Fiber Assembly Testing with the LOR-220

Introduction

Optical time-domain reflectometers are the standard tools for fiber optic testing in the telecommunication industry. An OTDR records the backscattered light intensity along the fiber under test. The resulting trace is a picture of the entire fiber revealing losses and reflective events as a function of the distance. All information required to characterize the fiber optic link, like fault locations return losses or insertion losses, can be easily extracted from the recorded trace. The OTDR technique has evolved since many years now, resulting in today's mature, high performance, and compact instruments. Unfortunately, these standard OTDRs, intended for telecom applications, are not very well suited for short distance, high resolution measurements. They were designed for distances of several kilometers with a resolution of several meters, whereas e.g. avionics fiber optic testing requires meter distances and centimeter resolution. In the following we present the specifications and a typical measurement session with the LOR-220; a novel OTDR specially designed for short range applications. The LOR-220 is based on photon-counting high-resolution technology. Nonetheless, the instrument is integrated in a lightweight, user friendly, field-portable platform.

Characteristics of the LOR-220

The most important technical parameters of an OTDR are the dynamic range, the spatial resolution and the dead-zones. The dynamic range is the difference between the highest Rayleigh backscatter level and the instrument's noise level. It reflects the instrument's maximum capability of total fiber loss measurement. Good telecommunication OTDRs achieve dynamic ranges of 40 dB or more but only at pulse durations of 10 µs (corresponding to a spatial pulse length of 1 km) or more. With short pulse-widths (< 2 ns), as required for short range fiber optics testing, the performance of conventional OTDRs is poor. We overcome this limitation by using photon-counting technique. This technique allows realizing high sensitivity optical detection (down to -100 dBm) and keeping at the same time the detection bandwidth above 2 GHz.

The dynamic range of the LOR-220 achieved with only 1 ns optical pulse-width is illustrated in Figure 1.

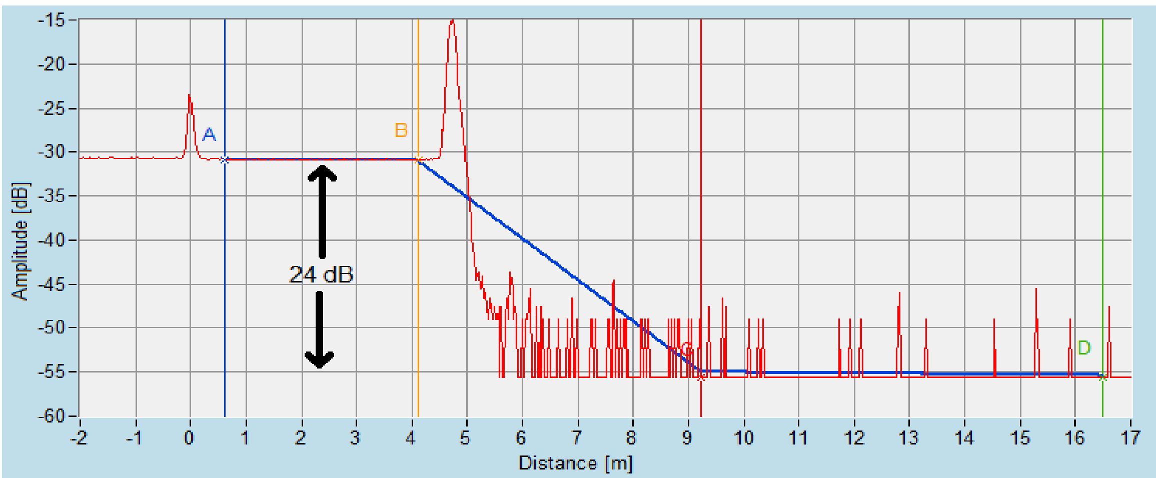


Figure 1: The Dynamic Range of the LOR-220

From the trace we find a dynamic range of 24 dB. This high dynamic range allows loss tests on fiber assemblies with a total loss of over 20 dB.

Even more important for short range fiber testing are the resolution and the dead-zone of the OTDR. The event dead zone indicates the minimum distance of two closely spaced events that can be separately resolved by the instrument. It is generally defined as the distance between one point on the rising edge of the peak, 1.5 dB below the maximum value, and the corresponding point on the falling edge (see Figure 1). The attenuation dead-zone indicates the minimum distance required after a reflective event to perform a loss measurement. It is defined as the distance between the rising edge of the peak and the position on the falling edge of the peak with an amplitude 0.5 dB above the Rayleigh backscatter level. Figure 2 shows a measurement of both dead-zones generated by the reflection of a typical FC/PC multimode connector (ORL= 50 dB). Note that the measurement is done on the output connector of the instrument. The measured trace of the LOR-220 can have a starting point even inside the instrument, making insertion losses at the output connector visible.

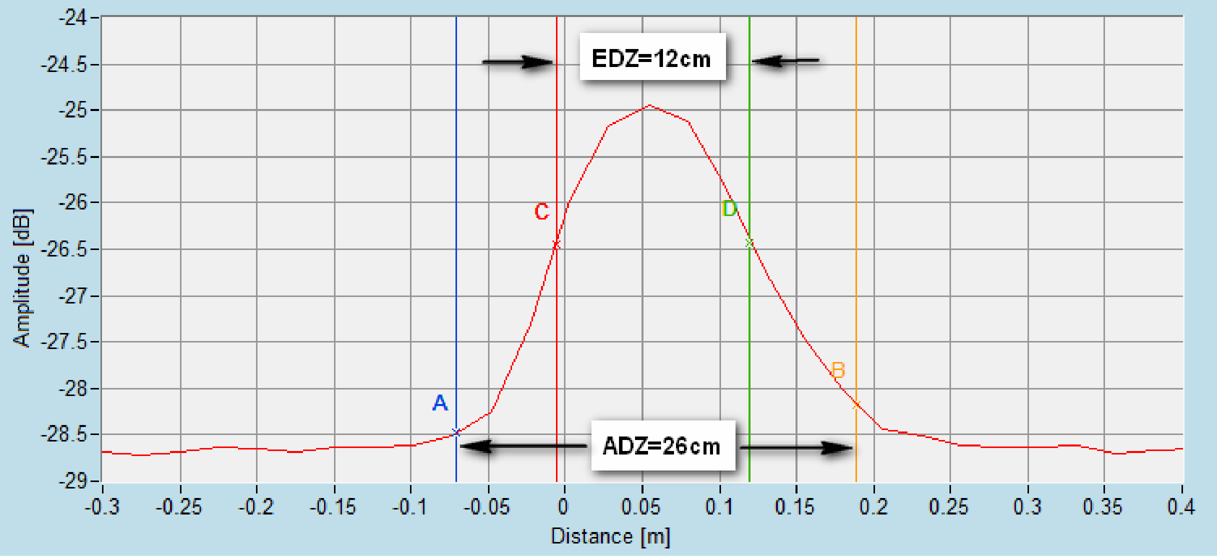


Figure 2: The dead-zones of the LOR-220. ORL = 50 dB. The measurement wavelength is 650 nm.

The short event dead-zone of only 12 cm and attenuation dead-zone of only 26 cm are optimally adapted for short range fiber optic testing as can be found for example in aircraft harnesses. A more detailed example measurement session can be found in the following section.

Testing a fiber assembly

In this section the LOR-220 is used to test a fiber assembly as illustrated in Figure 3.

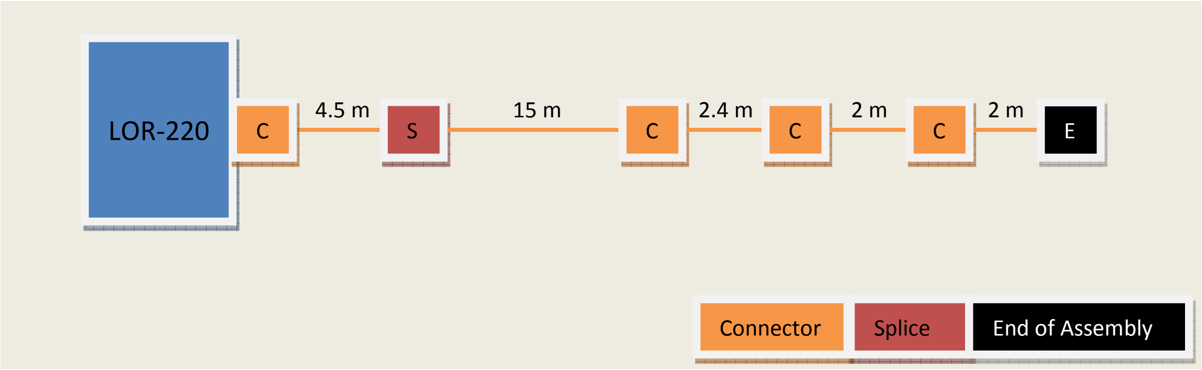
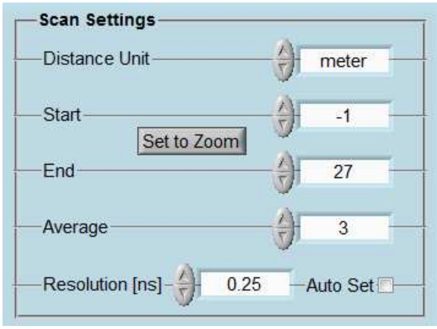
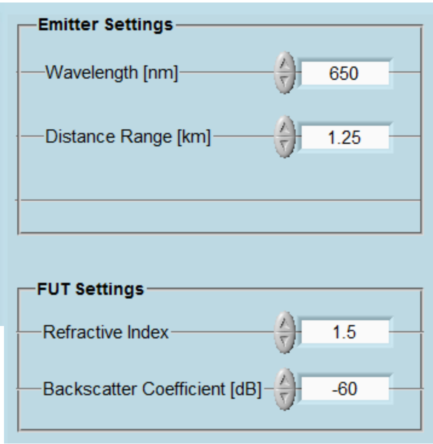


Figure 3: The fiber assembly under test. All fibers are graded index multimode fibers 62.5/125.

The LOR-220 is started with the settings as shown on the right. The *Start* position is set to -1. This way the recorded trace will also include a measurement of the insertion loss and the return loss at the instrument’s output connector. The *End* position of the trace is set to a value slightly longer than the total length of the assembly under test. An *Average* value of 3 has been chosen to ensure a precise, low-noise measurement. Higher values will further reduce the noise on the trace but will also increase the measurement time.





The recorded trace is shown in Figure 4. The textboxes contain the result of the various measurements that can be done with the LOR-220. From the trace we find: the total link loss, the insertion loss and the return loss at all connectors, bend losses, and splice losses and fiber breaks.

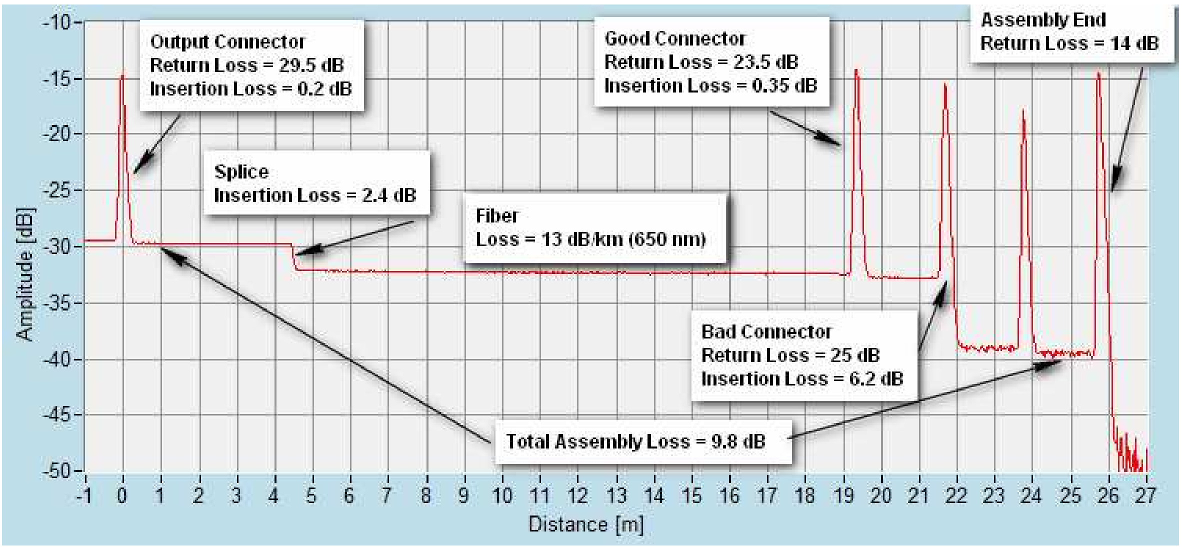


Figure 4: Total trace of the fiber assembly under test with some test results.

The LOR-220 software contains several tools to let the user carry out easily all the measurements listed above. Manual and automatic analysis tools are provided. An example of a manual insertion loss measurement is shown in Figure 5.

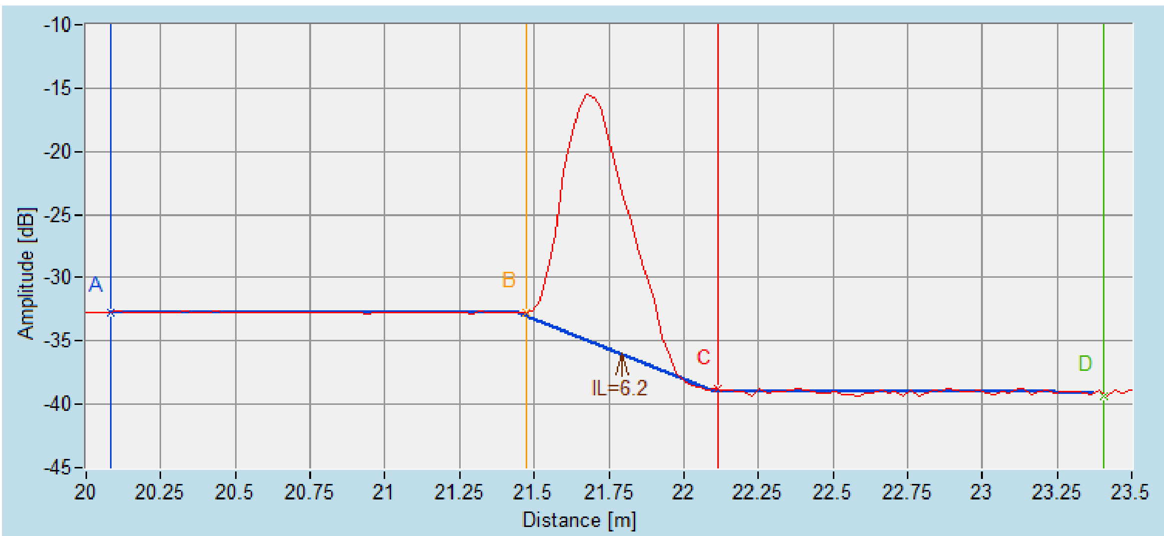


Figure 5: Insertion loss measurement with the LOR-220.

Select *Event Loss* form the measurement menu and simply set 2 cursors before and 2 cursors after the event. The application will do all the fitting and calculation of the insertion loss. The value can be added to an event table.

The fiber loss can be found in a similar way using the *Fiber Loss LMS* tool. Figure 6 shows another section of the total fiber assembly. Here the fiber loss is measured on a length of 10 m. A LMS line is automatically fitted to the data points between the two cursor positions, and the fiber loss is calculated. Note that since the total loss within this 10 m section is only 0.13 dB, the measurement cannot be very precise. For high precision fiber loss measurements longer sections should be tested.

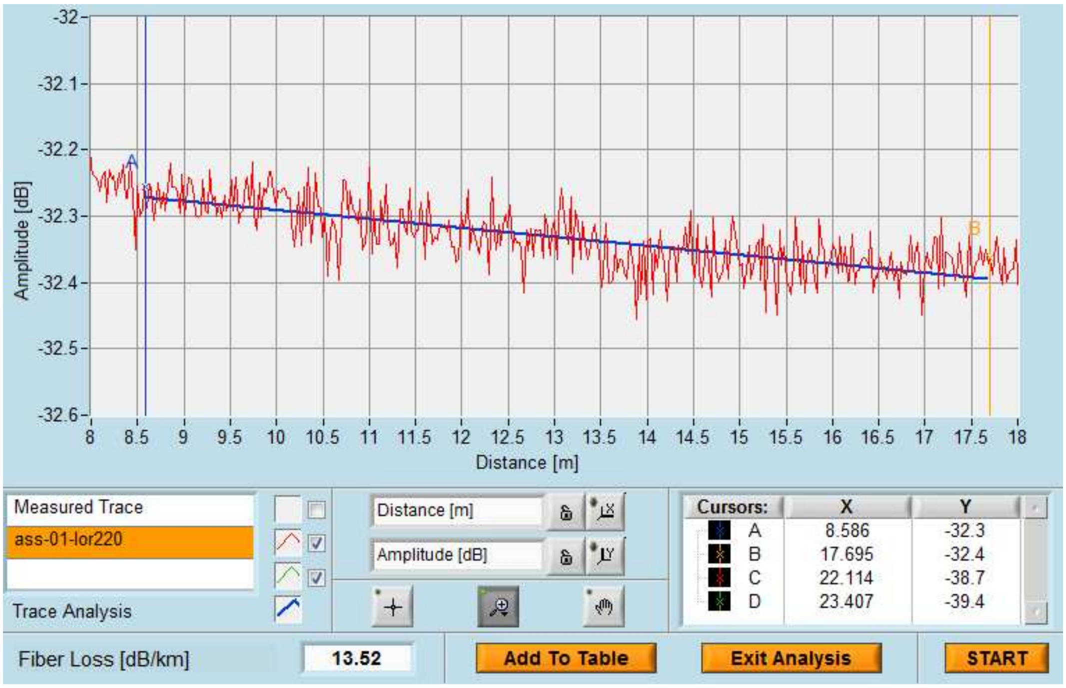


Figure 6: Fiber loss LMS measurement with the LOR-220.

The *Manual Peak* tool is used to find peak amplitudes and the optical return loss. Figure 7 is a detail of the fiber assembly showing the output connector at 0 m. The y-scale of the trace window is automatically changed to correspond to the reflected optical power. Here the measured optical return loss is 29.5 dB. Note that the indicated amplitudes on the trace are relative values compared to the emitted optical output power. In the presence of losses, the accumulated loss before the reflective event needs to be taken into account for local return loss calculations.

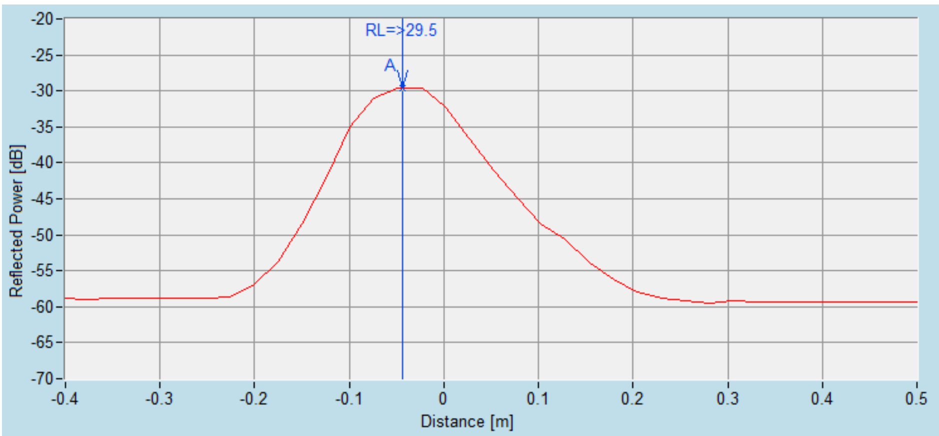


Figure 7: Return loss measurement with the LOR-220.

All measured values can be added to the event table. The table for the fiber assembly under test can be found in Figure 8.

Loaded Trace1: ass-01-lor220							
No.	Type	Location [m]	Reflectance [dB]	Insertion Loss [dB]	Attenuation [dB/km]	Cursor A [m]	Cursor B [m]
1	Reflection	-0.04	29.54			-0.04	
2	Event Loss	0.03		0.20		-0.61	-0.34
3	Event Loss	4.50		2.36		2.85	4.30
4	Fiber Loss	13.11			13.52	8.59	17.70
5	Reflection	19.33	23.52			19.33	
6	Event Loss	19.58		0.33		18.00	18.90
7	Reflection	21.68	25.0			21.68	
8	Event Loss	21.79		6.21		20.08	21.47
9	Reflection	23.75	18.2			23.75	
10	Event Loss	23.84		0.49		22.57	23.42
11	Reflection	25.74	14			25.74	

Figure 8: The event table for the fiber assembly under test.

Comparing Traces and Fault Location

The LOR-220 allows comparing the measured data with up to two previously saved reference traces. Comparing traces is very useful for troubleshooting and fault location as illustrated in Figure 9.

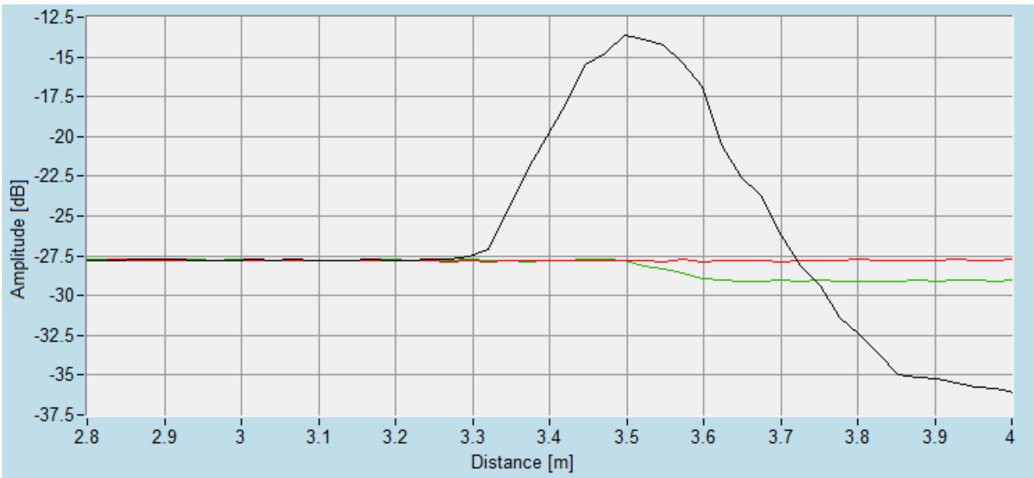


Figure 9: Fault locating with the LOR-220

The red trace serves as the reference data; a 1.2 m long fiber section with low losses is shown. The green trace shows the same fiber segment. Now an event at 3.5 meter is visible as a local fiber loss of 1.3 dB. In this case the loss was created by a fiber bend. The black trace is again the same fiber segment; now a fiber break is visible produced by further bending the fiber.

The LOR-220 allows locating and characterizing very precisely all kinds of faults in various types of fiber assemblies including single-mode and multi-mode fibers.

Überreicht durch:

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