*FIBER OPTIC INSPECTION · TEST · CLEANING*

# Optical End Face Inspection Guidelines

## For ceramic ferrule end-face connectors

### INTRODUCTION

Optical Fiber infrastructures are increasingly common in government, military, business, and industrial applications. This increased deployment of optical fiber networks, and the need for reliable high bandwidth makes the simple task of checking and inspecting connector end-faces a crucial process that must not be neglected. Clean optical connectors are paramount in providing a reliable, high-performance fiber optic infrastructure.

IEC 61300-3-35, 2nd edition, June 1, 2015 "Fibre optic interconnecting devices and passive components – Basic test and measurement procedures" and ARINC Report 805-4 "Fiber Optic Test Procedures" published January 6, 2014 are standards used to define and assess pass/fail certification for optical fiber end-face inspection.

A piece of dirt, speck of dust or any foreign particle/contaminant in the critical position of the optical end face connector may cause high reflection, insertion loss and fiber optical end-face damage. In high power transmission, a contaminant may burn and fuse the dirt with the silica material of the optical end face fiber, thus requiring rework, replacement, RMA and down time of the network. The source of contamination is usually due to connector mishandling during testing, installation and lack of understanding of optical end face fiber cleanliness.

Fiber optic companies, engineers, technicians should understand the role that cleaning plays in the application at hand, and must learn the best methods of cleaning the end-face optical connectors.

### CLEANLINESS REQUIREMENT AND PREVENTION

It's important to ensure that the proper connectors for the environment and application are chosen to minimize cleaning/testing/maintenance downtime, and to provide the highest reliability.

Engineers and technicians have no way of knowing if the optical end-face is clean unless they inspect it using a fiber inspection tool. The best answer to the question *"what should be inspected and cleaned?"* is *everything*—every optical end-face connector should be inspected, and every optical end-face connector that fails should be cleaned. If an optical end-face connector passes the specified pass/fail criteria, do not clean it. Always inspect, clean and inspect again before connecting.

### SOME COMMON MISTAKES

These are some common mistakes that cause optical end face connector contamination:

1. Not using a connector dust cap during installation and testing, or leaving the connector uncapped for even a short period of time in an uncontrolled environment or non-FOD facilities.
2. Engineers and technicians touching the connector's end-face with their fingers—leaving skin oil or passing on dirt/contaminant.
3. Using unsuitable cleaning methods or products to clean the optical end-face connectors such as tissue paper, water or any cloth.
4. Not cleaning both connector end-faces before mating or making a connection.

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### PROPER CLEANING WITH LINT-FREE WIPES AND ISOPROPYL ALCOHOL

Fiber optic end-faces may be cleaned using lint-free wipes with Isopropyl Alcohol. Wipe in one direction, not back and forth. Typically one or two short (1 cm) strokes on the end- face is sufficient. Enough pressure should be applied so that the wipe can conform to the end-face geometry and ensure that the entire end-face has been cleaned.

### DRY ACTION OR REEL CARTRIDGE CLEANING TOOLS

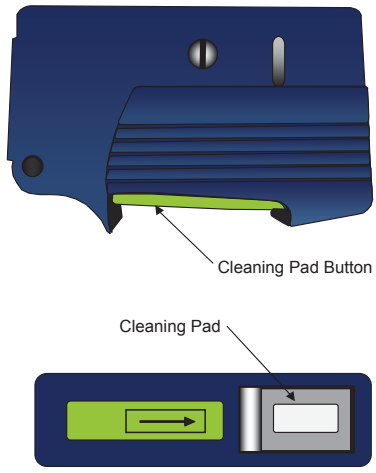


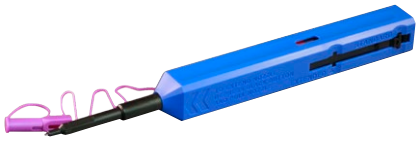

*Figure 1. Reel cartridge cleaner*

The optical fiber end face can be cleaned using Glenair Dry Action Cleaning Tools. The dry cleaning strand gently sweeps away dust and residue without the need for solvents. Dry action cleaning tools are easy to use, durable, and crush- and impact-resistant.

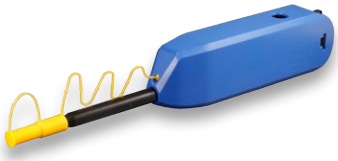
The proper Dry Action Cleaning Tool needs to be selected for the ferrule size or terminus that is being cleaned (aligned with the sleeve diameter.) One or two strokes with the cleaning tool with moderately light pressure is sufficient to clean the ferrule.

Note: the typical cleaning stick can be used over 525 cleanings per unit after which it must be disposed.

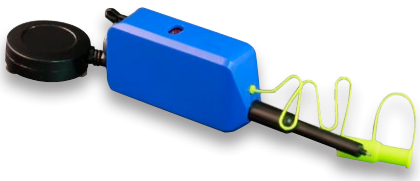
**GCLT-H160 Dry action cleaning tool for MIL-DTL-38999 system**



**GCLT-H125 Dry action cleaning tool for GHD, NGCON, and ARINC 801 systems**



**GCLT-HC250 Dry action cleaning tool for GFOCA system**



**GCLT-H100 Dry action cleaning tool for D38999 #20 and Mighty Mouse #20HD systems**

***Figure 2. A selection of Glenair Dry Action Cleaning Tools. See www.glenair.com or contact the factory for our full range of fiber optic cleaning tools***

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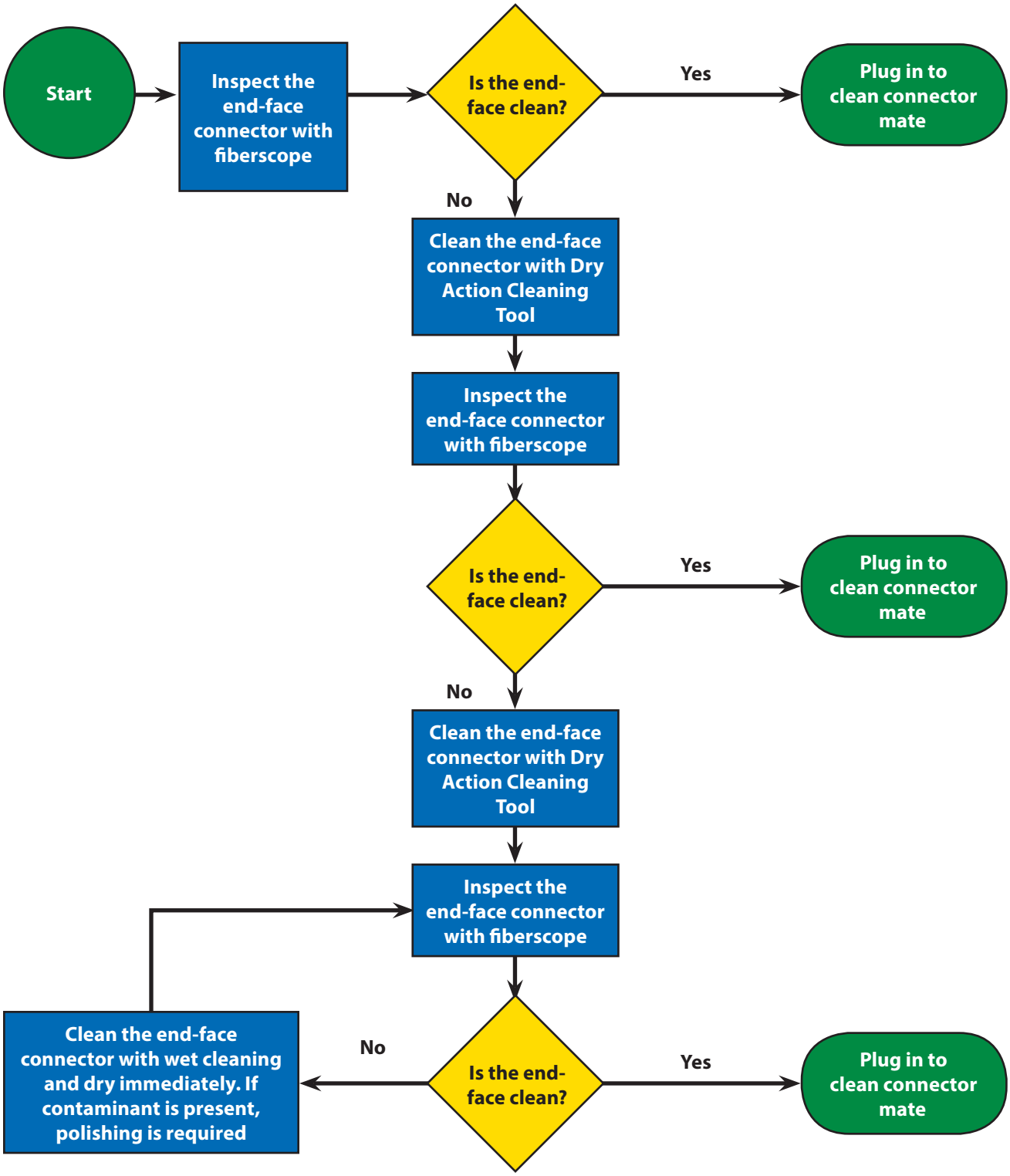
## For ceramic ferrule end-face connectors

### OPTICAL FIBER END-FACE CONNECTOR CLEANING PROCESS FLOW



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## For ceramic ferrule end-face connectors

### OPTICAL FIBER END-FACE PASS/FAIL CRITERIA

**GBS1001 Inspection Probe with USB Adapter and Fiber Chek Software**

**GBS1001 Includes:**

- *Inspection probe with USB adapter*
- *2 tips: GIT-003 Universal 1.25mm patch cord; GIT-002 Universal 2.5mm patch cord*
- *Fiber Chek Software*

Fiber Chek is an integrated hardware/software package engineered with the single purpose of critically and consistently grading fiber end-faces. Works hand in hand with the Quick Capture Analog Probe for visual inspection, taking pictures and testing fibers. The GBS1001 inspection probe features a digital sensor and USB2 video stream which delivers high-resolution uncompressed images directly to your personal computer.

- Automatic debris and defect detection, including fine scratches
- Measures epoxy ring for out-of-tolerance conditions
- Inspection results, including image data, can be printed or archived
- Utilizes industry standards or user defined threshold settings

***Figure 3. GBS1001 Inspection Probe with USB Adapter and Fiber Chek Software***

A longtime concern in fiber optic end-face inspection is the subjective and inconsistent process in determining cleanliness. Determination can vary greatly based on a technician's experience, eyesight, lighting, and the inspection tools used.

IEC 61300-3-35 standard categorizes the defects into two groups (scratches and defects). Defects including scratches, chips, cracks, pits, fixed contamination, loose contamination and film/oil. Scratches are identified as permanent linear surface features while defects include all detectable non-linear features that can typically be cleaned. Scratches are usually caused by small contaminants in the polishing materials, appears white in color/light or dark in appearance. Severe scratches or a larger number of scratches may affect insertion loss and back reflection.

Glenair's connector end-face visual inspection criteria is based on the ARINC 805-4. Depending on the product, it is classified as either Beginning of Life or In Service. Cables and discrete connectors are classified as "Beginning of Life". Electronic assemblies which incorporate a fiber end face are classified as "In Service". Classification as "Beginning of Life," defined as new from Glenair's final inspection prior to shipping to customer and/or being received by customer, and mated a minimum of one time. As soon as the connector's cap is opened for installation, mating or testing, the connector end-face is classified as "In-Service" per the ARINC 805-4 standard. If the customer's end-face visual inspection requirement is more stringent than the IEC 61300-3-35 and ARINC 805-4 requirements, please contact: fibertechsupport@glenair.com for more information.

The Glenair beginning of Life visual inspection criteria at 200x magnification for Multimode and Singlemode optical fiber end face are described in Table 2 & 3 respectively. During end-face visual inspection using a scope at 200x magnification, if a debris or scratch can be seen, then it will be considered that the item is larger than 1 micron. In Glenair, inspection scope software is used as an aid in determining the type and amount of end-face defects and scratches.

Glenair uses the GBS1001 Inspection Probe with USB Adapter and Fiber Chek Software. The Fiber Chek Software uses an algorithmic process to automatically analyze the fiber optic end-face based on Glenair's pass/fail criteria. This analysis provides a "Pass" or "Fail" result, thus removing any ambiguity since it eliminates human subjective assessment.

The Fiber Chek Software determines pass or fail is based on the number of scratches and defects found in each measurement region of the fiber end-face, including the core, cladding, adhesive layer and contact zones, as well as the quantity and size of the scratches and defects.

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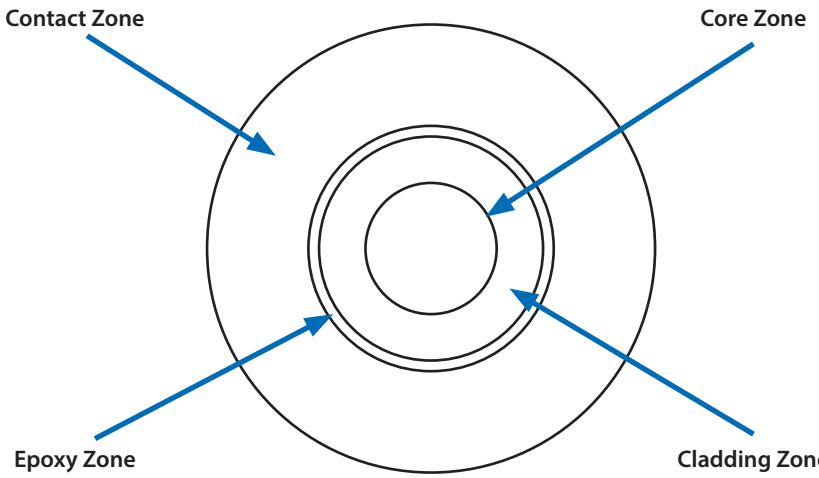
### FIBER MEASUREMENT REGION DIAGRAM FOR MULTIMODE AND SINGLEMODE

As defined in IEC 61300-3-35, an optical connector end face is separated into zones:

The Core (Zone A) Critical zone, where light travels and it is a restricted area of the fiber end-face surface; the Cladding (Zone B) which is the outer section of the Core which reflects light back into the Core; the Epoxy/Adhesive Zone (Zone C); the Contact Zone or Jewel (Zone D).




| Multimode Fiber Measurement Region | |
|---|---|
| **Zone** | **Diameter** |
| Core Zone A | 0 – 66 µm |
| Cladding Zone B | 66 – 120 µm |
| Epoxy Zone C | 120 – 135 µm |
| Contact Zone D | 135 – 250 µm |
| **Singlemode Fiber Measurement Region** | |
| **Zone** | **Diameter** |
| Core Zone A | 0 – 25 µm |
| Cladding Zone B | 25 – 120 µm |
| Epoxy Zone C | 120 – 135 µm |
| Contact Zone D | 135 – 250 µm |

*Table 1. Fiber Measurement Region*

# Optical End Face Inspection Guidelines

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### VISUAL INSPECTION CRITERIA TABLES FOR MULTIMODE AND SINGLEMODE FIBER

| Visual Inspection Criteria for Multimode Fiber | | | | |
|---|---|---|---|---|
| **Visual Inspection Criteria** | **Zone A Core Area** | **Zone B Cladding Area** | **Zone C Adhesive Area** | **Zone D Ferrule Area** |
| Cracks | None | None | None | None |
| Chips/Pits/ Contamination | Any < 1 µm | 2 < 5 µm | No limit on size or number | No limit on size or number |
| Scratches | Any < 1 µm | Any < 3 µm | No limit on size or number | No limit on size or number |
| Debris | None | None | Maximum of 5 pcs of debris < 10 µm in diameter | Maximum of 5 pcs of debris < 10 µm in diameter |
| Film/Oil | None | None | None | None |

*Table 2. Visual Inspection Criteria for Multimode Fiber*

| Visual Inspection Criteria for Singlemode Fiber | | | | |
|---|---|---|---|---|
| **Visual Inspection Criteria** | **Zone A Core Area** | **Zone B Cladding Area** | **Zone C Adhesive Area** | **Zone D Ferrule Area** |
| Cracks | None | None | None | None |
| Chips/Pits/ Contamination | Any < 1 µm | Maximum of 2 ≤ 5 µm | No limit on size or number | No limit on size or number |
| Scratches | Any < 1 µm in width. No limit on number of scratches | Any ≤ 3 µm in width. No limit on number of scratches | No limit on size or number | No limit on size or number |
| Debris | None > 1 micron | Maximum of 2 pieces of debris ≤ 10 µm in Diameter | Maximum of 5 pcs of debris ≤ 10 µm in Diameter | Maximum of 5 pcs of debris ≤ 10 µm in Diameter |
| Film/Oil | None | None | None | None |

*Table 3. Visual Inspection Criteria for Singlemode Fiber*

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### SOFTWARE PROFILES FOR MULTIMODE AND SINGLEMODE FIBER

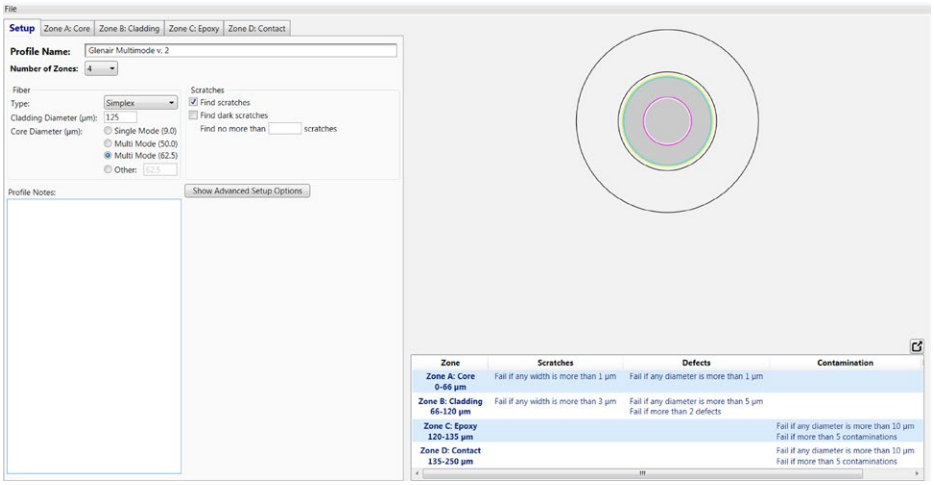


*Figure 4. Multimode Fiber Criteria Software Profile*

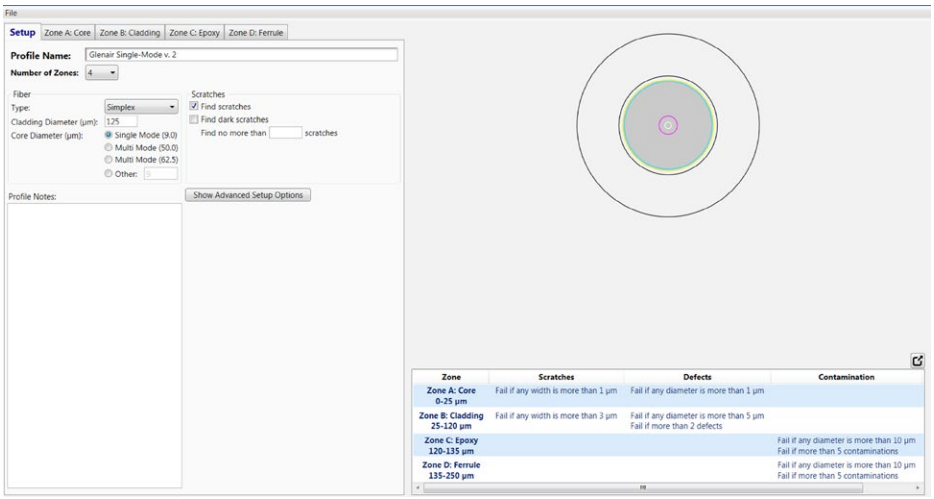


*Figure 5. Singlemode Fiber Criteria Software Profile*