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# Mini-spectrometer

[ TM series ] | C11697MB

## Trigger function and a high sensitivity CMOS image sensor included

The C11697MB is a polychromator integrated with optical elements, an image sensor and a driver circuit. Light to be measured is guided into the entrance port of TM series through an optical fiber and the spectrum measured with the built-in image sensor is output from the USB port to a PC for data acquisition. The C11697MB is a mini-spectrometer with a high-sensitivity CMOS image sensor mounted on the optical system platform of the previous type C10083MD. The trigger function accepts even short-time integration so emission spectra from pulsed light can be measured. The readout time is drastically reduced, making the C11697MB ideal for LED test on industrial productions lines.

The C11697MB comes supplied with free evaluation software that allows setting measurement conditions, acquiring and saving data, and displaying graphs. Original measurement software can be designed on an end-user's side as DLL's function specification is disclosed.

## Features

→ **Internal high sensitivity CMOS image sensor (rivaling that of a CCD)**
→ **Trigger function included**
→ **High-speed readout (2 ms approx.)**
→ **Simultaneous charge integration type**
→ **Wavelength conversion factor[1] is recorded in internal memory.**

*1: A conversion factor for converting the image sensor pixel number into a wavelength is recorded in the module. A calculation factor for converting the A/D converted count into the input light intensity is not provided.

## Applications

→ **Quality check on LED test line**
→ **Measurement of pulsed light emission**

## Optical characteristics

| Parameter | | Value | Unit |
|---|---|---|---|
| Spectral response range | | 320 to 1000 | nm |
| Spectral resolution (FWHM)[2] | Typ. | 5 | nm |
| | Max. | 8 | |
| Wavelength reproducibility[3] | | -0.2 to +0.2 | nm |
| Wavelength temperature dependence | | -0.04 to +0.04 | nm/°C |
| Spectral stray light[2] [4] | | -33 max. | dB |

*2: Depends on the slit opening. Values were measured with the slit listed in the table "Structure".
*3: Measured under constant light input conditions
*4: When monochromatic light of 650 nm is input, spectral stray light is defined as the ratio of the count measured at the input wavelength, to the count measured in a region of the input wavelength ±40 nm.

## Electrical characteristics

| Parameter | Specification | Unit |
|---|---|---|
| A/D conversion | 16 | bits |
| Integration time | 30 to 100000 | µs |
| Interface | USB 2.0 | - |
| Consumption current of USB bus power | 250 max. | mA |

## Structure

| Parameter | Specification | Unit |
|---|---|---|
| Dimensions (W × D × H) | 94 × 90 × 55 | mm |
| Weight | 470 | g |
| Image sensor | High sensitivity CMOS linear image sensor S11639 | - |
| Number of pixels | 2048 | pixels |
| Slit (H × V)*5 | 70 × 800 | µm |
| NA*6 | 0.22 | - |
| Connector for optical fiber | SMA905D | - |

*5: Entrance slit aperture size
*6: Numeric aperture (solid angle)

## Absolute maximum ratings

| Parameter | Value | Unit |
|---|---|---|
| Operating temperature*7 | +5 to +40 | °C |
| Storage temperature*7 | -20 to +70 | °C |

*7: No dew condensation
   When there is a temperature difference between a product and the surrounding area in high humidity environment, dew condensation may occur on the product surface. Dew condensation on the product may cause deterioration in characteristics and reliability.
Note: Exceeding the absolute maximum ratings even momentarily may cause a drop in product quality. Always be sure to use the product within the absolute maximum ratings.
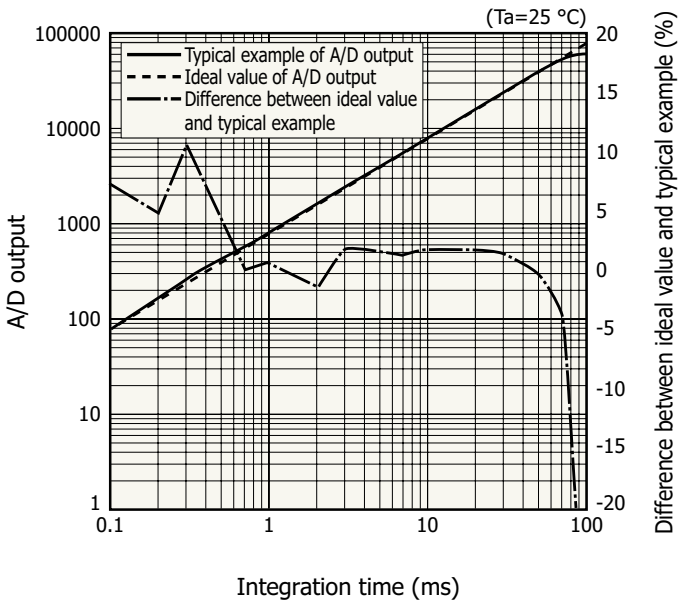
## Spectral response
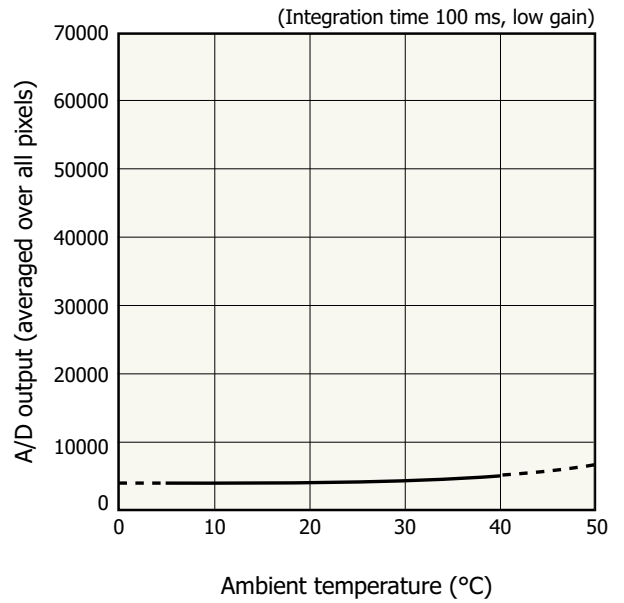


KACCB0359EA
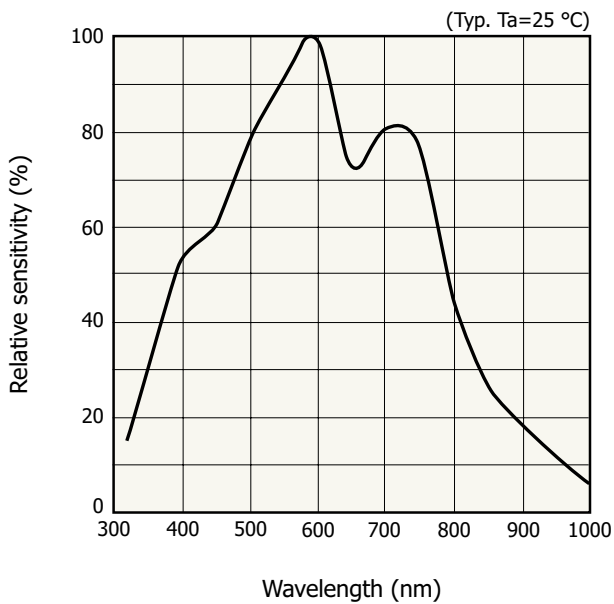
## Spectral resolution vs. wavelength



KACCB0360EA
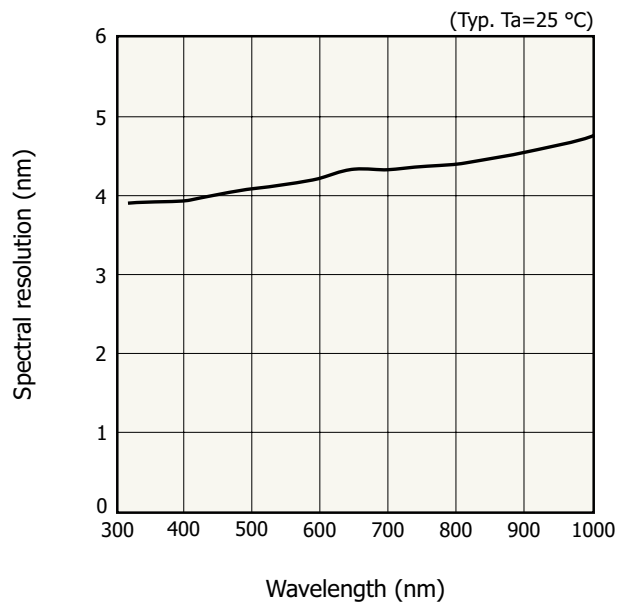
## Linearity (typical example)



(Ta=25 °C)

Typical example of A/D output
Ideal value of A/D output
Difference between ideal value and typical example

X-axis: Integration time (ms)
Y-axis (left): A/D output
Y-axis (right): Difference between ideal value and typical example (%)

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A/D output is the output with dark output is subtracted when light is input. The difference between the ideal value and typical example contains a measurement error. The smaller the A/D output, the larger the measurement error.

## Dark output vs. ambient temperature (typical example)



(Integration time 100 ms, low gain)

X-axis: Ambient temperature (°C)
Y-axis: A/D output (averaged over all pixels)

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A/D output is the sum of the sensor and circuit offset outputs and the sensor dark output.

## Optical component layout

TM series mini-spectrometers use a transmission holographic grating made of quartz and precision optical components arranged on a rugged optical base, making it possible to deliver high throughput and highly accurate optical characteristics.



Input slit
Collimating mirror
Transmission grating
Focus mirror
Image sensor

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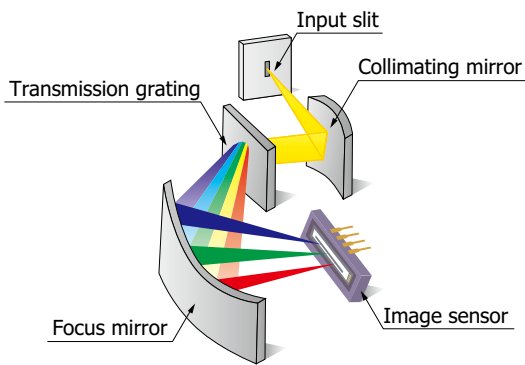
## Connection example (transmission light measurement)

Light to be measured is guided into the entrance port of TM series through an optical fiber and the spectrum measured with the built-in image sensor is output through the USB port to a PC for data acquisition. There are no moving parts inside the unit so stable measurements are obtained at all times. An optical fiber that guides light input from external sources allows a flexible measurement setup.

PC

USB cable

Light source

Mini-spectrometer

Fiber

Quartz cell
(For holding liquid sample)
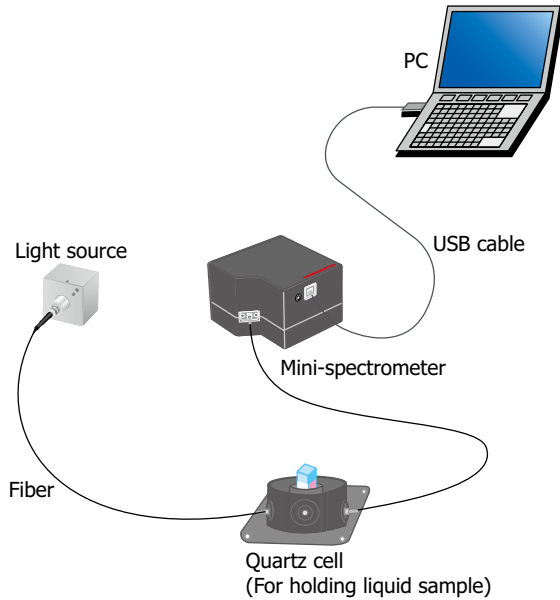
KACCC0570EB

## Trigger operation mode

The C11697MB has trigger operation modes as shown below. These operation modes can be selected on the evaluation software that comes with the C11697MB.

| (1) Data measurement at software trigger input (asynchronous) |
| --- |

This mode acquires digital data that is first converted after a software trigger input from a PC.

Software trigger      Software trigger

Measurement cycle

Charge integration

Charge readout
(A/D conversion)

Digital data
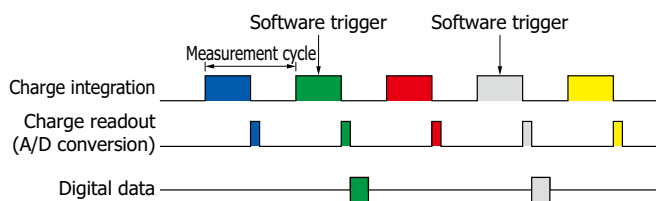
KACCC0503EC

| (2) Data measurement at software trigger input (synchronous) |
| --- |

This mode starts sensor operation (integration) after a software trigger input from a PC.

Software trigger      Software trigger

Measurement cycle

Charge integration

Charge readout
(A/D conversion)

Digital data

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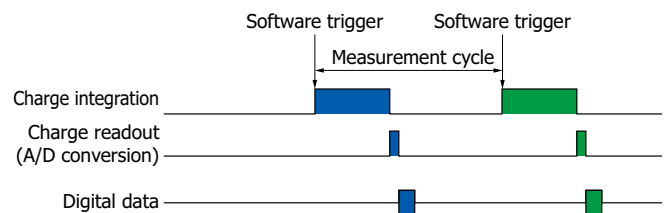
## (3) Data measurement at external trigger input (asynchronous)

This mode acquires digital data that is first converted after the edge (rising or falling edge selectable) of an external trigger input to the external trigger terminal.
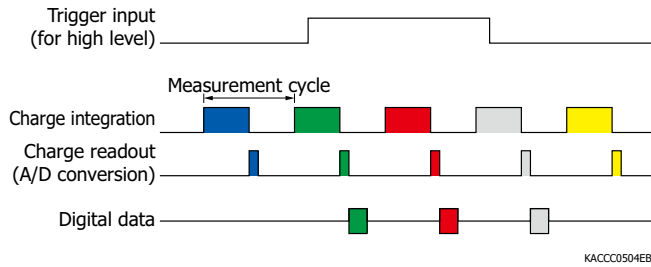


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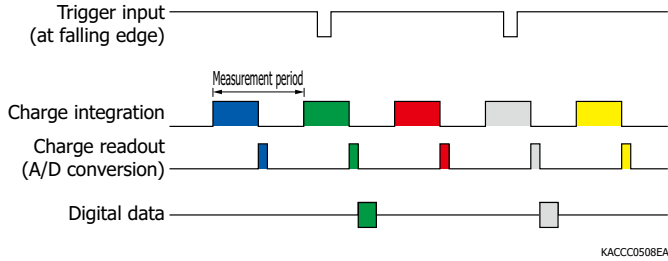
## (4) Data measurement at external trigger input (synchronous)

This mode starts sensor operation (integration) at the edge (rising or falling edge selectable) of an external trigger input to the external trigger terminal, and acquires digital data.



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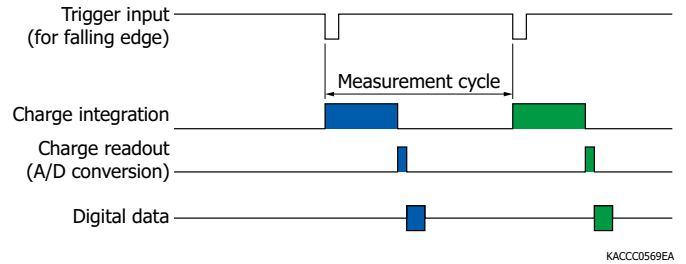
## (5) Measurement by external trigger input level (asynchronous)

This mode acquires digital data when an external trigger (high or low level selectable) is input to the external trigger terminal.



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## (6) Measurement by external trigger input level (synchronous)

This mode starts sensor operation (integration) when an external trigger (high or low level selectable) is input to the external trigger terminal, and acquires digital data.



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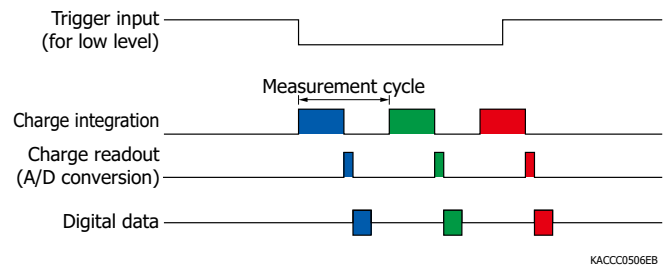
In either of the modes (1) to (6), the input trigger is ignored if the trigger input interval is shorter than the mini-spectrometer measurement period.

## (7) Trigger signal output

An integration start timing (pulse width: 10 μs) can be output from the external trigger terminal. (trigger output edge: rising or falling edge selectable)



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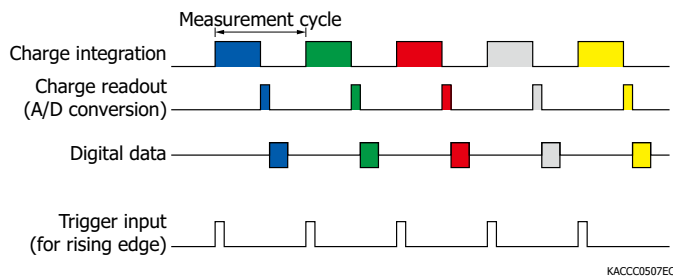
## Evaluation software package (supplied with unit)

Installing the evaluation software (SpecEvaluationUSB2.exe)*8 into your PC allows running the following basic tasks:
· Measurement data acquisition and save
· Measurement condition setup
· Module information acquisition
  (wavelength conversion factor, polychromator type, etc.)
· Graphic display
· Arithmetic function
  Pixel number to wavelength conversion
  Comparison calculation with reference data
  (transmittance, reflectance)
  Dark subtraction
  Gaussian approximation (peak position and count, FWHM)
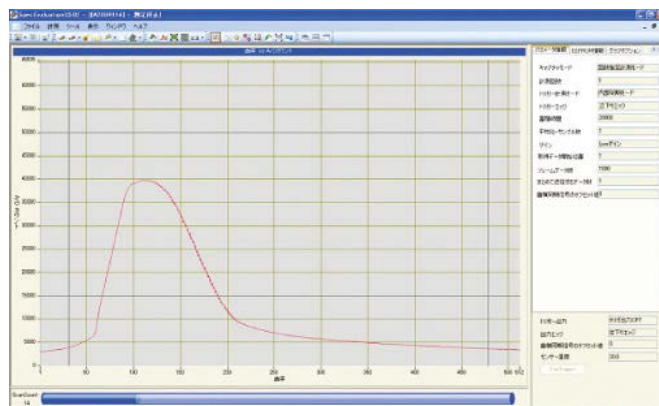
Note: Up to 8 mini-spectrometers can be connected and used with one PC.

*8: Compatible OS: Microsoft Windows 10 Professional (32-bit, 64-bit)

DLL for controlling hardware is also provided.
You can develop your own measurement programs by using a following software development environment.
Microsoft Visual Studio® 2008 (SP1) Visual C++®
Microsoft Visual Studio 2008 (SP1) Visual Basic®
Note: Microsoft, Windows, Visual Studio, Visual C++ and Visual Basic are either registerd trademarks or trademarks of Microsoft Corporation in the United States and other countries.
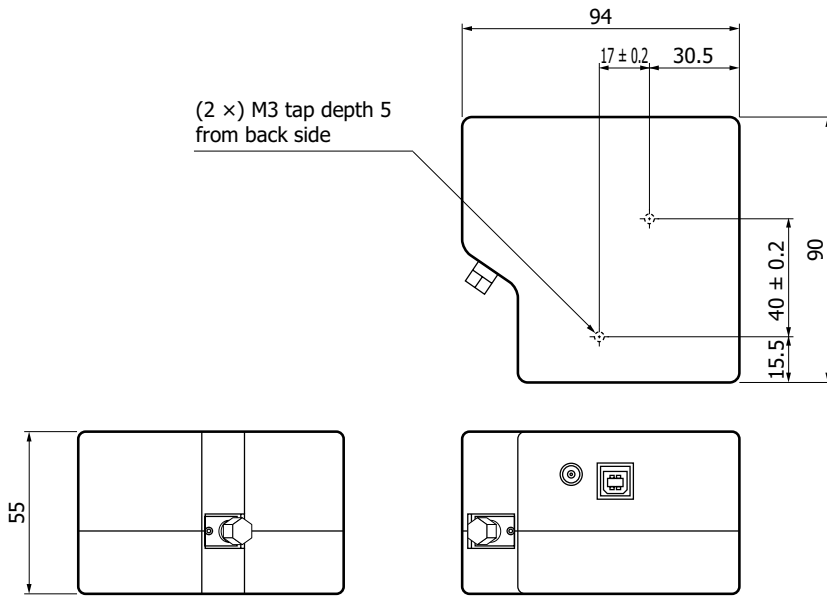
## Measurement example

Measurement of visible LED

(Typ. Ta=25 °C)

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## Dimensional outline (unit: mm)

94

17 ± 0.2    30.5

(2 ×) M3 tap depth 5
from back side

40 ± 0.2

90

15.5

55
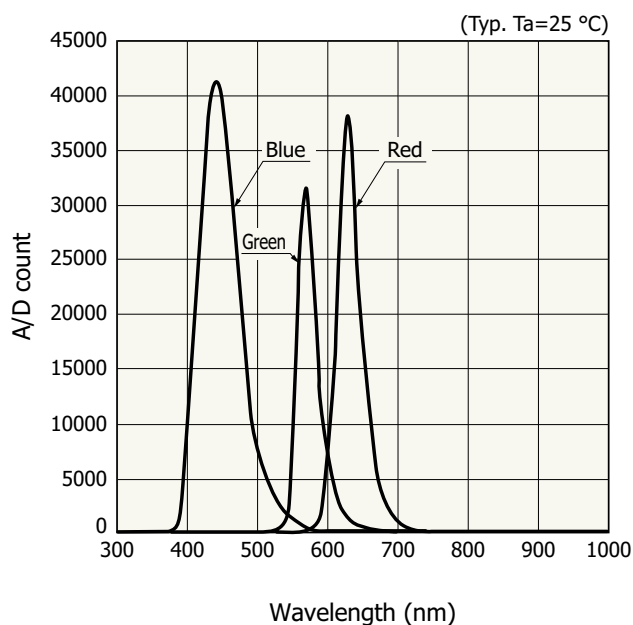
Tolerance unless otherwise noted: ±0.5
Weight: 470 g

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## Accessories

· USB cable
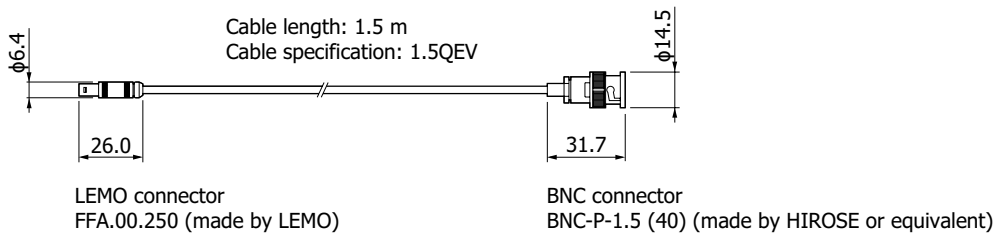· Dedicated software (evaluation software, sample software, DLL)

## Options (sold separately)

· Optical fiber for light input

| Type no. | Product name | Core diameter (μm) | Specification |
|---|---|---|---|
| A16962-01 | Fiber for UV/visible range (resistance to UV) | 600 | NA=0.22, length 1.5 m, connectorized SMA905D at both ends |

· Coaxial cable for external trigger input A10670

Dimensional outline (unit: mm)

$\phi$6.4

Cable length: 1.5 m
Cable specification: 1.5QEV

$\phi$14.5

26.0

31.7

LEMO connector
FFA.00.250 (made by LEMO)

BNC connector
BNC-P-1.5 (40) (made by HIROSE or equivalent)

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## ▗ Related information

www.hamamatsu.com/sp/ssd/doc_en.html

■ Precautions

· Disclaimer
· Mini-spectrometers

■ Technical information

· Mini-spectrometers

Information described in this material is current as of March 2024.

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