3M

Dynatel™ 900/900M Series Test Set

Operators Manual

Auto Cal

Dial

DC Line Test

Voltage

Current

Ohms

Ohms to Dist.

Res. Flt. Loc.

Tone

Opens

Splits

AC Line Test

Ringers

REG

Loss

Noise

September 1996
78–8093–0453–4 Revision D

Dynatel™
900/900M Series
Test Sets

Operators Manual

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This manual is being issued to reflect the 900 seires and 900M series test sets in one manual. This manual includes additional information and corrections to the previous versions including (but not limited to) some organizational changes to aid in use of this manual.

Comments concerning the contents or organization of this document, as well as suggestions for improvement are welcomed. Direct comments to:

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How to Use This Manual

Although your test set may not have all the functions described here, all the 900 Series test sets tell you what to do at every step, including where to connect the test leads. Turn to the tabbed pages for information about each test.

Section One – Operation introduces and describes the 900/900M Series test sets, with operating instructions for each function. Instructions include descriptions of each test, hookup instructions, and a step-by-step example of each test function.

Section Two – Special Applications contains instructions for locating multiple resistance faults, wet sections, performing section analysis, compensating for load coils in cable measurement, some special opens locating techniques, and temperature conversion.

Section Three – Specifications

Section Four – Care and Maintenance

Appendix – Generally Accepted Criteria for Standard Telephone Service

Glossary of Terms

3M 1020B:
Testline for two-way gain/slope or step tone functions.

Access:
Telephone line or circuit connection to test equipment.

Address:
Information specifying a physical location of trunk termination in a switch, or the logical location of the trunk termination data in the switch computer.

Analog:
Any system where data is represented by a continuously variable range of values, such as the hands of a clock or the needle on a meter.

AWG:
American Wire Gauge. A numerical table designating the cross-sectional area of wire. The larger the AWG number, the smaller the wire.

Balance:
The amount of current cancellation along tip and ring conductors. The subscriber hears non-cancelled currents as noise metallic. BALANCE (dB) = POWER INFLUENCE minus CIRCUIT NOISE.

C–Message Weighting:
This filtering makes measurements of noise more like the response of the human ear to various frequencies over a telephone circuit. Sensitivity of the ear drops at frequencies below 800 Hz, and above 2500 Hz.

Central Office (C.O.):
Telephone switching center for connecting calls.

Cursor:
A flashing symbol on a display screen indicating position for data entry.

Database:
All of the information stored in a computer available for retrieval and updating.

dBm:
A measurement of the power of a signal received above a reference power of 1 milliwatt (10^{-3} watts).

dBrn:
(dB reference noise): The reference for noise measurement, a level equivalent to a tone at –90 dBm. 0 dBrn = –90 dBm and 0 dBm = 90 dBrn.

dBrnC:
dBrn measured with C-message weighting.

Decibel (dB):
A unit for measuring the relative strength of a signal parameter, such as power or voltage, often used in measuring loss or gain of power in a device or circuit.

DLL:
Dial Long Line – a loop treatment device to boost the loop current.

Dial Pulse:
The method of telephone dialing by alternately opening and closing (pulsing) a contact in the telephone (dialing the digit 7 produces seven pulses).

Dial Up:
The means of establishing a connection through the network over public dial ports.

Digital:
Information or graphic data that has been translated into a discrete numerical value, and therefore can be manipulated and reproduced without loss of quality.

DTMF:
Dual Tone Multiple Frequency – a touch-tone dial frequency.

Ground Resistance:
The resistance between the subscriber protector ground and C.O. ground.

Line Loss (Circuit Loss):
Measurement of power loss in dBm, measured with flat weighting over the voice frequency band.

Loading, Cable:
Adding inductance (load coils) at specific intervals along a cable to reduce distortion and improve frequency response, compensating for transmission-degrading distributed capacitance between conductors.

Loop Current:
Current in mA required to operate C.O. equipment and station apparatus at the subscriber premises.

Loop Treatment (REG., DLL, etc.):
This is C.O. extension equipment placed on a pair to overcome excessive line loss.

Loss:
Decrease in power (dB) of a transmitted signal.

Maintenance Test Unit (M.T.U.):
Device at protector that allows tester to isolate trouble to premise wiring.

Noise:
Signal producing undesirable sound on telephone line, caused by impedance discontinuities, crosstalk, or other interference.

Noise Metallic (Nm):
Noise measured across the tip and ring of a circuit that the customer actually hears on the line. The same as circuit noise, measured in units of dBrnC.

Power Influence (PI):
Noise measured between ground and the tip and ring conductors shorted together. Not heard by the subscriber, the power influence affects the amount of noise metallic the subscriber hears. The same as noise-to-ground (Ng), measured in dBrnC.

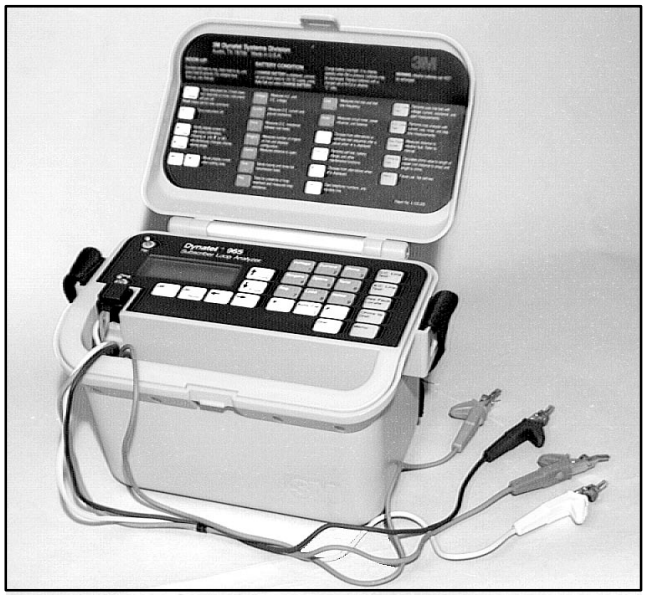
REG:
Range Extender with Gain (loop treatment) boosts C.O. battery voltage and amplifies AC speech signal.

Ringers:
The ringer circuit of a subscriber telephone set, wired tip, wired ring, or bridged. Measured in tenths of a ringer, allows identification of nonstandard equipment.

Slope:
The rate of change in attenuation relative to frequency of a transmission line.

Step Tone:
A three - nine frequency tone generator used to detect loading problems.

Test Set Operation



1. INTRODUCTION

1.1 This manual provides operating instructions for the Dynatel 900/900M Series test instruments. The first in the series, the 955 and 955M Combination Fault Locators performs dead-cable (vacant pair) diagnostic testing and resistance fault locating as well as opens and splits test functions and load-coil counting. The 945 and 945M Subscriber Loop Testers combine the 955/955M functions (except resistance fault locating and splits) with an active-cable diagnostic routine and its associated tests. The 965 and 965M Subscriber Loop Analyzers combine all tests, diagnostic routines, and fault locating capabilities of the 900/900M Series test sets.

The Digital World – Some Differences Between Analog and Digital Testing

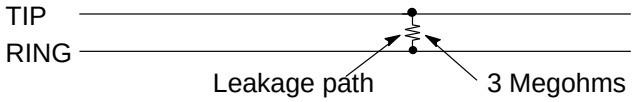
1.2 Each 900/900M Series test set contains a computer that tests the line and displays the results. **Read the display carefully.** The results may look different and have more information than what you're used to.

1.3 Analog meters have relatively low high-resistance limits; for example, some can read up to 3 Mohms, while others can read up to 30 Mohms. In comparison, the digital 900/900M Series unit can read high resistance faults up to 100 Mohms.

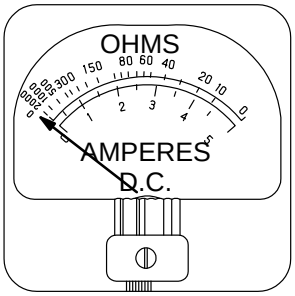
1.4 With an analog meter, you have to manually move the clips from across the pair to ring-to-ground and tip-to-ground, to determine if the fault is a short or ground. With just one hookup, the 900/900M Series test set tests the pair tip-to-ring, ring-to-ground and tip-to-ground. The unit displays the fault and its value on the display screen (see example, next page) at the press of a key on the unit's front panel.

Comparative Displays
of Digital and Analog Readings of a Faulted Pair

SHORT – (High Resistance):



900/900M Series Test Set Display
(Digital Reading)



Volt/Ohm Meter Display
(Analog Reading)

1.5 Other analog meters have converted ohms into points. The chart on the next page shows comparative values for ohms and points.

OHMS TO POINTS

Ohms	Points
0	100
6K	95
11K	90
24K	80
40K	70
67K	60
100K	50
150K	40
230K	30
400K	20
900K	10
2M	5
3M	0

2. 900/900M Series TEST SET

2.1 This section of the operators manual contains operating instructions for 900/900M Series test set functions, including descriptions of each available test, hookup instructions, and step-by-step flowcharts of each test function.

Notes on Using the Test Set

2.2 **DISPLAY –** Adjust display visibility by pressing ↑ (up-arrow key) or ↓ (down-arrow key) when the unit is first turned on. If your set is equipped with a backlight, hold down the * (star key) and press the ← (left-arrow key) to turn the backlight on and off. For a 900-T series test set, see its accompanying Terminal Emulation Manual for backlight instructions.

2.3 **STORED TELEPHONE NUMBERS –** Eight numbers may be stored under the **DIAL** key for general use. Eight numbers each reside under the **LOSS**

key, **NOISE** key, and in the step tone and 3M 1020B options under the **AC LINE TEST** key. To enter a telephone number, press the **DIAL** key, **LOSS** key, or **NOISE** key. Press the * (star key) to advance to the **SELECT/EDIT** screen. Use the arrow keys to move the cursor, then type the number. Use the **OHMS TO DISTANCE** key to erase a number. Press the **DIAL** key to store the number. Press the **ON/RESET** key to escape the program without dialing.

3. AUTO CAL

3.1 The **AUTO CAL** key gives you access to the following maintenance and accessory functions. Use the up- and down-arrow keys to move the cursor to your choice, then press the * (star) key to activate the function.

A. Charge Battery

3.2 For rechargeable batteries only, use this option and follow the displayed instructions to use the internal battery charger. The unit determines when the batteries are fully charged and turns itself off automatically.

Warning:

Never try to charge a non-rechargeable battery. Damage to the battery or personal injury from explosion may result.

B. Self Calibration

3.3 To maintain accuracy, use this option to self-calibrate the unit **every day** and during temperature changes. Press the * (star) key to select **SELF CALIBRATION**, then short all the test clips together. Press the * (star) key. The unit displays **"PLEASE WAIT"** while it self-calibrates, then "beeps" and instructs you to disconnect the leads and press the * (star) key. When you have disconnected the leads, and

Auto Cal

made sure they are not shorting against one another, press the * (star) key and wait while the unit performs a RAM (random-access memory) test. The screen displays **"SELF CALIBRATIONS ARE COMPLETED ✶."** Press the * (star) key to return to the **AUTO CAL** menu. If the unit fails self calibration, return it for service. The only exception may be if the error message is "**OPEN TEST LEAD**," a condition that may be solved by replacing the test lead assembly. (See the phone number for 3M Technical Service in the front of this manual.)

C. Access

3.4 **ACCESS** has no user function. If you select this option, press the **Reset** key to continue.

D. Battery Type

3.5 To control charging, the unit must know what type batteries it contains. Select this function, then press either the * (star) key for rechargeable nickel-cadmium batteries, or the # (pound) key for dry cells (alkaline batteries).

3.6 To replace the batteries, refer to Section Four, "Care and Maintenance" in this manual.

E. Identification

3.7 This function displays the unit's model, serial, version, and terminal identification numbers. Press the * (star) key to return to the menu.

F. Custom Cable

3.8 Use this option to program cable capacitance into the unit for use on non-standard cables. Type the mutual and tip-ground capacitances as requested. You will use these cable specifications when you select the **CUSTOM CABLE** option from the **CABLE TYPE** menu in the **OPENS** test routines.

3.9 To determine a cable's capacitance, press the **OPENS** key. Press the * (star) key to select **NORMAL MODE**, then wait. When the display changes, press the # (pound) key to call up the **OPENS** menu. Move the cursor to **CALIBRATE TO CABLE** and press the * (star) key. The display tells you to connect the black and red leads to a reference pair of known length in the cable, and connect the green lead to grounded shield. You must be hooked up to a non-standard cable of known length. Press the * (star) key, then enter the length and press the * (star) key again. The unit displays the calibration results. Press the **AUTO CAL** key and follow the instructions in para. 3.8, above, to program the capacitance under the **CUSTOM CABLE** option.

G. Other Setups

3.10 Use this option to control the sound of the keystroke "beeps." **For the 900-T series test sets**, use this option to setup the real-time clock and view the log which shows information about the last time the set was on the battery charger.

3.11 To setup the clock, use the arrow key to move the cursor next to the "setup clock" option, and press the * (star key). Use the arrow keys or numeric keypad to edit the number. Enter the time by pressing the * (star key). Next, use the arrow keys or numeric keypad to edit the date. Enter the date using the * (star key).

3.12 To view the battery-charge log, use the arrow key to move the cursor next to the "xxxxxxx" option, and press the * (star key). The battery-charge log shows the beginning and ending dates and times of the last charging. The first charging voltage and current are displayed, along with the percentage of charge capacity and the bettery voltage before the charging cycle begins.

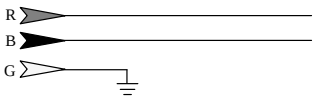
Dial

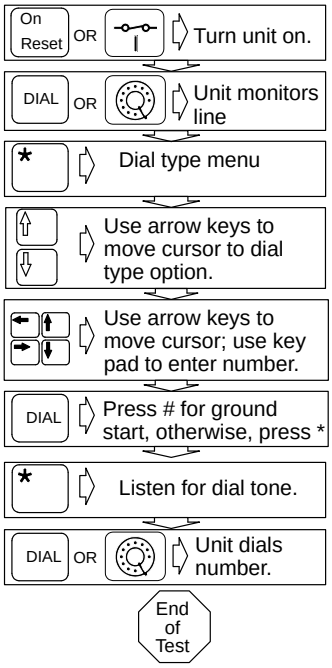
4. DIAL

4.1 DIAL lets you connect to a working line, monitor it for conversation, then dial any number such as for battery kill, automatic number announcing (ANA), voice dispatch systems, loss or noise testing, or to listen to the called party. When the number is dialed, you can press the LOSS or NOISE keys to start those test routines. The unit can provide 1-second ring ground (ground start) if open tip is detected. Some units are optionally equipped to test for caller I.D. and message waiting.

Example – Dial Number

Hookup:
RED to RING
BLACK to TIP
GREEN to GROUND





Disregard this step if the unit is on.

To dial, go off-hook when instructed on the display.

Choose touch-tone or dial pulse. "Manual" allows you to enter additional access digits.

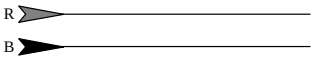
To select a number on the screen, line up the cursor with the number, then press DIAL. To erase a digit, press the Ohms to Distance key. In automatic dial mode, move the cursor to the left to type a number with more than 7 digits.

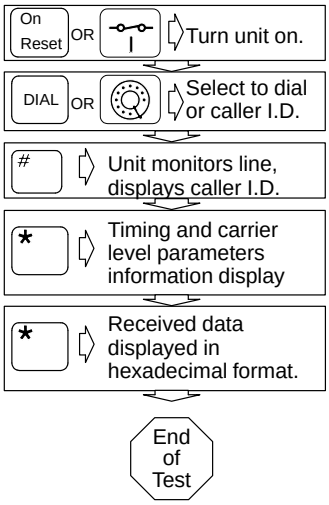
When the number is dialed, you can press the LOSS or NOISE keys to go directly into those test routines, or monitor voice.

Example – Caller I.D. Option

Hookup:

RED to RING
BLACK to TIP





Disregard this step if the unit is on.

*You can press the * key to go to number dialing.*

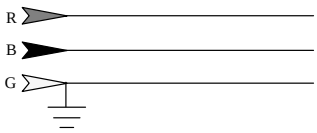
The unit monitors the line for message waiting signal, and indicates if the message waiting light is off or on.

The data displayed includes seizure characters (hex 55) and " - - " to indicate a period of about 10 ms in which no character was received.

DC Line Test

Hookup:

RED to RING
BLACK to TIP
GREEN to GROUNDED SHIELD



About DC Line Test

Use the automatic DC Line Test routine to evaluate a vacant pair being placed into service or any pair with suspected problems.

Attach the leads, then turn the unit on.

Always verify results with appropriate manual tests (blue keys) before taking corrective action.

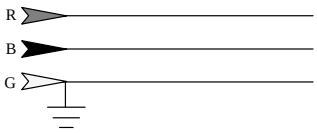
Caution

If hazardous voltage warnings are displayed when the test set is switched on or reset (or at any time during the testing procedure) follow standard procedures for de-energizing and discharging cables.

DC Line Test

Hookup:

RED to RING
BLACK to TIP
GREEN to GROUNDED SHIELD



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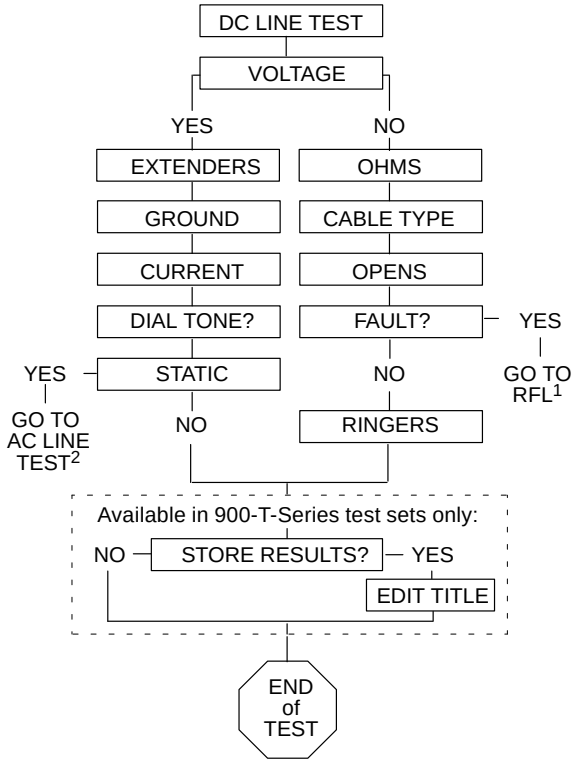
Note: *On some floating-tip switches such as #5 ESS, ground resistance cannot be measured because the switch operates on a floating ground.*

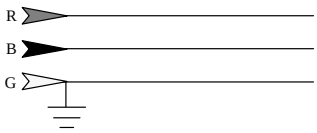


[1]*RFL = Resistance Fault Locate (not available in 945/945M)*
[2] *Not available in 955/955M.*

Voltage

Hookup:

RED to RING
BLACK to TIP
GREEN to GROUNDED SHIELD



About the Voltage Test

The **VOLTAGE** key detects and measures for central office battery or foreign DC and AC voltages on a pair, updating the measurement continually.

Note: *Voltage accuracy can be affected when source impedance exceeds the 900/900M Series Test Set input impedance of 1.11 Megohms. The user can compute the true voltage reading considering the 1.11 Megohms input impedance if accuracy is required.*

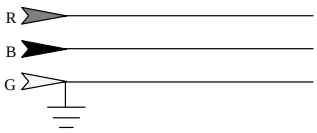
Caution

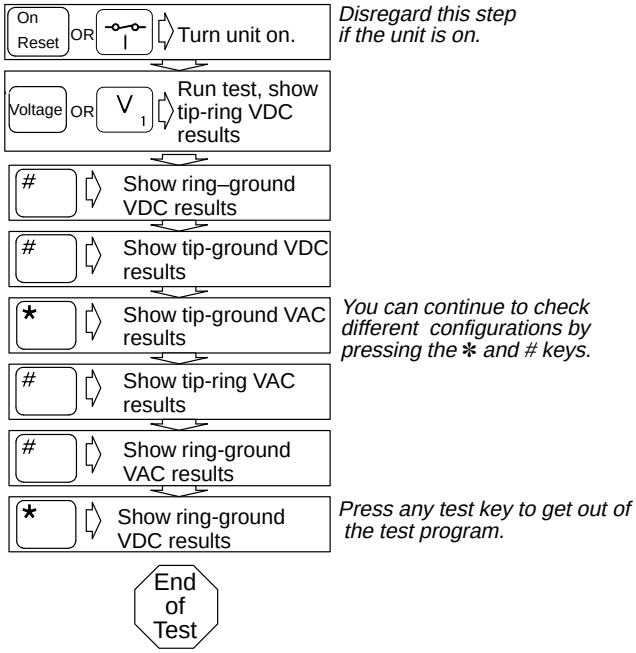
If hazardous voltage warnings are displayed when the test set is switched on or reset (or at any time during the testing procedure) follow standard procedures for de-energizing and discharging cables.

Voltage

Hookup:

RED to RING
BLACK to TIP
GREEN to GROUNDED SHIELD

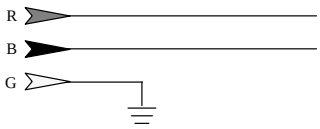




Current

Hookup:

RED to RING
BLACK to TIP
GREEN to GROUND



About the Current Test

The **CURRENT** key measures DC current on the subscriber loop to see if the telephone set has enough power for operation, continually updating the information. On the 945/945M and 965/965M, the **CURRENT** key function also tests ground resistance to check integrity of the ground connection at the station protector.

Press the **CURRENT** key, and the unit applies a 430 ohm short across the pair to simulate an off-hook condition. The unit displays loop current in milliamps and updates the reading about two times per second.

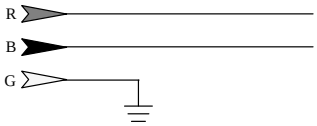
Caution

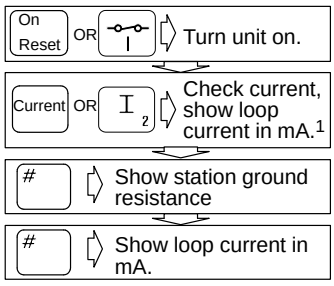
If hazardous voltage warnings are displayed when the test set is switched on or reset (or at any time during the testing procedure) follow standard procedures for de-energizing and discharging cables.

Current

Hookup:

RED to RING
BLACK to TIP
GREEN to GROUND





Disregard this step if the unit is on.

On the 945/945M and 965/965M units only, you can press the # (pound key) to switch the display from loop current to station ground resistance and back.

End of Test

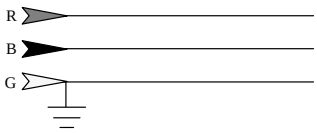
[1] To measure RING TO GROUND current, move the black lead and connect it to ground. The unit automatically makes the measurement and displays the result.

Note: *On some floating-tip switches such as #5 ESS, ground resistance cannot be measured because the switch operates on a floating ground.*

Ohms

Hookup:

RED to RING
BLACK to TIP
GREEN to GROUNDED SHIELD



About the Ohms Test

The **OHMS** key measures resistance between conductors, or from a conductor to ground. Measurements are displayed in ohms and points.

Measurements can fluctuate with power influence, variations in fault resistance or C.O. battery level, or dirty test clips (keep them clean). A rising or falling tone indicates large resistance fluctuations.

Use the **OHMS** key to test the good and faulty conductors before using the **RESISTANCE FAULT LOCATE** key.

Use the **OHMS** key with the **OHMS TO DISTANCE** key to estimate the distance to a **solid** short or ground.

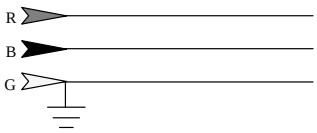
Caution

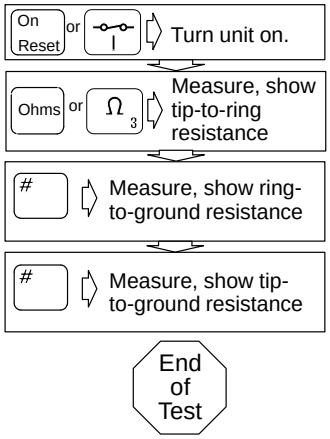
If hazardous voltage warnings are displayed when the test set is switched on or reset (or at any time during the testing procedure) follow standard procedures for de-energizing and discharging cables.

Ohms

Hookup:

RED to RING
BLACK to TIP
GREEN to GROUNDED SHIELD





Disregard this step if the unit is on.

The letters "CO" on the display indicate battery on the line, <u>while</u> loop resistances is being measured.

You can press the ohms to distance key to convert the resistance measurement to distance, or press any other test key to exit this test program.

Ohms to Distance

Hookup: none required

About the Ohms to Distance Conversion

When you encounter a SOLID SHORT (0 Ohms), you can find the equivalent distance in feet/meters by converting the ohms value with the OHMS TO DISTANCE key. By measuring the resistance with the **OHMS** key first, then pressing the **OHMS TO DISTANCE** key, the conversion is automatically calculated.

Note: *When the fault is a SOLID SHORT (0 ohms), divide the distance by two. You cannot calculate the distance to "light" or "wet" troubles using the OHMS TO DISTANCE function.*

You can also use the keypad to enter the value to be converted. Remember, this function is a calculator -- it does not replace the resistance fault locate measurements.

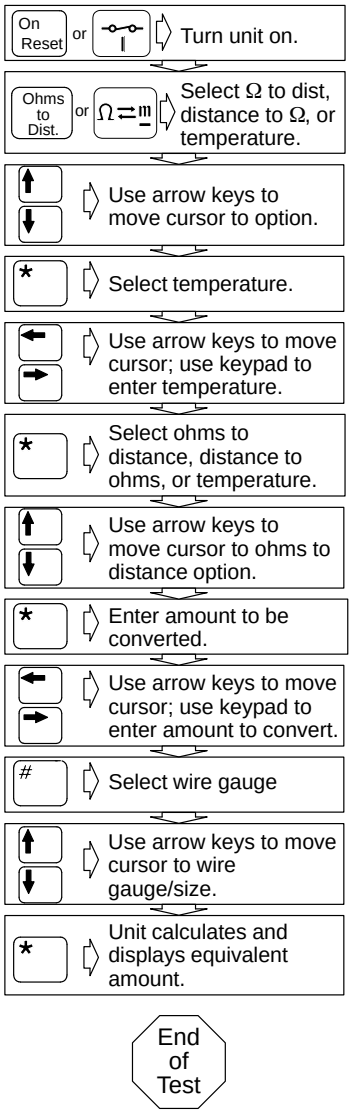
Caution

If hazardous voltage warnings are displayed when the test set is switched on or reset (or at any time during the testing procedure) follow standard procedures for de-energizing and discharging cables.

Temperature is an important factor in ohms-to-distance or distance-to-ohms conversions. The unit defaults to the temperature selected in the resistance fault locate function set-ups; you can also choose to change the temperature with the **OHMS TO DISTANCE** key. To enter a temperature less than zero, type the value, then press the **OHMS TO DISTANCE** key to enter the value as a negative.

Ohms to Distance

Hookup: none required



Disregard this step if the unit is on.

The unit uses the temperature last used by resistance fault locate unless you change it. For this example, select set temperature.

*To enter a temperature less than zero, type the number, then press the **OHMS TO DISTANCE** key next, instead of the ✻ (star key), to enter it as a negative number. Then continue as shown.*

The unit also displays the wire gauge and temperature used to make calculation. When the fault is a short, divide the distance by two. To exit the results display, press the up- or down-arrow key.

Resistance Fault Locate

Hook-up: *As instructed on the unit's display screen – varies by application (see page 23)*

About Resistance Fault Locate

The **RESISTANCE FAULT LOCATE** (RFL) function measures the distance to the fault (DTF); distance from the strap to the fault (STF); distance to the strap (DTS); and distance to a splice (on multi-gauge cable of known distance to strap).

First, test **good** and **faulty** conductors with the **OHMS** key; test continuity with the **OPENS** key.

At the end of the test, 900-T-Series units have the option of storing the results for later retrieval in the terminal mode (for more information, see the Terminal Emulation manual for your unit).

A detailed setups chart and examples follow the RFL flowchart. There are four major set-ups:

a. Unit measures DTS (distance to strap)
b. DTS known
c. Fault locate — multiple gauge
d. Splice locate — multiple gauge

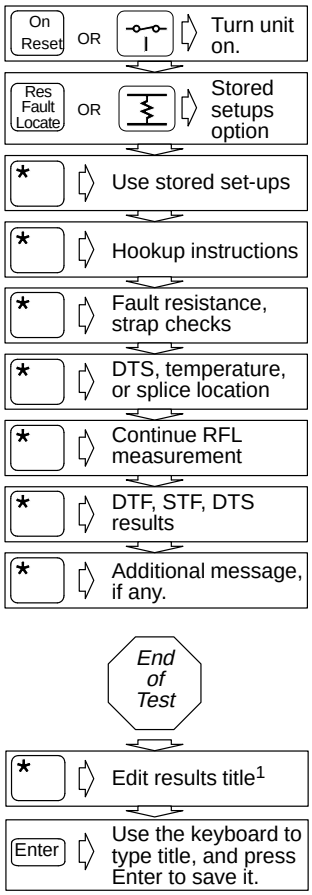
In RFL mode, the display "XX NULL" indicates an automatic null operation required in the measurement. During the distance-to-fault (DTF) measurement, the display "XX.XXX%" indicates fault location relative to distance to strap (DTS) (e.g., 50% indicates halfway to strap).

Caution

If hazardous voltage warnings are displayed when the test set is switched on or reset (or at any time during the testing procedure) follow standard procedures for de-energizing and discharging cables.

Resistance Fault Locate

Hook-up: *As instructed on the unit's display screen – varies by application (see p. 23)*



Disregard this step if the unit is on.

This is the last used setup (start here if coming from RFL setups on page 22).

Use up- and down-arrow keys to see all the instructions. Continue as instructed.

The display may tell you to "wait" during the tests.

The results depend on the tests you specified in the set-ups earlier.

"Please wait." You may see "AC DETECTED, PUSH # TO STOP" during a difficult test. You can press the # (pound key) to repeat the test.

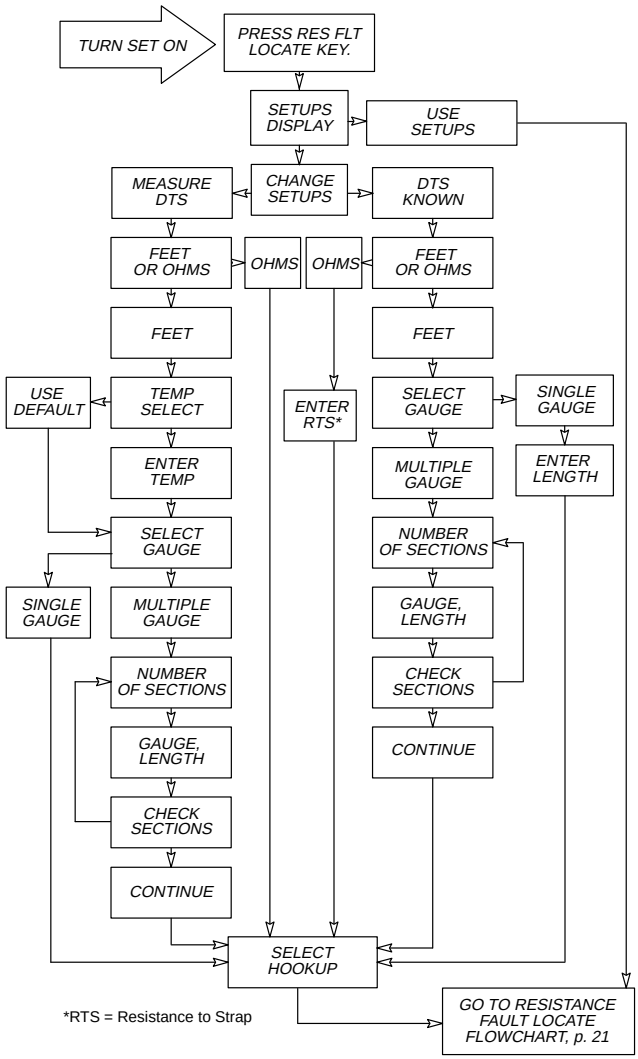
If the unit tells you to move closer to the fault, move the unit and straps nearer the fault and retest; look for similar faults on other pairs. Check good conductor resistance; use only if good conductor readings are 500 times greater than on fault pair (example: good conductor readings = 45 M ohms and fault pair readings = 90 k ohms).

At the end of the test, the T-series unit prompts you to store the results. Press the # (pound) key if you do not want to save them. The default title contains the time and date of test. Press the Esc key to accept it without editing. (See Terminal Emulation manual for more information on storing and retrieving test results.)

[1]900T-Series units only

DTS = Distance to strap
DTF = Distance to fault
STF = Distance strap to fault

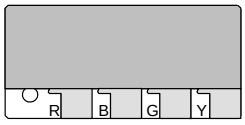
RFL Setups



Note: *Contact your 3M Technical Service Representative at the number shown in the front of this manual for a copy of Field Note #2 with detailed instructions on estimating cable temperature.*

RFL Examples

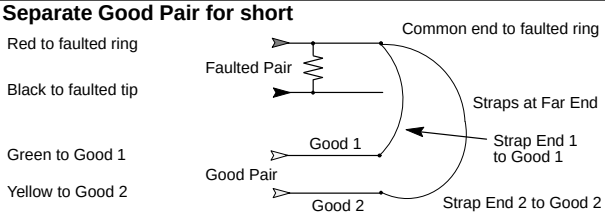
These examples use the Cable Self Test Circuit, (below). Connect the leads RED to R, BLACK to B, GREEN to G, and YELLOW to Y. In the field, hookups vary with the application. Be sure to hook up the unit as the display screen instructs.



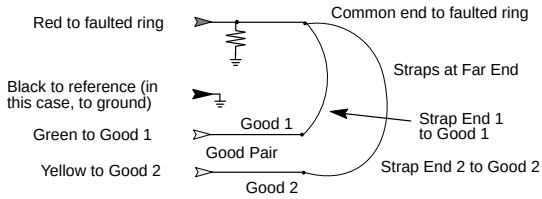
Cable Self Test Circuit

Examples of Possible RFL Hookups:

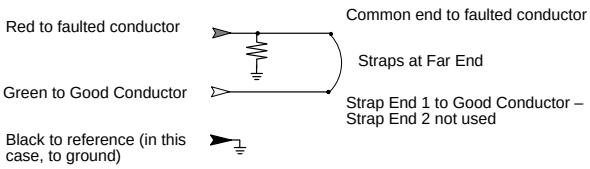
Separate Good Pair for short



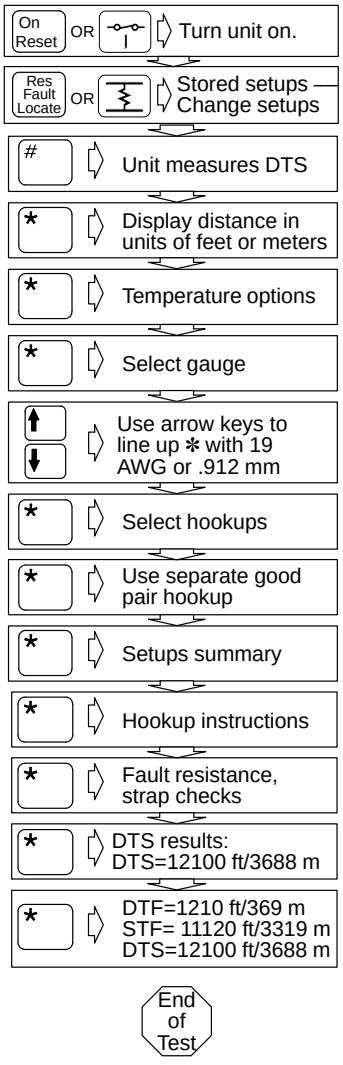
Separate Good Pair for ground or battery cross



Single Pair for ground or battery cross



RFL Example 1 – Unit Measures DTS



Disregard this step if the unit is on.

For this example, press the ✻ (star key) to use the temperature default (21°C or 70°F)

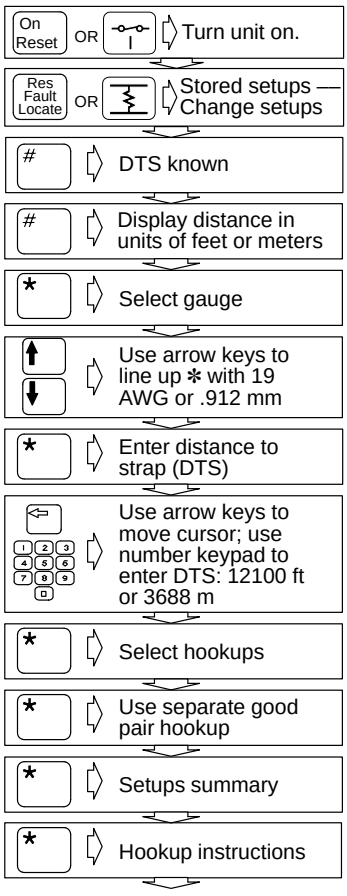
For this example, use 19 AWG or .912 mm

The display summarizes the setups you just entered.

In the field, use the arrow keys to view all the hookup instructions.

The numbers displayed may vary due to variations in the resistors in the Cable Self Test Circuit. See page 85 for limits.

RFL Example 2 – DTS Known (Compute Temperature)



Disregard this step if the unit is on.

Always check the setups. Press the ✻ (star key) to use the stored setups if they are correct.

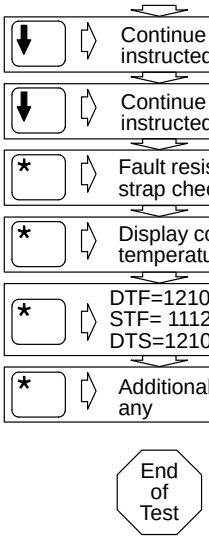
For this example, use 19 AWG or .912 mm.

The display summarizes the setups just entered. Press the ✻ (star key) to use them as displayed.

continued on next page...

RFL Example 2, continued

continued from previous page...



In the field, use the arrow keys here to view the rest of the instructions and continue making the hookup.

The display may tell you "wait" while the tests run.

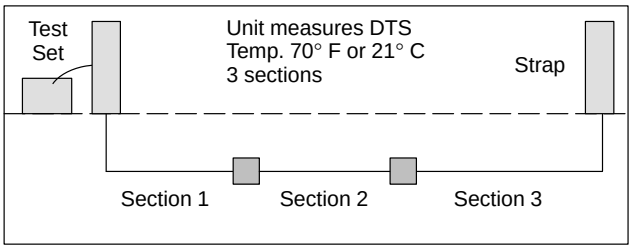
You can press the # (pound key) to repeat the temperature calculation.

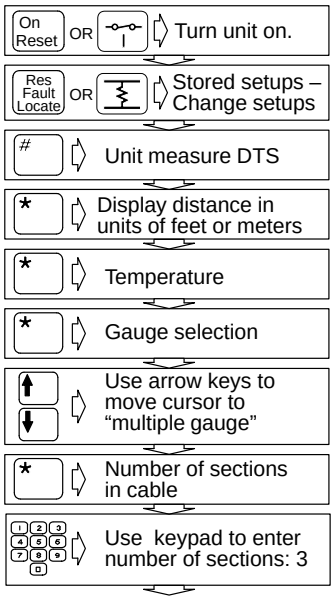
The numbers displayed may vary due to variations in the resistors in the Cable Self Test Circuit. See page 85 for limits.

You can press the # (pound key) to repeat the test.

RFL Example 3
Fault Locate – Multiple Gauge

1. Set up the unit for the locate:





Press the ✻ (star key) to use the stored setups if they are correct.

For this example, press the ✻ (star key) to use the temperature default (21° C or 70° F)

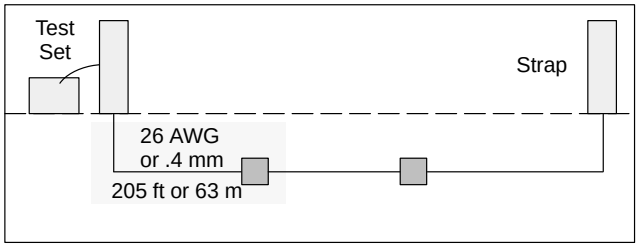
For this example, use three sections.

continued on next page...

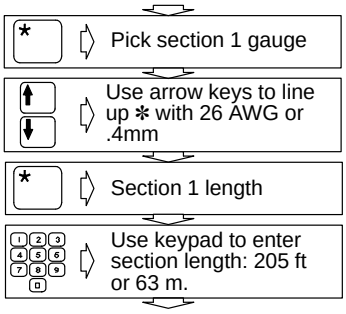
Res.Flt.Loc.

RFL Example 3, continued
Fault Locate – Multiple Gauge

2. Set up for the first section:



continued from previous page...

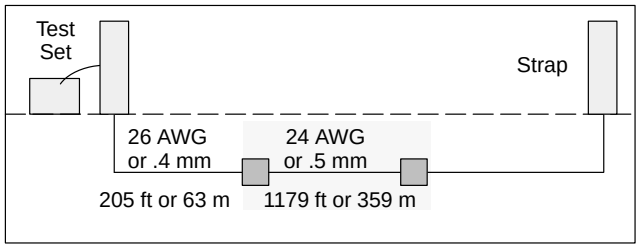


For this example, use 26 AWG or .4 mm.

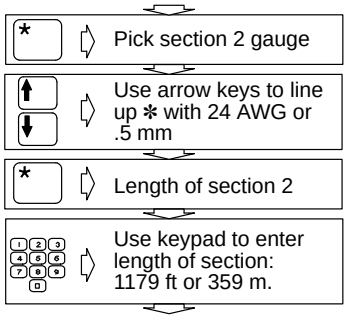
continued on next page...

RFL Example 3, continued
Fault Locate – Multiple Gauge

3. Set up for the second section:



continued from previous page...

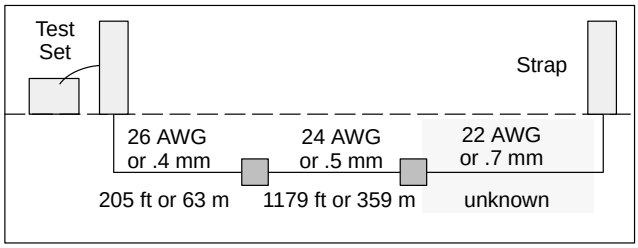


For this example, use 24 AWG or .5 mm.

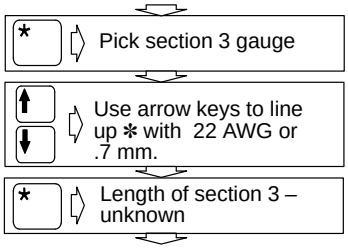
continued on next page...

RFL Example 3, continued
Fault Locate – Multiple Gauge

4. Set up for the third section:



continued from previous page...



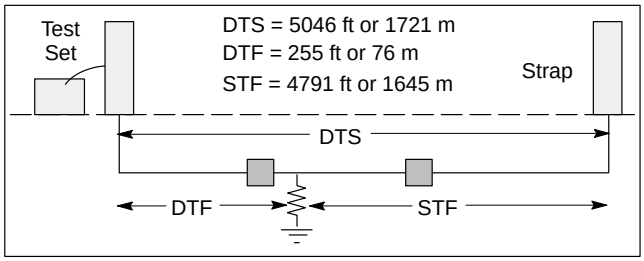
For this example, use 22 AWG or .7 mm.

*On multiple gauge fault locate, one section must be entered as "**unknown**," even if you know it.*

continued on next page...

RFL Example 3, continued
Fault Locate – Multiple Gauge

5. Hookup and measurement:



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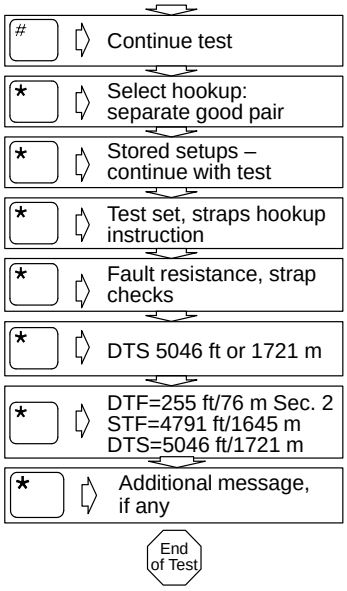


The stored setups display should say "multiple gauge."

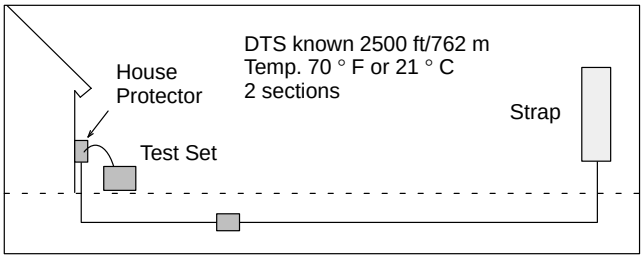
In the field, use the arrow keys here to view the rest of the instructions and continue making the hookup.

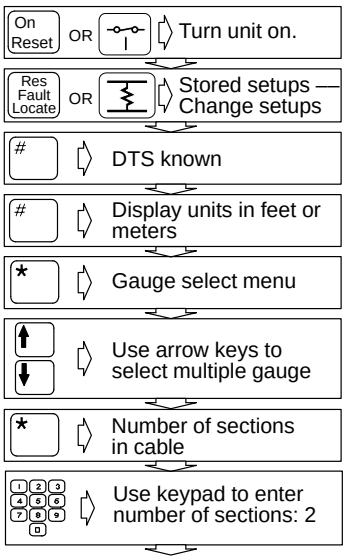
In this example, the display shows that the fault is in section 2.

The numbers displayed may vary due to variations in the resistors in the Cable Self Test Circuit. See page 85 for limits.

RFL Example 4
Splice Locate – Multiple Gauge

1. Set up the unit for the locate:



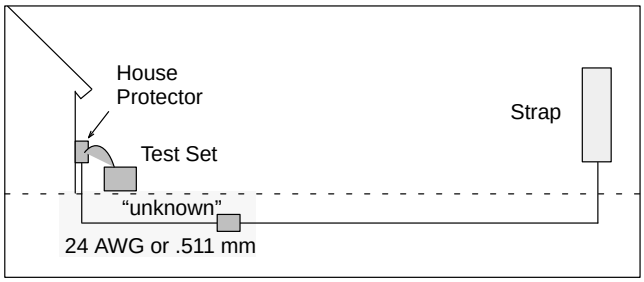


For splice locate, you must use only two sections.

continued on next page...

RFL Example 4, continued
Splice Locate – Multiple Gauge

2. Set up for the first section:



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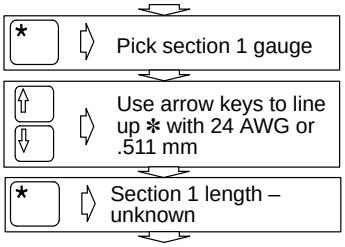
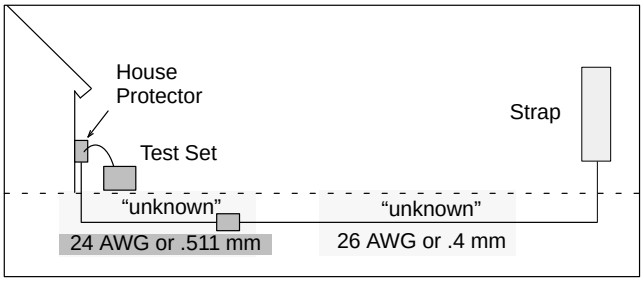


For this example, use 24 AWG or .511 mm.

continued on next page...

RFL Example 4, continued
Splice Locate – Multiple Gauge

3. Set up the next section:



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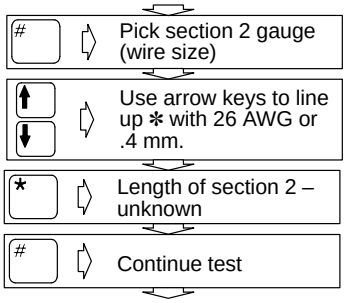
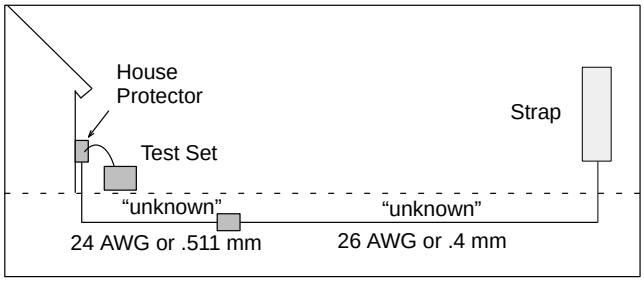


For this example, use 26 AWG or .4 mm.

continued on next page...

RFL Example 4, continued
Splice Locate – Multiple Gauge

4. Complete the setups:



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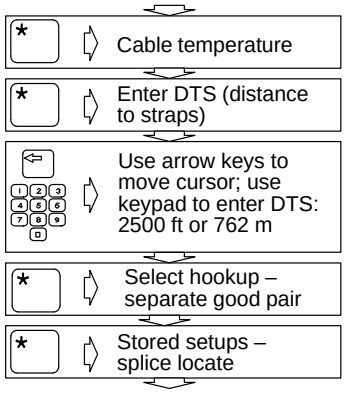


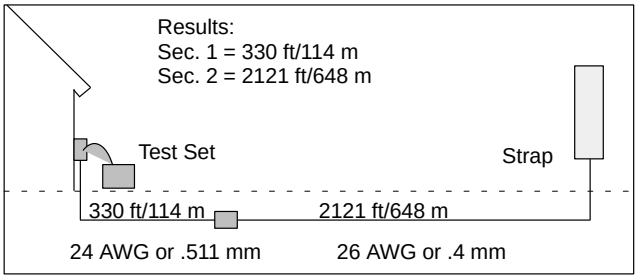
Use the default, 21° C or 70° F , for this example.

Use the arrow keys to see the rest of the setups.

continued on next page...

RFL Example 4, continued
Splice Locate – Multiple Gauge

5. Hookup and measurement:



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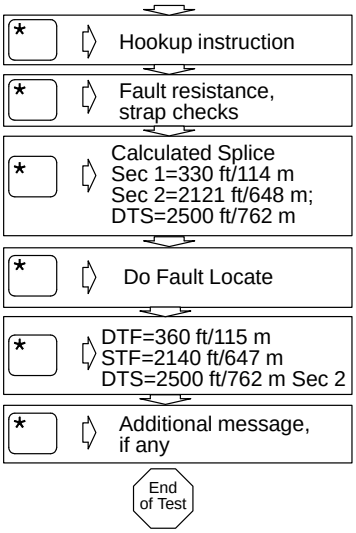


In the field, you would use the arrow keys here to view the rest of the instructions and continue making the hookup as instructed.

The numbers displayed may vary due to variations in the resistors in the Cable Self Test Circuit. See page 85 for limits.

In this example, the display shows that the fault is in section 2.

Notes on RFL

The set computes a measurement accuracy value based on the set accuracy, hookup, cable length and fault resistance magnitude. Depending on this value, the set may tell you to move closer and measure. Move the set and straps to a point on the cable near the fault and re-test. Look for similar faults on other pairs.

Leakage resistance between the reference lead and the good pair or good conductor affects fault location measurement accuracy. Test the good conductor/pair for leakage faults (results displayed prior to strap checks between red and black), and use them only if the fault magnitude is more than 500 times the magnitude of the faulted conductor.

The "good conductor" used in **separate good pair hookup** mode does not have to match the length and gauge of the faulted pair. However, in **single pair hookup** mode, fault location accuracy depends on the "good conductor" being the same length, gauge, and preferably in the same pair or cable group. For example, if the good conductor is shorter than the faulted conductor, or is a larger wire diameter than the faulted conductor, the test set will give erroneous fault location results. In a case like this, if the actual fault was near the strap end, the test set could show a fault location beyond the strap end with a negative distance to fault.

During distance or temperature measurements, if the test set encounters excessive AC power line influence, metallic noise, or high fault resistance, it displays information with the following message that allows you to complete the measurement operation:

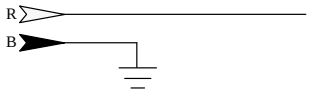
AC DETECTED
XXXX NULL
*** PUSH # TO STOP**

In this case, the measurement time can be up to two minutes longer than normal while the test set attempts to complete the measurements. You can stop the measurement any time after the "PUSH # TO STOP" message appears, but the results are more accurate in most cases if you wait as long as practical before manually stopping the measurement (by pressing the # (pound) key).

Tone

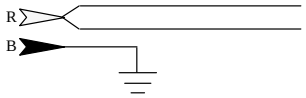
Hookup: *For pair identification:*

RED to the CONDUCTOR
TO BE IDENTIFIED
BLACK to GROUND
GREEN not used



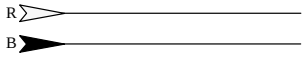
For louder tone (dead pairs only):

RED to TIP and RING
BLACK to GROUND
GREEN not used



Hookup: *For loss or gain/slope measurements:*

RED to RING
BLACK to TIP
GREEN not used



About the Tone Function

The tone function provides tone for pair identification. The unit can send tone for two hours before automatic shut-off.

With the **TONE** key, you can apply precision tone to the cable for loss measurements. With the 965/965M, you can also apply tone of any **user-entered** frequency and amplitude for loss or gain/slope measurements.

For the specific tone output of your test set, see Section Three, “Specifications.”

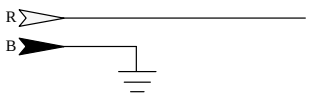
Caution

If hazardous voltage warnings are displayed when the test set is switched on or reset (or at any time during the testing procedure) follow standard procedures for de-energizing and discharging cables.

Tone

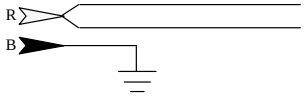
Hookup: *For pair identification:*

RED to the CONDUCTOR
TO BE IDENTIFIED
BLACK to GROUND
GREEN not used



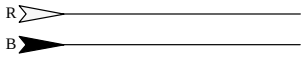
For louder tone (dead pairs only):

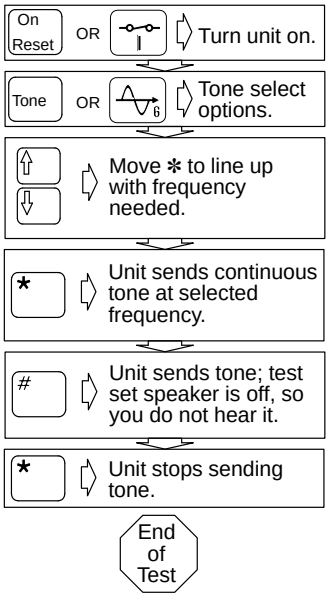
RED to TIP and RING
BLACK to GROUND
GREEN not used



Hookup: *For loss or gain/slope measurements:*

RED to RING
BLACK to TIP
GREEN not used





Disregard this step if the unit is on.

You can select tone for loss and gain/slope tests. After entering your selection, press the ✻ (star key) to send continuous tone. With the 965/965M only, you can select user entry and type in the frequency and amplitude.

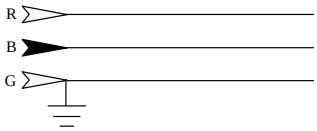
If you choose an ID tone, you can choose to send interrupted tone by pressing the ✻ (star key), or continuous tone by pressing the # (pound key). Interrupted mode makes tone more distinctive for use with an amplifier while identifying pairs on a cable.

Loud tone on the speaker indicates complete loops and loops less than 500 ohms. Soft tone indicates loops of greater than 500 ohms.

Opens

Hookup:

RED to RING
BLACK to TIP
GREEN to GROUNDED SHIELD



About the Opens Test

Use the **OPENS** key to detect and measure the distance to an open, partial open or "dirty" open. You can also measure pair length; distance to a split due to an improper splice; and detect bridge taps, water in the cable, and detect and count load coils*.

Note: *See Section 1, para. 3.8 on page 6 to program custom cable characteristics using the AUTO CAL key. See Section 4 "Care and Maintenance" for instructions on how to check the OPENS performance.*

The test set has two Opens functions: normal and special. Use the special mode on cables shorter than 10,000 feet for opens with resistance faults, crossed battery, or high noise. The special mode does not read through load coils. Add 10% to the measured mutual length for the distance to the first load coil.

Caution

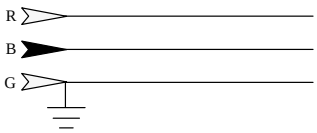
If hazardous voltage warnings are displayed when the test set is switched on or reset (or at any time during the testing procedure) follow standard procedures for de-energizing and discharging cables.

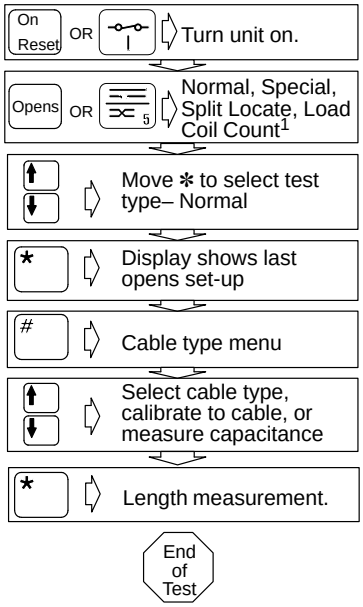
** Early software versions of the 900/900M Series test sets are not equipped to count load coils. To determine if your set is equipped to do load coil counts, press the* **OPENS** *key. If the set is so equipped, the menu includes a "load coil count" option.*

Opens

Hookup:

RED to RING
BLACK to TIP
GREEN to GROUNDED SHIELD





Disregard this step if the unit is on.

Both Normal and Special modes operate the same. For this example, select Normal mode.

You can measure the cable capacitance, or measure to the open using one of five standard cable profiles, or calibrate to cable. Use the AUTO CAL key to set up CUSTOM CABLE (see Sec. 1). For this example, select aircore cable.

Press the ✻ (star key) to switch the display between tip, ring and mutual measurements. Mutual is not used for locating opens.

***Note:** An "overrange" message on the display means the pair is longer than the unit can measure, or the resistance fault is too heavy. Try the special mode to locate the open, or use the* **OHMS** *key to verify.*

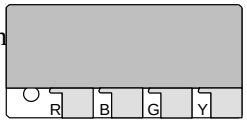
[1] Early software versions of the 900/900M Series test sets are not equipped to count load coils. To determine if your set is equipped to do load coil counts, press the **OPENS** *key. If the set is so equipped, the menu includes a "load coil count" option. See Section 2 of this manual "Special Applications" for more information on load coils, and an example of the load coil count procedure.*

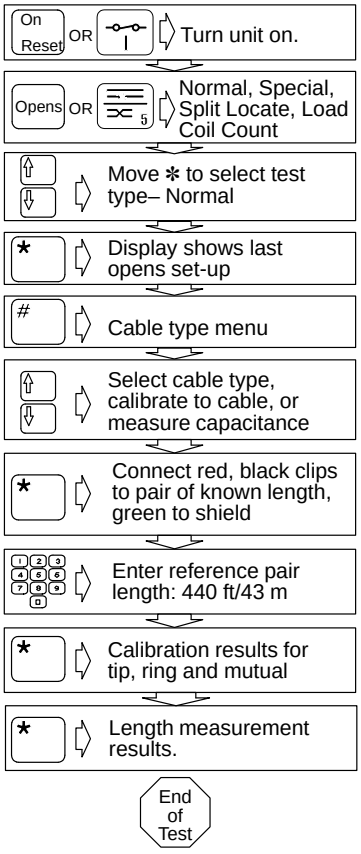
Opens Example: Calibrate to Cable

The unit is calibrated for cables of standard capacitance. For greatest measurement accuracy, use the "calibrate to cable" option.

Opens

For this example, connect the leads to the Cable Self Test Circuit (shown here) RED to R and BLACK to B **only**.





Disregard this step if the unit is on.

Both Normal and Special modes operate the same. For this example, select Normal mode.

For this example, select calibrate to cable.

For this example, connect the red and black leads only to the Cable Self Test Circuit (see above).

Use arrow keys to move cursor.

Record these results for custom cable programming in the Auto-Cal function.

The results are now stored under the "Use Calibration" option in the cable type menu. Press the ✻ (star key) to switch the display between tip, ring and mutual. Mutual is not used for locating opens.

Limits of Opens Functions: Normal Mode and Special Mode		
	Normal	**Special**
Partial Opens:	>15K ohms	15K–1200 ohms
Dirty Opens:	>15K ohms	15K–1200 ohms
Total Cable Distance, if Loaded:	100,000 ft or 30480 m	3000 ft/914 m (*from CO)* 6000 ft/1829 m *(between loads)*
Total Cable Distance, Non-loaded:	100,000 ft or 30480 m	10,000 ft or 3048 m
Load Coils[1]:	Reads through	Reads to within 10% of the first

[1] *Early software versions of the 900/900M Series test sets are not equipped to count load coils. To determine if your set is equipped to do load coil counts, press the* **OPENS** *key. If the set is so equipped, the menu includes a "load coil count" option.*

Note: *In order to successfully locate an OPEN, partial OPEN, or dirty OPEN, the test set operator must have a good knowledge of the cable plant (splice points, load coil locations, access points, etc.). This will help in section analysis (see page 61). Voltage, Capacitance and Resistance measurements along with isolation techniques, are a must for cable fault location.*

Splits

Hook-up: *As instructed on the unit's display screen – varies by application, see p. 46*

About the Splits Test

Use "LOCATE SPLIT" in the OPENS function to locate splits of two or more pairs open at both ends of the section. The pairs must have **NO** opens, shorts, grounds, or battery crosses. You must know the length of the cable section. The pair capacitance must be balanced (see hookup examples for balance check following the flowchart.)

When a pair has been "corrected" by splitting the pairs back at a different location, excessive crosstalk may result. To correct the original split and the "correcting" split, use the "far-end to split" measurement to get the distance between the splits. Then get between the two splits, disconnect the wires, and measure to the splits using the simple splits hook-up to remeasure one split in each direction.

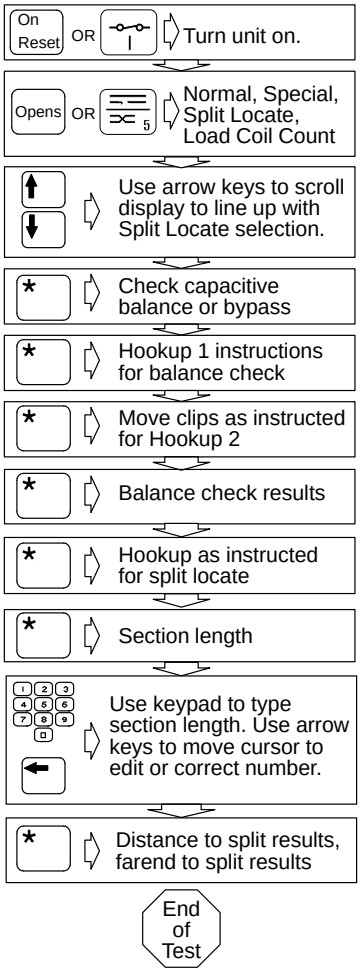
Note: *Splits can only occur at splice points. It is recommended to test for a split from both ends of the section, then average the distances and open the splice point closest to this average.*

Caution

If hazardous voltage warnings are displayed when the test set is switched on or reset (or at any time during the testing procedure) follow standard procedures for de-energizing and discharging cables.

Splits

Hook-up: *As instructed on the unit's display screen – varies by application, see p. 46*



Disregard this step if the unit is on.

See examples on the next page for Hookup 1 and 2.

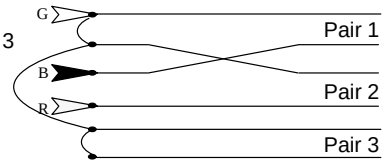
If capacitance balance is poor, press the ✻ (star key) to determine which conductor causes the imbalance. Correct the problem before continuing the test.

Example Splits Hookups

Capacitive Balance Check

Hookup 1:

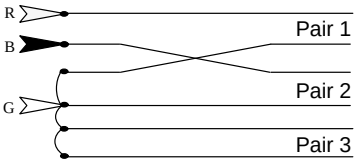
GREEN to PAIR 1
shorted to PAIR 3
BLACK to SPLIT 2
RED to GOOD 2



Hookup 2:

RED to GOOD 1
BLACK to SPLIT 1

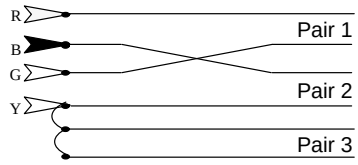
GREEN to PAIR 2
shorted to PAIR 3



Split Locate Hookup

Hookup:

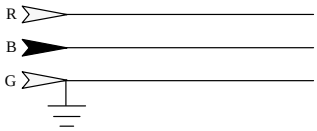
RED to GOOD 1
BLACK to SPLIT 1
GREEN to SPLIT 2
YELLOW to GOOD 2
shorted to PAIR 3



AC Line Test

Hookup:

RED to RING
BLACK to TIP
GREEN to GROUNDED SHIELD



About the AC Line Test

Use **AC LINE TEST** to automatically evaluate a working pair. You can measure slope with a step-tone generator or a 3M brand 1020B test line or other equipment that performs two-way loss measurement (not available in the 945/945M). Use the appropriate blue keys to verify results before taking corrective action.

To be sure you can dial to the farend test lines, learn about the unit's **LOSS** and **NOISE** functions (found in this section of the manual) before running **AC LINE TEST**.

Attach the leads as shown, then turn the unit on.

At the end of the test, 900-T-series units have the option of storing the results for later retrieval in the terminal mode (for more information, see the Terminal Emulation manual for your unit).

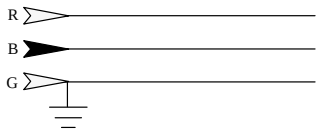
Caution

If hazardous voltage warnings are displayed when the test set is switched on or reset (or at any time during the testing procedure) follow standard procedures for de-energizing and discharging cables.

AC Line Test

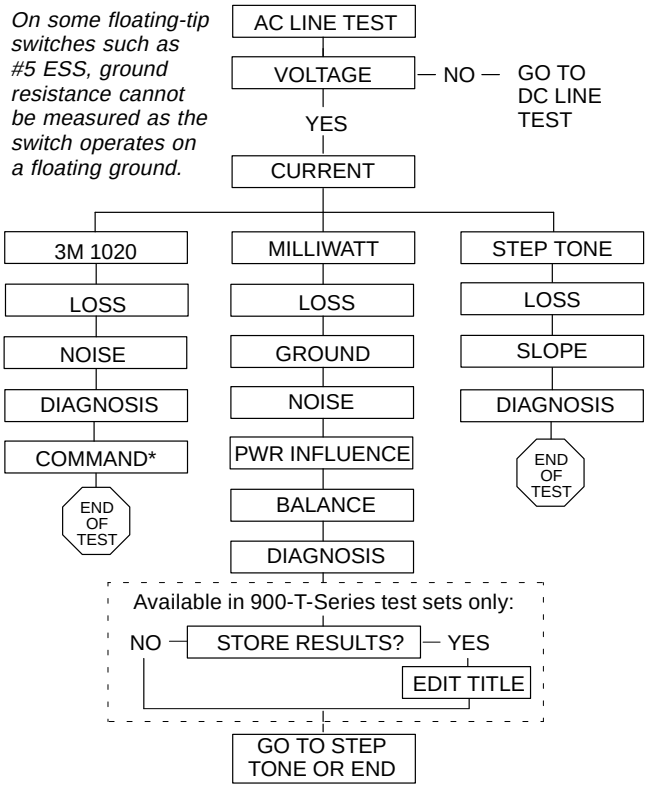
Hookup:

RED to RING
BLACK to TIP
GREEN to GROUNDED SHIELD



Note: *This chart shows the tests in order as they run for each of three testline types in a typical AC Line Test. The test and diagnostics may differ for your application.*

On some floating-tip switches such as #5 ESS, ground resistance cannot be measured as the switch operates on a floating ground.

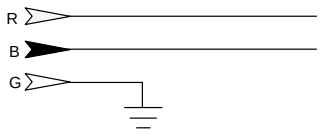


*See 3M 1020B Operators Manual for instructions.

Ringers

Hookup:

RED to RING
BLACK to TIP
GREEN to GROUND



About the Ringers Test

Use the RINGERS key to count the ringer equivalences and display bell circuit wiring configuration at the subscriber premises, based on a type 5200 telephone having a 1.0 ringer equivalence, and to check for the presence of a maintenance test unit (MTU) at the subscriber premises.

To count ringers on a pair, connect at the subscriber protector, remove cable plant and press the RINGERS key. The 900/900M Series test set shows ringer wire configuration as bridged, wired tip, or wired ring. Exceptions to these wiring configurations are numerous and we do not attempt to list them.

Note: *Resistance faults, as well as capacitive imbalance, can cause false readings such as "RESISTANCE TOO LOW" or "INVALID RINGERS HOOKUP."*

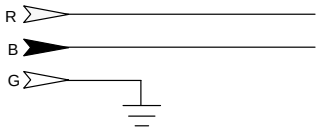
Caution

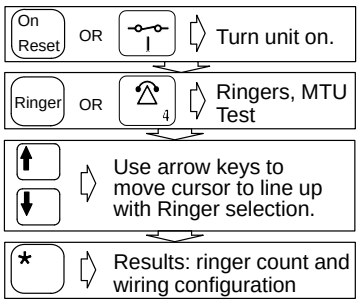
If hazardous voltage warnings are displayed when the test set is switched on or reset (or at any time during the testing procedure) follow standard procedures for de-energizing and discharging cables.

Ringers

Hookup:

RED to RING
BLACK to TIP
GREEN to GROUND





Disregard this step if the unit is on.

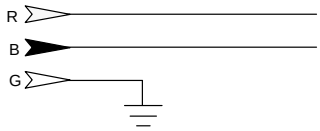
You can select MTU Test to check for the presence of a maintenance test unit at the subscriber premises.

"PLEASE WAIT" until the results appear.

REG

Hookup:

RED to RING
BLACK to TIP
GREEN to GROUND



About the REG Test

Use the **REG** key to detect loop extenders, Range Extenders With Gain (REGs) or Dial Long Line (DLL) adapters in long subscriber loops.

The unit displays two-way loop resistance; it also indicates internal resistance of C.O. wiring, coils and battery as C.O. resistance measurements.

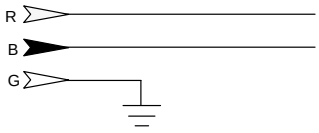
Caution

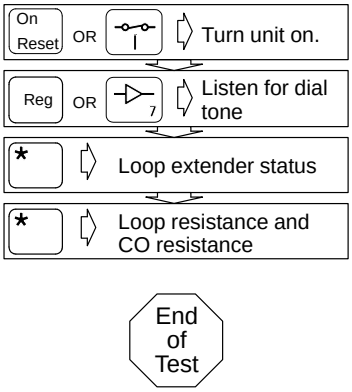
If hazardous voltage warnings are displayed when the test set is switched on or reset (or at any time during the testing procedure) follow standard procedures for de-energizing and discharging cables.

REG

Hookup:

RED to RING
BLACK to TIP
GREEN to GROUND





Disregard this step if the unit is on.

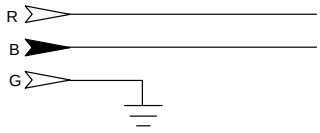
The C.O. Switch type identifies the tip-to-ground on-hook resistance; if there are unusual line cards, select 'unknown' C.O. type then enter the tip-to-ground on-hook resistance. You can measure the resistance in the C.O. directly on the frame by using the **OHMS** *key.*

Note: *On some floating-tip switches such as #5 ESS, ground resistance cannot be measured as the switch operates on a floating ground.*

Loss

Hookup:

RED to RING
BLACK to TIP
GREEN to GROUND



About the Loss Test

Use the **LOSS** key to measure attenuation in subscriber loops. The unit calls up a milliwatt or step-tone generator and measures and displays test tone frequency and loss.

Note: *If the milliwatt number dials to a combination line (10 seconds of milliwatt tone followed by quiet line), you can press the* **NOISE** *key after the loss measurement to perform a noise test and power influence calculation on this line.*

The 900/900M Series test set can also measure loss from a tone source on a vacant pair.

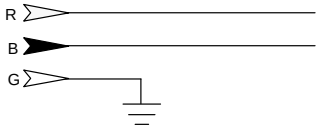
Caution

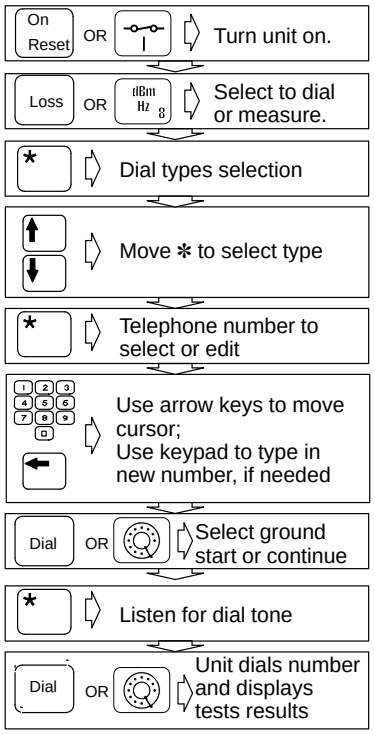
If hazardous voltage warnings are displayed when the test set is switched on or reset (or at any time during the testing procedure) follow standard procedures for de-energizing and discharging cables.

Loss

Hookup:

RED to RING
BLACK to TIP
GREEN to GROUND





Disregard this step if the unit is on.

You can press the # (pound key) to bypass the dial routine.

The unit measures voltage on the line. If the display shows "VOLTAGE LOW," as on a vacant pair, you can press the ✻ (star key) to measure loss from a tone source connected at the far end.

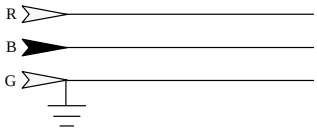
You can hear the unit dialing the number, testline going off-hook, and the test tones.

Note: *If the milliwatt number dials to a combination line (10 seconds of milliwatt tone followed by quiet line), you can press the* **NOISE** *key after the loss measurement to perform a noise test and power influence calculation on this line.*

Noise

Hookup:

RED to RING
BLACK to TIP
GREEN to GROUNDED SHIELD



About the Noise Test

Use the **NOISE** key to dial to a quiet line and measure unwanted signal in subscriber loops. The unit displays noise metallic, power influence (noise to ground), and calculated balance. Some units are equipped to measure longitudinal balance* with the Noise routine.

The 900/900M Series test sets can also measure noise, power influence and calculate balance on a vacant pair. The far end should be terminated with a 600-ohm balance termination for this process.

Note: *If your test set is equipped with an optional backlight, you must turn it off for the noise test. The activated backlight affects the line noise test results.*

Caution

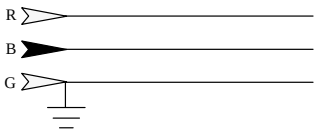
If hazardous voltage warnings are displayed when the test set is switched on or reset (or at any time during the testing procedure) follow standard procedures for de-energizing and discharging cables.

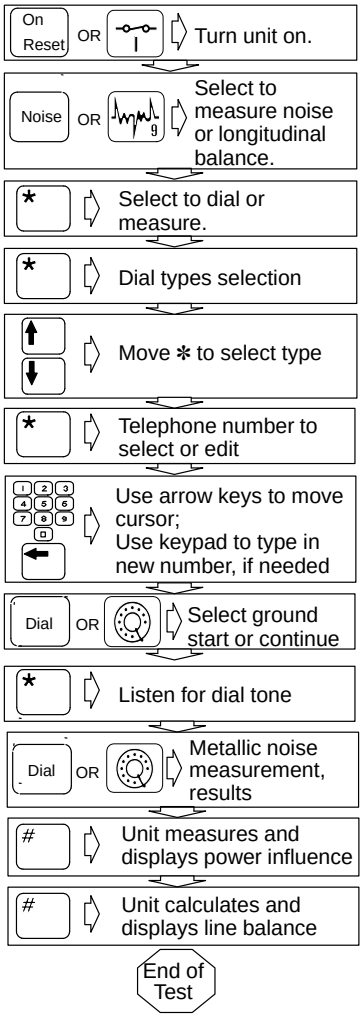
**Longitudinal balance test in accordance with ANSI/IEEE standard 455–1985.*

Noise

Hookup:

RED to RING
BLACK to TIP
GREEN to GROUNDED SHIELD





Disregard this step if the unit is on.

You can press the # (pound key) to measure longitudinal balance.

You can press the # (pound key) to bypass the dial routine.

The unit measures voltage on the line. If the display shows "VOLTAGE LOW," as on a vacant pair, you can press the ✻ (star key) to measure noise with a balance termination connected at the far end.

For access code, dial the number manually.

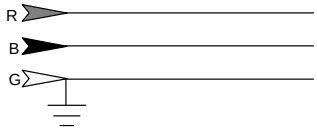
Press DIAL key when you hear dial tone.

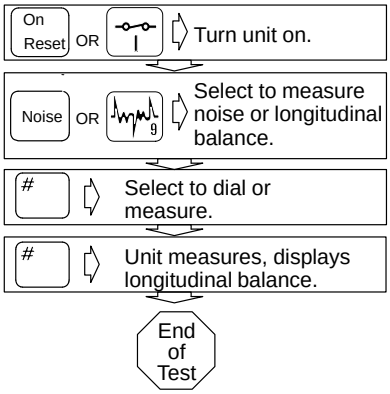
Unit dials number, begins measurement when quiet line connects.

Noise Routine – Measure Longitudinal Balance[1]

Hookup:

RED to RING
BLACK to TIP
GREEN to GROUNDED SHIELD





Disregard this step if the unit is on.

You can press the # (pound key) to measure longitudinal balance.

*You can press the * (star key) to use the dial function.*

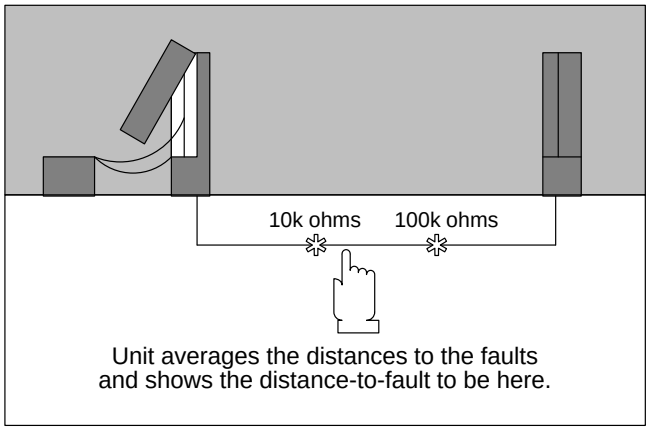
The unit measures longitudinal balance and displays the results. The results are continuously updated on the screen.

[1] *Longitudinal balance test in accordance with ANSI/IEEE standard 455–1985.*

Special Applications

1. Multiple Resistance Faults

1.1 For resistance faults at more than one location on a pair, the resistance fault locate operation gives a distance to the average of the fault locations. For example, if a 3000 ft/914 m cable has one 10k ohm fault at 1000 ft/304 m and a 100k ohm fault at 2000 ft/610 m, the unit should show a 9.09k ohms fault at about 1091 ft/333 m (the average), or just past the major fault.



2. Water In Cable - Resistance Faulted Pair

2.1 Where water in the cable causes a resistance fault, the unit measures to the middle of the wet section, or the average of the total resistance faults. Use the following procedure to estimate the length of cable damaged by water:

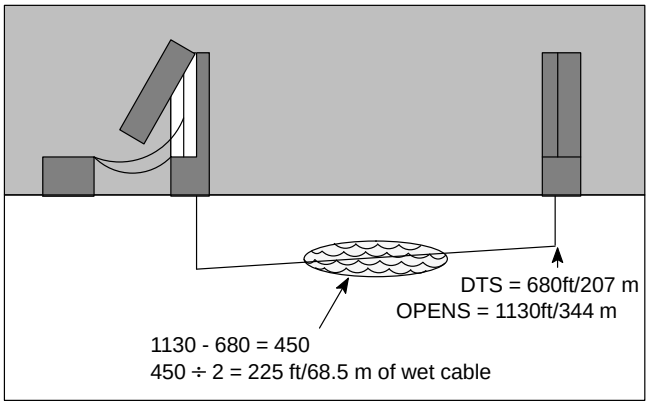
a. Measure the length of the cable (DTS) with the RFL function.

b. Measure the tip or ring length of the cable again, using the OPENS function.

c. The equivalent length of water in the cable is the OPENS measured length minus DTS measured length divided by two.

Example:

DTS reading = 680 ft/207 m
OPENS reading = 1130 ft/344 m
length of wet cable = $\frac{(1130-680)}{2}$ = 225 ft/68.5 m



Water in Cable - Resistance Faulted Pair

3. Section Analysis

3.1 To analyze a section of cable, first use the **RESISTANCE FAULT LOCATE** function to measure as many resistance faults as you can in the section. Next, use the OPENS key to measure to as many open faults in the section as possible, then refer to the chart below:

Pattern of Symptoms	Look for:
Several light faults with mostly ring-battery crosses with tips clear.	Water in the cable at some location other than a splice or encapsulation.
Several high resistance troubles with shorts, crosses and grounds on both tip and ring with some tips open.	Water in a splice case or encapsulation.
Both solid and light troubles with some conductors shorted and some open; many faults.	Physical damage to the cable due to stakes, trenches, construction, etc.

4. Load Coils

4.1 The electrical length of load coils makes a pair with load coils measure longer than the actual cable length. For example, load coil leads are usually 24 gauge (AWG). If the conductor under test is 19 gauge, a five-foot or 1.5 meter stub adds more than 32 feet or 9 meters to your measurement, plus the electrical length of the coil itself. The total error from each load coil on the pair varies from 91 feet (27 meters) to more than 480 feet, depending on the conductor gauge and the coil. The table below lists the amount to subtract from your measurement for each load coil, based on a five-foot stub at the default temperature (70° F or 21.1° C).

Electrical Length (Feet/meters) of Coil and Stub*

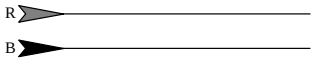
Code	19 AWG	22 AWG	24 AWG	26 AWG	Ohms
632	470/143	235/72	147/45	91/28	4.14
652	484/147	242/74	150/46	94/29	4.17
662	480/146	240/73	149/45	95/29	4.25

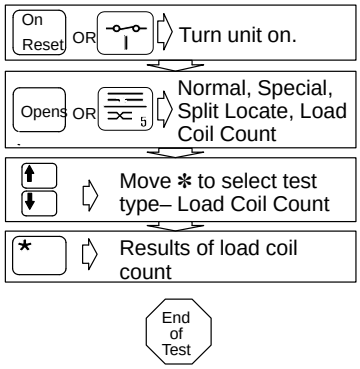
* Calculated for two five-foot 24 AWG stubs at 70° F.

Counting Load Coils[1]

Hookup:

RED to RING
BLACK to TIP





Disregard this step if the unit is on.

The load coil count takes 1.5 minutes to complete. When the unit displays the results, you can press the ✻ (star) key to repeat the test.

[1] Early software versions of the 900 Series/900M Series test sets are not equipped to count load coils. To determine if your set is equipped to do load coil counts, press the **OPENS** *key. If the set is so equipped, the menu includes a "load coil count" option.*

5. Locating Opens by Ratio Quick Reference

Step 1 – Setup:

- Disconnect the open conductor at both ends
- Determine the length of the section under test and record as measurement "D."

Step 2 – Hookup:

- Red – open conductor
- Black and green – shield or other conductor

Step 3 – Measure from near end:

- Press the ON/RESET key, then the OPENS key and select NORMAL MODE
- Press the # (pound) key and select AIRCORE CABLE
- Record the RING measurement as "A."

Step 4 – Measure from far end:

- Repeat Step 3 from the far end.
- Record the RING measurement as "B."

Step 5 – Calculate:

If C = A + B and D = section length, use this formula to calculate distance to open from end A or B:

$$d = \frac{(A \text{ or } B) \times D}{C}$$

Example:

If A = 240ft, B = 110ft, and D = 290ft,
then C = A + B = 240 + 110 = 350ft
distance to open from end B:

$$d = \frac{B \times D}{C} = \frac{110 \times 290}{350} = 91.14 \text{ ft}$$

6. Locating Open Shield

Step 1 – Setup:

- Disconnect shield bond to isolate the shield at both ends.
- Determine the length of the section under test and record as measurement "D."

Step 2 – Hookup:

- Red – shield
- Black and green – ground rod; or when induction is interfering, connect to several bunched vacant pairs.

Step 3 – Measure from near end:

- Press the ON/RESET key, then the OPENS key and select SPECIAL MODE.
- Press the # (pound) key and select AIRCORE CABLE.
- Record the RING measurement as "A."

Step 4 – Measure from far end:

- Repeat Step 3 from the far end.
- Record the RING measurement as "B."

Step 5 – Calculate:

If C = A + B and D = section length, use this formula to calculate distance to open from end A or B:

$$d = \frac{(A \text{ or } B) \times D}{C}$$

Example:

If A = 73.2 m, B = 33.5 m, amd D = 88.4 m, then C = A + B = 73.2 + 33.5 = 106.7 m
distance to open from end A:

$$d = \frac{A \times D}{C} = \frac{73.2 \times 88.4}{106.7} = 60.6 \text{ m}$$

7. Temperature Conversion

7.1 With a resistance measurement, you can get the equivalent length in feet for a different temperature, using the following procedure.

1. Press [ON Reset] to turn unit on.
2. Press [Ohms to Dist.].
3. Select SET TEMPERATURE using [↓] [↑] keys. Press [*].
4. Enter temperature to convert. Press [*].
5. Select DISTANCE TO OHMS using [↓] [↑] keys; press [*].
6. Enter length to convert. Press [#].
7. Select gauge to convert using [↓] [↑] keys. Press [*].
8. Press [ON Reset].
9. Press [Ohms to Dist.].
10. Select SET TEMPERATURE using [↓] [↑] keys. Press [*].
11. Enter conversion temperature. Press [*].
12. Select OHMS TO DISTANCE using [↓] [↑] keys. Press [*].
13. Display shows converted temperature and footage.

Example:

500 feet of 24 gauge at 50° to convert to 95°.

Complete steps 1, 2, and 3.

For step 4, enter temperature as 50, and press [*].

Complete step 5.

For step 6, enter 500 feet, and press [*].

Complete steps 7 to 10.

For step 11, enter temperature as 95 and press [*].

Complete step 12.

Step 13 shows converted length 454 feet at 95°.

Specifications

1. 955/955M Combination Fault Locator

A. Measurements

Function	Range	Resolution	Accuracy
AC Voltage:	0 to 75 VAC 75 to 250 VAC	0.1V 1.0V	0.7V 3%
DC Voltage:	0 to 100 VDC 100 to 350 VDC	0.1V 1.0V	0.5V 3%
DC Current:	0 to 100 mA DC (Zin = 430 ohms)	0.1 mA	0.3 mA
Resistance[1]:	0 to 100 Mohms	100 ohms @ 50 kohms	1% @ 50 kohms
Opens[1]:(normal mode)			
	0 to 9.99 kft	10 ft @ 10 kft	±1%
	10 k ft to 100 kft	100 ft	+1/–10%
	0 to 30000 m	3 m @ 500 m	1.5 m ±1% @ 500 m

Tolerance to Leakage,
Normal Mode: >15 kohm to ground / 190 kohm to battery

Opens[1]:(special mode)			
	0 to 999 ft	1 ft	±1%
	1 kft to 10 kft	100 ft @ 10 kft	+1/–10%
	0 to 30000 m	3 m @ 500 m	6m ±1% @ 500 m

Tolerance to Leakage,
Special Mode: >1200 ohms to ground / 18 kohms to battery

Note: [1] Perform a self-calibration before taking the readings.

B. Resistance Fault Locate

Note: *Accuracy is dependent on power influence noise; the resistance fault specifications are for low noise situations.*

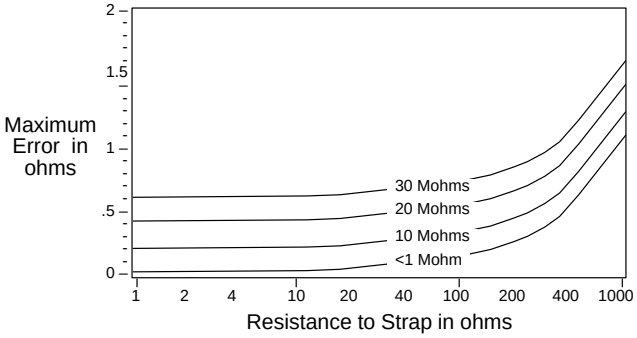
Function	Range	Resolution	Accuracy[1,2]
Fault Range:	Up to 30 Mohms		
Resistance to Fault:[2]	0 to 9 ohms	0.01 Ohm	±0.1% RTS
(@ 70° F no noise)			±0.01 Ohm
	10 to 99 ohms	0.01 Ohm	±0.1% RTS
			±0.01 Ohm
	100 to 999 ohms	0.1 Ohm	±0.2% RTS
	1k to 7 kohms	1.0 Ohm	±1.0% RTS
Resistance to Distance Conversion Resolution:[3]	1 ft to 1,000 ft	0.1 ft	
	1k ft to 10k ft	1.0 ft	

	10k ft to 100k ft	10.0 ft	
	1 to 99 m	0.1 m	
	100 to 999 m	1.0 m	
	1000 to 30000 m	10.0 m	
Temperature Sensor:	0° to 140° F	1° F	±2° F
	–18° to 60° C	.5° C	±1° C
Noise Immunity:	7 VAC limit for all frequencies		

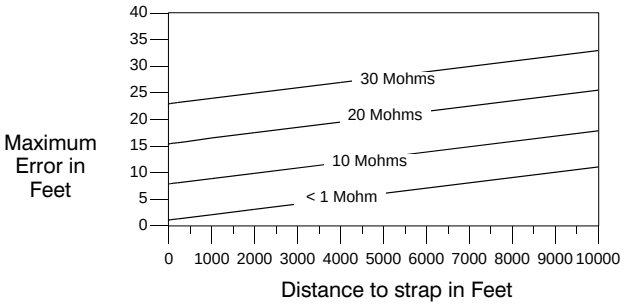
Note: [1] See figures below for accuracies. All resistance to fault measurement accuracies have an added factor of (2×10^{-8}) RF ohms.

[2] Single pair hook-up measurement accuracy is strictly dependent on whether the reference pair is exactly the same electrical length as the faulted pair. Accuracies are doubled for single pair hook-up.

[3] Accuracy depends on correct temperature setting as well as gauge accuracy of copper. The temperature can be read by the built-in sensor or can be operator-entered.



Accuracy in ohms for Various Fault Resistances



Accuracy for 24 Gauge for Various Fault Resistances

C. Outputs

Tones	Frequency	Level	Impedance
Identification:	577.5 Hz	6V PK to PK	100 ohms (Current limited to 6 mA)
Precision Tones:	1004 ±1 Hz	0 dBm ± 0.2 dB	600 Ohm

Harmonic distortion: <45 dB (up to 10th harmonic)

D. Environment

	Operation	Storage
Temperature:	0° to +140° F	–40° to 165° F
	–18° to 60° C	–40° to 74° C
Humidity:	0 to 100% (condensing)	0 to 100% (condensing)
Altitude:	0 to 15,000 ft 0 to 5000 m	0 to 40,000 ft 0 to 12000 m
Shock:	Can withstand a drop onto a wood surface from a distance of four ft (1.25 m)	

E. Dimensions

Height	7.0 in/ 18 cm
Width	10.5 in/ 27 cm
Depth	7.5 in/ 19 cm
Weight	7.5 lbs/ 3.4 kg
Cord length	5 ft/ 1.5 m

F. Battery Power

The operating time between battery change-out or charges depends on temperature of set and operation modes used.

For non-rechargeable batteries typical operating time is about 200 hours between battery change-out.

For rechargeable batteries typical operating time is about 80 hours between charges.

2. 945/945M Subscriber Loop Tester

A. Measurements

Function	Range	Resolution	Accuracy
AC Voltage:	0 to 75 VAC 75 to 250 VAC	0.1V 1.0V	0.7V 3%
DC Voltage:	0 to 100 VDC 100 to 350 VDC	0.1V 1.0V	0.5V 3%
DC Current:	0 to 110 mA DC (Zin = 430 ohms)	0.1 mA	0.3 mA
Resistance[1]:	0 to 100 Mohms	100 ohms @ 50 kohms	1% @ 50 kohms
Loss:	–40 to +10 dBm (Zin = 600 ohms)	0.1 dB 200 to 5,000 Hz	0.2 dB
Noise Metallic[2]:	10 to 50 dBrnC 0 to 10 dBrnC (Zin = 600 ohms)	0.1 dB 0.3 dB	0.5 dB 2.0 dB
Noise to Ground:	40 to 100 dBrnC (Zin = 600 ohms)	0.1 dB	0.5 dB
Opens[1]:(normal mode)			
	0 to 9.99 kft 10k ft to 100 kft 0 to 30000 m	10 ft @ 10 kft 100 ft 3 m @ 500 m	±1% +1/–10% 1.5 m ±1% @ 500 m
Tolerance to Leakage, Normal Mode:	>15 kohm to ground / 190 kohm to battery		
Opens[1]:(special mode)			
	0 to 999 ft 1 kft to 10 kft 0 to 30000 m	1 ft 100 ft @ 10 kft 3 m @ 500 m	±1% +1/–10% 6m ±1% @ 500 m
Tolerance to Leakage, Special Mode:	>1200 ohms to ground/18 kohms to battery		
Frequency Measurement:	20 to 20,000 Hz during Loss, single frequency only	1 Hz	2 Hz
Ground Resistance:	0 to 500 ohms	1 Ohm	3 ohms
Loop and C.O. Resistance:	0 to 5000 ohms	1 Ohm	±10% + 50 ohms

(read through the REG key assuming on-hook resistance is known)

Note: [1] Perform a self-calibration before taking the readings.
[2] C-message specifications have an additional frequency-dependent tolerance. Refer to “IEEE Standard 743–1984.” The 945/945M far exceeds these tolerances. For most frequencies the total error is less than 0.7 dB.

B. Outputs

Tones	Frequency	Level	Impedance
Identification:	577.5 Hz	6V PK to PK	100 ohms (Current limited to 6 mA)
Precision Tones:	1004 ±1 Hz	0 dBm ± 0.2 dB	600 Ohm

Harmonic distortion: <45 dB (up to 10th harmonic)

Dial	Frequency	Remarks
DTMF:	Standard	100 msec on 100 msec off meets CCITT Q.23 Standard for frequency and amplitude i.e. ±1 Hz @ –10 dBm ±1 dB
Dial Pulse:	10 pulses per sec	60 msec break 40 msec make 600 msec between digits

C. Environment

	Operation	Storage
Temperature:	0° to +140° F	–40° to 165° F
	–18° to 60° C	–40° to 74° C
Humidity:	0 to 100% (condensing)	0 to 100% (condensing)
Altitude:	0 to 15,000 ft 0 to 5000 m	0 to 40,000 ft 0 to 12000 m
Shock:	Can withstand a drop onto a wood surface from a distance of four feet (1.25 m)	

D. Dimensions

Height	7.0 in/ 18 cm
Width	10.5 in/ 27 cm
Depth	7.5 in/ 19 cm
Weight	7.5 lbs/ 3.4 kg
Cord length	5 ft/ 1.5 m

E. Battery Power

The operating time between battery change-out or charges depends on temperature of set and operation modes used.

For non-rechargeable batteries typical operating time is about 200 hours between battery change-out.

For rechargeable batteries typical operating time is about 80 hours between charges.

3. 965/965M Subscriber Loop Analyzer

A. Measurements

Function	Range	Resolution	Accuracy
AC Voltage:	0 to 75 VAC 75 to 250 VAC	0.1V 1.0V	0.7V 3%
DC Voltage:	0 to 100 VDC 100 to 350 VDC	0.1V 1.0V	0.5V 3%
DC Current:	0 to 100 mA DC (Zin = 430 ohms)	0.1 mA	0.3 mA
Resistance[1]:	0 to 100 Mohms	100 ohms @ 50 kohms	1% @ 50 kohms
Loss:	–40 to +10 dBm (Zin = 600 ohms)	0.1 dB 0.2 dB 200 to 5,000 Hz	
Noise Metallic[2]:	10 to 50 dBrnC 0 to 10 dBrnC (Zin = 600 ohms)	0.1 dB 0.3 dB	0.5 dB 2.0 dB
Noise to Ground:	40 to 100 dBrnC (Zin = 600 ohms)	0.1 dB	0.5 dB
Longitudinal Balance with Tone Option[3]:	62 to 51 dB 51 to 40 dB	0.1 dB 0.1 dB	2.0 dB 1.0 dB
Opens[1]:(normal mode)			
	0 to 9.99 kft 10k ft to 100k ft 0 to 30000 m	10 ft @ 10 kft 100 ft 3 m @ 500 m	±1% +1/–10% 1.5 m ±1% @ 500 m
Tolerance to Leakage, Normal Mode:	>15 kohm to ground / 190kohm to battery		
Opens[1]:(special mode)			
	0 to 999 ft 1 kft to 10 kft 0 to 30000 m	1 ft 100 ft @ 10 kft 3 m @ 500 m	±1% +1/–10% 6m ±1% @ 500 m
Tolerance to Leakage, Special Mode:	>1200 ohms to ground / 18 kohms to battery		
Frequency Measurement: (during Loss, single frequency only)	20 to 20,000 Hz	1 Hz	2 Hz

Measurements continued...

Function	Range	Resolution	Accuracy
Ground Resistance:	0 to 500 ohms	1 Ohm	3 ohms
Loop and C.O. Resistance:	0 to 5000 ohms	1 Ohm	±10% + 50 ohms

(read through the REG key assuming on-hook resistance is known)

Caller I.D. Option: –4 dBm to –32 dBm

Note:
1. Perform a self-calibration before taking the readings.
2. C-message specifications have an additional frequency-dependent tolerance. Refer to "IEEE Standard 743-1984." The 965/965M far exceeds these tolerances. For most frequencies the total error is less than 0.7 dB.
3. The optional longitudinal balance function obtains a result in agreement with "IEEE STANDARD 455-1985 Standard Test Prodedure for Measuring Longitudinal Balance for Telephone Equipment Operating in the Voice Band" at the specified tolerance for power influence less than approximately 80 dBrnc. When power influence is above 80 dBrnc, the test set reverts to a hybrid of the IEEE method and the method of calculating longitudinal balance by taking the difference between power influence and noise metallic.
4. The splits function does not have accuracy tolerances.

B. Resistance Fault Locate

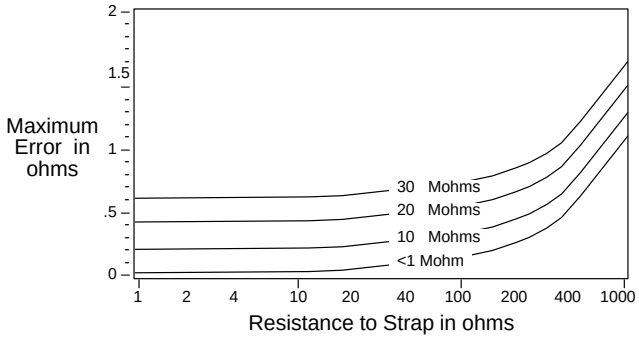
Note: *Accuracy is dependent on power influence noise; the resistance fault specifications are for low noise situations.*

Function	Range	Resolution	Accuracy[1,2]
Fault Range:	Up to 30 Mohms		
Resistance to Fault:[3]	0 to 9 ohms	0.01 Ohm	±0.1% RTS ±0.01 Ohm
(@ 70° no noise)	10 to 99 ohms	0.01 Ohm	±0.1% RTS ±0.01 Ohm
	100 to 999 ohms	0.1 Ohm	±0.2% RTS
	1k to 7 kohms	1.0 Ohm	±1.0% RTS
Resistance to Distance Conversion Resolution:[3]	1 ft to 1,000 ft	0.1 ft	
	1k ft to 10k ft	1.0 ft	
	10k ft to 100k ft	10.0 ft	
	1 to 99 m	0.1 m	
	100 to 999 m	1.0 m	
	1000 to 30000 m	10.0 m	
Temperature Sensor:	0° to 140° F	1° F	±2° F
	–18° to 60° C	.5° C	+1° C
Noise Immunity:	7VAC limit for all frequencies		

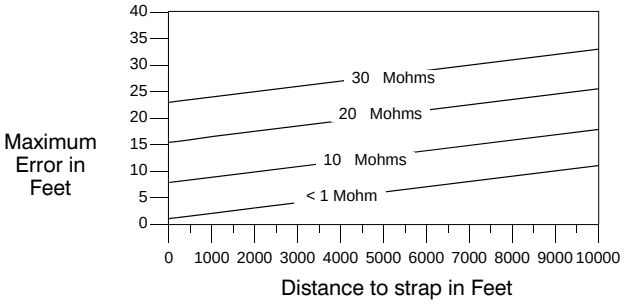
Note: [1] See figures next page for accuracies. All resistance to fault measurement accuracies have an added factor of (2 x 10 $^{-8}$) RF ohms.

[2] Single pair hookup measurement accuracy is strictly dependent on whether the reference pair is exactly the same electrical length as the faulted pair. Accuracies are doubled for single pair hookup.

[3] Accuracy depends on correct temperature setting as well as gauge accuracy of copper. The temperature can be read by the built-in sensor or can be operator-entered.



Accuracy in ohms for Various Fault Resistances



Accuracy for 24 Gauge for Various Fault Resistances

C. Outputs

Tones	Frequency	Level	Impedance
Identification:	577.5 Hz	6V PK to PK	100 ohms (Current limited to 6 mA)
Precision Tones:	404, 1004, 2804 ±1 Hz	0 dBm ± 0.2 dB	600 Ohm

Harmonic distortion: <45 dB (up to 10th harmonic)

User-Entered Tone:

Frequency Range	Resolution	Frequency Accuracy	Amplitude Accuracy
2 to 100 Hz	±0.1%	±1%	±1dB
100 to 1 kHz	±1.0%	±1%	±1dB
1 kHz to 10 kHz	±3.0%	±1%	±1dB
10 kHz to 20 kHz	±3.0%	±1%	±3dB

Harmonic distortion: <45 dB (up to 10th harmonic)

Dial	Frequency		Remarks
DTMF:	Standard		100 msec on 100 msec off

meets CCITT Q.23 Standard for frequency and amplitude
i.e. ±1 Hz @ –10 dBm ±1 dB

Dial Pulse:	10 pulses per sec	60 msec break 40 msec make 600 msec between digits	R–T

D. Environment

	Operation	Storage
Temperature:	0° to +140° F	–40° to 165° F
	–18° to 60° C	–40° to 74° C
Humidity:	0 to 100% (condensing)	0 to 100% (condensing)
Altitude:	0 to 15,000 ft 0 to 5000 m	0 to 40,000 ft 0 to 12000 m
Shock:	Can withstand a drop onto a wood surface from a distance of four ft (1.25 m)	

E. Dimensions

Height	7.0 in/ 18 cm
Width	10.5 in/ 27 cm
Depth	7.5 in/ 19 cm
Weight	7.5 lbs/ 3.4 kg
Cord length	5 ft/ 1.5 m

F. Battery Power

The operating time between battery change-out or charges depends on temperature of set and operation modes used.

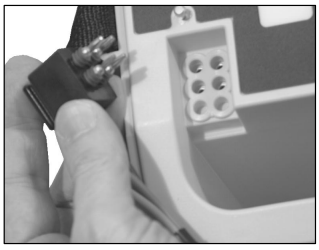
For non-rechargeable batteries typical operating time is about 200 hours between battery change-out.

For rechargeable batteries typical operating time is about 80 hours between charges.

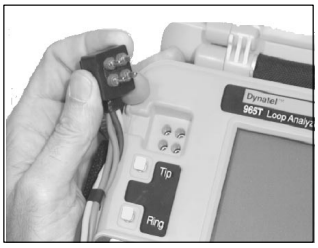
Care & Maintenance

1. TEST LEAD AND BATTERY INSTALLATION INSTRUCTIONS

Step 1 Insert the test lead plug into the top four holes.



900 /900M Series Test Set



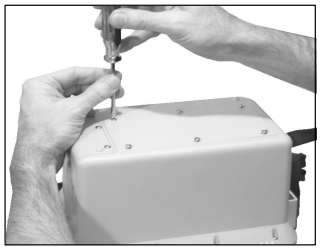
900-T-Series Test Set

Step 2 Press down firmly. Test leads are now installed.

900 /900M Series Test Set

900-T-Series Test Set

Step 3 Invert case and remove the battery cover by loosening the six screws with a flat-blade screwdriver.



Step 4 Install batteries, matching the polarity markings (+ and –) on the batteries with those in the bottom of the battery box.

Note: *Some models are equipped with battery "sticks" to prevent data interruption in the units. Do not separate the batteries.*

Step 5 Replace the battery cover. Turn the unit on. The message "**PLEASE IDENTIFY BATTERIES USED**" appears. Press the # (pound key) or * (star key) to identify battery type, then press the **AUTO CAL** key and run self calibration.

Note: *When installing new rechargeable batteries, or to compensate for weak rechargeable batteries, use the internal battery charger to overcharge the cells (18 hours, maximum). Follow the instructions on the display to connect the leads to an external 12-volt source, such as a Dynatel Model 1658 or 1678 battery charger kit. Turn the unit on. Press the AUTO-CAL key. Use the arrow keys to select the "CHARGE BATTERY" function, and press the * (star key). Press the # (pound key) to select the overcharge function, and press the * (star key) to activate the charging process. The unit turns off automatically when charging is complete.*

2. BATTERY MAINTENANCE

2.1 Rechargeable batteries last longer when properly recharged. The unit keeps track of power usage, displays an estimate of the battery charge, and displays a message prompting you to charge the batteries at the correct time.

Battery Types and Capacity Table		
	ALKALINE	**NICKEL-CADMIUM***
QUANTITY	5	5
SIZE	"C" CELLS	"C" CELLS
NEDA NUMBER	14A	
ORDER NUMBER	26-0000-4787-3	26-1006-2163-5
"BATT OK"	>6 VOLTS	>6 VOLTS
"BATT LOW"	5.9 – 5.75 VOLTS	5.9 – 5.75 VOLTS
SOFTWARE SHUTDOWN	<5.75 VOLTS	<5.75 VOLTS
RECHARGEABLE	NO	YES
EXPECTED BATT LIFE (TYPICAL USE): NEW/100% CHARGE**	6 WEEKS	2 WEEKS
"CHARGE BATTERIES TONIGHT, PLEASE:"		1 DAY

***** *Zinc-carbon cells are not recommended, as they have lower capacity and they may leak.*

****** *Typical use is considered four hours per day of power ON in the Voltage mode.*

2.2 When the unit displays **"BATTERIES NEED CHARGE *,"** you cannot use the unit without recharging or replacing the batteries. Press the [*] (star key) as prompted to put the unit in charge mode.

Caution

Promptly remove discharged alkaline batteries from the unit; they can leak and damage the contacts. Damage of this kind voids your warranty.

2.3 Damaged nickel-cadmium batteries can make the battery status message go quickly from "**CHARGE TONIGHT**" to "**NEED CHARGE.**" If this happens, discharge the batteries as much as possible, then overcharge them with either the internal or an external charger. Repeat this cycle twice.

A. When To Charge Or Replace Batteries

2.4 The unit displays an estimate of battery charge: voltage for alkaline batteries and percent of power used for rechargeable batteries. The unit also displays "**CHARGE BATTERIES**" to prompt you to recharge the batteries (if rechargeable), or replace them with either alkaline dry cells or a spare set of rechargeable batteries.

2.5 With the batteries removed, the unit can retain stored telephone numbers up to three minutes. After ten minutes without battery power, stored numbers are lost. When you install a freshly-charged set of nickel-cadmium batteries, press the **AUTO CAL** key and select the battery identification option. Answer the questions correctly to make the display indicate full charge.

B. Internal Battery Charging

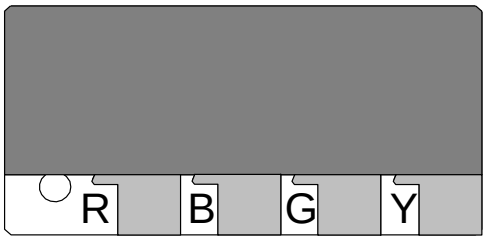
2.6 To use the internal battery charger, follow the instructions on the display to attach the leads to a 12-volt source (e.g., a Dynatel 1678 Battery Charger Kit for one unit, or 1658 for up to three units). Turn the unit on and press the **AUTO CAL** key. Press the * (star key) to select **CHARGE BATTERY**, then press the * (star key) for normal charging or the # (pound key) for overcharging. The unit turns off automatically when charging is complete.

C. External Battery Charging

2.7 If the battery charge gets too low to turn the unit on, take off the battery cover and remove the batteries. Recharge the cells with an external (user-supplied) AC-powered battery charger. Charge the cells at approximately 180 mA for no more than 18 hours.

Important:

Prolonged overcharging (maximum 18 hours) reduces battery life.

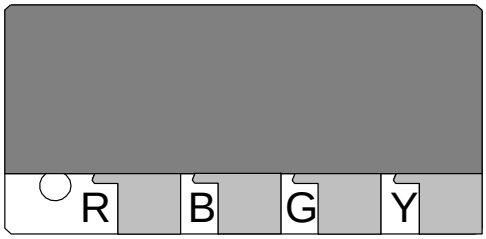


3. CHECK OPENS PERFORMANCE

3.1 To check OPENS performance, use the Cable Self Test Circuit included with your set, shown above. Attach the red lead to terminal "R" and the black lead to terminal "B." Press the **OPENS** key. The results in feet or meters should be in the ranges shown in the table below.

Note: *The test set circuits are more accurate than the Cable Self Test Circuit, so the limits in the table below are wider than in the Specification section.*

Opens Self Test Limits in feet/meters						
Cable Type:		**Capaci-tance**	**Air Core**	**Jelly-Filled**	**2-Pair Drop**	**5-Pair Drop**
Normal Tip or Ring	MIN	9.35 nF	395/120	350/107	320/98	330/101
	MAX	.01065 uF	450/137	400/122	365/111	375/114
Normal Mutual	MIN	9.35 nF	595/181	595/181	595/181	595/181
	MAX	.01065 uF	680/207	680/207	680/207	680/207
Special Tip or Ring	MIN	8.75 nF	370/113	330/101	300/91	310/94
	MAX	.01125 uF	475/145	425/130	385/117	395/120
Special Mutual	MIN	8.75 nF	560/171	560/171	560/171	560/171
	MAX	.01125 uF	715/218	715/218	715/218	715/218



4. CHECK RESISTANCE FAULT LOCATE PERFORMANCE

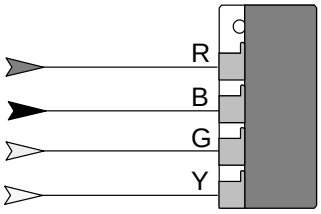
4.1 The Cable Self Test Circuit (above) allows you to test the resistance fault locate function at any time. This test is particularly important when potentially damaging physical conditions such as shock or prolonged submersion could affect performance.

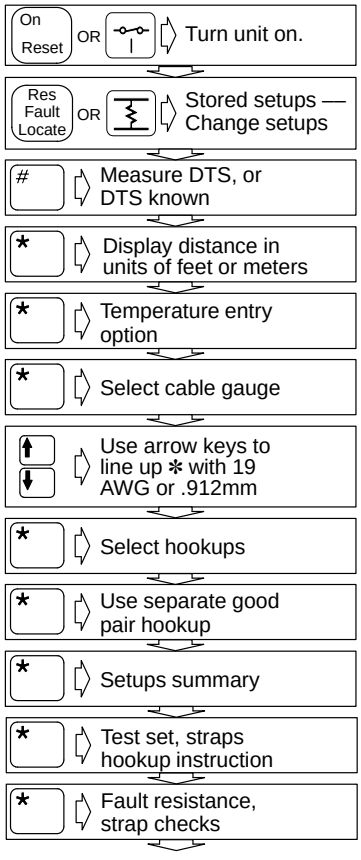
Note: *The test set circuits are more accurate than the Cable Self Test Circuit; therefore, the limits in the tables following the example flowchart are wider than in the Specification section.*

4.2 Connect the test leads to the circuit terminals: red to R, black to B, yellow to Y, and green to G. Press the **RES FAULT LOCATE** key. Use the separate good pair hookup and procedure in the following example. Compare the information in the tables that follow to the results displayed by the unit. If the results fall within the ranges listed, your unit works correctly.

Check RFL Performance Flowchart

Hookup (to Cable Self Test Circuit):





Press the ✻ (star key) to choose Measure DTS

Press the ✻ (star key) to use the temperature default (21.1°C or 70°F)

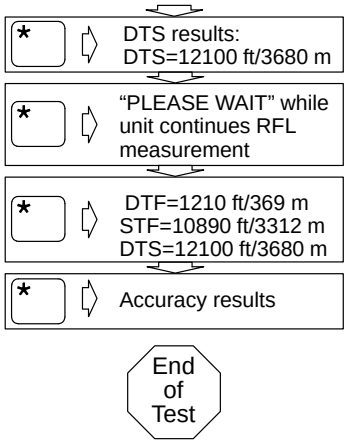
The display summarizes the setups you just entered. Press ✻ to use them.

When you complete the hookup, press ✻ to begin the measurements.

The display may tell you to "wait" while the unit runs tests.

continued on next page...

CHECK RFL FUNCTION, continued



You can press # to repeat the test with the most commonly used cable gauges.

Self Test: Fault Magnitude Straps Check Table		
	Min	**Max**
Fault Resistance:	995k	1M
Strap Checks:		
RED to GREEN	193	207
RED to YELLOW	94	104

English RFL Self Test						
70°F	**DTS**		**DTF**		**STF**	
AWG	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
19 *	11910	12290	1170	1230	10730	11070
22 *	5986	6171	592	613	5393	5559
24 *	3755	3871	371	385	3383	3488
25 *	2970	3063	293	305	2676	2759
26	2347	2420	232	240	2114	2180
28	1479	1526	146	152	1332	1375
Ohms	99.3	102.5	9.8	10.2	89.5	92.3

** Disregard the ‘move closer to fault...’ message for the self-test.*

Metric RFL Self Test								
21.1°C	DTS		DTF		STF			
wire size	min	max	min	max	min	max		
.912	3630 m	3746 m	356 m	375 m	3274 m	3371 m		

Appendix

Generally Accepted Criteria for Plain Old Telephone Service

Parameter	Acceptable	Marginal	Unacceptable
Loop Current mA	≥23[2]	≥20< 23[2]	<20[1, 2]
Circuit loss dBm	≤8.5	–	>8.5
Metallic Noise dBrnC	≤20	>20< 30	≥30
Power Influence dBrnC	≤80	>80<90	≥90
Balance dB	≥60	>50<63	≤50
*Station Ground Ohms	≤25	——	> 25
Slope dB	≤7.5	——	> 7.5

Parameter	Insulation Good	Light Fault (Service Affected)[3]	Heavy Fault (Out of Service)
Insulation Resistance	≥ 3.3 MOhms	>2.8 kOhms < 3.3 MOhms	≤2800 Ohms

1 These are negative values.

2 ≥18 to <20 mA acceptable for emergency service only.

3 Lines having good insulation but equipped with ringer isolators or selective ringing devices will test as having light faults on tip and ring.

NOTE: > means “more than”
≥ means “more than or equal to”
< means “less than”
≤ means “less than or equal to”

* On some floating-tip switches, such as #5 ESS, ground resistance cannot be measured because the switch operates on a floating ground.

Notes on AC line Analysis Procedures

Loop current and circuit loss work together. When loop current approaches –23 mA the circuit loss should be approximately –8.0 dBm. If the loop current is low and the circuit loss is less than –8.0 dBm, the problem is probably a defective loop aid. If the loop current is good and the circuit loss is high, the problem is either bridged tap or incorrect loading. If both loop current and circuit loss are bad, the problem is incorrect resistance zoning. When circuit loss exceeds –8.5 dBm, the actual measured loss should be compared with an estimated measured loss based on loop make–up. If they differ significantly, dial up a step tone generator and make a frequency run to check loading. If both actual and estimated loss exceed –8.5 dBm and are approximately the same, install a VF repeater to decrease the loss.

Noise and Power influence work together. If noise is high and power influence is low, the problem most likely is a defective pair. If power influence is high, the problem is an open shield or missing ground.

For touch dialing problems, dial up a step tone generator and make a frequency run to check for loaded bridge tap.

If in doubt, measure additional pairs. If other pairs are good, your problem is a single bad pair. If other pairs read defective as the one you're working on, the problem is in the cable or complement.

For 2–party lines, a missing ringer isolator at one party causes noise to the other party. Ringer isolators must be placed at both parties.

Unacceptable Balance When noise and power influence are shown as acceptable, but the balance reading is not, such as:

Noise = 19.3 dBrnC (OK)
Power Influence = 68.2 dBrnC (OK)
Balance = 48.9 dBrnC (unacceptable)

The unacceptable balance reading is a clue that there may be noise problems during peak power periods when power

influence will be higher than at the time the service call is made. If noise was the subscriber's complaint, then balance is the cause of problem; if the complaint was not related to noise, the low balance may not be a problem. Noise caused by balance is a common cause of multiple service calls. The noise and power influence levels are more likely to be acceptable at the time of the service call than when the subscriber is at home and using the phone during morning and evening peak power periods. An unacceptable balance reading is the only clue in this situation.

3M

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