ADVANTEST®

ADVANTEST CORPORATION

Q7750

Optscope

Operation Manual

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Safety Summary

To ensure thorough understanding of all functions and to ensure efficient use of this instrument, please read the manual carefully before using. Note that Advantest bears absolutely no responsibility for the result of operations caused due to incorrect or inappropriate use of this instrument.

If the equipment is used in a manner not specified by Advantest, the protection provided by the equipment may be impaired.

- **Warning Labels**

  Warning labels are applied to Advantest products in locations where specific dangers exist. Pay careful attention to these labels during handling. Do not remove or tear these labels. If you have any questions regarding warning labels, please ask your nearest Advantest dealer. Our address and phone number are listed at the end of this manual.

  Symbols of those warning labels are shown below together with their meaning.

  DANGER: Indicates an imminently hazardous situation which will result in death or serious personal injury.

  WARNING: Indicates a potentially hazardous situation which will result in death or serious personal injury.

  CAUTION: Indicates a potentially hazardous situation which will result in personal injury or a damage to property including the product.

- **Basic Precautions**

  Please observe the following precautions to prevent fire, burn, electric shock, and personal injury.

  - Use a power cable rated for the voltage in question. Be sure however to use a power cable conforming to safety standards of your nation when using a product overseas.
  - When inserting the plug into the electrical outlet, first turn the power switch OFF and then insert the plug as far as it will go.
  - When removing the plug from the electrical outlet, first turn the power switch OFF and then pull it out by gripping the plug. Do not pull on the power cable itself. Make sure your hands are dry at this time.
  - Before turning on the power, be sure to check that the supply voltage matches the voltage requirements of the instrument.
  - Connect the power cable to a power outlet that is connected to a protected ground terminal. Grounding will be defeated if you use an extension cord which does not include a protected ground terminal.
  - Be sure to use fuses rated for the voltage in question.
  - Do not use this instrument with the case open.
  - Do not place anything on the product and do not apply excessive pressure to the product. Also, do not place flower pots or other containers containing liquid such as chemicals near this

product.

- When the product has ventilation outlets, do not stick or drop metal or easily flammable objects into the ventilation outlets.
- When using the product on a cart, fix it with belts to avoid its drop.
- When connecting the product to peripheral equipment, turn the power off.

- **Caution Symbols Used Within this Manual**

Symbols indicating items requiring caution which are used in this manual are shown below together with their meaning.

DANGER: Indicates an item where there is a danger of serious personal injury (death or serious injury).

WARNING: Indicates an item relating to personal safety or health.

CAUTION: Indicates an item relating to possible damage to the product or instrument or relating to a restriction on operation.

- **Safety Marks on the Product**

The following safety marks can be found on Advantest products.

 : ATTENTION - Refer to manual.

 : Protective ground (earth) terminal.

 : DANGER - High voltage.

 : CAUTION - Risk of electric shock.

- **Replacing Parts with Limited Life**

The following parts used in the instrument are main parts with limited life.
Replace the parts listed below before their expected lifespan has expired to maintain the performance and function of the instrument.
Note that the estimated lifespan for the parts listed below may be shortened by factors such as the environment where the instrument is stored or used, and how often the instrument is used.
The parts inside are not user-replaceable. For a part replacement, please contact the Advantest sales office for servicing.

Each product may use parts with limited life.
For more information, refer to the section in this document where the parts with limited life are described.

Main Parts with Limited Life

Part name	Life
Unit power supply	5 years
Fan motor	5 years
Electrolytic capacitor	5 years
LCD display	6 years
LCD backlight	2.5 years
Floppy disk drive	5 years
Memory backup battery	5 years

- **Hard Disk Mounted Products**

The operational warnings are listed below.

- Do not move, shock and vibrate the product while the power is turned on.
  Reading or writing data in the hard disk unit is performed with the memory disk turning at a high speed. It is a very delicate process.

- Store and operate the products under the following environmental conditions.
  An area with no sudden temperature changes.
  An area away from shock or vibrations.
  An area free from moisture, dirt, or dust.
  An area away from magnets or an instrument which generates a magnetic field.

- Make back-ups of important data.
  The data stored in the disk may become damaged if the product is mishandled. The hard disc has a limited life span which depends on the operational conditions. Note that there is no guarantee for any loss of data.

- **Precautions when Disposing of this Instrument**

When disposing of harmful substances, be sure dispose of them properly with abiding by the state-provided law.

Harmful substances: (1) PCB (polycarbon biphenyl)
(2) Mercury
(3) Ni-Cd (nickel cadmium)
(4) Other
Items possessing cyan, organic phosphorous and hexadic chromium and items which may leak cadmium or arsenic (excluding lead in solder).

Example: fluorescent tubes, batteries

Environmental Conditions

This instrument should be only be used in an area which satisfies the following conditions:

- An area free from corrosive gas
- An area away from direct sunlight
- A dust-free area
- An area free from vibrations
- Altitude of up to 2000 m

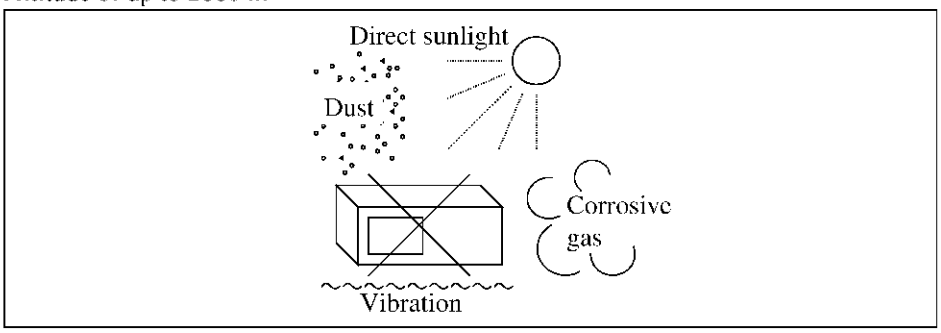


Figure-1 Environmental Conditions

- Operating position

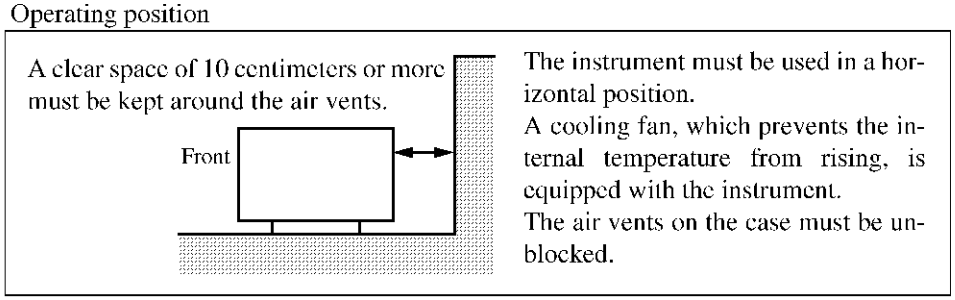


Figure-2 Operating Position

- Storage position

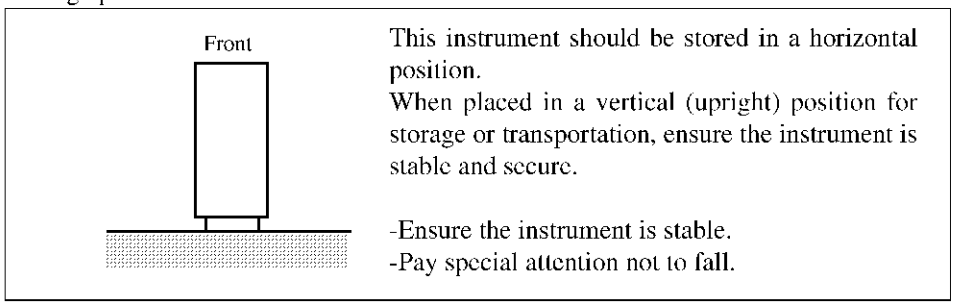


Figure-3 Storage Position

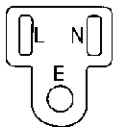
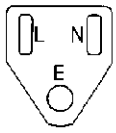
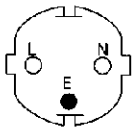
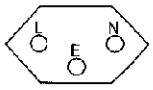
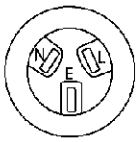
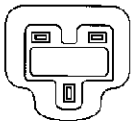
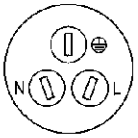
- The classification of the transient over-voltage, which exists typically in the main power supply, and the pollution degree is defined by IEC61010-1 and described below.

  Impulse withstand voltage (over-voltage) category II defined by IEC60364-4-443

  Pollution Degree 2

Types of Power Cable

Replace any references to the power cable type, according to the following table, with the appropriate power cable type for your country.

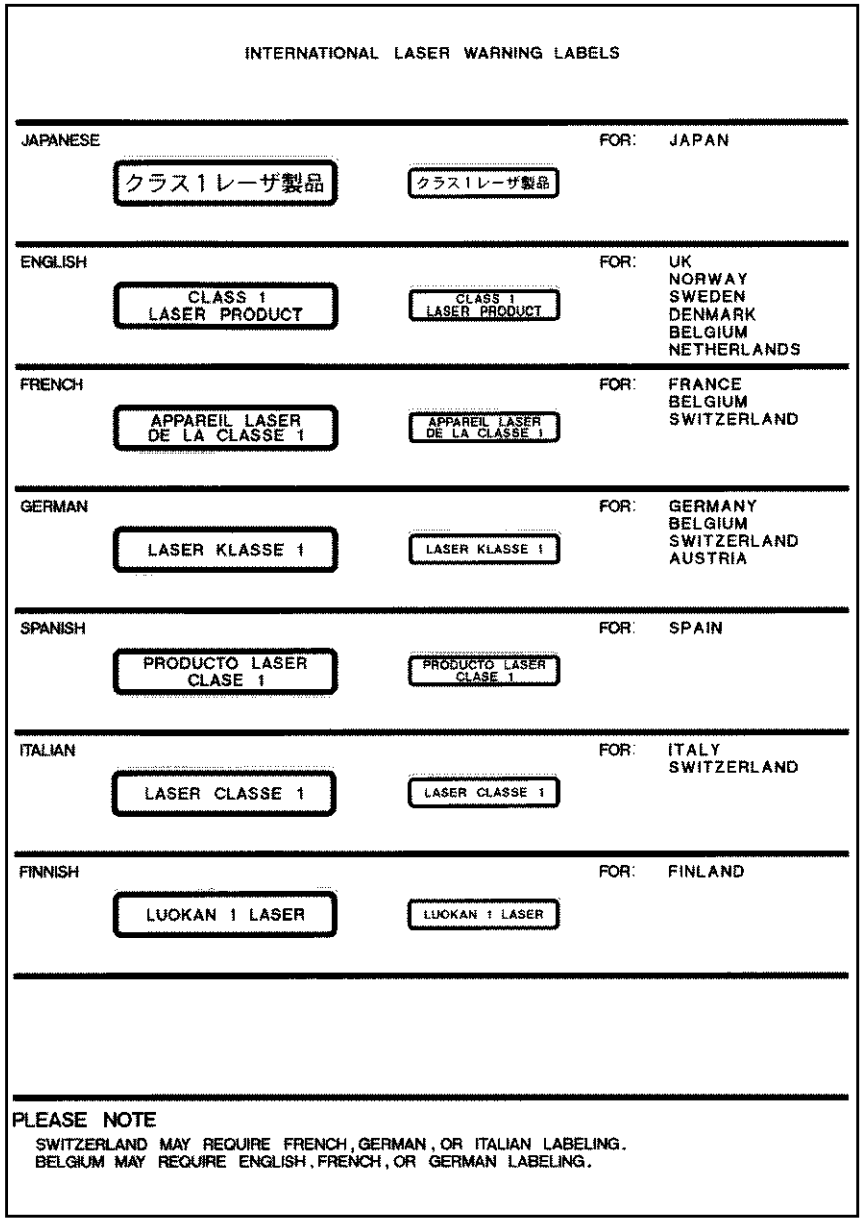
Plug configuration	Standards	Rating, color and length	Model number (Option number)
	PSE: Japan Electrical Appliance and Material Safety Law	125 V at 7 A Black 2 m (6 ft)	Straight: A01402 Angled: A01412
	UL: United States of America CSA: Canada	125 V at 7 A Black 2 m (6 ft)	Straight: A01403 (Option 95) Angled: A01413
	CEE: Europe DEMKO: Denmark NEMKO: Norway VDE: Germany KEMA: The Netherlands CEBEC: Belgium OVE: Austria FIMKO: Finland SEMKO: Sweden	250 V at 6 A Gray 2 m (6 ft)	Straight: A01404 (Option 96) Angled: A01414
	SEV: Switzerland	250 V at 6 A Gray 2 m (6 ft)	Straight: A01405 (Option 97) Angled: A01415
	SAA: Australia, New Zealand	250 V at 6 A Gray 2 m (6 ft)	Straight: A01406 (Option 98) Angled: ---------
	BS: United Kingdom	250 V at 6 A Black 2 m (6 ft)	Straight: A01407 (Option 99) Angled: A01417
	CCC:China	250 V at 10 A Black 2 m (6 ft)	Straight: A114009 (Option 94) Angled: A114109

CAUTIONS

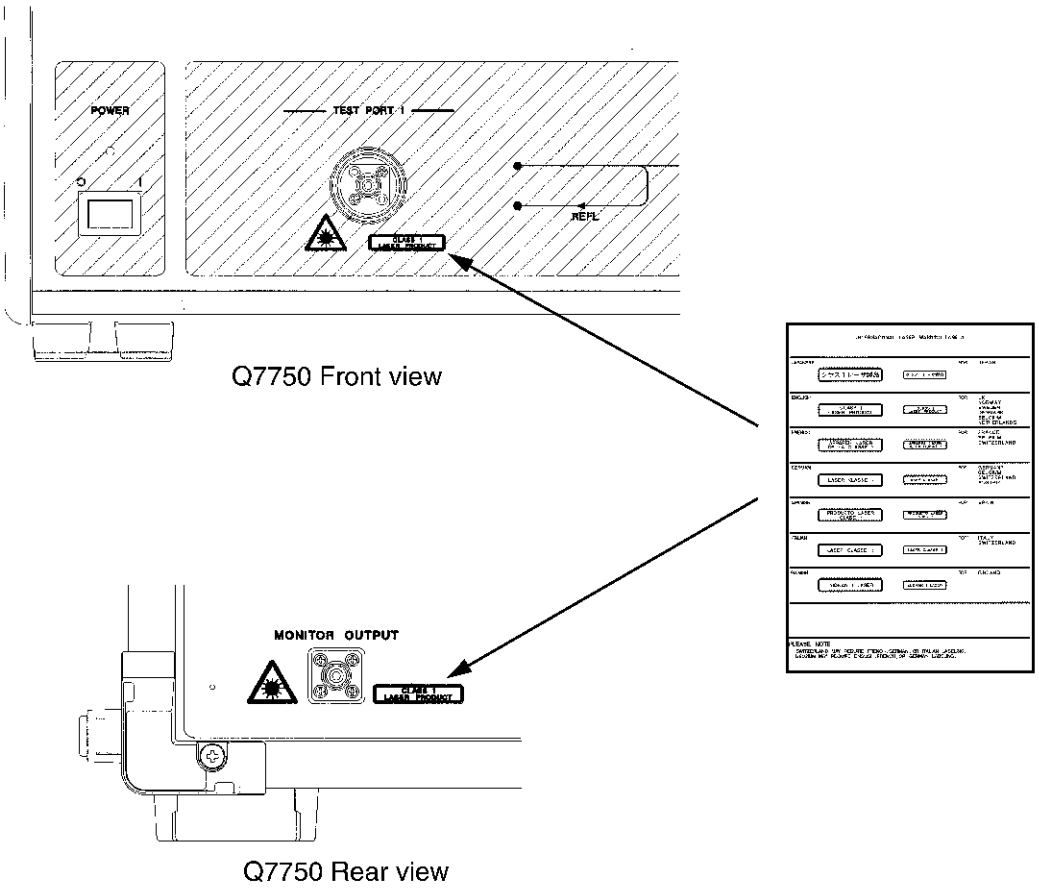
1. OptscopeCLASS 1 LASER PRODUCT LABEL

The Q7750 is a class 1 laser product.

A sheet of warning labels shown below comes with the instrument as a standard accessory.



Attach two seals of your language in the figures shown below.



Q7750 Front view

Q7750 Rear view

2. LASER SPECIFICATIONS

Wavelength	1.55μm
Output Level	-5dBm

3. AUTOMATIC COMPENSATION

This analyzer system automatically compensates for the errors caused by its internal circuitry.
The changing set values and sweeping cannot be performed during the compensating operation. Normal operation is possible after compensation is completed.
The automatic compensation operation is performed under the following conditions:

(1) Approximately two hours after turning the power on.
Operating time: Approximately 5 minutes (during the operation, a buzzer sounds)

(2) Every two hours thereafter.
Operating time: Approximately twenty seconds

Certificate of Conformity

CE

This is to certify, that

Optscope

Q7750

instrument, type, designation

complies with the provisions of the EMC Directive 89/336/EEC in accordance with EN50081-1 and EN50082-1 and Low Voltage Directive 73/23/EEC in accordance with EN61010.

ADVANTEST Corp.

Tokyo, Japan

ROHDE&SCHWARZ

Engineering and Sales GmbH
Munich, Germany

7750.00

PREFACE

This manual provides the information necessary to check functionality, operate and program the Q7750 Optscope Operation. Be sure to read this manual carefully in order to use the Optscope safely.

- Organization of this manual
  This manual consists of the following chapters:

1. Introduction • Product Description • Standard Accessories and Power Cable Options • Operating Environment • Operation Check • Cleaning, Storing and Transporting	Includes a description of the Optscope and its' parts along with information on its' operating environment and how to perform a system checkout.
2. Operation • Controls and Connectors on the Front and Rear Panels • Screen Annotation • Basic Operation • Measurement Examples	Describes the names and the functions of each part on the panels. You can learn the basic operation of the Optscope through the examples shown in this chapter.
3. Measurement Examples	Describes the basic measurement examples.
4. Reference • Menu Index • Menu Map • Functional Description	Shows a list of operation keys, and describes the function of each key.
5. Remote Control • GPIB	Gives an outline of the GPIB interface, and how to connect and set them up. Also included are a list of commands necessary for programming and using the program examples.
6. Principle of measurement	Describes the principle of operation necessary for taking measurements more accurately.
7. Specifications	Shows the specifications of the Optscope.
APPENDIX 1. Troubleshooting	Refer to this section when you have any problems.
APPENDIX 2. Error Code List	If an error occurs during operation, an error number and its corresponding error message are displayed. The meaning of each error is explained in this section.
APPENDIX 3. Glossary	Terminology related to the Optscope is explained in this section.

- Key notations in this manual
  Typeface conventions used in this manual.

Panel keys: In bold type	Example: **MAG**, **SYSTEM**
Soft keys: In bold and italic type	Example: ***CENTER***, ***PRESET***

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LIST OF ILLUSTRATIONS

LIST OF TABLES

1 INTRODUCTION

This chapter provides the following information:

- Product description
- A list of standard accessories and power cable options
- Operating environment
- Setup
- Precautions for use
- How to verify that the Optscope is functioning properly
- How to clean, store, and transport the Optscope

1.1 Product Description

The Q7750 OPTSCOPE is an analyzer used to analyze the amplitude, group delay time, dispersion characteristics and dispersion slope characteristics of transmitted and reflected light from optical devices at high speed and with high resolution by adopting the phase shift method for chromatic dispersion measurement.

The features of the Q7750 are as follows.

(1) Measurable wavelength range: 1525 nm to 1635 nm

(2) Absolute wavelength accuracy: ±0.050 nm

(3) Modulation frequency range: 40 MHz to 3 GHz

(4) Measured items: Amplitude, group delay time, dispersion characteristics and dispersion slope characteristics of transmitted and reflected light.

(5) Dynamic range: 40 dB (Typical)

(6) Save and recall functions which you can use to store measurement conditions and data in TEXT format.

(7) A 3.5-inch floppy disk drive equipped as standard.

(8) Support for ESC/P, ESC/P-R and PCL compatible printers.

(9) Remote control capabilities which allow you to setup an automatic measurement system. This remote control function complies with GPIB specifications.

1.2 Standard Accessories and Optional Accessories

1.2.1 Standard Accessories

Table 1-1 lists the standard accessories shipped with the Optscope. If any of the accessories are damaged or missing or, to order additional accessories, contact the nearest ADVANTEST Field Office or representative.

Table 1-1 Standard Accessories List

Name	Model name	Quantity	Remarks
Power cable	A01412	2	*1
N cable	DCB-FF0388X06	4	
I/O cable	DCB-RR9980X01	1	
GPIB cable	DCB-SS1076X01	1	
Operation manual	EQ7750	1	
Class 1 laser Product label	MNS-E1068A	2	
Joint set	MAE-J7488A	1	
Fuse	DFT-AA6R3A	2	
Fuse	DFT-AA3R15A	2	

* 1: The cable supplied with the Optscope depends on what type (specified by model number above) was ordered when the Optscope was purchased.
There are 11 types of power cable available (see Table 1-4).
To order another power cable, contact an ADVANTEST Field Office or representative. When ordering, refer to power cables by their option number or model number.

1.2.2 Option

Table 1-2 Option

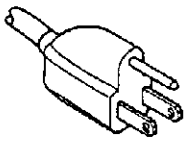
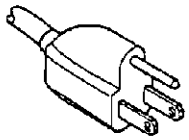
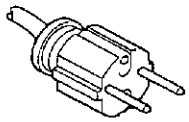
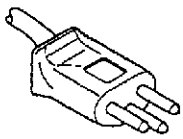
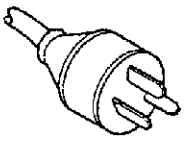
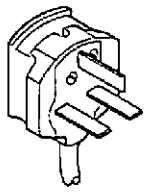
Name	Model Name	Remarks
Optical output	Option 10	For monitoring wavelength

1.2.3 Accessories

Table 1-3 Accessories

Name	Model Name	Remarks
SC connector	A08162	For the test port
ST connector	A08163	For the test port

Table 1-4 Power Cable Options

Plug configuration	Standards	Rating, color and length	Model number (Option number)
	JIS: Japan Law on Electrical Appliances	125 V at 7 A Black 2 m (6 ft)	Straight: A01402 Angled: A01412
	UL: United States of America CSA: Canada	125 V at 7 A Black 2 m (6 ft)	Straight: A01403 (Option 95) Angled: A01413
	CEE: Europe DEMKO: Denmark NEMKO: Norway VDE: Germany KEMA: The Netherlands CEBEC: Belgium OVE: Austria FIMKO: Finland SEMKO: Sweden	250 V at 6 A Gray 2 m (6 ft)	Straight: A01404 (Option 96) Angled: A01414
	SEV: Switzerland	250 V at 6 A Gray 2 m (6 ft)	Straight: A01405 (Option 97) Angled: A01415
	SAA: Australia, New Zealand	250 V at 6 A Gray 2 m (6 ft)	Straight: A01406 (Option 98) Angled: ---------
	BS: United Kingdom	250 V at 6 A Black 2 m (6 ft)	Straight: A01407 (Option 99) Angled: A01417

1.3 Operating Environment

This section describes the environmental conditions and power requirements necessary to use the Optscope.

1.3.1 Environmental Conditions

The Q7750 should be only be used in an area which satisfies the following conditions:

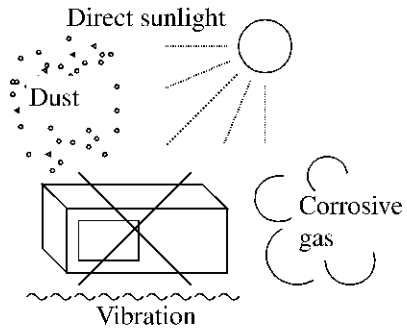
- Ambient temperature: +15°C to +35°C (operating temperature)
- Relative humidity: 85% or less (without condensation)
- An area free from corrosive gas
- An area away from direct sunlight
- A dust-free area
- An area free from vibrations
- A low noise area
  Although the Q7750 has been designed to withstand a certain amount of noise riding on the AC power line, it should be used in an area of low noise. Use a noise cut filter when ambient noise is unavoidable.
- An area allowing unobstructed air flow

CAUTION: This analyzer should be used in a horizontal state.

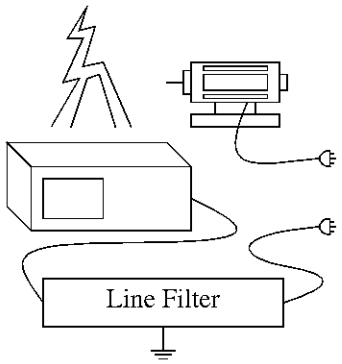
An exhaust fan is installed on the rear panel. Additional vents are provided on both sides.

Never block these areas as the resulting internal temperature rise will affect measurement accuracy.

- Avoid operation in the following areas.



- Use a noise cut filter when there is a large amount of noise riding on the power line.



- Keep the rear panel 10cm away from the wall

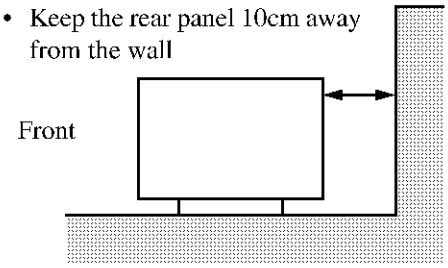


Figure 1-1 Operating Environment

The analyzer can be used safely under the following conditions:

- Altitude of up to 2000 m
- Installation Categories II
- Pollution Degree 2

1.3.2 Power Requirements

The power supply specifications of the Optscope are listed in Table 1-5.

Table 1-5 Power Supply Specifications

		In operation under 100 VAC	In operation under 200 VAC
Display unit			
	Input voltage	90V to 132V	198V to 250V
	Frequency	50Hz/60Hz	
	Power consumption	300VA or less.	
Optical network analyzer unit			
	Input voltage	90V to 132V	198V to 250V
	Frequency	50Hz/60Hz	
	Power consumption	310VA or less.	

CAUTION ***To prevent damage, operate the Optscope within the specified input voltage and frequency ranges.***

During operation, the power supply automatically switches between input voltage levels of 100VAC and 200VAC. Be sure, however, to use a power cable that matches the input voltage and meets the related standard (see Table 1-4).

1.3.3 Power Fuse

CAUTION ***When a fuse blows, there may be some problem with the analyzer so contact a qualified ADVANTEST service representative before replacing the fuse.***

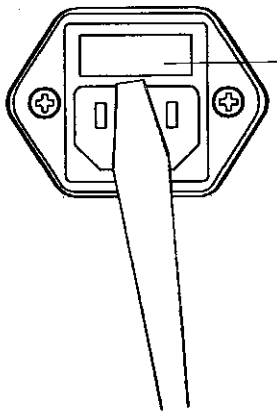
The power fuse is placed in the fuse holder which is mounted on the rear panel.
To check or replace the power fuse, use the following procedure:

1. Press the **POWER** switch to the OFF position.
2. Disconnect the power cable from the AC power supply.
3. Remove the fuse holder on the rear panel.
4. Check (and replace if necessary) the power fuse and put it back in the fuse holder.

Table 1-6 Fuse

Unit	Part code	Rated current
Display unit	DFT-AA6R3A	T6.3A
Optical network analyzer unit	DFT-AA3R15A	T3.15A

Pull out the fuse holder using a slotted head screwdriver.



Check (and replace if necessary) the power fuse and put it back into the fuse holder.

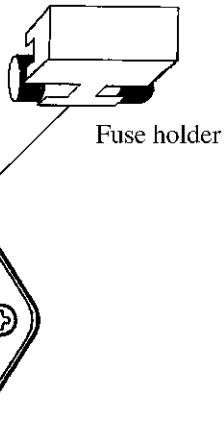


Figure 1-2 Replacing the Power Fuse

1.3.4 Power Cable

A detachable power cable with a three-contact plug is included with the Optscope. The protective earth ground contact on the plug connects (through the power cable) to the accessible metal parts of the instrument. For protection against electrical shock, insert the plug into a power-source outlet that has a properly grounded, protective-ground contact.

The manufacturer ships a power cable, as ordered, with the Optscope. A list of other available power cables is shown in Table 1-4. Contact your ADVANTEST representative or the local ADVANTEST Field Office for information on how to order these.

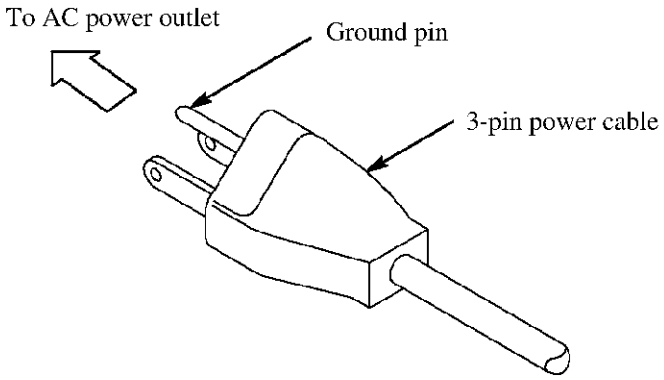


Figure 1-3 Power Cable

1.4 Precautions in Use

(1) Before starting measurement

When turning power on, do not connect the DUT.

(2) Opening the case

Only ADVANTEST authorized service personnel can open the case.
This analyzer contains high-temperature and high-voltage components.

(3) If an abnormality occurs

If the analyzer issues smoke, a bad odor, or an unusual sound, turn off the power switch. Pull out the power cable from the outlet and contact ADVANTEST.

(4) Warming up

After the analyzer is at room temperature, turn the power on and allow it to warm up for approximately 2 hours.

(5) Calibration

This analyzer system requires yearly calibration. Calibration work should be done at an ADVANTEST CORPORATION site. Please contact ADVANTEST CORPORATION concerning the calibration.

(6) Electromagnetic interference

High-frequency noise is generated when using this analyzer.
Electromagnetic interference may adversely affect the television or the radio due to improper installation and use of this analyzer.
If turning off the power of this analyzer reduces electromagnetic inference, then this analyzer is its cause.
Prevent electromagnetic interference as follows:

- Change the direction of the television or radio antenna to stop the electromagnetic interference.
- Place this analyzer on the other side of the television or the radio.
- Place this analyzer away from the television or radio.
- Use a different outlet for the television or radio.

(7) Part life spans

The following part life spans are used in this analyzer.

Soft key switch	Half million times operable
LCD back-light	Seven thousand hours operable

1.5 Setup

This section explains how to set up the Q7750.

This analyzer consists of an optical network analyzer unit and a display unit. It is recommended that you set up the analyzer system according to the following procedure.

CAUTION: ***The setup should be done on a horizontal work-bench without connection to an electrical power.***

---

1. First, stack the two units.
   Lay the display unit on top of the optical network analyzer unit.
   At this time, be sure to fit the foot projection at the front of the base of the display unit into the slot at the front of the top of the optical network analyzer unit.

CAUTION: ***Be careful not to connect any cables from the connectors on this unit to other units during the following setup procedure. Otherwise, the analyzer and/or other connected units may be damaged.***

---

2. The two units are connected.
   Connect the display unit to the optical network analyzer using the attached joint set.

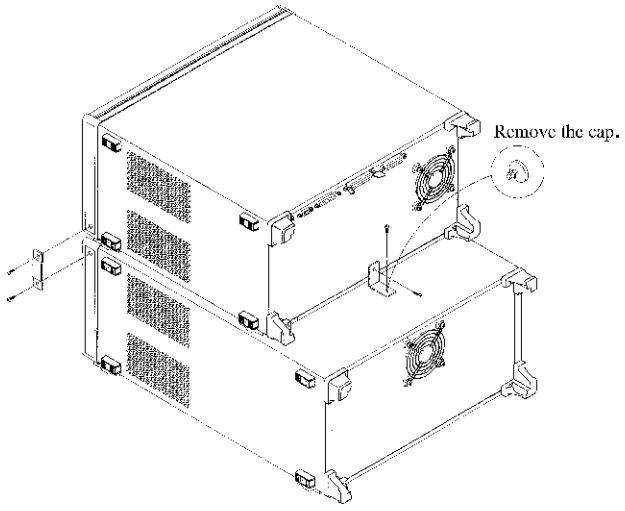


Figure 1-4 Connecting Units

CAUTION: ***When transporting this analyzer system, disconnect the units, then transport the display unit and the optical network analyzer unit separately.***

---

3. Connect signal ports.
   Connect the N cables from the A, B, C and D connectors (on the front panel) on the display unit signal port to the corresponding connectors (on the front panel) on the optical network analyzer.

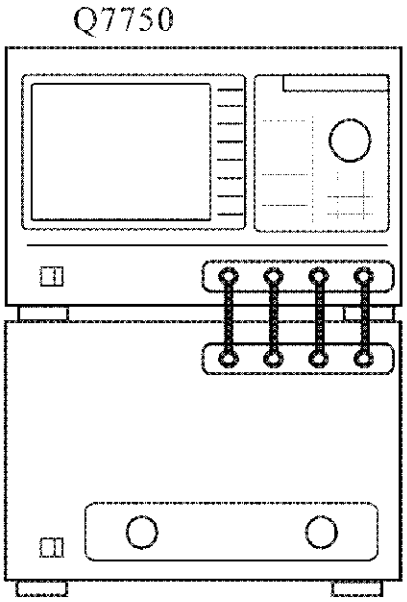


Figure 1-5 Front Panel Connections

4. Connect I/O connectors.
   Connect the I/O cable from the A port on the rear panel of one unit to the A port on the rear panel of another unit.

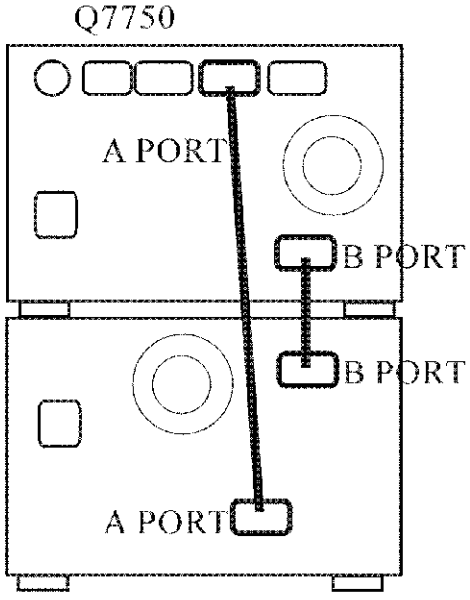


Figure 1-6 Rear Panel Connections

5. Connect B port connectors
   Connect the GPIB cable from the B port on the rear panel of one unit to the B port on the rear panel of another unit.

6. Connect power cords
   Connect the power cords to the AC connectors on the rear panels of the two units.

1.6 System Checkout

This section describes the Self Test which must be performed when operating the Optscope for the first time. Follow the procedure below:

1. Referring to the 1.5 Setup, connect the display unit to the optical network analyzer unit.

2. Make sure that the **POWER** switch (on the front panel) on each unit is in the OFF position.

3. Connect the power cable provided to the AC power supply connector (on the rear panel) on each unit.

CAUTION: ***To prevent damage, operate the Optscope within specified input voltage and frequency ranges.***

---

4. Connect the power cable to the outlet on each unit.

5. On the Optical Network Analyzer unit (which is underneath of the Display unit), press the **POWER** switch to the ON position.

6. On the Display unit (which is mounted on top of the Optical Network Analyzer unit), press the **POWER** switch to the ON position.
   The Optscope performs the Initial test for approximately one minute, then displays the startup screen as shown in Figure 1-7.

NOTE: ***There is a possibility that the screen display is different from the one shown in Figure 1-7, depending on previously saved conditions.***

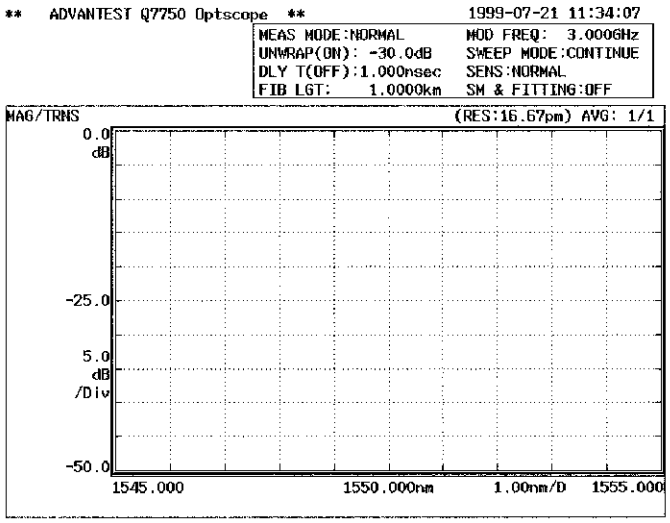


Figure 1-7 Startup Screen

1.7 Cleaning, Storing and Transporting the Q7750 Optscope

1.7.1 Cleaning and Replacement of Optical Connectors and Adapters

(1) Replacing optical connector-adapter

Although the Q7750 is equipped with FC-type connector-adapter as standard, SC-type and ST-type optical connector-adapters are also available. To replace it with other part, unscrew the adapter cap and take the connector adapter away as shown in Figure 1-8.

(2) Cleaning optical connector tip

Clean the optical connector tip using alcohol in the same manner as for the connector-adapter.

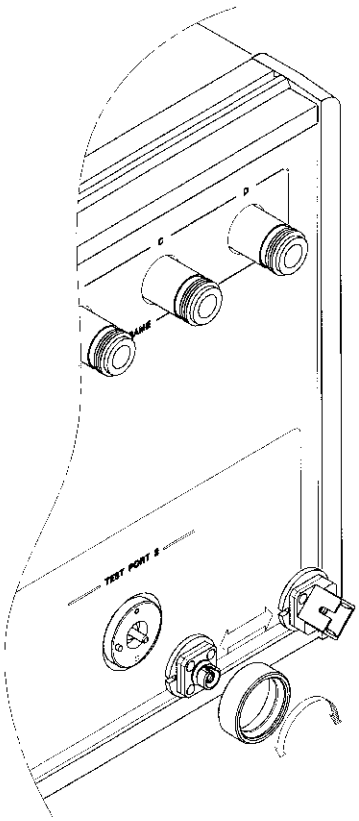


Figure 1-8 Replacing/Cleaning Optical Connector-adapters for the Q7750

CAUTION: ***Be sure to tighten the adapter cap after replacing or cleaning the optical connector-adapter.***

1.7.2 Cleaning

Remove dust from the outside of the Optscope by wiping or brushing the surface with a soft cloth or small brush. Use a brush to remove dust from around the panel keys. Hardened dirt can be removed by using a cloth which has been dampened in water containing a mild detergent.

CAUTION:

1. ***Do not allow water to get inside the Optscope.***
2. ***Do not use organic cleaning solvents, such as benzene, toluene, xylene, acetone or similar compounds, since these solvents may damage the plastic parts.***
3. ***Do not use abrasive cleaners.***

1.7.3 Storing

Store the Optscope in an area which has a temperature from -10°C to +45°C. If you plan to store the Optscope for a long period (more than 90 days), put the Optscope in a vapor-barrier bag with a drying agent and store the Optscope in a dust-free location out of direct sunlight.

1.7.4 Transporting

When you ship the Optscope, use the original container and packing material. If the original packaging is not available, pack the Optscope using the following guidelines:

- To allow for cushioning, use a corrugated cardboard container with inner dimensions that are at least 15 centimeters more than those of the Optscope.
- Surround the Optscope with plastic sheeting to protect the finish.
- Cushion the Optscope on all sides with packing material or plastic foam.
- Seal the container with shipping tape or a heavy-duty, industrial stapler.

If you are shipping the Optscope to a service center for service or repair, attach a tag to the Optscope that shows the following information:

- Owner and address
- Name of a contact person at your location
- Serial number of the Optscope (located on the rear panel)
- Description of the service requested

2 OPERATION

This chapter describes the following items.

- Front and rear panels
- Display annotation
- Basic operation
- Measurement examples
- Enhanced functions

2.1 Description of Panels

This section gives an explanation of the names of the parts and the functions of the front and rear panels and the display annotation.

2.1.1 Front Panel (Display Unit)

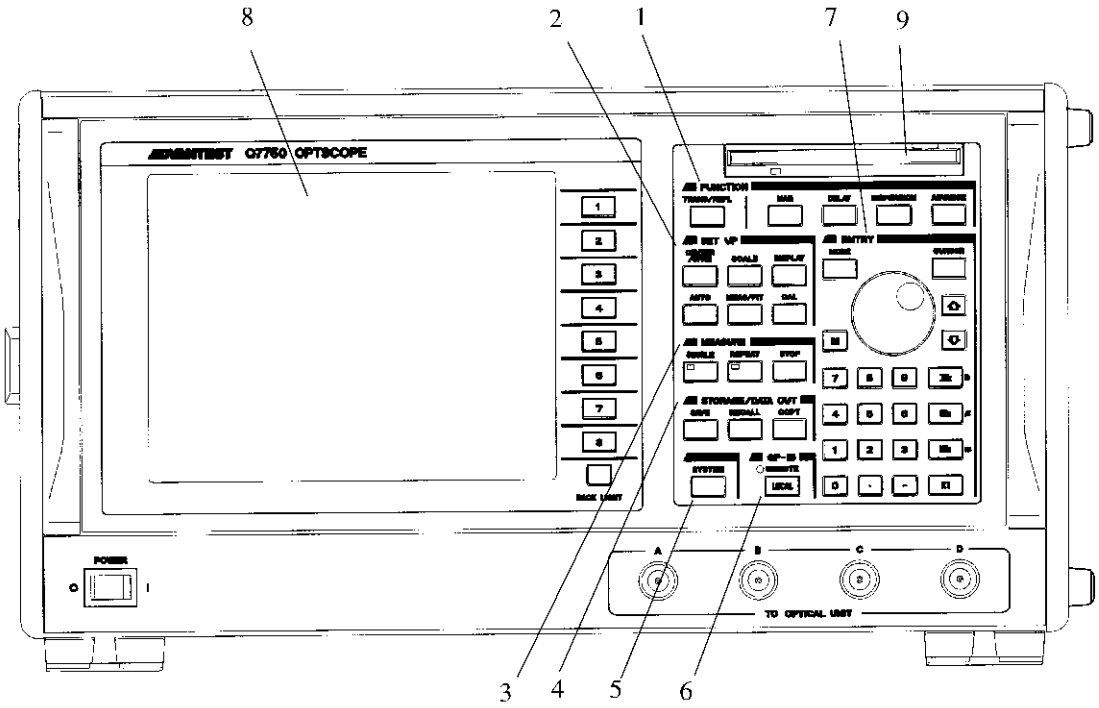


Figure 2-1 Description of the Front Panel

1. FUNCTION section
2. SET UP section
3. MEASURE section
4. STRAGE/DATA OUT section
5. SYSTEM section

6. GPIB section
7. ENTRY section
8. Display section
9. Floppy disk drive section
10. POWER switch section

2.1.1.1 Display section

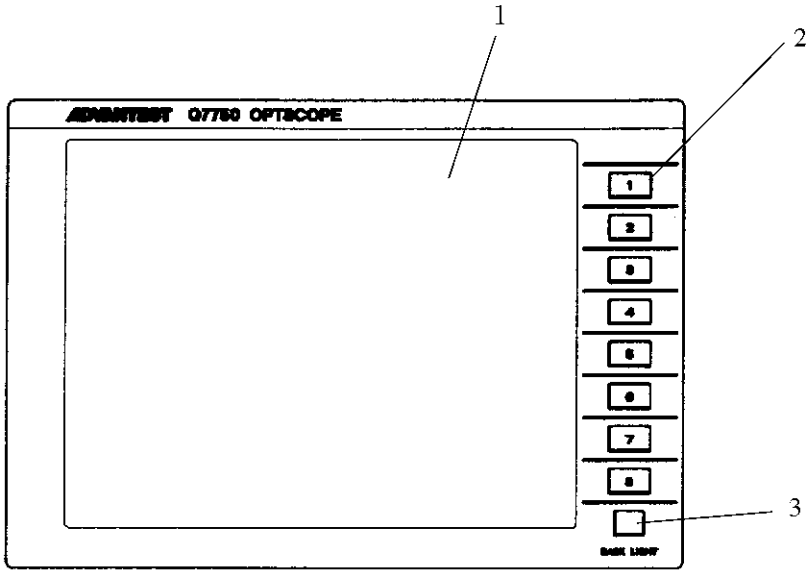


Figure 2-2 Description of the Display Section

1.	Liquid crystal display	Displays trace and measurement data.
2.	Soft keys	The eight soft keys correspond to the menu display on the left side. Pressing the soft keys enables you to select a soft menu.
3.	BACK LIGHT key	Turns the back light on or off.

2.1.1.2 FUNCTION section

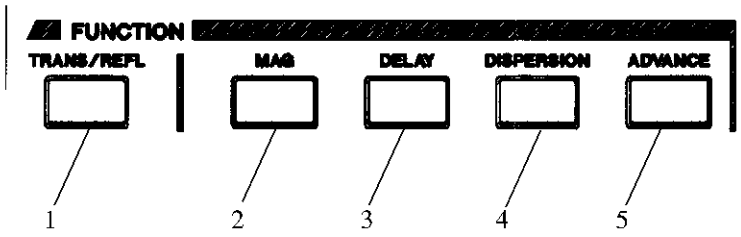


Figure 2-3 Description of FUNCTION Section

1.	TRANS/REFL key	Selects transmission/reflection characteristics.
2.	MAG key	Displays amplitude characteristics.
3.	DELAY key	Displays group delay characteristics.
4.	DISPERSION key	Displays chromatic dispersion characteristics.
5.	ADVANCE key	Displays delay characteristics.

2.1.1.3 SET UP section

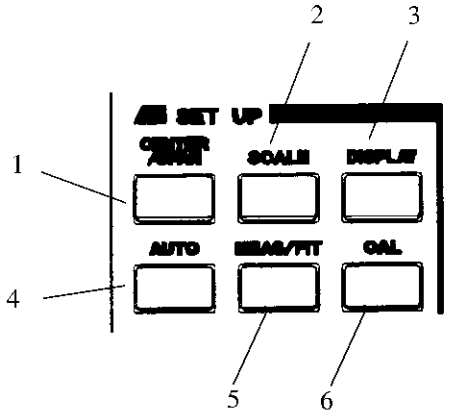


Figure 2-4 Description of SET UP Section

1.	CENTER/SPAN key	Sets the range of sweeping.
2.	SCALE key	Sets the vertical axis range.
3.	DISPLAY key	Sets the display modes.
4.	AUTO key	Sets the wavelengths and levels of measurements automatically.
5.	MEAS/FIT key	Sets averaging and leveling.
6.	CAL key	Performs calibration.

2.1.1.4 MEASURE section

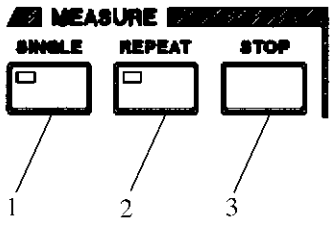


Figure 2-5 Description of MEASURE Section

1. SINGLE key — Performs sweeping in single mode.
2. REPEAT key — Performs sweeping in repeat mode.
3. STOP key — Stops sweeping.

2.1.1.5 STORAGE/DATA OUT section

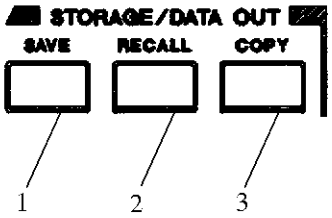


Figure 2-6 Description of STORAGE/DATA OUT Section

1. SAVE key — Saves measurement conditions and measurement data.
2. RECALL key — Recalls measurement conditions and measurement data.
3. COPY key — Outputs displays.

2.1.1.6 SYSTEM section

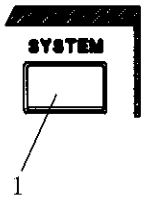


Figure 2-7 Description of SYSTEM Section

1. SYSTEM key — Sets the clock and the display colors.

2.1.1.7 GPIB section

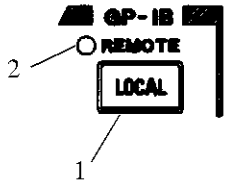


Figure 2-8 Description of GPIB Section

1.	LOCAL key	Sets operating conditions of interfaces, etc.
2.	REMOTE indicator	Goes ON in remote mode.

2.1.1.8 ENTRY section

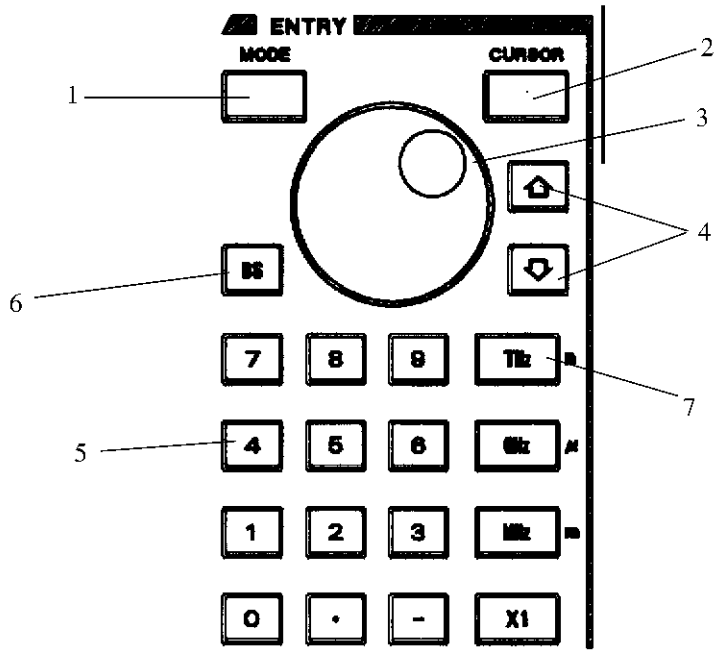


Figure 2-9 Description of ENTRY Section

1.	MODE key	Selects cursor functions.
2.	CURSOR key	Displays the cursor.
3.	Data knob	Enters continuous data.
4.	Step key	Enters steps of data.
5.	TEN key	Enters numbers. Numeric keys (0 to 9) and decimal point key (.) are provided.
6.	BS key	Revises ten key entries.

7.	Unit key	Selects units and sets numbers. The THz key sets THz unit or nm unit. The GHz key sets GHz unit or um unit. The MHz key sets MHz unit or mm unit. The X1 key sets dB unit. In addition, defines the entered data.

2.1.1.9 Signal Port section

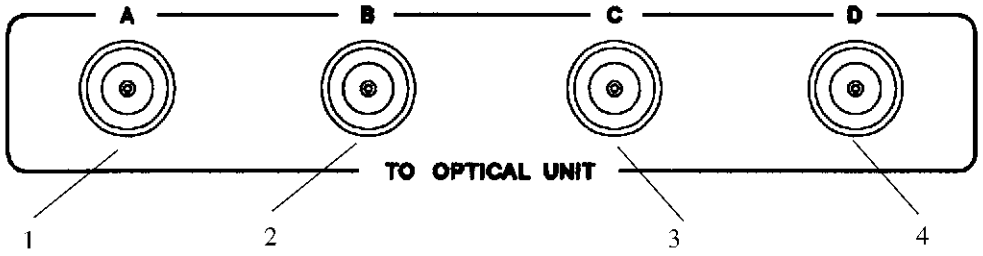


Figure 2-10 Description of Signal Port Section

1.	A connector	Connected to the optical analyzer unit.
2.	B connector	Connected to the optical analyzer unit.
3.	C connector	Connected to the optical analyzer unit.
4.	D connector	Connected to the optical analyzer unit.

2.1.1.10 Floppy Disk Drive section

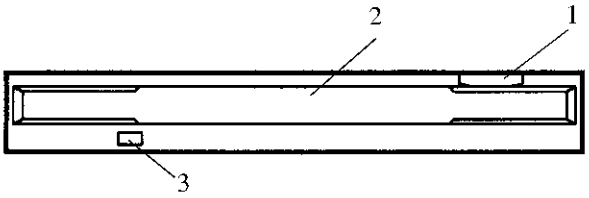


Figure 2-11 Description of Floppy Disk Drive Section

1.	Eject button	Ejects the inserted floppy disk.
2.	Slot for inserting Floppy Disk	Sets up the Floppy disk.
3.	Access indicator	Turns on when accessing the floppy disk.

2.1.1.11 POWER Switch section

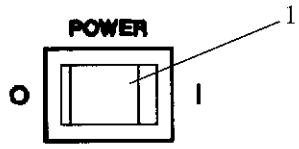


Figure 2-12 Description of POWER Switch Section

1. POWER switch — Turns the power on or off.

2.1.2 Front Panel (Optical Network Analyzer Unit)

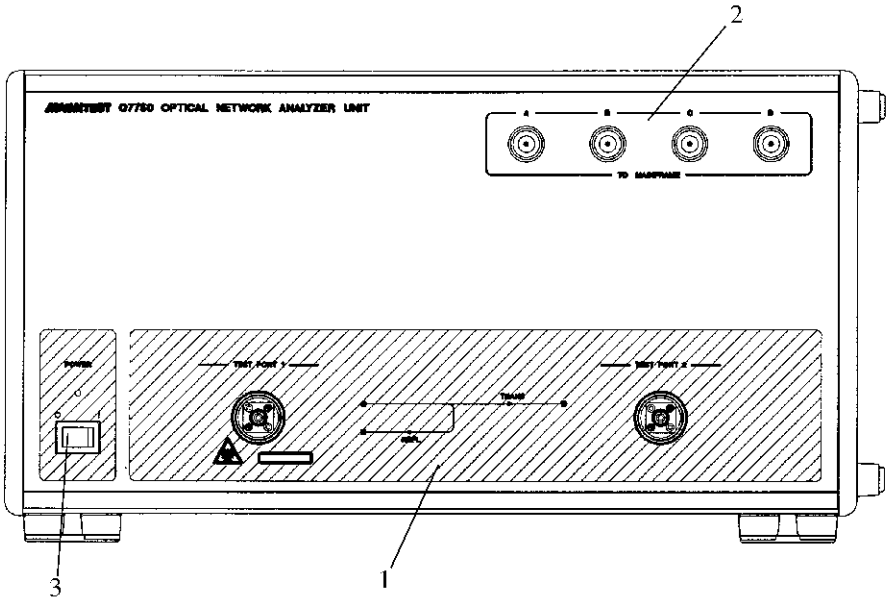


Figure 2-13 Description of the Front Panel

1.	Test port section	Connected to the DUT.
2.	Signal port section	Connected to the display unit.
3.	POWER switch section	Turns the power on or off.

2.1.2.1 Test Port section

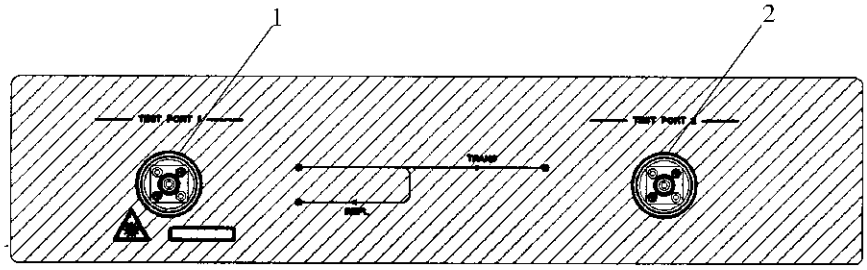


Figure 2-14 Description of Test Port Section

1.	TEST PORT 1 connector	Connected to the input connector of the DUT.
2.	TEST PORT 2 connector	Connected to the input connector of the DUT.

2.1.2.2 Signal Port section

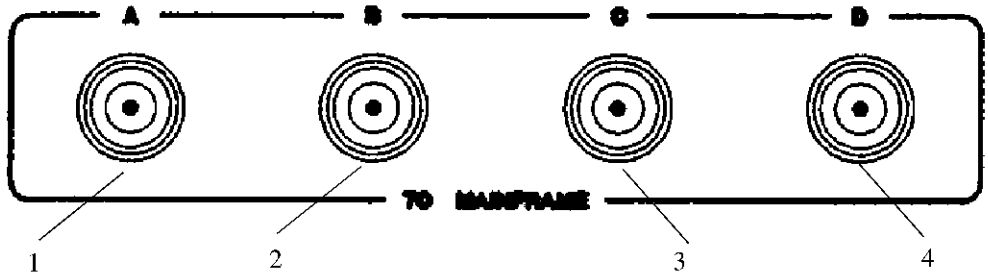


Figure 2-15 Description of Signal Port Section

1. A connector — Connected to the display unit.
2. B connector — Connected to the display unit.
3. C connector — Connected to the display unit.
4. D connector — Connected to the display unit.

2.1.2.3 POWER Switch section

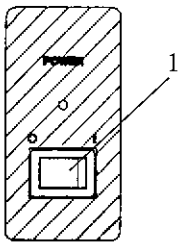


Figure 2-16 Description of POWER Switch Section

1. POWER switch — Turns the power on or off

2.1.3 Rear Panel (Display Unit)

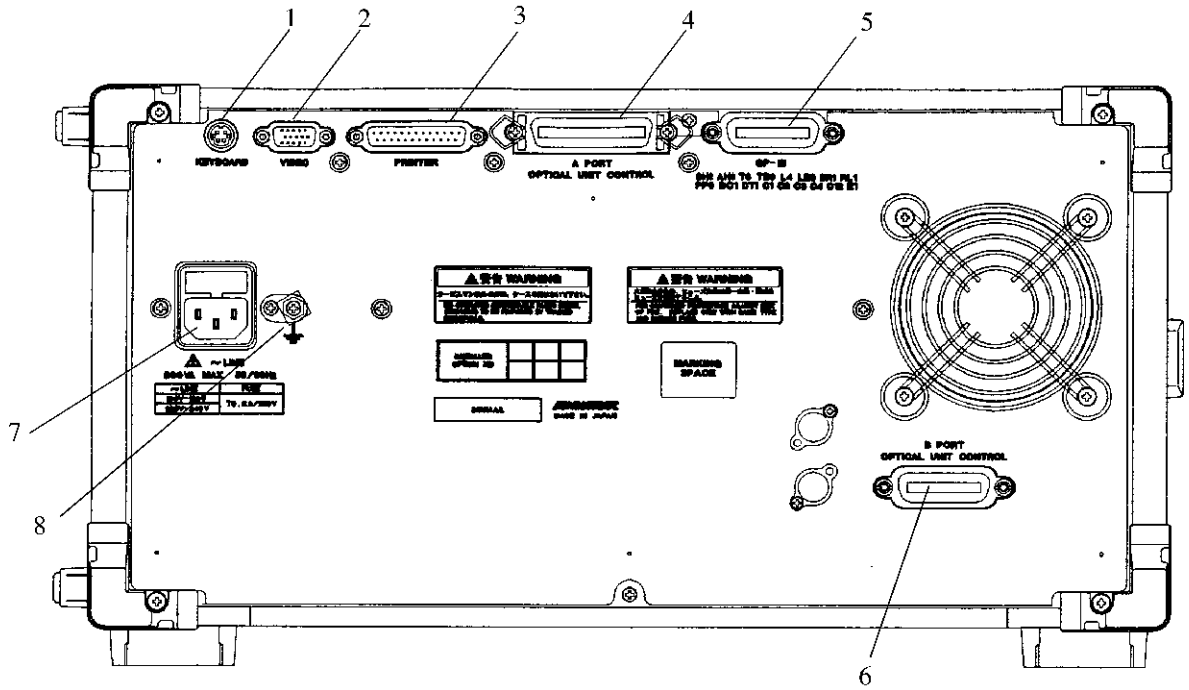


Figure 2-17 Description of Rear Panel (Display Unit) Section

1.	KEYBOARD connector	Connects the external keyboard.
2.	VIDEO connector	Connects the external display.
3.	PRINTER connector	Connects the printer.
4.	A PORT connector	Connected to the optical network analyzer unit.
5.	GPIB connector	Connects the external controller.
6.	B PORT connector	Connected to the optical network analyzer unit.
7.	AC connector	Connects the power cable.
8.	Earth terminal	Connected to the earth.

2.1.4 Rear Panel (Optical Network Analyzer Unit)

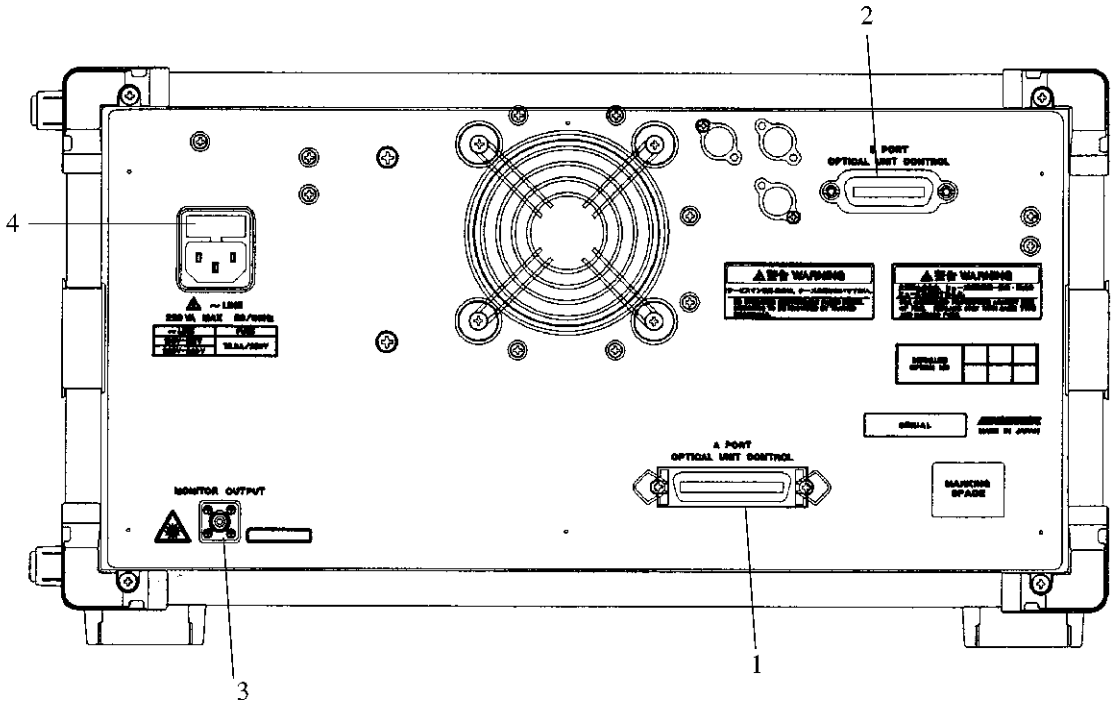


Figure 2-18 Description of Rear Panel (Optical Network Analyzer Unit) Section

1.	A PORT connector	Connected to the display unit.
2.	B PORT connector	Connected to the display unit.
3.	MONITOR OUTPUT connector	Performs wavelength monitoring. (option)
4.	AC connector	Connects the power cable.

2.1.5 Display Annotation

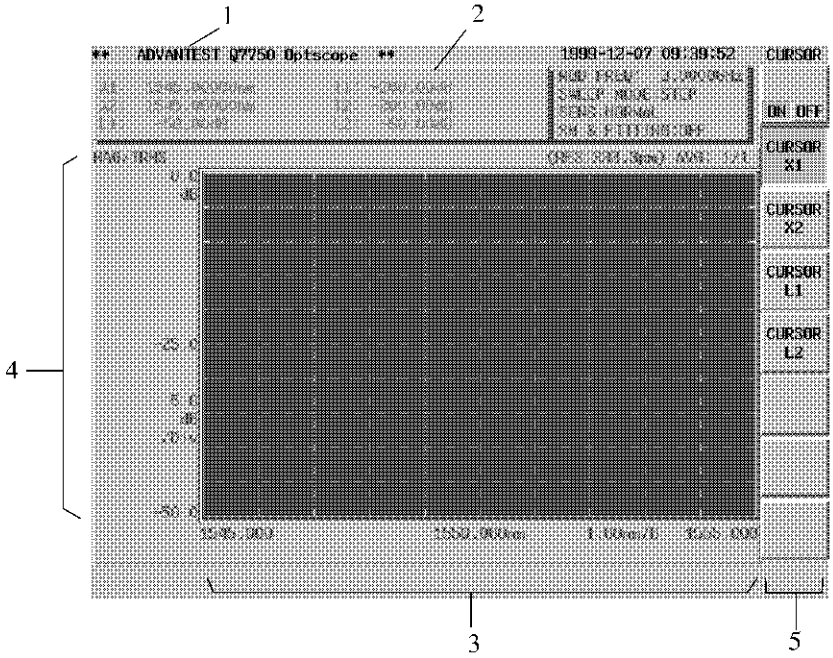


Figure 2-19 Display Annotation

1. Title area — Displays labels and calendars.
2. Cursor area — Displays cursor values.
3. X axis area — Displays set values for the X axis.
4. Y axis area — Displays set values for the Y axis.
5. Soft key area — Displays soft key menu.

2.1.6 Report Display

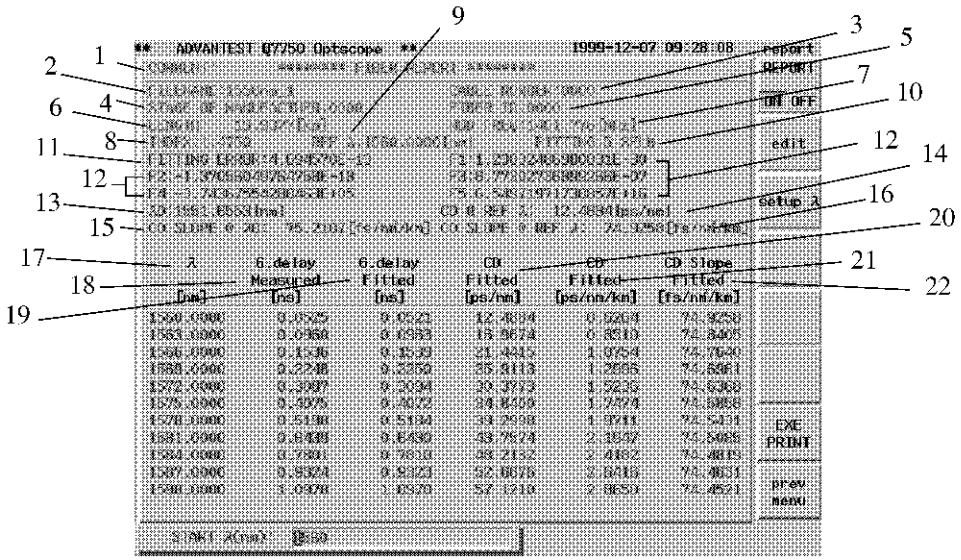


Figure 2-20 Report Display

Selecting ON from the Report menu displays the report as shown in Figure 2-20.

1. COMMENT
2. FILENAME
3. CABLE NUMBER
4. STAGE OF MANUFACTUER
5. FIBER ID
6. LENGTH: Fiber length
7. MOD FREQ: Modulated frequency
8. INDEX: Refractive index of the fiber
9. REF λ: Reference value for λ
10. FITTING: Fitting type
11. FITTING ERROR: Statistical dispersion modified by the curve fitting
12. F1 to F5: Fitting coefficients
13. λ0: Zero-dispersion wavelength
14. CD @ REF λ: Chromatic dispersion per one kilometer at the reference value for λ
15. CD SLOPE @ λ0: Chromatic dispersion slop per one kilometerat λ0
16. CD SLOPE @ REF λ: Chromatic dispersion slope per one kilometer at the reference value for λ
17. λ: Wavelength
18. G.Delay measured: Group delay time measurements *
19. G.Delay Fitted: Group delay time measurements modified by the curve fitting *

20. CD Fitted: Chromatic dispersion measurements modified by the curve fitting
21. CD Fitted/km: Chromatic dispersion per one kilometer modified by the curve fitting
22. CD Slope Fitted/km: Chromatic dispersion slopes per one kilometer modified by the curve fitting

* The group delay time is normalized with reference to the minimum measured group delay time, which is changed to zero, and displayed in the report.

2.2 Basic Operation

2.2.1 Menu Operation and Data Entry

This subsection explains how to operate panel keys and soft keys.

Menu selection

Pressing the panel key displays the soft menu on the display area of the screen (some keys such as SINGLE, however, may not be displayed.

For example, pressing **CENTER/SPAN** key displays the following soft menus.
When selecting a soft menu, press the soft key on the right.

CEN/SPN
CENTER
SPAN
START
STOP
CUR TO CENTER
FREQ DOMAIN

Figure 2-21 Soft Menu

Hierarchy of Soft Menu

Some soft menus include lower submenus.
The settings will be switched every time you press the soft keys in some soft menus.
Figure 2-22 shows the hierarchy of a soft menu, as exemplified by the **DISPLAY** key.

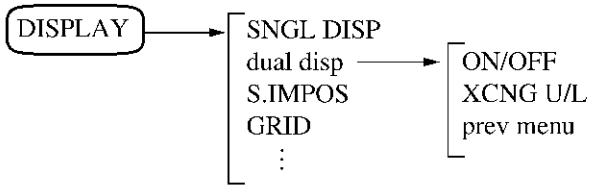


Figure 2-22 Hierarchy of Soft Menu

Submenu Display

With a menu with which a display is shown in small letters, pressing the soft key displays the next or the previous layer.

Switching Setting

In using soft menus (ON/OFF) that contain a function to switch settings, the settings can be switched every time you press the soft key.
The status currently selected is displayed in reverse video.

Entering Data

When a set value is displayed on the active area, it is possible to change the set value with the numeric keys, the step keys or the data knob.

Data Entry with numeric keys

Data is entered using the numeric keys, decimal point key, - (minus) and BS (back space) keys.
If a mistake is made in entering data, reenter the correct data by erasing the characters one by one with BS key.
Upon entering values and then pressing the unit, data entry is completed.

CAUTION: ***Prior to completing data entry, pressing another panel key will invalidate the entered data.***

Example 1: Set the center wavelength to 1550 nm with the numeric keys.
Press **CENTER/SPAN**, ***CENTER*** and **1, 5, 5, 0, THz(n)**.
The center wavelength setting becomes active, and the entered data will then be displayed.
A center wavelength of 1550 nm is set.

Data Entry with step keys

The step keys are used to enter data with a predetermined step size. Pressing the "↑" key increases the data value; while pressing "↓" key decreases the value.

Data Entry with data knob

Using the data knob permits you to enter data continuously. This is conveniently used for fine adjustment of entered data.

Entering Data and Controlling Menus from the External Keyboard

The following actions can also be performed from the external keyboard attached to this instrument which are normally controlled from the panel keys.

- Selecting soft menus.
- Entering file names.
- Entering titles.
- Entering numeric data

Associated Keys

- Selecting soft menus
  Function keys F1 to F8 (on the external keyboard) correspond to soft keys 1 to 8, respectively.
- Entering file names or titles
  Use the cursor keys(↑ ↓ ← and →) to select characters. In addition, use sign and alphanumeric keys to enter data directly from the external keyboard.
- Entering numeric data
  Use the numeric and function keys F9 to F12 (see below for the units corresponding to these keys).

  F9 THz(n)
  F10 GHz(μ)
  F11 MHz(m)
  F12 X1

2.2.2 Measurements and Cursor Operation

This subsection describes a simple measurement of fiber grating (with a center wavelength 1551.9 nm) and data reading with the cursor.

NOTE: ***In order to make accurate measurements, this analyzer should be used within the specified environmental temperature range. In addition, calibration should be done after warming up the analyzer for more than 2 hours, following turning on the power. A description of warm-up and calibration is omitted here because this description is of operations.***

Setup

1. Referring to the 1.5 Setup, connect the display unit to the optical network analyzer unit.

Turning the Power On

2. Check whether the power switch on each front panel is turned OFF.

CAUTION: ***To prevent damage, input voltage or frequency over the specified range should not be applied to this analyzer.***

---

3. Connect the power cables to the outlets.
4. Turn on the power switches (on the front panels).
   The internal initialization and self test will be performed.
   Upon completing the self test, the initial screen will be displayed. (It takes about one minute to display the screen.)

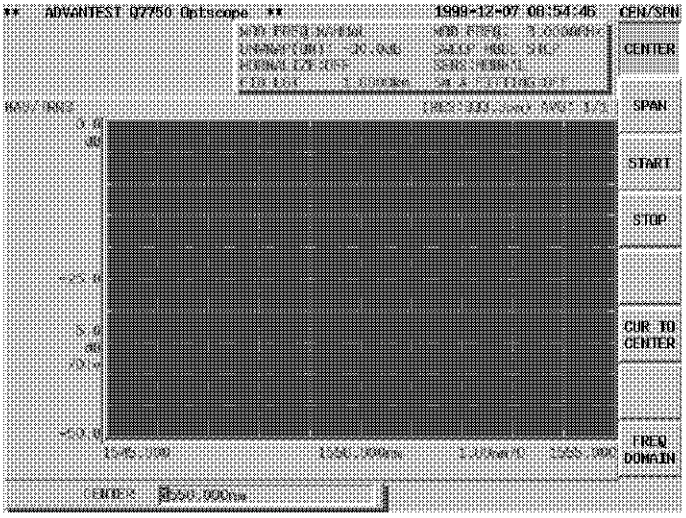


Figure 2-23 Initial Screen

NOTE: The display after tuning the power on will differ depending on the previous state of use.

Initializing Set State

Initialize the set state of this analyzer.

5. Press the **SYSTEM** and ***PRESET***.
   The initial set conditions will be read out

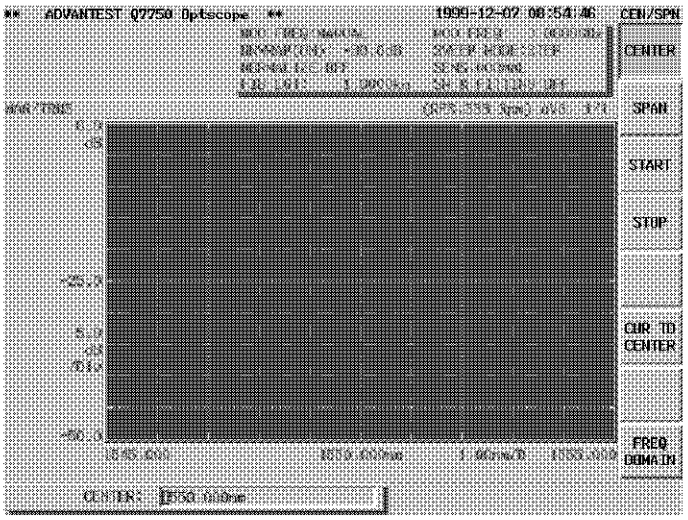


Figure 2-24 Initial Set Screen

Connecting DUT

6. Connect the optical fiber cable from **TEST PORT 1** on the front panel to the input connector of the DUT.

7. Connect another optical fiber cable from **TEST PORT 2** on the front panel to the output connector of the DUT.

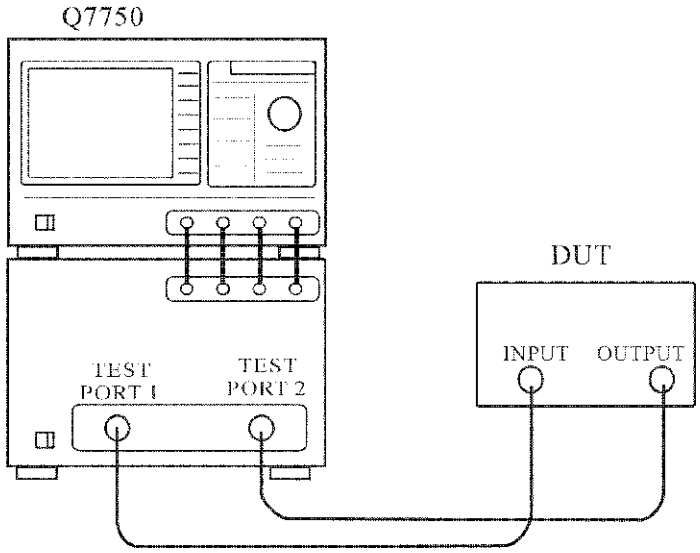


Figure 2-25 Connecting the DUT

Setting Measurement Conditions

Set the measurement conditions so that the input signal may be easily observed.

8. Press **TRANS/REFL**.
The TRANS/REFL menu for setting the measurement mode will be displayed

9. Press the ***REFL***.
The measurement mode will be set to the reflection mode.

10. Press the **MAG**, ***MAG***.
The display mode will be set to the amplitude characteristic mode.

11. Press **CENTER/SPAN**.
The CEN/SPAN menu for setting the display range will be displayed.

12. Press ***CENTER*, 1, 5, 5, 1, ., 9** and **THz** (n).
The center wavelength will be set to 1551.9 nm.

13. Press ***SPAN*, 1, ., 2** and **THz** (n).
The display width will be set to 1.2 nm.

14. Press the **SINGLE**.
The reflection amplitude characteristics of the DUT will be displayed.

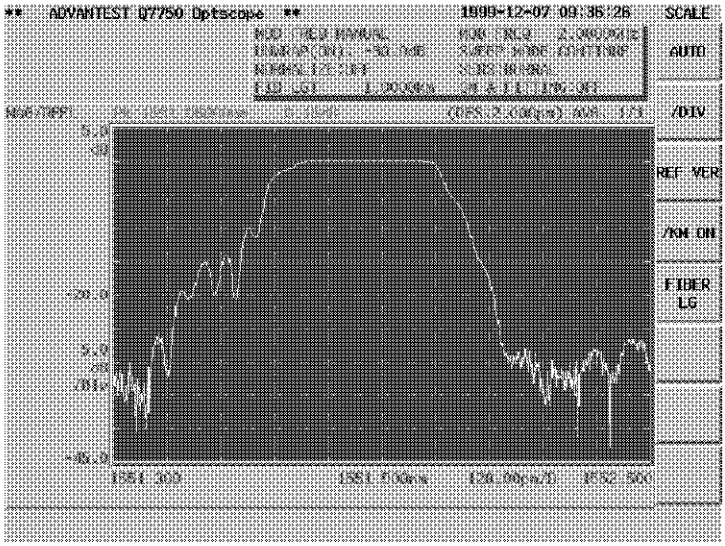


Figure 2-26 Reflection Amplitude Characteristics

Displaying Cursor

15. Press **CURSOR** and ***ON/OFF***(ON).
The X1 cursor will be displayed. Also the wavelength and level of this position will be displayed on the cursor area of the screen.

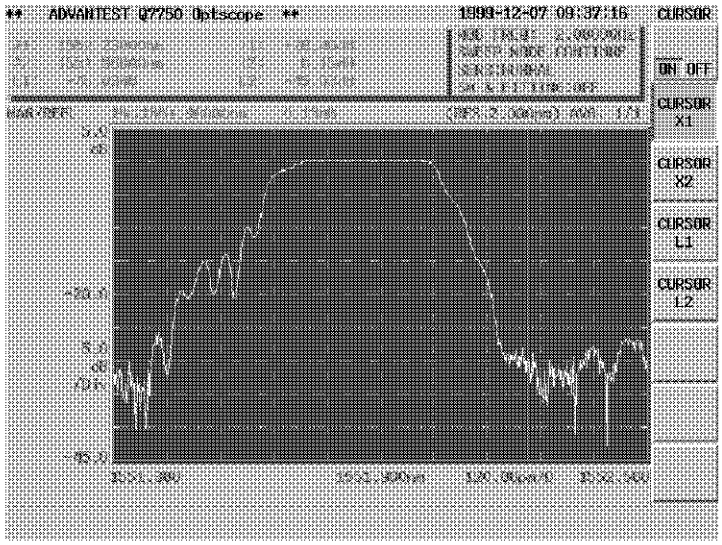


Figure 2-27 Displaying the Cursor

16. Move the cursor by turning the knob.
    Turn the knob so that the X1 cursor will meet the flat part (pass band) of the trace. The wavelength at the position of the cursor and the loss at the point will be displayed on the cursor area.

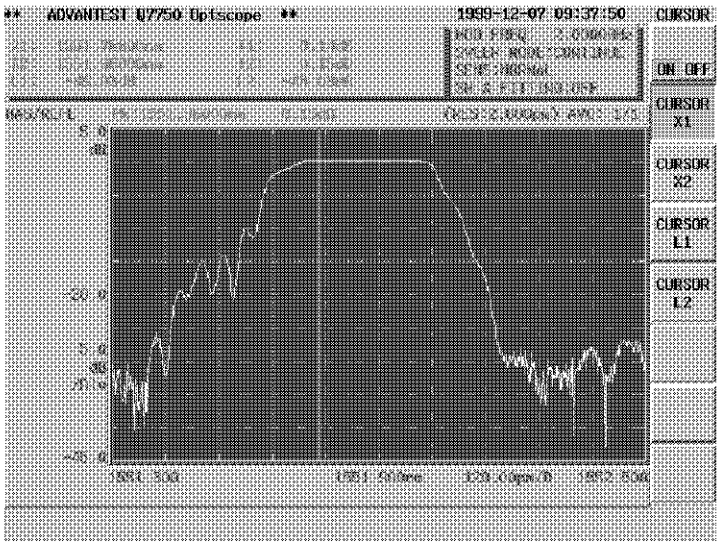


Figure 2-28 Reading with the Cursor

2.2.3 Analysis with Dual Screen Display

The amplitude and group delay characteristics can be observed simultaneously by use of the dual screen mode.

Setup

1. Referring to the 1.5 Setup, connect the display unit to the optical network analyzer unit.

Turning the Power On

2. Turn the power switch on each front panel ON.
   The internal initialization and self test will be performed.
   Upon completing the self test, the initial screen will be displayed. (It takes about one minute to display the screen.)

Initializing Set State

Initialize the set state of this analyzer.

3. Press **SYSTEM** and ***PRESET***.
   The initial set conditions will be read.

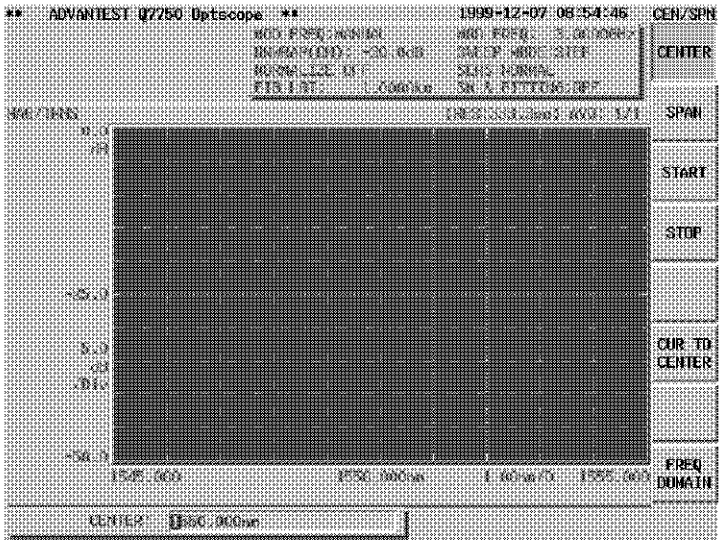


Figure 2-29 Initial Set Screen

Connecting DUT

4. Connect an optical fiber cable from **TEST PORT 1** on the front panel to the input connector of the DUT.

5. Connect another optical fiber cable from **TEST PORT 2** on the front panel to the output connector of the DUT.

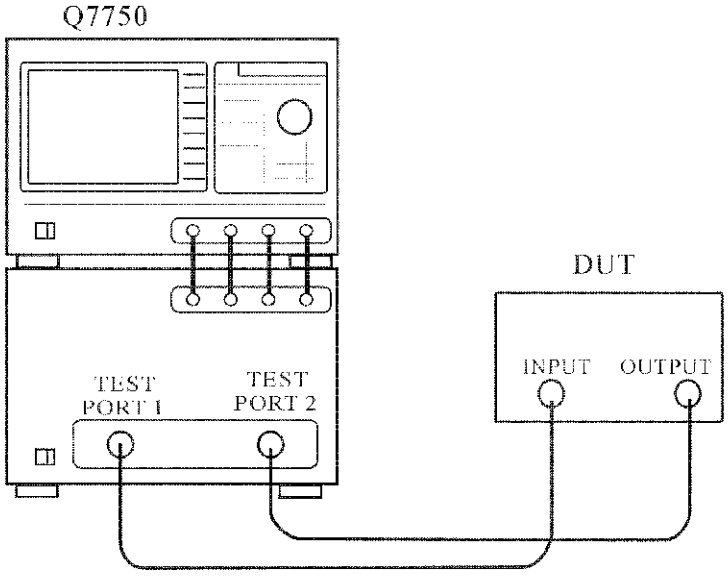


Figure 2-30 Connecting the DUT

Setting Measurement Conditions

Set the measurement conditions so that the input signal may be easily observed.

6. Press **TRANS/REFL**.
   The TRANS/REFL menu for setting the measurement mode will be displayed.

7. Press ***REFL***.
   The measurement mode will be set to the reflection mode.

8. Press **MAG** and ***MAG***.
   The displayed mode will be set to the amplitude characteristic mode.

9. Press **CENTER/SPAN**.
   The CEN/SPAN menu for setting the display range will be displayed.

10. Press ***CENTER*, 1, 5, 5, 1, ., 9** and **THz** (n).
    The center wavelength will be set to 1551.9 nm.

11. Press ***SPAN*, 1, ., 2** and **THz** (n).
    The display width will be set to 1.2 nm.

12. Press the **SINGLE**.
    The transmission amplitude characteristics of the DUT will be displayed.

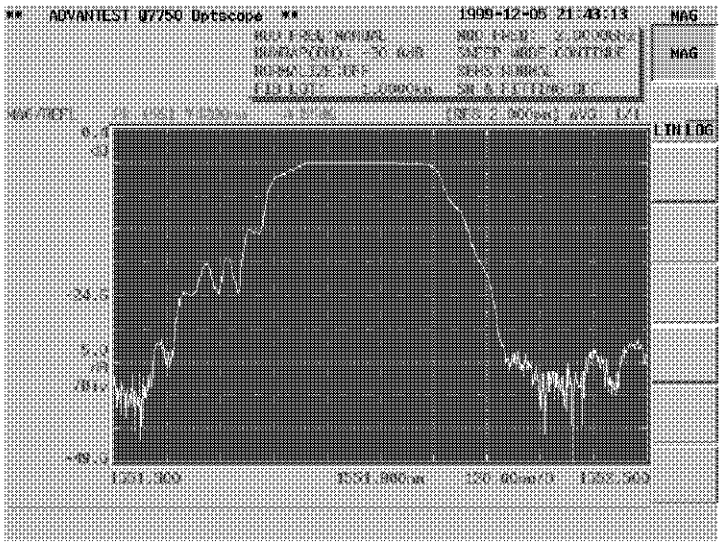


Figure 2-31 Single Screen Display

Dual Screen Display

Switch the screen display mode to the dual screen display mode.

13. Press **DISPLAY**, ***dual disp*** and ***ON/OFF***(ON).
    The display mode will be switched to the dual screen display mode. The reflection amplitude characteristics will then be displayed on both screens.

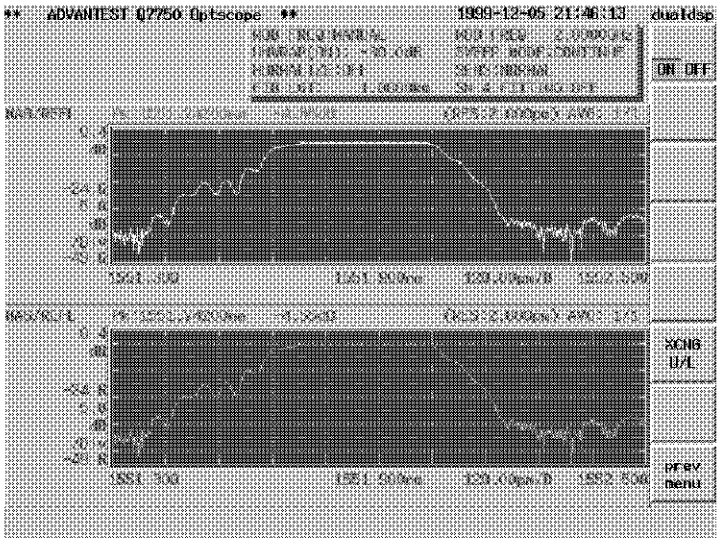


Figure 2-32 Dual Screen Display (1)

The amplitude and group delay characteristics are displayed.

14. Press **DELAY** and ***GROUP DELAY.***
    The upper screen will be changed to display of the group delay characteristics. In dual screen display, the entry of measurement conditions is valid only for the upper screen.

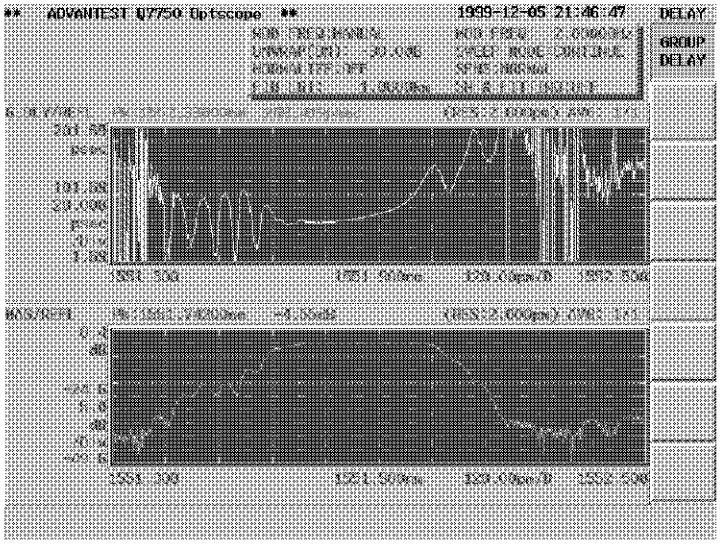


Figure 2-33 Dual Screen Display (2)

15. Press **DISPLAY,** ***dual disp*** and ***XCNG U/L.***
    The upper screen will be replaced with the lower screen. The amplitude characteristics will then be displayed on the upper screen while the group characteristics are displayed on the lower screen.

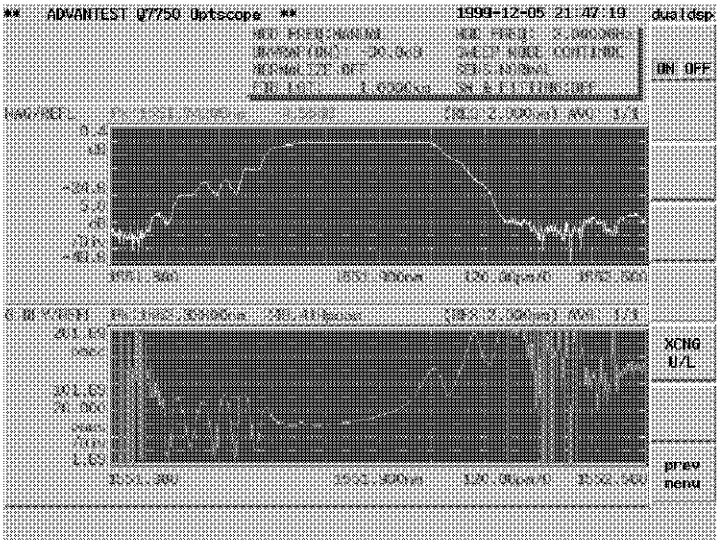


Figure 2-34 Replacing Screens

2.2.4 Partial Fitting Operation

This section describes how to fit measurements within the specified range using the partial fitting function.

Setup

1. Connect the optical network analyzer and display unit.

Turning the power on

2. Check that the POWER switch on each front panel is turned off.
3. Connect the power cables to the receptacles.
4. Turn on the POWER switch on each front panel. The initialization and self-test are performed individually. On completion of the self-test, the initial screen is displayed (it takes approximately one minute).

Initializing Settings

5. Press **SYSTEM** and ***PRESET*** to initialize the panel settings of the instrument.

Connecting the DUT

6. Connect the optical fiber cable between the **TEST PORT1** on the front panel and the DUT input connector.
7. Connect the optical fiber cable between the **TEST PORT2** on the front panel and the DUT output connector.
8. Press **TRANS/REFL** and ***REFL***.
   The measurement mode is set to reflection t.
9. Press **DELAY** and ***GROUP DELAY***.
   The measurement mode is set to group delay time t.
10. Press ***CENTER/SPAN***.
    The CEN/SPAN menu that sets the measurement range is displayed.
11. Press ***CENTER***,**1**,**5**,**5**,**1**, **.**, **9** and **THz(n)**.
    The center frequency is set to 1551.9 nm.
12. Press ***SPAN***,**1**, **.**, **2** and **THz(n)**.
    The display span is set to 1.2 nm.
13. Press **MEAS/FIT**, ***sweep mode*** and ***CONT SWEEP***.
    The sweep mode is set to continuous sweep.
14. Press **SINGLE**.
    The measurement starts. The group delay characteristic of the DUT is displayed.

15. Press **SCALE** and ***AUTO***.
The vertical axis scale is optimized to display measurements on the entire screen.

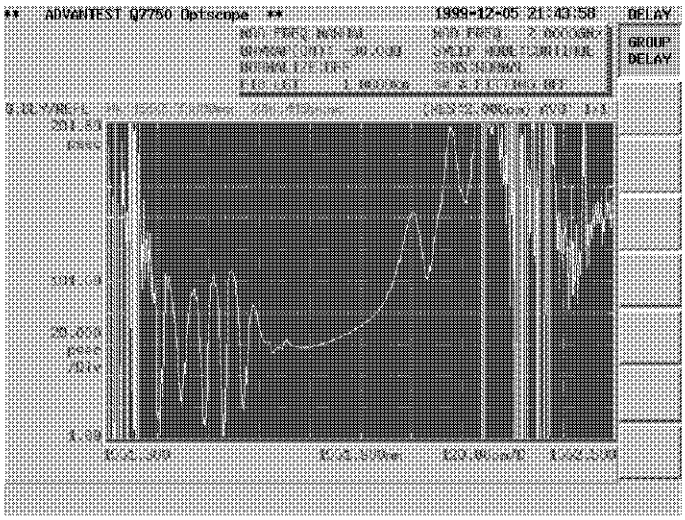


Figure 2-35 Partial Fitting 1

16. Press **CURSOR** and ***CURSOR X1***.
The X1 cursor is activated.

17. Turn the knob to set the X1 cursor to the left end of the fitting range.

18. Press **CURSOR** and ***CURSOR X2***.
The X2 cursor is activated.

19. Turn the knob to move the X2 cursor to the right end of the fitting range.
The partial fitting range is set between the cursors X1 and X2.

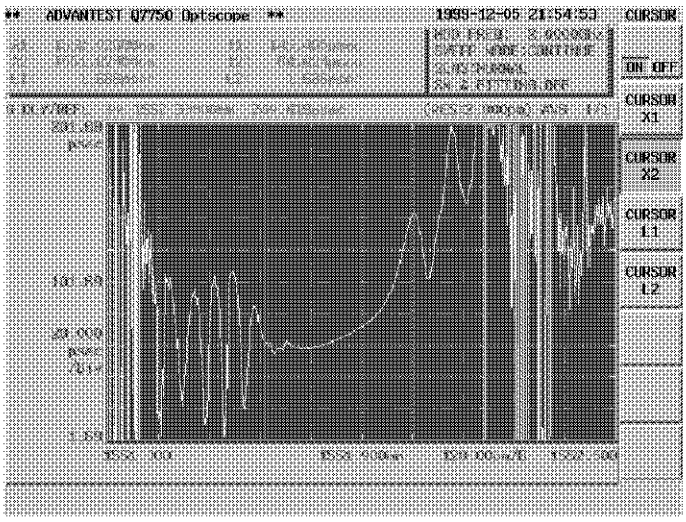


Figure 2-36 Partial Fitting 2

20. Press **MEAS/FIT**, ***fit*** and ***PERSIAL ON/OFF***(ON).
    The partial fitting function is activated.

21. Press **MEAS/FIT**, ***fit*** and ***QUAD FIT***.
    A quadratic polynomial is selected for the curve fitting function.

22. Press **MEAS/FIT**, ***fit*** and ***FIT ON/OFF***(ON).
    The fitting function is activated. Fitting is executed in the range between the cursors X1 and X2.

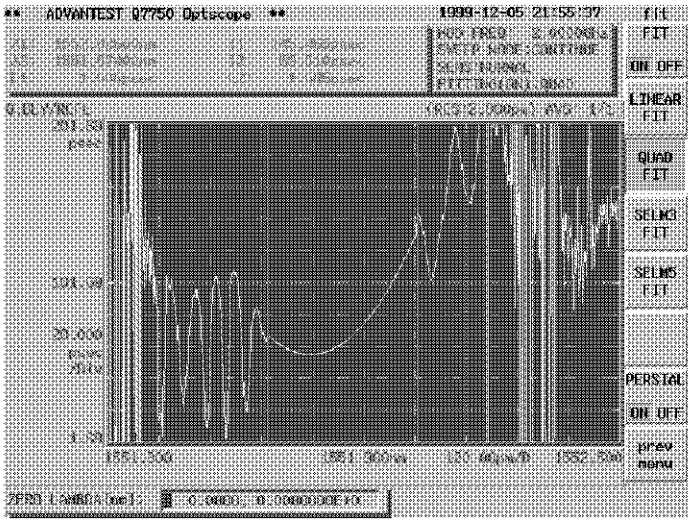


Figure 2-37 Partial Fitting 3

2.2.5 Limit Line Operation

This section describes how to make an automatic pass/fail judgment on the measurement result using the limit line function.

Setup

1. Connect the optical network analyzer and display unit.

Turning the power on

2. Check that each POWER switch on the front panel is turned off.
3. Connect the power cables to the receptacles.
4. Turn on the POWER switch on each front panel. Initialization and self-test are performed individually. On completion of the self-test, the initial screen is displayed (it takes approximately one minute).

Initializing Settings

5. Press **SYSTEM** and ***PRESET*** to initialize panel settings of the instrument.

DUT Connection

6. Connect the optical fiber cable between the **TEST PORT1** on the front panel and the DUT input connector.
7. Connect the optical fiber cable between the **TEST PORT2** on the front panel and the DUT output connector.

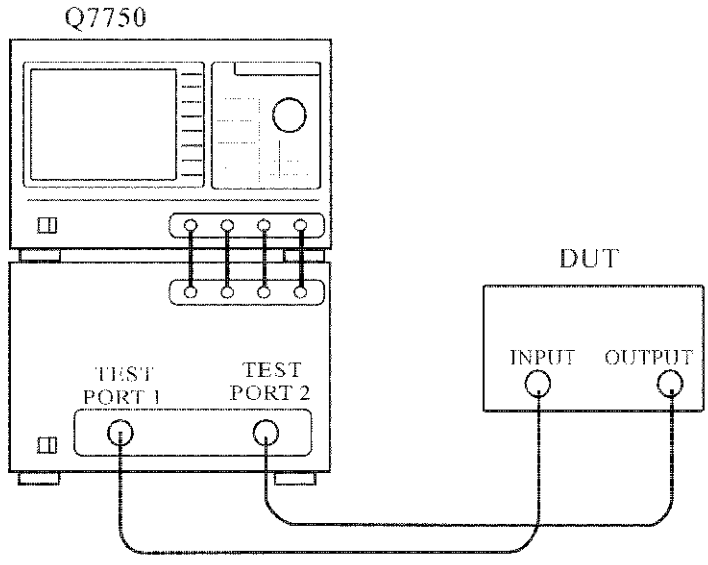


Figure 2-38 DUT Connection

Setting measurement conditions

8. Press **TRANS/REFL** and ***REFL***.
   The measurement mode is set to reflection.

9. Press **MAG** and ***MAG***.
   The measurement mode is set to reflection magnitude

10. Press **CENTER/SPAN**.
    The CEN/SPAN menu that sets the measurement range is displayed.

11. Press ***CENTER***, **1**, **5**, **5**, **1**, **.**, **9** and **THz(n)**.
    The center frequency is set to 1551.9 nm.

12. Press ***SPAN***, **1**, **.**, **6** and **THz(n)**.
    The display span is set to 1.6 nm.

13. Press **MEAS/FIT**, ***sweep mode*** and ***CONT SWEEP***.
    The sweep mode is set to continuous sweep.

14. Press **MEAS/FIT**, ***MOD FREQ***, **2** and **GHz**.
    The modulation frequency is set to 2 GHz.

Measurement

15. Press **SINGLE**.
    The measurement starts. The magnitude characteristic of the DUT is displayed (it takes approximately 30 seconds).

16. Press **SCALE** and ***AUTO***.
    The vertical axis scale is optimized to display measurements on the entire screen.

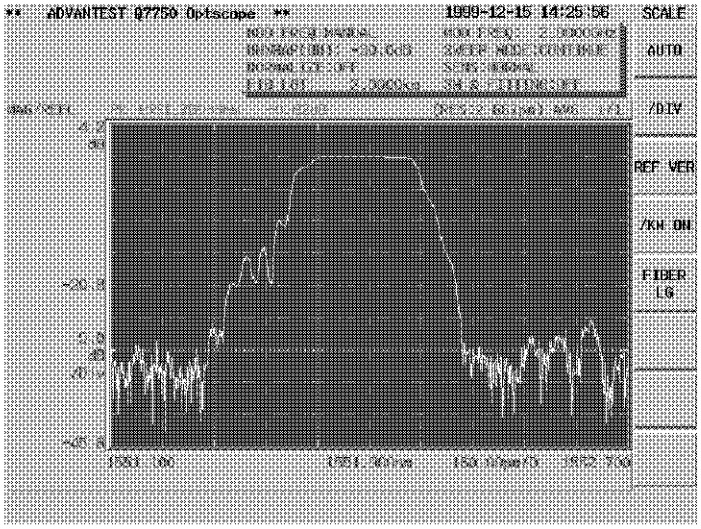


Figure 2-39 Reflection Magnitude Characteristic.

Setting the limit line

17. Press **DISPLAY**, ***limit line manual*** and ***ON/OFF***(ON).
The screen switches to the limit line display, then the menu that sets the limit line is displayed.

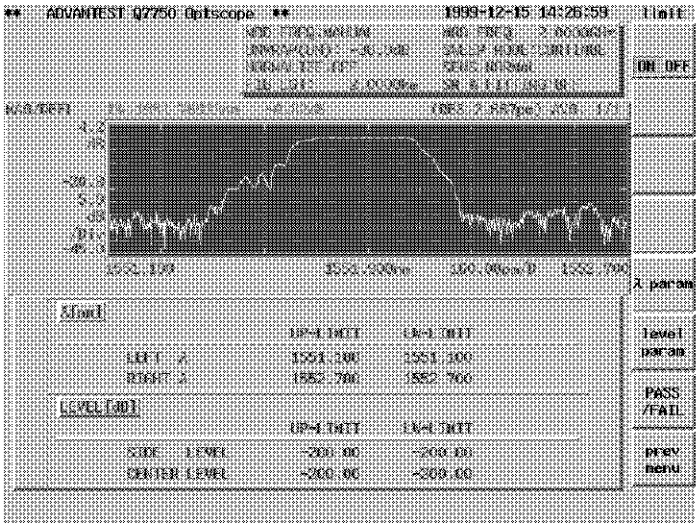


Figure 2-40 Limit Line Function 1

18. Press ***λparam***.
The menu to set the wavelength axis of the limit line is displayed.

19. Press ***UPPER LEFT λ***, **1**, **5**, **5**, **1**, **.**, **4**, **2** and **THz(n)**.
The LEFT λ parameter of the UP limit line is set to 1551.42 nm.

20. Press ***UPPER RIGHT λ***, **1**, **5**, **5**, **2**, **.**, **3**, **8** and **THz(n)**.
The RIGHT λ parameter of the UP limit line is set to 1552.38 nm.

21. Press ***prev menu***.
The screen is restored to the previous menu.

22. Press ***level param***.
The limit line level setting menu is displayed.

23. Press ***UPPER SIDE LV***, **-**, **2**, **0** and **x1**.
The SIDE level parameter of the UP limit line is set to -20 dB.

24. Press ***UPPER CENT LV***, **0** and **x1**.
The CENTER level parameter of the UP limit line is set to 0 dB.
The upper limit line is displayed under the conditions set in steps 17. through 24.

25. Press ***prev menu***.
The screen is restored to the previous menu.

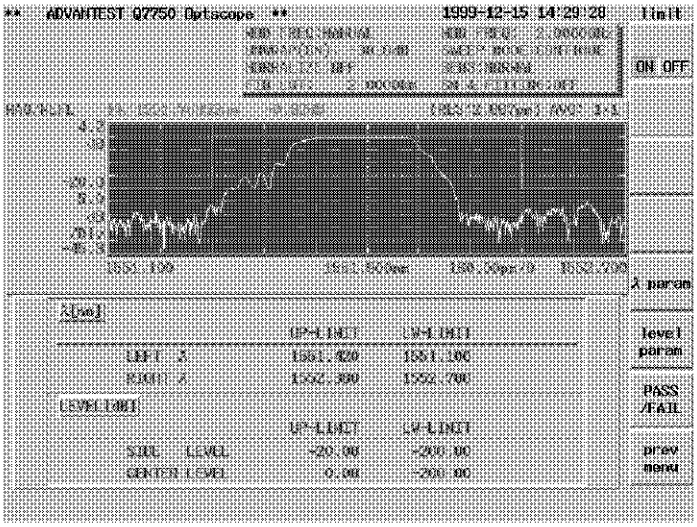


Figure 2-41 Limit Line Function 2

26. Press ***λ param***.
The menu to set the wavelength axis of the limit line is displayed.

27. Press ***LOWER LEFT λ***, **1**, **5**, **5**, **1**, **.**, **7**, **4** and THz(n).
The LEFT λ parameter of the LW limit line is set to 1551.74 nm.

28. Press ***LOWER RIGHT λ***, **1**, **5**, **5**, **2**, **.**, **0**, **6** and THz(n).
The RIGHT λ parameter of the LW limit line is set to 1552.06 nm.

29. Press ***prev menu***.
The screen is restored to the previous menu.

30. Press ***level param***.
The limit line level setting menu is displayed.

31. Press ***LOWER SIDE LV***, **-**, **4**, **0** and **x1**.
The SIDE level parameter of the LW limit line is set to -40 dB.

32. Press ***LOWER CENT LV***, **-**, **1**, **5** and **x1**.
The CENTER level parameter of the LW limit line is set to -15 dB.
The lower limit line is displayed under the conditions set in steps 26 through 32.

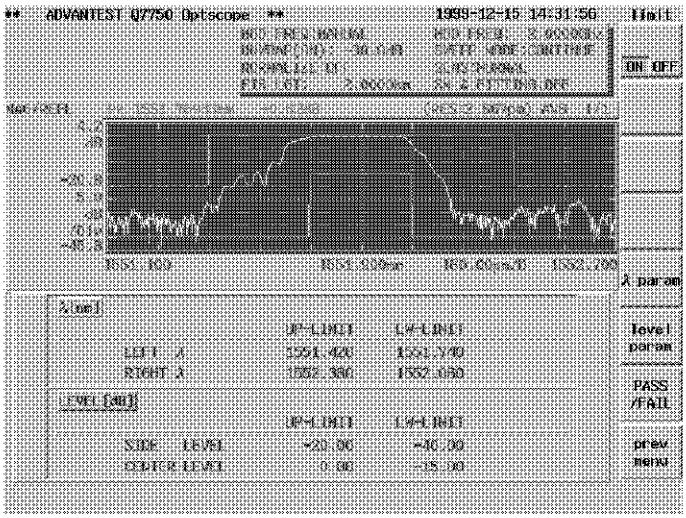


Figure 2-42 Limit Line Function 3

2.2.6 Limit Line Function (Using a User File)

This section explains how to make pass/fail judgments for measurements using a user file that was edited with a personal computer.

Setup

1. Connect the optical network analyzer and display unit.

Turning the power on

2. Check that each POWER switch on the front panel is turned off.
3. Connect the power cables to the receptacles.
4. Turn on the POWER switch on each front panel. Initialization and self-test are performed individually. On completion of the self-test, the initial screen is displayed (it takes approximately one minute).

Initializing Settings

5. Press **SYSTEM** and ***PRESET*** to initialize panel settings of the instrument.

DUT Connection

6. Connect the optical fiber cable between the **TEST PORT1** on the front panel and the DUT input connector.
7. Connect the optical fiber cable between the **TEST PORT2** on the front panel and the DUT output connector.

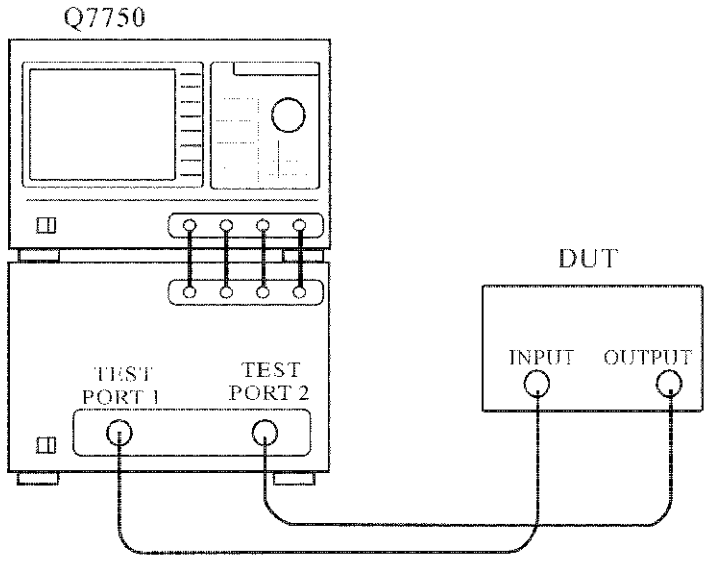


Figure 2-43 DUT Connection

Creating a limit line data file

8. Create a limit line data file using a personal computer and enter the limit line data. Then save the file to a floppy disk using the name listed in the table below.
   For example, the limit line data is saved to the FD:¥LmtLn¥LmtLn1.txt file as shown in Figure 2-44.
   (For more information, refer to Section 6.10, "Creating Limit Line Data Files.")

Specified file name	Remarks
FD:¥LmtLn¥LmtLn1.txt	Corresponds to ***PATTERN 1***
FD:¥LmtLn¥LmtLn2.txt	Corresponds to ***PATTERN 2***
FD:¥LmtLn¥LmtLn3.txt	Corresponds to ***PATTERN 3***
FD:¥LmtLn¥LmtLn4.txt	Corresponds to ***PATTERN 4***
FD:¥LmtLn¥LmtLn5.txt	Corresponds to ***PATTERN 5***

```
[Fundamental]
MeasMode=MAGLOG              ' MAG table
Domain=WAVE                  ' Waveform domain

[Reference]
DataModeX=REL                ' Sets the X-axis coordinate to the relative scale.
RefModeX=LEFT                ' Sets the left edge of the screen graph to a reference point.
RefUserX=                    ' No specification
OffsetX=0                    ' Sets the X offset to zero.
DataModeY=ABS                ' Sets the Y-axis coordinate to the absolute scale.
RefModeY=                    ' No specification
RefUserY=                    ' No specification
OffsetY=0                    ' Sets the Y offset to zero.

[TableUp]
PassRange=UNDER              ' The test result is pass if the measurement is below the line.
+0.0,  +5.0                  ' The X axis coordinate is relative to the START waveform
+1.0,  +5.0                  ' and is expressed with the nm unit.
+1.0, +10.0                  ' Power (dB) is used to express Y-axis amplitudes.
+3.0, +10.0                  ' The psec unit is used to express other than
+3.0, +30.0                  ' Y-axis amplitudes.
+5.0, +30.0
+5.0, +25.0
+8.0, +25.0
+8.0, +15.0
+10.0,+15.0

[TableLow]
PassRange=OVER               ' The test result is pass if the measurement is above the line.
+0.0,  -5.0
+1.0,  -5.0
+1.0, -10.0
+3.0, -10.0
+3.0, -30.0
+5.0, -30.0
+5.0, -25.0
+8.0, -25.0
+8.0, -15.0
+10.0,-15.0
```

Figure 2-44 Limit Line Data Example

Setting the limit line and measurement conditions

9. Press **DISPLAY** and ***limit line floppy*** to display the limit menu.

10. Insert the floppy disk that includes the limit line data file to the floppy drive.

11. Select the pattern you want to use. (***PATTERN 1- 5***)
For the purpose of this example, select ***PATTERN 1***.

    Load the limit line pattern data file from the floppy disk to display the limit line on the screen. The limit line data file also causes the Q7750 to change the measurement mode and domain information as appropriate.

NOTE: ***If the appropriate file has not been saved in the floppy disk, or the floppy disk is not inserted into the floppy drive, attempting to load one of these files causes an error.***

---

12. Change the measurement conditions such as the START/STOP wavelength and REF level as necessary.

Measurement

13. Press **SINGLE** to start the measurement.

Pass/fail judgment

14. When the measurement has been completed, press ***PASS/FAIL*** to make a pass/fail judgment and display the result on the screen.

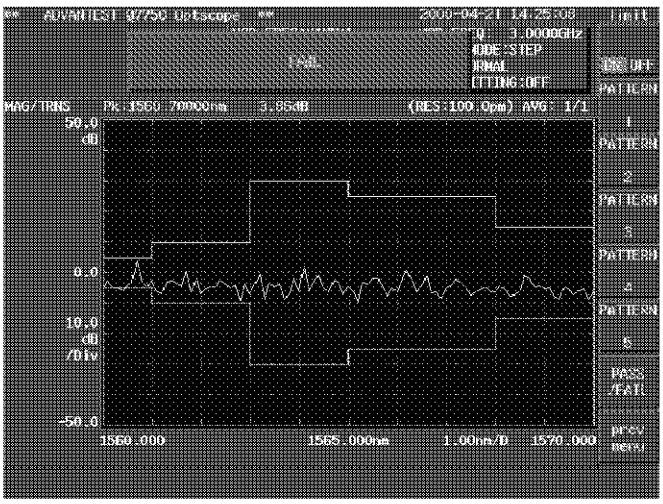


Figure 2-45 Pass/Fail Judgment Result

2.2.7 Normalization

Normalization is used to measure correct DUT characteristics by correcting measurement errors caused by elements such as optical fiber cables and connectors for connecting the DUT.

Acquiring the correction data for the normalizing function should be performed in the same mode and wavelength range as when actually measuring the DUT.

2.2.7.1 Normalization (Transmission Characteristics Mode)

DUT transmission characteristics are measured using a center wavelength of 1534.95 nm and a span of 1.6 nm with the normalization function enabled.

Setup

1. Referring to 1.5 Setup, connect the display unit to the optical network analyzer.

Turning Power On

2. Turn on the power switches on the front panels.
   Initialization and self-test are done.
   When the self-test is completed, the initial screen is displayed (it takes about one minute).

Initializing Set State

Initialize the set state of this analyzer.

3. Press **SYSTEM** and ***PRESET***.
   Initial set conditions are read out.

Acquiring Normalized Data

4. Connect the cable between **TEST PORT 1** and **TEST PORT 2** bypassing the DUT.

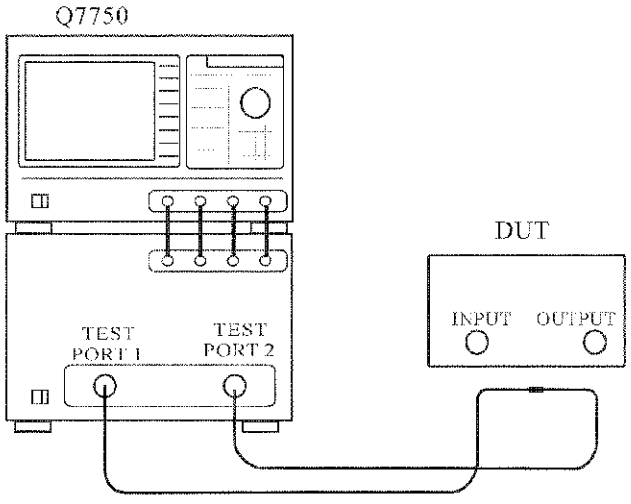


Figure 2-46 Connection with the DUT Bypassed

Measurement system characteristics are measured in the same mode and wavelength range as when actually measuring the DUT.

5. Press **TRANS/REFL** and ***TRANS***.
   The measurement mode is set to the transmission characteristic mode.

6. Press **MAG** and ***MAG***.
   The display mode is set to the amplitude characteristic mode.

7. Press **CENTER/SPAN**, ***CENTER***, **1, 5, 3, 4, ., 9, 5** and **THz**(n).
   The center wavelength is set to 1534.950 nm.

8. Press ***SPAN***, **1, ., 6** and **THz**(n).
   The display width is set to 1.6 nm.

9. Press **SINGLE**.
   Measurement system characteristics are displayed.

10. Press **CAL**, ***SV REF(TRANS)***.
    Measured measurement system characteristics are stored in reference memory.

11. Press ***NORML(TRANS)***.
    For subsequent measurement, normalization is effective.

Connecting the DUT

12. Connect the DUT to be measured to the analyzer.

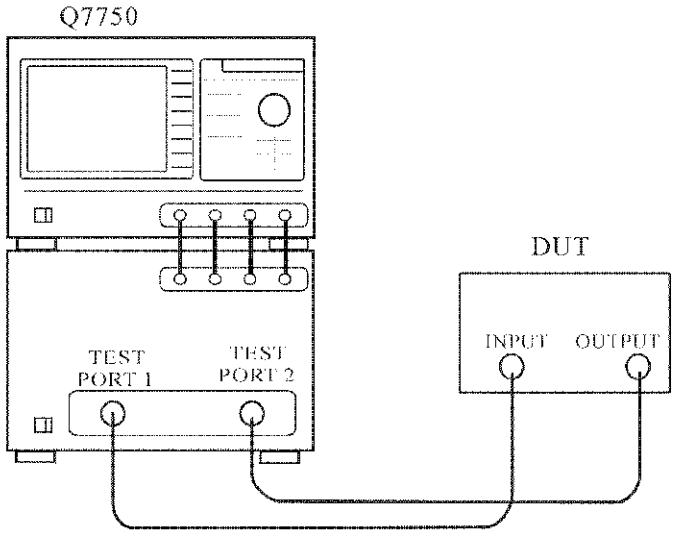


Figure 2-47 Connecting the DUT

Measuring the DUT

13. Press **SINGLE**.
Corrected DUT characteristics acquired by correcting errors in the measurement system are displayed.

NOTE: ***Changing the wavelength range invalidates normalization. Set the new wavelength, then acquire normalized data.***

2.2.7.2 Normalization (Reflection Characteristics Mode)

Normalization is available in the two states shown below with reference to the correction.

(1) Total reflection state (A total reflection fiber is connected to the tip of the fiber).

(2) Full Fresnel reflection (The tip of the fiber is opened).

DUT reflection characteristics are measured at a center wavelength of 1534.95 nm and a span of 1.6 nm with reference to the total reflection state using the normalization function.

Setup

1. Referring to 1.5 Setup, connect the display unit to the optical network analyzer.

Turning Power On

2. Turn on the power switches on the front panels.
Initialization and self-test are done.
When the self-test is completed, the initial screen is displayed (it takes about one minute).

Initializing Set State

Initialize the set state of this analyzer.

3. Press **SYSTEM** and ***PRESET***.
Initial set conditions are read out.

Acquiring Normalized Data

4. Connect the full reflection fiber.

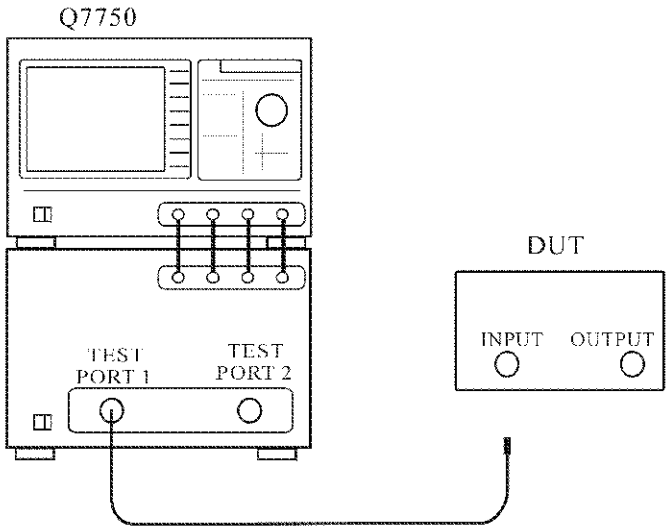


Figure 2-48 Connection with the DUT Bypassed

Measurement system characteristics are measured in the same mode and wavelength range as when actually measuring the DUT.

5. Press **TRANS/REFL** and ***REFL***.
   The measurement mode is set to the reflection characteristic mode.

6. Press **MAG** and ***MAG***.
   The display mode is set to the amplitude characteristic mode.

7. Press **CENTER/SPAN**, ***CENTER***, **1, 5, 3, 4, ., 9, 5** and **THz**(n).
   The center wavelength is set to 1534.950 nm.

8. Press ***SPAN*, 1, .,6** and **THz**(n).
   The display width is set to 1.6 nm.

9. Press **SINGLE**.
   Measurement system characteristics are displayed.

10. Press **CAL**, ***SV REF(REFL)***.
    Measured measurement system characteristics are stored in reference memory.

11. Press ***NORML(REFL)***.
    For subsequent measurement, normalization is effective.

Connecting the DUT

12. Connect the DUT to be measured to the analyzer.

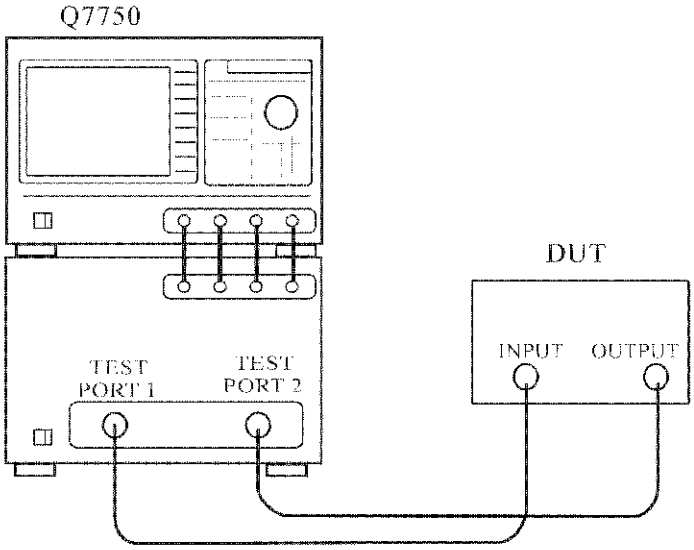


Figure 2-49 Connecting the DUT

Measuring the DUT

13. Press **SINGLE**.
Corrected DUT characteristics acquired by correcting errors in the measurement system are displayed.

NOTE: ***Changing the wavelength range invalidates normalization. Set the new wavelength, then acquire normalized data.***

2.2.8 Correcting Wavelength

Combining this analyzer with a wavelength meter TQ8325/Q8326 enables highly accurate wavelength measurement with wavelength error correction.

DUT reflection characteristics are measured within a central wavelength of 1534.95 nm and a span of 1.6 nm using wavelength correction.

Setup

1. Referring to 1.5 Setup, connect the display unit to the optical network analyzer.
2. Connect the B PORT of the display unit to the GPIB connector of the wavelength meter.
3. Connect the optical fiber cable from the MONITOR OUPUT connector on the rear panel of the optical network analyzer of the opt scope to the input connector of the wavelength meter.

Angled PC/FC connectors are used for the MONITOR OUTPUT terminals.
Accordingly, angled PC/FC connectors should be used to connect the unit. Using other types of connector may damage the internal connectors.
Insert an isolator with more than 40dB between the MONITOR OUTPUT and the INPUT of the wavelength meter TQ8325/Q8326 to avoid the effect of returned light.

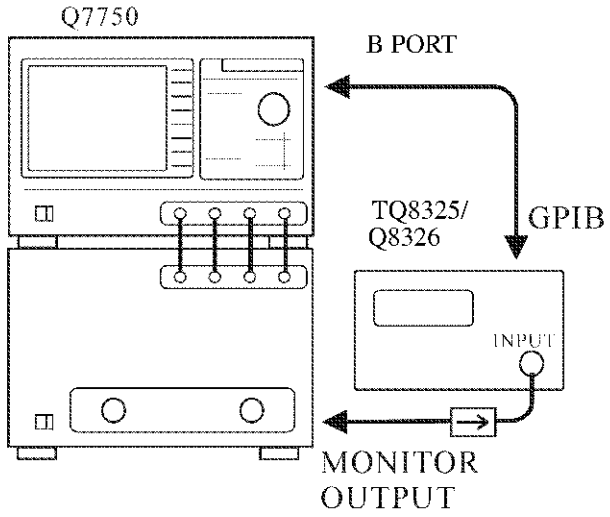


Figure 2-50 Connecting the Wavelength Meter

Turning the Power On

4. Turn on the **POWER** switch on the front panel.

Initializing Set State

5. Press **SYSTEM** and ***PRESET***.
   Initial setting conditions are read out.

Setting GPIB

6. Set the GPIB address of the wavelength meter to 8.
   For address setting, refer to the wavelength meter operation manual.

Wavelength Compensation Function

Setting the wavelength compensation function

7. Press **CAL** and ***λ comp***.
   The wavelength compensation menu is displayed.

8. Press ***λ COMP ON/OFF***(ON).
   The wavelength compensation function is turned on.

9. Press ***NORMAL ACRACY.***
   Wavelength compensation is executed with normal accuracy.

CAUTION: ***For the Q8326, select NORMAL ACRACY. Since NORMAL ACRACY allows the Q8326 to compensate the wavelength, HIGH ACRACY is not needed.***

---

10. Press ***WAVMTER AT IIP***(AT).
    The type of wavelength meter is set to ADVANTEST.

Connecting the DUT

11. Connect the optical fiber cable from **TEST PORT 1** connector on the front panel to the input connector of the DUT.

12. Connect the optical fiber cable from **TEST PORT 2** connector on the front panel to the output connector of the DUT.

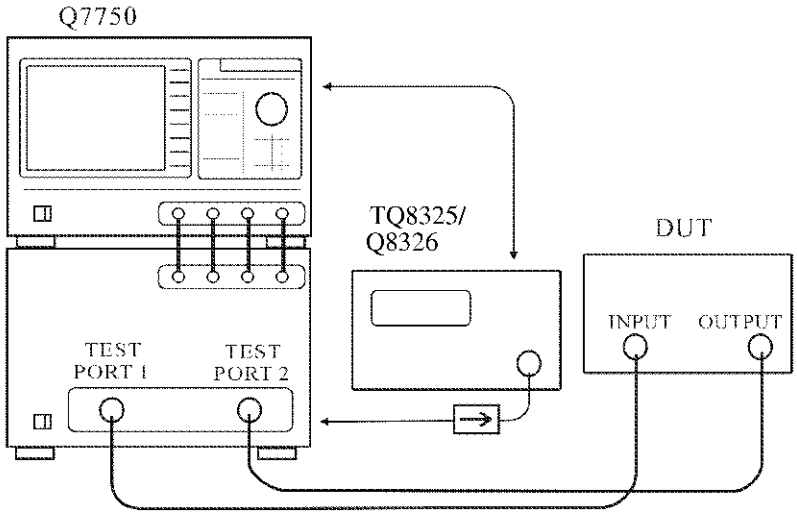


Figure 2-51 Connecting the DUT

Setting Measurement Conditions.

13. Press **TRANS/REFL** and ***REFL***.
14. Press **MAG** and ***MAG***.
15. Press **CENTER/SPAN**.
16. Press ***CENTER***, **1, 5, 3, 4, ., 9, 5** and **THz(n)**.
17. Press ***SPAN***, **1, ., 6** and **THz(n)**.
18. Press **SINGLE**.
    The highly accurate horizontal axis with wavelength error correction and DUT reflection amplitude characteristics are displayed.

2.3 Enhanced Functions

2.3.1 Save/Recall

This analyzer is provided with a function to save/recall the measurement conditions and measurement results in memory and on floppy disks. The analyzer can save/recall three sets of measurement results in memory by a simple operation.

The following operational examples are explained here.

Simple save /recall for measurement results.
Save/recall of the measurement conditions.
Saving displayed screen data

(1) Simple saving of measurement results

Saving measurement results

1. Press **SAVE**.
   The SAVE menu will be displayed.

2. Press ***SAVE MEAS1***.
   The measurement result currently displayed on the screen will be saved in the first block of memory.
   Likewise, other measurement results can be saved in the second and third blocks respectively.

(2) Simple recalling of measurement results

Recalling of measurement results

1. Press the **RECALL**.
   The RECALL menu will be displayed.

2. Press ***RECALL MEAS1***.
   The measurement results saved in the first block of memory will be recalled to the screen.
   Likewise, the measurement results saved in the second and third blocks can be recalled.

(3) Saving measurement conditions to floppy disk

Setting the saving destination

1. Press **SAVE**.
   SAVE menu will be displayed.

2. Press the ***MED FD***(FD).
   The floppy disk will be selected.

Selecting file

3. Press ***save panel***.
   The directory list of the floppy disk and the save panel menu will be displayed.

4. Turn the knob to select the empty column.
   Select the empty row of the directory list in order to save the measurement conditions again.

File name entry

When saving, it is possible to fix a unique name as well as the file name to the file automatically (based on the current center wavelength and the serial number).
If a unique name is not needed, skip to the 8 step. In this case, enter "AMP_TEST" as the file name.

5. Press the ***name***.
   The name menu and the Character list will be displayed.

6. Enter the character "A"
   Turn the knob to put the cursor on "A" in the character list, then press the ENTER key.
   The character "A" will be entered into the input buffer.
   Enter "A," "M," "P," "_," "T," "E," "S" and "T" likewise.

7. Press any one of the keys **THz(n)**, **GHz(μ)**, **MHz(m)** and **X1**.
   "AMP_TEST" entered into the input buffer will be displayed as a file name on the directory list.

Executing save

8. Press ***SAVE***.
   The currently set measurement conditions will be saved to floppy disk.

9. Press ***EXIT***.
   The mode will return to the measurement state.

(4) Recalling measurement conditions from floppy disk

Setting the recall source

1. Press **RECALL**.
   The RECALL menu will be displayed.

2. Press the ***MEM FD*** (FD).
   The floppy disk will be selected.

Selecting file

3. Press **RECALL** then ***recall panel***.
   The directory list of the floppy disk and the rcl panel menu will be displayed.

4. Turn the knob to select a file. Then press ***RECALL***.
   The specified file is recalled and the analyzer system enters the measurement state.

(5) Saving displayed screen data to a floppy disk

Displayed screen data is saved to a floppy disk as a bitmap file (extension: rle).
These bitmap files can be opened on any personal computer which uses Windows 95, Windows 98 or the Macintosh OS.

Saving Displayed Screen Data

1. Press **SAVE** and ***BITMAP SAVE***.
   The currently displayed screen data is saved to a floppy disk as image data.

2.3.2 Initializing Media

This section explains how to initialize floppy disks.

A new floppy disk must be formatted before storing data on it.

3.5 inch 2DD 720KB, and 2HD 1.44MB floppy disks (conformed to the MS-DOS format) can be used for this analyzer.

Write protection of floppy disk

A floppy disk has a write protection function so that stored data will not be erased or overwritten by an operational error.
The write protection tab on the rear side of the floppy disk is used for write protection.

Setting write protection: Slide the write protection tab so that the hole is opened.

Releasing write protect: Slide the write protection tab so that the hole is closed.

Initializing the floppy disk

Confirming write protection

1. Check whether write protection on the floppy disk has been released.
2. Insert the floppy disk into the disk drive.

Initializing the floppy disk

CAUTION: Initializing the floppy disk will erase all data on the disk.

---

3. Press **SYSTEM,** ***floppy*** and ***format***.
   The format menu initializing the floppy disk will be displayed.
4. Press ***2HD (1.44M)*** and ***EXECUTE***.
   The floppy disk is initialized to MS-DOS 1.44MB format. The access indicator flashes during initialization (for about one minute).
5. Press ***prev menu***.

Volume name entry

When there is no need to manage floppy disks with a volume name attached, the following operation is unnecessary.

In this case, set the volume name to "DATA1."

6. Press ***volume***.
   The volume name and the Character list will be displayed.

7. Enter the character "D"
   Turn the knob to put the cursor on "D" in the character list. Then press the ENTER key.
   The character "D" will be entered into the input buffer.
   Enter "A," "T," "A" and "1."

8. Press any one of the keys **THz(n)**, **GHz(μ)**, **MHz(m)** and **x1**.
   The "DATA1" entered in the input buffer will be read as a volume name into the floppy disk.

2.3.3 Setting Date/Time

This section explains how to set the date and the time.

For example, the clock is set to 13:45, February 9, 1999.

Setting date

1. Press **SYSTEM** and ***clock***.
   The clock menu will be displayed.

2. Press ***YEAR***.
   Set "1999" with the data knob, ↑ or ↓ key.
   The year 1999 is set.

3. Press ***MONTH***.
   Set "2" with the data knob, ↑ or ↓ key.
   February is set.

4. Press ***DAY***.
   Set "9" with the data knob, ↑ or ↓ key.
   The ninth is set.

Setting time

5. Press ***HOUR***.
   Set "13" with the data knob, ↑ or ↓ key.
   13:00 is set.

6. Press ***MINUTE***.
   Set "45" with the data knob, ↑ or ↓ key.
   00:45 is set.

2.3.4 Screen Data Output

This section describes how to print out screen data.

This analyzer system can output screen data to the provided printer using a parallel interface (compliant with the Centronics). Even though a color printer is connected to the analyzer, the printer prints out in monochrome.

NOTE: ***The output resolution of this analyzer system is 180 dots/inch. Using a printer with a resolution other than integral multiples of 180 dots/inch may cause striped patterns to appear.***

Printers provided with ESC/P, ESC/P raster, or HP PCL as the printer control code can be used with this analyzer (some printer operations may be restricted).
Table 2-1 shows typical examples.

Table 2-1 Recommended Printers

Manufacturer	Model
EPSON	PM-750C (ESC/P R)
HEWLETT-PACKARD	DeskJet 694C, DeskJet 880L (PCL)
CANON	BJC-430J (ESC/P)

Connecting the printer

1. Connect the printer cable to the PRINTER connector on the rear panel.
   The printer cable specified by the printer manufacturer must conform to IBM-PC specifications.

CAUTION: ***To prevent the units from being damaged, the printer cable should be connected after turning the power off.***

Setting the print mode

2. Press **COPY** while displaying the screen to be printed.
   The COPY menu used to copy measurement results will be displayed.

3. Press ***ESC/P, ESC/P R or PCL.***
   ESC/P, ESC/P R or PCL then becomes valid.
   This analyzer system uses ESC/P (Epson Standard Code for Printers), ESC/PR (Epson Standard Code for Printer Raster mode), or HP PCL (Hewlett-Packard Printer Command Language) as the printer control code. Choose the printer control code that matches the printer to be used.

Print Operation

4. Press **EXE PRT** while displaying the screen to be printed.
   The screen data will be output to the printer. The time required for printing depends on the print mode and the printer used, etc.

3 Measurement Examples

3.1 Fiber Bragg Grating Filter Measurement

This optscope can be used to measure the following reflection and transmission characteristics simultaneously: magnitudes (MAG), the group delay time (DELAY), chromatic dispersion (CD) and chromatic dispersion slope (CD SLOPE). This example shows how to measure the magnitudes of reflection and transmission, and group delay time characteristics of Fiber Bragg Gating filters (which are used for adding or dropping signals over a transmission bandwidth of 50 GHz) using the following functions.

- 2-screen display: Two graphs are displayed simultaneously.
- Cursor display: The measured value can be verified using the cursor.
- Bandwidth analysis: Analyzes the bandwidth.

Measurement conditions

Center wavelength: 1551.9 nm

Wavelength span: 1.2 nm

Sweep mode: Continuous sweep

Modulation frequency: 2 GHz

Setup

1. Connect the appropriate cables between the optical network analyzer and the display units.

Turning Power On

2. Make sure that the Power switch (on the front panel) is in the OFF position for each panel.

3. Plug the power cable into the outlet.

4. Turn on the power switch (on the front panel) of each unit.
   Internal initialization and self-test are automatically performed. The initial screen is displayed when the self-test is complete (This process approximately one minute in total).

Initializing the Set Conditions

5. Press **SYSTEM** and ***PRESET***.
   This initializes the set conditions of this analyzer.

Connecting the DUT

6. Connect the optical fiber cable from **TEST PORT 1** on the front panel to the input connector of the DUT.

7. Connect another optical fiber cable from **TEST PORT 2** on the front panel to the output connector of the DUT.

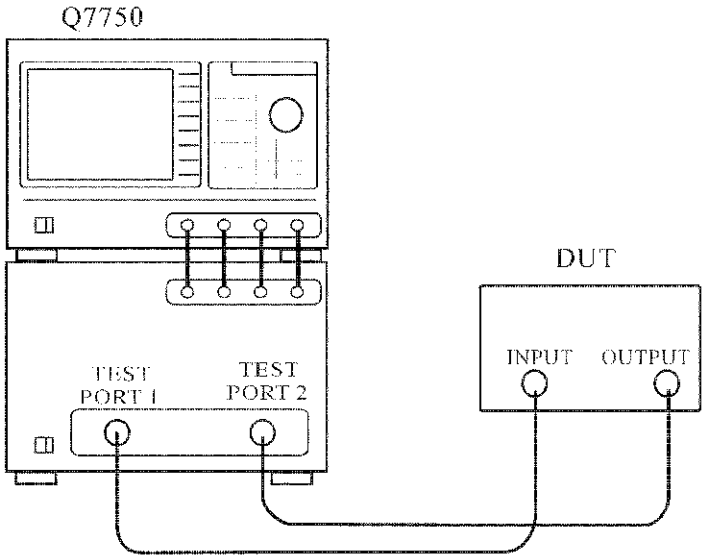


Figure 3-1 Connecting the DUT

Setting the Measurement Conditions

8. Press **TRANS/REFL** and ***TRANS***.
   The measurement mode is set to the transmission measurement mode.

9. Press **MAG** and ***MAG***.
   The measurement mode is set to the transmission magnitude.

10. Press **CENTER/SPAN**.
    The CEN/SPAN menu used to set measurable ranges is displayed.

11. Press ***CENTER***, **1**, **5**, **5**, **1**, **.**, **9** and **THz(n)**.
    A center wavelength of 1551.9 nm is set.

12. Press ***SPAN***, **1**, **.**, **2** and **THz(n)**.
    A display width of 1.2 nm is set.

13. Press **MEAS/FIT**, ***sweep mode*** and ***CONT SWEEP***.
    The sweep mode is set to Continuous sweep mode.

NOTE: ***Two sweep modes are available for any span of less than 10 nm: Continuous and Step sweep modes. Continuous sweep mode is suitable for measuring Fiber Bragg Grating filters and so on which require a narrow-band; and Step sweep mode is suitable for measuring long distance fibers which require a wide-band.***

---

14. Press **MEAS/FIT**, ***sens*** and ***NORMAL***.
    The sensitivity is set to NORMAL.

NOTE: ***There are four settings: HIGH SENS, MIDDLE SENS, NORMAL SENS and III SPEED.***
If HIGH SENS is used, better S/N ratio measurement results are obtained, although the sweep speed is slower. If III SPEED is used, S/N ratio measurement results are not as good, but the sweep speed is faster (refer to Section 6.4, "Technical Information"). When the continuous sweep is used, we recommend that the sensitivity be set to NORMAL because the difference in sweep speed is very large. When the step sweep is used, however, the sweep speed remains the same, although the difference in sensitivity is still very large.

15. Press **MEAS/FIT**, ***MOD FREQ***, **2** and **GHz**.
A modulation frequency of 2 GHz is set.

NOTE: ***The modulation frequency determines the resolution of the vertical axis and the effective range when measuring the group delay time, dispersion or dispersion slope (refer to 6.2 Modulation Frequency). A high modulation frequency must be used to obtain a high group delay time resolution for optical devices which have a low dispersion.***

Measuring the DUT

16. Press **SINGLE**.
The measurement starts, and then DUT magnitude characteristic data is displayed (This process approximately 30 seconds to do this).

17. Press **SCALE** and ***AUTO***.
The scale of the vertical axis is optimized according to the measured value.

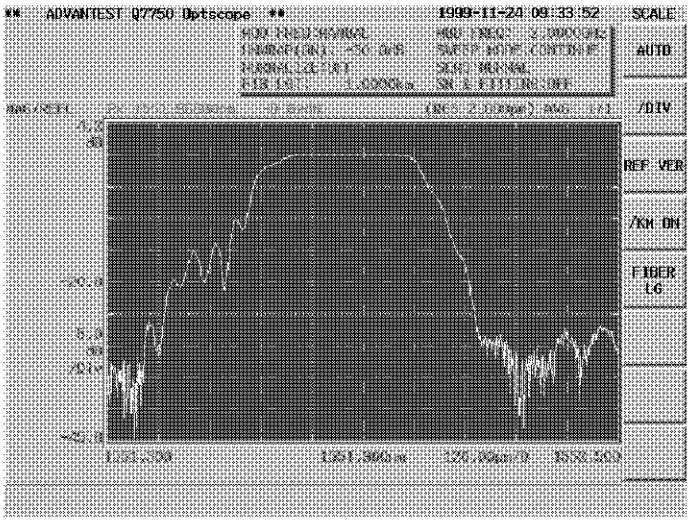


Figure 3-2 Transmission Magnitude Characteristics

18. Press **TRANS/REFL** and ***REFL***.
    The reflection magnitude characteristic data is displayed.

19. Press **SCALE** and ***AUTO***.
    The scale of the vertical axis is optimized according to the measured value.

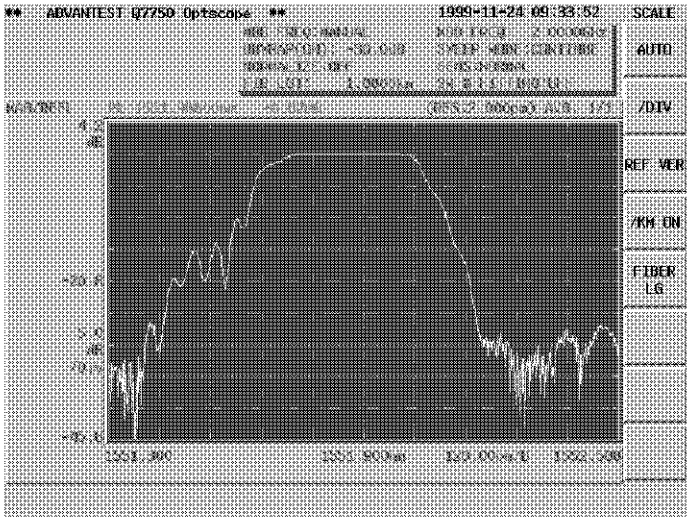


Figure 3-3 Reflection Magnitude Characteristics

20. Press **DELAY** and ***GROUP DELAY***.
    The reflection group delay time characteristic data is displayed.

21. Press **SCALE** and ***AUTO***.
    The scale of the vertical axis is optimized according to the measured value.

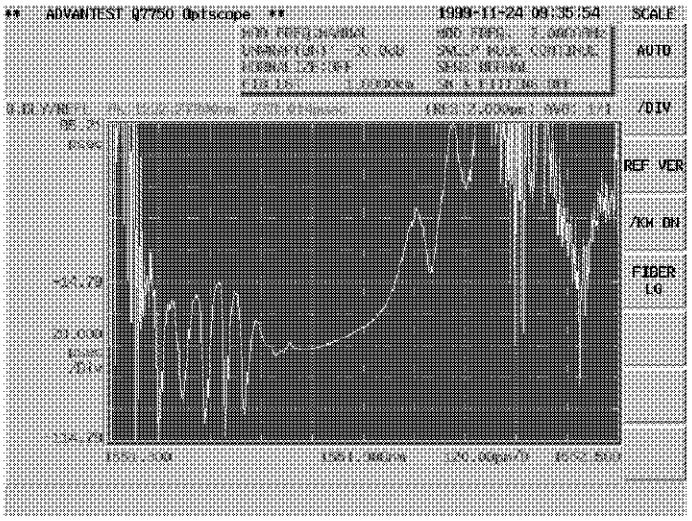


Figure 3-4 Reflection Group Delay Time Characteristics

Two-screen Display

22. Press **DISPLAY**, ***dual disp*** and ***ON/OFF***(ON).
The screen display is in 2-screen display mode.

23. Press **MAG** and ***MAG***.
The reflection magnitude characteristic data is displayed in the upper part of the screen, and the group delay time characteristic data of reflection is displayed in the lower part of the screen.

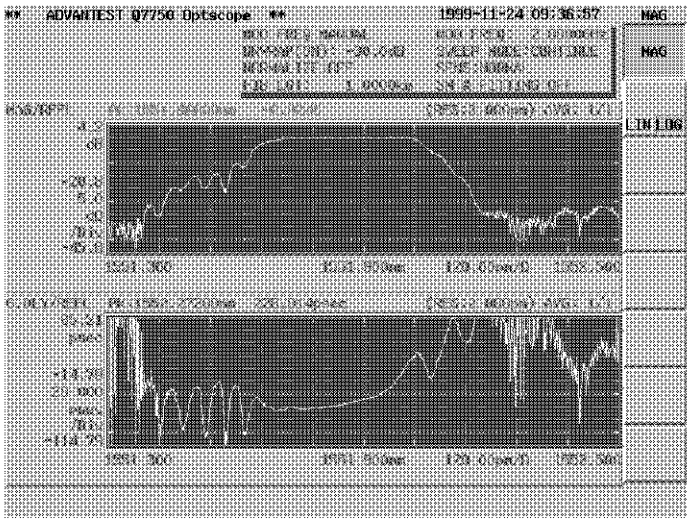


Figure 3-5 Two-Screen Display

24. Press **DISPLAY**, ***dual disp*** and ***ON/OFF***(OFF).
The screen display is switched back to one-screen mode.

Using the Cursor

25. Press **CURSOR** and ***ON/OFF***(ON).
The X1 cursor is displayed. The wavelength and level of the current cursor position is displayed in cursor area.

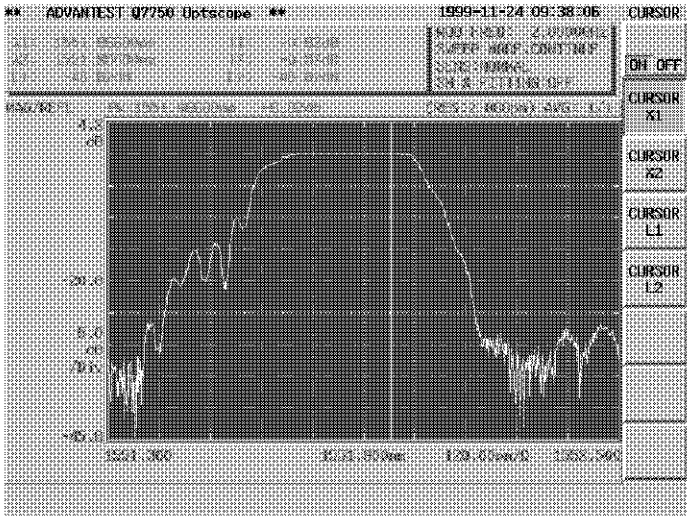


Figure 3-6 Cursor Display

26. Move the cursor using the data knob.
    Turn the data knob until the X1 cursor is within the flat part (pass band). The wavelength and the transmission magnitude characteristic data of the current cursor position are displayed in the cursor area.

27. Press **CURSOR** and ***CURSOR X2***.
    The X2 cursor is displayed. The wavelength and level of the current cursor position are displayed in the cursor area. Turning the data knob under these conditions moves the X2 cursor.

Measuring Bandwidth

Analyzes a bandwidth and its center wavelength.

28. Press **CURSOR** and ***CURSOR X1***.
    The X1 cursor is activated.

29. Move the X1 cursor to the left end of the analysis range by turning the data knob.

30. Press **CURSOR** and ***CURSOR X2***.
    The X2 cursor is activated.

31. Move the X2 cursor to the right end of the analysis range by turning the data knob.
    The span between the X1 and X2 cursors becomes the target band.

32. Press **MODE**, ***band width***, ***param***, ***XdB***, **3** and **x1**.
    The attenuation, which is used to calculate the bandwidth, is set to 3 dB.

33. Press ***prev menu***.

34. Press ***PK-XdB***.
The two cursors are displayed at both ends of the 3-dB bandwidth, and this 3-dB bandwidth and the center wavelength are displayed in the cursor area.

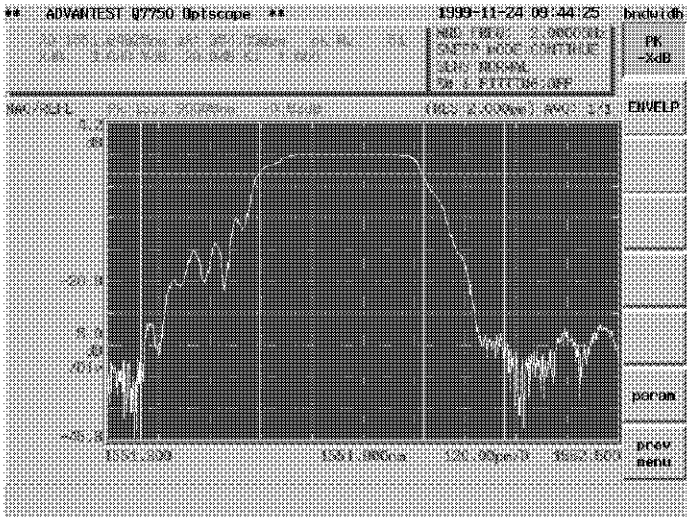


Figure 3-7 Bandwidth Analysis

3.2 Example of Optical Fiber Characteristic Measurement

This optscope can be used to measure the following reflection and transmission characteristics simultaneously: magnitudes (MAG), the group delay time (DELAY), chromatic dispersion (CD) and chromatic dispersion slope (CD SLOPE). This example shows how to measure the transmission group delay time, chromatic dispersion and chromatic dispersion slope of a dispersion shift fiber of approximately 20 km using the following functions.

- Differential measurement function: Removes the effects caused by the group delay drift of a DUT.
- Normalization function: Compensates for the characteristics of the fiber used to connect the DUT.
- Distance measurement: Measures the length of the DUT.
- Curve fitting function: Makes an approximation from the measurement data using a polynomial.
- Report display function: Displays a list of measurement conditions or measurement data.

Measurement conditions

Wavelength range: 1530 nm to 1590 nm

Sweep mode: Step sweep

Number of measurement points: 21 (Wavelength resolution: 3.0 nm)

Optical fiber refraction factor: 1.475

Setup

1. Connect the necessary cables between the optical network analyzer and the display units.

Turning the Power On

2. Plug the power cable into the outlet.

3. Turn on the power switch (on the front panel) for each unit.
   Internal initialization and self-test are automatically performed. The initial screen is displayed when the self-test is complete (This process approximately one minute to complete).

Initializing the Set Conditions

4. Press **SYSTEM** and ***PRESET***.
   This initializes the set conditions of this analyzer.

Setting Measurement Conditions

The measurement conditions are set so that the characteristic data can easily be observed.

5. Press **TRANS/REF** and ***TRANS***.
   Measurement mode is set to the transmission characteristic mode.

6. Press **DELAY** and ***GROUP DELAY***.
   The group delay time of the transmission characteristics is selected as the measurement target.

7. Press **CENTER/SPAN**.
   The CEN/SPAN menu used to set the measurable range is displayed.

8. Press ***START***, **1**, **5**, **3**, **0** and **THz(n)**.
   A start wavelength of 1530.0 nm is set.

9. Press ***STOP***, **1**, **5**, **9**, **0** and **THz(n)**.
   A stop wavelength of 1590.0 nm is set.

10. Press **MEAS/FIT**, ***sweep mode*** and ***STEP SWEEP***.
    The sweep mode is set to Step Sweep mode.

11. Press **MEAS/FIT**, ***sweep mode***, ***meas mode*** and ***DIFF MEAS***.
    The differential measurement mode is turned on.

NOTE: ***If NORMAL MEAS is turned on, adjacent data points are measured sequentially. If DIFF MEAS is turned on, differential measurements are made to cancel the effects of group delay time drift to provide a stable measurement. The amount of time required to perform the sweep, however, is approximately two times that for NORMAL MEAS Mode (refer to Section 6.5, "Differential Measurement").***

---

12. Press ***DATA POINTS***, **2**, **1** and **x1**.
    The number of measurement points is set to 21.

NOTE: ***There are two sweep modes: Continuous and Step sweep modes. Continuous sweep mode is suitable for measuring fiber grating which require a narrow-band, and Step sweep mode is suitable for measuring long distance fibers which require a wide-band. The number of measurement points for Continuous sweep mode is fixed at 601, but the number of measurement points for Step sweep can be any value between 11 and 301. In addition, the wavelength resolution can be specified directly instead of using the number of points.***

---

13. Press ***MEAS/FIT, sens*** and ***HIGH SENS***.
The sensitivity is set to HIGH SENS.

NOTE: ***There are four classes of sensitivities: IIIGII SENS, MIDDLE SENS, NORMAL SENS and HI SPEED.***
If IIIGII SENS is used, better S/N ratio measurement results are obtained, although the sweep speed is slower. If HI SPEED is used, S/N ratio measurement results are not as good, but the sweep speed is faster (refer to Section 6.4). When the step speed is used, we recommend that the sensitivity be set to HIGH SENS because the sweep speed remains unchanged even if the sensitivity setting is changed. When the continuous sweep is used, however, the difference in sweep speed is large.

---

14. Press **ADVANCE**, ***FIBER INDEX***, **1**, **.**, **4**, **7**, **5** and **x1**.
The refraction factor of the targeted optical fiber is set to 1.475.

Acquiring Normalized Data

NOTE: ***This function is used to cancel the effect caused by the dummy fiber. Use this function as needed.***

---

15. Bypass the DUT and connect the optical fiber used for the setup.

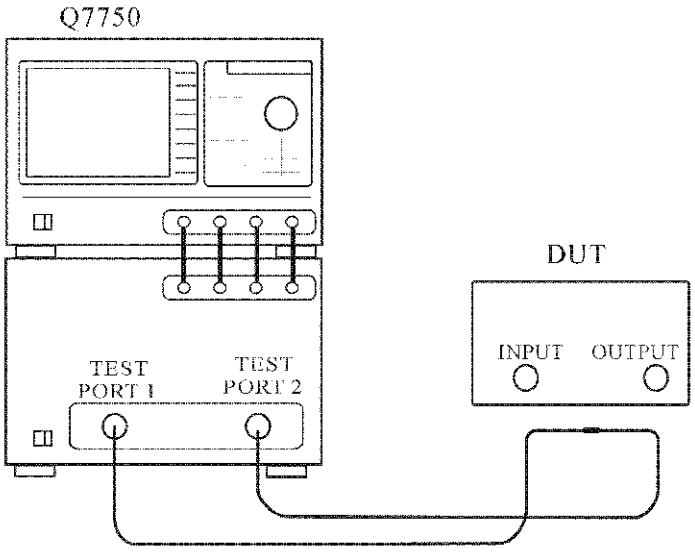


Figure 3-8 Connection Bypassed the DUT

16. Press **ADVANCE** and ***DISTANC***.
The length of the optical fiber used for the setup is measured. (It takes a few minutes to complete.)

17. Press **AUTO** and ***MOD FREQ***.
The modulation frequency is automatically set, and the characteristics of the optical fiber used for the setup are measured. (It takes approximately three minutes to complete.)

NOTE: ***The modulation frequency determines the resolution of the vertical axis and the effective range when measuring the group delay time, dispersion or dispersion slope (refer to 6.2 Modulation Frequency). The modulation frequency must be set to an optimum value to accurately measure an optical fiber using a long span because measured values vary greatly. MOD FREQ AUTO is used to do this by automatically adjusting the modulation frequency to an optimum value.***

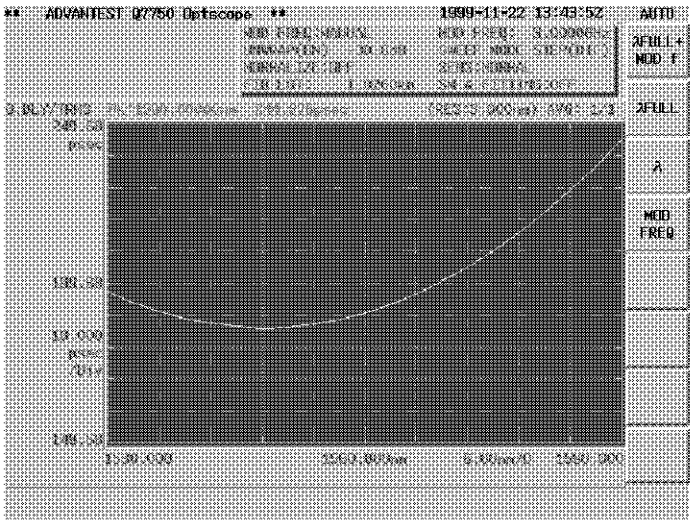


Figure 3-9 Characteristics Obtained By Bypassing the DUT

18. Press **CAL** and ***SV REF (TRANS)***.
The measured data of the optical fiber is saved as reference data. The measured data on the fiber length (obtained in Step 16.) is also saved.

Measuring the DUT

19. Connect the DUT.

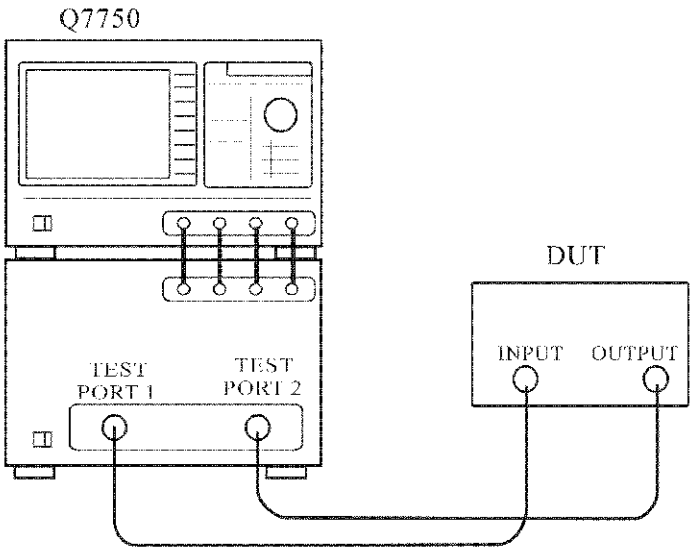


Figure 3-10 Connecting the DUT

20. Press **ADVANCE** and ***DISTANC***.
The fiber length of the DUT is measured (This process a few minutes to do this). The result is displayed in the lower left-hand corner on the screen when the measurement finishes.

21. Press **AUTO** and ***MOD FREQ***.
The modulation frequency is automatically set to measure the characteristics of the DUT (This process approximately three minutes to measurement).

22. Press **CAL** and ***NORMAL (TRANS)***.
The normalization function is turned on. The DUT characteristic data (which has been compensated for the distance of the fiber (used for the setup) and has been saved in Step 18.) is displayed.

23. Press **SCALE,** ***AUTO***.
The scale of the vertical axis is optimized.

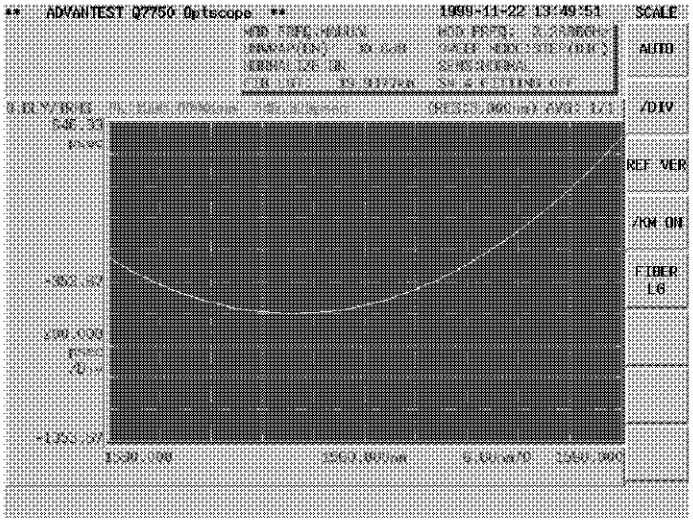


Figure 3-11 Group Delay Time Characteristics

Curve Fitting Function

The curve fitting function is used to analyze optical fiber measurement results.

24. Press **MEAS/FIT** and ***fit***.
The menu used for fitting is displayed.

NOTE: ***There are four expressions used to perform curve fitting: the linear expression (LINEAR FIT), the quadratic polynomial (QUAD FIT), the Sellmeier's cubic polynomial (SELM 3 FIT) and the Sellmeier's quintic polynomial (SELM 5 FIT) (refer to 6.8 Curve Fitting Function and Statistical Variance).***

---

25. Press ***SELM5 FIT***.
The curve fitting function is set to the Sellmeier's quintic polynomial.

26. Press ***FIT ON/OFF***(ON).
The curve fitting function is turned on and a graph using curve fitting is displayed. The zero-dispersion wavelength and the fitting error are displayed in the upper left corner together with the graph using curve fitting.

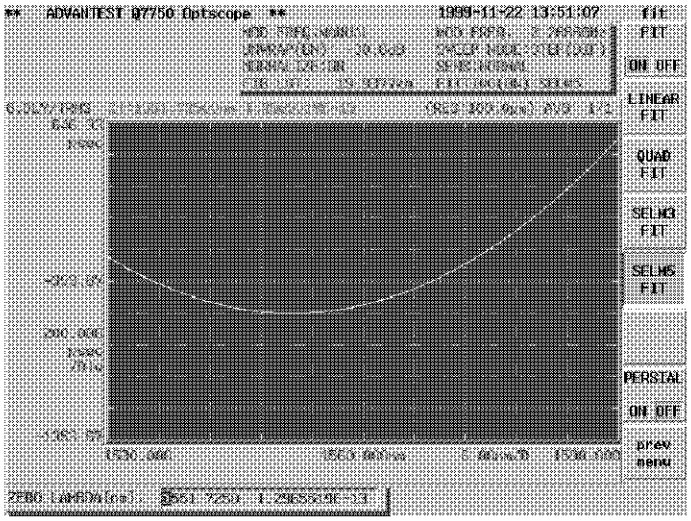


Figure 3-12 Group Delay Time Characteristics with Curve Fitting

27. Press **DISPERSION** and ***CD*** or ***CD SLOPE***.
The chromatic dispersion characteristic data (chromatic dispersion slope characteristics) is displayed.

28. Press **SCALE** and ***AUTO***.
The scale of the vertical axis is optimized according to the measurement results.

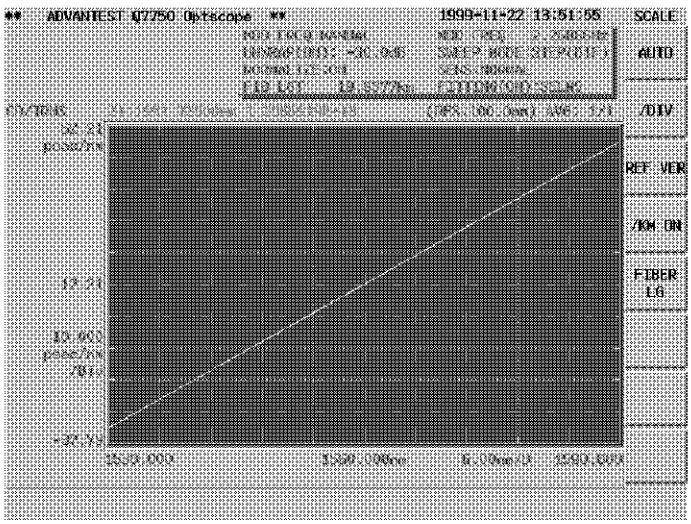


Figure 3-13 Chromatic Dispersion Characteristics with Curve Fitting

29. Press **SCALE** and ***/KM ON***.
The characteristic data per kilometer is displayed.

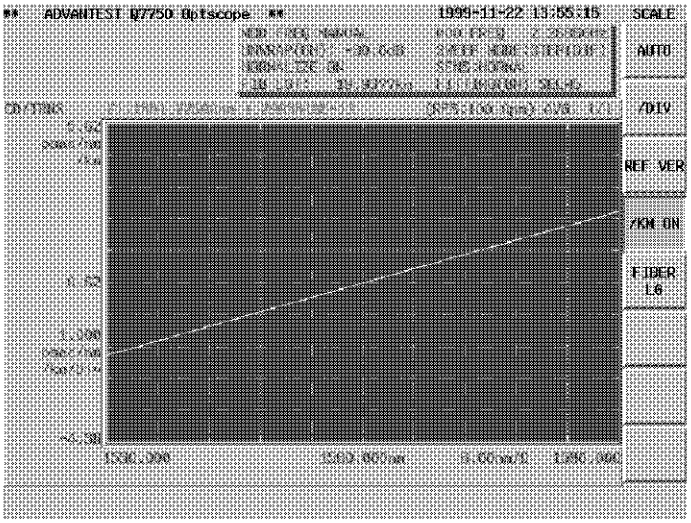


Figure 3-14 Chromatic Dispersion Characteristic Data per Kilometer

Report Display Function

30. Press **DISPLAY**, ***report*** and ***ON/OFF***(ON).
A list showing the measurement conditions and measured values is displayed.

NOTE: ***The following information is displayed, starting from the left side:***
- Wavelength (λ)
- Group delay time (G. Delay Measured)
- Group delay time using curve fitting (G. Delay With Fitted)
- Group delay dispersion using curve fitting (CD Fitted)
- Group delay dispersion slope using curve fitting (CD Slope Fitted)
- Group delay dispersion slope using curve fitting and displayed in kilometers (CD Slope Fitted /km).
Take notice that the relationships between the displayed values in the report, actual value in the report and the measured values are:
Displayed value in the report = [Actual value in the report] - [Minimum measured value]

---

31. Press **1**, **5**, **6**, **0** and **THz(n)**.
    A value of 1560 nm is set to the top of the list.
    In addition, you can scroll through the list turning the knob.

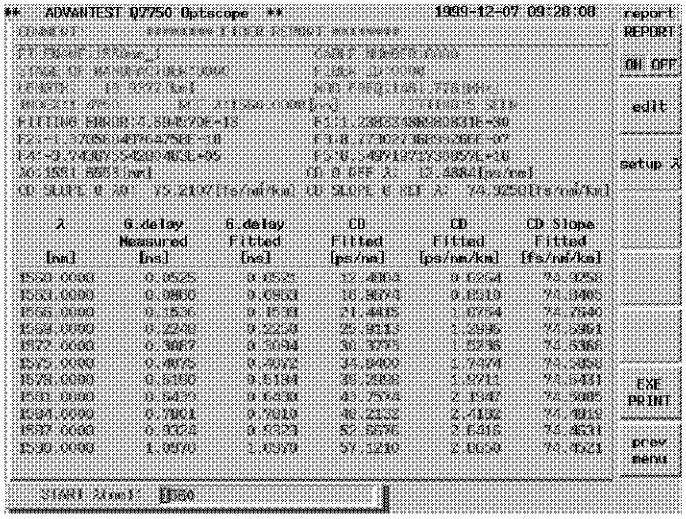


Figure 3-15 Displaying the Report

4 REFERENCE

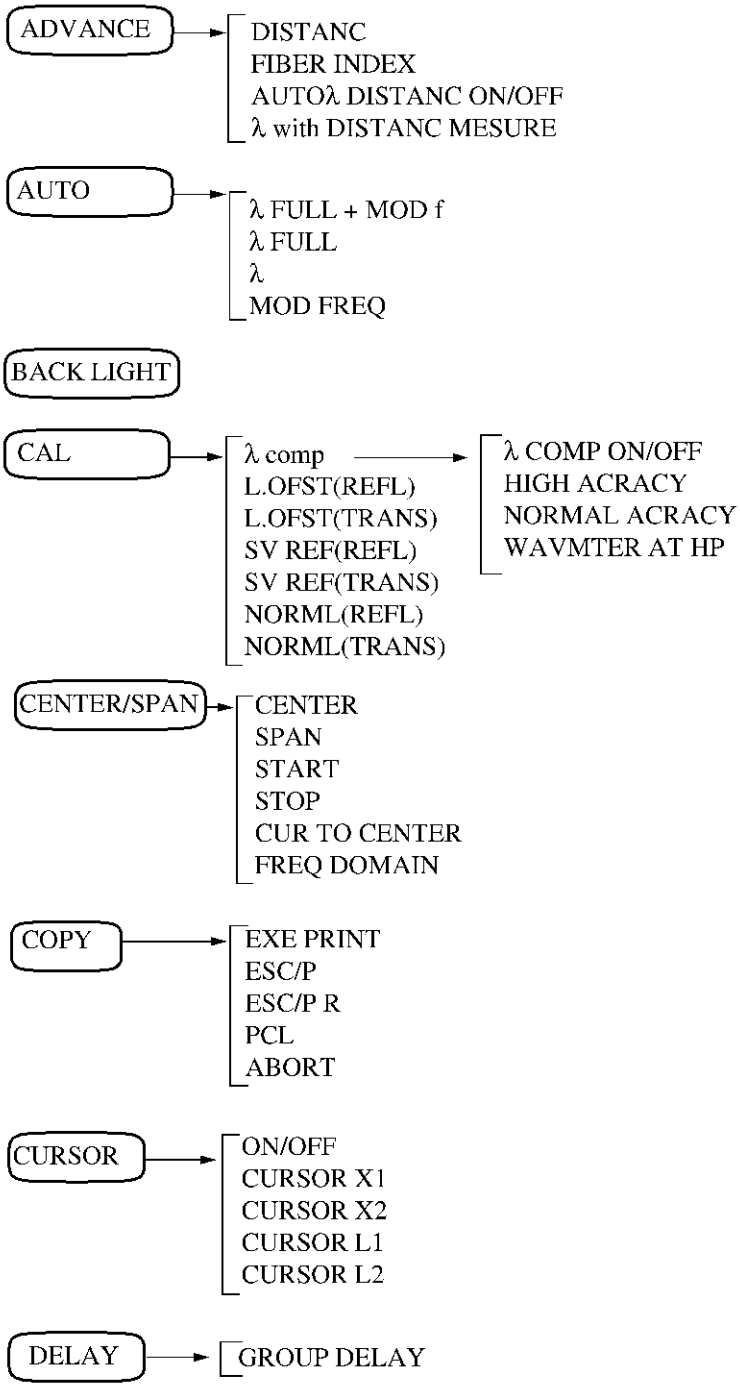
4.1 Menu Index

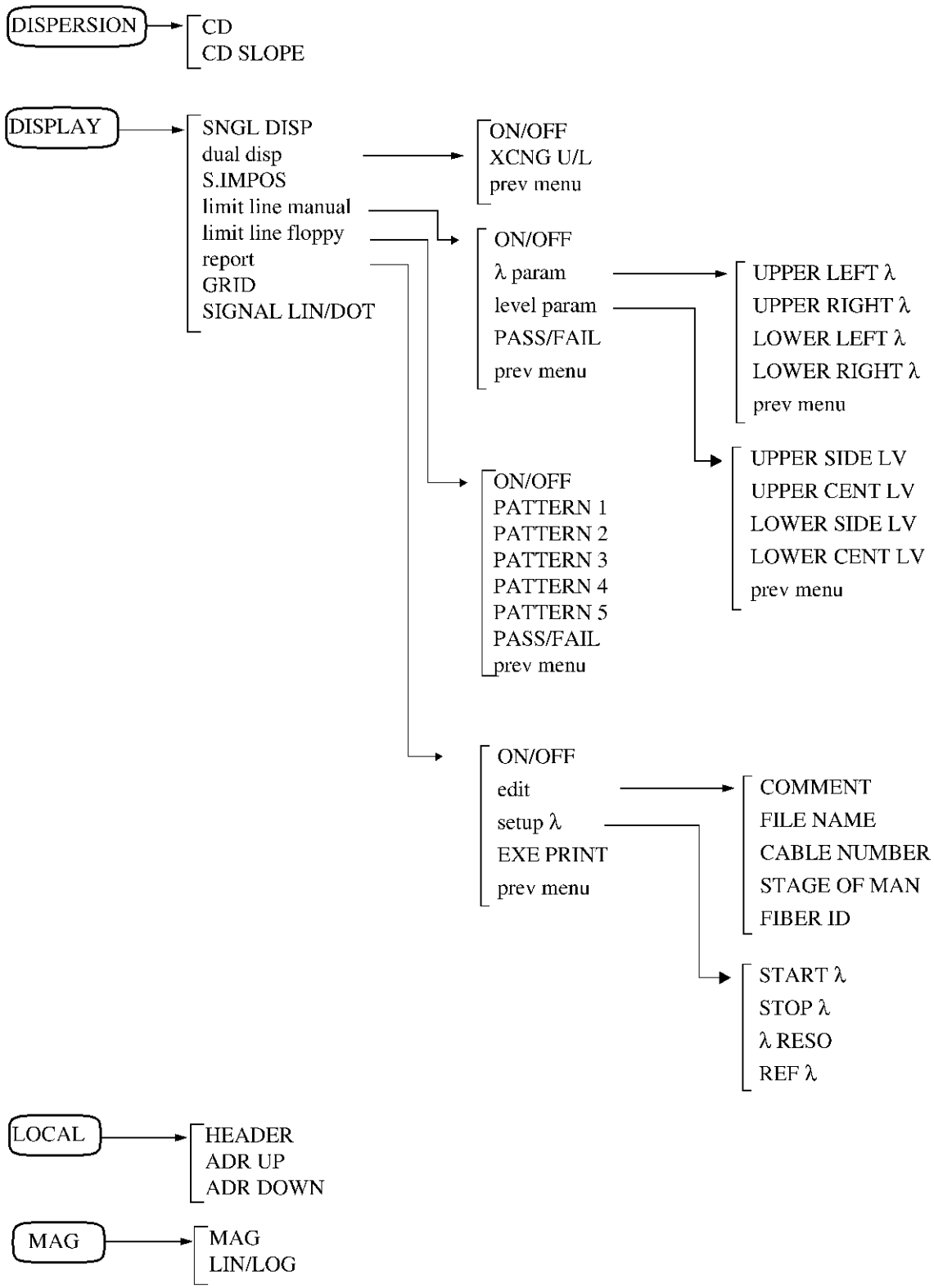
This menu index is used to easily find the keys described in Chapter 4.

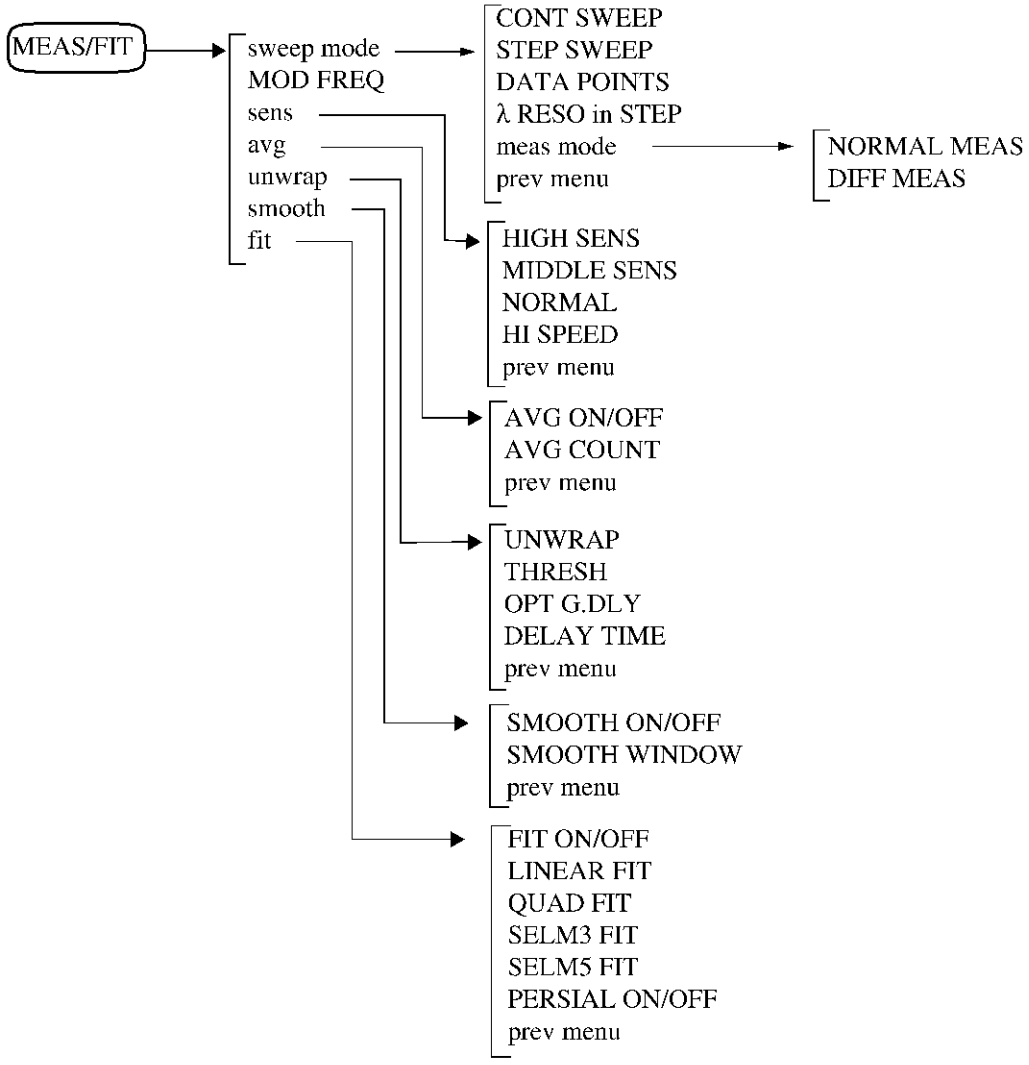
4.2 Menu Map

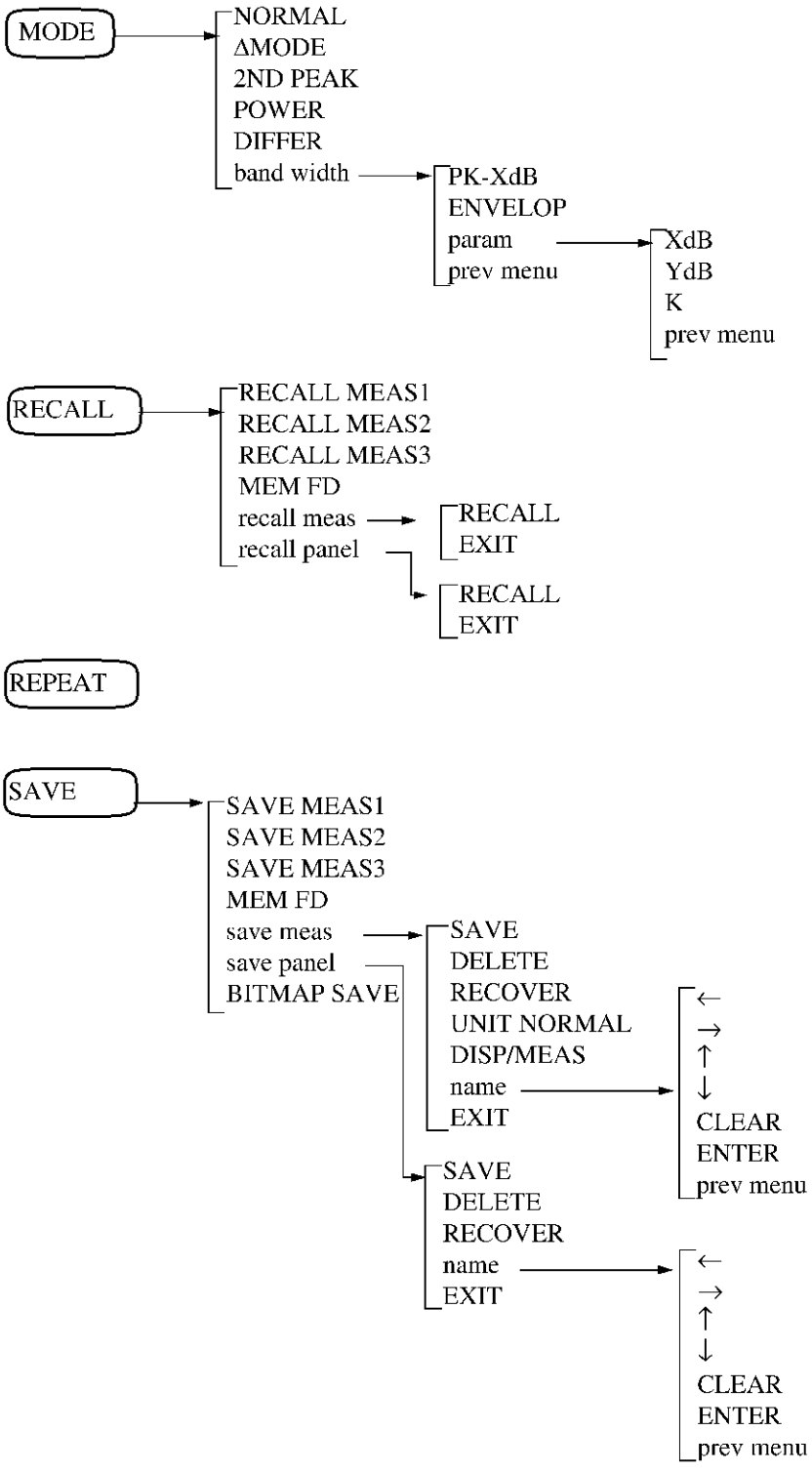
This section shows the hierarchical menu configuration on a panel key basis.

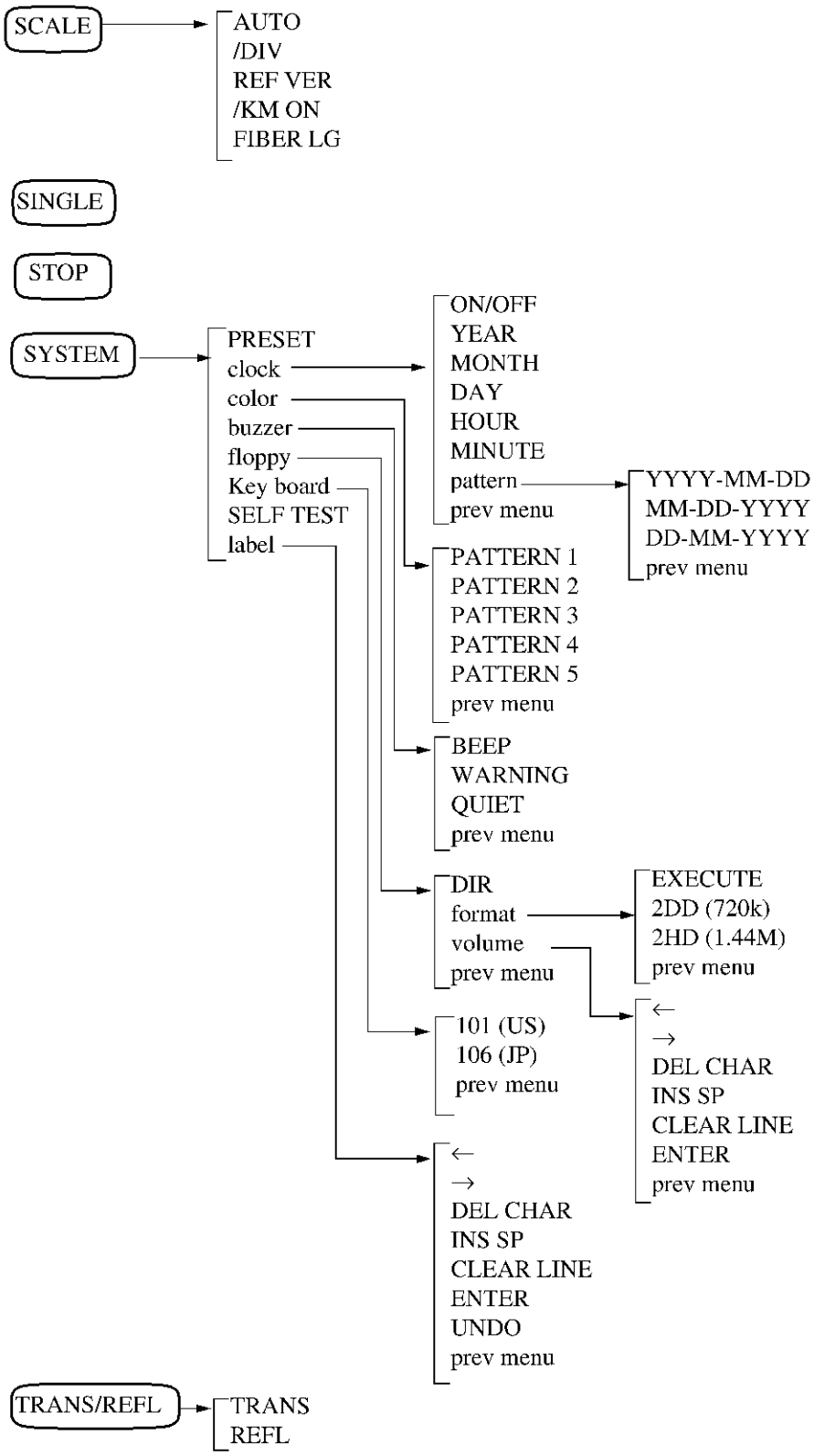
NOTE: ( ) ***is Panel key.***




DISPERSION
CD
CD SLOPE
DISPLAY
SNGL DISP
dual disp
S.IMPOS
limit line manual
limit line floppy
report
GRID
SIGNAL LIN/DOT
ON/OFF
XCNG U/L
prev menu
ON/OFF
λ param
level param
PASS/FAIL
prev menu
UPPER LEFT λ
UPPER RIGHT λ
LOWER LEFT λ
LOWER RIGHT λ
prev menu
UPPER SIDE LV
UPPER CENT LV
LOWER SIDE LV
LOWER CENT LV
prev menu
ON/OFF
PATTERN 1
PATTERN 2
PATTERN 3
PATTERN 4
PATTERN 5
PASS/FAIL
prev menu
ON/OFF
edit
setup λ
EXE PRINT
prev menu
COMMENT
FILE NAME
CABLE NUMBER
STAGE OF MAN
FIBER ID
START λ
STOP λ
λ RESO
REF λ
LOCAL
HEADER
ADR UP
ADR DOWN
MAG
MAG
LIN/LOG


MEAS/FIT
sweep mode
MOD FREQ
sens
avg
unwrap
smooth
fit
CONT SWEEP
STEP SWEEP
DATA POINTS
λ RESO in STEP
meas mode
prev menu
NORMAL MEAS
DIFF MEAS
HIGH SENS
MIDDLE SENS
NORMAL
HI SPEED
prev menu
AVG ON/OFF
AVG COUNT
prev menu
UNWRAP
THRESH
OPT G.DLY
DELAY TIME
prev menu
SMOOTH ON/OFF
SMOOTH WINDOW
prev menu
FIT ON/OFF
LINEAR FIT
QUAD FIT
SELM3 FIT
SELM5 FIT
PERSIAL ON/OFF
prev menu


MODE
NORMAL
ΔMODE
2ND PEAK
POWER
DIFFER
band width
PK-XdB
ENVELOP
param
prev menu
XdB
YdB
K
prev menu
RECALL
RECALL MEAS1
RECALL MEAS2
RECALL MEAS3
MEM FD
recall meas
recall panel
RECALL
EXIT
RECALL
EXIT
REPEAT
SAVE
SAVE MEAS1
SAVE MEAS2
SAVE MEAS3
MEM FD
save meas
save panel
BITMAP SAVE
SAVE
DELETE
RECOVER
UNIT NORMAL
DISP/MEAS
name
EXIT
←
→
↑
↓
CLEAR
ENTER
prev menu
SAVE
DELETE
RECOVER
name
EXIT
←
→
↑
↓
CLEAR
ENTER
prev menu


SCALE
AUTO
/DIV
REF VER
/KM ON
FIBER LG
SINGLE
STOP
SYSTEM
PRESET
clock
color
buzzer
floppy
Key board
SELF TEST
label
ON/OFF
YEAR
MONTH
DAY
HOUR
MINUTE
pattern
prev menu
YYYY-MM-DD
MM-DD-YYYY
DD-MM-YYYY
prev menu
PATTERN 1
PATTERN 2
PATTERN 3
PATTERN 4
PATTERN 5
prev menu
BEEP
WARNING
QUIET
prev menu
DIR
format
volume
prev menu
EXECUTE
2DD (720k)
2HD (1.44M)
prev menu
101 (US)
106 (JP)
prev menu
←
→
DEL CHAR
INS SP
CLEAR LINE
ENTER
prev menu
←
→
DEL CHAR
INS SP
CLEAR LINE
ENTER
UNDO
prev menu
TRANS/REFL
TRANS
REFL

4.3 Functional Description

ADVANCE — Displays the ADVANCE menu used to set the display modes.

- ***DISTANC*** — Calculates and displays the fiber length after DUT's group delay time was measured based on the refraction factor set in the FIBER INDEX menu.
- ***FIBER INDEX*** — Allows you to set DUT's refraction factor to calculate the fiber length.
- ***AUTOλ DISTANC ON/OFF*** — Toggles AUTO λ DISTANC setting on or off.
  - ON: Sets the current center wavelength for distance measurements.
  - OFF: Sets the wavelength for distance measurements using λ with DISTANC MESURE menu.
- ***λ with DISTANC MESURE*** — Enters a wavelength for distance measurements.

AUTO — Displays the AUTO menu.

- ***λ FULL + MOD f*** — Optimizes both the measurement span and modulation frequency by setting the full span for the measurement range.
- ***λ FULL*** — Optimizes the measurement span by setting the full span for the measurement range.
- **λ** — Optimizes the measurement span by setting the current span for the measurement range.
- ***MOD FREQ*** — Optimizes the modulation frequency by setting the current span for the measurement range.

BACK LIGHT — Turns the back light on or off.

CAL — Displays the CAL menu.

- ***λ comp*** — Displays the λ comp menu.

λ COMP ON/OFF Toggles the wavelength compensation function on or off.

ON: Takes a measurement compensated for wavelength using the wavemeter (TQ8325/Q8326)

OFF: Does not compensate for the wavelength.

HIGH ACRACY Compensates for the wavelength with high accuracy.

CAUTION: ***For the Q8326, select NORMAL ACRACY. Since NORMAL ACRACY allows the Q8326 to compensate the wavelength, HIGH ACRACY is not needed.***

NORMAL ACRACY

Compensates for the wavelength with normal accuracy.

WAVMTER AT HP

Selects the type of the wavemeter.

AT: ADVANTEST-made

HP: HP-made

L.OFST(REFL) Calibrates the power level in the reflection characteristic mode. (-20dB to +20dB)

L.OFST(TRANS) Calibrates the power level in the transmission characteristic mode. (-20 dB to +20 dB)

SV REF(REFL) Saves the current measured value to the reference memory as the compensation data into reference memory in the reflection characteristic mode.

SV REF(TRANS) Saves the current measured value to the reference memory as the compensation data into reference memory in the transmission characteristic mode.

NORML(REFL) Sets the mode in which level compensation for the reflection characteristics is performed based on the data saved in the reference memory.

NORML(TRANS) Sets the mode in which level compensation for the transmission characteristics is performed based on the data saved in the reference memory.

CENTER/SPAN Displays the CEN/SPAN menu setting for the range of the display.

CENTER Sets the center of the display to active.

SPAN	Sets the span of the display to active.
START	Sets the start point of the display to active.
STOP	Sets the stop point of the display to active.
CUR TO CENTER	Sets the cursor wavelength to the center wavelength.
FREQ DOMAIN	Selects the wavelength and frequency for the horizontal axis unit. ON: sets the horizontal axis unit to frequency. OFF: sets the horizontal axis unit to wavelength.

COPY — Displays the COPY menu for copying measurement results.

EXE PRINT	Outputs displayed data to the printer.
ESC/P	Enables to use the printer to be used with ESC/P specifications.
ESC/P R	Enables to use the printer to be used with ESC/P raster specifications.
PCL	Enables to use the printer to be used with PCL specifications.
ABORT	Outputting to a printer is canceled.

CURSOR — Displays the CURSOR menu.

ON/OFF	Selects the window and whether or not cursor information is displayed. ON: Displays the cursor information. OFF: Erases the four cursors and cursor information.
CURSOR X1	Selects ON and OFF for the X CURSOR 1. ON: displays the X CURSOR 1 and makes the setting active. OFF: erases the X CURSOR 1.
CURSOR X2	Selects ON and OFF for the X CURSOR 2. ON: displays the X CURSOR 2 and makes the setting active. OFF: erases the X CURSOR 2.
CURSOR L1	Selects ON and OFF for the L CURSOR 1. ON: displays the L CURSOR 1 and makes the setting active. OFF: erases the L CURSOR 1.

CURSOR L2 Selects ON and OFF for the L CURSOR 2.

ON: displays the L CURSOR 2 and makes the setting active.

OFF: erases the L CURSOR 2.

DELAY The DELAY menu which sets the display mode is displayed

GROUP DELAY Sets the display mode to the group delay mode.

DISPERSION The DISPERSION menu to set the display mode is displayed.

CD Sets the display mode to the dispersion mode.

CD SLOPE Sets the display mode to the dispersion slope mode.

DISPLAY Displays the DISPLAY menu for setting the display mode.

SNGL DISP Sets the display mode to the single screen figure mode.

dual disp Displays the dual disp menu.

ON/OFF Selects ON and OFF for the dual screen display mode.

ON: sets the display mode to the dual screen mode.

OFF: sets the display mode to the single screen mode.

XCNG U/L Replaces the upper screen with the lower screen.
This operation is disabled when the average function is turned or any item of the measurement conditions (such as wavelength range) in one screen does not match the counterpart of another screen.

prev menu Displays the DISPLAY menu.

S.IMPOS Sets the display mode to the superimposing mode.

limit line manual Displays the limit menu.

ON/OFF Toggles the limit line display on or off.

ON: Displays the limit line.

OFF: Displays the graph.

λparam Displays the λ param menu.

UPPER LEFT λ
Enters LEFT λ of the upper limit line.

UPPER RIGHT λ
Enters RIGHT λ of the upper limit line.

LOWER LEFT λ
Enters LEFT λ of the lower limit line.

LOWER RIGHT λ
Enters RIGHT λ of the lower limit line.

level param Displays the level param menu.

UPPER SIDE LV
Enters SIDE LEVEL of the upper limit line.

UPPER CENT LV
Enters CENTER LEVEL of the upper limit line.

LOWER SIDE LV
Enters SIDE LEVEL of the lower limit line.

LOWER CENT LV
Enters CENTER LEVEL of the lower limit line.

PASS/FAIL Checks whether or not the measurements exceed the limit lines. If the measurements do not exceed the limit lines, PASS is displayed. Otherwise, FAIL is displayed.

prev menu Returns to the DISPLAY menu.

limit line floppy Displays the limit menu.

ON/OFF Toggles the limit line display on or off. If the limit has not been loaded, the limit line cannot be displayed.

PATTERN 1 Loads the FD:¥LmtLn¥LmtLn1.txt file from the floppy disk and display the limit line.

PATTERN 2 Loads the FD:¥LmtLn¥LmtLn2.txt file from the floppy disk and display the limit line.

PATTERN 3 Loads the FD:¥LmtLn¥LmtLn3.txt file from the floppy disk and display the limit line.

PATTERN 4 Loads the FD:¥LmtLn¥LmtLn4.txt file from the floppy disk and display the limit line.

PATTERN 5 Loads the FD:¥LmtLn¥LmtLn5.txt file from the floppy disk and display the limit line.

PASS/FAIL Checks the waveform and limit line. If the waveform is inside the specified area, PASS is displayed. Otherwise, FAIL is displayed.

prev menu Returns to the DISPLAY menu.

report Displays the REPORT menu.

ON/OFF Toggles the report display on or off.

ON : Displays the report.

OFF : Displays the graph.

edit Displays the edit menu.

COMMENT
Enters your comment in the report.

FILE NAME
Enters the file name in the report.

CABLE NUMBER
Enters the cable number in the report.

STAGE OF MAN
Enters the manufacturing process name in the report.

FIBER ID
Enters the ID in the report.

setup λ Displays the setup λ menu.

START λ
Enters the start wavelength displayed in the report.

STOP λ
Enters the stop wavelength displayed in the report.

λ RESO
Enters the wavelength resolution displayed in the report.

REF λ
Enters the reference wavelength displayed in the report.

EXE PRINT Prints the measurement results in report form as described below.

First page:
In the upper half of the first page, the group delay time measurements and a graph modified using curve fitting is printed.
In the lower half of the first page, the chromatic dispersion measurements and a graph modified using curve fitting is printed.

Second page or later:
The current displayed screen, showing all measurements, is printed.

	prev menu	Returns to the DISPLAY menu.
	GRID	Selects ON and OFF for the grid display in the display area. ON: displays the grid. OFF: erases the grid.
	SIGNAL LIN/DOT	Toggles the dot line display (used in superimposed display mode) on or off. DOT : Displays one of the characteristics in a dotted line. LIN : Displays both characteristics in a solid line.
LOCAL		Displays the LOCAL menu for setting the GPIB. If this analyzer is in the lockout state at this time, the state will be released.
	HEADER	Selects ON and OFF for the header. ON: attaches the header to the output data. OFF: does not attach the header to the output data.
	ADR UP	Increases the GPIB address. (0 to 30)
	ADR DOWN	Decreases the GPIB address. (0 to 30)
MAG		Displays the MAG menu for setting the display mode.
	MAG	Sets the amplitude characteristic mode.
	LIN/LOG	Selects the display method for the level. LIN: displays the level with linear power. LOG: displays the level with dB.
MEAS/FIT		Displays the MEAS/FIT menu.
	sweep mode	Displays the swp mod menu.
	CONT SWEEP	Sets the number of data points to 601.
	STEP SWEEP	Sets the number of data points based on the number of data points (set in the DATA POINTS menu) or the wavelength resolution (set in the λ RESO in STEP).
	DATA POINTS	Sets the number of data point to any value between 11 and 301.

λ RESO in STEP Sets the wavelength resolution.

meas mode Displays the meas mode menu.

NORMAL MEAS
Turns the mode in which adjacent data points are sequentially measured on.

DIFF MEAS
Turns the mode in which differential measurements are made on.

prev menu Displays the MEAS/FIT menu.

MOD FREQ Sets the MOD FREQ value. (Units: Time or frequency)

sens Displays the sens menu.

HIGH SENS Sets high sensitivity mode.

MIDDLE SENS Sets middle sensitivity mode.

NORMAL Sets normal mode.

HI SPEED Sets high-speed mode.

prev menu Displays the MEAS/FIT menu.

avg Displays the avg menu.

AVG ON/OFF Toggles the averaging function on or off.

ON: Displays the averaged value of the measurement results for the counts set to the AVG COUNT.

OFF: Does not average the measurement results.

AVG COUNT Allows you to set the counts used for averaging. (1 to 16)

prev menu Displays the MEAS/FIT menu.

unwrap Displays the unwrap menu.

UNWRAP Toggles the unwrapping function on or off.
This function is valid only when measuring the following characteristics.

- Phase characteristics
- Group delay characteristics
- Dispersion characteristics

ON: Expands the continuous display range of the phase characteristics within the effective range set by the THRESHOLD menu.

OFF: Turns the unwrapping function off.

THRESH Allows you to set the effective range of the unwrapping function. The unwrapping function becomes valid (unit: dB) within the range where the amplitude characteristic is greater than the threshold set here.

OPT G.DLY Selects ON or OFF for the group delay compensation function.

ON: Displays the group delay characteristics in which this function compensates for the compensation value set by the DLY TIME menu.

OFF: Turns the group delay compensation function off.

DELAY TIME Allows you to set the group delay compensation values.

prev menu Displays the MEAS/FIT menu.

smooth Displays the smooth menu.

SMOOTH ON/OFF

Toggles the smoothing function on or off.

ON: Displays the smoothed value of the measurement results in the section set in SM COUNT.

OFF: Does not smooth the measurement results.

SMOOTH WINDOW

Allows you to set the width of the section to be smoothed.

prev menu Displays the MEAS/FIT menu.

fit Displays the fit menu.

FIT ON/OFF Toggles the fitting function on or off.

LINEAR FIT Sets the approximation function to the linear expression.

QUAD FIT Sets the approximation function to the quadratic polynomial.

SELM3 FIT Sets the approximation function to Sellmeier's cubic polynomial.

SELM5 FIT Sets the approximation function to Sellmeier's quintic polynomial.

PERSIAL ON/OFF

Specifies the range used for curve fitting.

ON: Curve fitting applies to the range between two X cursors. For other areas, linear interpolation is used.

OFF: Curve fitting applies to the entire range.

prev menu Displays the MEAS/FIT menu.

MODE Displays the MODE menu.

NORMAL Displays the wavelength (frequency) and the level at the cursor position.

ΔMODE Displays the wavelength (frequency) difference and the level difference between cursors.

2ND PEAK Displays the wavelength (frequency) difference and the level difference between the maximum peak and the second peak.

POWER Displays the total power between the X cursor 1 and the X cursor 2.

DIFFER Displays the vertical difference between the two values indicated by λ cursors on the superimposed screen.

diff1: Difference between the two values indicated by the λ1 cursor.

diff2: Difference between the two values indicated by the λ2 cursor.

band width Displays the band width menu for obtaining the band width.

PK-XdB Displays the full width half maximum calculated with the peak XdB method.

ENVELOP Displays the full width half maximum calculated by the Envelope method.

param Displays the parameter menu.

XdB Makes setting of the level difference calculated by peak XdB active.
Initial value: 3 dB Setting range: 0.1 dB to 59.9 dB

YdB Makes setting the peak threshold which is used for the envelope method active. (Otherwise, this is also used in need of the numbers of peaks.)
Initial value: 20 dB Set range: 0.1dB to 99.9 dB

K Makes setting of the correction coefficient of band width active.
Initial value: 1.0 setting range: 0.100 to 100.00

prev menu
Displays the band width menu.

prev menu	Displays the MODE menu.
RECALL	Displays the RECALL menu.
RECALL MEAS1	Reads out measurement results from file 1 of the memory.
RECALL MEAS2	Reads out measurement results from file 2 of the memory.
RECALL MEAS3	Reads out measurement results from file 3 of the memory.
MEM FD	Selects whether read data is stored in the backup memory or the floppy disk.
recall meas	Displays the rcl meas and the directory list for reading out the measurement results. At this time, selection of the object file can be made with the knob.
RECALL	Reads out measurement results from memory or the file specified on a floppy disk.
EXIT	Returns to the measurement state.
recall panel	Displays the rcl panl menu and the directory list for reading out measurement conditions. At this time, the selection of the object file can be made with the knob.
RECALL	Reads out the measurement conditions from the memory or the file specified on a floppy disk.
EXIT	Returns to the measurement state.
REPEAT	Repeats measurement. During measurement, current measurement is interrupted. It is started again.
SAVE	Displays the SAVE menu.
SAVE MEAS1	Saves the first measurement result in file 1 of the memory.
SAVE MEAS2	Saves the second measurement result in file 2 of the memory.
SAVE MEAS3	Saves the third measurement result in file 3 of the memory.
MEM FD	Selects whether to store data in the backup memory or the floppy disk.

save meas Displays the sv meas menu and the directory list for saving the measurement results.
At this time, selection of the object file can be made with the knob.

SAVE Saves the measurement results in the specified file to memory or floppy disk.

DELETE Deletes the specified file of measurement results in memory or on the floppy disk.

RECOVER Recovers the specified file of measurement results from memory or floppy disk.

UNIT NORMAL

Toggles the normalized form on or off.

ON: Data is saved in normalized form which is expressed using a basic unit (such as m, sec, and sec/m).

OFF: Data is saved using the displayed unit (such as nm, psec and psec/nm).

Wavelength:	nm
Frequency:	THz
MAG:	dB (log display, lin display)
G.Delay:	psec
CD:	psec/nm
CD Slope:	psec/nm2

Example:

If the wavelength is 1550.5 nm:

Selecting ON saves the wavelength as 1.5505e-6.

Selecting OFF saves the wavelength as 1550.5.

DIS/MEA Toggles the data type which is saved.

DIS: Saves the currently displayed data.

MEA: Saves data of all formats (consisting of magnitudes, group delays, chromatic dispersions and chromatic dispersion slopes). (Only applicable to floppy disks)

Since DISP is used to save the currently displayed data, only the displayed data can be reloaded from the file and displayed on the screen.
Since MEAS is used to save all data to the file, opening the file will display magnitudes, group delays, chromatic dispersions and chromatic dispersion slopes.

name Makes file name entry active and displays the name menu and Character list.
At this time, the selection of characters can be performed by knob.

← Moves the cursor in the input buffer to the left by one character.

→ Moves the cursor in the input buffer to the right by one character.

↑ Moves the selection for the object file up by one.

↓ Moves the selection for the object file down by one.

CLEAR Clears the input buffer.

ENTER Enters the specified character in Character list into the input buffer.

prev menu
Displays the SAVE menu.

EXIT Returns to the measurement state.

save panel Displays the sv panl menu and the directory list for saving the measurement results.
At this time, the selection of characters can be performed by knob.

SAVE Saves the measurement results in the specified file to memory or floppy disk.

DELETE Deletes the specified file of measurement results in memory or on the floppy disk.

RECOVER Recovers the specified file of measurement results from memory or floppy disk.

name Makes file name entry active and displays the name menu and Character list.
At this time, the selection of characters can be performed by knob.

← Moves the cursor in the input buffer to the left by one character.

→ Moves the cursor in the input buffer to the right by one character.

↑ Moves the selection for the object file up by one.

↓ Moves the selection for the object file down by one.

CLEAR
Clears the input buffer.

ENTER Enters the specified character in Character list into the input buffer.

prev menu
Displays the SAVE menu.

EXIT Returns to the measurement state.

BITMAP SAVE Saves the displayed data to the floppy disk in bitmap format.

SCALE Displays the SCALE menu for setting the display conditions of levels.

AUTO Automatically sets the display level range according to the measurement results.

/DIV Makes the level setting per 1DIV active and fixes the display level range.

REF VER Makes setting active for the reference level.

/KM ON Selects either ON or OFF for km conversion.

ON: converts the measurement results to values per km, then displays the values.

OFF: does not perform per km conversion.

FIBER LG Makes the setting of sample lengths active.

SINGLE Performs measurement once then stops. Interrupts the current measurement in progress, then starts a new measurement from the beginning.

STOP Interrupts measurement, then stops. While the analyzer system is in idle, a new measurement will be started when you press the **REPEAT** or the **SINGLE** key.

SYSTEM Displays the SYSTEM menu.

PRESET Initializes the settings for this analyzer.

clock Displays the clock menu.

ON/OFF Selects either ON or OFF for the clock display.
ON: displays the date and time.
OFF: erases the date and time.

YEAR Makes setting of the year active.

MONTH Makes setting of the month active.

DAY Makes setting of the day active.

HOUR Makes setting of the hour active.

MINUTE Makes setting of the minute active.

pattern Displays the Pattern menu.

YYYY-MM-DD
Displays YYYY-MM-DD for the date display pattern.

MM-DD-YYYY
Displays MM-DD-YYYY for the date display pattern.

DD-MM-YYYY
Displays DD-MM-YYYY for the date display pattern.

prev menu
Displays the clock menu.

prev menu Displays the SYSTEM menu.

color Displays the color menu.

PATTERN 1 Sets the color of the display screen to pattern 1.

PATTERN 2 Sets the color of the display screen to pattern 2.

PATTERN 3 Sets the color of the display screen to pattern 3.

PATTERN 4 Sets the color of the display screen to pattern 4.

PATTERN 5 Sets the color of the display screen to pattern5.

prev menu Displays the SYSTEM menu.

buzzer Displays the BUZZER menu.

BEEP Selects either ON or OFF for operating sound.
ON: outputs operating sound.
OFF: does not output operating sound.

WARNING Selects either ON or OFF for warning sound.

ON: outputs warning sound.

OFF: does not output warning sound.

QUIET Selects the volume levels for the operating sound and warning sound.

ON: lowers the volume levels for the operating sound and warning sound.

OFF: sets the volume levels for the operating sound and warning sound to the normal level.

prev menu Displays the SYSTEM menu.

floppy Displays the floppy menu for saving measurement results.

DIR Displays the contents of the floppy disk.

format Displays the format menu for initializing the floppy disk.

EXECUTE
Executes initialization.

2DD (720k)
Sets the format to 2DD (720 k).

2HD (1.44M)
Sets the format to 2HD (1.44 M).

prev menu
Displays the floppy menu.

volume Makes input of volume active, then displays the volume menu.

← Moves the cursor in the input buffer to the left by one character.

→ Moves the cursor in the input buffer to the right by one character.

DEL CHAR
Deletes the character at the cursor position in the input buffer.

INS SP Inserts a space at the cursor position in the input buffer.

CLEAR LINE
Clears all characters in the input buffer.

ENTER Enters the character selected by the character menu into the input buffer.

	prev menu	Displays the floppy menu.
	prev menu	Displays the system menu.
Key board		
	101 (US)	Sets the 101 type key board.
	106 (JP)	Sets the 106 type key board.
	prev menu	Displays the floppy menu.
SELF TEST		Performs a self test.
label		The label input buffer is displayed.
	←	Moves the input buffer cursor one character to the left.
	→	Moves the input buffer cursor one character to the right.
	DEL CHAR	Deletes the character at the current position of the input buffer cursor.
	INS SP	Inserts a space at the current position of the input buffer cursor.
	CLEAR LINE	Deletes all characters in the input buffer.
	ENTER	Enters the characters selected by the CHARACTER menu in the input buffer.
	UNDO	Cancels the edited series of characters and restores them to the original series of characters before editing.
	prev menu	Displays the SYSTEM menu.
TRANS/REFL		Displays the TRANS/REFL menu for selecting measurement modes. This key has no effect during sweeping.
	TRANS	Sets the measurement mode to the transmission characteristics mode.
	REFL	Sets the measurement mode to the reflection characteristics mode.

4.4 Initialize

Item	Initial value
Trans/Refl	Trans
Dispertion/Mag/Delay/Phase	Mag
Center wavelength	1550.000nm
Span	10.00nm
Wavelength/Frequency	Wavelength domain
/Div(Scale)	5.0dB/div
Ref Ver	0.0dB
MOD FREQ	3.0GHz
Average	off
Smothing	off
Sensitivity	NORMAL
Normalize	off
/km display	off
MEM/FD (Specifying places for storing)	MEN
Specifying colors	PATTERN 1
BEEP(BUZZER)	on
WARNING(BUZZER)	on
QUIT(BUZZER)	off
Label	**ADVANTEST Q7750 Optscope**
CURSOR Mode	NORMAL
Band width Mode	PK-XdB

4.5 Floppy Disk

4.5.1 Media Specifications

Disk type: 3.5-inch micro floppy disk

Usable media: 2DD (double-sided double density)
2HD (double-sided high density)

Format capacity: 720 Kbytes (2DD)
1.44 Mbytes (2HD)

Storage format: In conformance with MS-DOS.
2DD (720 Kbytes)
2DH (1.44 Mbytes)

4.5.2 Data type Used with Floppy Disk

The format for storing measurement conditions and measurement data onto the floppy disk is as follows.

<Measurement conditions file>

Item	Size (byte)
(1) Header	128
(2) Measurement conditions (ASCII)	640
(3) Measurement conditions (binary)	768

<Measurement data file>

Item	Size (byte)
(1) Header	128
(2) Measurement data (ASCII)	Maximum 80K
(3) Measurement conditions (ASCII)	640
(4) Measurement conditions (binary)	768
(5) Data measurement conditions (binary)	840
(6) Reserved	840
(7) X-axis raw data item (Binary)	4816
(8) Y-axis raw data item (Binary)	9624
(9) Normalization condition data (Binary)	9624
(10) Normalization condition data (Binary)	356

4.5.3 Items in a Data File

(1) Header

Information such as company name, product model, software revision and file type is stored. For more information, see the chart below.

Item	Number of bytes	Remarks
Manufacturer name	16	Remainder is filled with space codes.
Product name	16	Remainder is filled with space codes.
Revision	16	Remainder is filled with space codes.
File type	16	Remainder is filled with space codes.
Reserved	32	
ASCII data size	16	Total number of measurement data bytes (in ASCII)
Is there raw measurement data item?	1	If the data is 16(h), raw measurement data item exists. Otherwise, no raw measurement data item exists.
Must the measurement data unit be used?	1	If the data is 16(h), the unit is converted to the display data. Otherwise, the unit is converted to m, sec or Hz.
Is there normalization data?	1	If the data is 16(h), normalization data exists. Otherwise, no normalization data exists.
Reserved	1	
Which band must be used?	1	If the data is 11(h), the normal band is used If the data is 22(h), the L band is used. If the data is any other than above, the normal band is used.
Is all waveform data saved?	1	If the data is 16(h), all waveform data (in ASCII) is saved. Otherwise, only the displayed data is saved.
Is there the header of measurement data (in ASCII)?	1	If the data is 16(h), the header exists (header, X and Y). Otherwise, the header does not exist (X and Y).
Reserved	9	

(2) Measurement data (ASCII)

Wavelength data and the corresponding level data are stored.

You can select whether or not to use the displayed unit for the wavelength and level data when they are recorded. If ***UNIT NORMAL*** is selected, the units are converted to m, sec or Hz when recorded. The level data, however, is recorded with [sec], [deg] or no unit regardless of the scale used (LIN or LOG). As a result, the following formula should be used when converting to [dB].

Conversion formula to [dB]: $P_{dB} = 10 \times \log_{10}(P)$
$(= 10 \times (\log_2 P / \log_2 10)$

If ***UNIT NORMAL*** is not selected, the unit is converted to a unit such as nm, psec or THz and then recorded. The level data, however, is recorded using the scale (LIN or LOG) in which the measurement was made. As a result, [dB] is used when the logarithmic scale is used.

Measurement data has a variety of formats which depend on the combination of different conditions as listed in Table 4-1.

Table 4-1 Data Format

FD DATA Condition	Revision	Data Format (¥t refers to the tab code)
FD DATA DIS/MES(DIS)	A10 or earlier	Number of data N<CR/LF> x(1) ¥t Y(1)<CR/LF> ..... x(N) ¥t Y(N)<CR/LF>
	A11 or later	Header ¥t Number of data N<CR/LF> Header ¥t x(1) ¥t Y(1)<CR/LF> ..... Header ¥t x(N) ¥t Y(N)<CR/LF>
FD DATA DIS/MES(MES)	A10 or earlier	Number of data N<CR/LF> x(1) ¥t Y(1)<CR/LF> ..... x(N) ¥t Y(N)<CR/LF>
	A11 or later	Header 1 ¥t Number of data N<CR/LF> Header 1 ¥t x(1) ¥t Y(1)<CR/LF> ..... Header 1 ¥t x(N) ¥t Y(N)<CR/LF> Header 2 ¥t Number of data N<CR/LF> Header 2 ¥t x(1) ¥t Y(1)<CR/LF> ..... Header 2 ¥t x(N) ¥t Y(N)<CR/LF> Header 3 ¥t Number of data N<CR/LF> Header 3 ¥t x(1) ¥t Y(1)<CR/LF> ..... Header 3 ¥t x(N) ¥t Y(N)<CR/LF> Header 4 ¥t Number of data N<CR/LF> Header 4 ¥t x(1) ¥t Y(1)<CR/LF> ..... Header 4 ¥t x(N) ¥t Y(N)<CR/LF>

The header is a mnemonic representing the measurement mode for the specified data.

- Header 1: MLG --- MAG(LOG) or MLN --- MAG(LIN)
- Header 2: GDL --- Group Delay
- Header 3: CD --- CD
- Header 4: CDS --- CD Slope
- Header: Header 1 thru Header 4 includes the current measurement mode.

The waveform data must be arranged in the following sequence as shown in Table 4-1: Number of data items (N) and sets of waveform data X(n) and level data Y(n), each of which are separated with a tab code (¥t=09h). Every Y(n) is followed by CR(0Dh/LF(0Ah).

If a header is used, it must show the measurement mode at the beginning of each line and must be delimited by the tab code (¥t=09h).

(3) Measurement conditions (ASCII)

Each parameter within the measurement conditions is stored as a character string of ASCII code. When regenerating the data in a floppy disk on a computer, the measurement conditions are read out of this portion. Numeric values are formed as "mantissa + exponent" based on the reference units [m, Hz, dB, sec] and stored in the following order.

In addition, the size occupied by each parameter is fixed and the code "0" (NULL) is entered into the unused portion.

The two characters CR(0x0D) and LF(0x0A) are stored at the end of the character strings for each parameter.

Table 4-2 Parameter Data Examples

Parameter	SIZE (byte)	Data example
1.Label	80	**Q7750 Optscope**
2.Number of measurement data	18	601
3.Start wavelength [frequency]	18	1.5432000E-06
4.Stop wavelength [frequency]	18	1.55200000E-06
5.Center wavelength	18	1.31250000E-06
6.Span	18	200.000000E-09
7.Resolution	18	14.6666667E-12
8.REF LEVEL (Upper)	18	0.00000E+00, 1.00000E-06
9.REF LEVEL (Lower)	18	-50.0000E+00, -1.00000E-06
10.Times of averaging processing	18	1/1
11.Year/month/day	18	1999- 2-22
12.Time:minute:second	18	20:35:14

Parameter	SIZE (byte)	Data example
13.REFLECTION/TRANS	18	REFLECTION
14.FORMAT	18	MAG(LOG)
15./KM ON/OFF	18	/KM: ON
16.FIBER LG	18	10.0000E-3
17.F-DOMAIN	18	F-DOMAIN: OFF
18.MOD FREQ	18	3.00000E+9
19.DELAY TIME	18	25.0000E-9
20.SENSITIVITY	18	HI SPEED
21.SMOOTHING ON/OFF	18	SMOOTHING: OFF
22.SMOOTHING WINDOW	18	0.00000000E-9
23.Empty area	182	

(4) Measurement conditions (binary)

Basically, the same parameter as in (3) is stored; however, it is used when regenerating measurement conditions or measurement data using this analyzer system.

A string of ASCII code characters is used in item (3). This portion, however, is in binary floating point form and is an integral value or a numeric code.

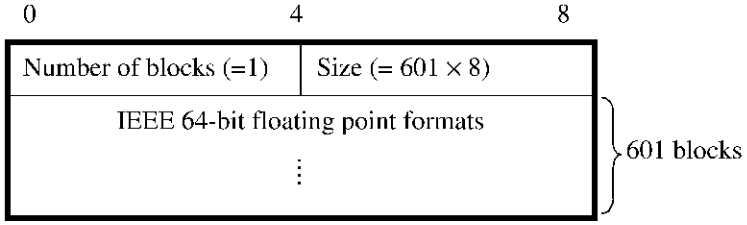
(5) Data measurement conditions (binary)

The measurement conditions related to the measurement data block in item(2) are stored here. This portion is also a binary form similar to item (4).

(6) Reserved

(7) X-axis raw data item (Binary)

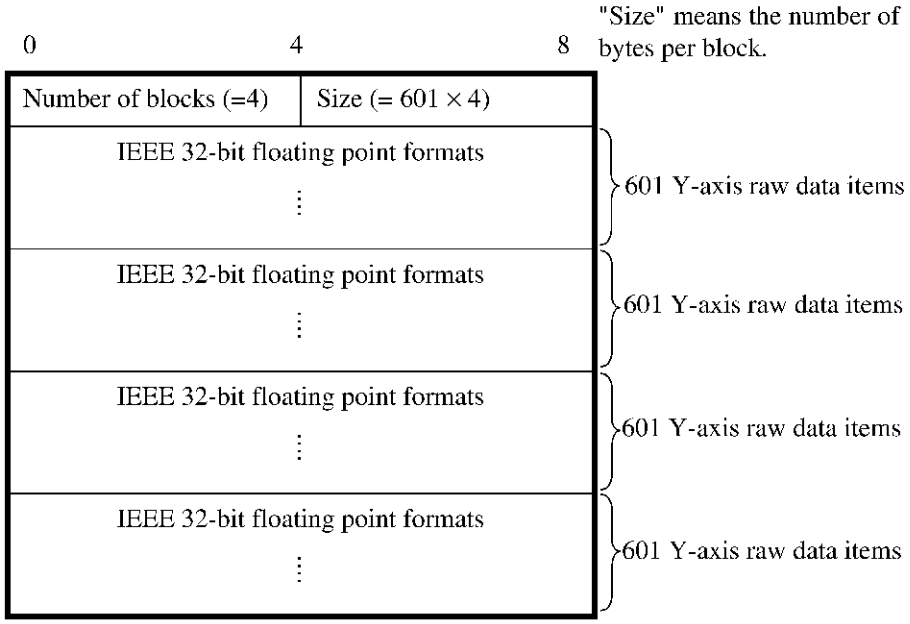
The wavelength data is in binary and consists of 601 items.
The data format is as follows.



The data is arranged in order of: four bytes representing the number of blocks starting from the beginning, four bytes representing the total number of bytes for the wavelength data and 601 wavelength data items. Each wavelength data item, however, consists of 8 bytes.
This data is used to reproduce measurement result using this instrument.

(8) Y-axis raw data item (Binary)

REFL (LIN or MAG), REFL(Phase), TRANS(LIN or MAG) and TRANS(Phase) data, each of which correspond to waveform data described in (7) and have 601 items.
The data format is shown below.



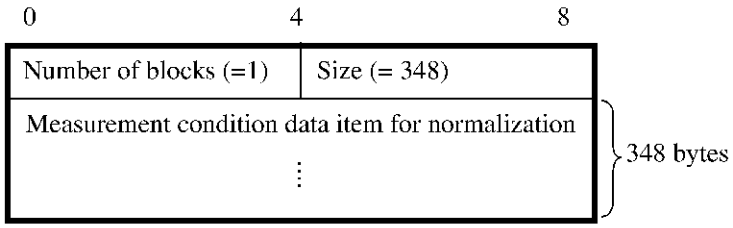
The data is arranged in order of: four bytes representing the number of blocks (starting from the beginning), four bytes representing the total number of bytes per block, and four blocks of Y-axis raw data items (each block contains 601 Y-axis raw data items). As a result, each Y-axis raw data item consists of 4 bytes.
This data is used to reproduce measurement result using this instrument.

(9) Normalization data (Binary)

REFL(LIN or MAG), REFL(Phase), TRANS(LIN or MAG) and TRANS(Phase) data, each of which have 601 normalization reference data items, are used as reference data for normalization.
For information on the data format, refer to paragraph (8), "Y-axis raw data item."
This data is used to reproduce measurement results using this instrument.

(10) Measurement condition data item for normalization (Binary)

The measurement condition data items for normalization is recorded in binary mode.
Data format is as follows.



The data is arranged in order of: four bytes representing the number of blocks (starting from the beginning), four bytes representing the total number of bytes for the measurement condition data items (for normalization), and the measurement condition data items (for normalization).
This data is used to reproduce measurement results using this instrument.

5 REMOTE PROGRAMMING

5.1 GPIB Command Index

This GPIB command index can be used as the index for Chapter 5.

5.2 Overview of GPIB

The GPIB is an interface connected to the measurement device, controller, and peripheral units, etc., through a simple cable (bus line).

The GPIB is more expandable than conventional interfaces, is easy to use, and has electrical, mechanical, and functional compatibility with other manufacturers' products, making it applicable to system configurations from simple systems to automatic design systems with high-level functions using one bus cable.

To use the GPIB, first setting an "address" for each instrument connected to the bus line is required. Each instrument is assigned one or more roles from the following three roles: controller, talker (TALKER), or listener (LISTENER).

During system operation, only one "talker" can send data to the bus line, but plural "listeners" can receive it.

The controller specifies the addresses of "talker" and "listener" to transfer data from "talker" to "listener", and the controller sets setting conditions from "talker" to "listener".

Data is synchronously transferred synchronously bidirectionally between devices via eight data lines in the bit-parallel, byte-serial form. Because this is a synchronous system, using high-speed and low-speed devices together in the same system is possible.

Data (messages) transferred between devices include measurement data, measurement conditions (programs), and commands; they are in ASCII.

In addition to eight data lines, the GPIB has three handshake lines for controlling the synchronous data transmission between instruments, and five control lines for controlling the bus information flow.

5.3 Interface Functions

Table 5-1 shows analyzer interface functions.

Table 5-1 Interface Functions

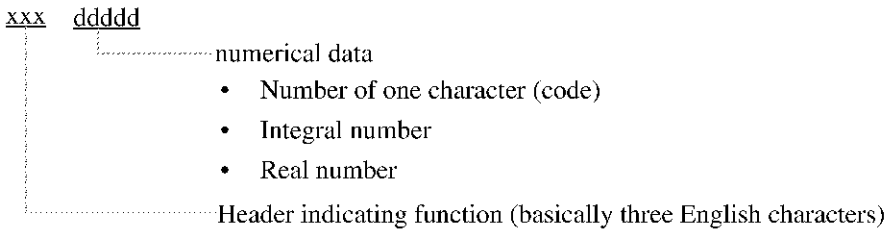
Code	Function
SH1	Source handshake
AH1	Acceptor handshake
T5	Basic talker Serial polling Talk only *1 Talker reset based on listener specification
L4	Basic listener Listener reset based on talker specification
SR1	Service request
RL1	Remote
PP0	No parallel function
DC1	Device clear
DT1	Device trigger
C0	No controller function
E2	Three-state-bus-driver used

*1 Talk only operates on plotters

5.4 Program Code

This section explains the program code through which the outside controller sets analyzer conditions.

Each program code consists of three English characters which indicate the functions and numerical data for setting functions as follows:



The state of each condition is read in by adding "?" after the functional header.

NOTE

1. ***For the functional header and unit, either a capital letter or a lower-case letter is used for setting. Any space code (20H) is set in a program code.***
2. ***In this analyzer, the program code is processed in one row to the terminator. The maximum allowable characters set in one row are 255.***
   When describing a plurality of program codes in one row, set the program codes by punctuating with comma (,) or semicolon (;).

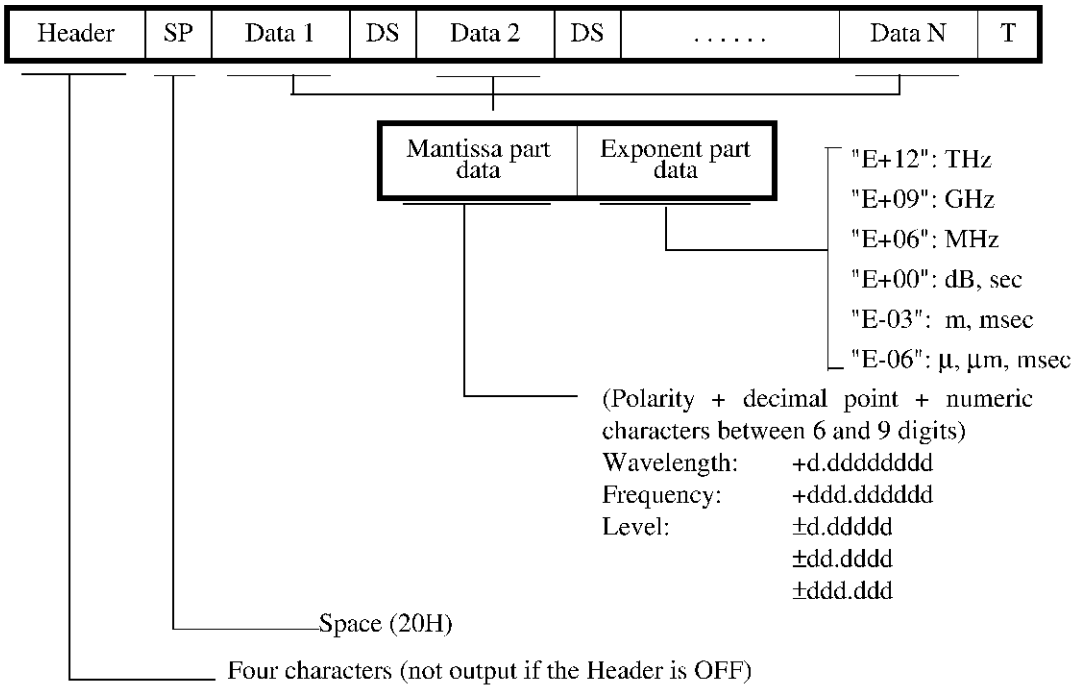
5.5 Talker Formats (Data Output Formats)

This section describes the talker formats used when this analyzer system transfers data to an external controller.

Data is classified roughly into six types of formats: waveform data, peak search data, cursor data, half-width data and condition data.

(1) Waveform data (program code "OSD0," "OSD1")

- ASCII format (format specification code "FMT0")

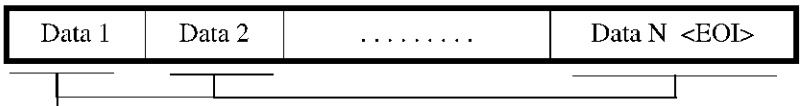


Header	Data type
LMUM	Wavelength [m]
FQTH	Frequency [Hz]
LVLG	Level data in logarithmic scale [dB]
LVLI	Level data in linear scale

DS: Data Separator (either ',' ';' CR or NL)
Can be specified by the program code "SDLn" ("DSn").

T: Terminator (either NL<EOI>, NL<EOI> or "CR,NL<EOI>")
Can be specified by the program code "DELn" ("DLn").

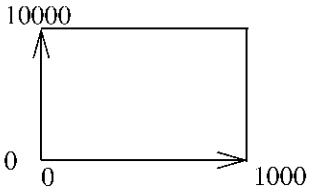
- BINARY format (format specification code ("FMT1", "FMT2", "FMT3", "FMT4"))



Is output in either of the following four formats according to the setting of the format specification code "FMTn."

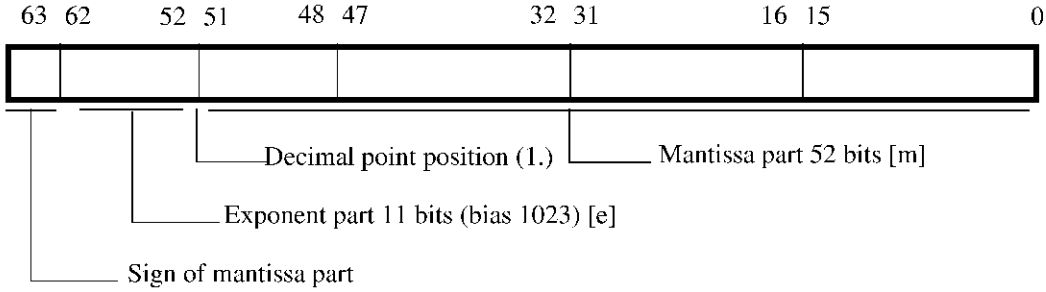
(a) "FMT1" ... 64 bits (integer type)

Is output within the range of 0 to 10000 on the X axis and within 0 to 10000 on the Y axis by setting all data on the screen as linear scale.



(b) "FMT2" ... 64 bits (floating point type)

Outputs data in the floating-point format (IEEE Std.754-1985 format) as shown below.

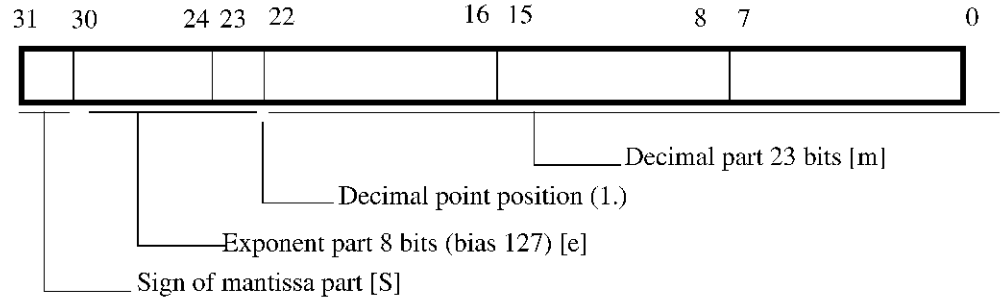


The formula is shown below.

$(-1)^S \times 1.m \times 2^{(e-1023)}$

(c) "FMT3" ... 32 bits (IEEE floating-point type)

Outputs data in the floating-point format (IEEE Std.754-1985 format) as shown below.

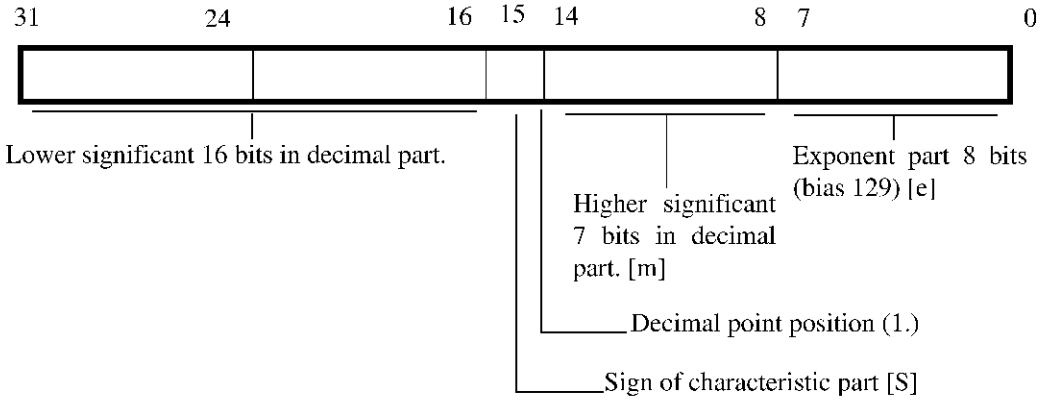


The formula is shown below.

$(-1)^S \times 1.m \times 2^{(e-127)}$

(d) "FMT4" ... 32 bits (NEC floating point type)

Outputs data in the floating-point format (NEC-PC internal format) shown below.

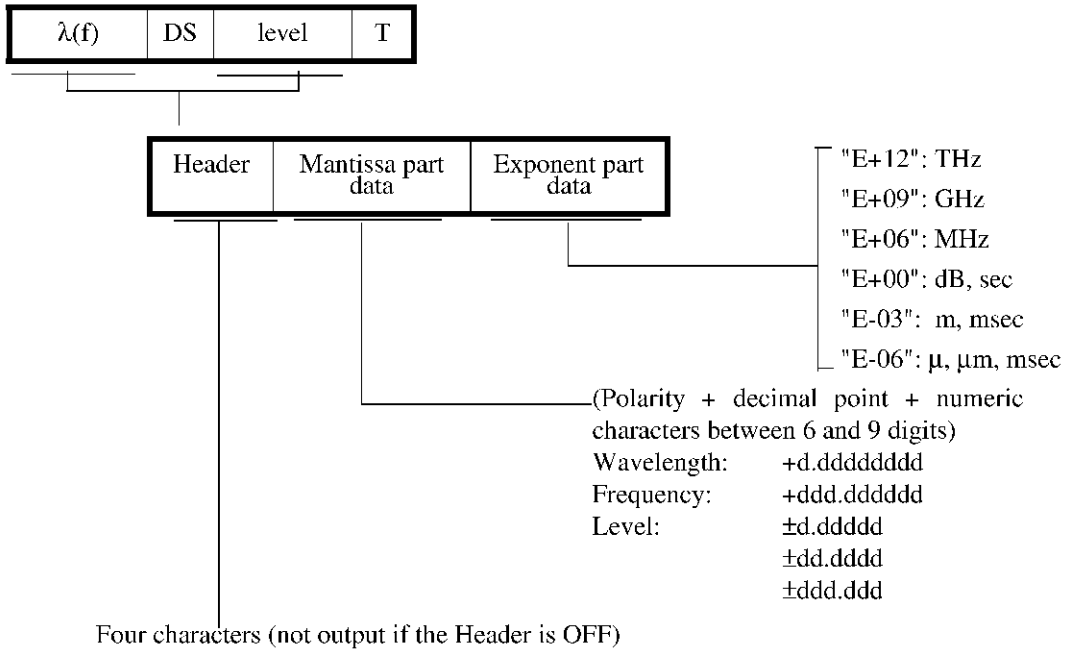


The formula is expressed below.

$(-1)^{S)} \times 1.m \times 2^{(e-1023)}$

(2) Peak search data (program code "OPK")

- Spectrum mode

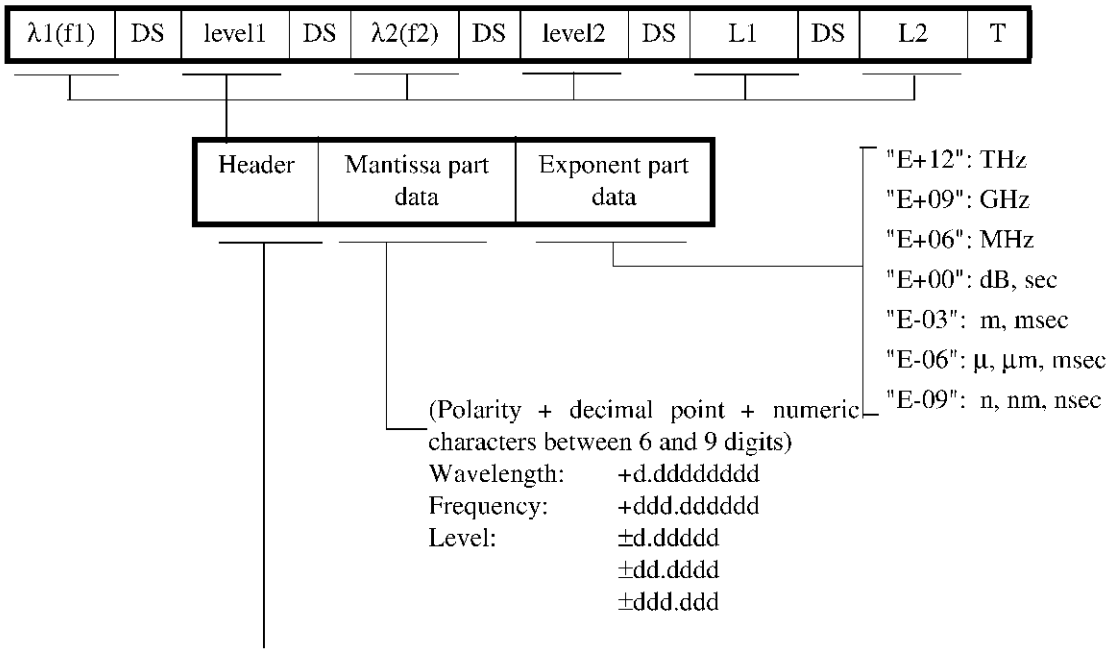


Header	Data type
LMPK	Peak wavelength (λ)
LVPK	Peak level (level)
FQPK	Peak Frequency (f)

(3) Cursor data (program code "OCD")

Is output in one of the following four types of formats according to the specification code "CUDn" in the cursor display mode.

- "CUD0" ... NORMAL



Header	Data type
LMXA	Wavelength of X1 cursor (λ1)
LVXA	Level of X1 cursor (level 1)
LMXB	Wavelength of X2 cursor (λ2)
FQXA	Frequency of X1 cursor (f1)
FQXB	Frequency of X2 cursor (f2)
LVXB	Level of X2 cursor (level 2)
LVYA	Level of Y1 cursor (L1)
LVYB	Level of Y2 cursor (L2)

DS: Data Separator (either "',' ';' CR" or NL)
Can be specified by the program code "SDLn" ("DSn").

T: Terminator (NL<EOI>, NL<EOI>or "CR,NL<EOI>")
Specification by the program code "DELn" ("DLn").

NOTE: ***The data becomes "0" if the corresponding cursor is OFF.***
The formats of the mantissa and exponent parts are common to all "CUDn."

- "CUD1" ... ΔMODE

λ1(f1)	DS	level1	DS	Δλ(Δf)	DS	Δlevel	DS	L1	DS	ΔL	T

Four characters (not output if the Header is OFF)

Header	Data type
LMXA	Wavelength of X1 cursor (λ1).
LVXA	Level of X1 cursor (level 1).
LMDX	Wavelength difference between X1 cursor and X2 cursor (Δλ).
FQXA	Frequency of X1 cursor (f1).
FQDX	Frequency difference between X1 cursor and X2 cursor (Δf).
LVDX	Level difference between X1 cursor and X2 cursor (Δlevel).
LVYA	Level of Y1 cursor (L1).
LVDY	Level difference between Y1 cursor and Y2 cursor (ΔL).

- "CUD2" ... 2ND PEAK

λ1(f1)	DS	level1	DS	Δλ(Δf)	DS	Δlevel	T

Four characters (not output if the Header is OFF)

Header	Data type
LMPK	Peak wavelength (λ1)
LVPK	Peak level (level 1)
LMDP	Wavelength difference between the maximum peak and the second peak (Δλ)
FQPK	Peak frequency (f1)
FQDP	Frequency difference between the maximum peak and the second peak (Δf)
LVDP	Level difference between the maximum peak and the second peak (Δlevel)

- "CUD3" ... POWER

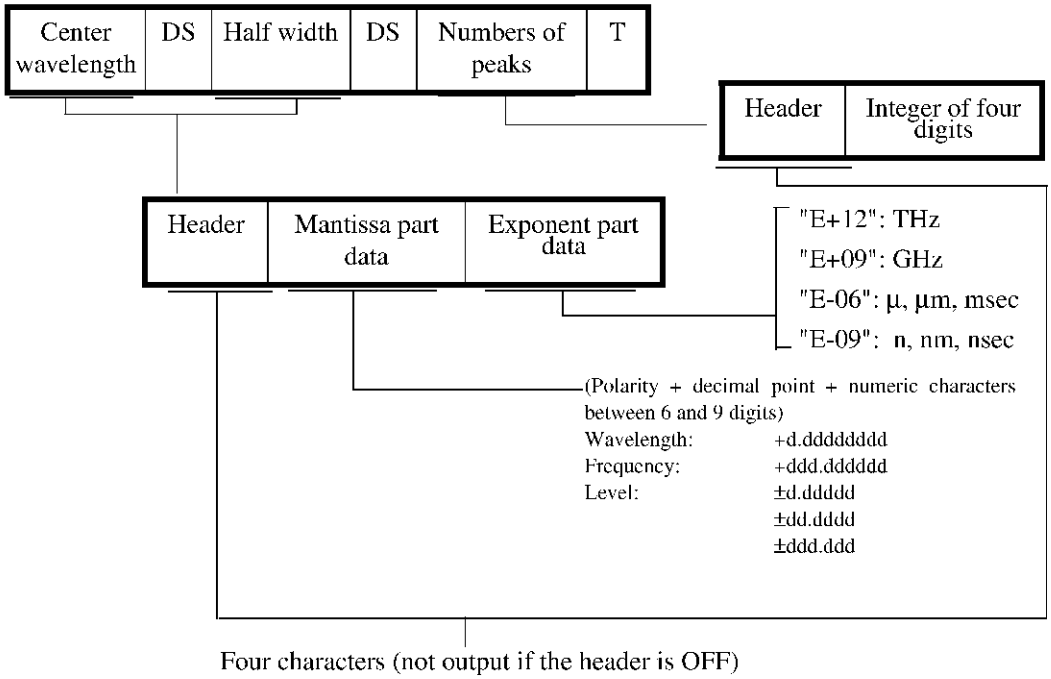
λ1(f1)	DS	λ2(f2)	DS	ΣL	T

Four characters (not output if the Header is OFF)

Header	Data type
LMXA	Wavelength of X1 cursor (λ1)
LMXB	Wavelength of X2 cursor (λ2)
FQXA	Frequency of X1 cursor (f1)
FQXB	Frequency of X2 cursor (f2)
LVPW	Total sum of levels between X1 cursor and X2 cursor (ΣL).

(4) Half-width data (program code "OSW")

In the case of any of the four types of calculation methods, data will be output in the following format.



Header	Data type
LMCN	Center wavelength
LMHW	Half width (wavelength domain)
FQCN	Center frequency
FQHW	Half width (frequency domain)
NOSP	Numbers of peaks

DS: Data Separator (',', ';', CR or NL)
Can be specified by the program code "SDLn" ("DSn").

T: Terminator (NL<EOI>, NL<EOI>, or "CR,NL<EOI>")
Can be specified by the program code "DELn" ("DLn").

(5) Inquiry about the analyzer ID

Outputs the following data by receiving the program code "*IDN?."

ADVANTEST , Q7750, 12345678, A01

- A01: Serial number (Manufacturing number)
- 12345678: Software revision (Processing system)

(6) Condition data

Header	Data	T

- Data
  - •Integer

    RTR, FOR, LIN, FDO, LEV, DUA, SIM, GRI, EAV, AVG, SMO, SEN, NOR, NRT, PKM, UWR, EGD, DPS, DTM, DIF, FIT, FIM, WCA, ACR, MEA, PRT, CKD, CPT, CBK, BUZ, WAR, QUI, *TST?, FON, CUD, SPW, WTY, CUR, XAC, XBC, YAC, YBC, DSP, HED, DEL, SDL, MSP, FMT, OVS, SRQ, S

  - •Mantissa part data + exponent part data

    - Exponent part data:
      - "E+12": THz
      - "E+09": GHz
      - "E+06": MHz
      - "E+00": dB, sec
      - "E-03": m, msec
      - "E-06": μ, μm, msec
      - "E-09": n, nm, nsec
    - Mantissa part data: (Polarity + decimal point + numeric characters between 6 and 9 digits)

      Wavelength: +d.ddddddddd
      Frequency: +ddd.dddddd
      Level: ±d.ddddd, ±dd.dddd, ±ddd.ddd

    CEN, SPA, STA, STO, REF, MOF, SMW, LCA, LCT, STL, FIB, UWP, EDT, XAS, XBS, YAS, YBS, WPX, WPY, WPK

  - •Others

    LAB 1 to 48 characters
    CLO YY-MM-DD,hh:mm:ss
    CUS RRR-GGG-BBB

- T: Same as the functional header to be set.

5.6 Device Triggering Function

This analyzer system performs a SINGLE measurement operation similar to the case in which it receives the program codes "MEA1," "E" and "*TRG" through the address specification command 'GET' (Group Execute Trigger).

5.7 Device Clear Function

This analyzer system is set to the initial state when turning the power on, similar to the case in which it receives the program codes "C" and "*RST" through the address specification command 'SDC' (Selected Device Clear) and the universal command 'DCL' (Device CLear).

The initial state after turning the power on is shown in Table 5-2.

Table 5-2 Initial State After Turning the Power On

Item	Initial state
1. Measurement conditions (FUNCTION section)	Previous state
2. Data display	Normal display (Dual screen, superimposing, three-dimensional display and list display are all OFF).
3. Cursor display	All are OFF.
4. Half width calculation	OFF
5. GPIB-related Status byte Masking status bytes Transmission of SRQ signal Output format of waveform data Terminator Data separator	 0 (Clear) "MSK0" (No mask) "SRQ0" (Mode in which the SQR signal is not sent) "FMT0" (ASCII) "DEL0" (DL0) ⇒ (NL<EOI>) "SDL0" (DS0) ⇒ (,)

5.8 State Changes According to the Commands

This analyzer system will be in the states listed in Table 4-3 after turning the power on and receiving the various commands.

Table 5-3 State Changes According to the Commands

Command code	Talker	Listener	Remote	SRQ	Status byte	Transferred data	Parameters and Operation State
POWER ON	Clear	Clear	Local	Clear	Clear	Clear	Partial initialization
IFC	Clear	Clear	-	-	-	-	-
DCL	-	-	-	Clear	Clear	Clear	Partial initialization
SDC	Clear	Set	-	Clear	Clear	Clear	Partial initialization
C, *RST	Clear	Set	Remote	Clear	Clear	Clear	Partial initialization
IPR	Clear	Set	Remote	Clear	Clear	Clear	Initialization
GET	Clear	Set	-	=	Clear b0, 2, 3 and 5	Clear	-
E, *TRG	Clear	Set	Remote	=	Clear b0, 2, 3 and 5	Clear	-
Specifying the talker for this analyzer system.	Clear	Clear	-	-	-	-	-
Command for turning the talker off.	Clear	-	-	-	-	-	-
Specifying the listener for this analyzer system.	Clear	Set	-	-	-	-	-
Command for turning the listener off.	-	Clear	-	-	-	-	-
Serial polling	Set	Clear	-	Clear	-	-	-

-: Indicates that the previous state does not change.

=: Indicates indefinite state

DCL: Device Clear

SDC: Selected Device Clear

GET: Group Execute Trigger

5.9 Status Byte

The functions of each bit in the status byte (used for this analyzer system) are shown below.

b7	b6	b5	b4	b3	b2	b1	b0

b0: measure end
Set to 1 at the end of measurement.
Set to 0 upon starting the next measurement.

b1: syntax error
Set to 1 if there are any grammatical/setting errors in the received program codes.
Set to 0 upon receiving the next program codes.

b2: calculation end
Set to 1 when half width calculation or distance measurement is complete.
Set to 0 when starting a measurement.

b3: copy end or floppy access end
Set to 1 at the end of printer output or access to the floppy disk (writing, reading or initialization).
Set to 0 upon starting a measurement, receiving an "EPR" code to the floppy disk.

b4: The status bit is set to 1 during calibration, and set to 0 when the calibration is completed.

b5: average end
Set to 1 if the measurements of specified counts are completed while averaging processing is ON.
Set to 0 when measurement is started or averaging processing is OFF.

b6: RQS
Is the bit that indicates that it is issuing a service request and Set to 1 if any of bits b0 to b5 and b7 is 1.
Set to 0 if all bits are 0.

b7: self-test error
Set to 1 if any abnormality occurs while performing the self-test function.

5.10 Code Table

Table 5-4 FUNCTION

Item	Command		Query	Description
	Header	Parameter		
REF/TRANS REF/TRANS	RTR	0, 1	RTR?	0: Refrection 1: TRANS
FORMAT FORMAT	FOR	0, 2, 3, 4	FOR?	0: Mag 2: Gdelay 3: CD 4: CD SLOPE
LIN/LOG	LIN	0, 1	LIN?	0: OFF(LOG) 1: ON (LINEAR)
Fiber Index	IND	---	IND?	
Execution of Distance	ELG	---	---	
Distance readout	---	---	OFL?	
ADVANST AUTO λ DISTANCE	ALD	0, 1	ALD?	0: OFF, 1: ON
ADVANST λ with DISTANCE	LWD	Numeric value + unit	LWD?	UM: μm(Default), NM: nm

Table 5-5 SETUP

Item	Command		Query	Description
	Header	Parameter		
CENTER/SPAN				
CENTER	CEN	Numerical value+Unit	CEN?	UM: μm(Default) NM: nm THZ: THz GHZ: GHz Ex. CEN1.55UM Ex. CEN1530nm Ex. CEN1.54
SPAN	SPA	Numerical value+Unit	SPA?	UM: μm NM: nm(Default) NMD: nm/DIV THZ: THz GHZ: GHz THZD: THz/DIV GHZD: GHz/DIV Ex.SPA50NM
FREQ DOMAIN	FDO	0, 1	FDO?	0: Wave Length 1: Frequency
START	STA	Numerical value+Unit	STA?	UM: μm(Default) NM: nm THZ: THz GHZ: GHz Ex. STA1.55UM Ex. STA1530NM
STOP	STO	Numerical value+Unit	STO?	UM: μm(Default) NM: nm THZ: THz GHZ: GHz Ex. STO1.6UM Ex. STO1560NM

Item	Command		Query	Description
	Header	Parameter		
CURSOR TO CENTER	CUC	---	---	Sets the wavelength of Cursor X1 or Cursor X2 to the center wavelength.
LEVEL SCALE				
AUTO	LAU	---	---	Auto Level
LEVEL SCALE	LEV	0 to 5	LEV?	0: 10dB/D 1: 5dB/D 2: 2dB/D 3: 1dB/D 4: 0.5dB/D 5: 0.2dB/D
REF VER	REF	Numerical value+Unit	REF?	DB: dB (LOG MAG) M: m(*1) U: μ(*1) N: n(*1) (*1 LIN MAG, DELAY, CD)
MODURATION FREQUENCY				
MODURATION FREQUENCY	MOF	Numerical value+Unit	MOF?	GHZ: GHz (Can be omitted)
MES/FIT AUTO FM				
AUTO FM	AUM	0, 1	AUM?	0: OFF, 1: ON
DISPLAY				
DUAL	DUA	0, 1	DUA?	0: OFF 1: ON (dual screen display)
SUPER IMPOSE	SIM	0, 1	SIM?	0: OFF 1: ON (superimposing mode)
XCNG U/L	XUL	---	---	Exchange of upper and lower screens
GRID	GRI	0, 1	GRI?	0: OFF 1: ON
DOT	DOT	0, 1	DOT?	0: OFF, 1: ON
DISPLAY LIMIT LINE				
LIMIT LINE ON/OFF	LIM	0, 1	LIM?	0: OFF, 1: ON

Item		Command		Query	Description
		Header	Parameter		
	UPPER LEFT λ	ULL	Numeric value + Unit	ULL?	UM: µm (Default), NM: nm
	UPPER RIGHT	ULR	Numeric value + Unit	ULR?	UM: µm (Default), NM: nm
	LOWER LEFT	LLL	Numeric value + Unit	LLL?	UM: µm (Default), NM: nm
	LOWER RIGHT	LLR	Numeric value + Unit	LLR?	UM: µm (Default), NM: nm
	UPPER SIDE LEVEL	USL	Numeric value + Unit	USL?	DB: dB (when LOG and MAG are selected) M: m, U: µ, N: n
	UPPER CENTER LEVEL	UCL	Numeric value + Unit	UCL?	DB: dB (when LOG and MAG are selected) M: m, U: µ, N: n
	LOWER SIDE LEVEL	LSL	Numeric value + Unit	LSL?	DB: dB (when LOG and MAG are selected) M: m, U: µ, N: n
	LOWER CENTER LEVEL	LCL	Numeric value + Unit	LCL?	DB: dB(when LOG and MAG are selected) M: m, U: µ, N: n
	PASS/FAIL	LPF	---	LPF?	0: FAIL, 1: PASS
DISPLAY REPORT					
	REPORT ON/OFF	REP	0, 1	REP?	0: OFF, 1: ON
	COMMENT	RCO	#Volume name#	RCO?	Sets the COMMENT statement. (Up to 47 characters are available.)
	CABLE NUMBER	RCA	#Volume name#	RCA?	Sets the CABLE NUMBER statement. (Up to 11 characters are available.)
	STAGE OF MANUFACTUER	RSM	#Volume name#	RSM?	Sets the STAGE OF MAN statement. (Up to 11 characters are available.)
	FIBER ID	RFB	#Volume name#	RFB?	Sets the FIBER ID statement. (Up to 11 characters are available.)
	FILENAME	RFI	#Volume name#	RFI?	Sets the FILENAME statement. (Up to 11 characters are available.)
	EXECUTE REPORT PRINT	ERP	---	---	Prints the report.

Item	Command		Query	Description
	Header	Parameter		
START λ	RSL	Numeric value + Unit	RSL?	UM: µm (Default), NM: nm
STOP λ	RPL	Numeric value + Unit	RPL?	UM: µm (Default), NM: nm
λ RESOLUTION	RRS	Numeric value + Unit	RRS?	UM:µm (Default), NM: nm
REFERENCE λ	RRF	Numeric value + Unit	RRF?	UM: µm (Default), NM: nm
Fitting coefficient1(F1)	---	---	OFA?	Fitting coefficient, F1 value
Fitting coefficient2(F2)	---	---	OFB?	Fitting coefficient, F2 value
Fitting coefficient3(F3)	---	---	OFC?	Fitting coefficient, F3 value
Fitting coefficient4(F4)	---	---	OFD?	Fitting coefficient, F4 value
Fitting coefficient5(F5)	---	---	OFE?	Fitting coefficient, F5 value
CD @ REFERENCE λ	---	---	ORC?	CD @ REFERENCE λ value
CD SLOPE @ REFERENCE λ	---	---	ORS?	CDSLOPE @ REFERENCE λ
CD SLOPE @ ZERO -DISPERSION λ	---	---	OZS?	CD SLOPE @ ZERO-DISPERSION λ value

Item	Command		Query	Description
	Header	Parameter		
MEAS/FIT				
AVG ON/OFF	EAV	0, 1	EAV?	0: OFF (STOP) 1: ON (START)
AVERAGE	AVG	1 to 16	AVG?	Integer value Ex. AVG 16
SMOOTHING ON/OFF	SMO	0, 1	SMO?	0: OFF 1: ON
SMOOTHING WINDOW	SMW	Numerical value+Unit	SMW?	UM: μm NM: nm (Default) THz: THZ GHz: GHZ
Data point	DPS	0 to 301	DPS?	
Data point Mode	DTM	0, 1	DTM?	0: CONTINUE 1: STEP
Setting of wavelength resolution	STL	Numerical value	STL?	
MEAS MODE	DIF	0, 2	DIF?	0: NORMAL MEAS 2: DIFF MEAS MEAS MODE cannot be set to DIFF MEAS when set to CONTINUOUS SWEEP.
Fitting ON/OFF	FIT	0, 1	FIT?	0: OFF 1: ON
Fitting Mode	FIM	0 to 3	FIM?	0: Liner Fit 1: Quad Fit 2: Selm3 Fit 3: Slem5 Fit
MEAS/FIT-FIT PERSIAL FIT ON/OFF	PFT	0, 1	PFT?	0: OFF, 1: ON
Zero-dispersion warve-length readout	---	---	OZL?	
FITTING ERROR	---	---	ODI?	Fitting error
SENSITIVITY (RBW)	SEN(RBW)	0 to 4	SEN? (RBW?)	0: HIGH SENS(10Hz) 1: MIDDLE SENS (30Hz) 2: NOMAL (100Hz) 3: HI SPEED (300Hz)

Item	Command		Query	Description
	Header	Parameter		
CALIBRATION				
WAVE LENGTH	WCA	0, 1	WCA?	0: OFF 1: ON
Setting of wave-length compensation accuracy	ACR	0, 1	ACR?	0: NORMAL ACRACY 1: HIGH ACRACY
Selects the type of the wavemeter	WMT	0, 1	WMT?	0: AT 1: HP
Level CAL (REFL)	LCA	Numerical value+Unit	LCA?	DB: dB (Can be omitted)
Level CAL (TRANS)	LCT	Numerical value+Unit	LCT?	
SAVE REF (REFL)	SAR	---	---	Save to Ref. memory (REFL)
SAVE REF (TRANS)	SRT	---	---	Save to Ref. memory (TRANS)
NORMALIZE (REF)	NOR	0, 1	NOR?	0: OFF
NORMALIZE (TRANS)	NRT	0, 1	NRT?	1: ON
/KM Coefficient	PKM	0, 1	PKM?	0: OFF 1: ON
FIBER LENGTH	FIB	0.01 to 1000.0	FIB?	Scaling value
Phase Unwrap	UWR	0, 1	UWR?	0: OFF 1: ON
Phase Unwrap threshold(dB)	UWP	Numerical value	UWP?	Range of setting: -100.0 to 20.0 Ex. UWP-10.0
OPT G.DLY	EGD	0, 1	EGD?	0: OFF 1: ON
OPT G.DLY Time value (nsec)	EDT	0.0001 nsec to 50.000 msec	EDT?	NSEC (Can be omitted) USEC MSEC

Table 5-6 MEASRE

Item	Command		Query	Description
	Header	Parameter		
MEASURE	MEA	0 to 2	MEA?	0: STOP 1: SINGLE 2: REPEAT

Table 5-7 STORAGE/DATA OUT

Item		Command		Query	Description
		Header	Parameter		
SAVE					
	SAVE MEAS	SAV ##	1 to 15	---	1 to 15:MEAS 1 to 15(memory)
	DATA (Memory or floppy disk)		Plus [# memory name #] or [# file name #] Terminator character (# or !)		Ex. SAV#LD-No15# (floppy disk) Ex. SAV15#LD-No15# (memory)
	SAVE PANEL (Memory or floppy disk)	SVP ##	1 to 10	---	1 to 10: PANEL1 to 10
			Plus [# memory name #] or [# file name #] Terminator character (# or !)		Ex. SVP9#MAG1530# (memory) Ex. SVP#MAG1520# (floppy disk) (No memory name for data Nos. 00 and 99)
	DELETE MEAS	DMD	1 to 15	---	1 to 15: MEAS 1 to 15
	DELETE PANEL (Only for memory)	DPC	1 to 10	---	1 to 10: PANEL 1 to 10
	DISP/MEAS	SMS	0, 1	SMS?	0: DISP, 1: MEAS
	BITMAP SAVE	BIT	---	---	Save the bitmap image.
	UNIT NORMALIZE	UNM	0, 1	UNM?	0: OFF, 1: ON
RECALL					
	RECALL MEAS (memory or floppy)	RCL	0 to 15	---	0: REF 1 to 15: MEAS 1 to 15 Ex. RCL10 (memory) Ex. RCL#LD123.SPE# (floppy)
			(# file name #) terminator character (# or !)		
	RECALL PANEL (memory or floppy)	RCP	0 to 10	---	0: REF 1 to 10: PANEL 1 to 10 Ex. RCP5 (memory) Ex. RCP#LD123# (floppy)
			(# file name #) terminator character (# or !)		
COPY					
	PRINT	EPR	---	---	Output to Ext. printer
	PRINTER TYPE	PRT	0 to 2	PRT?	0: ESC/P 1: ESC/P R 2: PCL

Table 5-8 SYSTEM

Item	Command		Query	Description
	Header	Parameter		
SYSTEM				
PRESET	IPR	---	---	Sets the measurement conditions etc. to the pre-determined initial state.
CLOCK				
CLOCK ON/OFF	CKD	0, 1	CKD?	0: CLOCK display OFF 1: CLOCK display ON
CLOCK	CLO ##	Refer to the following	CLO ##?	Setting the date and the hour.
		CLO # YY-MM-DD,hh,mm:ss # Terminator character (# or !) YY: year (00 to 99) MM: month (01 to 12) DD: date (00 to 31) hh: hour (00 to 23) mm: minute (00 to 59) ss: second (00 to 59) YY=80 to 90: 1980 to 1999 YY=00 to 79: 2000 to 2079		
COLOR				
COLOR PATTERN	CPT	0 to 4	CPT?	Setting color patterns 0: Color pattern 1 1: Color pattern 2 2: Color pattern 3 3: Color pattern 4 4: Color pattern 5
BUZZER				
BUZZER(BEEP)	BUZ	0, 1	BUZ?	0: OFF 1: ON
WARNING	WAR	0, 1	WAR?	0: OFF 1: ON
QUIET BEEP	QUI	0, 1	QUI?	0: NORMAL 1: QUIET

Item	Command		Query	Description
	Header	Parameter		
SELF TEST				
SELF TEST	---	---	*TST?	Execution of self-diagnostic feature and output request for results 0000: Normal 010X: ROM error 02XX: RAM error 030X: Backup-RAM error 040X: Peripheral circuitry error : (internal clock, timer, : printer interface, 070X: etc.)
FLOPPY				
FROPPY ON/OFF	FON	0, 1	FON?	0: FROPPY-OFF (MEMORY) 1: FROPPY-ON
FORMATTING	FFO	1, 2	---	Executes initialization of the floppy disk. 1: 2DD(720k) 2: 2HD(1.44M)
VOLOME LABEL	FVO	#volume name# Terminator character (# or!)	FVO?	Sets the volume name for the floppy disk (up to eleven characters) Ex. FVO#LD-1530# Ex. FVO#BEUE-LED#
LABEL	LAB	#LABEL# Terminator character (# or!)	LAB?	Set the label LAB#----------# (up to 48 characters)

Table 5-9 MODE

Item		Command		Query	Description
		Header	Parameter		
MODE					
	NOMAL	CUD	0 to 4	CUD?	0: NORMAL
	ΔMODE				1: ΔMODE
	2ND PEAK				2: 2ND PEAK
	POWER				3: POWER
	DIFFER				4: DIFFER
	band width	SPW	0, 1	SPW?	0: OFF 1: ON
	band width mode	WTY	0, 1	WTY?	0: PK - XdB 1: ENVELOPE
	XdB parameter	WPX	Numerical value	WPX?	Range of setting: 0.1 to 59.9 Ex. WPX3.0,WPX12.0
	YdB parameter	WPY	Numerical value	WPY?	Range of setting: 0.1 to 99.9 Ex. WPY20,WPY35.0
	K parameter	WPK	Numerical value	WPK?	Range of setting: 0.1 to 100.0

Table 5-10 CURSOR

Item	Command		Query	Description
	Header	Parameter		
CURSOR				
ON/OFF	CUR	0, 1	CUR?	0: CURSOR OFF 1: CURSOR ON
CURSOR-X1 ON/OFF	XAC	0, 1	XAC?	0: X1 OFF 1: X1 ON
SET CURSOR-X1	XAS	Numerical value+Unit	XAS?	UM: μm NM: nm THZ: THz GHZ: GHz Ex. XAS0.78UM
CURSOR-X2 ON/OFF	XBC	0, 1	XBC?	0: X2 OFF 1: X2 ON
SET CURSOR-X2	XBS	Numerical value+Unit	XBS?	UM: μm NM: nm THZ: THz GHZ: GHz Ex. XBS 630.5nm
CURSOR-L1 ON/OFF	YAC	0, 1	YAC?	0: Y1 OFF 1: Y1 ON
SET CURSOR-L1	YAS	Numerical value+Unit	YAS?	DB: dB M: m U: μ N: n
CURSOR-L2 ON/OFF	YBC	0, 1	YBC?	0: L2 OFF 1: L2 ON
SET CURSOR-L2	YBS	Numerical value+Unit	YBS?	DB: dB M: m U: μ N: n

Table 5-11 GPIB

Item	Command		Query	Description
	Header	Parameter		
Output request for peak search data	---	---	OPK? (OPK)	
Output request for cursor data	---	---	OCD? (OCD)	Output data differ depending on the cursor display mode.
Output request for waveform data	OSD	0, 1	---	0: output of Y axis data 1: output of X axis data
Output request for numbers of waveform data	---	---	ODN? (ODN)	Output of number of data items existing on screen specified by OVSn.
Query for the half-width operation results	---	---	OSW? (OSW)	
ON/OFF for displays of measurement data	DSP	0, 1	DSP?	Sets whether or not the display is updated at the end of measurement. 0: turns the display OFF. 1: turns the display ON.
Output control of header data	HED (HD)	0, 1	HED?	0: HEADER OFF 1: HEADER ON
Specification of terminator	DEL (DL)	0 to 3	DEL?	0: NL<EOI> 1: NL 2:<EOI> 3: CR NL<EOI>
Specification of data separator (ASCII waveform data)	SDL (DS)	0 to ,	SDL?	0: ,(comma) 1: SP (space) 2: CR NL
Specification of data output format (valid for waveform data)	FMT	0 to 4	FMT?	0: ASCII 1: BINARY(16bit) 2: BINART(64bit float) 3: BINART(32bit float) 4: BINART (32bit float NEC)
Specification of data output screen	OVS	0, 1	OVS?	0: upper (upper screen) 1: lower (lower screen) (Valid in dual screen display mode)

Item	Command		Query	Description
	Header	Parameter		
Control of SRQ signal	SRQ (S)	0, 1	SRQ?	0: mode sending no SRQ 1: mode sending SRQ
	S	0, 1	S?	0: mode sending SRQ 1: mode sending no SRQ
Masking status byte	MSK	0 to 255 (Masking is impossible in case of bit 6)	MSK?	Sets "1" to the bit to be masked in the status byte (initial value: 0). Ex. masks b1 and b2 : MSK6
Clearing status byte	CSB	---	---	
SINGLE measurement	E (*TRG)	---	---	Execution of SINGLE measurement operation.
Setting to the initial state	C (*RST)	---	---	Sets this analyzer to the initial state when the power was turned on.
Output request for the unit ID	---	---	*IDN?	Output request for manufacturer name, product name, serial number and software revision.

6 PRINCIPLE OF MEASUREMENT

6.1 Measurement Principle

This section describes the measurement principle of the Q7750.

Figure 6-1 shows a block diagram of the Q7750.
The CW light emitted from the tunable light source is projected into the light intensity modulator, where it is intensity-modulated by the phase reference signal. The intensity-modulated light is passed through the optical coupler and applied to the DUT (device under test) through the test port 1.

The light signal that passes through the DUT enters test port 2 and is converted to an electrical signal by the O/E converter to measure its intensity. Then the phase difference between the light signal and the phase reference signal is measured by the phase comparator for the transmitted light.

This determines the amplitude and phase characteristics of the transmission characteristics of the DUT.

The delay time is obtained from the phase difference Φtrans, using the following formula.

$$\tau_{trans} = \frac{\Phi trans}{2\pi\, fm}$$

The characteristics against wavelengths are calculated by taking measurements and making calculations while sweeping the tunable light source along its wavelengths

The chromatic dispersion Dtrans can be calculated by differentiating the values of group delay times with respect to the wavelengths.

$$D_{trans} = \frac{\partial\, \tau_{trans}}{\partial\, \lambda opt}$$

Furthermore, the reflection characteristics of the DUT can be obtained through the same process after the light reflected from the DUT is returned to test port, branched by the optical coupler and converted to an electrical signal by the O/E converter.

This method is generally referred to as the phase shift method.

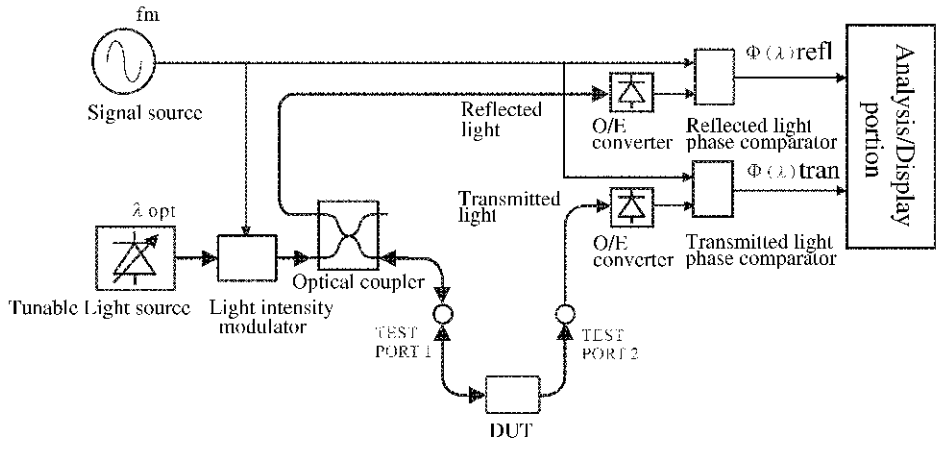


Figure 6-1 Q7750 Block Diagram

6.2 Modulation Frequency

The modulation frequency refers to the frequency of the modulation signal used for the light intensity modulator. In the phase shift method, the higher the modulation frequency is, the more accurately the phase difference between the reference phase signal and modulation frequency can be measured, which heightens the resolution of delay time.

The measurement range equals the modulation signal period, therefore, if the modulation frequency becomes higher, the effective range is narrower.

The effective range of group delay time, ΔT, is expressed using the modulation frequency of fmod as follows:

$\Delta T = 1/fmod$

For example, when the modulation frequency is 1 GHz, the effective range of group delay time is -0.5 nsec to 0.5 nsec.

6.3 Principle of Distance Measurement

Distance measurement specifies the wavelength and refractive index of light, and measures the group delay time. The distance can be figured using the following expression.

$$L = \frac{c}{n} \times \tau$$

L: Length of DUT [m]

n: Refractive index

c: Velocity of light [m/s],($= 2.99792458 \times 10^8$)

τ: Group delay time [s]

Since the refraction index normally varies depending on the wavelength of light, the wavelength and refraction index must be specified to figure the distance measurement.

6.4 Sensitivity

Four levels of sensitivity can be set.

1. HIGH SENS : High sensitivity
2. MIDDLE SENSE : Middle sensitivity
3. NORMAL SENS : Normal sensitivity
4. HI SPEED : High-speed sensitivity

The measurement sensitivities are graded in order of 1, 2, 3 and 4 (with the highest as one). The higher measurement sensitivity allows the S/N ratios of the magnitude and group delay time characteristic to be improved. On the other hand, the lower the measurement sensitivity, the less the S/N ratios and measurement time.

The S/N ratio is improved depending on the sensitivity.

HIGH SENS: 2.4 dB as compared with MIDDLE SENS

MIDDLE SENS: 2.6 dB as compared with NORMAL SENS

NORMAL SENS: 2.4 dB as compared with HI SPEED.

6.5 Differential Measurement

Errors due to group delay time drift (caused by fiber length changes resulting from temperature changes) may occur when group delay time and chromatic dispersion characteristics are measured.

Figure 6-2 shows that group delay times are sequentially measured in the order of λ1, λ2 and so on when the group delay time drift tends to decrease. The characteristic curve indicated by the black dots shows that the measured group delay times are not affected by the group delay time drift. If the group delay time decreases along the time axis as shown in Figure 6-3, the characteristic curve indicated by the white dots, which contains group delay time errors, is shown Figure 6-2. As a result, there is a possibility that large errors in the zero chromatic dispersion wavelength, chromatic dispersion and the chromatic dispersion slope may occur.

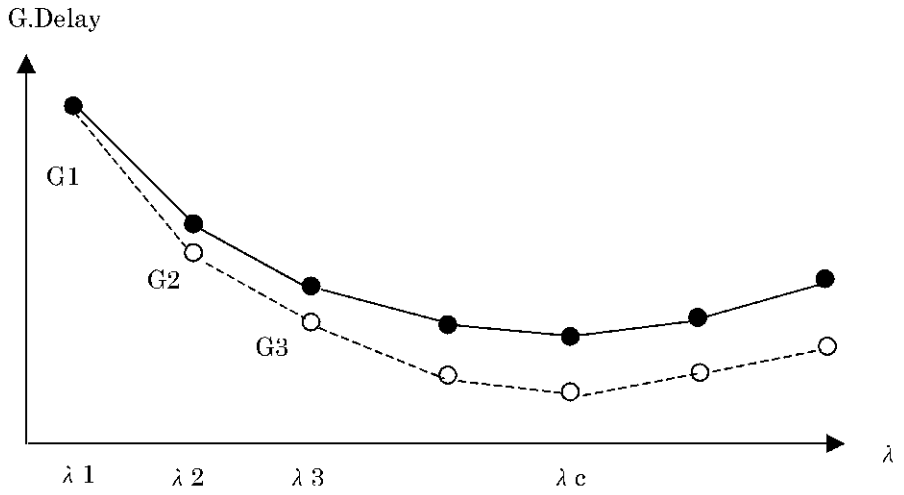


Figure 6-2 Difference between Group Delay Time Characteristics due to Group Delay Time Drift

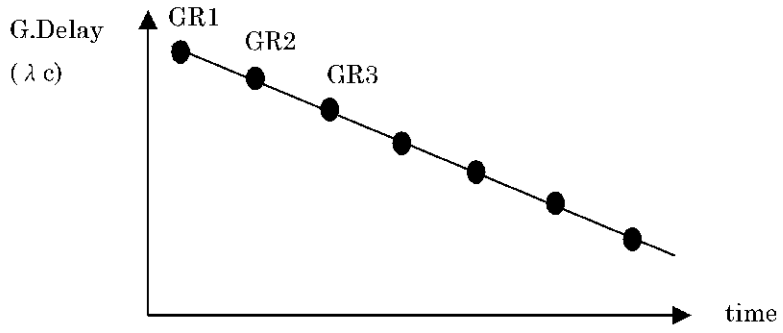


Figure 6-3 Group Delay Time Drift at the Reference Wavelength (λc)

A differential measurement is made in the following manner: the reference wavelength (λc) is set to examine the group delay time drift, and then the difference between the group delay time at a measurement point and the group delay time at the reference wavelength is calculated for each measurement point to make a measurement accurately by canceling the error due to group delay time drift (see Figure 6-4). This method, however, needs a sweep time twice that for the normal method.

Calculate the group delay time of the nth point in the differential measurement (Dn) using the following expression. Where Gn is the nth point group delay time, GRn is the group delay time at the reference wavelength used when Gn is measured.

Dn = Gn - GRn (n: 0, 1, 2 ...)

The reference wavelength is set to the center wavelength of the set span, and measured by performing sweeps in the order of λ1, λc, λ2 and λc.

NOTE: ***The differential measurement mode is not available to calculate measurement data for the magnitude characteristic .***

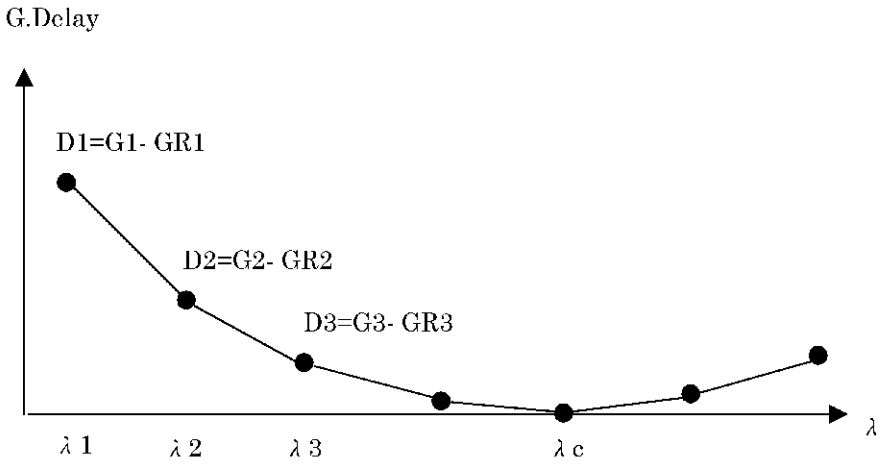


Figure 6-4 Result Obtained in Differential Measurement Mode

6.6 Unwrap Function

When the measured value is between -180° and 180°, the phase shift method is executed to rotate the phase as shown in Figure 6-5. As a result, the phase characteristic is dramatically changed.

When the difference between the measured and displayed values is 180° or greater, the unwrap function senses that the phase rotation has occurred, and unwraps the displayed value as shown in Figure 6-5 .

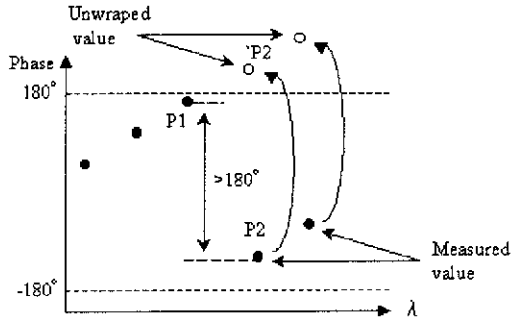


Figure 6-5 Unwrap Function

Specific conditions and expressions for unwrapping are as follows:

When (P1 - P2) is greater than 180°, P2' = P2 + 360°

When (P1 - P2) is less than -180°, P2' = P2 - 360°

Where, P1 is the previous measured value, P2 is the measured value before unwrapping, and P2' is the measured value after unwrapping.

When the DUT magnitude level is low, noises from group delay time affect phase measurements. As a result, the phase measurements are unwrapped incorrectly.

Therefore, a threshold level which is specified by selecting THRESH from the menu can be used as the minimum magnitude level to be unwrapped. The minimum magnitude level (or lower) is not unwrapped. (See Figure 6-6.)

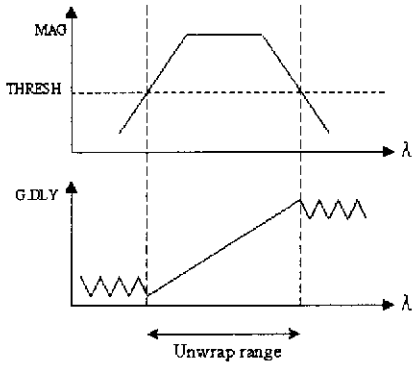


Figure 6-6 Setting Threshold for Unwrapping

6.7 Smoothing Calculation

Use the following expressions to smooth data.

$$d'_i = \frac{1}{n} \sum_{k=i+(n-1)/2}^{i-(n-1)/2} d_k$$

$d_0, d_1, .., d_N$: Measured values

$d'_0, d1'_1, .., d'_N$: Smoothed data

N: Number of measurement points

n: Number of points for smoothing

"n" can be obtained using the width of the smoothing zone as shown below.

n = (Smoothing zone width/Wavelength span) × N

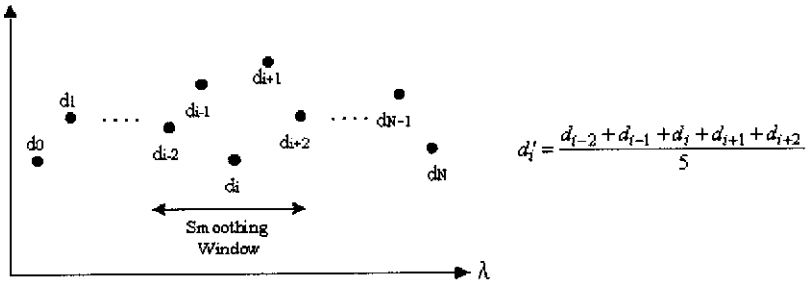


Figure 6-7 Smoothing Calculation

6.8 Curve Fitting Function and Statistical Variance

Curve fitting function

Linear expression (LINER)	$F_1\lambda+F_2$
Quadratic polynomial (QUAD)	$F_1\lambda^2+F_2\lambda+F_3$
Three-term Sellmeier's polynomial (SELM3)	$F_1/\lambda^2+F_2\lambda+F_3\lambda^2$
Five-term Sellmeier's polynomial (SELM5)	$F_1/\lambda^4+F_2/\lambda^2+F_3+F_4\lambda^2+F_5\lambda^4$

F through F represent fitting coefficients displayed on the report screen.

When the curve fitting is executed, the group delay is approximated by the above expressions.

CD can be obtained by differentiating the group delay obtained by the curve fitting once with respect to λ The CD slope can also be obtained by differentiating the group delay twice.

The statistical variance is shown by the following expression:

$$\text{Statistical variance} = \sqrt{\frac{1}{N}\sum_{i=0}^{N}(d_i-\dot{d_i})^2}$$

$d_0, d_1, .., d_N$: Measured values

$\dot{d_0}, \dot{d1_1}, .., \dot{d_N}$: Curve fitting values

N : Number of measurements

6.9 Bandwidth Calculation Method

The Q7750 Pk-XdB function allows an easy calculation of transmission bandwidth.

Processing procedure

(1) The maximum peak of the trace is obtained.

(2) Intersections a and b on the XdB attenuation level curve from the maximum peak value of the trace are defined.

(3) The bandwidth and center wavelength are obtained from each wavelength at intersections a and b using the following formula.

$\lambda o = (\lambda a+\lambda b)/2$

$\triangle \lambda = \lambda b-\lambda a$

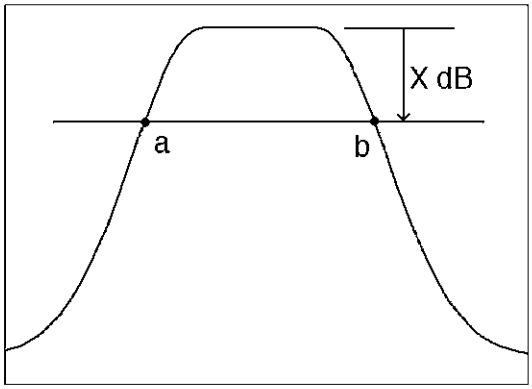


Figure 6-8 Bandwidth Calculation Method

6.10 Creating Limit Line Data Files

The Q7750 can make pass/fail judgments on measurements using the limit line function.

(1) Creating the data file

Use a personal computer and text editor such as Note to create data files and save the files using the names as listed below.

Specified file name:
FD:¥LmtLn¥LmtLn1.txt
FD:¥LmtLn¥LmtLn2.txt
FD:¥LmtLn¥LmtLn3.txt
FD:¥LmtLn¥LmtLn4.txt
FD:¥LmtLn¥LmtLn5.txt

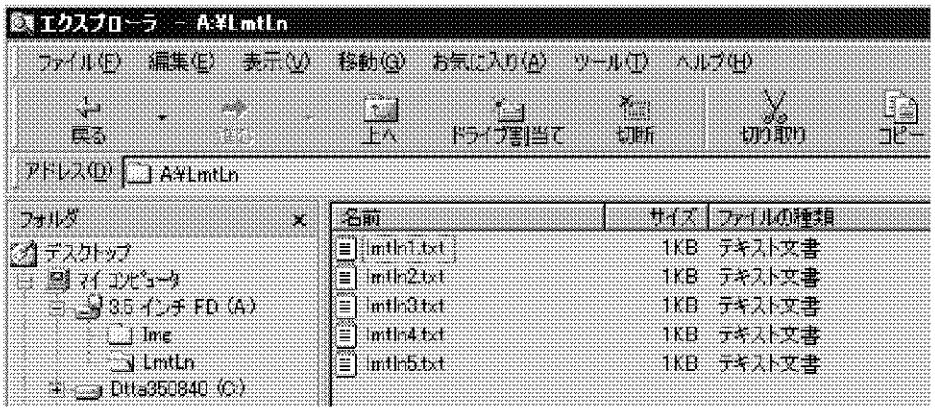


Figure 6-9 Data File in the LmtLn Folder

Each file corresponds to the menu items ***PATTERN 1*** through ***PATTERN 5*** as shown below.

FD:¥LmtLn¥LmtLn1.txt corresponds to ***PATTERN1***.
FD:¥LmtLn¥LmtLn2.txt corresponds to ***PATTERN2***.
FD:¥LmtLn¥LmtLn3.txt corresponds to ***PATTERN3***.
FD:¥LmtLn¥LmtLn4.txt corresponds to ***PATTERN4***.
FD:¥LmtLn¥LmtLn5.txt corresponds to ***PATTERN5***.

Figure 6-10 shows a sample of limit line data. When the data is loaded to the Q7750, the limit lines shown in Figure 6-11 are displayed.

```
[Fundamental]
MeasMode=MAGLOG              ' MAG table
Domain=WAVE                  ' Waveform domain

[Reference]
DataModeX=REL                ' Sets the X-axis coordinate to the relative scale.
RefModeX=LEFT                ' Sets the left edge of the screen graph to a reference point.
RefUserX=                    ' No specification
OffsetX=0                    ' Sets the X offset to zero.
DataModeY=ABS                ' Sets the Y-axis coordinate to the absolute scale.
RefModeY=                    ' No specification
RefUserY=                    ' No specification
OffsetY=0                    ' Sets the Y offset to zero.

[TableUp]
PassRange=UNDER              ' The test result is pass if the measurement is below the line.
+0.0,  +5.0                  ' The X axis coordinate is relative to the START waveform
+1.0,  +5.0                  ' and is expressed with the nm unit.
+1.0, +10.0                  ' Power (dB) is used to express Y-axis amplitudes.
+3.0, +10.0                  ' The psec unit is used to express other than
+3.0, +30.0                  ' Y-axis amplitudes.
+5.0, +30.0
+5.0, +25.0
+8.0, +25.0
+8.0, +15.0
+10.0,+15.0

[TableLow]
PassRange=OVER               ' The test result is pass if the measurement is above the line.
+0.0,  -5.0
+1.0,  -5.0
+1.0, -10.0
+3.0, -10.0
+3.0, -30.0
+5.0, -30.0
+5.0, -25.0
+8.0, -25.0
+8.0, -15.0
+10.0,-15.0
```

Figure 6-10 Limit Line Data File Example

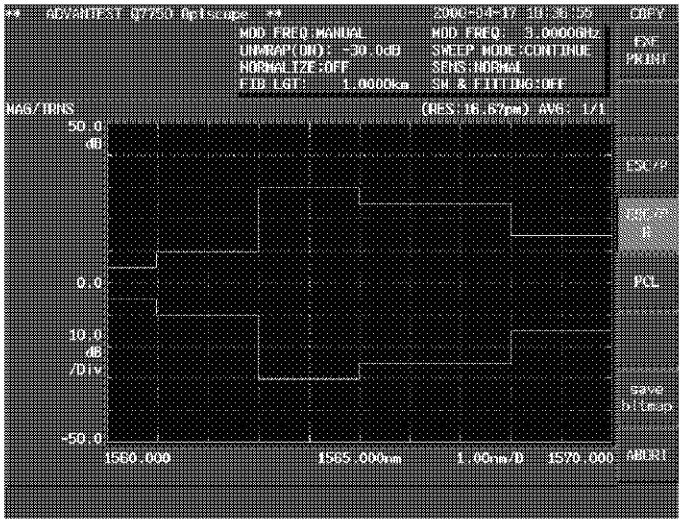


Figure 6-11 Limit Line Examples

(2) Limit line settings

Limit lines are defined using specified keywords and values as shown below.

```
[Group name]
Keyword = One or two values delimited by a comma.
```

(a) Group name

There are four groups Fundamental, Reference, TableUp and TableLow. Each group title is parenthesized by brackets [] and follows a keyword, equal (=) and value(s) written line by line.

Various keywords and values are provided for each group.

To define a limit line, X and Y values have to be specified being delimited by a comma.

(b) MeasMode: Belongs to the Fundamental group.

```
MeasMode=MAGLOG     ' Specifies amplitude measurements and displays the measured
                      amplitudes in the logarithmic scale.
        MAGLIN      ' Specifies amplitude measurements and displays the measured
                      amplitude in the linear scale.
        GDELAY      ' Specifies group delay measurements.
        CD          ' Specifies chromatic dispersion measurements.
        CDS         ' Specifies chromatic dispersion slope measurements.
```

The measurement mode is specified.

NOTE: ***Loading the MeasMode setting to the Q7750 automatically changes the current limit line setting.***

(c) Domain: Belongs to the Fundamental group.

```
Domain=FREQ         ' Specifies a frequency domain.
       WAVE         ' Specifies a waveform domain.
```

The domain is specified.

NOTE: ***Loading the Domain setting to the Q7750 automatically changes the current limit line setting.***

(d) DataModeX: Belongs to the Reference group.

```
DataModeX=ABS       ' Sets the X-axis coordinate to the relative scale.
          REF       ' Sets the X-axis coordinate to the absolute scale.
```

This keyword is used to select relative or absolute scale for the X-axis coordinate. When absolute scale is selected, the actual measurements are used. However, when relative scale is selected, the measurements are converted to values which are relative to the reference point.

NOTE: ***When REL is selected for the above setting, REL has to be specified for both RefModeX and RefUserX.***

(e) RefModeX: Belongs to the Reference group.

RefModeX=LEFT ' Sets an X coordinate reference point at the left edge of the screen graph when relative scale is selected.

CENTER ' Sets an X coordinate reference point at the center of the screen graph when relative scale is selected.

USER ' Sets an X coordinate reference point on the screen graph at the desired location when relative scale is selected.

This keyword is used to specify a reference point.

NOTE: When USER is selected, RefUserX (described in the next section) must also be specified.

(f) RefUserX: Belongs to the Reference group.

RefUserX=Waveform or frequency
' Sets an X coordinate reference point at the desired location. (This can be omitted.)

NOTE: Waveform data is expressed in nm and frequency data is expressed in THz.

(g) OffsetX: Belongs to the Reference group.

OffsetX=Waveform or frequency
' Specifies an offset.

This keyword is used to specify an offset, which causes the limit line to move to the left or right on the screen.

NOTE: Waveform data is expressed in nm and frequency data is expressed in THz.

(h) DataModeY: Belongs to the Reference group.

RDataModeY=ABS ' Sets the Y-axis coordinate to relative scale.

REF ' Sets the Y-axis coordinate to absolute scale.

This keyword is used to select relative or absolute scale for the Y-axis coordinate. When absolute scale is selected, the actual measurements are used. However, when relative scale is selected, the measurements are converted to values which are relative to the reference point.

NOTE: When REL is selected for the above setting, REL has to be specified for both RefModeY and RefUserY.

(i) RefModeY: Belongs to the Reference group.

RefModeY=TOP ' Sets an Y coordinate reference point on the top of the screen graph when relative scale is selected.

MIDDLE ' Sets an Y coordinate reference point on the middle level of the screen graph when relative scale is selected.

BOTTOM ' Sets an Y coordinate reference point on the bottom of the screen graph when relative scale is selected.

USER ' Sets an Y coordinate reference point at the desired location when relative scale is selected.

This keyword is used to specify a reference point.

NOTE: When USER is selected, RefUserY described in the next section also has to be specified.

(j) RefUserY: Belongs to the Reference group.

RefUserY=Level ' Sets an Y coordinate reference point on the screen graph as desired. (This can be omitted.)

NOTE: The amplitude in logarithmic scale is expressed in dB but the amplitude in linear scale is expressed without a unit. Other measurements are expressed in psec.

(k) OffsetY: Belongs to the Reference group.

OffsetY=Level ' Specifies an offset.

This keyword is used to specify an offset, which causes the limit line to move up or down on the screen.

NOTE: The amplitude in logarithmic scale is expressed in dB but the amplitude in linear scale is expressed without a unit. Other types of measurement are expressed with psec.

(l) PassRange: Belongs to the TableUp and TableLow groups.

PassRange=UNDER ' Set the upper limits.

OVER ' Sets the lower limits.

This keyword is used to specify the criteria for pass/fail judgement

(m) Value, value

Specify X and Y coordinates delimited by a coma according to the Meas and Domain settings. The X coordinate can be used to indicate waveform data in nm and also to indicate frequency data in THz.

The Y coordinate can be used to indicate optical amplitudes in dB in logarithmic scale and also to indicate optical amplitudes without a unit in linear scale. Other measurements are expressed in psec using the Y coordinate.

NOTE: Write only numeric values without a unit as shown below.

Correct

1.549E+03 ' 1549 nm

193.0 ' 193 THz

```
        -20.5                   ' -20.5 dB
Incorrect
        1549 nm
        193 THz
        -20.5 dB
```

(3) Limit lines and measurement type

Limit lines can be loaded when the measurement type is changed. For example, suppose that limit line settings are written for the optical amplitude measurement and group delay measurement in LmtLn1.txt and LmtLn2.txt, respectively.

Once PATTERN 1 and PATTERN 2 are pressed to load LmtLn1.txt and LmtLn2.txt to the Q7750 internal memory, the limit lines are automatically displayed depending on the selected measurement type.

If the limit line data for the chromatic dispersion measurement has not been loaded to the internal memory, changing the measurement type to the chromatic dispersion measurement will not display the required limit lines even though a limit line is being displayed for the optical amplitude measurement.

Limit lines for necessary measurement type should be loaded in the internal memory beforehand.

NOTE: ***There is no need to change the limit lines when the measurement type is changed.***

---

(4) Maximum allowable number of limit line tables

Only one limit line table can be used for each measurement. Even for frequency-domain and waveform-domain measurements, one table is used.

To toggle the wavelength and frequency axes, load the limit line data from the floppy disk.

NOTE: ***Even when the domain is changed, the displayed limit line is not converted so that it can be used for a new domain.***

---

7 SPECIFICATIONS

Characteristics		Description
Measurement function	Sweep channel	2 channels (Input reflection characteristics and forward direction transmission characteristics)
	Input reflection characteristics (S11)	Amplitude characteristics Group delay time characteristics Chromatic dispersion characteristics Chromatic dispersion slope characteristics
	Forward direction transmission characteristics (S21)	Amplitude characteristics Group delay time characteristics Chromatic dispersion characteristics Chromatic dispersion slope characteristics
Optical signal source characteristics *1	Measurable wavelength range	1525 nm to 1635 nm
	Absolute wavelength accuracy *2	±0.050 nm (Typ. ±0.025 nm) ±5ppm ±1pm (measured by the Q7750 (with Option 10 installed) in combination with the TQ8325) ±2ppm (measured by the Q7750 (with Option 10 installed) in combination with the HP86120C: Reference value)
	Wavelength set resolution	0.001 nm
	Wavelength range (used to be set)	Arbitrary value between 0.1 nm and 110 nm. (Arbitrary value between 12.5 GHz and 13.2 THz.)
	Repeatability of wavelength *3	span × (±0.3%) ±30 MHz or less
	Sweep time (measurement time) *4	approx. 6.7 msec/point approx. 4 sec/span
	Optical output level *5	-15 dBm or more

<table>
<tr><th colspan="2">Characteristics</th><th>Description</th></tr>
<tr><td rowspan="5">Amplitude characteristics</td><td>Scale</td><td>Logarithmic (0.2, 0.5, 1.0, 2.0, 5.0 or 10.0 dB/ div) and linear</td></tr>
<tr><td>Modulation frequency range</td><td>40 MHz to 3 GHz</td></tr>
<tr><td>Dynamic range *6</td><td>Forward direction transmission characteristics:
35 dB (Typically 40 dB)
Input reflection characteristics:
33 dB (Typically 38 dB.)</td></tr>
<tr><td>Linearity *7</td><td><table><tr><th rowspan="2">Linearity</th><th colspan="2">Relative level</th></tr><tr><th>S21</th><th>S11</th></tr><tr><td>±0.10 dB</td><td>0 to -25 dB</td><td>0 to -23 dB</td></tr><tr><td>±0.25 dB</td><td>-25 to -30 dB</td><td>-23 to -28 dB</td></tr></table></td></tr>
<tr><td>Polarization dependency</td><td>Forward direction transmission characteristics
(Test port 2): 0.05 dB
Input reflection characteristics
(Test port 1): 0.10 dB</td></tr>
<tr><td></td><td>Repeatability of connection/disconnection *8</td><td>±0.1 dB</td></tr>
<tr><td rowspan="4">Group delay time characteristics</td><td>Modulation frequency range (fm)</td><td>40 MHz to 3 GHz</td></tr>
<tr><td>Maximum measurable group delay time</td><td>15 µsec</td></tr>
<tr><td>Group delay time resolution</td><td>0.1 psec (at a modulation frequency of 3 GHz)</td></tr>
<tr><td>Accuracy of relative group delay time *7</td><td><table><tr><th rowspan="2">Linearity</th><th colspan="2">Relative level</th></tr><tr><th>S21</th><th>S11</th></tr><tr><td>±0.2%/fm</td><td>0 to -15 dB</td><td>0 to -13 dB</td></tr><tr><td>±0.4%/fm</td><td>-15 to -20 dB</td><td>-13 to -18 dB</td></tr><tr><td>±1.0%/fm</td><td>-20 to -25 dB</td><td>-18 to -23 dB</td></tr></table></td></tr>
</table>

Characteristics		Description
Chromatic dispersion characteristics	Measurement units	Wavelength domain (ps/nm), frequency domain (ps/GHz) Chromatic dispersion slope (ps/nm^2) ps/nm km, ps/GHz km, ps/nm^2 km, ps/GHz^2 km
	Measurable range	0.1 psec/nm to 1 μsec/nm
	Measurement resolution	0.01 ps/nm
Fiber's chromatic dispersion measurements *9	Repeatability of dispersion coefficient measurement	0.025ps/nm, 0.003ps/nm/km
	Repeatability of zero-dispersion wavelength	0.030nm
	Repeatability of dispersion slope measurement (at the zero-dispersion wavelength)	0.025ps/nm^2/km, 0.002ps/nm^2/km
	Accuracy of zero-dispersion wavelength measurement	±0.080nm ±0.035nm (measured by the Q7750 (with Option 10 installed) in combination of the TQ8325) ±0.030nm (measured by the Q7750 (with Option 10 installed) in combination of the HP86120C: Reference value)
	Waveform approximation function	linear approximation, second order polynomial, 3-term Sellmeier's polynomial and 5-term Sellmeier's polynomial
Fiber length measurement	Measurement range	0.2m to 10,000km
	Resolution	0.02 mm or 0.01% of measured length, whichever is larger.
	Input range of refractive index	1.000000 to 2.000000

Characteristics		Description
Processing function	Memory function	Measured data is saved into the backup memory or onto a floppy disk.
	Display	Optical frequency display, superposition display, up-and-down 2-screen display and the cursor functions.
	Operation/Analysis	Automatic measurement function, automatic phase offset compensation function, half-width calculation function Averaging function, Normalize and Smoothing Waveform approximation function (linear approximation, second order polynomial, 3-term Sellmeier's polynomial and 5-term Sellmeier's polynomial)
Optical input/output	Optical connector *10	FC-type optical connector SC-type optical connector (option) ST-type optical connector (option)
Input/Output interface	GPIB	IEEE-488-1978 compliant
	Floppy disk drive	3.5-inch MS-DOS format
	Printer	D-SUB 25-pin for ESC/P, ESC/P-R and PCL
	Keyboard	IBM PC-AT compliant
	Display	15-pin D-SUB connector (VGA)
General specifications	Operating environment range	Temperature range: 15°C to 35°C, Relative humidity 85% or less (without condensation)
	Storage environment range	Temperature range: -10°C to 45°C, Relative humidity 90% or less (without condensation)
	AC input power source	Display unit: 100 to 120 V, 220 to 240 V, 50 Hz/60 Hz, 300 VA or less Optical network analyzer unit: 100 to 120 V, 220 to 240 V, 50 Hz/60 Hz, 310 VA or less
	Outer dimensions	Display unit: Approximately 424 (W) × 220 (H) × 400 (D) mm Optical network analyzer unit: Approximately 424 (W) × 220 (H) × 500 (D) mm
	Mass	Display unit: 16 kg or less Optical network analyzer unit:25 kg or less

Characteristics		Description
Option (OPT10)	Optical monitor output	Output level: -20dBm or more connector: Angled PC/FC type connector (Fixed)

*1 Warm-up time: 2 hours
*2 At a constant temperature and when performing step sweeps.
*3 At a constant temperature and when performing uninterrupted continuous sweeps.
*4 When performing uninterrupted continuous sweeps. SPAN≤60GHz, not include internal settling time.
*5 AVG Power
*6 This is the difference between an amplitude level and averaged noise level for the through state (S21) or the total reflection state (S11).
*7 The relative value is in reference to amplitude level for the through state (S21) or the total reflection state (S11).
*8 After repeating the following 10 times: connect and then disconnect the SMF fiber (with a FC connector) at the specified connector.
*9 At a constant temperature and after an 11-km dispersion shift fiber has been measured 20 times. The zero-dispersion wavelength is set to the center wavelength, and a measurement wavelength span of 10 nm is used in step sweep measurement mode that has 11 points (the distance between adjacent points is 1 nm).
Values are calculated approximately using second order polynomial. A dispersion slope of 0.074 ps/nm(2)/km is used. Unless otherwise specified, an external wavemeter is not used.
*10 Can be converted to the SC or ST connector by using the optional adapter.

APPENDIX

A.1 TROUBLESHOOTING

Problems	Suspected causes	Troubleshooting
Power is not turned on.	Any power cable may not be correctly connected.	Turn the power switch off, then connect the cable to the connector for AC power supply of this analyzer. Connect the cable to the outlet.
	A power fuse has blown.	Check for a blown fuse. If so, an abnormality is suspected. Ask ADVANTEST Corp. to repair the analyzer.
The system does not start up (The self-test is not completed).	Optical network analyzer	Turn power off, then turn it on again.
	The PORT B is not connected.	Turn power off and after connecting PORT B, turn it on again.
An error message is displayed.	An operation error is suspected.	Referring to the list of error messages, correct the problem.
	A malfunction or defect in this analyzer is suspected.	
No sweeping.	PORT A is not connected.	Turn power off and after connecting PORT A, turn it on again.
Keys do not work.	This analyzer may have been placed in REMOTE control mode by a GPIB command.	Interrupt the program if it is running, then press LOCAL.
Can not read the data from the floppy disk.. (Recalling is not possible.)	An abnormality may have occurred in the floppy disk.	An abnormality may have occurred in the disk drive.
	Check operation using another floppy disk.	Ask ADVANTEST Corp. to repair the analyzer.
Can not save the data in the floppy disk..	The write protect is set to on.	Set the write protect of the floppy disk to off.
	The floppy disk is not initialized.	Initialize the floppy disk.
	The floppy disk is short of capacity.	Use another floppy disk.

A.2 ERROR CODE LIST

Code	Description
0000X	Normal
010X	ROM error
02XX	RAM error
030XX	backup-RAM error
040X 070X	Peripheral circuit error (internal clock, timer, printer, interface etc.)
110X 30XX	Error in the measurement system (memory in the measurement system, interferometer, A/D converter etc.)

A.3 GLOSSARY

Automatic power control (APC)

The mechanism for supplying power so that the optical output is kept constant. The optical output from a laser diode driven by constant current falls or stops when the temperature rises, and increases when the temperature lowers. The optical output may exceed the maximum rating when the temperature is too low. In order to protect the laser diode and stabilize the optical output, this circuit receives the monitor light of laser diode through the photo diode and then make it feed back to the drive circuit for laser diode.

Avalanche photo diode

A light-receiving element frequently used for optical-fiber communications. It uses an avalanche effect: a high reverse bias-voltage (100V to 200V) given to a semiconductor pn junction first moves a few carriers, causing successive carriers to be generated and making the current increase at an accelerated rate.

Baseband transmission characteristics

When an optical pulse is input to an optical fiber, the output pulse at the other end diverges, and this phenomenon is called divergence. That is, the transmission loss increases in the time domain. When converted to the frequency domain, it shows an increase in the transmission loss in the high-frequency band. The transmission characteristics in this frequency domain are called the baseband transmission characteristics, and these are important for optical-fiber performance.

Beam divergence angle

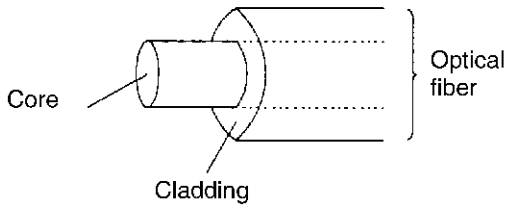
The angle from the optical axis that halves the radiant intensity from its maximum. For a laser diode, the horizontal direction to the junction is indicated by θ // and the perpendicular direction is indicated by $\theta\perp$. ($\theta\perp > \theta$ //)

Chopped light

A light with its intensity modulated by a square wave. Its optical output goes on and off repeatedly at a certain cycle.

Cladding

A part of the optical-fiber structure. An optical fiber consists of the core axis and the cladding surrounding the core. The fibers are generally made of quartz glass or plastics. The cladding has a refractive index approximately 1% less than that of the core, which helps contain the light flux within the core.



Coated fiber

One type of optical fiber, the core and cladding of which are covered by primary coating (silicon resin) and secondary coating (protective nylon layer).

Coherence

1. The existence of a timing correlation between the phases of two or more waves.
2. When the wavelengths, phases, and wave faces of light are exactly the same, the light is said to be coherent. There are two types of coherence: temporal and spatial. Temporal coherence is wavelength uniformity and phase continuity. Spatial coherence is the convergence of light into one point by a lens. As represented by laser light, light that has a constant wavelength and stable phase relationships is called coherent.

Coherent

Light is one type of electromagnetic wave, and has an extremely short wavelength. However, visible light has characteristics significantly different from those of the electromagnetic waves used for radio and TV programs. That is, while the frequencies, phases, and wave faces of electromagnetic waves are exactly the same, those of visible light vary. Visible light is therefore regarded as a certain type of noise. Light that has exactly the same frequencies, phases, and wave faces is said to be coherent. The light emitted from a laser diode used for optical communications has very high coherence, although it is not perfect.

Continuous-wave (CW) light

A non-modulated light with constant intensity. Also known as a DC light.

Core

Part of the optical-fiber structure. The core is the central axis, surrounded by cladding. A light flux propagates through the core. It is made of quartz glass and has a refractive index that is larger than that of the cladding by 1%. There are two types of optical fiber: multi mode fibers, with a core thickness of 50 to 100 μmϕ, and single-mode fibers, with a core thickness of approximately 10 μmϕ. Optical fibers can also be classified into the graded index (GI) and step index (SI) types, depending on the refractive index distribution of the core.

Core and cladding

The core is the central axis of the optical fiber, and cladding covers the core. Because the cladding has a lower refractive index than that of the core, the incident light propagates through the core, within which it is contained, repeating total reflection at the boundary face between the core and cladding. Generally, the core and cladding diameters are indicated as 50/125 μm, which means a core diameter of 50 μm and a cladding diameter of 125 μm.

Dark current

Current output from a light-receiving element when no incident light is given to it.

Direct modulation

The method that use a modulating signal as drive current to turn the light source on. The method of using a lightwave modulator is called external modulation.

Directivity

The property of having a large optical output or responsivity in a specific direction.

Distributed feedback laser (DFB laser)

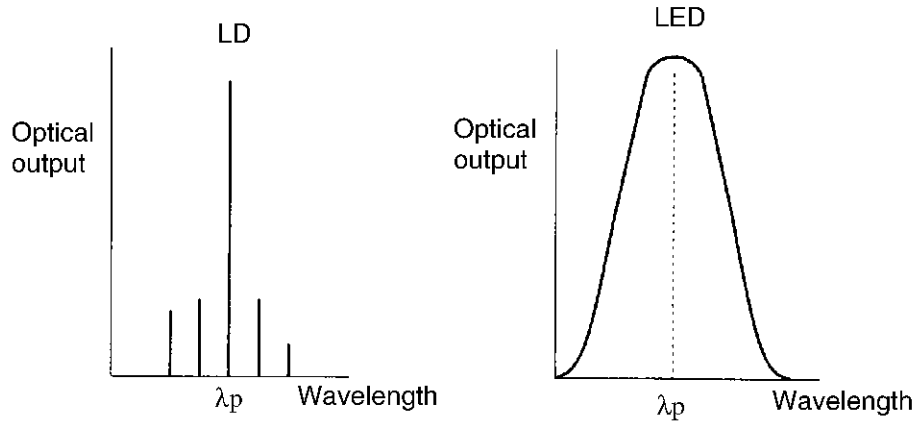
A type of laser that has a waveguide with a cyclic structure, to form a resonator that has a selective wavelength.

Double heterojunction

A heterojunction means a junction by crystals with different atomic structures. The double heterojunction in laser diodes places a cladding layer with a large energy gap on both sides of the active layer. It is used to raise the minority carrier density and to form an optical waveguide.

Emission peak wavelength

The wavelength of a light-emitting element that produces the maximal energy density of the emission spectrum.



Excess noise factor

Factor of shot noise multiplication occurring in an avalanche photodiode. It is defined as F = Mx.

Because of the fluctuation in the multiplication process, shot noise current iN increases as

$\langle iN^2 \rangle = 2qIM^{2+X} B.$

M: Multiplication factor

B: Signal bandwidth

x: Excess noise factor

q: Electron charge

I: Average current flowing in the avalanche area

FM

Frequency modulation

Free spectral range (FSR)

Peak-to-peak interval of the output from the Q7605A/B's built-in Mach-Zehnder interferometer. The narrower the FSR is, the more accurately FM measurement is carried out, but the frequency characteristics deteriorate.

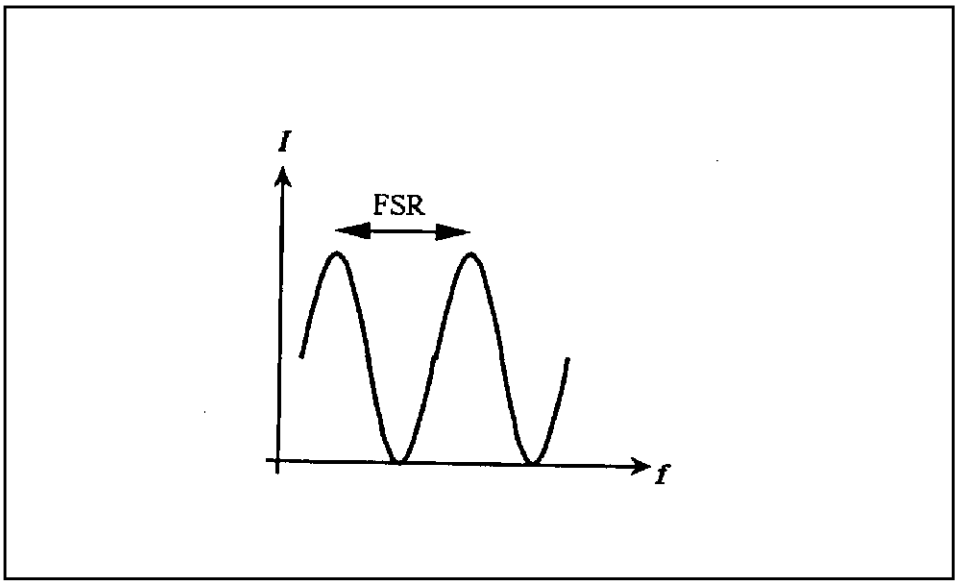


Figure A-1 Interference Characteristics and FSR of the Mach-Zehnder Interferometer

Fundamental mode

0-dimensional electromagnetic field distribution. Also known as single lateral mode.

Graded index fiber

One type of multi mode fiber, the core refractive indices of which are distributed in a parabolic form. This means that the light passing through the center of the core goes more slowly, and the light passing through the periphery goes faster, making the propagation speed constant regardless of the light path. In addition, the timing distribution of output pulses can be made extremely small (little mode dispersion). This means that the transmission band (hundreds of MHz · km) is much wider than that of the step index fiber.

IM

Intensity modulation

Infrared rays

Light with wavelengths longer than those of visible light.

Wavelength 0.78 to 3 μm : Near-infrared light

3 to 30μm : Mid-infrared light

30μm to 1mm: Far-infrared light

Laser

There are several types of laser: solid-state, gas, liquid, etc. Solid-state lasers are used as the light source for optical-fiber communications, because they are smaller than other types of laser and allow direct modulation. Compared to LEDs, lasers have better coherence and faster responses, and they are therefore important elements as a light source. A solid-state laser is sometimes abbreviated LD, standing for laser diode.

Laser diode

One type of semiconductor light-emitting element. The word laser stands for Light Amplification by Stimulated Emission of Radiation. A laser is an oscillator that emits light using this principle. A laser diode gives a high optical output. Laser diodes have advantages such as high optical output, the possibility of fast direct modulation, good optical-fiber coupling efficiency, etc., but they have a problem in the stability of the light emission. This is why LEDs have mainly been used. Recently, since this problem is now being solved, laser diodes are being used more than before for long-distance, fast communications.

Leak light

When an optical fiber is bent or pressed, the light propagation path in the core is distorted, causing the propagating light to leak out of the optical fiber. This is called leak light.

Light-emitting diode (LED)

One type of light-emitting element. As in the case of a laser diode, it uses the light emitted when the carriers injected into the semiconductor pn junction face recouple. In a laser diode, light is generated by induced emission, whereas in an LED it is generated by spontaneous emission. An LED has advantages such as long life, stability, low cost, and good linearity. However, because an LED produces only a small output to send to the fiber and is not suitable for fast modulation, it is advantageous for short-distance, small-capacity communications or analog-type communications.

Light sensor

For optical-fiber communications, a photodiode (PD) using the photovoltaic effect or photoconductive effect is used. There are two types of PDs: pn and pin. Those applying the avalanche effect by giving reverse bias voltage are called avalanche photodiodes (APD). These photoreceivers are mainly used for measurement devices. In addition, thermopiles employing the thermo effect have constant sensitivity regardless of the wavelength, and are used as detectors in reference optical power meters.

Longitudinal mode

A state which emission spectrum, that a half height width is extremely small, exist discontinuously. An individual emission spectrum is also called a longitudinal mode. The wavelength difference with the adjacent mode is called a longitudinal mode interval. When there is only one mode, it is called a single longitudinal mode.

Long wavelength region

Among the optical wavelengths used for optical-fiber communications, this is the region of 1.0 to 1.5 μm . This region is used for long-distance communications, because it produces little transmission loss with optical fibers.

Luminous flux

$$F = Km \int_{380}^{780} V(\lambda) d\lambda$$

Unit: lm (lumen)

Km: Maximum visibility 680lm/W

V(λ): Standard spectral luminous efficiency

Value determined by International Commission on Illumination (CIE)

1.0004 when λ = 555nm (yellow-green)

Luminous intensity

$$i = \frac{dF}{dw}$$

Unit: Cd (candela)

F: Luminous flux

w: Solid angle

Radiant intensity is the value indicated by an energy unit.

Mach-Zehnder interferometer

A type of interferometer which the incident light is split into two routes, and a delay is given to one route but not to the other. The two waves are then composed again to cause interference.

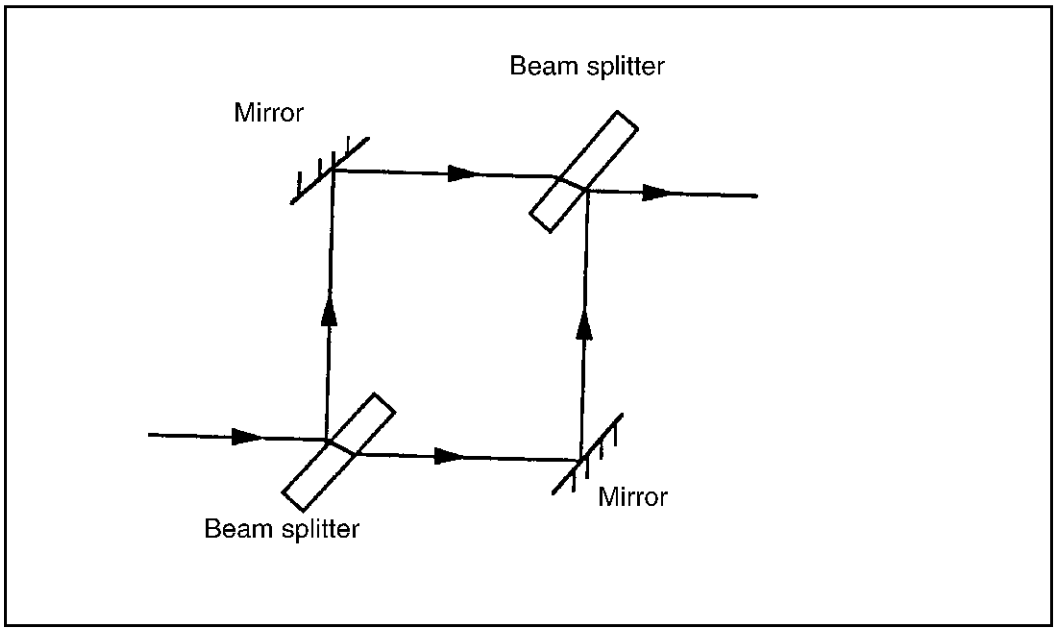


Figure A-2 Typical Mach-Zehnder Interferometer Configuration

Monitor current

Monitor diode output generated when the light emitted from the rear of the laser diode chip is received by the monitor diode.

Monitor output

A light emitted from the rear of the laser diode chip.

Multi mode fiber

An optical fiber that has more than one propagation mode, and many of these modes (which can be assumed to be light with various angles to the optical fiber's central axis) propagate through the core at the same time. Multi mode fibers can be classified into step, graded, and other types, depending on the refractive indices of the core. They are advantageous in that the core diameter is comparatively large (50 to 100μm), and connections are easier than with single mode fibers. On the other hand, the transmission band area is somewhat narrow (mode divergence), because many modes propagate at different speeds through the optical fiber.

Numerical aperture

The degree of extension of light at the end of an optical fiber, which has a cylindrical core having a refractive index of n_1 and which is surrounded by clad having a refractive index of n_2 ($n_1 > n_2$), due to a similarity in the lens system, Of the light falling on a plane, which includes the axis of the core of the optical fiber and which crosses the axis (the meridian light), if some light, which attains critical angle with respect to the axis, crosses the axis of the core outside the optical fiber at angle θ , the NA of the optical fiber can be expressed by the equation given below.

$$NA = n\sin\theta = \sqrt{n_1^2 - n_2^2}$$

n: Refractive index of the media in which the optical fiber is placed

Optical fiber

An optical waveguide in which the outer refractive index is made less than the inner one to give the fiber such characteristics that enable the light to propagate inside the fiber, even when the fiber is bent.

A fiber with a diameter of approximately 0.12mmϕ consisting of two types of quartz glass (core and cladding) with different refractive indices. It shows superior characteristics such as wide band, small loss, and noninduction.

Optical fiber connector

A detachable connector for connecting optical fibers to one other, or an optical fiber to a device. Usually simple matching is used for connection, that is, optical-fiber faces are connected directly to each other by using connectors with their cores well aligned. Compared with electrical connectors, an optical fiber connector has some disadvantages: high mechanical precision is necessary, a connection loss of approximately 0.5 to 1dB occurs, and careful treatment is required to prevent dust.

Optical rotating power

A phenomenon in which the plane of polarization rotates when a linear polarized light passes through a substance.

Pigtail fiber

A fiber with its one or both ends are open.

Polarizer

An element that converts natural light into a linear polarized wave.

Quantum efficiency

- Light-emitting element (light-emitting diode, laser diode)

The ratio of the number of photons generated inside an element to the number of carriers generated (internal quantum efficiency); or the ratio of the number of photons emitted outside to the number of generated carriers (external quantum efficiency).

The quantum efficiency can be expressed as follows:

$$\eta = \frac{q\lambda}{hc} \cdot \frac{p}{I} = \frac{\lambda}{1.24} \cdot \frac{p}{I}$$

h: Planck's constant

c: Light speed in vacuum

q: Charge of electron

λ: Wavelength (μ m)

P: Optical output

I: Current

In addition, a differential quantum efficiency is also used for a laser diode.

- Light receiving element (PIN photodiode APD)

The ratio of the number of generated carriers to the number of input photons. The quantum efficiency η' is expressed as follows. This is the reverse of that of a light-emitting diode

$$\eta' = \frac{hc}{q\lambda} \cdot \frac{I}{P} = \frac{1.24}{\lambda} \cdot \frac{I}{P}$$

The quantum efficiency of an avalanche photodiode is calculated assuming that the multiplication factor is 1.

Radiant flux

Optical energy emitted and propagated in a unit of time.

Responsivity

Current that can be generated when a unit radiant flux is input to a light-receiving element.

$$R = \frac{I}{P} = 0.806 \times \eta \times \lambda \times M \quad [A/W]$$

R : Responsivity

η : Quantum efficiency

λ : Wavelength

M : Multiplication factor

ROM

Stands for Read-Only Memory.

Short wavelength region

Optical-fiber communications use light with a wavelength of approximately 0.8 to 1.5 μm , or the near-infrared region. Within this region, the region around 0.8 μm is called the short-wavelength region. This region was developed during an earlier stage in the field of optical-fiber communications, and produced the largest number of results for production systems. Recently, the long wavelength region exceeding 1 μm has been under development.

Single-mode fiber

When the core diameter is reduced to approximately 10 μm , the result is an optical fiber with only one propagation mode. This is called a single-mode fiber. This fiber is advantageous in that, unlike the multi mode fiber which causes mode distribution, it has a very wide range (a few GHz).

Specific rotating power

A value indicating the magnitude of the optical rotary power of material.

Speckle effect

A noise generated when a coherent light is dispersed in an optical fiber, causing interference under irregular phase relationships.

Spectral width/Full width at half maximum/Δλ

An interval between two wavelengths of a light emitting element, in which the emission spectrum energy is half the maximal value.

Spectrum

An ordinary light consists of sine wave components. An array of such components arranged along the wavelength axis is called a spectrum.

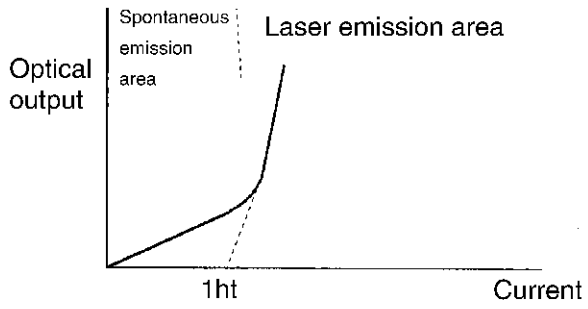
A white light source has a flat spectrum, and an LD has one concentrated in a narrow area.

Splicing

Permanent connection of an optical fiber, necessary for optical-fiber cabling operations. Although there are various splicing methods, the method generally used is fusion splicing, in which glass is melted by arc discharge. This method allows stable connections with the least connection loss.

Threshold current

Minimum current that allows laser emission. Since the boundary area between the spontaneous and laser emissions is not rigid, it is sometimes represented by the crossing point of the line prolonged from the current optical output characteristics curve for laser oscillation and the current value for optical output zero.



Ultraviolet rays

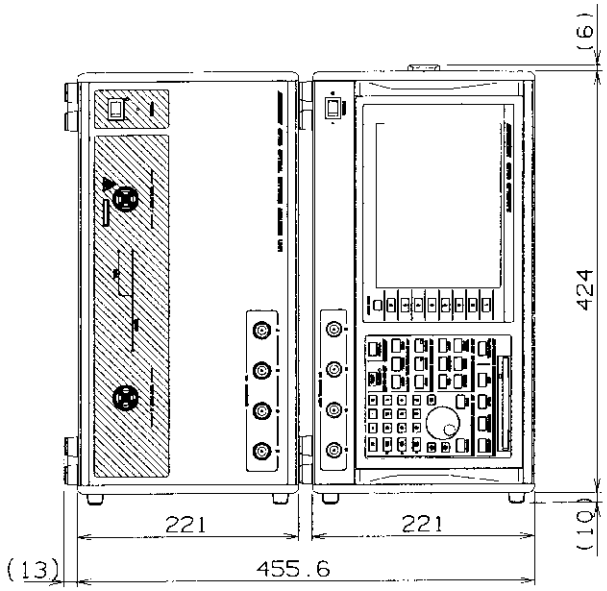
Light with a shorter wavelength than visible light. The wavelengths range from 300 to 380nm.

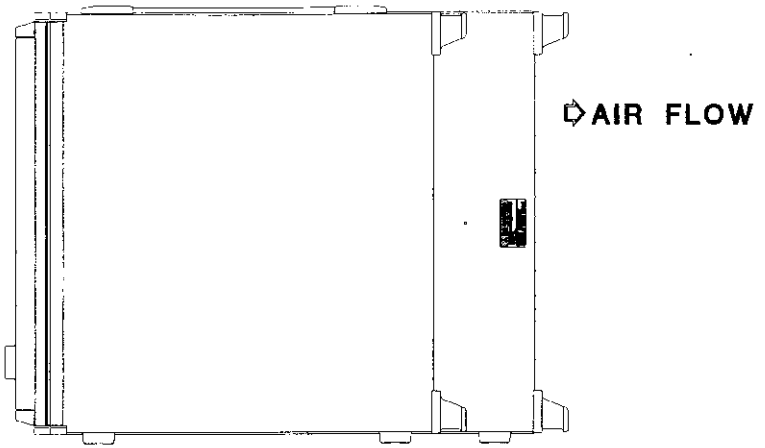
Visible light

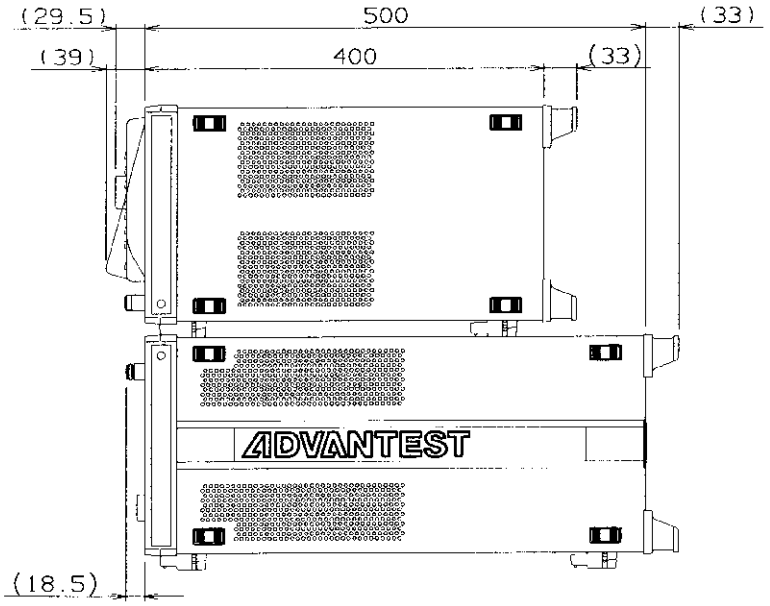
Light that can be seen by the human eye. The wavelength range is 380 to 780nm.

Wavelength division multiplying

A communication method in which two or more types of signals are simultaneously transmitted through one optical fiber. In the transmitter, light-emitting and laser diodes of various wavelengths are used. This method allows one-way or two-way communications.







Unit : mm

CAUTION
This drawing shows external dimensions of this instrument.
The difference in products and options used can cause a change in the appearance of the instrument.

DIMENSIONAL OUTLINE DRAWING

ALPHABETICAL INDEX

[Symbol]

[Numerics]

[A]

[B]

[C]

[D]

[E]

[F]

[G]

[H]

[I]

[K]

[L]

[M]

[N]

[O]

[P]

[Q]

[R]

[S]

[T]

[U]

[V]

[W]

[X]

[Y]

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   (f) Advantest's incorporation or use of any specifications or designs supplied by Purchaser;

   (g) the occurrence of an event of force majeure, including, without limitation, fire, explosion, geological change, storm, flood, earthquake, tidal wave, lightning or act of war; or

   (h) any negligent act or omission of the Purchaser or any third party other than Advantest.

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