Anritsu

OPERATION MANUAL

OPTICAL TIME DOMAIN REFLECTOMETER

MW910C

PLUG-IN UNITS

MH963A/A1, MH937A/A1, MH938A/A1/C/C1,
MH939A/A1/C/C1, MH955A/A1/C/C1

Printed in Japan
start from MT24649
MAY 1991 Ver. II

MAY 1993x150 N(2)-17(

3. Some MW910C plug-in units have an LED light source for self-checking, the other do not. In this operation manual, the LED light source description is always for plug-in units with a built-in LED light source.

	Plug-in unit
With LED light source	MH963A, MH937A, MH938A/C, MH939A/C, MH955A/C
Without LED light source	MH963A1, MH937A1, MH938A1/C1, MH939A1/C1, MH955A1/C1

4. The MW910C has a battery backed-up memory for storing data. Incorrect operation or power failure may cause the contents of the memory to be lost.

   Anritsu recommends that you make a back-up record to guard unexpected data loss. Anritsu does not indemnify lost damaging data.

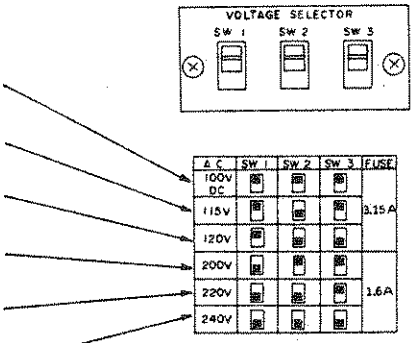
   The lifespan of the back-up battery is approximately 7 years; replace it before its rated lifespan is exceeded.

Notes:

1. The MW910C Optical Time Domain Reflectometer (OTDR) is operable on nominal voltages of 100, 115, 120, 200, 220, and 240 Vac by setting the VOLTAGE SELECTOR switches on the rear panel to match the ac power supply rating.

2. The power supply voltage is set as shown in the following figure. The required fuse is also indicated.

Line Voltage (Vac)
100 to 108
108 to 117
117 to 127
200 to 216
216 to 234
234 to 250

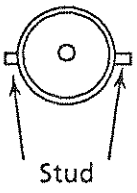
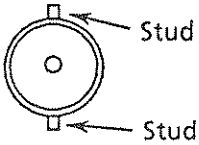


CAUTION

1. When setting the switches, turn the POWER switch OFF and unplug the power supply cord from the ac inlet.
2. When the MZ146A DC-AC Inverter is used, set the switches to "AC 100 V/DC" and use 3.15 A fuses.

BNC-TYPE CONNECTOR INSTALLATION

The BNC-type connector installation has been modified as follows:

Before Modification	After Modification
	

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SECTION 1

GENERAL

1.1 Introduction

The MW910C is a very accurate measuring instrument for locating faults and measuring the transmission loss, fusion splice losses, and connector losses in optical fiber cable.

Its compact (177H x 284W x 381D mm), lightweight ($\leq$13.7 kg) design, make it convenient for field use.

The MW910C can use 16 types of plug-in units.

A-type units: standard dynamic range, with LED light source

A1-type units: standard dynamic range, without LED light source

C-type units: high dynamic range, with LED light source

C1-type units: high dynamic range, without LED light source.

These units are listed on the next page.

Table 1-1 Combination of MW910C and Plug-in Unit

Model		Wavelength and Fiber Type			
		0.85μm Multi-mode	1.31μm Multi-mode	1.31μm Single mode	1.55μm Single mode
MW910C (Main Frame)		√	√	√	√
Standard Plug-in Units	MH963A/A1	√			
	MH937A/A1		√		
	MH938A/A1			√	
	MH939A/A1				√
	MH955A/A1			√	√
High Dynamic Range Plug-in Units	MH938C/C1			√	
	MH939C/C1				√
	MH955C/C1			√	√

1.2 Features

. Optical Plug-in units

The MW910C uses interchangeable optical plug-in units. Available units are provided for 0.85 μm GI, 1.31 μm GI, 1.31 μm SM, 1.55 μm SM and 1.31/1.55 μm SM.

. Excellent stability

The use of a temperature-controlled laser light source ensures stable optical output and wavelength for very accurate and reproducible measurement.

. One-meter readout resolution over long distances

The MW910C measures distances up to 144 km with a readout resolution of 1 m. The horizontal scales can be varied from 25 m/div to 8 km/div. A shift function enables zooming for enlargement or reduction of any desired location.

. High Dynamic Range

The C/C1 high-dynamic range plug-in units are provided for 1.31 μm and 1.55 μm SM fibers which are especially necessary for long-distance measurement. Table 1-2 lists these high-dynamic range plug-in units.

Table 1-2 C/C1 Type Plug-in Unit

Unit Name	MH938C/C1	MH939C/C1	MH955C/C1
Wavelength	1.31 μm	1.55 μm	1.31/1.55 μm
Fiber	SM	SM	SM
One-way dynamic range (PW=10μs)	30 dB	27 dB	28/25 dB

Note: The C1 plug-in units have no LED light source.

. Optical masking function

Three optical masks can be set. This optical masking function also eliminates detector saturation caused by large Fresnel reflection at the light input coupling to improve measurement linearity.

. 0.01 dB loss readout resolution

Loss can be read-out at a high resolution of 0.01 dB. Linear approximation using the "least squares" method enables accurate measurement even under poor S/N ratio conditions.

. High-speed averaging

The internal 16-bit microprocessor performs high-speed averaging to improve the S/N ratio. For example, at a distance range of 36 km, the data is displayed on the CRT after 0.4 s averaging with an improved S/N ratio of 30 dB.

. Built-in thermal printer

The MW910C has a built-in thermal printer for hard-copying measurement conditions and results displayed on the CRT. This printer has a buffer memory so the MW910C can continue measurement during printing.

. Self-diagnosis function

A built-in LED light source for self-diagnosis is provided to check the functions from the LASER OUTPUT connector to the receiving system.

. Laser output safety device

A laser output safety device is provided so that laser radiation is only emitted when an optical fiber cable is connected to the LASER OUTPUT connector.

. HELP Function

For easy handling, operation instructions for distance, transmission loss, and splice loss measurements are displayed on the CRT as a menu. So you can easily operate the MW910C without the operation manual.

. Auto Attenuator Function

By displaying the range to be observed on the CRT, the backscattered light level is automatically set to a suitable level so the attenuator does not need adjustment each time.

. 32-screen Memory

A built-in memory with battery backup can store up to thirty-two screens of measurement results and other information.

. Video signal output connector

An external video plotter can be connected to copy the measurement conditions and results displayed on the CRT.

. GP-IB interface (option)

An automatic measurement system can be constructed by using the GP-IB interface to connect the MW910C to a Packet V Personal Technical Computer.

. Portable

The MW910C is compact and lightweight, so it is very easy to carry.

. Optimized keys (number/layout) permit easy operation.

. An optional dc-ac inverter allows both 12 and 24 Vdc power supplies to be used.

SECTION 2

COMPOSITION AND SPECIFICATIONS

2.1 Composition

2.1.1 Standard Composition

Table 2-1 lists the standard composition of the MW910C.

Table 2-1 Standard Composition

Item	No.	Name	Qty.	Remarks
Equipment	1	MW910C	1	
Accessories	2	Ac power cord	1	
	3	Fuse	6	For 100/115/120 Vac 3.15 A -- 2, 1.6 A -- 4 For 200/220/240 Vac 3.15 A -- 4, 1.6 A -- 2
	4	Operation manual	1	
	5	Service manual	1	
	6	CRT hood	1	
	7	Protective lid	1	
	8	Printer paper	3	

2.1.2 Options and optional accessories

Table 2-2 Options and Optional Accessories

Name		Qty.	Remarks
GP-IB interface		1	
Plug-in unit	MH963A/A1	1	0.85 µm wavelength GI fiber Accessories: GI fiber cord with FC connector (2m) Qty. 1 Plug-in unit service manual Qty. 1
	MH937A/A1	1	1.31 µm wavelength GI fiber Accessories: GI fiber cord with FC connector (2m) Qty. 1 Plug-in unit service manual Qty. 1
	MH938A/A1/C/C1	1	1.31 µm wavelength SM fiber Accessories: SM fiber cord with FC connector (2m) Qty. 1 Plug-in unit service manual Qty. 1
	MH939A/A1/C/C1	1	1.55 µm wavelength SM fiber Accessories: SM fiber cord with FC connector (2m) Qty. 1 Plug-in unit service manual Qty. 1
	MH955A/A1/C/C1	1	1.31/1.55 µm wavelength SM fiber Accessories: SM fiber cord with FC connector (2m) Qty. 1 Plug-in unit service manual Qty. 1
MZ146A DC-AC Inverter		1	For converting 12/24 V dc to ac
Camera		1 set	M-085D camera with #85-23 camera hood
Connector cleaning set		1 set	Cleans connectors which have a sleeve diameter more than 2.5 mmø of the following: FC, Diamond, ST, DIN, Biconic, and F & G. Composition: Cotton-bud applicator Qty. 60 A bottle of alcohol Qty. 10 cc Applicator holder Qty. 4 Dimension and weight: 34 H x 150 W x 130 D mm, <200 g
UA-455A Video Plotter		1	The hard copy of the CRT display can be easily obtained. The plotter is connected to the MW910C simply by means of a coaxial cable with BNC connectors.

Note: The option and optional accessories listed above must be purchased separately.

2.2 Specification

Table 2-3 Specifications-(1)

Mainframe		MW910C
Distance range		18/36/72/144 km
Horizontal axis	Scale (km/full scale)	0.25/0.5/1/2.5/5/10 (18 km range) 0.25/0.5/1/2.5/5/10/20 (36 km range) 0.25/0.5/1/2.5/5/10/20/40 (72 km range) 0.25/0.5/1/2.5/5/10/20/40/80 (144 km range)
	Readout resolution	1 m (0.25/0.5/km/full scale) 2 m (1 km/full scale) 10 m (2.5/5/km/full scale) 20 m (10 km/full scale) 40 m (20 km/full scale) 80 m (40 km/full scale) 160 m (80 km/full scale)
	Shift	0 to 18 km (18 km range) 0 to 36 km (36 km range) 0 to 72 km (72 km range) 0 to 144 km (144 km range)
	Accuracy	±3 m ± measured value x 2 x 10^{-5} without uncertain factors of fiber refractive index
Vertical	Scale (dB/div)	0.2/0.5/1/2.5/4
	Readout resolution	0.01 dB
Linearity		0 to 5 dB: ±0.3 dB, 0 to 10 dB: ±0.5 dB, 0 to 15 dB: ±0.7 dB
CRT		5.5 inch, green
GP-IB (Option) IEEE-488		Interface function, SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C0
Thermal printer		Built-in
Video output		Composite video signal =1 Vp-p (75 Ω), BNC Connector
Power		100, 115, 120, 200, 220 Vac $^{+10\%}_{-15\%}$, 240 Vac $^{+4\%}_{-15\%}$, 50/60 Hz, ≦110 VA
Ambient temperature		0° to 40° (Spec. meet), -15° to 55°C (Workable), -40° to 60°C (Storage)
Dimensions and weight		177H x 284W x 381D mm, ≦13.7 kg

Table 2-4 Specifications-(2)

A/A1 Type Plug-in Unit (MH963A/A1, MH937A/A1, MH938A/A1, MH939A/A1, MH955A/A1)

Main Frame		MW910C				
Plug-in Unit		MH963A/A1	MH937A/A1	MH938A/A1	MH939A/A1	MH955A/A1
Wavelength (μm)		0.85 ±0.02	1.31 ±0.02	1.31 ±0.02	1.55 ±0.02	1.31/1.55 ±0.02 (Switchable)
Fiber under measurement		GI	GI	SM	SM	SM
Optical connector *1		FC-type (GI)	FC-type (GI)	FC-type (SM)	FC-type (SM)	FC-type (SM)
Mask function		Provided (can be set at three points)				
Pulse width (μs) *2		0.1, 0.5, 2	0.1, 0.5, 2	0.1, 1, 4	0.1, 1, 4	0.1, 1, 4
Dynamic range (One-way back-scattered light level) (dB) *3		17, 20, 23	15, 19, 22	12, 17, 20	10, 15, 18	10/8, 15/13, 18/16
LED light source	Wave-length (μm)	0.85 ±0.03	1.31 ±0.03	1.31 ±0.03	1.55 ±0.03	1.31 ±0.03
	Peak Power (dBm Typ.)	-40	-40	-40	-42	-40
	Wavelength half width (nm)	≦150	≦150	≦150	≦230	≦150
	Repeti-tive cycle	409.6 μs				
	Duty cycle	50%				
	Waveform	Square wave				

Table 2-5 Specifications-(3)

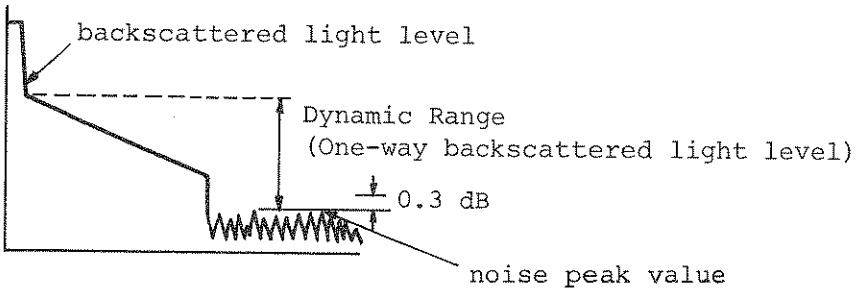
C/C1 Type Plug-in Unit (MH938C/C1, MH939C/C1, MH955C/C1)

Main Frame		MW910C		
Plug-in Unit		MH938C/C1	MH939C/C1	MH955C/C1
Wavelength (μm)		1.31 ±0.02	1.55 ±0.02	1.31/1.55 ±0.02 (switchable)
Fiber under measurement		SM	SM	SM
Optical connector *1		FC-type (SM)	FC-type (SM)	FC-type (SM)
Mask function		Provided (can be set at three points)		
Pulse width (μs) *2		0.1, 1, 10	0.1, 1, 10	0.1, 1, 10
Dynamic range (One-way backscattered light level) (dB) *3		20, 25, 30	17, 22, 27	18/15, 23/20, 28/25
LED light source	Wavelength (μm)	1.31 ±0.03	1.55 ±0.03	1.31 ±0.03
	Peak Power (dBm Typ.)	-40	-42	-40
	Wavelength half width (nm)	≦150	≦230	≦150
	Repetitive-cycle	409.6 μs		
	Duty cycle	50%		
	Waveform	Square wave		

*1 The standard optical connector is FC. For other connectors, please consult your nearest Anritsu representative.

*2 A pulse width of 2 or 4 μs cannot be selected when the distance range is 18 km. A pulse width of 10 μs cannot be selected when the distance range is 18, 36, or 72 km.

*3 The dynamic range shows the range between the near-end level of backscattered light and the level 0.3 dB above the noise peak value.



SECTION 3

OPERATION

3.1 Precautions

WARNING

1. The MW910C uses a laser diode as the light source. Do not look directly into the emitted laser radiation or your eyesight will be damaged.

   The LASER OUTPUT connector protective cover is provided to protect the operator. A safety device is also installed to prevent the laser from radiating until the fiber cable is connected to the LASER OUTPUT connector.

2. Always ground the ground terminal (⏚) on the rear panel to protect the operator against electric shock.

3. High voltage is used by the CRT. Do not disassemble the cabinet while the POWER switch is ON.

4. Use of controls or performance adjustments other than those specified in this manual may result in hazardous invisible laser radiation exposure.

CAUTIONS

1. Do not touch or insert metallic items into the connector for the plug-in unit while the POWER switch is ON.

2. Do not plug the power cord into the ac outlet while the POWER switch is ON.

3. Ensure that the ac line voltage is the same as that set by the VOLTAGE SELECTOR switches on the rear panel. Also confirm that the correct fuse is being used (see note before table of contents).

3.2 Plug-in Units

3.2.1 Insertion and removal procedure

CAUTION

Insert or remove the plug-in unit only when the MW910C POWER switch is set to OFF.

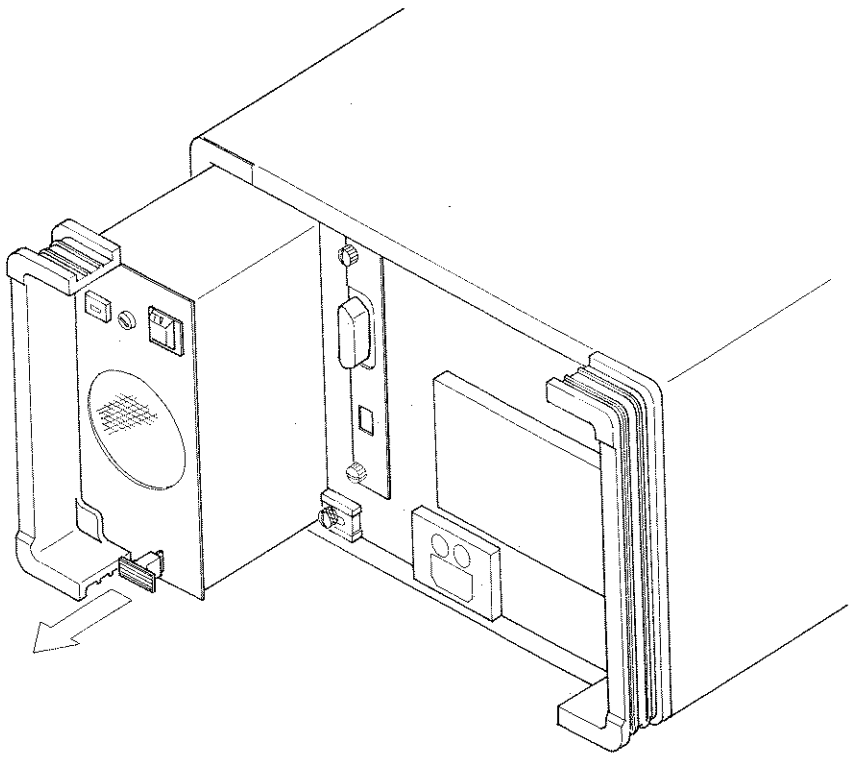


Fig. 3-1 Plug-in Unit Insertion and Removal

The plug-in units are inserted or removed from the rear of the MW910C as shown in Fig. 3-1. The installed plug-in unit is unlocked by sliding the lock clasp to the right and pulling the lock knob on the back of the plug-in unit. In this state, the plug-in unit can be removed by pulling. When inserting a plug-in unit, push it fully in until it locks. After inserting the plug-in unit, slide the mainframe lock clasp to the left and tighten the screw.

CAUTION

After inserting the plug-in unit, ensure it locks completely.

3.3 Explanation of Controls

3.3.1 Control layout

Figures 3-2, 3-3, and 3-4 show the layout of the controls.

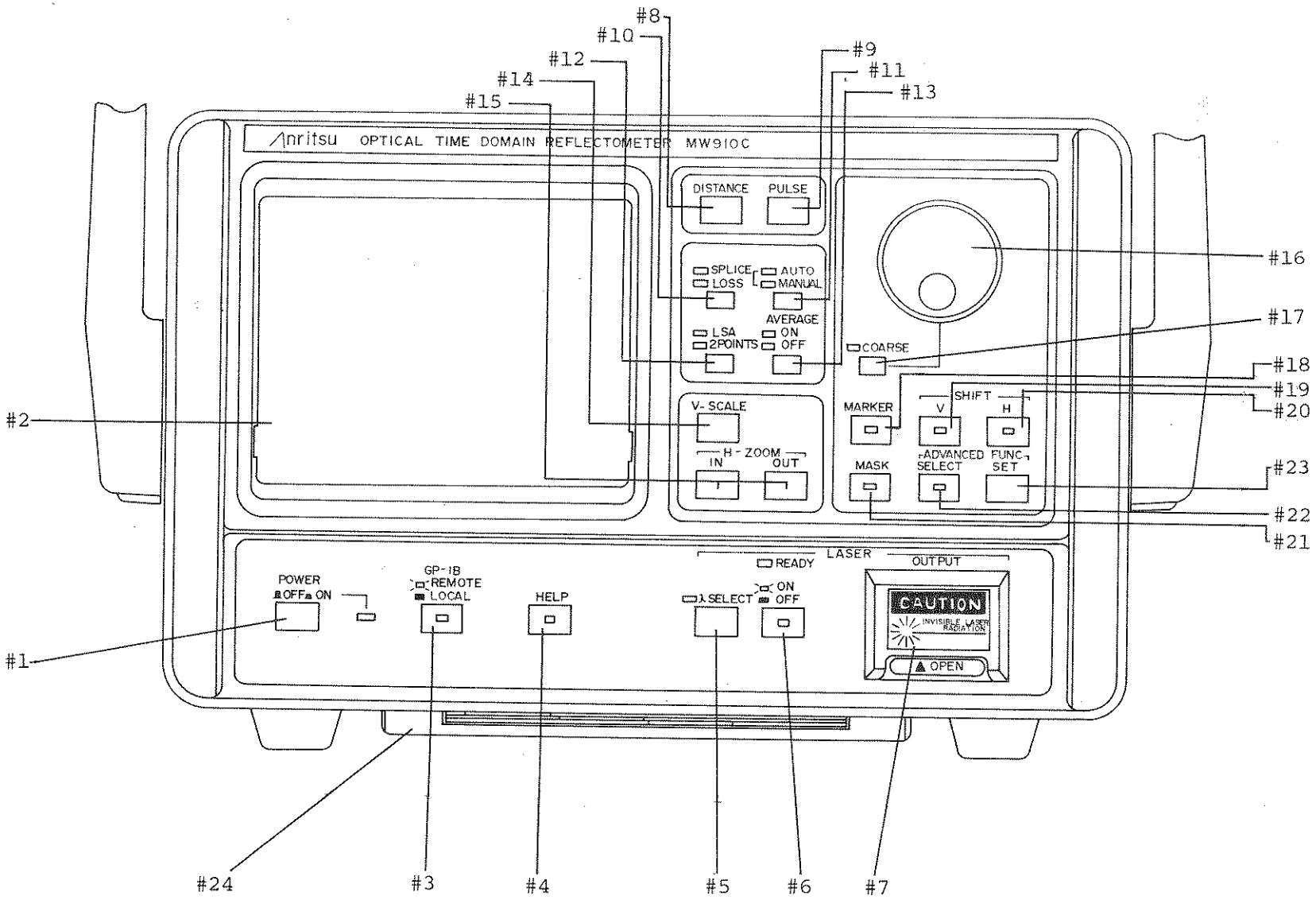


Fig. 3-2 Front Panel

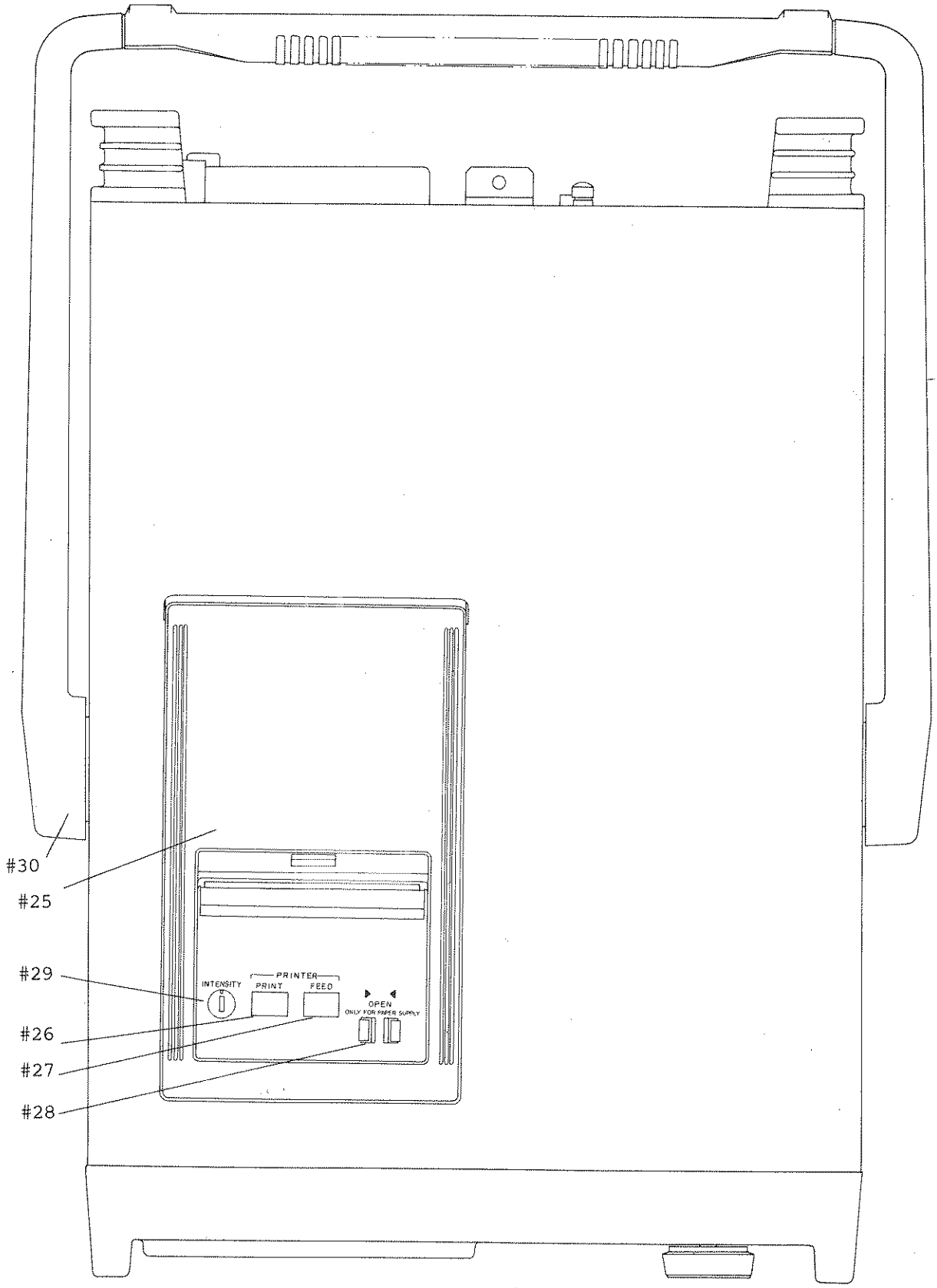
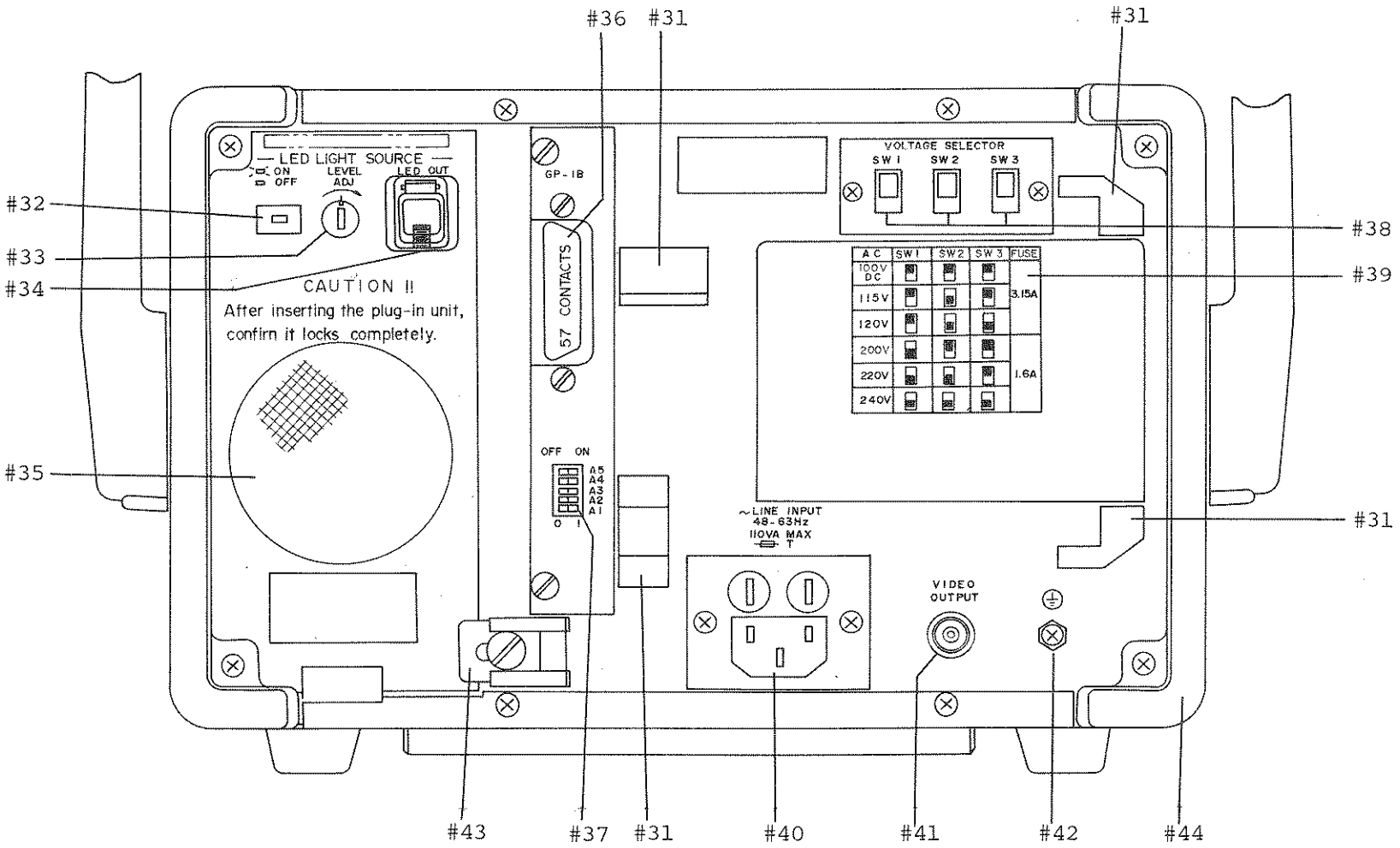


Fig. 3-3 Top Cover



*: MH963A1, 937A1, 938A1/C1, 955A1/C1 and 939A1/C1 do not have #32 to #34.

Fig. 3-4 Rear Panel

3.3.2 Explanation of controls

Table 3-1 lists the control functions. The numbers marked # in the table correspond to the numbers in Figs. 3-2, 3-3, and 3-4.

Table 3-1 Explanation of Controls

No.	Label	Function
#1		POWER [ON/OFF] key. When this key is pressed, the LED to the right comes on to indicate that power is being supplied.
#2	(CRT)	Displays waveforms, scales, measurement conditions, and measured results
#3		Permits remote operation by external controller. The LED lights when an external device controls the OTDR. The LED is off when the LOCAL mode is selected. Also sets the REMOTE to LOCAL even if the REMOTE LED is lit. Notes: 1. Local lockout prevents switching into the LOCAL mode. 2. The GP-IB is optional.
#4		Displays description of the various OTDR functions and operations on the CRT (HELP mode). The description includes the following five functions: 1. Distance measurement 2. Transmission loss measurement 3. Splice loss measurement 4. Explanation of key operation 5. Advanced function When the HELP mode is set (when the above descriptions are displayed on the CRT), all keys other than the [HELP] key #4 and the rotary knob #16 are locked out. "Prints out help screen" displayed on the CRT in the HELP mode means that information displayed on the CRT can be hard-copied by the built-in printer.

Table 3-1 Explanation of Controls (Cont'd)

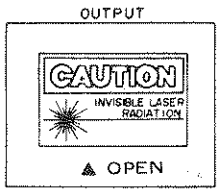
No.	Label	Function
#5		Selects the wavelength. When the MH955A/A1/C/C1 plug-in unit is used, 1.31 μm and 1.55 μm is alternately selected each time the key is pressed. When other plug-in units are used, the LED does not come on, and this key cannot be used. The wavelength is displayed at the lower-right side of the CRT. Do not attempt measurements for approximately 10 seconds after switching the wavelength. The LASER READY LED may momentarily go off approximately 10 seconds after switching the wavelength. Start measurements by pressing the LASER [ON/OFF] key #6 after the LED comes back on. Note: This key can be used even when the LASER [ON/OFF] key is OFF when the power switch is turned on first. However, if the LASER [ON/OFF] key is set to ON and is then set to OFF, this key cannot be used.
#6	LASER ON/OFF 	Turns the laser radiation ON/OFF. When the LD temperature is constant, the READY LED comes on to indicate that the LD is ready to emit. Laser beam radiation is enabled only when a fiber cable is connected to the LASER OUTPUT connector. #7. When the key is turned OFF, the waveform displayed on the CRT is retained and can be recorded by an external plotter.
#7		The connector for the fiber cable to be measured is located under the protective cover. A safety device is provided in addition to the protective cover to prevent hazardous laser beam radiation. Laser beam radiation is enabled only when a fiber cable is connected to this connector. However, the cover will prevent laser beam radiation if the safety device malfunctions.
#8		Sets the measurement distance range. The following distances are selected each time the key is pressed and are displayed at the upper-right corner of the CRT. 144 km → 72 km → 36 km → 18 km

Table 3-1 Explanation of Controls (Cont'd)

No.	Label	Function
		When the refractive index is 1.5000, the maximum distance ranges that can be displayed on the CRT at one time are as follows: Range — Maximum displayable distance range 18 km — 10 km 36 km — 20 km 72 km — 40 km 144 km — 80 km When a distance range other than the one displayed on the CRT is required for observation, shift to the new range by using the [H-SHIFT± key #20 and rotary knob #16. Note: This key can be used even when the LASER [ON/OFF] key is OFF when the power switch is turned ON first. However, if the LASER [ON/OFF] key is set to ON and is then set to OFF, this key cannot be used.
#9	PULSE	Selects the pulse width of laser beams. The following pulse widths are selected and are displayed at the bottom of the CRT each time the key is pressed. For the 144 km distance range, the following pulse widths are alternately selected. MH963A/A1, MH937A/A1; → 100ns → 500ns → 2µs → MH938A/A1, MH939A/A1, MH955A/A1; → 100ns → 1µs → 4µs → MH938C/C1, MH939C/C1, MH955C/C1; → 100ns → 1µs → 10µs → For the 36 km and 72 km distance ranges, the following pulse widths are alternately selected. MH963A/A1, MH937A/A1; → 100ns → 500ns → 2µs → MH938A/A1, MH939A/A1, MH955A/A1; → 100ns → 1µs → 4µs →

Table 3-1 Explanation of Controls (Cont'd)

No.	Label	Function
		MH938C/C1, MH939C/C1, MH955C/C1; ↱100ns → 1µs↰ For the 18 km distance range, the following pulse widths are alternately selected. MH963A/A1, MH937A/A1; ↱100ns → 500ns↰ MH938A/A1, MH939A/A1, MH955A/A1; ↱100ns → 1µs↰ MH938C/C1, MH939C/C1, MH955C/C1; ↱100ns → 1µs↰ Note: This key can be used even when the LASER [ON/OFF] key is OFF when the power switch is turned on first. However, if the LASER [ON/OFF] key is set to ON and is then set to OFF, this key cannot be used.
#10	SPLICE LOSS	Selects splice loss or optical fiber transmission loss measurement. The measurement is switched each time the key is pressed and the selected measurement LED comes on. . SPLICE With the asterisk (*) marker set in the middle, four X markers are displayed at the standard positions. Note: When the markers are not at the standard positions, switch from SPLICE to LOSS and back to SPLICE. The markers will then be set at the standard positions. (see paragraph 3.4.12). . LOSS One x marker and one asterisk (*) marker are displayed.

Table 3-1 Explanation of Controls (Cont'd)

No.	Label	Function
#11	AUTO MANUAL	Selects automatic setting of the markers for SPLICE measurement. The selected mode LED comes on. In AUTO, the [LSA/2 POINTS] key #12 is automatically set to LSA.
#12	LSA 2POINTS	Selects whether linear approximation is calculated using the Least Squares Approximation (LSA) or the 2-point approximation (2 POINTS) methods. Each method is alternately selected each time the key is pressed. The selected method is displayed on the lower left corner of the CRT and the corresponding LED of the selected method comes on.
#13	AVERAGE ON OFF	Selects averaging, ON or OFF. . ON Averaging starts. The S/N ratio of the waveform displayed on the CRT is gradually improved as time elapses after averaging begins to facilitate highly-accurate measurement. When the following keys are pressed, averaging is momentarily reset and restarted. DISTANCE, PULSE, H-ZOOM, MASK, SHIFT-H, ATT. Manual (Advanced Function) Note: This key can be used even when the LASER [ON/OFF] key is OFF when the power switch is turned ON first. However, if the LASER [ON/OFF] key is set to ON and is then set to OFF, this key cannot be used. . OFF Averaging is discontinued and new waveforms are constantly displayed on the CRT.
#14	V-SCALE	Selects the vertical scale. The following scales are selected each time the key is pressed. → 4dB/div→2.5dB/div→1dB/div→0.5dB/div→0.2dB/div →

Table 3-1 Explanation of Controls (Cont'd)

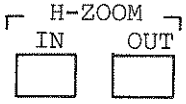
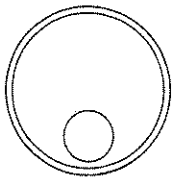
No.	Label	Function
#15		Selects the CRT horizontal axis distance scale. The scale from 25 m/div to 8 km/div can be selected by using the [IN] and [OUT] keys. The selected scale is displayed at the upper-right corner of the CRT. The scale below is for when the refractive index set to 1.5000. Distance range — Horizontal scale (/div) 18 km — 25 m, 50 m, 100 m, 250 m, 500m, 1.0 km 36 km — 25 m, 50 m, 100 m, 250 m, 500m, 1.0 km, 2.0 km 72 km — 25 m, 50 m, 100 m, 250 m, 500m, 1.0 km, 2.0 km, 4.0 km 144 km — 25 m, 50 m, 100m, 250 m, 500 m, 1.0 km, 2.0 km, 4.0 km, 8.0 km Note: This key can be used even when the LASER [ON/OFF] key is OFF when the power switch is turned ON first. However, if the LASER [ON/OFF] key is set to ON and is then set to OFF, this key cannot be used.
#16		The rotary knob is used with the following items. . MARKER . MASK . SHIFT-V . SHIFT-H . ATT. Manual (Advanced function) . Ave. Number (Advanced function) . I.O.R. (Advanced function) . M-Save (Advanced function) . M-Recall (Advanced function) . Title (Advanced function) . Date/Time (Advanced function) . Meter/Feet (Advanced function) . Trace (Advanced function) . HELP

Table 3-1 Explanation of Controls (Cont'd)

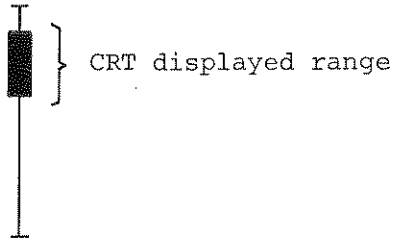
No.	Label	Function
#17	COARSE	By pressing this key the LED comes on. In this condition, the following key operations shift at high speed. MARKER SHIFT-V MASK SHIFT-H
#18	MARKER	Positions the cursor on the marker as follows each time the key is pressed. The marker under the cursor is shifted by using the rotary knob #16. 1. SPLICE measurement →X1 → X2 → * → X3 → X4→ When the cursor is set to the * marker and shifted, all five markers shift simultaneously. 2. LOSS measurement →X1 → *→
#19	SHIFT V	This key enables the displayed wave from to be moved up or down the CRT by using the rotary knob. The thick part of the vertical line at the left of the CRT represents the displayed range. 
#20	SHIFT H	Shifts the start position of the waveform displayed on the CRT. The shiftable distance can be calculated as follows: Shiftable distance = Selected DISTANCE range - horizontal scale (km/div) x 10

Table 3-1 Explanation of Controls (Cont'd)

No.	Label	Function
		The position of the currently displayed waveform in the entire distance range is represented at the top of the CRT as shown below. Vertically-measurable waveform range displayed on CRT.  CRT display range Note: 1. When the DISTANCE range is switched, the waveform start position is reset to 0 km. 2. This key can be used even when the LASER [ON/OFF] key is OFF when the power switch is turned ON first. However, if the LASER [ON/OFF] key is set to ON and is then set to OFF, this key cannot be used.
#21	 	Sets masks at up to three points on the CRT. When the [MASK] key is pressed, the first MASK marker is selected and the mask position can be shifted by using the rotary knob #16. The selected MARK marker is displayed at the top side of the scale on the CRT screen as "▀". When this key is pressed again, the second and third MASK markers are selected and the mask positions can be shifted by using the rotary knob #16. The three MASK functions can be shifted individually in the same way. Note: This key can be used even when the LASER [ON/OFF] key is OFF when the power switch is turned ON first. However, if the LASER [ON/OFF] key is set to ON and is then set to OFF, this key cannot be used.
#22	 	Press this key to display the advanced functions on the CRT. The key LED will also come on. In this state, an advanced function can be selected by pressing the [ADVANCED FUNCTION SELECT] key #22 again.

Table 3-1 Explanation of Controls (Cont'd)

No.	Label	Function
		The ADVANCED FUNCTION consists of the following 11 functions. 1. Initialize The follow conditions are automatically set. DISTANCE 144 km (472 kft) PULSE max. SPLICE/LOSS loss LSA/2 POINTS 2 points AVERAGE off V-SCALE 4.0dB/div H-ZOOM 8.0km/div MASK all clear V-SHIFT 0 H-SHIFT 0.000 km (0.000 kft) ATT. auto Press the [ADVANCED FUNCTION SET] key #23 to complete the setting.
		2. ATT. Manual (Attenuator manual) This function enables the attenuator to be manually. Select AUTO or the attenuator value by using the rotary knob. AUTO is used when the attenuator is in auto setting. Selectable values: AUTO 0.0 2.5 5.0 7.5 10.0 12.5 Press the [ADVANCED FUNCTION SET] key #23 to complete setting. It cannot be set at LASER OFF.
		3. Ave. Number (Averaging number) This function enables the number of averagings to be set when the average processing is ON by pressing the [AVERAGE] key #13. This number of averagings can be set to unlimited (∞), or 100 to 45000 times in steps of 100.

Table 3-1 Explanation of Controls (Cont'd)

No.	Label	Function
		4. Mask Clear This function clear all the optical masks simultaneously. Press the [ADVANCED FUNCTION SET] key #23 to complete mask clearing. It cannot be set at LASER OFF.
		5. I.O.R. (Index Of Refraction) This function enables the refractive index of the optical fiber to be set. The index range is 1.4000 to 1.5999 in 0.0001 steps. The reverse-displayed digit is settable with the rotary knob. Press the [ADVANCED FUNCTION SET] key #23 to input this digit and move to the next settable digit. When all four decimal places have been input, complete the input by pressing the [ADVANCED FUNCTION SET] key #23.
		6. M-Save (Memory save) This function writes the measurement results in the bulit-in backed up memory. Select a memory from M1 to M32 by using the rotary knob and press the [ADVANCED FUNCTION SET] key #23. All information on the CRT will be stored in the chosen memory. However, if unit is removed or changed when the power is turned oN, data is lost.
		7. M-Recall (Memory recall) This function reads stored data from the built-in backed up memory. Select a memory from M1 to M32 by using the rotary knob and press the [ADVANCED FUNCTION SET] key #23. Data stored in the memory will be displayed on the CRT. If there is no data written in the memory or the data has been lost because the backup battery has been discharged, the CRT displays DATA ERROR.

Table 3-1 Explanation of Controls (Cont'd)

No.	Label	Function
		8. Title This function enables up to 20 of the following characters to be input. 0 to 9, A to Z, a to z, Space, (,), *, +, -, period (.), / The reverse-displayed character can be changed with the rotary knob. After changing the settable character, input the character by pressing the [ADVANCED FUNCTION SET] key #23. After inputting up to 20 characters or selecting the return mark (↵), complete the input by pressing the [ADVANCED FUNCTION SET] key #23.
		9. Date/Time The reverse-displayed item can be changed by using the rotary knob. Press the [ADVANCED FUNCTION SET] key #23 to input the new data and shift the changeable item to the next item. Input data in the following order: 1. Day 2. Month 3. Year 4. Hour 5. Minute After setting the minute, press the [ADVANCED FUNCTION SET] key #23 to complete the input. Verify that the correct data has been set, since an incorrect data will result in improper execution.
		10. Meter/Feet This function enables the length to be set in meters or feet with the rotary knob. Press the [ADVANCED FUNCTION SET] key #23 after selecting meters or feet.

Table 3-1 Explanation of Controls (Cont'd)

No.	Label	Function
		11. Trace This function enables either a dotted or line display to be selected with the rotary knob. Press the [ADVANCED FUNCTION SET] key #23 after selecting dotted or line display.  Line Dot
#23	ADVANCED FUNCTION SET	This key sets the advanced functions. If an advanced function mode is left without pressing this key, all the previous settings become void.
#24		Operation guide explaining simplified operations.
#25	(Built-in printer)	Measurement can be made during printing because the printer has a buffer memory. However, while printing data is being transferred to the buffer memory after the [PRINT] key #26 has been pressed, other keys are in operable for a few seconds.
#26	PRINTER PRINT	When this key is pressed, all information displayed on the CRT is printed by the built-in printer.
#27	PRINTER FEED	The built-in printer recording paper is fed when this key is pressed.
#28	OPEN ONLY FOR PAPER SUPPLY	When this lock is pinched together in the direction of the ▶◀ marks, the cover can be lifted so that the built-in printer recording paper can be easily replaced.
#29	INTENSITY	Adjusts CRT brightness
#30	(Handle)	This handle is used for carrying the MW910C. During instrument use, the handle can be folded underneath the instrument to adjust the front panel height and angle.
#31		Receptacles for MZ146A holding pins

Table 3-1 Explanation of Controls (Cont'd)

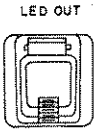
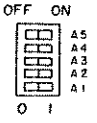
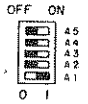
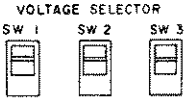
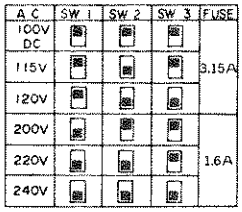
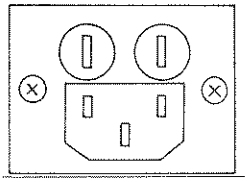
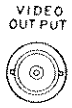
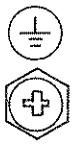
No.	Label	Function
#32 *1	LED LIGHT SOURCE 	Sets the plug-in unit LED light source ON or OFF. When this key is on, LED output is emitted from the LED OUT connector #34 and "LED MODE" is displayed at the upper-left side of the CRT.
#33 *1		Adjusts LED output level at LED OUT connector #34.
#34 *1		The LED output connector is mounted under this cover.
#35	(Fan)	Cooling fan CAUTION Do not obstruct the exhaust port.
#36	GP-IB (OPTION)	GP-IB connector
#37	 (OPTION)	GP-IB address switch. The address is set to 1 when the instrument is shipped from factor. 
#38		Input voltage selecting switches. Set the SW1, SW2, and SW3 switches to the positions shown in chart #39 so that the ac input voltage setting corresponds to the ac power supply. Settable voltages are 100, 115, 120, 200, 220 and 240 V. CAUTION Before setting these switches, set the POWER switch to OFF and unplug the power supply cord from the ac inlet.

Table 3-1 Explanation of Controls (Cont'd)

No.	Label	Function
#39		VOLTAGE SELECTOR switches #38 setting chart
#40		Ac inlet with fuse holders
#41		Composite video signal output connector for hard-copying information displayed on CRT at external video plotter.
#42		Ground terminal
#43		Unit locking mechanism. After inserting the plug-in unit in the mainframe, slide the clasp to the left and tighten the screw.
#44	(Cable winder)	Wind the power supply cord around these hooks when not using the instrument.

*1: #32 to #34 are provided only with MH963A, 937A, 938A/C, 939A/C, 955A/C.

3.4 Measurement Preparations

Check the following items prior to measurement:

1. Ambient temperature

This instrument operates within the specifications at an ambient temperature range of 0° to 40°C.

Do not use the instrument under rapidly changing temperature conditions because condensation may form on the optical lenses.

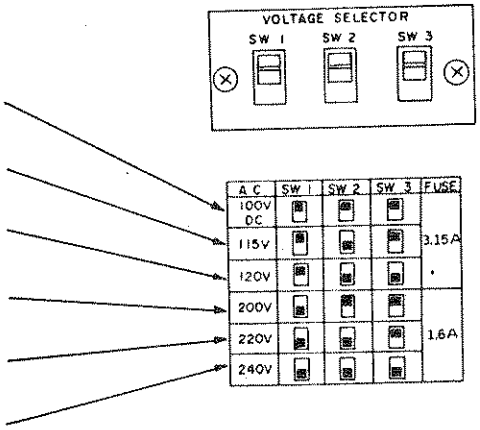
Dry the surface of the cabinet if it gets wet.

2. Ac line voltage

Confirm that the VOLTAGE SELECTOR switches on the rear panel are set to the ac line voltage.

The power supply voltage is set as shown in the following figure. The required fuse is also indicated.

Line Voltage (Vac)
100 to 108
108 to 117
117 to 127
200 to 216
216 to 234
234 to 250



CAUTION

1. Before setting the VOLTAGE SELECTOR switches, set the POWER switch to OFF and unplug the ac power supply cord from the ac inlet.
2. When the MZ146A DC-AC Inverter is used, set the VOLTAGE SELECTOR switches to "AC 100 V/DC" and use a 3.15 A fuse.

3. Grounding

To prevent accidental electric shock, ground the rear panel ground terminal (⏚) #42.

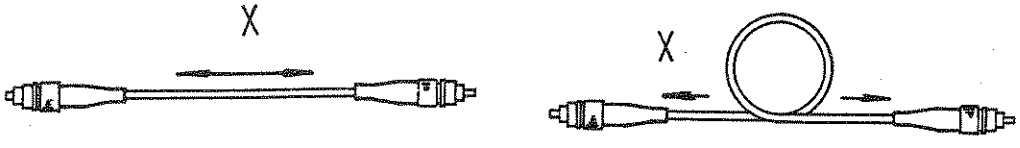
4. Installation site

Do not use this instrument where:

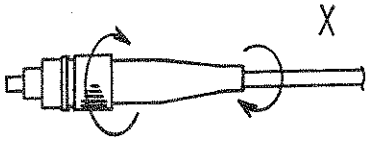
1. Vibration is severe.
2. It may fall over.

3.4.1 Precautions for handling optical fiber cable and optical connectors

1. Do not pull the optical fiber cable too hard or bend it too sharply.



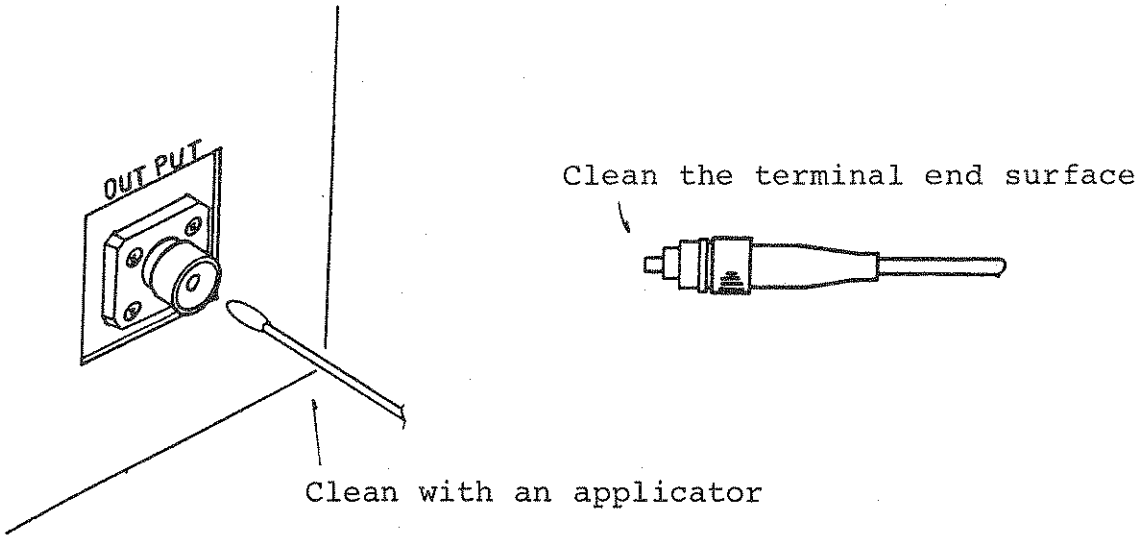
2. Do not twist the fiber cable where it is connected to the optical connector.



3. Confirm that there is no dust or condensation on the optical adaptor or plug. Be especially careful of the fiber terminal surface. Use caps and always keep the parts clean. An applicator moistened with alcohol should be used for cleaning.

4. If the fiber under test is connected to the OUTPUT connector and no trace is displayed on the CRT although the LASER ON/OFF switch is on and the LED is on, it may be due to dust in the connector, or the fiber under test may be broken near the measured section.

   Clean the connector terminal surface or use another cable.



3.4.2 General waveform analysis

Figure 3-5 shows the CRT waveform display when measuring the splice and transmission losses of a fiber. The horizontal axis is the distance equivalent to the transmission time that actually corresponds to the fiber length.

The vertical axis represents reflected light power detected by the OTDR.

The first spike to the extreme left is caused by Fresnel reflection at the near-end connector.

The backscattered light indicates the fiber characteristics. For example, if the fiber is low loss and the characteristics are homogeneous along the entire fiber, the trace will be a straight line falling along the horizontal axis.

The gradient corresponds to the optical fiber loss. If there is a break or a connection along the fiber, a Fresnel reflection will also appear as shown in Fig. 3-5.

When a fiber with a spliced connection is measured, a spike similar to the type caused by a break does not appear, although a step does appear. The step indicates the splice loss.

If the fiber is broken or the end of the fiber cable is detected, a large Fresnel reflection will appear.

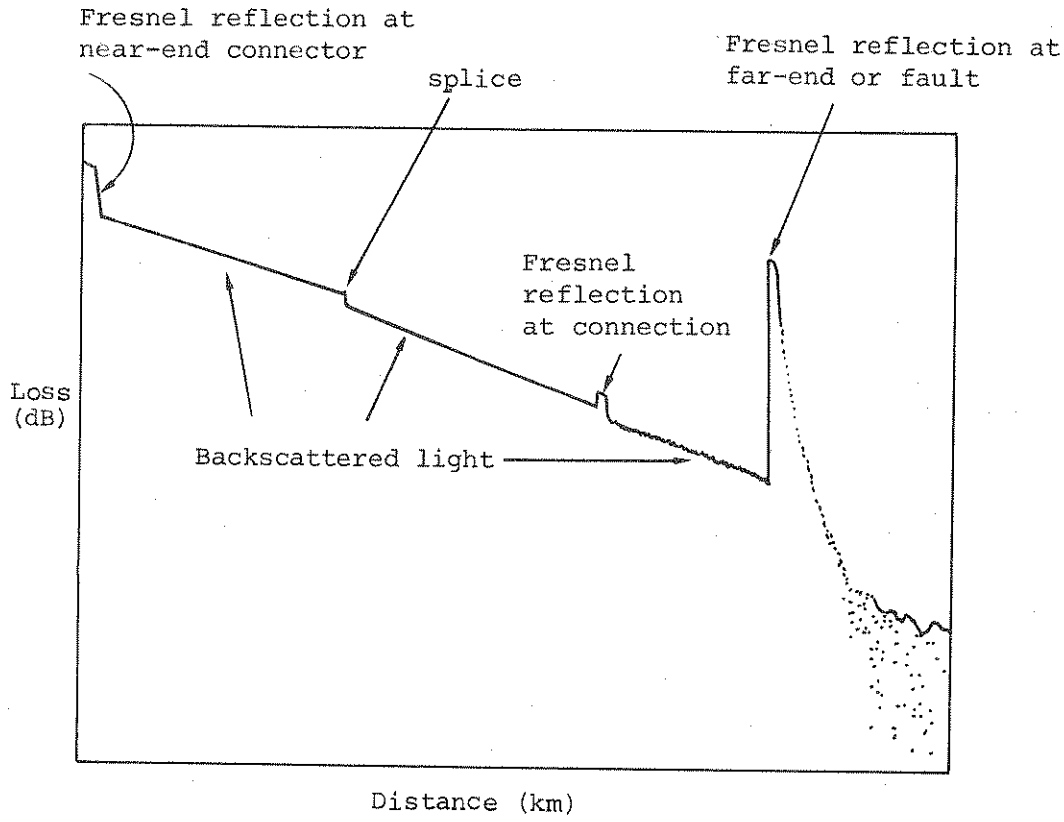


Fig. 3-5 General Waveform Analysis

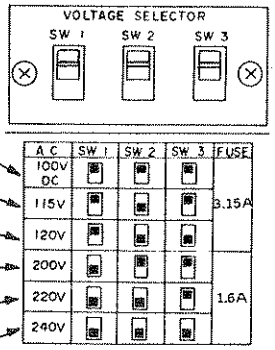
The following paragraphs (3.4.3 to 3.4.16) describe step-by-step splice and loss measurements. Control settings should be made in the following order.

3.4.3 POWER ON

(1) Confirming power supply used

Match the VOLTAGE SELECTOR switches to the ac line voltage used as shown below. Because the rated fuses differ for the 100 and 200 Vac systems, ensure that the correct fuse is used.

Line Voltage (Vac)
100 to 108
108 to 117
117 to 127
200 to 216
216 to 234
234 to 250



CAUTION

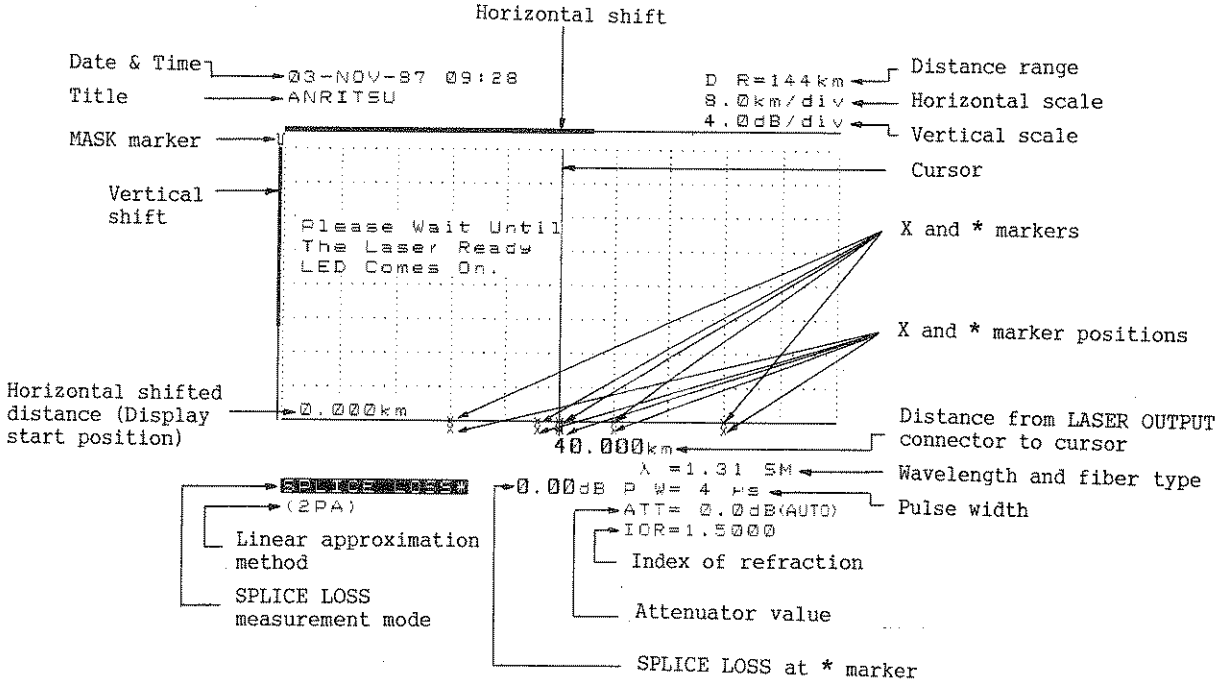
1. Before setting the switches, set the POWER switch to OFF and unplug the power supply cord from the ac inlet.
2. When the MZ146A DC-AC Inverter is used, set the switches to "AC 100 V/DC" and use a 3.15 A fuse.

(2) Power ON (Fig. 3-6)

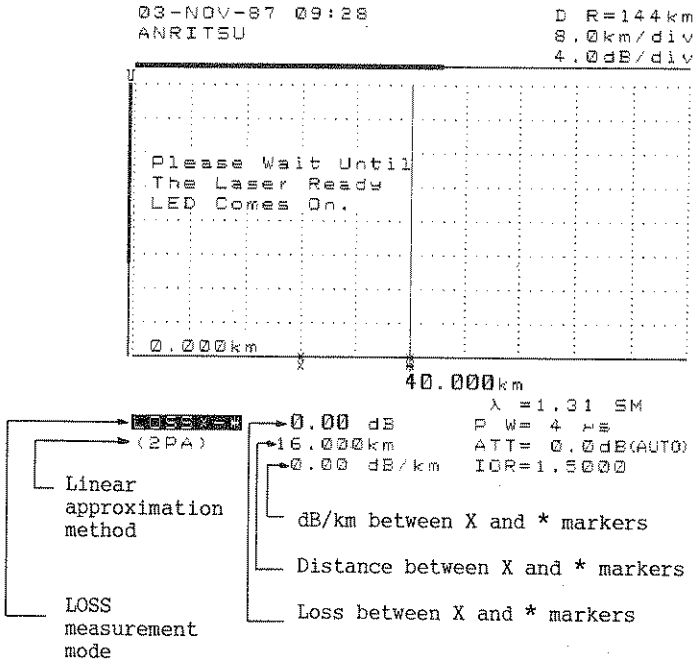
When POWER switch #1 is set to ON, the LED on the right side comes on to indicate that power is being supplied to the MW910C. Initial setting of the controls are:

- GP-IB ---------- LOCAL
- LED LIGHT SOURCE ON/OFF ---- OFF
- LASER ON/OFF ---------- OFF
- Printer ---------- OFF

For other controls, the settings at power off are restored at power-on. If the plug-in unit is changed to another type at power-off, the pulse width of the replaced plug-in unit is set to the max at power-on. When the MH955A/A1/C/C1 plug-in units are used, the initial wavelength setting is 1.31 μm.



(a) SPLICE mode



(b) LOSS mode

Fig. 3-6 Initial CRT Display Examples

3.4.4 Wavelength selection

When using the MH955A/A1/C/C1 plug-in unit, select wavelength 1.31 μm or 1.55 μm according to the measurement requirements by using the [λ SELECT] key #5. When using these plug-in units, the λ SELECT LED indicator comes on. The selected wavelength is displayed at the bottom-right of the CRT.

However, when other plug-in units are used, the LED does not come on. When using these plug-in units, wavelengths cannot be selected. However, the wavelength is displayed on the CRT.

Note:

Do not attempt measurements for approxmately 10 seconds after switching the wavelength.

3.4.5 LASER OUTPUT ON

When the READY LED comes on after the LD temperature has stabilized optical pulses are emitted from the LASER OUTPUT connector after connecting the fiber to the LASER OUTPUT connector and setting the [LASER ON/OFF] key #6 to ON.

Notes:

1. The [LASER ON/OFF] key #6 does not come on unless the fiber is connected.
2. <Precaution when turning off laser output>
   When turning off the laser output immediately after changing the measurement conditions, do not turn the [LASER ON/OFF] key off until the displayed waveform has been swept at least once.

   Also follow this procedure when removing the optical fiber plug from the LASER OUTPUT connector.

3.4.6 I.O.R. (Index OF Refraction)

Press the [ADVANCED FUNCTION SELECT] key #22 to set the I.O.R. mode. The first decimal place is then reverse-displayed. Select the required numeric value by using the rotary knob #16, and then press the [ADVANCED FUNCTION SET] key #23. After the first decimal place is set, the second decimal place is automatically reverse-displayed for setting. Select the numeric value and set it in the same way using the rotary knob #16 and the [ADVANCED FUNCTION SET] key #23. The procedure is the same for the third and fourth decimal places. After the fourth decimal place is set, press the [ADVANCED FUNCTION SET] key #23 again to complete setting the refractive index.

The setting range is from 1.4000 to 1.5999 and the set value is displayed at the bottom right of the CRT.

3.4.7 DISTANCE (Distance range)

Select a distance range that exceeds the length of the fiber to be measured by using the [DISTANCE] key #8. To view the entire length of the fiber on the same display, select a range that is at least twice the distance range of the fiber to be measured.

3.4.8 PULSE (Pulse width)

Select pulse width with the [PULSE] key #9. To measure at high resolution, select 100 ns. However, the distance which can be measured will be shortened. To measure long distances, select the maximum pulse width. Select the optimum resolution and measurement distance.

		Resolution	Measurable Distance
Pulse Width	2 µs (MH963A/A1, MH937A/A1) 4 µs (MH938A/A1, MH939A/A1, MH955A/A1) 10 µs (MH938C/C1, MH939C/C1, MH955C/C1)	Low	Long
	0.5 µs (MH963A/A1, MH937A/A1) 1 µs (MH938A/A1, MH939A/A1, MH955A/A1) 1 µs (MH938C/C1, MH939C/C1, MH955C/C1)	Middle	Middle
	100 ns	High	Short

Note: The maximum pulse widths can be used only when the following distance ranges are selected.

Maximum pulse width	Distance range
2 µs	36 km, 72 km, 144 km
4 µs	36 km, 72 km, 144 km
10 µs	144 km

3.4.9 ATT (Attenuator)

The backscattered light level varies with pulse widths and fiber observation positions.

The attenuator optimum setting is automatically set by setting attenuator mode to AUTO, which makes operations very easy. When the attenuator is set to auto control, "(AUTO)" is displayed after the attenuation value displayed at the bottom-right of the CRT.

When the attenuator is set to auto control, the optimum attenuator value is set:

- When the pulse width changed by the [PULSE] key #9
- When the pulse width changed by switching the [DISTANCE] key #8

- When the wavelength is switched by the [λ SELECT] key #5 for a switchable plug-in unit
- When the LD output is set to ON by the [LASER ON/OFF] key #6. However, except when LD output is set ON after an averaging number set by using the Ave. Number function is completed and LD is OFF.
- When the "ATT Manual" mode is selected by the [ADVANCED FUNCTION SELECT] key #22, and the attenuator is changed from manual control to auto control.

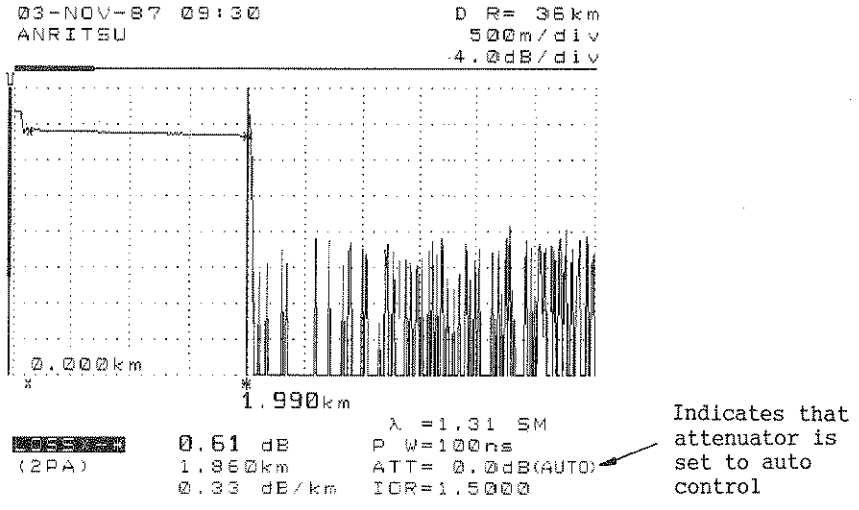


Fig. 3-7 Indication showing Attenuator in Auto Control

For special cases (1) and (2) as described below, set the attenuator value to manual mode by pressing the [ADVANCED FUNCTION SELECT] key #22, selecting "ATT. Manual" mode and turning the rotary knob #16. After setting, always press the [ADVANCED FUNCTION SET] key #23 to set the value. This operation cannot be executed when the LD output is OFF.

(1) When the level of optical fiber Fresnel reflection or backscattered light is too high, the waveform is as shown in Fig. 3-8 and cannot be controlled by the [SHIFT V] key because the MW910C amplifier becomes saturated. This adversely affects the loss measurement accuracy, so eliminate the curve by adjusting as described above.

(2) When the backscattered light level is low, increase the gain by adjusting as described above.

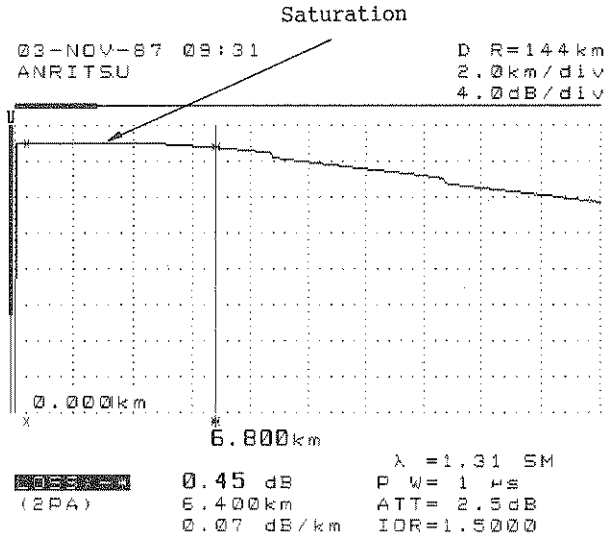


Fig. 3-8 Waveform Caused by Amplifier Saturation

3.4.10 Cursor and marker

The cursor is a vertical line displayed on the CRT. It is used for the following purposes.

1. Shifting markers
2. Measurement of optical fiber length from the LASER OUTPUT connector to the cursor-waveform intersection

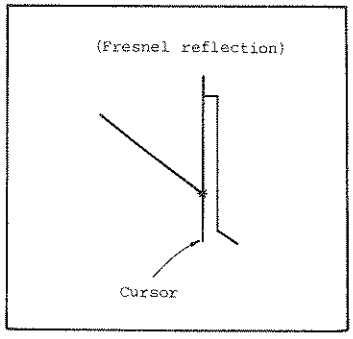
To shift the cursor, press the [MARKER] key #18 and turn the rotary knob #16.

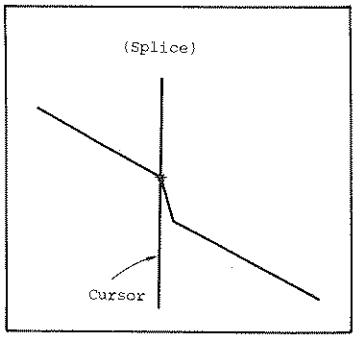
The cursor can be shifted at high-speed by setting the [COARSE] key #17 to ON. The minimum cursor step distances for each horizontal scale are as follows: (IOR = 1.5000)

HORIZONTAL SCALE	MINIMUM CURSOR STEP
25 m, 50 m	1 m
100 m	2 m
250 m, 500 m	10 m
1 km	20 m
2 km	40 km
4 km	80 km
8 km	160 km

Note:

To measure the Fresnel reflection and splice positions, set the cursor to the left edge where the waveform changes as shown in the figures below.





3.4.11 H-SCALE (Horizontal scale) and SHIFT-H (Horizontal Shift)

The waveform displayed on the CRT can be enlarged, reduced, or shifted by the following operations.

(1) H-SCALE (Zooming)

Step	Procedure
1	Move the cursor to the desired point used for zoom by pressing the [MARKER] key #18 and turning rotary knob #16 (see Fig. 3-9).
2	Press the [H-ZOOM IN] key #15 to set a smaller scale until the desired magnification is reached (see Fig. 3-10). The selected scale will be displayed at the upper-right side of the CRT.
3	To reduce waveform zooming, press the [H-ZOOM OUT] key #15 to set larger scale.

The newly-zoomed CRT is displayed with the set cursor positioned at the center.

Note:

If the cursor is set too far from the center, the waveform zooming is based on the edge of the CRT.

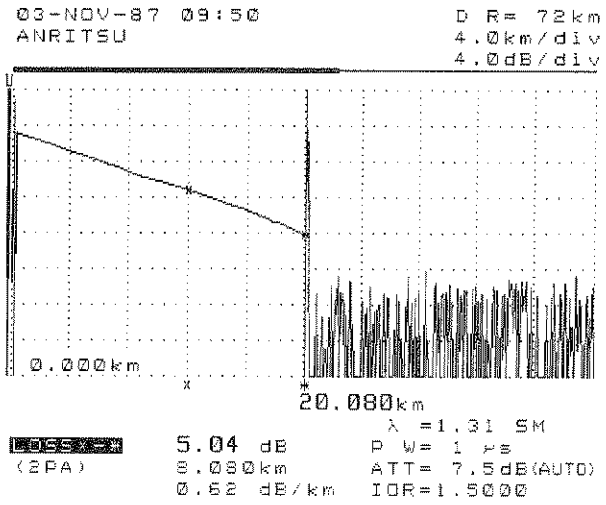


Fig. 3-9 Waveform Before Zooming

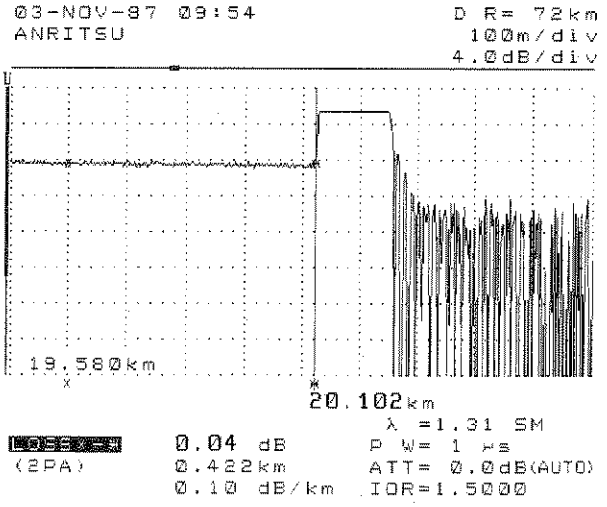


Fig. 3-10 Zoomed Waveform

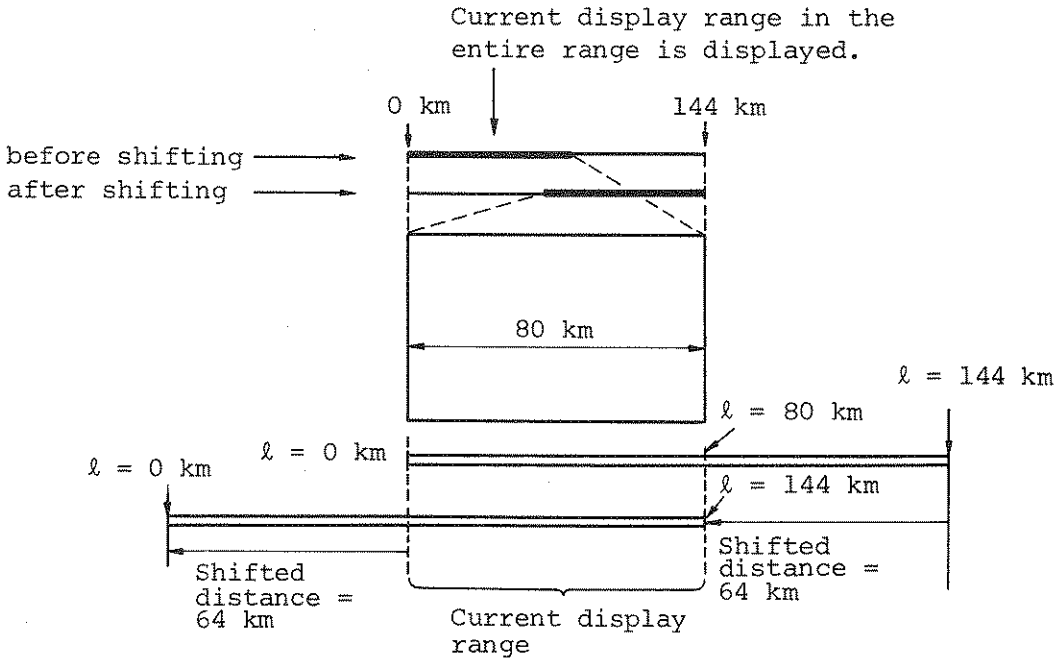
Figure 3-10 shows the magnified waveform of Fig. 3-9. The cursor has been moved to the center of the CRT, but the distance remains unchanged at 20.080 km. The start position of the waveform on Fig. 3-10 is 20.102 km which indicates waveform magnification.

(2) SHIFT-H (Horizontal shift)

The waveform can be shifted to the left or right by pressing the [SHIFT H] key #20 and turning the rotary knob #16.

The CRT waveform will be displayed as follows:

For example, when the DISTANCE range is set to 144 km, up to 80 km from the LASER OUTPUT connector is displayed as shown in the figure below. To observe distances beyond 80 km, press [SHIFT H] key #20 and turn the rotary knob #16 counterclockwise. The displayed range will then shift.



The ranges that can be displayed on the CRT for each distance range are listed in the following table. The part not displayed on the CRT can be observed by shifting the displayed range.

DISTANCE range	Maximum display distance	Shiftable distance
144 km	80 km	64 km
72 km	40 km	32 km
36 km	20 km	16 km
18 km	10 km	8 km

(For IOR = 1.5000)

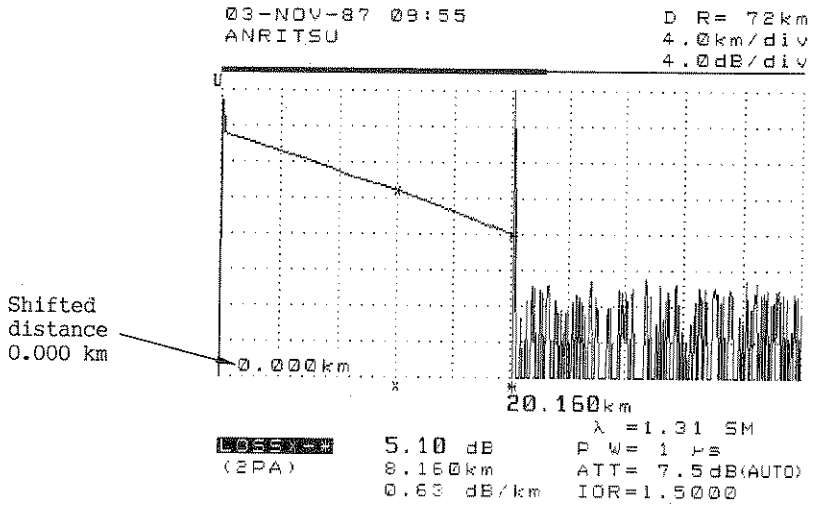


Fig. 3-11 Display Before Shifting

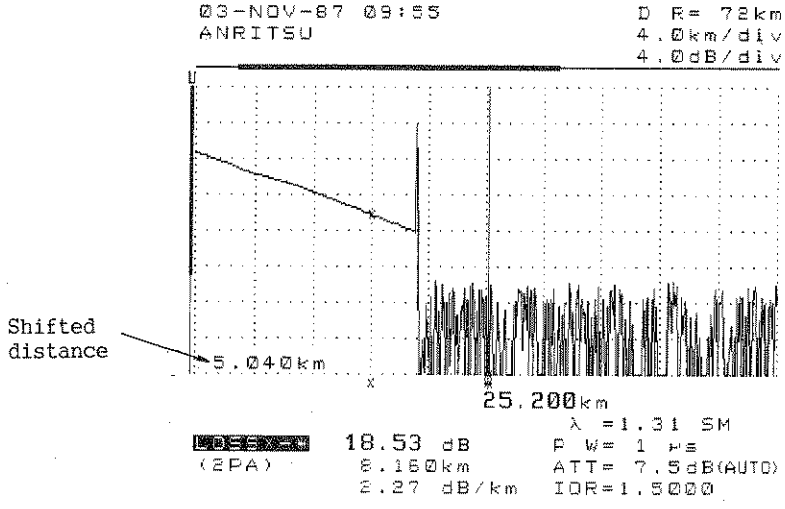


Fig. 3-12 Shifted Display

3.4.12 MASK function

The MASK function is used to erase a part of the waveform on the CRT; up to three parts can be erased. The spikes caused by large Fresnel reflection from the connectors, splices, or break point may distort the waveform and affect measurement accuracy. Erasing the spikes using the MASK function, eliminates waveform distortion and enables accurate measurement.

(1) MASK function procedure

Step	Procedure
1	When the [MASK] key #21 is pressed, the selected MASK marker is changed from ⌐⌐ to ▀ (Fig. 3-13). The three markers may be overlapped at this position.
2	The first mask can be shifted to the Fresnel reflection point or splice point by using the rotary knob #16. The MASK shift speed can be increased by setting the [COARSE] key #17 ON or reduced by setting it OFF.
3	When the [MASK] key is pressed again, the second MASK marker is selected, and can be shifted by using the same procedures. The third mask is also set using the same procedure. By selecting the mask marker "▀" to be shifted with the [MASK] key, three mask markers can be shifted independently on the CRT (Fig. 3-14).
4	To release the MASK function, shift the three mask markers to the left edge of the CRT by using the rotary knob #16. The three mask markers can be cancelled simultaneously by first selecting the Mask Clear mode of the ADVANCED FUNCTION, and then by pressing the [ADVANCED FUNCTION SET] key #23.

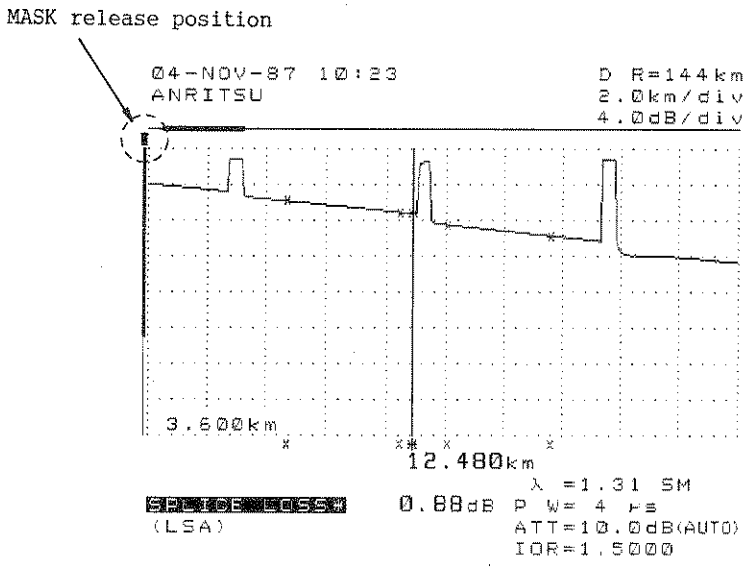


Fig. 3-13 Waveform Before Using MASK Function

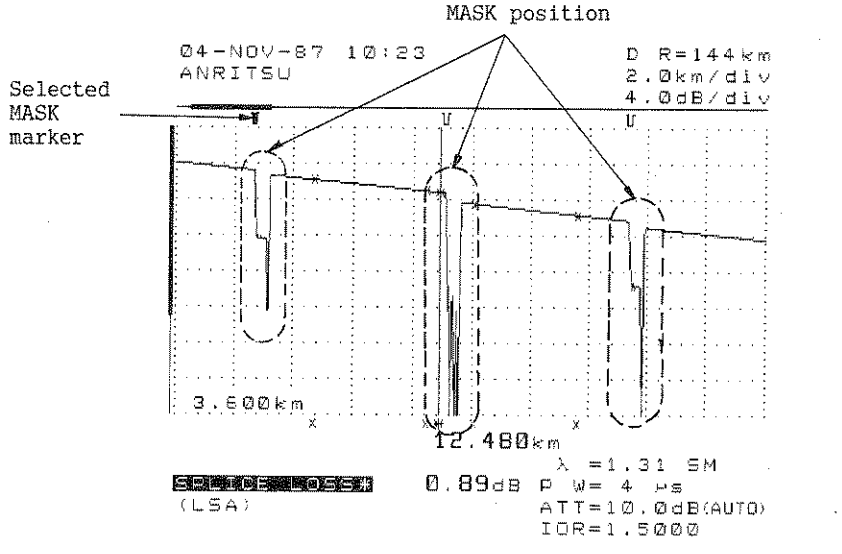


Fig. 3-14 Waveform After Using MASK Function

3.4.13 Marker positions for [SPLICE/LOSS] key

(1) SPLICE

Markers X1, X2, X3, and X4 are set at their standard positions around the asterisk (*) marker. The standard positions of the markers are as follows:

With the * marker as center, X1 is set two graticles to the left of the * marker, X2 to 2/5 graticles on the same side, X3 one graticle to the right of the * marker, and X4 two graticles to the right of marker X3.

Note:

When the four X markers are not set to the standard positions, switch the [SPLICE/LOSS] key #10 to LOSS and then back to SPLICE again. The four X markers will then be set to the standard positions with the * marker in the middle.

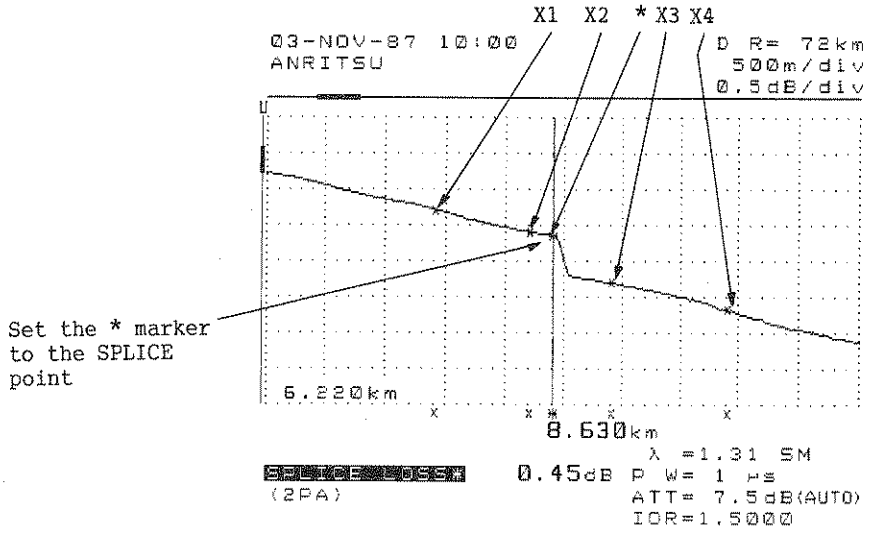


Fig. 3-15 Marker Positions in SPLICE Mode

When the cursor is set to the * marker and then shifted, all five markers move simultaneously. However, when the cursor is set to an X marker using the [MARKER] key #18, only that X marker shifts with the rotary knob. Therefore, each X marker can be shifted separately by using the [MARKER] key #18, cursor, and rotary knob but they cannot be skipped over other markers. If an X marker is moved to another X marker or the * marker, both markers then shift together.

When setting the * marker manually, set it to the leading edge of the splice point or Fresnel reflection (Fig. 3-15).

(2) LOSS

When LOSS is selected, the X marker and * marker are displayed. (Fig. 3-16)

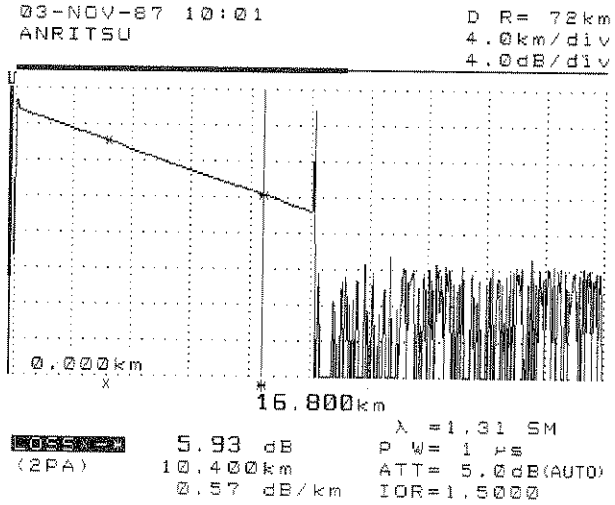


Fig. 3-16 Marker Positions at LOSS Mode

Shifted the X marker and the * marker with the cursor; set the * marker to the right end of the measured waveform and the X marker to the left end (See Fig. 3-16).

Note:

To ensure accurate measurement, the markers must be correctly set (see paragraph 3.8.1 for details).

3.4.14 Approximation methods (LSA/2 POINTS)

There are two data processing methods for splice and fiber loss measurements.

1. When the least squares approximation (LSA) method is selected, a straight line is obtained from all waveform data between the markers X1 to X2, X3 to X4 or X to *.

   For example, splice loss can be measured by plotting straight lines between the X1 to X2 and X3 to X4 markers (see paragraph 4.3 for details).

2. When the 2 POINTS method is selected, only the data at the two markers is used (paragraph 4.2 for details).

   Usually, the LSA method is more accurate than the 2 POINTS method.

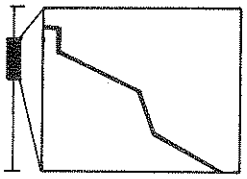
3.4.15 V-SCALE and SHIFT V

(1) V-SCALE

Set the vertical scale according to the fiber loss using the [V-SCALE] key #14. Each time the key is pressed, the scale changes from 4 → 2.5 → 1 → 0.5 → 0.2 dB/div. The dB/div is the one-way loss and the set value is displayed on the upper-middle part of the CRT.

(2) SHIFT V

Press the [SHIFT V] key #19 and turn the rotary knob #16 to shift the waveform up and down the CRT. The displayed range is represented by the thick part of the line to the left of the CRT scale.



3.4.16 AVERAGE ON/OFF

(1) ON

When there is excessive noise in the waveform (Fig. 3-17) and accurate measurement cannot be made, start averaging by selecting ON by using the [AVERAGE] key #13.

In this mode, the waveform S/N ratio is improved as time elapses, and the result is displayed on the CRT.

Averaging is momentarily reset and restarted when the following keys and advanced functions are operated.

DISTANCE, PULSE, H-ZOOM, SHIFT-H, MASK key, Initialize, ATT. Manual, Mask clear

If the number of averagings of the Advanced Function is set in the AVERAGE ON state and the set value is less than the current number of averagings, the averaging is reset and restarted.

If the fiber is disconnected from the OUTPUT connector, averaging is also reset and restarted.

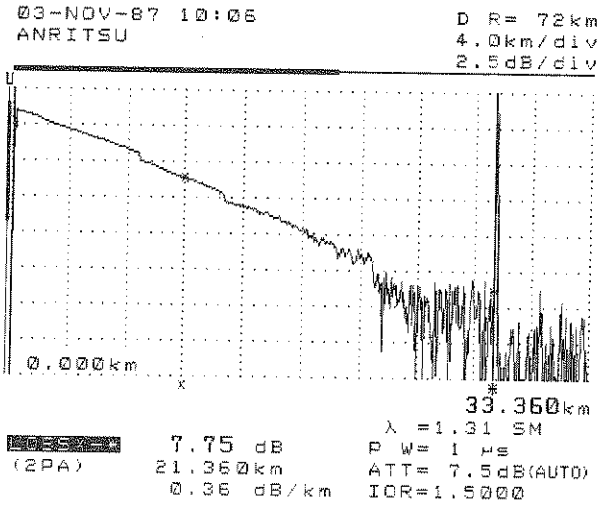


Fig. 3-17 Waveform Before Averaging

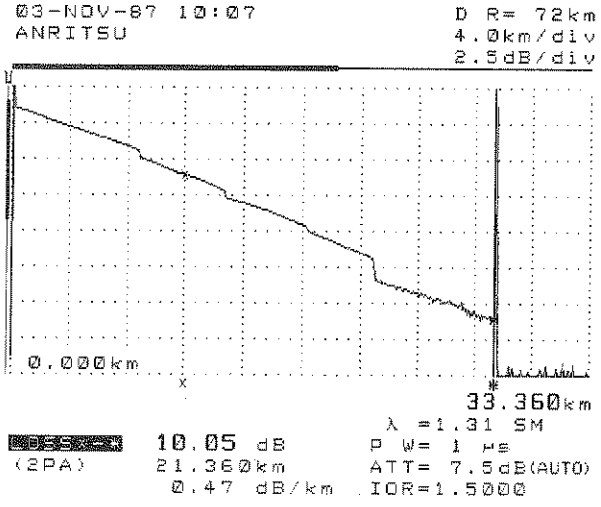


Fig. 3-18 Averaged Waveform

Figure 3-18 shows a waveform after averaging; the waveform S/N ratio has been improved and splice points have become clear to enable waveform pinpointing.

Note:

1. Since the averaging time is not restricted, the longer the time, the clearer the waveform.
2. Do not change the fiber state during averaging. If it is changed, the correct result may not be obtained.

(2) OFF

When OFF is selected, the averaged waveform is erased. In the AVERAGE OFF mode, a new waveform is displayed for each sweep regardless of the previous waveform.

This is effective while checking a splice or connection.

If INITIALIZE is set in the Advanced Function, the averaging is set to OFF.

Note:

The [AVERAGE] key #13 can be used even when the LASER [ON/OFF] key is OFF when the power switch is turned ON first. However, if the LASER [ON/OFF] key is set to ON and is then set to OFF, the [AVERAGE] key cannot be used.

3.4.17 HELP

OTDR measurement procedures or key functions are displayed on the CRT by operating the [HELP] key #4 and rotary knob #12.

After power-on, the HELP mode can be selected from either the measurement state or the LED mode (self-checking). When the HELP mode is set, all keys other than the [HELP] key #4 and rotary knob #12 are locked out. Selectable items are displayed on each screen in the HELP mode and these items are enclosed by a square. Use the rotary knob to select items. Clockwise rotation shifts the square on the screen to the upper item; counterclockwise rotation shifts to the lower item.

After the required item has been selected, a fresh HELP screen can be displayed on the CRT by pressing the [HELP] key #4.

When the [HELP] key #4 is pressed in a measurement state or the LED mode (self-checking), the initial HELP mode screen (Fig. 3-19) is displayed on the CRT.

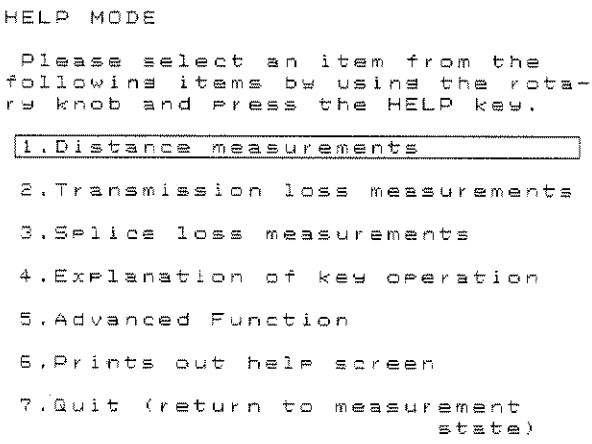


Fig. 3-19 HELP Mode Initial Screen

The above items No.1 to No.3 are related to various OTDR measurements. Item No.4 explains the function of each key. Item No.5 explains the 11 advanced functions; No.6 hard copies the CRT display at the built-in printer; and No.7 returns to the state prior to entering the HELP mode.

When No.3 (Splice loss measurement) on the HELP mode initial screen (Fig. 3-19) is selected by turning the rotary knob #12 and pressing the [HELP] key #4, pressing it once more, displays the screen shown in Fig. 3-20 on the CRT.

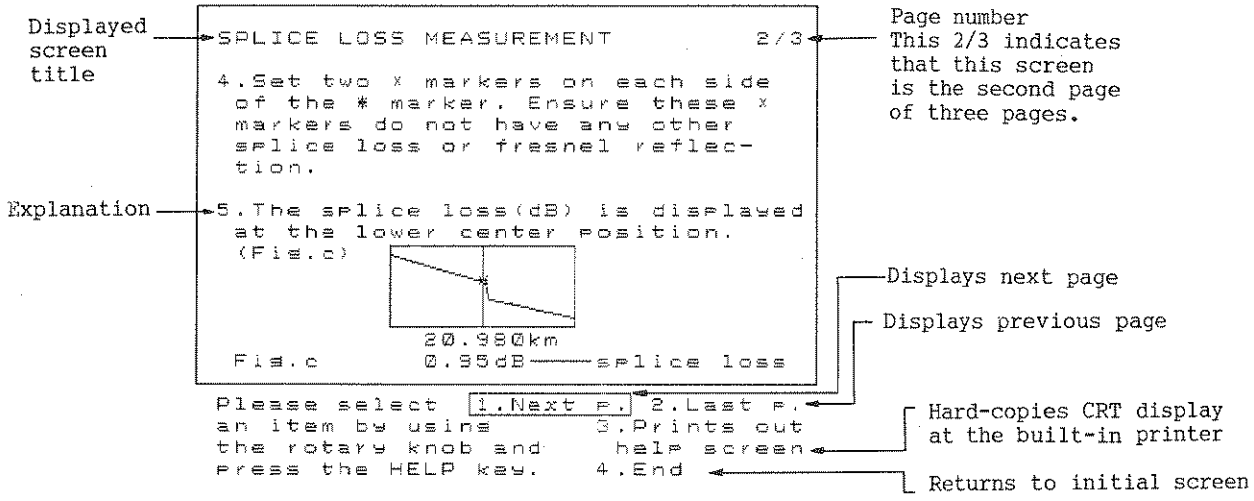


Fig. 3-20 HELP Mode Screens

The title of the displayed screen and page number are displayed on the top line. The numbers 1 to 4 at the bottom-right are selected by turning the rotary knob #12. When "1.Next page" is selected while Fig. 3-20 is displayed on the CRT, the screen changes to the "Splice loss measurement 3/3". When "2.Last page" is selected, while Fig. 3-20 is displayed on the CRT, the screen changes to the "Splice loss measurement 1/3". When "3.Print out help screen" is selected, the screen displayed on the CRT is hard-copied at the built-in printer. When "4.End" is selected, the screen is reset to the initial screen (Fig. 3-19).

When "4.Explanation of key operation" is selected in the HELP mode initial mode (Fig. 3-19) and the [HELP] key #4 is pressed, the screen shown in Fig. 3-21 is displayed on the CRT.

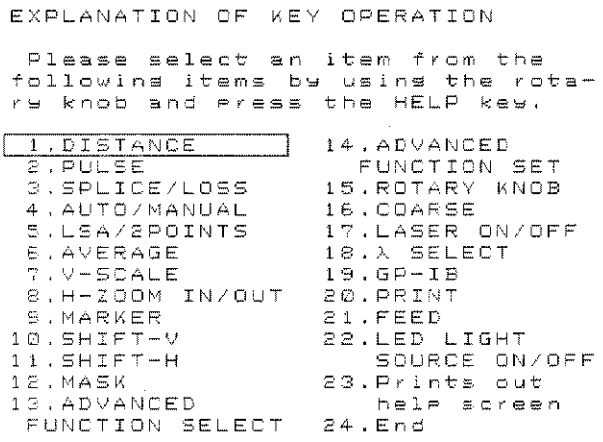


Fig. 3-21 Key Operation Explanation Initial Screen

In Fig. 3-21, items No.1 to No.22 are the MW910C key names. An explanation of a key function can be displayed on the CRT by selecting the item and pressing the [HELP] key #4. The screen is reset to that shown in Fig. 3-19 by selecting "24.End" and pressing the [HELP] key #4.

When "1.DISTANCE" is selected and the [HELP] key #4 is pressed, the DISTANCE KEY explanation shown in Fig. 3-22 is displayed on the CRT.

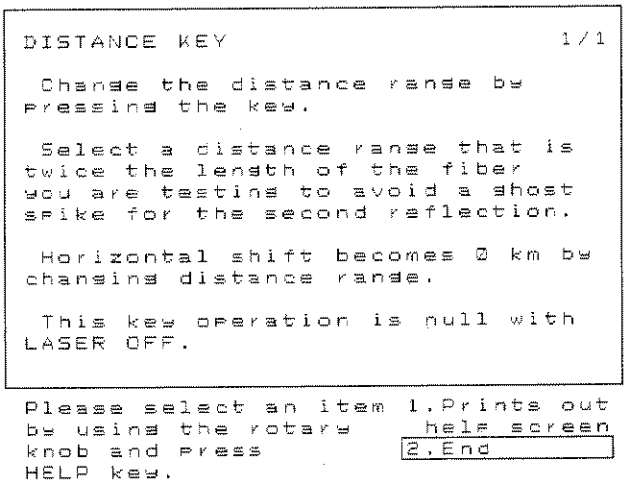


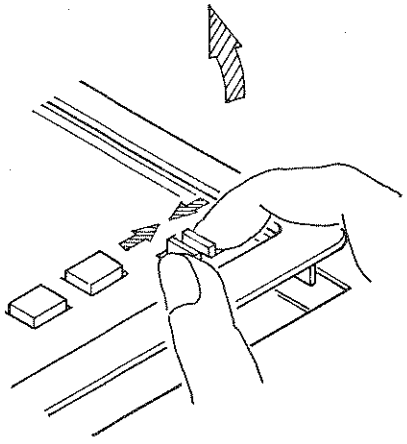
Fig. 3-22 Distance Key Explanation Screen

When "2.End" is selected from Fig. 3-22 and the [HELP] key #4 is pressed, the screen is reset to the initial screen shown in Fig. 3-21.

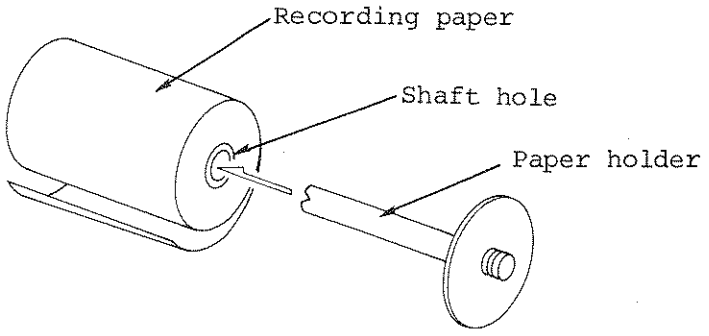
When "5.Advanced Function" is selected from the HELP mode initial screen (Fig. 3-19), an initial screen explaining the Advanced Function appears from which each function can be selected.

3.4.18 Replacing printer recording paper

Step	Procedure
1	Turn the power off.
2	Pinch the cover opening lock #28 on the top cover to open the printer cover.

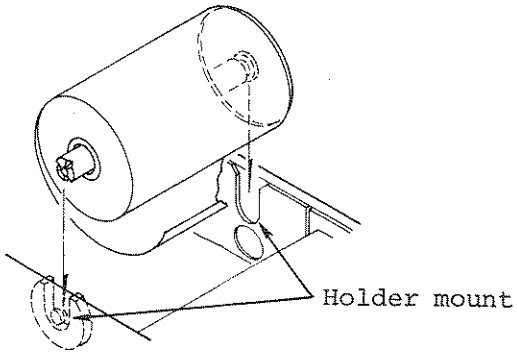


3	Raise the left side of the paper holder, and remove it by lifting straight up. The paper holder is under spring tension against the shaft; it will feel tight, but this does not prevent removal.
4	Unwrap the new recording paper; peel off the pasted end that fastens the tip, and insert the paper holder in to the recording paper shaft hole as shown below.

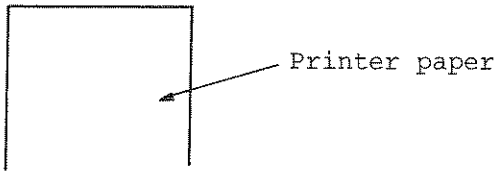


Step	Procedure

5 Mount the recording paper in the paper holder as shown below.

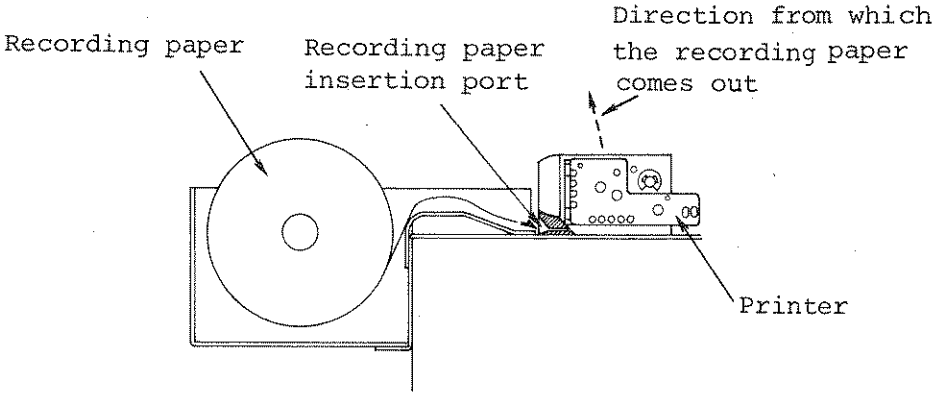


6 Cut the end of the printer paper at a right angle.



7 Insert the tip of the recording paper as shown below into the recording paper insertion port until it stops.

Correct insertion:



(Cont.)

Step	Procedure
8	Turn the power on and press the [FEED] key #20; the recording paper will emerge from the top exit (Fig. 3-23).
9	Return the printer cover to the original position after passing the recording paper tip through the recording paper exit.

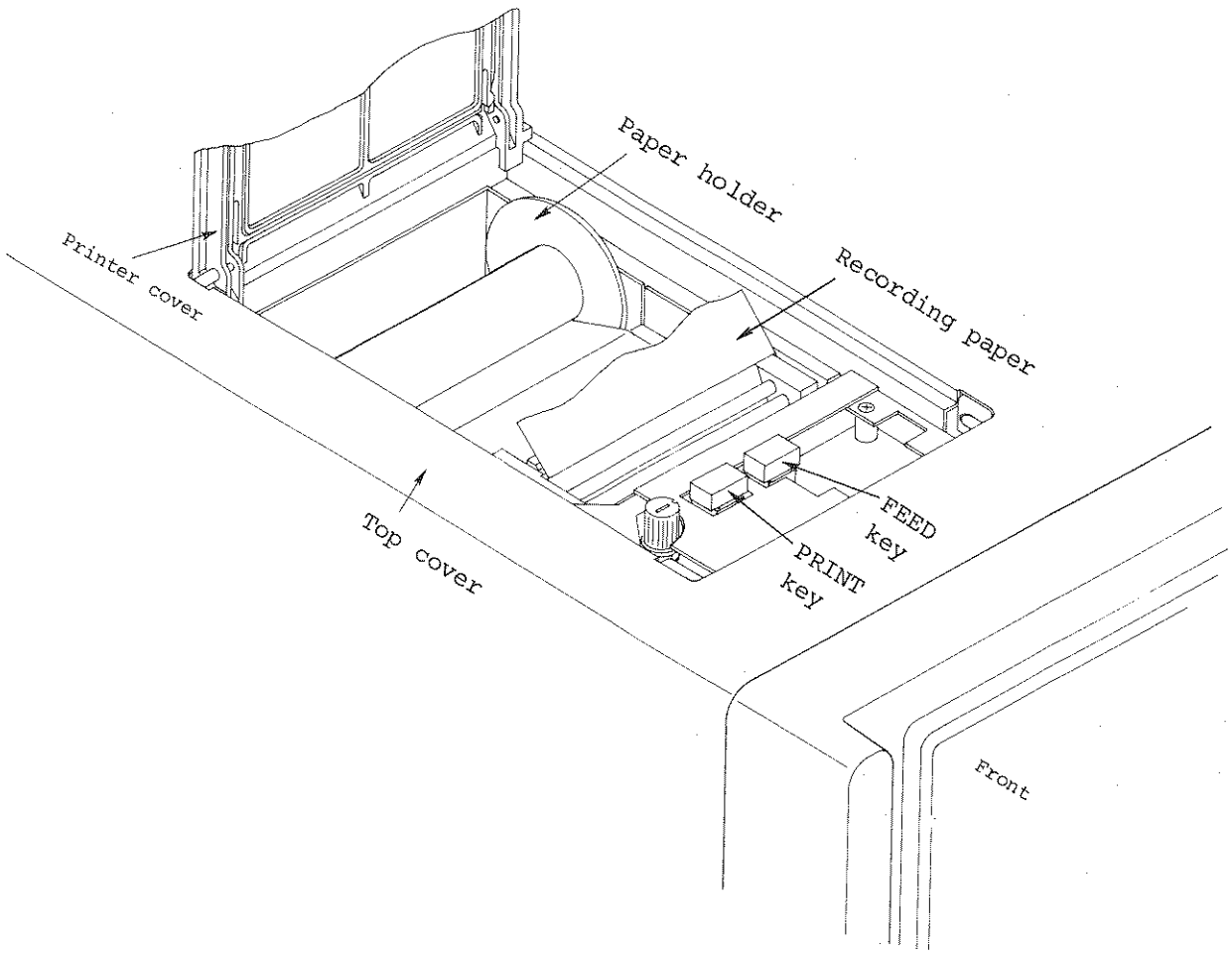
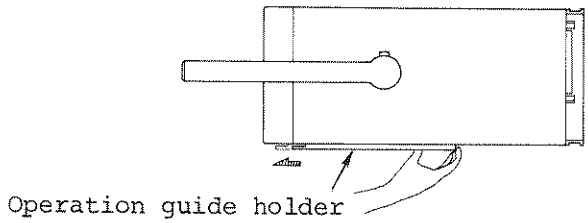


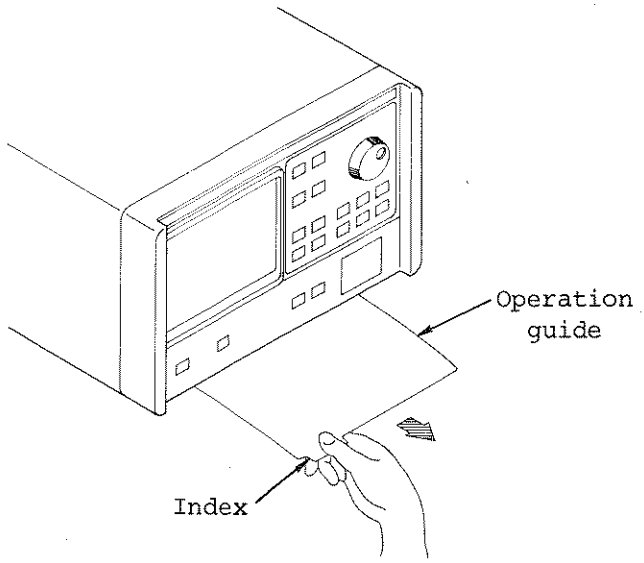
Fig. 3-23 Replacing Printer Recording Paper

3.4.19 Operation guides

Step	Procedure
1	When using the operation guides, pull out (approx. 10 mm) the guide holder toward the instrument front in the direction of the arrow.



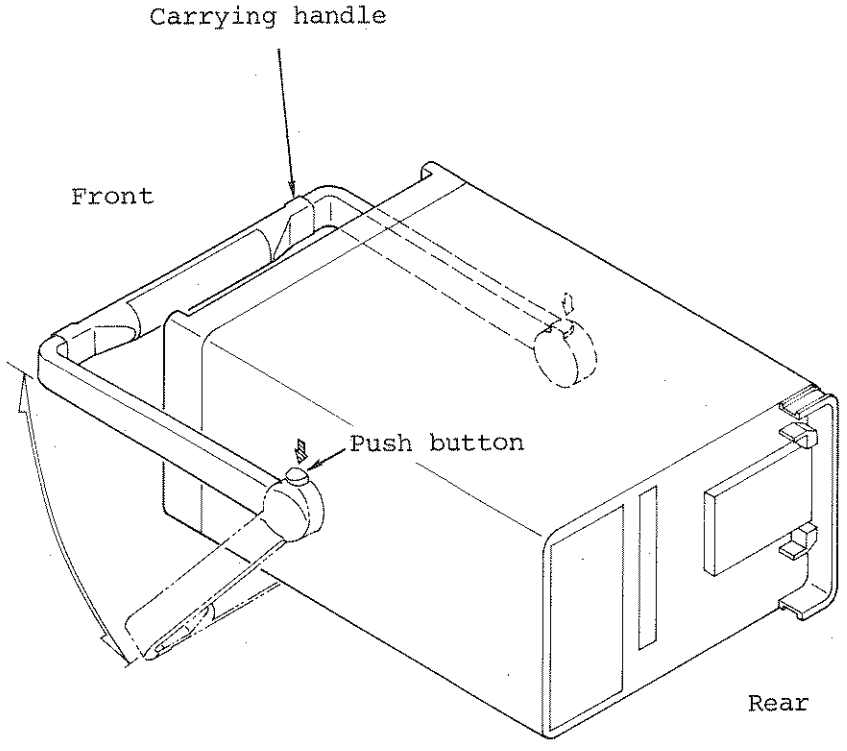
2	Pull out the operation guide by holding the index section.



3	Returning the operation guide to the original position in the reverse order.

3.4.20 Carrying handle

The carrying handle is unlocked so that it can be rotated by pressing the push buttons on both sides of the carrying handle in the direction of the arrow shown below.



3.5 Fault Locating

A break in an optical fiber is characterized by the disappearance of the backscattered light. When the surface of the break is perpendicular to the fiber axis, a large Fresnel reflection is generated (see Fig. 3-24).

When the surface of the break is sloping or jagged, a Fresnel reflection is not generated (see Fig. 3-25).

3.5.1 Measurement procedures

Step	Procedure
1	Display the waveform to measure the breakpoint (paragraph 3.4.2 to 3.4.15).
2	When there is a lot of noise on the waveform, set the [AVERAGE] key to ON (paragraph 3.4.16).
3	Set the * marker with the cursor to the faulty point by using the [MARKER] key and rotary knob. The [SPLICE/LOSS] key may be set to either SPLICE or LOSS because it makes no difference in the actual measurement. The setting position of the * marker for a waveform with Fresnel reflection is at the rising edge as shown in Fig. 3-24. For a waveform without Fresnel reflection, the setting position is at the point where the waveform starts trailing as shown in Fig. 3-25.
4	The distance from the LASER OUTPUT connector to the cursor is displayed under the cursor.

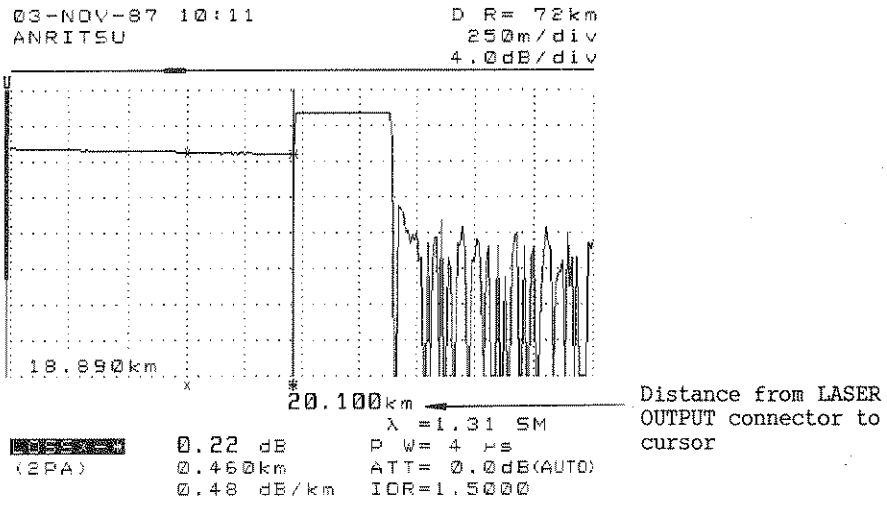


Fig. 3-24 Fault Location Measurement

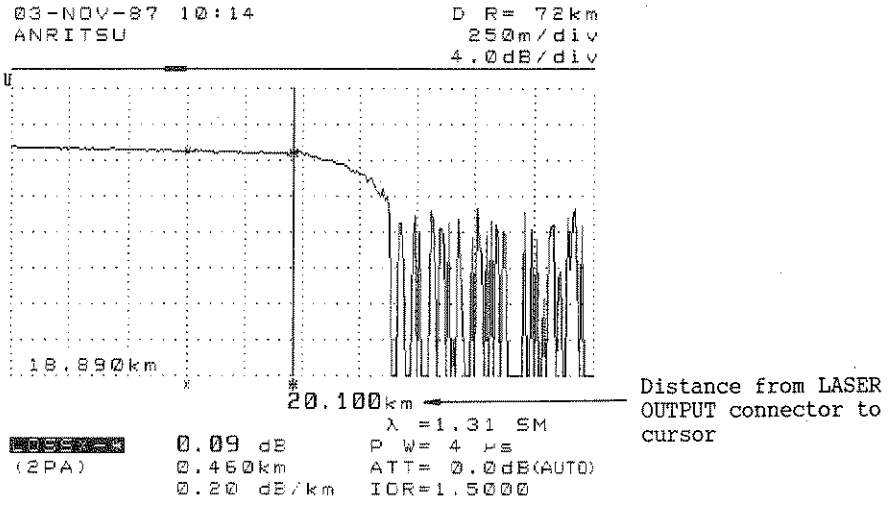


Fig. 3-25 Fault Location Measurement

Notes:

1. See paragraphs 3.4.10 and 3.4.11 for details on the shift distance and resolution for one cursor step.
2. If several fibers in a multiple fiber are broken at the same point, check all the fibers.

3.6 Ghost Spikes

False spikes, generally known as "ghosts", may appear on the CRT. They are caused by a large Fresnel reflection or by the relationship between the Fresnel reflection point and the DISTANCE Range.

3.6.1 Ghosts caused by large Fresnel reflection

As shown in Fig. 3-26, when large Fresnel reflection occurs at 2.00 km, a secondary reflection of the Fresnel reflection occurs at the LASER OUTPUT connector of the MW910C.

This causes ghost spikes to be displayed, which makes the faulty point appear as if it were twice as far away as it actually is.

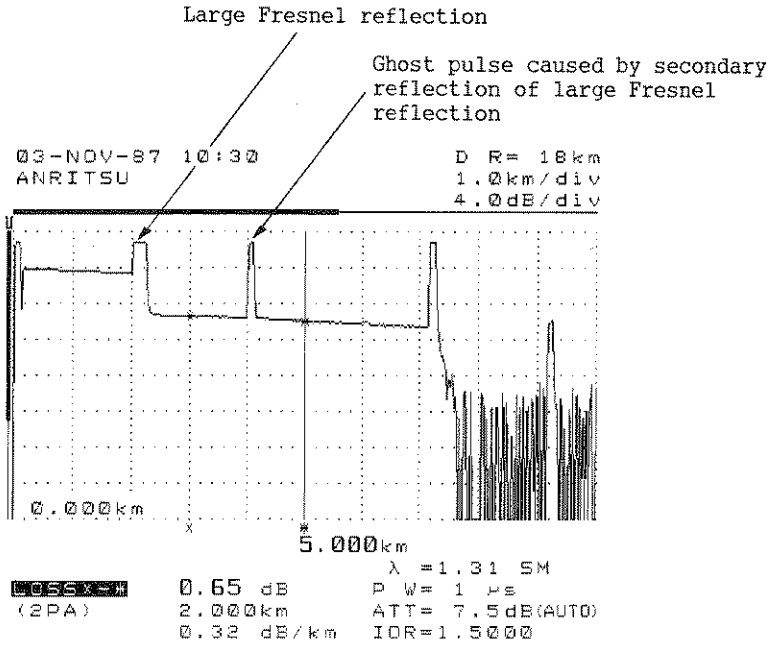
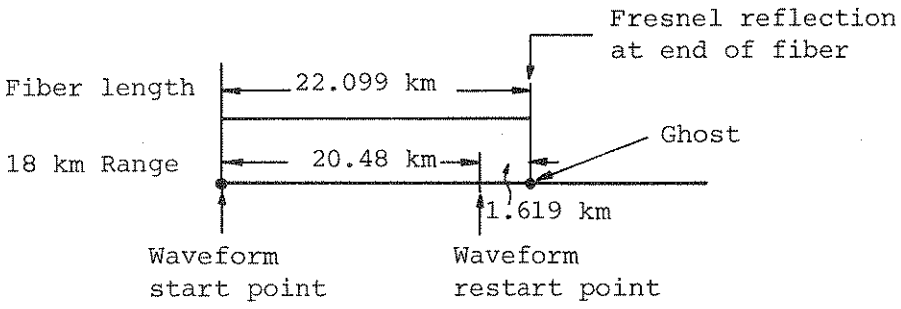


Fig. 3-26 Ghost Spikes Caused by Secondary Reflection

3.6.2 Ghost caused by Fresnel reflection point and distance range relationship

As shown in Fig. 3-27, the pulse at 1.60 km is a ghost caused by the Fresnel reflection at the 22.099 end of the fiber.

When the distance range is set to 18 km, it corresponds to the 20.48 km repetition distance for displaying the waveform. Therefore a ghost appears on the CRT at 1.60 km from the OUTPUT CONNECTOR.



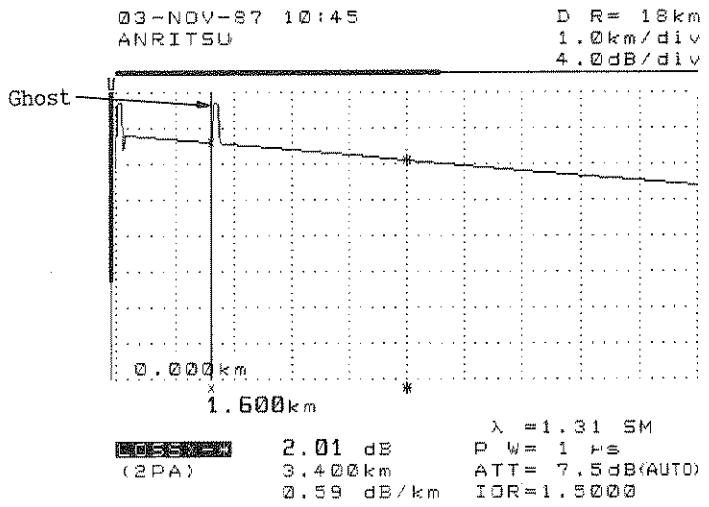


Fig. 3-27 Ghost Pulse Caused by Distance

3.6.3 Distinguishing ghost spikes

It is difficult to distinguish a ghost spike from a real spike and it requires careful scrutiny during measurement.

Step	Procedure
1	Use the cable layout to determine where the fiber connections (splice and connector connections) are located.
2	Compare the distance of the Fresnel reflection point displayed on the CRT with that of the connection points determined in step 1.
3	If a Fresnel reflection occurs at a point other than at the connection point shown in the cable layout, it is either a real spike of a faulty point or a ghost spike.
4	If one or more pulses occur at the same distance span as the large Fresnel reflection, the large reflection is a real spike of a faulty point and the other spikes are ghosts (see Fig. 3-26).
5	If unknow spikes other than those noted in step 4 occur, switch the DISTANCE range. If a spike occurs at the same distance before and after switching the distance range, the spike indicates a faulty point. If the spike does not appear in the longer range, it was a ghost.

3.6.4 Eliminating ghost spikes

(1) When a ghost is suspected of being caused by multiple reflections from a connector, adjust the connection to minimize the Fresnel reflection or apply matching oil to the fiber interface.

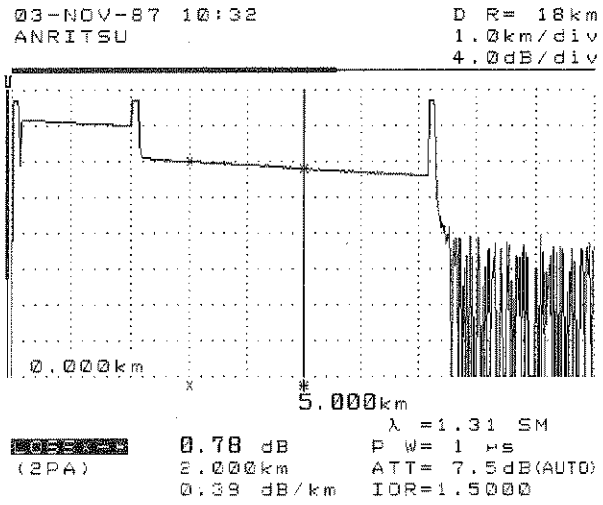


Fig. 3-28 Waveform Eliminated Ghost Caused by Secondary Reflection

(2) When a ghost is caused by the relationship between the Fresnel reflection and DISTANCE range, select a DISTANCE range of more than twice the length of the fiber to be measured.

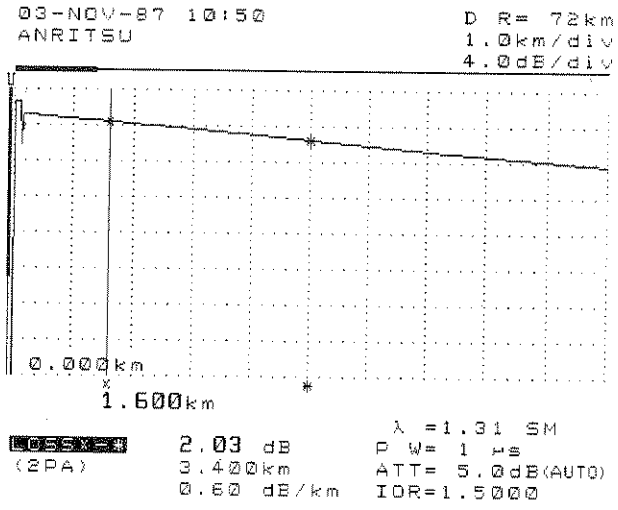


Fig. 3-29 Waveform with Ghost Erased by Doubling Distance Range

Notes:

1. The effect of secondary reflection may be ignored when a faulty point occurs at a distance exceeding 70 km.

2. When a ghost appears between the markers, set the markers to avoid the ghost or measure using the 2 POINTS method.

3.7 Distance Measurement

To measure the distance between any two points, follow the procedures below.

3.7.1 Measurement procedure

Step	Procedure
1	Display the waveform between the two points to be measured according to paragraphs 3.4.2 to 3.4.16.
2	Set the [SPLICE/LOSS] key to LOSS.
3	Set the X (Fig. 3-30 (A)) and * (Fig. 3-30 (B)) markers to the points to be measured.
4	The result of the distance measurement between the two markers is displayed at the lower-middle side of the CRT (Fig. 3-30).

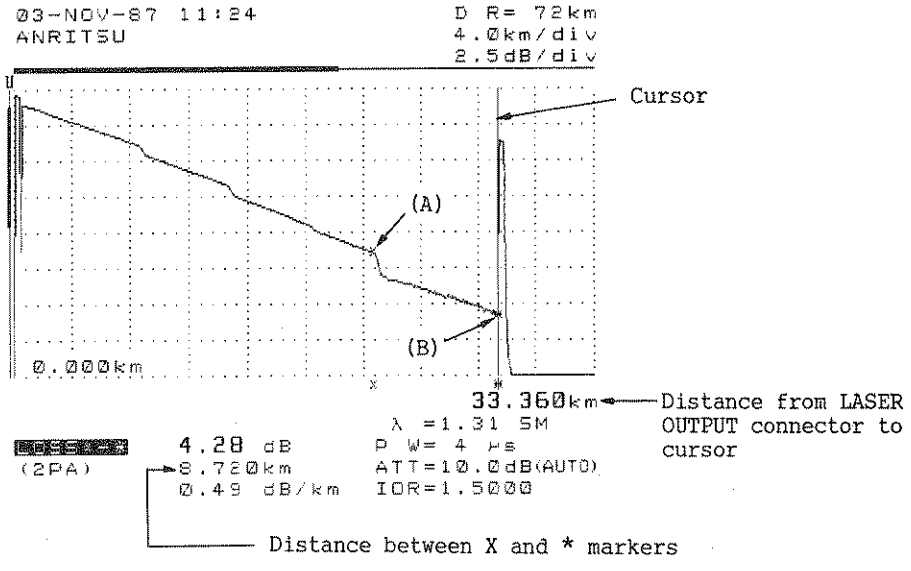


Fig. 3-30 Two-point Distance Measurement

3.8 Transmission Loss Measurement

The loss and dB/km between any two points on the optical fiber can be measured with the MW910C.

3.8.1 Measurement procedure

Step	Procedure
1	Display the waveform for which loss is to be measured on the CRT according to the procedures in paragraphs 3.4.2 to 3.4.11.
2	Set the AVERAGE to ON and perform complete waveform averaging (see paragraph 3.4.16 for details).
3	Set the [SPLICE/LOSS] key to LOSS. The * and X markers are displayed on the trace of the CRT.
4	Select LSA to improve the measurement accuracy.
5	Press the [MARKER] key and set the X marker to the left end of the section to be measured (Fig. 3-31 (A)) and the * marker to the right end (Fig. 3-31 (B)) by using the rotary knob.
6	The measured loss, distance, and dB/km between the X and * markers are displayed to the right of the [LOSS X-*] mark on the CRT. Note: If there is a spike or ghost between the X and * markers, use the 2 POINTS method for the measurement.

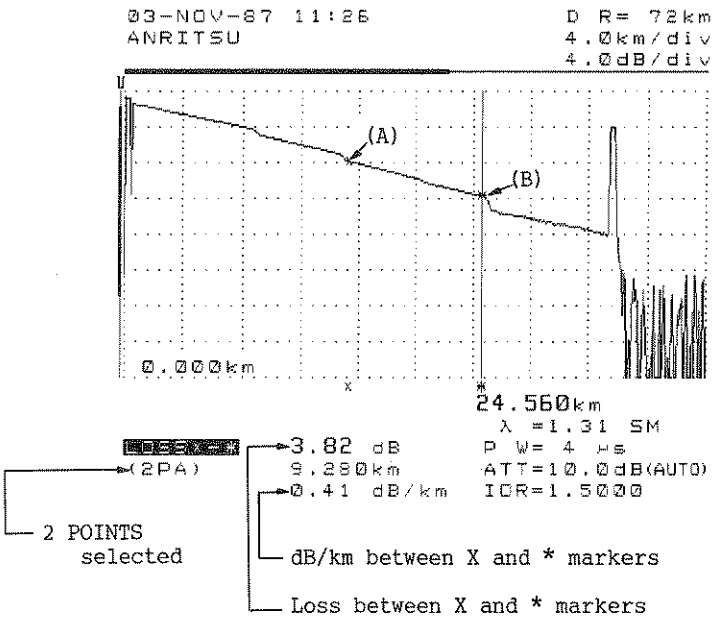
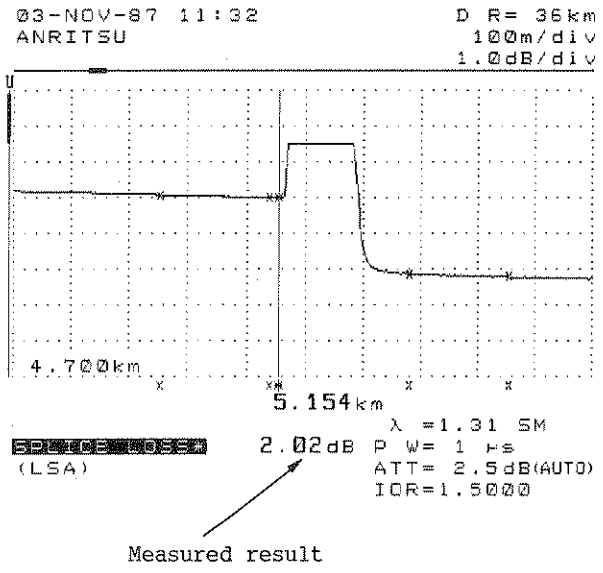


Fig. 3-31 LOSS Measurement

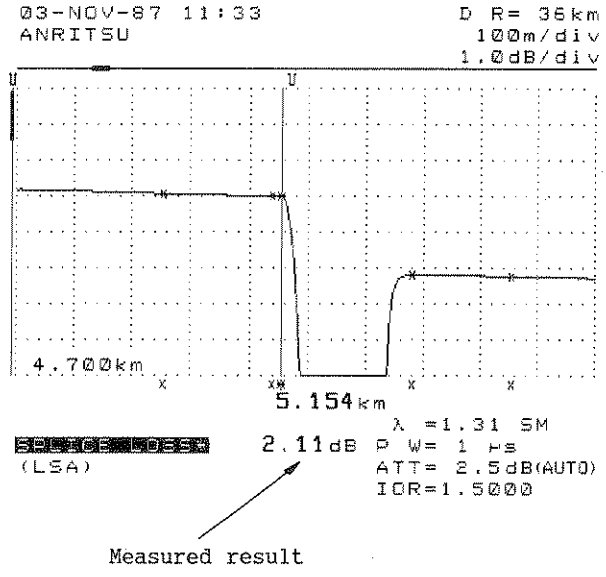
3.9 Splice Loss Measurement

3.9.1 Measurement procedure

Step	Procedure
1	Display the waveform for the splice measurement on the CRT according to paragraphs 3.4.2 to 3.4.11.
2	Set the [AVERAGE] key to ON. Complete averaging in this state (see paragraph 3.4.15 for details).
3	Set the [SPLICE/LOSS] key to LOSS.
4	Use the [MARKER] key and set the cursor to the * marker. Then shift the * marker along with the cursor to the splice point by using the rotary knob.
5	Set the [SPLICE/LOSS] key to SPLICE.
6	If there is a step or pulse waveform between markers X1 - X2 - * and X3 - X4, set the markers by using the [MARKER] key and rotary knob as follows: Set markers X1 and X2 to where the line is straightest to the left of the * marker. Set markers X3 and X4 to where the line is straightest to the right of the splice point.
7	For more accurate measurement, set the [LSA/2 POINTS] key to LSA.
8	The measured results are automatically displayed at the lower-middle side of the CRT. Fig. 3-32 (b) shows the results of the SPLICE/LOSS measurements using the MASK function.



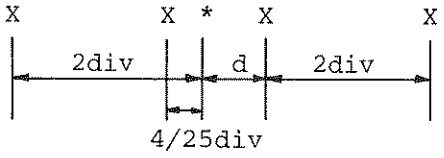
(a) Wave distortion caused by Fresnel reflection



(b) Good waveform linearity due to masking

Fig. 3-32 SPLICE Measurement

3.10 Auto Splice Loss Measurement

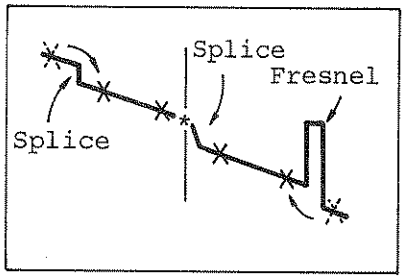
Step	Procedure
1	Set the * marker to the leading edge of the splice step.
2	Set the [SPLICE/LOSS] key to SPLICE.
3	Set the [AUTO/MANUAL] key to AUTO. The X and * markers are set to the standard positions automatically. Standard marker positions 

pulse width	d(*-X)
100 ns	100 m
500 ns	200 m
1 µs	200 m
2 µs	300 m
4 µs	500 m
10 µs	1100 m

4	Read the displayed splice loss.

Notes:

1. If a splice or Fresnel reflection is displayed on the trace between the two X markers before or after the * marker, move one X marker to the position shown in the figure.



2. The AUTO mode is automatically switched to the MANUAL mode when operating the keys DISTANCE, PULSE, SPLICE/LOSS, H-ZOOM, and SHIFT-H, and when moving the X and * markers with the rotary knob.

3.11 Waveform Recording

When records of the information displayed on the CRT are required, hard copies can be obtained by using the built-in video printer or an external video plotter connected to the VIDEO OUTPUT terminal.

3.11.1 Built-in printer hard copy

Press the [PRINT] key to hard-copy the information displayed on the CRT.

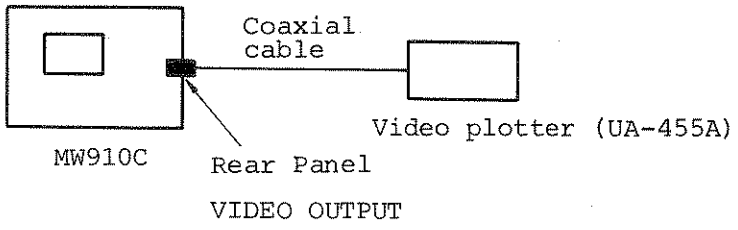
Note:

After the measurement conditions have been changed or the "BUSY" display goes off, do not press the [PRINT] key until the display waveform has been swept at least once.

3.11.2 External video plotter hard copy

(1) Setup

Connect the video plotter as follows.



(2) Procedure

Step	Procedure
1	Connect the VIDEO OUTPUT connector on the rear panel of the MW910C to the video plotter input connector by using a coaxial cable with BNC connectors.
2	Set the [LASER ON/OFF] key to OFF and hold the waveform displayed on the CRT.
3	Press video plotter PRINT key. The video plotter will then copy the information displayed on the CRT.

Note:

After the measurement conditions have been changed, do not turn the [LASER ON/OFF] key off until the displayed waveform has been swept at least once.

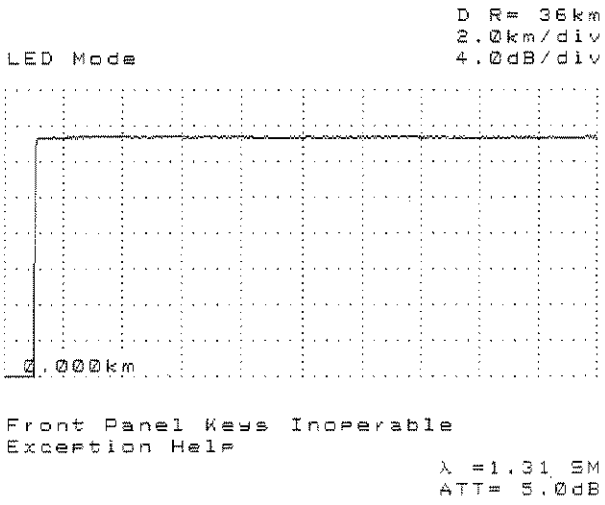
3.12 MW910C Receiving System Performance Self-Check Function

Input optical signals from the MH963A, 937A, 938A/C, 939A/C or 955A/C plug-in units LED OUT connector on the rear panel to the LASER OUTPUT connector to check the performance of the receiving system.

However, this self-check function is not available when the MH963A1, 937A1, 938A1/C1, 939A1/C1 or 955A1/C1, plug-in units are used.

Step	Procedure
1	Confirm that the LASER [ON/OFF] key is OFF, and connect the LED OUT and LASER OUTPUT connectors with the supplied fiber cable.
2	Confirm that the POWER switch is ON and set the rear panel LED LIGHT SOURCE [ON/OFF] key to ON. The LED above the key will come on.
3	The received optical level will be displayed on the CRT. When the waveform shown in Fig. 3-33 is displayed, the receiving system is operating normally. Note: When the rear panel LED LIGHT SOURCE [ON/OFF] key is set to ON, the front panel keys except the [HELP] key cannot be operated.

Step	Procedure



←If the step pulse is displayed within three divisions from the top, the instrument is operating normally.

Fig. 3-33 Self-check Waveform

3.13 MZ146A DC-AC Inverter (Option)

3.13.1 Introduction

This inverter is used to supply ac power to the MW910C from a dc power supply.

CAUTION

When the MZ146A is used, set the MW910C VOLTAGE SELECTOR switches for "AC 100 V/DC".

3.13.2 Composition and specifications

(1) Standard composition

Item	Name	Q'ty	Remarks
Instrument	MZ146A DC-AC Inverter	1	
Accessories	Dc power cord	1	
	Ac power cord	2	2.5 m --- 1 0.3 m --- 1
	Fuse 10 A	2	
	Fuse 5 A	2	

(2) Specifications

Input: 12/24 Vdc ±15%

Output: 125 V_{0-p} (400 Hz square wave)

Capacity: Input Approx. 8A (dc, 12 V SELECT)
4A (dc, 24 V SELECT)

3.13.3 Operation

(1) Mounting the MZ146A on the MW910C

Step	Procedure
1	Pull the MZ146A locking pin and turn it clockwise to release the lock.
2	Insert the three holding pins in the receptacles on the MW910C Rear Panel.
3	Turn the locking pin counterclockwise. The locking pin spring will automatically insert the pin in the locking hole to secure the inverter to the MW910C.
4	To remove the inverter, reverse the above steps.

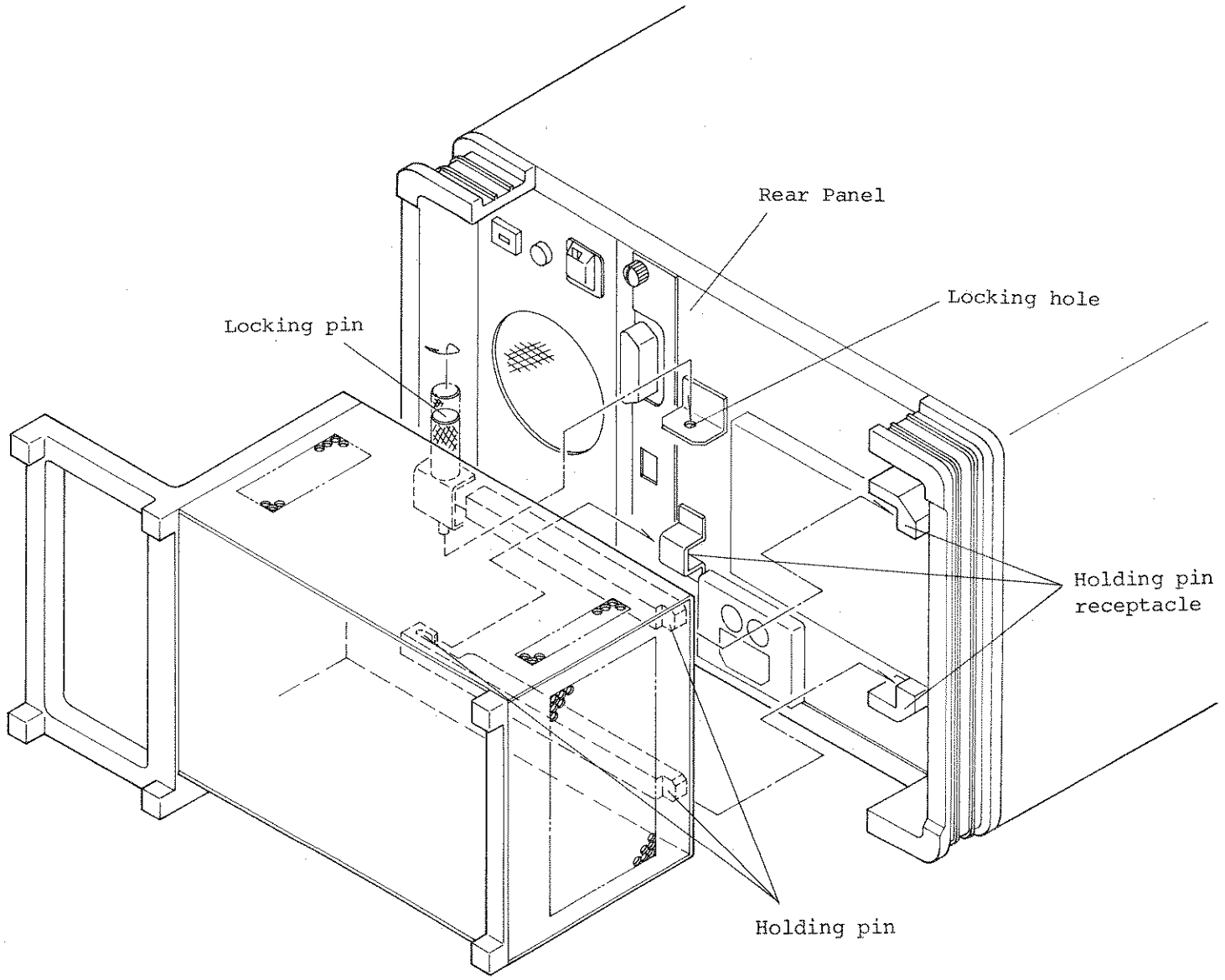


Fig. 3-34 Mounting MZ146A DC-AC Inverter on MW910C

(2) Explanation of Controls

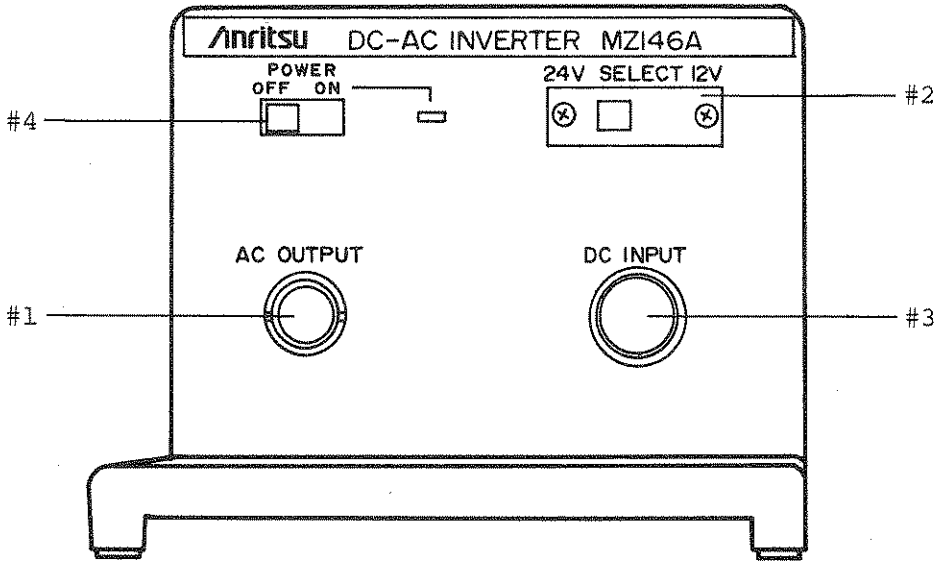


Fig. 3-35 MZ146A Front Panel

No.	Label	Function
#1	AC OUTPUT	100 Vac output connector
#2	SELECT 24 V/ 12 V	Dc power supply input voltage selector switch
#3	DC INPUT	Dc power supply input connector
#4	POWER OFF/ON	Power supply ON/OFF switch

(3) Operation

Step	Procedure
1	Turn the POWER ON/OFF switch #4 and MW910C POWER switch OFF.
2	Set the MW910C VOLTAGE SELECTOR switches for "AC 100 V/DC".
3	Connect the inverter AC OUTPUT connector #1 to the MW910C ac power supply inlet using ac power cord.
4	Set the SELECT switch #2 for the dc power supply voltage. Remove the switch cover and set the switch to the correct input voltage. Because the cover also serves as a switch lock, remember to replace it after setting the voltage.
5	Plug the dc power cord connector into DC INPUT connector #3.
6	Clamp the dc power cord red alligator clamp to the dc power positive electrode, and the black clamp to the negative electrode.
7	Set the POWER ON/OFF switch #4 to ON. The LED will come on to indicate that ac power is being supplied to the MW910C.

SECTION 4

PRINCIPLES OF OPERATION

4.1 General

Figure 4-1 shows the MW910C block diagram.

The timing generator generates trigger pulses with 204.8 µs, 409.6 µs, 819.2 µs or 1638.4 µs repetition rates from the clock signals of the 100 MHz oscillator.

These pulses drive the laser diode in the optical plug-in unit.

The optical pulses generated by the laser diode are sent to the fiber to be measured. The Fresnel reflection or backscattered light from a break or splice in the measured fiber is converted to an electric signal by an optical detector (APD) in the plug-in unit. The electrical signal is sent to the mainframe (MW910C) through the plug-in unit connector.

The offset (zero deviation) from the lower limit of the A/D converter that is caused by dc amplifier drift is compensated automatically; the linearity is maintained when the received signal is logarithmically-converted by passing through the D/A converter.

The A/D converter converts the waveform displayed on the CRT, using the control signal from the timing generator, to a 6-bit digital signal by sampling 1024 points at 1.25, 2.5, 5, 10, and 100 MHz sampling rates. This digital signal is added 1024 times for each of the 1024 points at a 1024-times repetition rate by an adder and memory (RAM (1)) and the result is stored in RAM (1). This addition improves the S/N ratio to about 30 dB. (S/N improvement = 20 log $\sqrt{N}$, N: Number of additions) At the end of the 1024 additions, the CPU is interrupted and the waveform data sum is transferred to RAM (2).

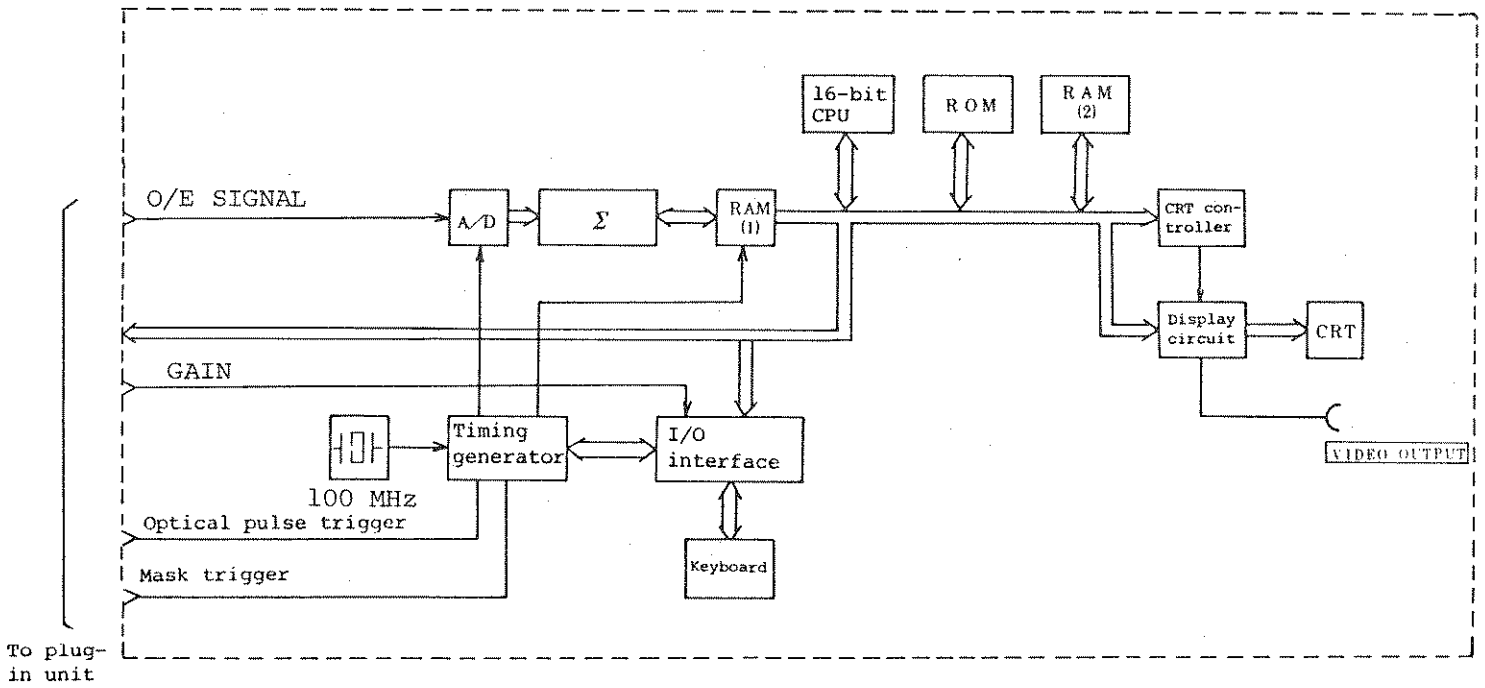


Fig. 4-1 MW910C Block Diagram

The waveform data of RAM (2) and the waveform data sent every other 1024 times are exponentially averaged through the CPU. To display the measured data, the result data in RAM (2) is converted to raster scan display data. Horizontal and vertical synchronized signals and video signals are generated by the display circuit in accordance with access from the CRT controller. These signals are applied to the CRT and the observed waveform is displayed.

The scale lines, measurement conditions, and measured results are displayed in the same way. The display circuit also generates composite video signals for the video printer.

The I/O interface sends the keyboard information to the CPU or the various setting conditions from the CPU to the timing generator and thus sends the information which turns the control lamps on and off.

4.2 Fault Location Measurement

The pulse reflected from the interface between the fiber and the LASER OUTPUT terminal is O/E converted. The time is made t = 0 when the O/E converted signal is applied to the O/E INPUT. The signal is sampled at sampling width Δt (Δt = 10/100/200/400/800 ns) based on an accurate clock signal from the reference oscillator. The sampled signals are sequentially stored from memory address 0, and the stored signals are sequentially displayed on the CRT from the left hand side. The * marker is set to the position of the desired fault on the waveform on the CRT.

The CPU searches for the memory address (address N) corresponding to the * marker. The time up to the * marker is found by computing $T = \Delta t \times N$, and the result is displayed in characters.

In distance measurement, if the refractive index of the fiber is made n, the propagation velocity V of the light pulse is

$$V = \frac{300}{n} \text{ (m/μs)} \quad \ldots\ldots\ldots \quad (1)$$

Therefore, the distance D (one-way) corresponding to T obtained by time measurement can be computed from 2D = T x V.

The refractive index (n) of the fiber to be measured is set, and D is computed from Eq. (2) below; the result is displayed in characters on the CRT.

$$D = \frac{150}{n} \times T \text{ (m)} \quad \ldots\ldots\ldots \quad (2)$$

4.3 Splice Loss Measurement by "Least Squares" Method

The backscattered light from the fiber is received at a power of the exponent in the direction of the fiber. Therefore, the linear loss characteristics can be obtained by converting this value to a logarithmic value. (This conversion is performed by the CPU.)

However, when the S/N ratio is low and the waveform looks like that shown in Fig. 4.2, using only two points may causes a large error depending on how the measurement points (X1 marker) are specified.

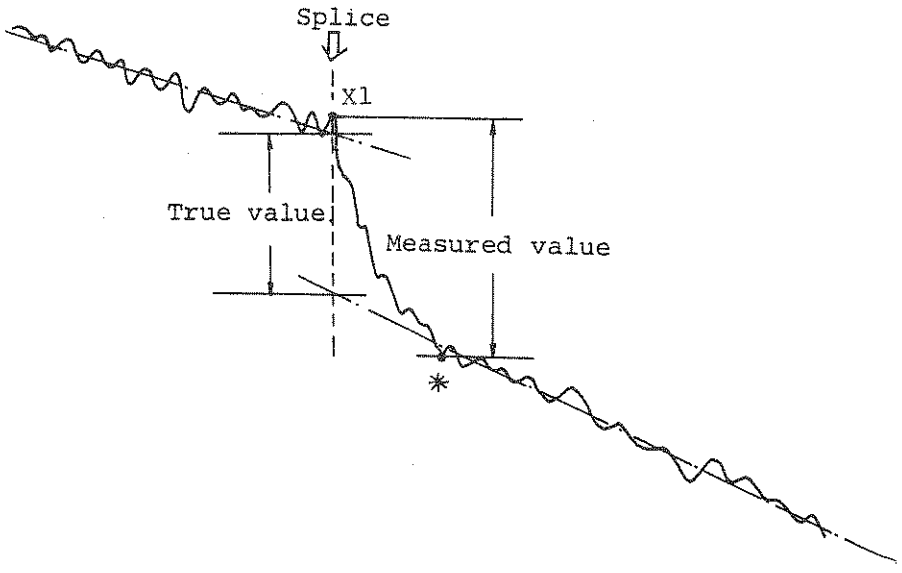


Fig. 4-2 Splice Loss Measurement by Two Point Specification

To avoid this, set the asterisk (*) marker to the splice point and the X3 marker to the lower knee of the waveform after the splice point as shown in Fig. 4-3.

Considering the time axis of the two points and the X3 marker, the CPU sets X1 to two divisions to the left of the asterisk marker, X2 to 2/5 divisions to the left of the asterisk marker, X3 to one division to the right of asterisk marker, and X4 to two divisions to the right of the X3 marker.

The approximate straight line is found by the least squares method from the waveform data between X1 and X2 and X3 and X4. | P-Q | equals the connection loss at the * marker and is computed as shown in Fig. 4-3; the results are displayed in characters on the CRT.

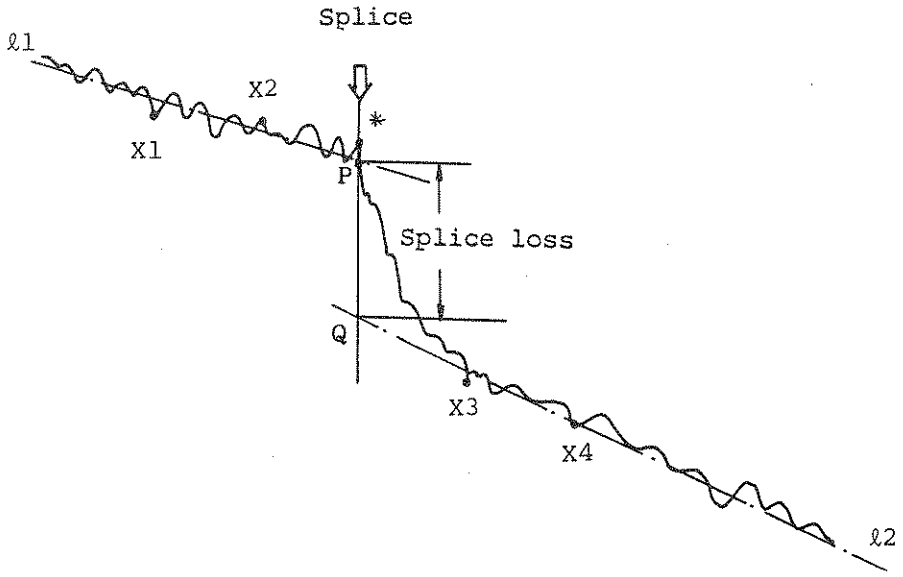
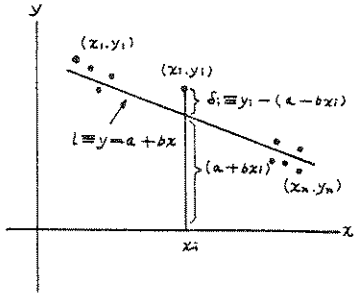


Fig. 4-3 Measurement of Splice Loss by Least Squares Method

Note:

Straight line approximation by least squares method

As shown in the figure below, $\ell \equiv y = a + bx$ is given for n points (x1, y1), (x2, y2), ..., (xn, yn), the deviation δi is computed from i = 1 to n, and the parameters a and b are found at which the sum of the square of these deviations (E) becomes minimum.



The least squares method is based on the equation

$$E=\sum_{i=1}^{n}\delta_i^{\,2}=(y_1-a-bx_1)^2+(y_2-a-bx_2)^2+\cdots\cdots+(y_n-a-bx_n)^2$$

For this equation,

$\frac{\partial E}{\partial a}=0$ and $\frac{\partial E}{\partial b}=0$ are necessary conditions for E minimum.

Rewriting the equation

$$a=\frac{\bar{y}\sum_{i=1}^{n}(x_i)^2-\bar{x}\sum_{i=1}^{n}(x_iy_i)}{\sum_{i=1}^{n}(x_i)^2-n(\bar{x})^2}\qquad b=\frac{\sum_{i=1}^{n}(x_iy_i)-n\bar{x}\bar{y}}{\sum_{i=1}^{n}(x_i)^2-n(\bar{x})^2}$$

Where,

$$\bar{x}=\frac{1}{n}\sum_{i=1}^{n}(x_i)\quad,\quad\bar{y}=\frac{1}{n}\sum_{i=1}^{n}(y_i)$$

From this, the approximated straight line y = a + bx is found.

SECTION 5

PERFORMANCE CHECKS

5.1 Equipment Required for Performance Checks

The equipment required for performance checks is listed in the table below.

Table 5-1 Equipment Required for Performance Tests

Equipment	Required Performance	Application
Optical Spectrum Analyzer (MS96A)	0.6 to 1.6 μm	Wavelength
Optical Power Meter (ML93A)	(MA98A) -40 to +10 dBm (MA97B) -65 to +10 dBm	Optical output
Sensor (MA98A) with MP92A for Optical Power Meter	0.75 to 1.8 μm	Optical output
Waveform Monitor (MP96A)		Pulse width
Oscilloscope	Dc to 200 MHz	Pulse width

5.2 Specifications

The major specifications of the MH963A/A1, MH937A/A1, MH938A/A1, MH939A/A1, MH955A/A1, and the major specifications of the MH938C/C1, MH939C/C1, and MH955C/C1 are shown in Table 5-3.

Table 5-2 A/A1 Type Plug-in Unit Major Specifications

A/A1 Type Plug-in Units (MH963A/A1, MH937A/A1, MH938A/A1, MH939A/A1, MH955A/A1)

Plug-in Unit		MH963A/A1 *1			MH937A/A1 *1			MH938A/A1 *1			MH939A/A1 *1			MH955A/A1 *1		
Wavelength (μm)		0.85 ±0.02			1.31 ±0.02			1.31 ±0.02			1.55 ±0.02			1.31/1.55 ±0.02 (switchable)		
Mask Function		Provided (Optical)														
Pulse Width (μs)		0.1	0.5	2 *2	0.1	0.5	2 *2	0.1	1	4 *2	0.1	1	4 *2	0.1	1	4 *2
Dynamic Range (One-way backscattered light level) (dB)		17	20	23	15	19	22	12	17	20	10	15	18	10/8	15/13	18/16
LED light source	Wavelength (μm)	0.85 ±0.03			1.31 ±0.03			1.31 ±0.03			1.55 ±0.03			1.31 ±0.03		
	Peak power (Typ.)	-40 dBm			-40 dBm			-40 dBm			-42 dBm			-40 dBm		
	Wavelength half width (nm)	$\leqq$150			$\leqq$150			$\leqq$150			$\leqq$230			$\leqq$150		
	Repetitive cycle	409.6 μs														
	Duty cycle	50%														
	Waveform	Square wave														

Note:

*1 The A1 plug-in units do not have a built-in LED light source.

*2 2 μs and 4 μs pulse widths cannot be set for the 18 km range.

Table 5-3 C/C1 Type Plug-in Unit Major Specifications

C/C1 Type Plug-in Units (MH938C/C1, MH939C/C1, MH955C/C1)

Plug-in Unit		MH938C/C1 *1			MH939C/C1 *1			MH955C/C1 *1		
Wavelength (μm)		1.31 ±0.02			1.55 ±0.02			1.31/1.55 ±0.02 (switchable)		
Mask Function		Provided (Optical)								
Pulse Width (μs)		0.1	1	10 *2	0.1	1	10 *2	0.1	1	10 *2
Dynamic Range (One-way backscattered light level) (dB)		20	25	30	17	22	27	18/15	23/20	28/25
LED light source	Wavelength (μm)	1.31 ±0.03			1.55 ±0.03			1.31 ±0.03		
	Peak power (Typ.)	-40 dBm			-42 dBm			-40 dBm		
	Wavelength half width (nm)	≦150			≦230			≦150		
	Repetitive cycle	409.6 μs								
	Duty cycle	50%								
	Waveform	Square wave								

Note:

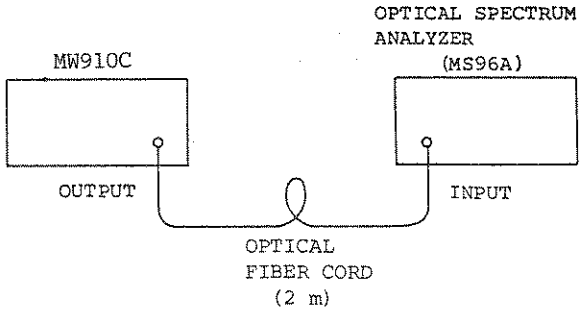
*1 The C1 plug-in units do not have a built-in LED light source.

*2 10 μs pulse widths cannot be set for the 18 km, 36 km, and 72 km ranges.

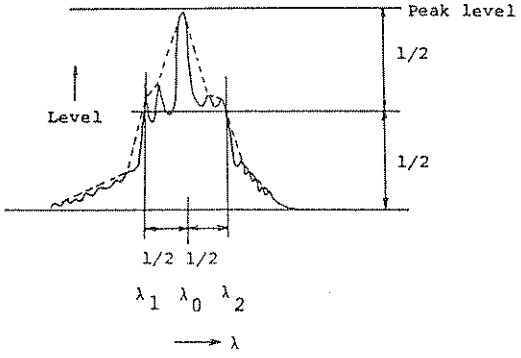
5.3 Performance Checks

5.3.1 Wavelength

(1) Setup

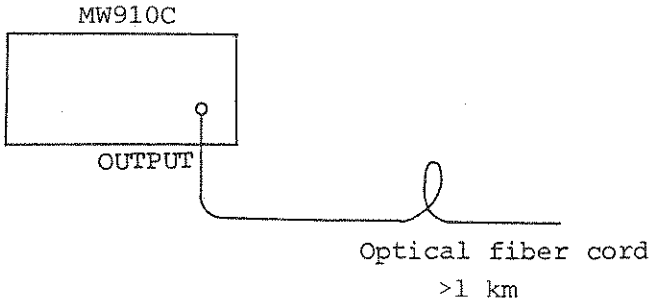


(2) Procedure

Step	Procedure
1	Connect the MW910C and MS96A as shown above, then hard-copy the wavelength measurement.
2	As shown in the figure below, draw an envelope that joins the highest points of the wavelength characteristics. The points where this envelope and the midway level of the peak level of the wavelength characteristics intersect are the λ_1 and λ_2 wavelengths. Wavelength λ_0 is calculated from the following equation: $\lambda_0 = \frac{\lambda_1 + \lambda_2}{2}$ 

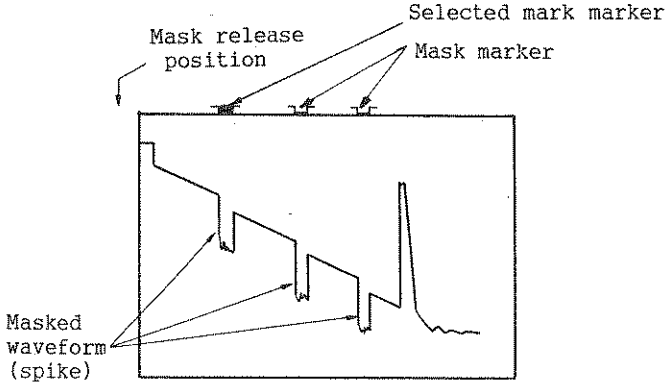
5.3.2 MASK function

(1) Setup



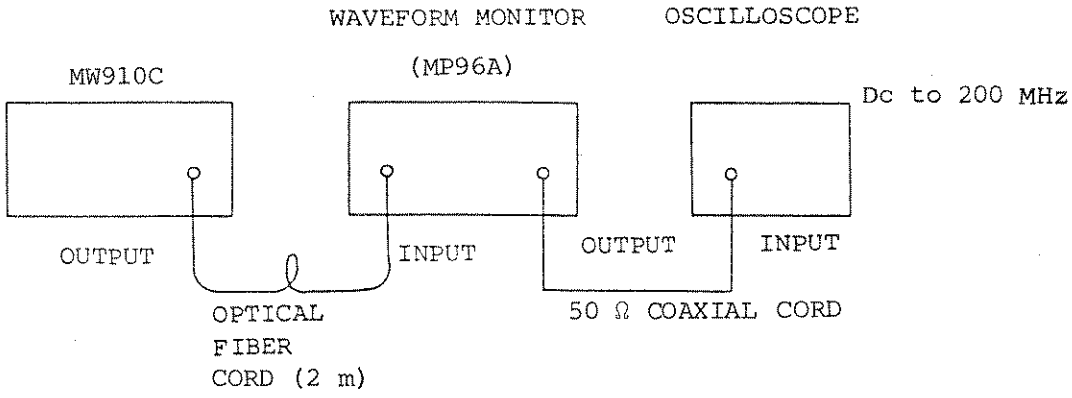
(2) Procedure

Step	Procedure
1	Set the start point of the waveform to 0.000 km by using the [SHIFT H] key and rotary knob.
2	Press the [MASK] key; the selected mask marker displayed on the upper side of the CRT changes from " ⌐⌊ " to " ▀ ".
3	Shift the mask marker " ▀ " to the selected point on the fiber trace by using the rotary knob.
4	Confirm that the waveform at the mask marker is masked under the mask marker and a spike is generated.
5	Another mask marker can be selected by pressing [MASK] key. Confirm the two other mask marker functions in the same way as described above.



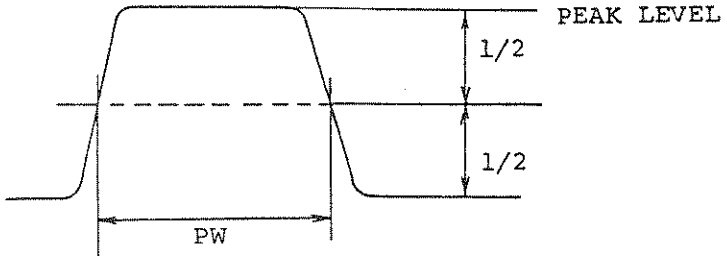
5.3.3 Pulse width

(1) Setup



(2) Procedure

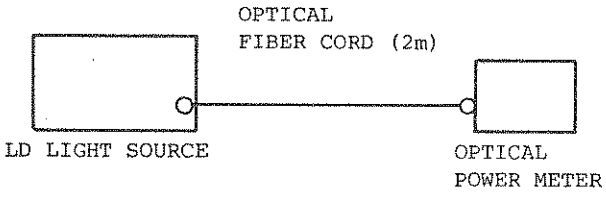
Step	Procedure
1	Connect the MW910C, waveform monitor and oscilloscope as shown above, then measure the pulse width PW.
2	Use the [PULSE] key on the MW910C front panel to check the pulse width displayed on the MW910C CRT.



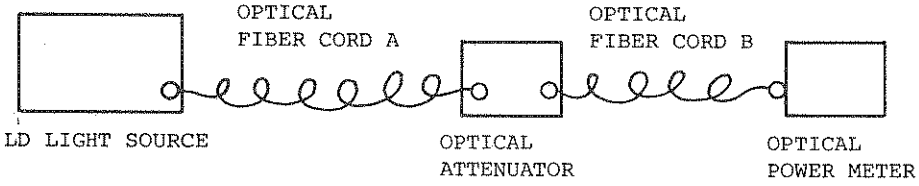
5.3.4 Dynamic range

(1) Setup

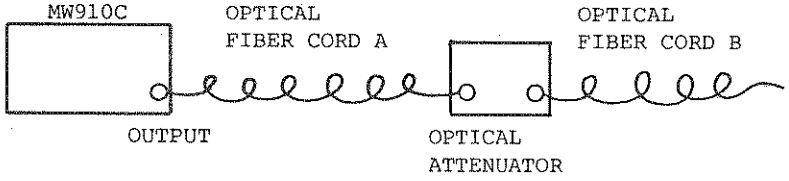
(a)



(b)

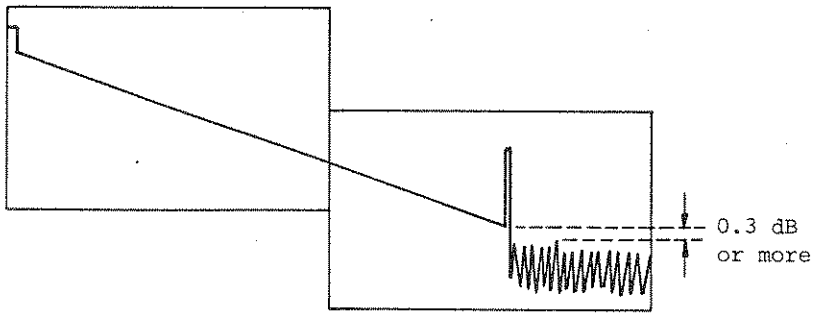


(c)



(2) Procedure

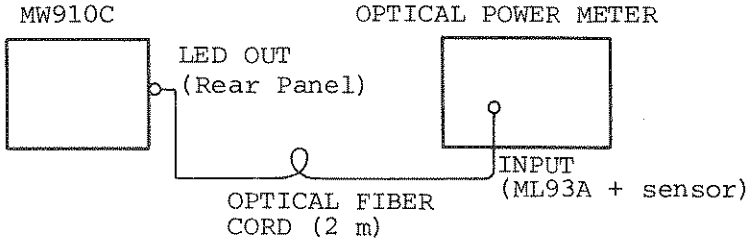
Step	Procedure
1	Connect the LD light source output terminal to the optical power meter sensor by using a 2 m optical fiber cord (Setup [a]). Measure the output level of the LD light source. Use an LD light source, optical power meter and optical fiber cord with the same wavelength and fiber as the plug-in unit that measures dynamic range.
2	Replace the optical fiber cord connecting the LD light source to the optical power meter with the long optical fiber cords A and B and an optical attenuator (Setup [b]).

Step	Procedure
	Adjust the total loss of the optical fiber cords A and B and optical attenuator to the dynamic range of the plug-in unit that is used for measurement. Adjust the loss of the optical attenuator to 5 dB or less. The optical fiber cords A and B may have a midpoint splice connection but the splice loss must be 5 dB or less.
3	Connect the optical fiber cords and optical attenuator adjusted in Step 2 to the MW910C output connector. Adjust the attenuation value so that the level at the fiber - OTDR connection is not saturated and observe the waveform. If the difference between the far end of the optical fiber cord and the noise level peak value is 0.3 dB or more after averaging for 10 minutes, the waveform is normal. Note: When the dynamic range of the 10 μs pulse width for the Type C/C1 plug-in units is measured, use two traces to observe the waveform, that is, split the observation into two screens. When the second screen is measured, similarly adjust the attenuation value so that the level is not saturated. 

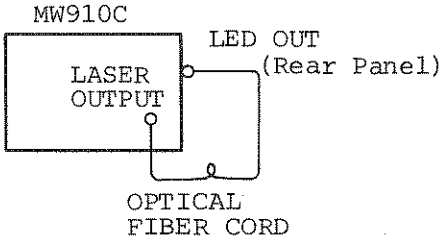
5.3.5 Receiving system check

(1) Setup

(a)

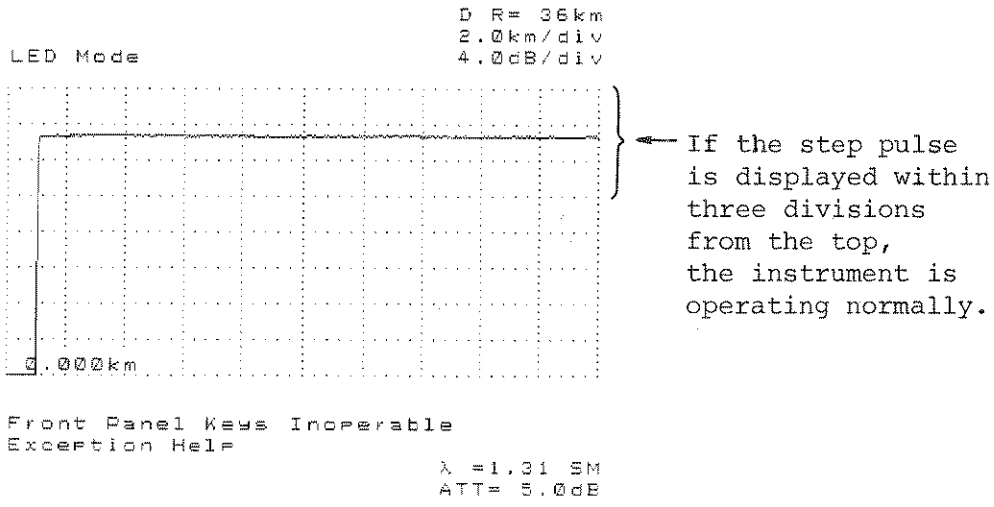


(b)



(2) Procedure

Step	Procedure
1	Connect an optical power meter to the LED OUT connector on the rear panel as shown in setup (a). Then adjust the LEVEL ADJ so that the peak power is -40 dBm (0.85μm, 1.31 μm) or -42 dBm (1.55 μm).
2	Connect the LED OUT connector to the front panel LASER OUTPUT connector by using the supplied optical fiber cable as shown in setup (b). When the waveform shown in the following figure is displayed, the receiving system is operating normally.



SECTION 6

STORAGE

6.1 Storage Conditions

When the instrument will not be used for a long time, cover it with a plastic sheet, etc. and store it where the humidity is low and the temperature change is small according to the specification in Table 2-3.

6.2 Precautions after Storage

If this instrument is operated at room temperature after being used or stored for a long period at low temperatures, condensation may occur and cause short-circuiting. To prevent this do not turn the power on until the instrument is completely dry.

6.3 Carrying Case (Option)

Use the optional carrying case to transport the MW910C, plug-in unit, and MZ146A.

Step	Procedure
1	Unfasten the five hooks, and open the case lid.
2	Insert the two accessory boxes in the right rear position.
3	Set the MZ146A DC-AC Inverter (option) in the middle rear with the handle upward.
4	Fit the protective front lid to the MW910C; rotate the carrying handle to the rear, and insert the MW910C as shown Fig. 6-1.
5	Insert the extra plug-in unit in the left side as shown in Fig. 6-1.

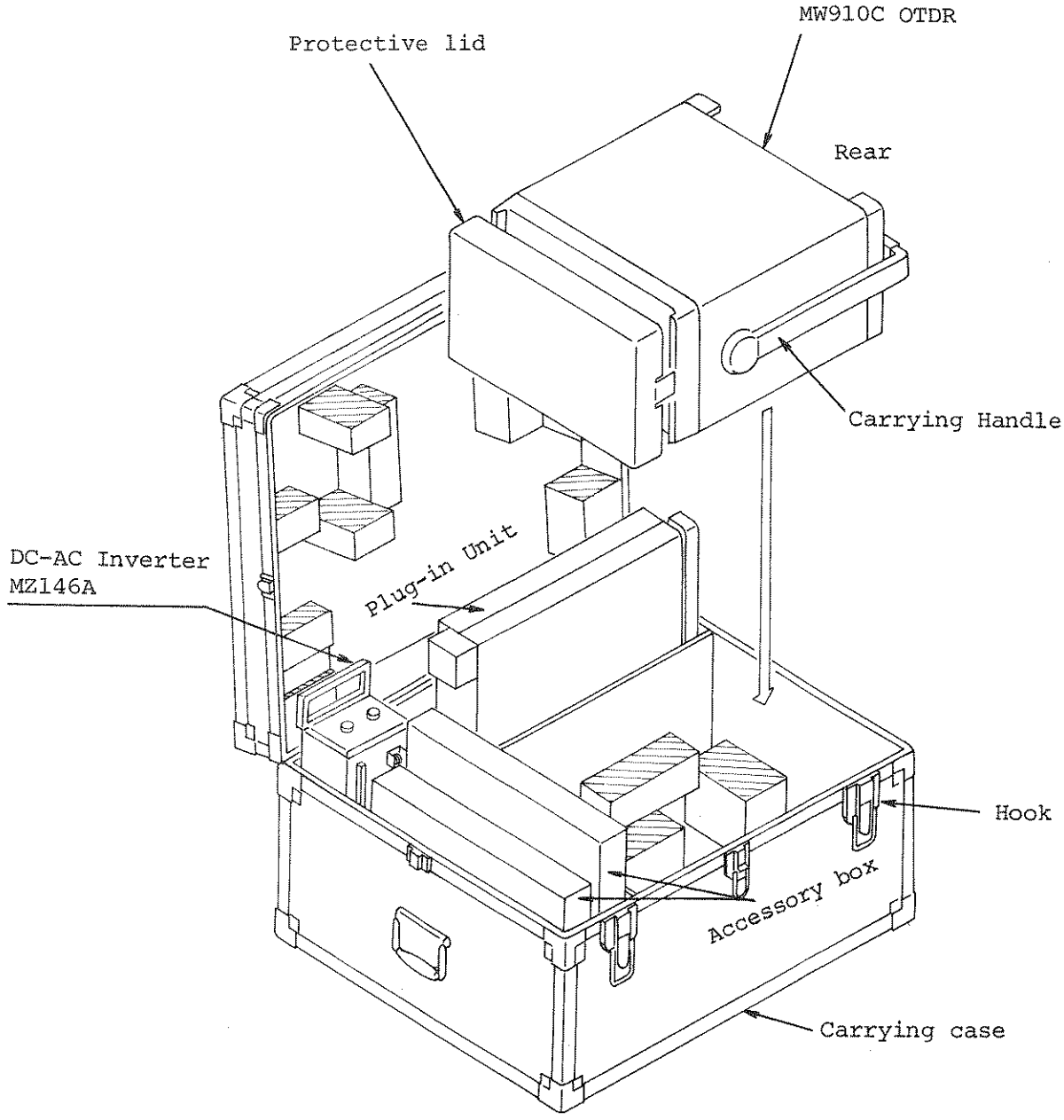


Fig. 6-1 Carrying Case Packing Diagram

OPERATION MANUAL

MW910C

GP-IB INTERFACE

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.

Note:

The MW910C GP-IB commands take precedence over the MW910A.

However, the MW910C built-in attenuator ignores commands sent during automatic adjustment.

Therefore, all unmodified programs developed for the MW910A do not always operate the MW910C.

If this happens, control the MW910C attenuator manually.

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SECTION 1

GENERAL

The MW910C Optical Time Domain Reflectometer has the GP-IB option. The General Purpose Interface Bus (GP-IB) is an interface bus that meets IEEE-488 standard (Institute of Electrical and Electronics Engineers).

All MW910C functions except the POWER switch, VOLTAGE SELECTOR switches, INTENSITY knob of the CRT, and HELP mode can be externally controlled with the GP-IB option.

For details about the GP-IB, read "GP-IB Basic Guide" which is available from Anritsu.

SECTION 2

GP-IB FUNCTIONS

GP-IB functions of the MW910C Optical Time Domain Reflectometer are listed in paragraphs 2.1 and 2.2 below.

2.1 GP-IB Talker/Listener Function

SH1	---	With source handshake function
AH1	---	With acceptor handshake function
T 6	---	With talker function, without talk only function
L 4	---	With listener function, without listen only function
SR1	---	With service request function
RL1	---	With remote/local function
PP0	---	Without parallel poll function
DC1	---	With device clear function
DT1	---	With device trigger function

2.2 GP-IB Controller Function

	Without response function to SRQ
C 0	Without controller transfer function

SECTION 3

GP-IB ADDRESSES

3.1 GP-IB Addresses

Each device on the GP-IB has an address. The GP-IB is specified as a listener or a talker by the MLA (My Listen Address) or MTA (My Talk Address) command from the controller. Each device has a switch on its rear panel to set the dip switch addresses.

3.2 How to Change the GP-IB Address with the ADDRESS Switch

Set the "ADDRESS 1 to 5" switch on the rear panel as appropriate. This switch is set to address 1 as shown in Figure 3-1 on shipment of the MW910C.

Addresses 1 to 5 correspond to binary numbers $2^0 = 1$, $2^1 = 2$, $2^2 = 4$, $2^3 = 8$, and $2^4 = 16$, respectively when set to position "1".

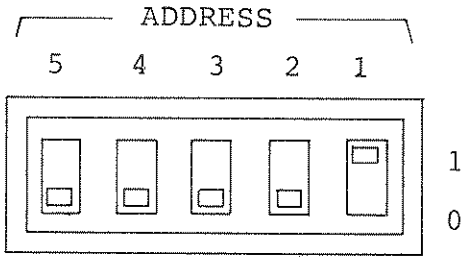


Fig. 3-1 Status of ADDRESS Switch

SECTION 4

DEVICE MESSAGES

Device messages are commands for controlling the MW910C and transmitting and receiving data. Device messages are divided into control messages which control the MW910C, status request messages which are used to request status from the MW910C, and data request messages which are used to read messages and data.

4.1 Overview of MW910C Device Messages

Figure 4-1 shows the syntax of a device message used by the MW910C.

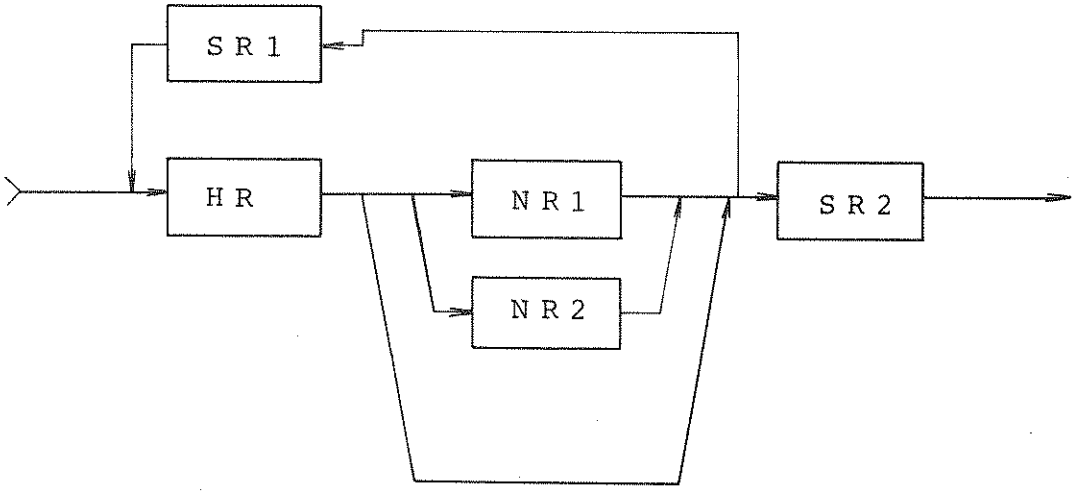


Fig. 4-1 Device Message Syntax

(1) HR (Header) section

The HR section is located at the beginning of the device message to indicate the type and contents of the data. In the MW910C, the HR section is represented by three to five alphabetic characters/ symbol corresponding to the function display on the front panel. If an unregistered HR is used, the device message containing such an HR is ignored.

(2) NR (Numeric) section

The NR section is the data area indicating numerics. The following two types of NR are available for the MW910C:

- NR1 type: Integer type numeric
- NR2 type: Real type numeric

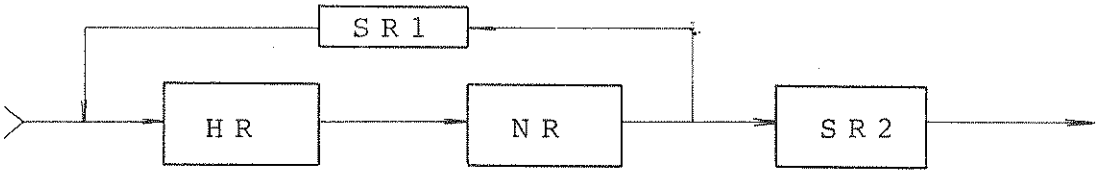
(3) SR section

The SR section is a separator section indicating the end of one numeric data or one message. When two or more messages are to be transferred consecutively, the SR is inserted between messages to indicate the end of one data transfer and the start of the next operation.

The following two SR types are available for the MW910C:

- SR1 type: Comma (,)
- SR2 type: Either Line Feed (LF) or Carriage Return (CR) and Line Feed (LF) can be accepted. CR is represented as 0D, and LF is represented as 0A in hexadecimal code.

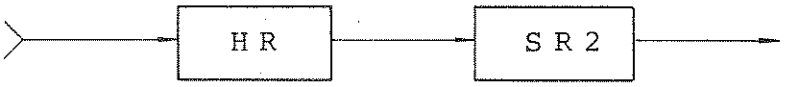
4.2 Control Message General Format



As shown in the above figure, a control message consists of a header section, a numeric section, and a separator section.

Example: DSRO (DISTANCE RANGE 18 km)
ATT12.5 (ATTENUATION 12.5 dB)

4.3 Status Request Message General Format



As shown in the above figure, a status request message consists of a header section and a separator 2 section.

Example: DSRR (Request for status of DISTANCE RANGE)

4.4 Data Request Message Format

The data request message is used to read the result measured by the MW910C, and an R is added to the header indicating the measured value.

4.4.1 Data request message format 1

As shown in the above figure, this format consists of a header section and a separator 2 section.

Example: LSDR (Request for measured loss value, etc.)

4.4.2 Data request message format 2

As shown in the above figure, this format consists of a header section, a numeric section, and a separator 2 section.

Example: DPDR10.000 (Request for MEASURING DATA 1)

SECTION 5

DETAILS OF DEVICE MESSAGES

5.1 DISTANCE RANGE

(1) Control message

DSRm: Selects measuring distance range

m	DISTANCE RANGE
0	18 km
1	36 km
2	72 km
3	144 km

(2) Status request message

DSRR

5.2 HORIZONTAL SCALE

(1) Control message

HSCm: Selects CRT horizontal scale

m	HORIZONTAL SCALE
0	8.0 (km/div)
1	4.0 (km/div)
2	2.0 (km/div)
3	1.0 (km/div)
4	500 (m/div)
5	250 (m/div)
6	100 (m/div)
7	50 (m/div)
8	25 (m/div)

(2) Status request message

HSCR

5.3 PULSE WIDTH

(1) Control message

PLSm: Selects pulse width of transmitted optical pulse

m	MH937A/A1, MH963A/A1	MH938A/A1, MH939A/A1, MH955A/A1	MH938C/C1, MH939C/C1, MH955C/C1
0	0.1 (μs)	0.1 (μs)	0.1 (μs)
1	0.5 (μs)	1 (μs)	1 (μs)
2	2 (μs)	4 (μs)	10 (μs)

(2) Status request message

PLSR

5.4 HORIZONTAL SHIFT (1)

(1) Control message

HSFℓ: Sets display starting distance on CRT

The distance converted for the refractive index 1.5000 is set.

ℓ : 0.0 to 143.750 (km)
(when DISTANCE RANGE is 144 km and HORIZONTAL SCALE is 25 m/div)

HORIZONTAL SCALE	DISTANCE RANGE			
	144 (km)	72 (km)	36 (km)	18 (km)
25 (m/div)	0.01 km	0.01 km	0.01 km	0.01 km
50 (m/div)	0.01 km	0.01 km	0.01 km	0.01 km
100 (m/div)	0.01 km	0.01 km	0.01 km	0.01 km
250 (m/div)	0.01 km	0.01 km	0.01 km	0.01 km
500 (m/div)	0.01 km	0.01 km	0.01 km	0.01 km
1 (km/div)	0.02 km	0.02 km	0.02 km	0.02 km
2 (km/div)	0.04 km	0.04 km	0.04 km	——
4 (km/div)	0.08 km	0.08 km	——	——
8 (km/div)	0.16 km	——	——	——

(2) Status request message

HSFR

5.5 HORIZONTAL SHIFT (2)

(1) Control message

HIFℓ: Sets display starting distance on CRT

The distance at the refractive index specified by IOR is set.

ℓ : 0.0 to 143.750 (km)
(when DISTANCE RANGE is 144 km and IOR is 1.5000)

(2) Status request message

HIFR

5.6 MASK (1)

(1) Control message

MSKm:ℓ: Masks part of the waveform displayed on the CRT

The distance converted for the refractive index 1.5000 is set.

m : 0 to 2 (specify one of three masks)

ℓ : 0.0 to 144.00 (km) (0.01 km steps), -1 (MASK OFF)

(2) Status request message

MSKmR

5.7 MASK (2)

(1) Control message

MIKm:ℓ: Masks part of the waveform displayed on the CRT

The distance converted for the refractive index specified by IOR is set.

m : 0 to 2 (specify one of three masks)

ℓ : 0.0 to 144.00 (km) (0.01 km steps), -1 (MASK OFF)

(When DISTANCE RANGE is 144 km and IOR is 1.5000)

(2) Status request message

MIKmR

5.8 AVERAGE

(1) Control message

AVRn: Turns exponential averaging processing ON/OFF

n	AVERAGE
0	OFF
1	ON

(2) Status request message

AVRR

5.9 FUNCTION

(1) Control message

FNCm: Selects measuring method for loss, etc.

m	FUNCTION
0	LOSS (Loss between markers, dB/km)
1	SPLICE

(2) Status request message

FNCR

5.10 APPROX METHOD (LSA/2 POINTS)

(1) Control message

APRm: Selects approximation method

m	METHOD
0	2POINTS
1	LSA

(2) Status request message

APRR

5.11 HOLD

(1) Control message

HLDn: Stops waveform display

n	HOLD
0	Release
1	Stop

(2) Status request message

HLDR

5.12 MARKER SELECT

(1) Control message

MKSm: Selects cursor

m	CURSOR SELECT
0	M Marker
1	X1
2	X2
3	X3
4	X4

(MKS2, 3, and 4 can be set only for the SPLICE measurement.)

(2) Status request message

MKSR

5.13 MARKER INITIALIZE

(1) Control message

MKI1: Resets each marker to the standard position

(2) Status request message

None

5.14 MARKER SHIFT (1)

(1) Control message

MSmℓ: Sets each marker position

The distance converted for the refractive index 1.5000 is set.

m	MARKER SHIFT
M	M Marker
1	X1
2	X2
3	X3
4	X4

(MS2, MS3, and MS4 can be set only for the SPLICE measurement.)

ℓ : 0.0 to 144.000 (km)
(when DISTANCE RANGE is 144 km and IOR is 1.5000)

The number of steps varies with the CRT horizontal scale and DISTANCE RANGE.

HORIZONTAL SCALE	DISTANCE RANGE			
	144 km	72 km	36 km	18 km
8 km/div	0.16 km	—	—	—
4 km/div	0.08 km	0.08 km	—	—
2 km/div	0.04 km	0.04 km	0.04 km	—
1 km/div	0.02 km	0.02 km	0.02 km	0.02 km
0.5 km/div	0.01 km	0.01 km	0.01 km	0.01 km
0.25 km/div	0.01 km	0.01 km	0.01 km	0.01 km
100 m/div	0.002 km	0.002 km	0.002 km	0.002 km
50 m/div	0.001 km	0.001 km	0.001 km	0.001 km
25 m/div	0.001 km	0.001 km	0.001 km	0.001 km

(2) Data request message

MSmR

5.15 MARKER SHIFT (2)

(1) Control message

MImℓ: Sets each marker position

The distance at the index of refraction specified by IOR is set.

m	MARKER SHIFT
M	M Marker
1	X1
2	X2
3	X3
4	X4

(MI2, MI3, and MI4 can be set only for the SPLICE measurement.)

ℓ : 0.0 to 144.000 (km) (when DISTANCE RANGE is 144 km and IOR is 1.5000)

(2) Data request message

MImR

5.16 VERTICAL SCALE

(1) Control message

VSCm: Selects CRT vertical scale

m	dB/div
0	4
1	2.5
2	1
3	0.5
4	0.2

(2) Status request message

VSCR

5.17 VERTICAL SHIFT

(1) Control message

VSFℓ: Shifts vertical position of displayed waveform either up or down

ℓ :

VERTICAL SCALE	ℓ
4.0 dB/div	0 to 85 (dot)
2.5 dB/div	0 to 232 (dot)
1.0 dB/div	0 to 820 (dot)
0.5 dB/div	0 to 1800 (dot)
0.2 dB/div	0 to 4740 (dot)

(2) Status request message

VSFR

5.18 LASER READY

(1) Control message

LDRn: Turns LASER OUTPUT ON/OFF

n	LASER OUTPUT
0	OFF
1	ON

(2) Status request message

LDRR

5.19 INITIALIZE

(1) Control message

IST1: Sets MW910C as listed below.

1.	DISTANCE RANGE	144 km (472 kft)
2.	HORIZONTAL SCALE	8.0 km/div
3.	HORIZONTAL SHIFT	0.000 km (0.000 kft)
4.	VERTICAL SCALE	4.0 dB/div
5.	VERTICAL SHIFT	0
6.	PULSE WIDTH	2 µs (MH963A/A1, MH937A/A1)
		4 µs (MH938A/A1, MH939A/A1, MH955A/A1)
		10 µs (MH938C/C1, MH939C/C1, MH955C/C1)
7.	FUNCTION	LOSS
8.	APPROX METHOD	2PA
9.	AVERAGE	OFF
10.	HOLD	OFF
11.	MASK	OFF
12.	ATT	AUTO
13.	MARKER	INITIALIZE
14.	AUTO	OFF

(2) Status request message

None

5.20 ATTENUATOR MANUAL

(1) Control message

ATTℓ: Selects resistance attenuator

ℓ : 0.0 to 12.5 (dB) (2.5 dB steps)

(2) Status request message

ATTR

5.21 ATTENUATOR AUTO

(1) Control message

ATAm: Sets resistance attenuator automatically

m	MEASUREMENT
0	Undefined
1	AUTO

(2) Status request message

ATAR

AB

A	MEASUREMENT
0	MANUAL
1	AUTO

B	AUTO Processing
0	Termination
1	During execution

Example

10: The measurement is performed in AUTO and the AUTO processing is terminated.

Note:

When the MW910C attenuator is set to AUTO control, if the pulse width etc. is changed, the attenuator starts automatic adjustment. Note that the MW910C/D ignores all the GP-IB commands sent during this operation.

5.22 AVERAGING NUMBER

(1) Control message

AVHℓ: Sets number of averagings

ℓ : 0 to 45000 (100 steps)
(when ℓ is 0, averaging is unlimited)

(2) Status request message

None

5.23 MASK CLEAR

(1) Control message

MSCl: Sets all masks off simultaneously

(2) Status request message

None

5.24 IOR

(1) Control message

IORℓ: Sets refractive index of fiber core to be measured

ℓ : 1.4000 to 1.5999 (0.0001 steps)

(2) Status request message

IORR

5.25 MEMORY SAVE

(1) Control message

MESm: Saves all CRT information

m : 1 to 32 (single steps)

(2) Status request message

None

5.26 MEMORY RECALL

(1) Control message

MERm: Displays information stored by MEMORY SAVE on CRT

m : 1 to 32 (single steps)

(2) Status request message

None

5.27 TITLE

(1) Control message

TTL display characters: Sets TITLE name

Up to 20 display characters can be input

0 to 9, A to Z, a to z, space, (,), *, +, -, ., /

(2) Status request message

TTLR

5.28 DATE/TIME

(1) Control message

TDEm0-m1-m2-m3-m4: Sets data and time

m0	Day	01 to 31
m1	Month	01 to 12
m2	Year	00 to 99
m3	Hour	00 to 23
m4	Minute	00 to 59

(2) Status request message

TDER

5.29 METER/FEET

(1) Control message

MFTn: Selects either meters or feet as length unit

n	METER/FEET
0	METER
1	FEET

(2) Status request message

MFTR

5.30 TRACE

(1) Control message

TRCn: Selects either DOT or LINE for trace display format

n	TRACE
0	LINE
1	DOT

(2) Status request message

TRCR

5.31 LED LIGHT SOURCE (Only MH937A, 938A/C, 939A/C, 955A/C and 963A)

(1) Control message

LEDn: Turns LED output ON/OFF

n	LED output
0	OFF
1	ON

(2) Status request message

LEDR

5.32 PRINT

(1) Control message

PRIR: Prints CRT screen at built-in printer

Note:

When a λ SELECT control message is sent to switch the wavelength, do not send the PRINT control message for 10 seconds.

5.33 FEED

(1) Control message

FEDℓ: Feeds built-in printer paper

ℓ	FEED
1	1 line
2	2 lines
⋮	⋮
9	9 lines

5.34 PLUG-IN UNIT

(1) Status request message

UNTR: Displays type of plug-in unit used

Display	Type
0.85 GI	MH963A/A1
1.31 GI	MH937A/A1
1.31 SM	MH938A/A1/C/C1
1.55 SM	MH939A/A1/C/C1
1.31/1.55 SM	MH955A/A1/C/C1

5.35 AUTO/MANUAL

(1) Control message

AUTm:

m	MEASUREMENT
0	———
1	AUTO

(2) Status request message

AUTR

	MEASUREMENT
0	MANUAL
1	AUTO

5.36 λ-SELECT (Only MH955A/A1 and MH955C/C1)

(1) Control message

WAVm

m	λ
0	1.31 μm
1	1.55 μm

Note:

When a λ SELECT control message is sent to switch the wavelength, wait more than 10 seconds, then start measurement.

(2) Status request message

WAVR

AB

A	λ
0	1.31 μm
1	1.55 μm

B	Fiber
0	SM
1	GI

Example

00 : 1.31 μm SM

SECTION 6

MEASURING DATA

The measuring data is data sent from the MW910C when requested by a data request message.

6.1 Overview of MW910C Measuring Data

Figure 6-1 shows the syntax of the MW910C measuring data.

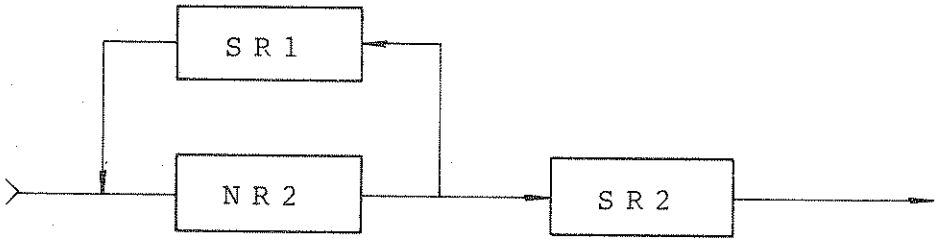


Fig. 6-1 Syntax of Measuring Data

(1) NR (Numeric) section

Same as device data

(2) SR section

The SR section serves as a separator indicating the end of one numeric data or one message. The following two types of SR are available for the MW910C:

- SR1 type: Comma(,)
- SR2 type: Carriage Return (CR). Line Feed (LF)

SECTION 7

DETAILS OF MEASURING DATA

7.1 LOSS DATA

(1) LOSS DATA

ℓ_1, ℓ_2, ℓ_3, ℓ_4 .... Output results of loss measurements, etc.

ℓ_1: Loss between X_1 and M markers; signed 4-digit output; up to two decimal places; dB unit
(0 for SPLICE measurement)

ℓ_2: Distance between X_1 and M markers; six-digit output; up to three decimal places; km unit
(0 for SPLICE measurement)

ℓ_3: Loss per km between X_1 marker and M marker; signed 4-digit output; up to two decimal places; dB/km unit
(0 for SPLICE measurement)

ℓ_4: SPLICE measurement result; signed 4-digit output; up to two decimal places; dB unit
(0 for LOSS measurement)

(2) Data request message

LSDR

7.2 MEASURING DATA (1)

(1) Output data

ℓ_1, ℓ_2 .... The measurement results [(input level) - (reference level)] are output sequentially from the point requested.

ℓ_1: Distance; 6-digit output; up to three decimal places; km unit (The distance converted for the index of refraction 1.5000 is output.)

ℓ_2: Measurement result [(input level) - (reference level)]; 4-digit output; up to two decimal places; dB unit

(2) Data request message

DPDRℓ .... Sets output starting distance of measurement results [(input level) - (reference level)]

If this message is omitted, the display starting distance set by HSF is assumed. The number of data to be output is 251 or 501 from the display starting distance.

ℓ : 0.0 to 144.000 (km)

(The distance converted for the refractive index 1.5000 is set.)

HORIZONTAL SCALE	Step
8 (km/div)	0.16 km
4 (km/div)	0.08 km
2 (km/div)	0.04 km
1 (km/div)	0.02 km
500 (m/div)	0.01 km
250 (m/div)	0.01 km
100 (m/div)	0.002 km
50 (m/div)	0.001 km
25 (m/div)	0.001 km

7.3 MEASURING DATA (2)

(1) Output data

ℓ_1, ℓ_2 ... The measurement results [(input level) - (reference level)] are output sequentially from the point requested.

ℓ_1: Distance; 6-digit output; up to three decimal places; km unit
(The distance converted for the refractive index specified by IOR is output.)

ℓ_2: Measurement result [(input level) - (reference level)]; 4-digit output; up to two decimal places; dB unit

(2) Data request message

DPIRℓ .... Sets output starting distance of measurement results [(input level) - (reference level)]

If this message is omitted, the display starting distance set by HIF is assumed. The number of data to be output is 251 or 501 from the display starting distance.

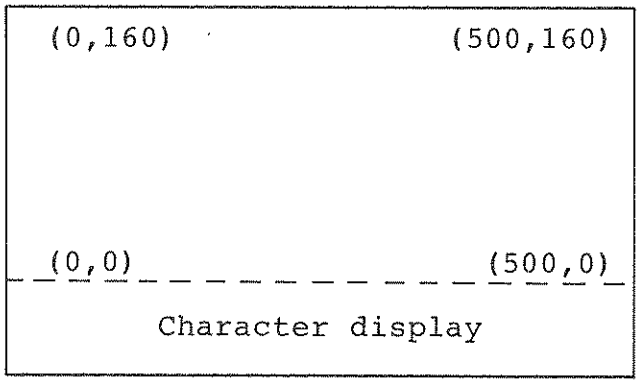
(The distance converted for the refractive index specified by IOR is set.)

ℓ : 0.0 to 144.000 (km)
(when DISTANCE RANGE is 144 km and IOR is 1.5000)

7.4 DISPLAY DATA

(1) Output data

x, y ..... Outputs results of waveform measurements on display sequentially from CRT start point to end point



x : Integer (0 to 500) indicating X-axis position on CRT

y : Integer (0 to 160) indicating Y axis position on CRT

(2) Data request message

DADR

Number of data to be output : 501

SECTION 8

STATUS BYTE

The status byte is transmitted by the device in response to the serial poll sequence.

Value	Message							
	RQS	STB						
	DIO7	DIO8	DIO6	DIO5	DIO4	DIO3	DIO2	DIO1
1	Service requested	-	-	-	DATA READY	ERROR	-	-
0	Service not requested	0	0	0	DATA NOT READY	NO ERROR	0	0

RQS: Request Service

STB: Status Byte

DATA READY/NOT READY

Indicates whether preparation for outputting measuring data completed or not

ERROR/NO ERROR

Indicates whether error occurred in input message (control, status request, or data request message) or not

SECTION 9

DEVICE CLEAR/TRIGGER

9.1 Device Clear

The MW910C can be reset to its initial status by using the DCL or SDC message.

DCL: Device Clear

SDC: Selected Device Clear

Initial status

No.	Function	Setting
1	DISTANCE RANGE	144 km
2	HORIZONTAL SCALE	8.0 km/div
3	HORIZONTAL SHIFT	0.000 km
4	VERTICAL SCALE	4.0 dB/div
5	VERTICAL SHIFT	0
6	PULSE WIDTH	2 µs (MH963A/A1, MH937A/A1) 4 µs (MH938A/A1, MH939A/A1, MH955A/A1) 10 µs (MH938C/C1, MH939C/C1, MH955C/C1)
7	FUNCTION	LOSS
8	APPROX METHOD	2PA
9	AVERAGE	OFF
10	HOLD	OFF
11	MASK	OFF
12	AUTO	OFF
13	MARKER	Initialize
14	λ-SELECT	1.31 µm SM (only for MH955A/A1/C/C1)
15	COARSE	OFF
16	ATT. MANUAL	AUTO
17	AVE. NUMBER	∞ (Unlimited)

Initial status (Cont'd)

No.	Function	Setting
18	IOR	1.5000
19	MEMORY SAVE	M1
20	MEMORY RECALL	M1
21	TITLE	ANRITSU
22	METER/FEET	METER
23	TRACE	LINE

9.2 Device Trigger

The GET message sets AVERAGE to ON.

GET: Group Execute Trigger

List of MW910C Device Messages

No.	Function	Control message	Request message	Paragraph
1	DISTANCE RANGE	DSRm	DSRR	5.1
2	HORIZONTAL SCALE	HSCm	HSCR	5.2
3	PULSE WIDTH	PLSm	PLSR	5.3
4	HORIZONTAL SHIFT (1)	HSFℓ	HSFR	5.4
5	HORIZONTAL SHIFT (2)	HIFℓ	HIFR	5.5
6	MASK (1)	MSKm:ℓ	MSKmR	5.6
7	MASK (2)	MIKm:ℓ	MIKmR	5.7
8	AVERAGE	AVRn	AVRR	5.8
9	FUNCTION	FNCm	FNCR	5.9
10	APPROX METHOD	APRm	APRR	5.10
11	HOLD	HLDn	HLDR	5.11
12	MARKER SELECT	MKSm	MKSR	5.12
13	MARKER INITIALIZE	MKI1	——	5.13
14	MARKER SHIFT (1)	MSmℓ	MSmR	5.14
15	MARKER SHIFT (2)	MImℓ	MImR	5.15
16	VERTICAL SCALE	VSCm	VSCR	5.16
17	VERTICAL SHIFT	VSFℓ	VSFR	5.17
18	LASER READY	LDRn	LDRR	5.18
19	INITIALIZE	IST1	——	5.19
20	ATTENUATOR MANUAL	ATTℓ	ATTR	5.20
21	ATTENUATOR AUTO	ATAm	ATAR	5.21
22	AVERAGING NUMBER	AVHℓ	——	5.22
23	MASK CLEAR	MSC1	——	5.23

List of MW910C Device Messages (Cont'd)

No.	Function	Control message	Request message	Paragraph
24	I.O.R.	IORℓ	IORR	5.24
25	MEMORY SAVE	MESm	——	5.25
26	MEMORY RECALL	MERm	——	5.26
27	TITLE	TTL display characters	TTLR	5.27
28	DATE/TIME	TDEm0-m1-m2-m3-m4	TDER	5.28
29	METER/FEET	MFTn	MFTR	5.29
30	TRACE	TRCn	TRCR	5.30
31	LED LIGHT SOURCE	LEDn	LEDR	5.31
32	PRINT	PRIR	——	5.32
33	FEED	FEDℓ	——	5.33
34	PLUG-IN UNIT	——	UNTR	5.34
35	AUTO/MANUAL	AUTm	AUTR	5.35
36	λ-SELECT	WAVm	WAVR	5.36

SECTION 10

GP-IB EXAMPLE PROGRAMS

10.1 Introduction

This section describes some example programs used to control the MW910C Optical Time Domain Reflectometer with the Packet V Personal Technical Computer (Anritsu Corp.) and some precautions on compiling programs.

The commands used to control the MW910C and to transmit and receive data are called device messages; they are divided into control messages for controlling the MW910C, status request messages for requesting the status from the MW910C, and data request messages for reading messages and data.

Here, some Packet V programs are presented to describe the basic methods for using the device messages and combined usage of the control, status request, and data request messages.

10.2 Example Programs Using SH, AH, T, and L Functions

10.2.1 Control message

The execution of the following command sets DISTANCE RANGE to 36 km:

```
WRITE @101:"DSR 1"
           |  |
           |  +-- NR of DISTANCE RANGE
           +----- HR of DISTANCE RANGE
```

The execution of the following command transfers several control messages at a time:

```
WRITE @101: "HSC 1 , VSC 3"
             |   |   |   |
             |   |   |   +-- NR of VERTICAL SCALE
             |   |   +------ HR of VERTICAL SCALE
             |   +---------- SR1
             +-------------- NR of HORIZONTAL SCALE
             +-------------- HR of HORIZONTAL SCALE
```

10.2.2 Status request messages

The status of DISTANCE RANGE can be read by executing the following commands:

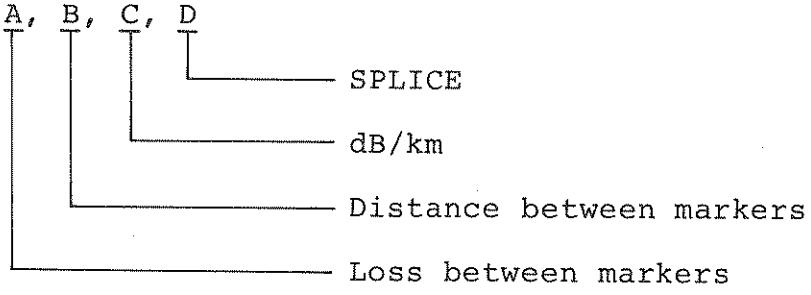
```
WRITE @101: "DSRR"
READ  @101: A$
             |
             +-- "0" .....  18 km
             +-- "1" .....  36 km
             +-- "2" .....  72 km
             +-- "3" ..... 144 km
```

10.2.3 Data request messages

The results of loss measurement, etc. can be read by executing the following commands:

```
WRITE @101: "LSDR"

READ  @101: A, B, C, D
```

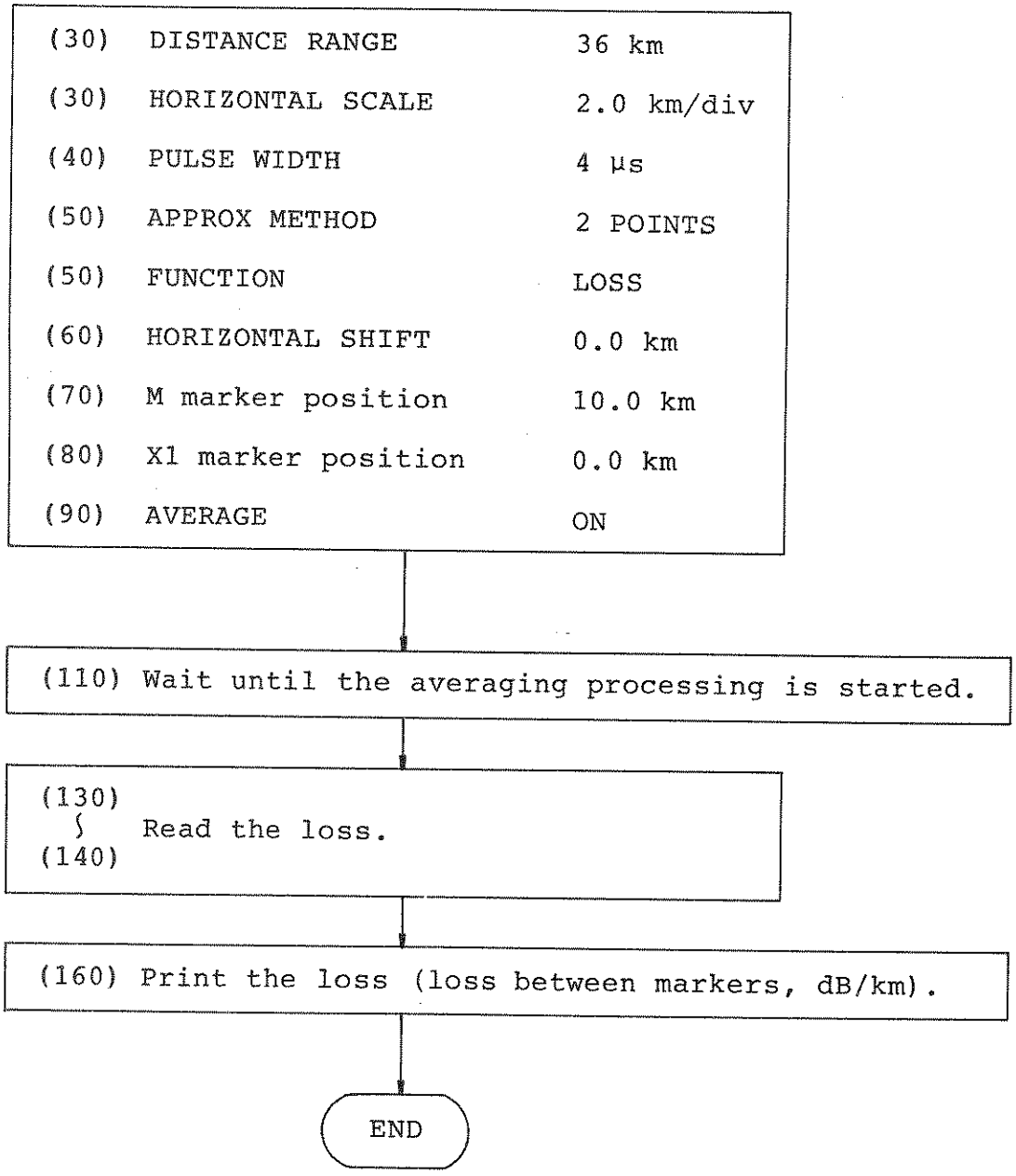


10.2.4 Example programs of combined messages

(1) Program for measuring loss between two arbitrary points

(a) Flowchart

Set the MW910C measuring conditions.



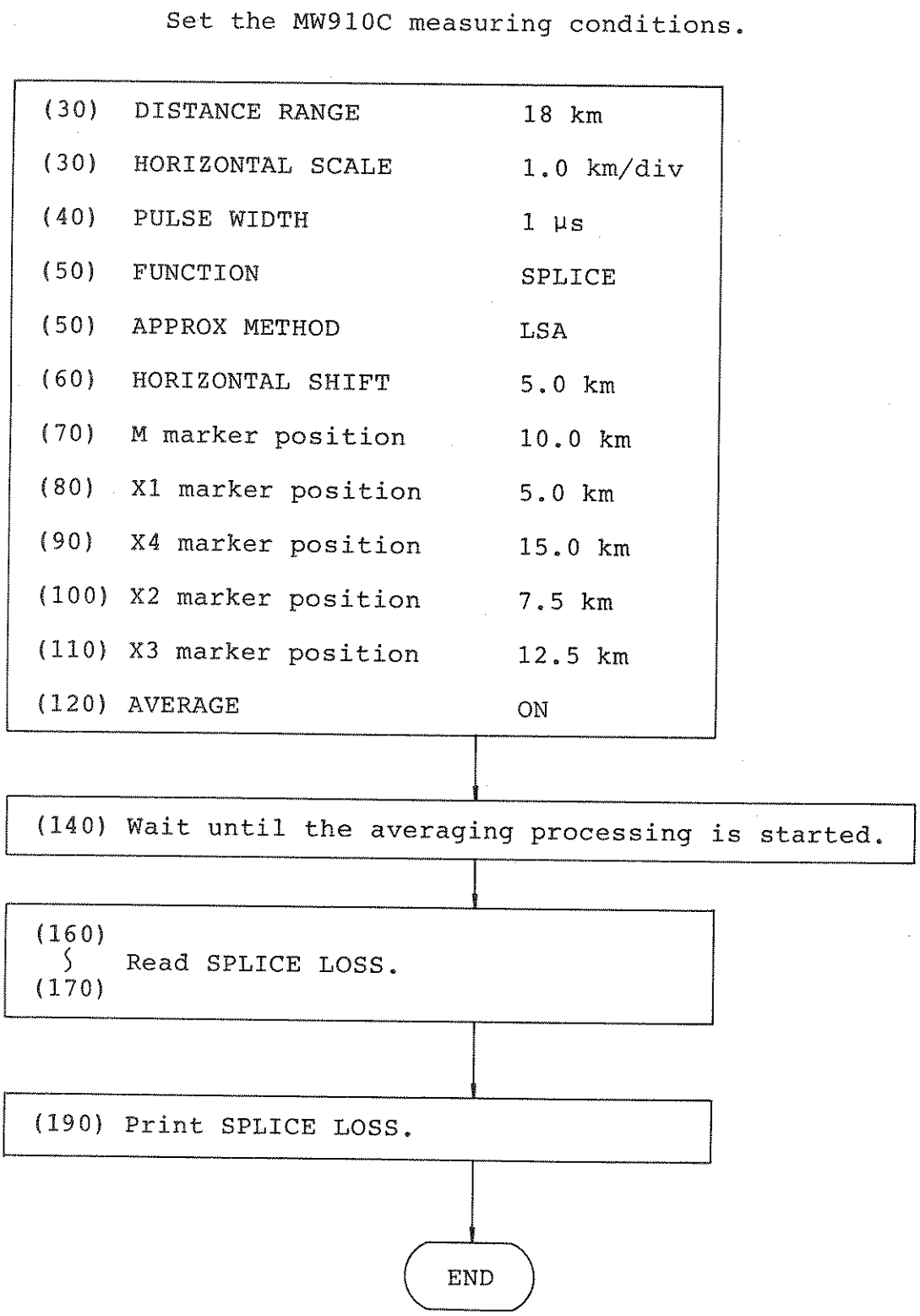
(b) Program

```
 10 !                                < 2.4.1 > SAMPLE PROGRAM
 20 !
 30 WRITE @101:"DSR 1,HSC 2"
 40 WRITE @101:"PLS 2"
 50 WRITE @101:"FNC 0,APR 0"
 60 WRITE @101:"HSF 0.0"
 70 WRITE @101:"MSM 10.0"
 80 WRITE @101:"MS1 0.0"
 90 WRITE @101:"AVR 1"
100 !
110 WAIT DELAY 60
120 !
130 WRITE @101:"LSDR"
140 READ @101:A,B,C,D
150 !
160 PRINT A;"dB",B;"Km",C;"dB/Km"
170 !
180 END
```

-26 dB 10 Km -2.6 dB/Km

(2) Program for measuring SPLICE LOSS by linear approximation

(a) Flowchart



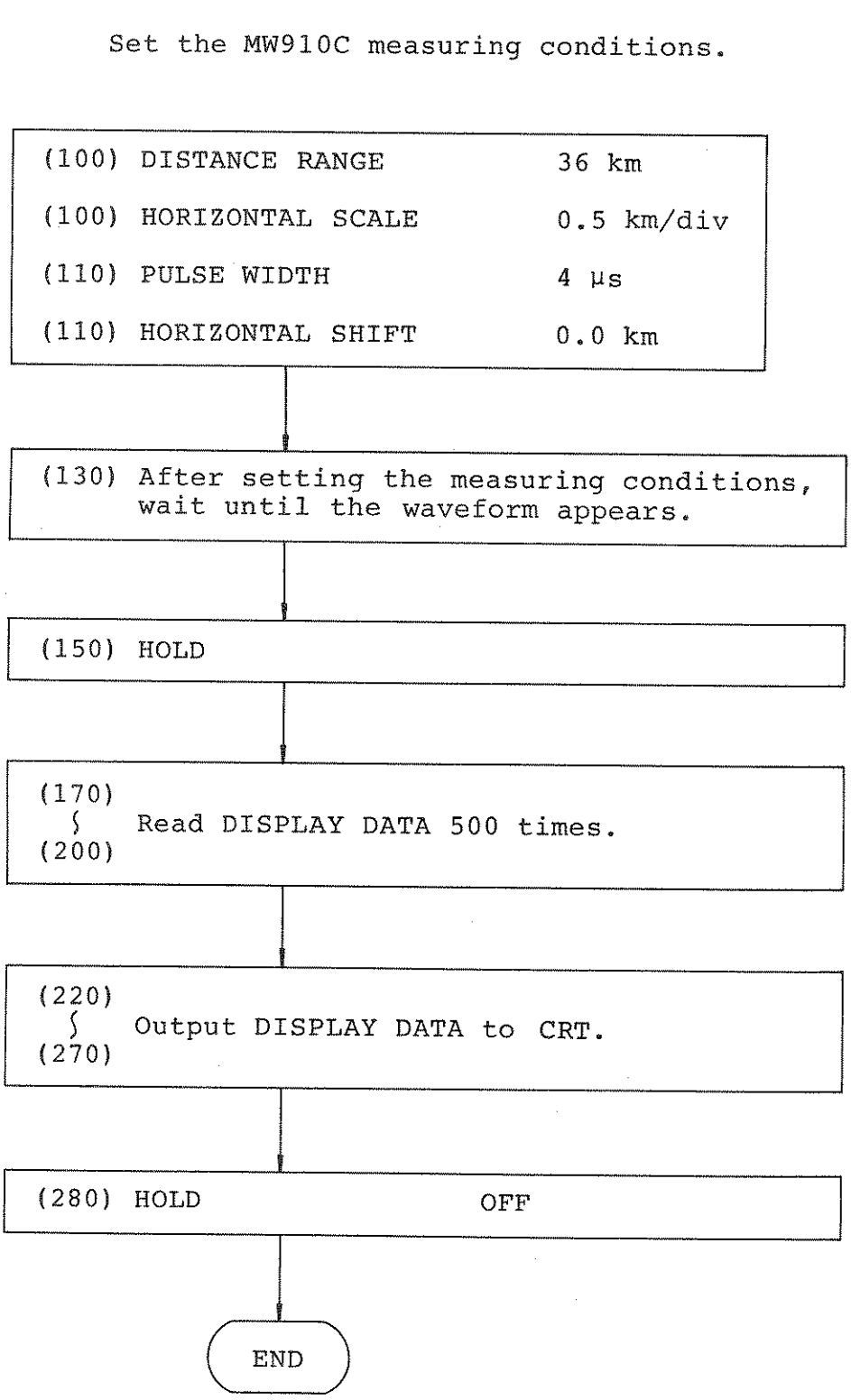
(b) Program

```
 10 !                              < 2.4.2 > SAMPLE PROGRAM
 20 !
 30 WRITE @101:"DSR 0,HSC 3"
 40 WRITE @101:"PLS 1"
 50 WRITE @101:"FNC 1,APR 1"
 60 WRITE @101:"HSF 5.0"
 70 WRITE @101:"MSM 10.0"
 80 WRITE @101:"MS1 5.0"
 90 WRITE @101:"MS4 15.0"
100 WRITE @101:"MS2 7.5"
110 WRITE @101:"MS3 12.5"
120 WRITE @101:"AVR 1"
130 !
140 WAIT DELAY 60
150 !
160 WRITE @101:"LSDR"
170 READ @101:A,B,C,D
180 !
190 PRINT D;"dB"
200 !
210 END
```

14.3 dB

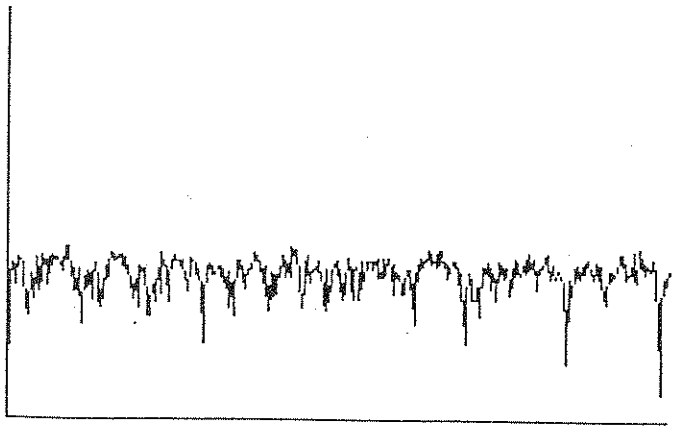
(3) Program for outputting measurement results of waveforms on display

(a) Flowchart



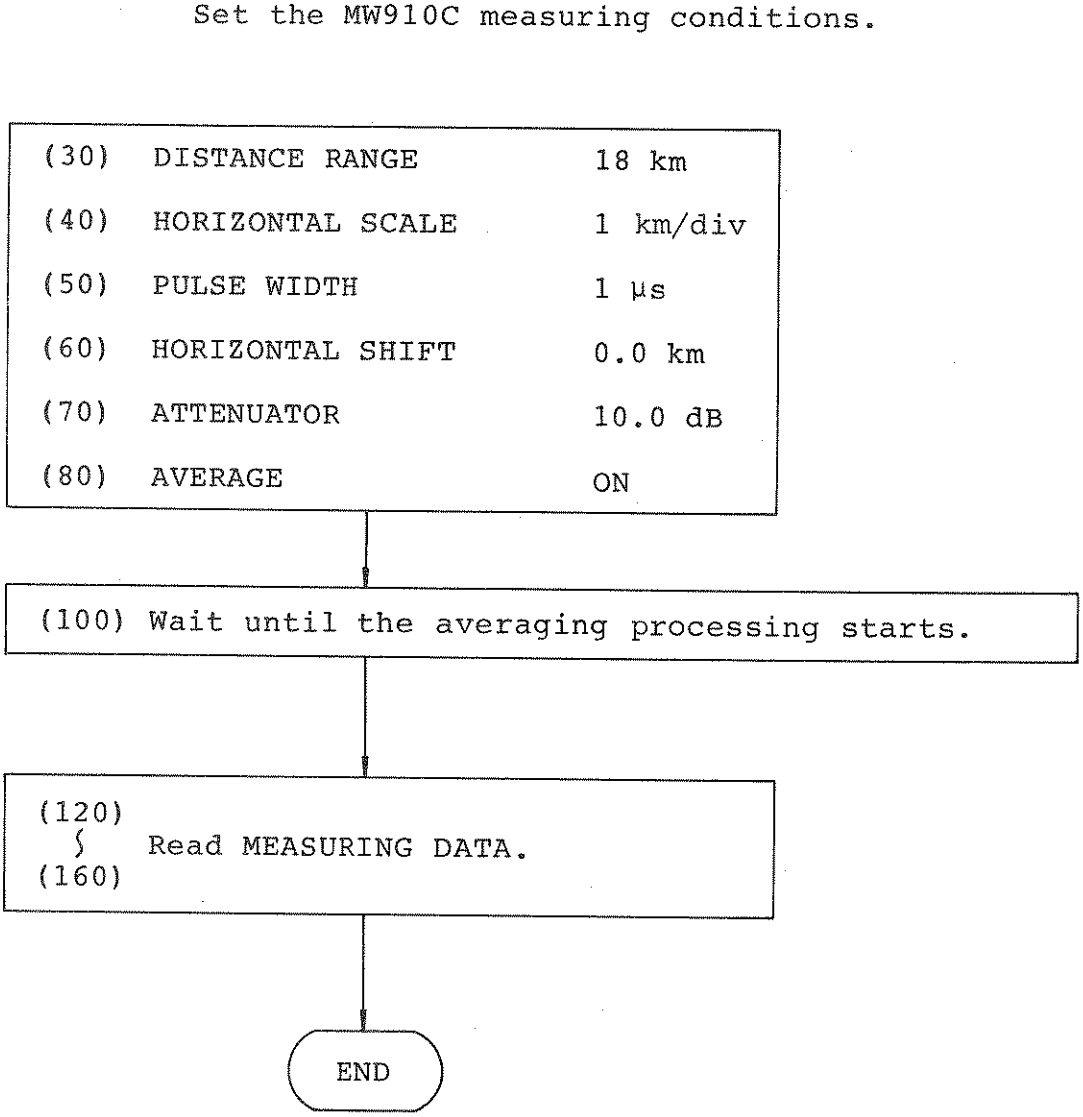
(b) Program

```
 10 !                              < 2.4.3 > SAMPLE PROGRAM
 20 !
 30 SET CLIP "ON"
 40 SET BOUNDS 0,147,0,100
 50 SET VIEWPORT 0,147,0,100
 60 SET WINDOW -50,550,-90,200
 70 DIM X(500),Y(500)
 80 CLEAR 0
 90 PLOT 0,160;0,0;500,0
100 !
110 WRITE @101:"DSR 1,HSC 4"
120 WRITE @101:"PLS 2,HSF 0.0"
130 !
140 WAIT DELAY 5
150 !
160 WRITE @101:"HLD 1"
170 !
180 WRITE @101:"DADR"
190 FOR I=0 TO 500
200 READ @101:X(I),Y(I)
210 NEXT I
220 !
230 PLOT 0,0;
240 FOR I=0 TO 499
250 PLOT X(I),Y(I);
260 NEXT I
270 !
280 PLOT X(500),Y(500)
290 WRITE @101:"HLD 0"
300 !
310 END
```



(4) Program for outputting MEASURING DATA

(a) Flowchart



(b) Program

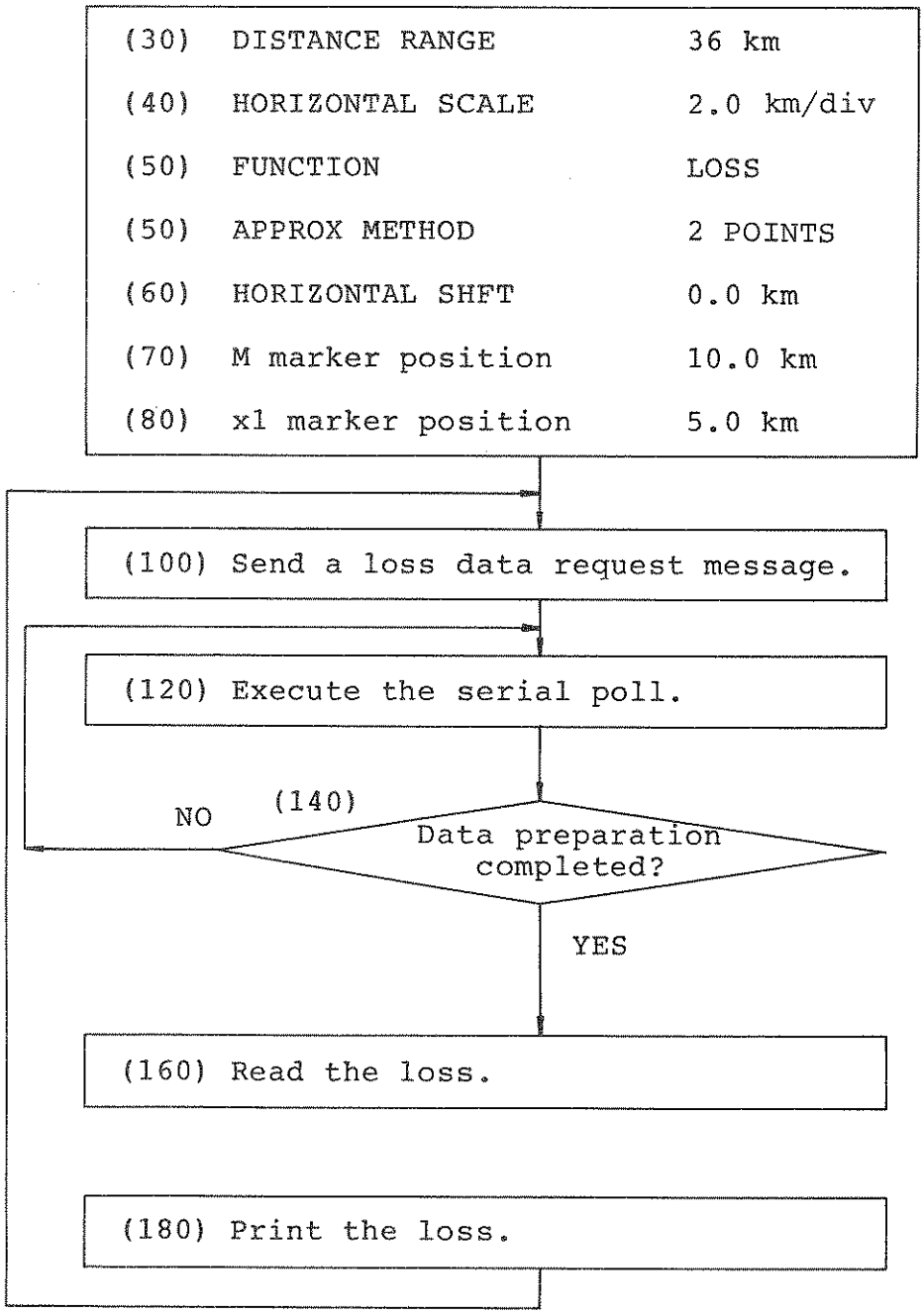
```
 10 !                          < 2.4.4 > SAMPLE PROGRAM
 20 !
 30 WRITE @101:"DSR 0"
 40 WRITE @101:"HSC 3"
 50 WRITE @101:"PLS 1"
 60 WRITE @101:"HSF 0.0"
 70 WRITE @101:"ATT 10.0"
 80 WRITE @101:"AVR 1"
 90 !
100 WAIT DELAY 60
110 !
120 WRITE @101:"DPDR"
130 FOR I=0 TO 5
140 READ @101:A,B
150 PRINT A;"Km",B;"dB"
160 NEXT I
170 !
180 END
```

```
0 Km     29.94 dB
.02 Km   30.46 dB
.04 Km   29.8 dB
.06 Km   29.96 dB
.08 Km   29.7 dB
.1 Km    30.51 dB
```

10.3 Example Program Using SR Function

10.3.1 Program for measuring loss between two arbitrary points with continuous operations

(1) Flowchart



(2) Program

```
 10 !                          < 3.1 > SAMPLE PROGRAM
 20 !
 30 WRITE @101:"DSR 1"
 40 WRITE @101:"HSC 2"
 50 WRITE @101:"FNC 0,APR 0"
 60 WRITE @101:"HSF 0.0"
 70 WRITE @101:"MSM 10.0"
 80 WRITE @101:"MS1 5.0"
 90 !
100 WRITE @101:"LSDR"
110 !
120 STATUS @101:A
130 !
140 IF A<>72 THEN 120
150 !
160 READ @101:A,B,C,D
170 !
180 PRINT A;"dB",B;"Km",C;"dB/Km"
190 !
200 GO TO 100
210 !
220 END
```

```
25.9 dB     5.000 Km  5.19 dB/Km
28.0 dB     5.000 Km  5.61 dB/Km
30.7 dB     5.000 Km  6.15 dB/Km
30.9 dB     5.000 Km  6.19 dB/Km
30.6 dB     5.000 Km  6.12 dB/Km
30.4 dB     5.000 Km  6.08 dB/Km
3.47 dB     5.000 Km  0.69 dB/Km
1.45 dB     5.000 Km  0.29 dB/Km
0.36 dB     5.000 Km  0.07 dB/Km
0.31 dB     5.000 Km  0.06 dB/Km
```