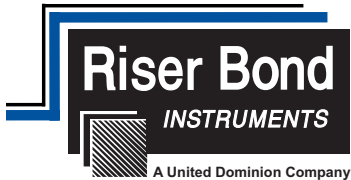


# Model 3200

Coaxial  
Metallic Time Domain Reflectometer

Operator's Manual



Thank you for purchasing Riser-Bond Instruments' Model 3200 Metallic Time Domain Reflectometer. Our goal is to provide you with a high quality troubleshooting tool which is both powerful and easy to use. We all share a commitment to quality and excellence, and will do our best to continue to provide you with test equipment to meet your needs. Please read the operator's manual thoroughly to insure the best results from your TDR. As always, Riser-Bond Instruments welcomes your comments and suggestions.

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## SECTION 1: GENERAL INFORMATION

### 1.1 Safety Information

Symbols:



Caution: Refer to accompanying documents.

**Warning** Any **Warning** sign identifies a procedure or process, which if not followed correctly, may result in personal injury.

**Caution** Any **Caution** sign identifies a procedure or process, which if not followed correctly, may result in equipment damage or loss of data.

### Warnings

Before using, review all safety precautions. Note and observe all warning and caution statements on the equipment and in the documentation.

Do not operate this instrument near flammable gases or fumes.

Do not modify any part or accessory of this instrument. If the unit is damaged, do not use. Make sure the product is secured from use by others.

To avoid electric shock, do not remove covers or any parts of the enclosure.

If the instrument or any associated accessory is used in any manner not detailed by the accompanying documentation, the safety of the operator may be compromised.

**Caution:** As with most electronic equipment, care should be taken not to expose the equipment to extreme temperatures. To insure that your Model 3200 will be ready to use, store the instrument indoors during extreme hot or cold temperatures. If the instrument is stored overnight in a service vehicle, be certain the instrument is brought to specified operating temperatures before using.

## **1.2 Introduction**

The Model 3200 is a multipurpose metallic time domain reflectometer, cable fault locator. Model 3200 is designed to quickly and easily locate cable faults in metallic cables, primarily coaxial cables.

Using time domain reflectometry, or cable radar, the Model 3200 transmits a signal down the cable. Impedance discontinuities along the length of the cable reflect some or all of the signal energy back to the instrument. These reflections are measured and displayed as both a waveform and a numeric distance to the fault.

The Model 3200 will test all types of metallic paired cables for opens, shorts, impedance discontinuities, and many other cabling problems.

### **1.3 General Features**

Locates cable and connector faults in all types of coaxial cables.

Compact, lightweight, portable.

Rugged packaging for testing in all types of weather conditions.

Preset Ranges for quick testing.

Exclusive SUPER-STORE waveform storage.

RS-232 Port.

Automatic and manual cursor placement functions.

Intermittent Fault Detection capabilities.

## **SECTION 2: OPERATING PROCEDURES**

### **2.1 Theory of Operation**

A Time Domain Reflectometer (TDR) works on the same basic principle as radar. Pulses of energy are transmitted down the cable under test. If the cable has a constant impedance and is properly terminated, all of the energy will be absorbed.

If the pulse reaches an impedance discontinuity, part or all of the pulse energy is reflected back to the instrument. If the cable is an open circuit, the reflected pulse will be in-phase (upward reflection) with the output pulse. If the cable is a short circuit, the reflected pulse will be out-of-phase (downward reflection) with the output pulse.

In either case, a substantial amount of energy will be reflected. If it were possible to have a cable with no loss, all

of the signal energy would be reflected. The incident and the reflected signals would look identical.

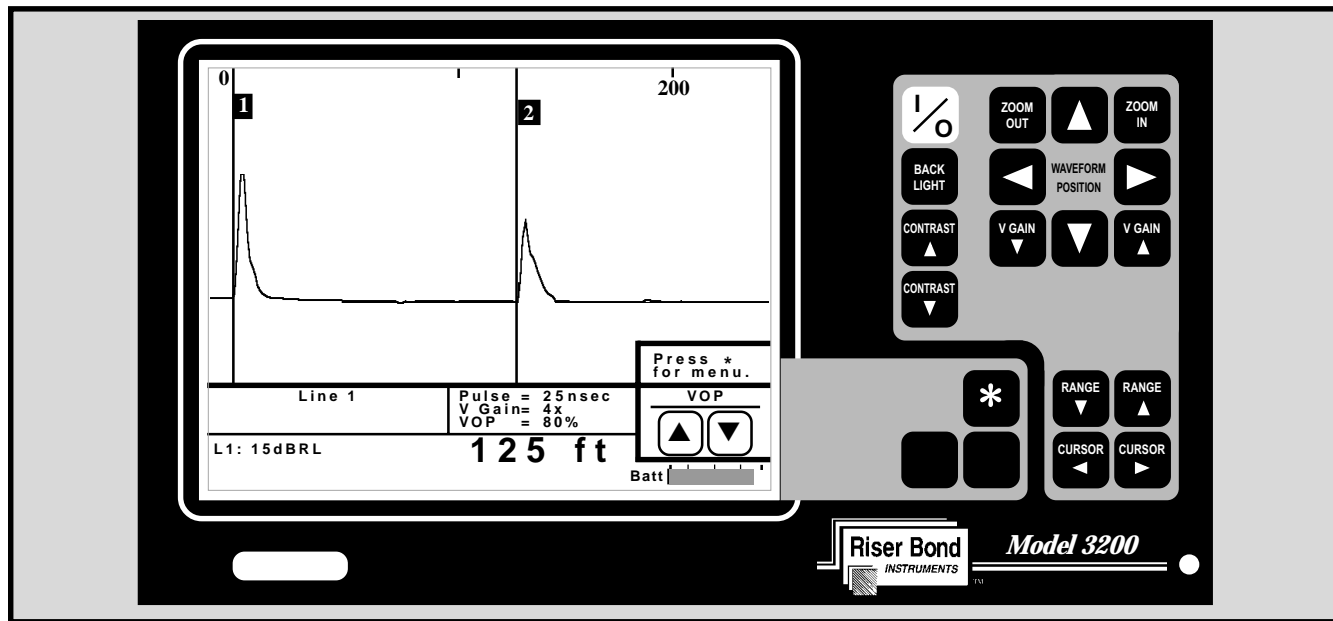
Reflections from an impedance higher than the characteristic impedance of the cable are in-phase, or upward. Reflections from an impedance lower than the characteristic impedance of the cable are out-of-phase, or downward.

Inductive faults cause the TDR to display an impedance higher than the characteristic impedance of the cable being tested. Capacitive faults cause the TDR to display an impedance lower than the characteristic impedance of the cable.

The Model 3200 displays the cable under test as a digitized waveform and a numeric distance readout on the Liquid Crystal Display.

The digitized waveform enables the operator to view the signature of the cable in great detail. An impedance mismatch (opens, shorts or faults of less severity) can be identified and distances to the faults determined.

## 2.2 Front Panel Description



## Keypad

**I/O** Use the I/O key to turn the instrument on and off.

**Backlight** Use the backlight key to turn the electroluminescent backlight on or off.

**Contrast** Use the two arrow keys to change the contrast of the LCD.

**Zoom In, Zoom Out** Use the two zoom keys to “zoom” in or out on an area of interest on the waveform display.

**Waveform Position** Use the four arrow keys to move the position of the waveform(s) left, right, up, and down.

**V Gain** Use the two arrow keys to decrease and increase the vertical waveform amplitude or gain.

**Range** Use the two range keys to increase and decrease

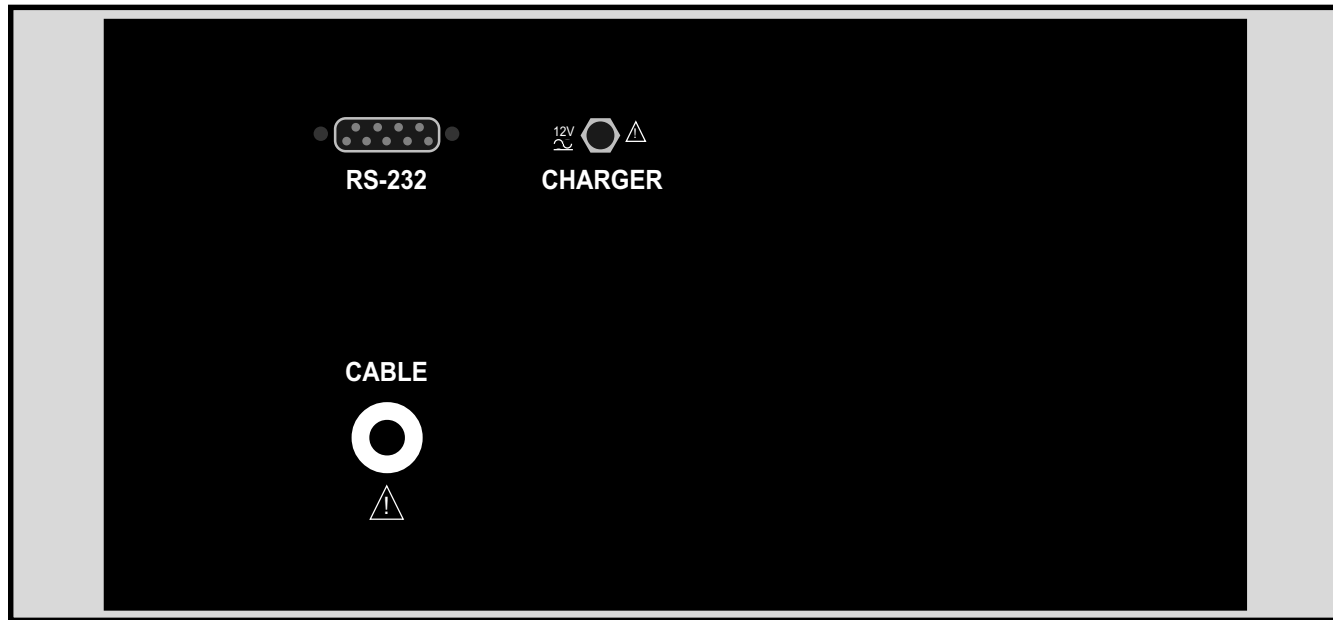
the cable distance displayed on screen. Pulse width and vertical gain are automatically adjusted for each range.

**Cursor** Use the two arrow keys to move the cursor left and right.

\* A menu will pop-up when the asterisk key is pressed. The unlabeled icon keys control a selection cursor for choosing the desired instrument control. Once the control is selected, pressing the asterisk key will close the pop-up menu and activate the control.

When a control is activated, the icon keys will control the function and on-screen icons will graphically represent how the keys affect the control. The icons will change depending on the type of action in the particular control.

## Back panel description



The Model 3200 has three sections to the back panel.

RS-232 Serial I/O Port enables the operator to transfer waveforms to a printer.

The Model 3200's battery pack is charged by plugging the external battery charger into the charging socket and AC power. The Model 3200 may be operated while the batteries are charging as long as the charge level is above the minimum level.

Coaxial cables are connected to the Model 3200 back panel female BNC connector.

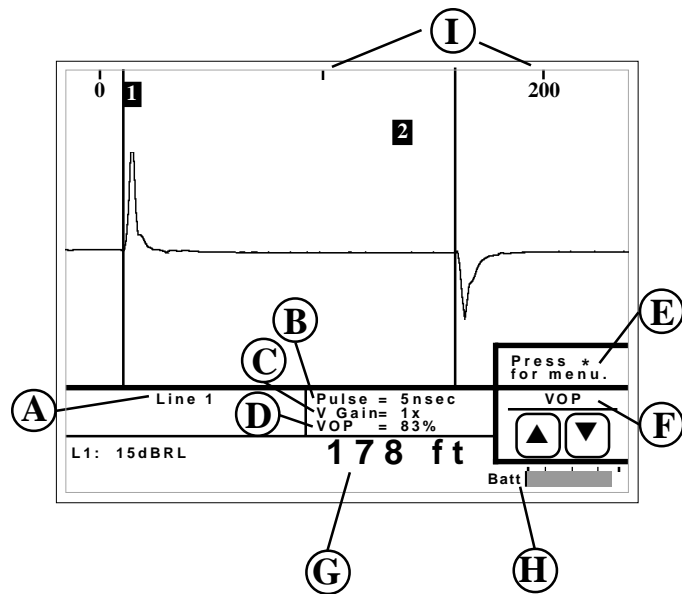
## Display

The display is a 320 x 240 dot-matrix, high contrast, SUPERTWIST Liquid Crystal Display (LCD) with electroluminescent back lighting. The top two thirds of the display contains the waveform and cursors. Instrument settings and measurements are located on the bottom third of the display.

Information areas on the Liquid Crystal Display (LCD) are:

A. MESSAGE CENTER. The message center displays various information about the status of the instrument and waveform display modes. Additional messages are displayed when utilizing the standard and optional waveform storage functions.

B. PULSE WIDTH. Model 3200 has selectable pulse widths for testing various lengths of cable.



C. **VERTICAL GAIN.** Displays the level of vertical amplitude or gain applied to the waveform.

D. **VOP.** The programmed velocity of propagation is displayed as a percentage of the speed of light from 30% to 99%, and matches the instrument to the cable being tested.

E. **MENU.** Pop-up menu for selecting instrument controls.

F. **SELECTED MENU ITEM.** Displays the currently active menu selection which is controlled by the icon keys. The on-screen icons graphically represent how the keys affect the control.

G. **DISTANCE BETWEEN CURSORS.** Model 3200 automatically calculates and displays the distance between the 1st and 2nd cursors or between a cursor and the zero distance reference, depending on the setup configuration.

(See Setup Options Menu Section.) Each time the cursor placement is changed or the VOP is adjusted, the **DISTANCE BETWEEN CURSORS** reading will automatically update.

H. **BATTERY LEVEL INDICATOR.** A horizontal bar graph indicates the battery level. When the battery level reaches the one-quarter full scale mark, the low battery message is activated.

I. **DISTANCE MARKERS.** These tick marks are displayed along the top of the screen and can be in feet or meters format. These distance markers enable the operator to view the distance along the cable being tested.

### Pop-up menu

**Pulse** Use the two icon keys to decrease and increase the pulse width.

**VOP or V/2** (depending on the velocity format setting chosen in the setup menu) Use the two icon keys to decrease and increase the velocity of propagation.

**Filter** Use the two icon key to cycle through the available software filters.

**Setup** Use the \* key to display the setup options menu.

**Store** Use the \* key to store a waveform to an available storage location.

**Recall** Use the \* key to recall a stored waveform from memory and display the list of the stored waveforms.

Press * to select.	
Pulse	Overlay
VOP	Mode
Filter	Print
Setup	Search
Store	Cable
Recall	

**Overlay** Use the two icon keys to adjust the trace separation in dual waveform display modes. This control is only available when two waveforms are displayed.

**Mode** Use the two icon keys to cycle through the available display modes for single, dual, or difference waveform display modes.

**Print** Use the \* key to print the on-screen waveform to a serial printer for documentation.

**Search** Use the \* key to preform an auto-search of the cable to find major faults or the end of the cable.

**Cable** Use the two icon keys to scroll through a menu of cable types in order to obtain the correct VOP of the cable being tested.

## 2.3 Instrument Operation

Proper operation and precise distance readings will be assured if you remember the following procedures and choose the mode of operation to best suit your cable testing conditions:

1. Establish a quality cable connection.
2. Enter the correct VOP of the cable under test.
3. Start the test in the shortest pulse width.

### 2.3.1 Range

RANGE operation will step through and display a preset distance of cable. A range consists of a specific pulse width, gain setting, and distance of cable. The transmitted pulse is on the left side of the screen and the cable span is shown to the right. The exact length of cable on the screen for each range will be relative to the VOP being used. When using RANGE, you still have complete manual control and

can change the pulse width, zoom-level and other key functions as needed.

With the distance format set in feet mode and a 80% VOP, the ranges are 20, 50, 100, 200, 500, 1,000, 2,000, and 5,000 feet.

With the distance format set in meters mode and a 80% VOP, the ranges are 10, 20, 50, 100, 200, 500, 1,000, and 2,000 meters.

Characteristics of RANGE operation:

1. To switch to the next range, press the RANGE up or down arrows. The distance graduations will change as the range is changed.
2. The cursor can be moved while in the RANGE mode. As the ranges are changed, the cursor will remain at the same position as the previous range.
3. If the instrument is set-up in dual cursor mode,

cursor 1 can also be adjusted; however, it will be placed back at the “0” distance marker whenever a new range is selected.

### **2.3.2 Distance Between Cursors**

Distance readout format may be selected in the setup menu as either single distance cursor or dual distance cursors.

#### Single Cursor Operation

Single cursor operation uses a single distance cursor to display the distance to fault. All measurements are referenced from the zero distance marker and the front panel cursor keys control cursor movement.

Remember that the distance measurement is from the transmitted pulse to the cursor. Accuracy of the distance reading is dependent on the placement of the cursor and an accurate VOP.

#### Dual Cursor Operation

When a test is initiated, the independent cursors are used to measure the distance to a fault or to the end of the cable. The cursors are interchangeable but, to reduce confusion, use the 1st cursor to mark the point you are measuring from and the 2nd cursor to mark the point you are measuring to. The cursors will retain their accuracy and resolution regardless of distance or horizontal zoom settings.

Model 3200’s unique dual independent cursors allow you to place cursors at, and measure to (or between) ANY TWO POINTS on the waveform. The distance displayed will automatically adjust with the movement of the cursors. The front panel cursor keys control Cursor 2 and a menu selection controls Cursor 1.

DISTANCE BETWEEN CURSORS is automatically calculated and displayed. Distance is determined from the cursor placement on the waveform. Therefore, the accu-

racy of the cursor placement is crucial for accurate readings. For greatest accuracy, place the 1st cursor at the “0” distance marker and the 2nd cursor at the leading edge of the reflected pulse.

To set the cursors manually, zoom in on the first cursor using HORIZONTAL ZOOM. Set the first cursor by using the 1st cursor left and right arrows to the “0” distance marker on the waveform. To set the second cursor, zoom in on the point of interest and use the 2nd cursor left and right arrows to move the second cursor to the leading edge of the reflection. For the most accurate distance reading, always zoom in on the reflected pulse and adjust cursor placement manually. The distance between the cursors is displayed on the LCD. Remember that the distance measurement is not from the transmitted pulse, but from the first cursor to the second cursor. Accuracy of the distance reading is dependent on the placement of the cursors and an accurate VOP.

### 2.3.3 Display Modes

There are a number of different display modes to choose from. Scroll to Mode and cycle to the desired display mode. A waveform must be recalled to access the dual display modes.

Live	Live cable waveform
Live & Stored	Live and stored (recall) waveform
Live - Stored	Difference between live and stored
Stored	Stored (recall) waveform

### 2.3.4 Zoom Control

The Horizontal Zoom control expands and contracts the waveform around center screen. This control can be used to closely examine a feature found using preset RANGE operation or can be adjusted manually for complete control of the waveform display distance.

### 2.3.5 Intermittent Fault Detection (IFD)

IFD detects and displays intermittent faults, whether they are opens or shorts. Some TDRs have a similar feature; however, if the waveform is repositioned, the intermittent fault function is interrupted and the process must be started over. The Model 3200's IFD retains the waveform trace. The waveform can be adjusted, repositioned, zoomed in and out, and the cursors moved, without affecting the IFD function. The Model 3200 will monitor the cable, waiting for an intermittent fault to occur.

Upon entering the intermittent fault mode:

The LCD's waveform area displays and saves the maximum and minimum reflections of the waveform trace. The auto-off 10 minute timer is disabled so the instrument does not turn off in the middle of the test.

The IFD waveform area stores waveform changes. If an open or short occurs, the instrument will keep the fault trace displayed against the live waveform. This function allows the user to find intermittent problems.

The operator can adjust the waveform with the horizontal position controls, increase or decrease the vertical gain, zoom in or out, and move the cursors. When zooming during the IFD mode, the instrument may need to pause slightly to fill in additional waveform data.

During the IFD mode, do not change the pulse width. If the pulse width is changed the IFD routine will reset and start collecting data at the new pulse width.

The intermittent fault waveforms are stored in memory. This is an important difference between the Model 3200 and other TDRs. While the waveform is in memory, there are three important things to note:

1) The waveform can be adjusted as if it were a live waveform.

2) Make sure the Model 3200 battery is fully charged. In the IFD mode, if the instrument battery level goes below a minimum safe level, the instrument will turn itself off to prevent possible battery damage.

3) Waveforms can be stored and taken back to the office for printing to a serial printer for archiving.

### Storing an IFD Waveform

To store an IFD waveform, select Store from the pop-up menu while in the IFD mode. The instrument will save the intermittent waveforms in a dedicated IFD memory location. If a waveform has been stored in the IFD memory, the next time you enter the IFD mode, a prompt will appear to confirm you wish to overwrite the old waveform.

### **2.3.6 Vertical Gain**

The Vertical Gain increases or decreases the vertical gain of the waveform display. Increasing the vertical gain of the waveform display allows the user to see smaller reflections or minor faults on the cable signature.

### **2.3.7 Setup Options Menu**

Before using the Model 3200, there are several setup options you can choose from. The options chosen will remain selected, even when the instrument is turned off.

#### Options available

Distance format: FEET or METERS

*Distance graduation markers are the same format as the distance reading display.*

Velocity format: VOP % or V/2

Backlight ON or OFF at start-up	ON or OFF
Single or dual cursor option:	SINGLE / DUAL
Cancel test lead length in distance reading	YES or NO
Horizontal Reference	ON or OFF

The distance format option allows the operator to select the distance between cursor and waveform distance markers to either feet or meters.

The backlight at start-up option is used to select whether the LCD backlight is on or off at start-up.

The velocity format option selects whether the velocity of propagation control is displayed as a percentage of the speed of light (VOP) or as meters or feet per microsecond velocity divided by 2 ( $V/2$ ).

The cancel test lead length option allows the user to auto-

atically subtract the length associated with the test leads from the distance between cursor readout. The instrument will place the first cursor and the zero reference at the end of the test leads.

Note: Always use the test leads provided. Using test leads of a different length will result in erroneous distance measurements.

The serial printer option is used to select the type of serial printer for RS-232 printing. The options available are Seiko DPU 411 thermal printer and the Citizen PN60 plain paper printer.

### **2.3.8 Waveform Storage and Recall**

Model 3200's SUPER-STORE waveform storage capability allows the operator to store a waveform for later comparison and analysis. SUPER-STORE stores the entire

cable under test, not just the section of cable displayed on screen at the time of storage. This feature is helpful if; the incorrect section of cable was on screen at the time of storage; in comparing two separate waveforms (cables); or for comparing the same waveform (cable) before and after repairing the cable.

The Model 3200 comes standard with four SUPER-STORE waveform memory locations. The Extended memory option is available to increase the stored waveform capacity to 16 waveforms. The waveform(s) will remain in storage, even after the instrument is switched off.

**Caution:** Replacing the batteries, or running down the batteries to a totally discharged state will cause the waveform storage data to be lost.

To store a waveform, scroll through the menu items until STORE is highlighted. SUPER-STORE will prompt the

operator to select a memory location or overwrite a used location.

Choose a previously stored waveform to be displayed by scrolling through the menu until RECALL is highlighted. A memory selection list will appear allowing the user to select the desired memory location.

If any waveforms are currently stored in memory, the operator may choose the stored waveform by scrolling to the desired number. When the desired location number is highlighted, press \* to select the stored waveform to be displayed with the live waveform. All instrument functions will operate normally.

### **2.3.9 Overlay Control**

The overlay control allows adjustment of the waveform trace separation of two simultaneously displayed wave-

forms, such as Line 1 and Stored. The primary purpose is to enhance the ability to see differences in waveforms when performing comparison tests by positioning the two waveform traces directly on top of each other.

### **2.3.10 Charging the Batteries**

The Model 3200 is powered by a rechargeable battery pack contained within the instrument. The Model 3200 is shipped from the factory with a full charge and will operate approximately 10 hours between charges.

When the battery supply has been depleted and the batteries need to be recharged, plug the external battery charger into the charger socket and into any common AC outlet. The front panel green LED will light to indicate the batteries are being charged. The LED indicator will stay illuminated while the charger is plugged in.

The Model 3200 has a built-in, current-limiting circuit which limits battery charge current. As the batteries approach maximum charge, the charging rate is decreased. Do not leave the batteries charging for long periods of time; their useful life will be shortened. The Model 3200 can be charged with either an AC or DC power source with correct voltage and current specifications.

The Model 3200 will operate while being charged as long as the battery level indicator is above one-quarter charge, but this will increase the charging time. Allow at least 16 hours charging time for the batteries to cycle from a completely discharged state to a fully charged state.

Note: The Model 3200 may also be charged using an optional 12 volt cigarette lighter adapter.

### 2.3.11 RS-232 Interface

Model 3200 includes an RS-232 Interface Connector for serial printing. The default serial print device is a Citizen PN60 using the Epson LQ860 emulation format.

## SECTION 3: TDR FUNDAMENTALS

### 3.1 First Time Start-up

Before using your Model 3200, there are several setup options to choose from. Select the Setup menu control and select the desired default settings for the instrument. The options chosen will remain selected, even when the instrument is turned off. See Section 2.3.7 for setup options.

### 3.2 Cable Connection

It is important to establish a quality connection to the cable under test. The TDR sends a high frequency signal that is not efficiently transmitted through poor connections or inadequate test leads.

Cables are connected to the Model 3200 by way of a BNC connector. A BNC connector provides the versatility to test in, and adapt to, various kinds of environments and industries.

### 3.3 Cable Check

Do a quick check of the cable. Get as close to the suspected fault as possible. Use common sense when examining the area near the suspected fault. For example, if there is a new fence or sign post, *that* is probably where the problem is located.

When testing a section of cable where different types of cable are spliced together, use the independent cursors and the correct VOP for each section of cable to yield the most accurate readings.

### **3.4 Cable Impedance**

Any time two metallic conductors are placed close together, they form a transmission line which has a characteristic impedance. A TDR tests for a change in impedance which can be caused by cable damage, water ingress, change in cable type, improper installation, taps and “tees”, and even manufacturing flaws.

The insulating material that keeps the conductors separated is called the cable dielectric. The impedance of the cable is determined by the conductor diameter, the spacing of the conductors from one another, and the type of dielectric or insulation used.

### **3.5 Velocity of Propagation (VOP)**

#### Determining the VOP

Knowing the correct velocity of propagation is one of the most important factors in successfully finding the distance to a fault. A quick reference VOP card is included with each instrument.

The VOP of a cable not listed on the VOP card can be obtained from the manufacturers’ catalog specifications or by contacting the manufacturer. If you cannot obtain the VOP of a particular type of cable, the VOP can be determined by the following method:

Measure a length of cable identical to the type to be tested. The longer the cable length, the more accurate the result. Connect the cable under test to the Model 3200 and set the cursors to the zero distance marker and the leading edge of the reflected pulse.

Change the VOP setting until the distance reading matches the known cable length. The VOP has now been determined. If you are testing buried cable, be certain to allow for cable snaking and depth.

### Reducing VOP error

NOTE: Procedures 1 and 2 (explained below) will work on faulted cables only. When measuring undamaged cable (as on a reel) simply test (measure) the cable from one end only. Testing from each end of an undamaged cable will obtain the same reading from either end.

PROCEDURE 1. *Procedure 1 assumes only one fault per cable length. If there are extreme changes in the VOP setting, multiple faults may be present or the cable route may be incorrect.* Testing a cable from both ends is the most common and most accurate method of eliminating VOP error. Using a cable locator and measuring wheel, determine the length and path of the cable being tested.

Test the cable from both ends and record the distance readings. If the two readings do not equal the measured length of the cable under test, change the VOP setting and retest. For each VOP setting, test the cable from both ends. When the sum of the two readings equals the known cable length, the VOP error has been minimized and the exact location of the fault has been determined.

PROCEDURE 2. The same result can also be determined mathematically when testing cables from both ends: Take the actual cable length and divide it by the sum of the two (tests from each end) TDR readings. This gives you an adjustment factor. Next, multiply each of the TDR readings by the adjustment factor. The result will be the corrected length readings.

PROCEDURE 3. If you are unable to test both ends of a cable you suspect is damaged, simply measure an undamaged cable of identical type to that which you wish to test.

When testing a section of cable where different types of cable are spliced together, use the independent cursors and the correct VOP for each section of cable to yield the most accurate readings.

### **3.6 Pulse Widths**

Many TDRs have selectable pulse width settings. The pulse width allows the TDR signal to travel down a cable at different levels of energy and distances. The wider the pulse width, the more energy is transmitted, and therefore, the further the signal will travel down the cable, measuring longer cable lengths.

**NOTE:** Always start the fault finding procedure in the shortest pulse width available, as the fault may be only a short distance away. Use the zoom and gain controls. If the fault is not located, switch to the next larger pulse width and retest. Keep switch-

ing to the next larger pulse until the fault is located.

#### Cable Loss

Cable has loss. A signal attenuates as it travels down a cable. Some cables have greater loss or signal attenuation than others. Because the pulse amplitude is reduced by the loss in the cable, major faults at long distances will appear to be of the same amplitude as minor faults close to the instrument.

Attenuation affects the maximum length of cable that can be tested. The greater the cable attenuation, the more energy must be sent down the cable to test longer lengths. To increase the amount of energy transmitted into the cable, increase the pulse width. Model 3200 has multiple pulse widths which the operator can select to best accommodate the cable length being tested. However, since the location of a fault is unknown, it is best to start the testing proce-

duration in the shortest pulse and increase the pulse widths as you increase the distance being tested.

### **3.7 Noise Filter / Powered Cable**

Testing cable with power or a signal present is possible, although for safety reasons, it is not recommended.

**WARNING:** For safety reasons, it is recommended that the Model 3200 not be connected to cable that has a signal or power present. The Model 3200 is input protected and features a **POWERED CABLE WARNING** indicating power is present on the cable under test. The **POWERED CABLE WARNING** will appear in the message center.

If you must test a powered cable, the Model 3200 features **NOISE FILTERS** which allow the testing of cables with some signal or power present. If the Model 3200 is con-

nected to a cable with power present, the microprocessor automatically filters the power signal and displays only the normal waveform of the cable under test. When the **NOISE FILTER** automatically engages, the message center will alternately display **POWERED CABLE** and **AUTO FILTER**.

If noise or power is present at levels not sufficient to automatically engage the noise filter, the filter can be switched on manually.

#### Multifunction Waveform Filtering (Optional)

This feature provides a unique system for filtering out various types of interference on the cable. The operator has the option to try many types and levels of filtering until the appropriate filter is located for each test. The **AUTO FILTER** will automatically engage if power is present on a cable under test. Testing cable with power present may

cause instrument damage. The auto-filter option may also be disengaged, when not required, to speed up the test process.

Riser-Bond Instruments' waveform TDRs offer the most filtering of any TDR. This is extremely beneficial when RF, or any other type of interference is introduced to a cable. If this occurs, the waveform may become noisy and difficult to interpret. The user would then engage the filters to remove the "noise" on the waveform. The waveform will become smoother and easier to interpret. Multi-level/Multifunction filtering allows the user to test antennas or cellular sites that may be receiving signals.

There are many different types of signals that can be present on the cable. They range from 50/60 Hz power to audio frequency, to data in the 1 to 100 MHz range, to RF. No single filter will eliminate all of these signals. Riser-Bond Instruments' waveform TDRs have multiple types and lev-

els of filters which eliminate almost any type of problem. In a filtering application, it is necessary for the operator to step through various filters to see which filter works best.

The TDR noise filters are extremely useful when testing noisy cable, but experience will enhance success so practice with different noise sources using different filters.

## **SECTION 4: APPLICATION NOTES**

### **4.1 TDR - Tap Plate Connector**

A useful accessory when testing coaxial cable is a universal tap plate which has been modified to the IN and OUT ports on the tap housing. The purpose is to make a quick connection to the cable without having to break down the hard-line connector and install an F adapter.

Use a tap plate which will fit as many of the tap housing devices in your system as possible. Remove the circuit board from the tap plate and remove all of the components on the circuit board. In most designs, there is a large choke coil which blocks the RF from IN to OUT ports but allows AC power to pass through the tap. Remove the coil and locate the holes in the circuit board which are connected to the IN and OUT ports.

Make two jumpers out of the center conductor of RG-6 cable or any similar wire. On the tap plate, solder a jumper from the point which is connected to the IN port to the center conductor of a tap port. Do the same for the OUT port, but wire this jumper to a different tap port so the cable connected to the IN and OUT ports can be tested independently.

To use the device, make sure there is no AC on the cable under test. Remove the tap plate from the tap and install

the modified tap plate. Connect the TDR to the respective ports to test the cable upstream and downstream from the tap.

### Quick F Connector

Some coaxial hardware is manufactured with F type connectors which connect the tap plate electronics to the tap housing. For these devices, it is very simple to connect to either the IN or the OUT port by using a slip-on F male adapter. To connect to the cable, remove the tap plate and using a jumper cable with the slip-on F connected, connect to the IN or OUT port tap connector.

## **4.2 Missing Signals, Corroded Splices, and Unidentified Cables**

Missing Signals - In certain situations cables may go bad for no apparent reason. Start your troubleshooting process by verifying the problem is not within the transmitting

equipment. If it is not in the transmitting equipment, then check the cable with a TDR. Check the cable from both ends to find the fault.

After locating the fault, measure the distance to the fault and check for anything unusual. For example, a new sign driven into the ground or a new fence post, can cause a good cable to quit working.

Corroded Splices - All cable system will eventually have cable splices. Many are old and their locations are unknown. With most splices, it is just a matter of time before they go bad. Use a TDR to locate corroded splices that need repair.

Identifying Cables - If no identification marks were used while setting up a system a technician go back with the aid of a plant map and use a TDR to identify cables by their length. This is a very efficient way to locate, identify, and accurately mark cables.

### **4.3 Detecting Intermittent Faults**

The Intermittent Fault Detection mode is designed to find series resistance problems and intermittent, noisy static type problems. The Intermittent Fault Detection Mode (IFD) will continuously monitor a cable under test and memorize the irregularities that occur even if they occur for only a moment.

Riser-Bond Instruments' IFD retains the waveform trace. The waveform can be adjusted, repositioned, zoomed in or out, and the cursors moved, without affecting the IFD function. The user is then able to look at the waveform and find any changes that have taken place.

### **4.4 Measuring and Documenting**

Measuring - Cable inventory and management can be very expensive and time consuming. Many companies have a

problem getting technicians to use up partial reels of cable, due to unknown lengths.

While learning to use the TDR, an installation crew experimented measuring reels of cable. They learned to measure and use the partial reels, which saved money and extra trips back to the warehouse.

The TDR can also be used to verify the lengths of incoming new reels by the length in new construction or if the cables are unmarked.

Documenting - When installing new cable plant, ideally a company will map their own system. Using a waveform TDR and either storing or printing the TDR reading, they can document and archive each new build and add it to their existing database. This can provide specific information regarding the cable plant and its condition for future reference. This information can be used for reference

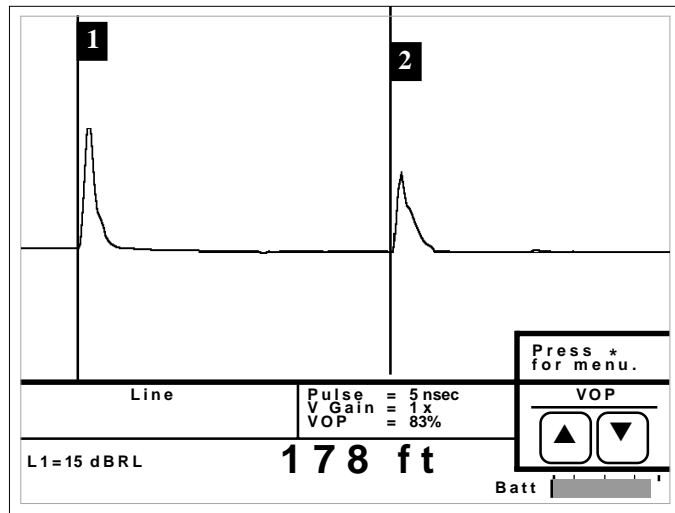
and comparison if and when problems occur.

## SECTION 5: WAVEFORM EXAMPLES

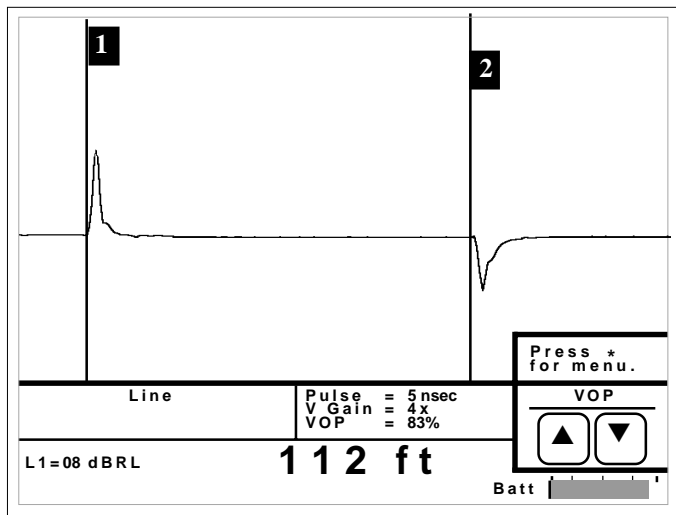
A great variety of waveforms may be encountered. This is due to the various applications and electrical and environmental characteristic differences found in cables today. Remember also: The reflection of a fault or component will look different on a short length of cable than it will on a long length of cable.

Various industries, cable types, and components produce many different waveforms. The TDR's pulse width, horizontal zoom, and vertical gain settings all affect how a waveform will appear. Practice testing various known cable segments, with and without components. Become familiar with how each segment looks prior to any problems. Use a printer to document the segment when it is operating properly. Compare waveforms later, as problems arise.

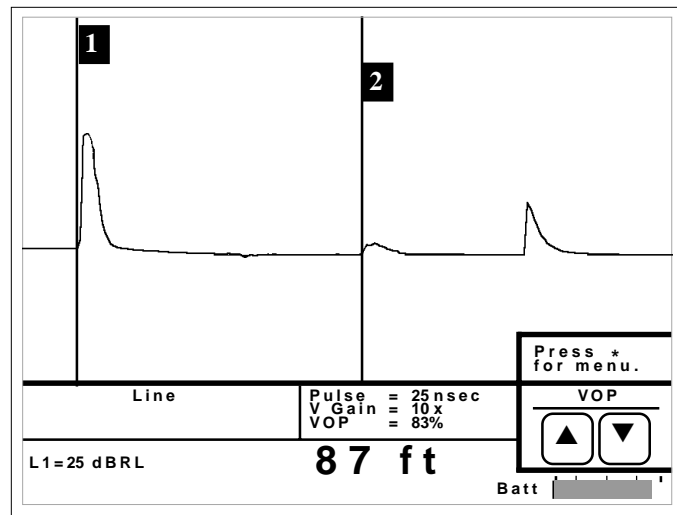
The following are samples of some waveforms.



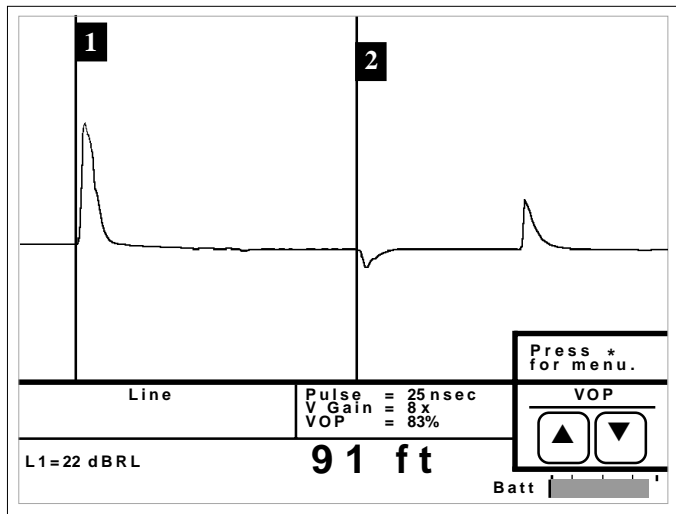
A reflection with the same polarity (upward pulse) indicates a fault with OPEN (high impedance) tendencies. The reflection shown at the 2nd cursor is a complete open.



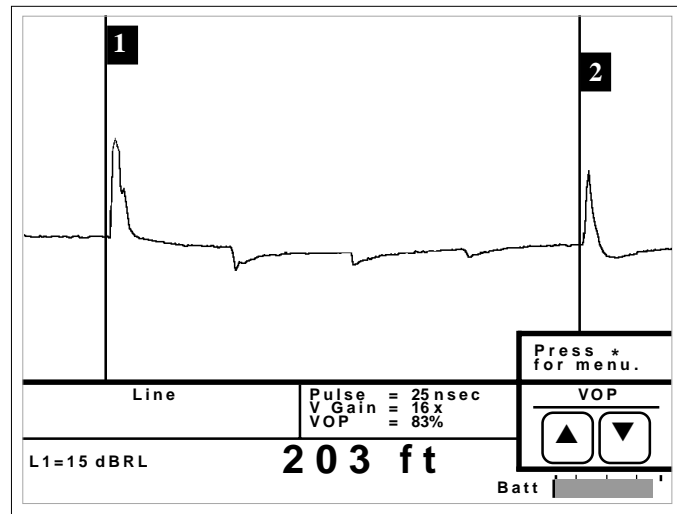
A reflection with the opposite polarity (downward pulse) indicates a fault with short (low impedance) tendencies. The reflection shown at the 2nd cursor is a dead short.



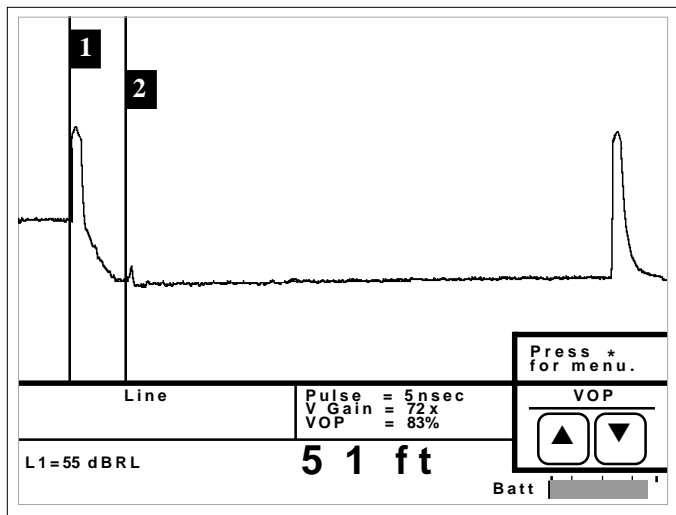
The middle reflection at the 2nd cursor is a partial open followed by a complete open (end of the cable). The more severe the fault, the larger the reflection.



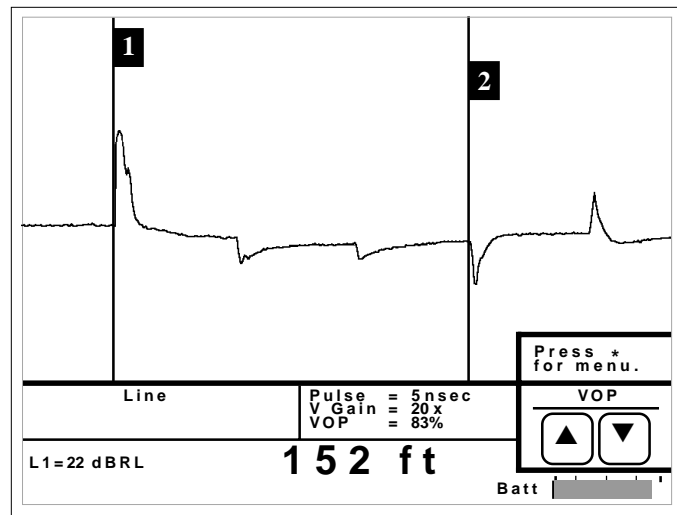
The middle reflection at the 2nd cursor is a partial short followed by a complete open (end of the cable). The more severe the fault, the larger the reflection.



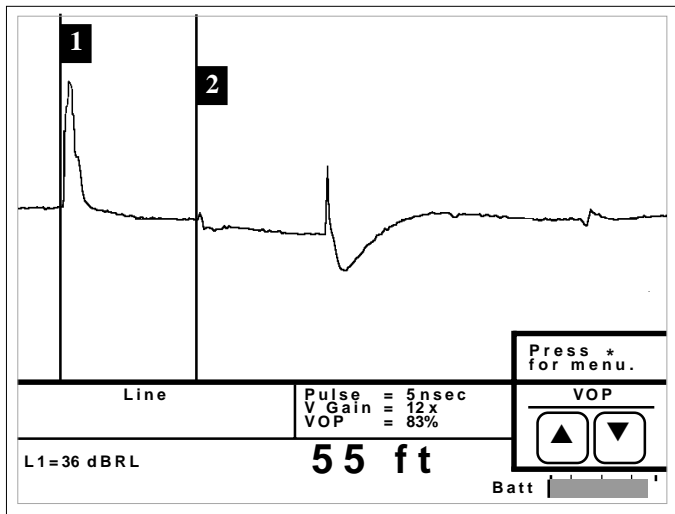
Due to attenuation, the reflections caused by each equally spaced taps are progressively smaller. A larger reflection (2nd cursor) beyond a smaller reflection may indicate an unterminated or faulty tap, or the end of the cable.



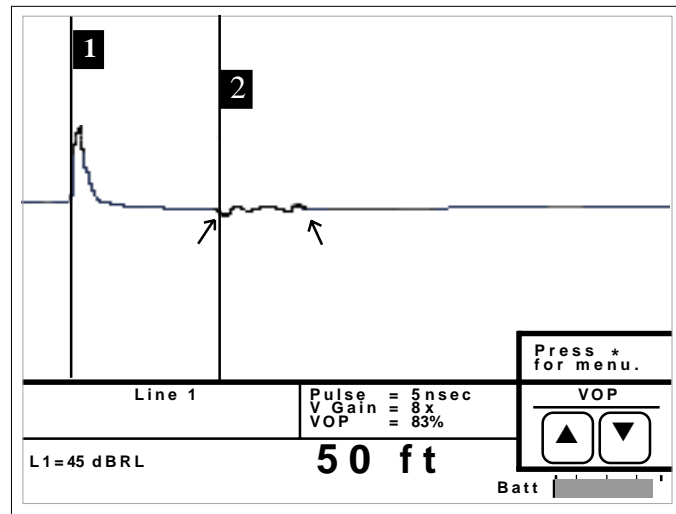
Two sections of cable with a splice shown at the 2nd cursor. The amount of reflection caused by the splice is directly proportional to the quality of the splice. A good splice = small reflection; a bad splice = large reflection.



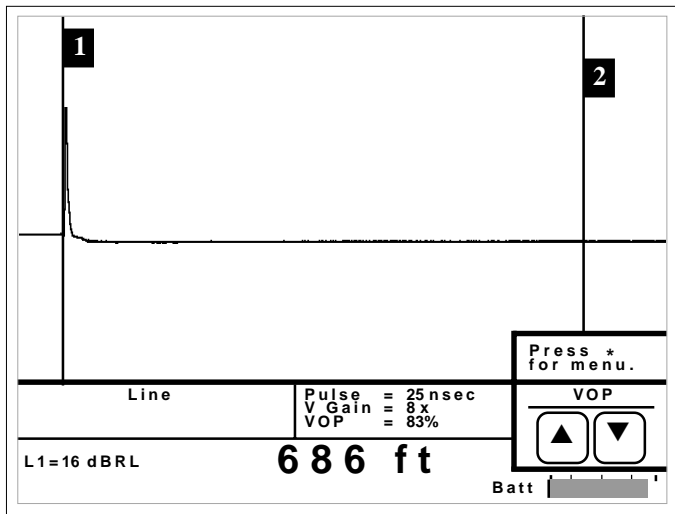
Coaxial taps (both indoor and outdoor) will cause reflections along the waveform. The quality and value of each tap determines the amount of reflection.



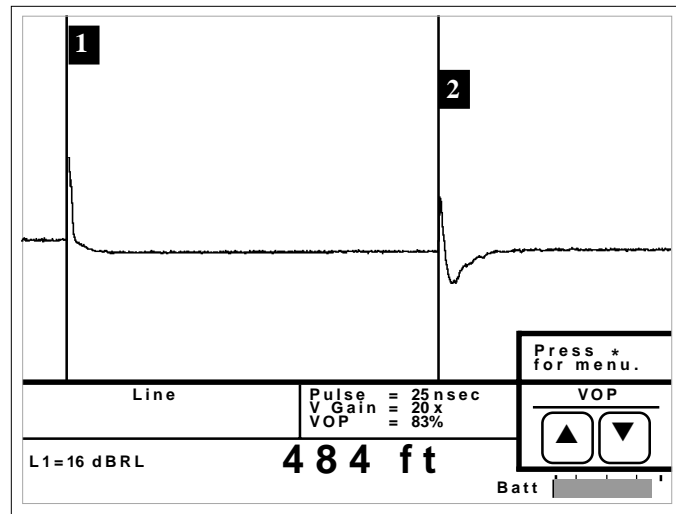
A splitter or directional coupler can be identified although accurate measurements are difficult due to multiple reflections. The 2nd cursor identifies the splitter. The two reflections following are the ends of each of the segments.



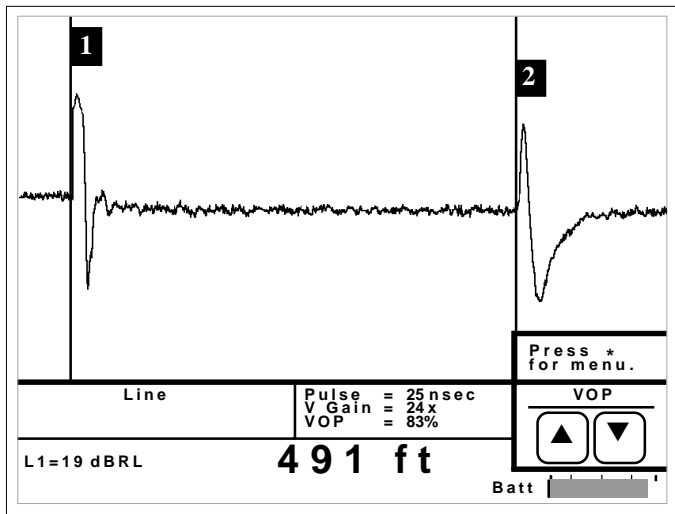
A water-soaked cable will display a waveform with a downward slope indicating the beginning of the water and an upward rise at the end of the water. Generally, the area between the two reflections will appear “noisy.”



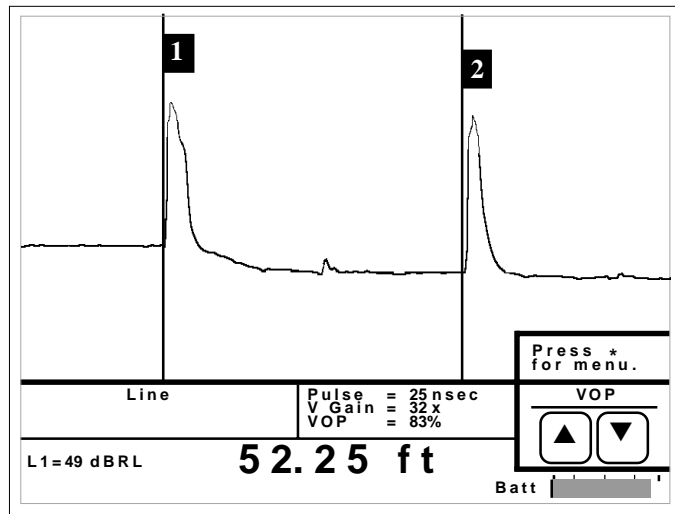
A properly TERMINATED cable will absorb the TDR signal, resulting in no reflection. Faults prior to the termination may appear as reflections along the waveform.



Testing through to an antenna usually results in a “S” shaped reflection, although reflections can vary greatly depending on the antenna.



Testing tower cables with antennas can be challenging due to energy induction from high RF areas as shown in this waveform. Stepping through various noise filter settings will result in a “cleaner” waveform.



Mechanical inner-connectors (known as bullets) connecting sections of broadcast transmission line sometimes burn open causing power outages. These bullets can be detected by a TDR.

## **SECTION 6: MAINTENANCE**

### Cleaning

Remove dust from the outside of the instrument and connectors with a lint free cloth or a small, soft brush.

Clean the case and instrument with a mild soap and water cleanser. Make sure the cloth is only *damp* to avoid getting water in the instrument.

Do not use harsh chemicals or abrasive cleaners. Damage to the front panel overlay may result.

### Periodic Inspection

To maintain the instrument in peak operating condition, periodically inspect the instrument and accessories to make sure there is no damage, worn or missing parts, or deformations in the enclosure.

If the unit is regularly operated in harsh, dusty, or wet environments, inspect after every use. The instrument should be inspected and cleaned after no more than 250 hours of use in any environment.

Inspect the front panel connectors for dirt, broken or deformed insulation and contacts. Clean or replace as necessary.

Inspect cable accessories for damaged insulation, bent or broken clips. Replace as necessary.

### Service

There are no user serviceable parts on or in this instrument. It is recommended that service of any type, to the instrument or any accessories, be referred to Riser-Bond Instruments or other authorized repair facility.

**WARNING:** To avoid risk of electric shock, do not perform service of any type to the instrument or any accessory.

### Instrument Disposal

This instrument is equipped with non user serviceable Nickle Metal Hydride batteries. Should this instrument need to be disposed of, please consult your local regulations as to the standard disposal procedures.

## **SECTION 7: SPECIFICATIONS**

### **Specifications for Model 3200**

#### **Physical - Instrument Only**

Height: 4.7 inches (120 mm)  
Width: 9.5 inches (240 mm)  
Depth: 2.4 inches (60 mm)  
Weight: 2.75 pounds (1.2 kg)

#### **Physical - Instrument with Nylon Carrying Case & Accessories**

Height: 6 inches (152 mm)  
Width: 11 inches (280 mm)  
Depth: 4.5 inches (115mm)  
Weight: 4.75 pounds (2.15 kg)

#### **Environmental:**

Operating temperature: 0°C(+32°F) to +50°C (+122°F)  
Storage temperature: -20°C (-4°F) to +60°C (+140°F)  
Humidity: 95% maximum relative, non-condensing

#### **Distance Accuracy:**

+ / - 0.5 ft plus + / - 0.01% of reading

#### **Safety:**

EN61010-1:1993 inc AMD A2:1995

#### **Display:**

320 x 240 dot-matrix, HYPERTWIST Liquid Crystal Display (LCD) with Electroluminescent backlighting.

#### **Power:**

Battery: Internal, rechargeable, 7.2 V Nickel Metal Hydride  
Charging Source: External 12 VAC transformer, 1.3 A  
Operating Time: Greater than 10 hours, continuous, without backlight

Output Signal: 5, 25, 100, and 500.

#### **Horizontal Resolution:**

1 foot (.1m) at any VOP

Vertical Resolution:

14 bits with 170 dots displayed

Maximum Ranges:

63,000 ft (19.2 km) at 99% VOP

51,000 ft (11.7 km) at 80% VOP

Range varies with VOP. Maximum testable cable lengths varies with pulse width and cable type.

Waveform Storage:

Standard: 4 at 6144 samples per waveform

Optional: 16 at 6144 samples per waveform

Input Protection:

400 V (AC+DC) from DC to 400 Hz, decreasing to 10 V at 1 MHz

Velocity of Propagation: *Two userselectable display formats*

VOP (%) with 2 digits precision ranging from 30% to 99%

V/2 with 3 digit precision ranging from 45 to 148 in meters mode or from 148 to 478 in feet.

Vertical Sensitivity:

Greater than 56 dB

Standard Accessories:

Operator's manual, 12 VAC charger, nylon carrying case, test leads

Optional Accessories:

Extended storage memory, Extended warranty, and additional noise filters.

## APPENDIX A

### Serial I/O Printer Port Connection

#### Epson LQ-860 Emulation

The Riser-Bond Instruments Model 3200 will print to an Epson LQ-860 type printer through the Epson LQ-860 command set. Serial communication parameters: no parity, two-stop bits, and 9,600 baud.

#### Citizen PN60 Pocket Printer

Riser-Bond Instruments Model 3200 will print to the Citizen PN60 Pocket Printer through the Epson LQ-860 command set. The printer setup parameters are as follows:

Language:	English
Font:	Roman
Font Lock:	Off

Line Spacing:	6 LPI
Character Set:	Italics
Code Page:	USA
Space Skip:	Enable
Stylewriter:	Auto
Protocol:	DTR
Emulation:	Epson
Pitch:	10 CPI
Compress:	Off
Form Length:	11 letters
Slash Zero:	On
Internal Char Set:	USA
Auto LF:	Off
Power Off:	3 minutes
Baud Rate:	9,600

This printer may be connected to the Model 3200 with a DB-9 female to AMO178234-4 cable. This cable must be wired in a Null modem fashion (transmit to receive, receive to transmit). The serial printer cable connections are as follows:

9-Pin	26-Pin
3200	Printer
2	15 Rx
4	18 DTR
5	1, 2 GND
7	20 RTS

RS-232 pin connections for the Serial I/O printer port.

## APPENDIX B: VELOCITY OF PROPAGATION TABLE

The Model 3200 will test all types of metallic paired (multiconductor) cables. To assure accuracy, the Model 3200 should be set to the exact VOP of the cable being tested. Due to the wide variety of applications and industries, it is not practical to list all varieties of cable and their VOPs. The following tables show the VOPs of common cables used in a variety of industries.

### CATV

<u>CABLE</u>	<u>VOP</u>	<u>CABLE</u>	<u>VOP</u>
Beldon		Scientific Atlanta	
RG-59 Foam	.78	RG-59	.81
Solid	.66	Trunk	.87
Capscan		Times Fiber	
RG-59	.82	RG-59	.83
CC	.88	T 4, 6, & 10	.87
TR	.87		

Commscope		TX, TX10	.89
Trunk/Dist PIII	.87	RG-6, 11, & 59	.82
QR	.88	Dynafoam	.90
Drop PIII	.82		
QR	.88	Trunk / Feeder	.83
		Drop (foam 59, 6, & 11)	.82
CZ Labs		7 Series	.93
RG-59	.82	MC2	.93
General Cable			
RG-59	.82		
MC2	.93		

TELEPHONE

CABLE	AWG	MM	VOP
PIC	19	.912	.72
	22	.643	.67
	24	.511	.66
	26	.404	.64
JELLY FILLED	19	.912	.68
	22	.643	.62
	24	.511	.60
PULP	26	.404	.58
	22	.643	.67
	24	.511	.68
	26	.404	.66

**LAN****CABLE**

	<b><u>TVE</u></b>	<b><u>PVC</u></b>
Arcnet	.84	.84
Ethernet (thick)	.77	.77
Ethernet (thin)	.70	.67
Terminal coax	.84	.84
Token ring	.78	.78
TV cable	.84	.78
Twisted pair	.67	.67

**CABLE**

	<b><u>TVE</u></b>
IBM 1	.64
IBM 2	.66
IBM 3	.70
IBM 4	.72
IBM 5	.76
IBM 6	.78
IBM 7	.82
IBM 8	.84
IBM 9	.82

**LAN****CABLE**

	<b><u>VOP</u></b>
Non plenum	.66
Transceiver	.66
Plenum transceiver	.70
Broadband	.625
plenum (trunk)	.86
RG-11 MATV (CL2+CATVP)	.84
RG-11 MATV (CL2+CSA FT4)	.82
RG-6 MATV (CL2P+CATVP)	.84
RG-6 MATV (CL2+CSA FT4)	.82
RG-59 MATV	.82
53.5 ohm 58 / U type	.70
73 ohm	.70
78 ohm	.70
93 ohm	.85
100 ohm	.72
9907	.80
Apple Talk	.66
Belden 53 ohm	.70

LAN

CABLE

Cellular ply foam	.78
DEC	.78
Foam or Cellular PE (FPE)	.78
Paired computer	.66
Plycore dielectric	.66
Polyethylene	.66
Polyethylene (PIC, DE, SPE)	.66
Polyvinyl-chloride	.45
PTFE (Teflon) or TFE	.70
RG-58/U	.66
RG-58	.78
Semi-solid PE (SSPE)	.84
Thicknet	.77
Thinnet / non plenum	.66
Thinnet / plenum	.70
Thinnet / DEC	.78
Twinaxil air	.80
Twinaxil	.71
APPLETALK	
#9999	non plenum .66

VOP

LAN

CABLE

802.3 Ethernet Thin	#9880	.78	#89880	.78
10 base 2 Ethernet	#9907	.80	#89907	.80
10 base 5 STP Ethernet	#9902	.78	#9903	.66
#8999		.69		
10 base T Twisted pair		(UPT) 24 AWG		
802.5 Token Ring				
IBM 1	#9688	.78	#82688	.78
IBM 2	#9689	.78	#82689	.78
IBM 3	#1154A	.60	#1155A	.62
IBM 6	#1215A	.78		
IBM 9				#1156A .80
<u>Dielectric</u>		<u>VOP</u>		
Impregnated paper		.50 to .57		
Dry paper		.72 to .88		
PE		.66		
XLPE		.52 to .58		
PVC		.51 to .58		
PTFE		.71		

<u>TYPE</u>	<u>LAND / MOBILE</u>	<u>SIZE</u>	<u>VOP</u>			
Andrew						
Radiax		All	.79			
Helix						
FHJI-50		1/4"	.79			
FSJ4-50B		1/2"	.81			
LDF2-50		3/8"	.88			
LDF4-50A		1/2"	.80			
LDF4-75		1/2"	.88			
LDF5-50A		7/8"	.89			
LDF7-50		15/8"	.88			
FT4-50		1/2"	.85			
FT5-50		7/8"	.89			
HJ4-50		1/2"	.91			
HJ5-50		7/8"	.92			
HJ5-75		7/8"	.90			
HJ7-50A		15/8"	.92			
HJ8-50B		3"	.93			
HJ11-50		4"	.92			
HJ9-50		5"	.93			
				Cablewave		
				FLC12-50J	1/2"	.88
				FLC78-50J	7/8"	.88
				Cellflex Foam FCC = FLC		
				FCC 38-50J	3/8"	.81
				FLC 12-50J	1/2"	.88
				FLC 78-50J	7/8"	.88
				FLC 158-50J	15/8"	.88

<u>TYPE</u>	<u>LAND / MOBILE</u>	<u>SIZE</u>	<u>VOP</u>			
Coax Transmission Line				Spir-O-Line A.S.		
920213		7/8"	.99	SOL 38-50A	3/8"	.84
920214		1 5/8"	.99	SOL 12-50A	1/2"	.85
Flexwell HCC				SOL 78-50A	7/8"	.85
HCC12-50J		1/2"	.91	SOL 38-HT50	3/8"	.85
HCC78-50J		7/8"	.91	SOL 12-HT50	1/2"	.85
HCC158-50J		1 5/8"	.95	SOL 78-HT50	7/8"	.85
HCC300-50J		3"	.96	Spirafil SLA	All	.90
HCC312-50J		3 1/2"	.96			
HF41/2CU244		1/2"	.97			
Foamflex		All	.81			
Low VSWR Coax						
810918-003		1/2"	.88			
810919-003		7/8"	.88			
810920-003		1 5/8"	.88			
810961-004		7/8"	.90			
810902-004		7/8"	.91			
810903-004		1 5/8"	.95			

## **WARRANTY**

Riser-Bond Instruments warrants the Model 3200 for a period of ONE YEAR from the date of shipment from Riser-Bond Instruments' factory or its designated distributor, that the Time Domain Reflectometer Model 3200 shall be free from defects in material and workmanship that develop under normal use in accordance with Riser-Bond Instruments' operating instructions.

Items returned for repair or replacement shall be shipped with a copy of the dated invoice, freight charges prepaid, to:

RISER-BOND INSTRUMENTS  
5101 NORTH 57TH STREET  
LINCOLN, NEBRASKA 68507-3141  
402-466-0933  
800-688-8377

This warranty will be void if products manufactured by Riser-Bond Instruments are modified by the purchaser during the period of warranty without Riser-Bond Instruments written consent. This warranty is expressly made in lieu of all other warranties expressed or implied, including merchantability, whether arising by law, custom or conduct. The rights or remedies provided herein are exclusive in lieu of any other rights or remedies unless specifically stated in the purchase order for this equipment. This warranty covers repair or replacement of the purchased item only and does not cover any subsidiary damages to associated customer equipment. If the extended warranty is purchased, it does not apply to the battery pack.

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Riser-Bond Instruments  
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