T1 OUTSTATE (T1/OS) DIGITAL LINE FAULT-LOCATING SYSTEM DESCRIPTION AND OPERATION DIGITAL TRANSMISSION SYSTEMS

CONTENTS PAGE

1. GENERAL

1.01 This section contains a description, initial test requirements, maintenance routines, and operation of the T1/OS digital line fault-locating (FL) system. The active FL system recommended for T1/OS applications uses voltage polarity-sensitive active filters (single or dual amplifiers) that provide higher level FL outputs from the apparatus cases than passive filters do. The adjacent channel rejection of the active filters is greater than that of passive filters. The polarity-sensitive characteristic of the filters provides a binary selectivity that allows effective doubling of the 12 FL frequency assignments. The higher level output and increased frequency assignments extend the distance over which end-to-end fault locating can be accomplished. The polarity-sensitive characteristic of the active filters may be used in combination with automatic remote looping of the far-end span terminating equipment to accomplish "two-direction" FL testing capability from one span terminating office. This active FL system may be implemented for either the bidirectional or unidirectional mode of T1/OS operation. Application of the active FL system requires a guarantee of the fault-locate pair T and R (Tip and Ring) integrity since the polarity of the powering voltage is used to identify filter locations or direction of digital transmission at the repeater locations. These FL capabilities are required for rapid and efficient determination of the particular repeater or cable section that is malfunctioning in a T1/OS digital line.

1.02 The reason for reissuing this section is to include information on the items listed below. Since this reissue covers a general revision, arrows ordinarily used to indicate changes have been omitted. This issue does not affect the Equipment Test List.

(a) 800-Type Apparatus Case

(b) J98725AJ Fault Line Powering Module

(c) ED-2C375 Fault-Locate Filter and Jack Panel

(d) ED-2C374 G2 Fault-Locate Control Unit

(e) ED-2C373-30 G4 Fuse and Alarm Panel

1.03 Section 855-350-104, Fault-Locate System Engineering, provides design procedures that guarantee that an FL system meets engineering objectives. These objectives are:

(a) To provide adequate signal-to-noise (S/N) and signal-to-interference (S/I) ratios at the measuring offices so that reliable tests can be made for continuity and margin in any specific repeater of a maintenance span.

(b) To provide adequate powering for all amplifier-type filters from each testing office. The S/N and S/I objectives may be met using passive filters only in limited distance installations.

2. SYSTEM DESCRIPTION

A. General

2.01 Fault locating a T1/OS digital system is the process of determining which repeater section in a particular cable span is malfunctioning. In fault locating a defective T1/OS digital line, a stressed fault-locate digital 1.544-Mb/s signal (DS-1 level) with bipolar violations inserted at a voice frequency rate must be applied to the line under test. The signal is regenerated within an operating line repeater, and part of the output is applied to the FL filters in each apparatus case. The filters extract and amplify the audio component for application to a fault-locate line via a narrow bandpass filter. The FL line is monitored at a span terminating office by an FL test set for the presence of this return test tone. This basic concept of T1/OS fault locating is illustrated in Fig. 1. The ***maintenance span*** extends between the two ends of an automatic protection switching system (Section 365-010-110).

> ***Note:*** Fault locating can only be accomplished within a maintenance span because the fault-locating digital signal cannot be transmitted through automatic protection switching units.

2.02 The passive FL system uses 12 unique frequency assignments, and these same frequencies are used for the active filters. The identifying suffix used in the active and passive filter codes and the assigned test tone frequencies are listed in Table A. Each repeater case location in a span is assigned a unique FL test tone. If the FL line is used for one direction of testing, the active FL system allows a maximum of 24 of the single input active filters to be assigned to one FL line. If the FL line is used for two directions of testing, the active FL system uses 12 dual input active filters to one FL line. Polarity reversal and midspan T and R lead reversal provide double use of the test tone frequencies in one-direction testing. Polarity reversal provides identification of signal transmission direction and double use of the test tone frequencies (once for each direction of transmission) in two-direction testing.

2.03 The basic active FL system provides for termination of a maximum of six fault-locate pairs to accommodate T1/OS routes. This basic system provides individual identification of a maximum of 72 repeater locations with direction discrimination, or 144 repeater locations with single input filters (including the span terminating offices). The pairs are included as a part of the cable facility and are normally loaded in the apparatus cases.

2.04 The FL panel (Fig. 2) is mounted in the equipment bay in the span terminating offices. The panel accepts the plug-in units required to configure the fault-locate system and allows termination of the FL lines and collector pairs from the office repeaters. The active filter powering panel with its fault-locate control unit (FLCU) plug-in provides testing capability for all filters, passive and active. The FL signal levels described in the engineering guidelines (Section 855-350-104) apply to the integrated circuit Western Electric T1 repeaters. The levels produced by the older (Mfr. Disc.) discrete component repeaters (201A through F and 205A through E) should be considered 6 dB lower.

2.05 Those installations not equipped with an FL panel should use the J98725AJ Fault Line Powering Module. The powering module can replace the T1/OS FL panel if access to the fault-locate line is available. The powering module is used for powering an active FL line and the associated fault-locate test set (FLTS). The J98725AJ Fault Line Powering Module is shown in Fig. 3. Refer

TABLE A

FILTER OUTPUT LEVELS*

FILTER CODE SUFFIX	FREQ HZ	PASSIVE FILTERS			ACTIVE FILTERS		
		1 REGEN	50 REGENS	TOL (DB)	1 REGEN	50 REGENS	TOL (DB)
A	832	−56.0	−62.0	±3 dB	−26.0	−32.0	±3 dB
B	928	−54.5	−60.5	±3	−26.0	−32.0	±3
C	1049	−52.5	−58.5	±3	−26.0	−32.0	±3
D	1206	−51.5	−57.5	±2.5	−26.0	−32.0	±2.5
E	1340	−51.0	−57.0	±2.5	−26.0	−32.0	±2.5
F	1508	−50.0	−56.0	±2.5	−26.0	−32.0	±2.5
G	1722	−48.0	−54.0	±2.5	−26.0	−32.0	±2.5
H	2008	−46.5	−52.5	±2.5	−26.0	−32.0	±2.5
J	2193	−46.0	−52.0	±2.5	−26.0	−32.0	±2.5
K	2413	−45.5	−51.5	±2	−26.0	−32.0	±2
L	2680	−44.5	−50.5	±2	−26.0	−32.0	±2
M	3017	−43.0	−49.0	±2	−26.0	−32.0	±2

* dBm into 500Ω, Reference Stress Level (1:11). MEAS 1

to Section 103-494-109 for a detailed description of the powering module.

B. Equipment Arrangement

2.06 The fault-locate panel ED-2C374( ) is the basic span terminating office component of the active FL system. The panel requires 2 inches of vertical mounting space in the equipment bay. The panel consists of a jack field and four slots to accommodate plug-in units. The jack field provides access to -48V office power and a 25-dB pad. Any of the three plug-in slots on the left (facing panel) will accommodate either a code 1068( ) passive filter, code 1114( ) active filter, or a code 1115( ) active filter. The right-hand plug-in is an FLCU which provides powering and control of a selected FL line and transformer-coupled access to the selected FL line for reception of the return test tones. Internal panel wiring allows filter unit 3 (FU3) position to be configured in a filter test circuit associated with the FLCU.

2.07 Filter codes 1114A through M and 1115A through M are used in the active FL system (Table A). The 1114-type has one amplifier providing input to a single filter while the 1115-type has two amplifiers providing input to a single filter. These filters are physically the same size as the code 1068A through M passive filters and can be interchanged in the plug-in positions of the fault-locate panel and the 475-type or 800-type apparatus cases. The 1115-type filter is used with the one-cable bidirectional mode of T1/OS operation. The 1114-type filter is used in the equipment bay to serve the office repeaters, and with the two-cable unidirectional mode of T1/OS operation, or with the bidirectional mode of T1/OS operation when two-direction fault locating is not desired or cannot be accomplished. Figure 4 illustrates the use of the FL filters at the repeater locations.

2.08 The active FL system is used with the J98725AD T1C/T1 fault-locate test set to determine which repeater or associated cable section of the T1/OS line is causing a failure. The J98725AD T1C/T1 fault-locate test set is shown in Fig. 5. Refer to Section 103-494-106 for a detailed description of the J98725AD FL test set.

2.09 One of the main features of the active FL system is the ability to fault locate both directions of transmission from one span terminating office. Essential to this one-man fault location is provision for testing of an incoming failure by automatically looping back the distant end during a fault-location test. This may be accomplished from either end of the span line. The line repeaters may then be tested up to the faulty repeater without the assistance of the craft at the distant end. Automatic protection switching equipment in the span terminating module provides the looping feature on an optional basis. Refer to Section 365-250-110 for a description of the Lynch B302 switching equipment used for T1/OS applications.

2.10 Passive FL filters (1068A through M) may be used on T1/OS FL lines that serve simple, relatively short repeatered lines. These filters are compatible with much of the T1/OS equipment and may be used with an active FL panel which serves other active FL lines; however, passive filters and active filters may ***not*** be used together on the same FL line, primarily because of the large signal level differences. The engineering objectives of S/N and S/I ratios for the FL line are more difficult to meet using passive filters because of their up-to-30 dB lower signal levels and their poorer adjacent channel selectivity.

2.11 The nonpowering FL panel (ED-2C375) may be used for filter mounting and wiring in intermediate and remote end offices from which capability of interrogating active FL lines is not required. This panel provides bay mounting space for up to six passive or active FL filters (1068, 1114, or 1115) and provision for wiring these filters to the repeater shelf collector pairs and to the incoming or through FL pairs. Jacks supplying -48 volts to the test sets are provided.

C. Circuit Description

(1) Fault-Locate Panel (ED-2C374)

2.12 The functional capabilities of the active FL system are provided by the panel and associated plug-in units. A functional diagram of the panel is provided in Fig. 6 in which the panel markings can be correlated with the designations used in the functional diagram.

2.13 The external connections to the panel include termination of up to six FL lines; -48 volt relay, control circuitry and lamp power; +130 volt power source for FL line powering; and termination for up to eight fault-locate signal collector pairs from the office repeaters. All interconnections are made at two rear terminal strips. These include connections between the following: six inputs to the three filter positions, three outputs of these filters, eight collector pairs of the office repeaters, and six FL lines.

2.14 The FL pairs may be either terminated or through-connected at the panel. This feature is determined by appropriate selection of either option X or option W. Option X provides a termination for the fault-locate lines and is used when the lines terminate at the panel. Three normal-through lines are possible by using combinations of FL 1 and 2, FL 3 and 4, and FL 5 and 6, and by using option W. The options may be mixed as required. For example, FL 3 and 4 may be used for a through FL pair, employing option W between them while terminating four other incoming FL lines using FL 1, 2, 5, and 6 with option X associated with them. Option X is normally furnished, and option W can be implemented by reorienting jumper clips.

2.15 The -48 volt jacks on the FL panel allow access to the -48 volt power source for testing and powering the fault-locate test set. The availability of the FL line voltage can be verified at the V_L test points on the panel, and the line current can be checked at the I_L test points.

2.16 The normal function of the panel in the active FL system is to provide access to any one of the six FL lines terminating (or through-connected) on the panel. This is accomplished by connecting a cord to the FL LINE OUT jack which: (1) allows access to the secondary of transformer T1 for measuring the audio frequency test tones, and (2) provides -48 volt power to one side of FL line selection relays. The particular FL line to be used is determined by the 6-position (corresponding respectively to the six FL lines) switch S2. Completion of the circuit for any particular selection relay is controlled by the busy/ready logic circuit mounted on the FLCU plug-in and connected in series with the coil circuits of the fault-locate line selection relays. This circuitry tests for the existence of power voltage on any of the FL lines selected by switch S2. If power exists on the selected line, the BUSY lamp is lighted and the logic circuitry prevents activation of the selection

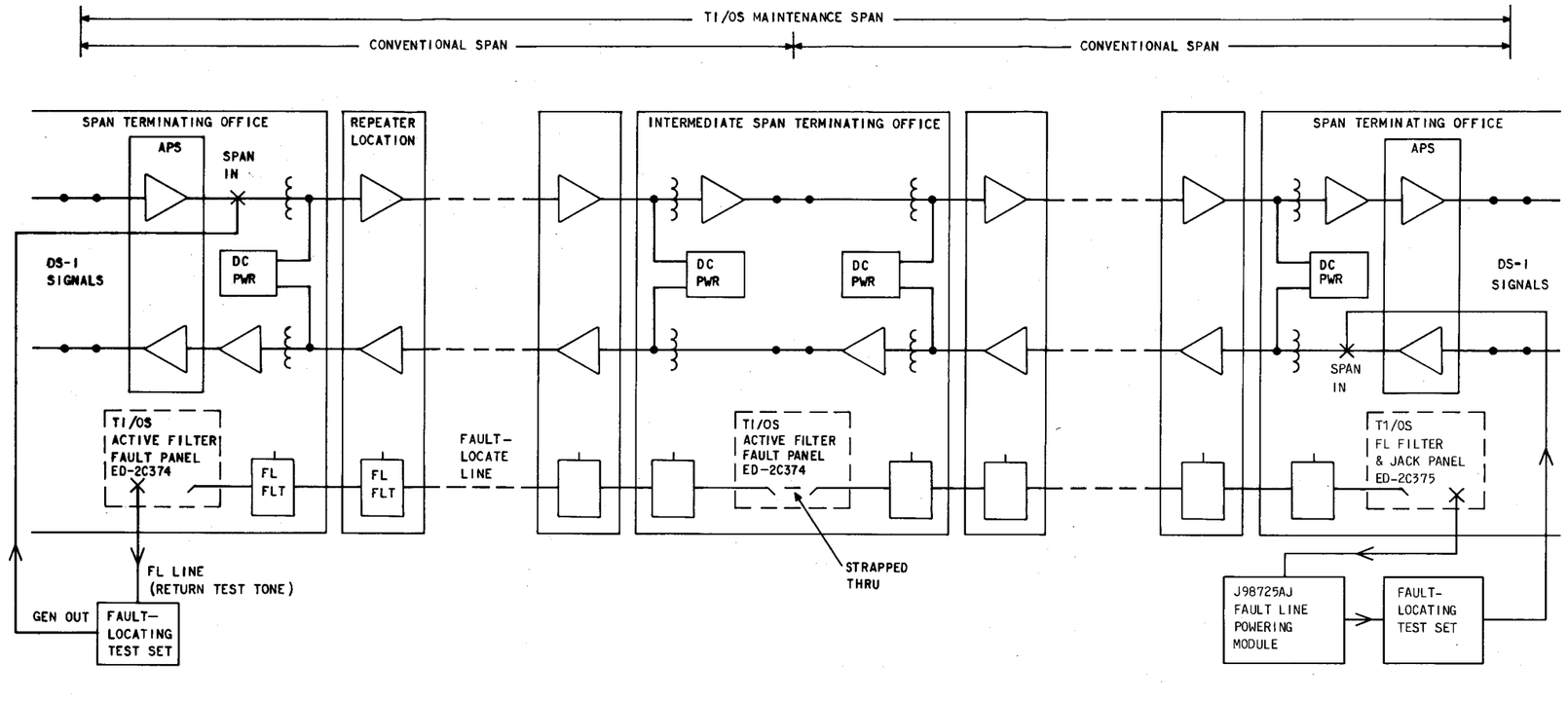


Fig. 1—Fault Location of a T1/OS Repeatered Line

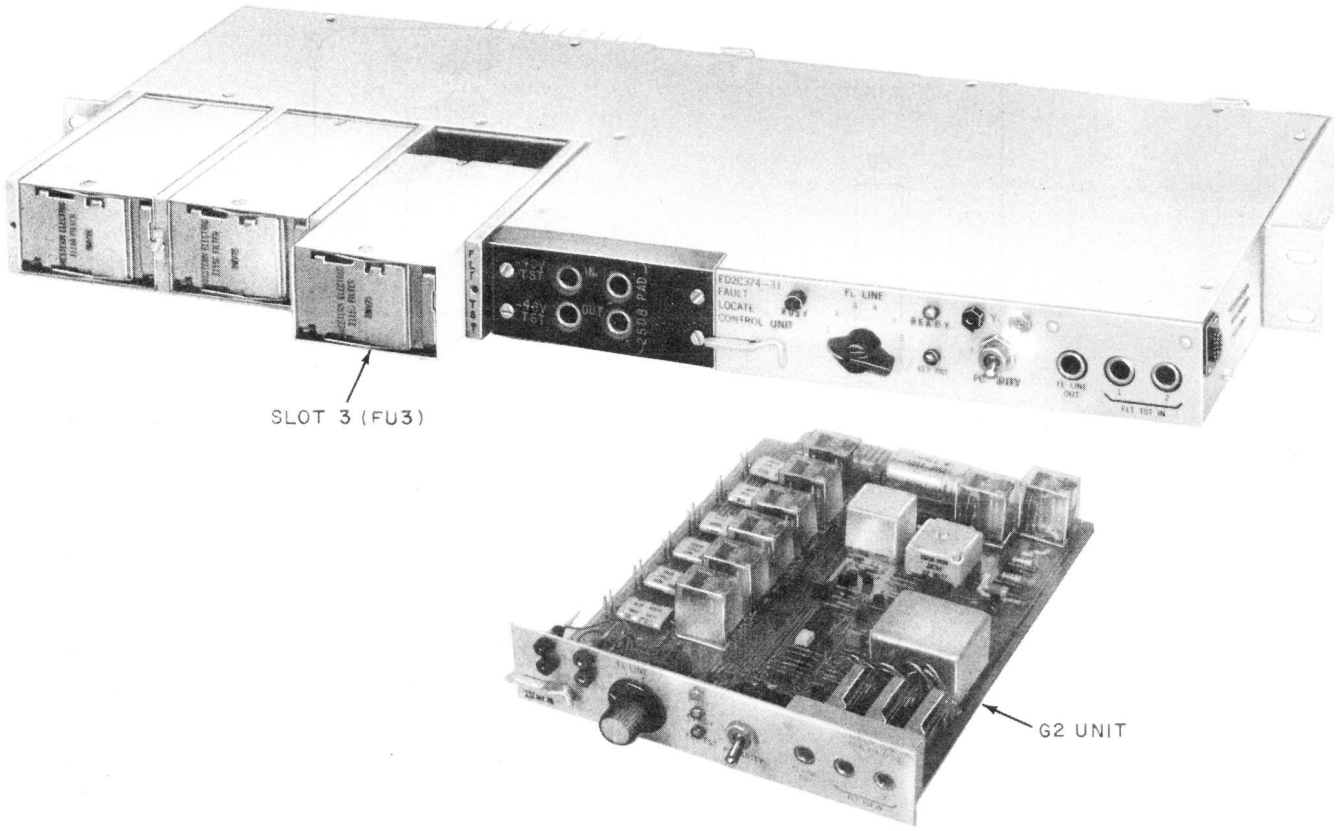


Fig. 2—Fault-Locate Panel

relay and denies access to the selected FL line. If no power exists on the selected line, the logic circuitry allows operation of the selection relay, and access to an FL line is indicated by illumination of the READY lamp. Operation of a selection relay provides line voltage to the selected FL line and allows transmission of the incoming audio test tones to the primary of T1 and subsequently to the FL LINE OUT jack.

2.17 A 25-dB pad on the FL panel reduces the high-level audio returns from filters close to the office. The 10F test set and some of the commercial fault-locating test sets were designed originally for the passive filters, and the active filters within about 30 miles of the office may exceed test set capabilities. Since the 25-dB pad also attenuates interference and noise, its use does not impair testing accuracy.

2.18 The POLARITY switch is connected in series with the power applied to the FL line. This switch serves to reverse the polarity of the applied line voltage on the FL line. Since transmission from the active filters is polarity sensitive, this action serves to identify the specific filter or direction of digital transmission responding to the interrogating test signal. Figure 7 shows the bay label card which provides correlation of the filter types and received signal levels with the assigned repeater location in the span line. This record is attached to the right side (facing bay) of the span terminating bay adjacent to the FL panel.

2.19 When one direction of a normalled-through FL pair (option W) is being interrogated, the other direction is powered to provide a busy signal to other offices on the same FL line.

2.20 Filter position FU3 is uniquely arranged in association with the internal components of the panel to provide a filter test circuit. This circuit consists of FLT TEST IN jacks 1 and 2, FLT TST lamp, relay K7, FL LINE OUT jack,

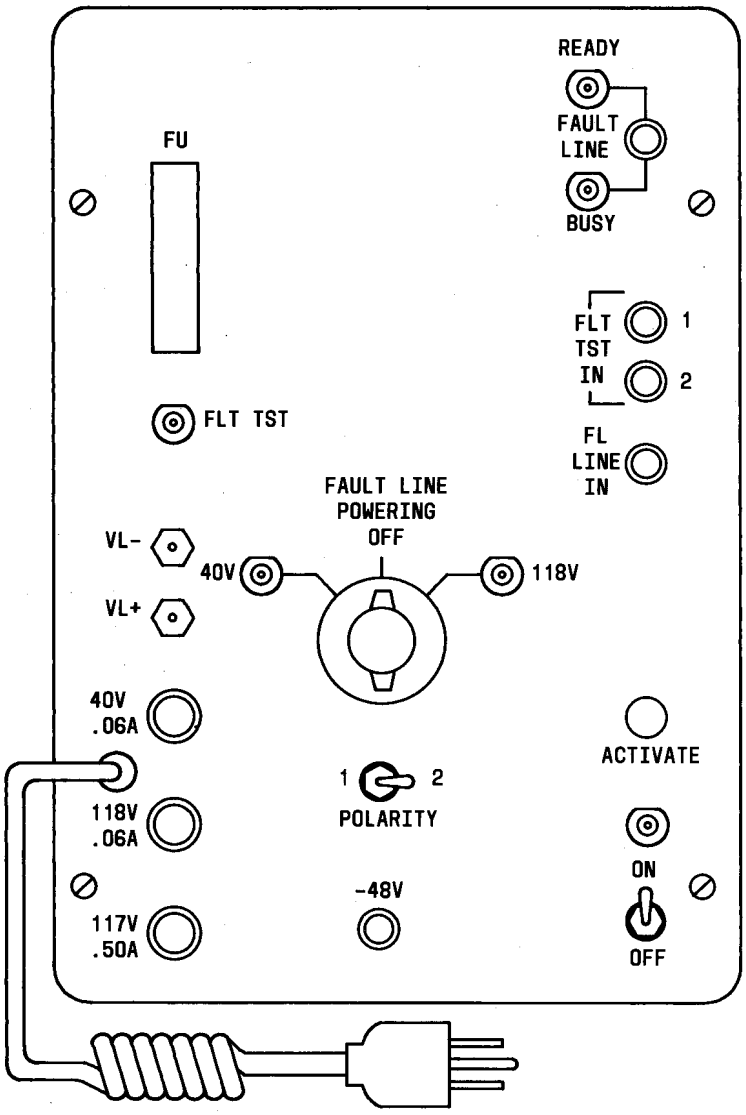


Fig. 3—J98725AJ Fault Line Powering Module

RLC networks, -48 volt power, and switch S2. The test circuit is activated by connecting a signal input to either FLT TEST IN jack 1 or 2. The signal output from the filter is obtained at the FL LINE OUT jack. Accessing the filter for test completes the circuit path from GRD, through the coil of K7, through the FLT TST lamp, and to the -48 volt power supply. The filter test mode of operation is indicated by the lighting of FLT TST lamp, and operation of K7 allows access to the inputs of filter position FU3. Access to the test signal at the FL LINE OUT jack is obtained by properly setting switch S2. This setting is determined by the FL line strapping to the output of filter position FU3. This information must be obtained from the office records. The FU3 position on the panel is used for regular application of an office repeater filter and, hence, is normally connected to one of the S2 positions. If FU3 is not in regular use, a cross-connection must be made to give test access. With the proper setting of switch S2, direct access of the FL LINE OUT jack to the output of filter position FU3 is automatically provided by means of one of the six relays (refer to Fig. 6) unless the busy-ready logic detects a busy condition on the FL line being used.

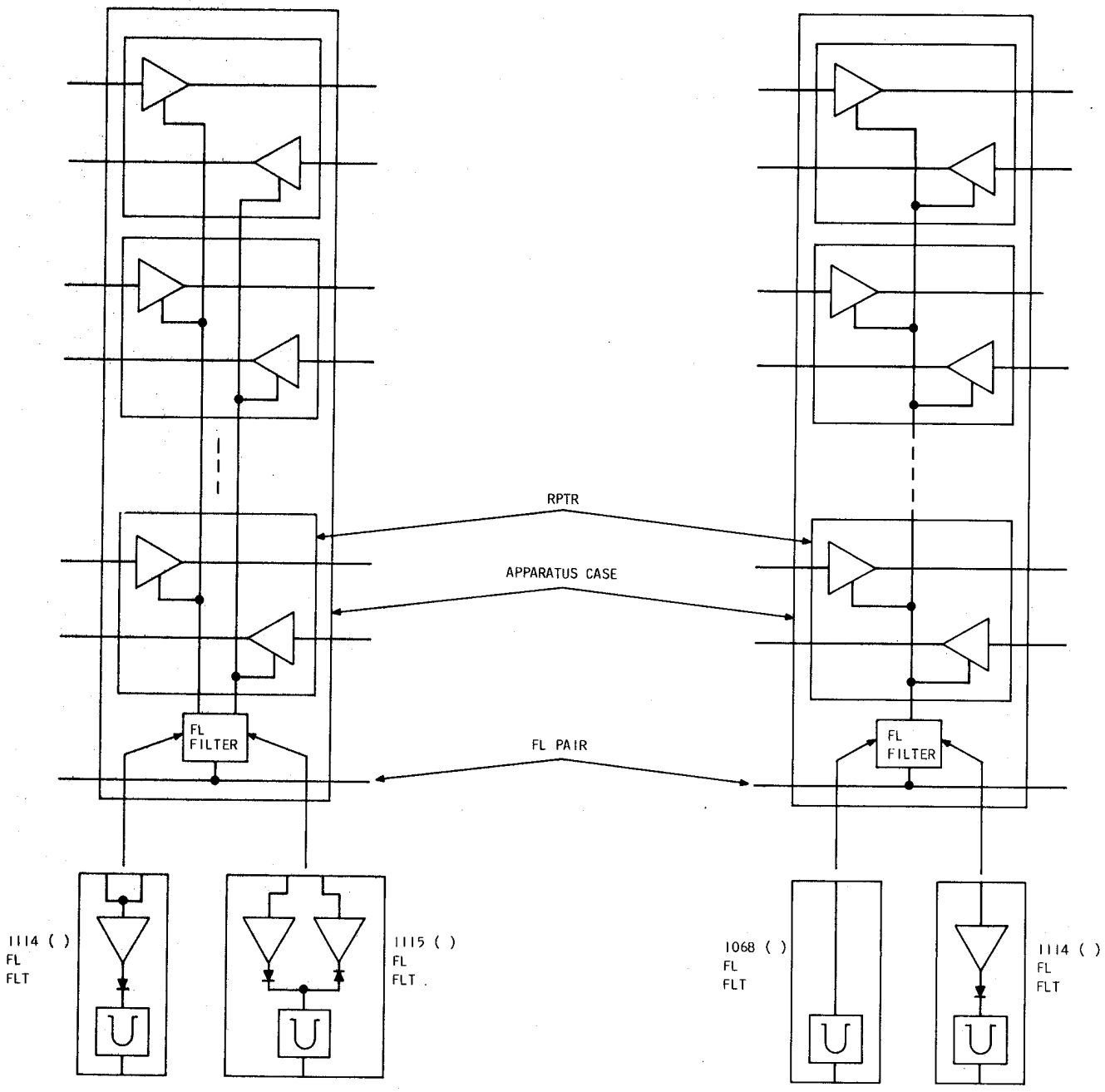


Fig. 4—Illustration of Use of FL Filters at Repeater Locations

(2) Fault-Locate Filter and Jack Panel (ED-2C375)

2.21 In those applications where only passive FL lines are required, or where the J98725AJ Fault Line Powering Module is available, it is usually preferrable to install the ED-2C375 panel. This panel has provision for terminating eight fault lines or through-connecting four fault lines. It has two -48V TST jacks and provision for six fault-locate filters for connection to the office repeaters.

2.22 Resistors E and G (1000 ohms) are normally provided to terminate the passive FL lines. For active FL lines, there are eight active line terminations consisting of 909-ohm resistors in series with 1-μf capacitors which can be cross-connected

Fig. 5—J98725AD Fault-Locating Test Set

to the FL jacks. For through connection of FL lines, remove the E and G resistors and connect the F straps. Switches connected to each filter socket short the collector pairs from the repeaters when the filter is removed from its socket.

2.23 When fault locating an active FL line, the powering and identification functions usually provided by the ED-2C374 panel are provided by the J98725AJ Fault Line Powering Module.

(3) Passive and Active Filters

2.24 The passive or nonamplifier filters for T1 digital transmission systems are coded 598( ) and 1068( ) and are used in the 468( ), 475( ), or 800-type apparatus cases, respectively. Electrically, the filter circuit is the same for both codes.

2.25 The code 1114 (single) and 1115 (dual) active filters, developed for the T1/OS system, use an amplifier in front of each passive filter circuit

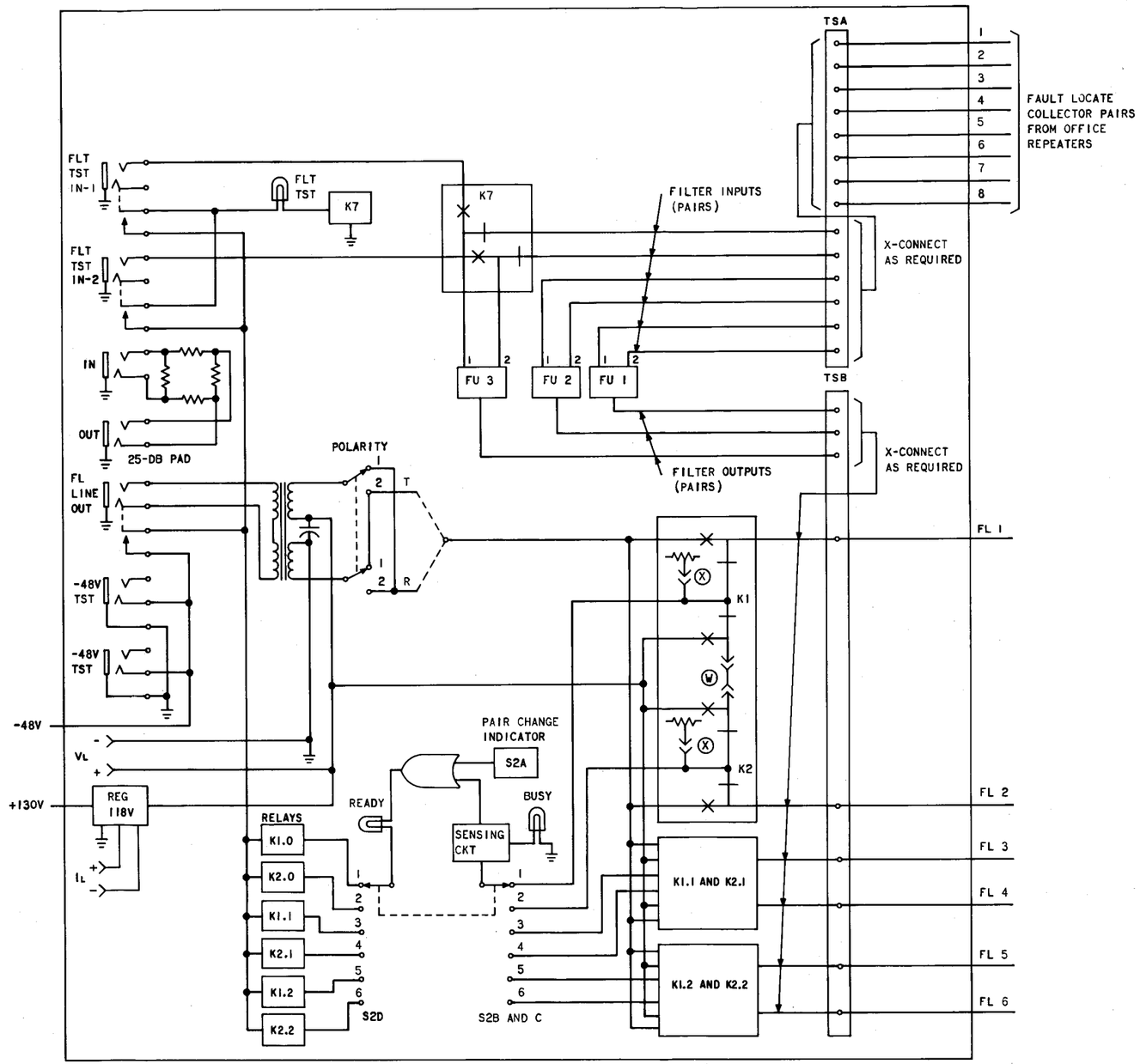


Fig. 6—Functional Diagram of Fault-Locate Panel

FL LINE NO. ____

FILTER GROUP LOC. _____

POLARITY 1		FLT	POLARITY 2	
LEV	LOC		LOC	LEV
		A		
		B		
		C		
		D		
		E		
		F		
		G		
		H		
		J		
		K		
		L		
		M		

Fig. 7—Fault-Locate Panel Designation Card

to provide: (1) signal gain, (2) better filter rejection to adjacent tones, and (3) double frequency use through FL pair powering reversal. These filters require either code 475F, 475G, 468C6 or 800-type apparatus cases to establish the two-direction FL testing capability. Figure 8 shows code 1114 and 1115 active filters. The 1114( ) is used mainly for one-direction FL testing and the 1115( ) is used mainly for two-direction FL testing.

2.26 Power for the active filters is applied to the FL line from a span terminating office. Depending on the polarity, the 1114-type filter will be turned on or off, and the 1115-type filter will have one amplifier on and the other off. A positive voltage on the ring (R) relative to the tip (T) will activate side 1 of the 1115-type filter, which is connected in the apparatus case to side 1 of the repeater. A negative voltage on the R relative to the T will activate side 2 of the 1115 filter. A negative voltage on R relative to T at the active filter location is required to activate the 1114 filter. When there are between 13 and 24 repeater locations, each frequency of the 1114-type active filter may be assigned twice, once to each side of the tip and ring reversal of the FL pair which is placed at midspan in order to separate the two groups. ***Therefore, it is very important to guarantee T-R integrity of the FL pair from apparatus case to apparatus case because of the obvious use of the T-R relationship to identify the individual repeater locations or direction of digital transmission.***

2.27 The active filters are connected in shunt across the FL pair and will draw from 0.7 mA to 1 mA, depending on the T-R voltage. The minimum current drain occurs when the voltage is at its lowest possible level (17 volts) and the highest when the active filter is directly across the 118-volt office source. The T-R drive voltage at a filter must not be lower than 17 volts since nonlinear operation will result.

(4) Fault-Locate System for Bidirectional Mode of Operation of a T1/OS System

2.28 Bidirectional operation of a T1/OS system may be obtained by using one-cable or two-cable configurations (refer to Section 365-010-110). In the bidirectional T1/OS system operation, each direction of transmission is served by one of the two regenerators within each line repeater. Therefore, each line repeater is dedicated to a single T1/OS system. The method of the T1/OS active fault-locate system, as utilized with the bidirectional mode of T1/OS operation, is shown in Fig. 9. The two directions of transmission in an apparatus case are differentiated by reversing the polarity of the line powering voltage.

2.29 This method of fault locating requires that each separate repeater location be assigned one of the 12 unique audio frequency test tones. The ED-2C374 panel used for the active FL system can accommodate 6 fault-locate lines. Since any one of the 6 lines can accept all 12 of the test tones, a maximum of 72 unique repeater locations can be accommodated by a single panel. The ED-2C375 panel, used with the J98725AJ, can accommodate 8 fault-locate lines and a maximum of 96 unique repeater locations. This number of unique repeater locations includes the office

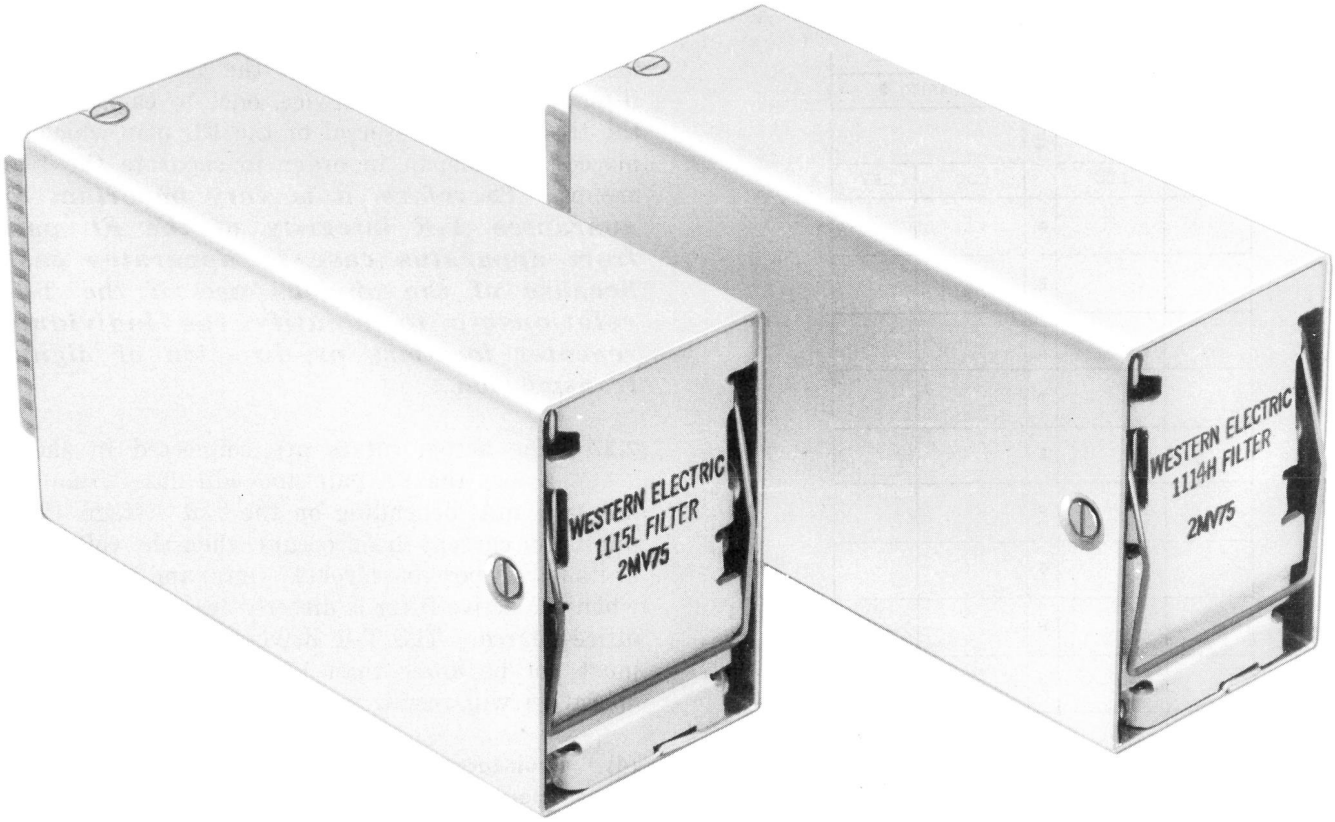


Fig. 8—1114- and 1115-Type Filters

repeaters, although a single assigned test tone can accommodate 2 span terminating offices by using the polarity characteristic of the 1114 active filters.

2.30 The active FL system allows two-direction testing with automatic loopback of the stressed digital signal at the far-end span terminating office. Successful fault locating with this feature requires identification of the direction of digital transmission since any particular repeater location will transmit the same test tone for both directions of transmission. This is accomplished in the bidirectional mode of T1/OS operation by using 1115-type active filters. The system is established with polarity 1 assigned to one direction of transmission and polarity 2 assigned to the other direction of transmission. If the R of the FL pair is at +118 volts with respect to T, side 1 of the filter will be activated, interrogating side 1 of the repeater. The polarity is controlled by the POLARITY switch on the panel or the powering module. Office records must establish correlation of the direction of transmission with the panel designation of polarity 1 and polarity 2.

2.31 If the two span terminating offices are separated by up to 11 repeater locations (not including the office repeaters), only one FL line is required. The filters are assigned in alphabetical order along the line, with a code 1114A active filter responding to polarity 1 in one office and a code 1114A active filter responding to polarity 2 in the other office. For a lesser number of repeater locations, filter assignments are omitted by dropping first the M filter, then L, etc (reverse alphabetically). The higher frequency filters are omitted first because their frequencies correspond to higher line loss. The filters are arranged in alphabetical order because of adjacent channel interference considerations.

2.32 When the system has between 12 and 23 repeater locations (not including the office repeaters), two FL lines are required. The same

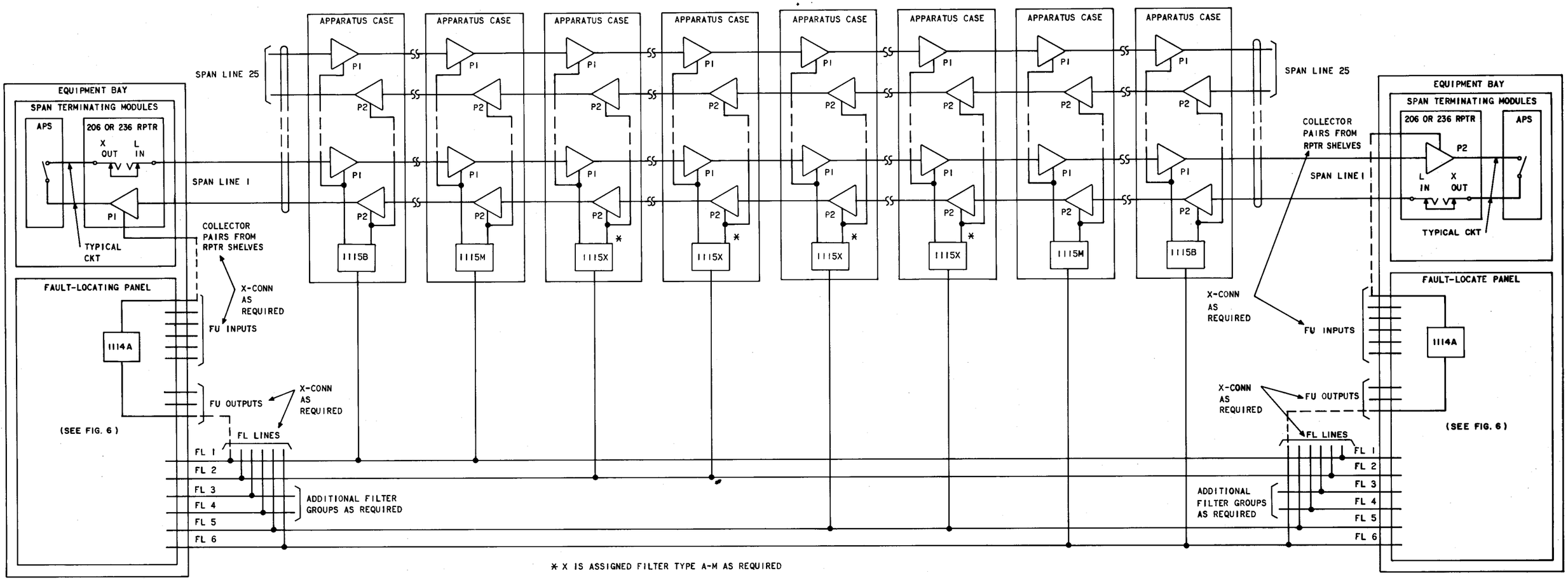


Fig. 9—T1/OS Active Fault-Locate System (Bidirectional Mode of T1/OS Operation)

assignment philosophies apply except that the filters are installed alphabetically toward the midpoint starting from each end office. When assigning the A code for the second and subsequent FL lines, the 1115-type active filter will be used instead of the 1114-type that was used in the first FL line for the span terminating offices.

2.33 When the system has 24 or more repeater locations (not including the office repeaters), other FL lines are added as required to accommodate the filters. The first and last lines are arranged per paragraph 2.32, while the other lines have the filters arranged alphabetically as required. Figure 9 illustrates the philosophies discussed in paragraphs 2.30 and 2.32 for the filter assignment system. With multiple pairs, it is best to have the number of filters per group somewhat equal.

Note: All filter groups will be interrogated and/or powered from either end office.

2.34 Codes 468C6, 475-, and 800-type apparatus cases are used in the active FL system; the 475F, 475G (unprotected and protected), and 800-type cases provide separate fault-locate outputs for each regenerator in the line repeaters. The capacity of the 475- and 800-type cases is 25 T1/OS systems. All FL outputs from the regenerators in one direction of transmission are bridged to the input of the 1115-type active filter that responds to a particular polarity of the FL line voltage. All FL outputs from the regenerators in the other direction of transmission are bridged to the input of the 1115-type active filter that responds to the other polarity of the FL line voltage. This bridging arrangement is illustrated in Fig. 9. The low input impedance of the filters prevents interaction between the regenerators due to the multiple connection of the FL output windings.

2.35 When fault-locating is conducted by a craftsperson at one span terminating office only, it is desirable to loop the far-end office to allow the interrogating test signal to fault locate the other direction of transmission in a T1/OS maintenance span. Figure 9 shows that an automatic protection switch (APS), when provided and properly optioned, performs looping for the T1/OS line. See Section 365-250-110 for a detailed description of the Lynch B302 APS used in the T1/OS system.

(5) Fault-Locate System for Unidirectional Mode of Operation of a T1/OS System

2.36 The unidirectional mode of operation of a T1/OS system may be obtained by using one-cable or two-cable configurations (refer to Section 365-010-110). In the unidirectional T1/OS system operation, both regenerators in the line repeaters serve the same direction of signal transmission. Therefore, a separate apparatus case for each direction of transmission is required and each T1/OS system uses two separate repeaters (one for each direction of transmission). The T1/OS active FL system with the unidirectional mode of T1/OS operation is shown in Fig. 10. A typical termination of the panel and a T1/OS span line (CKT 1) is illustrated.

2.37 The FL line T and R reversal and the polarity sensitive characteristic of the 1114 filter allow each line to accommodate a total of 24 unique locations (including the offices) in either direction of transmission. A total of at least two FL lines is required to accommodate both directions of transmission. One group of 12 filters will then be activated by polarity 1 and the other group will be activated by polarity 2 on any particular FL line. The office records must be consulted to determine the test tone assignment to specific repeater locations, correlation of the polarity 1 and polarity 2 designation with line voltage being used, and the appropriate FL line that must be used to receive the return test tones.

2.38 Since the panel used for the active FL system can accommodate a total of 6 FL lines for the ED-2C374, and 8 for the ED-2C375, a maximum of 72 or 96, respectively, unique repeater locations (including offices) can be accommodated. The active FL system arrangement for two-cable unidirectional mode of T1/OS operation allows a system density of 50 systems when terminated in each office with a single FL panel. A full capacity single-route arrangement is shown in Fig. 10, and the 72 or 96, respectively, unique repeater locations (including offices) may be obtained by using additional FL lines configured as indicated.

2.39 Two-directional FL testing from one span terminating office, using automatic or manual loopback at the far-end office, can be accomplished with the unidirectional mode of T1/OS operation. Successful fault locating using the loopback feature requires careful attention to the polarity of the

applied FL line voltage and the particular FL line selected to receive the return test tones.

2.40 If the two span terminating offices are separated by up to 23 repeater locations (not including the office repeaters), one FL line per cable with T and R reversal following first use of the 12 test tones is required. The filters are assigned in alphabetical order along each FL line, starting at each office, to ensure that the lower frequency filter will be used at those locations potentially the longest distance from the FL test set. The "A" code for the first two FL lines used would be allocated to the offices.

2.41 When the FL system has between 24 and 71 repeater locations (not including the office repeaters), other FL lines, using the circuit configuration (both directions of transmission) shown in Fig. 10, are added as required. Systems exceeding 72 repeater locations must add additional fault-locate panels to accommodate added FL lines. The six FL lines per panel can be used to access up to six separate routes if two-directional testing is not required.

2.42 The unidirectional mode of T1/OS operation requires two 475-type (unprotected, 475A or F; protected, 475B or G) or 800-type apparatus cases at each repeater location. The 475-type or 800-type case can accommodate a total of 25 repeaters. Since all repeaters in each case operate in the same direction of transmission, all FL outputs from the 50 regenerators are bridged to the input of the 1114-type active filters that respond to a specific polarity of the line voltage.

3. INITIAL TESTS

3.01 Initial testing of the active FL system includes those tests which are made on the cable facilities and apparatus prior to establishing the fault-locating capability.

A. Cable tests include tests of loss, resistance, resistance unbalance, noise, conductor turnover between repeaters, shorts, crosses, grounds, and crosstalk on the cable facilities.

B. In particular, T-R integrity of each fault pair section should be verified. Access to the fault pair at the 475-type or 800-type apparatus case is made on terminals 8 or 11 (tip) and 9 or 12 (ring) of the coil slot using a 247A adapter.

Caution: The use of test probes on apparatus case connectors has damaged them and caused intermittent problems. Access these terminals only with a proper adapter, such as a 247A.

C. Apparatus tests include tests in accordance with appropriate Bell System Practices.

3.02 Detailed requirements for initial turnup tests for the T1/OS active FL system are provided in Section 365-224-600.

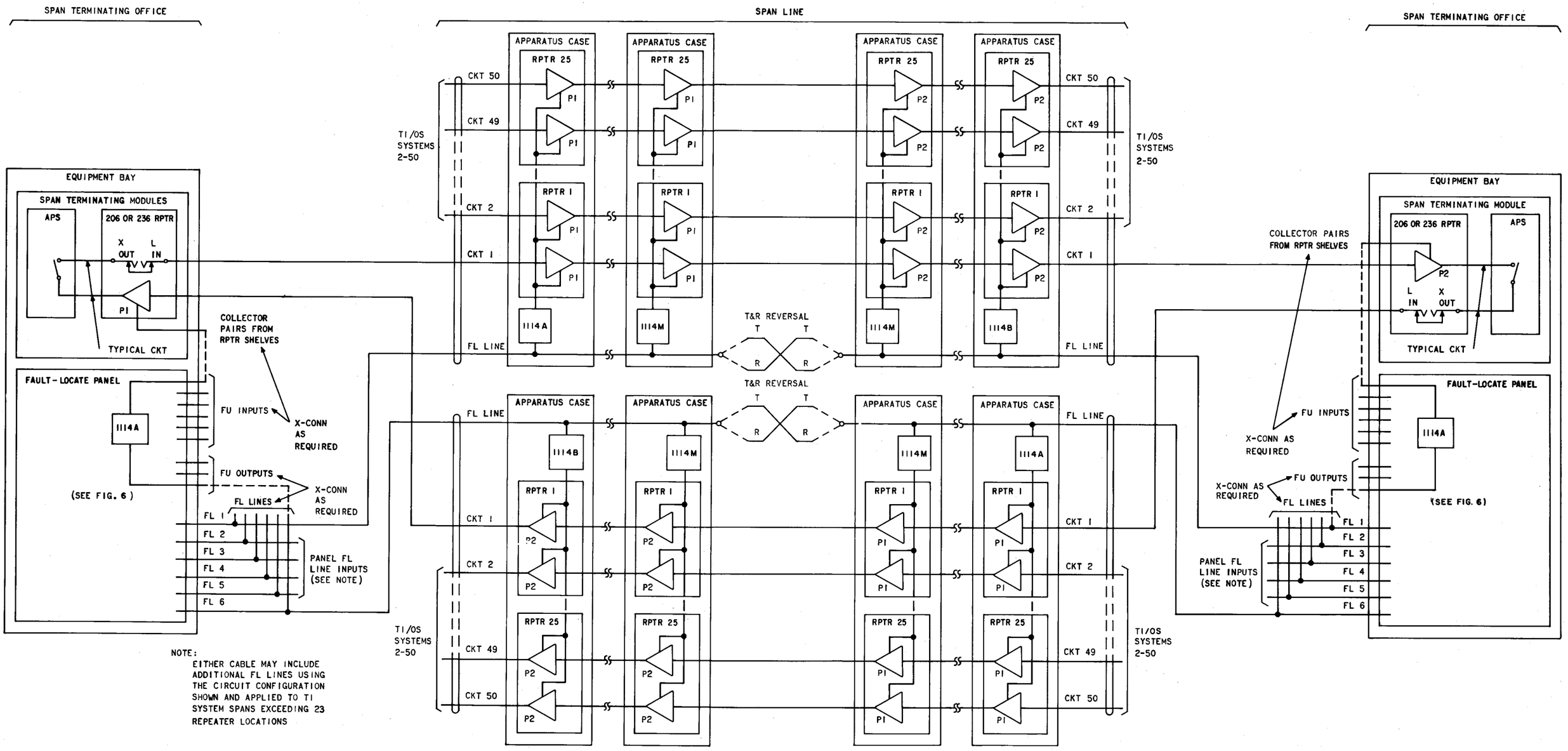
4. MAINTENANCE

4.01 The active fault-locate system does not require scheduled periodic maintenance tests. However, operational capability will be verified prior to performing fault-locate procedures to locate trouble in a T1/OS system. These required operational tests are provided in Section 365-200-410.

5. OPERATION

A. General

5.01 When a T1/OS span line fails, the active FL system is used to determine which repeater or associated section of line is causing the failure. This can be accomplished on the maintenance span between APS offices by utilizing the loopback function of the APS. Fault locating is accomplished by applying a stressed fault-locate DS-1 digital signal containing an audio tone in its spectrum to the failed T1/OS system. The audio component will be present in the output of each operating line repeater in the span under test. This output from each repeater along the route is coupled to the assigned narrow band selective filter for application to an FL line. The FL panel at a span terminating office controls the polarity of the voltage applied to the active 1114/1115 filters and allows the audio frequencies on an FL line to be selectively monitored. The FL test signal also accomplishes the loopback of the far-end office after normal service has been switched to the protection line. The office records provide correlation of the test tones to a specific assigned repeater location and, therefore, the absence of an expected response indicates the location of the fault in the T1/OS



NOTE:
EITHER CABLE MAY INCLUDE ADDITIONAL FL LINES USING THE CIRCUIT CONFIGURATION SHOWN AND APPLIED TO TI SYSTEM SPANS EXCEEDING 23 REPEATER LOCATIONS

Fig. 10—T1/OS Active Fault-Locate System (Unidirectional Mode of T1/OS Operation)

system. Normal obscure trouble or margin testing can also be pursued as in Section 365-227-500.

B. Fault-Location Testing

5.02 Fault-location testing requires the new J98725AD T1C/T1 fault-locating test set (FLTS), or equivalent. Power for the test set is obtained by plugging the -48 volt cord from the test set into one of the -48 volt jacks in the fault-locate panel located in a span terminating bay, or into the -48V jack on the J98725AJ Fault Line Powering Module (FLPM). The signal from the J98725AD test set is applied to the failed T1/OS system by connecting a cord from the GEN/SPAN LINE jack on the test set (see Fig. 5) to the L IN jack on the 206-type or 236-type repeaters (or equivalent) as shown in Fig. 9 and Fig. 10. The equipment is arranged for receiving the return test tones by connecting a cord from the FL LINE OUT jack on the fault-locate panel (see Fig. 2 and Fig. 6) or the FLPM (Fig. 3) to the RCV/FL LINE jack on the test set (see Fig. 5). The particular FL line connected to the test set is determined by referring to the office records and selected by positioning the FL LINE switch on the FL panel to the desired line. If an FLPM is used, each FL line is individually accessed and connected to the FLPM through the fault-line jack. Operation of the test equipment is described in Section 103-494-106, 103-491-100, or 103-494-109.

C. Filter Testing

5.03 Filter testing allows verification of the operating capabilities of the 1114/1115 active filters prior to installation in the apparatus cases or for general maintenance. The J98725AD T1C/T1 fault-locating test set is used, and the internal wiring for the fault-locate panel (see Fig. 2 and Fig. 6) is located in a span terminating bay. The switching function of the FL panel provides access to the two inputs of an 1115 filter or the single input of an 1114 filter when installed in the FU3 position. The output of this filter position is strapped to an operating (or nonoperating) FL line termination as shown in Fig. 6. Access to this output is provided on the FL panel.

5.04 Power for the test equipment is obtained by plugging the -48 volt cord from the test set into one of the -48 volt jacks on the FL panel. The signal from the test set is applied to the filter under test (1114 or 1115) by connecting a cord from the GEN/SPAN LINE jack on the test set (see Fig. 5) to either FLT TST IN-1 or FLT TST IN-2 jacks in the FL panel (see Fig. 2 and Fig. 6). The FLT TST IN-1 jack provides access to the side 1 input of the 1115 filter. The FLT TST IN-2 jack provides access to the other input of the 1115 filter or the single input of the 1114 filter. The equipment is arranged for receiving the test tones by connecting a cord from the FL LINE OUT jack on the fault-locate panel to the RCV/FL LINE jack on the test set.

5.05 Consult the office records to determine the FL line termination that is strapped to the output of filter position FU3. Testing the filters can be accomplished by selecting this fault line by the switching function of the fault-locate panel. The basic conditions for filter testing require that test connections be made to either FLT TST IN-1 or FLT TST IN-2, and to the FL LINE OUT to activate relay K7. Also, access to the output requires that the busy/ready logic sense a READY condition for the FL line termination being used. The FLPM has the same provisions for filter testing as the FL panel.

6. REFERENCES (NOT ATTACHED)

6.01 SD-1C603-01
CD-1C603-01
Section 103-491-100
Section 103-494-106
Section 103-494-109
Section 365-010-110
Section 365-200-410
Section 365-250-110
Section 855-350-104