



When to Use an OTDR and How to Use it Correctly

Tuesday, April 18th, 2023

Milan, Italy

Nigel Hedges

Product Application Specialist

Fluke Networks



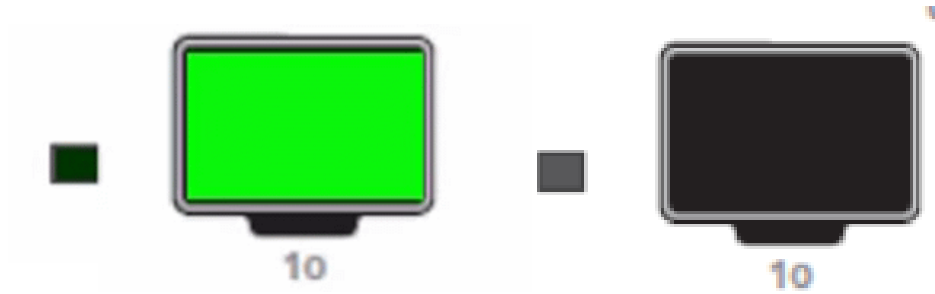
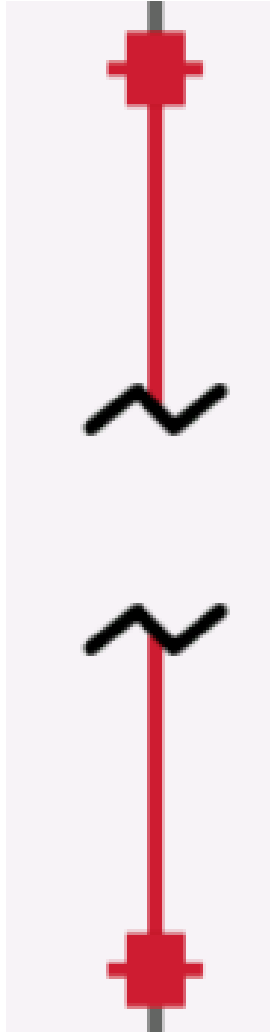


Agenda

- Fiber Issues
- Tools to use before you go to an OTDR
- Common mistakes to avoid:
 - If you are going to use an OTDR, use it correctly**
 - Even if you are not a fiber expert
- Examples of traces and issues that affect them

Fiber Issues

- Link doesn't work
- No Link Light



Fiber Issues

- Link doesn't work
- No Link Light
- Too much loss

Propagation Delay (ns)	1376	
Length m	281.0	PASS
Limit 40000.0		
	1310 nm	1550 nm
Result	FAIL	FAIL
Loss (dB)	30.80	29.40
Limit (dB)	1.78	1.78
Margin (dB)	-29.02	-27.62
Reference (dBm)	-2.39	-2.38

Fiber Issues

- Link doesn't work
- No Link Light
- Too much loss
- CRC/FCS errors

<input type="checkbox"/>	Interface	Total Packets Received Without Errors	Packets Received With Errors
<input type="checkbox"/>	g1	9156	8538

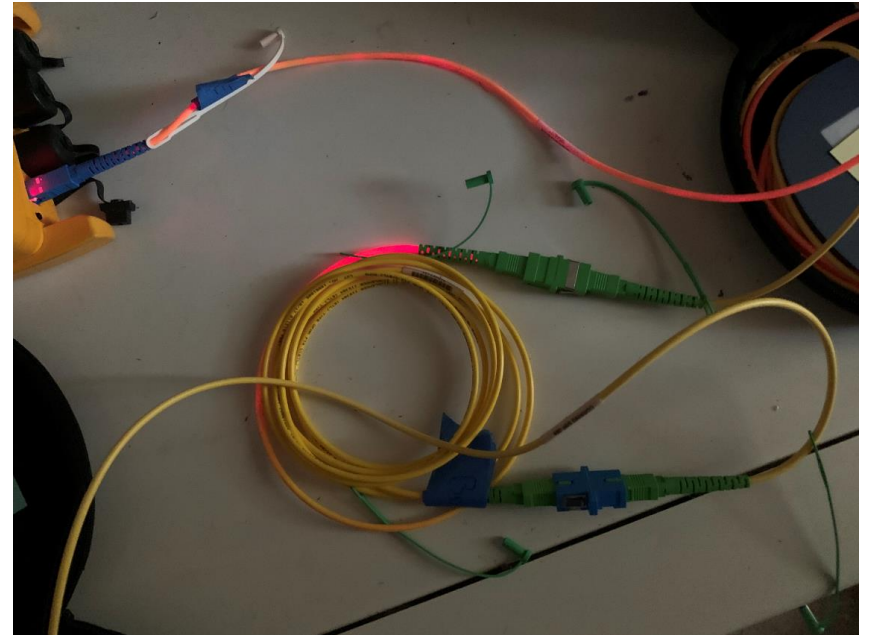
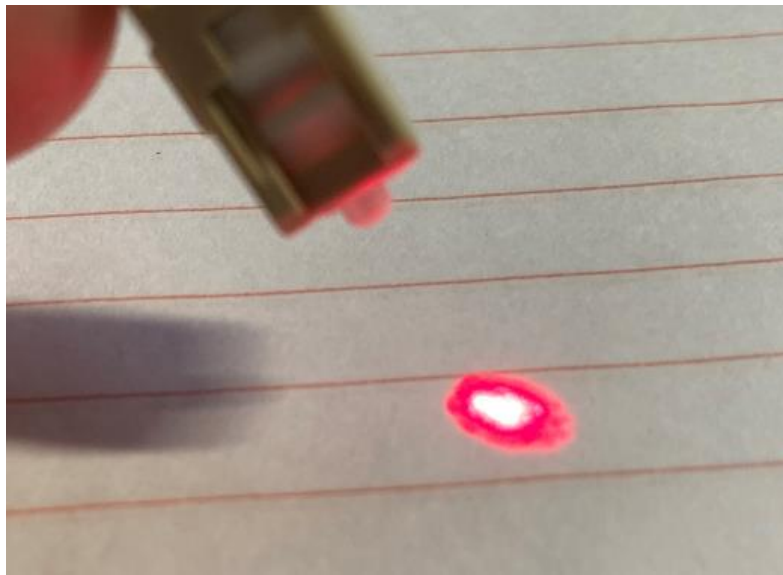
Fiber Issues

- Link doesn't work
- No Link Light
- Too much loss
- CRC/FCS errors
- Contractual obligation to deliver an OTDR Trace
 - New Construction testing
 - Required documentation

C. Testing shall be carried out in accordance with the condition of the installed cable plant with an optical time domain reflectometer (OTDR). The condition of the fiber end faces shall

Tools to use before an OTDR for Troubleshooting

- VFL – Is there light coming out? Is it coming out of the right fiber? Distance limitation



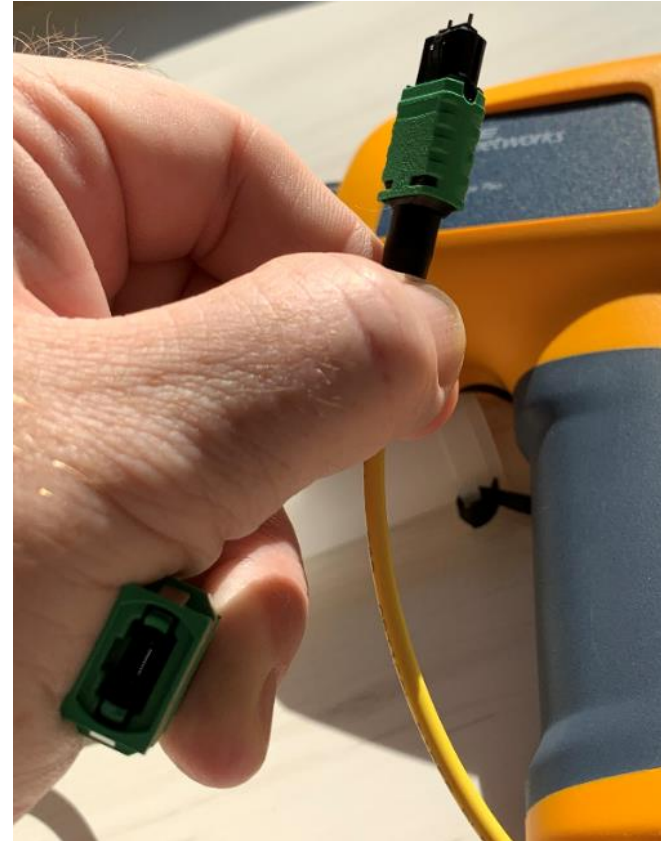
Tools to use before an OTDR for Troubleshooting

- VFL – Is there light coming out? Is it coming out of the right fiber? Distance limitation
 - Use Sunlight if needed (and available)



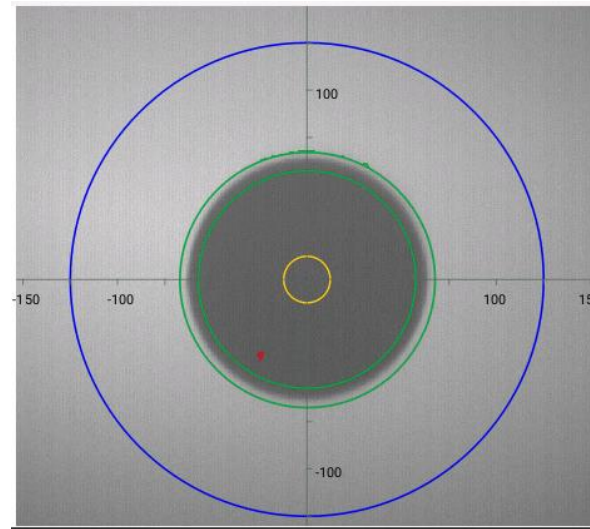
Tools to use before an OTDR for Troubleshooting

- VFL – Is there light coming out? Is it coming out of the right fiber? Distance limitation
 - Use Sunlight if needed (and available) Is that an 8 fiber MPO? Which 8?



Tools to use before an OTDR for Troubleshooting

- VFL – Is there light coming out? Is it coming out of the right fiber? Distance limitation
 - Use Sunlight if needed (and available)
- Inspection – How dirty is it? Inspect again after cleaning. Perhaps a whole slide on cleaning



Tools to use before an OTDR for Troubleshooting

- VFL – Is there light coming out? Is it coming out of the right fiber?
- Inspection – How dirty is it? Inspect again after cleaning. Perhaps a whole slide on cleaning
- Live Fiber Detector – Is there light in the fiber



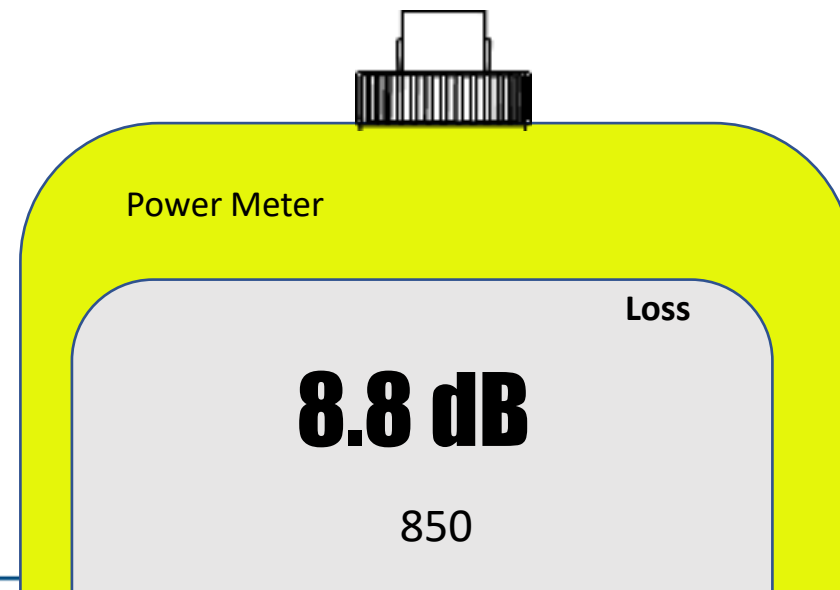
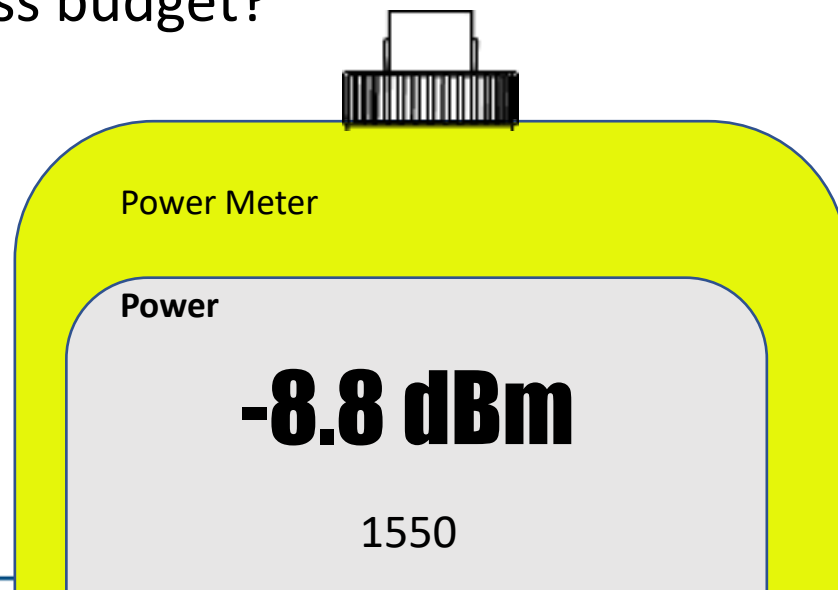
Tools to use before an OTDR for Troubleshooting

- VFL – Is there light coming out? Is it coming out of the right fiber?
- Inspection – How dirty is it? Inspect again after cleaning. Perhaps a whole slide on cleaning
- Live Fiber Detector – Is there light in the fiber or coming out of the end of the fiber



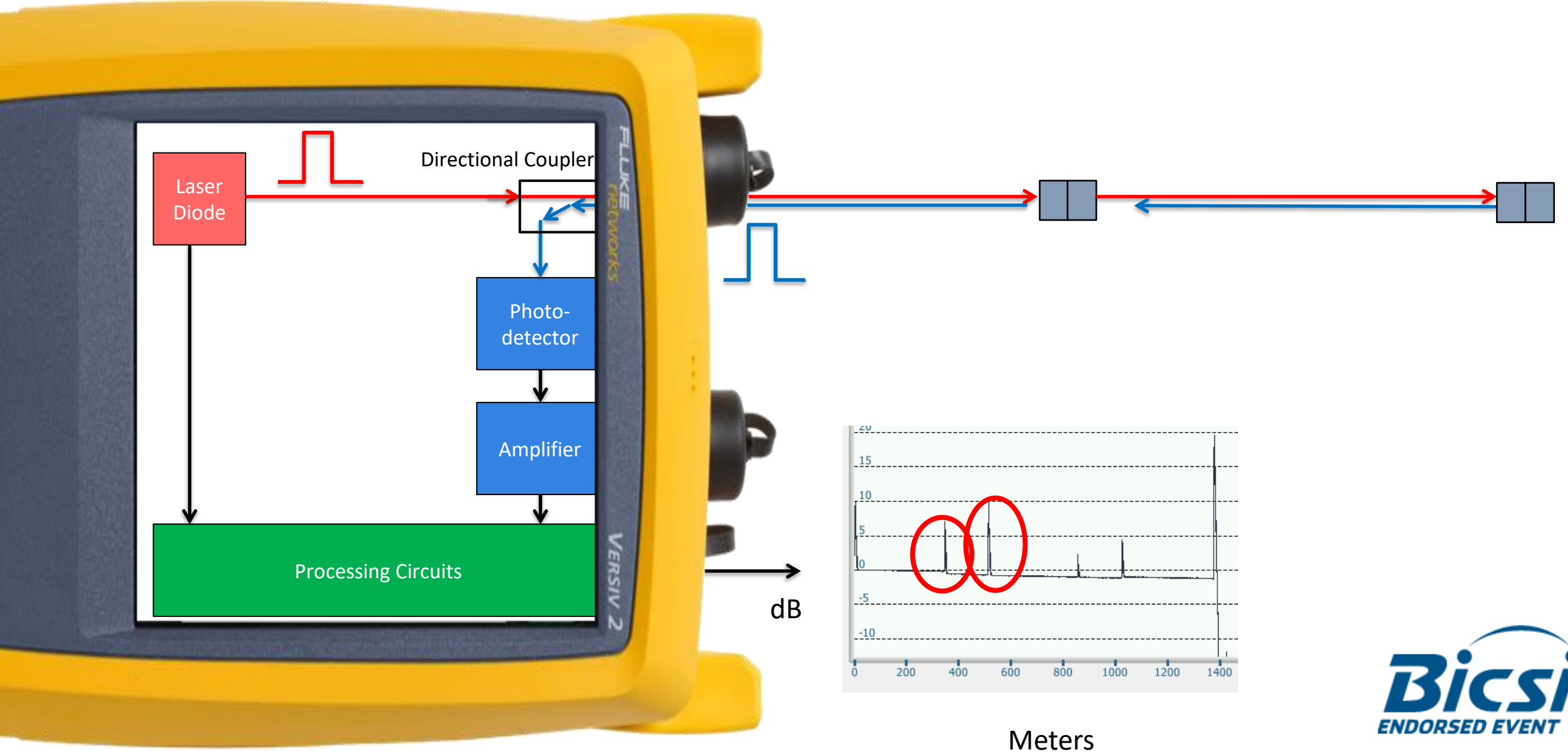
Tools to use before an OTDR for Troubleshooting

- VFL – Is there light coming out? Is it coming out of the right fiber?
- Inspection – How dirty is it? Inspect again after cleaning. Perhaps a whole slide on cleaning
- Live Fiber Detector – Is there light in the fiber
- Power Meter – dB vs dBm – What is power requirement of transceiver? What is your loss budget?

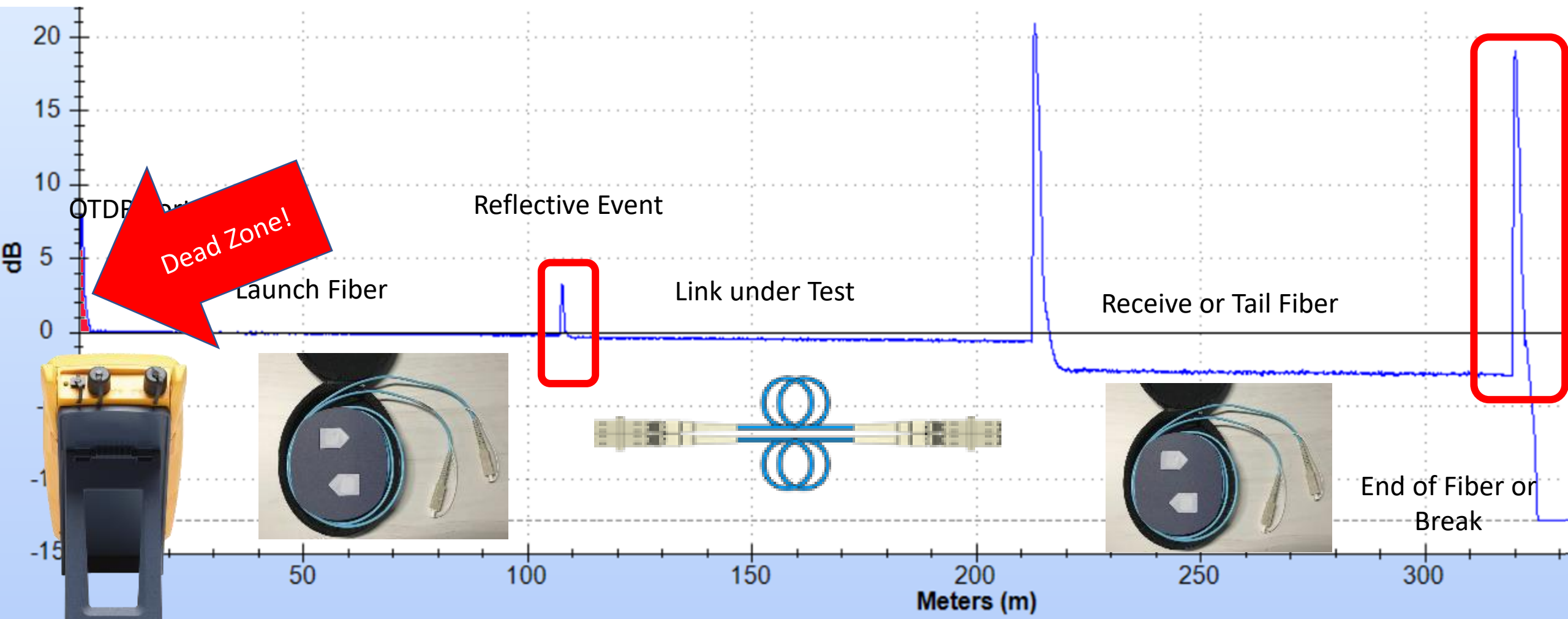


So, The Problem Hasn't Gone Away
and it is Time to Get the OTDR

How does an Optical Time Domain Reflectometer work



An OTDR Trace

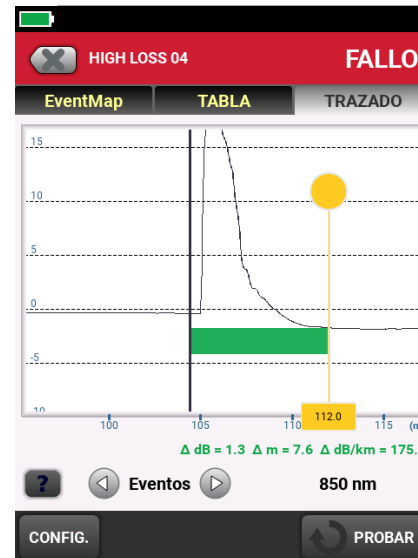
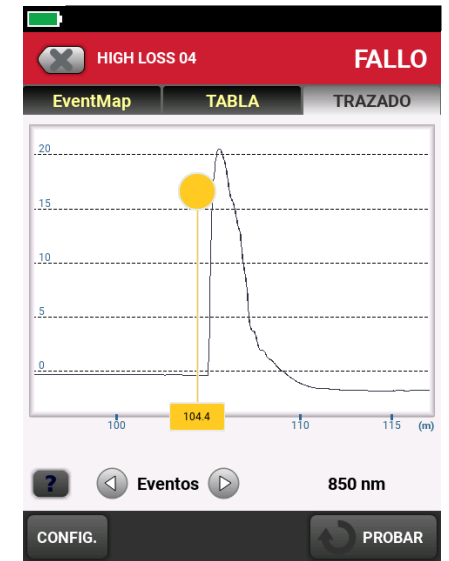


Loss Measurement on an OTDR

- To measure the loss, we will set a cursor before and after an event

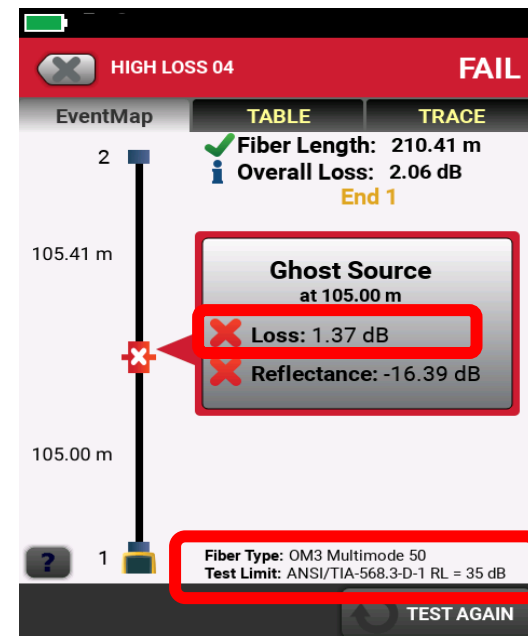
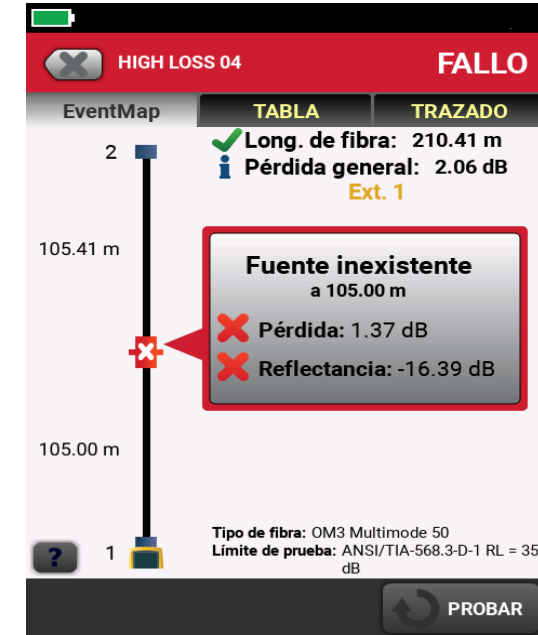
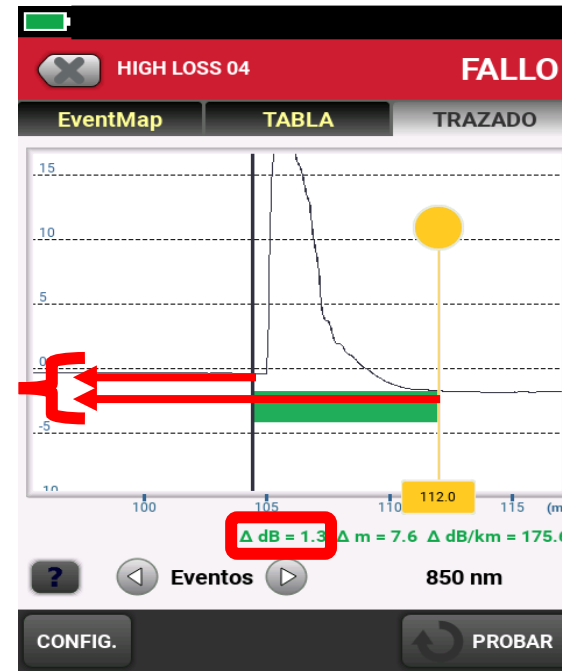
- Here is the before

- And here it is set after

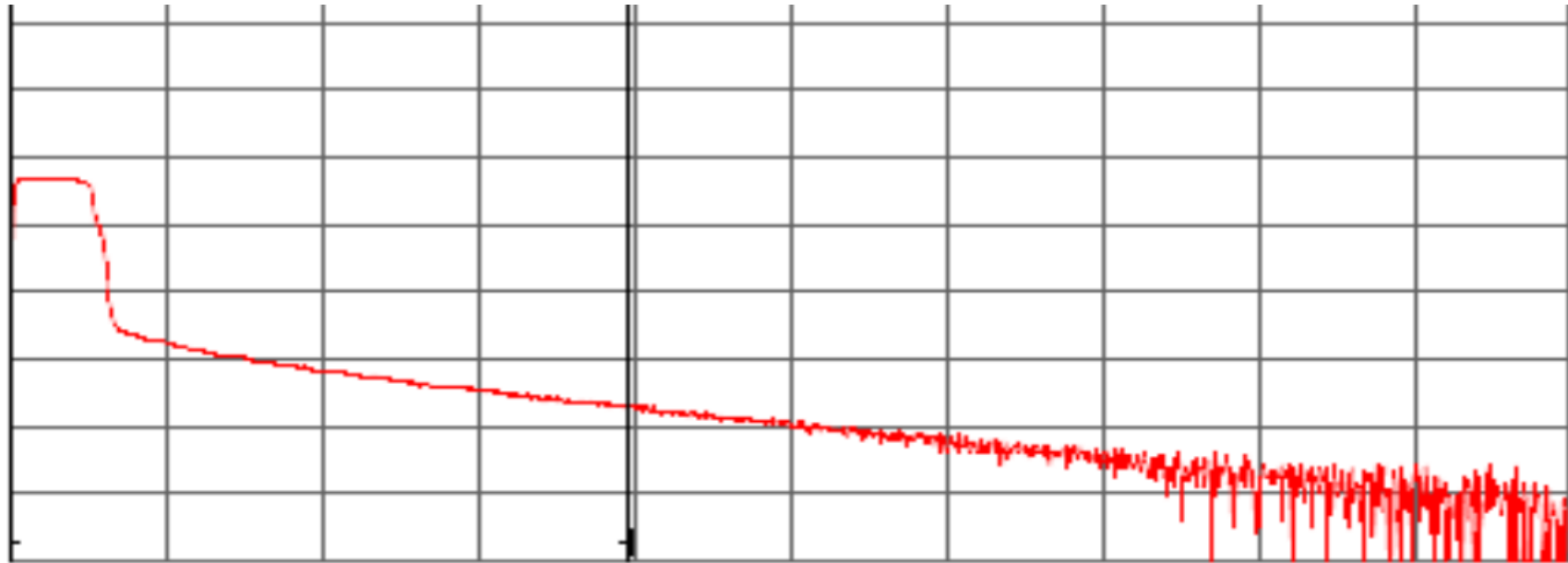


Loss Measurement on an OTDR

- To measure the loss, we will set a cursor before and after an event
- Here is the before
- And here it is set after
- Here are the details of the loss
- We are measuring the loss on the vertical scale
- Don't be scared! The expert module in the OTDR will calculate all of this for us automatically
- Here is the loss value, our limit is 0.75 dB so this is a failing event



You don't have to be an Expert at Reading Traces to Use an OTDR!



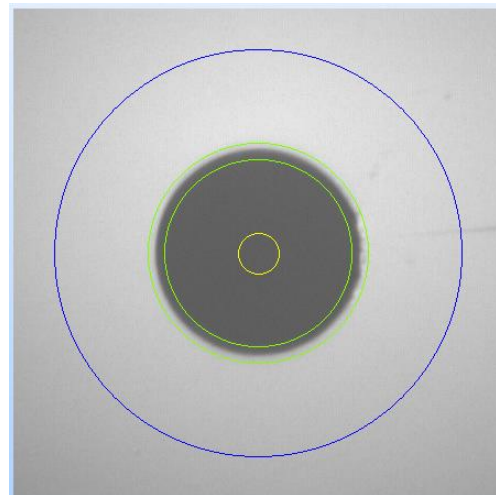
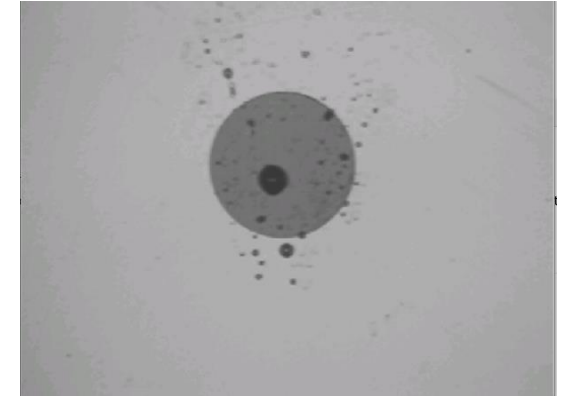
Here are the Best Practices to get a good Trace – These will help whoever has to read the trace

Expert modules are great, but, if you don't set up the test correctly, the expert module can't overcome these problems

- 1) A Clean Port on the OTDR
- 2) Verify the launch and tail before testing, and save that test
- 3) Use a Launch fiber to see the first connection
 - Don't add a short adapter cable to the end of the launch fiber!
- 4) Use a Tail Fiber to see the last connection
- 5) Correct IOR to find correct length to an event
- 6) Need to test the fiber in both directions – preferably without disconnecting the launch and tail fibers
- 7) Use a limit that includes pass/fail for reflectance

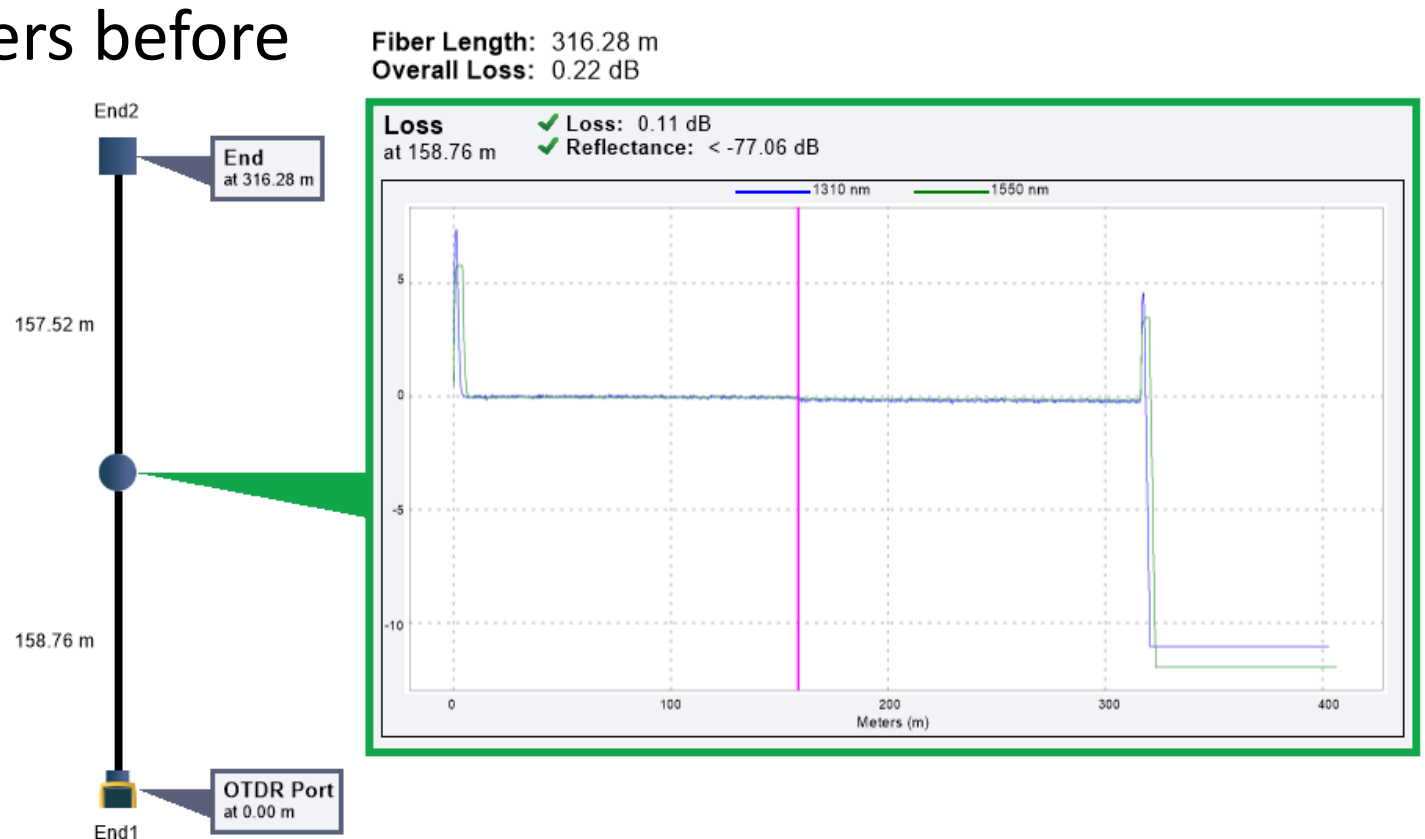
Be Careful with the Port of your OTDR

- Inspect the port before testing
 - Clean if necessary



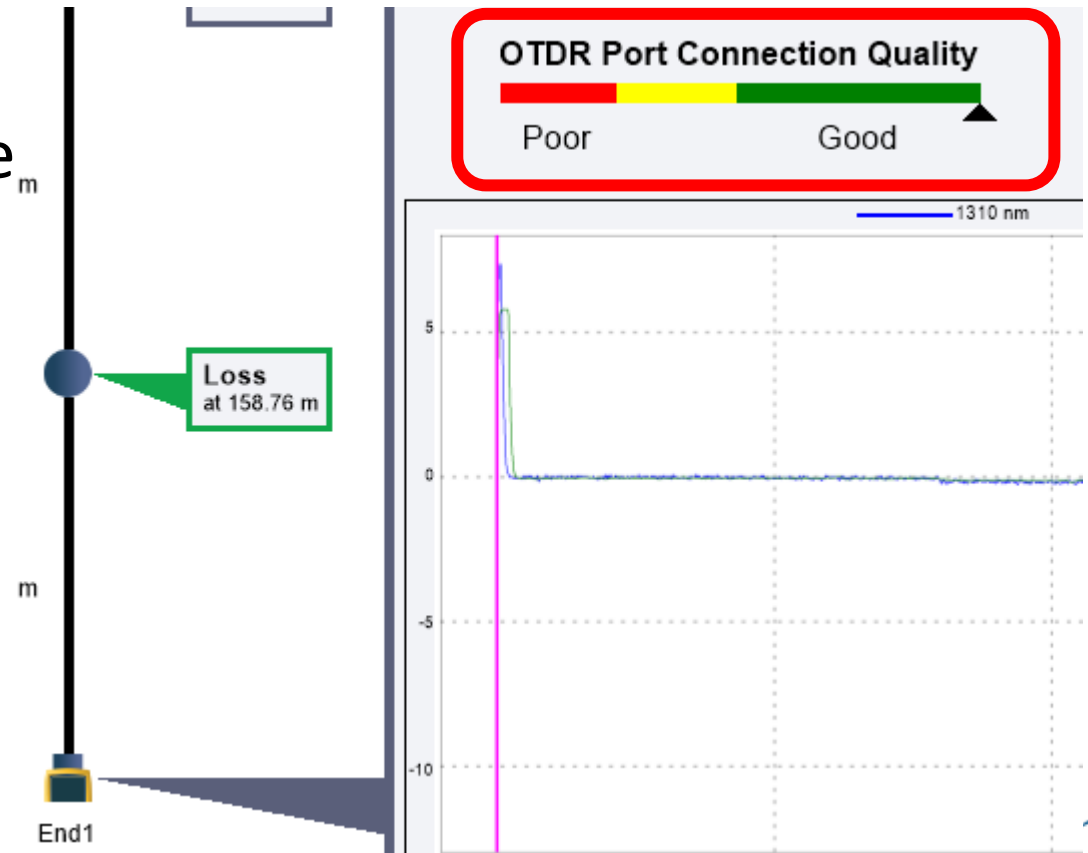
Be Careful with the Port of your OTDR

- Inspect the port before testing
 - Clean if necessary
- Test your launch and tail fibers before testing
 - Save that test



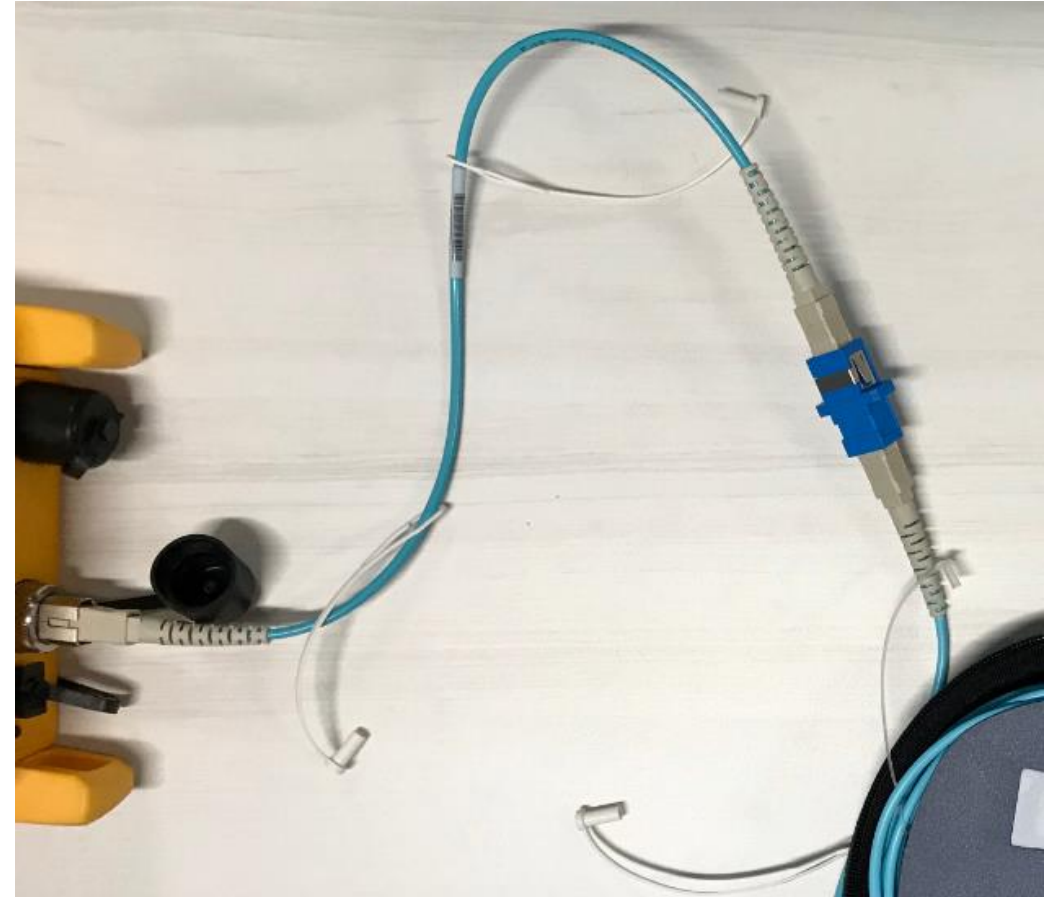
Be Careful with the Port of your OTDR

- Inspect the port before testing
 - Clean if necessary
- Test your launch and tail fibers before testing
 - Save that test
- Check the port quality



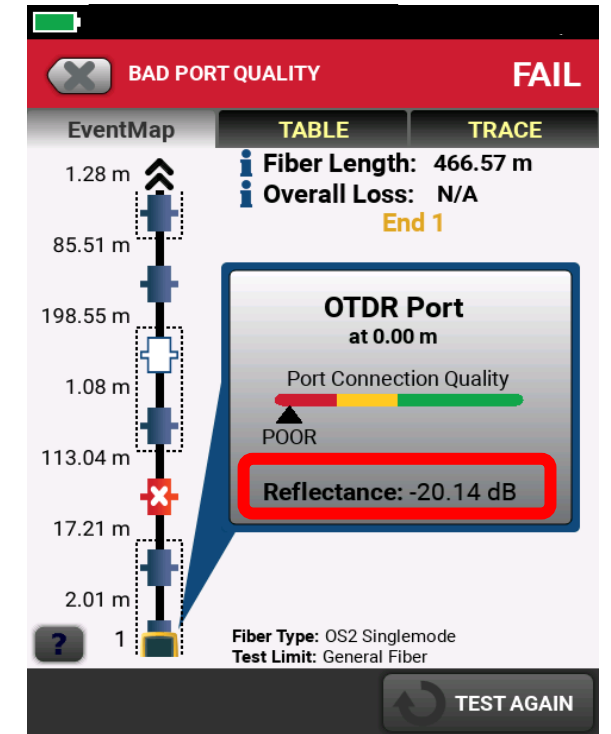
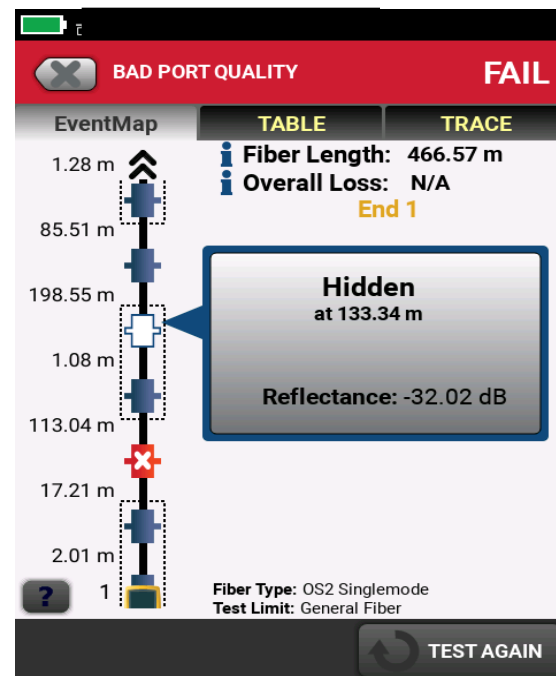
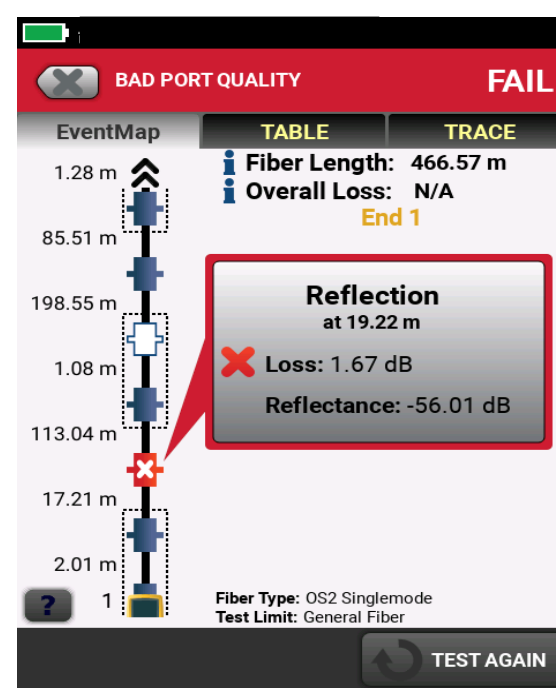
Be Careful with the Port of your OTDR

- Inspect the port before testing
 - Clean if necessary
- Test your launch and tail fibers before testing
 - Save that test
- Check the port quality
- Use a 'sacrificial cord' to reduce wear and tear
 - This short cord will be lost in the reflection of the port of the tester and won't impact the measurement



Example of Trace with poor quality OTDR Port

- Look at all of those events!
- Even a Hidden Event! (what is that?)
- I always start with the port
- If the Window is dirty, it is hard to see outside
- That reflectance is terrible



A Quick Study on Pulse Width and Dead Zones

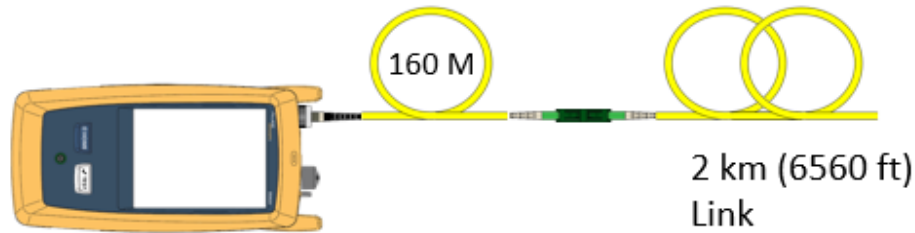
Longer Pulse Widths Make Larger Dead Zones
You need a longer pulse to 'see' a longer fiber
Or through a Splitter (PON and PON LAN)

What problem are you trying to solve?

Do you need a launch fiber?

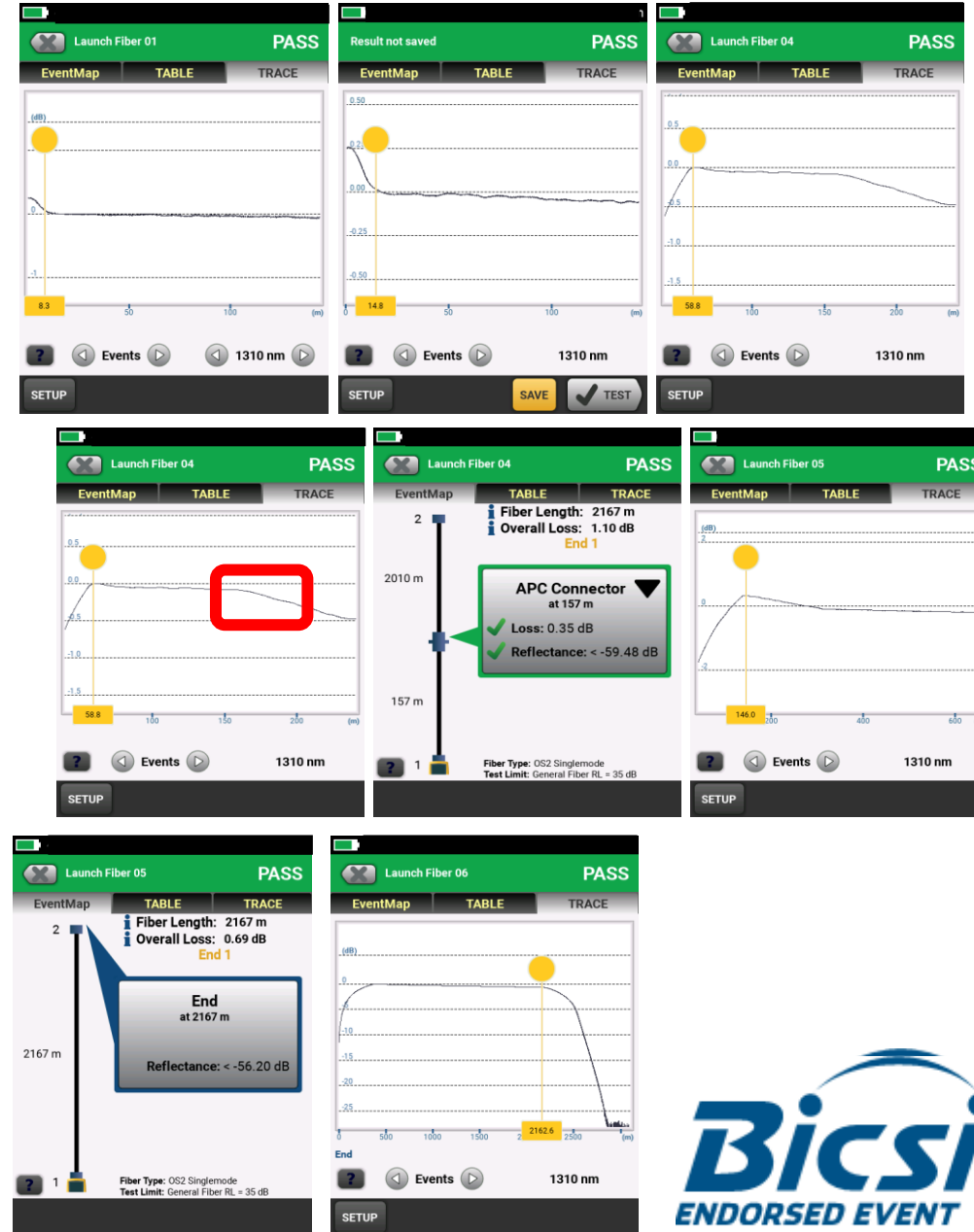
- There is no light coming out of the fiber and I need to quickly find the distance to open
- We put a splice into the fiber at X thousand feet and we need to show it is a good splice
 - Quick explanation of “Span”
- There is an issue, and the fiber is being blamed. I need to show it isn't the fiber.
 - Fully characterize the link
- I am contractually obligated to deliver a Tier II test report on a fiber

Dead Zone Vs Pulse Width



- Let's start small
- Here is a 160-meter Launch Fiber
- When we zoom in we can see there is about an 8 meter attenuation dead zone with a 30 ns pulse
- Here is 50 ns, about 15 meters
- 500 ns pulse is about 60 meters
 - Notice the first connector at 160
 - We still see the first connection in the 'expert module'
- 1000 ns pulse, about 145 m dead zone
 - We have lost the first connection
- At 5000 ns We are losing our 2000 m link

Longer Pulse makes Longer Dead Zone



How Long Should my Launch / Tail Fiber Be?

Long enough for the pulse to fit

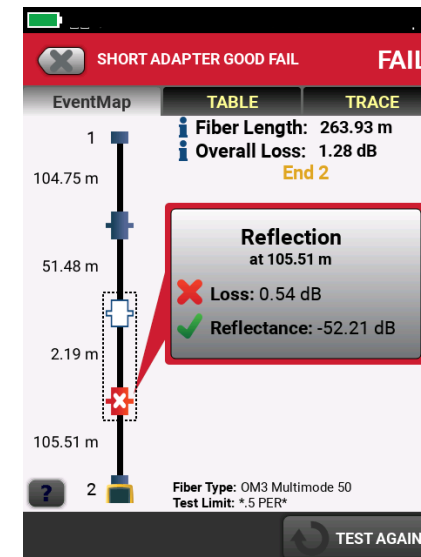
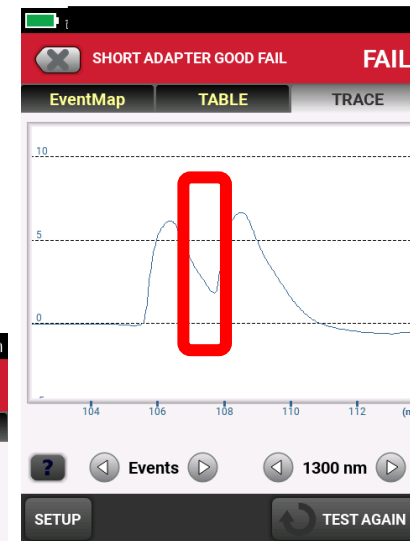
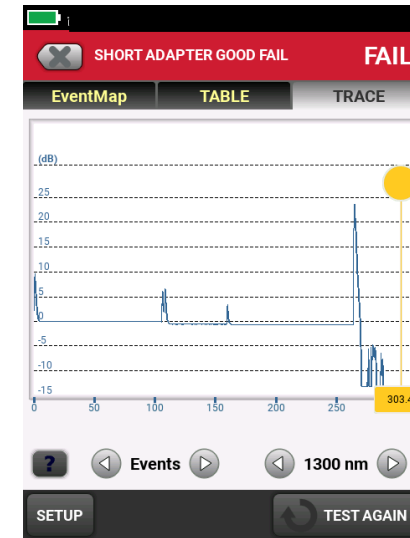
- As a guide only, for Single Mode – Your results may vary

Maximum length of Link (km)		Typical Pulse Width (ns)	Minimum Launch & Tail Cord Length (meters)*
1310 nm	1550 nm		
0 to 35	0 to 50	≤ 1,000	160
35 to 45	50 to 65	3,000	400
45 to 50	65 to 75	10,000	1,000
≥ 50	≥ 75	20,000	2,400

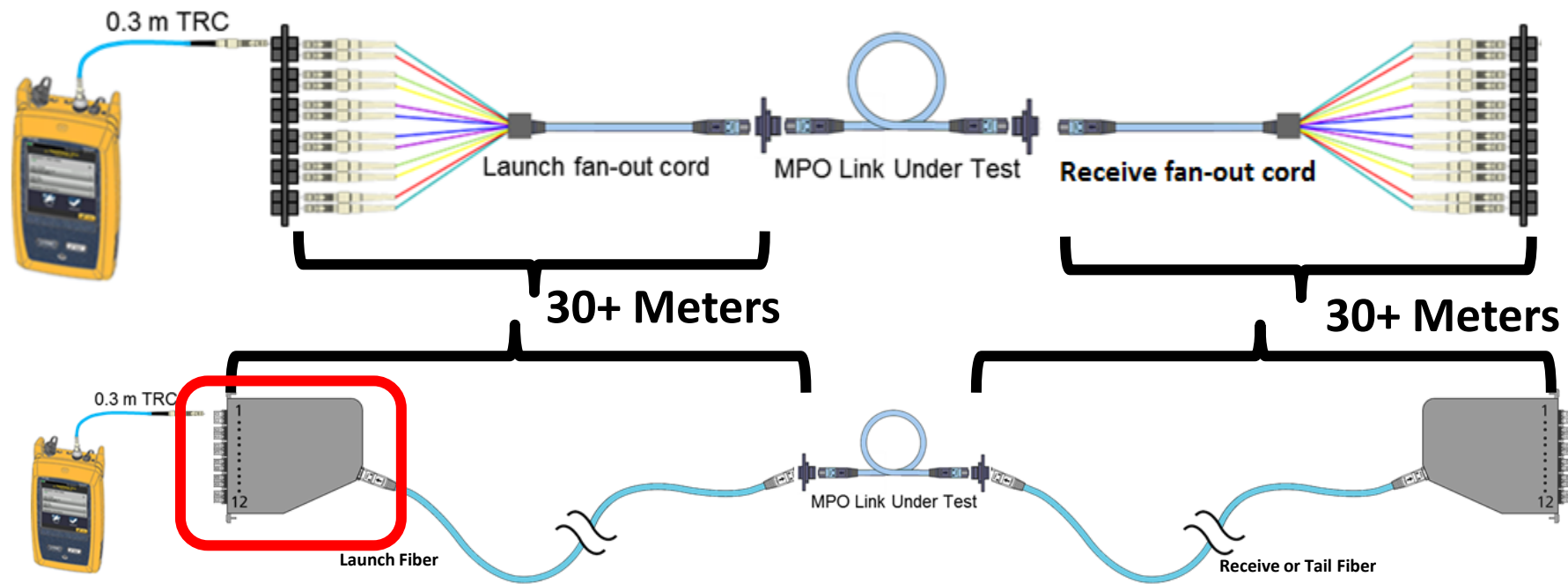
* For fiber with typical attenuation (≤ 0.35 dB/km at 1310 nm; ≤ 0.2 dB/km at 1550 nm) and event loss less than 0.8 dB

Example of Trace with short adapter cord on end of launch fiber

- Back to a Hidden Event
- Your Launch (and Tail) fibers must have the right connector. Don't add a short hybrid cord to adapt
- On the Trace, we can see...
- The distinctive “double bump” of two connectors
- Since the trace did not “recover” between them, here, the loss of the second event cannot be measured, hence, the “hidden” event
- In this example, the loss of the two connectors together exceeds the custom 0.50 dB limit and it is failing

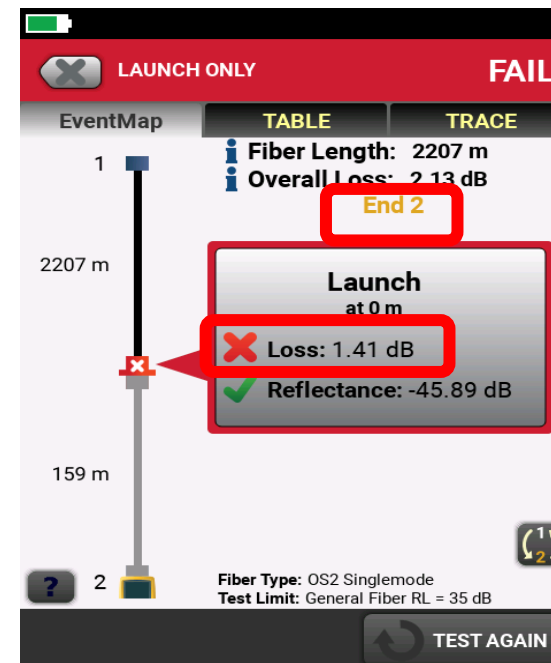
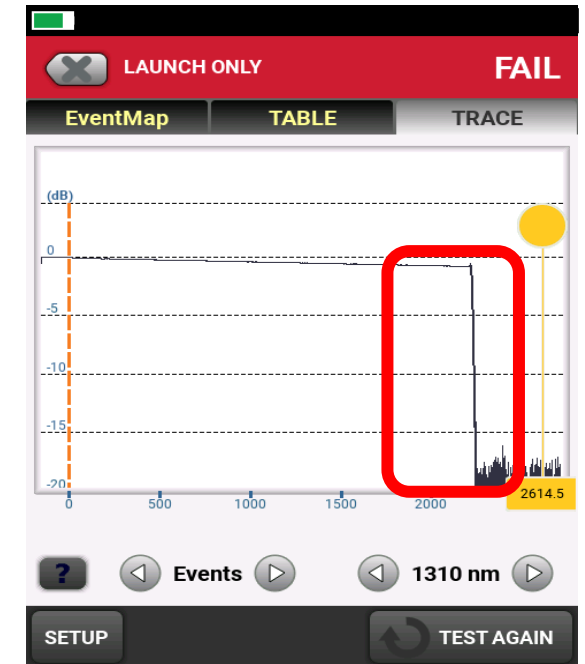
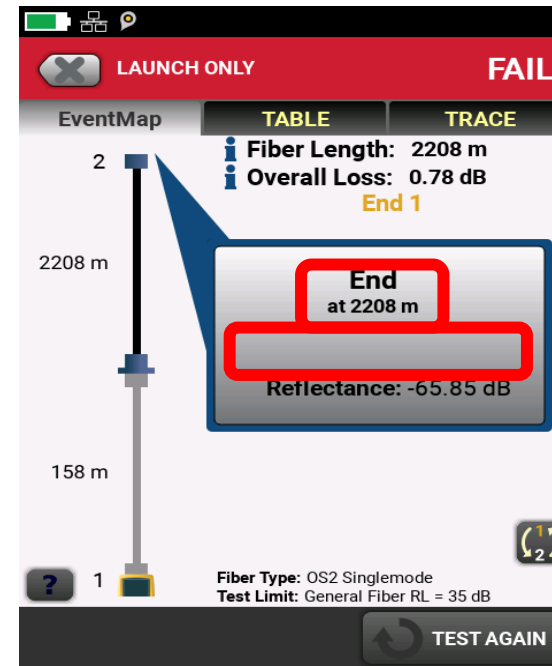


OTDR Testing of MPO with Connector Loss and Reflectance Requires a Launch and Receive Fiber



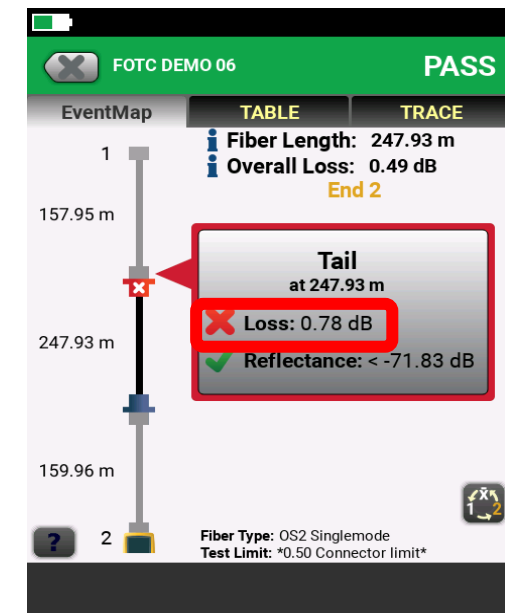
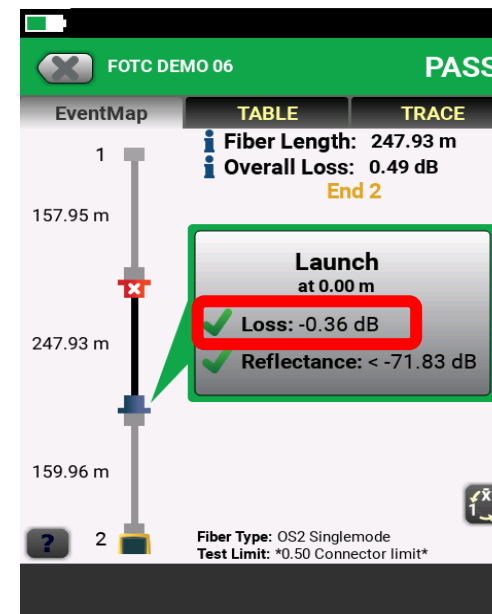
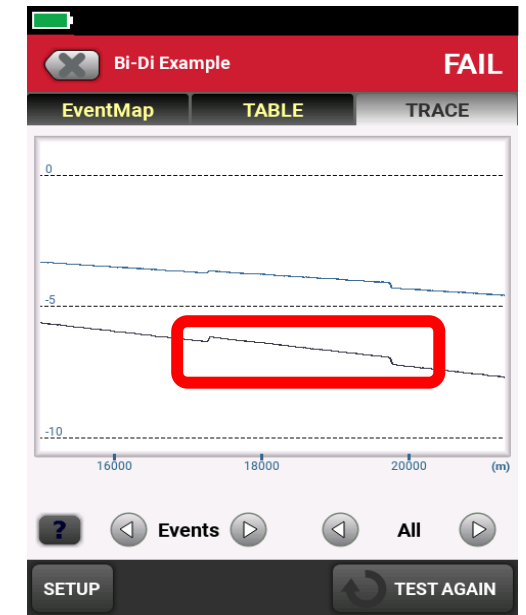
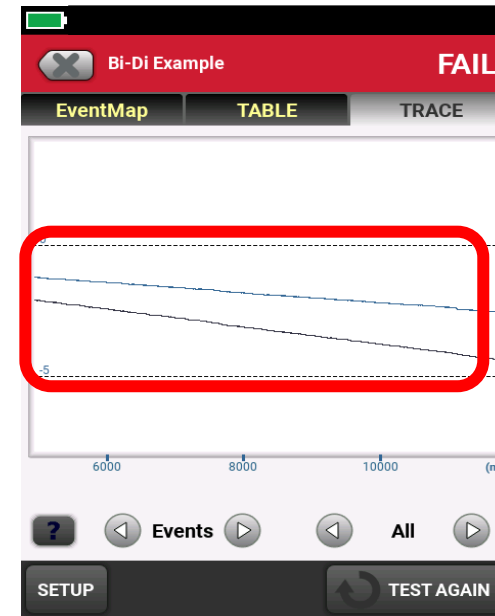
In Order to Measure the connector on the far end, you need a tail fiber

- Here we can see the end of the fiber
- There is no loss value for this connector
- The trace just ends
- One Solution is to shoot the trace from the other end
- Here we see that this is End 2
- It looks like it is failing for too much loss
- Which is a great lead-in to Bi-Directional testing



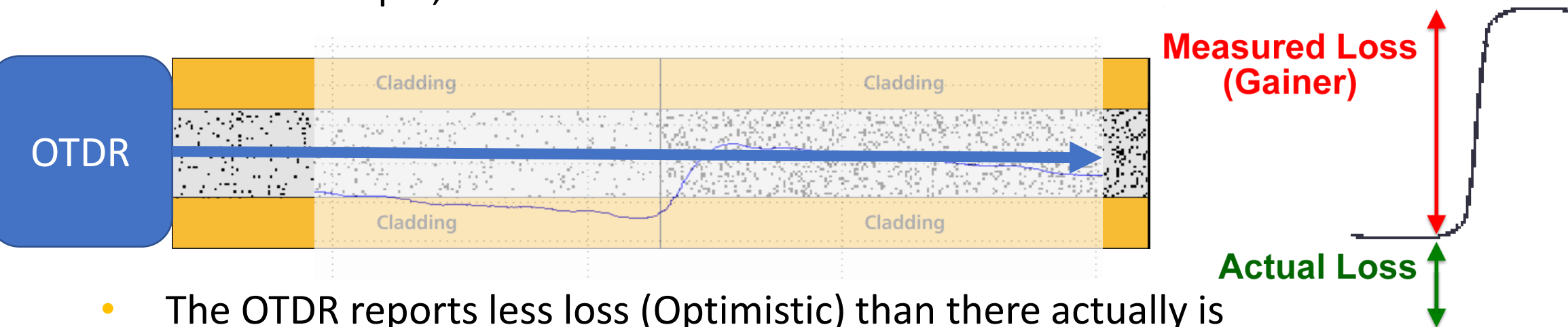
Bi-Directional Averaging

- An OTDR expects the fiber to have the same “backscatter co-efficient” for the whole length of the fiber
 - Notice the nice smooth Raleigh Scattering
- But in the real world, you may have to connect two fibers together, that are both good, but that have a slightly different properties
 - Notice the Gainer
- Here we see the Gainer in the Expert Module
 - Notice the negative loss
- Oh No! A Failing connection, too much loss
- Perhaps not though



Variations in Backscatter Co-Efficient drive the need for Bi-Directional Testing with an OTDR

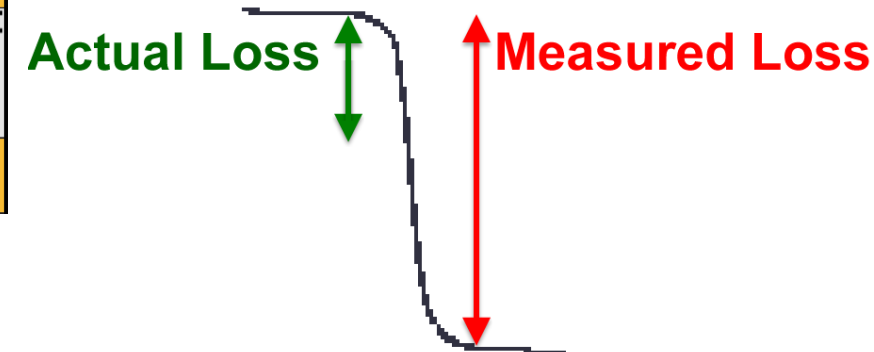
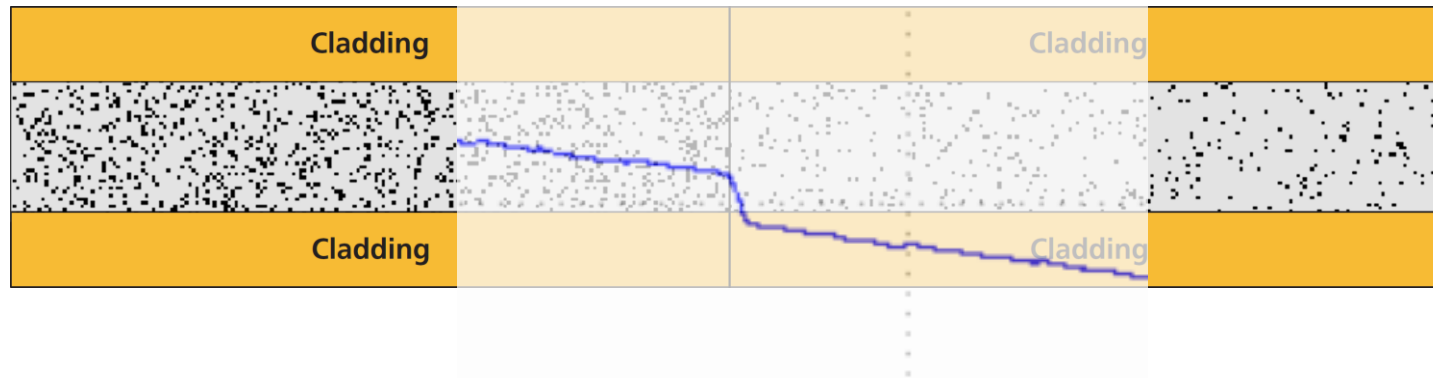
- OTDRs determine event loss based on variations in the amount of reflected light (Rayleigh Scattering) received
 - Typically, there is less reflected light received after an event, suggesting loss
- In this example, the attached fiber has more backscatter



- The OTDR reports less loss (Optimistic) than there actually is
- This can result in a negative loss (gainer) as shown here

What Goes Up...

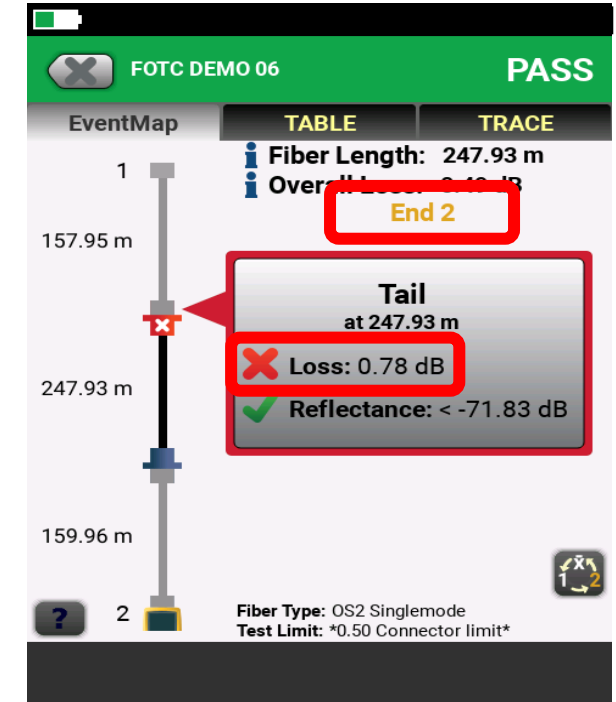
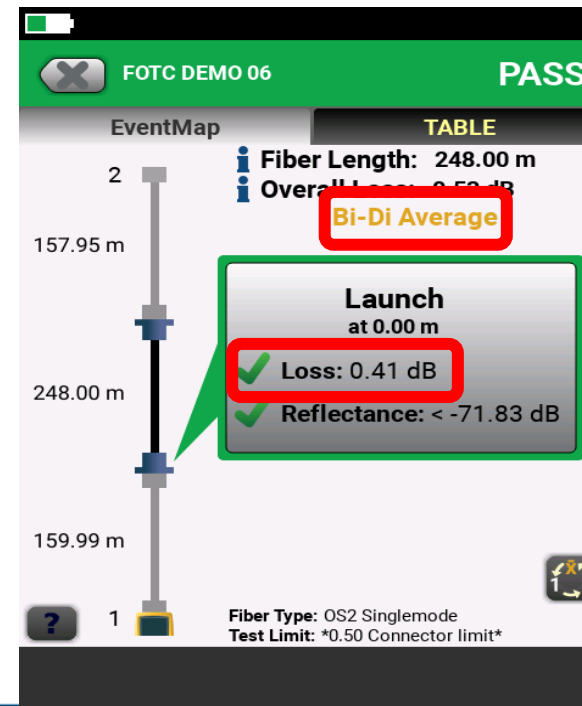
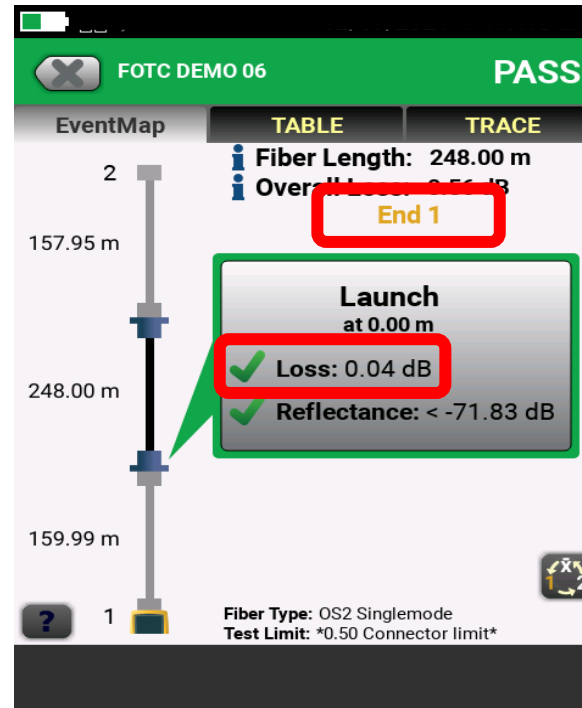
- OTDRs determine event loss based on variations in the amount of reflected light (Rayleigh Scattering) received
- In this example, the attached fiber has less backscatter



- The OTDR reports more loss (pessimistic) than there actually is
- This can result in a false failure
- For this reason, the OTDR trace needs to be shot in both directions and the loss values averaged to find the 'true' loss of an event

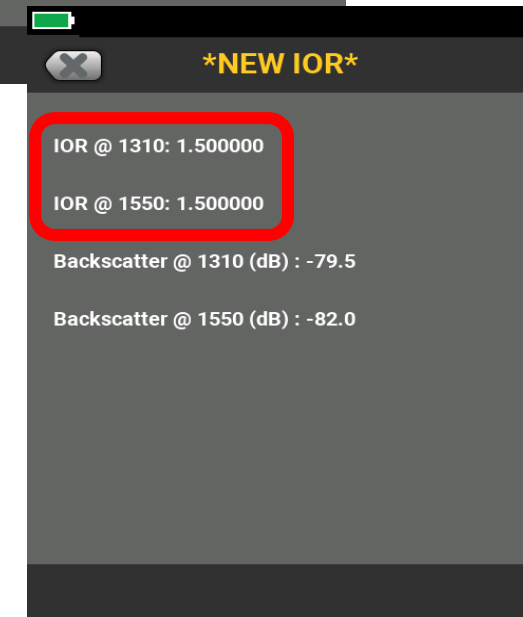
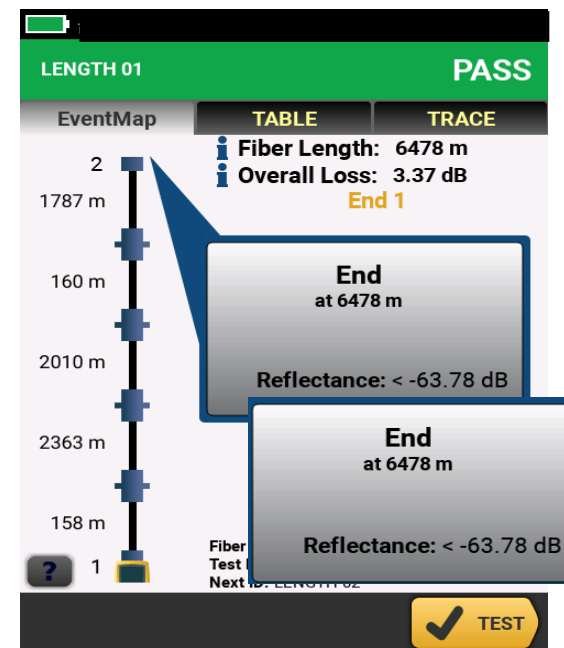
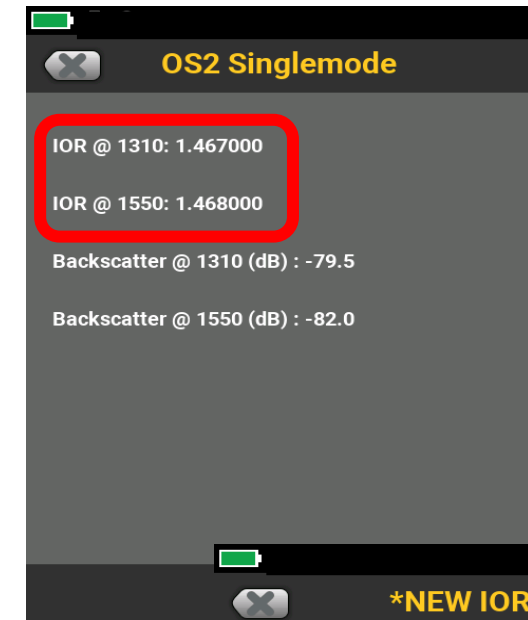
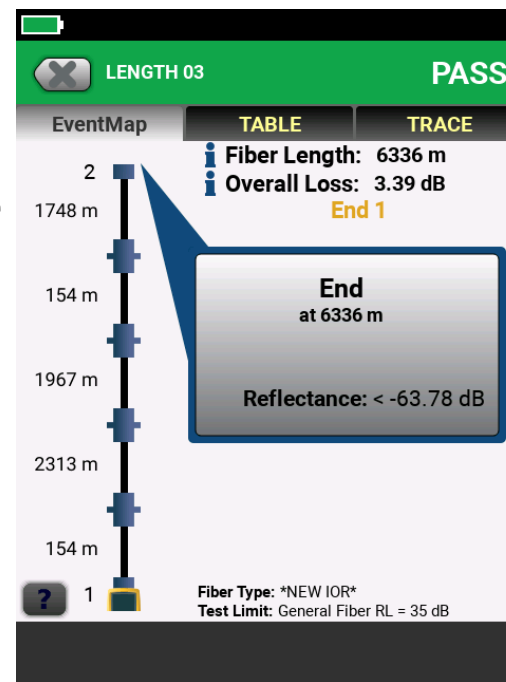
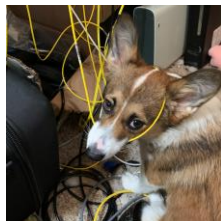
Bi-Directional Averaging

- Let's go back to the example that showed an optimistic (gainer) loss and the pessimistic loss that was failing
 - From End 2 it is 0.78 dB
- From End 1 that failing event doesn't look so bad (this is the Optimistic loss) 0.04 dB
- The correct loss for that first event is the average of the two loss values, and it is a pass, this link is fine. Nothing to fix.



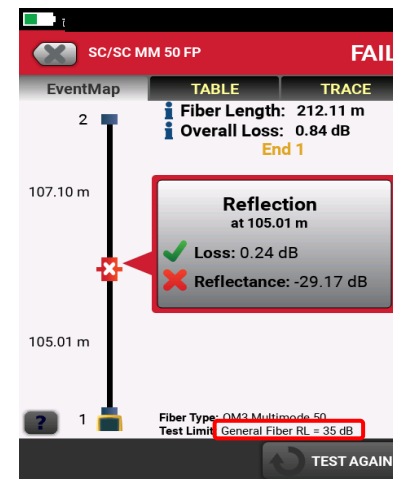
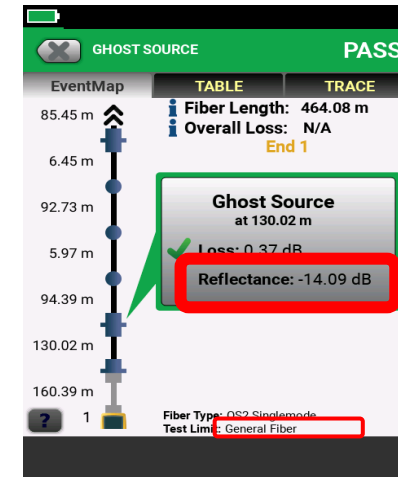
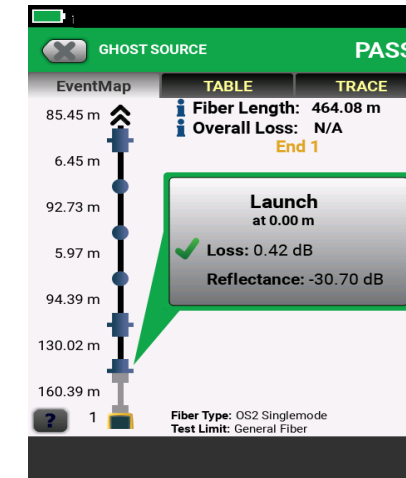
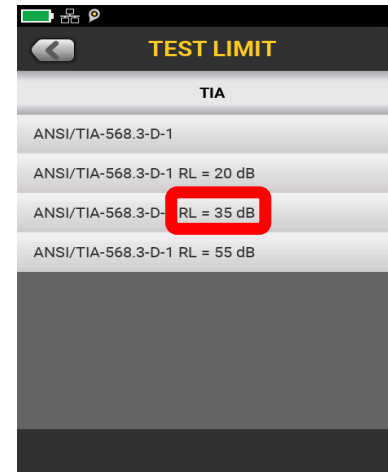
What is the distance to the end or a break in the fiber?

- The length is calculated by measuring the time it takes for a reflection to come back on the fiber. $\text{Time} * V \text{ (speed)} = \text{Length}$
- The speed of light in the fiber is expressed as a function of the speed of light in a vacuum, known as the Index of Refraction or IOR
- A Change in the IOR will change the length of the fiber
- Remember, this had been 6478 m
- Where is the break? Discuss



Pick a limit with Reflectance

- Reflectance is not a mandatory value in the TIA-568 limit or General Fiber
- Pick the limit that is correct for your connectors and your applications
- Look at this nice Passing Result
- Someone asked me at a recent Bicsi show, “What is a Ghost Source”
- It is an event with Terrible Reflectance
 - Did you notice?
 - This limit doesn't have a reflectance requirement so it doesn't pass or fail
 - May be caused by poor polish or dirt
- If you use a limit with reflectance limits, you will be more likely to see this failure in the field without having to look at the trace

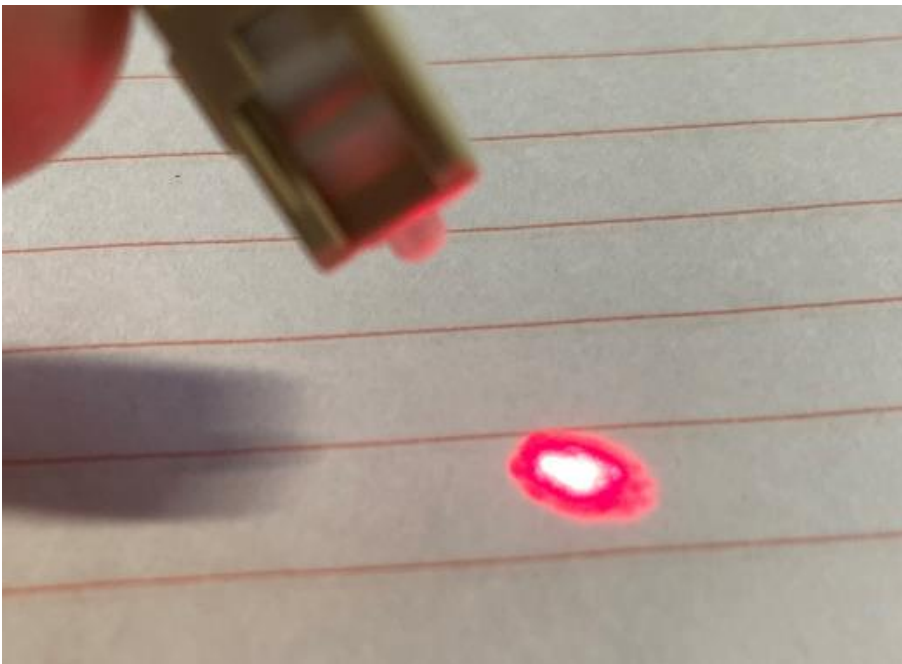


There are more topics we could cover, but not today – take a class and learn!

- Manual Settings
 - Pulse Width
 - Averaging time
- Bend
- UPC Vs APC
- Splitter
- An example of Core Size Mismatch? 50 v 62.5?
 - Is this still a valid issue?
- And more!

Summary of Today's Learning

- Tools to use before an OTDR – VFL, Microscope, Live Fiber Detector



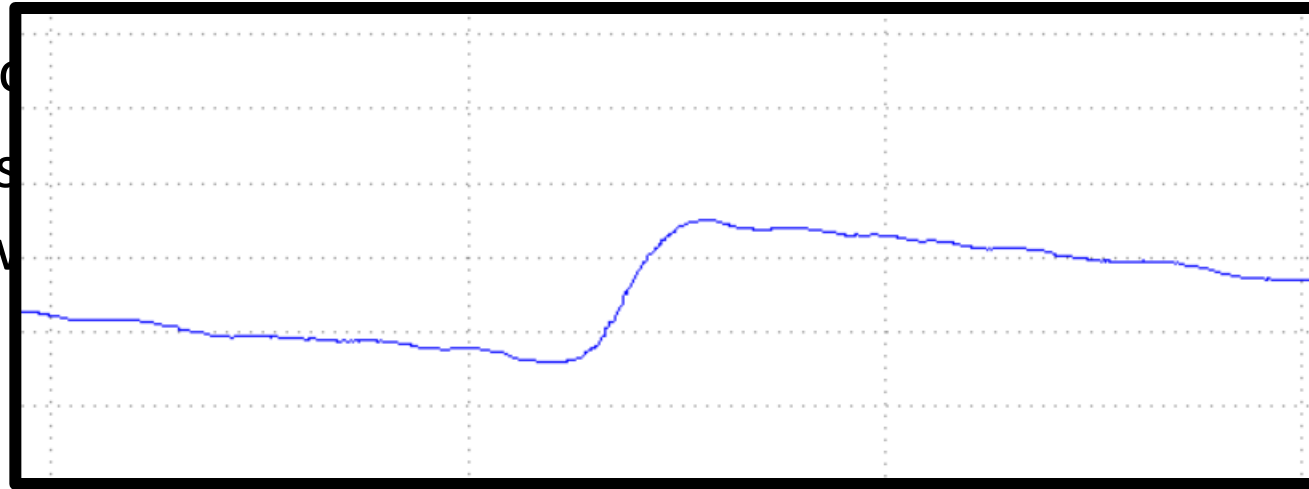
Summary of Today's Learning

- Tools to use before an OTDR – VFL, Microscope, Live Fiber Detector
- If you have to use an OTDR, you need a good set up to get a good trace
 - The person who must read the trace will thank you
- Launch and Tail Fiber
 - Check them before you start and save that test



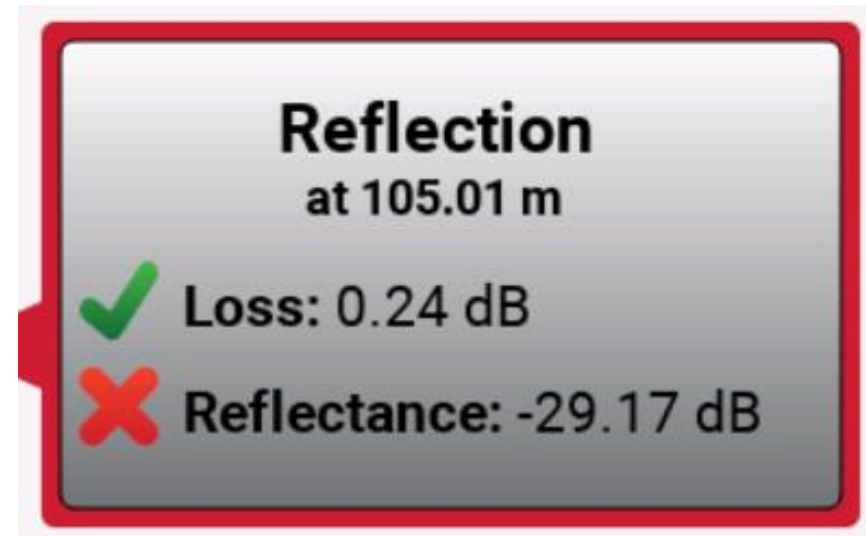
Summary of Today's Learning

- Tools to use before
- If you have to use
 - The person who
- Launch and Tail
 - Check them
- Shoot the fiber in both directions to calculate the bi-directional average



Summary of Today's Learning

- Tools to use before an OTDR – VFL, Microscope, Live Fiber Detector
- If you have to use an OTDR, you need a good set up to get a good trace
 - The person who must read the trace will thank you
- Launch and Tail Fiber
 - Check them before you start and save that test
- Shoot the fiber in both directions to calculate the bi-directional average
- Use a limit that includes pass/fail for reflectance
- Take a class!





Nigel Hedges
nigel.hedges@Flukenetworks.com

