CE4000
Cable Explorer TDR Module

SUNRISE TELECOM
B R O A D B A N D

User Manual

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Cable Explorer TDR

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Version B00
March 2004

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Chapter 1 **General Information**

INTRODUCTION

The CE4000 TDR (Time Domain Reflectometer) module is for use with the CM1000 Cable Modem System Analyzer. The Cable Modem System Analyzer tests both upstream and downstream DOCSIS (Data Over Cable Systems Interface Specification) paths in terms of error rate, transmit level, lost packets and cable modem power ranging and registration. The CE4000 TDR module is used in conjunction with the CM1000 to locate cable faults.

INSTRUMENT OVERVIEW

The CM1000 mainframe unit (Figure 1-1) houses the CE4000 TDR plug-in. The hand-held device features a full color display, which indicates instrument status, signal identification, and measurement values. The controls are pressure-sensitive keypad switches with tactile feedback. A 75-ohm "F" connector accepts the cable connection. A female DB9 provides access to a computer serial interface connection. The DC input accepts power from the supplied AC adapter. The weatherized hard plastic case provides excellent protection from typical bumps and bangs of normal use. Back panel access is provided for easy battery pack replacement and the system memory card is readily accessible from the side panel of the unit.

When installed in the mainframe, the CE-4000 plug-in module provides comprehensive TDR testing capability. When activated, the CE4000 TDR goes through the self-mode and provides the user with a menu of TDR tests. The user may select an Auto Test mode, Manual Test mode, recall stored data or set up the configuration of the TDR. Once a cable is selected or the VOP is set, the Auto Test mode will automatically identify any impairments on the cable under test, greatly simplifying operation.

Note: This manual covers CE4000 TDR model and its options. A software upgrade is required to use the CE4000 module in an existing CM1000. Software upgrades are available from the Sunrise web site: www.sunrisetelecom.com.

CM1000 MAINFRAME AND CE4000 MODULE

1. **Mainframe Input/Output**

   The mainframe I/O section, located at the top of the unit, provides a female RS-232 9-pin connector (DB-9) for a serial computer interface. In addition, there is an external power connection to accept power from the DC power adapter provided with the unit.

2. **Plug-In Module Slot**

   The plug-in module slot accepts the CE4000 TDR or the CM1000 Cable Modem Network Analyzer module.

   Warning!   **Do not remove or install a module with the base unit powered on or connected to the system or other equipment. Always turn unit off before removing or installing a module.**

3. **CompactFlash memory slot**

   This slot located on the lower right hand side of the unit houses the mainframe's CompactFlash memory card. This memory card further enhances the unit's ability to accommodate future memory expansion/upgrades.

4. **Battery Access**

   An access panel at the lower back of the unit provides easy access to the user-replaceable battery pack.

5. **Full Color Display**

   The full color display provides clear, easily discernable test and menu screens in both dark and full sunlight conditions.

6. **Status LED indicators**

   Seven LED indicators show the status of downstream connection, upstream connection, link, Ethernet connection, power and battery functions.

7. **RF "F" Connector**

   Connection to the cable under test. Field replaceable.

8. **Fan Outlet**

   Exhaust from cooling fan—**Do not block airflow**.

① Input/Output Section

⑥ LED Status Lights

⑤ Color Display

⑥ Slot for Plug-in Module

③ Memory Card Slot

④ Battery Access in Back of Unit

CM1000 MAINFRAME

Fan Outlet ⑧

⑦ RF "F" Connector

CE4000 Module

Figure 1-1 CM1000 mainframe and CE4000 module

CE4000 Keyboard Functions

Figure 1-2 CM1000 keypad

Function Keys F1 through F4
Soft keys to perform various tests and setups. Functions are described on the display.

SETUP
Takes the user to the Main Setup screen. This screen allows access to select a cable type, run a cable test on a known cable or setup the CE4000 configuration information in System Setup.

MENU
The menu button brings the user to the Main Menu screen. Choices are Auto, Manual, Stored Data and Setup.

STATUS
Displays current firmware revision, module type, module firmware and module serial number.

HISTORY
Not used. (Reserved for a future enhancements)

CONTRAST (◗)
Activates the up/down arrows to raise or lower the screen contrast level.

BACKLIGHT (☀)
Turns the screen backlight on or off.

VOLUME (◀))
Activates the up/down arrows to raise or lower the volume.

ERR INJ
Not used in the TDR mode.

START/STOP
Not used in the TDR mode.

LEFT ARROW
Moves cursor or marker to the left.

UP ARROW
Moves cursor upward. Raises level of volume and brightness when those functions are selected.

RIGHT ARROW
Moves cursor or marker to the right.

DOWN ARROW
Moves cursor downward. Lowers the level of volume and brightness when those functions are selected.

SHIFT
Activates second function on keys (gold lettering).

ESC
Returns user to previous screen or backs up one space in the alphanumeric mode.
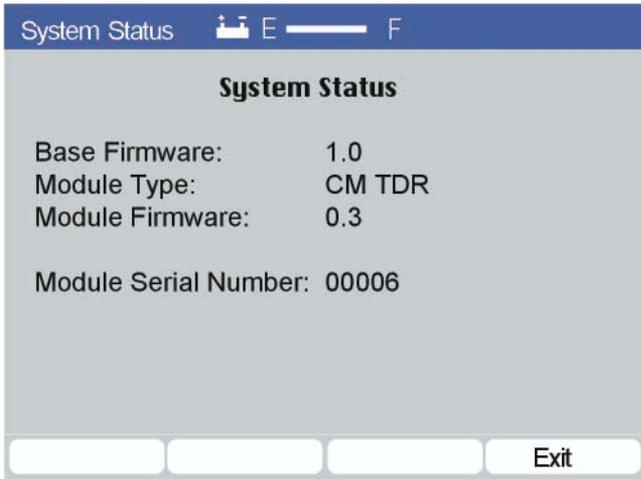
POWER
Turns unit on/off.

Figure 1-3 Status Display

PREPARATION FOR USE

Follow the instructions for unpacking and inspecting the CE4000. Compare the received items to the packing list. Read all warnings and information on power requirements. Follow the initial checkout procedure to verify that the CE4000 is in good working order. Be sure to turn off the power of the CM1000 before swapping modules.

Unpacking And Initial Inspection

Inspect the shipping container when the CE4000 is received. If the shipping container is damaged, keep the container and packing materials for inspection by the carrier, and notify the carrier as well as Sunrise. If the container or shipping material is damaged, check the contents for completeness. Check the mechanical and electrical condition of the CE4000. Notify Sunrise if the contents are incomplete, if there is mechanical damage or defect, or if the CE4000 does not pass its internal self-test.

Shipment Contents

The CE4000 TDR module comes with:

- CE4000-01 module
- CompactFlash memory card
- User manual

Charging Instructions

Charge the CM1000 before its first use for approximately 8 hours. To avoid damaging the internal battery, optimize its life and guarantee a full charge in 6-8 hours, follow these steps:

- Let the CM1000 cool to room temperature before recharging.
- Turn the CM1000 OFF before plugging in the charger.
- Leave the CM1000 OFF while recharging.
- Always leave the charger connected whenever the CE4000 is not in use.

Caution: **Do not charge the CM1000 while above room temperature or with the unit turned ON. The internal battery can become hot, reducing its life and significantly increasing the time required to reach full charge.**

Power Requirements

Operate the CM1000 from its internal battery, the supplied external AC adaptor or the optional 12 VDC adaptor. The supplied AC adaptor is a universal adaptor that converts 100-240 VAC 50 Hz or 60 Hz to 18 VDC at 2.8A maximum. The AC adaptor can power the unit for normal use. However, fast charging will take place only when the unit is powered down before and during charging.

CAUTION: **Do not attempt to use any other charger or apply DC voltage in excess of 18 VDC.**

Safety Precautions

Read and follow these safety precautions before connecting the CM1000 with CE4000 module to the cable plant.

CAUTION: **Do not remove the module from the base unit while it is connected to the cable plant or other equipment.**

CAUTION: **Do not exceed the rated input AC plant operating voltage maximum of 90V AC.**

CAUTION: **Do not remove the module from the base unit or plug in another module while the CM1000 power is turned on or the unit is connected to any other equipment, damage to the electronic circuitry or shock hazard may result.**

NOTE: **The CM1000 is weather resistant but not waterproof during normal operation.**

CAUTION: **The CM1000 with CE4000 module contains delicate electronic circuitry. The chassis and case have been designed for year-round, day-to-day field use, but severe mechanical shocks and temperature extremes could degrade the operation of the unit or damage it. Do not drop the unit.**

CAUTION: **Do not allow moisture to enter the ventilation holes on the plug-in module as this may result in damage to the internal components of the unit or cause electrical shock when connected to the cable plant.**

CAUTION: **Do not allow foreign material to clog or enter the ventilation holes or to block the fan blades. Blocking airflow or stalling the fan can cause overheating.**

Note: **Always follow the procedures outline in this manual and do not attempt to modify the CE4000 or to use in any manner not intended or outlined in this manual.**

First Time Module Installation

When installing the CE4000 into your existing CM1000 chassis, please follow these instructions carefully. The CE4000 module is shipped with a replacement CompactFlash memory card. To install the module:

Memory Card   Memory Card Cover   Thumbscrew

Figure 1-4

1. Power down the CM1000.
2. Loosen the four module thumbscrews and remove the CM1000 module. Be sure to place the CM1000 module in the optional carry bag or other safe location.
3. Insert the CE4000 TDR module, seating it firmly and tighten the four thumbscrews.
4. Remove the CompactFlash memory card cover, eject and remove the original memory card. See detailed instructions for memory card replacement in the Service section of this manual.
5. Insert the new CompactFlash card, being sure that it is fully seated in the socket (Sunrise label facing down) and replace the cover.
6. Connect the AC charger to the CE4000.

7. After turning the power on, a message will be displayed that the CE4000 is loading. This process takes approximately 10 minutes. Once the process is completed, follow the on-screen instructions to cycle power (turn off and back on).

8. Installation is complete and the CE4000 TDR is ready for use. The new memory card contains the firmware program for both the CM1000 Cable Modem System Analyzer and the CE4000 TDR. **The memory card does <u>not</u> have to be swapped when you switch back to the CM1000 Cable Modem module.**

Chapter 2 **Setup**

GETTING STARTED

Power Up To Self Test Screen

Press the Power button. The green power LED will light as the unit boots up and performs its self-test. After about 10 seconds, each of the status LEDs in the upper left portion of the instrument will individually blink green and then red as the unit completes the test process. The screen will display the following information:

Performing Self Test:

    Serial NVRAM   Pass
    Loading FPGA   (Please wait)

You may not see the last reported "Pass" because the unit immediately goes to the Main menu (Figure 2-1) when the test is complete with all criteria passed.
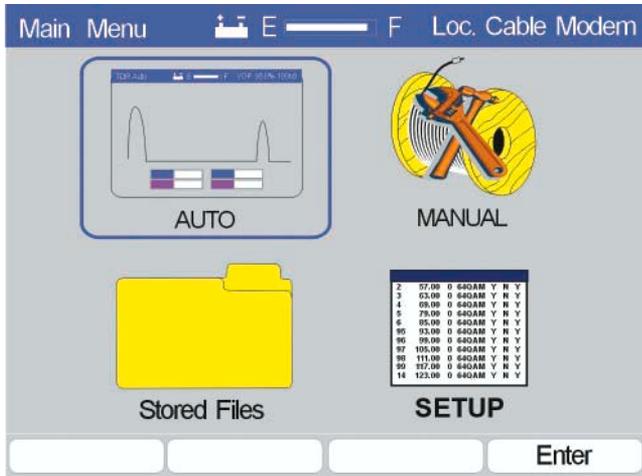

Figure 2-1

BASIC SCREEN LAYOUT
The basic screen layout for the CE4000 remains consistent throughout the menus. The center of the screen always displays the current command icons and test information.

The blue bar at the top of the screen provides current status information for the module. The current screen name is shown on the left side of the banner. In the center of the bar, the battery status is displayed. A battery icon indicates the unit is on battery power. An AC plug icon indicates the unit is externally powered. The gauge to the right of the Power icon provides a relative indication of battery status. This gauge indicates "charging" when either an external power source is connected or the unit is in charge mode. On the right side of the blue bar, the VOP and Test Pulse width are displayed. At the bottom of the screen are the function indicators that correspond with the F1 through F4 function keys.

Main Menu Screen Detail

The CE4000 is designed for easy-to-use operation. Any of the menu choices may be selected by using the left/right or up/down arrow keys and pushing either Enter (F4) or the Enter key. The four Main menu choices are:

AUTO
Select the Auto TDR test mode by pressing Enter (F4) to initiate an immediate series of automatic TDR tests. The CE4000 will use the current (last used) VOP and automatically sequence through the various pulse widths available, testing the connected cable. It will configure the display to provide the best representation of the first fault on the cable under test. The loss of the cable under test (at the frequency of the test pulse) and the distance to the fault are displayed at the bottom of the screen.

MANUAL
Choose the Manual mode to make adjustments to pulse width, vertical gain, horizontal gain and position, and to set cursors for measuring distance and loss. Operational details are provided in Chapter 3. The initial Manual screen uses the first Auto test screen as a starting point.

STORED DATA
The Stored Data menu provides access to the data files stored as a result of screen saves. Operational details are provided in Chapter 3.

SETUP
Provides access to the CE4000 Setup and Configuration icon screen. Setup includes Select Cable, Cable Test and System Setup.

SETUP OVERVIEW

All Setup menus for the CE4000 can be accessed by pressing the Setup key located just below the F1 key on the keyboard or by selecting the System Setup icon on the Main menu. The Main Setup screen is shown in Figure 2-2. Utilize the keyboard arrows to highlight the setup screen you wish to edit and press Enter (F4). The Setup menu label in the upper left corner of the screen easily identifies this screen type.

Figure 2-2

CABLE SELECT
Select the type of cable under test from the built in table of 50+ common cables or add your own data. Insert new cables or edit the existing data. The cable VOP is used to determine the distance to faults on the cable.

SYSTEM SETUP
Selecting the System Setup provides access to general system functions such as backlight and power down timers, date/time settings, RS232 serial port setup and display preferences.

CABLE TEST
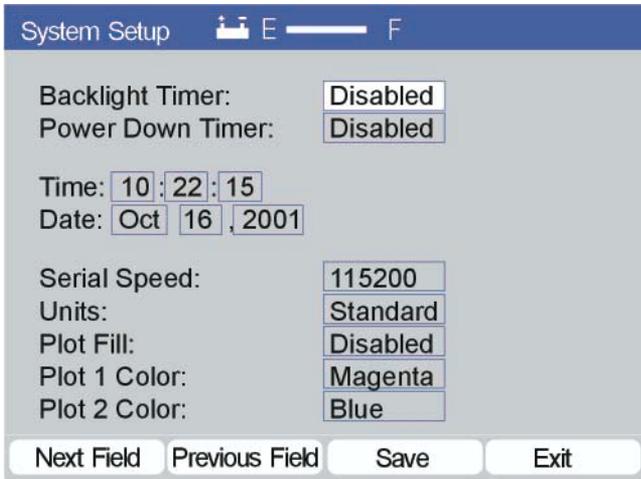 If the VOP of a cable is unknown, the VOP may be measured using this utility for a known length or known VOP.

Figure 2-3

System Setup Detail

SYSTEM

The System Setup screen (Figure 2-3) can be accessed at any time by pushing the Setup button on your CE4000 keypad, highlighting the System icon and pushing Enter (F4).

The Next Field (F1) key allows the user to move forward through the screen menu. The Prev Screen (F2) key allows the user to move backward through the screen menu. The Save (F3) key activates and saves any changes. Exit takes you back to the Setup menu.

BACKLIGHT TIMER

The backlight timer default is Disable. When Enabled, it will automatically turn off the backlight after one minute of operation, if no keys are pressed. Press Save to activate your choice and save the parameter to memory. Even with the backlight timer Disabled, the CE4000 will automatically turn the backlight off after 15 minutes if no keys are pressed.

POWER DOWN TIMER

The Power Down Timer default option is Enable. This option will power the unit down after a 3-minute period of inactivity. When disabled the unit will remain powered on until turned off manually utilizing the power button. Press Save to activate your choice and save the parameter to memory.

TIME & DATE
The time and date on the CE4000 is set from the System Setup screen (Figure 2-3). The time and date are in the formats hh:mm:ss and mm, dd, yy. Simply use the next field (F1) or the Prev Field (F2) keys to highlight the parameter you would like to change and use the Up/Down arrow keys to increment through the choices. The clock in the CE4000 is set in a 24-hr time format. Press Save to activate your choice and save the parameters to memory.

SERIAL PORT SETTINGS
The serial port speed settings may be set by highlighting them, using the Next Field (F1) or the Prev Field (F2) keys and then choosing the desired value by pressing the Up/Down or Left/Right arrow keys. Press Save to activate your choice and save the parameter to memory.

> Available Serial port speeds (baud rates):
> 115,200 and 19,200 and 9600.

UNITS
The CE4000 may be set to US measurement units of feet (ft) or to meters (m).

PLOT FILL
The default mode is Disabled. In the default Disabled mode the incidence pulse and reflections are displayed as a simple line graph on the display. When Plot Fill is Enabled, the TDR trace will be filled in under the trace to enhance the viewability.

PLOT 1 COLOR
The color of the main TDR trace may be selected from the list of Magenta, Red, Cyan, Green, Blue, Black and Brown. The default is Magenta.

PLOT 2 COLOR
The color of a second trace, used when comparing traces, may be selected form the list of Magenta, Red, Cyan, Green, Blue, Black and Brown. The default is Blue.

Cable Select Detail

To access the Cable Select selection screen (Figure 2-4), press the Setup button on the keypad, highlight the Cable Select icon using the arrow keys and press ENTER (F4).

Select Cable	⚏ E ━━━ F		
Cable	**Manufacturer**	**UOP%**	**Loss /100' @750MHz**
P3 412	Commscope	87.0%	2.78dB
P3 500	Commscope	87.0%	2.16dB
P3 565	Commscope	89.0%	1.85dB
P3 625	Commscope	87.0%	1.78dB
P3 700	Commscope	89.0%	1.49dB
P3 750	Commscope	87.0%	1.48dB
P3 840	Commscope	89.0%	1.30dB
P3 875	Commscope	87.0%	1.29dB
Next Set	Previous Set	Select	More

Figure 2-4

SELECT A CABLE
For cable selection, select the Cable Select icon and use the Next Set (F1) or Prev Set (F2) key to sequence through the pages of cable data. Next, use the up/down arrows to highlight the cable to be made active and then press the Select key (F3). The cable type, manufacturer, VOP (velocity of propagation) and typical loss of 100 feet of cable at 750 MHz are all displayed. The VOP of the selected cable will be used in calculating the distance to cable faults in the TDR mode. Cable data for approximately 50 common cable types is available.

Cable - Up to 10 characters describing the cable type.

Manufacturer - Up to 12 characters describing the manufacturer of the cable.

VOP - Three digits describing the cable's VOP as a percentage to the nearest 0.1%.

Loss/100 feet at 750 MHz - The typical loss of the cable at 750 MHz for a length of 100 feet.

Additional functions, as shown in Figure 2-5, are available by pressing the More (F4) key. Cable data may be edited or changed using the Insert (F1), Delete (F2) or Edit (F3) key. Pressing More again returns you to the original Cable Select screen.

Select Cable			
Cable	**Manufacturer**	**VOP%**	**Loss /100'** **@750MHz**
P3 412	Commscope	87.0%	2.78dB
P3 500	Commscope	87.0%	2.16dB
P3 565	Commscope	89.0%	1.85dB
P3 625	Commscope	87.0%	1.78dB
P3 700	Commscope	89.0%	1.49dB
P3 750	Commscope	87.0%	1.48dB
P3 840	Commscope	89.0%	1.30dB
P3 875	Commscope	87.0%	1.29dB
Insert	Delete	Edit	More

Figure 2-5

INSERT
 Press the Insert (F1) key to open a new screen, similar to the one shown in Figure 2-6 (data fields blank), to provide fields for entering the new cable data.

> **Cable Type** - Enter up to 10 characters describing the cable type using the alphanumeric keypad.

> **Cable Manufacturer** - Enter up to 12 characters describing the cable manufacturer using the alphanumeric keypad.

> **VOP** - Use the Up and Down arrow keys to increment/ decrement until the desired VOP is displayed in the three digits describing the cable's VOP as a percentage (to the nearest 0.1%).

> **Loss / 100 feet at 750 MHz** - Use the Up and Down arrow keys to increment/decrement until the desired loss is displayed in the three digits describing the cable's loss per 100 feet at 750 MHz (to the nearest 0.01 dB).

Figure 2-6

DELETE
Press the Delete (F2) key to delete the currently highlighted cable.

> **Note:** **No warning or confirmation is provided. Data for the highlighted cable is deleted and can only be recovered by re-entering the data. A list of the standard cables and data is provided in the Appendix for reference.**
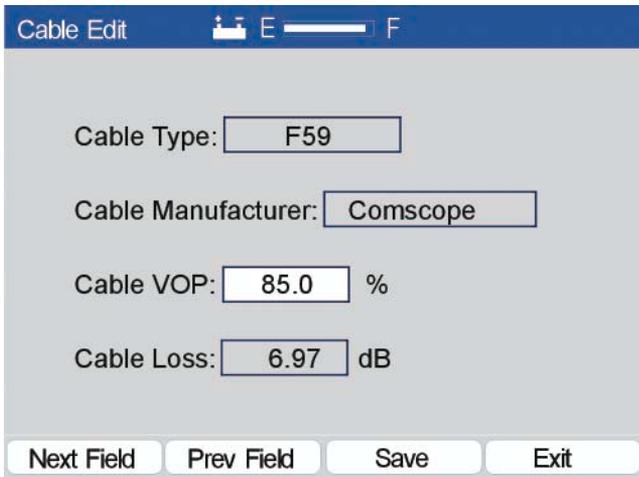
EDIT
Press the Edit (F3) key to open the screen that displays the data for the highlighted cable (Figure 2-7). Only the VOP and the Cable Loss may be edited. Use Insert to add additional cable types.

SELECT A FIELD
Press Next Field (F1) or Prev Field (F2) to sequence through the VOP and Loss data fields. Data may be changed by using the up and down arrow keys.

SAVE
Save changes by pressing the Save (F3) key.

Figure 2-7

EXIT
Press Exit to return to the Select Cable main screen.

Cable Test

Cable Test determines the VOP of a cable if the length of the cable is known. This simple method only requires knowing the length of cable. The length of the cable is entered into the CE4000 and the unit calculates the appropriate VOP for that length of cable under test.

Since the VOP is directly proportional to the distance measurement, a 1% error in the VOP will project a 1% error in the distance measurements. Determining an accurate VOP is critical to the accuracy of the distance measurements. When possible, choose a test cable of at least 100 feet (30m) to reduce calculation errors. Longer cables increase the accuracy, but may be difficult to measure accurately. Also avoid cable on reels, since the coiling slightly affects the VOP. Lengths marked on spools are often inaccurate.

To determine the VOP of a cable using the CE4000, select the Setup icon from the Main Menu or press the Setup key. Next, select the Cable Test icon and press enter. The screen shown in Figure 2-8 is displayed.
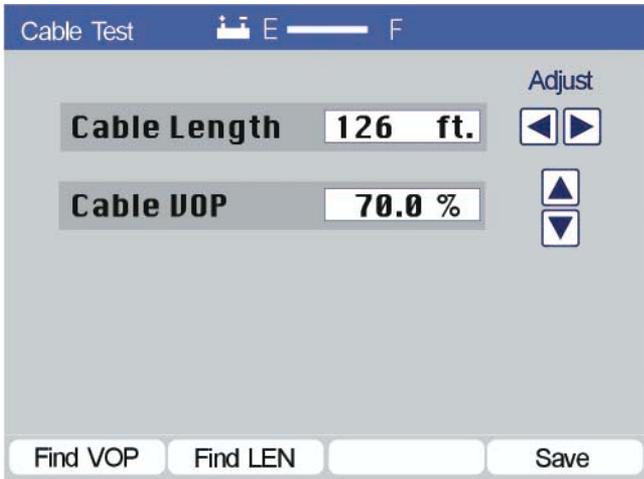
Figure 2-8

SET CABLE LENGTH

Use the Left/Right arrow keys to adjust the Cable Length displayed to the length of the cable under test. The arrow keys will increment or decrement the numbers displayed slowly when first pressed. The step size of change will increase the longer the key is pressed. For simple operation, hold down the key, noting the step size as the numbers change. Release the key momentarily when the number approaches the desired setting. This reduces the step size. Then press the key for individual steps to fine-tune the setting.

Measure VOP - Once the test cable's length is set and connected to the CE4000, press the Find VOP (F1) function key. The CE4000 will calculate and display the Cable VOP (Figure 2-8).

Measure LEN - The Cable Test mode can also be used to make quick cable length measurements by setting the VOP and pressing the Find LEN (F2) function key. The CE4000 will calculate and display the cable length (Figure 2-8).

Save - Be sure to save the information if you want to use the measured VOP for subsequent cable tests. Press Save (F4) to display the screen shown in Figure 2-9. You must enter a cable type and manufacture in this screen for the information to be saved.

FIGURE 2-9

CABLE TYPE
Use the alphanumeric keypad to enter up to 10 characters to describe the cable type and press Enter. If you press Next Field or Prev Field before Enter, the entry will be lost. Use the ESC key to back up and delete the previous character input.

CABLE MANUFACTURER
Use the alphanumeric keypad to enter up to 12 characters to describe the cable manufacturer and press Enter. If you press Next Field or Prev Field before Enter, the entry will be lost. Use the ESC key to back up and delete the previous character input.

SAVE
Be sure to save the entered information if you want to use it for subsequent cable tests. Press Save (F3) to save the information.

EXIT
Exit completes this operation and returns you to the Select Cable screen (Figure 2-4). To use the information just entered, select the highlighted cable by pressing the Select (F3) function key.

Chapter 3 **Measurements**

TDR BASICS

Locating Cable Faults

The CE4000 TDR has two cable test modes, Auto and Manual. Select the desired icon on the Main menu for the preferred mode of operation. Press the MENU key at any time during operation and the unit will return to the Main Menu screen (Figure 3-1).
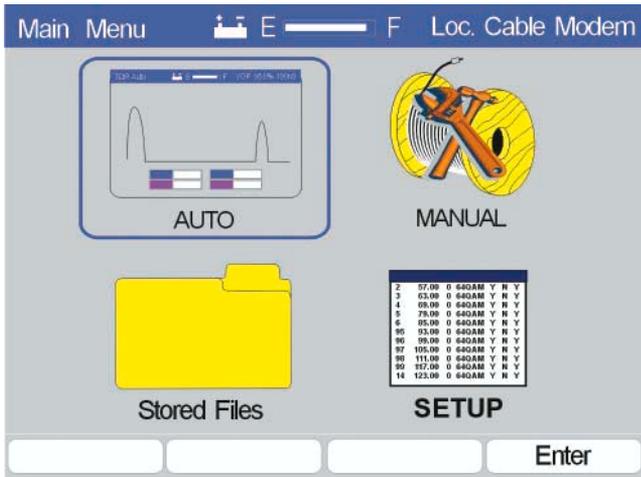

Figure 3-1

The CE4000 operates on the same principle as most TDRs. A test pulse, typically called the incidence pulse is transmitted into the cable under test. The pulse travels down the cable at a speed that is controlled by the properties of the cable. The speed is called the VOP or velocity of propagation and is measured as a percentage or decimal fraction of the speed of light. When the pulse reaches a discontinuity in the cable some of the energy (all of the energy if the cable is open or shorted) is reflected back up the cable toward the original source. The TDR measures the time required for the round trip of the reflected pulse from the TDR, from which it was launched, to the fault and back to the TDR. The distance to the fault is then calculated by the formula:

Distance = Rate $\otimes$ Time

$$D = VOP \otimes \frac{\text{Round Trip Time}}{2}$$

VOP
The velocity of propagation is the speed at which the signal travels on the cable under test. The time required for the television signals to reach the customers is normally not a concern, however some delay is present in the system, due primarily to the delay of the cable and filters in the network.

The VOP of a cable is the speed at which the signal travels divided by the speed of light and is expressed as a decimal or as a percentage (i.e. .85 or 85%). Most hard line cable will have a VOP of .87 or 87% or better. Typical (newer) drop cable will have a VOP of 80% to 85%. Older drop cables may have VOPs as low as 70%.

Approximately 50 cables are pre-programmed into the CE4000 for use. The user may add, delete or edit this data table. (VOP specifications are available from the cable manufacturer's data sheet.) As shown in the previous equation, TDR simply measures the time between the incidence and reflected pulse and calculates the distance to the fault. Obviously, the accuracy of the VOP has a direct relationship to the accuracy of the resultant distance measurements. A 1% error in the VOP will result in a 1% error in the distance measurement, plus any inaccuracy in the time measurement capability of the TDR. A cable's VOP can also be measured if the cable's length is known by using the same formula. This procedure is detailed in the Operation section of this manual.

PULSE WIDTH
The pulse is 1/2 of a sine wave (negative pulse, but displayed as positive). The pulse width is typically programmable, so that longer pulses can be used for longer ranges—pulses with more energy can travel longer distances. The cable under test exhibits the same loss characteristics on the incidence pulse as they do on the typical RF signals on the network. The longer the cable is, the higher the loss. Note that the reflected pulse has traveled down the cable and back, thus it has experienced twice the cable attenuation.
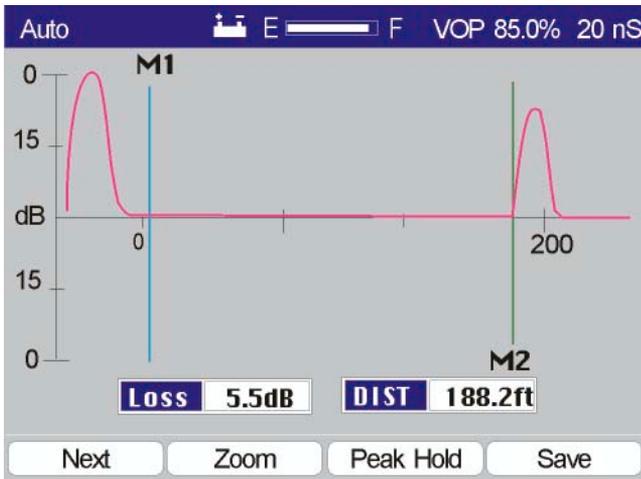
Figure 3-2

Short pulse widths are advantageous for two reasons. First, the time period of the pulse prevents seeing reflections that occur in the time period between the rise and fall of the incidence pulse. Secondly, multiple reflections that are close together are seen as a single fault because the time period of the reflected pulse obscures any other reflections between the time of the rise and fall of the reflected pulse.

The distance associated with the time during the rise and fall of the incidence pulse is called the "dead zone"—an area where the TDR cannot make measurements. **The CE4000 eliminates this dead zone by incorporating a built in delay line, which effectively moves the "0 distance" to the right of the incidence pulse allowing measurements right up to the connector on the CE4000.**

Figure 3-2 shows a typical CE4000 TDR display. The incidence pulse is shown to the left of the display (just left of the "0" on the horizontal distance scale). The reflection pulse can be seen just below the 200-foot mark on the horizontal scale.

The CE4000 offers pulse widths of 10 nSec, 20 nSec, 50 nSec, 100 nSec, 200 nSec, and 350 nSec. Faults at longer distances may be masked by the cable loss. Longer pulses represent more

energy and a lower frequency and thus more energy is transmitted and less loss is present in the cable. This allows a longer range. The range is dependent on the VOP and pulse width used for the test. A table providing maximum ranges for each pulse width is provided in the Appendix.
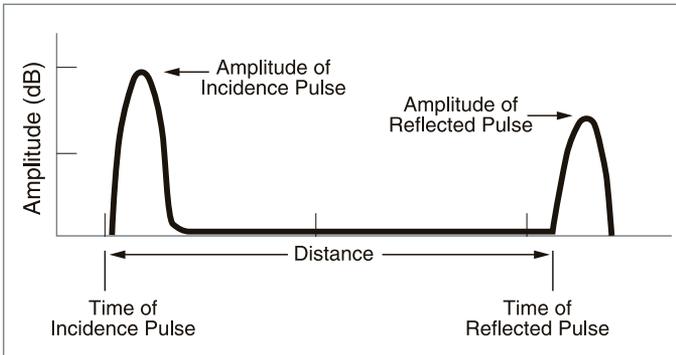

Figure 3-3

THE TDR TRACE

The TDR trace provides detailed information about the cable under test. The horizontal axis is calibrated in distance, either feet or meters. The vertical scale is calibrated in dB of loss with both positive and negative axes. The positive axis represents reflections, which result from impedances higher than the nominal 75W impedance of the cable. The negative axis represents reflections that result from impedances lower than the nominal 75W impedance of the cable. Thus, an open cable will result in a positive reflection pulse and a shorted cable will result in a negative inclined reflection pulse. A perfect cable, terminated in its characteristic impedance will absorb all of the energy from the incidence pulse and no reflection will be seen on the TDR.

High impedance series mismatches (corroded or loose connectors, loose seizure screws, and radial cracked sheath) will produce positive inclined trace signatures.

Low impedance parallel mismatches (kinked cable, water ingress, and shorts) will produce a negative inclined trace on the TDR screen.

The amplitude of the reflected pulse is proportional to the return loss of the cable at the fault location plus two times the cable loss between the TDR and the fault. Measuring the reflected pulse from an open or shorted cable and dividing the resultant by two can measure the loss of a cable. The cable loss is the loss at the frequency of the incidence pulse. The frequency of the incidence pulse is equal to the inverse of two times the pulse width.

$$F = \frac{1}{2 \otimes \text{Pulse Width}}$$

Since the loss of the cable is proportional to the frequency, the loss of the cable will depend on the pulse width used for the test. Cable loss may be estimated for any frequency, when the loss is known at some frequency. Cable loss may be estimated by the formula:

$$L_1 = L_2 \otimes \sqrt{\frac{F_1}{F_2}}$$

Often, faults are not pure opens or shorts and therefore may result in a complex reflected trace. System components typically have reactive components (capacitors and inductors) and will produce complex trace displays. Although the TDR is not designed to test system components, each component will have a typical signature that often can be used to determine the difference between a good and bad component. A collection of sample traces is provided in the Appendix.

See the Operation section of this manual for procedures to make specific measurements with the CE4000, including cable loss, return loss and distance to a fault.

LOSS AND RETURN LOSS (RTL)
The severity of a fault is determined by the amplitude of the reflection. More severe faults will reflect more of the energy back to the TDR. The vertical scale is calibrated with 0 dB equal to the amplitude of the incidence pulse (both positive and negative axes). The scale then increases logarithmically as it approaches the center, where the horizontal axis crosses. The loss may be read from the trace using the vertical axis or more accurately read from the digital readout. The severity of the fault or the quality of the termination is typically measured in Return

Loss (RTL). RTL is the ratio of the reflected signal to the transmitted signal in dB. A 20 dB return loss means that the reflected signal is 20 dB down from the transmitted signal. Manufacturers provide Return Loss specifications for most RF components.
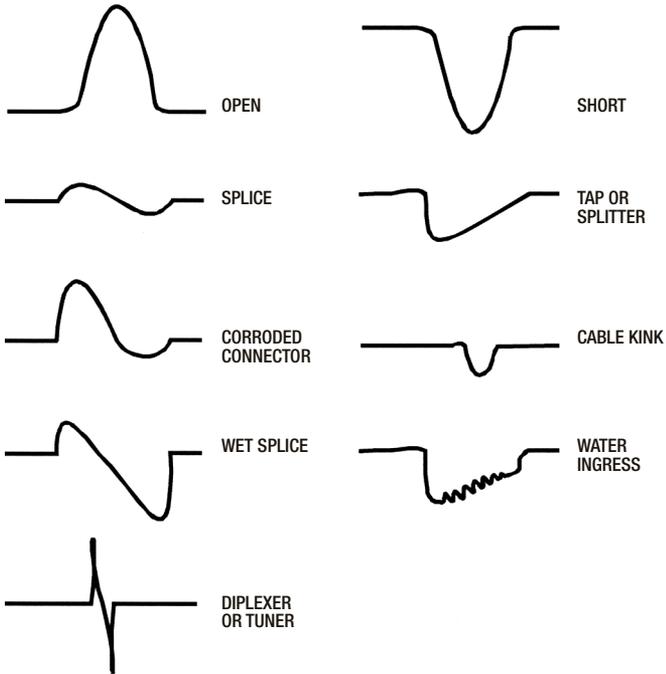

Figure 3-4

TRACE SIGNATURES
The TDR trace can be interpreted beyond the typical open and short condition. Cable impairments and components on the network have characteristic traces or signatures, representing both good and bad performance. Figure 3-4 gives examples of typical trace signatures for common cable faults and components. Some variation should be expected in component signatures. Technicians should note the characteristic trace signature of good components as they use the TDR to recognize the bad traces when testing similar components. Remember that the cable under test has loss, which increases with distance, so the

farther the reflection is from the TDR, the higher the cable loss. Be sure to increase the TDR's vertical gain to display any impairments that could be hidden by the cable loss.

TDR TESTS WITH THE CE4000

The CE4000 has two basic TDR modes, Auto and Manual. Auto is an automatic mode which automatically tests the cable connected to the CE4000, sets the Pulse Width, Horizontal Gain and Position, Vertical Gain and places the Markers on the first fault to make a distance measurement to the fault.

Manual is a secondary mode that allows the user to control all of the TDR functions. To provide a user-friendly starting point, the initial Manual screen displays the result of an AUTO test. This places the first fault (if there is a fault) on screen and sets all of the TDR parameters. After the initial screen is displayed the user may change any of the settings for Pulse Width, Horizontal Position and Gain, Vertical Gain and move the two markers as desired.

To select a TDR test mode, select either the Auto or Manual icon from the Main Menu (Figure 3-5). From any screen, press the Menu key and use the arrow keys to highlight the desired icon and press Enter.
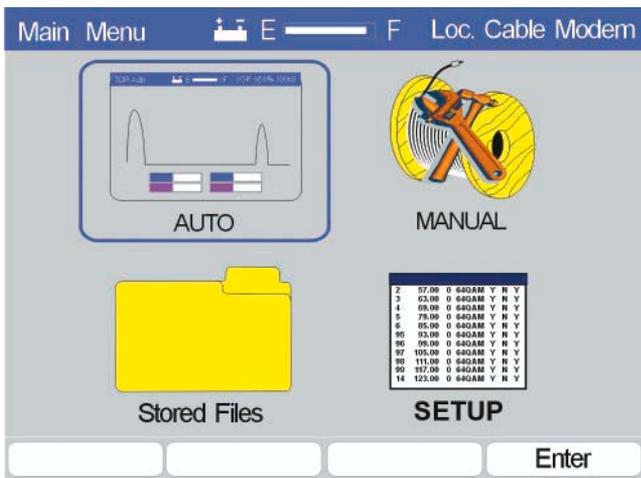

Figure 3-5

Auto Test Mode

When the Auto test mode is selected, the CE4000 TDR will use the last selected cable data (see Setup section) and initiate a series of TDR tests. The initial screen will take several seconds to appear, as the Auto test is being performed. A progress bar is displayed with the text " Initializing" (Figure 3-6)
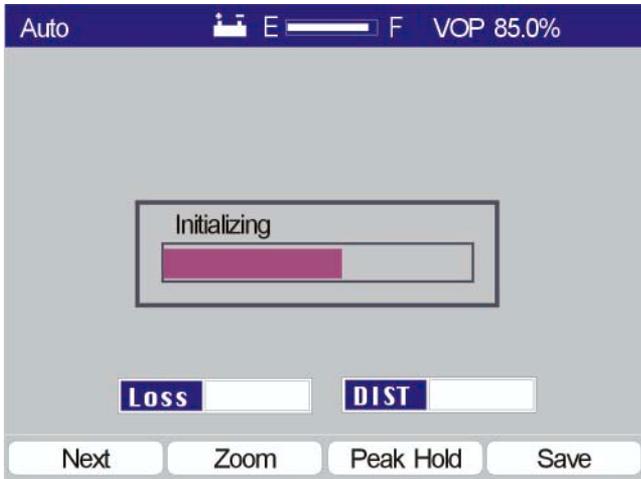

Figure 3-6

Once the tests are completed, the Auto test screen is displayed (Figure 3-7). The cable VOP used for the test is shown in the upper right corner. The Pulse Width, Horizontal Gain and Position, Vertical Gain and Markers are all set automatically.

Although multiple faults may be present and found on the cable under test, the CE4000 will automatically go to the first cable fault, place the marker at that location and display the distance to the fault.

Auto is the fastest and most accurate mode of operation. Under microprocessor control, the CE4000 can sequence through the various TDR settings very quickly and provide the best display of the test results. Since the Auto test results are calculated based on the raw test data, the accuracy is not subject to the limitations of the display resolution as with most TDRs.
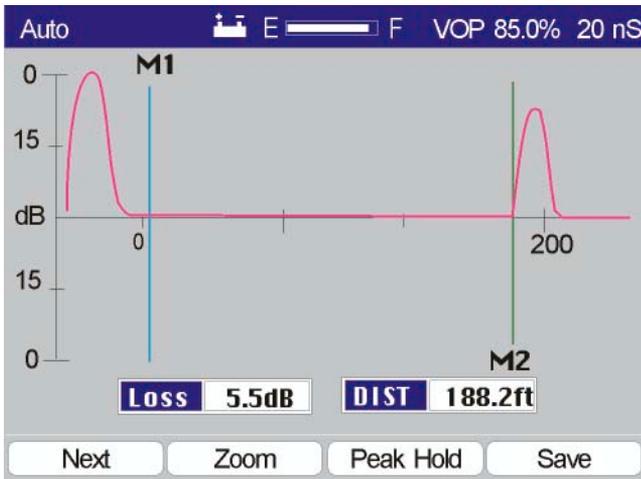
Figure 3-7

DISPLAY

The CE4000 color display provides comprehensive information and measurement details.

Top Bar - The top bar provides basic unit information, including the current test mode "Auto". The battery icon indicates operation from battery power; the bar graph indicates the battery charge condition (full), the VOP (85.0%) used for the test and the Pulse Width (20 nSec).

Axes - The horizontal and vertical axes depict the distance to the fault and the severity of the fault in dB of Return Loss. The scale of the axes is dependent on automatic or manual settings. Calibrated marks with numbers are provided.

Markers – Two markers are provided and automatically placed in the Auto test mode. The Loss and DIST measurements are made at the markers.

DIST - Distance is the measurement of the cable's distance from the TDR to the reflection from the fault.

Loss - The Loss is the measurement of the Return Loss at the fault plus two times the cable loss over the distance from the TDR to the fault.

The TDR displays the distance measurement both on the horizontal scale and digitally based on the placement of the M2 marker. M1 is automatically placed at the beginning of the cable under test and M2 is placed at the point of the reflection (fault). The loss at the point of the reflection is also displayed, indicating the loss to the reflection—or the ratio of the level of the reflection to the level of the incidence pulse in dB. The vertical scale is logarithmic, with level marks, also indicating the ratio of the reflected pulse to the incidence pulse.

> **Note:** **An open or shorted cable would only measure the loss of the cable between the TDR and the fault, since both (short and open) will reflect 100% of the pulse.**

At the bottom of the display the user is offered additional function keys, Next (F1), Zoom (F2), Peak Hold (F3) and Save (F4) to further investigate the results of the TDR auto test.

NEXT - The Next (F1) function will sequence the CE4000's Auto test mode from the first fault to any subsequent faults on the cable under test, as shown in Figure 3-8.
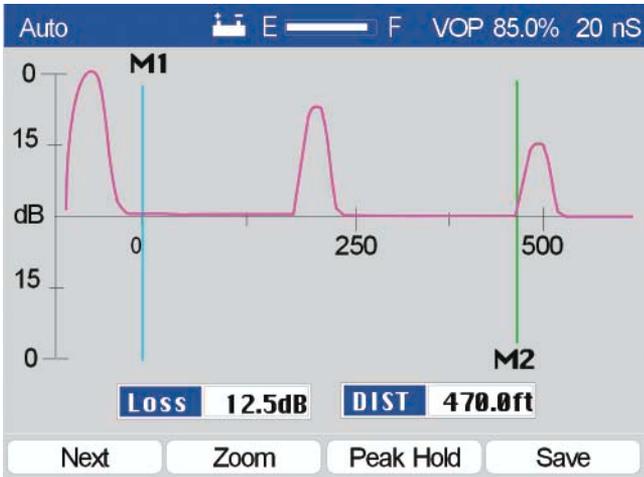

Figure 3-8

The marker is automatically set to the next reflection fault, the vertical and horizontal scales are adjusted and the measurements are displayed. If no faults are found, the CE4000 will display a message over the TDR screen indicating "No Faults" and the range of the TDR test. Once "No Faults" are found, the TDR will wrap back around to the original test screen displaying the first fault.

ZOOM
The Zoom (F2) function key readjusts the CE4000 display, increasing the horizontal gain and moving the M2 marker to the center of the screen (Figure 3-9). Although the M1 marker may not be displayed, it remains the reference for distance measurements. Use the Up and Down arrows to increase or decrease the vertical gain.
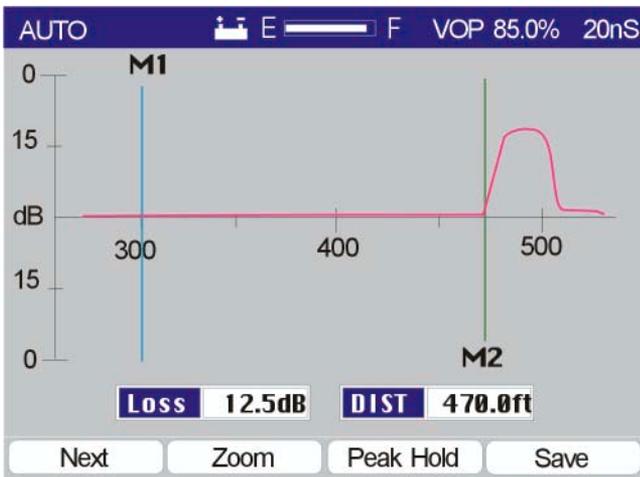

Figure 3-9

PEAK HOLD

The Peak Hold (F3) function key will cause the CE4000 display to hold the worst-case peak measurements—both positive (near open) and negative (near short), as shown in Figure 3-10.

The positive peak trace is displayed in blue, the negative peak trace in green and the normal trace (current test result) in purple.

In Figure 3-10, note that the highest loss (worst case) is held on the display (at 470 feet), while the current display (less positive result) is displayed below the worst-case result. Use this display type to troubleshoot intermittent-type problems where the cable may alternately test good and then bad. While in the Peak Hold mode, the user would flex or stress the components under test to see if good or bad results can be displayed. The TDR captures the worst-case results.

Note: The display update speed will slow down, since the TDR is displaying three separate traces alternatively.
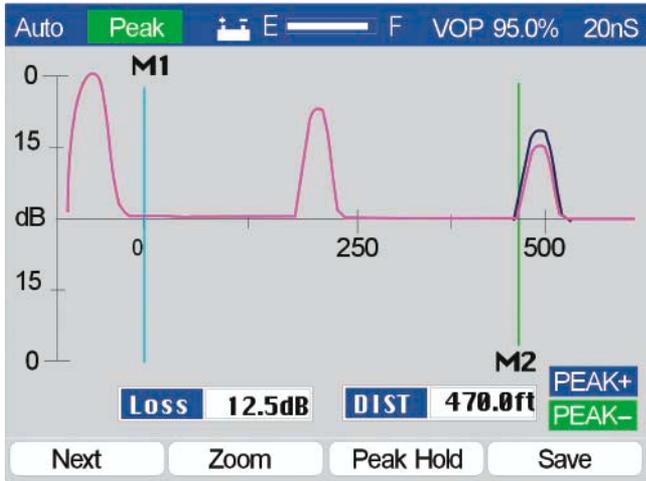

Figure 3-10

SAVE

The Save (F4) function key freezes the current screen to allow entering a Site Name for the screen to be stored (Figure 3-11). Up to 10 characters may be entered to describe the screen data. Use the alphanumeric keys to enter the information. Press ESC to back up one space if the wrong character is entered. Press Enter when the desired Site Name is displayed. The type of display, date and time will automatically be saved along with the data.
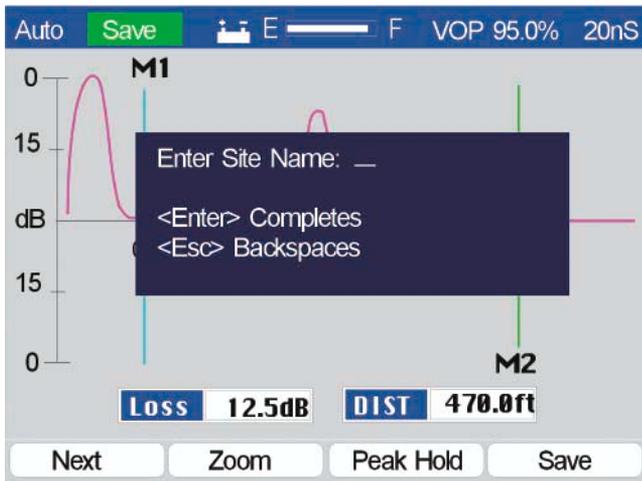

Figure 3-11

Manual TDR Measurements

The Manual measurement mode allows you to set manually all of the TDR controls for maximum test flexibility, but requires more than the one-button operation of the Auto test mode. Manual TDR operation is not complex if time is taken to review TDR basics in Chapter 2 of this manual and carefully follow the outlined procedures in this Operational section.
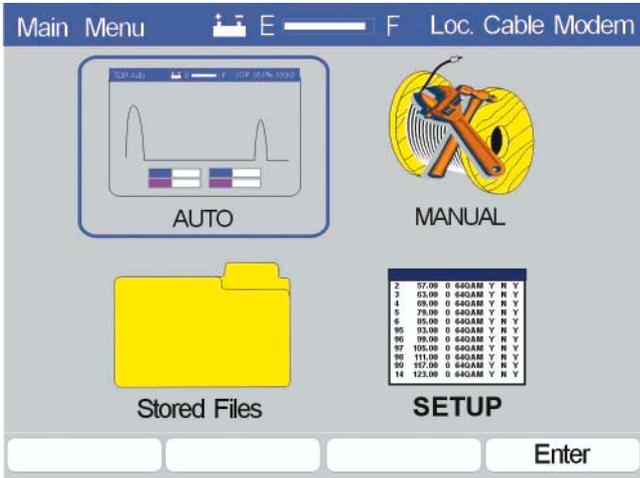

Figure 3-12

To access the Manual test screen from the Main Menu (Figure 3-12), use the UP/DOWN or LEFT/RIGHT arrows to highlight the Manual icon and then press Enter (F4).

The CE4000 will use automatically the VOP setting last selected in the Setup procedure. The VOP data is preserved, even when the CE4000 is turned off. The initial Manual screen is configured based on the results of an Auto test.

MANUAL
The initial screen will take several seconds to appear, as the initial auto test is being performed. A progress bar is displayed with the text " Initializing". Once the tests are completed, the Manual test screen is displayed (Figure 3-13). The tested cable VOP is shown in the upper right corner. The Pulse Width, Horizontal Gain and Position, Vertical Gain and Markers are all set automatically, but may be manually controlled by the user with the function and arrow keys.
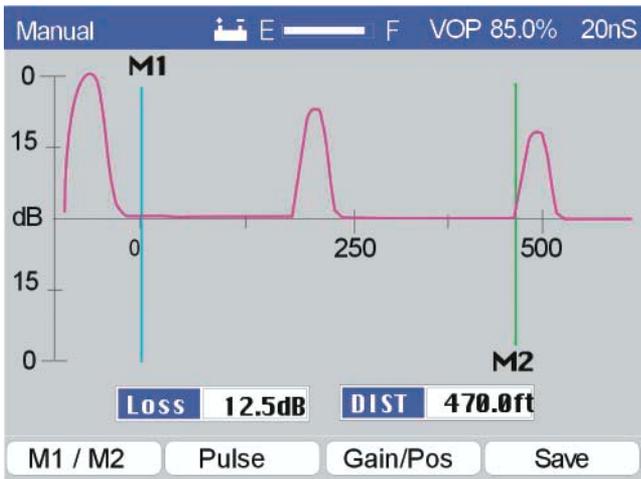
Figure 3-13

Although multiple faults may be present and found on the cable under test, the CE4000 will automatically go to the first cable fault, place the marker at that location and display the distance to the fault. The best practice is always to repair the first fault and retest. This is because the first reflection reduces the energy delivered to the second fault and prevents an accurate measurement of the return loss at subsequent faults.

Auto is the fastest and most accurate mode of operation. Under microprocessor control, the CE4000 can sequence through the various TDR settings very quickly and provide the best display of the test results. Since the Auto test results are calculated based on the raw test data, the accuracy is not subject to the limitations of the display resolution, as with most TDRs.

DISPLAY

The CE4000 color display provides comprehensive information and measurement details.

Top Bar - The top bar provides basic unit information, including the current test mode "Manual". The battery icon indicates the unit is operating from battery power, the bar graph indicates the battery charge condition (full), the VOP (85.0%) used for the test and the Pulse Width (20 nSec).

Axes - The horizontal and vertical axes depict the distance to the fault and the severity of the fault in dB of Return Loss. The scale of the axes is dependent on automatic or manual settings with the numeric values shown with calibrated tic mark locations.

Markers - Two markers are provided and automatically placed. The Loss and DIST measurements are made at the markers. Arrow keys can be used to move the markers.

DIST - Distance is the measurement of the cable's distance from the TDR to the reflection from the fault.

Loss - The Loss is the measurement of the Return Loss at the fault plus two times the cable loss over the distance from the TDR to the fault.

The TDR displays the distance measurement both on the horizontal scale and digitally for the placement of the M2 marker. M1 is automatically placed at the beginning of the cable under test and M2 is placed at the point of the reflection (fault). The loss at the point of the reflection is also displayed, indicating the return loss of the reflection—or the ratio of the level of the reflection to the level of the incidence pulse in dB. The vertical scale is logarithmic, with level marks, also indicating the ratio of the reflected pulse to the incidence pulse.

Function Keys - At the bottom of the display are additional function keys, M1/M2 (F1), Pulse Width (F2), H Pos/Gain (F3) and Save (F4). These may be used to further investigate the results of the TDR display.

M1/M2
The M1/M2 (F1) function will sequence the Left and Right arrows between controlling the M1 marker, the M2 marker, both markers and turning off both markers. The selected marker is indicated at the top left of the display next to the screen name and is highlighted with a green background.

Use the Left and Right Arrow keys to move the selected marker. The marker may be moved one pixel at a time with one press of the button, or the button may be held down, causing the marker to sequentially move in larger increments.

Distance measurements are made at the beginning of the reflection pulse. Position the marker at the point on the TDR trace where the pulse rises quickly. The measured distance will be displayed in the DIST box on the screen.

Loss is measured in the same fashion. The actual loss measurement is made at the peak of the pulse automatically when the marker is placed on the rising edge of the pulse. Thus, the distance and the loss are made from a single marker position. The loss measurement window is roughly as wide as the reflected pulse displayed on the screen.
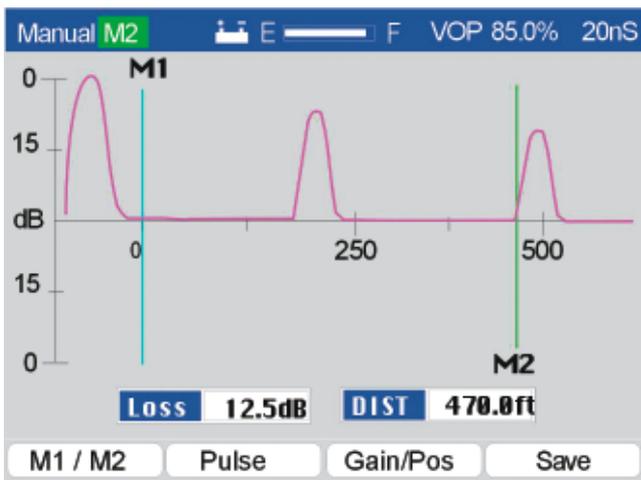

Figure 3-14

PULSE
The Pulse Width (F2) function key permits using the Left and Right Arrow keys to sequence through the available pulse widths of the CE4000. Pulse widths of 10 nSec, 20 nSec, 50 nSec, 100 nSec, 200 nSec and 350 nSec are available.

The right arrow key increases the pulse width, while the left arrow key decreases the pulse width. A new trace is provided when the pulse width is changed (Figure 3-15).

Longer pulse widths allow you to test longer cables and to view higher return losses. Since they provide more energy in the incidence pulse, more energy is reflected by the fault and detectable for display.
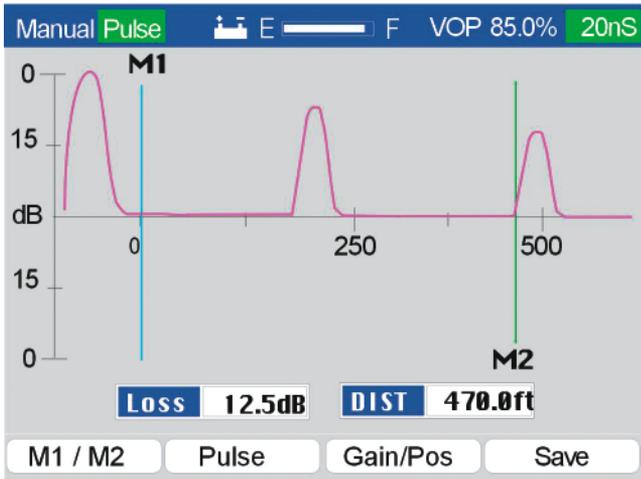
Figure 3-15

GAIN / POS

The Gain/Pos (F3) function key toggles the Left and Right arrow keys to control the horizontal position and range on the CE4000 display. Pressing the Gain/Pos (F3) key once will display Gain next to the screen name (upper left portion of the screen), highlighted by a green background (Figure 3-16), and will allow the Right and Left arrow keys to sequence through the horizontal gain ranges. The CE4000 full scale ranges are 100, 250, 500, 1300, 2700 and 5500 feet or 30, 76, 152, 396, 822 and 1676 meters.

Pressing the Gain/Pos (F3) key a second time will display "Pos" next to the screen name (upper left portion of the screen), highlighted by a green background (Figure 3-17), and will allow the Right and Left arrow keys to slide the horizontal scale to the left or right on the display increasing or decreasing the full scale value, but not changing the range. POS allows the user to re-position the trace on the display.
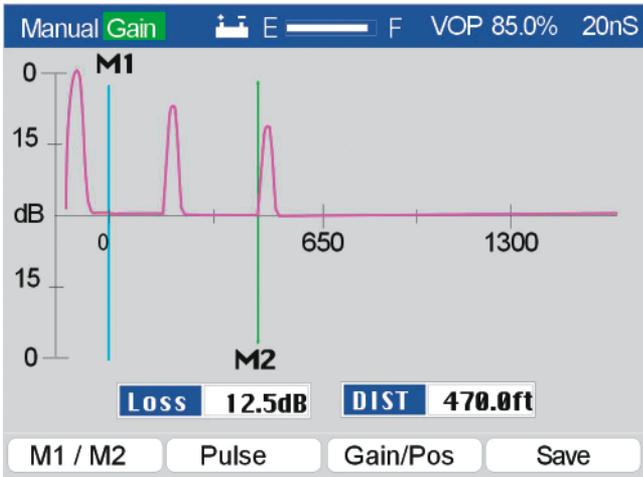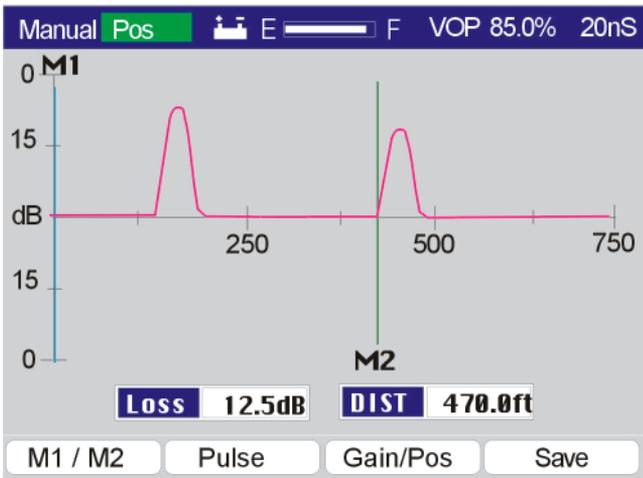
Figure 3-16

Figure 3-17

Using a combination of Gain and Pos, the user can expand the horizontal resolution and view any distance on the horizontal scale.

SAVE - The Save (F4) function key freezes the current screen and permits the entry of a Site Name for the screen to be stored (Figure 3-18). Up to 10 characters may be entered to describe the screen data. Use the alphanumeric keys to enter the information. Press ESC to back up one space if the wrong character is entered. Press Enter when the desired Site Name is displayed. The type of display, date and time will be saved automatically along with the data.
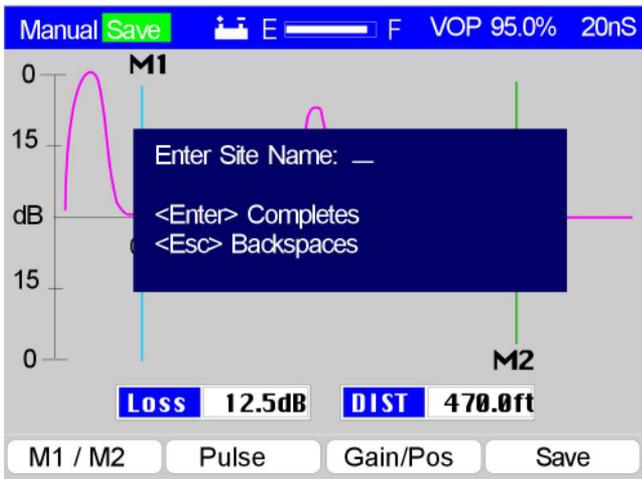

Figure 3-18

STORED FILES

Screens that have been saved may be recalled to the display through the Stored Data icon on the Main Menu.

Figure 3-19

Highlight the Stored Files icon from the Main Menu using the arrow keys and press Enter (F4). The Stored Files screen will be displayed as shown in Figure 3-19.

The display lists the Stored Data Log information that has been stored using the Save functions in the Manual or Automatic measurements modes. The information listed is the site name that the user entered for the screen when it was saved, the date and time and type of screen that were stored. The list is sorted by the date and time, most recent listed first. Screens may be selected using the arrow keys to highlight the data and pressing the Display (F3) key. Approximately 50 screens may be saved.

As shown in figure 3-19, the user is offered the functions: Next Set, Prev Set, Display and More.

Next Set – With Next Set (F1) allows the user to scroll a page at a time—Page Down.

Figure 3-20

Prev Set - Previous Set (F2) allows the user to scroll backward a page at a time—Page Up.

Display - Recalls the stored screen to the display.

More - Provides the user with additional functions: Erase, Erase All and More (Figure 3-20).

Erase - Erase (F1) clears the currently selected set of data from the file.

Note: **No warning is provided and recovery is not possible. Once the ERASE (F1) key is pressed the data is lost.**

Erase All - Erase All (F2) clears all of data from the files.

Note: **No warning is provided and recovery is not possible. Once the ERASE ALL (F2) key is pressed the data is lost.**

More - More (F4) wraps back to the original list of functions.

When the user selects a Stored File by pressing the Display (F3) function key, the TDR screen is displayed, just as it was stored. When the screen was saved, the data which produced the test results was stored, not just a bitmap image. Thus, additional

views of the data are available by pressing the Nest (F1) function key to display the next fault or the Adjust (F2) function key to adjust the vertical gain or horizontal gain (range).

Two stored files may be compared by pressing the Compare (F3) function key and selecting a second saved file.

DISPLAY CONTROLS
The Up and Down arrow keys adjust the vertical gain. Increasing the vertical gain shows smaller reflections from faults (higher return loss). The Left or Right arrow keys adjust the horizontal gain (range) of the display as shown in Figure 3-21. In comparing Figure 3-21 to Figure 3-22, notice that the horizontal scale has increased from 250 to 500, showing a second fault at 480.
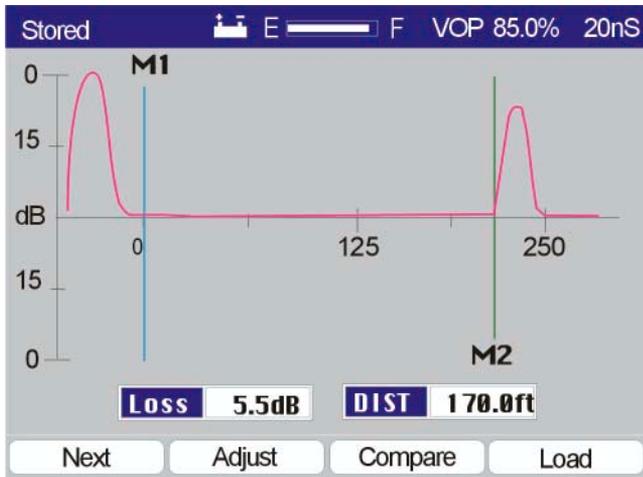
Figure 3-21

NEXT
The Next (F1) function will sequence the CE4000's Auto test mode from the first fault to any subsequent faults on the cable under test (Figure 3-22).

The marker is set automatically to the next reflection fault, the vertical and horizontal scales are adjusted and the measurements are displayed. If no faults are found, the CE4000 will display a message over the TDR screen, which indicates: "No Faults" and the range of the TDR test. Once "No Faults" is found, the TDR will wrap back around to the original test screen displaying the first fault.
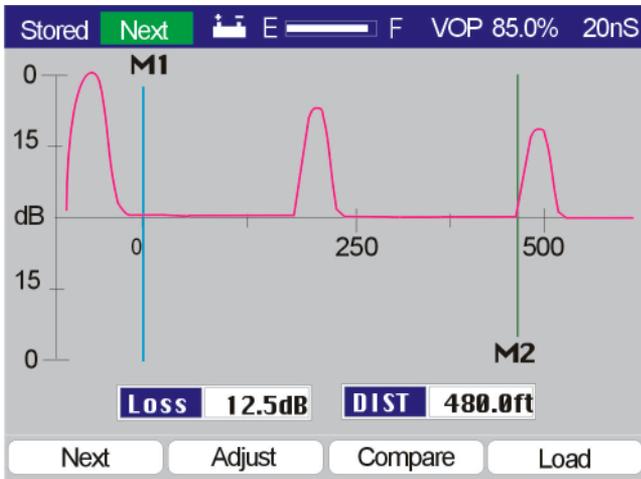
Figure 3-22

ADJUST

The Adjust (F2) function allows adjustment of the Pulse Width using the Up/Down arrow keys, as shown in Figure 3-23. Typically two pulse widths will be stored automatically, depending on the mode and length of cable under test. Only Pulse Widths stored may be viewed. After pressing the Adjust (F2) function key you may also press the Left/Right arrow keys to adjust the position of the second marker M2. As in the Manual operating mode, the digital display measures the Distance and Loss relative to the placement of the M2 marker. The correct placement for distance measurements is at the beginning of the rising edge of the reflected trace. The Loss measurement is made automatically 1/2 the distance of the pulse width to the right of the marker placement. Pressing the Adjust (F2) key again will turn the adjust mode off.
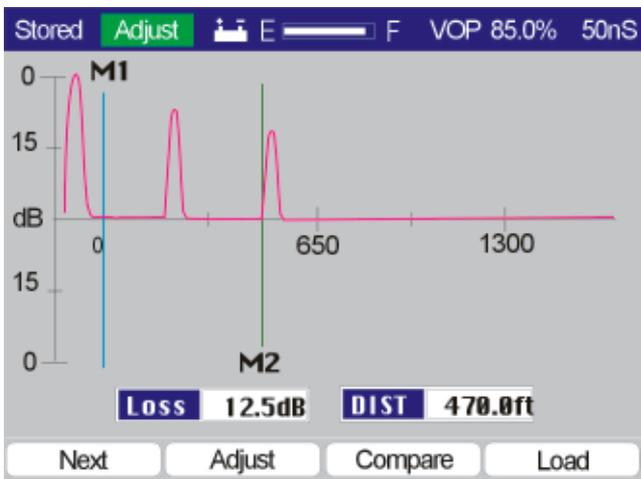
Figure 3-23

COMPARE

The Compare (F3) function key displays a Stored Data screen, (Figure 3-19), prompting the user to select a second saved screen to display. The first and second screens will be displayed simultaneously, the first in the normal Plot 1 color and the second in the Plot 2 color, as selected in the Setup screens. See the Setup section for details of selecting trace colors. A sample Compare display is shown in Figure 3-24, displaying two traces of the same cable with an intermittent fault shown at 170 feet. The first trace shows a loss of only 5.5 dB (a very poor return loss) and the second trace shows a return loss of 18.5 dB (much better), thus indicating that a problem such as a loose or corroded connecter likely exists at 188 feet down the cable under test.

Next and Adjust provide the same functions in the Compare mode as in the normal Single Trace mode. Next will display the next cable fault. Adjust will allow you to adjust the vertical and horizontal scale.

LOAD

 Load returns the user to the Stored Data screen (Figure 3-19), to select another saved screen to display.
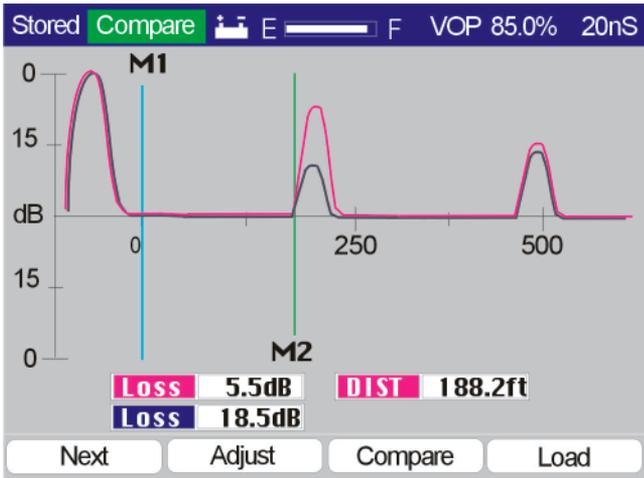
Figure 3-24

Chapter 4 **Specifications**

PERFORMANCE SPECIFICATIONS AND KEY FEATURES

Horizontal Resolution

<2000 ft: at .99 VOP 0.25 ft
>2000 ft: at any VOP 1.00 ft

Vertical Resolution

Bits 14
Pixels 140
Vertical Sensitivity: 62 dB

Range

Maximum All VOPs 4000 ft
Dead Zone   0 ft
Distance Accuracy: ± .1ft ±.01%

Input Protection

DC to 400 Hz 400 V
>1 MHz 10 V

Measurements

Loss Measurement accuracy ±2 dB
VOP 0.01
Velocity of Propagation: .300 to .990 or 30.0% to 99.0%
Increments. 0.001 or .1%
Pulse Widths 10, 20, 50, 100, 200, 350

Waveform Storage

Full resolution
Standard: 25
Automatic Noise Filter
Power filters 50 & 60 Hz

Cable VOP Database

Pre-Programmed Database ~50 Common Cables
Cable Loss Compensation

Environment

Min. Operating temperature: 0˚C
Max. Operating temperature: 50˚C
Humidity: (non-condensing.)   95%
Storage temperature: -4 deg F (-20 C) to
                              +140 deg F (+60 C)

Interfaces

RF Input: 75-ohm F81 (Do not exceed 90V AC/DC or
10V > 1 MHz)
RS232 serial port (DB9 female)
RJ-45 Ethernet 10/100Base-T

Power

Internal: NiMH battery pack, part number:
ASY-12183-010
Operating time: 3 hours continuous (typical)
Automatic low battery shutdown
Charger Input: Min. 15.5VDC 2.5A— Max 18VDC 2.8A

Display

Color Active Matrix LCD 320 x 240
Backlight—Programmable Auto Off

Physical

Size: 11" high x 5" wide x 2-3/4" deep
Weight: 3 lbs.
Operating Temperature Range: 0˚C to 50˚C
                                       (32˚F to 122˚F)

Chapter 5 **Maintenance And Service**

INTRODUCTION

This section contains information on maintenance and service for the CM1000 Cable Modem Analyzer.

Battery Replacement

The CM1000 uses a user-replaceable nickel metal hydride battery. Battery replacements are available from Sunrise. The use of batteries other than those specifically approved may damage the test equipment and will void the warranty.

Figure 5-1

The battery is easily replaced by removing four screws located in the lower portion of the unit's rear panel. The part number for the replacement battery is ASY**-12183-010**.

GENERAL MAINTENANCE

Internal Rechargeable Battery

To avoid damaging the internal battery, optimize its life and guarantee a full charge in 6-8 hours, the following steps should be followed:

- Let the CM1000 cool to room temperature before recharging.
- Turn the CM1000 OFF before plugging in the charger.
- Leave the CM1000 OFF while recharging.
- Always leave the charger connected whenever the CM1000 is not in use.

PRECAUTION: **Do not charge the CM1000 above room temperature or with the unit turned ON. The internal battery may be *hot*, or can become *hot*, reducing its life and significantly increasing the time required to fully charge the battery.**

NOTE: **Use only the supplied AC adapter or the optional DC adapter to recharge the CM1000. Incorrect polarity or voltage could damage the CM1000 or its internal battery.**

Cleaning

Clean the CM1000 with a soft cloth moistened with water. Use a small amount of mild soap if necessary. Do not apply abrasive or chemical cleaners. These may damage the plastic finishes on the case, keypad, or display windows.

TROUBLESHOOTING

If the CM1000 fails to operate and no front panel indicators are illuminated, the internal nickel metal hydride battery may be discharged. Use the supplied AC adapter to power the unit and recharge the battery. If the failure persists while using the AC adapter, call Sunrise for service.

If the internal battery fails to recharge, verify that the AC adapter is actually sending power to the CM1000. Plug the AC adapter into the CE4000 RECHARGE input and then connect the AC adapter to the 115VAC source. Turn the CM1000 on to test the battery condition and then back off. If the internal battery fails to recharge, but the AC adapter delivers power to the CM1000, the battery may be deeply discharged or damaged. A deep discharge requires a longer charge time. If the battery is not restored to normal operation by an eight-hour recharge (unit off), call Sunrise for service.

Firmware Upgrades

Firmware upgrades may be downloaded from the Sunrise web site at www.sunrisetelecom.com. Complete instructions are provided at the web site.

CompactFlash Card Replacement

The CE4000 utilizes a removable CompactFlash card for future expansions and/or firmware upgrades.

Before removing the CompactFlash card, be sure that the CM1000 is off.

Set the unit on its side on a flat surface with the plug-in module slot facing upward and the keypad facing you. The memory card slot is located on the side of the unit just to the right of the keypad and is protected by a small cover held in place by two Phillips head screws. Remove the two Phillips head screws and the protective cover. The memory card will be visible in the slot. A small rectangular shaped button to right of the memory card will also be visible. Press this button to eject the memory card from its slot and then pull the card out of the slot (a pair of tweezers or needle nose pliers may be helpful).

Insert the new memory card and press it firmly but gently into the slot. Replace the protective cover. Powering the unit on will automatically load the new software into the CM1000. This process may take several minutes depending on the software being loaded. The Link LED will flash green during the software update process.

Be sure to seat the memory card fully and tighten the access cover screws.

> **Note:** **The CompactFlash card installs with the Sunrise label facing down.**

TECHNICAL SUPPORT

Sunrise is located in the Eastern Time zone with regular office hours from 8:00AM to 8:00PM. A toll free number service covering all of North America is provided at no charge. Key Sunrise personnel can always be reached any time of the day through a toll free number or electronic mail service over the Internet.

International customers should contact the nearest Sunrise Representative or the factory at 1-725-6652 or by fax at 1-514-725-5637

North America Toll Free: 1-800-297-9726

Outside of North America: 1-514-725-6652

**E-mail address for Technical Support:
catv@sunrisetelecom.com**

website: www.sunrisetelecom.com

WARRANTY

Sunrise warrants the CE4000 Cable Explorer TDR module against defects in materials and workmanship for a period of one year from receipt by the customer. During the warranty period, Sunrise will, at its option, repair or replace defective products.

Liability under this warranty extends only to the replacement value of the equipment.

This warranty does not apply under the following conditions:

The CE4000 has been partially or fully disassembled, altered or repaired by persons not authorized by Sunrise.

The CE4000 is installed or operated other than in accordance with instructions contained in its operating manual.

No other warranty is expressed or implied. Sunrise is not liable for consequential damages.

RETURNING EQUIPMENT TO SUNRISE

Sunrise manufactures equipment to very high standards. Products are warranted against defects in materials and workmanship, as specified in our published product warranty. When properly used and operated, your equipment will provide many years of service. Should it become necessary to return the, equipment to Sunrise for in or out of warranty repairs or calibration, the following steps should be followed.

> **Note:** **If products are repaired or altered by persons not authorized by Sunrise, or not in accordance with instructions furnished by Sunrise or if the products have become defective due to a result of misuse, improper repair, abnormal operating conditions, the labor and materials required to effect the changes will be billed at our standard repair rates.**

Customer's Responsibility

1. Contact Sunrise and request a Returned Material Authorization (RMA) number. Be sure to have your model and serial number ready.

2. After receiving the RMA number, return the equipment with an accurate description of the symptoms and be sure to state the authorization number on your paperwork. The client is responsible for all transportation charges to Sunrise.

3. Original packaging is preferred. If unavailable, carefully package the equipment in alternate packing material to ensure adequate protection during shipping.

Sunrise's Responsibility

1. Sunrise will acknowledge the receipt of the returned equipment and at that time bring any discrepancies to your attention.

2. Sunrise will replace or repair, at its discretion, any component or sub-assembly it deems necessary to return the unit to a proper condition.

3. After the necessary repairs, Sunrise will perform complete test and re-calibration of the unit.

All precautions are taken by Sunrise to ensure that every unit meets all electrical and mechanical specifications prior to returning the equipment to the client.

> **Note:** **Sunrise is not responsible for failures caused by transportation to/from the customer's location, nor by rough handling by the customer after receipt causing further damage to the product. Sunrise is solely responsible for the defects stated above and in our standard product warranty policy.**

If you require information or assistance, contact Sunrise Telecom Broadband at 1-800-297-9726 toll free from anywhere in North America or by fax 1-514-725-5637 or by e-mail to: info@sunrisetelecom.com.

Chapter 6   Appendix

Additional Cable data

Cable Type	Cable Manufacturer	VOP	Cable Loss

Cable Type	Mfg.	VOP	Attenuation 750 MHz
P3-412	Comscope	87.0%	2.65 dB
P3-500	Comscope	87.0%	2.04 dB
P3-565	Comscope	89.0%	1.78 dB
P3-625	Comscope	87.0%	1.66 dB
P3-700	Comscope	89.0%	1.44 dB
P3-750	Comscope	87.0%	1.38 dB
P3-840	Comscope	89.0%	1.26 dB
P3-875	Comscope	87.0%	1.21 dB
P3-1000	Comscope	87.0%	1.21 dB
QR-540	Comscope	88.0%	1.80 dB
QR-715	Comscope	88.0%	1.36 dB
QR-860	Comscope	88.0%	1.17 dB
QR-1125	Comscope	88.0%	0.93 dB
MDU-320	Comscope	87.0%	3.15 dB
F59	Comscope	85.0%	6.97 dB
F6	Comscope	85.0%	5.65 dB
F7	Comscope	85.0%	4.57 dB
F11	Comscope	85.0%	3.65 dB
MC.440	Trilogy	93.0%	2.13 dB
MC.500	Trilogy	93.0%	1.83 dB
MC.650	Trilogy	93.0%	1.50 dB
MC.750	Trilogy	93.0%	1.25 dB
MC1.00	Trilogy	93.0%	0.97 dB
MVP-59	Trilogy	85.0%	7.34 dB
MVP-6	Trilogy	85.0%	5.76 dB
MVP-7	Trilogy	85.0%	4.64 dB
MVP-11	Trilogy	85.0%	3.79 dB
T10-412	Times Fiber	87.0%	2.68 dB
T10-500	Times Fiber	87.0%	2.16 dB
T10-625	Times Fiber	87.0%	1.79 dB
T10-750	Times Fiber	87.0%	1.48 dB
T10-875	Times Fiber	87.0%	1.29 dB
T10-1000	Times Fiber	87.0%	1.21 dB
TX10-565	Times Fiber	89.0%	1.85 dB
TX10-700	Times Fiber	89.0%	1.49 dB
TX10-840	Times Fiber	89.0%	1.30 dB
TX10-1160	Times Fiber	89.0%	1.01 dB
SPC-625	Times Fiber	87.0%	1.82 dB
T10 RG-59	Times Fiber	85.0%	6.96 dB
T10 RG-6	Times Fiber	85.0%	5.62 dB
T10 RG-7	Times Fiber	85.0%	4.50 dB
T10 RF-11	Times Fiber	85.0%	3.58 dB
TX Flex	Times Fiber	88.0%	2.23 dB
Beldon 59	Beldon	82.0%	6.97 dB
Beldon 6	Beldon	82.0%	5.35 dB
Beldon 7	Beldon	82.0%	4.13 dB
Beldon 11	Beldon	82.0%	3.39 dB