VIAVI Solutions

Application Note

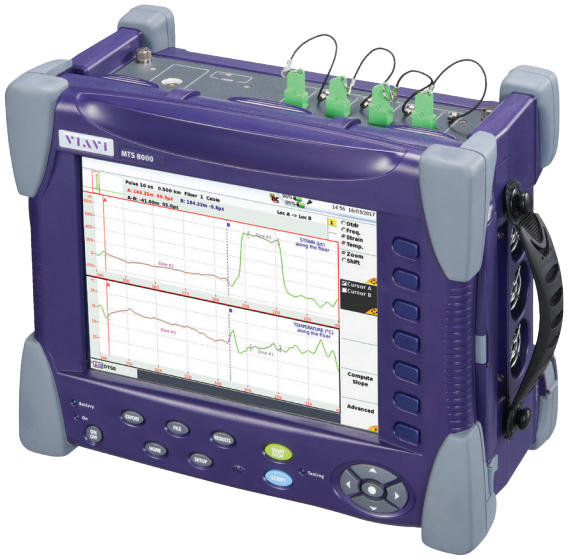
Discover Fiber Strain and Temperature Risks Using VIAVI B-OTDR for the T-BERD/MTS-8000 Platform

Advances in Fiber Optic Cable Characterization Help Network Operators Protect the Network

VIAVI OTDRs allow technicians all over the world to characterize optical cables by measuring the optical length, the global loss and, the common events such as splices, connectors and slopes that affect cable performance and signal transmission. Now the B-OTDR enables engineers to utilize a fiber as a fiber optic sensor to measure strain and temperature across the fiber.

In the case of abnormal splice or slope values, the associated event is immediately and automatically identified, highlighted and located in the results table, facilitating the technician's work of troubleshooting service affecting faults.

By using a dual wavelength OTDR (for instance 1550, 1625nm) and by making comparison between measured values at the two wavelengths, a technician can detect bends along the cable route.



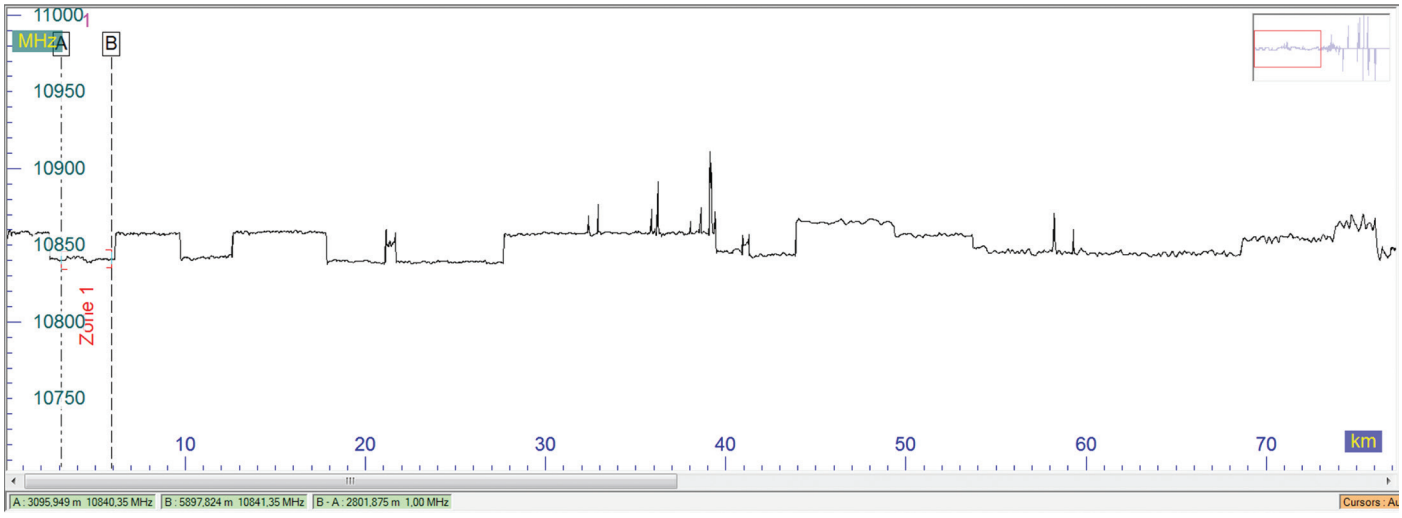
All the measurements done above give information regarding the quality of the optical network.

Recently, VIAVI introduced a new type of OTDR, the DTSS Brillouin OTDR, for its portable T-BERD/MTS-8000 which allows additional information regarding the fiber's health and which type of fiber is installed. See information on the DTSS at viavisolutions.com.

Identifying the Fiber Type Installed

Using the VIAVI Brillouin OTDR, a technician can identify the different types of fiber used along the cable route by analyzing its Brillouin spectrum. Why might you want to conduct this kind of fiber archeology? Various makes of fiber have different Maximal Allowable Tension (MAT) tolerances and light propagations characteristics. One type of fiber may be optimal at a more narrow spectrum than another. As the network requires maintenance and new spectrum standards are used such as in the next gen PON standards, one might need to inventory the type of fiber in line along with any elongation (strain) present.

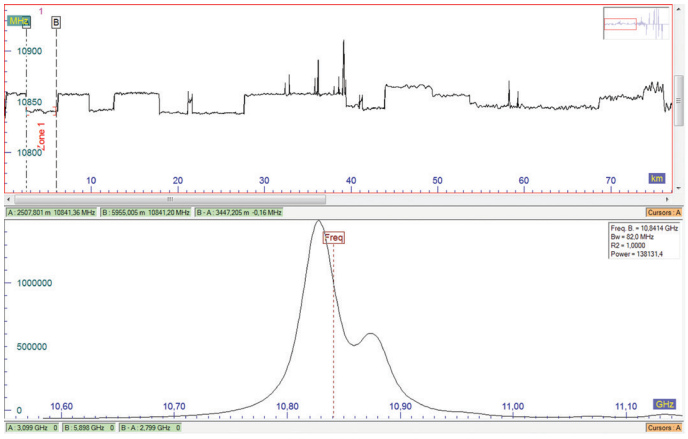
Each type of fiber has its own Brillouin spectrum signature, so when a technician makes a Brillouin measurement, he will get the following trace:



Brillouin shift measurement along the fiber showing different types of fiber used on the line.

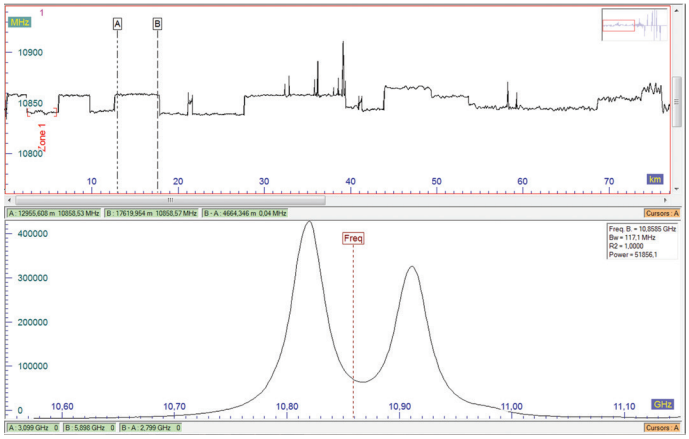
Moving a cursor in the different areas, the Brillouin spectrum signature can be displayed; identifying the fiber type under measurement.

For instance, in zone [2507m – 5890m], we have a fiber with 2 peaks.



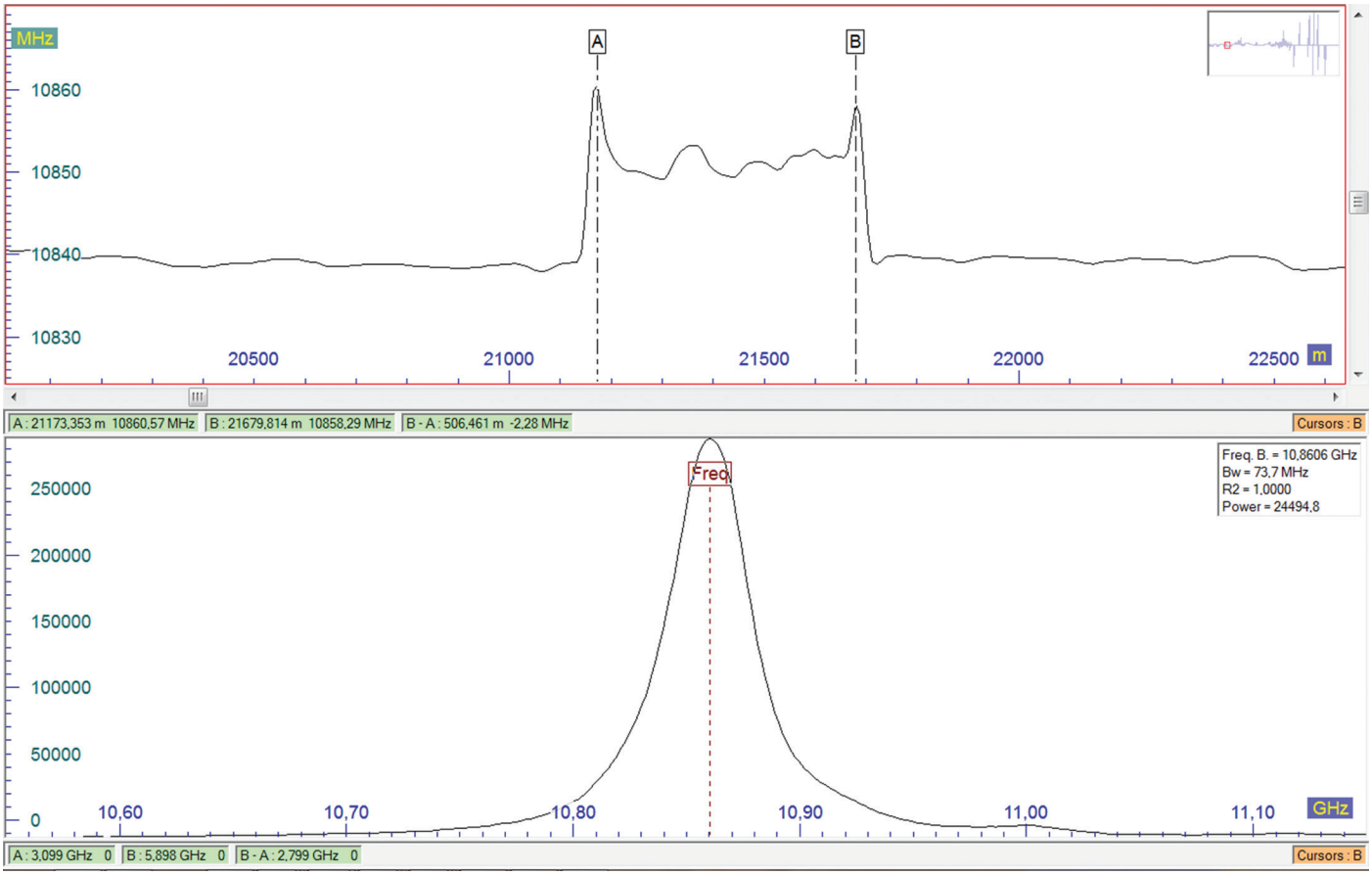
Brillouin Spectrum: This image shows one type of fiber having 2 Brillouin peaks.

In zone [12955m – 17620m], we have another type of fiber with 2 peaks.



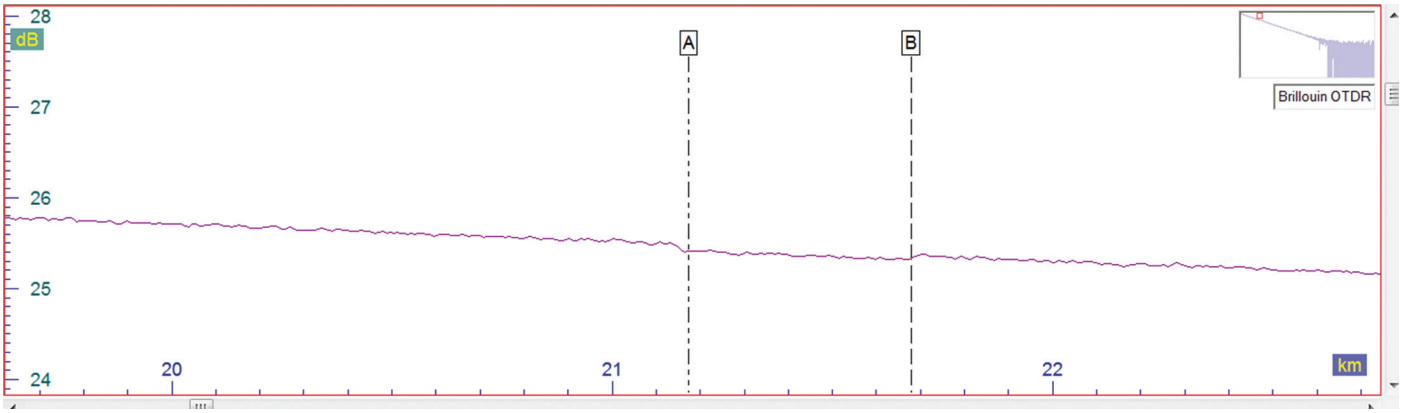
Brillouin Spectrum: This image identifies another type of fiber having 2 Brillouin peaks.

In zone [21173m – 21680m], the cable has been repaired using another type of fiber creating a hybrid cable.



Brillouin Spectrum: The image of one type of fiber having 1 Brillouin peak also shows how the fiber types vary across the line.

The traditional OTDR trace based on Rayleigh scattering below doesn't give any information about the fiber type because it is blind to this fiber type signature.



A Traditional OTDR measurement does not help to indentify the fiber type in the line.

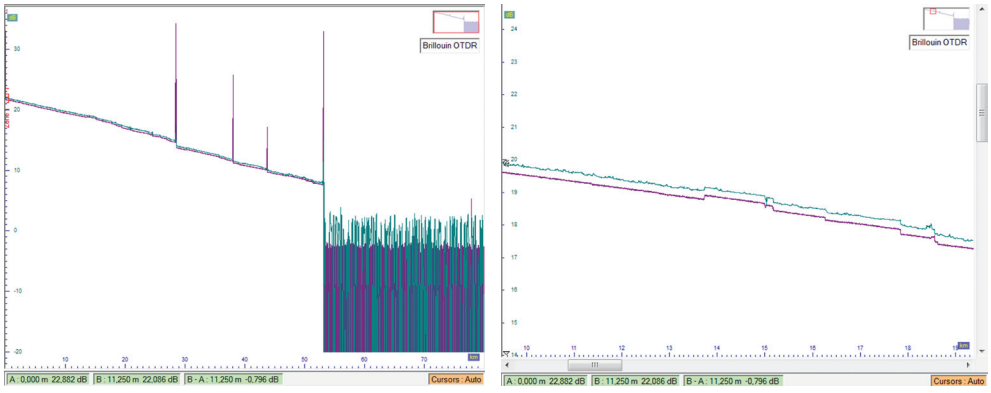
For more information about the Brillouin spectrum of your fibers, please contact the fiber manufacturer. Corning maintains a white paper WP4259 that reports their main fiber's characteristics, with Brillouin spectrum and tolerances and the below URL:

https://www.corning.com/media/worldwide/coc/documents/Fiber/RC-%20White%20Papers/WP-General/WP4259_01-15.pdf

Ensuring Fibers Do Not Exceed Maximal Allowable Tension (MAT) Protects Cable Life

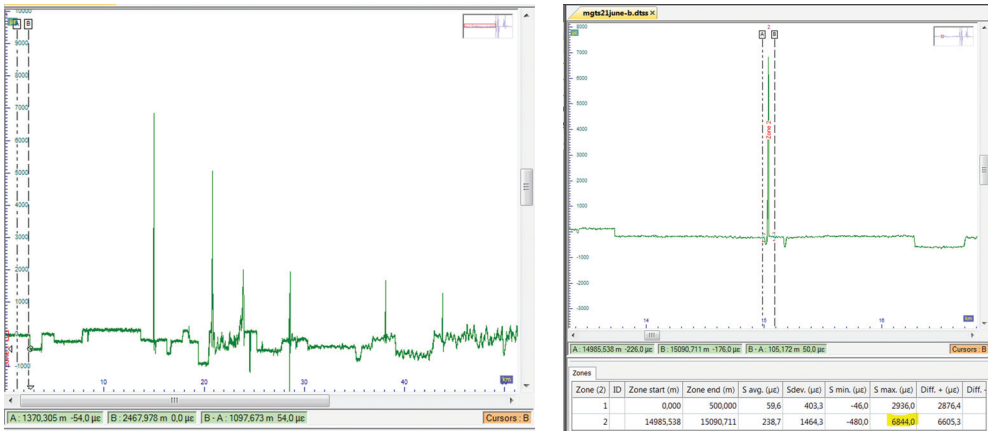
When an optical telecom cable is deployed, all the steps involved must warrant that the strain along the cable never exceeds the cable's Maximal Allowable Tension (MAT) or the cable will be damaged and may perform poorly or break. The following factors affect the cable's ability to remain within the MAT tolerance: the choice of a cable should be adapted to a given environment, the cable quality, the deployment process, and the equipment used to attach it to poles or lay cable into ducts or underground. The IEC 60794-3-20 defines that at the Maximal Allowable Tension, the cable protects the fibers from any elongation larger than 0.2% (or 0.34% for fibers that are proof-tested under the submarine grade). Discovering a strain that exceeds 0.2% on a network is already a clear indication of a mechanical issue on the line. The most probable cause is that the cable suffers a charge that exceeds its Maximal Allowable Tension (MAT). Regular measurements are strongly recommended for avoiding a surprise break or malfunction due to multiple cable tearing off/repairs, effects of aging typically seen under especially severe weather conditions, and damage in areas subject to human activities or ground movements. *For more information, see also ITU-T Rec G.Sup59 , ITU-T Rec L.25.*

Only strain measurement using a Brillouin OTDR will give you an indication of the current health of the fiber; traditional Rayleigh OTDR measurement (single/dual wavelengths) doesn't provide useful information in this case as shown in the following case.



OTDR measurement with zoom on the splices at 15km.

In the second example below, the Rayleigh OTDR trace shows a normal fiber with splices, high reflective connectors as displayed in the trace below. Zooming around 15km displays a splice.



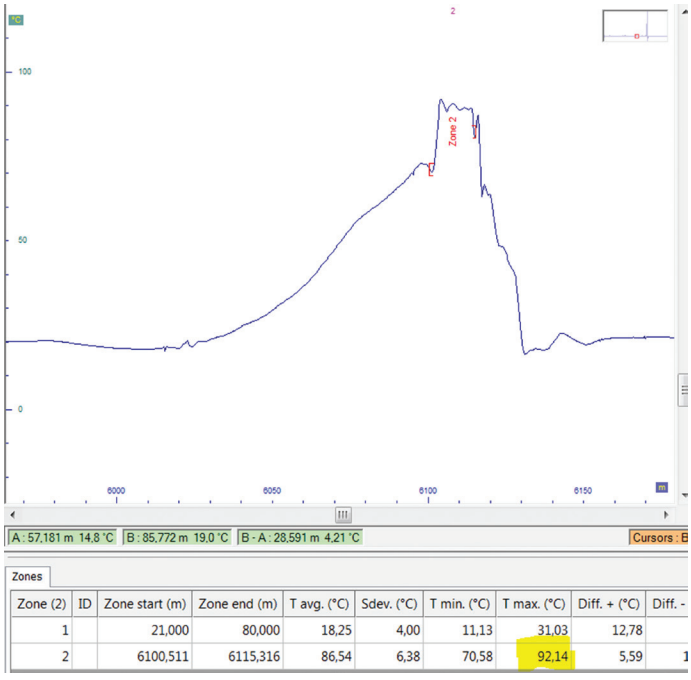
Strain at 15, 21, 24 and 27.5km along fiber with zoom on strain peak at 15km.
This allows the technician to see what section is at risk and should be replaced.

Doing a Brillouin measurement discovers significant stress areas along the cable. This fiber is resisting even a 0.7% elongation, but this situation cannot last much longer... In total, 58 meters of this link are exceeding a 0.2% elongation. All the fibers in the cable suffer the same strain conditions. To assess the risk, one should multiply this distance by the number of fibers contained in the cable. You can weigh the return on your investment of applying B-OTDR by looking at the cost of a sudden repair on this link, evaluating all the customers likely to be affected or making assumptions about the SLA penalties that might be incurred during an outage. Careless handling of the fiber at the cable manufacturing stage and poor cable manipulation increase the probability of a flaw, while the presence of humidity further increases the probability of a break at a fiber flaw.

Assessing Temperature to Prevent Damage and Protect Cable Life

Moreover; in metro areas, optical cables share or use existing infrastructure. In some cases, metro fiber cables are adjacent to existing ducts (water steam, power cables etc.). Brillouin OTDR measurements can detect and highlight issues which can jeopardize life span of your cable.

As in the example on the right, having a temperature greater than 90°C over 15 meters of cable is outside the standard use environment for optical cables. This drastically reduces its life time. With the double sensitivity to strain and to temperature of the Brillouin frequency shift, a regular BOTDR is not capable of determining whether events on the below trace is due to 90°C hotspot or a 0.2% elongation, however VIAVI DTSS B-OTDR is uniquely capable of making this discrimination.



Zones

Zone (2)	ID	Zone start (m)	Zone end (m)	T avg. (°C)	Sdev. (°C)	T min. (°C)	T max. (°C)	Diff. + (°C)	Diff. -
1		21,000	80,000	18,25	4,00	11,13	31,03	12,78	
2		6100,511	6115,316	86,54	6,38	70,58	92,14	5,59	1

Conclusion: Use of DTSS Brillouin OTDR Visibility Identifies Life Shortening Threats

The VIAVI Brillouin OTDR provides real insight into your optical network health and the effects of your procedures. By identifying the weak points and locations at risk of temperature damage, you'll predict locations with a high probability of future break that can be prioritized for maintenance before your customers suffer. By testing for strain before and during installation, you can eliminate the scenario of installing a new cable that will underperform, affect optical budgets excessively or break quickly. Identify locations that risk temperature damage to formulate a plan for mitigation or pre-emptive maintenance. Mitigating these risks can save thousands of dollars of material and labor, prevent lost service revenue caused by service affecting faults, and maintain your good reputation for good infrastructure and service.

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