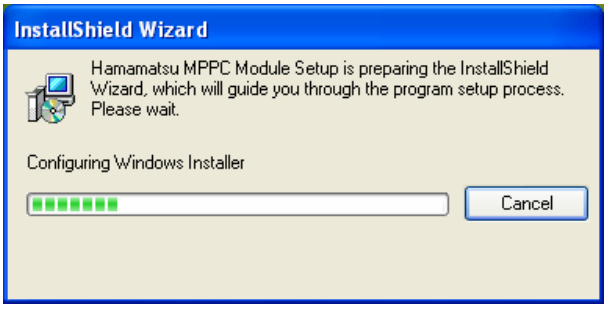
The USB standard supports up to 127 units of the same device connectable to one PC. So up to 127 MPPC modules can theoretically be connected and operated simultaneously. However, problems with the actual physical connection act to limit the maximum number of units that can correctly operate while connected.

Setup

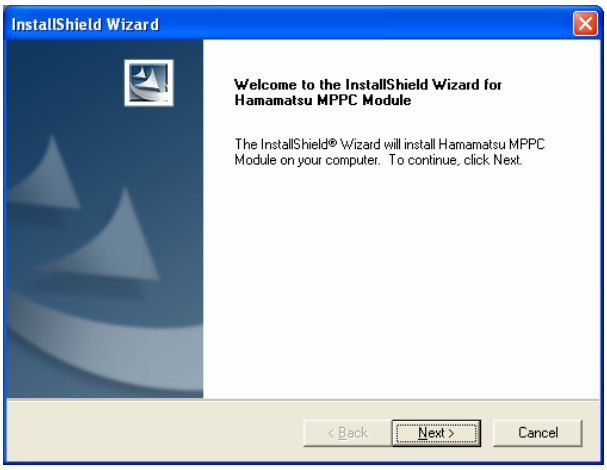
Install software that can control the MPPC module from a personal computer (PC). The following explains the procedure for installing the sample software using Windows XP Professional SP2. To install the sample software, log in as a user with administrator rights. (* Always first install the software. Do not connect the MPPC to the PC and then try to install the device driver manually before installing the software.)

【Installing the software】

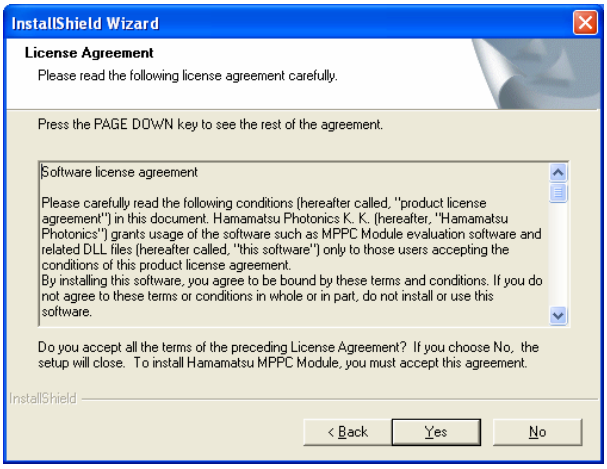
After Windows has started, insert the supplied CD-ROM into the DVD/CD-ROM drive on the PC. When the auto run for the CD is enabled, the installer automatically starts. If the installer does not start, double-click ″Setup.exe″ on the CD-ROM to start the installer.



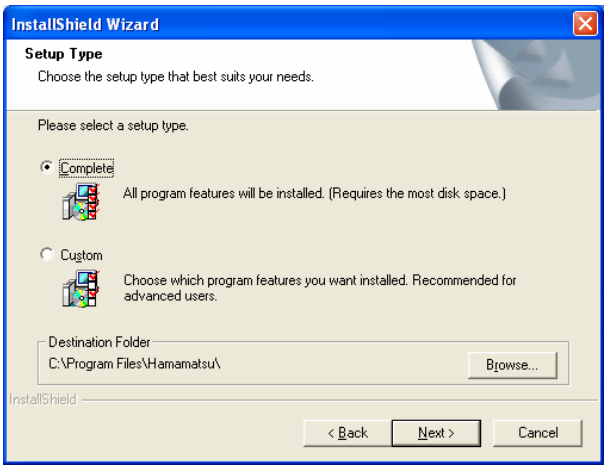
When the "Welcome" window appears, click **[Next]**.



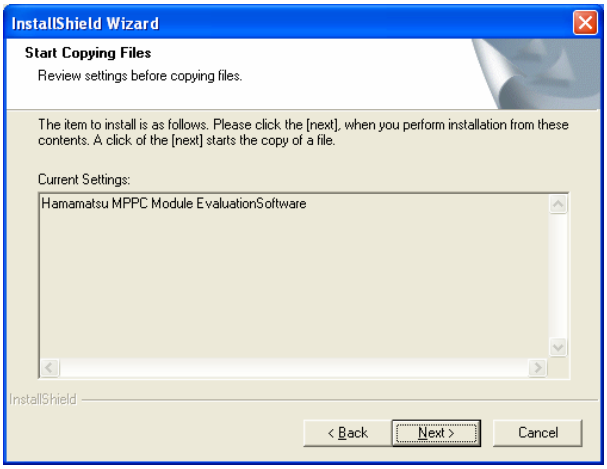
The license agreement window appears. Read through the contents carefully. If you accept the agreement, click **[Yes]**. You may not install the sample software unless you accept the terms of the license agreement.



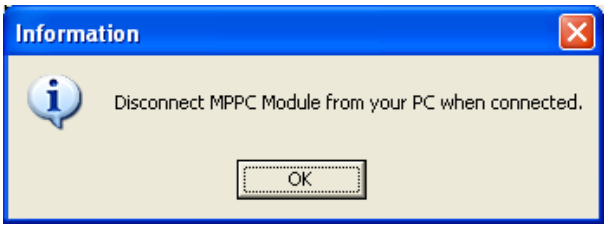
Select the components you want to install. Select "Complete" (default) in most cases, and then click **[Next]**.



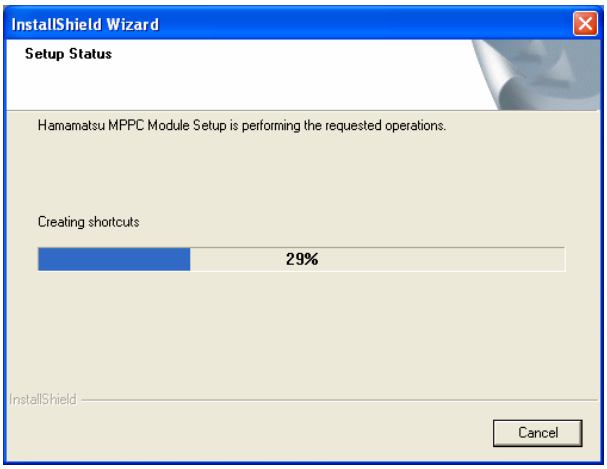
The window for copying files appears. It shows a list of components to be installed. Click **[Next]**.



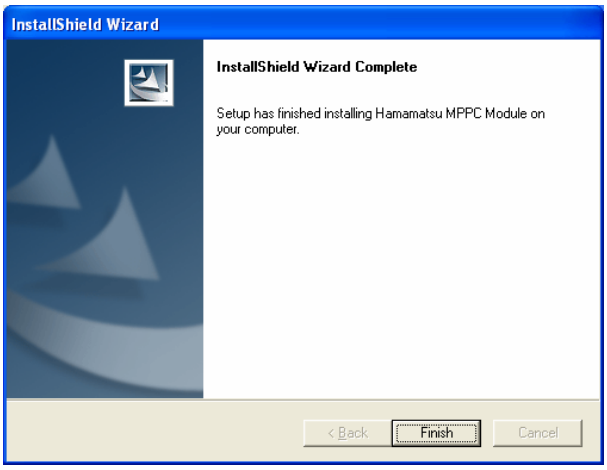
Make sure that the MPPC module is not connected to the PC and then click [OK].



The software installation starts.



This screen appears when the installation is complete. Click **[Finish]** to end the installation wizard.



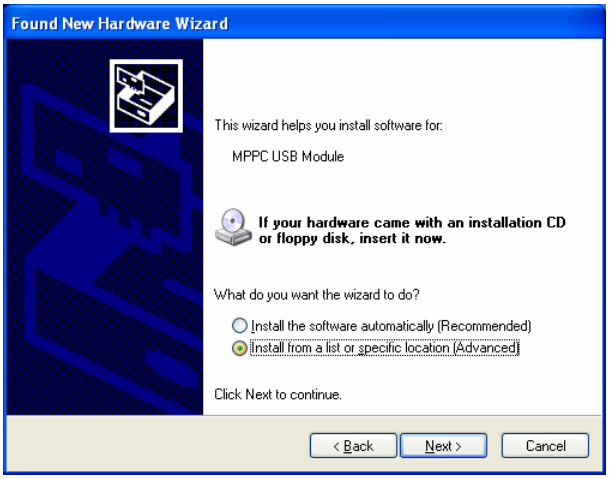
【Installing the device driver】

For Windows XP, please install the device driver to the following procedures. It is installed automatically for Windows 2000.
The device driver must be installed when you connect the MPPC module for the first time to the PC. If you connect two or more MPPC modules to the PC, repeat the same procedure to install the device driver for each MPPC module. When the PC has two or more USB ports and you connect the MPPC module to another USB port, you will have to repeat the same procedure to install the device driver.

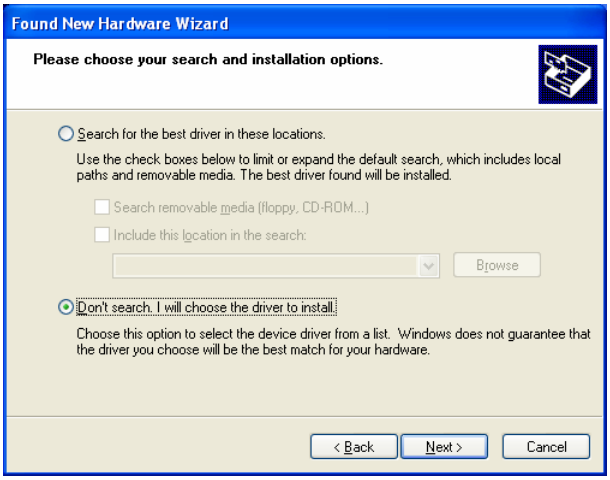
Connect the MPPC module to the PC. The MPPC will be detected as new hardware and the "Found New Hardware Wizard" will appear to guide you through the device driver installation. Select **"No, not this time"** and click **[Next]** to continue.

Select **"Install from a list of specific location (Advanced)"** and click **[Next]** to continue.

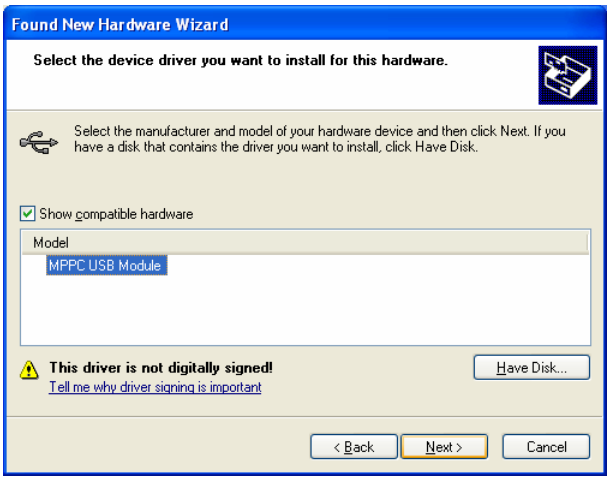
*** If you select "Install the software automatically (recommended)" while the PC is connected to a LAN, the PC will search for the device driver via the network, possibly causing no response. Always select "Install from a list of specific location (Advanced)".**



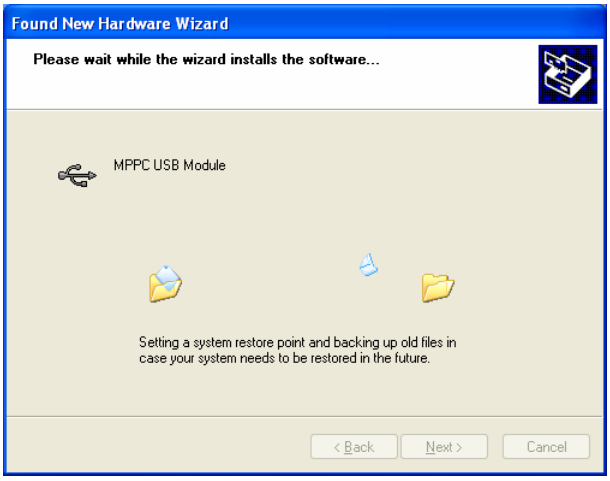
Select **"Don't search I will choose the driver to install"** and click **[Next]** to continue.



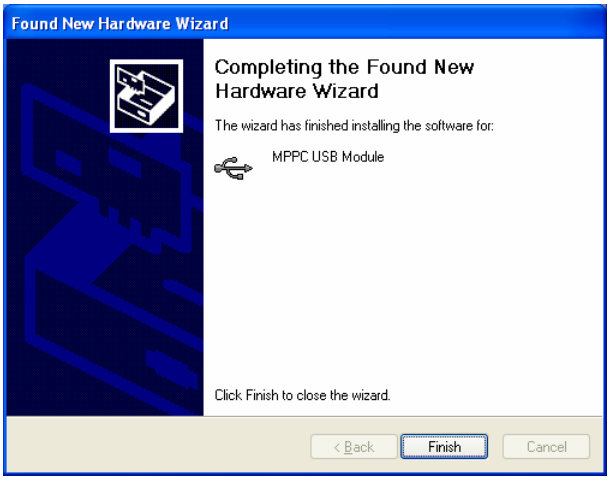
Make sure the "Show compatible hardware" check box is checked (default), select "MPPC USB Module" in the "Model" list, and click **[Next]** to continue.



The device driver installation starts.



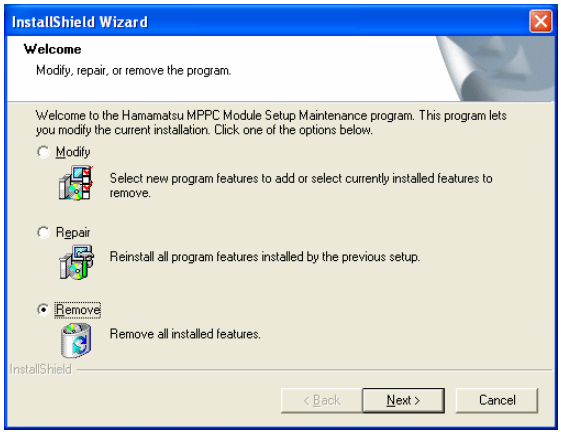
This screen appears when the installation is complete. Click **[Finish]**.



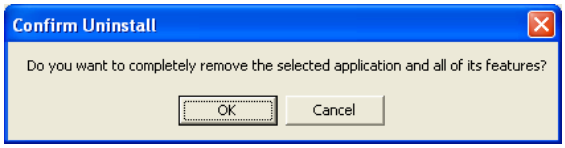
【Uninstalling the software】

First disconnect the MPPC from the PC.
From the [Start] menu, select [All Programs] → [Hamamatsu MPPC Module] → [Change or Remove].

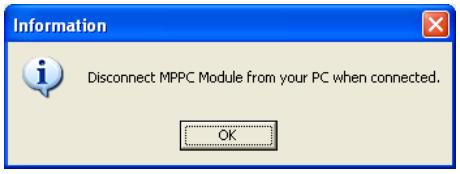
When this screen appears, select **"Remove"**, then click **[Next]**.



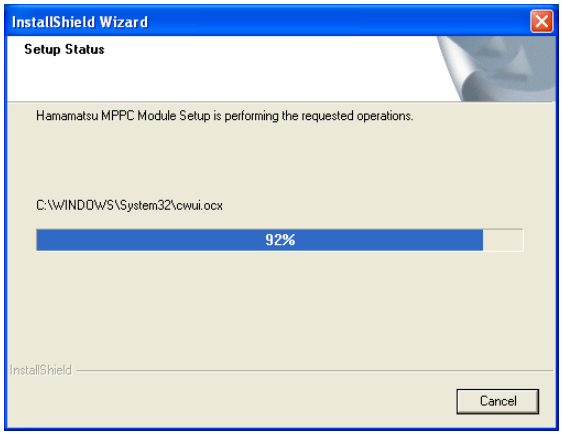
When this confirmation message appears, click **[OK]**.



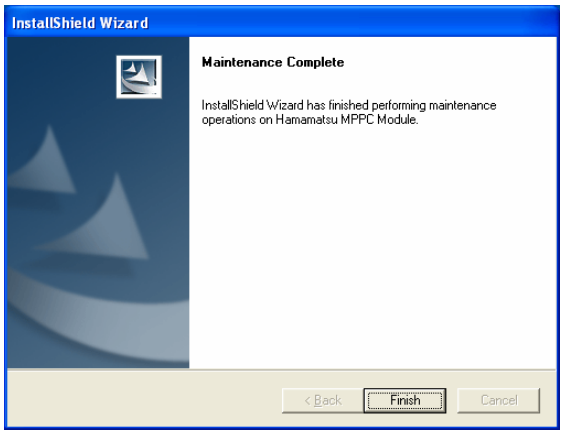
If the MPPC is connected to the PC, disconnect it from the PC and then click **[OK]**.



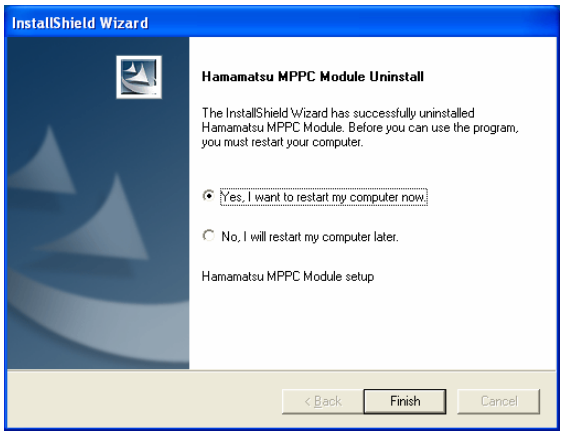
Uninstallation starts.



This screen appears when uninstallation is complete. Click [Finish].



After uninstallation, this screen appears asking if you want to restart the PC. Select **"Yes, I want to restart my computer now"** and then click **[Finish]**.



Software operation

Never disconnect the MPPC from the PC while the software is running. If disconnected, trouble might occur on the Windows system.

【Starting the software】

Connect the MPPC to the PC using the USB cable.
Double-click the MPPC short-cut icon created on the desktop, or from the [Start] menu select [All Programs] → [Hamamatsu MPPC Module] → [Software] → [Evaluation].

The "Select MPPC Module" dialog box first appears. From the drop-down list, select the MPPC module to be used, and then click [Select]. (Figure A)

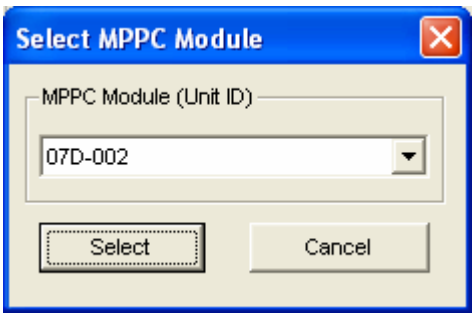


Figure A: Selecting the MPPC module to be used

When the "Option" dialog box appears, select the operating conditions from the "Gate Time [ms]" and "Threshold Level" drop-down lists. The gate time can be selected from 7 different settings (1 / 2 / 5 / 10 / 20 / 50 / 100 ms). The threshold level can be selected from 5 different settings (0.5 p.e. / 1.5 p.e. / 2.5 p.e. / 3.5 p.e. / Disable). After selecting the conditions, click [Update] (see Figure B). The dialog box closes and the software screen then appears (see Figure C). You are now ready to start measurements.
If "Disable" is selected for the threshold level, no data can be acquired. Select this setting only when using the analog signal output from the MPPC module.

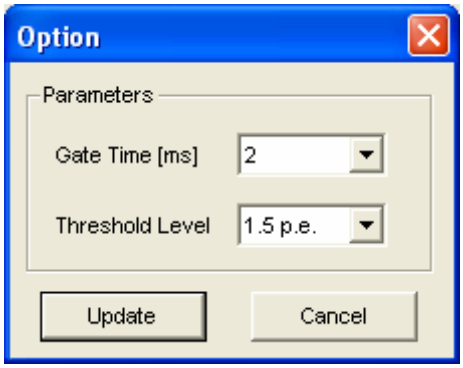


Figure B: Selecting the operating conditions

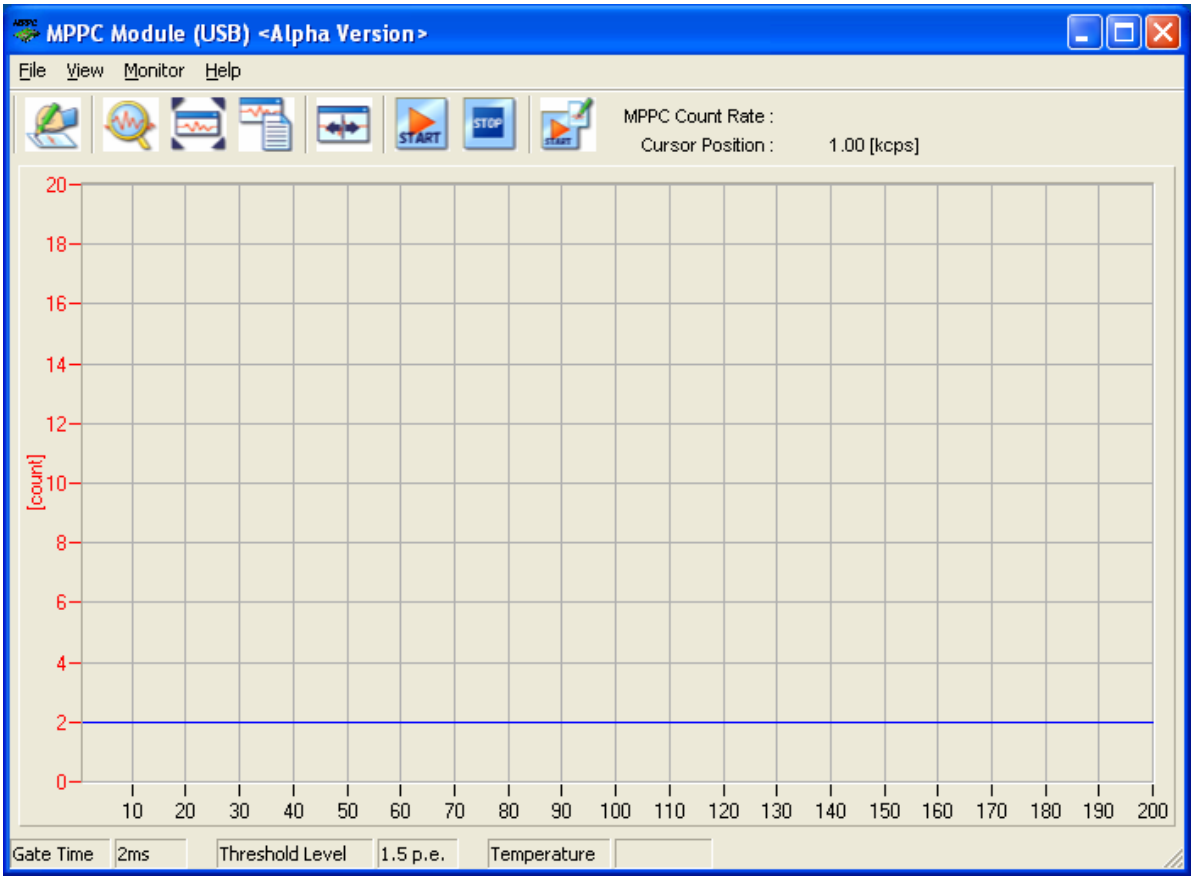


Figure C: Software screen right after start-up

【Measurement: Start and stop】

To start measurement, select [Start] from the [Monitor] menu as shown in Figure D, or click the  button on the toolbar.

To stop measurement, select [Stop] from the [Monitor] menu (see Figure E) or click the  button.

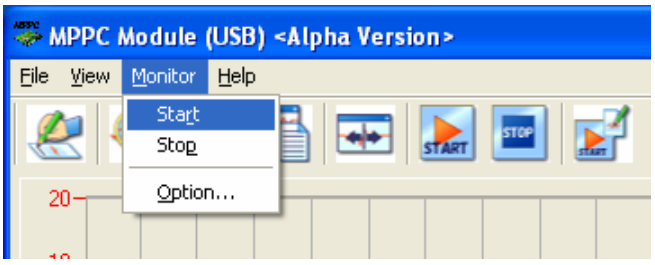


Figure D: Starting measurement

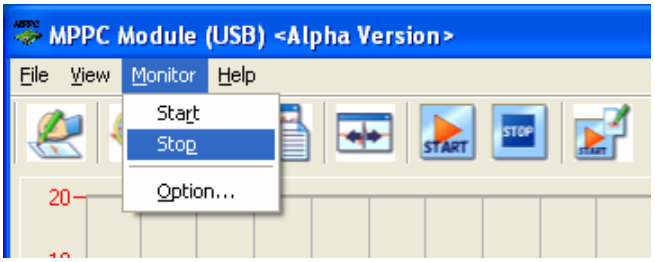


Figure E: Stopping measurement

【Software screen configuration】

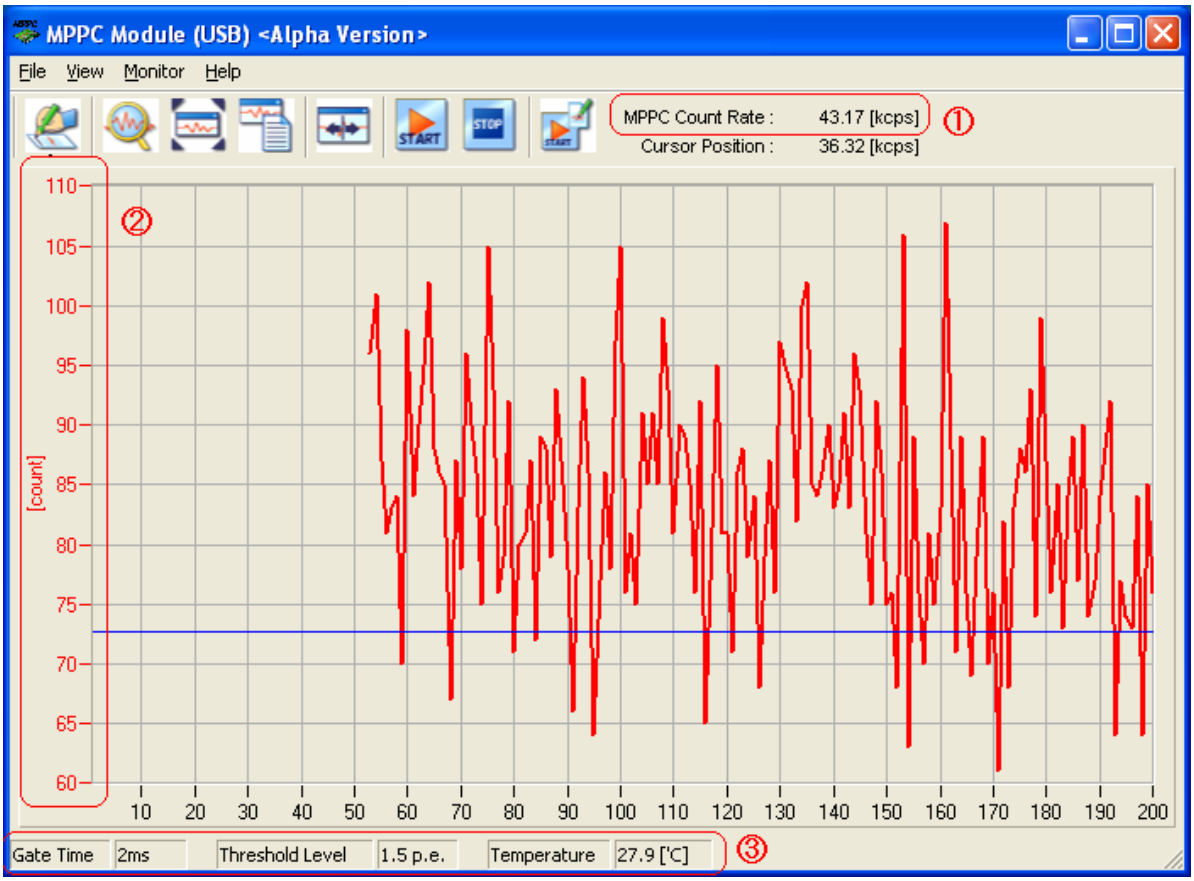


Figure F: Screen configuration

① Shows the current count rate [kcps].
② Shows the number of input counts per gate time. (* Not in "cps" units)
③ Shows the current option settings and temperature information.

The graph is a time-series display and is updated every 100 ms.
(Measurement data is thinned out and plotted on the graph.)

【Changing the options】

To change the measurement conditions, select [Option] from the [Monitor] menu (see Figure G) or click the  button on the toolbar.

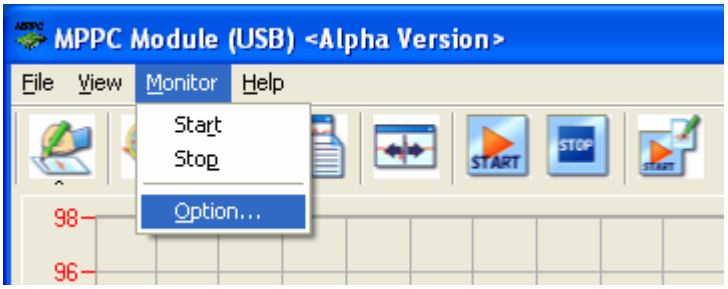


Figure G: Changing the options

【Saving the data】

To save the data, stop the measurement and then select [Save] from the [File] menu (see Figure H) or click the  button on the toolbar. Then, in the dialog box that appears, specify a file name for saving the data. The data is saved in text format (*.txt).

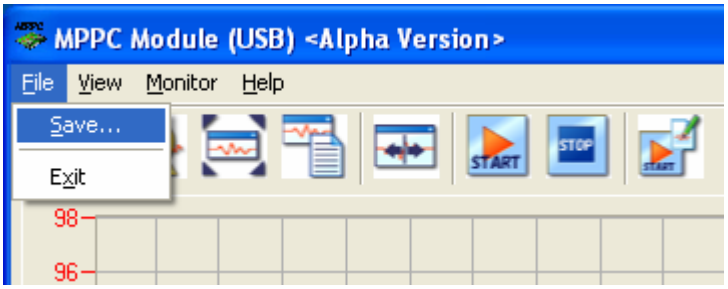


Figure H: Saving the data

The sample software stores data acquired during measurement (from the start to stop of measurement) into the memory. That data is retained in the memory until the next measurement begins.
Data saved with the [Save] command or button are the operating condition settings and number of input counts per gate time.
(Example) If measurement is performed for 1 hour with a gate time of 10 ms, then a total of 360,000 data items (1 hour / 10 ms = 360,000) will be acquired.
The maximum number of data the memory can hold is 3,600,000 (this is equivalent to a 1-hour measurement with 1 ms gate time). If this value is exceeded, then new data will overwrite the old data starting from the oldest one.

【Others: Graph manipulation】

This sample software includes display tools such as zoom-in () of a selected area, auto scaling (), vertical scale setting option (), and cursor display ().

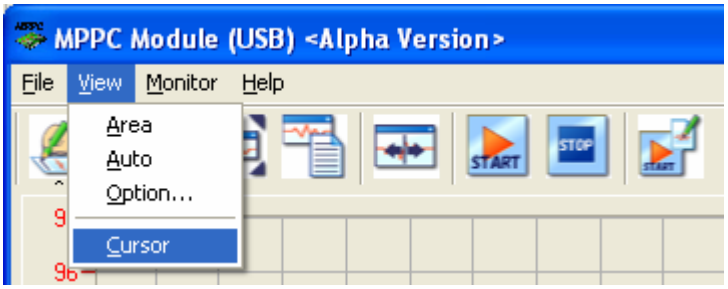


Figure I: Display tools

【Quitting the software】

To quit the software, select [Exit] from the [File] menu.

【Tool button description】

Name		Icon	Menu and description
Save			[File] → [Save] Saves acquired data.
Graph	Zoom		[View] → [Area] Zooms in on selected area.
	Auto		[View] → [Auto] Sets the graph display scale automatically or resets the zoom display.
	Option		[View] → [Option] Specifies the vertical axis scale.
	Cursor		[View] → [Cursor] Changes to "cursor" mode and shows a cursor line.
Measurement	Start		[Monitor] → [Start] Starts data acquisition.
	Stop		[Monitor] → [Stop] Stops data acquisition.
	Option		[Monitor] → [Option] Changes the measurement conditions.

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1) Failure or trouble was caused by incorrect handling.
2) The product was used for a purpose other than the original purpose.
3) The product was serviced or modified electrically or mechanically by someone other than our service personnel or authorized personnel.
4) Failure or trouble was caused by accidents such as natural or man-made disasters.
5) Failure or trouble was due to another piece of equipment used with this product.

■ After-sales service

If a failure has occurred after extended periods of operation which was caused by long-term wear on replaceable parts, ship the product back to us for repair, replacement and adjustment.
We will make every effort to repair the returned product in as short a time as possible. However, the repair or adjustment might require extra time if the product was purchased a long time ago. The repair might also be refused if the maintenance parts in the product are not in current production or the product is severely damaged.

Appendix

A.Specifications

•C10507-11-025U, C10507-11-025C, C10751-01

Parameter	Condition	Min.	Typ.	Max.	Unit
Operating temperature			-10 to +40		°C
Storage temperature			-20 to +50		°C
Effective active area			1 × 1		mm
Number of pixels			1600		-
Spectral response range			320 to 900		nm
Peak sensitivity wavelength			440		nm
Photon detection efficiency*1	λ=400nm, 0.5p.e.	-	20	-	%
Dark count	0.5p.e.	-	500	900	kcps
Temperature stability of analog output voltage	25±10°C	-	±2.5	±5	%
Analog output voltage		80	100	120	mV/p.e.
Comparator output			TTL compatible		-
Comparator threshold level			0.5, 1.5, 2.5, 3.5, Disable Adjustable 5 state		p.e.
Interface			USB1.1		-

*1: Photon detection efficiency includes effects cross talk and after pulses.

- **C10507-11-050U, C10507-11-050C, C10751-02**

Parameter	Condition	Min.	Typ.	Max.	Unit
Operating temperature			-10 to +40		°C
Storage temperature			-20 to +50		°C
Effective active area			1 × 1		mm
Number of pixels			400		-
Spectral response range			320 to 900		nm
Peak sensitivity wavelength			440		nm
Photon detection efficiency[*1]	λ=400nm, 0.5p.e.	-	35	-	%
Dark count	0.5p.e.	-	600	1200	kcps
Temperature stability of analog output voltage	25±10°C	-	±2.5	±5	%
Analog output voltage		80	100	120	mV/p.e.
Comparator output			TTL compatible		-
Comparator threshold level			0.5, 1.5, 2.5, 3.5, Disable Adjustable 5 state		p.e.
Interface			USB1.1		-

*1: Photon detection efficiency includes effects cross talk and after pulses.

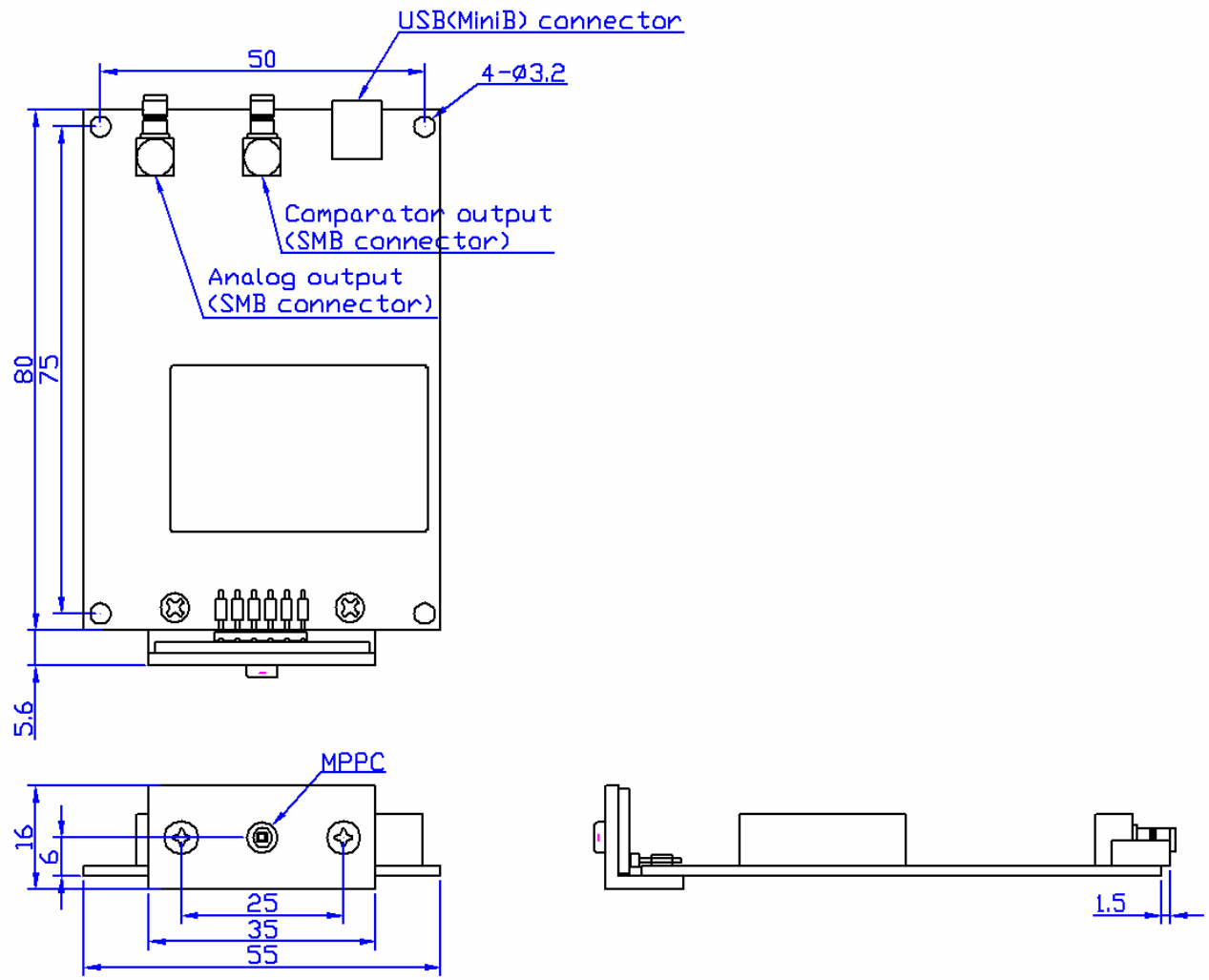
• **C10507-11-100U, C10507-11-100C, C10751-03**

Parameter	Condition	Min.	Typ.	Max.	Unit
Operating temperature			-10 to +40		°C
Storage temperature			-20 to +50		°C
Effective active area			1 × 1		mm
Number of pixels			100		-
Spectral response range			320 to 900		nm
Peak sensitivity wavelength			440		nm
Photon detection efficiency[*1]	λ=400nm, 0.5p.e.	-	45	-	%
Dark count	0.5p.e.	-	900	1500	kcps
Temperature stability of analog output voltage	25±10°C	-	±2.5	±5	%
Analog output voltage		80	100	120	mV/p.e.
Comparator output			TTL compatible		-
Comparator threshold level			0.5, 1.5, 2.5, 3.5, Disable Adjustable 5 state		p.e.
Interface			USB1.1		-

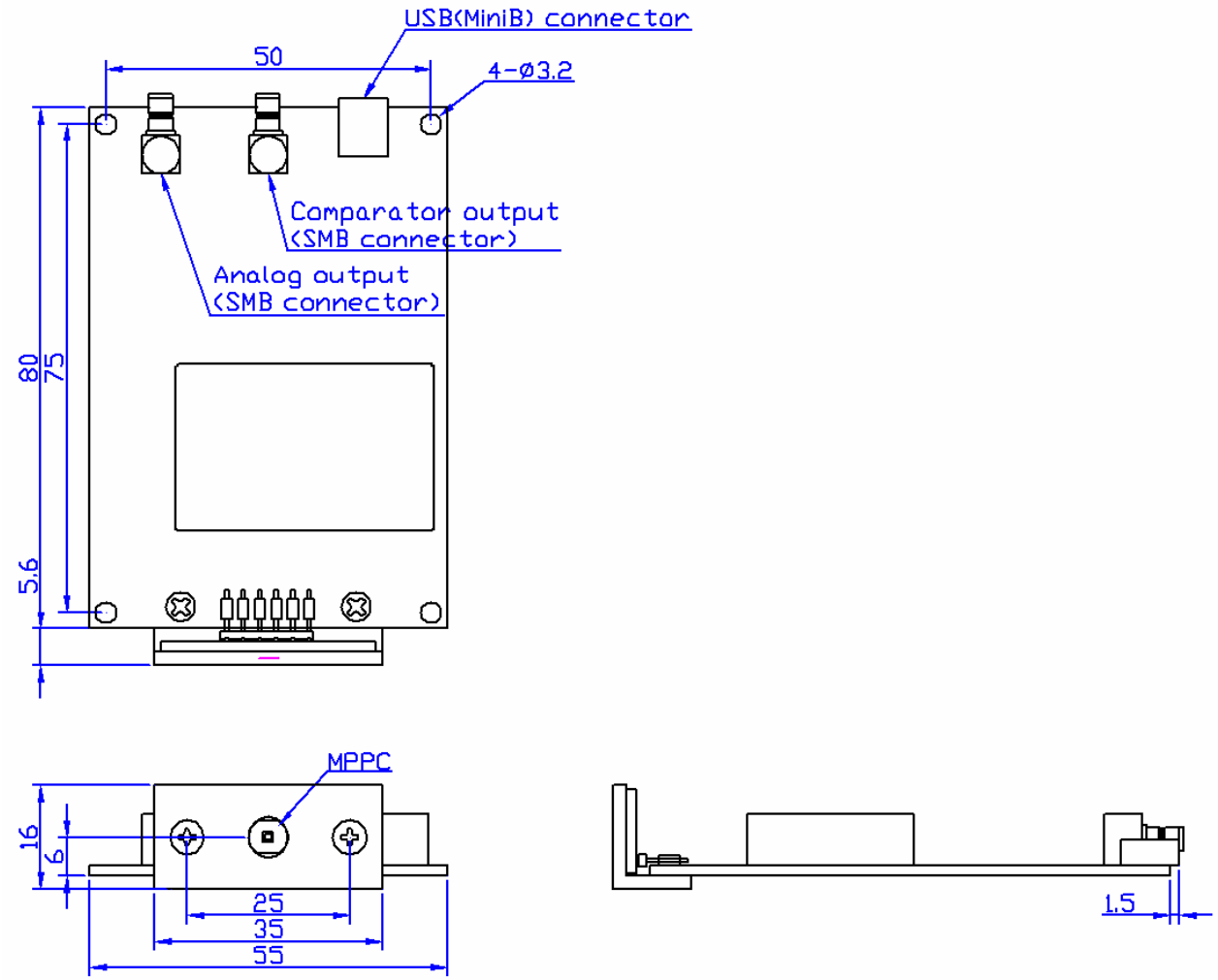
*1: Photon detection efficiency includes effects cross talk and after pulses.

B. Dimensional outline (Unit: mm)

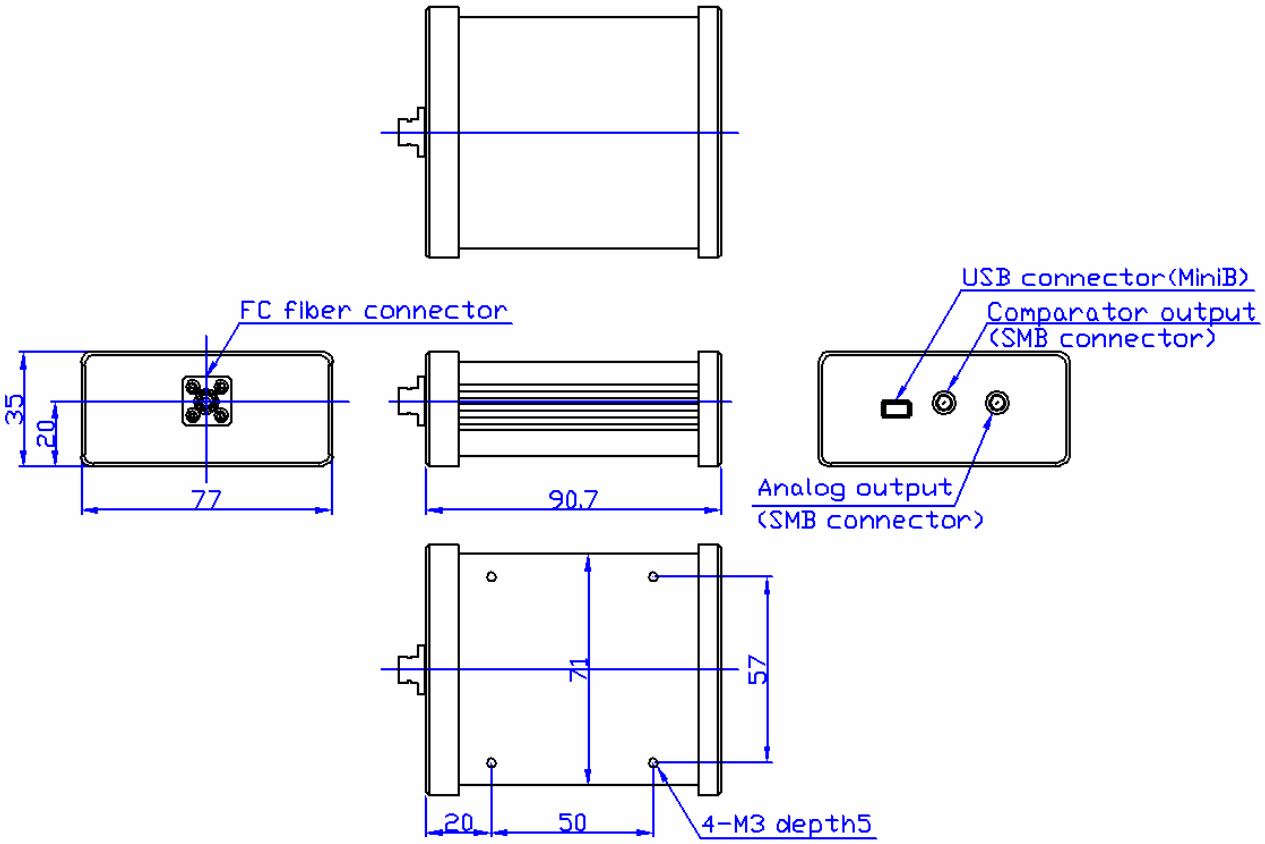
•C10507-11-025U, C10507-11-050U, C10507-11-100U



•C10507-11-025C, C10507-11-050C, C10507-11-100C



•C10751 series



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