MW9077A/A1
OTDR Module
Operation Manual

14th Edition

For safety and warning information, please read this manual before attempting to use the equipment.
Keep this manual with the equipment.

ANRITSU CORPORATION

Document No.: M-W2254AE-14.0

Safety Symbols

To prevent the risk of personal injury or loss related to equipment malfunction, Anritsu Corporation uses the following safety symbols to indicate safety-related information. Ensure that you clearly understand the meanings of the symbols BEFORE using the equipment. Some or all of the following symbols may be used on all Anritsu equipment. In addition, there may be other labels attached to products that are not shown in the diagrams in this manual.

Symbols used in manual

⚠ DANGER This indicates a very dangerous procedure that could result in serious injury or death if not performed properly.

⚠ WARNING This indicates a hazardous procedure that could result in serious injury or death if not performed properly.

⚠ CAUTION This indicates a hazardous procedure or danger that could result in light-to-severe injury, or loss related to equipment malfunction, if proper precautions are not taken.

Safety Symbols Used on Equipment and in Manual

The following safety symbols are used inside or on the equipment near operation locations to provide information about safety items and operation precautions. Ensure that you clearly understand the meanings of the symbols and take the necessary precautions BEFORE using the equipment.

This indicates a prohibited operation. The prohibited operation is indicated symbolically in or near the barred circle.

This indicates an obligatory safety precaution. The obligatory operation is indicated symbolically in or near the circle.

This indicates a warning or caution. The contents are indicated symbolically in or near the triangle.

This indicates a note. The contents are described in the box.

These indicate that the marked part should be recycled.

MW9077A/A1
OTDR Module
Operation Manual

30 October 2003 (First Edition)
15 May 2015 (14th Edition)

For Safety

⚠ WARNING

- ALWAYS refer to the operation manual when working near locations at which the alert mark shown on the left is attached. If the advice in the operation manual is not followed, there is a risk of personal injury or reduced equipment performance. The alert mark shown on the left may also be used with other marks and descriptions to indicate other dangers.

- Overvoltage Category
  This equipment complies with overvoltage category II defined in IEC 61010. DO NOT connect this equipment to the power supply of overvoltage category III or IV.

- Laser radiation warning
  - NEVER look directly into the cable connector on the equipment nor into the end of a cable connected to the equipment. There is a risk of injury if laser radiation enters the eye.
  - The Laser Safety label is attached to the equipment for safety use as indicated in "Laser Safety" later in this section.

Repair

- Only qualified service personnel with a knowledge of electrical fire and shock hazards should service this equipment. This equipment cannot be repaired by the operator. DO NOT attempt to remove the equipment covers or unit covers or to disassemble internal components. In addition, there is a risk of damage to precision components.

Calibration

- The performance-guarantee seal verifies the integrity of the equipment. To ensure the continued integrity of the equipment, only Anritsu service personnel, or service personnel of an Anritsu sales representative, should break this seal to repair or calibrate the equipment. Be careful not to break the seal by opening the equipment or unit covers.If the performance-guarantee seal is broken by you or a third party, the performance of the equipment cannot be guaranteed.

For Safety

⚠ WARNING

Falling Over

- This equipment should always be positioned in the correct manner. If the cabinet is turned on its side, etc., it will be unstable and may be damaged if it falls over as a result of receiving a slight mechanical shock.
  Always set up the equipment in a position where the power switch can be reached without difficulty.

For Safety

Class 1 indicates the danger degree of the laser radiation specified below according to IEC 60825-1: 2007.

Class 1: Lasers that are safe under reasonably foreseeable conditions of operation, including the use of optical instruments for intrabeam viewing.

Class Ⅰ indicates the degree of danger of the laser radiation outlined below as defined by 21 CFR 1040.10.

Class Ⅰ: Class Ⅰ levels of laser radiation are not considered to be hazardous.

⚠ CAUTION

Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

The use of optical instruments with this product will increase eye hazard.

For Safety

Laser Safety

The laser in this equipment is classified as Class 1 according to the IEC 60825-1: 2007 standard, or as Class I according to the 21 CFR 1040.10 standard. These classes of lasers are safe under reasonably foreseeable operating conditions.

Table 1 Laser Safety Classifications Based on IEC 60825-1:2007

Model Name	Class	Max. Optical Output Power (W)*	Pulse Width (s)/ Repetition Rate	Emitted Wavelength (nm)	Beam Divergence (deg)	Incorporated Laser Specification (refer to Table 2)	Laser Aperture
MW9077A	1	0.10	20×10^{-6}/ 0.019	1310	11.5	a)	Figure 1, [1]
MW9077A1	1	0.10	20×10–6/ 0.019	1550	11.5	b)	Figure 1 [1]
MW9077A2	1	0.10	20×10–6/ 0.019	1625	11.5	c)	Figure 1 [1]
MW9077B	1	0.10	20×10–6/ 0.019	1310	11.5	a)	Figure 1 [1]
	1	0.10	20×10–6/ 0.019	1550	11.5	b)	Figure 1, [1]

*: Indicates the possible optical output power when each and every reasonably foreseeable single-fault condition is included.

Table 2 Incorporated Laser Specification

Incorporated Laser	Max. Optical Output Power (W)*	Pulse Width (s)/ Repetition Rate	Emitted Wavelength (nm)	Beam Divergence (deg)
a)	020	20×10–6/ 0.019	1310	11.5
b)	020	20×10–6/ 0.019	1550	11.5
c)	020	20×10–6/ 0.019	1625	11.5

*: Maximum output power is the estimated value when something breaks down.

For Safety

Laser Radiation Markings

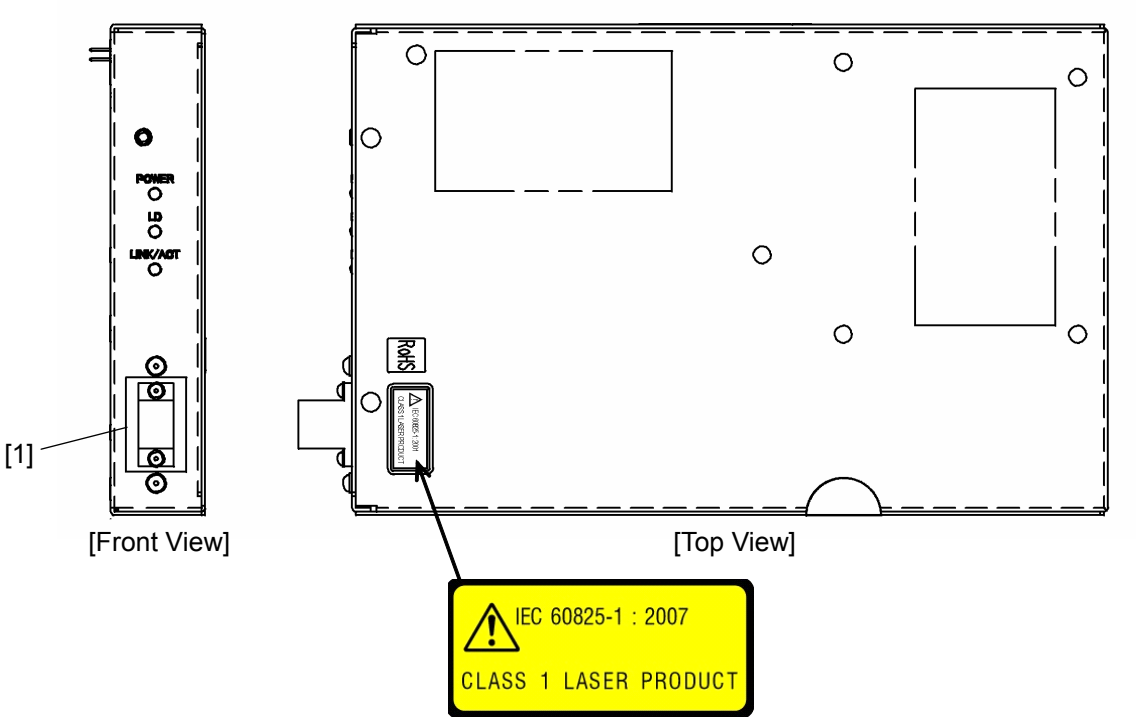


Figure 1 Locations of Laser Beam Apertures and Affixed Labels

For Safety

⚠ CAUTION

Disconnect from Communication Equipments

The OTDR Module outputs high-power optical pulses. Disconnect the communication equipments from the optical fibers before a measurement, or the optical sensor of the equipment may be broken.

Use in a residential environment

This instrument is designed for an industrial environment.
In a residential environment this instrument may cause radio interference in which case the user may be required to take adequate measures.

Equipment Certificate

Anritsu Corporation certifies that this equipment was tested before shipment using calibrated measuring instruments with direct traceability to public testing organizations recognized by national research laboratories, including the National Institute of Advanced Industrial Science and Technology, and the National Institute of Information and Communications Technology, and was found to meet the published specifications.

Anritsu Warranty

Anritsu Corporation provides the following warranty against stoppages arising due to manufacturing error, and against problems with operation occurring even though the procedures outlines in the operation manual were followed.

Hardware:
Problems occurring within a period of one year from the date of delivery will be corrected by Anritsu Corporation at no cost to the user.

Software:
Software reported as faulty within a period of 6 months from the date of delivery will be corrected or replaced by Anritsu Corporation at no cost to the user.
Following correction or replacement the software will remain under warranty for either the remainder of 6 months from the date of initial delivery, or for a period of 30 days, whichever is shorter.
The hardware and software warranties are not valid under any of the following conditions:

- The fault is outside the scope of the warranty conditions separately described in the operation manual.
- The fault is due to mishandling, misuse, or unauthorized modification or repair of the equipment by the customer.
- The fault is due to severe usage clearly exceeding normal usage.
- The fault is due to improper or insufficient maintenance by the customer.
- The fault is due to natural disaster, including fire, wind, flooding, earthquake, lightning strike, or volcanic ash, etc.
- The fault is due to damage caused by acts of destruction, including civil disturbance, riot, or war, etc.
- The fault is due to explosion, accident, or breakdown of any other machinery, facility, or plant, etc.
- The fault is due to use of non-specified peripheral or applied equipment or parts, or consumables, etc.

- The fault is due to use of a non-specified power supply or in a non-specified installation location.
- The fault is due to use in unusual environments(Note).
- The fault is due to activities or ingress of living organisms, such as insects, spiders, fungus, pollen, or seeds.

In addition, this warranty is valid only for the original equipment purchaser. It is not transferable if the equipment is resold.

Anritsu Corporation shall assume no liability for injury or financial loss of the customer due to the use of or a failure to be able to use this equipment.

Note:
For the purpose of this Warranty, "unusual environments" means use:

- In places of direct sunlight
- In dusty places
- Outdoors
- In liquids, such as water, oil, or organic solvents, and medical fluids, or places where these liquids may adhere
- In salty air or in places where chemically active gases (sulfur dioxide, hydrogen sulfide, chlorine, ammonia, nitrogen oxide, or hydrogen chloride etc.) are present
- In places where high-intensity static electric charges or electromagnetic fields are present
- In places where abnormal power voltages (high or low) or instantaneous power failures occur
- In places where condensation occurs
- In the presence of lubricating oil mists
- In places at an altitude of more than 2,000 m
- In the presence of frequent vibration or mechanical shock, such as in cars, ships, or airplanes

Anritsu Corporation Contact

In the event that this equipment malfunctions, contact an Anritsu Service and Sales office. Contact information can be found on the last page of the printed version of this manual, and is available in a separate file on the CD version.

Notes On Export Management

This product and its manuals may require an Export License/Approval by the Government of the product's country of origin for re-export from your country.
Before re-exporting the product or manuals, please contact us to confirm whether they are export-controlled items or not.
When you dispose of export-controlled items, the products/manuals need to be broken/shredded so as not to be unlawfully used for military purpose.

Notice

The following actions are strictly prohibited for all of the software installed in this product or otherwise provided by Anritsu:

1. Copying, except for archival purposes.
2. Transferring to a third party separately from this product.
3. Analyzing the incorporated software including but not limited to modifying, decompiling, disassembling, and reverse engineering.
4. Using the software other than in connection with this product.

Cautions against computer virus infection

- Copying files and data
  Only files that have been provided directly from Anritsu or generated using Anritsu equipment should be copied to the instrument.
  All other required files should be transferred by means of USB or CompactFlash media after undergoing a thorough virus check.
- Adding software
  Do not download or install software that has not been specifically recommended or licensed by Anritsu.
- Network connections
  Ensure that the network has sufficient anti-virus security protection in place.

Crossed-out Wheeled Bin Symbol

Equipment marked with the Crossed-out Wheeled Bin Symbol complies with council directive 2012/19/EC (the “WEEE Directive”) in European Union.

For Products placed on the EU market after August 13, 2005, please contact your local Anritsu representative at the end of the product's useful life to arrange disposal in accordance with your initial contract and the local law.

RoHS Compliance

The European Community Directive 2002/95/EC (the so-called “RoHS Directive”) limits the use of the hazardous substances in electrical and electronic equipment.
Anritsu has classified MW9077A/A1 into the component for category 3, as shown by the following 4 documents:

- Directive 2002/95/EC of the European Parliament and of the Council
- Directive 2002/96/EC of the European Parliament and of the Council
- Frequently Asked Questions on Directive 2002/95/EC on the Restriction of the Use of certain Hazardous Substances in Electrical and Electronic Equipment (RoHS) and Directive 2002/96/EC on Waste Electrical and Electronic Equipment (WEEE) by EUROPEAN COMMISSION
- DTI RoHS Regulations Government Guidance Notes (June 2006)

Anritsu designates MW9077A/A1 as RoHS compliant. (This component contains lead, as permitted by the following exemption specified in the Annex of the RoHS Directive. Lead in solders for servers, storage and storage array systems, network infrastructure equipment for switching, signalling, transmission as well as network management for telecommunications.)

RoHS-Compliant means that:

- firstly, our supplier for the specifically RoHS-compliant products or product parts has confirmed in writing that it will only supply products or product parts that are RoHS-compliant;
- secondly, that we have implemented clear processes to confirm and document the validity of the said supplier’s written confirmation;
- lastly, that notwithstanding the above, we carry out material sample or content testing if and when Anritsu deems it necessary.

Our suppliers can confirm that their products or product parts are RoHS-compliant when:

- either the products or product parts do not contain any of the restricted substances referred to in Article 4 (1) of the RoHS Directive at concentrations in excess of those permitted under the RoHS Directive;
- or the removal of the restricted substances is not technically possible and their existence in the products at levels in excess of these concentrations is allowed as one of the particular applications listed in the Annex to the RoHS Directive.

The following notices are applicable to China RoHS Requirements only.

1. 产品中有毒有害物质或元素的名称及含量

(The names and contents of the toxic or hazardous substances or elements contained in this product)

部件名称	有毒有害物质或元素					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 [Cr(VI)]	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
印刷线路板	×	○	○	○	○	○
机壳，支架	×	○	○	○	○	○
其他（电缆，风扇，连接器等）	×	○	○	○	○	○

○：表示该有毒有害物质在该部件所有均质材料中的含量均在 SJ/T11363-2006 标准规定的限量要求以下。

×：表示该有毒有害物质至少在该部件的某一均质材料中的含量超出 SJ/T11363-2006 标准规定的限量要求。

2. 环保使用期限［The Environment-Friendly Use Period (EFUP)］

这个标记是根据 2006/2/28 公布的「电子信息产品污染控制管理办法」以及 SJ/T 11364-2006「电子信息产品污染控制标识要求」的规定，适用于在中国销售的电子信息产品的环保使用期限。仅限于在遵守该产品的安全规范及使用注意事项的基础上，从生产日起算的该年限内，不会因产品所含有害物质的泄漏或突发性变异，而对环境污染，人身及财产产生深刻地影响。

CE Conformity Marking

Anritsu affixes the CE Conformity marking on the following product(s) in accordance with the Council Directive 93/68/EEC to indicate that they conform to the EMC and LVD directive of the European Union (EU).

CE marking

CE

1. Product Model

Model: MW9077A/A1/A2/B OTDR Module

2. Applied Directive

EMC: Directive 2004/108/EC
LVD: Directive 2006/95/EC

3. Applied Standards

- EMC: Emission: EN 61326-1: 2013 (Class A)
  Immunity: EN 61326-1: 2013 (Table 2)

	Performance Criteria*
IEC 61000-4-2 (ESD)	B
IEC 61000-4-3 (EMF)	A
IEC 61000-4-4 (Burst)	B
IEC 61000-4-6 (CRF)	A

*: Performance Criteria

A: The equipment shall continue to operate as intended during and after the test. No degradation of performance or loss of function is allowed below a performance level specified by the manufacturer, when the equipment is used as intended. The performance level may be replaced by a permissible loss of performance. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, either of these may be derived from the product description and documentation and what the user may reasonably expect from the equipment if used as intended.

B: The equipment shall continue to operate as intended after the test. No degradation of performance or loss of function is allowed below a performance level specified

by the manufacturer, when the equipment is used as intended. The performance level may be replaced by a permissible loss of performance. During the test, degradation of performance is however allowed. No change of actual operating state or stored data is allowed. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, either of these may be derived from the product description and documentation and what the user may reasonably expect from the equipment if used as intended.

- LVD: EN 61010-1: 2010 (Pollution Degree 2)

4. Authorized representative

Name:	Murray Coleman Head of Customer Service EMEA ANRITSU EMEA Ltd.
Address, city:	200 Capability Green, Luton Bedfordshire, LU1 3LU
Country:	United Kingdom

C-Tick Conformity Marking

Anritsu affixes the C-Tick marking on the following product(s) in accordance with the regulation to indicate that they conform to the EMC framework of Australia/New Zealand.

C-Tick marking

1. Product Model

Model: MW9077A/A1/A2/B OTDR Module

2. Applied Standards

EMC:Emission: EN 61326-1: 2013 (Class A equipment)

About This Manual

This operation manual explains the interface for remote control of the MW9077A/A1 OTDR Module using a connected controller such as a controller board. The features of the OTDR Module are described in Chapter 1 “Outline.”

Refer to the Chapter 3 “Interface” and Chapter 4 “Commands” for information on the type of interface and commands to be used for connecting this equipment.
The interface is described in general terms first, and the commands are explained in alphabetical order.

Table of Contents

IV.

This section explains the features of the MW9077A/A1 OTDR (Optical Time Domain Reflectometer) Module and the measurement principle. For the performance and function specifications, refer to Appendix A "Specifications."

1.1 Overview of MW9077A/A1 OTDR Module

The MW9077A/A1 OTDR Module can be used as an OTDR for supporting measurements at various wavelengths by combining with a interface board and by sending various types of remote commands.

The MW9077A/A1 OTDR Module has been developed for the detection of faults in optical fibers during the maintenance of optical fiber systems. It can be used to measure the total loss, interval loss, and cable length (distance) of an optical fiber system.

An automatic measurement procedure and small lightweight design facilitate its use in maintenance of optical fibers. In addition, the OTDR has an interface (RS-232C and Ethernet) to read the measurement results from a computer connected to the interface board.

Faults are located and losses can be automatically measured by sending remote commands, after setting the measurement conditions.

Automatic fault location

Auto or Manual mode measurement

Detailed measurement of loss and splice loss

1.1.1 Measuring cable loss and distance

When laser light of a specific wavelength is introduced into an optical fiber cable from the OTDR, it is scattered as it propagates towards the far end of the cable.
A part of this scattered light returns to the OTDR as backscattered light. The intensity of this backscattered light is measured and is used to determine the cable loss.
In addition, the time duration (from the introduction of the optical pulse into the fiber till it return to the OTDR from a fault) is used to calculate the distance to the fault. For an accurate measurement, the light (sent into the fiber) must propagate to the far end of the cable and return to the OTDR as the backscattered light before the next optical pulse is sent into the fiber. Therefore, the length of the measured cable is set as “Distance Range.” When the “Distance Range” and “Pulse Width” are set to Auto, the OTDR sets the optimum values of these parameters.

1.2 Features

1.2.1 Automatic search of faults

This function is convenient for use when the user does not know the locations of the faults or the length of the fiber.
Set the measurement conditions to Auto (Ex. “Distance range” and “Pulse width”). And faults in the cable are detected automatically by measurement. Users can obtain these information of the detected faults by sending a command to ask the measurement result.

Automatically detected result contains the information like:

- Number of faults counted from the OTDR (NO.)
- Distance to the fault from the OTDR
- Splice loss, Return loss, and Total loss for the fault
- Length of the fiber
- Types of the faults ··· etc

Note:

Results of auto search function:
Auto measurement function is a supporting function to reduce the workload of an operator, while it may generate false detection.
If false detection is presumed, check the measured waveform.

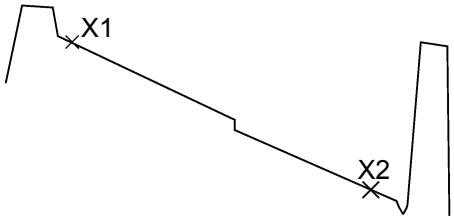
1.2.2 Making high resolution measurements

The number of measured data points can be switched among the following two settings: Normal and Fine. Since 20001/25001 points are sampled in the Fine mode, all errors that could not be detected with the previous equipment can now be detected. It is also possible to measure long distances with high resolution or to make a rough measurement at high speed, as required.

1.3 Loss, Splice, Return Loss and Total Return Loss Measurements

(1) Loss measurement

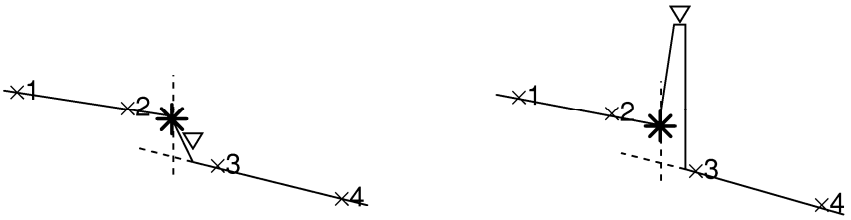
Using the remote command LOS2?, the loss between X1 and X2 location can be measured.

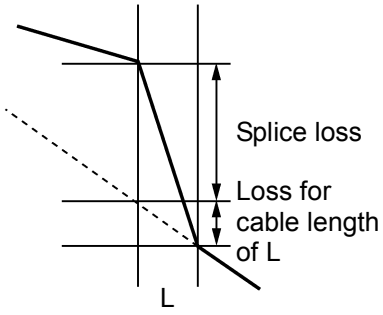


(2) Splice and return loss measurement

Using the remote commands EVN2?, SPLICE? and REFLCT?, the loss at a connection can be measured. In this measurement, a * marker is set at the connection and a pair of × markers are set on each side of the * marker as shown in the figure below. If Fresnel reflection occurs at the connection, a ∇ marker is set at the peak point.

The four × markers are called ×1, ×2, ×3, and ×4 from the left. The splice loss is determined from the vertical difference at the * marker between straight lines drawn between the ×1 and ×2, and ×3 and ×4 markers.





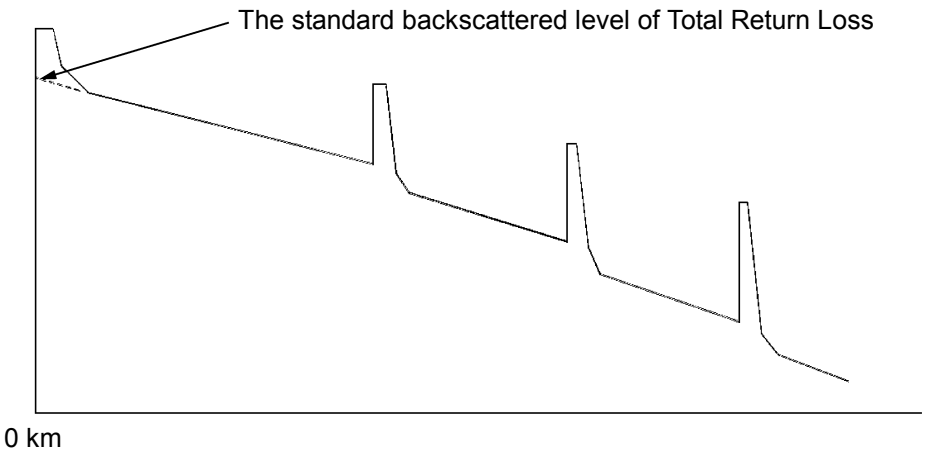
In this measurement, the distance between the ×1 and ×2 markers and that between the ×3 and ×4 markers, as well as the fiber loss (loss per unit length) are also displayed.

There is a section at the splice where the backscattered light cannot be measured precisely during a time which is equivalent to the pulse width. The distance L shown in the figure on the left is equivalent to this section. Because of the distance L, the fiber loss in the L section is included in the measurement if splice loss is measured using the same method as Loss Measurement.

More detailed explanations of the splice loss measurement and the return loss measurement are given in “Appendix C” and “Appendix D,” respectively.

(3) Total return loss measurement

Using the remote command AUT?, the total return loss from 0 km to the far end of the fiber cable is measured. The backscattered level used as reference is in the location shown in the following figure.



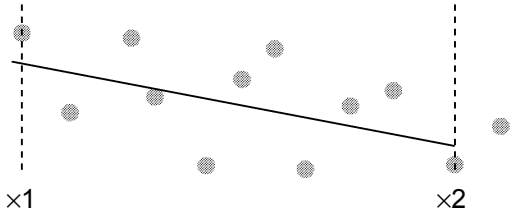
Refer to “Appendix E” for an explanation of the total return loss measurement.

1.4 Linear Approximation Methods LSA/2PA

In the measurement, the loss is calculated by drawing an imaginary line between the two set markers. There are two methods for drawing the line.

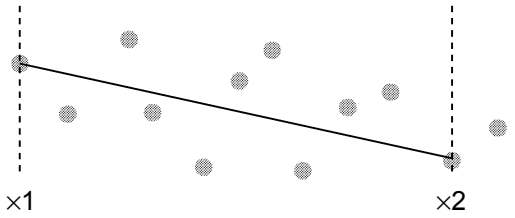
LSA (Least Square Approximation) Method

In this method, the line is drawn by computing the least square of the distances from all the measured data between the two markers. This method is useful when the data contains noise. Refer to Appendix B for further details.



2PA (Two Point Approximation) Method

This method draws a line linking the two measured data points at the two markers.

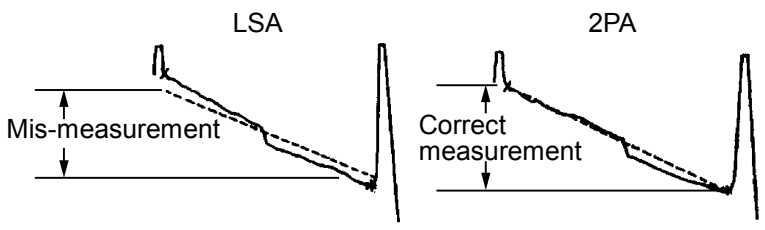


Comparison on LSA and 2PA

These two methods are compared when the data contains a lot of noise as follows:

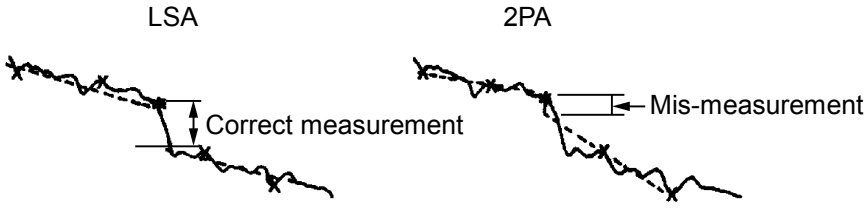
When LSA is selected

When LSA is selected, there is a probability of the occurrence of a large error when a fiber with splice loss is measured along its length.



When 2PA is selected

There is a probability of the occurrence of a large error when the noise is large. An example is shown below.



This section provides information that should be thoroughly understood before actually using the OTDR Module. In particular, it explains about the dimensional requirement for controller board.

Refer to Section 3 “Interface” for setup parameters about the RS-232C and the Ethernet connections.

2.1 Equipment Composition

2.1.1 Standard composition

The standard composition of the MW9077A/A1 OTDR Module is listed in the following table. After unpacking, check the packing list and make sure that all the components are included. If any part is missing or damaged, contact Anritsu or your Anritsu sales agent immediately.

Table 2.1.1-1 Standard composition

	Name	Q'ty	Model name or Ordering No.	Remarks
Main unit	OTDR Module	1	MW9077A or MW9077A1	Select any model.
Accessories	Packing list	1		
	Operation manual	1	M-W2254AE	

2.1.2 Options

The following optional parts can be selected for the OTDR Module. Note that all the options need to be installed in an Anritsu factory. For the specifications, refer to Appendix A "Specifications."

1550 nm filter (MW9077A-01)
This option adds the function of preventing 1500 to 1625 nm optical signals from entering into the OTDR Module.

Optical connectors (MW9077A/A1-33 to 43)
Connectors for the OTDR Module input/output.

PC-type connectors.
-33: LC, -37: FC, -38: ST, -39: DIN, -40: SC, -43: HMS-10/A

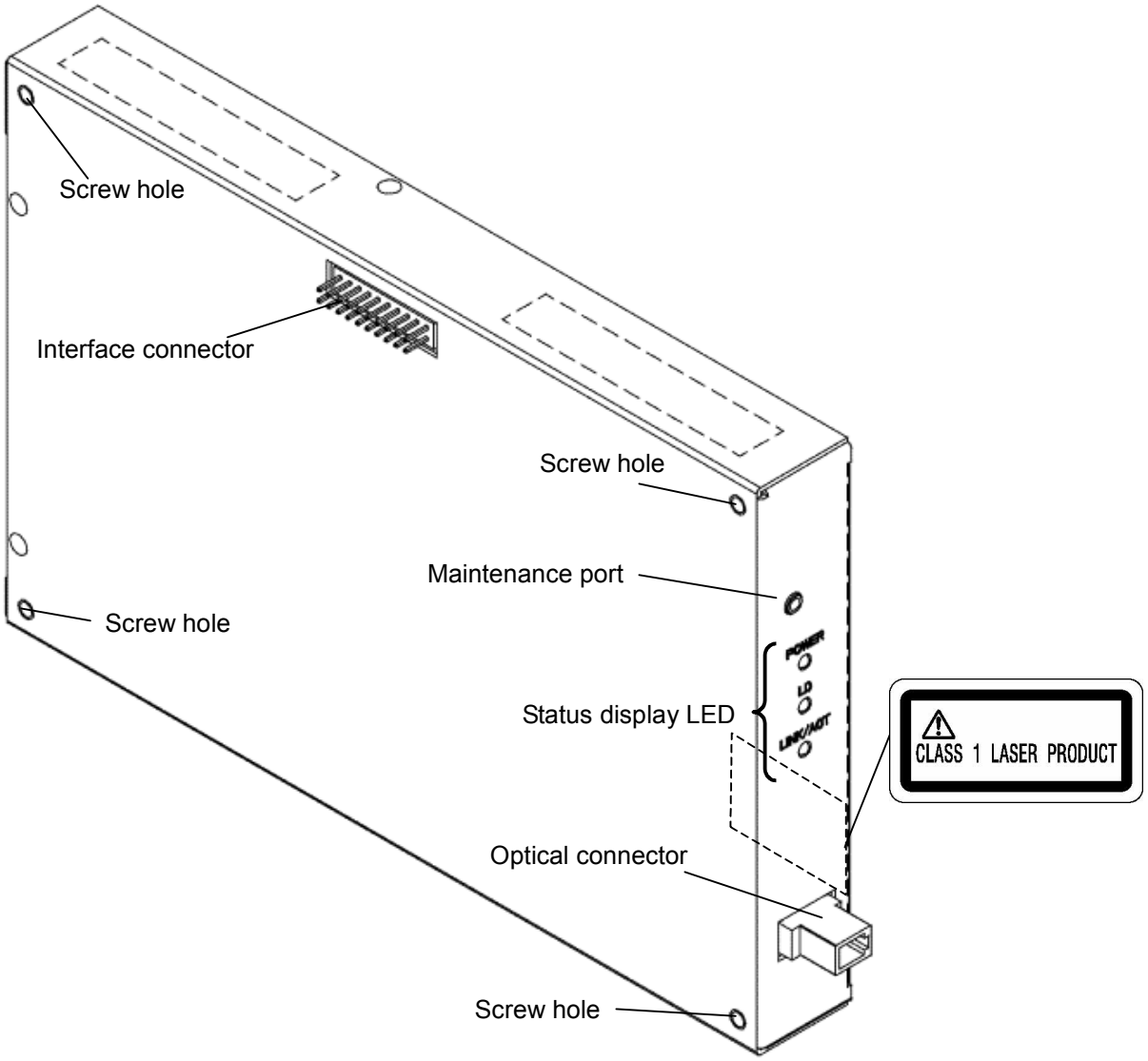
APC-type connectors.
-25: FC-APC, -26: SC-APC, -47: HRL-10

Damp proofing (MW9077A/A1-03)
General specifications and environmental conditions remain the same as MW9077A/A1.

2.2 Names of Parts

Check the name and function of each part.

The figure below shows the model with option 33 (LC) connector.



Optical connector	OTDR input/output optical connector
Maintenance port	Connector for maintenance. It is only for Anritsu's engineer.
Status display LED	
Power	Illuminates when power is supplied to the OTDR Module.
LD	Illuminates when LD is emitting light.

LINK/ACT	Illuminates when the OTDR Module is operated by Ethernet control. Link: LED is lighting. ACT: LED is blinking.
Interface connector	Connector to link-up with a controller board. Refer to 2.3 “Installing the OTDR Module” for a pin assignment.
Screw holes	Use these holes when securing the OTDR Module on the controller board. Refer to 2.3 “Installing the OTDR Module” for dimensional information.

⚠ WARNING

NEVER look directry into the laser radiation emitted from the OTDR I/O connector or the end of the cable connected to the OTDR. If you do so, the laser light may damage your eye.

2.3 Installing the OTDR Module

This section explains the requirements and setup to install the OTDR Module on the controller board.

2.3.1 Mechanical dimensions

The figure below shows the model with option 33 (LC) connector.

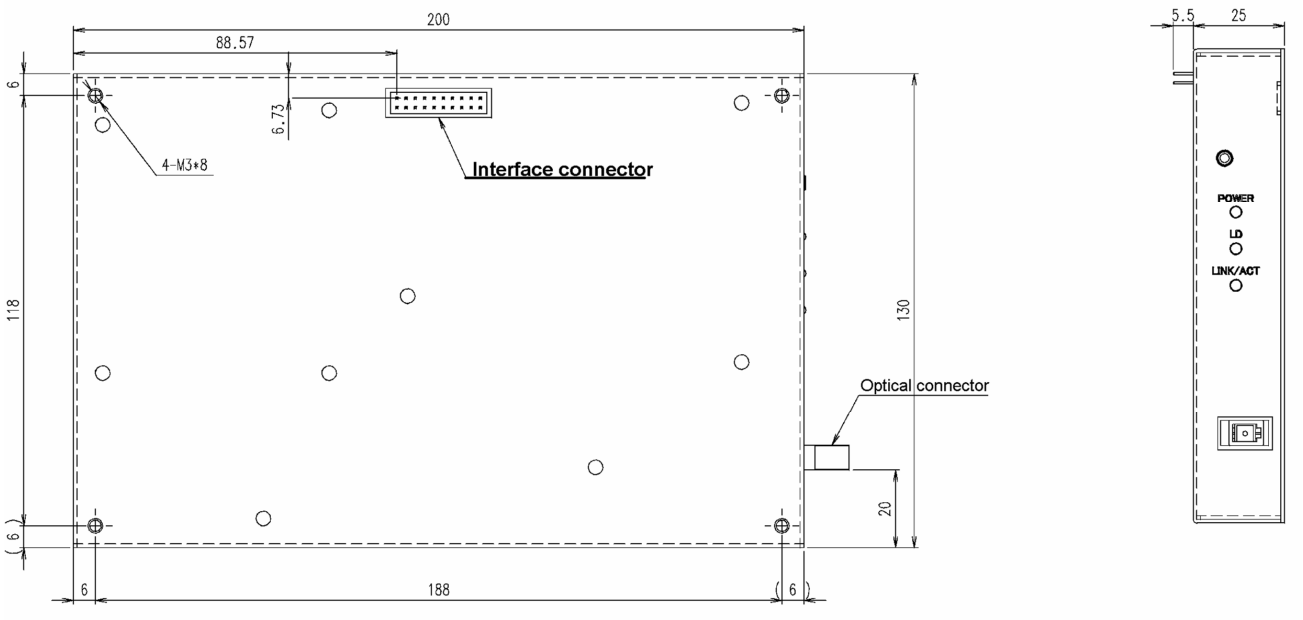


Figure 2.3.1-1 OTDR Module

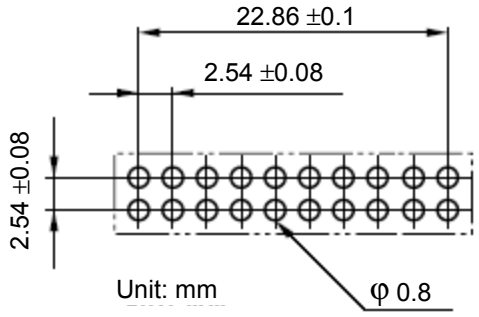


Figure 2.3.1-2 Interface connector

2.3.2 Pin assignment

Table 2.3.2-1 Interface connector pin assignment

Pin	I/O	Signal	Description	Pin	I/O	Signal	Description
1	I	+12 V	1.5 A Tolerance: ±1 V	2	I	+12 V	1.5 A Tolerance: ±1 V
3		GND	Chassis and four mounting holes are connected to GND.	4		GND	
5	I	TPIP	Ethernet	6	I	TPIN	Ethernet
7	O	TPOP		8	O	TPON	
9		GND		10		GND	
11		CD	RS-232C	12		RD	RS-232C
13		SD		14		ER	
15		SG		16		DR	
17		RS		18		CS	
19	I	RESET	TTL level Active “L” Assert Pin-19 for more than 10 ms for Reset.	20		GND	

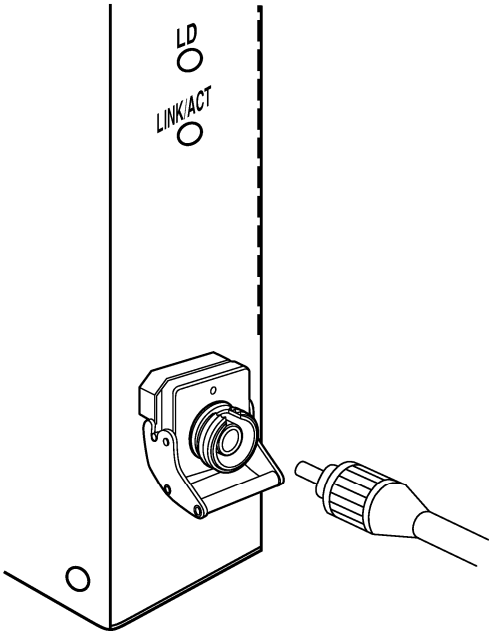
2.3.3 Specification of power supply

Power supply (Interface connector pins 1 & 2) for OTDR Module is +12 Vdc ±1 V, 1.5 A max.

2.4 Connecting the Optical Fiber Cable

Connect the optical fiber cable as shown in the figure below.

The figure below shows the model with option 37 (FC) connector.



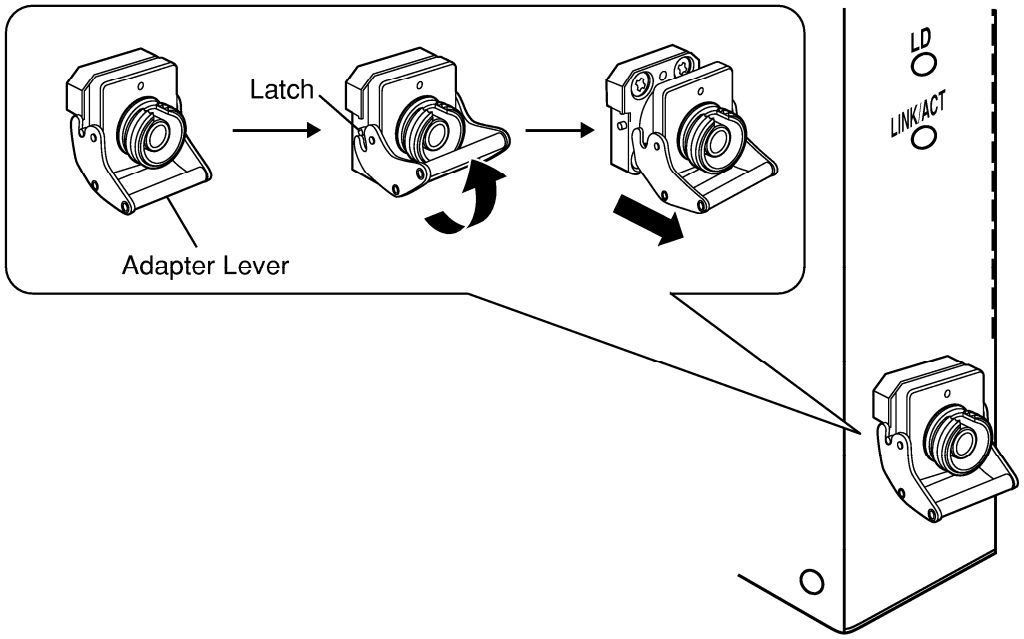
⚠ WARNING

NEVER look into the cable connecting end of the optical connector of the OTDR or the end of the cable connected to the OTDR. If you do so, the laser light may damage your eye.

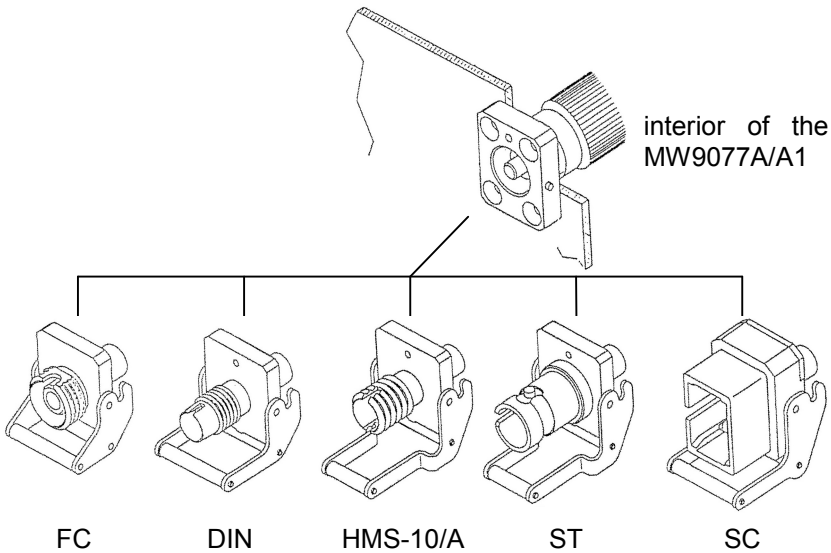
2.5 Replacing the Optical Connector

This section describes only for the OTDR Module with the user-replacable connector type.

To replace the optical connector, pull the adapter lever towards you until the latch is released. Then, remove the connector by lifting it.



Connector types are shown below for reference.



⚠ CAUTION

When replacing the optical connector, take care not to damage the connector and the connecting surface of the connector.

⚠ WARNING

NEVER look directory into the laser radiation emitted from the OUTPUT connector or the end of the cable connected to the OTDR. If you do so, the laser light may damage your eye.

2.6 Precautions

Disconnect from communication equipments

The OTDR Module outputs high-power optical pulses. Disconnect the communication equipments from the optical fibers before a measurement, or the optical sensor of the equipment may be broken.

Limit to the interface

The OTDR Module provides two interfaces such as RS-232C (serial) and Ethernet.
However, as there is a limit in the OTDR's firmware, use only one system when linking up from the controller.
It is not assured to control the OTDR coincidentally or dynamically by both means.

As a port for integration with your system, an Ethernet port is more appropriate than a serial one.

Connector cover

The interface connector has a dust-proof cover. Do not remove the cover except when a cable is to be connected to the connector.

Condensation

If the OTDR Module is carried from a low-temperature environment to a warm room, there is a danger of condensation in it. In this case, allow the OTDR to dry completely before turning on its power.

Exposure to extremely high temperature in vehicles

Do not leave the OTDR Module in a vehicle. The ambient remperature may exceed the storage temperature (–40 to +70°C) which may result in the failure of the OTDR. Do not expose the OTDR Module to an extremely high or low temperature.

Results of auto search function

Auto measurement function is a supporting function to reduce the workload of an operator, while it may generate false detection. If false detection is presumed, check the measured waveform data.

Chapter 3 Interface

This section explains the RS-232C and Ethernet interfaces of OTDR Module (hereafter “OTDR”), and the transmission sequence between an external PC (controller) and the OTDR.

3.1 RS-232C

3.1.1 Port configuration

Table 3.1.1-1 Port specification of RS-232C

Parameter	Value
Baud rate	115200
Data length	8 (bits)
Parity	None
Stop bit	1 (bit)
Flow control	Hardware flow

3.2 Ethernet

3.2.1 Port configuration

Table 3.2.1-1 Port specification of Ethernet

Port	Characteristics
Ethernet	10M Ethernet
Parameter	**Default setting**
IP address	10.108.5.101
Netmask	255.255.255.0
Gateway	10.108.5.120
Port number	6000

☞ 4.2.2 Commands (Net)
☞ 5.1.3 Change the network parameters

⚠ CAUTION

The OTDR Module provides two interfaces such as RS-232C (serial) and Ethernet (10 Mbps).
However, as there is a limit in OTDR firmware, use only one interface when linking up from the controller.
It is not assured to control the OTDR coincidentally or dynamically by both means.
As a port for integration with your system, an Ethernet port is more appropriate than a serial one.

3.3 Data Format

3.3.1 Text data

All text messages such as Command, Query, and Response messages have a terminator code in the last two bytes. The terminator code is 0x0D0A.

Text message (ex. “LD□1”, “ANS0”)	Terminator 0x0D0A

Figure 3.3.1-1 Text data format

3.3.2 Binary data

Binary data do not have a terminator code. Instead of that, the total data size information is contained at the message in the top 4 bytes (except for “DAT?” command. Refer to 4.2.2 “Commands” for details about DAT?). Detail format of binary data of each command or response is different. See each command details. 4.2.2 Commands

Data size (Binary)	Data (Binary)

Figure 3.3.2-1 Typical binary data format

3.4 Transmission Sequence

3.4.1 Command

If the sending command is received by OTDR successfully, a response message “ANS0” is sent from OTDR. However, OTDR does not send any response message when OTDR receives “RST” command.

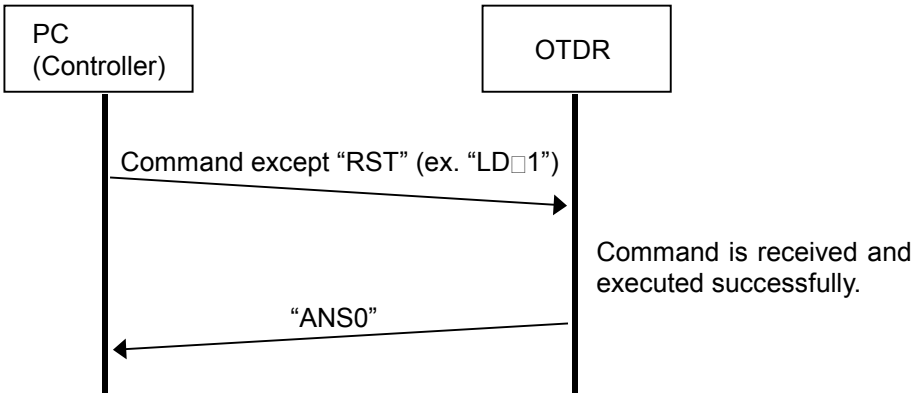


Figure 3.4.1-1 Command except “RST” sequence (Normal)

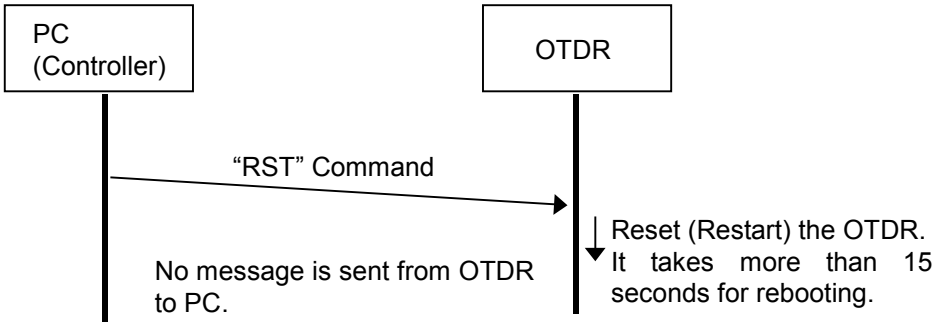


Figure 3.4.1-2 “RST” command sequence (Normal)

3.4.2 Query

If the sending query command is received by OTDR successfully, the response message described in Section 4.2.2 is sent from OTDR.

4.2.2 Commands

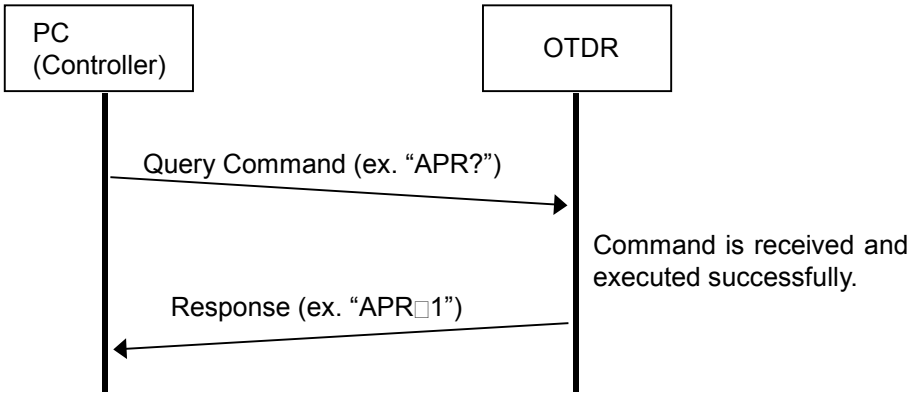
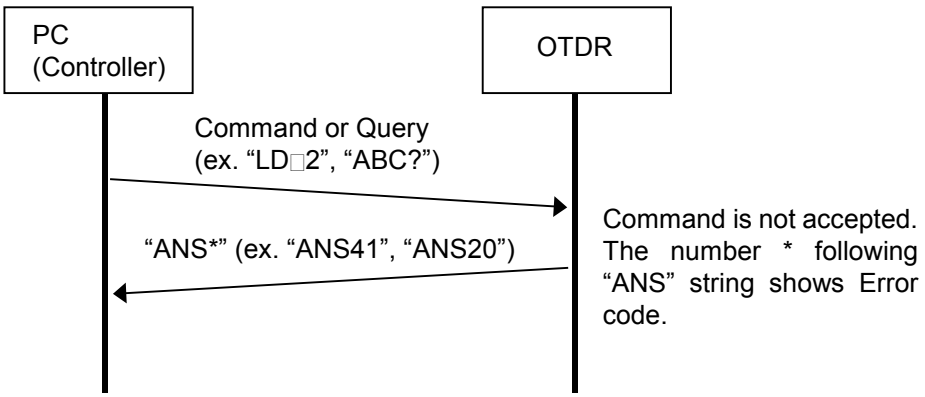


Figure 3.4.2-1 Query sequence (Normal)

3.4.3 Error sequence

The “ANS*” is sent from OTDR instead of “ANS0” or normal response, if the sending command or query is not accepted by OTDR. The “*” (asterisk) in the figure below shows Error code number.

Table 4.2.2-1 Error list



*: Error code 1 to 255 (See Table 4.2.2-1 Error list)

Figure 3.4.3-1 Command/Query error sequence (Error)

Chapter 4 Commands

This section explains the command usage of the MW9077A/A1 OTDR Module (hereafter "OTDR").

4.1 Command Type

The remote commands are classified as follows.

Table 4.1-1 Measurement operation

No.	Function	Command	Query
1	Start sweep (measurement)	LD	LD?

Table 4.1-2 Measurement settings

No.	Function	Command	Query
2	Wavelength	WLS	WLS?
3	Average limit	ALA	ALA?
4	Averaging mode	AVG	AVG?
5	Measurement parameters (Distance range, pulse width, sampling points)	STP	STP?
6	Automatic attenuator	ATA	ATA?
7	Attenuation	ATT	ATT?
8	Get attenuation values	—	ATV?
9	Linear approximation method	APR	APR?
10	Splice loss threshold	THS	THS?
11	Reflectance threshold	THR2	THR2?
12	Fiber-end threshold	THF	THF?
13	IOR (Index of Refraction)	IOR	IOR?
14	Backscatter coefficient	BSL2	BSL2?
15	Sampling points and resolution	—	SMPINF?

Table 4.1-3 File settings

No.	Function	Command	Query
16	SR-4731 format level	SRLV	SRLV?
17	Get SR-4731 data from OTDR	—	GETFILE?
18	Set SR-4731 data to OTDR	SETFILE	—
19	Data flag	HDFG	HDFG?

Note:

The SR-4731 data is described in this document, which includes the Anritsu original parameters. Those parameters are not specified in *Telcordia SR-4731 Issue 1 February 2000*, but Anritsu's commands require these Anritsu original parameters. If the SR-4731 data do not contain the Anritsu original parameters, Anritsu's commands can not handle the data. If the SR-4731 data including Anritsu original parameters are modified by user (ex.: edited by binary editor or another system), Anritsu commands can not support the data any more.

Table 4.1-4 System settings

No.	Function	Command	Query
20	Local date, time and time difference	DATE2	DATE2?
21	IP, port, netmask and gateway	NET	NET?
22	Get system information	—	MINF?
23	Ethernet timeout setting	CONNTM	CONNTM?

Table 4.1-5 Measurement result requests

No.	Function	Command	Query
24	Auto-measurement result	—	AUT?
25	Waveform data (LOG)	—	DAT?
26	Averaging result	—	AVE?
27	Event measurement result	—	EVN2?
28	Calculates the Splice loss	—	SPLICE?
29	Calculates the Reflectance	—	REFLCT?
30	Calculates the Loss	—	LOS2?
31	Calculates the Total loss	—	TLOS?
32	Relative distance	OFS	OFS?
33	Start point/end point for calculating the Total loss	—	MKDR?

Table 4.1-6 Status readout

No.	Function	Command	Query
34	Status	—	STATUS?
35	Error code	—	ERR?
36	Waveform data existence	—	WAV?

Table 4.1-7 Other settings

No.	Function	Command	Query
37	Initialize	INI	—
38	Reset	RST	—
39	Selftest	—	SLFTST?
40	Change Mode	DLMODE	DLMODE?
41	Download the software	DWNLD	DWNLD?

4.2 Command Details

This section explains the details of each command in alphabetical order.

4.2.1 Notations

This document uses the following notations:

(1) A hexadecimal value is preceded by "0x."

ex.: "0x0100" means "256" in decimal.

(2) A character "□" is a space. That is 0x20 in ASCII code.

ex.: "A□B" means "A B." One space code is in the string between"A" and "B."

(3) A character string enclosed in **{}** represents one or more parameters. "|" in {} means "or."

ex.: "{ 0 | 1 }" means "0 or 1."

(4) Command parameters are represented with character strings each enclosed in **< >**.

ex.: "<Parameter1>,<Parameter2>" means that the command has two parameters.

(5) A character string enclosed in **[ ]** is optional (may be omitted).

ex.: "<A>[,<B>]" means "B" may be or may not be inserted. In other words, there are two patterns such as "<A>,<B>" and "<A>."

(6) A character string **>** is a command or query message. Following message is sent from PC (Controller) to OTDR.

ex.: ">LD?" means "LD?" query is sent from PC (Controller) to OTDR.

(7) A character string **<** is a response message. Following message is sent from OTDR to PC (Controller).

ex.: "<LD□0" means "LD□0" query is sent from OTDR to PC (Controller).

(8) Commands and Queries are not case sensitive.

ex.: OTDR interprets "LD□0" "Ld□0", "lD□0" and "ld□0" commands as the same command.

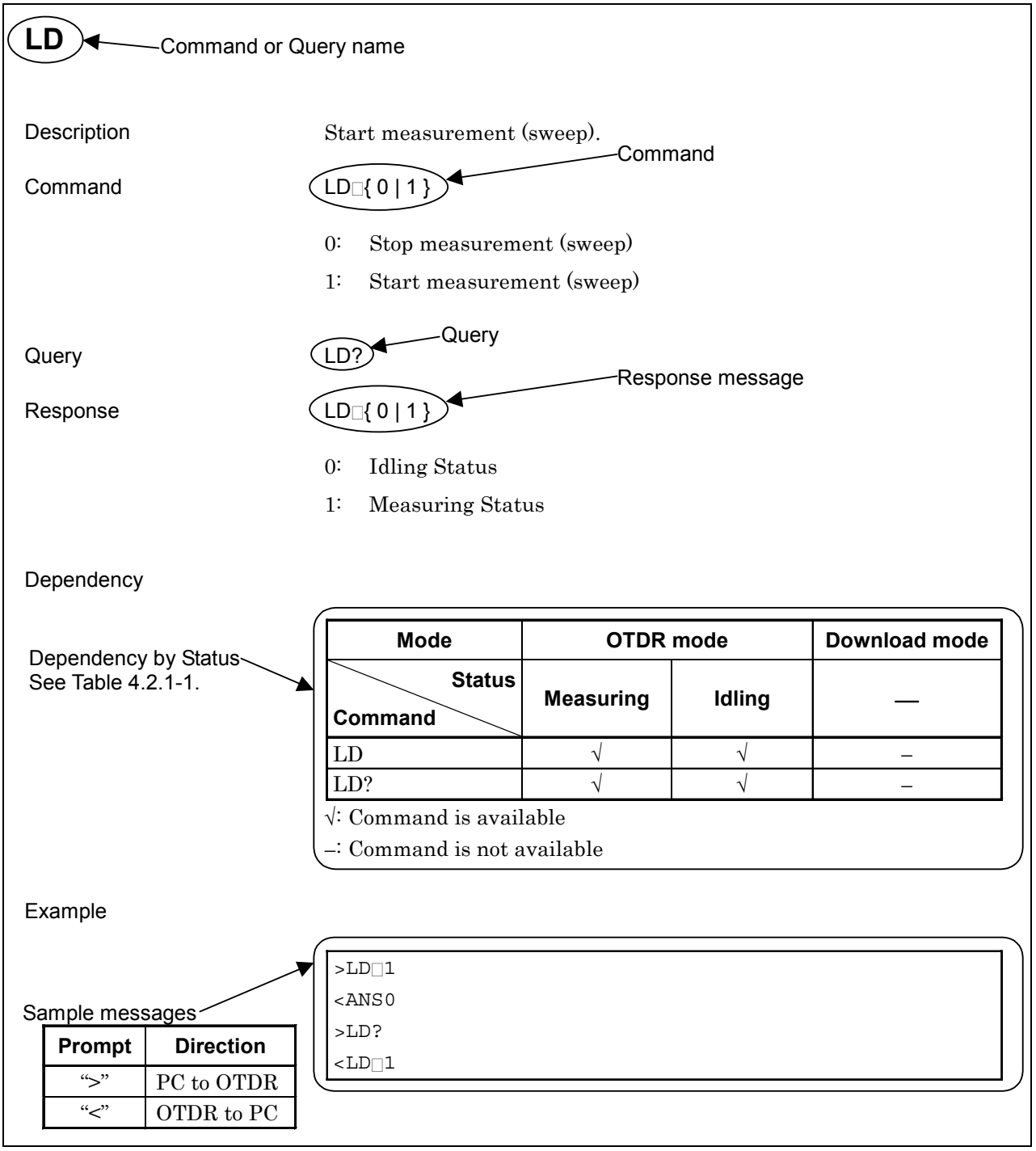


Figure 4.2.1-1 Sample page of command details

Table 4.2.1-1 OTDR mode and status

Mode	Status	Description
OTDR mode	Measuring	OTDR is measuring. Most query commands except for retrieving result are available. In contrast, most setting commands are not available in this status in order to avoid the incoherence conditions during the measurement.
	Idling	OTDR is not measuring. Generally, most commands are available not only queries but also setting commands.
Download mode	—	To Download the software to OTDR. Commands not related to download are not available.

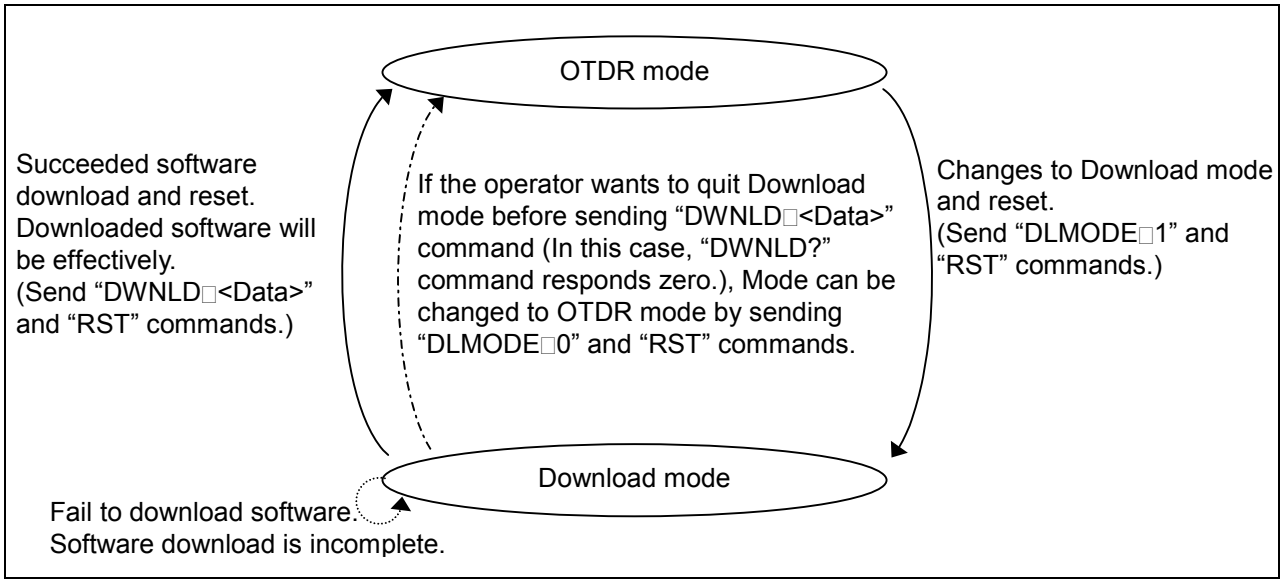


Figure 4.2.1-2 State transition diagram between modes

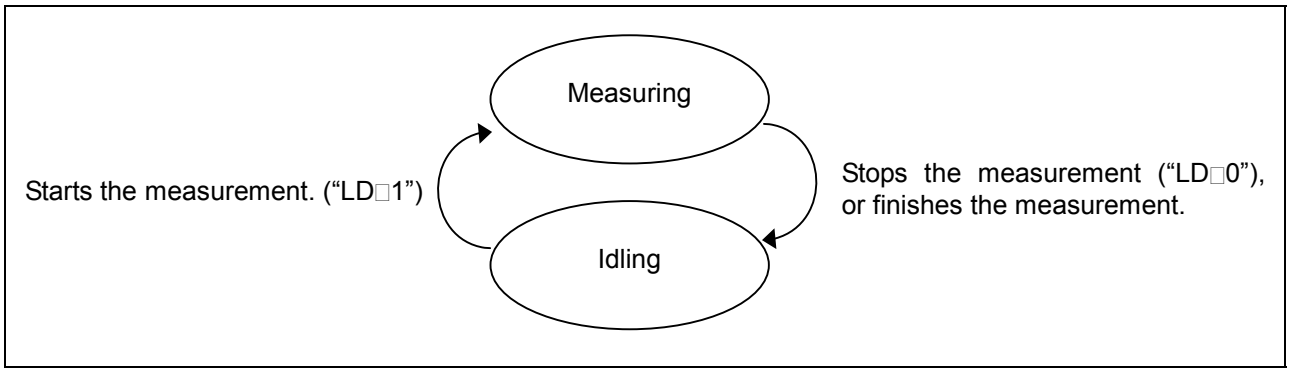


Figure 4.2.1-3 State transition diagram between status

4.2.2 Commands

ALA

Description

Set averaging limit.

Command

ALA□<Mode>,<Setting>

<Mode>

0: Number of times

1: Elapsed time

2: Auto setting

<Setting>

If Averaging mode is Auto, this variable is ignored.

1 to 9999: times (when Mode is Number of times)

1 to 9999: sec (when Mode is Elapsed time)

Query

ALA?

Response

ALA□<Mode>,<Setting(Number of times)>,<Setting(Elapsed time)>

<Setting(Number of times)>

1 to 9999: times

The response is "***" when the Mode is Auto setting and Setting is invalid.

<Setting(Elapsed time)>

1 to 9999: sec

The response is "***" when the Mode is Auto setting and Setting is invalid.

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idling	—
ALA	–	√	–
ALA?	√	√	–

√: Command is available

–: Command is not available

Example

```
>ALA□0,1
<ANS0
>ALA?
<ALA□0,1,2

>ALA□2,1
<ANS0
>ALA?
<ALA□1,***,***
```

APR

Description

Set linear approximation method. This setting value is used for "LOS2?" and "SPRICE?" commands.

Command

APR□{ 0 | 1 }

0: 2PA (Two Point Approximation)

1: LSA (Least Square linear Approximation)

Query

APR?

Response

APR□{ 0 | 1 }

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idling	—
APR	–	√	–
APR?	√	√	–

√: Command is available

–: Command is not available

Example

```
>APR□1
<ANS0
>APR?
<APR□1
```

ATA

Description

Sets the attenuator in auto setting.
When the pulse width setting is auto, the attenuator setting mode is set in the automatic setting mode.

Command

ATA

Query

ATA?

Response

ATA□{ 0 | 1 }

0: Manual attenuation mode

1: Automatic attenuation mode

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idling	—
ATA	*1	√	–
ATA?	√	√	–

√: Command is available
–: Command is not available

*1: Even if the status is set in Measuring, the ATA command is valid when "WAV?" command result is 1 (a waveform exists).
And if the setting value is changed, the command restarts the measurement.
During transition to measurement status or from measurement to idle status, ANS60 error is returned.

Example

```
>ATA?
<ATA□0
>ATA
<ANS0
>ATA?
<ATA□1
```

ATT

Description

Sets attenuation with attenuator.

Command

ATT□<Attenuation>

Sets by the number of 3 decimal places in 1=1 dB unit.

The set attenuation value can be obtained with the attenuator value selected in the " AVT? " command.

When the pulse width setting is auto, the attenuation setting mode is also set to the automatic setting mode.

When the pulse width setting is auto, ANS103 error is returned for the setting on this command.

Query

ATT?

Response

ATT□ <Attenuation>

When attenuation setting is auto, the value is automatically determined. Moreover, until automatic determination, the attenuation value is kept to be indefinite value.

In this case, "ATT□***" is returned as the response.

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idle	—
ATT	*1	√	–
ATT?	√	√	–

√: Command is available

–: Command is not available

*1: Even if the status is set in Measuring, the ATT command is valid when the "WAV?" command result is 1 (a waveform exists). And if the setting value is changed, the command restarts the measurement.

During transition to measurement status or from measurement to idle status, ANS60 error is returned.

Example

```
>ATA□3
<ANS0
>ATT?
<ATT□3.000
```

ATV?

Description

Obtains the valid attenuation value for the specified pulse width.

Query

ATV?□<Pulse Width>

<Pulse Width> is one of the values that can be set with the OTDR unit, shown in 1= 1ns unit.

ex.: The one of the following values is selected.

(10, 30, 100, 300, 1000, 3000, 10000, 20000 ns)

Response

ATV□<Attenuation>{,<Attenuation>}

<Attenuation>

1 = 1dB and the value is output to three decimal

Returns by the number of 3 decimal places in 1=1 dB unit.

All available attenuation values are output for the specified pulse width.

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idle	—
ATV?	√	√	–

√: Command is available

–: Command is not available

Example

```
>ATV?□10
<ATV□0.0003,3.000,8.000,13.000,18.000
```

AUT?

Description

Read auto-measurement results.

Query

AUT?

Response

AUT□<Total number of the events>,<Fiber length>,<Total loss>,<Total return loss>

<Total number of the events>

0 to 99

<Fiber length>

Distance unit, IOR correction distance data.
The numeric value in meters is rounded to the three decimal point.
"***" is output if measurement is impossible.

<Total loss>

The unit is dB. The value is output with the third decimal place.
"***" is output if measurement is impossible.

<Total return loss>

The first byte indicates the status of the reflectance as the following table:

1st byte	Total return loss
"<"	The value is saturated.
"□" (space)	The value is not saturated.

The unit is dB. 1 = 1 dB and the value is output with three decimal places.
"***" is output if measurement is impossible.

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idling	—
AUT?	–	√	–

√: Command is available
–: Command is not available

Example

```
>AUT?
<AUT□1,1009.11,0.247,<19.848
```

AVE?

Description

Read current averaging count and time.

Query

AVE?

Response

AVE□<Averaging mode>,<Count value (Count)>,<Count value (Time)>

<Averaging mode>

0: Manual (“Number of times” or “Elapsed time”)

1: Auto setting

<Count value (Count)>

Current averaging count in the number of times unit

<Count value (Time)>

Current averaging times in second unit

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idling	—
AVE?	√	√	–

√: Command is available

–: Command is not available

Example

```
>AVE?
<AVE□1,0,0
```

AVG

Description

Sets the Averaging mode (ON/OFF).
When Averaging mode is ON, the value set with the ALA command is valid.

Command

AVG□{0|1}
0: Averaging OFF (Real time trace).
1: Averaging ON.

Query

AVG?

Response

AVG□ {0|1}

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idle	—
AVG	–	√	–
AVE?	√	√	–

√: Command is available
–: Command is not available

Example

```
>AVG□0
<ANS0
>AVG?
<AVG□0
```

BSL2

Description

Set Backscatter coefficient value.

Command

BSL2□<Backscatter coefficient>

<Backscatter coefficient>
dB unit.
The setting range is –40.00 to –90.00 dB (0.01 dB step)

The setting value should be the value at a 1 ns pulse width.
It is not necessary to set the value for each pulse width.

Query

BSL2?

Response

BSL2□<Backscatter coefficient>

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idling	—
BSL2	–	√	–
BSL2?	√	√	–

√: Command is available
–: Command is not available

Example

```
>BSL2□-45.68
<ANS0
>BSL2?
<BSL2□-45.68
```

CONNTM

Description

Set time to keep alive Ethernet connection with controller. This setting is effective when there is no response from the TCP connection of the controller.

Command

CONNTM□<Timeout set value>

<Timeout set value>
The setting range is 1 to 7200 (1sec. step)

Query

CONNTM?

Response

CONNTM□<Timeout value>

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idling	—
CONNTM	–	√	–
CONNTM?	√	√	–

√: Command is available
–: Command is not available

Example

```
>CONNTM□30
<ANS0
>CONNTM?
<CONNTM□30
```

DAT?

Description

Read waveform data.

Query

DAT?□[<Data start distance>,<Data end distance>[,<Read skipping interval>]]

<Data start distance>

Specify the distance value where the first data to be sent is.
The numeric value in meters is rounded to the three decimal point.

<Data end distance>

Specify the distance value where the end data to be sent is.
The numeric value in meters is rounded to the three decimal point.

<Read skipping interval>

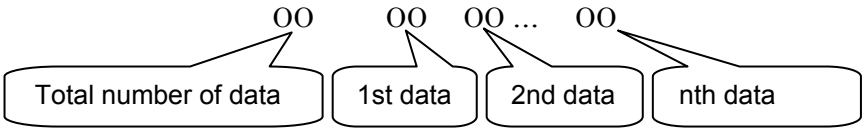
Designate the Read skipping interval of output data with the number of points.
If this parameter is omitted, this parameter is set to zero.

[Omitted form]

When a part which follows <Data start distance> is omitted, reads out the data from the sampling start to the end.

Response

2 bytes 2 bytes 2 bytes…2 bytes (Big endian)



<Total number of data>, <Data>

Both the data number and data are binary numbers.
One data item is expressed by 16 bits (2 bytes). One data item is divided into the 8 most significant bits and the 8 least significant bits. They are output in sequence.
1 digit is equivalent to 0.001 dB.

ex.: 37.580 dB is expressed as 92CC (Hex).
37.580 x 1000 = 37580
37580 (Dec) ---> 92CC (Hex)
1st byte: 92 (Hex)
2nd byte: CC (Hex)

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idling	—
DAT?	√	√	–

√: Command is available

–: Command is not available

Example

```
>DAT?
<00011234 (Binary data)
```

DATE2

Description

Set local date and time, then assign the time difference from UTC (Universal Coordinated Time) to local time.

Command

DATE2□<Year>,<Month>,<Day>,<Hour>,<Minute>,<Second>,<Time difference>

<Year>
2000 to 2098

<Month>
1 to 12

<Day>
1 to 31

<Hour>
0 to 23

<Minute>
0 to 59

<Second>
0 to 59

<Time difference>
hour unit
–12 to 12

Query

DATE2?

Response

DATE2□<Year>,<Month>,<Day>,<Hour>,<Minute>,<Second>,<Time difference>

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idling	—
DATE2	–	√	–
DATE2?	√	√	–

√: Command is available
–: Command is not available

Example

```
>DATE2□2003,3,31,12,34,56,-9
<ANS0
>DATE2?
<DATE2□2003,3,31,12,34,58,-9

>DATE2□2003,1,23,1,23,45,-8
<ANS0
>DATE2?
<DATE2□2003,1,23,1,23,47,-8

>DATE2□2005,11,22,10,20,30,5
<ANS0
>DATE2?
<DATE2□2005,11,22,10,20,32,5
```

Location:Tokyo Time difference: -9hours
Local time: Mar.31.2003 12:34:56

Location: Beijing Time difference: -8hours
Local time: Jan.23.2003 1:23:45

Location: New York Time difference: 5hours
Local time: Nov.22.2005 10:20:30

DLMODE

Description

Change the OTDR mode to Download mode for downloading the software. The setting is effective after the reset.

Command

DLMODE□{ 0 | 1 }

0: OTDR mode

1: Download mode

Query

DLMODE?

Response

DLMODE□{ 0 | 1 }

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idling	—
DLMODE	–	√	*A
DLMODE?	√	√	√

√: Command is available

–: Command is not available

*A: When "DWNLD?" response is zero, the command is available. In other cases, this command is not available.

Example

```
>DLMODE□1
<ANS0
>DLMODE?
<DLMODE□1
```

DWNLD

Description

Download the software. The downloaded software is effective after the reset.

Command

DWNLD□<Data>

<Data>
Specify the binary data of the file to be sent.
First four-bytes data indicate the file size.

ex.: When 256 (0x00000100) byte file data is sent:

1st byte	2nd byte	3rd byte	4th byte	5th byte	…	260th byte
0x00	0x00	0x01	0x00	0x00	…	0x00
File size (bytes)				Data		

Query

DWNLD?

Response

DWNLD□{ 0 | 1 | 2 | 3 }

0: The download software has not been accepted to the ROM. In this case, the OTDR can back to OTDR mode from current Download mode by sending "DLMODE□0" and "RST" commands.

1: Writing the software to the ROM.

2: Succeeded of updating the software. (The download software is effective after the reset.)

3: Failed to download. (Need to retry the download.)

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idling	—
DWNLD	–	–	√
DWNLD?	–	–	√

√: Command is available
–: Command is not available

Example

```
>DWNLD□00000001FF (Binary data)
<ANS0
>DWNLD?
<DWNLD□2
```

ERR?

Description Read Error code of the last Command or Query.

Query ERR?

Response ERR□<Error code>

<Error code>
0: No error

1 to 255: Error code (See Table 4.2.2-1 Error list, below.)

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idling	—
ERR?	√	√	–

√: Command is available
–: Command is not available

Example

```
>ERR?
<ERR□0

>LD□2
<ANS41
>ERR?
<ERR□41
>ERR?
<ERR□0
```

The command parameter is

Table 4.2.2-1 Error list

Type	Contents	Error code	Probability
Query errors (Error codes: 1 to 19)	Query does not match measurement conditions	1	—
	Received non-executable query when no waveform	15	"GETFILE?","AUT?","DAT?","EVN2?", "SPLICE?", "REFLCT?","LOS2?","TLOS?","MKDR?"
Command errors (Error codes: 20 to 39)	Received command or query in illegal format	20	All input
	Command error	21	—
Execution errors (Error codes: 40 to 59)	Illegal parameter value	40	All commands and queries
	Out-of-range (integer, negative value)	41	
	Illegal parameter data type (Specified real value in data that can only handle integer value)	42	
	Specified other value that cannot be processed.	43	—
Status errors (Error codes: 60 to 79)	Command is OK, but does not match OTDR's status.	60	All commands and queries if it has prohibitive dependency.
	Received an invalid command during OTDR's mode.	61	All commands and queries except "RST" and "DLMODE?"
	The query command is not acceptable while the other commands are carrying out.	68	All commands and queries except "RST"
Unit errors (Error codes: 80 to 99)	Received command or query not handled by unit.	81	—
	Not supported parameters (distance range, pulse width, etc.)	82	"STP"
Setting errors (Error codes: 100 to 119)	Received command that does not match setting conditions.	100	—
	Received distance range that does not match the current pulse width.	101	—
	The set value is not acceptable for the current pulse width.	103	"ATT"
	Received pulse width that does not match the current distance range.	102	"STP"
	Received non-executable when there are no waveforms.	115	—
(Error codes: 120 to 139)	(Reserved for future use)	Reserved for future use	Reserved for future use

Sequence errors (Error codes: 140 to 159)	Message timeout (Remote command is interrupted over 30 seconds.)	143	All input
File errors (Error codes: 160 to 179)	File type incorrect	167	“SETFILE”, “DWNLD”
	The unit can’t support the file.	168	“SETFILE”
(Error codes: 180 to 254)	(Reserved for future use)	Reserved for future use	—
Device error (Error codes: 255)	OTDR is out of order.	255	All commands except “RST” , “DLMODE” and “SLFTST?”

EVN2?

Description

Read event results.

Query

EVN2?□<Event number>

Response

EVN2□<Event number>,<Location>,<Splice loss>, <Reflectance>,<Total loss>,<Event type>

<Event number>
Event number
1 to 99

<Location>
Event location
m (meter) unit
The numeric value in meters is rounded to the three decimal point.

<Splice loss>
The unit is dB. 1 = 1 dB and the value is output with three decimal places.
When the selected event is regarded as the far end, "END" is output.

<Reflectance>
The first byte indicates the status of the reflectance as the following table:

1st byte	Reflectance
"<"	The value is saturated.
"□" (space)	The value is not saturated.

The unit is dB. 1 = 1 dB and the value is output with three decimal places.
"***" is output if measurement is impossible.

<Total loss>
The unit is dB. 1 = 1 dB and the value is output with three decimal places.
"***" is output if measurement is impossible.

<Event type>
N: Non-reflective event

R: Reflective event

S: Saturated reflective event

E: Fiber-end event

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idling	—
EVN2?	–	√	–

√: Command is available

–: Command is not available

Example

```
>EVN2?□1
<EVN2□1,1009.11,END,□-18.714,0.227,E
```

GETFILE?

Description

Get SR-4731 data from OTDR.

Query

GETFILE?

Response

<Data>

<Data>
Binary data of the file specified to be received.
First four bytes data indicate the file size.

ex.: When 56000 (0x0000DAC0) byte file data is received:

1st byte	2nd byte	3rd byte	4th byte	5th byte	…	56004th byte
0x00	0x00	0xDA	0xC0	0x4D	…	0x00
File size (bytes)				Data		

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idling	—
GETFILE?	–	√	–

√: Command is available
–: Command is not available

Example

```
>GETFILE?
<000000020102 (Binary data)
```

HDFG

Description

Input the data flag of the header. This value is corresponded to CDF (Current Data Flag) in SR-4731.

Command

HDFG□{ 0 | 1 | 2 }

0: BC (Installation)

1: RC (Repair)

2: OT (Other)

Query

HDFG?

Response

HDFG□{ 0 | 1 | 2 }

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idling	—
HDFG	–	√	–
HDFG?	√	√	–

√: Command is available

–: Command is not available

Example

```
>HDFG□0
<ANS0
>HDFG?
<HDFG□0
```

INI

Description

Recall the parameter information, and set OTDR condition to the power-on. The network parameters (ie. IP, port, netmask and gateway) are not initialized.

Command

INI

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idling	—
INI	√	√	–

√: Command is available

–: Command is not available

Example

```
>INI
<ANS0
```

IOR

Description

Set IOR (Index of Refraction) limit.

Command

IOR□<IOR value>

<IOR value>
Valid up to six decimal places from 1.400000 to 1.699999

Query

IOR?

Response

IOR□<IOR value>

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idling	—
IOR	–	√	–
IOR?	√	√	–

√: Command is available
–: Command is not available

Example

```
>IOR□1.456789
<ANS0
>IOR?
<IOR□1.456789
```

LD

Description

Start measurement (sweep).

Command

LD□{ 0 | 1 }

0: Stop measurement (sweep)

1: Start measurement (sweep)

Query

LD?

Response

LD□{ 0 | 1 }

0: Idling Status

1: Measuring Status

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idling	—
LD	√	√	–
LD?	√	√	–

√: Command is available

–: Command is not available

Example

```
>LD□1
<ANS0
>LD?
<LD□1
```

LOS2?

Description

Calculate the loss between X1 and X2.

Query

LOS2?□<X1 location>,<X2 location>

<X1 location>
m (meter) unit
Location of the X1 marker. This value is rounded off to the sampling location internally.

<X2 location>
m (meter) unit
Location of the X2 marker. This value is rounded off to the sampling location internally.

Response

LOS2□<Sampled X1 location>,<Sampled X2 location>,<Loss>

<Sampled X1 location>
m (meter) unit
X1 location of the nearest sampling position

<Sampled X2 location>
m (meter) unit
X2 location of the nearest sampling position

<Loss>
The unit is dB. 1 = 1 dB and the Value is output with three decimal places.
"***" is output if measurement is impossible.

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idling	—
LOS2?	√	√	–

√: Command is available
–: Command is not available

Example

```
>LOS2?□123.45,156.78
<LOS2□123.50,157.00,3.456
```

Sampling resolution: 0.50 (m)

MINF?

Description

Get OTDR Module information.

Query

MINF?

Response

MINF□<Maker>,<Model name>,<Comment>,<Serial number>,<MAC address>,<Software version>

<Maker>
Maker name
"Anritsu"

<Model name>
Model name
"MW9077A"

<Comment>
Comment
ex.: "41(dB)1310(nm)"

<Serial number>
Serial number
ex.: "SN6200000000"

<MAC address>
MAC address
ex.: "00-00-91-12-34-56"

<Software version>
Software version
ex.: "1.0"

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idling	—
MINF?	√	√	–

√: Command is available
–: Command is not available

Example

```
>MINF?
<MINF□Anritsu,MW9077A,41(dB)1310(nm),SN6200000001,
00-00-91-00-00-01,1.0
```

MKDR?

Description

Read the point position of start and end that are for calculating the loss.

Query

MKDR?

Response

MKDR□<Start point position>,<End point position>

<Start point position>
0 to 5000, 6250, 20000 or 25000
"***" is output if measurement is impossible.

<End point position>
The point position of the fiber-end event.
0 to 5000, 6250, 20000 or 25000
"***" is output if measurement is impossible.

Sampling point is always from 0.
If the relative distance is set by "OFS", start point position becomes there.
<Start point position>, <End point position> becomes invalid value ("****"), if the relative distance is set to over than the fiber end point position.

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idling	—
MKDR?	–	√	–

√: Command is available
–: Command is not available

Example

```
>MKDR?
<MKDR 321,2693
```

NET

Description

Set network parameters. The setting parameters are effective after the reset.

Command

NET□<IP address>,<Port number>,<Netmask>,<Gateway>

<IP address>
0.0.0.0 to 255.255.255.255 (except 0.0.0.0 and 255.255.255.255)

<Port number>
1024 to 65535

<Netmask>
0.0.0.0 to 255.255.255.255 (except 0.0.0.0 and 255.255.255.255)

<Gateway>
0.0.0.0 to 255.255.255.255
If Gateway is set 0.0.0.0 or 255.255.255.255, gateway is not used.

Query

NET?

Response

NET□<IP address>,<Port number>,<Netmask>,<Gateway>

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idling	—
NET	–	√	–
NET?	√	√	–

√: Command is available
–: Command is not available

Example

```
>NET□192.168.0.10,7232,255.255.255.0,192.168.0.1
<ANS0
>RST

>NET?
<NET□192.168.0.10,7232,255.255.255.0,192.168.0.1
```

OFS

Description

Set the relative distance. This value is corresponded to UOD (User Offset Distance) in SR-4731.

Command

OFS□<Relative distance>

<Relative distance>
Relative distance
This value is rounded off to the third decimal point in m (meter) unit.

Query

OFS?

Response

OFS□<Relative distance>

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idling	—
OFS	–	√	–
OFS?	√	√	–

√: Command is available
–: Command is not available

Example

```
>OFS□34.50
<ANS0
>OFS?
<OFS□34.50
```

REFLCT?

Description

Calculate the reflectance.

Query

REFLCT?□<Event location>,<Peak location>

<Event location>
m (meter) unit
Event location is corresponded to EPT (Event Propagation Time) in SR-4731. This value is rounded off to the sampling location internally.

<Peak location>
m (meter) unit
Location of the Peak marker. The peak marker corresponds to ML5 in SR-4731. This value is rounded off to the sampling location internally.

Response

REFLCT□<Sampled Event location>,<Sampled Peak location>,<Reflec-tance>

<Sampled Event location>
m (meter) unit
Event location of the nearest sampling position

<Sampled Peak location>
m (meter) unit
Peak location of the nearest sampling position

<Reflectance>
The first byte indicates the status of the reflectance as the following table:

1st byte	Reflectance
"<"	The reflectance value is saturated
"□" (space)	The reflectance value is not saturated

The unit is dB. 1 = 1 dB and the Value is output with three decimal places.
"***" is output if measurement is impossible.

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idling	—
REFLCT?	√	√	–

√: Command is available

–: Command is not available

Example

```
>REFLCT? 800.05,849.95
<REFLCT 800.00,850.00,-19.585
```

Sampling resolution: 1.00 (m)

RST

Description

Hardware reset (restart) of the OTDR Module. After the reset, OTDR Module does not send "ANS0" message.
TCP/IP connection is dis-connected, if TCP/IP port is in use.
After rebooting (it takes more than 15 seconds), re-connection is required for TCP/IP port.

Command

RST

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idling	—
RST	√	√	√

√: Command is available
–: Command is not available

Example

```
>RST
```

No response (No message is sent from OTDR.)
See Figure 3.4.1-2.

SETFILE

Description

Set SR-4731 data to OTDR. The waveform and setting parameters in the SR-4731 data are set to the OTDR.

Command

SETFILE□<Data>

<Data>
Binary data of the file specified to be sent.
First four-byte data indicate the file size.
The maximum data size accepted by OTDR is 200 KBytes.

ex.: When 11000 (0x00002AF8) byte file data sent:

1st byte	2nd byte	3rd byte	4th byte	5th byte	…	11004th byte
0x00	0x00	0x2A	0xF8	0x4D	…	0x00
File size (bytes)				Data		

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idling	—
SETFILE	–	√	–

√: Command is available
–: Command is not available

Example

```
>SETFILE□00000003010203 (Binary data)
```

SLFTST?

Description

Get the selftest results.
The OTDR always checks itself.
If the OTDR detects any troubles in itself, the OTDR notifies it by sending the error message "Ans 255" to the response of the 1st command just after the trouble detected.

Query

SLFTST?

Response

SLFTST□<Selftest result>

<Selftest result>

0: OK

1: Slight trouble. The OTDR operates normally.

2 to 65535: NG

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idling	—
SLFTST?	–	√	√

√: Command is available
–: Command is not available

Example

```
(When no trouble detected.)
>SLFTST?
<SLFTST□0

(When trouble detected.)
>LD□1
<ANS0
(A slight trouble here detected.)
>STATUS?
<STATUS□1
(A trouble here detected.)
>STATUS? (1st command after a trouble detected.)
<ANS255
>SLFTST?
<SLFTST□16
```

SMPINF?

Description

Get the sampling information (Sampling points and Sampling resolution).

Query

SMPINF?

Response

SMPINF□<Sampling points>,<Sampling resolution>

<Sampling points>
5001: 5001 (points)

6251: 6251 (points)

20001: 20001 (points)

25001: 25001 (points)

The response is "***" when the Sampling points is invalid (not decided).

<Sampling resolution>
m (meter) unit
The response is "***" when the Sampling points is invalid (not decided).

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idling	—
SMPINF?	√	√	–

√: Command is available
–: Command is not available

Example

```
>SMPINF?
<SMPINF□5001,1.00
>STP□1,0,1,0,1
<ANS0
>SMPINF?
<SMPINF□***,***
>LD□1
<ANS0
>SMPINF?
<SMPINF□20001,0.50
```

Sampling points: 5001 (points)
Sampling resolution: 1.00 (m)

Distance range mode: Auto setting
Pulse width mode: Auto setting
Sampling mode: Fine

If Distance range mode is Auto setting, Sampling points and Sampling resolution are invalid before the measurement.

Sampling points: 20001 (points)
Sampling resolution: 0.50 (m)

SPLICE?

Description

Calculate the splice loss.

Query

SPLICE?□<Event location>,<X1 location>,<X2 location>,<X3 location>,<X4 location>

<Event location>
m (meter) unit
Event location corresponds to EPT (Event Propagation Time) in SR-4731. This value is rounded off to the sampling location internally.

<X1 location>
m (meter) unit
Location of the X1 marker. The X1 corresponds to ML1 in SR-4731. This value is rounded off to the sampling location internally.

<X2 location>
m (meter) unit
Location of the X2 marker. The X2 corresponds to ML2 in SR-4731. This value is rounded off to the sampling location internally.

<X3 location>
m (meter) unit
Location of the X3 marker. The X3 corresponds to ML3 in SR-4731. This value is rounded off to the sampling location internally.

<X4 location>
m (meter) unit
Location of the X4 marker. The X4 corresponds to ML4 in SR-4731. This value is rounded off to the sampling location internally.

Response

SPLICE□<Sampled Event location>,<Sampled X1 location>,<Sampled X2 location>,<Sampled X3 location>,<Sampled X4 location>,<Splice loss>

<Sampled Event location>
m (meter) unit
Event location of the nearest sampling position

<Sampled X1 location>
m (meter) unit
X1 location of the nearest sampling position

<Sampled X2 location>
m (meter) unit
X2 location of the nearest sampling position

<Sampled X3 location>
m (meter) unit
X3 location of the nearest sampling position

<Sampled X4 location>
m (meter) unit
X4 location of the nearest sampling position

<Splice loss>
The unit is dB. 1 = 1 dB and the value is output with three decimal places.
"***" is output when the value of Splice loss is under –99.999 (dB) or over 99.999 (dB).

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idling	—
SPLICE?	√	√	–

√: Command is available
–: Command is not available

Example

```
>SPLICE?□100.00,90.00,96.10,110.50,120.15
<SPLICE□100.00,90.00,96.00,110.50,120.00,13.456
```

Sampling resolution: 0.50 (m)

SRLV

Description

Set the SR-4731 level.

Command

SRLV□{ 1 | 2 | 3 }

1: Level I .... Only key event data block is stored.

2: Level II ... Only trace data is stored in the data point block.

3: Level III .. Both key event data block and data point block information are stored.

Query

SRLV?

Response

SRLV□{ 1 | 2 | 3 }

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idling	—
SRLV	–	√	–
SRLV?	√	√	–

√: Command is available

–: Command is not available

Example

```
>SRLV□3
<ANS0
>SRLV?
<SRLV□3
```

STATUS?

Description

Read the status of OTDR Module.

Query

STATUS?

Response

STATUS□{ 0 | 1 }

0: Idling (Not measuring)

1: Measuring

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idling	—
STATUS?	√	√	–

√: Command is available

–: Command is not available

Example

```
>STATUS?
<STATUS□0

>LD□1
<ANS0
>STATUS?
<STATUS□1
```

STP

Description

Set measurement parameters. (Distance range, pulse width and sampling mode parameters)

Command

STP□<Distance range mode>,<Distance range>,<Pulse width mode>,<Pul-se width>,<Sampling mode>

<Distance range mode>

0: Manual setting

1: Auto setting

<Distance range>

If Distance range mode is Auto setting, this variable should be any following value or zero:

5000: 5 (km)

10000: 10 (km)

25000: 25 (km)

50000: 50 (km)

100000: 100 (km)

200000: 200 (km)

250000: 250 (km)

400000: 400 (km)

The response is "***" when the Distance range mode is Auto setting and Distance range is invalid.

<Pulse width mode>

0: Manual setting

1: Auto setting

<Pulse width>

If Pulse width mode is Auto setting, this variable should be any following value or zero:

10: 10 (ns)

30: 30 (ns)

100: 100 (ns)

300: 300 (ns)

1000: 1 (us)

3000: 3 (us)

10000: 10 (us)

20000: 20 (us)

The response is "***" when the Pulse width mode is Auto setting and Pulse width is invalid.

<Sampling mode>

0: Normal

1: Fine

Query

STP?

Response

STP□<Distance range mode>,<Distance range>,<Pulse width mode>,<Pul-se width>,<Sampling mode>

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idling	—
STP	–	√	–
STP?	√	√	–

√: Command is available

–: Command is not available

Example

```
>STP□0,5000,0,10,0
<ANS0
>STP?
<STP□0,5000,0,10,0
```

Distance range mode: Manual setting
Distance range: 5 (km)
Pulse width mode: Manual setting
Pulse width: 10 (ns)
Sampling mode: Normal

```
>STP□1,0,1,10,1
<ANS0
```

Distance range mode: Auto setting
Pulse width mode: Auto setting
Sampling mode: Fine

```
>STP?
<STP□1,***,1,***,1
```

If Distance range mode or Pulse width mode is Auto setting, the Distance range or Pulse width is invalid before the measurement.

```
>LD□1
<ANS0
>STP?
<STP□1,10000,1,30,1
```

Distance range mode: Auto setting
Distance range: 10 (km)
Pulse width mode: Auto setting
Pulse width: 30 (ns)
Sampling mode: Fine

THF

Description

Set Fiber-end threshold value.

Command

THF□<Threshold>

<Threshold>
dB unit
The setting range is 1 to 99 dB. (1 dB step)

Query

THF?

Response

THF□<Threshold>

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idling	—
THF	–	√	–
THF?	√	√	–

√: Command is available
–: Command is not available

Example

```
>THF□20
<ANS0
>THF?
<THF□20
```

THR2

Description

Set Reflectance threshold value.

Command

THR2□<Threshold>

<Threshold>
dB unit
The setting range is –14.0 to –70.0 dB. (0.1 dB step)

Query

THR2?

Response

THR2□<Threshold>

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idling	—
THR2	–	√	–
THR2?	√	√	–

√: Command is available
–: Command is not available

Example

```
>THR2□-26.8
<ANS0
>THR2?
<THR2□-26.8
```

THS

Description

Set Splice loss threshold value.

Command

THS□<Threshold>

<Threshold>
dB unit
The setting range is 0.01 to 9.99 dB. (0.01 dB step)

Query

THS?

Response

THS□<Threshold>

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idling	—
THS	–	√	–
THS?	√	√	–

√: Command is available
–: Command is not available

Example

```
>THS□2.46
<ANS0
>THS?
<THS□2.46
```

TLOS?

Description

Calculate the Total loss.

Command

TLOS?□<X1 location>,<X2 location>

<X1 location>
m (meter) unit
Location of the X1 marker. This location is used as the reference level location for calculating the total loss.

<X2 location>
m (meter) unit
Location of the X2 marker. This location is used as the calculated location for the total loss.

Response

TLOS□<Sampled X1 location>,<Sampled X2 location>,<Total loss>

<Sampled X1 location>
m (meter) unit
X1 location of the nearest sampling position

<Sampled X2 location>
m (meter) unit
X2 location of the nearest sampling position

<Total loss>
The unit is dB. 1 = 1 dB and the Value is output with three decimal places.
"***" is output if measurement is impossible.

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idling	—
TLOS?	–	√	–

√: Command is available
–: Command is not available

Example

```
>TLOS?□10.20,1234.25
<TLOS□10.00,1234.00,8.123
```

Sampling resolution: 1.00 (m)

WAV?

Description

Read existence of waveform data during OTDR measurement.

Query

WAV?

Response

WAV□{ 0 | 1 }

0: No waveform data

1: Waveform data exists.

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idling	—
WAV?	√	√	–

√: Command is available

–: Command is not available

Example

```
>WAV?
<WAV□0

>LD□1
>WAV?
<WAV□1
```

WLS

Description

Select wavelength.

Command

WLS□<Wavelength>

<Wavelength>
um unit (Numeric value rounded to three decimal points.)

Query

WLS?

Response

WLS□<Wavelength>

Dependency

Mode	OTDR mode		Download mode
Status / Command	Measuring	Idling	—
WLS	–	√	–
WLS?	√	√	–

√: Command is available
–: Command is not available

Example

```
>WLS□1.310
<ANS0
>WLS?
<WLS□1.310
```

Chapter 5 Sample Sequences

This section shows sample sequences about using commands and queries of the OTDR Module (hereafter “OTDR”).

5.1 Sample Sequences

5.1.1 Sequence overview

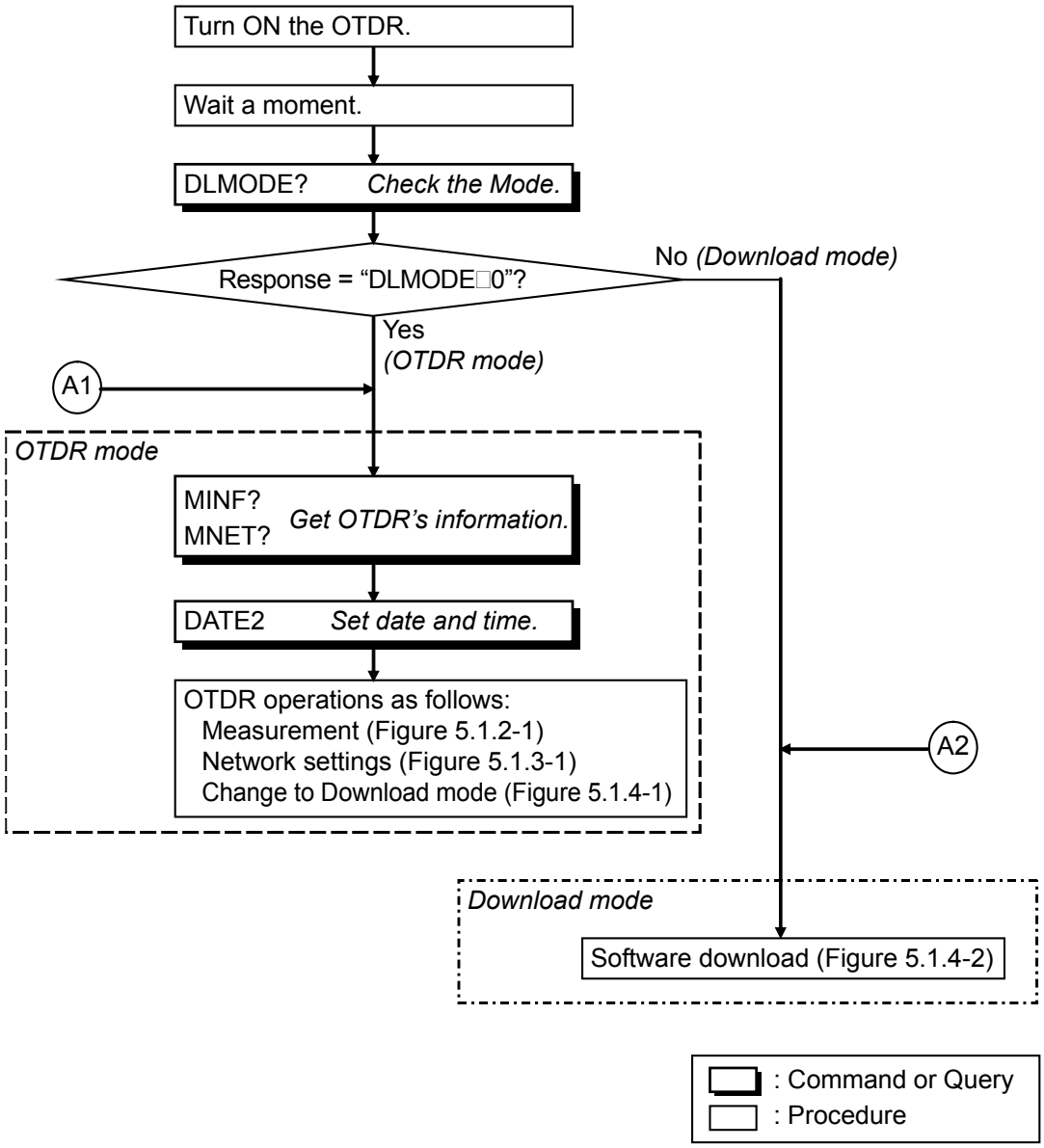


Figure 5.1.1-1 Sequence Overview

5.1.2 Measurement

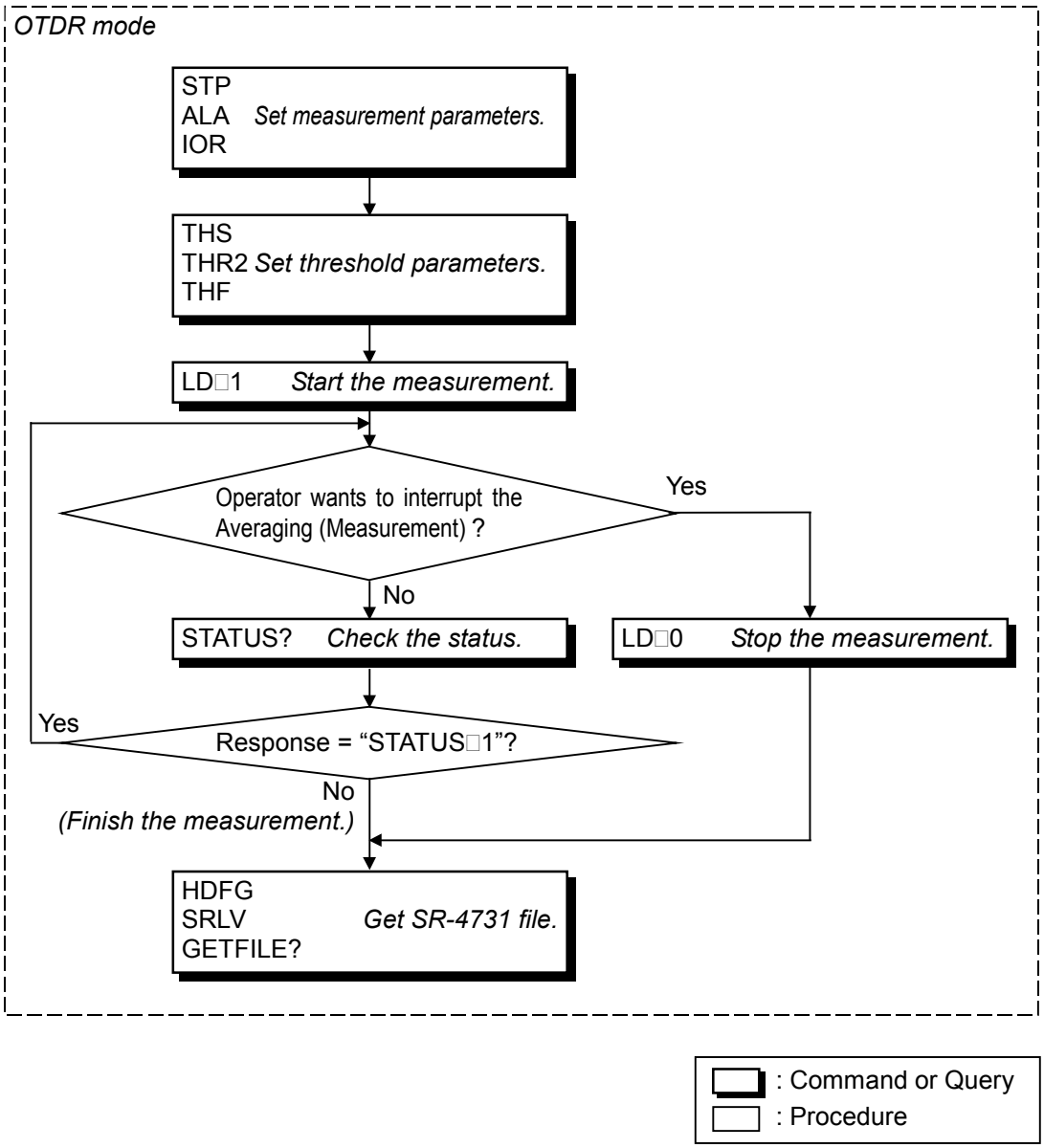


Figure 5.1.2-1 Sample sequence of the measurement

5.1.3 Change the network parameters

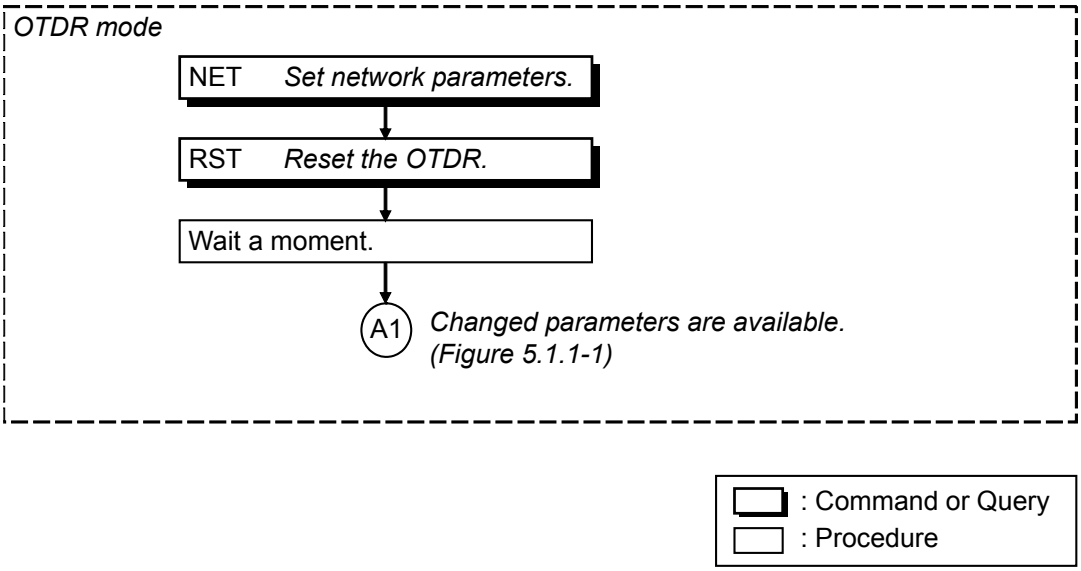


Figure 5.1.3-1 Sample sequence of changing the network parameters

5.1.4 Software download

When operator want to download the software to OTDR, the following two steps are needed, if the current mode is OTDR mode. If the current mode is Download mode, only Step 2 is needed.

Step 1. Change to Download mode (Figure 5.1.4-1).

Step 2. Software download (Figure 5.1.4-2).

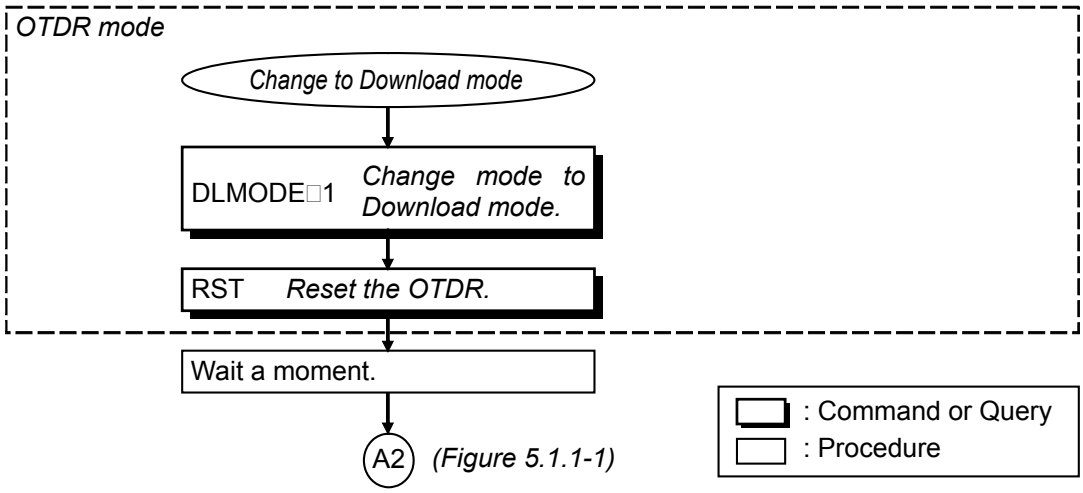


Figure 5.1.4-1 Sample sequence of changing the Mode

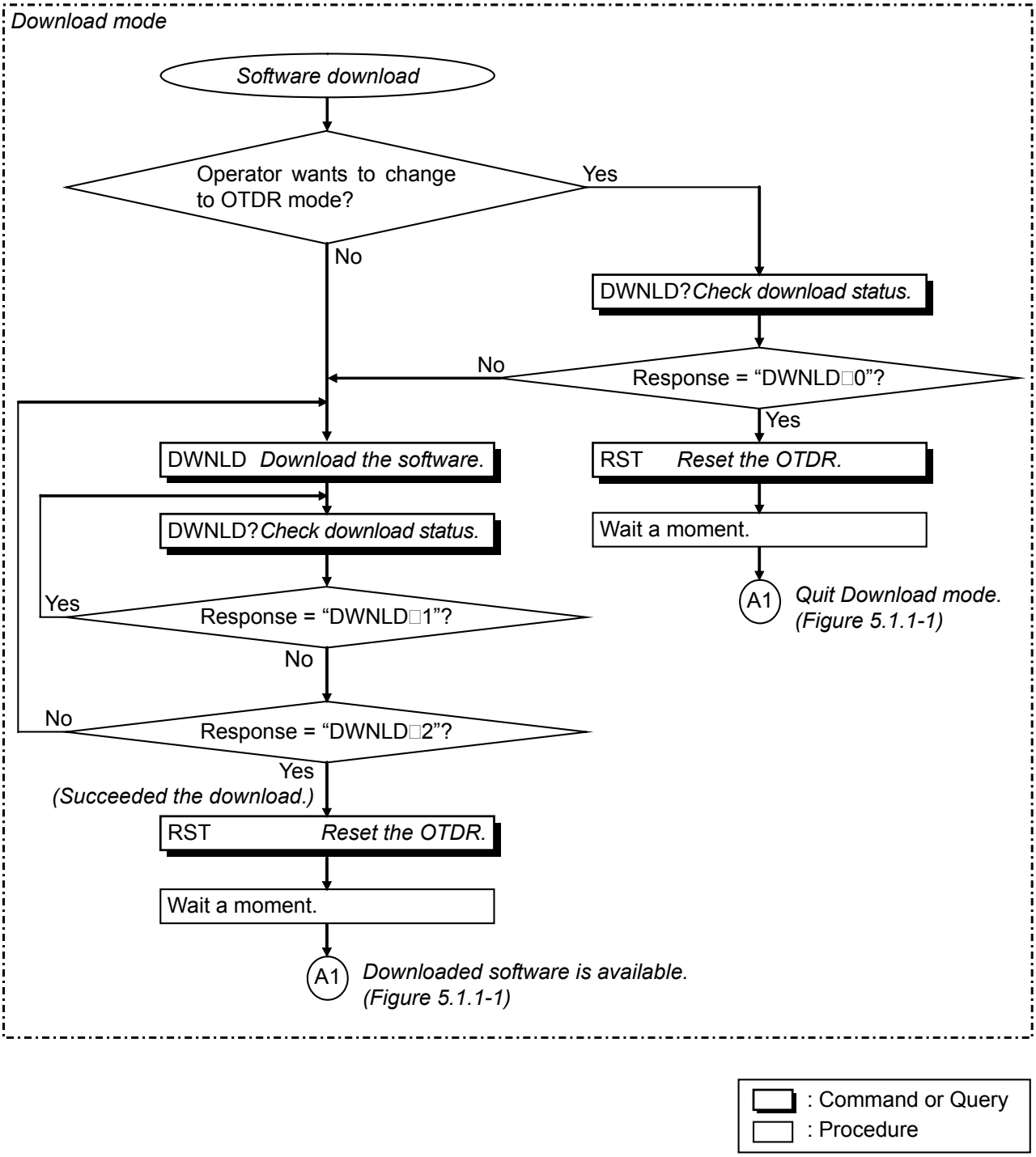


Figure 5.1.4-2 Sample sequence of software download

Chapter 6 Performance Test and Calibration

This section explains how to check the performance of the OTDR Module and how to calibrate the measured values.

Contact Anritsu Corporation or your nearest service representative if the performance test described in this section reveals that the system does not conform to specifications.

Provide the following data in advance when requesting repairs.

(1) Model name, and instrument serial number affixed at the bottom of the machine.

(2) Failure details

(3) Name and telephone number of the person in charge whom Anritsu can contact for the detail of the failure or report the completion of repair.

⚠ WARNING

NEVER look directry into the optical connector of the OTDR or the end of the optical cable connected to the OTDR as the laser light can injure your eye.
Procedures other than those specified herein may result in hazardous radiation exposure.

⚠ CAUTION

The OTDR Module outputs high-power optical pulses. Disconnect the communication equipments from the optical fibers before a measurement, or the optical sensor of the equipment may be broken.

6.1 Performance Test

The following 5 items should be tested to check the performance of the OTDR.

1. Wavelength
2. Pulse width
3. Dynamic range
4. Distance measurement accuracy
5. Loss measurement accuracy (Linearity)

Specification values of test items

The following specification values are guaranteed at a temperature of 25±5°C.

1. MW9077A

Item	Specification value								Remarks
Wavelength	1310 ±25 nm								Pulse width: 1 µs
Pulse width	10 ns ±30% 30 ns ±25% 100 ns ±10% 300 ns ±10% 1 µs ±10% 3 µs ±10% 10 µs ±10% 20 µs ±10%								
Dynamic range (dB)	10 ns	30 ns	100 ns	300 ns	1 µs	3 µs	10 µs	20 µs	Noise peak
	7.4	10.3	12.9	19.8	22.9	25.3	35.9	38.4	
Distance measurement accuracy	±1 m ±3×10^{-5}×measurement distance ±sampling space (excluding uncertainty caused by fiber IOR)								
Loss measurement accuracy (Linearity)	±0.05 dB/dB or ±0.1 dB (whichever is greater)								
Wavelength	1550 ±25 nm								Pulse width: 1 µs

2. MW9077A1

Item	Specification value								Remarks
Pulse width	10 ns ±30% 30 ns ±25% 100 ns ±10% 300 ns ±10% 1 µs ±10% 3 µs ±10% 10 µs ±10% 20 µs ±10%								
Dynamic range (dB)	10 ns	30 ns	100 ns	300 ns	1 µs	3 µs	10 µs	20 µs	Noise peak
	6.4	9.3	11.9	18.8	21.9	24.3	34.9	37.4	
Distance measurement accuracy	±1 m ±3×10^{-5}×measurement distance ±sampling space (excluding uncertainty caused by fiber IOR)								
Loss measurement accuracy (Linearity)	±0.05 dB/dB or ±0.1 dB (whichever is greater)								

Measuring Instruments and Optical Fibers Required for Performance Test

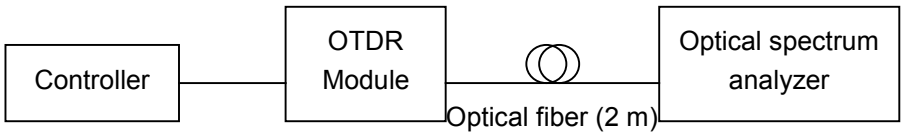
Test item	Wavelength	Pulse width	Dynamic range	Distance measurement accuracy	Loss measurement accuracy
Optical spectrum analyzer MS9710C Wavelength: 1.2 to 1.6 µm Level: –6.5 to +20 dBm	√				
Optical variable attenuator MN9625A Wavelength: 1.31/1.55 µm Attenuation: 60 dB or more		√	√		√
Waveform monitor Wavelength: 1.2 to 1.6 µm Rise/Fall: 500 ps or less		√			
LD light source MT9810B+MU951501A Wavelength: 1.55 µm			√		
Oscilloscope DC 200 MHz		√			
SM Optical fiber (75 km)			√		
SM Optical fiber (2 km)				√	
SM Optical fiber (2 m)	√	√			
Optical fiber coupler (3 dB)			√		
1310 nm cut optical filter Insertion loss: ≥40 dB (1310 ±25 nm) ≤3 dB (1550 nm)			√ (Only for option 01)		

6.1.1 Wavelength

This test measures the center wavelength of the laser output light and checks that it meets the specification.

Setup

Connect the OTDR Module as shown in the figure below.



Test procedure

(1) Set the distance range to 50 km, pulse width to 1000 ns and average limit to 300 sec with the OTDR Module.

(2) Start the OTDR measurement and input the laser light into the optical spectrum analyzer, then adjust its measurement level and wavelength resolution. Use variable optical attenuator if optical spectrum analyzer is saturated because of the high input power of the OTDR.

(3) Select the RMS method on the optical spectrum analyzer.

(4) Check that the measurement result is within specification values.

Related command

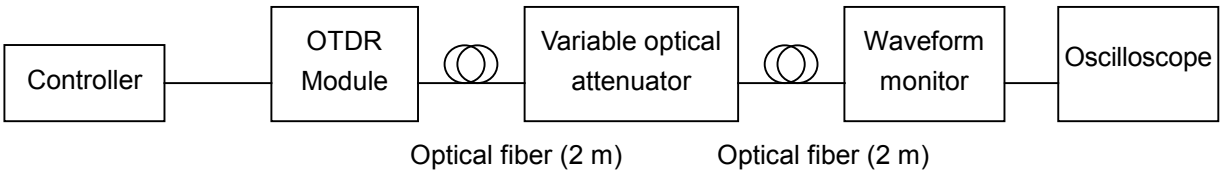
ALA, STP, LD

6.1.2 Pulse width

This test measures the pulse width of the OTDR output pulse and checks that it meets the specification.

Setup

Connect the OTDR Module as shown in the figure below.



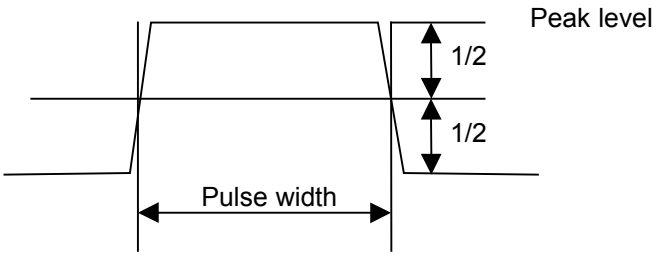
Test procedure

(1) Set the pulse width to be measured and average limit to 300 sec.

(2) Start the OTDR measurement.

(3) Adjust the oscilloscope amplitude and time axis scale to display the waveform on the oscilloscope. Adjust the variable optical attenuator so that the waveform monitor is not saturated.

(4) Observe the waveform on the oscilloscope and measure the pulse width at an amplitude half its maximum value as shown in the figure below and check that the measurement result is within specification values.



Related command

ALA, STP, LD

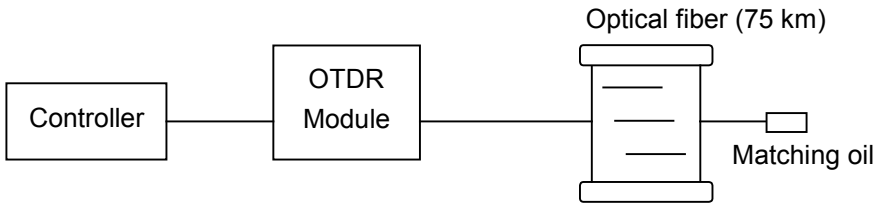
6.1.3 Dynamic range (one-way back-scattered light dynamic range)

This test checks if the dynamic range conforms to specifications. This test is performed for each pulse width.

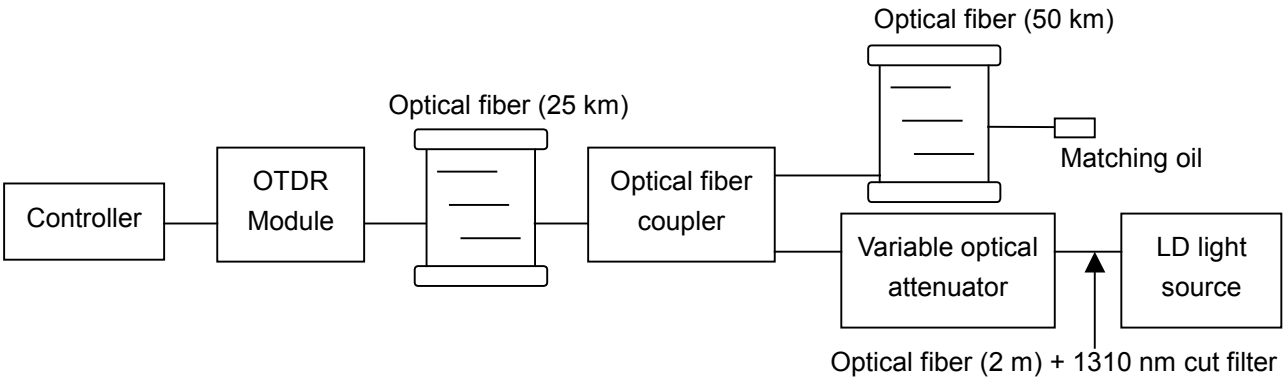
Setup

Connect the OTDR Module as shown in the figure below.

(a) When MW9077A-01 (Opt 01) is "not" installed.



(b) When MW9077A-01 (Opt 01, 1550 nm filter) is installed and measuring pulse width is 20 μs.



Test procedure

(1) Set the distance range to 100 km, the attenuator to Auto, average limit value to 180 sec and the pulse width to be measured.

(2) Start the OTDR measurement.

(3) After averaging is completed, read the following value from the results.
Difference between the level at the near-end of the optical connector in the OTDR Module and the peak level of floor noise.

(4) Check that the level difference conforms to the specification set for each pulse width.

(5) When MW9077A-01 is installed and measuring with pulse width 20 μs, input 1550 nm CW-light by use of the optical fiber coupler (see figure above) and check the level difference conforms to the specification. Adjust the input power of the LD light source to be –20 dBm. When calculating the difference, be sure to consider the loss of the optical fiber coupler.

Related command

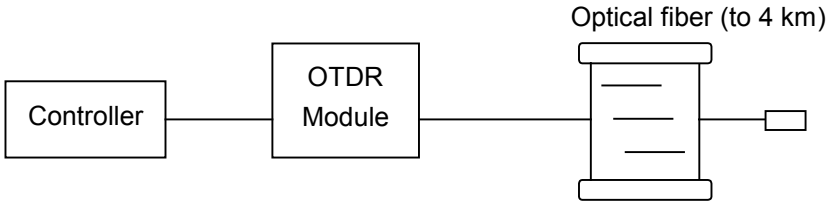
ALA, STP, LD, DAT?

6.1.4 Distance measurement accuracy

This test checks the accuracy of the measured distance, by making a measurement on an optical fiber whose fiber length and IOR are known. This test needs to be performed only at one distance range.

Setup

Connect the OTDR Module as shown in the figure below.



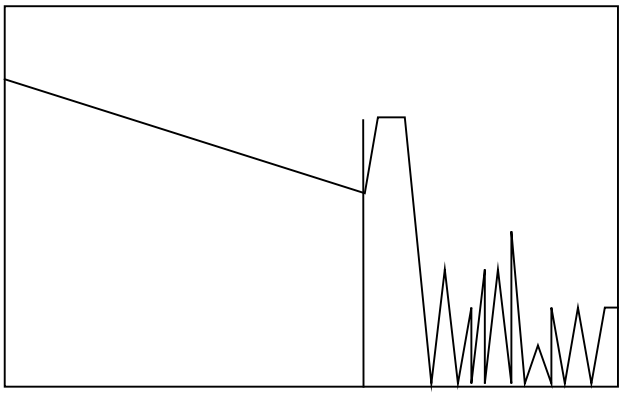
Test procedure

(1) Set the distance range to 5 km, IOR (index of refraction) and the pulse width to be measured.

(2) Start the OTDR measurement.

(3) Read the absolute distance precisely at the rising edge of the Fresnel reflection of the far-end of the optical fiber.

(4) Check that this value conforms to the specifications.



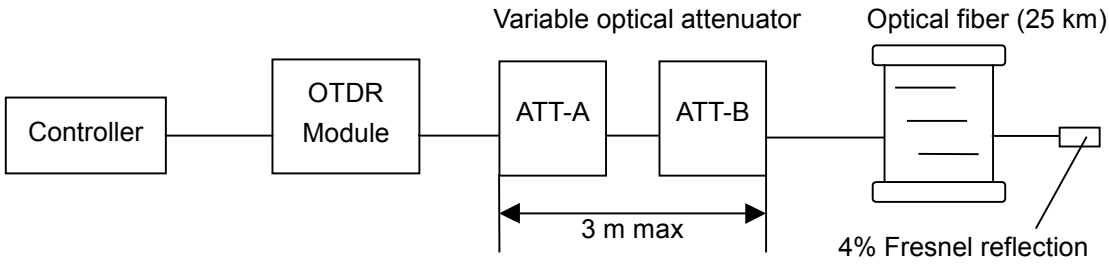
Related command

ALA, STP, IOR, LD, DAT?

6.1.5 Loss measurement accuracy (Linearity)

This test checks the accuracy of the loss measurement.
There are 2 procedures for test.

Setup 1.
Connect the OTDR Module as shown in the figure below.
This case is for users who cannot prepare the fibers which are calibrated for the linearity.



Test procedure

(1) Set the pulse width to 100 ns.

(2) Start the OTDR measurement.

(3) Set ATT-B to 0 dB, and then adjust ATT-A so that the far-end Fresnel reflection peak is slightly below the saturation level (within 0.2 dB).

(4) Read the level of the Fresnel reflection and define this value as PL_0.

(5) Set ATT-B to 2 dB and measure the level of Fresnel reflection. Define this value as PH_0.

(6) Return ATT-B to 0 dB and increase the attenuation of ATT-A by 1 dB and measure the level of Fresnel reflection. Define this value as PL_1.

(7) Set ATT-B to 2 dB and measure the level of Fresnel reflection. Define this value as PH_1.

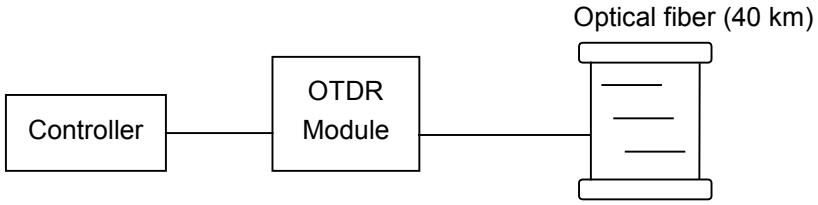
(8) Increase the attenuation of ATT-A by 1 dB step up to 15 dB to measure PL_i and PH_i at each step.

(9) Obtain the loss measurement accuracy at each ATT-A setting using the following formula and check that they conforms to the specifications.
Loss measurement accuracy = $\{(PL_i - PH_i) - \Delta A\}/\Delta A$
where, ΔA is the defference between ATT-B settings at 0 dB and 2 dB (calibrated in advance).

Related command
ALA, STP, LD, DAT?

Setup 2.

Connect the OTDR Module as shown in the figure below.
This case is for users who can prepare the fibers which are calibrated for the linearity.



Test procedure

(1) Set the pulse width to 100 ns and the wavelength to 1.31 μm.

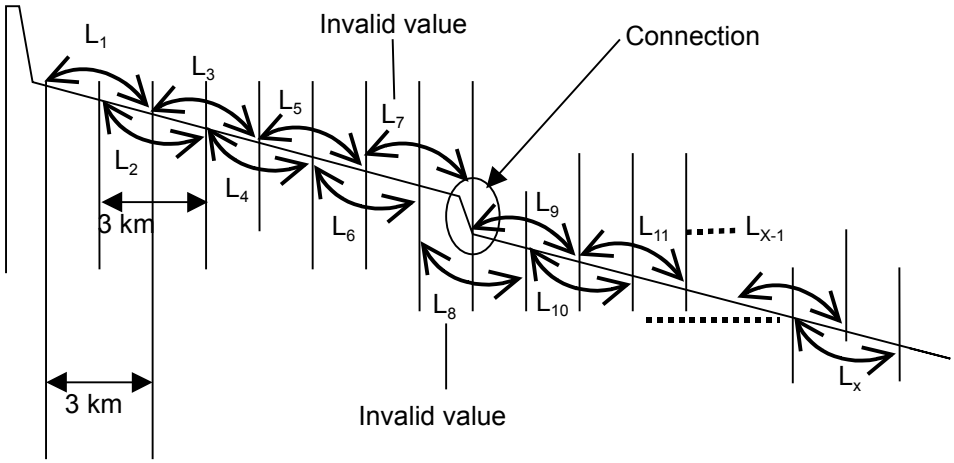
(2) Start the OTDR measurement.

(3) Measure the loss (L_x) of the fiber by 3 km through 30 km, and calculate the average (L_{ave_m}) of them. When calculating the average, be sure to calculate for each different fiber.

(4) Calculate the difference (L_{diff_n}) between L_x and L_{ave_m} (L_x -L_{ave_m}).

(5) Check that the difference (L_{diff_n}) is smaller than ±0.1 dB.

ex. When 2 fibers (20 km×2) are connected.



$L_{ave\_1} = (L_1 + L_2 + L_3 + L_4 + L_5 + L_6)/6$
$L_{diff\_1} = (L_1 – L_{ave\_1})$, $L_{diff\_2} = (L_2 – L_{ave\_1})$, ·····$L_{diff\_6} = (L_6 – L_{ave\_1})$

$L_{ave\_2} = (L_9 + L_{10} + L_{11} + ···· + L_x)/(x – 9 + 1)$
$L_{diff\_9} = (L_9 – L_{ave\_2})$, $L_{diff\_10} = (L_{10} – L_{ave\_2})$, ·····$L_{diff\_x} = (L_x – L_{ave\_2})$

Check whether ($L_{diff\_n} \leq \pm 0.1$ dB) or not.

Related command

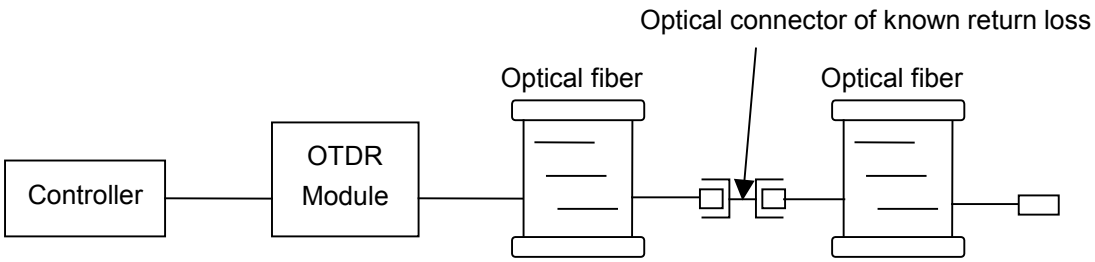
ALA, STP, LD, DAT?

6.2 Calibration

Only the back-scattered level can be calibrated using the OTDR.
This calibration is needed only when user wants to fit the return loss to the known value.

Setup

Prepare an optical connector with a known return loss R_0 dB and connect the OTDR as shown in the figure below.



Calibration procedure

(1) Set backscatter level to 0 dB, pulse width to 100 ns.

(2) Start the OTDR measurement.

(3) After the measurement is completed, set the linear approximation method to LSA and measure the return loss of the known connector. Define this value as R_1 dB.

(4) Obtain the difference between R_1 and R_0 (R_1–R_0) and set this value as backscatter level.

(5) Calibration is completed when the measured return loss at the connector becomes equal to R_0.

Related command

ALA, STP, APR, BSL2, LD, EVN2?, DAT?

6.3 Performance Test Result Record Form

Test location: _____ Report No.: _____

_____ Date: _____

_____ Tested by: _____

Unit name: _____

Serial No.: _____

Ambient temperature: _____ °C

Relative humidity: _____ %

Remarks: _____

_____

_____

_____

_____

MW9077A/A1 OTDR Module

Test item		Specification		Result		Remarks
Wavelength	1310 nm	±25 nm				Pulse width: 1 μs
	1550 nm	±25 nm				Pulse width: 1 μs
Pulse width	10 ns	10 ns ±30%				
	30 ns	30 ns ±25%				
	100 ns	100 ns ±10%				
	300 ns	300 ns ±10%				
	1 μs	1 μs ±10%				
	3 μs	3 μs ±10%				
	10 μs	10 μs ±10%				
	20 μs	20 μs ±10%				
Dynamic range (dB)	Wavelength	1310 nm	1550 nm	1310 nm	1550 nm	
	10 ns	7.4	6.4			
	30 ns	10.3	9.3			
	100 ns	12.9	11.9			
	300 ns	19.8	18.8			
	1 μs	22.9	21.9			
	3 μs	25.3	24.3			
	10 μs	35.9	34.9			
	20 μs	38.4	37.4			
Distance measurement accuracy	±1 m ±3 × 10^{-5} × measurement distance ±sampling space (excluding uncertainty caused by fiber IOR)					
Loss measurement accuracy	±0.05 dB/dB or ±0.1 dB (whichever is greater)					

Chapter 7 Maintenance

This section explains how to clean the OTDR Module to maintain its performance, as well as the suggestions for storage and transportation.

7.1 Optical Connector & Optical Adapter Cleaning

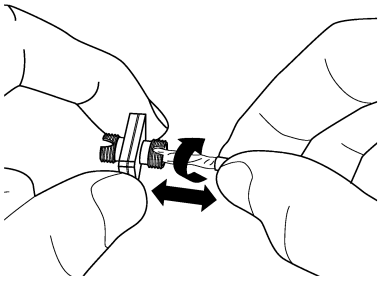
Cleaning built-in ferrule end-face

Use adapter cleaner supplied for this module to clean the built-in optical I/O connector ferrule. Clean the ferrule periodically.

Cleaning optical adapter

Use adapter cleaner supplied for this module to clean the optical adapter for connection to the fiber-optic cable. An example of the FC adapter is described below. Follow similar methods and steps for cleaning other adapters. In addition, clean the adapter which was removed to clean the built-in ferrule end-face using the following steps.

Insert the adapter cleaner to the split sleeve interior of the adapter then move it back and forth while rotating it in one direction.



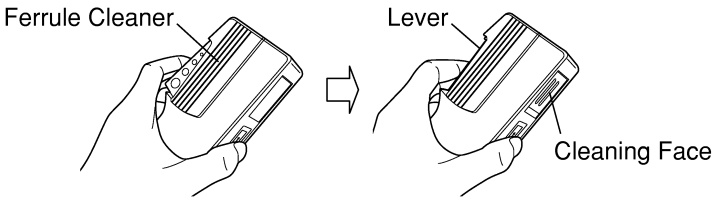
Note:

Check the ferrule radius. Use only a ϕ1.25 mm or ϕ2.5 mm dedicated adapter cleaner.

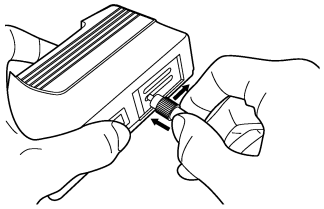
Cleaning the ferrule end-face of the fiber-optic cable

Use ferrule cleaner supplied for this module to clean the ferrule of the cable end. An example of the FC connector is described below. Follow similar methods and steps for cleaning other connectors.

(1) Lift the ferrule cleaner lever to access the cleaning face.



(2) Keep the lever in this position then press down the ferrule end-face of the optical connector on the cleaning face and rub in one direction.



Notes on cleaning

(1) Do not clean with used adapter cleaner.

(2) Do not finish clean with a cotton swab as cotton fibers may adhere to the surface.

(3) Make sure to cap adapters that are not in use.

⚠ WARNING

Ensure that no light is emitted when cleaning or checking the ferrule end-face.

⚠ CAUTION

Performance may be degraded if used when dust or dirt is adhering to the ferrule end-face. In addition, the connected fiber-optic cable & ferrule end-face of this module may burn out if high-output light is used in this state. Clean the connected fiber-optic cable and ferrule end-face of this module before performing measurements.

7.2 Suggestions for Storage

The following points should be kept in mind if the module is not to be used for a long period of time.

(1) Store the module after removing the dust on it.

(2) Do not store the module at a place where the temperature in greater than 60°C or less than –20°C, or where the humidity is greater than 85%.

(3) Do not store the module in a place where it is exposed to direct sunlight or dust.

(4) Do not store the module in a place where there is a possibility of condensation or erosion by active gas.

(5) Do not store the module in the place where there is a possibility of oxidization or strong vibrations.

(6) It is recommended that the battery pack is removed from the module.

Recommended conditions for storage

It is recommended that the module be stored in a place which satisfies the above requirements and the conditions below.

(1) Temperature: from 5 to 30°C

(2) Humidity: from 40 to 75%

(3) Where the changes in temperature and humidity within one day are not large.

7.3 Method of Transportation

To transport this module, repack it using the packing materials used at the time of purchasing. If the packing materials have not been kept, repack it as indicated in step (3) and (4) below.
The repackaging procedure is as follows.

(1) Clean the module surface with a dry cloth.

(2) Check that the screws are tight.

(3) Cover the projections and portions which can be easily deformed, and wrap this module in a polyester sheet.

(4) Place the wrapped module into a corrugated paper box and seal the box with an adhesive tape. Then, insert this into a wooden box suitable for long-distance transportation.

7.4 Disposal

Follow the instructions of your local waste disposal office when disposing of theOTDR Module.

(1) OTDR Module (MW9077A/A1)

Items	Specifications	Remarks
Model name/Unit name	MW9077A/A1 OTDR Module	
Wavelength	1310 ±25 nm (MW9077A) 1550 ±25 nm (MW9077A1)	at 25°C Pulse width: 1 µs
Fiber under test	10/125 µm SMF (ITU-T G.652)	
Optical connector	LC: Option 33 SC: Option 40	Fixed PC type (Factory option)
	FC: Option 37 ST: Option 38 DIN: Option 39 HMS-10/A: Option 43	PC type
	FC-APC: Option 25 SC-APC: Option 26 HRL-10: Option 47	APC type (Factory option)
Automatic measurement Measurement items Threshold value Splice loss Return loss Reflectance Far end of fiber Detected events Auto setting	 Total loss. Distance, splice loss, return loss and reflectance of each event (Table form). 0.01 to 9.99 dB (0.01 dB step) 20 to 60 dB (0.1 dB step) –14 to –70 dB (0.1 dB step) 1 to 99 dB (1 dB step) Up to 99 Distance range, pulse width and number (or time) of averaging.	*1
Manual measurement Measurement items Real time sweeping	 Loss and distance between any two points, splice loss, return loss or reflectance. Sweeping time: 0.1 to 0.2 seconds or less.	 *2
Distance range	5/10/25/50/100/200/250/400 km	IOR=1.500000
Maximum output power	≤+20 dBm	
Pulse width	10 ns ±30% 30 ns ±25% 100 ns ±10% 300 ns ±10% 1 µs ±10% 3 µs ±10% 10 µs ±10% 20 µs ±10%	

Items		Specifications	Remarks
Dynamic range		MW9077A ≥41 dB ≥39 dB MW9077A1 ≥40 dB ≥38 dB	 at 25°C, 20 µs at –5 to +55°C (SNR=1) at 25°C, 20 µs at –5 to +55°C (SNR=1)
Deadzone (Back-scattered light)		≤20 m	Pulse width: 10 ns
Deadzone (Fresnel reflection)		≤5 m	Pulse width: 10 ns Return loss: ≤35 dB
Marker resolution		0.05 to 800 m	IOR=1.500000
Sampling resolution		0.05 to 80 m	IOR=1.500000
Sampling points		Normal mode: 5001, 6251 Fine mode: 20001, 25001	*3
IOR setting		1.400000 to 1.699999 (0.000001 step)	
Distance measurement accuracy		±1 m ±3 × 10^{-5} × measurement distance ±sampling space (excluding uncertainty caused by fiber IOR)	
Loss measurement accuracy (Linearity)		±0.05 dB/dB or ±0.1 dB (whichever is greater)	
Return loss measurement accuracy		±2 dB	
Optical filter		Includes 1500 to 1625 nm cut optical filter. Operates normally when there is an optical power inputs under –20 dBm.	Option 01: only for MW9077A
Damp proofing		General specifications and environmental conditions remain the same as MW9077A/A1.	Option 03
Other functions		Relative distance setting (zero cursor set). Calender and clock (no battery backup). Distance unit setting (fixed to m).	
Laser safety specification		21CFR Class I, IEC 60825-1:2007 Class 1	
Power supply		+12 Vdc ±1 V, 1.5 A max	
Interface		Serial interface RS-232C: 115.2 kbps max Ethernet 10 Mbps	
Size		200×130×25 mm	
Environmental condition Operating temperature Humidity Storage temperature Vibration		 –5 to +55°C, ≤95% (no condensation) –40 to +70°C Conforms to MIL-T-28800E Class 3	
EMC	Emission	EN 61326-1 (Class A)	
	Immunity	EN 61326-1 (Table 2)	

*1 While automatic measurement is a supporting function which enables to operate easier, it doesn't assure the measured results. As there is a case of miss detection, check the waveform as well.

*2 Sweeping times in OTDR. Limitted by the interface with a controller and a software to read out. Waveform is displayed on a monitor of the controller.

*3 Either value is automatically selected in each mode, depending on the distance range.

(2) 1550 nm filter (MW9077A-01)

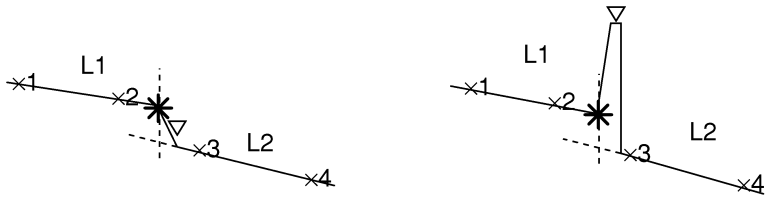
Item	Specifications	Remarks
Filter characteristics	Insersion loss ≥55 dB (1500 to 1650 nm) ≤0.8 dB (1310 ±25 nm) Return loss ≥50 dB	

(3) Peripherals and parts

Item	Specifications	Model name
MW9077A/A1/B Operation manual		W2254AE
Replaceable FC optical connector		J0617B
Replaceable ST optical connector		J0618D
Replaceable DIN optical connector		J0618E
Replaceable HMS-10/A optical connector		J0618F
Replaceable SC optical connector		J0619B
Ferrule cleaner		Z0282
Replacement reel for ferrule cleaner	For Ferrule cleaner (6 pcs/set)	Z0283
Cleaner for optical adapter	Stick type (200/set)	Z0284

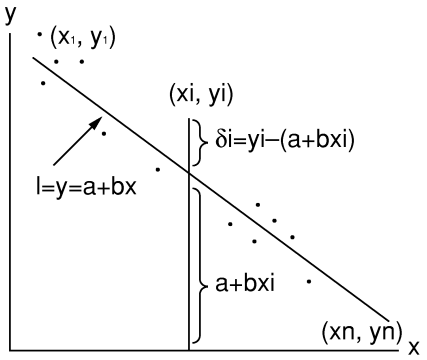
Appendix B Least Square Linear Approximation Method

When splice loss is measured, assume two lines, L1 and L2, from the measurement data and obtain the loss as shown in the figure below.



There are two methods for determining these lines: the LSA and 2PA methods. Of these methods, this section explains the LSA (Least Square Approximation) method.

The Least Square Approximation method obtains a straight line such that the variation of distances from all the measurement data points that exist between the markers to the straight line is a minimum.



As shown in the figure above, let see this the straight line L from which the variation of distances from n data points (x_1, y_1), (x_2, y_2), ... (x_n, y_n) becomes minimum be y = a + bx. The straight line L is determined by finding the deviation from each point (δ1, δ2, δ3, ...) to the straight line L as a value including the variables a and b and finding the variables a and b so that the sum E of the squares of the deviation of points δi becomes minimum.

δi = yi – (a + bxi)

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

In the above equation, the necessary and sufficient condition to minimize E is:

$$\frac{\partial E}{\partial a} = 0, \quad \frac{\partial E}{\partial b} = 0$$

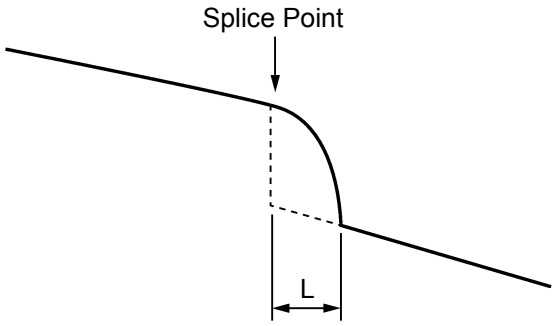
When this equation is solved, the variables a and b can be found as shown below.

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

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

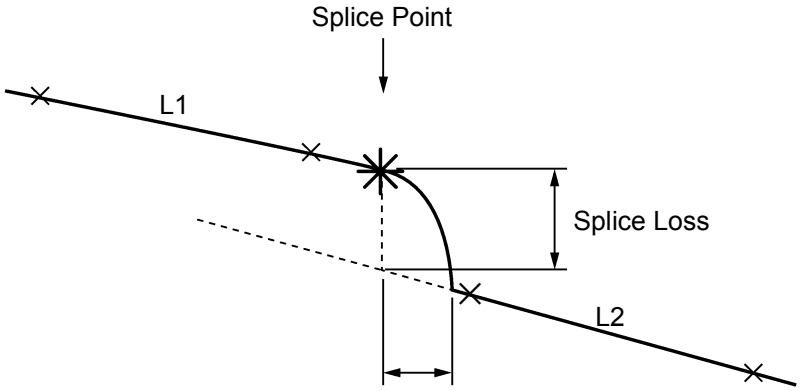
Appendix C Splice Loss Measurement Principle

The trace waveform at the splice point should be displayed as indicated by the dotted line in the figure below, but is actually displayed as indicated by the solid line. The reason why section L is generated is because the waveform inputted to the OTDR shows a sharp falling edge at the splice point so that the circuit cannot respond correctly. Section L increases as the pulse width increases.



Therefore, the splice loss cannot be measured correctly in the Loss mode. In the Splice & Return Loss mode, two markers are set on each side of the splice point. The splice loss is calculated as shown below.

Draw Lines L1 and L2 as shown below. The part of the straight line immediately after the splice point is the forward projection of straight line L2. The splice loss is found by dropping a perpendicular from the splice point to this projection of L2 and measuring the level difference between the splice point and the intersection.



Appendix D Return Loss Measurement Principle

The return loss R is found from the following equation.

$$R = -\left(10\log_{10} bsl + 10\log_{10}\left(10^{L/5} - 1\right)\right)$$

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

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

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

W (sec): Currently set pulse width

L: Difference of levels between * and ∇ markers

BSL = 10 $\log_{10}$bsl: Back-scattered light level

S: Back-scattered coefficient

α_R: Rayleigh scattering loss (Np/m)
= $0.23026 \times 10^{-3} \times$ RSL

RSL: Rayleigh scattering loss (dB/km)

V: Group velocity in optical fiber

K: Available constant of optical fiber

N1: Index of refraction of optical fiber core

N2: Index of refraction of optical fiber cladding

N_e: Effective group index of refraction of optical fiber

C (m/s): Speed of light (3×10^8)

Appendix E Total Return Loss Measurement Principle

Use the following equation to obtain the total return loss, or TRL, in dB.

$$TRL = -10\log_{10}\frac{ER}{Ein}$$

$$= -10\log_{10}\frac{\int_0^\infty P(t)dt}{P_0 W}$$

$$= -10\log_{10}\frac{bsl\int_0^\infty P'(t)dt}{W} \quad where,\ P'(t) = \frac{P(t)}{P_O bsl}$$

$$= -10\log_{10} bsl + 10\log_{10} W - 10\log_{10}\int_0^\infty P'(t)dt$$

E_R: Reflected light energy

Ein: Incident light energy

P (t): OTDR measurement power

P_0: Incident light pulse peak power at t = 0

W: Incident light pulse width

$10\log_{10}bsl$: Back-scattered light level

$\int_0^\infty P'(t)dt$: Measured waveform normalized and integrated over the back-scattered light intensity at the incident end

Reference:

bsl is determined according to the fiber, wavelength, and pulse width.

Typical values for 1.3 μm single mode optical fiber are shown below.

Pulse width	Back-scatter level (dB)	
	λ = 1.31 μm	λ = 1.55 μm
100 ns	–60	–62.5
1 μs	–50	–52.5
10 μs	–40	–42.5

Appendix F Pulse width, Distance range and Resolution

Pulse Width (ns)	Auto Distance Range			Manual Distance Range		
	Selectable Measure Range (km)	Resolution		Selectable Measure Range (km)	Resolution	
		Fine	Normal		Fine	Normal
10	1	0.05	0.2	1	0.05	0.2
	2.5	0.1	0.5	2.5	0.1	0.5
	5	0.2	1	5	0.2	1
	10	0.5	2	10	0.5	2
				25	1	5
				50	2	10
				100	5	20
				200	10	40
				250	10	40
				400	20	80
30	1	0.05	0.2	1	0.05	0.2
	2.5	0.1	0.5	2.5	0.1	0.5
	5	0.2	1	5	0.2	1
	10	0.5	2	10	0.5	2
				25	1	5
				50	2	10
				100	5	20
				200	10	40
				250	10	40
				400	20	80
100	1	0.05	0.2	1	0.05	0.2
	2.5	0.1	0.5	2.5	0.1	0.5
	5	0.2	1	5	0.2	1
	10	0.5	2	10	0.5	2
	25	1	5	25	1	5
				50	2	10
				100	5	20
				200	10	40
				250	10	40
				400	20	80

Pulse Width (ns)	Auto Distance Range			Manual Distance Range		
	Selectable Measure Range (km)	Resolution		Selectable Measure Range (km)	Resolution	
		Fine	Normal		Fine	Normal
300	25	1	5	25	1	5
	50	2	10	50	2	10
	100	5	20	100	5	20
				200	10	40
				250	10	40
				400	20	80
1000	25	1	5	25	1	5
	50	2	10	50	2	10
	100	5	20	100	5	20
	200	10	40	200	10	40
	250	10	40	250	10	40
	400	20	80	400	20	80
3000	50	2	10	50	2	10
	100	5	20	100	5	20
	200	10	40	200	10	40
	250	10	40	250	10	40
	400	20	80	400	20	80
10000	100	5	20	100	5	20
	200	10	40	200	10	40
	250	10	40	250	10	40
	400	20	80	400	20	80
20000	100	5	20	100	5	20
	200	10	40	200	10	40
	250	10	40	250	10	40
	400	20	80	400	20	80