Tech Article

A Sticky Situation: Removing Electrostatic Charges Improves Fiber Network Performance

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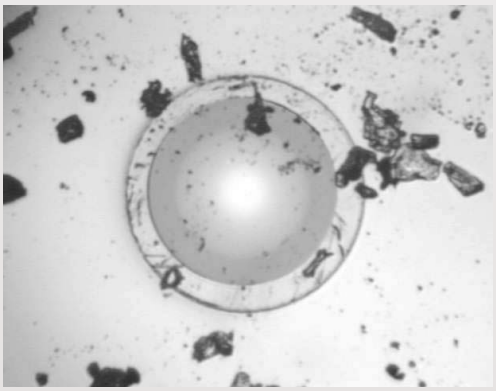

Electrostatic charges draw and hold unwanted dust particles onto fiber network connector end-faces just like a magnet.

Static is an invisible hazard to fiber optic networks. Electrostatic charges draw and hold unwanted dust particles onto fiber network connector end-faces just like a magnet. Although this dust contamination is merely microns in size and only visible when magnified with an inspection scope, it still causes serious performance problems for a network. Dust in a signal's path changes or obstructs the light's index of refraction, or the route of the signal, through the fiber. This causes insertion loss that weakens the signal and slows down the network speed. And if the refraction angle is altered enough, the network signal may be lost altogether.

Modern fiber networks are especially susceptible to this problem since the higher the light frequency, the greater its sensitivity to changes of the refractive angle. This means faster networks like 5G, that need every milliwatt of power to function flawlessly, are more vulnerable to static and the resulting dust contamination. Therefore, it is critical to remove electrostatic charges and dust from fiber end-faces to help networks run faster and more reliably.

Friction – Where the Static Comes From:
Any time there is contact friction on a fiber end-face or its ferrule, an electrostatic charge is generated. Typical fiber end-faces are made of nonconductive materials such as plastic, ceramic, glass and epoxies. Therefore, the static charge doesn't have a path to ground and the charge cannot dissipate. The technical term for this is "triboelectric charging." As a result, the end-face stays electrostatically charged and attracts oppositely charged dust particles onto the connector. Dust clings to both the outer regions of the connector and at the ferrule apex in the contact zone. To complicate matters, the endface is often engineered with a convex geometry to minimize back reflection, but that design actually encourages static charges to concentrate at the contact region of the mated pair, actively encouraging particle migration to right where it will do the most damage. Electrostatic charges on end-faces are generated by contact friction in a number of ways including the following:

- **Dry Wiping:**
  One of the most common sources of contact friction and static comes from wiping a nonconductive end-face with a dry wipe or cleaning stick. The wiping action creates a triboelectric charge that attracts unwanted airborne dust to the connector face. Also, a poorly engineered wipe will shed clouds of particles during cleaning adding dust to the equation. This static build-up is especially intensified in low humidity environments.

- **Air Cleaning or Drying:**
  Another source of friction is cleaning or drying an end-face with compressed air or canned dusters. The rapidly moving air creates friction and delivers an electrostatic charge to the end-face.

- **Connector Mating:**
  Inserting or removing an end-face connector into the adapter during mating creates static and produces wear debris including dust and other particles.

An optical-grade cleaning fluid that is engineered specifically for cleaning fiber optic end-faces is the best choice.

- **Removing Protective Caps:**
  Removing manufacturer installed protective end caps from a new end-face connector which was perfectly clean during the last inspection at the factory will generate static and attract contamination to the end-face when the end cap is removed by the installer in the field.

- **Network Testing:**
  Connecting an end-face to an inspection scope, power meter or light source creates friction. In addition, those testing tools are almost always dirty, meaning they will cross-contaminate the end-face.

Minimize Static During Network Installation

Dust particles stay electrically bonded to a cable end-face until the electrostatic charges are dissipated through proper cleaning. Therefore, the best way fiber installers can remove electrostatic charges and dust from a fiber network is to properly clean the fiber end-faces during installation. There are a number of recommended cleaning tools and methods that are effective at controlling static charges and meet the IEC 6130-3-35 standard for fiber end-face cleanliness.

They Include:

- **Wet/dry Cleaning is Best for Dissipating Static:**
  Wiping an end-face with a dry wipe, dry cleaning stick or dry clicker tool generates a significant static charge which in turn attracts dust that is extremely difficult to dissipate. Therefore, “wet/dry” cleaning is recommended by both IPC (Institute of Printed Circuits) and iNEMI (international Electronics Manufacturing Initiative) to reduce static and meet the IPC-8497-1 fiber optic cleaning standard. Wet/dry cleaning increases the humidity on the end-face and dissipates the surface static. During the wet/dry cleaning process, an installer uses a section of an optic-grade cleaning wipe, dampened with a static dissipative cleaning fluid. The installer wipes the connector end-face starting at the damp area and moving in one direction towards the dry area of the cleaning wipe. This removes the contamination and minimizes the static charge in one step. In the case of port cleaning sticks or clicker devices, the cleaning stick or device is dampened with a cleaning fluid first and then used to clean the end-face.

- **Static-Dissipative Cleaning Fluid:**
  Dust remains bonded to an end-face until the static charge finds a conductive path for it to dissipate. The introduction of a static dissipating cleaning fluid temporarily creates that conductive path for the static to disperse, making it easy to physically wipe the debris away. An optical-grade cleaning fluid engineered specifically for cleaning fiber optic end-faces is the best choice. The cleaning fluid should be ultra-pure, residue-free and nonflammable. It should also be in a hermetically sealed (un-refillable) container to prevent cross-contamination and spilling. Using a fast-drying, static-dissipative fluid also eliminates any additional drying step, saving time.

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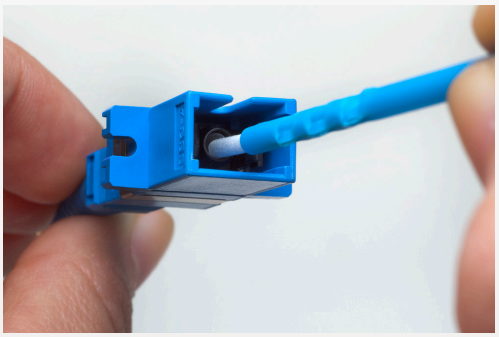
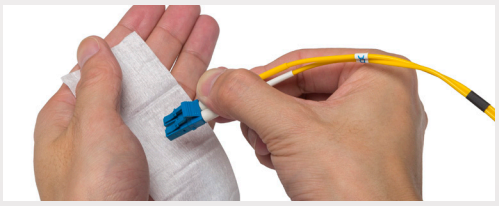


A well-engineered cleaning stick makes incidental contact with the alignment sleeve sidewalls allowing fluid from the cleaning stick to contact the sidewalls and instantly defuse static charges.



Dry wiping creates a triboelectric charge that attracts unwanted airborne dust to the connector face.

Avoid IPA (Isopropyl Alcohol)

Some fiber installers use Isopropyl Alcohol (IPA) to clean fiber end-faces. However, IPA is hygroscopic, meaning it absorbs moisture out of the air. As the IPA absorbs the water molecules, it also picks up airborne microscopic dust particles such as exhaust particles from traffic, pollen from plants, construction dust and absorbed minerals and salts from the water molecules. In addition, IPA is slow drying. In some instances, an installer might use an aerosol duster to speed up the drying. However, this increases the static charge, attracting more dust. Plus, IPA is very flammable making it regulated as dangerous goods for transportation.

Cleaning Sticks

The combination of a cleaning stick and static dissipating cleaning fluid are perfect for cleaning and removing static from connectors mounted in hard-to-clean alignment sleeves. When cleaning, an installer dampens the cleaning stick with cleaning fluid first. After inserting the stick into the connector, they rotate it about six times in the same direction. They avoid extreme force and do not excessively scrub the end-face to prevent scratching, pitting or scarring end-faces. A cleaning stick should be engineered specifically to match the configuration of the end-face and be non-linting for optimal cleaning. A well-engineered cleaning stick will also make incidental contact with the alignment sleeve sidewalls allowing fluid from the cleaning stick to contact the sidewalls and instantly defuse static charges so debris that exists on the alignment sleeve stays put, and does not jump onto the clean connector end face during insertion. Cleaning sticks should be kept in their package until ready to use to prevent soiling or damage. Also, cleaning sticks are single-use. Reusing the same stick spreads contamination from one end-face to the other. In addition, all connectors should be cleaned, both sides, every time before mating them to prevent cross-contamination.

High-Grade Optical Wipes

Less expensive wipes are rarely up to the task of cleaning microscopic contamination from optical connectors. They tend to rip and shred easily, leaving lint and debris behind and often generate high static charges making their use counterproductive. Therefore, high grade, optical grade wipes that do not lint and do not generate static charges are the preferred choice. Economize by purchasing smaller sized wipes that reduce waste. Look for a wipe sold in packaging engineered to minimize static charges as individual wipes are dispensed. Also, leave the wipes in the packaging until ready to use to keep them clean and prevent waste. Like the cleaning sticks, wipes should be used only once and then thrown away to prevent cross-contamination on the network end-faces.

Conclusion

Static is a threat to fiber optic network performance. Triboelectric charges attract dust particles to the end-faces and lock them in place. Dust contamination on the core of the fiber, where the signal travels through, causes insertion loss, impacting network speeds. In addition, the dust particles are ground into the ferrule face, causing pits and scratches, which might require complete end-face replacement. Therefore, it is important to eliminate electrostatic charges to help improve end-face cleaning and overall fiber network performance.

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Dry cleaning creates a static charge on connector end-faces. Therefore, wet/dry cleaning is recommended. A modern, water-free, high-purity fluid engineered for cleaning fiber optic connectors both dissipates and prevents triboelectric charges in the connector end-face. In addition, the proper use of high-quality cleaning sticks and optical grade cleaning wipes on both ends of the connectors prior to mating delivers cleaner end-faces and ultimately a more robust network.

Those looking for help in cleaning and removing static from their fiber-optic end-faces should work with a company that has experience and expertise in fiber optic cleaning. They can recommend the best fluids, tools and methods for each individual cleaning challenge.

About the Author:
Jay Tourigny is Senior Vice President at MicroCare which offers precision cleaning, lubricating and debinding solutions. He has been in the industry more than 30 years and holds a BS from The Massachusetts College of Liberal Arts. Tourigny holds numerous U.S. patents for cleaning-related products that are used on a daily basis in medical, fiber optic and precision cleaning applications. For more information, visit microcare.com.

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