ADVANTEST

Q7750
Optscope (Optical Network Analyzer)

Performs chromatic dispersion measurements for ultra-high-speed optical devices and optical devices for Dense WDM with high resolution up to 0.4 pm (50 MHz)

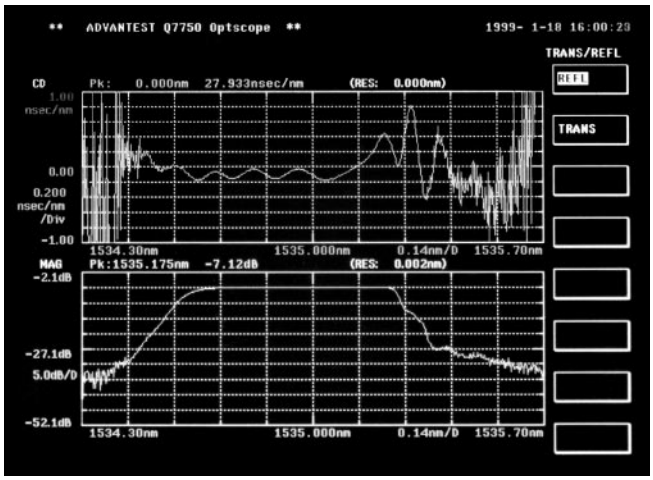
- Comprehensive measurement of optical transfer characteristics in the optical carrier frequency domain
- Maximum optical frequency resolution: 50 MHz (Wavelength of 0.4 pm)
- High-speed measurement: Approx. 6.7 msec. (at each measurement point)
  Approx. 4 second (at each sweep span)
- Measurement wavelength range: 1525 to 1635 nm
- Wide dynamic range: 40 dB
- Extensive group delay-time measurement range: Maximum resolution: 0.1 ps
  Maximum measurement range: 25 ns
- Chromatic dispersion characteristics of optical fiber can be easily measured
- Accurate wavelength measurements (up to ±5 pm)

Q7750

High resolution high speed measurement of optical transmission characteristics in the optical carrier frequency domain

In recent years, progress in the research and development of ultra-high-speed optical transmission and dense wavelength division multiplexing transmission (Dense WDM) has been considerable. To some extent, these technologies are already in commercial use. This requires designers to measure amplitude characteristics, chromatic dispersion, and group delay time of optical devices and optical subsystems with high optical frequency resolution.Examples of devices for which such characteristics must be measured are AWGs, Fiber Bragg Gratings filters, and dispersion compensators. Because chromatic dispersion characteristics in particular are an obstacle when optical transmission bit rate increases, chromatic dispersion values must be decreased or controlled.

The Q7750 Optscope is an optical network analyzer capable of measuring many characteristics of optical devices at high resolution and high speed in the optical carrier frequency domain. It can measure amplitude characteristics, group delay time and phase-of-transmission characteristics, and reflection characteristics of optical devices. This analyzer can also measure the chromatic dispersion characteristics including the zero dispersion wavelength of optical fiber such as dispersion-shift fiber and non-zero dispersion fiber, and the chromatic dispersion slope characteristics. The Q7750 employs the phase-shift method of measurement to achieve both high resolution and wide dynamic range.

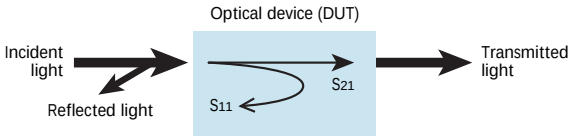


Amplitude characteristics and chromatic dispersion of an FBG optical filter

Features

Comprehensive Measurement of Optical Transfer Characteristics in the Optical Carrier Frequency Domain

The Q7750 incorporates a tunable light source. By sweeping the wavelength (optical frequency), transmission and reflection characteristics (S_{21} and S_{11} in the S parameters) can be measured in the optical carrier-frequency band simultaneously. Table 1 lists the measurement items. The Q7750 can measure all these items in a single sweep.



• **Table 1 Measurement items**

Measurement item	Reflection characteristics (S_{11})	Transmission characteristics (S_{21})
Amplitude	Yes	Yes
Group delay-time	Yes	Yes
Chromatic Dispersion	Yes	Yes

High Optical Frequency Resolution

Maximum optical frequency resolution: 50 MHz (Wavelength of 0.4 pm)

The Q7750 has a maximum optical frequency resolution of 50 MHz, enabling measurement with ultra high resolution in the optical carrier-frequency domain. This capability facilitates measurement of amplitude characteristics and chromatic dispersion of optical devices for Dense WDM, which use channel spacing such as 25, 50, and 100 GHz. The wavelength axis can be set in the range of a minimum of 0.1 nm to a maximum of 70 nm.

High-speed Measurement

Measuring time: Approx. 6.7 msec. (at each measurement point)
Approx. 4 second (at each sweep span)

The time required for a single sweep (measurement) is approximately 4 seconds compared to conventionally instruments which require > 10 minutes. Measurements taking a long time cannot be achieved precisely as environment influences, such as temperature, can cause the DUT characteristics to vary. Since the Q7750 requires only a short measurement time, high-speed and high-precision measurement can be implemented without influences of elements such as DUT temperature characteristics.

Extensive Measurement Wavelength Range

Measurement wavelength range: 1525 to 1635 nm

Because optical-fiber amplifiers have evolved to operate in long wavelength bands optical transmission wavelengths have shifted toward 1635 nm. The Q7750 is capable of measuring characteristics at a maximum wavelength of 1635 nm. This allows designers to evaluate optical devices in the next generation optical transmission wavelength band.

* Developed in cooperation with KDD.

High Precision Wavelength Measurement

Absolute wavelength accuracy: ±0.025 nm (standard)
±2 ppm ±1 pm (with the Q8326)
(Note: OPT7750 + 10 required)

The Q7750's absolute wavelength accuracy is ±0.025 nm. It can be improved to to ±2 ppm ±1 pm using Option 10 and the separately available optical wavelength meter Q8326. The Q8326 is automatically controlled from the Q7750 main unit, requiring no complicated settings or operation.

Wide Dynamic Range

Dynamic range: 40 dB (Typical)

The Q7750 has achieved a dynamic range of 40 dB together with high optical frequency resolution. The Q7750 is capable of measuring optical transmission amplitude characteristics of optical filters and other devices in the same way as optical spectrum analyzers do. In addition, the Q7750 can measure chromatic dispersion characteristics over a wide dynamic range simultaneously with measurement of optical transmission amplitude characteristics.

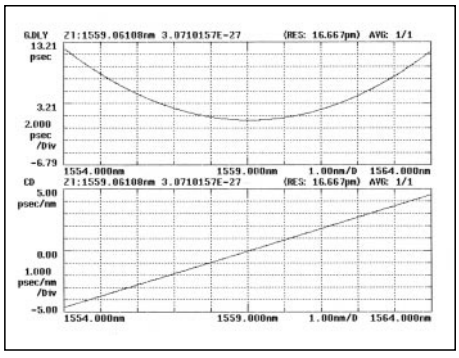
Extensive Group Delay-Time Measurement Range

Group Delay-time measurement range/
Maximum resolution: 0.1 ps
Maximum measurement range: 25 ns

A maximum group delay-time resolution of 0.1 ps and a maximum measurement range of 25 nm can be achieved. The chromatic dispersion can be measured with the same time resolution. The Q7750 can be used to measure the characteristics of a wide range of devices from low to high-dispersion optical devices (such as dispersion-compensation devices).

Enhanced Optical Fiber Chromatic Dispersion Measurement Functions

The Q7750 is equipped with four types of optical fiber fitting systems so that chromatic dispersion characteristics, chromatic dispersion slope characteristics, and zero dispersion wavelength of optical fiber can be measured with ease and accuracy. The Q7750 performs various dispersion measurement applications ranging from a narrow band optical devices to optical fibers such as non zero dispersion (NZDS) shift fiber.



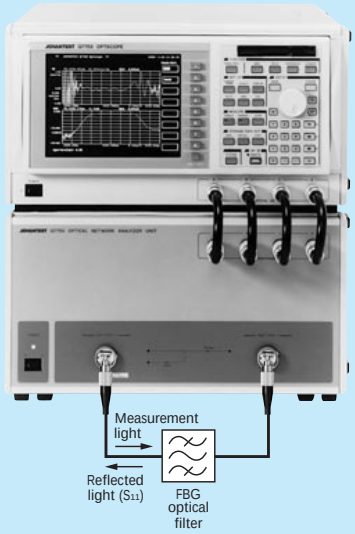
Example measurement of 1.55 nm dispersion shift fiber

Portable with ease

Most conventional dispersion measuring units are system products, inconvenient for portable use. The Q7750, a stand-alone type, can be easily carried. Since setup requires only connecting the electric cables, no complicated calibration is necessary and the Q7750 system can be immediately started.

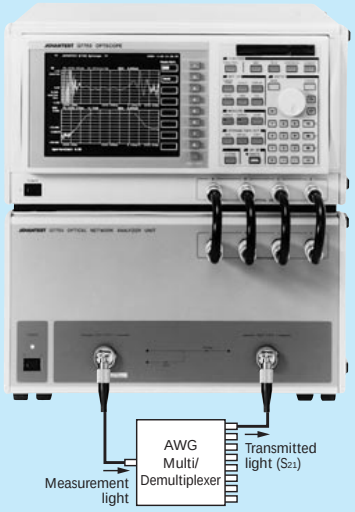
Measurement Samples

Measurement example using an FBG optical filter (for 100 GHz space)



The measurement examples shown to the right is reflected light measured in an FBG optical filter (band-pass characteristics). The Q7750 can measure reflected light (S_{11}) by connecting to a DUT. The examples show that the characteristics of group delay time and chromatic dispersion are measured with high resolution, as well as the optical intensity bandpass characteristics.
In particular, the system clearly analyzes that there are cycles of ripple in the chromatic dispersion characteristics.

Measurement example using an AWG Multi/Demultiplexer



The measurement examples shown to the right is the transmission characteristics (S_{21}) measured in an AWG Multi/Demultiplexer. Mild changes in the group delay time within the transmission band are measured.

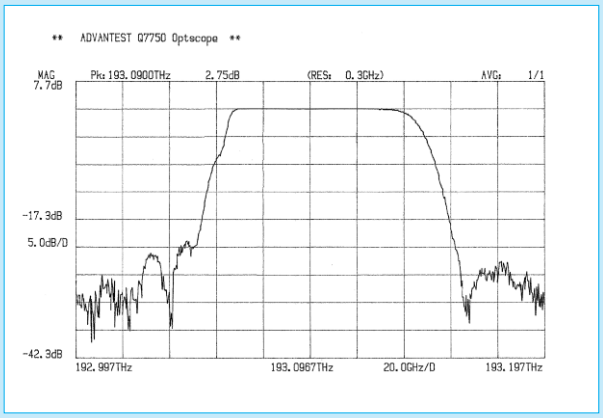


Figure 1.1 Amplitude characteristics (optical intensity bandpass characteristics)

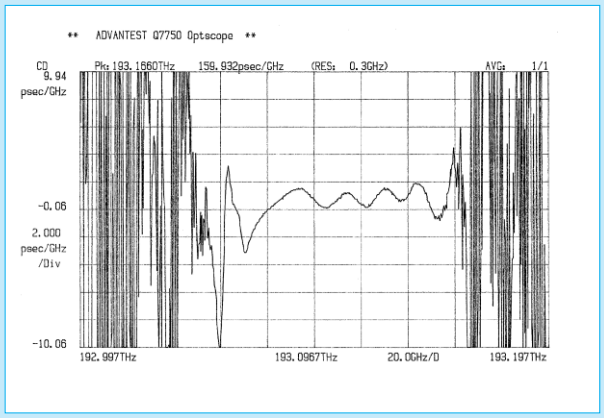


Figure 1.3 Chromatic dispersion characteristics

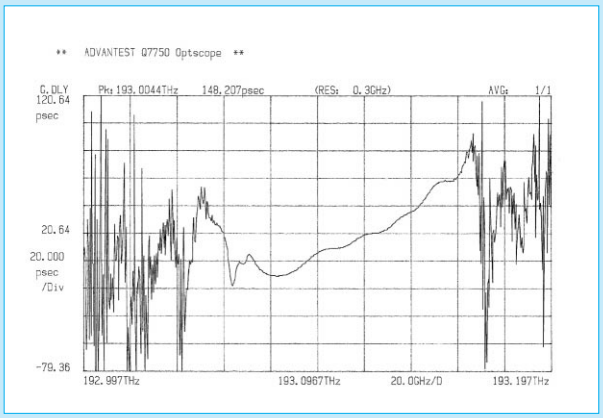


Figure 1.2 Group delay characteristics

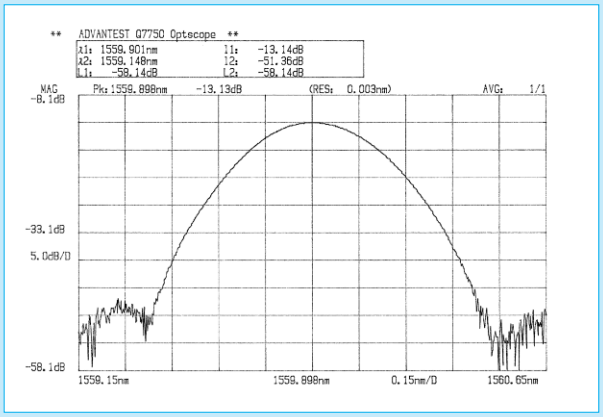


Figure 2.1 Amplitude characteristics (optical intensity bandpass characteristics)

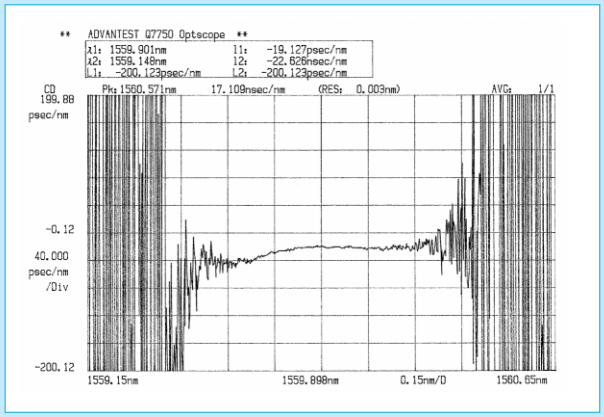


Figure 2.3 Chromatic dispersion characteristics

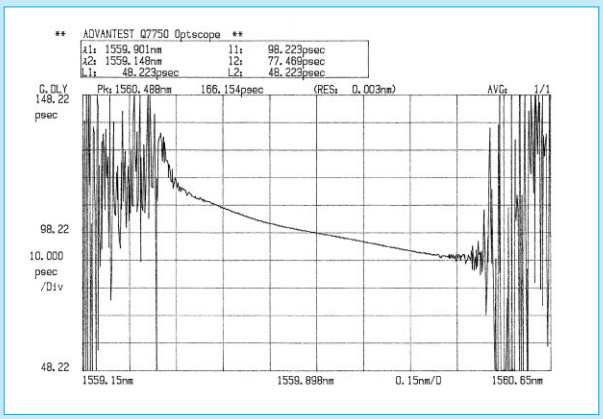


Figure 2.2 Group delay characteristics

Specifications

Measurement Functions

Sweep channels:	2 channels (input-end reflection characteristics, forward transfer characteristics)
Input-end reflection characteristics (S_{11}):	Amplitude Group delay time Chromatic dispersion
Forward transfer characteristics (S_{21}):	Amplitude Group delay time Chromatic dispersion Chromatic dispersion slope characteristics

Optical Signal Source Characteristics*1)

Measurement range:	1525 to 1635 nm
Absolute wavelength accuracy*2):	±0.025 nm (standard) ±2 ppm ±1 pm (when used with OPT7750 + 10 and Q8326)
Wavelength setting resolution:	0.001 nm
Sweep wavelength range:	Settable within 0.1 to 110 nm range (Settable within the optical frequency range of 12.5 GHz to 13.2 THz)
Sweep repeatability*3):	Set span X (±0.3%) ±30 MHz or less
Sweep time (measurement time)*4):	Approx. 4 sec.. (at each sweep span) Approx. 6.7 msec. (at each measurement point)
Optical output power level*5):	-15 dBm or more

Amplitude Characteristics

Scale:	Logarithmic table (0.2, 0.5, 1.0, 2.0, 5.0, 10.0 dB/div) and also linear
Modulation frequency range:	40 MHz to 3 GHz
Dynamic range*6):	Forward transfer characteristics; 35 dB (Typ. 40 dB) Input-end reflection characteristics; 33 dB (Typ. 38 dB)
Linearity*7):	±0.10 dB (Relative level 0 to -25 dB) ±0.25 dB (Relative level -25 to -30 dB)
Polarization dependency:	Forward transfer characteristics (test port 2); ±0.05 dB Input-end reflection characteristics (test port 1); ±0.10 dB
Repeatability at connector insertion*8):	±0.1 dB

Group Delay Time Characteristics

Frequency modulation range (fm):	40 MHz to 3 GHz	
Max. measurement range:	At fm = 40 MHz; 25 ns At fm = 3 GHz; 333 ps	
Group delay time resolution:	0.1 psec	
Relative group delay time accuracy*7):	Relative level (dB)	Accuracy
	0 to -15 dB	±0.2%/fm
	-15 to -20 dB	±0.4%/fm
	-20 to -25 dB	±1.0%/fm

Chromatic Dispersion

Measurement unit:	Wavelength range (ps/nm), optical frequency range (ps/GHz), chromatic dispersion slope (ps/nm^2) Displays in ps/nm-km, ps/GHz-km, ps/nm^2-km, and ps/GHz^2-km are also possible by inputting the length of optical fiber under test
Measurement range:	0.1 psec/nm to 1 µsec/nm
Measurement resolution:	0.01 ps/nm

Fiber Wavelength Dispersion Measurement *9)

Repeatability of dispersion coefficient measurement:	0.025 ps/nm, 0.003 ps/nm/km
Repeatability of zero dispersion wavelength measurement:	0.030 nm
Repeatability of dispersion slope measurement at zero dispersion wavelength:	0.025 ps/nm^2, 0.002ps/nm^2/km
Accuracy of zero dispersion wavelength measurement:	±0.080 nm ±0.035 nm (when OPT7750 + 10 and Q8326 are used in combination) ±0.030 nm (when OPT7750 + 10 and HP86120C are used in combination-Reference value)
Waveform approximation function:	Linear approximation, Quadratic polynomial, Sellmeier's polynomial of degree three, Sellmeier's polynomial of degree five

Fiber Length Measurement

Range of measurements:	0.2 m to 10,000 km
Resolution:	0.02 mm or 0.01 % of measured length, whichever larger
Range of inputs for index of refraction:	1.000000 to 2.000000

Processing Functions

Memory function:	Save measurement date to back-up memory and/or to a floppy disk
Display:	Optical frequency display, overlay, dividing into two parts, cursor function
Computing/analysis:	Averaging, Normalization, Smoothing Waveform fitting functions (linear approximation, quadratic polynomial expression, Sellmeier's three-term polynomial expression, and Sellmeier's five-term polynomial expression)

Optical Input/Output

Optical connector type*10):	FC type connector (Standard) Adapts to SC and ST type by using adapters sold separately

Input/Output Interface

GPIB:	IEEE488-1978
Floppy disk drive:	3.5 inch, MS-DOS format
Printer:	D-SUB 25 pin ESC/P, ESC/P-R, PCL
Keyboard:	Conforms to IBM PC-AT
Display:	15 pin, D-SUB connector (VGA)

General Specification

Operating environment:	Ambient temperature; 15 to 35˚C Relative humidity; 85 % or less (no condensation)
Storage environment:	Ambient temperature; -10 to 45˚C Relative humidity; 90 % or less (no condensation)
Power:	Display unit; AC 100 to 120 V, AC 220 to 240 V, 50/60 Hz, 300 VA or less Optical network analyzer unit; AC 100 to 120 V, AC 220 to 240 V, 50/60 Hz, 310 VA or less
Dimensions:	Display unit; Approx. 424 (W) X 220 (H) X 400 (D) mm Optical network analyzer unit; approx. 424 (W) X 220 (H) 500 (D) mm
Mass:	Display unit; 16 kg or less Optical network analyzer unit; 25 kg or less

Accessories (sold separately)

Optical connector adapters	
FC connector adapter:	A08161
SC connector adapter:	A08162
ST connector adapter:	A08163

Option OPT7750 + 10

Monitor output emission power:	-20 dBm or more
Optical connector type:	FC connector (fixed)

**1) Warm-up time: 2 hrs.*
**2) At initial sweep wavelength and at stable temperature.*
**3) Under a specific temperature.*
**4) Excluding internal setting time when Set span ≤ 60 GHz.*
**5) At average power.*
**6) Difference between amplitude level and noise level (average value) at during direct measurement. At sensitivity = High.*
**7) Relative level with amplitude level at through measurement as standard.*
**8) Value taken by 10 times connector insertion using SMF fiber with FC connector.*
**9) Under a specific temperature.*
When 11 km dispersion shift fiber was measured for 20 times.
With zero dispersion wavelength as the center wavelength, measured wavelength span = 10 nm, stepped sweep measurement = 11 points (1 point/1 nm).
By approximation derived from polynomial of degree two.
Dispersion slope = 0.074 ps/nm^2/km.
No external wavemeter was used, unless otherwise noticed.
**10) Exchangeable by user-side.*

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

ADVANTEST

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