

FHO5000 Optical Time Domain Reflectometer (OTDR)

Manual

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Manual

Foreword

Thank you for purchasing FHO5000 OTDR (Optical Time Domain Reflectometer). This user's manual contains useful information about the instrument's functions and operating procedures and the handling precautions of FHO5000 OTDR. To ensure correct use, please read this manual thoroughly before beginning operation. After reading the manual, keep it in a convenient location for quick reference whenever a question arises during operation.

Note

- The contents of this manual are subject to change without prior notice as a result of continuing improvements to the instrument's performance and functions. The figures given in this manual may differ from those that actually appear on your screen.
- Every effort has been made in the preparation of this manual to ensure the accuracy of its contents. However, should you have any questions or find any errors, please contact your nearest GRANDWAY dealer.
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- Respective trademark names or registered trademark names.

Version

E1350

Standard Accessory

OTDR standard accessory showed in next table.

| Num. | Description | Quantity |
|------|--------------------------|----------|
| 1 | Power Adapter(220V 50Hz) | 1 |
| 2 | Power Patchcord | 1 |
| 3 | Data Cable | 1 |
| 4 | CD | 1 |
| 5 | Carrying Case | 1 |
| 6 | Securing Strip | 1 |
| 7 | Manual | 1 |

Module

OTDR optional accessory showed in next table.

| Num. | Item | |
|------|-------------------------------------|----------|
| 1 | OTDR1 module | Standard |
| 2 | VFL(visual fault locator) module | Standard |
| 3 | OTDR2 module | Optional |
| 4 | OPM(optical power meter) module | Optional |
| 5 | OLS(optical laser source) module | Optional |
| 6 | FLM(Fiber Link Measurement) module | Optional |
| 7 | FIM(fiber inspector) Module | Optional |
| 8 | Waterproofing work | Optional |
| 9 | Touch Screen | Optional |

* All changes with standard accessory and optional accessory prices are subject to change without notice.

Safety Precautions

To use the instrument safely and effectively, be sure to observe the precautions given in the user's manual. Not complying might result in injury or death.



Before test with OTDR module please ensure there is no active signal in optical network under test, any signal which power is higher than 0dBm will permanently damage this meter and this kind of damage are not within the scope of free warranty!

Warning

Use the Correct Power Supply

Before connecting the power cord, ensure that the source voltage matches the rated supply voltage of the AC adapter and that it is within the maximum rated voltage of the provided power cord.

Use the Correct Power Cord

Use only the power cord that comes with the instrument. Do not use it for other devices.

Use the Correct AC Adapter

Use only the AC adapter specified for the instrument. Do not use it for other devices.

Use Only the Designated Battery pack

Use only the battery pack specified for the instrument. Do not use it for other devices.

Do Not Look at the Laser Light

Do not look at the laser's direct ray, reflected ray from a mirror, or indirect ray without the proper protective eyewear. In addition, avoid being exposed to the laser light. It can cause blindness or damage to the eye.

Do Not Operate in an Explosive Atmosphere

Do not use the thermocouple in a location where any flammable or explosive gas/vapor is present. Operation in such an environment constitutes a safety hazard.

Do Not Remove Covers

The covers should be removed by qualified personnel only.

Opening the cover is dangerous, because some areas inside the instrument have high voltages.

Carrying and Moving the Instrument

Remove all power cords and connection cables from the main unit before moving the instrument. When carrying the instrument, hold it firmly by the handle. Also, if storage media is inserted into the instrument, always remove the storage media before carrying or moving the instrument. Never leave the media inserted when carrying or moving. The storage media can become damaged.

Symbol

Icons on the main body or in manual



Warning: handle with care. Refer to the user's manual or service manual. This symbol appears on dangerous locations on the instrument which require special instructions for proper handling or use. The same symbol appears in the corresponding place in the manual to identify those instructions



Direct current



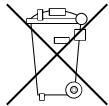
Stand-by (power)



Recycle



Hazard, radiation of laser apparatus



Comply WEEE(Waste Electrical and Electronic Equipment) Directive (2002/96/EC)



Content

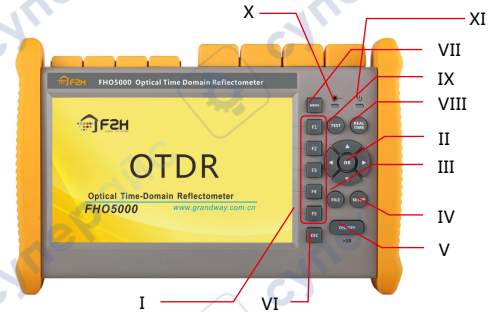
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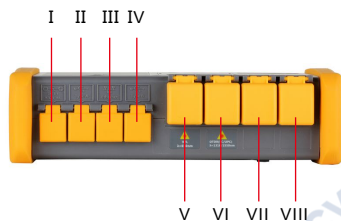
0.0 Names and Functions of Parts

0.1 Front Panel



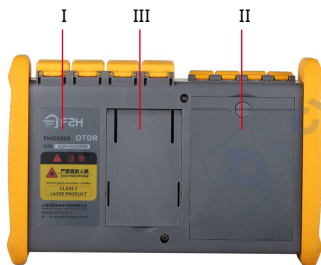
| Num. | Item | Function |
|------|--------------------------|---|
| I | Tag select button(F1-F5) | Enter relevant menu |
| II | Direction key | Move cursor and confirm |
| III | FILE | Open Database |
| IV | SETUP | Proceed quick set |
| V | ON/OFF | Turn on/off OTDR |
| VI | ESC | Cancel current menu |
| VII | MENU | Back to menu |
| VIII | REAL TIME | Realtime test mode |
| IX | TEST | Averaging test mode |
| X | Test State Indicator | Indicate test state (green-averaging mode, red-realtime mode) |
| XI | Power Indicator | Indicate working state and charging state (Green -working state or fully charged, Red -charging) |

0.2 Top Panel



| Num. | Item | Description |
|------|--------------------------------|--|
| I | AC-DC port | Connect to AC adapter |
| II | Main USB | Connect external device like: U disk ,keyboard and FIM Probe |
| III | Internet Access | Connect to internet |
| IV | Sub USB(mini USB) | Remote control through PC |
| V | VFL(visual fault locator) port | VFL module port |
| VI | OTDR1 port | 1310/1490/1550nm Test/Laser Source port |
| VII | OTDR2 port | 850/1310nm or 1625nm Test/Laser Source port |
| VIII | OPM(Power Meter) port | |

0.3 Back Panel



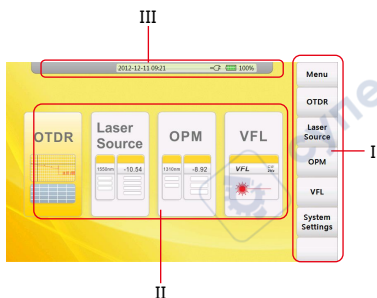
| Num. | Item |
|------|----------------------|
| I | Warning label |
| II | Battery compartments |
| III | Supporting plate |

0.4 Side Panel



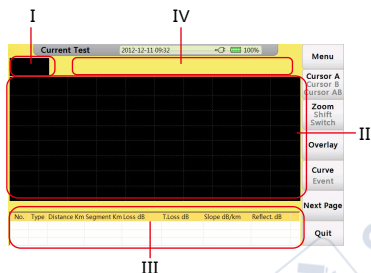
| Num. | Description |
|------|--------------------|
| I | Handle belt buckle |
| II | Fenders |

0.5 Main Menu Interface



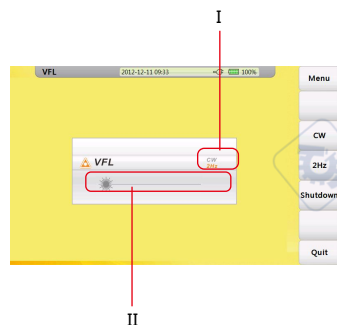
| Num. | Function | Description |
|------|------------------------------|---|
| I | Side menu | Enter relevant interface |
| II | Function Modules Area | Enter relevant module |
| III | Basic State Information Area | Display information of date ,time and power |

0.6 OTDR Module Interface



| Num | Function | Description |
|-----|----------------------------------|--|
| I | Thumbnail of current curve | For user's reference to the integrated curve. |
| II | Curve display and operating area | Display events and curves. |
| III | Event list area | Display event information including: "Type", "distance(Km)", "Loss(dB)", "T.Loss(dB)", "Slope (dB/km)" and "Reflection(dB)". |
| IV | Test condition information area | Display condition information of test including "PW"(Pulse width), "WL"(wavelength), resolution of X axis and Y axis (dB/div), distance, averaging and total loss from cursor A to cursor B. |

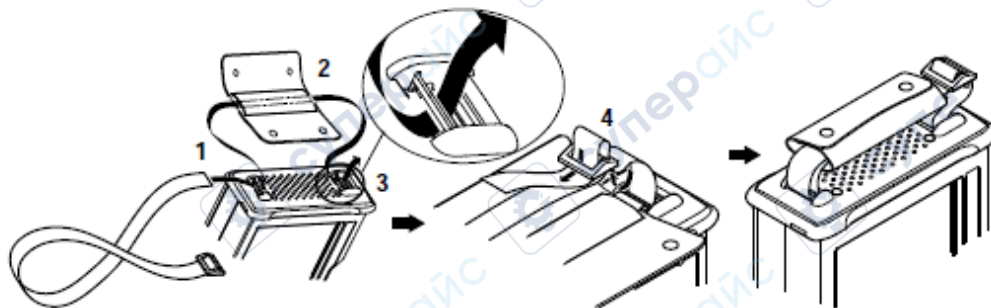
0.7 VFL Module Interface



| Num | Function |
|-----|---------------------------|
| I | VFL mode indicator |
| II | Launching state indicator |

1.0 Preparation

1.1 Attaching the Belt

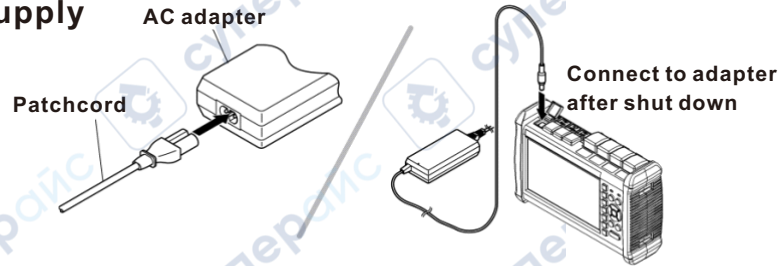


Procedure:

1. Introduce belt through the buckle.
2. Put on the sheath.
3. Introduce belt through another buckle.
4. Fix the belt.

1.2 Connecting the Power Supply

Using AC adapter



Once connect to AC adapter , power indicator turns red(if it is not fully charged), adapter is charging the battery , after fully charged power indicator turns green.

Installing Battery

1. Rotate buckle anticlockwise to open.
2. Install battery.
3. Close the cover, rotate buckle clockwise to close.

Caution

- Proper charging temperature is: $-10\sim 50^{\circ}\text{C}$,high charging temperature may shorten battery life.
- Charging time is about 5 hours with power on, about 3 hours with power off .
- Don't charge battery more than 8 hours.

1.3 Turning on

Press power button(>2s) to turn on OTDR, power state indicator turns green .when power is low some warning information will display on the screen.

Power state indicator

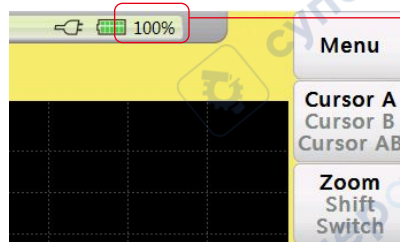
Green light: Working state or fully charged

Red light: Charging state

Launching state indicator

Green light: Proceed realtime test

Red light: Proceed averaging test



Power Indicator

| | |
|--|---------------|
| | Full |
| | 80% Power |
| | 60% Power |
| | 40% Power |
| | 20% Power |
| | Less than 20% |

Caution

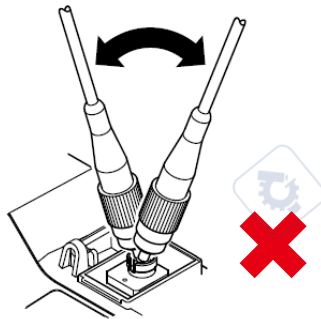
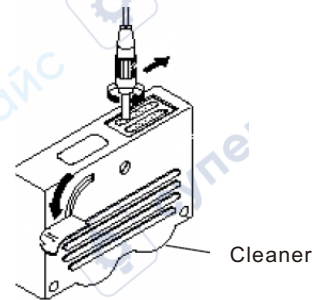
- In case of low power, special icon will appear, and after that for a while FHO5000 will turn off automatically.
- If it has not been used for an extended period of time, FHO5000 will turn off immediately after turned on to protect the internal battery, please connect the AC adapter.

1.4 Connecting the Fiber

Before connect fiber to FHO5000, clean fiber end first ,the dust which on the end of connector may damage the optical port or reduce test quality.

Procedure:

1. Put connector against the cleaner.
2. Rotate the handle of cleaner.
3. Rub each other carefully to clean the contaminant.
4. Repeat procedure 1 and 3.
5. Open the protecting cover of optical port.
6. Insect connector into optical port carefully.



Caution

Insect connector carefully into optical port, unproper operation may cause the damage of optical port.

Warning

Before connection with OTDR module, make sure that there is no optical signal exist inside the fiber.



2.0 Introduction of OTDR

2.1 Purpose of Measurement

OTDR shows the back-scatter light power of the optical signal relative to the distance. With this information, the OTDR could measure a series of important information of an optical fiber such as the quality of the line, distance of the line and etc.

2.2 Content of Measurement

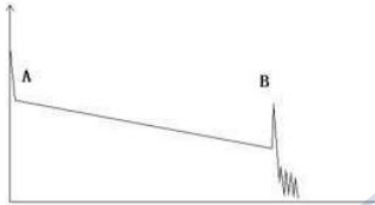
- Event position—a broken point or the end of the tested fiber.
- Optical attenuation coefficient of a optical fiber.
- Single event loss, such as the loss of a connection or a macro bending. Or the loss of a end-to-end line on the tested optical fiber.

2.3 Analyze of Curve

OTDR can auto analyze a tested trace, the position process shows below:

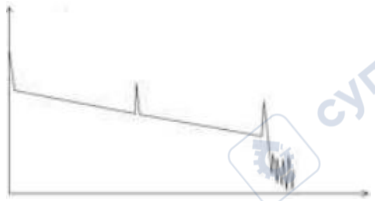
- Get the reflection events generated by connectors or mechanical splicer.
- Non-reflection events(usually it is splicing points or macro bending).
- End: the first point which the loss of it is over the threshold would be scanned as the end of a trace.
- Events list: event type, loss, reflection and distance.

Normal Curve



A normal trace shows as above, the A mark is a start-peak and the B mark is a end-reflection-peak. The tested trace is oblique, the total loss will become bigger with the increasing of the fiber length. The total loss(dB) divides total length is the average loss(dB/km) of a fiber.

Curve with Jumper Connected



If there is additional reflection peak in a tested trace, this may be caused by a connection point or some other reasons. Anyway, appearance of the reflection peak shows that the two connecting surfaces of the connection are smooth. The smoother the connection surfaces are, the higher the reflection peak is.

For an instance, if a broken optical line is under test, the OTDR trace will show a broken point. After a maintenance of this line, use the OTDR test it again, we may see a reflection peak replacing the broken point on the OTDR trace, this shows the maintenance is done.

Curve with Broken Point



If the tested trace is just like the figure shows above, this might be caused by several reasons like: a bad connection between the connector and the launching port, the optical pulse cannot be launched into the optical fiber or a short distance broken point of the tested fiber from the initial connection and the preset testing distance and pulse width is larger.

To fix this problem, we should:

1. Check the connection of the connector and the launching point
2. Reset the test parameters, decrease the preset distance and the pulse width.

If the problem still exists, we could estimate:

1. The connector of the test fiber is broken or polluted.
2. The launching port on the OTDR is broken or polluted.
3. The distance of the broken point of the from the initial connection is too close.

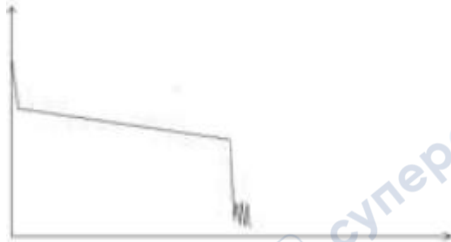
Curve with Non-reflective Event



There is a common phenomenon that an obvious step is on the middle of a tested trace, it often caused by a fiber bending, fiber knot, being pressed by something heavy or a fuse splicing point. The step means a bigger loss of a fiber, it is also called event point. If the direction of it is downward, it could be called non-reflection event. If the direction is upward, we can call it reflection event.

Sometimes, the loss value could be a negative value, it does not means the loss does not exist. It is common phenomenon called pseudo gain, it is by a connection of two fibers with different back scatter coefficient, the scatter coefficient of the back fiber is large than the front one's. In addition, the different refract ratio also can cause the phenomenon. To avoid it, we could test a fiber bi-directionally.

Abnormal Condition



The situation that there is no reflection peak at the end of a trace shows above should be paid attention on. If the distance of the tested fiber is available and the distance shown on OTDR is not equal to the original distance, this shows that the fiber might be broken down or twisted and the bending radius of it is over limited. The distance shown on OTDR is the position of the fault point.

This phenomenon is often used in maintenance. If a fiber is uncertain, we can bend a fiber and make sure the bending radius is over limited, then use real time testing function of the OTDR to confirm the fiber.

Distance is Too long



This situation often happened in a long distance testing, caused by under-range dynamic range of the OTDR that the energy of it can not support a long distance transmission or caused by a under-range preset testing range of distance or pulse width corresponding to the actual fiber length. To avoid this situation, adjust the testing distance and the pulse bigger and extend the sampling time.

2.4 Fundamental of OTDR

OTDR—Optical Time Domain Reflector is a high precision optical testing meter that use the theory of Rayleigh scattering and Fresnel reflection. It is widely used in the maintenance, construction and monitoring of an optical line. All the important parameters like fiber length, optical loss, connection loss, broken or twisted point and etc. of a fiber can be shown on the OTDR. When the a light transmits along a fiber, it would be scattered to various directions caused by the difference of come properties of the transmission medium, this phenomenon called Rayleigh scattering. During the scattering process, some of the light will be scattered along the absolutely converse direction, this phenomenon is called Rayleigh back-scattering. It provides some details about the fiber length. The parameters about fiber length can be got by calculation with the parameter of time(This is the derivation of TD in OTDR—Time Domain optical Time Domain Reflectometer).

These back-scattering signals shows the loss level of a fiber and through these information, OTDR can generates a backward oblique trace which reflects several important attributes of a optical fiber. When the light, transmitting downward along the fiber, meet a different density medium, a part of the light will be reflected, this phenomenon is called Fresnel reflection. There are many reasons can cause the changing of the medium density like a little slot at the splicing point, a broken of fiber or etc. This phenomenon is usually used to locate the discontinuous point. Compare to the Rayleigh scattering, the consuming amount of the light in Fresnel reflection is much more then it is in Rayleigh scattering. The power of Fresnel reflection is tens of thousands times to the back-scattering's. The reflection level depends on the changing grade of refraction ratio.

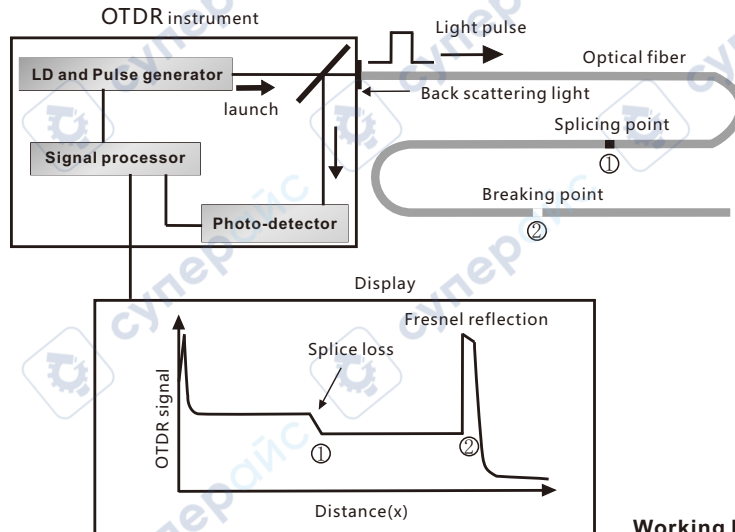
Formula of the distance: $\text{distance} = (c/n) \cdot (t/2)$.

Here: c is the light speed traveled in vacuum ($2.998 \cdot 10^8 \text{m/s}$).

T is the delay between launching pulse and receiving pulse.

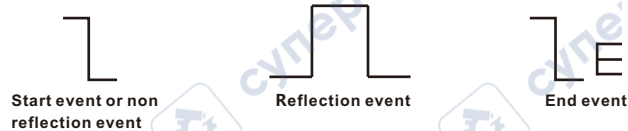
N is the refraction ratio of the testing fiber (specified by manufacturer).

When display the whole trace, each point of the trace represents the average value of several sampling points. By zoom in and zoom out function, the value of each sampling point can be got.



Working Principle of OTDR

2.5 Event Type



The events on trace are all the points that the value of power loss fluctuates abnormally. It usually contains various types of connection and bending, crack, broken and etc. The event points marked on trace with special marks are the abnormal points in a fiber that cause the excursion of a normal trace.

The events can be divided into Reflection-event and Non-reflection-event

Start event

The Start-Event on a OTDR trace is the initial point. Under the default setup, Start-Event is located on the first event(usually it is a connection between the OTDR launching port and the connector of a fiber) of a fiber. It is a Reflection-event.

End event

The End-Event on a OTDR trace is the end point of a fiber. Under the default setup, End-Event is located on the last event(usually it is an end face or a broken down point of a fiber). Usually, it is a Reflection-event.

Reflection-event

The phenomenon on a trace that some power of the optical pulse is reflected called a reflection event. Reflection-event is displayed as a peak signal on a trace.

Non-reflection-event

The phenomenon on a trace that there exists some abnormal loss in a optical line, but no reflection occurred is called a Non-reflection-event. It is displayed as a drop with no peak on a trace.

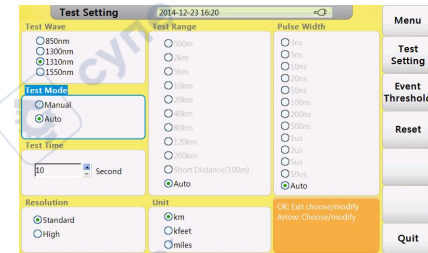
Event detection

OTDR launches a bunch of optical pulse into a under-test fiber, receives the returned optical signal and starts calculating the distance from a event. The more the distance from the event is, the longer the returning time is cost. According to the receiving time, distance can be calculated. By detecting the trace generated by the returned optical signal, the attributes of the fiber itself, the connector of the fiber, adaptor in the fiber and splicing point in the fiber can be confirmed.

3.0 Setting Measurement Conditions

Press 【SETUP】 button on the panel to enter test setting interface.

The meaning of items indicated in the following table:



| | |
|--------------------|---|
| Test Wave | Test wavelength of OTDR. |
| Test Mode | Auto Mode: FHO5000 will set best parameters for current test Manual Mode: set parameters manually. |
| Test Time | Under averaging test mode(TEST), longer test time has better SNR (Signal Noise Ratio) but takes more time . |
| Test Range | Test distance of OTDR .adjust only in manual mode, in auto mode this item set as "Auto". |
| Pulse Width | Wider pulse has stronger backward signal, OTDR has longer detecting distance but wide pulse width will cause the saturation of backward signal, make blind area bigger. so the selection of pulse width has close relationship with the length of fiber. Long fiber has wide pulse width.. pulse width could only modified in "Manual"mode. |
| Resolution | Sampling resolution of test. High resolution has more sample point and high precision, but take more memory space. |
| Unit | Unit of test result, including km/kfeet/miles. |

3.1 Setting to Auto Mode

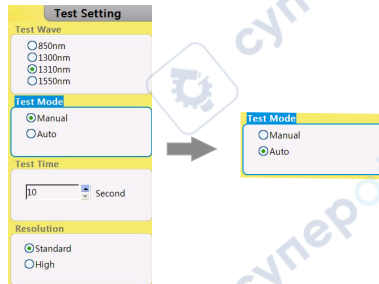
In Auto mode, you could just proceed test by setting proper wavelength.

Procedure:

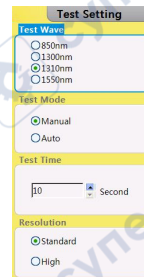
1. Press **【SETUP】** button to enter "Test Setting" interface.



2. Set "Auto" mode.



3. Set test wave.



Caution

Auto test mode is not suitable to proceed Blind area test, user should enter "Manual" mode and choose "Blind area test" to proceed blind area test.

3.2 Setting to Manual Mode

In manual mode, user could set proper range and pulse width manually.

Procedure:

1. Press **【SETUP】** button to enter "Test Setting" interface.



2. Set "Manual" mode.

| Test Setting | |
|--------------|--|
| Test Wave | <input type="radio"/> 850nm <input type="radio"/> 1300nm <input checked="" type="radio"/> 1310nm <input type="radio"/> 1550nm |
| Test Mode | <input checked="" type="radio"/> Manual <input type="radio"/> Auto |
| Test Time | <input type="text" value="10"/> Second |
| Resolution | <input type="radio"/> Standard <input type="radio"/> High |



| Test Mode | |
|-----------|---|
| | <input checked="" type="radio"/> Manual <input type="radio"/> Auto |

3. Set test wave.

| Test Setting | |
|--------------|--|
| Test Wave | <input type="radio"/> 850nm <input type="radio"/> 1300nm <input checked="" type="radio"/> 1310nm <input type="radio"/> 1550nm |
| Test Mode | <input checked="" type="radio"/> Manual <input type="radio"/> Auto |
| Test Time | <input type="text" value="10"/> Second |
| Resolution | <input type="radio"/> Standard <input type="radio"/> High |



| Test Range | Pulse Width |
|--|---|
| <input checked="" type="radio"/> 500m <input type="radio"/> 2km <input type="radio"/> 5km <input type="radio"/> 10km <input type="radio"/> 20km <input type="radio"/> 40km <input type="radio"/> 80km <input type="radio"/> 120km <input type="radio"/> 160km <input type="radio"/> 240km <input type="radio"/> Short Distance(100m) <input type="radio"/> Auto | <input type="radio"/> 3ns <input type="radio"/> 5ns <input type="radio"/> 10ns <input checked="" type="radio"/> 20ns <input type="radio"/> 50ns <input type="radio"/> 100ns <input type="radio"/> 200ns <input type="radio"/> 500ns <input type="radio"/> 1us <input type="radio"/> 2us <input type="radio"/> 5us <input type="radio"/> 10us <input type="radio"/> 20us <input type="radio"/> Auto |

4. Set range and pulse width.

Caution

- When "Pulse width" set to "Auto", test will choose proper pulse width automatically.
- When "Test Range" set to "Auto", test will choose proper range automatically.
- Once you set the "Test range", "Pulse width" item will adjust automatically you could also adjust manually.

Proper relationship between Range(MR) and pulse width(PW)(For user's reference only):

| MR \ PW | 100m | 500m | 2km | 5km | 10km | 20km | 40km | 80km | 120km | 160km | 240km |
|---------|------|------|-----|-----|------|------|------|------|-------|-------|-------|
| 3ns | √ | √ | △ | △ | △ | △ | △ | △ | △ | △ | △ |
| 5ns | √ | √ | √ | △ | △ | △ | △ | △ | △ | △ | △ |
| 10ns | △ | √ | √ | √ | △ | △ | △ | △ | △ | △ | △ |
| 20ns | △ | √ | √ | √ | √ | △ | △ | △ | △ | △ | △ |
| 50ns | △ | △ | √ | √ | √ | √ | △ | △ | △ | △ | △ |
| 100ns | △ | △ | △ | √ | √ | √ | △ | △ | △ | △ | △ |
| 200ns | △ | △ | △ | △ | △ | √ | √ | △ | △ | △ | △ |
| 500ns | △ | △ | △ | △ | △ | △ | √ | √ | △ | △ | △ |
| 1us | △ | △ | △ | △ | △ | △ | √ | √ | √ | △ | △ |
| 2us | △ | △ | △ | △ | △ | △ | △ | √ | √ | √ | △ |
| 5us | △ | △ | △ | △ | △ | △ | △ | √ | √ | √ | √ |
| 10us | △ | △ | △ | △ | △ | △ | △ | △ | √ | √ | √ |
| 20us | △ | △ | △ | △ | △ | △ | △ | △ | △ | △ | √ |

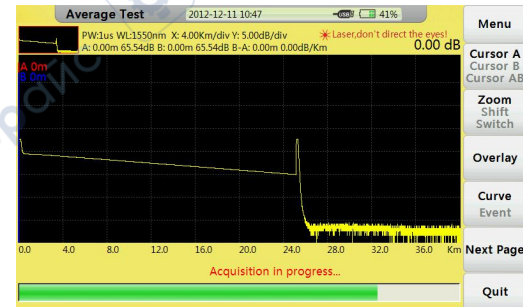
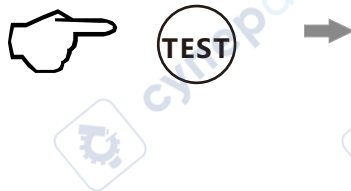
4.0 Making Measurements

FHO5000 has two test modes: averaging test mode and realtime test mode.

4.1 Averaging Test Mode

Averaging test mode can calculate the data of curve over a period of time and display as a averaging one ,test time could set "Test Time" in "Test Setting".

Press **【 TEST 】** button on the control panel, test state indicator turns red, enter averaging test interface.

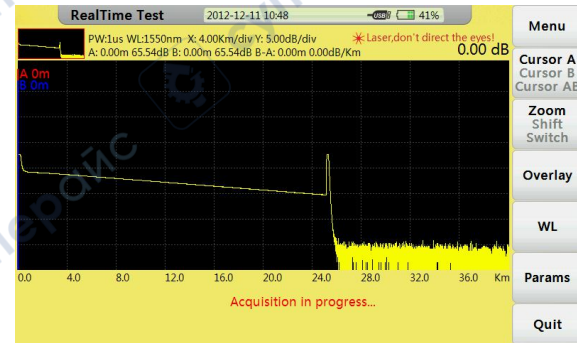


Averaging test interface

4.2 Realtime Test Mode

Realtime test mode could check network , adjust test range and pulse width in real-time.

Press 【REALTIME】 button on control panel, test state indicator turns green,enter realtime test interface.

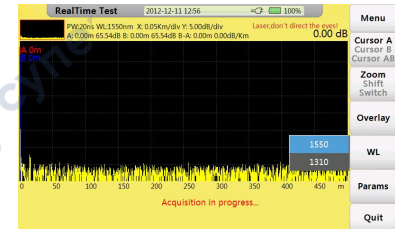


Realtime test interface

4.2.1 Setting Wavelength

Procedure:

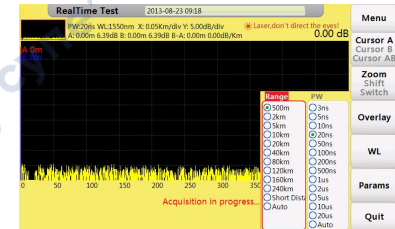
1. Select wavelength (WL) tag to set wavelength.
2. Confirm by **【OK】** button.



4.2.2 Setting Test Range and Pulse Width

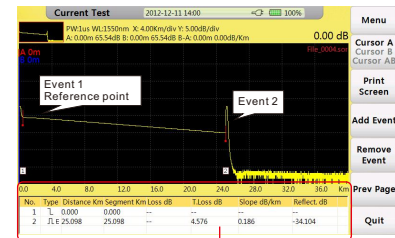
Procedure:

1. Select tag "Params" to set Test range(MR) and Pulse width(PW)button.
2. Confirm by **【OK】** button.



4.3 Event List

After test, event list will appear immediately at the bottom of the window, user could get detail information about this test from the list.



Event List

Description of items showed in chart below:

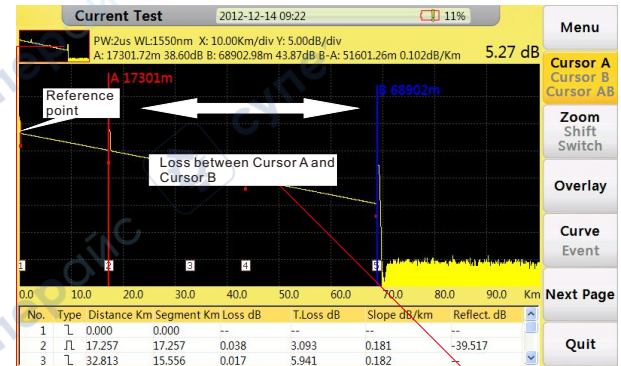
| Num | Item | Description |
|-----|-------------|---|
| I | Type | Type of event(Attenuation events, Reflection events and End event) |
| II | Distance | Distance from start point to event |
| III | Section | Distance from this event to last event. |
| IV | Loss | Loss of this event(dB) |
| V | T. Loss | Total loss from start event to this event(dB) |
| VI | Slope dB/km | Ratio of event loss value(dB) (from this event to last event)to distance (Km)(distance from this event to last event) |
| VII | Reflect.dB | Return loss of this event(dB) |

4.4 Distance Measurement

Measure the distance from one point to another.

Procedure:

1. Press **【F1】** button to active cursor function.
2. Control **【◀】 / 【▶】** to move cursor A or B.
【◀】 : move left **【▶】** : move right
3. Get information by following the guide below:



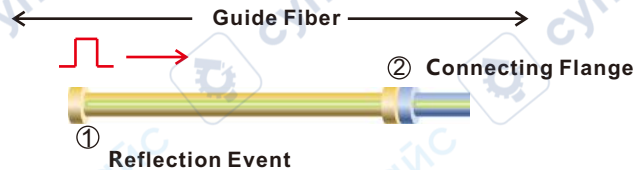
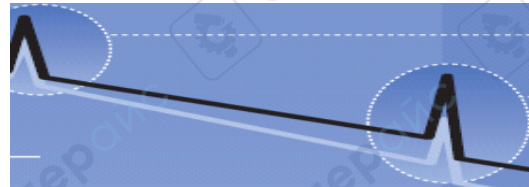
Current pulse width and wavelength

Resolution of X axis and Y axis

PW:2us WL:1550nm X:10.00Km/div Y:5.00dB/div
 A:17301.72m 38.60dB B:68902.98m 43.87dB B-A:51601.26m 0.102dB/Km 5.27 dB

Indicate distance of cursor A and cursor B which relative to the reference point(start event), relative distance(km) and loss(dB) between cursor A and cursor B.

4.5 OTDR Optimizing Tool



1. Guide fiber

Use an guide fiber to figure out the character of connector. By adding this fiber we could move the first connector out of the blind area. In the same way we could use this way to figure out the character of last connector.

2. About guide fiber

Proper length of Guide fiber is 100~1000m, it depends on the blind area of OTDR. In theory, minimum length of guide fiber should be two times longer than attenuation blind area , but it should be longer in practice.

4.6 Setting Proper Parameters

At the first time using OTDR, if user choose some testing parameter which is not suitable to the real condition may cause the bad result. User should take Testing range, pulse width and wavelength into consideration.

Setting proper testing range

Testing range means maximum display range. This parameter will indicate how long will OTDR display on its screen. this range must longer than testing fiber, Usually we choose range which is 20% longer than testing fiber. Take note that testing range should not has large difference with testing fiber, Otherwise it will affect the effective resolution and overlarge testing range will result in the generation of huge and useless data(see Figure 1).

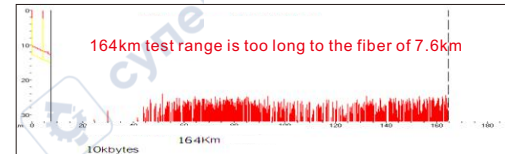


Figure 1

Setting proper pulse width

Pulse width and blind area, dynamic range are directly related to the maximum length ,in below picture, use ten different pulse width to test one testing fiber.the smallest pulse width result in the smallest blind area and the most terrible noise. The longest pulse width result in the smoothest curve and almost 1km blind area(see Figure 2).

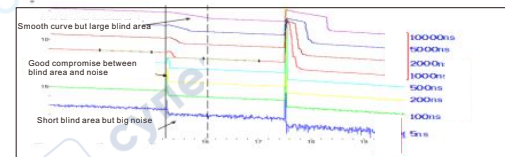


Figure 2

It is obviously at the top of testing fiber influence on Pulse width , in below chart,we cant detect the first connecting point locate in the 540m by large pulse width(see Figure 3).

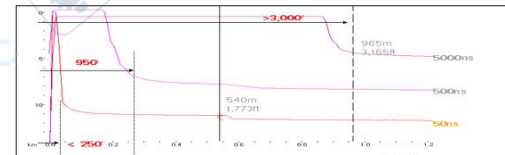


Figure 3

Dynamic range decided by Pulse width, larger pulse width will spend more optical power, but it reach further(see Figure 4).

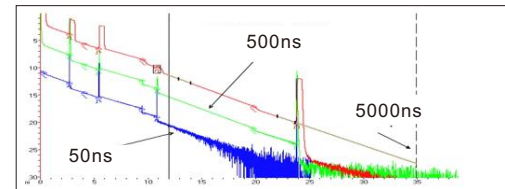


Figure 4

Setting proper wavelength

Proceed test with same fiber but different wavelength we will get different result. Longer the testing wavelength is, more sensitive of the bending, in below chart ,first splicing point has bending problem, splicing loss value under 1550nm is bigger than that under 1310nm. the other points are similar with 1310nm and 1550nm. This phenomenon indicate that this fiber is just bended at the first point. If it's possible please always compare the point state under 1310nm and 1550nm and judge whether it's bended or squashed (see Figure 5).

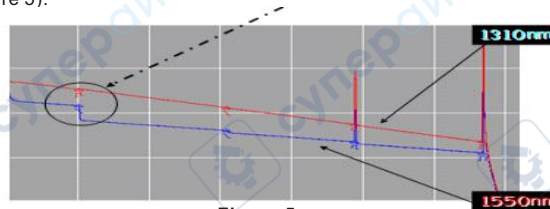


Figure 5

Setting proper test time

In averaging mode, long testing time could reduce noise during the data sampling and improve precision to get better and smoother curve (see Figure 6).

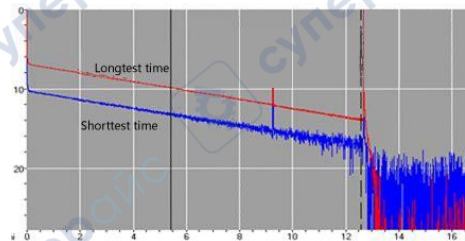


Figure 6

5.0 Expanding the Waveform and Moving the Display Area

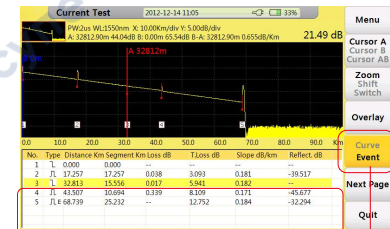
5.1 Switching between Event List and Display Window

In "current test" interface, press **[F4]** button to switch between "Curve" and "Event", expand each section after switch, this function could also switch between cursor("Curve") and selection tag("Event").

Procedure:

In test interface,

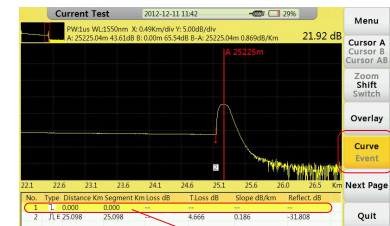
1. Press **[F4]** button to switch from curve to event windows.
2. Control **[▶]** / **[◀]** or **[▲]** / **[▼]** to move selection tag.



Original event window ↓

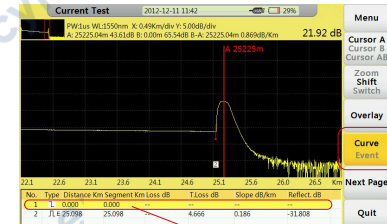


Event window became larger



Switch to "Event", move selection tag to choose event.

Every time move selection bar to an event in event list, cursor will move synchronously to relevant event on curve. User could use "Zoom", "Move", "Switch" function to adjust curve to a better position, for more information please refer next sections.

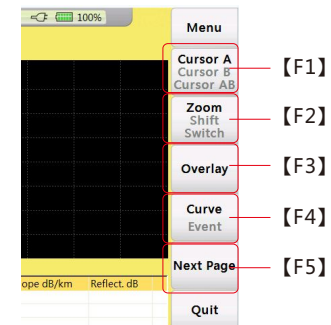


Switch to "Event", move selection tag to choose event.

5.2 Cursor Operation

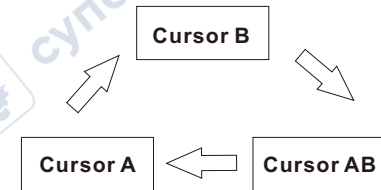
5.2.1 Activating Cursor

In "Current Test" interface, press **[F1]** button, "cursor" tag turns yellow, means it has been activated.



5.2.2 Moving Cursor

Set proper cursor, press **▶** / **◀** button to move current cursor, long press to move cursor faster.



Sequence of cursor switching

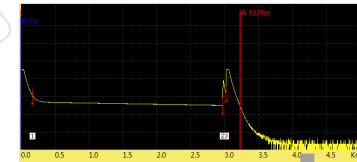
5.3 Curve Operation

5.3.1 Horizontal Zoom

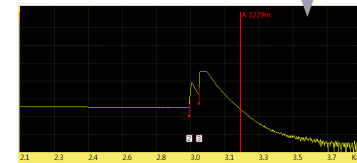
Procedure:

In "Current Test" interface,

1. Press **F2** button to activate "Zoom" function.
2. Control **▶** / **◀** button to zoom in or zoom out curve.
▶ : Zoom in curve **◀** : Zoom out curve



Original



After operation

5.3.2 Vertical Zoom

Procedure:

In "Current Test"interface,

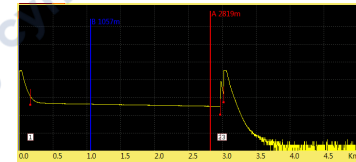
1. Press **【F2】** button, activate "Zoom"function.
2. Control **【▶】** / **【◀】** button to zoom in or zoom out curve.
【▶】 : Zoom out **【◀】** :Zoom in
3. Press **【OK】** button to reset curve.

5.3.3 Horizontal Shift

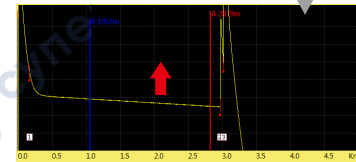
Procedure:

In "Current Test"interface,

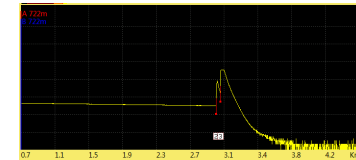
1. Press **【F3】** button, activate "shift "function.
2. Control **【▶】** / **【◀】** button to move right or left.
【▶】 : move right **【◀】** : move left
3. Press **【OK】** button to reset curve.



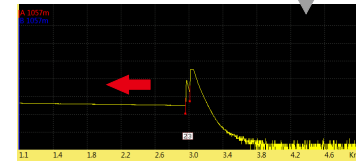
Original



After operation



Original



After operation

5.3.4 Vertical Shift

Procedure:

In "Current Test" interface,

1. Press **【F3】** button, activate "shift" function.
2. Control **【▲】** / **【▼】** button to move up or down.
【▲】 : move up **【▼】** :move down.
3. Press **【OK】** button to reset curve.

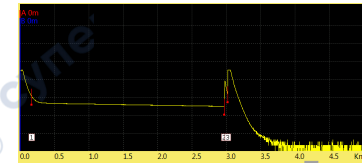
5.4 Elaborating Event

This section we will introduce how to elaborate an event on curve, example as event 2 in right curve.

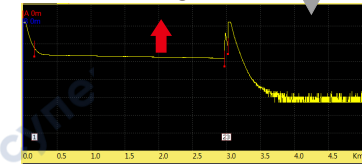
Procedure :

In "Current Test" interface,

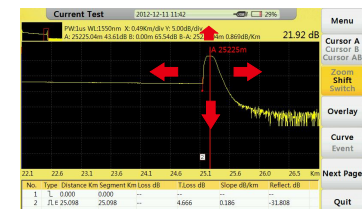
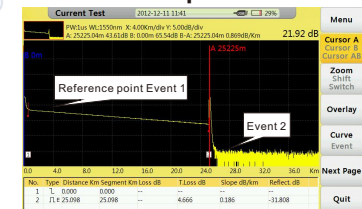
1. Press **【F1】** button to activate cursor function.
2. Control **【▶】** / **【◀】** lto move cursor(A or B) left or right.
3. Move to event 2.
4. Press **【F2】** button to active Zoom function.
5. Control **【▶】** button to zoom out event(cursor as the center).
6. Press **【F3】** button to activate "shift" function.
7. Control **【▲】** / **【▼】** / **【▶】** / **【◀】** button to adjust to a proper position.



Original



After operation



5.5 Switching between Curves

This function could be used to switch between several curves, current curve displayed in yellow.

Procedure :

In "Current Test" interface,

1. Press **【F2】** button, active "switch" function.
2. Control **【▲】** / **【▼】** button to switch between curves.
【▲】 : Switch to above curve **【▼】** : switch to below curve
3. Press **【OK】** button to reset all curves

Caution

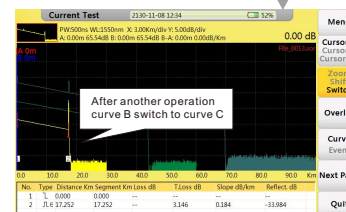
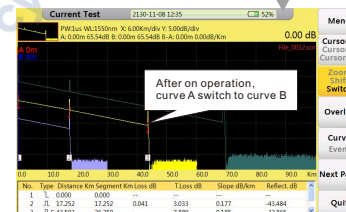
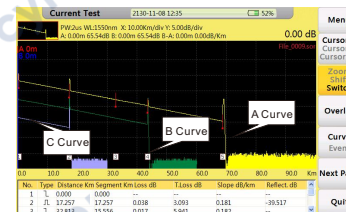
Display maximum 8 curves at one time, if load more than 8 curves last curve will recover the former one, please refer 6.2 "Loading Curve(S)" for learning how to load curve(s).

5.5.1 Removing Curve(s)

User could remove one or several curves.

Press **【F3】** "Overlay" tag menu:

- Remove Current Trace Remove the Curve which has been selected.
- Remove Other Trace Remove the Curve(s) which has not been selected.
- Remove All Remove all the Curves.

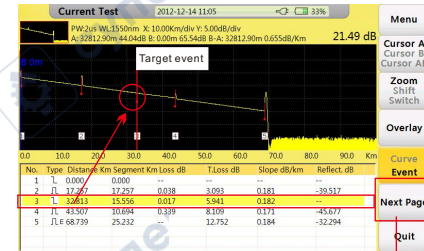


5.6 Removing an Event

Procedure:

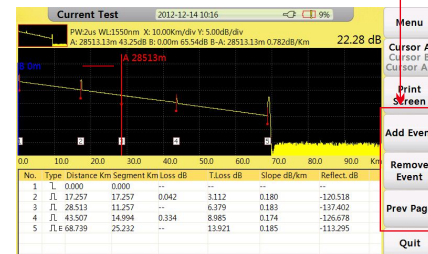
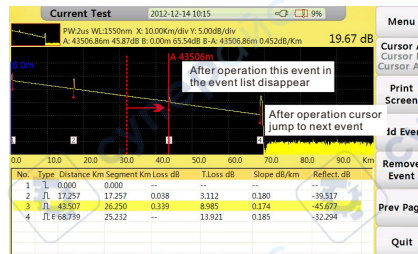
In current Test interface,

1. Press **【F1】** button to activate tag, move cursor to the target event



Appear by pushing "Next page" tag

3. Press **【F4】** "Remove Event" tag to remove event(S).
2. Press **【F5】** button to select "Next Page" tag.



5.7 Adding an Event

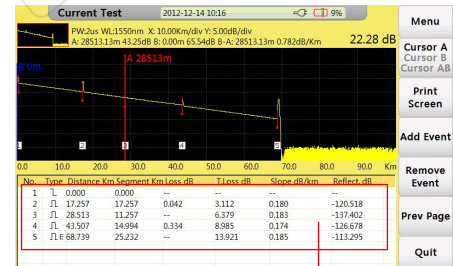
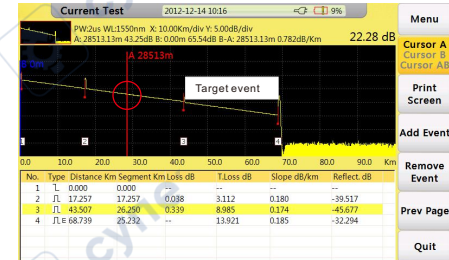
Procedure:

In current Test interface,

1. Press **【F1】** button to activate tag, move cursor to the target event
2. Press **【F5】** button to select "Next Page" tag (Please refer last section 5.6 "Remove an Event").
3. Press **【F3】** to add event.

Caution

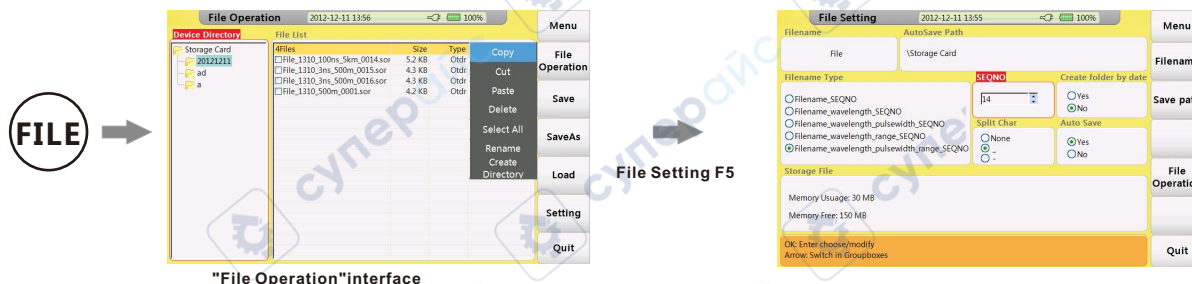
Event addition may not operate successfully for too close to another event, user could move cursor a bit away from near event and have another try.



After operation, this event will appear in the event list sequence will be rearranged.

6.0 File Operation

In "Current Test" interface Save the current curve , press **【 FILE 】** button on the board ,open "File Operation"interface,showed as follow:



"File Operation"interface

6.1 Saving Curve

Procedure:

In"Device Directory"window,

1. Press **【▲】** / **【▼】** to choose file and subfile then press **【OK】** .
2. Press **【F5】** button to enter "File Operation"interface ,user can change way of saving,decide way of naming and check storage state.
3. Press **【F2】** "Save" tag to save current curve as default name(set in "Filename Type"under "File Setting"interface).
- 4.If user want to change a name before saving , press **【F3】** "Save As"tag to input your ideal name(refer section "Entering Characters" to learn how to input characters) and confirm by **【OK】** button.

6.2 Loading Curve(s)

Procedure:

In "Device Directory" window,

1. Press **【▲】** / **【▼】** to choose relative file and subfile press **【OK】** .
2. Press **【▶】** switch to "File list" window.
3. Control **【▲】** / **【▼】** button to to select relevant file curve file(s),press **【OK】** button to select the relevant file(s).
4. Press **【F4】** "Load" tag to load curve(s) .

6.3 Deleting Curve(s)

Procedure:

In "File Operation" interface,

1. Select the curve file(s) which you want to remove.
2. Press **【F1】** "file operation" select "delete" sub menu to delete curve file(s).

6.4 Copying/Moving Curve(s)

Procedure:

In "File Operation" interface,

1. Select the curve file which you want to remove.
2. Press **【F1】** "File operation" select "Cut" or "Copy" to move or copy curve file(s).
3. Choose the target folder, press **【F1】** "File Operation" .
4. Select "Paste" tag to finish this operation.

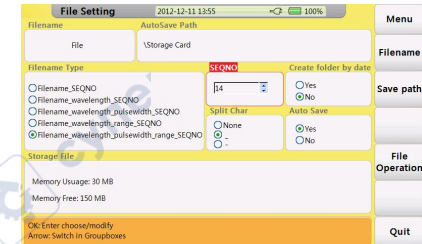
6.5 File Setting

Tags:

| Item | Description |
|----------------|------------------------------------|
| Menu | Back to main menu |
| Filename | Modify prefix of file name |
| Save Path | Modify the save path of files |
| File Operation | Back to "File Operation" interface |
| Quit | Quit current interface |

Items :

| Item | Description |
|-----------------------|---|
| Filename | Prefix of file name , modify by "Filename"tag menu |
| AutoSave Path | Save path of auto save |
| Filename Type | Naming way of files after auto save |
| SEQNO | Sequence number of next test,and auto increment after each test |
| Create folder by date | Set create folder by today's date and save files separately into them |
| Split char | Set the type of separator |
| Auto save | Set Auto save |



"File Setting" interface

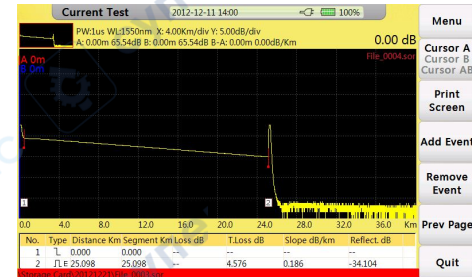
6.6 Print Screen

FHO5000 could capture current screen and save as ".BMP" format file.

Procedure:

1. Press "Next page" tag ,under test interface.
2. Press **【F1】** button to capture.

User could check captured screen in "File Operation" by pushing **【FILE】** button.



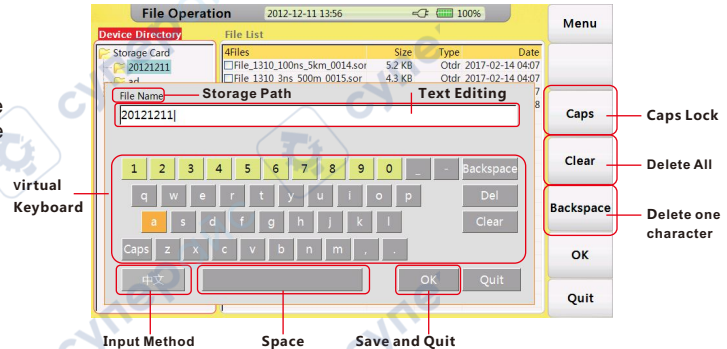
Save Path

Caution

User could change save path under "File Setting"(refer section 6.5).

7.0 Entering Characters

You can enter file names and comments from the character input screen shown below when saving the measured waveforms.



7.1 Renaming

Next guide will teach you how to change the name of file.

Procedure:

1. Select your target file.
2. Press **[F1]** "File Operation", select "Rename".
3. Input name.
4. Confirm by "OK".

7.2 Creating Directory

Before create a folder system will inquire you to input a name.

Procedure:

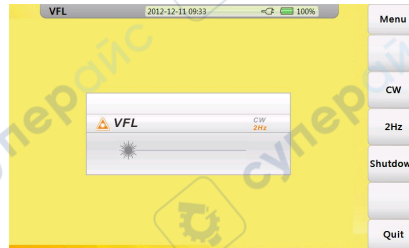
1. Select your target folder or root directory.
2. Press **[F1]** "File Operation", select "Create Directory".
3. Input name and confirm by "OK" on visual keyboard.

8.0 VFL Module

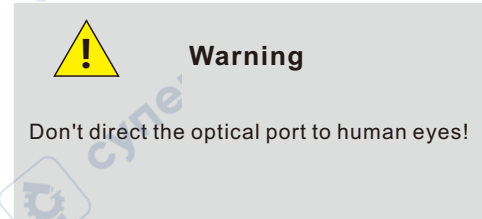
VFL module could launch visible light to identify the fiber, locate fault of SM or MM fibers. It is the supplementary to the testing of blind area and basic tool of optical network, LAN, ATM fiber system and telecommunication network maintenance.



VFL launching port



VFL interface



VFL module has two modes:

CW

Launching continuous wave(650nm)

2Hz

Launching 2Hz modulated wave (650nm)

Press "Quit" to quit VFL interface

Specification

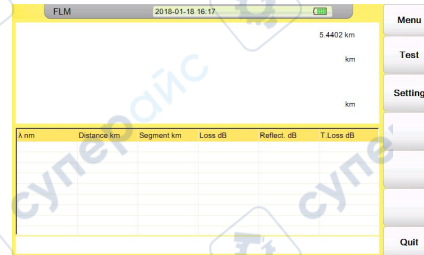
| | |
|------------|--------|
| Wavelength | 650nm |
| Power | 10mw |
| Modulation | CW/2Hz |
| Adapters | FC |

9.0 FLM Test (Optional)

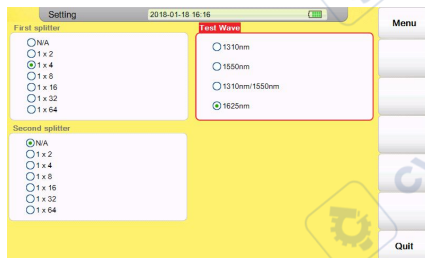
FLM Test (Fiber Link Measurement), also known as "Optical Eye", uses multiple pulse width acquisitions and advanced algorithms to quickly characterize the fiber under test and display the optical events applying intuitive symbols.



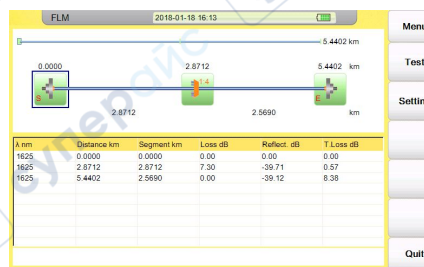
Select "FLM" module and press **【OK】** to enter FLM interface as below:



Press **【F2】** "Setting" to enter the setup interface.



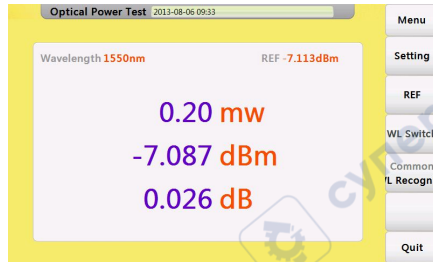
Set "First splitter", "Second splitter" or "Test wavelength" option according to the actual condition of your fiber under test. After setup is finished, press **【ESC】** back to test interface and press **【F1】** to start the FLM test.



Each event is shown graphically and the detailed information is listed below.

10.0 OPM Module(Optional)

User could use OPM module to measure the power value in optical network and get the loss of the line with optical light source.



OPM interface

Setting

Set offset value and Display precision

Reference value

Press "REF" to set current power value as reference value

Wavelength switch

Press "WL switch" to switch wavelength

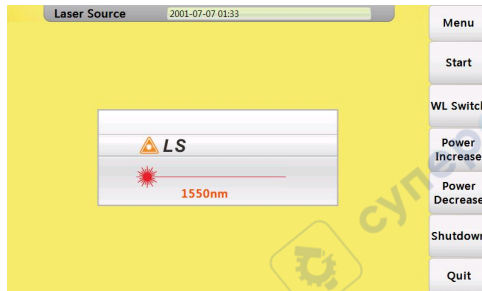
Mode switch

Press "Common/WL Recognize" to switch between normal mode and WL recognizing mode.

Specification

| | |
|-----------------------|-------------------------------------|
| Sensor Type | InGaAs |
| Wavelength Range | 800~1700nm |
| Calibrated Wavelength | 850/1300/1310/1490/1550/1625/1650nm |
| Testing Range | -50~+10dBm |
| Resolution | 0.01dB |
| Accuracy | $\pm 0.35\text{dB} \pm 1\text{nW}$ |
| Adapter | FC |

11.0 OLS Module(Optional)



OLS Module interface

Start

Turn on the laser source

WL switch

Switch between wavelengths

Power Increase

Increase the power value

Power Decrease

Decrease the power value

Shutdown

Turn off the laser source

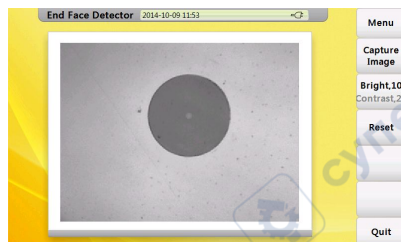
Specification

| | |
|--------------------|--------------------------------------|
| Working wavelength | 850/1300/1310/1490/1550/1625/1650nm① |
| Output power | -25~0dBm |
| Accuracy | ±0.5dB |

① 1310/1490/1550nm wavelength use OTDR1 port, while 1625/1650nm or 850/1550nm wavelength use OTDR2port, OTDR can not use 1620nm or 850/1550nm without OTDR2 module

12.0 FIM Module(Optional)

FIM Module is qualified for field connector inspection by connecting a probe to USB port, also this probe can use computer as a display with no additional software.



FIM Module Interface

Capture Image

Save current image

Bright/Contrast

Adjust Bright and Contrast for image

Reset

Recover to factory settings

Specification

| | |
|-----------------------------|---|
| Magnification | 400X |
| Resolution(μm) | 1.0 |
| View of Field(mm) | 0.40*0.31 |
| Storage/working Condition | -18 $^{\circ}\text{C}$ ~35 $^{\circ}\text{C}$ |
| Dimension(mm) | 235*95*30 |
| Sensor | 1/3 inch 2 million of pixel |
| Weight(Kg) | 0.15 |
| USB | 1.1/2.0 |

13.0 Waterproofing work(Optional)

Through special process, FHO5000 can compliance with IPX5 protection level. This could make FHO5000 withstand harsher environments. Test for the ratings IPX5 address the possibility of water ingress from a jetting stream. They are conducted using a jet nozzle kit .

14.0 Touch Screen (Optional)

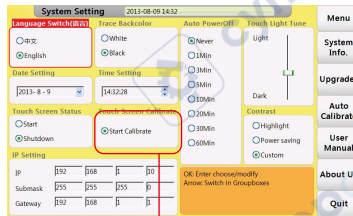
After select this optional module ,a Resistance Screen will be added to FHO5000,user could select item or input words by just touch the relvent area,a specialized pen is attached.

Calibration

Once you can't touch the certain point you want on screen that means you need to calibrate the touch screen.

Please follow next procedure to proceed calibration:

1. Open "system setting" interface and select "Touch Screen Calibration" area,enter calibration interface.



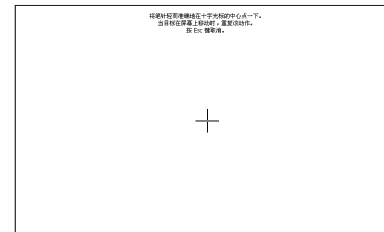
Start calibration from here



Warning

Press gently on the screen, any strike or crash may damage it.

2. Follow the direction, press "+" icons on the screen, then calibration done.

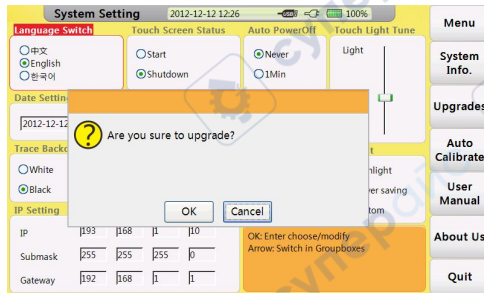


15.0 Software Update

FHO5000 could proceed update by one U disk(with patch storage in root directory).

Procedure:

- 1.Download patch from PC and storage into U disk(must storage in root directory).
2. Insert U disk into USB port.
- 3.Turn on FHO5000, press **【F5】** to enter system setting,press **【F2】** to proceed upgrades.



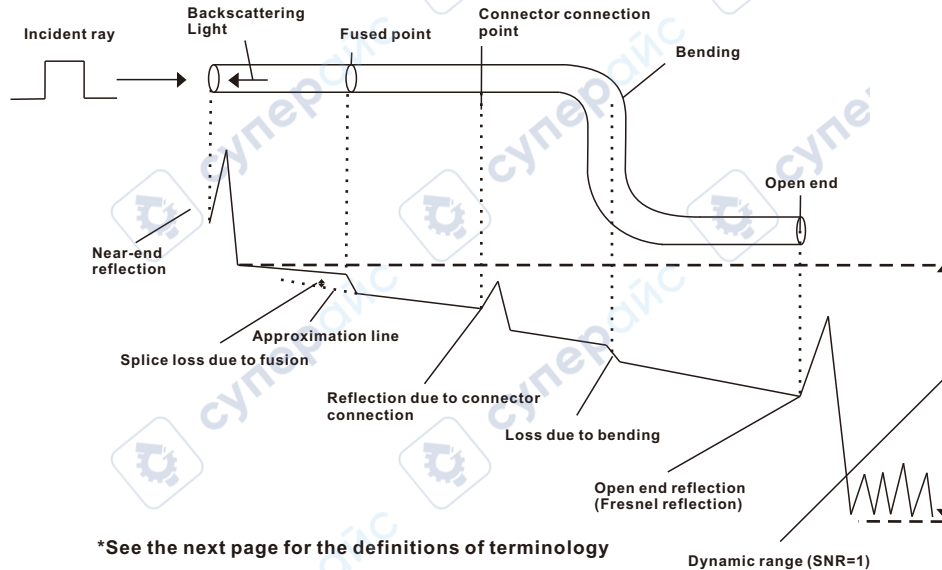
Upgrades interface1



Upgrades interface2

16.0 Background Information on Measurements

16.1 Viewing the Optical Pulse Measurement Waveform



16.2 Terminology

Near-end reflection

A reflection occurs in the gap between OTDR and the connector for the optical fiber cable. Losses and reflections of the connection points cannot be detected in the section in which this reflection is detected. This section is called a dead zone.

Backs cattering light

When light propagates through the optical fiber cable, a phenomenon called Rayleigh Scattering occurs due to the nonuniformity of the density or constituents of materials smaller than the wavelength unit. The scattered light that is transmitted opposite to the direction of propagation is called backscattering light.

Splice loss due to fusion

A splice loss occurs at the fused section mainly due to axis offset and angle offset.

Reflection due to connector connection

Unlike the fused section, a slight gap occurs in the connection section of connectors. Because the group refraction index changes in this gap, a reflection occurs causing a loss.

Fresnel reflection at the far end of the optical fiber cable

Fresnel reflection occurs at the location where the optical fiber cable is broken or a location where the group refraction index changes such as the far end of the cable (glass and air) when light enters the cable. If the end face of the optical fiber cable is vertical, approximately 3.4 % (−14.7 dB) of the incident light power is reflected.

Dynamic range

Dynamic range refers to the difference between the backscattering light level at the near end and the noise (RMS = 1).

Dead zone

The locations where measurements cannot be made due to the effects of Fresnel reflection, connection point of connectors, etc.

17.0 Maintenance

17.1 Notice

FHO5000 OTDR Use rechargeable Li-ion battery.

Pay attention to the following:

- Keep OTDR dry and clean store at room temperature(15°C~30°C).
- Charge it monthly if you don't use it for a long time(more than one month).
- Keep Optical port clean by alcohol soaked cotton and recover dust cap after use.
- Clean optical port and connector at fixed period .

Follow the principles below before cleaning:

- Shut off before cleaning.
- Any operations contrary to the instructions may result in dangerous laser injuries.
- Disable laser launching before cleaning.
- When the instrument is in operation, please always avoid looking directly into optic output. Although laser radiation is invisible, it may do serious injury to eyesight.
- Be cautious of electric shock and make sure AC power is disconnected from the instrument before cleaning. Always use dry or moist soft cloth to clean the outside of the instrument, and never touch inside.
- Don't proceed any modification on OTDR.
- For maintenance, please always operated by qualified worker.

17.2 Cleaning Tools

- Optic fiber cleaner (for cleaning of optic connectors)
- Optic fiber cleaning rod (for cleaning of optic outputs)
- Optic fiber cleaning tissue (for cleaning optic interfaces)
- Isopropyl alcohol
- Cotton ball
- Paper tissue
- Cleaning brush
- Compressed

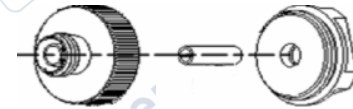
17.3 Cleaning of Optical Port

Procedure:

1. Screw down the cap.
2. Pull out ceramic core by fingers.
3. Clean port carefully.
4. Recover ceramic core.
5. Screw on the cap.

17.4 Calibration

We suggest to calibrate FHO5000 OTDR twice a year, for more information please contact us (check section 17.4 "Customer Service and Support" to find our contact information).



Structure of optical port

Caution

Be careful, don't use tools like plier, it may cause permanent damage to optical port

18.0 Diagnosis Center

18.1 FAQ

| Fault | Reason | Solution |
|---|---|--|
| Can't turn on | <ol style="list-style-type: none"> 1. Holding time on power button is not enough(>2s). 2. Run out of power / battery has broken. 3. No battery. 4. Too cold there. | <ol style="list-style-type: none"> 1. Long press on ON/OFF key. 2. Connect external power/ Replace a new battery. 3. Install battery. 4. Change another environment. |
| Display shows nearly nothing after turned on | <ol style="list-style-type: none"> 1. Brightness need to be adjusted. 2. Connection between display and motherboard is not good. | <ol style="list-style-type: none"> 1. Adjust brightness. 2. Open and reconnect. |
| Battery does not work properly | <ol style="list-style-type: none"> 1. Temperature is too high. 2. Connection is not proper. 3. Battery is nearly broken. | <ol style="list-style-type: none"> 1. Try to decrease temperature. 2. Reconnect battery. 3. Replace a new one. |
| Power state indicator turns yellow | Battery has broken | Replace a new one |
| Measuring graphic only has front end reflection | <ol style="list-style-type: none"> 1. Connector loose, polluted, damaged or unmatched. 2. Locating pin has broken. | <ol style="list-style-type: none"> 1. Clean and reconnect. 2. Change a new adapter. |
| No response | | Restart |
| Find Ghost | <ol style="list-style-type: none"> 1. Often happened in large plus width, long range and short link condition. 2. Common ghost caused by continuous reflection of connector. | <ol style="list-style-type: none"> 1. Use proper measuring range and pulse width setting. 2. Reconnect fault point of Reflection event, reduce reflection strength. |

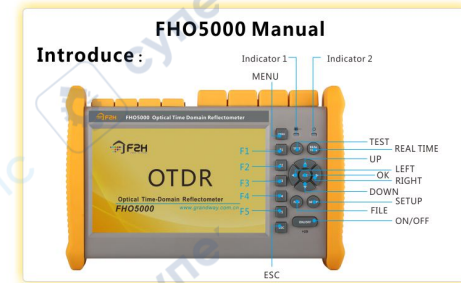
18.2 Help Information

FHO5000 has an build-in manual with essential information.

Procedure:

Turn on OTDR,

1. Press **【F5】** enter system setting, press **【F4】** to read manual Control **【▲】** / **【▼】** button to flip over.
2. Press **【Esc】** to quit.



19.0 Specification

19.1 Physical Parameter

| | |
|-----------------------------|---|
| Display | 7inch TFT-LCD(touch screen is optional) |
| Working temperature | -10~+50°C |
| Storage temperature | -20~+75°C |
| Humidity | <95% |
| Dimension | 253X168X73.6mm |
| Weight | 1.5kg(with battery) |
| Battery | 7.4V/4.4Ah lithium battery |
| Battery working temperature | -10~+50°C |
| Battery storage temperature | -20~+70°C |
| Working hours | 6hours(Condition: Full power,70% brightness, realtime mode) |
| Battery life time | >500times |
| Power | DC9~12V 4A |
| Charging time | 4-5hours |
| Shock resistance | Bear 1.2m free fall |

19.2 Parameters

| Type ^① | Testing wavelength | Dynamic range ^② | Event/Attenuation dead-zone ^③ |
|--------------------|----------------------|----------------------------|--|
| FHO5000-M21 | 850/1300nm | 21/19dB | 1.5/8m |
| FHO5000-MD21 | 850/1300/1310/1550nm | 21/19/35/33dB | MM: 1.5/8m SM: 1.5/8m |
| FHO5000-MD22 | 850/1300/1310/1550nm | 21/19/40/38dB | MM: 1.5/8m SM:1.75/11m |
| FHO5000-D26 | 1310/1550nm | 32/30dB | 1.5/8m |
| FHO5000-D32 | 1310/1550nm | 32/30dB | 1.5/8m |
| FHO5000-D35 | 1310/1550nm | 35/33dB | 1.5/8m |
| FHO5000-D40 | 1310/1550nm | 40/38dB | 1.75/11m |
| FHO5000-D43 | 1310/1550nm | 43/41dB | 2/14m |
| FHO5000-D45 | 1310/1550nm | 45/43dB | 2/14m |
| FHO5000-T40/T40F | 1310/1550/1625nm | 40/38/38dB | 1.75/11m |
| FHO5000-T43/T43F | 1310/1550/1625nm | 43/41/41dB | 2/14m |
| FHO5000-T45/T45F | 1310/1550/1625nm | 45/43/43dB | 2/14m |
| FHO5000-TP35 | 1310/1490/1550nm | 35/33/33dB | 1.5/8m |
| FHO5000-TC35/TC35F | 1310/1550/1650nm | 35/33/34dB | 1.5/8m |

Test parameter

| | |
|-----------------------------|--|
| Pulse width | 3ns, 5ns, 10ns, 20ns, 50ns, 100ns, 200ns, 500ns, 1 μ s, 2 μ s, 5 μ s, 10 μ s, 20 μ s |
| Testing distance | Dead zone test(100m), 500m, 2km, 5km, 10km, 20km, 40km, 80km, 120km, 160km,240km |
| Sampling resolution | Minimum 0.25m |
| Sampling point | Maximum 128,000 points |
| Linearity | ≤ 0.05 dB/dB |
| scale indication | X axis: 4m~70m/div, Y axis:0.09dB/div |
| Loss threshold | 0.01dB |
| Loss resolution | 0.001dB |
| Distance resolution | 0.01m |
| Distance accuracy | $\pm(1m+\text{measuring distance} \times 3 \times 10^{-5} + \text{sampling resolution})$ |
| Refractivity Setting | 1.4000~1.7000, 0.0001 step |

VFL Module

| | |
|-----------------------|-------------------|
| Wavelength | 650nm |
| Power | 10mw, CLASS III B |
| Range | 12km |
| Connector | FC/UPC |
| Launching Mode | CW/2Hz |

OPM Module(Optional)

| | |
|------------------------------|-------------------------------------|
| Sensor Type | InGaAs |
| Wavelength Range | 800~1700nm |
| Calibrated Wavelength | 850/1300/1310/1490/1550/1625/1650nm |
| Testing Range | -50~+10dBm |
| Resolution | 0.01dB |
| Accuracy | ± 0.35 dB ± 1 nW |
| Adapter | FC/UPC |

OLS Module(Optional)

| | |
|---------------------------|--|
| Working wavelength | 850/1300/1310/1490/1550/1625/1650nm ^④ |
| Output power | -25~0dBm |
| Accuracy | ±0.5dB |
| Connector | FC/UPC |

FIM Module(Optional)

| | |
|----------------------------------|---|
| Magnification | 400X |
| Resolution | 1.0μm |
| View of Field | 0.40×0.31mm |
| Storage/working Condition | -18~35 |
| Dimension | 235×95×30mm |
| Sensor | 1/3 inch 2 million of pixel |
| Weight | 150g |
| USB | 1.1/2.0 |
| Adapter^⑤ | SC-PC-F(For SC/PC connector) FC-PC-F(For FC/PC connector) LC-PC-F(For LC/PC connector) 2.5mm -Male (For 2.5mm adapter) |

① Model T40F/T43F/T45F/TC35F are intergrated with optical filter, this allow them to test PON network online(use 1625nm wavelength) and will not interrupt the fiber signal.

② Dynamic range is measured with maximum pulse width,averaging time is 3 minutes

③ Event dead zone is measured with minimum pulse width

④ 1310/1490/1550nm laser source use OTDR1 port, 1625nm uses OTDR2port, 1625/1650nm or 850/1300nm uses OTDR3 port..

⑤ For more adapters please contact us

19.3 Dimension



Top view

Unit:mm

Except where noted, tolerance default as: $\pm 3\%$
(if size < 10mm, tolerance: $\pm 0.3\text{mm}$)



253

Front view



168

73.60

Side view

20.0 Warranty

20.1 Terms of Warranty

All GRANDWAY products are warranted against defective material and workmanship for a period of time from the date of shipment to the original customer. Any product found to be defective within the warranty period would be repaired or replaced by GRANDWAY free of charge. In no case will GRANDWAY liabilities exceed the original purchase price of the product.

20.2 Exclusions

The warranty on your equipment shall not apply to defects resulting from the following:

- Unauthorized repair or modification
- Misuse, negligence, or accident
- GRANDWAY reserves the right to make changes to any of its products at any time without having to replace or change Previously purchased units.

20.3 Transportation

To return instrument for reasons of yearly calibration or other, please contact us. to obtain additional information and RMA#code(Return Materials Authorization number). And describe briefly reasons for the return of the equipment, to allow us offer you more efficient service.

To return the instrument in the case of repair, calibration or other maintenance, please note the following:

- Pack the instrument with soft cushion like Polyethylene, so as to protect the shell of the instrument.
- Please use the original hard packing box. If use other packing material, please ensure at least 3 cm soft material cover around the instrument.
- Be sure to correctly fill out and return the warranty registration card, which should including following information: company name, postal address, contact, phone number, email address and problem description.
- Seal the packing box with exclusive tape.
- Ship to your representative or the agent of the Company in a reliable way.