BURIED PIC CABLE
FAULT LOCATING

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1. GENERAL

1.01 This section describes procedures for determining the location of electrical faults in buried PIC cable.

1.02 These procedures will serve to locate conductor and/or sheath faults whether conductor to conductor, conductor to shield, or shield to ground. Electrical faults having impedance values from zero ohms to several megohms can be located.

1.03 Some of the methods described are applicable to all of the cable plant but since this section is directed to fault locating in buried PIC cable, it is assumed that the trouble has been localized to the buried PIC cable plant. It is further assumed that the trouble is not located in aboveground facilities: pedestals, splices, aerial breakouts, etc.

INTENT

1.04 THE GENERAL INTENT IS TO EFFECT A SERVICE RESTORATION ON A REPORTED PAIR TROUBLE OR TO CLEAR A DEFERRED PAIR TROUBLE RESULTING FROM SERVICE RESTORATION BY PAIR TRANSFER.

1.05 The specific intent of this section is to rehabilitate the buried air core PIC cable plant and to that end, emphasis is placed on locating and repairing the source of the conductor faults.

1.06 After the completion of all tests, ascertain that all bonds have been replaced.

2. TEST EQUIPMENT

2.01 The following test sets (or equivalents) are required:

(1) KS-8455 Test Set (volt-ohmmeter)

(2) Dynatel 710A Fault Locator

(3) Cable Path Tracer

(4) AT-7851 L1A Test Set (sheath fault locator)

2.02 The Delcon 4910F open fault locator test set may also be useful in locating open-conductor faults.

3. FAULT LOCATING PROCEDURE

Note: The following procedures are summarized in a flowchart in Fig. 1.

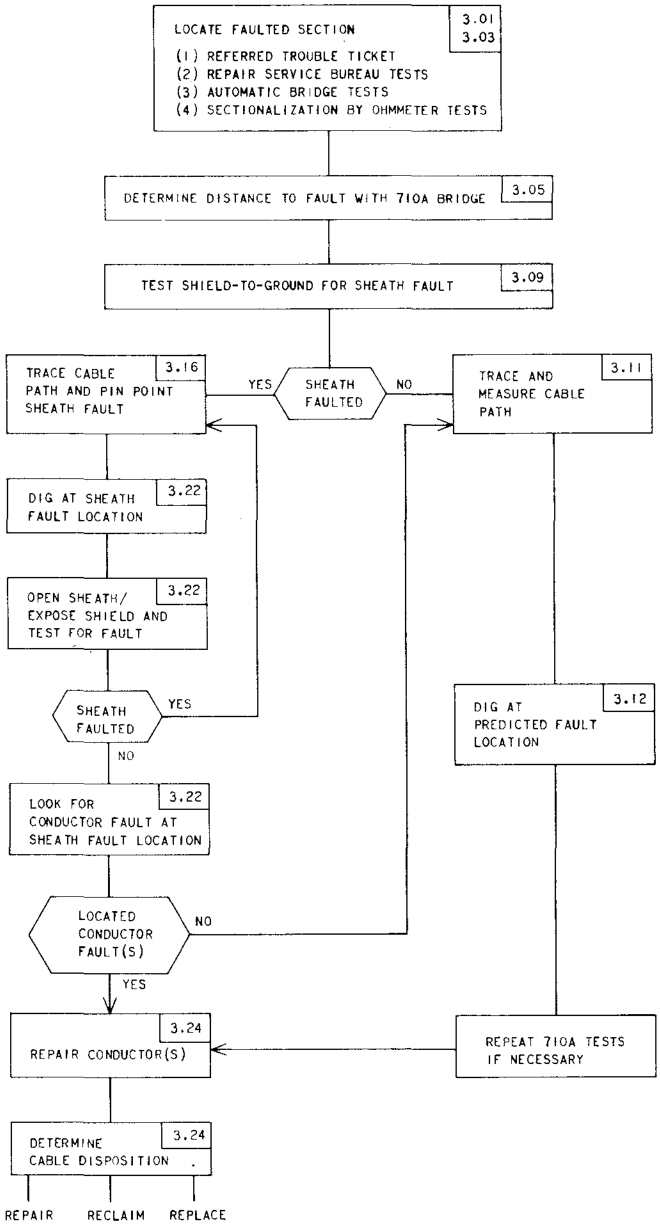


Fig. 1—Fault Locating Procedure Summarized

PRELOCATION

3.01 If the pair trouble has not been localized to a single cable section, this should be accomplished first.

3.02 The preferred method is to use the Dynatel 710A fault locator to isolate the fault to a single cable section (Fig. 2).

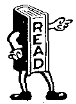
Note: For further information on the use of this test set, refer to Section 634-305-514, Locating Faults Using the Dynatel 710A Test Set—Description And Use.

PREDICTION OF CONDUCTOR FAULT LOCATION

3.03 Verify that the fault is in the section by opening the pair at the nearest point of access on each side of the faulty section and testing the faulted pair with the Dynatel 710A faultmeter or the KS-8455 ohmmeter.

Note: For further information on the use of this meter refer to Section 106-020-100, KS-8455 Test Set—Description And Use.

3.04 A useful property of conductor faults in buried PIC cable (where moisture is present), is that the conductors, whether tip or ring, typically have a shunt fault to ground (shield). This is important because it means that conductor troubles may nearly always be treated as ground faults without looking for the cross which may also be present. Therefore, each conductor of a battery cross can be looked at as a separate trouble. A conductor which has a much greater series resistance than normal (for its gauge and type) has series fault resistance.



These conductor fault-locating techniques will not accurately locate a conductor fault which has series fault resistance.

3.05 To determine the location of the conductor fault, connect the Dynatel 710A as in Fig. 3. It is preferable to use a separate good pair laid on the surface (for sections up to about 600 feet length) to a good pair in the cable for the following reasons:

(1) The time spent in finding a good spare pair is eliminated.

(2) The necessity of interrupting another customer's service when a good spare pair is not available is avoided.

(3) The quality of the good pair is assured.

(4) A talk pair can also be easily provided.

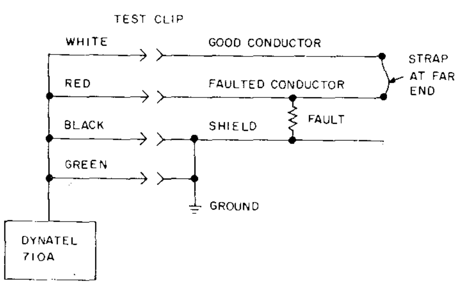


Fig. 2—Conductor Fault Location Using Only The Pair in Trouble

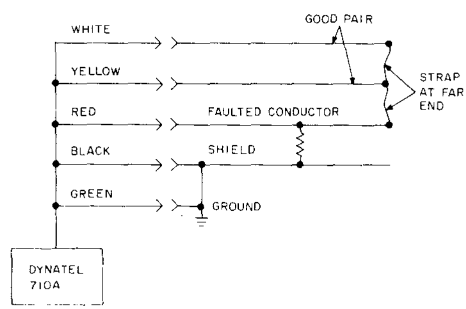


Fig. 3—Conductor Fault Location Using a Separate Good Pair

3.06 It is convenient to construct a good pair reel as shown in Fig. 4 to provide these facilities. The wire used in the good pair reel does not have to be the same length or gauge as the faulted pair. The difference in these pairs does not affect the operation of the Dynatel 710A when connected as in Fig. 3.

TESTING FOR PRESENCE OF SHEATH FAULT

3.07 The second phase of the fault location procedure (before a hole is dug) is to test the cable shield for ground faults which indicate sheath damage. The reason for this course is that conductor faults (particularly conductor-shield faults) are relatively rare in ***dry*** PIC cable. Since there is such a high probability of water associated with conductor faults on a buried PIC cable section, then clearly a repair which does not locate and mend the source of the water entrance guarantees future conductor and shield deterioration. Also, pinpointing sheath faults will avoid fruitless cable dig-ups.

3.08 Disconnect the cable shield bond at each end of the section to isolate the shield from ground. Refer to Fig. 5.

3.09 With the KS-8455 ohmmeter, measure the resistance between shield and ground. Operate the reverse switch on the test set several times and note the meter indications. Some interpretations of the meter indications are as follows:

METER INDICATION	INTERPRETATION
Open — both polarities	Sheath good
Equal resistance to ground — both polarities	Sheath damage, probable moisture in cable
Different indication on each polarity	Battery leak on shield, shield to conductor fault moisture in cable, probable sheath damage.

Note: For further information on the use of this meter, refer to Section 106-020-100, KS-8455 Test Set—Description And Use.

SHEATH FAULT NOT INDICATED

3.10 If no sheath damage is indicated, continue conductor fault location procedure with Dynatel 710A.

3.11 After obtaining a distance to fault and strap to fault measurement from the Dynatel 710A, trace and mark the cable path between access points.

3.12 Mark the location of the conductor fault by measuring off the predicted distance from the nearer of the access points with a distance wheel or measuring tape and dig at this point.

ALTERNATE METHOD

3.13 An alternate method is to trace the cable path prior to fault locating and lay the good pair from the reel along this path. This wire can be marked in feet to provide both cable location and distance information. An additional advantage of this technique is that if the distance to strap measurement from the Dynatel 710A does not closely agree with the laid length of the good pair then it should be suspected that the cable may have slack loops or other deviations not apparent from the surface. A closer examination with the cable tracer will sometimes reveal these conditions. This difference betweeen the electrical length and apparent surface length will explain why the conductor fault is sometimes not found in the hole dug at the predicted location.

MULTIPLE FAULTS

3.14 If the meter pointer of the Dynatel 710A is observed to drift or waver when the null operation is being performed or if several measurement attempts do not result in the same predicted fault distance, then it is likely that multiple faults exist on the conductor. Since this would normally indicate the presence of moisture and sheath damage, the recommended action is to proceed with sheath fault location. However, should the cable shield not be faulted, then the cable should be exposed at the average predicted location since this will be between the faults and the pair may then be examined in either direction.

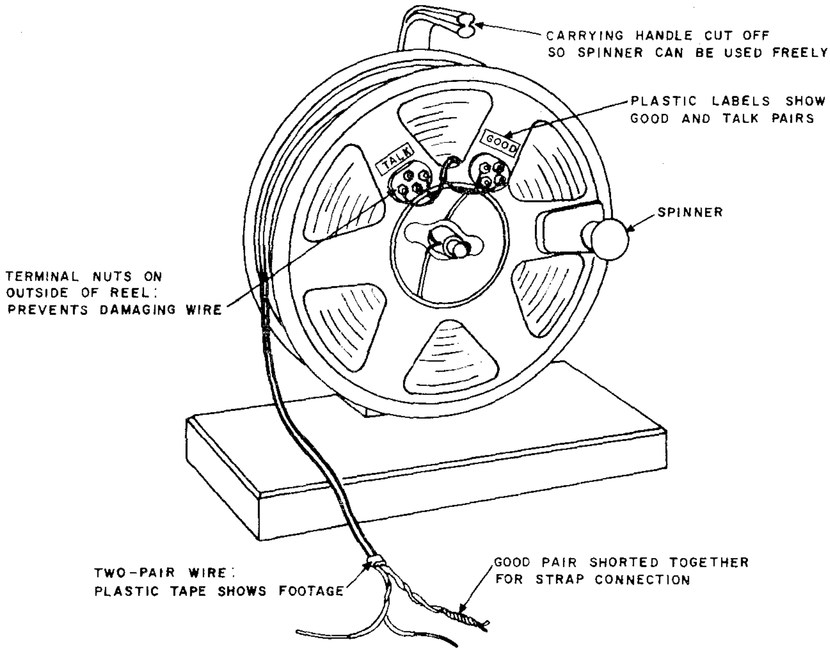


Fig. 4—Convenient Reel For Separate Good And Talk Pair

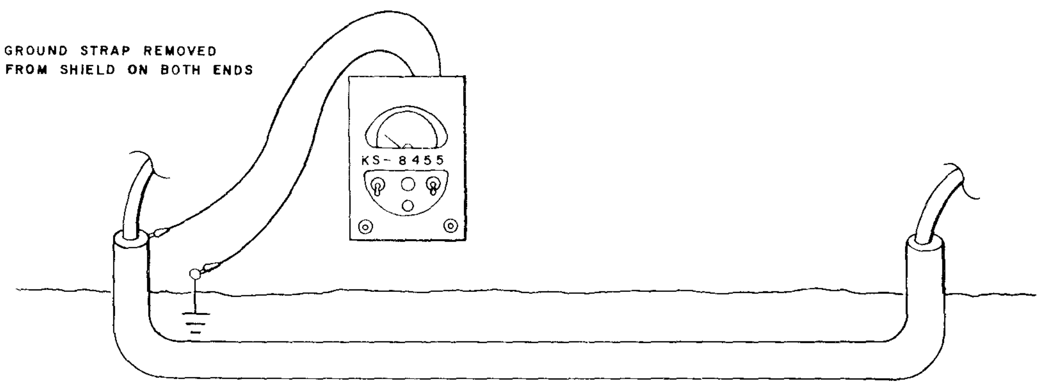


Fig. 5—Shield-to-Ground Fault Test

SHEATH FAULT INDICATED

3.15 If a sheath fault is indicated, then the cable should be first exposed at the location of the sheath fault for the following reasons:

(1) The predicted conductor fault location could be in error.

(2) The sheath fault should be repaired anyway.

(3) Even if the conductor fault is not found at this dig, it will provide an excellent access point from which to make another bridge measurement since the cable path will likely be predictable from this point toward the fault.

(4) It is also likely that when the moisture is drained or otherwise removed from the cable core, the high resistance conductor faults will disappear.

3.16 If sheath damage is indicated connect the AT-7851 L1A test set as shown in Fig. 6.

Note: For operating instructions of the AT-7851 L1A, refer to Section 634-315-500, Cable Testing—General Locating Sheath Openings in Buried PIC Cable.

3.17 The method consists of placing an interrupted dc voltage between the metallic shield and ground. The dc current establishes a potential gradient in the earth which is greatest at the fault location. The potential gradient is detected by measuring the voltage between two probes inserted at intervals along the cable path with the probes connected to the AT-7851 L2A detector as shown in Fig. 6. The detector measures the magnitude and polarity of the gradient and the polarity indicates the direction of the fault.

3.18 The AT-7851 L3A voltage control unit or transmitter is connected between the shield at one end of the cable and a ground rod. The ground rod should be placed in the earth in approximate line with the cable and as far behind the point of access as practicable so as to make sheath faults located at or very near to the point of access more easily detected.

A GRAPHICAL REPRESENTATION

3.19 A graphical representation of the current distribution in the earth which is induced to flow between the cable shield fault and the ground rod is illustrated in Fig. 7. The magnitude and polarity of the earth voltage gradient observed on the AT-7851 L2A detector is shown in Fig. 7B. The voltage gradient is greatest near either side of the fault and changes polarity at the fault.

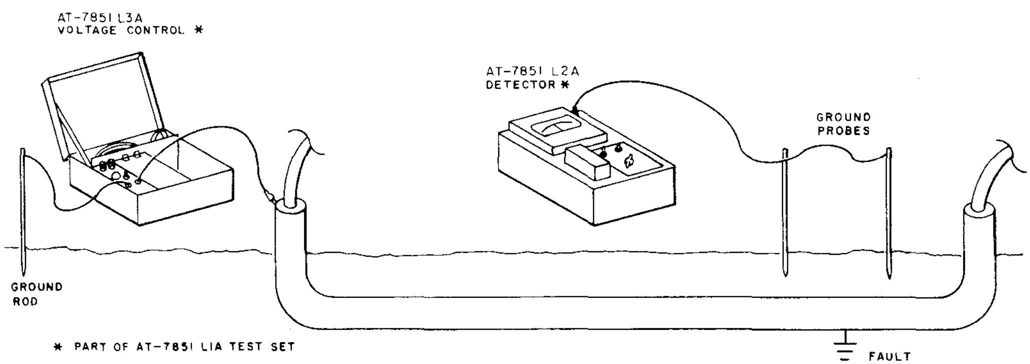


Fig. 6—Shield-to-Ground Fault Location

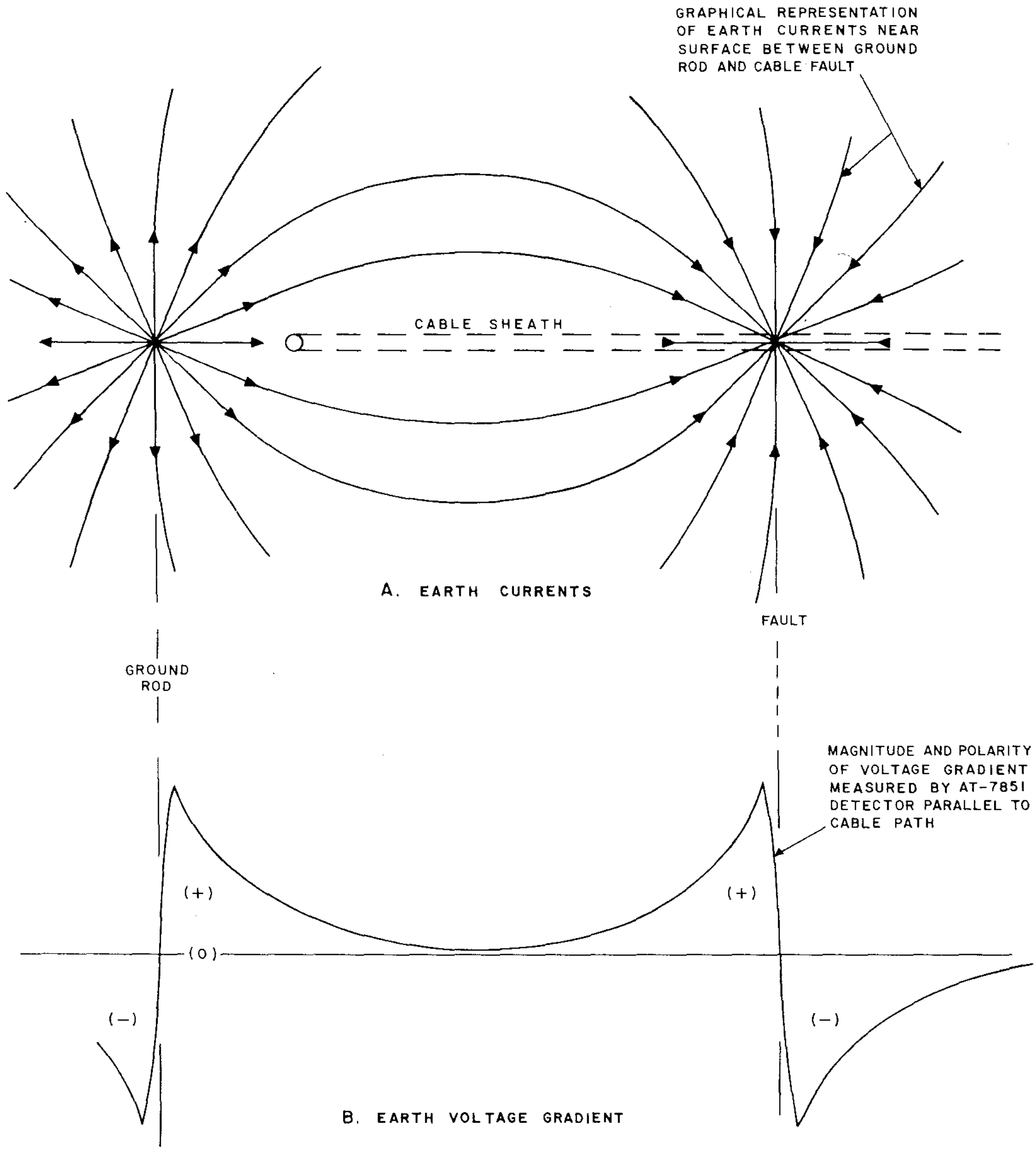


Fig. 7—Earth Currents—Earth Voltage Gradient

AN ALTERNATE METHOD

3.20 An alternate method of locating the sheath fault to that given in Section 634-315-500 is to sample the voltage gradient with the probes along the cable path until the polarity reverses, indicating that the fault has been passed. The sample intervals should be more frequent as the signal magnitude increases approaching the fault. When the detected signal is nulled (nearly zero) and reverses polarity for small probe movements in opposite directions, then the fault is located equidistant from each probe.

CABLE UNDER ROADS, DRIVEWAYS, ETC.

3.21 It is sometimes not possible to follow the cable path with the probes when the cable passes under roads, driveways, parking lots, etc. In these cases, it is usually possible to locate an area to one side of the cable where the earth may be probed along a line parallel to the cable path. The AT-7851 L1A test set is capable of locating a sheath fault at lateral distances of 50 feet from the cable. If the probes are placed on a line parallel to the cable path when the null is reached, then the fault will be located where a line drawn from the midpoint of the probes and perpendicular to the cable intersects the cable path.

3.22 After the sheath fault has been pinpointed, a hole should be dug and the cable exposed. Turn off AT-7851 L3A voltage control unit and disconnect it from the cable. The faulted area of the sheath should be opened at this point and a new measurement made from shield to ground in both directions with the KS-8455.

3.23 Open the conductor. It will often be possible to zero-in on the conductor fault by physically wiggling the cable while the resultant variation in the fault resistance is observed on the KS-8455 ohmmeter or the Dynatel 710A. If the conductor fault is not found here, a new measurement from this location should be made with the Dynatel 710A.

CABLE DISPOSITION

3.24 The general questions being asked are:

- Can the cable be repaired?
- Is the cable worth repairing? (Does it have enough remaining good pairs?)
- What is the most economic method of repair?

3.25 Factors which determine the course of action are:

(1) The extent of the damage.

(2) The amount of moisture in the cable and the length of time it is presumed to have been present. (See Section 644-104-101.)

(3) The number of faulted pairs in the section—past and present.

(4) The number of good spare pairs remaining.

(5) Local conditions—is the section likely to be damaged or submerged by water again?

3.26 At this point a decision must be made on the disposition of the cable section. The alternatives are:

(1) Water removal by drying methods. (See Section 644-200-030.)

(2) In-place reclamation with reclamation compound. (See Section 629-295-312.)

(3) Replacement.

3.27 The ***choices*** are then to ***repair the section*** and leave it dry, ***reclaim the section*** with B reclamation compound or ***replace the section*** with a new cable. If the section can be repaired and can reasonably be expected to remain dry, then this is the preferred and most economic method. If the moisture cannot easily be removed (or kept out) or the conductor degradation is such that the first choice is not applicable, then the section should be filled with B reclamation compound. If it is evident that the whole section is in trouble or that not enough good pairs would remain after reclamation to provide the required service, then the section should be replaced.