# Finding Split Pairs with the JDSU HST-3000 Crosstalk TDR

## Test Challenge: Why Should I Care About Split Pairs ?

Electrical dissimilarities between tip and ring copper wires in outside plants are well-known causes for disruptions in data, voice, and video triple-play services. At worst, depending upon environmental factors, such as temperature, humidity, and precipitation, customers may experience intermittent service, increasing the likelihood of repeatedly dispatching technicians who then find no problems. Often, problems are the result of one conductor in the pair becoming separated, or "split," from its mate between the central office (CO) and the customer, eliminating the pair's ability to reject common mode noise. Split pairs remove the protections inherent to twisted-pair cabling by destroying the pair's balance, thereby increasing its susceptibility to noise it would otherwise reject.

Figure 1 shows the difference between properly wired (normal) twisted pairs and those with split wiring. In this example, conductor B in pair 1 was inadvertently twisted with conductor D in pair 2 mistakenly wired at a cross-connect (street cabinet). Similarly, conductors A and C are now incorrectly twisted together. Technicians would fix the wiring error at a downstream pedestal to maintain correct wiring continuity from the CO to the customer premises for both pairs. However, a section of cable between the cabinet and the pedestal, which houses the conductors for the two pairs, are now no longer properly twisted together.

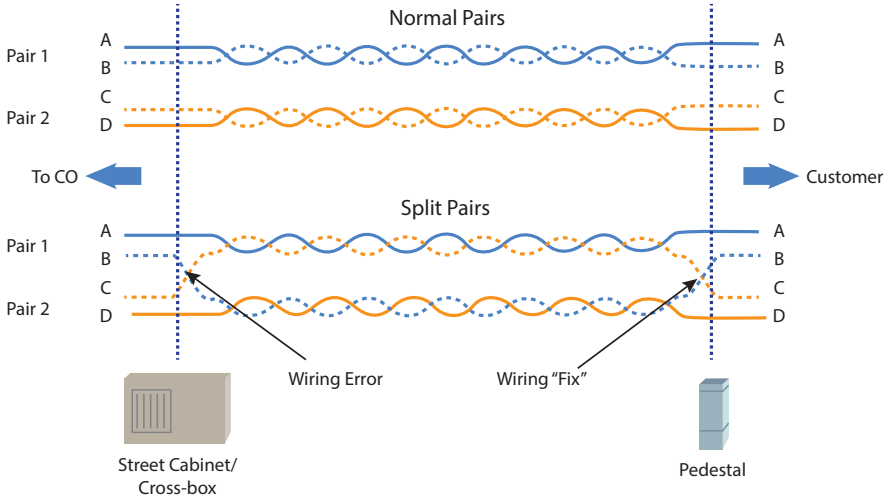



Figure 1. Normal vs. Split Pairs

Although the split pairs appear to be wired correctly to direct current (DC) electrical signals and even though they pass continuity testing, the impedance change from the disrupted twisted pairs radically alters their alternate current (AC) electrical performance. This disruption creates an imbalanced pair which ultimately degrades xDSL performance. Longer-length split sections directly correlate to the pair's vulnerability to interferers and impulse events. Steady-state interferers that ingress through a split section will reduce xDSL line capacity abnormally versus the total line length. Also, impulse noise similarly coupled through the split is frequently a source of chronic circuit trouble and repeat service calls. Finding and fixing split pairs is, therefore, critical to optimizing network performance and stability and improving customer satisfaction.

## Addressing the Challenge

Poor longitudinal balance (AC balance) readings may be the first indication of a split copper pair. Longitudinal balances lower than approximately 40 dB together with basic copper measurements that do not indicate causes for poor balance, such as battery cross or a resistance or capacitance anomaly, may indicate a split pair.

Battery cross and resistance anomalies can be identified using a digital volt ohmmeter to measure voltage and resistance. Capacitance anomalies can be identified using an opens (dis capacitance) meter.

## Finding the Split Pair 2 with the JDSU HST-3000 Crosstalk TDR

The JDSU HST-3000 Crosstalk TDR (time-division reflectometer) can isolate the companion pair in the split. Figure 2 shows one conductor in pair 1 inadvertently twisted with a conductor in pair 2. Connecting an HST-3000 and launching the crosstalk TDR, the HST-3000 transmits energy onto pair 1 (through the yellow and blue leads) inducing an echo on pair 2 at the HST (through the red and black leads). Figure 3 depicts a representative crosstalk TDR trace.

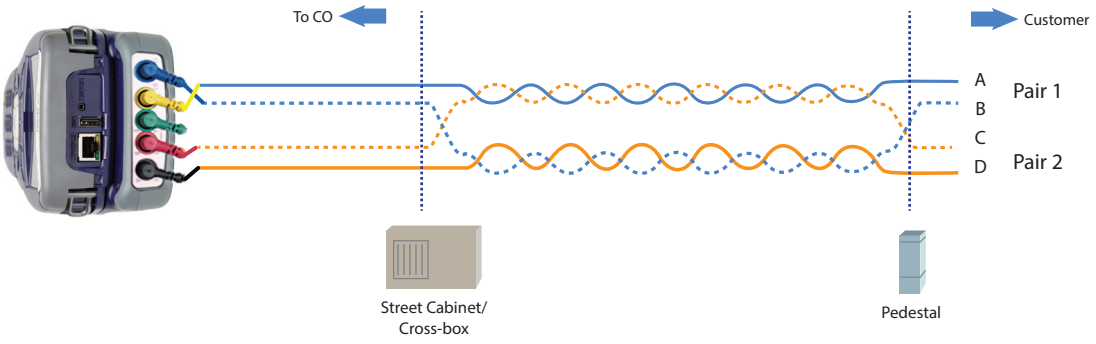



Figure 2. Finding the Split Pair Companion

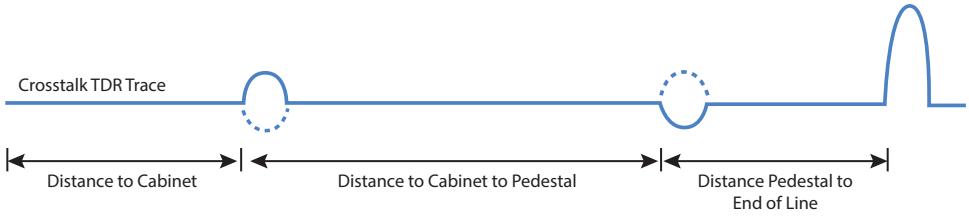



Figure 3. Finding the Split Pair Companion

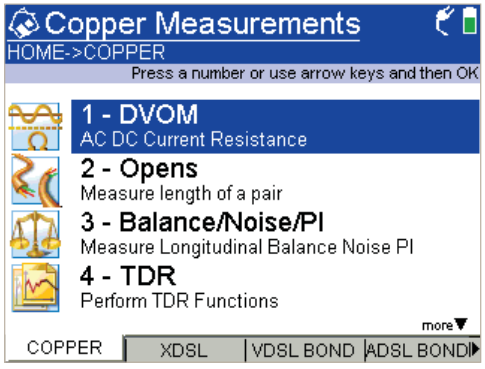
Note that the echo received on the red and black pair may differ from the polarity of the transmitted pulse. Therefore, technicians cannot conclude whether impedance increased or decreased from the direction of the echo deflection. Accordingly, swapping the red and black leads will alter the received echo polarity displayed on the HST-3000 Crosstalk TDR screen. Therefore, at times, the split-pair echo can suspiciously resemble a bridged-tap echo, a downward deflection followed by an upward deflection.

Uninvolved pairs will have no induced echo. Therefore, technicians must still scan the pairs in the bundle for induced TDR echo to isolate companion pair(s) involved in the split.

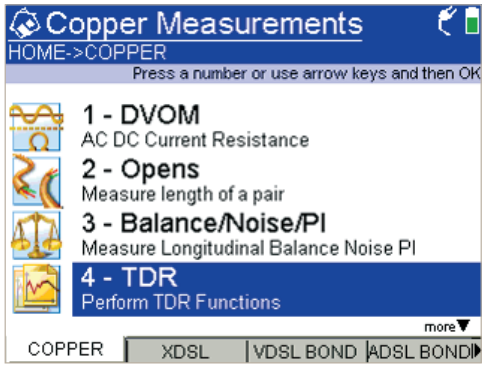
## Running the HST-3000 Crosstalk TDR

The steps below summarize how to use the HST-3000 Crosstalk TDR to isolate the affected companion pair in the previous example.

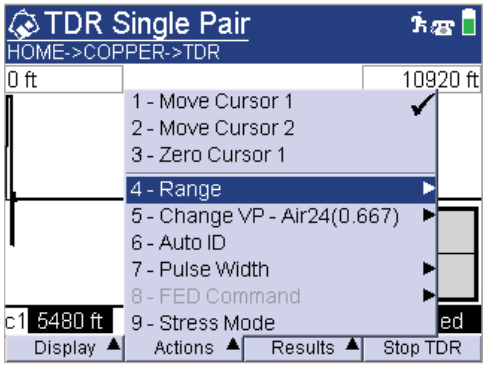

1. Press the home key on the HST-3000.




2. Press the copper soft key.

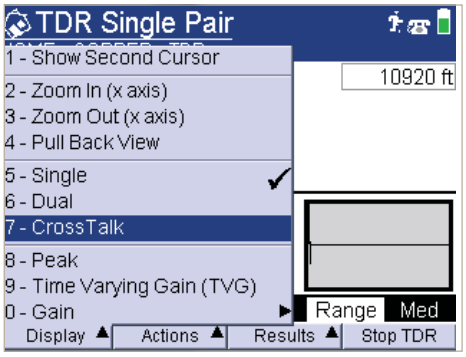



3. Press 4 on the keypad, or use the copper measurements menu and the up/down arrow keys followed by the OK key to select the TDR application.

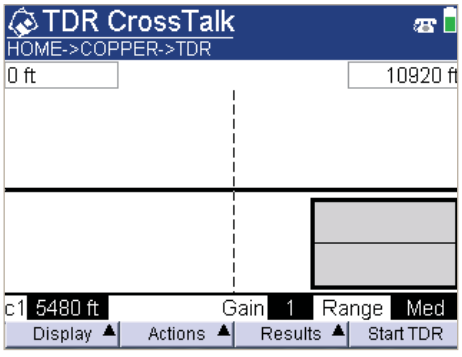



4. As appropriate, adjust the TDR range, gain, velocity of propagation (Vp), and mode for the circuit under test. Note that the crosstalk TDR will not work at extra-short ranges. (Refer to the HST-3000 User Guide in the TDR section for a description of these parameters.)


5. Press the display soft key.




6. Press the up/down arrows and the OK key to select Cross Talk
7. Attach the yellow and blue leads (shown in Figure 2) to the suspected split pair.
8. Attach the red and black leads to another pair in the binder to which the first pair might be split.




9. Press Start TDR to run the CrossTalk TDR test.
10. Move the red and black leads across the available pairs until the HST-3000 displays that it has located the crosstalk TDR echo and its split pair companion.

## Conclusion

Historically, detecting and isolating a split pair has been a difficult testing challenge for field technicians. The correct DC arrangement of the wiring of a split tends to mask the line's impaired AC performance. Likewise, balance loss incurred by the split increases the line's vulnerability to steady-state and impulse noise sources. Degraded xDSL service capacity and customers experiencing highly intermittent problems arising from split sections frequently result in repeat service calls, customer dissatisfaction, and ultimately churn. The HST-3000's industry-leading copper test capabilities, specifically when combined with the crosstalk TDR, provide a complete and comprehensive test suite ideally suited for finding and fixing split pairs in the field.

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