L4 CARRIER

OVERALL SYSTEM

TESTS

FAULT LOCATION USING L4 LINE POWER SUPPLIES

CONTENTS PAGE

1. GENERAL

1.01 This section contains charts which can be used to locate faults on the L4 carrier coaxial cable system. These tests are valid for both main and branch routes. The voltages and currents produced by the power supplies of the L4 system are used in all charts. Faults can be isolated by observing the voltage level required to produce a given amount of current through the coaxial tube being checked. To isolate the fault, voltage and current are compared to the cumulative line voltage drops calculated for the coaxial conductor under test.

1.02 This section is reissued to correct voltage drop information in 1.04. Arrows have been used to indicate significant changes. ***Equipment Test Lists are not affected.***

1.03 Although not applicable to the tests in this section, it may also be possible to locate faults by using the monitoring oscillators located at each station.

1.04 ▶The following conditions are present for normal operating repeatered coaxial:

Cable (coaxial): 2.8 volts drop/mile

Basic repeater: 28.6 volts drop/repeater

Regulating repeater: 65.6 volts drop/repeater

Equalizing repeater:
152.0 volts drop/repeater (auto)
116.0 volts drop/repeater (manual)
Resistance of inner conductor at 55°F:
5.4 ohms/mile◀

1.05 The voltage-current method of fault location can isolate only the fault within one or two manholes. For final location, a Wheatstone bridge must be used. For final location between manholes, refer to Sections 634-310-500, 634-310-501, and 634-305-510.

1.06 Chart 4 of this section is used for location of open faults. Although the line voltage-current method cannot be used in the open fault location, the power supplies will indicate that an open exists on the line.

1.07 If any of the paper pairs are involved in the fault, they may provide, by using the Wheatstone bridge, a more accurate location of the fault than the voltage-current method.

1.08 The dc power for the L4 repeaters is obtained by series-feeding the dc voltage over the coaxial center conductor from the main stations. The necessary operating voltage for each repeater is obtained by using the voltage drop across the zener diodes which are connected in series with the center conductor of the coaxial at the repeater stations. The desired voltage drop is produced when 520 mA is supplied to the coaxial tubes by the power supplies. The zener diodes will maintain

the voltage to an accuracy of ±5 percent across the repeater when the current through the coaxial is 520 mA; however, when the current drops below 500 mA, the results are not as reliable.

1.09 If a direct short of the coaxial is present at some point on the line, the voltage required from the power supplies to produce the normal current (520 mA) will be the same voltage that would be present if the coaxial were operating normally (operating with no fault).

Caution: The line voltage applied to the coaxial conductor must not exceed 1800 volts. If 1800 volts are reached before the 520 mA is obtained, a lower current must be used for trouble location.

1.10 Table C will assist in identifying and evaluating various coaxial line troubles.

2. TESTS

2.01 *Apparatus:* The tests in this section do not require external apparatus. The internal power supplies provide the required voltages and currents.

CHART 1

SOLID FAULT LOCATION

A coaxial short can produce one or more of the following alarm conditions at the main station:

(a) Loss of pilot alarm

(b) High-current shutdown

(c) Low-current shutdown

(d) High-current alarm

(e) Low-current alarm

(f) Ground alarm.

Establish voice contact between main stations of the coaxial route containing the fault and, if possible, perform the following steps simultaneously at each station. If one main station is unattended, it may be possible to test from one station only if power shutdown occurs at the far station. If results from the two stations indicate that the fault is not at the same location, the midpoint of the two results can be used to determine a more accurate location.

STEP	PROCEDURE
	Note: If the responsible engineering organization has not furnished a cumulative voltage-current listing for the coaxial line section under test, Form A must be completed using Table A as an example and Table B and station records as sources of data. Form A can be locally reproduced as required. It is suggested that the completed forms be retained for future reference.
1	Operate the coaxial power supplies at both main stations to the grounded mode.

CHART 1 (Cont)

STEP	PROCEDURE
2	Energize the power supplies as prescribed in Section 167-776-301.
3	Slowly increase the line voltage until a current of 520 mA is indicated on the voltmeter. ***Caution: The line voltage must not exceed 1800 volts. If the 1800-volt limit is reached before the current reaches 520 mA, refer to Form A and select a lower current. (350 mA is preferable to 250 mA.) Use this current for the remainder of the tests.***
4	Read and carefully note the voltage obtained in Step 3.
5	Refer to Form A or data furnished by the engineering department and find the nearest equivalent voltage, in the appropriate current column, of the cumulative line voltage drop for that line section under test. The manhole listed in the first column is near the fault location.
6	If the far-end main station is attended, repeat Steps 1 through 5 from the far end. Use the midpoint of the results for a more accurate location of the fault.
7	Make the final fault location from the manhole near the fault using a Wheatstone bridge. ***Note:*** The resistance of the 0.375-inch coaxial inner conductor at 55°F is 5.4 ohms per mile.

CHART 2

RESISTANCE FAULT LOCATION

A resistance short from the center conductor to ground will develop a voltage across the fault. This condition can be checked by powering from both ends and by using the difference of the two indicated locations as the actual location.

STEP	PROCEDURE
1	Operate the coaxial power supplies at both main stations to the grounded mode.
2	Increase the line voltage at both ends until a current of 520, 350, or 250 mA is obtained. ***Caution: Do not exceed a line voltage of 1800 volts.***

CHART 2 (Cont)

STEP	PROCEDURE
3	Referring to Form A or data furnished by the engineering department, locate the nearest equivalent voltage under the appropriate column for the line section under test. The manhole listed in the first column is near the fault location. ***Note:*** If the suspected location (from both stations) is not the same manhole, the fault probably has some resistance.
4	If a resistance fault was indicated in Step 3, proceed as follows to locate the fault: (a) Add the voltages of the power supplies at both main stations (faulty line). (b) Subtract the normal total voltages from the sum of the voltages in (a). (c) Subtract one half the value obtained in (b) from each line voltage reading obtained in Step 2. Use the resulting voltage and Form A or engineering data to determine the location of the resistance fault. ***Note:*** On lines powered from only one end, there is no way to compensate for the resistance at a fault.

CHART 3

MIDPOINT FAULT LOCATION

When a fault is located near the cable midpoint, the transmission and/or pilots will be interrupted, but the power supplies and associated alarms will have no reaction to the fault.

STEP	PROCEDURE
1	Operate both main station power feed points to the grounded mode and adjust to a current of 500 mA.
2	Slowly vary one of the power supplies to a current of 475 mA and observe the current at the other station. ***Requirement:*** The current at the other station should change. If no change is noted, the cable is shorted near its electrical center.
3	If a short is indicated near the electrical center, proceed to isolate the fault using Chart 1 of this section.

CHART 4

OPEN FAULT LOCATION

Open coaxial faults are indicated by an inability to turn up a power supply when both ends are in the grounded mode. If there is no current flow indicated when the line voltage is increased towards 1800 volts, an open center conductor is the probable fault. The fault location should be made from both ends to confirm that the open fault exists.

A special effort should be made to minimize the number of repeater openings required because a large portion of testing time will be consumed in opening and closing, replacing seals and desiccant, purging air, and testing for leaks.

Built-in facilities at equalizing repeaters provide for ventilation and lighting. Because of these facilities, it is recommended that the initial open location test be performed at these locations.

The instructions prescribed in the sections listed below should be followed when entrance to any manhole is required:

SECTION	TITLE
620-140-501	Testing and Ventilating Manholes
620-145-010	Gasoline in Manholes
620-150-010	Removing and Replacing Manhole Covers

STEP	PROCEDURE
1	Dispatch maintenance personnel to an equalizing repeater at the midpoint of the faulty line. ***Caution: When personnel are working on the line, the power must be shut down for their safety.*** ***Note:*** The following steps should be performed as required by the type of repeater visited and the conditions found at the repeater.
2	Remove the manhole cover as prescribed in Section 620-150-010.
3	Test the manhole for hazardous gas, per Section 620-140-501.
4	Using the 100-type communication set, establish voice contact with the main station.
5	If water condensation is present, wipe the manhole ceiling using a squeegee or sponge (Section 106-020-114).
6	Confirm that power has been removed from the coaxial under test at both stations.

CHART 4 (Cont)

STEP	PROCEDURE
	Caution: Do not continue with this test if an unattended station is still providing power to the faulty coaxial. Voltage may suddenly appear on the faulty coaxial from an intermittent fault. This voltage may be hazardous to equipment and lethal to personnel.
7	Locate the apparatus case containing the coaxial line to be tested and remove the cover.
	Warning: Use the prescribed method of opening and closing the apparatus case. Do not attempt to open or close the apparatus case without referring to and closely following the procedures in Section 640-440-203.
8	Remove the repeater from the case and store it in a moisture-proof bag.
	Caution: Certain 471-type apparatus cases may contain one, two, or four repeaters. Remove only the repeater associated with the defective coaxial.
9	Insert a shorted test cord into the IN or OUT jack of the apparatus case depending on the direction of transmission and main station manned.
10	Request that the main station supply power to the faulty line. If current is present, the fault is not between the repeater and the main station.
11	Request that the station(s) remove voltage from the coaxial and remove the shorted cord from the IN jack.
12	Repeat Step 9 in the opposite direction of transmission if both main stations are manned.
13	If line current is observed at both main stations, replace the removed repeater with a unit known to be good. The open circuit may be located in the removed repeater.
14	Follow the procedure prescribed in Section 640-440-205 for desiccant and seal replacement, purging pressuration, and gas leak detection.
15	Move to a repeater midway along the defective direction of coaxial and repeat Steps 2 through 13 until the fault is isolated between two manholes.
16	If the fault has been isolated between two manholes, use a portable Wheatstone bridge and oscillator or open fault locator to further isolate the exact location of the open coaxial.
	Note: Generally, open coaxial center conductor location occurs where a cable-to-cable splice was made during installation.

FORM A

L4 CUMULATIVE LINE VOLTAGE DROP

LINE SECTION: _____

MH #	TYPE REPEATER	SPACING MILES	CUMULATIVE VOLTAGE DROP AT 520 MA	CUMULATIVE VOLTAGE DROP AT 350 MA	CUMULATIVE VOLTAGE DROP AT 250 MA

TABLE A

L4 CUMULATIVE LINE VOLTAGE DROP
LINE SECTION: INDIANAPOLIS - LOUISVILLE

MH NO.	TYPE REPEATER	ACTUAL SPACING MILES	CUMULATIVE VOLTAGE DROP AT 520 MA	CUMULATIVE VOLTAGE DROP AT 350 MA	CUMULATIVE VOLTAGE DROP AT 250 MA
L41S	BASIC	1.9	33.9	25.6	18.9
L42S	BASIC	2.0	68.1	51.4	38.0
L43S	BASIC	2.0	102.3	77.2	57.1
L44S	BASIC	2.0	136.5	103.0	76.2
L45S	BASIC	1.7	169.9	128.2	94.9
L46S	REG	1.8	240.5	182.3	134.3
L47S	BASIC	2.0	274.7	208.1	153.4
L48S	BASIC	2.0	308.9	233.9	172.5
L49S	BASIC	2.0	343.1	259.7	191.6
L410S	BASIC	1.5	375.9	284.6	210.0
L411S	BASIC	1.8	409.5	310.0	228.8
L412S	REG	2.0	480.7	364.5	268.5
L413S	BASIC	1.7	514.1	389.7	287.2
L414S	BASIC	1.9	548.0	415.3	306.1
L415S	BASIC	1.9	581.9	440.9	325.0
L416S	BASIC	2.0	616.1	466.7	344.1
L417S	BASIC	2.0	650.3	492.5	363.2
L418S	REG	1.7	720.7	417.7	402.5
L419S	BASIC	2.0	754.9	543.5	421.6
L420S	BASIC	2.0	789.1	569.3	440.7
L421S	BASIC	2.2	823.8	595.5	460.0
L422S	BASIC	2.3	858.8	621.9	479.5
L423S	BASIC	1.1	890.5	646.0	497.4
L424S	EQL	2.0	1048.1	773.4	592.7

TABLE B

VOLTAGE DROP OF REPEATER AND PREVIOUS COAXIAL SECTION									
LINE LENGTH MILES	BASIC			REGULATING			EQUALIZING		
	520 mA	350 mA	250 mA	520 mA	350 mA	250 mA	520 mA	350 mA	250 mA
1.0	31.4	23.9	17.7	68.4	52.6	38.3	154.8	125.5	93.9
1.1	31.7	24.1	17.9	68.7	52.8	38.5	155.1	125.7	94.1
1.2	32.0	24.3	18.0	69.0	53.0	38.6	155.4	125.9	94.2
1.3	32.2	24.5	18.1	69.2	53.2	38.7	155.6	126.1	94.3
1.4	32.5	24.7	18.3	69.5	53.4	38.9	155.9	126.3	94.5
1.5	32.8	24.9	18.4	69.8	53.6	39.0	156.2	126.5	94.6
1.6	33.1	25.0	18.5	70.1	53.7	39.1	156.5	126.6	94.7
1.7	33.4	25.2	18.7	70.4	53.9	39.3	156.8	126.8	94.9
1.8	33.6	25.4	18.8	70.6	54.1	39.4	157.0	127.0	95.0
1.9	33.9	25.6	18.9	70.9	54.3	39.5	157.3	127.2	95.1
2.0	34.2	25.8	19.1	71.2	54.5	39.7	157.6	127.4	95.3
2.1	34.5	26.0	19.2	71.5	54.7	39.8	157.9	127.6	95.4
2.2	34.7	26.2	19.3	71.7	54.9	39.9	158.1	127.8	95.5
2.3	35.0	26.4	19.5	80.0	55.1	40.1	158.4	128.0	95.7

TABLE C

Coax Condition	VOLTAGE (E) & CURRENT (I) OK	HIGH "E", LOW "I"	LOW "E", HIGH "I"	NO "I"	PAPER PAIRS OK	PAPER PAIRS NG	PRESSURE OK	PRESSURE NG	PILOTS OK	PILOTS LOW	PILOTS LOSS
Shorted (Center Conductor and Shield)			X			X	X				X
Open (Center Conductor and Shield)		X		X	?	?		X			X
Center Conductor Open		X		X	X		X				X
Center Conductor High Resistance		X			X		X			?	?
Short at Midpoint of Span	X				X		X				X
Open Outer Conductor	?				?			X	?	?	
Defective Amplifier at Repeater	X				X		X				X

High "E" — Higher than normal voltage required to obtain 520 mA of current

High "I" — 520 mA obtained before normal operating voltage reached