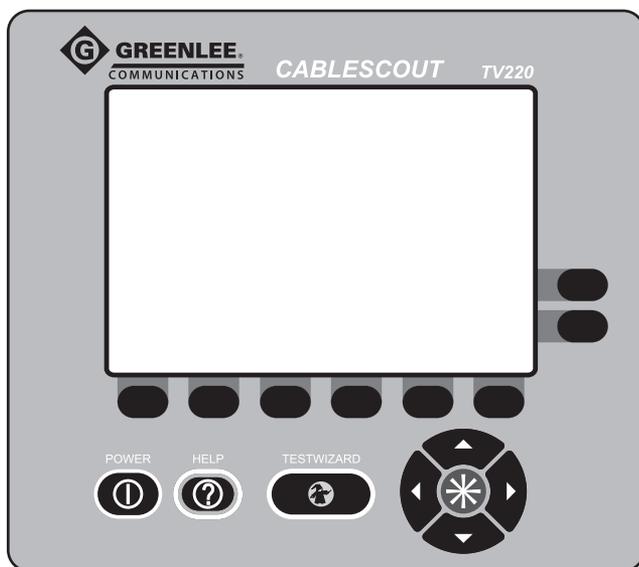


# INSTRUCTION MANUAL



## **TV220 CableScout™ Metallic Time-Domain Reflectometer for Cable TV**



**Read and understand** all of the instructions and safety information in this manual before operating or servicing this tool.

**Register this product at [www.greenlee.com](http://www.greenlee.com)**



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## Preface

### Description

The Greenlee Communications TV220 CableScout™ Time-Domain Reflectometer (TDR) is specifically intended for technicians and troubleshooting experts in the outside-plant cable TV and other coaxial-cable test environments. This tool's uses include: fault identification, fault location, cable installation, and cable maintenance. The TV220 is easy to use, very accurate, and characterizes coaxial cable up to 3.7 km (12,000 ft) in length.

### Safety

Safety is essential in the use and maintenance of Greenlee tools and equipment. This manual and any markings on the tool provide information for avoiding hazards and unsafe practices related to the use of this tool. Observe all of the safety information provided.

### Purpose of this Manual

This manual is intended to familiarize all personnel with the safe operation and maintenance procedures for the TV220 CableScout Time-Domain Reflectometer.

Keep this manual available to all personnel. Replacement manuals are available upon request at no charge.

### Warranty

Greenlee Textron Inc. warrants to the original purchaser of these goods for use that these products will be free from defects in workmanship and material for one year. This warranty is subject to the same terms and conditions contained in Greenlee Textron Inc.'s standard one-year limited warranty.

For all Test Instrument repairs, contact Customer Service at 800-642-2155 or 760-598-8900 and request a Return Authorization.

For items not covered under warranty (such as items dropped, abused, etc.), a repair cost quote is available upon request.

*Note: Prior to returning any test instrument, please check replaceable batteries or make sure the battery is at full charge.*

All specifications are nominal and may change as design improvements occur. Greenlee Textron Inc. shall not be liable for damages resulting from misapplication or misuse of its products.

CableScout and TestWizard are trademarks of Greenlee Textron Inc.



**Do not discard this product or throw away!**

For recycling information, go to [www.greenlee.com](http://www.greenlee.com).

***KEEP THIS MANUAL***

# Important Safety Information



## SAFETY ALERT SYMBOL

This symbol is used to call your attention to hazards or unsafe practices which could result in an injury or property damage. The signal word, defined below, indicates the severity of the hazard. The message after the signal word provides information for preventing or avoiding the hazard.

### **DANGER**

Immediate hazards which, if not avoided, **WILL** result in severe injury or death.

### **WARNING**

Hazards which, if not avoided, **COULD** result in severe injury or death.

### **CAUTION**

Hazards or unsafe practices which, if not avoided, **MAY** result in injury or property damage.



### **WARNING**

**Read and understand** this material before operating or servicing this equipment. Failure to understand how to safely operate this tool could result in an accident causing serious injury or death.



### **WARNING**

Electric shock hazard:  
Contact with live circuits could result in severe injury or death.

### **WARNING**

Fire hazard:  
Do not operate this tool in an explosive atmosphere.  
Failure to observe this warning could result in severe injury or death.

---

## Important Safety Information

### CAUTION

Electric shock hazard:

- Do not expose the battery to fire or intense heat. Do not incinerate the battery.
- Do not open or mutilate the battery.
- Do not charge the battery in a gas-tight container.
- Do not short the battery terminals.
- Avoid contact with released electrolyte, which is corrosive and may damage eyes, skin, and clothing. Flush with water at once if contact is made with electrolyte (acid).
- Disconnect battery when stored for long periods of time.

Failure to observe these precautions may result in injury and may damage the unit.

### CAUTION

Electric shock hazard:

- Use only the power/charger adapter that is specified for the TV220.
- The power/charger adapter is not hermetically sealed. Do not expose it to moisture.
- Do not remove covers or panels except to access the battery. Do not operate the instrument without covers and panels in place.

Failure to observe these precautions may result in injury and may damage the unit.

**Battery:** The TV220 is powered by a rechargeable, 10.8 V, 2.4 Ah, lithium-ion battery. Only the entire battery is replaceable. Individual cells are not replaceable. The battery must be recycled. Dispose of depleted batteries in accordance with Local, State, and Federal Laws.

**Fuse:** The fuse is not user replaceable.

**Electromagnetic Emissions:** The TV220 has been verified for compliance to FCC Class A and European Union EMC.

## Symbols on the Unit



Warning—Read the instruction manual



Danger—high voltage



Protective ground (earth terminal)

---

# How to Use This Manual

*Note: The procedures in this manual apply to all instrument options.*

## **Chapter 1. TestWizard.**

Instructions on using TestWizard, the quickest and easiest way to test a cable.

## **Chapter 2. Front Panel Controls.**

Locations and descriptions of buttons, softkeys, and connectors.

## **Chapter 3. Setting Up the Instrument.**

Detailed instructions on how to set up the instrument to test a cable, and information about the different types of tests the TV220 can perform.

## **Chapter 4. Testing a Cable.**

Detailed instructions on the three ways of testing a cable, including TestWizard (quickest and easiest way to test a cable), Auto TDR (most settings are controlled automatically by the TV220), and Manual TDR (for the expert user who wants full control over instrument settings).

## **Chapter 5. Save/Load.**

Detailed instructions on saving and loading data, and transferring data to or from a PC.

## **Chapter 6. Maintenance.**

Information on maintenance, inspection, and cleaning of the TV220.

## **Appendix A. Specifications, Options, and Accessories.**

## **Appendix B. Glossary.**

In this manual, the word *waveform* refers to the image of a test cable displayed on the LCD.

Because of different instrument configurations and operating setups, the example screens printed in this manual may not be identical to screens displayed by your instrument.



**TestWizard**



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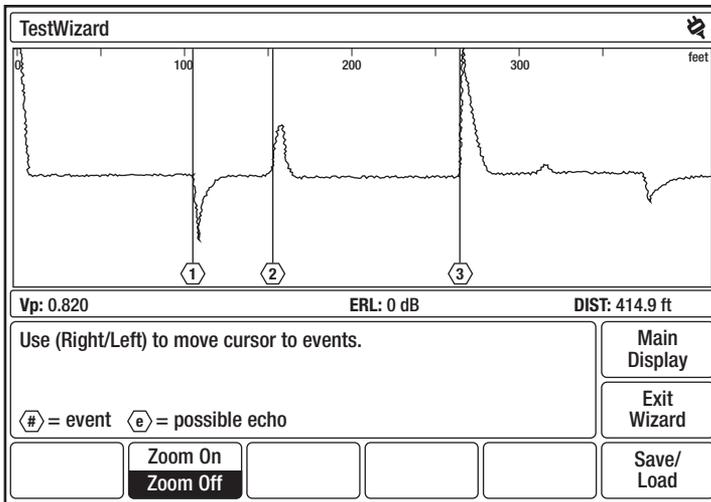
## Chapter 1. TestWizard

TestWizard is the quickest and easiest way to test a cable. You press one button, and the TV220 asks you some simple questions and then automatically tests the cable and displays a waveform with events marked.

Access TestWizard from any display in the instrument by simply pressing **TESTWIZARD** on the front panel. To use the TestWizard option, follow these steps:

1. Press **TESTWIZARD** to display the **TestWizard – Choose Cable Type (User List)** menu. Use **▲▼** to select your cable type from this list. If your exact cable type is not on this list, select one that is the most similar to your cable type, or press **Exit Wizard** and go to the **Setup** menu to add the proper cable type or to create a custom cable type. (Refer to “Choosing the Cable Type” in Chapter 3.)
2. Press **Next** to display the **TestWizard – Choose Cable Span** menu. Use **▲▼** to select cable length. To be sure that the TV220 locates the event, pick the smallest span that is greater than the length of cable you are testing.
3. Press **Next** to display the **TestWizard – Choose Event Type** menu. Use **▲▼** to select the appropriate level of analysis, as follows:
  - If the system you are testing is not working at all, select **FIND LARGEST EVENT**.
  - If the system is working poorly and you want to find the most significant problem areas, select **FIND 3 LARGEST EVENTS**.
  - If you want to confirm that the cable and all passive devices are within specifications, and you want to find everything on the system that could possibly affect it, select **FIND ALL EVENTS**.

4. Press **Next** to display the **TestWizard Measurement** display (Figure 1-1).  
(This may take 10 to 30 seconds.)



**Figure 1-1: TestWizard Measurement Display**

This display shows a waveform with the events of the selected type marked and numbered.

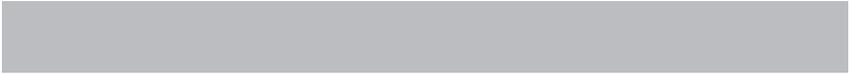
Use the **Zoom On/Zoom Off** softkey to magnify sections of the waveform for closer viewing

- **Zoom On** expands the waveform around the cursor. When zoom is on, moving the cursor to a different event causes that event to be redrawn so that it fits in the display without being clipped. (The event may be magnified or reduced to fit properly in the display.)
- **Zoom Off** returns the waveform to normal view.

Press **Exit Wizard** from any menu or display to exit TestWizard and return to the menu or display you were in when the **TESTWIZARD** button was pressed.

For more information on TestWizard and for detailed instructions on setting up the TV220 to test a cable in Auto TDR and Manual TDR, refer to Chapters 2–4.

To save or load the waveform from your test cable, refer to Chapter 5 for detailed instructions.



## **Front Panel Controls**



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## Chapter 2. Front Panel Controls

### Controls, Indicators, and Connectors

The TV220 controls are described briefly in this chapter. More detailed information is available in the descriptions of each measurement and function.

The TV220 maintains consistency in all operating modes. If a control is not available in a particular mode of operation, the softkey is blank. If a control is available in a particular mode of operation but is disabled at a particular point in the testing procedure, the softkey text is gray. If you attempt to use that softkey, a beep sounds.

### Display/Indicators

The display is a 640x480-pixel liquid-crystal display (LCD). The display conveys three distinct kinds of information to the operator at all times: operating mode (current status), softkey labels, and data or information for the current operating mode.

The name of the current menu or display of the instrument appears on the top status line of the display, above the window. This window includes data, menu choices, or a test waveform, depending upon what selections you have made. Any additional messages to the operator appear in the dialog text box, which is the smaller framed window in the lower portion of the LCD (Figure 2-3).

A five-level battery-status indicator, located in the upper right corner of all displays, shows the battery-charge level. A low-battery/power-off message is displayed when the battery level is too low to continue operation of the instrument; the user should then use the AC charger or the DC adapter. When the battery is in the recharge now condition, it is recommended that the user connects the AC adapter/charger or the DC adapter charger cable to the instrument to recharge the battery. The TV220 can continue to be used while the battery is being charged.

	Full charge
	3/4 charge
	1/2 charge
	1/4 charge
	Recharge now
	Battery being charged
	AC/DC adapter/charger in use

## Controls

All operator controls are pushbuttons.

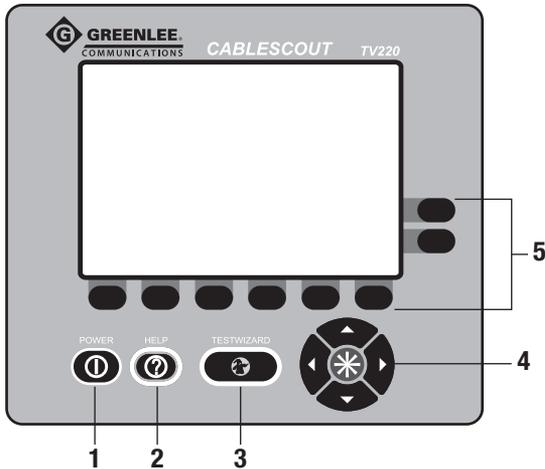


Figure 2-1: TV220 Front Panel Controls

1. **POWER Button:** This button turns the TV220 on and off.
2. **HELP Button:** Press **HELP** to display detailed information on the current display and the operation of the controls. The help displays are context-sensitive popup windows that overlay the current display when you press the **HELP** button. You can access detailed information for all menus, displays, and functions of the instrument by pressing **HELP**. Press **HELP** a second time to remove the help display.

In selected menus, Lesson softkeys are available that provide tutorials about using the TV220, Auto TDR, Manual TDR, cable selection, saving, and transferring data.

3. **TESTWIZARD Button:** TestWizard is one of three ways to test a cable. TestWizard is a quick and easy way to run a test. Press **TESTWIZARD** to start a test at any time, no matter what menu you are in.
4. **Scroll Controls:** The arrow buttons serve the functions of moving the cursor left and right across the displayed waveform or changing values (◀▶), scrolling through a menu or changing values (▲▼), and scrolling pages (\* + ▲▼).
5. **Softkeys:** There are six softkeys across the bottom of the LCD and two on the right side. These are called softkeys because their labels are displayed on the LCD. Their functions vary according to the instrument function. Softkeys are used to 1) change functions or modes, 2) select a menu item, and 3) turn functions on and off.

Softkey explanations are found within each description of the display types in this manual, or by pressing **HELP** and then the softkey.

## Connectors

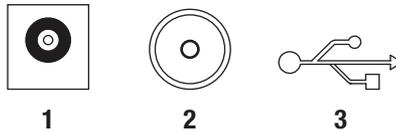


Figure 2-2: Connectors

1. **AC Adapter/Charger:** This connector is for the battery charger/adaptor.
2. **75  $\Omega$ :** This connector is a 75  $\Omega$ , F-type for connecting to the cable under test.
3. **Type B USB Port:** Use this connector to connect the TV220 to a computer to download test data.

## Power-Up Settings

When you press **POWER** to turn on the instrument, the TV220 shows the **Main Display**. The instrument powers up with the same settings in place as when it was powered off.

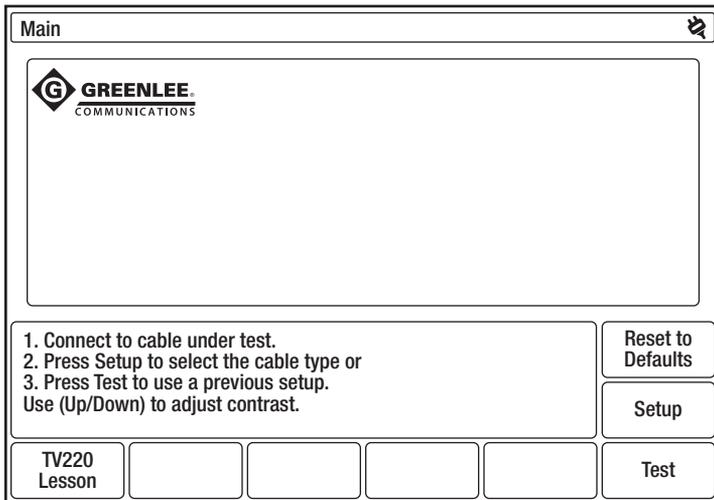
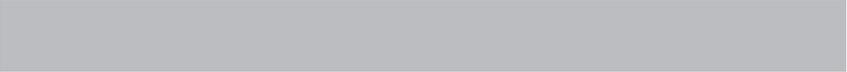


Figure 2-3: Main Display





# Setting Up the Instrument

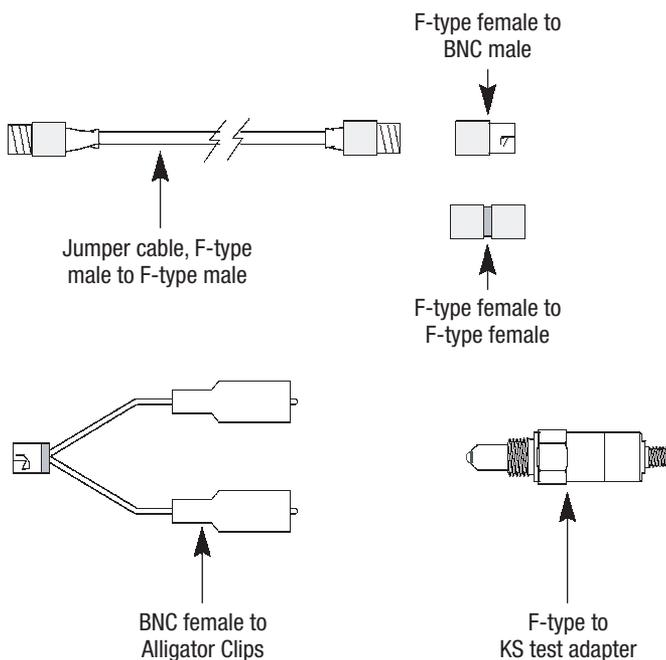


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## Chapter 3. Setting Up the Instrument

### Connecting the Cable

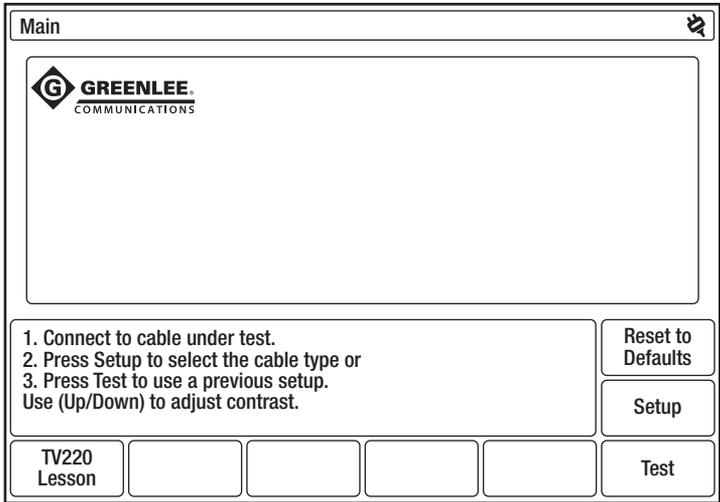
Select the appropriate connector adapter and/or jumper cable from the TV220 accessory package. The standard accessories supplied are shown below.



- To connect to an F-type female, use the male-to-male F-type jumper cable. Connect one end to the instrument and the other end to the cable under test.
- To connect to an F-type male, attach the jumper cable to the instrument and the F-type female-to-female adapter to the end of the jumper. Then attach the other end of that to the cable under test.
- To test loose wires, attach the jumper cable to the instrument, and then the F-type female to BNC-male adapter to the free end of the jumper. Next, attach the BNC-female-to-alligator to that adapter, and then the alligator clips to the cable under test. This type of connection causes an impedance mismatch and reduces the measurement effectiveness.
- The F-type to KS test adapter makes it easy and efficient to test cable at taps or amplifiers using the threaded port where the seizure screw is located (KS port). This adapter provides the best connection and matches impedance for the most effective instrument performance. If you are connecting to a KS port, use this adapter. Attach the KS end to the tap or amplifier, and then attach the F-type end to one end of your test lead. Attach the other end of the test lead to the instrument.

## Setup Menu

Press the **POWER** button to turn on the instrument and reach the **Main Display** (Figure 3-1).



**Figure 3-1: Main Display**

From the Main Display, you can:

- Press **TV220 Lesson** for a tutorial about using the TV220.
- Press **Reset to Defaults** to restore factory defaults if instrument settings have been changed and you want to reset them.
- Connect your cable and press **Test** to display the waveform for your test cable if you do not need to change settings.
- Press **Setup** to display the **Setup – Choose Cable Type (User List)** menu (Figure 3-2) if you need to change settings. The Setup menu is the gateway to all setups for the TV220.

Setup – Choose Cable Type (User List)		
Cable Name	Loss(dB)/100m @ 500 MHz	Vp
< Current Settings >	15.48	0.820
Belden RG-6/U	15.48	0.820
Comm/Scope (QR) 540 Series	4.89	0.880
Comm/Scope (QR) 715 Series	3.90	0.880
Comm/Scope 6 Series	15.09	0.850
Times Fiber T10 6 Series	14.50	0.850
Times Fiber T10 500 Series	5.68	0.870
Times Fiber T10 750 Series	3.87	0.870
Trilogy MC2 (.500)	4.86	0.930
Trilogy MC2 (.750)	3.38	0.930

Use (Up/Down) to select cable type.

Use (Up/Down) to select cable type.					Main Display
					Return to Test
Test Type		Add Cable	Remove Cable	Cable Lesson	More Settings

Figure 3-2: Setup – Choose Cable Type (User List)

A **Cable Lesson** softkey is available from this menu. Press this softkey for detailed instructions on adding and creating cable types.

### Choosing the Cable Type

The most important step in operating the TV220 is to select the correct cable type. The cable type defines the velocity of propagation (Vp) and cable-loss values for the test cable. Press ▲▼ to select a cable type from the User List.

If your cable type is not listed on the User List, press **Add Cable** to display the **Setup – Add Cable Type from Factory List** menu (Figure 3-3).

Setup – Add Cable Type from Factory List		
Cable Name	Loss(dB)/100m @ 500 MHz	Vp
Times Fiber T10 412 Series	7.05	0.870
Times Fiber T10 500 Series	5.68	0.870
Times Fiber T10 625 Series	4.69	0.870
Times Fiber T10 750 Series	3.87	0.870
Times Fiber T10 875 Series	3.38	0.870
Times Fiber T10 1000 Series	3.15	0.870
Times Fiber T10 59 Series	17.80	0.850
Times Fiber T10 6 Series	14.50	0.850
Times Fiber T10 611 Series	11.80	0.850
Times Fiber T10 11 Series	9.35	0.850

Use (Up/Down) to select cable type.		Main Display
		Return to Test
Copy to User List	Create Custom Cable	Previous Menu

**Figure 3-3: Setup – Add Cable Type from Factory List**

The Factory List is a comprehensive list of cable types from major cable manufacturers. You can select a factory cable type from this list and copy it to the User List.

1. Press ▲▼ to highlight the factory cable type.
2. Press **Copy to User List** to copy the selected cable type to the User List.

### Creating a Custom Cable Type

If the exact cable type you want is not on the Factory List, press ▲▼ to select one that is most similar to it, and then press **Create Custom Cable** to display the **Setup – Create Custom Cable Type for User List** menu (Figure 3-4).

Cable Name	Loss(dB)/100m @ 500 MHz	Vp
< Current Settings >	15.48	0.820

Use (Up/Down) to select cable to edit.  
Press \* to create new cable.

Main Display

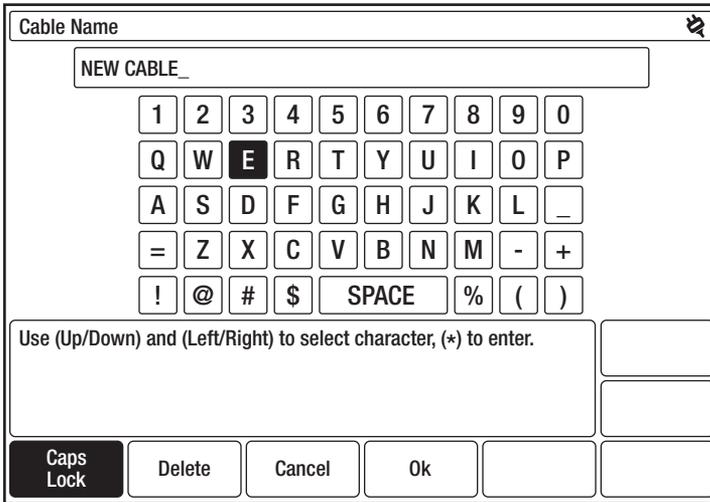
Return to Test

Copy to User List   Cable Name   Loss   Vp   Delete Cable   Done

Figure 3-4: Setup – Create Custom Cable Type for User List

From this menu, you can create a custom cable type using the selected cable type from the Factory List as an example.

1. The <Copy of Selected Cable> line is highlighted with the loss and Vp values copied from the selected factory cable type. To name your new cable type, use ▲▼ to highlight an <Empty> entry.
2. Press **Cable Name** to display the **Setup – Create Custom Cable Type for User List – Cable Name** display (Figure 3-5).



**Figure 3-5: Setup – Create Custom Cable Type for User List – Cable Name**

3. Use ◀▶ and ▲▼ to move through the characters to the letter or number you want.
4. Press \* to add highlighted characters to your cable name.
5. When finished, press **OK** to return to the previous display, which shows the new text on the highlighted line (Figure 3-6).

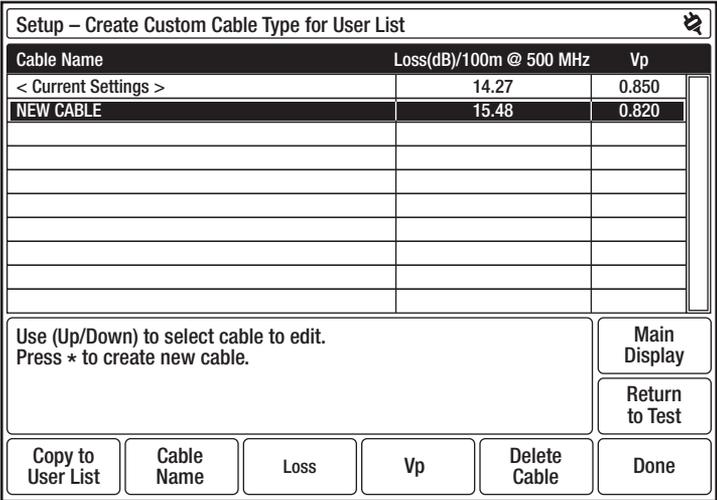


Figure 3-6: Setup – Create Custom Cable Type for User List

- 6. From here, you can set the loss and Vp for your custom cable type. You can then add this custom cable type to the User List by pressing **Copy to User List**.
- 7. Press **Done** to return to the **Setup – Choose Cable Type (User List)** menu, where your completed cable type appears on the User List (Figure 3-7).

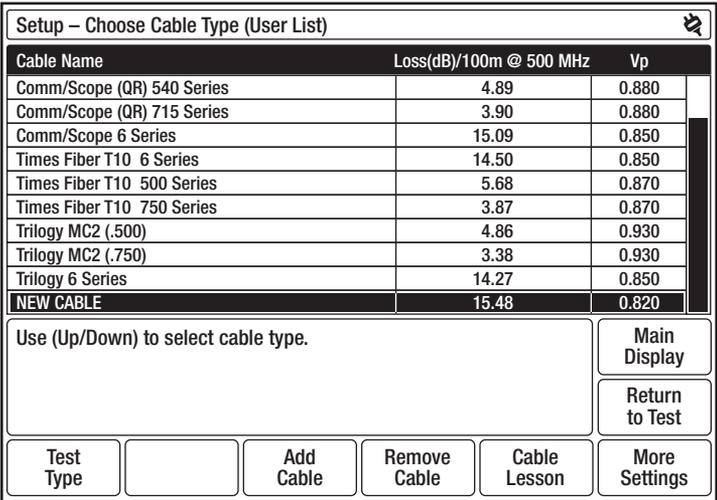


Figure 3-7: Setup – Choose Cable Type (User List)

## More Settings

From the **Setup – Choose Cable Type (User List)** menu, press **More Settings** to display the **Setup – More Settings** menu (Figure 3-8).

Setup – More Settings	
Item Name	Setting
Distance Units	METERS
Velocity of Propagation Units	0.XXX
Language	ENGLISH
Display Contrast (0-100%)	50
<b>Backlight Level (0-100%)</b>	<b>30</b>
Backlight Auto Shutoff Time	5 Minutes
TV220 Auto Shutoff Time	15 Minutes
High-Pass Filter in Auto TDR	Automatic
Smoothing	3
Power-On Test Type	TEST

Use (Up/Down) to select item, (Right/Left) to change setting.					Main Display
					Return to Test
Reset to U.S.	Reset to Metric	Reset to Defaults		Set Time/Date	Previous Menu

**Figure 3-8: Setup – More Settings**

From the **Setup – More Settings** menu, you can change the following:

- Distance units – choose metric or English distance units for all distance measurements.
- Velocity of propagation units – choose metric or English units for the Vp setting. (Refer to Appendix B for a definition of Vp.)
- Language – choose the language option for the instrument's menus, waveform displays, and online help.
- Display contrast – set the display contrast.
- Backlight level – adjust the backlight for operation between 0 and 100%.
- Backlight auto shutoff time – set the time the instrument is idle before the backlight automatically turns off.
- TV220 auto shutoff time – set the time the instrument is idle before it automatically powers off.
- High-pass filter in Auto TDR – choose the high-pass filter setting. The high-pass filter reduces noise for a cleaner waveform and is used when the gain is at a high setting.

- Smoothing – choose the smoothing setting. Smoothing reduces waveform noise by averaging test results over time.
- Power-on Test type – choose the test type that is selected when the TV220 is turned on. (Refer to “Test Types” in this chapter.)
- Auto event locator threshold – choose the severity of the events that are located and marked when the Auto Event Locator is on.
- Return loss (RL) – choose the type of return-loss measurement. (Refer to “Return Loss and Event Return Loss” in Chapter 4 for an explanation of return-loss measurements.)

Use ▲▼ to move through the various selections. Use ◀▶ to select specific settings.

Press **Reset to U.S.** to reset the current settings to standard U.S. defaults. When **Reset to U.S.** is selected, Distance Units is set to Feet and Vp Units is set to 0.xxx.

Press **Reset to Metric** to reset the current settings to standard metric defaults. When **Reset to Metric** is selected, Distance Units is set to Meters and Vp Units is set to m/μs.

Distance and velocity-of-propagation units are the only selections that are affected by the **Reset to U.S.** and **Reset to Metric** softkeys.

Press **Reset to Defaults** to reset the current settings to the factory defaults. The last eight selections on the **Setup – More Settings** menu are affected by pressing this softkey.

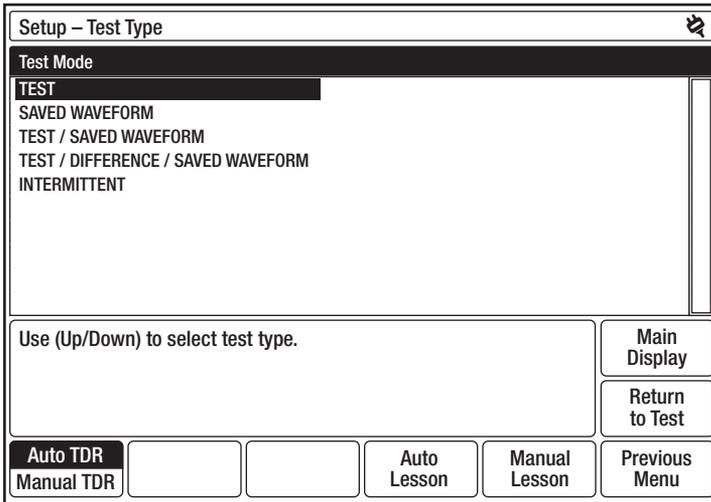
Language is not affected by pressing any of the **Reset** softkeys, and the instrument always powers up in the language set in this menu.

Press **Previous Menu** to return to the **Setup – Choose Cable Type (User List)** menu when finished making your selections.

Press **Set Time/Date** to set the time and date that will be saved within the TV220 and data files. Scroll through the fields using ◀▶ and ▲▼ to set as desired. Press **OK** to complete.

## Test Types

From the **Setup – Choose Cable Type (User List)** menu, press **Test Type** to display the **Setup – Test Type** menu (Figure 3-9).



**Figure 3-9: Setup – Test Type**

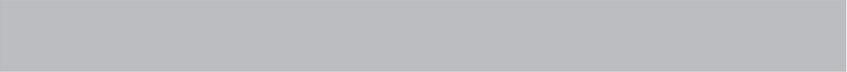
This menu shows the five types of tests that the TV220 can perform:

- **TEST**, the most common type of test, displays a waveform for the current cable test. Use this test to characterize, document, and troubleshoot cables.
- **SAVED WAVEFORM** displays a saved waveform.
- **TEST/SAVED WAVEFORM** displays the current cable test waveform and a saved waveform. Use this test to compare current data to historical data.
- **TEST/DIFFERENCE/SAVED WAVEFORM** displays the current cable test waveform, a saved waveform, and a waveform that shows the difference between the test and saved waveforms. This is another test that lets you compare current data to historical data.
- **INTERMITTENT TEST** displays the current waveform, plus minimum and maximum waveforms. The minimum and maximum waveforms consist of the minimum and maximum values for each data point on the current waveform. The minimum and maximum waveforms may be redrawn as new minimum and maximum data points are acquired on the current waveform. Use this test to detect cable problems that occur only once in a while, or periodically.

Use **▲▼** to select the test type.

When you are finished making your selection, press **Return to Test** to display the waveform for the test you selected.

For more detailed explanations and illustrations of the different test types and for information on Auto and Manual TDR, refer to Chapter 4.



## Testing a Cable



## Chapter 4. Testing a Cable

You can choose from three ways to test a cable: TestWizard, Auto TDR, and Manual TDR. TestWizard is the quickest and easiest method. In Auto TDR, most settings are controlled automatically by the instrument. Manual TDR is for the expert user, and all settings are controlled by the user.

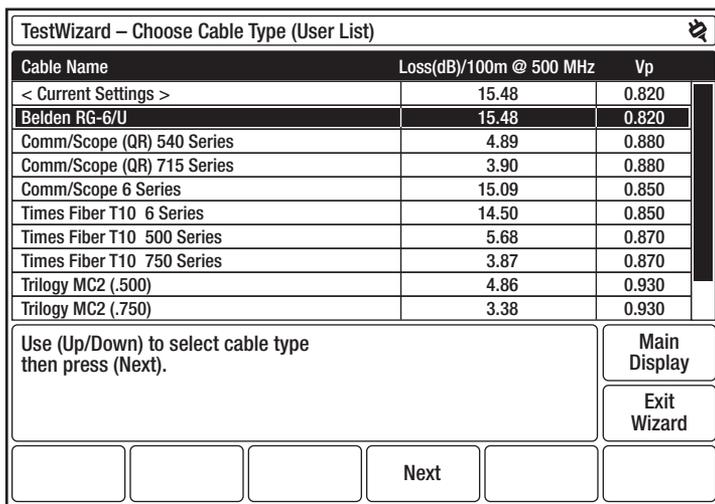
For detailed instructions on saving and transferring waveforms to a computer for any test type, refer to Chapter 5.

### TestWizard

TestWizard is the quickest and easiest way to test a cable. Settings are automatically selected and adjusted during the test to provide the best test data. Use TestWizard for most applications, especially if you are unfamiliar with TDR. TestWizard automatically marks the locations of cable events.

Press **TESTWIZARD**, and TestWizard guides you through three simple steps and then automatically tests the cable. The first step is to select your cable type; the second step is to select the cable length; and the final step is to select the appropriate level of analysis.

1. Press the **TESTWIZARD** button to display the TestWizard – Choose Cable Type (User List) menu (Figure 4-1).



Cable Name	Loss(dB)/100m @ 500 MHz	Vp
< Current Settings >	15.48	0.820
<b>Belden RG-6/U</b>	<b>15.48</b>	<b>0.820</b>
Comm/Scope (QR) 540 Series	4.89	0.880
Comm/Scope (QR) 715 Series	3.90	0.880
Comm/Scope 6 Series	15.09	0.850
Times Fiber T10 6 Series	14.50	0.850
Times Fiber T10 500 Series	5.68	0.870
Times Fiber T10 750 Series	3.87	0.870
Trilogy MC2 (.500)	4.86	0.930
Trilogy MC2 (.750)	3.38	0.930

Use (Up/Down) to select cable type then press (Next).

Main Display

Exit Wizard

Next

Figure 4-1: TestWizard – Choose Cable Type (User List)

2. Select your cable type from the User List using ▲▼. If your exact cable type is not on this list, select one that is the most similar to your cable type or press **Exit Wizard** and go to the **Setup** menu to add the proper cable type or to create a custom cable type. (Refer to “Choosing the Cable Type” in Chapter 3.)
3. After selecting your cable type, press **Next** to display the TestWizard – Choose Cable Span menu (Figure 4-2).

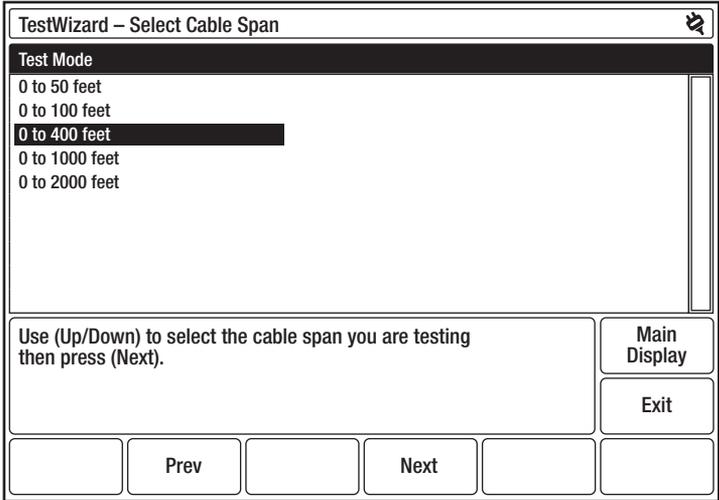


Figure 4-2: TestWizard – Choose Cable Span

4. Use ▲▼ to select the cable length. To be sure that the TV220 locates the event, pick the smallest span that is greater than the length of cable you are testing.
5. After selecting the cable span, press **Next** to display the **TestWizard – Choose Event Type** menu (Figure 4-3).

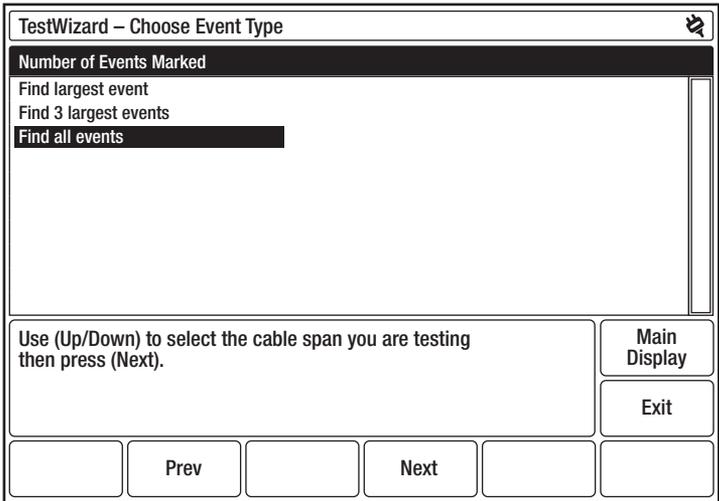
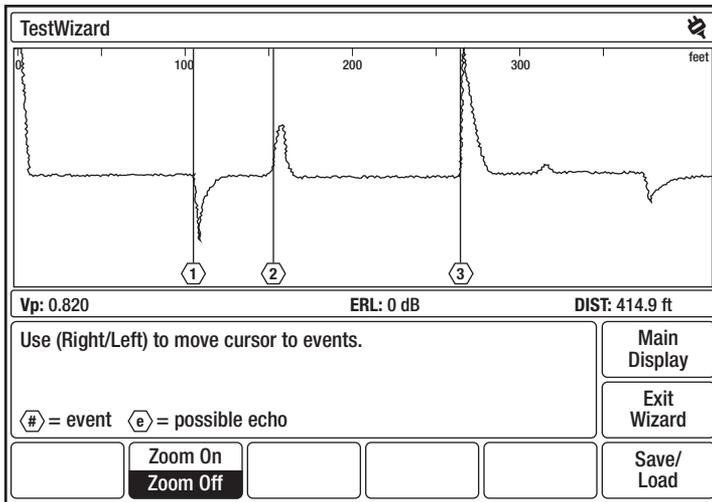


Figure 4-3: TestWizard – Choose Event Type

6. Use ▲▼ to select the appropriate level of analysis, as follows:
  - If the system you are testing is not working at all, select FIND LARGEST EVENT.
  - If the system is working poorly and you want to find the most significant problem areas, select FIND 3 LARGEST EVENTS.
  - If you want to confirm that the cable and all passive devices are within specifications, and you want to find everything on the system that could possibly affect it, select FIND ALL EVENTS.
7. After selecting the event type, press **Next** to display the TestWizard Measurement display (Figure 4-4).



**Figure 4-4: TestWizard Measurement Display**

This display shows a waveform with events of the selected type marked and numbered.

Use the **Zoom On/Zoom Off** softkey to magnify sections of the waveform for closer viewing.

- **Zoom On** expands the waveform around the cursor. When zoom is on, moving the cursor to a different event causes that event to be redrawn so that it fits in the display without being clipped. (The event may be magnified or reduced to fit properly in the display.)
- **Zoom Off** returns the waveform to normal view.

Press **Exit Wizard** from any menu or display to exit TestWizard and return to the menu or display you were in when the **TESTWIZARD** button was pressed.

## Auto TDR

In Auto TDR, most settings are controlled automatically by the instrument. Use Auto TDR when you want an automatic test with some user control of test settings. In Auto TDR, you can control gain setting and cable length during the test. If you want a fully automatic test, refer to Chapter 1.

1. To test a cable in Auto TDR, press **Setup** from the **Main Display** to display the **Setup – Choose Cable Type (User List)** menu (Figure 4-5).

Setup – Choose Cable Type (User List)		
Cable Name	Loss(dB)/100m @ 500 MHz	Vp
< Current Settings >	15.48	0.820
<b>Belden RG-6/U</b>	<b>15.48</b>	<b>0.820</b>
Comm/Scope (QR) 540 Series	4.89	0.880
Comm/Scope (QR) 715 Series	3.90	0.880
Comm/Scope 6 Series	15.09	0.850
Times Fiber T10 6 Series	14.50	0.850
Times Fiber T10 500 Series	5.68	0.870
Times Fiber T10 750 Series	3.87	0.870
Trilogy MC2 (.500)	4.86	0.930
Trilogy MC2 (.750)	3.38	0.930

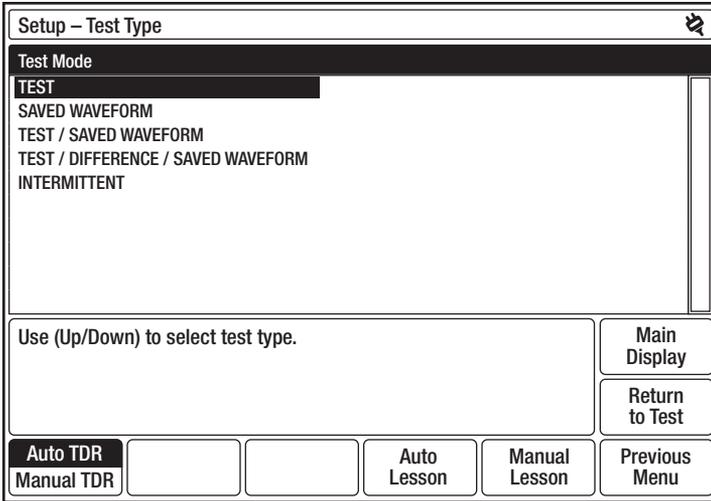
  

Use (Up/Down) to select cable type.		Main Display
		Return to Test
Test Type		Add Cable
		Remove Cable
		Cable Lesson
		More Settings

**Figure 4-5: Setup – Choose Cable Type (User List)**

2. From this menu, select your cable type, add the proper cable type, or create a custom cable type using a cable type from the Factory List as an example. Refer to “Choosing the Cable Type” in Chapter 3 for detailed instructions on adding and creating cable types.

3. Next, press **Test Type** to display the **Setup – Test Type** menu to select Auto TDR (Figure 4-6).



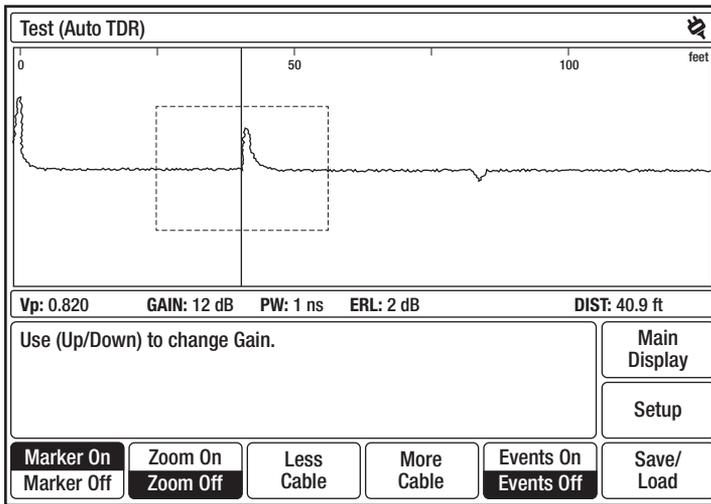
**Figure 4-6: Setup – Test Type**

4. The TV220 automatically selects Auto TDR at power-on, so you have to select Auto TDR only when the instrument is in Manual TDR.
- The **Auto TDR/Manual TDR** softkey toggles between Auto and Manual TDR, and the highlighted label is the current mode.
  - **Auto Lesson** and **Manual Lesson** softkeys are available from this menu. Press these softkeys for detailed instructions on Auto and Manual TDR.
5. Next, use ▲▼ to select the test type. The TV220 can perform five types of tests in Auto TDR:
- **TEST WAVEFORM**, the most common type of test, displays a waveform for the current cable test. Use this test to characterize, document, and troubleshoot cables.
  - **SAVED WAVEFORM** displays a saved waveform.
  - **TEST/SAVED WAVEFORM** displays the current cable test waveform and a saved waveform. Use this test to compare current data to historical data.
  - **TEST/DIFFERENCE/SAVED WAVEFORM** displays the current cable test waveform, a saved waveform, and a waveform that shows the difference between the test and saved waveforms. This is another test that lets you compare current data to historical data.

- **INTERMITTENT** displays the current waveform, plus minimum and maximum waveforms. The minimum and maximum waveforms consist of the minimum and maximum values for each data point on the current waveform. The minimum and maximum waveforms persist until a new test is started, and may be redrawn as new minimum and maximum data points are acquired on the current waveform. Use this test to detect cable problems that may occur only once in a while, or periodically.

To power up your instrument with a test type other than TEST, change the Power-on Test Type in the **Setup – More Settings** menu (Figure 3-8).

6. If you selected TEST, press **Return to Test** to view the waveform for your test cable. Figure 4-7 shows a waveform for a TEST in Auto TDR.

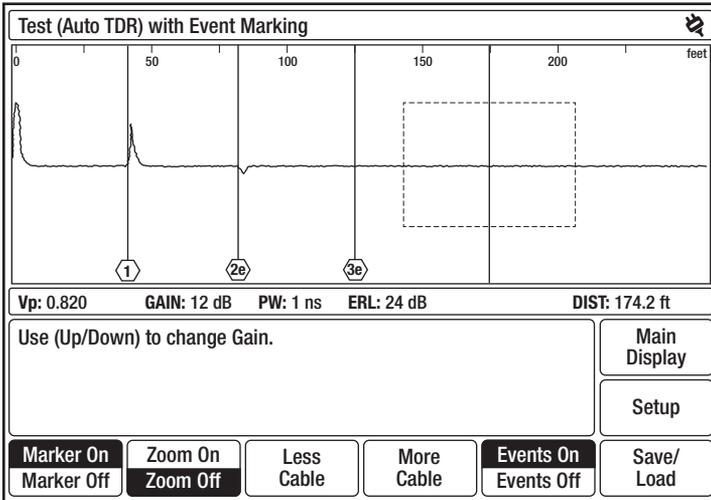


**Figure 4-7: Test (Auto TDR)**

Use ◀▶ to position the cursor on the left edge of the event. The distance to the event is displayed in the DIST box in the lower right corner of the display. In Auto TDR, the following softkeys are available:

- **Marker** sets and clears the event marker (◆). When set, the cursor readout shows both distance from zero (DIST) and distance from the marker (Δ). The marker is always set at the current cursor location.
- **Zoom On** expands the waveform around the cursor. **Zoom Off** returns the waveform to normal view. After pressing **Zoom On**, press **Less Cable** or **More Cable** to zoom further in or further out along the cable.
- **Less Cable** and **More Cable** decrease and increase the waveform distance view one range setting for each press of the softkey.

- **Events On/Off** turns the Auto Event Locator on and off. Auto Event Locator enables the TV220 to automatically detect and mark events. The Auto Event Locator Threshold determines the severity of the events that are located, marked, and displayed. To select the desired event threshold, go to the **Setup – More Settings** menu (Figure 3-8). **Events On** marks events with a vertical line and hexagonal event numbers. Events that are possible echoes are marked with an 'e' after the event number. Figure 4-8 illustrates a waveform with event marking.



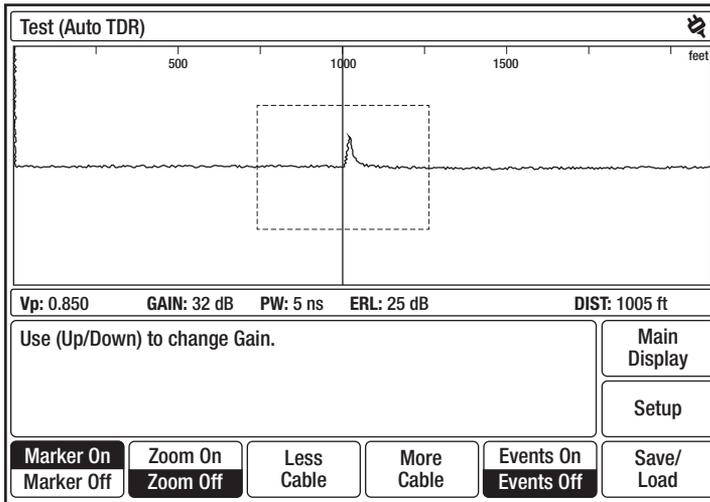
**Figure 4-8: Test Waveform (Auto TDR) with Event Marking**

The following functions are controlled automatically in Auto TDR:

- Vertical position of the waveform.
- High-pass filter – high-pass filter reduces the front-end bandwidth so the waveform noise is reduced for a cleaner waveform. High-pass filter is used primarily when the gain is at a high setting.
- Pulse width – pulse width changes based upon the span of the cable being tested.
- Noise filtering (smoothing) – smoothing is a method of reducing random noise by averaging test results over a period of time. Higher smoothing provides a cleaner waveform but slows down the response time of the instrument.

## Return Loss and Event Return Loss

The TV220 can measure Return Loss (RL) and Event Return Loss (ERL). Both RL and ERL measure the severity of an event. The difference between RL and ERL is that ERL measures the true severity of an event by subtracting the manufacturer's specified cable loss from the measurement. RL does not account for cable loss (Figure 4-9).



**Figure 4-9: Test (Auto TDR) with Event Marking**

In the above example, the RL for this event is 25 dB. ERL equals RL (25 dB) minus the cable loss. Note that a smaller return-loss value represents a bigger event.

To measure RL and ERL:

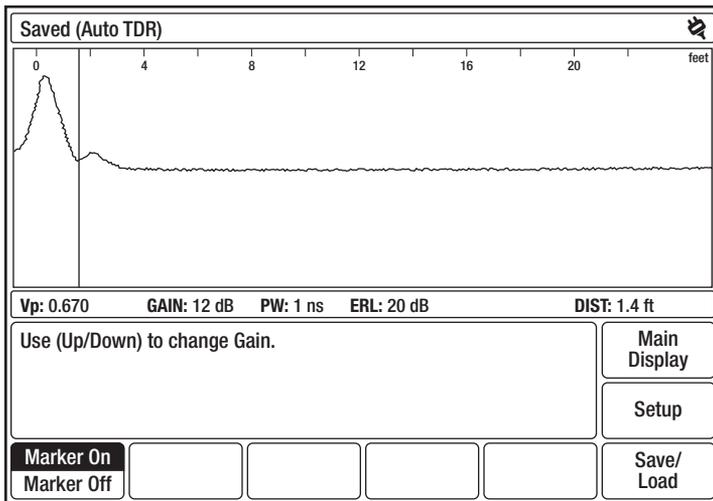
1. Select the type of return-loss measurement you want (or turn off return loss) in the **Setup – More Settings** menu (Figure 3-8).
2. Use ◀▶ to position the cursor on the left edge of the event. The TV220 looks in front of the cursor for the event closest to the cursor.
3. To calculate RL or ERL for a different event, use ◀▶ to move the cursor to the left of a different event. In order to get an accurate RL or ERL measurement, you need to be able to see the entire event on the display.
4. Use ▲▼ to lower the gain value until the entire event (from top to bottom) is displayed.

## Saved Waveform (Auto TDR)

To select a test type other than TEST, go to the **Setup – Test Type** menu (Figure 4-6). Use ▲▼ to select the test type.

To display a saved waveform, follow these steps:

1. From the **Setup – Test Type** menu, use ▲▼ to select **SAVED WAVEFORM**.
2. Press **Return to Test**.
3. Press **Save/Load** to display the list of saved waveforms in the **Save/Load** menu.
4. Use ▲▼ to select the waveform.
5. Press **Return to Test** to display the saved waveform (Figure 4-10).



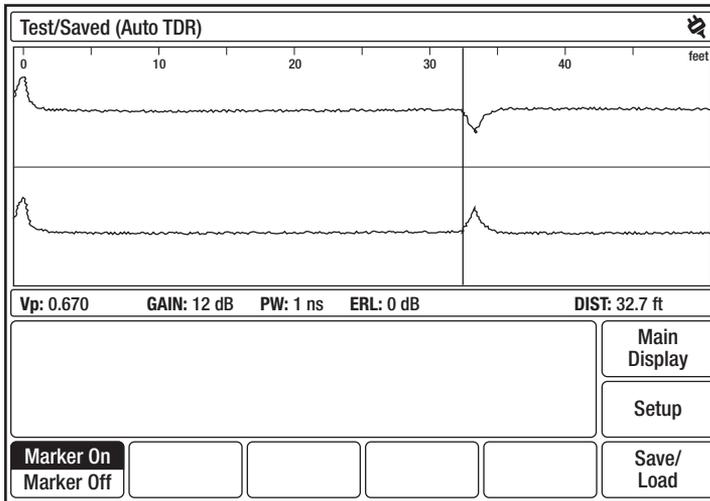
**Figure 4-10: Saved (Auto TDR)**

When displaying a saved waveform, any setup changes that would affect the waveform are disabled. That is, **Zoom On/Off**, **Less Cable**, **More Cable**, and **Events On/Off** are not available, and the softkey labels for these functions are blank.

### Test/Saved Waveform (Auto TDR)

To display the current test waveform side by side with a saved waveform, follow these steps:

1. From the **Setup – Test Type** menu, use **▲▼** to select **TEST/SAVED WAVEFORM**.
2. Press **Return to Test**.
3. Press **Save/Load** to display the list of saved waveforms in the **Save/Load** menu.
4. Use **▲▼** to select the waveform.
5. Press **Return to Test** to display the test and saved waveforms (Figure 4-11).



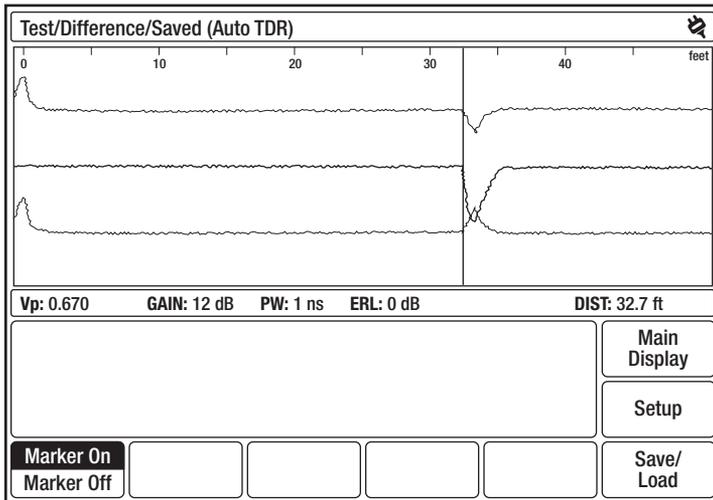
**Figure 4-11: Test/Saved (Auto TDR)**

The current test waveform is displayed in the top half of the waveform display, and the saved waveform is in the bottom half. The test waveform is scaled the same as the saved waveform and displayed with a common cursor. Test settings are those of the saved waveform. Return-loss values apply only to the current test waveform. Softkeys that affect the waveforms are not available just as in the Saved waveform display.

## Test/Difference/Saved (Auto TDR)

To display the current test waveform, a saved waveform, and a waveform that shows the difference between the test and saved waveforms, follow these steps:

1. From the **Setup – Test Type** menu, use **▲▼** to select **TEST/DIFFERENCE/SAVED WAVEFORM**.
2. Press **Return to Test**.
3. Press **Save/Load** to display the list of saved waveforms in the **Save/Load** menu.
4. Use **▲▼** to select the waveform.
5. Press **Return to Test** to display the test, saved, and difference waveforms (Figure 4-12).



**Figure 4-12: Test/Difference/Saved (Auto TDR)**

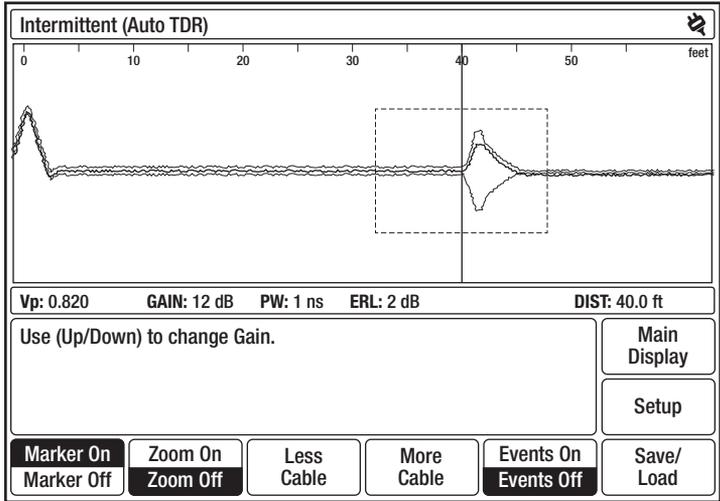
The current test waveform is displayed in the top half of the waveform display, and the saved waveform is in the bottom half. The difference waveform is displayed between the two source waveforms, which are displayed in gray. In any operation that involves a saved waveform, the settings used for the current test waveform are those of the saved waveform. Return-loss values apply only to the current test waveform. Softkeys that affect the waveforms are not available just as in the Saved waveform display.

Note that if the difference waveform is a straight line, there are no differences between the saved waveform and the current test waveform.

### Intermittent (Auto TDR)

To display an intermittent test waveform, follow these steps:

1. From the Setup – Test Type menu, use ▲▼ to select INTERMITTENT TEST.
2. Press **Return to Test** to display the waveform (Figure 4-13).



**Figure 4-13: Intermittent (Auto TDR)**

This display is the same as in Auto TDR Test, except that in addition to the current test waveform, minimum and maximum waveforms are displayed in gray. The minimum and maximum waveforms are made up of the minimum and maximum values for each data point on the current waveform. The minimum and maximum waveforms persist until a new test is started, and may be updated if any new minimum or maximum data points are acquired.

All the softkeys available in Auto TDR Test are available on this display.

---

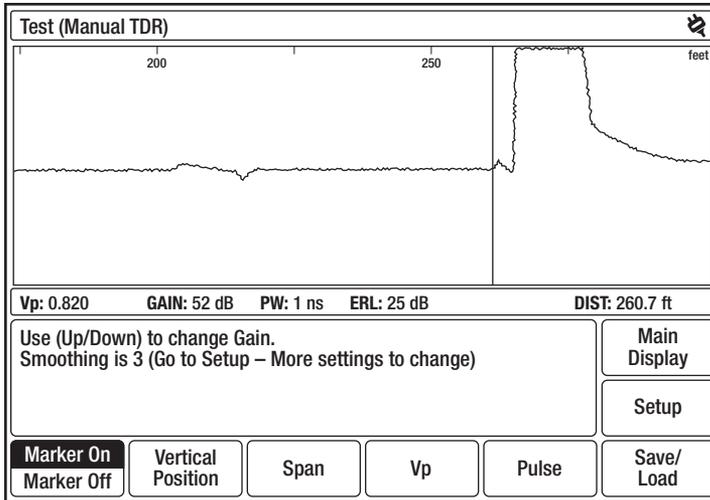
## Manual TDR

Manual TDR is for the expert user who wants full control over instrument settings.

1. To test a cable in Manual TDR, press **Setup** from the **Main Display** to display the **Setup – Choose Cable Type (User List)** menu (Figure 4-5).
2. From this menu, select your cable type, add the proper cable type, or create a custom cable type using a cable type from the Factory List as an example. Refer to “Choosing the Cable Type” in Chapter 3 for detailed instructions on adding and creating cable types.
3. Next, press **Test Type** to display the **Setup – Test Type** menu to select Manual TDR (Figure 4-6).
  - The **Auto TDR/Manual TDR** softkey toggles between Auto and Manual TDR, and the highlighted label is the current mode.
  - **Auto Lesson** and **Manual Lesson** softkeys are available from this menu. Press these softkeys for detailed instructions on Auto and Manual TDR.
4. Next, use **▲▼** to select the test type. The TV220 can perform five types of tests in Manual TDR:
  - **TEST WAVEFORM**, the most common type of test, displays a waveform for the current cable test. Use this test to characterize, document, and troubleshoot cables.
  - **SAVED WAVEFORM** displays a saved waveform.
  - **TEST/SAVED WAVEFORM** displays the current cable test waveform and a saved waveform. Use this test to compare current data to historical data.
  - **TEST/DIFFERENCE/SAVED WAVEFORM** displays the current cable test waveform, a saved waveform, and a waveform that shows the difference between the test and saved waveforms. This is another test that lets you compare current data to historical data.
  - **INTERMITTENT TEST** displays the current waveform, plus minimum and maximum waveforms. The minimum and maximum waveforms consist of the minimum and maximum values for each data point on the current waveform. The minimum and maximum waveforms persist until a new test is started, and may be redrawn as new minimum and maximum data points are acquired on the current waveform. Use this test to detect cable problems that may occur only once in a while, or periodically.

If you would like your instrument to power up with a test type other than TEST, change the Power-on Test Type in the **Setup – More Settings** menu (Figure 3-8).

5. If you selected TEST, press **Return to Test** to view the waveform for your test cable. Figure 4-14 shows a waveform for a TEST in Manual TDR.



**Figure 4-14: Test (Manual TDR)**

Use ◀▶ to position the cursor on the left edge of the event. The distance to the event is displayed in the DIST box in the lower right corner of the display. In Manual TDR, the following softkeys are available:

- **Marker** sets and clears the event marker (◆). When set, the cursor readout shows both distance from zero (DIST) and distance from the marker (Δ). The marker is always set at the current cursor location.
- **Vertical Position** of the waveform can be changed using ▲▼. The \* button toggles between auto and manual positioning when this softkey is highlighted.
- **Span**, or test distance of the cable, can be increased and decreased using ▲▼.
- **Vp** can be increased and decreased using ▲▼. The TV220 uses Vp to calculate distance measurements.

If you change the Vp, the TV220 allows you to define a new cable type using the new Vp value. If you press the **Setup** softkey, you can see the new Vp value shown in the **Setup – Choose Cable Type (User List)** menu on the <Current Settings> line, which is now highlighted.

To define a new cable type using the new Vp value, follow the directions given under “Choosing the Cable Type” in Chapter 3.

- **Pulse** can be increased and decreased using ▲▼. Available pulse widths are 1 ns, 5 ns, and 25 ns.

## Choosing Test Settings in Manual TDR

Pulse width is the time duration of the pulse transmitted by the TV220. Longer pulses are useful for testing long lengths of cable. Using a long pulse results in a cleaner waveform, but less resolution. Shorter pulses provide excellent resolution, but testing long cables may result in a “noisy” waveform. Use the shortest pulse that can provide a reasonable waveform. If you select a shorter pulse width manually, the TV220 can detect events closer to the test leads, events that are close together, and smaller events at higher frequencies.

You can also control smoothing in Manual TDR. Smoothing is a method of reducing random noise by averaging test results over a period of time. Higher smoothing provides a cleaner waveform but slows down the response time of the instrument. You can set smoothing values in the **Setup – More Settings** menu (Figure 3-8).

The TV220 can measure Return Loss (RL) and Event Return Loss (ERL) in Manual TDR, just as in Auto TDR. (Refer to “Return Loss and Event Return Loss” in this chapter for an explanation of return-loss measurements.) In order to get an accurate RL or ERL measurement, you need to be able to see the entire event on the display. In Manual TDR, use ▲▼ when no softkey is selected (highlighted) to adjust the gain value or press the **Vertical Position** softkey, press **Star** to select manual positioning, and then use ▲▼ to change the vertical position of the waveform until the entire event is displayed.

### Saved Waveform – Manual TDR

To select a test type other than TEST, go to the Setup – Test Type menu (Figure 4-16). Use ▲▼ to select the test type.

In Manual TDR, display a saved waveform the same way as in Auto TDR, described under “Saved Waveform – Auto TDR” in this chapter. Figure 4-15 shows a saved waveform in Manual TDR.

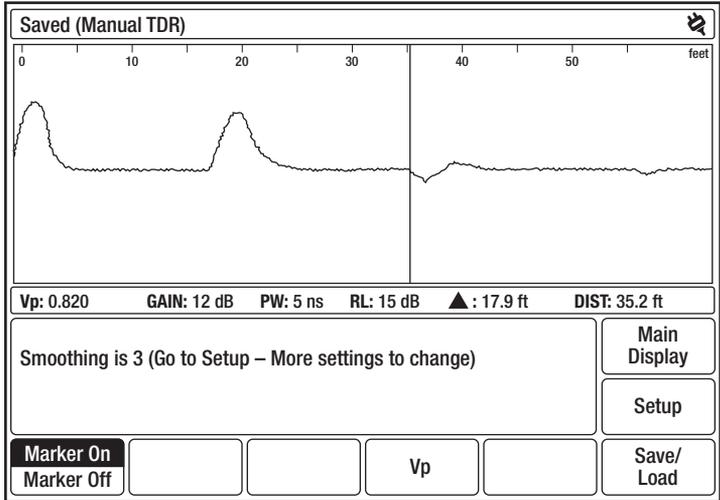


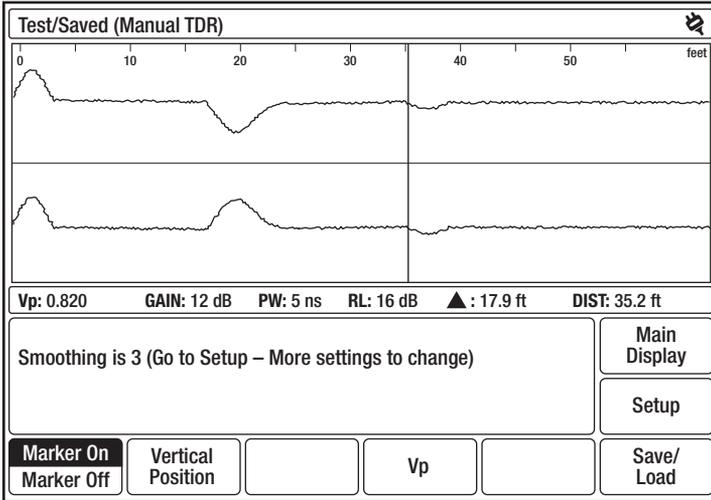
Figure 4-15: Saved (Manual TDR)

When displaying a saved waveform in Manual TDR, **Vertical Position**, **Span**, and **Pulse** are not available, and the softkey labels for these functions are blank.

All test settings are from the saved waveform, but you can change the Vp value on the screen using ▲▼. This does not affect the Vp value stored in the waveform file.

## Test/Saved Waveform – Manual TDR

Display the current test waveform side by side with a saved waveform the same way as in Auto TDR, described under “Test/Saved Waveform – Auto TDR” in this chapter. Figure 4-16 shows test and saved waveforms in Manual TDR.



**Figure 4-16: Test/Saved (Manual TDR)**

The current test waveform is displayed in the top half of the waveform display and the saved waveform is in the bottom half. The test waveform is scaled the same as the saved waveform and displayed with a common cursor. Test settings are those of the saved waveform. Return-loss values apply only to the current test waveform.

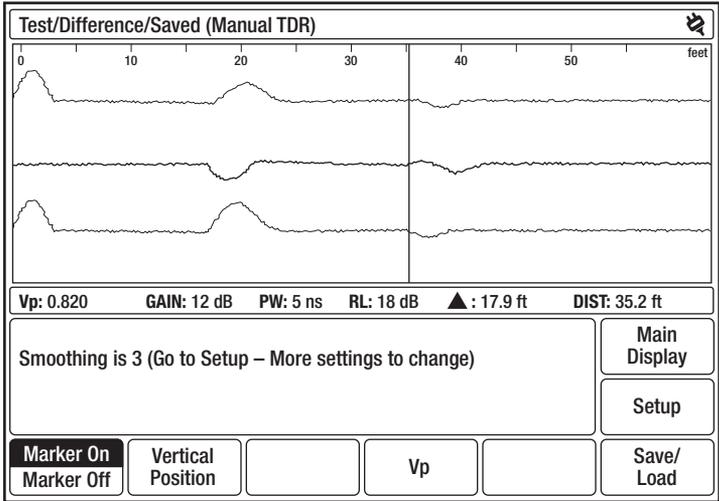
All test settings are from the saved waveform file, but you can change the Vp value on the screen using ▲▼. This does not affect the Vp value stored in the saved waveform file.

You can change the vertical position of the current test waveform.

**Span** and **Pulse** softkeys are not available from this display.

### Test/Difference/Saved Waveform (Manual TDR)

Display the current test waveform, a saved waveform, and a waveform that shows the difference between the two the same way as in Auto TDR, described in “Test/Difference/Saved Waveform – Auto TDR” in this chapter. Figure 4-17 shows the test, saved, and difference waveforms in Manual TDR.



**Figure 4-17: Test/Difference/Saved (Manual TDR)**

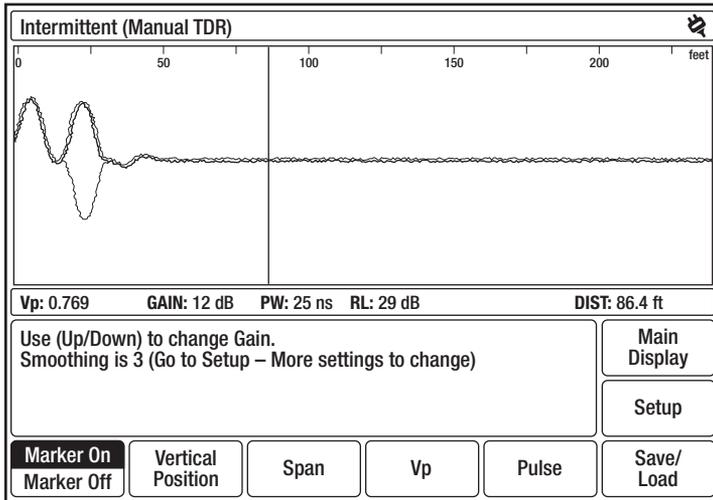
The current test waveform is displayed in the top half of the waveform display, and the saved waveform is in the bottom. The difference waveform is displayed between the two source waveforms, which are displayed in gray. In any operation that involves a saved waveform, the settings used for the current test waveform are those of the saved waveform. Return-loss values apply only to the current test waveform.

Note that if the difference waveform is a straight line, there are no differences between the saved waveform and the current test waveform. You can change the vertical position of the current test waveform. You can also change the Vp value using ▲▼. Changing the Vp value affects both the test and saved waveforms.

**Span** and **Pulse** softkeys are not available from this display.

## Intermittent (Manual TDR)

Display an intermittent test waveform the same way as in Auto TDR, described in “Intermittent Test – Auto TDR” in this chapter. Figure 4-18 shows an intermittent test waveform in Manual TDR.

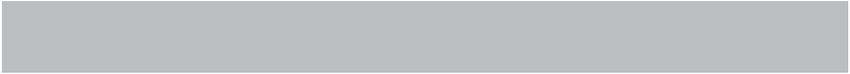


**Figure 4-18: Intermittent (Manual TDR)**

This display is the same as in Manual TDR Test, except that in addition to the current test waveform, minimum and maximum waveforms are displayed in gray. The minimum and maximum waveforms are made up of the minimum and maximum values for each data point on the current waveform. The minimum and maximum waveforms persist until a new test is started, and may be updated if any new minimum or maximum data points are acquired.

All the softkeys available in Manual TDR Test are available in this display.





**Save/Load**



## Chapter 5. Save/Load

The TV220 allows you to save the current waveform data and to load (preview) saved waveforms. Data files can also be transferred to the trace viewer program or an external computer.

### Save

When you finish testing a cable and want to save the waveform data for later use, press the **Save/Load** softkey to display the **Save/Load** menu (Figure 5-1).

Waveform Name	ID
< No Saved Traces >	000
	001
	002
	003

Use (Up/Down) to select waveform.

Main Display

Return to Test

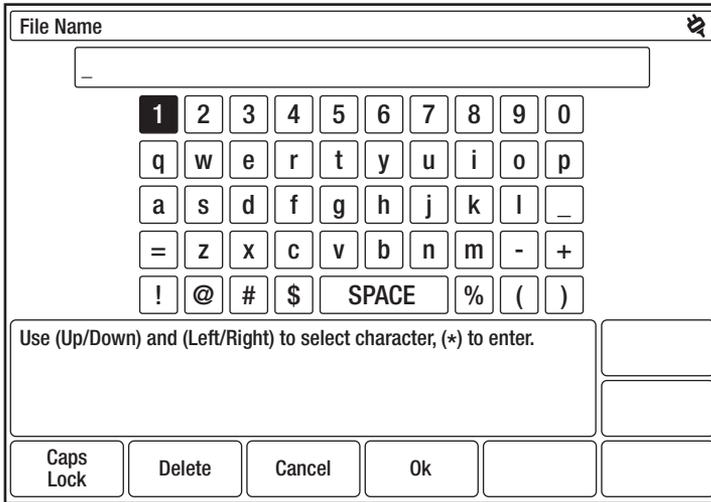
Preview Save Delete

Figure 5-1: Save/Load

This menu contains previously saved waveforms that can be loaded. The first line after these waveforms is the **CURRENT WAVEFORM**, which is the waveform of the last cable you tested before displaying this menu.

To save the current waveform, follow these steps:

1. Press the **Save** softkey to display **Save/Load – Waveform Name** (Figure 5-2).

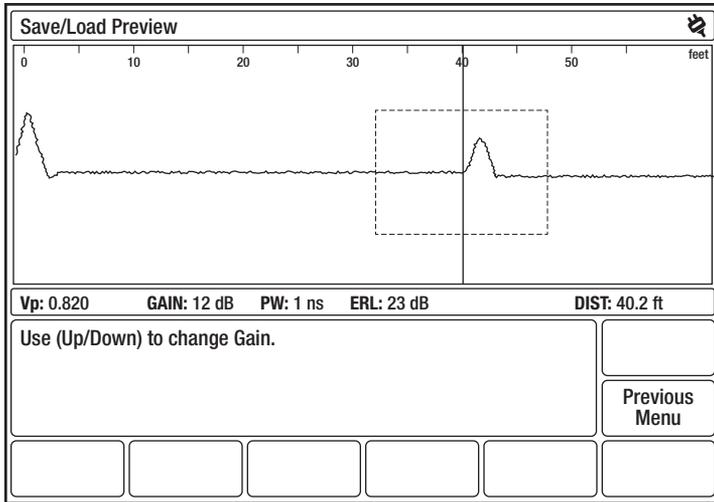


**Figure 5-2: Save/Load – Waveform Name**

2. Use ◀▶ and ▲▼ to move through the characters to the desired letter or number.
3. Press **Insert Char** or \* to add highlighted characters to your waveform name.
4. When finished, press **OK** to return to the previous display, which shows the new text on the highlighted line.

To delete a saved waveform, use ▲▼ to highlight the waveform. Press the **Delete** softkey. A confirmation display allows you to verify or abort the deletion.

## Save/Load Preview



**Figure 5-3: Save/Load – Preview**

To check that a waveform is the one you want to test or load, use ▲▼ to highlight the waveform, and then press the **Preview** softkey. You cannot preview the current waveform. Preview displays a waveform in limited measurement-style display without manipulations available. To return to the **Save/ Load** menu, press **Previous Menu**.

## Transferring a File to a PC

Saved files can be transferred to a PC for use with the TV220 Trace Viewer via the USB port. When the TV220 connection is made with the PC, the USB connection symbol will be displayed next to the power/battery status indicator symbol in the top right-hand corner of the screen.

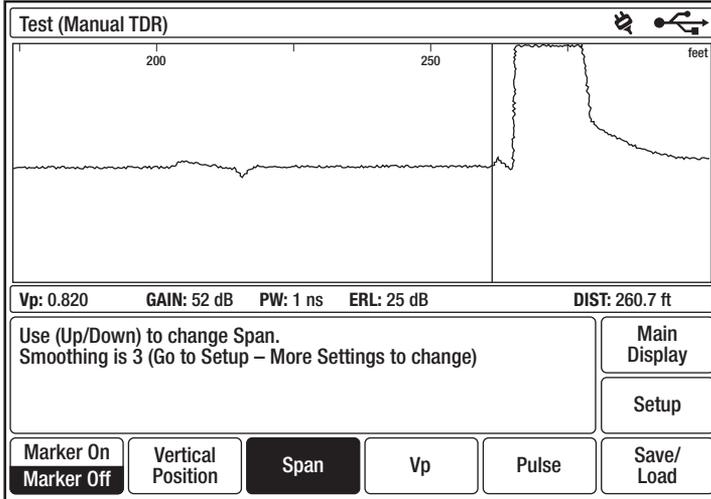
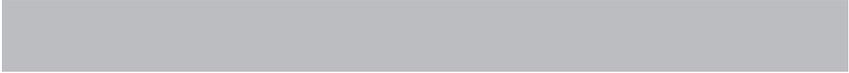


Figure 5-4: Transferring a File to the Trace Viewer Program on a Computer



# Maintenance



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## Chapter 6. Maintenance

For information about using your TV220, questions on particular applications, or to send your instrument in for service, refer to the telephone numbers listed under “Warranty” in the Preface section of the manual.

### Error Messages

Most error messages are the result of an internal failure, either hardware or software. If any error message is displayed, write down the error message and include it when you call or send the instrument in for service.

### Inspection and Cleaning

Inspect and clean your TV220 as often as operating conditions require. If used indoors, this might be once every 1000 hours of use. If used outdoors, this might be after each use, depending on field conditions, but it should be inspected and cleaned after no more than 500 hours of use.

#### Inspection

- Inspect the exterior of the TV220 for wear, missing parts, or cracks in the enclosure. Replace any defective parts.
- Inspect connectors for cracked insulation, broken shells, deformed contacts, or dirt in the connectors. Clean or replace as necessary.
- Inspect test cables for bent or broken plugs/clips or frayed/cut insulation. Replace as necessary.

#### Cleaning

<b>⚠ CAUTION</b>
<ul style="list-style-type: none"><li>• To avoid the possibility of getting water in the instrument, use only enough liquid to dampen the cloth.</li><li>• Do not use abrasive cleaners or harsh chemicals (e.g., alcohol or acetone) as damage to the enclosure might result.</li></ul>

- To avoid the possibility of getting water in the instrument, use only enough liquid to dampen the cloth.
  - Do not use abrasive cleaners or harsh chemicals (e.g., alcohol or acetone) as damage to the enclosure might result.
1. Remove dust from the outside of the instrument by wiping with a lint-free cloth or small brush. Use the brush to remove dust from the connectors.
  2. Clean the remaining dirt with a lint-free cloth, dampened in a solution of mild general-purpose detergent and water.





## **Appendixes**



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# Appendix A. Specifications, Options, and Accessories

## Specifications

### Physical

Size: 9 cm x 25 cm x 30 cm (3.5" x 10" x 12"), nominal

Weight: 2.3 kg (5.1 lb), nominal

### Environmental

Temperature:

Operating: -10 °C to 40 °C (11 °F to 104 °F)\*

Non-operating: -20 °C to 60 °C (-4°F to 140 °F)\*\*

Package Product Shock/Vibration/Drop, Non-operating:

Exceeds industry standards for immunity to damage during shipping

Water/Rain: Drip proof

Freefall Drop, Non-operating: 2 m, in soft carrying case with front flap closed

\* LCD performance is best at 0 °C to 40 °C.

\*\* Storing at room temperature, ~40% charge, extends battery life.

### Certifications and Compliances

EC Declaration of Conformity: Meets intent of Directive 2004/108/EC for Electromagnetic Compatibility. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Communities:

EN 61000-6-3 Emissions:

EN 55011: Radiated, Class A

EN 55011: Conducted, Class A

EN 61000-3-2/3: Current Harmonics and Voltage Fluctuations

EN 61000-6-1 Immunity:

EN 61000-4-2: Electrostatic Discharge

EN 61000-4-3: Radiated Immunity

EN 61000-4-4: Electrical Fast Transients

EN 61000-4-5: Surge withstand

EN 61000-4-6: Conducted Immunity, Current and Voltage

EN 1000-4-11: Voltage Dips, Short Interrupts and Voltage Variation

Installation Category Designation: CAT I—Secondary (signal level) or battery-operated circuits of electronic equipment.

### Power Source

Battery: 10.8 V, 2.4 Ah, lithium-ion

Input Max. Current: 2.0 A maximum from charger connector

AC Adapter/Charger: 12 VDC @ 2.5 A coax plug connector, 5.5 mm OD, 2.1 mm ID, Center + Sleeve

Duration of Battery Operation: 8 hours minimum continuous operation, without backlight

## Interface

USB Port

## Operational

Test Signal: 1/2 sine, unbalanced

Amplitude: 6 V into 75  $\Omega$ , typical

Output Impedance: 75  $\Omega$

Pulse Widths: 1 ns, 5 ns, and 25 ns

Maximum Range: 3657 m (12,000 ft), depending on cable type and condition

Horizontal Accuracy:

0 to 610 m,  $\pm 0.6$  m (0 to 2000 ft,  $\pm 2$  ft)  $\pm$  uncertainty of Vp

610 to 1829 m,  $\pm 0.9$  m (2001 to 6000 ft,  $\pm 3$  ft)  $\pm$  uncertainty of Vp

1829 to 3657 m,  $\pm 1.2$  m (6001 to 12,000 ft,  $\pm 4$  ft)  $\pm$  uncertainty of Vp

Display Resolution: 0.17 ft minimum on 640 x 480 pixel high-resolution LCD

Display Ranges: 8 ranges plus single-key expand window

Gain: 0 to 90 dB, in 3 dB steps

Input Protection:  $\pm 400$  (VDC + peak AC) to maximum of 440 Hz, 30 second duration

Waveform Storage: Up to 20 waveforms

Battery Saver:

Power off: 5 to 30 minutes or always on, user selectable

Backlight: 10 s to 10 min or always on, user selectable

Return Loss: Automatic at cursor

Resolution: 1 dB

## Accessories

### Standard

Part Number	Accessory
52046851	Universal AC adapter/charger, 100–240 VAC, 12 VDC 2.5 A
52034774	AC adapter charger cable
52034532	Test cable, BNC female to alligator clips
52034945	Cable, USB A male to B male
52034786	Coaxial jumper cable, F-type male to F-type male
52034557	Adapter connector, F-type female to F-type female
52034533	Adapter connector, F-type female to BNC male
52034620	F-type to KS test adapter
52040329	Soft carrying case
52038462	Shoulder strap for carrying case
52040565	TV220 Instruction Manual
52040566	Quick Reference Card

### Optional

Part Number	Accessory
52059312	Extra battery pack



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## Appendix B. Glossary

### AC

Alternating Current: a method of delivering electrical energy by periodically changing the direction of the flow of electrons in the circuit or cable. Even electrical signals designed to deliver direct current (DC) usually fluctuate enough to have an AC component.

### Cable Attenuation

See “Line Loss.”

### Cable Fault

Any condition that makes the cable less efficient at delivering electrical energy. Water leaking through the insulation, poorly mated connectors, and bad splices are typical types of cable faults.

### Δ

Delta: this symbol indicates a difference-distance. When a marker (◆) is placed on the waveform display, the instrument then calculates the distance from that marker to the current cursor location and displays that number in the Δ box of the Readout Bar.

### dB

Decibel: a method of expressing power or voltage ratios. The decibel scale is logarithmic. It is often used to express the efficiency of power distribution systems when the ratio consists of the energy put into the system divided by the energy delivered (or in some cases, lost) by the system. This instrument measures return loss. The formula for decibels is:  $\text{dB} = 20 \log (V_i/V_r)$ , where  $V_i$  is the voltage of the incident pulse,  $V_r$  is the voltage reflected back by the load, and  $\log$  is the decimal-based logarithmic function.

### DC

Direct Current: a method of delivering electrical energy by maintaining a constant flow of electrons in one direction. Even circuits designed to generate only alternating current (AC) often have a DC component.

### ERL

Event Return Loss: measures the true severity of an event by subtracting the manufacturer's specified cable loss from the measurement.

### Incident Pulse

The pulse of electrical energy sent out by the TDR. The waveform shown by the TDR consists of this pulse and the reflections of it coming back from the cable under test.

### Insulation

A protective coating on an electrical conductor that will not readily allow electrical energy to flow away from the conductive part of the cable or circuit. Insulation is also called dielectric. The kind of dielectric used in a cable determines how fast electricity can travel through the cable (see “Velocity of Propagation”).

## **LCD**

Liquid Crystal Display: a kind of display used in this instrument. Therefore, the terms *LCD* and *display* are often used interchangeably in this manual.

## **Line Loss**

The amount of signal that is absorbed in the cable as the signal propagates down it. Cable attenuation is typically low at low frequencies and higher at high frequencies, which should be corrected for in some TDR measurements. Cable attenuation is usually expressed in decibels (dB) at one or several frequencies. See also “dB.”

## **Noise**

Any unwanted electrical energy that interferes with a signal or measurement. Most noise is random with respect to the signals sent by the TDR to make a measurement and appears as if the waveform moves slightly up and down on the display.

## **Open Circuit**

In a cable, a broken conductor does not allow electrical energy to flow through it. These circuits are also called broken circuits. The circuit is “open” to the air, which appears on the display like very high impedance.

## **PW**

Pulse Width: the horizontal size of the transmitted pulse, usually measured in nanoseconds.

## **RL**

Return Loss: measures the severity of an event. RL does not account for cable loss in the measurement.

## **TDR**

Time-Domain Reflectometer: an instrument that sends out pulses of energy and times the interval to reflections (also called cable radar). If the velocity of the energy through the cable is known, distances to faults in the cable can be computed and displayed. Conversely, the speed that energy travels through a cable of known length can also be computed. The way in which the energy is reflected and the amount of the energy reflected indicate the condition of the cable.

## **Velocity of Propagation (Vp)**

The speed that electricity travels in a cable is often expressed as the relative velocity of propagation. This value is a ratio of the speed in the cable to the speed of light. This is always a number between 0 and 1. A velocity of propagation value of 0.50 indicates that the electrical energy moves through that particular cable at half the speed of light.





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