"How to Secure Media-Converter's Efficiency Under Hard Climatic Conditions”

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Optical networking has continued to grow in popularity in access networks and backhaul applications, replacing copper not only in green field installations, but frequently in plant upgrades. For both access networks and backhaul applications, the use of media converters to extend the reach of Ethernet networks through fiber optics has consistently grown in popularity. As more services are converted to IP, like voice and video, media converters will continue to find new applications.

Today media converters are used in a variety of applications. Due to their high bandwidth availability they can be used to address single customers with a lot of traffic or a single location with multiple customers to aggregate traffic.

Single customers using a lot of bandwidth are usually commercial customers. They might be consuming services such as Internet, virtual private networks, long distance learning, voice over internet protocol, or storage area networks.

Single locations with multiple customers are usually found in MTU’s, either commercial or residential. In this case a media converter can be used to aggregate a lot of traffic, even though each individual customer’s usage may be quite small. Such services in this case may be Internet and voice/video over internet protocol.

A new market is evolving from the proliferation of wireless equipment in the network. Both 802.11 WiFi and 802.16 WiMax solutions are starting to present themselves as viable alternatives to directly connected, point to point customers over copper or fiber.

Considering the equipment used in the application, it is very common to find the wireless radios mounted on the outside of buildings, hanging from the strand, or mounted on a tower. While equipment powering is usually not a problem, access to inexpensive T1 lines for backhaul is not always available. In terms of scalability to meet future bandwidth requirements, traditional T1 lines do not provide the necessary bandwidth for Wi-Max or mesh networks. In this case, media converters present an interesting alternative to provide this bandwidth

Another consideration is the growing demand for bandwidth to backhaul cellular traffic. Traditionally T1/E1’s are used to backhaul cellular traffic. However there are two reasons why service providers are considering alternatives.

The first reason is due to the need for more bandwidth. TDM based services are not easily scalable. So either more T1/E1’s need to be added, or a higher bandwidth option needs to be used. This can be costly and again restricts scalability in the future.

The second reason is due to the fact that in many places in the world the local wire line phone company often offers their own cellular service. This then presents a challenge for competing cellular companies, who are often forced to pay the local telephone company to lease the T1/E1 line to get access to coverage. This presents a conflict of interest. However, alternative service providers who own and leas fiber can use media converters to backhaul this traffic separating the competitors.

These media converters frequently need to be installed outdoors under hard climatic conditions for the following reasons:

First for access networks in applications such as high speed data and VoIP, the growth in customer base has extended optical access network CPE’s from only large enterprises to include small and medium size business customers who traditionally utilize T1/E1 for their telecom needs. These smaller customers frequently will not have the large, air conditioned data centers that large enterprises have, so optical network CPE equipment may need to be installed in non-environmentally controlled rooms or even outdoors.

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Second, service providers need convenient access to the CPE for maintenance and troubleshooting. Outdoor installations allow the service provider 24/7 access without need for troublesome coordination with the customer's IT department. Typical service level agreements require the ability to restore a link that is down, without access to the equipment this guarantee is impossible to meet.

Third, outdoor installations allow service providers to power the device from their own plant (coax in the case of a CATV operator and twisted pair in the case of telephone operators), eliminating service calls resulting from customer premise power failures. Even the use of battery backups can not guarantee the up-time requirements of some service level agreements. The only way to ensure access to a reliable power source is for the operator to provide their own power.

Fourth, a single CPE device may provide service to multiple customers due to economic and bandwidth considerations. In such case, the CPE cannot reside at any one customer premise. If a media converter is installed inside one tenants premise, within an MTU it may present a single point of failure for the rest of the tenants in the same MTU.

Fifth, in backhaul applications, the installation will typically be on a utility pole, at a cellular transmission tower, or even suspended from a cable. These are not only subject to outdoor temperature and humidity conditions, but also to vibration, wind, etc.

Finally, by having a flexible housing virtually any place in the network becomes a possibility for installation. These housings can be mounted on a line, or with use of brackets on a wall. They can be mounted inside of pedestals or wall boxes and eliminate the need for racks, which take up valuable space.

Manufacturers of media converters will often focus only on 'hardening' circuit board components that simply involves selection of components that will operate over a greater temperature, i.e., the so-called hard climatic conditions.

Two frequently ignored issues relate to the power supply and optical parameters.

Power Supply

Carefully thought must be given to the design of the power supply. Components such as electrolytic capacitors, ferrites, etc. have temperature limitations. Designers who do not pay careful attention to their power supplies will be faced with product failures at temperature extremes and cold start failures.

Optical Parameters

Most service providers today recognize that using a pair of fiber (one downstream and one upstream) to connect to a single CPE is a waste of fiber. A popular network topology today is to use DWDM (dense wavelength division multiplexing) in the core network, and use CWDM (coarse wavelength division multiplexing) in the access network.

CWDM media converters are an excellent way to make significant amounts of bandwidth available to customers, while providing flexibility and scalability to the service provider. Ten wavelengths are commonly available, 1430 to 1610nm. While other wavelengths are actually available these ten wavelengths avoid the water peak commonly found in older fiber optic cable. By using GigE CWDM media converters a pair of fiber can scale to 10 gigabits bi-directionally, or 5 gigabits on a single fiber.

Another advantage of using CWDM media converters is that an operator can add IP services to existing fiber optic networks. Specialized couplers can be used to add CWDM services to fiber currently lit with 1310nm services such as video.

However the use of CWDM raises issues such as optical add/drop filter (OADF) temperature and vibration stability, and laser transmitter center wavelength drift.

OADF's differ in construction (Figure 2) from a fused coupler that affect their performance when subject to extended temperature and vibration conditions. As shown in the figure, the OADF consists of various elements (thin film filter, GRIN lens, fiber pigtail) that are held together with epoxy in a mechanical housing.

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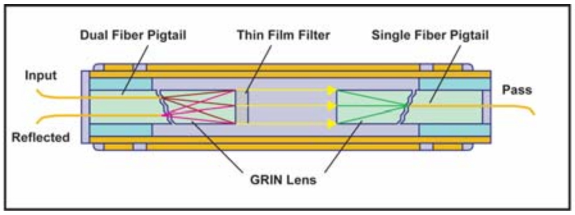

Figure 1. OADF

Both the mechanical mounting and the epoxy used must be able to withstand both temperature and vibration in hard climatic conditions. There are many modern known cases where OADF failed in the field due to epoxy problems. One particular case had failures occur in cold conditions during winter in northern United States. Many manufacturers even use special formulated, proprietary epoxy in their OADF's to guarantee reliable performance. Figure 2 shows the performance stability from an OADF that has been designed to operate over extended temperature range.

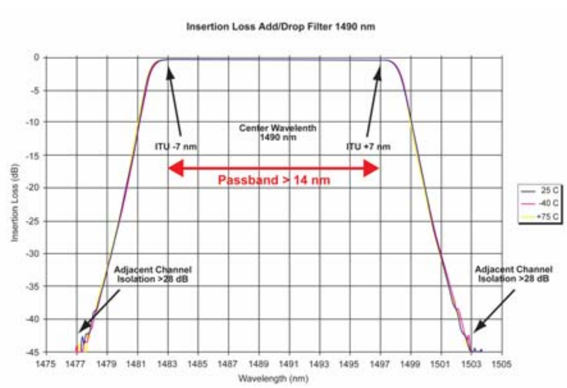

Figure 2. OADF Temperature Performance

CWDM lasers are specified to a tolerance of the ITU defined center wavelength for that particular CWDM channel. Most manufacturer's specify a tolerance of ±3 nm at room temperature, so for a 1550 nm laser, the actual wavelength could vary from 1547 nm to 1553 nm at room temperature (Figure 3).

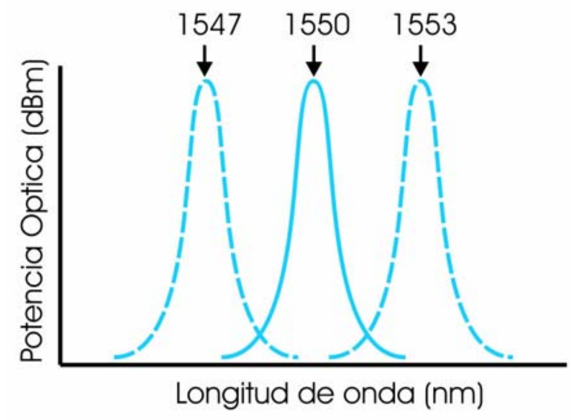

Figure 3. Laser center wavelength tolerance

Typical rule of thumb for CWDM lasers is that the center wavelength drift is approximately 1 nm per change in 1 degree Celsius. Applying then the tolerance of laser center wavelength and adding to that the expected laser center wavelength drift over temperature, we see that typical commercial products will have no problems up to +60 ℃, but will have problems at -20 ℃. Note that in many parts of the world it is not uncommon for temperatures to reach -40℃, and in certain extremes temperatures can reach below -50℃.

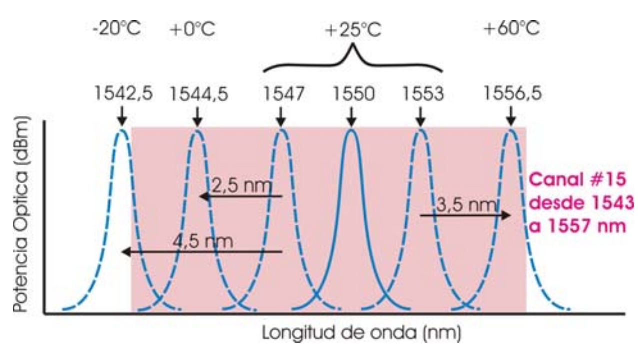

Figure 4. Wavelength drift over temperature.

While some solutions use temperature compensation in the form of heating elements to maintain stability of the laser's center wavelength, this leads to greater power consumption and more points of failure in the system. The other approach is to use lasers specially designed for extended temperature range operation. These lasers are designed so that over a temperature range of -40 ℃ to +60 ℃ the center wavelength stays

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within the ITU channel bandwidth for that particular CWDM channel.

An example of a product designed for outdoor installations to withstand hard climatic conditions is the THC-2312BTFx from PCT International (shown in Figure 5). The product can be strand mounted, comes with options for 60/90VAC or 48VDC powering, and features lasers designed to operate from -40℃ to +60℃ without the laser wavelength straying out of the ITU defined CWDM channel width.

Figure 5. PCT Hardened media converter

In conclusion, service providers who want more flexibility in deploying optical network equipment for access networks and backhaul applications can use media converters designed specifically for hard climatic conditions. Careful attention should be paid to the issues mentioned in this article. Often, there is incremental cost associated, but the benefits of service convenience, reliability, multi-user service provisioning, and reliability can outweigh the incremental cost and should be evaluated on a case-by-case basis.

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