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ADVANTEST®

ADVANTEST CORPORATION

Q73351
Optical Spectral
Line Width Test Set
(Q7335 Measurement System)
Operation Manual

MANUAL NUMBER FOE-8324229B01

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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

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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.

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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

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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

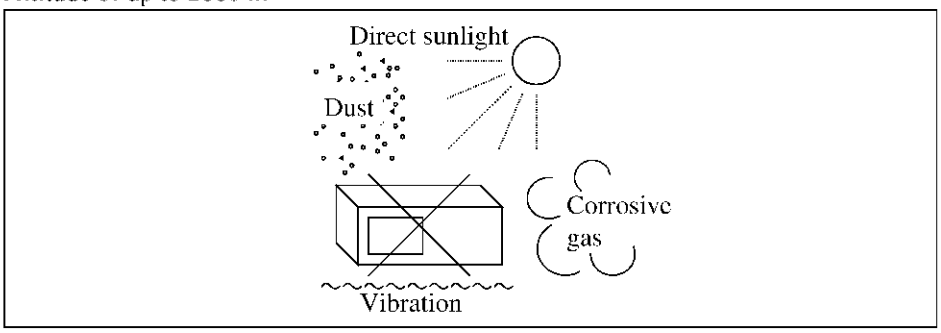


Figure-1 Environmental Conditions

- Operating position

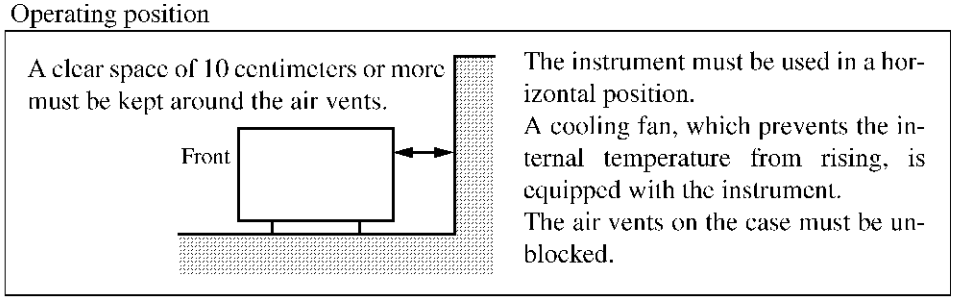


Figure-2 Operating Position

- Storage position

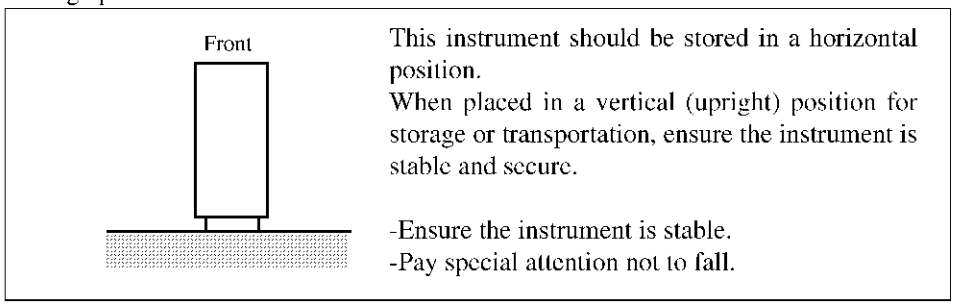


Figure-3 Storage Position

- 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.

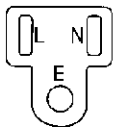
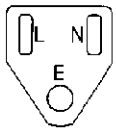
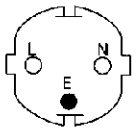
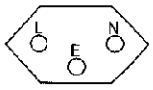
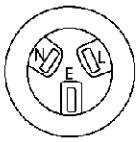
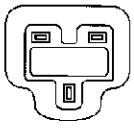
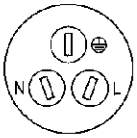
  Impulse withstand voltage (over-voltage) category II defined by IEC60364-4-443

  Pollution Degree 2

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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

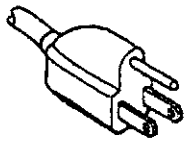
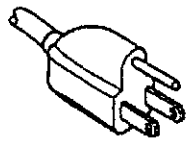
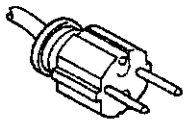
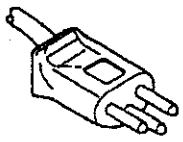
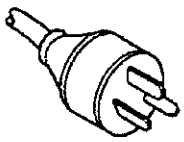
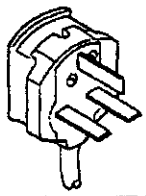
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Table of Power Cable Options

There are six power cable options (refer to following table).

Order power cable options by Model number.

	Plug configuration	Standards	Rating, color and length	Model number (Option number)
1		JIS: Japan Law on Electrical Appliances	125 V at 7 A Black 2 m (6 ft)	Straight: A01402 Angled: A01412
2		UL: United States of America CSA: Canada	125 V at 7 A Black 2 m (6 ft)	Straight: A01403 (Option 95) Angled: A01413
3		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
4		SEV: Switzerland	250 V at 6 A Gray 2 m (6 ft)	Straight: A01405 (Option 97) Angled: A01415
5		SAA: Australia, New Zealand	250 V at 6 A Gray 2 m (6 ft)	Straight: A01406 (Option 98) Angled: ---------
6		BS: United Kingdom	250 V at 6 A Black 2 m (6 ft)	Straight: A01407 (Option 99) Angled: A01417

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1. GENERAL

1.1 Outline

(1) The Q73351 optical spectral line width test set (see Figure 1-1) measures the spectrum distribution of a 1.55μm range or 1.3μm range distribution feedback type (DFB) laser.

The test set is based on the principle of the delayed self heterodyne method, developed by the electronics department, faculty of technology, of Tokyo University. Spectrum distribution of the source light is converted into an electric signal in the equipment, and is output from the output connector (BNC connector/50Ω). This signal can be observed on the CRT display by connecting the RF spectrum analyzer (specifically, the R4131D analyzer/indicator for the Q7335 measurement system).

A single mode delay optical fiber with a length of approx. 5km is provided with the equipment. An optical fiber polarization controller is also provided, to adjust the conditions of the polarization planes being observed on the level meter.

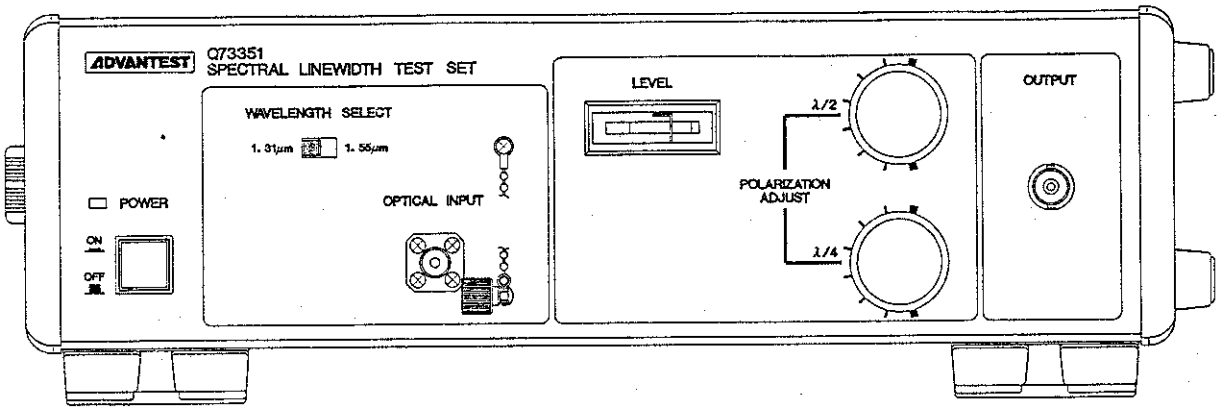


Figure 1 - 1 Q73351 Optical Spectral Line Width Test Set

*.. T. Okoshi, K. Kikuchi, and A. Nakayama:
'Novel method for high resolution measurement of laser output spectrum', Electronic letters, 31st July 1980. Vol.16 No.16 p. 630 to 631

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(2) The Q7335 optical spectral line width measurement system consists of the Q73351 optical measurement device and the R4131D analyzer/indicator. The measurement system measures spectrum distribution of a DFB laser. (See Figure 1-2.)

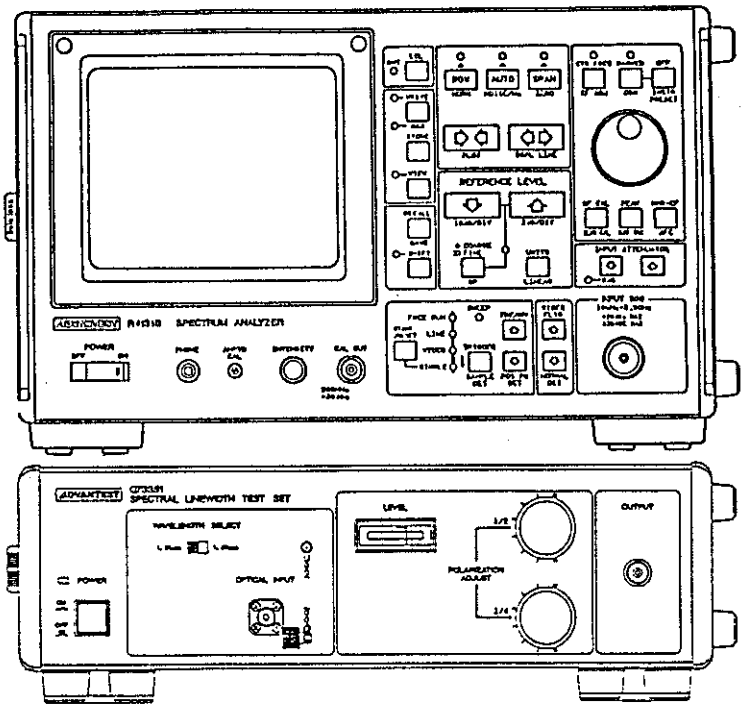


Figure 1 - 2 Q7335 Optical Spectral Line Width Measurement System

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1.2 Features of the Q73351 and Q7335

(1) Features of the Q73351

① Adoption of the Delayed Self Heterodyne Method

The use of the delayed self heterodyne method enables high resolution measurement of asymmetric spectrum distribution of source light.

② Minimum Measurable Spectral Line Width (resolution) is 20kHz (FWHM)

The incorporated delay optical fiber (5km long) enables measurement of source light with a minimum measurement spectral line width of 20kHz (FWHM)

③ Built-in Polarization Controller

The polarization controller is provided to control the polarization planes in the equipment for optimum measurement.

④ Wide Input Range

The Q73351 measurement device supports a wide range of input light intensities of +10 to -35dBm.

(2) Features of the Q7335 Optical Spectral Line Width Measurement System

The measurement system consists of the Q73351 measurement device and the R4131D analyzer/indicator, and features the following facilities:

① FWHM Read Out Facility (option)

The full width at half maximum of the measured spectrum can be read directly on the R4131D indicator.

② Save/Recall Facility

Measurement data can be readily compared with measurement conditions and measured waveforms stored in memory.

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1.3 Preparation Before Operation and General Requirements

1.3.1 Check of Appearance and Accessories

On the delivery of the equipment, check if any damage has occurred during transport. Then check the standard accessories and their specifications according to Table 1-1.

It any damage or storage of parts is found, contact the nearest sales office, or agency. The addresses and phone numbers are given on the last page.

Table 1 - 1 Standard Accessories

Product name	Type name	Stock No.	Q'ty	Remarks
Power cable	MP-43B	DCB-DD2428X01-1	1	
Fuses	EAWK0.8A	DFT-AAR8A	2	
Instruction Manual	-	J Q73351	1	Japanese version
	-	E Q73351		English version

Note: Use the type number or stock No. to specify accessories to order additional accessories.

1.3.2 Precautions

(1) Grounding

To prevent electrific shock, connect the center pin of the power connector of Q73351 to ground.

The attached power cable has a 3-pin connector with a round grounding pin in the middle. The test set is grounded when the connector is plugged into a triple pole receptacle. If a triple pole receptacle is not available, use a triple-to-double converting adapter (A09034) and by sure to connect the grouding wire led out from the adapter (see Figure 1-3a) to ground.

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The A09034 adapter has two electrodes of different widths (see Figure 1-3b). Match the widths of the electrodes and the slots of the receptacle. If the A09034 adapter cannot be used because the available receptacle has slots of the same width, use a separately provided KPR-13 adapter and connect the grounding pin on the rear panel of the test set to ground.

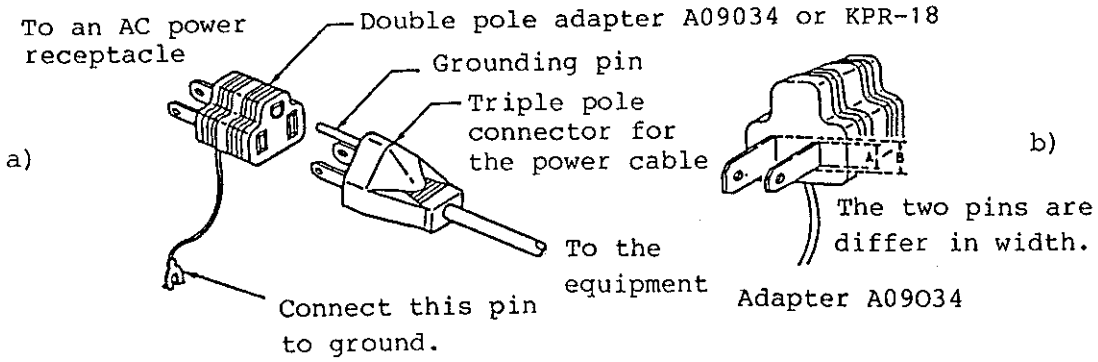


Figure 1 - 3 Power cable

(2) 90 to 250V at 48 to 66Hz AC power supply is required. Do not use power cables othre than the special cable provided. The power switch must be turned off before connecting the power cable.

(3) The operating ambient conditions are 0 to +40°C, and an RH of 85% or less. The equipment must not be exposed to direct sunlight, and should be placed well-ventilated room.

(4) The equipment must be handled with care and must be prevented from excess mechanical shock.

(5) Storage

If it is expected that the Q73351 test set will not be used for a long period, wrap it in a vinyl sheet, etc., place in a carton, and store in a dry and shaded location.
The temperature must be kept at 0 to 40°C during storage.

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1.4 Replacement of Fuse

If the equipment fails to operate with the power switch is turned on, the power fuse has probably blown. If this is the case, replace the fuse.

The specification of the power AC line fuse is 0.8A/250V at input voltage of 90 to 250V.

[Replacement Procedures]

To replace the fuse, turn off the power switch and disconnect the power cable from the power connector.

To remove the fuse for replacement, turn the fuse holder cap counter clockwise.

(Rear panel)

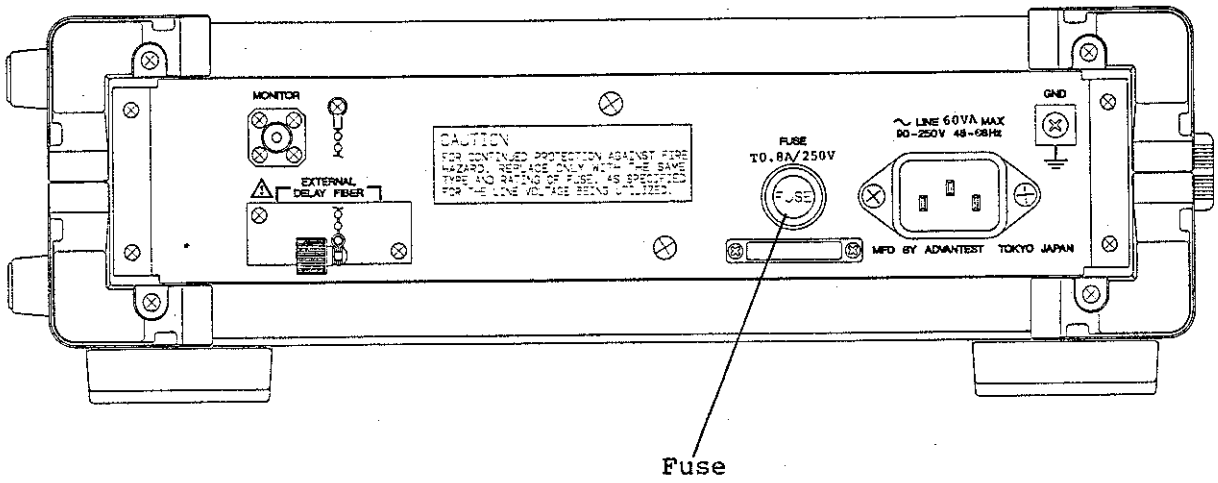


Figure 1 - 4 Replacement of the Power Fuse

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1.5 Cleaning the Optical Input (Output) Connector

Figure 1-5 shows how to clean the optical input (output) connector. Remove two of the screws on the four corners of the adaptor. The FC connector can then be drawn out.

Remove the adaptor and gently wipe the tip and side of the connector ferrule with lens cleaning paper or sanitary gauze soaked in alcohol.

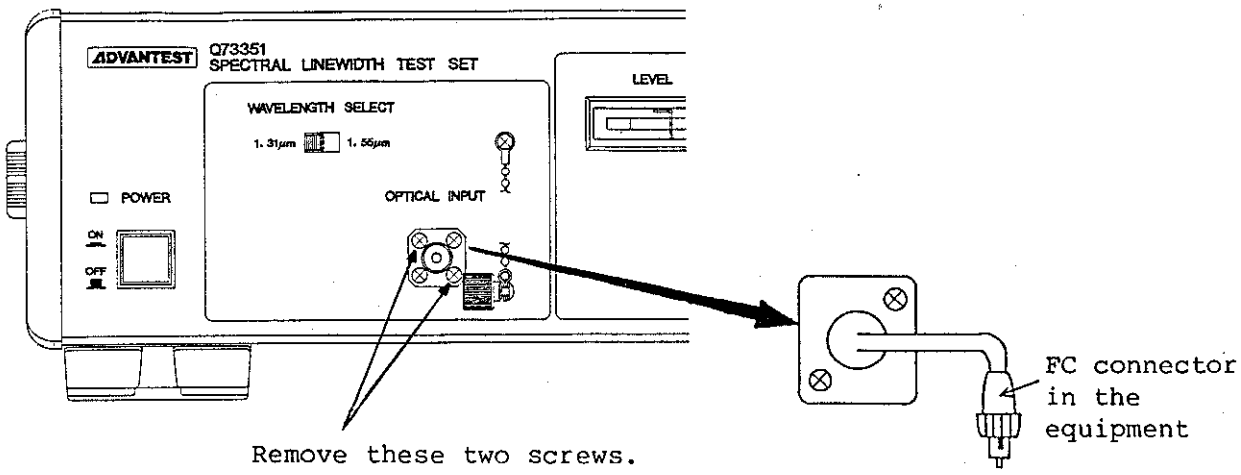


Figure 1 - 5 Cleaning the Optical Connector

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2. HOW TO USE THE TEST SET

2.1 Description of the Panels

Figure 2-1 shows the front and rear panels of the Q73351 test set. Functions of each feature is explained in the following pages, in the order of the numbers in the figure.

(1) Front Panel

① Power Switch

The switch turns the power alternately on or off each time it is pressed.

② Power Indicator

The power indicator comes on when the power is on.

③ Optical Input Connector

The source light is input through this connector. An FC connector is incorporated in the equipment. The end face is PC-finished.

④ Dummy Cap

The dummy cap is used to cover the optical input connector when it is not in use, to prevent dust from entering the connector.

⑤ Level Meter

The level meter is used to adjust the polarization planes using the polarlization controller. Adjustment can be performed more easily by observing the level meter.

⑥ Polarization Control Knob

The polarization controller is provided with two adjustment knobs. The upper is for /2 and the lower is for /4. Use them to optimize the polarization plane in the equipment.

⑦ RF Output Connector (BNC connector)

The RF output connector converts the optical signal obtained by the delayed self heterodyne system into an electric signal and outputs it. The output impedance is 50Ω.

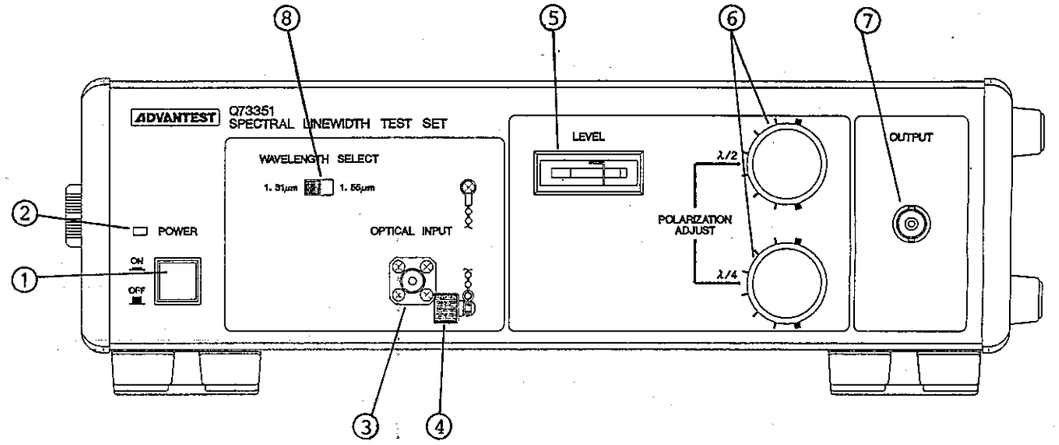


Figure 2 - 1 Front Panel

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⑧ Wavelength Switch

Select the 1.55μm band or the 1.31μm band for the source light wavelength.

1.55μm band : (1.52μm to 1.57μm)
1.31μm band : (1.29μm to 1.33μm)

(2) Rear Panel

⑨ Monitoring Light Output Connector

The optical signal obtained from the delayed self heterodyne system is output to this connector. The connector is the FC type, and the end face is PC-finished.

⑩ Dummy Cap

The dummy cap is used to cover the monitoring light output connector when it is not in use, to prevent dust from entering.

⑪ External Delay Fiber Take-up (option)

This take-up is used to modify the length of the delay optical fiber cable in the equipment to change the minimum measurable spectral line width.

The use of the optional external delay fiber take-up enables changes in the delayed self heterodyne system as shown in Figure 2-2.

The addition of the external delay optical fiber changes the minimum measurable spectral line width (Δf) as expressed in the formula:

$$\Delta f = \frac{1.5}{\pi \cdot (25\ \mu sec + \tau d)}$$

Where,
Δf : Full width at half maximum (FWHM)
τd : Delay time obtained by the external delay optical fiber
25 μsec : The delay time of the internal optical fiber
1.5 : coefficient

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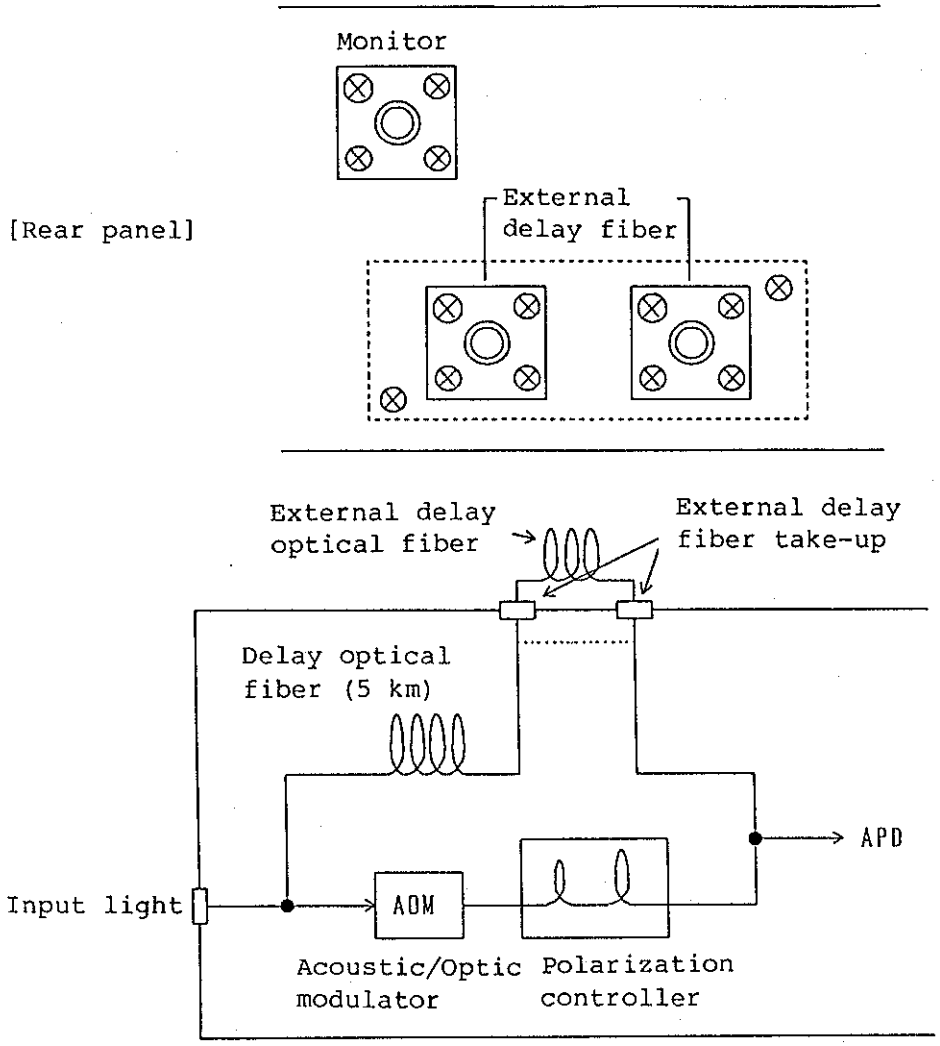


Figure 2 - 2 Delayed Self Heterodyne System

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⑫ Power Connector

This is the AC power connector. Connect it to the attached power cable.

⑬ Ground Pin

This pin is used to ground the chassis of the Q73351 test set.

This ground pin is used when the power cable is connected to a two-pole receptacle with a triple-to-double converting adaptor. The ground wire led out from the adapter may be connected to ground instead of the ground pin.

⑭ Serial Nameplate

The serial nameplate gives the lot number of the Q73351 test set.

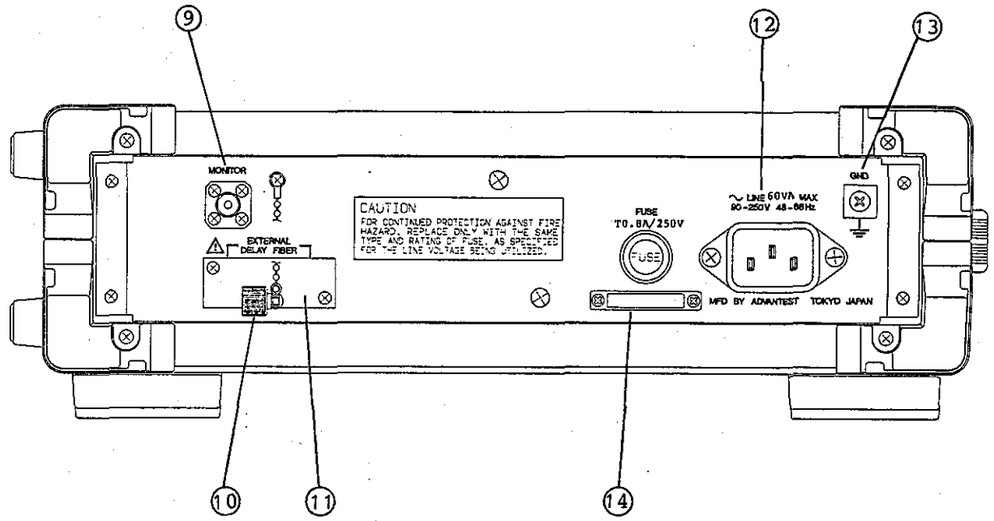


Figure 2 - 3 Rear Panel

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2.2 Basic Operation

[Operation Procedures]

(1) Be sure the power switch is turned off before connecting the power cable.

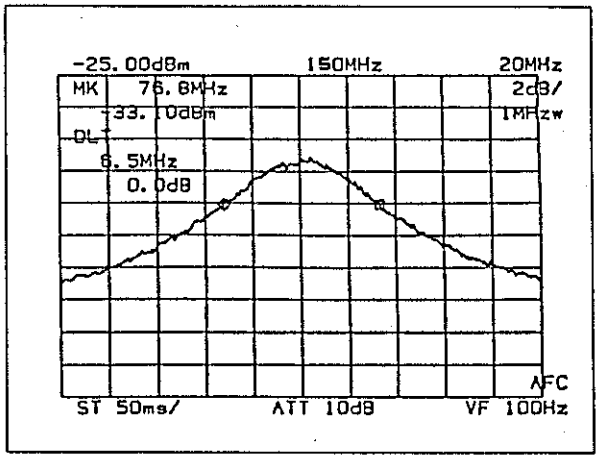
(2) Turn on the power switch.

(3) Connect the Q73351 test set output connector (⑦ on the front panel) and the RF spectrum analyzer input connector with a cable (of impedance of 50Ω).

Select the switch (⑧ on the front panel) 1.31μm band or 1.55μm band for the source light wavelength.

(4) Set the measurement conditions for the RF spectrum analyzer.

[Example of spectrum analyzer R4131D setting]



Center frequency : 150MHz (1.55μm band)
175MHz (1.31μm band)

Frequency span (x-axis scale) : 20MHz

Reference level : -25dBm

Resolution : 1MHz

Y-axis scale : 2dB/div.

Video filter : 100Hz

(5) Connect the source light to the optical input connector (③ on the front panel) with the single mode fiber.

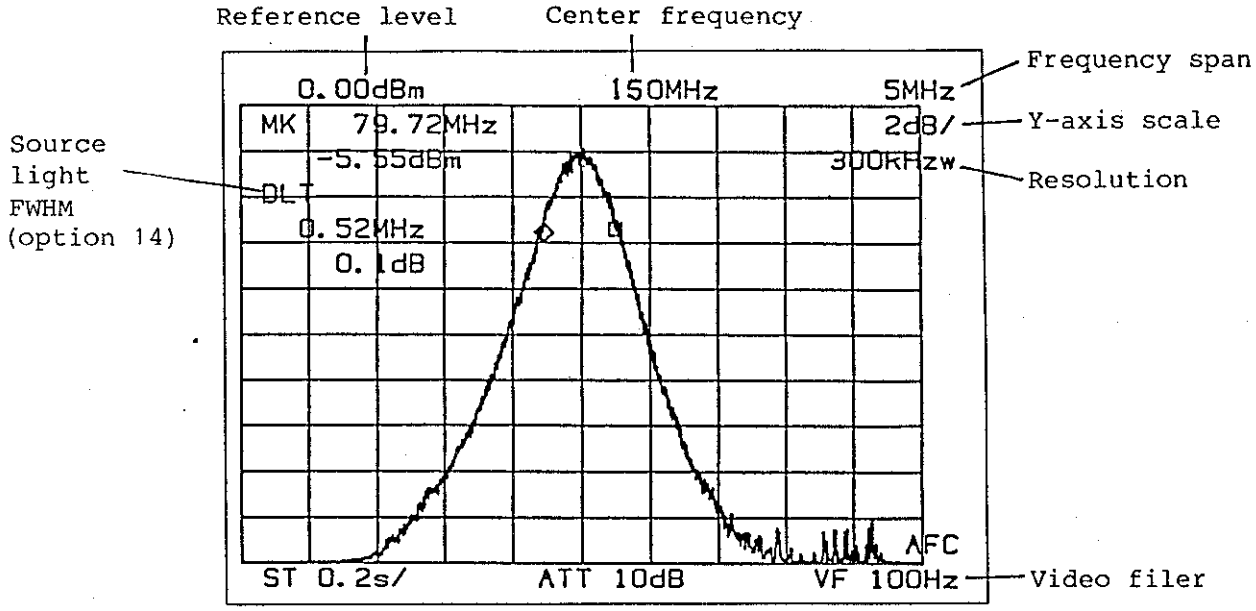
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(6) Before measurement of the spectral line width, adjust the polarization plane in the Q7335. Turn the polarization control knobs $\lambda/2$ and $\lambda/4$ (⑥ on the front panel), observing the waveform displayed on the spectrum analyzer CRT, or the Q73351 level meter (⑤ on the front panel):

(a) Adjust the knobs so that the Q73351 level meter (⑤ on the front panel) indicates the maximum.

(b) Adjust the knobs so that the amplitude of the waveform displayed on the CRT of the spectrum analyzer reaches the maximum.

(7) An example of measurement of spectral line width is shown below: (RF spectrum analyzer is R4131D option 14)



(8) How to read out the FWHM with the RF spectrum analyzer R4131D

① Press the shift and marker keys in this order. The menu screen will be displayed on the R4131D CRT as shown below.

```
#  OBW
   3dB DOWN
   3dB DOWN Loop
   NEXT PEAK

QUIT : OFF
```


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② To acquire the FWHM, select one of the following two menu items by pressing the reference level keys ⇧ or ⇩.

3dB down : FWHM is measured once.

3dB down loop : FWHM is measured at every sweep of the spectrum analyzer.

③ After selecting the menu item, press the marker key again and the requested FWHM value will be indicated on the left end of the CRT display, replacing the above menu display.

```
DLT
 XXXMHz
 0.0dB
```

④ To clear the display of the FWHM value, press the marker off key.

(9) To terminate the measurement, turn off the power switch.

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3. DESCRIPTION OF OPERATIONS

3.1 Operations of the Q73351 Optical Measurement Device

The structure of the Q73351 optical measurement device is based on delayed self heterodyne method, as shown in Figure 3-1 Measurement device diagram.

The frequency shift by the acoustic/optic modulator reaches the maximum at frequencies 150MHz (1.55μm band) or 175MHz (1.31μm band).
The incorporated single mode optical fiber (approx. 5km long) allows a minimum measurable spectral line width of 20kHz (FWHM).

The polarization controller is also provided to match the polarization planes obtained via path 1 and path 2, with the aid of the level meter for easier adjustment. The heterodyned output light is photoelectrically transferred and amplified at APD, and is output from the RF output.

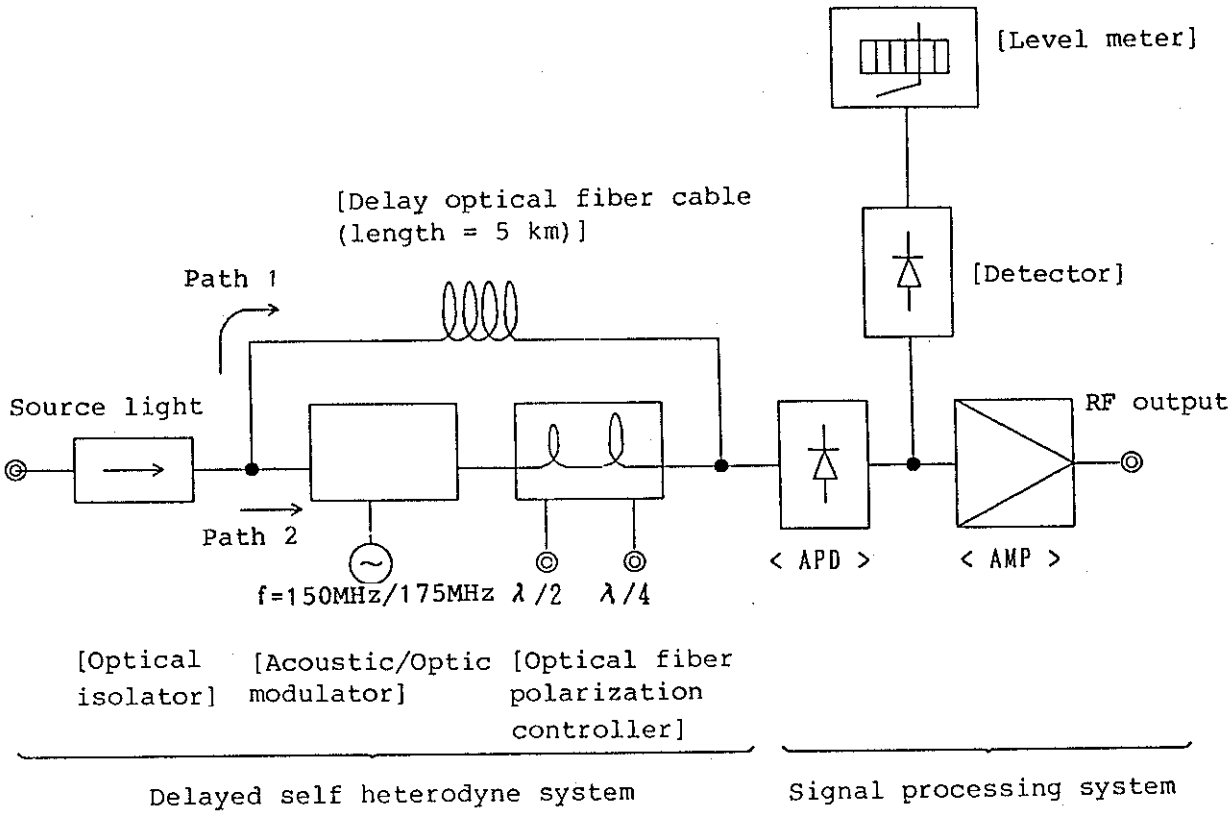


Figure 3 - 1 Block Diagram of Measurement by Q73351 Optical Measurement Device

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3.2 Operations of Q7335

The Q7335 measurement system consists of the Q73351 optical measurement device and the R4131D analyzer/indicator.

The power spectrum distribution of the source light, which has been electrically transferred at the Q73351 test set APD, can be observed by the general purpose RF spectrum analyzer.

The R4131D analyzer/indicator supports the FWHM read out facility and the save/recall zacility which performs panel setting and waveform recording.

The measurement data can be directly connected to a plotter via the GPIB interface for recording, or connected to a personal computer for further analysis.

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3.3 Principle of Optical Measurement with the Q73351

The source light is input through the light input block (FC/PC connector), passes through the optical isolator, and is separated into two paths (refer to Figure 3-1).

Path 1 contains the delay optical fiber cable to give a delay time of d. The output light is used as the local oscillation.

In Path 2, the acoustic/optic modulator inparts a frequency shift to the light, and the light is input to the polarization controller.

The two frequencies of the light coming through Paths 1 and 2 are mixed at the optical detector (APD), and photoelectric transfer of the beat signal of the shift frequency is carried out.

This heterodyned output (from the RF output, BNC connector) is observed with the spectrum analyzer (R4131D for Q7335), to measure the spectrum distribution of the source light. The spectrum analyzer indicates twice the spectral line width of the source light. The minimum measurable spectral line width Δf is expressed by the formula:

$$\Delta f = \frac{1.5}{\pi \cdot \tau_d}$$

Hence, Δf = 20kHz (FWHM) for the 5-km long delay fiber cable.

A feature of this method is that it needs no frequency stabilization local oscillation laser because part of the source light is appropriated.

Another feature is that the source light spectrum waveform can be measured.

* References

T. Okoshi, K. Kikuchi, and A. Nakayama:
'Novel method for high resolution measurement of laser output spectrum', Electronic letters, 31st July 1980. Vol.16 No.16 p. 630 to 631

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4. PERFORMANCE

4.1 Specifications of Q73351

(1) Q73351 measurement range and functions

Item	Standard	Remarks
Measurable wavelength range	1.55μm band	1.52μm to 1.57μm
	1.31μm band	1.29μm to 1.33μm
Minimum measurable spectrum width	20kHz	FWHM
Measurement input level range	+10 to -35dBm	
Acoustic/Optic modulator frequency	150MHz	1.55μm band
	175MHz	1.31μm band
Delay optical fiber length	Approx. 5km	(Delay time 25 μsec)
Polarization compensation	Optical fiber polarization controller incorporated	
Optical input connector	FC type	The connector end face PC-polished.
Output connector/ Output impedance	BNC/50Ω	

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(2) Common Specifications of Q73351

Item	Specifications
Operating ambient conditions	Ambient temperature : 0°C to 40°C Relative humidity : 85% or less
Storage temperature	0°C to 40°C
Power supply	Power voltage : 90 to 250VAC Power frequency : 48 to 66Hz
Power consumption	60VA or less
Dimensions	Approx. 300(W) x 100(H) x 500(D) (mm)
Weight	Approx. 7.5kg

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4.2 Main Specifications of the Q7335

(1) Optical measurement device

Same as the Q73351.

(2) Analyzer/indicator (R4131D, option14)

Measurable frequency range	:	10kHz to 3.5GHz
Resolution	:	1kHz to 1MHz, 1, 3 steps
Input impedance	:	50Ω
Functions	:	FWHM read out facility Save/Recall facility GPIB/Direct plot facility

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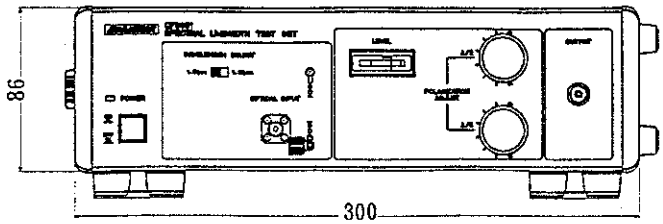
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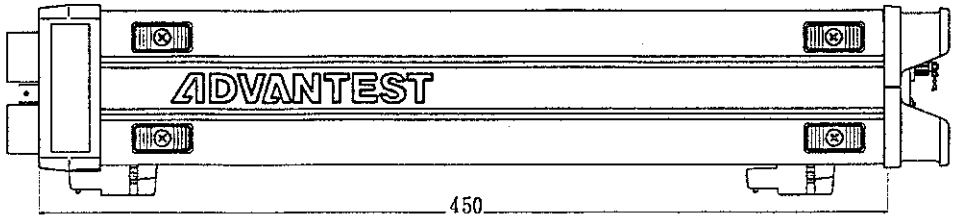
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Q73351 FRONT VIEW



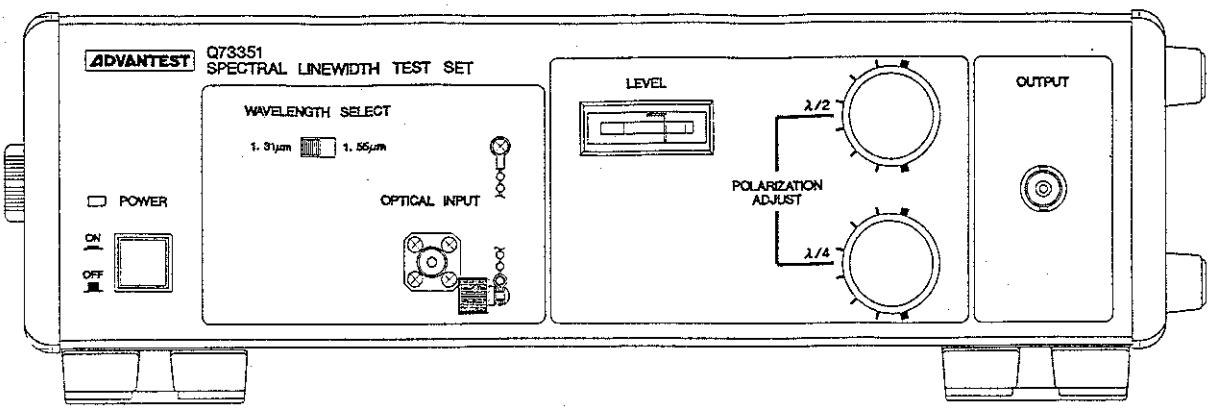
Q73351 SIDE VIEW

Unit : mm

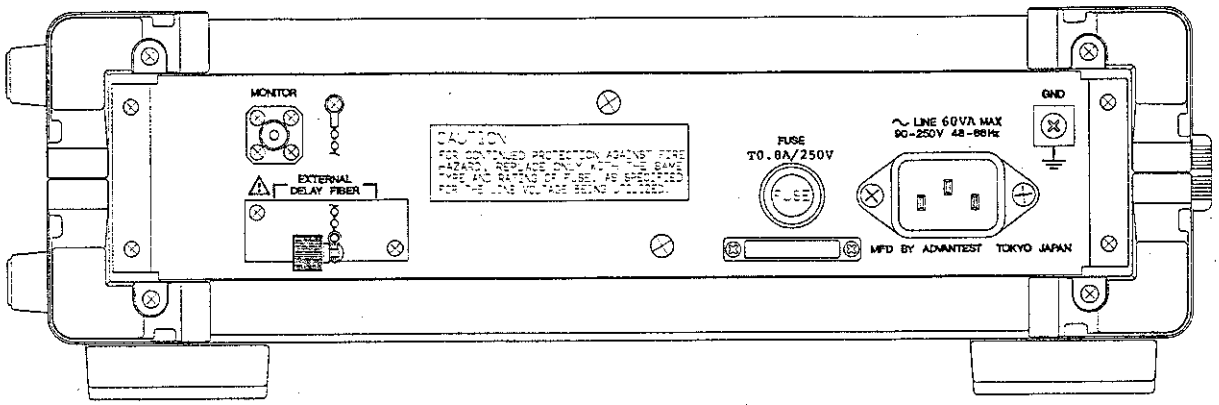
Q73351EXT1-909-A

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Q73351 FRONT VIEW



Q73351 REAR VIEW

Q73351EXT2-9003-B

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Phone: +82-2-532-7071
Fax: +82-2-532-7132

Advantest (Suzhou) Co., Ltd.
Shanghai Branch Office:
Bldg. 6D, NO.1188 Gumei Road, Shanghai, China 201102 P.R.C.
Phone: +86-21-6485-2725
Fax: +86-21-6485-2726

Shanghai Branch Office:
406/F, Ying Building, Quantum Plaza, No. 23 Zhi Chun Road,
Hai Dian District, Beijing,
China 100083
Phone: +86-10-8235-3377
Fax: +86-10-8235-6717

Advantest (Singapore) Pte. Ltd.
438A Alexandra Road, #08-03/06
Alexandra Technopark Singapore 119967
Phone: +65-6274-3100
Fax: +65-6274-4055

Advantest America, Inc.
3201 Scott Boulevard, Suite, Santa Clara, CA 95054, U.S.A
Phone: +1-408-988-7700
Fax: +1-408-987-0691

ROHDE & SCHWARZ Europe GmbH
Mühldorfstraße 15 D-81671 München, Germany
(P.O.B. 80 14 60 D-81614 München, Germany)
Phone: +49-89-4129-13711
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ADVANTEST CORPORATION
Shin-Marunouchi Center Building, 1-6-2 Marunouchi, Chiyoda-ku, Tokyo 100-0005, Japan
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