Pulse Selection vs. Dead Zone

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PREFACE

Generally speaking, the rationale behind selecting the shortest pulse on an OTDR is to obtain the best spatial resolution, and the best event and attenuation dead zones needed to detect and measure very closely spaced events.

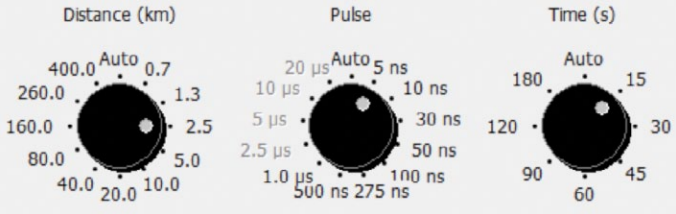

Figure 1. Selecting OTDR parameters

PROBLEM STATEMENT

The definition used to establish the width of the pulse is not standardized, and therefore, there is some divergence in the method used by each OTDR manufacturer. And, because no reference is provided in marketing specification sheets, this calculation is subject to different definitions. For instance, some manufacturers recommend a 1.5 dB width instead of full width at half maximum (FWHM), which is equal to a 3 dB width (Figure 2).

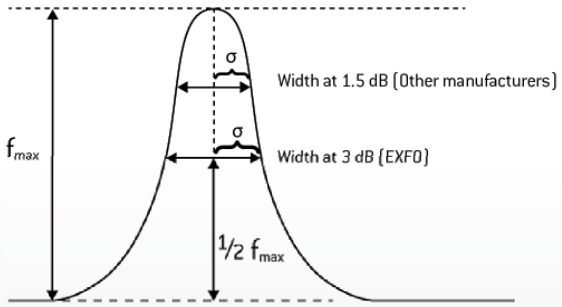

Figure 2. Divergence in the method used to establish pulse width

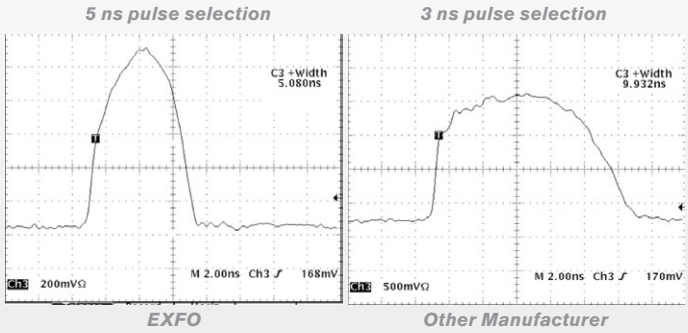

Figure 3. Results with an oscilloscope: 5 ns vs. 3 ns pulse selection

As can be seen in Figure 3, when measured at 3 dB as per the EXFO unit, the other manufacturer's OTDR shows a pulse width much closer to 10 ns than the stated 3 ns.

SHORTER PULSE: NO GUARANTEE OF A SHORTER DEAD ZONE

The pulse alone is not sufficient to compare an OTDR's resolution or ability to detect closely spaced events. The receiver bandwidth and recovery time are key, and their combined performance is typically based on event dead zones and attenuation dead zones. A good way to compare two OTDRs is to measure the dead zone at the same reflectance. As a recommendation, a –45 dB reflectance should be used for measurements, but a simple PC/PC connection can also be used if the reflectance is between –55 dB and –45 dB.

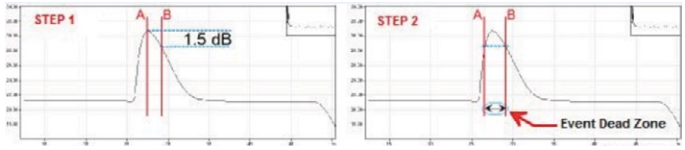

Figure 4. Event dead-zone measurement method

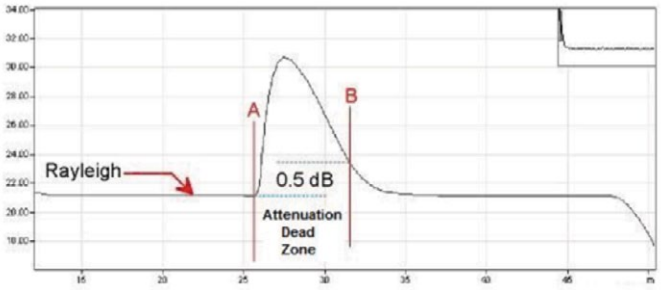

Figure 5. Attenuation dead-zone measurement method

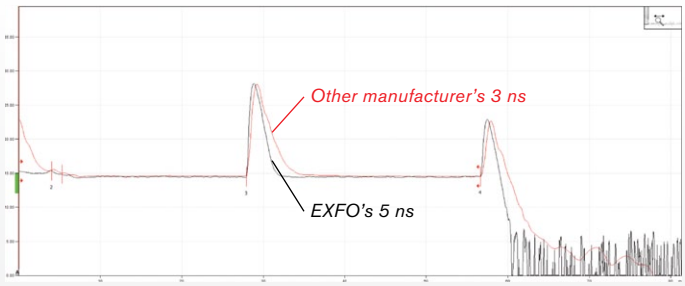

Figure 6. EXFO's 5 ns dead zone vs. COMPETITOR'S 3 ns attenuation dead zone

In theory, a 3 ns pulse width should produce a better attenuation dead zone than a 5 ns pulse width. But, although this is true on paper, it can clearly be seen that the EXFO unit using a 5 ns pulse width achieves a better attenuation dead zone than the other manufacturer's unit, which claims to be using a 3 ns pulse width (Figure 6). Again, the receiver bandwidth and the recovery time are key, and make a huge difference in a side-by-side comparison.

COMPARISON

Specifications vs. real measurements

	EXFO		Other Manufacturer	
	Specification sheet	Lab Measurement	Specification sheet	Lab Measurement
Shortest Pulse (ns)	5	5 (FWHM)	3	5 (FWHM)
Event Dead Zone (m)	0.8	0.8	0.8	0.8
Att. DZ. On typical FC/UPC Connector (–55 dB) (m)	3.5	3	4	3.9
Att. DZ. at –45 dB (m)	4.5	3.8	n.a.	6.3

Figure 7. Comparison: Reflectance specifications vs. real measurements

Some manufacturers do not use the –45 dB reflectance to test dead zones, but rather an unknown value in the vicinity of –55 dB. Knowing the reflectance value for the attenuation dead zone is important, because it represents the amount of light reflected back to the receiver. The higher the value (–45 dB is a higher reflectance than –55 dB), the longer it will take for the receiver to return back to the Rayleigh backscattering (fiber level). The next figure shows a peak reflectance at –45 dB, and another at –55 dB. Notice the distance traveled by the –45 dB reflectance pulse before it returns to the fiber level, as compared with that of the –55 dB reflectance pulse.

Therefore, if the distance specified as an attenuation dead zone is the same, but one unit's reflectance value is specified at –55 dB, while the other's value is specified at –45 dB, the unit with –45 dB reflectance is the best.

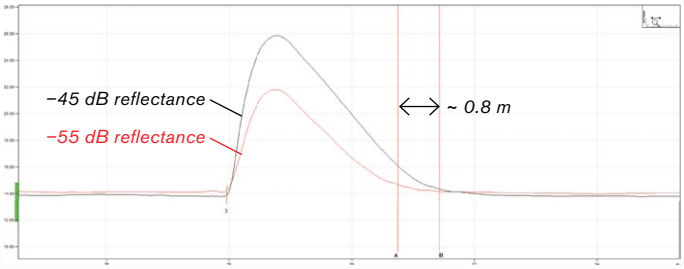

Figure 8. Peak distance traveled by the reflectance pulse

What is the impact on a measurement in the field? The easiest way to illustrate this is with a real case study in which there are two connectors separated by 6 meters (≈20 ft), with the reflection of the first connector being –45 dB. Refer to the next figure for evidence that the EXFO unit recovered faster than the other manufacturer's unit, therefore enabling a more accurate measurement to be performed.

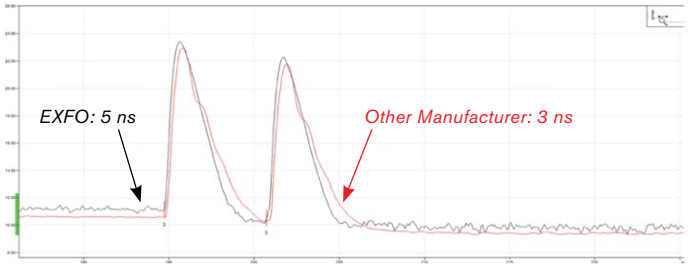

Figure 9. Case study: Recovery speed

CONCLUSION

A shorter pulse does not guarantee a shorter dead zone. As previously demonstrated, OTDR receiver electronics are very important. While EXFO typically uses –45 dB reflectance, some manufacturers test their dead zones on smaller and/or unspecified reflectances to produce better numbers. An easy way to determine the real value of an OTDR is to test its dead zone against that of EXFO at both units' shortest pulses and with the same reflectance.

A long attenuation dead zone could lead to more merged events, in which case the user will have hard time determining which connector failed. This could lead to a perfectly good connector or cable (jumper) being replaced; in an FTTA deployment it could lead to a tower crew being called unnecessarily, with money and time spent where there is no problem. The other effect is inaccurate loss measurement due to the unit not having recovered from the previous reflectance, in which case the loss measurement could generate a false pass.

Prior to selecting an OTDR, it is important to read and understand the fine print in the specification sheets, and to ask for clarification if any information is unclear. The best way to address any unanswered questions is to compare the units side to by side under the same conditions.

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