Optical Components: Not to be Taken for Granted

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Optical components should not be taken for granted in your Passive Optical Network (PON). Optical Components are a very important part of PON architecture. Before true PON was introduced most of the Optical Components were installed in controlled environments. However, pushing the splitters further out into the fiber network helps to eliminate the amount of fibers and fiber panels needed in the central office thus reducing the overall foot print and cost. PON networks will be installed into some of the harshest climates. The components could see extreme temperatures of -40˚C to +85˚C (-40˚F to +150˚F). Passive optical components will be deployed in an outside plant (OSP) environment below grade in vaults and above grade in pedestals. They will also be installed in splice closures and in terminals like Clearfield's YOURx™-Terminal, mounted on poles, hung in aerial closures and in outdoor enclosures outside of buildings. The last thing you want to do is install an inferior optical component in your fiber network and have it fail due to extreme or sudden change in temperature or because the mechanical durability was not there.

The Weakest Link

Just like a weak link failing in a chain, you do not want any of your optical components to fail while deployed in your fiber network in the extreme elements. When it comes to fiber optic networks you can dramatically reduce the chance of any failure by choosing a proven optical component from Clearfield that has been designed and truly tested and documented to perform without flaw in the extreme climates that they could see.

One of the most common optical components installed in a passive optical network is the passive fiber optic splitter. The fiber optic splitter will split the light signal being transmitted through it into 2 or more outputs. Some of the more common splitters used in PON networks are 1 x 8, 1 x 16 and 1 x 32's. In a distributed split fiber optic passive network there could be a single fiber leaving a central office or head-end traveling miles to a fiber distribution hub once the signal gets to the hub it will then be passed through a splitter and distributed to homes, businesses of even continue further to other fiber terminals that could be split again. Typically fiber networks are designed to split up to 32 times, but some have gone further by splitting the signal 64 times. The amount of times a network can be split really comes down to the total distances the network is going and ultimately the signal power loss caused by insertion loss of the fiber link.

Other ways that users are getting the most they can out of fiber optic networks is by introducing Wave Division Multiplexing (WDM) technology. WDM uses optical filters to combine or Multiplex and then separate or Demultiplex the optical wavelengths as opposed to just splitting the light as with a splitter. By multiplexing and then demultiplexing the wavelengths this allows you to transmit multiple different signals over the same fiber in a passive optical network. For example there could be 8 different networks at the central office that could be transmitted or received over 8 different wavelengths while only using one fiber from point A to point B. Other designs could still have 8 separate wavelengths leaving the central office on one fiber then drop or add one or two wavelength every so often along the way until all wavelengths are exhausted. This design is referred to as Optical Add/Drop Multiplexing (OADM).

With all of the different PON designs that are out there, you could see networks being split 8, 16, 32 or even up to 64 times. Inside of a fiber distribution hub there could be multiple splitters being distributed in multiple different directions. The number of users signed up for cable TV, internet and phone could be in the hundreds that are distributed out of one hub. Having an optical component fail could cause numerous outages at the most in-opportune time. With WDM technology the optical component could be feeding business class with multiple clients using high speeds of data with enormous amount of information being transferred all at once. Having an outage due to an optical component failure can be prevented by demanding high quality optical components that can be found at Clearfield. Our components have been designed and proven to be durable and perform in extreme elements.

Future Proof Your Network

Whether you want to run BPON, GPON, XGS PON or NGPON2, the Passive Optical Networks will need to use fiber optic splitters and WDMs that are designed to allow for new next generation PON wavelengths to coexist with existing networks when called upon. This requires the component to be designed and tested to the full wavelength spectrum of 1260nm to 1650nm. Not all suppliers have done their due diligence to test and certify that their components will allow both existing and new networks to work together. Clearfield's optical components are designed to coexist with existing networks and perform in the harsh outside plant environment – which ultimately serves to help future proof your fiber network.

Selecting the Right Component

A couple things to look for when it comes to high quality and reliable components is accreditation and certification of known testing plans. Some of the most trusted testing plans for fiber optic components come from Telcordia Generic Requirements (GR). These are complete testing plans for specific products such as fiber optic cable, fiber terminations and optical components. The first two are components used in manufacturing the optical components. Making sure the fiber along with the fiber terminations are all GR certified is required within the GR-1209 and GR-1221 testing criteria for optical components. If neither of these are truly GR certified, then the optical component cannot be certified.

Optical performance is something that should be looked at and compared when selecting optical components once you have verified from the supplier that they have the full certification and test data to back up their claim to have been tested to the full Telcordia GR test plan. Some of the statements like "tested to" or "designed to" do not necessarily guarantee that they have done and passed the full testing and have the certification and data to back it up. If the supplier will not share the certification or test data with you, that should raise a red flag that they likely aren't fully certified. Another thing to watch for is making sure the certification is for the same product that you are interested in and not just a sub-component or another product that is manufactured or designed differently.

Some of the more critical optical performance specs that should be verified and compared are the Operational Wavelength, Insertion Loss, Return Loss, Uniformity and Operating Temperature.

Operational Wavelength

This is the wavelength spectrum that the component is designed and manufactured to work within. The typical singlemode spectrum is 1260nm to 1650nm. Make sure splitters are designed for this full spectrum. It is good to look for this when choosing WDM's, however not all will have the full operating wavelength spectrum of 1260nm to 1650nm. Some could be restricted to the specific filter being used for that application. It is somewhat common for DWDM filters to not have an operating wavelength of 1260nm to 1650nm because they typically fall within the C-band and L-band of the optical spectrum (1530nm to 1625nm).

Insertion Loss

When it comes to splitters and WDMs there can be significant amount of insertion loss as compared to the fiber itself or the terminations used on fiber cables. Typical singlemode cable has a dB/km loss of 0.35dB at 1310nm and 0.25dB at 1550nm. *Typical connectors have a loss of 0.35dB, however Clearfield's Fiber Deep program guarantees a maximum insertion loss of 0.20dB per connector with a typical loss of 0.15dB*. Using premium optical components with premium low loss terminations will reduce your total insertion loss budget and allow you to extend the fiber network further reducing overall build costs. A quality 1x32 splitter from Clearfield will have a max insertion loss of 16.8dB as a terminated component. This means all fibers are terminated with connectors and not unterminated as a bare fiber splitter. Some suppliers show their max loss as an unterminated component. If the component is above 16.8dB stay away, especially if it is showing specs above that as unterminated.

Return Loss

Optical Return Loss is the percentage of power reflected back from a particular point in a light path. It is measured as a negative decibel (dB). Reflections can be caused by any impurities in the core or cladding, micro-bends or macro-bends and any splices or terminations. A quality optical component should have minimal return loss. The component itself will have some reflections generated at the actual split within discrete component itself. A quality optical component should be around -50dB or better.

Uniformity

Uniformity is the maximum insertion loss difference between one input or common port and all the outputs ports. The tighter the uniformity, the better. This helps to ensure that the transmission power at each output port is within a specified range. This will allow for simpler more consistent network design. Uniformity for a quality 1x32 should be 1.7dB or better. If your application calls for a terminated module then keep in mind that you want to see the max insertion loss uniformity with the terminations included.

Operating Temperature

The operating temperature is a very important factor when selecting true outside plant (OSP) hardened optical components. This is not to be confused with the storage temperature. Storage temperature is only the temperature that the component can be stored at. Operating temperature states that the component will continue to work at the specified performance levels at the specified high and low temperatures. For example, if a component has an operating temperature of -20°C to +75°C then it will only perform to the specs listed within that temperature range. A true OSP hardened optical component should show an operating temperature of -40°C to +85°C. Clearfield's optical components have an operating temperature of -40°C to +85°C. If the operating temperature is not -40°C to +85°C then it most likely has not been fully GR-1209/1221 certified. This should put up another red flag to stay away from that supplier.

Mechanical and Durability

The mechanical and durability characteristics of an optical component are certainly something that should not be overlooked. When it comes to Mechanical Integrity there are four main concerns mechanical shock, vibration, thermal shock and fiber integrity. These tests are designed to ensure reliable optical performance when subjected to the extreme temperatures when being installed and manipulated as they would see in the field. You do not want to see a fiber jacket pull out from a component module exposing an unprotected fiber that could break. You also don't want the hassle of fiber damage when turning up a new customer – or worse breaking an input fiber to a 1x32 splitter, shutting down 32 customers and replacing the complete 1x32 module. Unless you are keeping stock of the 1x32s in a warehouse somewhere you could be waiting days or weeks to get a new one. Choosing an optical component from Clearfield ensures that the effort has been made designing, testing and receiving full certification. This will save you a lot of hassle and expense down the road.

Endurance

Optical Endurance is the accelerated aging process to try to expose the components weaknesses that consist of eight major tests. High Temperature Storage (Dry), High Temperature Storage (Damp), Low Temperature Storage, Temperature Cycling, Cyclic Moisture Resistance, Airborne Contaminants, Water Immersion and Salt-Fog. The moisture coupled with the thermal cycle temperature levels will have an effect within the optical component, especially with the epoxy which provides a high level of structural integrity for the splitter waveguide chip, WDM ferrule and filter adhesion in the discrete package.

Other areas that have proven to show a quality product is cleanliness, labeling, documentation and packaging. Cleanliness of the product itself - and especially if terminated - the cleanliness and polish of the connector ferrule end-face. Clearfield uses automated visual inspection equipment that includes geometry inspection and a pass/fail criteria software. Using the automated equipment removes human judgement or error out of the equation. This helps to eliminate startup failures due to poor quality product. The labeling should include serialization of the

component itself and each input and output. Clearfield takes this one step further with their ruggedized splitters by identifying the input with a bright red boot to help quickly identify to speed up installation time. The labels should stay in place throughout the full GR testing process and still be legible. Product documentation including serialized test results of each component with individual port results at multiple wavelengths is a must. Packaging that will protect the component and fiber along with its terminations is important. Cable management separators that will reduce the chance of fibers being tangled up or possibly damaged during shipment or handling will not only protect the product it will decrease installation time saving money.

Summary

Choosing an optical component from Clearfield guarantees a component designed and certified to the industry test standards, saving broadband providers significant hassle and expense down the road. There are a lot of inferior suppliers that are manufacturing lower quality optical components that should not be installed in a network. They are most likely using lesser quality materials and components and have not made the financial investment or taken the time to do the testing required for true PON applications. They likely do not maintain the high level of consistency or repeatability in their processes, which is a must with this kind of component. The truth is in the reports. Don't hesitate to ask to see documentation on the testing that was done along with proof of the results. Choosing Clearfield's optical components will guarantee that you have the highest of quality and most reliable products you can deploy in a passive optical network. A quality product may appear more expensive up front, however with less time and material spent on repairing and possibly replacing poor quality components the total cost of ownership will be far less.