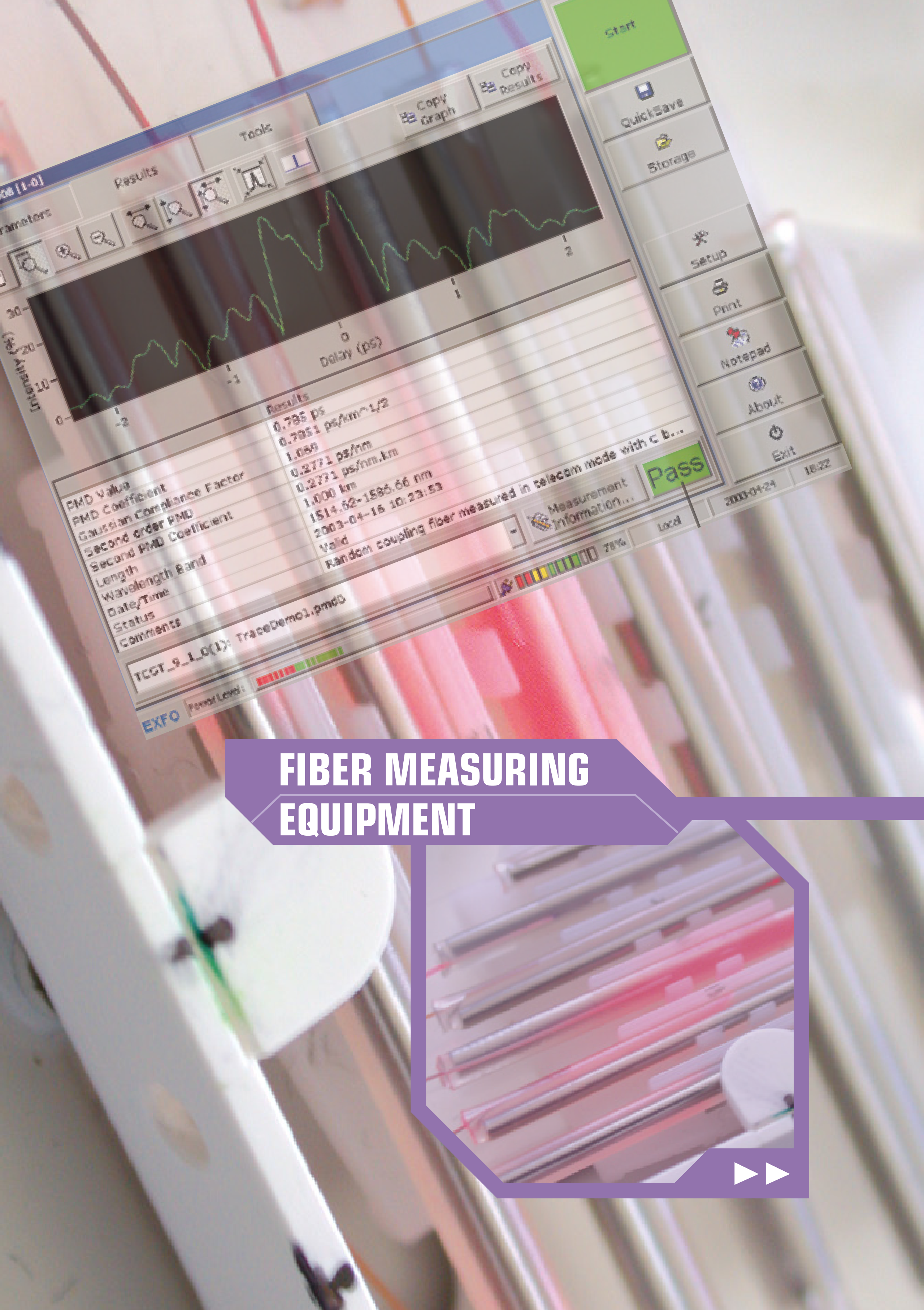


FIBER MEASURING EQUIPMENT

Fiber Measuring Equipment

This chapter will deal with measuring equipment for optical fiber installations. How do you find out, what kind of equipment will you have to purchase and what are the costs.

From the very start of your buying it is essential to consider, which part of the area you want to cover.

- Is it about certification?
- Is it about documentation?
- Is it about trouble-shooting?

Many measurings can be – and should be – made, depending on which part of the installation you are dealing with, and which kind of transmission that takes place. Relative to these two parameters, you can allways find out what should be measured and, especially, what must be measured.

On the market you can find equipment well suited for trouble-shooting, and precisely trouble-shooting may very well turn out to be a significant area in the future, especially when it comes to considerable bandwidths.

A standard installation consists of a connector, a piece of fiber, possibly some splicings and then a second connector. So what can we actually measure?

Attenuation – It is possible to measure the losses in an installation. Loss is measured in dB. The lower loss the better. Before the actual measuring of the attenuation, you must calibrate the transmitter as well as the reciever. You must measure in both directions, at the wavelengths being used or at wavelengths you want to start using. In other words, you will normally have to perform 4 measurements per fiber. If it is a multi mode installation, you must measure from left to right at 850nm and at 1300nm – and from right to left at 850nm and at 1300nm. If it is a single mode installation, you must measure at 1310nm and at 1550nm plus, preferably, also at 1625nm. Also in both directions, which gives a total of 6 measurements. If you are dealing with a cable containing 24 fibers, you will have to perform a considerable number of measurements.

Figure 1

EXFO power meter and light source.

Figure 2

JDSU power meter and light source.

Figure 3

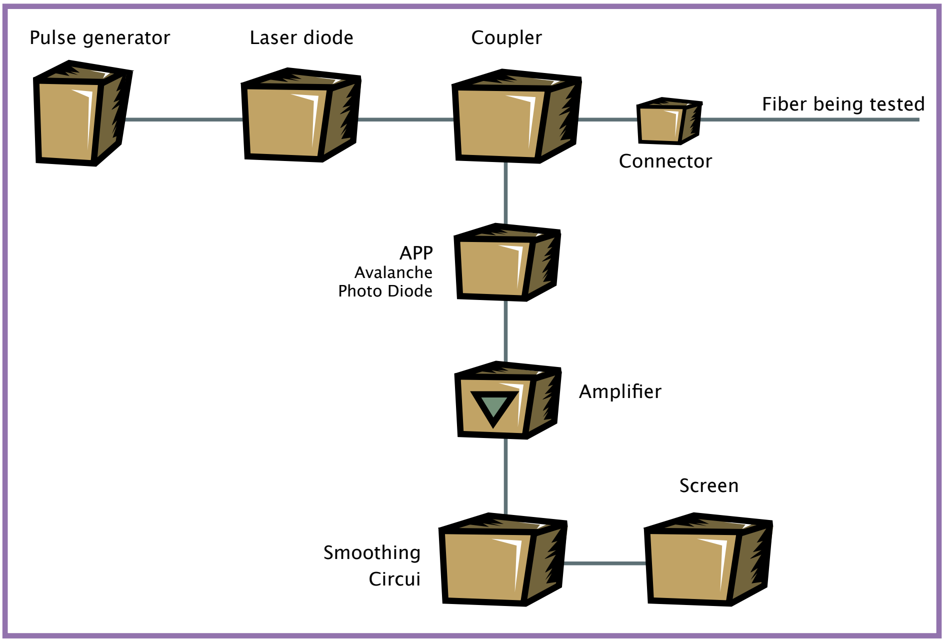
OPL-55 power meter from JDSU

Return loss – reflections (RL = Return Loss). It is possible to measure, how much of the transmitted optical signal that is reflected back. Try to imagine that you are looking through a window glass. Besides it not being completely clear, which corresponds to the attenuation in an optical fiber, the window glass also reflects light. If you take a picture with your camera through a window, using a flash, you will experience a powerful light reflection from the glass. The total number of light reflections in an optical fiber is named the Return Loss (RL). The Return Loss is measured in dB. The more positive the number is, the better. 30dB is not so good, 50dB is good and if you pass 60dB, you are entering the area of analog tv installations. Return Loss meters look very much like Attenuation meters, but the prices are much higher.

The Installation Quality – is measured with an OTDR, an Optical Time Domain Reflectometer. This instrument is capable of making a fingerprint of an installation, a so called trace. The OTDR transmits a light pulse into the fiber and subsequently analyzes the returning reflections. It may be reflections from the fiber itself (called backscatter), but it may also be reflections from connectors, splicings or from bending the fiber.

A good meter may detect faults at distances above 400 km. A skilled person will be able to find a fingerprint at a distance of 150 km. All things being equal, it is quite impressive to find faults so far away from the measuring instrument.

Figure 4



The Basics of An OTDR

In brief, the OTDR works as follows (see figure 4): Activating a laser diode, a pulse generator transmits a very short light pulse. The light pulse passes through the coupler and continues into the customer's fiber. A part of the light pulse is reflected from the fiber and is subsequently sorted out in the coupler .This reflection is detected by a photo diode (a very fast version). After being amplified, the reflected light is straightened in a smoothing circuit. An average value of the light pulses is shown on a display.

Figure 5 and 6 show examples of OTDRs. Looking at the photos, you will notice relatively few keys plus some kind of display. The displays are large, as large displays result in better readings. Some types have a touch display, which makes it somewhat easier to operate the instrument.

Figure 5

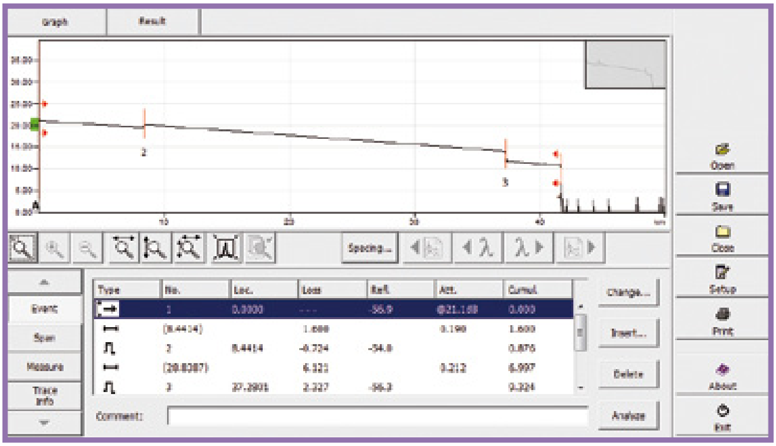
OTDR from EXFO

Figure 6

OTDR from Yokogawa

An OTDR is rather complicated. The volume of the manual may be several hundred pages, normally written in an understandable (highly technical) English. Besides the instrument itself, you will need a launch box, or a piece of fiber with a length of approx one kilometer. The box or fiber is necessary to measure the first section of the installation. The optical pulse width and the time range must be set correctly. The length of the installation you intend to measure must be set as well. It is important to be very particular, as all settings influence the measurement. If one or more of the settings is incorrect, you will get faulty results. Besides the settings already mentioned, you must choose the right wavelengths etc. So it is understandable, why the manual is extensive.

Figure 7



An example of a trace showed on the display. It is possible to zoom in on an area, you want to study more closely.

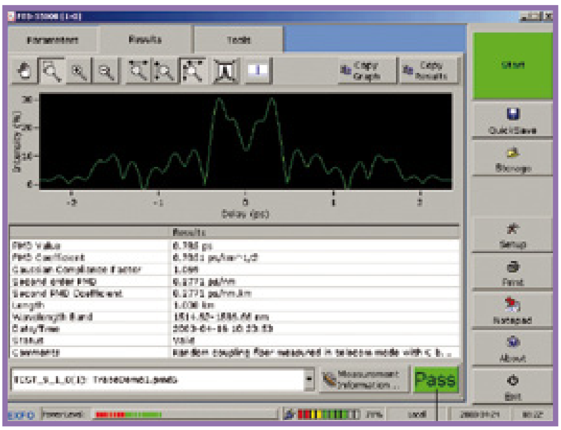
PMD Polarisation Mode Dispersion

When light is transmitted through a piece of fiber, the light will pass the fiber either horizontally polarised or vertically polarised, much in the same way horizontally/vertically polarised radio/tv signals are transmitted. But light travelling through a fiber presents a special problem. On its way through the fiber the light will be more or less delayed in one direction, compared to the other direction. As a result of this delay, the light pulse will level off, and lead to unrecognisable data. In other words, you will not be able to understand the incoming messages. That is why it is necessary to perform PMD measurements, when making installations, which must be able to handle speeds from 10Gbit and up. These speeds are already in use today, in backbone installations.

Figure 8

PMD instrument from EXFO

Figure 9



A PMD reading

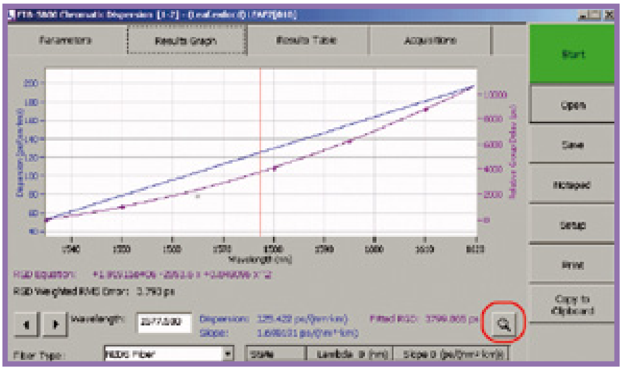
CD – Chromatic Dispersion

Another property of light is that different colours (=different wavelengths) will travel through the fiber at different speeds. As a result of this, the signal may be disturbed on the way, by mixing with each other, resulting in a signal that can not be understood.

Figure 10

CD instrument from EXFO

Figure 11



A CD reading

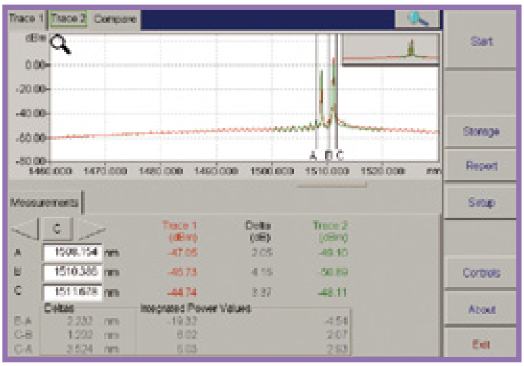
OSA – Optical Spectrum Analyser

This instrument is able to measure the attenuation in a fiber at different wavelengths. At 1310nm the attenuation is approx 0,4dB/km and at 1550nm the attenuation is 0,2dB/km, but there are variations at the wavelengths between 1310 and 1550nm. If you want to transmit more wavelengths at the same time, it is advisable to perform an OSA-measurement. Where the OTDR measures attenuation over distance, the OSA measures attenuation over wavelength.

Figure 12

OSA instrument from EXFO

Figure 13



An OSA reading

The problem concerning the last three measuring instruments mentioned (PMD,CD,OSA) is the price. The price for these instruments is close to 170.000 USD (december 2008), so it is doubtful if you will find them in small companies. However, if you need to test installations longer than 40 km, at speeds of 10Gbit or more, there is no way around it – you will have to invest.

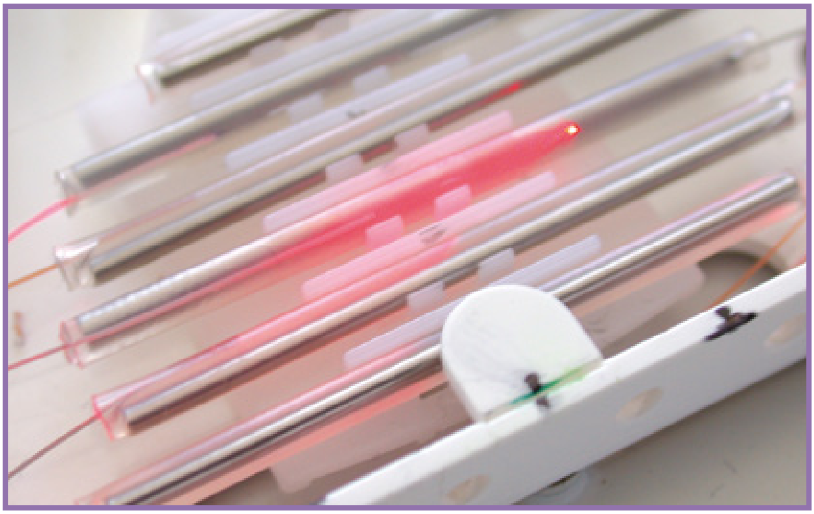
Visual fault locater

When you are going to find faults, it may be difficult to locate the fault itself. Therefore it may be very helpful to send visible light into the installation. If you then, subsequently, are able to see light coming out from the installation, you may have found a possible fault. The fault locater is good tool at finding some fault types, but less good at others. The bottom line is, that if you can see light from your light source coming out from the installation, then something is wrong.

Figure 14

Visual fault locator

Figure 15



In this photo you can actually see light coming out from the installation. The fault is a very bad splice.