Options for testing and certification of fibre optic cabling

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Fibre certification comes in two flavours

Field certification of fibre optic cable is critical to ensure that cabling performance supports the demanding requirements of today's high-bandwidth applications. Allowable signal loss can be so low that seemingly small issues can cause excessive errors in network transmission. Field certification has two tiers that define the measurements which are performed on installed fibre. Tier 1 and Tier 2, which utilise different types of test equipment to characterise the performance of fibre cabling. Additionally, the test limits used to determine pass/fail performance can be cabling-based to support a broad range of applications (network speeds), or application specific to check the fibre's ability to support specific speeds of network equipment.

Tier 1 certification

Tier 1 certification documents the insertion loss and length of the cabling. Insertion loss is also known as attenuation, which is the total amount of power lost across the link. It is measured using a light source and power meter (Optical Loss Test Set – OLTS), where a known amount of light is injected into one end of the fibre and the power is measured at the other end. The difference between the two power levels is the insertion loss which is displayed in dB (decibels). An OLTS can be a stand-alone device, or more commonly it is a set of modules that is added to a copper cable certifier.

Fibre loss limits

The ISO and TIA standards bodies have defined dB allowances for fibre loss, connections, and splices. These three components comprise the cabling system and the values are used to calculate a loss budget, which is the maximum amount of loss allowed for the link to pass certification. Calculating the loss budget is a matter of multiplying the length of the cable by its attenuation coefficient which determines the maximum loss for the fibre, then summing up the number of adapters/connections and splices to arrive at the total allowable link loss.

The complication with calculating a loss budget is that it changes depending on the length of the fibre under test. Short fibres have less loss than long fibres. To calculate the budget, the technician needs to know the length of the fibre that is being tested. Therefore, a certifier that measures length is preferred over one that does not. Such a certifier first tests the fibre to measure its length, then it calculates the loss budget using the length measurement. The technician only needs to input the number of connections and splices into the budget calculator to arrive at the total allowable loss.

Cabling loss budgets are application agnostic, meaning they are not designed to support any particular network speed, such as 40 Gb/s. Instead, they are based on the maximum allowable losses for the components as defined by ISO and TIA standards, and it is assumed that an application will run on the installed cabling if its loss is within budget.

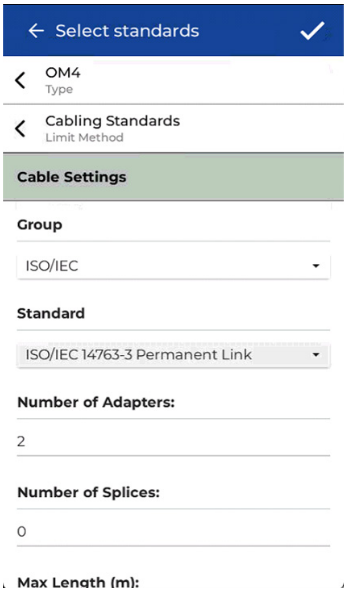

Figure 1: Loss budget setup screen on FiberTEK IV Tier 1 certifier

When the speed of the networking equipment that is going to be run over the fibre is known, a test limit based on application standards can be used instead. For Ethernet these would be limits for 10 Gigabit, 25 Gigabit, 40 Gigabit, 100 Gigabit, etc. Application limits define the maximum insertion loss and length values for that type of optical transceiver. Testing fibre cabling with application limits is not typical for cabling installers as they do not usually know what networking equipment the end-user is going to run on the fibre. However, in cases where the network designer knows what application is intended to run on the fibre, they can instruct the cabling installers which test limits to use. Or network owners who perform their own cabling moves/adds/changes and have access to test equipment can measure the loss to ensure it is appropriate for their network.

Multimode Ethernet Applications	Fiber Type	62.5/125 µm		50/125 µm		850 nm laser-optimized 50/125 µm			
	Fiber Standard	TIA 492AAAA (OM1)		TIA 492AAAB (OM2)		TIA 492AAAC (OM3)		TIA 492AAAD (OM4)	
	Nominal wavelength (nm)	850	1300	850	1300	850	1300	850	1300
Application	Parameter								
Ethernet 10/100BASE-SX	Channel attenuation (dB)	4.0	-	4.0	-	4.0	-	4.0	-
	Supportable distance m (ft)	300 (984)	-	300 (984)	-	300 (984)	-	300 (984)	-
Ethernet 100BASE-FX	Channel attenuation (dB)	-	11.0	-	6.0	-	6.0	-	6.0
	Supportable distance m (ft)	-	2000 (6560)	-	2000 (6560)	-	2000 (6560)	-	2000 (6560)
Ethernet 1000BASE-SX	Channel attenuation (dB)	2.6	-	3.6	-	-	-	-	-
	Supportable distance m (ft)	275 (900)	-	550 (1804)	-	Note 1	-	Note 1	-
Ethernet 1000BASE-LX	Channel attenuation (dB)	-	2.3	-	2.3	-	2.3	-	2.3
	Supportable distance m (ft)	-	550 (1804)	-	550 (1804)	-	550 (1804)	-	550 (1804)
Ethernet 10GBASE-S	Channel attenuation (dB)	2.4	-	2.3	-	2.6	-	2.9	-
	Supportable distance m (ft)	33 (108)	-	82 (269)	-	300 (984)	-	400 (1312)	-
Ethernet 10GBASE-LX4	Channel attenuation (dB)	-	2.5	-	2.0	-	2.0	-	2.0
	Supportable distance m (ft)	-	300 (984)	-	300 (984)	-	300 (984)	-	300 (984)
Ethernet 10GBASE-LRM	Channel attenuation (dB)	-	1.9	-	1.9	-	1.9	-	1.9
	Supportable distance m (ft)	-	220 (720)	-	220 (720)	-	220 (720)	-	220 (720)
Ethernet 40GBASE-SR4	Channel attenuation (dB)	-	-	-	-	1.9	-	1.5 2	-
	Supportable distance m (ft)	-	-	-	-	100 (328)	-	150 (492)	-
Ethernet 100GBASE-SR4	Channel attenuation (dB)	-	-	-	-	1.9	-	1.9	
	Supportable distance m (ft)	-	-	-	-	70 (230)	-	100 (328)	
Ethernet 100GBASE-SR10	Channel attenuation (dB)	-	-	-	-	1.9	-	1.5 2	-
	Supportable distance m (ft)	-	-	-	-	100 (328)	-	150 (492)	-

Figure 2: Summary of Ethernet fibre applications and allowable insertion loss and fibre length

As the fibre application table shows, the allowable insertion loss for high bandwidth applications is quite low. The 100GBase-SR10 application allows just 1.5 dB of total loss. To put that into perspective, the ISO/TIA standards allow a maximum loss for a connection of 0.75dB. With a connection on each side of the link (totalling 1.5dB), the fibre would be allowed no loss for the link to stay within the maximum allowed by the application. Meaning the connection losses need to be less than the standard allows to account for any loss in the fibre itself.

Tier 2 certification

Tier 2 certification adds and OTDR test to the OLTS test used for Tier 1 certification. It is not performing an OTDR test instead of an OLTS test. This is a common point of confusion in the industry. An OTDR is an optical time-domain reflectometer, and it is a device that injects pulses of laser light into a fibre, then measures the time and intensity of light that is reflected back to the OTDR. Think of it as radar for fibre. The OTDR can "see" events on the link such as connections and splices and measure their loss. This allows the user to identify components in the link that are causing excessive loss. It can also measure the loss of the fibre itself to identify the location of bends or kinks in the cable that introduce loss into the system.

Historically, due to their cost and complexity of operation, OTDRs were used in local area networks only to find faults in the cabling. They were not used to document a new cabling installation. In the past 5-10 years OTDR's have become more affordable and easier to operate, allowing practical use to document any fibre installation. The benefit of Tier 2 certification with an OTDR is that each component of the fibre cabling can be tested against industry standards, providing a more comprehensive test of the system. With an OTDR report, network designers can rest assured that all of the points of failure in the cabling have been tested and meet specifications.

An OTDR result can be presented in three different ways. Traditionally a "trace" is generated, which is a plot with the optical power on the y-axis and the distance from the OTDR on the x-axis. The trace depicts the loss of power along the length of the fibre, and an experienced user can interpret the data to identify events on the fibre and decide if the links meets specifications. When there are faults, the trace can also be used to identify their severity and location.

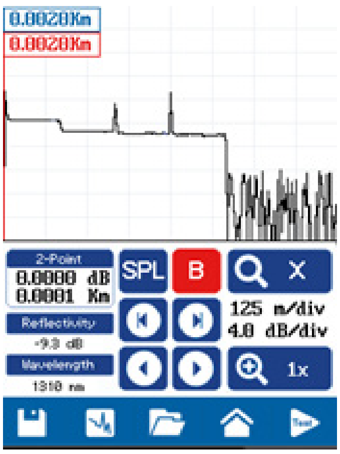

Figure 3: OTDR trace featuring a splice and two connections

The second data presentation is an event table. The event table is a list of each connector, splice and section of fibre with their associated distance and loss. The event table allows the operator to quickly scan the list to check the status of each event on the link. If the OTDR allows the user to select an industry test standard, the event table will typically identify whether each event passes or fails the requirements of the standard.

The third and newest data presentation is commonly called a link map. A link map is a linear block diagram of the events on the link with a symbol that represents each connection and splice. The symbols will identify the distance and loss of each event on the link and may be color coded to allow for quick identification of the pass/fail status of each event. The graphical representation of the link events is easy for inexperienced OTDR users to interpret, and fault location is much more intuitive compared to the trace or event table presentations.

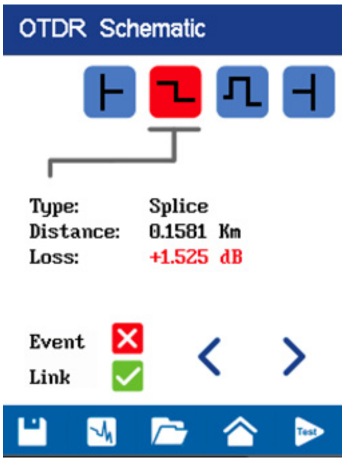

Figure 4: OTDR link map identifying a failing splice

Don’t settle for the minimum

Tier 1 certification is considered the minimum requirement by ISO and TIA standards for fibre cabling installation. A Tier 1 certification ensures that the total loss and length of the link meets the standards, but it does not identify whether each component is within specifications. Tier 2 certification, by adding the OTDR measurement provides the most thorough test of the link and can identify individual components that exceed specifications. Such insight allows the installer to correct potential failure points before the network is turned over to the owner/operator. While OTDR testing may have been prohibitively expensive and difficult in the past, that is no longer the case. Tier 2 certification should be considered by every network designer for the best peace of mind.

Figure 5: FiberTEK Tier 1 Certifier and FiberMASTER OTDR Tier 2 Certifier

Learn more about fibre optic cable testing and certification at www.trend-networks.com.