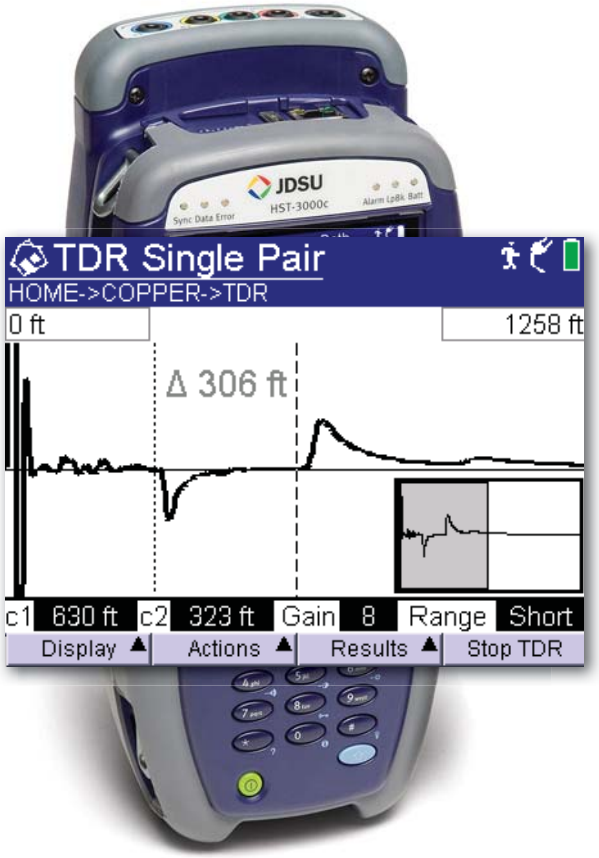
HST-3000 VDSL QUICK CARD

USING TIME DOMAIN REFLECTOMETER (TDR)



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Technical Assistance: 1-866-228-3762 TAC@jdsu.com

TDR Testing

Manual TDR

The purpose of this test is to identify and locate fault conditions such as load coils, opens, shorts, wet sections and low-resistance faults (across tip and ring) which may have been indicated by the results of the VDSL Good Pair Check. This test is also used to identify and locate bridged taps and can be operated in either Manual or Auto ID mode.

This test is typically run from the SAI / cross box towards the customer premises with the pair open at the pedestal or NID.

HST-3000 Test Interface

Connect dual tip & ring + ground leads to the mini-banana connectors on the top of the HST as shown below.

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TDR Testing

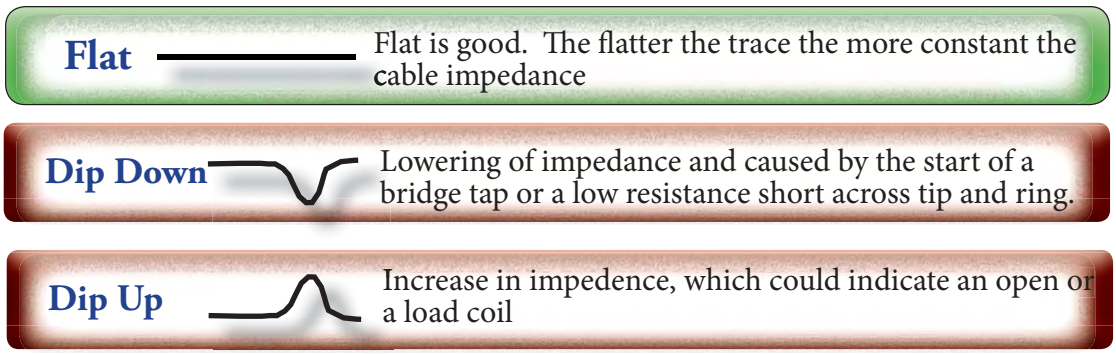
Manual TDR Use and Setup

Purpose: Although Auto-ID is a great feature there are several additional features available to the user in manual TDR mode.

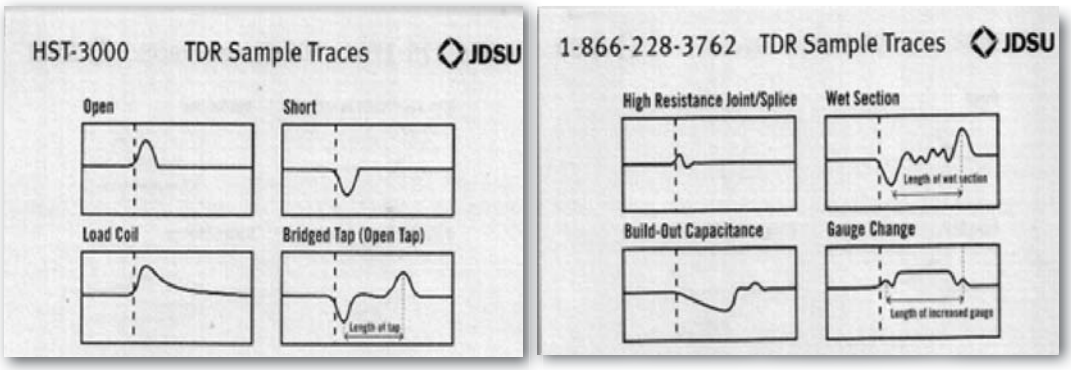
Theory of Operation: Before describing TDR setup and features a basic understanding of how the TDR operates is needed. In addition, an understanding of what type of cable faults TDR can locate and the type of faults it cannot.

TDRs basically work by sending a high frequency energy pulse down the cable pair (Tip and Ring), at a predetermined speed and count time until some or all of the energy is reflected back. The TDR takes the reflected signal and displays a picture or "trace" on the screen. It converts the time component to distance which allows the user to determine distance to fault.

Very similar to radar or sonar the key in using the TDR is determining the proper speed setting for the cable tested and interpreting the returned trace. Basic trace interpretation is as follows:



Example JDSU Quick Cards Showing TDR Traces



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TDR Testing

Manual TDR Setup and Test Functions

Fault types

As discussed TDR is the preferred tool depending on the fault type. Below is a list of fault types and how they correspond to using TDR to locate them.

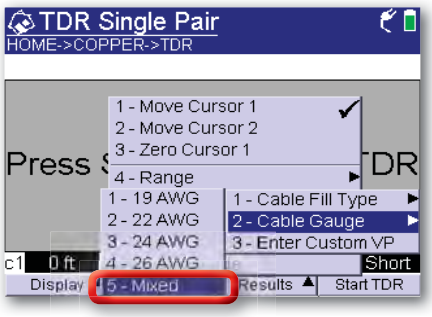
Table: 4 - Preferred and Non-Preferred Fault-Finding with a TDR

TDR	Preferred	Non-Preferred
Low resistance faults across tip and ring	√	
Low resistance faults from tip or ring to ground		√
Opens all types, complete or partial	√	
Bridge Tap	√	
Water or start of wet section	√	
High resistance fault across tip and ring or from either side to ground		√
Battery Cross		√
Load Coil[2]	√	√
NOTE[1] There are sophisticated TDR procedures that can be used for non-preferred fault types but they are outside the scope of this document		
NOTE[2] The TDR is very accurate in determining distance to a load but cannot "see" past a load		

Setup- Setting the "speed limit"

Velocity of Propagation (Vp) Velocity of propagation is the term for how quickly the TDR energy pulse travels down the cable pair. Each cable gauge and corresponding fill type have a unique "speed limit" or Vp.

6. **Setting Velocity of Propagation** - To change Vp, press the Action soft key, select Change Vp, and change the Cable Fill Type and Cable Gauge accordingly or enter a custom Vp setting as desired. The Vp for 24-gauge Air Core cable is typically 0.67
7. Often mixed gauge cable will be measured. In these instances a **MIXED** Vp selection is available.



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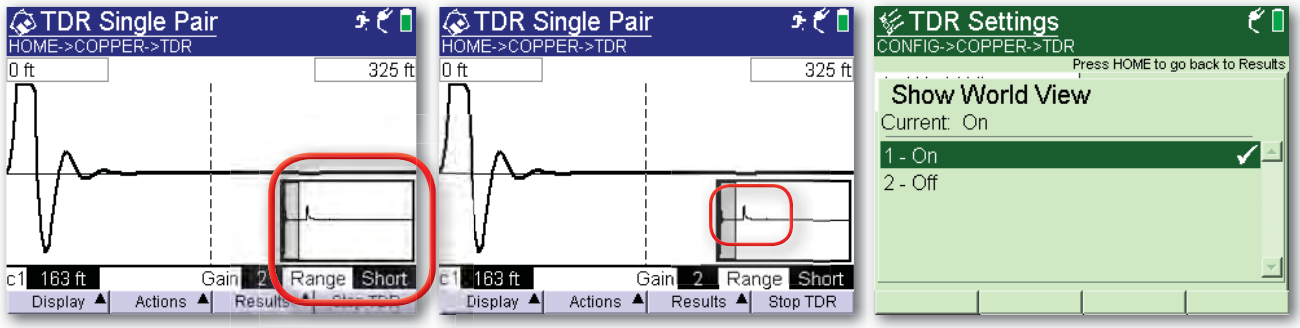
TDR Testing

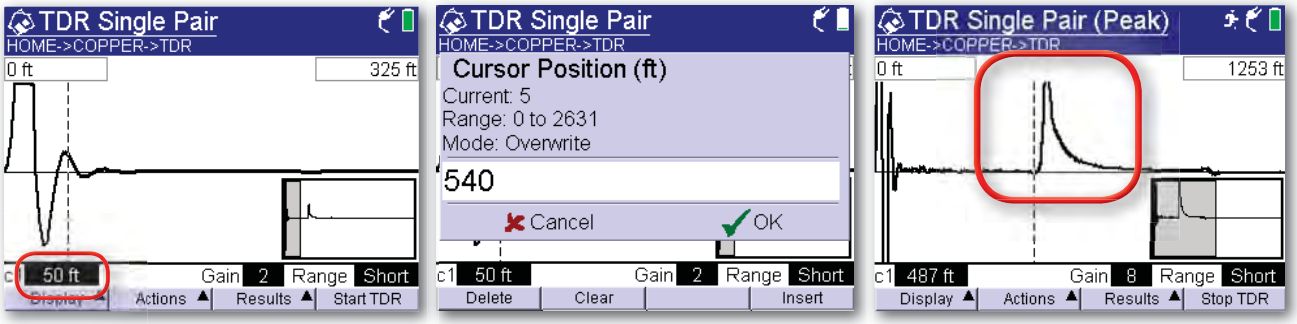
Manual TDR Setup and Test Functions (continued)

1. **World View** – The small window at the lower right of the display is the **World View** feature. This feature allows viewing of a miniature version of the entire trace including the portion of the trace beyond what is currently displayed on the main screen. This aids in navigation enabling the user to see potential faults or events beyond the portion currently visible on the screen. The highlighted (gray) portion of the window indicates what is currently displayed on the screen.
2. To enable or disable the **World View** feature, while the TDR application is active, press the **Conf gure** key and select **World View On** or **Off** as desired.
3. Press the **Home** navigation key to return to the TDR application.



Cursor movement and functions

1. **Single cursor** - movement can be controlled with the LEFT and RIGHT arrow keys. As the cursor is moving the corresponding distance is display in the box labeled c1.
2. Another convenient method to move the cursor is by typing the numerical distance using the keypad dial keys, selecting OK will snap the cursor to the corresponding distance
3. **Placing the cursor** - JDSU instructs on placing the cursor at the "apex" or where the trace turns from horizontal to vertical in either direction



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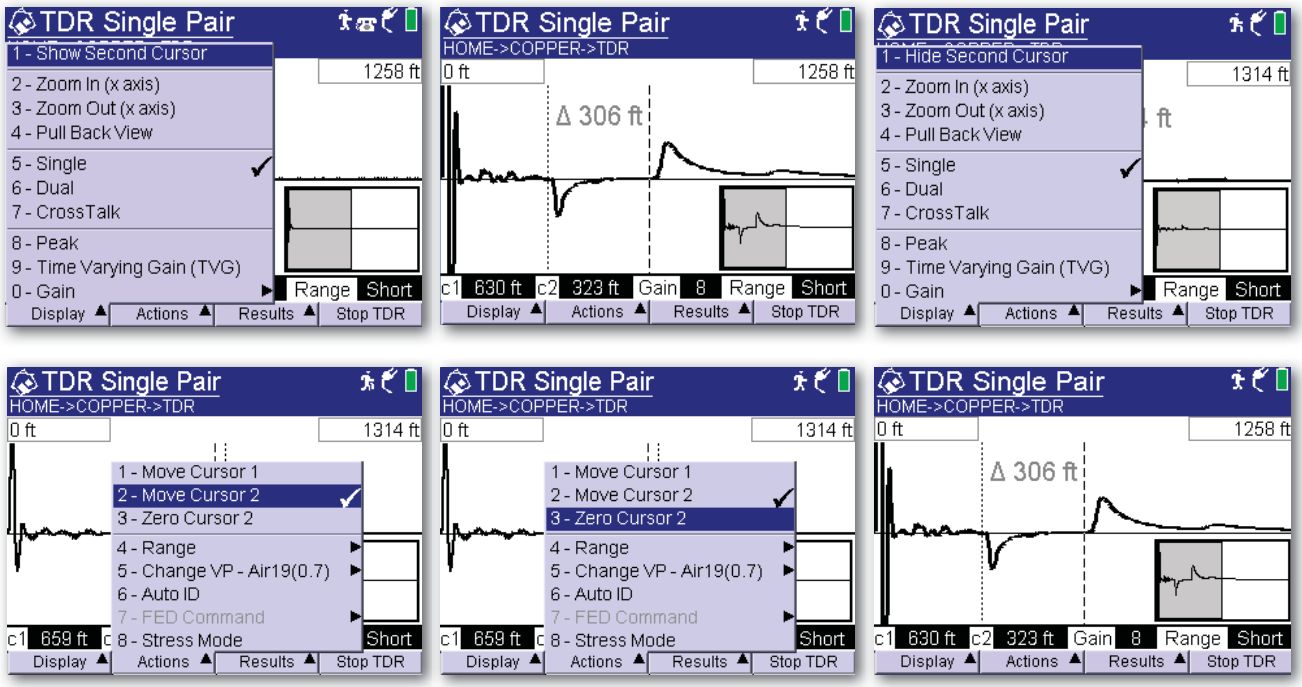
TDR Test

Manual TDR Setup and Test Functions (continued)

4. **Dual Cursor** - To measure the length of a particular event such as a bridged tap or wet section, the second cursor function can be used.
5. Press the **Display** soft key and select **Show Second Cursor** from the pop-up menu. The second cursor should now be visible on the screen.
6. The position (distance in feet) of each cursor is displayed in the windows on the lower left side of the display.
7. The distance between the two cursors is displayed on the screen next to the Δ symbol.
8. To select which cursor is controlled by the arrow keys, press the **Action** soft key and select **Move Cursor 1** or **Move Cursor 2** as appropriate. Typically, the first cursor is positioned at the start of the fault (such as a bridged tap); the second cursor is then enabled, and positioned at the end of the event.
9. To hide the second cursor select **Display**, and then **1 - Hide Second Cursor**



Zero cursor option is available for either cursor.

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TDR Test

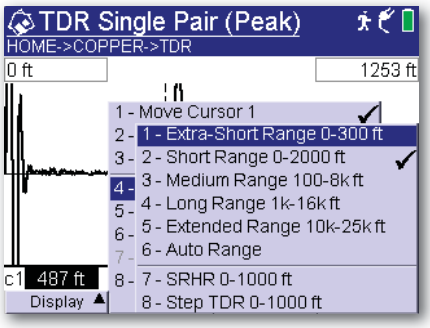
Manual TDR Setup and Test Functions (continued)

TDR Ranges

The typical TDR has a starting reflection, or launch pulse. The launch pulse is actually a visual depiction of the TDR energy leaving the test leads at the point the test leads connect to the cable pair. Because the launch pulse has its own reflection, any faults near the launch point run the risk of being obscured. This area is often referred to as a "blind spot". The length of the blind spot directly corresponds with the range setting, with SHORT range having a shorter blind spot then LONG range.

Due to the blind spot it is good practice to start in the Short range and work up through the long ranges until the event can be seen. The HST-3000 has five different ranges and they are displayed by:

1. Press the **Actions** soft key, select **Range** and view available ranges.



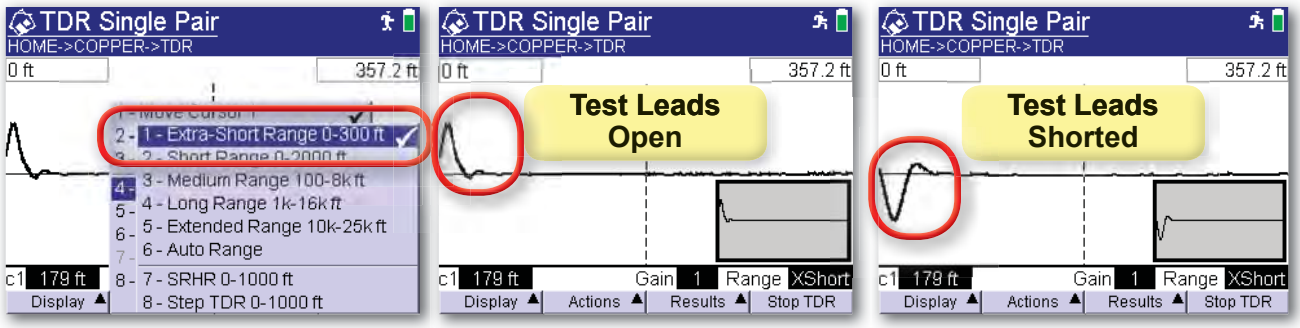
TDR Test

Manual TDR Setup and Test Functions (continued)

TDR Extra Short Range

In the past, blind spot issues were avoided by placing a known length of wire between the test leads and the cable pair, thereby absorbing the blind spot in the known length that was then subtracted from the distance to fault reading. JDSU has incorporated a new "zero dead zone" extra short range setting which virtually eliminates the blind spot.

1. Press the **Actions** soft key and select Range, **Extra-Short Range**
   a. What appears to be the launch pulse is actually the end of the test leads.



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TDR Test

Manual TDR Setup and Test Functions (continued)

TDR Peak and Stress Modes

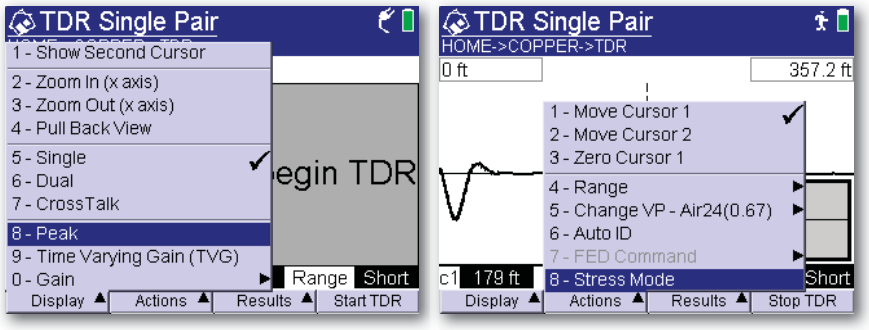
One of the more difficult problems to locate is a conductor that is partially broken. This condition is referred to as a "High Open" or "High Resistance Open". The difficulty is due to the dynamic nature of the fault; in some instances the resistance lowers and the line appears fine at first, but then the resistance increase resulting in unsatisfactory service.

The HST-3000 incorporates two manual features which can be used separately or in combination to help locate high resistance opens. These features are **Peak** and **Stress** modes.

PEAK - TDRs appear to run continuously. In reality, their operation is a series of "snapshots" in which the TDR sends the high frequency TDR signal, waits for the returned reflection and finally displays the "trace" or reflection results. In addition, each snapshot displays its own unique trace -- erasing the previous one. **Peak** mode does not erase the trace. Instead each new trace over-writes the previous one. This allows the user to see subtle differences which often indicate the location of the high resistance open.

STRESS - As previously discussed, high resistance opens are difficult because the resistance at the fault location increases and decreases. In addition to monitoring the trace for changes, another technique is to inject a signal which hopefully disrupts the fault resistance -- thereby revealing its location along the trace. **Stress**, when activated, momentarily stops the TDR and connects the HST-3000 Leakage Ohm meter momentarily and instantly returns to the TDR. The Leakage Ohm meter applies approximately 120 VDC in a dual polarity, attempting to disrupt the fault resistance and make its location viewable on the trace.

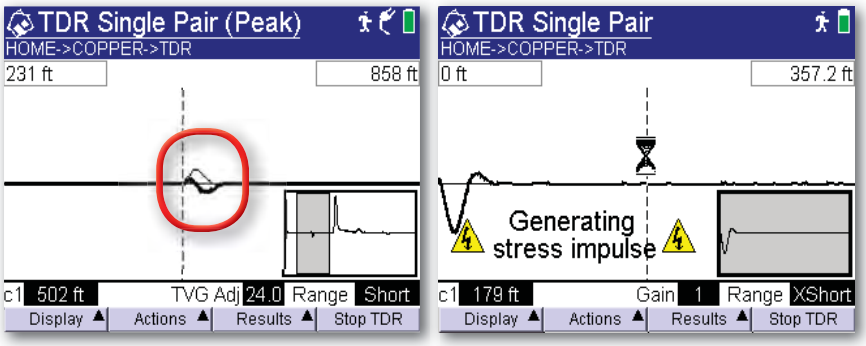
1. Press the **Display** soft key, select **Peak**
2. With **Peak** mode running press the **Actions** soft key select **Stress**



TDR Test

Manual TDR Setup and Test Functions (continued)

- The trace below and left is an example of PEAK capturing a change during the test
- The trace below and right is an example of activating the STRESS feature

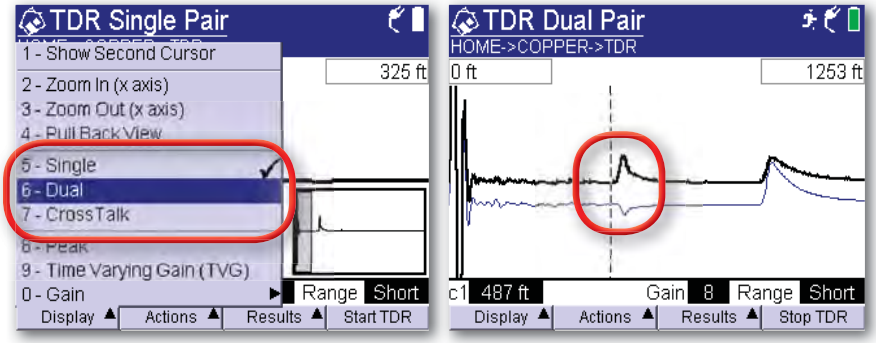


TDR Dual Trace

The HST-3000 incorporates a **Dual Trace** TDR function. Dual trace can be a powerful comparison tool that allows the user to compare the faulted pair with a known good pair. This helps to include or exclude suspect events as the location of the fault.

1. Press the **Display** soft key and select **Dual** from the pop-up menu.
2. TDR will be tested on both the BLACK, RED test leads and the BLUE, YELLOW test leads

The trace below clearly shows a difference between a "good pair" (light blue) and the faulted pair. This is an excellent illustration of a good versus faulted splice.



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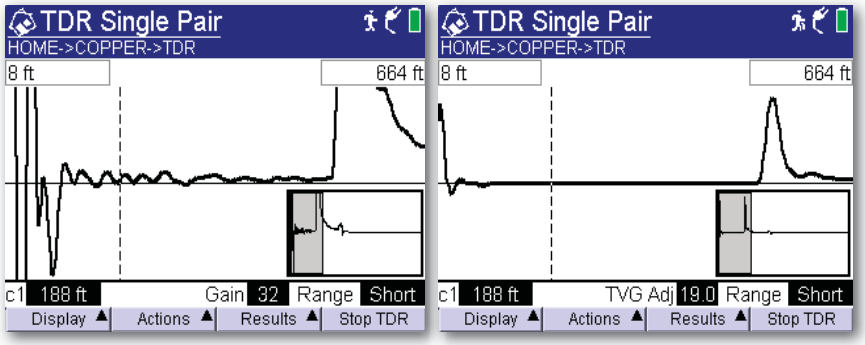
TDR Test (Continued)

Time Varying Gain (TVG)

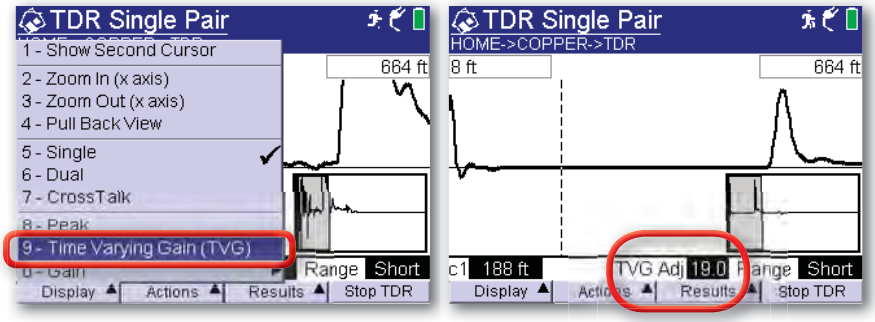
TVG is a patented JDSU feature which varies TDR GAIN over time. Traditional TDRs apply GAIN in a linear fashion. This means that as gain is increased all corresponding events -- GOOD and BAD -- on the cable pair both are amplified. **TVG's** ability to vary gain over time allows it to ignore naturally occurring events (splices, gauge changes) and focuses the gain on the fault location.

Consider the two TDR traces below. The trace on the left has gauge changes and is over-gained, resulting in many "ghost events" being displayed. The trace on the right is the same cable pair using TVG. All ghost events are ignored and GAIN is applied only to the fault event.



To enable the TVG feature

1. Press the **Display** soft key and select **TVG**
2. The GAIN level on the main TDR page is replaced by TVG adjust (**TVG Adg**)
3. TVG adjust is a representation of cable gauge and can be increased or decreased in half step increments. The user selects the appropriate gauge or the **TVG Adj** setting that produces the most "readable" trace.



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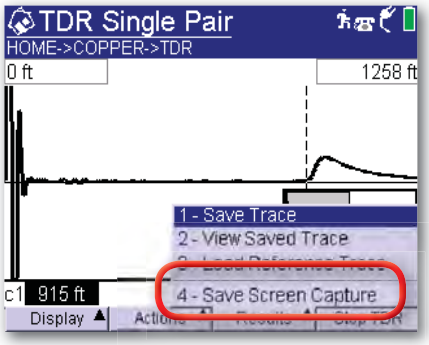
TDR Test *(Continued)*

Saving TDR results

1. To save test results, press the **Results** soft key and select either **Save Trace** (saves the array data for the entire trace) or **Save Screen Capture** which saves only the portion of the trace visible on the screen as a bitmap file.
2. To export a "picture" of a particular fault to attach to an email, select **Save Screen Capture**.
3. To view or analyze the result using another HST or for viewing on a PC, select **Save Trace**.
4. Previously saved traces can be viewed by selecting **View Saved Trace** from the **Results** soft key pop-up menu TDR



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