



There's More Inside Your
Splice Closure than You Think

COMMSCOPE®

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Network connectivity has often been referred to as the 4th utility of the 21st century. But even in many developed countries, affordability and access to this critical part of the national infrastructure is still lacking. In the U.S., for example, when the coronavirus pandemic forced millions to stay home, an estimated one in five school-aged children lacked the high-speed internet connection needed to access lessons and other materials.ⁱ

The issue, it turns out, is not limited to those living in depressed and underserved urban areas. A 2020 study by the National Association of Counties (NACo) estimated that 65-percent of U.S. counties have average connection speeds lower than the FCC's definition of broadband. While counties of all sizes had connectivity issues, the majority were seen in small and medium-sized counties (populations of 500,000).ⁱⁱ

The lack of accessible and affordable high-speed broadband is global. According to [Internet World Stats](#), 42-percent of the world was yet to be connected to any type of broadband as of mid-2019. Those who do have access pay an average of \$56.59 per month or more depending on extra costs like equipment fees and installation costs.^{iv}

Building out the infrastructure needed to connect a majority of the world's population will involve a massive amount of new fiber. At the same time, the number of connected nodes—small cells, IoT sensors, Wi-Fi access points, etc.—needed to support emerging 5G applications is exploding. A Deloitte Consulting analysis estimates that the United States will require an investment of \$130–\$150 billion in fiber infrastructure over the next five to seven years to adequately support broadband competition, rural coverage, and wireless densification.^v

The focus on connecting un-served and underserved areas and preparing for fiber-dense 5G applications means significant changes in the outside plant. New topologies such as distributed access architectures and fiber indexing drop strategies are leading to increases in deployment and application diversity.

As a result, network operators must consider the effects on their distribution and drop networks. At the same time, the labor pool of skilled fiber technicians able to execute these new strategies is drying up. The takeaway? Building a new broadband backbone for a 21st century economy requires more than addressing the “what.” Network operators must tackle the “how.”

- How can you roll out more infrastructure faster and more reliably?
- How can you ensure it is agile and easily expandable and upgradable?
- How can you make it easier to repair when needed?

One key can be found in a single, often-overlooked aspect of the distribution and access network. The fiber splice closure and how it is sealed.

\$130–\$150 billion over the next five to seven years:

The required investment in fiber infrastructure in the United States to adequately support broadband competition, rural coverage, and wireless densification

DeLoitte Consulting analysis

“The ultimate challenge facing network operators is how to scale up from millions of endpoints to the billions of endpoints that 5G services enables when it is completely built out.”

ISEmag.com March 1, 2021

Splice closures: an overview

Wherever fibers need to be aggregated, branched or accessed in the outside plant, fiber splice closures are used to house and protect the splices and manage fiber cables. Outside plant FTTX networks can be broadly segmented into three main areas: trunk, feeder/distribution and drop.

The trunk network is the backbone, where each fiber strand aggregates traffic from many customers. Hence, its main characteristic is reliability. Installations in this part of the network require expert staff and specialized tools for intervention. Once the network is in place, however, technicians rarely go back for changes or maintenance.

Closer to the customer is the feeder network—or, even more so, the distribution network. As the network extends farther out in the last mile, better installability and flexibility are needed. The drop network connects homes, buildings, wireless base stations, or other nodes. Here, deployment speed is of utmost importance.

With the exception of the trunk, all areas of the outside plant network must support a significant number of fiber connections, access points, and flexibility nodes. It's here that service providers test and diagnose their network and make frequent alterations so they can add fiber. Each of these splice points is housed in a fiber splice closure.

As networks have become more complex, splice closure designs have evolved to address specific challenges and requirements. The basic requirements can be grouped into four main categories:

- **Reliability:** Ability to protect spliced fibers from moisture, dust, vibrations and other factors
- **Installability:** The ease, amount of training and tools required to properly install the closure
- **Flexibility:** How well the closure supports various applications and fiber configurations
- **Speed:** Ability to quickly and easily add or modify fibers within the closure when needed

Depending on where within the network the closure is located, one of these characteristics will be more important than the others. For example, the farther out toward the edge of the network, the less specialized the installation crew generally is and the more installer friendly the closures need to be. That's why more connectorized and hardened solutions will be found in the drop and distribution part of the network. Typically, a mix of spliced and pre-terminated cabling solutions is deployed to address the diversity of outside plant environments.

The basic requirements of splice closure designs can be grouped into four main categories:



RELIABILITY



INSTALLABILITY



FLEXIBILITY



SPEED



NOVUX™
Compact Closure

The evolution of closure sealing

As fiber is pushed deeper into the OSP network and technologies grow more sensitive to performance-eroding contamination, the variety of sealing technologies used to protect the fibers inside the closures have evolved. Until very recently, there were three main types of seals: heat shrink, rubber seals (also referred to as grommets) and thermoplastic elastomer (TPE) gel.

Recently, CommScope material scientists developed a fourth technology—silicone gel—that adds critical capabilities and performance features unavailable with the previous three. The following is an overview of the sealing technologies now available to protect the network operators' fiber investment.

Heat shrink

Developed in the 1980s, the earliest fiber closure, CommScope's FOSC-100, used a dual-wall heat shrink seal to protect cable bundles and connectors. Fiber cables are placed within entry ports designed into the closure and inside a heat-shrinkable tubing (HST) lined with hot-melt adhesive. When the tubing is heated, one end of the adhesive-lined HST shrinks onto the outside diameter of the cable entry port and the other shrinks onto the outside diameter of the cable itself, creating a complete seal.

Heat-shrink seals are basic in terms of construction but effective in "fit-and-forget" applications, such as in-line closures or branch joints in the trunk and feeder networks. Known for long-term durability, they can be used aerially, underground or in manholes. They are also a good choice for applications involving rigid, thick-jacketed cabling. As one of the most established sealing technologies, heat-shrink is familiar to most of the more experienced installers. It also provides

Closure sealing technologies include:

HEAT SHRINK

RUBBER GASKET

THERMOPLASTIC ELASTOMER (TPE) GEL

SILICONE GEL

CommScope products using heat shrink sealing



excellent torsion performance, particularly with cables greater than 18mm in diameter. While heat-shrink is one of the most economical sealing solutions in terms of component cost, it does require specialized tools, open flame or heat gun, more time and extensive training.

Rubber

Shortly after the introduction of heat-shrink closure seal, some operators began adopting mechanical rubber sealing. The biggest advantage of the mechanical rubber seal is that it can be pre-installed at the factory. This saves time, ensures consistent quality and eliminates the need for specialized equipment and training.

This solution uses a bolt and screw system to bring rubber under compression. The other big advantage of rubber sealing versus heat-shrink sealing is that it enables easy re-entry into the closure. The rubber used is typically acrylonitrile butadiene rubber, commonly referred to as nitrile or NBR rubber. The NBR rubber grommets are typically matched to the outer-diameter and/or shape of the cable to be sealed.

A relatively inexpensive solution, the rubber seal helps operators reduce the overall cost of last mile deployment. However, it offers limited re-entry capabilities and does not conform to surface imperfections in the closure or the cabling as well as a heat-shrink or a gel-type seal. It also provides limited torsion to protect splices during a cable pull and may require grease or secondary waterproofing.

Rubber sealing technology continues to be used in a variety of OSP and inside plant applications. Outside, it is an ideal solution for aerial installations and is widely used in the distribution and drop network. It provides a good balance between cost and re-entry, making it suitable for last-mile applications. Inside, where sealing requirements are less stringent, it is also used for in-building connections, such as wall-mounted fiber termination boxes in multiple dwelling units (MDUs) and multiple tenant unit (MTUs).

TPE gel

In the 1990s, to counter some of the issues of the mechanical rubber seal, CommScope and other OEMs introduced TPE gel sealing. A more heavily engineered solution, TPE gel seals use proprietary compounds that typically feature a rubber polymer extended with oil. The resulting semi-solid/semi-liquid compound fills voids and conforms to irregular shapes when under compression and has natural moisture and dust blocking properties.

Like mechanical rubber seals, TPE gel seals for ports and closure are pre-installed at the factory, eliminating the need for specialized tools and training. Having ultra-low modulus and being super-elastic, gel conforms to variations in cable sizes and abrasions or imperfections in the cable jacket and closure. The seal is tight enough to eliminate the need for any grease or secondary sealing. It is also robust, enabling it to withstand potential abrasion and wear during repeated

CommScope closures using rubber sealing



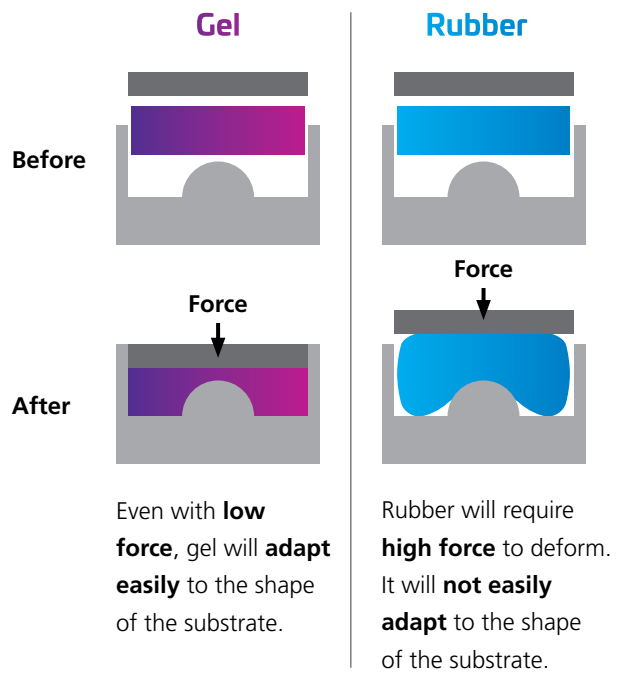
re-use and re-entry. It provides long term, high-reliability protection for both aerial and underground applications in feeder, distribution and drop networks.

Silicone gel

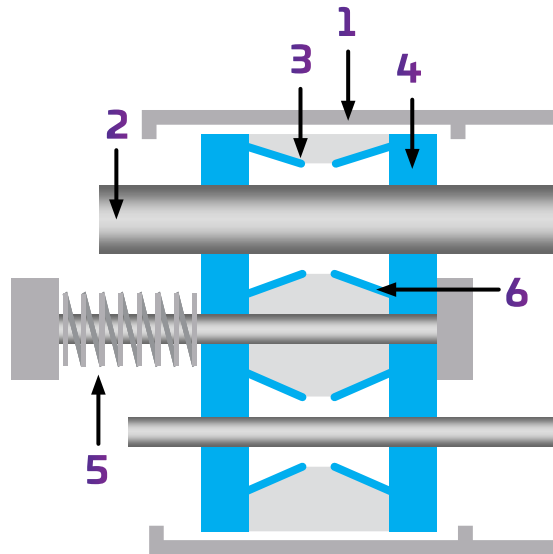
In 2020, CommScope material engineers announced development of an advanced gel sealing technology that takes advantage of the inherent properties of silicone. Launched under the brand name of Octopus Gel, the sealing compound is more conformable and resilient than TPE gel, enabling a single seal to cover a wider diameter range of cables.

The new technology also addresses another challenge faced by installers and network owners. Traditional rubber and TPE gel sealing methods rely on the installer's experience to achieve the right amount of compression when activating the seal. The process adds time to the installation/maintenance process; more importantly it requires some expertise to ensure the right amount of compression.

How gels work

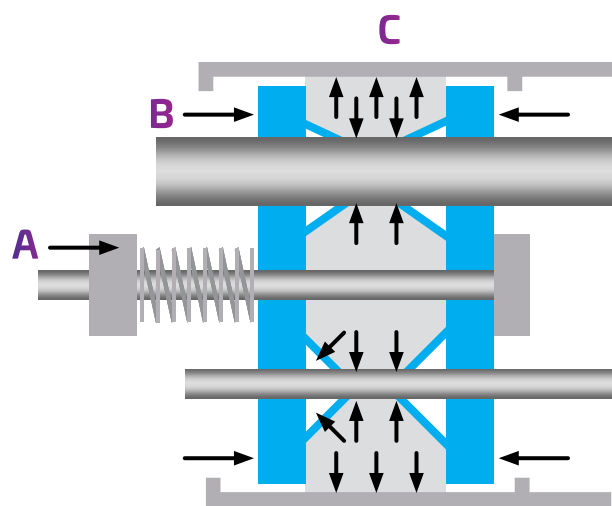


Gel cable seal system elements



1. Closure body
2. Cable
3. Gel (sealant)
4. Plunger elements (apply pressure on gel)
5. Spring element (control/maintain pressure)
6. Containment (keep gel in place)

Activating the cable seal



- A. Compress the spring. This causes the plungers to move toward each other.
- B. The gel is forced against the closure body as well as against the cables with a controlled contact pressure
- C. During this action, the containment features of the gel block will adapt to the cable diameter automatically.

With the Octopus Seal, the seal is activated by simply latching the closure. CommScope uses a self-loading mechanism to create the proper amount of compression eliminating the negative effect of time, temperature variation, and dimensional variations. The hyper-elastic behavior of the silicone gel enables it to be deformed extensively and still return to its original shape once the closure is re-opened.

The result is a highly reliable, easier to install closure that is reusable and re-enterable. It can be deployed throughout the feeder/distribution and drop network and accommodate a wide variety of cable sizes and jacket thicknesses. The design makes it suitable for aerial, ground level and below grade applications.

Another key difference between rubber seals, TPE gel and the new silicone gel is in how the unused cable ports are sealed. Rubber seals and TPE gel seals use hole plugs to take the place of a cable when it is not installed or removed. The Octopus silicone seal requires no hole plugs because the gel can seal the empty ports and up to the closure's maximum cable diameter with one seal design.

Understand the tradeoffs

It is important to note that the evolution of sealing technologies, as mentioned above, is not meant to suggest a hierarchy from good to better to best. As with virtually any aspect of network design, there are a number of tradeoffs, such as

CommScope closures using TPE gel sealing



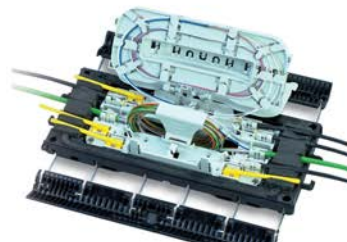
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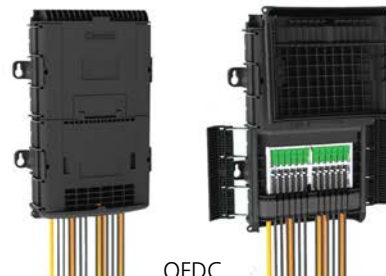
FOSC 450



TENIO



SCIL-A



OFDC

CommScope closures using silicone gel sealing



SRC 100



CSC 100



SEC 100

price, deployment speed, performance, reliability, etc. Selecting the best technology for an individual application requires an understanding of the properties of the various technologies and the specific sealing requirements for the application. The requirements vary based on where in the network the closure will be located.

For example, closures in the trunk and feeder network, where fibers are less likely to be touched once installed, often rely on heat-shrink seal technology. While heat-shrink is one of the oldest seal technologies, it also remains one of the most familiar to many of the experienced craft fiber installers. In the access network, however, the dominant variable is typically reuse and re-entry. This is especially true as the network extends closer to the customer premise. As subscribers and new service zones are added, the same closure can be accessed multiple times. In this case, the repeatable conformity of silicone gel gives it a distinct advantage.

Making the right choice upfront saves time and money down the road

As larger traditional operators continue to push fiber deeper in their networks, and new players such as rural co-ops and municipal utilities roll out fiber broadband in smaller communities, the number of spliced network connections above and below ground is set to skyrocket. At the end of every spliced connection are homes and businesses that rely on a high-speed connection. Operators can't afford to overlook even the smallest detail that could affect performance or reliability.

The seals within the splice enclosures represent a minuscule fraction of the CapEx cost but can dramatically impact OpEx. Today, there are more sealing options than ever, and each has an important role to play in safeguarding the entire OSP network. CommScope offers the depth of experience and breadth of product solutions to help you get the best possible performance from your seals, splice closures and—most importantly—your network.

ⁱ 2021 Report Card for America's Infrastructure; American Society of Civil Engineers; March 3, 2021

ⁱⁱ National Association of Counties, "Understanding the True State of Connectivity in America," February 2020

ⁱⁱⁱ <https://www.internetworldstats.com/stats.htm>

^{iv} The Cost of Connectivity 2020; Open Technology Institute; July 15, 2020

^v Deep Deployment of Fiber Optics is a National Imperative; Deloitte Consulting; July 2017

CommScope pushes the boundaries of communications technology with game-changing ideas and ground-breaking discoveries that spark profound human achievement. We collaborate with our customers and partners to design, create and build the world's most advanced networks. It is our passion and commitment to identify the next opportunity and realize a better tomorrow. Discover more at commscope.com

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