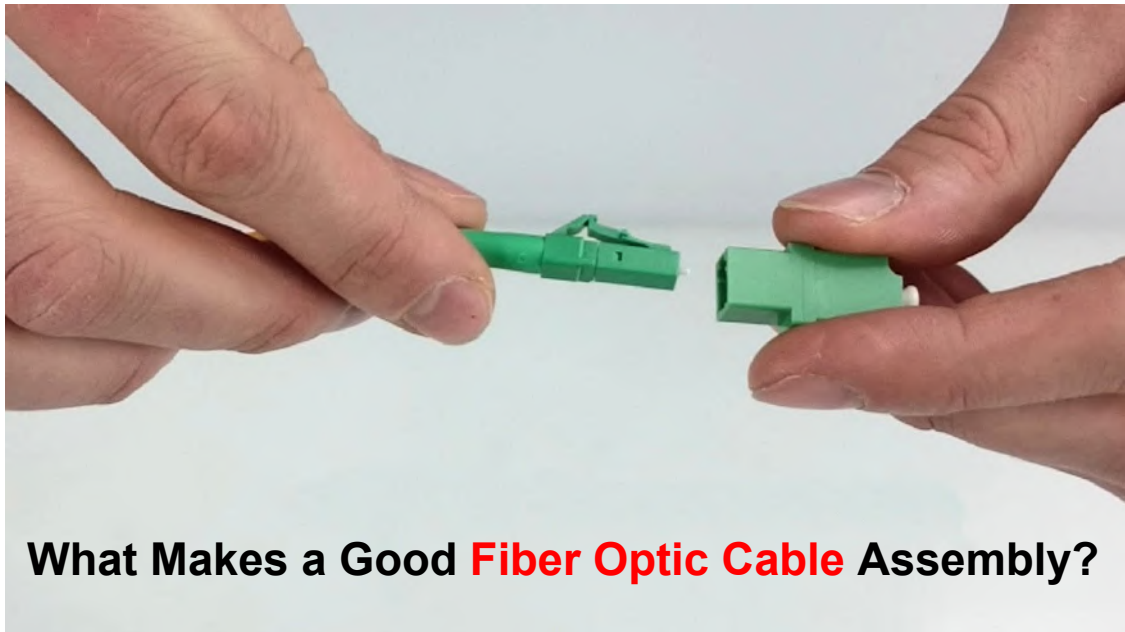




What Makes a Good **Fiber Optic Cable** Assembly?

Optical **Performance**

Insertion loss and return loss performance are fundamental parameters used to assess the compatibility of optical fiber links and channels with the specific networking applications they support. Insertion loss is commonly used as the basis for acceptance testing of installed links and channels. Although return loss testing of installed cabling is not required by industry standards, it is a normative requirement for fiber connectors and assemblies. Return loss is critical to optical performance of links and channels because reflected optical signals can interfere with detectors on both the forward and rearward directions. These reflections degrade signal to noise ratio and are commonly presented using “eye diagrams”, with higher return loss resulting in a smaller eye opening (height, peak to peak). Likewise, testing in both directions and at both wavelengths will detect abnormalities that degrade optical performance of cabling channels.

Many network performance problems occurring at the physical layer are directly related to cable assembly quality. In fact, the overall performance and reliability of a network port is only as good as the cabling to which it is connected. This is particularly true of optical fiber cable assemblies, where seemingly minute variances in tight fiber connectivity tolerances can drastically undermine cabling performance. While a percentage of assembly performance issues may be identified through field testing of installed channels, field testing is not inclusive of all potential issues. Although a critical step, field testing can provide a false sense of security. For example, a single passing result for insertion loss does not guaranty long term reliability.

Insertion Loss is typically the only field measurement, but not the only parameter that can affect network performance and reliability. Control of end face geometry, cleanliness, surface defects and mechanical integrity should all be considered to ensure long-term reliability.

End Face Geometry

Overall performance of the fiber optic connectivity depends on the mechanical characteristics that control alignment and physical contact of the fiber cores. End face geometry is an essential characteristic of repeatable and reliable optical fiber connections.

The three critical parameters for connector end-face geometry are:

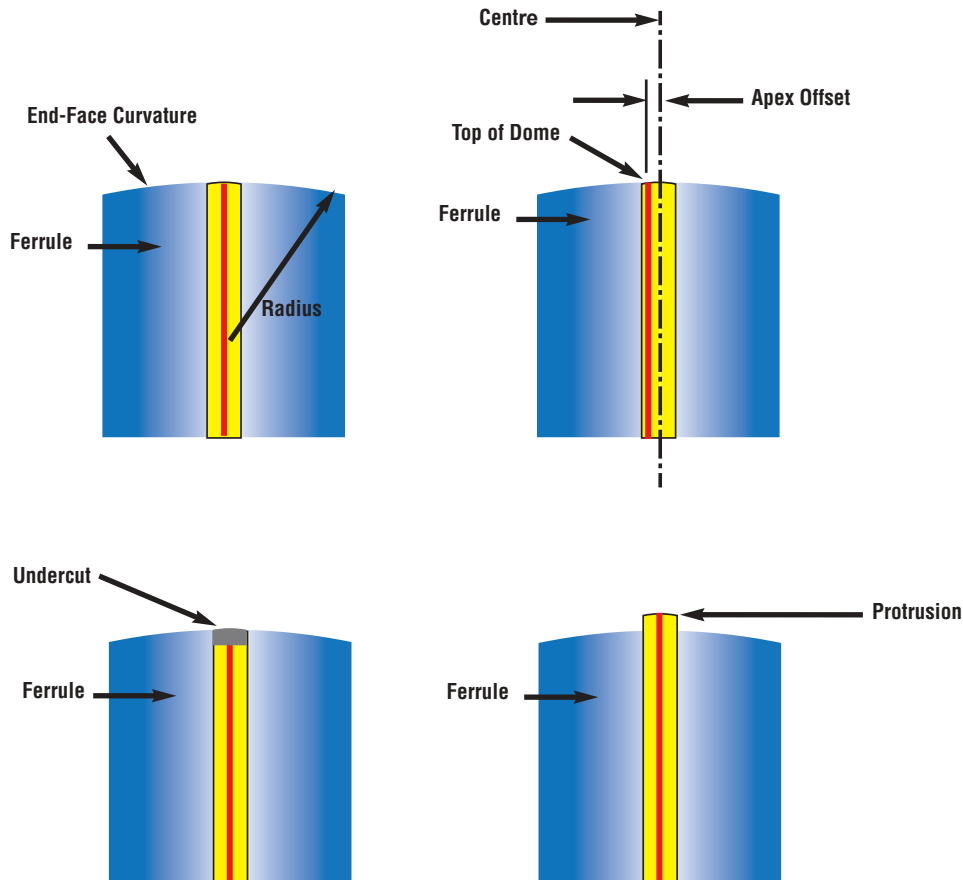
Radius of curvature: the roundedness of the ferrule's end-face surface

Apex Offset: The degree to which the end face "dome" is centered

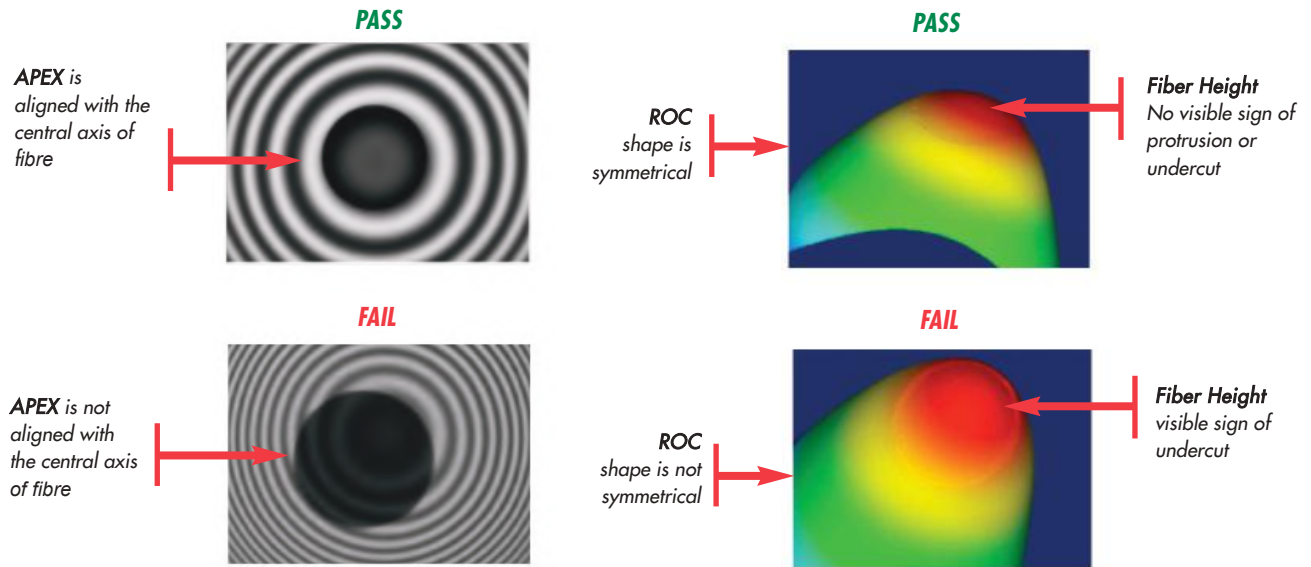
Fiber Undercut/Protrusion: the height or depth that the fiber core protrudes or undercuts the ferrule surface.

Because the quality and consistency of the physical contact between fiber cores depends on end-face geometry, it must be rigorously controlled to support the premise that cabling is fully intermateable and interoperable. Otherwise, the percentage of mated connections that do not conform with optical performance requirements will statistically increase. In other words, poor end face control poses increased risk that a "day-one" pass will be followed by trouble on "day-two".

End Face Geometry



APEX and ROC Test Examples



A connection between a patchcord having non-compliant end-face geometry, and one that is standards compliant will exhibit inconsistent test results. For example, optical fibre links that pass acceptance testing using a compliant reference patchcord will exhibit higher optical loss and greater variability when replacing the reference cords with non-compliant patchcords.

Contamination and Surface/Subsurface Defects

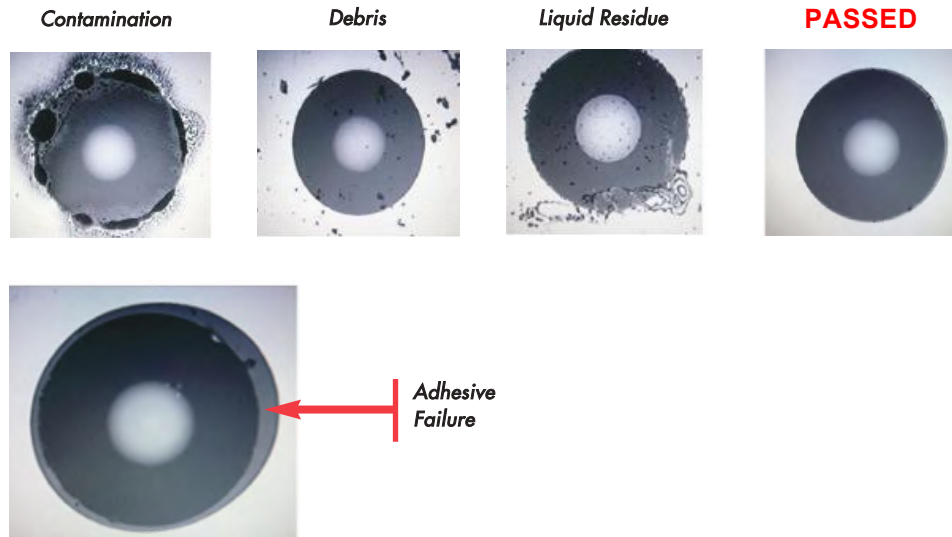
Fiber core fractures and the presence of contamination on ferrules, alignment sleeves or dust caps cause wide variations in both insertion loss and return loss performance. These issues are separate from end face geometry, but have an equally high impact on first pass yield for cabling acceptance testing. More importantly, these irregularities undermine network integrity because uncorrected contamination or fractures interfere with optical performance and results are highly variable and completely unpredictable.

End Face Visual Inspection

Surface defects and cleanliness are critical, but will not always be detected with insertion loss or end face geometry testing. A smooth but fractured fiber will not necessarily fail end face geometry checks for radius of curvature, apex offset and fiber height. Because proper cleanliness of the fiber jumper during manufacturing and installation is critical to reliability and optical performance, Aston utilises automated end face inspection for jumper cleanliness and surface defects according to IEC 61300-3-35 and IEC 62627. This equipment automatically detects surface defects and contamination that can directly impact performance.



End Face Contamination and Surface Defects



Non compliant end-face geometry, and contamination are the leading causes for erratic optical test results in the field and are responsible for wasted time and effort in trouble-shooting optical fibre cabling. These issues translate to low first pass yield on acceptance testing of installed fiber cabling channels. Faced with time constraints, installers will sometimes retest until they achieve a passing result. Unless the non-compliant patchcords are replaced, they pose a risk of unacceptably high insertion loss for the channel on “day two”. Another problem is that contamination can act as a virus that is transferred onto reference patchcords and the equipment interface. Even if the infected patchcord is replaced, the damage is done.

Mechanical Reliability

There are several tests required as part of industry standard specifications for mechanical reliability. Mechanical reliability parameters include Flex Testing, Torsion Testing, Pull Testing, Cable Retention, Impact Testing, Vibration Testing, Durability and Transmission with an Applied Load. These mechanical tests verify that a fiber patchcord can endure the installation and maintenance performed in a typical fiber optic network, and that they can dependably withstand the internal stresses imposed by spring loaded physical contact over time under in a variety of environmental conditions. Mechanical tests performed on each assembly were Cable Pull, Flex, Torsion and Retention.



ASTON, LONDON, UNITED KINGDOM