

Agilent Technologies Gigabit Ethernet Fiber Certification

Application Note 1403

Introduction

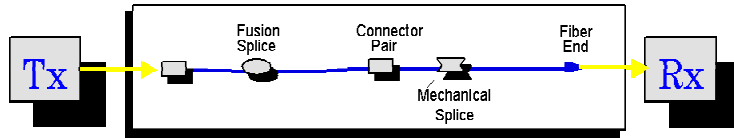
Fiber Optic Cable Plant Certification

This note is designed as a practical guide to test the fiber links associates with the Gigabit Ethernet standard. The goal is to save the reader from reading the over 1500 pages that comprise the 802.3 standard. The following section will cover the following four topics.

- Gigabit Ethernet fiber standards (overview)
- The main Test you need to make to ensure compliance
- Tips for test equipment to make the best measurements
- Advantages of Agilent products in this environment.

The application note is written with a view to an installer who is asked to verify the fiber path for a given link.

Gigabit Ethernet fiber standards (overview)



The following are figures taken from the Gigabit Ethernet standard so help users test their physical fiber plant against some criteria. Note the figures are subject to change with the latest standard revision.

Operating range for 1000BASE-SX over each optical fiber type (850nm)

Fiber type	dB/km attenuation	Maximum recommended length
62.5µm	3.75	275 meters
50µm	3.75	550 meters
10µm	Not supported	Not supported

Operating range for 1000BASE-LX over each optical fiber type (1300nm)

Fiber type	dB/km attenuation	Maximum length
62.5µm	3.75	500 meters
50µm	3.75	550 meters
10µm	0.25	5000 meters

Fiber details and Operating range for 10Gigabit systems

10G Base standard	Wavelength and fiber type	Maximum length
SR/SW	62.5/50µm @850nm	36/300 m
LR/LW	10µm @ 1310nm	10 000 m
ER/EW	10µm @ 1550nm	40 000 m
Link Insertion Loss	Minimum Launch Power at transmitter	Average receive power (Max)
1.6/2.5dB	-7dBm	-1dBm
7dB	-6dBm	+1dBm

Please note that fiber systems should operate easily when installed lengths are under those specified in the above tables. Longer links are possible with better transceivers. A transceiver, which exceeds the operational range requirement while meeting all other optical specifications, is considered compliant.

For readers turning up systems, note that power levels are given as a guide. Checking the transmitter for minimum power level to ensure a good signal and the maximum average power at the receiver to avoid errors is a quick check that nothing unexpected or unacceptable is happening.

Other optical characteristics:

Connector quality: Connectors should have an optical return loss no greater (lower number) than 26dB. A figure of 35dB and higher is preferable. Remember to clean connectors when connecting.

Connector Loss: Individual connector pairs should not have a loss higher than 1db. 0.5dB is often achievable with new connections.

A splice (permanent mechanical or fusion connection) is rare because of the short distances involved but the loss should not exceed that of connector loss above. An easy spec given today fusion splice machines.

Minimum Requirements to Ensure Compliance

The following measurements should be made to ensure compliance to Gigabit Ethernet standards:

Tests 1-3 should preformed with an OTDR at least at the proposed transmission wavelength (850nm or 1300nm)

1. The fiber length measured corresponds to the estimated span length as per the route

diagram. It should not exceed the length shown above unless transceiver are chosen that exceed performance indicated in the standard.

2. No individual losses (such as bad or dirty connectors or bends) exist on the fiber that are in excess of 1dB each.

3. Make a full link length measurement using an OTDR. Calculate the end-to-end loss by using the markets displayed on the OTDR and recording the 2 point loss between both marker when placed just before both ends for the fiber. Alternately, a total cumulative value may be shown on the unit's screen. Either method will show the approximate loss of the fiber under test. It is recommended to do this simple loss test at 2 wavelengths to detect bending problems. A change in loss at a different wavelength usually indicates a bend. If the OTDR is the primary tool, then an addition loss measurement should be preformed in opposite direction and the results averaged to achieve the most accurate loss results.

4. Using the source, connect a patch cord to another (with a through adapter). Then connect the second patch cord to the power meter. Take a reference measurement. The set up is now calibrated, and the source can be connected using the same patch cord to the transmitter end of the link. Connect the Power meter using it's patch cord to perform the loss test with. It should be noted that a source/power meter derived loss measurement is the most accurate loss measurements possible and recommended over an OTDR especially for short link lengths under 1km (3000ft).

The results of the tests should be stored. Agilent recommends storing the OTDR traces in the Bellcore standard file format for universal viewing on most OTDR PC software packages. The most common format for Power meter measurements is in Excel format allowing easy statistics and archiving.

Tips for test equipment to make the best measurements

CLEAN: The #1 thing concern that anyone responsible for the physical fiber in a Gigabit Ethernet LAN is "keep it Clean". Although much of this paper is devoted to protocols and troubleshooting, check the basics before going into anything complicated. After all, you wouldn't overhaul an engine on a car without first checking if you ran out of gas. Studies show that between 80-98% of transmission problems can be caused simply by dirty connector end-faces! This becomes more critical at higher speeds and smaller fiber types. Blow out bulk heads (make sure they are free on both sides first), to remove any dust that can be

pushed up against connectors when another is inserted in the other end. Use a Fiber Optic Reel Cleaner for connectors and for equipment where you cannot access the ferrule, use a pre-moistened cleaning pad containing at least 99% isopropyl alcohol. Always clean a connector before you make a connection and clean both sides of a mating pair. Good connections need not be cleaned unless a new connection must be made. The same rules of cleanliness go for test equipment. Make sure you use protective caps and clean connectors and lens often. Contact Agilent Technologies for a complimentary copy of the optical cleaning guide.

For sources, make sure you observe the recommended warm up time with the source on to reduce the instability to a minimum and get the most accurate reading. Most sources are dual wavelength, so make sure you have it set to the wavelength you want.

For power meters make sure you set the wavelength calibration to that of the source. The detector in any Power meter does not have a flat response and a difference in wavelength the source is emitting and the power meter is set to can make a huge difference easily measured in dB's.

For Optical Time Domain Reflectometers (OTDR's) make sure the range is set to slightly longer than that of the assumed run length. This ensures the best possible resolution. Take great care in cleaning and caring for the front connector on the instrument to assure you are able to measure as close after the front connector as possible. A poor front connector causes strong reflections that blind the OTDR's sensitive detector causing an extended deadzone after the front connector. Try to use the smallest pulsewidth (e.g, 100ns) that permits a clean trace in a reasonable amount of time. If the instrument offers a setting for increase resolution, it should be selected unless noise is too high.

Lastly, try and use solid state memory on all instruments. This means using PC card flash memory over hard disks or floppies. The first time you invest 6 hours in driving and measuring, only to lose your data to a roughly handled case or a floppy sitting in the sun too long, you will understand this tip. PC Cards also free up the instrument from lengthy downloading times.

Advantages of Agilent products in this environment

For Gigabit Ethernet testing , Agilent provides excellent tools for professionals working in a high productivity, high accuracy capacity. That is the test equipment Agilent design and provides is better suited to people making lots of measurements, and/or those who must stand by the measurement results as apposed to merely go/no go testing.

Agilent's Handheld Power meter (E3970A) has an instant on feature with no warm up. It offers 1 button memory storage of up to 850 readings. Each reading also notes the wavelength the unit was set to when the measurement was stored. Compatible with all fiber types in the Gigabit standard unit comes with 3 easily interchangeable interfaces for different connector types. The battery life of over 100 hours also ensures productivity in a mobile environment. Memory can be downloaded as measurements are taken or afterwards directly into a customizable Excel loss test report.



The Agilent Mini-OTDR offers many unique advantages here. The most obvious being size and weight, it can be used all day without search for a table or chair. 8cm sample resolution help localize problems closer to actual causes. Using only non-volatile memory and flash cards prevents hard-disk crashes and flaky floppies from causing rework. An immediate cost savings is realized when choosing either of Agilent's multimode modules since the not only measure 62.5 and 50 μm fiber at 850nm/1300nm but are perfectly suitable for testing all lengths of single mode fiber permitted in the Gigabit Ethernet 1000Base-SX and 1000Base LX standard. Finally, with only 4 buttons, extensive built in help and wizards, it lets the user concentrate on the job at hand, not the test equipment. Agilent OTDR's can be rented from major test equipment rental companies worldwide. Bottom Line Economics. This section highlights three different actual customer case studies in which the use of Agilent tools for installation and maintenance made a significant economic contribution.

Case Study: Fiber Optic Cable Installation

In a Gbit Ethernet Metropolitan Area Network, all fiber optic links must be tested to verify that they meet minimum specifications of loss and reflections. A check must also be performed to ensure the maximum allowable distance is not violated. The primary test tools used are an Optical Time Domain Reflectometer (OTDR) and a source/power meter combination.

These tests can take a huge amount of time. Reading the above, 4 OTDR measurements and Loss set measurements may be required. It is essential to reduce expenses during the installation of fiber optic cable through efficient test equipment. Nearly 10% of the total cost of installation is attributed to testing each individual fiber strand in the cable. Therefore, the time spent in testing each strand increases proportionally with the number of strands within the cable.

The table below outlines the results of an independent study that compared the Agilent E6000C Hand-Held OTDR. It shows that an instrument with a decrease in required measurement time from 75 seconds to 10 seconds can have a dramatic ROI.

Number of Fibers	Hours of Test Time Bi-directional / Two Wavelengths	
	Agilent E6032A	Popular OTDR
72	0.80	6
144	1.60	12
864	9.60	72

For one 432-fiber span	
Time Saving	31 Hours
\$ per hour	\$200
Cost	\$6,200

Conclusion

Agilent Technologies has already begun to offer faster, more portable, less expensive, easier to use, and highly integrated test tools that can coexist amongst different technologies within the same testing environment. This significant accomplishment has raised the bar for innovative network testing methodology. As a result, the new functionality of Agilent Technology tools should become a default requirement for the installation and maintenance of Gigabit Ethernet networks in the LAN, MAN, and WAN.

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with all your test & measurement needs**

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