edu Guide

An educational resource published by Communications Specialties, Inc..

The Optical Power Meter: The Indispensable Tool for Working with Fiber Optic Systems

Learn how this simple tool can minimize your troubleshooting efforts.

CSI™ Communications Specialties, Inc.

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edu Guide

Making sense out of complex Pro A/V and Broadcast technologies.

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October 8, 2009

Introduction

This eduGuide is provided to assist all those charged with installing and supporting fiber optic systems of all kinds. This brief eduGuide will demonstrate how a simple fiber optic power meter can be used to properly install and maintain these systems. The Communications Specialties Fiberlink® 6615 is a compact battery operated power meter that is both accurate and easy to use.

The power meter, as it is commonly called, measures the optical power of light present on a fiber optic cable. This light can be generated directly from the output of a fiber optic transmitter device or from another common fiber optic testing device: a laser light, such as the Fiberlink® 6620. Your optical power is measured in dBm or in mW.

Using the Power Meter During System Design

The first thing a system designer needs to know about a fiber optic link is how much optical loss will be experienced between the end points of any fiber optic cable. All fiber optic transmitters and receivers will specify a maximum amount of optical attenuation, or loss budget, that can be tolerated before the equipment will no longer work properly. This loss budget is specified in dB and can vary from as little as 5 dB to as high as 30 dB depending on the product's design.

Before determining an optical loss measurement, you need to know two things:

- The type of fiber being used - either single mode or multimode. We strongly recommend the use of single mode fiber whenever possible.
- The operating wavelength of the transmitter you are using for the light source you are injecting into the fiber. This is usually 850nm, 1310nm or 1550nm

You will need two devices to determine the optical loss measurement:

- An optical power meter, such as the Fiberlink® 6615
- A light source, as described above, to launch a beam of light into the fiber. This can be an existing fiber optic transmitter or a light source such as the Fiberlink® 6620 Three Wavelength Laser Light Source

The procedure to measure the optical loss in the fiber optic cable is as follows:

- Set the power meter to the wavelength of the light source you are using
- Connect a short fiber jumper cable between the light source and the power meter. See Figure A.
- Make note of the power level, in dBm. We will call this "Reading A".
- Connect the fiber cable under test to the output of the light source
- Connect the power meter, set at the same wavelength as the power source, to the far end of the fiber cable under test. See Figure B.
- Make note of the power level, in dBm. We will call this "Reading B".
- The optical loss in the fiber cable is equal to "Reading A" minus "Reading B

  Optical Loss = "Reading A" – "Reading B"

Figure A:

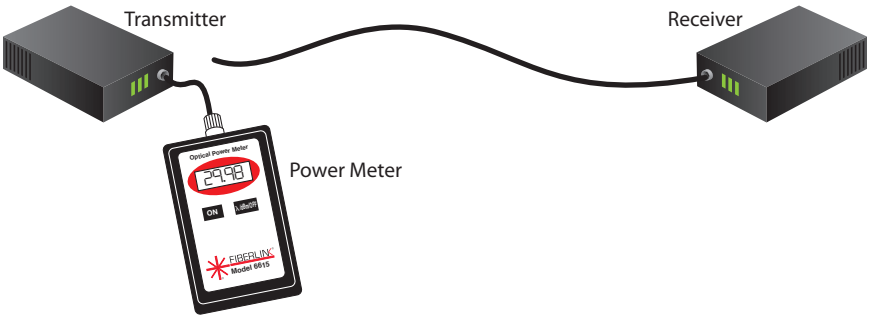
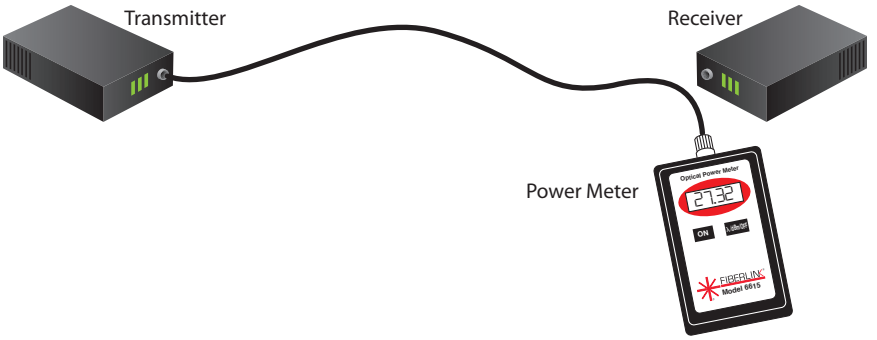


Figure B:



When multimode fiber is used, measurements should be made at 850nm or 1310nm. It is preferred that measurements be made at both wavelengths, if possible, as the optical loss can vary significantly as the wavelength varies when multimode fiber is used.

When single mode fiber is used, measurements should be made at 1310nm as this is the most common wavelength used with single mode fiber.

These measurement procedures should be repeated for every fiber cable in the system.

Using the Power Meter During System Installation

During system installation, the use of the power meter will be essential to verifying that the fiber cable you are working with is performing as well as it should. Typical problems include dirty fiber connectors, breaks, kinks and knots in the fiber, poor splices, faulty connector terminations and the use of incorrect patch cables based on the type of fiber used (multimode or single mode).

During the installation, it is assumed you have a working fiber optic transmitter unit that you intend to install. On this transmitter, please note the following:

- The operating wavelength (850nm, 1310nm, or 1550nm)
- Whether it is designed to operate with single mode, multimode or both fiber types

Next, determine the type of fiber installed. The jacket of the fiber cable should be marked.

- For multimode fiber, it may be marked:
  - multimode
  - 62.5/125
  - 50/125
- For single mode fiber, it may be marked:
  - single mode
  - 9/125

The procedure to measure the optical loss in the complete fiber optic link is as follows:

- Set the power meter to the wavelength of the fiber optic transmitter you are using
- Connect a short fiber jumper cable between the fiber transmitter and the power meter. See Figure A.
- Make note of the power level, in dBm. We will call this "Reading A"
- Connect the fiber cable under test to the output of the light source
- Connect the power meter, set at the same wavelength as the fiber transmitter, to the far end of the fiber cable under test. See Figure B.
- Make sure there are no active components such as amplifiers, repeaters, routers, etc., in line with the fiber cable you are measuring
- Make note of the power level, in dBm. We will call this "Reading B"
- The optical loss in the fiber cable is equal to "Reading A" minus "Reading B"

Optical Loss = "Reading A" – "Reading B"

Figure A:

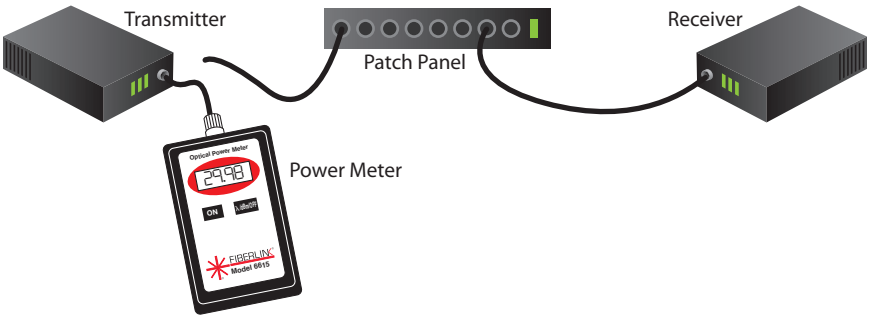
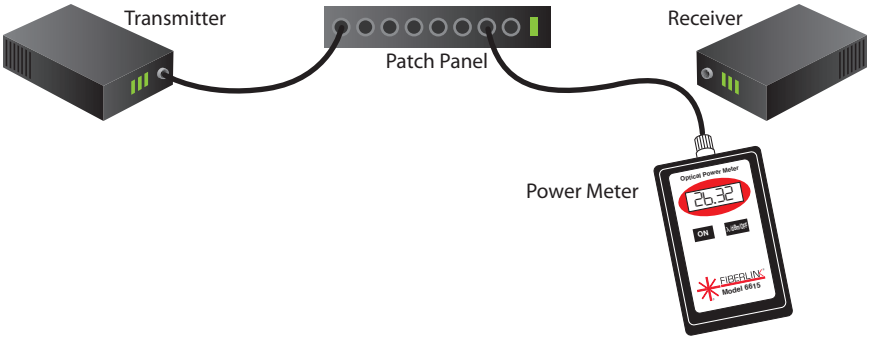


Figure B:



If patch panels are part of the optical link they should be connected and operational so as to be part of the end-to-end measurement. Ensure that the fiber cable used to make the patch is utilizing the same type of fiber (multimode or single mode) as the fiber cable itself. In fact, improper pairing of fiber optic cabling types at the switch and/or router is a common occurrence.

Having made these measurements you will be able to determine if your fiber cable is performing properly. That is, does it have too much optical loss. Of course, some optical loss is not only expected, it's quite normal. Use the following table to determine the amount of optical loss you should typically expect from your fiber optic link:

Typical Optical Loss to Expect	
Cables	**Optical Loss**
62.5u Multimode Fiber at 850nm	3 dB per km
62.5u Multimode Fiber at 1310nm	1 dB per km
50u Multimode Fiber at 850nm	1 dB per km
50u Multimode Fiber at 1310nm	1 dB per km
Single Mode Fiber at 1310nm	0.35 dB per km
Single Mode Fiber at 1550nm	0.25 dB per km
Connectors, Splices and More	**Optical Loss**
Each Connector	0.2 dB
Each Splice	0.3 dB
Each Jack on a Jack Field	0.2 dB
Each Patch Cord	0.2 dB

Add up all the losses for your system based on the above estimates and compare this total to the loss you measured using the power meter. If your fiber cable link is properly installed, the measured loss on the power meter should be the same or less than the estimated loss using the above numbers. If your measured loss is significantly more (i.e. >25%) you should investigate where the excess loss might be occurring, even if your link is operational, as this is a sign of future trouble. Start with cleaning the tips of all fiber connectors in the optical link from beginning to end and verifying the integrity of all connections and terminations.

When you are finished installing the system and all links are operating normally, it is a great idea to measure the optical loss in all of your fiber optic links and record them for future reference. You can use this data to compare it against future measurements.

Using the Power Meter to Troubleshoot and Maintain a System

You now have a working fiber optic system. Optical link losses are as they should be and the system is functioning normally. What should you do to maintain the system over time to extend the useful life of the system?

In a digital fiber optic system, where the baseband signals are transmitted digitally over the fiber, small variations of optical loss in the fiber link will not be noticed. Usually, a properly operating link will have ample margin in the loss budget such that a 1 to 3 dB variation in optical loss can be tolerated with no adverse effect. However, a slow deterioration of the optical power in the link can be a sign of system problems or a failure to come.

There are several periodic things you can do when you suspect the link loss may be increasing:

- Over time, small amounts of dirt and film may build up on these connectors. Start by cleaning all optical connectors in the fiber optic link. No exceptions. This can be done with a small alcohol pad applied to the tip of the connector.

- Use your optical power meter, as described in the procedure *Using the Power Meter During System Installation* to check the optical loss in the fiber links you suspect may be excessive. Compare the loss you measure now to the loss you measured when you first installed the link.

- Substitute a known good fiber optic transmitter of the same type for the one currently installed to see if performance improves. Measure the output power of the new transmitter and compare it the old transmitter. They should match within 1 to 2 dB.

Conclusions

Designing, installing and troubleshooting a fiber optic system is not a difficult task. However, an optical power meter is an indispensable tool for installing, maintaining and troubleshooting fiber optic links. Think of it as the digital voltmeter (DVM) of the fiber optic world. The power meter, together with common troubleshooting techniques, are all you will need in most cases.

And remember to keep the connectors clean and the fiber cables free of kinks.

Other issues in the eduGuide Series

Introduction to Fiber Optics
Undisputably, fiber is the future. Learn all about the benefits of fiber optic technology in this easy-to-read guide.

Advantages of Digital Fiber Optics
Examine how digital signals over fiber are accomplished, the phenomenal results they achieve, and how cost-effective it is.

Fiber Optic Cables, Connectors and Integration
Learn how easy it is to terminate and fabricate your own fiber optic cables, what types of fiber and fiber jackets are available and how to design and integrate a fiber optic system.

Scan Converters Buyer's Guide
Everything you need to evaluate and decide on the perfect Scan Converter.

Video Scaling
A comprehensive overview of the technology, how it works and when to use this technology effectively.

Advanced Video Scaling
Easy explanations of Inverse 3:2 Pulldown, Anamorphic Scaling and Other Confusing Concepts.

Other Educational Resources

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Visit our website for online education resources, product literature and more!

Pure Digital Fiberlink® Application Brief – Everyday Pro A/V
This application brief illustrates the benefits of using Pure Digital Fiberlink® in any Pro A/V installation. Regardless of your Pro A/V market specialty, this Application Brief is a valuable guide to integrating and specifying Pure Digital Fiberlink® products.

Pure Digital Fiberlink® Intelligence Brief – Government/Military
Detailed analysis of how Pure Digital Fiberlink® has become the solution of choice for mission critical government, intelligence and military applications. If you are involved in this market segment, this document will prove to be valuable during your next project specification.

About Communications Specialties, Inc.

Communications Specialties, Inc. (CSI) is an award-winning, Long Island based company that manufactures and sells a variety of products for the distribution, conversion or transmission of television and computer video signals, including fiber optic transmission systems, scan converters and video scalers.

The company was founded in 1983 by veterans of the broadcast industry. Since then, CSI has managed to consistently design innovative products that are used worldwide by Fortune 500 Companies and Government Agencies in a variety of markets such as Broadcast, Professional A/V, Videoconferencing, Education, Home Theater, Security, ITS, Industrial Monitoring, Digital Signage, Government/Military and more!

The **Pure Digital Fiberlink®** line offers an extensive and affordable family of fiber optic transmission systems for the Professional A/V marketplace and includes several ground-breaking products for the transmission of high-resolution RGB signals. Systems for point-to-point and point-to-multipoint signal distribution make these products highly desirable for any Pro A/V applications.

Our premier product line, the **Scan Do®** family of computer to video scan converters, has redefined industry standards in computer video to NTSC/PAL technology with unsurpassed performance in its price range. All models support high resolutions and refresh rates and are VGA and Mac® compatible. The feature-rich and versatile Scan Do family offers the widest range of scan converters on the market.

The award-winning, **Deuce®** video scalers convert NTSC and PAL to high-resolution, non-interlaced video and offer a far superior and affordable alternative to line doubling and quadrupling. The new generation of Deuce products offer a wide range of non-interlaced resolutions and refresh rates for every application, from professional A/V installations to home theater, including a model designed especially for use with HDTV displays.

In addition, CSI manufactures a comprehensive selection of distribution amplifiers, VGA monitor, keyboard and mouse extenders and accessories for our entire product line.

Communications Specialties and its products have been the recipient of numerous industry awards. In 2005, the Pure Digital Fiberlink® 7220 Series for high-resolution RGB and Stereo Audio was honored as one of the AV industry's best technological innovations of the year by receiving a "rAVe Radical Product of the Year" award as "Best New Analog Signal Processing Product". The rAVe email newsletter is published by professional audiovisual industry veterans and is read industry-wide.

Among CSI's many other awards are AV Video Magazine's Platinum Award (given to Scan Do® Ultra and Deuce®) and the Video Systems' Vanguard Award (given to Deuce).

The company is headquartered in the United States on Long Island, New York, with Sales Offices in Florida, Indiana and Virginia. Research, development, design, engineering, manufacturing and customer support operations are performed at the New York headquarters. Other locations include Communications Specialties Pte Ltd (CSPL) - a wholly owned subsidiary office in Singapore that provides support to distributors in the Far East and Pacific Rim.

Our in-house sales department handles complete product-line sales directly to end-users as well as to an international network of representatives and resellers. All of our products are backed by an exceptional warranty.

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