HST-3000 TDR

What is a TDR?

A TDR is used to identify bridged taps, wet sections, load coils, shorts, opens, and splices on copper cabling. Functioning much like sonar on a submarine, the TDR sends an electrical pulse down a copper pair and analyzes the energy that is reflected back.

Reflection occurs when the launch pulse detects any changes in the characteristics or impedance on the copper pair. The shape of the reflection identifies the nature of the fault. Impairments that cause the impedance to increase (such as load coils and the open end of a pair) create an upward pulse on the trace, while a decrease in impedance (such as shorts, start of a bridged tap or wet section, and build out capacitance) cause a downward pulse.

Because the launch pulse attenuates as it travels down the pair, the farther an event is from the test set, the weaker the reflection. Additionally, because cable gauge affects attenuation, the maximum distance that a TDR can locate a fault is less with smaller wire gauges.

JDSU's HST-3000 TDR

The accuracy of the HST-3000 TDR is 0.5% of full scale for each range. To eliminate noise and transients, the HST-3000 averages the trace and filters out low-frequency noise (like power line interference) before analyzing and displaying TDR data.

Using the HST-3000 TDR

The HST-3000 TDR automatically displays two views of the trace: the main view and world view.

The world view display is the box located at the bottom right-hand corner of the screen. Grey shading indicates the point on the trace currently being viewed. Figure 1 on page 2 shows a *World View*-enabled TDR trace.

The user can turn off world view and display only the main view of the trace.

Turn off world view
- Press the *Configure* navigation key.
- Press *OK* to select *World View*.
- Select *Off* and press *OK*.
- Press *Home* to return to the TDR screen.
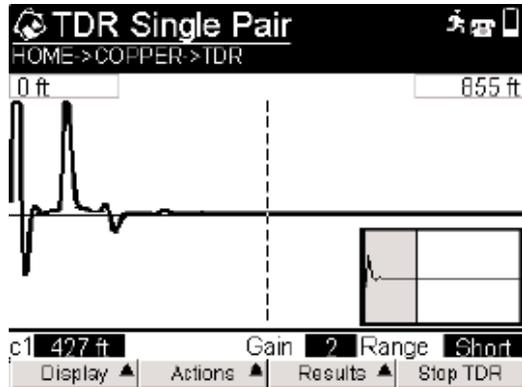
Figure 1   TDR with *World View*

Configuration

The TDR is most accurate when the *Range* and *Velocity of Propagation (VP)* are set correctly and the cursors are used properly.

The following instructions describe how to configure the HST-3000 for accurate TDR measurements.

Settings
Velocity of propagation (VP)

VP is the speed the TDR signal travels down the wire pair relative to the speed of light. The distance to an event is measured by multiplying the time it takes for a reflection to return to the source by the speed of the TDR pulse. Because there is no simple way for a test set to automatically determine the *VP* of a pair under test, the user can enter the gauge and fill type, and the HST will estimate the *VP*. Or the user can enter the *VP* found on the cable spool.

Note: A cable's *VP* can change due to environmental conditions such as water and temperature. For example, water in the cable will usually make the cable length appear shorter than it actually is.

Option 1: HST sets the VP
  – Press the *Actions* soft key.

  – Select *Change VP* (See Figure 2).

  – Select *Cable Fill Type*.

  – Select *Aircore* (PIC), *Jelly Filled*, or *Pulp* (Paper).

  – Press the *Actions* soft key again.

  – Select *Cable Gauge*.

  – Select the correct gauge. If the cable contains mixed-gauge pairs, select the gauge of the copper pair that comprises the highest percentage of the cable for better accuracy.

Note: If the cable contains mixed gauge pairs, the distance calculation is not as accurate as with a single-gauge pair.

Once the cable fill and gauge are entered, the HST-3000 will set the VP for the cable.
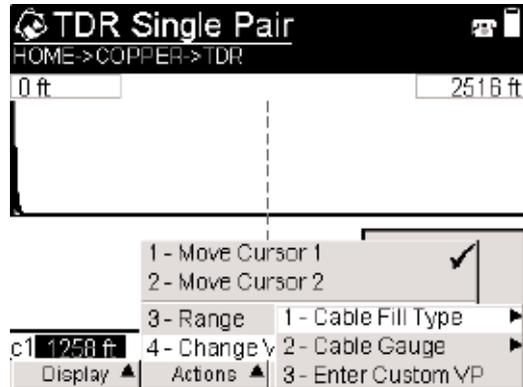
Figure 2   Setting the velocity of propagation (VP)

Option 2: User enters the VP
– Press the *Actions* soft key.

– Select *Change VP*.

– Type the *Custom VP* into the text entry box using the keypad.

The *VP* is stored when the HST-3000 is powered down.

Ranges

The HST-3000 TDR operates in three ranges: Short, Medium, and Long. When set to Short Range, the HST-3000 has a 6-foot (2 m) dead zone, one of the industry's smallest, and the cursor can be moved in smaller increments. The Short Range setting provides the highest measurement accuracy.

Set *Range*
– Press the *Actions* soft key.

– Select one of the following *Ranges*.

> *Short Range – 0-2000 ft or 0-600 m*

> *Medium Range – 100-8000 ft or 30 m-2.5 km*

> *Long Range – 1000 k-16,000 ft or 300 m-5 km*

> *Auto –* When the HST-3000 is set to Auto, push the arrow key repeatedly to progress through several different TDR settings to select the setting needed.

Note: Each time the up arrow is pressed, either the gain, pulse width, range, or zoom changes.

See Table 1 for the cursor resolution for each range.

Range	Cursor	*Pull Back View* **Steps**
Short	3 ft (1 m)	8 ft (2 m)
Medium	21 ft (6 m)	34 ft (10 m)
Long	21 ft (7 m)	68 ft (21 m)

Table 1   Cursor resolution for each range

Launch pulse

The electrical pulse transmitted by the TDR is the launch pulse, and it is the first peak seen on the TDR trace. One common limitation to TDRs is the dead zone. This blind spot, created by the width of the pulse, prevents events very close to the test set from being detected.

The dead zone in most TDRs can be up to 50 feet (15 m). When the HST-3000 TDR is set to Short Range, the launch pulse is smaller than the 6 foot (2 m) leads, creating zero dead zone.

Although it is not recommended that the default launch pulse width settings be changed, the user must be aware that the launch pulse attenuates as cable length increases. Consequently, in certain situations the user must increase the pulse width to see events that are far from the test set. Adding energy to the pulse and lowering its frequency helps compensate for the cable length and maximizes reach.

Note: Although changing the launch pulse width is not recommended, the default setting can be changed when the HST-3000 is set for Medium or Long Range operation.

Change Pulse Width

– Press the *Actions* soft key.

– Select *Pulse Width*.

– Select from the available pulse width settings.

Navigation

Cursor

Move the cursor

– Press either the right or left arrow keys to move the cursor along the trace in the desired direction.

The location of an event can be found by placing the cursor at the beginning of the event and reading the distance measurement in the bottom left corner of the screen, indicated as cursor 1 *(c1)*.

Dual Cursor

The HST-3000's *Dual Cursor* feature enables the position of two events and the distance between them to be measured simultaneously.

Activate Dual Cursor
- Select *Display*.

- Select *Show Second Cursor*.

- Use the arrow keys to position Cursor 2. To position Cursor 1, select *Actions* then *Move Cursor 1* and use the arrow keys.

- Read the distance between cursors on the screen as the delta.

Gain

Gain increases or decreases the displayed trace image. As a rule, the gain should be kept in the lowest setting possible while still allowing the event to be clearly seen.

Set the Gain
- Press the up arrow key to increase the gain.

- Press the down arrow key to decrease the gain.

Reset the Gain to 1
- Select *Display*.

- Select *Pull Back View*. This will also reset your zoom settings.

Time Varying Gain (TVG)

The HST-3000's TVG is a patented feature that helps users read faults that are very far from the test set. By providing a normalization factor to counteract line attenuation, this feature increases the gain on the trace as the distance increases.

Turn on TVG
- Select *Display*.

- Select *Time Varying Gain*.

Zoom

Zoom magnifies a particular area of the TDR trace.

Change Zoom level

    – Select *Display*.

    – Select *Zoom In* or *Zoom Out*.

Control Zoom

    – Press and hold the *Second Function* key (the blue key with an arrow) at the keypad's lower right corner.

    – Press the left arrow key to zoom out and the right arrow key to zoom in.

Reset Zoom to view the entire trace

    – Select *Display*.

    – Select *Pull Back View*.

Note: This also resets the Gain to 1.

TDR trace

The trace is the vertical line that spans the HST-3000's display area.

Move the TDR trace vertically

    – Press and hold the *Second Function* key.

    – Press the up or down navigation arrows.

Move the TDR trace horizontally

    – Press the left and right arrow keys to move the cursor to the desired end of the screen.

    – Continue pressing the key to scroll through the trace.

If the approximate distance to an event is known

    – Press any number on the keypad to display a pop-up menu.

    – Enter the distance in feet.

    – Press *OK*.

The screen will show the TDR trace with the cursor positioned at the distance that was entered.

Features

Dual Trace

Dual Trace displays two TDR traces simultaneously. Useful in troubleshooting, this feature allows a user to compare a known good pair in a binder to a suspected faulty pair. Additionally, by comparing before and after traces, a user can verify that a fault has been fixed.

Activate Dual Trace
  – Select *Display*.

  – Select *Dual*.

  – Connect the red and black leads to the first pair. The trace for the first pair will be a thick line.

  – Connect the blue and yellow leads to the second pair. The trace for the second pair will be a thin line. (See Figure 3.)
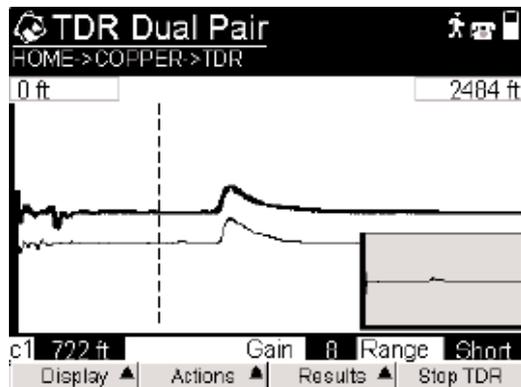
Figure 3   Dual TDR mode

Compare a saved reference trace to a live trace
  – Press the *Results* soft key, then select *Load Reference Trace*.

  – Select a previously saved trace listed in the dialog box.

  The reference trace is a thin line and the live trace is a thick line.

View a single trace
  – Select *Results*.

  – Select *View Single*.

View both traces on top of each other
  – Select *Results*.

  – Select *View Both*.

View the mathematical difference of the two traces
  – Select *Results*.

  – Select *View Difference*.

View separate traces on the same screen
  – Select *Results*.

  – Select *View Comparison*.

Peak

The Peak feature is useful for analyzing faults that occur intermittently. The HST-3000 can display minimum, maximum, and current TDR traces over a test period. Dual Trace must be turned off to access this feature.

The current TDR peak trace is a thick line, and the maximum and minimum traces are thin lines. Figure 4 shows the Peak trace feature enabled.
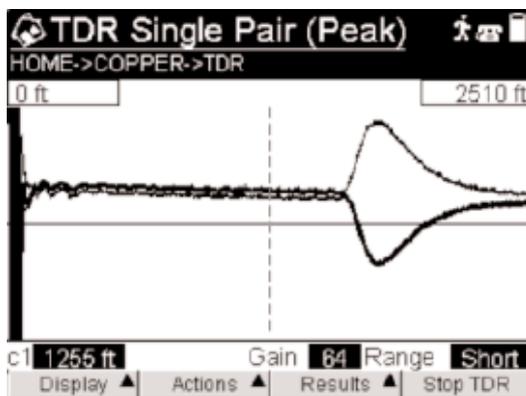
Figure 4   TDR with Peak trace

Fault identification and location

It is much easier to identify a single fault on an otherwise clean pair than to identify and locate several faults on a long pair. With the HST-3000's full suite of copper tests, users can determine the nature of the fault and then use the TDR to locate it.

Pinpoint the location of a fault
  – Sectionalize the pair as much as possible.

  – Test in both directions before undertaking extraordinary measures such as digging or climbing to fix the fault.

Faults include:

Opens

An open on the cable appears as a peak on the trace. A clean open, such as the open end of the cable pair will be the tallest peak other than the launch pulse. Figure 5 below shows an open at 1009 feet.
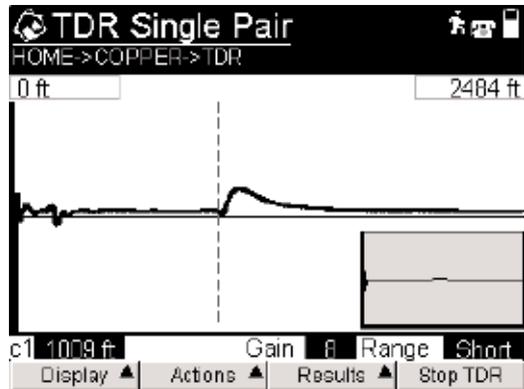
Figure 5   TDR trace of a clean open at 1009 feet

Shorts

A Short between tip and ring appears as a valley. A hard short (low resistance) will be the lowest valley on the trace. Figure 6 shows a short at 986 feet.
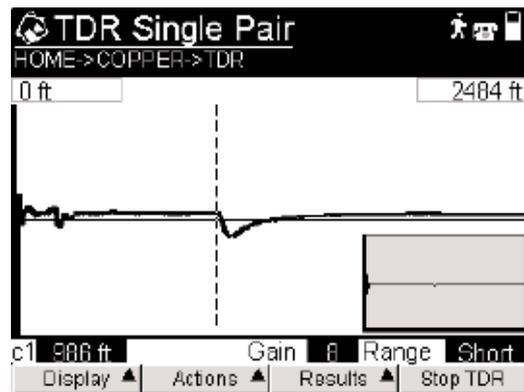
Figure 6   TDR trace of a hard short at 986 feet

Bridged Taps (Laterals)

A bridged tap appears as a valley followed by a peak, resembling a short followed by an open. The start of the bridge tap is represented by a valley, and the reflection caused by the open end of the tap is represented by a peak.

Measure the length of the tap
- Place the cursor at the lowest point of the valley.

- Select *Display*.

- Select *Show Second Cursor*.

- Move the second cursor to the highest point of the peak. The display shows the positions of cursor one (c1) and cursor two (C2) at the bottom of the screen and the distance between the two on top of the trace. This distance measurement is the length of the tap. Figure 7 shows a bridged tap at 608 feet with a length of 378 feet.
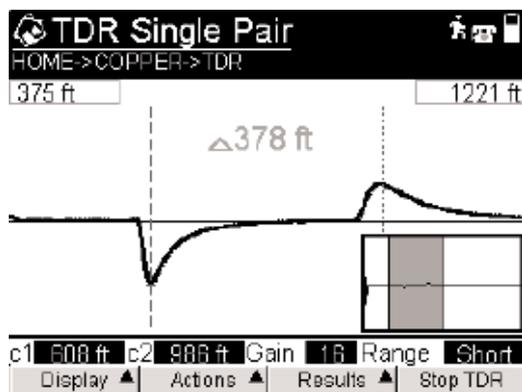
Figure 7 Bridged tap trace

If there is a bridged tap on a pair that is longer than the rest of the cable, the peak may not be seen on the trace display. The valley followed by peak display for bridged taps is not always a mirror image above and below the line. The length and condition of the tap determines how the trace is displayed. Also, bridged taps that are less than 20 feet (6 m) long are very hard to see beyond 200 feet (60 m) from the test set.

Note: A bad splice followed by open can look similar to a short bridged tap.

Load Coils

A load coil looks similar to an open—a sharp peak. The load coil acts as a low pass filter, effectively stopping the TDR trace from going any farther.

Determine if there are any loads on the line
  – Use the load coil counter.

  – Use the TDR to locate the first load coil. Because the TDR cannot shoot past the first load, the TDR must be re-run after each load is removed to check the cable beyond the load.

Figure 8 shows a load coil at 1009 feet.
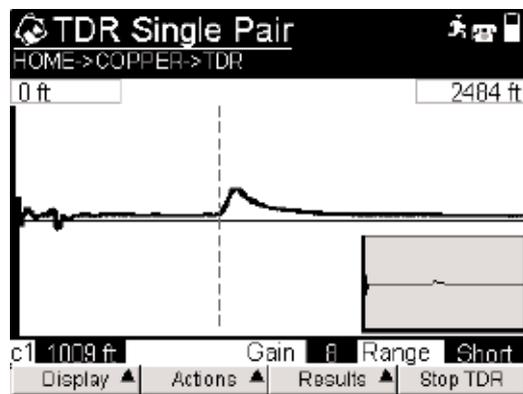
Figure 8   TDR trace of a load coil at 1009 feet

High Resistance Splice

The reflection from a splice appears as a peak and valley in succession. This is a much smaller event than an open or a short.

Wet Section

A section of cable with water inside will appear as noise—many peaks and valleys in succession.

Note: Because water in the cable affects the VP, the cable appears shorter than it actually is.

Determine the approximate length of a wet section
  – Use the Dual Cursor by placing one cursor at the beginning of the event and one at the end.

TDR Tips

A clean open will be the tallest peak other than the launch pulse on the trace display.

A dead short across the pair will be the lowest valley on the trace.

There normally is a reflection from the point where the leads are hooked to the pair under test. Connections and splices that are close will cause big reflections. It is best to ignore these big reflections right after the launch pulse and look beyond them unless the objective is to find close faults.

If possible, measure from both ends to make sure the distances to the fault match closely.

Trouble on a single pair in the count can be determined by running the TDR on as many pairs in the binder or cable as possible and comparing the traces.

A TDR cannot read anything past an open, short, or load coil.

Shorts above 100 ohms will be difficult to read, if they are read at all.

The TDR is across tip and ring (red and black). Shorts to ground may not be read at all.

A great deal of noise is generated when the TDR is used from tip or ring to ground or sheath that it is difficult to tell the difference between the fault and the noise.

Faults beyond big events or reflections are difficult to read.

The first fault should be measured and cleared before continuing.

Unlike other TDRs, the HST-3000 continues to display the last trace for reference after selecting *Stop TDR*.

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