OPTICAL TIME DOMAIN REFLECTOMETER

And

OTDR Simulator

For Windows XP

USER MANUAL

Information in this document is a subject to change without notice.

CONTENTS

1. INTRODUCTION

User manual intends for the study of the arrangement and functioning of optical time domain reflectometer OR-2-1 and its units. User manual includes information about the technical characteristics, design, operating principle, method of verification and rules of using of the optical reflectometer OR-2-1.

2. APPLICATION

Optical time domain reflectometer OR-2-1 (hereinafter referred to as reflectometer) is destined for measuring of attenuation in optical fibers (OF) and its junction, OF length and distance to its any part.

Reflectometer can be used for the OF and optical cables production as well as under the maintain and construction of fiber optic links. Reflectometer can operate at the field and laboratory conditions.

Reflectometer working conditions:

Temperature of surrounding air..... 0°C - 40°C

Relative humidity of air..... .....no more then 90% under 25°C

Atmospheric pressure..... 84 – 106,7 kPa

3. TECHNICAL CHARACTERISTICS

3.1. Wavelength of the optical source at the reflectometer output is corresponding to the Table 3.1.

Table 3.1

Plug-in optical unit	Wavelength, mkm
MM – 0,85 (multimode)	0,85 ± 0,03
MM – 1,3 (multimode)	1,31 ± 0,03
SM – 1,3 (singlemode)	1,31 ± 0,03
SM-1,55 (singlemode)	1,55 ± 0,03

3.2. Range of measured distances – 2; 5; 10; 20; 40; 90 and 180 km.

3.3. Minimal resolution of indicating measured distance at the PC' screen is

0,4 m within the range of measured distances 2,5,10,20 km
0,6 m within the range of measured distances 40 and 90 km
1,0 m within the range of measured distances 180 km

3.4. Limits of assumed value of the measured distance absolute error are

$dL = \pm (dl + L*dn/n + 5*10^{-5} *L)$,

where dl equal to:
3 m - within the range of measured distances 2,5,10,20 km
6 m - within the range of measured distances 40 and 90 km
12 m - within the range of measured distances 180 km
L – OF length, m
N – OF refractive index
dn – error of refractive index for measured OF.

3.5. Minimal resolution of measured attenuation indicating at the PC' screen – 0,001 dB.

3.6. Values of dynamic range in dB under SNR=1 for different optical units and pulses duration are corresponding to the Table 3.2.

Table 3.2

Pulsewidth, ns	30	90	330	1000	3000	10000
MM-0.85	15	18	21	25		
MM-1.3	17	20	23.5	27		
SM-1.3	13	16	19	22	25.5	29
SM-1.55	12	15	18	21	24.5	28

3.7 Absolute error under attenuation measurement is no more then ± 0,02 dB/km.

3.8. Reflectometer allows to set the pulsewidths according to the Table 3.3.

Table 3.3

Plug-in optical unit	Probing pulses duration, nsec
MM- 0,85	30,90,330,1000
MM-1,3	30,90,330,1000
SM – 1,3; SM-1,55	30,90,330,1000,3000,10000

3.9. Reflectometer provides function with the number of measurement results averaging, which is set by the user, 1, 2, 4, 8, 16, 32, 64, 128, 256.

3.10. Multimode OF are connected to the reflectometer through the optical adaptor “List-X” or ST – type and singlemode OF – through the connector FC-type. There is the possibility of the arrangement of another optical adaptors.
3.11. Reflectometer operating, mapping and storing of measuring information are realize by PC notebook-type. PC can be used separately.

Besides that, any PC ,compatible with IBM PC through the port RS-232 by the connecting cable (including to the reflectometer’ kit), can be used for the work with reflectometer.

3.12. Reflectometer provides its technical characteristics after the time of working mode arrangement, is equal to 10 min.

3.13. Reflectometer saves its technical characteristics within the working conditions during 8 hours of continuous functioning.

3.14. Reflectometer can be supplied from:
- built-in battery Panasonic VW-VBF2E (12 V, 2 Ah);
- constant current source with voltage 12±4 V providing load current no less then 3 A;
- alternative current main with voltage 220±20 V and frequency 50±2,5 Hz (or according to user requirement) through the special power source IP-2-1 (including to the reflectometer kit). Voltage at the power source IP-2-1 is 12 ± 0,5 V.

3.15 Time of uninterrupted work from the built-in full charged battery no less then 3 hours. Time of battery charging from constant voltage source 8...14 V – 10 hours.

3.16. Reflectometer consumes power less then 15 W, with PC notebook-type – no more then 36 W.

3.17. Reflectometer units size
- mainframe – 260 x290 x 65 mm;
- Supply source – 150 x 85 x 45 mm

3.18 Reflectometer units weight
- main unit – 5 kg
- Supply source – 0,4 kg.

4. REFLECTOMETER KIT

4.1. Reflectometer kit is at the Table 4.1.

Table 4.1.

Name	Marking	Q-ty	Note
1	2	3	4
Optical reflectometer OR-2-1		1	
Including:			
Mainframe		1	
Plug-in optical unit:			
MM-0,85		1	According to the delivery contract
MM-1,3		1	According to the delivery contract
SM-1,3		1	According to the delivery contract
SM-1,55		1	According to the delivery contract
PC notebook type		1	According to the delivery contract
Accessories kit			
Power source IP-2-1		1	Supply from the main 220 V
Main cable		1	Connection of the power source to the main supply 220 V
Supply cable +12 V (with two single-pin plugs)		1	Connection to the power source 12 V
Floppy disk with software		1	FD 3,5 “
Key for the replacement of plug-in optical units		1	
User manual		1	

5. REFLECTOMETER STRUCTURE AND WORKING PRINCIPLE

5.1. REFLECTOMETER STRUCTURE

Reflectometer consists of mainframe, plug-in optical units, PC notebook type, power source and connecting cables.

Mainframe is designed in table-portable rectangular plastic enclosure from “Bopla”.

In the mainframe there are battery, pulse transformer of voltage, electronic subassemblies for measurement process control and information accumulation, plug-in optical unit.

There is the special key at the front panel of the plug-in optical unit for the easy replacement of the last.

Plug-in optical unit includes optical receiver, optical transmitter and optical coupler. At the front panel of the plug-in optical unit there is the optical adaptor for the measured OF connection.

Power source from the main supply 220 V is designed in table-portable rectangular plastic enclosure from “Bopla”.

5.2 REFLECTOMETER WORKING PRINCIPLE

Reflectometer operating principle is based on the measurement of the Relay backscattering signal when the strong single optical pulse passage through OF. Weak signal of backscattering is registered by the sensitive optical receiver, transformed to the digital form and multiply averaged for the decreasing of apparatus noises influence.

Structure diagram of reflectometer is presented at Figure 1
Reflectometer includes:

- register R for the data reading from the analog-digital converter output and data transferring to processor
- analog-digital converter ADC for transformation of the signal from matching amplifier to the digital form
- matching amplifier MA for the matching of signal levels from optical receiver and ADC
- shifter S for increasing of reflectometer spatial resolution by the creating of additional shift of laser pulse with respect to processor control signal
- former F for formation of switch signal for optical transmitter
- RAM to store the data memory after some cycles of trace measurement
- ROM for programs storing
- generator G for processor cycle signals forming
- input-output I/O for creation of processor – PC connection on the serial interface
- plug-in optical unit POU consisting from optical transmitter OT, optical receiver OR and optical coupler OC is including powerful laser diode and use for generation of optical pulses with preset duration. OR is use for registration and amplification of scattered signal. OC is use for insertion of pulses to tested OF and delivery of backscattering signal to OR
- temperature stabilization circuit TSC, which holds constant temperature and power of laser diode radiation and constant temperature of laser photodiode.
-

Units S, F, RAM, ROM, G, I/O are integrated at the plate of the signal processor PSP. Processor creates the control signals for the control by the R, SU, RAM, ROM, I/O, reads data from these units and connects reflectometer with PC.

Reflectometer operates in the next manner. According to the commands of the control program in the operative memory of PC, processor produces the code for optical pulse starting (with the aim of SU, F and OT units). When this pulse is pass through the OF, part of its energy is back scatters and proceeds to OR where is transform to electrical form and amplify. Duration of backscattered signal at the OR output is equal to the double time of light passing through OF.

Structure diagram of reflectometer

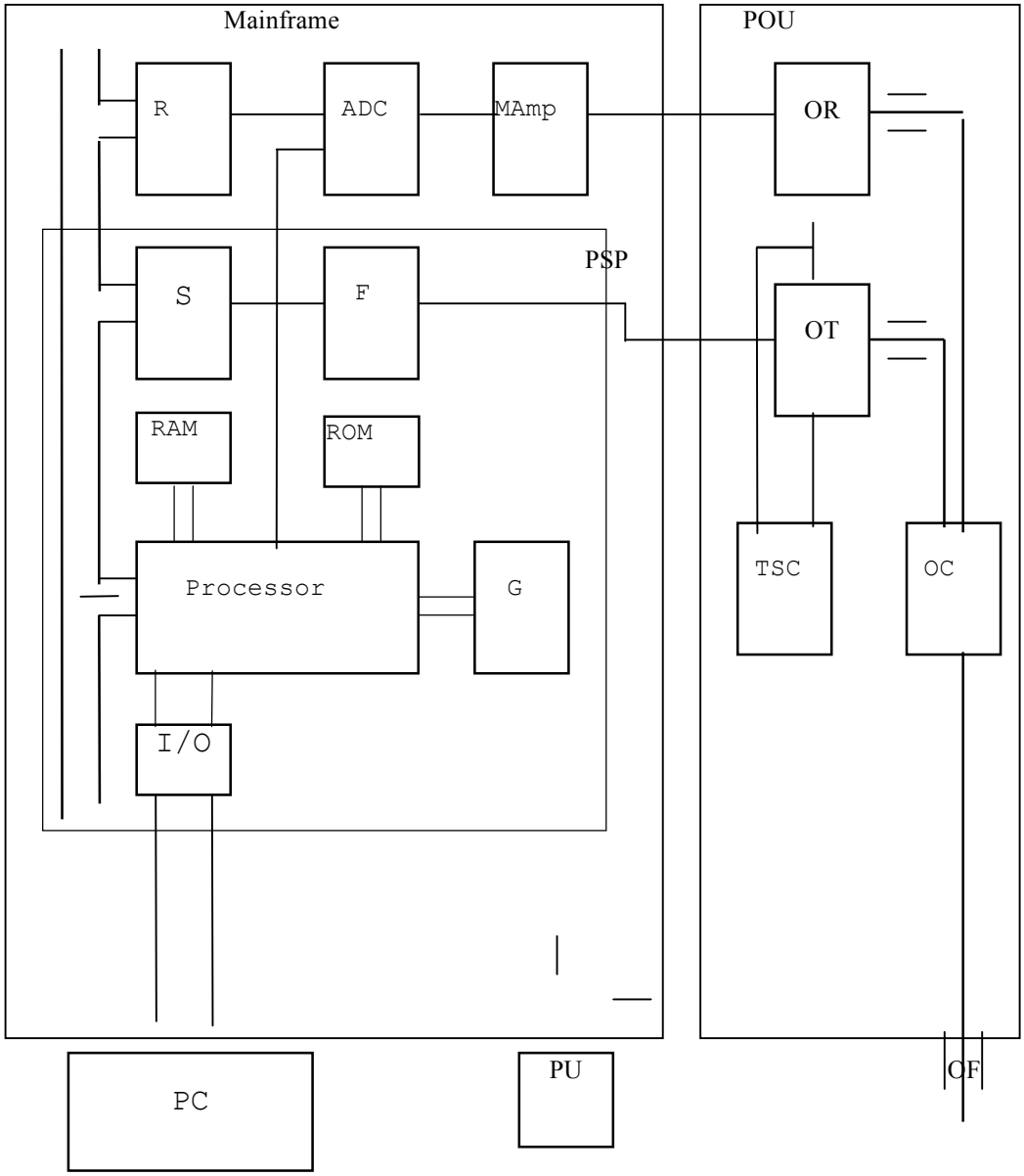


Figure 1.

R - register, ADC – analog-digital converter, MAmp – matching amplifier, PSP – plate of signal processor, S - shifter, F – pulse former, G - generator, I/O- input-output unit, POU – plug-in optical unit, OT – optical transmitter, OR – optical receiver, OC - optical coupler, TSC - termo-stable circuit, PU - power unit.

Backscattered signal through the matching amplifier MA proceeds to ADC input and is transforming to the digital form. The processor synchronizes ADC function. ADC reads 16384 cycles of measuring backscattered signal during one period of starting. Cycle at the time moment "t" is correspond to the signal scattered from OF point at the distance

$$Z = ct/(2n)$$

Where c – speed of light in vacuum, n - refractive index of OF core. So, during one period of optical pulse starting signals from large number of OF points are measuring.

Every cycle transformed by ADC to digital form is memorized by random access memory RAM. Multiply starting of the optical pulse is realize for precious measurement of backscattered signal. Processor is averaging the cycles corresponding to same points of OF , that bring to the signal-noise-ratio increasing. After the some of such cycles signal values from RAM is transferred to PC, is memorized and reflected at the PC screen. Thus, process of measuring, averaging and clearance of RAM registers is repeat again. So, all OF trace is measured, memorized and reflected. For increasing of accuracy and dynamic range of measurement, reflectometer' operator can increase number of averaging by the setting of Nrep > 1 at the MEAS mode (see p.8.4.4.3). This value can be set is equal to 1, 2, 4, 8 and so on to 1024. At that measuring time increases.

Temperature stabilization circuit TSC supports constant temperature of laser diode and avalanche photodiode; these elements are included to OT and OR correspondingly. They are set each at the separate thermo-cooler, its temperature is controlling by thermistors and TSC.

6. WORK WITH REFLECTOMETER AND MEASUREMENTS

6.1. PREPARATION OF REFLECTOMETER FOR OPERATING

6.1.1. There are switch and indicating light diodes with above mark “ON” at the front panel of the mainframe. There are the red indicating light diode “DIS BAT” (battery discharge) and green indicating light diode “CHAR BAT” (battery charge). At right there is the plug-in optical unit (POU).

At the back panel are placed:

- two connectors “=12 V” – for connection of reflectometer main cable and PC notebook main cable;
- connector “PC” – for connection of the interface cable for connection with PC
- fuse lock holder “3A”
- “BAT” cap which closes the access to battery

6.1.2. Before the work starting it is necessary to connect reflectometer with PC and power source.

Mainframe is connected with PC by the interface cable (cable with plug and socket for 9 pins), which is connected to “PC” connector at the back panel of reflectometer, and at PC to RS-232 connector.

Mainframe is connected to the inside power source (12±2) V by cable with two single-pole plugs (red plug – to “+” of supply, blue – to “-“ of supply). Short cable is connect to another plug “=12V”and by the second end to the main supply plug of PC notebook.

When reflectometer feeding from main supply 220 V 50 Hz it is necessary to connect the output cable of power source IP-2-1 to main unit and PC as mentioned above, and to connect main cable 220 B 50 Hz to input of IP-2-1.

Reflectometer can also feed from built-in battery Panasonic VW-VBF2E (12 V, 2 Ah). So PC notebook has to feed from built-in battery as well as from main supply 220 V 50 Hz through the power source (in PC’ kit).

6.2 REFLECTOMETER SWITCH ON

After connection of main cable to the source of constant current 12±2 V and connection of the mainframe to PC it is necessary to switch on reflectometer by main switch at the front panel of the mainframe. Indicator “ON” has to light.

If built-in battery is not full charged then when reflectometer feeding from outside source, will be charge and green light diode “CHAR BAT” will be light. After the battery charge to nominal voltage, light diode will become dim.

When reflectometer feeds from built-in battery for indicating of its discharge red light diode “DIS BAT” is use. After its light reflectometer can function from battery no more then 30 minutes. When full discharge of battery refectometer will switch off, LED “ON” at front panel will become dim and LED “DIS BAT” will be light. When switch on of reflectometer from the full discharged battery only LED “DIS BAT” will be light. If reflectometer with full discharge battery will switch on from the outside power source, then diode “ON” will light with some delay (1-10 min) and only after you can work with reflectometer.

Tested OF is connected to the reflectometer through the optical connector or weld on to the short piece of optical fiber inserted to this connector already.

6.3. REFLECTOMETER SOFTWARE

6.3.1. Basics

The OTDR kit includes software, which operates under Windows™ 95/98/NT operational systems and going on the standard PS's or Notebooks with 486 processor or higher and 4 Megs of the RAM at least.

The software includes:

- application file reflect.exe;
- help file reflect.hlp;
- hardware data file bwi81a.bit or or510.bit.
-

The software is supplied on the floppy disk. Insert "DISK 1" labeled diskette to 3.5 floppy drive and run setup.exe file, follow to installation instructions. Software can be used separately from reflectometer. All features of it will present accept traces measuring.

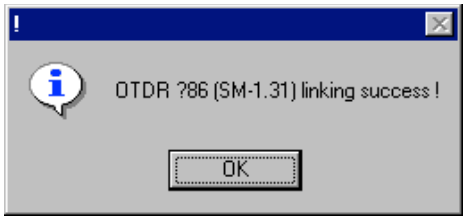
6.3.2. Software appearance

Application appearance with a compliance of Windows™95 GUI (Graphic User Interface).

After application loading main window appear and hardware initialization is produced.

If in a time of the hardware initialization process an application can't communicate with the OTDR, a corresponding message will appear. A possible cause of the initialization falling is described in 6.5. chapter of the manual.

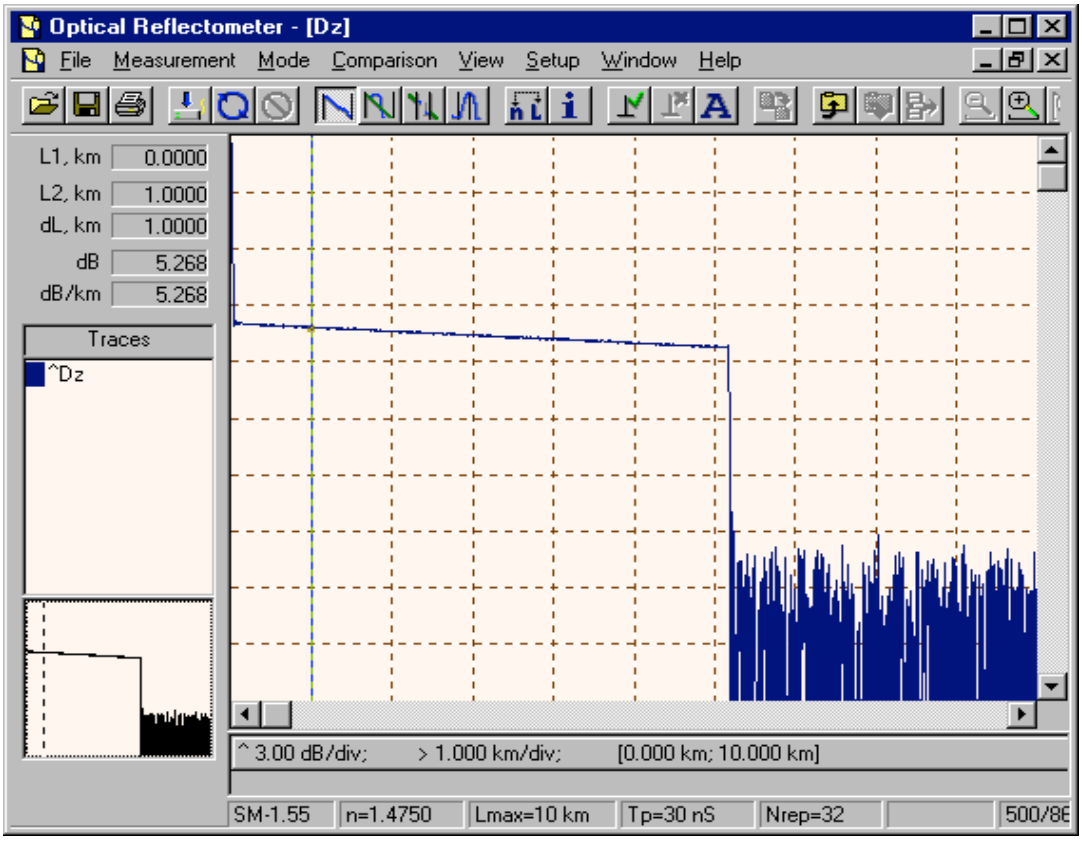
Software can be used without the reflectometer as a OTDR simulator. Under such condition all functions of software is available, except measurement mode.



If initialization process is successful next message will appear, which include the OTDR number and type of the POU.

The software main window include:

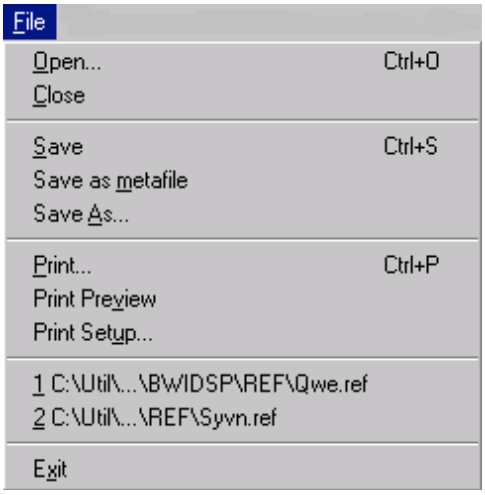
- an application name string;
- a menu string;
- a buttons toolbar;
- information panel at the left part of main window (it will appear with a trace opening only).



6.3.3. Software menu

A software main menu consists of the next submenus and points (describing from left to rigt and from up to down; " * " symbol mean that these submenus and points will appear when trace is open only):

6.3.3.1. "**File**" submenu

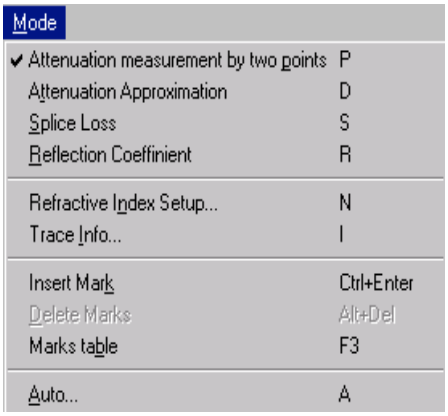


- opening a previously saved trace;
- closing a current trace window (*);
- saving to file a current trace (*);
- saving to enhanced meta file;
- saving current trace to file under another name (*);
- printing a current trace(*);
- print preview;
- printer setup;
- list of the last opening traces;
- exitting of the application.

6.3.3.2. "**Measurement**" submenu

- beginning of the measurement process;
- cancelling of the measurement process;
- setting up of the measuring parameter.

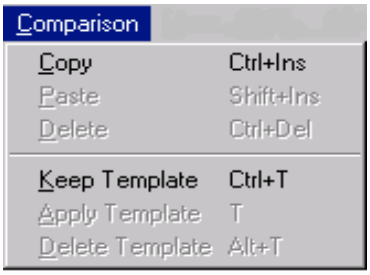
6.3.3.3. "**Mode**" submenu (*)



- attenuation measuring by two points mode;
- attenuation approximation mode;
- splice loss measuring mode;
- reflection coefficient measuring mode;
- refractive index setup mode;
- entering trace info;
- inserting mark of the current mode and marker position;
- delete all marks between markers;
- invoking table of the current trace

marks;
- automatic trace analysis.

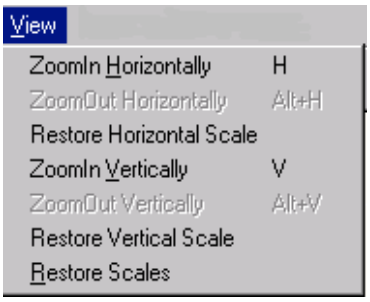
6.3.3.4. "**Comparision**" submenu (*)



- copying current trace to clipboard;
- inserting trace from clipboard upon current;
- deleting inserted trace;

- storing current trace marks as a template;
- applying template to current trace;
- deleting template.

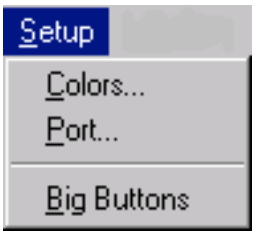
6.3.3.5. "**View**" submenu (*)



- zooming in trace horizontally;
- zooming out trace horizontally;
- restoring scale horizontally;

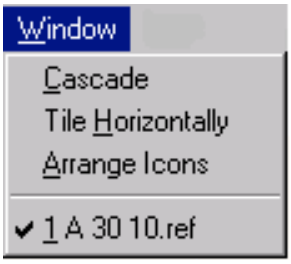
- -zooming in trace vertically;
- zooming out trace vertically;
- restoring scale vertically;
- restoring all scales.
-

6.3.3.6. "**Setup**" submenu



- setting up colour palette;
- setting up serial port for OTDR connection;
- switching between normal and big buttons of the button panel.

6.3.3.7. "**Window**" submenu



- cascading windows;
- tiling windows horizontally;
- arrange all icons;
- list of child windows.

6.3.3.8. “**Help**” submenu

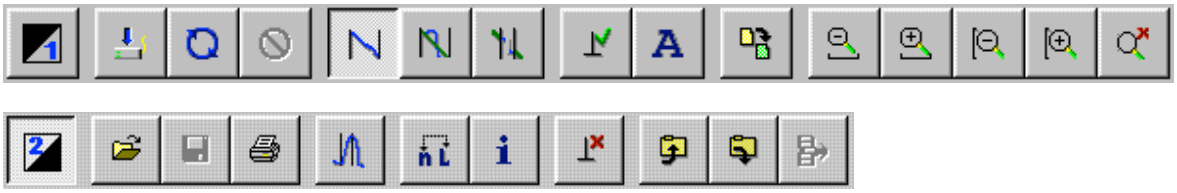
- invoke help topic;
- invoke about info.

6.3.4. Toolbar

On the toolbar is placed next buttons (description left to right, and corresponding “hot-keys”):

- opening a previously saved trace;
- saving a current trace;
- printing a current trace;
- setting up a measuring parameters;
- starting measuring process (**Enter**);
- cancelling of the measuring process (**Esc**);
- attenuation measuring by two points mode (**P**);
- attenuation approximation mode (**D**);
- splice loss measuring mode (**S**);
- reflection coefficient measuring mode (**R**);
- refractive index setup mode (**N**);
- entering trace info (**I**);
- inserting mark of the current mode and marker position (**Ctrl+Enter**);
- delete all marks between markers (**Alt+Enter**);
- automatic trace analysis (**A**);
- applying template to current trace (**T**);
- copying current trace to clipboard (**Ctrl+Ins**);
- inserting trace from clipboard upon current (**Shift+Ins**);
- deleting inserted trace (**Ctrl+Del**);
- zooming in horizontally/vertically (**H** / **V**);
- zooming out horizontally/vertically (**Ctrl+H** / Ctrl+**V**);
- restoring all scales.

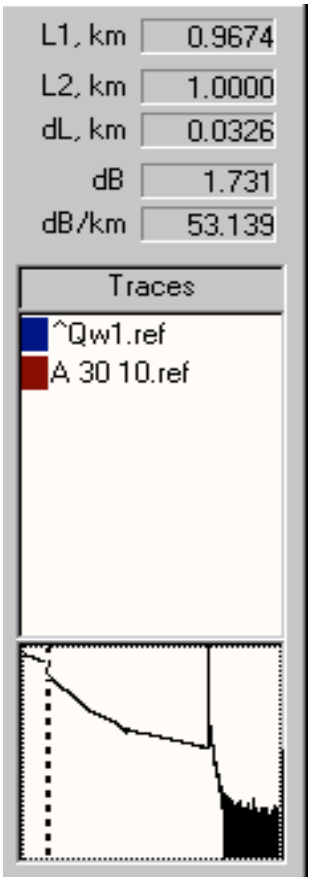
Software allows switch normal size buttons to big it. In the big buttons mode not all buttons is placed on the one panel, so two panel exists and switching between first or second subpanel makes by pressing **F2**-key or by left button on the panel.



Icons on the normal-size and big-size buttons are the same.

6.3.5. Information panel

Information panel appears on the left part of the main window, when trace window is opened. It contains next data, corresponding to child window:



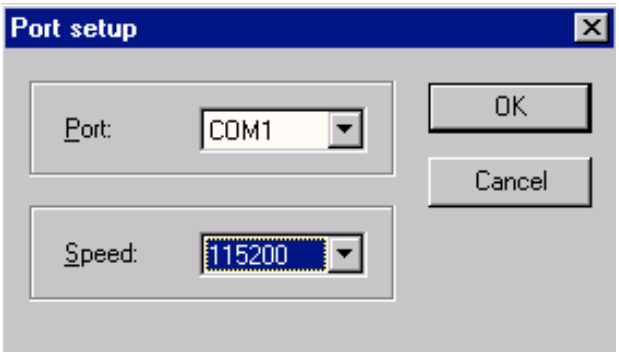
- **L1** left marker position;
- **L2** right marker position;
- **dL** distance between markers;
- attenuation between markers (according to mode);

- traces list at the current child window with corresponding colors; control switching between child window and traces list is produced by **F4** key pressing; current trace name marks by " ^ " symbol; changing to current trace is produced by double mouse click on the trace name or by **SPACE** pressing.

- "viewing" window, which contains current trace; the trace part, which displayed in the child window is marked by pointed rectangle, markers – by dashed lines.

6.3.6. Communication port setting up

Before first time OTDR running on the given PC, it's necessary to set up a communication serial port (**COM**), where OTDR is connected. To do it chooses ***Setup → Port***. Next dialog box will appear.

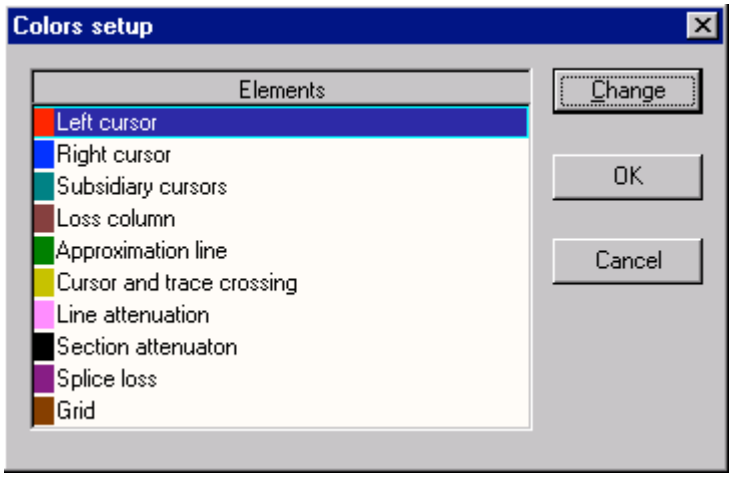


Choose serial port number and corresponding communication speed (maximum speed 115200 bit/sec is recommended). If PC not support such speed (it can be happened on the old types of PC's or some models of notebooks), the initializing of OTDR hardware will not be successful. In that case lower communication speed have to be choosen. All changes on the port setting will work after application restarting, so close and run it again.

6.3.7. Color palette setting up

To provide a convinient condition for OTDR user, the color palette can be changed.

To do this chooses ***Setup → Color;*** dialog box with list of different elements and corresponding colors will appear.

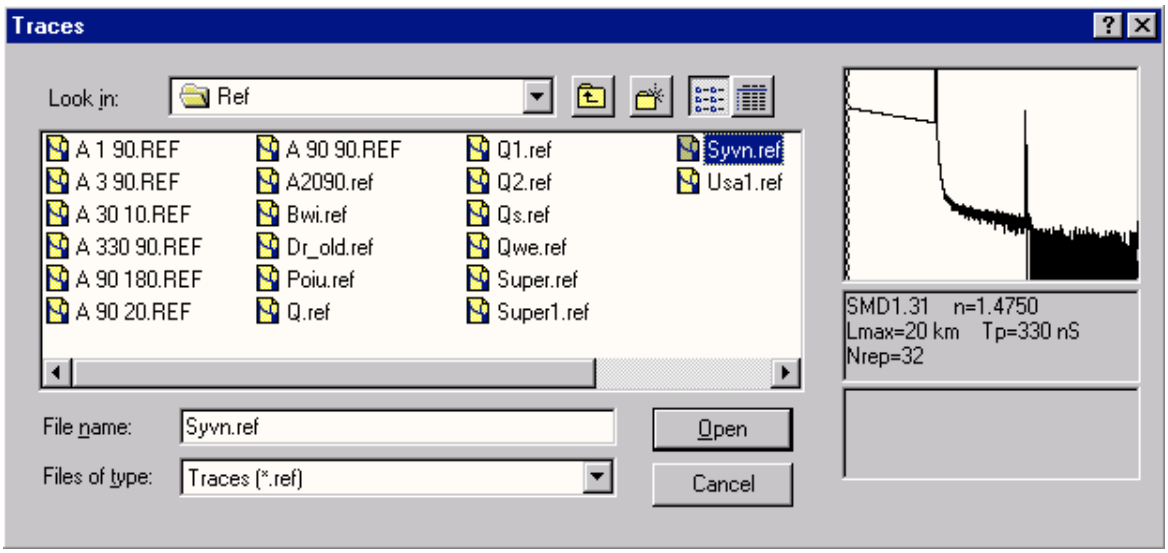


To change element color, select element needed by mouse double clicking or by using, ↑,↓ arrow keys and **SPACE** pressing, a standard Windows™ "Color" window will appear.

Choose color you wish and press OK. Do it for all necessary elements. To store changes and return to software press OK or Cancel for quitting without color changes.

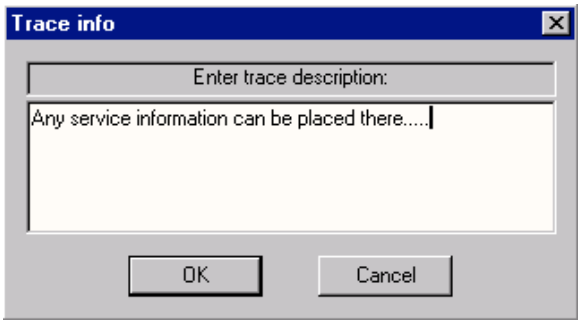
6.3.8. Opening file with previously saved trace

To open file with previously saved trace choose ***File → Open*** or press  button on the toolbar, next dialog will appear.



The left part of the window looks like standard Windows™ “Open file” dialog box. If selected file contain a trace, it will be displayed in the right part of dialog box with measurement parameters.

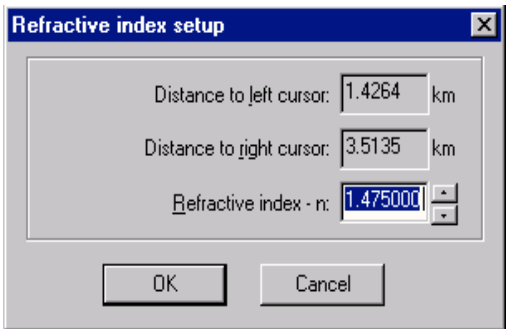
6.3.9. Trace description entering



The trace can be accompanied by service information. Choose ***Mode → Trace Info*** or press  button on the toolbar, trace information dialog box will appear. Now you can type any informations inside “Trace info” dialog box and store it by OK pressing. This trace description will appear on the bottom part of the current trace child window. This information will be saved to file as well.

6.3.10. Refractive index setting

To change a refractive index choose ***Mode → Refractive index setup*** or press  button on the toolbar. “Refractive index setup” dialog box will appear, which include position of the markers. When refractive index is changed, a markers position will be recalculated. Pressing “OK” button will close this dialog box and store new refractive index value, “Cancel” button will close dialog box without refractive index changing.

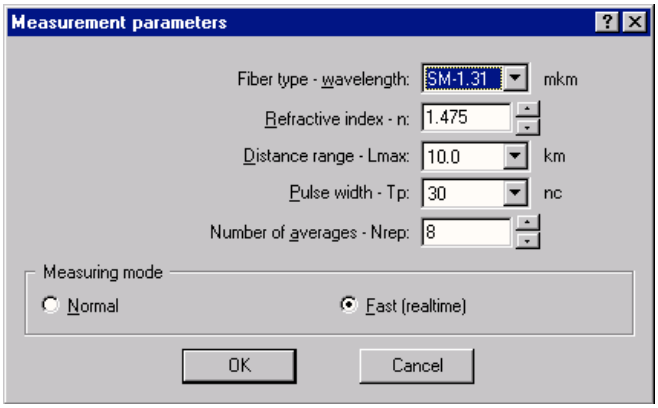


6.4. MEASUREMENTS

The next actions are accessible if under software loading hardware initializing was successful only.

6.4.1. Measurement parameters setting up

Before measurements it's necessary to setup it's parameters. Choose from main menu ***Measurement*** → ***Parameters*** or press  button of the buttons menu. Next dialog box will appear. **Fiber type – wavelength** – indicates type of optical unit plugged to OTDR mainframe. One of five types are available: **MM-0.85** mkm, **MM-1.3** mkm, **OM-1.3** mkm, **OM-1.55** mkm or **SMD-1.3/1.55**. Under hardware initializing, type of the optical plug-in unit will define automatically.



Refractive index – n – refractive index of the optical fiber; 1.475 – default value.

Distance range – Lmax – measuring distance range; this value has to be choosen by user and it must be greater than measuring line distance. Next values for **Lmax** are available: 2, 5, 10, 20, 40, 90 and 180 km. This value defines a laser probe pulses period, which have to be a twice greater than light propagation time in the optical fiber.

Pulse width – Tp – laser probe pulse width; possible values are placed in the Table 3.3. Software limits pulse width according to distance range **Lmax** choosen as displayed in the next table.

Distance range **Lmax,** km	Possible pulse width **Tp**, ns
2	30, 90
5	30, 90, 330
10, 20	30, 90, 330, 1000
40	30, 90, 330, 1000, 3000
90,180	30, 90, 330, 1000, 3000, 10000

Number of averages – Nrep – number of averages of trace in PC RAM.

Measuring mode – Normal/Fast (realtime) – measuring mode setting: **Normal** – with **Nrep** averages or **Fast** – without averages.

Values of measuring parameters, which set by user are depended from assumed OF (line) parameters: length and average attenuation. Under testing of these characteristics by OTDR, value of full measuring attenuation (dynamic range) is increased with the optical pulse width increasing, but distance measurement error is increased simultaneously:

$dL = c*Tp/(2*n)$,

where c – light velocity in vacuum. For example, value dL = 9 m is correspond to the pulse width Tp = 90 nsec. It is possible to increase the dynamic range with increasing of number of averaging **Nrep** (add 0,75 dB to dynamic range when **Nrep** doubling), but measuring time is increased.

So, if the measuring line with some kilometers length and full attenuation about 10 dB (or initial part of more long line) is measured, the good accuracy of measurements can be obtained when optical pulse width is 30 or 90 nsec for multimode OF and less then 1 mksec for singlemode OF, the **Nrep** value can be 1 -16. To maximize a dynamic range and investigate the attenuation at heterogeneousness at the far parts of more long lines, it is necessary to increase the pulse width and number of averaging.

Lmax value must exceed the length of measuring line. If the line length is almost same to Lmax value (or is more than 2/3 of its value), the presence of strength pulse in the backscattering signal from back end of OF can lead to the small distortions of attenuation or to the appearance of the false scattered pulses at the smooth part of the trace (“ghosts”). It is recommended to increase the **Lmax** value to avoid such situation.

6.4.2. Measuring process

Starting of measuring process is produced or by choosing ***Measurement → Run*** or by pressing  button on the toolbar or by hot key pressing. For pre-term halting of measuring process press **Esc** or choose ***Measurement → Stop*** or press  button on the toolbar.

6.4.2.1. Fast mode measurement

At this mode (**Fast Measurement**) the trace is displayed at the screen with periodicity in the time, so the picture is fully renewed and averaging is not done. This mode, in general, is used under the alignment of two OF before its welding or in analogous cases. Nrep number in this mode assigns the speed of the picture changing: if Nrep is big, then trace is changed more seldom.

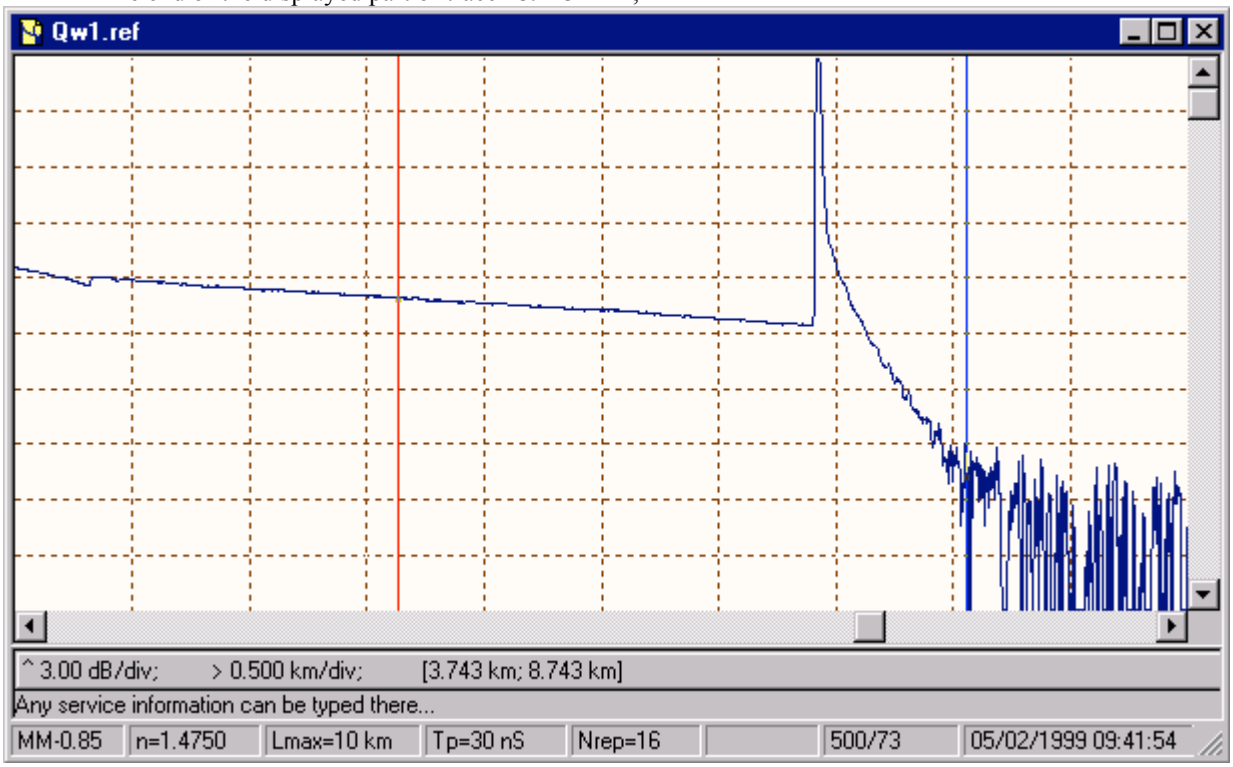
6.4.2.2. Normal mode measurement

Normal mode is intended for OF measurements with following investigation of its parameters. When process under going, averaging process is reflected on the window. In the information string on the bottom part of the current trace child window is displayed number of passed averages. The measuring process is ended when this number will be equal to **Nrep**.

6.4.3. Trace window

Trace and two movable markers are displayed on the trace window. Marker positions are fixed on the information panel (see **6.3.5.**). At the bottom part of this window next parameters are displayed:
(see next picture, for instance)

Scale value vertically "^ **3.00 dB/div**";
Scale value horizontally "^ **0.500 km/div**";
The beginning of the displayed part of trace "**3.743 km**";
The end of the displayed part of trace "**8.743 km**";



Trace info string;
Trace parameters: optical plug-in unit type **MM-0.85**, refracting index **n=1.4750**, measured distance range **Lmax=10 km**, laser probe pulse width **Tp=30 nS**, number of averaging **Nrep=16**, hardware type and OTDR number **500/73**, date and time of measurement making **05/02/1999 09:41:54**.

6.4.4. Changing scales vertically and horizontally

The displayed trace can be zoom in horizontally or vertically using menu or corresponding buttons on the toolbar or by pressing hot keys, which collected in the table below.

Function	Hot key
Zoom In horizontally	**H**
Zoom In vertically	**V**
Zoom Out horizontally	**Ctrl + H**
Zoom Out vertically	**Ctrl + V**
Restore scale horizontally	**Alt + H**
Restore scale vertically	**Alt + V**

Scrolling of the displayed part of trace is produced by scrolling bars or using next key combination: **Alt** + ←, ↑, →, ↓.

6.4.5. Markers movement

Markers movement upon trace is produced by two methods: using mice or keys.

To move marker using mouse places mouse pointer to marker (mouse pointer will change to ⇹), "catch" marker and move it to necessary position. Markers movement using keys are produced according to follow table:

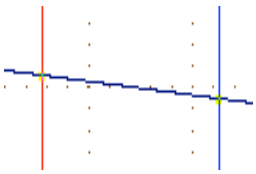
Marker	To left	To right
Left basic	←	↑
Right basic	↓	→
Left subsidiary	**Shift** + ←	**Shift** + ↑
Right subsidiary	**Shift** + ↓	**Shift** + →
Attenuation column	**Ctrl** + ←	**Ctrl** + →
All simultaneously	**Ctrl** + ←	**Ctrl** + ←

Markers movement is possible by mouse clicking on the trace: left marker – left mouse button, right marker – right mouse button.

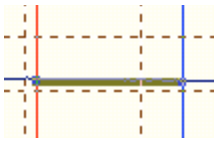
6.4.6. Attenuation measuring

To measure attenuation at the any region of the trace, it's necessary to place markers on the end points of this region and read measured parameters on the information panel (**6.3.5.**): full attenuation (**dB**) between intersection points of markers with trace and loss between this points (**dB/km**). Under attenuation measuring, the left marker must be placed outside of the dead zone.

L1, km	6.5550
L2, km	7.0592
dL, km	0.5042
dB	-0.848
dB/km	-1.681

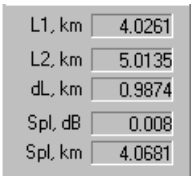


To increase accuracy of attenuation measuring, the trace region can be approximated by straight line (**Attenuation approximation** mode). To do it choose ***Mode → Attenuation Approximation*** or press **D** key or press  button on the toolbar. At that case an approximating line will be displayed upon the trace. This method shall be applied to the homogeneous parts of trace.

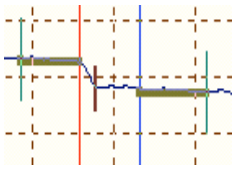


6.4.7. Attenuation measurement in optical fiber splices

The software allows measuring splice attenuation using so-called “five markers” method.



To do it, place markers near the splice, so that splice will locate between markers and put to “**Splice Loss**” mode (***Mode → Splice Loss*** or press **S** key or press  button on the toolbar). At that three subsidiary markers will be invoked, left-left and right-right parts of trace will be approximated by straight lines and splice loss will be calculated and displayed on the information panel. Splice point will be marked by vertical column, approximation parts – by bold lines, all markers positions can be changed independently. Vertical column must be placed to the left edge of splice.



6.4.8. Distance measurement

To measure distance to the heterogeneousness, marker must be placed at the its left side and the distance is read out from information panel.

The accuracy of the distance measurement on the trace is depended, in particular, from the accuracy of the refractive index value setting. If it is unknown, but measured OF length is known, then refractive index can be chosen such that OF length measuring from the trace to coincident with known one.

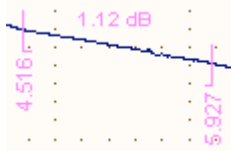
To do it, place any cursor at the trace and press the **N** key or  button on the toolbar, it will invoke a "**Refractive index setup**" dialog box (**6.3.10.**).

Using the ←, → keys or scrolling bar of the **N** string, it can be changed the refractive index **N** and simultaneously will be changed the distances values. When the distance to the cursor is coincided with known length of measured OF, then you have to press the ENTER key or OK button, and chosen value of refractive index n will fix.

6.4.9. Inserting marks upon the trace

The measured attenuaton value of the trace part or splice can be fixed upon the trace.

To mark position and attenuation of any trace part it's necessary after finishing of the measuring procedure choose ***Mode → Insert Marks*** or press **Ctrl+Enter** or press  button on the toolbar. At that marker position and full attenuation between markers well be appeared.

If attenuation by two points is been measured (**6.4.6.**), a markers position and full attenuation in dB's will fix on the trace.	
If attenuation with approximation is been measured (**6.4.6.**), a markers position and full attenuation in dB/km's will fix on the trace.	
If attenuation of splice is been measured (**6.4.7.**), a subsidiary vertical column position and splice attenuation in dB's will fix on the trace.	

All marked parameters will print and save to file.

To delete any marks it's necessary to place markers so that it marks was between markers and choose ***Mode → Delete Marks*** or press **Alt+Enter** keys or press  button on the toolbar.

6.4.10. Traces comparision

There is an ability to compare some traces, for example, the same optical fiber measured in a different time or different fibers of the one optical cable.

To insert trace from current child window to another child trace window for comparision it's necessary:

- copy this trace to clipboard (press **Ctrl+Ins** or choose ***Comparision → Copy*** or press  button on the toolbar);
- choose a child trace window where have to be produced comparision and press **Shift+Ins** keys of choose ***Comparision → Insert*** or press  button on the toolbar.

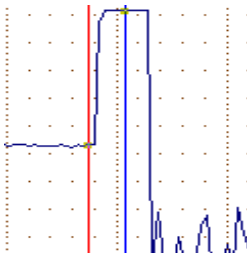
Now on the trace window will display two traces: main and inserted, and at the traces list at the current child window the inserted trace name will add. By such manner, to the current trace window a seven traces can be inserted.

Attenuation and distance measurements can be produced for single trace only, so-called "active", it trace name marked by ^ symbol. To do "active" another trace double click on it name. Using keyboard it can be done by next manner:

- press **F4** key;
- choose name of necessary trace using arrow keys;
- press **Space** bar, the ^ symbol will appear near chosen trace;
- press **F4** key again.
-

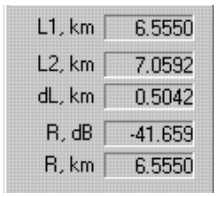
To delete an inserted trace from window, choose it (do "active") and press **Ctrl+Del** keys or choose ***Comparision → Delete*** or press  button on the toolbar. At the inserted trace there is an ability to measure parameters, insert marks, enter an information, apply template function, but all marks will not transfer to child window of this trace. It's unpossible to save or print inserted traces from "strange" window.

6.4.11. Reflection coefficient measurement



To measure a reflection coefficient from two connectors or from fiber end it's necessary to place a right marker to reflection pulse peak, a left marker – before it. And then choose ***Mode → Reflection Coefficient*** or press **R** key or press  button on the toolbar.

The result will display on the upper table of the information panel: R, dB - -reflection coefficient, R, km – distance to left marker from trace beginning.



6.4.12. Traces printing

To print trace choose ***File → Print*** or press **Ctrl+P** or press  button on the toolbar.

Before printing preview (***File → Print Preview***) and printer setup (***File → Print Setup***) available.

6.5. TROUBLESHOOTING

1. Reflectometer not turns on.

Close application, turn on reflectometer and run application again.

2. Reflectometer not connects to PC.

Close application, turn off reflectometer and PC, connect reflectometer to PC communication port (**COM**) turn on reflectometer and PC and run application again.

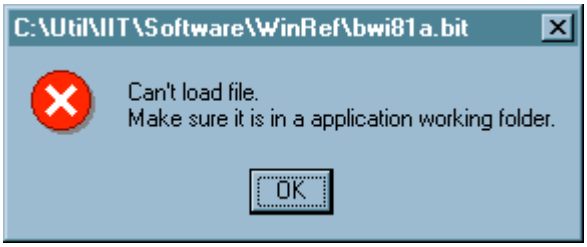
3. Wrong COM port number in the application setup.

Choose correct COM port number (see 6.3.6.).

4. Pointed COM port does not support a mentioned communication speed.

Change a communication speed (see 6.3.6.).

5. Unpossible to find a **bwi81a.bit** (or **or510.bit**) file with service hardware data.



Make sure, that a **bwi81a.bit** (or **or510.bit**) file is in the application working folder.