VTI SERVICES

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VTI Services Technical Bulletin (TB)
OTDR Measurement of Installed Optical Fibre Cabling
Permanent Links and Links

Text in *Blue Italics* is derived from the standards.

1. Applicability

The following applies only to telecommunication cabling installations in Australia and New Zealand using an Optical Time Domain Reflectometer (OTDR) for measurement of installed optical fibre links and permanent links, in accordance with AS/NZS 14763.3:2017.

2. Link definition

Permanent Link is horizontal cabling between the floor distributor and the telecommunications outlet. Link is any other cabling usually comprising a single fixed cable with connectors at each end. Hereinafter the word 'Link' is used to collectively describe both permanent links and links.

3. Summary

OTDR testing to AS/NZS 14763.3:2017 needs to show/report in both graphical and numerical form the test results for;

- attenuation of
  - the link
  - the local and remote test interface connections
  - any embedded components
- length of the link
- propagation delay of the link
- optical return loss of connecting hardware (ORL is not a requirement unless stated in the client's quality plan QP, AS/NZS 3080 Appn ZA5)

4. Conformance requirements for testing

The following requirements apply to OTDR testing to achieve conformance to AS/NZS 14763.3:2017 and conformance to AS/NZS 3080.

4.1. Test equipment

Launch and tail cords shall be longer than the dead zone of the tester.
Launch cord should be least 75m for MMF [1] and 150m for SMF. [2]
Tail cord should be least 75m for MMF and 150m for SMF. [3]

OTDR characterisation using launch cord only is not permitted in the test standard.

The connector hardware on the launch and tail cords interfacing to the cabling under test shall be reference connectors with correct end face geometry. The attenuation between two reference connectors shall be no greater than 0.10 dB (MMF) and 0.20 (SMF). [4]

The OTDR tester itself must provide the specified launch modal distribution for MMF (e.g. meet Encircled Flux requirements). Otherwise, add a suitable mode controlling device at the OTDR-end of the launch cord.[5]

4.2. Wavelength of measurement

Attenuation measurements [6] (and return loss if specified in the QP) shall be done at;

- MMF, 850 nm and 1300 nm
- SMF, 1310 nm and 1550 nm

There are no standard's requirements to measure at other wavelengths.

4.3. Direction of measurement

OTDR testing of link attenuation using a launch cord and tail cord is obtained by measuring in both directions and averaging the results. This is not necessary where the link contains a single length fixed cable and terminating connectors only and where the scattering characteristics of the optical fibre within the launch and tail cords are the same. [7]

When OTDR testing the attenuation of cabling components (local and remote connections) the cabling under test shall be tested in both directions. [8]

When OTDR testing in two directions the attenuation measurements are derived by averaging the associated bi-directional test results. [9]

Optical Return Loss (ORL) results (when specified in the QP) are not averaged; the worst result from either direction is to be reported.

If the link contains any embedded connections (e.g. Consolidation Point, connector or splice), bi-directional testing shall be done at both wavelengths

5. OTDR test method

The OTDR optical source shall be selected for the mode and wavelength required and appropriate settings established for range, pulse width, index of refraction (IOR), and averaging time. Annex C (Informative) of AS/NZS 14763.3:2017 sets out the operational capabilities and limitations of optical time domain reflectometry.

All connectors should be inspected and cleaned as necessary before each and every individual test.

Prior to (and at regular times during) *OTDR attenuation testing the reference connectors on the launch and tail test cords shall be mated to verify* and record *the quality of the connection.*[10]

Connect the test equipment to the cabling under test as per Figure 5.1 below using a launch test cord (LTC) and a tail test cord (TTC).

The OTDR trace should clearly show the attenuation elements and the length of the link. The accompanying tables or numerical values (both not shown in Fig 5.1) should indicate the attenuation (and optical return loss if specified in the QP) of connecting hardware.

During ORL testing, a variable attenuator between the OTDR and the cabling under test may be required to reduce the optical power to a level that does not saturate the OTDR receiver. See Item 7.

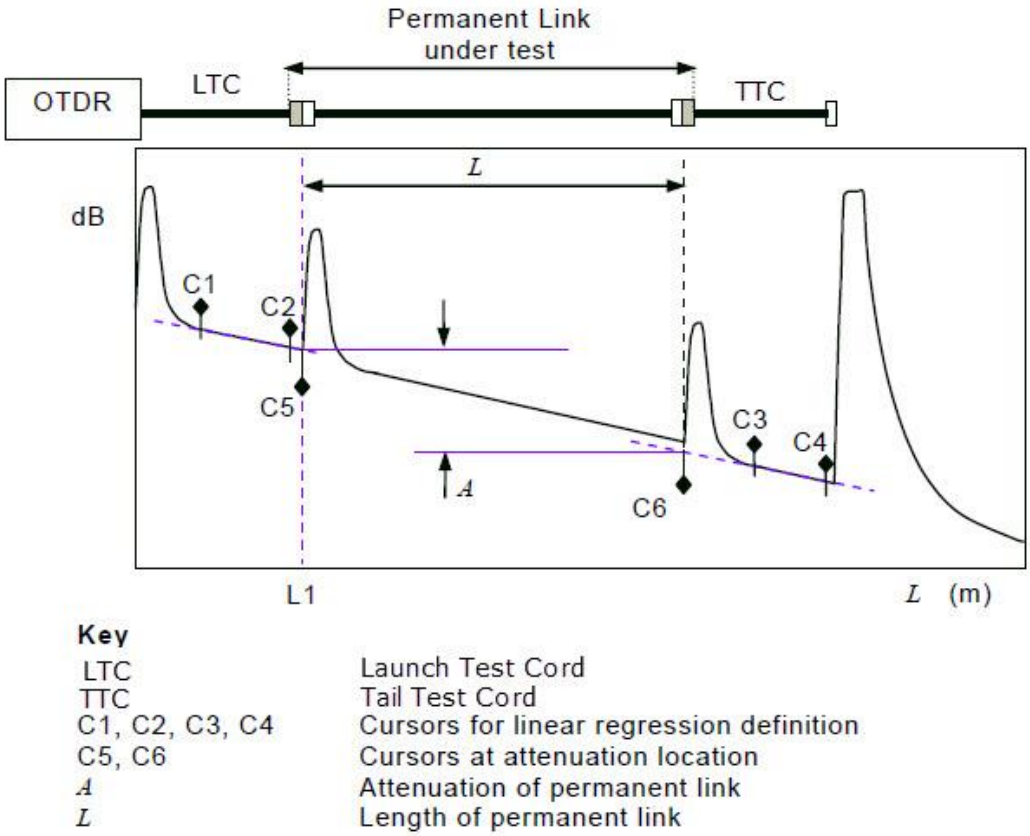

Figure 5.1 OTDR equipment set-up and one-direction trace of link attenuation
Note: There are no pigtail (spliced) terminations in this trace.

6. Treatment of attenuation test results

Compliance to AS/NZS 3080 requires the OTDR attenuation test results be compared to the PASS Limit (the sum of all the components in the link) to determine an overall PASS or FAIL.

The PASS Limit based on components is calculated from;

MMF Limit = (2 x 0.5 dB) + Σ (cable attenuation) + Σ (embedded connector attenuation)
SMF Limit = (2 x 0.65 dB) + Σ (cable attenuation) + Σ (embedded connector attenuation)

In addition the calculated PASS Limit based on components, the client may also have an Application PASS Limit. The lower of these two limits will determine the overall PASS or FAIL.

Allowable attenuation values
Table 6.1 below sets out the allowable attenuation values to be used in the calculation of the component PASS Limit and for each hardware connection.

Application Pass Limits should be obtained from the client or from the relevant application standard.

Table 6.1 Allowable component attenuation values

Component and Wavelength	**AS/NZS 14763.3:2017 Attenuation (Loss)** Maximum
Mated Ref to Ref Connection at 850 & 1300 nm at 1310 & 1550 nm	 MMF 0.10 dB SMF 0.20 dB
Mated Ref to Non-Ref Connection at 850 & 1300 nm at 1310 & 1550 nm Non-Ref to Non-Ref at all w'lengths	 MMF 0.50 dB (new value) SMF 0.65 dB (new value) MMF & SMF 0.75 dB
Splice at 850 & 1300 nm and at 1310 & 1550 nm	 0.30 dB
MMF All multimode fibres at 850 nm at 1300 nm	 3.50 dB/km 1.50 dB/km
SMF at 1310 & 1550 nm OS1 OS2	1.0 dB/km 0.4 dB/km

Ref = Reference Connector Non-Ref = Non-reference (embedded) Connector

7. Treatment of ORL for connecting hardware (if specified in the Quality Plan)

The optical return loss (ORL) of cabling components is calculated by the tester from the heights of the reflected event peaks. Any peak saturation (indicated by a horizontal flat line at the peak) will result in incorrect ORL results.

The terms 'Return Loss and ORL' are sometimes expressed by some OTDR manufacturers as 'Reflectance' with a negative sign.

Allowable ORL values
To determine an overall PASS or FAIL for the link, the ORL of each component shall be not greater than the allowable ORL value shown in Table 7.1.

Table 7.1 Allowable return loss values

Component at Both Relevant Wavelengths	**Grade***	**IEC 61755-2-1 &-2 Return Loss** Minimum
Connectors SM APC	 1	 60 dB mated 55 dB unmated
SM PC MM PC	3 -	35 dB 20 dB (ISO/IEC 11801)

* Grades are defined in IEC 61755-2-1 & -2 for SM connectors
For SM PC:- A Grade 3 connector allows 2 (≤1 um) scratches and 3 (≤1 um) pits within Zone A.
A Grade 2 connector allows 0 scratches and 0 pits within Zone A.
A higher quality Grade 2 connector would have an ORL min of 45 dB.
Zone A is the central 25 um dia end-face circle and includes the core & cladding.

8. Propagation delay

Propagation delay must be reported as part of the documented results for compliance to AS/NZS 3080. If the OTDR tester results do not report propagation delay, it must be calculated and recorded in the final test report. Submission of an OTDR trace without a propagation delay record makes the whole test results non-compliant.

Propagation Delay = (Cable Length, L x 5) nano-seconds

9. Mated connections in close proximity

Mated connections in close proximity within the dead zone of the OTDR *shall be deemed to be two mated connection interfaces when determining the optical attenuation budget.* [11]
E.g. applies to MPOs, Stub connectors, Spliced Pigtails.

The optical return loss of two or more mated connections within the OTDR event dead zone shall be that of a single mated connection. [12]
E.g. applies to MPOs, Stub connectors, Spliced Pigtails.

A link containing connections in close proximity must be tested in both directions and at both wavelengths.

References

[1] AS/NZS 14763.3:2017 Clause 6.3.3.6 b)
[2] AS/NZS 14763.3:2017 Clause 6.3.3.6 b)
[3] AS/NZS 14763.3:2017 Clause 6.3.3.7 b)
[4] AS/NZS 14763.3:2017 Table 3
[5] AS/NZS 14763.3:2017 Clause 6.4
[6] AS/NZS 14763.3:2017 Clause 8.3
[7] AS/NZS 14763.3:2017 Clause 6.2.2 e) & 9.1.2.3
[8] AS/NZS 14763.3:2017 Clause 6.2.2 d)
[9] AS/NZS 14763.3:2017 Clause 6.2.2 f)
[10] AS/NZS 14763.3:2017 Clause 9.1.2.2
[11] AS/NZS 4763.3:2017 App ZZ2 CL 9.1.1.8
[12] AS/NZS 14763.3:2017 App ZZ2 CL 10.4.2