Achieving IEC Standard Compliance for Fiber Optic Connector Quality through Automation of the Systematic Proactive End Face Inspection Process

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Executive Summary

It is widely known in the fiber optic industry that scratches, defects, and dirt on fiber optic connector end faces negatively impact network performance. As bandwidth requirements continue to grow and fiber penetrates further into the network, dirty and damaged optical connectors increasingly impact the network. If dirty and damaged end faces are not dealt with systematically, these defects can degrade network performance and eventually take down an entire link.

In the effort to guarantee a common level of performance from the connector, the International Electrotechnical Commission (IEC) created Standard 61300-3-35, which specifies pass/fail requirements for end face quality inspection before connection. Designed to be a common reference of product quality, use of the IEC Standard supports product quality throughout the entire fiber optic life cycle, but only when compliance to the standard occurs at each stage.

In response, current best practices recommend systematic proactive inspection of every fiber optic connector end face before connection. While current research shows that this practice is eliminating the installation of contaminated fibers and improving network performance, the uncontrollable variables of technician eyesight and expertise, ambient lighting, and display conditions keep manual inspection and analysis from being a 100-percent reliable and repeatable method of assuring IEC compliance. In addition, because manual inspection does not create a record of the inspection process, certification of quality at the point of installation is not practical.

Because compliance to the IEC Standard is the only way to achieve the promise of today's fiber-rich, high-connectivity networks, this white paper proposes the automation of the inspection process through the addition of analysis software programmed to the Standard's pass/fail criteria to the practice of systematic proactive inspection.

Automation of the systematic proactive inspection process using software programmed to the IEC Standard eliminates the variables associated with manual inspection, provides a documentable record of the quality of the connector end face at the point of installation, and provides a 100-percent repeatable and reliable process. Combined, these benefits make automated end face inspection the most effective method available to assure and certify compliance to the IEC Standard throughout the fiber optic product life cycle, and achieve the promise of next-generation networks.

IEC Standard 61300–3–35

IEC Standard 61300-3-35 is a global common set of requirements for fiber optic connector end face quality designed to guarantee insertion loss and return loss performance. The Standard contains pass/fail requirements for inspection and analysis of the end face of an optical connector, specifying separate criteria for different types of connections (for example, SM-PC, SM-UPC, SM-APC, MM, and multi-fiber connectors). For more detail on the Standard, copies of the copyrighted document are available for purchase at www.ansi.org by searching for "61300-3-35".

These criteria are designed to guarantee a common level of performance in an increasingly difficult environment where fiber is penetrating deeper into the network and being handled by more technicians, many of whom may be unfamiliar with the criticality of fiber optical connector end face quality or possess the experience and technical knowledge required to properly assess it.

The standard is designed to be used as a common quality reference between supplier and customer, and between work groups in several ways:

- As a requirement from the customer to the supplier (for example, integrator to component supplier or operator to contractor)
- As a guarantee of product quality and performance from the supplier to the customer (for example, manufacturer to customer, contractor to network owner, or between work groups within an organization)
- As a guarantee of network quality and performance within an organization

As more stages in the fiber optic product life cycle, shown in Figure 1, are outsourced to disparate vendors, the standard takes on renewed importance in ensuring the optimized performance of today's fiber-dense networks.

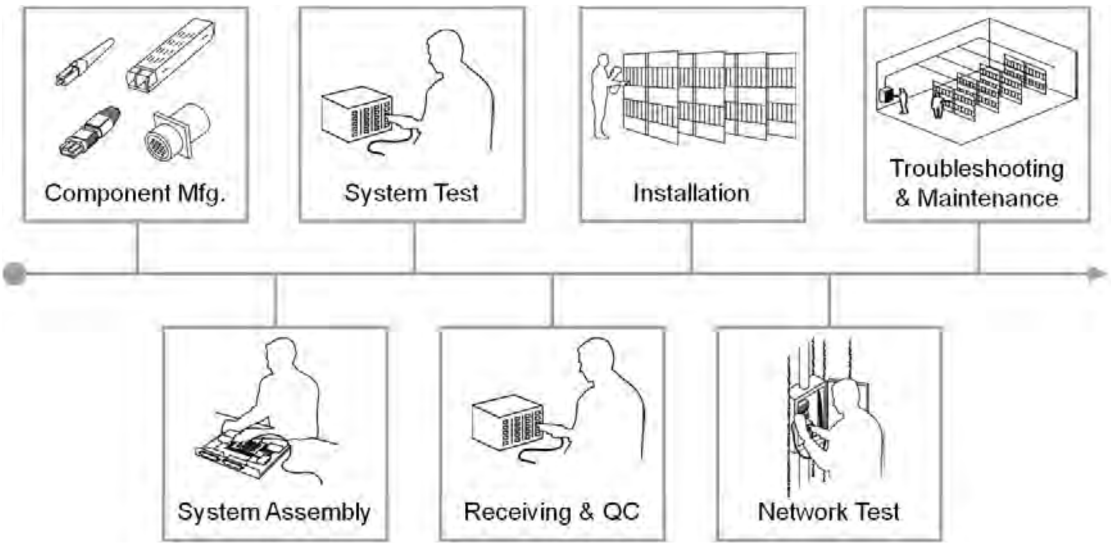

Figure 1. Fiber Optic Product Life Cycle

The Development of the IEC Standard

The quality values used in the IEC standard are the result of years of extensive testing of scratched, damaged, or dirty optical connectors conducted by a coalition of industry experts including component suppliers, contract manufacturers, network equipment vendors, test equipment vendors, and service providers. This work has been published previously in a number of papers as noted in the References section of this paper.

Understanding the variables and limitations of manual visual inspection, fiber optic test and measurement manufacturer Viavi contributed its automated objective inspection and analysis software FiberChek2™, as illustrated in Figure 2, to the IEC for use in the development of the 61300-3-35 visual inspection standard. Automating the pass/fail process using research-based parameters extracted from testing conducted by the aforementioned industry coalition provided the IEC with a repeatable standard of quality that would guarantee a common level of performance, creating a positive impact on both product and network performance.

More than 8 years of testing on a constantly expanding database of fibers and fiber devices (for example, SM, MM, Ribbon, E2000, SFP/XFP, Bend-insensitive fibers, Lenses, and other interfaces), combined with widespread use in the industry by component manufacturers, integrators/CMs, OEMs, third-party installers, and service providers, makes the Viavi software program the only proven automated objective inspection software program that assures compliance to the IEC standard at every step of the fiber optic life cycle.

Testament to this is the fact that this software program is currently used by three of the top five U.S. cable assembly manufacturers, along with six of the largest optical component manufacturers, five of the largest network equipment vendors, and five of the top Network Service Providers (NSPs) in the world, making Viavi FiberChek2 software the current worldwide industry standard for automated objective fiber optic connector end face inspection.

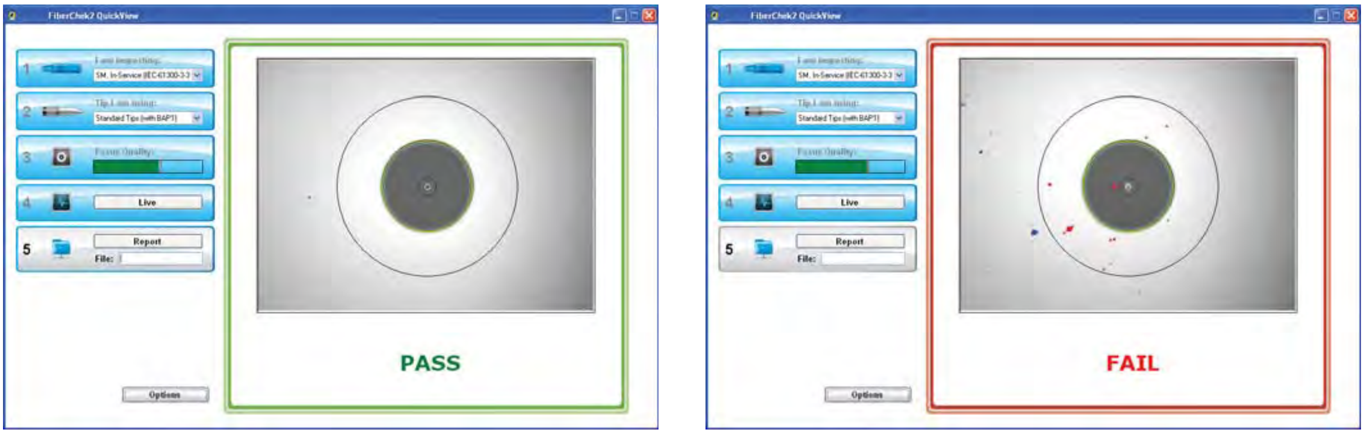

Figure 2. Example of the Proven Inspection and Analysis Software Program FiberChek2 from Viavi

The criteria in the IEC Standard requires the user to know the exact location and size of surface defects (for example, scratches, pits, and debris) on the fiber optic connector end face. As a result, it is only through the use of automated inspection and analysis software that compliance to the IEC Standard (or customer specification) can be tested and certified.

The combination of common requirements (the IEC Standard) and automated inspection and analysis (FiberChek2) have measurably impacted product quality through the supply chain. This is providing improved repeatability and stability of inspection analysis throughout the fiber optic product life cycle, ensuring consistent product performance regardless of the number and expertise of vendors and technicians involved in the manufacture, installation, and network administration processes.

Proactive Inspection Model: Step One Toward Achieving IEC Compliance

Despite its role in the development of the IEC Standard and usage by industry leaders, automated inspection and analysis software is not yet in widespread use across the fiber optic industry. In an effort to enable compliance to the Standard even when using manual visual inspection equipment alone, IEC and industry leaders are supporting the promotion of fiber handling best practices. An example of one such educational effort is the proactive inspection model developed and promoted by fiber optic test equipment manufacturer Viavi, "Inspect Before You Connect" (IBYC), as illustrated in Figure 3.

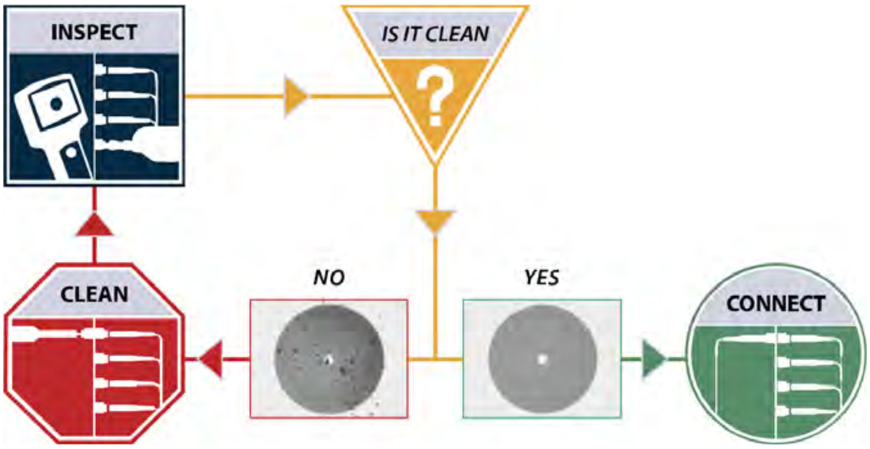

Figure 3. Example of the Proactive Inspection Model: Inspect Before You Connect™

The simple four-step IBYC model, which supports and is mandated by the IEC Standard, effectively guides technicians of varying levels of expertise in the proper implementation of systematic proactive inspection.

- **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.

Consistent use of the IBYC model ensures that proactive inspection is performed correctly every time and that fiber optic end faces are clean prior to mating connectors, eliminating the installation of dirty or damaged fibers into the network and optimizing network performance. As a result, IBYC has been incorporated into manufacturing procedures for the majority of the world's leading organizations using fiber, increasing knowledge of this process and helping it become routine practice around the world.

Automated Inspection and Analysis: Achieving and Certifying IEC Compliance

Even with the aid of the IBYC model, manual inspection using only a video microscope can be difficult depending on the technician's expertise and can result in variable connector quality and network performance. Reliant on technician eyesight and expertise along with variable display settings and ambient lighting, manual inspection and analysis is not 100 percent reliable, repeatable, or certifiable. Because it produces no visual record of the end face condition in the manual inspection process, certifying compliance at the point of installation through images or reporting is both unreliable and impractical, as Figure 4a shows.

To ensure IEC compliance is achieved, automated inspection of fiber optic connector end faces using inspection and analysis software built on the IEC Standard's pass/fail criteria is the most effective method available. With it technicians of all skill levels can effectively accomplish both compliance and certification through images and reports, as Figure 4b shows.

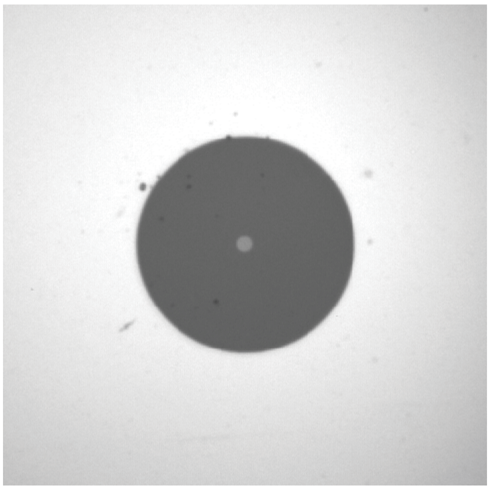

Figure 4a. Manual Inspection requires technicians to judge whether the connector complies with the IEC Standard.

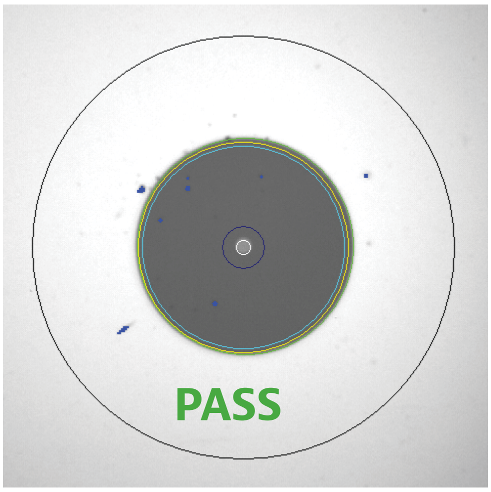

Figure 4b. Automated Inspection gives technicians a pass or fail result.

Using the software, automated inspection and analysis can produce a visual record of the end face condition as shown in Figure 5, which can be used in reports and archived for future reference.)

As a result, automated inspection and analysis presents several clear advantages over subjective inspection:

- Eliminates variation in results
- Certifies and records product quality at time of inspection
- Enables technicians of all skill levels to certify quality reliably and systematically
- Makes advanced pass/fail criteria simple to use
- Improves product and network performance and yields

Using a fiber optic inspection and analysis software program that is preloaded with the IEC Standard specifications, such as Viavi FiberChek2 software, any technician can effectively:

- Inspect and certify compliance with IEC 61300–3–35 or other customer-specified standards at every stage of the fiber optic product life cycle at the push of a button
- Implement simple pass/fail acceptance testing; no skill in quality judgment is necessary
- Generate detailed analysis reports that can be archived

VISUAL INSPECTION SUMMARY REPORT

Telco

100 York rd , October 7, 2010, 1:11:35 PM
Matt

FiberChek2™

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nspection Result / Fiber Name:

File Name:	5 Pass
Serial Number:	ROADM Install 37A
Lot Number:	Port 137
L:	
RL:	
Profile:	SM, In-Service (IEC-61300-3-35 Table 3)

****PASS****

Inspection Summary:

Zone Name	Diameter (µ)		Defects			Scratches	
	Inner	Outer	Result	Count	Area (µ²)	Result	Count
Zone A	0	25	PASS	0	0	PASS	0
Zone B	25	120	PASS	5	23.3802	PASS	0
Zone C	130	250	PASS	3	33.4003	PASS	0
Epoxy Gap:			Fiber Type:	Simplex		Core Size:	9

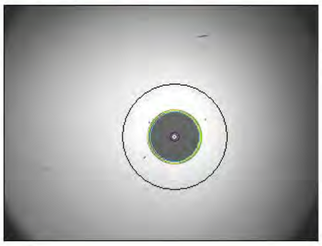
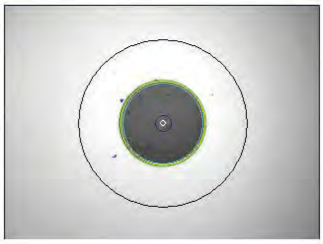
Low Magnification	High Magnification
	

Figure 5. Automated inspection enables the technician to certify compliance to the standard by producing a date stamped test report.

Conclusion: Business Impact of Automated End Face Analysis

The combination of common requirements (the IEC Standard) and automated fiber optic inspection and analysis software (FiberChek2) has positively impacted product quality across the supply chain. The business impacts of reliable, repeatable automated fiber optic connector inspection and certification include:

- Insured and repeatable product quality through the quantification of connector end face condition at installation
- Assurance of customer satisfaction and supplier protection through the reliable documentation of connector end face quality
- Competitive advantage for component and system vendors, and for installation contractors who can cost-effectively document end face quality
- A common, repeatable system provides correlation through the supply chain
- Easy deployment of custom requirements analysis

Combined, these benefits make automated end face inspection the most effective method available to assure and certify compliance to the IEC Standard throughout the fiber optic product life cycle, and achieve the promise of next-generation networks.

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