

v-OTDR - High resolution OTDR

Application Note 4: Reflectance measurement

One of the most important applications of the high resolution OTDR is the measurement of the reflectance (R) of components or connectors¹. The advantage of this instrument is that it offers a spatially resolved measurement: each reflection can be seen and measured, even at short distances. In addition, the very low value of the Rayleigh Back Scattering (RBS) level, due to the short pulses used, allows the detection of very low reflectance levels, which cannot be seen with a standard OTDR (see AN 2)

In all cases, reflectance measurements are obtained by measuring the height between a peak and a flat level, as shown below.

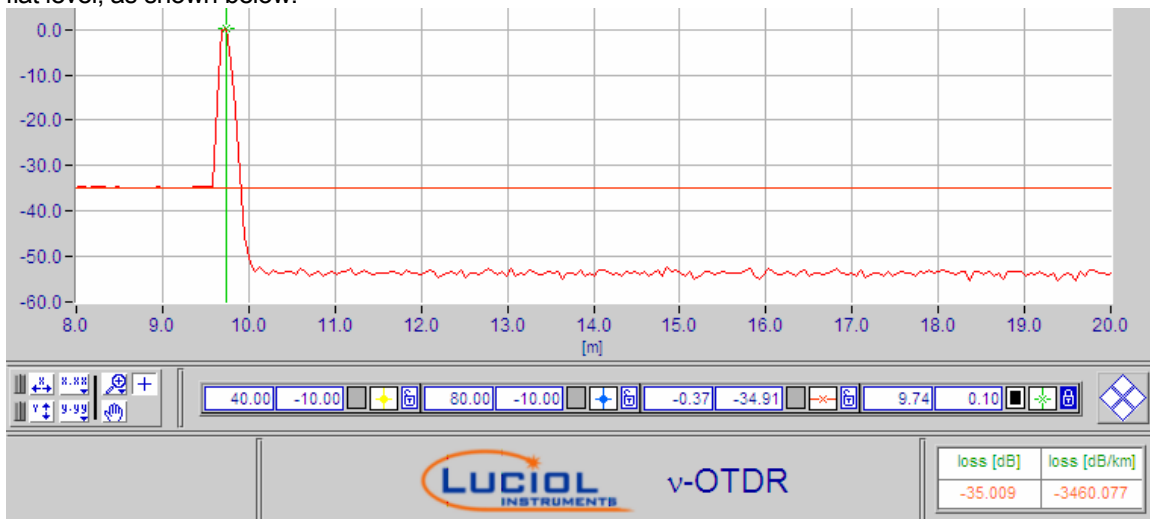




Figure 1: Use of the cursors for a reflectance measurement

Using the red and green cursors, the v-OTDR can give this height directly. One cursor has to be set on FREE and the cursor style has to be a horizontal line (). Bring this cursor to the flat level. The second cursor should be kept locked on the curve (), and brought to the highest point on the reflection. Use the MEASUREMENT menu and LOSS tag to get directly the height between the cursors, here 35 dB.

Depending on the value of the reflectance, there are two different solutions. For high reflectance ($R \geq -40$ dB), we can use a known reflection, such as a Fresnel reflection to calibrate the others. For low reflectance ($R \leq -40$ dB), we use the RBS as calibration.

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An example of a high reflectance measurement is shown below.

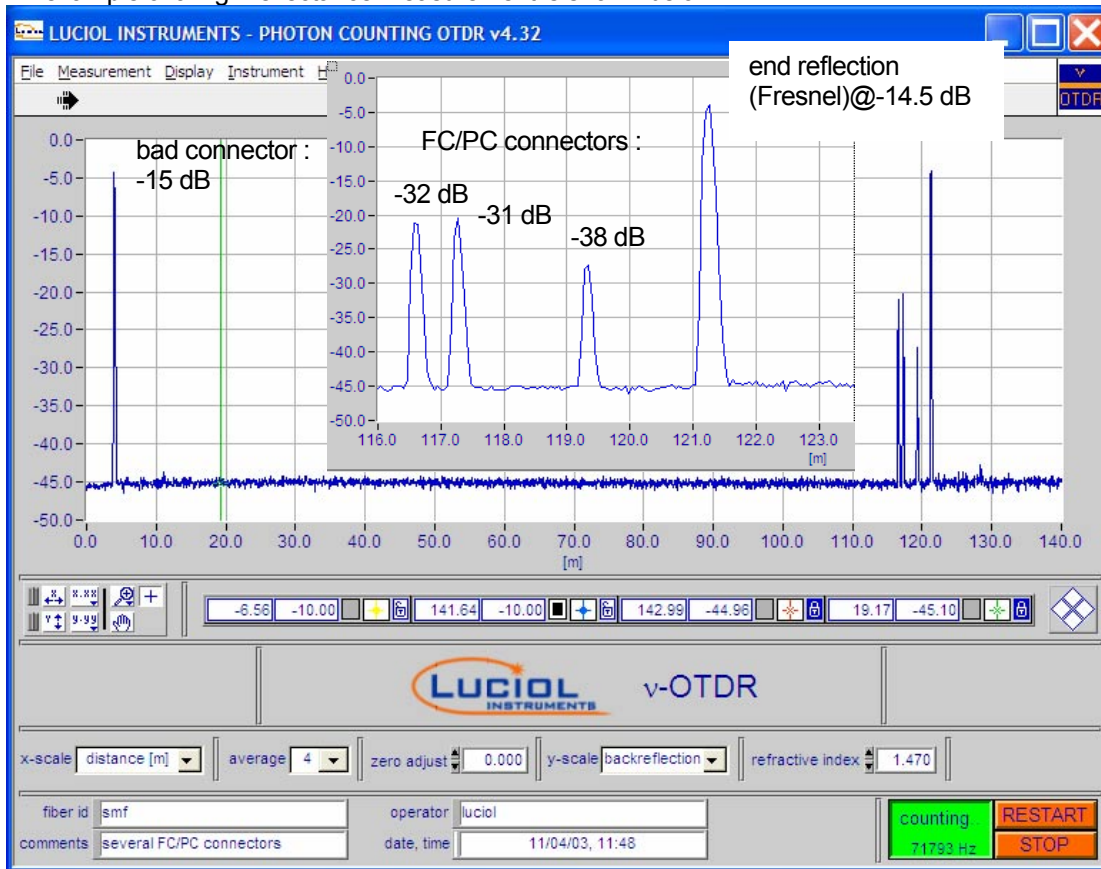


Figure 2: High reflectance measurement with a calibrated Fresnel reflection

This measurement represents a series of patchcords, with standard FC/PC connectors. The inset is a zoom of the end section, showing several connectors with greater details. The end reflection is a flat PC connector, leading to a Fresnel reflection (-14.5 dB). Note that the signal level after the end of the fiber is the same as within the fiber. This shows that we do not see the RBS inside the fiber, but only noise (see AN 3). As mentioned in AN 3, this is due to the fact that the Fresnel reflection (-14.5 dB) is more than 40 dB (the dynamic range of the instrument) above the RBS (around -81 dB). The only meaningful features of this trace are therefore the reflection peaks. As shown above, use the cursors to measure the height of each peak above the noise level. Then, using the end reflection as reference (-14.5 dB), one can infer the reflectance of each of the connectors. The first connector at 4 m has -15 dB reflectance, which is too high for a good FC/PC. This connector should be carefully checked and possibly replaced. Other connectors down the fiber, between 116 m and 120 m, have reflectance below -30 dB, which is more reasonable. Note that the front panel connector, at 0 m, is an APC connector: the reflectance is too low to see in this trace (it would be below the noise level).

This type of trace is useful to obtain information about the quality of the connectors, or to find a break in a fiber, which would be seen as a reflection. However, it cannot provide information about loss at an event. In fact, in order to measure the reflectance, one has to assume that loss at connectors is minimal, so that the end reflection can be used as a reference. The high resolution OTDR is thus better adapted for low reflectance measurement, where complete information about the fiber can be obtained.

A low reflectance measurement is shown below.

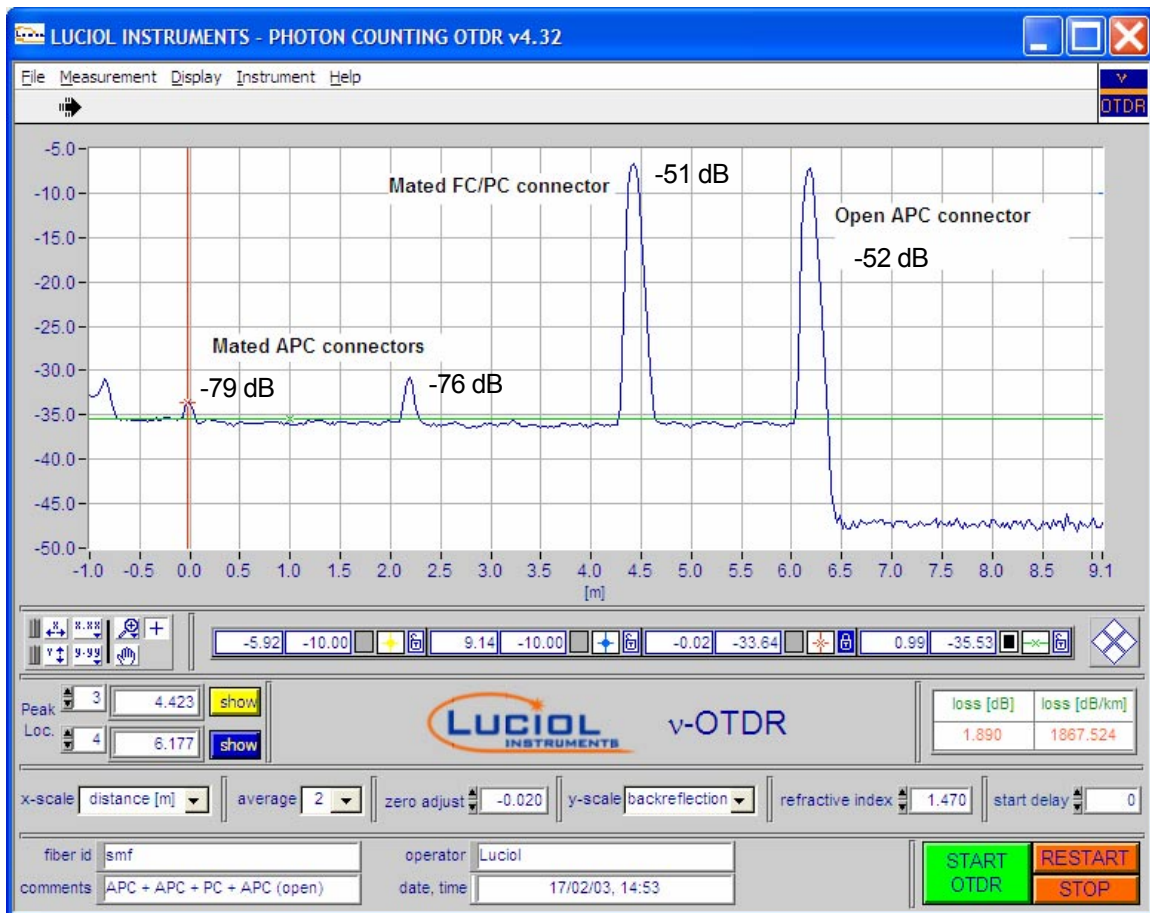


Figure 3: Low reflectance measurement using RBS level

Here the noise after the end of the fiber (from 6.5 m) is more than 10 dB below the signal in the fiber. This is the clear sign that the horizontal signal in the fiber is indeed RBS (see AN 3). In order to make reflectance measurements, the first step is to calibrate the RBS of the fiber used. This is explained in AN 2. Note however that, since the RBS is similar for most standard (G652) fibers, it is necessary to do this calibration only once. Typical value for the v-OTDR at 1550 nm is -81 dB. Measuring the height of the reflection with respect to the RBS immediately before thus gives a calibrated reflectance, as shown above.

In this case, it is also possible to measure the loss at the connector. The very weak RBS, due to the short pulses used, allow the measurement of very weak reflection, typically for mated APCs. This measurement is impossible with standard OTDRs, where the RBS value is much higher.

ⁱ In this AN, we shall use the terminology defined in Telcordia™ GR-196-CORE: the reflectance is the ratio of reflected power to the incident power at a reflection point. In dB units, this number is always negative. In contrast, the optical Return Loss (RL), is a property of the whole fiber link. It represents the ratio of the total power reflected to the incident power. In dB units, it is always a positive number.