OPERATING MANUAL

20/20 TDR

Hand Held Step TDR

AEA Technology

Data available in this manual or in the 20/20 TDR instrument regarding cable characteristics reflects information published by manufacturers. This information is believed to be accurate but is not guaranteed. Please consult manufacturer's catalogs for up-to-date information.

The 20/20 TDR instrument is not to be used for any critical applications where failure of the instrument or inaccuracies in data might cause personal injury or property damage. Use in such applications is not recommended.

6020-3000 October 2010

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1. Introduction

20/20 TDR Highlights

The 20/20 TDR product line is a family of "Step" Time Domain Reflectometers designed for the Communications, Telephone, Broadband, and Private Network markets or wherever high bandwidth copper media testing is required. The 20/20 TDR models identify and pin-point faults in all twisted pair and coax cables. The advantages of the 20/20 TDR's step technology are the elimination of dead zones; increased informational data at the cursor location such as distance and impedance, plus higher resolution and greater accuracy over traditional pulse TDR's.
The 20/20 TDR features include multiple display formats, an intermittent fault capture, and a pair-balance test (Multi-Channel only). You can store up to 99 screen traces or 15 full range traces in the TDR memory for retrieval or downloading to the new TDR PC Vision™ software.

All Time-Domain-Reflectometer (TDR) devices are built on the same general principle. Radio Frequency waves travel at a speed that can be measured. The speed of the RF signal varies depending on the material it is traveling through. RF travels fastest through vacuum (100%) and slowest through twisted wire pair (50% to 75%). When RF encounters an obstacle or impedance shift in twisted wire pair or Coaxial cable, some or all of the energy bounces back towards the origin end. The time it takes for this bounced energy or reflection to arrive back at the source is measured and divided by two to account for the round trip. If the Velocity Factor or Velocity of Propagation (VoP) of the medium is known, the time can be translated into an accurate distance measurement. The following equation expresses the TDR's basic principle of operation:

$$\frac{\text{Time}}{2} \times \text{Velocity} = \text{Distance}$$

Step verses Pulse Technology

Pulse technology is similar to AM Radar, where a short burst of a sine wave is transmitted. The transmitter emits a single pulse then shuts off. The TDR then enables the receiver to listen for reflections. The longer the transmitted pulse, the longer the distance before the receiver can start looking for reflections. This is called the "Dead Zone" or "Blind Spot", and can be quite long in less expensive TDRs. Pulse technology can only measure the time between reflections and cannot interpret information between reflections such as gradual cable losses. The width of the pulse needs to be set by the operator, using a shorter pulse reduces the Dead Zone but limits the range. The longer pulse widths have good range but a correspondingly larger Dead Zone. The pulse, when compared to a step TDR, has less signal energy which results in a plot that has a lower signal to noise ratio and a less clear picture of the cable.

Step Technology is more like a Doppler radar, where the transmitter always emits energy while the receiver simultaneously listens for returned signals. This eliminates the "Dead Zone" pitfall of pulse technology, and allows the receiver to "see" right from the TDR's connector. Since the receiver looks at a constant signal, it accurately detects information that the pulse types cannot such as the cable's impedance along it's length. Due to the higher energy in a step signal TDR, the signal to noise ratio is improved. Couple this with the addition of noise filters and you can effectively reduce or eliminate outside interfering noise with less degradation of the received signal.

Unpacking your new 20/20 TDR

One each of the items listed below should be included with your 20/20 TDR. If any of the items are missing or damaged in shipment, please contact our Customer Service Department immediately at 1-800-258-7805.

One of the 20/20 TDR Models listed below:

Model	Part Number	Options	Equipped
20/20N TDR	6020-5000	Broadcast	"N" style connector
20/20T TDR	6020-5012	Telco	"RJ45" style connector
20/20B TDR	6020-5020	Broadcast	"BNC" style connector
20/20F TDR	6020-5031	CATV	"F" style connector
20/20F Network TDR	6020-5041	CATV	"F" and "RJ-45" style connectors
20/20F Network TDR	6020-5042	Telco	"F" and "RJ-45" style connectors
20/20F Network TDR	6020-5043	VDV/RF	"F" and "RJ-45" style connectors
20/20B Network TDR	6020-5053	VDV/RF	"BNC" and "RJ-45" style connectors

NOTE: Internally rechargeable models use the same part numbers with an "R" preceding the 50xx. Example: The part number the 20/20N TDR with internal recharger is 6020-R5000

Accessories included with the 20/20 TDR vary slightly with different model numbers. Check the packaged accessories against the Accessory Matrix (Figure 1-1) to ensure all "Included" accessories are delivered for the model ordered.

TDR Type	N Style	Telco	BNC Style	F Style	F or B Network Style
Model No.	**6020-500x**	**6020-501x**	**6020-502x**	**6020-503x**	**6020-504x/505x**
Accessories					
Soft Carrying Case with strand hook and shoulder strap P.N. 5001-1002	Included	Included	Included	Included	Included
Universal Power Adapter P/N 5001-0202	Included	Included	Included	Included	Included
Operations Manual P/N 6020-3000	On CD & Printed	On CD & Printed	On CD & Printed	On CD & Printed	On CD & Printed
Quick Start Guide: Standard P/N 6020-3010 or CATV P/N 6020-3011	On CD & Printed	On CD & Printed	On CD & Printed	CATV ver. On CD & Printed	F -CATV or BNC - standard On CD & Printed
TDR PC Vision Software	On CD	On CD	On CD	On CD	On CD
Test Leads Telco P/N 6020-0250	N/A	Included	N/A	N/A	Included
Test Leads, "BNC"-to-Alligator clips P/N 0070-1221 or "F"-to-Alligator Clips P/N 0070-1220	N/A	N/A	BNC Included	F Included	BNC or F Included
8 AA Alkaline Batteries Non-rechargeable units only	Optional	Installed	Optional	Installed	F –Installed BNC - Optional
Internal Rechargeable Models	6020-R500x	6020-R501x	6020-R502x	6020-R503x	6020-R504x/5x
8 AA NiMH 2000mAhr P/N 0010-0218	Installed	Installed	Installed	Installed	Installed
DC Vehicle Charger P/N 6025-0250	Installed	Installed	Installed	Installed	Installed

Figure 1-1

In addition to our standard accessories, AEA carries a complete line of termination kits, hard and soft kit cases, and other optional accessories for the 20/20 TDR. See Appendix A for details.

All rechargeable TDR's come with 8 AA NiMH cells installed. Some non-rechargeable models come with 8 AA alkaline cells installed. Replacement NiMH cells are available from AEA Technology (P/N 0010-0218) or can be replaced with any reliable commercial brand sold in local stores. Additionally, rechargeable units can operate on AA alkaline cells and non-rechargeable units can operate on externally recharged AA NiMH or NiCd cells. **CAUTION: You should never mix cells. All 8 cells should be replaced at the same time and with the same type of cell.** See Section 5 for battery replacement and Section 2 for rechargeable cell selection in the F2, Battery Menu.

Using This Manual

Throughout this manual, references are made to ZOOM, STEP, and CURSOR keys. Each of these keys has an ◀ or ▶ option and the operator selects the key depending on desired results. There are some menu selections that only need ◀ or ▶ selections. In this case, any ZOOM, STEP, or CURSOR key will work to make the desired selection.

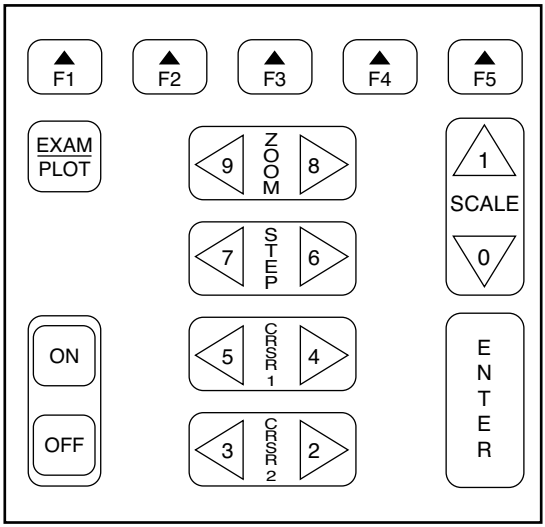


Figure 1-2

There are references to SCALE ▲ and ▼ keys. These are also labeled with the numerals 1 and 0.

Certain words that appear as all capitals (ZOOM, STEP, ON, OFF etc.) refer to keys on the 20/20 keypad. Other capitalized "words" are acronyms (TDR, SWR, PC, etc). Capitalized and italicized words (***ENTER*** etc.) refer to keys on your PC when using the TDR PC Vision Software.

TDR Quick Start Guide

Refer to the laminated Quick Start Guide enclosed in this package. A copy of the guide is also on the enclosed on the CD-ROM and available on AEA Technology's web site at **www.aeatechnology.com**.

Key Terminology

The following terms and abbreviations are used throughout this manual and are important to understand. In some cases dissimilar terms have the same meaning. To reduce confusion only one common term will be used throughout the manual. It may not be the most common one for your industry, but it does not alter the basic meaning or application of the term.

Dead Zone (DZ) aka Blind Zone or Blind Spot – Refers to a length of the cable from the connection on the TDR outward that does not display impedance reflections. Typical in Pulse TDRs, the Dead Zone increases as the pulse width is increased to see further along the cable. Since the 20/20 is a "Step" TDR designed to avoid this problem, it has no Dead Zone on any range scale.

Dribble Up – Slow rise in the impedance over the length of the cable. This effect is due to the increase in wire resistance over that same length. This causes the horizontal trace to display a slow rise on longer cables. Twisted pair cables display more than coax due to the higher amount of loop resistance. In power cables, where the resistance is very low, users may observe "Dribble Down."

Horizontal Scale (H Span) or Range Scale– Represents the displayed distance of returned reflections over the length of the cable. The TDR measures the reflections in time/2 and multiplies by the Vf to obtain the distance.

Impedance (Zo or Z) – Zo refers to the manufacturers specified value for a specific cable and Z refers to the measured value of impedance. This value refers to the amount of resistance a cable pair or coaxial cable offers to the flow of an AC signal. This is a factor of both the conductor's properties and the dielectric properties of their insulation. Deviations from the normal or expected impedance create RF reflections which are displayed as upward or downward deviation in the Vertical Scale along the time/distance domain on a TDR trace or plot.

Velocity Factor (Vf or VF) aka Velocity of Propagation (VoP or VP) or Nominal Velocity of Propagation (NVP) – Refers to the speed at which an RF signal will travel on twisted pair cable conductors or coaxial cable. It is expressed as a fraction of the speed of light in vacuum. (e.g. .66c). See the cable tables stored in the 20/20 TDR for a list of common cable types and their velocities.

Plot or Trace – refers to the display presentation on the 20/20 TDR's LCD or AEA Technology's TDR PC Vision Software for storing and displaying uploaded information. In some cases the reference "plot" refers only to the cable's reflections trace and in other cases it may refer to the entire chart on which it is presented.

Vertical Scale (V Scale) – Represents the impedance range displayed on the plot. For optimum presentation the full scale should be set to about twice the cable under test's normal impedance (Zo).

Vf Uncertainty – This is an important factor in judging the accuracy of any TDR's distance measurement. The cable manufacturer can only hold the tolerance of a cable's Vf within certain limits to the published specification. Additionally, all the stresses of spooling cable, un-spooling, pulling, cutting, untwisting and connectorizating will alter a cable's nominal velocity over it's length.

These terms and more are covered in greater detail in the Application Section of the manual.

Physical Description

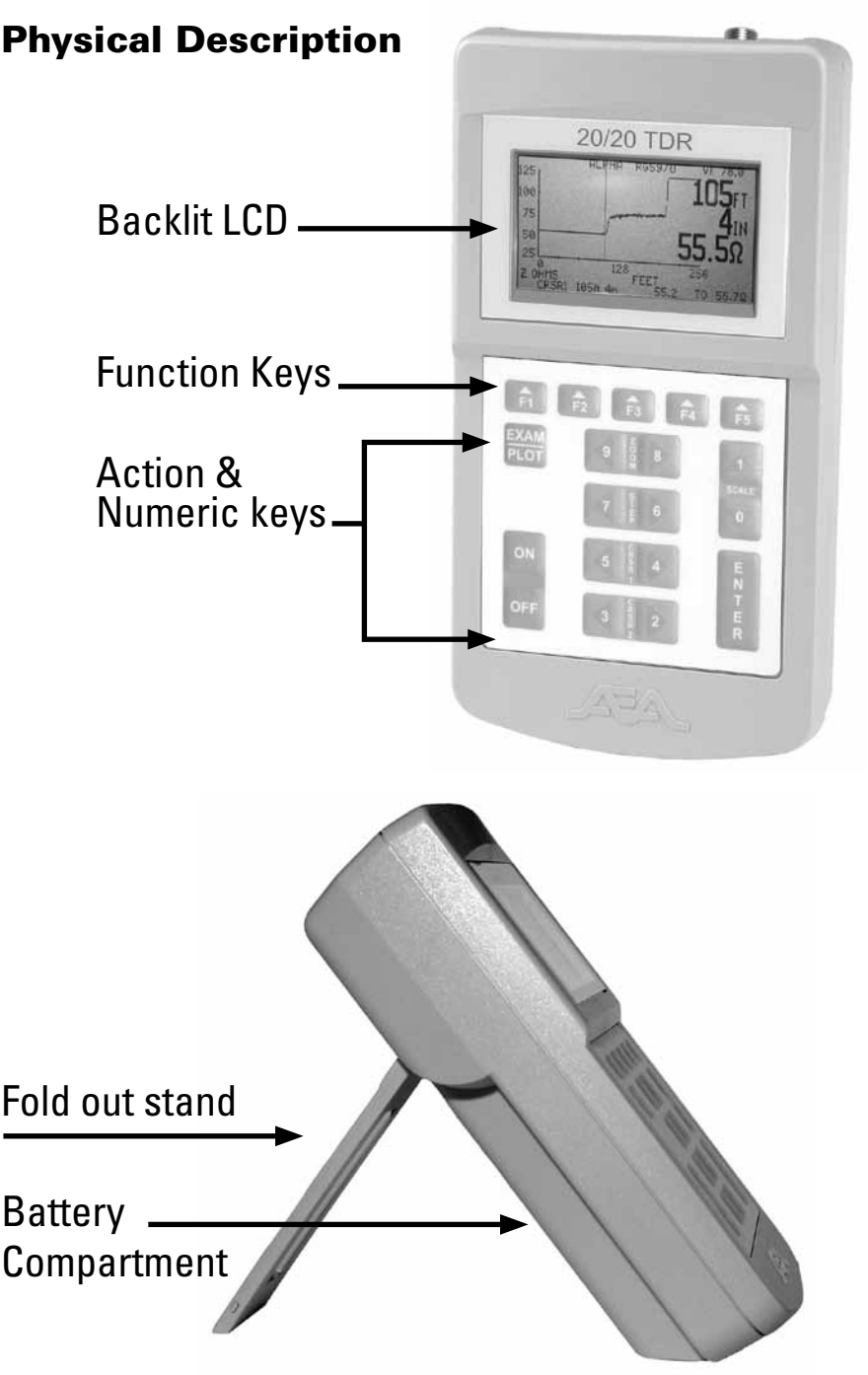


Figure 1-3

20/20 TDR Model Top Ends

“N” Model
6020-500X

Telco Model
6020-501X

“BNC” Model
6020-502X

“F” Model
6020-503X

“F” Network Models
6020-504X

“BNC” Network Model
6020-505X

Figure 1-4

20/20 TDRs with Included Accessories

Figure 1-5

Optional Accessories available from AEA Technology

Accessory	Part Number
Kit Carrying Case, Soft	6015-1002
Kit Carrying Case, Hard	6015-1003
DC Vehicle Charger (optional for non-rechargeables)	6025-0250
NiMH Batteries (8 pack AA)	0010-0218

For more details on accessories, including pictures, refer to Appendix A or AEA Technology's web site shown below.

For pricing and delivery contact AEA Technology at
1-800-258-7805 or +1 760-798-9687, FAX +1-760-798-9689, or email us at www.aeatechnology.com.

2. 20/20 TDR Setup and Operation

Powering the TDR

There are three methods of powering the 20/20 TDR:

1. AC wall power via the AC-to-DC converter provided – Highly recommended when working at a lab, office or production location or when working with TDR PC Vision software. Plugging in the DC jack on the 20/20 TDR will remove battery power and preserve the batteries in non-rechargeable TDRs. When rechargeable TDR's are connected to the AC wall power they will automatically start the recharge cycle. However, they will recharge slower if being used during this time.
2. Using internal battery power. This can be any 8 AA cells: NiMH or NiCd either internally recharged in units so equipped or externally charged, or Alkaline cell. Alkaline cells may also be used in rechargeable TDR's, but remember to select the F2 Battery Menu and select alkaline cells to turn off the charger.
3. Using DC Vehicle power. This requires using the DC Vehicle Adapter supplied with the rechargeable units and optional with non-rechargeable units. DC Vehicle power can generally NOT supply sufficient voltage to both operate and recharge the TDR at the same time. The optimum recharging on DC Vehicle power will be while the vehicle is running.

To install the AA batteries, remove the 20/20 TDR from its soft case, place face down on a clean padded surface and raise the bench stand to expose the battery cover screws. Using a #1 Phillips head screwdriver, remove the two battery cover screws and the battery cover. Install the first four batteries by sliding them under the retainer strap towards the top of the TDR observing the installation polarity markings. Install the last four batteries at the bottom of the battery holder also observing the polarity markings. Before replacing the battery cover, press the ON key and ensure the 20/20 TDR properly powers on and displays a measurement screen. Finally replace the battery cover by installing the two retaining screws snuggly. Be careful not to over tighten the screws as this will prematurely wear out the threads on the retaining inserts.

Powering ON

When the power ON key is pressed the splash screen in Figure 2-1 will display for about 5 seconds. After which the measurement screen will appear as shown in Figure 2-2. If the splash screen remains on constantly with word "Calibrating" in the center window, refer to the Troubleshooting Guide in Section 5.

Splash Screen

Figure 2-1

Measurement Screen

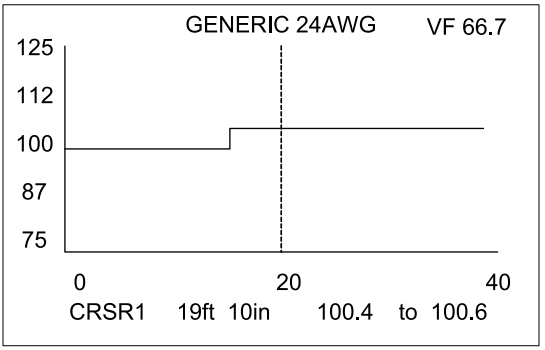


Figure 2-2

Powering ON with Soft Reset

In the rare event that the 20/20 TDR powers on, but the display screen does not appear correct (i.e. information located incorrectly) or the unit's keys do not respond in the manner described, the TDR's firmware may require a soft reset.
This would also be required if the cursor arrows in the Function Menus do not appear or do not respond to the ▲▼ keys. To accomplish a soft reset, first power the unit off using the OFF key. Now press the power ON key and simultaneously press the ENTER key in rapid succession three to four times and wait for a normal Measurement Screen to appear.

High Voltage Warnings

If the 20/20 TDR is connected to a cable with excessive AC or DC voltage present a warning will be presented by returning the display to the splash screen and displaying the "HIGH VOLTAGE DETECTED" warning in the center window. Use the following action guide along with appropriate safety procedures to avoid contact with the cable pair.

AC Voltage detected, but less than 0.5 Volts RMS – Press ENTER to continue.
AC Voltage detected greater than 0.5 Volts RMS – Disconnect the test leads and remove the voltage from the cable prior to attempting further testing.
DC Voltage detected, but less than 100 Volts DC – Press ENTER to continue
DC Voltage detected greater than 100 Volts DC – Disconnect the test leads and remove the voltage from the cable prior to attempting further testing.

CAUTION: Per EIC 1010-1, voltages greater than 27 VAC and 70 VDC are considered hazardous to humans. Always use a voltmeter or safety voltage detector to test for the presence of hazardous voltages before connecting other electronic test equipment.

Cold Weather Operation

Operating the 20/20 TDR at colder temperatures will bring some noticeable changes. The LCD screen changes will slow down and the contrast will require higher than normal range settings to make the screen visible. The batteries may have difficulty maintaining power output until they warm up. NiMH batteries are better in cold weather than Alkaline cells or NiCd cells. Most of this can be improved or overcome by using the battery power to warm the unit. When operating at temperatures below 0°C (32°F) with the 20/20 TDR starting at room temperature, use the following setups to keep the LCD and batteries warm:

1. Use the soft case for insulating the instrument
2. Power the unit up before going into the cold environment
3. Set the LCD back light to ON Continuous and raise the brightness level
4. Set the Battery Saver to OFF
5. If the LCD contrast fades, raise the contrast setting to a higher number
6. Protect the instrument from wind chill as much as practical. If usage is intermittent, close the soft case cover as much possible while leaving the unit powered on.

If the 20/20 TDR was stored at temperatures below 0°C (32°F), move it to a heated location, power the unit on with backlight. It may take 5 – 10 minutes before the LCD is readable. Follow the 6 steps above for about 15 minutes to recover the LCD and full battery power. Continue to follow the cold weather operation steps for use if required.

Function Keys and Menus

The factory default settings in the 20/20 TDR are generic in nature. Because the 20/20 TDR serves a broad market of customers, these setting may not be the best options for your specific application. AEA recommends taking a few minutes before going on the first job site and customize the options you need the most. This will make the 20/20 easier to use and improve efficiency for obtaining the measurements required.

Navigating through the four menus are options that control the operation of the 20/20 TDR and make it operate most efficiently for specific cable types and applications. Most menus operate in a similar manner. The F1 key is different as it provides an on-screen menu for the F2-F5 keys, a Channel Translation guide (Multi-Channel models only) and is the ESCAPE key to exit the F2-F5 menus back to the Measurement Screen. The top level menu is entered by pressing one of the F2-F5 keys. The cursor on the left is scrolled to the desired choice by using the SCALE ▲▼ keys. With the cursor aligned to the desired choice, press any ◀ or ▶ key to scroll through the choices or press ENTER to select the present choice. If there is a sub menu, repeat this process. Some sub menus require different keys to operate, and this will be noted on the display. If a sub-menu is a YES/NO selection, that choice will toggle using either the ◀ or ▶ on any function key. If the sub-menu has three or more choices, use the ▶ to advance and the ◀ to go back through the list. A few functions require numeric entries instead of cursor movement. Enter the required number using the numeric keys. Example, numeric entries set cable Impedance (Zo) and Velocity Factor (VF).

When navigating in any menu, the 20/20 TDR will list available choices for keypad entries to help make choices and return to the Measurement Screen. A table of menu selections is shown in Figure 2-3:

20/20 TDR Menu Chart - Non-Rechargeable TDRs

Function Key Operations

Function Key	1st menu level	Sub-menu Options
F1 Press once = Press twice =	F Key Menu Channel Translation Menu (Multi-channel models only)	
F2 Unit Settings	Back-Light Timer	Off, 10, 20, 50 Sweeps, Continuous
	Brightness	10 Levels
	Contrast	16 Levels
	Audio Volume	4 Levels
	Audio Mode	Silent, Key Beep, Continuous
	Baud Rate	4800 to 57,600 in 5 steps
	Battery Saver	On or Off
	Self Test	
F3 Data Display Options	V Scale	0 to 20, 50, 100, 200, 500, &1000 Ohms
	H Span	20, 40, 80, 160, 320, 640, 1280, 2560, 5120, &10,240' 6, 12, 25, 50, 100, 200, 400, 800, 1600 & 3200 meters
	Plot Start	User definable
	Units	Feet or Meters
	Horizontal Grid Lines	1, 2, 3, or 4
	Big Numerals	On or Off
	Plot Type	Z, SWR, RTN Amplitude
F4 Special Functions	Memory Action	To Save/Recall
	Noise Filter	0, 1, 2, 3, 4
	Averaging Filter	0, 1, 2, 3, 4, 5, 6, 7
	Video Filter	0, 1, 2, 3, 4
	Intermittent Grab	On or Off
	Fault Finder	On or Off
	Step or Pulse	Step, Narrow Pulse or Wide Pulse
	Input Channel	Varies (Multi-channel models only)
F5 Cable Operations	AEA Cable List	Displays entire Coax catalog
	View User List	Displays your Coax catalog
	Edit User List	Asks you for new coax data
	Sample a Cable	Steps you through sampling process
	Test Lead Cal	Steps you through calibration process
	Current Cable:	
	(Manufacturer) (Cable Type) ZO(impedance) VF(velocity %)	

Figure 2-3

20/20 TDR Menu Chart - Rechargeable TDRs

Function Key Operations

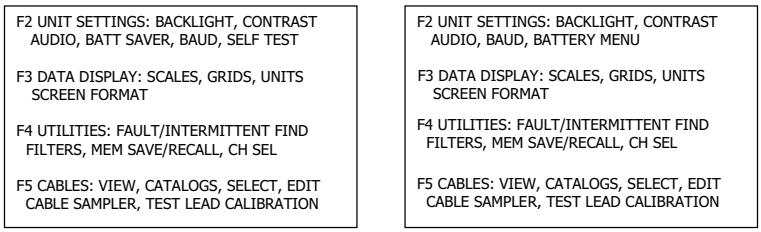
Function Key	1st menu level	Sub-menu Options	
F1 Press once = Press twice =	F Key Menu Channel Translation Menu (Multi-channel models only)		
F2 Unit Settings	Back-Light Timer	Off, 10, 20 50 Sweeps, Continuous	
	Brightness	10 Levels	
	Contrast	16 Levels	
	Audio Volume	4 Levels	
	Audio Mode	Silent, Key Beep, Continuous	
	Baud Rate	4800 to 57,600 in 5 steps	
	Battery Menu	Enter Sub-Menu below	
		Battery Saver	On, Off
		Battery Type	None, NiMH-NiCd, Alkaline
		Batt Capacity	400-5300 mAHrs in steps
		Est. Run Time	Calculated time remaining
		Battery Status	Voltage & +/- MA
		Battery Temp	OK, Too Hot, Too Cold
		Charger Status	Idle, Batt Chk, Pre Chrg, Charging or Trickle
F3 Data Display Options	V Scale	0 to 20, 50, 100, 200, 500 & 1000 Ohms	
	H Span	20, 40, 80, 160, 320, 640, 1280, 2560, 5120 & 10,240 feet 6, 12, 25, 50, 100, 200, 400, 800, 1600 & 3200 meters	
	Plot Start	User definable	
	Units	Feet or Meters	
	Horizontal GridLines	1, 2, 3 or 4	
	Big Numerals	On or Off	
F4 Special Functions	Memory Action	To Save/Recall	
	Noise Filter	0, 1, 2, 3, 4	
	Averaging Filter	0, 1, 2, 3, 4, 5, 6, 7	
	Video	0, 1, 2, 3, 4	
	Intermittant Grab	On or Off	
	Fault Finder	On or Off	
	Input Channel	Coax, RJ-45 Channels A, B, C & D and pair Δ's	
F5 Cable Operations	AEA Cable List	Displays entire Cable Catalog	
	View User List	Displays User Selected Cables	
	Edit User List	Enter new cable type and data	
	Sample Cable	Find a cable's Velocity Factor	
	Test Lead Cal	Eliminates Test Lead length from distance	
	Current Cable:	(Manufacturer) (Cable Type) Zo(Impedance) VF(Velocity Factor)	

Figure 2-3 continued

NOTE: ANY MENU SELECTIONS OR SETTINGS ARE SAVED WHEN THE 20/20 TDR IS POWERED OFF USING THE "OFF" KEY OR IF IT AUTO-POWERS OFF BASED ON A BATTERY SAVER SETTING. THE SAVED SETTINGS WILL BE PRESENTED ON SUBSEQUENT POWER ON AS THEY WERE LAST SET. HOWEVER, IF THE POWER IS LOST INADVERTENTLY OR THE DC POWER JACK IS REMOVED TO POWER THE UNIT DOWN, ALL CHANGES ARE LOST. THE NEXT 20/20 TDR POWER ON WILL HAVE THE SAME MENU SETTING AS THOSE ON THE PREVIOUS POWER UP.

F1 F-key Menus

Press the F1 key once to see a list of menus for the F2-F5 keys. When navigating the F2-F5 menus press the **F1** key again to escape back to the operational screens. The F1 key's F-Menu is shown in Figure 2-4



Non-Rechargeable Menu Rechargeable Menu

Figure 2-4

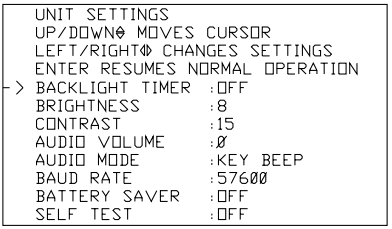
Press the F1 twice to view the channel selection table (Multi-channel models only) as shown in Figure 2-5. The table is an abbreviated version (due to LCD size) of the matrix shown in Appendix B and in the Quick Start Guide. However, it can be useful if the other references are not on hand.

RJ45 CH	TEL	568A	568B	USOC	10BT	TP-PMD	TKN RING
A	R/B	PR1	PR1	PR1			RX
B	G/B	PR2	PR3	PR2	RX		TX
C		PR3	PR2		TX	RX	
D		PR4	PR4			TX	
AΔB	RΔG	1Δ2	1Δ3	1Δ2			TXΔRX
AΔC		1Δ3	1Δ2				
AΔD		1Δ4	1Δ4				
BΔC		2Δ3	2Δ3		TXΔRX		
BΔD		2Δ4	3Δ4				
CΔD		3Δ4	2Δ4			TXΔRX	

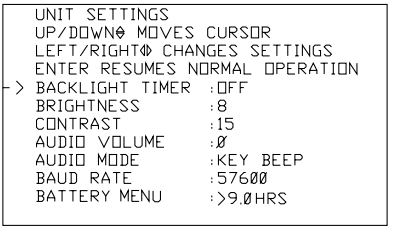
Figure 2-5

Press ENTER to exit the F1 menus.

F2 UNIT SETTINGS



Non-Rechargeable Menu



Rechargeable Menu

Figure 2-6

BKLIGHT TIMER This feature permits conserving battery power when operating on batteries. Use any of the ◀ ▶ keys to navigate the sub-menu options:

OFF – No backlight
10 SWEEPS – About 15 seconds of backlight on from any key pressed
20 SWEEPS – About 30 seconds of backlight on from any key pressed
50 SWEEPS – About 1 ¼ minutes of backlight on from any key pressed
CONTINUOUS – Backlight is always on

NOTE: The use of Continuous ON mode is NOT normally recommended when operating on batteries as it seriously impacts battery life. However, if the TDR is operated in temperatures below 32ºF (0ºC) use CONTINUOUS to heat the LCD and maintain it's visibility

BRIGHTNESS – Controls the brightness of the backlight. In certain lighting conditions this will only appear as a subtle change. Use any of the ◀ ▶ keys to navigate the sub-menu options:

Range: 0-10 with 0 being off and 10 the brightest

CONTRAST – Controls the LCD background contrast. Use any of the ◀ ▶ keys to navigate the sub-menu options:

Range: 0-15 with 0 being the lightest and 15 being the darkest.

The optimum contrast will vary with the temperature of the TDR. Lower numbers will be better in warmer conditions and higher numbers in colder conditions.

AUDIO VOLUME – Controls the volume of the audio feedback signal. Use any of the ◀ ▶ keys to navigate the sub-menu options:

Range: 0-3 with 0 being a click and 3 the loudest setting

AUDIO MODE – Sets the audio mode of operation. Use any of the ◀ ▶ keys to navigate the sub-menu options:

Silent – No audio feedback
Key Beep – Beeps once each time a key is depressed
Continuous – Continuous audio has a variable pitch that provides an indication of the trace's impedance value at the Cursor 1 position. This can be helpful when using the Intermittent Grabber mode to listen for a change in Z value while trying to locate the intermittent fault.

BAUD RATE – Sets the baud rate for communications with a PC. Use any of the ◀ ▶ keys to navigate the sub-menu options:

Range: 4,800-57,600. Recommend using the fastest rate as most PC's today can accept that rate. If connecting to an older PC, a baud rate reduction may be required to avoid exceeding the modem's fastest speed.

When the baud rate is changed, power the TDR OFF then back ON for the new baud rate to activate.

NOTE: The baud rate in the PC and the 20/20 TDR MUST match for successful communications. If the baud rate is changed in the 20/20 TDR be sure to change the PC baud rate using TDR PC Vision software to match. See Section 4, Options window, "COM Port Utilities" tab.

Non-Rechargeable TDRs Only

BATTERY SAVER – When in the ON mode this will auto power off the 20/20 TDR after approximately 9 minutes of elapsed time from the last key depressed. Use any of the ◀ ▶ keys to toggle between ON (▶) and OFF (◀).

NOTE: This auto-power off is a normal power down and will automatically save any setting changes since the unit was turned on.

SELF TEST – Runs a series of internal tests on the circuits to ensure proper operation. It also permits the user to test the keypad and unit for correct key recognition. Start at the top and press each key in turn and note the key's characters will display in the LCD. See the Self Test screen, Figure 2-7. The ON/OFF keys cannot be tested and their proper operation should be obvious when used. Press the ENTER key to exit Self Test.

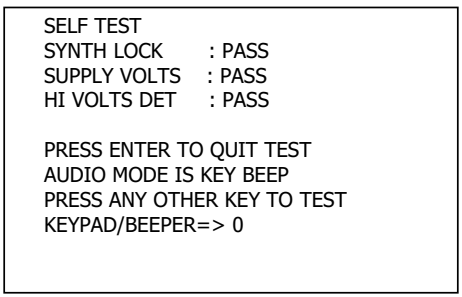


Figure 2-7

20/20 TDRs with Internal Recharging

The new rechargeable 20/20 TDR's can be recognized by the "R" in the part number (6020-R5xxx) on the battery cover label. These TDRs have an intelligent charger that permits selecting the type of replacement cells, NiMH/NiCd, alkaline/carbon types or no batteries. The charger will be turned off when alkaline or none is selected. Rechargeable alkaline cells may NOT be used. Additionally, it permits setting the unit's processor via the F2, BATTERY MENU to optimize the charge and discharge time for cells with different capacities (mAhr ratings). We install eight 2500 mAhr NiMH cells at the time of manufacture. These cells will provide approximately 9 hrs continuous operation. Age and condition of the cells and use of the backlight will reduce this time depending on the brightness setting and amount of time used. It will require 8-12 hrs to fully recharge. Recharging while the unit is in use is an option, but will extend the recharge time significantly. Here are some recharging recommendations and tips:

1. The TDR will give a 30 minute warning prior to a low power auto shutdown. This is the time to save plots and switch to AC or DC adapter power or find a fresh set of AA cells. The 30 min. is only an approximate and the TDR may shutdown in 10 or 15 minutes depending battery condition.
2. Use only AEA Technology supplied power packs; AC-to-DC Universal Adapter P/N 5001-0202 or DC-to-DC Vehicle Adapter P/N 6025-0250. If a substitute is used ensure the DC plug is the correct size and polarity – Center positive. Minimum requirements 13.3VDC and 600mA.
3. When recharging via the Vehicle Adapter, the vehicle's engine MUST be running to ensure minimum charging voltage is available. A non-operating vehicle's battery voltage is too low to charge the NiMH or NiCd cells.
4. Whenever possible start the recharging process before the batteries reach the low voltage warning state. This will reduce the recharge time and prevent potential unit or cell damage. "Cell memory" is not an issue with NiMH or newer NiCd cells.
5. Always charge the TDR's batteries with the soft belt case open or outside the soft case. The recharging process generates heat in the battery compartment that can cause the Smart Charger to halt or delay the charging process until the batteries cool. Ambient room temperature plays a large factor in dispersing this heat.

F2 – Battery Menu

BATTERY SAVER:	ON
BATTERY TYPE:	NICD NIMH
BATT CAPACITY:	2500 MAHR
EST. RUN TIME:	>4.3 HRS
BATTERY STATUS:	10.7V -220MA
BATTERY TEMP:	TEMPERATURE OK
CHARGER STATUS:	IDLE

Figure 2.7.1

To view the Battery Menu screen above Press the F2 key, then ▼ to select BATTERY MENU and press any ▶ key.
NOTE: Run Time, Statuses and Temperature will NOT update while in the Battery

Menu. To update press F2, then ▶ key to return and see updates.
Battery Saver: Has two settings, ON or OFF. Use any ◀▶ key to switch between the settings. On will power down the TDR if no key is pressed in approximately 5 minutes.
Battery Type: Permits selecting between NONE, ALKALINE or NIMH NICD cells. "Alkaline" MUST be selected if carbon or alkaline cells are place in the unit or damage to the TDR and/or cells may result.
Batt. Capacity: This setting is required when new rechargeable batteries are installed to ensure the optimum recharge and operational times. This will also make the estimated run time more accurate. The mAhr rating for NiMH or NiCd cells is specified on the manufacturer's packaging and should be set to exactly what the manufacturer states. Setting the capacity higher or lower than the manufacturer's specifications will degrade performance rather than enhance it. To set the mAhrs, press any ◀▶ until the reading matches the manufacturer's specification. Range is 400 to 5300 mAhrs.
Est. Run Time: Calculated by the charger based on amount of charge in cells. New cells may require several charging/discharge cycles for charger to synchronize with the cells and make the estimate accurate.
Battery Status: Displays the voltage and charging (positive) or discharging current (negative). Normal voltages for the cells will range from 9.3 to 12.5. See the Battery Current Table, figure 2-7.2 for it's indication. NOTE: It may take 20 seconds after a power change (power ON, plugging in external power, etc.) for correct status values to display.
Battery Temp: If the batteries are too hot or cold they can not be charged. The charger reads their temperature constantly and adjusts for temperature changes. See the Troubleshooting Table for temperature related symptoms.
Charger Status: IDLE = No DC input power, alkaline cells detected or cells are already at full charge - charging will not start.
BATT CHK = Charger is checking batteries' condition
PRE CHRG = Conditioning Charge
CHARGING = Normal Charging
TRICKLE = Batteries fully charged and being sustained

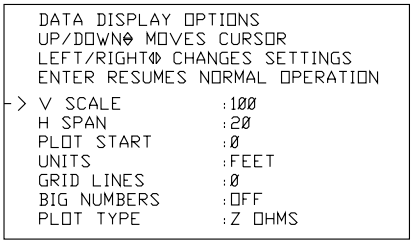
Battery Current Table

Current (mA)	Charge/Discharge State
~ 500	Charging with unit off – Not a viewable value
~ 175	Charging with unit in use - Normal
~ 90	Trickle Charge – Normal charging complete
< +/- 10	Charger is off or in BATT CHECK mode
~ -220 to –400	Operating on batteries – Varies with settings

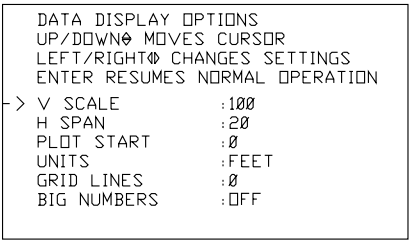
Figure 2-7.2

See Section 5 Maintenance, Service and Warranty for battery replacement information and a troubleshooting guide.

F3 DATA DISPLAY OPTIONS



Non-Rechargeable Menu



Rechargeable Menu

Figure 2-8

V SCALE - The vertical scale on the plot indicates the range of impedance to display. This control permits setting the vertical scale on the plot for optimum viewing. The vertical scale should be set in a range that is approximately twice the impedance of the cable being measured. This will position the cable's normal reflections horizontally centered on the scale and permit optimum viewing of any excursions from the cable's normal impedance. The 20/20 TDR will place Zo in the center of the range when practical to do so. Some common impedances are 25 Ohms for power cables, 50 & 75 Ohms for coaxial cables and 100 Ohms for twisted pair cables. Use any of the ◀ ▶ keys to navigate the sub-menu options:
V Scale Settings: 0 to 20, 50, 100, 200, 500 & 1000 Ohms

H SPAN – The Horizontal Span on the plot indicates the distance displayed on the plot. Adjusting this setting provides an optimum initial reading point for the type of measurement being taking. The ZOOM and STEP keys on the keypad will provide direct control of the H SPAN when the Measurement screen is displayed. Use any of the ◀ ▶ keys to navigate the sub-menu options:
NOTE: The range scales are adjusted depending on whether the Big Numbers feature is enabled or disabled. This was done to optimize the H Span on the LCD for all the information.

Ranges:

<u>Big Numbers OFF</u>

0-20, 40, 80, 160, 320, 640, 1,280, 2,560, 5,120 & 10,240 feet

0-6, 12, 25, 50, 100, 200, 400, 800, 1,600 & 3200 meters

<u>Big Numbers ON</u>

0-16, 32, 64, 128, 256, 512, 1024, 2048, 4096 & 8192 feet

0-5, 10, 20, 40, 80, 160, 320, 640, 1280 & 2560 meters

PLOT START – This value indicates the distance from the TDR's connector at which

the plot will start reporting on the cable's Z. Use any of the ◀ ▶ keys to call up the "Enter Start Distance" screen, then use the numeric keys to enter a distance. When the desired distance has been entered, press the ENTER key to set the value and return to the F3 Menu screen. Note the Plot Start distance to ensure correct entry and press ENTER again to return to the Measurement Screen.

Range: 0 – ½ maximum selectable range as shown in the H Span ranges above.

The ZOOM key will vary H Span while keeping the start distance at the set point. The STEP key will change the Plot Start distance setting. Hence, once the STEP key or Plot Start sets the lower distance reading, all span changes by the ZOOM key will use that starting point.

UNITS – Defines the reported ranges in either feet or meters. Use any of the ◀ ▶ keys to toggle between METERS (▶) and FEET (◀).

GRID LINES – When enabled, this feature paints horizontal dotted lines on the plot to help align the Z value observed to the reading on the left Vertical Scale. Use any of the ◀ ▶ keys to navigate the sub-menu options:

Lines: 0 = No grid lines enabled
1 = Center of plot
2 = Center and top of plot
3 = Center and one division up and one division down
4 = Center and one division up and one division down and top

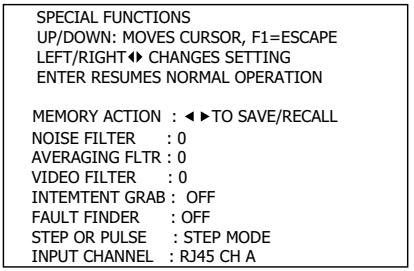
BIG NUMBERS – This feature displays Cursor 1's distance, and either impedance (Z) for TDR mode, or SWR for SWR mode, or dB for Rtn Ampl mode in large characters on the right side of the LCD. This enables reading the TDR's primary cursor from over 8 feet away from the unit. It can also help display these readings in glaring lighting conditions that can make the smaller characters harder to see.
NOTE: When Big Numbers is enabled, the H SPAN range scales are reduced and the maximum range scale is 8192 feet (2560 meters).

Non-Rechargeable Only

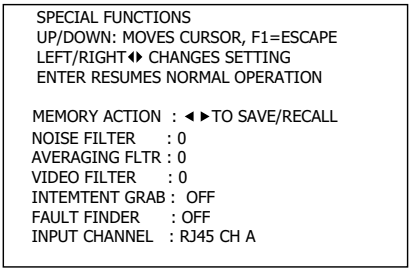
PLOT TYPE – The 20/20 TDR can display three different plot types or scales. The major change is in the V SCALE. Note the V SCALE range setting whenever changing PLOT TYPES and adjust that scale before starting a measurement. Use any of the ◀ ▶ keys to navigate the sub-menu options:

Types: Z OHMS – For TDR plots
SWR – For Standing Wave Ratio plots
RTN AMPL DB – For Return Amplitude plotted in Decibels (dB)

F4 SPECIAL FUNCTIONS



Non-Rechargeable Menu



Rechargeable Menu

Figure 2-9

MEMORY ACTION – This feature is for saving or recalling instrument settings, screen plots or entire traces. Use any ◀ ▶ key to save or recall information. This action will call a complete new sub-menu as shown in Figure 2-10:

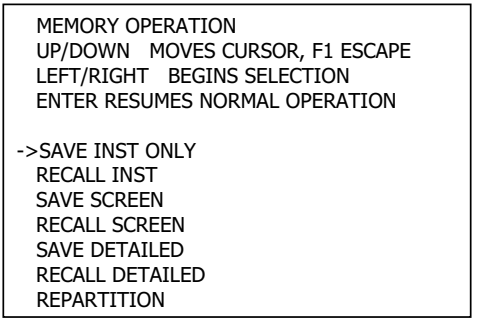


Figure 2-10

SAVE INST ONLY - Permits the user to save only the instrument's setups. This makes it handy to have multiple set ups stored ready use with dissimilar cable types and recall them for use without having to go to several F-Menus and restore each of the optimum set ups. The maximum number of user designated Instrument Setups that can be saved is nine, slot numbers (1-9). Two items of note - These slots are not the same locations as the SCREEN and DETAILED PLOT saves. Instrument Setup slots do not subtract from the number of plots that can be saved. Additionally, slot "0" is used by the instrument to automatically save the setups at the time power is turned off. If you save a setup in slot "0" it will be overwritten with any setup changes when powering down.

The steps involved in this type save are:

1. Use any ◀ ▶ key to enter the SAVE INST ONLY function

This will call a series of memory action screens that permit entering a name up to 11 characters in length for a customized Instrument Setup.
See Figure 2-11.

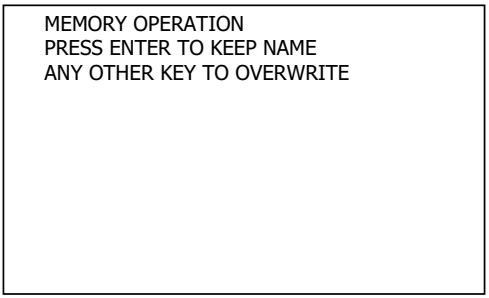


Figure 2-11

If ENTER is pressed here, the TDR will take you directly to the Memory Slot Selection screen shown below. Pressing any other key will call a prompt to enter a plot name

2. Enter a name for the instrument settings being saved. For this example we will use the name “RG6”

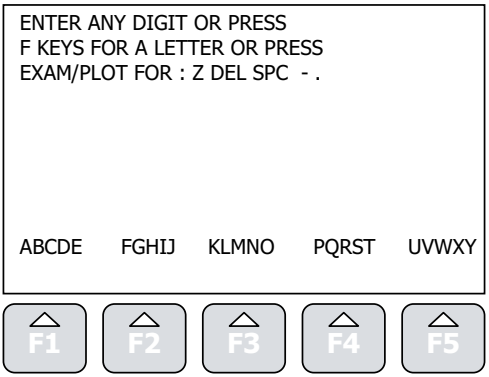


Figure 2-12

To enter an Instrument Setup name, press either the desired number on the keypad or select the desired letter from the LCD menu. Selecting a letter or special character is accomplished in two steps. First press the corresponding F key under the group of letters containing the desired letter. Or press the EXAM/PLOT key for special characters or a space. See Figure 2-12. In this example (name = RG6), press the F4 key to select the group containing the letter “R”. This will resort that group of letters to permit selecting the letter “R” directly. See Figure 2-13.

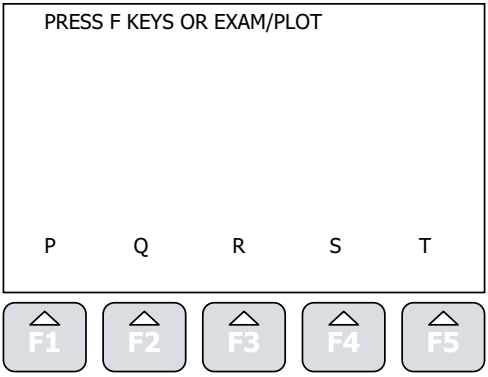


Figure 2-13

Press the F3 Key this time to select just the letter "R" and the screen will jump back one level with the letter "R" as the first letter of the Save Instrument Setups name. Repeat the process using the desired letter, number or special character key until the name "RG6" is completed. A maximum of 11 characters, including spaces, is permitted.

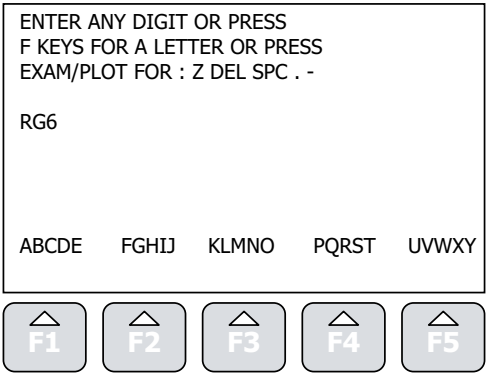


Figure 2-14

When the name is complete, press the ENTER key to choose a memory slot

3. Choose a memory slot and finalize the save on screen shown in Figure 2-15.

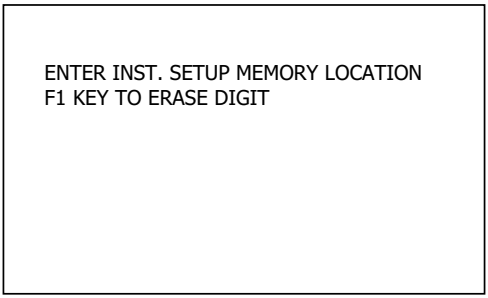


Figure 2-15

Press a numeric key to enter a location 1-9, then press ENTER to store the Instrument Setup as RG6 in location 1 for example.

4. Make a written note, in pencil, of this saved name, memory slot and any info of importance about these setups in Appendix C Instrument Setup Memory. When recalling these setups, it will be important and helpful to know the memory slot number to find the correct setup. If you are reading this manual from the CD, please go to Appendix C and print that page now to keep with your TDR.

RECALL INST - Recall Instrument Setup is designed to permit going directly to a memory slot where previous setups were stored and restore those setups. This is a more efficient method of changing the setups than going to each F-Menu and changing the settings one at a time.

1. Use any ◀ ▶ key to enter the RECALL INST function

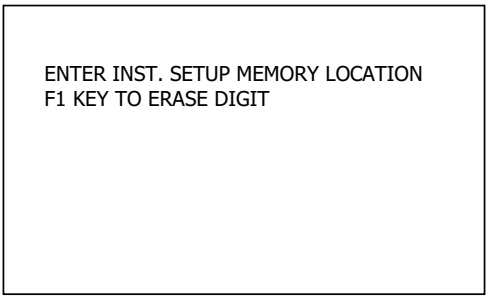


Figure 2-16

NOTE: Refer to the list of Instrument Setups entered in Appendix C. If the location and name was noted there at the time it was saved, this will be of assistance in finding the desired setup.

2. Enter the memory location (1-9) of the desired Instrument setup using the numeric key, then press ENTER.

The 20/20 TDR splash screen will display the name of the recalled setup for about one second while returning to the Measurement Screen. See figure 2-17

Figure 2-17

NOTE: If a memory slot does not contain a user saved setup, a factory pre-stored setup "20-20 TDR" will be recalled. To return to the previous setup follow the Recall Inst steps 1 & 2 above and enter "0" for the memory cell. This will return the display to the last saved setup when the unit was turned off.

SAVE SCREEN - Saves the current plot at screen resolution. The trace in the plot can have up to 2000 plot points. The Save Screen function will only save about 250 plot points. If the cable to be saved is a relatively short cable trace (<1K feet or 300 meters) this may be sufficient. However, if it is a very long plot and/or if it is desired to upload the plot to TDR PC Vision and examine it closer, AEA recommends performing a Save Detailed. Use any ◄ ► key to perform this action. More screens with instructions will follow the first screen shown in Figure 2-18 and operate the same as the ones shown in Figures 2-11 through 2-15. Enter the name desired on the first screen and select the memory slot on the second screen.

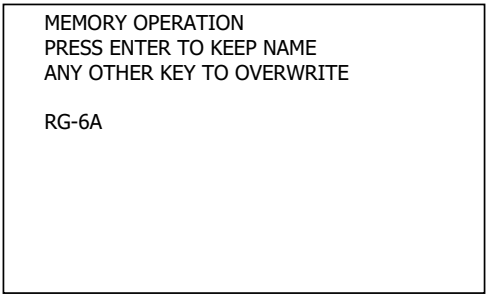


Figure 2-18

If ENTER is pressed here first, the TDR will go to directly to the Memory Slot Selection screen. If any other key is pressed, a prompt will appear to enter a plot name.

For instructions on entering a plot name refer back to the SAVE INST ONLY information concerning entering the characters. All the screens and actions are the same and the limit of 11 characters, including spaces, also applies.

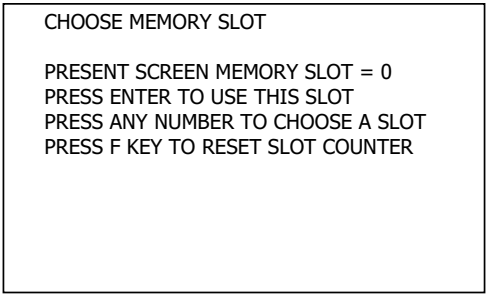


Figure 2-19

The memory slots referred to in this screen will increment automatically to make it easier to manage the storage of multiple plots. If it is desired to choose a particular memory slot, press one or two numeric keys to indicate the memory slot number. To reset the slot counter press any "F" key. A counter start entry screen will be presented to permit selection of the memory slot to start the counter at.

Why reset the memory slot counter? Two reasons:

1. The desire to over write no longer needed plots or plots already uploaded to TDR PC Vision.
2. For creating saved plot groups. Example: If plots were saved from the first job site visited and the last used memory slot was 13, it might be easier to start saving plots from the next job site starting with slot 20 and the next site with slot 30 and so forth. Having plots in sorted groups also makes the job of uploading plots to the PC more convenient.

CAUTION: The auto-incrementing will overwrite individually selected memory slots' data without warning as it increments. It is advised to always use auto-increment to the maximum extent to store plots to avoid any unintentional overwrites.

Full Memory

Auto-incrementing will display a warning when it stores a plot in the last available memory slot. This indicates the next incremented memory slot will be slot 0 and the next screen plot saved will overwrite the first screen plot saved in slot 0.
Options:
1. If you have already saved the earlier screen plots to your PC hard drive using TDR PC Vision software, continue and let the TDR overwrite the archived plots.
2. If you need more memory slots, go to REPARTITIONING and reduce the number of Save Detailed memory slots in order to increase the number of Save Screen memory slots.

Memory Slot Range: 0 to 99
Memory Maximums: Save Screens = 99, or Save Detailed = 16, but not both
Default Memory Partitioning: Save Screens = 50 maximum and Save Detailed = 8 maximum.

NOTE: More information concerning the management of the memory partitioning is available in the REPARTITIONING section on the following pages.

RECALL SCREEN – Permits the user to recall a stored Save Screen plot and display the trace in EXAM mode. Use any ◀ ▶ key to perform this action.
The screen in Figure 2-20 will be displayed.

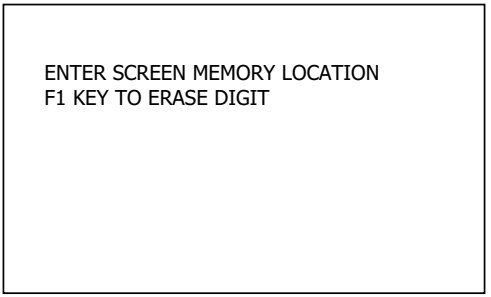


Figure 2-20

Use the numeric keys to enter the number of the memory slot desired to display. The numeric entry will display on the LCD screen. Then press the ENTER key to view the stored screen plot. The stored plot's name will be displayed in the lower right corner of the LCD when it is displayed as shown in figure 2-21

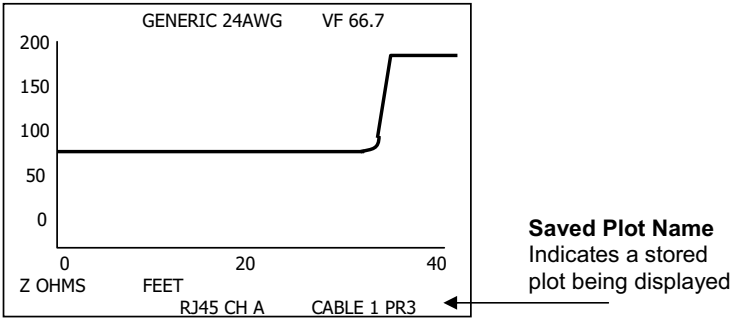


Figure 2-21

Press EXAM/PLOT once to escape the saved plot display and return to a live trace.

If you should select an empty memory slot, the 20/20 TDR splash screen's status display will read "EMPTY MEMORY SLOT" during the return to Measurement screen phase and the Measurement screen will offer a choice to retry or escape from the recall as shown in figure 2-22

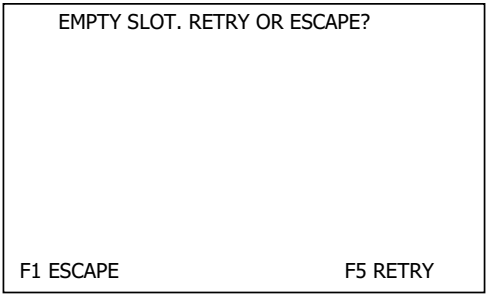


Figure 2-22

Pressing F1 to escape will exit the recall and jump to the Measurement screen. Pressing F5 to RETRY will return to the memory slot selection screen, figure 2-20.

SAVE DETAILED – Saves up to 2000 points of a full trace. This feature is particularly helpful to upload the entire trace (not just the trace appearing in the current plot) to a PC using the TDR PC Vision software. The entire trace with increased resolution will be saved and transferred to the PC, which will provide a far more flexible storage site and work center for viewing, printing and saving the data. Use any ◀ ▶ key to perform this action. More screens with instructions will follow as shown below. Enter the name desired on the first screen and select the memory slot on the second screen.

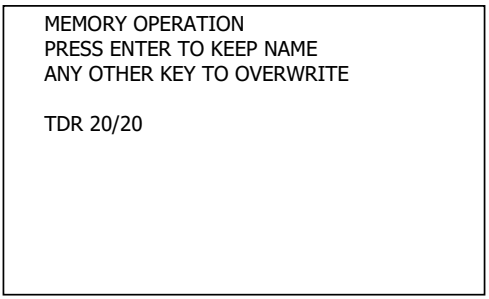


Figure 2-23

If ENTER is pressed here first, the TDR will take you directly to the Memory Slot Selection screen. If you press any other key, a prompt will appear to enter a plot name.

For instructions on entering a plot name refer back to the SAVE INST ONLY information concerning entering the characters. All the screens and actions are the same and the limit of 11 characters, including spaces, also applies.

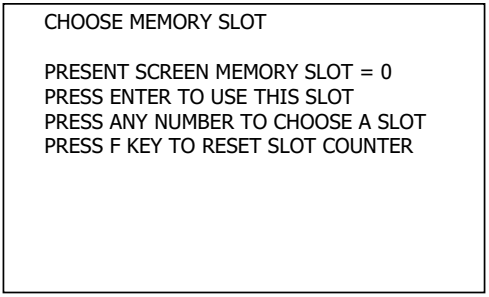


Figure 2-24

The memory slots referred to in this screen will increment automatically to make it easier to manage the storage of multiple plots. If a particular memory slot is desired, press one or two numeric keys to indicate the memory slot number. To reset the slot counter press any "F" key. A counter start entry screen will be presented to permit selection of the memory slot to start the counter at.

Why reset the memory slot counter? Two reasons:

1. The desire to over write no longer needed plots or plots already uploaded to TDR PC Vision.
2. For creating saved plot groups. Example: If plots were saved from the first job site visited today and your last used memory slot was 13, it might be easier to start saving plots from the next job site starting with slot 20 and the next site with slot 30 and so forth. Having plots in sorted groups also makes the job of uploading plots to the PC more convenient.

CAUTION: The auto-incrementing will overwrite individually selected memory slots' data without warning as it increments. It is advised to always use auto-increment to store plots to avoid these unintentional overwrites.

Full Memory

Auto-incrementing will display a warning when it stores a plot in the last available memory slot. This indicates the next incremented memory slot will be slot 0 and the next screen plot saved will overwrite the first screen plot saved in slot 0.
Options:

1. If you have already saved the earlier screen plots to your PC hard drive using TDR PC Vision software, continue and let the TDR overwrite the archived plots.
2. If you need more memory slots, go to REPARTITIONING and reduce the number of Save Screens in order to increase the number of Save Detailed slots.

Memory Slot Range: 0 to 99
Memory Maximums: Save Screens = 99, or Save Detailed = 16, but not both
Default Memory Partitioning: Save Screens = 50 maximum and Save Detailed = 8 maximum.

NOTE: More information concerning the management of the memory partitioning is available in the REPARTITIONING section on the following pages.

RECALL DETAILED – Permits the user to recall a stored Detailed plot and display the trace in EXAM mode. Use any ◀ ▶ key to perform this action.
The screen in Figure 2-25 will be displayed.

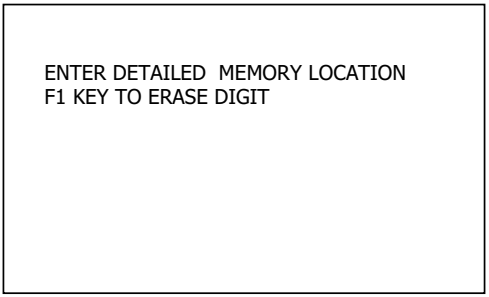


Figure 2-25

Use the numeric keys to enter the number of the memory slot desired to display. The numeric entry will display on the LCD screen. Then press the ENTER key to view the stored Detailed plot.

If you should select an empty memory slot, the 20/20 TDR splash screen's status display will read "EMPTY MEMORY SLOT" during the return to Measurement screen phase and the Measurement screen will offer a choice to retry or escape from the recall as shown in figure 2-22

REPARTITIONING – The memory in the 20/20 TDR is partitioned between Screen and Detailed Saves in order to accommodate the two formats and avoid errors during PC uploads. Use any ◀ ▶ key to perform this action and open the Repartitioning Screen shown in Figure 2-26.

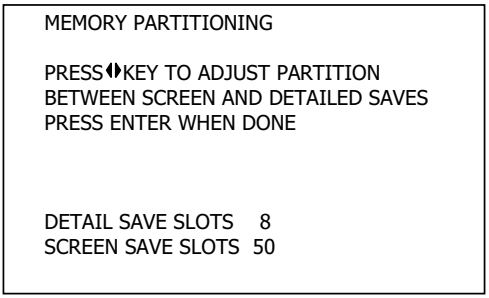


Figure 2-26

With the Memory Partitioning screen open any ◀ ▶ key will adjust the partition for more or less slots for Screen and Detailed. Note the ratio of about 6:1 between Screen and Detailed.

Screen Range:	0-99
Detailed Range:	0-16
Default Setting	Screens = 50, Detailed = 8

CAUTION: Repartitioning with saved plots in memory can cause the loss of some plots depending on the number of plots saved and the amount of change in the partition. Recommend saving all plots on the PC in TDR PC Vision software before Repartitioning.

Press ENTER to save the new partition. A prompt will appear to warn about the caution note shown above and ask to confirm the partition by pressing any "F" key. Pressing any key other than an "F" key will exit without changing the partition.

NOISE FILTER - The Noise Filter is an actual low-pass filter on the front end of the receiver. It is best used to reduce high frequency noise on the plot. In the strongest setting it will attenuate the noise level by 12 dB. There are 4 levels plus OFF (0). This filter should be the first one to use as it has the lowest "side effects". Add other filters as required. Use any ◀ ▶ key to navigate the sub-menu options:

Range: 0 = Filter Off
1 = Low Filter
2 = Medium Filter
3 = High Filter
4 = Maximum Filter (6 dB)

AVERAGING FILTER - The Averaging Filter accumulates sweep data in memory and plots the average. This option permits choosing how many sweeps are averaged by selecting 0 (off),1,2,3,4,5,6 or 7 (strongest). Each level is 3dB of filtering. The larger the number of sweeps averaged, the greater the noise suppression, but this creates a longer settling time. This filter acts like a low-band pass filter and is good for medium to high frequency noise rejection. This is the slowest acting, but most effective filter as it can reduce the noise level by 21 dB. Use any ◀ ▶ key to navigate the sub-menu options:

Range: 0 = Filter Off
$1 - 7 = 2^1 - 2^7$ or (2-128) Sweeps Averaged

To reset averaging filter (start a new average), press F4, point cursor to "AVERAGING FILTR" and press ENTER. Additionally, this filter will reset automatically when changes are made to the H SPAN or start distance.

VIDEO FILTER - The Video Filter is effective for high frequency noise that causes the plot line to be thick or 'hairy'. It compresses the thickness of the plot line. This filter has only a slight impact on sweep speed and is most effective when used to clean up noise that gets through the other filters. This filter is inactive in the shortest sweep span. Use any ◀ ▶ key to navigate the sub-menu options:

Range: 0 = Filter Off
1 = Low Filter
2 = Medium Filter
3 = High Filter
4 = Maximum Filter

INTRMTENT GRABBER - The Intermittent Grabber feature is like a storage mode on screen. When selecting this mode the screen plot area is not refreshed after every sweep. If the sweep is consistent, the plot on the screen will not change. If there is any change in a sweep from the prior sweeps, both the old sweeps and the changed sweep, with the difference area blackened out (see example under Section 5 – Applications...). This permits setting the TDR in INTRMTENT GRAB mode, walk to a suspected intermittent location, do whatever is required to force the intermittent, go back to the unit and see if and where the fault occurred. Intermittent mode requires some data compression during memory save, so saved data is not exactly the same as original, but quite representative. ***This mode disables the Averaging and Video filters.***
To reset, press F4, point cursor to "INTRMTENT GRAB" and press ENTER.

FAULT FINDER – The Fault Finder feature is designed to scan the trace during the measurement and jump Cursor 1 to a fault/suspect fault condition. The determination factor for a fault/suspect fault is a user defined deviation limit from the normal impedance (Zo) expected from the cable. Set too high and the Fault Finder will jump right past events of interest, set too low and the cursor will be jumping to any small event on the cable. With some experience using a Step TDR users can become very proficient at selecting the limits for the types of cable networks being examined in the course of work. Press any ◀ ▶ key to open the Fault Finder Threshold Selection Screen, Figure 2-27

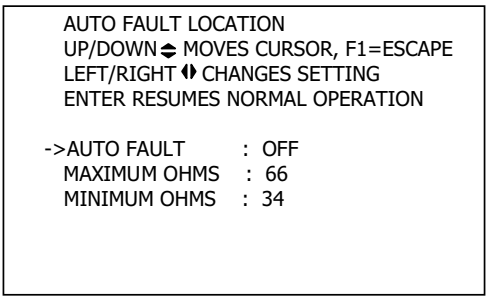


Figure 2-27

Step 1 – Use the ▲▼ key to align the cursor with AUTO FAULT, then use any ◀ ▶ key to change to ON.
Step 2 – Select MAXIMUM OHMS by moving the cursor to that line and press any ▶ key. This will open a number entry screen as shown in figure 2-28.

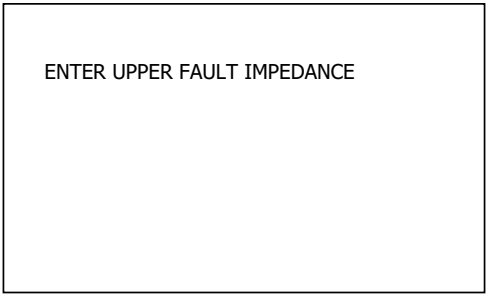


Figure 2-28

Step 3 – Use the numeric keys to enter a value for the upper threshold limit of impedance. Once entered, press ENTER to change the value. The screen will return to the Auto Fault Location screen.

Step 4 – Select MINIMUM OHMS by moving the cursor to that line and press any ◀ ▶ key. This will open a number entry screen as shown in figure 2-29.

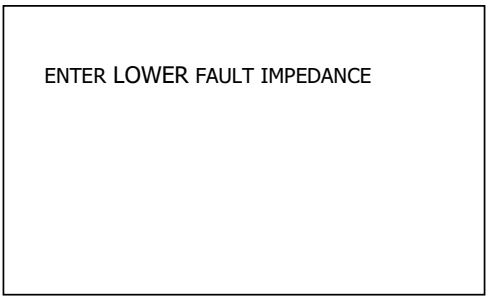


Figure 2-29

Step 5 – Use the numeric keys to enter a value for the lower threshold limit of impedance. Once entered, press ENTER to change the value. The screen will return to the Auto Fault Location screen.

Step 6 – Press ENTER again to activate the Auto Fault Find mode and return to the Measurement screen. Cursor 1 will jump to the first point on the trace exceeding the impedance limits thresholds. The words “FAULT FIND” will appear in the upper left corner of the LCD screen to indicate this mode is active.

NOTES: 1. If Cursor 2 is activated when Fault Finder is turned on, the cursor will be deactivated until activated again by pressing the CRSR2 key ▶.
2. When either Cursor 1 or Cursor 2 is manually moved with the ◀ ▶ keys, the Fault Find mode turns off and releases the cursors to user control. To re-enter the Fault Find mode press F4, Any ▶ twice and ENTER. The limits previously set will be used.

Non-Rechargeable TDRs Only

STEP OR PULSE – While the 20/20 TDR is by design a Step TDR it can represent the cable's trace events as a pulse TDR would display its return.Use any ◀ ▶ key to sequence through the sub-menu options:

Options: STEP MODE – Normal TDR function and display
NARROW PULSE – For short cables or to better view faults close to the TDR.
WIDE PULSE – For longer cables to see events better farther from the TDR

INPUT CHANNEL – The input channel determines which connector or which pair(s) on the RJ45 connector will be used to provide the input for the plot. When "Differential" readings are selected, the input is on two pairs, but only the difference between them is displayed. Use any ◀ ▶ key to select from the options in the table:

INPUT CHANNEL Sub-menu

The input channel on the Multi-channel models is designed to map different Wiring Schemes to the 20/20 TDR by using Channels to select the desired pairs. It has a wide selection of cable types that can perform single-pair selection measurements or two-pair differential measurements. Optimum use of the channel selection can be achieved by making a custom test lead with two RJ45 style male connectors for the network type or wiring scheme to be measured. Plug this test lead directly into the 20/20 TDR's RJ45. AEA Technology supplies an RJ45 to Telco Test Lead set with two pairs connected to Popper Clips. Figure 2-30 is an Input Connection Translation Table of Wiring Scheme selection to RJ45 Channel Selection. Refer to Appendix B for a complete description of the Wiring Schemes and Channels.

Input Connection Translation Table

Wire Map Scheme *=Supplied Test Lead	20/20 TDR Test Channel
Coaxial Connector	Coax
Red/Black Clips*	RJ45 CH A
Green/Black Clips*	RJ45 CH B
Red/Black & Green/Black Clips*	RJ45 CH A Δ B
T-568A Pair 1	RJ45 CH A
T-568A Pair 2	RJ45 CH B
T-568A Pair 3	RJ45 CH C
T-568A Pair 4	RJ45 CH D
T-568A Δ Pairs 1 & 2	RJ45 CH A Δ B
T-568A Δ Pairs 1 & 3	RJ45 CH A Δ C
T-568A Δ Pairs 1 & 4	RJ45 CH A Δ D
T-568A Δ Pairs 2 & 3	RJ45 CH B Δ C
T-568A Δ Pairs 2 & 4	RJ45 CH B Δ D
T-568A Δ Pairs 3 & 4	RJ45 CH C Δ D
T-568B Pair 1	RJ45 CH A
T-568B Pair 2	RJ45 CH C
T-568B Pair 3	RJ45 CH B
T-568B Pair 4	RJ45 CH D
T-568B Δ Pairs 1 & 3	RJ45 CH A Δ B
T-568B Δ Pairs 1 & 2	RJ45 CH A Δ C
T-568B Δ Pairs 1 & 4	RJ45 CH A Δ D
T-568B Δ Pairs 2 & 3	RJ45 CH B Δ C
T-568B Δ Pairs 3 & 4	RJ45 CH B Δ D
T-568B Δ Pairs 2 & 4	RJ45 CH C Δ D
USOC Pair 1	RJ45 CH A
USOC Pair 2	RJ45 CH B
USOC Δ Pairs 1 & 2	RJ45 CH A Δ B
10BASE-T Tx	RJ45 CH C
10BASE-T Rx	RJ45 CH B
10BASE-T Δ Tx & Rx	RJ45 CH B Δ C
TP-PMD Tx	RJ45 CH C
TP-PMD Rx	RJ45 CH D
TP-PMD Δ Tx & Rx	RJ45 CH C Δ D
Token Ring Tx	RJ45 CH B
Token Ring Rx	RJ45 CH A
Token Ring Δ Tx & Rx	RJ45 CH A Δ B

Figure 2-30

F5 CABLE OPERATIONS

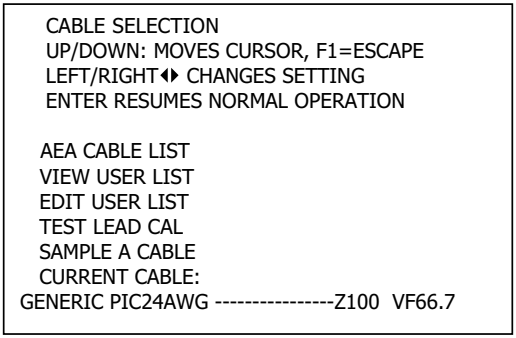


Figure 2-31

NOTE: In the F5 sub-menus AEA CABLE LIST and VIEW USER LIST, the highlighter is a clear bar traveling in a shaded table. This is different than the arrow used in other menus, but better serves these cable lists.

AEA CABLE LIST – The AEA Cable List is actually a catalog or data base which can be searched by: Manufacturer, Impedance (Zo), Cable Type, any two or all three of those parameters. To search the catalog, use the Feature Keys as follows:

ZOOM – Scrolls up (◀) and down (▶) the Manufacturer List.

- Will call up a list of all the cables in the catalog by the selected manufacturer

STEP - Scrolls up (◀) and down (▶) the Cable Impedances (Zo).

- Will call up a list of all the cables in the data base with the highlighted Impedance

CRSR 1 or **CRSR 2** - Scrolls up (◀) and down (▶) the Cable Types. CRSR1 will scroll a screen page at a time and CRSR2 will scroll an item at a time.

- Will call up a list of all the selected Cable Types in the catalog

To perform a multi-parameter search, select a “Manufacturer” first, then an “Impedance” and finally a “Cable Type” until all three are lined up in the clear cursor zone. If only two of the parameters are desired, select “ANY” for the third parameter in that column.

- Will call up a list of all the cables in the catalog that meet the two or three criteria highlighted. If no cables are found that meet these criteria the screen message "NO MATCH FOUND" will flash on screen and exit the user back to the F5 menu screen.

SELECTING A CABLE FROM THE AEA CABLE LIST

This sub-menu displays the cable types in the following format:

Manufacturer Std Designator Mfg P/N Zo Vf

Once the search has been performed and a list of cable options presented a single cable can be found and selected for use using the following commands:

SCALE ▲▼ – Scrolls up or down the list one cable at a time

ANY ◀ ▶ - Skips up or down the list by one screen page at a time

ENTER – Selects the cable type for use.

F1 Key – Escape back to F5 menu

VIEW USER LIST – This list of cables is a user definable cable table. It permits the user to have a specific list of commonly tested cables in their daily work. They can be added to this list and more readily accessed than using the larger AEA CABLE LIST. The table has already been populated with cables that AEA Technology knows are commonly used by AEA Technology's customers. However, you can replace any cable on the list with a different cable type. See EDIT USER LIST for instructions on updates.

Range: 0-55 Cable Types

Action Keys

SCALE ▲▼ – Scrolls up or down the list one cable at a time

ANY ◀ ▶ – Skips up or down the list by one screen page at a time

ENTER – Selects the cable type for use.

F1 Key – Escape back to F5 menu

EDIT USER LIST – This sub-menu provides screens and prompts to add a specific cable to VIEW USER LIST. Cables can be added in two ways: 1. Select a cable from the AEA Cable List and assign it a memory slot, and 2. Build a cable by entering the data fields individually

NOTE: The first data required for adding a cable is the memory slot number where that new cable will be stored. Before starting the cable add or edit process, AEA recommends reviewing the USER LIST and choose a memory slot to overwrite. Place the most common cables you test in the lowest numbered slots so they are quicker to access. AEA also recommends avoiding "slot 0" as this is the default placeholder in this feature and is vulnerable to be unintentionally overwritten.

Method 1, Transferring a cable from the AEA Cable List

Step 1 – Follow the instructions above for finding and selecting a cable in the AEA Cable list. When ENTER is pressed the selected cable will appear at the bottom of the F5 menu under Current Cable:
Step 2 – Go to the VIEW USER LIST and choose a memory slot to overwrite. Then press F1 to escape.
Step 3 – Go to EDIT USER LIST, position the cursor (->) at SAVE LOCATION and press any ▶ to select.
Step 4 – Use numeric key(s) to enter the memory slot chosen in step 2 and press ENTER. Note the correct slot number should now appear with this cable's data.
Step 5 – Press ENTER to store this cable in the USER LIST and exit back to measuring.

Method 2, Building a cable type into the USER LIST

This method requires having the data concerning the desired cable type and entering each parameter individually.

Data Sources for editing the User List.

Cable manufacturer's catalog or data sheet
Label on the box or reel of cable
Cable manufacturer's web site
The cable jacket information (this is the least helpful as it often does not contain all the data required)

Step 1 - Go to the USER LIST and choose a memory slot to overwrite

Step 2 – Go to EDIT USER LIST, position the cursor (->) at SAVE LOCATION and press any ▶ to select.

Step 3 – Use numeric key(s) to enter the memory slot chosen in step 1 (limits are 0-55) and press ENTER. Note the correct slot number should now appear in the sub-menu.

Step 4 – Select CABLE Zo and use the numeric keys to enter the cable's impedance. Press ENTER to save the Zo and note it should now appear in the sub-menu.

Step 5 – Select VELOCITY FACT. and use the numeric keys to enter the cable's Velocity Factor. Limits are a velocity between 20 and 99. A third digit position can be entered, but the third digit will be rounded to a 0, 3 or 7. Choose the number closest to the specified

third digit. Press ENTER to save the Vf and note it should now appear in the sub-menu.

Step 6 – Select CABLE TYPE and enter the characters one at a time using the Function Key entries or enter numbers using the numeric keys (8 characters maximum). Guidance on using the Function Key character entry is contained in Section 2 on F4 menu's "Save Inst. Only" instructions. If you do not have the cable type, recommend enter an "X" as a place holder. Press ENTER to save the Cable Type and note it should now appear in the sub-menu.

Step 7 – Select MANUFACTURER and use the Function Keys to enter the name (7 characters maximum). Press ENTER to save the Manufacturer and note the name or abbreviation should now appear in the sub-menu.

Step 8 – Select PART NUMBER and use the Function Keys or numeric keys to enter the manufacturer's part number (8 characters maximum). If the part number is not available recommend entering a "0" or a "-" as a place holder. Press ENTER to save the Part Number and note it should now appear in the sub-menu.

Step 9 - Select MISC R, C, BW (Resistance, Capacitance & Band Width). Enter the values for each of the screens as they are presented. Resistance is for 1000 feet of cable, Capacitance is for 1 foot and Band Width is specified at the -6dB level. If this data is not available, enter a single "1" at each screen as a place holder. These values have no current application in the 20/20 TDR and will not affect any of it operations. They are for possible future expansion of the Vision software for PCs. Press ENTER to save the Miscellaneous data and note all three values should now appear in the sub-menu.

Step 10 – Take a few seconds and review the data entered on the "Defining Cable" screen. If an error appears, use the ▲▼ keys to position the cursor at the line needing correction and make the correction as required. If all the data is correct, press ENTER to store the cable in the User List and return to the measurement screen. The entered cable will now be the one used for the measurements.

TEST LEAD CAL - Permits calibrating the test lead out of the plots by eliminating it's length from the trace. This saves time and eliminates errors when subtracting out the test leads. All the plot readings will be directly from the end of the test leads as opposed to the end of the instrument. It also permits using a very long lead to reach access points where you may not want to take the 20/20 TDR (i.e. up a telephone pole or down a manhole) and automatically subtract that lead. Test Lead Cal should always be done before Sample A Cable to ensure the test leads are not part of a cable's velocity calculation.

Step 1 – Select the Input Channel (Multi-channel models only) and cable type to be tested. The velocity of the selected cable may not be the same as the test leads, but that will be calibrated out and is not a concern.

Step 2 - Connect the desired test lead planned for use. If it is a twisted pair lead, ensure the twists are tightly maintained from the instrument end to the connection end. Open the connection end of the leads.

Step 3 – Press F5 and select Test Lead Cal and a reminder set of instructions will appear on screen.

Step 4 – With Steps 1 & 2 completed press ENTER and use the ZOOM, SPAN, SCALE and CRSR1 keys to position the cursor at the end of the leads. See Figure 2-32. NOTE: The normal cursor information will NOT appear in the Test Lead Cal procedure as it can be in error and misleading.

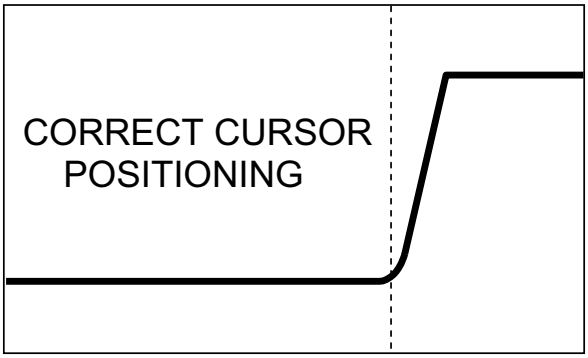


Figure 2-32

Step 5 - Press ENTER again to begin the calibration operation.

Results: **Completed** - If the calibration was successful, the Measurement screen will return with the V-Span and H Span reset to the pre-calibration values and the H Span's 0 distance will be the end of the test leads.
Try Again - The 20/20 TDR may request repeating steps 4 and 5 to improve the accuracy of the measurement.

SAMPLE A CABLE – The Sample a Cable feature allows the user to attach a sample length of cable with unknown Impedance and/or velocity, enter the cable's measured physical length (aka Jacket Length) and obtain the average impedance and velocity. This is a very good way to confirm the velocity of a cable type, even if the manufacturer's specified velocity is available, before taking measurements on unknown lengths or looking to obtain precise distances to faults. See the Theory and Applications section on Cable Velocity variances and uncertainty

Step 1 – If test leads are used and not already calibrated out of the testing, perform Test Lead Cal now. This will remove test lead delay from the sample cable's calculation.

Step 2 – Select SAMPLE A CABLE and connect both the test leads and/or a sample length of cable. If twisted pair leads are used, ensure the leads are twisted together as much as possible at the connection point and that the sample cable is open at the opposite end.

NOTE: AEA Technology recommends sample cables be between 20 and 50 feet (6 to 15 meters) to get an accurate measurement.

Step 3 – Press ENTER to start the Sample A Cable operation and use the ZOOM, SPAN, SCALE and CRSR1 keys to position the cursor at the end of the leads. See Figure 2-32.

NOTE: The normal cursor information will NOT appear in the Sample A Cable procedure as it can be in error and misleading.

Step 4 – Press ENTER again to go to the Length Entry screen. First enter the sample's physical length in feet or meters (meters enters in nnnn.nnn format to include mm) and press ENTER. Then, if set to Feet Mode, enter the "inches" and press ENTER. In the meters mode the TDR will jump directly to calculating the Vf. The results screen will appear as shown in figure 2-33 with both the Impedance and Velocity displayed.

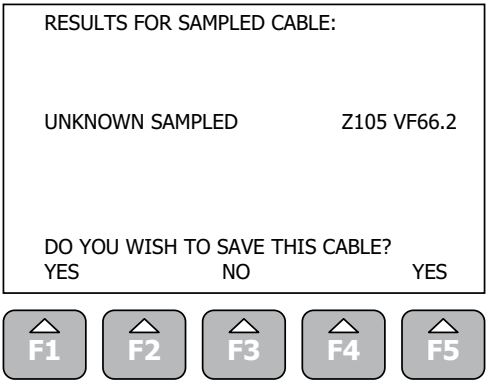


Figure 2-33

Step 5 - If the velocity and impedance appear in the nominal range for the type of cable being sampled, accept the results and save it to User Cables List by pressing F1 or F5. When choosing to save the results, the next screen will ask for a memory slot in the User Cables list. Enter an available memory slot from 0 - 55.

Step 6 - Press ENTER to complete the save and return to the measurement screen. If the velocity or impedance are outside the expected normal limits, Press F3 to erase the data and return to the F5 menu screen. Recheck the test setup and cable's physical measured length to ensure all is correct.

CURRENT CABLE:

The Current Cable entry is only for displaying information about the cable type in use. The cursor cannot be positioned at Current Cable. Cable type changes must be done through the AEA Cable List or User Cables function. The information will display in the following format:

MFG & Cable Type	**Mfg P/N**	**Zo**	**VF**
Some example Current cable types are:			
BELDEN DS3-4	734D2T	Z 75	VF80.7
GENERIC PIC 24AWG		Z100	VF66.0
UNKNOWN SAMPLED		Z102	VF68.5

TDR OPERATIONS

The operations section will cover each of the displays and all of the front panel keys. However, reading this section alone will not make anyone a proficient TDR user. For those readers who are already familiar with a Step TDR, AEA Technology recommends starting with this section and using the references to the Theory and Application Notes on the CD-ROM only as required. For novice users or those unfamiliar with what a TDR can do, AEA recommends reading the Theory and Applications Notes first, then start here. In either case, AEA Technology stands ready to support all our customers with technical support assistance at our toll free number. 1-800-258-7805 M-F, 7:00am – 5:00pm PST. Email:

sales@aeatechnology.com

Key Display Features

The TDR display has four similar, but varied screen formats. Examples of each will be shown as this section progresses.

Basic Plot with no Cursors on

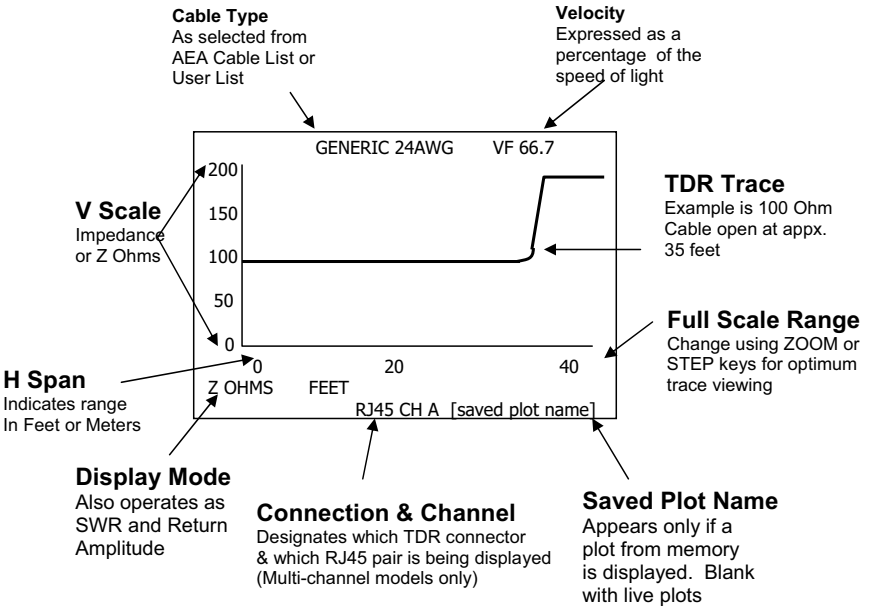
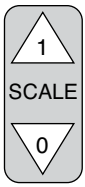


Figure 2-34

Basic Plot

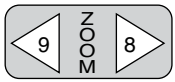
V Scale or Vertical Scale displays the TDRs reading of the Impedance of the cable. If the TDR is correctly set up the cable being measured will have its expected impedance centered and about twice that visible in the Y axis as shown above. Impedance variations from a cable's nominal expected value (in this case 100 Ohms) are events. In figure 2-33 there is only one event displayed, a major impedance rise at approximately 35 feet indicating an open.

Controls: 

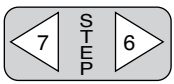
To vary the V Scale, use the SCALE key's ▲▼ and note the change in the display. The V Scale can also be set using the F3 menu and selecting the Vertical Scale.

Limits: 20 – 1000 Ohms in TDR Mode
2 – 33 in SWR Mode
2 – 48 dB in Return Amplitude Mode

H SPAN or Horizontal Scale displays the range down the length of the cable. The range can be displayed in either feet or meters as desired by using the F3 key and selecting Units.

Controls: 

ZOOM expands the scale's range from the starting point outward. This permits a user to see the entire cable's length in the LCD window. The trade-off is that as the range expands, the trace's resolution diminishes. This will make it harder to place the cursor(s) accurately at the faults The H Span has a list of preset range values that are automatically selected with each press of the ZOOM's ◀ ▶ keys. For multiple sets of range changes, press and hold the ZOOM key to move quickly to the desired pre-set range scale.



STEP moves the Start Distance (plot display) along the cable in ½ Horizontal Span intervals. If the Horizontal Span is at 40 ft, and Start Distance is at 0, then 0 to 40 feet is displayed. Push the STEP right arrow button once, and 20 to 60 feet is now displayed. See figure 2-35 for a graphic of these changes. Press the STEP right arrow key a second time and 40- 80 feet is now displayed etc. Using STEP provides a higher resolution view of the cable's trace, more accurate cursor positioning and more accurate cursor data. However, using STEP can blind the user to other events

on the cable. It should only be used after taking a full view of the cable to ensure no significant event is missed.

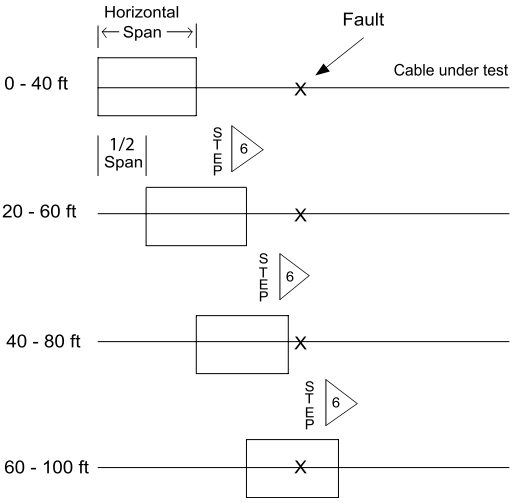


Figure 2-35

Plot with Cursor 1 on

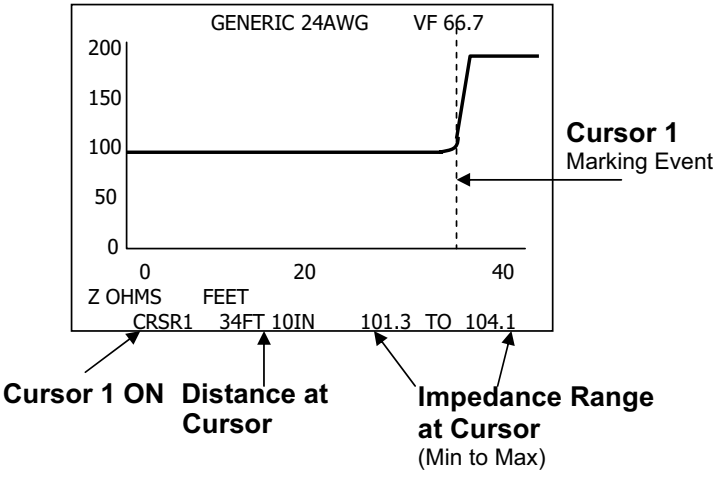
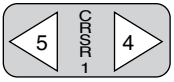


Figure 2-36

Controls:



The CURSOR 1 key controls the left right movement of the cursor. When pressed it automatically adds Cursor 1 to the display along with the distance and impedance readings at the cursor.

Distance is displayed in feet and inches, or in meters down to the centimeter resolution (nnn.nn). The units can be changed by pressing the F3 key and selecting Units.

Impedance is displayed showing the minimum and maximum readings at the cursor. There is a range of Z or impedance at the cursor as information in the TDR's software from the cable's reflections is more refined than the pixel position of the cursor on the LCD. As the display's range increases the number of data points covered by a single pixel increases causing a slight widening between the minimum and maximum Z readings. Short range readings and readings at points on very horizontal trace points will have minimum and maximum reading much closer together.

Cursor positioning is important to obtain the most accurate distance and impedance measurements. The cursor should always be positioned at the leading edge (left side) of the reflection curve or the start of the deviation from the baseline impedance as shown in figure 2-37. The reason is the 20/20 TDR is measuring distance to an event that caused the start of the reflection

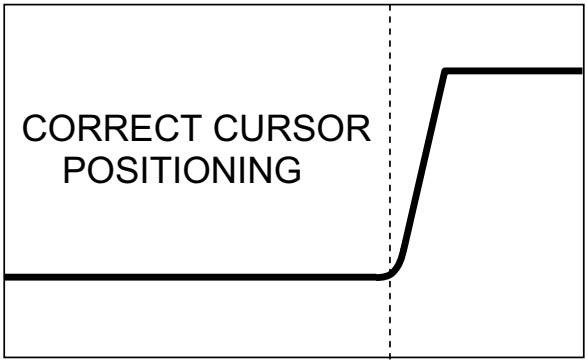


Figure 2-37

Plot with Cursors 1 & 2 on Providing Differential Data

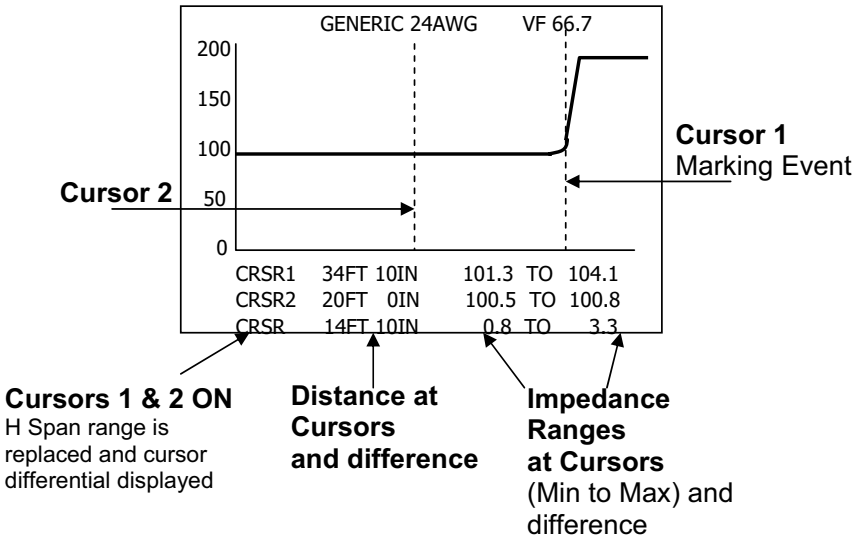
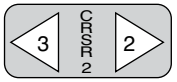


Figure 2-38

Controls: 

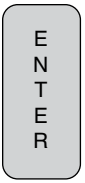
The CURSOR 2 key controls the left right movement of this cursor. When pressed it, automatically adds Cursor 2 to the display along with the distance and impedance readings at the cursor. This addition changes the plot by eliminating the H Span's range markers and adds both the Cursor 2 data and a line of Cursor Δ (difference) data.

To turn CURSOR 2 off, press the CURSOR 2 ◀ repeatedly until the cursor is off the plot on the left side.

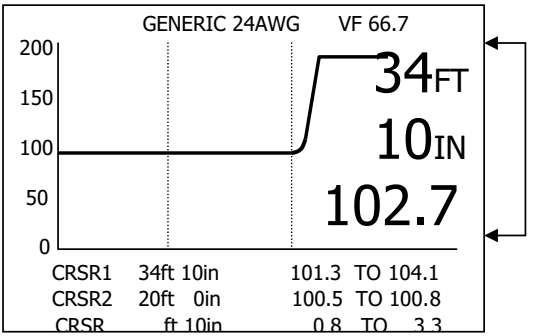
Cursor Δ Displays Cursor 1 and Cursor 2 differential information for both the range and impedance. As long as Cursor 1 is in the lead or right-hand position in reference to Cursor 2, the range difference will show positive numbers for greater ranges at Cursor 1 and the impedance will be positive if greater impedances are at Cursor 1. If the cursors are reverse; in other words, Cursor 1 is moved to the left of Cursor 2; the polarity of the readings for both range and impedance will also reverse.

ENTER Key Hides/Reveals Cursors

When either of the cursors is on, their data fields may mask other information at the bottom of the Measurement Screen's display. Rapid access to that information is accomplished by pressing the ENTER key once to hide the cursor(s) and pressing it again to reveal the Cursor(s).



Plot with Cursors 1 & 2 on and Enlarged Data (Cursor 1 only)



CURSOR 1 DATA ENLARGED
Impedance reading is presented as an average of the min/max.

Figure 2-39

Controls: 

Select BIG NUMBERS on the menu list and press any ▶ to turn on the Big Numbers. Then press F1 to return to the measurement screen. The large digits improve visibility when standing further away from the TDR or in difficult lighting conditions. Additionally, the large digits display average impedance at Cursor 1.

In order to present the larger digits on the LCD, the H Span on the plot must be reduced slightly. This reduction is noticeable on the right side of the LCD and in the preset range jumps when using the ZOOM key. To see a complete list of the preset range changes refer to the TDR Setup and Operations section, F3 key menu, H Span settings.

EXAM/PLOT Display Changes

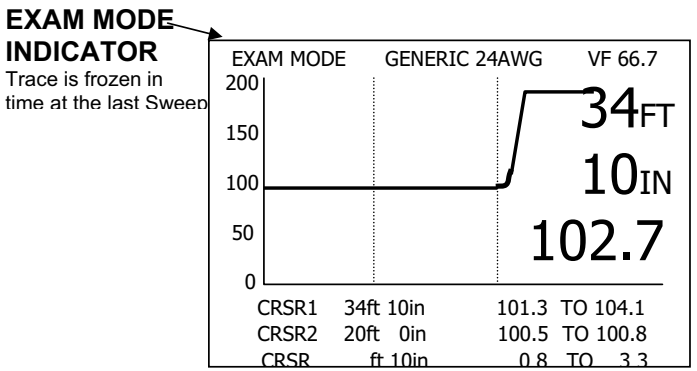


Figure 2-40

Control:

When a plot is displayed and a trace from the cable needs to be examined closer, but while physically away from the cable access point, press the EXAM/PLOT key once. This will freeze the trace and permit time to use the ZOOM, STEP or CURSOR keys to examine specific points on the trace or the entire trace more closely after disconnecting from the cable. The test leads or cable need not be connected once in EXAM mode as there are no more live sweeps updating the plot.

In some cases it is advantageous to "Freeze" the trace, then take the time to examine events along the trace. One use for this feature is to disconnect the TDR from the cable and carry it along as the cable run is walked and examined. A noted physical defect or connection points can be examined more closely on the plot to decide if they are or are not significant events. Since the velocity may be unknown on some cables, walking to known measured points and marking them on the plot with the cursor can help decide if the Vf is set too slow or too fast. It will also help orient the position of events at an unknown distance.

Press EXAM/PLOT a second time to resume the sweep action and a live trace.

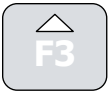
EXAM/PLOT will also exit a memory plot being displayed and return the display to a live trace.

This completes the Setup and Operational section of the manual. Again, AEA recommends reading the Theory and Applications section to gain more insight into what the 20/20 TDR can do to make TDR measurements easier to perform and understand the different reflection patterns that may be encountered.

3. ADVANCED FEATURES

PULSE Mode

Both the Introduction and Theory and Applications sections discuss the basic difference between a Pulse TDR and a Step TDR. If a user is accustomed to using a pulse TDR and wishes to see the reflections on 20/20 TDR in pulse format, that mode can be selected as follows:

Controls: 

Press F3 and select the STEP or PULSE. Press any ▶ once to select NARROW PULSE and twice to select WIDE PULSE. Being familiar with pulse TDRs you would normally use the narrow pulse for short range cables or fault examination and the wide pulse for long range. Since the 20/20 TDR is still transmitting and receiving in the Step Mode and only changing the presentation to pulse mode, this selection will not change your ability to see faults or the end of cable. Although the further away a fault is along the length of the cable, the better it can be seen in the V Scale axis when in wide pulse mode.

Figures 3-1 & 3-2 show two views of the same cable in both Step and Pulse modes:

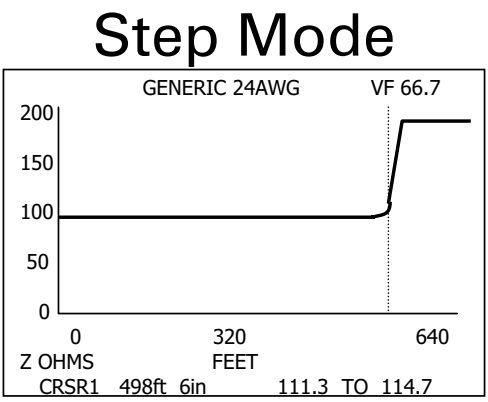


Figure 3-1

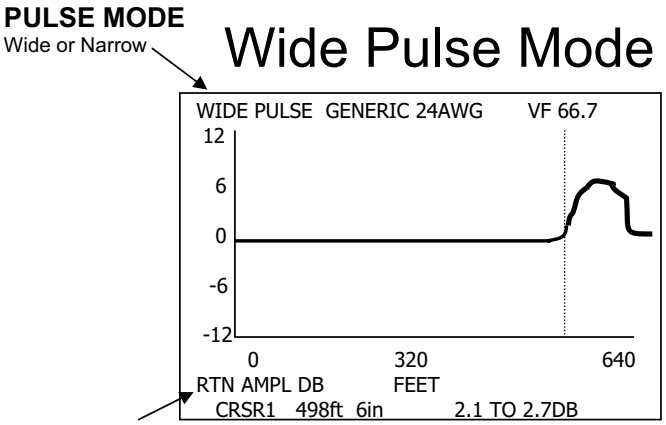


Figure 3-2

When in the Wide or Narrow Pulse mode the V Scale reading will change to reflect the approximate Return Amplitude in dB. If the Narrow Pulse were selected for a cable with this approximate length and similar loss the Return Amplitude reading would be less than half that of the Wide Pulse.

While most simple events will appear the same as a regular Pulse TDR, more complex event like bridged taps with end sections may appear quite different. Please refer to the Theory and Applications section to see examples of these different events.

DIFFERENTIAL Mode (Multi-channel models only)

The Differential Trace mode of operation can be extremely helpful in comparing two cable pairs that should be fairly identical. The 20/20 TDR sweeps both pairs and presents a single trace that displays the difference between the two. In other words, where the impedance is equal in both pairs sweeps, the line will remain horizontal (at near zero Ohms) along their length. If both pairs have an equal amount of deviation in the same manner at exactly the same distance (i.e. 3ft or 1 meter splice) with 10 Ohms added impedance, the line will remain horizontal along the H Span. However, in a case where only one pair has a splice with 10 Ohms of variation for 3 feet (1 meter), the trace line will show the 10 Ohms of deviation beginning at the splice. If only one line is open or shorted, the trace will show where the line opens or shorts. The TDR chooses which cable is "first" and which is "second." If the second cable opens before the first, the trace will drop to –999 Ohms (i.e. first=Zo – second=∞; truncated to –999 Ohms). Based on this method of operation, two pairs with equal and opposite events at the same distance will still show the user a difference at that distance.

In the example that follows, one of the two pairs being compared is open at 498ft 6 inches. Since this is the first significant event, one can assume the two pairs are relatively identical from the TDR or test lead ends until 498 ft. At this point the differential reading shows the significant change that was the goal of the function. Readings beyond this point would vary depending on how the second cable terminates.

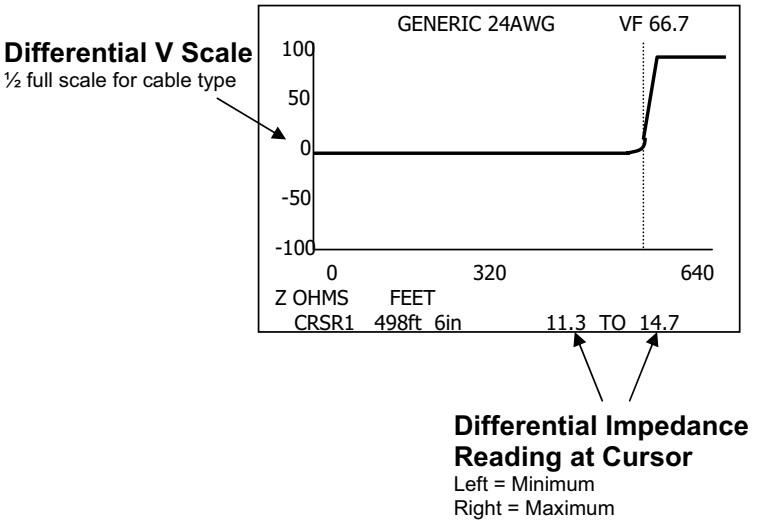
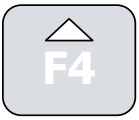


Figure 3-3

Controls:



Press the F4 key and select INPUT CHANNEL. There are several selections in this menu for different twisted pair types that indicate (Δ) for differential. Select the twisted pair cable standard and Δ pairs desired. Press any ◀ ▶ key to scan through the selection and use Channel Translation Table in Appendix B to select the desired pairs. Press ENTER or F1 to return to the Measurement Screen.

Connect both pairs at the same time to the test lead pairs chosen for a differential reading. Note the trace in the plot and mark the distance to any deviations from the horizontal trace centered on the V Scale.

More information about using the Differential Mode is addressed in the Theory and Applications section.

INTERMITTENT GRABBER (Detection)

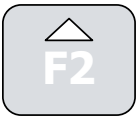
The Intermittent Grabber mode is designed to capture transient events, paint them in a bold manner on the plot, and retain the bolded trace. This permits the user to move away from the TDR to manipulate the suspect cable at different positions and return to see if the trace has changed. Additionally, a continuous tone can be employed to help with fault detection. The tone is reactive to any change in impedance at the cursor and changes frequency as impedance changes.

NOTE: Before engaging the Intermittent Grabber mode, first connect the cable to be tested and adjust the V Scale and H Span to view the entire cable or segment desired.

Controls:

Press the F4 key and select INTRMTMENT GRAB mode. Press any ▶ key to turn ON the mode, then press ENTER to activate and return to the measurement screen.

Optional Control:



If unable to view the TDR's LCD screen for impedance changes while manipulating the cable or its connections, AEA recommends using the audio tone to signal any change in impedance.

Press the F2 key and select AUDIO MODE. Press any ▶ once or twice, as required to select the CONTINUOUS audio tone. Then select AUDIO VOLUME and press any ◀ ▶ keys to adjust the volume. When ENTER is pressed the tone will adjust it's frequency to the trace's impedance at the cursor*. If the impedance changes at the cursor, the tone will change to indicate that an intermittent event has been recorded. For this reason it is important to position the cursor at a point beyond the suspected fault, but not beyond the end of the cable. This is the part of the trace that will change when the fault occurs.

*NOTE: Audio tone will follow either active cursor. If both cursors are active at the time of choosing this function, the audio tone will follow Cursor 1.

Locating the intermittent fault can now be accomplished by moving the cable in suspect locations (i.e. connection points, suspension points, loose spans, etc.). Remember the 20/20 TDR's sweep phase is approximately 1.5 seconds. Each time a change is made in the cable or a connector's position be sure to hold that change for a 2 second count for the sweep to see the change and record the event. Figure 3-4 is an example of an "intermittent open" changes encountered when the 20/20 TDR detects a change in impedance. The change point to the end of the cable will be blacked out and frozen to permit examinations later.

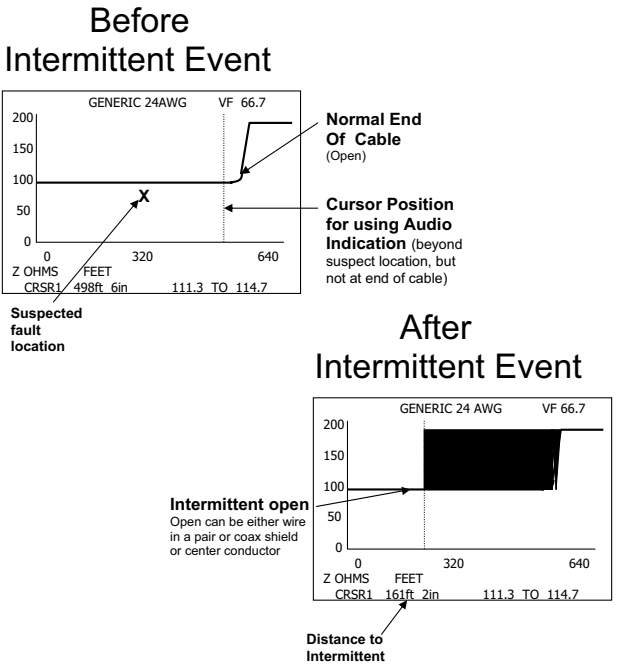


Figure 3-4

The 20/20 TDR will present a solid indication that the impedance changed. If the intermittent event and the cable's termination are same type of event, either both open or both shorts, the distance to the intermittent event can be accurately measured. If the events are opposite type events (1 open and 1 short), the plot will show erratic broken dark areas or total dark trace, even if the event was at the end of the cable away from the TDR. Normally, this is not a problem as you now have located the spot that caused the event. However, should a distance measurement be required, change the end of the cable to the opposite termination (If was open, short the end, if it was shorted, open the end). Then return to the spot that caused the intermittent event and trigger it again. This time a clean demark point should appear that permits a distance measurement.

FAULT FINDER

The Fault Finder feature is designed to scan the trace during the measurement and jump Cursor 1 directly to a fault or suspect fault condition. The determination factor for locating a fault or suspect fault is user defined. This is accomplished by selecting minimum and maximum acceptable impedance for the cable. Both a high impedance and a low impedance defines what the zone or limit in which the impedance is considered normal or acceptable deviation. The 20/20 TDR will mark the first reading outside the limits specified. This deviation limit should be set to a value that will find faults, but skip unimportant events (i.e. good splice). If set too high the Fault Finder will jump right past events of interest, if set too low the cursor will jump to a small event on the cable. With some experience using a TDR, users can become very proficient at selecting the limits for the types of cable networks they look at in the course of work.

Controls:

Press the F4 key and select FAULT FIND. Press any ◀ ▶ key to open the Fault Finder Threshold Selection Screen

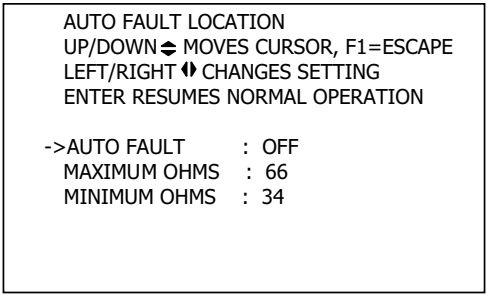


Figure 3-5

Step 1 – Use the ▲▼ key to align the cursor with AUTO FAULT, then use any ▶ key to select ON.
Step 2 – Select MAXIMUM OHMS by moving the cursor to that line and press any ▶ key. This will open a number entry screen as shown in figure 3-6.

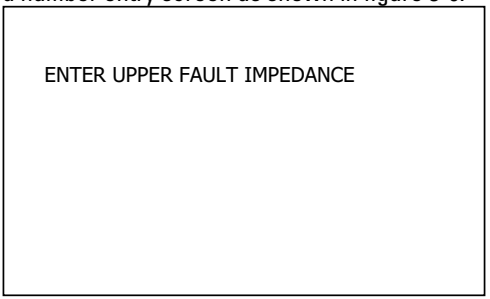


Figure 3-6

Step 3 – Use the numeric keys to enter a value for the upper acceptable impedance. Press ENTER to use the value displayed. The screen will return to the Auto Fault Location screen.

Step 4 – Select MINIMUM OHMS by moving the cursor to that line and press any ▶ key. This will open a number entry screen as shown in figure 3-7.

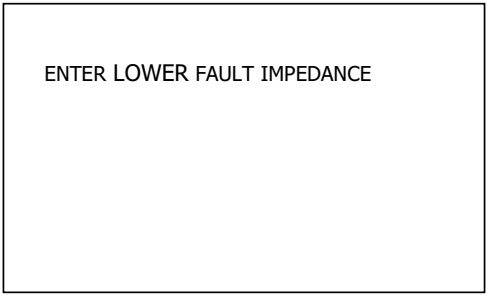


Figure 3-7

Step 5 – Use the numeric keys to enter a value for the lower acceptable impedance.

Press ENTER to use the value displayed. The screen will return to the Auto Fault Location screen.

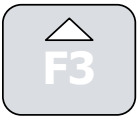
Step 6 – Press ENTER again to activate the Auto Fault Find mode and return to the measurement. Cursor 1 will jump to the first point on the trace exceeding the Z limits. The words "FAULT FIND" will appear in the upper left corner of the LCD screen to indicate this mode is active.

NOTES: 1. If Cursor 2 is activated when Fault Finder is turned on, the cursor will be deactivated until activated again by pressing the CRSR2 key ▶.
2. When either Cursor 1 or Cursor 2 is manually moved with the ◀ ▶ keys, the Fault Find mode turns off and releases the cursors to user control. To re-enter the Fault Find mode press F4, Any ▶ twice and ENTER. The limits previously set will used.

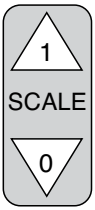
SWR (Standing Wave Ratio)

SWR is a ratio of the signal (power or voltage) that will be reflected back to the transmitting source by impedance mismatches along a transmission line. A ratio of 1:1 indicates there is no impedance mismatch and that all the power transmitted will travel the length of the transmission line. This is an ideal situation that will never exist in the real world, so it becomes effective to document and understand that some amount of the power injected into a transmission line will reflect back to the source. The SWR feature in the 20/20 TDR measures the actual impedance of a cable and calculates the SWR ratio by comparing the measured impedance against the manufacturer's specified impedance. For example: connect a 50 Ohm coax cable, select a 50 Ohm cable type, and the measured impedance is either 48 Ohms or 52 Ohms, then the cable will have a an SWR of 1.04:1. SWR readings do not indicate if the impedance (Z) is above or below normal. Thus the impedance (Z) offers more useful information about the cable. The lower the SWR (closer to 1:1) the better the cable. The higher the SWR, the more power that will be reflected back to the transmission source.

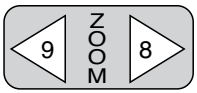
Controls:



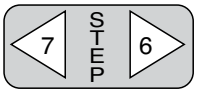
Press the F3 key and select PLOT TYPE. Press any ◀▲▼▶ key once to change the Plot Type from Z OHMS to SWR and then press ENTER to return to the Measurement Screen. This will change the Plot as detailed below.



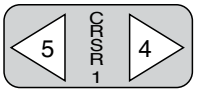
The SCALE key will control the V Scale by using the ▶ to range the SWR. Since this is a ratio, the lowest reading is a 1. A reading of 1 is a 1:1 ratio, or no reflected power.



The ZOOM key will control the full range of visibility along the cable by changing the plot's range in H Span.



The STEP key will jump the window of visibility in the H Span in the same manner as with the TDR mode.



The CURSOR keys will control the cursors and provide an SWR reading at specific points along the cable as marked by the cursor(s).

SWR

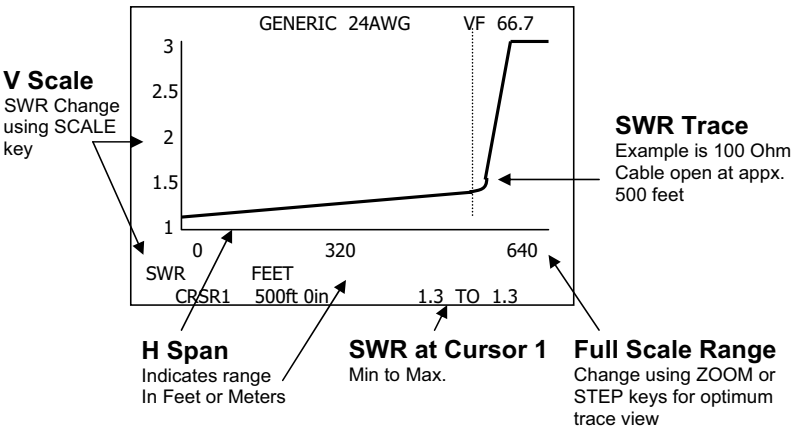


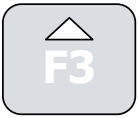
Figure 3-8

The 20/20 TDR not only displays a cable's SWR, but has the ability to show what the SWR is any point along the cable. A gradual and relatively linear increase over a cable's length is normal. A sudden jump at a particular spot in the cable indicates an impedance mismatch that should be examined in the TDR mode. Conversely, an impedance mismatch found in the TDR mode can be quickly translated into it's affect on the overall SWR for a given cable.

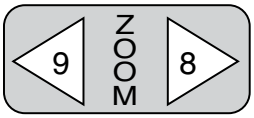
RTN AMPL DB (Return Amplitude in decibels)

Another measurement related to SWR and Z Ohms is Return Amplitude. Like SWR, it is a measurement of the power being reflected back to the transmission source by impedance mismatches along the length of the cable. In this mode the reflected power is expressed in decibels (dB).

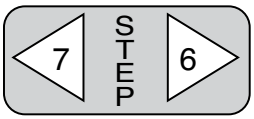
Controls:



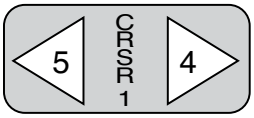
Press the F3 key and select PLOT TYPE. Press any ▶ key once or twice to change the Plot Type from Z OHMS or SWR to RTN AMPL DB and then press ENTER to return to the Measurement Screen. This will change the Plot as detailed below.

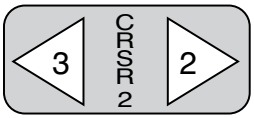


The ZOOM key will control the full range of visibility along the cable by changing the plot's range in H Span.



The STEP key will jump the window of visibility in the H Span in the same manner as with the TDR mode.





The CURSOR keys will control the cursors and provide a Return Amplitude reading at specific points along the cable. It is important to remember that the Return Amplitude reading is actually a total Return Amplitude from the TDR connector to the marked point at the cursor.

Return Amplitude Display

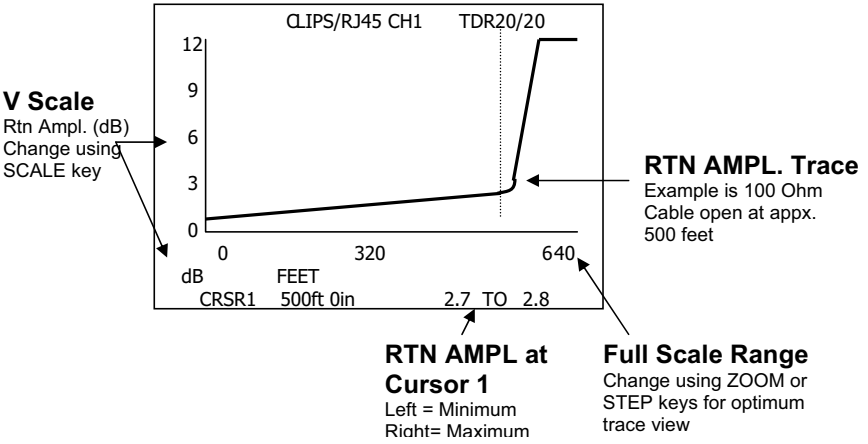


Figure 3-9

4. TDR PC Vision Software

Introduction

AEA Technology's PC Vision™ software is designed to work in concert with and to enhance the capabilities the 20/20 TDR. The true resolution and accuracy of the 20/20 TDR is most apparent when viewing it's measurement results on a full size color display of a monitor or laptop as opposed to the hand-held convenience of it's LCD. TDR PC Vision uses a serial interface to communicate between the PC and the 20/20 TDR to perform all of the following functions:

- Upload and display 20/20 TDR stored plots or live plots
- Viewing plots in MS Window's graphical display format
- Permit the saving, exporting or file re-formatting of plots to meet the user's requirements
- Take remote control of the 20/20 TDR to change the setups
- Copy plots into documents to enhance text information about a cable condition
- PC COM Port Setting

Installation

TDR PC Vision software can be found on the CD-ROM enclosed with the 20/20 TDR or on AEA Technology's web site at www.aeatechnology.com. When looking on the CD-ROM, open the "Software" folder to locate the installation files. Installation can be performed from the CD or by copying the folder's files to a directory on your PC or Laptop's hard drive.

NOTE: Some older versions of Windows and some Windows XP version installations do NOT have all the dll files required to operate TDR PC Vision software. If during installation you receive a message that indicates files are missing or if the installation fails to complete properly, exit the SETUP routine and run the "DOTNETFX.EXE" application. This application is included on the CD in the Software folder or can be downloaded directly from Microsoft's web site. DOTNETFX is not on AEA's web site as part of the download because it is a very large file that most people will not require.

Installation Steps

1. Place AEA Technology's CD in your PC's CD-ROM drive.
2. Use Windows Explorer to view the CD's directory as shown in figure 4-1.

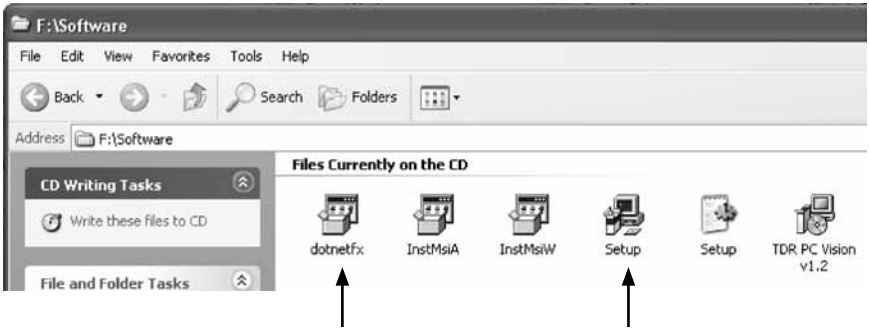


Figure 4-1

3. Double-click on the Setup file shown in figure 4-1. (Optional is to copy the contents of the "Software" folder to a directory on your PC hard drive and start the installation from that directory. In either case the results should be a dialog box as shown in figure 4-2

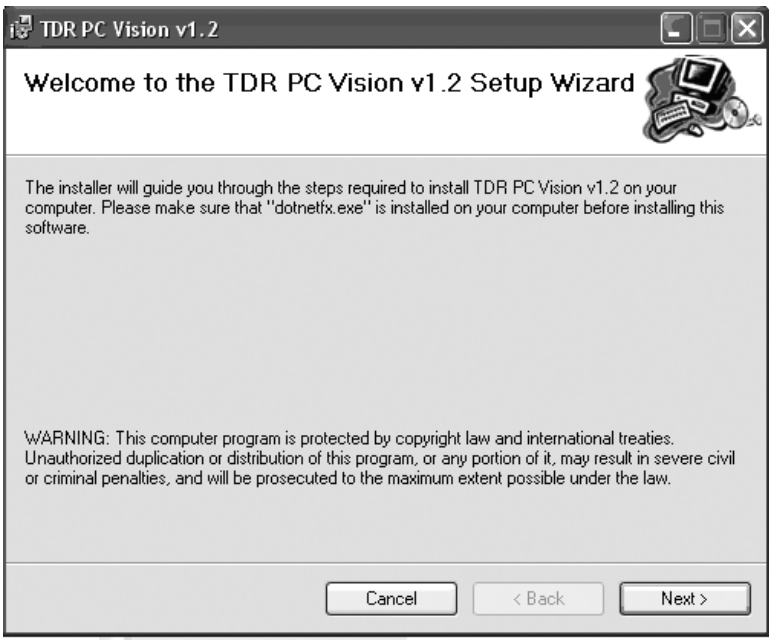


Figure 4-2

4. Click on the "Next" key to start the installation. The next dialog box will be a shown in figure 4-3

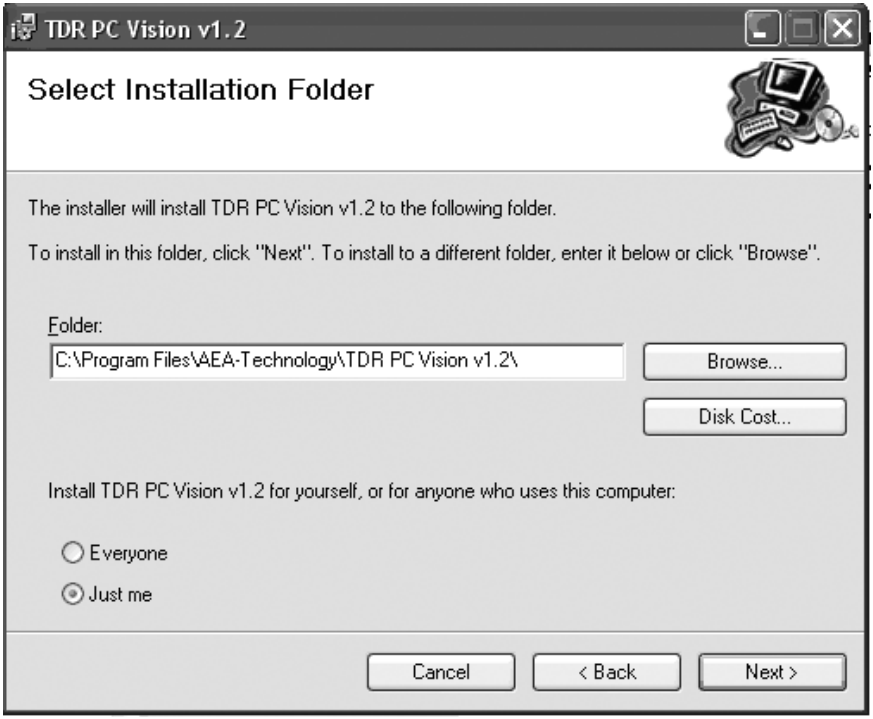


Figure 4-3

5. AEA Technology recommends accepting the default installation folder (Figure 4-3), however the Select Installation Folder dialog box offers an option to select a different folder for installation. Enter a folder or click on "Browse" to choose a folder for installation.

   The "Disk Cost…" button will display a list of available disks for installation along with the memory space available and the required space for installation.

   Select either "Everyone" or "Just Me" depending on your preference as to who should have access to TDR PC Vision on your PC. Everyone will let all logins have access, Just Me will limit access to your login only.

Press the "Next" key when ready to start the installation.

Figure 4-4

6. Follow any installation dialog or error messages that may be presented. As successful installation will be ended with the “Installation Complete” box shown in Figure 4-4. Press the “Close” key to exit the installation process.

NOTE: If a desktop icon (shown in figure 4-5) does not automatically appear on your PC, it can be created by using Windows Explorer to locate and open the application in folder: C:\Program Files\AEA-Technology\TDR PC Vision ver x.x. Right click on the file “TDR Vision.exe.” In the menu presented position the mouse on “Send To” and in the sub-menu select “Desktop (create shortcut).”

Figure 4-5

Getting Started with TDR PC Vision

Preliminary

The TDR PC Vision application normally expects to be used with a 20/20 TDR connected to a serial port. Before opening the application connect the 20/20 TDR to the PC using the enclosed serial cable.

Steps

1. Open the TDR PC Vision application by either double-clicking the Desk Top icon or by opening Windows Program Folders, locating the PC Vision folder and double-clicking on the executable file.
2. If the 20/20 TDR is connected, powered on and in the Measurement Mode, the TDR PC Vision application will search the available serial ports to locate the TDR and establish communications. If the 20/20 TDR is not connected, click “Ignore” to use the program.
3. When communications are established or Ignore is selected, the user Options window shown in Figure 4-6 will appear. The Options window has three tabs for operating TDR PC Vision: Get Plots, COM Port Utilities, TDR Setup.

Options Window with “Get Plots” Tab Open

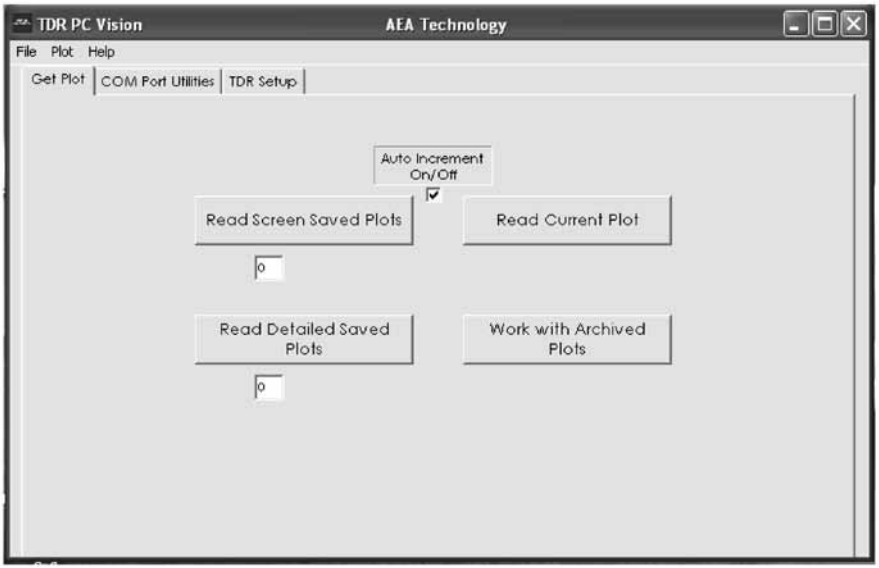


Figure 4-6

NOTE: If you receive the dialog box indicating no 20/20 TDR could be located, as shown in figure 4-7, this could indicate any of the following conditions:

A. The 20/20 TDR's power is off
B. The 20/20 TDR is in the Menu Mode
C. The serial cable is not connected
D. Another application is using the same serial port making it unavailable
E. Or this may be the condition desired for operating

Figure 4-7

Abort – Select this option to back out of the TDR PC Vision and close the application

Retry – Select this option after correcting any of the error condition listed in A through D above.

Ignore – Select this option to operate TDR PC Vision without a 20/20 TDR connected (condition E above). This mode permits reading, printing or exporting saved plots on the PC only.

Selecting "Retry" or "Ignore" should take you to the Get Plots screen in

Figure 4-6. If Retry does not open the Get Plots screen, refer to the Troubleshooting Table in Section 5 of this manual.

4. The Get Plots screen offers each of the following action buttons:

"Read Screen Save Plots" – This button will retrieve the "Screen Saves" stored in the 20/20 TDR starting with memory cell entered into the action button's number entry window. If the number "0" is not changed, it will start with the first Screen Save memory cell. (See "Auto-increment" below)

"Read Detailed Saved Plots" – This button will retrieve the "Detailed Saves" stored in the 20/20 TDR starting with memory cell entered into the action button's number entry window. If the number "0" is not changed, it will start with the first Detailed Saved memory cell. (See "Auto-increment" below)

"Read Current Plot" – This button will read the plot currently displayed on the 20/20 TDR and freeze that plot on the PC monitor.

"Work with Archived Data" – This button will open a plot previously uploaded and saved on the PC, floppy, CD or other memory media loaded to the PC.

"Auto-Increment ON/OFF" – When checked, this option will sequence in ascending order through the Saved Screen or Saved Detailed plots stored on the 20/20 TDR. This is extremely helpful to upload several plots without having to manually sequence the number window for the action button. The TDR PC Vision application will increment the number automatically.

"Read Screen Saved Data" and "Read Detailed Saved Data"

Preliminary

If this upload is a sequence of Screen Saves or Detailed Saves ensure "Auto-Increment" is ON by clicking to enter a check in the box. If the uploads will be random memory cells "Auto-Increment" can be turned off by clicking on the check mark.

Steps

1. Enter the memory cell number for first Screen Save (Detailed Saved) desired to upload.
2. Click on the "Read Screen Saved Data" or "Detailed Saved Data" button once.
3. Review the screen as shown in Figure 4-8 to ensure the uploaded plot is the saved plot desired.

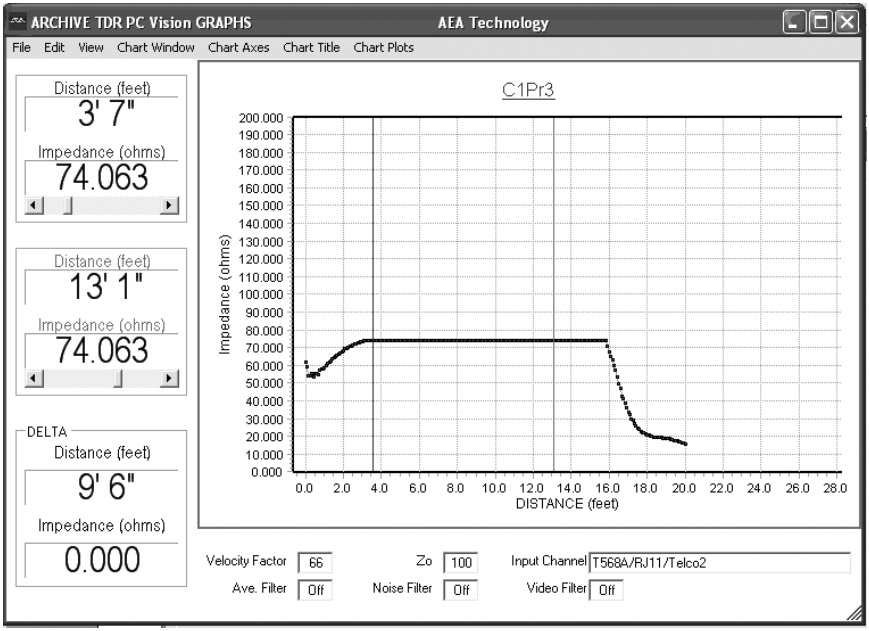


Figure 4-8

NOTE: TDR PC Vision will now have two active windows – the Options window and the displayed data and graph window. This also makes it possible to have more than one Saved Plot display open at once.

CAUTION: <u>Only the last plot read is available for Archive.</u> If you desire to archive a plot, this MUST be accomplished prior to reading another plot from the TDR. A similar caution applies to resaving archived plots.

TDR PC Vision GRAPHICS

Chart Title – Will open with the name of the Screen Save (Detailed Save) entered into the 20/20 TDR memory. TDR PC Vision has an option in the pull down menu bar to edit this name for saving on the PC.

Cursors 1 & 2 – Cursor data for both are shown at the left in Blue for Cursor 1 and Red for Cursor 2. The cursor difference (Delta) data is in the third block at the bottom. Cursors are controlled by right clicking on the vertical line (look for Windows Cursor) and moving it left or right as desired with the right click button depressed.

Graphic Plot – Is similar to the 20/20 TDR, which presents the Impedance (Z) on the vertical (left) axis and the distance on the horizontal (bottom) axis. The graph for a Screen Save will appear as the LCD's screen was saved on the 20/20 TDR.

Plot Size - The size of the plot can be altered in two ways:

A. By dragging mouse draw a rectangle from upper left to lower right of desired view area.
B. Click on "Chart Axes" then "Axes Editor" in the menu bar and enter the values desired for each axis. Be sure to deselect the "Autoscales" box so the entered values can be applied.

Measurement Parameters – The Velocity Factor, Z, Input Channel, Noise Filter and Average Filter all show the values used at the time the measurement was taken. These cannot be altered on the PC. The Video Filter only operates on the compressed data of the LCD and has no effect on the PC plots. It's setting is uploaded but not applied to the trace on the PC graph.

Pull Down Menu Bar

Many of the items in the pull down menu bar work exactly as they do in any other MS Windows applications. Explanation on these items will be minimized or eliminated for economy of words.

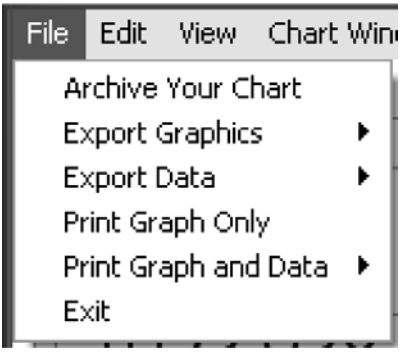


Figure 4-9

File

Menu as shown in Figure 4-9

Archive Your Chart – Offers standard Windows File Save options. Files will save with the default (*.AEA) extension unless otherwise specified.

CAUTION: Only the last plot read is available for Archive. If you desire to archive a plot, this MUST be accomplished prior to reading another plot from the TDR. A similar caution applies to resaving archived plots.

Export Graphics – Sub-menu offers exporting the graph ONLY (no cursors or parameters data) in BMP, JPEG, GIF or TIFF format.

Export Data – Sub Menu offers exporting the graph, cursors and parameter data in MS Word, MS Excel, HTML or XML file format.

Save Report as Delimited Text – Will save as comma delimited text file (*.txt).

Print – Prints graph ONLY to selected printer via a page setup window.

Print Graph and Numbers – Prints the full plot with cursor and parameter data as it appears on the screen at the time this menu item is executed.

Exit – Exits plot display.

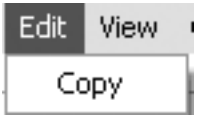


Figure 4-10

Edit

Menu as shown in Figure 4-10

Copy – Copies the plot, graphics and data, to MS Window's Clipboard. This image can then be pasted into any MS Windows compatible file or into the Paint accessory for cropping or embellishment before saving, printing or pasting in another file.

Figure 4-11

View

Menu as shown in Figure 4-11

Cursor Values Displayed – (Default) Click on this item to exit "Maximize Plots" and see the cursor data.

Maximize Plots – Click on this item to remove the cursor data and enlarge the graphical display.

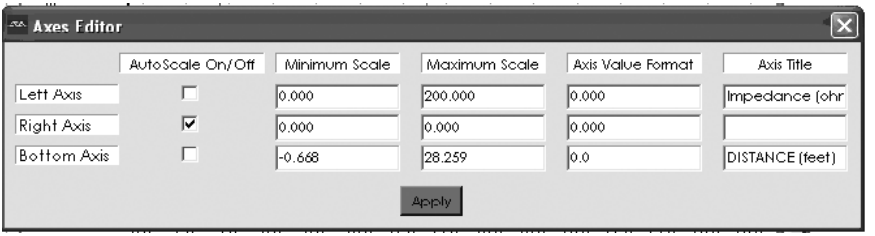


Figure 4-12

Chart Axes

Pull down item will open the Axes Editor as shown in Figure 4-12

Auto Scale On/Off – When checked TDR PC Vision will auto select a scale based on the uploaded data. When unchecked the "Left Axis" and "Bottom Axis" data entry applies.

Left Axis – Controls for the plot's vertical or impedance (Z) scale. Enter the figures or "Axis Title" directly in the entry windows.

Right Axis – Not used with TDR PC Vision plots at this time.

Bottom Axis - Controls for the plot's horizontal or distance scale. Enter the figures or "Axis Title" directly in the entry windows.

Apply – Enters changes and exits "Axes Editor"

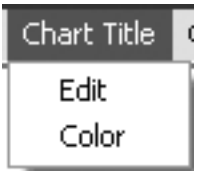


Figure 4-13

Chart Title

Menu as shown in Figure 4-13

Edit – Opens a sub-window to enter or edit the plot's title

Color – Opens a sub-window to select a font color for the title.

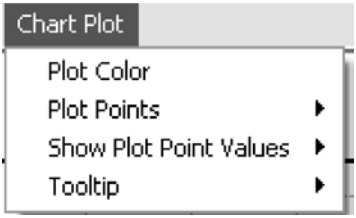


Figure 4-14

Chart Plots

Menu as shown in Figure 4-14

Plot Color – Opens sub-window to select a color for the trace line connecting the plot points.

Plot Points – Opens a sub-window to turn the points ON or OFF. With points ON a black dot will appear at each data point along the trace. If the points are close together, they may appear as a straight or curved line. Positioning the mouse on a data point with Tooltip turned ON will open a data box with X, Y or XY data as selected in Show Plot Point Values.

Show Plot Point Values – Opens a sub-menu to turn on X or Y Points only or both X & Y Points. These values will appear in the data point boxes if Tooltips is selected to ON.

Tooltip – Opens a sub-window to select ON or OFF. When ON, the plot points data will display when the mouse is placed on the plot point.

COM Port Utilities Tab

This tab provides a way to manually lock the COM Port to the desired port and set the Baud Rate for a slower PC serial port. Normally, action at this tab is not required. However, if the 20/20 TDR is powered on and connected via the serial cable to a COM port on the PC, but is not being found by TDR PC Vision when opening, click the "Ignore" button in the error dialog box and then click on the "COM Port Utilities" tab. The window in Figure 4-15 will open.

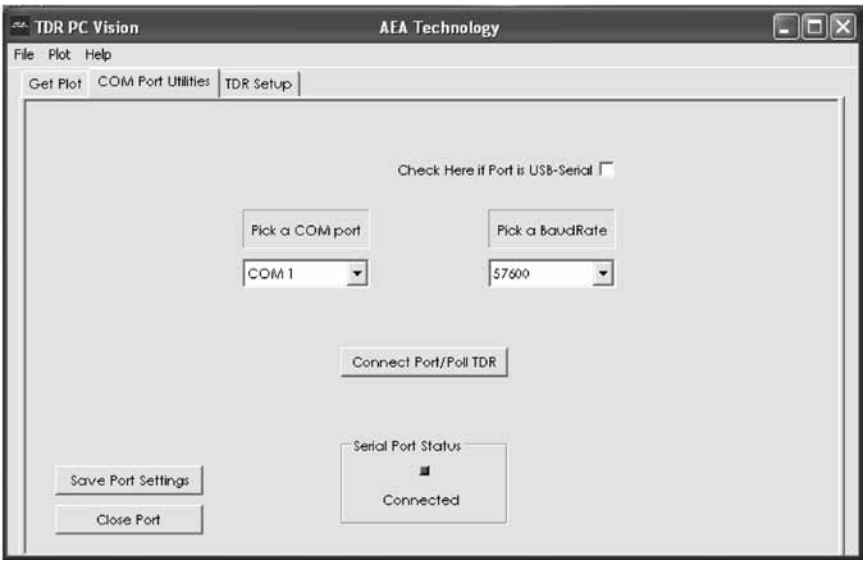


Figure 4-15

Pick a COM Port – Click on the down arrow to view a list of serial ports. Then click on the selected port to use.

Pick a Baud Rate – Click on the down arrow to view a list of Baud Rates. Then click on the selected Baud Rate that matches the baud rate set in the 20/20 TDR. The 20/20 TDR can be set to any of these baud rates and defaults to the highest rate. See Section 2, F2 Menu for instructions on changing the 20/20 TDR's baud rate. Remember, the baud rate set in the PC and the 20/20TDR must match for communications to be successful.

Connect Port/Poll TDR – Use this button after making changes to "Pick a COM Port" or "Pick a Baud Rate" to initiate the serial port connection.
Serial Port Status – Indicator will be green when connected to the TDR and grey if not
connected to the TDR.
Save Port Settings – Once connected to the TDR press this button to lock TDR PC Vision into looking at only this COM Port at only the set Baud Rate. This will open the TDR PC Vision faster by not searching the COM Ports for the 20/20 TDR.
Close Port – Pressing this button will terminate the COM Port connection to the 20/20 TDR and free up the port for another application while continuing to use TDR PC Vision to work with archived plots. Use the Connect Port/Poll TDR button to reconnect when the COM Port is available again.

TDR Setup Tab

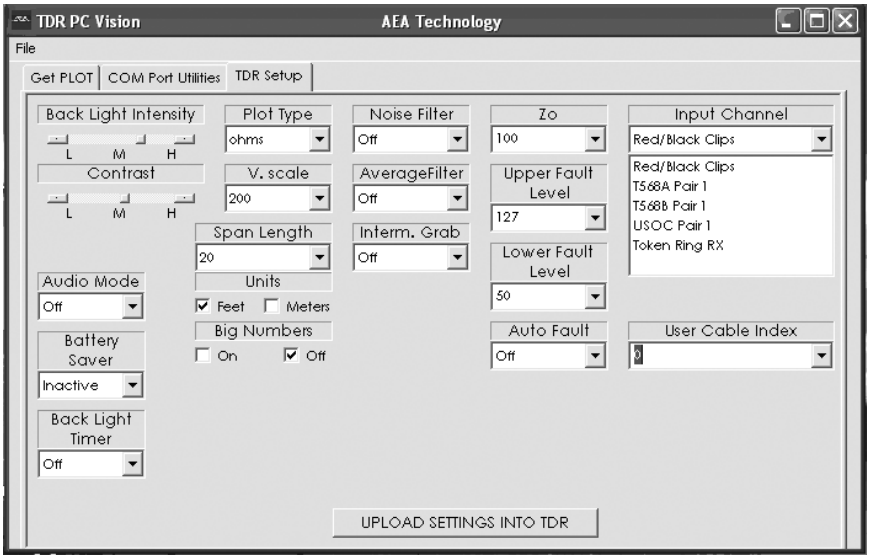


Figure 4-16

The TDR Setup Tab displays a series of parameter settings for the 20/20 TDR. These are all the instrument parameters that can be controlled remotely via TDR PC Vision. Simply select the parameter changes desired on the PC and when ready press "UPLOAD SETTINGS INTO TDR." In about 1 second the 20/20 TDR will jump out to the splash screen and display the word "CALIBRATING" in the center window. When it returns to the measurement screen the settings will be the ones selected on the PC. If it is desired to save these changes use the F4 Menu to Save Instrument (see Section 2 for complete instructions on this feature).

Backlight Intensity & Contrast – These parameter controls can be changed by clicking on the right or left control bar and note the selection value in the data box under the mouse pointer. The slide bar can also be used for control by clicking on it and dragging the bar left or right until the desired value is reached. Values are the same as listed in Section 2 under F2 Menu.

Units & Big Numbers – Both these items are selected by clicking directly on the box next to the desired value.

All Other Settings are controlled with pull-down menus activated by clicking the down arrow on the right and then clicking on the desired value. All values are the same as listed for the selected setting in Section 2.

Input Channel – This setting displays both the channel selected and its translation to all the other wiring schemes that use that same channel. A complete list of all the selection options in this pull-down menu is contained in Appendix B.

User Cable Index – This setting refers to the memory slot in the 20/20 TDR's User List of cables. Selecting a slot number here will call for using the cable listed in the 20/20 TDR in that slot. To choose a slot, press F5 and select "View User List" on the TDR. Scroll to the desired cable type and note the slot number at the bottom of the display. Select that slot number in the User Cable Index to call the desired cable type.

When all desired settings have been selected, click on "UPLOAD SETTINGS INTO TDR"

5. Maintenance, Service and Warranty

Operating Precautions

Although the 20/20 TDR is a rugged instrument, care should be taken to avoid exposing it to excessive external RF or DC voltage (either from a nearby transmitting site or from your own installation).
Before attaching the 20/20 TDR to a cable leading to an antenna, it's a good practice to briefly ground the feed line in order to shunt any accumulated static charge to ground.

External DC Power

If you wish to power the 20/20 TDR from an external DC source (other than the AEA's AC-1 wall adapter), ensure that it meets the following requirements :

- 2.1 mm (**+**) center pin DC power connector.
- Minimum 12 VDC (350 ma)
- Nominal 13.6VDC (250ma)
- Maximum 20VDC (250 ma)

Note: Quarter VGA Display performance is impaired when input is below 12VDC.
Positive polarity must be applied to the center pin of the power jack for proper operation.

Replacing Battery Cells

There are both rechargeable and non-rechargeable TDR models. A rechargeable model can be identified by an "R" in the part number. Example: 6020-R5000. If you have a non-rechargeable TDR you can use either 8 AA alkaline cells or externally rechargeable NIMH or NiCd batteries. If you have a rechargeable model you can also use 8 AA alkaline Cells, NiMH or NiCd. See the instructions below to ensure the internally charging circuit is ON for rechargeable cells and OFF for alkaline cells.

The 20/20 TDR was designed to let the user replace the 8 AA rechargeable cells with an equivalent set of NiMH 2000 mAhr cells or substitutes with more or less capacity. NiCd type cells, carbon or alkaline cells can also be used. In all cases the Battery Type and Battery Capacity MUST be set to the type of cells in use or the TDR, cells or both may suffer damage.
NOTE: If the replacement NiMH or NiCd cells have more or less mAhrs capacity, this will lengthen or shorten both operational and charging times respectively.

Steps

1. Remove all power from the TDR.
   NOTE: Removing power and removing the batteries will NOT cause a loss of stored traces or setups.
2. Open the battery cover and remove all old cells. Check the contacts to ensure they are clean and free of corrosion before new cell installation.
3. Install 8 new AA cells. Do NOT mix old and new cells or mix the type of cells. Then re-install the battery cover.
4. If rechargeable cells were installed, apply external power to the TDR.

5. Turn ON the TDR and press F2, select BATTERY MENU and set both the BATTERY TYPE and BATT CAPACITY per those menu item actions.

NOTE: If you install 8 AA Alkaline cells you MUST select "ALKALINE" battery type to prevent attempted recharging. If you select NICD NIMH, the Battery Status should read BATT CHCK when external power is applied.

6. Press ENTER, wait 2 - 3 minutes and return to BATTERY MENU. The Battery Status should now read CHARGING or PRE CHRG.

NOTE: Deeply depleted batteries may require a few conditioning charges and longer charge cycles before returning to normal cycles. If the status is still BATT CHCK or IDLE refer to the troubleshooting guide on the next page for potential reasons.

7. If Status is CHARGING or PRE CHRG, turn the TDR off and permit to charge overnight. If the Battery Type and Capacity have been set correctly, it can NOT overcharge the batteries. When charging is completed the status will return to TRICKLE.

NOTES: Charging times may vary depending on cell depletion, temperature, cell age, etc. Setting the cells capacity in the Battery Menu is important to provide the charger with correct information and prevent cell outgassing (leaking) or TDR damage. Est. Run Time: 0.0 hrs is normal for new cells until the charger learns their charge and discharge levels.

If the 20/20 TDR is to be stored for more than 30 days, the alkaline batteries should be removed. Battery leakage can seriously damage the 20/20 TDR's battery compartment and other circuits. Damage from battery leakage is not a factory workmanship issue and therefore not covered under warranty.

Cleaning

The 20/20 TDR is designed to operate in a variety of conditions and dirty environments. Cleaning on regular basis should be accomplished with a soft, water moistened cloth. If dirt must be removed, use a mild detergent sprayed on the cloth first. Do NOT spray detergents or water directly on the instrument. Avoid using solvents or ammonia based glass cleaners that can discolor the LCD protective cover and that may attack the plastic case or test lead insulation. Use orange based liquid or gel cleaner on a clean soft rag to remove cable gel from the instrument, test leads or carrying case.

The soft case should be cleaned in the same manner as the instrument, but a soft brush will help remove dirt, grime or cable gel. Always remove the carrying case from the instrument first. Washing in a machine or total immersion in soap and water is NOT recommended. Drying in a clothes drier or oven is also NOT recommended. Dry overnight on a clean cloth in fresh warm air.

The following are recommended cleaning agents for specific contamination:

Soil or light oily soil marks	Household glass cleaner (non-ammonia based)
Cable gel	Orange based gel or liquid cleaner non-abrasive
Tar, creosote or sticky adhesives	WD40 followed with household cleaner

NOTE: Always spray cleaners and rinse water on the cloth NOT the instrument. Wiping dry with a soft lint free cloth will improve appearance over air drying.

Contact Us

If you have any questions concerning instrument cleaning or care, please contact AEA Technology at 1-800-258-7805 M-F 7:00am – 5:00pm PST or by email at **techsupport@aeatechnology.com**

Return Material Authorization (RMA) Number

If after contacting AEA Technology's Technical Support, it is determined your instrument needs to return for calibration or repair, we need to issue you an RMA number to include on the package addressing. The RMA number will tell everyone handling your instrument exactly what to do, who to contact about repair costs, and who to return the instrument to when repairs are completed. It makes the entire process go smoothly and efficiently. Before returning any instrument for calibration or repair, in or out of warranty, be sure to contact us for an RMA Number and add that number to the AEA Technology address as it appears on the back of this manual.

Specifications

Specifications for the 20/20 TDR are contained in Appendix D.

Limited Warranty

AEA Technology, Inc., warrants to the original purchaser that the 20/20 TDR Analyzer shall be free from defects in material or workmanship for a period of one year from the date of shipment. All units returned to the factory, delivery charges prepaid, and deemed defective under this warranty, will be replaced or repaired at this company's option. No other warranties are implied, nor will responsibility for operation of this instrument be assumed by AEA Technology, Inc

There are no warranties that extend beyond express warranties stated herein. No other warranties are express or implied. AEA TECHNOLOGY SPECIFICALLY DISCLAIMS ALL IMPLIED WARRANTIES, INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. AEA TECHNOLOGY SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

Remedies for any breach of warranty, either express or implied, are limited to repair, replacement, or return of the instrument, at the option of AEA Technology. Any warranty is valid for the original purchaser only.

All warranties of performance are disclaimed.

AEA Technology assumes no liability for applications assistance or customer product design.

User Troubleshooting Guide

Some problems may be identified and solved by the operator. More involved problems will require factory service. To try to solve a problem yourself, refer to the chart below:

Symptom	Possible causes	Solutions
On power up, relays may click but there is no visible display	Display contrast setting	Press F2, Try any ◀▶, If contrast does not adjust, press F1, wait, press F2 again and 1 press of the ▼ and then the ◀▶ again. Repeat until you hit on contrast and see a display. Use the manual's printed menu to guide you in the F2 menu. Alternate Solution: Perform soft reset by pressing the ENTER key repeatedly while powering ON.
On power up, no relays click nor do I get a display	Power source or batteries	Try a second power source. If on batteries try the AC wall power if on AC wall power try a different outlet or changing to good batteries.
On power up, a display appears, but there appears to be no activity	Illegal instrument state	Turn OFF, then repeatedly press ENTER key while turning ON. This is a built in reset.
TDR has large offset distance	Cable nulling function is in wrong state	Set Cursor 1 all the way to the left. Press F5 & select "Test Lead Cal"
TDR's distance readings are in error	Wrong cable selected or cable Vf differs from manufacturers spec	Select correct cable type or use cable sampler function (F5 menu) to check actual Vf.
TDR PC Vision software		
No TDR Available	Improper baud rate selected, TDR not connected properly, TDR off or NOT in Measurement mode, other software has COM port tied up.	Set bauds rates to match. Verify serial cable connected to correct port. Close other applications that might conflict on the COM port. Turn on TDR and ensure it's in the Measurement Screen, not a Menu
Plot did not Archive or wrong plot archived	Multiple Plots open on PC	Upload saved plot again from TDR and Archive before opening another plot on the PC

Rechargeable TDR Power Troubleshooting Guide

Symptom	Possible Cause(s)	Correction
Operational time is getting shorter with each use.	Cells may be at or near mfg limit for number of recharges (nominal 750 times).	Lengthen recharge time, if no improvement replace cells with 8 new AA rechargeable cells (NiMH or NiCd)
Not very old cells stop recharging	1. Battery Type: NONE or ALKALINE selected. 2. Charging power is not sufficient or not on. 3. Battery Temperature too HOT or COLD. 4. Batteries are damaged, missing, or have dirty contacts	1. Set Battery Type and Battery Capacity to match cell type 2. Correct AC or DC input to TDR 3. Recharge at room temperature 4. Examine batteries and contacts correct any issues
TDR auto powers down when batteries still workable	By design to protect the cells & TDR from damage by operating at too low voltage	Operate on external power or change to fresh cells
Charger goes directly to IDLE or TRICKLE	Cells may already be fully charged	Use battery power only & check Battery Status for full charge
External power is applied, but Status is always IDLE or stuck in BATT CHK (Some of these symptoms are more likely to occur when a new set of batteries are installed)	1. Battery Type: NONE or ALKALINE previously selected. 2. Batteries may be damaged, defective, missing, improperly installed or have expired shelf life 3. Contacts may be dirty or corroded 4. External power may not be properly connected. 5. Non-AEA recommended power pack 6. Cells may be alkaline or carbon 7. Deeply depleted cells may take longer to condition	1. Set Battery Type and Battery Capacity to match cell type. 2. Replace with new set of batteries or install cells per polarity guides 3. Clean or replace contacts 4. Check external power (wall switch off, bad plug, broken cord, etc.) 5. Use correct power pack 6. Set battery type to ALKALINE 7. Have patience, recheck status in one hour
Charger Status jumps from BATT CHK to IDLE	1. Cells may be missing, damaged or defective 2. One or more cells is installed with polarity reversed	1. Replace with new set of batteries. 2. Reinstall cells per polarity guides
Can not call up Battery Menu	Unit's BAUD Rate is set lower than 57600	Change unit's BAUD Rate to 57600

Appendix A

AEA Technology's Cable Testing Accessories

INCLUDED ACCESSORIES/REPLACEMENT ITEMS

Each model has different included accessories suited to that model. Refer to Section 1, Accessory Matrix for identifying which accessories are included with which 20/20 TDR models.

Telco Test Lead Set
P/N 6020-0250

Coax "F"-to-Alligator Clips Leads
P/N 0070-1220

Coax "BNC"-to-Alligator Clips Leads
P/N 0070-1221

Serial Cable
20/20 TDR to PC (1/8" jack-to-DB9)
P/N 0070-1201

Universal Power Adapter
P/N 5001-0202

DC Vehicle Charger
P/N 6025-0250

Padded Soft Case
Includes: Belt Loop, Strand Hook & Shoulder Strap
P/N 5001-1002

OPTIONAL ACCESSORIES

Available from AEA Technology
or through your local AEA Rep or
Distributor

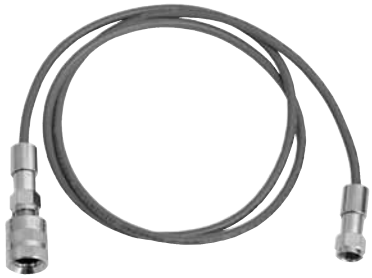
Soft Carrying Case
Reinforced sides, closed cell foam insert
and shoulder strap
P/N 6015-1002

Hard Carrying Case
Rugged weather tight with closed cell
foam insert & padlock holes
P/N 6015-1003

Rechargeable Batteries
8 AA pack of NiMH 2000mAhr each
P/N 0010-0218

RJ11 Shorting Plug
RJ11 Telco jack with Tip-to-Ring short on
both pairs 1 and 2

1 Each – P/N 6020-0260
Package of 10 Each – P/N 6020-0261
Package of 50 Each – P/N 6020-0262



F- Test Lead
Three foot lead with two F-male
connectors and one male quick connect
adapter
P/N 0070-1230

Appendix B

Input Channel Translation Table to Cable Pairs, Pins and Wires

Authority	Wire Map Scheme	Jack/ Plug Pins	Wiring Color Code	20/20 TDR Input Channel
AEA	Coaxial Connector	Coaxial	Alternative Red/Black Lead	COAX
Technology	Red/Black Clips	4 & 5	N/A	RJ45 CH A
Accessories	Green/Black Clips	3 & 6	N/A	RJ45 CH B
	Red/Blk & Green/Blk Clips	4/5 & 3/6	N/A	RJ45 CH A Δ B
TIA/EIA 568A	T-568A Pair 1	4 & 5	Blue/White	RJ45 CH A
	T-568A Pair 2	3 & 6	White/Orange	RJ45 CH B
	T-568A Pair 3	1 & 2	White/Green	RJ45 CH C
	T-568A Pair 4	7 & 8	White/Brown	RJ45 CH D
	T-568A Δ Pairs 1 & 2	4/5 & 3/6	Blue/White & White/Orange	RJ45 CH A Δ B
	T-568A Δ Pairs 1 & 3	4/5 & 1/2	Blue/White & White/Green	RJ45 CH A Δ C
	T-568A Δ Pairs 1 & 4	4/5 & 7/8	Blue/White & White/Brown	RJ45 CH A Δ D
	T-568A Δ Pairs 2 & 3	3/6 & 1/2	White/Orange & White/Green	RJ45 CH B Δ C
	T-568A Δ Pairs 2 & 4	3/6 & 7/8	White/Orange & White/Brown	RJ45 CH B Δ D
	T-568A Δ Pairs 3 & 4	1/2 & 7/8	White/Green & White/Brown	RJ45 CH C Δ D
TIA/EIA 568B	T-568B Pair 1	4 & 5	Blue/White	RJ45 CH A
	T-568B Pair 2	3 & 6	White/Green	RJ45 CH C
	T-568B Pair 3	1 & 2	White/Orange	RJ45 CH B
	T-568B Pair 4	7 & 8	White/Brown	RJ45 CH D
	T-568B Δ Pairs 1 & 3	4/5 & 3/6	Blue/White & White/Green	RJ45 CH A Δ B
	T-568B Δ Pairs 1 & 2	4/5 & 1/2	Blue/White & White/Orange	RJ45 CH A Δ C
	T-568B Δ Pairs 1 & 4	4/5 & 7/8	Blue/White & White/Brown	RJ45 CH A Δ D
	T-568B Δ Pairs 2 & 3	1/2 & 3/6	White/Orange & White/Green	RJ45 CH B Δ C
	T-568B Δ Pairs 3 & 4	3/6 & 7/8	White/Green & White/Brown	RJ45 CH B Δ D
	T-568B Δ Pairs 2 & 4	1/2 & 7/8	White/Orange & White/Brown	RJ45 CH C Δ D
Telcordia	USOC Pair 1	4 & 5	Blue/White	RJ45 CH A
	USOC Pair 2	3 & 6	White/Orange	RJ45 CH B
	USOC Pair 3	2 & 7	White/Green	RJ45 CH C
	USOC Pair 4	1 & 8	White/Brown	RJ45 CH D
	USOC Δ Pairs 1 & 2	4/5 & 3/6	Blue/White & White/Orange	RJ45 CH A Δ B
	USOC Δ Pairs 1 & 3	4/5 & 2/7	Blue/White & White/Green	RJ45 CH A Δ C
	USOC Δ Pairs 1 & 4	4/5 & 1/8	Blue/White & White/Brown	RJ45 CH A Δ D
	USOC Δ Pairs 2 & 3	3/6 &2/7	White/Orange & White/Green	RJ45 CH B Δ C
	USOC Δ Pairs 2 & 4	3/6 & 1/8	White/Orange & White/Brown	RJ45 CH B Δ D
	USOC Δ Pairs 3 & 4	2/7 & 1/8	White/Green & White/Brown	RJ45 CH C Δ D
	= Requires special adapter T-568A male to USOC female			

Authority	Wire Map Scheme	Jack/ Plug & pins	Wiring Color Code	20/20 TDR Input Channel
IEEE 802.3	10BASE-T Tx	1 & 2	White/Blue	RJ45 CH C
	10BASE-T Rx	3 & 6	White/Orange	RJ45 CH B
	10BASE-T Δ Tx & Rx	1/2 & 3/6	White/Blue & White/Orange	RJ45 CH B Δ C
ANSI X3.263	TP-PMD Tx	1 & 2	White/Blue	RJ45 CH C
	TP-PMD Rx	7 & 8	White/Orange	RJ45 CH D
	TP-PMD Δ Tx & Rx	1/2 & 7/8	White/Blue & White/Orange	RJ45 CH C Δ D
IEEE 802.5	Token Ring Tx	3 & 6	White/Orange	RJ45 CH B
	Token Ring Rx	4 & 5	White/Blue	RJ45 CH A
	Token Ring Δ Tx & Rx	3/6 & 4/5	White/Orange & White/Blue	RJ45 CH A Δ B

Abbreviated Channel Translation displays by pressing the F1 key twice.

RJ45 CH	TEL	568A	568B	USOC	10BT	TP-PMD	TKN RING
A	R/B	PR1	PR1	PR1			RX
B	G/B	PR2	PR3	PR2	RX		TX
C		PR3	PR2		TX	RX	
D		PR4	PR4			TX	
AΔB	RΔG	1 2	1Δ3	1Δ2			TXΔRX
AΔC		1Δ3	1Δ2				
AΔD		1Δ4	1Δ4				
BΔC		2Δ3	2Δ3		TXΔRX		
BΔD		2Δ4	3Δ4				
CΔD		3Δ4	2Δ4			TXΔRX	

TEL = Refers to the RJ45-to-telco style Popper clips test leads included.
568A & 568B are TIA/EIA standards for data cabling systems
USOC = Telco wiring pattern
10BT = Abbreviation for 10BASE-T wiring standard (IEEE 802.3)
TP-PMD = ANSI wiring standard
TKN RING = Token Ring (IBM) standard (IEEE 802.5)

Appendix C

Saved Instrument Setup Memory Table

Slot No.	Inst. Setup Name	Cable Type	VF	Zo
0	Reserved for	Power	OFF	Saves
1				
2				
3				
4				
5				
6				
7				
8				
9				

Make all entries in pencil to accommodate changes

Procedures for "Save Inst. Setup" can be found in Section 2, under the F4 menu's "Memory Action." Note the instrument setups saved here for easy reference and recall. Recall requires knowing the correct slot number where those setups are saved.

The table above notes only limited important information concerning the Instrument Setups that are saved. This feature will save all the setups entered via the function keys including the V Scale, H-Scale, and even the cursor positioning.

Slot 0 is used at each normal power off by the TDR to save the setups active at the time of the power down. Normal power downs are via the OFF key or Battery Saver timeouts. Abnormal power downs are an unexpected loss of power (i.e. DC power jack is pulled out, AC power failure or battery expiration with no battery saver timeout to protect the instrument).

Appendix D

20/20 TDR Specifications

Characteristic	AEA Technology 20/20 TDR
	Specification
Distance	
Range	0-6,600ft (2010m) (@ VoP =.66c 0-10,000ft (3047m) @ VoP =.96c
Resolution	1 in (2.54cm) 0-5000 ft 5'4" (1.63m)5000-10000 ft or 0.1% of span distance
Accuracy	<0.2% $\pm$ 1 inch (2.54cm) + VoP uncertainty
Impedance (Z)	
Range	1-1K Ohms
Resolution	0.1 Ohms
Accuracy	<2% @ 40< Z <120
Velocity of Propagation (VoP)	
Range	0.20 - 0.99c
Resolution	0.003c
Dead Zone	None - Soft Z readings $\leq$2 ft (600mm)
Output Impedance	75 Ohms
Pulse	
Amplitude	300mV Nominal into 50 Ohm load
Width	25 μsec Nominal
Repetition Rate	50 μsec Nominal
Rise Time	~1nsec
Operating Modes (step)	
Step Trace	Yes
Differential	Yes
Intermittent Detection	Yes
Exam/Plot (freeze trace)	Yes
SWR	Yes
Reflection Amplitude	Yes

Operating Modes (Pulse)	
Pulse Trace	Yes
Reflection Amplitude	Yes
Filtering	
Noise	4 levels
Video	4 levels
Averaging	7 levels
Display	
Type	Qtr VGA LCD, Backlit
Size	279 X 156 pixel, 2.8 X 1.45 inch (67 X 37.5mm)
Display Plots - Step Mode	
Impedance Scales	Z ±10, ±25, ±50; 0-200, 500,999 Ohms
SWR Scales	1:1 to 2:1, 3:1, 4:1, 8:1, 16:1, and 32:1
Reflection Amplitude (dBs)	0-2, 4, 8, 12, 24, 48 dBS
Cursors	2 with independent & delta distances & Impedances
Input Protection	
Operational	0-0.5VAC, 0-100VDC
Limit	300VAC or VDC
Advanced Features	
Auto Fault Locate	Yes
Intermittent Grabber	Yes
Cable Sampler	Yes
Test Lead Calibration	Yes
Audio Readout	Yes
Memory	99 Display Traces or 15 Full Traces or combinations thereof
Trace Export	Serial Port to PC. AEA supplied PC software and serial cable (DB9)
PC Software	"Vision" software supplied with 20/20 for trace upload, storing, printing & export to MS Excel
Power	
Batteries	8 AA alkalines, NiMH or NiCd

Battery Operating Times	Alkalines = 8 hrs nominal NiMH or NiCd = 9 hrs nominal from a full charge Backlight use will reduce operating time
Battery Charging Time	8 - 12 hours depending on state at the start of charging
AC Power	100-240VAC, 50-60Hz
DC Vehicle Power	13.3VDC minimum required, nominal when vehicle is running
Physical	
Size	8.5" (216mm) x 4.3" (109mm) x 2.25" (57mm)
Weight	1.9lbs (864g) with batteries
Environmental	
Operating Temperatures	-18˚ to +50˚C (0˚ to 122˚F)
Non-operating Temperatures	-20º to +70ºC (-5˚ to 158˚F)
Relative Humidity	0-95% non-condensing
Weather	rain & dust resistant
Drop Resistance	MIL-STD 810F transit Drop Protocol 122cm (48")

Specifications subject to change without notice

Detailed Save's Data Points Resolution			
TDR Screen Range	**Detailed Save Range**	**Data Points / Foot**	**Resolution**
Feet	**Feet**		**Inches**
10240	10240	0.1875	64
5120	5120	0.1875	64
2560	2560	0.375	32
1280	1280	0.75	16
640	640	1.5	8
320	320	3	4
160	320	6	2
80	160	12	1
40	160	12	1
20	160	12	1
TDR Screen Range	**Detailed Save Range**	**Data Points / Meter**	**Resolution**
Meters	**Meters**		**CM**
3200	3200	1	100
1600	1600	1	100
800	800	3	33
400	400	5	20
200	200	5	20
100	100	10	10
50	50	20	5
25	48	40	2.5
12	48	40	2.5
6	48	40	2.5

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