VIAVI Solutions

Application Note

Set-up the VIAVI B-OTDR DTSS for Fiber Optic Sensing

With the "Fiber Discovery" and "Brillouin Discovery" functionalities, the VIAVI B-OTDR automatically defines a whole set of acquisition parameters adapted to the link under test. The use of these automated settings is recommended for the non-expert, and it was developed to meet the requirements of most common use-cases. Auto discovery facilitates and speeds the measurement acquisition. Note the VIAVI B-OTDR DTSS comes in a portable and a rack-mounted version. Both temperature and strain can be measured on the same fiber using a VIAVI patented process to distinguish both on a single fiber under test.

OTU-8000

The B-OTDR instrument is highly configurable, allowing the frequent user will want to optimize set up to a specific problem. The purpose of the present document is to explain how the various settings will influence the performance and to demonstrate precise values for best achievable performance.

T-BERD/MTS-8000

The quality of the fiber optic sensing measurement acquisitions performed with a Brillouin OTDR depends on three essential parameters:

1. The length of the fiber link under test
2. The spatial resolution
3. The duration of the acquisition

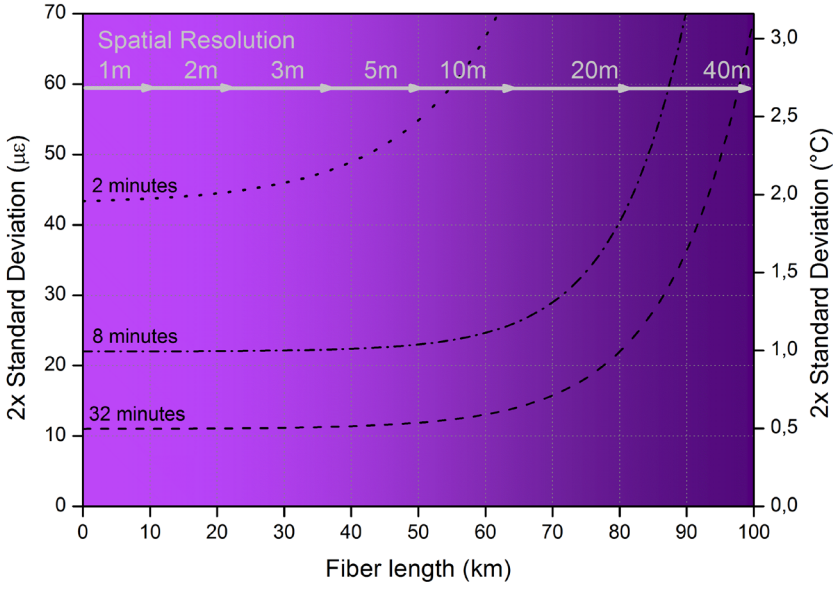
This is true of any distributed measurement, and the classic Rayleigh OTDR is the best-known example.

The length of the fiber under test defines the minimal range of the reflectometer, which sets a repetition rate at which the pulse can be sent into the fiber. Averaging multiple acquisitions is the common practice in reflectometry to improve the signal to noise ratio. The total time required to obtain a given averaging benefit scales inversely with the reflectometer range. The budget loss of the link also has its influence on the signal to noise ratio at the end of the fiber, so to simplify the debate we assume a 0.2dB/km that is typically observed at 1550nm.

The effective spatial resolution is essentially set by the pulse duration. The energy of each pulse is directly proportional to the pulse duration; therefore, a higher spatial resolution implies a lower signal to noise ratio and a lower potential range.

The duration of the acquisition can be configured by the user by choosing an averaging level, but also by changing the spatial sampling resolution or the frequency resolution (steps in the Brillouin spectrum). These two last choices also have their own direct influence on the final accuracy, but for the sake of simplicity we will consider here that the exact sampling values does not have any major impact as far as they remain close to the nominal values (our auto setting). It is worth mentioning that making more frequency steps or increasing averaging level produce the same improvement on the Brillouin frequency shift accuracy, as far as the total measurement time is kept constant, so in the end the total duration of the acquisition is what matters most.

A single chart as below gives the measurement performance of VIAVI B-OTDR product for the most representative use-cases.



This is a repeatability chart with repeatability defined as per IEC 61757 standard (maximum value of the 2 sigma repeatability over 20 successive acquisitions). Measurements were performed over a large range of possible cases:

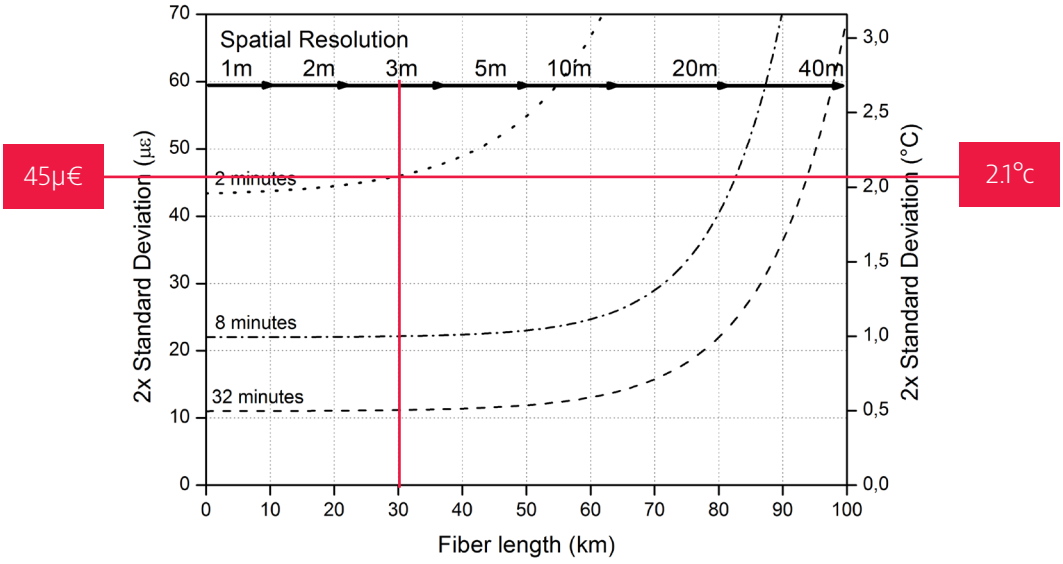
- Fiber length up to 100km
- All pulse durations available on the instrument were used to compose this chart. Each pulse duration corresponds to a spatial resolution with a correspondence of 1m per 10ns. The values of spatial resolutions are indicated in grey on the top of the graphic, centered on the fiber length range where they are best applicable.
- Three repeatability curves are displayed for total acquisition duration of 2, 8 and 32 minutes.

These additional factors were used:

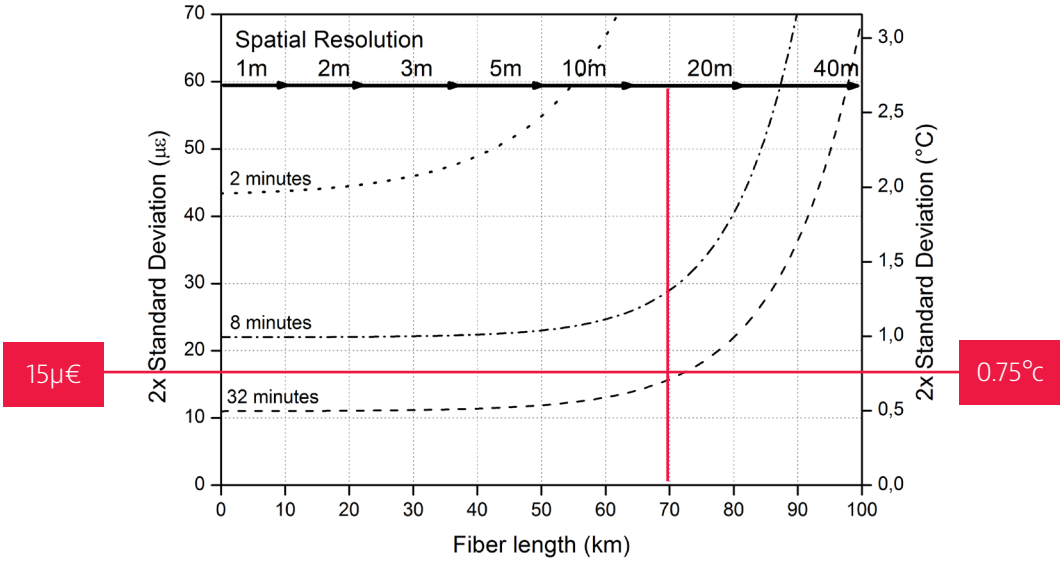
- Links were composed of fibers and patch-cords with typical fiber attenuation of 0.2dB/km
- A comfortable 600MHz scanning range for the Brillouin spectrum (could be set anywhere from 9 to 13GHz).
- Spatial sampling resolution was left to “auto” value, i.e. 3–4 acquisition points per spatial resolution as set by the pulse duration. Under-sampling can be exploited as a mean to speed up the averaging effect and improve the reach at the cost of a lower effective spatial resolution.
- For B-OTDRs, the maximum repeatability is always observed at the most distant point of the fiber length considered (exponential decay of signal with distance).
- Strain-Only or Temperature-Only mode of operation were used as is standard for Brillouin systems (the temperature and strain mode will be qualified later).

Reading this graph:

If you would like to measure 30km, using a short acquisition time 2 minutes: with 30ns pulse /3m spatial resolution will allow you to reach 30km with a measurement repeatability of 45µ€/2.1°C (2 x the standard deviation).



If you would like to measure 70km, using a short acquisition time 32 minutes: with 200ns pulse /20m spatial resolution will allow you to reach 70km with a measurement repeatability of 15µ€/0.75°C (2 x the standard deviation).



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