



CableScout™ TV220E & TV220EX



Features

- Large 7", Full Color, **HiRes** Super Backlit Display
 - ❖ **Readable in Bright Sunlight Conditions**
- Touchscreen **and** pushbutton GUI
- Splash, Dust and Shock-Resistant Packaging
- Zero Dead Zone
- Fast “smooth” precision pulses for low noise
- Fast rise time “long range” “square” pulses
- **TestWizard™** event finder & measurement
- Protected 75Ω F Connector
- Intermittent Fault Locator Feature
- User Selectable Language Menus
- Context- Sensitive
 - ❖ **Help Screens Available for all Functions**
- Rechargeable Lithium Ion Battery for 8+ hrs of use
- Overview Window Shows entire cable to speed navigation

Benefits

- Locate Damage in Drops & Defective Passive Devices
- Find Impedance Mismatches
 - ❖ **Corrosion, Water Ingress or Cable Type Changes**
- Narrow Pulse Width & fast rise time for Precision
- High bandwidth fast recovery signal chain, enables close in and adjacent Fault ID and measurement
- Document an entire cable with a few clicks
- Compare current and previous cable state
- Grab screen-shots when this is sufficient
- PC, Android & iOS “Tempo Report Writer Enhanced” (TRWE)
- Wireless (Wi-Fi and Bluetooth) or USB drive file transfer
- Small Portable, Lightweight Package
- Option of ruggedized case TV220EX model
- Library of Cable Types for Fast, Accurate Testing

CableScout™ TV220E

Technical Specifications



Output Pulse

Widths: 1, 5 or 25 ns (Shape: ½ Sinusoid)
Widths: 125, 250, 500 ns (manual mode only, “digital” with sub nanosecond rise time)
Impedance: 75 Ω
Voltage: 4V to 6V peak

Test Connection

F-connector for high bandwidth
Male bulkhead with female barrel adaptor for protection
Surge protection: ±400V peak

Performance

Input filtering: 1, 2, 4, 8, 16 or 32 averages
Horizontal resolution: 204 ps (approx. 3” or 75 mm)
Maximum range: 5.58 km (18 kft) @ $V_p = 0.93$
Display resolution: 1024 x 600 full colour
Display size: 180 mm (7”) diagonal
Backlight brightness: up to 800 nits (sunlight viewable)

General

Result Storage: Internal flash or USB drive
Wireless data transfer: Wi-Fi or Bluetooth Low Energy (BLE)
Battery type: Lithium Polymer (2S2P arrangement)
Battery Capacity: 60 Wh (>8 hrs use @ typical brightness)
Battery management system ensures maximum lifetime
Recharge from 12V DC (10 to 15V) via 5.5/2.1mm “barrel” plug, up to 2A. Rate of recharge is approximately 25% per hour (10% to 80% in approximately 3 hours)

Physical

Size: 262 x 162 x 55 mm (10.3 x 6.4 x 2.2 inches)
Weight: 1200 g (2.6 lb)
Operating Temperature: -20 to +50 C (-4 to +120 F)
Battery charge temperature: 0 to +30 C (32 to 86 F)
Storage temperature: -30 to +60 C (-22 to +140 F)
Kits are supplied in a washable “shoulder bag” with sufficient space for all accessories and a few tools.
Individual kits are supplied in a corrugated card box, approximately 34 x 24 x 28 cm, weight 3.2 kg.

CableScout™ TV220EX

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Physical

Size: 32 x 23 x 11 cm (12.6 x 9 x 4.3 inches)
Weight: 2109 g (4.6 lb)
Operating Temperature: -20 to +50 C (-4 to +120 F)
Battery charge temperature: 0 to +30 C (32 to 86 F)
Storage temperature: -30 to +60 C (-22 to +140 F)
TV220EX is built into a rugged case with sufficient space for all accessories and a few tools.
Individual kits are supplied in a corrugated card box, approximately 34 x 25 x 12 cm, weight 2.3 kg.

Why CableScout™ TV220E?

Designed specifically for Cable TV and other 75Ω coaxial cable applications, the TV220E builds on the previous TV220 and applies recent technology enhancements to improve ease of use and coaxial cable testing performance. Best in class performance not found in any other TDR at this price point.

- Simply select the cable type to be tested and the TV220E does the rest.
- Use TestWizard™ to automatically pinpoint and measure faults.
- Pulse width, Vp, gain, and vertical position are automatically selected and adjusted.
- As you scan the cable. Move the cursor to the fault and use the one-button zoom function to pinpoint its location.
- The TV220E offers narrow pulses & fast rise time for close-in fault resolution.
- High bandwidth, fast recovery amplifiers ensure zero event dead zone.
- Faults as near as 1m (3 feet) from the test port are located with ease.
- Optimized pulsing and sampling, coupled with advanced filtering and signal-processing techniques provide a clean waveform for easy event identification.

CableScout™ TV220E

Optimised for the HFC (Hybrid Fibre Coax) Network

- Precision shaped pulses and fast rise time “digital” pulses have frequency components to >>400MHz.
- “Zero” dead-zone means you can test from the test port itself and fast amplifier recovery means you can see two adjacent faults pulse width or rise-time apart.
- Highly optimised for checking to shorter lengths of cables now present in the network. You can even pre-set your normal working range to avoid the unit looking for trouble where it may never exist.
- Automatically identify the worst, the worst three or all faults above a threshold. Distances to the faults and their scale, which can be expressed as Return Loss (RL), Event Return Loss (ERL) will be shown in the events table.

CableScout™ TV220E

Manual Markers & Saving Data

- You can manually add further events or markers to the record, perhaps indicating where a splice was made.
- The entire cable record can be saved locally or on a USB drive for later analysis and more formal documentation using the Tempo Report Writer Enhanced (TRWE) PC, Android and Apple software (more details later).
- If only a simple record of work is required, then a screen-shot (PNG file) can be instantly grabbed and saved to the USB drive.

Connectivity TV220E

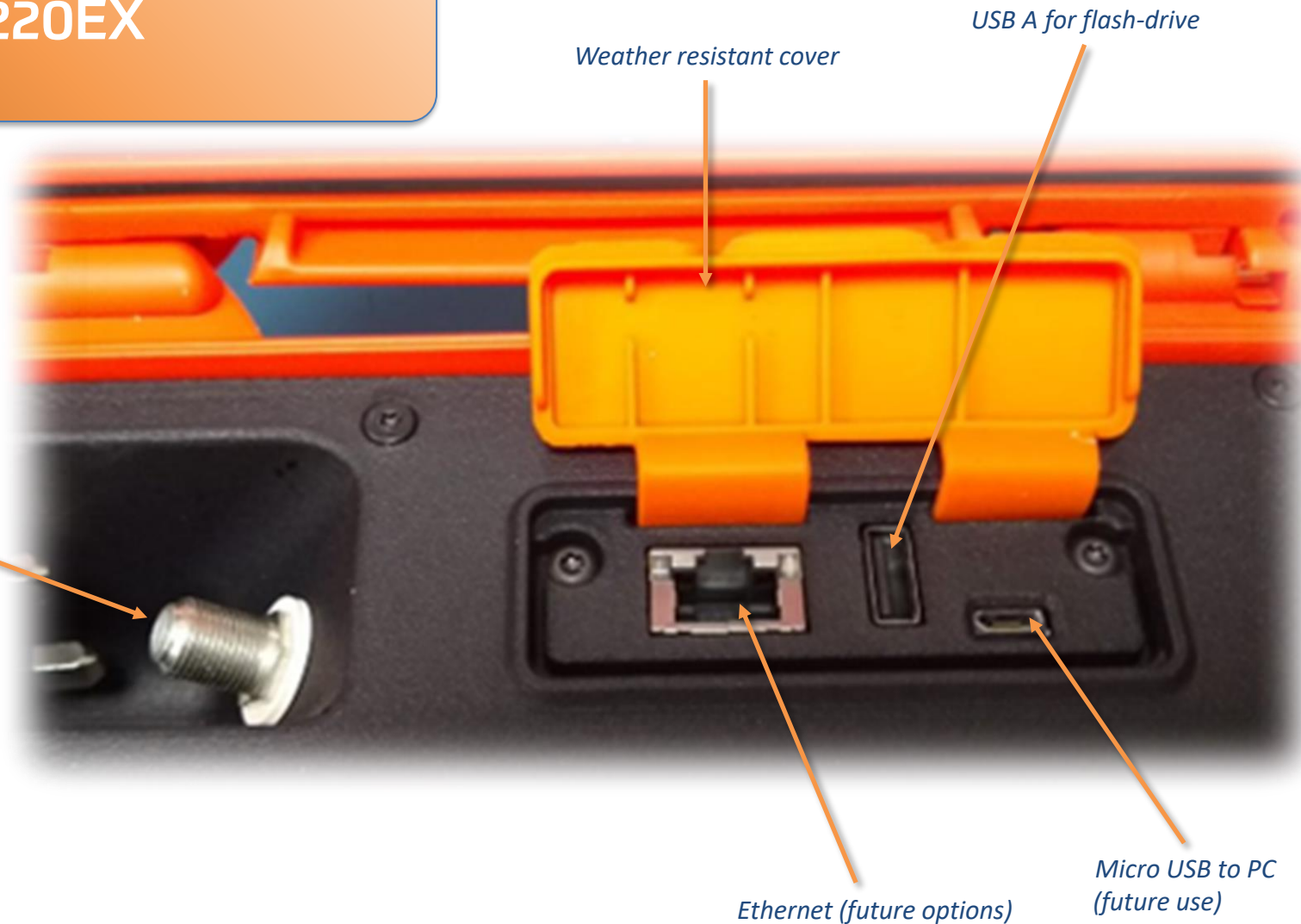
Joining things up



Connectivity TV220EX

Joining things up

Test Port
F (male) bulkhead
protected by
Replaceable
"coupler"

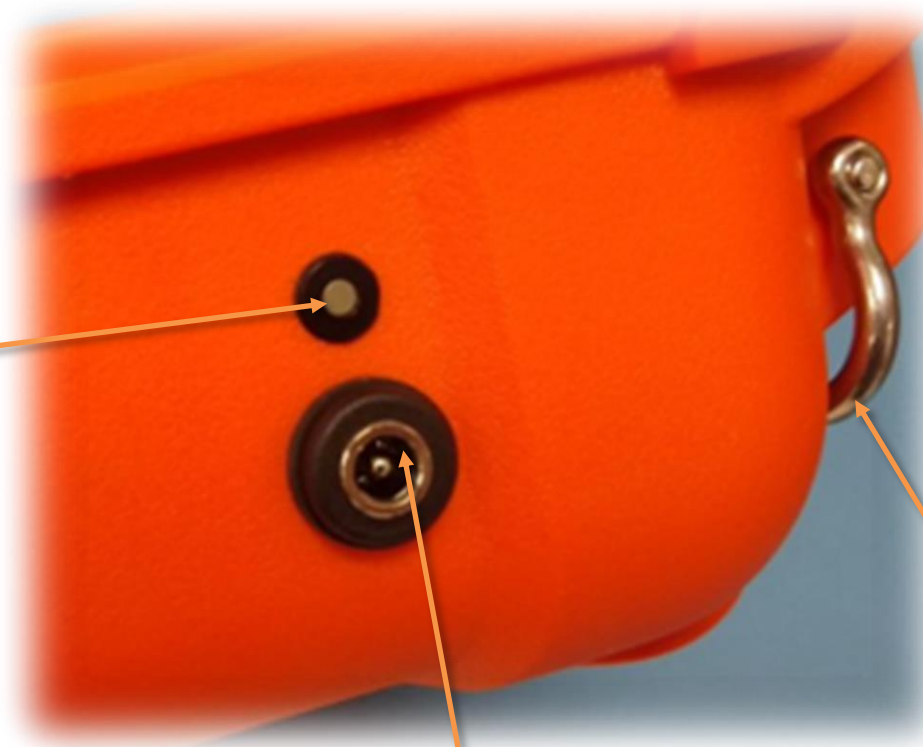


Connectivity TV220EX

Joining things up

You charge TV220EX using the 12V dc port on the right-hand side of the unit. The status LED is alongside. Red for charging, green for full. This simplifies charging with the unit closed.

Charge status LED



12V Charging Port

Shackles are provided to which the supplied shoulder strap can be attached, or by which the unit can be secured to an elevated platform or similar for enhanced safety.



Shackles for secure attachment

Shoulder Strap TV220E

Securing things

*Stainless pins for
securely attaching
the supplied
shoulder strap.*

*Similar at bottom
for fabric strap (not
supplied)*



Front Panel Controls

Getting Started

- **Power:** Press this button for one to two seconds to turn on or to standby. Settings are retained with the unit in standby. This button illuminates blue whilst the unit is starting and stopping.
- **Help:** Press ? to display detailed information on the current display and the operation of the controls. Press HELP (?) a second time to remove the help display.
- **Menu:** Press the ≡ button for quick setup options:-
 - Home – back to the “Home” screen
 - Display brightness
 - Live or Intermittent mode
 - Distance units (nanoseconds, metres or feet)
 - Velocity of Propagation unit (factor, percentage, metres per microsecond or feet per microsecond)



Front Panel Controls

Getting Started

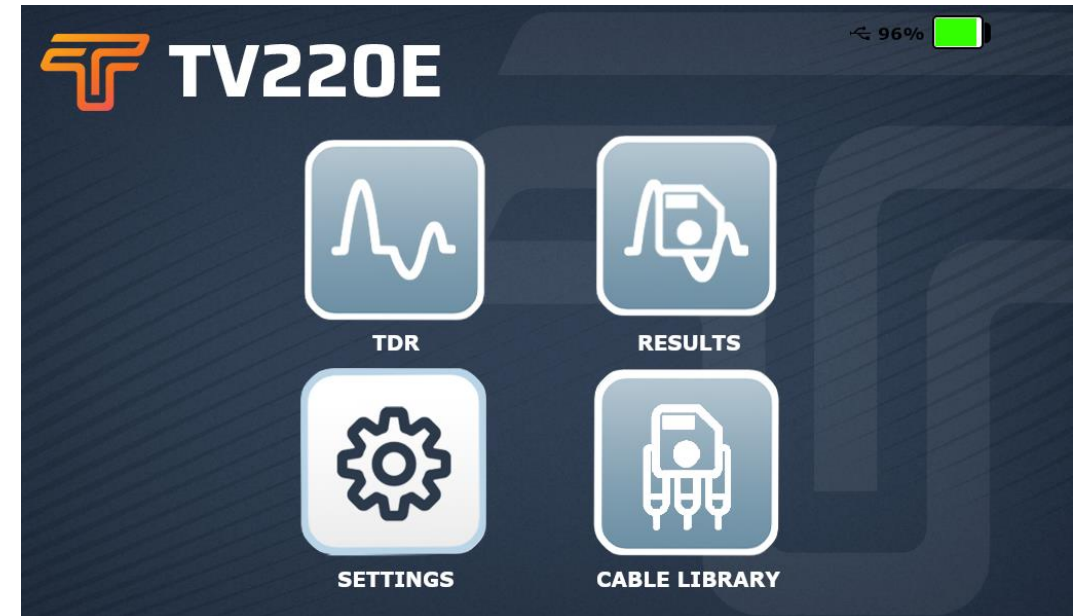
- **Five Softkeys:** Located across the bottom of the LCD.
 - These are called softkeys because their labels are displayed on the LCD.
 - Their functions vary according to the instrument function.
- **Softkeys let you:**
 - 1) change functions or modes,
 - 2) select a menu item, and
 - 3) turn functions on and off.
- **Left (←), right (→), up (↑), and down (↓) arrow buttons** serve the functions of moving the cursor or active window left and right across the displayed waveform, changing values and raising or lowering gain, or scrolling through a menu.
- **Enter:** The “center” key (↵) is used to switch between the “overview” and “detail” windows and to select highlighted options throughout the user interface.

“Home” or Start-Up Screen

Getting Started

The “home” screen is shown on first power up after re-boot, on re-starts from “standby” you will see the screen you were on when powered down:

- **TDR:** The main application of the unit is accessed by tapping or selecting this icon.
- **RESULTS:** Tap or select this to manage result files on your unit or to copy them to a USB drive.
- **CABLE LIBRARY:** Tap or select here to manage the list of cables you normally use.
- **SETTINGS:** Very important. Use this to check the date and time and time-zone on your unit when you receive it.

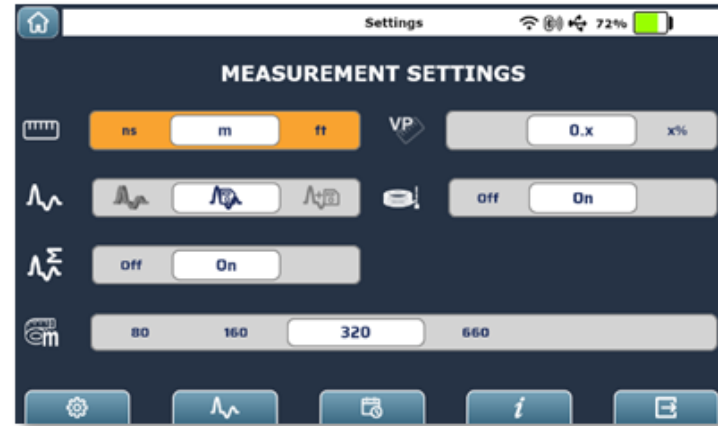


Settings Screens

Getting Started



Backlight level
Backlight timeout
Sleep timeout
Power Down Time
Wireless menu
Marker text size
Language



Units
VP type
Test Type
End-of-Cable detector on/off
Sum of Event
Return Loss
"User distance"



Day
Month
Year
12/24 hour
Hour
Minute
Time-zone

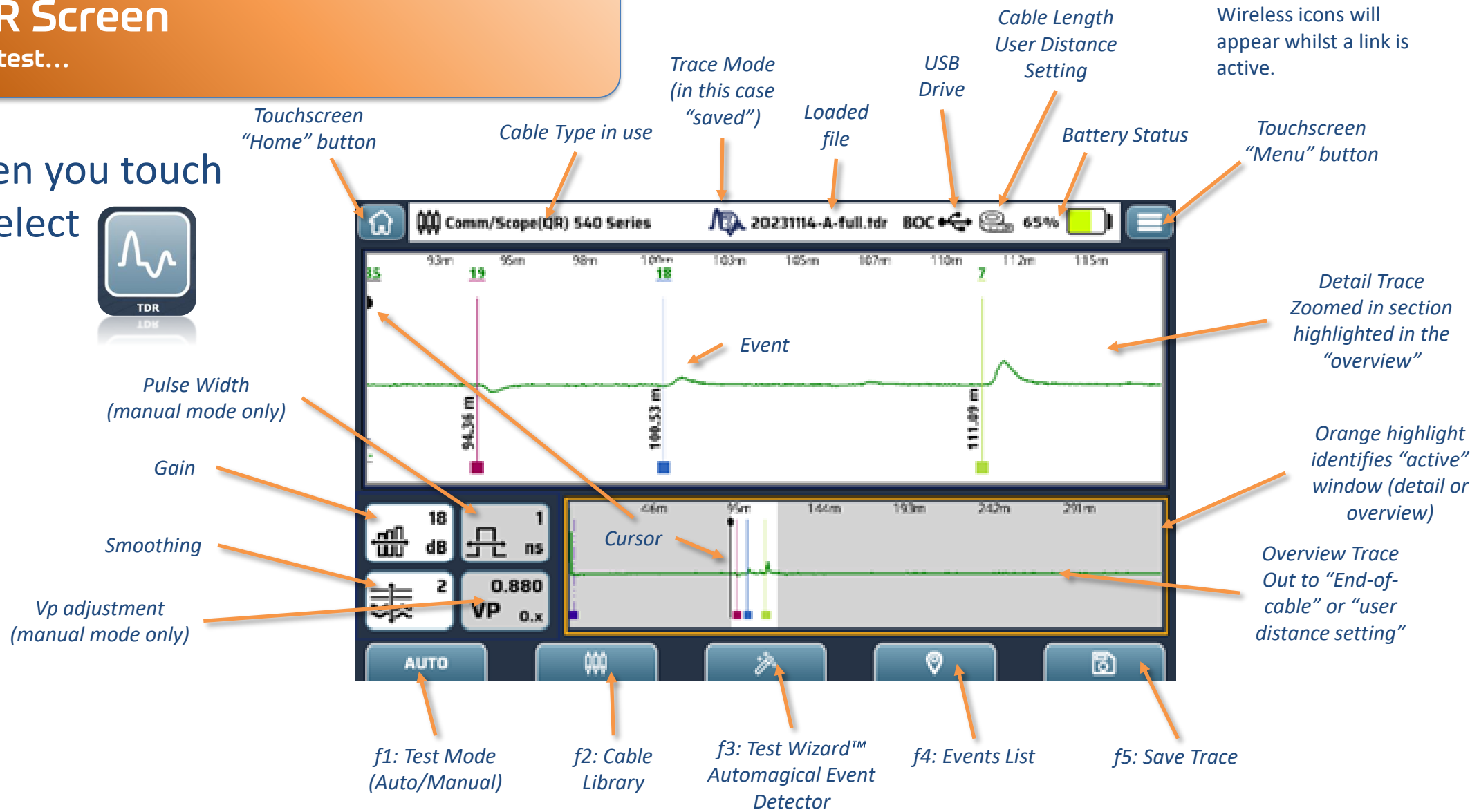


Unit information
Software update

TDR Screen

Let's test...

When you touch or select



TDR Windows

Let's navigate the cable

Detail Window Navigation

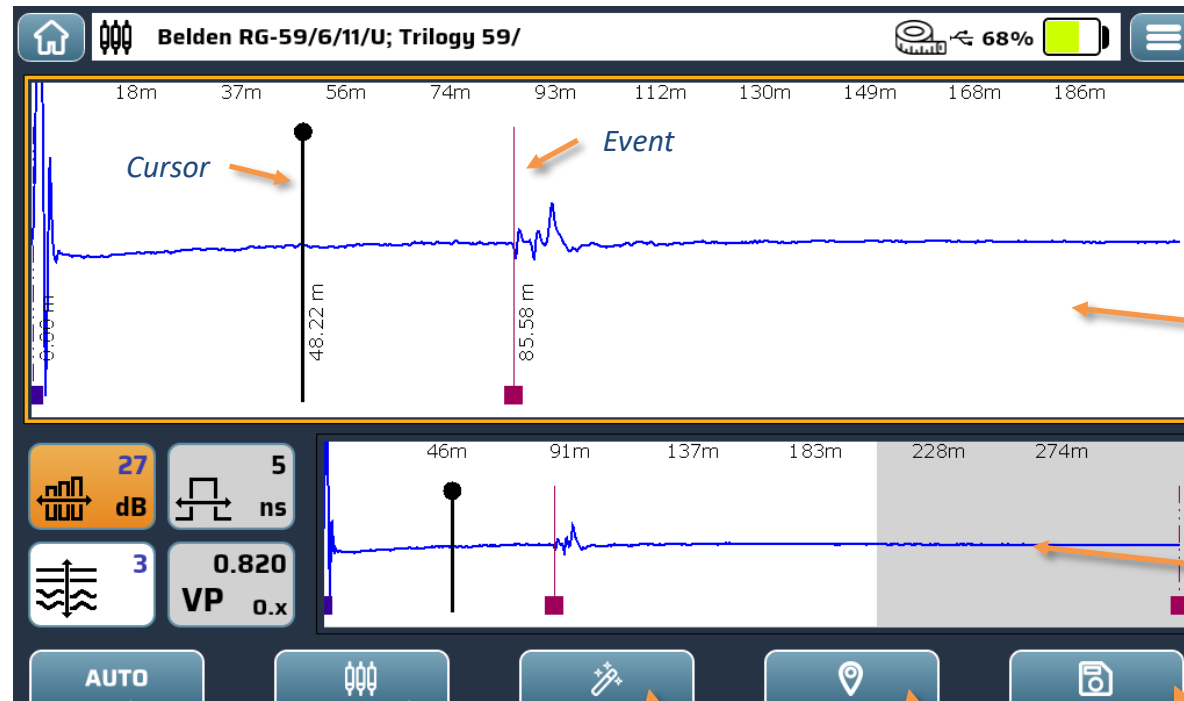


Enter key (↵) toggles to overview (or tap the window)
Up (↑) and down (↓) adjust highlighted parameter (or tap the parameter; gain, smoothing, or pulse width and Vp when in "manual" mode)
Left (←) and right (→) move cursor (or just tap where you want to place the cursor)

Overview Window Navigation



Enter key (↵) toggles to detail window (or tap the window)
Up (↑) and down (↓) zoom (or "pinch" with two fingers – works in both windows)
Left (←) and right (→) move window (or touch and drag – this works in both windows)



Orange highlight identifies "active" window (detail or overview). Press (↵) to toggle between windows.

Detail Trace Zoomed in section highlighted in the "overview"

Overview Trace Out to "End-of-cable" or "user distance setting"

f1: Test Mode (Auto/Manual)

f2: Cable Library

f3: Test Wizard™ Automagical Event Detector

f4: Events List






f5: Save Trace

TDR Screen

Let's choose a cable...

The instrument powers up with the same settings in place as when it was last powered off.

The TV220E is already testing as soon as the TDR function is enabled, and if in “auto” mode, the overview window should automatically show the extent of the cable within a few seconds.

- Press  (cables) to select the cable type being tested:
 - The cable type defines the velocity of propagation (V_p) and cable loss per unit length values for the test cable. The latter figure is important for the TestWizard & measurement features to work well.
 - Use the up  and down  arrows to highlight the cable type to be used or directly scroll the list with your finger. Tap a cable to highlight it.
 - Press  (download) to select the cable type.
 - Press  (exit) to return to the test screen.

Cables Screen

Let's choose a cable...

Sort by tapping
column headings
or by using the
menu button (≡)

Active Cable
marker

Custom ↑	Name	Loss	VP 0.x	Type
↓	Custom One-Ay	12.450	0.814	Coax PE-Foam
	Belden RG-59/6/11/U; Trilogy 59/	15.000	0.820	
	Belden RG-6/U	15.480	0.820	
	Comm/Scope 59/6/7/11	15.000	0.850	
	Comm/Scope 6 Series	15.090	0.850	
	Comm/Scope Quantum Reach (QR)	15.000	0.880	
	Comm/Scope(QR) 540 Series	4.890	0.880	
	Comm/Scope(QR) 715 Series	3.900	0.880	
	Times Fiber T10 500 Series	5.680	0.870	Coax PE-Foam
	Times Fiber T10 59/6/611/11	15.000	0.850	
	Times Fiber T10 6 Series	14.500	0.850	

Highlight a cable. By tapping or moving the highlight with the cursor keys.

Add a new custom cable by tapping (f1)

Tap “download” (f2) to “activate” the highlighted cable.

Custom cables can be deleted (f3 , 🗑)

Cable library can be copied to or from USB drives (f4)

Exit from this screen with (f5)

f1: Add Cable

f2: “Activate”
highlighted cable

f3: Delete
highlighted cable
(custom only)

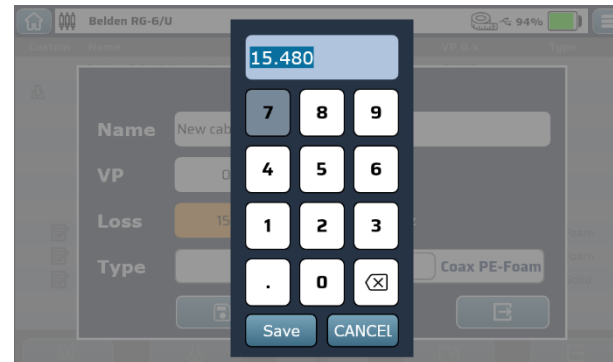
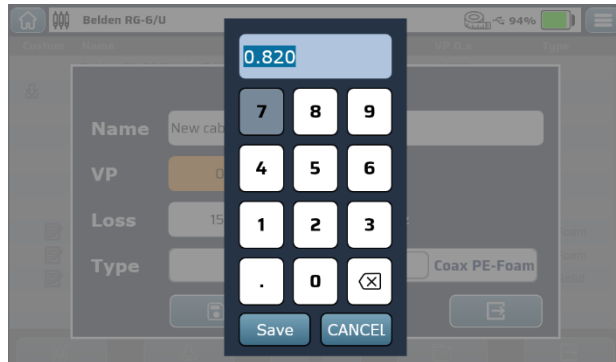
f4: Save or load
cables to/from USB

f5: Exit

Cables Screen

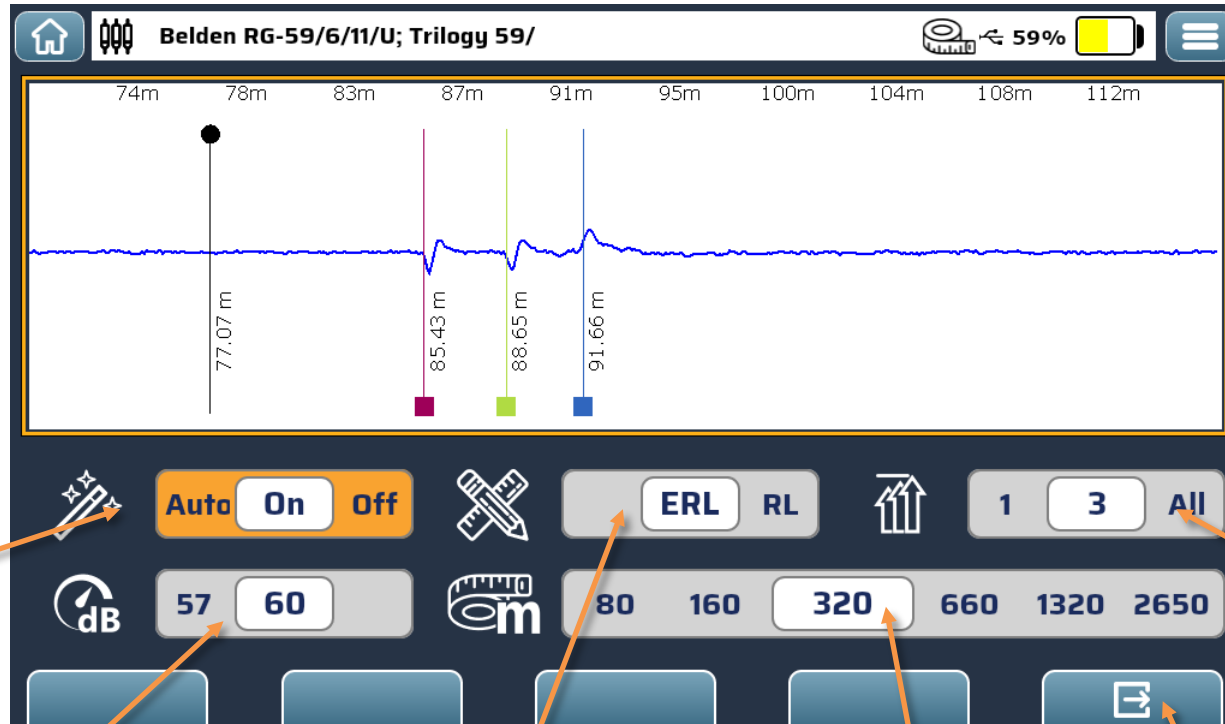
Let's add a custom cable...

1. Name the cable
2. Enter the typical VoP
3. Enter the typical loss per 100m (at approximately 500MHz)
4. Set the "type" (optional)



TestWizard™ (Find Events)

What's happening out there...



Enable

Event threshold (in "On" mode)

Return Loss or Event Return Loss

User distance setting

Exit

Automatic event detection can be switched on in "Auto" mode only. In Auto mode the TV220E has control over more parameters and then knows better how to interpret the trace.

Select "On" to enable event detection in the current window.

Select "Auto" to automatically detect events throughout the cable.

How many events to show, the worst one, three or all above the threshold?

Event List

Where do we start...



List of events

Set "beginning of cable" BOC at the cursor

Notes can be added to events

Manual "add event at cursor" button

Exit

Set the "beginning of cable" marker at the end of any patch cord that you are using.

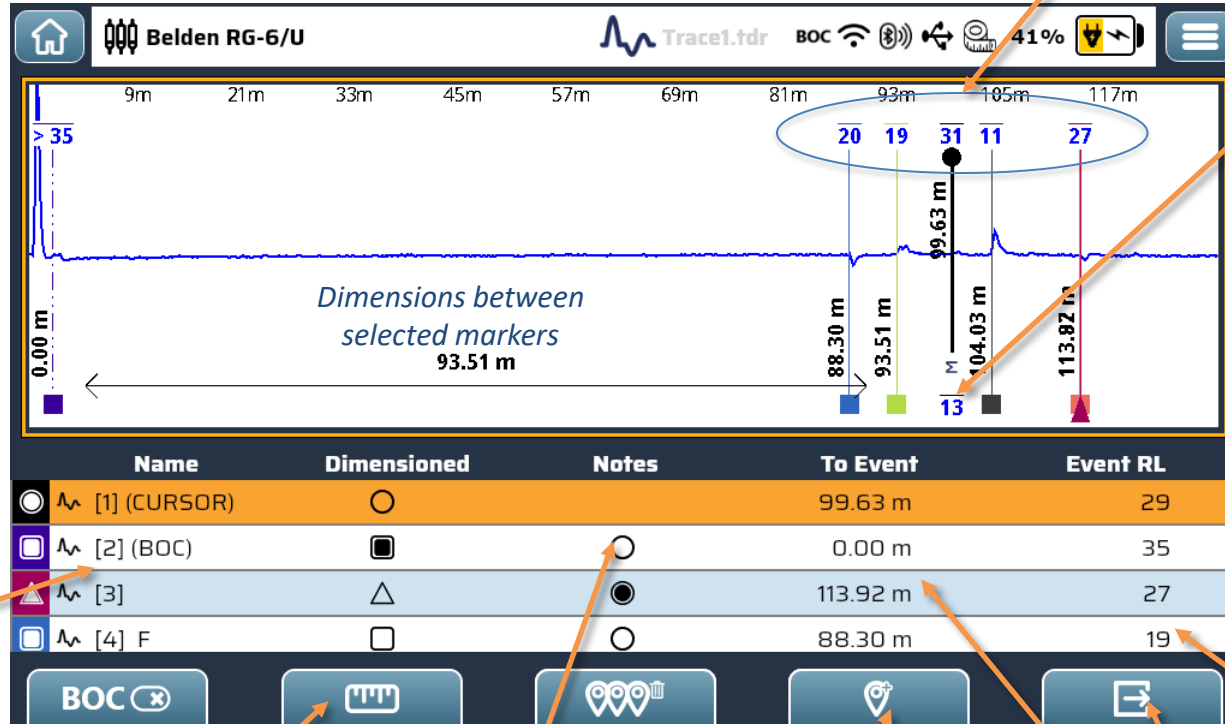
In the "Markers" page, move the cursor to the place you want "BOC" and tap the "BOC (o)" key (f1). You can clear it again by ensuring it is selected in the list of events and pressing on "BOC (x)" (f1) again.

Event List

Show the details...

Numbers above events or cursor are ERL at that point

Numbers below cursor represents total return loss to that point



Once events are active you can review their severity on the “Events” list screen.

Here you can also manually add events; choose which if any have “dimensions” and add notes where relevant.

List of events

Return loss at each event will be shown here in this column

Activate measurement for highlighted “event” (or cursor)

Notes can be added to events

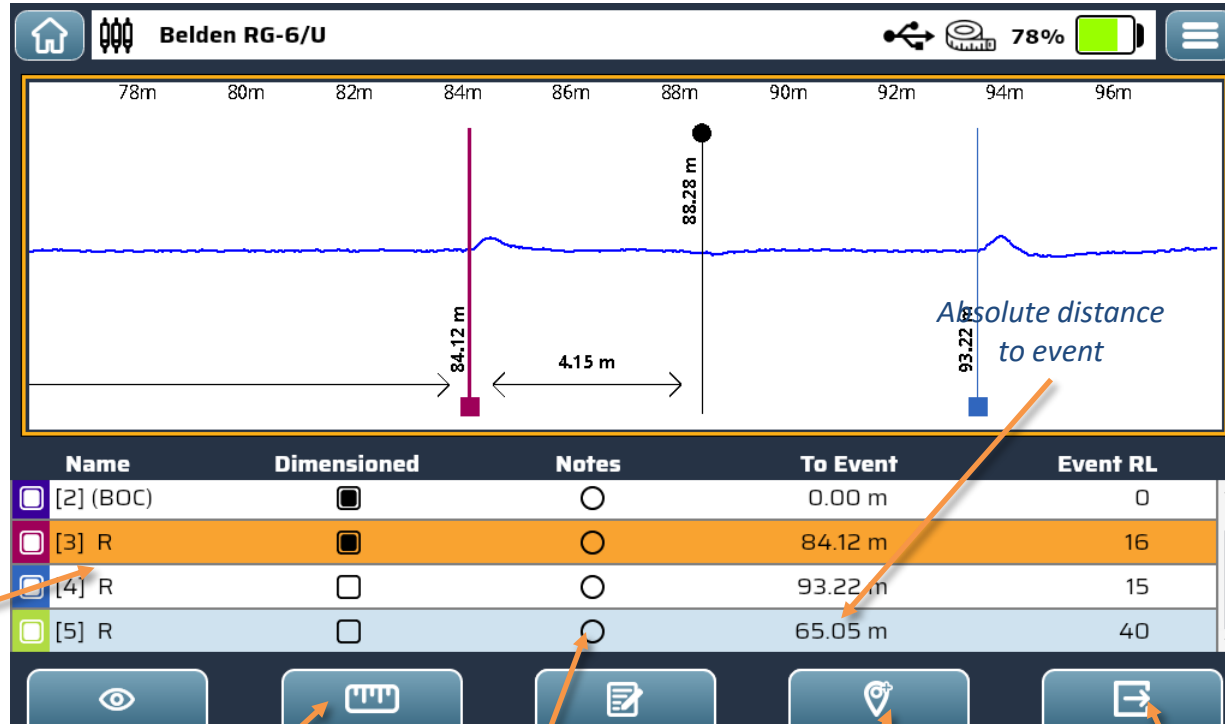
Manual “add event at cursor” button

Exit

Absolute distance to event

Event List

Show the details...



List of events

Activate measurement for highlighted "event" (or cursor)

Notes can be added to events

Manual "add event at cursor" button

Exit

Here I have added an event manually then chosen to "dimension" this and the "cursor". You can also add a note to any "event" including "auto" ones.



Events

Call the them “faults” or “markers” whatever...

There’s some more detail about events and why they are seen further on when we discuss TDR theory, but for now, a summary:

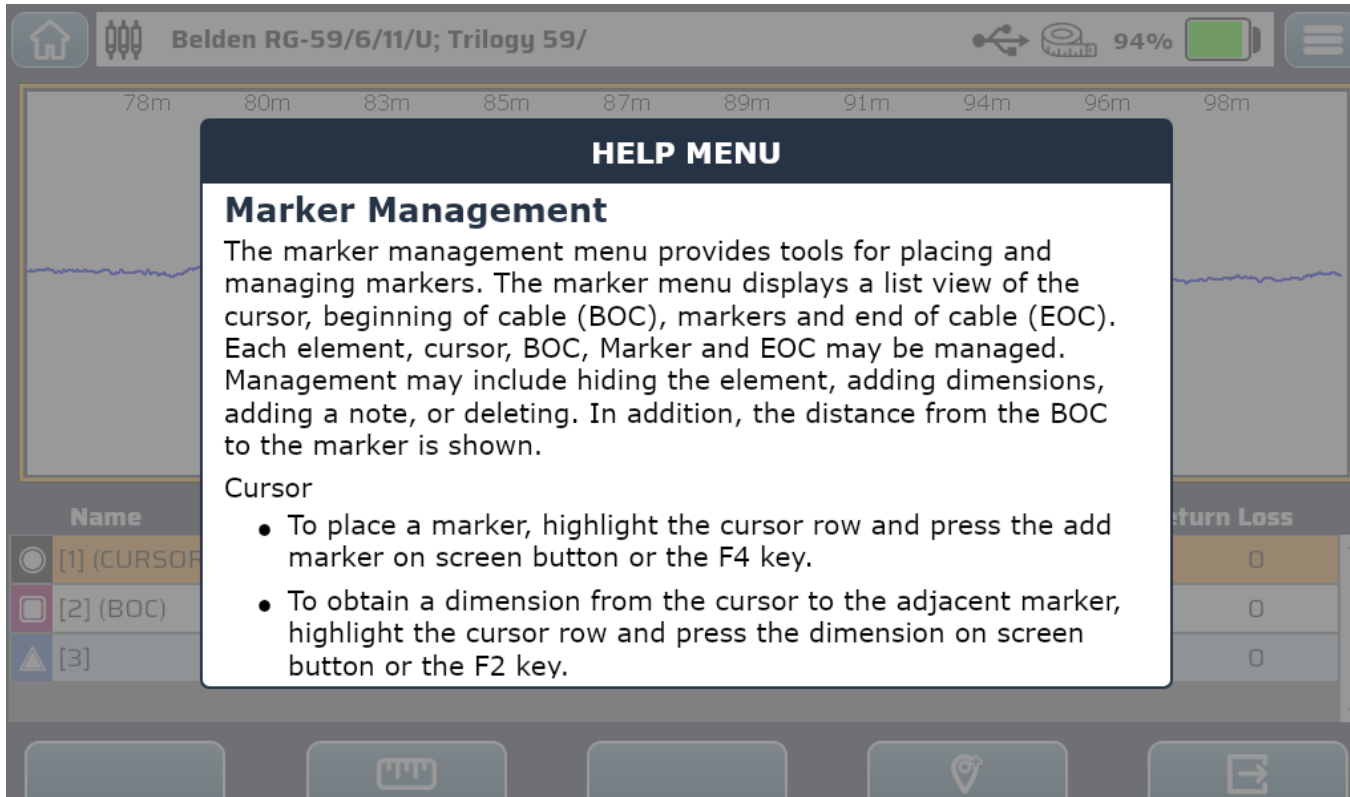
Deviations from a straight line on the trace indicate a change of impedance of the cable. Below the line where an event is of “lower impedance” than the surrounding cable. Above the line for events of “higher impedance” than the cable. The amplitude (height) of the wiggle above or below the line is directly proportional to the difference in impedance (see “reflection co-efficient” later).

You can use events, added manually or better still automatically to judge which events are worst on a cable and target these for repair. Your CATV company may have recommendations relating to maximum event size, perhaps expressed as “percentage” of signal loss or “dB ERL” and maybe also maximum total event loss between source and customer.

If your company has specific “rules” that you apply and would like the software of TV220E customized to implement these thresholds, let us know. For now, the simplest way to find “service affecting” faults is to set the “return loss” threshold in the automatic event detector.

Online Help

Press ? For Clues



The screenshot shows the Cable Scout TV220E interface. At the top, the title bar reads "Belden RG-59/6/11/U; Trilogy 59/". The main display area shows a cable trace with distance markers from 78m to 98m. A "HELP MENU" is overlaid on the screen, titled "Marker Management". The help text explains that the marker management menu provides tools for placing and managing markers, displaying a list view of the cursor, beginning of cable (BOC), markers, and end of cable (EOC). It states that each element can be managed, including hiding, adding dimensions, adding notes, or deleting. The distance from the BOC to the marker is also shown. Below the text, a table lists the elements:

Name	Return Loss
[1] (CURSOR)	0
[2] (BOC)	0
[3]	0

The help menu also includes a section for "Cursor" with two bullet points:

- To place a marker, highlight the cursor row and press the add marker on screen button or the F4 key.
- To obtain a dimension from the cursor to the adjacent marker, highlight the cursor row and press the dimension on screen button or the F2 key.

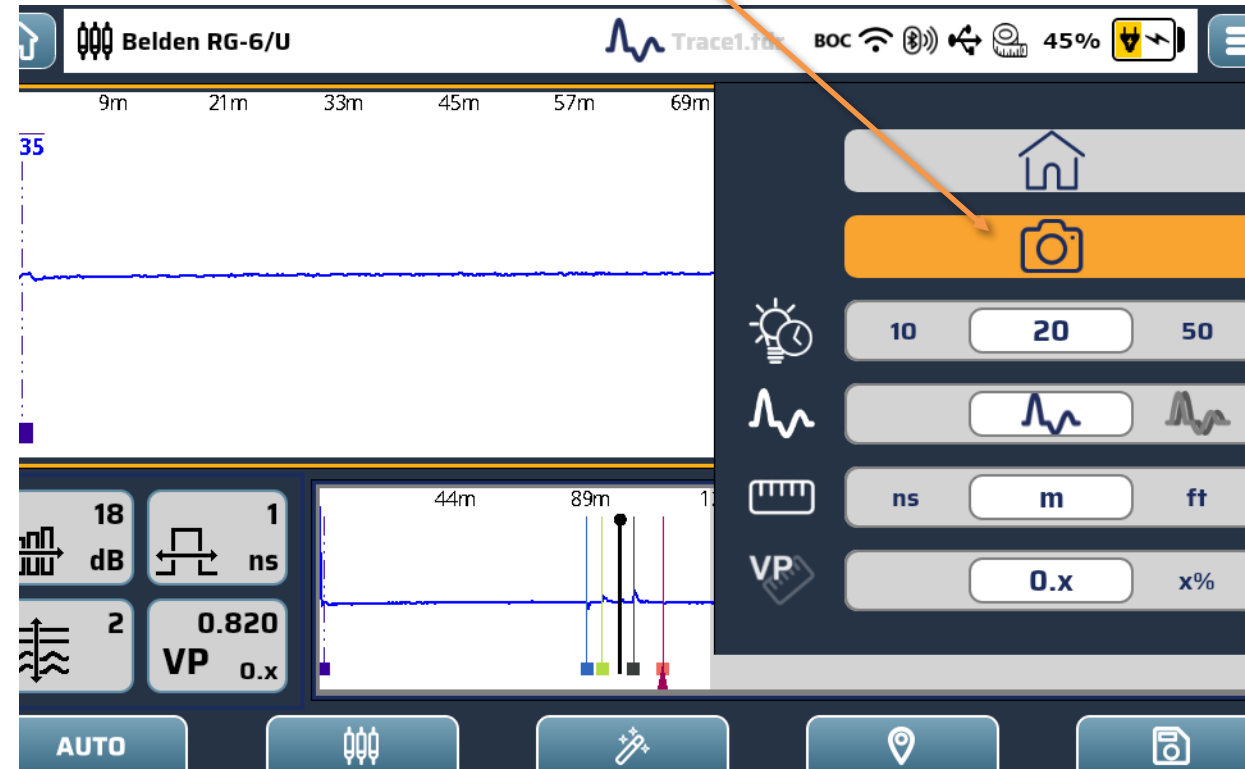
If you press the “?” button at any time you will see context relevant help, explaining the functions that you are currently working with.

Screen-Shot Quick Menu

Quick capture of the screen...

- Ensure you have a USB drive inserted. Check that the “USB” icon is visible on the status bar.
- Press “Menu”.
- Press “Down” to select the “camera” icon and press “enter” or tap the icon directly on the screen.
- A PNG file is saved to the USB drive named “screenshot_YYYY.MM.DD_HH.MM.SS.SSS.png” where this is year, month, day, hour, minute, seconds and milliseconds.
- When saving a screen-shot this way the “quick-menu” is not saved in the image.

Quick Menu
Screen-shot
button



Practicalities TV220E

Physical features for ease of use



TV220E is supplied in a tough washable shoulder bag with a grab handle on the top which has a removable, wide & comfortable strap. This bag is adequately sized to be suitable for the TV220E, its accessories and a few tools.

There is also a removable shoulder strap included that can be attached to the stainless-steel anchor points of the TV220E itself.

Both straps have sufficient adjustment range to be used to anchor the device on a rail, perhaps of an access platform.



Practicalities TV220EX

Physical features for ease of use



TV220EX is built into in a tough waterproof (when closed), shower resistant (when open) carry case. There's sufficient space inside for most everyday accessories and maybe a couple of small tools.

There is a removable shoulder strap included that can be attached to the stainless-steel anchor shackles on the TV220EX.

This strap has sufficient adjustment range to be used to anchor the device on a rail, perhaps of an aerial access platform.



Other Uses for TV220E/EX

Can I test other cable types...

TV220E is targeted at 75Ω CATV COAX cable testing BUT can be used for:

- 75Ω satellite LNB downlink cables or 50Ω coaxial or similar may be tested fully with TV220E
- But many cable types Can be tested MANUALLY:
 - 50Ω COAX, e.g. antenna feed cables
 - Twisted Pair (e.g. telephone or structured cabling, industrial control)
 - Piezoelectric detection cables
 - Underfloor heating cables
 - Even use it to check lengths of cable on drums
 - If you only test cables like these, we recommend CS90 as a simpler solution without the TV220E “smarts” and wireless result transfer that cost extra



[Linked](#) article about
Testing other cable types

The fact that the TV220E has a 75 ohm output impedance means that when connected to other cable types there will be a small reflection (insertion loss) of signal. For example, when connecting to a 50 ohm antenna feed the insertion loss will be just 0.2 dB showing as an event with return loss of around 14 dB. Keeping things in perspective: Cable matching is important for avoiding noise due to reflections but not critical when testing manually, provided you're expecting it and allow for it.

Tempo Report Writer (enhanced edition) TRWE

Working with Saved Traces

TV220E/EX trace interpretation and report generation

As you saw earlier you can save traces directly to a USB drive connected to TV220E/EX or copy files that have been saved to local memory onto the drive. These can be just the section shown “live” on the display window (Min) or can be a “full” trace captured throughout the available range of the TV220E from zero to over 5.6 km (18 kft) at typical Vp (Max).

If you visit the Microsoft Store, Google Play or App Store search for “Tempo Report Writer Enhanced”. Or scan one of these codes...



Windows

TV220E/EX TRWE in Windows is shown here...

Examples

We will show most of the functions of TRWE using the Windows application as an example, the application on tablets and phones works similarly, but the smaller screens have a few necessary changes to fit everything in. We will show some screen-shots from those devices at the end.

Connectivity

You may use the USB drive to transfer files from TV220E/EX to the PC or “mobile device”. But Wi-Fi and Bluetooth Low Energy (BLE) may prove simpler and quicker where permitted.

Either or both wireless links needs to be activated in the “settings” menu as detailed above. Wi-Fi connectivity is “more robust” and generally provides faster transfer rates, but BLE is simpler and “fast enough” as the files are generally small. “BLE” connection must be initiated via the TRWE application.

Familiarity

Keeping things simple by keeping them similar

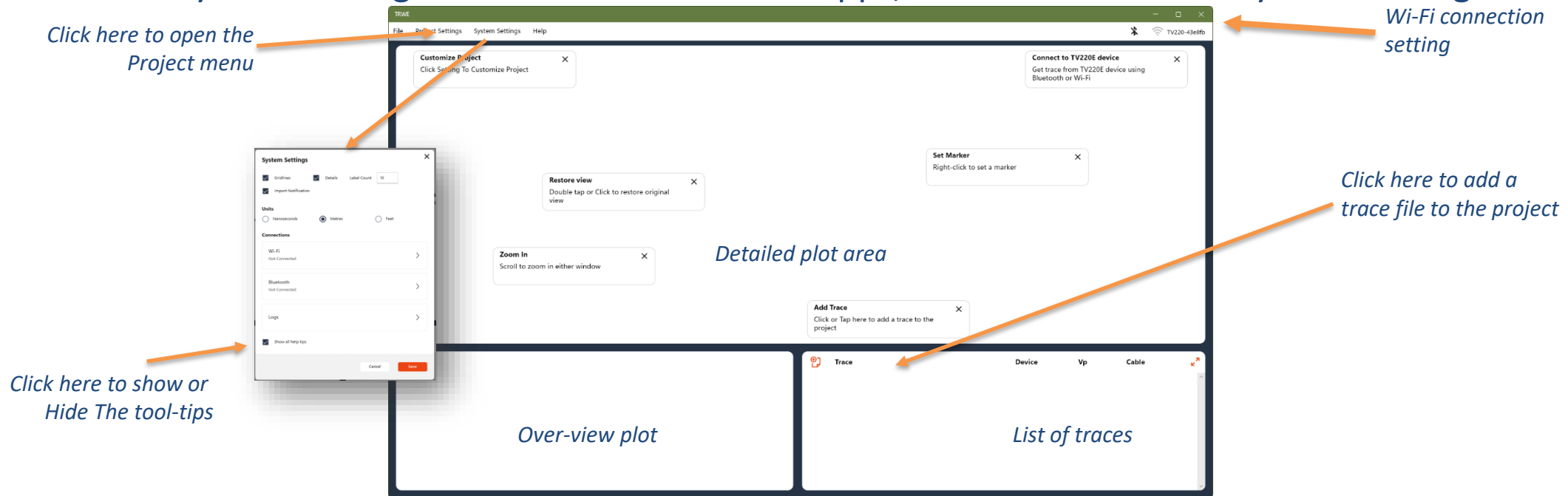
When you first open the Tempo Report Writer (TRWe), you will see that this adopts the now familiar layout of an “overview” trace in a lower window and a more detailed, zoomed in, trace above. The list of loaded trace files is shown in the lower right window.



Tool Tip Help

Helping to get you started...

When you first open the Tempo Report Writer (TRWe), you will now see that several “Tool Tips” are shown around the screen as an aide memoire, helping you get started. These can be individually “clicked” off or all switched off or back on again using the check box alongside “Help” in the “System Settings” menu. In the “mobile” apps, look for “Guide” in “System Settings”.



Wi-Fi Connection

Getting your data immediately...

To connect to TV220E via Wi-Fi, turn on the feature on the TV220E in its settings screen (see above). Then, on your laptop ensure that you are **NOT connected to any other network, whether wireless or wired**. Then click on the “Wi-Fi” connection link (top right). Enter the SSID and password as detailed by your TV220E. You should see “connection successful”.

Next choose which files you would like to import from TV220E and press “import”. The files will be imported to a sub-folder “./TRWE/TDR” in your “downloads” folder in Windows.

In the mobile apps the files are downloaded to “private” application storage “Local Files” in the menu.

The screenshot displays the 'Tempo Report Writer Enhanced' application interface. A 'File' menu is open, with 'Import from Device' highlighted. A 'Wi-Fi Settings' dialog box is overlaid, showing the SSID 'TV220-43e8fb' and a masked password. An arrow points to the 'Wi-Fi connection setting' in the top right corner of the application window. Below the main interface, a 'Wi-Fi Settings' status window shows 'Status: Connected' and 'SSID: TV220-43e8fb', with a 'Get Data' button highlighted by an arrow. The background shows a 'List of traces' section with columns for 'Trace', 'Device', 'Vp', and 'Cable'.

Bluetooth (BLE) Connection

Getting your data immediately...

To connect to TV220E via Bluetooth, turn on the feature on the TV220E in its settings screen (see above). Allow about thirty seconds for the wireless sub-system to restart. Then click on the “Bluetooth” connection icon (top right). Refresh the list of available devices, you should see your TV220E listed. Click on “connect”... (sometimes Windows is fussy, try again...) accept the connection on TV220E

Next choose which files you would like to import from TV220E and press “import”. The files will be imported to a sub-folder “./TRWE/TDR” in your “downloads” folder in Windows.

In the mobile apps the files are downloaded to “private” application storage “Local Files” in the menu.

The screenshot displays the TRWE application interface with several overlays and annotations:

- Bluetooth (BLE) connection setting:** An arrow points to a Bluetooth icon in the top right corner of the application window.
- Bluetooth dialog:** A dialog box titled "Bluetooth" is open, showing a "Last connected device" section with "TV220-43e8fb" and a "Connect" button. Below it, the "Available Devices" section lists "TV220-43e8fb" with a "Connect" button. A "Refresh" button is also present. An arrow points to the "Connect" button for the available device with the text "Click here to connect".
- Import TDR files dialog:** A dialog box titled "Import TDR files from TV220-43e8fb" is open, showing a table of files. An arrow points to the "Import" button.
- Bluetooth status dialog:** A dialog box titled "Bluetooth" shows "Status: Connected" and "Name: TV220-43e8fb". It has "Disconnect" and "Get Data" buttons. An arrow points to the "Get Data" button with the text "Click here to browse traces on TV220E".
- List of traces:** The background interface shows a "List of traces" section with columns for "Device", "Vp", and "Cable".

Load a Trace

Adding a saved trace to the screen

Click on the add trace button in the top left of the traces list window. Choose a file from your traces' directory (copied using Windows file manager from the USB drive or the sub-folder of your "downloads" if using wireless transfer, or from "Local Files" in the mobile apps).



Click here to add a trace file to the project

Setup Your Project

Set parameters and job details

From the “File” menu, you can start a new project, open a previously saved one, save the current one or create a PDF report of the current project. Click on the “Project Settings” & “System Settings” to add notes and headers and footers to reports. Cursors and markers that were present on the TV220E when saved are automatically shown.

Click here to open the
Project Settings

The screenshot displays the TRAVE software interface. A 'Project Settings' dialog box is open in the foreground, allowing users to adjust the 'Velocity of Propagation' (set to 0.820) and add 'Project Notes', 'Header Notes', and 'Footer Notes'. The background shows a TDR trace plot with a peak at 90.83 m. A table at the bottom right lists the detected traces:

Name	Details	Time/Distance	Type
[2] (BOC)	<input checked="" type="checkbox"/>	0.00 m	Undimensioned
[3] (EOC)	<input checked="" type="checkbox"/>	90.83 m	Undimensioned

Project Settings:
Here you can add a block of notes for the project and adjust the overall Vp and add headers and footers.

Working with Multiple Traces

Compare before and after etc.

Whether you want to document “before” and “after”, show some new detail about a single cable or otherwise compare multiple traces, only if all traces have the same Vp, they can be loaded into one report. Here we have a “full” trace loaded with the detailed trace previously loaded...

Purple line is the “second” trace
And the brown line is the
original one

Hover over the trace and
Use the scroll wheel to zoom

Click and drag to move
The “detail window”
Along the “overview” trace



Click here to expand the traces list...

Trace	Device	Vp	Cable
[5] (EOC)		0.82	Dummy Cable
[6] F		0.82	Dummy Cable
[5] F		0.82	Dummy Cable

Name	Details	Time/Distance	Type
[5] (EOC)	<input type="checkbox"/>	85.35 m	Dimensioned
[6] F	<input type="checkbox"/>	85.35 m	Undimensioned
[5] F	<input type="checkbox"/>	85.60 m	Dimensioned

In the mobile apps, click on the “Trace” button so see similar details. Click on “Chart” to return to the TDR view.

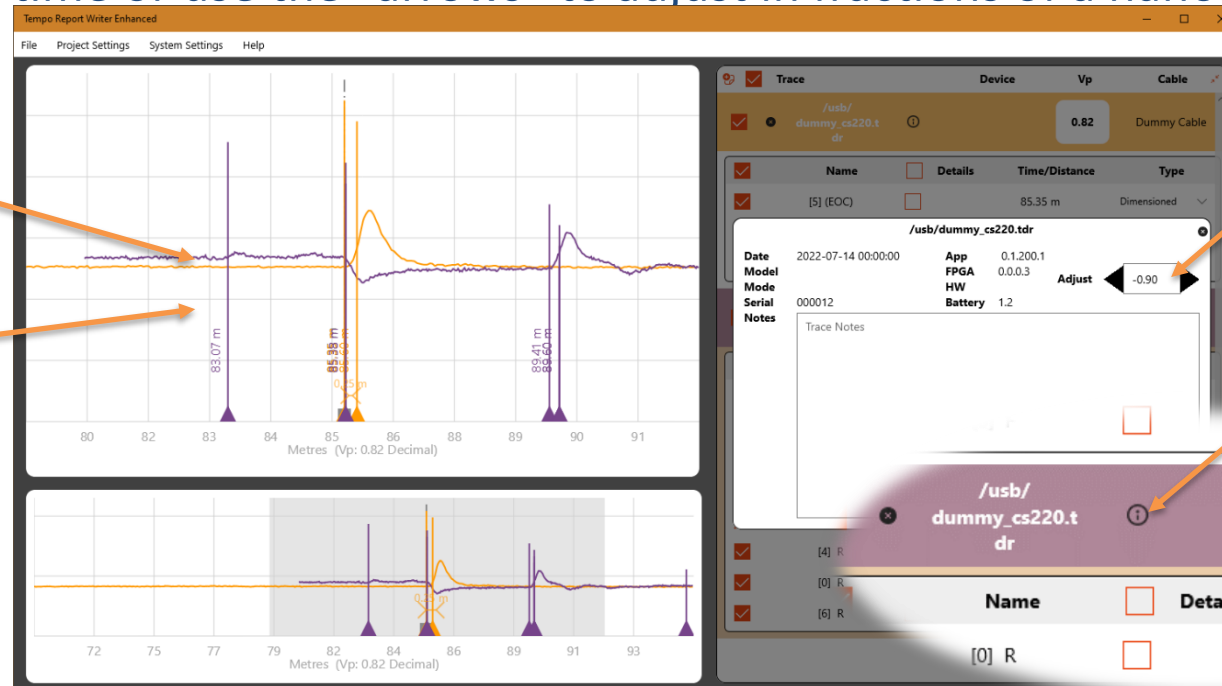
Trimming Time (Windows)

Align traces where trace calibration differs by ns...

When traces are taken at different times or with different units, the “zero” point of each trace could have a slightly different calibration value. To re-align the displayed traces, click on the info button of the trace to be adjusted, then drag the trace a few nanoseconds left or right in the detail window or type a time or use the “arrows” to adjust in fractions of a nanosecond.

Drag the selected trace to align some key point as a reference to the “master”

Right-click (long press) to add a new marker...



Adjust timing here

Click the info button of the trace to be adjusted to show the adjustment tool

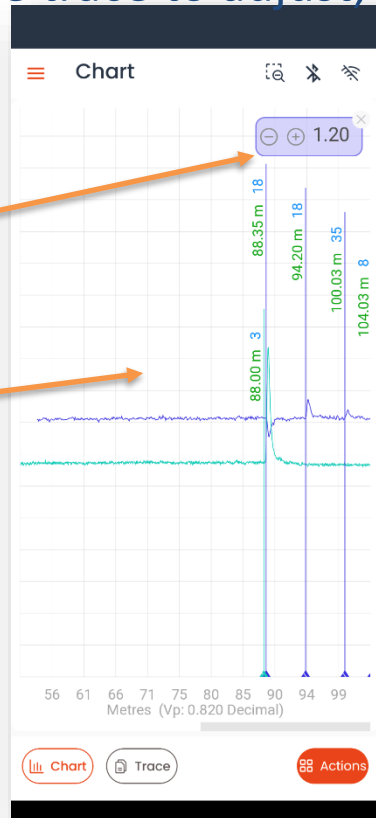
Trimming Time (mobile app)

Align traces where trace calibration differs by ns...

When traces are taken at different times or with different units, the “zero” point of each trace could have a slightly different calibration value. To re-align the displayed traces, click on the “:” context menu for the trace to adjust, then tap on + or – to adjust. Click on X to close the adjuster.

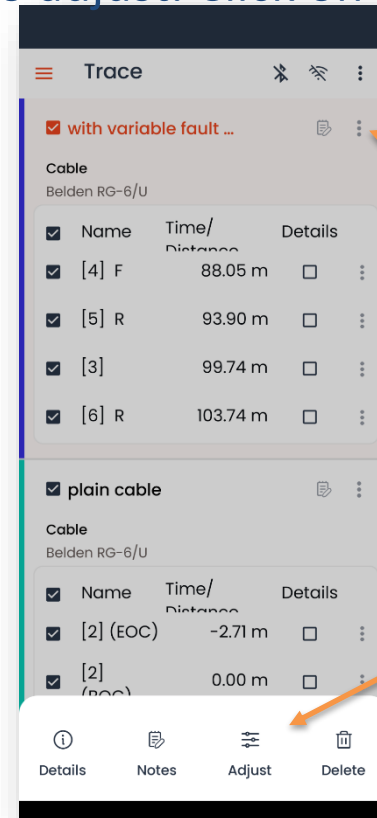
Use + and – to align some key point as a Reference between traces

Double-tap to Add a new marker...



Click the info button : of The trace to be adjusted To show the tools for “details”, “notes”, “timing adjustment” or to “delete” the trace.

Select trace details, add notes, adjust relative timing or delete the trace



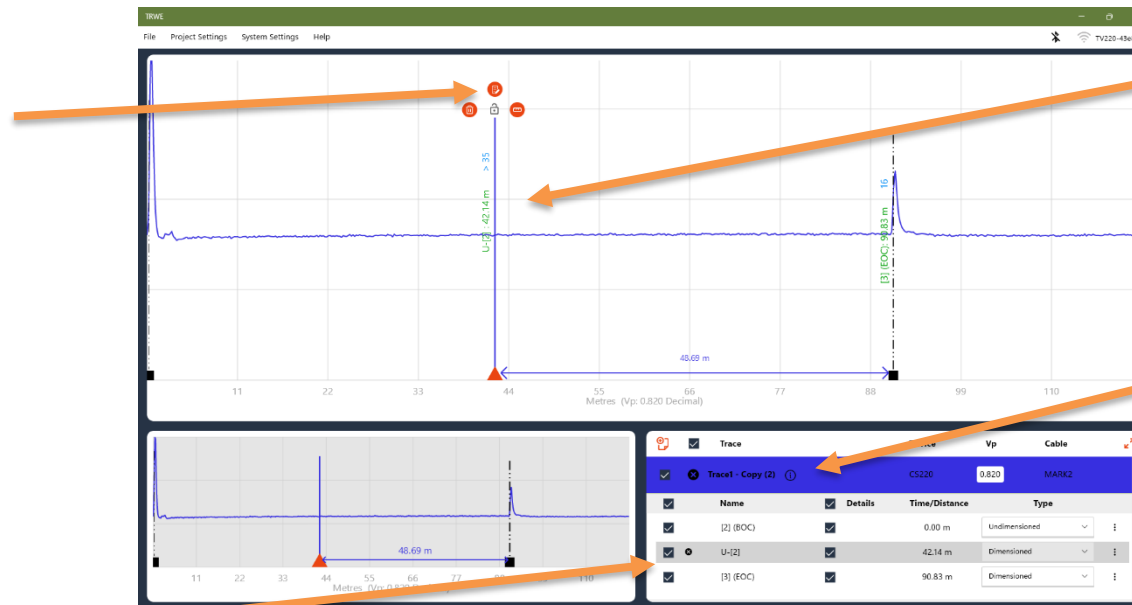
Manage Markers

Measure things on the traces

To add a new cursor to a trace, first click on the title of the trace to select it in the traces window (if there's more than one active). Then right click on the trace in the window to add a marker (or long press on a Windows touch-screen or double tap on the mobile apps).

To measure the distance between markers, drop down the “Un-dimensioned” and change to “Dimensioned” on at least two cursors. A dimension line will be added between.

Marker manipulation options are shown above the marker whilst it is selected. Delete, Notes and Dimension are available here. Click the “lock” icon to close these options. Click again to reopen them. Note that only “user added” markers can be deleted.



Right-click (long press)
To add a new marker.
Markers can be adjusted
By left-clicking and dragging

Click to select the trace to
have a new marker added

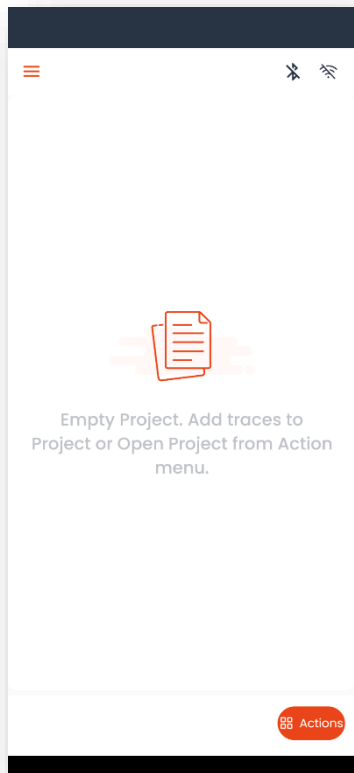
Click and choose
“Dimensioned” on at least
two markers.

Click to hide a marker.
Click the X to delete

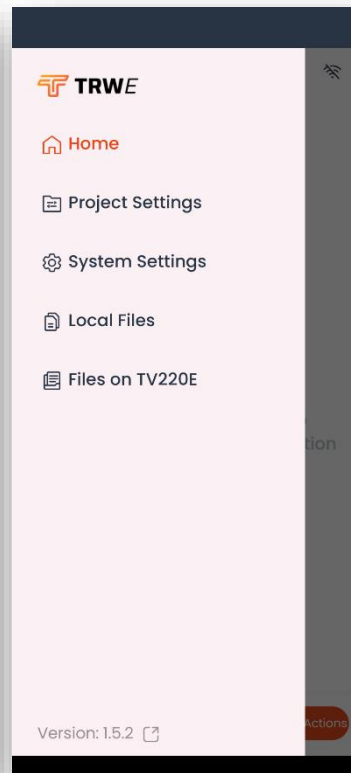
Phone (iOS and Android) App

Let's show you the key points

TRWE in “mobile apps” has the same features as in Windows, but laid out differently (Android shown)...



Opening screen



Main menu

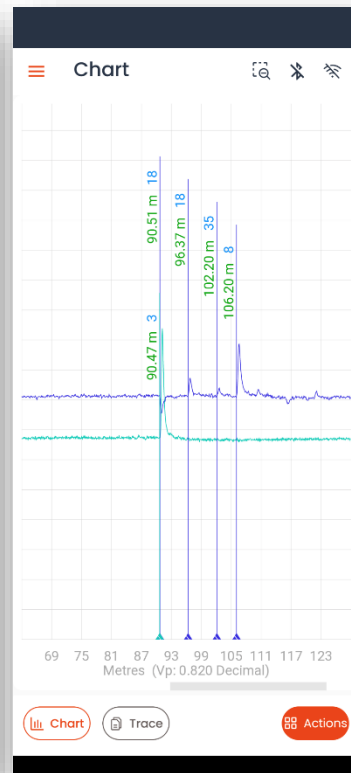
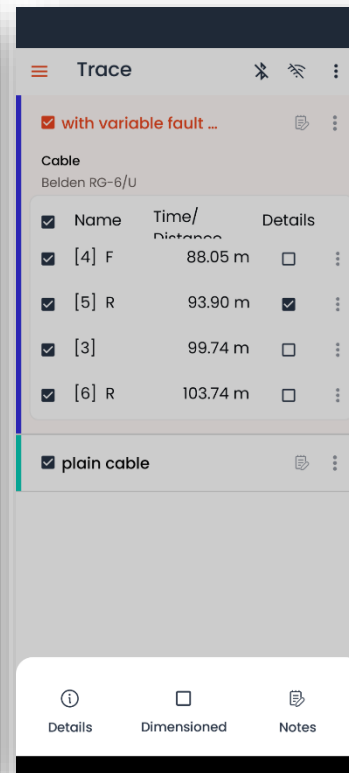
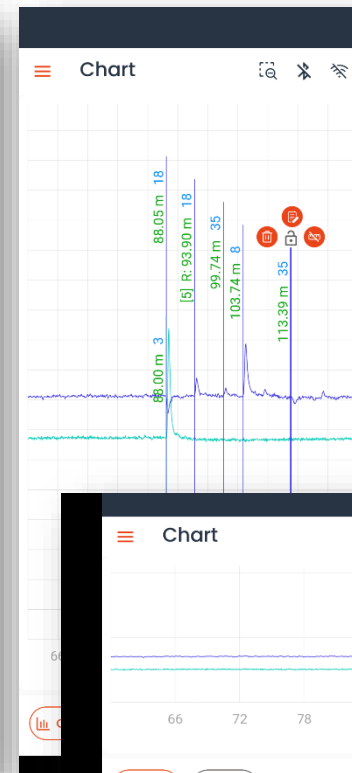


Chart display



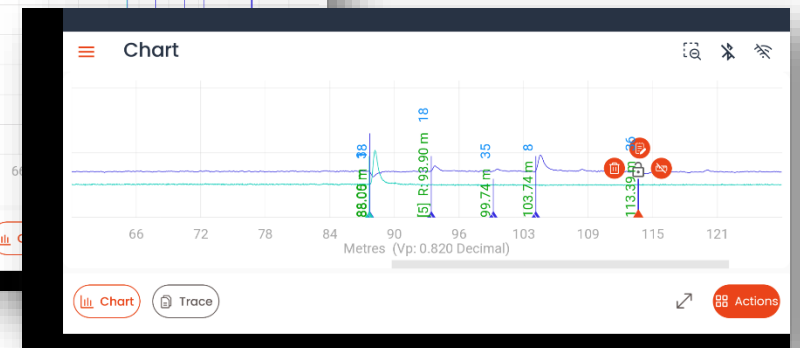
Name	Time/Distance	Details
[4] F	88.05 m	
[5] R	93.90 m	
[3]	99.74 m	
[6] R	103.74 m	

Trace display (extended)



Double tap on the trace to add a new marker.

Rotate your device to move to landscape mode (if enabled on your device)



Tablet (iOS and Android) App

Let's show you the key points

TRWE in “tablet apps” is pretty much the same as the Phone “app” just bigger (iOS shown)...



Opening screen

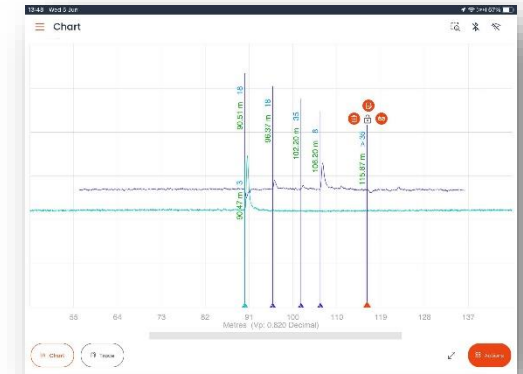


Main menu

Name	Notes	Time/Distance	Details
[4] 7	Not available	80.91 m	ⓘ
[5] 4	Not available	96.37 m	ⓘ
[3] 3	Location of variable fault	102.20 m	ⓘ
[6] 4	Not available	106.20 m	ⓘ

plain cable

Trace display (extended)



Double tap on the trace to add a new marker.

Reference Material

Power

The rate of transfer of energy

What The Watt

Fundamentally one WATT, the unit of “electrical power”, is the delivery of energy at a rate of one JOULE per second. Hopefully, you remember “ohms law” and the electrical “power” equations which are all interrelated:

Power $P = \frac{V^2}{R} = IV = I^2R$	Current $I = \frac{P}{V} = \frac{V}{R} = \sqrt{\frac{P}{R}}$
Voltage $V = \frac{P}{I} = IR = \sqrt{PR}$	Resistance $R = \frac{V^2}{P} = \frac{V}{I} = \frac{P}{I^2}$

Decibels

Compressing numbers using logarithms

The Decibel

The decibel (dB) originally named after Alexander Graham Bell; the decibel is one tenth of a “Bel”. Being a “logarithmic” function, it allows representation of large power ratios in manageable numbers and calculation of overall system gains and losses by simple addition and subtraction as opposed to multiplication and division.

The ratio of two POWER measurements is expressed as:

$$dB = 10 \times \log_{10} \left(\frac{P_1}{P_2} \right)$$

The ratio of two VOLTAGE measurements is expressed as:

$$dB = 20 \times \log_{10} \left(\frac{V_1}{V_2} \right)$$

Voltages as Decibels

Useful to keep numbers “manageable”

The dBV

Voltages can be expressed in decibel (dB) form.

In terms of “x Volts”

$$dBV = 20 \times \log_{10}(x \text{ volts})$$

If working in millivolts:

$$dBmV = 20 \times \log_{10}(x \text{ millivolts})$$

If working in microvolts:

$$dB\mu V = 20 \times \log_{10}(x \text{ microvolts})$$

As there are three “decades” between volts and millivolts and between millivolts and microvolts you can simply add or subtract 60 to any “dB” measurement to convert...

$$+10 \text{ dBmV} = +70 \text{ dB}\mu V$$

Be careful not to confuse dBmV for millivolts (mV) expressed in decibels for “dBm” a power measurement – more on dBm next...

Signal Powers Decibels

Useful to keep numbers “manageable”

The dBm

Signal “power” is the ability of the “potential” (voltage) present to develop “heat” (power) if dumped into a perfect termination of the correct matching impedance, expressed in “milliwatts”, hence the “m”. Therefore, dBm are ALWAYS referenced to the characteristic impedance of the system. It can be confusing as the characteristic impedance is almost always “implied” (i.e. you need to know it) rather than specified. For telephony this is commonly 600 ohms in the audio band, 100 ohms from about 100 kHz up, for CATV and broadcast TV antenna coax 75 ohms and for most other “RF” antennas 50 ohms. Early RF pioneers have a lot to answer for, but we’re stuck with it, dBm should probably be dBmW(z), where z is the “reference impedance” – but that’s not the convention.

A reading of “x dBm” therefore means a signal is x dB greater than that which develops one milliwatt in the reference impedance, a negative dBm value means that it is x dB less than one milliwatt.

$$dBm = 10 \times \log_{10}(x \text{ milliwatts})$$

General TDR Training

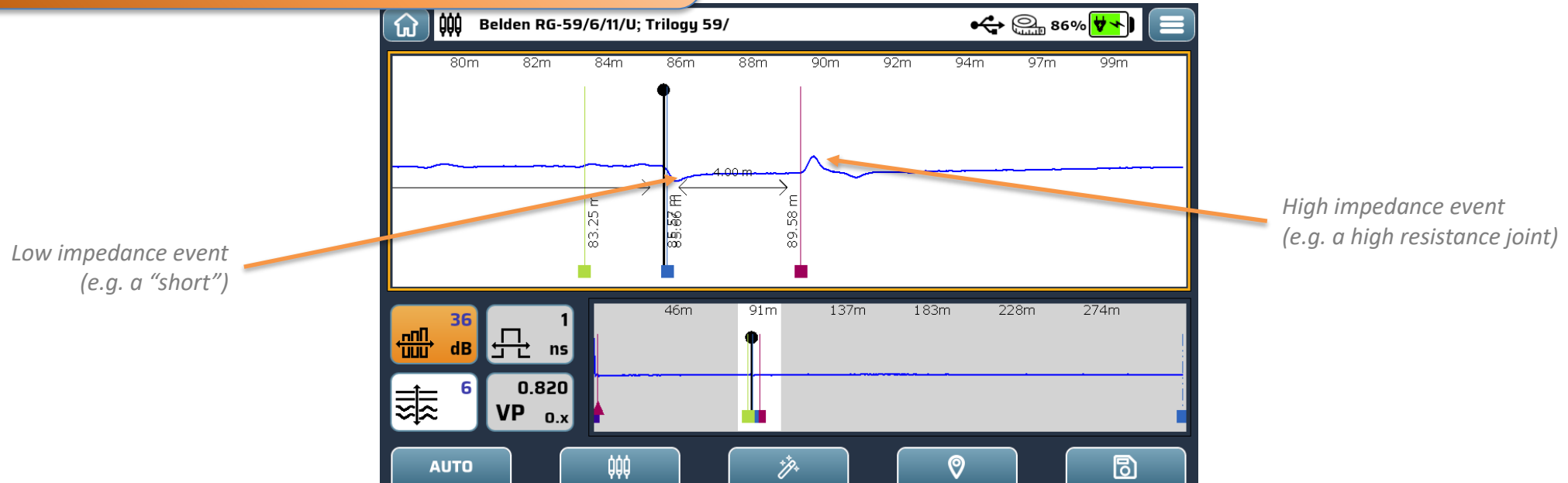
Principle of Operation

What exactly is a TDR?

- A Time-Domain Reflectometer (TDR) is a device using a principle like radar to measure time and distance over a length of cable.
- A TDR sends out energy into the cable and records the reflected energy coming back from “events” (changes of impedance) along the length of the cable.
- The TDR measures the time taken for the reflections to return and can also convert this into distance along the cable.
- The results are shown as a trace of amplitude vs time/distance on the screen.
- The amplitude of the event return signal can be used to calculate the scale of change of impedance and expressed as “return loss”.
- The events that a TDR can detect are normal occurrences such as Taps, Splitters, Couplers, Loop Extenders, etc., as well as accurately pinpointing trouble such as Shorts and Opens.
- A TDR can provide the exact location of the start of the flooded section and a rough estimate of the total amount of cable that is wet.

Basic TDR trace analysis

What exactly are we seeing?



- The TDR displays a graph of the tested cable with time to reflection, optionally converted to "distance", on the horizontal axis.
- The on-screen cursor helps by displaying nanoseconds, feet or meters to a point on the cable.
- The vertical axis on the TDR display shows the type and severity of fault.

Cable Fundamentals

How do signals propagate in a cable?

Velocity of Propagation (Vp)

A cable's velocity of propagation ("VoP" or Vp) specification is simply a measure of how fast a signal travels in the cable. It is typically expressed as a percentage of the speed of light.

For example, a cable with a Vp value of 0.85 indicates that the signal is traveling down the cable at 85% of the speed of light. Since a time-domain reflectometer (TDR) is really making measurements in the time domain, the distance accuracy of the TDR is dependent upon having the correct Vp value.

- Pulses of energy travel at different velocities on different cables just as an object travels at different speeds through different fluids.
- Vp varies between cable types, sizes, and manufacturers, but is mostly influenced by the types of insulation material and its density (its construction, solid, foam or air-spaced).
- Identifying the correct Vp for the cable being tested is imperative to have accurate distance measurements.

Cables

What exactly is a TDR?

Cable Impedance

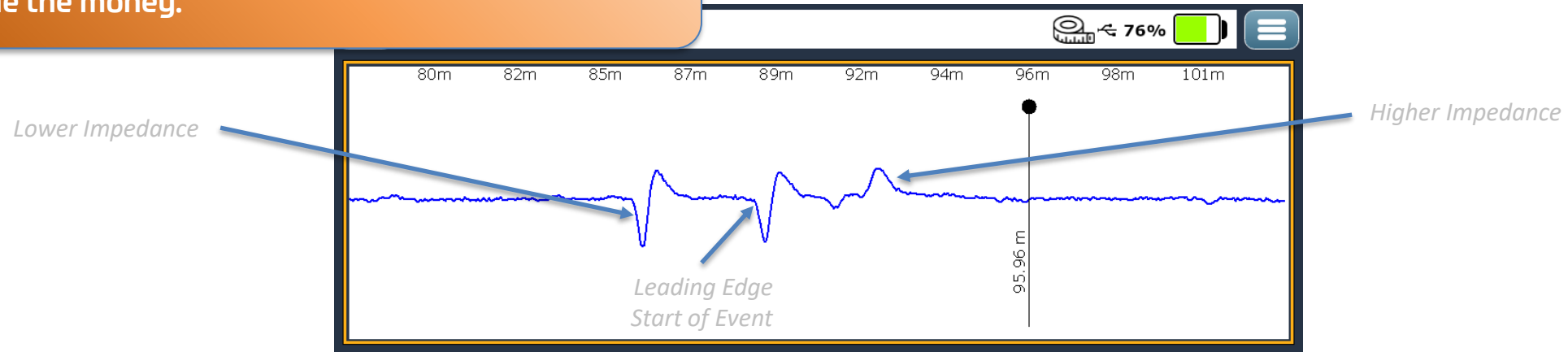
- Cable impedance is made up of resistance, inductance, and capacitance inherent in a cable.
- Energy is reflected at impedance changes.
- TDRs can measure reflections caused by series impedances from several hundred ohms down to a few ohms.
- TDRs can also measure reflections caused by shunt impedances up to several hundred ohms.

Proper Cable Termination

- Cable TV standardizes on 75-ohm termination on all cable ends, taps, and terminations.
- When all ports are correctly terminated, the ability to distinguish faults in a cable is greatly enhanced.
- The 75-ohm termination absorbs all the incident energy resulting in no reflection whilst all incident energy is reflected by an open or fully shorted cable.

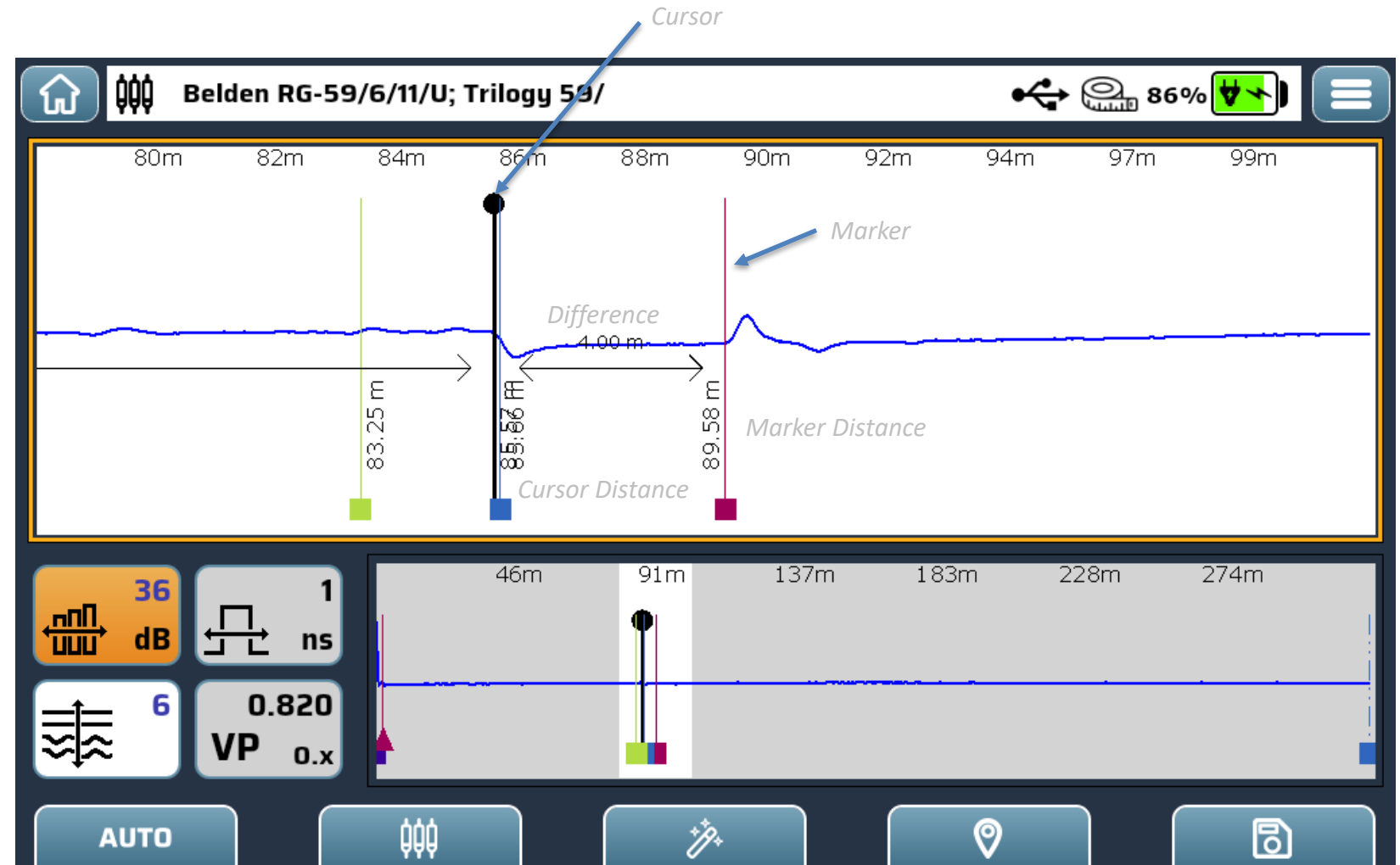
Interpreting the Trace

Show me the money.

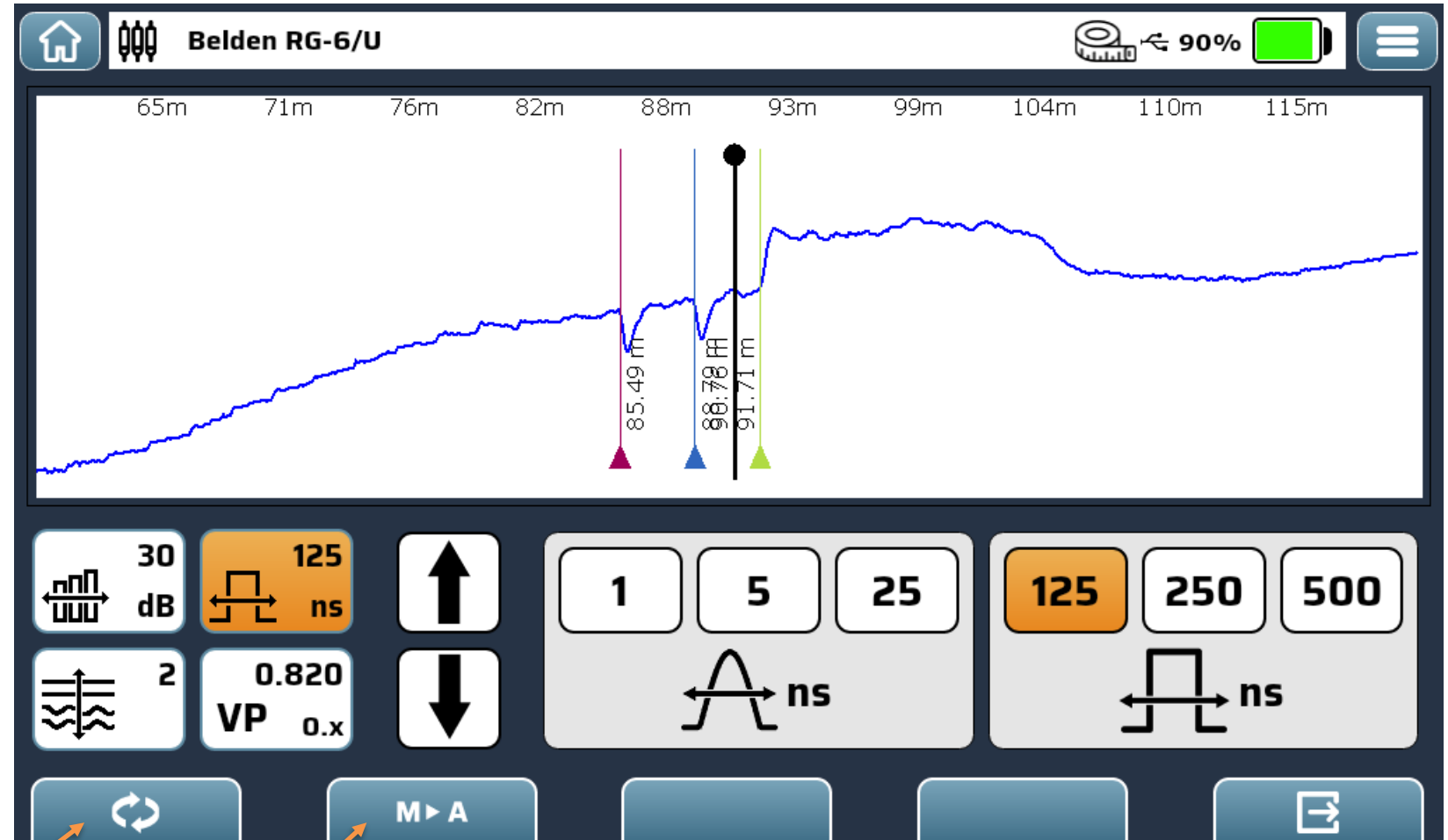


- **Higher impedance:** Will cause a peak to display above the mean position of the pulse reference line.
- **Lower impedance:** Will cause the waveform to dip below the average level of the line.
- **LEADING EDGE:** Indicates where the event is located. The left edge is the precise point where the waveform breaks the plane above or below the pulse reference line. Such as shown by the red cursor line above.
- **MARKER:** A Cursor or Marker can be set at the Leading Edge of the pulse break so that distances can be read on the TDR. Markers may be moved anywhere on the screen to mark distance from the left-hand zero reference point.
- **GAIN:** Acts as an amplifier control. Adjusting the vertical amplitude (height) of the waveform displayed. However, amplitudes that are too high may produce distorted waveforms.

- **MARKER:** A Cursor or Marker can be set at the Leading Edge of the pulse break so that distances can be read on the TDR. Markers may be moved anywhere on the screen to mark distance from the left-hand zero reference point.
- **GAIN:** Input amplifier control. Adjusts the gain of the received signal increasing the “height” of features on the displayed waveform. Beware amplitudes that are too high; they may produce distorted waveforms.



- **Manual Mode Controls**
- **FUNCTIONS:** Press the “Select Function” button repeatedly to select which parameter you want to change. Use ↑ and ↓ to adjust:
- Here we’ve moved from Gain to pulse width
- The available options are:
 - 1 ns
 - 5 ns
 - 25 ns
 - 125 ns
 - 250 ns
 - 500 ns

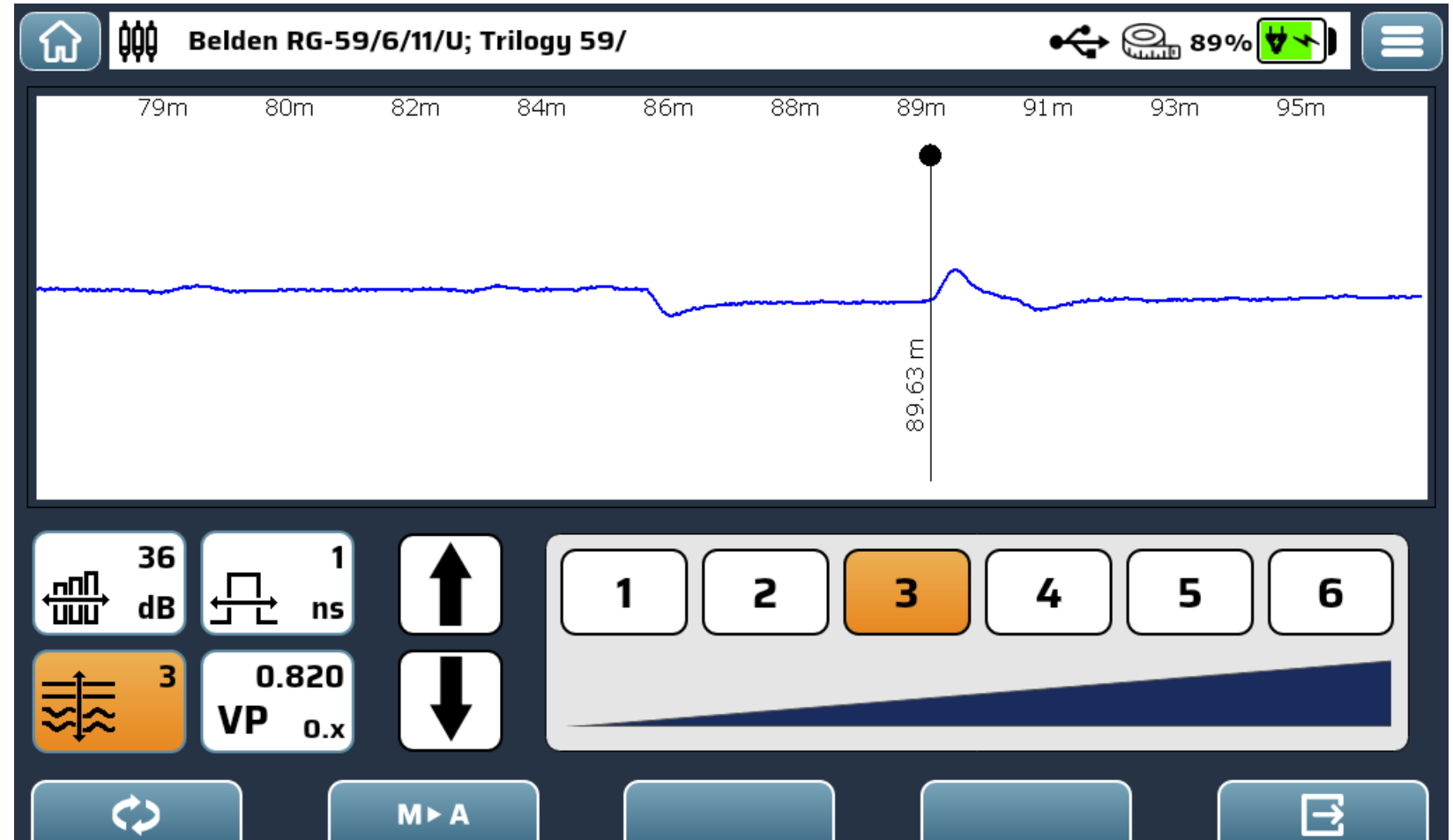


Select Function

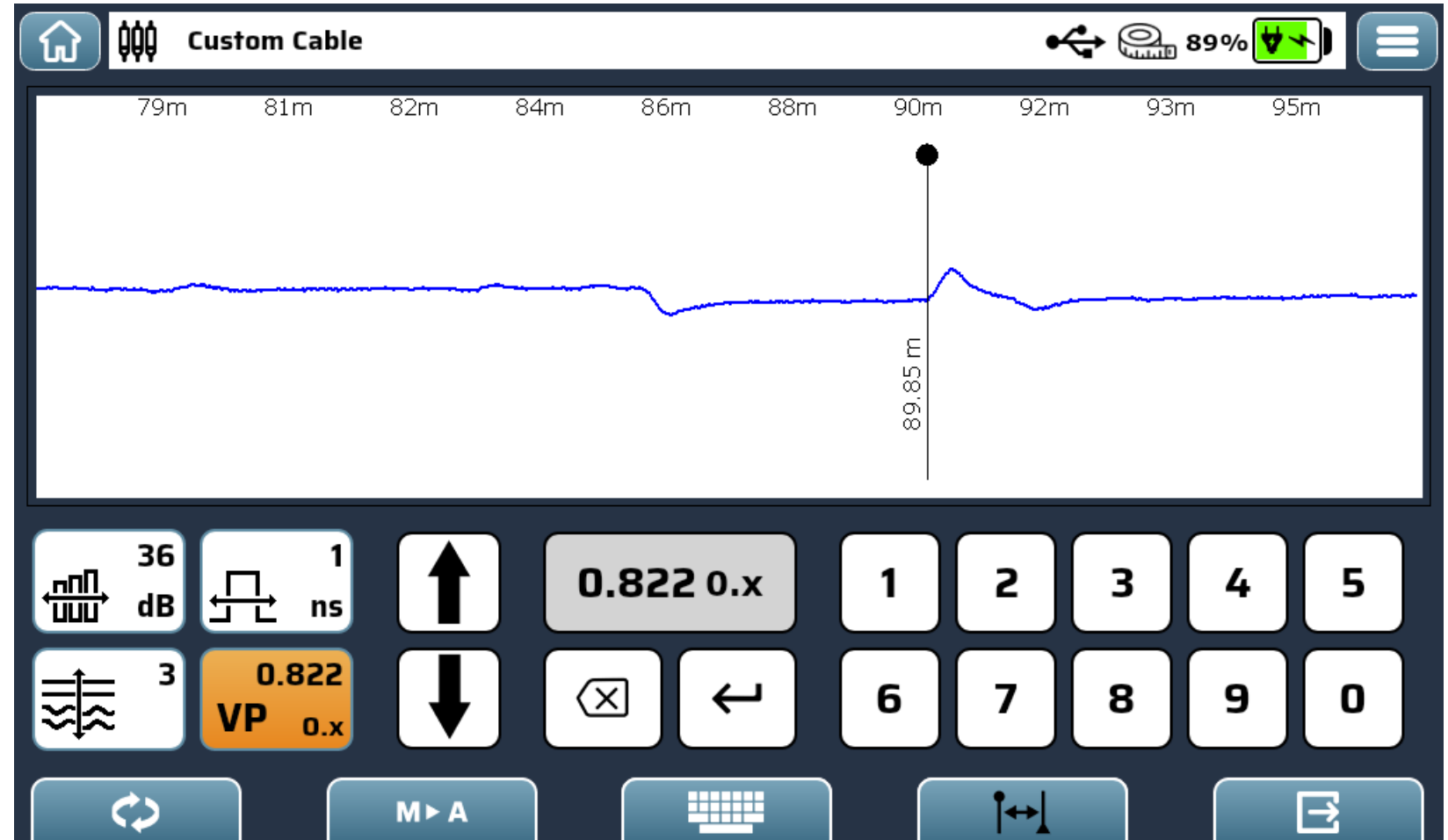
Manual to Auto


- **FUNCTIONS:** Press the “Select Function” button repeatedly to select which parameter you want to change. Use \uparrow and \downarrow to adjust:
- Here we’ve moved from pulse width to Filter.
- The available options are:
 - 1 (minimum 2^0)
 - 2 2^1 (2)
 - 3 2^2 (4)
 - 4 2^3 (8)
 - 5 2^4 (16)
 - 6 2^5 (32)

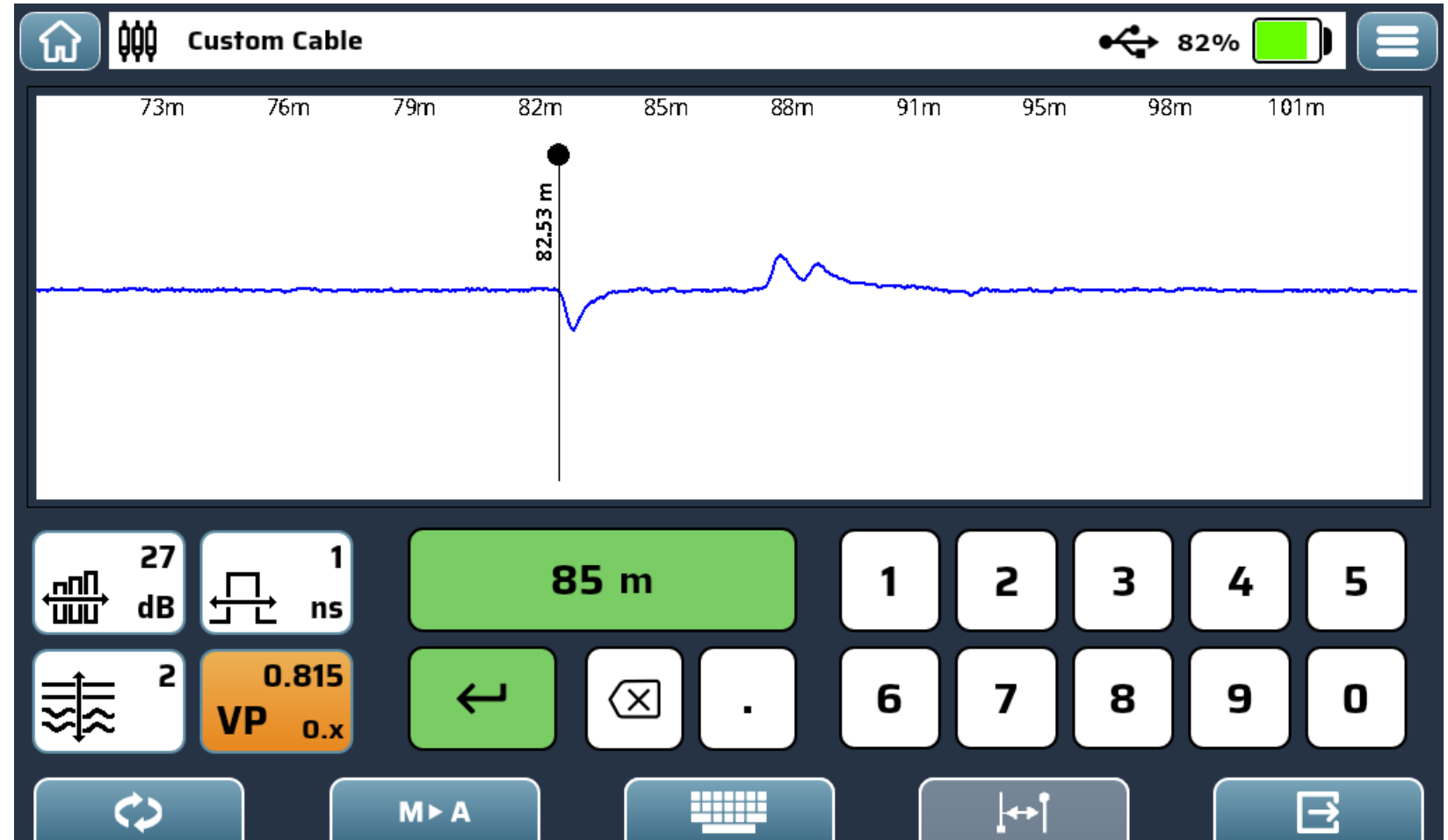
The larger the number the “smoother” the trace, removing noise, but slower response to intermittent faults.



- **FUNCTIONS:** Press the “Select Function” button repeatedly to select which parameter you want to change. Use ↑ and ↓ to adjust:
- Here we’ve moved from Filter to Velocity of Propagation (Vp).
- You can adjust the Vp to suit the actual cable being tested for maximum precision of measurement.
 - 0.300 to 1.000 expressed as a factor of the speed of light in a vacuum.
 - From the settings menu you can choose different ways of expressing this.



- **Measuring VoP.**
- Press f4. 
- Set the cursor at the feature you know the range of.
- Enter the known distance in your chosen units.
- The box will only turn green if the resulting VoP is in the valid range 0.300 to 1.000, expressed as a factor of the speed of light in a vacuum.



Fundamentals

The real mathematics and physics behind why TDR works...

Cables & Velocity of Propagation

Very optional content

This section is entirely optional.

You can skip over this section completely or skim it. Entirely up to you.

We will delve into the detail of how electromagnetic “waves” propagate along “transmission lines” (COAX cables), what governs the speed of propagation, what might cause “reflections” and how they manifest as “blips” on the recorded trace.

Plus, we will help you understand how small changes to the characteristics of the cable can result in “events” that can be seen on the trace of the TDR. Then, how the TDR can estimate the severity of the event from the reflected energy.

Cables & Velocity of Propagation

Why the differences?

- **Cable Construction:** The metals used, “shape” and general makeup of the cable have little effect on “speed”. Twisted pairs or coax made with similar materials have the same “speed” – but different frequency responses.
- **Dielectric Interaction:** Cables conduct electric fields from A to B. The insulation between the parts of the cable, which can be called a “dielectric” is the key to understanding the speed of a cable:
- $V_P = \frac{1}{\sqrt{\epsilon}}$ where epsilon is the effective dielectric constant giving typical “speeds” in different cable dielectrics of:
- Where dielectric materials are not solid and instead “foamed” or formed into a structure containing a large proportion of “air” then velocity of propagation can be increased and often “loss” reduced.

Dielectric Material	Dielectric Constant	Velocity Factor	Velocity of Propagation
Polyethylene (PE)	2.3	0.659	65.9%
Foam Polyethylene	1.3 - 1.6	0.79 - 0.88	79% to 88%
Air Spaced Polyethylene		0.84 - 0.88	84% to 88%
Solid PTFE	2.07	0.695	69.5%
Air Spaced PTFE		0.85-0.90	85% to 90%

Return Loss

Just how bad is it?

Return Loss: This is a measure of how much energy is being reflected by an “event” on a cable. We are going to get all “mathsy” now; don’t worry this is here if you want to know the “reasons why”. If you’re happy just looking at the numbers, skim over this.

Earlier we stated that energy is “reflected” whenever there is a change of impedance of the medium in which a signal is propagating (light from a surface, radio waves from the side of a ship or sound from the wall of a canyon). We are concentrating here on coaxial cables that generally have a uniform impedance along their length. This impedance is derived from their geometry and the dielectric constant of the dielectric (insulation).

So where does this “impedance” come from?

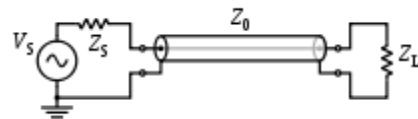
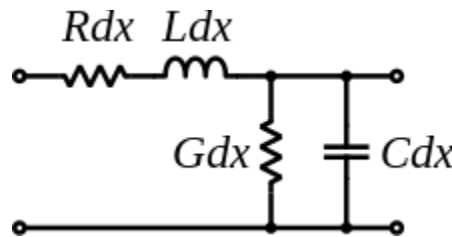
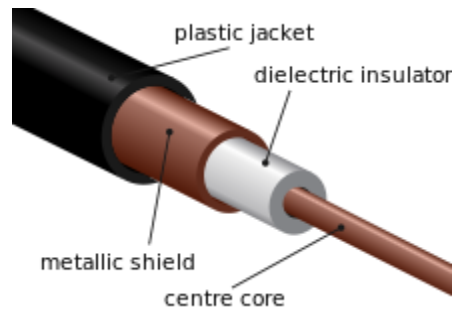
You probably already know about “resistance” which can be expressed in ohms; this is the ability or perhaps inability for a conductor to carry current; when some “electrical potential” (field) is applied to a conductor then a current (I) will flow and voltage (V) (assuming a “non-zero” impedance) will be developed across the conductor where:

$$V = R \times I$$

Where R is the “resistance” of the conductor. But what happens as we increase the frequency from DC upwards, through “mains” (50 or 60Hz), past audio (20 kHz) and into the truly “RF” realm?

Impedance

How is a Coaxial cable measured?



[Coaxial cable - Wikipedia](#)

$$C = \frac{2\pi\epsilon_0\epsilon_r}{\ln(D/d)}$$

Where C is expressed as farads per metre, D is the inside diameter of the “shield” and d is the outer diameter of the “core”, ϵ_0 is the permittivity of free space, ϵ_r is the relative permittivity of the dielectric (inner insulator).

$$L = \frac{\mu_0\mu_r}{2\pi} \ln(D/d)$$

Where L is expressed in henrys per metre, D is the inside diameter of the “shield” and d is the outer diameter of the “core”, μ_0 is the permeability of free space and μ_r is the “relative” permeability of the dielectric. For most dielectrics this is 1.

Series resistance R in “ohms per metre” is the resistance of the inner core and outer shield at DC and low frequencies. At higher frequencies, skin effect increases this as the conduction is restricted to a thin layer on the surface of each conductor.

Shunt conductance G in “siemens per metre” is normally very low because good dielectric insulators are used. However, at high frequencies a dielectric can have significant resistive loss, hence why foam or air cores are used to minimise losses.

At higher frequencies:

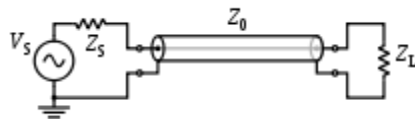
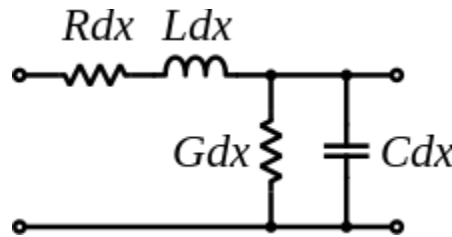
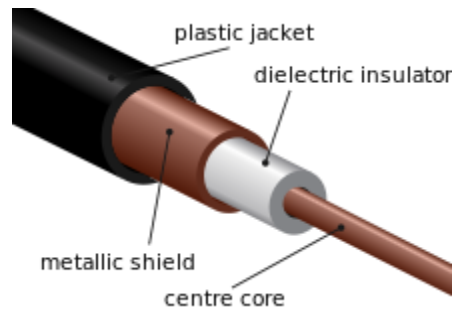
$$z_0 = \sqrt{L/C}$$

With some re-arranging:

$$Z_0 = \frac{1}{2\pi} \sqrt{\frac{\mu}{\epsilon}} \ln \frac{D}{d} \approx \frac{59.9\Omega}{\sqrt{\epsilon_r}} \ln \frac{D}{d}$$

Impedance

Practical Considerations



[Coaxial cable - Wikipedia](#)

Foam Dielectrics

When working with “foam” dielectrics the proportion of “air” to “dielectric” determines the effective relative permittivity. But foam is less tough and must be treated carefully when manipulated. Some super low loss and super high frequency cables will have construction more like pipes with very little dielectric material – just spacers keeping the core in the centre of the “tube” of the shield.

Steel Wires

You will equally note that the majority of CATV coax cables use a steel core with copper plating as it is only that very thin “skin” of copper that conducts at the frequencies of concern. This minimises cost and improves robustness.

Impedance – Final Notes

In the end, impedance of the cable is almost entirely down to the relative permittivity of the dielectric and the dimensions of the core relative to the shield. We can spot damage or other changes to the cables such as increased loss and change of speed due to water ingress etc. These all manifest themselves as wiggles in the line of the TDR’s trace.

Reflection

So, when impedance changes, how bad can it be?

Reflection Co-efficient: This is a measure of the amplitude of the reflected energy relative to the “incident wave”. Where Z_0 is the source impedance and Z_L is the “load” impedance.

$$\Gamma = \frac{Z_L - Z_0}{Z_L + Z_0}$$

When $Z_L = Z_0$ then reflection is zero. When Z_L is less than Z_0 then the co-efficient is negative and with Z_L greater than Z_0 then the co-efficient is positive. This is sometimes expressed as a “percentage” loss:

$$\Gamma(\%) = \Gamma \times 100$$

But in the realm of TDRs we traditionally tend to concern ourselves with the relative loss of “power” not reaching the destination, because it has been reflected. The equation for Return Loss (RL) gives larger positive values for “low” reflection and tends to zero as the reflected energy approaches 100% of the incident wave (short circuit or open circuit).

$$RL = -20 \log_{10} \Gamma$$

Event Return Loss

But isn't there a loss of signal?

Return Loss: is a measure of the severity of a fault at a particular location on a cable. But between the TDR and that “event” there is also normal signal loss in the cable due to resistive and dielectric losses. Let's account for that...

Event Return Loss:

When an event is spotted with a TDR – a wiggle on the trace – then we can apply our knowledge of the loss per unit length of that cable (this figure must be measured and is often input to the cable library from the cable manufacturer's datasheet) to “correct” for this “loss” in the signal “there and back” to the event.

When we do this, we can express the result as “event return loss” or ERL. This allows us to “normalize” for the losses along the cable and then be able to better compare the true “severity” of different events along a cable whether they're near to the tester or closer to the far end of the cable.

By using **ERL**, the technician can quickly identify the worst service affecting faults and correct these first.

ERL is in effect a convenient way of displaying the normalized impedance of the cable at an event. Here the “normalization” is correction for the approximate signal loss between the event itself and the measured reflected energy.

Percentage Return Loss

ERL as a simple percentages?

This table shows the calculated reflection coefficient based on the mismatch between load and source impedance.

The colour grading here gives a guide as to what may be acceptable. Individual CATV companies may apply different thresholds. It is common for companies to require RL to exceed 49dB (0.75%) in new cable.

Z_L	Reflection co-efficient expressed as a percentage																				Z_0	
85	13.3	12.6	11.8	11.1	10.4	9.7	9.0	8.3	7.6	6.9	6.3	5.6	4.9	4.3	3.7	3.0	2.4	1.8	1.2	0.6	0.0	
84	12.8	12.0	11.3	10.5	9.8	9.1	8.4	7.7	7.0	6.3	5.7	5.0	4.3	3.7	3.1	2.4	1.8	1.2	0.6	0.0	0.6	
83	12.2	11.4	10.7	9.9	9.2	8.5	7.8	7.1	6.4	5.7	5.1	4.4	3.8	3.1	2.5	1.8	1.2	0.6	0.0	0.6	1.2	
82	11.6	10.8	10.1	9.3	8.6	7.9	7.2	6.5	5.8	5.1	4.5	3.8	3.1	2.5	1.9	1.2	0.6	0.0	0.6	1.2	1.8	
81	11.0	10.2	9.5	8.7	8.0	7.3	6.6	5.9	5.2	4.5	3.8	3.2	2.5	1.9	1.3	0.6	0.0	0.6	1.2	1.8	2.4	
80	10.3	9.6	8.8	8.1	7.4	6.7	6.0	5.3	4.6	3.9	3.2	2.6	1.9	1.3	0.6	0.0	0.6	1.2	1.8	2.4	3.0	
79	9.7	9.0	8.2	7.5	6.8	6.0	5.3	4.6	3.9	3.3	2.6	1.9	1.3	0.6	0.0	0.6	1.3	1.9	2.5	3.1	3.7	
78	9.1	8.3	7.6	6.8	6.1	5.4	4.7	4.0	3.3	2.6	2.0	1.3	0.6	0.0	0.6	1.3	1.9	2.5	3.1	3.7	4.3	
77	8.5	7.7	6.9	6.2	5.5	4.8	4.1	3.4	2.7	2.0	1.3	0.7	0.0	0.6	1.3	1.9	2.5	3.1	3.8	4.3	4.9	
76	7.8	7.0	6.3	5.6	4.8	4.1	3.4	2.7	2.0	1.3	0.7	0.0	0.7	1.3	1.9	2.6	3.2	3.8	4.4	5.0	5.6	
75	7.1	6.4	5.6	4.9	4.2	3.4	2.7	2.0	1.4	0.7	0.0	0.7	1.3	2.0	2.6	3.2	3.8	4.5	5.1	5.7	6.3	
74	6.5	5.7	5.0	4.2	3.5	2.8	2.1	1.4	0.7	0.0	0.7	1.3	2.0	2.6	3.3	3.9	4.5	5.1	5.7	6.3	6.9	
73	5.8	5.0	4.3	3.5	2.8	2.1	1.4	0.7	0.0	0.7	1.4	2.0	2.7	3.3	3.9	4.6	5.2	5.8	6.4	7.0	7.6	
72	5.1	4.3	3.6	2.9	2.1	1.4	0.7	0.0	0.7	1.4	2.0	2.7	3.4	4.0	4.6	5.3	5.9	6.5	7.1	7.7	8.3	
71	4.4	3.6	2.9	2.2	1.4	0.7	0.0	0.7	1.4	2.1	2.7	3.4	4.1	4.7	5.3	6.0	6.6	7.2	7.8	8.4	9.0	
70	3.7	2.9	2.2	1.4	0.7	0.0	0.7	1.4	2.1	2.8	3.4	4.1	4.8	5.4	6.0	6.7	7.3	7.9	8.5	9.1	9.7	
69	3.0	2.2	1.5	0.7	0.0	0.7	1.4	2.1	2.8	3.5	4.2	4.8	5.5	6.1	6.8	7.4	8.0	8.6	9.2	9.8	10.4	
68	2.3	1.5	0.7	0.0	0.7	1.4	2.2	2.9	3.5	4.2	4.9	5.6	6.2	6.8	7.5	8.1	8.7	9.3	9.9	10.5	11.1	
67	1.5	0.8	0.0	0.7	1.5	2.2	2.9	3.6	4.3	5.0	5.6	6.3	6.9	7.6	8.2	8.8	9.5	10.1	10.7	11.3	11.8	
66	0.8	0.0	0.8	1.5	2.2	2.9	3.6	4.3	5.0	5.7	6.4	7.0	7.7	8.3	9.0	9.6	10.2	10.8	11.4	12.0	12.6	
65	0.0	0.8	1.5	2.3	3.0	3.7	4.4	5.1	5.8	6.5	7.1	7.8	8.5	9.1	9.7	10.3	11.0	11.6	12.2	12.8	13.3	
	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	Z_0

Decibel Return Loss

ERL expressed as decibels?

Remember that when working in decibels, the “log” function returns an “indeterminate” result for zero. Therefore, where the impedances match, the “ERL” is a “big number”. Faults need repair when return loss is **less** than about 40 dB or so (you company’s threshold may differ). Adding event losses in decibels is tricky; better to use percentages.

Z _L	Reflection co-efficient expressed as dB (E)RL																					
	85	84	83	82	81	80	79	78	77	76	75	74	73	72	71	70	69	68	67	66	65	
85	17.5	18.0	18.5	19.1	19.7	20.3	20.9	21.6	22.4	23.2	24.1	25.1	26.1	27.3	28.7	30.4	32.4	34.9	38.5	44.6		
84	17.9	18.4	19.0	19.6	20.2	20.8	21.5	22.3	23.1	24.0	24.9	26.0	27.2	28.6	30.3	32.3	34.8	38.4	44.5		44.6	
83	18.3	18.9	19.4	20.1	20.7	21.4	22.2	23.0	23.9	24.8	25.9	27.1	28.5	30.2	32.1	34.7	38.3	44.3		44.5	38.5	
82	18.7	19.3	19.9	20.6	21.3	22.1	22.9	23.8	24.7	25.8	27.0	28.4	30.0	32.0	34.6	38.2	44.2		44.3	38.4	34.9	
81	19.2	19.8	20.5	21.2	21.9	22.8	23.6	24.6	25.7	26.9	28.3	29.9	31.9	34.5	38.1	44.1		44.2	38.3	34.8	32.4	
80	19.7	20.4	21.1	21.8	22.6	23.5	24.5	25.6	26.8	28.2	29.8	31.8	34.4	38.0	44.0		44.1	38.2	34.7	32.3	30.4	
79	20.2	20.9	21.7	22.5	23.4	24.4	25.5	26.7	28.1	29.7	31.7	34.3	37.8	43.9		44.0	38.1	34.6	32.1	30.3	28.7	
78	20.8	21.6	22.4	23.3	24.3	25.3	26.6	28.0	29.6	31.6	34.2	37.7	43.8		43.9	38.0	34.5	32.0	30.2	28.6	27.3	
77	21.5	22.3	23.2	24.1	25.2	26.4	27.8	29.5	31.5	34.0	37.6	43.7		43.8	37.8	34.4	31.9	30.0	28.5	27.2	26.1	
76	22.2	23.0	24.0	25.1	26.3	27.7	29.4	31.4	33.9	37.5	43.6		43.7	37.7	34.3	31.8	29.9	28.4	27.1	26.0	25.1	
75	22.9	23.9	25.0	26.2	27.6	29.2	31.2	33.8	37.4	43.5		43.6	37.6	34.2	31.7	29.8	28.3	27.0	25.9	24.9	24.1	
74	23.8	24.9	26.1	27.5	29.1	31.1	33.7	37.3	43.3		43.5	37.5	34.0	31.6	29.7	28.2	26.9	25.8	24.8	24.0	23.2	
73	24.7	26.0	27.4	29.0	31.0	33.6	37.1	43.2		43.3	37.4	33.9	31.5	29.6	28.1	26.8	25.7	24.7	23.9	23.1	22.4	
72	25.8	27.2	28.9	30.9	33.4	37.0	43.1		43.2	37.3	33.8	31.4	29.5	28.0	26.7	25.6	24.6	23.8	23.0	22.3	21.6	
71	27.1	28.8	30.8	33.3	36.9	43.0		43.1	37.1	33.7	31.2	29.4	27.8	26.6	25.5	24.5	23.6	22.9	22.2	21.5	20.9	
70	28.6	30.6	33.2	36.8	42.9		43.0	37.0	33.6	31.1	29.2	27.7	26.4	25.3	24.4	23.5	22.8	22.1	21.4	20.8	20.3	
69	30.5	33.1	36.7	42.7		42.9	36.9	33.4	31.0	29.1	27.6	26.3	25.2	24.3	23.4	22.6	21.9	21.3	20.7	20.2	19.7	
68	32.9	36.5	42.6		42.7	36.8	33.3	30.9	29.0	27.5	26.2	25.1	24.1	23.3	22.5	21.8	21.2	20.6	20.1	19.6	19.1	
67	36.4	42.5		42.6	36.7	33.2	30.8	28.9	27.4	26.1	25.0	24.0	23.2	22.4	21.7	21.1	20.5	19.9	19.4	19.0	18.5	
66	42.3		42.5	36.5	33.1	30.6	28.8	27.2	26.0	24.9	23.9	23.0	22.3	21.6	20.9	20.4	19.8	19.3	18.9	18.4	18.0	
65		42.3	36.4	32.9	30.5	28.6	27.1	25.8	24.7	23.8	22.9	22.2	21.5	20.8	20.2	19.7	19.2	18.7	18.3	17.9	17.5	
	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	Z ₀

TV220EX Case Latches

TV220EX Case Latches

These look fiddly?

TV220EX is supplied in a tough and weathertight case. This is kept closed with two secure “interlocked” latches. That require the correct technique to open easily.



Pull down on the locking part whilst simultaneously lifting the bottom lever of the mechanism. This will lift the latch away from the lid and this can then be flipped out of the way.

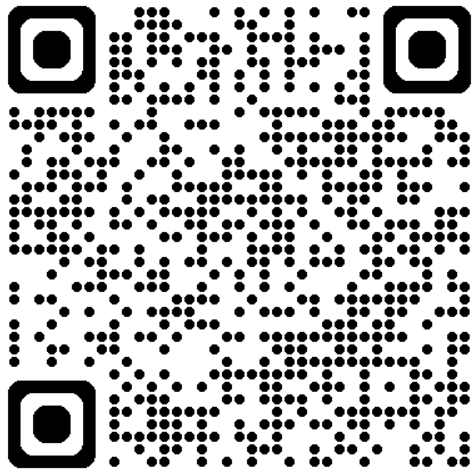
Occasionally, the locking part can become engaged whilst the latch is open, just pull it down and unlock it again to allow re-locking.

To re-lock: Engage the top latch with the notch on the lid and snap down the bottom lever.

Note that TV220EX is NOT WATERPROOF WHEN OPEN. It can withstand a little splashing (light rain for a minute or two or drizzle) on the screen and keyboard but like most electronics (or CATV network) does not appreciate a lot of water. If it does get visibly wet, please wipe it dry before closing the lid and trapping moisture inside. Ideally, leave it open to “air” and fully dry when back in an indoor environment.

Questions & Contact Details

CableScout™ TV220E & TV220EX **The TDR for Digital Cable Broadband**



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