

# Demystifying Fiber Test Methods – Back to Basics

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## Overview

The methods used for measuring attenuation of installed optical fiber with a light source/power meter (LSPM) are well documented in many standards. Some describe how to test a link. Some describe how to test a channel. Link and channel attenuations are measured using the procedures specified in various Standards (see Table 1). Frequently, test methods, especially for special cases, can be confusing. The purpose of this article is to help clarify how and when to use the various test methods.



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## Permanent Link and Channel

The permanent link reference plane includes the attenuation of the installed fiber and the attenuation of the two connections on either end. The link can include other connections and splices. The attenuation of the equipment cords is not included since the equipment cords are not used during the reference or attenuation measurement (see Figure 1).

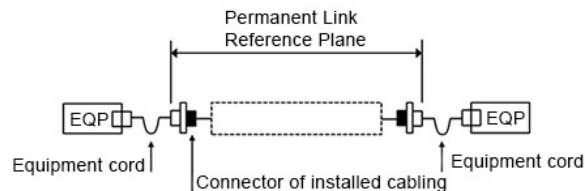


Figure 1. Permanent Link Reference Plane

The channel reference plane includes the attenuation of the installed fiber, connections, splices, and the attenuation between the equipment cords and the installed cabling which in most cases is the permanent link. The channel does not include the attenuation of the equipment cord connections coupled to the equipment (see Figure 2).

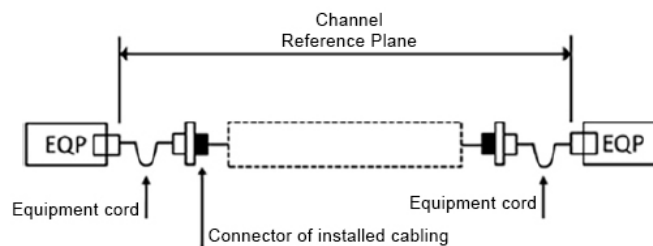


Figure 2. Channel Reference Plane

## Cabling Configurations

Cabling configurations can take on these known forms:

- Adapters or sockets on both ends of the cabling
- Plugs on both ends of the cabling
- Plug on one end, adapter on the other end of the cabling
- Plugs on both ends of the cabling using equipment cords

There are five unique test methods that can be used to test the four cabling configurations:

- One-cord method
- Two-cord method
- Three-cord method
- Enhanced three-cord method

- Equipment cord or channel method

The one-cord method is used for permanent link testing and calls for the launch cord to be attached directly to the power meter for the reference and assumes the power meter has an interchangeable adapter. It is used when the cabling under test has adapters or sockets on both ends of the cabling. The one-cord method is always the preferred method when possible because it has the lowest measurement uncertainty.

The two-cord method is used for permanent link testing and can be used for two cabling configurations. First, when there are plugs on both ends of the cabling. And second, when there is a plug on one cable end and an adapter on the other end. The two-cord method essentially measures the cabling but only one end connection.

The three-cord method excludes the attenuation of both connections to the cabling under test. It may be used when pigtailed are spliced onto both cable ends and directly connected into transmission equipment. This method may also be used for channel testing when better methods are not practical.

The enhanced three-cord method includes the attenuation of both connections to the cabling under test and can be used for link measurements. This method can be used for permanent link measurements when the connectors on each end of the cabling are different from each other, making the one-cord method difficult.

The equipment cord/channel test method is used when equipment cords are installed on both ends of the cabling and are awaiting connection to transmission equipment. This method is used for channel attenuation measurements. This method has lower uncertainty than the three-cord method but can be more difficult to use.

Table 1 summarizes the known attenuation measurement standards for installed optical fiber cabling, their test methods, and most importantly, when they should be used. A careful study of the table will reveal over-lap between standards. The one unique test method that is specified in only one standard is the enhanced three-cord method.

Test Methods Defined by Standards			
Standard	Test Methods	When Used	Comment
TIA-526-14-C, adaption of IEC 61280-4-1, edition 2	One-cord	Required test method for links when adapters are attached to plugs or sockets at both ends of the cabling.	
	Two-cord	Required test method for links with mixed connectors on both ends of the cabling, where one end is terminated with an adapter and the other end is terminated with a plug	
	Three-cord	Required test method for links with plugs on both ends of the cabling.	
IEC 61280-4-1, edition 3 in revision	One-cord	Required test method for link when adapters are attached to plugs or sockets to both ends of the cabling.	Assumes the connector on the power meter is compatible with the cabling under test into which the launch cable is connected (power meter has interchangeable adapter).
	Two-cord	Required test method for links that have plugs on both ends of the cabling; Required test method for links with mixed connectors on both ends of the cabling, where one end is terminated with an adapter and the other end is terminated with a plug	
	Three-cord	Link testing as the alternate method for the one-cord, three-cord, and equipment cord methods.	
	Equipment-cord	Required test method for links with plugs on both ends of the cabling utilizing equipment cords	Mostly a variant of the 1-cord method.

TIA-526-7, adoption of IEC 61280-4- 2, edition 2	One-cord	Required test method for link when adapters are attached to plugs or sockets to both ends of the cabling.	Straight adoption, no adaptation so contents from IEC 61280-4-2 are the same.
	Two-cord	Required test method for links with mixed connectors on both ends of the cabling, where one end is terminated with an adapter and the other end is terminated with a plug	
	Three-cord	Required test method for links with plugs on both ends of the cabling.	
TIA-568.3-D	As specified in TIA 526-7 and TIA 526-14.	Channel testing should use the three-cord method as defined by IEC standards, not ISO/IEC test standard.	One-cord method is preferred for both multimode and single-mode links.
ISO/IEC 14763-3, edition 2	One-cord	Link attenuation when the cabling under test has the same interface as the power meter; measures the permanent link.	Amendment in process
	Enhanced three-cord	Link attenuation when the cabling under test has different connectors on each end of the cabling; measures the permanent link.	
	Channel	Channel attenuation using equipment (customer) cords excludes connections to equipment (transceivers); measures the channel.	
ARINC 805	One-cord for multimode and single-mode	Required test method	Based on TIA-526-7 (SM) and TIA-526-14 (MM)

Permanent link test includes the attenuation of both connections on each end of the cabling under test. Channel test does not include that connection attenuation between the equipment cord and transceiver.

## One-Cord Method

- a. Set a reference between the light source and power meter using the launch cord (see Figure 3).

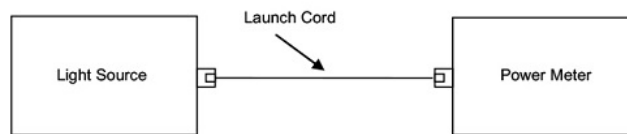
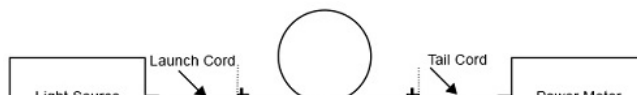


Figure 3. Set the reference

- a. Attach a tail cord to the power meter.
- b. Attach the launch cord and tail cord to the cabling under test (see Figure 4).
- c. Make the measurement and compare to the reference measurement



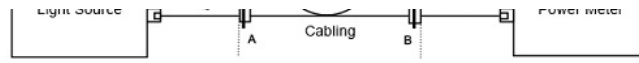


Figure 4. Measure attenuation of cabling, A connection, and B connection

## Two-Cord Method

a. Set a reference between the light source and power meter using the launch and tail cord (see Figure 5).

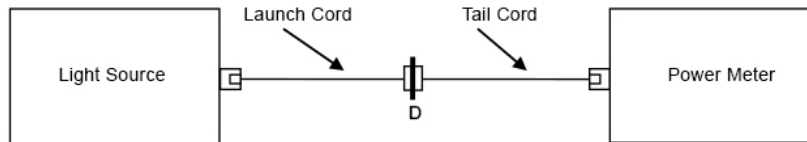


Figure 5. Set the reference

b. Make the measurement and compare to the reference measurement (see Figure 6a and Figure 6b).

c. For case 2, an adapter cord becomes part of the launch cord (see Figure 6b)

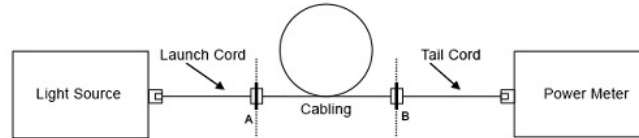


Figure 6a. Measure attenuation for case 1 (plug-adapter and plug on cabling ends)

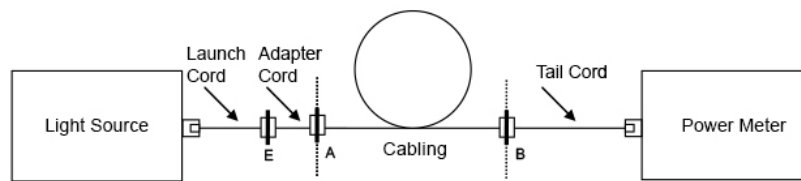


Figure 6b. Measure attenuation for case 2 (both ends of cabling are socketed)

## Three-Cord Method

a. Set a reference between the light source and power meter using the launch cord, substitution cord, and tail cord (see Figure 7).

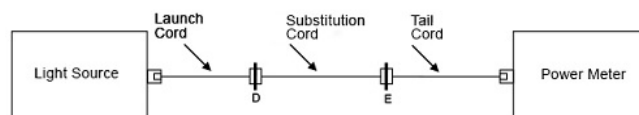


Figure 7. Set the reference

- a. Remove the substitution cord and replace with the cabling under test.
- b. Make the measurement and compare to the reference measurement (see Figure 8).

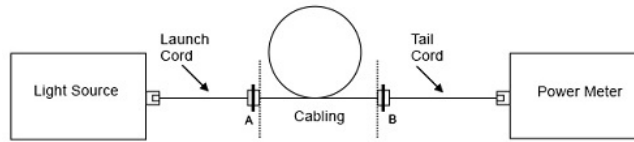


Figure 8. Measure attenuation

### Enhanced Three-Cord Method

- a. Set a reference between the light source and power meter using the launch cord (see Figure 9).

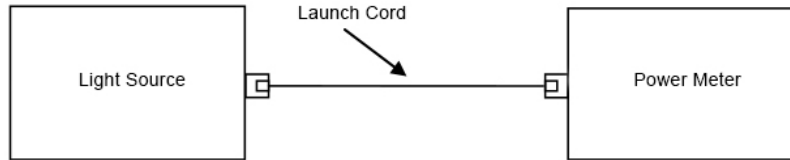


Figure 9. Set the reference using the one-cord

- a. Add a tail cord to the power meter and a substitution cord between the launch and tail cords and check for low loss connections such as 0.4 dB for single-mode (see Figure 10).

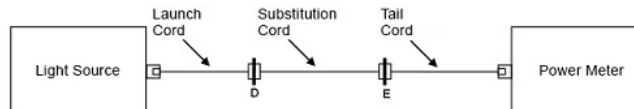


Figure 10. Check for low loss connections

- a. Remove the substitution cord and replace with the cabling under test.
- b. Measure the attenuation of the cabling and compare to the reference (see Figure 11).

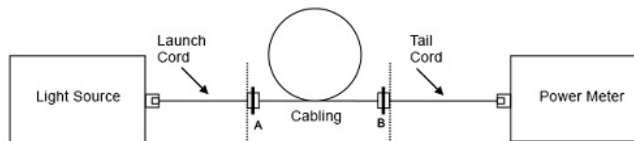
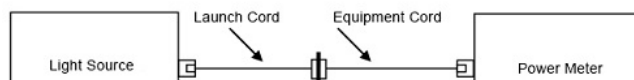


Figure 11. Measure attenuation

### Equipment-Cord, Channel Test Method

- a. Set the reference using the launch cord and first equipment cord attached to the light source (see Figure 12).



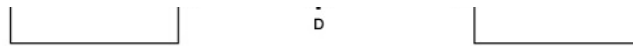


Figure 12. Set the reference

- a. Add the second equipment cord to the power meter.
- b. Attach the equipment cords to the cabling and measure attenuation (see Figure 13).

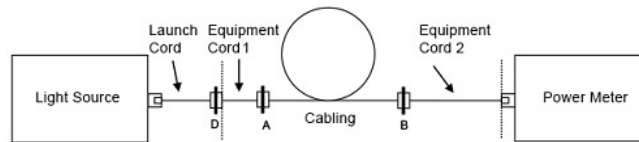


Figure 13. Measure the attenuation

## Summary

Understanding the difference between a permanent link and channel can be a challenge, and knowing which test method to apply is confusing especially for hybrid configurations. These hybrid configurations do exist and understanding how to test them is a benefit for installers. There are many standards available for testing but standards also overlap for the test methods. Table 1 provides a useful outline of the various standards, which test method should be used, and which method should be applied based on cabling configuration. While there are other test methods available, Fluke Networks continues to recommend the one-cord method for all testing.



## About Fluke Networks

Fluke Networks is the worldwide leader in certification, troubleshooting, and installation tools for professionals who install and maintain critical network cabling infrastructure. From installing the most advanced data centers to restoring service in the worst weather, our combination of legendary reliability and unmatched performance ensure jobs are done efficiently. The company's flagship products include the innovative LinkWare™ Live, the world's leading cloud-connected cable certification solution with over fourteen million results uploaded to date.

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