SUNRISE TELECOM®

SunSet® MTT ACMII

User's Manual

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User's Manual

MAN-22480-001 Rev. D00

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Warning

Using the supplied equipment in a manner not specified by Sunrise Telecom may impair the protection provided by the equipment.

Warning

This is a Class 1 LASER product. Avoid looking directly at the Transmitter source. For added safety, turn off the laser when not in use.

End of Life Recycling and Disposal Information

DO NOT dispose of Waste Electrical and Electronic Equipment (WEEE) as unsorted municipal waste. For proper disposal return the product to Sunrise Telecom. Please contact our local offices or service centers for information on how to arrange the return and recycling of any of our products.

EC Directive on Waste Electrical and Electronic Equipment (WEEE)

The Waste Electrical and Electronic Equipment Directive aims to minimize the impact of the disposal of electrical and electronic equipment on the environment. It encourages and sets criteria for the collection, treatment, recycling, recovery, and disposal of waste electrical and electronic equipment.

SSMTT ACM II User's Manual
Table of Contents

1 Initial Setup

To unpack and test a new test set:

1. Remove the packing list, test set, and accessories from the shipping container.
2. Inspect all parts and immediately report any damage to the carrier and to Sunrise Telecom.
3. Verify that all parts specified on the packing list were received.
4. Complete the Warranty Registration Card and return it immediately to Sunrise Telecom.
   Note: Sunrise Telecom must receive the Warranty Registration Card in order to provide software updates.
5. Ensure that the software cartridge is fully seated in it's slot as shown in *Section 2.4.3.*

- The inside card contains the software needed to operate the test set. This card may be upgraded in the field to provide you with new software options or releases.
- The outside slot can be used for extra memory storage.

6. Plug the AC Battery Charger into an AC wall outlet and connect it to the test set. The charger plugs in at the top of the test set, where it is labeled DC 15V.

- The test set uses a NiMH battery. Use only the SS138D adapter supplied with the test set. The SS138D AC adapter should be used for charging the test set batteries only.
- Charge the test set overnight before its first use.
- For optimum performance, the test set should be operated on batteries only. The AC adapter will affect DMM measurement accuracy.

7. Turn the test set on by pressing POWER. Verify that it passes the self test. If the test set does not turn on, charge it for five minutes before operating.
8. Upon powering up, the screen should show several download and calibrate messages, all should say "PASS". The final message should read "Downloading (type of module) Module PASS". After this, either a module main menu or test set main menu screen appears.
9. To set the date and time see *Section 9.1.*

2 Test Set Description

2.1 Introduction

You will soon find that the SunSet MTT ACM II (Modular Test Toolkit-Advanced Cable Maintenance) is an indispensable tool for troubleshooting and qualifying access network services.

Figure 1 shows the test set testing from the Central Office, Cross-Box (or B-Box), and NID (Network Interface Device).

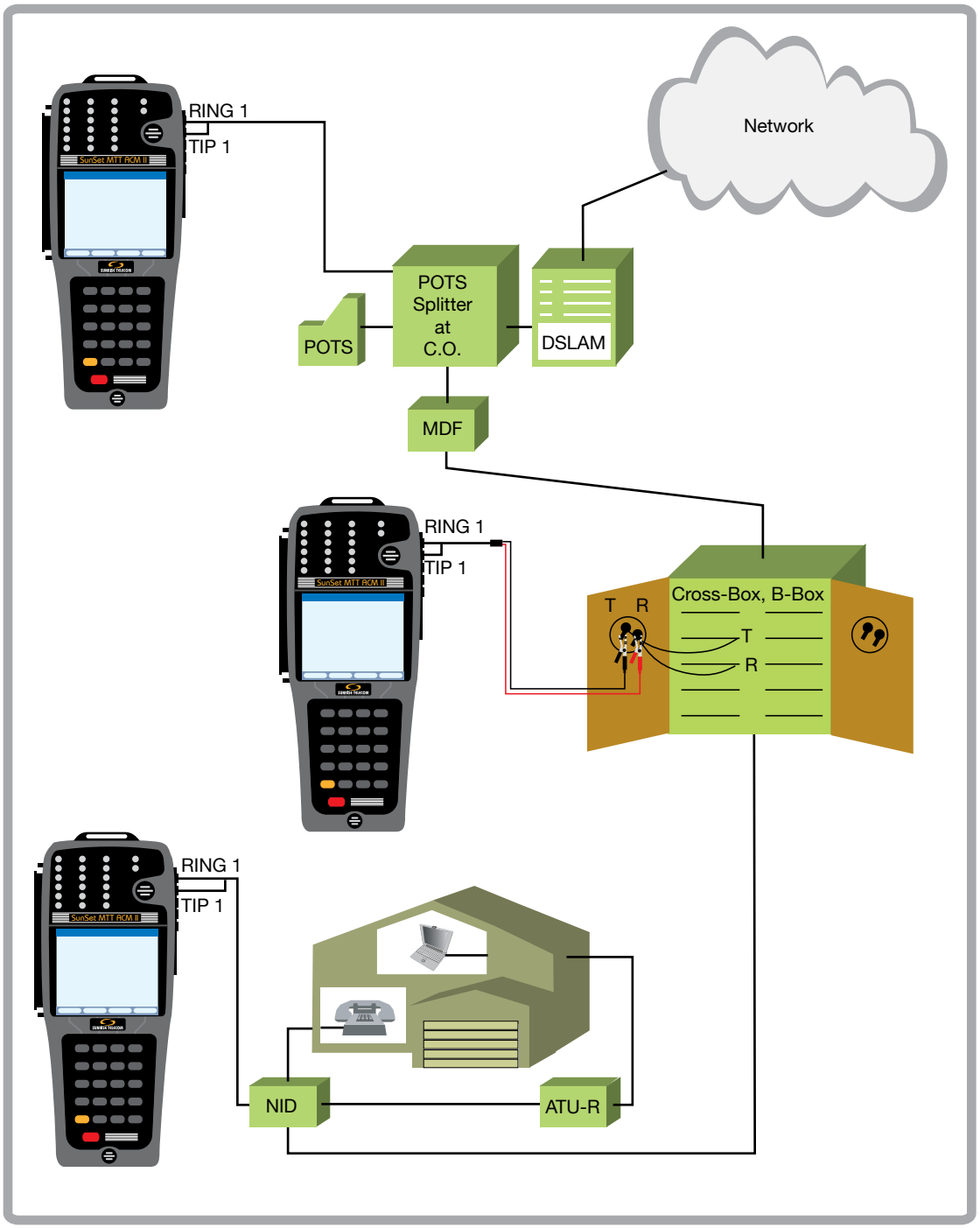


Figure 1 DSL Span

Physical Layer Testing

Time Domain Reflectometer (TDR); up to 2 lines simultaneously

- Locate cable faults.
- Determine distance to a open, short, load coil, and bridge tap.

Load Coil Detector

- Determine presence of load coils.

Resistance Fault Locator (RFL-optional)

- Detect and find ground, cross battery and shorts.

Capacitance Meter; with Ring, Tip, and Ground results

- Estimate loop length.
- Determine capacitive cable balance.

Resistance Meter; with Ring, Tip, and Ground results

- Verify insulation resistance.
- Detect the presence of shorts.

DC Volt Meter; with Ring, Tip, and Ground results

- Verify proper POTS line power.
- Detect foreign DC voltage.

AC Volt Meter; with Ring, Tip, and Ground results

- Detect Foreign AC induced voltage T/G, R/G, T/R, from adjacent power lines.

DC Current Meter; with Ring to Tip results

- Verify POTS DC Loop current.

Frequency Response/Attenuation Measurement

- Determine loss characteristics for the entire VDSL/ADSL band.

PSD Background Noise Measurement

- Characterize spectral compatibility in binder group for the entire VDSL/ADSL/VF band.
- Measure ambient noise.

Signal-to-Noise

- Measure Signal-to-Noise (SNR) for the entire VDSL/ADSL band.

Loop Resistance

- Estimate loop length.

NEXT (Near End Crosstalk)/FEXT (Far End Crosstalk)

- Measure near end and far end crosstalk.

Cable Pair Detect

- Listen to audible confirmation of connectivity. Useful when running dual ended tests.

Longitudinal Balance

- Checks whether the cable pair has adequate balance for crosstalk immunity.

VF Noise Measurement:

- Metallic Noise measures the background noise on a cable pair.
- Power Influence measures the noise from sources such as power.
- Balance is derived from Metallic Noise minus Power Influence.

Other Testing

Plug-in modules allow assembling the test set needed for testing digital subscriber lines or other technologies. The modular platform extends the life of your test equipment investment. Simply add a new module whenever the requirement for a new technology arises. For information on the available modules, contact your sales distributor or visit our web site:

http://www.sunrisetelecom.com/

The rest of this chapter describes the physical features of the test set: the LEDs, keypad functions, and connector panels. The front view of the test set is shown in Figure 2.

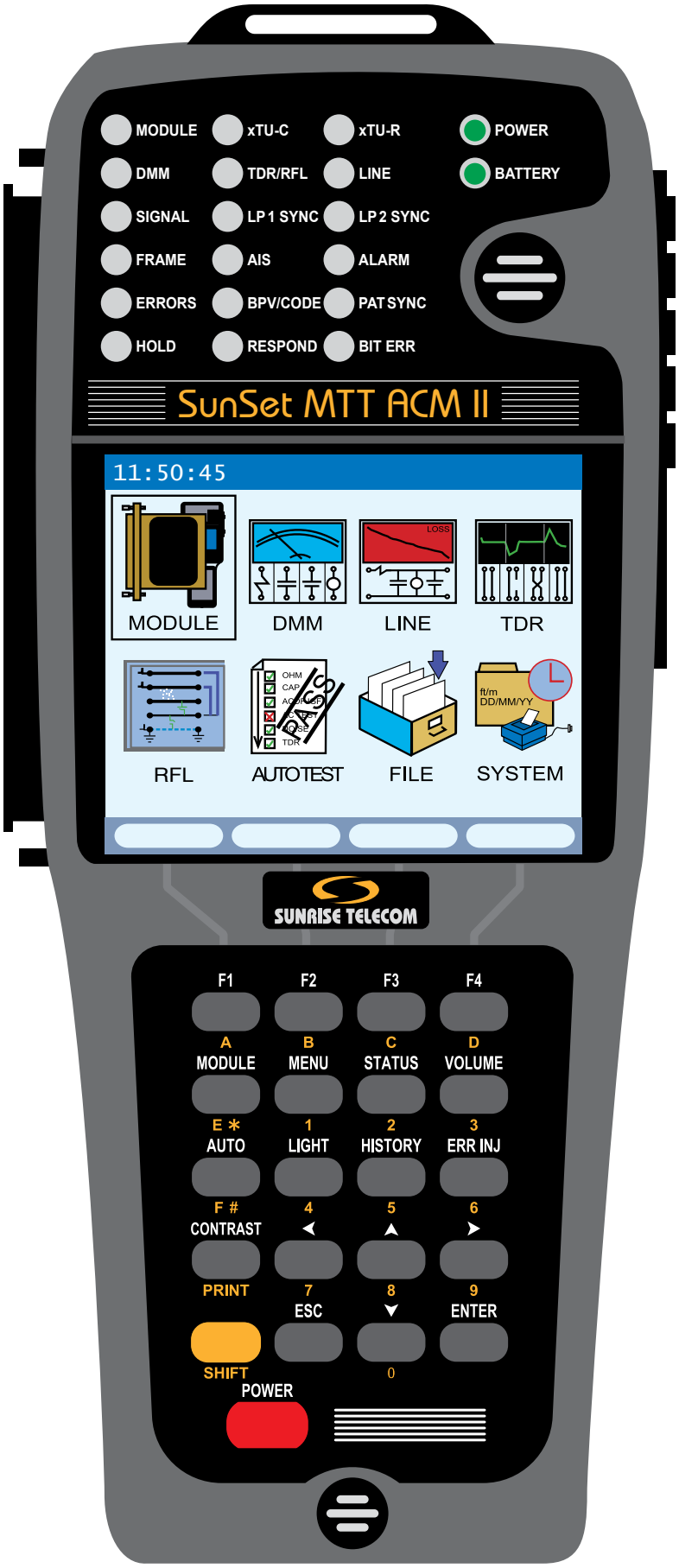


Figure 2 Test Set Front View

2.2 Keypad Functions

The keypad has two sets of functions:

- The white text indicates what function will be performed if the key is pressed by itself; primary functions (i.e., MODULE or HISTORY).
- The orange text shows what function will be performed if SHIFT is pressed; shift functions (i.e., PRINT or alphanumeric entry).

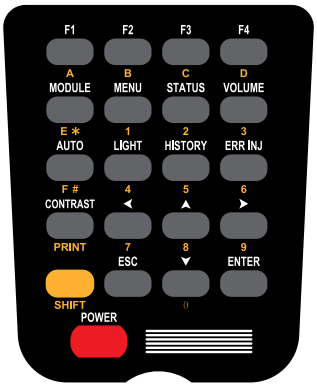


Figure 3 Keypad

2.2.1 Primary Functions

F1-F4: Select choices listed at the bottom of the screen via the keys labeled F1, F2, F3, and F4. If more than four F-key choices are available, "more" will appear in the F4 position; pressing F4 will display the other available options for F1–F3. See Figure 4 for their relationship to the screen.

MODULE: Displays the main menu of the module installed into the chassis. Use it to access all module functions.

MENU: Displays the chassis main menu, shown to the right and in Figure 5.

The main menu screen displays icons, representing the main functions of the test set. To access a particular function, use ◄,▲,▼,► to move the cursor to the icon representing a function of interest, then press ENTER. The selected function menu is then displayed.

Note: The following convention is used throughout this manual. For example; SYSTEM > SYSTEM CNFG means, use the keypad arrow keys (◄,▲,▼,►) to move the cursor to the SYSTEM icon and press ENTER, then use▲,▼ to select the SYSTEM CNFG line, and press ENTER.

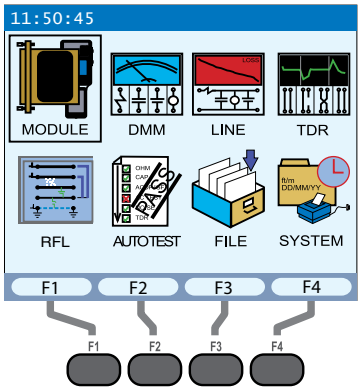
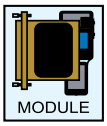
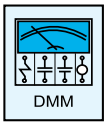


Figure 4 Main Menu Screen

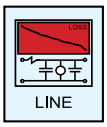
The following is a list of functions available under each icon, this is followed by the chassis main menu tree shown in Figure 5.



Display the main menu of the module installed into the chassis. This can also be accessed by pressing MODULE.



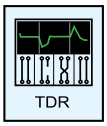
Digital Multimeter with DCV, ACV, DC mA, CAP, OHM and Utility (Calibration) functions



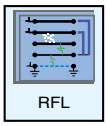
Line can be optioned in two ways.

- Optional extended VDSL frequencies range.
- Standard ADSL 2 frequency range.

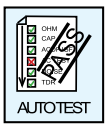
The following are available: PSD Background noise, Logitudinal Balance, VF Measurements, Impulse Noise, Near End Crosstalk, Coil Detection, Frequency generator, Controller and Responder functions.



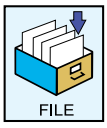
Time Domain Reflectometer



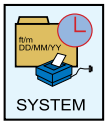
Resistance Fault Locator is an optional feature.



Automatic test routines.



Manage, print, and transfer stored files.



Manage basic system functions such as system clock, printing, NV RAM ERASE, and others.

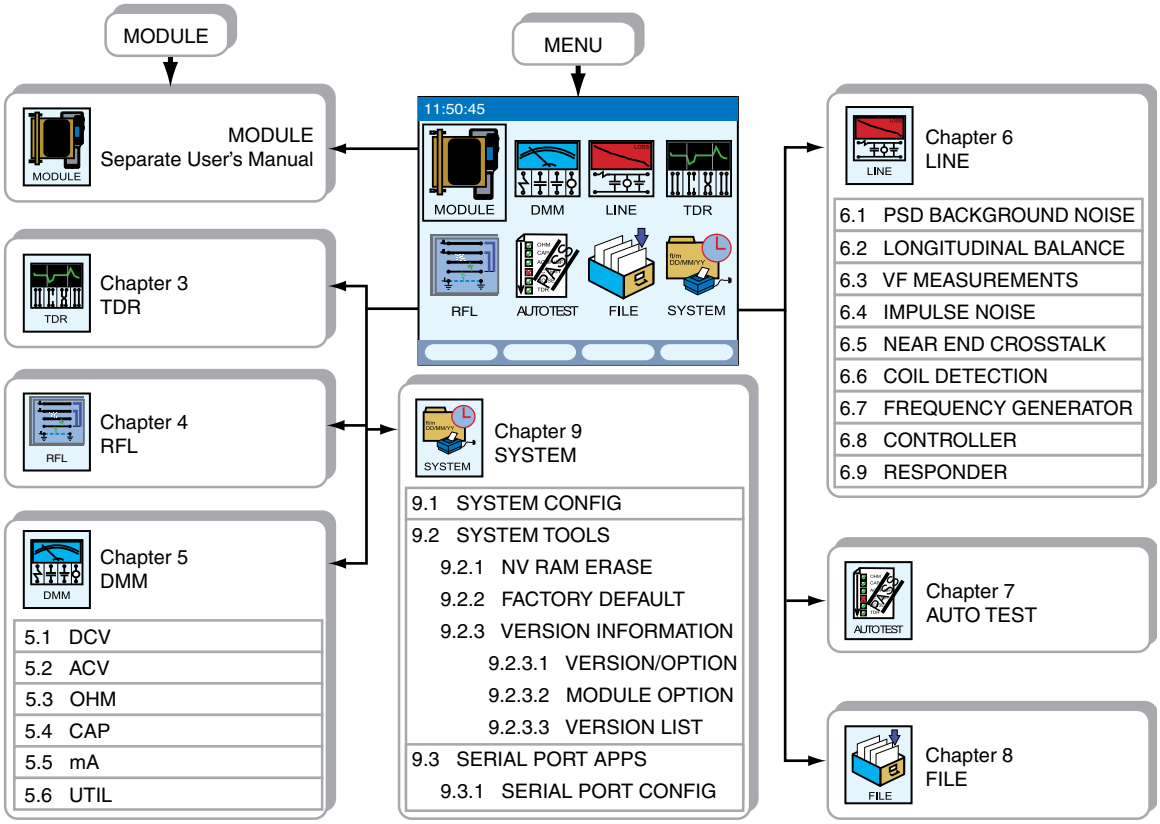


Figure 5 Main Menu Tree

STATUS: Applicable only to certain modules. See the module User's Manual for specific details.

VOLUME: Adjust the speaker's volume for talk/listen applications, like ISDN or VF TIMS testing.

AUTO: Applicable to certain modules. See the module User's Manual for details.

LIGHT: Manually turn on/off the screen backlight. See *Section 9.1* for setting an on time:

HISTORY: Clear any flashing LEDs. LEDs flash to indicate an error or alarm condition has occurred, but is no longer present.

ERR INJ: Applicable only to certain module functions, used to inject errors on the transmit signal.

CONTRAST: Adjust the contrast of the display. Repeat until the desirable contrast level has been achieved.

ESC: Move back toward the main menu.

ENTER: Access the highlighted choice.

◄,▲,▼,►: Move the cursor in the indicated direction.

2.2.2 Shift Functions

The SHIFT key activates the functions specified by the orange labels. The SHIFT key should always be pressed and released before the orange-label key is pressed. When pressed, a “Shift” indicator is displayed at the top of the screen. Press the key again to remove the indicator, allowing access to the primary white-label functions.

The orange shift keys have the following functions:

0-9: Use to enter numbers during testing. Examples are entering IP addresses during PING testing or entering user test patterns.

A-F: Use to enter hexadecimal values.

PRINT: Use to print the test set screen. Note that in the SERIAL PORT CONFIGURATION screen, PRINT MODE must be set for GRAPHIC.

2.3 LEDs

The LEDs provide valuable information on:

- The test set's current test mode.
- The status of the received signal. For example, when the test set detects an alarm, the ALARM LED lights red.
- The status of modem synchronization. In DSL testing, a solid green LED for XTU-R (for ATU-R testing) indicates the test set has achieved synchronization with the DSLAM.

Figure 6 shows the Sunset MTT ACM II LED panel.

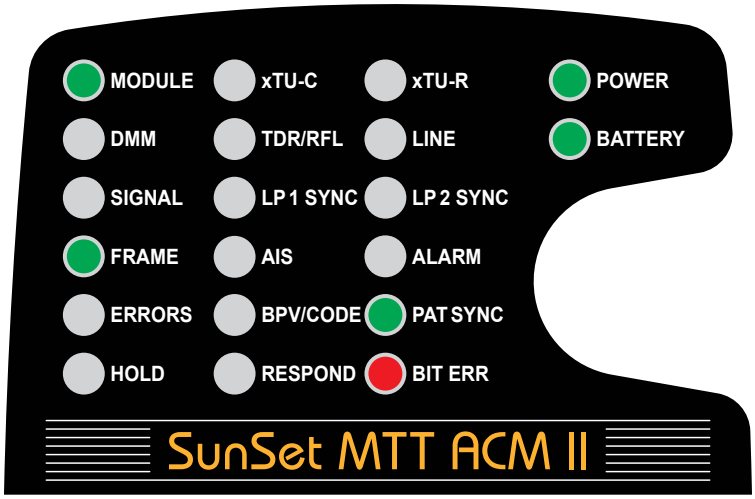


Figure 6 LED Panel

The LEDs have the following meanings:

MODULE
- Green: The test set is in the module mode.
- Red: An error in recognizing module has occurred.

xTU-C

This LED is active when the test set is emulating an xTU-C.
- Green: The test set has synchronized with the xTU-R.
- Red: No connection with the xTU-R.
- Blinking Red: The test set is attempting to open the link with the xTU-R.

xTU-R

This LED is active when the test set is emulating an xTU-R.
- Green: The test set has synchronized with the xTU-C.
- Red: No connection with the xTU-C.
- Blinking Red: The test set is attempting to open the link with the xTU-C.

POWER
- Green: The test set is powered on.

DMM
- Green: The test set is in Digital Multimeter mode.

TDR/RFL
- Green: The test set is in Time Domain Reflectometer or Resistance Fault Locator mode.

LINE
- Green: The test set is in Line measurement mode.

BATTERY
- Green: The SS138D AC charger is connected and the test set is charging.
- Red: Low battery condition. The test set should be connected to the charger as soon as possible.

SIGNAL
This LED is applicable only to certain module functions.

LP 1 SYNC
This LED is active during test modes with 2 loops. For example, in HDSL T1/E1 testing it displays the status of HDSL loop 1.
- Green: Loop 1 (i.e. HDSL Loop 1) is in sync.
- Red: Loop 1 is not in sync.

LP 2 SYNC
This LED functions the same as LP 1 SYNC, except it indicates the status of HDSL loop 2.

FRAME
This LED is active when the test set is in a framed test mode, such as T1/E1 testing.
- Green: The test set has achieved frame sync and the framing found on the received signal matches the framing set in Test Configuration.
- Red: The configured framing type is not found on the received signal. This could indicate either a loss of framing on the received signal or a framing mismatch.

AIS
- Red: An Alarm Indication Signal is detected.
- Blinking Red: An AIS was detected, but it is no longer present. Press HISTORY to clear the flashing LED.

ALARM
This LED is applicable only to certain module functions.

ERRORS
- Red: An Error is detected.
- Blinking Red: An error was detected, but it is no longer present. Press HISTORY to clear.

BPV/CODE
- Red: A Bipolar Violation or Code error is detected.
- Blinking Red: A BPV or code error was detected, but it is no longer present. Press HISTORY to clear.

PAT SYNC
This LED is active whenever the test set is performing a BERT with a known test pattern. For example, it is active in HDSL, IDSL, Datacom/DDS, or T1/E1 testing.
- Green: The test set has achieved pattern synchronization.
- Red: The test set has lost pattern synchronization or cannot achieve pattern synchronization.

HOLD
- Green: An F-key (HOLD) has been pressed that freezes the screen display. Press the same F-key to resume.

RESPOND
- Green: The test set is in responder mode. This is applicable only to Line testing.

BIT ERR
This LED is active whenever the test set is performing a BERT with a known test pattern. For example, it is active in HDSL, IDSL, Datacom/DDS, or T1 testing.
- Red: The test set is currently detecting bit errors.
- Blinking Red: The test set previously detected bit errors, but they are no longer present. Press HISTORY to clear.

2.4 Connector Panels

The test set has two side panels and one top panel. The left side contains a slot to insert plug-in modules. The right side contains ports for physical layer testing. The top panel of the test set contains a COMM PORT and DC power port.

2.4.1 Physical Layer Connector Panel

The test set's right side has two sets of TIP/RING ports with a GRND (Ground) port. They use 2 mm test leads.

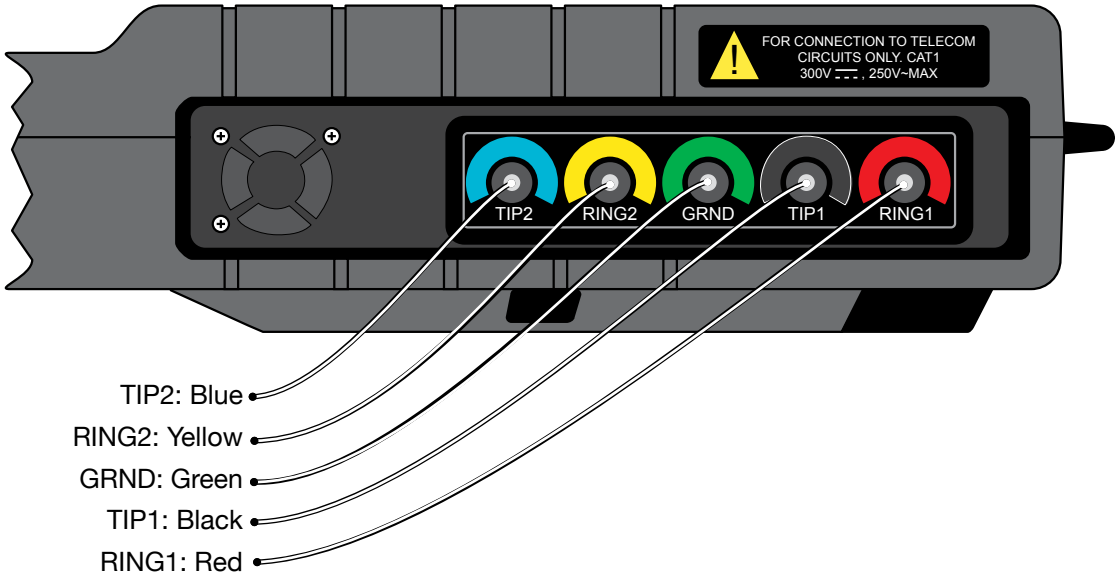


Figure 7 Right Panel

2.4.2 Module Side Panel

The left side of the test set contains a module slot to insert modules. Upon ordering the test set with module, the module will already be in place. To change modules, use the this procedure:

⚠ **Caution**: Changing modules with the power on will damage the module and or the test set. Always verify that the test set is off before changing modules.

1. Turn the test set off and loosen the two thumb screws on either side of the module.
2. Gently pull the module out from the slot. Place it in its hard case or protective wrapper.
3. Insert the other module. Make sure it is firmly seated.
4. Hand tighten the two thumb screws. Make sure they are secure.
5. Turn on the test set. The screen should show that the test set is downloading the new module and should read "PASS".
7. Perform an NV RAM ERASE; see *Section 9.2.1*.

2.4.3 Top Panel

The top panel is shown in illustration to the right. Note that the panel is shown with all protector covers removed.

The following is available:

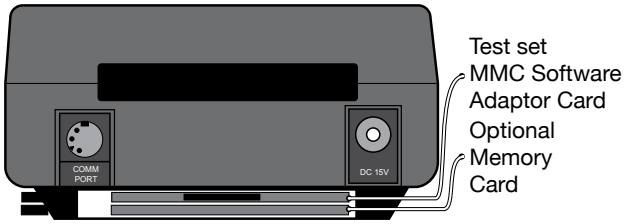


Figure 8 Top Panel

DC 15V

⚠ CAUTIONS

- Do not use any charger other than the SS138D charger provided with the test set. Use of other chargers may cause damage to the test set and will void the warranty.
- Whenever possible, do not use the SS138D charger during normal operation. For optimum results, fully charge the test set and then perform all tests on battery power.

Plug the SS138D AC charger into the DC 15V port. The charger's input voltage is 100-240 VAC, it's output is 15 VDC. The test set may be operated while charging, but optimum performance will be with battery operation.

COMM PORT

This 8-DIN port is used for direct printing or connection to a PC for results transfer. Required optional printer cables are a DIN-8 to DB-9 (SS115D) or a DIN-8 to DB-25 (SS115). For connection to a PC, an optional null modem adapter (SS122B or SS122C) is also required. For setup details, see *Section 9.3.1.*

Software Card

The test set's software can be upgraded via the MMC card. The software card is inserted into the inner card slot of the test set using a PCMCIA to MMC adapter. Use The following procedures:

To Replace the MMC Card

1. Turn off the test set and unplug any cables.
2. Flip down the hinged cover on the back of the test set. Note: Do not remove the adapter.
3. Remove the MMC card.
4. Insert the new MMC software card as shown in the illustration to the right.
5. Flip up the hinged protective top cover.
6. Power up the test set and confirm proper operation.

After Installing New Software

1. The test set may need to update it's screen drivers; if so, the process typically takes 5 minutes.
   Do not turn the test set off during this process.
   If problems occur, contact Customer Service at 1-800-701-5208.

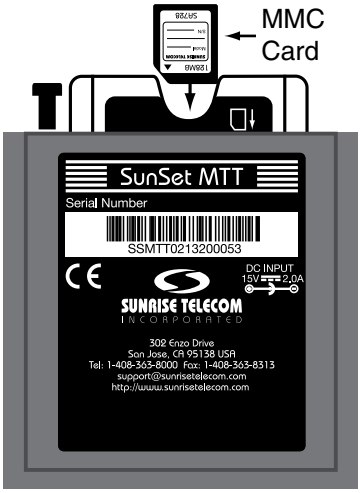


Figure 9 Card Installation

⚠ *Handling Precautions*

- Keep the card dry at all times.
- Do not bend or subject the card to strong shocks.
- Do not directly touch any electrical connectors on the card.

MMC Files

There are four test set/PC readable folders on the MMC Card:

- SOFTWARE: Contains a files for each module and chassis.
- SYSTEM: Contains encrypted test set system files.
- PROFILE: Contains configuration settings known as profiles.
- RESULTS: Contains stored results.

2.5 Battery Care and Storage

It is important to observe these basic battery care procedures in order to avoid possible damage to the battery and to maintain it's performance.

⚠ Warnings

- Failure to observe the following procedures and precautions can result in electrolyte leaks, heat generation, bursting, fire, and serious personal injury.
- Battery electrolyte is a strong colorless alkaline solution, which is extremely corrosive and will burn skin.
  - If skin comes in contact with the electrolyte from the battery, thoroughly wash the area immediately with clean water.
  - If clothing comes in contact with the electrolyte from the battery, discard the clothing.
  - If any fluid from the battery comes in contact with eyes, immediately flush thoroughly with clean water and immediately consult a doctor. The electrolyte can cause permanent loss of eyesight.
- Keep the battery out of reach of children.

⚠ Cautions

- Never dispose the battery in a fire.
- Never heat the battery.
- Never strike or drop the battery.
- Do not apply water, or other oxidizing agents to the battery. This will cause corrosion and heat generation. If the battery becomes rusted, the gas release vent may no longer operate and cause the battery to burst.
- Do not charge the battery using an AC adapter or charger not specified by Sunrise Telecom. Charge the battery only with the Sunrise Telecom charger that came with your test set.
  - If the battery is not fully charged after the battery charger's predetermined charging period has elapsed, stop the charging process. Prolonged charging may cause leakage of battery fluid, heat generation, and or bursting.
  - Charge the battery within a temperature range of 0°C (+32°F) to +40°C (+104°F).
- Do not use the battery if it leaks fluid or changes shape; otherwise it may cause heat generation, bursting, and fire.
- Do not short circuit the battery by connecting the positive (+) and negative (-) terminals together with electrically conductive materials, such as lead wires, etc.
- Do not connect the battery directly to a power source or the cigarette lighter socket in a car. Use a specified cigarette lighter charger from Sunrise Telecom.
- Never disassemble the battery. Doing so may cause an internal or external short circuit, or result in exposed material of battery reacting chemically with the air. It may also cause heat generation, bursting, and or fire.
- Never modify or reconstruct the battery pack. Protective devices are built into the battery pack. If damaged, excessive current flow may cause loss of control during charging or discharging of the battery, which can result in leakage of battery fluid, heat generation, bursting, and or fire.
- The gas release vent, which releases internal gas is located in the positive (+) terminal of the battery. For this reason, never deform, cover, or obstruct this vent.
- When the battery operating time becomes much shorter than its initial operating time even after recharged, the battery has reached its end of life and should be replaced with a new one.

Extended Battery Storage

- Fully charge the battery before storing.
- Remove the battery from the test set, per *Section 2.5.1*.
- Do not store battery in high temperatures, such as direct sunlight, in cars during hot weather, or near any other heat source. This will impair the performance and shorten the operating life of the battery, and may cause battery leakage.

- For maximum battery life, store the battery between -20°C (-4°F) and +30°C (+86°F).

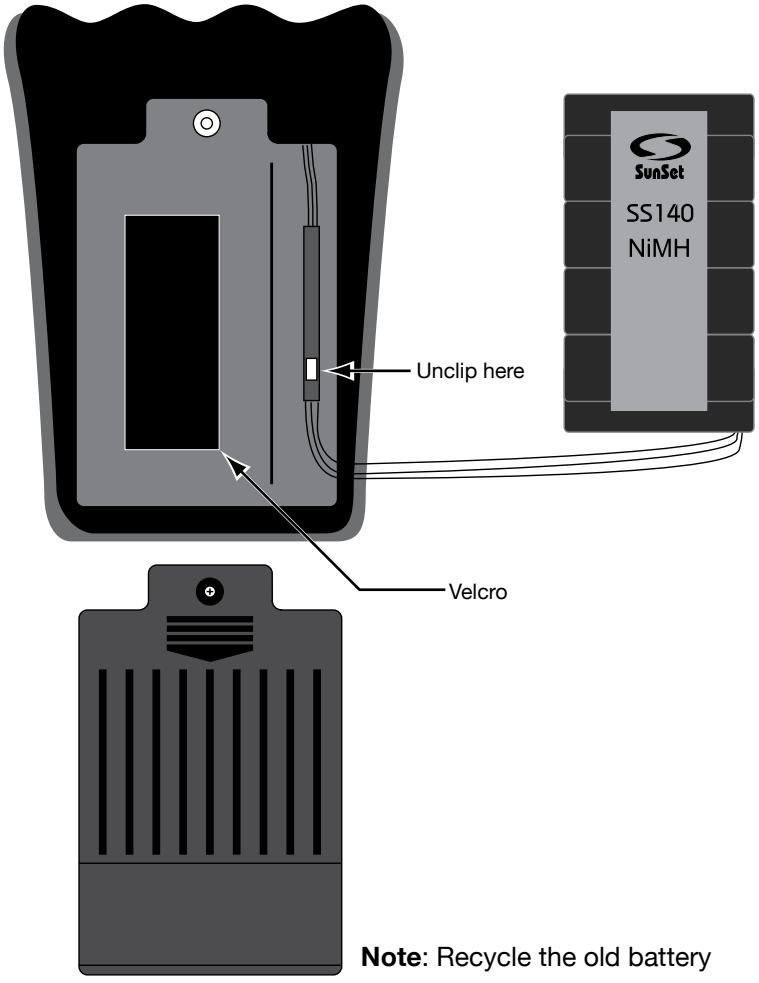
- During storage the battery will need to be regularly recharged. The interval ranges from approximately 30 to 90 days at temperatures between -20°C (-4°F) and +30°C (+86°F). In general, the higher the storage temperature the shorter the recharge cycle.
  - To recharge, install the battery into the test set and use the supplied Sunrise Telecom battery charger to recharge the battery.
  - Charge the battery within a temperature range of 0°C (+32°F) to +40°C (+104°F).
- After long-term storage, there is a possibility that the battery will not fully recharge. To fully charge it, charge and discharge the battery for a few times (discharge the battery with the test set).

Note: For optimum test set performance, it is recommended that the test set should only be operated on batteries. AC charger can affect DMM measurement accuracy.

2.5.1 Replacing the Battery

The test set is designed with a field-replaceable 9-cell NiMH battery. A replacement battery (SS140) is available from Sunrise Telecom by contacting customer service at 1-800-701-5208. Follow these steps to replace the battery:

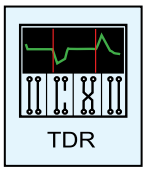
1. Swing the test set support stand out of the way.
2. Remove the cover retainer screw and push down on the battery cover on the back panel, in the direction indicated by the arrow, as shown in Figure 10.
3. Unclip the battery, as shown in Figure 10.
4. Pull the old SS140 NiMH battery off its Velcro backing, and out of the test set.
5. Install the new battery using the reverse of this procedure.



Note: Recycle the old battery

Figure 10 Replacing the Battery Pack

3 TDR

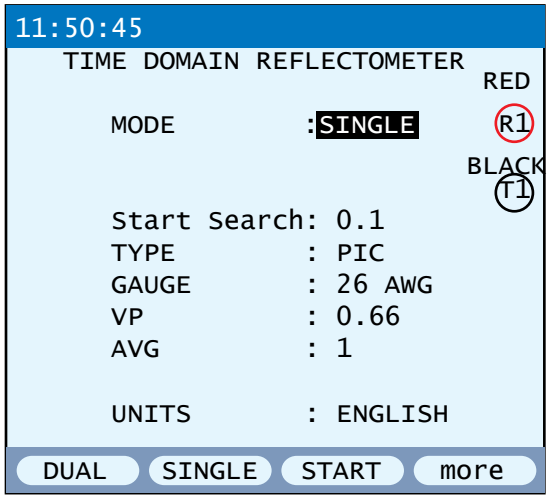


A TDR (Time Domain Reflectometer) operates by sending a pulse of energy down the cable. It then measures any reflections that return to the test set. These reflections are caused by faults that cause impedance changes in the cable. For example, a load coil looks like a large increase in impedance (the high frequency pulses cannot pass through) and can easily be detected by a TDR. Any major change in the twisted pair's plastic insulation or the cable fill's material (water in the cable) causes a reflection.

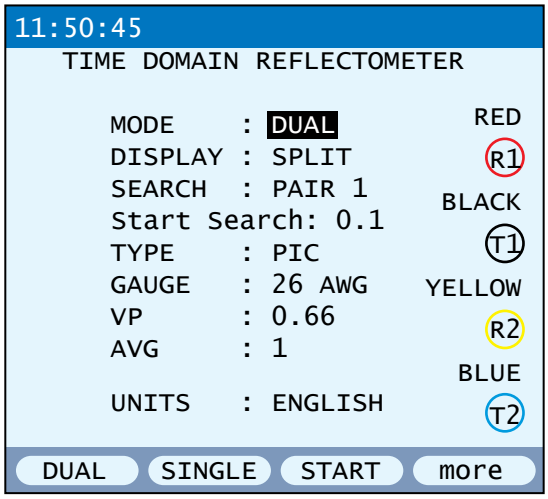
A TDR plays an integral role in testing DSL circuits. It can:

- Locate bridge taps, indicating the presence of a bridge tap, the exact location, and the length of the lateral.
- Locate load coils, showing the presence and exact location of load coils.
- Detect any other circuit faults like an open or shorted cable.

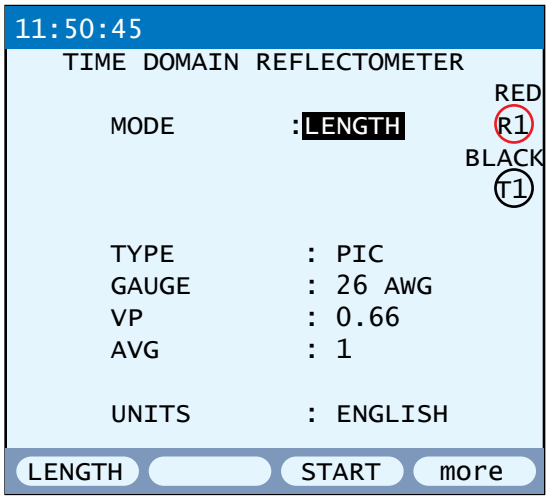
3.1 TDR Setup



Single Mode



Dual Mode



Length Mode

Figure 11 TDR Setup Screens

Configure the following:

MODE

Options: DUAL (F1), SINGLE (F2). LENGTH (more, F1)

Select an operating mode:

- DUAL: Dual trace mode. As shown in Figure 11 Dual Mode, use R1 (Ring 1-Red), T1 (Tip 1-Black), R2 (Ring 2-Yellow) and T2 (Tip 2-Blue) ports to connect to the circuit.
- SINGLE: Single trace mode. As indicated in Figure 11 Single Mode, use R1 (Ring 1-Red) and T1 (Tip 1-Black) ports to connect to the circuit.
- LENGTH: Discover the length of the entire cable; find the last event.

DISPLAY (only if MODE: DUAL): Select a display mode

Options: SPLIT (F1), OVERLAP (F2), DIFF (F3)

Options: SPLIT, OVERLAP, DIFF

- SPLIT: Displays the results of the measurement as two separate traces, pair 1 at the top of the screen, pair 2 at the bottom.
- OVERLAP: Similar to SPLIT, as a trace is displayed for each pair, but they are overlapped on-screen for easy comparison.
- DIFF: Displays a single trace, but it is the mathematical difference of the results of pairs 1 and 2.
- See *Section 3.2* for examples of these screens.

SEARCH (only if MODE: DUAL): Select a pair to search.

Options: PAIR 1 (F1), PAIR 2 (F2)

START SEARCH: Set a specific distance away from the tester to begin the auto search at.

Options: 0-20.0 feet

Use the +.1 (F1), -.1 (F2), +10 (more, F1) and -10 (more, F2) keys to set the distance.

TYPE: Specify the cable insulation type, a factor in determining VP.

Options: PIC (F1), GEL (F2), PVC (more, F1), PAPER (more, F2)

- PIC: Polyethylene/air filled, insulated cable
- GEL: Polyethylene/jelly filled, insulated cable
- PVC: Polyvinyl insulated cable
- PAPER: Paper/pulp insulated cable

GAUGE: Specify the wire gauge, a factor in determining VP.

English Options: F1= 24/19/28, F2= 26/22/20

Metric Options: F1= .4/.6/.3, F2= .5/.9/.8

- An incorrect setting may result in less accuracy. If testing a cable span with mixed gauge values, select the highest gauge value.
- The UNITS setting determines if the gauge is expressed in AWG (English) or mm (Metric). In North America, thickness is expressed in AWG (American Wire Gauge). A value of 24 AWG refers to wire that is 1/24 inch diameter.
  Outside North America, thickness is expressed in millimeters (i.e., 0.4 mm is comparable to 26 AWG; 0.5mm is comparable to 24 AWG).

VP: Set the Velocity of Propagation

Options: from .40 to .99

Use F1 and F2 to change the Velocity of Propagation. F4 sets the increment/decrement factor at +/- .01 or +/-.1.

This setting calibrates the test set for the particular cable type and is crucial for accurate results.

VP indicates the speed of the signal traveling down the cable. It is a ratio of the speed in cable to the speed of light; a value of .65 means the signal travels at 65% the speed of light.

Find the VP in the cable's specification sheet or from the manufacturer. If it cannot be found, take a representative cable of a known length and measure it with the test set's TDR. Change the VP setting until the test set provides an accurate distance reading.

AVG: Determine the number of times the test set sends the pulse
Options: 1-5. The recommended setting is 1.

Use F1 and F2 to determine the number of times the test set sends the pulse. If AVG is set to greater than one, the test set displays an average of all attempts.

UNITS: Select a measurement system.
Options: ENGLISH (F1), METRIC (F2)

When finished with configuration, see the next section.

3.2 Performing a TDR Measurement

Follow this procedure for making a TDR measurement:

1. Select TDR. Note that the TDR/RFL LED turns green. See *Section 3.1* for configuration details.
2. Connect to the cable pair(s) as shown as in Figure 12.

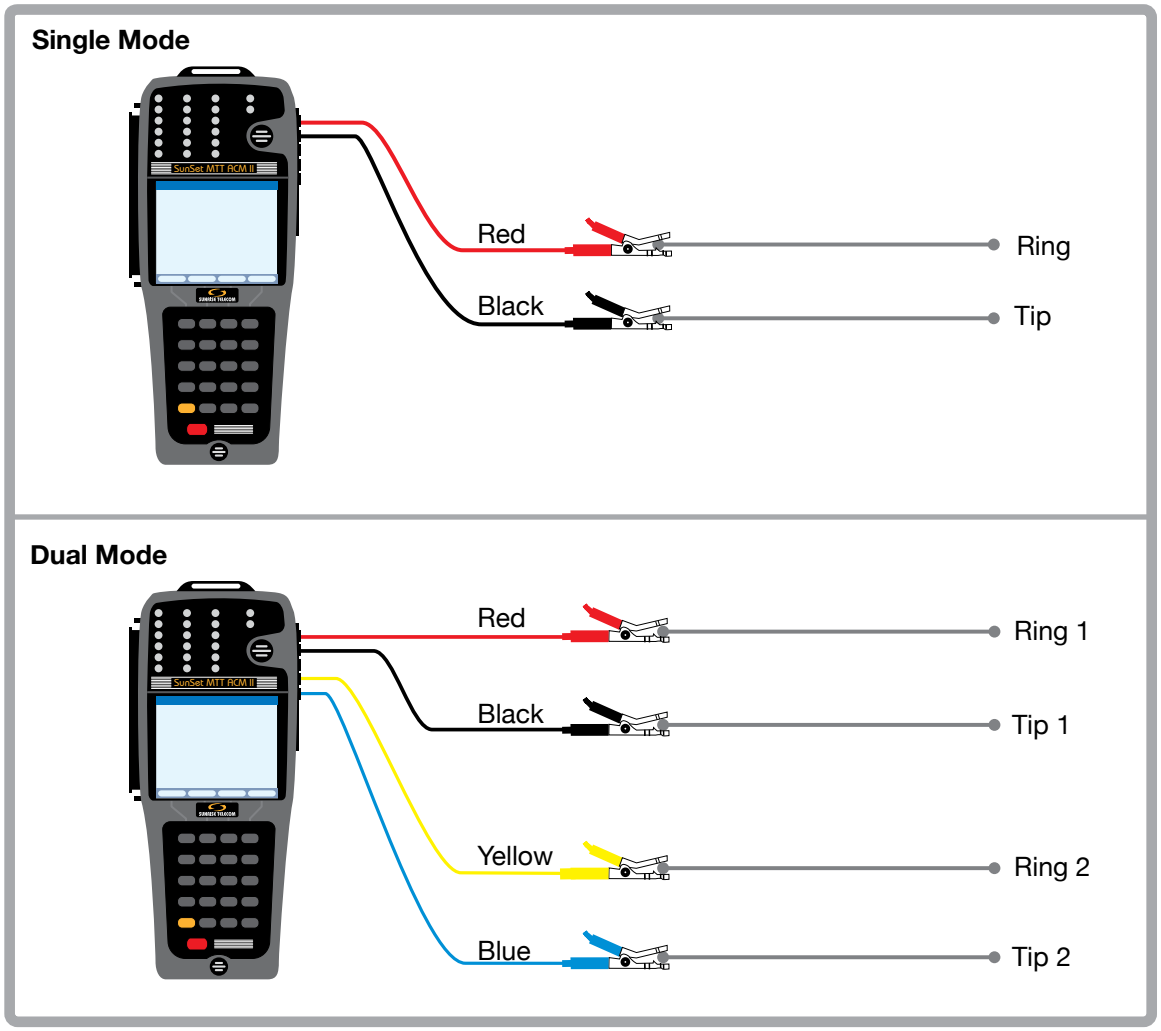


Figure 12 Connecting to the Cable Pair(s)

3. When ready, press START (F3). Refer to *Section 3.2.1* for single mode, or *Sections 3.2.1 and 3.2.2* for dual mode measurements.

3.2.1 Single Mode Measurements

After START has been pressed, the waveform is displayed. Use ◄,► to move the cursor to a displayed reflection.

- The gold region pertains to the original trace. The white region pertains to the detection region for reflection. In general, focus on the white region for detecting faults.
- DISTANCE reports the location of the cursor. Place the cursor at the start of the reflection to locate the fault.
- To adjust the display vertically, press +OFFSET (more, F1) or -OFFSET (more, F2).

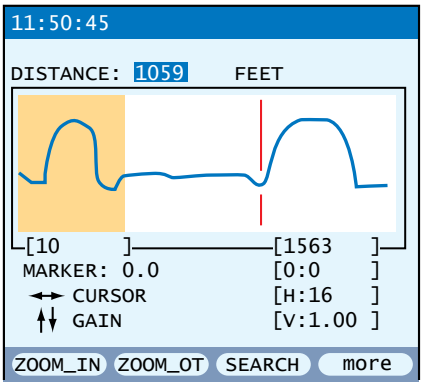


Figure 13 Fault Found Screen

Adjusting the Zoom

Use ZOOM_IN (F1) and ZOOM_OT (F2) to scan the entire cable span for faults or focus on a particular fault or cable segment.

- ZOOM_OT shows more of the cable span, while ZOOM_IN shows shorter portions.
- The “H” (Horizontal) value reports the zoom factor. It can range from 1-320 (1 being the closest range and 320 being the farthest).
- Zooming out to the maximum value (H=320) allows for viewing the entire span length to easily locate cable faults. Zooming in allows interpreting potential faults.

The screen shown to the right shows a bridge tap with the zoom out (H=128). The screen shows the whole cable span: from 10 to 12,436 feet. A bridge tap can be made out in the far left of the screen. Press ► to move the cursor (red line) near the fault; the DISTANCE reading shows it at 701.5 feet.

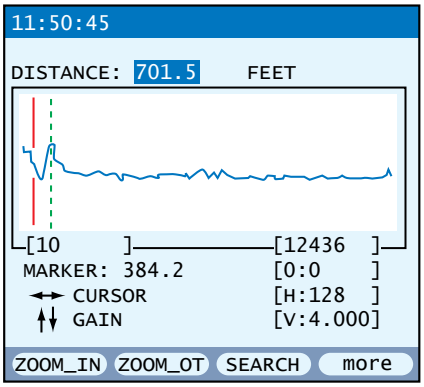


Figure 14 Result Zoomed Out Screen

Press ZOOM_IN (F1) to zoom in on the fault. Since the test set zooms in on the cursor’s location, move the cursor to the fault-then press ZOOM_IN (F1). The screen to the right shows the test set at H=64; the bridge tap is now more visible. The screen displays from 10 to 6224 feet.

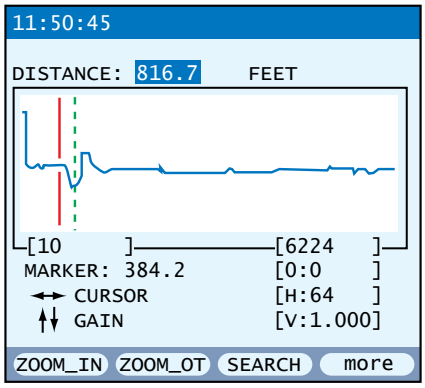


Figure 15 Zooming in Once

TDR F-keys (shown in Figure 16)
ZOOM_IN (F1) and **ZOOM_OT** (F2): Adjust the scale of the screen. ZOOM_OT shows more of the cable span, while ZOOM_IN focuses on shorter portions. Note the “H” (Horizontal) value at bottom right displays the zoom factor.

SEARCH (F3): The Auto Search feature searches for the first fault on the cable pair as described in *Section 3.2.1.1.*

+OFFSET (more, F1) and -**OFFSET** (more, F2): Control the vertical position of the trace on the screen. +OFFSET moves the trace up; -OFFSET moves the trace down. The offset value is shown as “O” at the bottom of the screen.

MARKER/CURSOR (F1): Determine the function of ◄, ►. Press CURSOR to move the solid cursor with ◄, ►. Press MARKER to move the dotted marker with ◄, ►.

ALIGN (more, F3): Shift the cursor position (solid line) to the left of the screen. The display is now to the right of the cursor.

HOLD (more, F1): Pause the measurement and activate the HOLD LED. Press again to release the HOLD.

STORE (more, F2): Press to save; see *Chapter 8.*

PG_LFT (more, F1) and **PG_RGT** (more, F2): Shift the display 1/2 page to the left or 1/2 page to the right.

In addition to the F-keys:

- Use ◄, ► to move the position of the cursor or Marker.
- Use ▲, ▼ to adjust the Gain (pulse strength). Increasing the Gain (▲) increases the strength of the reflection.

Lower Display Features
Below the reflection, there are several display items, as seen in Figure 16:

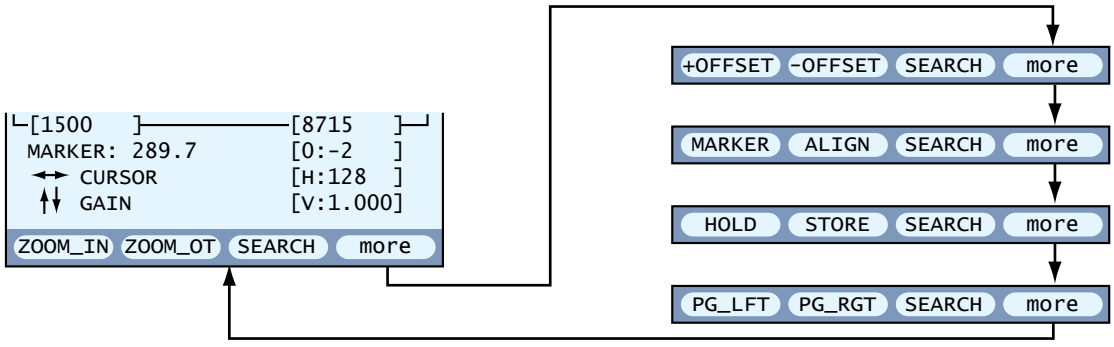


Figure 16 Auto Search Lower Screen Items with F-keys

[1500]: Distance at the left-most start of the screen.

[8715]: Distance at the right-most end of the screen.

MARKER: Distance between the Marker and the cursor. When the cursor is at the beginning of a bridge tap and the marker is at the open end, this value shows the length of the bridge tap.

O: Offset value. Offset represents the vertical position of the trace on the screen. This can range from +112 (high on screen) to -112 (low on screen).

H: Zoom (scale) factor. This can range from 1 to 320. 1 shows only a limited portion of the screen in more detail. 320 shows the whole cable span.

V: Gain value. Gain adjusts the amplification of the pulse. This can range from 32 (highest) to 0.13 (lowest).

3.2.1.1 Using Auto Search

Use AUTO SEARCH to search for the first fault on the cable pair. The test set locates the first dip or spike and displays that cable segment.

To use Auto Search:

1. Start a measurement.
2. Press SEARCH (F3) and SEARCHING is displayed until a fault is found.
2. FOUND is displayed along with the fault waveform when a fault is found.
3. The test set also places the cursor (red line) near the fault. DISTANCE reports the cursor's location. Use ◄,► to adjust the cursor's position.
4. If the test set does not find any faults, NONE is displayed. If this occurs, zoom out and manually

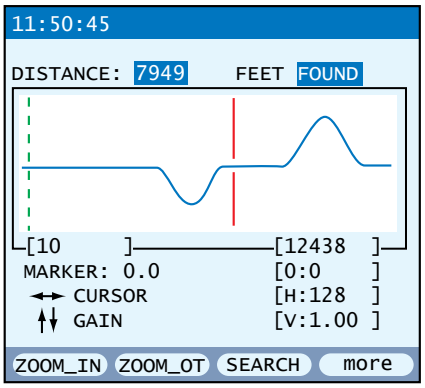


Figure 17 Auto Search Screen

3.2.1.2 Finding Multiple Faults

A TDR can see past a bridge tap, cable splice, wet cable, or other impairments. However, it cannot show beyond an open, load coil, or short. For example, if a load coil is detected, it must be removed before continuing with fault detection.

The screen to the right shows a bridge tap at 1589 feet. The Cursor (red line) indicates the location (DISTANCE). The Marker (green line) indicates the length of the lateral (MARKER).

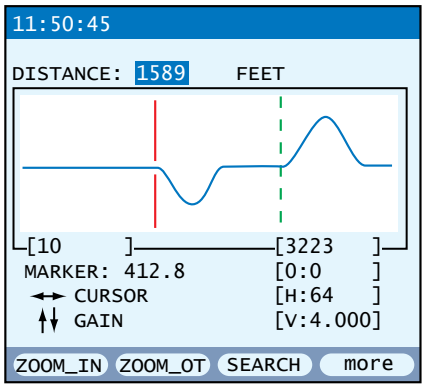


Figure 18 Bridge Tap at 1589 ft

Press PG_RGT (more, F2) to look past this length of cable. Pressing PG_RGT one time displays the cable span from 1625 to 4838 feet as shown in the screen to the right.

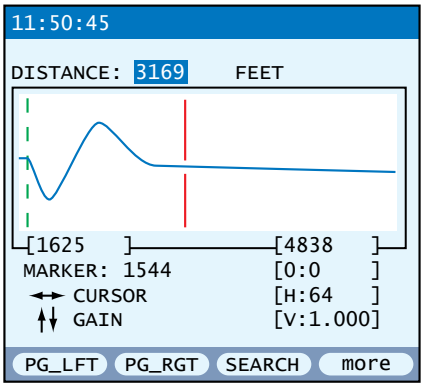


Figure 19 1625 to 4838 ft View

Press PG_RGT again to show 4856 to 8069 feet. A potential fault begins to appear at the right of the screen shown to the right. Press ZOOM_OT (F2) to reveal more of the cable span. Remember that the test set zooms in on the position of the cursor; to focus on a potential fault, move the cursor to that position.

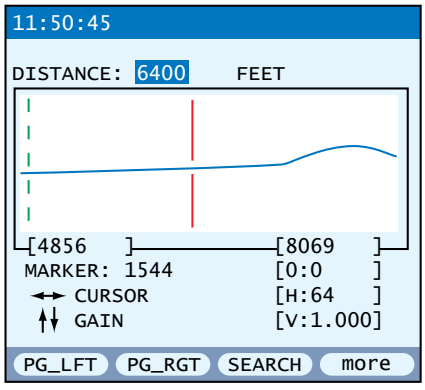


Figure 20 4856 to 8069 ft View

Press ZOOM-OT (F2) to display from 4856 to 11281 feet (screen to the right). The open is now visible with position of the cursor showing it to be at 6902 feet.

Note: To make the fault more visible, press ▲once to increase the Gain. Note in Figure 21, it is 2.000, where it was 1.000 in Figure 20.

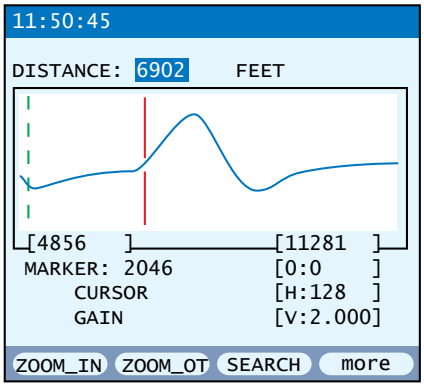


Figure 21 4856 to 11281 ft View

TDR Hints

- Adjust the zoom value to the approximate cable length; check the right-side distance in brackets. Zooming out as much as possible (H=320) allows you to view the entire cable length, but it may make locating smaller or near faults more difficult.
- The test set has a fixed pulse width for the displayed span. When viewing long spans, make far faults more visible by increasing the gain. Press ▲ to increase value at the lower right (V).
- To find the exact distance between two points (i.e the start of a bridge tap and the end of the lateral), place the cursor at one end, and the Marker at the other. The MARKER reading below the graph provides the difference between the two.
- The polarity of the reflection reveals the type of fault:
  - Up spike: indicates an open or a load coil.
  - Down spike: indicates a short.
  - Down followed by up: indicates a bridge tap.

Typical Fault Examples

Load Coil/Open

Figure 22 shows a load coil or open at 3335 feet. Load coils are typically 88 mH inductors placed in POTS circuits longer than 18,000 feet. Since high frequency signals do not pass through load coils, ADSL circuits cannot tolerate load coils. All load coils must be removed for ADSL transmission.

One key to identifying load coils is location. Load coils are placed approximately 3000 feet from the Central Office. They are then placed every 6000 feet. Another key is shape; the waveform is typically more rounded than that of an open and the baseline after the reflection is lower than before the reflection.

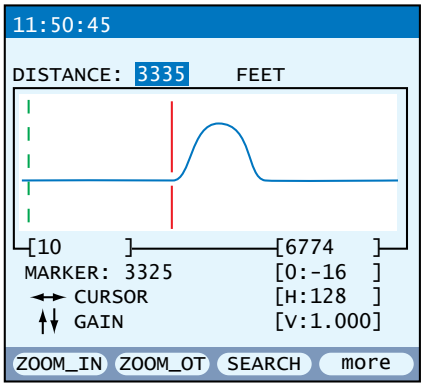


Figure 22 Typical Load Coil/Open

Typical Short

Figure 23 shows a short occurring at 3335 feet. A short is represented as a sharp dip in the waveform.

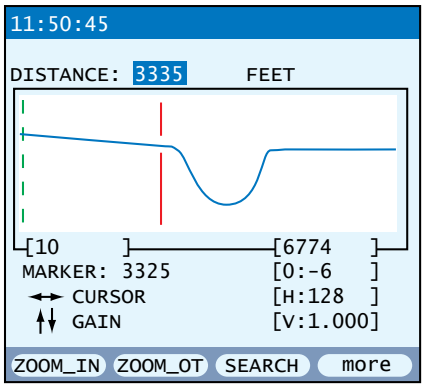


Figure 23 Typical Short

Bridge Tap

Figure 24 shows a typical bridge tap. It begins at 835 feet and extends for 249 feet (DISTANCE provides the beginning; MARKER provides length). It starts with the steep downward slope; the lateral continues until the sharp upward slope, or bump, which represents the open at the end.

Here are some guidelines for bridge taps in DSL circuits:

- The sum of all bridge taps must be less than 2500 feet (Bellcore TA-NWT-00120, for HDSL circuits).
- One individual bridge tap may be no longer than 2000 feet (Bellcore TA-NWT-00120, for HDSL circuits).

After finding and removing a lateral, retest the cable for any other laterals or faults that may have been missed.

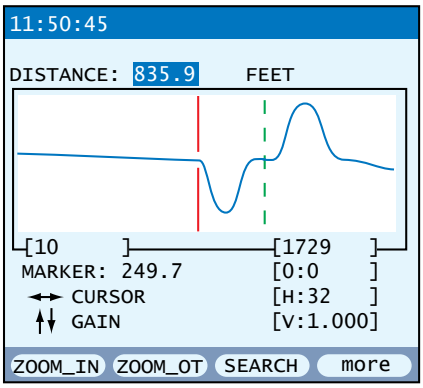


Figure 24 Typical Bridge Tap

3.2.1.3 Comparing a Live TDR Trace to Stored TDR Traces

Once a TDR trace is stored, it can be recalled and compared to a current trace for analysis. Use the following procedure:

1. Store a TDR result; see *Section 8*.
2. Run the TDR measurement.
3. To recall the previously stored result for comparison, press ESC to reach the main menu and select FILE.
3. In the VIEW/STORE/PRINT screen, select the comparison file and press VIEW (F1). Then press RECALL (F2).
4. The TDR display will now be split horizontally in two sections as shown to the right. The top section displays the stored trace. The bottom section displays the active trace.
5. Values displayed in red correspond to the stored trace in the top section. Values displayed in blue correspond to the active trace in bottom section.
   Note: The stored trace is static and does not change. F-key functions apply only to the active trace.
6. To escape from Stored TDR Trace mode, press ESC twice.

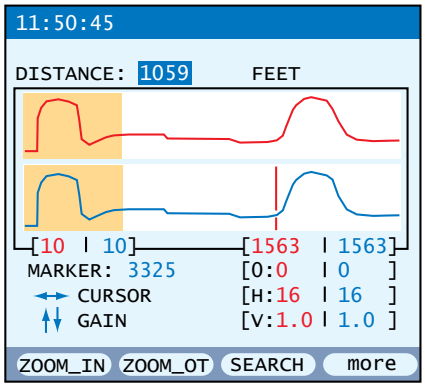


Figure 25 Stored and Live Trace Comparison

3.2.2 Dual Mode Measurements

Using this mode, the test set can display the measurements from two lines simultaneously as described in the following sections.

Note: A Dual Trace screen is stored as a split screen. When recalled, the F-keys allow changes to the view, overlap, difference, or back to split.

3.2.2.1 Dual Trace Split Screen

In Figure 26, PAIR 1 is the top trace; PAIR 2 is the bottom trace. Changing the view or offset, changes the view for both traces. For details on how to use this screen and interpret results from it, see *Section 3.2.1*.

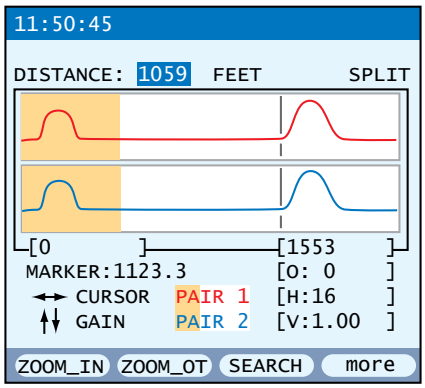


Figure 26 Dual Trace Split Screen

3.2.2.2 Dual Trace Overlap Screen

In Figure 27, the traces are positioned almost on top of each other for easy visual comparison. For details on how to use this screen and how to interpret results from it, see *Section 3.2.1*.

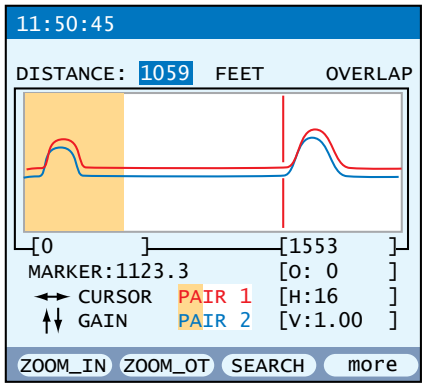


Figure 27 Dual Trace Overlap Screen

3.2.2.3 Dual Trace Difference Screen

In Figure 28, the mathematical difference of the two traces is displayed. A flat line indicates no difference. For details on how to use this screen and how to interpret results from it, see *Section 3.2.1*.

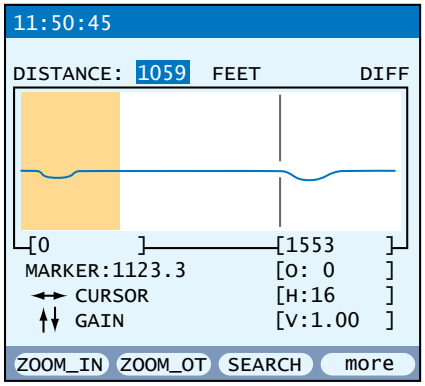


Figure 28 Dual Trace Difference Screen

3.2.3 Cable Length

Use the LENGTH MODE to find the length of a cable. The search function will find the last open event on the trace.

Once the test has started, you will see a CABLE LENGTH reading of 0.0 FT at the top of the screen.

Press SEARCH (F3) to scan. It takes a few minutes for the test to reach its conclusion.

When the result has returned, the distance will appear. In this sample, the cable length is 1582 feet.

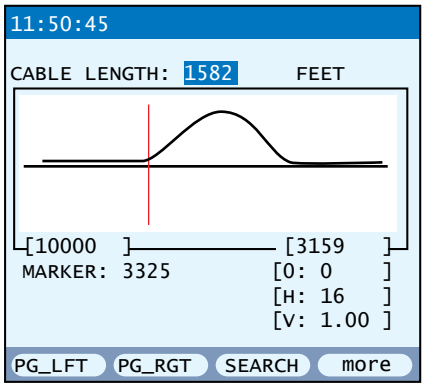
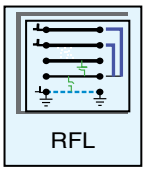


Figure 29 Length Mode Results

4 RFL



When the resistance of a T-G or a R-G test is less than the resistance of the copper loop (Solid), use the TDR function to locate the fault. However, when the resistance of a T-G or a R-G test is greater than the resistance of the copper loop, use the optional RFL (Resistance Fault Locator) to locate it.

From the chassis main menu, select RFL and press ENTER. The test set will display the following setup screen. The results are described in the following sections.

4.1 RFL Setup

Configure the following:

METHOD: Choose the method of measurement.
Options: DUAL (F1), SINGLE (F2)

- DUAL: Separate conductor pair method.
- SINGLE: Single conductor method.

GAUGE: Select the wire gauge of the cable.
UNITS=ENGLISH Options: 24 (F1), 26 (F2), 19 (more, F1), 22 (more, F2), 28 (more, F1), 20 (more, F2), MULTI (more, F1)
UNITS=METRIC Options: .4 (F1), .5 (F2), .6 (more, F1), .9 (more, F2), .3 (more, F1), .8 (more, F2), MULTI (more, F1)

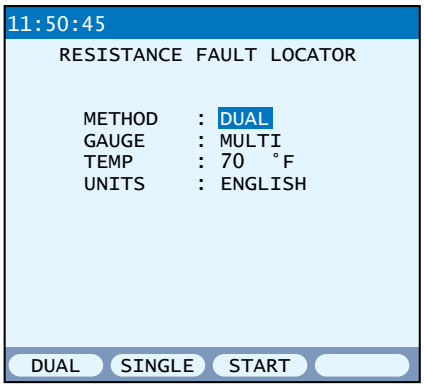


Figure 30 RFL Setup Screen

If MULTI is selected, the screen shown in Figure 30 is

Use the MULTI-SECTION screen if the cable is made up of sections that are of different gauges, different lengths, or when the distance to the strap is known.

When the cursor is in the GAUGE column, use the F-keys to select the wire gauge for each strand. Use ▲,▼ to move the cursor between the 6 strands.

When finished with the gauge selection, press LENGTH (F3), then enter a length from 1 to 10000, using SHIFT and the numeric keypad.

The TOTAL length is reported at the bottom of the LENGTH column. This total is the DTS (Distance To Strap) number that is used to calculate DTF (Distance To Fault) and STF (Strap To Fault) in the result screens.

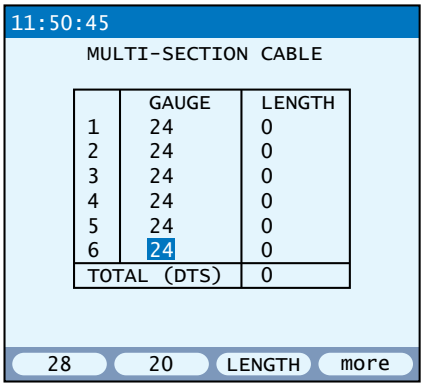


Figure 31 Multi-Section Cable Setup Screen

When finished, press ESC to return to the RFL Setup screen shown in Figure 30 and configure the remainder of the setup items:

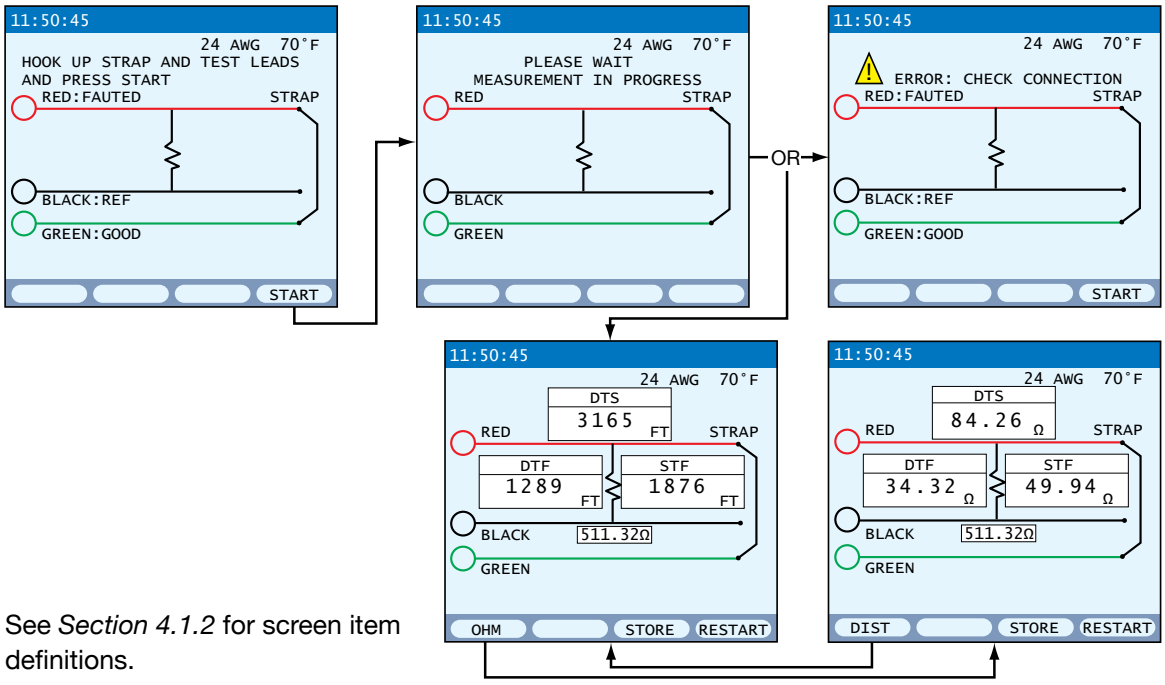
TEMP: Select the ambient temperature (F or C**)**
Press SHIFT and use the numeric keypad to set the temperature. Out of range entries are rejected.

Note: The accuracy of the measurement is dependent on the GAUGE and TEMP settings.

UNITS: Select the unit of measurement
Options: ENGLISH (F1)or METRIC (F2).

When finished, press START (F3) to begin. A new screen is displayed reflecting the choices made in the setup screen (top left screen of Figures 32 and 33). These screens are described in the following subsections:

4.1.1 Single Conductor Setup



See *Section 4.1.2* for screen item definitions.

Figure 32 Single Conductor Screens

4.1.2 Dual Setup (Separate Pair)

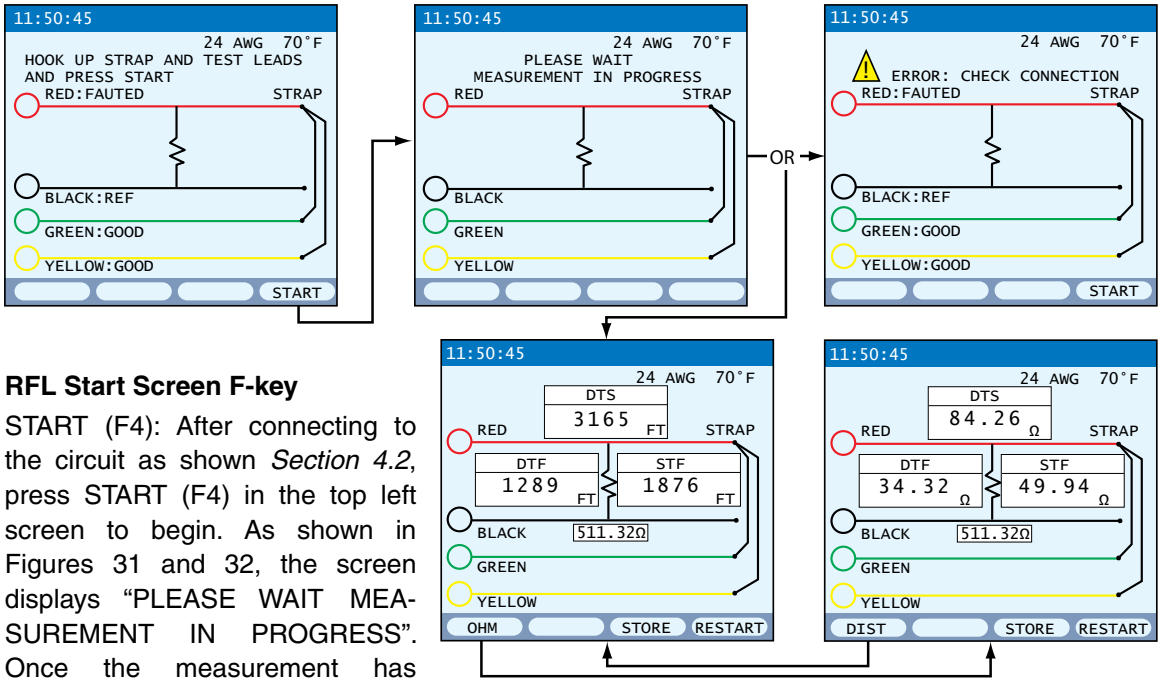


Figure 33 Dual Conductor Screens

RFL Start Screen F-key

START (F4): After connecting to the circuit as shown *Section 4.2*, press START (F4) in the top left screen to begin. As shown in Figures 31 and 32, the screen displays “PLEASE WAIT MEASUREMENT IN PROGRESS”. Once the measurement has completed, either an error or a results screen is displayed, with new F-keys.

RFL Result Screen F-keys

OHM/DIST (F1): If a result is displayed, a distance measurement is displayed for each line of the circuit. Press F1 to display the resistance for each line; press it again to display the distance.

STORE (F3): Store the results. See *Chapter 8.*

RESTART (F4): Start another test.

4.2 Fault Location

There are four main resistance faults: Cross, Battery Cross, Ground, and Short. They are discussed in the following subsections.

4.2.1 Cross Fault

A Cross Fault is a fault between a non-working pair (pair under test) and another or other non-working pairs. To locate a cross, the pairs must be initially identified. The faults are shown in Figure 34.

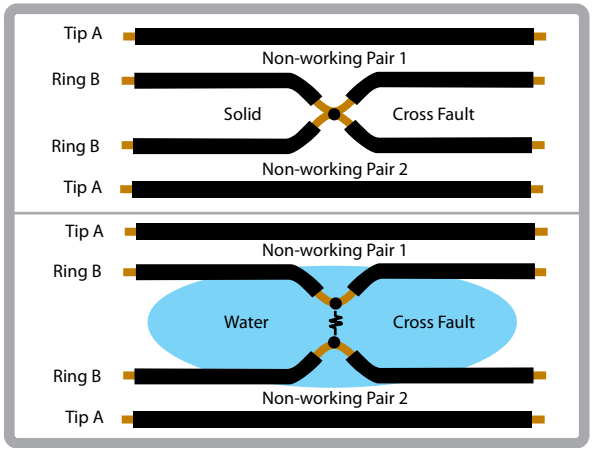


Figure 34 Cross Fault Conditions

Figure 35 shows various test set connections for determining which line is at fault, using the single and separate setups.

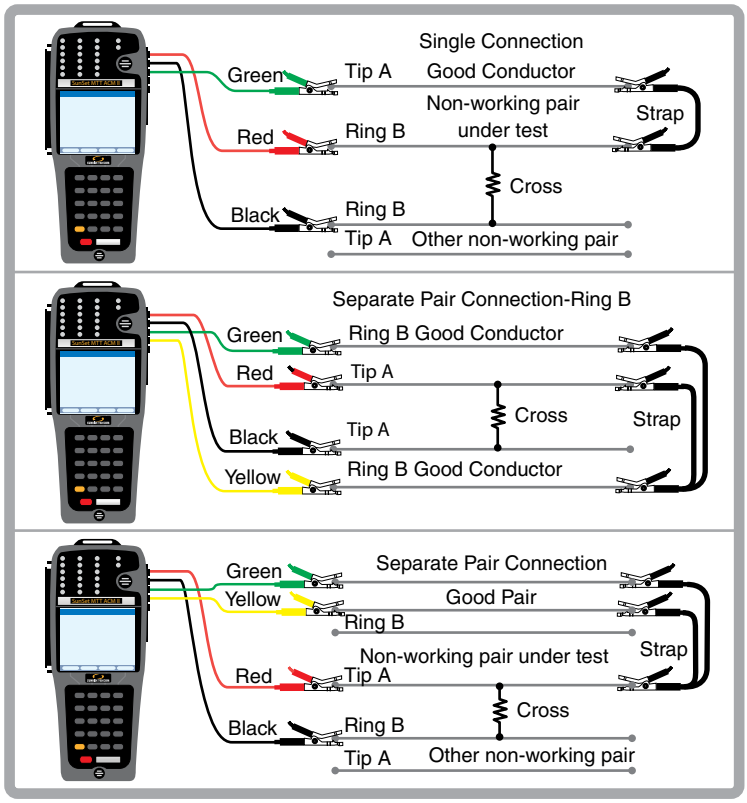


Figure 35 Cross Fault Test Setups

4.2.2 Battery Cross Fault

A Battery Cross Fault is a fault between a working pair and a non-working pair (pair under test). To locate the fault, there is no need to identify the working pair. The fault locating procedure is the same as locating a ground due to the battery's internal resistance to ground.

In a Solid Cross Fault, the voltage reading on the pair under test is quite high (the same or very close to the central office battery voltage). In a Non-solid Cross Fault, the voltage reading is considerably lower. Figure 35 shows the faults.

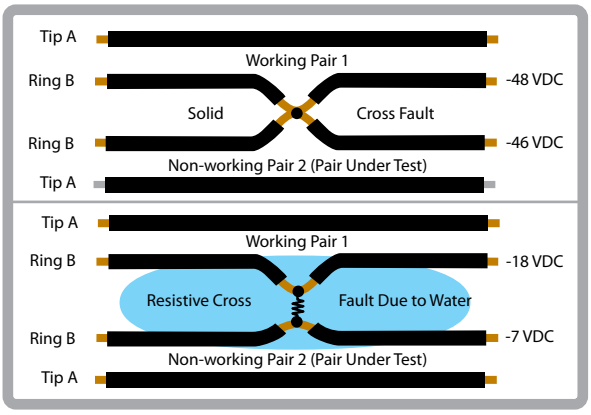


Figure 35 Battery Cross Fault Conditions

Figure 36 shows various test set connections for determining which line is at fault using the single and separate setups.

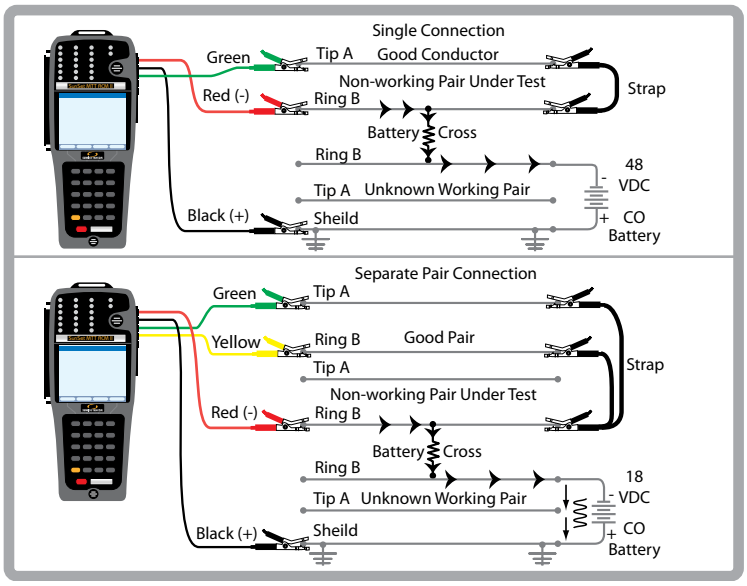


Figure 36 Battery Cross Fault Setups

4.2.3 Ground Fault

When a fault causes current to flow from any line to ground, it is called a ground fault. The faults are shown in Figure 37.

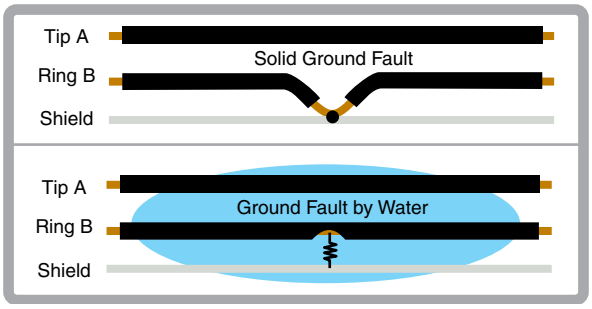


Figure 37 Ground Fault Conditions

Figure 39 shows various test set connections for determining which line is at fault using single and separate pair setups.

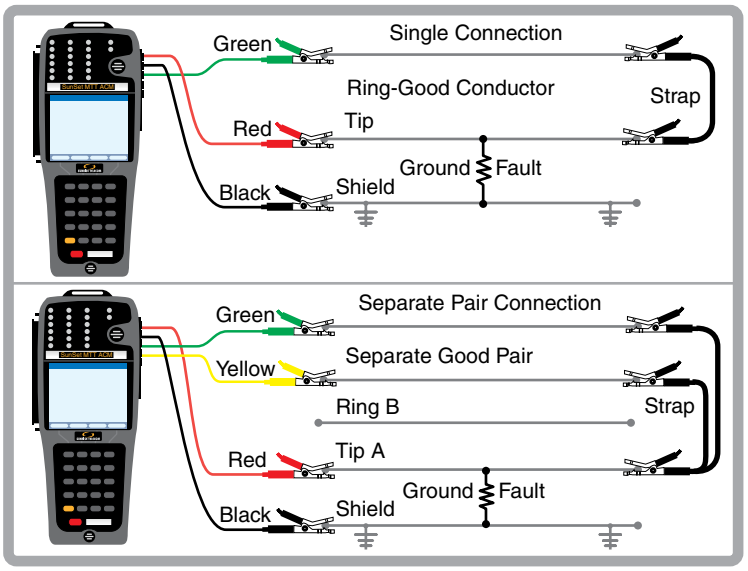


Figure 38 Ground Fault T est Setups

4.2.4 Short Fault

A Short Fault is any condition that causes current to flow between tip and ring conductors. The faults are shown in Figure 39.

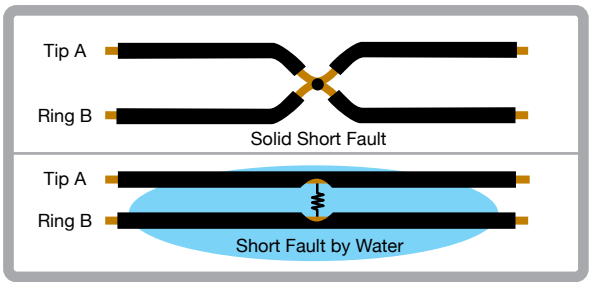


Figure 39 Short Fault Conditions

Figure 40 shows various test set connections for determining which line is at fault using the single and separate setups.

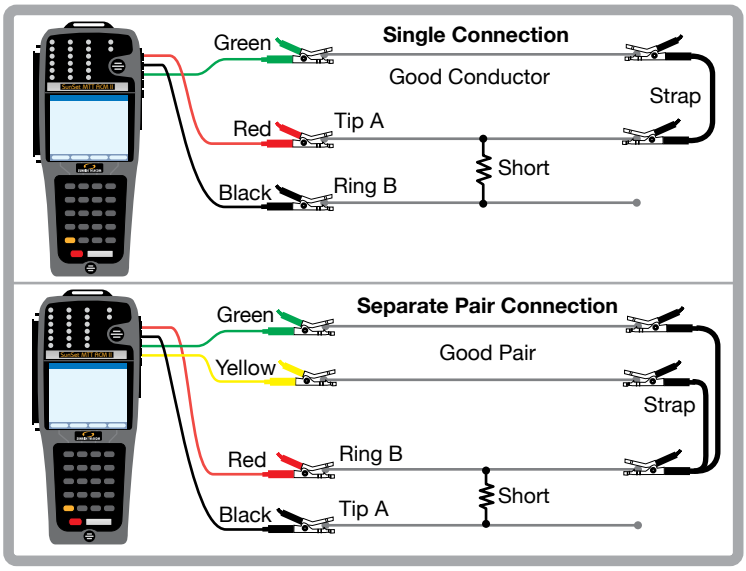
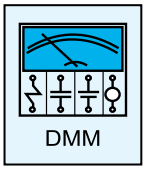


Figure 40 Short Fault Test Setups

5 DMM



Digital Multimeter tests should be used for qualifying or troubleshooting the physical layer. These tests verify required conditions on the line.

Select DMM to display the Digital Multimeter functions, which are:

- DC Voltage
- AC Voltage
- Resistance
- Capacitance
- DC Current
- Utilities, contains Calibration

The Digital Multimeter menu screen is shown to the right. In it, use ◄, ▲, ▼, ► to select the desired DMM measurement. Press ENTER to take the measurement.

Sections 5.1-5.5 provide specific requirements and interpretations for each of the measurement types. *Section 5.6* contains calibration procedures. *Section 5.7* provides a sample step-by-step procedure for performing DMM tests.

Note: The **STORE** (F4 or MORE F3) F-key is available in all DMM result screens. Use it to save a measurement, see *Chapter 8.*

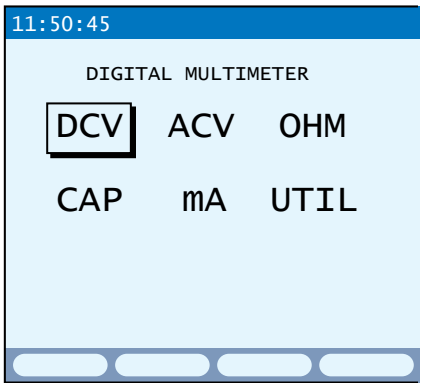


Figure 41 Digital Multimeter Menu Screen

5.1 DC Voltage

The test set can be used to verify that there is appropriate power on the line. The test set can measure voltage up to 300 VDC.

- For ADSL circuits that support POTS, verify POTS Voltage. POTS, which is offered on the same circuit, requires the following line power:
  - Tip to Ring: +48 VDC
  - Ring to Ground: -48 VDC
- For HDSL circuits, verify power at the HDSL remote unit:
  - HTU-R typically requires 140-225 VDC line power (unless it is locally powered).

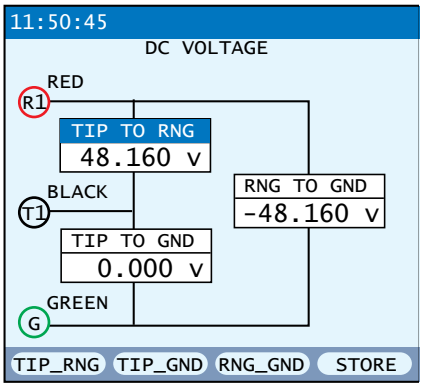


Figure 42 DC Voltage Screen

First, select the type of measurement to be performed:

TIP_RNG (F1) to measure tip to ring.

TIP_GND (F2) to measure tip to ground.

RNG_GND (F3) to measure ring to ground.

Note: All three measurements are displayed simultaneously. However, only the highlighted measurement (TIP TO RNG in Figure 42) is a live measurement.

The recommended readings are:

- TIP TO RNG: ≤ 3 VDC
- RNG TO GND: ≤ 3 VDC
- TIP TO GND: ≤ 3 VDC

5.2 AC Voltage

An AC Voltmeter is used for troubleshooting the loop. It can identify an unwanted power influence. The test set can measure up to 250 VAC.

⚠**WARNING**: AC voltage can kill or cause serious injury.

First, select the type of measurement to be performed:

TIP_RNG (F1) to measure tip to ring.

TIP_GND (F2) to measure tip to ground.

RNG_GND (F3) to measure ring to ground.

Note: All three measurements are displayed simultaneously. However, only the highlighted measurement (TIP TO RNG in the screen to the right) is a live measurement.

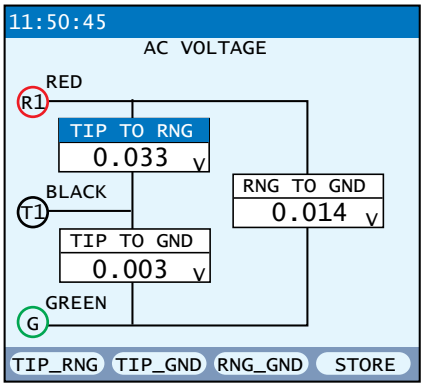


Figure 43 AC Voltage Screen

The recommended readings are:

- TIP TO RNG: ≤ 3 VAC
- RNG TO GND: ≤ 25 VAC
- TIP TO GND: ≤ 25 VAC

5.3 Ohm

This measurement is a prequalification test to verify that the loop meets the proper metallic criteria. Use it to:

- Measure Insulation DC Resistance for T-G/ R-G:
  - Tip to Ground should be >3.5 MΩ.
  - Ring to Ground should be >3.5 MΩ.
  - Check for grounds: If either value is less than 3.5 MΩ, a ground may exist in the circuit.
- Measure Insulation DC Resistance for T-R:
  - Tip to Ground should be >3.5 MΩ.
  - Tip to Ring should be >3.5 MΩ.
  - Check for shorts: If it is less than 3.5 MΩ, a short may exist in the circuit.
- Locate a short or ground.The test set can measure from 1Ω to 100 MΩ. The LOW range covers 1Ω to 10 MΩ, HIGH covers 10 MΩ to 100 MΩ. Both ranges operate the same and the following instructions apply to both ranges.

  Note: After a power cycle, when entering the HIGH range, the test set will automatically perform a HIGH RESISTANCE CALIBRATION routine. Do not power off the test set during this routine. The measurement will be performed after the routine.

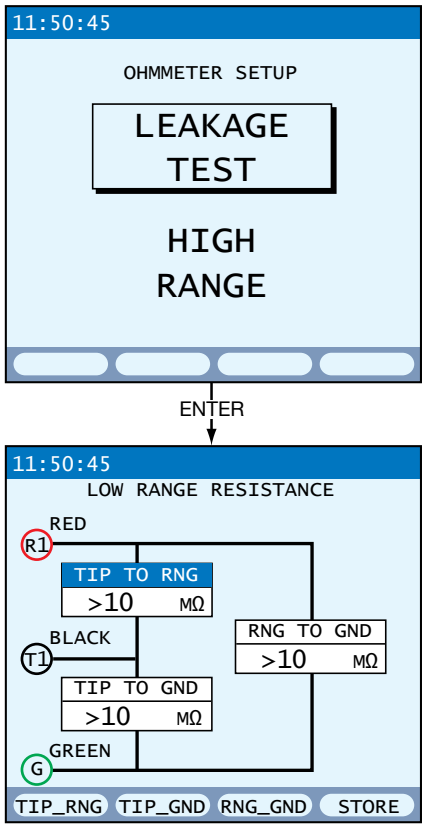


Figure 44 Resistance Screens

After selecting a measurement and pressing ENTER, select the type of measurement to perform:

TIP_RNG (F1) to measure tip to ring.

TIP_GND (F2) to measure tip to ground.

RNG_GND (F3) to measure ring to ground.

Note: All three measurements are displayed simultaneously. However, only the highlighted measurement (TIP TO RNG in the bottom screen shown in Figure 44) is a live measurement.

5.4 Capacitance

The test set can measure from 1 nF to 2 µF. The measurement can also be used to estimate loop length (tip-ring).

- This measures the loop to the far end with an open circuit.
- The top left box in the top righ screen provides a distance calculation; it is based on, 83 µF/mile (52 µF/km), conversion factor as specified in ANSI T1.601 Annex E.
- This calculation assumes there are no bridge taps present. It will add any bridge tap lengths to the total distance.

Note: Perform a LOW CAP CALIBRATION, see *Section 5.6.1* for the procedure. This must be done at power up.

After any needed calibration, select the type of measurement to perform:

TIP_RNG (F1) to measure tip to ring.

TIP_GND (more, F2) to measure tip to ground.

RNG_GND (more, F3) to measure ring to ground.

Note: All measurements are displayed simultaneously. However, only the highlighted measurement (RNG TO GND in the right screen of Figure 45) is a live measurement.

BALANCE (F2): The test set calculates capacitive balance and is reported in the CAP BALANCE box in the right screen of Figure 45. The recommended figure is >95%.

SETUP (F3): Change the following measurement settings as shown in the bottom screen of Figure 45.

UNITS: Select ENGLISH (F1) or METRIC (F2).

CABLE TYPE: PIC is the only choice.

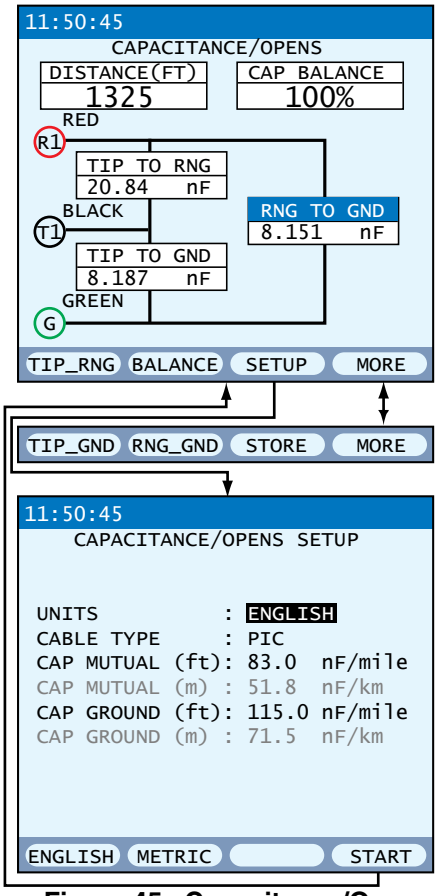


Figure 45 Capacitance/Opens Screens

CAP MUTUAL (ft)/(m): Press SCROLL+ (F1) or SCROLL- (F2) to change, press DEFAULT (F3) to use the test set's default.

CAP GROUND (ft)/(m): Press SCROLL+ (F1) or SCROLL- (F2) to change, press DEFAULT (F3) to use the test set's default.

5.5 Current

The test set performs a protection check before taking a measurement to protect itself from damage. Because of this, connect the test set to the circuit before selecting this screen. Once the protection test passes, the test set can measure from 0 to 110 DC mA. A sample result is shown in the bottom screen of Figure 46

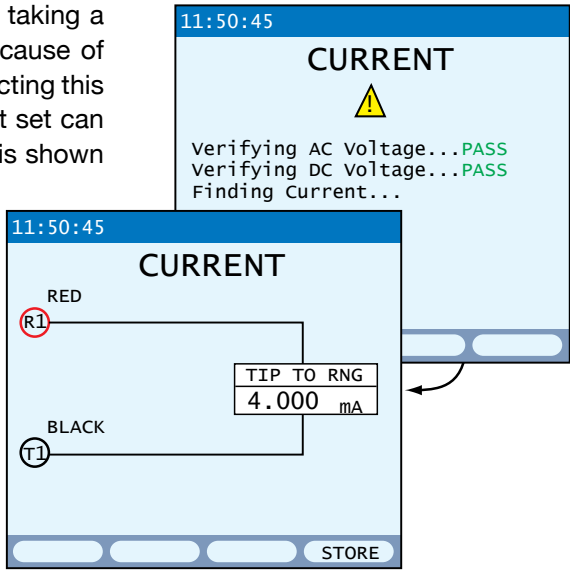


Figure 46 Current Screens

5.6 Utilities-Calibration

This menu screen contains:

- LOW CAP CALIBRATION
- HIGH OHM CALIBRATION

5.6.1 Low Capacitance Calibration

Perform this calibration each time the test set is powered up and a capacitance measurement will be performed.

To perform this calibration:

1. Remove all input cables and charger from the test set. The test set should be operating on batteries for optimal results.
2. Select DMM > UTIL > CALIBRATION > LOW CAP CALIBRATION.
3. Follow the on-screen instructions and press ENTER to begin. The procedure takes less than a minute to perform.

5.6.2 High Ohm Calibration

This procedure is automatically performed each time the test set is powered up, and each time a high range resistance measurement is performed.

To manually perform this calibration:

1. Remove all input cables and charger from the test set. The test set should be operating on batteries for optimal results.
2. Select DMM > UTIL > CALIBRATION > HIGH OHM CALIBRATION.
3. Follow the on-screen instructions and press ENTER to begin. The procedure takes less than a minute to perform.

5.7 DMM Measuring Procedures

Use this procedure for performing a DMM measurement:

1. Select DMM.
2. Connect to the circuit using the RING1/TIP1/ (if needed GRND) ports.

- A common method is to use a set of alligator clip cables as shown in the illustration to the right. Plug the connector cable into the test set ports on the right side. Use alligator clips to clip directly onto the copper pair at the NID, Cross-Box (B-Box), aerial, or other access points.

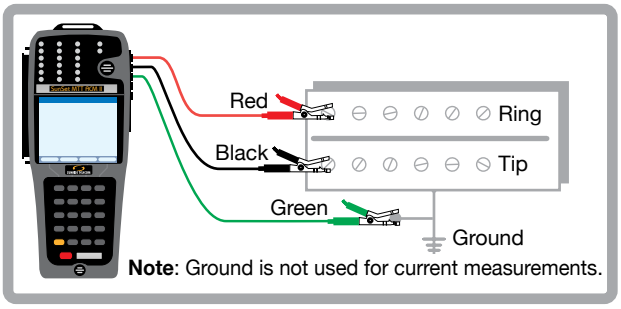


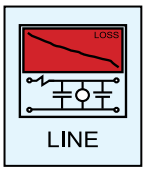
Figure 47 Connecting with Alligator Clips

3. Press ◄,▲,▼,► to select a measurement and press ENTER.
4. Once in a measurement screen, select a measurement type:

- TIP_RNG to measure tip to ring.
- TIP_GND to measure tip to ground.
- RNG_GND to measure ring to ground.

Refer to the previous sections to learn the significance and requirements for each of the results.

6 Line



There are two types of Line measurements, single-ended and paired. As shown in Figure 48, single-ended tests require one test set; the test set performs the test and takes the measurement from one end of the cable.

Line measurements can be optioned in two different ways. The standard feature supports the VF6000 Hz and ADSL 2.2 MHz frequency range. The Extended VDSL Range option (SWMTT-ACMp-VDSL) enables support for VDSL spectrums and NEXT/FEXT features. “FEATURE OPTION NOT AVAILABLE” is displayed when optional features are not enabled.

The single-ended tests are:

- PSD BACKGROUND NOISE checks for interfering services or noise.
- LONGITUDINAL BALANCE checks if the cable pair has adequate balance for crosstalk immunity.
- VF MEASUREMENTS provides data on Metallic Noise, Power Influence, and Calculated Balance.
- IMPULSE NOISE checks for any transient noise sources.
- NEAR END CROSSTALK (NEXT) checks for cross-talk between two cable pairs at the near end.
- COIL DETECTION detects load coils in the circuit.
- FREQUENCY GENERATOR sends test tones.

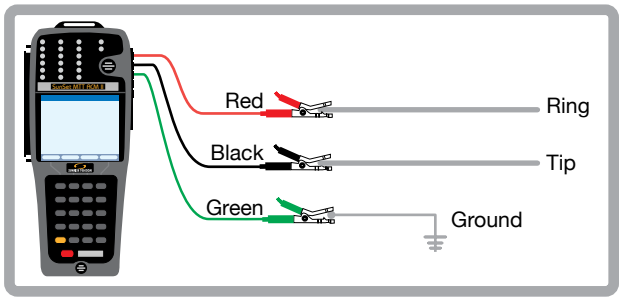


Figure 48 Single-ended Test Setup

Single-ended tests are described in *Sections 6.1–6.7.*

Dual-ended tests require two test sets, one on each end of the cable pair. As shown in Figure 49, there is a Controller, which sends the commands and takes the measurement. The Responder at the far end responds to commands by sending the tone or shorting the far end.

The dual-ended tests are:

- INSERTION LOSS measures attenuation over the chosen frequency range.
- SIGNAL TO NOISE measures the signal-to-noise ratio over the chosen frequency range.
- LOOP RESISTANCE determines loop length by measuring loop resistance with a responder test set at the far end providing a short.
- FAR END CROSSTALK (FEXT) checks for crosstalk between one cable pair at the near end and an adjacent pair at the far end.
- CABLE PAIR DETECT and TX CABLE PAIR TONE check for connectivity.
- RESPONDER DETECTION detects the type of responder is at the far end.

Dual-ended tests are described in *Section 6.8.*

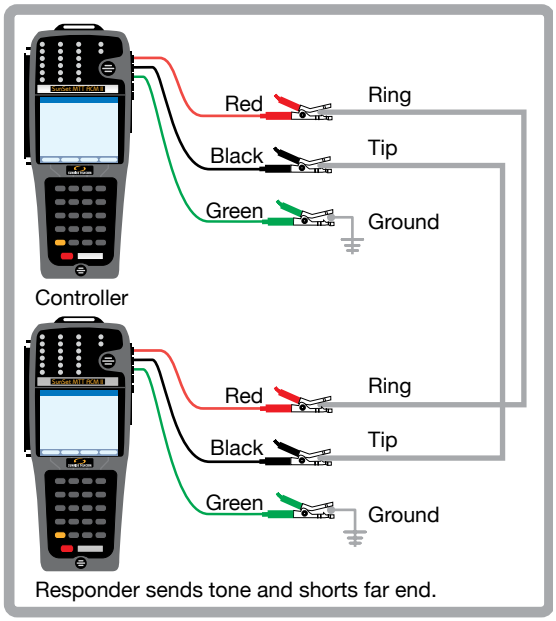


Figure 49 Dual-ended Test Setup

6.1 PSD Background Noise

This PSD (Power Spectral Density) Background Noise test is used to detect interferers from such sources as neighboring digital services or AM radio. It is a single-ended test. The full 30 MHz band, or narrower frequency bands can be tested for background noise.

Use ◄,▲,▼,► to choose the frequency range for noise measurement in the screen to the right.

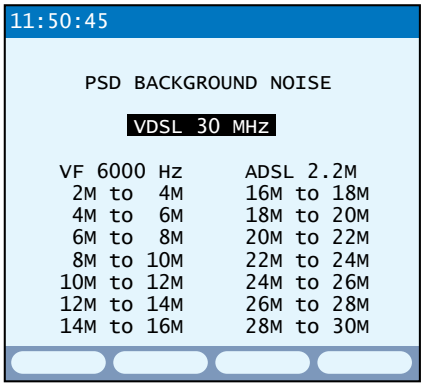


Figure 50 PSD Background Noise Setup Screen

VDSL 30 MHz: Uses a resolution bandwidth of 34.5 kHz spectrum, covering the VDSL spectrum as well as ADSL2+, ADSL2, ADSL, SHDSL, and other access transmission technologies.

VF 6000 Hz tests at a resolution of 60 Hz.

The other selections test sections of the VDSL spectrum, using a resolution bandwidth of 4.3125 kHz, which allows for a more detailed view of any interferers.

Once a test has been selected, connect to the circuit as shown in Figure 48, and press ENTER. See the following subsections for details on testing and measurement results.

6.1.1 VDSL 30 MHz Results

1. Connect the test set to the pair as in Figure 48.
2. Select LINE > PSD BACKGROUND NOISE and in the setup screen, select VDSL 30 MHz. Press ENTER, and the graph view screen on the top right is displayed.

PSD BACKGROUND NOISE Screen F-keys

ZOOM_OUT/IN (F1): This sets the display scale for the graph screen. The resolution is three tones/pixel with the highest noise value of the three tones plotted on the screen. When zoomed in the full amount, two additional F-keys are available:

|<< (F2) and **>>|** (F3): Move the screen display to the left or right to display the lower or higher tone frequencies.

dBm or **dBm/Hz** (F2): Change reference to the noise reading at the bottom of the screen. dBm is a pure power reading with a reference to 1 milliwatt. The dBm/Hz measurement uses a resolution bandwidth of 34.5 kHz for the reading.

TABLE/GRAPH (F3): Display the results as a table or a graph.

STORE (F4 or more, F3): Save the results, see *Chapter 8*.

In TABLE view, the following F-keys are also available:

PG_DN (F1) and **PG_UP** (F2): Page through the results table.

Other Screen Features

Cursor line: Use◄,►to move the cursor. It's position reports the frequency on the "X(MHz)" line.

GAIN: Use▲,▼to increase/decrease the vertical signal gain.

HI and **LO**: Determine the Y-axis for the graph (automatically scaled).

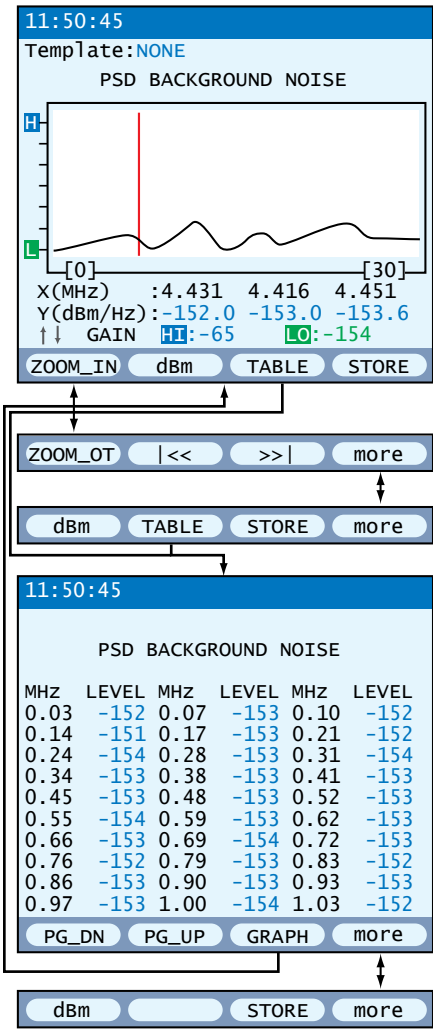


Figure 51 VDSL 30 MHz PSD Background Noise Screens

6.1.2 VF 6000 Hz Results

1. Connect the test set to the pair as shown in Figure 48.
2. Select LINE > PSD BACKGROUND NOISE and in the setup screen, select VF 6000 Hz. Press ENTER and VF POWER HARMONICS (tip and ring to ground measurement) screen shown at the bottom of Figure 52 will be displayed in 60 Hz steps.

VF BACKGROUND NOISE Screen F-keys

dBrn/dBm (F1): Toggles between dBm and dBrn at Y. dBm is a pure power reading with a reference to 1 milliwatt. dBm uses a resolution bandwidth of 60 Hz.

POWER/NOISE (F2): Toggles between the VF POWER HARMONICS screen shown at the bottom of Figure 52 or the VF BACKGROUND NOISE screen shown at the top of Figure 52.

The VF POWER HARMONICS screen displays the power harmonics (tip and ring to ground measurements) in 60 Hz steps with a resolution bandwidth of 60 Hz.

TABLE/GRAPH (F3): Displays the results in a table for VF BACKGROUND NOISE or VF POWER HARMONICS (VF BACKGROUND NOISE is the middle screen in Figure 51a) or a graph view for both.

STORE (F4 or more, F3): Save the results, see *Chapter 8*.

In TABLE view, the following F-keys are also available:

PG_DN (F1) **PG_UP** (F2): Page through the results table.

Other Screen Features

X (Hz) (frequency) and Y (power level in dBm or dBrn): Displays the frequency and power level of the current cursor location.

Cursor line: Use ◄,► to move the cursor in 60 Hz increments. X and Y then reflect the new readings.

Gain: Use ▲,▼ to increase/decrease the vertical signal gain.

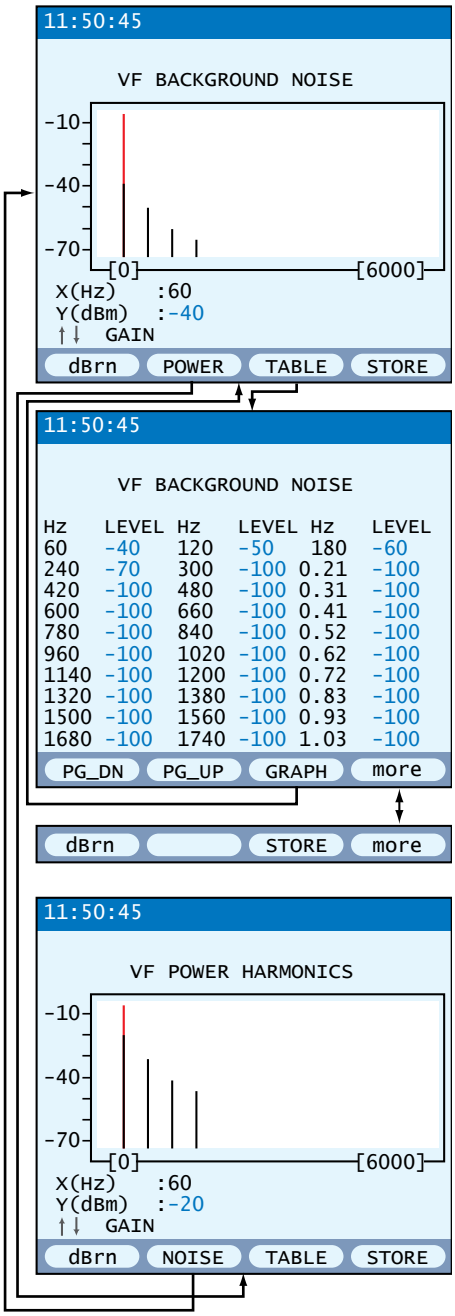


Figure 52 VF Measurement Screens

6.1.3 ADSL 2.2M Results

This selection measures the background noise in the 2.2 MHz ADSL/ADSL2/ADSL2+ spectrum, with a resolution bandwidth of 4.3125 kHz.

1. Connect the test set to the pair as in Figure 48.
2. Select LINE > PSD BACKGROUND NOISE and in the setup screen, select ADSL 2.2 M. Press ENTER, and the graph view screen on the top right is displayed.

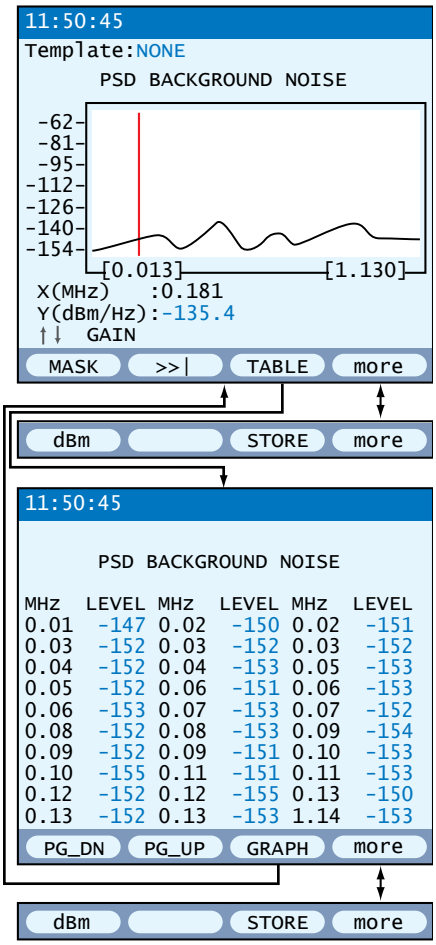


Figure 53 ADSL 2.2M Background Noise Screens

PSD BACKGROUND NOISE Screen F-keys

MASK/CURSOR (F1): When MASK is shown at F1, move the CURSOR by pressing ◄,►. The CURSOR reports the exact frequency of a disturber at x(MHz).

When CURSOR is shown at F1, use ◄,►to select a MASK. MASKs are based on crosstalk models defined in various standards based on the number and type of disturber.

The masks described in the Table 1 represent common disturbers associated with DSL circuits. If an increase in the background noise level is observed (Y-value), try scrolling through the various templates until a template matches the signal. This helps distinguish the noise source on the circuit.

>>| / |<< (F2): Initially the screen shows 0.004 through 1.121, press >>| to view 1.082 through 2.199. Press |<< to view the previous screen.

TABLE/GRAPH (F3): Display the results as a table or graph.

dBm/dBm/Hz (more, F1): Toggles the noise reading at Y. dBm is a pure power reading with a reference to 1 milliwatt. The dBm/Hz measurement uses a resolution bandwidth of 4.3125 kHz for the reading.

STORE (F3, more F3): Save the results; see *Chapter 8*.

In TABLE view, the following F-keys are also available:

PG_DN (F1) and **PG_UP** (F2): View the table of results.

Other Screen Features

Cursor line: Use ◄,► to move the cursor. Its position reports the frequency on the “X(MHz)” line.

GAIN: Use ▲,▼ to increase/decrease the vertical signal gain.

6.1.4 All Other Range Results

These measurements work the same as described in *Section 6.1.1*. They just cover different sections of the spectrum and have a resolution bandwidth of 4.3125 kHz.

Interferer Type	Description
24-DSL NEXT 24	IDSL services in same binder group
10-HDSL NEXT	HDSL services in same binder group
4-T1 ADJ NEXT	4 T1 services in an adjacent binder group
24-T1 ADJ NEXT	24 T1 services in an adjacent binder group
10-ADSL DN NEXT	10 ADSL downstream services in same binder group
10-ADSL UP NEXT	10 ADSL upstream services in same binder group
T1.601 NEXT	ANSI T1.601 Basic Rate ISDN in same binder pair
10-DSL NEXT	10 IDSL services in same binder group
10-ADSL NEXT	10 ADSL services in same binder group
10-T1 ADJ NEXT	10 T1 services in an adjacent binder group
INTL AMI 2M	International 2.048 Mbps AMI signal (E1)
ETSI BRA	ETSI Basic Rate ISDN service
ETSI HDSL	ETSI HDSL service
ADSL XTALK, ANSI 7, 13	ADSL cross-talk ANSI loops 7 & 13
ADSL XTALK CSA 4	ADSL cross-talk, CSA loop 4
ADSL XTALK CSA 6	ADSL cross-talk, CSA loop 6
ADSL XTALK CSA 7	ADSL cross-talk, CSA loop 7
DSL NEXT	IDSL service in same binder group
HDSL NEXT	HDSL service in same binder group
G.DMT EC ADSL UP NEXT	G.DMT Echo-cancellation ADSL upstream service in same binder group
G.DMT FDM ADSL UP NEXT	G.DMT Frequency division multiplexing ADSL upstream service in same binder group
HDSL2 DN NEXT	HDSL2 downstream service in same binder group
HDSL2 UP NEXT	HDSL2 upstream service in same binder group
T1 NEXT	T1 service in same binder group
EC ADSL DN	Echo-cancellation downstream ADSL
G.DMT FDM ADSL DN NEXT	G.DMT Frequency division multiplexing ADSL downstream service in same binder group

Table 1 Interferer Type Masks

6.2 Longitudinal Balance

Determine whether the cable pair has adequate balance for crosstalk immunity. The test set generates a perfectly balanced disturbing tone between the cable pair and ground. The resultant voltage on the cable pair is measured and displayed in units of dB.

To perform the test:

1. Connect the test set to the pair as in Figure 48.
2. Select LINE > LONGITUDINAL BALANCE. “WAITING” is displayed. The measurement appears as shown in the screen to the right. The measurement range is from 0 dB to 70 dB. The measurement value should be as high as possible.

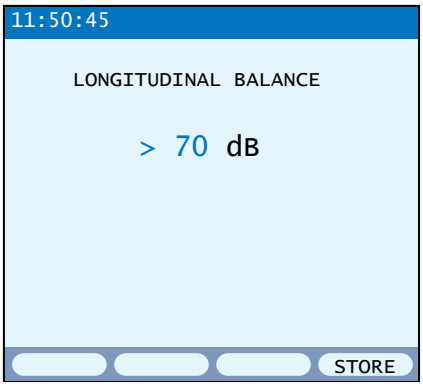


Figure 54 Longitudinal Balance Screen

LONGITUDINAL BALANCE Screen F-key

STORE (F4): Save the results; see *Section 8*.

6.3 VF Measurements

When this measurement is selected, a message screen will appear prompting you to connect TIP1, RING1, and the Ground test leads. Connect the test set, as shown in Figure 48, and press CONTINU (F4).

The measurement uses a FILTER as indicated at the top of the screen. C-MESSAGE filter weighs frequencies between 600 Hz and 3 kHz most heavily. Therefore, it measures noise in the frequency spectrum most noticeable to the human ear. This measurement is called metallic noise.

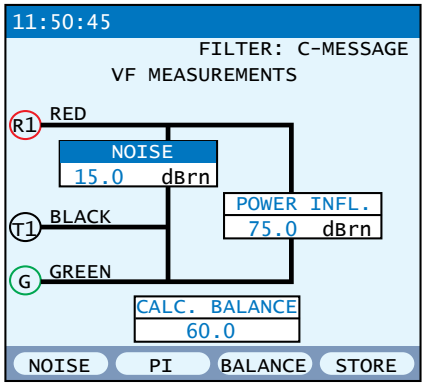


Figure 55 VF Measurements Screen

VF MEASUREMENTS Screen F-keys

NOISE (F1): Measure the background noise on a cable pair. To perform this measurement, there must be a quiet termination or open at the end of the cable pair. It is measured in dBrn (decibels relative to noise). dBrn= dBm +90.

PI (F2): Power Influence is noise to ground measurement that measures noise from sources such as induced AC voltage from power utility lines. It is displayed in the POWER INFL. box.

BALANCE (F3): Displays CALC. BALANCE. This is the difference between Power Influence and Metallic Noise.

6.4 Impulse Noise

Detect impulse noise spikes on the signal and keep a running count of the number of impulse events over time. Impulse noise is defined as a random pulse whose amplitude is much higher than that of background noise.

Use this procedure:

1. Connect the test set to the pair as in Figure 49.
2. Select LINE > IMPULSE NOISE, and see the top right screen.
3. Configure the following:

THRESHOLD
Range: 50 to 100 dBrrn
Adjust the lower threshold value for an impulse noise event. When the test set detects noise above this threshold, the test set records it as an impulse noise event.

Press F4 to use the +/-1 or +/-10 increment values

DELTA
Range: Fixed at 3 dB

MAX COUNT
Range: 1 to 9999
This is the maximum number of impulse events that will be counted during a single measurement.

Press F4 to use the +/-1, +/-10, +/-100, or +/-1000 value keys.

DEAD TIME
Range: 0.1 ms to 255 ms
This refers to the measurement delay after the test set detects the initial impulse. Dead Time begins as soon as the test set detects the initial impulse. The test set resumes measuring events after the dead time has elapsed. This prevents the test set from measuring the same impulse noise spike multiple times.

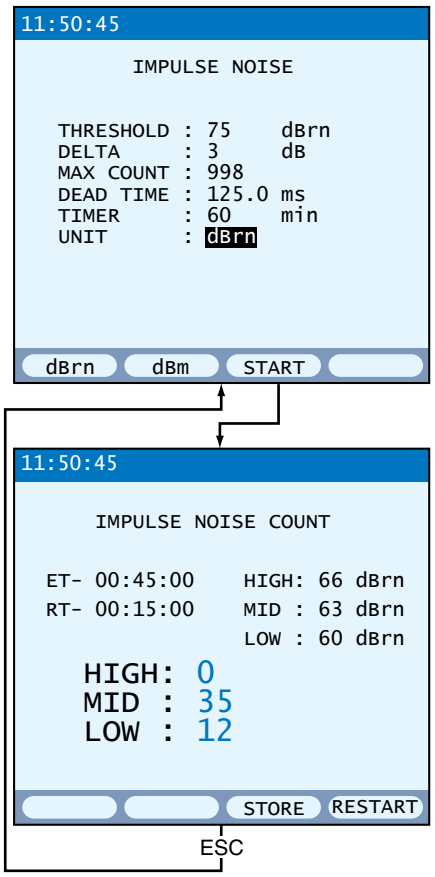


Figure 56 Impulse Noise Screens

TIMER: Set the duration time of the measurement.
Range: 1 to 999, CONTINU

As soon as the measurement is started, the elapsed time starts counting up to this value. When it reaches the timer value, the test stops. Press F4 to use the +/-1, +/-10, +/-100, or CONTINU (for a continuous test).

UNIT: Set the unit of measurement. test.
Options: dBrn (F1), dBm (F2)

- dBrn: Decibels above reference noise.
- dBm: Pure power reading with a reference to 1 milliwatt.

4. When ready, press START (F3) and refer to the following explanation of the items shown in the bottom screen in Figure 56.

The following is reported at the top half of the screen:

ET: Elapsed Time begins counting as soon as START or RESTART is pressed. It continues counting until it reaches the set TIMER value.

RT: Remaining Time is the amount of time left in the test. It shows CONTINU for continuous testing.

HIGH: Noise level for HIGH count. This is equal to MID plus the DELTA count.

MID: Noise level for a MID count. This is equal to the THRESHOLD setting plus the DELTA value.

LOW: Noise level for a LOW count. This is equal to the THRESHOLD setting in the Setup screen.

The following results are shown at the bottom half of the screen:

HIGH: Number of impulse noise spikes detected whose level falls within the HIGH value shown above (above HIGH).

MID: Number of impulse noise spikes detected whose level falls within the MID value shown above (in between MID and HIGH).

LOW: Number of impulse noise spikes detected whose level falls within the LOW value shown above (between LOW and MID).

IMPULSE NOISE Screen F-keys

RESTART (F4): Press to restart the measurement and reset all counters to zero.

STORE (F3): Press to save the results; see *Chapter 8*.

6.5 Near End Crosstalk-NEXT

Measure the crosstalk between one cable pair and an adjacent cable pair at the same point on the line.

This measurement consists of a single test set transmitting a test signal on one pair and simultaneously measuring the induced crosstalk on an adjacent pair.

The measurement range covers a sweep from 34.5 kHz to 30 MHz in 34.5 kHz steps. Results for test frequency and NEXT level are presented in both graphical and tabular format.

To perform the test:

1. Connect the test cable from the RING1/TIP1 ports to the desired cable pair under test as in Figure 57. Note that these ports measure the amount of induced NEXT.
2. Connect a second test cable from the RING2/TIP2 ports to the desired adjacent cable pair. Note that the test signal is transmitted from these ports.
3. Select LINE > NEAR END CROSSTALK.
4. Press ENTER to start the 30 MHz SWEEP test.

- The NEXT measurement is shown in dB.
- The measurement value should be as high as possible.

NEAR END CROSSTALK Screen F-keys

|<< (F1) and >>| (F2): Available only in graph view. Shift the page display 1/2 page to the left, or 1/2 page to the right.

PG_DN (F1) and PG_UP (F2): Available only in the table view. Page through the table of results.

TABLE/GRAPH (F3): Display the results as a table or graph.

STORE (more, F1 or more, F2): Save the result; see *Section 8*.

RESTART (more, F2 or more, F3): Restart the test.

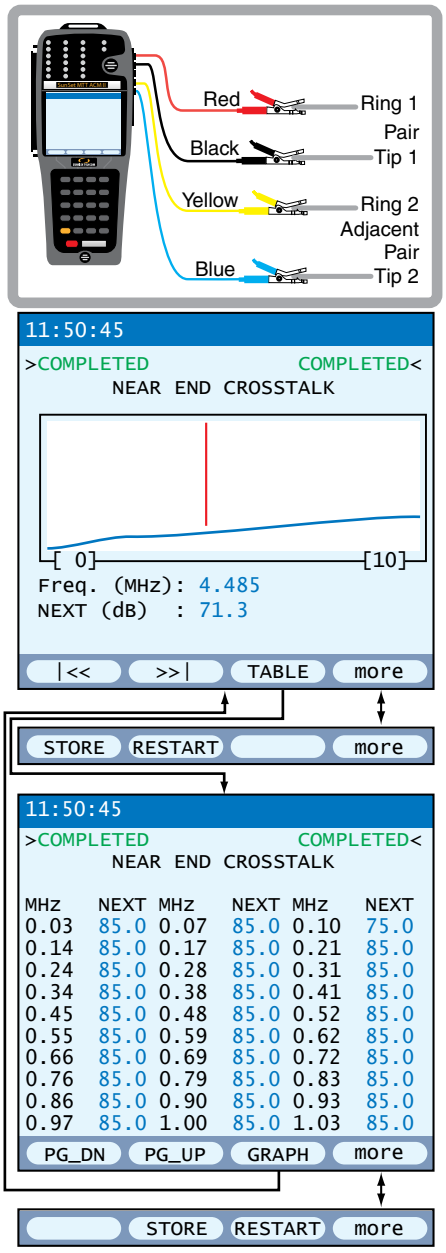


Figure 57 NEXT Connection and Screens

6.6 Coil Detection

This test is a quick and easy way to check for load coils on a cable. The test cannot locate load coils, (use the TDR function for this) but it will show if any are present.

What is a Load Coil?

Over long cable lengths, upper voiceband signals are attenuated due to increased capacitance. Phone companies deal with these long loops by placing load coils at regular intervals. A load coil is an inductor, typically 88 mH. Load coils are placed at regular intervals on cable longer than 18,000 feet. The first appears 3,000 feet from the central office or exchange. Then, load coils are placed every 6,000 feet.

Loaded cable enables transmission between 300 Hz to 3.1 kHz at a higher power level than unloaded cable. However, after 4 kHz, the power level drops below that of an unloaded circuit. The result is that higher frequencies (>4 kHz) are more heavily attenuated with load coils. Therefore, high frequency signals, like ADSL, are severely attenuated by load coils.

Performing a Coil Detection Test

Follow this procedure to perform the Coil Detection test. For accurate results, the load coils on the circuit should comply to standard spacing rules.

1. Connect the test set to the circuit as shown in Figure 48.
2. Select LINE > COIL DETECTION.
3. The following status messages are displayed at the top of the screen:

- PROCESSING: The test set has finished initializing and is in the process of taking the measurement. The processing stage takes approximately 30 seconds.
- COMPLETED: The test set has completed the measurement and now displays the results. These results do not constantly update; press RESTART (F4) to update the results. Press STORE (F3) to save the results.

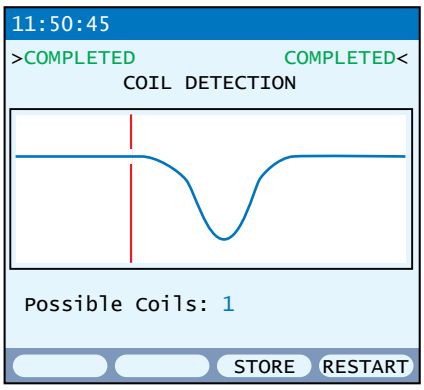


Figure 58 Coil Detection Screen

4. Refer to the graph in the screen shown shown in Figure 58. The plot measures impedance (y-axis) by frequency (x-axis).

- A load coil causes a change in impedance. This is displayed on the graph. A big dip in the impedance (y) represents a coil.
- The number of “Possible Coils” is displayed at the bottom of the screen. In Figure 58, there is one dip in the graph indicating a coil.

Removing Load Coils

The Coil Detection test is the fastest method for determining the presence of load coils. If testing proves the presence of load coils, use the TDR function, described in *Chapter 3*, to determine the exact location of the load coils for removal.

The safest way to ensure that all load coils are removed is to remove the first load coil, then run the test again to check if there are more farther down the cable. Continue this same process: find a load coil, remove it, then check for the presence of another one.

Remember all load coils must be removed for DSL transmission.

6.7 Frequency Generator

Send a tone at a specified frequency and level. At the far end of the circuit, use a tone analyzer to measure the level and frequency.

Set the following to send a tone:

FREQ

Range: 10 to 20000 kHz

Adjust the transmitted tone frequency by pressing SHIFT and using the numeric keypad. Use <-- (F2) and --> (F3) to move the cursor in the indicated direction.

dBm

Range: -40 to 0 dBm

Adjust the transmit level by pressing SHIFT and using the numeric keypad. Use <-- (F2) and --> (F3) to move the cursor in the indicated direction. Use +/- (F1) to change the sign.

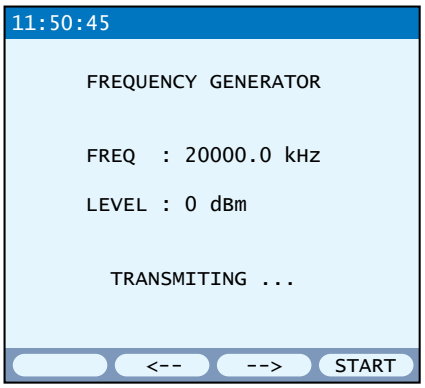


Figure 59 Frequency Generator

When ready press START (F4). “TRANSMITING...” is displayed, as in Figure 60, when the that the test set is transmitting the tone. When finished transmitting the tone, press ESC.

6.8 Controller

The following are available in this menu:

- INSERTION LOSS
- SIGNAL TO NOISE
- LOOP RESISTANCE
- FAR END CROSSTALK
- CABLE PAIR DETECT
- TX CABLE PAIR TONE
- RESPONDER DETECTION

These are paired tests requiring another test set in responder mode at the far end. This section outlines the controller function for each application. *Section 6.9* discusses how to set the test set for responder mode.

Note: An ACM II controller is only compatible with another ACM II chassis responder.

6.8.1 Insertion Loss

Insertion loss testing is an excellent prequalification tool. It measures attenuation using two test sets: the Responder test set sends the tones from the far end, while the Controller test set conducts the measurement. It provides loss characteristics up to 30 MHz, applicable to VDSL, ADSL2, ADSL2+ and other access services. Narrower bands can be selected in the screen shown to the right.

After connecting to the circuit, pick a band to test, then press ENTER to start. See the following sections for connection and setup details.

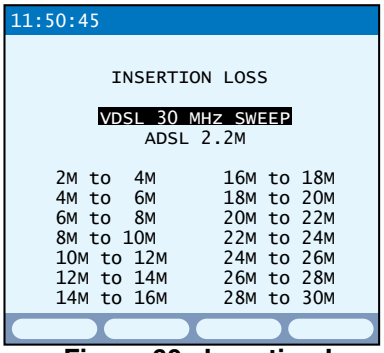


Figure 60 Insertion Loss Setup Screen

6.8.1.1 VDSL 30 MHz Insertion Loss (Optional)

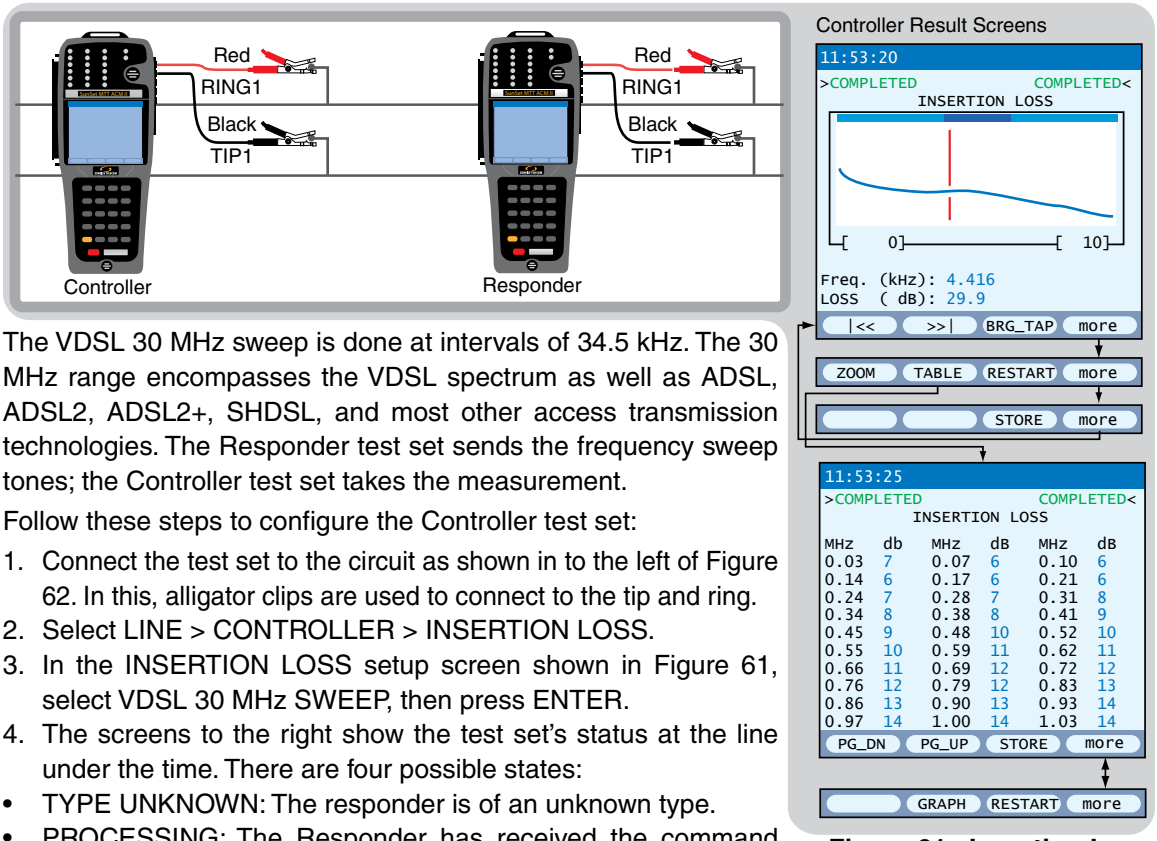


Figure 61 Insertion Loss Connection and Result Screens

The VDSL 30 MHz sweep is done at intervals of 34.5 kHz. The 30 MHz range encompasses the VDSL spectrum as well as ADSL, ADSL2, ADSL2+, SHDSL, and most other access transmission technologies. The Responder test set sends the frequency sweep tones; the Controller test set takes the measurement.

Follow these steps to configure the Controller test set:

1. Connect the test set to the circuit as shown in to the left of Figure 62. In this, alligator clips are used to connect to the tip and ring.
2. Select LINE > CONTROLLER > INSERTION LOSS.
3. In the INSERTION LOSS setup screen shown in Figure 61, select VDSL 30 MHz SWEEP, then press ENTER.
4. The screens to the right show the test set's status at the line under the time. There are four possible states:

- TYPE UNKNOWN: The responder is of an unknown type.
- PROCESSING: The Responder has received the command and is in the process of sending a tone.
- COMPLETED: The Responder has carried out the command.
- FAILED: The Responder has failed to reply to the command.

5. The result graph screen displays a level versus frequency plot. To find the exact insertion loss for a particular frequency, refer to the results provided below the graph. Use ◄,► to move the cursor. Check the frequency reading (Freq. MHz) until the cursor has reached the desired frequency. Then refer to the loss reading (Loss dB) for that particular frequency.

INSERTION LOSS Result Screen F-keys

<<| (F1) and >>| (F2): Use to move the graph view to the left or right. These views are available; 0 MHz-10 MHz, 10 MHz-20 MHz, and 20 MHz-30 MHz.

BRG_TAP (F2): This searches for and reports any bridge taps on the cable pair. See the following subsection; *Detecting Bridge Taps with Insertion Loss*.

STORE (F3): Press to save the results; see *Chapter 8.*

PG_DN (F1) and **PG_UP** (F2): Scroll through the table.

TABLE/GRAPH (more, F2): Displays the results as a table or graph.

RESTART (more, F3): Restart the measurement.

ZOOM (more, F1): Use to get a close view of a peculiar frequency range. The ZOOM level is indicated by the vertical cursor line and the attached bar at the top of the graph. To use:

1. Use a combination of |<< (F1), >>| (F2) and ◄,► to position the cursor at a frequency of interest.
2. Press ZOOM. The test set will conduct an Insertion Loss test for that peculiar range at intervals of 4.3125 kHz.
3. After a few seconds the zoomed in area is displayed. Note that the frequency cursor is available, but that the bar is not.
4. Press ZOOM again to return to the previous display range.

Note: Use ZOOM to look at frequencies listed in Figure 61, instead of having to escape out of the test.

Detecting Bridge Taps with Insertion Loss

Sunrise Telecom has developed a patented technology which enables bridge tap detection using the Insertion Loss measurement. Insertion loss can be advantageous because it allows testing a greater range than a TDR. This method shows the presence of bridge taps and can calculate the approximate length. However, a TDR is still needed to determine the exact location.

1. In the INSERTION LOSS screen, press BRG_TAP (F2).
2. The test set looks for any dips in the frequency curve. A typical insertion loss result without any faults is a linear curve sloping downward. A bridge tap will appear as a subtle dip in the curve. The bridge tap length affects different frequencies.
3. If a bridge tap is found, the test set moves the cursor to the dip. It then reports the length of the bridge tap (BT Ln) in feet. Note that this is not the location of the bridge tap.
4. The test set calculates the length based on the Vp (Velocity of Propagation). The default setting is 0.66. If the specific Vp setting is known, use the +VP (F2) and -VP (F3) to adjust the value. The Vp setting will affect the length calculation for the bridge tap. See *Chapter 3* for more details on Vp.
5. Insertion loss can detect multiple bridge taps on the cable pair. After it has detected the first bridge tap, press BRG_TAP (F1) again to detect the next tap.

Note: Insertion loss checks for dips in the frequency curve. These dips could be caused by other impairments or cable factors; always verify the presence of a bridge tap with a TDR.

6.8.1.2 Additional Insertion Loss Tests

The other Insertion Loss tests consist of more detailed sweep measurements with 4.3125 kHz spacing.

Follow these steps to configure the Controller test set:

1. Connect the test set to the span.
2. Select LINE > CONTROLLER > INSERTION LOSS.
3. Select the desired Insertion Loss test and press ENTER. The tests should be used as follows:
   ADSL 2.2M: 13 kHz to 2.2 MHz range for ADSL/ADSL2/ADSL2+
   The following are optional:
   2M to 4M: 2 MHz to 4 MHz range
   4M to 6M: 4 MHz to 6 MHz range
   6M to 8M: 6 MHz to 8 MHz range
   8M to 10M: 8 MHz to 10 MHz range
   10M to 12M: 10 MHz to 12 MHz range
   12M to 14M: 12 MHz to 14 MHz range
   14M to 16M: 14 MHz to 16 MHz range
   16M to 18M: 16 MHz to 18 MHz range
   18M to 20M: 18 MHz to 20 MHz range
   20M to 22M: 20 MHz to 22 MHz range
   22M to 24M: 22 MHz to 24 MHz range
   24M to 26M: 24 MHz to 26 MHz range
   26M to 28M: 26 MHz to 28 MHz range
   28M to 30M: 28 MHz to 30 MHz range
4. The results show the frequency tested, this screen works the same as described in *Section 6.8.1.1*.

6.8.2 Signal-to-Noise Test

Two frequency ranges are available:

- VDSL 30 MHz Sweep (Optional)
- ADSL 2 MHz Sweep

The two sweeps work in a similar manner. 30 MHz Sweep uses 34.5 kHz intervals and 2 MHz Sweep uses 4.3125 kHz intervals. The following description and procedure apply to both, except as noted.

The ADSL 2 MHz test is another paired test. It independently measures the achievable signal-to-noise performance over the full range of carrier frequencies used by DSL modems. These results correlate to the SNR measurements used by ADSL DMT systems to determine bit rates, bit distribution, and transmit power levels. It also can identify carrier frequencies which have low noise margins.

Upon completion of the SNR sweep measurement, predicted ADSL bit rates are reported for downstream and upstream directions, based on either Annex A ADSL over POTS, or Annex B ADSL over ISDN standards.

The Responder test set transmits tones; the Controller test set measures the level of each tone, as well as the background noise, and yields a signal-to-noise ratio.

Follow this procedure for measuring signal-to-noise:

1. Connect the test set to the span as shown in Figure 61.
2. Select LINE > CONTROLLER > SIGNAL TO NOISE and press ENTER to start the test.
3. The results are displayed in a signal-to-noise (in dB) versus frequency plot for the graph view, or as table view, as shown in Figure 61.

SIGNAL TO NOISE Screen F-keys

|<< (F1) and **>>|** (F2): Available only in graph view. They move the screen display to the left or right.

PG_DN (F1) and **PG_UP** (F2): Available only in table view. Use to page up, or page down through the table of results.

TABLE (F2), **GRAPH** (F3): Display the results as a table or a graph.

ANNEX-A/ANNEX-B (more, F1): Use these to switch between the two standards for ADSL Bit rate prediction. These are only available for the ADSL 2 MHz Sweep test.

CAP_UP (more, F2) and **CAP_DN** (more, F2): Use these to adjust the ADSL line capacity. 100% is the default value, adjustment range is 1-100%. This setting is one of the parameters used in calculating the UP/DOWN ADSL rates. These are only available for the ADSL 2 MHz Sweep test.

STORE (F3 or more, F1): Save the results, see *Chapter 8.*

RESTART (F4 or more, F3): Restart the measurement.

Note: To learn the exact signal-to-noise reading at a particular frequency, refer to the results below the graph. Use ◄,► to move the cursor to the desired frequency (as read at Freq. kHz). The S/N (dB) shows the exact signal-to-noise ratio for that frequency.

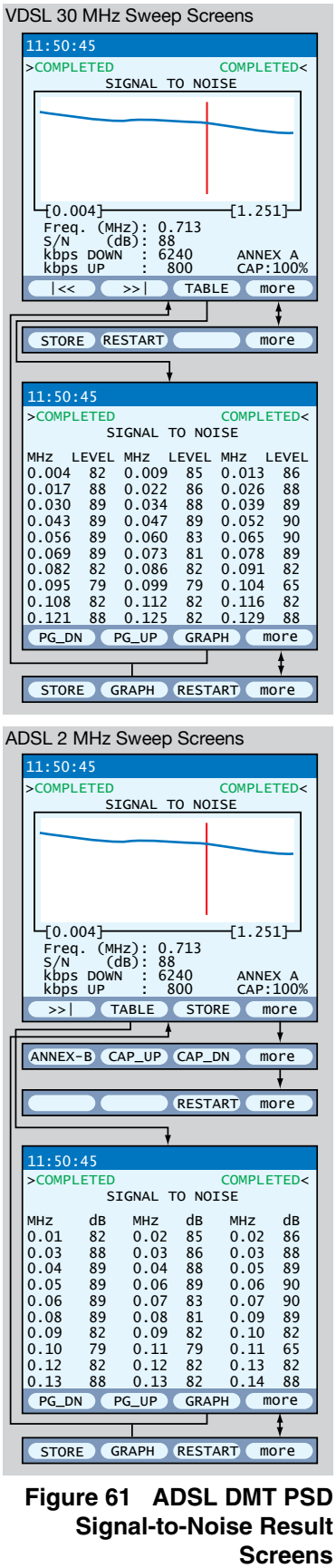


Figure 61 ADSL DMT PSD Signal-to-Noise Result Screens

6.8.3 Loop Resistance

This measurement provides an estimated loop length. This is a paired test with a test set acting as a responder providing the short at the far end.

This test can be used to:

- Estimate loop length. The test set provides the calculation based on ANSI T1.601, Annex G. This conversion factor is based on cable type, AWG (cable width), and temperature.
- Verify that the circuit has acceptable loop resistance (tip-ring). The following are maximum values with the far end shorted.
  - HDSL Requirement: 900Ω
  - ADSL Requirement: 1300Ω

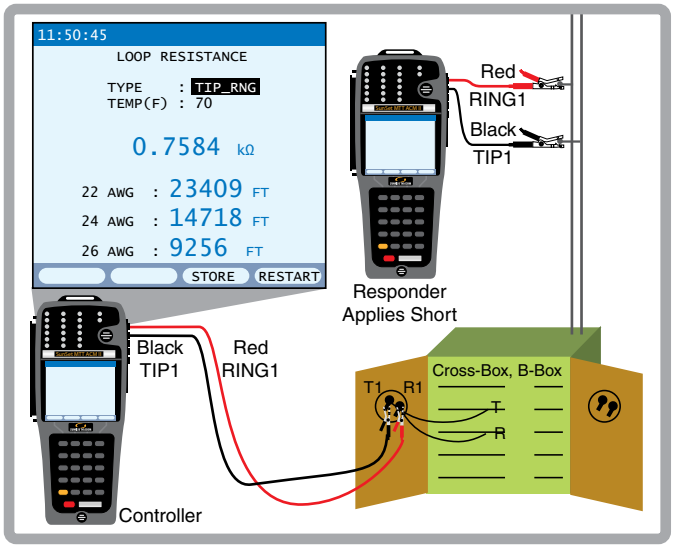


Figure 63 Measuring Loop Resistance Setup with Results Screen

Use the following procedure:

1. Connect the test set to the circuit as shown in Figure 63. In this example, alligator clips are used to connect to the tip and ring at a Cross-Box, B-Box.
   Note: Use another test set to provide the short at the far end. We recommend waiting 10 seconds before restarting the measurement due communication lag between the two test sets.
2. Select LINE > CONTROLLER > LOOP RESISTANCE. The screen is shown in Figure 63.
3. Configure the following two settings for this test:

TYPE
Displays the measurement type: TIP to RING.

TEMP (F)
Set to Controller's surrounding temperature by pressing INC (F1) or DEC (F2).

Note: The far end must be shorted in order to run this test. If it is not, the Controller's screen will display "OPEN" and will not provide a measurement.

LOOP RESISTANCE Result Screen F-keys
STORE (F3): Press to save the results. See *Chapter 8.*
RESTART (F4): Restart the measurement.

6.8.4 Far End Crosstalk (FEXT) (Optional)

FEXT refers to the crosstalk between one cable pair at the near end and an adjacent cable pair at the far end. This measurement requires two test sets, one at each end of the cable pair. A test set can function either as a Controller or Responder. One test set transmits a test signal on one pair at one end. The second test set measures the induced crosstalk on an adjacent pair at the far end.

The measurement range covers a sweep from 34.5 kHz to 30 MHz in steps of 34.5 kHz.

To perform the test:

1. Connect the Controller as shown in Figure 50.
2. Connect the Responder placed at the far end of the line as in Figure 50, and set up the test set as a RESPONDER.
   Note: After connecting, use CABLE PAIR DETECT and TX CABLE PAIR TONE testing for audible confirmation of connectivity before performing this test.
3. Once all connections are established, begin testing.

   The Controller will control the test as well as present the results. On the Controller, select LINE > CONTROLLER > FAR END CROSSTALK > MHz SWEEP.

   The measurement is shown in dB. The value should be as high as possible.

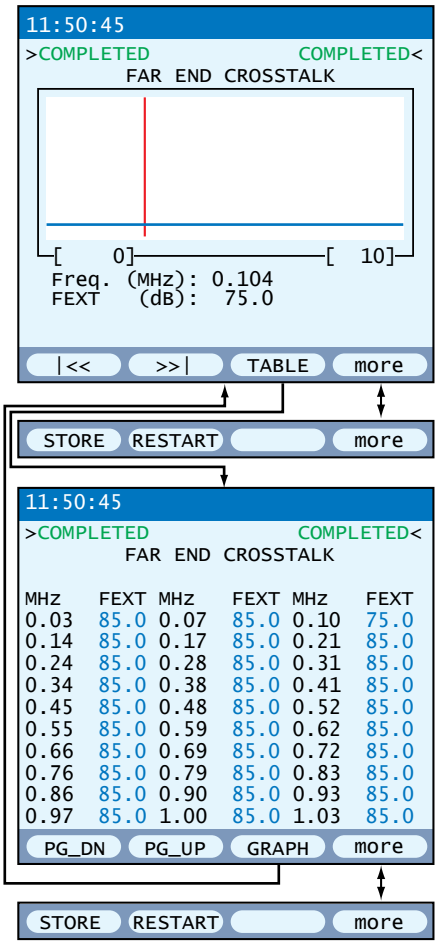


Figure 64 Far End Crosstalk Screens

FAR END CROSSTALK Screen F-keys

|<< (F1) and >>| (F2): Available only in graph view. Move the screen display to the left or right.

PG_DN (F1) and PG_UP (F2): Available only in table view. Use to page up, or page down through the table of results.

TABLE/GRAPH (F3): Display either a table or a graph.

STORE (more, F1): Save the results, see *Section 8*.

6.8.5 Cable Pair Detect

Use CABLE PAIR DETECT with a tone generator at the far end of the cable pair for audible confirmation of connectivity. Listen for the tone and use VOL↑(F1) and VOL↓(F2) to adjust the volume. Use in conjunction with another test set setup for Tx CABLE PAIR TONE mode at the far end of the cable.

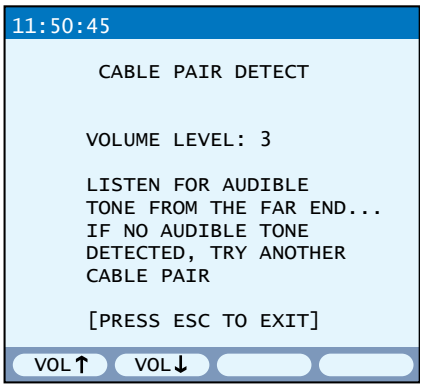


Figure 65 Cable Pair Detect Screen

6.8.6 TX Cable Pair Tone

Use the TX CABLE PAIR TONE screen with a tone detector at the far end of the cable pair for audible confirmation of connectivity. The test set transmits a dual tone signal that can be detected by a detector, such as the test set configured for CABLE PAIR DETECT mode.

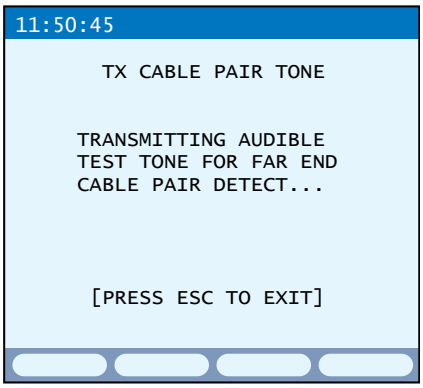


Figure 66 TX Cable Pair Tone Screen

6.8.7 Responder Detection

Use the RESPONDER DETECTION screen to determine the type of responder at the far end. Connect as shown in the procedure associated with Figure 48.

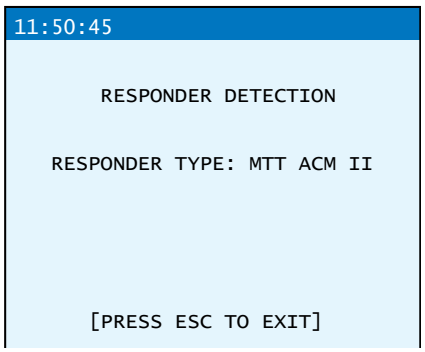


Figure 67 Responder Detection Screen

6.9 Responder

Paired tests (Insertion Loss, Signal-to-Noise, Loop Resistance, and FEXT) require a responder at the far end.

To setup the test set as a Responder:

1. Connect the test set to the span as a responder.
2. Select LINE > RESPONDER and the RESPOND LED turns green.
3. The test set will now respond to commands from the Controller while it is in this screen.
   Note: Press RESET (F4) to reset the responder.

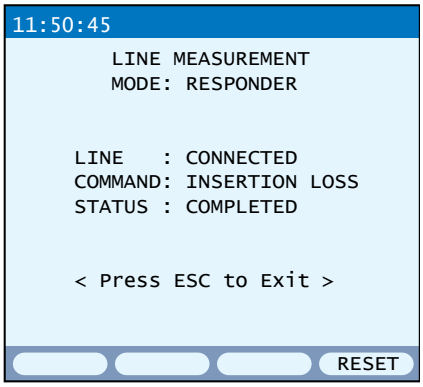


Figure 68 Responder Screen

The following information is displayed:

LINE: Status of the connection with the Controller. LINE displays IDLE (when it's not receiving anything from the Controller) or CONNECTED (when it's receiving messages from the Controller).

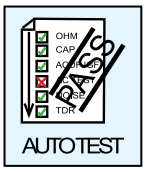
COMMAND: Type of command received from the Controller. Here, the Controller is running an Insertion Loss test.

STATUS: Responder status. This can be:

- RECEIVED: A command from the controller has been received.
- PROCESSING: The test set is in the process of responding to the controller.
- COMPLETED: The test set has responded to the controller.

4. When finished testing, press ESC.

7 Auto Test



Automatically step through a series of tests, and where applicable, report PASS, MARGINAL, or FAIL, depending on adjustable criteria. The tests can be a single ended or dual ended. The tests can be custom configured and saved for future use. You can save up to nine custom test sequence

7.1 Test Procedure and Results

1. Connect the test set(s) to the pair to be tested, as shown in Figure 69.

   Note: See *Section 6.9* if a responder is used.

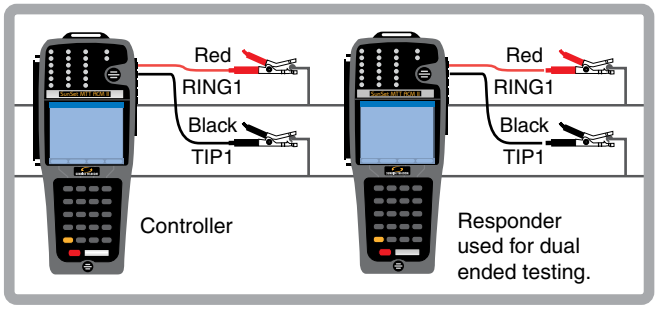


Figure 69 Dual and Single Ended Testing

2. From the chassis main menu, select AUTO TEST and the AUTO TEST MAIN MENU screen is displayed.

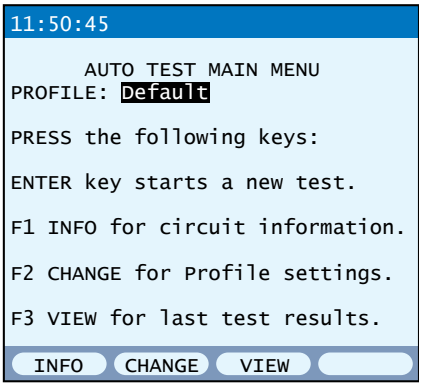


Figure 70 Auto Test Main Menu Screen

3. If needed, press INFO (F1) to enter the following Test Loop Information in the screen shown to the right:

   Note: Enter numbers by, pressing SHIFT and use the numeric keypad along with <- (F2) and -> (F3).

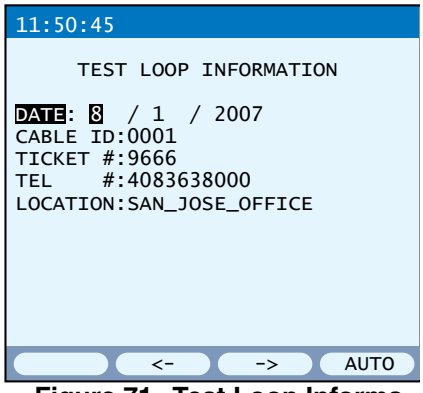


Figure 71 Test Loop Information Screen

DATE: Enter a date, or press AUTO (F4) to enter the current date.

CABLE ID: Enter an identification number.

TICKET #: Enter a ticket number.

TEL#: Enter a telephone number.

LOCATION: Press EDIT (F1) to display a character entry screen. Use the following procedure to enter a location:

A. Press INPUT (F3). Note that the "a" character is highlighted and the INPUT F-key has changed to STOP.
B. Press ◄,▲,▼,► to select a character, and press ENTER to place the character in LOCATION. Repeat until finished.

- If a mistake is made in the entry:

I. Press STOP (F3),then move the FILENAME cursor to the incorrect character.
II. Press DELETE (F2) to delete the character, or press INSERT (F1) to insert a character.
III. Press INPUT (F3) to select a character. Press ENTER to insert the new character to the left of the cursor.

C. Press SAVE (F4) to store the entry and return to the TEST LOOP INFORMATION screen, as shown in Figure 71.

4. When finished, press ESC to return to the AUTO TEST MAIN MENU screen.

5. If needed, press CHANGE (F2) to adjust the test profile settings, found in the screens to the right.

   In the screen shown on the top right, PROFILE is selected and there are two F-keys available:

   NEW (F1): Create a test profile name via a character entry screen like the one described in Step 3-LOCATION. When finished, press SAVE (F4) to return to the top right screen. Now change the settings in the three screens and press STORE (F3) to save the new profile.

   SELECT (F2): Select an existing profile from the AUTO TEST PROFILES selection screen. The Default profile cannot be changed, but any other profile can be renamed or deleted.

   The screens shown to the right contain the following settings, that can be ON (F1) or OFF (F2). Change numeric values by using SHIFT and the numeric keypad.

   The first group of settings are DUAL ENDED.

   DUAL ENDED (require a responder if set to YES)
   - LOOP OHM: NO or YES
   - VDSL LOSS: NO or YES
   - VDSL SNR: NO or YES

   INSULATION OHM (single ended testing)
   - TIP_GROUND: NO, YES
     * If Yes, select from 1000 to 9999Ω.
   - RING_GROUND: NO, Yes
     * If YES, select from 1000 to 9999Ω.

   CAP BALANCE: NO or YES, >/= 95%

   DISTANCE (CAP): NO or YES

   AC VOLTAGE (single ended testing)
   - TIP_RING: NO, or if YES, select from 0 to 99 VAC
   - TIP_GROUND: NO, or if YES, select from 0 to 99 VAC
   - RING_GROUND: NO, or if YES, select from 0 to 99 VAC

   DC VOLTAGE (single ended testing)
   - TIP_RING: NO, or if YES, select from 0 to 99 VDC
   - TIP_GROUND: NO, or if YES, select from 0 to 99 VDC
   - RING_GROUND: NO, or if YES, select from 0 to 99 VDC

   TDR DISTANCE: NO or YES. Performs a TDR Auto Search.
   CABLE LENGTH: NO or YES.
   VDSL PSD NOISE: NO or YES.

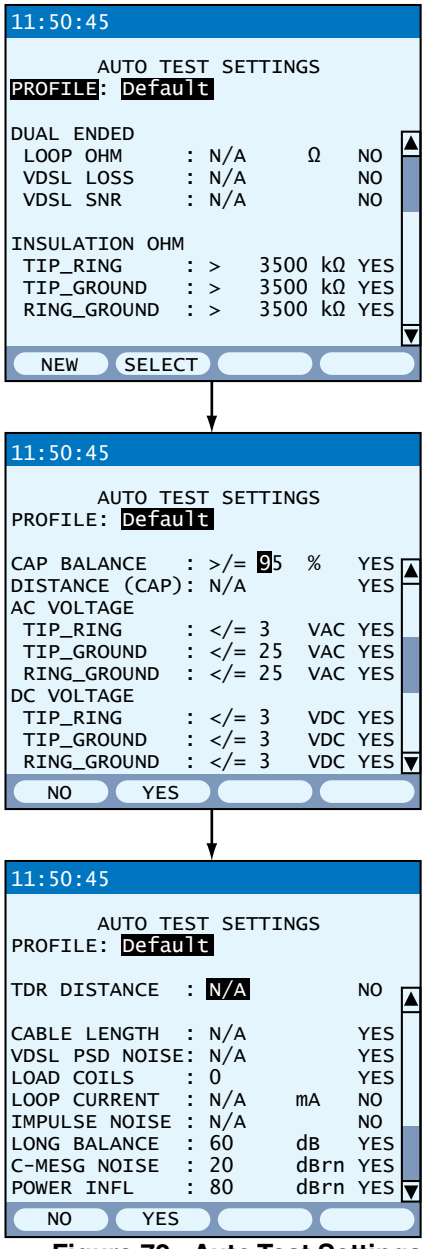


Figure 72 Auto Test Settings Screens

LOAD COILS: NO, or if YES, select from 0 to 9.
LOOP CURRENT: NO or YES.
IMPULSE NOISE: NO or YES.
HIGH: This can not be changed.
C-MESG NOISE: NO or YES. Default is 20 dBrn YES
POWER INFL: NO or YES. Default is 80 dBrn YES

6. When the screen settings are as desired, press SAVE (F4) and ESC to return to the AUTO TEST MAIN MENU.
7. When ready, press ENTER to display the AUTO TEST screen.
8. Press START (F1) to begin testing. The AUTO TEST screen displays an in progress indicator to the right of "IN PROGRESS" in the screen to the right.

   If needed, press STOP (F1) to stop testing.

   In Figure 73 there was no response from a responder, so the test skipped to the INSULATION OHM part of the test.

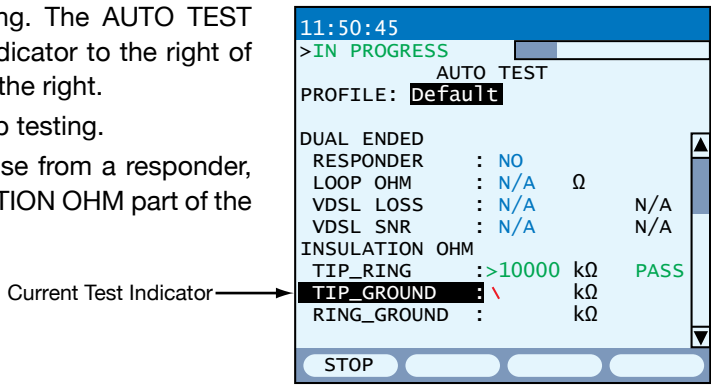


Figure 73 Auto Test Progress Screen

9. Once the test is completed, the test results are available as shown in the AUTO TEST result screens. Refer to the listed sections for details on a specific test.

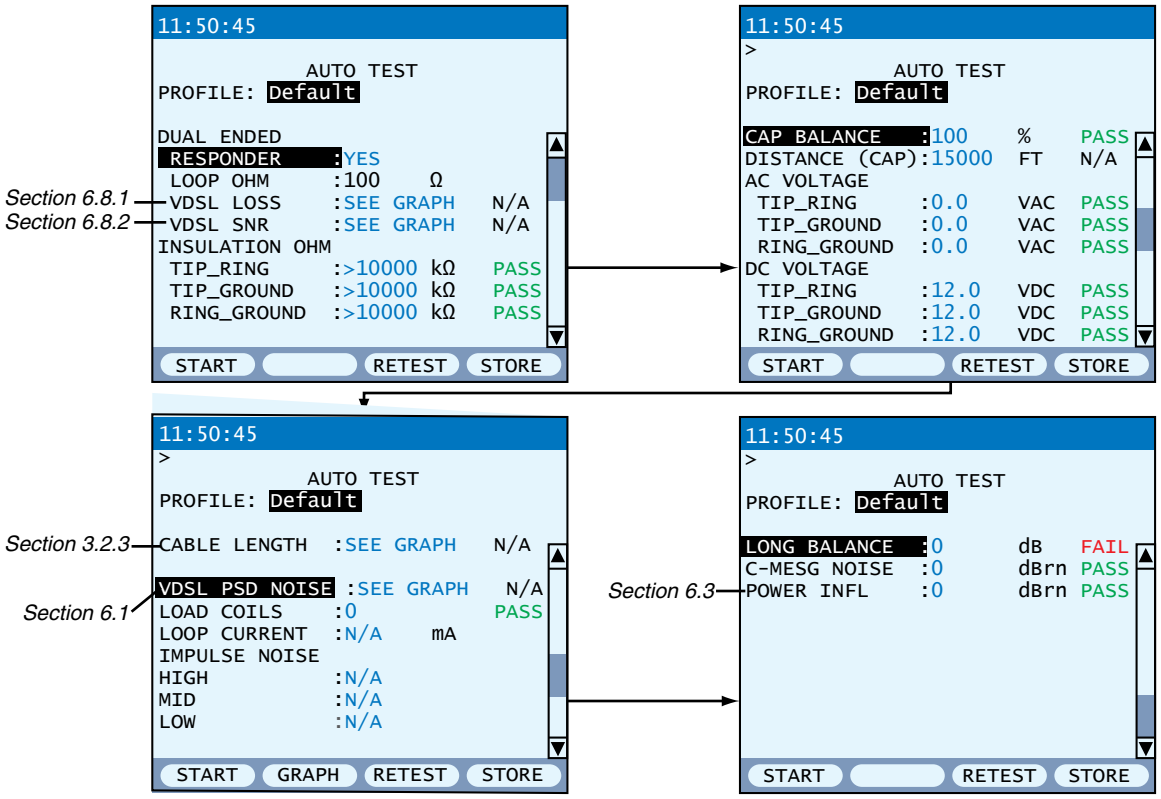


Figure 74 Auto Test Result Screens

AUTO TEST Result F-keys

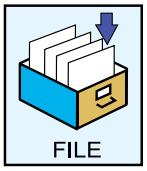
START/STOP (F1): Start and stop testing.

GRAPH (F2): For some tests, a graph is available. See the sections listed in Figure 74 for details.

RETEST (F3): Available after the test is completed; use it to restart the test from a selected line.

STORE (F4): Save the test results; see *Chapter 8*.

8 File



Results can be stored so that they can be viewed or printed at a later time. Each result can be labeled with a filename for easy identification. Store up to 50 individual results, depending on available memory, by using the STORE F-key found in the results screens; see *Section 8.1*.

Upon selecting FILE, the VIEW/STORE/PRINT screen is displayed. It lists all stored tests.

View/Store/Print F-keys

VIEW (F1): View a selected file; see *Section 8.2*.

PRINT (F3): Print a selected file; see *Section 8.3*.

RENAME (more, F1): Rename a selected file; see *Section 8.6*.

UN/LOCK (more, F2): Lock and unlock a selected file; see *Section 8.5*.

DELETE (more, F3): Delete a selected file, unless locked; see *Section 8.4*.

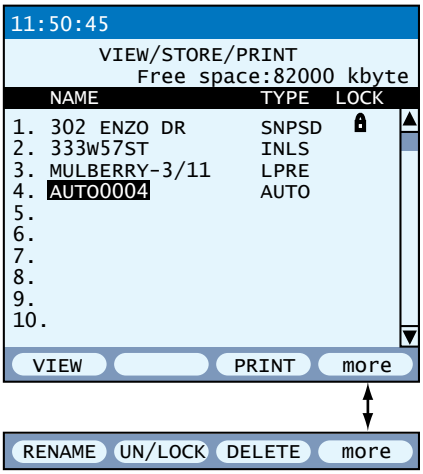


Figure 75 View/Store/Print Screen

8.1 Saving a Test

1. From any screen with a STORE F-key, press the key, and measurements are saved with a generic file name starting with XXXX0001, continuing with XXXX0002, and so on.

   XXXX is the type of saved measurement, i.e., AUTO for auto test, COIL for coil detection, INNS for impulse noise count, BKNS for background noise, etc.

   The saved file can be renamed, as described in *Section 8.6.*

8.2 Viewing a Stored Test

1. Select FILE and press ENTER.
2. Select the desired file from the VIEW/STORE/PRINT screen using ▲,▼.
3. Press VIEW (F1), and the stored result can be viewed.
4. Use ▲,▼ to scroll through the available screens.
5. When finished, press ESC to return to VIEW/STORE/PRINT.

8.3 Printing a Stored Test

1. Connect a SunSet printer to the COMM PORT.

- For other types of printers or for more information, see *Section 8.7*.

2. Select FILE and press ENTER.
3. Select the desired file from the VIEW/STORE/PRINT screen using ▲,▼.
4. Press PRINT (F3), and the file will begin printing.
5. When finished, press ESC to return to VIEW/STORE/PRINT.

8.4 Deleting a Stored Test

1. Select FILE and press ENTER.
2. Select the desired file from the VIEW/STORE/PRINT screen using ▲,▼.
3. Press DELETE (more, F3), and the file is deleted (if the file is unlocked).

8.5 Locking and Unlocking a Stored Test

1. Select FILE and press ENTER.
2. Select the desired file from the VIEW/STORE/PRINT screen using ▲,▼.
3. Press UN/LOCK (more, F2), and the file is locked or unlocked as indicated by the lock icon to the right of the file name. The lock icon is shown in Figure 75.

8.6 Renaming a Stored Test

1. Select FILE and press ENTER.
2. Select the desired file from the VIEW/STORE/PRINT screen using ▲,▼.
- If the file is locked, as indicated by the lock icon, press UN/LOCK (more, F2).
3. Press RENAME (more, F2) to use the screen shown to the right to rename the file.
4. Press INPUT (F3). Note that the “A” character is highlighted and the INPUT F-key has changed to STOP.
5. Press ◄,▲,▼,► to move the cursor to a character and press ENTER to place that character in the FILENAME line. Repeat until finished. Up to 16 characters can be entered.

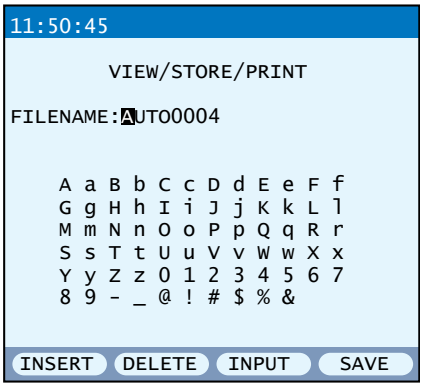


Figure 76 Character Screen

- If a mistake is made:
  A. Press STOP (F3) and move the FILENAME cursor to the incorrect character.
  B. Press DELETE (F2) to delete the character, or press INSERT (F1) to insert a character.
  C. Press INPUT (F3) to select a character in the character grid . Press ENTER to insert the new character to the left of the cursor.

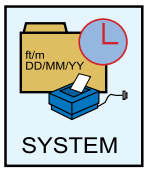
6. Press SAVE (F4) to save and return to the VIEW/STORE/PRINT screen shown in Figure 75.

8.7 Transferring Results to a PC

Test set data can be sent to a PC running the SunSet Reporter. To do so:

1. Verify that the com port is configured for both the computer and the test set; see *Section 9.3.1.*
- 19200 baud rate is recommended.
2. Connect the test set to a PC using one of the following connections:
- SS115D (8-DIN to DB9) cable and a SS122B Null Modem adapter.
- SS115 (8-DIN to DB25) cable and a SS122C Null Modem adapter.
- SA296 (8-DIN) Serial to USB cable (driver software will need to be installed on the PC).
3. Another method is to transfer the data from the MMC card using a MMC reader and a PC; see *Section 2.4.3.*

9 System



This menu screen contains various system settings and functions divided into three groups:

- SYSTEM CONFIG
- SYSTEM TOOLS
- SERIAL PORT APPS

9.1 System Configuration

Use the SYSTEM CONFIGURATION screen to configure the following:

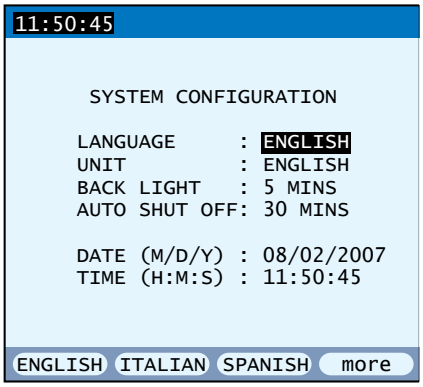


Figure 77 System Configuration Screen

LANGUAGE
Options: ENGLISH (F1), ITALIAN (F2), SPANISH (F3), FRENCH (more, F1), CHINESE (more, F2)
Select the language that the test set will display.

UNIT
Options: ENGLISH (F1), METRIC (F2)
Select the measurement system the test set will use.

BACK LIGHT
Options: 5-60 minutes
Use +5 MIN and -5 MIN enter the desired on time duration.

AUTO SHUT OFF: Set a time for the test set to shut down.
Options: OFF or 2-30 minutes
Use +1 MIN and -1 MIN to set the time for the shut down. When this feature is set, the on screen time is displayed against a black background as in Figure 77.

DATE: Set the date.
Use ◄, ► to select the month/date/year, along with INC (F1) and DEC (F2) to set the date. When finished, press SET (F3).

TIME: Set the time.
Use ◄, ► to select the hour: minute: second, along with INC (F1) and DEC (F2) to set the time. When finished, press SET (F3). Note that the clock can only be set for a 24 hour clock.

9.2 System Tools

This menu screen contains:

- NV RAM ERASE
- FACTORY DEFAULT
- VERSION INFORMATION

9.2.1 NV RAM Erase

Use the following procedure to perform NV RAM ERASE:

⚠ **CAUTION**: This will erase all stored information.

1. Select SYSTEM > SYSTEM TOOLS > NV RAM ERASE.
2. Press ENTER to start NV RAM ERASE. An “ERASING NV RAM” message will be displayed and the test set will shut down.
   - Press ESC to escape from the procedure.
3. After powering up the test set, configure it as required.

9.2.2 Factory Default

Use this procedure to return the test set to it’s original profiles.

1. Select SYSTEM > SYSTEM TOOLS > FACTORY DEFAULT.
2. Press ENTER, and the test set resets all settings to their original settings, or press ESC to escape from the procedure.

9.2.3 Version Information

This menu screen contains:

- VERSION/OPTION
- MODULE OPTION
- VERSION LIST

9.2.3.1 Version/Option

View a list of installed software options for the test set and supported modules. Also view basic hardware information such as serial numbers.

If necessary, use PAGE-UP (F1) and PAGE-DN (F2) to view the entire list.

Press PRINT (F3) to print the list.

9.2.3.2 Module Option

This function is currently not supported.

9.2.3.3 Version List

Displays a list of the software versions for the base chassis and supported modules.

If necessary, press “more” (F4) to view the entire list.

9.3 Serial Port Applications

This menu screen contains:

- SERIAL PORT CNFG
- Any optional applications that use the COMM PORT, such as:
  - VT100 EMULATION
  - TL1 MODE

  These optional features have their own User's Manuals.

9.3.1 Serial Port Configuration

In order to print or transfer results to a PC correctly, configure the COMM PORT to match the destination printer/PC.

To configure, select SYSTEM > SERIAL PORT APPS > SERIAL PORT CNFG and in the SERIAL PORT CONFIGURATION screen, configure the following:

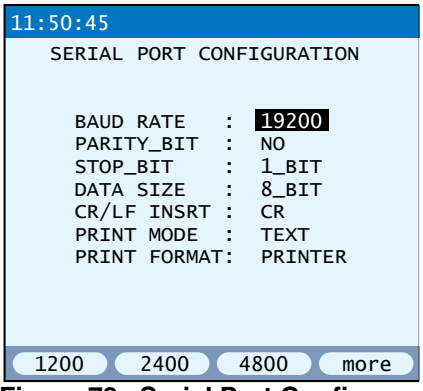


Figure 78 Serial Port Configuration Screen

BAUD RATE

Options: 1200 (F1), 2400 (F2), 4800 (F3), 9600 (more, F1), 19200 (more, F2)

Select the desired baud rate setting.

- Make sure this setting matches that of the destination printer.

PARITY BIT

Options: NO (F1), ODD (F2), EVEN (F3)

Parity is a method of checking the accuracy of transmitted or stored data. An extra bit, known as a parity bit, is added to the data as an accuracy check.

- Make sure this setting matches that of the destination printer.
- In Odd Parity, the total number of ones (including the added parity bit) is odd.
- In Even Parity, the total number of ones (including the added parity bit) is even.
- None signifies no parity checking.

STOP BIT

Options: 1-BIT (F1), 2-BIT (F2)

In asynchronous transmission, the stop bit is the last transmitted character which permits the receiver to come into an idle condition before accepting another character. Make sure this setting matches that of the destination printer.

DATA SIZE: Data Size specifies the number of bits per character.

Options: 5_BIT (F1), 6_BIT (F2), 7_BIT (F3), 8_BIT (F4)

- Make sure this setting matches that of the destination printer.

CR/LF INSRT

Options: CR (F1), CR+LF (F2)

- CR: Carriage return.
- CR+LF: Carriage return and line feed. This inserts an extra line space after every line.

PRINT MODE: Choose the print format.

Option: TEXT (F1)

Text: This mode prints a text-only format. The following Stored Results are printable to a serial printer or a PC terminal program:

- BACKGROUND NOISE PSD Tabular Results (F3: PRINT)
- NEXT Tabular Results (F3: PRINT)
- FEXT Tabular Results (F3: PRINT)

- INSERTION LOSS PSD Tabular Results (F3: PRINT)
- Signal to Background Noise Tabular Results (F3: PRINT)

PRINT FORMAT

Options: PRINTER (F1), VT100 (F2)

- Printer: Supports SunSet printers.
- VT100: Exports tabular results (as mentioned in PRINT MODE) in a two column format to terminal programs, such as Windows HyperTerminal , for post data processing.

10 General Information

10.1 Customer Service

General Sunrise Telecom Customer Service is available from 7:30 AM to 5:30 PM Pacific Standard Time (California, U.S.A.).

Customer Service performs the following functions:

- Answers customer questions over the phone on such topics as product operation and repair.
- Facilitates prompt repair of malfunctioning test sets.
- Provides information about product upgrades.

A Return Merchandise Authorization (RMA) Number is required before any product may be shipped to Sunrise Telecom for repair. Out-of-warranty repairs require both an RMA and a Purchase Order before the unit is returned. All repairs are warranted for 90 days.

Contact Customer Service at:

Sunrise Telecom Incorporated
302 Enzo Drive
San Jose, CA 95138
U.S.A.

Tel: 1-800-701-5208
Fax: 1-408-363-8313
Internet: http://www.sunrisetelecom.com
e-mail: support@sunrisetelecom.com

Or contact one our offices listed in *Section 10.2*.

MTT Support Hotline
In addition to general customer service, a 24-hour MTT support line is available for dedicated MTT technical support. Our knowledgeable MTT support staff is ready to help with any questions regarding MTT testing.

Call: 1-800-701-5208

10.2 Offices

Sunrise Telecom offices are located around the world:

- America: SUNRISE TELECOM INCORPORATED
  302 Enzo Drive, San Jose, CA 95138, USA
  Tel: +1-800-701-5208, +1-408-363-8000, Fax: +1-408-363-8313
  Email: support@sunrisetelecom.com or info@sunrisetelecom.com
- U.S.A. SUNRISE TELECOM ATLANTA

3075 Northwoods Circle, Norcross, GA 30071, USA

Tel: 770-446-6086, Fax: 770-446-6850

catv_tech_support@sunrisetelecom.com

- France: SUNRISE TELECOM
  ZA Courtaboeuf 2 - Immeuble le Ceylan6 Allée de Londres 91140 Villejust, FRANCE
  Tel: +33 (0) 1 69 93 89 90, Fax: +33 (0) 1 69 93 89 91
  Email:france@sunrisetelecom.com
- Germany: SUNRISE TELECOM
  Grabenstrasse 1, 72116 Mssingen, GERMANY
  Tel: +49 7473 378 2400, Fax: +49 7473 378 2424
  Email: info@sunrisetelecom.de

- China: SUNRISE TELECOM
  Room 1503, Tower 3, No. 1, Xizhimenwai Stree.
  Xicheng District, Beijing, 100044, CHINA
  Tel: +86-10-5830-2220, Fax: +86-10-5830-2239
  Email: info@sunrisetelecom.cn

- Taiwan: SUNRISE TELECOM Company Limited
  21, Wu Chuan 3rd Road, Wu-Ku Hsiang, Taipei County, 248, Taiwan, R.O.C.
  Tel: +886-2-5578-0788, Fax: +886-2-2298-2575
  Email: support@sunrisetelecom.com

10.3 Express Limited Warranty

This Sunrise Telecom product is warranted against defects in materials and workmanship during its warranty period. The warranty period for this product is contained inthe warranty page on http://www.sunrisetelecom.com.
Sunrise Telecom agrees to repair or replace any assembly or compo nent found to bedefective under normal use during this period. The obligation under this warrantyis limited solely to repairing or replacing the product that proves to be defective within the scope of the warranty when returned to the factory. This warranty doesnot apply under certain conditions, as set forth on the warranty page on http://www.sunrisetelecom.com. Please refer to the website for specific details.
THIS IS A LIMITED WARRANTY AND THE ONLY WARRANTY MADE BY SUNRISE TELECOM. SUNRISE TELECOM MAKES NO OTHER WARRANTY, REPRESENTATION OR CONDITION, EXPRESS OR IMPLIED, AND EXPRESSLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR APARTICULAR PURPOSE AND NON-INFRINGEMENT OF THIRD PARTY RIGHTS.

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