HST-3000 VDSL QUICK CARD

RESISTIVE FAULT LOCATION TESTING (RFL)

Revision 9.0
March 2012

Technical Assistance: 1-866-228-3762 TAC@jdsu.com

Resistive Fault Location (RFL) Test

Purpose

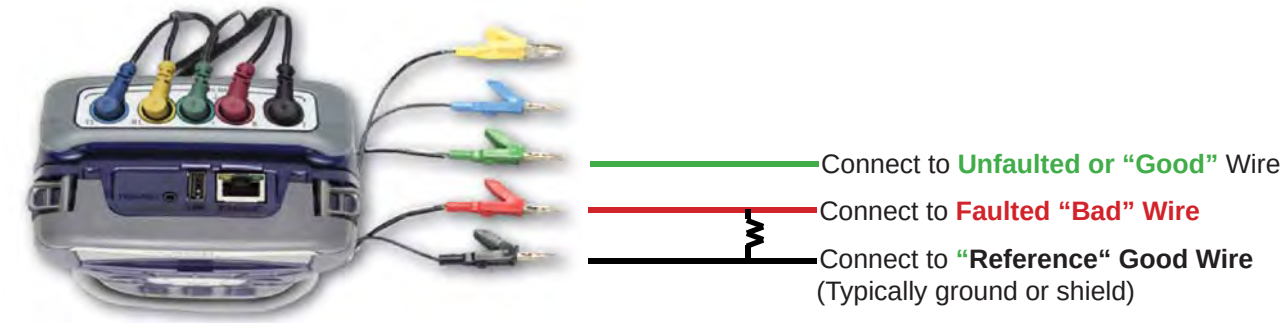
The purpose of this test is to identify and locate resistive fault conditions such as shorts, grounds and battery crosses faults the presence of which may have been indicated by the results of the **ATT_VDSL2_Test** .

How RFL works

A technician places a strap or short from the faulted wire to a good wire or pair and performs RFL using a series of precise resistance (ohmmeter) measurements to accurately determine the resistance to a fault. During this test, the resistance to the strap (short) is determined along with the fault size. After these measurements, both the temperature and gauge of the copper wire are taken into consideration and an ohms-to-feet conversion is performed. The results provide information such as DTF (distance to fault), DTS (distance to strap), and DSTF (distance strap to fault).

The RFL test performed with the HST-3000 (CAT 500 H/W)

When using an HST-3000 for an RFL test, the terms tip, ring, and ground are not used. Instead, the connections are as follows:



For separate pair RFL measurement, the HST-3000 blue test lead and the HST-3000 green test lead are connected to a known "good" pair.

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Resistive Fault Location (RFL) Test

Two Methods for Performing an RFL Test

Separate pair method (CAT 500 H/W)

The separate pair method is preferred because it is the only method that can be used for a double-sided fault (both wires in a pair are faulted). In this case, the user locates a known good pair, or if the distance to the strap is not too long, lays out a separate pair of wires across the ground to use as the known good pair. A strap is placed from each lead of the known good pair to the faulted lead, or the known good pair is strapped together and then strapped to the faulted wire. After these straps are placed, the loop is ready for RFL separate pair testing.

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Resistive Fault Location (RFL) Test

Two Methods for Performing an RFL Test

RFL Test Single Pair Method (CAT 500 H/W)

Single pair testing should be used only if the separate pair method is not an option. This situation occurs when there is no known good pair and if only one side (lead) of the pair under test is faulted. To perform single pair RFL testing, the technician straps the good wire in the pair under test to the faulted (bad) wire. It is important to note that RFL testing takes approximately 30 to 40 seconds. Arrows indicating the paths that are being tested will be displayed on the HST-3000's screen. Once the test is completed, each result will be shown in either ohms or feet.

Temperature and Gauge: The temperature and gauge of the wires must be entered into the HST-3000 before an accurate distance conversion can be performed.

Temperature: As the wires' temperature changes, so does their resistance. For example, the higher the temperature is, the greater the resistance. Because RFL determines the location of the fault through a series of resistance measurements, the accuracy of the distance conversion is skewed in proportion to the difference between the temperature setting and the actual temperature.

Gauge: Gauge affects distance conversion because different gauge wires have different levels of resistance. (See Table 5 below.) The higher the gauge is; the greater the resistance.

Table: 5 - Preferred and Non-Preferred Fault-Finding with a TDR

Measurement	Pass
19 gauge/.8mm	16.09 Ohms/1000 feet (305m)
22 gauge/.6mm	32.4 Ohms/1000 feet (305m)
24 gauge/.4mm	51.32 Ohms/1000 feet (305m)
26 gauge/.4mm	82.01 Ohms/1000 feet (305m)
NOTE[1]: Typical ohms-per-feet/meter values	

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Resistive Fault Location (RFL) Test

Two Methods for Performing an RFL Test

RFL Test Single Pair Method (CAT 500 H/W) (continued)

It is possible to have more than one gauge of wire over the length of the cable. There are different methods for adjusting the temperature and gauge when performing RFL testing on multi-gauge and single gauge cable spans.

Single-Gauge Cable Span: It is easy to adjust the temperature and gauge displayed on the HST-3000's RFL testing screen. Before or after the test is complete, push the **Up Arrow** to raise the temperature and the **Down Arrow** to lower it. Push the **Left Arrow** and **Right Arrow** keys to increase or decrease the gauge of the wire. The HST-3000 automatically recalculates the RFL results to reflect the change.

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Two Methods for Performing an RFL Test

RFL Test Single Pair Method (CAT 500 H/W) (continued)

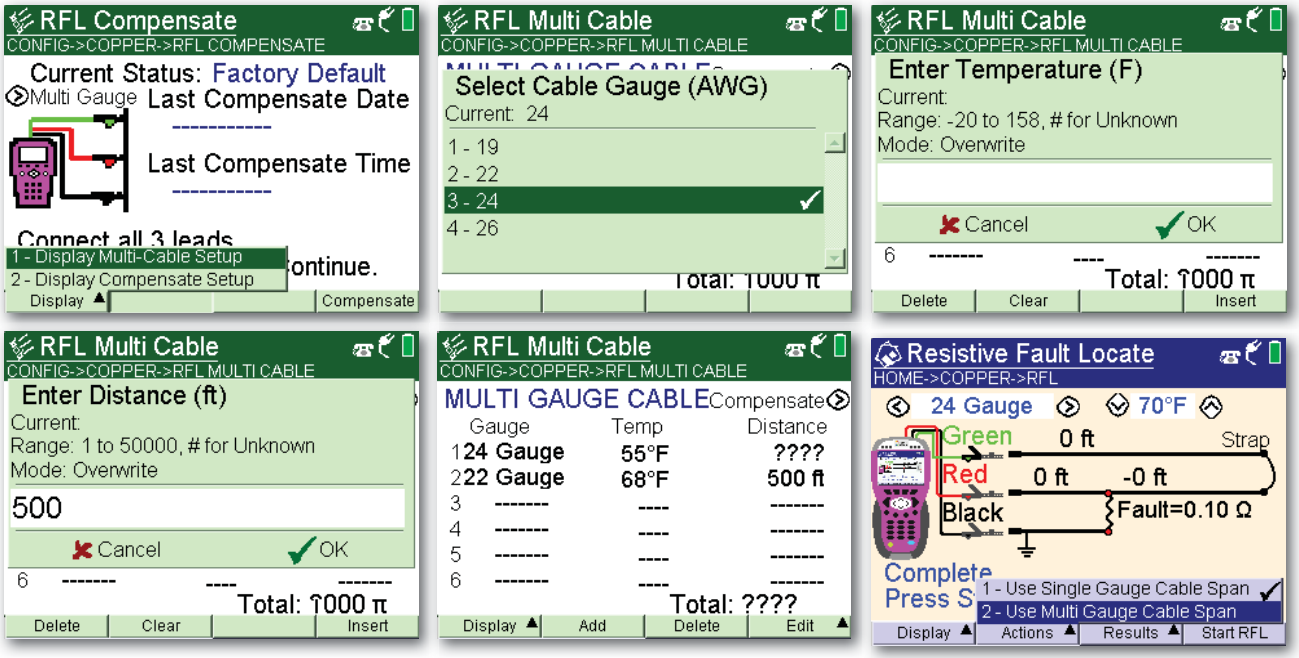
Multi-Gauge Cable Span: Technicians use the multi-gauge setup option to accurately measure a pair containing sections of multiple gauges and/or cable with different temperatures (buried and aerial). Because these variables affect the resistance of the pair, the accuracy of the conversion is also affected. Therefore, the HST-3000 must be configured to closely reflect the true conditions of the pair. The larger the error for cable gauge or temperature is, the greater the impact these variables will have on the accuracy of the measurements.

To prevent any discrepancies that can cause a distance conversion to be inaccurate, enter the gauge, temperature, and distance for each section of cable by following these steps:

1. Press the **Configure** action key
2. Press the **Display** soft key
3. Select "**Display Multi-Cable Setup**"

To add new sections of cable, press the **Add** soft key. When prompted, enter the gauge, temperature, and length of the cable section. If the **Delete** soft key is pressed, it will delete the last section listed. After entering each section of cable is entered, press the **Home** or **Cancel** button. To enter an unknown value for temperature or distance on one section of cable, type #; the HST will calculate the value of this missing field.

4. Press the Actions soft key and select "**Use Multi Gauge Cable Span**"

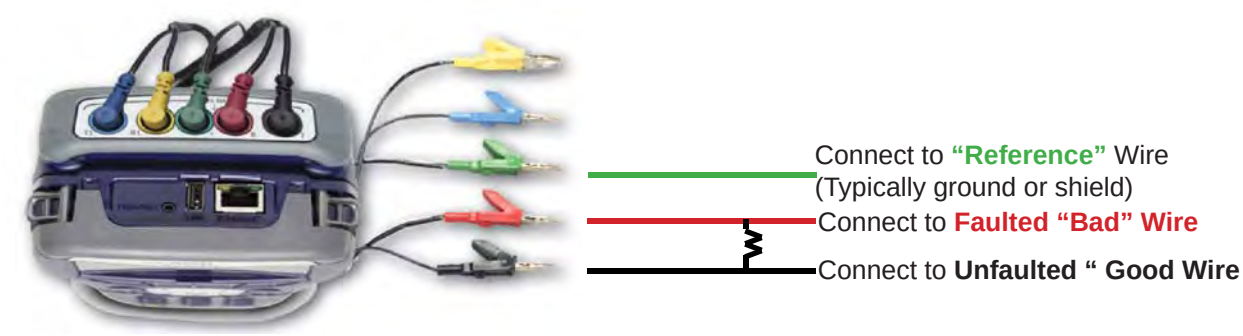


Resistive Fault Location (RFL) Test

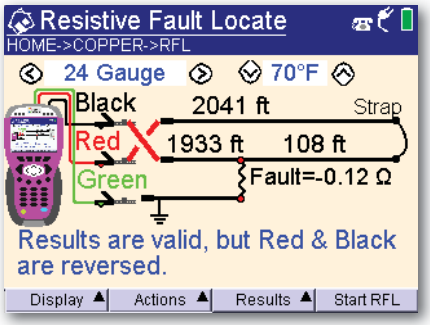
CAT 510 Hardware:

In efforts for continuous improvement, the latest hardware circuit board (CAT 510) adds new RFL functions and features, outlined below.

Green on Ground- Instead of connecting the Green lead to the GOOD wire, Green is connect to Ground for both single pair and separate good pair RFL.



Automatic Lead Reversal: Occasionally, a technician will incorrectly connect the Red or Faulted lead to the Good conductor. When this occurs the RFL test will still display distance to fault results but warn the operator of the incorrect hookup for single good pair RFL.



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RFL Test

Cat 510 Hardware

K-Test

The HST-3000 equipped with the CAT 510 copper board adds an additional RFL test feature called K (Kupfmuller) Test. The K-Test highlights its to locate double sided cable faults when no "good pair" is available. This scenario is common when Pulp or Paper insulated cable is damaged.

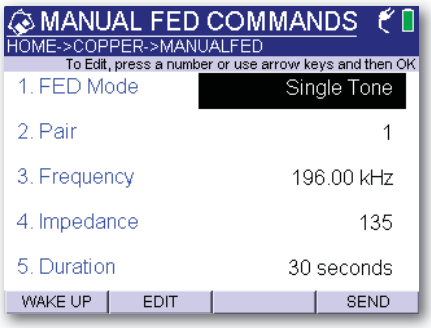
1. The K-Test requires the following criteria:
    a. Will provide accurate results on loops less than 7000 Ohm
    b. Will provide accurate results for common cable faults up to 20 Mega Ohm
    c. The fault ratio between the two faulted conductors must be at least 2:1
    d. The highest fault value must be at least 100 times greater than the loop Ohm
    e. The two faults must occur at the same physical location in the cable
    f. Because the K-Test is a two step process it is most effectively used in conjunction with the UFED.

UltraFED (uFED)

The ULTRA Far End Device (FED) is used as a test aid with other test equipment (such as the JDSU HST-3000c) when performing copper tests. After a technician has connected the FED to the far end of the pair under test and has connected other test set to the near end, the near end equipment controls the FED using DTMF tones to allow two-ended pair testing with a single piece of test equipment.

UFED Functions

- Open All
- Through Mode
- RFL Strap Mode
- Spectral Tone
- Wideband Balance
- Trace Mode
- Tip, Ring, Ground strap
- Tip, Ring Short
- Pair one, Pair Two short
- Quiet Term
- Single Tone
- ADSL2+ Tone sweep
- VDSL2 Tone sweep



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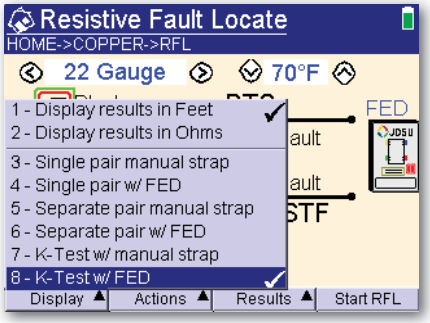
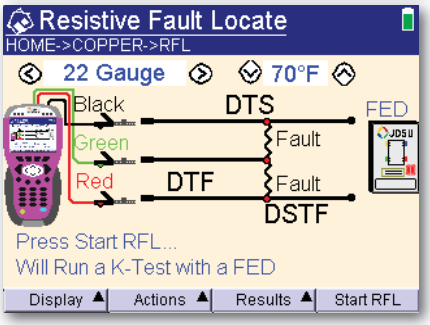
RFL Test

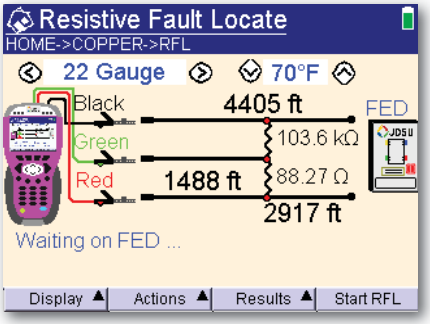
Cat 510 Hardware

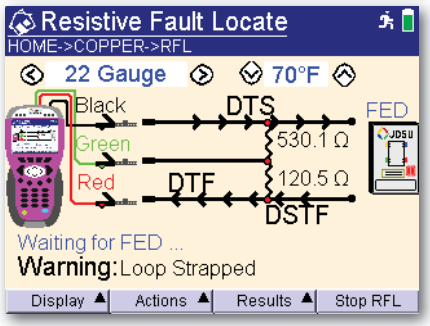
Using the K-Test

1. Using the HST-3000 Ohm meter, the technician identifies two conductors which meet the above criteria for the K-Test. It is important to note these can be any two conductors in the cable provided they meet the ratio requirements listed above.
2. The technician attaches the Blue test leads of the UFED to the chosen conductors (and attaches the ground lead to Earth) and turns on the UFED locate tone.
3. The technician goes to the far end of the test section, locates the two conductors and performs the K-Test.
4. From the HST-3000's RFL menu, technician selects **Display** soft key, **8 - K-Test W/FED**
5. Connect Tip, Ring and Ground as shown and select Start RFL
6. The HST will communicate with the UFED and perform the K-Test







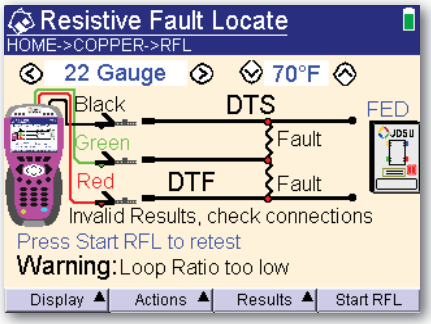


RFL Test

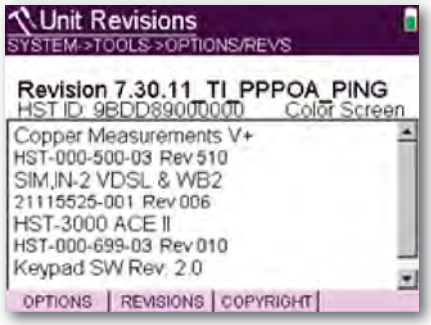
Cat 510 Hardware

Using the K-Test (continued)

7. The HST will determine if the ratio between conductors is correct. If an invalid ratio is present the HST will abort the K-Test.



8. To determine CAT version, System-Tools, 4 Options/Revs/Copyright, Revisions HST-000-500-03 Rev 510 (fig6)



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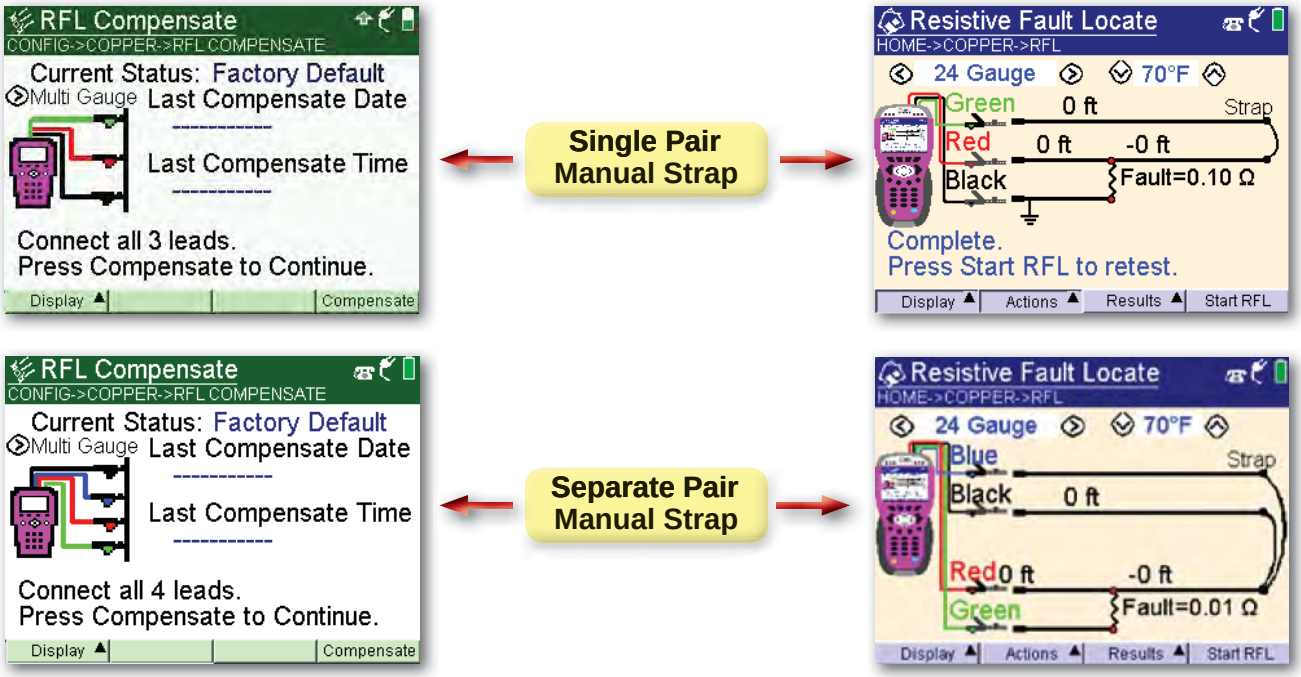
RFL Test

RFL Test Cord Compensation

Cord compensation

There is a different compensation for single and separate pairs. For the most accurate results, JDSU recommends compensating the RFL measurement to remove possible effects of the test leads by taking the following steps:

1. Press the **Display** soft key
2. Select the appropriate mode (Single Pair Manual Strap or Separate Pair Manual Strap) and press OK.
3. Press the **Configure** navigation key.
4. Follow the instructions on the screen and connect the HST-3000 test leads to the test cable
5. Press the **Compensate** soft key
6. The compensation stops automatically when finished, and the result is displayed. The date and time are recorded if it was successful.
7. Press the **Home** navigation key to return to the RFL
8. Check Compensate by running RFL with test leads shorted. Results for DTS, DTF and STF should be 0 or 1 foot.



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RFL Test

RFL Test Connections and Ohms

Helpful Hints and Tips

Distance to Strap (DTS): During RFL testing, it is important to keep DTS as short as possible due to distributed leakage -- small amounts of leakage that occur even over a good wire. More of this leakage is present over longer distances. Therefore, to keep DTS as short as possible, technicians can sectionalize the cable by using the HST-3000's Ohmmeter to locate the section of cable that contains the fault, then stop and test just that section.

The Good Pair and Leakage: Before performing RFL, it is important to verify that the good pair or wire is actually good by using the HST-3000's Leakage mode Ihmmeter. If leakage is present, the leakage should be 500 times greater than the fault size on the bad wire or the results will be affected. After confirmation that the pair has little or no leakage, the leads can be strapped to the faulted wire and RFL testing performed.

Testing from Both Ends: Performing RFL testing from both ends and comparing the results to see if they agree can help pinpoint the location of the fault. If the results conflict, this may indicate other problems and/or an inaccurate conversion.

Connections and Ohms: It is important to take into consideration that the wires, adapter, or screws that connect the HST-3000 to the pair also may introduce levels of resistance. For example, if the technician connects the clips to corroded screws, this will add resistance and cause an inaccurate measurement.

Testing Multiple Pairs: It is important to test multiple pairs if there is more than one faulted pair in a count or binder. Typically, the faults found using RFL are located in the same area as other faults; however, the distance to each fault may vary slightly due to the make up of the cable. Additionally, as more pairs are tested, the severity of the faults can provide insight as to when it is time to repair the cable. Because unusual line conditions can change and affect RFL, the same pairs should be tested multiple times to validate results and ensure accuracy.

Load coils: Load coils can make the pair's distance appear longer by a range of 91 feet to more than 480 feet. To derive the correct distance, technicians must subtract the designated amount (See Table 6), which is based on a 5-foot stub at 70 degrees Fahrenheit F. It is important to know the load's location so that the correct amount is subtracted from the correct section.

Table: 6 - Load Coil Corrective Distance

Code	19 AWG	22 AWG	24 AWG	26 AWG	Ohms
632	470	235	147	91	4.14
652	484	242	150	94	4.17
662	480	240	149	96	4.25

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RFL Test

RFL Test Connections and Ohms (continued)

Helpful Hints and Tips

Ohms in Strap: It is important that the strap attached to the end of the wires under test has the least amount of resistance as possible to maintain the accuracy of the RFL. The greater the strap's resistance, the more inaccurate the measurement.

Use Ground or Ring as Reference: If using ground as a reference to locate a battery cross does not give a good result, the ring lead of a working POTS line can be used as a reference.

Error messages

Fault Size> 20 Meg Ohms: The RFL test does not detect a measureable fault.

Loop > 7000 Ohms: The far end strap is not in place or the pair is OPEN.

RFL Definitions

Battery cross: A fault that occurs when the bad wire is shorted with the ring lead of a working pair

- DTF Distance to fault (the distance from the HST to the fault)
- DTS Distance to strap (the distance from the HST to the strap)
- DSTF Distance strap to fault (the distance from the strap at the far end of the pair to the fault)

Double-Sided Fault: Test condition where both wires in the pair are faulted. When this occurs, the pair must be tested using the separate pair method. Normally, the fault occurs on both wires at the same place; therefore, using either wire as the "bad" wire will locate the fault.

Reference pair: The pair or conductor that the test set uses in conjunction with the faulted wire to accurately calculate the distance to the fault.

RFL Test

RFL Test Connections and Ohms (continued)

Warnings

Multiple faults: RFL cannot accurately determine the location of multiple faults on a pair. Because distance is based on the assumption that resistance is caused by a single fault in one location, multiple faults cause errors in the resistance measurement, which, in turn, cause errors when converting resistance to a distance. For example, if a pair is 1000 feet long and there are two faults of equal resistance on the pair at 25 feet and 75 feet, then RFL results will indicate there is a fault at 50 feet. If the faults are equal, RFL results will show one larger fault located between the two faults.

Cross: If the pair under test is crossed with a working pair with a higher voltage than POTS (plain old telephone system), such as HDSL, then the voltage on the pair could be 190 volts or more.

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