Fiber-Handling Essentials for Next-Generation Networks

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Introduction

As demand for data continues to increase, so does the penetration of optical fiber into the network. While fiber's contribution to network performance is indisputable, fiber connectors are widely recognized as the physical network's most problematic element. Troubleshooting statistics show fiber end face contamination as the number one cause of poor network performance, and mated contaminated fibers as the primary cause of permanent optical component damage.

The increased reliance on fiber in next-generation networks coupled with its negative potential when contaminated make it critical that administrators and technicians unfamiliar with fiber quickly become proficient in the equipment and processes essential to proactive inspection and its systematic practice at every stage of fiber handling. Systematic proactive inspection is the cornerstone of fiber handling best practices, as it is the only way to ensure a contaminated fiber is never installed into the network.

In order to overcome intrinsic barriers to systematic proactive inspection, this white paper proposes replacing the optical power meter (OPM), currently the fundamental tool that fiber technicians use, with a new essential fiber tool: an integrated OPM/inspection device used systematically according to a proactive inspection model based on established International Electrotechnical Commission (IEC) fiber inspection standards. Equipping technicians with a model based on the IEC standard provides them with systematic procedures and pass-fail criteria, which are key to ensuring that proactive inspection is carried out correctly every time.

The replacement of the OPM with these essential fiber tools will enable and drive the best practice of systematic proactive inspection, eliminating the installation of contaminated fibers and optimizing network performance.

Testing Alone is Not Enough

Currently, the only tool considered essential to fiber technicians is the OPM, which measures the energy present in an optical fiber, allowing technicians to determine if enough power exists to support the application, or if the attenuation of the link meets specification.

Testing fiber signal strength alone is no longer considered adequate since optical fiber troubleshooting statistics revealed contamination as the number one cause of poor physical network performance. High-bandwidth equipment manufacturers and their installation teams were the first to discover the impact of contamination on network performance. Their experience revealed that even the best clean manufacturing practices cannot prevent microscopic particles from entering sealed bags and under dust caps, creating potential for contamination even in brand new components.

Just one microscopic particle on the fiber end face can become permanently embedded into the fiber core during mating. Once embedded in the core, this particle will cause significant back reflection and insertion loss—two primary causes of poor network performance.

Because microscopic particles on a fiber prior to mating can go undetected by the OPM, testing alone before mating is not enough. The only way to ensure a fiber is truly clean before mating is through proactive visual inspection using a microscope designed specifically for inspecting optical fiber.

The Case for Proactive Inspection

Because microscopic contamination is always a possibility, even in new fiber components, the full potential for a low-loss fiber connection is only realized when technicians ensure that no contamination is present prior to a fiber's first mating. This assurance is only possible through microscopic visual inspection of every fiber, every time, before it is mated, which defines systematic proactive inspection.

Anyone familiar with the physical layer of a network understands the potential for contamination once the fiber is in the network environment. As a result, it is essential to network performance that technicians practice systematic proactive inspection every time they handle a fiber.

When systematic proactive inspection is not practiced, administrators run the risk of installing dirty fiber that will impair the optical signal and decrease network performance. Mating dirty fibers carries the additional risk of embedding dirt into the fiber, which can result in permanent damage to the fiber and the connecting network equipment—all of which may lead to future network interruption when fiber repolishing or replacement becomes necessary.

Additionally, when fiber damaged by embedded dirt is discovered only after installation in costly network equipment, replacing or repolishing the fiber is not always an option, making future costs of troubleshooting, asset damage, and network downtime exponentially higher. Conversely, with systematic proactive inspection the fiber can almost always be cleaned, completely eliminating the potential for fiber contamination, network downtime, and permanent equipment damage.

The impact of contamination on network performance and the benefits of systematic proactive inspection led to practical research by the International Electronics Manufacturing Initiative (iNEMI). The findings of this research became the pillar for the international standard, IEC-61300-3-35.

This standard specifies visual inspection procedures and pass-fail criteria that must be used to achieve the measurable benefits associated with proactive inspection. Equipping technicians with a model based on this IEC standard that outlines proactive inspection procedures and pass-fail criteria is key to ensuring that proactive inspection is carried out correctly every time.

Benefits of Proactive Inspection

Companies that have adopted proactive inspection on a large scale have massively reduced the need for troubleshooting and lowered operating costs, showing that the operational benefits of proactive inspection clearly outweigh the costs.

Reduce the need for troubleshooting as well as network downtime and maintenance costs. Keeping the network active and users online improves productivity. And because proactive inspection ensures that network components operate at their highest level of performance, it can optimize signal and network performance, prevent network damage, and protect equipment and technology investment.

It is easy to make the connection between these benefits associated with proactive inspection of optical fiber in the network and the bottom line.

Barriers to Proactive Inspection

In spite of these considerable benefits, proactive inspection is not systematically practiced, which can be surmised in part by the disparity between the number of OPMs sold in 2008 (around 60,000) and the number of optical inspection devices sold in the same year (around 7,000). These figures illustrate the first of two barriers to proactive inspection: the equipment costs associated with the purchase of the optical fiber inspection device. The second barrier: the time costs associated with the addition of proactive inspection to the optical fiber handling process.

While real, these costs are significantly less than those associated with reactive inspection resulting from poor network performance. This fact, coupled with the financial and productivity benefits of proactive inspection should compel network administrators to make efforts to overcome these barriers.

Overcoming Barriers to Proactive Inspection

In the effort to help network administrators and technicians overcome the barriers to systematic proactive inspection, this white paper proposes adopting an integrated OPM/inspection device used systematically according to a proactive inspection model based on established IEC fiber inspection standards as essential to the fiber handling process.

One example of an integrated OPM/inspection device is the HP3-60 with patch cord module (FIT-HP3-60-P4) developed by optical fiber test and measurement equipment manufacturer JDSU. Guided by the IEC-61300-3-35 visual inspection standard and pass/fail inspection criteria, JDSU developed the HP3-60, suggesting to customers that it be used according to the supporting proactive inspection model, "Inspect Before You Connect" also developed by the test equipment manufacturer. When used together, these fiber-handling essentials give technicians everything they need to practice systematic proactive inspection and optimize network performance.

Example of an Integrated OPM/Inspection Device

JDSU HP3-60 System with Integrated Power Meter and Patch Cord Microscope (FIT-HP3-60-P4)

Designed to facilitate quick, easy inspection of the connector end face, the HP3-60 integrates an OPM with a video inspection monitor, a probe microscope, and patch cord microscope.

Combining the optical power meter, probe microscope, and patch cord microscope, the HP3-60 integrates the testing and inspecting procedures, thus driving and enabling best practice fiber handling. The addition of two high-performance handheld microscopes for inspecting both female (bulkhead) and male (patch cord) connectors (as well as other optical devices) creates a real workflow advantage while ensuring inspection and cleaning both sides of the fiber before they are connected; which is the only way to ensure the fiber will be free of contamination and defects and perform optimally within the network.

The dual-microscope design is a key advantage of the HP3-60. Having one microscope dedicated to male connectors and one dedicated to female connectors saves technicians time and effort by allowing them to inspect both sides of the connection without changing tips. This configuration also provides a safe "parking lot" for the male connector during fiber handling or testing.

The microscopes are compatible with a comprehensive selection of precision stainless-steel fiber inspection tips and adapters that are carefully engineered to produce consistent and accurate results. The adapters are interchangeable, utilizing a unique optics architecture that enables the probe to interface with every connector and application in a network.

To address the barrier of equipment costs, the HP3-60 is priced at a significant discount to the cost of separately purchasing an OPM and an optical inspection microscope.

To address the barrier of time costs, the design of the HP3-60 enables a seamless workflow for inspection, cleaning, and testing of both male patch cord and female bulkhead connectors.

Seamless Testing Workflow

To promote systematically adopting proactive inspection, JDSU developed the proactive inspection model "Inspect Before You Connect," which promotes the visual inspection procedures and pass/fail criteria set forth in the IEC-61300-3-35 visual inspection standard. By guiding technicians with varying levels of expertise in the proper implementation of proactive inspection, the addition of this model to fiber handling essentials ensures that proactive inspection is performed correctly every time.

1 INSPECT PATCH CORD

2 ACTIVATE PROBE

3 INSPECT BULKHEAD

4 CONNECT

5 TEST

Proactive Inspection Model

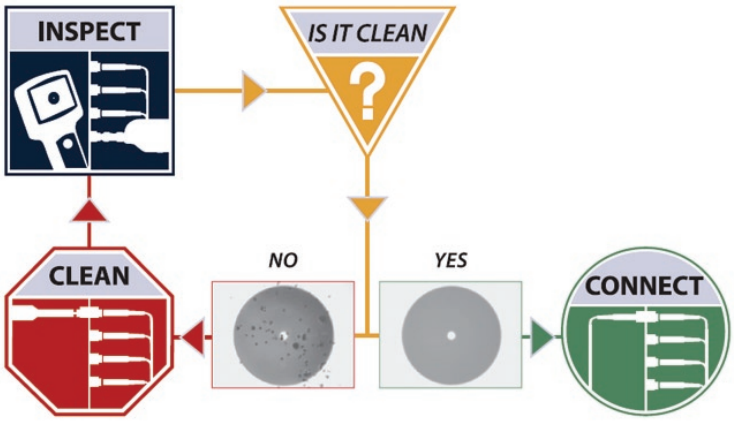
This simple inspection process will ensure fiber end faces are clean prior to mating connectors:

Step 1 **Inspect:** Use the microscope to inspect the fiber. If the fiber is dirty, go to step 2. If the fiber is clean, go to step 4.

Step 2 **Clean:** If the fiber is dirty, use a cleaning tool to clean the fiber end face.

Step 3 **Inspect:** Use the microscope to re-inspect and confirm the fiber is clean. If the fiber is still dirty, go back to step 2. If the fiber is clean, go to step 4.

Step 4 **Connect:** If both the male and female connectors are clean, they are ready to connect.



Summary

Fiber's increased penetration in next-generation networks coupled with its negative potential when contaminated makes systematic proactive inspection essential to next-generation network performance, and it makes the current practice of using only an OPM when testing fiber obsolete.

In order to overcome barriers to systematic proactive inspection, the adoption of two new essential fiber tools are critical: an integrated OPM/inspection device, and a proactive inspection model based on IEC fiber inspection procedures and pass/fail criteria.

The replacement of the OPM with these two fiber essentials will fully equip network technicians and drive them to systematically practice proactive inspection every time, reinforcing best practices and avoiding bad ones, no matter what their level of fiber expertise.

The widespread adoption of the fiber handling best practice of systematic proactive inspection will eliminate the installation of contaminated fibers and optimize the performance of next-generation networks.

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