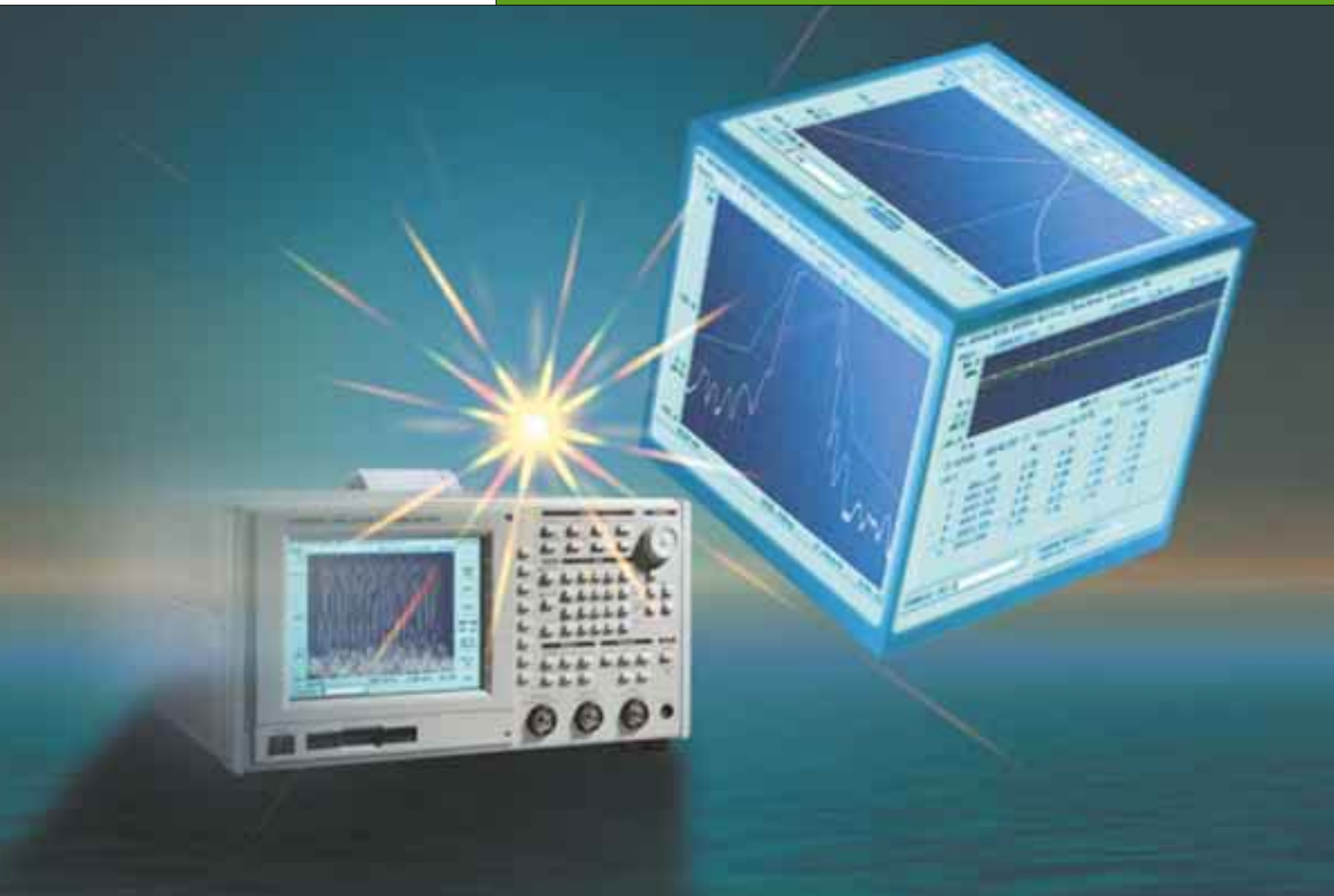
ADVANTEST

Q8384
Optical Spectrum Analyzer

Can measure and evaluate ultra high-speed optical DWDM transmission systems, and optical components at high wavelength resolution and high accuracy. New high-end optical spectrum analyzer adopting a new four-pass monochromator system providing high wavelength resolution and wide dynamic range.

- 10 pm resolution bandwidth
- 20 pm wavelength accuracy (after calibration with Opt. 25)
- Wide dynamic range: 50 dB (±0.1 nm), 60 dB (±0.2 nm)
- Optical frequency display
- Accurate NF measurement on EDFAs
- Can handle power levels as high as +23 dBm (200 mW)
- Abundance of WDM analysis functions
- Limit line function for Pass/Fail analysis provided

Q8384



High-end Optical Spectrum Analyzer Q8384

In DWDM optical communications, exacting wavelength measurements are required of the optical source. Evaluating these specifications requires an optical spectrum analyzer with enhanced resolution bandwidth and wavelength accuracy. To meet these stringent requirements, the Q8384 achieves 10 pm wavelength resolution, the best in the world* and attains 20 pm wavelength accuracy in the 1550 nm band. This high performance makes it possible for the Q8384 to measure the oscillation wavelength characteristics of laser diodes accurately.

DWDM optical communication systems also contain wavelength division multiplexed channels spaced at intervals as close as 50 GHz (0.4 nm). In this environment an optical spectrum analyzer with superior dynamic range is required to separate the optical signals and measure the noise figure (NF) of the optical amplifier. The Q8384 has a dynamic range as wide as 50 dB at 0.1 nm and 60 dB at 0.2 nm and therefore fulfills these requirements adequately. Equipped with automatic optical amplifier NF measurement and arithmetic facilities, the instrument allows the user to make measurements in a simple fashion. The Q8384 optionally has a built-in reference wavelength light source and an EE-LED (edge emitting LED). If calibrated with this reference light source, the instrument is assured to provide wavelength accuracy of 20 pm in the 1550 nm band. Using the EE-LED's broad-band light source, the Q8384 allows the user to conveniently measure and evaluate the transmission and loss characteristics of narrow-band optical filters.

**: at the time of printing (June, 2001)*

Excellent Basic Performance

10 pm high wavelength resolution

The Q8384 realizes a wavelength resolution bandwidth as high as 10 pm through the employment of a newly developed monochromator system. This makes it possible to measure and evaluate the side bands of optical signals which are intensity modulated at 10 Gbps, a task formerly impossible with conventional spectrum analyzers.

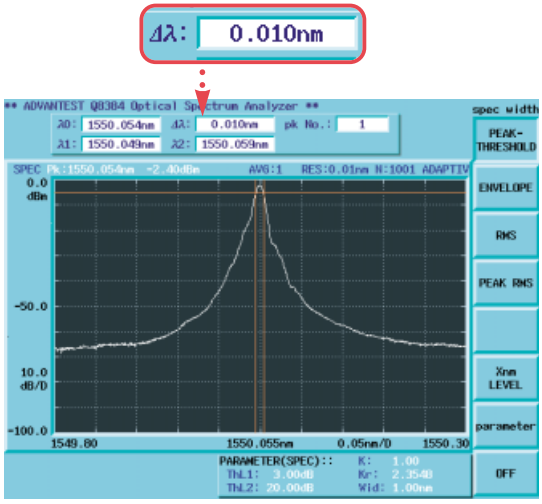


FIG. 1 Resolution band width of 10 pm

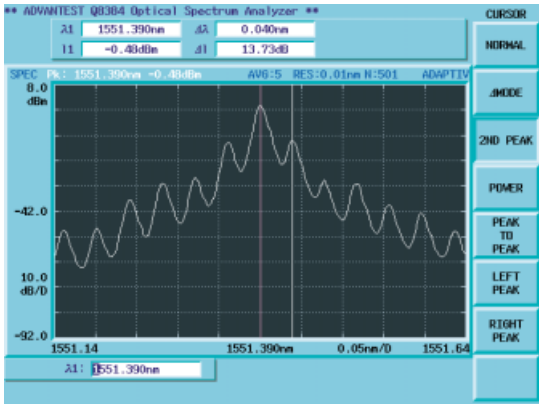


FIG. 2 Sample waveform modulated at 10 Gbps

20 pm high wavelength accuracy

The Q8384 can measure wavelengths at an accuracy of ±20 pm within the wavelength range of the 1530 to 1570 nm C-band and at ±40 pm within the L-band range of 1570 to 1610 nm after being calibrated with the built-in calibration light source (option 25). It can accurately evaluate the exacting characteristics of laser diodes and optical filters used in DWDM transmission systems. Since the Q8384 provides a wavelength linearity of ±10 pm for the wavelength range of 1530 to 1570 nm, it can also accurately measure the wavelength interval of wavelength division multiplexed signals.

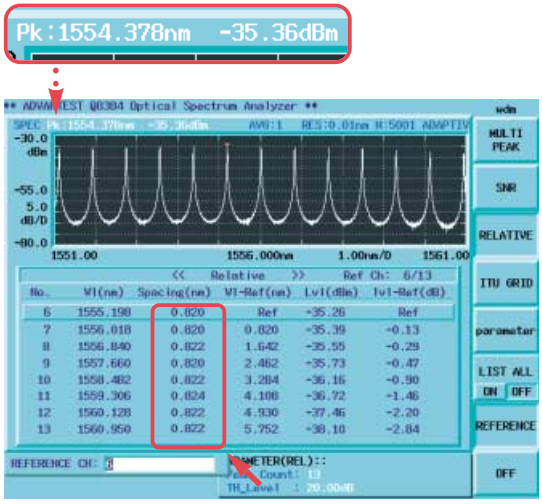
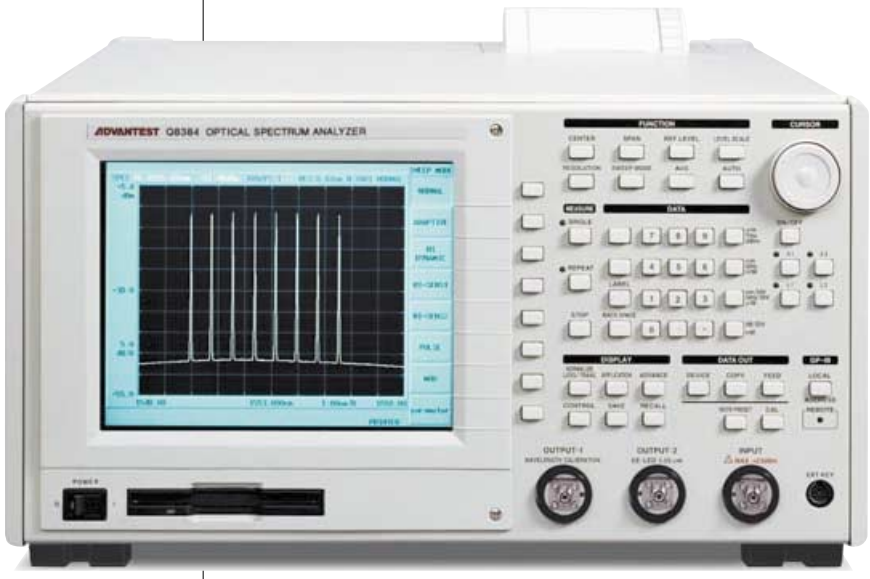


FIG. 3 A measurement example of a Fabry-Perot filter
Wavelength spacing can be measured with satisfactory linearity.



50 dB (±0.1 nm)/60 dB (±0.2 nm) wide dynamic ranges

Signals are subject to wavelength division multiplexing spaced at 50 GHz (0.4 nm) or shorter intervals in a DWDM system. An optical spectrum analyzer with superior dynamic range is required to separate and measure these tightly spaced signals. The Q8384 realizes a dynamic range of 60 dB or more at 0.2 nm making it ideal for this task. At 0.1 nm, the instrument provides a dynamic range of 50 dB or more, thus enabling it to support future DWDM systems with signals at even closer intervals.

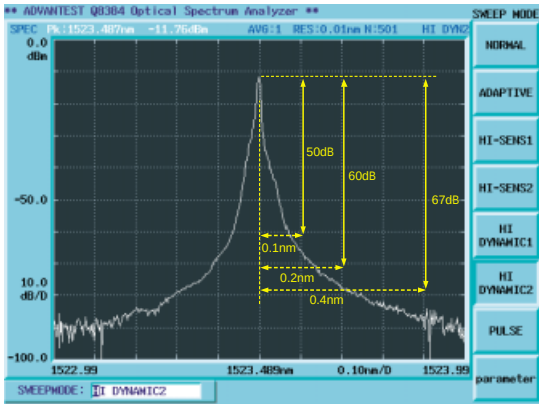


FIG. 4 Dynamic range

+23 dBm (200 mW) high-power direct input

The Q8384 can directly measure high-power signals from fiber amplifiers or pumped laser diodes without attenuation.

Abundance of analysis features

Frequency sweep function

The Q8384 allows the display of optical frequencies on the horizontal axis; This is ideal for measuring the standardized wavelength grid frequencies specified by the ITU-T (ITU Telecommunication Standardization Sector).

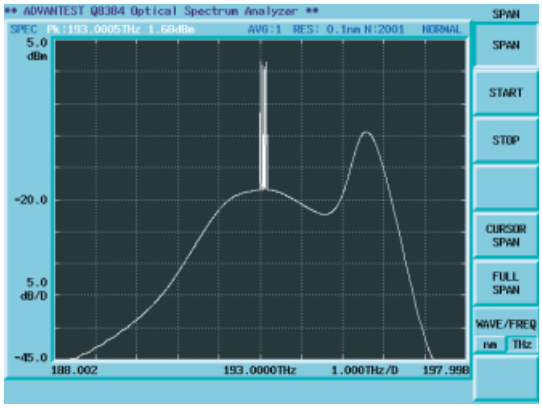


FIG. 5 Optical Fiber Amplifier Measurement using Frequency Sweep Function

Measuring the noise figure of an optical fiber amplifier

The Q8384 makes one button measurements of the noise figure with high accuracy possible through performance enhancements in dynamic range, polarization dependency, level accuracy, linearity, wavelength resolution setting accuracy, etc. and applying curve fitting and other functions. Since the Q8384 can accurately determine the ASE level of DWDM signals that are multiplexed at intervals of 50 GHz (0.4 nm) or narrower, it provides not only the capability to perform accurate noise figure measurements but also the capability to show a listing of multiple measurement results at the same time.

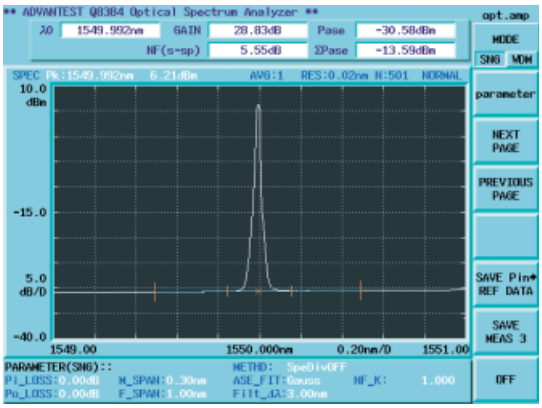


FIG. 6 Diagram of NF measurement using the interpolation method

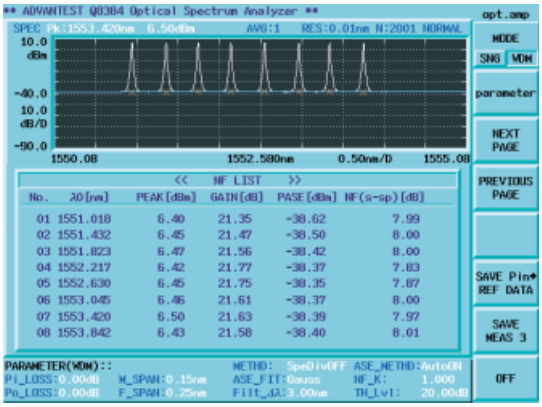


FIG. 7 Measurement Example, DWDM (50 GHz) Noise Figure
The measured waveform and a list of the obtained measurements are displayed at the same time.

WDM Analysis function

The Q8384 can display a maximum of 256 peak wavelengths and power levels of WDM signals. It can show wavelength and power level as deviations from the ITU-T channel spacing or from a reference signal as well as in absolute values.

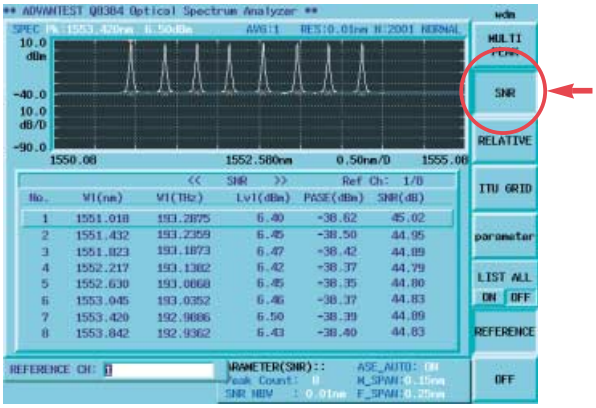


FIG. 8 SNR display
Wavelength-specific S/N ratio measurements are displayed.

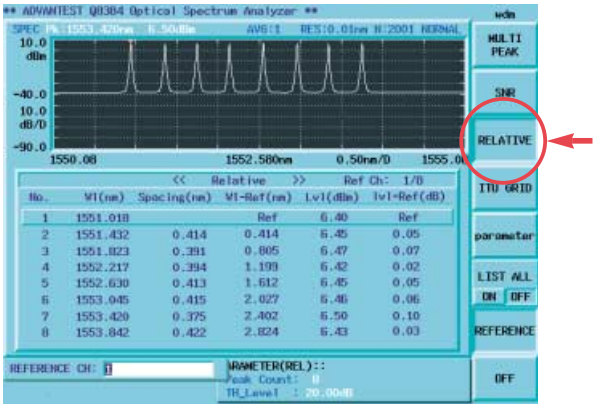


FIG. 9 Relative display
Differences from channel spacing and a reference signal are displayed.

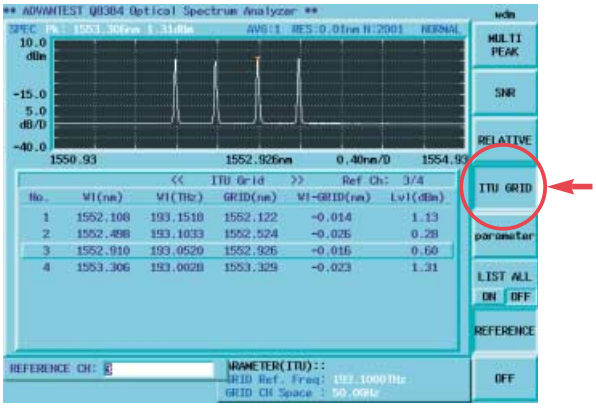


FIG. 10 ITU-T grid display
The nearest ITU-T channel and its difference are displayed

Alternate sweep function

The Q8384 can show two sets of measurement data with different setup conditions in two windows. These windows are always rewritable using the alternate sweep function of the Q8384. With this function the user can make detailed measurements of signals in a specific wavelength band while monitoring the entire wavelength area of the WDM system.

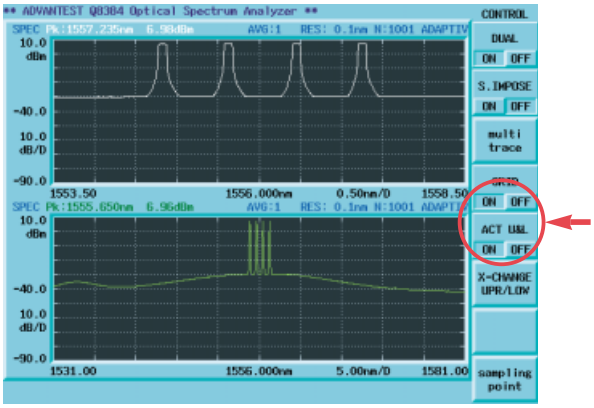


FIG. 11 WDM alternate sweeping
Upper: 5 nm SPAN, Lower: 50 nm SPAN

Pulse measuring function

The Q8384 supports long-distance transmission loop tests using an externally synchronized sweep function. It can measure very weak signals satisfactorily since it has a high sensitivity of approximately -65 dBm. Moreover, a pulse sweeping function makes it possible to measure a peak value of the measured light. Even pulsed light can be measured without missing any portion.

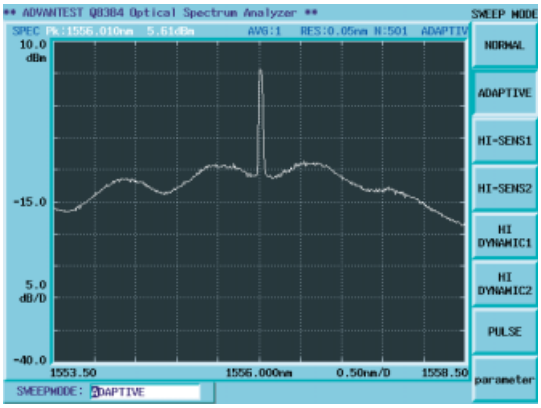


FIG. 12 Sample loop test measurement with the externally synchronized sweep function (5000 km transmission line)

Transmission and loss measurement function

In conventional transmission/loss measurements of an optical filter, it was necessary to measure a reference signal in advance and then carry out the intended measurements on the real signal under the same conditions. Since the Q8384 has a built-in zoom function, the user can make transmission and loss measurements while varying the center wavelength and measurement span freely within the wavelength range of the reference signal once the reference signal is measured in a wide wavelength range. The user does not need to measure the reference signal every time a different sample is used, thus enabling efficient measurement of transmission and loss characteristics. The Q8384 also permits one button measurement of cutoff frequency range of notch filters using a fiber grating filter and the pass band of band pass filters.

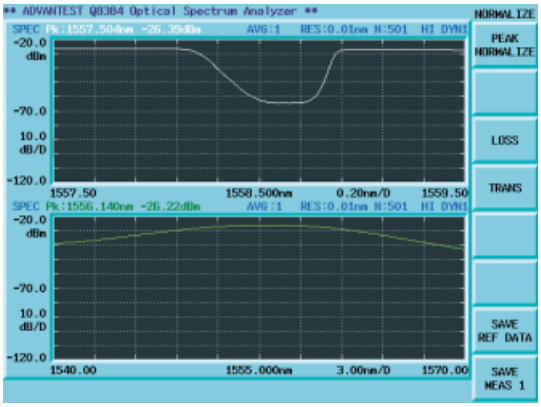


FIG. 13 Upper: measuring signal, 2 nm SPAN. Lower: reference signal, 30 nm SPAN
Although prior measurement systems required that reference and measuring signals be put under the same conditions, the Q8384 enables measurements even if these signals are under different conditions.

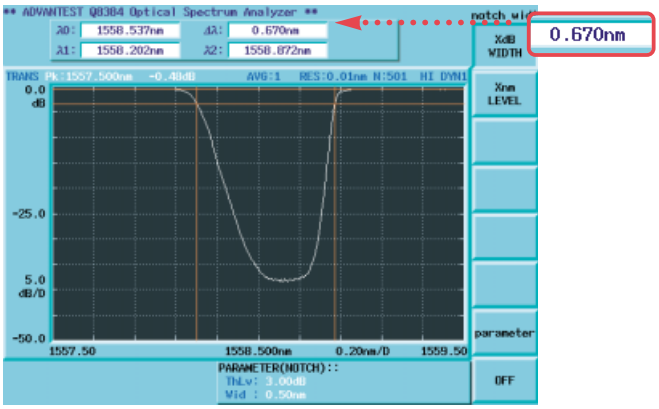


FIG. 14 Notch filter: wavelength width at 3 dB loss

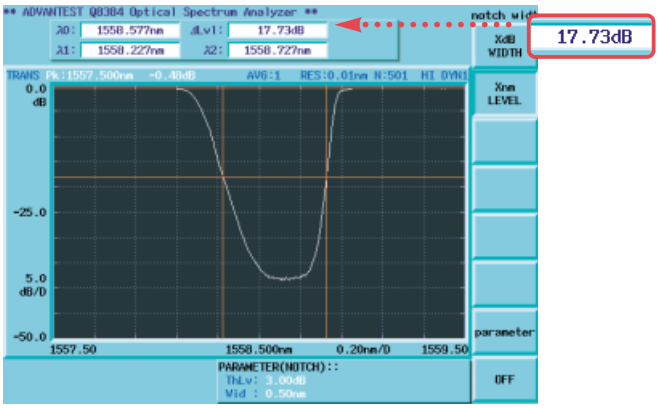


FIG. 15 Notch filter: loss measurement with a wavelength width of 0.5 nm

Multi-trace display function

The Q8384 supports cascaded display of up to 32 traces, which allows the simultaneously display of multi-channel device characteristics such as from AWGs.

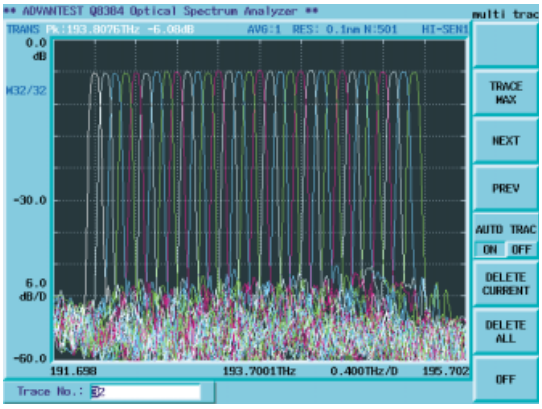


FIG. 16 Multi-trace display
Measurement example of AWG (100 GHz, 32 Ch) provided by NTT Electronics Corporation.

Limit line function

The Q8384 users can define limit lines for the DWDM signal spectrum or loss wavelength characteristics of an optical device to judge whether measurments fall between the upper and lower limits. This function can be used for Pass/Fail analysis on optical device manufacturing lines.

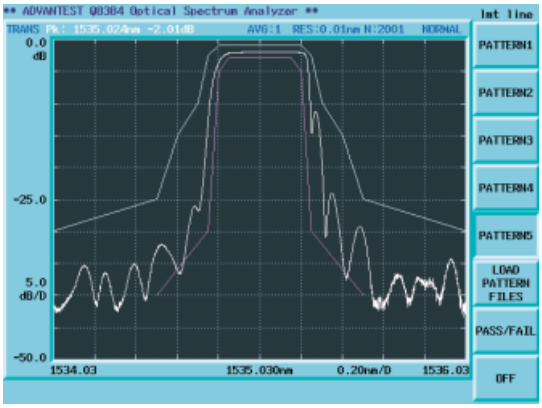


FIG. 17 Limit line function

WDM monitor function

The Q8384 allows monitoring of DWDM systems. It is possible to continuously monitor whether the peak wavelength, the level of each channel and the SNR fluctuation are within their respective tolerances. It is also possible to simultaneously display the current values relative to the initial value, 1st channel value, and reference value as well as displaying the absolute value.

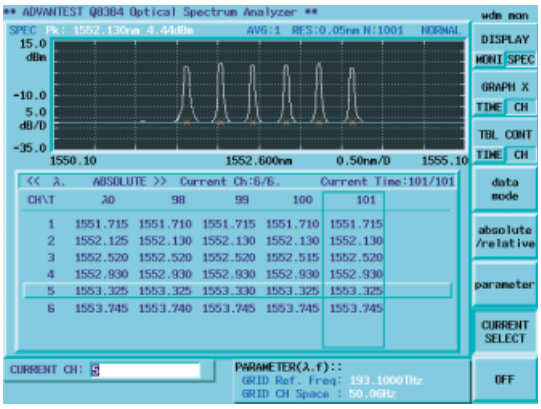


FIG. 18 WDM monitor (wavelength mode)

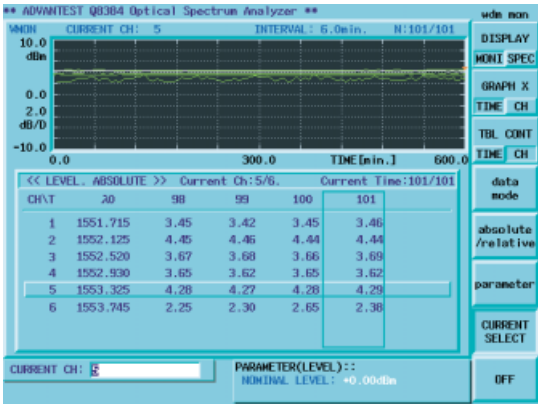


FIG. 19 WDM monitor (level mode)

Display example of level variations in each channel

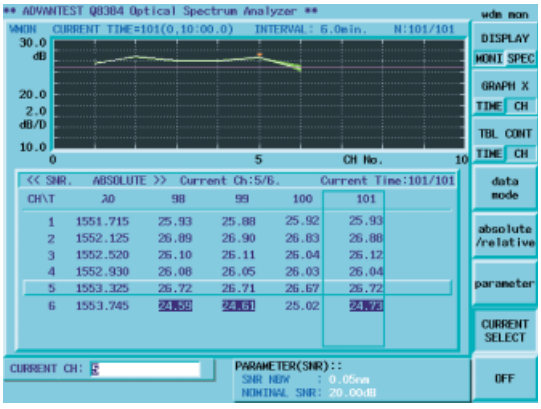


FIG. 20 WDM monitor (SNR mode)

SNR display with channel No. on the horizontal axis (with limit line)

MAX/MIN/CURRENT simultaneous display function

The Q8384 can simultaneously display the waveforms of the maximum value, minimum value, and current value of each measurement in repeated sweep. Display of the fluctuation range enables the user to understand at a glance the changes of the device characteristics against temperature and polarization change.

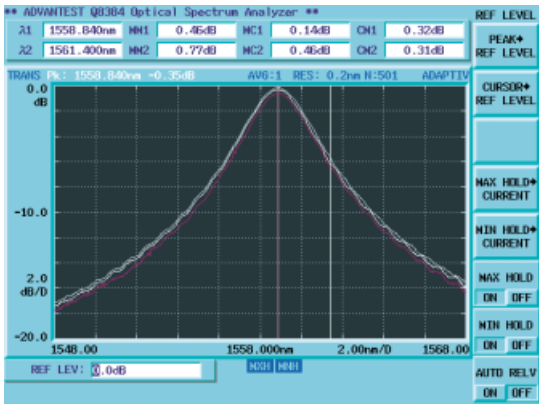


FIG. 21 MAX/MIN/CURRENT simultaneous display

Display example of the characteristics when the temperature of the Band Pass Filter changes.

Data storage capabilities

The Q8384 can store data in two formats with the built-in standard floppy disk drive.

TEXT format (numeric format)

Measurement conditions and data are in ASCII format. The stored data may be restored by the Q8384 or read directly with a personal computer.

BITMAP format

The BITMAP format is used to store a bitmap image of the screen display on a floppy disk with no data manipulation.

Built-in printer

Additionally, the built-in high-speed thermal printer allows the user to make hardcopy images of measured data.

Calibration light source with EE-LED Output (OPTION 25)

Built-in wavelength calibration light source with acetylene cell to guarantee high-precision wavelength accuracy, and the 1550 nm C-band EE-LED (Edge Emitting LED) light source. This LED source can also be used as a low level broadband light source for device measurement.

Option 25

Performance Parameters

Wavelength

Measurement range:	600 to 1700 nm
Accuracy:	≤±500 pm
Accuracy*1:	≤±20 pm (after calibration with built-in light source, option 25, 1530 to 1570 nm) ≤±40 pm (after calibration with built-in light source, option 25, 1570 to 1610 nm) ≤±200 pm (using built-in or ext. single point calibration light source, 600 to 1700nm)
Linearity*1:	≤±10 pm (1530 to 1570 nm) ≤±20 pm (1570 to 1610 nm)
Repeatability*1, *4:	≤±3 pm (1530 to 1610 nm)

Wavelength resolution

Settings:	10 pm, 20 pm, 50 pm,100 pm, 200 pm, 500 pm
Accuracy*1, *6:	≤±3% (Res. 50 pm, 1530 to 1610 nm) ≤±2% (Res. 100 pm or more, 1530 to 1610 nm)

Level

Measurement range*2, *3:	-87 to +23 dBm (1250 to 1610 nm) -77 to +23 dBm (950 to 1250, 1610 to 1700 nm) -55 to +23 dBm (600 to 1000 nm)
Accuracy*1, *3:	≤±0.4 dB (1550 nm)
Linearity*1:	≤±0.05 dB (-50 to -10 dBm, 1550 nm)
Scale:	Logarithmic 0.1, 0.2, 0.5, 1, 2, 5, 10 dB/DIV plus others user selectable, and Linear
Repeatability*1, *3, *4:	≤±0.02 dB (1530 to 1610 nm)
Flatness*1:	≤±0.2 dB (1530 to 1610 nm)
Polarization dependency*1, *3:	≤±0.05 dB (1250 to 1610 nm)
Dynamic range*1, *5:	≥50 dB (±0.1 nm from peak wavelength) ≥60 dB (±0.2 nm from peak wavelength) ≥67 dB (±0.4 nm from peak wavelength, High Dynamic Range Mode)

Sweep

Span:	0.2 nm from full span or zero span
Number of samples:	101, 201, 501, 1001, 2001, 5001, 10001
Measurement time:	≤500 ms (Span 10 nm, Normal Mode, 1550 nm, average 1 time, 501 samples)

Pulse Light Measurement

Peak holding mode:	Waiting time is set every one measurement point (Gate Time 1 ms to 1 S) and the peak level during this waiting time is displayed Minimum optical pulse width 10 nSec (30 µSec or longer recommended) Optical pulse frequency; 1 Hz or more
External synchronization:	The timing can be controlled by a SYNC signal at the external input. SYNC signal input level; TTL (High; 3.5 V, Low; 1.5 V) Pulse width; 10 ns or more
SyncLo Mode:	Minimum light pulse width measurement during SYNC high level is 10 ns (30 µs or longer recommended)
SyncHi Mode:	Sample timing from the rising or falling edge of the SYNC signal is set (0 to 1000 µs)

**1) At 23°C ±5°C*
**2) At 10 to 30°C*
**3) At least 100 pm resolution*
**4) At 1 min. repetition rate*
**5) At 1523 nm wavelength, resolution 10 pm*
**6) Correction by effective bandwidth*

Features

Memory feature	
Internal RAM:	Measurement data; at least 15 screens (501 samples) (battery backup)
Internal floppy DISK:	3.5 inch 2 HD 1.44 M, MS-DOS format
Display:	Wavelength/Frequency display on the horizontal axis, dual upper/lower display, superimpose display, cursor measurements, multi-trace display (up to 32 traces)
Operations/Analysis:	Auto peak search, Auto peak center, Auto reference level, Spectrum width analysis (Threshold, Envelope, RMS, Peak RMS, X nm level), Notch width analysis (X dB width, X nm level), Optical amplifier Noise Figure analysis function (up to 256 wavelengths), WDM signal analysis function (up to 256 wavelengths, level, SNR, ITU-T grid), Normalize with zoom function (LOSS/TRANS), WDM monitor function, limit line function, Peak power monitor function (with trend chart)
Others:	Wave length correction (built-in or external light source), wavelength/level offset correction, Label feature

Optical input

Internal adapting fiber:	9.5/125 µm SM fiber (master grade-A connector recommended)
Reflective attenuation:	≥35 dB
Connector (user replaceable):	FC (Std.), ST, SC (accessories sold separately)

Data Input/Output

GPIB:	IEEE488-1978
Printer:	Internal thermal printer
Printer interface:	D-SUB 25 pin ESC/P, ESC/P-R, PCL
Video output:	VGA (15 pins, female)

LabView and LabWindows driver available on request

Options	OPT8384+25
Light Source for wavelength calibration with EE-LED and acetylene cell output:	Output level*1; ≥-45 dBm/nm (1550 nm)

Environmental Specifications

Operating temperature:	+10 to +40°C, Relative humidity 85% or less (non-condensing)
Storage temperature:	-10 to +50°C, Relative humidity 90% or less (non-condensing)
Power Supply:	AC100-120 V/220-240 V, 50/60 Hz, 200 VA or less
Dimensions:	Approx. 424 (W) x 221 (H) x 500 (D) mm
Mass:	29kg or less

Accessories

FC connector adaptor (standard accessory):	**A08161**
SC connector adaptor:	**A08162**
ST connector adaptor:	**A08163**
Optical fiber cable (SM 9.5/125 µm 2m, with FC-SPC, master grade-A connectors) :	**A01291**

Please be sure to read the product manual thoroughly before using the products.
Specifications may change without notification.

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