AT&T Standard
Plant Training Course

Set Usage Guide
Unit 4B
DYNATEL TM 735
Open and Split Locator

Issue 1: March 1979
PTC No. 157
Cable Repair

Throughout these materials, persons who are involved in training are referred to as trainees, instructors or administrators (also students, conferees, candidates, etc. as appropriate). In addition, personal pronouns are used to refer to trainees, instructors and other individuals. This was done to improve readability and is in no way intended to discriminate against persons of either sex. Nothing in this Material should be construed to indicate a discrimination because of race, color, religion, sex, age or national origin.

Wisconsin Telephone Company
American Telephone & Telegraph Company

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LOCATING OPENS IN CABLE PAIRS

1 HOOK UP

- [ ] GREEN to shield (shield grounded)
- [ ] WHITE to tip
- [ ] RED to ring

2 LINE TEST

- [ ] LINE TEST
- [ ] MULTIPLY BY to correct range
- [ ] WHT TIP/SPLIT 1

meter needle points to:

- [ ] green   - [ ] white   - [ ] red

- [ ] RED RING/GOOD 1

meter needle points to:

- [ ] green   - [ ] white   - [ ] red

If needle points to green in both SPLIT 1 and GOOD 1 positions, proceed to step 3.

If needle points to white in either position, proceed to step 4.

If needle points to red in either position, proceed to step 5.

3 DISTANCE TO OPEN MEASUREMENT

A. GENERAL AREA OF OPEN

- [ ] LENGTH .083
- [ ] WHT TIP/SPLIT 1
- [ ] null with FEET dial

  reading 30
- [ ] RED RING/GOOD 1
- [ ] null with FEET dial

  reading 30

> When readings differ, the shortest reading is the most accurate!

B. PRECISE LOCATION OF OPEN

- [ ] LENGTH .083
- [ ] A. select a good pair in the same cable section as the open
- [ ] B. move WHITE lead to tip of good pair
- [ ] C. move RED lead to ring of good pair
- [ ] D. WHT TIP/SPLIT 1
- [ ] E. null with FEET dial

  reading (1) ________________
- [ ] F. RED RING/GOOD 1
- [ ] G. null with FEET dial

  reading (2) ________________

Reading (1) must be within 3% of reading (2), if not, select another good pair and repeat A. - G. until you find a pair that is balanced.

Continue on the next page.

B. PRECISE LOCATION OF OPEN (CONTINUED)

- [ ] determine the length of the good pair by one of the following:
  - measure the length with a Dynatel 710A(or equiv)
  - from cable markings
  - from cable records
- [ ] set FEET dial to length of good pair
- [ ] LENGTH μF/MILE
- [ ] null with CAPACITANCE

Do not move CAPACITANCE for remainder of test!

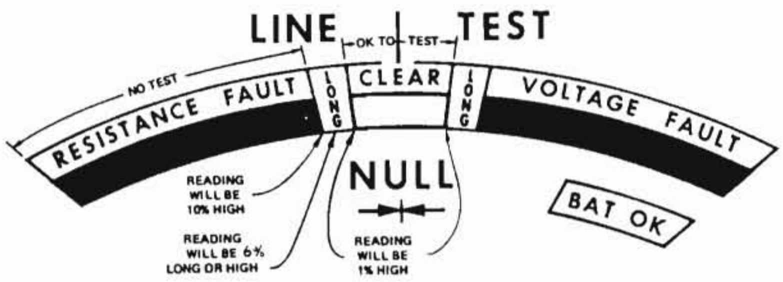
- [ ] move WHITE lead to tip of open pair
- [ ] move RED lead to ring of open pair
- [ ] WHITE TIP/SPLIT 1
- [ ] null with FEET dial

  reading ________________ (distance to open)
- [ ] RED RING/GOOD 1
- [ ] null with FEET dial

  reading ________________ (distance to open)

When readings differ, the shortest reading is the most accurate.

4 LINE TEST - NEEDLE POINTS TO WHITE



Example: If during the line test, the needle pointed to 6% part of the scale, when marking your final measurements, they will read 6% longer than they actually are.

Therefore, a 100' reading would actually be only 94' (6% shorter).

5 LINE TEST - NEEDLE POINTS TO RED

When the needle points to red, there is either a resistance fault or a voltage fault on the wire being tested.

Some opens can be found with the 735 even though the faults exist.

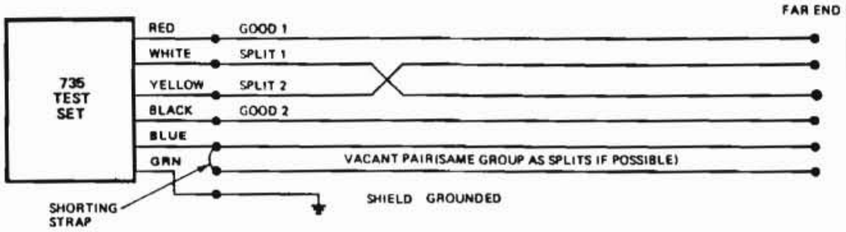
Try this procedure.

- [ ] MULTIPLY BY to SPECIAL 10 (or SPECIAL 100) needle points to:
  - [ ] green - leave in SPECIAL 10 (or SPECIAL 100) for remainder of test - proceed to step 3
  - [ ] white or red - can not be tested with the 735 until fault is cleared

<u>LOCATING SPLITS WITH THE DYNATEL 735</u>

1 HOOK-UP

A. Use this diagram if testboard identifies split pairs.



17
19
16

B. Use the following procedures if testboard can <u>not</u> identify split pairs.

- [ ] GREEN to shield (shield grounded)
- [ ] MUTUAL
- [ ] LENGTH .083
- [ ] MULTIPLY BY to correct range
- [ ] RED to ring of pair 1
- [ ] WHITE to ring of pair 2
- [ ] null with FEET dial

    reading 375

- [ ] Move WHITE to tip of pair 2
- [ ] Null with FEET dial

    reading 396

- [ ] BLACK to side of pair 2 that had shortest reading
- [ ] Move WHITE to tip of pair 1
- [ ] YELLOW to other side of pair 2
- [ ] BLUE to shorted good pair

proceed to Step 2

2 LINE TEST

- [ ] LINE TEST
- [ ] MULTIPLY BY to correct range
- [ ] BLACK/GOOD 2

meter needle points to:

[ ] green [ ] white [ ] red

- [ ] YELLOW/SPLIT 2

meter needle points to:

[ ] green [ ] white [ ] red

- [ ] RED RING/GOOD 1

meter needle points to:

[ ] green [ ] white [ ] red

- [ ] WHT TIP/SPLIT 1

meter needle points to:

[ ] green [ ] white [ ] red

If needle points to green in <u>all</u> positions, proceed to step 3.

If needle points to either white or red in <u>any</u> position, the split can <u>not</u> be tested until the fault(s) is cleared.

3 BALANCE TEST

- [ ] LENGTH .083
- [ ] SPLIT 1
- [ ] null with FEET dial

  reading 420
- [ ] GOOD 1
- [ ] null with FEET dial

  reading 460
- [ ] SPLIT 2
- [ ] null with FEET dial

  reading 452
- [ ] GOOD 2
- [ ] null with FEET dial

  reading 384

Readings must not vary more than 3% from highest to lowest.

If balance is "OK", proceed to step 4.

If balance is <u>not</u> "OK", proceed to step 5.

4 LOCATING THE SPLIT

- [ ] Find the length of the cable section by one of the following:
  - use the GOOD 1 reading from step 3
  - measure a good pair with a Dynatel 710A (or equivalent)
  - from "feet" markings on cable sheath
  - from cable records

- [ ] adjust FEET dial to show the length of the cable section
- [ ] SET LENGTH
- [ ] LENGTH μF/MILE
- [ ] null with CAPACITANCE
- [ ] NULL 1
- [ ] null with NULL 1 knob
- [ ] NULL 2
- [ ] null with NULL 2 knob
- [ ] NULL 3
- [ ] null with NULL 3 knob
- [ ] TO SPLIT
- [ ] null with FEET dial

  reading ____________________ distance to split
- [ ] FAR END TO SPLIT
- [ ] null with FEET dial

  reading ____________________ distance from far end to split

5 BALANCE TEST NOT "OK"

- [ ] Change BLUE lead to another good pair and repeat step 3. You may have to try several different good pairs before you find one that balances.

- [ ] If balance can not be achieved by switching to another good pair, read paragraph 4 in the Dynatel manual for helpful information.

LOCATING AN OPEN SHIELD WITH THE DYNATEL 735

- [ ] open the shield at both ends
- [ ] remove all grounds from the shield
- [ ] (1) connect WHITE to one end of shield
- [ ] (2) connect RED and GREEN to ground*
- [ ] (3) WHT TIP/SPLIT 1
- [ ] (4) LINE TEST

  needle points to:

  - [ ] GREEN (CLEAR)

    continue
  - [ ] WHITE (LONG)

    read Step 4 of LOCATING OPENS IN CABLE PAIRS; then continue with this procedure.
  - [ ] RED (FAULT)

    read Step 5 of LOCATING OPENS IN CABLE PAIRS; then continue with this procedure.
- [ ] (5) LENGTH .083
- [ ] (6) MULTIPLY BY to correct range
- [ ] null with FEET dial

  A. reading ______________
- [ ] repeat (1) through (6) at the opposite end of shield
- [ ] null with FEET dial

  B. reading ______________
- [ ] add A. and B. together

  C. total ______________
- [ ] determine the "section length" by one of the following;

  measuring the cable with a Dynatel 710A (or equivalent)

  from feet markings on the cable sheath

  from cable records

  D. write the "section length" here ______________
- [ ] multiply A. or B. (whichever is shortest) by D.

  E. total ______________

continue on the next page.

☐ divide E. by C.
answer _______________ this is the distance to the open from A. or B. (whichever is shortest)

*Earth ground does not always provide the most accurate readings.

Shorting good pairs in the cable and using them in place of earth ground, often produces the best accuracy. The more pairs you short together for this purpose, the more accurate your readings will be.

MEASURING THE APPROXIMATE AMOUNT OF WATER IN CABLE

- [ ] determine the section length by one of the following:
    - measuring with a Dynatel 710A (or equiv.)
    - from feet markings on cable sheath
    - from cable records
- [ ] (A) write the section length here ___________
- [ ] connect WHITE to tip of good pair
- [ ] connect RED to ring of good pair
- [ ] LENGTH .083
- [ ] MULTIPLY BY to correct range
- [ ] WHITE TIP/SPLIT 1
- [ ] null with FEET dial

    (B) reading ___________
- [ ] RED RING/GOOD 1
- [ ] null with FEET dial

    (C) reading ___________
- [ ] subtract (A) from (B) or (C) [whichever is least]

    (D) answer ___________
- [ ] divide (D) by 2

    answer ___________ this is the approximate amount of water in the cable section*

*IF ALL THE WATER IS IN ONE PLACE

4. SPECIAL APPLICATIONS

ERRORS IN DISTANCE MEASUREMENT

4.01 The 735 will measure distances accurately unless one of the following conditions exists:

(a) There are build-out capacitors on the line. The equivalent electrical length of the capacitance must be subtracted. Go to the plant records for their value and location. Refer to paragraph 4.03 for further details.

(b) Water in the cable. This will affect the cable capacitance as described in paragraph 3.10. See paragraph 4.15.

(c) Loading coils. See paragraph 4.04.

(d) Non-working cable. See paragraph 4.05.

(e) Bridge Taps. For locating splits only. Different bridge taps will unbalance the two pairs. Find the overall length of the section by another method (paragraph 4.02) and see 4.09.

(f) AC Induction. Sometimes ac current induced into the conductors will cause the needle to oscillate about the null point making an exact setting difficult. Use the following procedure to reduce the oscillation:

1) Find a separate pair, in the same group if possible and strap the far end of the pair to the faulted conductor under test as shown in Figure 4-1.

2) Using a 710A measure the distance to strap of the separate pair and set this distance on the 735.

3) Connect the 735 as shown in Figure 4-2. Set the TEST switch to LENGTH μF/MILE and set the CONDUCTOR switch to the good conductor of the faulted pair; using the CAPACITANCE control, null the meter.

4) Move the CONDUCTOR switch to the faulted (open) conductor and using the digital dial, null the meter. This is the distance to the open.

4.02 If the distance of the section cannot be measured accurately with a 735, measure it with a resistance type faultmeter such as the Dynatel 710A or obtain the distance from the records. See also 4.10.

4.03 BUILD-OUT CAPACITORS. Build-out capacitors add an error to the distance measurement. So when testing cables with build-out capacitors, be sure to subtract the equivalent electrical length of the build-out capacitor from the distance to fault measurement. Use the following procedure:

Note: The following procedure applies only to cables having mutual capacity of .083μF/MILE. For other cables or special applications, contact Dynatel Corporation for assistance.

(a) Measure the distance to the fault on the tip or the ring. Note and record the shortest distance.

(b) Find out if the cable is jelly-filled, or if it has an air core.

(c) From the plant records, locate the number and the value of any build-out capacitors that are between the 735 and the open.

(d) If the cable has an air core, divide the value of the build-out capacity by .0237. Other-

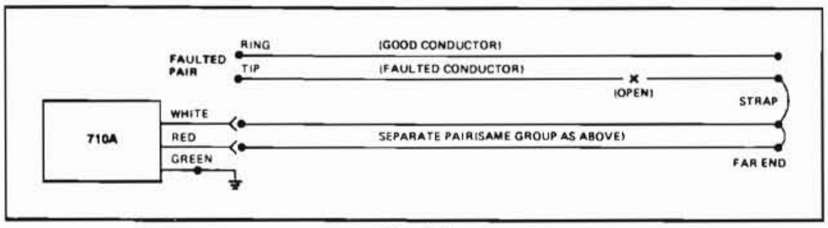


Figure 4-1.

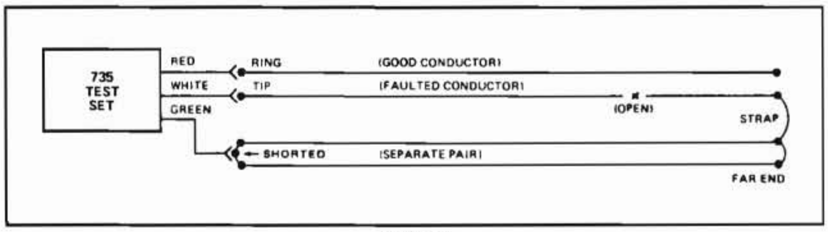


Figure 4-2.

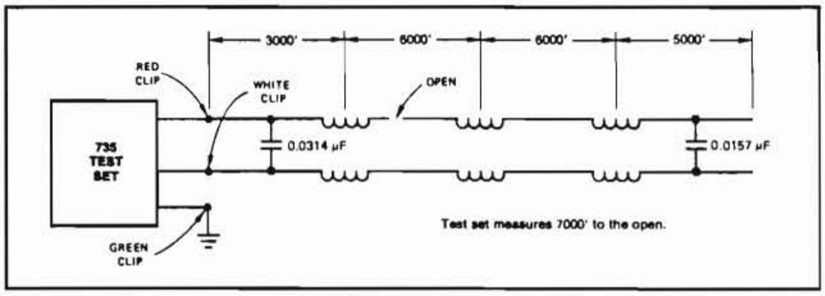


Figure 4-3. Build-out Capacitors Add to Distance Measured

wise, if the cable is jelly-filled, divide the value of the build-out capacity by .0265.

(e) Multiply the answer from (d) above by 1000.

(f) The answer from (e) above is an equivalent length–in feet–of the build-out capacity.

(g) Subtract the equivalent distance in step (f) from the distance to fault measurement in step (a).

EXAMPLE: A section of air-core cable is 20,000 feet long, and the capacitance is .083 μF/MILE, as shown in Figure 4-3. The test set indicates that the fault is at 7,000 feet. The plant records indicate that there is a build-out capacity of .0314μF at the next load coil, which is only 3,000 feet away. The equivalent electrical length of the build-out capacity is found as follows:

1) Since the cable is air-core, the build-out capacity should be divided by .0237:

$$.0314 \div .0237 = 1.325$$

2) Multiply the answer by 1000:

$$1.325 \times 1{,}000 = 1{,}325 \text{ feet}$$

3) Subtract this answer from the distance measured to the fault, which is 7,000 feet.

$$7{,}000 - 1{,}325 = 5{,}675 \text{ feet}$$

This is the actual distance to the fault.

Note: The .0157 μF capacitor is beyond the open and does not affect the measurement or the calculation.

4.04 LOADING COILS. An easy way to measure the approximate distance to the nearest load coil is to set the MULTIPLY BY selector to the X10 SPECIAL range, and the CONDUCTOR switch to MUTUAL. Do not use TIP or RING. Then measure the conductor length. Remember that this measurement is *approximate:* the measured distance will be less than the actual distance by about 5-10%. Multiply the measured length by 1.1 (110%) for the approximate true length.

EXAMPLE: From Figure 4-3 with the MULTIPLY BY control set to X10 SPECIAL and the CONDUCTOR switch set to MUTUAL a reading of 3893 feet is obtained (use the RED and WHITE clips). Build-out capacitor equivalent cable length (0.0314 μF) is 1,325 feet. The corrected length to the load coil is approximately (1.1 x 3,893) – 1,325 = 2,957 feet.

4.05 MEASURING NON-WORKING CABLE. Most standard telephone cables are manufactured with a nominal capacitance value of .083μF/MILE. However, this value varies between working and non-working cables. To make valid measurements in non-working cable, 12 or more pairs must be bunched together and connected to the shield with the green clip.

Note: The bunched pairs must be in the same group as the pair under test.

4.06 LINE TEST. If the meter reading is in the red zones during the LINE TEST procedure, it may still be possible to locate the fault. Set the MULTIPLY BY selector to 10 SPECIAL or 100 SPECIAL, using the lowest possible range. If the meter needle returns to the CLEAR zone, or into one of the LONG zones, the 735 can measure the distance to the fault. However, to do so, the MULTIPLY BY selector MUST remain in one of the SPECIAL ranges.

NOTE

Do not use the SPECIAL ranges when there are load coils between the test set and the fault.

LOCATING OPENS

4.07 LOCATING OPENS BY RATIO. This method can be used only if the conductors in the section under test are all the same size and gauge. Changes in cable size or gauge will cause errors. Use the following procedure:

(a) Determine the length of the section under test. This will be the "D" measurement.

(b) Connect the 735 and make tip and ring measurements with the TEST switch set to LENGTH .083. The shorter measurement will be the "A" measurement. See Fig. 4-4.

(c) Move the 735 to the FAR-END of the section under test and repeat step (b) for the shorter of the "B" measurements. See Fig. 4-4.

$C = A + B$

d = distance to open

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

Example:

$D = 290$ feet

$A = 240$ feet

$B = 110$ feet

$C = A + B = 240 + 110 = 350$ feet

$d = \frac{B \times D}{C} \quad \frac{110 \times 290}{350} = 91.14$ feet

The distance to open from the end where the "B" measurement was taken is 91 feet.

NOTE: Multiple opens on the same conductor will cause the measurement to the open to fall somewhere between the two (or more) opens. See Figure 4-5.

4.08 LOCATING OPEN SHIELDS. Use the following procedure to locate an opening in the shield.

(a) Isolate the shield at both ends.

(b) Determine the length of the section under test. This will be the "D" measurement.

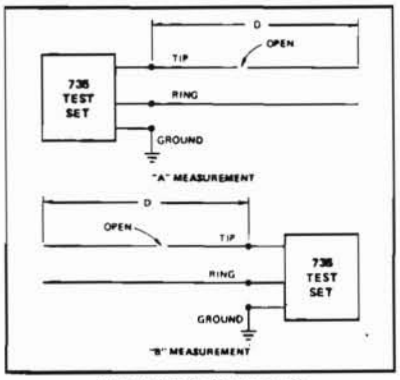


Figure 4-4. Ratio Measurements

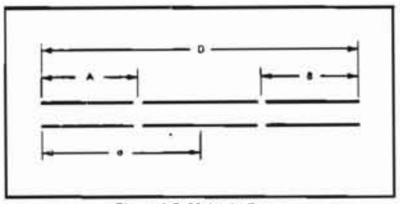


Figure 4-5. Multiple Opens

(c) Hook up the 735 with the white clip to the shield and the RED and GREEN clips to ground. Set the CONDUCTOR switch to TIP and the TEST switch to LENGTH .083. This will be the "A" measurement.

(d) Move the 735 to the far end of the cable under the test and repeat step (c) above. This will be the "B" measurement.

(e) Use the formula in 4.07(c) to compute the distance to the open.

Note: Multiple shield openings will cause the measurement to the open to fall somewhere between the two (or more) opens. See Fig. 4-5.

4.09 FINDING THE LENGTH OF A BURIED DROP. See Figure 4-6.

(a) Using a 710A Resistance Fault Locator, find the section length (example: 850 feet).

(b) Using the 735 measure the same pair and note the difference (example: 1285 − 850 = 435 feet). This difference is due to the drop wire.

(c) Connect the Test Cord to the six Test Terminals and set the FEET dial to 435.

(d) Set the TEST switch to LENGTH .083.

(e) Set the CONDUCTOR switch to FAR END TO SPLIT and null the meter using the NULL 3 control.

(f) Set the TEST switch to LENGTH μF/MILE and set the CAPACITANCE control to .060, which is one half of the drop wire capacitance 0.120 μF/MILE. Null the meter using the digital dial (600 feet).

(g) Since one half of the estimated cable capacitance was set in, the length of the buried drop is $\frac{600}{2}$ = 300 feet.

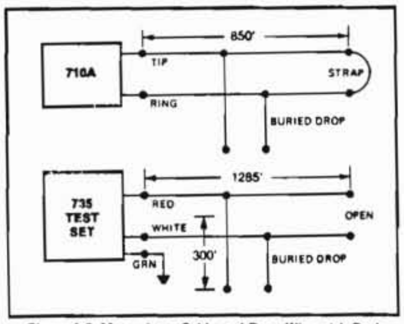


Figure 4-6. Measuring a Cable and Drop Wire with Both Test Sets.

LOCATING SPLITS

4.10 Bridge Taps. If the measurements made with the 735 on each of the four conductors is different by more than 3% and there are bridge taps on the lines, then this will unbalance the two split pairs and cause an error. *Isolate the bridge taps until the conductors balance.* If the bridge taps are between the split and the 735, the far end distance must be used for locating the split. If the bridge taps are toward the far end, then use the distance to split measurement.

4.11 Example of a bridge tap.

In the example in Figure 4-7, the true distance along the section is 700 feet, but with the bridge tap connected the 735 would see it as 1100 feet. The far end measurement of 300 feet would locate the split at Split 1. If the split were on the bridge tap (Split 2), the 735 will measure the far end to split as 100 feet.

4.12 Unbalanced bridge taps. See paragraph 4.10.

4.13 MULTIPLE SPLITS. Set up the 735 as shown in Figure 4-8 and measure the split as described in 3-11 for each connection in the figure.

4.14 CORRECTED SPLITS. See Figure 4-9. The TO SPLIT measurement displayed on the 735 is really the length of the cable that is not split, and is not related to the distance to the split in any way. This is the sum of parts a and c. To locate the distance to the splits, the cable must be opened between the splits and the split locating procedure detailed in paragraph 3-12 performed in both directions. Contact Dynatel for isolation techniques.

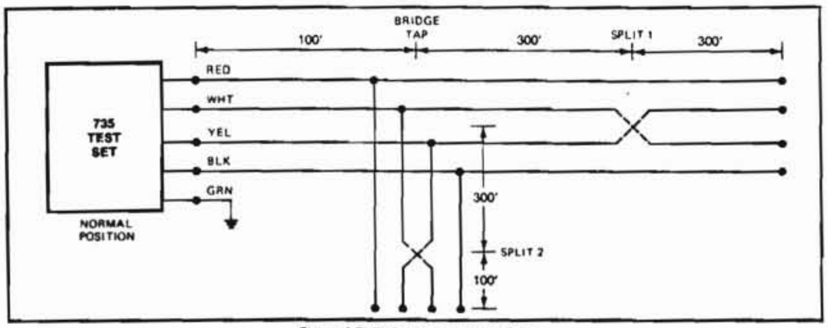


Figure 4-7. Example of a Bridge Tap.

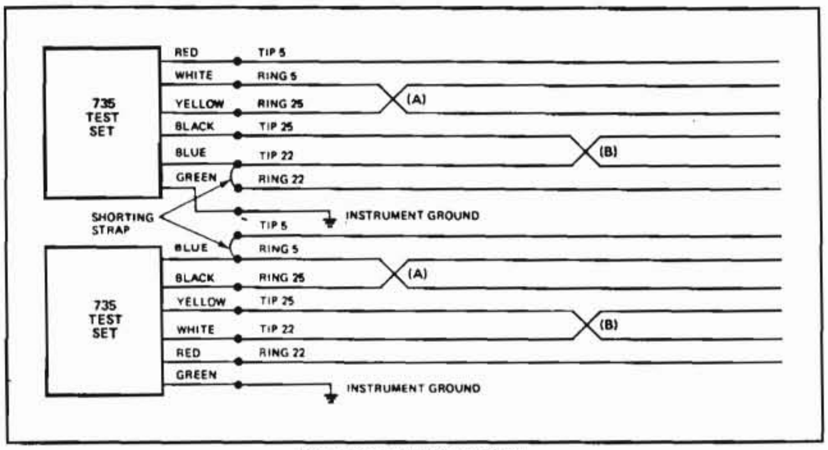


Figure 4-8. Locating Multiple Splits

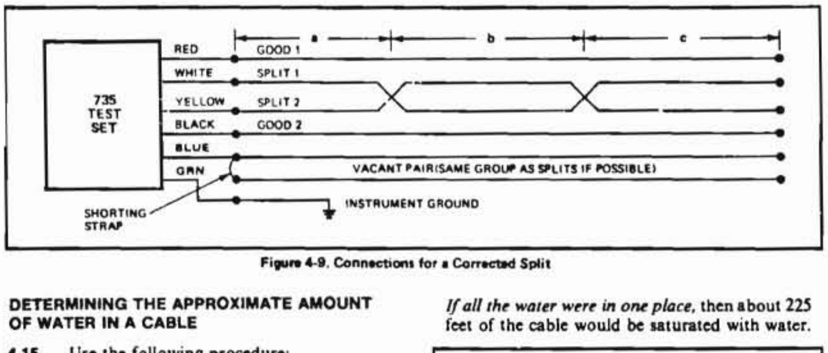


Figure 4-9. Connections for a Corrected Split

DETERMINING THE APPROXIMATE AMOUNT OF WATER IN A CABLE

4.15 Use the following procedure:

(a) Measure the length of the cable with a 710A fault locator (see Figure 4-10).

(b) Measure the tip or ring length of the cable again, using the 735 fault locator. Set the TEST switch to LENGTH .083 (see Figure 4-11).

(c) The equivalent length of water in the cable is:

$$\frac{\text{735 measured length} - \text{710A measured length}}{2}$$

(d) Example: 710A reading is 680 feet
735 reading is 1130 feet

$$\text{Equivalent feet of water} = \frac{1130 - 680}{2} = 225 \text{ feet.}$$

If all the water were in one place, then about 225 feet of the cable would be saturated with water.

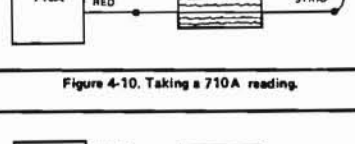


Figure 4-10. Taking a 710A reading.

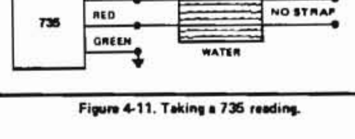


Figure 4-11. Taking a 735 reading.

5. OPERATING MAINTENANCE

OPEN FAULT LOCATING SELF TEST

5.01 Proper operation of the 735 can be checked with the following procedure.

(a) Plug the test cable into the TEST CABLE socket, Green clip to the green SELF TEST terminal.

(b) Set the 735 controls as follows:

CONDUCTOR switch: SPLIT 1
CABLE CAPACITANCE control: .083
MULTIPLY BY switch: X1-NORMAL
TEST switch: BATTERY TEST (Meter should indicate within BAT OK zone.)

(c) Set the TEST switch to LINE TEST.

(d) Note that the meter points to the edge of the resistance green zone.

(e) Set the CONDUCTOR switch to MUTUAL and note that the meter needle is at the NULL line.

(f) Set the TEST switch to LENGTH .083. With all TEST leads and clips lying free of each other, turn the FEET dial counter-clockwise to 000 and note that the meter needle to be no further than one needle-width from the NULL line.

(g) Repeat step (f) for all MULTIPLY BY switch positions; return to the X1-NORMAL range.

(h) Repeat step (f) for CONDUCTOR switch positions: (1) SPLIT 1, (2) GOOD 1, (3) SPLIT 2, (4) GOOD 2. Return to the MUTUAL position.

(j) Connect the test cord to the SELF TEST terminals (six places).

(k) Null the meter with the FEET dial; the dial reading should indicate from 495 to 505.

(l) Repeat step (j) for the GOOD 1, SPLIT 1, SPLIT 2, and GOOD 2 positions of the CONDUCTOR switch; return to the MUTUAL position. Set the digital dial to 500.

(m) Set the TEST switch to LENGTH µF/MILE. Null the meter with the CABLE CAPACITANCE control. The control setting should be from .082 to .084.

(n) Set the FEET dial to 1000. Re-null the meter with the CABLE CAPACITANCE. The control setting should be from .039 to .044.

(p) Set the 735 controls as follows:

TEST switch: LENGTH .083
MULTIPLY BY switch: X10 NORMAL

Set the digital dial so that the meter is nulled. The dial should indicate from 048 to 052.

(r) Set the MULTIPLY BY switch to X10-SPECIAL. Re-set the FEET dial so the meter is nulled. The dial should indicate from 048 to 052.

(s) Set the MULTIPLY BY switch to X100-SPECIAL. Re-set the FEET dial so the meter is nulled. The dial should indicate from 003 to 007.

(t) Set the MULTIPLY BY switch to X100-NORMAL. Reset the FEET dial so the meter is nulled. The dial should indicate from 003 to 007.

SPLIT LOCATING SELF-TEST

5.02(a) Set the CONDUCTOR switch to SPLIT 1.

(b) Set the CAPACITANCE control to .083 µF/MILE.

(c) Set the MULTIPLY BY switch to X1, NORMAL.

(d) Set the TEST switch to LENGTH .083.

(e) Connect all six test lead clips to their respective self-test terminals.

(f) Null the meter needle using the FEET dial (495-505).

(g) Repeat the last step for the GOOD 1 CONDUCTOR switch setting (495-505).

(h) Repeat step (f) for SPLIT 2 (495-505).

(j) Repeat step (f) for GOOD 2 (495-505).

(k) Set the CONDUCTOR switch to SET LENGTH, the TEST switch to LENGTH µF/MILE, the FEET dial to 500, and null the meter with the CAPACITANCE control (.082-.084).

(l) Set the CONDUCTOR switch to NULL 1, and null the meter needle using the NULL 1 control.

(m) Set the CONDUCTOR switch to NULL 2, and null the meter needle using the NULL 2 control.

(n) Set the CONDUCTOR switch to NULL 3, and null the meter needle using the NULL 3 control.

(p) Set the CONDUCTOR switch to TO SPLIT using the FEET dial, null the meter needle (350-370).

(r) Set the CONDUCTOR switch to FAR END TO SPLIT, null the meter needle using the FEET dial (130-150).

TRAINING FOR THE OPEN FAULT AND SPLIT LOCATOR

5.03 Training on the operating procedures for the 735 can be given by connecting the Test Cable to the SELF-TEST terminals and following the procedures in paragraphs 5.01 and 5.02.

FUSE

5.04 The 735 has a 1 amp 3AG fuse that limits current through the test leads. To check the fuse, set the CONDUCTOR switch to GOOD 1, the TEST switch to LINE TEST, and short the WHITE clip to the RED clip. If the meter remains on the NULL line, the fuse is probably defective.

5.05 To change the fuse, use the following procedure:

(a) Remove the screws that secure the front panel.

(b) Lift the chassis up and tilt. The fuse is near the bottom of the panel.

CARE AND STORAGE

5.06 When the 735 is not in use, it should be stored as follows:

(a) Disconnect the test cable and store it in the lid.

(b) Turn the TEST selector OFF.

(c) Close the lid.

5.07 Avoid placing the test set near direct heat, such as furnaces or heaters, and where the test set could be exposed to excessive humidity or moisture.

5.08 For long storage periods, remove the batteries from the test set. Do not leave discharged batteries in the test set.

BATTERY REPLACEMENT

5.09 For access to the batteries, open the two fasteners that secure the bottom section of the 735 enclosure. Remove the cover of the plastic battery tray. See Fig. 5-1. Disconnect and remove the old batteries.

5.10 Install new batteries. The red wire connects to the positive terminal and the black wire connects to the negative terminal. The 735 protective circuitry will prevent damage if the batteries are connected improperly, however it will not operate. See Table A for a list of replacement batteries.

Note: For best results, always replace both batteries at the same time.

Table A. Battery Cross Reference Chart

Voltage	NEDA	Burgess	Ray-O-Vac	Eveready
6	915	F4BP	915	510S

Figure 5-1. Dynatel 735 Battery Compartment

DYNATEL

Field Service Report

THE BASICS OF LOCATING OPENS

FAULTS – OPEN OR RESISTIVE

There are only two ways that telephone conductors can cause trouble:

- They can go open – or
- They can get a resistive fault.

A resistive fault is a short, a cross, or a ground, as shown in Figure 1. These faults can develop in several ways, but they all add up to one thing: current can go where it's not supposed to.

Resistive fault troubleshooting – with fault locator 710A – has been described in detail in the Field Aids, particularly, issues 9, 10 and 12.

Resistive fault locators usually work very well, as long as the conductors you test have continuity, which means that current flows *easily* along the conductor. There must be continuity from the point where you connect your test set to some other access point – beyond the fault – where you can connect a strap. See Figure 2.

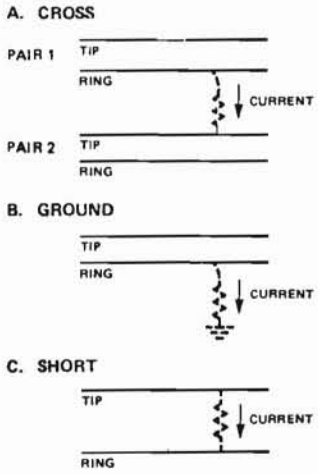


Figure 1. Basic Types of Resistive Faults

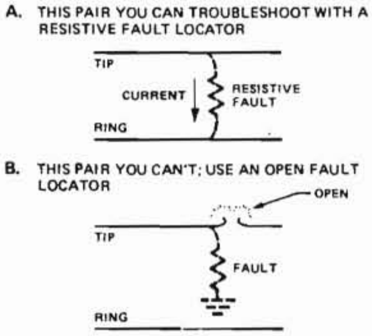


Figure 2. Circuit Continuity

In Figure 2A, both conductors have continuity, and both will conduct. In Figure 2B, the tip is open, so no current can flow.

Sometimes a conductor has a high resistance, allowing *limited* current flow. This is called a "partial" open or a "high-resistance" open. See Figure 3.

Usually, when a conductor has an open, it also has a resistive fault because the same things that cause an open also cause resistive faults. As a result, most opens also have a ground fault – particularly in PIC cable. Troubleshooting is that much tougher because you can't use a resistive locator on an open conductor.

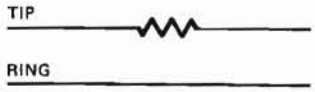


Figure 3. Partial (High-resistance) Open

This brings us to the subject of open locators. They are very useful in a situation where there are both restrictive and open faults.

WHEN CONDUCTORS GO OPEN

A properly installed and connected cable can get in trouble for one of two reasons:

- The sheath is worn, broken or defective, and water gets in.
- Somebody cuts or breaks one or more conductors, or the whole cable.

Suppose you get water in a cable. A pulp cable goes out of service immediately, so it doesn't have a chance to go open. But PIC cable is different. Water stays in the cable, and seeps into the various conductors through pin holes. Eventually, because of electrolytic corrosion, one or more conductors go open, and the resistive fault, usually a battery-cross that caused the corrosion in the first place, is still there.

If a cable is cut, some conductors get squeezed together and short out, and many of them short to ground. The result is a group of open conductors with more or less serious resistive faults. For more details, see Field Aid No. 6.

HOW OPEN LOCATORS WORK

The basic difference between a resistive fault locator and an open locator is that a resistive fault locator measures the conductor *resistance*, and the open locator measures conductor *capacity*.

Capacity is something you find in every telephone pair, just like resistance. It's better to have less capacity but some will always be there anyway. Both resistance and capacitance are handy for locating faults, but both get in the way of good telephone transmission. Less is better!

Basically, capacity is like a three-layer sandwich, where the top and bottom layers conduct electricity, and the middle layer doesn't. The top and bottom layers can be any shape at all, as long as they conduct, and the middle layer doesn't. This way, direct current can't go between the top and the bottom layers of the "sandwich." See Figure 4.

You can make the basic "sandwich" any size and shape you want. You can roll it up into a tube – like the "condensers" in a car ignition. Or you can stretch it out long and thin – like two

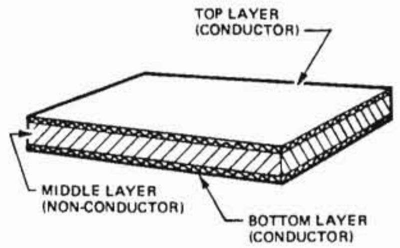


Figure 4. The Basic Capacitor

wires in a telephone pair. The amount of capacity is determined by three things:

- The area of the top and bottom layers. Bigger layers mean more capacity.
- The distance between the two layers. More distance means less capacity.
- The material in the middle.

CAPACITORS

A form of capacitor is created when two conductors are separated by a non-conducting material or insulator. A telephone pair has capacity spread evenly along its length, so that the longer a pair, the more capacity it has. Just like a real capacitor, this pair can 'store' a value of power depending on its capacity. Since there is an insulator between the conductors, current will flow into an open pair only until the capacity of the pair has been reached, then the current flow will stop. So if the capacity of the pair is the same along its length, then the current flow will depend on the length of the pair. To put it another way, if we know the capacity for a short length and we measure the current that flows before the pair is "charged up" then we can determine the total length of the conductors. If a conductor is open, then the pair will only charge up as far as the break.

Capacity is measured in "microfarads." Since it occurs all the way along its length we can say the telephone cable has a capacity of so many "microfarads per mile." This is written μF/mile where μ is the greek letter micro or one millionth, and F is for Farad, the unit of measurement for capacity.

Capacity has a symbol used on schematics:  or  or  some capacitors have positive and

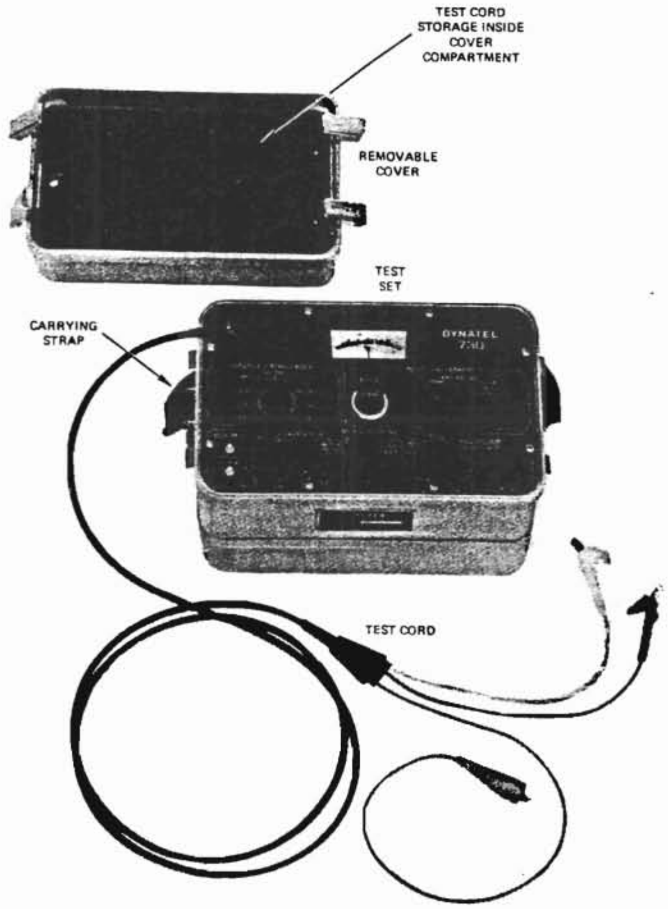


Figure 5. Dynatel 730 Test Set

negative terminals like batteries, and some can be charged in either direction.

Normally each mile of telephone cable has 0.083 μF of capacity. So two miles has 0.166 μF and so on.

A capacitor stores a charge of electricity. Remember that you measure resistance – with your ohmmeter – by measuring how much current goes through a resistor. When you connect your ohmmeter leads across a capacitor, the capacitor charges up, and the needle "kicks," and then goes back. Some of the electricity stored in the ohmmeter battery flows into the capacitor until the voltage across the capacitor is equal to the battery voltage. Then no more current flows.

The same thing happens when you connect your ohmmeter to a telephone pair. The meter needle "kicks" and the capacity of the pair stores the charge. The longer the wire, the bigger the "kick."

THE OPEN LOCATOR

An open locator works by using cable capacity, putting current into a pair, and measuring the "kick" accurately. If you tell the machine how many microfarads per mile are in the cable, then it can tell you how long the cable is, or where the open is.

This sounds very easy – and it is, as long as the open end of the cable is perfectly clean. However, this situation seldom happens with PIC cable, where you usually get a "dirty open," which means an open combined with a resistive fault.

There used to be no way to get around the problem of the "dirty open" until Dynatel designed the 730 Open Locator which ignores all but the worst dirty opens and still gives an accurate measurement. The Dynatel 730 can locate an open even if there is a resistive fault or a battery cross on the test pair.

HOW TO USE THE DYNATEL 730 OPEN LOCATOR

Hook up the clips of the 730 to tip, ring and ground, and do the Line Test. This checks for resistive faults or stray voltages. If the cable does have a resistive fault or a stray voltage, the Line Test will tell you how serious it is. If the fault or stray voltages are not too serious, you can still get a good reading. Otherwise, the 730 meter will tell you if you can measure the distance accurately using one of the special ranges. If the fault is too serious to be located accurately, the 730 meter will say so, and you don't have to waste any time. See Figure 7, Note 2.

There are three types of length measurement that you can make with the Dynatel 730.

The first type of measurement is the TIP measurement. In this measurement, the 730 connects the ring to ground, and measures the length of the tip by checking the capacity between the tip and the ground, actually between the tip and all the other conductors, many of which are grounded in a working cable. This measurement gives the length of the tip, or the distance to the fault, if the tip has an open.

The second measurement, the RING, is done the same way as the TIP measurement, except that the tip is grounded and the ring is measured.

The third is the MUTUAL length measurement. In this measurement, the 730 measures the capacity between the tip and ring conductor, and then converts it to feet. This is not used to actually locate an open conductor.

WHAT ABOUT WATER?

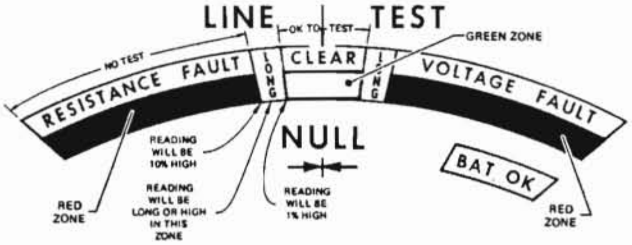
It was mentioned earlier that there are three things that change the value of a capacitor. The third is the non-conductor between the two conductive layers of the capacitor "sandwich." In air core cable, the main materials are plastic and air. However, you must also know if water is in the cable, because water makes the wet section appear two or three times longer. The reason is that water *increases* cable capacity. So does jelly and purging compound. This means that you don't just plug in your machine, turn it on and then go out and make a dig. If you do, you probably will dig in the wrong place.

RULE

> To prevent digging in the wrong place, always find the actual length of the cable – and use that number to calibrate your 730.

USING THE 730 OPEN LOCATOR IN WET CABLE

First find the true length of the cable section. Use a Dynatel 600 or 710A, strap the far end and measure the distance to strap on a good pair.



1. If the needle is in the Green Zone, make a normal measurement.
2. If the needle is in the LONG Zone, make a correction to the indicated length as described in the manual.
3. If the needle is deflected into the Red Zone, measurements can be made only if setting the MULTIPLY by switch in the SPECIAL position brings the needle back into the CLEAR or LONG Zones.

Figure 6. Reading the Meter

Then remove the strap and measure the same pair with the 730 Open Locator. Set the TEST switch to LENGTH .083. If the distance measured is the same, there is no significant amount of water in the cable. See Figure 7, Note 3.

If the distance indicated on the 730 is longer, water is present in the cable and the 730 must be recalibrated. Set the FEET indicator to the true length of the section. Set the TEST switch to Length µF/MILE, and adjust the CABLE CAPACITANCE control to set the meter in the null position. The Open Locator is now calibrated for the new value of cable capacitance. See Figure 7, Note 1.

Measure the TIP length of the bad pair.

Measure the RING length of the bad pair. If they are the same, the fault is close to the far end, and it is better to go to the far end and calibrate the 730, then make a new measurement along the shorter distance. If the difference between the two measurements is noticable, use the shorter measurement and dig.

730 Demonstration Kit

A free demonstration test kit – with complete instructions – is available from Dynatel. Use it to learn how to operate the 730 and to recognize dirty opens and series faults. Call (408) 733-4300 for yours.

HELPFUL HINTS

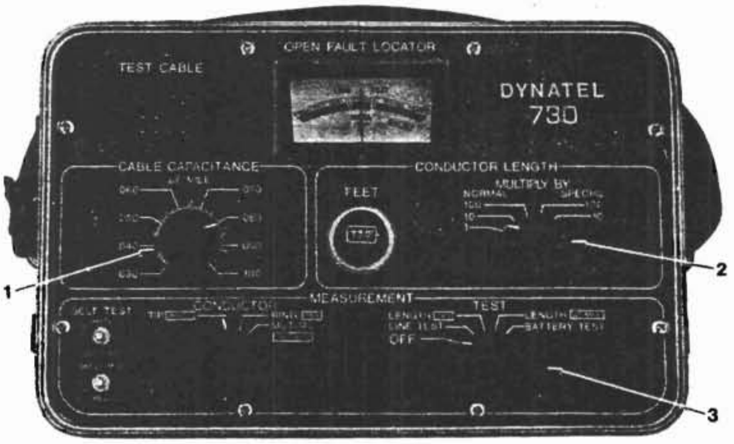
When you locate a cable fault, it's a good idea to test several pairs. Then look for patterns in both the fault and the distance measurements. Check Field Aid #6 for some typical fault patterns in FIC cable.

Remember that you get the best accuracy on short measurement. So, when you measure a long cable, get as close to the fault as possible. Your best bet may be to make two different measurements. First, locate the fault to within one or two sections. Then, move the test set close to the fault location and locate the fault within those sections. If indications show that the trouble is close to the far end, go there to make the tests. This method helps eliminate any errors due to differences in conductor capacitance, conductor resistance or gauge changes, slack loops, variations in twist, or other things.

Also, read the instruction manual and the back issues of the Dynatel Field Aids for more ideas and hints. To get copies, call us at (408) 733-4300.

If your test set does have a problem – return it to us. We try for one-day service; here's what to do:

1. Call us before you send your test set.
2. When you do send it, include a description of the symptoms or the problem.



1. **Cable Capacitance** — set to 0.083 μF for normal cable, or adjust for water logged cable.
2. Special scales used for very dirty opens.
3. **Test** — set to length 0.083 when comparing length measurements on the 730 and 710A or 600.

Figure 7. Controls on the Open Locator

3. Include the name of the owner, and the return shipping address. Don't forget special shipping instructions if they are required.
4. Include your phone number, or the number of someone who knows about the problem.

DYNATEL IS LISTENING

If you have any questions about operating the 730 Fault Locator, or you have found an interesting situation in the field, we would like to hear about it. We may help solve problems on the phone. Our number is (408) 733-4300.