

# ONX-580/580P – Finding Split Pairs with TDR and Crosstalk TDR

Split Pairs cause an imbalance and lower cross talk immunity. If a low longitudinal balance value is measured on two neighboring pairs, and longitudinal balance on other pairs is higher or significantly higher, split pairs is a potential cause.

## What is a Split Pair?

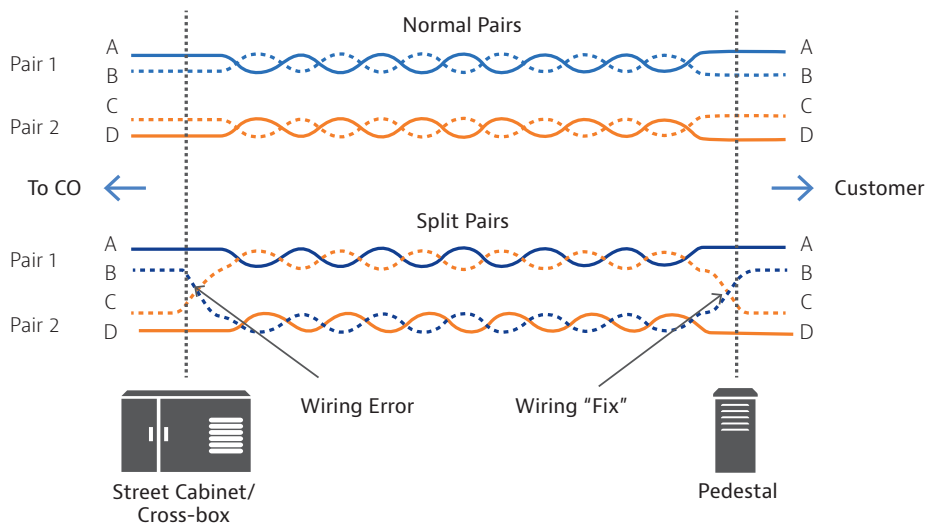
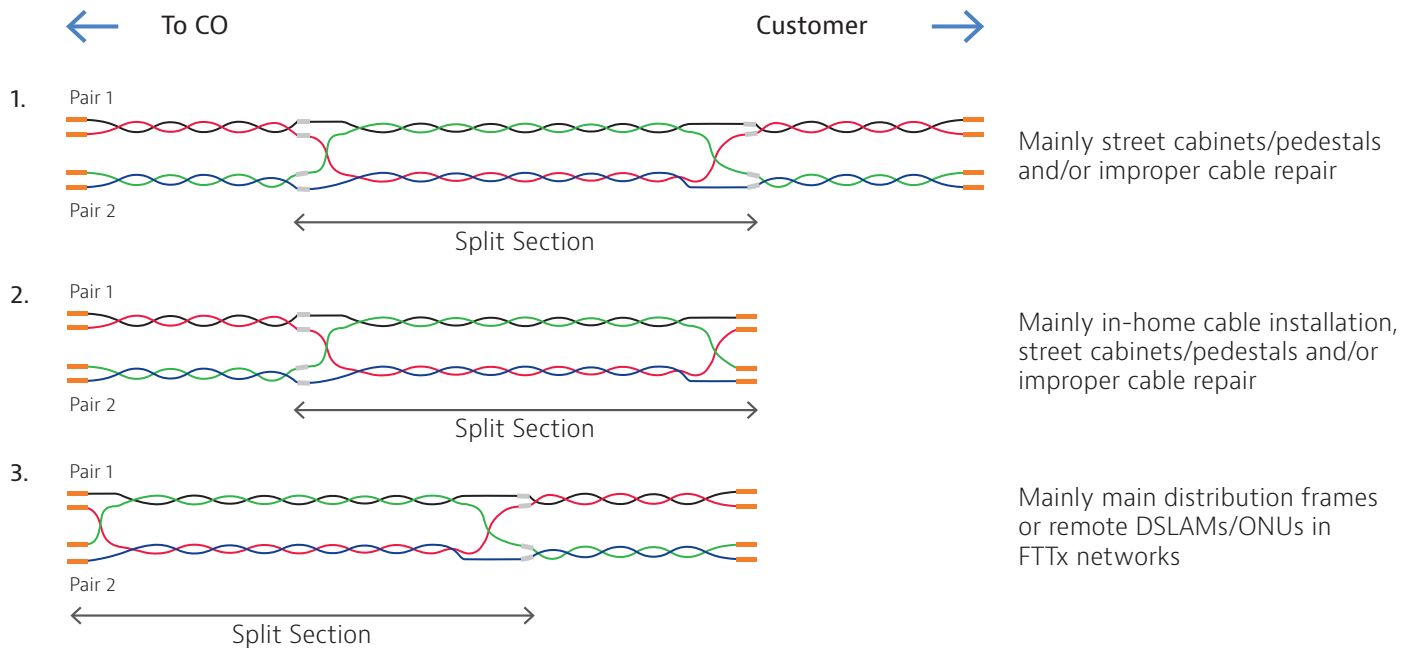


Figure 1: Normal vs. Split Pairs

Figure 1 above shows the difference between properly wired (normal) twisted pairs and pairs whose wiring has been split. In the split pair example, conductor B from Pair 1 has been inadvertently twisted with conductor D of pair 2 by a mistake in wiring at a street cabinet. Similarly, conductors A and C are now incorrectly twisted together. The wiring error is "fixed" at a downstream pedestal such that correct wiring continuity is maintained from the CO to the customer premise for both pairs; however, there is now a section of cable between cabinet and pedestal where the conductors for the two pairs are no longer properly twisted together.



The net result is that although the split pairs will appear correctly wired to DC electrical signals and continuity testing, their AC electrical performance is radically altered by virtue of the change in impedance caused by disrupted twist in the pairs. Three common split pair scenarios:



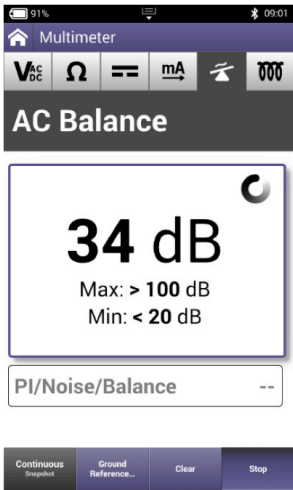
## Detecting a Split Pair with the ONX-580 or ONX-580P

The first indication that a copper pair is split might be poor longitudinal balance (AC balance). If longitudinal balance is approximately 40 dB or lower and basic copper measurements do not otherwise indicate a reason for poor balance such as battery cross, a resistance anomaly or a capacitance anomaly, then the pair may be split.

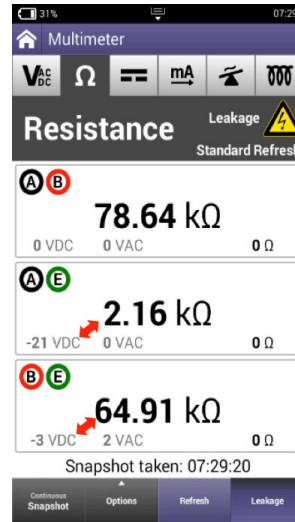
Note 1: Battery cross and resistance anomalies can be identified using the DC Volts and Resistance measurements found in the DVOM Multimeter application [Home key -> Copper Soft Key -> select DVOM Multimeter application from menu].

Note 2: Capacitance anomalies can be identified using the Opens (Dis Capacitance) measurement [Home key -> Copper Soft Key -> select Opens (Dis Capacitance) application from menu] If the distance calculated based on a tested line capacitance is significantly shorter than other lines within the cable profile, or is significantly shorter than distance measured with a standard TDR, it is a sign of potential split pair. **Split sections reduce capacitance!** *The Opens result (distance) is shorter than the true length of the pair because the distance is derived from the capacitance, and the capacitance is low because of the split.*

<sup>1</sup>TDR and capacitance tests must use the same "Cable type" settings.



AC Balance, also known as “longitudinal balance”



Foreign voltage and reduced insulation resistance correlation

### Confirming a Split Pair with the TDR

If a split pair is suspected, it can be confirmed using the ONX-580/580P Single Pair TDR function. In the split pair example of Figure 2 below, applying the TDR to Pair 2 as shown will typically yield a TDR signal like the one depicted.

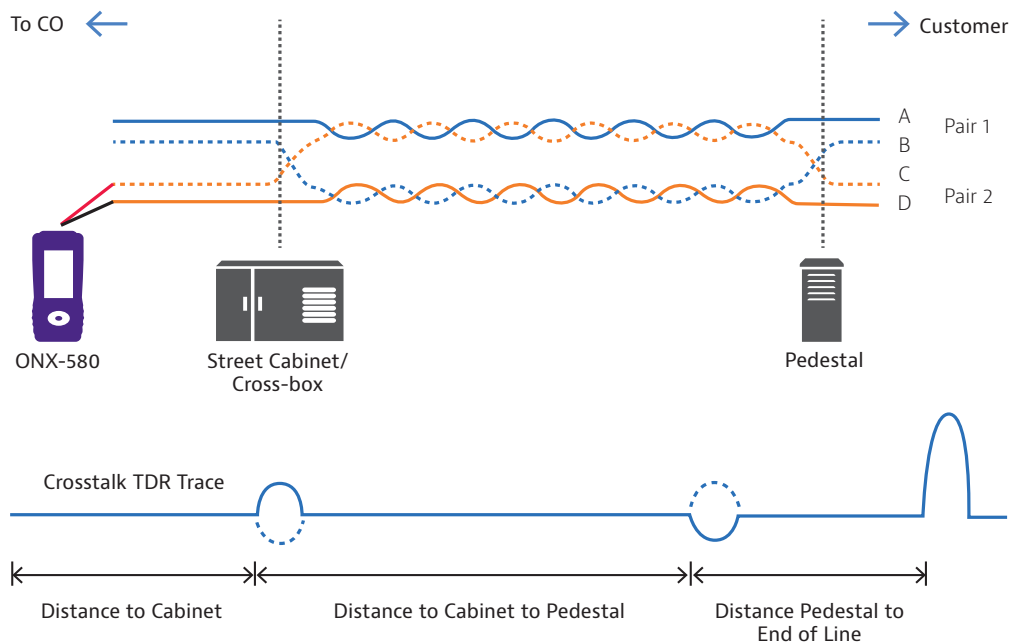


Figure 2: Confirming a Split Pair with TDR

The first small echo is indicative of an increase in line impedance (relative to the line’s characteristic impedance) that results from the loss of twist on Pair 2 due to the wiring error at the cabinet. The second small echo shows the relative decrease in impedance (back to characteristic) at the pedestal due to the wiring “fix”. The last, large echo shows the end of the line – an open in this case.

Although this TDR signature looks suspiciously like a bridged tap, the polarity of the first echo is not the correct polarity for a bridged tap signature. (Recall that for a bridged tap, the first echo is down followed by an up).

## Finding the Split Pair Companion with Crosstalk TDR

Once a split pair has been confirmed with the normal TDR, the ONX-580P Crosstalk TDR can be used to hunt for the companion pair in the split. With one conductor in Pair 2 inadvertently twisted with one conductor in Pair 1, and with the ONX-580P connected as in Figure 3 below, energy from the Crosstalk TDR pulse transmitted by the ONX onto Pair 2 (via the red-black leads) will induce an echo on Pair 1 at the ONX (via the Yellow-Blue leads). Note that the echo received on the Yellow-Blue pair is not necessarily in the same polarity as the transmitted pulse and one cannot infer increasing / decreasing impedance from the direction of the echo deflection. Accordingly, changing the polarity of the Yellow-Blue leads will change the polarity of the received echo displayed on the ONX Crosstalk TDR screen. Pairs not involved in the split will have no induced echo. It remains for the user to scan the pairs in the bundle, looking for the induced TDR echo in order to isolate the companion pair in the split.

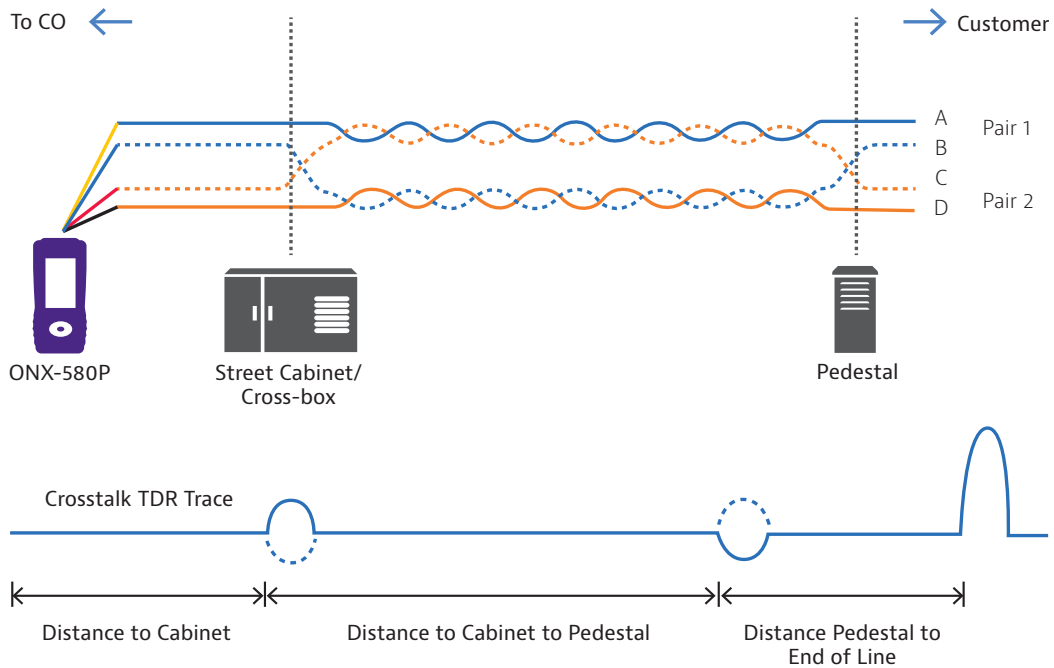


Figure 3: Finding the Split Pair Companion



ONX-580P screenshot with split pair TDR trace.

## Locating faults using the TDR

1. Connect the Tip (A), Ring (B), and Ground (Earth) leads to the line under test.
2. From the Copper menu, touch the **TDR** button. The TDR graph appears.
3. To change the TDR mode, press the Mode system key, and then select Standard TDR, In Home TDR (does not include Pulse Width), SmartGain TDR, OneCheck TDR or Crosstalk TDR.
4. If running In Home TDR, twist the cables for more consistent impedance.



5. To change the cable type, select the Options system key, and then select Cable Type.
6. To add a DC pulse in order to see changes in the graph, select the Options system key, and then select Stress. The spike or dip will shift when the pulse is applied.

**NOTE:** The TDR must be running for Stress Mode to be available. It is grayed out when the TDR is stopped.

A warning appears during the stress pulse to indicate higher voltage is present.

7. Using the Peak Hold mode, the ONX-580 can display minimum, maximum, and current TDR traces over a test period. This feature is useful for analyzing faults that occur intermittently. To enable Peak Hold mode, select the Options system key and then check the Peak Hold checkbox.
8. To adjust the Gain or Pulse Width, either drag the line across the bar or touch the + or – key to adjust it. Gain is used to identify small or distant faults. Using the + or – keys to gain the vertical axis and enhance the reflection of faults. Do not apply excessive gain. This makes a normal condition appear as a fault.

Pulse Width only appears when Pulse Width is selected on the Options pop-up menu (from the Options system key).

9. To help identify small or distant faults, use the up or down arrow keys to gain the vertical axis and enhance the reflection of faults. Do not apply excessive gain. This makes a normal condition appear as a fault.

## Locating faults using the TDR con't

10. If you are testing toward a FED, use the Options menu, then select TDR Helper to continuously open and short the pair. On a TDR trace, you can then see the end of the copper pair by watching the open trace (slope up) and the short trace (slope down) that will flip flop for the time you specify. This allows you to see where the FED is located.
11. The Options menu has a check box for Dual Trace. The Dual Trace TDR runs the TDR measurements on both primary and secondary pairs (A1 and B1).
12. The Reference menu contains not only the Save and Load options but also the View modes for the graphs on the screen. View Offset is the default and shows both traces. View Overlap shows the overlapping traces. View Difference highlights the differences between the traces.
13. To save the results to a report, use the Tray menu.
14. You can also view and compare current and saved TDR traces using the Results key.



Contact Us **+1 844 GO VIAVI**  
(+1 844 468 4284)

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visit [viavisolutions.com/contact](https://www.viavisolutions.com/contact)

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