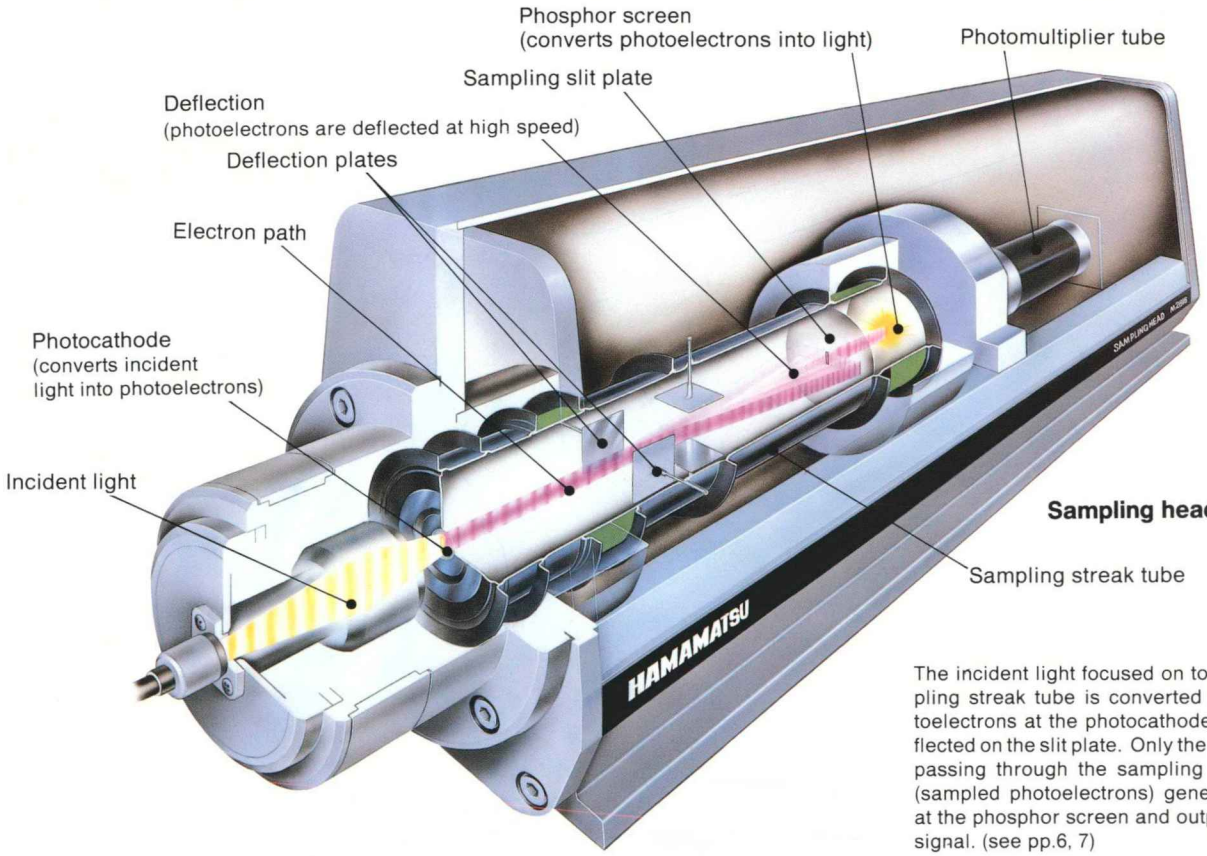
OPTICAL OSCILLOSCOPE OOS-01

New sampling method enables observation of optical waveforms above 30 GHz without distortion.



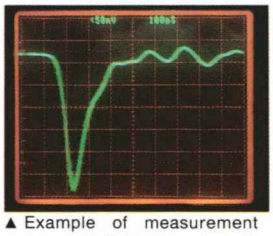
The incident light focused on to the sampling streak tube is converted into photoelectrons at the photocathode, and deflected on the slit plate. Only the electrons passing through the sampling slit plate (sampled photoelectrons) generate light at the phosphor screen and output as the signal. (see pp.6, 7)

A World's First! Electronic processing with one photoelectron tube from light detecti

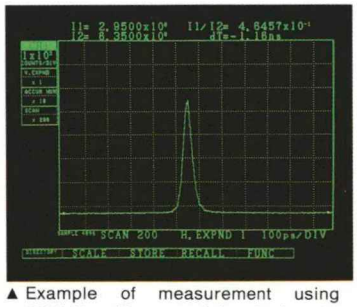
FEATURES

● No distortion

Processing from light detection to electron sampling performed in the sampling streak tube does not generate any waveform distortion such as ringing, reflection, overshoot and sag.



▲ Example of measurement using photodiode and oscilloscope. (100 ps/DIV)



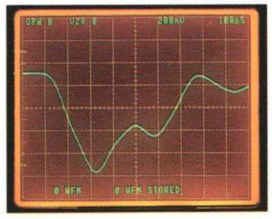
▲ Example of measurement using OOS-01, with none of the ringing observed in the picture on the left. (100 ps/DIV)

● Observation of optical waveforms above 30 GHz

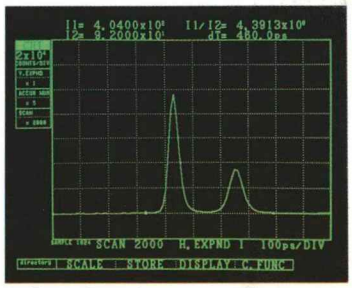
The OOS-01 permits observation of waveforms above 30 GHz — much higher than the 10 GHz which used to be considered the measurement limit for photodetectors and oscilloscopes. (Trigger frequency range is 30 Hz to 1 GHz.)

● 10 ps time resolution

With time resolution better than 10 ps, the OOS-01 has superb response. High speed phenomena which could not be measured before can now be captured accurately.



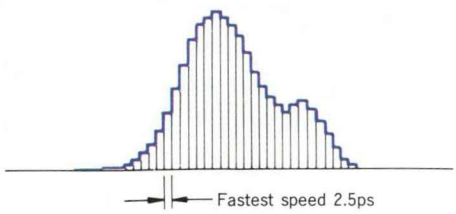
▲ Example of measurement using photodiode and oscilloscope. (100 ps/DIV)



▲ Example of measurement using OOS-01 showing the sharp rising and falling waveforms. (100 ps/DIV)

● Waveforms displayed at high resolution

High-precision analysis is performed at the high sampling interval of 2.5 ps. This makes it possible to produce accurate measurement of waveforms involving fine structure which could not previously be observed.



OSCILLOSCOPE REVOLUTION!

A single new photoelectron tube is rewriting the oscilloscope's history.....
The OOS-01 sampling optical oscilloscope uses a photoelectron tube — sampling streak tube — developed by Hamamatsu Photonics in a new method of optical measurement.
The sampling streak tube is not only a photodetector. All the processing from light detection to electron sampling is performed in one tube (electronic sampling). The signal transmission line required to link a photodetector and a conventional oscilloscope can now be dispensed with, using the new OOS-01. This eliminates the ringing and waveform distortion due to the transmission line, and enables accurate optical intensity waveform measurement. The OOS-01 also realizes time resolution better than 10 ps for the best performance in the world.

pling. Permits observation of optical waveforms above 30 GHz without distortion.

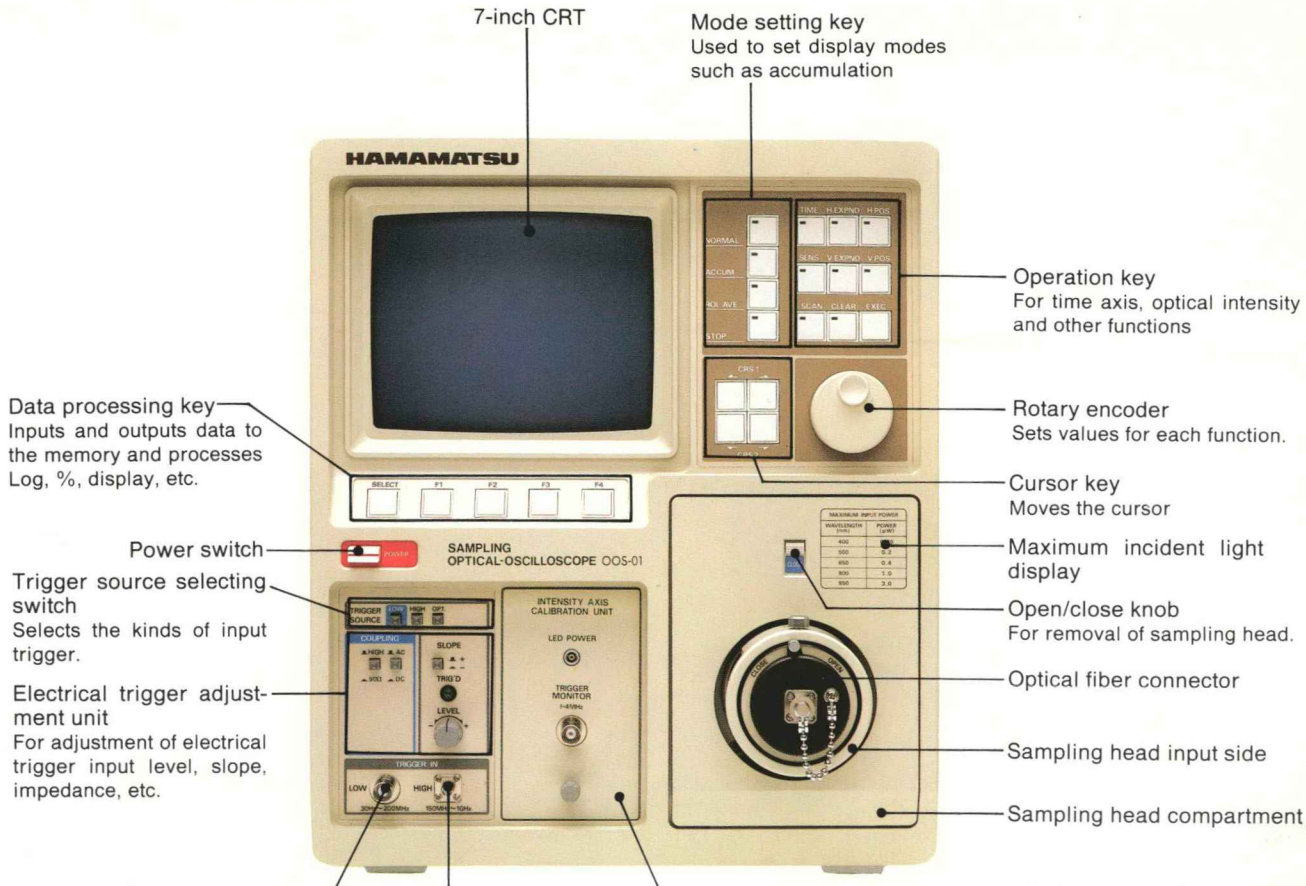
● Optical measurement has become much easier
The OOS-01 combines photodetector, circuitry, and oscilloscope in one unit. Eliminating the problems in selecting photodetector and oscilloscope equipment, the OOS-01 makes optical measurement much easier.

● Data analysis and calculation functions
Accumulation, time axis expansion, waveform calculation (arithmetic operations, FFT), and cursor functions (rise and fall time, FWHM, maximum and minimum values, modulation factor) are among the many easy-to-use functions included as standard features. (See Analysis and Calculation Functions, pp.4, 5.)

- **Enables high-speed sampling at up to 2 MHz**
- **Measuring wavelength region**
  OOS-01/VIS 350 to 850 nm
  OOS-01/IR 400 to 1550 nm
- **Dynamic range is more than 1:1000**
- **Four waveforms can be stored in memory**
- **GPIB interface provided as standard feature**

● Two optical signals can be measured at the same time
A second sampling head (option) can be attached for dual channel measurement. For example, when measuring the fluorescence life time, both the excitation light and fluorescence can be measured simultaneously.

● Sampling head can be separated from main unit
The sampling head, which consists of a sampling streak tube, a photomultiplier tube and the signal output circuit, can be separated from the main unit. It can therefore be placed on the optical bench — close to where the measurement must be made.

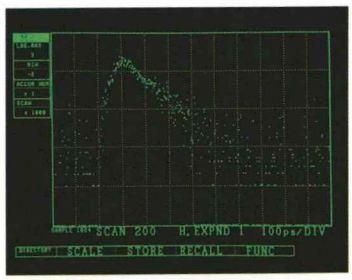


Main unit

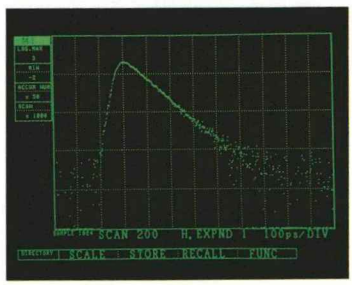
ANALYSIS AND CALCULATION FUNCTIONS

1 Accumulation function

For waveforms that are difficult to see due to noise or fluctuations, this function provides improved S/N ratio by means of waveform accumulation (addition). Up to 10,000 waveforms may be accumulated.



Example of real time measurement (1 accumulation vertical axis: log scale) ▶



Same waveform after 50 accumulations showing S/N improvement (vertical axis: log scale) ▶

2 Time axis expansion function

The time axis can be expanded by factors of 2, 4, and 8 for waveform observation.

3 Waveform calculation functions

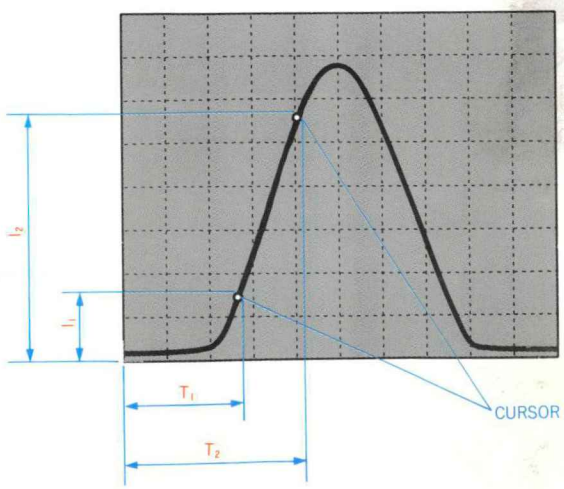
The four arithmetic operations (+, −, x, ÷) on two different waveforms and FFT (Fast Fourier Transform) can be performed.

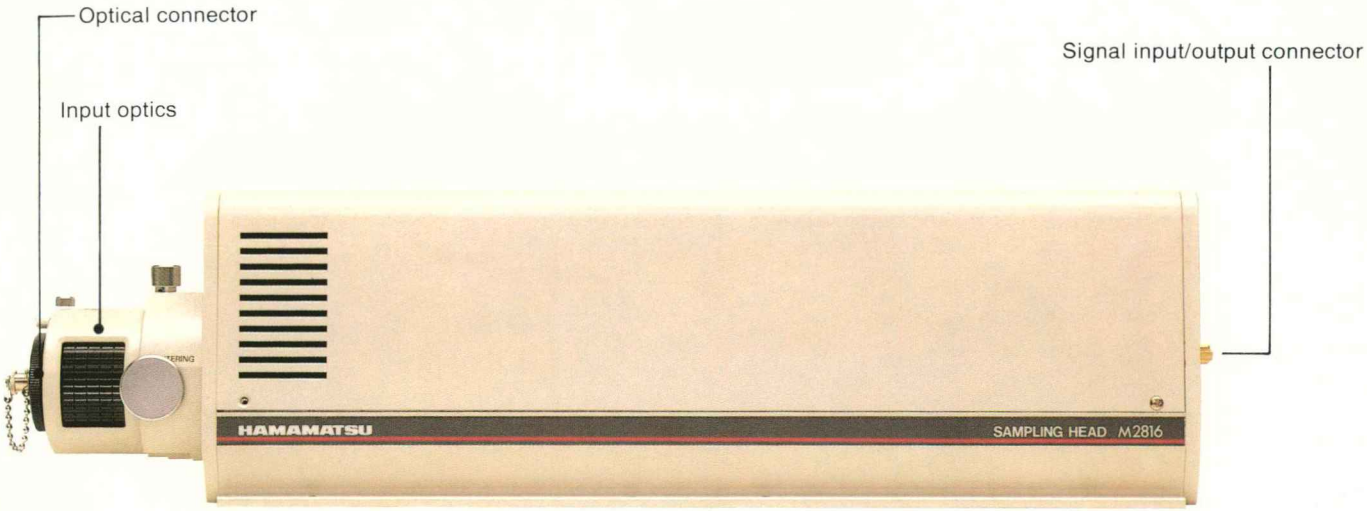
4 Cursor functions

- **Time and optical intensity display**

Time intervals and intensity ratio between the positions specified with two cursors, and intensities specified at cursors can also be displayed.

Measurement parameters : Time $T_1 - T_2$
: Intensity I_1, I_2, I_1/I_2





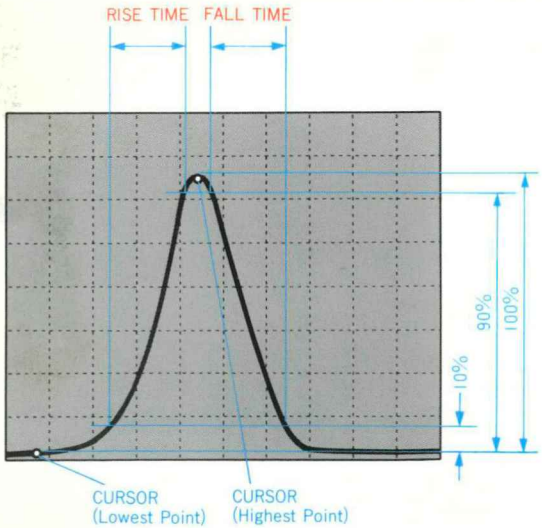
Sampling head
(Can be used installed in the main unit or separated from the main unit)

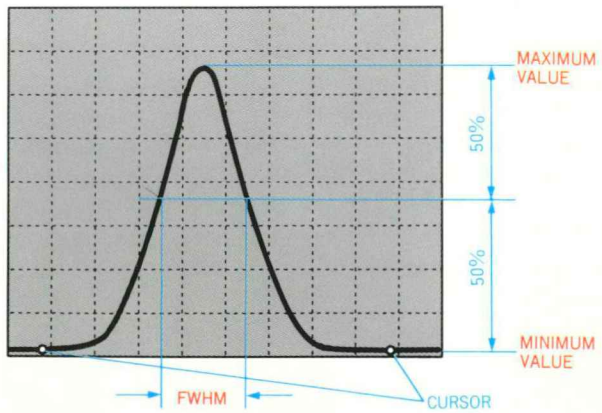
● **Rise time, fall time measurement**

The rise and fall times of optical phenomena can be measured and displayed by setting the cursors to the highest and lowest points of the waveform.

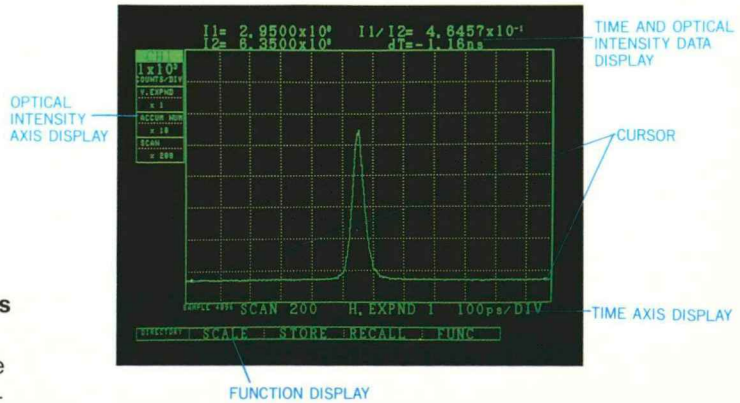
Rise time : This is the time required for the signal to rise from 10% to 90% of the highest point.

Fall time : This is the time required for the signal to fall from 90% to 10% of the highest point.





Display example



● **Measurement of FWHM, Minimum Value, Maximum Value, Modulation Factor, and Area Between Cursors**

By setting the cursors to points before and after the waveform, the FWHM, minimum value, maximum value modulation factor and area between cursors are measured and displayed.

OPERATING PRINCIPLES

The sampling streak tube — a single photoelectron tube which performs all the functions from light detection through sampling — is the heart of the OOS-01. This unique tube (see Figure 1) converts the light incident on the photocathode into photoelectrons in proportion to the input

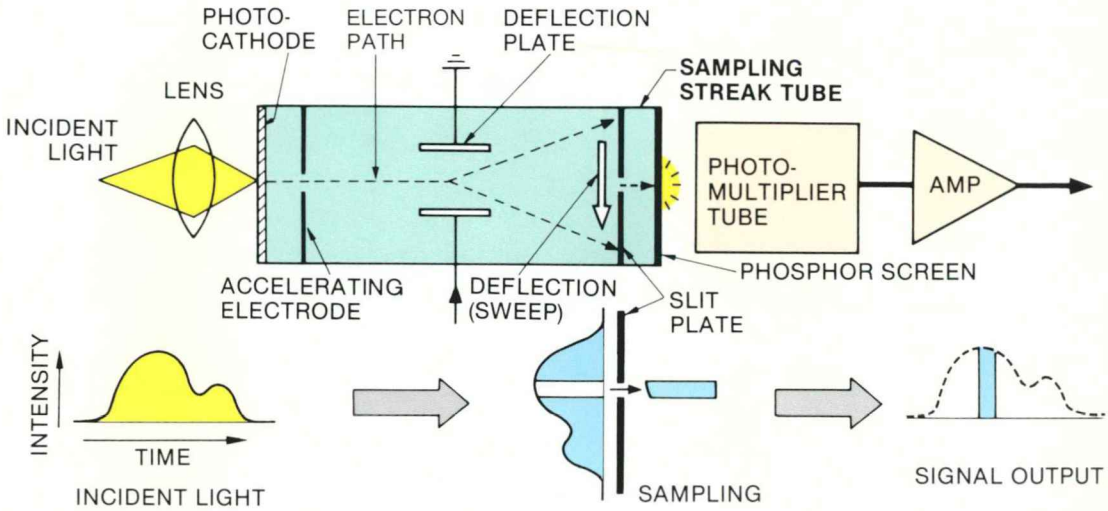
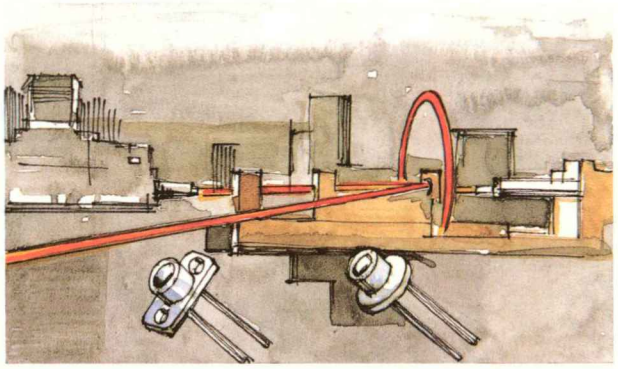


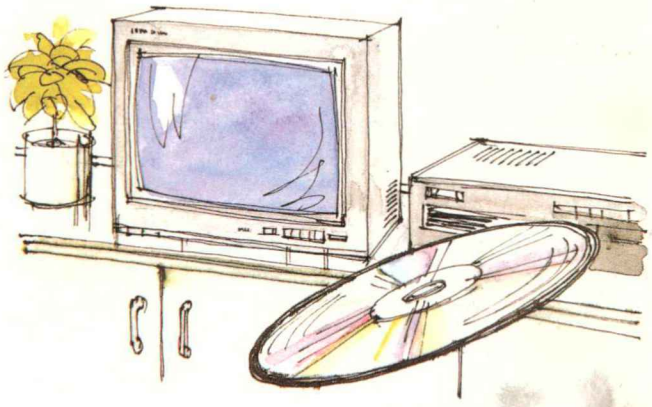
Figure 1: OOS-01 sampling principles

APPLICATION EXAMPLES

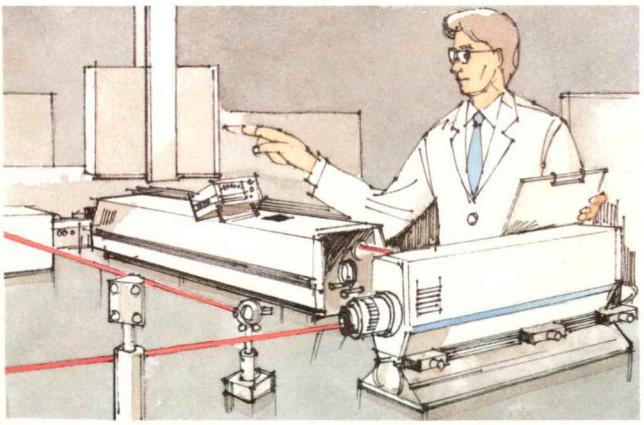
- **Evaluation and inspection of response characteristics for visible and infrared semiconductor lasers and ultra high-speed light source**



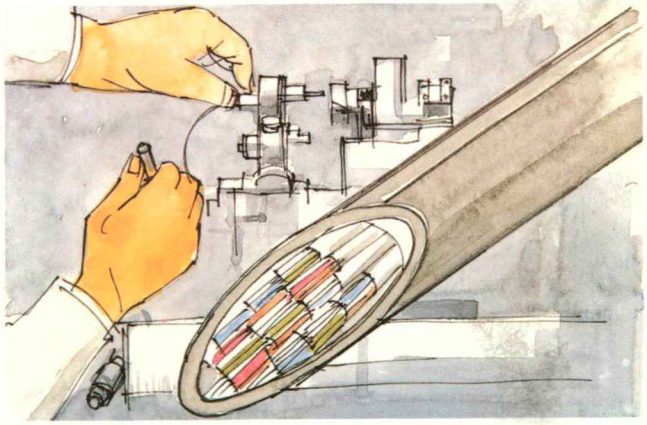
- **Evaluation and inspection of optical components used in optical discs (CD, video disc)**



- **Evaluation and inspection of mode-locked laser systems such as argon ion laser or Nd-Yag-laser.**



- **Evaluation and inspection of transmission characteristics of optical fiber.**



light intensity. These photoelectrons are accelerated and directed by the accelerating electrode past a pair of deflection electrodes towards the sampling slit plate. As they pass the deflection electrodes, they are deflected at high speed past a narrow slit on the sampling slit plate. Only the electrons which pass through the sampling slit are directed to the phosphor screen, where they are converted to light which is detected and converted into an electrical signal by a photomultiplier tube. This electronically sampled signal is then stored and processed. The sampling operation can be repeated many times with different delay timing between the trigger and the sampling to produce a waveform of optical intensity versus time of the incident light. (See Figure 2.)

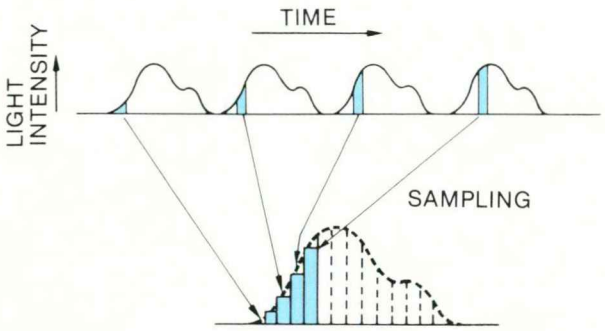
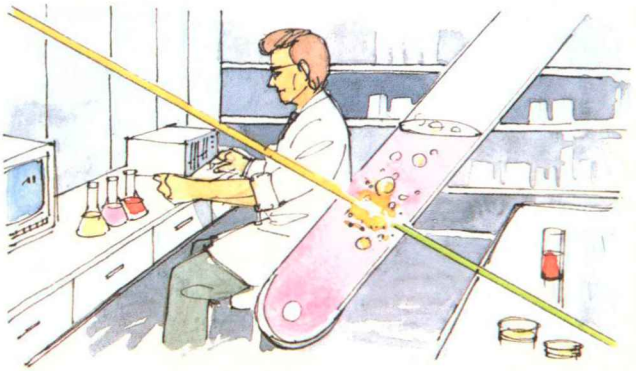


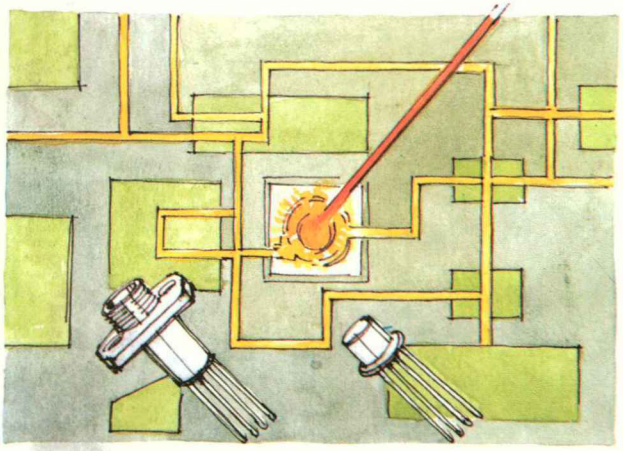
Figure 2: Optical intensity waveform formation

- **Evaluation of characteristics of optical transmission systems in optical LAN and other equipment**

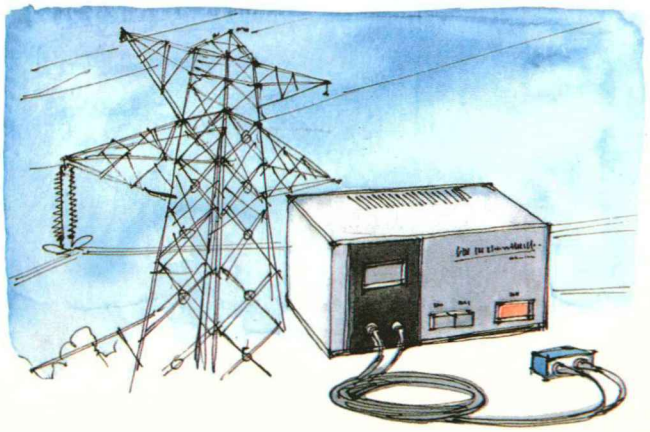
- **Spectrophotometry, fluorescence lifetime measurement in picosecond to microsecond range**



- **Evaluation of characteristics of optical ICs**



- **Measurement of physical quantities when combined with E/O converters and fiber sensors**



SPECIFICATIONS

● Sampling Head (M2816, M2816-01)

Optical signal input form ..... Fixed slit & optical connector
Spectral response (sensitive wavelength range)
M2816 for OOS-01/VIS ..... 350 to 850 nm
M2816-01 for OOS-01/IR ..... 400 to 1550 nm
Effective detection area ..... 2.5(H) x 0.03(W) mm (when fixed slit is used)
Time resolution ..... Better than 10 ps (equivalent to fc > 30 GHz)
Setting position ..... Installed in the main unit or separated from the main unit

● Main Unit

Time axis ..... 20 ps/div. to 1 μs/div.
Number of sampling points ..... 4096, 2048, 1024, 512, 256 points/full scale
Scan rate ..... 1 to 10,000 events/dot
Sampling rate ..... 2 MHz maximum
Sampling interval ..... 2.5 ps minimum
Jitter ..... Less than 20 ps
Rise and fall times (incl. jitter) ..... Less than 20 ps
Dynamic range ..... More than 1 : 1000
Trigger repetition rate : LOW ..... 30 Hz to 200 MHz (with slew rate more than 0.75 V/μs)
: HIGH .... 150 MHz to 1 GHz
A/D converter ..... 14 bits
Number of waveform memory ..... 4 (Capacity : 4096 x 32 bits)
Accumulation function ..... 1 to 10,000 times
Time-axis expansion function ..... 2, 4, 8 times
Waveform calculation function
Arithmetic operations (+, −, x, ÷) on two different waveforms, FFT (Fast Fourier Transform)
Cursor function
Rise time, fall time, FWHM, minimum value, maximum value, modulation factor, intensities specified at cursors, intensity ratio, area between cursors, time interval between the positions of two specified cursors.
Intensity axis display function ..... W, linear, %, Log, Ln
Waveform output ..... Plotter (HP-GL compatible)
Video printer (Horizontal sync frequency 24 KHz)
Standard interface ..... GP-IB (IEEE-488)

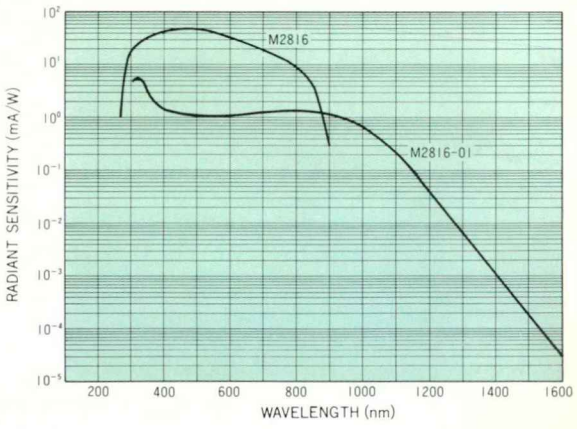
● Options

Optical trigger head: M2970
Optical connector adaptor:
(FC) A2971-00
(D4) A2971-01
(OF2) A2971-02
(Bi-conic) A2971-03
(SMA) A2971-04
(ST) A2971-05
One of the above optical connector adaptors is available as standard.
Polaroid camera: A3196
Transfer cart

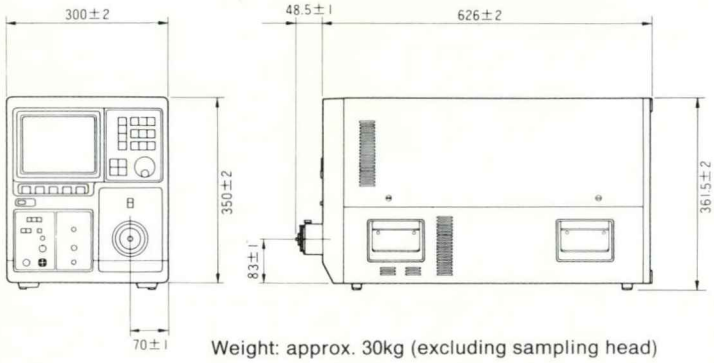
● General and Environmental Specifications

Line voltage ..... 100/117 or 220/240 VAC, 50/60 Hz
Power consumption ..... Approx. 250 VA
Operating temperature ..... 0 to +40°C
Storage temperature ..... −10 to +50°C
Operating and storage humidity ..... Below 70% (no condensation)

Spectral response

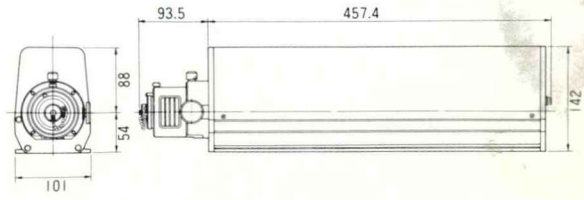


● Main Unit



Weight: approx. 30kg (excluding sampling head)

● Sampling Head



Weight: approx. 6 kg

(Unit: mm)

• Specifications and external appearance are subject to change without notice.

HAMAMATSU

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