Anritsu MW9040B

Optical Time Domain Reflectometer

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OPERATION MANUAL
OPTICAL TIME DOMAIN REFLECTOMETER
MW9040B
PLUG-IN UNITS
MW0945A·MW0946A·MW0947A/B·MW0942A
MW0944B·MW0967B

1992.02
Ver. II

ANRITSU CORPORATION

APR.
1992

CERTIFICATION

ANRITSU CORPORATION certifies that this instrument has been thoroughly tested and inspected, and found to meet published specifications prior to shipping.
Anritsu further certifies that its calibration measurements are based on the Japanese Electrotechnical Laboratory and Radio Research Laboratory standards.

WARRANTY

All parts of this product are warranted by Anritsu Corporation of Japan against defects in material or workmanship for a period of one year from the date of delivery.
In the event of a defect occurring during the warranty period, Anritsu Corporation will repair or replace this product within a reasonable period of time after notification, free-of-charge, provided that: it is returned to Anritsu; has not been misused; has not been damaged by an act of God; and that the user has followed the instructions in the operation manual.

Any unauthorized modification, repair, or attempt to repair, will render this warranty void.

This warranty is effective only for the original purchaser of this product and is not transferable if it is resold.

ALL OTHER EXPRESSED WARRANTIES ARE DISCLAIMED AND ALL IMPLIED WARRANTIES FOR THIS PRODUCT, INCLUDING THE WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE LIMITED IN DURATION TO A PERIOD OF ONE YEAR FROM THE DATE OF DELIVERY. IN NO EVENT SHALL ANRITSU CORPORATION BE LIABLE TO THE CUSTOMER FOR ANY DAMAGES, INCLUDING LOST PROFITS, OR OTHER INCIDENTAL OR CONSEQUENTIAL DAMAGES, ARISING OUT OF THE USE OR INABILITY TO USE THIS PRODUCT.

All requests for repair or replacement under this warranty must be made as soon as possible after the defect has been noticed and must be directed to Anritsu Corporation or its representative in your area.

WARNING

NO OPERATOR SERVICEABLE PARTS INSIDE.
REFER SERVICING TO QUALIFIED PERSONNEL.

CAUTION

FOR CONTINUED FIRE PROTECTION REPLACE
ONLY WITH SPECIFIED TYPE AND RATED FUSE.

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Note 1:

1. The instrument is operable on a nominal voltage of 100 to 127 Vac or 200 to 250 Vac by changing the voltage-rating selection switch under the top cover.

   The voltage and current ratings are indicated on the rear panel when the instrument is shipped from the factory.

   To operate on the other voltage, change the selection switch. The plate on the rear panel indicating the voltage and current ratings should be changed to the appropriate one. Order the plate from ANRITSU CORPORATION if needed.

2. In this manual, the power supply voltage and current ratings are represented by **Vac and ***A, respectively.

3. The relationship between power supply voltage and current ratings is shown below.

**Vac	***A
85 to 132 V	5 A
170 to 250 V	5 A

Note 2:

*WARNING*s, *CAUTION*s, *Note*s, and Explanatory footnotes are used in this manual. Their meanings are given below:

WARNING:	*WARNING is used when there is a personal injury hazard.*
CAUTION:	*CAUTION is used when the equipment may be damaged.*
Note:	Note is used to provide information about exceptions, corrections, and restrictions.
Explanatory footnote:	Explanatory footnotes provide comments on the same page as the text, figure or table. They are referenced by either an asterisk (*) or by combination of an asterisk and numeral.

Note 3:

STORAGE MEDIUM

This equipment stores data and programs using IC card (PMC), backed-up memories.

Data and programs may be lost due to improper use or failure.

ANRITSU therefore recommends that you back-up the memory.

ANRITSU CANNOT COMPENSATION FOR ANY MEMORY LOSS.

Please pay careful attention to the following points. Do not remove the IC card (PMC) from equipment being accessed.

For details refer to the relevant operation manual.

(IC card: PMC)

•• Isolate the card from static electricity.

•• The back-up battery in the card has a limited life; renew the battery periodically. See paragraph 2.6 for the life.

(Backed-up memory)

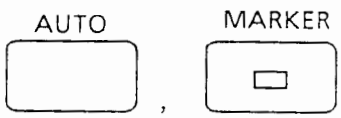
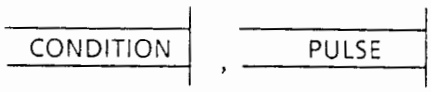
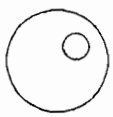
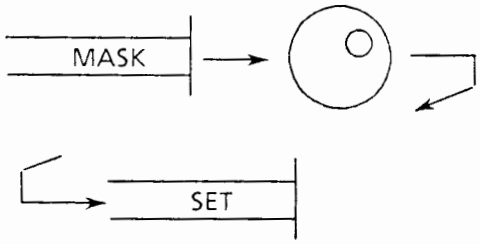
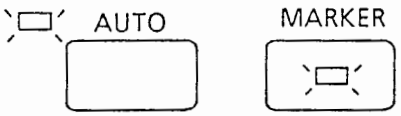
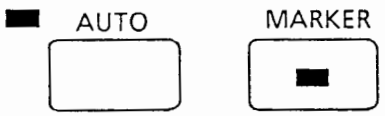
•• Isolate the memory from static electricity.

Note: The battery life is about 7 years. Early battery replacement is recommended.

Note 4:

Notation of operation keys, etc.

In the description of this manual, the operation keys, knobs, etc. are represented as follows:

Notation example	Explanation
Panel key 	When only keys are indicated in the description of operation procedure, it means you simply press the key. For soft keys, it means you press the soft key (F1 to F6) that corresponds to the label.
Soft key 	
Rotary knob 	
Indication of operation procedure 	An arrow is used when it is necessary to clearly indicate the sequence of key and other operations. In the example shown on the left, you first press the soft key corresponding to MASK, then turn the rotary knob, and then press the soft key corresponding to SET.
Lamp on/off On  Off 	Whether the lamp goes on or off when the key is pressed is respectively indicated by ▭ and ■.

(Continued)

Notation example	Explanation
Soft key label L1: (1/2) CONDITION MEASURE ⋮	This indicates an example of soft key labels displayed on screen when you operate the key. L1 indicates the first layer, and the second and third layers are respectively indicated by L2 and L3.

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TABLE OF CONTENTS

SECTION 1
OVERVIEW

This section outlines the features of the MW9040B Optical Time Domain Reflectometer and the organization of this manual, as well as describes the equipment composition of the MW9040B when it is used with standard fittings, plug-in units, expansion options, optional accessories and peripheral devices, and specifications.

1.1 Product Outline

The MW9040B Optical Time Domain Reflectometer lets you automatically or manually detect fault locations in fiber-optic cables and measure cable splice loss, optical-connector connecting loss, etc. with high accuracy. With its wide dynamic range of 34 dB in wavelength 1.3 μm band or 32 dB in 1.55 μm band, it can made precise measurement with a 10 cm read-out resolution even for 250 km long-distance measurement. Using hierarchically structured soft keys (3 layers), it allows such versatile functions as CONDITION (measurement conditions), MEASURE, DISPLAY, FILE (storing waveforms in internal or external memory), HARD COPY (outputting to external printers or plotters), and SYSTEM (GP-IB) to be used with ease.

The MW9040B comes with plug-in units that you can simply fit into it after selecting the appropriate type depending on the measurement wavelength band, kind of fiber, or measurement range (distance and resolution).

The MW9040B is designed and manufactured conforming to the FDA optical safety standard 21CFR1040.10, and is classed as Class-1 Laser Equipment under the standards. In addition, it is housed in the frame that conforms to the MIL-T-28800D, Class 3, Style C environment test standards.

1.2 Manual Organization

This manual consists of nine sections and an appendix. The following outlines the contents of each section.

Sections	Contents
Section 1 Overview	Product outline, manual organization, standard equipment composition, plug-in units, options, optional accessories and peripheral devices, and MW9040B specifications
Section 2 Preparations Before Use	Various preparatory operations before using the MW9040B (before power-on) and precautions to be observed when using the equipment
Section 3 Description of Panel	Names and functions of keys, connectors, knobs, indicators, etc located on front and rear panels
Section 4 Basic Method of Operation	Basic operations for distance range, pulse width, and refractive index settings; and basic configuration of screen information and circuitry
Section 5 Detail Method of Operation	Details on how to use various functions using panel keys and soft keys
Section 6 Measurement	Methods of measuring distance, splice loss, and transmission loss, as well as auto fault location measurement method
Section 7 Performance Test	Measurement equipment, setup, and test procedure necessary for conducting performance tests
Section 8 Calibration	Calibration period and calibration items
Section 9 Storage and Transport	Daily maintenance, long-term storage, and repackaging and transport
Appendix	Front and rear panel layout diagrams and soft key hierarchy transition dagrams

Thus, reading sections 2, 3, 4, and 6 you will learn the basic procedure to make measurement with the MW9040B.

When using the MW9040B, also refer to the operation manual for GP-IB. It will help you know details on GP-IB based remote control.

1.3 Equipment Composition

1.3.1 Standard composition

Table 1-1 shows the standard composition of theMW9040B.

Table 1-1 Standard Composition

Item	Model No./ Order No.	Name	Qty.	Remarks
Main frame	MW9040B	Optical Time Domain Reflectometer	1	Comes with one GP-IB PC board.
Accessories supplied	J0017	Power cord, 2.5 m	1	
	F0013	Fuse, 5 A	2	T5A250V
	B0292	Protective cover	2	Used for front and rear.
	W0648AE	Operation manual	1	

The MW9040B comes with one of the plug-in units listed in Table 1-2 that you can simply fit into the main frame for making measurement.

1.3.2 Plug-in units

Table 1-2 lists the plug-in units used for the MW9040B.

Table 1-2 Plug-in Units

Model No.	Name	Remarks
MW0942A	Plug-in unit	Used for 1.31 μm SM fiber, short distance, high resolution
MW0944B	Plug-in unit	Used for 1.3/1.55 μm SM fiber, short distance, high resolution
MW0945A	Plug-in unit	Used for 1.31 μm SM fiber, long-distance, wide-dynamic range measurement
MW0946A	Plug-in unit	Used for 1.55 μm SM fiber, long-distance, wide-dynamic range measurement
MW0947A/B	Plug-in unit	Used for 1.31/1.55 μm SM fiber, long-distance, wide-dynamic range measurement
MW0967B	Plug-in unit	Used for 0.85/1.30 μm GI fiber, short distance, high resolution

1.3.3 Options

Table 1-3 lists the options used for the MW9040B.

Table 1-3 Option

Model No./Order No.	Name	Remarks
MW9040B-01	GP-IB interface	
MW9040B-02	MC2102A Floppy Disk Drive	With attachment to plug the MC2102A on the MW9040B.
MW0942A/0944B/0945A/0946A/0947A/B/0967B-21	D4 connector	
MW0945A/0946A/0947A/B/0967B-22	AT&T Biconic connector	
MW0967B-23	Amphenol 906	
MW0942A/0944B/0945A/0946A/0947A/B/0967B-34	DIAMOND connector	
MW0945A/0946A/0947A/B-37	FC-PC adapter	
MW0942A/0944B/0945A/0946A/0947A/B/0967B-38	ST connector	
MW0942A/0944B/0945A/0946A/0947A/B/0967B-39	DIN connector	
MW0942A/0944B/0945A/0946A/0947A/B/0967B-40	SC connector	

1.4 Optional Accessories and Peripheral Devices

Tables 1-4 and 1-5 list the optional accessories and peripheral devices.

Table 1-4 Optional Accessories

Model No./Order No.	Name	Remarks
B172	CRT hood	
BS32F1-C-172	Memory card	RAM, 32 k bytes
BS64F1-C-173	Memory card	RAM, 64 k bytes
BS128F1-C-174	Memory card	RAM, 128 k bytes
BS256F1-C-1175	Memory card	RAM, 256 k bytes
BS512F1-C-1176	Memory card	RAM, 512 k bytes
J0007	GP-IB connection cable, 1 m	408JE-101
J0008	GP-IB connection cable, 2 m	408JE-101
J0126A	Coaxial cable, 1 m	Used for connecting UA455A video plotter
J0126B	Coaxial cable, 2 m	Used for connecting UA455A video plotter
FC-AP	Adapter	
J0200*	Optical fiber cord	GI optical fiber cord with FC connectors at both ends
J0056*	Optical fiber cord	SM optical fiber cord with FC connectors at both ends
J0087*	FC/D4 conversion cord	GI optical fiber
J0210*	FC/D4 conversion cord	SM optical fiber
J0209*	FC/Biconic conversion cord	GI optical fiber
J0208*	FC/Biconic conversion cord	SM optical fiber
J0207*	FC/DIAMOND conversion cord	GI optical fiber
J0206*	FC/DIAMOND conversion cord	SM optical fiber
J0516*	FC/DIN conversion cord	GI optical fiber
J0517*	FC/DIN conversion cord	SM optical fiber
J0518*	FC/ST conversion cord	GI optical fiber
J0519*	FC/ST conversion cord	SM optical fiber
J0520*	FC/SC conversion cord	GI optical fiber
J0521*	FC/SC conversion cord	SM optical fiber
MZ8012A	Connector cleaning set	
B0294	MW9040B carrying case (hard type)	Comes with casters
B0295	Plug-in unit carrying case (hard type)	Can accommodate two plug-in units
B0177	UA455A carrying case	
B0296	MW9040B soft carrying bag	Handbag type
B0927	Plug-in unit soft carrying bag	Handbag type
B0181	MW9040B carrying aid on back	

* Specify the desired type with character A to C according to the length of optical fiber cord. (A: 1 m, B: 2 m, C: 3 m)

Table 1-5 Peripheral Devices

Model No./Order No.	Name	Remarks
MC8104A	Data Storage Unit	Used for recording measured data.
MA9014A	Bare fiber connector	Shared for SM and GI
MA9013A	Fiber adapter	
MN9607A	SM/GI converter	
UA455A	Video plotter	
CTM-800	Printer	(Epson, Japan)
PD9411F-11	Plotter	(Graphtec, Japan)

1.5 Specifications

Tables 1-6 and 1-7 list the Specifications for the MW9040B and the Plug-in Units.

Table 1-6 MW9040B Specifications

Model			MW9040B
Sweep time			Max. 0.3 sec. (Used in Fast Sweep Mode and 2PA Mode)
Automatic searching	No. of search points		Max. 5 points
	Threshold		0.05/0.1/0.3/1.0/3.0/5.0 dB
Optical return loss measurement			Provided
Waveform comparison			Provided
Built-in memory			32 Waveforms (with setting conditions)
Memory card			Plug-in memory card 32KB/64KB/128KB/256KB/512KB
Title display			20 Characters × 2 Lines
IOR			1.400000 to 1.699999 (0.000001 Steps)
Unit of distance display			meters/feet/miles
CRT			6 inches, green
Video output			Composite video signal: 1 Vp-p (75 Ω load), Connector: BNC-type
Interface	GP-IB	Device-mode Controller-mode Conformity	SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C0,E2 SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C4, C7, E2 IEEE-488.1 and IEEE-488.2
	Direct-plotting output		The CRT screen can be copied to the external plotter or printer via the GP-IB connector without an external controller.
Power			AC 85 to 132 V (170 to 250 V), 50/60 Hz ±5%, ≦165 VA
Environ-mental specifi-cations	Ambient temperature *1 Relative humidity Physical vibration *2 Physical shock *2 Water resistance test		−10° to +55°C (spec.), −40° to +75°C (storage) ≦95% Frequency: 5 to 55 Hz, Amplitude: Max. 1.5 mm (in all 3 directions) Repetition time: 15 minutes Max. acceleration: 30 G, Shock time: 11 m sec. Shock impact: Sine half wave, Frequency: 3 times each at all 6 faces 16.3±1 liter/hour (8 minutes on, 4 minutes off with protective covers)
Dimensions and weight			177 H × 284 W × 401 D mm, <12.5 kg (With protective covers and without plug-in unit)

*1 As long as the plug-in memory card (PMC) is always installed in the main frame.
−10° to +55°C (spec.), −30° to +75°C (storage)

When the PMC is installed in/removed from the main frame.
0° to +55°C (spec.), −30° to +60°C (storage)

*2 These specifications do not apply to the MW0942A and the MW0944B.

Table 1-7 Specifications of Plug-in Units

Model		MW0945A			MW0946A			MW0947A		
Center Wavelength		1310±15 nm			1550±15 nm			1310/1550±15 nm		
Fiber under measurement		10/125 μm Single-mode fiber (CCITT G.652)								
Optical connector *1		FC-type								
Pulse width *2		0.1 μs	1 μs	10 μs	0.1 μs	1 μs	10 μs	0.1 μs	1 μs	10 μs
Dynamic range (one-way back-scattered light level)*3	Effective	20 dB	25 dB	34 dB	18 dB	23 dB	32 dB	18/16 dB	23/21 dB	32/30 dB
	S.N.R=1	23 dB	28 dB	37 dB	21 dB	26 dB	35 dB	21/19 dB	26/24 dB	35/33 dB
4% Fresnel reflection dynamic range *4	Effective	37 dB	41 dB	45 dB	36 dB	40 dB	44 dB	35/34 dB	39/38 dB	43/42 dB
	S.N.R=1	40 dB	44 dB	48 dB	39 dB	43 dB	47 dB	38/37 dB	42/41 dB	46/45 dB
Near-end deadzone *5, *6	Back-scattered light	75 m	200 m	1500 m	75 m	200 m	1500 m	75 m	200 m	1500 m
Effective distance resolution *5, *7		75 m	200 m	1500 m	75 m	200 m	1500 m	75 m	200 m	1500 m
Mask function	No. of masks	Max. 5 (Optical)								
Variable near-end mask-width function		Not provided								
Attenuation *8		AUTO/0.0/5.0/10.0/15.0/20.0/25.0 dB								
Variable optical output power function		Not provided								
Distance range *5		10/25/50/100/250 km								
Horizontal axis *5	Scale (m/div)	5/10/25/50/100/250/500/1 k (10 km range) 5/10/25/50/100/250/500/1 k/2.5 k (25 km range) 5/10/25/50/100/250/500/1 k/2.5 k/5 k (50 km range) 5/10/25/50/100/250/500/1 k/2.5 k/5 k/10 k (100 km range) 5/10/25/50/100/250/500/1 k/2.5 k/5 k/10 k/25 k (250 km range)								
	Resolution	Sampling resolution : 10 cm to 50 m Read-out resolution : 10 cm to 500 m								
	Accuracy	±1 m ±measured value (m) ×2×10^{-5} (does not include the uncertainty in the index of refraction for the fiber.)								

Table 1-7 Specifications of Plug-in Units (Continued)

Model		MW0945A	MW0946A	MW0947A
Vertical axis	Scale (dB/div)	0.1/0.25/0.5/1/2.5/5		
	Read-out resolution	0.001 dB		
	Linearity	±0.2 dB : 0 to 7 dB ±0.03 × measured value : 7 to 15 dB (PW = 100 ns) 7 to 20 dB (PW = 1 μs) 7 to 25 dB (PW = 10 μs)		
Ambient temperature	Spec.	−10°C to +55°C		
	Storage	−40°C to +75°C		
Weight		≦ 2.5 kg		

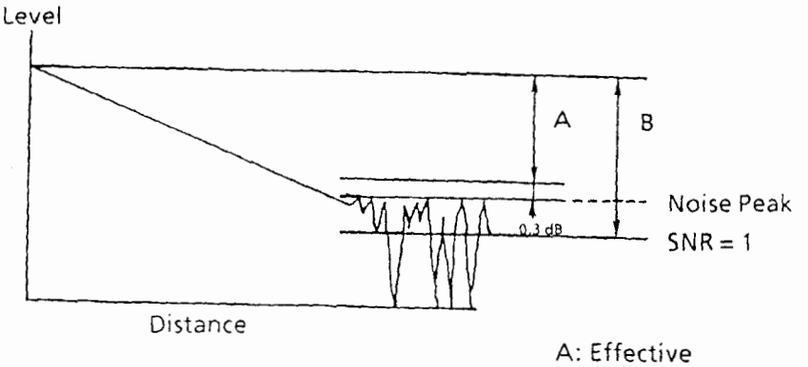
*1: The FC connector is the standard optical connector. For other optical connector types, see Table 1-3.

*2: When the distance ranges are 10 km and 25 km, the 10-µs pulse width cannot be selected.

*3: Dynamic range (one-way back-scattered light)

Effective: The difference between the level of the point which is 0.3 dB higher than the peak noise level and the level of the point at which near-end back-scattering occurs.

SNR = 1: Level difference between the RMS noise level and the level at which near-end back-scattering occurs.

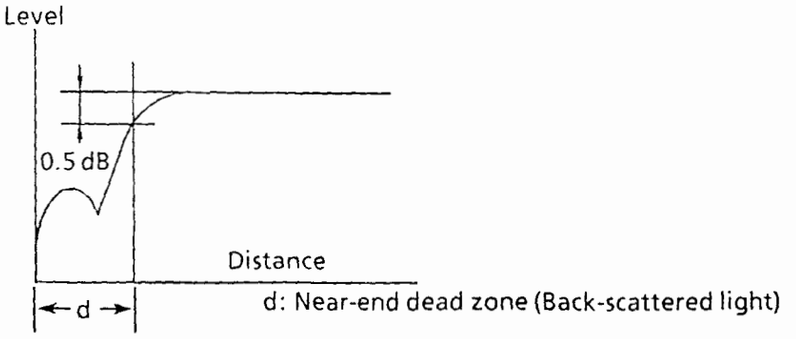


A: Effective
B: S.N.R = 1

*4: The 4% Fresnel reflection at the far end of the fiber (including the loss given in the specification) can be detected at values which are at least 0.3 dB from the noise peak of the noise floor.

*5: When IOR is set to 1.500 000.

*6: The near-end dead zone (for back-scattered light) is the distance at which the near-end back-scattered light level approaches to within ±0.5 dB of its final value.



*7: Effective distance resolution

The minimum distance between two adjacent connecting points (connections or splices) that can be distinguished through loss measurements.

*8: The value selected for the attenuation depends on the pulse width.

Table 1-7 Specifications of Plug-in Units (Continued)

Model		MW0942A				
Center Wavelength		1310±15 nm				
Fiber under measurement		10/125 μm Single-mode fiber (CCITT G.652)				
Optical connector *1		FC-PC type				
Pulse width		10 ns	20 ns	100 ns	500 ns	2 μs
Dynamic range (one-way back-scattered light level)*2	Effective	4.0 dB	5.5 dB	9.0 dB	12.5 dB	15.5 dB
	S. N. R = 1	7.0 dB	8.5 dB	12.0 dB	15.5 dB	18.5 dB
4% Fresnel reflection dynamic range	Effective	32.0 dB				
	S. N. R = 1	35.0 dB				
Near-end deadzone *3, *4	Back-scattered light	5 m	7.5 m	20 m	75 m	250 m
Spatial resolution *3, *5	Fresnel reflection	2 m	3 m	15 m	60 m	220 m
	Back-scattered light	2 m	3 m	15 m	60 m	220 m
Mask function	No. of masks	Max. 5 (Optical)				
Variable near-end mask-width function		Provided				
Attenuation		0.0 dB fixed				
Variable optical output power function		Not provided				
Distance range *3		10/25/50/100 km				
Horizontal axis *3	Scale (m/div)	2.5/5/10/25/50/100/250/500/1 k (10 km range) 2.5/5/10/25/50/100/250/500/1 k/2.5 k (25 km range) 2.5/5/10/25/50/100/250/500/1 k/2.5 k/5 k (50 km range) 2.5/5/10/25/50/100/250/500/1 k/2.5 k/5 k/10 k (100 km range)				
	Resolution	Sampling resolution : 5 cm to 20 m Read-out resolution : 5 cm to 200 m				
	Accuracy	±1 m ± measured value (m) ×2×10−5 (does not include the uncertainty in the index of refraction for the fiber.)				

Table 1-7 Specifications of Plug-in Units (Continued)

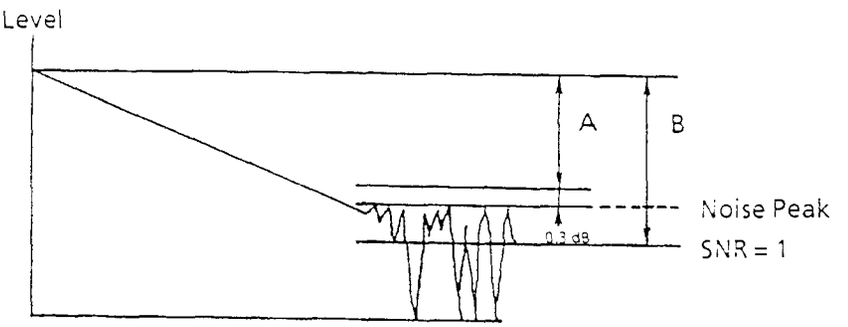
Model		MW0942A
Vertical axis	Scale (dB/div)	0.1/0.25/0.5/1/2.5/5
	Read-out resolution	0.001 dB
	Linearity	±0.3 dB (0 to 5 dB) ±0.5 dB (5 to 10 dB) ±0.7 dB (10 to 15 dB)
Ambient temperature	Spec.	5°C to +35°C
	Storage	−10°C to +60°C
Weight		≦ 2.5 kg

*1: The FC-PC connector is the standard optical connector type. For other optical connectors, please refer to Table 1-3.

*2: Dynamic range (one-way back-scattered light)

Effective: The difference between the level of the point which is 0.3 dB higher than the peak noise level and the level of the point at which near-end back-scattering occurs.

SNR = 1: Level difference between the RMS noise level and the level at which near-end back-scattering occurs.



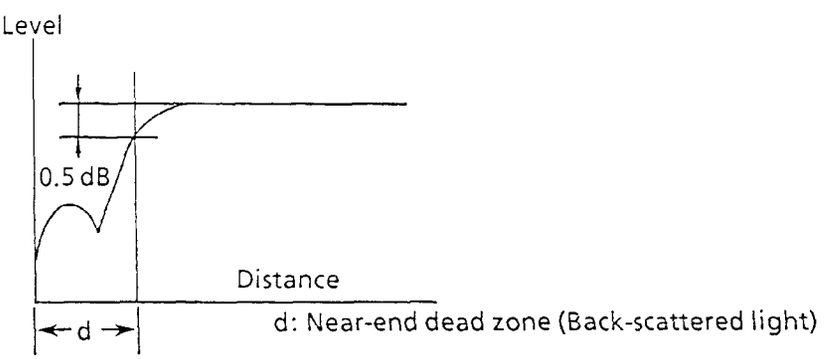
A: Effective
B: S.N.R = 1

*3: When IOR is set to 1.500 000.

*4: Near-end Dead Zone

(For Back Scattered light): The near-end dead zone (for back-scattered light) is the distance at which the near-end back-scattered light level approaches to within ±0.5 dB of its final value.

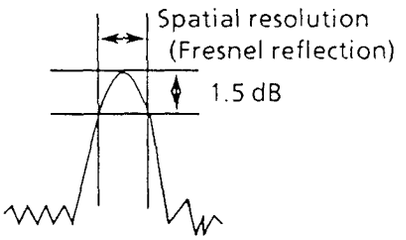
This specification represents the values for the FC-PC connector (when return loss ≧ 25 dB). When fiber which includes a PC connector (flat polished) is measured, the dead zone may be larger than the specified value.

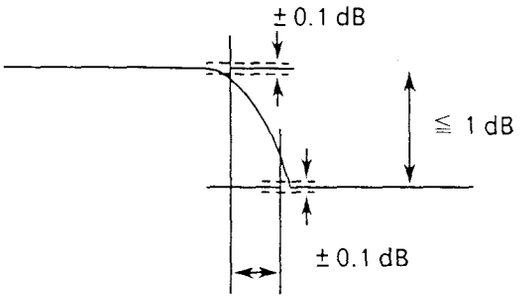


*5: Spatial resolution

For Fresnel Reflection: The width of an unsaturated Fresnel reflection pulse at a point which is 1.5 dB less than the peak value.

For Back-Scattering: The distance between the points at which the beginning and ending levels at a splice etc. gap (≦1 dB) are within ±0.1 dB of their initial and final values respectively.





Spatial resolution
(Back-scattered light)

Table 1-7 Specifications of Plug-in Units (Continued)

Model		MW0947B					
Center Wavelength *7		1310/1550 ± 15 nm					
Fiber under measurement		10/125 µm Single-mode fiber (CCITT G.652)					
Optical connector *1		FC					
Pulse width *10		20 ns	100 ns	500 ns	1 µs	4 µs	10 µs
Dynamic range (one-way back-scattered light level)*2	Effective	13/11 dB	18/16 dB	21/19 dB	24/22 dB	29/27 dB	32/30 dB
	S. N. R = 1	16/14 dB	21/19 dB	24/22 dB	27/25 dB	32/30 dB	35/33 dB
4% Fresnel reflection dynamic range	Effective	33/32 dB	37/36 dB	39/38 dB	40/39 dB	42/41 dB	43/42 dB
	S. N. R = 1	36/35 dB	40/39 dB	42/41 dB	43/42 dB	45/44 dB	46/45 dB
Near-end deadzone *3, *4	Fresnel reflection	35 m	50 m	95 m	200 m	700 m	1500 m
	Back-scattered light	35 m	50 m	95 m	200 m	700 m	1500 m
Spatial resolution *3, *5	Fresnel reflection	15 m	30 m	75 m	150 m	500 m	1500 m
	Back-scattered light	30 m	50 m	90 m	200 m	700 m	1500 m
Mask function *3, *6	No. of masks	Max. 5 (Optical)					
	Mask width *8	75 m	75 m	150 m	200 m	700 m	1500 m
Variable near-end mask-width function		Not provided					
Attenuation *9		AUTO/0.0 to 23.75 dB in 1.25 dB steps					
Variable optical output power function *6		Provided					
Distance range *3		10/25/50/100/250 km					
Horizontal axis *3	Scale (m/div)	5/10/25/50/100/250/500/1 k (10 km range) 5/10/25/50/100/250/500/1 k/2.5 k (25 km range) 5/10/25/50/100/250/500/1 k/2.5 k/5 k (50 km range) 5/10/25/50/100/250/500/1 k/2.5 k/5 k/10 k (100 km range) 5/10/25/50/100/250/500/1 k/2.5 k/5 k/10 k/25 k (250 km range)					
	Resolution	Sampling resolution : 10 cm to 50 m Read-out resolution : 10 cm to 500 m					
	Accuracy	± 1 m ± measured value (m) × 2 × 10^{-5} (does not include the uncertainty in the index of refraction for the fiber.)					

Table 1-7 Specifications of Plug-in Units (Continued)

Model		MW0947B
Vertical axis	Scale (dB/div)	0.1/0.25/0.5/1/2.5/5
	Read-out resolution	0.001 dB
	Linearity	±0.03 dB/dB
Ambient temperature	Spec.	−10°C to 55°C
	Storage	−40°C to 75°C
Weight		≦ 2.5 kg

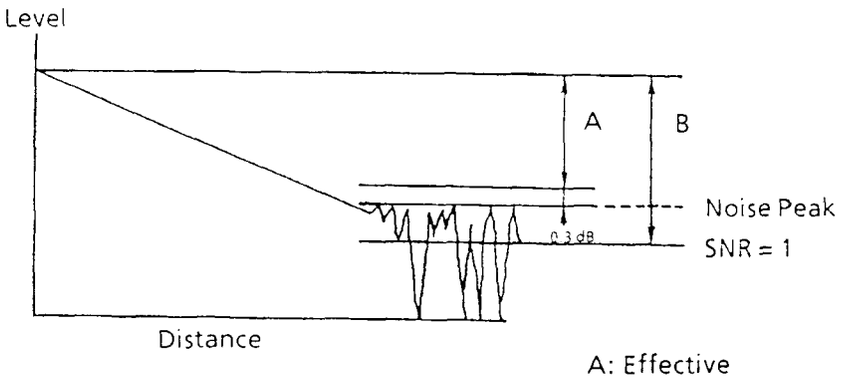
*1: The FC connector is the standard optical connector. For other optical connectors, please refer to Table 1-3.

However, the dynamic range is degraded by 0.5 dB for the DIAMOND, D4, and AT & T Biconic connectors.

*2: Dynamic range (one-way back-scattered light)

Effective: The difference between the level of the point which is 0.3 dB higher than the peak noise level and the level of the point at which near-end back-scattering occurs.

SNR = 1: Level difference between the RMS noise level and the level at which near-end back-scattering occurs.

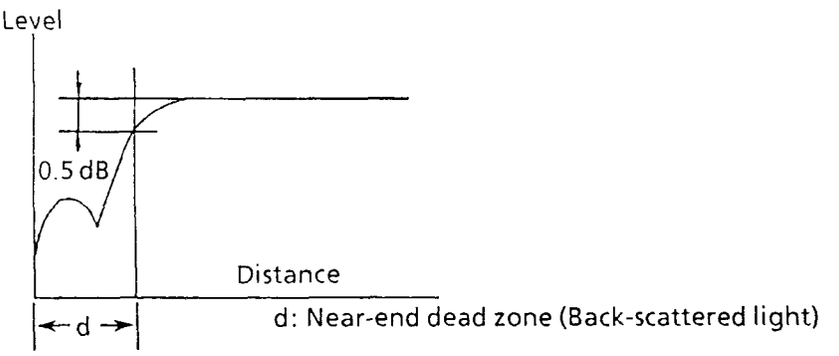


*3: When IOR is set to 1.500 000.

*4: Near-end Dead Zone

(For Fresnel Reflection): The minimum distance at which the 4% Fresnel Reflection generated by the fault point can be detected.

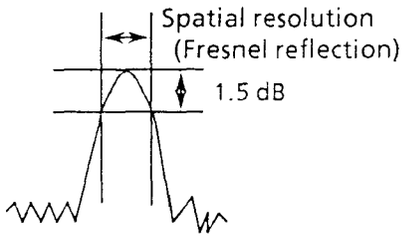
(For Back Scattered light): The near-end dead zone (for back-scattered light) is the distance at which the near-end back-scattered light level approaches to within ±0.5 dB of its final value.

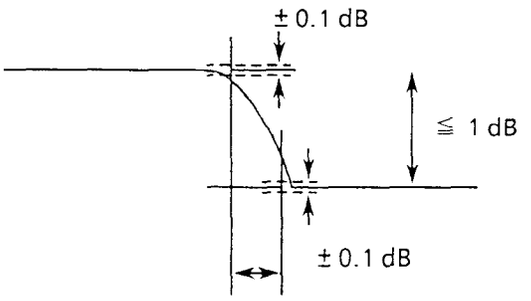


*5: Spatial resolution

For Fresnel Reflection: The width of an unsaturated Fresnel reflection pulse at a point which is 1.5 dB less than the peak value.

For Back-Scattering: The distance between the points at which the beginning and ending levels at a splice etc. gap (≦ 1 dB) are within ± 0.1 dB of their initial and final values respectively.



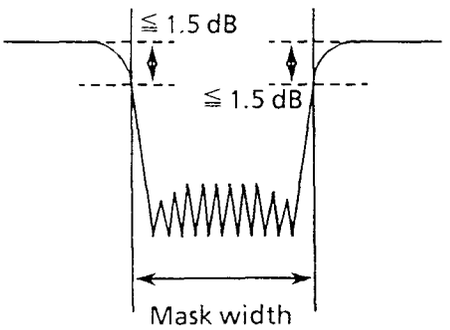


Spatial resolution
(Back-scattered light)

*6: All the masks except for the near-end mask are turned OFF in the variable optical output power mode.

*7: Not applicable in the variable optical output power mode.

*8: Mask width



*9: The value selected for the attenuation depends on the pulse width.

*10: Pulse widths of 4 μs and 10 μs cannot be selected for the 10-km, 25-km, and 50-km distance ranges. Furthermore, 1-μs pulse width cannot be selected for the 10-km and 25-km distance range.

Table 1-7 Specifications of Plug-in Units (Continued)

Model		MW0944B				
Center Wavelength *7		1310/1550 ± 15 nm				
Fiber under measurement		10/125 µm Single-mode fiber (CCITT G.652)				
Optical connector *1		FC-PC				
Pulse width		10 ns	20 ns	100 ns	500 ns	2 µs
Dynamic range (one-way back-scattered light level)*2	Effective	4.5/2.0dB	6.0/3.5 dB	9.5/7.0 dB	13.0/10.5 dB	16.0/13.5 dB
	S. N. R = 1	7.5/5.0 dB	9.0/6.5 dB	12.5/10 dB	16.0/13.5 dB	19.0/16.5 dB
4% Fresnel reflection dynamic range	Effective	32.5/31.0 dB				
	S. N. R = 1	35.5/34.0 dB				
Near-end deadzone *3, *4	Fresnel reflection	3 m	5 m	13 m	55 m	220 m
	Back-scattered light	8 m	10 m	20 m	65 m	240 m
Spatial resolution *3, *5	Fresnel reflection	2 m	4 m	13 m	55 m	220 m
	Back-scattered light	2 m	4 m	15 m	60 m	220 m
Mask function *3, *6	No. of masks	Max. 5 (Optical)				
	Mask width *8	13 m	13 m	18 m	65 m	240 m
Variable near-end mask-width function		Provided				
Attenuation		0.0 dB fixed				
Variable optical output power function *6		Provided				
Distance range *3		10/25/50/100 km				
Horizontal axis *3	Scale (m/div)	2.5/5/10/25/50/100/250/500/1 k (10 km range) 2.5/5/10/25/50/100/250/500/1 k/2.5 k (25 km range) 2.5/5/10/25/50/100/250/500/1 k/2.5 k/5 k (50 km range) 2.5/5/10/25/50/100/250/500/1 k/2.5 k/5 k/10 k (100 km range)				
	Resolution	Sampling resolution : 5 cm to 20 m Read-out resolution : 5 cm to 200 m				
	Accuracy	± 1 m ± measured value (m) × 2 × 10^{-5} (does not include the uncertainty in the index of refraction for the fiber.)				

Table 1-7 Specifications of Plug-in Units (Continued)

Model		MW0944B
Vertical axis	Scale (dB/div)	0.1/0.25/0.5/1/2.5/5
	Read-out resolution	0.001 dB
	Linearity	±0.05 dB/dB
Ambient temperature	Spec.	0°C to 35°C
	Storage	−10°C to 60°C
Weight		≦ 2.5 kg

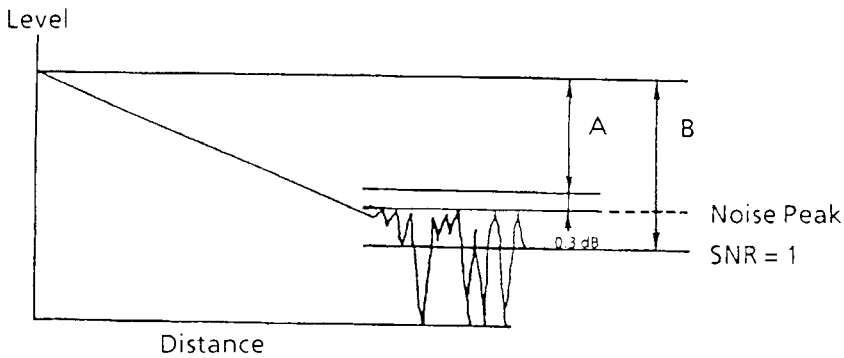
*1: The FC-PC connector is the standard optical connector type. For other optical connectors, please refer to Table 1-3.

The dynamic range is degraded by 0.5 dB for the DIAMOND and D4 connectors.

*2: Dynamic range (one-way back-scattered light)

Effective: The difference between the level of the point which is 0.3 dB higher than the peak noise level and the level of the point at which near-end back-scattering occurs.

SNR = 1: Level difference between the RMS noise level and the level at which near-end back-scattering occurs.



A: Effective
B: S.N.R = 1

*3: When IOR is set to 1.500 000.

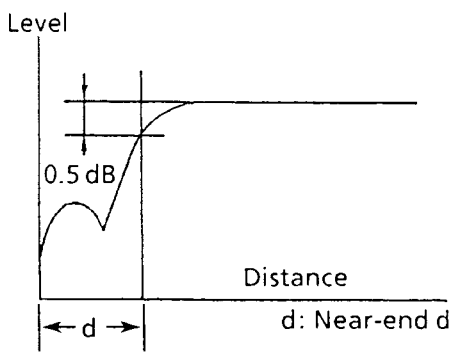
*4: Near-end Dead Zone

(For Fresnel Reflection): The minimum distance at which the 4% Fresnel Reflection generated by the fault point can be detected.

(For Back Scattered light): The near-end dead zone (for back-scattered light) is the distance at which the near-end back-scattered light level approaches to within ±0.5 dB of its final value.

This specification represents the values for the FC-PC connector (when return loss ≧ 25 dB). When fiber which includes a PC connector (flat polished) is measured, the dead zone may be larger than the specified value.

The variable near-end mask-width function can be used to suppress dead-zone widening to a value of 2~3 meters.

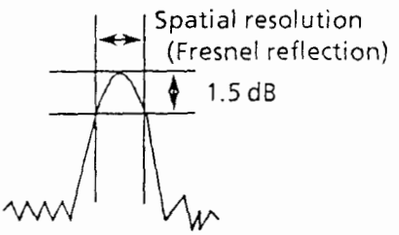


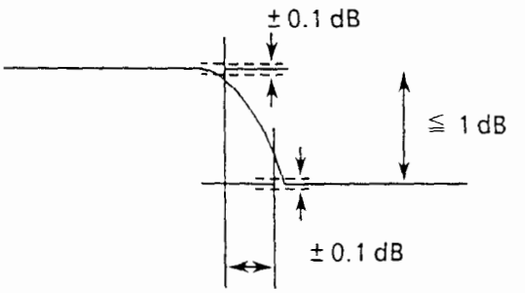
d: Near-end dead zone (Back-scattered light)

*5: Spatial resolution

For Fresnel Reflection: The width of an unsaturated Fresnel reflection pulse at a point which is 1.5 dB less than the peak value.

For Back-Scattering: The distance between the points at which the beginning and ending levels at a splice etc. gap (≦ 1 dB) are within ±0.1 dB of their initial and final values respectively.





Spatial resolution
(Back-scattered light)

*6: All masks including the near-end mask are turned OFF in the variable optical output power mode.

*7: Not applicable in the variable optical output power mode.

*8: Mask width

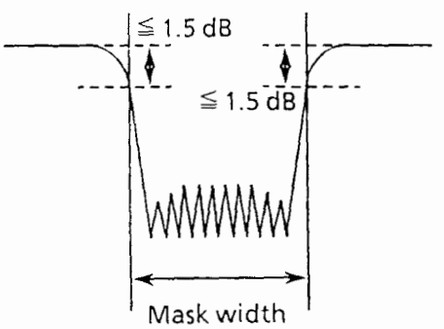


Table 1-7 Specifications of Plug-in Units (Continued)

Model		MW0967B				
Center Wavelength *7		850/1300±15 nm				
Fiber under measurement *6		50/125 µm GI multi-mode fiber (NA0. 2), (CCITT G.651)				
Optical connector *1		FC				
Pulse width		5 ns	20 ns	100 ns	500 ns	2 µs
Dynamic range (one-way back-scattered light level)*2	Effective	7.0/5.0 dB	10.0/8.0 dB	13.5/11.5 dB	17.0/15.0 dB	19.5/18.0 dB
	S. N. R = 1	10.0/8.0 dB	13.0/11.0 dB	16.5/14.5 dB	20.0/18.0 dB	22.5/21.0 dB
4% Fresnel reflection dynamic range	Effective	25/27 dB	27/29 dB			
	S. N. R = 1	28/30 dB	30/32 dB			
Near-end deadzone *3, *4	Fresnel reflection	1.5 m	1.5 m	1.5 m	1.5 m	1.5 m
	Back-scattered light	3 m	4.5 m	15 m	60 m	220 m
Spatial resolution *3, *5	Fresnel reflection	2 m	4 m	15 m	60 m	220 m
	Back-scattered light	2 m	4 m	15 m	60 m	220 m
Mask function		Not provided				
Variable near-end mask-width function		Not provided				
Attenuation		0.0 dB fixed				
Variable optical output power function		Provided				
Distance range *3		10/25/50/100 km				
Horizontal axis *3	Scale (m/div)	2.5/5/10/25/50/100/250/500/1 k (10 km range) 2.5/5/10/25/50/100/250/500/1 k/2.5 k (25 km range) 2.5/5/10/25/50/100/250/500/1 k/2.5 k/5 k (50 km range) 2.5/5/10/25/50/100/250/500/1 k/2.5 k/5 k/10 k (100 km range)				
	Resolution	Sampling resolution : 5 cm to 20 m Read-out resolution : 5 cm to 200 m				
	Accuracy	±1 m ±measured value (m) ×2×10−5 (does not include the uncertainty in the index of refraction for the fiber.)				

Table 1-7 Specifications of Plug-in Units (Continued)

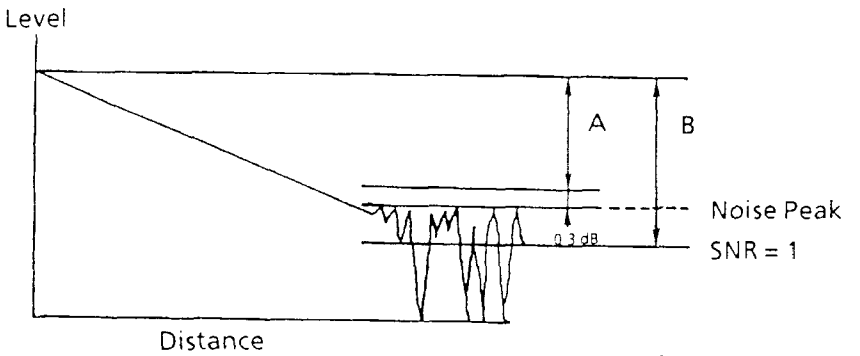
Model		MW0967B
Vertical axis	Scale (dB/div)	0.1/0.25/0.5/1/2.5/5
	Read-out resolution	0.001 dB
	Linearity	±0.05 dB/dB
Ambient temperature	Spec.	−10°C to 55°C
	Storage	−40°C to 75°C
Weight		≦ 2.5 kg

*1: The FC connector is the standard optical connector. For other optical connectors, please refer to Table 1-3.

*2: Dynamic range (one-way back-scattered light)

Effective: The difference between the level of the point which is 0.3 dB higher than the peak noise level and the level of the point at which near-end back-scattering occurs.

SNR = 1: Level difference between the RMS noise level and the level at which near-end back-scattering occurs.



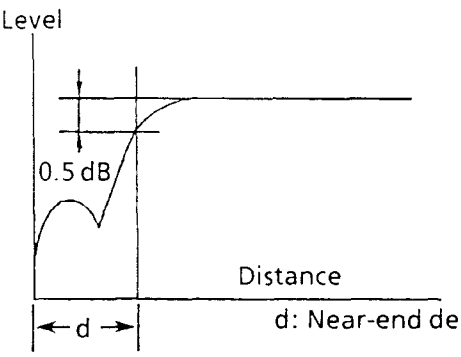
A: Effective
B: S.N.R = 1

*3: When IOR is set to 1.500 000.

*4: Near-end Dead Zone

(For Fresnel Reflection): The minimum distance at which the 4% Fresnel Reflection generated by the fault point can be detected.

(For Back Scattered light): The near-end dead zone (for back-scattered light) is the distance at which the near-end back-scattered light level approaches to within ±0.5 dB of its final value.

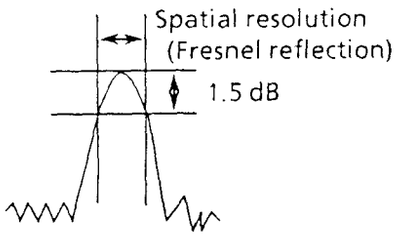


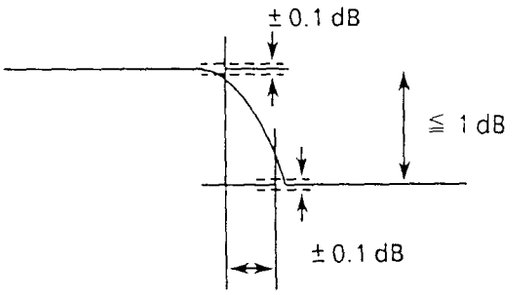
d: Near-end dead zone (Back-scattered light)

*5: Spatial resolution

For Fresnel Reflection: The width of an unsaturated Fresnel reflection pulse at a point which is 1.5 dB less than the peak value.

For Back-Scattering: The distance between the points at which the beginning and ending levels at a splice etc. gap (≦ 1 dB) are within ± 0.1 dB of their initial and final values respectively.





Spatial resolution
(Back-scattered light)

*6: The dynamic range is increased by about 1.5 dB when measuring 62.5/125 µm (NA 0.29) fibers. However, the transmission loss measurement result may differ from those obtained with NA 0.29 by as much as 0.1 dB/km.

*7: Not Applicable in the variable optical output power mode.

SECTION 2
PREPARATIONS BEFORE USE

This section describes various preparatory operations to be done before using the MW9040B and precautions to be observed when using the equipment.

2.1 Environmental Conditions at Place of Installation

The MW9040B is designed to operate normally at ambient temperatures of – 10° to 55°C (For some unit, this value is different. See paragraph 1.5.). However, to use the equipment under the best conditions, avoid using it in the following places:

- Vibration-prone places
- Humid or dusty places
- Places exposed to direct sunlight
- Places where the equipment may be attacked by active gas

In addition to the above recommended conditions, use the MW9040B under room temperature conditions in places where the supply voltage does not fluctuate, to maintain stable operation over a long time.

CAUTION

When using the MW9040B under room conditions after you used it at low temperatures below 0°C for a long time, note that the circuit may be shorted by water droplet attachment, causing trouble. In such a case, be sure to completely dry the equipment before turning the power switch on.

2.2 Safety Protection

2.2.1 Laser Safety

The MW9040B is designed and manufactured conforming to the FDA optical safety standards 21 CFR1040.10, and is classed as Class-1 Laser Equipment under the standards.

WARNING

1. *The MW9040B uses semiconductor laser as the optical source. For safety reasons, never look into the laser output opening and the far end of the fiber (being measured) connected to it.*
2. *When using the MW9040B, be sure to follow the method of operation described in this manual. Otherwise, you may be exposed to invisible laser radiation.*
3. *If any modification is made to the MW9040B, it must be subjected to laser classification again before it can be used.*

2.2.2 Electrical safety

The MW9040B is the product of Safety Class 1 (with its protective ground terminal provided on the rear panel).

WARNING

1. *To avoid getting an accidental electric shock, make sure the GND terminal* ⏚ *on the rear penel is grounded to the earth.*
2. *Because the MW9040B uses CRT-use high voltage, do not disassemble the cabinet while the power is on.*
3. *Do not touch or insert metallic objects into the MW9040B connectors used for plug-in units.*

CAUTION

1. *Confirm that the utility power supply voltage matches the voltage (100 V or 200 V system) indicated on the rear panel supply voltage nameplate.*
2. *Do not connect the power cord to the utility power outlet while the power switch is on.*
3. *Do not turn the power on while no plug-in unit is fitted in place.*
4. *Besure to turn the power off before inserting or removing a plug-in unit.*

2.3 Handling Plug-in Units and GP-IB Interface Board

2.3.1 Plug-in units

CAUTION

Be sure to turn the power off before inserting or removing a plug-in unit.

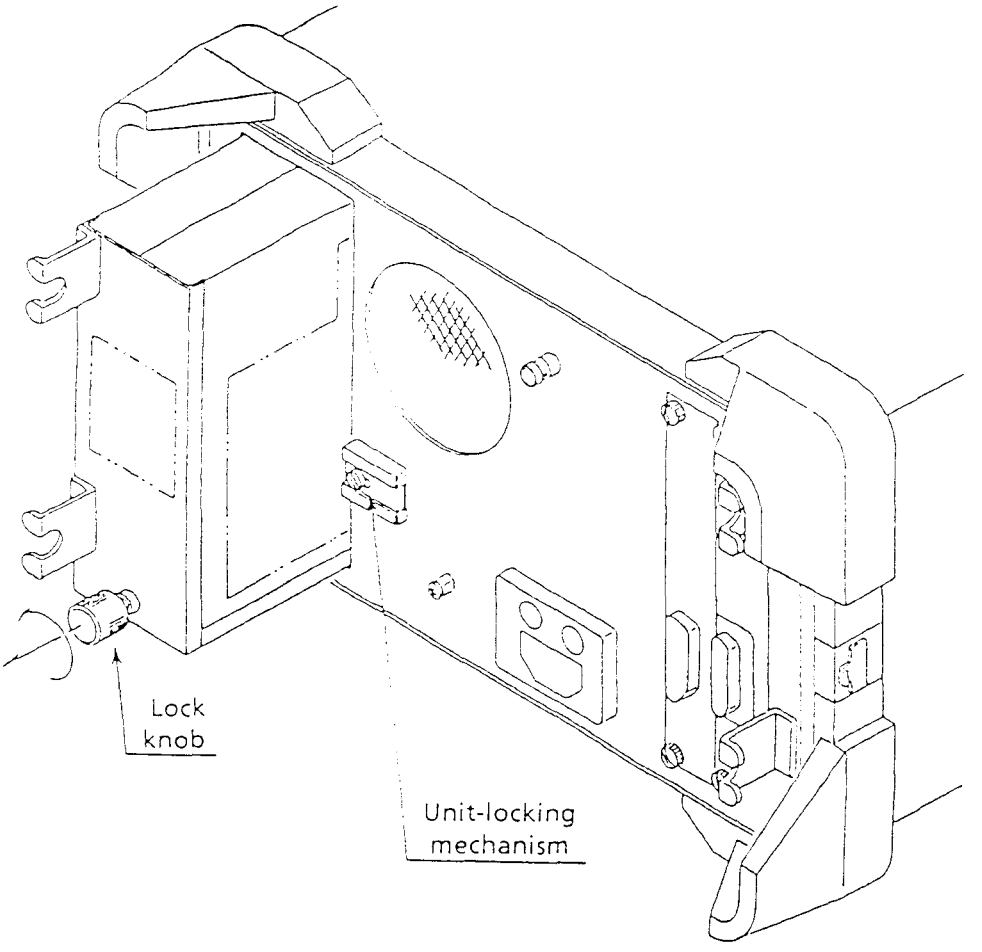


Fig. 2-1 Inserting and Removing Plug-in Unit

When inserting or removing a plug-in unit, do this from the rear of the MW9040B main frame as shown in Figure 2-1. When removing a plug-in unit fitted into position, follow the procedure below: Unfasten the screw of the unit-locking mechanism and slide it to the right, then turn the lock knob on the rear of the plug-in unit counterclockwise, and the lock will be released and the plug-in unit can be pulled out of position. When inserting a plug-in unit, push the plug-in unit into place until the plug-in unit and main frame rear surfaces are flush. Then set the lock by turning the lock knob clockwise. When the plug-in unit is fitted in place, slide the unit-locking mechanism to the left and fasten the screw.

2.3.2 GP-IB interface board

The MW9040B has two slots (SLOT0 and SLOT1) provided on its rear as shown in Figure 2-2. SLOT0 has a GP-IB board fitted in it as a standard component. SLOT1 is open, so that another GP-IB board may be fitted into it as an option. When fitting an optional board, gently push it into the slot with the connector fitted, printed board side first, then fasten the upper and lower screws to fix it into position.

Note: The MW9040B becomes a device/controller for the instrument connected to the SLOT0/SLOT1, respectively. (See paragraph 5.15.)

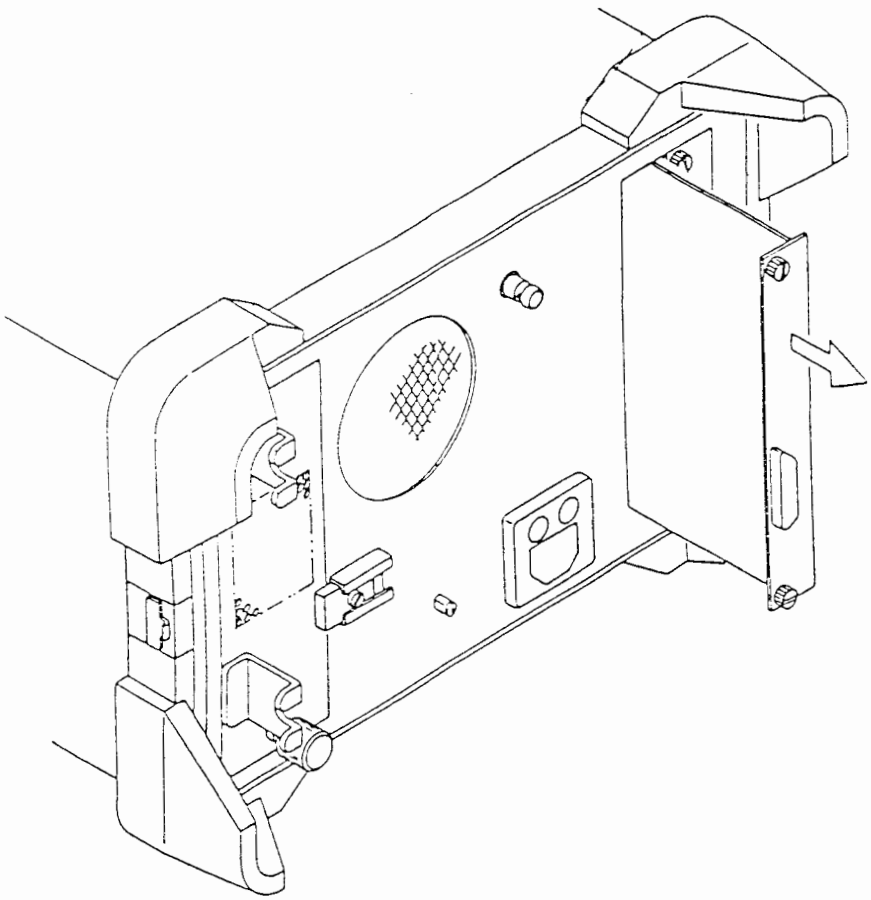


Fig. 2-2 Inserting and Removing GP-IB Interface Board

To remove the board,unfasten the upper and lower screws and, while holding the heads of these screws with your hand, pull the board out of place straight toward you.

CAUTION

Be sure to turn the power of the MW9040B off before inserting or removing the GP-IB interface board.

2.4 Preparations before Power-on

1. Confirming supply voltage

Confirm that the utility power supply voltage matches the voltage (100 V or 200 V system) indicated on the rear panel supply voltage nameplate.

Check whether the rear panel fuse holder contains a fuse of the appropriate capacity according to the table below.

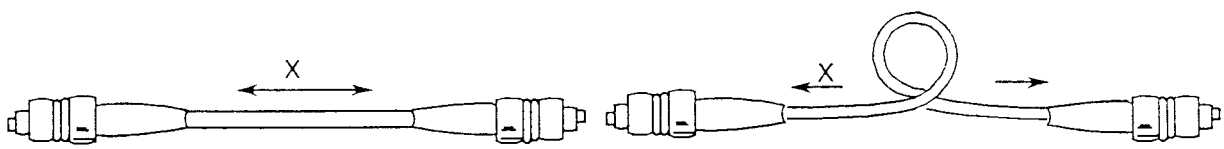
Indicated voltage	Fuse capacity	Fuse name
85 to 132 Vac 170 to 250 Vac	5 A 5 A	T5 A 250 V

2. Connect the AC cord to the inlet.
3. Ground the rear panel GND terminal ⏚ to the earth.
4. Correct the main-frame installation until its front panel becomes easy to see. Then, adjust the carrying handle angle as necessary.

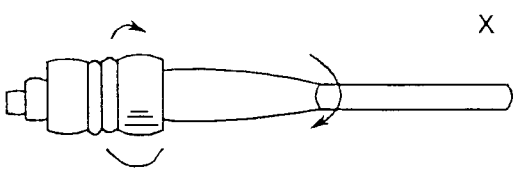
2.5 Precautions on Handling Fiber-optic Cables and Optical Connectors

Pay attention to the following when handling fiber-optic cables and optical connectors.

1. Do not forcibly pull or severely bend fiber-optic cables.



2. Do not twist the connection between fiber-optic cable and optical connector.



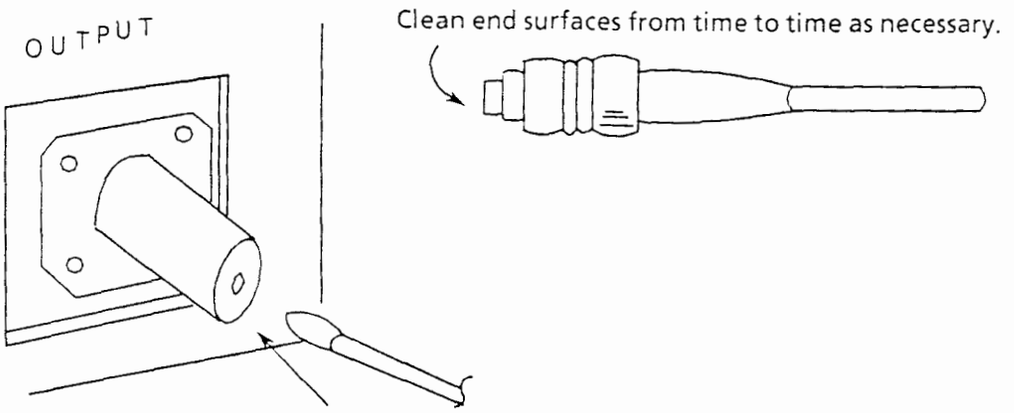
3. Check that the optical adapter and plug do not have dust or dewdrops.

   Especially, carefully check the end section of optical fiber.

   Keep them clear during storage also using caps, etc.

   To clean, use a alcohol-soaked cotton swab or other appropriate tools.

4. If the internal of the optical output connector is stained with dust or the optical fiber for test use is broken at its near end, trace waveform may not appear on the display even when the laser is on. In such a case, clean the end surface of the optical connector or use another fiber-optic cable.



2.6 Precautions on Handling Storage Media

The MW9040B uses plug-in memory cards (PMC) to save data. If the storage media is incorrectly used or has defects, your valuable data may be damaged or lost. To prepare for the worst, copy the data and keep it for backup.

Anritsu does not assume responsibility for loss of storage contents.

Pay attention to the following when using storage media. Especially, it is important that you never remove the plug-in memory card during access.

1. The plug-in memory card may be damaged when static electricity is applied to it.
2. Do not apply strong impact to the plug-in memory card by dropping or bending it.
3. Do not wet the plug-in memory card with water.
4. Do not expose the plug-in memory card to high-temperature, high-humidity environment or direct sunlight.
5. Do not insert tweezers or other foreign matter into the connector section of the plug-in memory card.
6. Be careful not to let dust or dirt enter the connector section of the plug-in memory card.
7. Do not insert any other plug-in memory cards than specified into the plug-in memory card slot.
8. The 128 K, 256 K, and 512 K-byte plug-in memory cards do not contain batteries when shipped from the factory, so fit the attached battery into the plug-in memory card before using it.
9. The table below shows battery life under normal temperature conditions. When the battery power runs out, the saved data may be lost. Replace the battery in advance.

Type of PMC	Memory capacity	Battery life	Type of battery used
BS32F1-C-172	32 K bytes	Approx. 5 years	BR2325
BS64F1-C-173	64 K bytes	Approx. 5 years	
BS128F1-C-174	128 K bytes	Approx. 4.3 years	
BS256F1-C-1175	256 K bytes	Approx. 2.2 years	
BS512F1-C-1176	512 K bytes	Approx. 1.1 years	

10. Replacing the battery (only for SRAM PMCs)

When replacing the battery, first turn the instrument power ON, then mount the PMC in the instrument, before performing the following procedure:

(Attention: PMC data will be lost, if this procedure is not followed.)

(a) Prepare the lithium battery.

(b) Turn the instrument power ON.

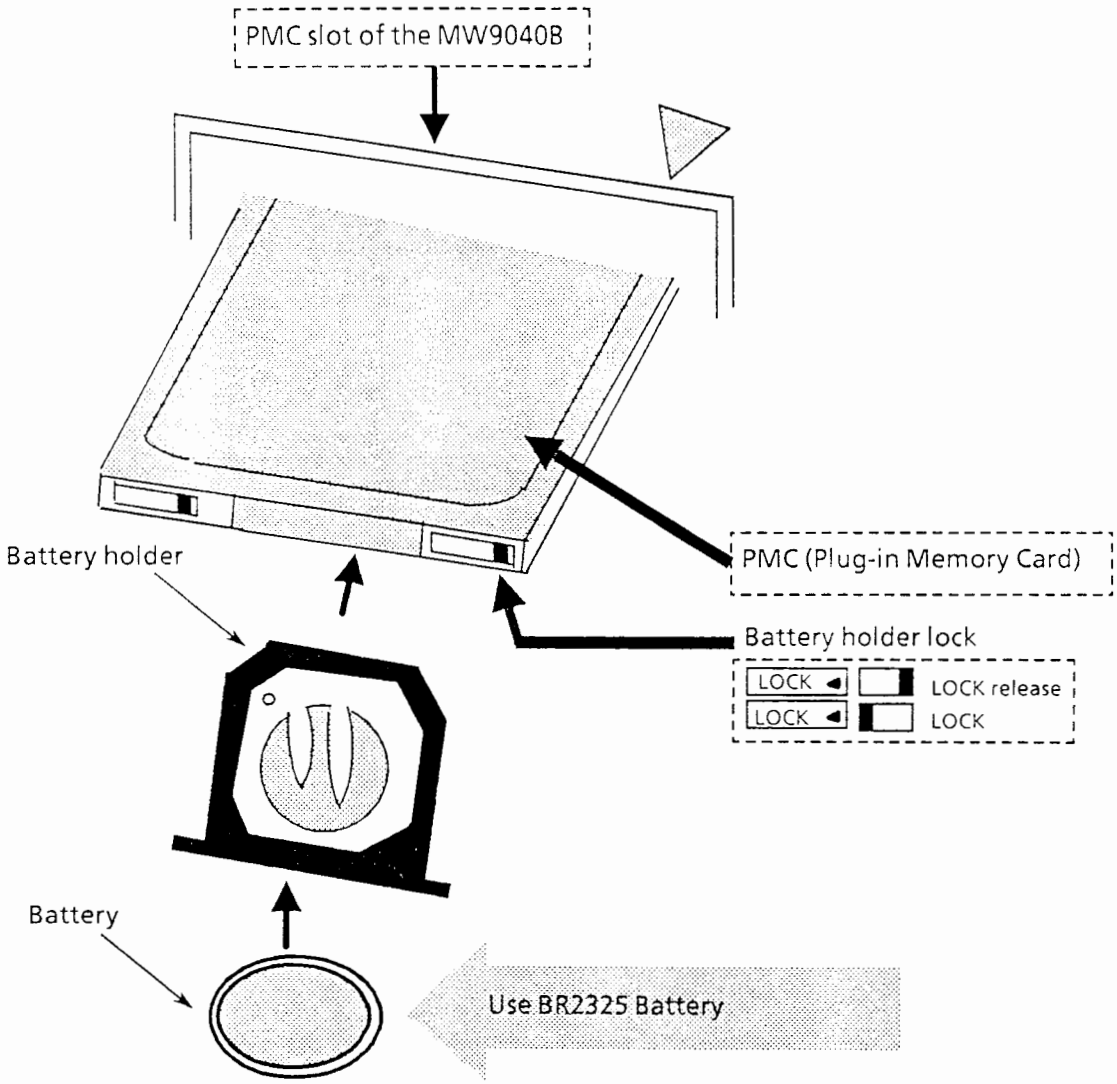
(c) Take the cap off the PMC, and mount the PMC in the instrument. (When mounting, aligh the ▼ and ▲ marks.)

(d) Release the battery holder lock.

(e) Remove the battery holder, and replace the old battery with the new one.

(f) Reinsert the battery holder into the PMC, and engage the battery holder lock.

(g) Take the PMC out of the instrument, and mount the cap.



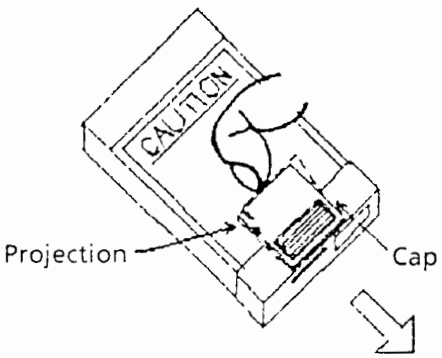
Removing the cap:

Position the PMC back-side up (such that the CAUTION faces upwards) so that the cap can be easily removed.

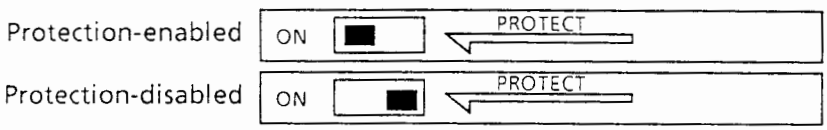
11. Using the write-protection switch (only for SRAM PMCs)

The write-protection switch has been preset at the factory to the "OFF" position. To enable write protection, move the switch to the ON position with a ball point pen.

If the software for the instrument performs write protection, set the write-protection switch to the "OFF" position.



While slightly lifting the cap projection (as indicated by the dotted line), push the cap in the direction of the arrow.



SECTION 3
DESCRIPTION OF PANEL

This section describes the layout and functions of front and rear panel keys, connectors, knobs, and indicators. Table 3-1 describes how to use operation keys. The numbers in this table correspond to those in front and rear panel layout drawings in Figures B-1 and B-2 in Appendix B. These drawings are folded into the manual; spread them whenever necessary to check.

Table 3-1 Description of Operation Keys (1/5)

No.	Name	Description
1	INTENSITY	Adjusts the screen brightness. Turn it clockwise to make the screen bright.
2	(CRT)	Dislays the observation waveform, scale, measurement conditions, measurement results, and soft key labels.
3	PRIOR	Returns the current soft key layer to the previous layer.
4	(Soft keys)	Executres each function of the function menu displayed on the right side of the screen. The keypad consists of six keys from F1 to F6. The function defined in the menu is selected and executed by pressing the key corresponding to each function (this key being called the soft key). The menu is hierarchically structured from layer 1 to layer 3. When there are six menu items or more within the same layer, the menu is displayed on two or more screens. In this case, press [etc.] key to go to the next screen. See paragraph 5.14 for details on the soft-key functions and hierarchical structure.
5	COARSE	Lights the key switch lamp to speed up the movement of markers and waveforms. When pressed again, the movement speed returns to the preveous original one.
6	(Rotary knob)	Used along with [H-SHIFT], [V-SHIFT], and [MARKER] keys and soft keys from [F1] to [F6], it moves the cursor, marker, or waveform and inputs various data (including conditions setting).
7	MARKER	Selects or moves the marker. Each time this key is pressed while the lamp is on, the next marker on the right is selected and the cursor is moved. Also, the marker and cursor can be moved by turning the rotary knob. *Note:* When the auto function actuated by the [AUTO] key is in operation, the marker and cursor cannot be moved with the rotary knob.

Table 3-1 Description of Operation Keys (2/5)

(Continued)

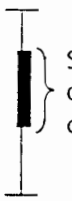
No.	Name	Description
8	V-SHIFT	Moves the waveform displayed on the screen up and down. Turn the rotary knob for this movement. The range currently displayed on the screen relative to the measurable range on the vertical axis will be indicated by a thick line on the left edge of the screen.  When the key is pressed once during 2-waveform comparison mode, the lamp goes on and both waveforms are moved up and down. When the key is pressed a second time, the lamp blinks and only the measurement waveform moves up and down. When the key is pressed one more time, the previous state returns with the lamp on.
9	H-SHIFT	Moves the start position of the waveform displayed on the screen. Turn the rotary knob for this movement. The movable range is as follows: 0 to {distance range − (minimum distance scale × 10)} × 1.5/ refractive index The thick line in the upper part of the screen indicates which part of distance range the currently displayed distance range is.  Section displayed on screen
10	V-ZOOM	Selects the level scale of the vertical axis on the screen. An expanded or reduced waveform can be obtained by the [IN] or [OUT] keys. The following scales can be selected: 0.1 / 0.25 / 0.5 / 1.0 / 2.5 / 5.0 dB/div
11	H-ZOOM	Selects the distance scale of the horizontal axis on the screen. An expanded or reduced waveform can be obtained by the [IN] or [OUT] keys. The scale (km/div) varies with the plug-in unit used. The set scale is displayed on the upper right of the screen.

Table 3-1 Description of Operation Keys (3/5)

(Continued)

No.	Name	Description
12	SPLICE LOSS	Switches between splice loss (SPLICE) measurement and optical fiber transmission loss (LOSS) measurement. The measurement modes are switched over each time the key is pressed, and the lamp for the selected mode lights. (1) SPLICE Two X markers are arranged in front and back each around the * marker. The splice loss measurement results are calculated by the LSA or 2PA method, and the value is displayed on the lower left part of the screen along with an indication that the mode is SPLICE. (2) LOSS The * and X markers are displayed one each. Loss and distance between two points and loss per unit length are displayed on the lower left part of the screen along with an indication that the mode is LOSS.
13	AUTO	Automatically detects fault location. When the automatic fault location detect function is in operation, the lamp lights and markers are positioned at fault locations (up to 5) greater than the set level difference with the cursor positioned at the first marker point. The cursor moves to the next marker point each time the [MARKER] key is pressed. When the cursor is positioned at a given fault location, fiber transmission loss before and behind that fault location, splice loss at the fault location, and the distance from the near end to the fault location are displayed.
14	LASER OUTPUT	A connector for fiber to be measured is fitted inside the protective cover. The protective cover has a safety device so that the laser is not emitted even when the cover is opened. The laser can only be emitted when a connector is connected.
15	LASER ON/OFF	The READY lamp lights when the laser diode (LD) temperature becomes constant, indicating that the LD is ready. The laser to the fiber to be measured can be turned on or off with this key only when the READY lamp is on and the fiber cable is connected to the LASER OUTPUT connector. ① ON The key switch lamp lights and the laser is emitted to the fiber to be measured. ② OFF The key switch lamp goes out and laser emission to the fiber to be measured is stopped. Also, the waveform on the screen is held in place.

Table 3-1 Description of Operation Keys (4/5)

(Continued)

No.	Name	Description
16	AVERAGE ON/OFF	Turns average on and off. (1) ON The key switch lamp comes on. Averaging starts, and noise components of the waveform shown on the screen are reduced along with an elapse of time, making waveform observation easier. When the AVERAGE is ON and the ATT is AUTO, simultaneously; the waveform summary display mode comes on. (See paragraph 5.10) Averaging is reset when set conditions are changed as follows: a. When the distance range is changed b. When the pulse width is changed c. When the wavelength (λ – SELECT) is changed d. When the AVERAGE setting is changed from ON to OFF e. When the laser is turned on by a change of sampling conditions while the laser is off f. When the laser is turned on after being turned off by action of the safety device g. When MASK is newly set or the previously set mask position is changed or cleared h. When the set value of averaging count limit is changed in which case the changed value is smaller than the hitherto counted averaging count/time i. When the sweep mode is changed j. When the output power is changed k. When the [INITIAL] key is pressed (2) OFF The key switch lamp goes out. New waveforms are displayed on the screen for each sweep.
17	λ-SELECT	Changes wavelength. Only when the wavelength-switchable unit is installed, the λ-SELECT lamp lights to indicate this key is effective.
18	(Plug-in memory card)	This slot is provided for the insertion of a plug-in memory card (PMC) as external storage media. The BUSY lamp located at the right side of this slot lights when the PMC inserted in this slot is being accessed for a read or write.
19	POWER	Turns the power on or off. When the key is depressed, the ON lamp lights indicating that the power is turned on.
20	INITIALIZE	Initializes the measurement conditions and screen display. However, when the MW9040B is in REMOTE, mode, pressing the key is ignored. See paragraph 5.20 for details on which items are initialized.

Table 3-1 Description of Operation Keys (5/5)

(Continued)

No.	Name	Description
21	(Fan)	Used to discharge the internally generated heat to the outside. Be careful not to block the exhaust opening while the MW9040B is in operation.
22	VIDEO OUTPUT	This connector outputs the screen or record waveform signals to an external video plotter.
23	GP-IB	A GP-IB interface board. This board is fitted in SLOT0. For details on how to insert and remove the board, refer to paragraph 2.3.2 in this manual.
24	(Optional I/O slot)	This slot is provided for fitting another GP-IB interface board. For details on how to insert and remove the board, refer to paragraph 2.3.2 in this manual.
25	– –	AC power inlet and fuse holder.
26	– –	Frame gound terminal.
27	(Unit lock mechanism)	This mechanism prevents the plug-in unit from being accidentally removed. After fitting a plug-in unit, slide the unit lock mechanism to the left and fasten the screw.
28	(Lock knob)	Used to lock the plug-in unit inserted from the rear of the frame. Turn the knob counterclockwise to unlock it, and the plug-in unit can be pulled out of place.
29	– –	Power cord reel.
30	(Carrying handle)	Used to carry the MW9040B. A round knob is provided in the handle fitting section. Push it inside from left and right sides, and the handle can be turned. Therefore, the handle can be used as a stand by fixing it at an appropriate angle.

(Blank)

SECTION 4
BASIC METHOD OF OPERATION

This section describes the basic operations such as distance range and pulse width settings which are performed in common in each measurement. This section also outlines the screen display information necessary for measurement, and circuitry to facilitate your understanding of their basic operation.

4.1 Power-on

The power is turned on and the ON lamp lights when you depress the POWER switch. When you press the switch a second time and the switch button protrudes, the power is turned off. All front-panel lamps light immediately after power-on; after the selftest completed, the equipment returns to the key state of the immediately preceding power-on time.

Notes: 1. When the result of the selftest is NG (no good), the MW9040B can not be used. It is necessary to repair.

2. When the power turned off, the measurement condition immediately before power-off is backed-up.
   However, when turned off during or immediately after changing of the measurement condition, sometimes the condition is not backed-up and initialized. (See paragraph 5.20 "[INITIALIZE] key".)

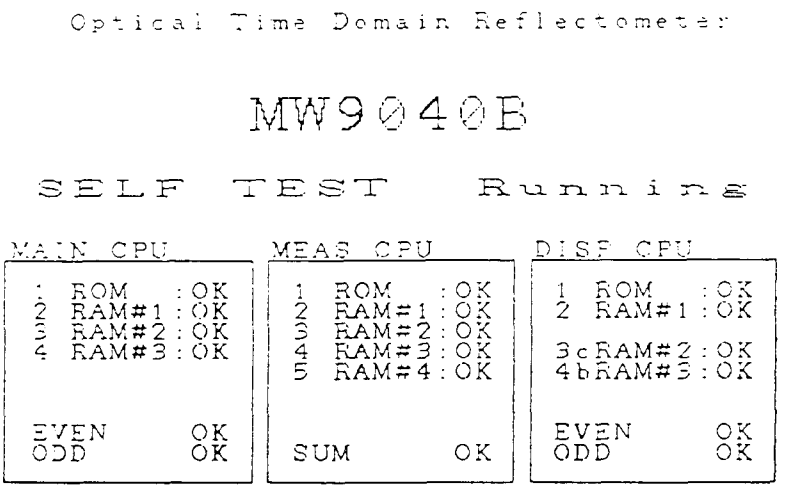


Fig. 4-1 Self-test Screen

4.2 Screen Display

Figure 4-2 shows an example of screen display. The table below lists the names of the displayed items in relation to the numbers in the diagram.

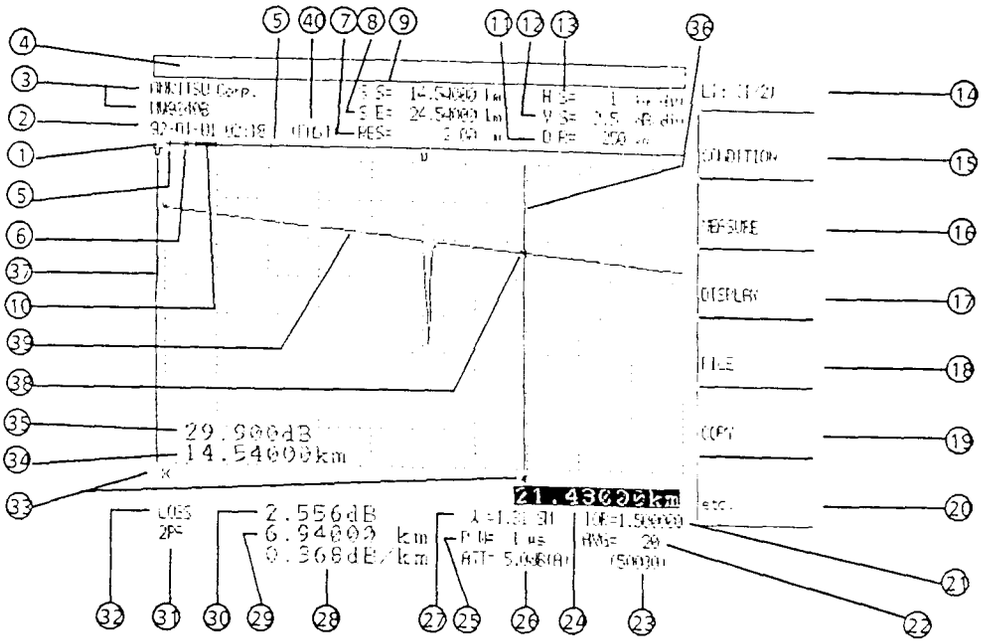


Fig. 4-2 Example of Screen Display

① Mask marker
② Indicates date and time
③ Title display area
④ Message display area
⑤ Markers indicating the sampling range
⑥ Marker set off the screen
⑦ Indicates distance resolution
⑧ End position of data sampling
⑨ Start position of data sampling
⑩ Thick line indicating the horizontal axis display range
⑪ Distance range
⑫ Vertical axis scale
⑬ Horizontal axis scale
⑭ Soft-key label and layer
⑮ to ⑳ Soft-key display areas
㉑ Set value of refractive index
㉒ Averaging count/time in progress
㉓ Set values of averaging count/time
㉔ Distance from output connector to cursor line
㉕ Set value of pulse width
㉖ Set value of attenuator (A) is added in AUTO mode
㉗ Wavelength and type of fiber-optic cable
㉘ Loss per unit length between X marker and ✻ marker
㉙ Distance between X marker and ✻ marker
㉚ Loss between X marker and ✻ marker
㉛ Linear approximation method (LSA/2PA)
㉜ Indication that the mode is LOSS. Indicated as SPLICE/R. LOSS when in SPLICE/RETURN LOSS mode, respectively
㉝ Positions of X marker and ✻ marker
㉞ Shift value of horizontal axis
㉟ Shift value of vertical axis
㊱ Cursor line
㊲ Thick line indicating the vertical axis display range
㊳ ✻ marker on waveform
㊴ Measurement waveform
㊵ Indicates when the sweep mode is FAST

Figure 4-3 schematically shows a general measurement waveform that is displayed on the screen when measuring optical fiber with the Optical Time Domain Reflectometer.

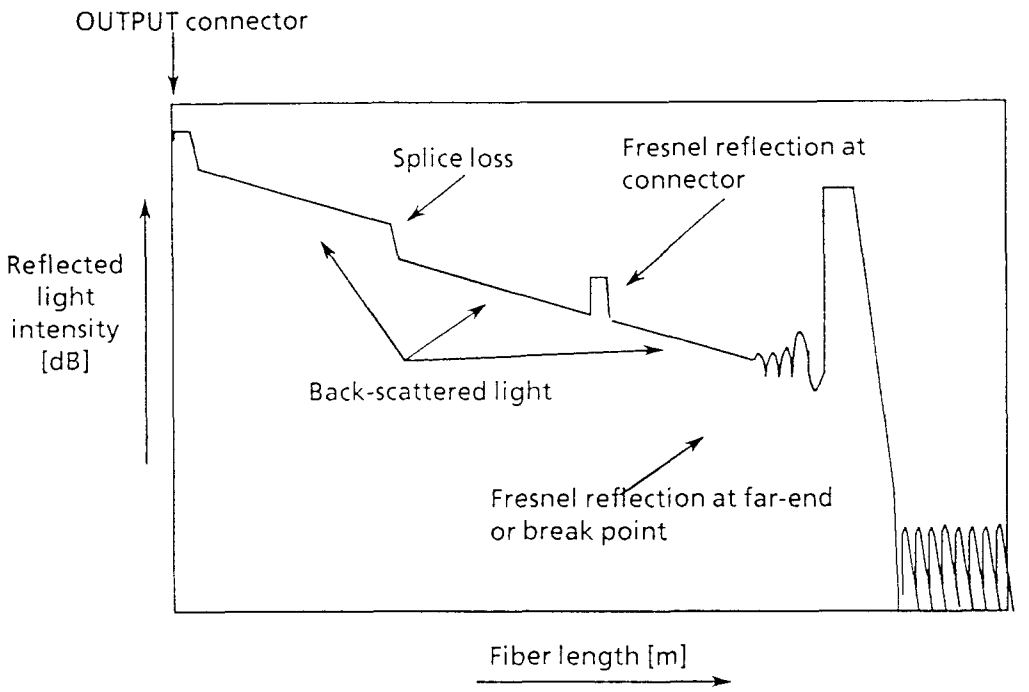


Fig. 4-3 General Measurement Waveform

The horizontal axis indicates distance, that is, fiber length. The vertical axis indicates the stength of reflected light. The back scattered light represents the characteristics of the optical fiber, and the inclination matches with transmission loss. For example, if the optica fiber has low-loss, consistent characteristics, the waveform should show a smooth linear line with a moderate inclination relative to the horizontal axis.

If the optical fiber has a break or connector-fitted point, Fresnel reflection is generated. The Fresnel reflection at the far left is caused by connection between the OUTPUT connector and fiber to be measured. When a fusion-connected fiber is observed, a stepwise difference (splice loss) results in place of the fusion-connected point without Fresnel reflection of a break-point. The magnitude of this step difference indicates the magnitude of splice loss.

4.3 Basic Operation

4.3.1 Items of basic operation

The operations necessary to set or select each item described below are the basic operations common in each measurement with the MW9040B. Set each item to the optimum value before starting measurement. Once set, the values are internally retained even when the power is turned off unless pressing the [INITIALIZE] key.

(1) Setting distance range

Set the distance range after selecting mimimum range among those longer than the length of the fiber to be measured.

(2) Setting pulse width

Select a wide pulse width when measuring long distance; select a narrow pulse width when measuring short distance. The distance that can be measured with the Optical Time Domain Reflectometer is determined by the dynamic range and loss in the fiber to be measured. Therefore, select the optimum pulse width by considering loss in the fiber to be measured and the dynamic range of each pulse width.

Note that when the pulse width becomes wider, the effective distance resolution (with which two adjacent fault points can be identified) becomes longer.

(3) Setting attenuator

An attenuator (ATT) is used to optimize the level of the receive system. First, set it for AUTO; then, select an ATT value according to the need.
For some unit, ATT is fixed. (See paragraph 1.5.)

When the AVERAGE is set to ON in ATT AUTO mode, the waveform summary display mode comes on. (See paragraph 5.10)

(4) Selecting wavelength

When using a wavelength switchable plug-in unit (MW0947A), select the LD wavelength according to the measurement wavelength of the fiber to be measured. When using a non-switchable unit, you need not select a wavelength because the wavelength is fixed.

(5) Setting refractive index

Set the refractive index (IOR) of the fiber to be measured. Because the refractive index varies with wavelength, set it for each wavelength when using a switchable plug-in unit.

(6) Selecting unit of distance

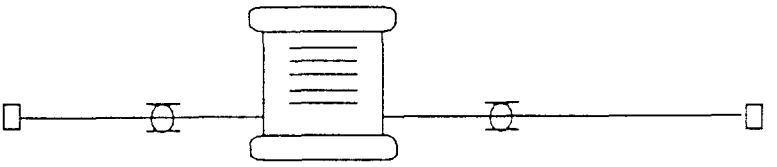
Select meter, foot, or mile. The unit of distance can be set (i.e., changed) for recalled waveforms (which are recalled onto the screen after being saved in memory), as well as for the currently measured waveform.

(7) Laser on

Turn the laser on after confirming that the READY lamp is on. Waveform sweep begins upon laser-on.

4.3.2 Example of basic operation

The following describes the basic operation before starting measurement after laser-on taking measurement of the optical fiber shown below as an example.



The fiber characteristics are as follows:

- Wavelength : 1.31 μm
- Refractive index : 1.482
- Type : Single mode (SM)

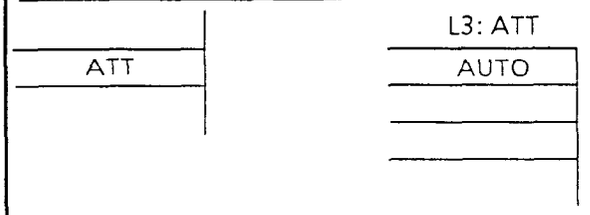
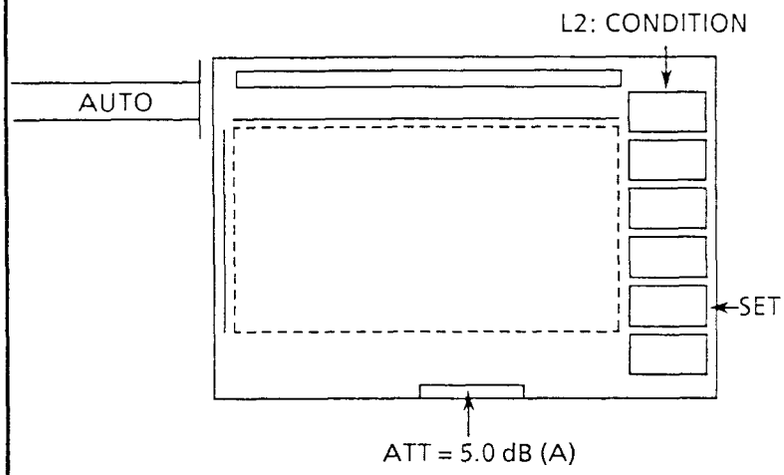
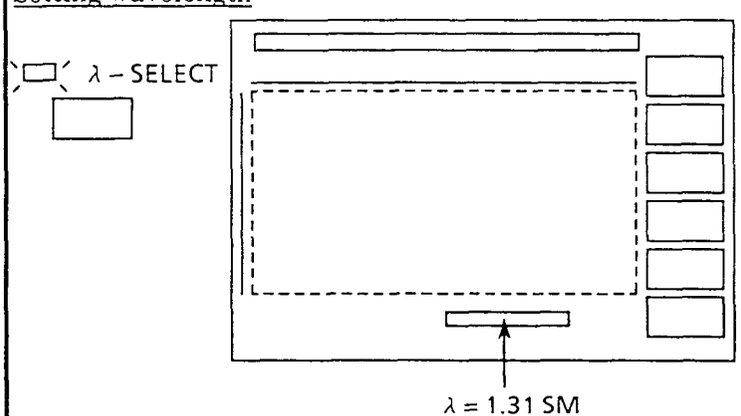
The plug-in unit used is the MW0947A (for 1.31/1.55 μm SM fiber). It is assumed here that this plug-in unit is fitted into the MW9040B main-frame and the equipment is in a power-on state.

Key operation	Screen display	Description
PRIOR	L1: (1/2) CONDITION MEASURE ⋮	The soft key is brought to the first layer.
CONDITION	L2: CONDITION DISTANCE ⋮	The soft key is brought to the CONDITION layer.

(Continued)

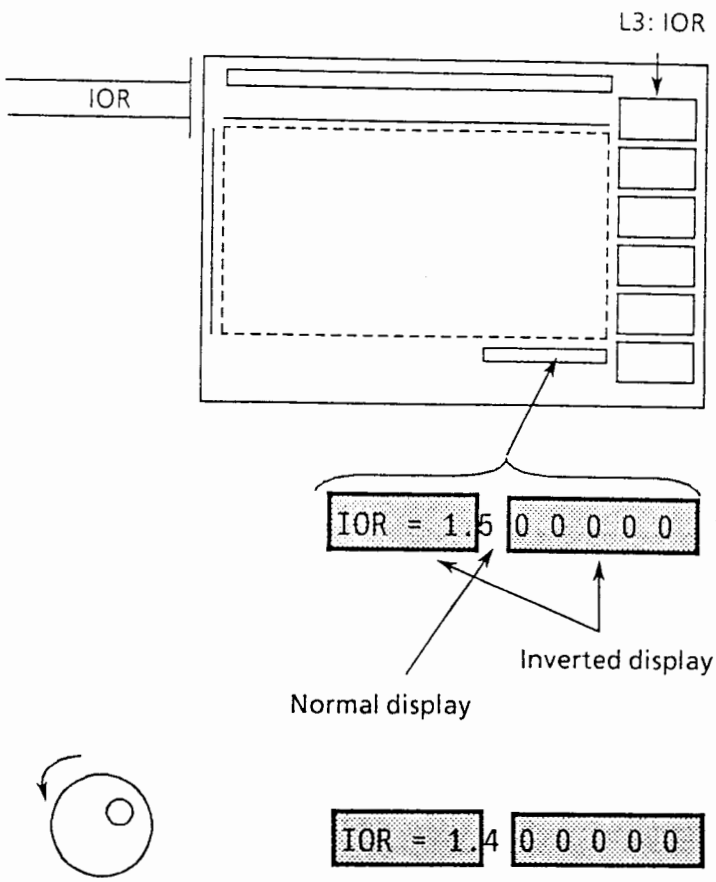
Key operation	Screen display	Description
Setting distance range DISTANCE	L3: DISTANCE 10 km 25 km ⋮	The soft key is brought to DISTANCE layer.
10 km	DR = 10 km L2: CONDITION	The display on the scale becomes DR = 10 km. The soft key returns to the CONDITION layer.
Setting pulse width PULSE	L3: PULSE →100 ns 1 μs ⋮	The soft key is brought to the PULSE layer.
100 ns	L2: CONDITION PW = 100 ns	The dispaly below the scale becomes PW = 100 ns. The soft key returns to the CONDITION layer.

(Continued)

Key operation	Screen display	Description
Setting attenuator (AUTO)		
		The soft key is brought to the ATT layer. The ATT display below the scale becomes reversed. ***Note:*** For some plug-in unit, the ATT is disabled fixed.
		The A (to the right of the attenuator set value under the scale) indicates that the attenuator is in AUTO mode. The soft key returns to the CONDITION layer. When the ATT is set by manual mode, the ATT level is adjusted by the rotary knob, then the SET soft key is pressed. ***Note:*** When returned to the CONDITION layer by pressing [PRIOR], [MARKER], [V-SHIFT], or [H-SHIFT] without [SET]. ATT set value returns to the preveous value before entering the ATT layer.
Setting wavelength		
		If the current wavelength setting is 1.55 μm, $\lambda = 1.31$ SM will be displayed below the scale. If the wavelength setting is 1.31 μm, the display changes to $\lambda = 1.55$ SM. The soft key returns to the first layer.

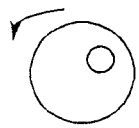
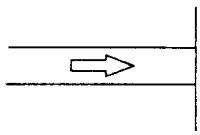
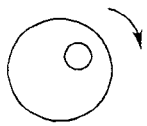
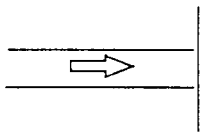
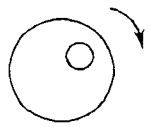
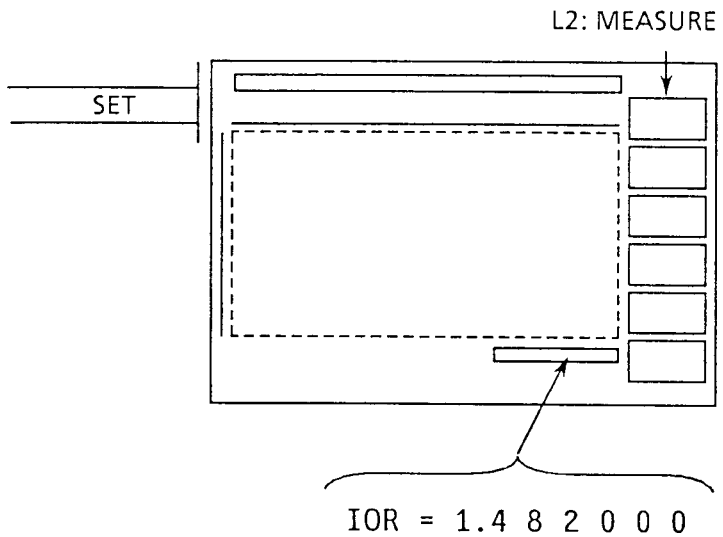
(Continued)

Key operation	Screen display	Description
Setting refractive index		
PRIOR	L1: CONDITION MEASURE ⋮	The soft key returns to the first layer.
MEASURE	L2: MEASURE LSA / 2PA THRESHOLD AVG. LIMIT IOR ⋮	The soft key is brought to the MEASURE layer.
IOR	L3: IOR	The soft key is brought to the IOR layer. The IOR display below the scale is inverted. The digit for which the set value can be changed is not inverted, however.



IOR = 1.4 0 0 0 0 0

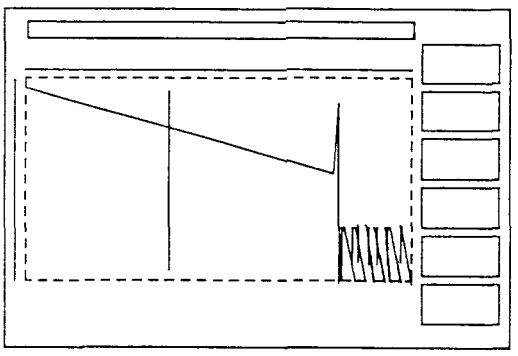
(Continued)

Key operation	Screen display	Description
	IOR = 1.4 0 0 0 0 0	
	IOR = 1.4 0 0 0 0 0	The IOR value in the first decimal place becomes 4. The digit in the second decimal place is selected with its value normally displayed (not inverted).
	IOR = 1.4 8 0 0 0 0	
	IOR = 1.4 8 0 0 0 0	The IOR value in the second decimal place becomes 8. The digit in the third decimal place is selected with its value normally displayed (not inverted).
	IOR = 1.4 8 2 0 0 0	
		IOR = 1.482000 is set, and the soft key returns to the MEASURE layer. ***Note:*** When returned to the MEASURE layer by pressing [PRIOR], [MEASURE], [V-SHIFT], or [H-SHIFT] without [SET]; IOR set value returns to the previous value before entering the IOR layer.

(Continued)

Key operation	Screen display	Description
Setting unit of distance		
PRIOR	L1: (1/2) CONDITION MEASURE ⋮	The soft key returns to the first layer.
DISPLAY	L2: DISPLAY TITLE UNIT ⋮	The soft key is brought to the DISPLAY layer.
UNIT	L3: UNIT METERS FEET MILES ⋮	The soft key is brought to the UNIT layer.
METERS	SS = ○○ m SE = ○○ km RES = ○○ m HS = ○○ km/div DR = ○○ km L2:DISPLAY ○○ km ○○ ○○ dB/km	All displayed distances are changed to the metric unit. The soft key is brought to the DISPLAY layer.

(Continued)

Key operation	Screen display	Description
Laser-on LASER ON OFF		Measurement waveform is displayed in the scale window.

4.4 Basic Circuit Configuration

Figure 4-4 shows the basic circuit configuration of the MW9040B.

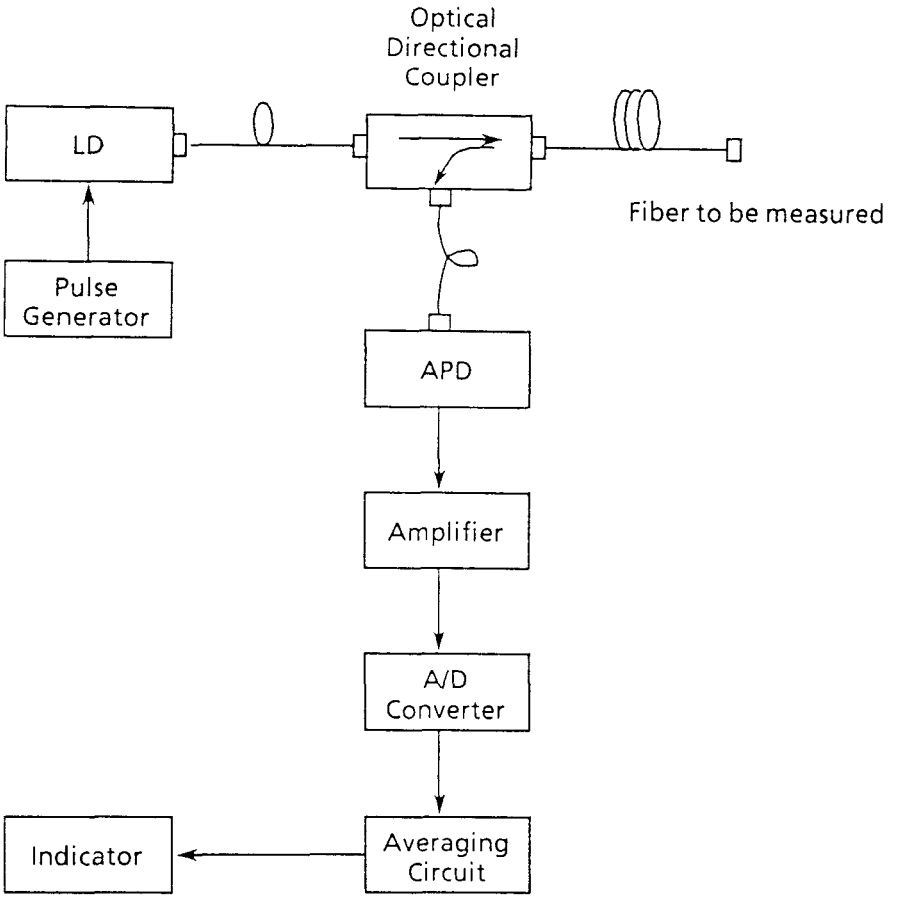


Figure 4-4 Basic Circuit Configuration

The optical pulse from the laser diode (LD) driven by the pulse generator is emitted into fiber to be measured through an optical directional coupler. The back scattered light generated in the measured fiber or Fresnel reflection light generated at a fault location returns to the emission end, and is fed via the optical directional coupler into the avalanche photodiode (APD) where it is converted into an electric signal. This electric signal is sufficiently amplified by an amplifier and then converted into a digital signal by an A/D converter. This signal is further processed by an averaging circuit to improve the S/N ratio before being displayed by an indicator.

SECTION 5
DETAIL METHOD OF OPERATION

This section describes the method of operation in detail using appropriate examples to ensure that the equipment is used to the full extent of its performance capabilities.

5.1 Sampling Range and Resolution

The sampling range and resolution are determined by the horizontal axis scale when one of the following operations is done:

① When the horizontal axis scale is changed while averaging is off

② When averaging is turned off

③ When the sweep mode is changed

④ When the distance range is changed

⑤ When the pulse width is changed

⑥ When the attenuator value is changed

⑦ When the wavelength is switched to another

⑧ When the mask position is changed

⑨ When the output power is changed

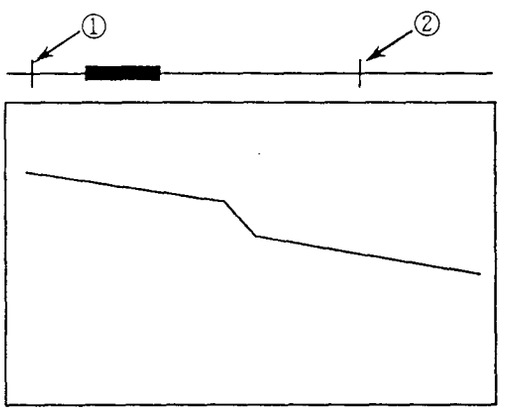
⑩ When the average limit TIME or NUMBER is changed to NUMBER or TIME, respectively.

⑪ When AVE. LIMIT [SET] key is pressed while averaging is on and the hitherto averaged count or time exceeds the set value of the average limit

⑫ When the laser is turned on while averaging is off

⑬ When the [INITIALIZE] key is pressed (in which case, the horizontal axis becomes full scale)

The markers (indicating the sampling-range start and stop points) are displayed on the horizontal bar, as shown below (① and ②).



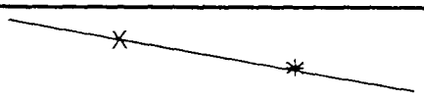
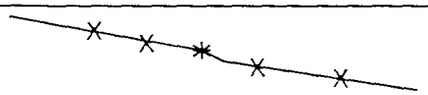
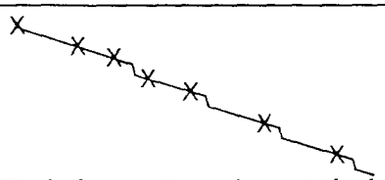
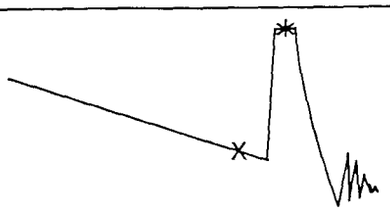
5.2 Selecting Marker and Moving Cursor

After pressing the [MARKER] key and the key lamp coming on, the next marker on the right is selected and the cursor is moved each time this key is pressed while in this state.

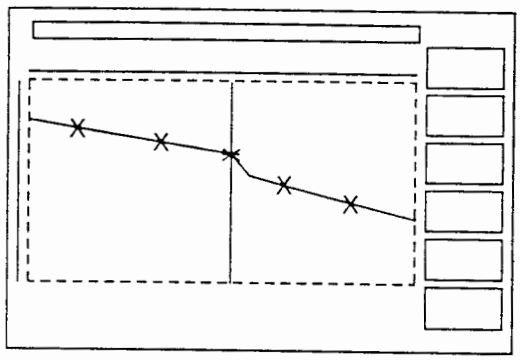
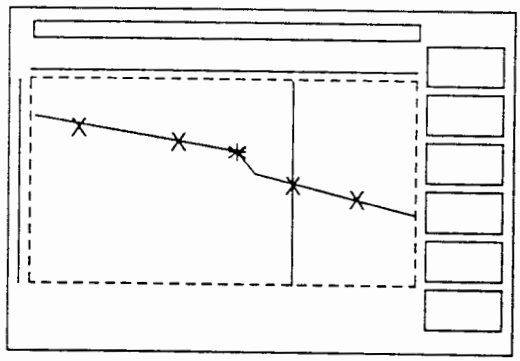
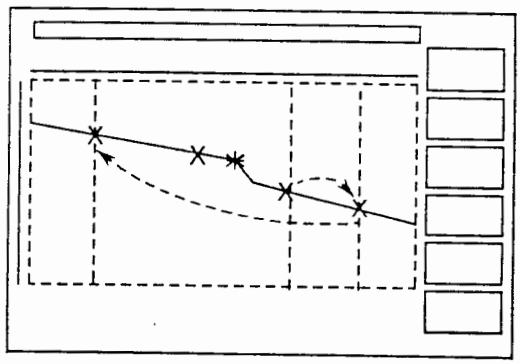
However, if the last selected marker is at the rightmost position, the leftmost marker is selected next. The marker overlapped with the cursor can be moved by turning the rotay knob. However, if the AUTO function is in operation, the marker and cursor cannot be moved with the rotay knob.

There are two kinds of markers: ✻ and X markers. The kind, number, movement and arrangement of markers displayed on the screen vary with each measurement mode as shown below.

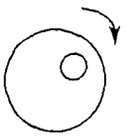
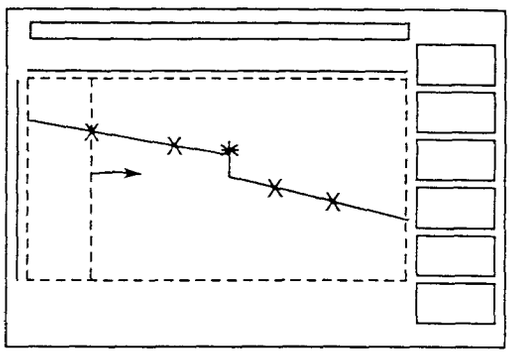
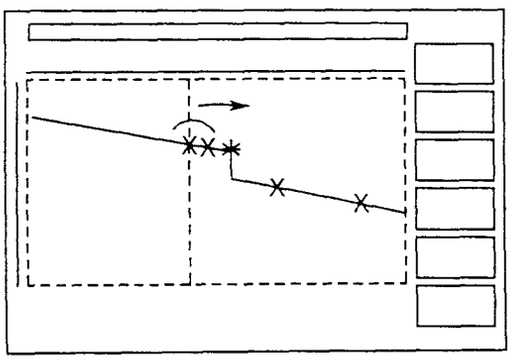
Table 5-1 Kind, Arrangement, Movement and Number of Markers

Measurement mode	Related keys	Kind, arrangement, movement and number of displayed markers
LOSS	SPLICE LOSS	 One X marker and one ✻ marker ***Note:*** × and ✻ move independently.
SPLICE	SPLICE LOSS	 One ✻ marker Four X markers ***Note:*** When the cursor is on the ✻marker, these 5 markers move simultaneously. When the cursor is on the × marker, it moves independently.
AUTO	AUTO	 One ✻ marker at selected fault location Each the two X markers at the left and right of other fault locations and selected fault location (up to 5 fault locations can be searched.) ***Note:*** The rotary knob cannot move the marker.
RETURN LOSS	RETURN LOSS R. LOSS PARA	 One × marker and one ✻ marker ***Note:*** When the cursor is on the ✻ marker, these 2 markers move simultaneously. When the cursor is on the × marker, it moves independently.

5.2.1 Examples of selecting and moving markers

Key operation	Screen display	Description
MARKER		The [MARKER] key lamp lights.
MARKER		When the [MARKER] key is pressed again, the cursor moves to another marker position (in the rightward direction).
MARKER (Pressed twice)		Each time the [MARKER] key is pressed, the cursor cyclically moves along the markers.

(Continued)

Key operation	Screen display	Description
Clockwise 		When the rotary knob is turned clockwise, the marker and cursor move in the rightward direction simultaneously. When turned counterclockwise, the marker and cursor move in the leftward direction.
	– *NOTE* –	
		When a marker comes in contact with the righthand-side marker while moving in the rightward direction, these two markers move together. When the marker moves in the leftward direction next, the righthand-side marker is left in place.

5.2.2 Markers outside scale area

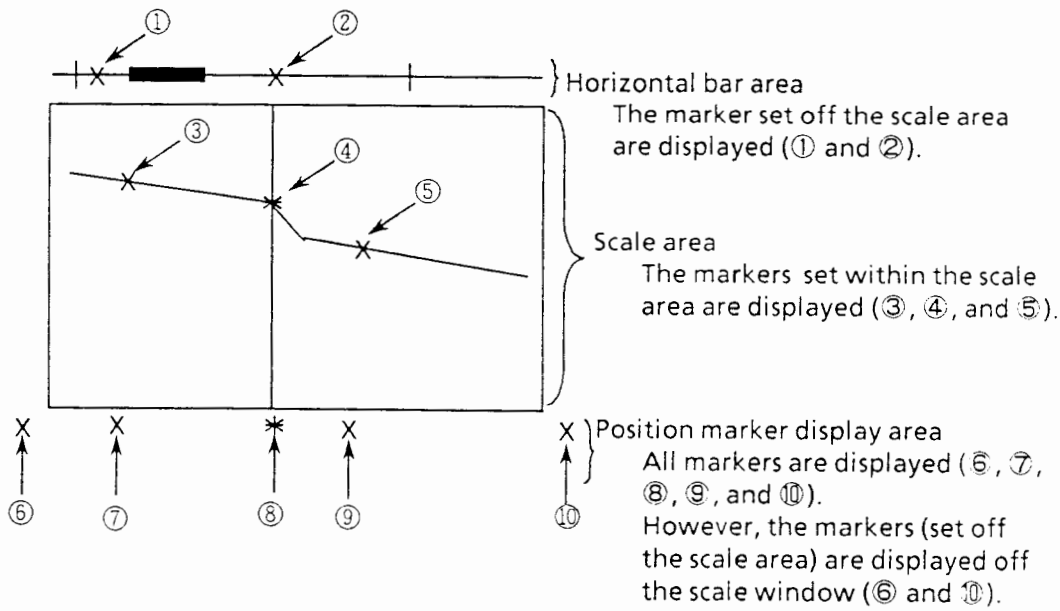
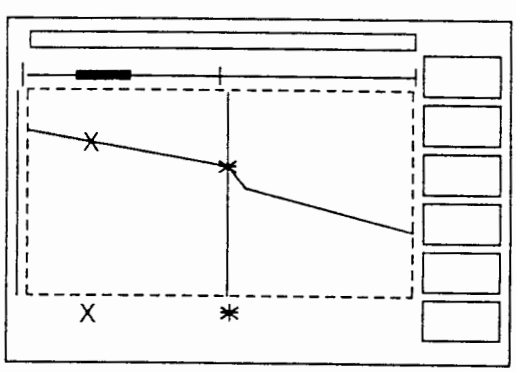
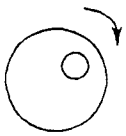
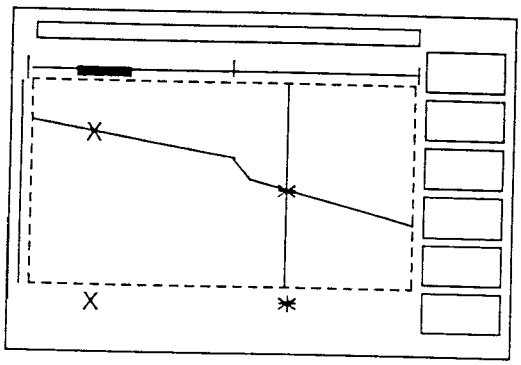
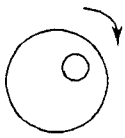
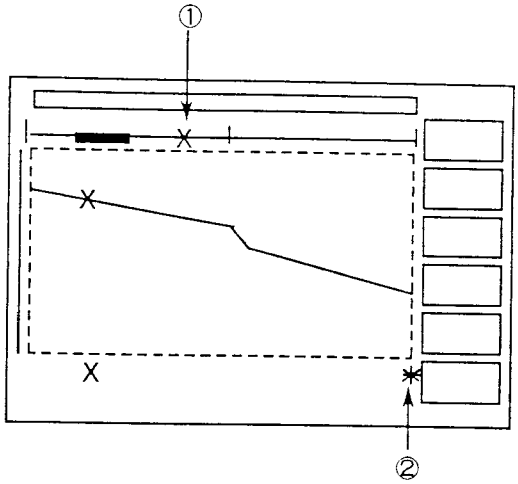


Fig. 5-1 Marker Display Area

Key operation	Screen display	Description
MARKER		Select the * marker.

(Continued)

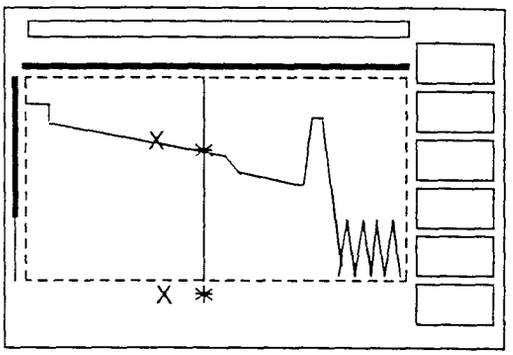
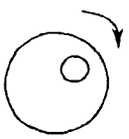
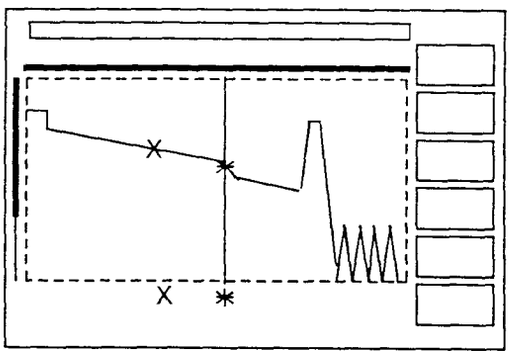
Key operation	Screen display	Description
		Move the * marker.
		Move the * marker off the scale area. The marker appears in the horizontal bar area (①). The * marker disappears from the scale area. The * marker stops at the edge of the position marker display area (②).

5.3 Setting Vertical-Axis and Horizontal-Axis Shifts and Scale

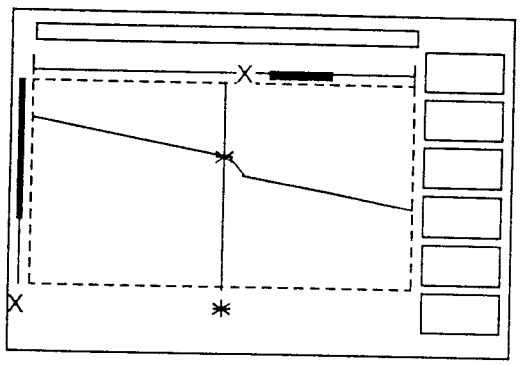
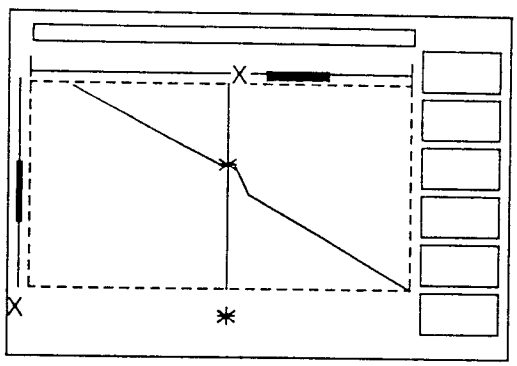
To set the vertical-axis and horizontal-axis shifts, press the [V-SHIFT] and [H-SHIFT] keys and, after confirming that the key lamps are on, turn the rotary knob.

To zoom in or out the vertical and horizontal axes, use the [V-ZOOM] and [H-ZOOM] keys. Each time the keys are pressed, the axes are zoomed in or out with the discrete scale. The waveform (displayed on the screen when pressing the [V-ZOOM] or [H-ZOOM] key) is zoomed in or out around the selected marker (the one overlapped with the cursor) by setting it at the center of the scale area. At this time, if zoomed in while the cursor is positioned at any other marker than the one that not wanted to be zoomed in, the desired waveform may not be observed. (For more details, see paragraph 5.3.2.)

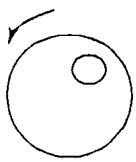
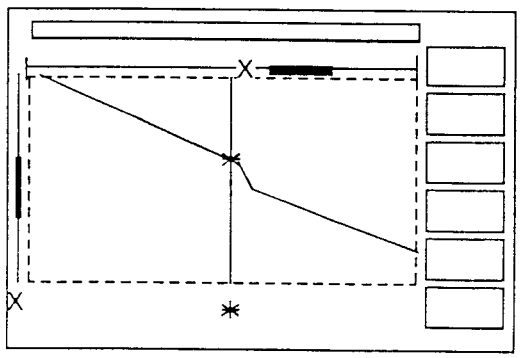
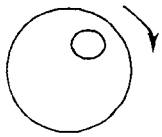
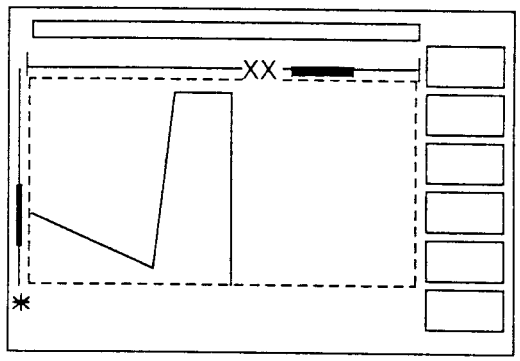
5.3.1 Examples of expanding fault location and shifting vertical/horizontal axes

Key operation	Screen display	Description
MARKER 		Select the * marker.
		Position the marker at the fault location.

(Continued)

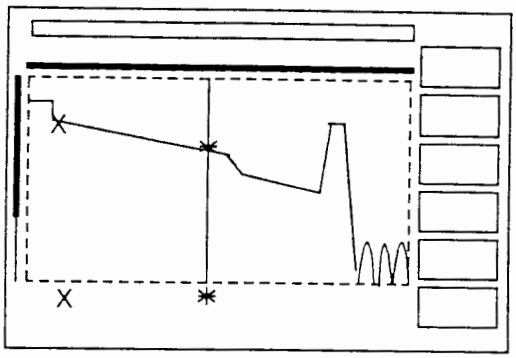
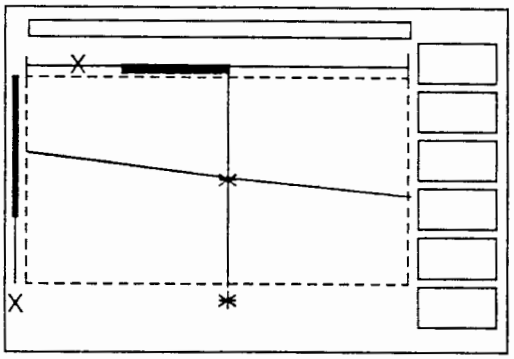
Key operation	Screen display	Description
H-ZOOM IN		The horizontal axis is expanded.
V-ZOOM IN		The vertical axis is expanded.
V-SHIFT	Same as above	The [V-SHIFT] key lamp lights. The MW9040B enters the vertical-axis shift mode.

(Continued)

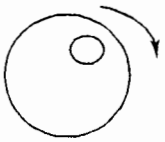
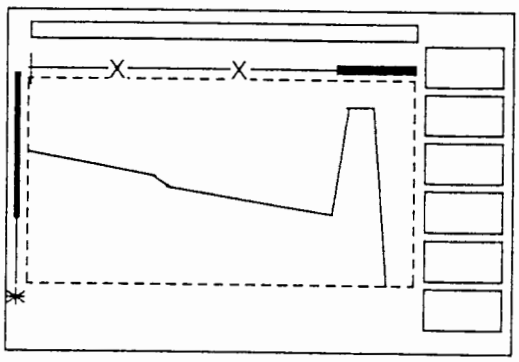
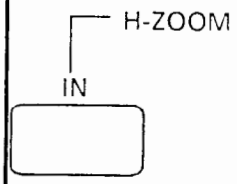
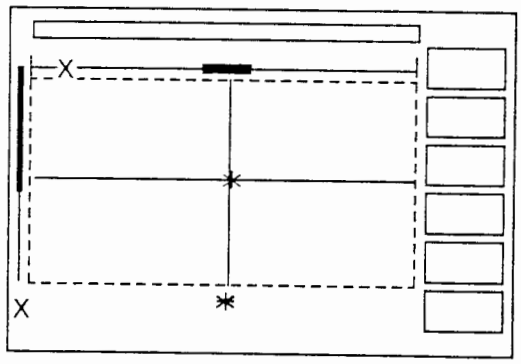
Key operation	Screen display	Description
		The waveform moves in the vertical-axis direction, an enlarged waveform at the fault location can be obserbed.
	Same as above.	The [H-SHIFT] key lamp lights. The MW9040B enters the horizontal- axis shift mode.
		The waveform moves in the horizontal-axis direction, an enlarged waveform of Fresnel reflection can be observed.

5.3.2 Examples of operation failure

Shown here is an example of operation failure that may be encountered when expanding waveforms. Be careful not to commit such error.

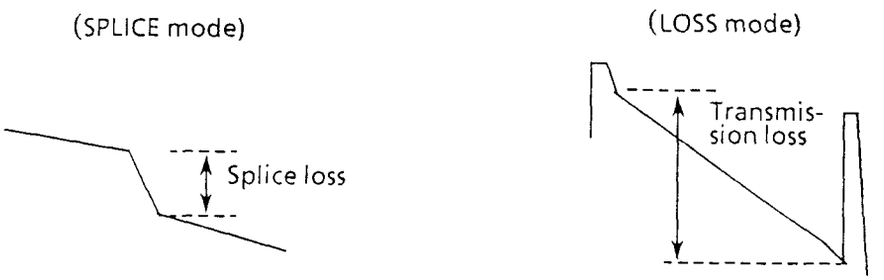
Key operation	Screen display	Description
		The * marker is selected.
H-ZOOM IN		The horizontal axis is expanded entering around the * marker.
H-SHIFT	Same as above.	The [H-SHIFT] key lamp lights. The MW9040B enters the horizontal-axis shift mode.

(Continued)

Key operation	Screen display	Description
		Shift the waveform in the horizontal-axis direction to have the waveform near the fault location displayed on the screen.
		Although attempted to expand a place near the fault location, an entirely different place is expanded. This is because the marker and cursor are not positioned at the place that wanted to be expanded.

5.4 Selecting Measurement Mode (SPLICE/LOSS) and Approximation Method (LSA/2PA)

When measuring loss, use one of the two modes (SPLICE/LOSS) available with the MW9040B according to the purpose.



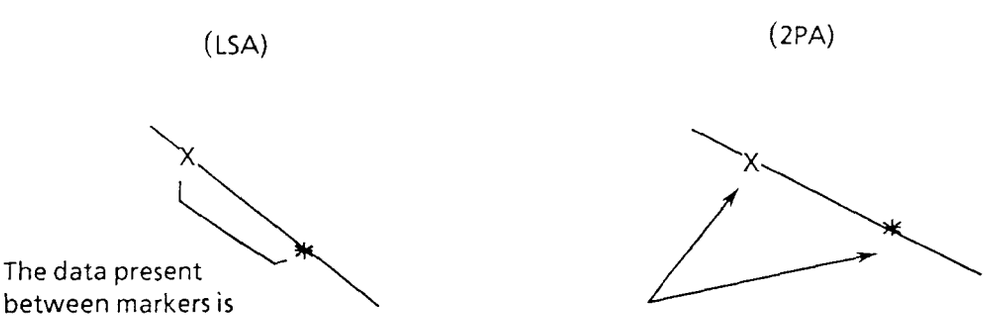
Measure splice loss at the connecting point (connector or fusion connection).

Measure transmission loss between two arbitrary points.

Fig. 5-2 Measurement Modes

Also, two linear approximation methods are provided that can be used according to the purpose when measuring loss.

These include the Least Square Approximation (LSA) and Two Point Approximation (2PA).



The data present between markers is processed by least square approximation.

Only the data at marker set points is used.

Fig. 5-3 Linear Approximation Methods

Figure 5-4 shows the difference in measurement results between the two methods of linear approximation.

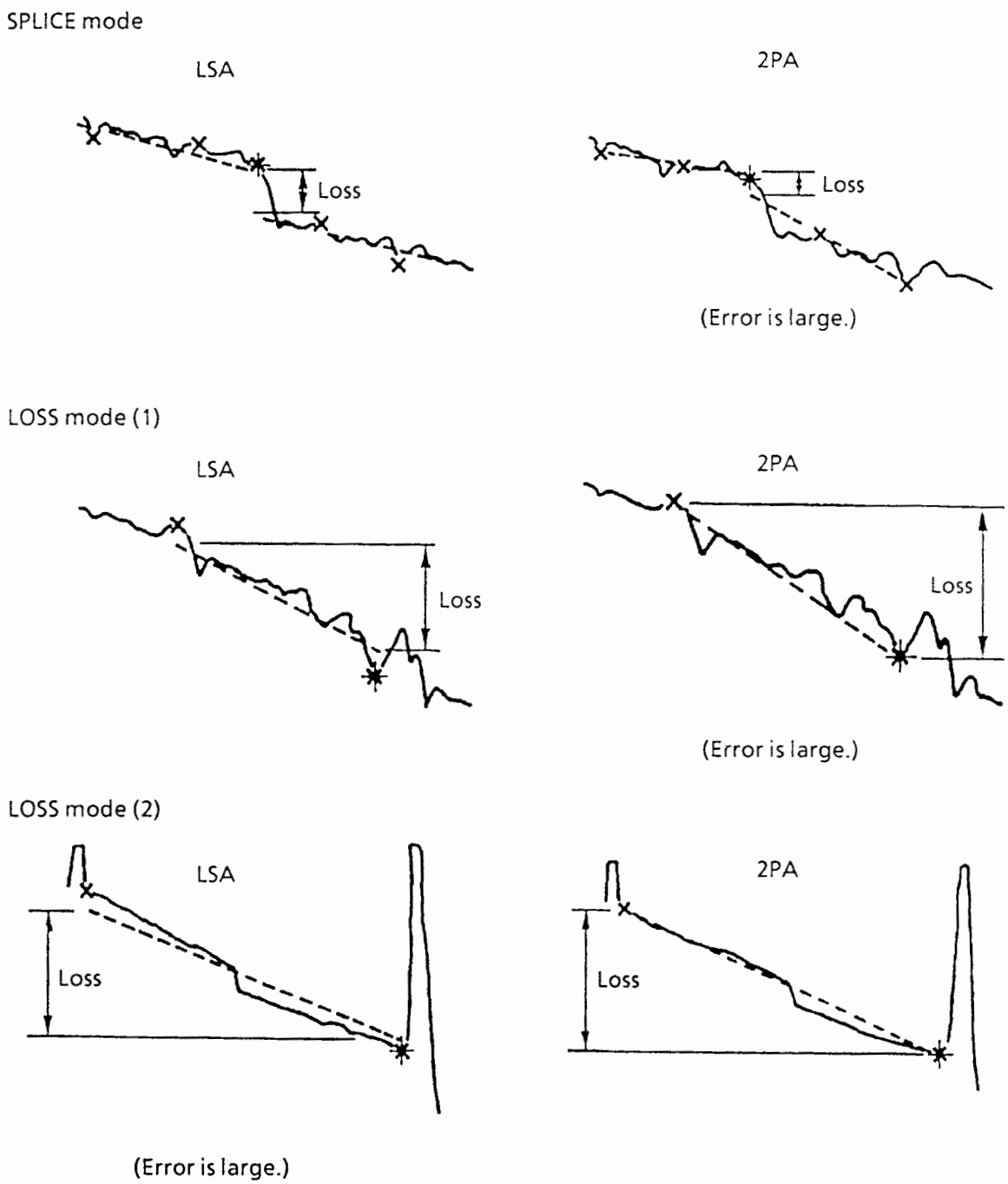
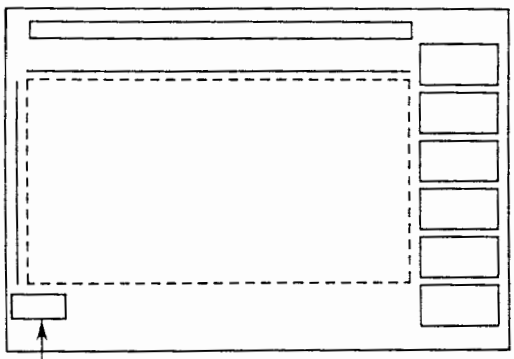
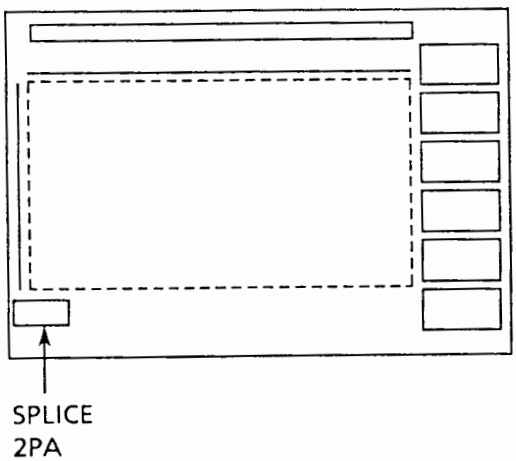


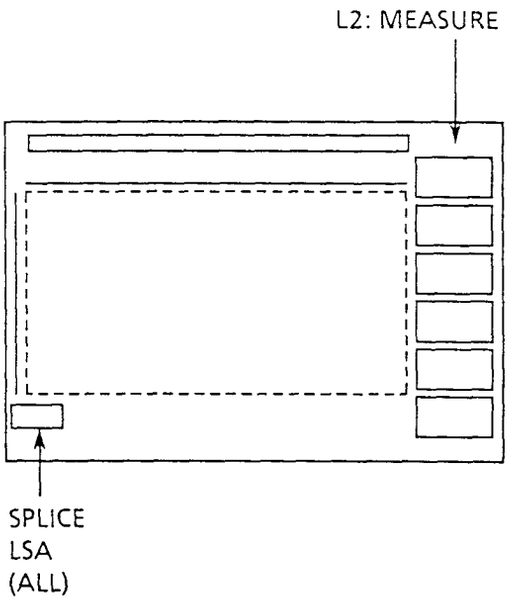
Fig. 5-4 Measurement Modes vs. Approximation Methods

The LSA method comes in two types: ALL and DISP. The LSA (ALL) method executes the LSA processing using all measured data including those not displayed on the screen. The LSA (DISP) method executes the LSA processing using only the data displayed on the screen. The LSA (ALL) method takes a longer time to process data than LSA (DISP), but it does approximation with fewer errors.

5.4.1 Example of setting when measuring splice loss with LSA

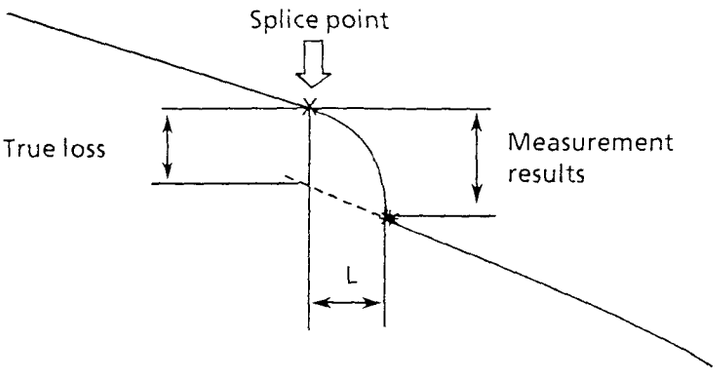
Key operation	Screen display	Description
		
SPLICE LOSS		The SPLICE lamp lights.
PRIOR	L1: (1/2) CONDITION MEASURE ⋮	The soft key is brought to the first layer.

(Continued)

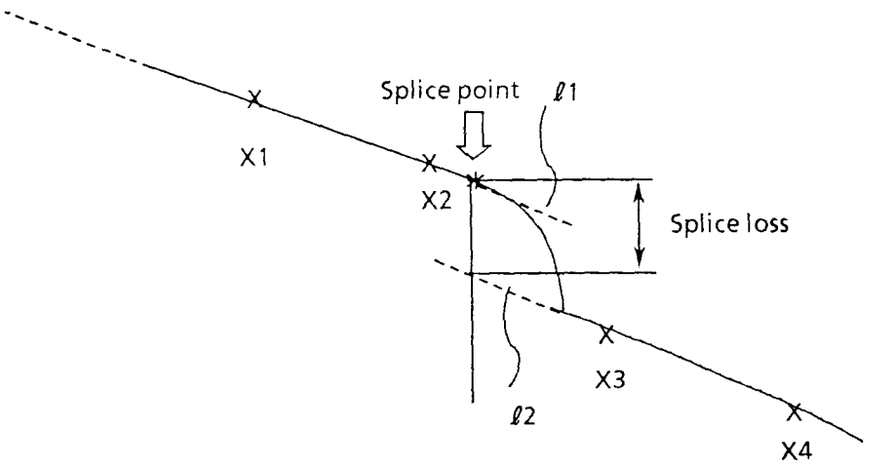
Key operation	Screen display	Description
MEASURE	L2: MEASURE LSA/2PA THRESHOLD ⋮	The soft key is brought to the MEASURE layer.
LSA/2PA	L3: LSA/2PA LSA(ALL) LSA (DISP) 2PA ⋮	The soft key is brought to the LSA/2PA layer.
LSA (ALL)		The screen display changes from 2PA to LSA (ALL). The soft key returns to the MEASURE layer.

5.4.2 Principle of splice measurement

At a splice point, there is a section (indicated by L in the diagram below) where back scattered light cannot be detected. (The distance varies with the pulse width). When measurement is made in LOSS mode (measurement between two points), loss in section L is not taken into account and accuracy is reduced accordingly.



The following shows the method of calculation in SPLICE mode. Approximated line $\ell 1$ of the fiber before the splice point is obtained from X1 and X2 markers; approximated line $\ell 2$ of the fiber after the splice point (except section L where back scattered light cannot be detected) is obtained from X3 and X4 markers. Loss at the splice point (* marker) is calculated from $\ell 1$ and $\ell 2$.



5.4.3 Approximated line by LSA

Least Square Approximation (LSA) is a method where all data (present between markers) have minimum dispersions relative to the approximated line. Therefore, this method is effective in cases when measurement results for an optical fiber (having consistent transmission loss) contain much noise.

As shown to the right, $\ell \equiv y = a + bx$ is assigned for n pieces of points (x1, y1), (x2, y2), ... , (xn, yn), and deviation $\delta 1$ from ℓ is calculated for each point. Then, parameters a and b are obtained that minimize the sum E of the square of these deviations.

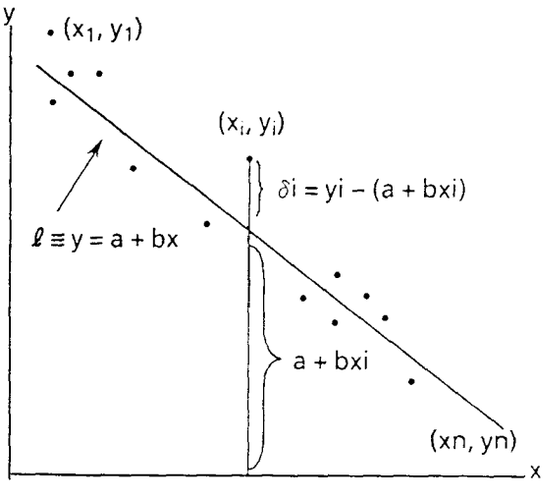


Fig. 5-5 Data and Approximated Line

$$E = \sum_{i=1}^{n} \delta_i^2 = (y1 - a - bx1)^2 + (y2 - a - bx2)^2 + \cdots\cdots\cdots + (yn - a - bxn)^2$$

From this equation,

$\frac{E}{a} = 0$ and $\frac{E}{b} = 0$ are the necessary and sufficient conditions for E to be minimum and smallest.

By solving this, the next equations are obtained.

$$a = \frac{\bar{y}\sum_{i=1}^{n} (xi)^2 - \bar{x}\sum_{i=1}^{n} (xi\, yi)}{\sum_{i=1}^{n} (xi)^2 - n(\bar{x})^2}$$

$$b = \frac{\sum_{i=1}^{n} (xi\, yi) - n\bar{x}\bar{y}}{\sum_{i=1}^{n} (xi)^2 - n(\bar{x})^2}$$

Where,

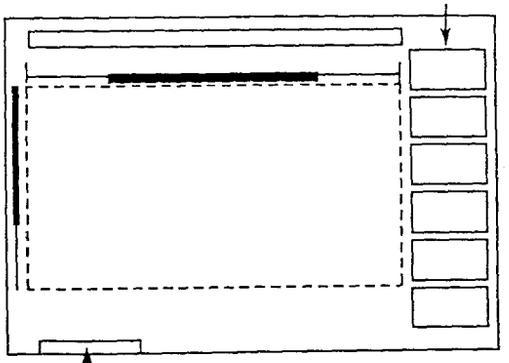
$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} (xi)\ ,\ \bar{y} = \frac{1}{n}\sum_{i=1}^{n} (yi)$$

From the above, the approximated line closest to n pieces of points, that is, y = a + bx can be obtained.

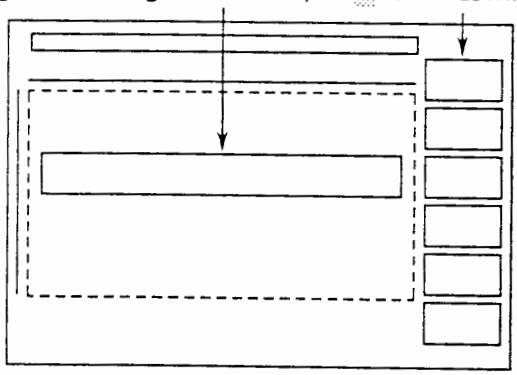
5.5 Return Loss (Reflection Factor) Measurement Mode

The return loss (reflection factor) is computed from the Fresnel reflection at the connector and the amount of immediate back scattered light it produces, and the measured results are displayed. Press the [RETURN LOSS] key or the [R. LOSS PARA] key in the MEASURE layer to enter Return Loss Mode.

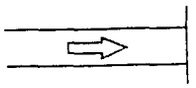
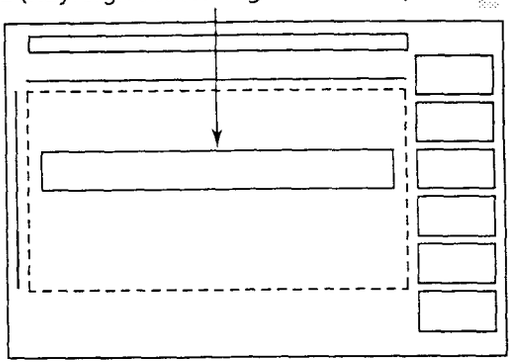
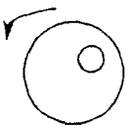
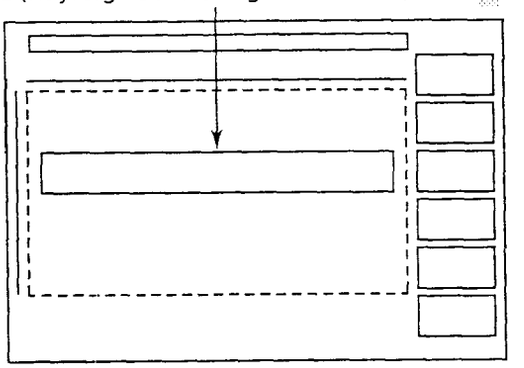
5.5.1 Setting return loss mode

Key operation	Screen display	Description
PRIOR	L1: (1/2) CONDITION MEASURE DISPLAY ⋮	The soft key is brought to the first layer.
MEASURE	L2: MEASURE LSA/2PA THRESHOLD ⋮	The soft key is brought to the MEASURE layer.
RETURN LOSS	L2: MEASURE  R. LOSS ○○ dB	Return Loss Measurement Mode is activated and the result is displayed on the lower left of the screen. ***Note:*** The parameters of the fiber should be set correctly in the R. LOSS-PARA layer.

5.5.2 Setting the fiber parameters for return loss measurements

Key operation	Screen display	Description
PRIOR	L1: (1/2) CONDITION MEASURE DISPLAY ⋮	The soft key is brought to the first layer.
MEASURE	L2: MEASURE LSA/2PA THRESHOLD ⋮	The soft key is brought to the MEASURE layer.
R. LOSS PARA	RSL (Rayleigh Scattering Loss:dB/km) = 0.400 L3:R. LOSS-PARA 	The screen display changes to the parameter setting screen for return loss measurements. (The first character position of the rayleigh scattering loss parameter (RSL) displayed on the screen is reversed.)

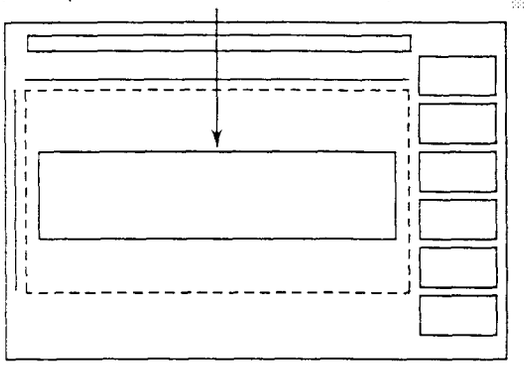
(Continued)

Key operation	Screen display	Description
	RSL (Rayleigh Scattering Loss:dB/km) = 0.400 	Use the arrow [→] key to select the digit to be changed.
	RSL (Rayleigh Scattering Loss:dB/km) = 0.300 	Change the setting with the rotary knob.
	(Use the arrow key and the rotary knob to change the settings. The display will be as shown below.)	

(Continued)

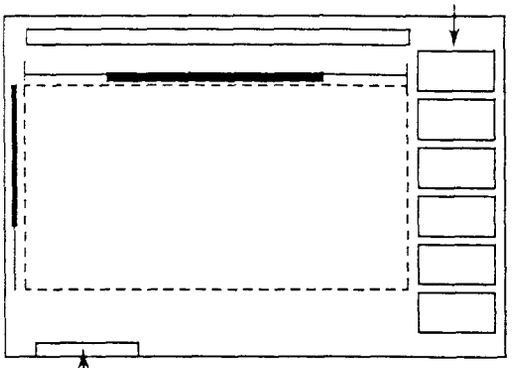
Key operation	Screen display	Description

RSL (Rayleigh Scattering Loss:dB/km) = 0.350
N1 (Refractive Index of Core) = 1.4666
N2 (Refractive Index of Clad) = 1.4616
Ne (Group Refractive Index of Fiber) = 1.4655



L2: MEASURE

SET



R. LOSS ○○ dB

Sets the fiber parameters.
The soft key returns to the MEASURE layer.

Note: When returned to MEASURE layer by pressing [PRIOR] without [SET], the parameter setting returns to the preveous state before entering the R. LOSS-PARA layer.

Parameter Ranges

RSL :0.005 to 9.999
N1 :1.0000 to 1.9999
N2 :1.0000 to 1.9999
Ne :1.0000 to 1.9999
BSL : −00.000 to −99.999

1. When the values for RSL, N1, N2, and Ne are entered, the BSL will be displayed as ***. ***. The BSL is automatically computed and the result is displayed. If the BSL value cannot be computed correctly, error occurs.
2. When the BSL value is entered;RSL, N1, N2, and Ne will be displayed as *. ****.
3. When the pulse width setting is changed, the BSL value will be automatically recomputed.

5.5.3 Computing return loss

Return loss is computed as follows:

$$\text{R. LOSS (dB)} = -(10\log_{10}\text{bsl} + 10\log_{10}(10^{L/5} - 1))$$

$$\text{bsl} = S \cdot \alpha_R \cdot V \cdot \frac{W}{2}$$

$$S = K \cdot \frac{N1^2 - N2^2}{N1^2}$$

$$V = \frac{C}{N_e}$$

$$\alpha_R\,(\text{np/m}) = 0.23026 \times 10^{-3} \times \text{RSL}$$

$$K = 0.23\ (\text{SM fiber})$$

$$0.25\ (\text{GI fiber})$$

$$C\,(\text{m/s}) = 3 \times 10^8$$

$$W\,(\text{sec}) = \text{Current pulse-width setting}$$

R. LOSS:Return loss
L:Level difference between X marker and * marker
BSL:$10\log_{10}$ (Back scattered light level)
S:Index of back scattering
α_R:Rayleigh scattering loss (np/m)
RSL:Rayleigh scattering loss (dB/km)
V:Group velocity in the optical fiber
K:Optical fiber constant
N1:Refractive index of the optical fiber's core
N2:Refractive index of the optical fiber's clad
Ne:Effective group refractive index of the optical fiber
C:Speed of Light

The values of these parameters when the [INITIALIZE] key is pressed are provided in paragraph 5.19.

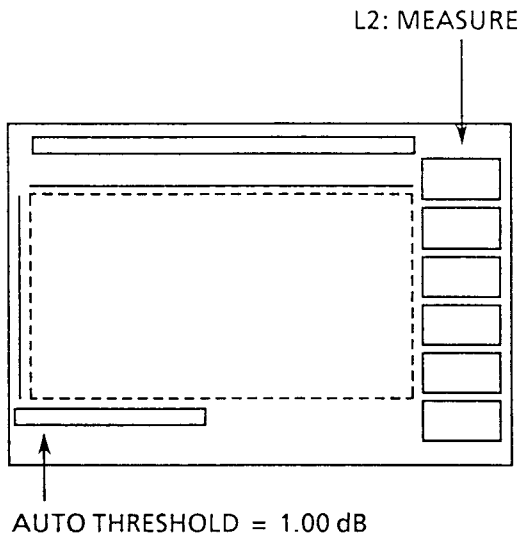
5.6 Setting Detection Level for Auto Fault Location

By pressing the [AUTO] key, it is possible to automatically detect fault locations in the measurement waveform shown on the screen and set markers at points (MAX. 5 points) assumed to be fault locations. The cursor is positioned at the near-end marker point, but sequentially moved toward far-end marker points each time pressing the [MARKER] key.

In auto fault location, the points where loss is greater than the designated value are assumed to be fault locations.

The designated value or detection level can be set to 0.05, 0.10, 0.30, 1.00, 3.00, or 5.00 dB as selected from the THRESHOLD layer of the soft key.

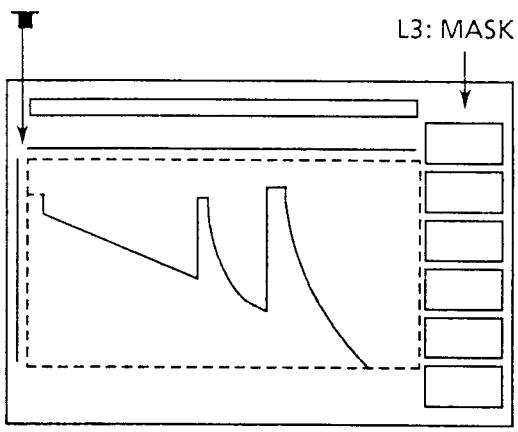
Example of detection level setting is described below.

Key operation	Screen display	Description
PRIOR	L1: CONDITION MEASURE DISPLAY ⋮	The soft key is brought to the first layer.
MEASURE	L2: MEASURE LSA/2PA THRESHOLD ⋮	The soft key is brought to the MEASURE layer.
THRESHOLD	L3: THRESHOLD 0.05 dB 0.10 dB 0.03 dB ⋮	The soft key is brought to the THRESHOLD layer.
1.00 dB		THRESHOLD = 1.00 dB is set. The soft key returns to the MEASURE layer.

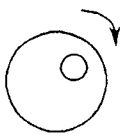
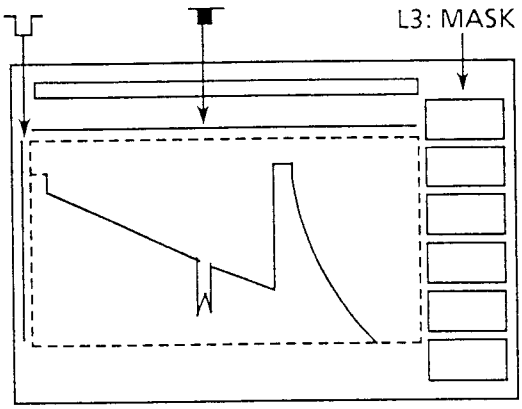
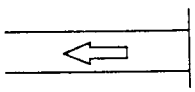
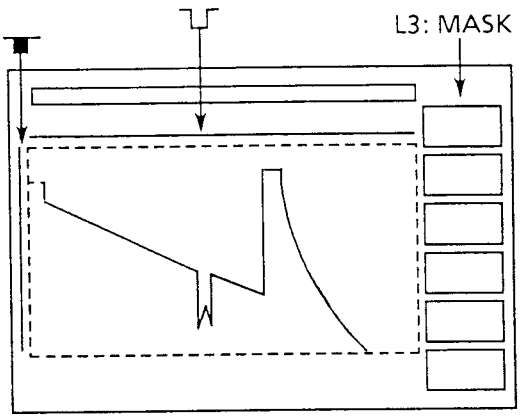
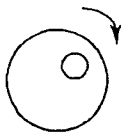
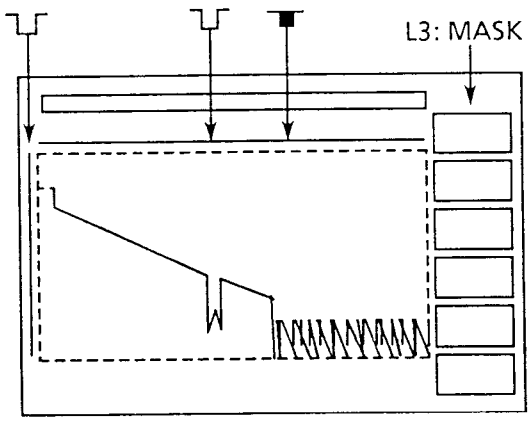
5.7 Setting and Clearing Mask

When the waveform is distorted by large Fresnel reflection, correct measurement cannot be taken. A mask is used to attenuate such Fresnel reflection to improve waveform linearity.

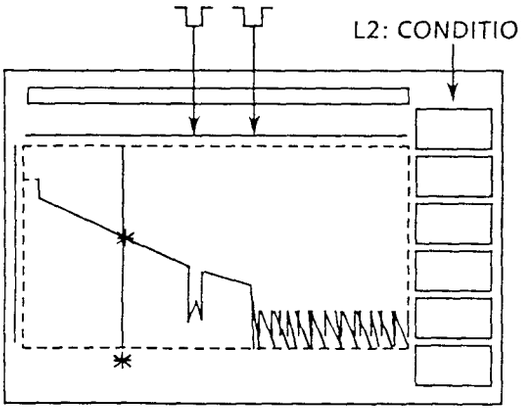
5.7.1 Example of setting mask

Key operation	Screen display	Description
PRIOR	L1: (1/2) CONDITION MEASURE ⋮	The soft key is brought to the first layer.
CONDITION	L2: CONDITION DISTANCE PULSE ATT MASK ⋮	The soft key is brought to the CONDITION layer.
MASK	L3: MASK 	The soft key is brought to the MASK layer. The cursor disappears and a mask marker ( ) is displayed on the upper left of the scale.

(Continued)

Key operation	Screen display	Description
		Fresnel reflection is attenuated as the marker is moved to the first Fresnel reflection point.
		A mask is set and another mask marker is selected. ▮ :Selected (movable) mask marker ⊔ : Unselected (unmovable) mask marker
		Fresnel reflection is attenuated as the mask marker is moved to the second Fresnel reflection point.

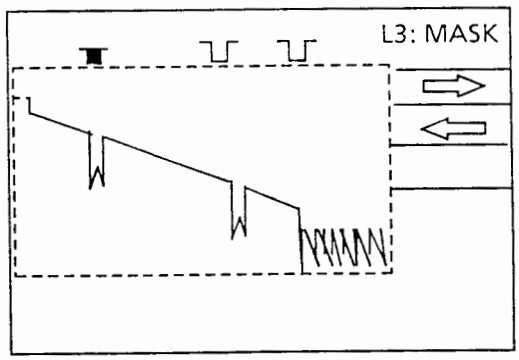
(Continued)

Key operation	Screen display	Description
SET		A mask is set and selected mask markers are none. The cursor is displayed. The soft key returns to the CONDITION layer.

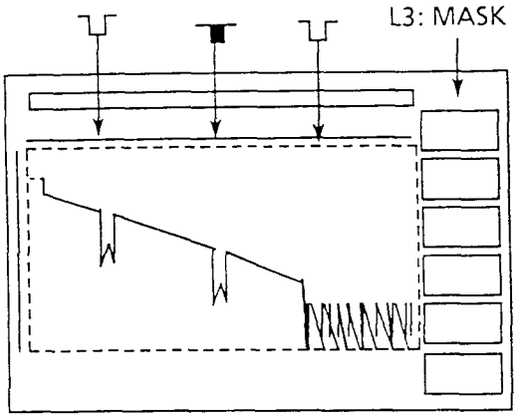
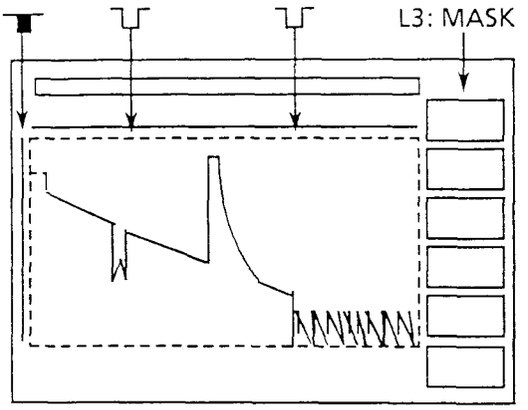
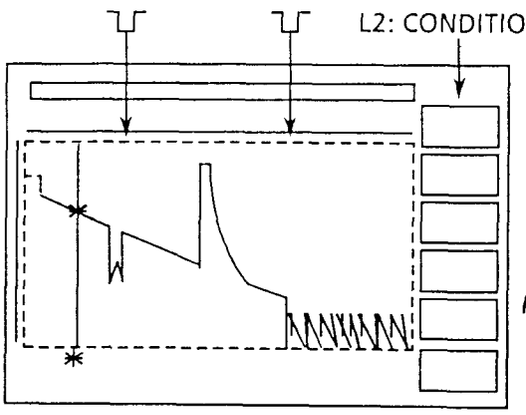
Note: When returned to the CONDITION layer by pressing [PRIOR], [MARKER], [V-SHIFT], or [H-SHIFT] without [SET]; the mask setting returns to the previous state before entering the MASK layer.

5.7.2 Example of clearing mask

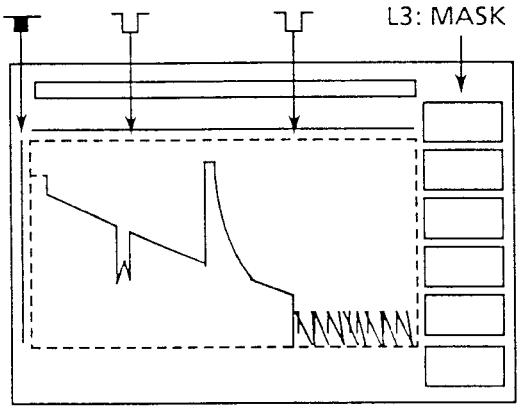
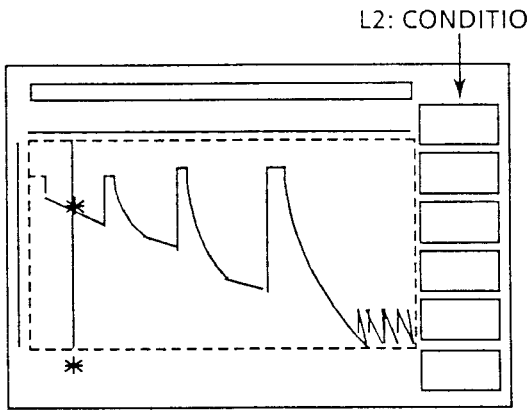
Assume that three masks are set. In this example, clear one of the three masks first and then clear the other two masks by all mask clear operation.

Key operation	Screen display	Description
When clearing one mask		
PRIOR	L1: (1/2) CONDITION MEASURE ⋮	The soft key is brought to the first layer.
CONDITION	L2: CONDITION DISTANCE PULSE ATT MASK ⋮	The soft key is brought to the CONDITION layer.
MASK		The soft key is brought to the MASK layer. The cursor disappears and mask markers are displayed. The mask marker that was last selected in the previous mask setting is indicated by ▀.

(Continued)

Key operation	Screen display	Description
		The mask marker to be cleared is selected by the soft keys [→] and [←].
CLEAR		The selected mask marker is moved to the left edge of the scale. Fresnel reflection waveform appears.
SET		One mask is cleared, and there is no selected mask marker. The cursor is displayed. The soft key returns to the CONDITION layer. ***Note:*** When returned to the CONDITION layer by pressing [PRIOR], [MARKER], [V-SHIFT], or [H-SHIFT] without [SET]; the mask setting returns to the previous state before entering the MASK layer.

(Continued)

Key operation	Screen display	Description
When clearing all masks		
MASK		The soft key is brought to the MASK layer. The cursor disappears and mask markers are displayed. The mask marker that was last selected in the previous mask setting is indicated by ⊓.
ALL CLEAR		All masks are cleared, and the soft key returns to the CONDITION layer. The cursor is displayed.

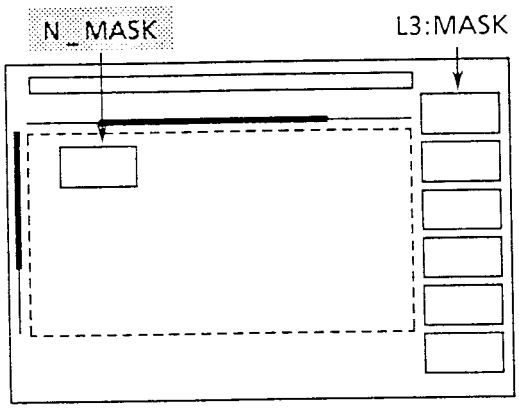
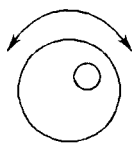
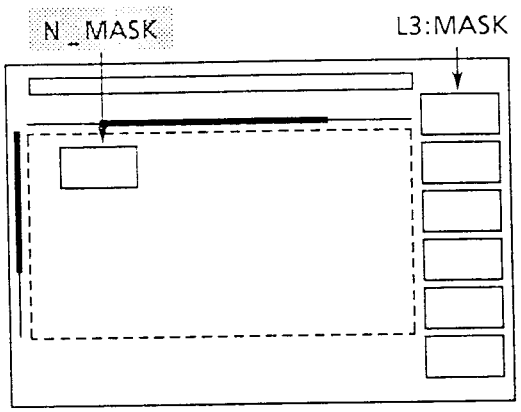
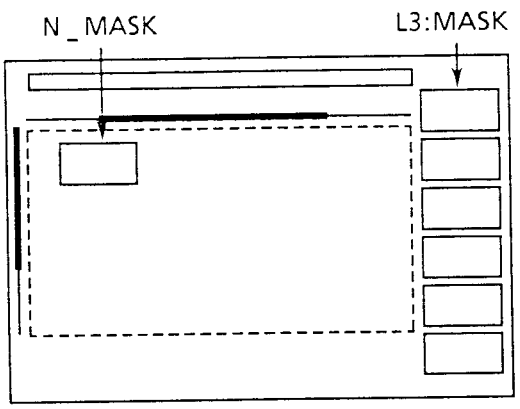
5.8 Varying Near-End Mask Width

When there are plural connecting points between the MW9040B and the fiber to be measured, only one mask can cover from the near-end of the MW9040B to the fiber to be measured by using near-end mask-width variable mode (NEAR END mode). There are no needs to set corresponding plural masks at the points.
In contrast, when a connector with a large return-loss value is used, the near-end dead zone becomes short by narrowing the near-end mask width. Then the fiber can be measured at the nearer end.

Note: Some plug-in unit cannot use this function. (See paragraph 1.5.)

Key operation	Screen display	Description
PRIOR	L1: (1/2) CONDITION MEASURE DISPLAY ⋮	The soft key is brought to the first layer.
CONDITION	L2: CONDITION DISTANCE PULSE ⋮	The soft key is brought to the CONDITION layer.
MASK	L3:MASK	The soft key is brought to the MASK layer. The cursor disappears and mask marker is displayed.

(Continued)

Key operation	Screen display	Description
NEAR END		The near-end mask-width variable mode (NEAR END mode) is set to reverse-display "N _ MASK" on the upper left.
		Set the mask width with the rotary knob. Turn on [COARSE] key to increase the step-change amount of mask width. ***Note:*** When the mask width is changed during averaging ON, the averaging turns OFF. Press [SET] or [PRIOR] to restart the averaging.
SET		Sets the near-end pulse width. "N _ MASK" label is reverse-displayed. The soft key returns to the CONDITION layer. ***Note:*** If returned to the CONDITION layer with the [PRIOR] key without the [SET] key, the near-end mask setting returns to the preveous setting before entering the MASK layer.

- When the [←] key is pressed with the most-left mask marker selected in ordinary mask setting mode, the NEAR END mode is fetched.
- When the [→] key is pressed in the NEAR END mode, the ordinary mask setting mode is fetched.
- When the [CLEAR] key is pressed in the NEAR END mode, the set near-end mask width is returned to the specific value and the ordinary mask setting mode is fetched.
- When the [ALL CLEAR] key is pressed, both the ordinary masks and near-end mask are cleared.
- In NEAR END mode, "N _ MASK" is displayed at the upper left.
- The variable range of the mask width is the specific value − 10 m to + 500 m for IOR = 1.500000.

Note: The mask-width varying function is effective only to the near-end mask. Therefore, when the mask width is varied without a near-end waveform on the screen, the waveform on the screen does not change.

5.9 Averaging

5.9.1 Averaging Start and Limit Value Setting

When the [AVERAGE] key is pressed on, processing is begun for data averaging. The result of noise improvement by averaging is displayed by sweep. The amount of averaging process can be set in terms of frequency (No. of operations) or time. When the preset frequency or time is over, the laser output is automatically switched off and sweep of waveforms is stopped.

Regarding frequency or time for the amount of averaging process to be set, the limit values and setting step are as specified below.

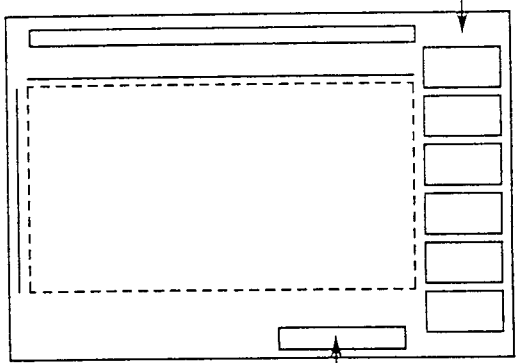
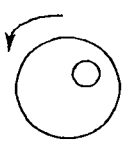
Table 5-2 Setting Items and Limit Values for Averaging

Setting item	Limit value	Setting step
Frequency	50,000 times	10-time step for 0 to 1000 100-time step for 1000 to 5000 500-time step for 5000 to 50000
Time	43,200 seconds	10-second step for 0 to 600 60-second step for 600 to 3600 600-second step for 3600 to 43200

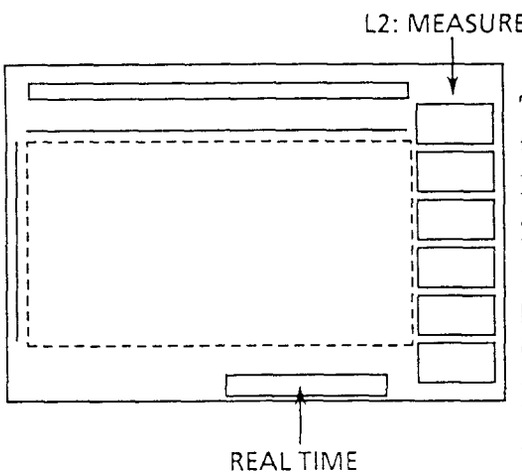
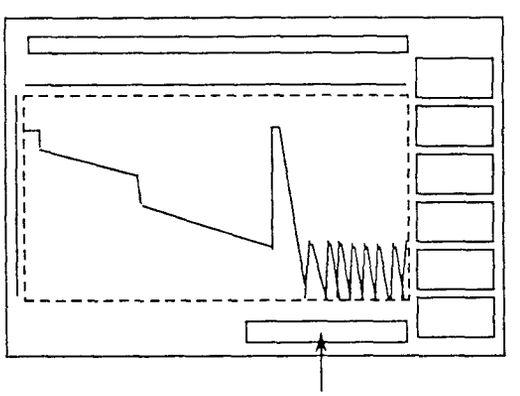
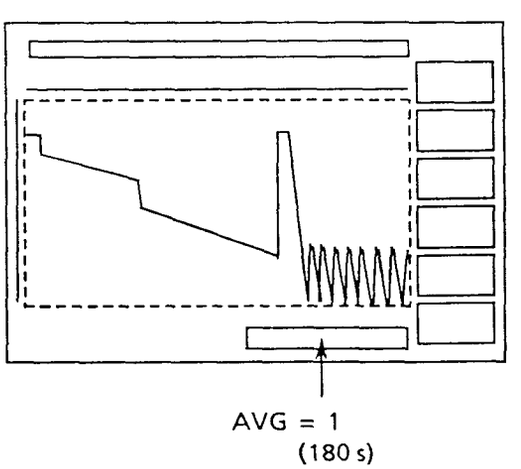
When setting is made with time, "S" is indicated after the setting value on the CRT screen.

When a measured-fiber plug is drawn out of the optical output terminal under the condition of averaging ON, the laser output is turned off and averaging is stopped. If this plug is connected again and laser output is turned on, averaging is reset.

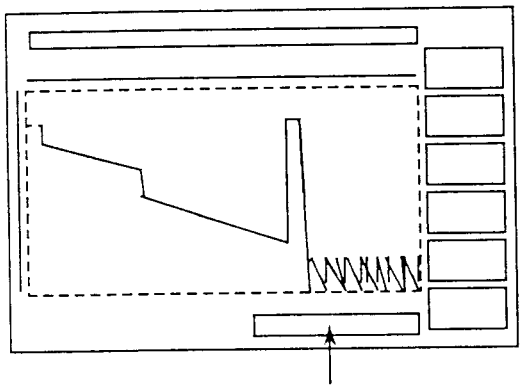
5.9.2 Example of setting averaging limit and starting averaging

Key operation	Screen display	Description
PRIOR	L1: CONDITION MEASURE ⋮	The soft key is brought to the first layer.
MEASURE	L2: MEASURE LSA/2PA THRESHOLD AVG. LIMIT ⋮	The soft key is brought to the MEASURE layer.
AVG. LIMIT	L3: AVG. LIMIT  AVG = 0 (5 0 0 0)	The soft key is brought to the AVG. LIMIT layer. The set count displayed on the lower right of the scale is reversed.
TIME	AVG = 0 (4 3 2 0 0 5)	The display changes for time indication. (Avraging is reset when display is changed from TIME to NUMBER or from NUMBER to TIME while averaging is on.)
	AVG = 0 (1 8 0 5)	The displayed time changes.

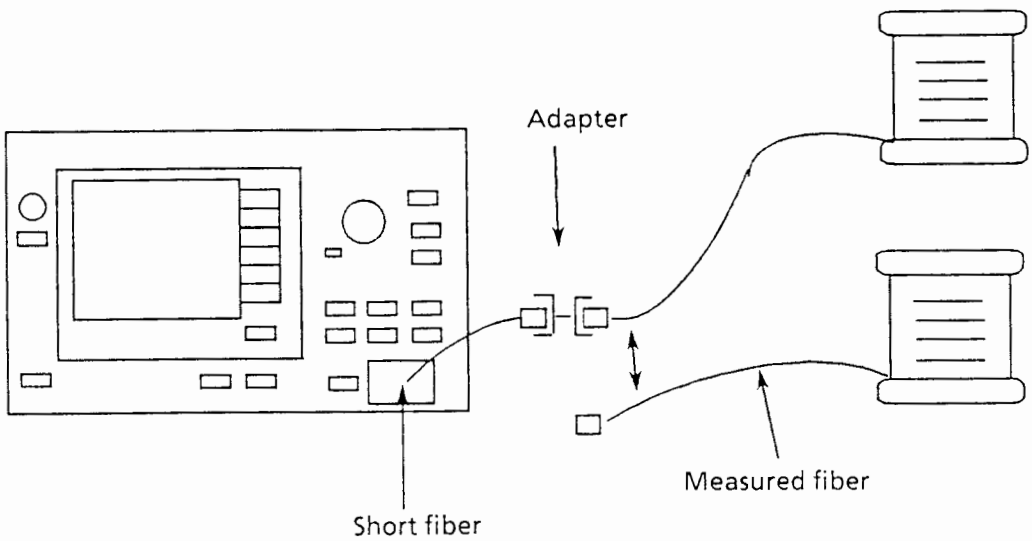
(Continued)

Key operation	Screen display	Description
SET		The averaging time is set, and the soft key returns to the MEASURE layer. ***Note:*** When returned to the MEASURE layer by pressing [PRIOR], [MARKER], [V-SHIFT], or [H-SHIFT] without [SET]; the AVERAGE setting returns to the previous state before entering the AVG.LIMIT layer.
LASER ON OFF		The waveform is swept in real time. (When above operation is executed at average OFF.)
AVERAGE ON OFF		Averaging is started, and noise begins to converge.

(Continued)

Key operation	Screen display	Description
(After an elapse of 180 seconds)		The laser is automatically turned off, and the waveform sweeping stops.

Note: When the measured fiber (connected to the OUTPUT connector via a short fiber as shown below) is replaced while averaging is on, correct waveform may not be displayed. In such a case, temporarily turn averaging off, then turn it on.



5.10 Waveform Summary Display

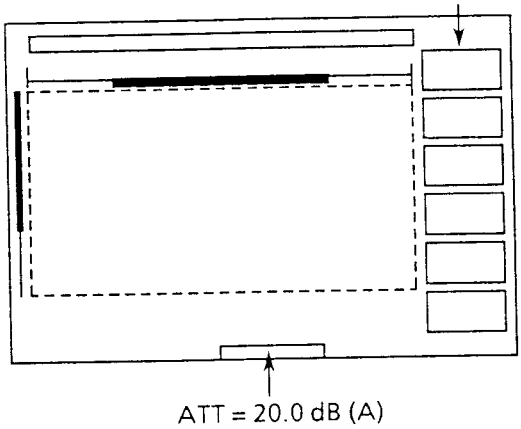
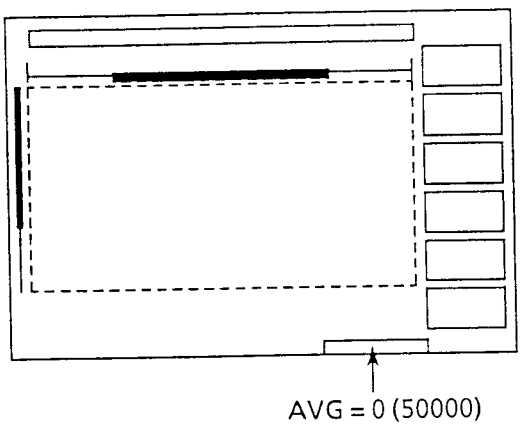
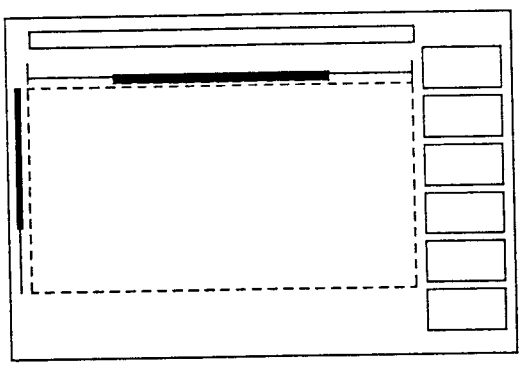
When the ATT is set to AUTO mode and the AVERAGING is set to ON, averaging will be performed while the attenuator is selected automatically. The waveform obtained at each attenuation is combined with each other to give a wide dynamic range that can be monitored in a single viewing.

Note: This function cannot be used in the plug-in units with no auto-attenuator function.

5.10.1 Setting waveform summary display

Key operation	Screen display	Description
PRIOR	L1: (1/2) CONDITION MEASURE DISPLAY ⋮	The soft key is brought to the first layer.
CONDITION	L2: CONDITION DISTANCE PULSE ⋮	The soft key is brought to the CONDITION layer.
ATT	L3: ATT	The soft key is brought to the ATT layer.

(Continued)

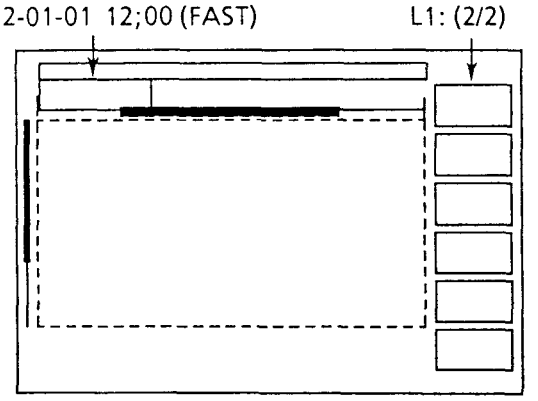
Key operation	Screen display	Description
AUTO		The A (to the right of the attenuator set value under the scale) indicates that the attenuator is in AUTO mode. The soft key returns to the CONDITION layer.
AVERAGE ON OFF		The number of averagings and the set value are displayed on the lower right of the screen.
LASER ON OFF		Averaging is performed while the attenuator is selected automatically. The summarized waveform starts to be displayed. ***Note:*** If the Fresnel reflection is saturated, the height of the Fresnel reflection may become lower when the attenuator is changed. Since the measured waveform at each attenuation is combined together, some waveform steps may be appeared at the combined positions.

5.11 Sweep Mode

To observe waveform in real-time at assembling cable connector, for on example; the sweep speed can be set to approximately 0.3 seconds.

Note: The sweep speed is lower when AVERAGING is set to ON.
Note also that more noise is produced when sweep mode is set to FAST than when it is set to NORMAL.

5.11.1 Setting sweep mode

Key operation	Screen display	Description
PRIOR	L1: (1/2) CONDITION MEASURE DISPLAY ⋮	The soft key is brought to the first layer (1/2).
etc.	L1: (2/2) COMPARE SYSTEM ⋮	The soft key is brought to the first layer (2/2).
SWEEP MODE		FAST is displayed to the right of the date and sweep speed becomes fast. Everytime the [SWEEP MODE] soft key is pressed, the sweep speed changes from NORMAL to FAST and vice-versa. ***Note:*** Only FAST is displayed. NORMAL is not displayed.

5.11.2 Sampling resolution, number of data, and range in FAST mode

The sampling resolution, number of data, and range for FAST sweep mode is shown below.

H-SCALE \ Distance range	2.5km	5km	10km	25km	50km	100km	250km
25km/div							50 → Sampling resolution [m]
							5001 → Number of sampling data
							250000 → Sampling range [m]
10km/div						20	20
						5001	5001
						100000	100000
5km/div					10	10	10
					5001	5001	5001
					50000	50000	50000
2.5km/div				5	5	5	5
				5001	5001	5001	5001
				25000	25000	25000	25000
1km/div			2	2	2	2	2
			5001	5001	5001	5001	5001
			10000	10000	10000	10000	10000
500m/div		2	2	2	2	2	2
		2501	5001	5001	5001	5001	5001
		5000	10000	10000	10000	10000	10000
250m/div	1	1	1	1	1	1	1
	2501	5001	5001	5001	5001	5001	5001
	2500	5000	5000	5000	5000	5000	5000
100m/div	1	1	1	1	1	1	1
	2501	5001	5001	5001	5001	5001	5001
	2500	5000	5000	5000	5000	5000	5000
50m/div	1	1	1	1	1	1	1
	2501	5001	5001	5001	5001	5001	5001
	2500	5000	5000	5000	5000	5000	5000
25m/div	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	5001	5001	5001	5001	5001	5001	5001
	500	500	500	500	500	500	500
10m/div	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	5001	5001	5001	5001	5001	5001	5001
	500	500	500	500	500	500	500
5m/div	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	5001	5001	5001	5001	5001	5001	5001
	500	500	500	500	500	500	500
2.5m/div	0.05	0.05	0.05	0.05	0.05	0.05	0.05
	5001	5001	5001	5001	5001	5001	5001
	250	250	250	250	250	250	250

Notes:

1. The values are for IOR = 1,500000.
2. The selectable distance range is different depending on the plug-in unit used. (See paragraph 1.5.)

5.11.3 Sampling resolution, number of data, and range in NORMAL mode

The sampling resolution, number of data, and range for NORMAL sweep mode is shown below.

H-SCALE \ Distance range	2.5km	5km	10km	25km	50km	100km	250km
25km/div							10
							25001
							250000
10km/div						5	5
						20001	25001
						100000	125000
5km/div					2	2	2
					25001	25001	25001
					50000	50000	50000
2.5km/div				2	2	2	2
				12501	25001	25001	25001
				25000	50000	50000	50000
1km/div			2	2	2	2	2
			5001	12501	25001	25001	25001
			10000	25000	50000	50000	50000
500m/div		2	2	2	2	2	2
		2501	5001	12501	25001	25001	25001
		5000	10000	25000	50000	50000	50000
250m/div	1	1	1	1	1	1	1
	2501	5001	10001	25001	25001	25001	25001
	2500	5000	10000	25000	25000	25000	25000
100m/div	1	1	1	1	1	1	1
	2501	5001	10001	25001	25001	25001	25001
	2500	5000	10000	25000	25000	25000	25000
50m/div	1	1	1	1	1	1	1
	2501	5001	10001	25001	25001	25001	25001
	2500	5000	10000	25000	25000	25000	25000
25m/div	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	25001	25001	25001	25001	25001	25001	25001
	2500	2500	2500	2500	2500	2500	2500
10m/div	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	25001	25001	25001	25001	25001	25001	25001
	2500	2500	2500	2500	2500	2500	2500
5m/div	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	25001	25001	25001	25001	25001	25001	25001
	2500	2500	2500	2500	2500	2500	2500
2.5m/div	0.05	0.05	0.05	0.05	0.05	0.05	0.05
	25001	25001	25001	25001	25001	25001	25001
	1250	1250	1250	1250	1250	1250	1250

→ Sampling resolution [m]
→ Number of sampling data
→ Sampling range [m]

Notes:

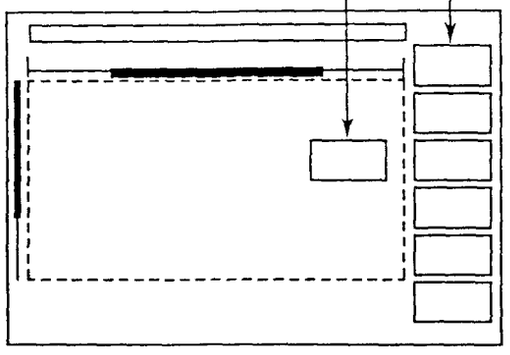
1. The values are for IOR = 1,500000.
2. The selectable distance range is different depending on the plug-in unit used. (See paragraph 1.5.)

5.12 Output-Power Variable Mode

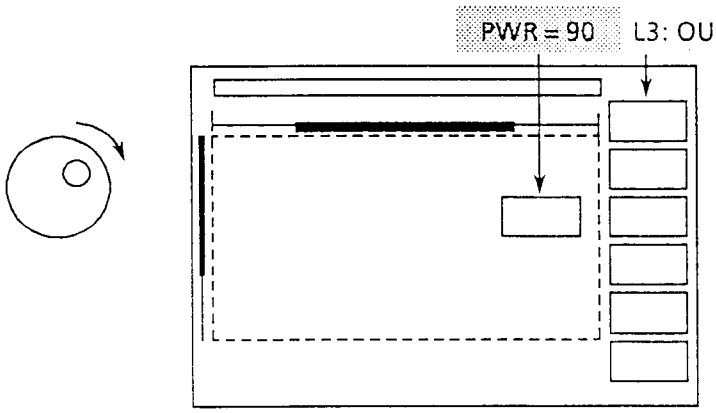
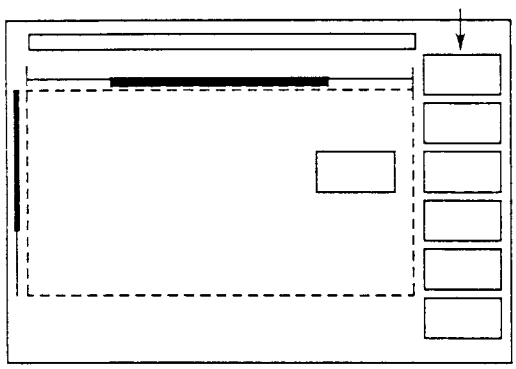
When Fresnel reflection occurs between two points, there are cases where the two points become undistinguishable because of waveform distortion. In normal cases, masking can be used to distinguish them. However, if they are very close to each other, distinguishing them becomes difficult even with masking. In this case, by decreasing the LD output power, they can become distinguishable.
There are some plug-in units which cannot use this function (refer to paragraph 1.5).

Note: When the output power is changed, the result of the fiber-loss measurement also varies because the spectrum of the laser varies.

5.12.1 Setting output power

Key operation	Screen display	Description
PRIOR	L1: (1/2) CONDITION MEASURE DISPLAY ⋮	The soft key is brought to the first layer.
CONDITION	L2: CONDITION DISTANCE PULSE ⋮	The soft key is brought to the CONDITION layer.
OUTPUT POWER	PWR = 0 L3: OUTPUT POWER 	Enters the Output Power Variable Mode. The set value displayed on the upper right of the screen is reversed.

(Continued)

Key operation	Screen display	Description
	PWR = 90 L3: OUTPUT POWER 	Decrease the output power with the rotary knob. ***Note:*** When the output power is changed while averaging is ON. Averaging is reset
SET	L2: CONDITION 	Sets the output power. The soft key returns to the CONDITION layer. ***Note:*** When returned to the CONDITION layer by pressing [PRIOR] without [SET], the output-power set value returns to the preveous value before entering the OUTPUT POWER layer.

- The output-power range can be set to any value from 0 to 127.
  The output-power set value is displayed on the upper right of the screen, except for the maximum setting (0).

Note: Normally set the output power to 0.

- The set mask is disabled during Output-Power Variable Mode. The mask will be enabled (recovered) again after the output power is returned to 0.

Note: Masks cannot be set while in Output-Power Variable Mode.

- If the Output-Power Variable Mode is enabled while in Auto-Attenuator Mode, the Auto Mode is disabled. Even if the output power is reset to 0, the Auto Mode will still remain disabled.

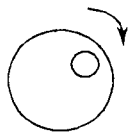
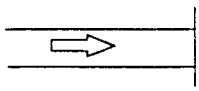
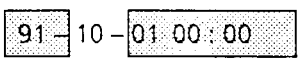
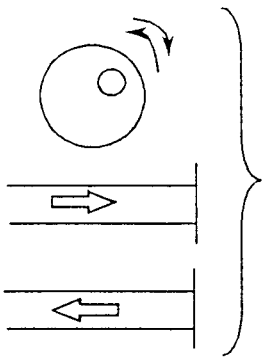
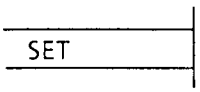
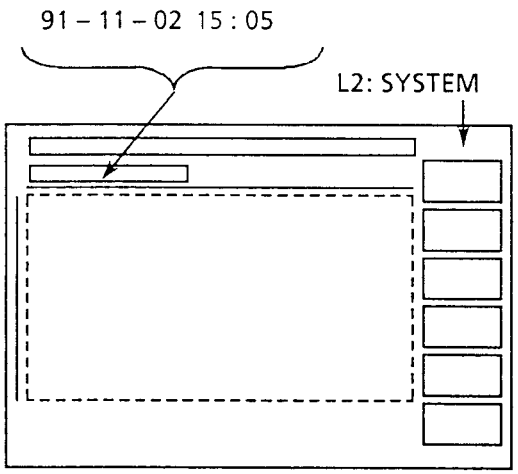
Note: Auto-Attenuator Mode cannot be set while in Output-Power Variable Mode.

5.13 Setting the Calendar

Here, sets the date (year, month, day) and time (hour, minute) to the internal RTC (real-time clock) of the MW9040B. This RTC is protected against power-off by a built-in battery. The date and time are displayed on the screen in the format of "year-month-day hour:minute"

Key operation	Screen display	Description
PRIOR	L1: (1/2) CONDITION MEASURE ⋮	The soft key returns to the first layer.
etc.	L1: (2/2) COMPARE SYSTEM ⋮	The second screen of the first layer is displayed.
SYSTEM	L2: SYSTEM INTERFACE CALENDER ⋮	The soft key is brought to the SYSTEM layer.
CALENDAR	Display not reversed Display reversed 91-10-01 00:00 L3: CALENDAR	The soft key is brought to the CALENDAR layer. The calendar part displayed on the upper left of the screen is reversed. However, item for which setting can be changed (the "year" part in this example) are not reversed.

(Continued)

Key operation	Screen display	Description
		
		The "year" item is changed to 90, and the "month" item is normally displayed (not reversed so that its setting can be changed).
		Each item has been changed by operating the rotary knob and arrow ([→] [←]) soft keys repetitively.
		The date and time have been set to the calendar, and the soft key returns to the SYSTEM layer. ***Note:*** When returned to SYSTEM layer by pressing [PRIOR], [MARKER], [V-SHIFT], or [H-SHIFT] without [SET]; the calendar setting returns to the previous state before entering the CALENDAR layer.

5.14 Setting Title

The MW9040B allows a title to be set on the upper left of the scale using 20 characters × 2 lines (total 40 characters). The characters that can be used for this title are as follows:

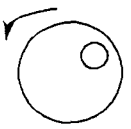
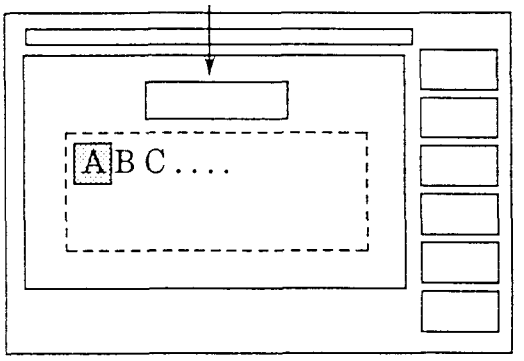
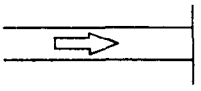
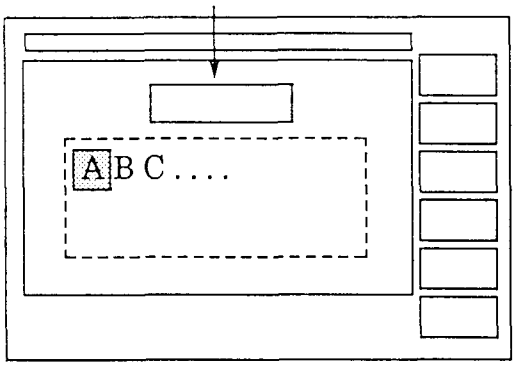
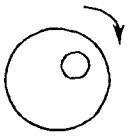
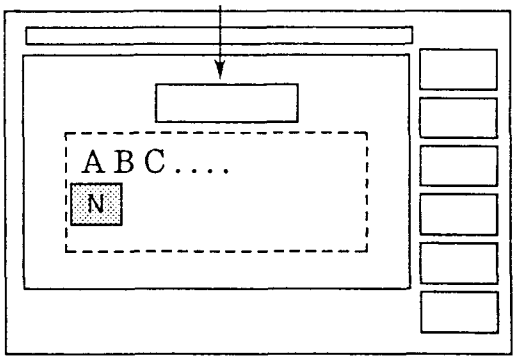
```
A B C D E F G H I J K L M
N O P Q R S T U V W X Y Z
a b c d e f g h i j k l m
n o p q r s t u v w x y z
1 2 3 4 5 6 7 8 9 0 ! # $
& % ' ( ) ^ @ _ { } .
Space
```

Example of title input is described below.

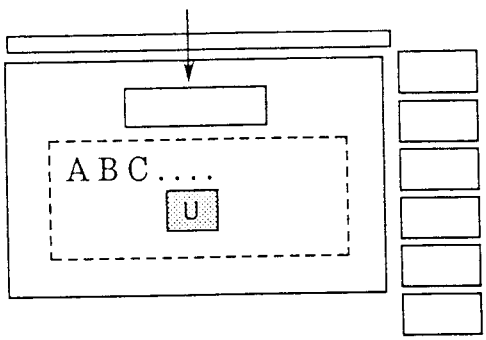
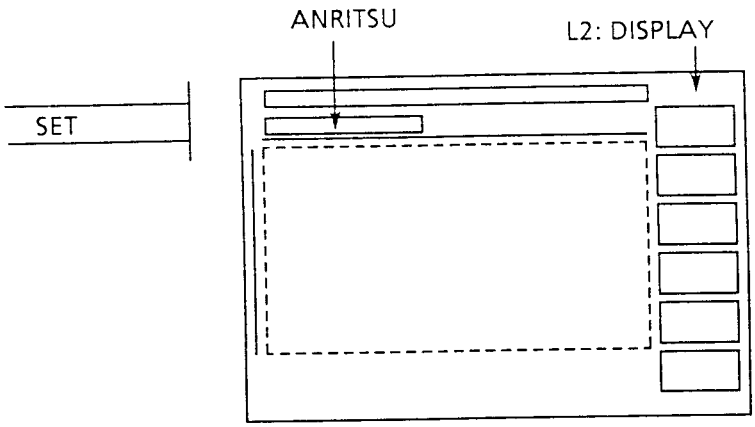
Title: ANRITSU

Key operation	Screen display	Description
PRIOR	L1: CONDITION, MEASURE, ⋮	The soft key is brought to the first layer.
DISPLAY	L2: DISPLAY — TITLE, UNIT, ⋮	The soft key is brought to the DISPLAY layer.
TITLE	TITLE: ▒ — L3: TITLE — A B C . . . . — Space	The screen display changes to a title setting screen. (The first character position of the title displayed on the screen is reversed.)

(Continued)

Key operation	Screen display	Description
	TITLE: A 	Select the character (A) to be input with the rotary knob. (The reversed character cursor moves.)
	TITLE: A A 	"A" is set in the first character position. Select the next character position (i.e., second character position) with the arrow [→] key.
	TITLE: A N 	Select the second character (N) to be input. (The reversed character cursor moves.)

(Continued)

Key operation	Screen display	Description
	(Repeat the above using the arrow key and rotary knob until all characters are set.) TITLE: ANRITSU 	
SET		The title has been set. the soft key returns to the DISPLAY layer ***Note:*** When returned to DISPLAY layer by pressing [PRIOR] without [SET]; the title setting returns to the previous state before entering the TITLE layer.

Use [DELETE] to delete one character at the character cursor position.

Use [INSERT] to insert one character immediately before the character where the character cursor is positioned.

Use [CLEAR] to delete all characters.

5.15 Setting External Interface

The two kinds of external interface boards can be fitted into the rear panel slots. The MW9040B functions as a device for the device connected to SLOT0 and as the controller for the device connected to SLOT1.

Therefore, when using the standard equipped GP-IB board;insert the board to the appropriate slot, depending on the connected device. The optional GP-IB board enables an external computer both to control the MW9040B and to print the measured results on an external plotter etc. , for an example.

Install the interface board and connect to external device with the GP-IB cable as necessary.

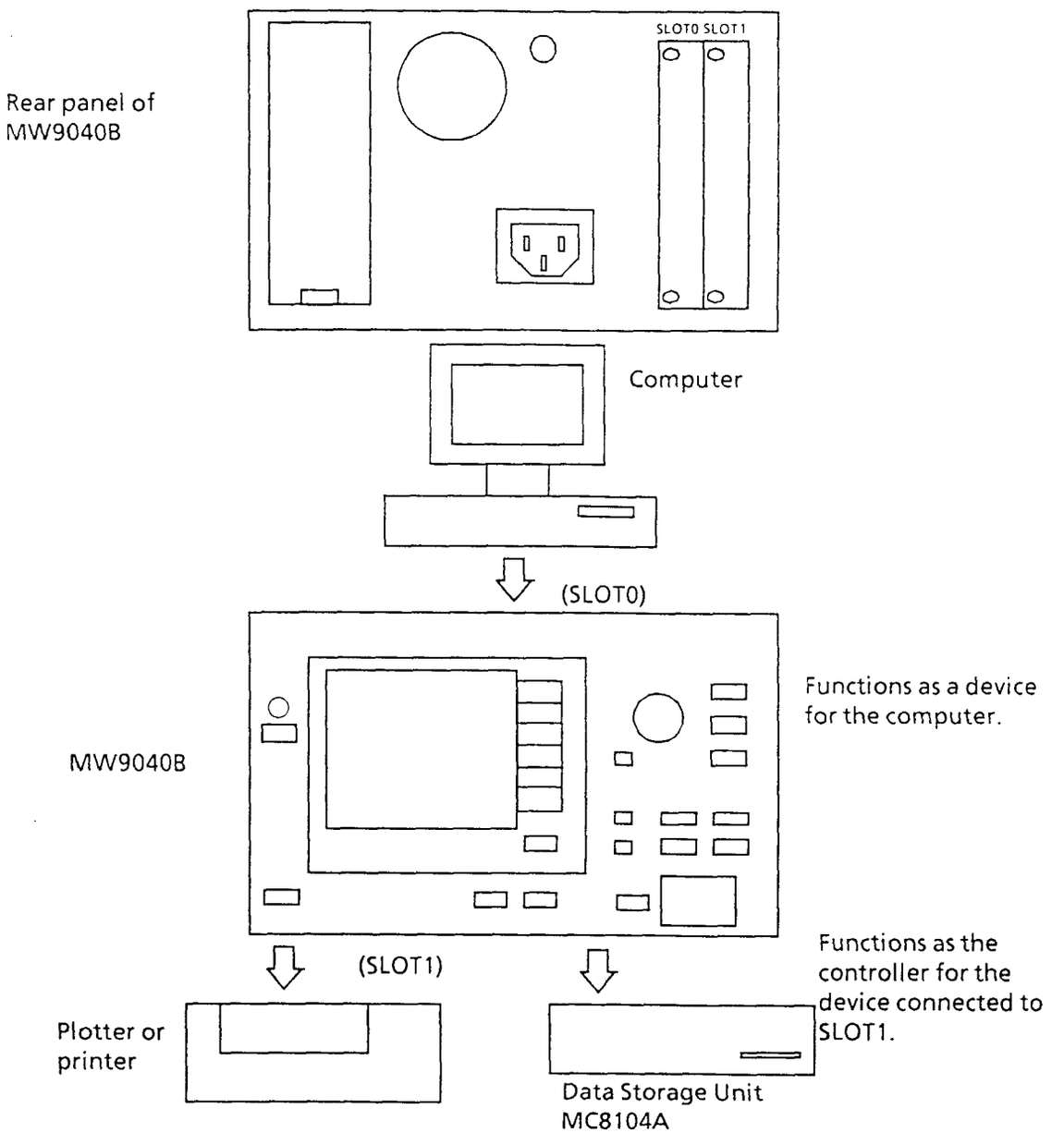


Fig. 5-7 External Interface

Figure 5-8 shows an interface setting screen. Addresses are set by a number from 0 to 30.
The GP-IB board is installed in the slot 1.

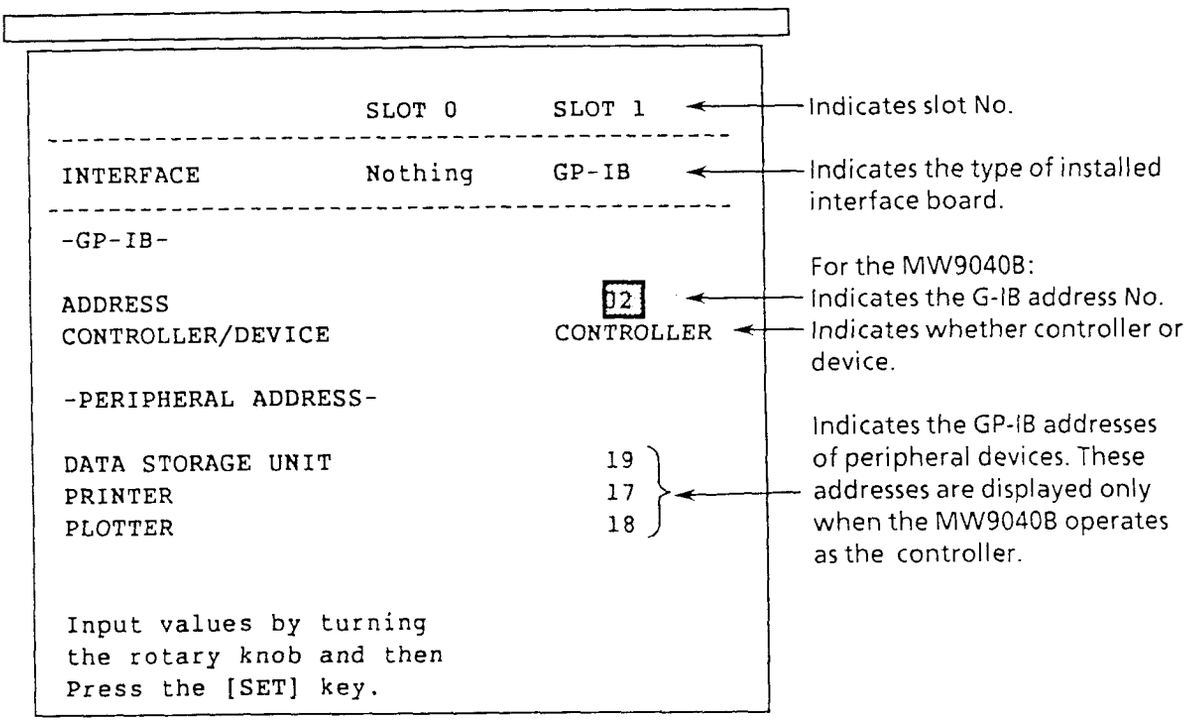
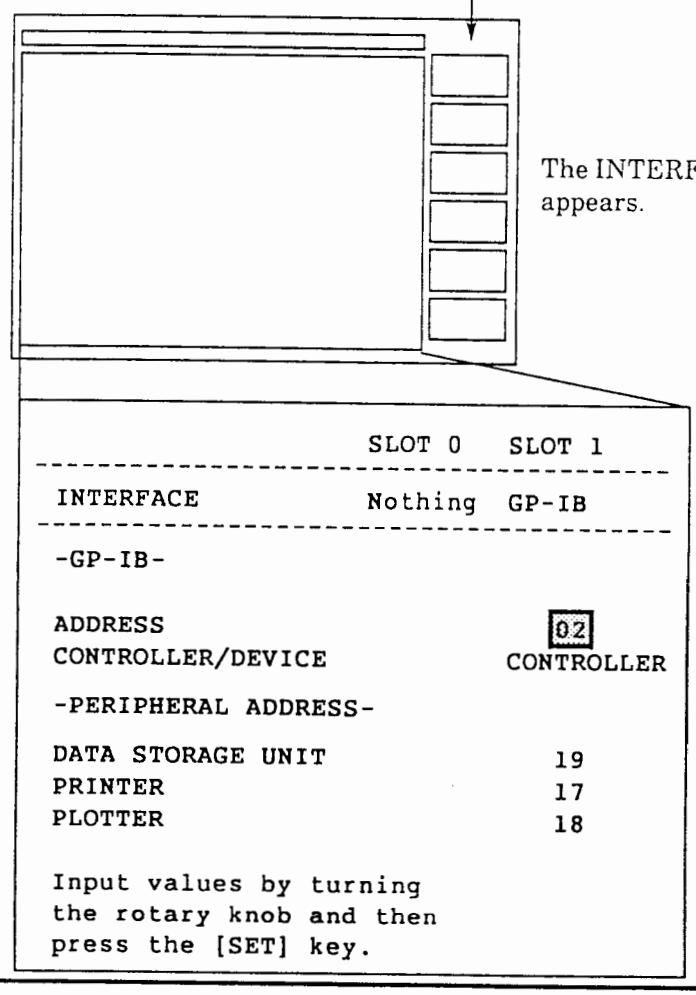


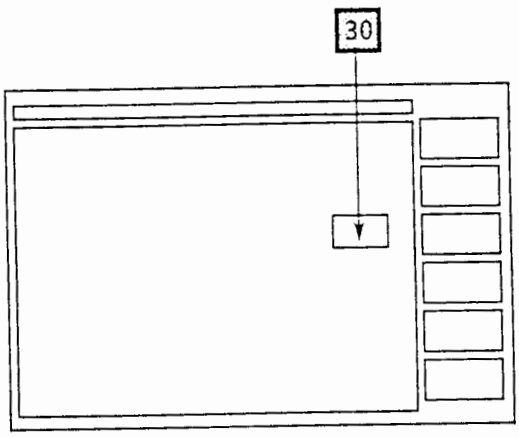
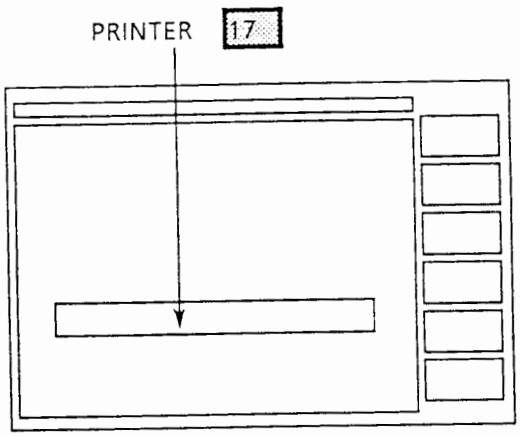
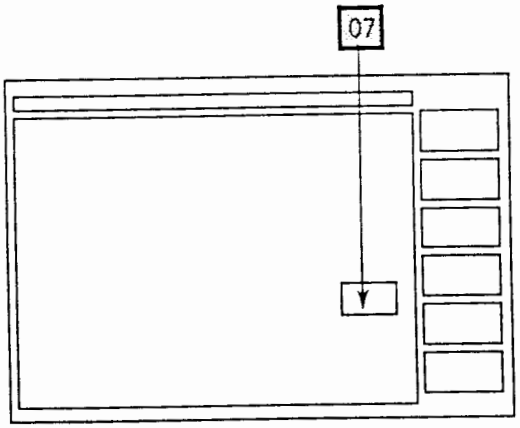
Fig. 5-8 Interface Setting Screen

Example of setting external interface

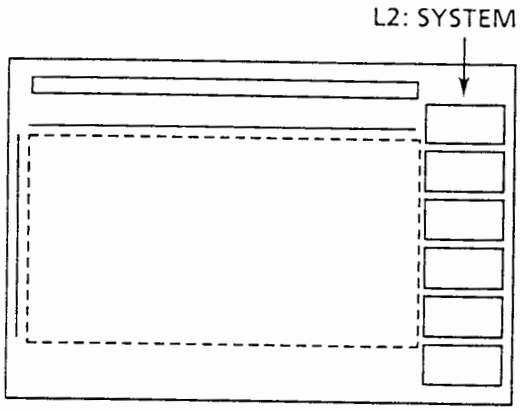
Key operation	Screen display	Description
PRIOR	L1: (1/2) CONDITION ⋮	The soft key is brought to the first layer.
etc.	L1: (2/2) COMPARE ⋮	The second screen of the first layer is displayed.
SYSTEM	L2: SYSTEM INTERFACE CALENDAR ⋮	The soft key is brought to the SYSTEM layer.
INTERFACE	L3: INTERFACE	The INTERFACE setting screen appears.



(Continued)

Key operation	Screen display	Description
		Set the MW9040B's GP-IB address to "30."
(Press 3 times)		Set the printer address.
		Set the printer address to "7." (The address on the printer must also be set to 7.)

(Continued)

Key operation	Screen display	Description
SET		The interface setting is completed. The soft key returns to the SYSTEM layer. ***Note:*** When returned to the SYSTEM layer by pressing [PRIOR] without [SET], the interface setting returns to the previous state before entering the INTERFACE layer.

5.16 Saving and Recalling Measurement Screen

Measurement screens can be saved in and recalled from three types of storage media: MW9040B's internal memory, plug-in memory card (PMC), and floppy disk (FD). For PMC, the data can be saved and recalled using the MC8104A Data Storage Unit, a peripheral device, as well as the MW9040B main frame. For FD, the data can be saved and recalled using the MC8104A Data Storage Unit or the MC2102A Floppy Disk Drive.

When saving data, the file name can be defined in up to 8 characters using the characters and symbols shown below. The file name can be followed by an extension within 3 characters. When using internal memory (INT MEMORY), specify the location by a memory No. (01 to 32).

```
A B C D E F G H I J K L M
N O P Q R S T U V W X Y Z
1 2 3 4 5 6 7 8 9 0 ! # $
& % ' ( ) ^ @ _ { } .
```

File name. (Up to 8 characters) Extension (Up to 3 characters)

Note: When the extension used, attach a period (.) at the end of the file name.

The table below shows the usable PMC and FD storage capacities.

PMC	32K, 64K, 128K, 256K, 512K bytes
FD	1.44 M bytes (2HD)

The following pages describe how to format storage media, save data in internal memory/plug-in memory card (INT MEMORY/PMC), recall waveforms from external FD, and erase files.

The maximum number of waveforms saved in the storage media is shown in the table below.

Media	Memory capacity	Range to be saved (Number of measurement point)						
		ALL MEASURED						DISP. RANGE
		2501	5001	10001	12501	20001	25001	501
Internal memory	——	——	——	——	——	——	——	32
PMC	32KB	5	2	1	1	0	0	16
	64KB	11	5	3	2	1	1	34
	128KB	22	11	6	4	3	2	69
	256KB	45	23	12	10	6	5	123
	512KB	91	47	24	20	12	10	248
3.5" FD	1.44MB	257	135	69	56	35	28	700

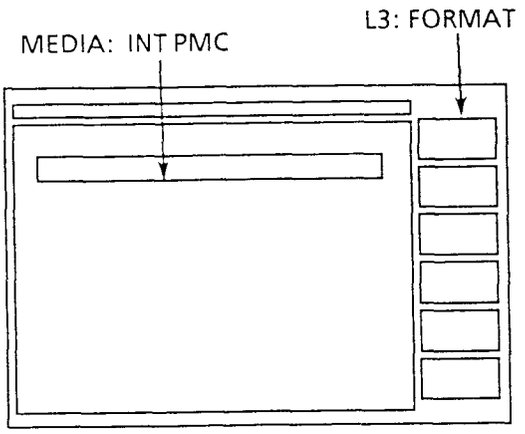
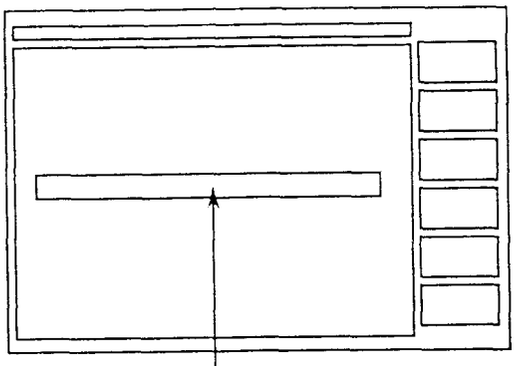
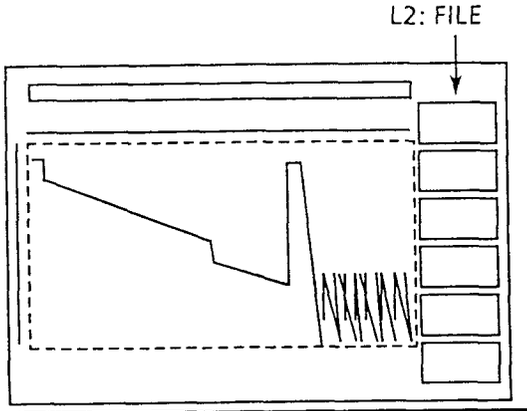
Note: See number of sampling data in paragraphs 5.11.2 and 5.11.3 for the number of measurement points at the save range.

5.16.1 Example of formatting media

When using new PMC or FD, first format it. The following describes how to format storage media taking PMC as an example. Insert PMC into the slot and then perform followings.

Key operation	Screen display	Description
PRIOR	L1: (1/2) CONDITION MEASURE ⋮	The soft key is brought to the first layer.
FILE	L2: FILE MEDIA ⋮	The soft key is brought to the FILE layer.
MEDIA	L3: MEDIA INT MEMORY INT PMC ⋮	The soft key is brought to the MEDIA layer.
INT PMC	L2: FILE MEDIA ⋮ FORMAT	INT PMC is selected, and the soft key returns to the FILE layer.

(Continued)

Key operation	Screen display	Description
FORMAT		The MW9040B enters the FORMAT layer.
	CAUTION ***The BUSY lamp lights when PMC is being accessed for a read or write. Never remove the PMC during this time.***	
EXECUTE		The PMC inserted in the MW9040B is formatted.
		When formatting is completed, the BUSY lamp goes out and the MW9040B returns to the FILE layer and measurement screen.

Note: If a PMC or FD (with data already written to) is formatted, all of the data is erasd. The media is formatted in MS-DOS format.

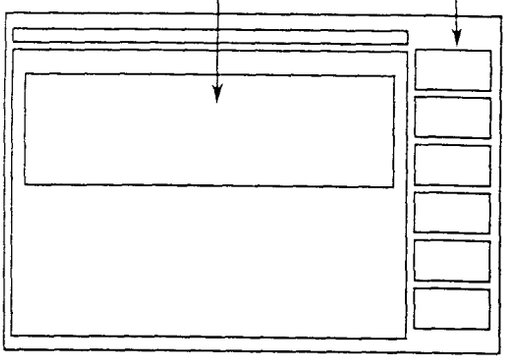
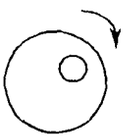
2DD 3.5-inch FDs are data compatible with the PC-9801 (NEC, Japan) and IBM PC.

2HD 3.5-inch FDs are data compatible with the IBM PC.

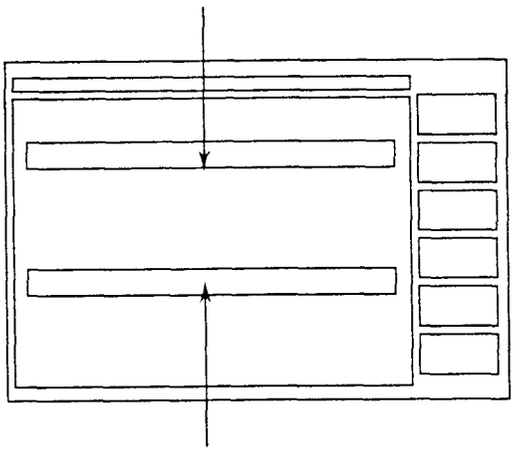
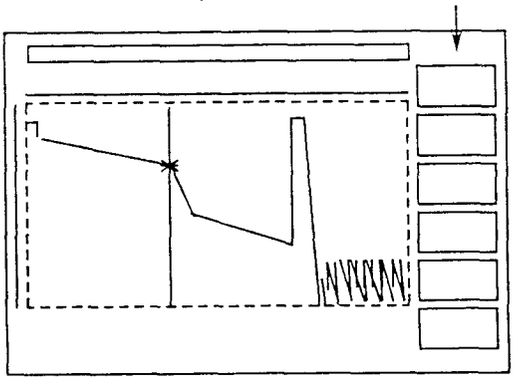
5.16.2 Example of saving measurement screen in INT MEMORY

Key operation	Screen display	Description
PRIOR	L1: CONDITION MEASURE ⋮	The soft key is brought to the first layer.
FILE	L2: FILE MEDIA SAVE ⋮	The soft key is brought to the FILE layer.
MEDIA	L3: MEDIA INT MEMORY INT PMC ⋮	The soft key is brought to the MEDIA layer.
INT MEMORY	L2: FILE MEDIA SAVE ⋮	INT MEMORY is selected as storage media. The soft key returns to the FILE layer.

(Continued)

Key operation	Screen display	Description
SAVE	MEDIA : INT MEMORY FILE No. : ○○ SAVE START = ○○○ m SAVE END = ○○○ km SAVE RES = ○○○ m	The soft key is brought to the SAVE layer, and the screen is changed. When media is INT MEMORY, all soft keys other than [EXECUTE] are invalid.
	L3: SAVE 	
	FILE No. : 07 (Unused)	To save data in internal memory No. 7, select memory No. 7 with the rotary knob.

(Continued)

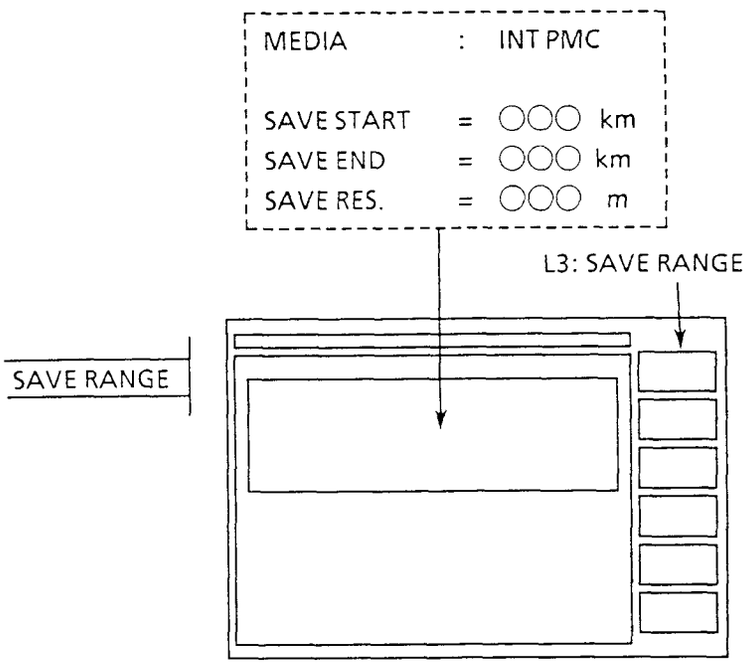
Key operation	Screen display	Description
EXECUTE	FILE No. : 07 (Unused)  Now saving L2: FILE 	Data is being saved into internal memory. When save is completed, the MW9040B returns to the FILE layer and measurement screen.

Note: When data is saved to INT MEMORY, the save is made with the save start, save end, and save resolution currently displayed on the CRT screen.

5.16.3 Example of saving measurement screen in INT PMC

Key operation	Screen display	Description
PRIOR	L1: CONDITION MEASURE ⋮	The soft key is brought to the first layer.
FILE	L2: FILE MEDIA SAVE ⋮	The soft key is brought to the FILE layer.
MEDIA	L3: MEDIA INT MEMORY INT PMC ⋮	The soft key is brought to the MEDIA layer.
INT PMC	L2: FILE MEDIA SAVE ⋮	INT PMC is selected as storage media. The soft key returns to the FILE layer.

(Continued)

Key operation	Screen display	Description
SAVE RANGE		A SAVE RANGE screen appears. The waveform range and resolution to be saved with are specified here.

Specifying save range

There are two methods to specify the save range as described below.

① When saving all measured data
Press the soft key [ALL MEASURED], and all data is specified.

② When saving waveform with the range and resolution displayed on the screen
Press the soft key [DISP. RANGE], and the data with the range and resolution displayed on the screen is specified.

The save range has been specified by the above operation.

SET

L2: FILE
MEDIA
SAVE
⋮

The specified range and resolution are fixed up.

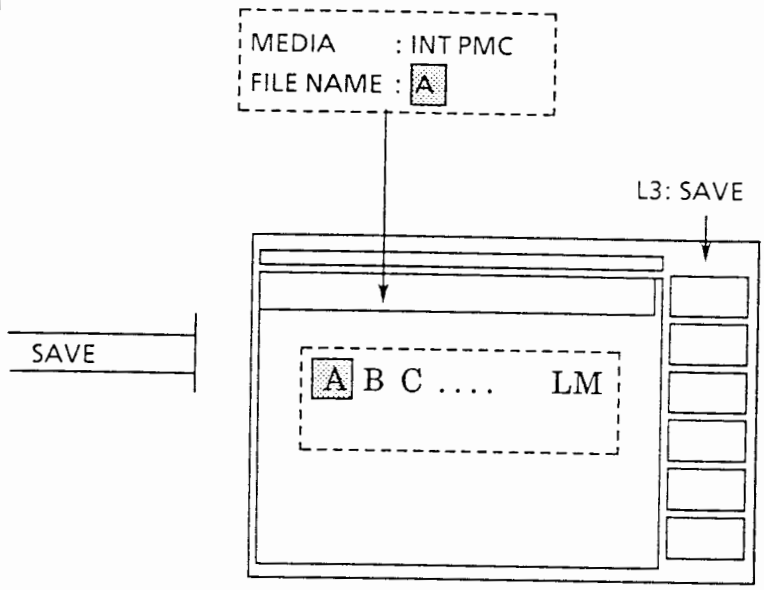
Note:

- When returned to the FILE layer by pressing [PRIOR] without [SET], the save-range set value returns to the preveous value before entering the SAVE RANGE layer.
- ALL MEASURED can not be set when MEDIA is set in the internal memory.

(Continued)

Key operation	Screen display	Description

Entering file name



The MW9040B enters the SAVE layer and SAVE screen. Input the file name using the soft key and rotary knob. The file name can be entered in up to 8 alphabetic characters and may be followed by an extension within 3 characters after a period. The method of entering a file name is the same as entering a title described in paragraph 5.14.1. (Refer to steps from [TITLE] key operation to [SET] key operation.)

The file name has been entered by the above operation.

(Continued)

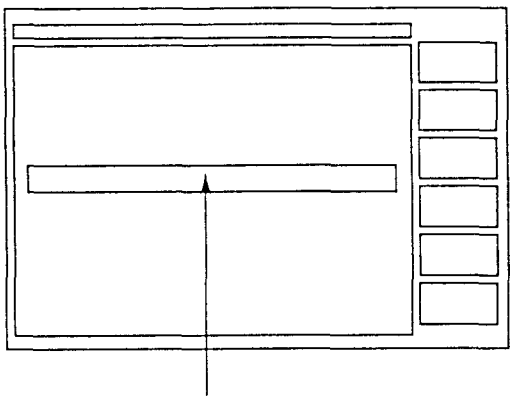
Key operation	Screen display	Description

Executing save

CAUTION

The BUSY lamp lights when PMC is being accessed for a read or write. Never remove the PMC during this time.

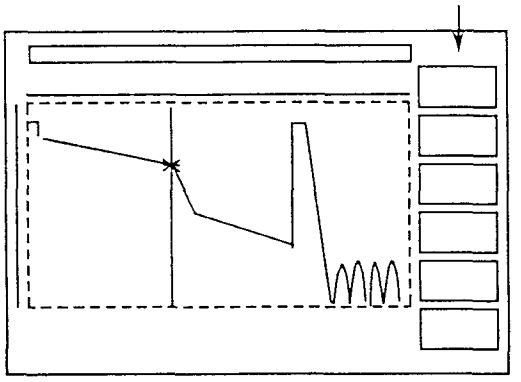
EXECUTE



Data is being saved in the PMC inserted in the MW9040B.

Now saving

L2: FILE



When save is completed, the MW9040B returns to the FILE layer.

5.16.4 Example of recalling waveform from external FD (MC8104A Data Storage Unit)

The following describes how to recall a waveform stored in external FD (MC8104A) onto the MW9040B screen. For this operation, connect the MC8104A Data Storage Unit to the MW9040B with a GP-IB cable.

Note: For the MC2102A, the same procedure can be applied.

Before using the MC8104A Data Storage Unit, confirm that its address is matched to the MW9040B interface setting. (The MC8104A address is set to 19 when shipped from the factory.)

For details on external interface settings, refer to paragraph 5.15.

When ready, insert the media (FD) containing waveform data into the MC8104A.

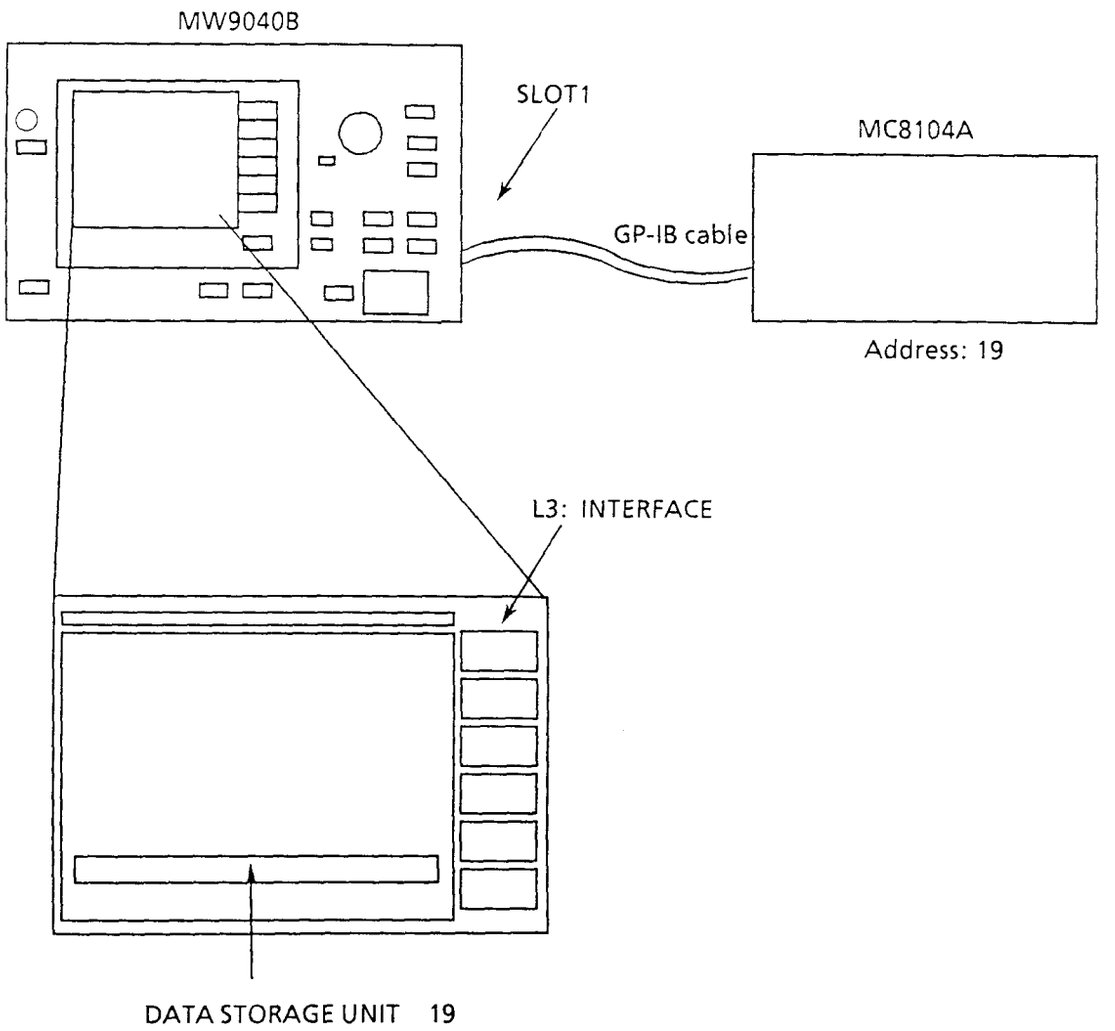
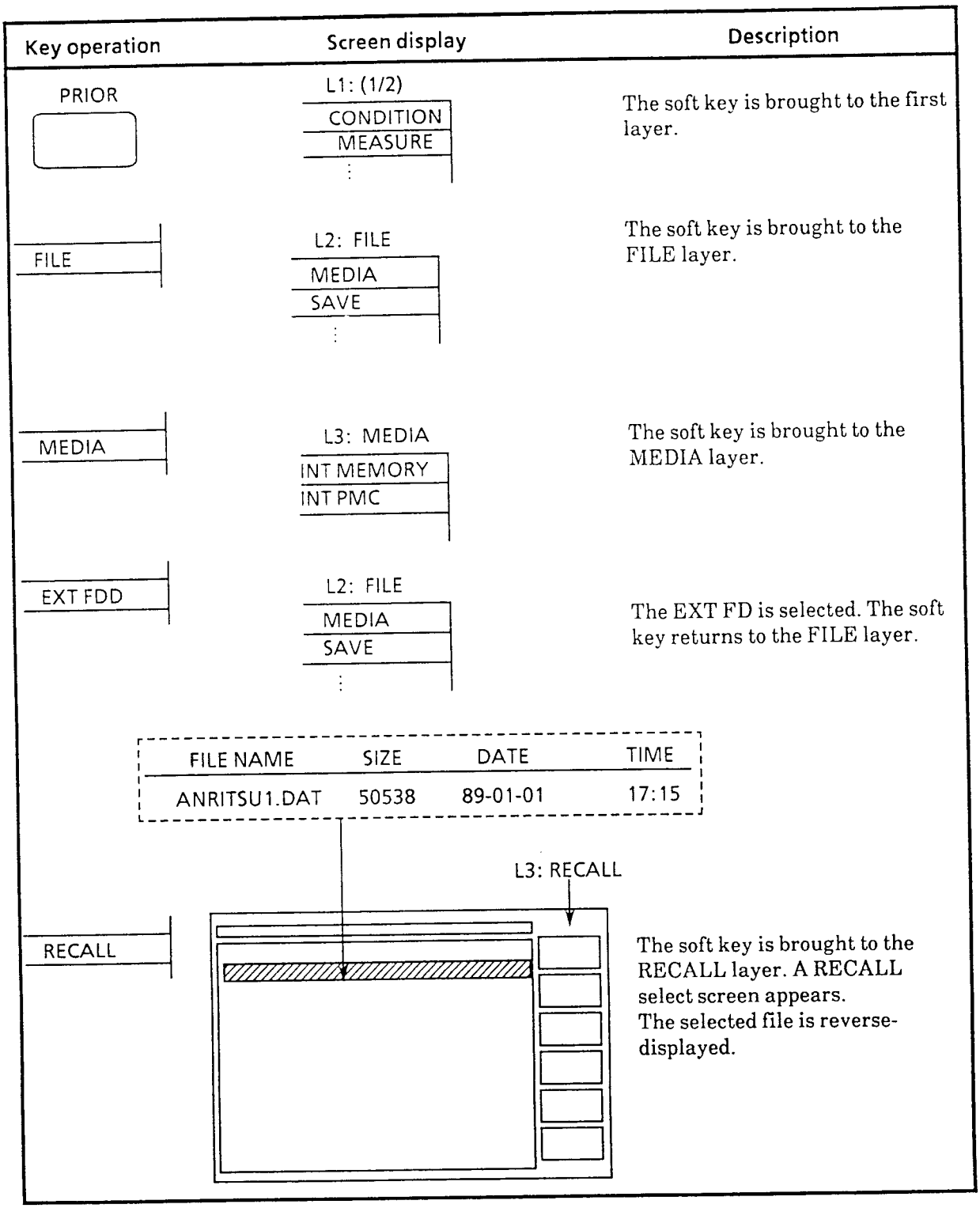
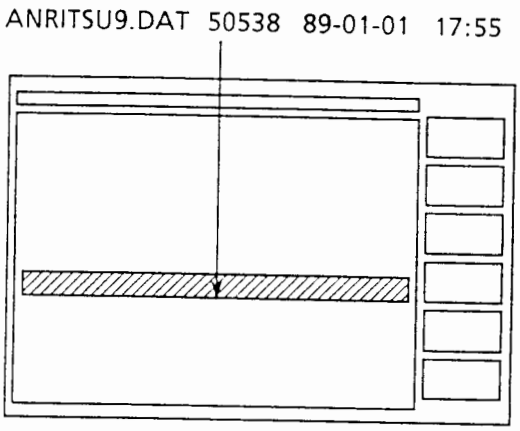
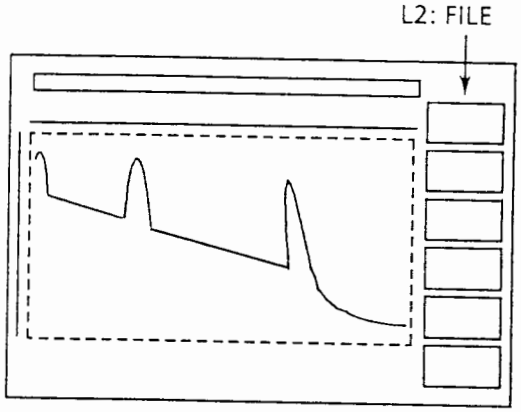


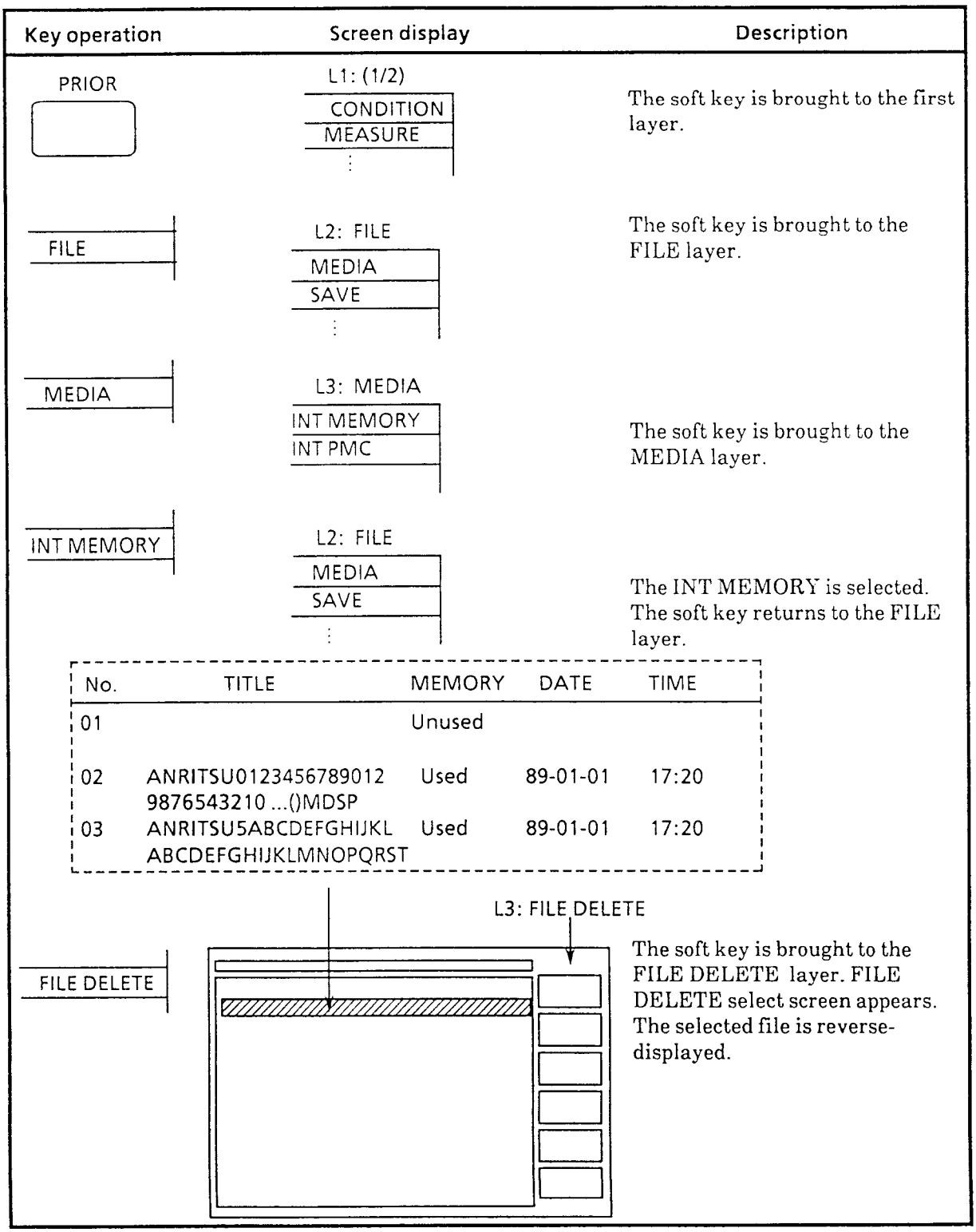
Fig. 5-9 Recalling Waveform from External FD (in MC8104A)



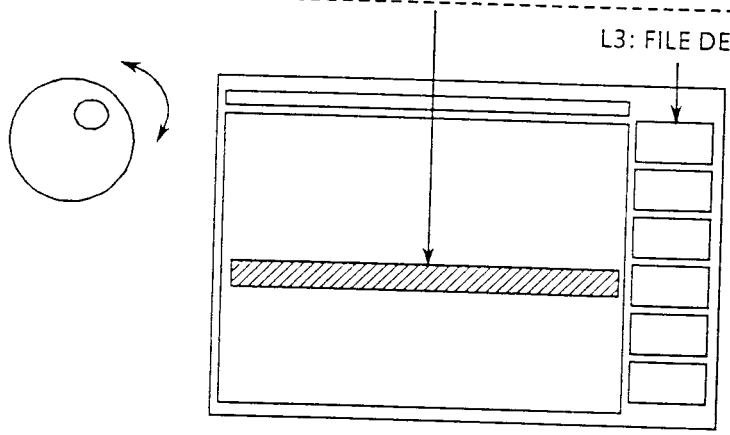
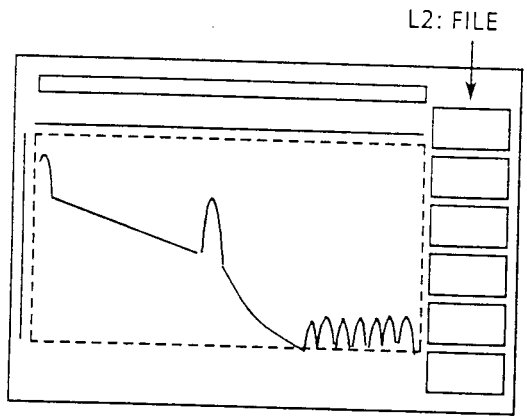
(Continued)

Key operation	Screen display	Description
		Select the measurement result file to be recalled with the rotary knob. ***Note:*** When the [COARSE] key is ON, the screen changes by the page (page scroll). So, search the file quickly by setting the [COARSE] key ON when the desired file name is not displayed on the screen.
EXECUTE		The selected waveform is displayed on the screen, and the soft key returns to the FILE layer. ***Note:*** If the current installed plug-in unit differs from the preveous installed plug-in unit which is used to save the file to be recalled now, the recalling cannot be performed.

5.16.5 Example of deleting files



(Continued)

Key operation	Screen display	Description
	08 ANRITSU5ABCDEFGHIJKL Used 89-01-01 19:25 ABCDEFGHIJKLMNOPQRST	
		Select the file desired to be deleted with the rotary knob. ***Note:*** When the [COARSE] key is ON, the screen changes by the page (page scroll). So, search the file quickly by setting the [COARSE] key ON when the desired file name is not displayed on the screen.
EXECUTE		The selected file is deleted, and the measurement screen appears. The soft key returns to the FILE layer.

5.17 Producing Screen Hard Copy

The MW9040B allows information on the screen to be output to an external printer or plotter via GP-IB without using an external controller. To produce screen hard copy; install a GP-IB board to the SLOT0 on the rear panel of the MW9040B, connect the MW9040B to an external printer or plotter with an GP-IB cable, and set the external interface address matched to the printer or plotter address. (The printer address is set to 17 and the plotter address is set to 18 when shipped from the factory.) For details on how to set external interface address, refer to paragraph 5.15.

Hard copy can be produced without interrupting measurement.

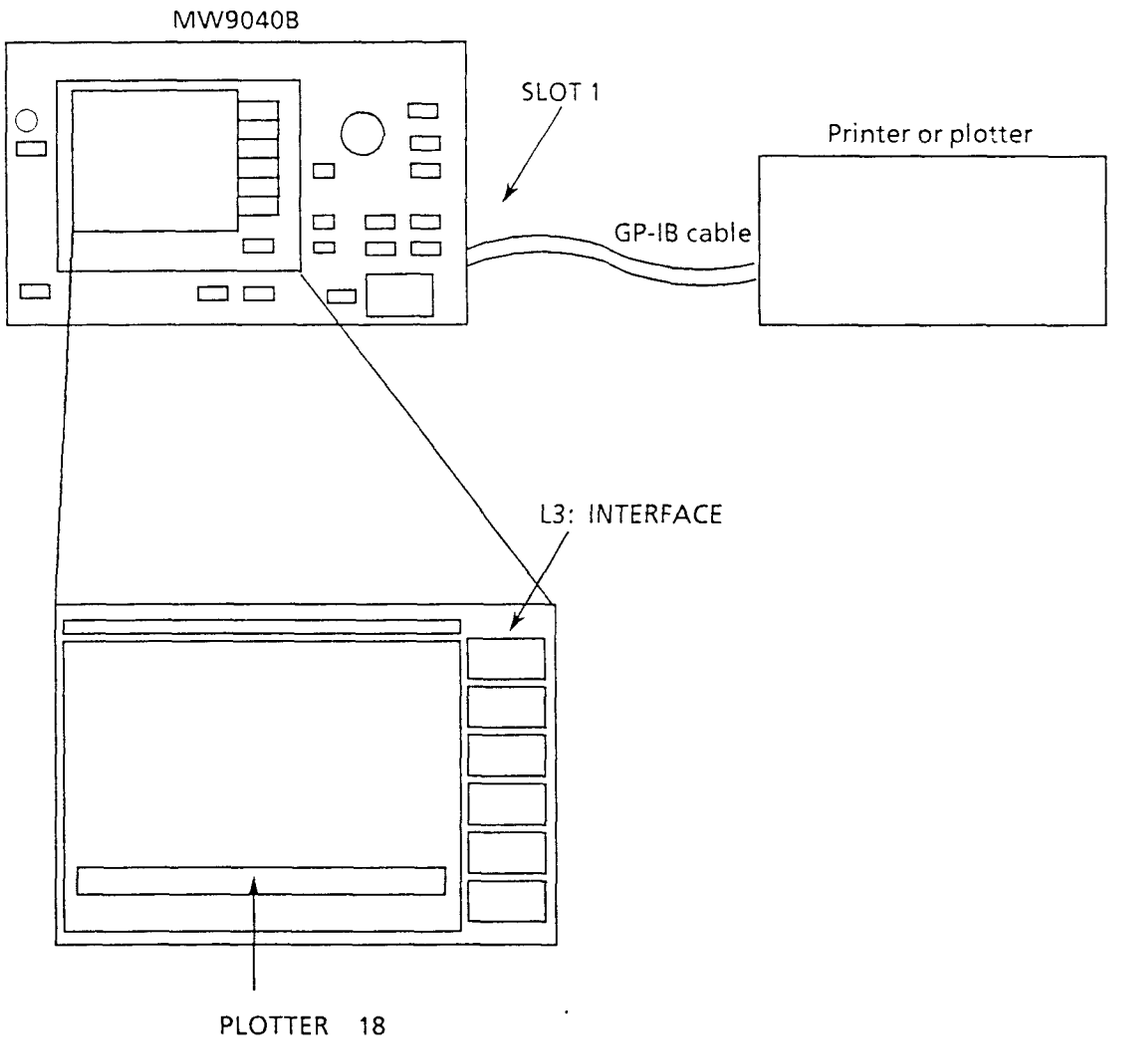


Fig. 5-10 Producing Hard Copy with External Printer/Plotter

Table 5-3 lists the printers and plotters that can be connected to the MW9040B, and shows the names of the corresponding soft keys.

Table 5-3 Connectable Printers and Plotters

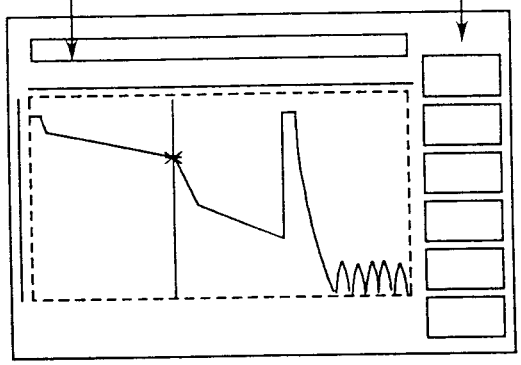
Soft key name (TARGET layer)	Output format	Equipment name
DSU	Based on MC8104A	MC8104A (Anritsu)
PL1	HP-GL plotter	7550A, 7475, 7470 (HP)
PL2	GP-GL plotter	PD9411F (Graphtec, Japan)
PR1	2225 based printer	2225 (HP)
PR2	CTM-800 based printer*	CTM-800 (Epson, Japan)

*:When printing with a CTM-800 based printer, use the automatic line-feed mode.

The following shows an example of how to set conditions for producing hard copy and operations to start and stop. In this example, the MC8104A Data Storage Unit is used and whole screen data is copied.

Key operation	Screen display	Description
Starting copy		
PRIOR	L1: (1/2) CONDITION MEASURE ⋮	The soft key is brought to the first layer.
COPY	L2: COPY COPY START COPY STOP ⋮	The soft key is brought to the COPY layer.
TARGET	L3: TARGET DSU PL1	The soft key is brought to the TARGET layer.

(Continued)

Key operation	Screen display	Description
DSU	L2: COPY COPY START COPY STOP ⋮	The output format based on the MC8104A is set. The soft key returns to the COPY layer.
ALL/TRACE	L3: ALL/TRACE ALL TRACE ⋮	The soft key is brought to the ALL/TRACE layer.
ALL	L2: COPY COPY START COPY STOP ⋮	This setting makes the whole screen data copied. The soft key returns to the COPY layer. ***Note:*** Since the waveform trace only is copied in the TRACE mode, overwrite the trace on the plotter to compare the waveforms each other.
COPY START	Copying L1: (1/2) 	The system starts copying data to a printer. The soft key returns to the first layer.

(Continued)

Key operation	Screen display	Description
Stopping copy Execute the following when you want to stop copy in middle.		
COPY	L2: COPY COPY START COPY STOP ⋮	The soft key is brought to the COPY layer.
COPY STOP	L1: (1/2) CONDITION MEASURE ⋮	COPY is stopped. The soft key returns to the first layer.

5.18 Setting Waveform Compare Mode

The MW9040B can recall a waveform stored in certain media and display it on the screen simultaneously with the waveform under measurement. For this operation to be done, the media that contains the waveform desired to be recalled must be selected with [MEDIA] in the FILE layer.

To make a comparison between two waveforms, turn the LD on and then move to the COMPARE hierarchy. Retrieve the waveform data at the COMPARE RECALL state. After that, make a comparison between a measured waveform and the stored waveform.

The H-ZOOM and H-SHIFT are disabled in the waveform-compare mode.

Assume that the waveform to be recalled is stored on the plug-in memory card (PMC) inserted in the front-panel slot in the example below.

Key operation	Screen display	Description
Selecting media		
PRIOR	L1: (1/2) CONDITION MEASURE ⋮	The soft key is brought to the first layer.
FILE	L2: FILE MEDIA SAVE ⋮	The soft key is brought to the FILE layer.
MEDIA	L3: MEDIA INT MEMORY INT PMC ⋮	The soft key is brought to the MEDIA layer.

(Continued)

Key operation	Screen display	Description
INT PMC	L2: FILE MEDIA SAVE ⋮	INT PMC is selected. The soft key returns to the FILE layer.

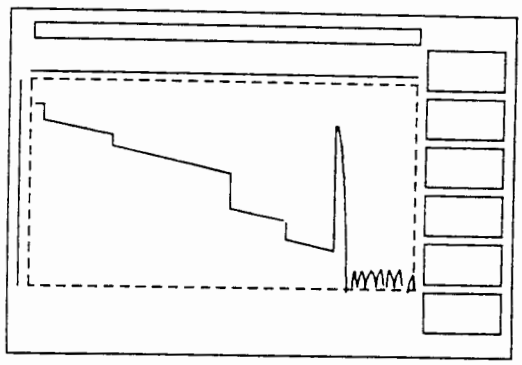
Thus, the media has been selected by the above operation.

Measured waveform display

LASER

ON

OFF



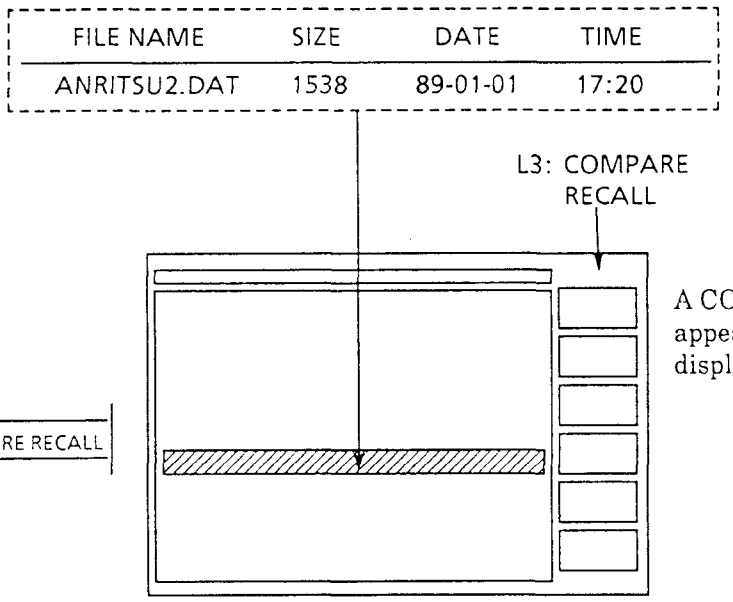
The measured waveform is displayed on the screen.

Waveform comparison

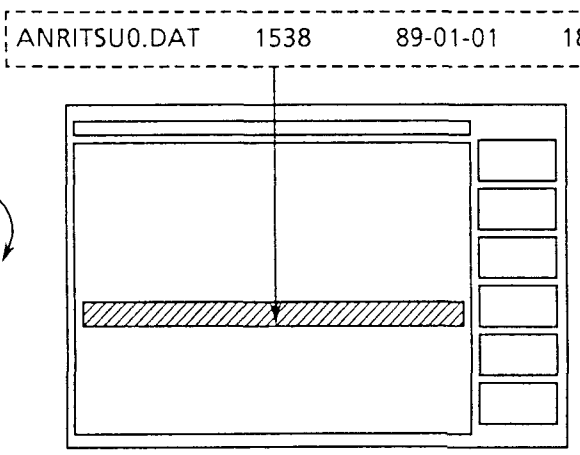
PRIOR	L1: (1/2) CONDITION MEASURE ⋮	The soft key is brought to the first layer.
etc.	L1: (2/2) COMPARE ⋮	The second screen of the first layer is displayed.
COMPARE	L2: COMPARE COMPARE RECALL ⋮	The soft key is brought to the COMPARE layer.

(Continued)

Key operation	Screen display	Description



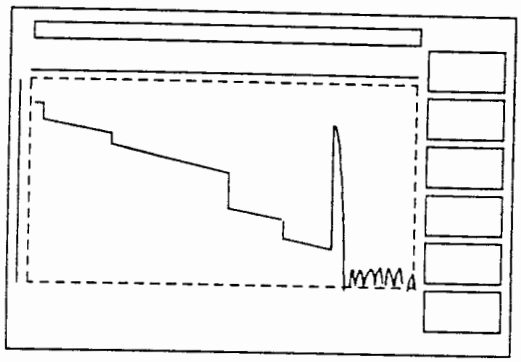
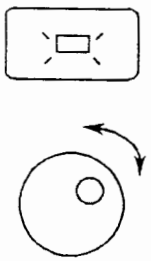
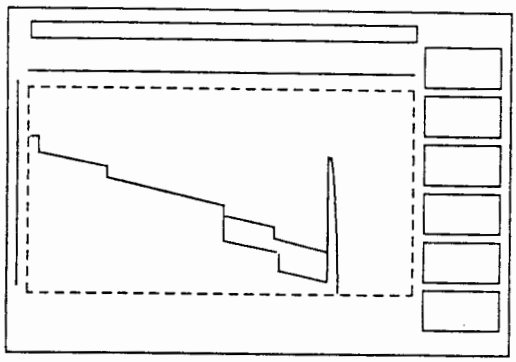
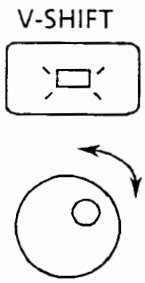
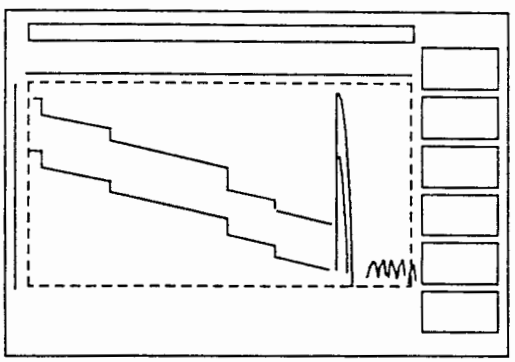
A COMPARE RECALL screen appears, and file names are displayed.



Select the file name desired to be recalled.

Note: When the [COARSE] key is ON, the screen changes by the page (page scroll). So, search the file quickly by setting the [COARSE] key ON when the desired file name is not displayed on the screen.

(Continued)

Key operation	Screen display	Description
EXECUTE		The recalled waveform is displayed on the screen. The stored waveform cannot be recalled unless five points or more of its data are displayed. ***Note:*** The RECALL operation can be enabled in the COMPARE RECALL mode even if the plug-in unit (used to save the file) and the current plug-in unit (used to recall it) are different.
V-SHIFT 		While the [V-SHIFT] lamp is on, the two waveforms can be simultaneously shifted in the vertical direction by turning the rotary knob.
V-SHIFT 		When the [V-SHIFT] key is pressed again while the [V-SHIFT] lamp is on, the lamp blinks. In this state, only the currently measured waveform can be shifted in the vertical direction by turning the rotary knob.

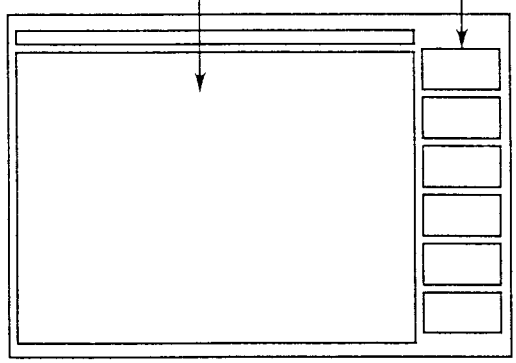
(Continued)

Key operation	Screen display	Description

Displaying measurement conditions

ITEMS		SELECT WAVE	UNSELECT WAVE
TITLE	:	ANRITSU CORP. MW9040B	ANRITSU CORP. MW9040B
CALENDAR	:	89-01-03 07:30	89-01-01 16:40
DISTANCE	:	250 km	820.2 kft
PULSE	:	100 ns	10 μs
ATT	:	10.0 dB	5.0 dB
MASK 1	:	165.50000 km	328.08399 kft
⋮		⋮	⋮

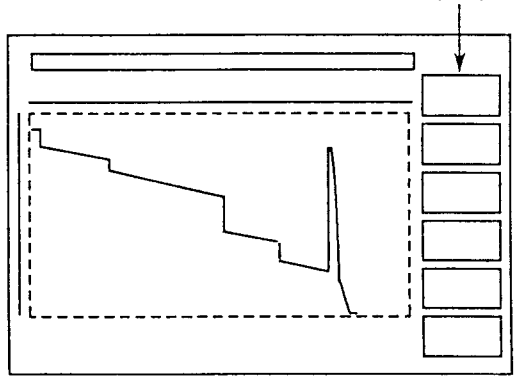
L2: COMPARE



SETTING ON/OFF

The measurement conditions of each waveform stored in the media are displayed on the screen. When this key is pressed again, the display returns to the two waveform compare screen.

L1: (1/2)



COMPARE OFF

The system exits from the compare mode and returns to the measurement state. The soft key returns to the first layer.

5.19 Soft Keys

The following describes the operation method, structure, and functions of soft keys.

5.19.1 Outline of operation

The MW9040B has six soft keys from F1 to F6. The menu of soft keys is displayed on the right edge of the screen. Any desired function in the menu can be selected and executed by pressing the key corresponding to that function (this key being called the soft key).

The menu is hierarchically structured from layer 1 to layer 3. Each time pressing any key in a given layer, it goes to the next layer. The third layer is used primarily for selecting function parameters, in which case use the rotary knob in combination with soft keys. The [PRIOR] key below the F1 to F6 keys is used to bring the selected function backward from the current layer to the immediately preceding layer.

Figure 5-11 schematically shows what is described above. Operating a key or the rotary knob moves the current layer to the layer indicated by the arrow.

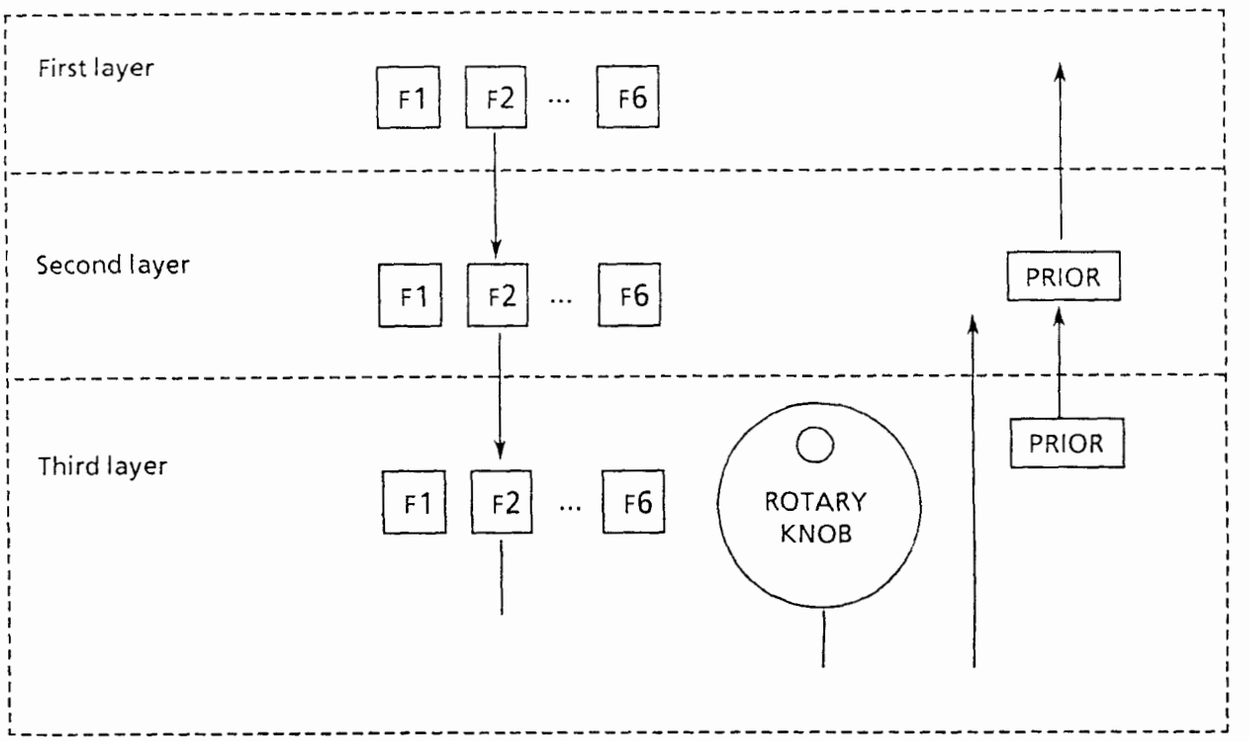
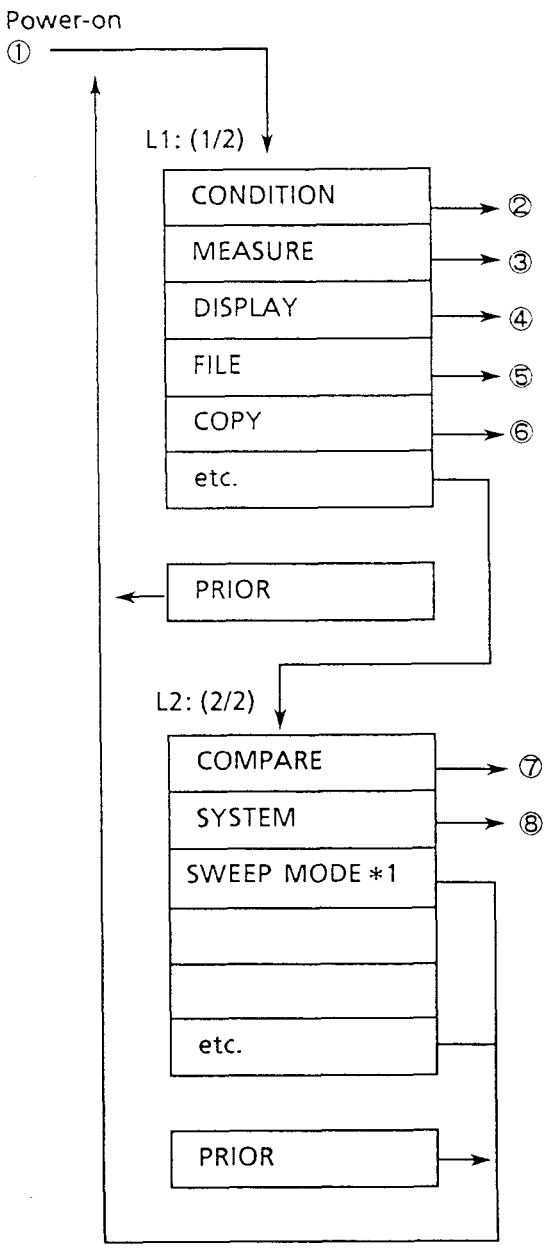


Fig. 5-11 Layer Transition of Soft Keys

5.19.2 Hierarchical structure

In the first layer, mainly functions are devided into certain groups of functions. In the second layer, each function is selected. In the third layer, function parameters are selected.

Figure 5-12 shows the soft key menu in the first layer. The first layer is divided into 8 function groups. Because the whole menu cannot be displayed at a time, the menu is displayed on two separate screens (L1: (1/2) and L2 (2/2)). When the menu is displayed on multiple screens, change the displayed menu within the same layer by pressing the [etc.] key.



Pressing a key in the first layer causes status transition to the second layer (② to ⑧) indicated by the arrow.

For more details, refer to soft key layer transition diagrams in Appendix A where soft key transitions for all layers from layer 1 to layer 3 are shown.

*1 Mode changes alternately. "FAST" is displayed on the screen in the FAST mode.

Fig. 5-12 Menu in First Layer

5.19.3 Description of functions of 1st/2nd layers

Table 5-4 shows the names of first and second layers and outline description of functions.

Table 5-4 Names of First/Second Layers and Description of the Functions

First layer	Second layer	Function
CONDITION	DISTANCE	Sets distance range.
	PULSE	Sets pulse width.
	ATT.	Sets attenuator. (For some unit, fixed value is set. See paragraph 1.5.)
	MASK.	Sets mask.
	OUTPUT POWER	Sets LD output power. (For some unit, this cannot be used. See paragraph 1.5.)
MEASURE	LSA/2PA	Selects the linear approximation method of loss measurement. (Least Square Approximation (LSA) or 2-point Approximation (2PA))
	THRESHOLD	Sets the detection level of auto fault location.
	AVG. LIMIT	Sets averaging count or time.
	IOR	Inputs the refractive index of fiber-optic cable.
	RETURN LOSS	Enters return-loss measurement mode.
	R. LOSS-PARA	Sets parameters for the return-loss measurement.
DISPLAY	TITLE	Inputs the title of measurement screen.
	UNIT	Sets the unit of distance.
FILE	MEDIA	Sets the media type when saving or recalling.
	SAVE	Inputs the file name of waveform to be saved and executes saving.
	SAVE RANGE	Inputs the range and resolution of data to be saved.
	RECALL	Recalls waveform from storage media.
	FILE DELETE	Deletes files in storage media.
	FORMAT	Formats storage media.

Table 5-4 Names of First/Second Layers and Description of the Functions (Cont'd)

First layer	Second layer	Function
COPY	COPY START	Starts producing hard copy.
	COPY STOP	Stops producing hard copy.
	TARGET	Selects the device for data to be copied.
	ALL/TRACE	Sets the contents of copy (whose screen/waveform trace-only)
COMPARE	COMPARE RECALL	Recalls stored measurement result and compares it with other measurement data.
	SETTING ON/OFF	Turns the list of displayed waveform setting conditions on or off.
	COMPARE OFF	Terminates waveform comparison.
SYSTEM	INTERFACE	Sets each parameter value of external interface.
	CALENDAR	Sets the date and time of built-in clock.
SWEEP MODE		Sets the sweep time. (Normal/Fast)

5.20 [INITIALIZE] Key

Pressing the front-panel [INITIALIZE] key initializes the measurement conditions and screen display. While in a remote state, however, pressing this key is ignored.

Table 5-5 lists the items to be initialized and their initial states/initial values. In this table, PID means the initial values inherent in each plug-in unit. Table 5-6 lists the initial values of each plug-in unit.

Table 5-5 Items to be Initialized and Initial States/Values

Item	Initial states/values
LASER	OFF
AVERAGE	OFF
SPLICE/LOSS	LOSS
LSA/2PA	2PA
AUTO	OFF
HORIZONTAL SCALE	PID
VERTICAL SCALE	5dB/div
Rotary knob	Marker shift mode
MARKER	
✳	5th div. from left of horizontal axis scale
X	3rd div. from left of horizontal axis scale
H-SHIFT	0 km
V-SHIFT	10 dB
DISTANCE RANGE	PID
SAMPLING	
START	0 km
END	PID
RESOLUTION	PID

Table 5-5 Items to be Initialized and Initial States/Values (Cont'd)

Item	Initial states/values
λ-SELECT (Valid only for MW0947A switchable plug-in unit)	PID
PULSE WIDTH	PID
ATT	AUTO
AVG. LIMIT	
TIME	12 hours (43,200 seconds)
NUMBER	50,000 times
MASK	OFF
THRESHOLD	1.0 dB
SETTING ON/OFF	OFF
OUTPUT POWER	0

Table 5-6 Initial Values of Plug-in Unit (PID)

Item	Plug-in unit						
	MW0945A	MW0946A	MW0947A	MW0942A	MW0944B	MW0947B	MW0967B
HORIZONTAL SCALE	25 km/div	25 km/div	25 km/div	1 km/div	1 km/div	25 km/div	1 km/div
DISTANCE RANGE	250 km	250 km	250 km	10 km	10 km	250 km	10 km
SAMPLING START	0 km	0 km	0 km	0 km	0 km	0 km	0 km
END	250 km	250 km	250 km	10 km	10 km	250 km	10 km
RESOLUTION	10 m	10 m	10 m	2 m	2 m	10 m	2 m
λ-SELECT	—	—	1.31 μm	—	1.31 μm	1.31 μm	0.85 μm
PULSE WIDTH	10 μs	10 μs	10 μs	2 μs	2 μs	10 μs	2 μs

(Blank)

SECTION 6
MEASUREMENT

This section describes measurement procedure for the typical measurement items with the MW9040B Optical Time Domain Reflectometer. The methods of operation to set individual items such as distance range and pulse width are described in detail in Sections 4 and 5. In this section, these operation items are briefly explained as measurement procedure centering around the sequence of execution. Note that the distance range, pulse width, and other values set in this procedure are just examples, and not actually required values.

Before entering each measurement procedure, it is assumed that the plug-in unit to be used is fitted to the MW9040B mainframe and the MW9040B is in a power-on state.

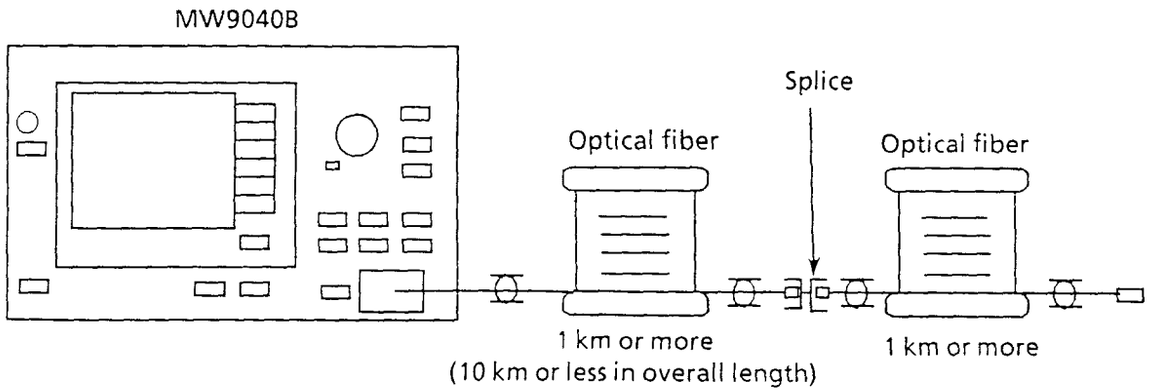
WARNING

For safety reason, never look into the laser output opening and the far end of fiber to be measured connected to it.

6.1 Measuring Absolute Distance

Here, measure the distance from the MW9040B OUTPUT connector to a fault location of fiber (splice point or break point) or its far end.

(1) Setup



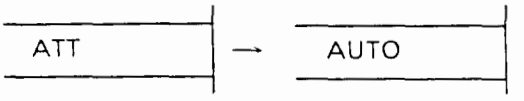
(2) Measurement procedure

Step	Procedure
1	Initialize. INITIALIZE
2	Set the distance range to 10 km. CONDITION → DISTANCE → 10 km
3	Set the pulse width to 100 ns. PULSE → 100 ns

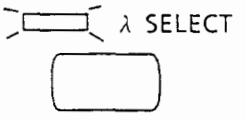
(Continued)

Step	Procedure

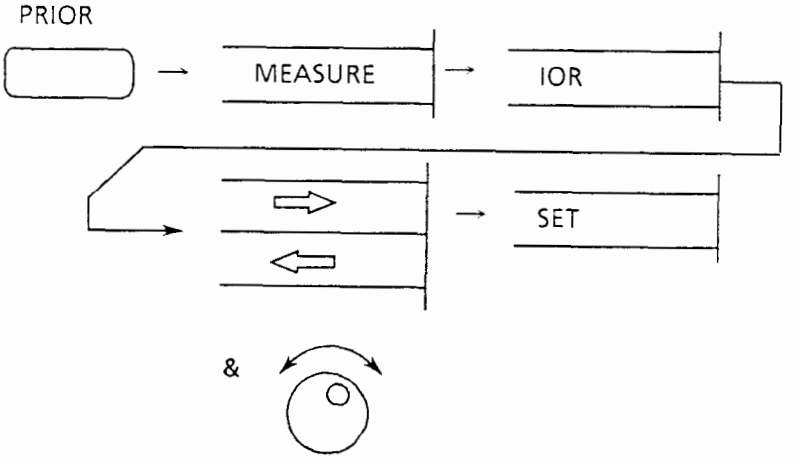
4 Set the attanuator to AUTO. (Some unit cannot be set. See paragraph 1.5.)



5 Select wavelength when using a switchable unit.



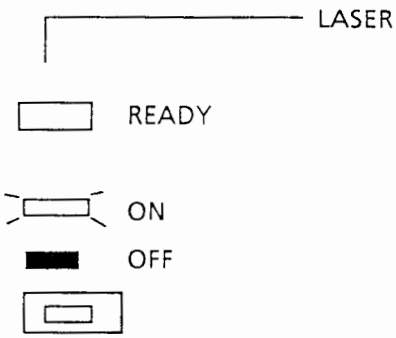
6 Input the reflective index of the fiber to be measured.



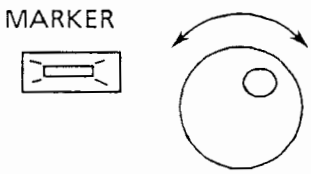
(Continued)

Step	Procedure

7 Press the [LASER] key after confirming that the READY lamp is on.

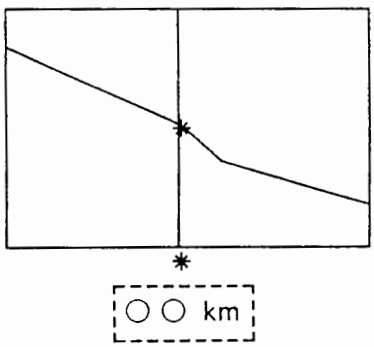


8 Press the [MARKER] key. When this is done, the cursor can be moved in the horizontal axis direction with the rotary knob.



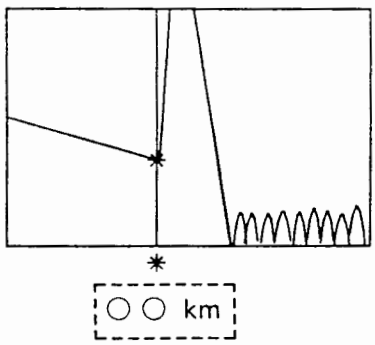
9 Position the cursor at the fault location.

For splice point



Position the cursor at the point where the step difference begins to rise or fall.

For Fresnel reflection point

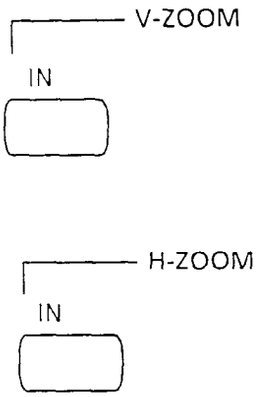


Position the cursor at the rising point of Fresnel reflection.

(Continued)

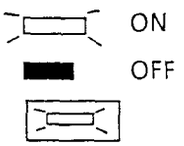
Step	Procedure

10 Get the optimum scale by zooming in the horizontal and vertical axes.

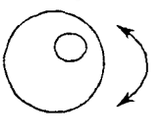


11 When there is much noise, press the [AVERAGE] key to turn averaging on.

AVERAGE



12 Then, precisely position the cursor at the fault location.

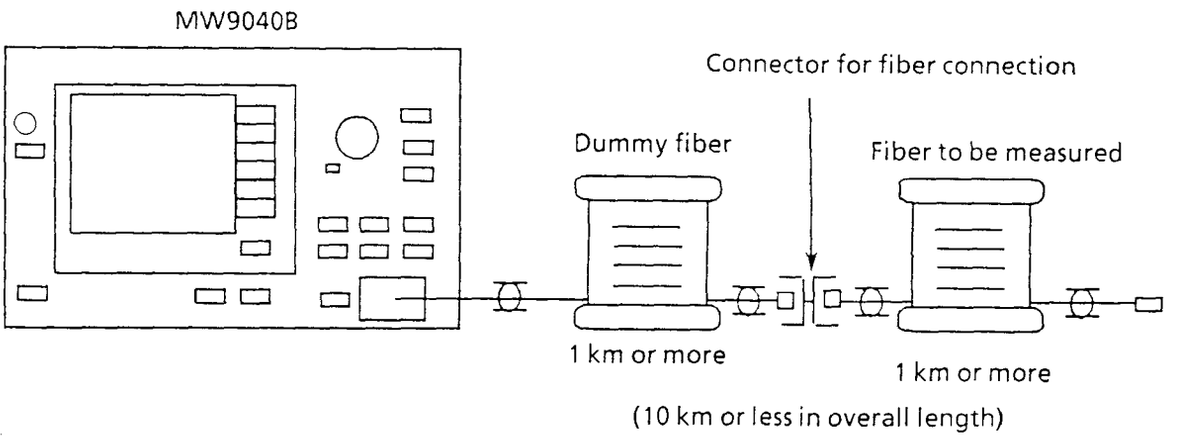


13 The value displayed below the cursor indicates the absolute distance from the OUTPUT connector to the fault location of fiber or end of fiber. ([------] section displayed on the screen in step 9)

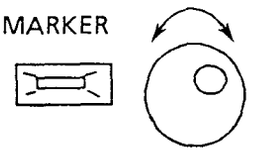
6.2 Measuring Relative Distance

Relative distance between two points is measured. Connect a dummy fiber between the MW9040B and a fiber to be measured as shown below, then measure the length of the fiber to be measured or distance from the connection point to the fault location by relative distance measurement. In this way, it is possible to obtain a value free of error (±1 m) at the measurement start point of the MW9040B and make measurement with much better accuracy than in absolute distance measurement. The length of the fiber to be measured is obtained using this method.

(1) Setup



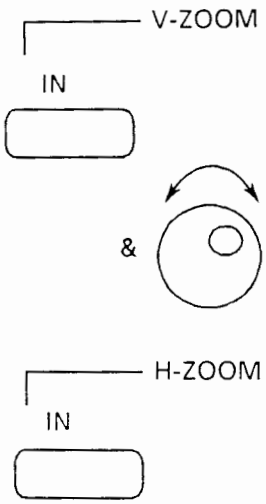
(2) Measurement procedure

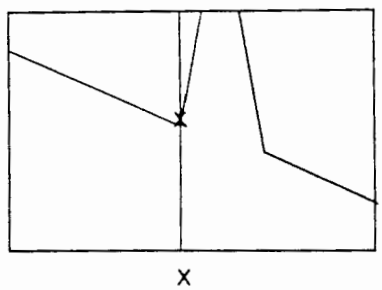
Step	Procedure
1	Execute steps 1 to 7 described in paragraph 6.1 (2).
2	Press the [MARKER] key, and the cursor can be moved in the horizontal axis direction with the rotary knob. 

(Continued)

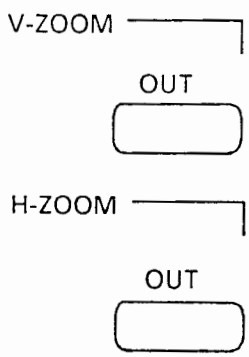
Step	Procedure

3 Position the cursor of the X marker at the Fresnel-reflection rising point of the connector connection between the dummy fiber and fiber to be measured. Position the cursor more accurately by zooming in the horizontal and vertical axes. Take notes of the X marker distance at this time (assumed to be X1 km).





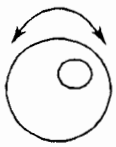
4 Zoom out the horizontal and vertical axes until Fresnel reflection at the far end of the fiber to be measured appears on the screen.

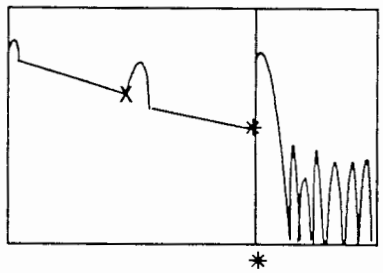


(Continued)

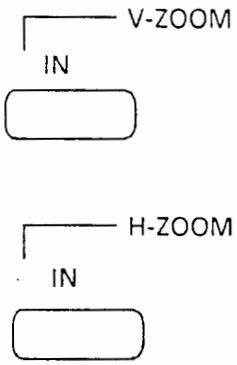
Step	Procedure

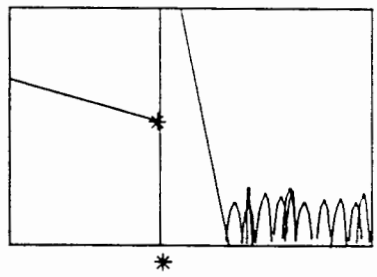
5 Position the cursor of the * marker to the Fresnel-reflection rising point at the far end of the fiber to be measured using the rotary knob.

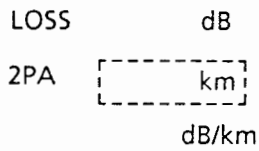




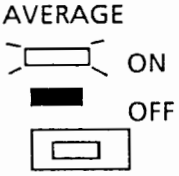
6 Zoom in the horizontal and vertical axes to get the optimum scale.





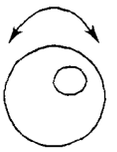


7 If there is much noise, press the [AVERAGE] key to turn averaging on.



(Continued)

Step	Procedure
8	Then, position the cursor more accurately. Get the * marker distance at this time (assumed to be X2 km).



Subtract the distance (X1) measured in step 3 from the * marker distance (X2) obtained here. In this way, the relative distance between two points can be measured with high accuracy.

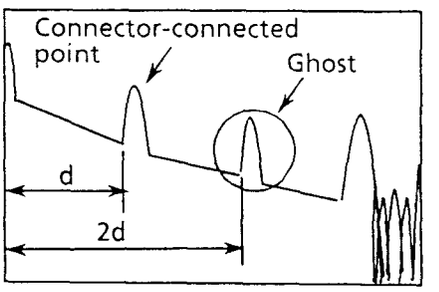
NOTE

- Ghost caused by multiple refelection

  If the reflected light at the connector-connected point returns to the LASER OUTPUT end and reflects again here, optical pulse may seem to be re-emitted from the LD. This irregular reflection appears as a ghost at a point two times the distance from the OUTPUT connector to the connector-connected point as enclosed with a circle in the waveform shown below.

  Be careful not to mistake the ghost for a fault location.

  To eliminate the ghost, adjust the connector's connecting condition or apply matching grease at the connecting surface of the connector to suppress Fresnel reflection to a minimum.

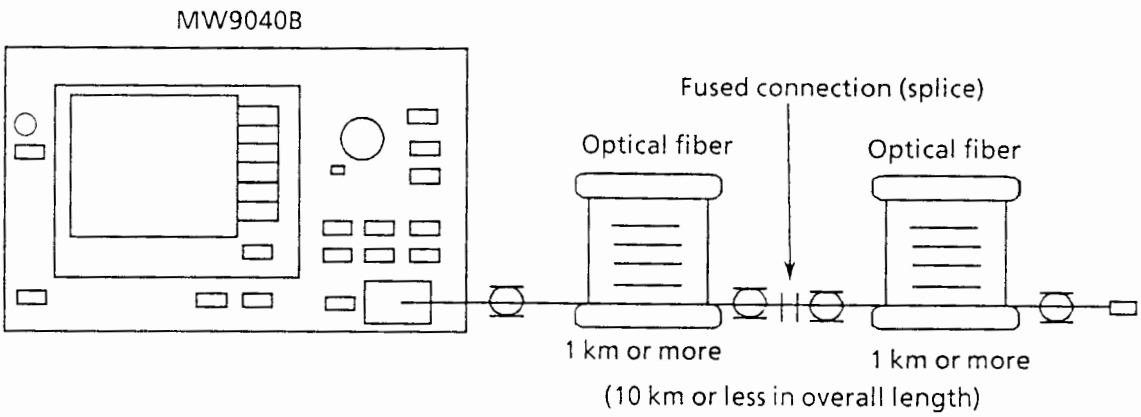


Ghost caused by multiple reflection

6.3 Measuring Splice Loss (fused connection point)

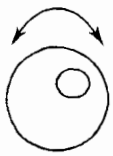
The splice loss at the fused connection point of fiber is measured.

(1) Setup



(2) Measurement procedure

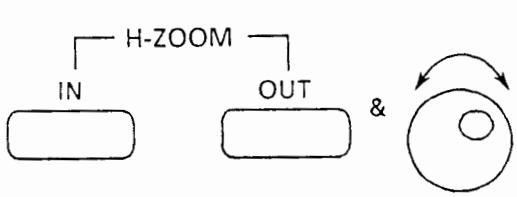
Step	Procedure
1	Execute steps 1 to 8 described in paragraph 6.1 (2).
2	Position the * marker at the splice point (point where the step difference begins to rise or fall).

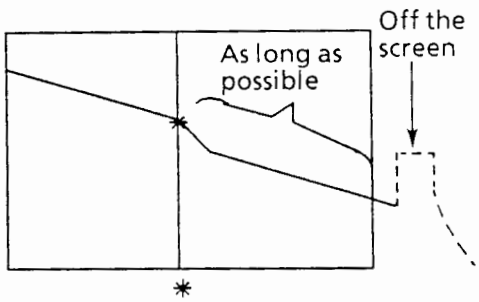


(Continued)

Step	Procedure

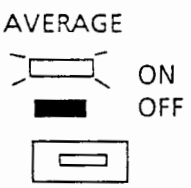
3 Set the horizontal axis scale so that the inclined portion of the waveform before and after the splice point is displayed to the full over the screen. (At this time, it is desirable that the inclined portion is as long as possible and that no fault locations other than the splice point to be measured are displayed on the screen.)



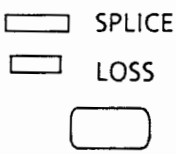


4 Press the [AVERAGE] key to turn averaging on.

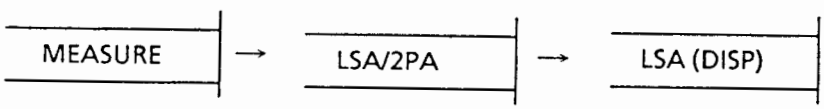
Wait until noise is compressed.



5 Set the measurement mode to SPLICE.



6 Set the approximation method to LSA.



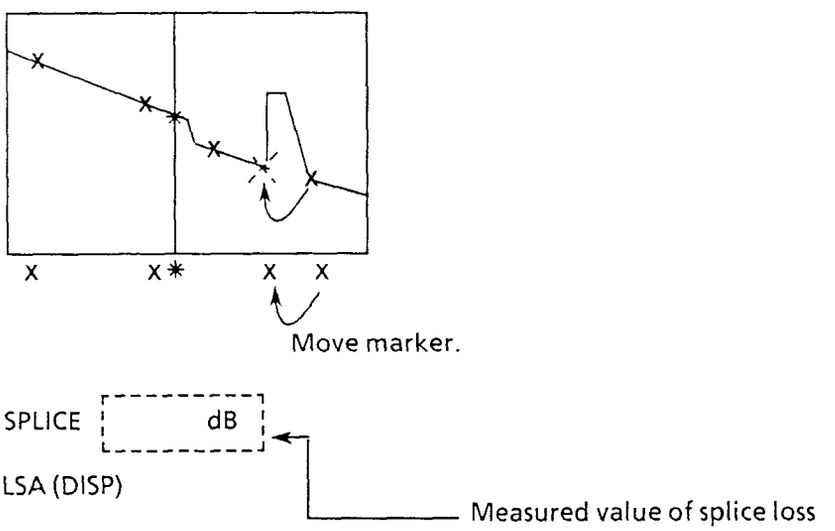
(Continued)

Step	Procedure

7 If there are no splice, etc. other than the object of measurement betrween the two X markers each before and after the * marker, read the measured value of SPLICE indicated in the lower left part of the screen.

Note: If there are splice or Fresnel reflection other than the object of measurement between the two X markers each before and after the * marker, change the X marker positions until there is no splice or Fresnel reflection between the X markers before step 6. At this time, the interval between the X markers should be as long as possible.

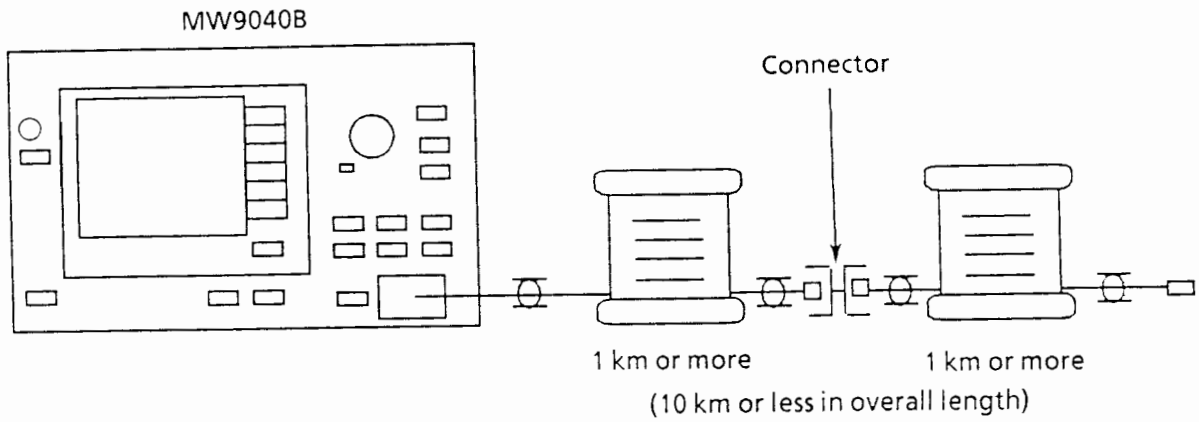
To move the X markers, press the [MARKER] key (two or more times as necessary) to position the cursor at the X marker desired to be moved, then turn the rotary knob.



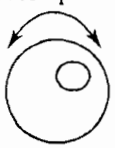
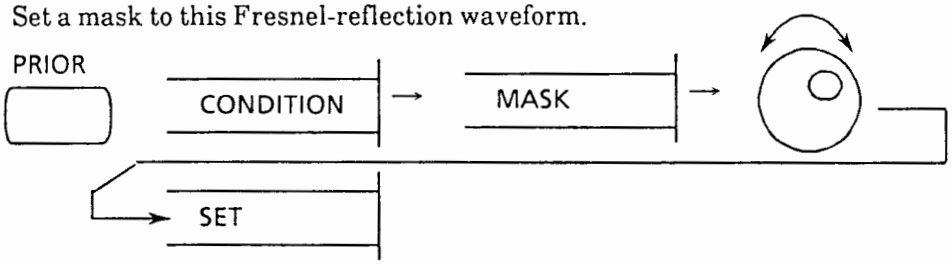
6.4 Measuring Splice Loss (connector point)

The splice loss at the connector point of fiber is measured.

(1) Setup



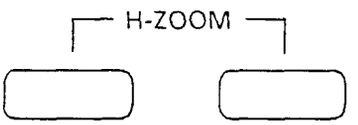
(2) Measurement procedure

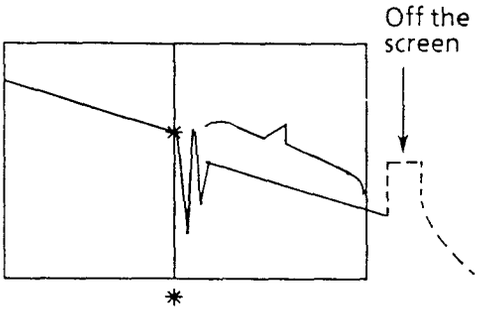
Step	Procedure
1	Execute steps 1 to 8 described in paragraph 6.1 (2).
2	Position the * marker at the splice point (Fresnel-reflection rising point at the connector point.) 
3	Set a mask to this Fresnel-reflection waveform. 

(Continued)

Step	Procedure

4 Set the horizontal axis scale so that the inclined portion of the waveform before and after the splice point is displayed to the full over the screen. (At this time, it is desirable that the inclined portion is as long as possible and that no fault locations other than the splice point to be measured are displayed on the screen.)

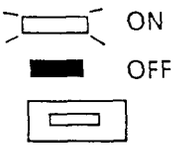




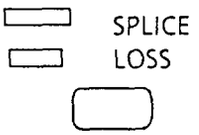
5 Press the [AVERAGE] key to turn averaging on.

Wait until noise is compressed.

AVERAGE

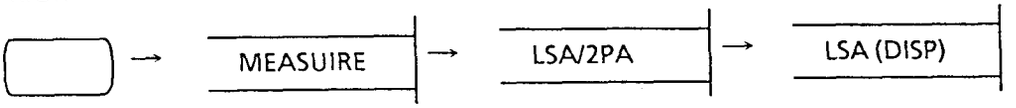


6 Set the measurement mode to SPLICE.



7 Set the approximation method to LSA.

PRIOR



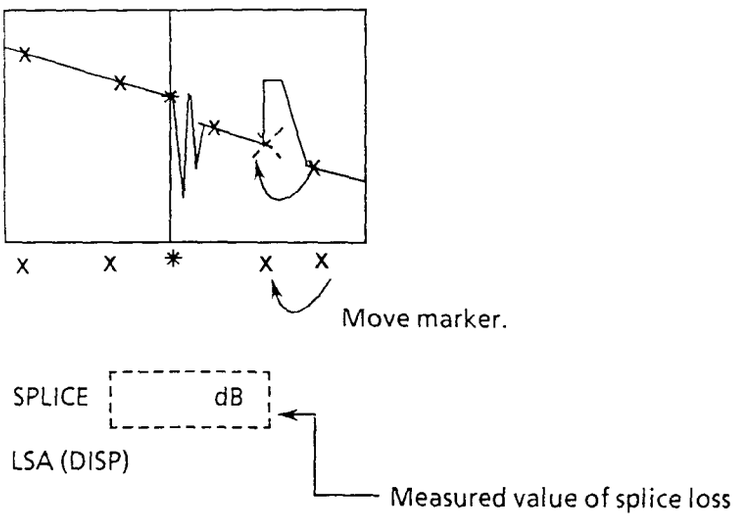
(Continued)

Step	Procedure

8 If there are no splice, etc. other than the object of measurement between the two X markers each before and after the * marker, read the measured value of SPLICE indicated in the lower left part of the screen.

NOTES:

1. If there are splice of Fresnel reflection other than the object of measurement between the two X markers each before and after the * marker, change the X marker positions until there is no splice of Fresnel reflection between the X markers. At this time, the interval between the X markers should be as long as possible.

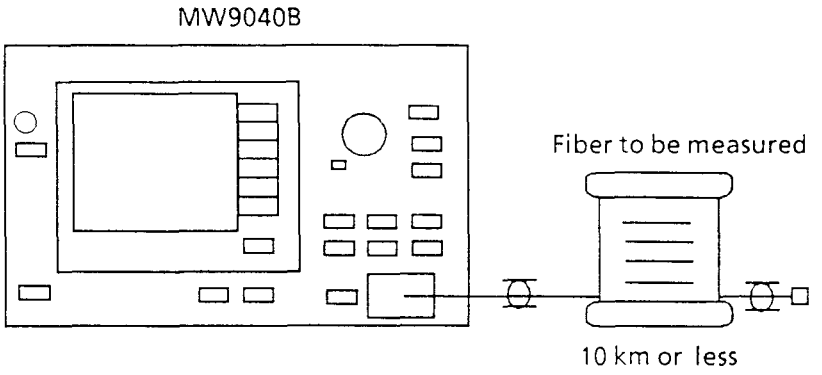


2. If secondary reflection (ghost) occurs, set the markers in front of the secondary reflection waveform or change the approximation method from LSA (DISP) to 2PA before making measurement. To set 2PA, use 2PA in place of LSA (DISP) in step 7.

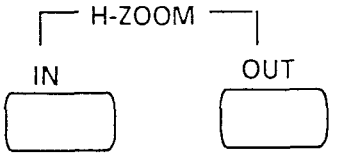
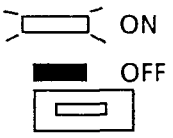
6.5 Measuring Transmission Loss

The transmission loss of fiber is measured.

(1) Setup



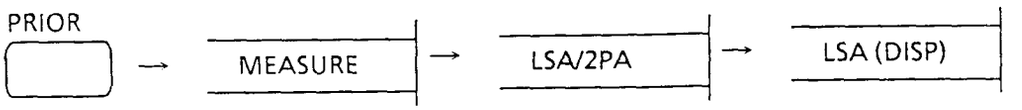
(2) Measurement procedure

Step	Procedure
1	Execute steps 1 to 7 described in paragraph 6.1 (2).
2	Set the horizontal axis scale so that the entire waveform is displayed over the screen. 
3	Press the [AVERAGE] key to turn averaging on. Wait until noise is compressed. AVERAGE 

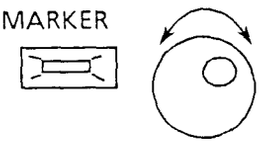
(Continued)

Step	Procedure

4 Set the approximation method to LSA.



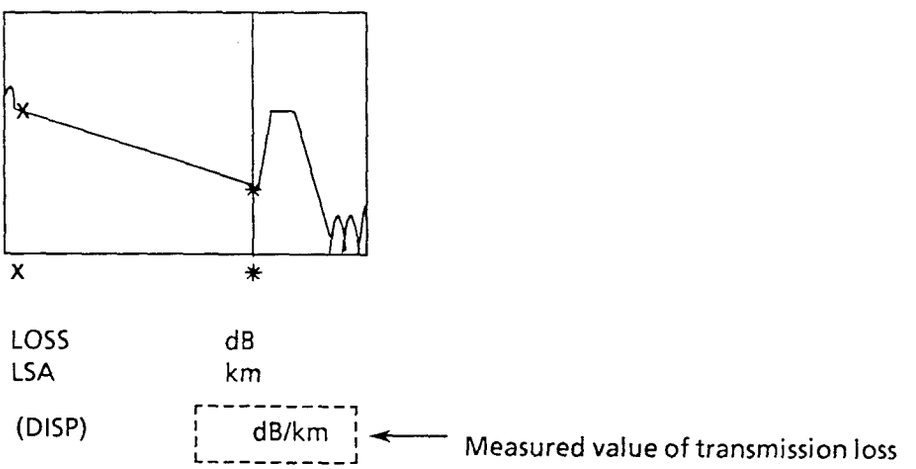
5 Press the [MARKER] key, and the cursor can be moved in the horizontal axis direction with the rotary knob.



NOTE:

Each time pressing the [MARKER] key, the cursor line alternately move along the * marker and X marker.

6 Set a X marker at the near end of fiber and a * marker at the Fresnel-reflection rising point at the far end of fiber.



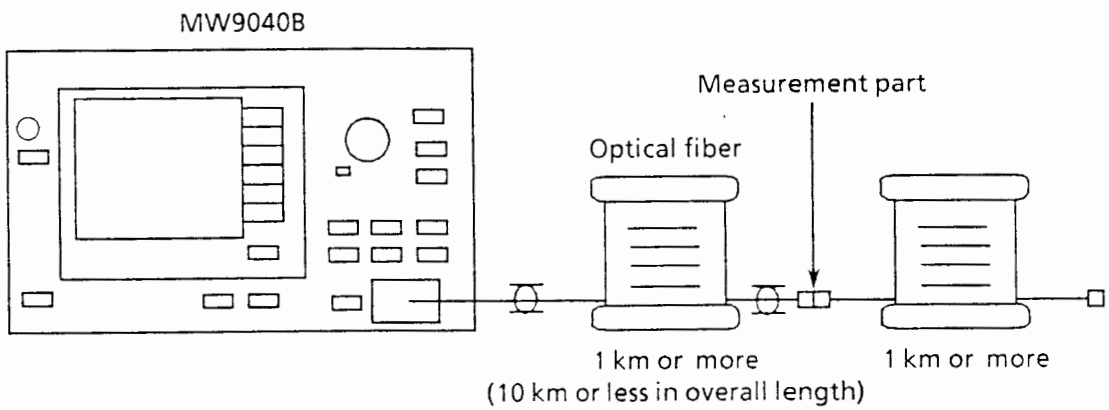
(Continued)

Step	Procedure
7	Read the measured value of transmission loss (indicated in the [------] section of the screen in step 6).

6.6 Measuring Return Loss

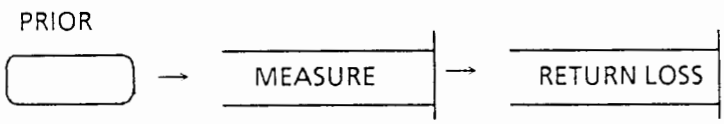
Measures the return loss of a connector.

(1) Set up

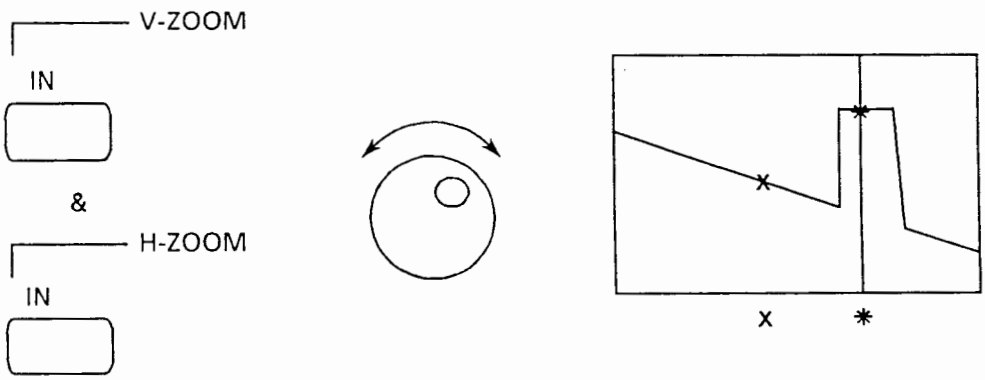


(2) Measurement procedure

Step	Procedure
1	Perform steps 1 to 7 in paragraph 6.1 (2).
2	Set to Return Loss Mode.



3	Using the rotary knob, position the cursor of the * marker at the peak of the Fresnel reflection of the connector to be measured. Zoom out the horizontal and vertical axes, and then adjust the position of the cursor more exactly.

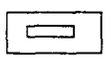


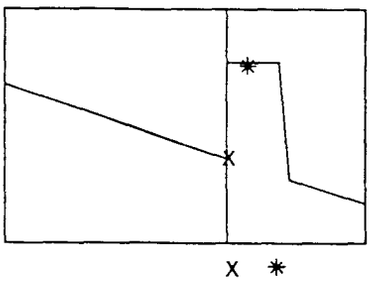
(Continued)

Step	Procedure

4 Press the [MARKER] key. Position the cursor of the × marker at the nearest back-scattered-light waveform immediately before the Fresnel reflection.

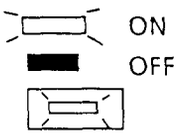
MARKER



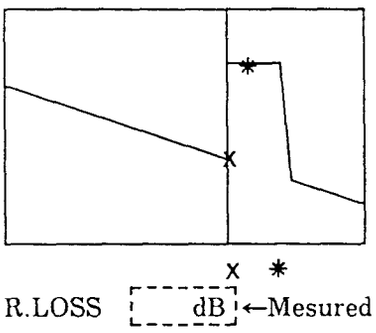


5 If there is a lot of noise, press the [AVERAGE] key to enable averaging.

AVERAGE



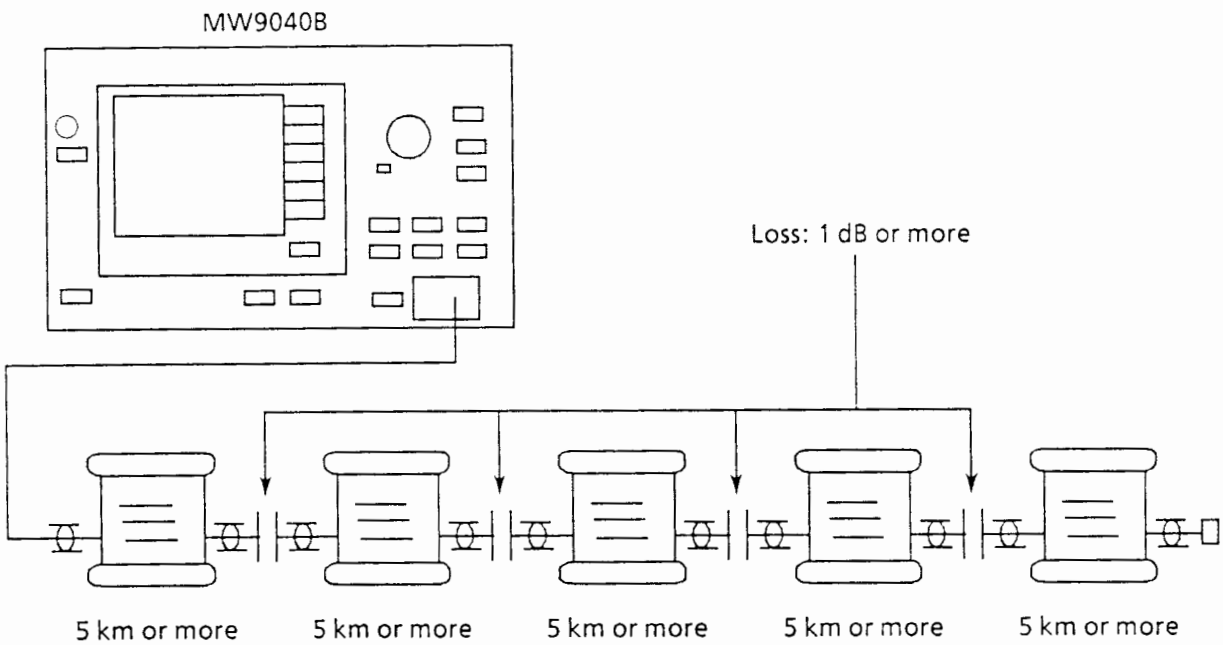
6 Read the return-loss (R.LOSS) value shown on the lower left of the screen.



6.7 Auto Fault Location

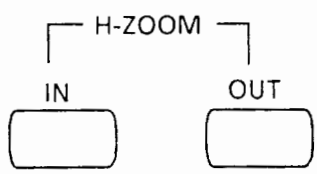
When splice loss is greater than the user's set value (threshold value), or when the difference between far-end back-scattered light level and noise floor level is greater than the threshold value within the waveform range displayed on the MW9040B screen, such points are regarded as fault points and automatically detected.

(1) Set up



(2) Measurement procedure

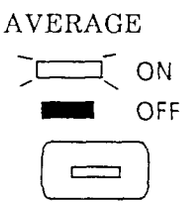
Step	Procedure
1	Make operation as per Steps 1 to 7 in Paragraph 6.1 (2).
2	Set the horizontal scale so that the whole waveform is fully displayed throughout the screen.



(Continued)

Step	Procedure

3 Press the [AVERAGE] key for average on.

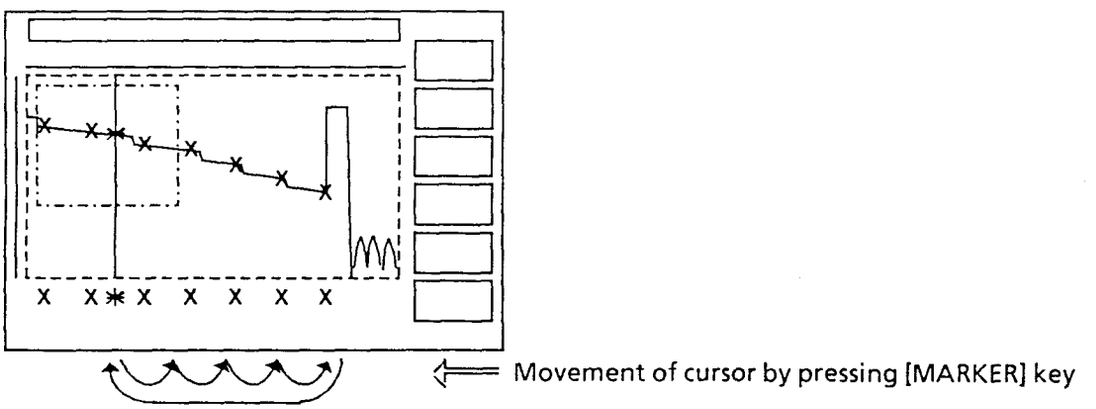


4 Set up the threshold level.

5 Make setting for the AUTO mode.

6 The result of measurement is displayed, as illustrated below.

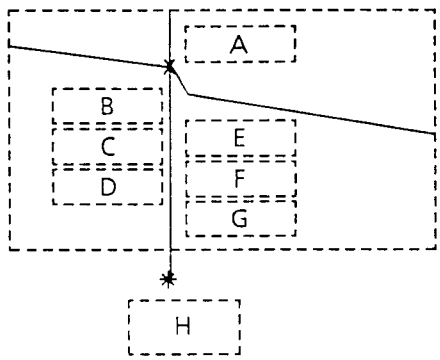
X marker is placed on a maximum of 5 fault points. In the first place, selection is made for the fault point closest to the laser output port. A cursor is given there. The selected fault point is indicated by * marker . Each time the [MARKER] key is pressed, the cursor moves to the neighboring fault point on the right and the result of related measurement is displayed.



(Continued)

Step	Procedure

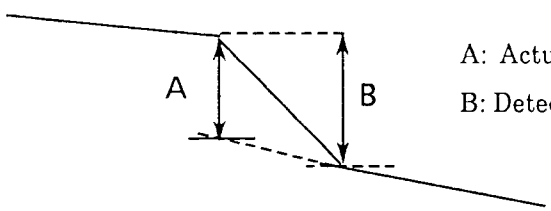
The following information is presented in the vicinity of the fault point box ( ) in the above illustration) where the cursor is placed.



A:	Loss at the fault point	dB
B and E:	Loss in fiber between X markers immediately before or after the fault point	dB
C and F:	Length of fiber between X markers immediately before or after the fault point	km
D and G:	Transmission loss in fiber between X marker immediately before or after the fault point	dB/km
H:	Distance from the fiber near-end to the fault point	km

Notes:

1. Since the threshold value to be detected is a value as shown in the illustration below, even a fault point with splice loss smaller than the present threshold value may actually be detected.



A: Actual splice loss

B: Detected threshold value

2 In addition to the * and X markers to indicate fault points, X Marker used for loss measurement is also displayed on the waveform being measured.

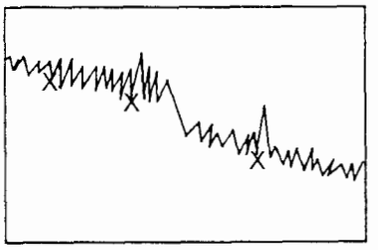
The X marker for loss measurement moves together with the * marker .

3 In case of measurement impossible, information about fiber loss, etc., is indicated by the character: "*."

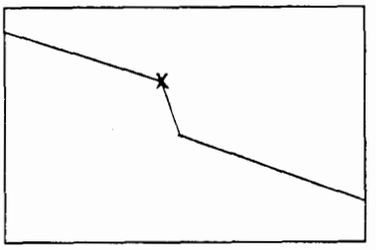
(Continued)

Step	Procedure

4. Where a considerable amount of noise is contained in a waveform being measured, and if the threshold value is very small, a singular point of noise may be identified as a fault point, as illustrated below.



In such a case, reduce the noise by either sufficiently averaging all values being used, or by increasing the threshold value.



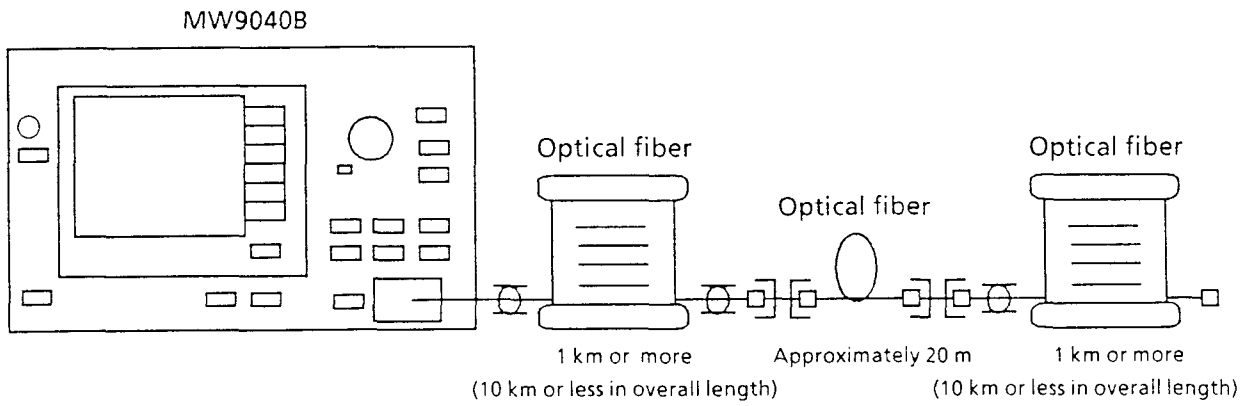
When averaging has been sufficiently conducted

5. If the set mask position is overlapped on the screen, multiple detection may be performed on the position.

6.8 Measuring Distance between Two Proximate Connecting Points

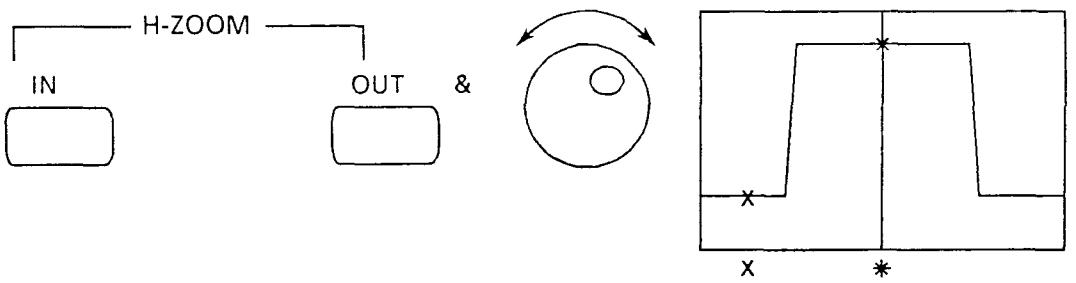
Measures the distance between two connecting points by connectors.
There are some plug-in units that cannot use this function. (refer to paragraph 1.5).

(1) Set up

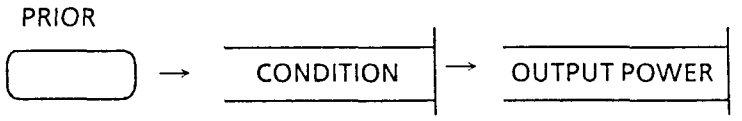


(2) Measurement procedure

Step	Procedure
1	Perform steps 1 to 7 in paragraph 6.1 (2).
2	Set the scale of the horizontal axis so that the Fresnel-reflection pattern (of the connecting points to be measured) appears on the screen.



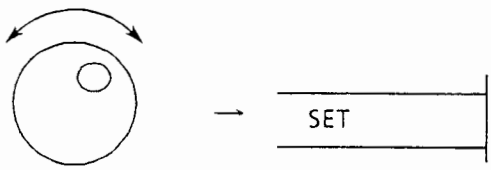
3	Set to Output-Power Variable Mode.

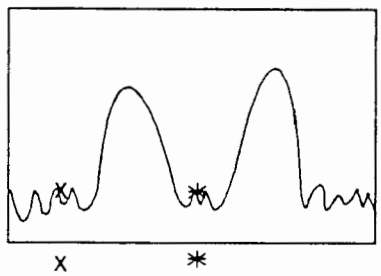


(Continued)

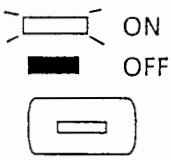
Step	Procedure

4 Set the output power.

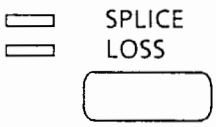




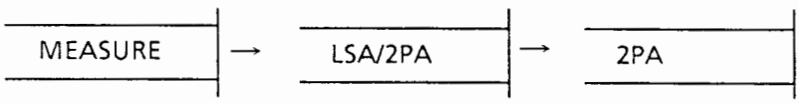
5 If there is a lot of noise, press the [AVERAGE] key to enable averaging.



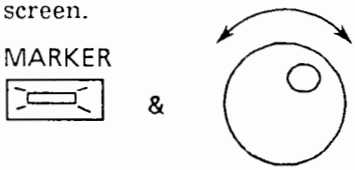
6 Set to LOSS mode.

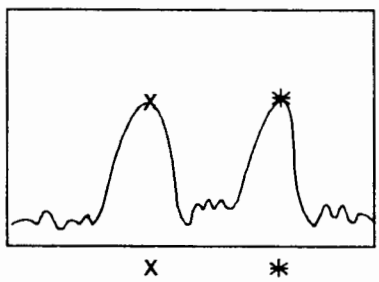


7 Set to 2PA approximation methed.



8 Position the × marker and the * marker at the two Fresnel-reflection peaks. The distance between the two connecting points will be displayed on the lower left of the screen.





LOSS ____ dB
2PA [____ km]
dB/km

← Measured value of distance between two points

SECTION 7
PERFORMANCE TEST

This section describes the testing equipment used to test the performance of the MW9040B and the method to set it up and procedure to conduct the test.

7.1 Need for Performance Test

The performance test described here is required as part of maintenance to prevent a reduction in measurement reliability due to performance deterioration of the MW9040B over time.

The performance test is made for the following items:

- Wavelength
- Pulse width
- Dynamic range
- Accuracy of distance measurement
- Accuracy of vertical axis

7.2 Testing Equipment

Table 7-1 lists the equipment used for the performance test.

Table 7-1 Testing Equipment

Equipment (recommended type)	Required performance	Measurement item
Optical spectrum analyzer (MS9001B)	Wavelength: 0.8 to 1.6 μm Level: −70 to 0 dBm	Wavelength
Stabilized optical source (MG9001A, MG0930C)	Wavelength: 1.31/1.55 ±0.02 μm Spectrum width: ≦0.01 μm Level: −10 to 0 dBm	Dynamic range Vertical-scale accuracy (for MW0945A, MW0946A, and MW0947A/B)
Optical power meter and sensor (ML9001A, MA9611A)	Wavelength: 1.2 to 1.6 μm Level: −70 to 0 dBm	Dynamic range (for MW0945A, MW0946A, and MW0947A/B)
Optical variable attenuator (MN924A)	Wavelength: 1.31/1.55 μm Attenuation: >60 dB max	Dynamic range Pulse width Vertical-scale accuracy (for SM units)
Optical variable attenuator (MN9002A, MN0901A, MN0902A)	Wavelength: 1.3/1.55 μm Attenuation: >60 dB max	Vertical-scale accuracy (for MW0944B and MW0947B)
Optical variable attenuator (MN938A)	Wavelength: 0.85/1.3 μm Attenuation: >60 dB max	Pulse width Vertical-scale accuracy (for GI units)
Waveform monitor (MP95A)	Wavelength: 0.7 to 1.0 μm Rise time/fall time: ≦2 ns	Pulse width (for 0.85 μm)
Waveform monitor (MP96A)	Wavelength: 1.2 to 1.6 μm Rise time/fall time: ≦500 ps	Pulse width (for 1.3/1.55μm)
Oscilloscope	Frequency: DC to 200 MHz	Pulse width
Optical power meter and sensor (ML9001A, MA9712A)	Wavelength: 0.75 to 1.8 μm Linearity: ±0.15 dB	Vertical-scale accuracy (for MW0945A, MW0946A, and MW0947A)

7.3 Test Method

The following describes the specification of each test item and the test procedure.

The equipment setup is indicated for each test item.

Carefully clean the optical connector part before connecting the connectors. (For details, see paragraph 9.1.)

The test procedure described here assumes that the necessary plug-in unit is fitted into the MW9040B and the MW9040B is in a power-on state before each test procedure is executed.

WARNING

For safety reason, never look into the MW9040B Optical Time Domain Reflectometer, its optical source laser output opening, or the far end or other parts of the fiber connected to it.

7.3.1 Specifications

Table 7-2 summarizes the specifications of each test item.

Table 7-2 Performance Test Specifications

Mainframe	MW9040B																																
Unit	MW0945A			MW0946A			MW0947A			MW0942A					MW0944B					MW0947B						MW0967B							
Measured fiber	SM																								GI							
Wavelength (nm)	1310±15			1550±15			1310±15 /1550±15			1310±15					1310±15 /1550±15					1310±15 /1550±15						850±15 /1300±15							
Pulse width (μs)	0.1	1	10	0.1	1	10	0.1	1	10	0.01	0.02	0.1	0.5	2	0.01	0.02	0.1	0.5	2	0.02	0.1	0.5	1	4	10	0.05	0.02	0.1	0.5	2			
One-way back scattered light dynamic range (dB) *	20	25	34	18	23	32	18 / 16	23 / 21	32 / 30	4.0	5.5	9.0	12.5	15.5	4.5 / 2.0	6.0 / 3.5	9.5 / 7.0	13.0 / 10.5	16.0 / 13.5	13 / 11	16 / 16	21 / 19	24 / 22	29 / 27	32 / 30	7.0 / 5.0	10.0 / 8.0	13.5 / 11.5	17.0 / 15.0	19.5 / 18.0			
Accuracy of distance measurement	±1 m ± measured value × 2 × 10^{-5} (However, this does not include the uncertain factor of the measured fiber's refractive index.)																																
Accuracy of vertical axis	±0.2 dB: 0 to 7 dB ±0.03 × measured value (dB): 7 to 15 dB (Pulse width = 100 ns) 7 to 20 dB (Pulse width = 1 μs) 7 to 25 dB (Pulse width = 10 μs)									±0.3 dB (0 to 5 dB) ±0.5 dB (5 to 10 dB) ±0.7 dB (10 to 15 dB)					±0.05 dB/dB					±0.03 dB/dB						±0.05 dB/dB							

* Difference between the near-end back-scattered light level and the level 0.3 dB higher than the noise peak on noise floor

7.3.2 Wavelength Test

Test the center wavelength of the laser output.

(1) Set up

Connect the equipment as shown in Fig. 7-1.

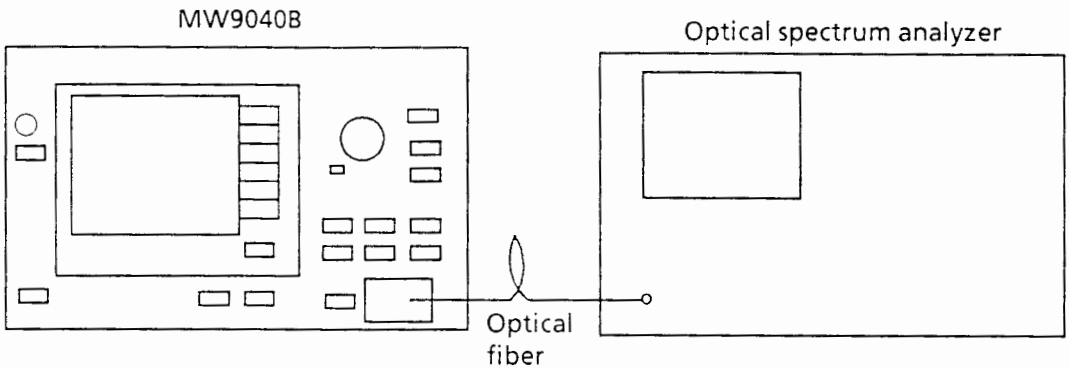
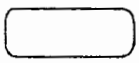
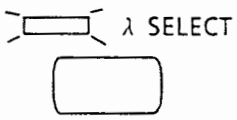
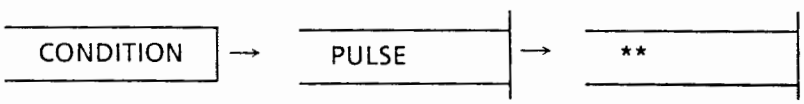
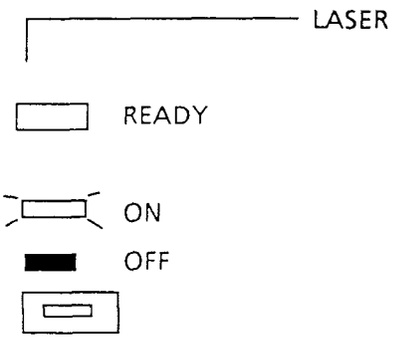


Fig. 7-1 Equipment Setup for Wavelength Test

(2) Test procedure

Step	Procedure
1	Press the [INITIALIZE] key to initialize the settings. INITIALIZE 
2	When using the wavelength switchable plug-in unit, select the wavelength to be used for testing. 
3	Select the maximum pulse width among the allowable ones.  ** : Selectable pulse width which differs depending on the distance range and plug-in unit (See para. 1.5.)

(Continued)

Step	Procedure
4	Press the [LASER] key after confirming that the [READY] lamp is on. 
5	Receive the laser light with an optical spectrum analyzer to adjust the measurement level and wavelength resolution.
6	Select the envelope method on the optical spectrum analyzer and set r = 0.25.
7	Confirm that the measured results are within the specifications.

7.3.3 Pulse Width Test

Test the pulse width of the laser output.

(1) Set up

Connect the equipment as shown in Fig. 7-2.

For testing the MW0967B; change the MN924A and MP96A to the MN938A and MP95A, respectively.

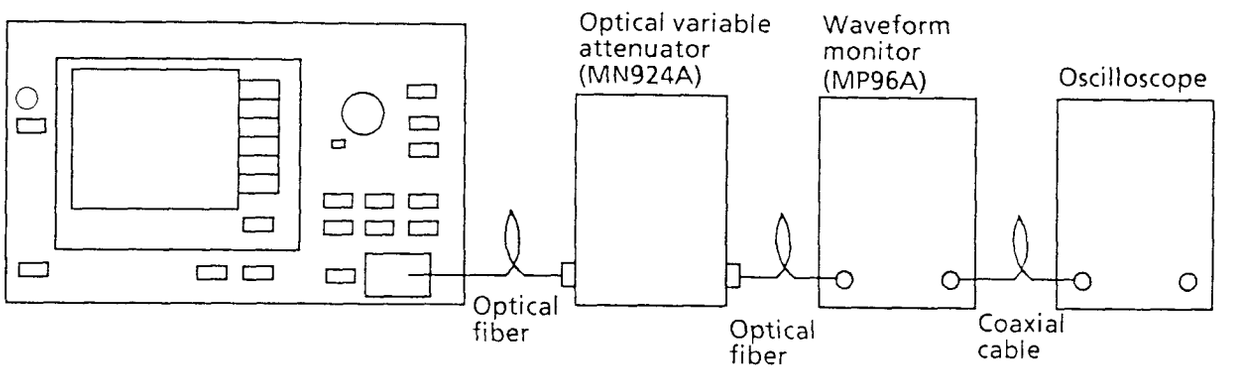
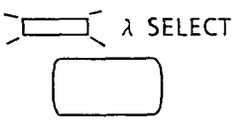


Fig. 7-2 Equipment Setup for Pulse Width Test

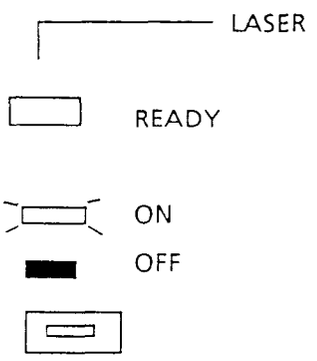
(2) Test procedure

Step	Procedure
1	Press the [INITIALIZE] key to initialize the settings. INITIALIZE 
2	When using the wavelength switchable plug-in unit, select the wavelength to be used for testing. 

(Continued)

Step	Procedure

3 Press the [LASER] key after confirming that the [READY] lamp is on.



4 Adjust the oscilloscope amplitude- and time-base scale appropriately, then display the waveform as shown in Fig. 7-3 on the oscilloscope screen.

Adjust the Optical Variable Attenuator so that the Waveform Monitor does not saturate.

5 Find the pulse width PW of the MW9040B laser output according to the procedure described below.

Measure the pulse width at the half peak level of the waveform on the oscilloscope screen as shown in Fig. 7-3.

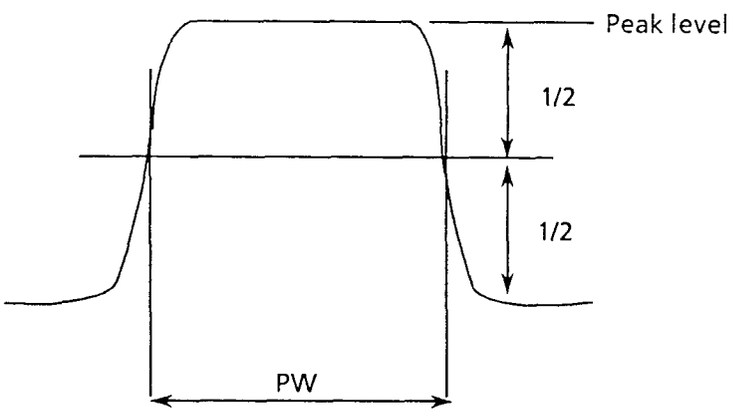
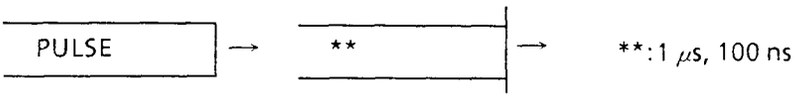


Fig. 7-3 Pulse Width

(Continued)

Step	Procedure
6	Confirm that PW is within the displayed value ±10%.
7	Change the pulse width. (The selectable pulse width differes depending on the unit. See paragraph 1.5.)



Repeat the above steps 4 to 6 after changing the pulse width each time.

7.3.4 Dynamic-range test for one-way back-scattered light

Test the dynamic range. This testing is required for each wavelength and each pulse width.

1. Testing the MW0945A, MW0946A, and MW0947A/B

(1) Setup

According to the test procedure, connections of (a) to (c) are made as shown in Fig. 7-4, bearing in mind the follwing conditions:

Conditions:

Fiber A and Fiber B shall be more than 40 km respectively, and minimum whole loss shall be 13 dB or less at 1.31 μm or 11 dB or less at 1.55 μm.

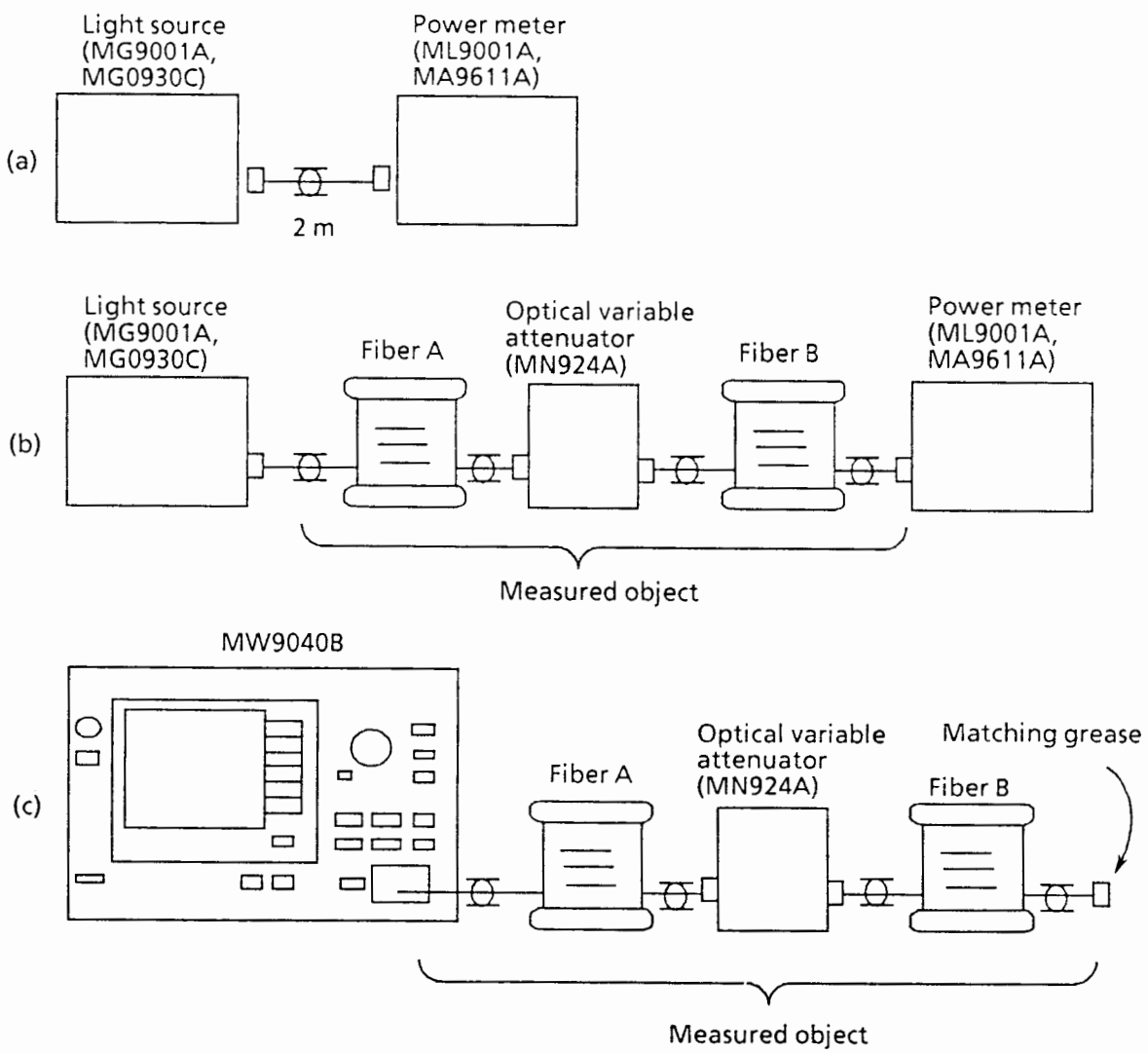


Fig. 7-4 Equipment Setup for Dynamic-Range Test (For MW0945A, MW0946A, and MW0947A/B)

(2) Test procedure

Step	Procedure
1	Connect equipment as shown in Fig. 7-4 (a).
2	Read out the output level P1 (dBm) of the light source with a power meter.
3	Make connections as shown in Fig. 7-4 (b).
4	Adjust the value for the optical variable attenuator so that the difference (P1 – P2, dB) between power meter read-out P2 (dBm) and P1 of Step 2 (dBm) becomes equal to the required dynamic range.

Note

Connects of operation for this step are to set up a measured object with a loss equal to the dynamic range. The measure object is a set of optical variable attenuator connected between Fiber A and Fiber B. Until completion of a series of measurements, it is not recommended to move connections and change the setting conditions for the optical variable attenuator.

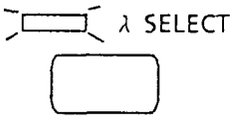
5	Disconnect the measured object from the light source and the power meter. Then connect it to the LASER OUTPUT connector as shown in Fig. 7-4 (c).
6	Apply a matching grease to the far end of the Fiber B.

Note

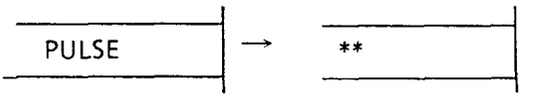
If a connector applied with a matching grease is being reconnected to other equipment, remove this matching grease thoroughly.

Refer to paragraph 2.5 herein.

7	When using the wavelength switchable plug-in unit, select the wavelength to be used for testing.



8	Set up the pulse width that is being used. (The selectable pulse width differs depending on the unit. See paragraph 1.5.)

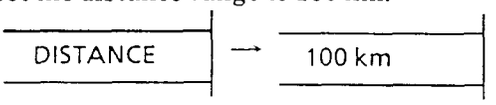


**: 10 μs, 1 μs, 100 ns

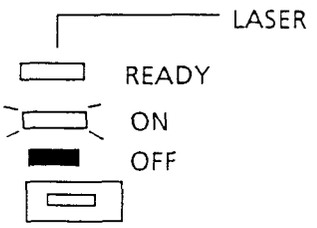
(Continued)

Step	Procedure

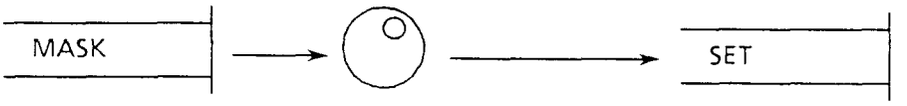
9 Set the distance range to 100 km.



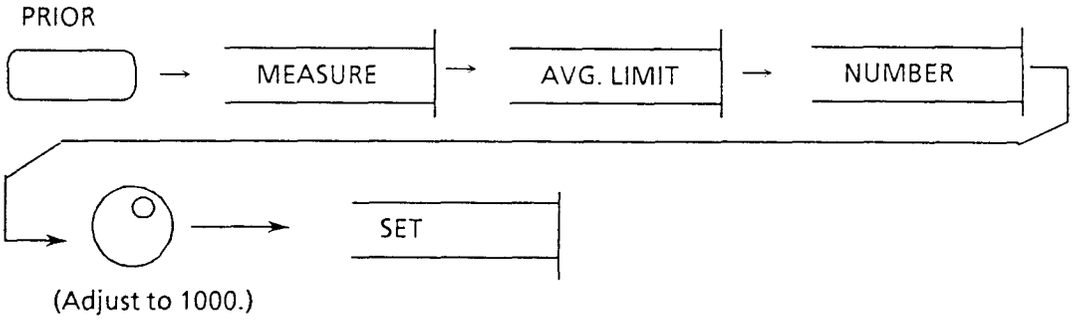
10 Press the [LASER] key after confirming that the READY lamp is on.



11 To attenuate Fresnel reflection, set a mask at a point of Fresnel reflection, which is located at the connector joint of the optical variable attenuator.

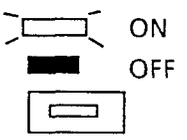


12 Set the averaging limit value to 1000.



13 Press the [AVERAGE] key to enable averaging.

AVERAGE



(Continued)

Step	Procedure

14 After averaging has been completed and the laser circuit has been turned off, confirm that the difference between fiber's far-end level and peak noise level (excluding anomalous points) is 0.3 dB or more.

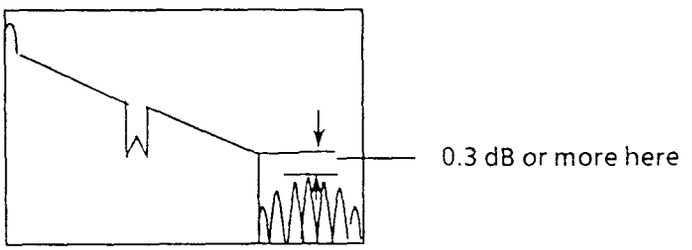


Fig. 7-5 Fiber Far-End Trace

2. Testing the MW0944B and MW0967B

(1) Setup

Set up the system as shown in Fig.7-6.

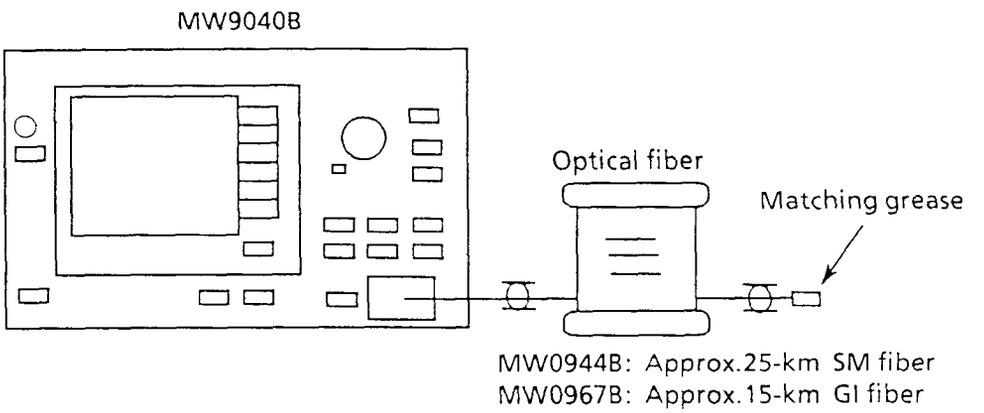
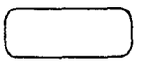
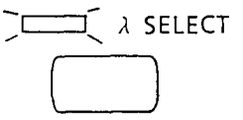
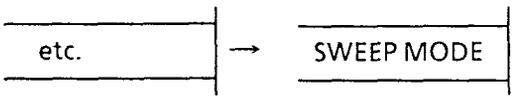
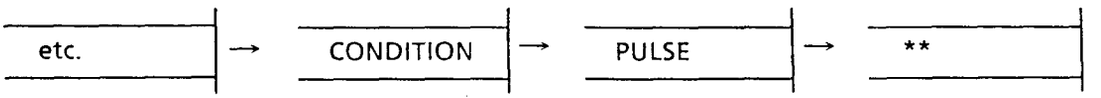


Fig. 7-6 Setup for Dynamic Range Test (For MW0944B and 0967B)

(2) Test procedure

Step	Procedure
1	Press the [INITIALIZE] key to initialize the settings. INITIALIZE 
2	When using the wavelength switchable plug-in unit, select the wavelength to be used for testing. 
3	Set the sweep mode to FAST. 
4	Set the pulse width to the appropriate value. (The range of the pulse width setting varies in accordance with the type of plug-in unit. See paragraph 1.5.) 

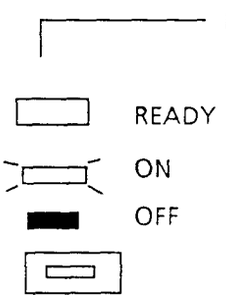
(Continued)

Step	Procedure

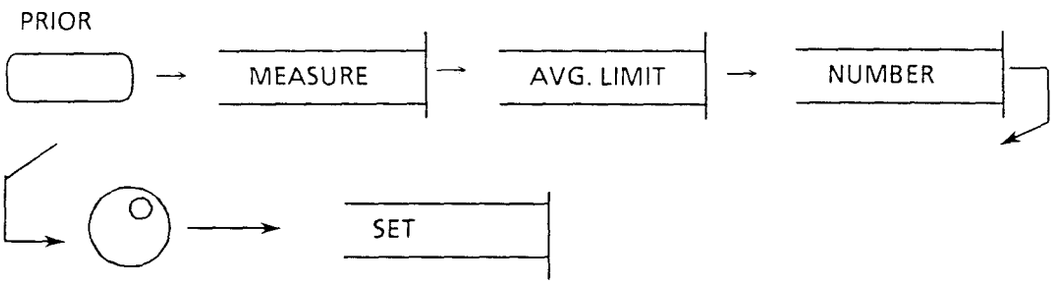
5 Set the distance range to 50 km or 25 km for the MW0944B or MW0967B, respectively.

** : 50 km for MW0944B
: 25 km for MW0967B

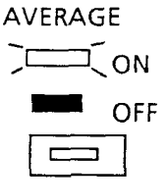
6 Press the [LASER] key after confirming that the READY lamp is on.



7 Set the averaging limit value to 2000.



8 Press the [AVERAGE] key to enable averaging.



9 After averaging has been completed and the laser circuit has been turned off, confirm that the difference between the near-end back-scattered light level and the level of the point which is 0.3 dB higher than the noise-floor peak (excluding anomalous points) is greater than the specified value.

7.3.5 Testing Accuracy of Distance Measurement

Test the horizontal axis, that is, the accuracy of distance measurement. This test may only be conducted with a certain distance range; there is no need to test with other ranges.

(1) Setup

Connect the equipment as shown in Fig. 7-7.

The length and refractive index of the fiber to be measured must be known values.

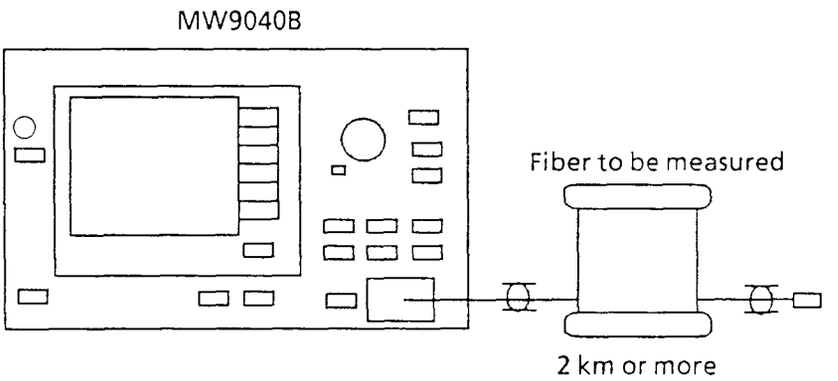
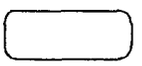
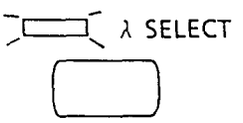


Fig. 7-7 Equipment Setup for Testing Accuracy of Distance Measurement

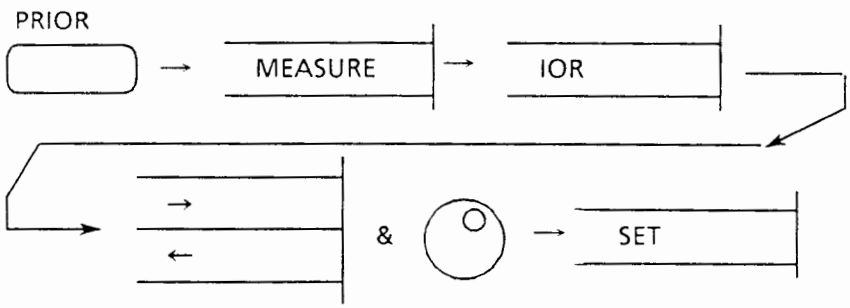
(2) Test procedure

Step	Procedure
1	Press the [INITIALIZE] key to initialize the settings. INITIALIZE 
2	When using the wavelength switchable plug-in unit, select the wavelength to be used for testeing. 

(Continued)

Step	Procedure

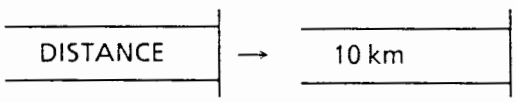
3 Set the refractive index of the fiber to be measured.



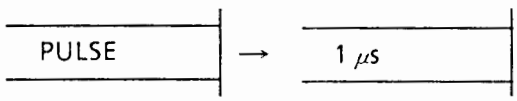
NOTE

The refractive index of fiber varies with wavelength. When using the wavelength switchable plug-in unit, set the refractive index for the wavelength selected in step 2.

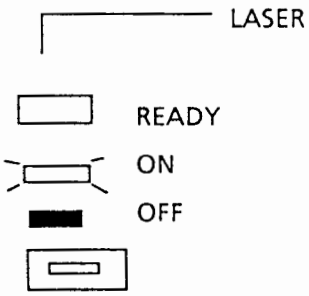
4 Set the distance range to 10 km.



5 Set the pulse width to 1 μs.



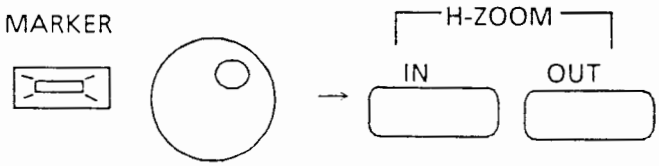
6 Press the [LASER] key after confirming that the [READY] lamp is on.



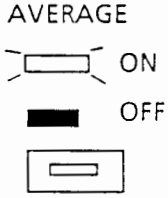
(Continued)

Step	Procedure

7 Position the marker at the far-end Fresnel reflection and set the horizontal axis sensitivity for 25 m/div.

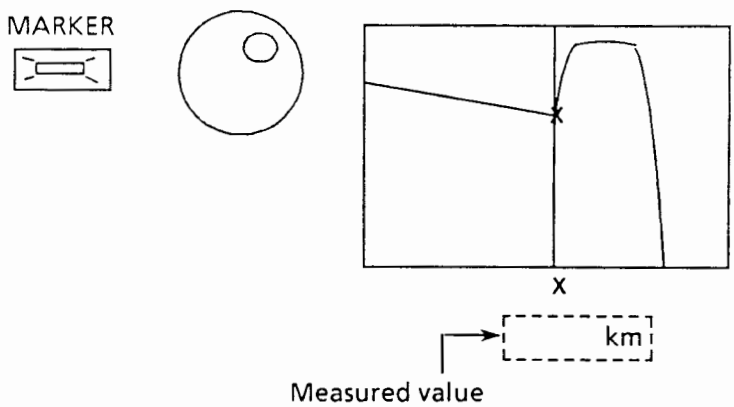


8 Press the [AVERAGE] key to enable averaging.



9 Precisely position the marker at the rising point of Fresnel reflection, then measure the absolute distance.

Confirm that this value is within the specifications for the accuracy of distance measurement.



7.3.6 Vertical-axis accuracy test

Test the accuracy of the vertical axis, or that of level measurements.

This test is required for each wavelength and each pulse width.

1. Testing the MW0945A, MW0946A, and MW0947A

(1) Setup

Connect the equipment as shown in Fig. 7-8.

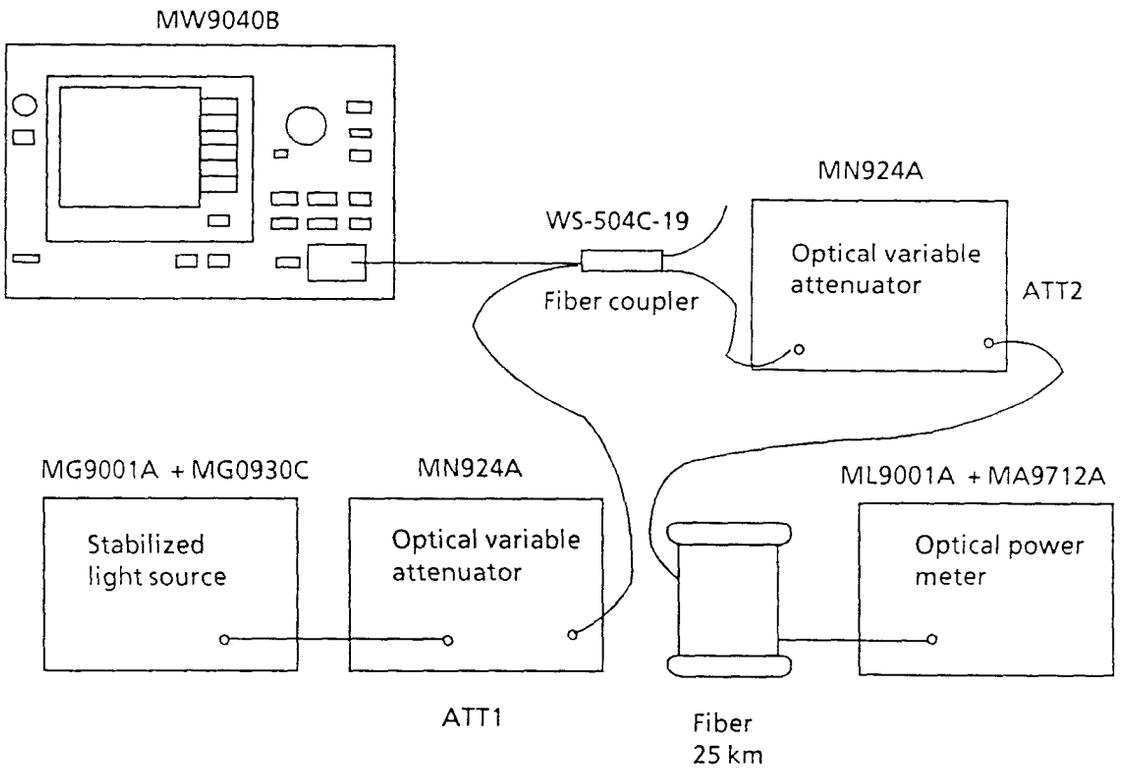
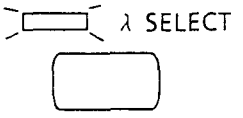
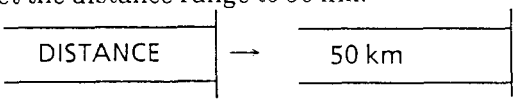
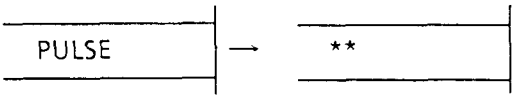
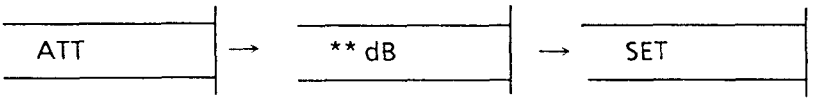
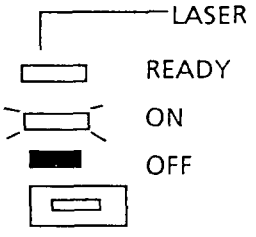


Fig. 7-8 Equipment Setup for Vertical-Axis Accuracy Test (For MW0945A, MW0946A, and MW0947A)

(2) Test procedure

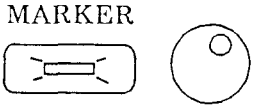
Step	Procedure
1	Press the [INITIALIZE] key to initialize the settings. INITIALIZE 
2	When using the wavelength switchable plug-in unit, select the wavelength to be used for testing. 
3	Set the distance range to 50 km. 
4	Select and set up the pulse width. (The selectable pulse width differes depending on the unit. See paragraph 1.5.)  ** : 10 μs, 1 μs, 100 ns
5	Set the MW9040B attenuator, based on the above-mentioned pulse width. Pulse width / ATT value: 100 ns — 10 dB 1 μs — 15 dB 10 μs — 25 dB 
6	Press the [LASER] key after confirming that the READY lamp is on. 

(Continued)

Step	Procedure

7 Adjust X marker to near-end back-scattered light and * marker to far-end Fresnel reflection.

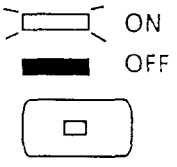
MARKER



8 Set ATT1 at ∞ dB and adjust ATT2 until the far-end Fresnel reflection level is equal to the near-end back-scattered light level. If the Fresnel reflection level is found lower than the near-end back-scattered light level in this case, the fiber used should be replaced with a shorter one.

9 At that time, read out the Fresnel reflection level on the MW9040B screen. This level is regarded as the MW9040B reference level.

10 Press the [LASER] key to turn off the LD output.



11 Set ATT1 at 0 dB. The indication of the power meter at that time is regarded as the reference level for this power meter.

12 Adjust ATT2 so that the power-meter indication is lowered by 1 dB.

13 Set ATT1 at ∞ dB, press the [LASER] key again, and turn on the LD output. Measure the Fresnel reflection level in this state.

The difference (between the amount of movement from the power-meter reference level and that from the MW9040B reference level) is defined as an error.

14 Repeat Steps 10 to 13 above until the power-meter indication is lowered by 5 dB.

15 Lower the ATT value of the MW9040B by 5 dB. The Fresnel reflection level at this time is regarded as the reference level again.

16 Repeat Steps 10 to 15 above until the amount of movement from the power-meter reference level attains the value specified below.

Pulse width	Amount of movement
100 ns	15 dB
1 μs	20 dB
10 μs	25 dB

2. Testing the MW0944B and MW0967B

(1) Setup

Connect the equipment as shown in Fig.7-9.
To test the MW0967B, substitute the MN9002A for the MN938A.

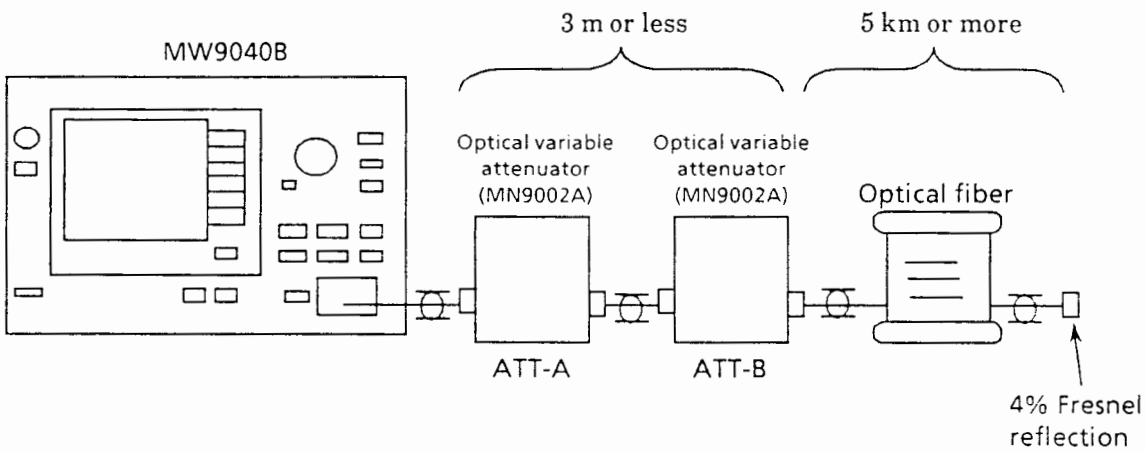
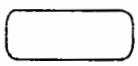
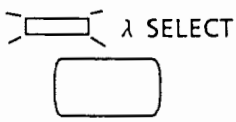
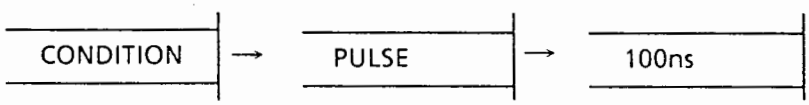
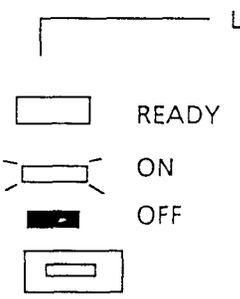
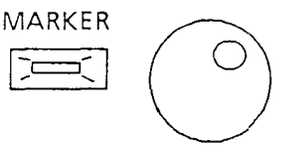


Fig. 7-9 Equipment Setup for Vertical-Axis Accuracy Test (FOR MW0944B and MW0967B)

(2) Test procedure

Step	Procedure
1	Press the [INITIALIZE] key to initialize the settings. INITIALIZE 
2	When using the wavelength switchable plug-in unit, select the wavelength to be used for testing. 
3	Set the pulse width to 100 ns. 

(Continued)

Step	Procedure
4	Press the [LASER] key after confirming that the READY lamp is on. 
5	Set the × marker to zero level and the * marker to far-end Fresnel reflection. 
6	Set ATT-B to 0 dB, and adjust ATT-A so that the peak level of the far-end Fresnel reflection is about 0.2 dB or so less than the saturation level.
7	Read the Fresnel reflection level via the OTDR screen. (Assume that this level is PL0.)
8	Set ATT-B to 2 dB and measure the Fresnel reflection level. (Assume that this level is PH0.)
9	Reset ATT-B to 0 dB and increase the attenuation of ATT-A by 1 dB. Then measure the Fresnel reflection level. (Assume that this level is PL1.)
10	Set ATT-B to 2 dB and measure the Fresnel reflection level. (Assume that this level is PH1.)
11	Increase ATT-A to 15 dB in 1-dB increments, and measure the PLi and PHi at each i-dB increment.
12	Calculate the vertical-axis accuracy at each ATT-A setting value with the following formula, and confirm that the accuracy conforms to specifications. $\text{Vertical-axis accuracy (dB/dB)} = \frac{(PLi - PHi) - \Delta A}{\Delta A}$ where, ΔA is the actual attenuation difference between the 0 dB and 2 dB ATT-B settings. (Note: Calibrate before testing.)

3. Testing the MW0947B

(1) Setup

Connect the equipment as shown in Fig.7-10.

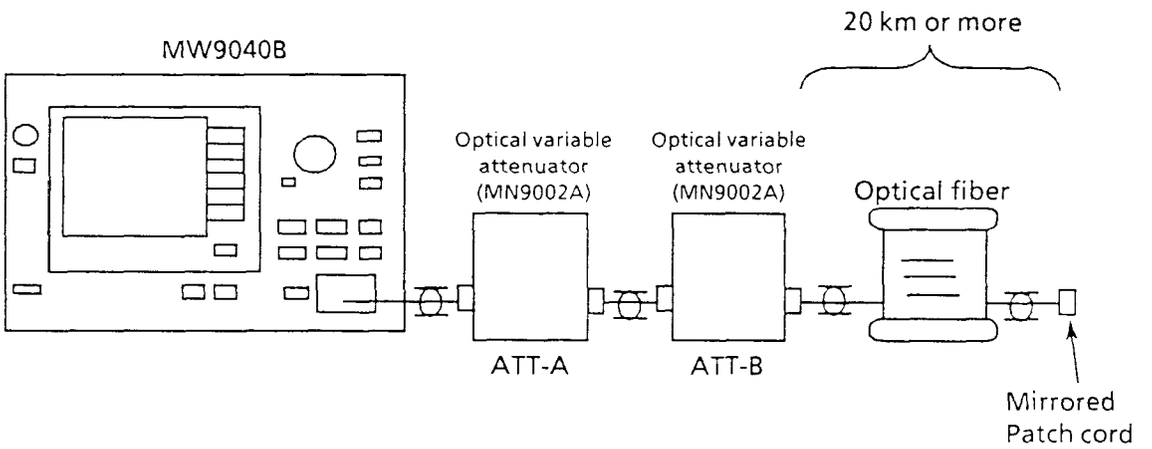
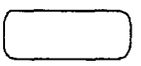
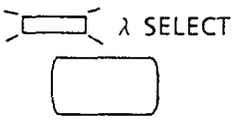
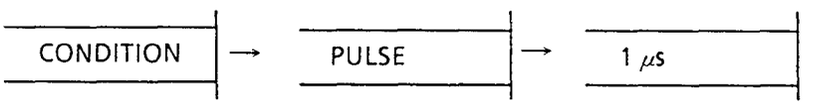
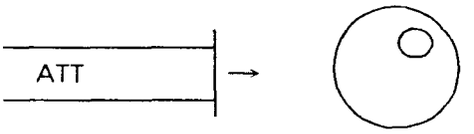
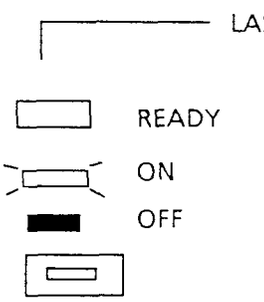
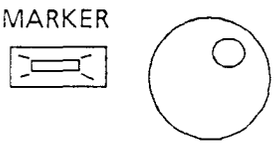


Fig. 7-10 Equipment Setup for Vertical-Axis Accuracy Test (For MW0947B)

(2) Test procedure

Step	Procedure
1	Press the [INITIALIZE] key to initialize the settings. INITIALIZE 
2	Set the wavelength to 1.55 μm. 
3	Set the pulse width to 1 μs. 
4	Set the ATT to 20.0 dB. 

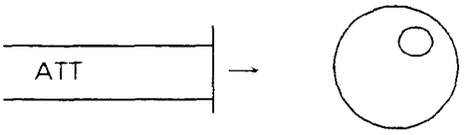
(Continued)

Step	Procedure
5	Press the [LASER] key after confirming that the READY lamp is on. 
6	Set the × marker to zero level and the * marker to far-end Fresnel reflection. 
7	Set ATT-B to 0 dB, and adjust ATT-A so that the peak level of the far-end Fresnel reflection is about 0.2 dB or so less than the saturation level.
8	Read the Fresnel reflection level via the OTDR screen. (Assume that this level is PL0.)
9	Set ATT-B to 2 dB and measure the Fresnel reflection level. (Assume that this level is PH0.)
10	Reset ATT-B to 0 dB and increase the attenuation of ATT-A by 1 dB. Then measure the Fresnel reflection level. (Assume that this level is PL1.)
11	Set ATT-B to 2 dB and measure the Fresnel reflection level. (Assume that this level is PH1.)
12	Increase the attenuation of ATT-A to 10 dB in 1-dB increments, and measure the PLi and PHi at each i-dB increment.

(Continued)

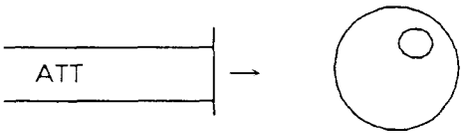
Step	Procedure

13 After measurements have been completed at ATT-A attenuations of up to 10 dB; set the ATT of the MW9040B to 10.0 dB, and, while once again increasing the attenuation of ATT-A by 1 dB, measure PLi and PHi.



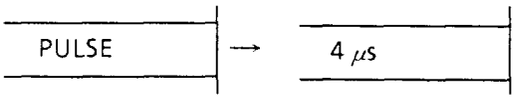
14 Increase the attenuation of ATT-A to 20 dB in 1-dB increments, and measure the PLi and PHi at each i-dB increment.

15 After measurements have been completed at ATT-A attenuations of up to 20 dB; set the ATT of the MW9040B to 0.0 dB, and, while once again increasing the attenuation of ATT-A by 1 dB, measure PLi and PHi.



16 Increase the attenuation of ATT-A to 30 dB in 1-dB increments, and measure the PLi and PHi at each i-dB increment.

17 Set the pulse width to 4 μs and the ATT of the MW9040B to 5 dB. Increase the attenuation of ATT-A by 19 dB from its initial value, and measure the PLi and PHi.



18 Increase the attenuation of ATT-A to 29 dB in 1-dB increments, and measure the PLi and PHi at each i-dB increment.

19 Increase the attenuation of ATT-A to 30 dB. Then, set the ATT of the MW9040B to 0.0 dB, and measure the PLi and PHi.

20 Increase the attenuation of ATT-A to 35 dB in 1-dB increments, and measure the PLi and PHi at each i-dB increment.

21 Calculate the vertical-axis accuracy at each ATT-A setting value with the following formula, and confirm that the accuracy conforms to specifications.

$$\text{Vertical-axis accuracy (dB/dB)} = \frac{(PLi - PHi) - \Delta A}{\Delta A}$$

where, ΔA is the actual attenuation difference between the 0 dB and 2 dB ATT-B settings.
(Note: Calibrate before testing.)

SECTION 8
CALIBRATION

Calibration is done in order to guarantee the reliability of measurment made with the MW9040B. Therefore, calibration is required when, for example, the equipment is repaired.

In addition, it is recommended that the MW9040B be periodically calibrated every year.

The calibration items and calibration procedure are the same as the performance test items and test procedure described in Section 7. For details, refer to Section 7.

7.4 Service

When the MW9040B is found incapable of meeting the specifications as a result of performance test, send it for repair after contacting your dealer or nearest office of Anritsu.

When requesting repair, supply us with information on the following:

(1) Equipment name and the equipment No. indicated on the rear panel nameplate

(2) Fault conditions

(3) Name and address of the person in charge in your company to be contacted for confirmation of the contents of fault or when repair is completed

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SECTION 9
STORAGE AND TRANSPORT

This section describes how to maintain the MW9040B Optical Time Domain Reflectometer during daily use, as well as how to do when storing it for a long time or repackaging and transporting it.

9.1 Daily Maintenance

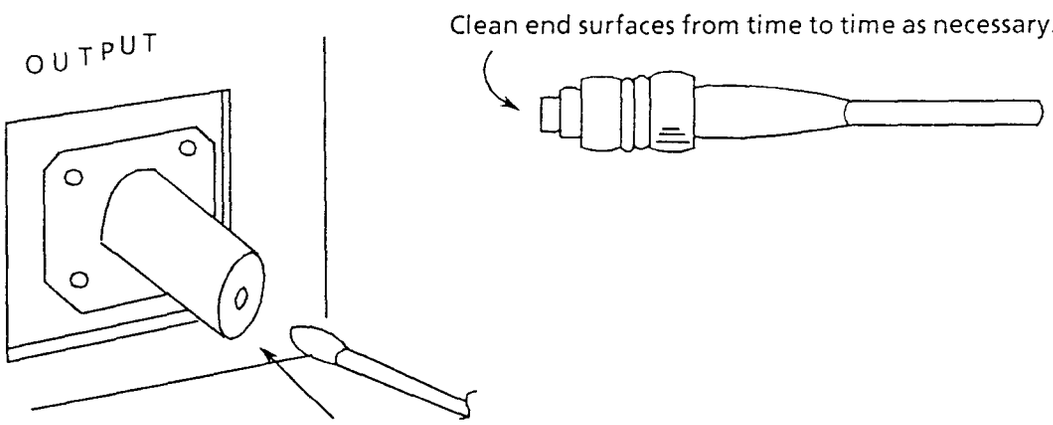
The table below shows the method of daily maintenance and the time when maintenance is required.

Daily Maintenance

Item	Time	Method of maintenance
External stain	• When the equipment is used indust-prone places • When foreign matter is entered the inside of the equipment • When there is noticeable accumulation of dust inside the equipment	Clean with soapy water or industrial gasoline, if proper ventilation is provided*.
Attachment of dust or dirt		Open the equipment frame and blow away the dust with compressed air, taking care to shield face from dust or dirt.
Slack in screw-fitted components	When loosely-fitted components are discovered	Refasten the screws with designated tools.

* Do not use thinner or benzene, or these chemicals may damage the coating.

Especially, for stain and dust in the optical output connector, carefully wipe them off with alcohol-soaked cotton swab or cleaning paper as shown below. For the optical fiber connectors connected to the optical output connector, clean their end surfaces as frequently as possible.



Note: The MZ8012A Connector Cleaning Set is sold separately.

9.2 Storage

When storing the MW9040B for a long period, follow the procedure described below.

(1) Before storing the MW9040B; remove dust, finger marks, and other stains by thoroughly wiping it with a cloth, then cover the equipment with vinyl or other appropriate sheet.

(2) Avoid storing the equipment in the following places:

1) Places exposed to direct sunglight or dust-prone places
2) Humid places where water droplets may attach to the equipment or water droplets may be generated by dew condensation
3) Places where the equipment may be damaged by active gas or exposed to oxidizing atmosphere
4) Extreme places where the temperature is above 75°C or below −40°C (for some unit, this value is different. See paragraph 1.5.) and humidity is more than 90%

(3) Recommended storage conditions

In additon to avoding the above places, it is desirable that the equipment be stored within the range of the recommended environment conditions shown below.

- Temperature: 0 to 30°C
- Humidity: 40 to 80%
- Changes in temperature and humidity within a day are moderate.

(4) When using the equipment after storage

If the equipment is suddenly exposed to normal or high temperatures after being stored under low-temperature conditions, water droplets may attach to it. In this case, leave the equipment for a sufficient time until it is dry before use. If not sufficiently dried, the circuit or components may be short-circuited, causing trouble. Also, check whether or not the air blower is clogged or stained with dust.

9.3 Repackaging and Transport

When transporting the MW9040B to a distance place, place the equipment in its dedicated carrying case. If the carrying case is not available, repackage the equipment by following the precaustions and procedure described below.

Use the packaging materials included with the MW9040B when it was first delivered. If these packaging materials discarded or damaged, package the equipment as follows:

(1) Fit protective covers to the MW9040B front and rear panels.

(2) Enclose the MW9040B with vinyl or other appropriate sheet.

(3) Prepare a carton, wooden, or aluminum box of an appropriate size so that there are 10 to 15 cm margins from each side of the MW9040B.

(4) Place the MW9040B at the center of the box, then fill the gaps on each side of the equipment with 10 to 15 cm thick cushioning material.

(5) Bind the box with packaging string, adhesive tape, or band.

NOTE

The equipment can be easily repackaged if the packaging materials (included with the MW9040B when it was first delivered) are available. So we recommend you to keep them in your place for transport at a later time.

When transporting the equipment, avoid vibration as much as possible. At the same time, it is desirable that the recommended storage conditions described in the preceding paragraph are applied when transporting the equipment, too.

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APPENDIX A
SOFT-KEY LAYER TRANSITION DIAGRAMS

A1 Format of Soft-Key Layer Transition Diagrams

The soft-key layer transition diagrams are described using the format shown in Fig. A-1. Layer transitions actuated by pressing such panel keys as [MARKER] and [H-SHIFT] other than soft keys are also indicated. The upper section marked by Ⓐ is for soft keys; the lower section marked Ⓑis for other panel keys. Note that the following symbols are used in the layer transition diagrams, but these symbols are actually not displayed on the screen.

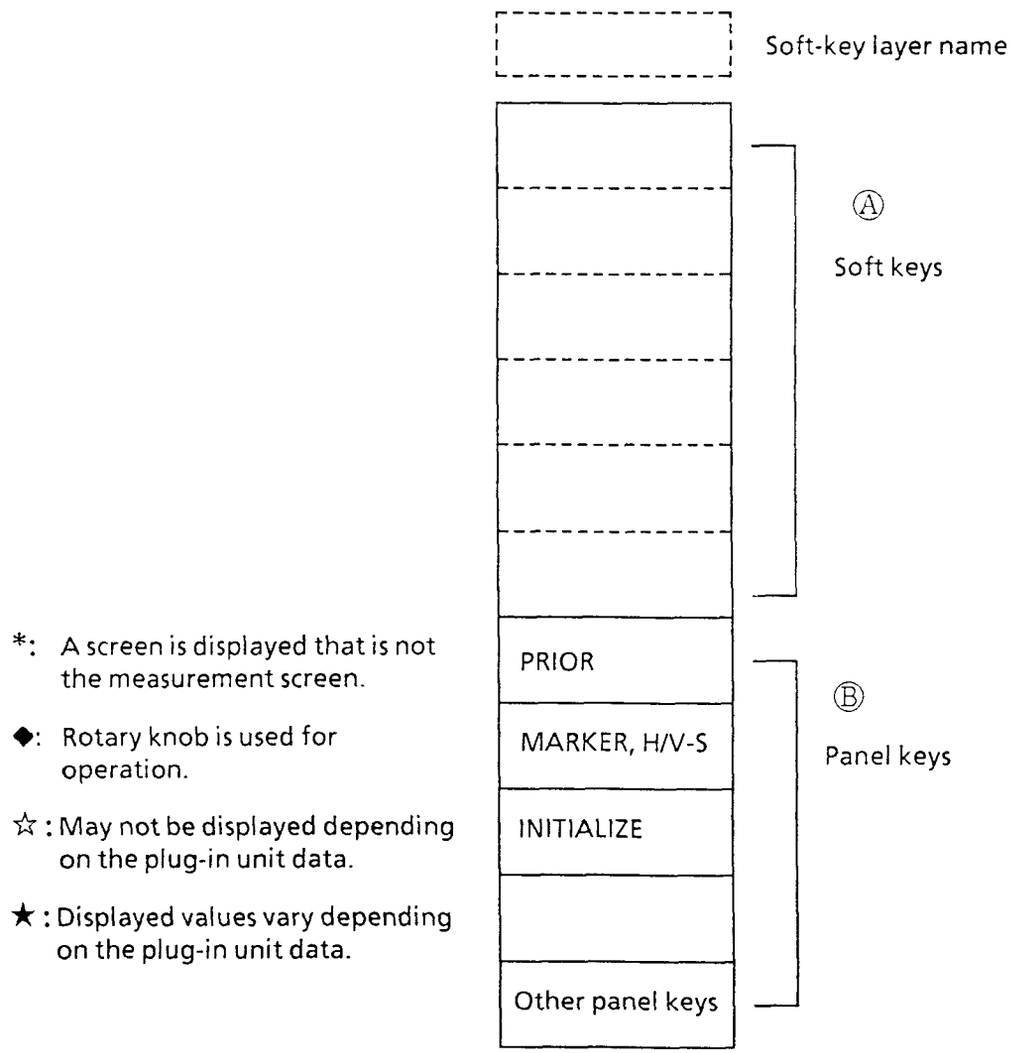


Fig. A-1 Format of Soft-Key Layer Transition Diagrams

When a soft key is pressed, the layer changes to a state in the destination indicated by the arrow mark.

When no arrow marks are indicated, the soft-key state does not change.

A2 Layer Transition Diagrams

The next pages show the layer transition diagrams of the MW9040B soft keys.

The following passage briefly explains how to see the transition diagram.

When powered on, the L1: (1/2) menu in the first layer is displayed. To set measurement conditions from here, for example, you may press the [CONDITION] soft key. Take a look at desination ② of the arrow mark. You find that the layer name is L2: CONDITION in the second layer.

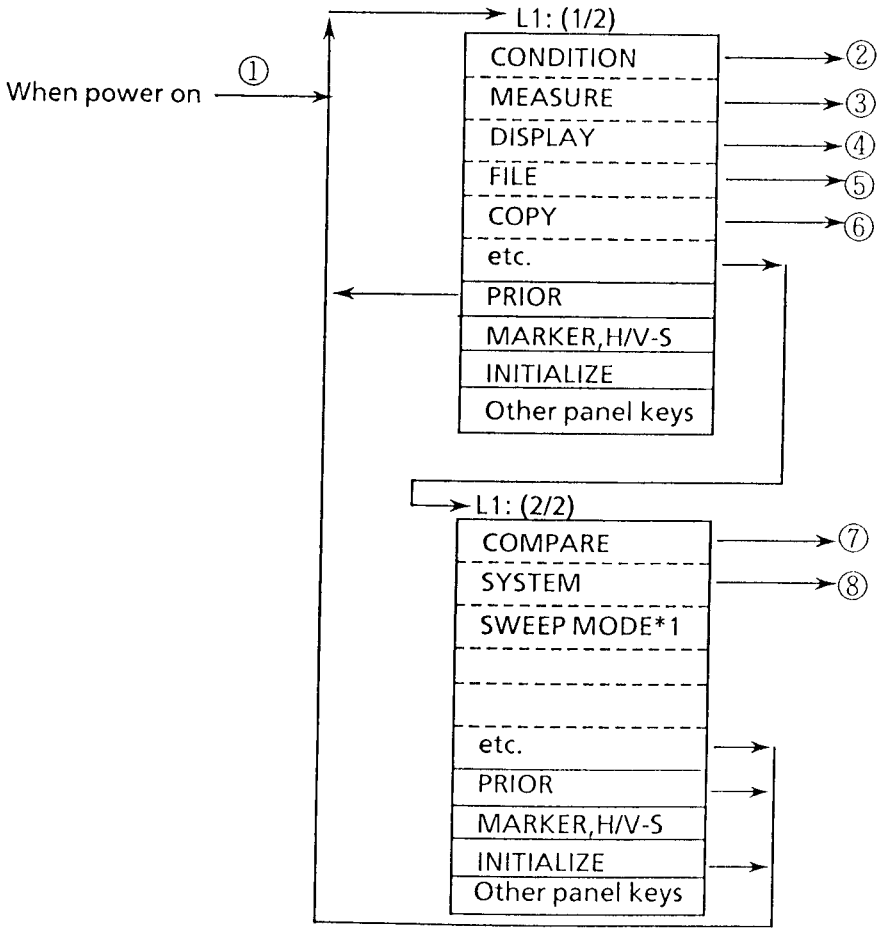
Assume that you set the pulse width next. Take a look at the destination of the arrow mark extended from PULSE.

You find that the layer name is L3: PULSE in the third layer. Selectable pulse widths are listed in the frame below this heading. (○○○○ in the third layer indicates the figure or value of each setting parameter.)

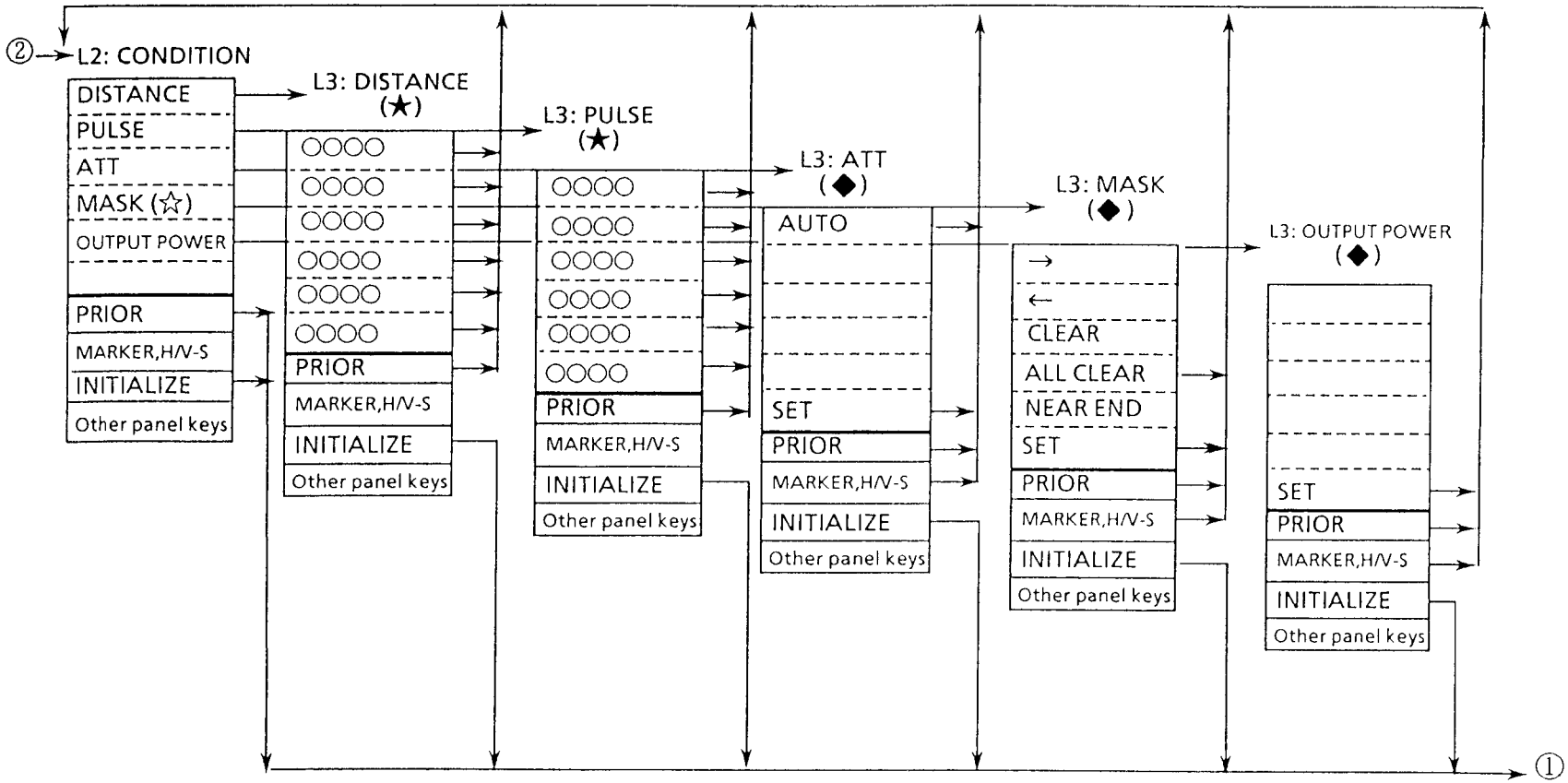
Select one from this list and look at the destination of the arrow mark extended from there. You see that it returns to L2: CONDITION in the second layer. So now you can set other measurement conditions. If measurement conditions need not be changed, press the [PRIOR] key and look at the destination of the arrow mark extended from there. You see you have returned to L1: (1/2) in the first layer. In this way, you can track the soft-key layer transition through its hierarchical structure.

Notes: 1. For some unit, ATT is fixed (See paragraph 1.5.)

2. For some unit, OUTPUT POWER can not be used. (See paragraph 1.5)



Note *1: Mode is changed alternately.
FAST is displayed at the FAST mode.



Note: L3: PULSE layer does not display pulse widths that cannot be used in the current distance range. The pulse widths that can be used are arranged to be displayed from F1.