Insertion Loss Measurement with the LOR-220: Comparison with OPM results

Introduction

The LOR-220 OTDR is a universal fiber optic testing tool. Insertion loss measurements are simplified by the single-ended test set-up and the automatic software analysis functions.
This document compares the results for insertion loss measurements with the results obtained from a two-sided measurement using a light source and an optical power-meter.
Several different causes leading to local insertion losses are investigated.

Test set-up

The set-up for the comparative measurements is shown in Figure 1:

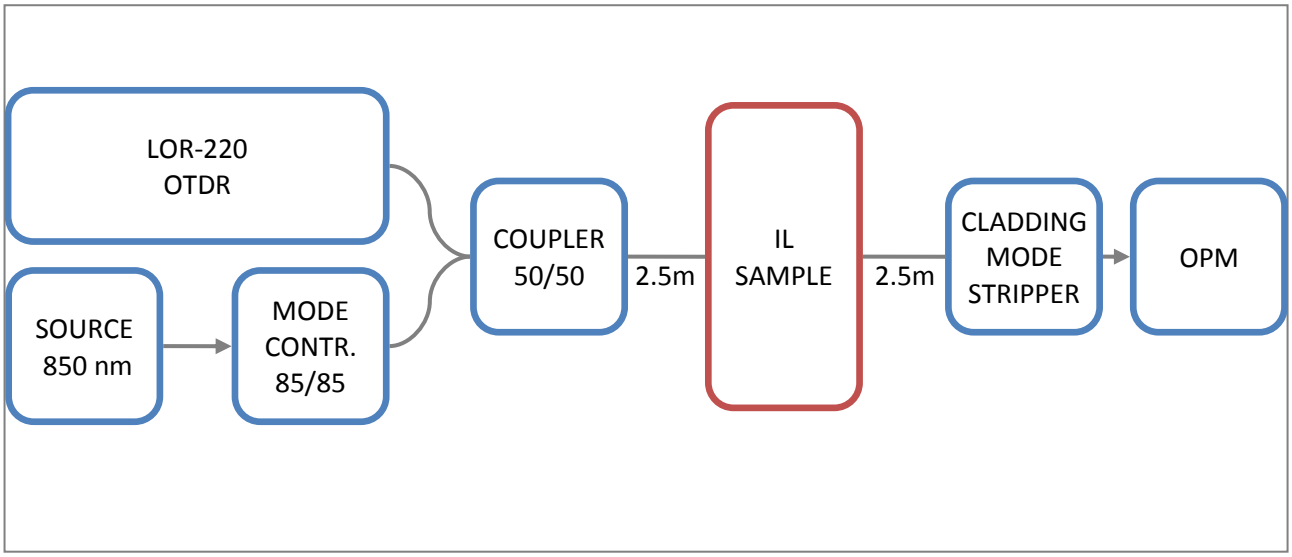

Figure 1: Test set-up

The modal distribution of the 850 nm light-source used for the measurements with the optical power meter (OPM, Tempo 557B) is controlled using an 85/85 mode controller (Arden Photonics MC-FC-62-E-85).
A 50/50 fiber coupler is used to direct alternatively the output of the OTDR or the light source to the insertion loss sample under test.
A cladding mode stripper (10x20mm loop) is used to prevent that light propagating in the fiber cladding reaches the OPM.
All fibers are 62.5/125 µm graded index multimode fibers.

Measurements and results

Fiber bend-loss

A typical reason for insertion losses is a sharp bend in the fiber. The comparative measurement procedure is the following:

- A reference power level is measured using the light source and the OPM (no bend loss)
- A single sharp bend is introduced in the fiber under test
- The difference to the reference power level is monitored with the OPM
- The light source is switched off and OTDR measurements are done under the same conditions
- OTDR settings:
    - Resolution 0.5 ns, Average 4
    - Wavelengths 670 and 810 nm
    - IL analysis with the single event function using fiber sections of 1.5 m before and 1.5 m after the event

Table 1: Results - bend loss

IL OPM [dB]	IL LOR 670 nm [dB]	IL LOR 810 nm [dB]
0.55	0.60	0.58
1.05	1.15	1.08
1.56	1.54	1.38
2.75	2.65	2.52

Dirty connector

A dirty connector is another typical reason for insertion losses in a fiber link. The comparative measurement procedure is the following:

- A reference power level is measured using the light source and the OPM (no connector loss)
- Dirt is deposited on the connector surfaces
- The difference to the reference power level is monitored with the OPM
- The light source is switched off and OTDR measurements are done under the same conditions
- OTDR settings:
    - Resolution 0.5 ns, Average 4
    - Wavelengths 670 and 810 nm
    - IL analysis with the single event function using fiber sections of 1.5 m before and 1.5 m after the event

Table 2: Results - dirty connector

IL OPM [dB]	IL LOR 670 nm [dB]	IL LOR 810 nm [dB]
0.40	0.37	0.36
1.8	1.78	1.76
4.1	4.11	4.05

Axially misaligned connectors

Mismatched connectors are another reason for insertion losses. Here we will investigate axial misalignments, i.e. an air gap between the two connector surfaces. The comparative measurement procedure is the following:

- A reference power level is measured using the light source and the OPM (no connector loss)
- The gap between the connector surfaces is increased
- The difference to the reference power level is monitored with the OPM
- The light source is switched off and OTDR measurements are done under the same conditions
- OTDR settings:
    - Resolution 0.5 ns, Average 4
    - Wavelengths 670 and 810 nm
    - IL analysis with the single event function using fiber sections of 1.5 m before and 1.5 m after the event

Table 3: Results - axial misalignment

IL OPM [dB]	IL LOR 670 nm [dB]	IL LOR 810 nm [dB]
0.70	0.81	0.73
1.15	1.29	1.26
2.1	2.41	2.30
3.0	3.43	3.23

Radially misaligned connectors

In this section we will investigate radial misalignments, i.e. the connector surfaces are in contact but the two axes are displaced. The comparative measurement procedure is the following:

- A reference power level is measured using the light source and the OPM (no connector loss)
- One fiber is displaced perpendicularly to the central axis
- The difference to the reference power level is monitored with the OPM
- The light source is switched off and OTDR measurements are done under the same conditions
- OTDR settings:
    - Resolution 0.5 ns, Average 4
    - Wavelengths 670 and 810 nm
    - IL analysis with the single event function using fiber sections of 1.5 m before and 1.5 m after the event

Table 4: Results radial misalignment

IL OPM [dB]	IL LOR 670 nm [dB]	IL LOR 810 nm [dB]
0.50	0.66	0.70
1.10	1.39	1.37
2.2	2.52	2.52
3.1	3.44	3.32
4.2	4.59	4.81

Conclusions

The comparative measurements confirm a good agreement between the results found by the two measurement methods. The difference is especially low for the two in practice most important cases: the bend loss and the dirty connector.
For misaligned connectors the OTDR seems to overestimate slightly the insertion losses. This might be due to a minor difference in the modal distribution between the two light sources. It is also possible that the OPM results are too low since some cladding mode light is still reaching the OPM even after the mode-stripper.