

MW9087 Series Card OTDR Operation Manual

Eighth Edition


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


ANRITSU CORPORATION


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.

MW9087 Series
Card OTDR
Operation Manual

2 June 2011 (First Edition)
17 June 2015 (Eighth Edition)

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Printed in Japan

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.

Electric Shock

- To ensure that the equipment is grounded, always use the supplied 3-pin power cord, and insert the plug into an outlet with a ground terminal. If power is supplied without grounding the equipment, there is a risk of receiving a severe or fatal electric shock or causing damage to the internal components.

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. There are high-voltage parts in this equipment presenting a risk of severe injury or fatal electric shock to untrained personnel. In addition, there is a risk of damage to precision components.

For Safety

WARNING

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.

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

Laser Safety

Class 1, and 1M indicate 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 1M: Lasers emitting in the wavelength range from 302.5 to 4000 nm that are safe under reasonably foreseeable conditions of operation, but may be hazardous if the user employs optics within the beam. Two conditions apply:

- a) for diverging beams, if the user views the laser output with certain optical instruments (for example, eye loupes, magnifiers and microscopes) within a distance of 100 mm; or
- b) for collimated beams, if the user views the laser output with certain optical instruments (for example, telescopes and binoculars).



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.



WARNING

The laser in this equipment is classified as Class 1 or 1M according to the IEC 60825-1:2007 standard, and is safe under reasonably foreseeable operating conditions.

Never use optical instruments to directly view Class 1M laser products. Doing so may result in serious damage to the eyes.

For Safety

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
MW9087B	1	0.15	$20 \times 10^{-6}/0.019$	1650	11.5	a)	Figure 1, [1]
MW9087D	1M	0.60	$20 \times 10^{-6}/0.019$	1550	11.5	b)	Figure 1, [1]

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



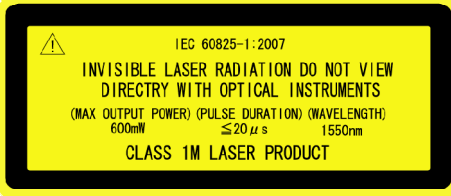

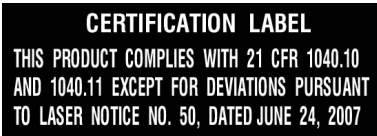

Table 2 Incorporated Laser Specification

Incorporated Laser	Max. Optical Output Power (W)*	Pulse Width (s)/ Repetition Rate	Emitted Wavelength (nm)	Beam Divergence (deg)
a)	< 0.30	$20 \times 10^{-6}/0.019$	1650	11.5
b)	< 1.20	$20 \times 10^{-6}/0.019$	1550	11.5

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

For Safety

Table 3 Indication Labels on Product (Ex: Label list)

	Type	Sample	Affixed to:	Model Name
1	Explanation	 <p style="text-align: center;">  IEC 60825-1:2007 CLASS 1 LASER PRODUCT </p>	Figure 1, A	MW9087B
2	Explanation	 <p style="text-align: center;">  IEC 60825-1:2007 INVISIBLE LASER RADIATION DO NOT VIEW DIRECTLY WITH OPTICAL INSTRUMENTS (MAX OUTPUT POWER) (PULSE DURATION) (WAVELENGTH) 600mW ≤20 μs 1550nm CLASS 1M LASER PRODUCT </p>	Figure 2, B	MW9087D
3	Certification	 <p style="text-align: center;"> CERTIFICATION LABEL THIS PRODUCT COMPLIES WITH 21 CFR 1040.10 AND 1040.11 EXCEPT FOR DEVIATIONS PURSUANT TO LASER NOTICE NO. 50, DATED JUNE 24, 2007 </p>	Figure 2, C	All Models
4	Identification	 <p style="text-align: center;"> IDENTIFICATION LABEL ANRITSU CORP. 5-1-1,ONNA,ATSUGI-SHI KANAGAWA 243-8555,JAPAN MANUFACTURED ATTOHOKU ANRITSU CO., LTD KORIYAMA PLANT, [REDACTED], 20[REDACTED] </p>	Figure 2, D	All Models

For Safety

Laser Radiation Markings

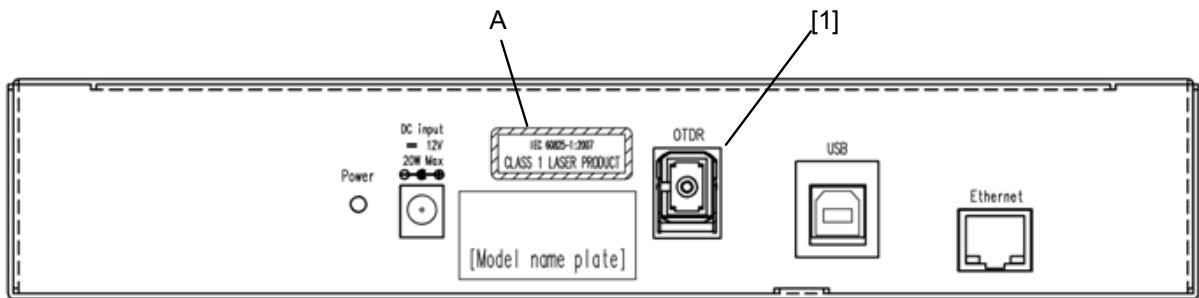


Figure 1 Locations of Laser Beam Apertures and Affixed Labels

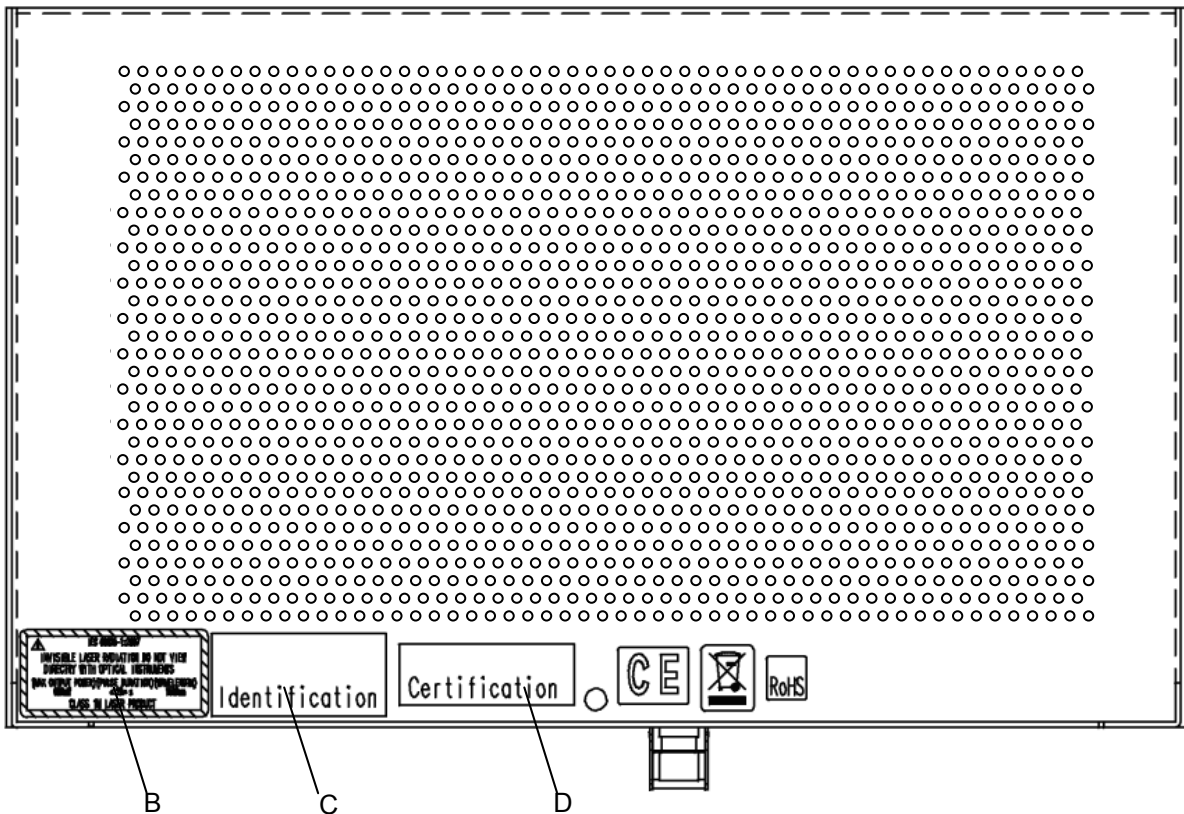


Figure 2 Label Locations

For Safety

CAUTION

Disconnect from Communication

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

Use in Corrosive Atmospheres

Exposure to corrosive gases such as hydrogen sulfide, sulfurous acid, and hydrogen chloride will cause faults and failures. Note that some organic solvents release corrosive gases.

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 will repair this equipment free-of-charge if a malfunction occurs within one year after shipment due to a manufacturing fault. However, software fixes will be made in accordance with the separate Software End-User License Agreement. Moreover, Anritsu Corporation will deem this warranty void when:

- 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
- 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 dioxide, 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.

Reuse parts

Anritsu group promotes recycling activities in order to reuse available resources and save energy. This product may use recycled parts (mechanical components) that conform to Anritsu's quality standards.

Lifetime of Parts

The life span of certain parts used in this instrument is determined by the operating time or the power-on time. Due consideration should be given to the life spans of these parts when performing continuous operation over an extended period. These parts must be replaced at the customer's expense even if within the guaranteed period described in Warranty at the beginning of this manual. For details on life span, refer to the corresponding section in this manual.

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.

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Please read this Software End-User License Agreement (hereafter this EULA) carefully before using (includes executing, copying, registering, etc.) this software (includes programs, databases, scenarios, etc., used to operate, set, etc., Anritsu electronic equipment). By reading this EULA and using this software, you are agreeing to be bound by the terms of its contents and Anritsu Corporation (hereafter Anritsu) hereby grants you the right to use this Software with the Anritsu-specified equipment (hereafter Equipment) for the purposes set out in this EULA.

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4. This EULA allows you to install one copy of this Software on one piece of Equipment.

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To the extent not prohibited by law, in no event shall Anritsu be liable for personal injury, or any incidental, special, indirect or consequential damages whatsoever, including, without limitation, damages for loss of profits, loss of data, business interruption or any other commercial damages or losses, arising out of or related to your use or inability to use this Software.

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- a. If a fault (bug) is discovered in this Software, preventing operation as described in the operation manual or specifications whether or not the customer uses this software as described in the manual, Anritsu shall at its own discretion, fix the bug, or exchange the software, or suggest a workaround, free-of-charge. However, notwithstanding the above, the following items shall be excluded from repair and warranty.
 - i) If this Software is deemed to be used for purposes not described in the operation manual or specifications.
 - ii) If this Software is used in conjunction with other non-Anritsu-approved software.
 - iii) Recovery of lost or damaged data.
 - iv) If this Software or the Equipment has been modified, repaired, or otherwise altered without Anritsu's prior approval.
 - v) For any other reasons out of Anritsu's direct control and responsibility, such as but not limited to, natural disasters, software virus infections, etc.
- b. Expenses incurred for transport, hotel, daily allowance, etc., for on-site repairs by Anritsu engineers necessitated by the above faults shall be borne by you.
- c. The warranty period for faults listed in article 3a above covered by this EULA shall be either 6 months from the date of purchase of this Software or 30 days after the date of repair, whichever is longer.

4. Export Restrictions

You may not use or otherwise export or re-export directly or indirectly this Software except as authorized by Japanese and United States law. In particular, this software may not be exported or re-exported (a) into any Japanese or US embargoed countries or (b) to anyone on the Japanese or US Treasury Department's list of Specially Designated Nationals or the US Department of Commerce Denied Persons List or Entity List. By using this Software, you warrant that you are not located in any such country or on any such list. You also agree that you will not use this Software for any purposes prohibited by Japanese and US law, including, without limitation, the development, design and manufacture or production of missiles or nuclear, chemical or biological weapons of mass destruction.

5. Termination

Anritsu shall deem this EULA terminated if you violate any conditions described herein. This EULA shall also be terminated if the conditions herein cannot be continued for any good reason, such as violation of copyrights, patents, or other laws and ordinances.

6. Reparations

If Anritsu suffers any loss, financial or otherwise, due to your violation of the terms of this EULA, Anritsu shall have the right to seek proportional damages from you.

7. Responsibility after Termination

Upon termination of this EULA in accordance with item 5, you shall cease all use of this Software immediately and shall as directed by Anritsu either destroy or return this Software and any backup copies, full or partial, to Anritsu.

8. Dispute Resolution

If matters of dispute or items not covered by this EULA arise, they shall be resolved by negotiations in good faith between you and Anritsu.

9. Court of Jurisdiction

This EULA shall be interpreted in accordance with Japanese law and any disputes that cannot be resolved by negotiation described in Article 8 shall be settled by the Japanese courts.

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.

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



1. Product Model

Model: MW9087 Series Card OTDR

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 61000-4-5 (Surge)	B
IEC 61000-4-6 (CRF)	A
IEC 61000-4-8 (RPFMF)	A
IEC 61000-4-11 (V dip/short)	B, C

*: 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.

C: Temporary loss of function is allowed, provided the function is self-recoverable or can be restored by the operation of the controls.

Harmonic current emissions:

EN 61000-3-2: 2006 +A1:2009 A2:2009

: No limits apply for this equipment with an active input power under 75 W.

- 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 mark 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 mark



1. Product Model

Model: MW9087 Series Card OTDR

2. Applied Standards

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

About This Manual

The configuration of the MW9087 Series Card OTDR operation manual is divided into the following three parts: Card OTDR Mainframe, LED Interface, and Password function.

This manual describes the operation/maintenance method for MW9087 Series Card OTDR.

Refer to Chapter 2 "Before Use" to understand the setting of this device and precautions.

Also, refer to Chapter 3 "Measurement Method" to understand the overview of operation flow.

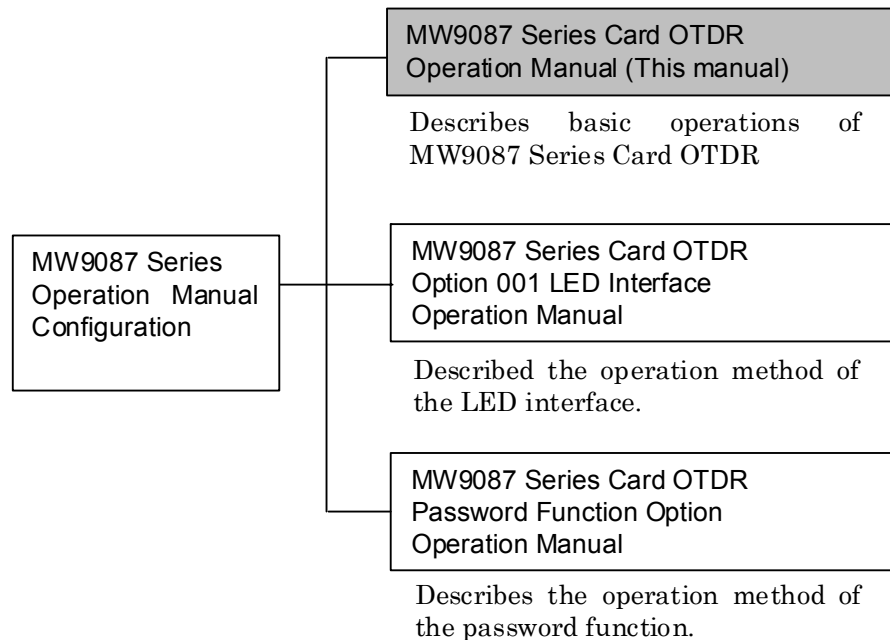


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Appendix

Chapter 1 Outline

This chapter explains the features of the MW9087 Series Card OTDR

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1.1 Introduction to MW9087 Series Card OTDR

MW9087 Series Card OTDR is a module form for the optical fiber measurement device.



Figure 1.1-1 Card OTDR Appearance (MW9087B)

This device has multiple models depending on wavelengths and dynamic ranges.

Table 1.1-1 Model Name of Card OTDR

Model	Wavelength	Dynamic range (Typ.)
MW9087B	1650 nm	41 dB
MW9087D	1550 nm	50 dB

1550 nm wavelength is used for communications.

To monitor the fiber loss/deterioration or breaks without effects on communications, the model with wavelength of 1650 nm is used.

To measure the fiber loss of the wavelength used for communications, the model with wavelength of 1550 nm is used.

If the fiber loss is large or the communication path has the fiber loss due to optical coupler, the model with a large dynamic range is used.

1.2 Features

The MW9087 Series Card OTDR has been developed in order to monitor faults in the optical fiber system.

You can control it via Ethernet; therefore, it can be used for automatic/remote measurement.

Partial sampling

Distance range to be measured can be set, and only the range set can be measured. This feature will shorten the measurement time.

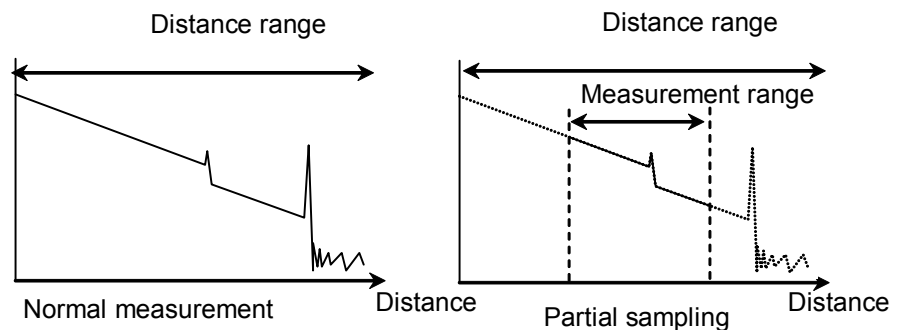


Figure 1.2-1 Normal Measurement and Partial Sampling

SR-4731 file format

The measurement results can be saved with Telcordia standard SR-4731 OTDR Data Format-compliant files. These files have the extension of SOR, and waveforms can be displayed with TraceView software.

This software is available from the following URL.

<http://www.anritsu.com/en-US/Downloads/Software/Drivers/Software-Downloads/DWL2761.aspx>

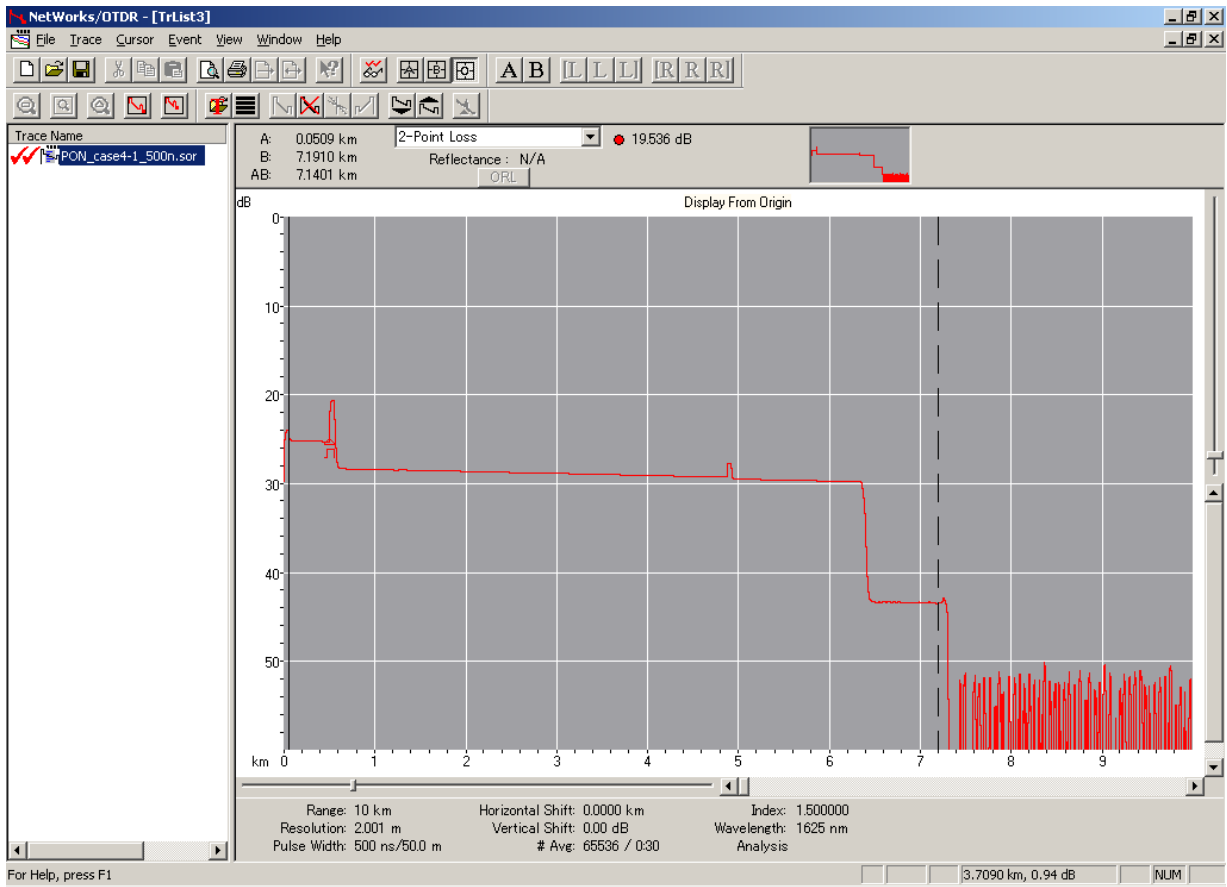


Figure 1.2-2 Waveform Display with TraceView software

Note:

The obtained waveform using the partial sampling cannot be displayed with the Trace View software properly.

1.3 Outline of OTDR

1

Outline

OTDR operating principle

OTDR (Optical Time Domain Reflectometer) transmits brief optical pulses to the fiber to measure the intensity and time difference of lights reflected from within the fiber.

The distance of the reflection point is calculated from the time difference, light speed, and index of refraction (IOR) of the fiber.

The light attenuation (fiber loss) is calculated from the light intensity reflected from within the fiber.

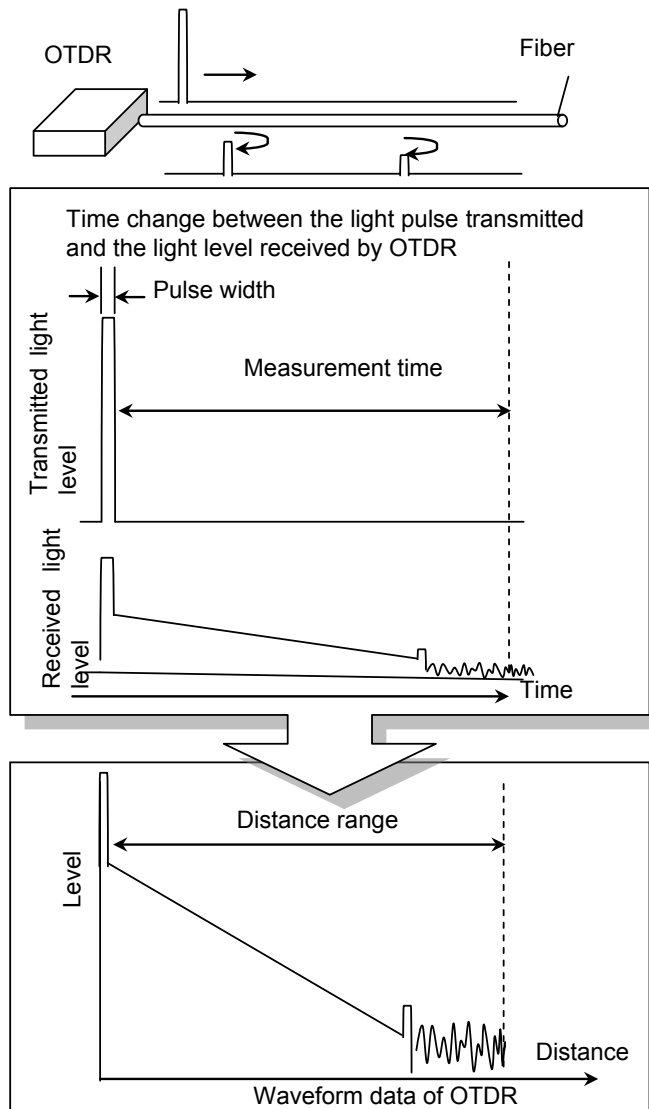


Figure 1.3-1 OTDR Transmitted/Received Waveform and Waveform Data

The maximum measurable distance (distance range) is determined by the time when OTDR measures the received light level after the optical pulse is transmitted.

Transmitted optical pulse is reflected little by little within the fiber. The more distant the reflected light is, the lower is the light level received by OTDR. Therefore, the waveform of measurement result becomes a downward-sloping rectilinear graph.

OTDR fiber measurement

In places where the fiber is connected or damaged, the fiber loss or the light reflection may become larger. These changes make the waveform of measurement result discontinuous.

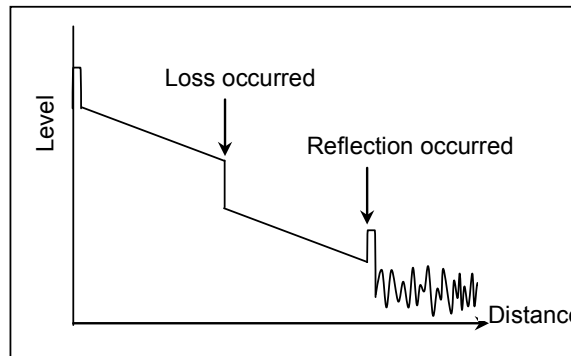


Figure 1.3-2 Detection of Fiber Loss and Reflection

Waveform change with pulse width

The larger is the transmitted optical pulse width, the higher is the received light level. Therefore, make the pulse width larger for the measurement system with large fiber loss such as the case of a long distance range.

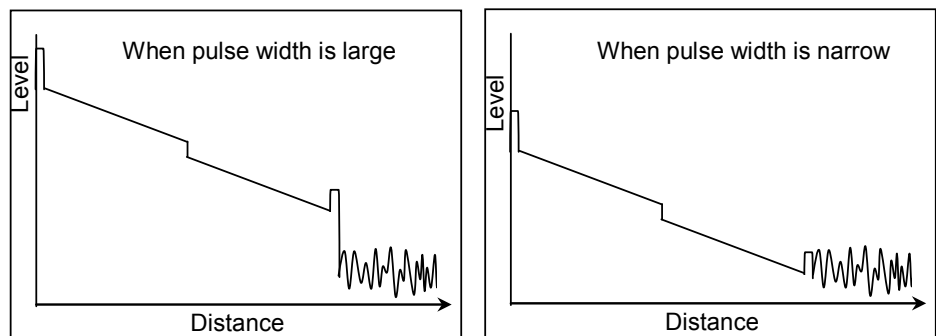


Figure 1.3-3 Level Change with Pulse Width

The narrower is the transmitted optical pulse width, the shorter is the optical pulse length within the fiber. Therefore, the loss change within the fiber can be measured to the direction of length finely (at high resolution).

1

Outline

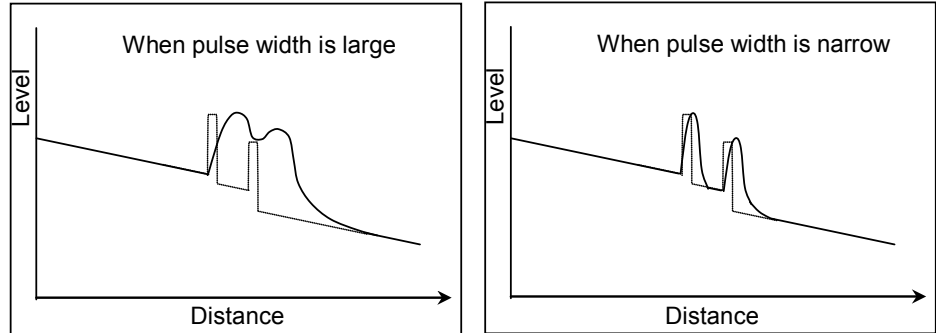


Figure 1.3-4 Resolution Change with Pulse Width

Chapter 2 Before Use

This chapter provides information that should be thoroughly understood before actually using the Card OTDR, such as the installation method, setting items, and precautions.

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2.1 Product Configuration

The standard composition of the MW9087 Series Card OTDR (hereafter, Card OTDR) 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 Standard Configuration

Item	Model	Product Name	Q'ty
Mainframe	MW9087B/D	Card OTDR	1
Accessories		CD-ROM	1

The MW9087 Series Card OTDR Operation Manual (W3543AE) and the USB serial driver are included in the CD-ROM.

2.2 Names of Parts

The following figure shows the names of parts.

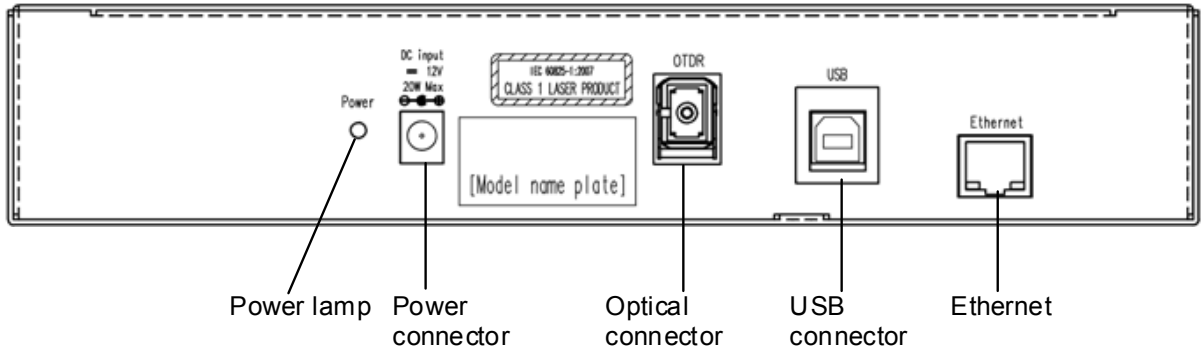


Figure 2.2-1 Front Panel (MW9087B)

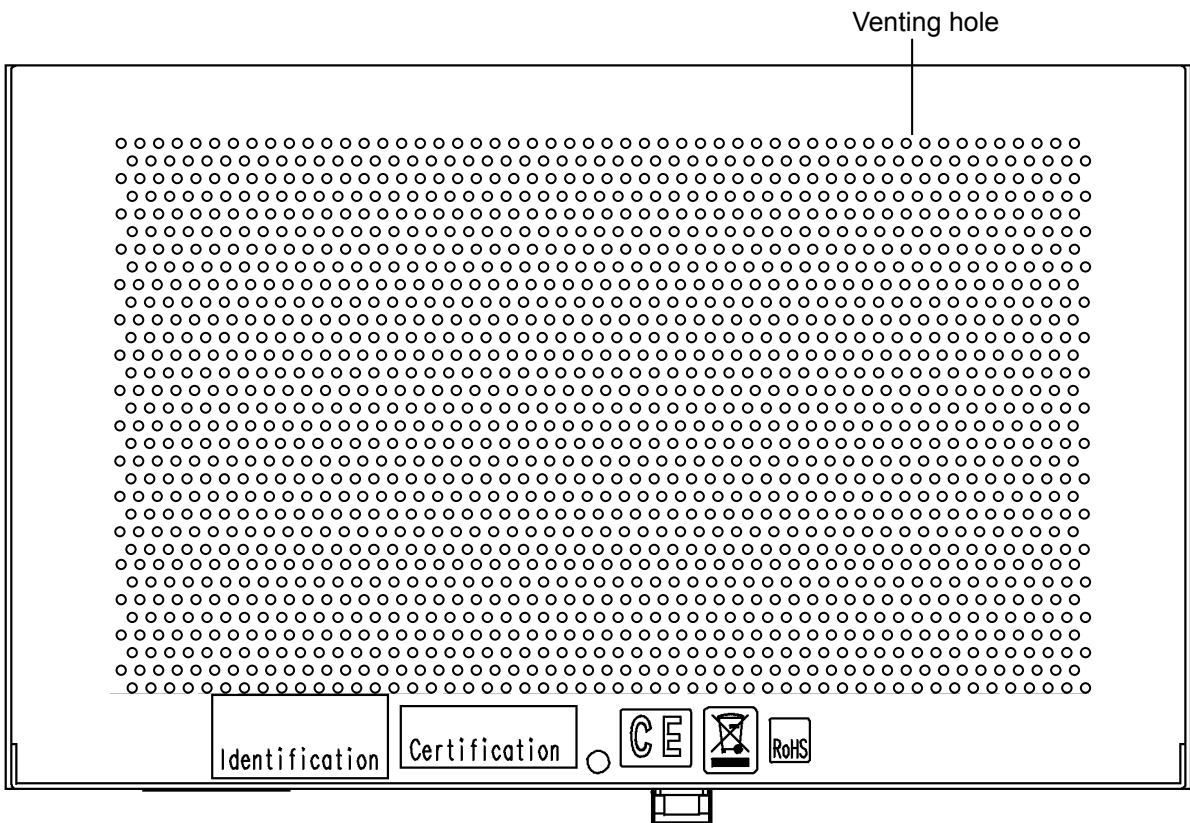


Figure 2.2-2 Upper Surface Panel

Table 2.2-1 Name and Function

Name	Function
Power lamp	Lights when power is supplied.
Power connector	Input terminal for DC power
Optical connector	Input/Output connector for optical pulse measurement
USB connector	Used for serial port communication
Ethernet connector	Connects the Lan cable.
Venting hole	

 **WARNING**

NEVER look directly into the laser radiation emitted from the Card OTDR optical connector or the end of the cable connected to the Card OTDR. If you do so, the laser light may damage your eyes.

2.3 Installing the Card OTDR

2.3.1 Installation method

Install the Card OTDR top surface or side up as shown in Figure 2.3.1-1.

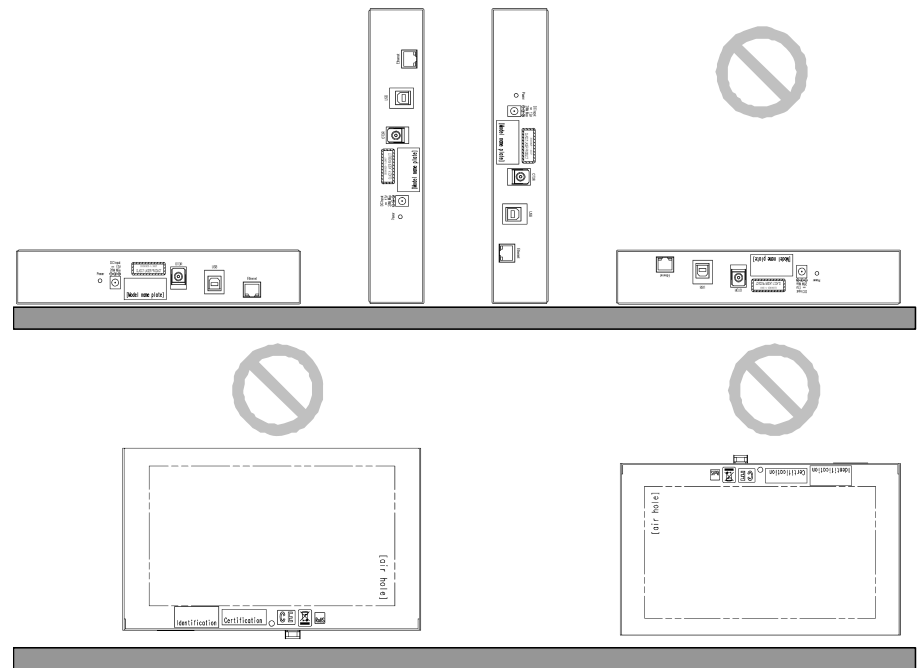


Figure 2.3.1-1 Installation Orientation

A venting hole is installed in the Card OTDR to prevent the internal temperature from rising. Install the Card OTDR in a location with the vents at least 10 cm away from walls, peripherals or other obstructions so as not to block the fan perimeter.

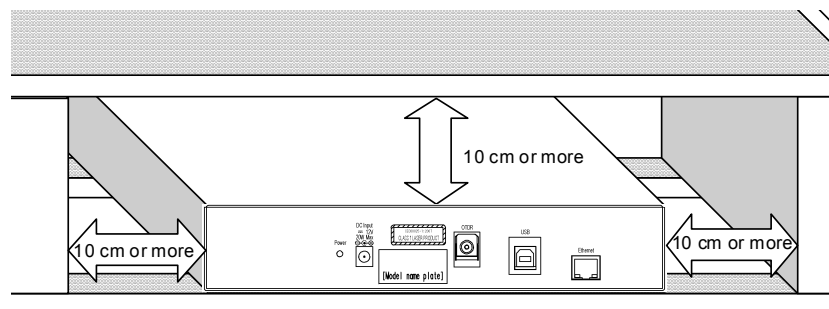


Figure 2.3.1-2 Vent Airflow System

The Card OTDR releases the air to the top surface. When two units of the Card OTDR are used, place them so that the air released from one unit is not received by the other unit.

2

Before Use

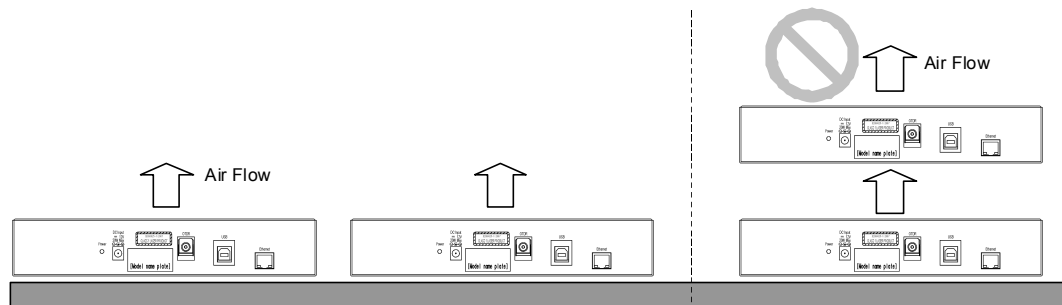


Figure 2.3.1-3 Arrangement for Multiple Units

Although the Card OTDR operates at an ambient temperature of 0° to 50°C, avoid using it in locations, such as the following, since it may cause failure.

- 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 place chemically active gases (sulfur dioxide, hydrogen sulfide, chlorine, ammonia, nitrogen dioxide, 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
- Locations where there is a risk of equipment toppling over, etc.

2.3.2 Dimension

The Card OTDR has holes on bottom panel to secure with screws. Install it using screws of M3 (8 mm or less).

The arrangement for screw holes is shown in the figure below. The unit is mm.

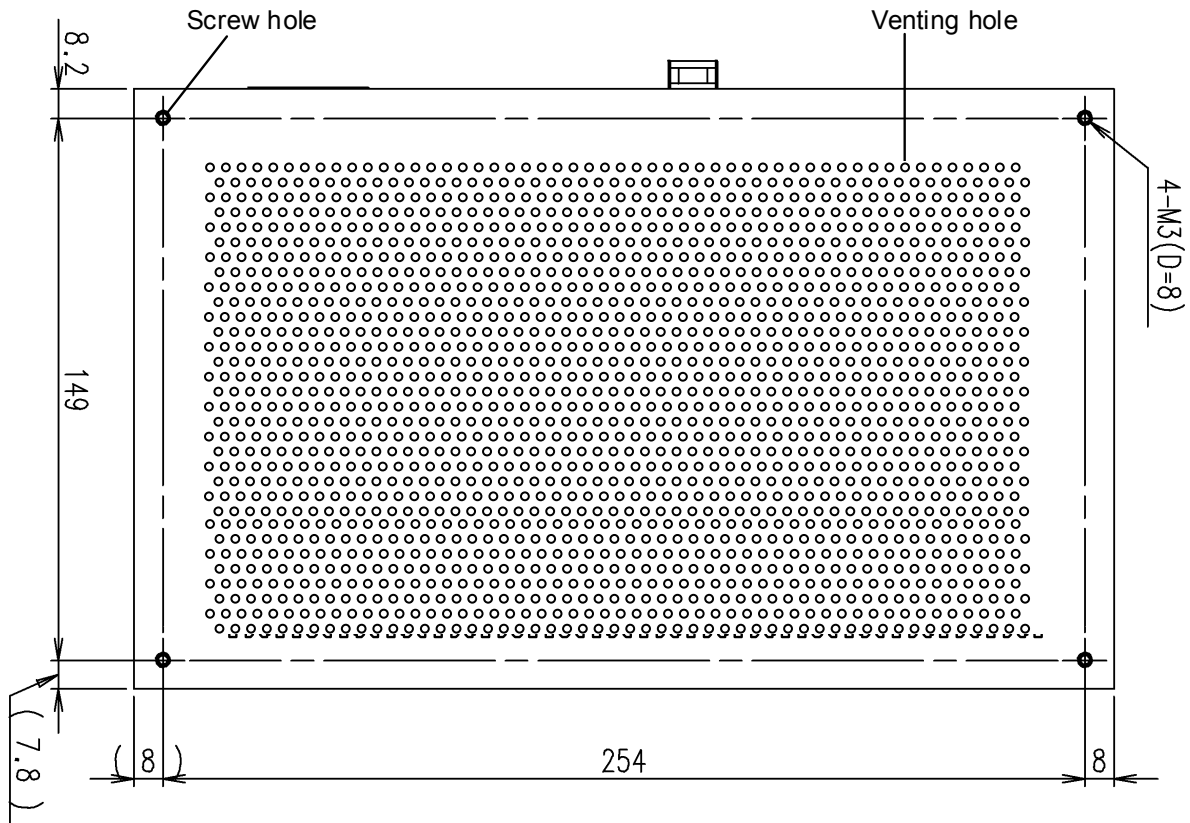


Figure 2.3.2-1 Dimensional Drawing (Bottom View)

2

Before Use

2.4 Power Connection

The Card OTDR operates with the DC 12 V power supply and it starts when the power is supplied.

Connect the polarities correctly as shown in Figure 2.4-1.

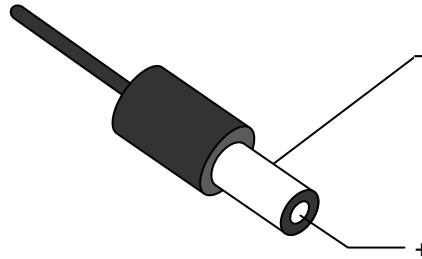


Figure 2.4-1 Power Connector Polarity

Hosiden DC Jack HEC-0470-01-630 is used as the power input pin. The recommended DC plug dimension is $\phi 2.1 \times \phi 5.5 \times 9.5$ mm (Refer to Figure 2.4-2).

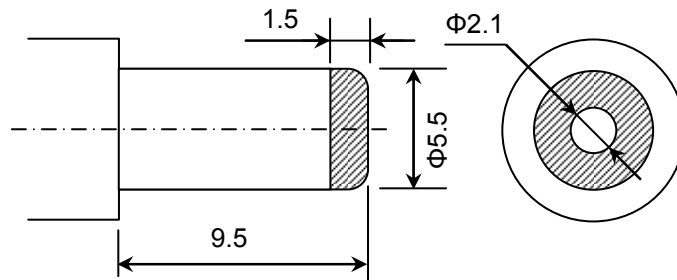


Figure 2.4-2 Dimension Figure for Power Connector

The specifications for the power source are as follows.

Table 2.4-1 Specifications for Power Source

Item	Specifications
Power Voltage	12 V \pm 10%
Power Consumption	\leq 20 W

WARNING

Be sure to check that the power source is set within the range specified. Supplying power exceeding the rated range may result in electrical shock, fire, failure, or malfunction.

2.5 Communication Settings

2.5.1 Interface

The enabled interfaces are as follows.

- PC side: RJ45 port, USB port type A
- The Card OTDR side: RJ45 port, USB port type B

When the Card OTDR is connected to a PC, use the Ethernet cable or USB cable of type A-B. Also Anritsu driver is required when the USB interface is used. Refer to Section 2.6 “Installation/Uninstallation for USB Serial Driver to install it in a PC.

When the Card OTDR is connected to a PC using the Ethernet cable directly, use the cross cable.

2.5.2 Network setting

When the Ethernet setting is not changed from the factory default, the PC should be set according to the following values.

- | | |
|----------------------|-----------------|
| • Communication mode | Autonegotiation |
| • IP address | 192.168.1.2 |
| • Subnet mask | 255.255.255.0 |
| • Default gateway | None |
| • Port number | 2288 |

Use NETNEG command to change the communication mode setting and NET command to change the Network setting. The Card OTDR is restarted using the RST command after setting the Network. The set values have been reflected since the Card OTDR is restarted.

2.5.3 Serial port setting

Set the serial port of the communication control software to be operated on the PC as follows.

- Baud rate (bit/sec) 115200 bps
- Data bit 8 bits
- Parity None
- Stop bit 1 bit
- Flow control Hardware

Note:

The communication condition of the serial port cannot be changed.

2.6 Installation/Uninstallation for USB Serial Driver

2.6.1 Installation (Windows XP)

The installation method for USB serial driver is explained with the example of Windows XP.

1. Copy the UsbSerialDrivers folder of the CD-ROM to the PC.
2. Power on the Card OTDR and PC and connect the USB cable.
3. When the cable is connected, the **Welcome to the Found New Hardware Wizard** is displayed.

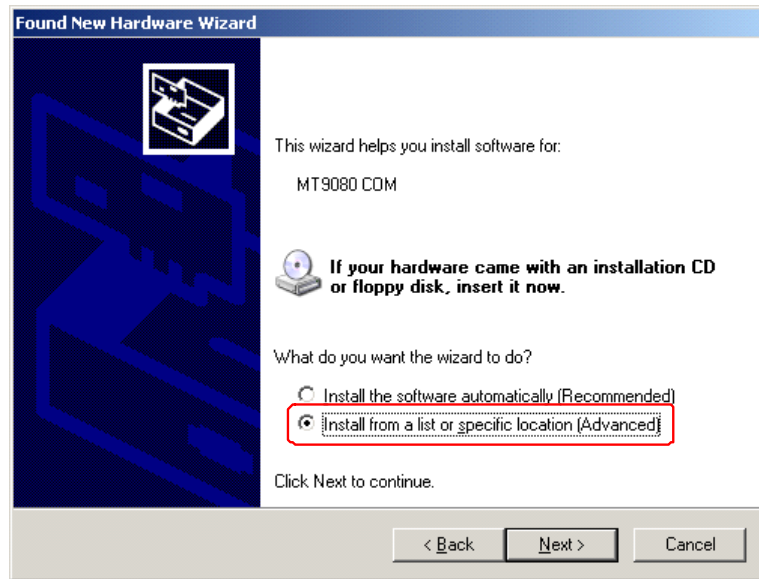


4. Select "No, not this time" and click **Next>**.

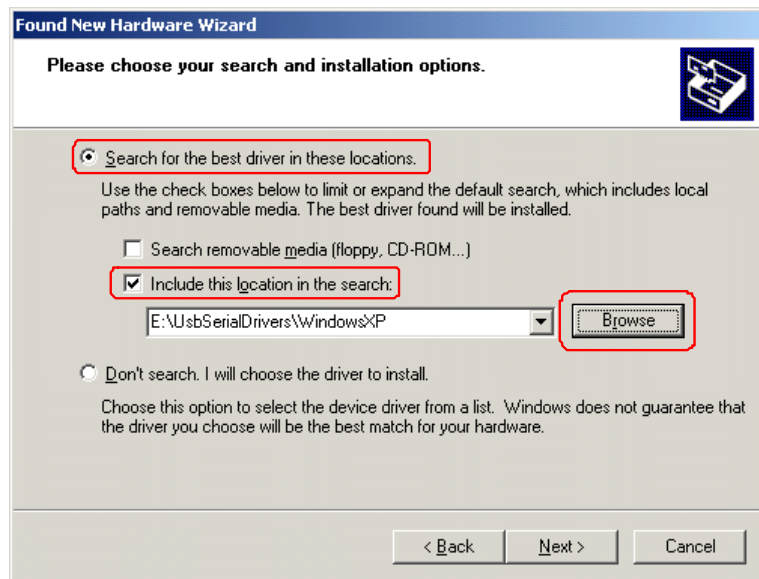
Note:

The above window is not displayed depending on the version of the Windows XP.

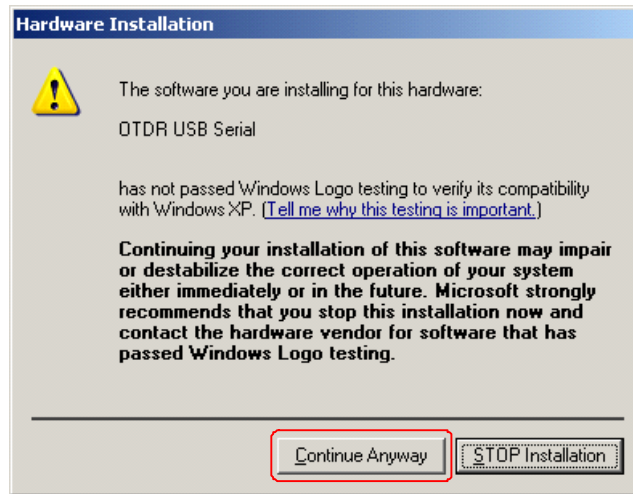
5. The installation selection window is displayed.



6. Select "Install from a list of specific location (Advanced)" and click Next>.
7. The windows describing "Please choose your search and installation option" is displayed.



8. Select "Search for the best driver in these location" and put the check mark in the "Include this location in the search:". Then, specify the RemoteControl folder saved at the procedure 1. (When clicking **B**rowse, the folder is enabled.)
9. Then, when clicking Next>, the driver is installed.
10. When the installation confirmation window is displayed, click Continue Anyway.



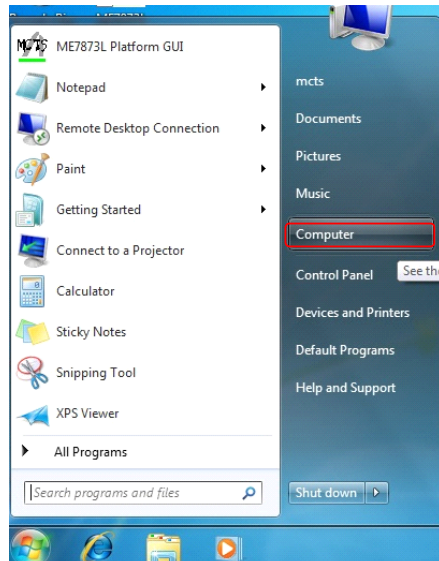
11. When the completion message is displayed, installing the driver is completed. Click **Finish**.



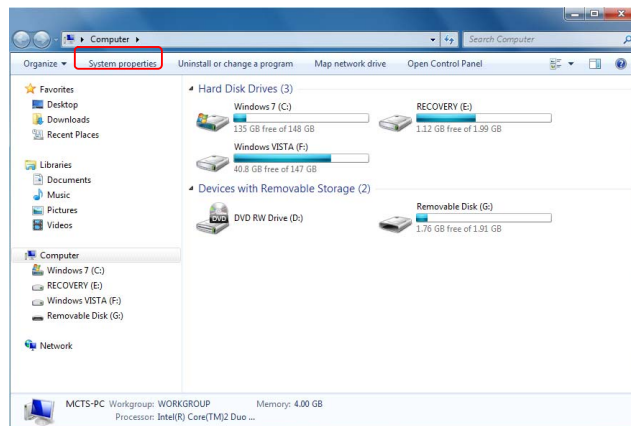
2.6.2 Installation (Windows 7)

The installation method for USB serial driver is explained with the example of Windows 7.

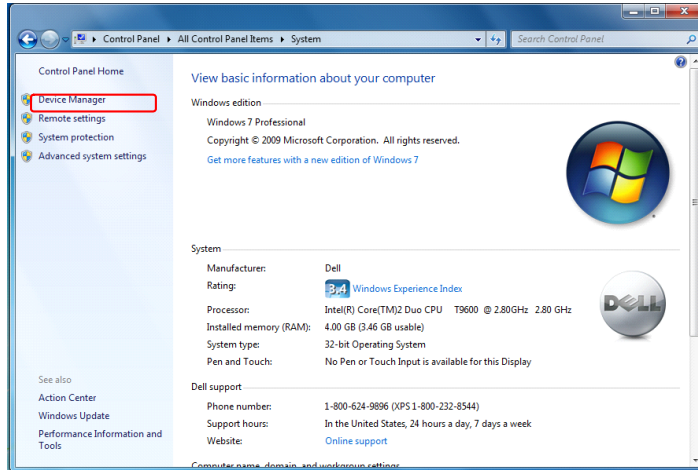
1. Copy the UsbSerialDrivers folder of the CD-ROM to the PC.
2. Power on the Card OTDR and PC and connect the USB cable.
3. Click **Computer** from **Start Menu**.



4. Click System Programs.



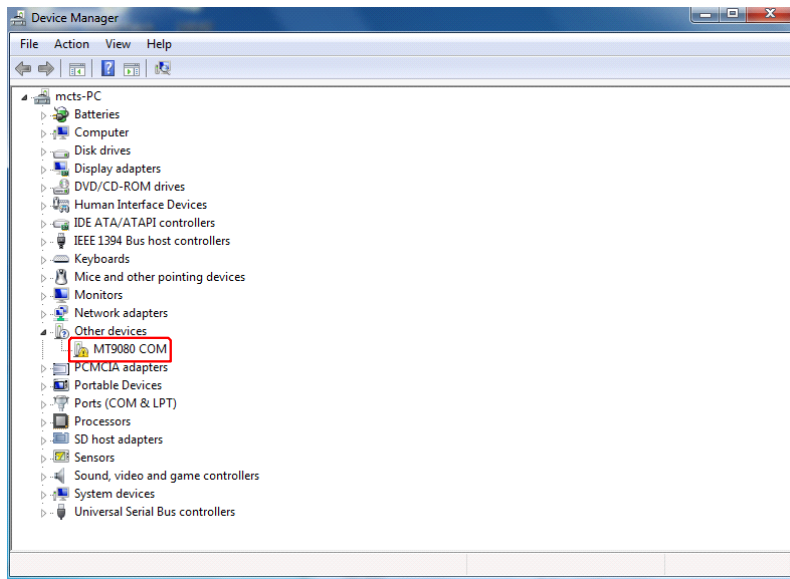
5. Click **Device Manager**.



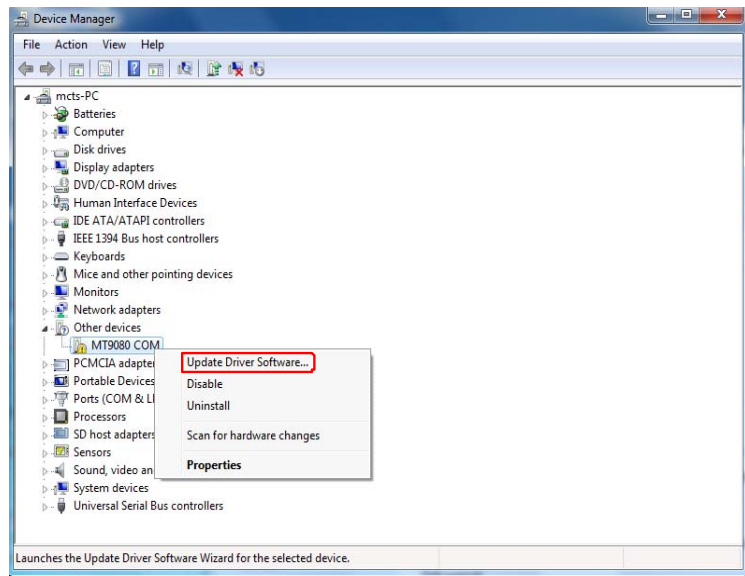
2

Before Use

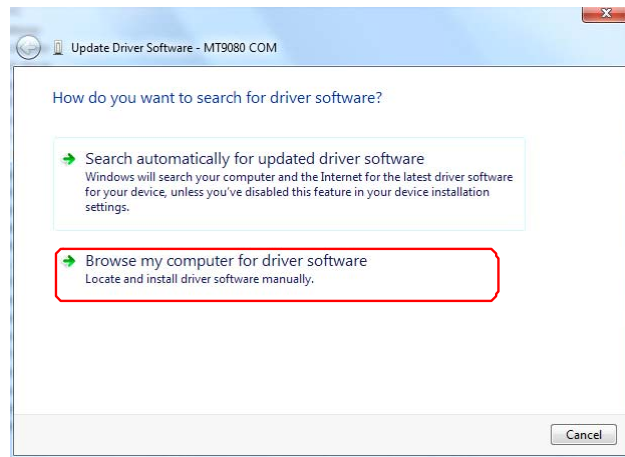
6. Check that **MT9080 COM** is displayed on the device manager.



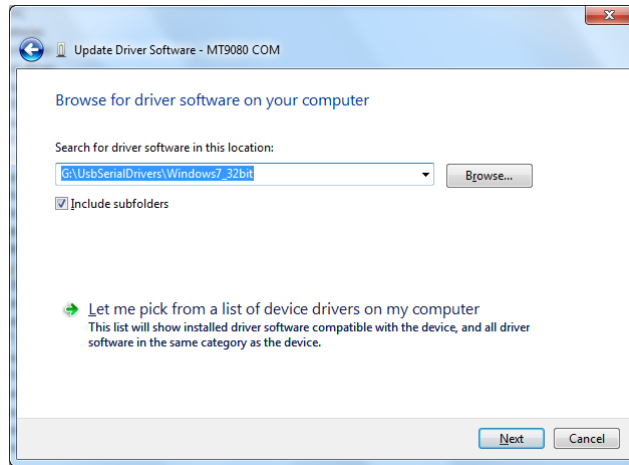
7. Right-click **MT9080 COM** and select **Updating Driver Software**.



8. Click "Browse my computer for driver software".



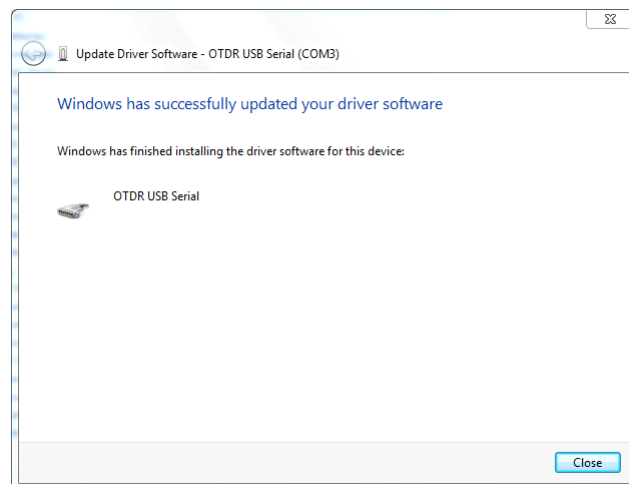
9. Specify the Win7 folder in the UsbSerialDrivers saved at the step 1. When using the Windows 32-bit version, specify the Windows 32-bit folder. When using the Windows 64-bit version, specify the Windows 64-bit folder. When clicking **Browse...**, the folder is enabled.



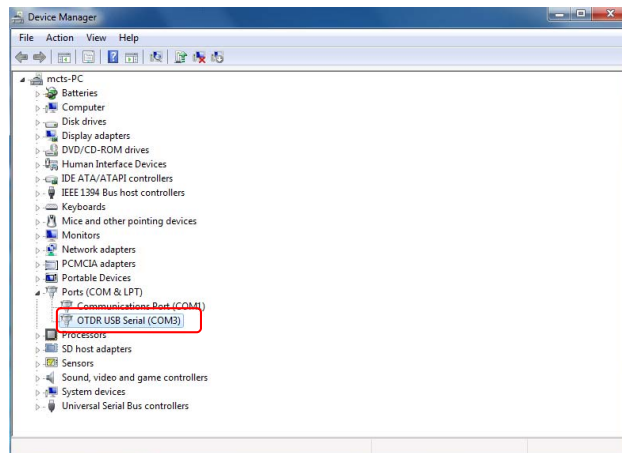
- 10. Then, when clicking **Next**, the driver installation is started.
- 11. When the installation confirmation screen is displayed, click "Install this driver software anyway".



- 12. When the completion message is displayed, the process is completed normally. Click **Close**.



- 13. The current port number is displayed on the right side of the OTDR USB Serial.



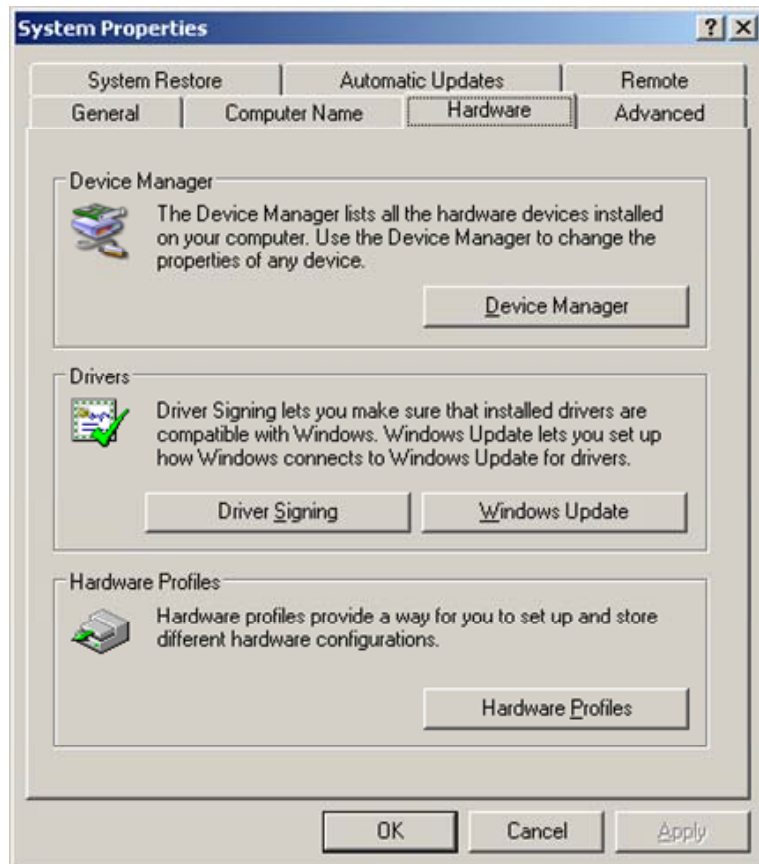
2.6.3 Uninstallation (Window XP)

Avoid turning off the power during uninstallation of the USB serial driver since the PC communicates with the Card OTDR.

1. Turn on the power of the mainframe and the PC, and connect them with a USB cable.
2. Click Control Panel from the Start menu of Windows.
3. Double-click **System**.
4. Click **Hardware** tab.

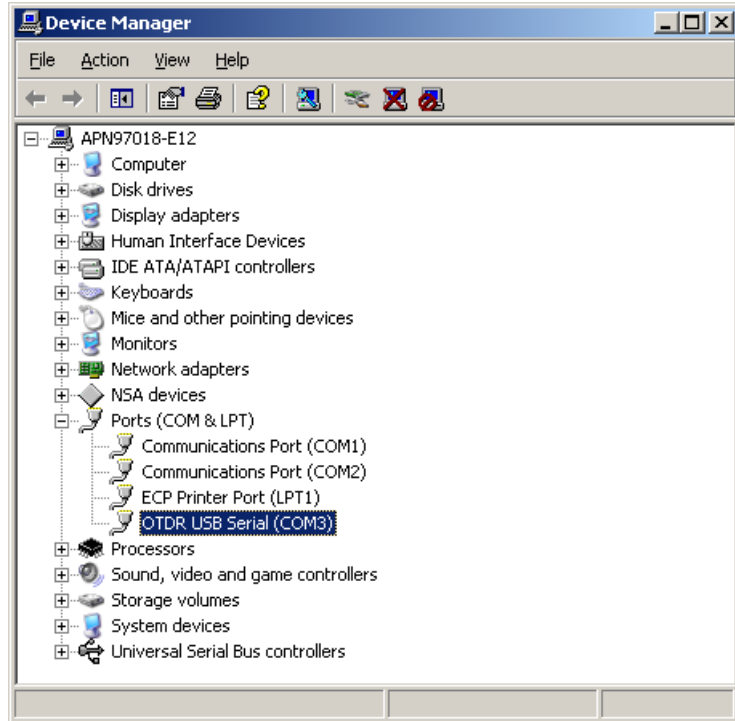
2

Before Use

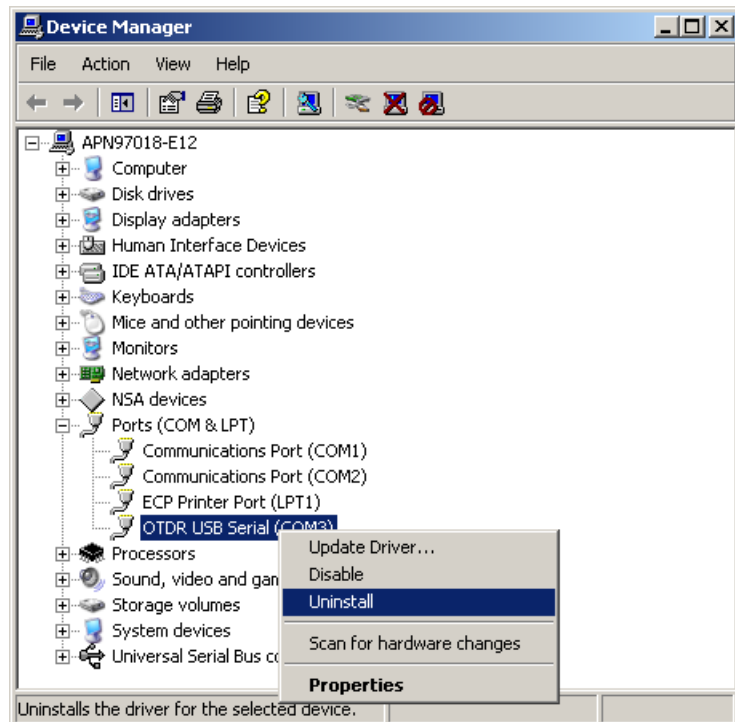


5. Click Device Manager.

6. Double-click the port (COM and LPT).



7. Right-click **OTDR USB serial** and click **Uninstall**.



8. When the Confirm Device Removal window is displayed, click **OK**.



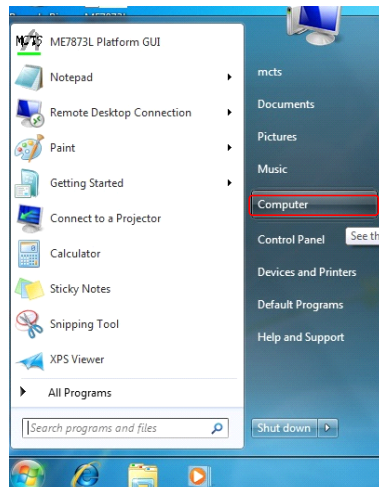
9. Confirm that the OTDR USB Serial is removed.
10. Close the opened windows such as the device manager and system properties.
11. Unplug the USB cable connected to the Card OTDR.

2.6.4 Uninstallation (Windows 7)

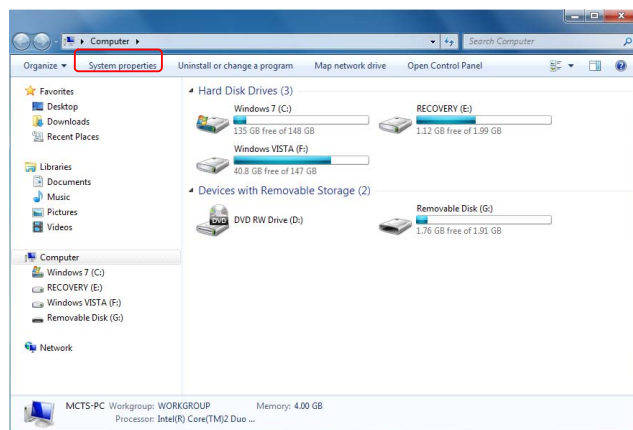
Uninstallation Procedures for the USB serial driver:

As the PC communicates with the Card OTDR during uninstalltion of the USB serial driver, set the Card OTDR to the remote control mode before uninstallation.

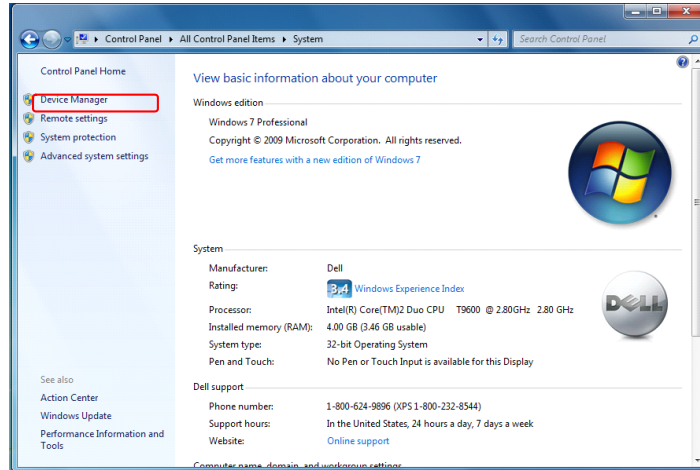
1. Power on the Card OTDR and PC and connect the USB cable.
2. Click **Computer** from the **Start Menu**.



3. Click **System Properties**.



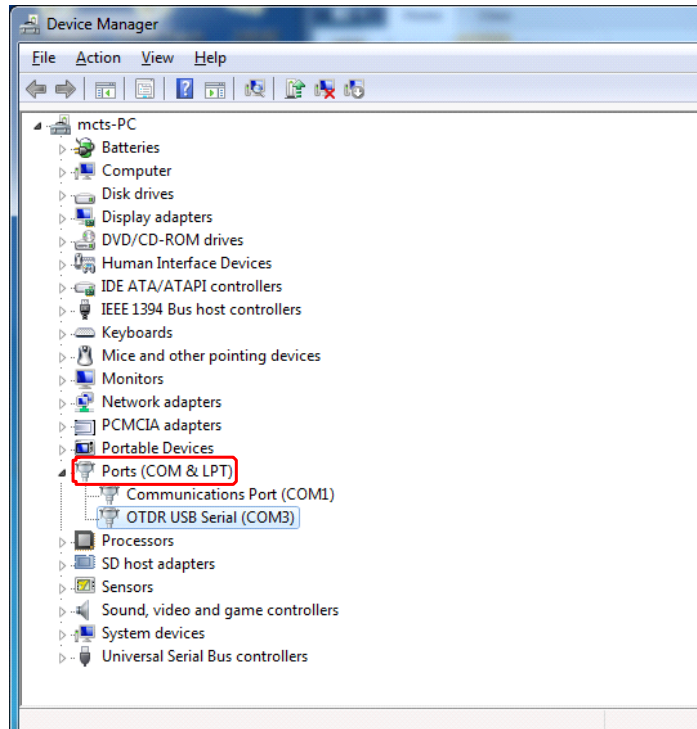
4. Click **Device Manager**.



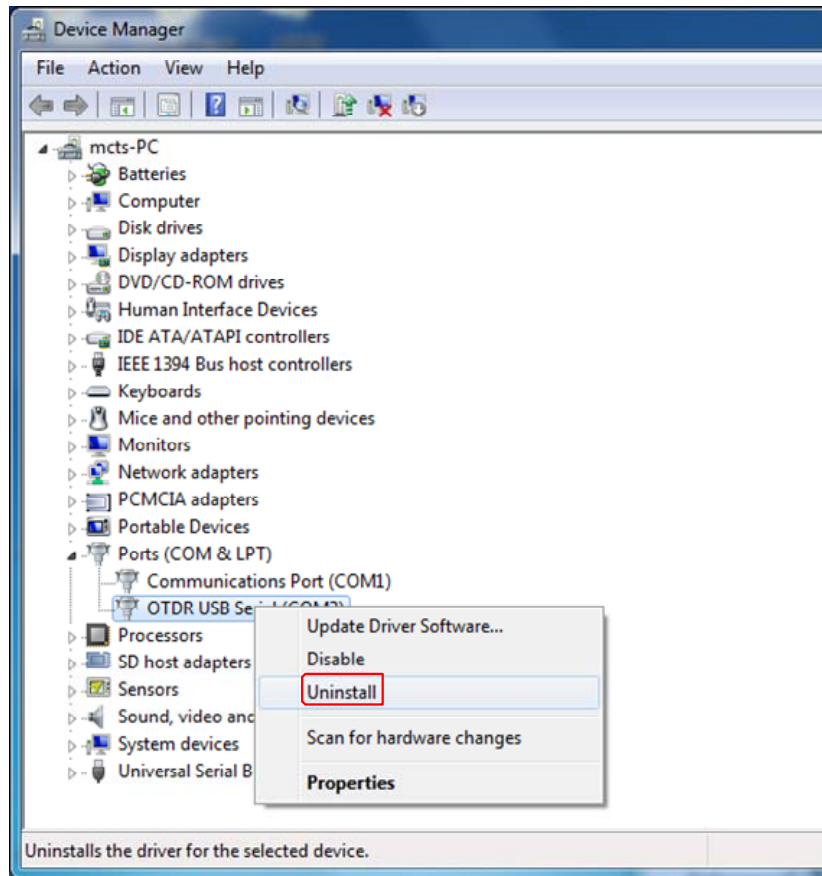
2

Before Use

5. Double-click the ports (COM and LPT).



6. Right-click **OTDR USB Serial** and click **Uninstall**.



7. The confirmation message for deleting the device, click **OK**.



8. Check that **OTDR USB Serial** is deleted.
9. Close the properties for the device manager, system, and etc.
10. Unplug the USB cable connected to the Card OTDR.

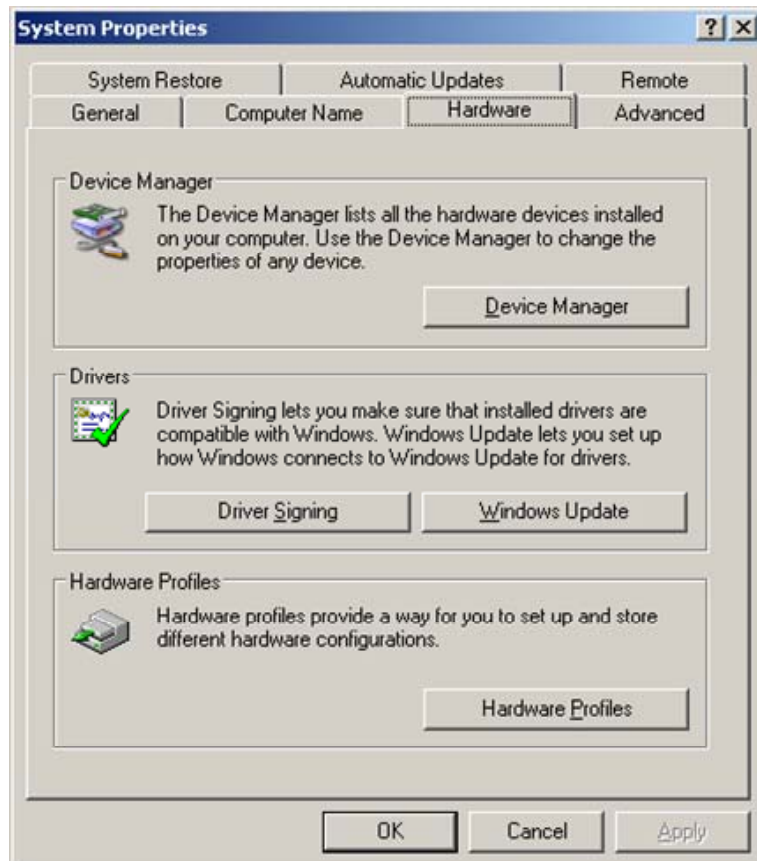
2.7 Confirmation of COM Ports

2.7.1 Confirmation of COM Ports (Windows XP)

Confirmation Procedures for COM Ports

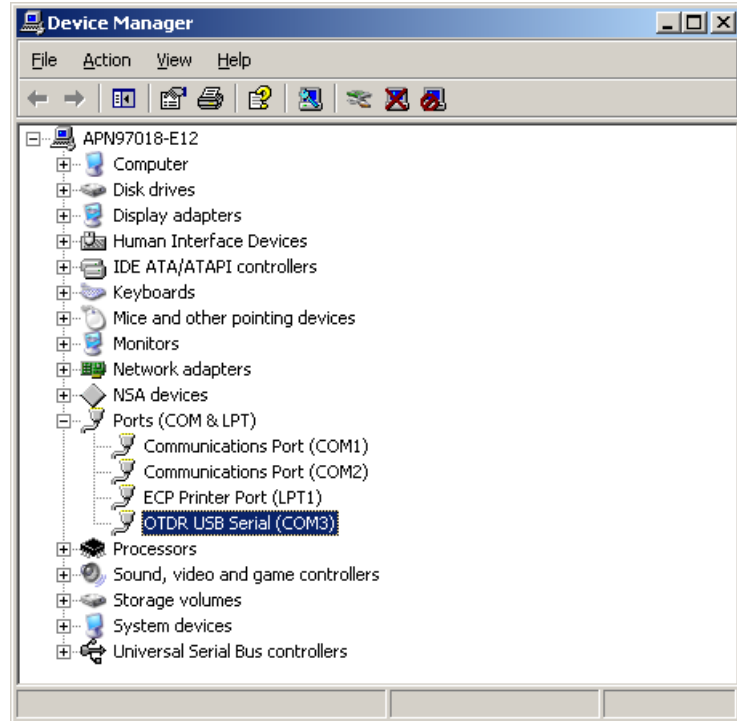
Avoid turning off the power during confirmation of COM port since the PC communicates with the Card OTDR.

1. Power on the Card OTDR and PC to connect the USB cable.
2. Click the control panel from the Windows start menu.
3. Double-click **System**.
4. Click **Hardware** tab.



5. Click **Device Manager**.

6. Double-click the port (COM and LPT).



7. Check the number displayed on the right side of the OTDR USB Serial.

The COM port number is acquired automatically. The COM port number varies with the PC to be installed.

2.7.2 Confirmation of COM Ports (Windows 7)

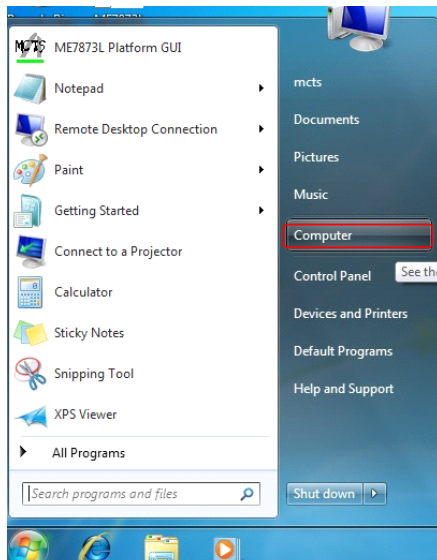
Confirmation Procedures for COM Ports

Communicate with the Card OTDR while confirming the COM port.

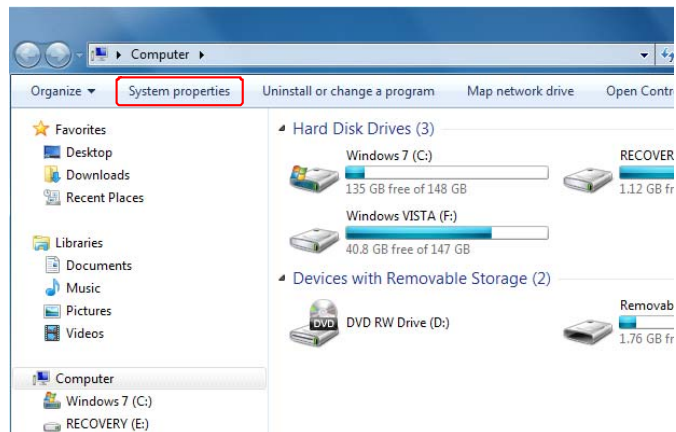
1. Power on the Card OTDR and PC and connect the USB cable.
2. Click **Computer** from the **Start Menu**.

2

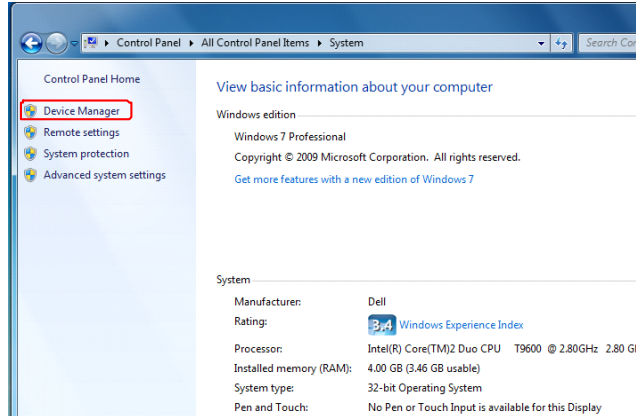
Before Use



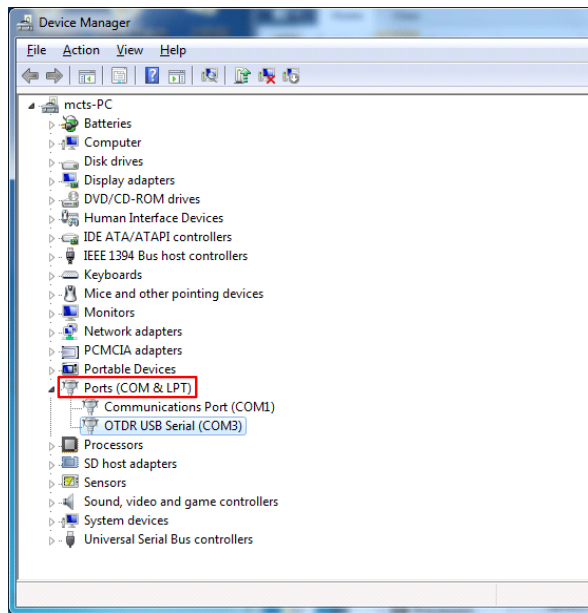
3. Click **System Properties**.



4. Click **Device Manager**.



5. Double-click the ports (COM and LPT).



6. Check the displayed number on the right side of the **OTDR USB Serial**.

The COM port number is acquired automatically. So, the COM port number varies with the PC.

2.8 Connecting the Optical Fiber Cable

Cleaning the Optical Fiber End Surface

Before connecting the optical fiber cable, clean the ferrule end surface with the dedicated cleaning device. In some cases, the cleaning of the ferrule side surface is effective.

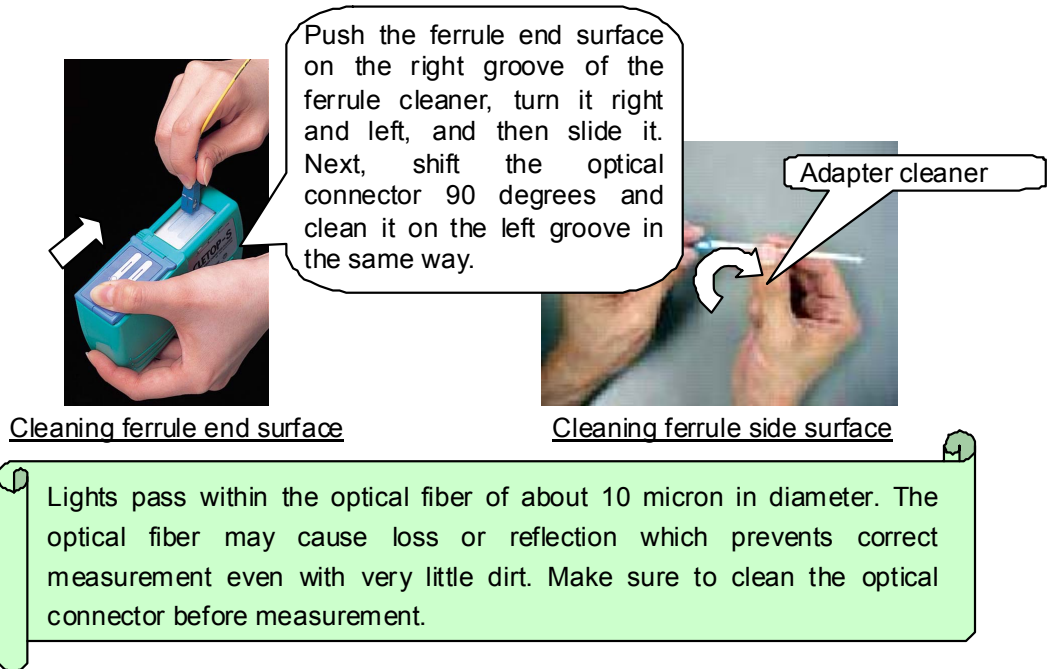


Figure 2.8-1 Cleaning the Ferrule

Cleaning the Measurement Port (Optical Connector)

Remove the replaceable connector to clean the ferrule end surface. Also, clean the dirt on sleeve within the replaceable connector with the adapter cleaner.

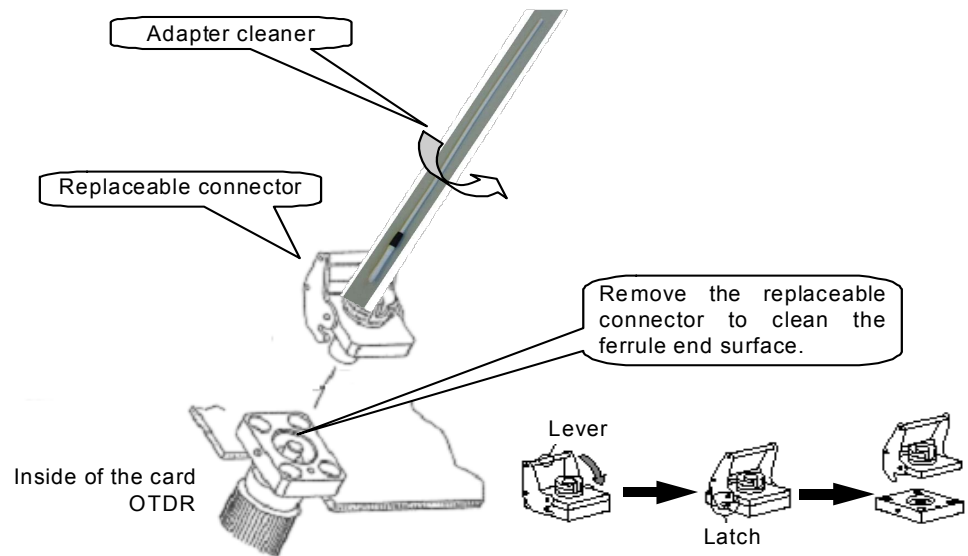


Figure 2.8-2 Cleaning the Optical Connector

Connect the optical fiber cable to the optical connector on the front panel.

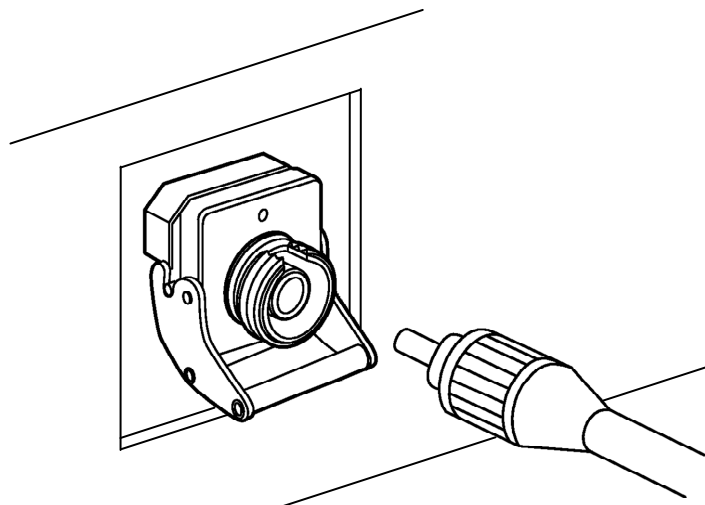


Figure 2.8-3 Connection of Optical Fiber Cable

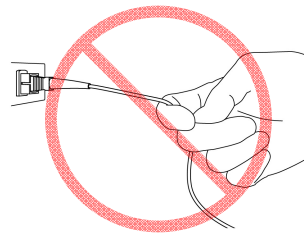
⚠ WARNING

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 eyes.

2.9 Cautions on Handling Optical Fiber Cables

Optical fiber cables may degrade in performance or be damaged if handled improperly.

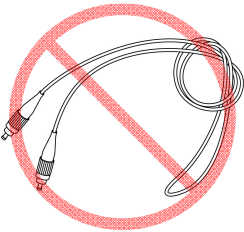
Note the following points when handling them.



CAUTION

Do not pull the cable when removing the connector.

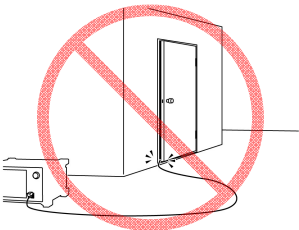
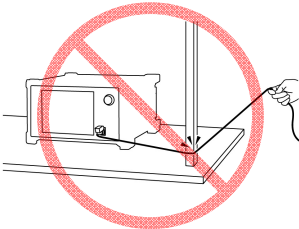
Doing so may break the optical fiber inside the cable, or remove the cable sheath from the optical connector.



CAUTION

Do not excessively bend, fold, or pinch an optical fiber cable.

Doing so may break the optical fiber inside the cable. Keep the bend radius of an optical fiber cable at 30 mm or more. If the radius is less, optical fiber cable loss will increase.

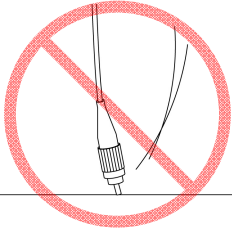


CAUTION

Do not excessively pull on or twist an optical fiber cable.

Also, do not hang anything by using a cable. Doing so may break the optical fiber inside the cable.

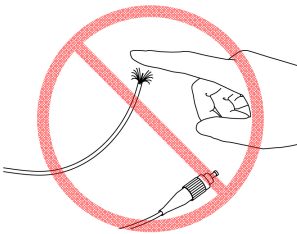




⚠ CAUTION

Be careful not to hit the end of an optical connector against anything hard such as the floor or a desk by dropping the optical fiber cable.

Doing so may damage the connector end and increase connection loss.



⚠ WARNING

Do not touch the end of a broken optical fiber cable.

The broken optical fiber may pierce the skin, causing injury.

⚠ CAUTION

Do not disassemble optical connectors.

Doing so may cause part to break or the performance to degrade.

2.10 Replacing the Optical Connector

The optical connector of the Card OTDR has SC as standard. This optical connector can be replaced with other connectors depending on the intended use.

To replace the optical connector

1. Pull the adapter lever towards you until the latch is released.
2. Remove the connector by lifting it.

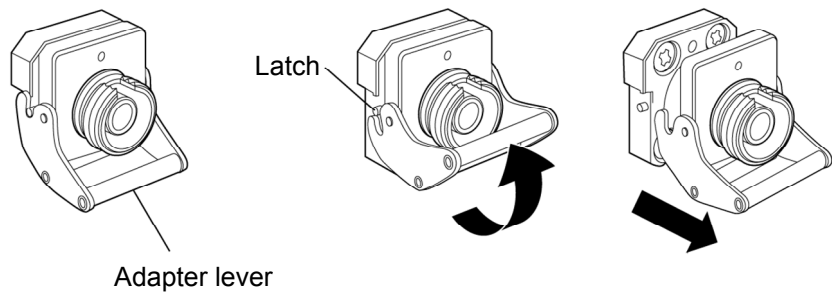


Figure 2.10-1 How to Remove the Optical Connector

For the types of optical connector, refer to Figure 2.10-2.

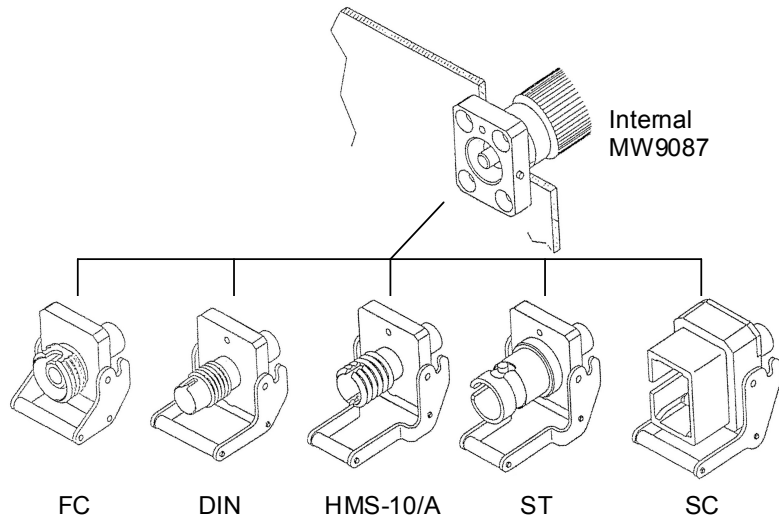


Figure 2.10-2 Types of Optical Connector

2.11 Precautions

Disconnect from communication equipments

If output pulses of the Card OTDR enter the communication device, the light receiving section of the device may be damaged. Before the measurement is started, remove the communication device from the optical fiber.

Limit to the interface

The Card OTDR has USB (serial port) and Ethernet. The serial port can be used only for the network setting of Ethernet. Also, the serial port and Ethernet cannot be used simultaneously.

Condensation

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

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 Measurement Method

This chapter explains the measurement procedures and calculation method.

3.1	Settings before Measurement.....	3-2
3.1.1	Network settings	3-2
3.1.2	System settings	3-2
3.2	Measurement Procedures	3-3
3.3	Setting Measurement Conditions.....	3-4
3.4	Measurement.....	3-5
3.5	Waveform Analysis	3-6
3.6	Calculation Method	3-7
3.6.1	Loss measurement.....	3-7
3.6.2	Return loss measurement	3-9
3.6.3	Event evaluation	3-10
3.6.4	Approximate line method.....	3-12
3.7	Obtaining State	3-14

3.1 Settings before Measurement

The network and system are set before performing the measurement.

3.1.1 Network settings

To control the Card OTDR via the Ethernet, set the following items.

- | | |
|---|---------|
| | Command |
| 1. Connect the Card OTDR and PC via the USB cable. | |
| 2. Set the Ethernet address and port number, etc. via RS-232C. | NET |
| 3. Set the Ethernet communication speed and flow control via RS-232C. | NETNEG |
| 4. Restart the Card OTDR. | RST |
| 5. Connect the Card OTDR and PC via the Ethernet cable. | |
| 6. Set the timeout time via the Ethernet. | CONNTM |

Other than the network settings, communicate with the Card OTDR via the Ethernet

3.1.2 System settings

Check the self diagnosis and set time of the Card OTDR via the Ethernet.

CAUTION

The optical pulse is output when performing self diagnosis. When the fiber is connected to the communication device, remove the fiber before performing the self diagnosis. The receiving parts of the communication device may be damaged depending on the optical pulse output from the Card OTDR.

- | | |
|---|---------|
| | Command |
| 1. Connect the Card OTDR and PC via the Ethernet cable. | |
| 2. Perform the self diagnosis. | SLFTST |
| 3. Check the date and time settings. | DATE2 |

3.2 Measurement Procedures

The following figure shows the fiber loss measurement procedures using the Card OTDR.

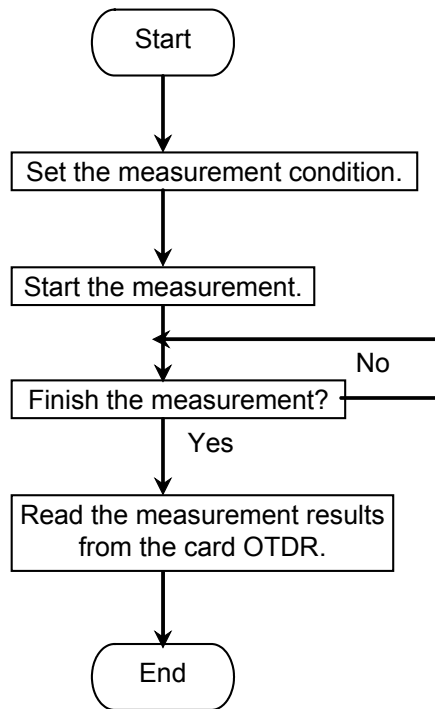


Figure 3.2-1 Procedures for Fiber Loss Measurement

3.3 Setting Measurement Conditions

The measurement conditions such as the distance range, correction values, and averaging process method are set.

	Command
1. Select the wavelength.	WLS
2. Set the pulse width.	PLA PLS
3. Set the distance range.	DSA DSR
4. Set the sampling mode.	RES
5. When the partial sampling is executed, set the range.	SSMP
6. Set IOR (fiber index of refraction).	IOR
7. Set the attenuation of the attenuator.	ATA ATT ATV
8. Set the backscatter coefficient level correction value.	CAL
9. Set the averaging processing method.	ALA
10. When the enhance mode is used, set the mode.	ENH

The INI command allows restoring measurement conditions to the factory default settings.

3.4 Measurement

The measurement is performed using the following procedures and the waveform data is obtained.

	Command
1. Connect the optical fiber to be measured to the Card OTDR.	
2. Set whether averaging process is executed or not.	AVG
3. Set whether smoothing process is executed or not.	SMTH
4. Set the distance offset for the optical connector of the Card OTDR.	OFS
5. Change Marker mode or Event table mode.	MES*
6. Set the approximate line method.	APR
7. Start the measurement.	LD
8. Query whether the measurement is finished or not.	STS
9. Query whether the waveform data is created or not.	WAV
10. Obtain the waveform data.	
SOR format	SRLV HDFG GETFILE
Binary format	DAT
11. When the averaging process is executed, query the number of times.	AVE

*: When Marker mode is selected, an event is not detected automatically.

The settings for the optical connector distance offset and approximate line method can be changed even after the measurement is completed. The data obtained with SOR format can be displayed with Trace View software.

3.5 Waveform Analysis

Waveform data analysis allows the detection of fiber reflection/loss occurrence positions and the measurement of reflection/loss amount.

	Command
1. Set the fiber far end threshold.	THF
2. Set the reflection threshold.	THR2
3. Set the splice loss threshold.	THS
4. Query the number of detected events.	AUT
5. Query the measurement result and event type of the event number.	EVN2
6. Query the measurement result of the splice loss.	SPLICE
7. Query the measurement result of the return loss.	REFLECT
8. Query the measurement result of the loss.	LOS2
9. Query the measurement result of all the losses.	TLOS MKDR

When thresholds are changed, events are redetected.

The INI command allows restoring thresholds to the factory default settings.

3.6 Calculation Method

The waveform analysis calculation method is as follows.

3.6.1 Loss measurement

Loss

LOS2 command displays the level difference of X1 marker and X2 marker in dB as the loss measurement result.

When the X1 marker level is higher than the X2 marker level, the loss will be a positive value.

$$Loss = L_1 - L_2$$

Loss: Loss (dB)

L₁: X1 marker level

L₂: X2 marker level

When connecting a fiber with a different Backscatter coefficient level correction value, sometimes the loss value may become negative.

LOS2 command is used to measure the loss between two points on the optical fiber.

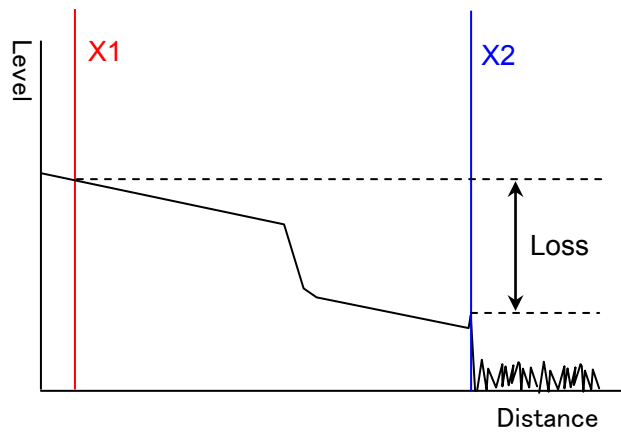


Figure 3.6.1-1 Measurement Method for Loss

Splice loss measurement

SPLICE command measures the loss of points where the optical fiber is connected with connectors, fusion splices, and couplers.

The measured waveform of splice points of the optical fiber looks like the solid line in the following figure. It is observed that the loss occurs over the distance of ΔL depending on the settings of pulse width and sampling count. In fact, loss only occurs at the splice points as shown by the dotted lines. LOS2 command cannot measure the loss shown with the dotted line.

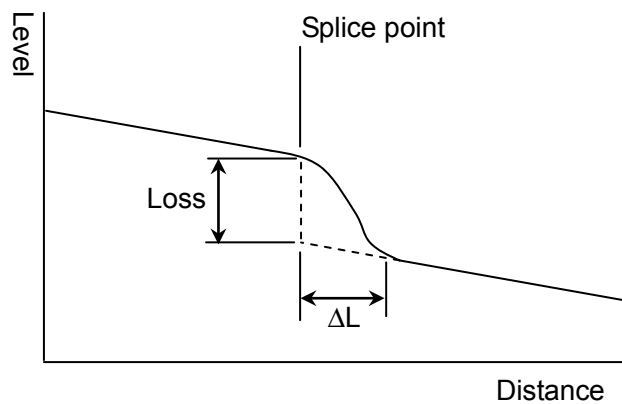


Figure 3.6.1-2 Example of Fiber Connection Measurement

Using SPLICE command, two approximate lines are generated from four markers range using the two-point method or the least square method. The level difference between the approximate lines at cursor B is the measured splice point loss.

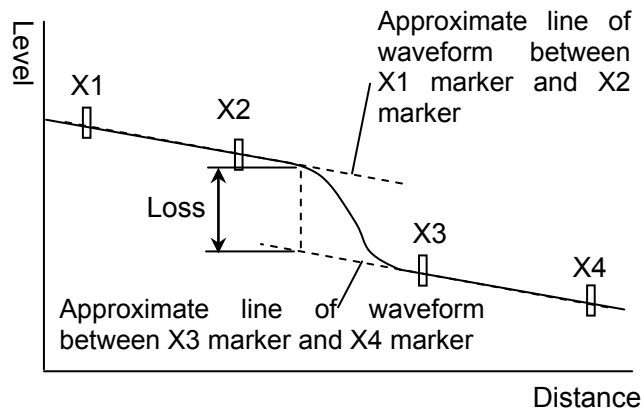


Figure 3.6.1-3 Splice loss Measurement Method

3.6.2 Return loss measurement

The return loss measurement method obtained with REFLECT command is as follows.

Detect the waveform local maximum level L_1 .

Measure the Rayleigh scattering level L_2 just before the local maximum level.

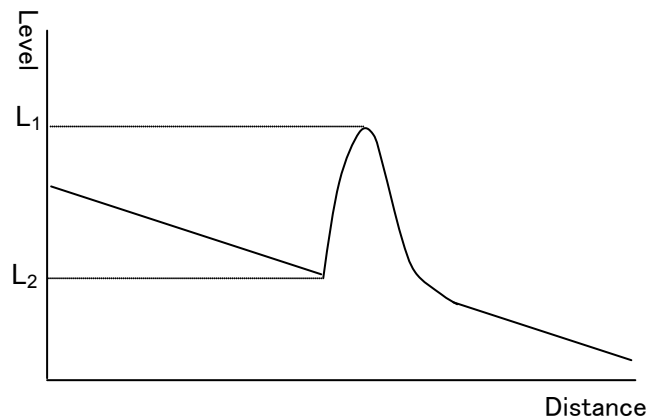


Figure 3.6.2-1 Return Loss Measurement Method

Obtain the return loss by the following formula.

$$ORL = -10\{\log_{10}(BSL) + \log_{10}(10^{\frac{|L_2 - L_1|}{5}} - 1)\}$$

$$BSL = \frac{BSC \times \alpha_R \times c \times PW}{2 \times IOR}$$

ORL: Return loss (dB)

α_R : Rayleigh scattering loss

c: Light velocity 3×10^8 (m/s)

BSC: Backscatter light coefficient

IOR: Index of refraction

PW: Pulse width

L_1 : Local maximum level

L_2 : Previous Rayleigh scattering level

3.6.3 Event evaluation

The event type evaluation method obtained with EVN2 command is as follows.

Reflection

Fresnel reflection has been generated with a light connector or mechanical splice.

Either one of the points below is evaluated as the reflection event.

- Point where the reflection rate measurement result is equal to or greater than the reflection threshold set with THR2 command.
- Point where the loss measurement result is equal to or greater than the splice loss threshold set with THS command.

Saturation

Point where the reflection light level is high and the measurement level is saturated among the reflection events.

Non-reflective

The loss without Fresnel reflection has been generated with fusion splice or fiber bending loss.

The point where the loss measurement result is equal to or greater than the splice loss threshold set with THS command is evaluated as the non-reflective event.

Group

When there are multiple points where the loss measurement result is equal to or greater than the splice loss threshold set with THS command, the points where the loss of each event cannot be measured due to its short interval are evaluated as the group event.

The measured loss result is displayed as the total of the losses of the multiple points.

Sometimes, reducing the pulse width makes it possible to separate the events.

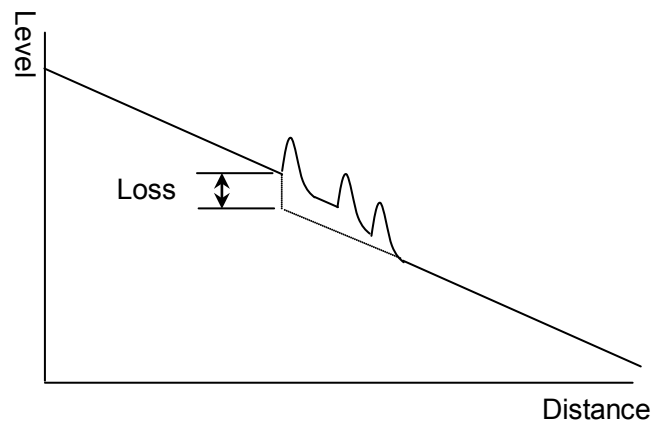


Figure 3.6.3-1 Group Event Loss

Far end

This is the far end of the fiber point or a break in point of the fiber.

The point where the loss measurement result is equal to or greater than the far end threshold set with THF command is evaluated as the far end event.

3.6.4 Approximate line method

The approximate line method set with APR command is explained.

Suppose, the two lines of L1 and L2 from the measurement data in order to obtain the splice point loss as shown in the figure below.

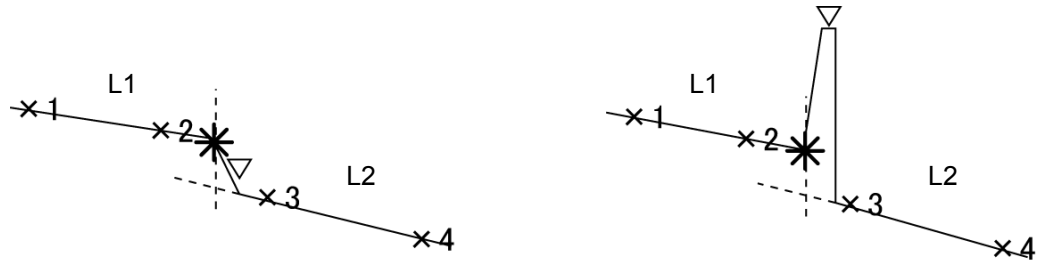


Figure 3.6.4-1 Method to Obtain Splice Point Loss

There are two methods, the least square method and two-point method, to obtain these lines.

Two-point method (2PA)

The line which goes through the two markers is the approximate line.

Least square method (LSA)

The least square method obtains the line that is the minimum distance variation from all data which exist between markers to the line.

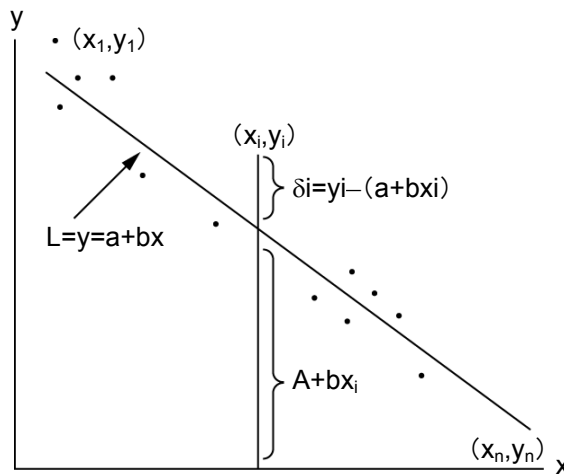


Figure 3.6.4-2 Approximate Line and Gap Amount

Line L is $y = a + bx$, when the variation of the distance from n points $(x_1, y_1), (x_2, y_2), \dots, (x_n, y_n)$ is the minimum as shown in the figure above.

Obtain gaps $\delta_1, \delta_2, \delta_3, \dots$ from each point to line L including variables a and b , and obtain variables a and b so that E , the sum of the square of δ_i (gap of each point) becomes the minimum to determine line L.

$$\delta_i = y_i - (a + bx_i)$$

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

The necessary and sufficient conditions for E to become the minimum with this formula are $\frac{\partial E}{\partial a} = 0$, $\frac{\partial E}{\partial b} = 0$.

When these formulas are solved, variables a and b can be obtained as follows.

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

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

3.7 Obtaining State

To obtain the information of the Card OTDR, use the following commands.

	Command
Error information query	ERR
System information query	MINF
Measurement state query	STS

For the detail of error messages, refer to Section 4.5 "Error Code."

Chapter 4 Command Reference

This chapter explains the command format, transmission procedure, and details of commands.

4.1	Command Format.....	4-2
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4.1 Command Format

The transmission format is classified as follows.

For text data:

Command Name	Data Part	TRM
--------------	-----------	-----

- **Command Name:** The control command or query command is entered.
- **Data Part:** Setting parameters of commands and values obtained from the Card OTDR are entered.
- **TRM:** When transmitting commands, the terminator (CR + LF) is added.
When receiving responses, the terminator (CR + LF) is added.

For binary data (control command):

Command Name	Data size (binary)	Data part (binary)
--------------	--------------------	--------------------

- **Command Name:** The control command is entered.
- **Data Size:** The byte length (big endian format) of the data part is indicated with 4 bytes.
- **Data Part:** The terminator is not added.

For binary data (response):

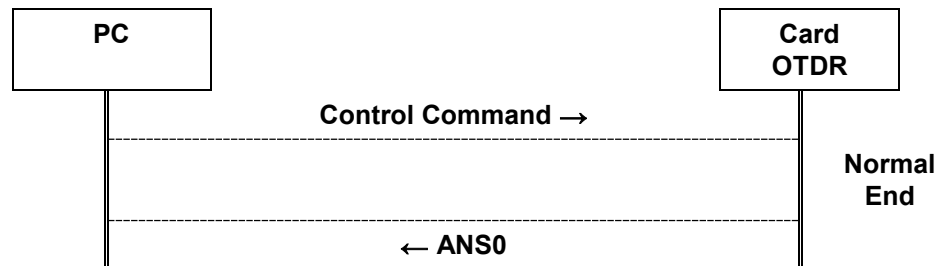
Data Size (binary)	Data Part (binary)
--------------------	--------------------

- **Data Size:** The byte length (big endian format) of the data part is indicated with 4 bytes.
- **Data Part:** The terminator is not added.

4.2 Transmission Procedures

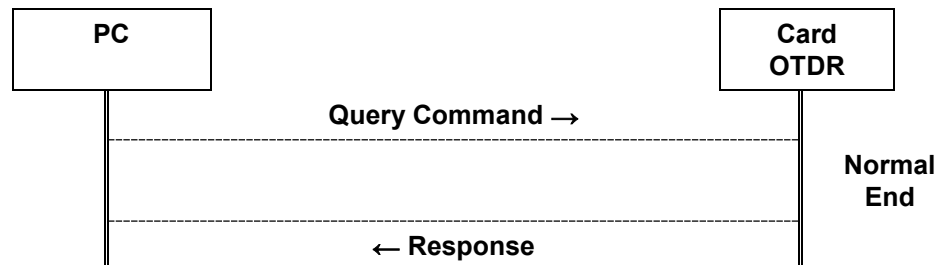
- (1) When the command is processed normally

When the control command is transmitted to the Card OTDR, processing the command normally returns ANS0. After it is received, the PC program (called the control program) transmits the following command.



For the query command, a response is returned.

After the response is received, the control program transmits the next command.

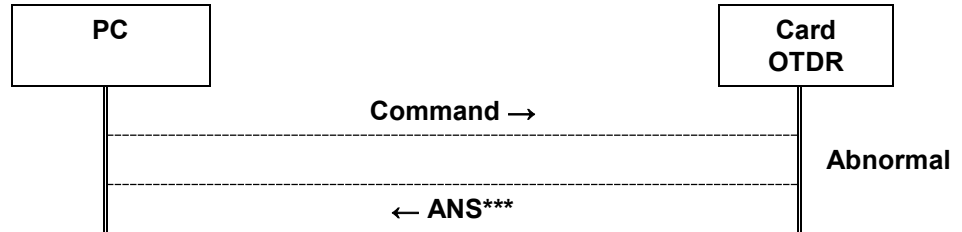


Note:

If the control program transmits the next command before the Card OTDR returns the response, the Card OTDR discards the command received by the time of response transmission (does not return the response for the command that has been received).

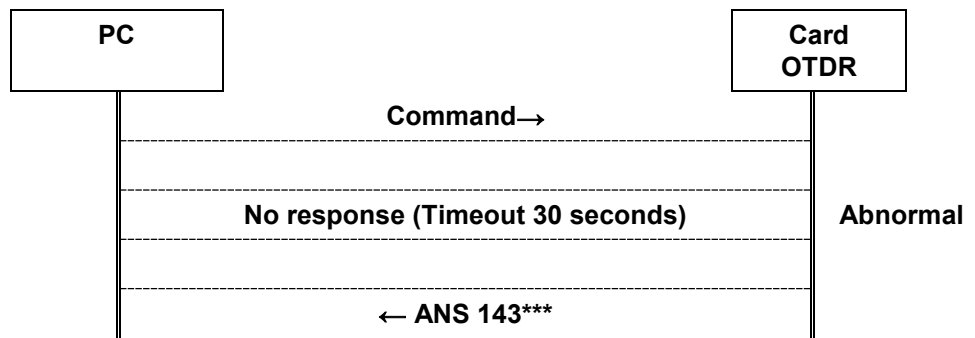
(2) When the command is not processed normally

When the Card OTDR cannot execute the received command, the negative response (ANS^{***}) is returned. Enter an error code to ^{***}.



(3) When there is no response

When the command from the control program stops for 30 seconds during transmission, the Card OTDR returns the error (ANS 143) as timeout.



4.3 Command List

Outline of each command is described in the following tables. Refer to 4.4 for the details of each command.

4.3.1 Alphabetical order

Table 4.3.1-1 Command List

Control Command	Query Command	Function
A		
ALA	ALA?	Averaging Mode Setup
APR	APR?	Approximate Line Method Setup
ATA	ATA?	Attenuator Setup in Auto Mode
ATT	ATT?	Attenuator Setup
–	ATV?	Query for available Attenuator
–	AUT?	Query for the result of Auto Search
–	AVE?	Query for Average Mode
AVG	AVG?	Average Setup
B		
–	BSL?	Query for Backscatter Coefficient Level
C		
CAL	CAL?	Backscatter Level Calibration Setup
CONNTM	CONNTM?	Timeout Interval Setup
D		
–	DAT?	Query for Waveform Data
DATE2	DATE2?	Date & Time Setup
DSA	DSA?	Distance Range Mode Setup
DSR	DSR?	Distance Range Setup
DWNLD	DWNLD?	Software Download
E		
–	ERR?	Query for Error Status
ENH	ENH?	High Dynamic Range Mode Setup
–	EVN2?	Query for Event Analysis Result
G		
–	GETFILE?	Data File Acquisition of Waveform
H		
HDFG	HDFG?	Data Flag Setup

Table 4.3.1-1 Command List (Cont'd)

Control Command	Query Command	Function
I		
INI	–	Initialization
IOR	IOR?	IOR Setup
L		
LD	LD?	OTDR Measurement Start/Stop
–	LOS2?	Query for Insertion Loss Measurement Results
M		
MES	MES?	Mode Setup
–	MINF?	Query for the Equipment Profile
–	MKDR?	Query for Total Insertion Loss Analysis Range
N		
NET	NET?	Network Configuration
NETNEG	NETNEG?	Ethernet Speed Setup
O		
OFS	OFS?	Relative Distance Setup
P		
PLA	PLA?	Pulse Width Mode Setup
PLS	PLS?	Pulse Width Setup
R		
–	REFLCT?	Query for Return Loss
RES	RES?	Sampling Auto Setup
RST	–	Reset Execution
S		
SETFILE	–	Waveform Data File Transfer
SLFTST	SLFTST?	Self-diagnosis
–	SMPINF?	Query for Sampling Conditions
SMTH	SMTH?	Smoothing Setup
–	SPLICE?	Query for Splice Loss Measurement
SRLV	SRLV?	File Data Format Setup
SSMP	SSMP?	Partial Sampling Mode Setup
–	SSMPINF?	Query for Partial Sampling Value
–	STS?	Query for the Equipment Status (OTDR)

Table 4.3.1-1 Command List (Cont'd)

Control Command	Query Command	Function
T		
THF	THF?	Fiber-end Threshold Setup
THR2	THR2?	Reflection Threshold Setup
THS	THS?	Slice Loss Threshold Setup
–	TLOS?	Query for Total Loss
W		
–	WAV?	Query for Waveform Data Status
WLS	WLS?	Wavelengths Setup

4.3.2 Setup Measurement Condition

CNT: Control command

QUR: Query command

RSP: Response for query command

Table 4.3.2-1 Commands for Measurement Conditions

No	Function	Message		Remarks
1	Wavelengths Setup	CNT	WLS w	w: Wavelength: 1 = 1 μ m 0: Current Wavelength [] can be omitted, 1: All n: Wavelength w1, ..., wn: Wavelength
		QUR	WLS? {[0] 1}	
		RSP	WLS w WLS n, w1, w2, wn	
2	Distance Range Mode Setup	CNT	DSA	0: Manual Setup 1: Automatic Setup
		QUR	DSA?	
		RSP	DSA {0 1}	
3	Distance range	CNT	DSR d	d: Distance Range 1 = 1 m Available range depends on pulse width and sampling mode
		QUR	DSR?	
		RSP	DSR d	
4	Pulse Width Mode Setup	CNT	PLA	0: Manual Setup 1: Automatic Setup
		QUR	PLA?	
		RSP	PLA {0 1}	
5	Pulse width Setup	CNT	PLS p	p: Pulse width 1 = 1 ns Available pulse width depends on distance range.
		QUR	PLS?	
		RSP	PLS p	
6	High Dynamic Range Mode Setup	CNT	ENH {0 1}	m: Mode 0: Standard 2: High Dynamic Range
		QUR	ENH?	
		RSP	ENH m	
7	IOR Setup	CNT	IOR i	i: IOR 1=1 1.000000 to 1.999999
		QUR	IOR:	
		RSP	IOR i	
8	Average Mode Setup	CNT	ALA m, [v]	m: Mode 0: Manual by number 1: Manual by time 2: Auto V= Set value 1=1 Number of time/ 1 second [] can be omitted. Vn: Number Vt: Time
		QUR	ALA?	
		RSP	ALA m, Vn, Vt	
9	Sampling Mode Setup	CNT	RES {0 1 3}	0: Coarse 1: Medium 3: Fine
		QUR	RES?	
		RSP	RES {0 1 3}	

Table 4.3.2-1 Commands for Measurement Conditions (Cont'd)

No	Function	Message		Remarks
10	Partial Sampling Mode Setup	CNT	SSMP s,r,q	s: Sampling start 1.00=1.00 m r: Resolution 1.00=1.00 m p: Number of point 0: 5001pt 1: 20001 or 25001 pt 2:100001 or 125001 pt
		QUR	SSMP?	
		RSP	SSMP s,r,q	
11	Query for Sampling Point and Resolution	CNT	---	p: Sampling point r: Resolution 1.00=1.00 m
		QUR	SMPINF?	
		RSP	SMPINF p,r	
12	Query for Partial Sampling Status	CNT	---	s: Sampling start distance 1.00=1.00 m r: Resolution 1.00=1.00 m p: Number of points
		QUR	SSMPINF?	
		RSP	SSMPINF s,r,p	
13	Attenuation Auto Setup	CNT	ATA	0: Manual Setup 1: Automatic Setup
		QUR	ATA?	
		RSP	ATA {0 1}	
14	Attenuator Setup	CNT	ATT a	a: Attenuation 1 = 1 dB "****" in Full trace mode
		QUR	ATT?	
		RSP	ATT a	
15	Query for available Attenuation	CNT	---	P: Pulse width a1, ..., an: Attenuation
		QUR	ATV? p	
		RSP	ATV a1,a2,an	
16	Query for Backscatter Coefficient Level	CNT	---	b: Backscatter coefficient level at current pulse width 1 = -1 dB
		QUR	BSL?	
		RSP	BSL b	
17	Backscatter Level Calibration Setup	CNT	CAL n	n: -9.99 to +9.99
		QUR	CAL?	
		RSP	CAL n	
18	Fiber-end Threshold Setup	CNT	THF s	s: Threshold, 1 = 1 dB 1 to 99 dB, (1 dB step)
		QUR	THF?	
		RSP	THF s	
19	Reflection Threshold Setup	CNT	THR2	s: Threshold,1=1 dB -60 to -20 dB (0.1 dB step)
		QUR	THR2?	
		RSP	THR2 s	
20	Slice Loss Threshold Setup	CNT	THS s	s: Threshold, 1 = 1 dB 0.01 to 9.99 dB (0.01 dB step)
		QUR	THS?	
		RSP	THS s	

4.3.3 Setup for Measurement

Table 4.3.3-1 Setup for Measurement

No	Function	Message		Remarks
1	Average Setup	CNT	AVG {0 1}	0: Real time measurement 1: Average Measurement
		QUR	AVG?	
		RSP	AVG {0 1}	
2	Linear Approximation Method Setup	CNT	APR {0 1}	0: 2PA 1: LSA
		QUR	APR?	
		RSP	APR {0 1}	
3	OTDR Measurement Start/Stop	CNT	LD {0 1 2}	0: Measurement stopped 1: Start normal measurement (In progress) 2: Start partial sampling measurement (In progress)
		QUR	LD?	
		RSP	LD {0 1 2}	
4	Mode Setup	CNT	MES {0 1}	0: Marker mode 1: Event table mode
		QUR	MES?	
		RSP	MES {0 1}	
5	Relative Distance Setup	CNT	OFS 1	1: Relative distance (zero point) 1 = 1 m
		QUR	OFS?	
		RSP	OFS 1	
6	Smoothing ON/Off Setup	CNT	SMTH {0 1}	0: Smoothing OFF 1: Smoothing ON
		QUR	SMTH?	
		RSP	SMTH {0 1}	

4.3.4 Query for Measurement Results

Table 4.3.4-1 Commands for Querying Measurement Results

No	Function	Message		Remarks
1	Query for Insertion Loss Measurement	CNT	---	e: Event position x1: Position X1 x2: Position X2 x3: Position X3 x4: Position X4 v: Event loss
		QUR	SPLICE? e,x1,x2,x3,x4	
		RSP	SPLICE? e,x1,x2,x3,x4,v	
2	Query for Return Loss Measurement Result	CNT	---	e: Event position p: Peak position v: Return loss
		QUR	REFLCT? e,p	
		RSP	REFLCT e,p,v	
3	Query for Loss Measurement Result	CNT	---	x1: Marker position X1 x2: Marker position X2 v: Loss
		QUR	LOS2? x1,x2	
		RSP	LOS2 x1,x2,v	
4	Query for the result of Auto Search	CNT	---	e: Number of Event d: Fiber length l: Total Loss r: Total Return loss
		QUR	AUT?	
		RSP	AUT e,d,l,r	
5	Query for Event Measurement Result	CNT	---	e: Event number d: Distance s: Slice loss r: Return loss l: Total Loss t: Events, types reported
		QUR	EVN2? e	
		RSP	EVN2 e,d,s,r,l,t	
6	Query for Total Loss	CNT	---	x1: Marker Position X1 x2: Marker Position X2 t: Total Loss
		QUR	TLOS? x1,x2	
		RSP	TLOS x1,x2,t	
7	Query for Waveform Data	CNT	---	s: Data start distance [] can be omitted. e: Data end distance [] can be omitted. k: Data decimation rate [] can be omitted. ds: Data length d: Data
		QUR	DAT? [s,e,[k]]	
		RSP	ds,d	
8	Query for Average Result	CNT	---	m: Average mode 0: Manual, 1: Auto k: number b: time
		QUR	AVE?	
		RSP	AVE m,k,b	
9	Query for Total Loss Analysis Range	CNT	---	s: Start point e: End point
		QUR	MKDR?	
		RSP	MKDR s,e	

4.3.5 Query for Statuses

Table 4.3.5-1 Command for Querying Statuses

No	Function	Message		Remarks
1	Query for the OTDR Status	CNT	---	1: In pre-process of measurement 2: Under measurement 3: In post-process of measurement 4: Stopped
		QUR	STS?	
		RSP	STS {1 2 3 4}	
2	Query for Waveform Data Status	CNT	---	0: No waveform data 1: Waveform data is available
		QUR	WAV?	
		RSP	WAV {0 1}	
3	Query for Error Information	CNT	---	e: Error number (ANS0 to ANS255)
		QUR	ERR?	
		RSP	ERR e	

4.3.6 File Data Access

Table 4.3.6-1 Command for File Data Access

No	Function	Message		Remarks
1	Query for Data File	CNT	---	s: Data size d: File data
		QUR	GETFILE?	
		RSP	s,d	
2	File Data Transmission	CNT	SETFILE s,d	s: File size d: File data
		QUR	---	
		RSP	---	
3	File Data Format Setup	CNT	SRLV {1 2 3}	1: Key event data block only 2: Data point block only 3: Both key event and data point blocks
		QUR	SRLV?	
		RSP	SRLV {1 2 3}	
4	Data Flag Setup	CNT	HDFG {0 1 2}	0: BC 1: RC 2: OT
		QUR	HDFG?	
		RSP	HDFG {0 1 2}	

4.3.7 System Maintenance

Table 4.3.7-1 Command for System Maintenance

No	Function	Message		Remarks
1	Date & Time Setup	CNT	DATE2 y,m,d,h,mm,s, diff	y: year m: month d: day h: hour mm: minute s: second diff: Time difference from UTC
		QUR	DATE2?	
		RSP	DATE2 y,m,d,h,mm,s, diff	
2	Self-Diagnostics	CNT	SLFTST	l: optical level w: warming up p: power voltage t: internal temperature 0: Normal 1 or more: Failure
		QUR	SLFTST?	
		RSP	SLFTST l,w,p,t	
3	Query for System Information	CNT	---	m: maker n: model name c: comment s: serial number mac: mac address v: software version
		QUR	MINF?	
		RSP	MINF m,n,c,s,mac,v	
4	Software Update	CNT	DWNLD s,d	s: File size d: File data
		QUR	DWNLD?	
		RSP	DWNLD {0 1 2 3}	

4

Command Reference

4.3.8 Network Configuration

Table 4.3.8-1 Command for Network Configuration

No	Function	Message		Remarks
1	Timeout Interval Setup	CNT	CONNTM t	t: Timeout interval 1 = 1 s
		QUR	CONNTM?	
		RSP	CONNTM t	
2	Network Configuration	CNT	NET i,p,m,g	i: IP address p: port number m: Netmask g: Gateway
		QUR	NET?	
		RSP	NET i,p,m,g	
3	Ethernet Speed Setup	CNT	NETNEG t,f	t: Communication speed (10 or 100 or AUTO) f: Flow control F:Full H: Half
		QUR	NETNEG?	
		RSP	NETNEG t,f	
4	Timeout Interval for Alarm Setup	CNT	ATO t	t: Timeout interval 1 = 1 s
		QUR	ATO?	
		RSP	ATO t	

4.3.9 Other Setup

Table 4.3.9-1 Command for Other Setup

No	Function	Message		Remarks
1	Reset	CNT	RST	Resets the Card OTDR.
		QUR	---	
		RSP	---	
2	Initialization	CNT	INI	Sets measurement conditions to the factory default.
		QUR	---	
		RSP	---	

4.4 Command Details

4.4.1 Description of Message Explanations

Command Syntax

"_" between the header and the arguments of the command means a space.

Effective argument range

Entered value in dB will be rounded off to four decimal places.

It will also be converted to a discrete value, for example in 0.1 dB steps, according to the definition of each command.

The distance argument entry in IOR calibration mode works as follows. The entered value is inversely converted to a law distance and rounded by current physical data resolution. After acceptable range verification (IOR=1.5), it will be used as an argument of the command.

4.4.2 Measurement Condition Setup

(1) Averaging Mode Setup

Command	ALA	
Description	Set the number of times for averaging or number of seconds used in measurement.	
Control	ALA_<mode>,[<argument>]	
	Mode	0: Times 1: Seconds 2: Auto For switching to Auto Times (Seconds), set to Times (Seconds) first, and then set to Auto.
	Set value	Times: 1 to 9999 times Seconds: 1 to 9999 seconds Auto: none
Query	ALA?	
Response	ALA_<mode>,< Set times >,< Set seconds >	
	Mode	0: Times 1: seconds 2: Auto
	Set number	1 to 9999 times
	Set number	1 to 9999 seconds
Remarks	When the mode is Auto, the value set with the auto setting will be returned. When the mode is Auto and in case of no waveform, the response will be ALA 2,***,*** . [] can be omitted.	

(2) Attenuator Setup in Auto Mode

Command	ATA	
Description	Set Attenuator in Auto mode.	
Control	ATA	
Query	ATA?	
Response	ATA_{0 1}	
	0	Manual Setup
	1	Automatic Setup
Remarks	When Pulse width is in Auto mode, Attenuator will be set to Auto mode. Also, when Attenuator is changed to Auto mode, the waveform data will be erased.	

(3) Attenuator Setup

Command	ATT	
Description	Sets Attenuation.	
Control	ATT_<attenuation>	
	Attenuation	Number rounded down to three decimal places Unit: dB Available attenuation range depends on Pulse width. Available attenuation rang can be obtained using ATV?_<Pulse width> command. When Pulse width setting is in Auto mode, Attenuator will be set to Auto mode automatically.
Query	ATT?	
Response	ATT_<attenuation>	
	Attenuation	Numeric value Unit : dB When Attenuator is in Auto mode, the response will be "ATT ***". When Pulse width is in Auto mode, the response will be "ANS103".
Remarks	When Pulse width is in Auto mode, Attenuator will be set to Auto mode. When Attenuation is changed, Auto mode will be released. When the setup value is changed with the command, the waveform data will be erased. However, when Attenuator is set to Auto mode, the waveform data will be erased even without setup value change. Also, if measurement is being executed, the measurement will stop, and it will restart after the command processing has been executed.	

(4) Query for Available Attenuator

Command	ATV	
Description	Queries available Attenuation values under the specific Pulse width.	
Control	---	
Query	ATV?_<pulse width>	
	Pulse width	Numeric value Unit: ns
Response	ATV_<attenuation>,[<attenuation>]	
	Attenuation	Number of three decimal places Unit: dB
Remarks	---	

(5) Query for Backscatter Coefficient Level

Command	BSL	
Description	Queries Backscatter coefficient level under the present Pulse width.	
Control	---	
Query	BSL?	
Response	BSL_<backscatter coefficient level>	
	Backscatter coefficient level	Numeric value Unit: dB 1=-1 dB When Pulse width is in Auto mode or in case of no waveform data, the response will be BSL ***.
Remarks	---	

(6) Backscatter Level Calibration Setup

Command	CAL	
Description	Sets the coefficient value to calibrate Backscatter level.	
Control	CAL_<coefficient value>	
	Coefficient value	Number rounded down to three decimal places Unit: dB Acceptable coefficient range: -9.99 to +9.99 In case of waveform data, changing the setup value with CAL command will re-execute auto search. When the setup range is exceeded (including integer or negative numbers), the response will be ANS41. When the parameter data format is incorrect, the response will be ANS42.
Query	CAL?	
Response	CAL_<coefficient value>	
	Coefficient value	-9.99 to +9.99
Remarks	---	

(7) Distance Range Mode Setup

Command	DSA	
Description	Sets the distance range control in Automatic Setup mode.	
Control	DSA	
Query	DSA?	
Response	DSA_{0 1}	
	0	Manual Setup
	1	Automatic Setup
Remarks	Waveform data will be erased as the result of DSA command execution.	

(8) Distance Range Setup

Command	DSR	
Description	Sets the distance range used at the measurement.	
Control	DSR_< Distance Range >	
	Distance Range	Value without IOR compensation. Unit: m Available distance range per present sampling mode: Medium: No less than 100 km Coarse or Fine: No less than 1 km
Query	DSR?	
Response	DSR_<Distance Range >	
	Distance Range	Value without IOR compensation. Unit: m In case of no waveform data in Automatic distance range mode, the response will be "DSR ***".
Remarks	Automatic distance range Setup mode will be released as the result of DSR command execution. The waveform data will be erased when Distance range is changed.	

(9) High Dynamic Range Mode Setup

Command	ENH	
Description	Sets high dynamic range mode for measurements	
Control	ENH_{0 1}	
	0	Standard Mode
	1	High dynamic range mode Available when the pulse width is between 50 ns to 2000 ns.
Query	ENH?	
Response	0	Standard Mode
	1	High dynamic range mode
Remarks	The wave form data will be erased when the high dynamic range mode is changed.	

(10) IOR Setup

Command	IOR	
Description	Sets IOR for measurements.	
Control	IOR_<IOR value>	
	IOR value	1.000000 to 1.999999
Query	IOR?	
Response	IOR?_ <IOR value>	
	IOR value	1.000000 to 1.999999
Remarks	---	

(11) Pulse Width Mode Setup

Command	PLA	
Description	Sets the pulse width to Automatic Setup mode.	
Control	PLA	
Query	PLA?	
Response	PLA_{0 1}	
	0	Manual Setup
	1	Automatic Setup
Remarks	Waveform data will be erased as the result of PLA command execution. Attenuator control is also set in Automatic Setup mode.	

(12) Pulse Width Setup

Command	PLS	
Description	Sets the pulse width for measurements.	
Control	PLS_<pulse width>	
	Pulse width	Numeric value Unit: ns The settable range varies with the distance range. Refer to Appendix B "Relationship between Pulse Width and Distance Range".
Query	PLS?	
Response	PLS_<pulse width>	
	Pulse width	Numeric value Unit: ns
Remarks	Automatic pulse width Setup mode will be released as the result of PLS command execution. The wave form data will be erased when the pulse width is changed. When the pulse width is Auto and in case of no waveform, the response will be PLS ***.	

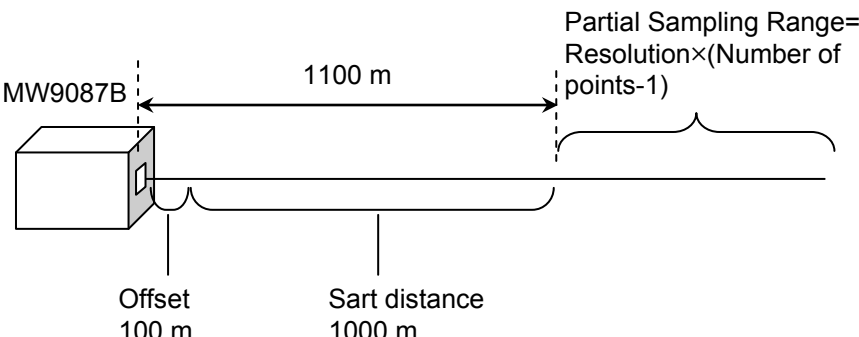
(13) Sampling Mode Setup

Command	RES	
Description	Sets Sampling Mode for measurements.	
Control	RES_{0 1 3}	
	0	Coarse: 5001 points
	1	Medium: 25001 points Available when Distance range is 1 km or more.
	3	Fine: 125001 points Available when Distance range is 100 km or more.
Query	RES?	
Response	RES_{0 1 3}	
	0	Coarse
	1	Medium
	3	Fine
Remarks	The wave form data will be erased when the sampling mode is changed.	

(14) Query for Sampling Point and Resolution

Command	SMPINF	
Description	Queries sampling information.	
Control	— — —	
Query	SMPINF?	
Response	SMPINF_< number of points >,<modified resolution(m)>	
	Number of points	Numeric value
	Modified resolution	Value without IOR compensation. Unit: m
Remarks	When distance range is in Auto mode and in case of no waveform data, the response will be SMPINF ***,***.	

(15) Partial Sampling Measurement Condition Setup

Command	SSMP	
Description	Sets the conditions for the partial sampling measurements.	
Control	SSMP_< start distance(m)>,< resolution(m)>,< number of points >	
	Start distance	Set the sampling start distance. Value rounded down to two decimal places with IOR compensation. Unit: m
	Resolution	Value without IOR compensation. Unit: m
	Number of points	0: 5001 points 1: 20001 points or 25001 points 2: 100001 points or 125001 points
Query	SSMP?	
Response	SSMP_< start distance(m)>,< resolution(m)>,< number of points >	
	Start distance	Set the sampling start distance. Value rounded down to two decimal places with IOR compensation. Unit: m
	Resolution	Value without IOR compensation. Unit: m
	Number of points	0: 5001 points 1: 20001 points or 25001 points 2: 100001 points or 125001 points
Remarks	<p>When distance offset is set with OFS command, the start distance is the distance from the distance offset.</p> <p>Example: When the position of start distance is set at 1000 m and distance offset at 0 m, then absolute distance of the start distance is 1000 m.</p> <p>When distance offset is 100 m, absolute distance of the start distance is 1100 m.</p>  <p style="text-align: right;">Partial Sampling Range= Resolution×(Number of points-1)</p>	

(16) Query for Partial Sampling Value

Command	SSMPINF	
Description	Queries set value for the partial sampling measurements.	
Control	---	
Query	SSMPINF?	
Response	SSMPINF_<Compensation start distance(m)>, <Modified resolution(m)>, < Sampling point >	
	Compensation start distance	A number rounded down to two decimal places in the resolution of measurement data with IOR compensation. Unit: m
	Resolution	Value with IOR compensation. Unit: m
	Sampling point	Numeric value
Remarks	---	

(17) Fiber-end Threshold Setup

Command	THF	
Description	Sets threshold.	
Control	THF_<threshold>	
	Threshold	Fiber -end threshold, integer in dB. Available threshold value: Integer from 1 to 99 dB In case of waveform data, changing the setup value with THF command will re-execute auto search. When the setup range is exceeded (including integer or negative numbers), the response will be ANS41. When the parameter data type is incorrect, the response will be ANS42.
Query	THF?	
Response	THF_<threshold>	
	Threshold	1 to 99 dB
Remarks	---	

(18) Reflection Threshold Setup

Command	THR2	
Description	Sets Reflection threshold.	
Control	THR2_<threshold>	
	Threshold Value	<p>Reflection threshold, value rounded down to one decimal place in dB. Available threshold value: -60.0 dB to -20.0 dB In case of waveform data, changing the setup value with THR2 command will re-execute auto search. When the setup range is exceeded (including integer or negative numbers), the response will be ANS41. When the parameter data type is incorrect, the response will be ANS42.</p>
Query	THR2?	
Response	THR2_<threshold>	
	Threshold Value	-60.0 dB to -20.0 dB
Remarks	---	

(19) Splice Loss Threshold Setup

Command	THS	
Description	Sets Slice loss threshold.	
Control	THS_<threshold>	
	Threshold	<p>Splice loss threshold, value rounded down to two decimal places in dB. Available threshold value: 0.01 dB to 9.99 dB In case of waveform data, changing the setup value with THS command will re-execute auto search. When the setup range is exceeded (including integer or negative numbers), the response will be ANS41. When the parameter data type is incorrect, the response will be ANS42.</p>
Query	THS?	
Response	THS_<threshold>	
	Threshold	0.01 dB to 9.99 dB
Remarks	---	

(20) Wavelength Setup

Command	WLS	
Description	Sets the measurement wavelength.	
Control	WLS_<wavelength>	
	Wavelength	Value rounded down to three decimal places Unit: μm The wavelength to be set varies with the optical units. The settable wavelength will be obtained by the query command, WLS? 1.
Query	WLS?_{0 1}	
	0	Queries currently set wavelength
	1	Queries all of the available wavelengths
Response	In case of the argument = "0": WLS_<wavelength>	
	In case of argument = "1": WLS_<number of wavelength n>,<wavelength 1>,...,<wavelength n>	
Remarks	[] can be omitted. When WLS command is executed, the waveform data will be erased.	

4.4.3 Settings for Measurement

(1) Linear Approximation Method Setup

Command	APR	
Description	Sets the approximate line method to 2PA or LSA.	
Control	APR_{0 1}	
	0	2PA (Two-point method)
	1	LSA (Least square method)
Query	APR?	
Response	APR_{0 1}	
	0	2PA
	1	LSA
Remarks	---	

(2) Average Setup

Command	AVG	
Description	Sets the real time measurement or average measurement.	
Control	AVG_{0 1}	
	0	Real Time Measurement
	1	Average Measurement
Query	AVG?	
Response	AVG_{0 1}	
	0	Real Time Measurement
	1	Average Measurement
Remarks	If the average measurement is being executed, the measurement will stop, and it will restart after the command processing has been executed. However, if the setup value is not changed, nothing will be executed.	

(3) OTDR Measurement Start/Stop

Command	LD	
Description	Start or stop the OTDR measurements.	
Control	LD_{0 1 2}	
	0	Stop measurement.
	1	Start measurement.
	2	Start Partial sampling measurement.
Query	LD?	
Response	LD_{0 1 2}	
	0	Measurement stopped.
	1	Measurement in progress
	2	Partial sampling Measurement in progress.
Remarks	<p>If LD_1 is executed while the measurement is being executed, the measured waveform will be erased, and the measurement will be restarted from the beginning. When LD_2 is executed while the measurement is being executed, an error is returned.</p> <p>For the partial sampling measurement, if LD_2 is executed with improper setup of the start distance and end distance, an error is returned.</p>	

(4) Mode Setup

Command	MES	
Description	Change Marker mode or Event table mode.	
Control	MES_{0 1}	
	0	Marker mode
	1	Event table mode
Query	MES?	
Response	MES_{0 1}	
	0	Marker mode
	1	Event table mode
Remarks	When Marker mode is selected, an event is not detected automatically.	

(5) Relative Distance Setup

Command	OFS	
Description	Set relative distance as the relative zero point.	
Control	OFS_< offset distance>	
	Offset distance	Value rounded down to three decimal places. Unit: m From 0.00 m to the current distance range When distance range is in Auto mode and in case of no waveform data, the response will be ANS60.
Query	OFS?	
Response	OFS_< offset distance >	
	Offset distance	Value rounded down to three decimal places. Unit: m When distance range is in Auto mode and in case of no waveform data, the response will be OFS ***.
Remarks	The distance set by OFS is the IOR compensation value when the IOR set value is exceeding 1.5, the higher value than the setting distance range can be set. When the distance range shorter than the relative distance value is set by the DSR command, the response will be OFS 0.00.	

(6) Smoothing On/Off Setup

Command	SMTH	
Description	Sets the smoothing processing ON/OFF.	
Control	SMTH_{0 1}	
	0	Smoothing OFF
	1	Smoothing ON
Query	SMTH?	
Response	SMTH_{0 1}	
	0	Smoothing OFF
	1	Smoothing ON
Remarks	---	

4.4.4 Querying Measurement Results

(1) Query for Auto Search Result

Command	AUT	
Description	Queries the auto search result.	
Control	---	
Query	AUT?	
Response	AUT_<number of events>,<fiber length>,<end to end loss>,<total return loss>	
	Number of events	0 to 99
	Fiber length	Value rounded down to three decimal places with IOR compensation. Unit: m When the measurement is unavailable, the response will be ***.
	Total loss	Value rounded down to three decimal places. Unit: dB When the measurement is unavailable, the response will be ***.
	Total return loss	Value rounded down to two decimal places. Unit: dB When the measurement is unavailable, the response will be ***. The saturation information is added as the first byte of the response data. <: Saturated _: Not saturated
Remarks	---	

(2) Query for Average Mode

Command	AVE	
Description	Queries the number of averages (seconds).	
Control	---	
Query	AVE?	
Response	AVE_ <average mode>, <number of average>, <time of average>	
	Average mode	0: Manual Setup 1: Automatic Setup
	Number of average	Numeric value Unit: number In case of no waveform or real time measurement, the response will be 0.
	Time of average	Numeric value Unit: second In case of no waveform or real time measurement, the response will be 0.
Remarks	---	

(3) Query for Waveform Data

Command	DAT	
Description	Queries waveform data.	
Control	---	
Query	DAT?_ [<data start distance>, <data end distance> [, <decimation rate>]]	
	Data start distance	Value rounded down to three decimal places with IOR compensation. Unit: m Value from the sampling start distance to sampling end distance. If omitted, the sampling start position is specified.
	Data end distance	Value rounded down to three decimal places with IOR compensation. Unit: m Value from the sampling start distance to sampling end distance. If omitted, the sampling end position is specified.
	Decimation rate	The number of points The skip interval for output data is specified. 0 to 150000 (according to the current resolution) 0 when omitted.
Response	<data length> <data>	
	Data length	Number of output data points in 32-bit binary format.
	Data	One item of the data is indicated with 16 bits. The data is divided into upper 8 bits and lower 8 bits, and first upper ones are output, and then lower ones are output. 1 = 0.001 dB If the data end distance is shorter than the start distance, 1 point of data which corresponds to the data start distance will be output. Example: For DAT? 100,0, data of 100 m (1 point) will be output.

(Cont'd)

Remarks	<p>There are three typical usage are as follows:</p> <ul style="list-style-type: none"> – DAT? : When measured data is to be output as it is – DAT? 100,2000 : When only a part of measured data is to be output – DAT? 100,2000,5: When partially swept measured data is to be output <p>In case of no waveform data, the response will be ANS15. Arguments in [] can be omitted.</p> <p>Example of the response: When outputting the data of 5001 points, 37.580 dB on 1st data. Data length: 5001 points → 5001 (Dec) = 00001389 (Hex) 1st data: 37.580 dB → 37.580 x 1000 = 37580 (Dec) = 92CC (Hex)</p> <p>$\underbrace{00h\ 00h\ 13h\ 89h}_{\text{Data length}}\ \underbrace{92h\ CCh}_{\text{1st data}}$ (second and subsequent data)</p>
---------	---

(4) Query for Event Analysis Result

Command	EVN2				
Description	Queries Event table.				
Control	---				
Query	EVN2?_<event number>				
	Event number	Number to identify each event on the event table. 1 to Number of events			
Response	EVN2_<event number>,<distance>,<event loss>,<return loss>,<total loss>,<event type>				
	Event number	Number of the event table. 1 to the number of events			
	Distance	Value rounded down to three decimal places with IOR compensation. Unit: m			
	Splice loss	Value rounded down to three decimal places. Unit: dB When the measurement is unavailable, the response will be ***. For the far end, the response will be END. The following threshold status is added as the first byte of the response data. "_" means a space character.			
		Event detection setup	Exceeding the threshold	Under the threshold	
		Enable	_	(
	Return loss	Value rounded down to three decimal places. Unit: dB When the measurement is unavailable, the response will be ***. The following threshold status is added as the first byte of the response data. "_" means a space character.			
		Event detection setup	Saturated	Exceeding the threshold	Under the threshold
		Enable	<	_	(

(Cont'd)

	Total loss	Value rounded down to three decimal places. Unit: dB When the measurement is unavailable, the response will be ***.
	Event type	N: Non reflective event, R: Reflective event, E: Fiber end, C:Grouped, S:Saturated reflective event For descriptions of event types, refer to Section 3.6.3. "Event evaluation."
Remarks	---	

(5) Query for Insertion Loss Measurement

Command	LOS2	
Description	Calculates the loss from the marker positions.	
Control	---	
Query	LOS2?<position X1>,<position X2>	
	Position X1	Value rounded down to two decimal places with IOR compensation.
	Position X2	Unit: m 0.00 m to the setup value of distance range
Response	LOS2?<calibrated position X1>,<calibrated position X2>,<insertion loss>	
	Calibrated position X1	Value of two decimal places rounded down to multiple number of data resolution with IOR compensation. Unit: m
	Calibrated position X2	When the relation of the positions of calibrated markers is not X1 < X2, the response will be ***.
	Insertion Loss	Value rounded down to three decimal places. Unit: dB When the loss exceeds +99.999 dB or falls below -99.999 dB, the response will be ***. Also when the relation of the positions of calibrated markers is not X1 < X2, the response will be ***.
Remarks	---	

(6) Query for Total Loss Analysis Range

Command	MKDR	
Description	Queries the calculation range of total loss.	
Control	---	
Query	MKDR?	
Response	MKDR_<start point>,<end point>	
	Start point	0 to number of data point When the measurement is unavailable, the response will be MKDR ***.
	End point	0 to number of data point When the measurement is unavailable, the response will be MKDR ***.
Remarks	---	

(7) Query for Return Loss

Command	REFLCT	
Description	Calculates the return loss from the marker positions.	
Control	---	
Query	REFLCT?_<event position>,<peak position>	
	Event position	Value rounded down to two decimal places with IOR compensation. Unit: m
	Peak position	0.00 m to the setup value of distance range
Response	REFLCT_< calibrated event position >, < calibrated peak position >, <return loss>	
	Calibrated event position	Value of two decimal places rounded down to multiple number of data resolution with IOR compensation. Unit: m
	Calibrated peak position	When the calibrated peak position is not higher than the calibrated event position, the response will be ***.
	Return loss	Value rounded down to three decimal places. Unit: dB When the measurement is unavailable (when the event position level is higher than the peak position or the peak position is shorter than the event position), the response will be ***. The saturation information is added as the first byte of the response data. <: Saturated _: Not saturated
Remarks	---	

(8) Query for Splice Loss Measurement

Command	SPLICE	
Description	Calculates the splice loss from the marker positions.	
Control	---	
Query	SPLICE?_<event position>,<position X1>,<position X2>,<position X3>,<position X4>	
	Event position	Value rounded down to two decimal places with IOR compensation. Unit: m 0.00 m to the setup value of distance range
	Position X1	
	Position X2	
	Position X3	
	Position X4	
Response	SPLICE_<calibrated event position>,<calibrated position X1>,<calibrated position X2>,<calibrated position X3>,<calibrated position X4>,<splice loss>	
	Calibrated event position	Value of two decimal places rounded down to multiple number of data resolution with IOR compensation. Unit: m When the relationship of the positions of calibrated markers is not $X1 < X2 \leq \text{event position} < X3 < X4$, the response will be ***.
	Calibrated position X1	
	Calibrated position X2	
	Calibrated position X3	
	Calibrated position X4	
Splice loss	Value rounded down to three decimal places. Unit: dB When the loss exceeds +99.999 dB or falls below -99.999 dB, the response will be ***. Also when the relation of the positions of calibrated markers is not $X1 < X2 \leq \text{event position} < X3 < X4$, the response will be ***.	
Remarks	---	

(9) Request for Total Loss

Command	TLOS	
Description	Queries the total loss of marker section.	
Control	---	
Query	TLOS?_ <position X1>,<position X2>	
	Position X1	Value rounded down to two decimal places with IOR compensation. Unit: m
	Position X2	0.00 m to the setup value of distance range
Response	TRL_ <calibrated position X1>,<calibrated position X2>,<total loss>	
	Calibrated position X1	Value of two decimal places rounded down to multiple number of data resolution with IOR compensation. Unit: m
	Calibrated position X2	When the relation of the positions of calibrated markers is not $X1 < X2$, the response will be ***.
	Total loss	Value rounded down to three decimal places. Unit: dB When the measurement is unavailable, the response will be ***.
Remarks	---	

4.4.5 Queries for statuses

(1) Query for Error Status

Command	ERR	
Description	Queries the error status of the command executed lastly.	
Control	---	
Query	ERR?	
Response	ERR_<error code>	
	Error code	ANS0 to 255
Remarks	For more information about the error code, refer to "4.5 Error Code".	

(2) Query for the Equipment (OTDR) Status

Command	STS	
Description	Queries the equipment status (OTDR).	
Control	---	
Query	STS?	
Response	STS_<status >	
	Status	1: In pre-process of measurement
		2: Under measurement
		3: In post-process of measurement (such as smoothing and auto search)
4: Stopped		
Remarks	---	

(3) Query for Waveform Data Status

Command	WAV	
Description	Queries the waveform data status.	
Control	---	
Query	WAV?	
Response	WAV_{0 1}	
	0	No waveform data
	1	Waveform data is available
Remarks	---	

4.4.6 Settings for Data File

(1) Data File Acquisition of Waveform

Command	GETFILE	
Description	Acquires the waveform data file.	
Control	---	
Query	GETFILE?	
Response	<data size> <file data>	
	Data size	File size (Binary data of 4 bytes) Upper bytes are output first, and then the lower bytes.
	File data	Binary data in SR4731 format
Remarks	<p>Example) For the 1000 bites waveform file data(1000=000003E8h): 00h 00h 03h E8h (hereafter, file data)</p> <p style="text-align: center;">File size</p> <p>Write the received binary data to the file, except the first 4-bytes (data size). If saved with the .sor file extension, this can be loaded by Trace View software.</p>	

(2) Data Flag Setup

Command	HDFG	
Description	Sets data flag.	
Control	HDFG_{0 1 2}	
	0	BC (Installation)
	1	RC (Repair)
	2	OT (Others)
Query	HDFG?	
Response	HDFG_{0 1 2}	
	0	BC (Installation)
	1	RC (Repair)
	2	OT (Others)
Remarks	---	

(3) Waveform Data File Transfer

Command	SETFILE	
Description	Transfers a Waveform data file to the Card OTDR.	
Control	SETFILE<file size> <file data>	
	File size	File size (Binary data of 4 bytes) Upper bytes are set first, and then the lower bytes. 800 to 400 Kbytes (409600 bytes)
	File data	Binary data of waveform file to be written
Query	---	
Response	---	
Remarks	<p>Example) When transferring the 1000 bytes waveform file(1000=000003E8h):</p> <p>53h 45h 54h 46h 49h 4Ch 45h 00h 00h 03h E8h (hereafter, file data)</p> <p>S E T F I L E File size</p>	

(4) File Data Format Setup

Command	SRLV	
Description	Sets the recording level of SR-4731 data file.	
Control	SRLV {1 2 3}	
	1	Event data only (Key event data block)
	2	Measurement condition and waveform data only (Data point block)
	3	Event data, measurement condition, and waveform data
Query	SRLV?	
Response	SRLV {1 2 3}	
	1	Event data only (Key event data block)
	2	Measurement condition and waveform data only (Data point block)
	3	Event data, measurement condition, and waveform data
Remarks	---	

4.4.7 System Maintenance

(1) Date & Time Setup

Command	DATE2	
Description	Sets the current Date & Time and the time difference from UTC.	
Control	DATE2_<year>,<month>,<day>,<hour>,<minute>,<second>,<time difference>	
	Year	2000 to 2036
	Month	1 to 12
	Day	1 to 31
	Hour	0 to 23
	Minute	0 to 59
	Second	0 to 59
	Time difference	-12 to +12 (0.5 step)
Query	DATE2?	
Response	DATE2_<year>,<month>,<day>,<hour>,<minute>,<second>,<time difference>	
	Year	2000 to 2036
	Month	1 to 12
	Day	1 to 31
	Time	0 to 23
	Minute	0 to 59
	Second	0 to 59
	Time difference	-12 to +12 (0.5 step)
Remarks	---	

(2) Software Download

Command	DWNLD	
Description	Updates the software of the equipment by downloading operation	
Control	DWNLD<file size><file data>	
	data	Data file in binary format. The size of the file is located in the first 4 bytes of the data.
Query	DWNLD?	
Response	DWNLD_{0 1 2 3}	
	0	Software is not received.
	1	Software is being updated.
	2	Software update is completed.
	3	Software update is failed.
Remarks	<p>Example) When sending the byte file(256=00000100h): 44h 57h 4Eh 4Ch 44h 00h 00h 01h 00h (hereafter, file data)</p> <p style="text-align: center;"> D W N L D File size </p> <p>Do not unplug the LAN cable and turn off the power while updating the software. This may cause the software failures.</p>	

(3) Query for the Equipment Profile

Command	MINF	
Description	Queries for the profile of the equipment.	
Control	---	
Query	MINF?	
Response	MINF_<maker>,<model name>,<individual information>,<serial number>,<MAC address>,<software version>	
	Maker	Anritsu
	Model name	MW9087B
	Information	Product information: Example) "1650nm"
	Serial number	Serial number: Example) "SN6200000000"
	MAC Address	MAC address: Example) "00-00-91-12-34-56"
	Software Version	Software version: Example) "1.00"
Remarks	---	

(4) Self-diagnosis

Command	SLFTST	
Description	Executes Self-diagnosis.	
Control	SLFTST	
Query	SLFTST?	
Response	SLFTST_<optical level>, <warming up>, <power voltage>, <internal temperature> SLFTST*** returns when self-test is not being executed.	
	Diagnosis report	0: Normal or measurement enabled 1: Abnormal or warming up
Remarks	ANS76 returns when other command is received during self-test.	

**CAUTION**

When performing the SLFTST command, the optical pulse is output.

When the fiber is connected to the communication device, remove the fiber before performing the SLFTST command. The receiving part of the communication device may be damaged depending on the optical pulse output from the Card OTDR.

4.4.8 Network Configuration

(1) Timeout Interval Setup

Command	CONNTM	
Description	Sets timeout interval for TCP/IP connection.	
Control	CONNTM_<timeout interval>	
	Timeout interval	1 to 7200 (1 second step)
Query	CONNTM?	
Response	CONNTM_<timeout interval>	
	Timeout interval	1 to 7200
Remarks	The set value will be reflected after restarting the equipment. If the timeout interval, which was set in the state of no reception of the command, passes, the connection will be forcibly terminated.	

(2) Network Configuration

Command	NET	
Description	Configures the network for remote control.	
Control	NET_< IP address>, < Port number >, <Netmask>,<Gateway>	
	IP address	0.0.0.0 to 255.255.255.255
	Port number	1024 to 65535
	Netmask	0.0.0.0 to 255.255.255.255
	Gateway	0.0.0.0 to 255.255.255.255
Query	NET?	
Response	NET_< IP address>, < Port number >, <Netmask>,<Gateway>	
	IP address	0.0.0.0 to 255.255.255.255
	Port number	1024 to 65535
	Netmask	0.0.0.0 to 255.255.255.255
	Gateway	0.0.0.0 to 255.255.255.255
Remarks	The gateway assigned to 0.0.0.0 or 255.255.255.255 is not effective. The set value will be reflected after restarting the equipment.	

(3) Ethernet Speed Setup

Command	NETNEG	
Description	Sets the communication speed of Ethernet link.	
Control	NETNEG _<communication speed>,<flow control>	
	Communication speed	10: 10 Mbps 100: 100 Mbps AUTO: Auto negotiation
	Flow Control	F: Full Duplex H: Half Duplex
Query	NETNEG?	
Response	NETNEG _<communication speed>,<flow control>	
	Communication speed	10: 10 Mbps 100: 100 Mbps AUTO: Auto negotiation
	Flow Control	F: Full Duplex H: Half Duplex When the communication speed is set to AUTO, the flow control is set to ***.
Remarks	The set value will be reflected after restarting the equipment.	

(4) Timeout Interval for Alarm Setup

Command	ATO	
Description	Sets timeout interval for Alarm.	
Control	ATO_<timeout interval>	
	Timeout interval	0 to 360 (1 second step)
Query	ATO?	
Response	ATO_<timeout interval>	
	Timeout interval	0 to 360
Remarks	When setting 0, Alarm does not occur.	

4.4.9 Other Settings

(1) Initialization

Command	INI
Description	Sets measurement conditions to the factory defaults.
Control	INI
Query	---
Response	---
Remarks	Refer to Appendix C "Factory Shipment Defaults" for the values to be affected by this command.

(2) Reset Execution

Command	RST
Description	Restarts the Card OTDR.
Control	RST
Query	---
Response	---
Remarks	---

4.5 Error Code

Table 4.5-1 Error Code

Item	Description	Error Code
Query error	The command which cannot be executed when a waveform does not exist was received.	ANS15
	The command which cannot be executed when an event does not exist was received.	ANS16
Command error	The command which does not conform to the format was received.	ANS20
Execution error	The number of parameters is incorrect.	ANS40
	The setup range is exceeded (including integer or negative numbers).	ANS41
	The data type of the parameter is incorrect. (e.g. specified real value at command using integers)	ANS42
Status error	The command which cannot be executed depending on the OTDR status was received.	ANS60
	The command which cannot be executed in the OTDR mode was received.	ANS61
	Hardware is warming up.	ANS71
	Hardware is out of the temperature range.	ANS72
	The command which cannot be executed during self-diagnosis was received.	ANS76
	The condition which cannot be measured with the partial sampling was set.	ANS77
Setting error	Self-diagnosis was failed.	ANS78
	The device cannot be used because it is unsupported.	ANS81
	Unsettable distance range, pulse width, or wave length was specified.	ANS82

Table 4.5-1 Error Code (Cont'd)

Item	Description	Error Code
Unsettable error	The distance range which is unsettable in combination with the pulse width was specified.	ANS101
	The value which is unsettable in combination with the distance range was specified.	ANS102
	ATT which is unsettable in combination with the pulse width was specified.	ANS103
	The distance range which is unsettable in combination with the sampling mode was specified.	ANS104
	The current pulse width cannot be set to the high dynamic range.	ANS105
	The pulse width which cannot be set in combination with the high dynamic range mode was specified.	ANS106
	The command which cannot be used when a waveform does not exist was received.	ANS115
	The command which cannot be used when an event does not exist was received.	ANS116
No response	The response has been terminated for 30 seconds while receiving the command.	ANS143
Media error	The file with unauthorized contents was specified with SETFILE.	ANS167
	The file by other companies or for other units was specified with SETFILE.	ANS168
Others	Other errors occurred.	ANS255

Chapter 5 Performance Test and Maintenance

This chapter describes the performance test, maintenance, storage and disposal procedures.

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5.1 Performance Test

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

- Optical output and wavelength for optical pulse test
- Pulse width
- Dynamic range (One-way back-scattered light dynamic range test)
- Distance measurement accuracy
- Loss measurement accuracy (Linearity)

Refer to Appendix E "Performance Test Result Form" for recording the performance test results.

Before the test, clean the optical connector. The test procedure explained here starts from the state where the power supply is ON and the Card OTDR is running.

5.1.1 Required Equipment for Performance Test

The following table lists the required equipment for the performance test.

Table 5.1.1-1 Required Equipment for Performance Test

Item	Required Performance	Recommended Model (Model Name)
Optical spectrum analyzer	Wavelength: 600 nm to 1650 nm Level: -65 dBm to +20 dBm Wavelength stability: ± 0.3 nm	MS9740A (Anritsu)
Optical variable attenuator	Wavelength: 1200 nm to 1650 nm Input loss: 3 dB or less Attenuation: 0 dB to 30 dB Resolution: 0.1 dB or less	8163B+81570A (Agilent Technologies)
O/E converter	Wavelength: 1100 nm to 1650 nm Uplink/Downlink: 500 ps or less Compatible fiber: Single-mode	P6703B (Tektronix)
Oscilloscope	Band frequency: DC GHz to 1 GHz	TDS5104B (Tektronix)
Single mode Optical fiber	Fiber length: 2 km per piece 20 km or more per piece 40 km to 50 km per piece 800 m per piece 300 m to 400 m per piece 2 m to 3 m in two pieces	
Optical coupler	Shape: 1x2 Branch ratio: 50%:50% Excess loss: 1 dB or less	

Table 5.1.1-1 Required Equipment for Performance Test

Item	Required Performance	Recommended Model (Model Name)
Light source (DFB-LD)	Wavelength: 1550 nm Laser type: DFB-LD Output: -5 dBm or more	8163B+81940A (Agilent Technologies)
Optical power meter (Wavelength 1550 nm)	Wavelength: 1550 nm Level: -50 to +10 dBm Level stability: ±0.2 dB	8163B+81634B (Agilent Technologies)
Light source	Wavelength: 1550±20 nm Level: -10 to 0 dBm Level stability: ±0.1 dB Compatible fiber: Single-mode	CMA5 (Anritsu)
Optical coupler (10:1)	Shape: 1×2 Branch ratio: 10%:90% Excess loss: 1 dB or less	

5.1.2 Wavelength Accuracy

Confirm whether the wavelength of the measurement light is satisfied with the specifications.

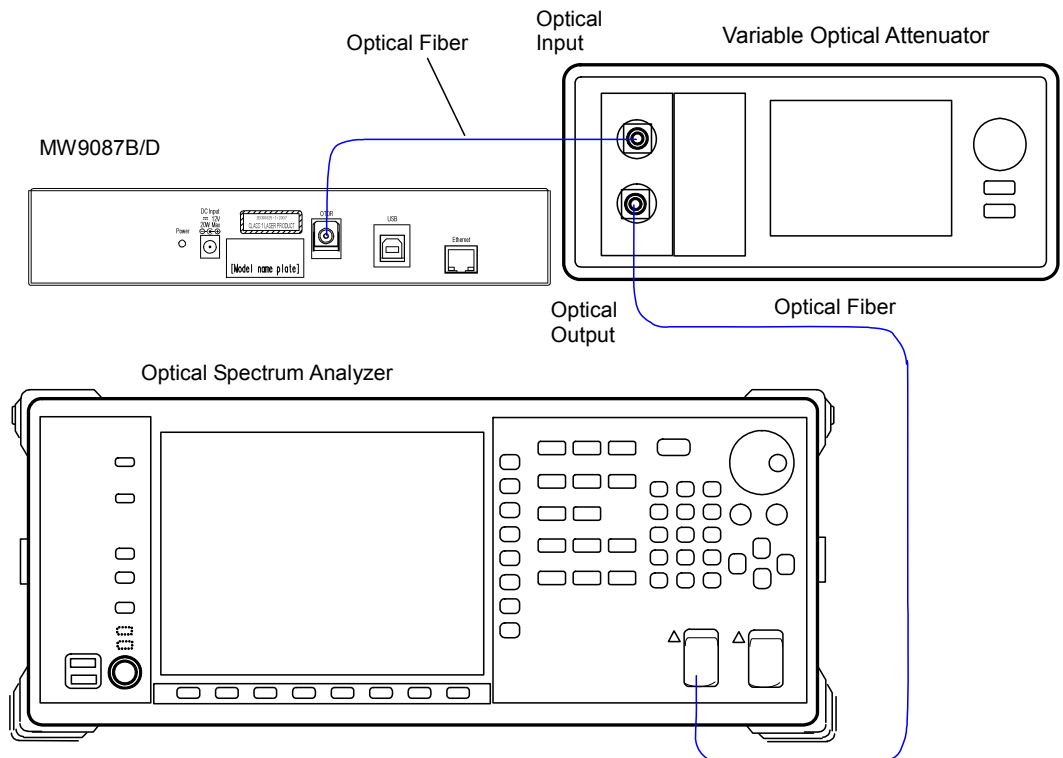


Figure 5.1.2-1 Connection Figure for Wavelength Measurement

<Test procedure >

1. Setup and connect as shown in Figure 5.1.2-1.
2. Set the optical spectrum analyzer as follows.
Span: 50 nm
Res: 0.05 nm
VBW: 1 kHz
Sampling Point: 2001
Analysis: RMS K = 1, S. Level: 20 dB
3. Set the wavelength of the main frame to the Center of the optical spectrum analyzer.
4. Set the distance range to 25 km using the DSA 0 or DSR 25000 command.
5. Set the pulse width to 1 μ s using the PLA 0 or PLS 1000 command.
6. Set to the real time measurement using the AVG 0 command.
7. Output the optical pulse when starting the measurement by LD 1 command.
8. Measure the spectrum of the optical pulse for the mainframe using the optical spectrum analyzer.
9. If the waveform level measured by the optical spectrum analyzer is saturated, adjust the attenuation of the variable optical attenuator.
10. Record the center wavelength measured with the optical spectrum analyzer.

5.1.3 Pulse width

Check whether the optical pulse width for the measurement is satisfied with the specifications.

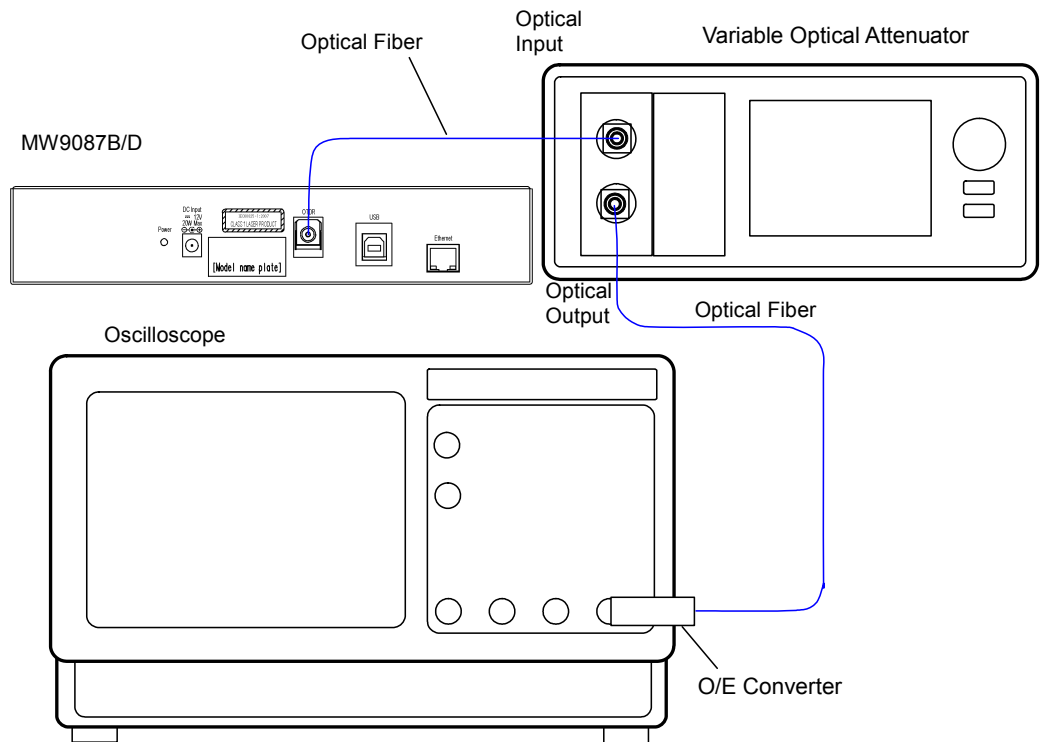


Figure 5.1.3-1 Pulse Width Measurement Setup

<Test procedure>

1. Connect the mainframe to the measurement equipment as shown in Figure 5.1.3-1.
2. Set the distance range to 100 km using the DSA 0 or DSR 100000 command.
3. Set the pulse width to 10 ns using the PLA 0 or PLS 10 command.
4. Set to the real time measurement using the AVG 0 command.
5. Output the optical pulse when starting the measurement by the LD 1 command.
6. Adjust the oscilloscope trigger level, amplitude, and time base scale to display the waveform in the oscilloscope. Adjust the optical variable attenuator to prevent the waveform monitor from becoming saturated.

7. Monitor the waveform with the oscilloscope and measure the pulse width at half the amplitude of the peak level as shown in Figure 5.1.3-2 and record the results.
8. Change the pulse width at the step 2 and repeat the steps 4 thru 6.

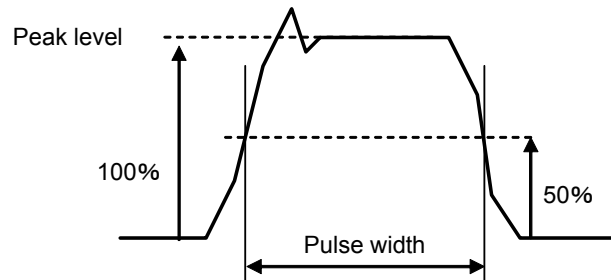


Figure 5.1.3-2 Waveform Measurement Points

9. Change the pulse width from 20 ns to 20 μ s at the step 2 and repeat steps 4 to 6.

5.1.4 Dynamic range

Check whether the dynamic range (One-way back-scattered light dynamic range) is satisfied with the specifications.
The measurement method varies with the model.

<Test Procedures for MW9087B>

For the dynamic range measurement for MW9087B, the background light is entered with the use of the light source.

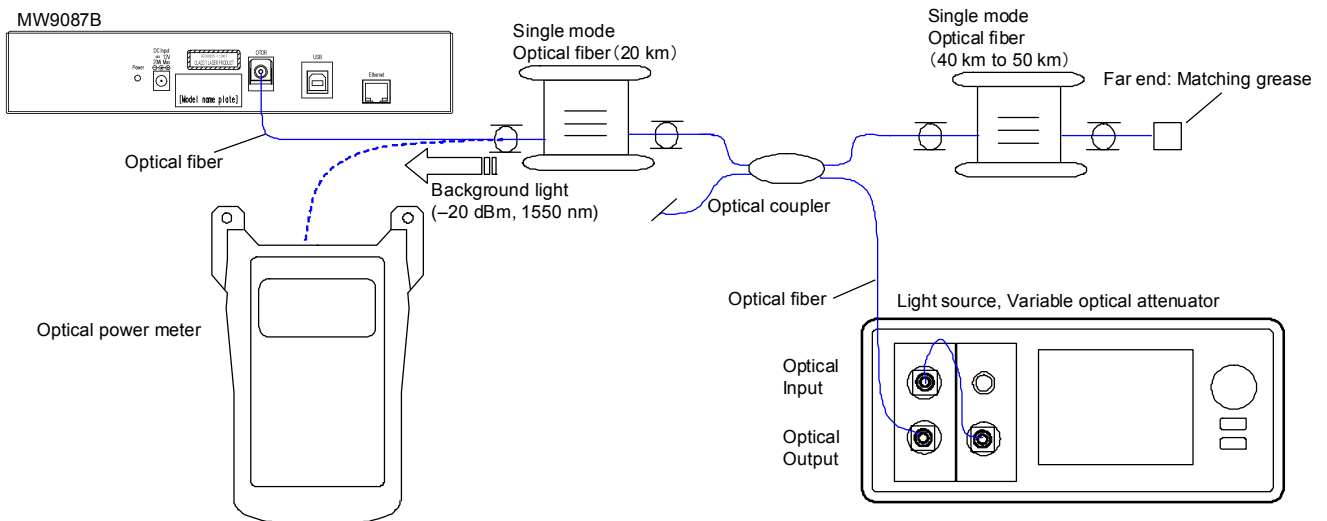


Figure 5.1.4-1 Dynamic Range Measurement Setup (MW9087B)

1. Connect the optical source, variable optical attenuator, Optical coupler, single mode optical fiber, and optical power as shown in Figure 5.1.4-1.
2. Set the wavelength of the optical power meter to 1550 nm.
3. Turn on the optical source.
4. Adjust the attenuation of the variable optical attenuator so that the optical power meter displays -19 ± 0.1 dBm.
5. Disconnect the optical fiber connected to the optical power meter and connect to the Card OTDR.
6. Set to the average measurement using the AVG1 command.
7. Set the averaging time to 180 seconds using the ALA 1,180 command.
8. Set the sampling to Coarse using the RES 0 command.
9. Set the pulse width to 100 ns using the PLA 0 or PLS 100 command.

10. Output the optical pulse when starting the measurement using the LD 1 command.
11. After the measurement is finished, obtain the waveform data using the GETFILE? command.
12. Display the waveform data using the waveform analysis software.
13. Move the cursor A to the position of the optical output connector (Refer to Figure 5.1.4-2), move the cursor B to the noise peak position, and then record 2-pt Loss.
14. Add 2.6 dB to the value recorded at the step 13. Record the measurement results.
15. Set the pulse width to 10 μ s using the PLS 10000 command at the step 9 and repeat steps 10 to 14.

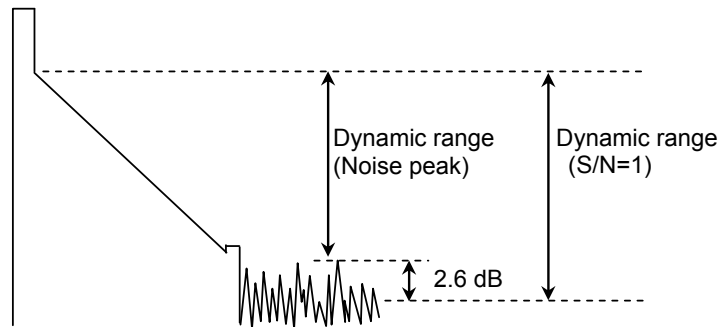


Figure 5.1.4-2 Waveform Measurement Position

<Test Procedures for MW9087D>

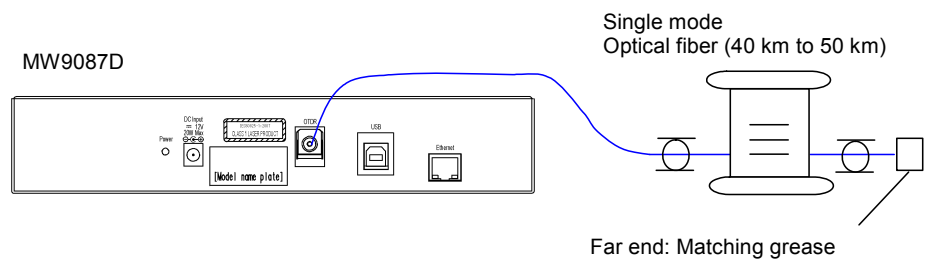


Figure 5.1.4-3 Dynamic Range Measurement Setup (MW9087D)

<Test Procedures>

1. Connect the measurement equipment to the mainframe as shown in Figure 5.1.4-3.
2. Set the average measurement using the AVG 1 command.
3. Set the averaging time to 180 seconds using the ALA 1,180 command.
4. Set the sampling to Coarse using the RES 0 command.
5. Set the pulse width to 100 ns using the PLA 0 or PLS 100 command.

6. Output the optical pulse when starting the measurement using the LD 1 command.
7. After the measurement is finished, obtain the waveform data using the GETFILE? command.
8. Display the waveform data using the waveform analysis software.
9. Move the cursor A to the position of the optical output connector (Refer to Figure 5.1.4-2), move the cursor B to the noise peak position, and then record 2-pt Loss.
10. Add 2.6 dB to the value recorded at the step 10. Record the measurement results.
11. Set the pulse width to 10 μ s using the PLS 10000 command at the step 5 and repeat steps 6 to 10.

5.1.5 Distance measurement accuracy

Measure the optical fiber whose length and index of refraction are known, then perform a horizontal axis (i.e., measurement distance) accuracy test. This is not required for other ranges when this test is performed at a certain distance range.

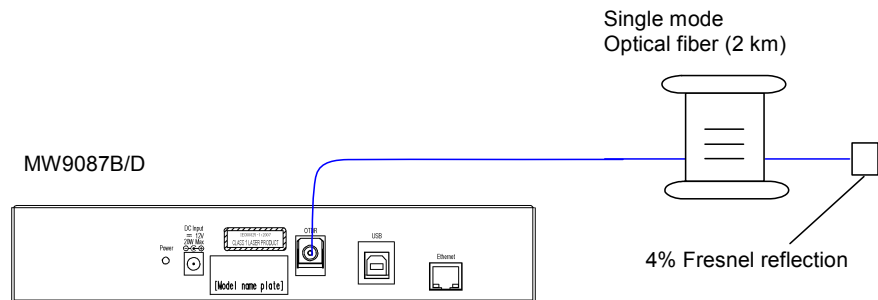


Figure 5.1.5-1 Accuracy Measurement for Distance Measurement

<Test Procedures>

1. Connect the measurement equipment to the mainframe as shown in Figure 5.1.5-1.
2. Set the average measurement using the AVG 1 command.
3. Set the distance range to 5 km using the DSA 0 or DSR 5000 command.
4. Set the pulse width to 10 ns using the PLA 0 or PLS 10 command.
5. Set the averaging time to 180 seconds using the ALA 1,180 command.
6. Set the optical fiber's index of refraction using the IOR command.
7. Output the optical pulse using the LD 1 command.
8. After the measurement is finished, obtain the waveform data using the GETFILE? command.
9. Display the waveform data using the waveform analysis software.
10. Move the cursor to the Fresnel reflection position (Refer to Figure 5.1.5-2).
11. Set the horizontal axis scale to 0.005 km/div centering around the cursor position.
12. Place the cursor on the rising point of the Fresnel reflection accurately, and read the absolute distance. Record the measurement results.

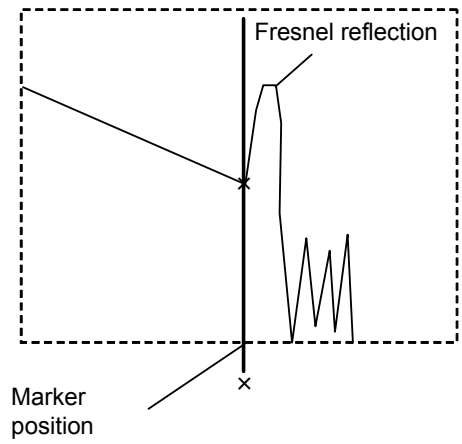


Figure 5.1.5-2 Waveform Measurement Position

5.1.6 Loss Measurement Accuracy (Linearity)

Check the accuracy of the vertical axis (level measurement).

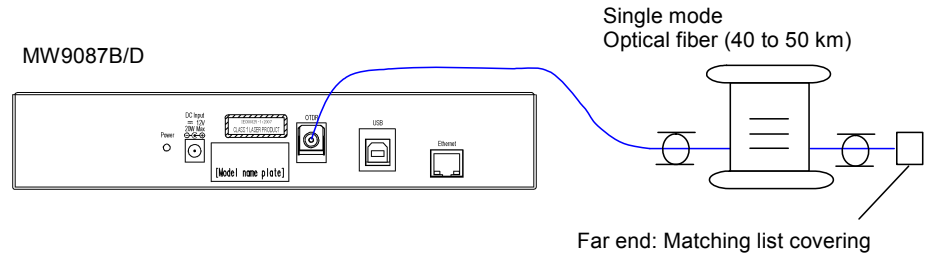


Figure 5.1.6-1 Linearity Measurement Setup

<Test Procedures for One Fiber Setup>

1. Connect the measurement equipment to the mainframe as shown in Figure 5.1.6-1.
2. Set the average measurement using the AVG 1 command.
3. Set the averaging time to 180 seconds using the ALA 1,180 command.
4. Set the sampling to Coarse using the RES 0 command.
5. Set the pulse width to 100 ns using the PLA 0 or PLS 100 command.
6. Output the optical pulse when starting the measurement using the LD 1 command.
7. After the measurement is finished, obtain the waveform data using the GETFILE? command.
8. Display the waveform data using the waveform analysis software.
9. Move the cursor A to the 0 km position.
10. Move the cursor B to the 4 km position, and record the dB/km LSA.
11. Move the cursor A to the 2 km position.
12. Move the cursor B to the 6 km position, and record the dB/km LSA.
13. Move the cursor A and B in 2 km increments until cursor B reaches the 30 km position, and record the dB/km LSA (Refer to Figure 5.1.6-2).
14. Calculate the averaging value recorded at the steps 10 thru 13.
15. Calculate the difference between the value calculated at the step 14 and the values recorded at the steps 10 thru 13, and multiply this value by four.

<Test Procedures for Multiple-Fiber Setup>

1. Execute the same operations as described for <Test Procedures for One Fiber Setup> up to step 9.
2. Move the cursor B to the 4 km position, and record the dB/km LSA.
3. With cursor B inside the splice point range, move cursor A and cursor B in 2 km increments and measure the dB/km LSA.
4. Calculate the averaging value recorded at the steps 2 thru 3.
5. Calculate the difference between the value calculated at the step 4 and the values recorded at the steps 2 thru 3, and multiply this value by four.
6. Move the cursor A to the position that is a multiple of 2 km further than the splice point.
7. Move the cursor B to a position 4 km distant from cursor A, and record the dB/km LSA.
8. With cursor B inside the splice point range, move cursor A and cursor B in 2 km increments and measure the dB/km LSA.
9. Calculate the average of the values recorded at the steps 7 thru 8.
10. Calculate the difference between the value calculated at the step 9 and the value recorded at the steps 7 thru 8, and multiply this value by four.
11. Move the cursor B to the position 4 km distant from cursor A, and record the dB/km LSA.
12. Repeat the steps 6 thru 10 until cursor B reaches the 30 km position.

[Example] When connecting fiber (16 km × 2)

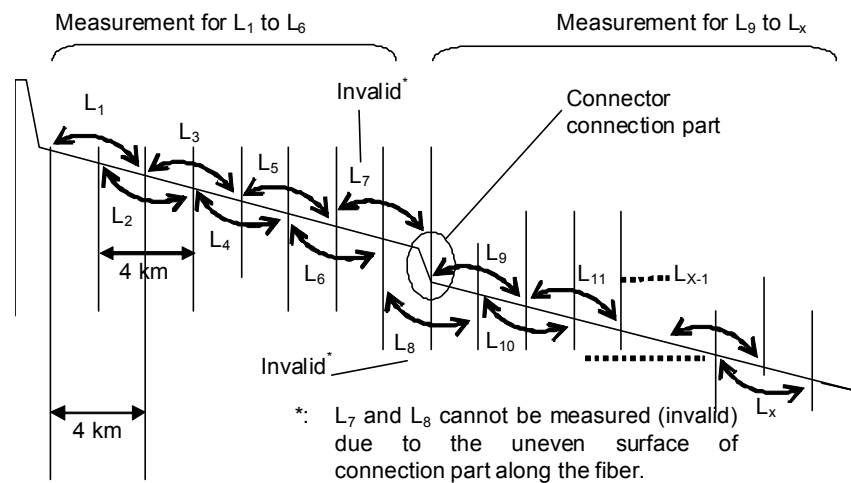


Figure 5.1.6-2 Loss Measurement Positions

Measurement for L_1 to L_6

Averaging value $L_{ave_1} = (L_1+L_2+L_3+L_4+L_5+L_6)/6$

$L_{diff_1} = (L_1-L_{ave_1}) \times 4$

$L_{diff_2} = (L_2-L_{ave_1}) \times 4$

.....

$L_{diff_6} = (L_6-L_{ave_1}) \times 4$

Measurement for L_9 to L_x

Averaging value $L_{ave_2} = (L_9+L_{10}+L_{11}+\dots+L_x)/(x-9+1)$

$L_{diff_9} = (L_9-L_{ave_2}) \times 4$

$L_{diff_10} = (L_{10}-L_{ave_2}) \times 4$

.....

$L_{diff_x} = (L_x-L_{ave_2}) \times 4$

$L_{diff_n} \{L_{diff_1}, L_{diff_2}, \dots, L_{diff_6}, L_{diff_9}, \dots, L_{diff_x}\}$: Check it is ± 0.1 or less.

5.2 Updating Software

When the software version is upgraded, update the software for the main frame using the following procedures.

		Command
1	Check the software version of the mainframe.	MINF
2	Send the software to the mainframe.	DWNLD
3	Check the updating progress.	DWNLD
4	Restart the mainframe after updating the software.	RST



CAUTION

Do not turn off the power while updating the software. Otherwise, the Card OTDR may cause failure.

5.3 Cautions on Storage

Avoid storing the Card OTDR in these places:

- (1) Wipe off dust, fingerprint marks, stains, spots, etc. from the surface of the Card OTDR before storing it.
- (2) Places with temperatures and relative humidity in the following ranges:
Temperature: lower than -20°C or higher than 60°C
Humidity: 95% or more
- (3) Places that are exposed to direct sunlight and dusty places.
- (4) Damp places where condensation may occur on the MS9740A surface or places where the Card OTDR may be corroded by active gases
- (5) Places where the Card OTDR may be exposed to strong vibration and shock or be oxidized

Recommended storage conditions

The Card OTDR should be stored in a place that meets the ambient conditions above, plus the following conditions if it is not to be used for a long time:

- (1) Temperature: 5° to 30°C
- (2) Humidity: 40% to 75%
- (3) Slight daily change in temperature and humidity.

5.4 Transporting and Disposal

The following describes precautions for transporting and disposing of the Card OTDR.

Repackaging

Repack the Card OTDR in the packing material (box) in which it was delivered. 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.

Transporting

Avoiding vibrations as much as possible and meet the recommended storage conditions during transport.

Disposal

Follow the instructions of your local waste disposal office when finally disposing of the Card OTDR.

To prevent leakage of information stored in the internal memory of the Card OTDR, destroy the Card OTDR before disposing.

Appendix A Specifications

Table A-1 Specifications of MW9087 Series

Item	Specifications		Remarks
Model name	MW9087B/D Card OTDR		
Configuration	Standard Application (Operation Manual)		
Wavelength *1	MW9087B	1645 to 1655 nm Wavelength range at peak value [Spectrum peak value] -20 dB)	
	MW9087D	1525 to 1575 nm	
Pulse peak power	MW9087B	≤ +15 dBm	
	MW9087D	—	
Measurement fiber	10/125 μm SM fiber (ITU-T G.652)		
Optical connector	<ul style="list-style-type: none"> •FC: Option037 •ST: Option038 •DIN: Option039 •SC: Option040 •HMS-10/A: Option043 		
Distance range	1/2.5/5/10/25/50/100/200/300 km		IOR=1.500000
Pulse width	3/10/20/50/100/200/500 ns 1/2/4/10/20 μs		
Dynamic range *2			SNR=1, 25°C, Pulse width 20 μs
	MW9087B	≥ 40 dB (Typical value: 41 dB)	
	MW9087D	≥ 49 dB (Typical value: 50 dB)	
Dead zone (Fresnel reflection) *3	MW9087B	≤ 0.5 m	25°C, IOR=1.500000, Pulse width 3 ns,
	MW9087D	≤ 1.0 m	
Dead zone (Backscatter light) *4	MW9087B	≤ 6.5 m	25°C, IOR=1.500000, Pulse width 10 ns
	MW9087D	≤ 4.3 m	
Linearity (Loss measurement accuracy)	±0.05 dB/dB or ±0.1 dB (Whichever greater)		
Sampling resolution	0.05 to 60 m		IOR=1.500000
Sampling points	Coarse: 5001 Medium: 15001, 20001 or 25001 Fine: 100001, 125001 or 150001		Either of the value is automatically selected depending on the distance range.
IOR setting	1.000000 to 1.999999 (0.000001 step)		
Distance measurement accuracy	±1m±3×Measurement distance×10 ⁻⁵ ±Sampling resolution (Uncertainty with fiber's index of refraction is excluded.)		
Loss minimum unit	0.001 dB		

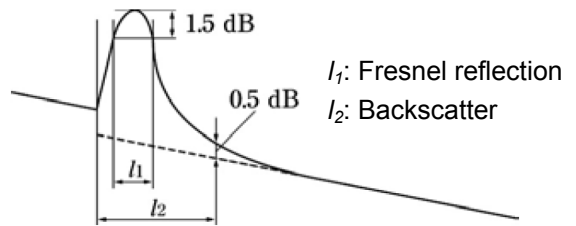
Table A-1 Specifications of MW9087 Series (Cont'd)

Item	Specifications		Remarks
Averaging time [Averaging count]	1 to 9999 times or 1 to 9999 seconds (settable range)		
Auto measurement *5	Measurement item: Total loss, Distance of each event, Splice loss, Return loss, or Reflectance Threshold: Splice loss 0.01 to 9.99 dB (0.01 dB step) Reflectance -60 to -20 dB (0.1 dB step), Far end 1 to 99 dB (1 dB step) Number of detected events: Up to 99 events Automatic setting: Distance range, pulse width, and averaging count (period)		
Manual measurement	Measurement item: 2-point loss, 2-point LSA, dB/km loss, splice loss, return loss, or level difference		
Other function	Partial sampling function Remote control function High dynamic range mode added (pulse width 50 ns to 2 μs) Distance unit setup: m fixed		
Interface	Ethernet: RJ45 Ethernet 10Base-T/100Base-TX Auto negotiation supported Ethernet Full Duplex/Half Duplex supported USB 1.1: Type B×1 *6		
Laser safety	MW9087B	IEC 60825-1: 2007 Class 1	21CFR1040.10 and 1040.11 except for deviations pursuant to Laser Notice No.50 (dated June 24, 2007)
	MW9087D	IEC 60825-1: 2007 Class 1M	
Power	+12 Vdc ± 10%		
Power consumption	≤ 20 W		
Dimensions	165 (H) × 50 (W) × 270 (D) mm (not including projection portion)		
Mass	≤ 1.5 kg		
Temperature/Humidity	Operating temperature and humidity: 0 to 50 °C, ≤ 95% (no condensation)		
	Storage temperature and humidity: -20 to +60 °C, ≤ 95%		

- *1 Pulse width: 1 μ s at 25°C
- *2 Distance range: 100 km, Average: 180 seconds, 25°C. With background light, 1310/1550 nm -19 dBm Continuous light (MW9087B)
Standard/High dynamic range mode added (pulse width 50 ns to 2 μ s)

*3 I_1 in the right figure. Return loss: 40 dB

*4 I_2 in the right figure. Return loss: 55 dB



*5 So that the automatic measurement function is used for simplifying the measurement, any detected results are not guaranteed. The faulty values might be detected. Be sure to check the waveform data when the final judgement is made.

*6 Interface for IP address setup. The specified driver installation is required for connection.

Appendix B Relationship between Pulse Width Distance Range

Table B-1 Settable Pulse Width

Distance Range (km)	Pulse Width (ns)											
	3	10	20	50	100	200	500	1000	2000	4000	10000	20000
1	✓	✓	✓	✓	✓	–	–	–	–	–	–	–
2.5	✓	✓	✓	✓	✓	–	–	–	–	–	–	–
5	✓	✓	✓	✓	✓	✓	–	–	–	–	–	–
10	✓	✓	✓	✓	✓	✓	✓	–	–	–	–	–
25	✓	✓	✓	✓	✓	✓	✓	✓	–	–	–	–
50	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	–	–
100	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
200	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
300	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

✓: Settable

–: Not settable

Appendix C Factory Shipment Defaults

The Card OTDR is set as follows at the factory default.

Items described in Table C-1 "Factory Shipment Defaults (Initialized Items)" are initialized when the remote command (INI command) is executed.

Table C-1 Factory Shipment Defaults (Initialized Items)

Item	Command	Setting Value
Averaging	ALA	Auto setting
Averaging unit	ALA	times
Wavelength	WLS	First wavelength (Shortest wavelength)
Distance range setting method	DSA	Auto setting
Distance range	DSR	Auto
Pulse width setting method	PLA	Auto setting
Pulse width	PLS	Auto
Attenuator	ATA	Auto setting
Index of refraction (IOR)	IOR	1550 nm:1.466100 1650 nm:1.466500
Enhance mode	ENH	Standard
Sampling mode	RES	Standard
Partial sampling setting	SSMP	Starting distance 0 m, Resolution 0.05 m, 5001 points
Backscatter coefficient level correction value	CAL	0.00 dB
Average setting	AVG	Average measurement
Approximate line method setting	APR	Least square method
Relative distance	OFS	0.00 m
Event automatic detection		
Splice loss threshold	THS	0.30 dB
Reflection threshold	THR2	-25.0 dB
Fiber far end threshold	THF	5 dB
File		
File format	SRLV	Event data, measurement condition, and waveform data
Data flag	HDFG	BC (When installed)

Appendix C Factory Shipment Defaults

Items described in Table C-2 "Factory Shipment Defaults (No Initialized Items)" are not initialized, even if the INI command is sent.

Table C-2 Factory Shipment Defaults (No Initialized Items)

Item	Command	Setting Value
Network address	NET	
Speed		10M Full
IP address		192.168.1.2
Subnet mask		255.255.255.0
Default gateway		None
Port number		2288
Ethernet speed	NETNEG	
Communication speed		Auto
Flow control		Auto
Time out	CONNTM	7200 seconds
Serial port	-	
Baud rate (bit/second)		115200 bps
Data bit		8 bits
Parity		None
Stop bit		1 bit
Flow control		Hardware

Appendix D Command Compatibility

MW9087 series remote command compatibility with MW9077A/A1 OTDR module remote command is shown below.

- ✓: Compatible
- △: Compatible, parameter to be changed
- : Not compatible

Table D-1 Command Compatibility

Control Command	Query Command	Compatibility	Function/Change
ALA	ALA?	✓	Average Mode Setup
APR	APR?	✓	Approximate Line Method Setup
ATA	ATA?	✓	Attenuator Setup
ATT	ATT?	✓	Attenuator Setup
–	ATV?	✓	Query for Available Attenuator
–	AUT?	✓	Query for the Result of Auto Search
–	AVE?	✓	Query for Average Mode
AVG	AVG?	✓	Average Setup
BSL2	BSL2?	–	Query for Backscatter Coefficient Level Change to BSL? for Backscatter Level, CAL? for Backscatter Coefficient Level.
CONNTM	CONNTM?	✓	Timeout Interval Setup
–	DAT?	△	Query for Waveform Data Format of number of data items of response is changed.
DATE2	DATE2?	✓	Date & Time Setup
DLMODE	DLMODE?	–	Start-up Mode Change MW9087 does not have the function.
DWNLD	DWNLD?	✓	Software Download
–	ERR?	✓	Query for Error Status
–	EVN2?	✓	Query for Event Analysis Result
–	GETFILE?	✓	Data File Acquisition of Waveform
INI	–	✓	Initialization
IOR	IOR?	△	Index of Refraction Setup Setup range is changed to 1.00000 to 1.999999.
LD	LD?	△	OTDR Measurement Start/Stop Partial sampling measurement start added to the parameter.
–	LOS2?	✓	Query for Insertion Loss Measurement
–	MINF?	✓	Query for the Equipment Profile
–	MKDR?	✓	Query for Total Loss Analysis Range

Table D-1 Command Compatibility (Cont'd)

Control Command	Query Command	Compatibility	Function/Change
NET	NET?	✓	Network Configuration
OFS	OFS?	✓	Relative Distance Setup
—	REFLECT?	✓	Query for Return Loss
RST	—	✓	Reset Execution
SETFILE	—	✓	File Data Write
—	SLFTST?	✓	Self-diagnosis
—	SMPINF?	✓	Query for Sampling Conditions
—	SPLICE?	✓	Query for Splice Loss Measurement
SRLV	SRLV?	✓	Assignment of File Data Format
—	STATUS?	—	Query for Status (OTDR) Changed to STS?
STP	STP?	—	Measurement Condition Setup Setup for DSR, ENH, PLS, and RES individually
THF	THF?	✓	Fiber Specific Setup
THR2	THR2?	△	Return Loss Threshold Setup Setup range is changed to -60 to -20.
THS	THS?	✓	Splice Loss Threshold Setup
—	TLOS?	✓	Query for Total Loss
—	WAV?	✓	Query for Waveform Data Status
WLS	WLS?	✓	Wavelengths Setup

Table D-2 Command Added to MW9087 Series

Control Command	Query Command	Function
CAL	CAL?	Backscatter Level Calibration Setup
DSA	DSA?	Distance Range Mode Setup
DSR	DSR?	Distance Range Setup
ENH	ENH?	Enhanced Mode Setup
HDFG	HDFG?	Assignment of the Data Flag of File Header
NETNEG	NETNEG?	Ethernet Speed Setup
PLA	PLA?	Pulse Width Mode Setup
PLS	PLS?	Pulse Width Setup
RES	RES?	Sampling Mode Setup
SMTH	SMTH?	Smoothing Setup
SSMP	SSMP?	Partial Sampling Mode Setup
—	SSMPINF?	Query of Partial Sampling Mode
—	STS?	Query for the Equipment (OTDR) Status

Appendix E Performance Test Result Form

Document number: _____

Test Location: _____

Date: _____

Test person in charge: _____

Product name: MW9087 Card OTDR _____

Serial number: _____

Software version: _____

Option: _____

Power voltage: _____ V

Ambient temperature _____ °C

Relative humidity _____ %

Instruments used: Model name _____ Serial number _____

Model name _____ Serial number _____

Model name _____ Serial number _____

Model name _____ Serial number _____

Remarks _____

Appendix

Appendix E

Appendix E Performance Test Result Form

Table E-1 MW9087B Performance Test Recording Table

Test Item		Specifications	Result	Remarks
Wavelength	1650 nm	1645 to 1655 nm		Pulse width: 1 μ s, wavelength range of 20 dB or lower than the peak value
Pulse width	10 ns	10 ns		$\pm 35\%$
	20 ns	20 ns		$\pm 35\%$
	50 ns	50 ns		$\pm 25\%$
	100 ns	100 ns		$\pm 0\%$
	200 ns	200 ns		$\pm 10\%$
	500 ns	500 ns		$\pm 10\%$
	1 μ s	1 μ s		$\pm 10\%$
	2 μ s	2 μ s		$\pm 10\%$
	4 μ s	4 μ s		$\pm 10\%$
	10 μ s	10 μ s		$\pm 10\%$
	20 μ s	20 μ s		$\pm 10\%$
Dynamic range	MW9087B	40 dB *		S/N = 1
Distance measurement accuracy		$\pm 1 \text{ m} \pm 3 \times \text{Measurement distance} \times 10^{-5} \pm \text{Marker resolution}$		
Loss measurement accuracy (linearity)		$\pm 0.05 \text{ dB/dB}$ or $\pm 0.1 \text{ dB}$ (Whichever greater)		

(Reference value)

*: Pulse width: 20 μ s, Distance range: 100 km, Averaging time: 180 seconds

Table E-2 MW9087D Test Recording Table

Test Item		Specifications	Result	Remarks	
Wavelength	1550 nm	1525 to 1575 nm			
Peak value		+15 dBm or less			
Pulse width	10 ns	10 ns		±35%	(Reference value)
	20 ns	20 ns		±35%	
	50 ns	50 ns		±25%	
	100 ns	100 ns		±20%	
	200 ns	200 ns		±10%	
	500 ns	500 ns		±10%	
	1 μs	1 μs		±10%	
	2 μs	2 μs		±10%	
	4 μs	4 μs		±10%	
	10 μs	10 μs		±10%	
	20 μs	20 μs		±10%	
Dynamic range	MW9087D	49 dB *		S/N=1	
Distance measurement accuracy		±1 m ±3×Measurement distance ×10 ⁻⁵ ±Marker resolution			
Loss measurement accuracy (linearity)		±0.05 dB/dB or ±0.1 dB (Whichever greater)			

*: Pulse width: 20 μs, Distance range: 100 km, Averaging time: 180 seconds

