FIBER OPTIC TECHNOLOGY
CALIBRATION LABORATORY

OFT-820
Loss Test Set

INSTRUCTION MANUAL

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Contents

Introduction

The OFT-820 series Loss Test Set is designed Optical Fiber network testing. It combines two optical test equipment – Light Source and Power Meter in the same box. The optical Light Source fulfills all the necessary technical requirements for field optical network measurements. The source sends optical light into output interface, available in required working wavelength. The optical Power Meter is designed to measure absolute or relative optical power in optical networks.

The memory capacity allows storage and uploading of up to 3000 measurements including memory position or fiber number, wavelength, absolute value or relative value and insertion loss. The SmartProtocol PC evaluation software supports memory download and test report generating. The rechargeable battery ensures long term working with a minimum life time of 5 years.

The removable and changeable IN/OUT adapters allow easy maintenance and cleaning of both ports, making the tester to be universal in wide range of application with various optical connectors. Both input and output adapters are changeable..

1 Features

- Small size, light weight
- S/N displayed during switch on
- AWD (Auto Wavelength Detection) function
- Powered by 3 AA type batteries, battery charging via USB port, µP controlled
- USB port - battery charging, data download, FW upgrade
- Easy to use with menu navigation
- Simple and fast calibration
- 10 min Auto Off, battery status indicator

- InGaAs or Si photodetector
- Detection of modulation 270 Hz, 1 kHz, 2 kHz
- Two levels high capacity memory: Cable No., Fiber No.
- SmartProtocol PC software - memory download, reporting solution
- Displayed units: dBm, dB, W
- Absolute and Relative optical power measurement

- Changeable IN/OUT connectors

2 Application

- Optical network measurements
- Measurement output power of optical transmitters
- Measurement input power of optical receivers
- Measurement attenuation in optical cabling.
- Measurement loss in connectors, adapters, switches and other components
- Easy and rapid identification of failure points in fiber networks

3 Accessories

3.1 Standard

- Loss Test set
- SmartProtocol PC software
- Universal 2.5 mm adaptor at power meter port (TE-ADP-250)
- FC/PC interface at light source port
- External USB Power charging adaptor
- USB connection cable
- Traceable calibration certificate
- Hard carrying case (TE-HC-03)

TE-HC-03

3.2 Optional

- Master patchcords
- Master adaptors
- Universal SFF 1.25 mm adaptor (TE-ADP-125) or SC FC, ST, ...testing adaptors at power meter port
- Changeable adaptors at light source port

Power metr adaptors

TE-ADP-FC FC adaptor | TE-ADP-LC LC adaptor | TE-ADP-SC SC adaptor | TE-ADP-250 2.5 mm | TE-ADP-125 1.25 mm

Other types available on request:

TE-ADP-ST	ST adaptor
TE-ADP-DIN	DIN adaptor
TE-ADP-SMA	SMA adaptor
TE-ADP-MU	MU adaptor

Light source adaptors

TE-ALS-FC TE-ALS-SC TE-ALS-ST

Standard configuration of IN/OUT ports:
LS TE-ALS-FC, FC adaptor
PM TE-ADP-250. universal 2.5 mm

USB Power charging adaptor

4 Specifications

Light Source		
Output power		**Note:**
850 nm, 1300 nm	0 dBm	
1310, 1490, 1550, 1625 nm	0 dBm	typ. value
Stability (1 hour, delta/2):		tested after 20 min warm up temperature 23 ± 1°
850, 1300 nm	± 0.03 dB	
1310, 1490, 1550, 1625 nm	± 0.05 dB	
Power meter		
Photodetector	1 mm InGaAs	
Working wavelengths	850, 1300, 1310, 1490, 1550, 1625 nm	can be customized
Dynamic range: Standard	-65 dBm to +10 dBm -57 dBm to +17 dBm	1300, 1310, 1490, 1550, 1625 nm 850 nm
Uncertainty	± 5%	1310, 1550 nm @ -20 dBm
Resolution	0.01	
AWD/Modulation Detection	-50 dBm -45 dBm	1300 – 1625 nm 850 nm
General		
Dimensions	165 x 80 x 50 mm	with 2.5 mm universal adapter
Weight	400 g	with battery
Temperature operating storage Humidity (non condensing)	-10 to +50 °C -40 to +70 °C 0 to 95%	
Operating temperature	-10 to +50 °C	
Battery working time	> 50 hrs	between battery charging
Battery life time	> 2 years	Li-Pol battery

Compliant with RoHS - requirements (2002/95/EG, 27.01.2003)

5 Safety information

OFT-820 Light source complies with the following safety classifications:
IEC825-1 and 21CFR1040: Class1

This applies to LD options up to 1 mW. Devices in this category are classified as safe for use by technicians under normal viewing, provided that magnifying devices are not used.

WARNING!

It is the responsibility of the user to acquire adequate training and familiarity with relevant safety issues and work practices before using this equipment.

The OFT-820 Power meter emits no optical power itself and does not create any hazards to the user.
To ensure a high level of operator safety during installation, commissioning and operating the equipment, as well as ensuring that the equipment remains undamaged, it is necessary to consider the following general warnings and recommendations.

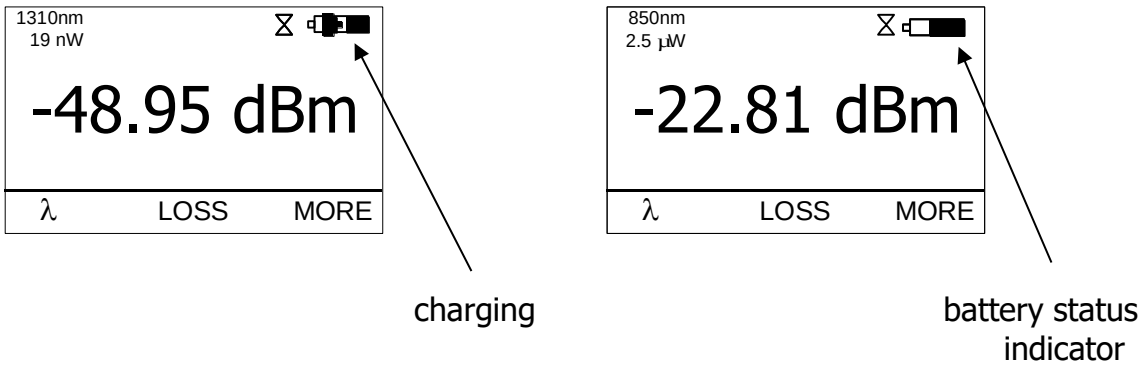
- Never use magnifying devices to inspect optical fiber ends unless you are certain that no optical power is being emitted
- Only use magnifying devices with a built-in infra-red filter to ensure safety
- Avoid direct exposure to the beam.

6 Maintenance

6.1 Battery care

The OFT-820 comes equipped with a built-in charger and is powered by LiPol type battery (standard accessories).

- Charging – via USB port (PC) or by using external USB power charging adapter (standard accessories)
- Before using the OFT-820 for first time, charge fully the batteries.
- Use only supplied USB power charging adapter.
- Charging is not recommended until battery status indicator is 30% or less. Recommended charging time of batteries is 12 to 14 hrs.
- Charge the batteries fully before storing OFT-820 for a long period. The batteries will lose its charge during storage.
- If you are not going to use the OFT-820 for long period, charge the batteries once every six months.
- The batteries are a consumable. Repeated charging and discharging decreases batteries lifetime.
- To extend batteries lifetime it is recommended that batteries be completely drained before re-charging – battery refresh. Otherwise the batteries lose its ability to fully recharge.



6.2 Instrument care

- During storage and transport keep the device in its carry case to protect against crushing, vibration, dust and moisture.
- Where possible keep the device away from strong sunlight.
- Clean the device housing using alcohol or other cleaning agents. Acetone or other active solvents may damage the case.
- The device is resistant to normal dust and moisture, however it is not waterproof. If moisture does get into device, dry it out carefully before using it again.

6.3 Recommended cleaning and mating instructions

Cleanliness will affect the performance of an optical fiber system. Perform the following procedures prior the installation. Clean all connectors, adapters, and attenuators before making any connections. The following cleaning materials are recommended and may form part of Your cleaning kit:

- Lint-free laboratory wipes.
- Isopropyl alcohol in pressurised dispenser
- Lint free pipe cleaners.
- Clean, dry, oil-free compressed air.

CLEANING

Connectors/Terminators:

1. Fold a clean, new wipe into a 2" by 2" square pad.
2. Moisten, but do not saturate, the pad with alcohol making a spot approximately 1/2" in diameter.
3. Open the protective cap (E2000 only).
4. Press the ferrule and face into a wet spot on the wipe. Using force, twist the ferrule so that a hard wiping action takes place. Repeat twice, using a clean alcohol-moistened at each time.
5. Press the ferrule end face into a dry spot on the wipe. Using force, twist the ferrule so that a hard wiping action takes place
6. Close the cap (E2000 only)
7. Discard the used pad.

Attenuators:

1. For an exposed ferrule (in-line type), see connector cleaning procedure, blow the other end dry with clean compressed air.
2. Clean bulkhead attenuators only by blowing with clean compressed air.

Adapters:

1. Moisten one end of a lint-free pipe cleaner with alcohol.
2. Remove express alcohol from the pipe cleaner with a clean wipe.
3. Insert the moisten pipe cleaner into either end of the adapter and scrub in and out so that the inside surface of the adapter is wiped by the pipe cleaner. Repeat this step for the opposite end.
4. Insert the dry end of the pipe cleaner into either end of the adapter to remove any residual alcohol. For oversized adapters (biconic), slightly blow the middle of the pipe cleaner fog better surface contact. Repeat this step for the opposite end.
5. Blow the adapter dry with clean compressed air.

MATING

SC, MT-RJ, LC:

1. Align the housing key with the slot in the adapter.
2. Push the connector into the adapter until a click is heard/felt indicating the latching system is engaged. When the SC connector is fully engaged, the white stripes on the side of the housing should be hidden inside the adapter.

FC:

1. Insert the ferrule tip into the adapter.
2. Align the key with the slot in the adapter.
3. Push the connector into the adapter until the coupling nut reaches the adapter housing.
4. Screw the coupling nut clockwise into the adapter.

E 2000:

1. Align slots with key on adapter.
2. Push the connector into the adapter until it clicks.

ST:

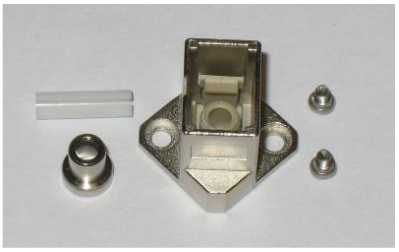
1. Align the ferrule hub key with the slot in the adapter.
2. Insert the connector into the adapter until the coupling nut reaches the adapter housing.
3. Align the bayonet slots-on the coupling nut with the pins on the outside of the adapter.
4. Push the coupling nut into the adapter while rotating the coupler nut clockwise to lock the bayonet and secure the connection.

Infrared radiation is invisible and can seriously damage the retina of the eye Do not look into the ends of any optical fiber

6.4 Light source Adaptor set exchange

The OFT-800 comes equipped with an adaptor set (FC, SC or ST adaptor). The adaptor set includes:

- adaptor body with flange
- two screws
- adaptor sleeve
- adaptor nut.



For exchanging the adaptor or cleaning the ferrule end face please use the following instructions:

1. Loosen the two adaptor flange screws

2. Carefully remove the adaptor body, be careful of the sleeve

3. Using the optical connector ferule, carefully remove the adapter sleeve

4. Remove the adaptor nut. Now the adaptor set is fully removed.

If necessary, carefully clean the ferrule end face using alcohol and lint-free laboratory wipes.

5. Insert the adaptor nut and the sleeve back.

6. Attach the appropriate adaptor body and tighten the screws again

7 Device and button function description

7.1 General description

[ON/OFF]
Press to turn the unit on.
Press to turn the unit off.
After switching on, the type of device, serial number and firmware version will be displayed.

The unit will start up with "AUTO OFF" feature – symbol "⧖" will be diplayed.
For disable the AUTO OFF feature press and hold the ON/OFF key until symbol ⧖ " " disappear.
If activated, the unit will turn off after approximately 10 minutes of no activity.

[BL]
Turns the Display Backlight On and Off.

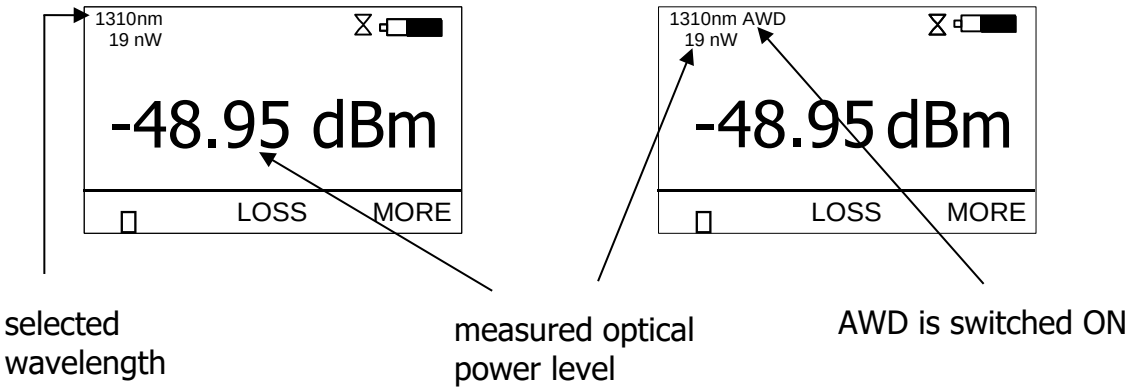
[⬆]
Meaning of these keys depends on current menu.

7.2 Power meter

7.2.1 Menu #1 –Absolute power measurement mode

In the absolute power measurement mode the absolute value of the optical signal in dBm units is shown on the display.
This screen will appear after the device is switched on and information regarding the type of device, serial number and firmware version will appear.

Reading the display:



[λ]
Selects required wavelengths

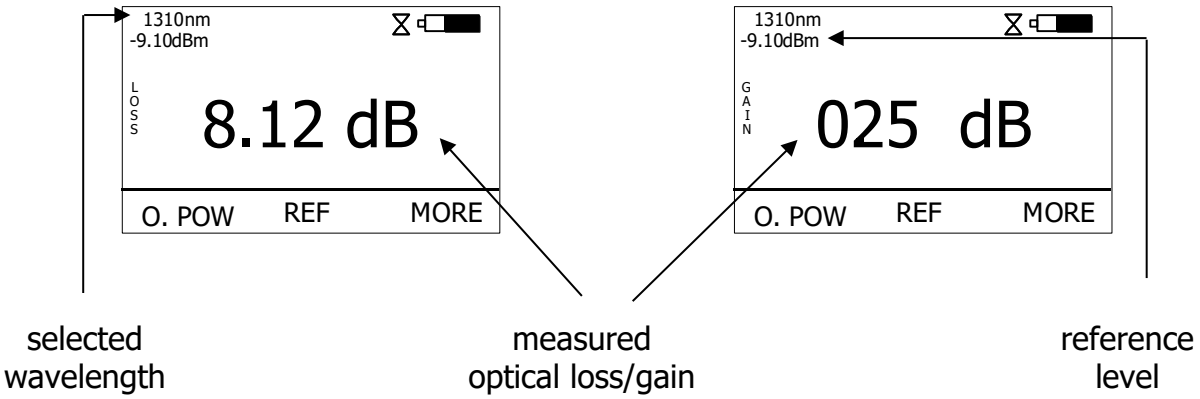
[LOSS]
Activates the relative power measurement mode (unit dB).
Recalls the last set reference for a selected wavelength.
Goes to menu #2.

[MORE]
Goes to navigation menu #3.

7.2.2 Menu #2 – Relative power measurement mode

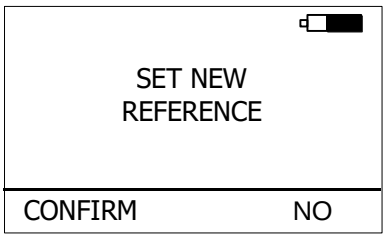
In the relative power measurement mode is on the value of optical insertion loss in dB units which corresponds to performed reference is shown on the display.

Reading the display:



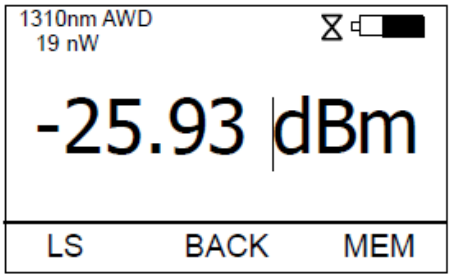
[O.POW]
Returns unit into absolute power measurement mode (unit dBm).
Goes to menu #1.

[REF]
Sets and stores the new reference for the selected wavelength
Note: The new reference must be confirmed by the following screen:



[MORE]
Goes to navigation menu #3.

7.3 Menu #3 – Navigation



[LS]
Goes to Light source menu#4.

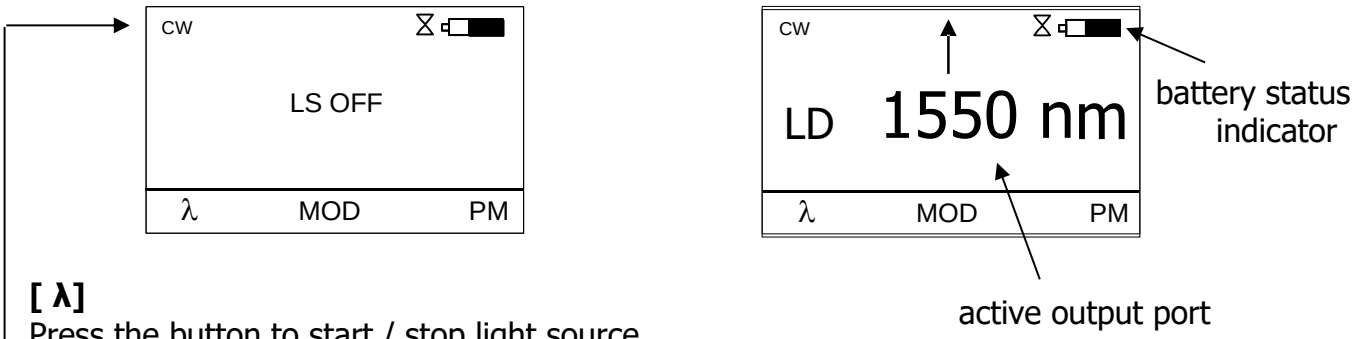
[BACK]
Returns unit into absolute or relative power measurement mode (unit dBm or dB).
Goes to the menu #1 or #2.

[MEM]
Goes to Memory menu #5.
Starts working with the internal memory.

7.4 Light source

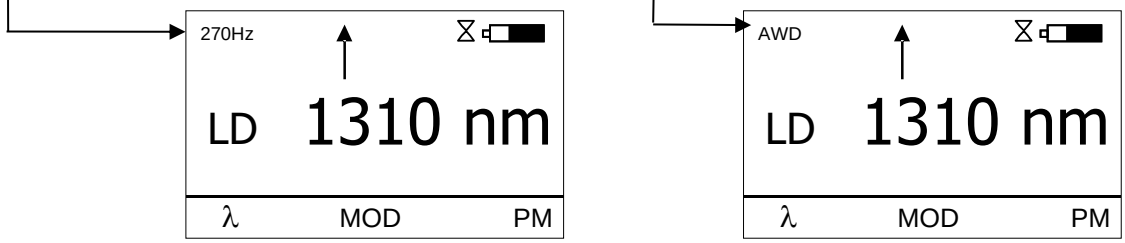
7.4.1 Menu #4 – Light source menu

Reading the display:



[λ]
Press the button to start / stop light source
For available source configurations, see relevant datasheet

[MOD]
Selects the modulation:
CW – Continuous wave
270Hz – 270kHz Modulation
1KHz – 1kHz Modulation
2KHz – 2kHz Modulation
AWD – Auto Wavelength Detection – Modulation



press λ to start / stop emitting light

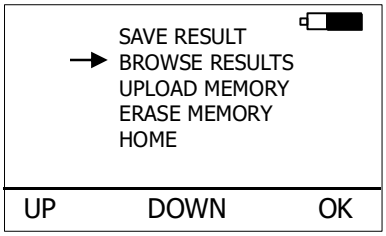
[PM]
Returns unit into absolute or relative power measurement mode (unit dBm or dB).
Goes to menu #1 or #2.

7.5 Menu #5 – Working with the internal memory

The memory of OFT-820 has a structured, two-level organization. The results are stored in memory positions (FIBER) in folders called Cable (CABLE). See table below:

CABLE001	FIBER001
	FIBER002
	FIBER003
	FIBER004
	FIBER005
	FIBER006
	.....
	FIBERXXX
CABLE002	FIBER001
	FIBER002
	FIBER003
	FIBER004
	FIBER005
	FIBER006
	.....
	FIBERXXX
.....	
CABLEXXX	FIBER001
	FIBER002
	FIBER003
	FIBER004
	FIBER005
	FIBER006
	.....
	FIBERXXX

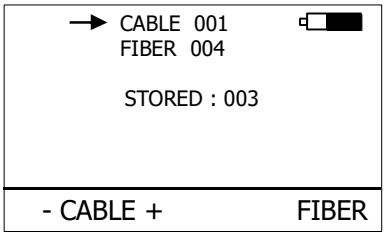
This screen will appear after pressing [MORE] key from Menu#1 or Menu#2 then [MEM].



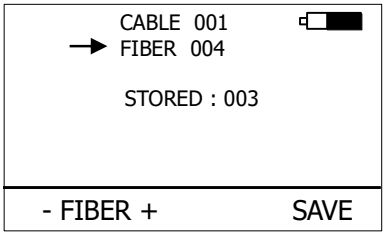
[UP], [DOWN], [OK]
Use these buttons for selection appropriate submenu.

7.5.1 Save results

1. By using [UP] [DOWN] select "SAVE RESULT" and press [OK].

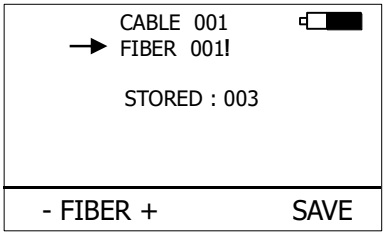


2. Select the cable (folder) using [- CABLE +], the unit will display the number of saved results under the selected cable, then press [FIBER].



3. The unit will suggest the FIBER position under the selected CABLE.
   Accept the suggested FIBER position and save the result by pressing [SAVE] or change the memory position using [- FIBER +], than press [SAVE] to save the result.

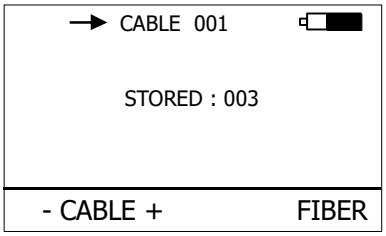
NOTE: If the selected memory position is already occupied, the "**!**" mark will appear on the display.



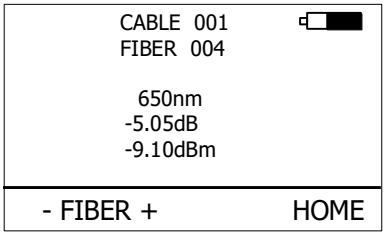
By pressing [SAVE], the new result will OVERWRITE the selected FIBER position and the old result will be discarded.

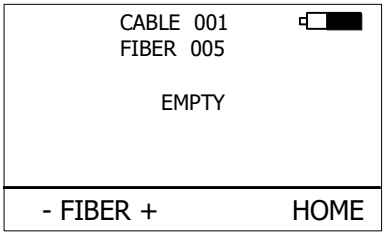
7.5.2 Browse results

1. By using [UP] [DOWN] select "BROWSE RESULTS" and press [OK]



2. Select the cable (folder) using [- CABLE +], the unit will display the number of saved results under the selected cable, then press [FIBER].



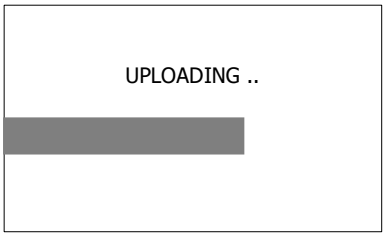


3. Use [- FIBER +] to browse through the results.

7.5.3 Upload memory

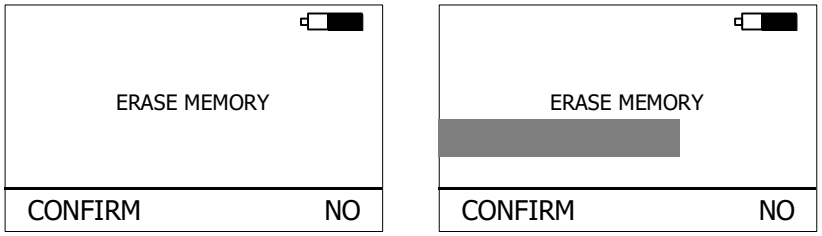
1. By using [UP] [DOWN] select "UPLOAD MEMORY".

2. Press [OK]. All memory content will be sent to the USB port. More information is contained in the chapter "setting up data transfer".



7.5.4 Erase memory

1. By using [UP] [DOWN] select "ERASE MEMORY" and press [OK].



2. Press [CONFIRM] to erase memory or [NO] for return to main screen.

7.5.5 Home

1. By using [UP] [DOWN] select "HOME".
2. Press [OK] for return to main screen.

8 Measurement loss

8.1 Basic theory

Loss measures the signal degradation in a fiber optic cable. A light source injects an optical signal of the appropriate wavelength into the fiber and a power meter measures the received signal at the same wavelength.
There are two different measurement methods according to EN 61300-3-4

- Method C2 – insertion method with direct coupling to the power meter
- Method C3 – insertion method with additional test patchcord

Power measurement is the basis of optical testing and determines the power budget of the fiber optic link by comparing the power of the transmitter and the sensitivity of the receiver. This difference is the maximum acceptable loss. Power loss is caused by different phenomena such as attenuation of the fiber, dirty connector mating faces, connector misalignment, loss of splices and other issues such as sharp fiber bends.
The "end to end" loss test is the most commonly used acceptance test for power loss in fiber optic links. The test is based on measurement the power difference at the input and output of the link.
The OFT-820 Power Meter and OFT-820 Light Source are used for this test, where the Light Source acts as a transmitter and the optical Power Meter as a receiver.

The "end to end" test includes two steps:

1. Setting the reference
2. Measurement the loss

Important

- Eventual connectors should be cleaned prior to testing (see chapter 7.3).
- The master cord used to set the reference should be the same type as the patchcords (cables) to be tested (MM: 50/125, 62.5/125 or SM: 9/125).
- It is very important that the connections are not disturbed after the reference value is established.

8.2 Method C3 - two devices

For method 6 two Master cords and one adapter are used to set reference. Method 6 cancels the effects of the Master Cords and one adapter for all subsequent measurements

8.2.1 Setting the reference

1. Connect first Master cord to Light source port of first OFT-820 device.
2. Connect second Master cord to Power meter port of second OFT-820 device.
3. Use Master adapter to connect the two fiber ends.
4. Power on first OFT-820 device (light source).
5. Push **[MORE], [LS].**
6. By pushing **[·]** activate light source.
7. Power on second OFT-820 device (power meter).
8. By pushing **[·]** select appropriate wave-length range.
9. Activate relative power measurement mode - by pushing **[LOSS].**
10. Set and store the new reference for selected wave-length - by pushing **[REF], [CONFIRM]**.

Do not disconnect
after referencing

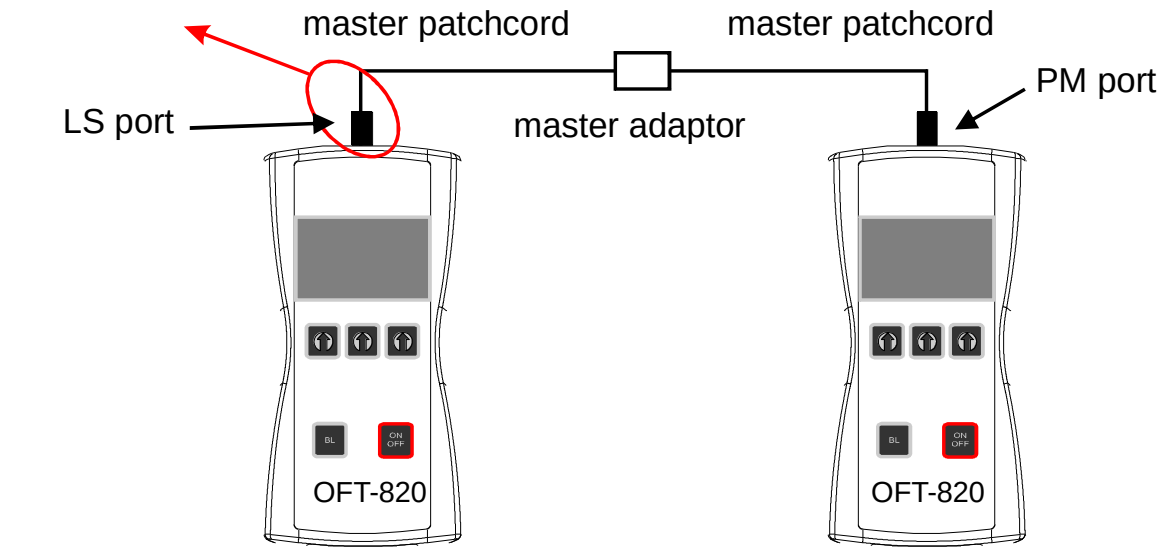


Fig. 1: Settings of reference.

8.2.2 Measuring Loss

1. Do not disconnect the Master cords from devices.
2. Disconnect one Master cord from adapter.
3. Connect the trace to be measured between the Master cords. An extra Master adapter is needed.
4. The power meter display will simultaneously report the value with the message "LOSS" or "GAIN" in dB.
5. This value represents a difference between the reference and the performed measurement.
6. If the value will be displayed with the "LOSS" message, the trace to be measured has just this loss.
7. If the value will be displayed with the "GAIN" message, this means that the trace to be measured has been compared with the reference for this gain.
8. Value of loss (or gain) can be stored in the internal memory (see "SAVE RESULT" chapter).

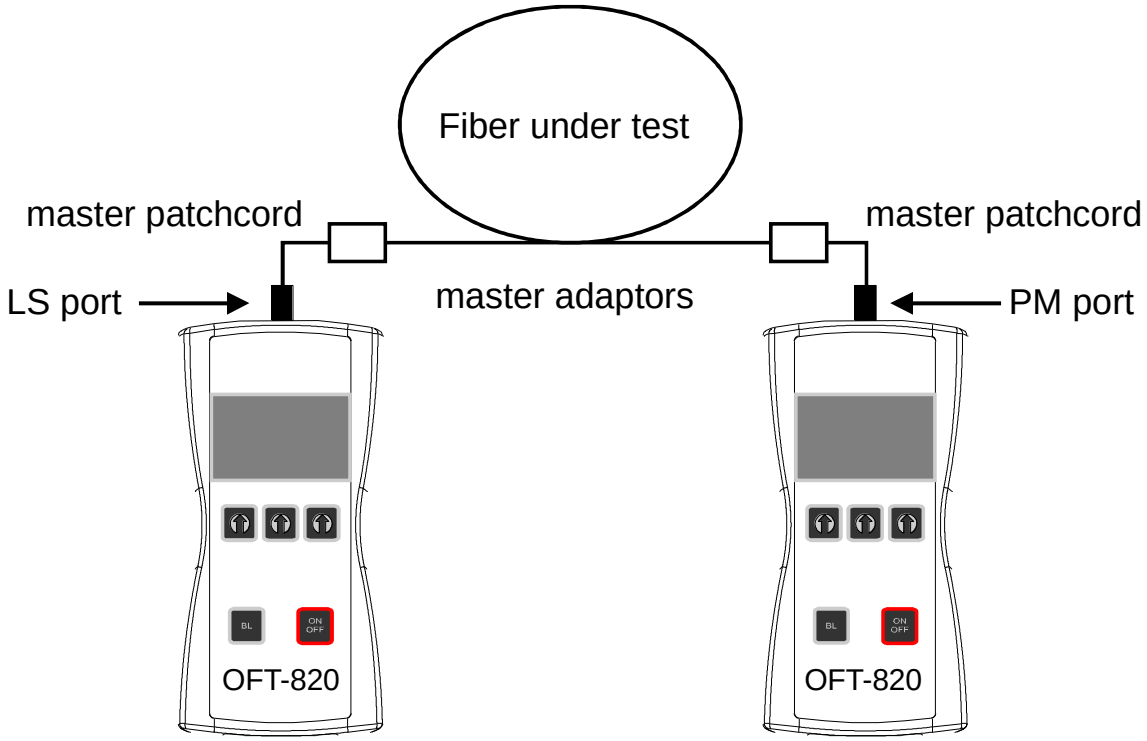


Fig. 2: Measurements of loss – with two devices and two master patchcords.

8.3 Method C3 - one device

For method 6 two Master cords and one adapter are used to set reference. Method 6 cancels the effects of the Master Cords and one adapter for all subsequent measurements.

8.3.1 Setting the reference

1. Connect first Master cord to Light source port.
2. Connect second Master cord to Power meter port.
3. Use Master adapter to connect the two fiber ends.
4. Power on OFT-820 device.
5. Push **[MORE], [LS].**
6. By pushing **[·]** activate light source (650 nm).
7. Push **[PM]** and select appropriate wave-length range - by pushing **[·]** (power meter).
8. Activate relative power measurement mode - by pushing **[LOSS].**
9. Set and store the new reference for selected wave-length - by pushing **[REF], [CONFIRM].**

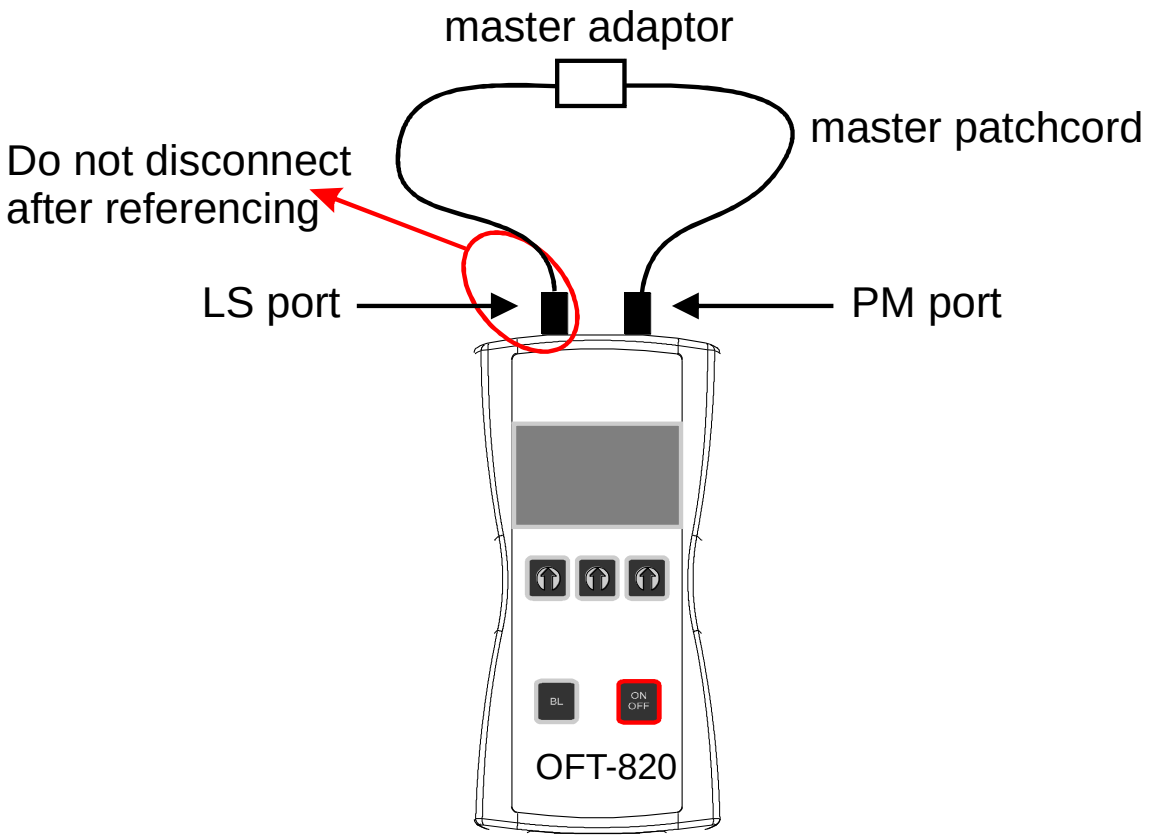


Fig. 3: Settings of reference – with one device and two master patchcords.

8.3.2 Measuring Loss

1. Do not disconnect the Master cords from device.
2. Disconnect one Master cord from adapter.
3. Connect the trace to be measured between the Master cords. An extra Master adapter is needed.
4. The power meter display will simultaneously report the value with the message "LOSS" or "GAIN" in dB.
5. This value represents a difference between the reference and the performed measurement.
6. If the value will be displayed with the "LOSS" message, the trace to be measured has just this loss.
7. If the value will be displayed with the "GAIN" message, this means that the trace to be measured has been compared with the reference for this gain.
8. Value of loss (or gain) can be stored in the internal memory (see "SAVE RESULT" chapter).

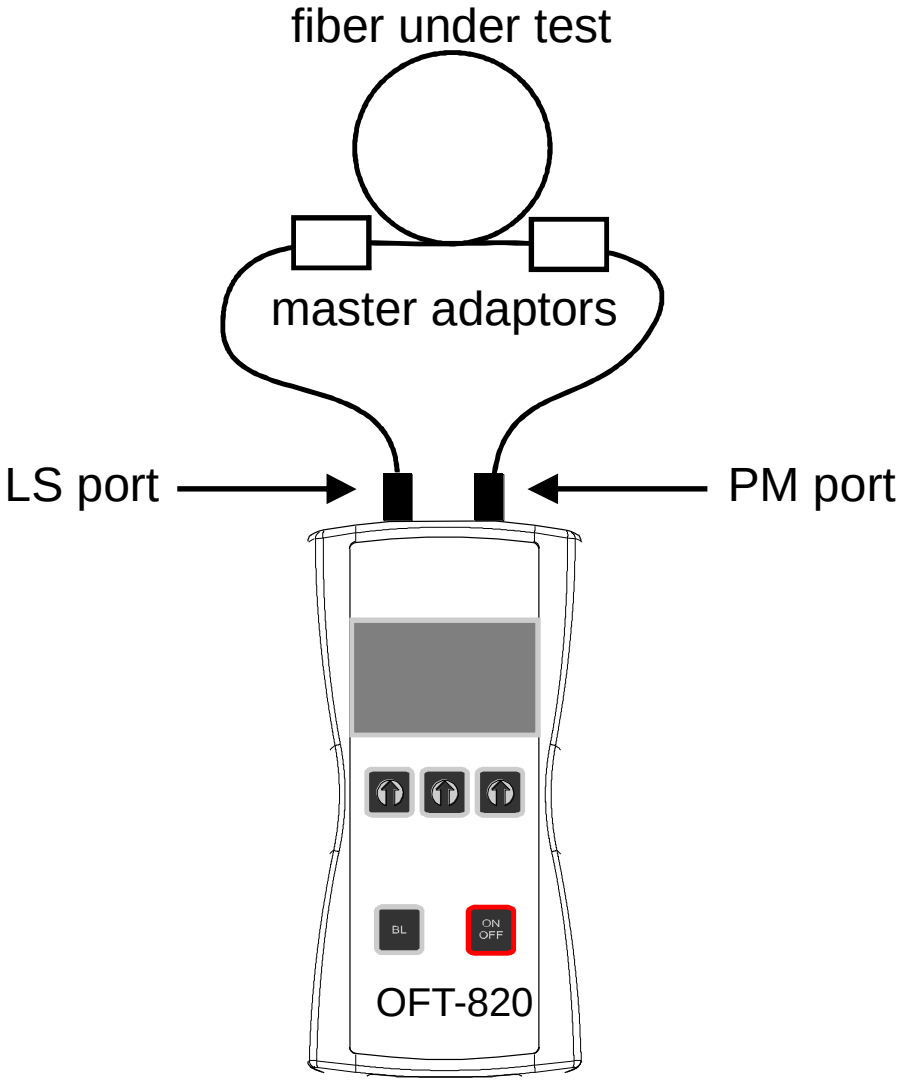


Fig. 4: Measurements of loss – with one device and two master patchcords.

8.4 Method C2 - two devices

For method 7 one Master cord are used to set reference. Master cord will be cancelled out for all subsequent measurements.

8.4.1 Setting the reference

1. Connect Master cord to Light source port of first OFT-820 device.
2. Connect second end of Master cord to Power meter port of second OFT-820 device.
3. Power on first OFT-820 device (light source).
4. Push **[MORE], [LS].**
5. By pushing **[·]** activate light source (650 nm).
6. Power on second OFT-820 device (power meter).
7. By pushing **[·]** select appropriate wave-length range.
8. Activate relative power measurement mode - by pushing **[LOSS].**
9. Set and store the new reference for selected wave-length - by pushing **[REF], [CONFIRM]**.

Do not disconnect
after referencing

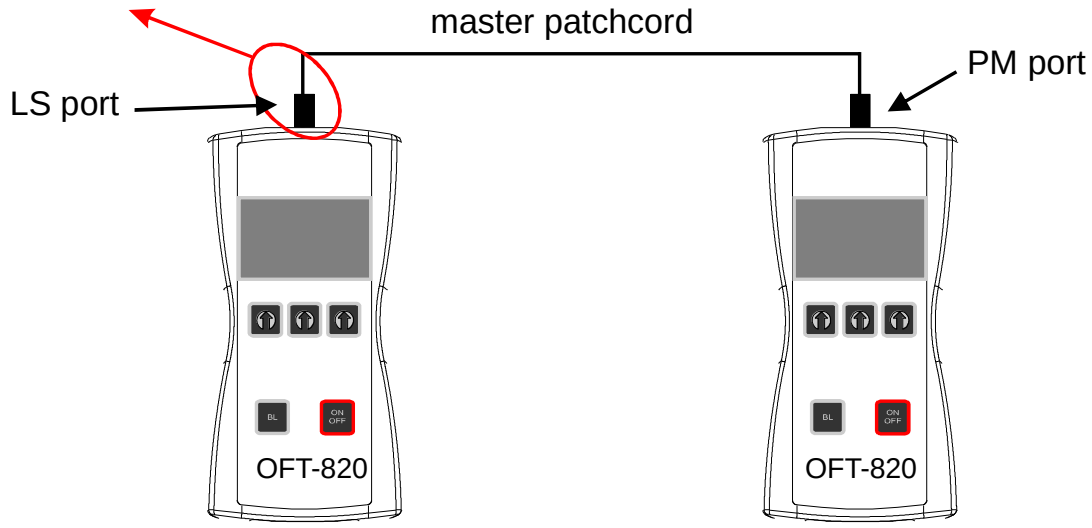


Fig. 5: Settings of reference – with two devices and one master patchcord.

8.4.2 Measuring Loss

1. Do not disconnect the Master cord from Light source port.
2. Connect the trace to be measured between the Power meter port and the Master cord that is attached to Light source. An extra Master adapter is needed.
3. The power meter display will simultaneously report the value with the message "LOSS" or "GAIN" in dB.
4. This value represents a difference between the reference and the performed measurement.
5. If the value will be displayed with the "LOSS" message, the trace to be measured has just this loss.
6. If the value will be displayed with the "GAIN" message, this means that the trace to be measured has been compared with the reference for this gain.
7. Value of loss (or gain) can be stored in the internal memory (see "SAVE RESULT" chapter).

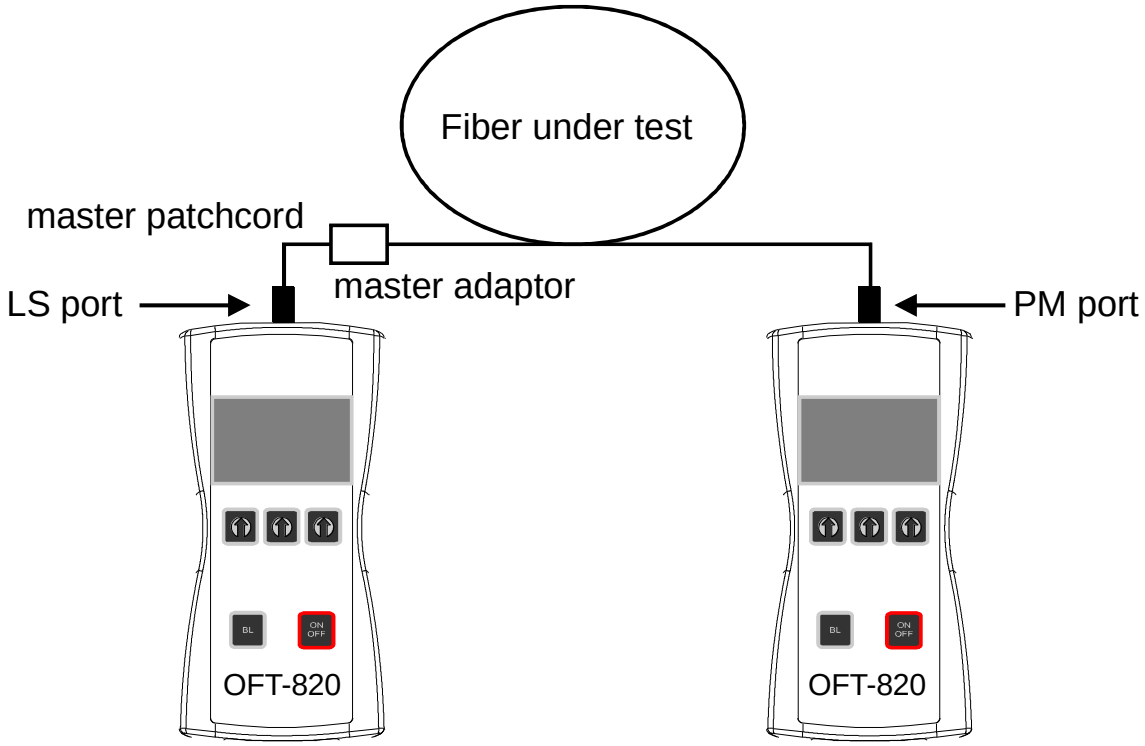


Fig. 6: Measurements of loss – with two devices, one master patchcord and one test fiber.

8.5 Method C2 - one device

For method 7 one Master cord are used to set reference. Master cord will be cancelled out for all subsequent measurements.

8.5.1 Setting the reference

1. Connect Master cord to Light source port.
2. Connect second end of Master cord to Power meter port.
3. Power on OFT-820 device.
4. Push **[MORE], [LS].**
5. By pushing **[·]** activate appropriate wave-length (light source).
6. Push **[PM]** and select appropriate wave-length range - by pushing **[·]** (power meter).
7. Activate relative power measurement mode - by pushing **[LOSS].**
8. Set and store the new reference for selected wave-length - by pushing **[REF], [CONFIRM].**

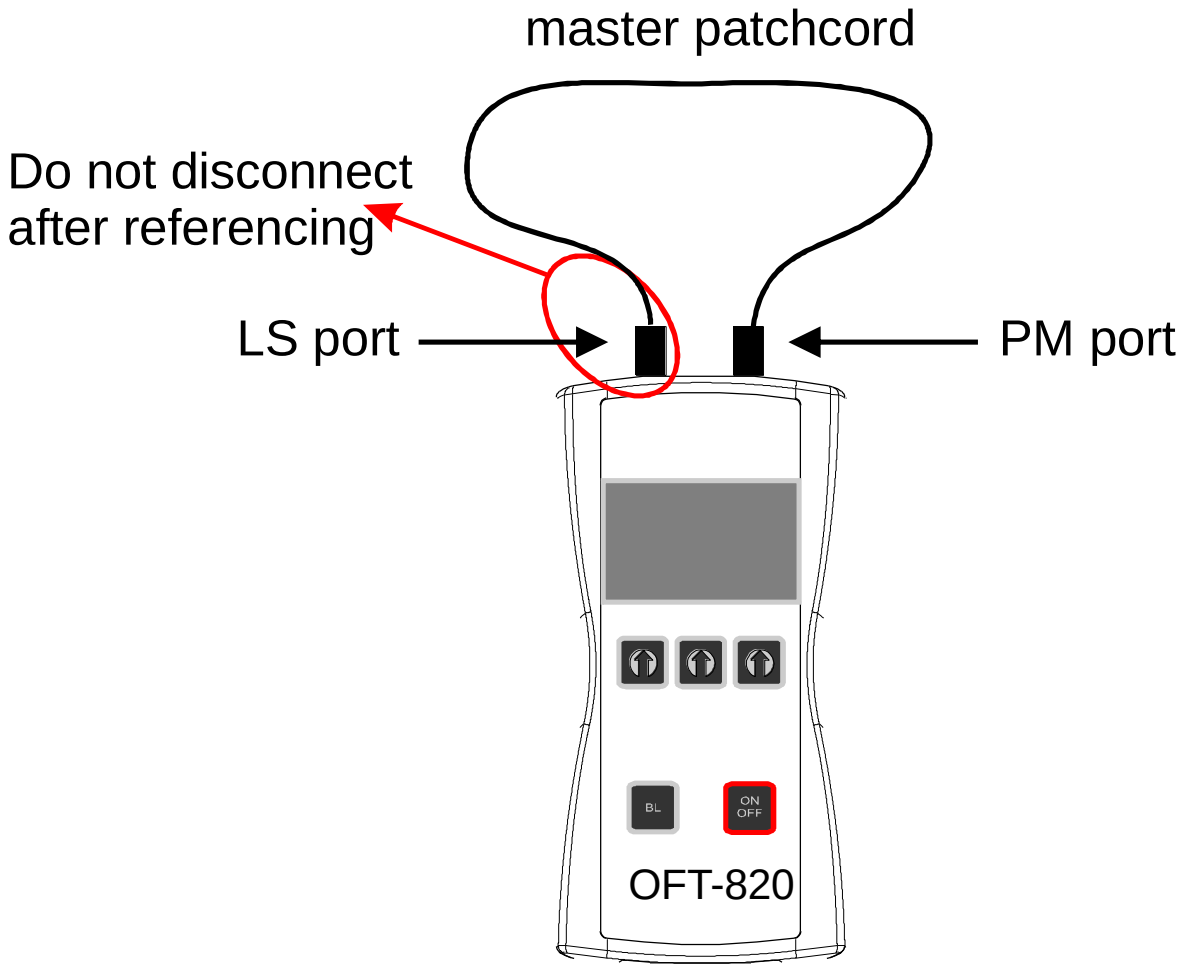


Fig. 7: Settings of reference – with one device and one master patchcord.

8.5.2 Measuring Loss

1. Do not disconnect the Master cord from Light source port.
2. Connect the trace to be measured between the Power meter port and the Master cord that is attached to Light source. An extra Master adapter is needed.
3. The power meter display will simultaneously report the value with the message "LOSS" or "GAIN" in dB.
4. This value represents a difference between the reference and the performed measurement.
5. If the value will be displayed with the "LOSS" message, the trace to be measured has just this loss.
6. If the value will be displayed with the "GAIN" message, this means that the trace to be measured has been compared with the reference for this gain.
7. Value of loss (or gain) can be stored in the internal memory (see "SAVE RESULT" chapter).

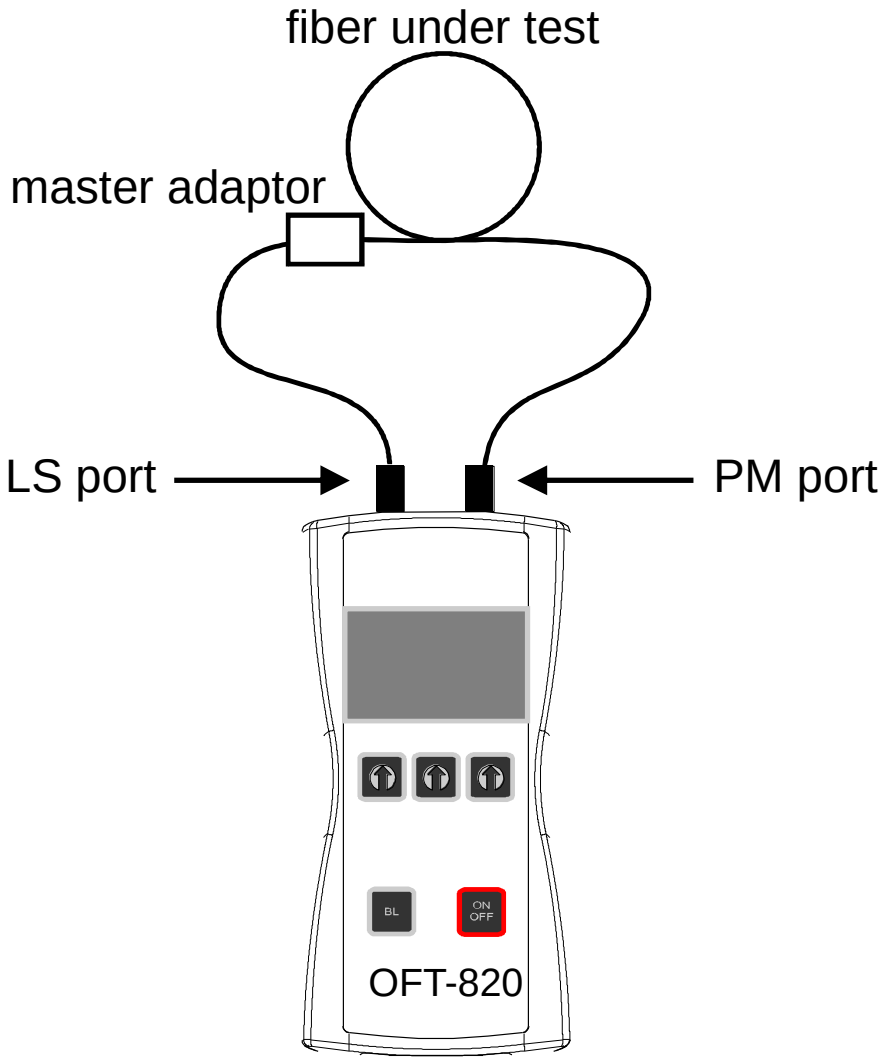


Fig. 8: Measurements of loss – with one device, one master patchcord and one test fiber.

9 Setting up data transfer

9.1 Data transfer via HyperTerminal

1. Connect the OFT-820 to a PC using the USB cable provided and turn the OFT-820 on. The PC will prompt you to install the drivers for new hardware. Use the drivers provided by OPTOKON. These drivers will create a virtual serial com port.
2. Start the HyperTerminal
   Start >> Programs >> Accessories >> Communication >> HyperTerminal

Fig. 9: Way to the HyperTerminal.

3. Enter the name of a connection, then click on OK.

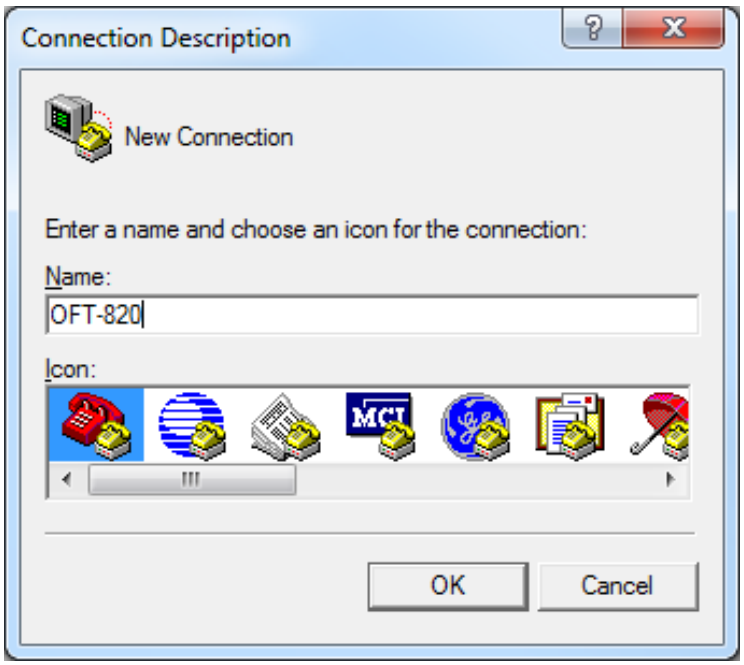


Fig. 10: Description of the connection.

4. Choose the virtual serial port the OFT-820 is connected to, then click on OK

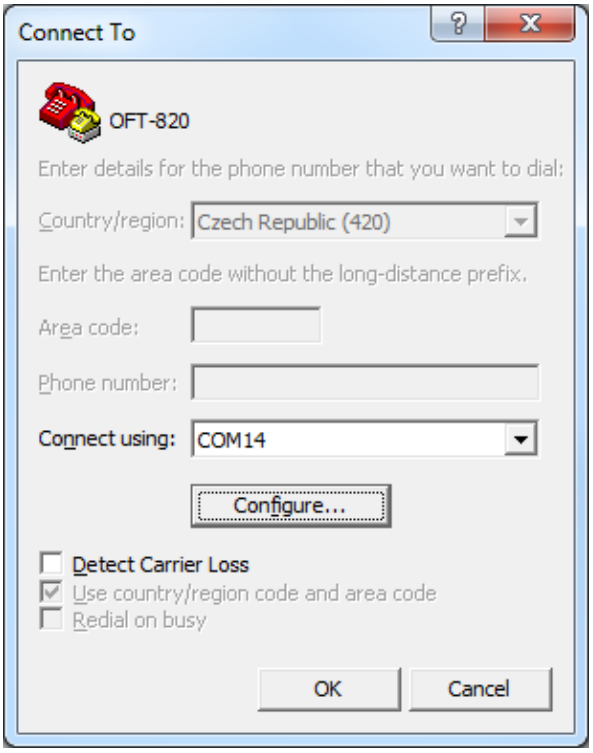


Fig. 11: Settings of COM port.

5. Set "Bits per second" to 19200, then click on OK

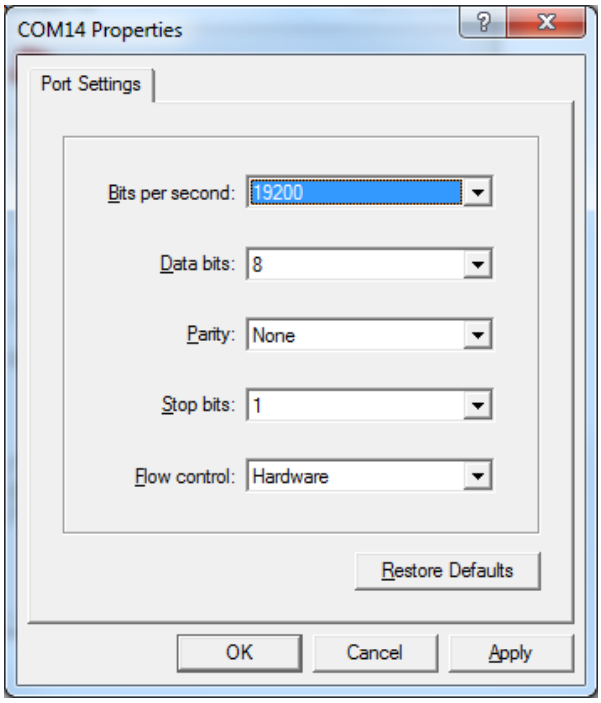


Fig. 12: Port settings.

6. Go to the menu in OFT-820 and push [MORE], [MEM], select [UPLOAD MEMORY], [OK].

The stored data will be transferred to the PC in this format:

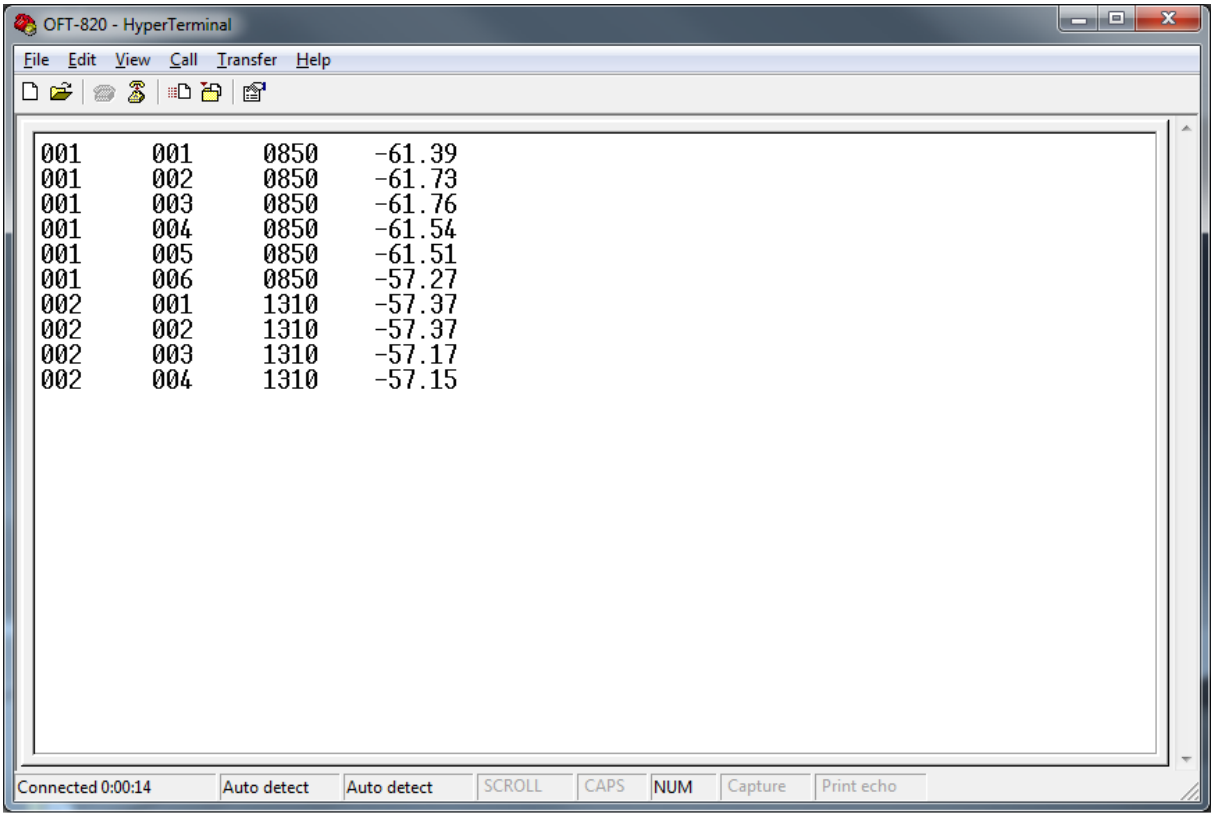


Fig. 13: Reading from the memory device.

The data from this window can be easily copied to any other application.

9.2 Control via HyperTerminal

Control is performed by entering commands that are written to the window of HyperTerminal.

Command	Significance	Notes
v	Actual value of display	This commands are shown in the window of HyperTerminal
r	Reference	
l	Actual wavelength	
n	Type and serial number	
1	Simulation of pushing first button	This commands are shown on the display of device
2	Simulation of pushing second button	
3	Simulation of pushing third button	
0	Reset device	

Tab. 1: Basic commands for HyperTerminal.

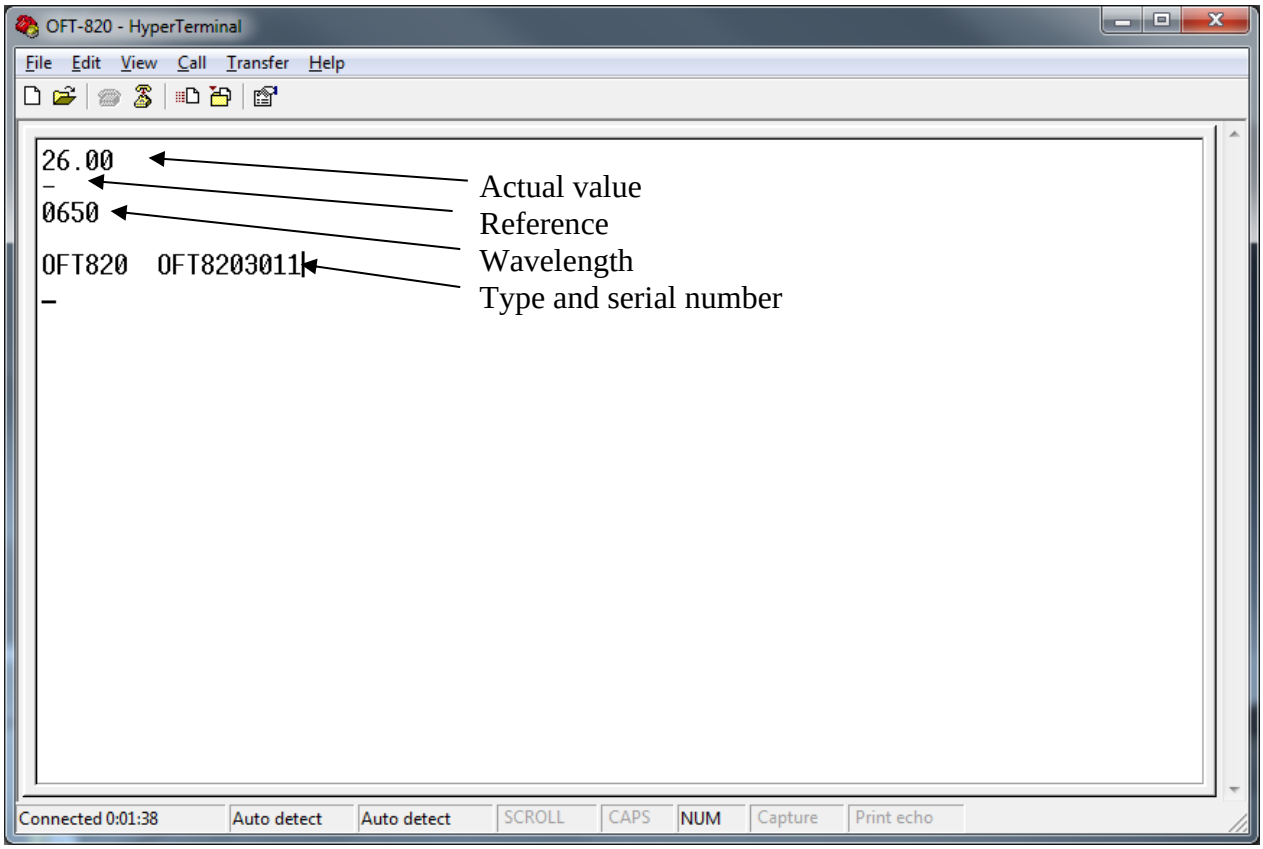


Fig. 13: Window of HyperTerminal with basic command.

9.3 Data transfer via SmartProtocol

Procedure, how to handle with SmartProcotol software, please see document:

TEQ_02-07_EN-SmartProtocol-M

10 Power loss and decibels

Loss (dB)	% Loss	dBm	Power (mW)
0	0.0	-50	0.00001
0.1	2.3	-40	0.0001
0.2	4.5	-30	0.001
0.3	6.7	-20	0.01
0.4	8.8	-10	0.10
0.5	10.9	-9	0.13
0.6	12.9	-8	0.16
0.7	14.9	-7	0.20
0.8	16.8	-6	0.25
0.9	18.7	-5	0.32
1	20.6	-4	0.40
2	36.9	-3	0.50
3	49.9	-2	0.63
4	60.2	-1	0.79
5	68.4	0	1.00
6	74.9	1	1.26
7	80.0	3	2.00
8	84.2	5	3.16
9	87.7	7	5.01
10	90.0	10	10.00
12	93.7	12	15.84
15	96.8	15	31.62
20	99.0	17	50.12
30	99.9	20	100.00

11 Notes

12 Calibration, service center

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