

**T1 OUTSTATE (T1/OS) SYSTEM
GENERAL DESCRIPTION
DIGITAL TRANSMISSION SYSTEMS**

CONTENTS	PAGE	CONTENTS	PAGE
1. GENERAL	2	D. Fault-Locating Filters	14
2. FEATURES OF THE T1/OS SYSTEM	2	E. Load Coils and Connectors	17
A. General	2	4. OFFICE EQUIPMENT	18
B. Transmission	3	A. J98728 Span Terminating Bay (STB)	18
C. Maintenance Span Concept	4	(1) Line-Terminating Module (LTM)	19
D. Modes of Operation	5	(2) Fuse and Alarm Panel	33
(1) One Cable Using Bidirectional Repeaters	9	(3) D3 Channel Bank	35
(2) One Cable Using Unidirectional Repeaters	9	(4) Hot Spare and Maintenance Shelf for D3 Banks	35
(3) Two Cables Using Bidirectional Repeaters	9	(5) D4 Channel Bank	35
(4) Two Cables Using Unidirectional Repeaters	9	(6) D4 Maintenance Bank	35
(5) Screened Cable Using Unidirectional Line Repeaters	10	(7) DS1 Jack and Cross-Connect Panel	36
(6) Screened Cable Using Bidirectional Line Repeaters	11	(8) Order-Wire Panel	36
(7) Combined T1/OS and T2 Operation	11	(9) Fault-Locating Panel	37
3. OUTSIDE PLANT EQUIPMENT	11	(10) Protector Panel	37
A. Cable	11	(11) Filter Panel	38
B. Apparatus Cases	12	B. Functional Diagram of J98728 Span Terminating Bay	38
C. Line Repeaters	12	5. POWERING OF T1/OS DIGITAL LINES	41
		6. T1/OS SYSTEM MAINTENANCE	41

NOTICE

Not for use or disclosure outside the
Bell System except under written agreement

	CONTENTS	PAGE
A.	General	41
B.	Facilities	43
	(1) Automatic Protection Switching (APS) System	43
	(2) Status Reporting and Control (SRC) External Telemetry System	44
	(3) Fault-Location System	46
	(4) Order-Wire System	50
7.	AUXILIARY TEST EQUIPMENT	50
A.	KS-20775, L2 Error Rate Test Set	50
B.	DS1/DS1C/DS2 Error Rate Test Sets (KS-22331, L1 Transmitter and KS-22332, L1 Receiver)	53
C.	J98725AA, T1C/T1 Pair Loss Test Set	53
D.	J98725AD T1C/T1 Fault-Locate Test Set	54
E.	J98725AC T1C/T1 Office Bipolar Violation Detector	54
F.	J98725AB T1C/T1 Manhole Bipolar Violation Detector	55
G.	KS-20599, L4 Digital Voltmeter	55
8.	REFERENCES	55

1. GENERAL

1.01 This section contains a general description of the T1 Outstate (T1/OS) Digital Carrier System and associated equipment. This description presents the T1/OS system as a special application of T1 principles that extends the range of the DS1 digital level [1.544 megabits per second (Mb/s)] to a maximum of 200 regenerator sections. This extended range is achieved while maintaining current T1 performance objectives through the use of: (a) new and/or modified T1 hardware with improved maintenance features, (b) a set of T1/OS engineering

rules that addresses the outstate environment, and (c) a T1/OS maintenance plan which provides a logical, systematic approach to maintaining and troubleshooting a T1/OS network.

1.02 This section is reissued to add information for new error rate test sets KS-22331, L1 and KS-22332, L1; digital voltmeter, KS-20599, L4; and a new series of passive FL filters, 1068AA through AM. Revision arrows are used to indicate changes. Equipment test list(s) are not affected.

2. FEATURES OF THE T1/OS SYSTEM

A. General

2.01 The T1/OS system is an application of the T1 transmission principles to the needs of rural toll-connecting and intertoll networks that exceed the maximum system length of 50 miles allowed for regular T1. Accordingly, the T1/OS system extends the range of T1 carrier to 200 regenerator sections. It has features that provide the ability to control and maintain single or multiple tandem connected powering spans in a network with unmanned offices that is consistent with the rural environment. It offers flexible office equipment arrangements suitable for small cross-section routes.

2.02 The extension of length is obtained by the more stringent application of existing T1 engineering rules. Some limitations on cable loading and type of plant are necessary. The engineering rules accommodate either one-cable or two-cable operation (Part 2D), with either unidirectional or bidirectional apparatus cases. Two-cable or screened one-cable operation with bidirectional apparatus cases is the preferred mode of operation.

2.03 The maintenance plan for T1/OS is characterized by the maintenance span concept (Part 2C). A maintenance span is defined by the two ends of the automatic protection switch (APS) and can include intermediate powering offices. The APS equipment terminates each end of a group of T1 lines (N "service" lines and one dedicated "protection" line) to comprise a maintenance span. The APS equipment is used in conjunction with an active fault-locating (FL) system which has improved signal-to-noise ratios (relative to the passive FL system) and the capability for either conventional or single-end fault location. The APS equipment also provides capability for remote monitoring of the T1/OS lines and control of the APS equipment.

This monitoring and control activity is accomplished by either of two optional means: (a) self-contained remote status reporting and control system (SRC), or (b) an external general purpose telemetry system. Either system permits remote identification of faulty maintenance spans and efficient dispatch of maintenance personnel. Consistent with the longer maintenance spans expected in T1/OS, an improved 2-wire order wire is provided (Part 6B). It is a dial loop line like the older T1 order wire, but provides greater range and sensitivity.

2.04 Flexible physical arrangements have been provided to accommodate the highly variable equipment groupings needed for implementation of the T1/OS system. The span terminating bay (Part 4) in the span terminating office (STO) is designed to accommodate D3 or D4 banks and repeatered-line line terminating modules (LTMs) in a common frame. Thus, within the bay itself, digital line powering spans or maintenance spans may terminate and be either through connected to tandem spans or dropped to D3 or D4 banks. A protector panel is available for directly terminating tip cables from the vault on the T1/OS bay. All the equipment for a small end office may therefore be accommodated in one span terminating bay. Larger size equipment groupings could use combinations of the various available T1/OS span terminating bays and standard D3 or D4 bays. The outside plant apparatus consists of existing and new codes of 208, 209, 238, 239, and 205 automatic line build out (ALBO)-type line repeaters, 475, 468C, and 800-type apparatus cases, and their associated fault-location and order-wire components. In some systems the low power line repeaters (238 and 239 type) have replaced the 208 and 209 types, but the two types should not be intermixed within the span. When a 468C6 apparatus case is used, the low power repeaters require that a 273A adapter also be installed.

B. Transmission

2.05 The T1/OS digital line consists of repeaters placed appropriately in sections of cable to produce a zero-loss facility for digital transmission between STOs. The digital signal consists of bipolar (alternate positive and negative polarity) pulse transmission using time division multiplex of pulse code modulation (PCM) at a rate of 1.544 Mb/s. The digital signal is defined as the DS1 level in the digital signal hierarchy.

2.06 In PCM, all the information in the message is transmitted by the presence or absence of pulses in particular time slots. The fundamental advantage gained by this transmission system is that the pulse train can be regenerated with little or no accumulation of noise and distortion from one repeater section to another. The repeater has only to respond to the presence of a pulse in a particular time slot and, if a pulse is present, generate a new pulse. In this way, a completely new pulse train is generated which is essentially free of noise and distortion. Since the repeater is relatively insensitive to variations in pulse height, width, and shape, exchange-type cables can be used for the transmission medium.

2.07 The pulses in the DS1 signal are of 50-percent duty cycle and thus have a pulse width of about 1/3 microsecond. The output of a repeater on the line is about 3 volts base-to-peak. Figure 1 shows the typical bipolar signal sent over the T1/OS line. This signal is produced by a DS1 source, such as a D-type channel bank or wideband data or multiplex equipment. The bipolar pattern applied to the line is assured in the last stage of the terminal equipment by inverting every second pulse of a unipolar pulse train generated by the encoding and monitoring circuits of that terminal. Therefore, every pulse in the resultant bipolar train is of opposite polarity from the preceding pulse regardless of the number of vacant pulse positions between them. However, the number of zeros between two pulses is limited to 15 so as to guarantee adequate repeater timing.

2.08 A Fourier analysis of the basic unipolar pulse will determine that it consists of a dc component, the fundamental repetition frequency, and all odd harmonics of the fundamental frequency. Therefore, the energy spectrum of a unipolar pulse train has a peak at zero (dc) and at each odd multiple of the pulse repetition frequency (f). In a bipolar pulse train the energy spectrum has a peak at one-half the unipolar repetition frequency (f/2) and at all odd multiples of this frequency; nulls occur at all even multiples of this frequency. Thus, the bipolar pulse train has an effective transmission frequency of one-half that of a unipolar train of the same pulse repetition rate and contains no dc component. This is illustrated in Fig. 2. Figure 3 shows the power density spectrum of a working T1/OS digital line, using bipolar pulses, for various amounts of traffic. This figure shows that the energy is concentrated in a band of

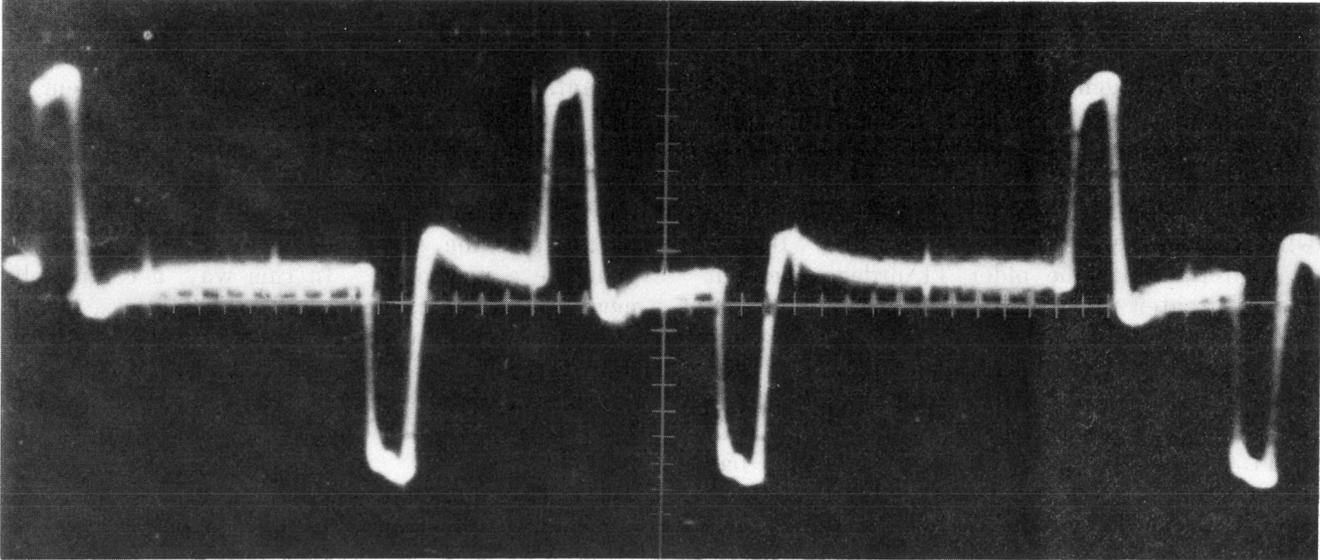


Fig. 1—Bipolar Pulse Pattern

frequencies near 0.772 MHz, and the bandwidth required for transmission of this signal is about 1.50 MHz.

2.09 The following advantages are gained in using a bipolar pulse train instead of a unipolar train:

- (a) The same amount of information can be transmitted in about one-half the bandwidth.
- (b) The reduced bandwidth lowers the transmission frequency limits; thus, the signal is attenuated less by the cable.
- (c) Crosstalk from other systems is reduced because crosstalk coupling is reduced at lower frequencies.
- (d) The absence of dc energy in the bipolar pulse train permits the repeaters to be transformer-coupled to the T1/OS digital line.
- (e) The intrinsic balance of the bipolar pulse pattern makes possible a simple method of measuring errors on the T1/OS digital line.

C. Maintenance Span Concept

2.10 A T1/OS SPAN LINE consists of a pair of wires with a string of regenerators from the J98728 span terminating bays (STB) in one office to the J98728 STB in another office with no intervening STBs. The aggregate of all span lines (in one cable sheath or multiple cables) between two STOs is called the SPAN between these offices as shown in Fig. 4. The signal at the repeater output jacks is at a standard level point; thus, the output of a span line may be connected to terminal equipment such as a digital channel bank (D3 or D4), a wideband data bank, or a modem in the STO, or it may be connected to any span line going out of the STO. This is shown in Fig. 4 by the span lines being through connected at the STM or the alternative of connecting to the terminal equipment. The inputs and outputs of span lines, digital channel banks, data banks, or modems can be made accessible for patching at the DS1 jack and cross-connect panel on the STB. Span lines may be in different cable sheaths and lie along different geographical routes. For administration, the span line is a convenient unit since all span lines from one office to another are, for all practical purposes, indistinguishable. For example, any span line from one office to another office could act as

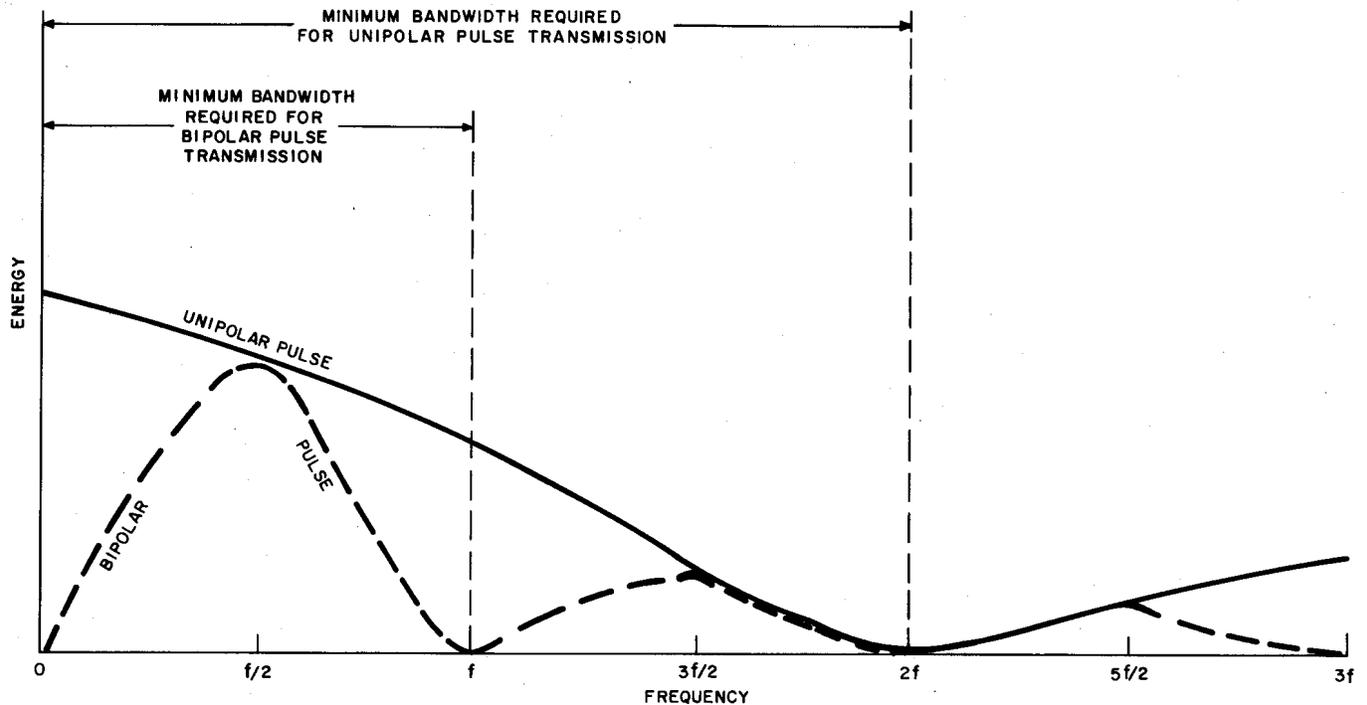


Fig. 2—Comparison of Unipolar and Bipolar Pulse Spectra

a maintenance line for any other span line between those offices in the same direction.

2.11 The T1/OS spans are terminated by a span terminating module (STM) in the J98728 STB in each office as shown in Fig. 4. The APS equipment is designed as an integral part of the STM and the use of plug-in units (Part 4A) implements the protection switching function. Establishing the switching function at a particular STM is optional and based on the desired network configuration. When the plug-in units are not used, shorting-type connectors allow a straight through connection of the associated span line. The T1/OS digital lines are powered by means of an office battery connection to the STM. More than one powering section may occur between the two STMs that implement the protection switching system, although the intermediate powering office STMs might not be equipped with APS plug-ins. A MAINTENANCE SPAN is defined as that part of a T1/OS line that exists between the two STMs that establish a protection switching system and it may contain more than one powering section.

2.12 The basic engineering of the T1/OS line consists of designing the individual span between STOs (Fig. 4) and equipping the STMs

appropriately to establish the protection switching ability required in the maintenance plan. This provides administrative units for assignment, maintenance, and powering of the T1/OS system. The fault-location system is designed on a maintenance span basis. The two-wire order-wire facility can be designed independently of the maintenance span.

D. Modes of Operation

2.13 The following seven modes of cable-repeater operation are used for T1/OS systems:

- (1) One cable using bidirectional line repeaters
- (2) One cable using unidirectional line repeaters
- (3) Two cables using bidirectional line repeaters
- (4) Two cables using unidirectional line repeaters
- (5) Screened cable using unidirectional line repeaters
- (6) Screened cable using bidirectional line repeaters
- (7) Combined T1/OS and T2 operation.

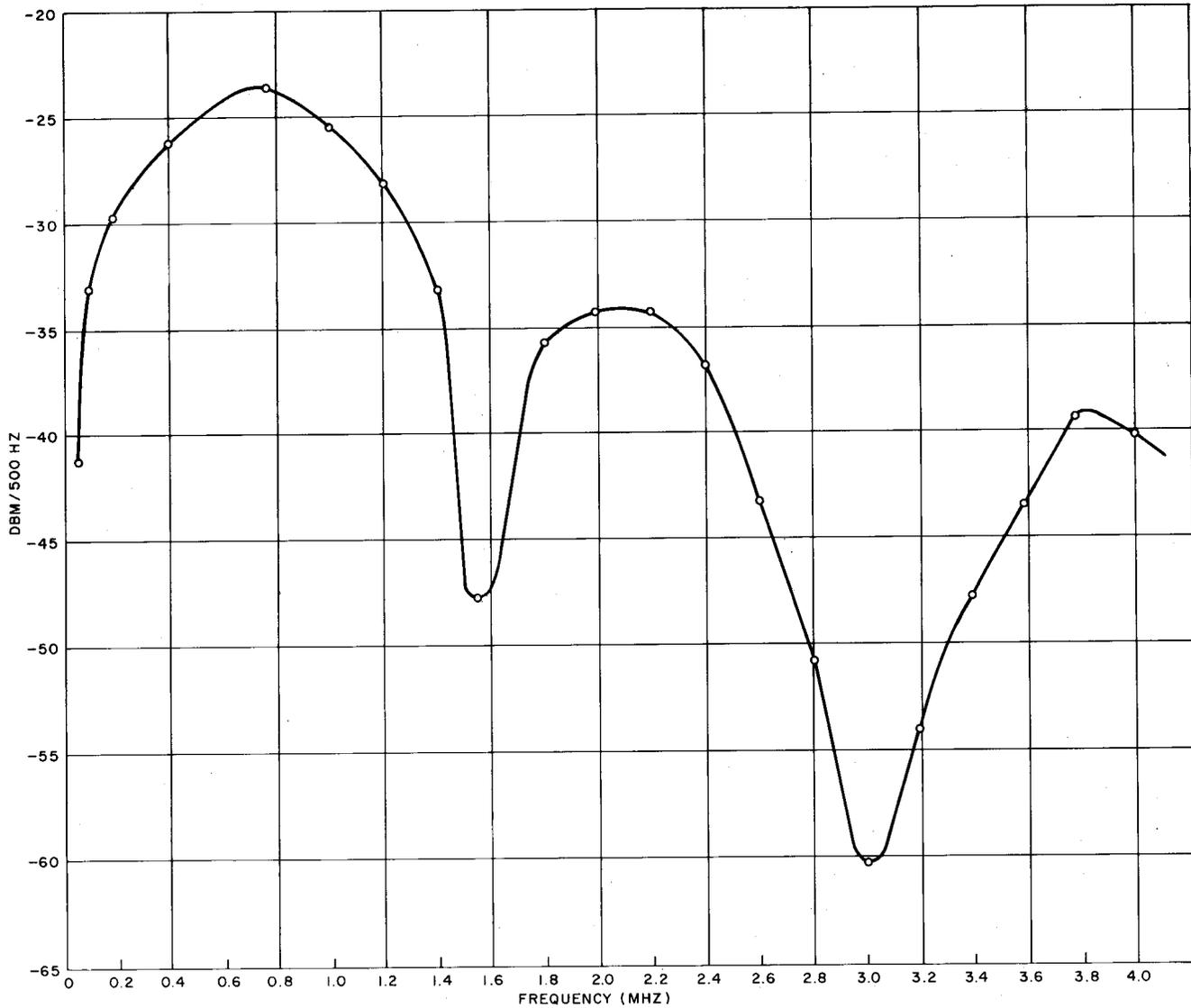


Fig. 3—Power Density Spectrum—Moderate to Heavy Traffic

Both directions of transmission are carried in a single cable sheath in Modes 1, 2, 5, and 6, while each direction of transmission is carried in a separate cable sheath in Modes 3 and 4. Modes 1, 4, and 6 are the most widely used modes. Mode 7 may be used where T1 lines are not available.

2.14 The line repeaters are plug-in units consisting of two separate regenerator circuits. These regenerators are factory-wired in the units so that they either provide regeneration for both directions of transmission (bidirectional) or one direction of

transmission (unidirectional). Thus, line repeaters are classified as bidirectional or unidirectional and are administered on that basis. All the line repeaters are powered from an STO over cable pairs and either loop powered back to that office or through powered to the next repeater.

2.15 The six modes of operation result from using either type of repeater with one cable (screened or unshielded) or two cables to provide both directions of transmission. The line repeaters are placed in an apparatus case located at manhole, pole, or pedestal locations. Integral to the apparatus

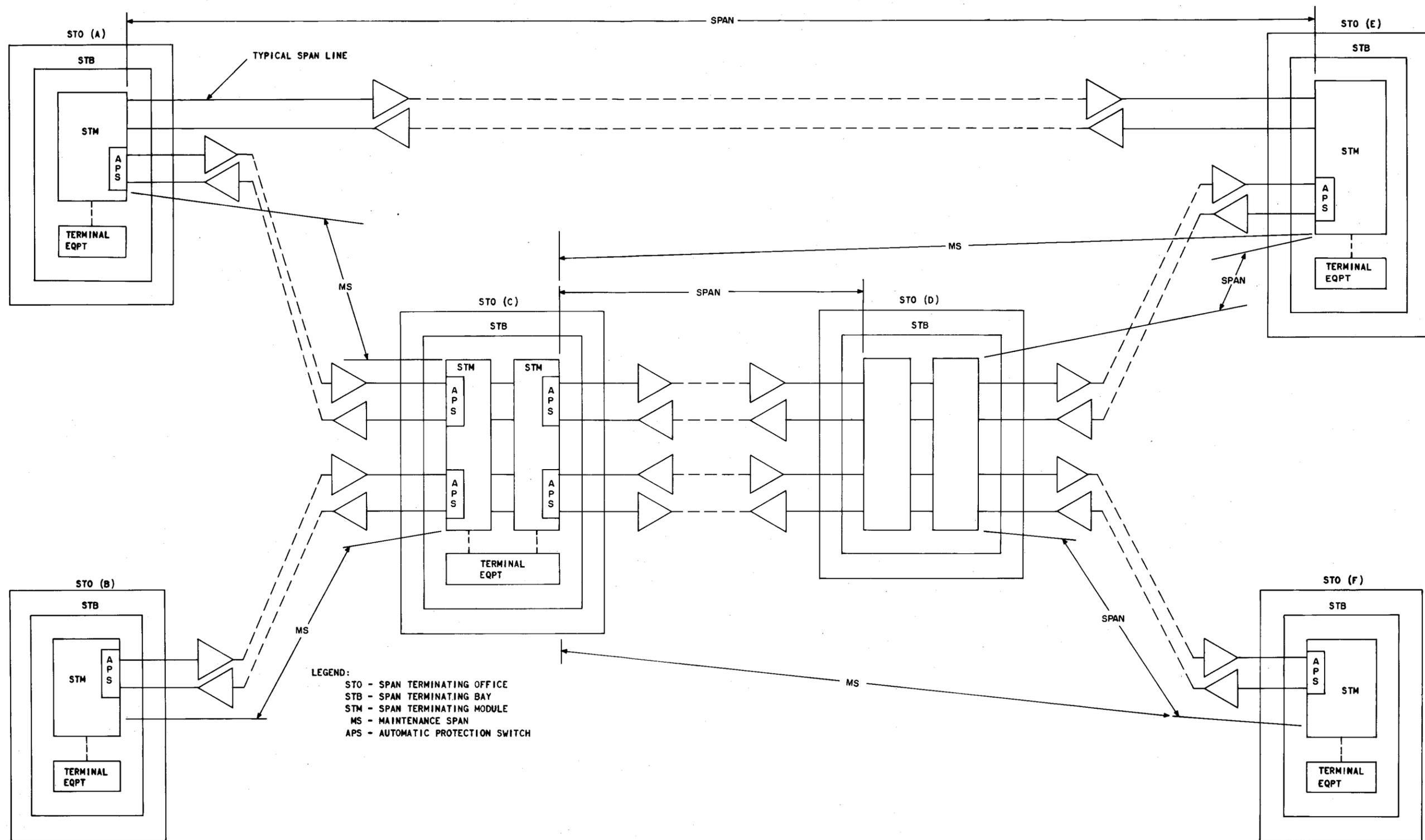


Fig. 4—T1/OS Span Concept

case is a cable stub that is used for splicing input and output repeater pairs to the main cable(s). The large apparatus case can be used to provide 25 two-way lines for 25 bidirectional repeaters or 50 one-way lines can be provided with 25 unidirectional repeaters. A smaller apparatus case can be used which provides for up to five repeaters.

(1) One Cable Using Bidirectional Repeater

2.16 With this arrangement, bidirectional repeaters are used with a single cable for both directions of transmission. Both repeater inputs and outputs appear at the same point in a cable, making near-end crosstalk the limiting factor in digital line design. This arrangement is shown in Fig. 5. The number of systems which can be installed in a single cable is largely controlled by the physical separation of pairs used for two directions of transmission. Increased pair separation decreases both the near-end crosstalk coupling and the interference from other systems. The number of systems which can be installed on a single cable also depends on the cable section loss, since this determines the difference in the signal level between the input and the output. The two sides of a single repeater serve both directions of transmission for a single system; therefore, each repeater is associated with one particular system.

(2) One Cable Using Unidirectional Repeater

2.17 With this arrangement, unidirectional repeaters are housed in two apparatus cases and spliced into only one cable so that a system is served by two regenerators in separate apparatus cases (see Fig. 6). Each repeater in one apparatus case serves two systems in one direction of transmission, and each repeater in the other apparatus case serves two systems in the other direction of transmission. This combination reduces apparatus case and stub cable crosstalk.

(3) Two Cables Using Bidirectional Line Repeater

2.18 With this arrangement, the bidirectional repeaters are associated with only one system but the two directions of transmission are carried in separate cable sheaths (see Fig. 7). Maximum repeater spacing and cable pair usage are realized by separating the directions of transmissions into two cables, but there are some margin degradations due to the common stub and close connector wiring.

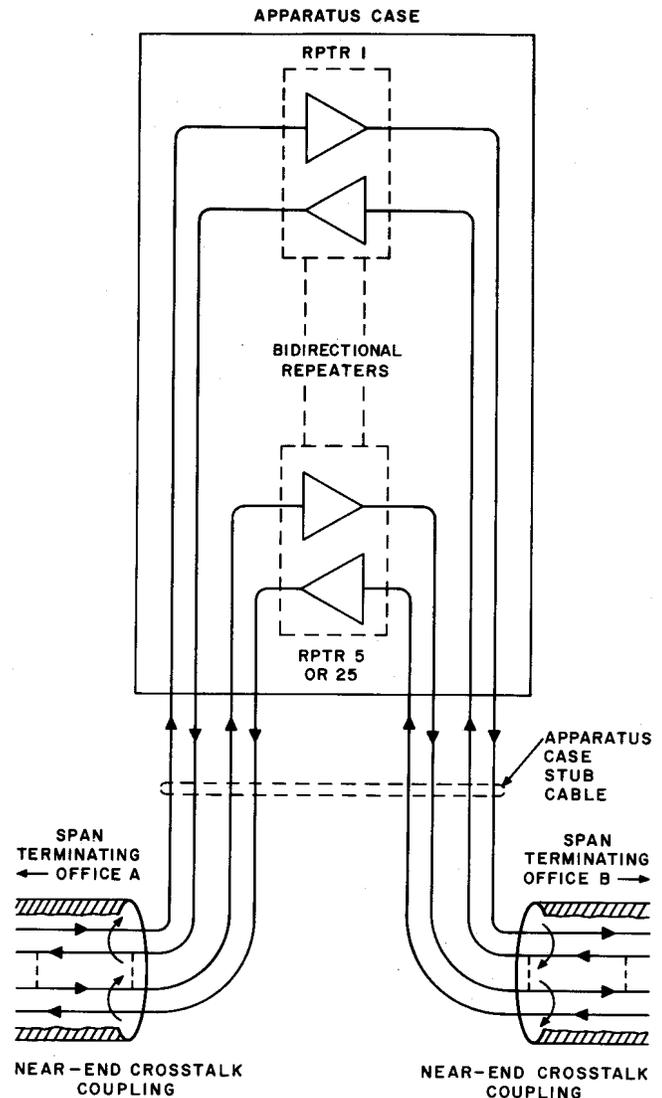


Fig. 5—One-Cable Bidirectional Repeater Operation

(4) Two Cables Using Unidirectional Line Repeater

2.19 With this arrangement, unidirectional repeaters are used with a separate cable for each direction of transmission. The signal levels at every corresponding point in the cable are the same for all systems; thus, near-end crosstalk ceases to be a controlling factor and does not limit the number of systems which can be installed on the cables. Figure 8 shows this cable-repeater arrangement. Since the two sides of a repeater are used for two span lines in the same direction of transmission, the two sides are always associated with two different systems; and one repeater cannot be

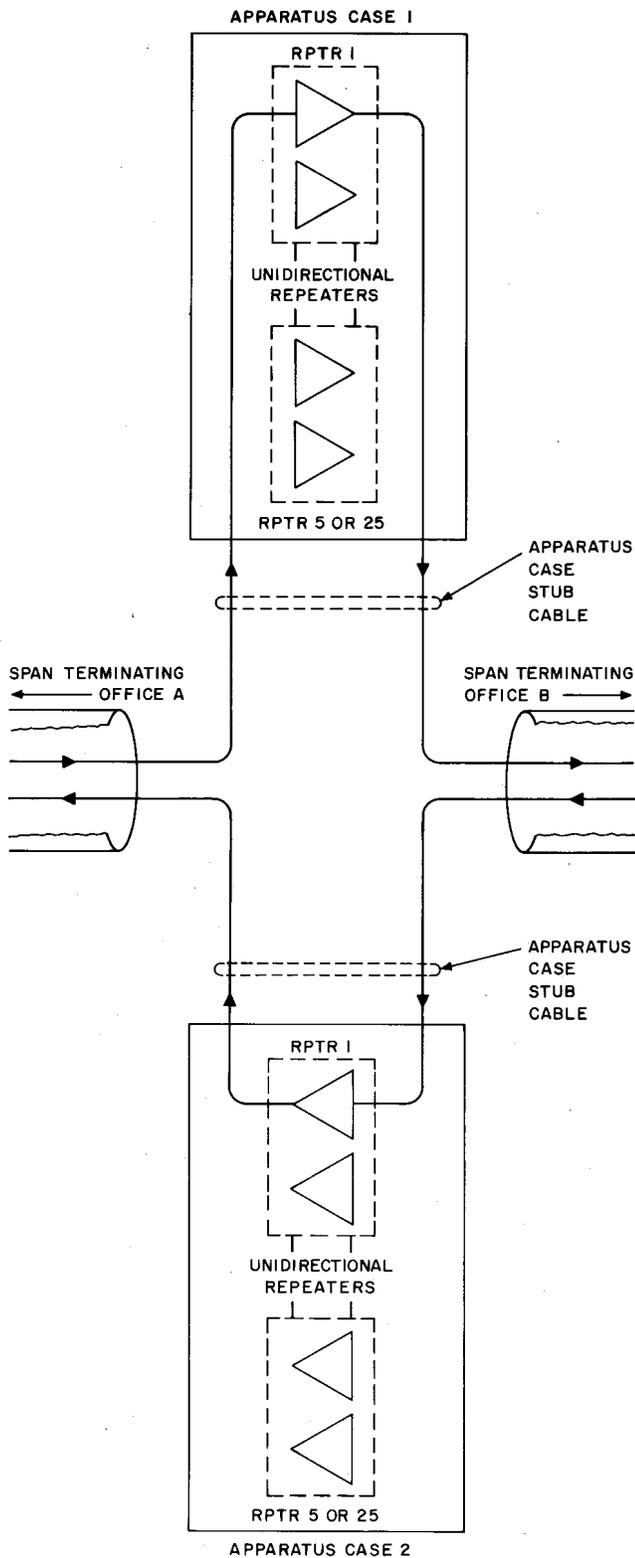


Fig. 6—One-Cable Unidirectional Repeater Operation

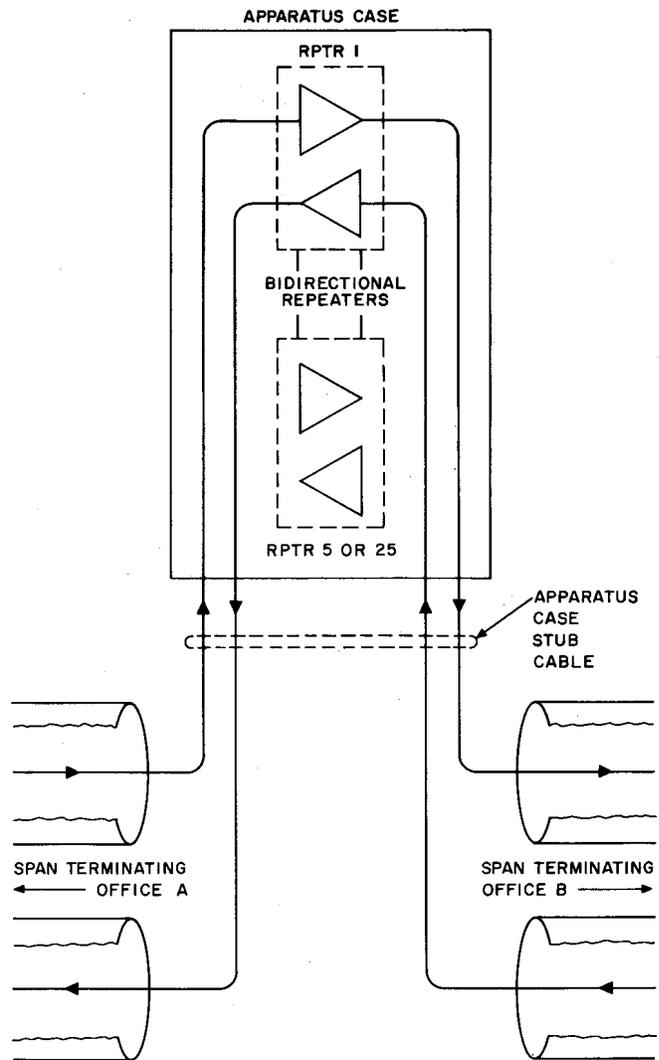


Fig. 7—Two-Cable Bidirectional Repeater Operation

associated with one particular system. In this arrangement the two apparatus cases serving the two directions of transmission must be spliced into the cables differently. For example, if the inputs to the repeaters in one apparatus case are connected to the office A side of the cable, then the inputs to the repeaters in the other apparatus case must be connected to the office B side of the cable so that both directions of transmission are obtained.

(5) Screened Cable Using Unidirectional Line Repeaters

2.20 This arrangement is similar to the arrangement in Mode 2 with the added capability of

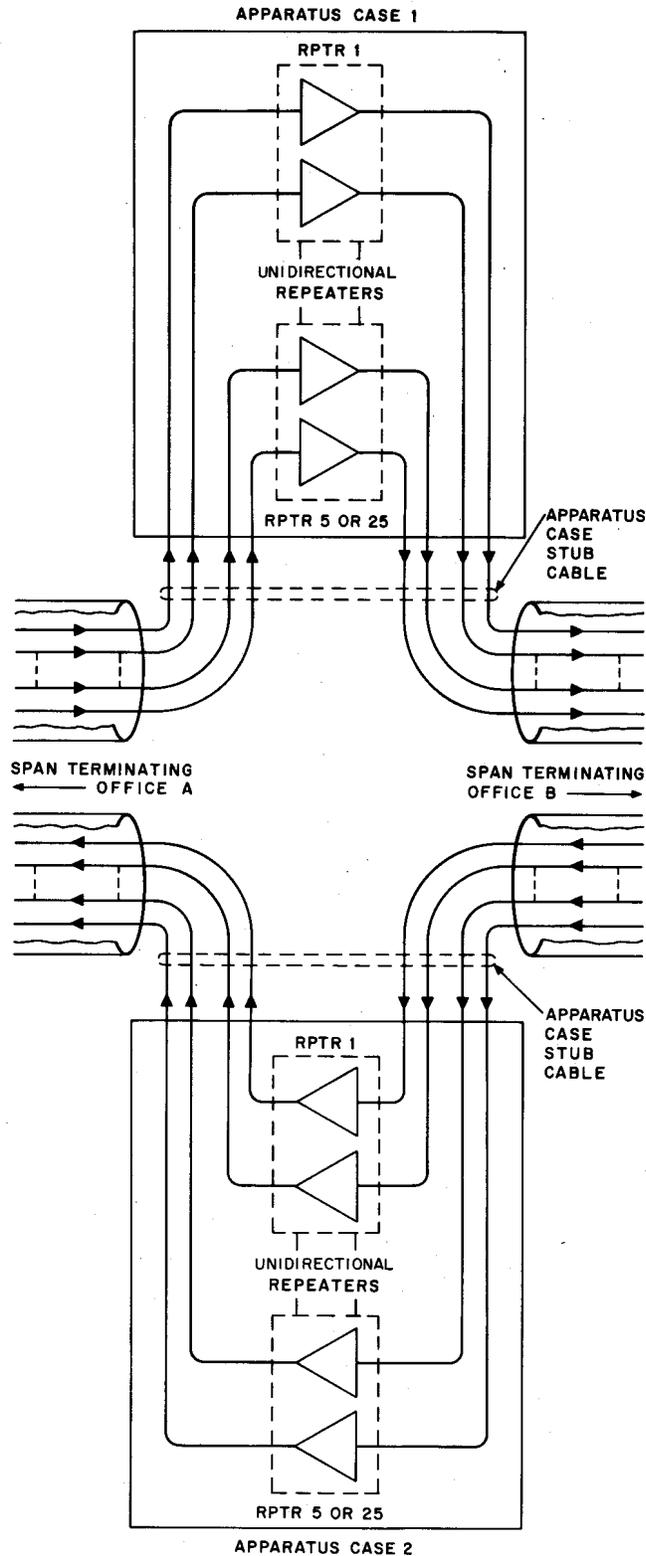


Fig. 8—Two-Cable Unidirectional Repeater Operation

providing separation of the two directions of transmission within the cable.

(6) Screened Cable Using Bidirectional Line Repeaters

2.21 This arrangement is similar to the arrangement in Mode 1 with the added capability of providing separation of the two directions of transmission within the cable. The use of screened cable in this mode as well as in Mode 5 greatly reduces near-end crosstalk and allows the use of the full complement of pairs within a cable for T1/OS systems.

(7) Combined T1/OS and T2 Operation

2.22 T1/OS lines can be implemented on T2 outside plant facilities constructed after 1976 which employ the 473A3, 473B3, and 477 C1 (or later) apparatus cases. A 7A T1 regenerator is available which fits the 473-type apparatus cases. The 7A regenerator is equivalent to one half a 209-type repeater and includes circuitry to prevent interaction between T1 and T2 signals. At T1/OS span terminating positions, the 236N repeater is required to match the LOCAP cable impedance. For details of combined T1/OS and T2 operation, refer to Section 855-352-101.

3. OUTSIDE PLANT EQUIPMENT

3.01 Outside plant apparatus consists of the transmission cable, 475-, 468C-, and 800-type apparatus cases, existing and new codes of 205, 208, and 209 ALBO-type line repeaters, 238 and 239 low power line repeaters, passive or active FL filters, and load coils and blocking capacitors for establishing the voice frequency fault-location and order-wire facilities.

A. Cable

3.02 It is anticipated that the T1/OS system will most often use filled cable, with 19- and 22-gauge copper pairs, often within a screened sheath. Line engineering (Section 855-351-200) accommodates several types of cable which include air-core or filled 19-/22-gauge copper or aluminum and 17-/19-gauge aluminum with aerial, buried, or underground installation. The use of screened cable in the one-cable operational mode is equivalent to the two-cable operational mode (Part 2D). Two-cable or screened one-cable operation with bidirectional

repeaters is the preferred mode of operation for T1/OS.

B. Apparatus Case

3.03 The T1/OS system uses the 475-type apparatus case illustrated in Fig. 9, the 468C-type illustrated in Fig. 10, or the 800-type repeater case illustrated in Fig. 11. The apparatus cases and associated plug-in equipment are listed in Section 640-525-315. Supplementary information for the contents of apparatus cases is given in the following paragraphs.

- (1) The **475A** is a rectangular case with receptacles for twenty-five 208-type or 238-type repeaters. The case is approximately 18-1/2 inches long, 8-1/2 inches high, and 10 inches deep. Three modules and a base section comprise the case, with two modules accepting ten repeaters each and the third module accepting five repeaters, the fault-locating filter, and loading coils for the order-wire and fault-locating pairs. A separate cover is fastened to the front side of each module (Fig. 9). An access port is available to accommodate an order-wire terminal.
- (2) The **475B** is similar to the 475A and accepts twenty-five 209-type or 239-type repeaters. The case is approximately 2 inches deeper to accommodate the secondary surge protection networks in the 209-type repeaters and the primary surge protection gas tubes in the apparatus case.
- (3) The **475F** is the same as the 475A except it provides for the fault-location outputs of each regenerator in each two-way repeater to be brought out separately to the directional, active fault-location filter. The 475F2 case will replace the 475A and 475F apparatus cases.
- (4) The **475G** is the same as the 475B except it provides for the fault-location outputs of each regenerator in each two-way repeater to be brought out separately to the directional, active fault-location filter. The 475G2 case will replace both the 475B and 475G apparatus cases.
- (5) The **468C6** provides for separate fault-locating outputs from each regenerator in each two-way repeater position, similar to the 475F and G cases. The same fault-locating and order-wire features found in the 475F and G are incorporated

in the 468C case. The 468C6 case is designed for five 205-type or 209-type line repeaters.

The 475A and 475B cases were developed for T1 Carrier and the 475F and 475G cases were specifically designed for the T1/OS application, using the active FL system. The 475F2 and 475G2 apparatus cases will serve all T1 modes. The 800-type case will serve the T1, T1C, and T1/OS systems.

- (6) The 800-type is a rectangular case constructed of lightweight molded plastic. The case is approximately 23 inches long, 9-1/2 inches wide, and 17-1/2 inches deep. Its housing contains two chambers which will accommodate the three existing repeater lengths. One chamber will hold 14 repeaters and the other will hold 11. These repeater cases will replace the 475 type. The 800-type case contains all the maintenance facilities of the 475.

3.04 Integral to the 475-type apparatus case is a cable stub (CA 2110) that is used for splicing input and output repeater pairs to the main cable(s). This standard stub cable is of unit construction with 104 pairs of 22-gauge copper wire: 50 pairs for inputs, 50 pairs for outputs, 2 pairs for order wire, and 2 pairs for fault location. The apparatus case can be used to provide 25 two-way lines for 25 bidirectional repeaters or 50 one-way lines can be provided with 25 unidirectional repeaters. The 475F2 and 475G2 codes have 106 pair stubs to allow for the R (plug-in) gas pressure contactor, AT8782.

C. Line Repeaters

3.05 The 205-, 208-, 209-, 238- and 239-type repeaters are used in the T1/OS digital line. The various codes of these repeaters, with their design applications, are given in Table A. The 205-type repeaters have been replaced by the 209 type and are not listed in the table. The 208 and 209 types operate at 140 mA current and the 238 and 239 types operate at 60 mA.

3.06 The line repeaters have preamplifiers and the ALBO in the regenerators. The amplified bipolar signal (Fig. 1) is rectified, clipped, and applied both to a logic circuit and to a clock circuit. The logic circuit produces an output pulse when the amplified input pulse reaches a threshold and the timing pulse arrives from the tuned clock. This output pulse drives a transformer to produce the bipolar signal on the line. The signal at the

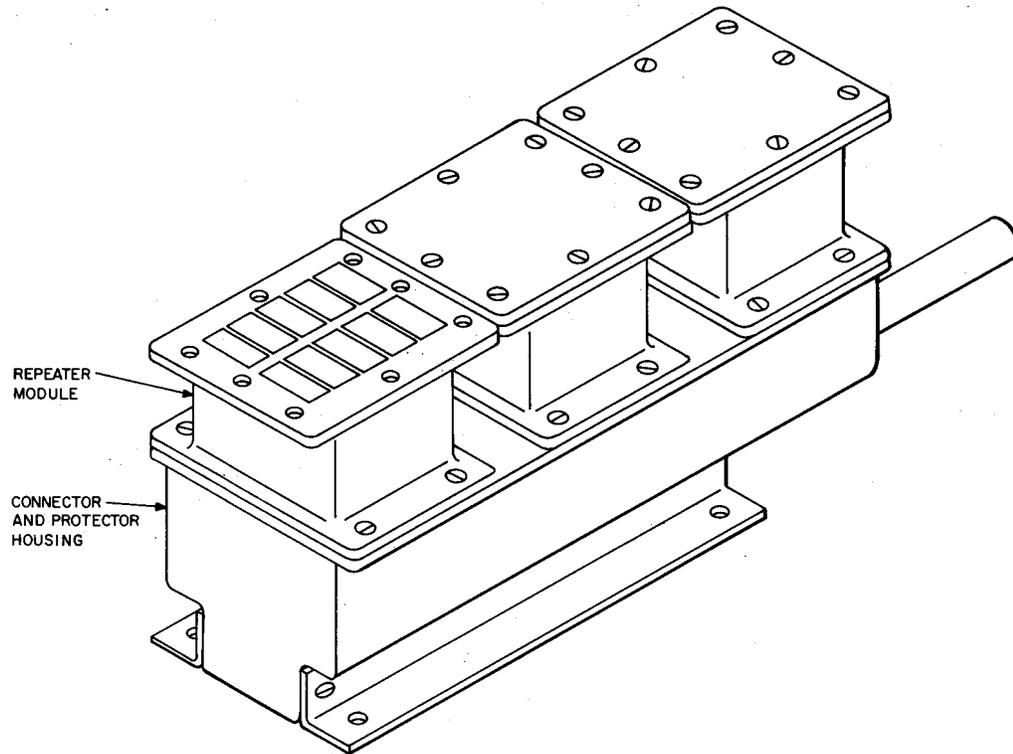


Fig. 9—475-Type Apparatus Case

input of a regenerator must consist of at least two pulses in every 16 consecutive time slots to maintain the ringing of the tuned clock. The frequency of the clock circuit (regenerator timing) is equal to the DS1 rate of 1.544 Mb/s.

3.07 The repeater is designed to operate on a cable section which has a maximum insertion loss of 35 dB at 0.772 MHz. If allowance is made for temperature and manufacturing variations in the cable, this equates to 32.2 dB or about 6300 feet of 22-gauge high-capacitance, non-waterproof or non-filled cable at 55°F. The ALBO feature of integrated circuit repeaters automatically builds the cable out to the correct loss at 0.772 MHz and compensates for cable variations caused by aging and temperature changes. The preamplifier in the integrated circuit repeater is optimized for a signal from 6000 feet of 22-gauge cable, equivalent to 31-dB section loss. When the detector circuit at the output of the preamplifier senses a change from optimum operation, it applies a control voltage to the ALBO for correction.

3.08 The repeater sections adjacent to STOs are subjected to impulse noise originating in the offices; therefore, these sections are usually shorter than a normal section. These sections may be any length up to 4500 feet (of 22-gauge cable) and are built out to the nominal repeater section loss of 31 ± 1.2 dB.

3.09 The 208E, 208F, 209E, and 209F repeaters were designed specifically for the T1/OS application using the active fault-location system (Section 365-200-160). These repeaters allow implementation of the single-ended fault-location feature of T1/OS which requires that the FL output for each direction of regeneration be available separately. Except for the separate FL output for each direction of regeneration, the 208E and F and 209E and F codes of repeaters are electrically and physically equivalent to the 208A and B, and 209A and B codes, respectively. These repeaters must use the 475F- and G-type apparatus cases which are wired to access and properly terminate the split FL outputs. The 208AA repeater replaces the 208A, B, E, and F types. Thru-loop powering

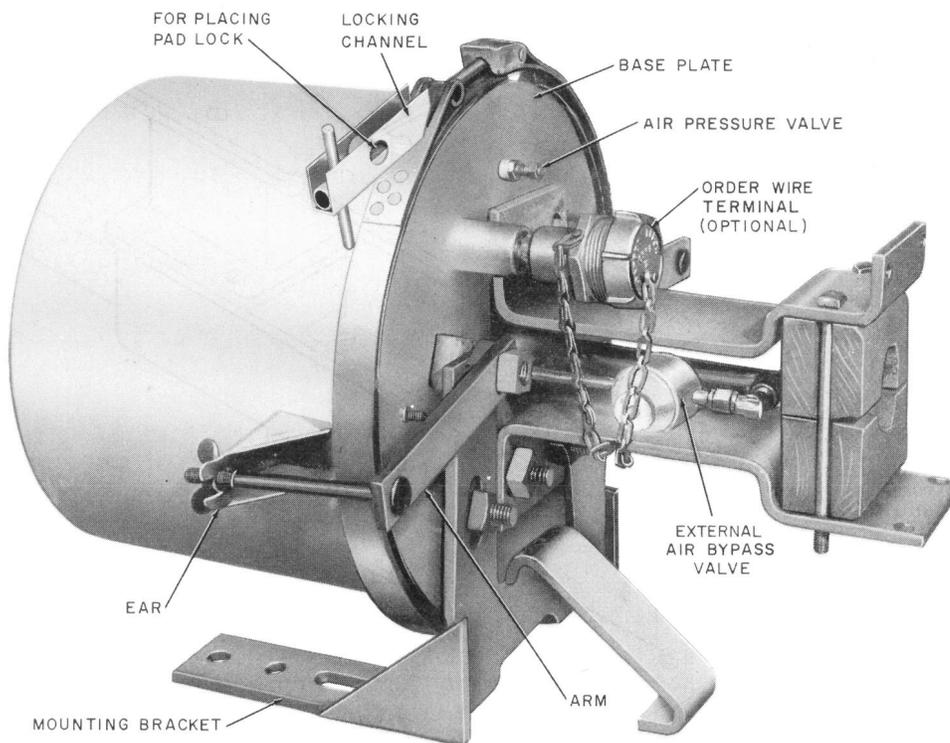


Fig. 10—468C Apparatus Case

and joint-split fault-locate output options must be set when using the 208AA.

3.10 The 238A, 238B, 238C, 238D, 239A, 239B, 239C, and 239D low power line repeaters can also be used to significantly lengthen the T1/OS powering spans. Options available on the repeater give the single or split fault-locate output capability plus through or looped power. A 236-type office repeater is required to obtain proper line powering for the low power repeated lines. The 238- and 239-type repeaters are the same size as the 208- and 209-type but should not be used as direct replacements since mixing of low and high power repeaters is not recommended. When the low power repeaters are installed in the 468C apparatus case a 273A adapter is required.

D. Fault-Locating Filters

3.11 Fault-locating filters are installed in the apparatus cases to implement the T1/OS FL system [Part 6B(3)]. An active or passive FL system may be established for the T1/OS system. The FL system is described in Section 365-200-160.

A mixture of passive and active filters on the same FL line is not permitted, but a mixture of lines using either all active or all passive filters can be terminated on the new active FL panel (ED-3C374). The following codes of FL filters are used for T1/OS:

- (1) 1114-type single-input active filter
- (2) 1115-type dual-input active filter
- (3) ♦1068A through M single-input passive filters
- (4) 1068AA through AM dual-input passive filters.♦

3.12 The 1114-type filter is usually used with the unidirectional mode of repeater operation. It may be used in T1/OS configurations that implement either the single-end or both-ends FL systems. It is powered from the FL pair and allows double use of the A-M frequencies on each FL pair through choice of power polarity and proper placement of a tip-ring reversal in the fault-locating line pair. It is physically the same size as the

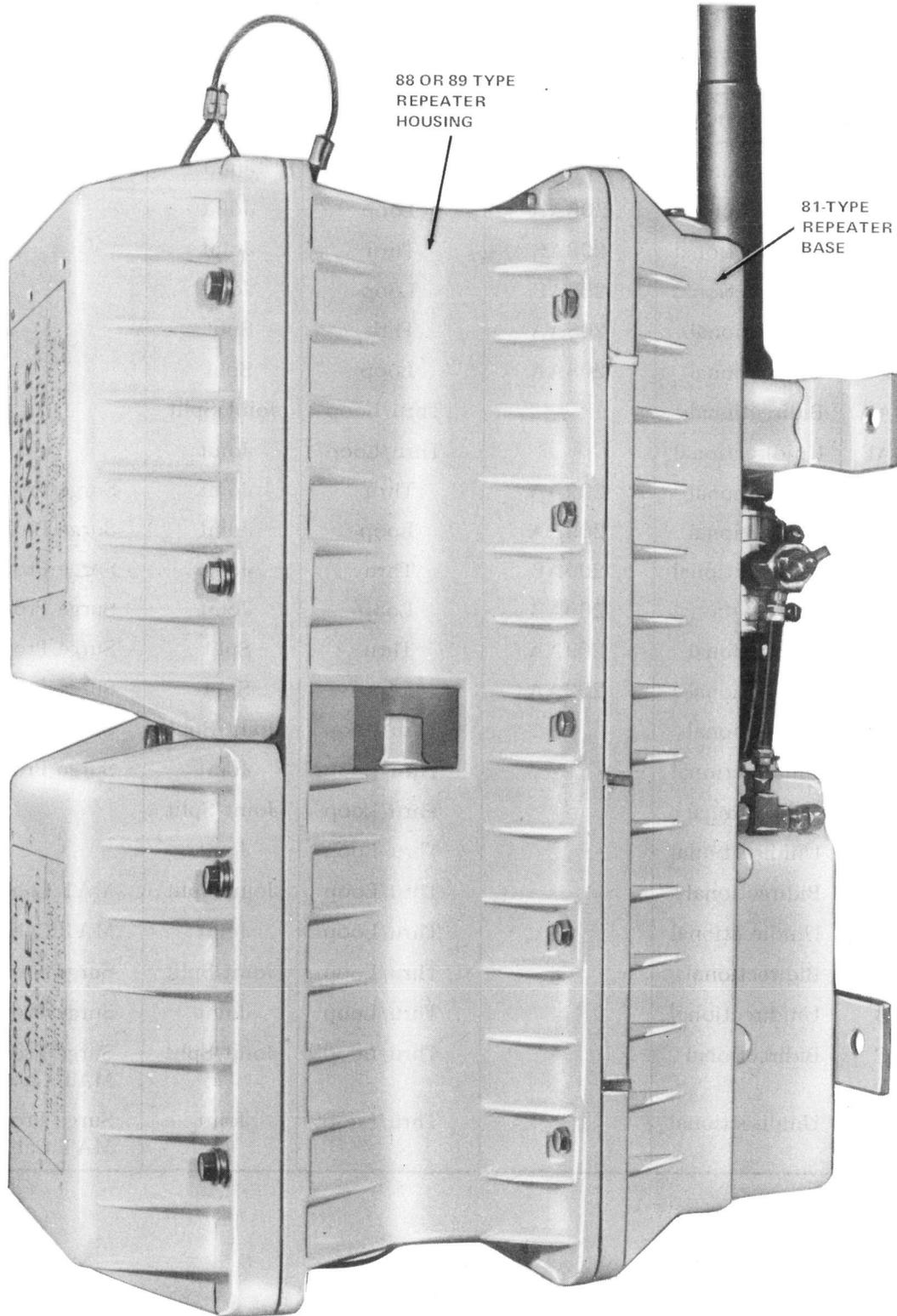


Fig. 11—800-Type Repeater Case

TABLE A
LINE REPEATERS

CODE	OPERATION	REPLACEMENT	LINE POWERING	FL OUTPUTS	REMARKS
208A	Bidirectional	208AA	Thru	Joint	
208B	Bidirectional	208AA	Loop	Joint	
208C	Unidirectional	208AB	Thru	Joint	
208D	Unidirectional	208AB	Loop	Joint	
208E	Bidirectional	208AA	Thru	Split	
208F	Bidirectional	208AA	Loop	Split	
208AA	Bidirectional		Thru/Loop	Joint/Split	
208AB	Unidirectional		Thru/Loop	Joint	
209A	Bidirectional	209AA	Thru	Joint	Surge Protection
209B	Bidirectional	209AA	Loop	Joint	Surge Protection
209C	Unidirectional	209AB	Thru	Joint	Surge Protection
209D	Unidirectional	209AB	Loop	Joint	Surge Protection
209E	Bidirectional	209AA	Thru	Split	Surge Protection
209F	Bidirectional	209AA	Loop	Split	Surge Protection
209AA	Bidirectional		Thru/Loop	Joint/Split	Surge Protection
209AB	Unidirectional		Thru/Loop	Joint	Surge Protection
238A	Bidirectional		Thru/Loop	Joint/Split	
238B	Unidirectional		Thru/Loop	Joint	
238C	Bidirectional		Thru/Loop	Joint/Split	MAT Cable
238D	Unidirectional		Thru/Loop	Joint	MAT Cable
239A	Bidirectional		Thru/Loop	Joint/Split	Surge Protection
239B	Unidirectional		Thru/Loop	Joint	Surge Protection
239C	Bidirectional		Thru/Loop	Joint/Split	Surge Protection, MAT Cable
239D	Unidirectional		Thru/Loop	Joint	Surge Protection, MAT Cable

1115-type filter (Fig. 12) but contains only one amplifier filter corresponding to side 2 of the 1115-type filter.

3.13 The 1115-type active filter is used only with the bidirectional mode of repeater operation. It is used in T1/OS configurations that implement the single-end testing FL systems. It requires one FL pair and is powered from the FL pair. One powering polarity activates only one of the amplifier filters and reversing the polarity activates only the other amplifier filter. The 1115-type active filter is illustrated in Fig. 12 and is the same physical size as the 1114-type filter. The dashed lines show the approximate signal flow path.

3.14 The 1068A through M or 1068AA through AM passive filters may be used with the T1/OS system to establish a passive FL system similar to that used on the T1 digital carrier system. Because of the differences in output levels, 598- or 1068-type filters should not be used on the same FL line with either of the active FL filters (1114- or 1115-type). The 1068AA through AM series are used in apparatus cases wired to accept split FL output repeaters.

E. Load Coils and Connectors

3.15 In addition to the line repeaters (Part 3C) and FL filters (Part 3D), each of the slots

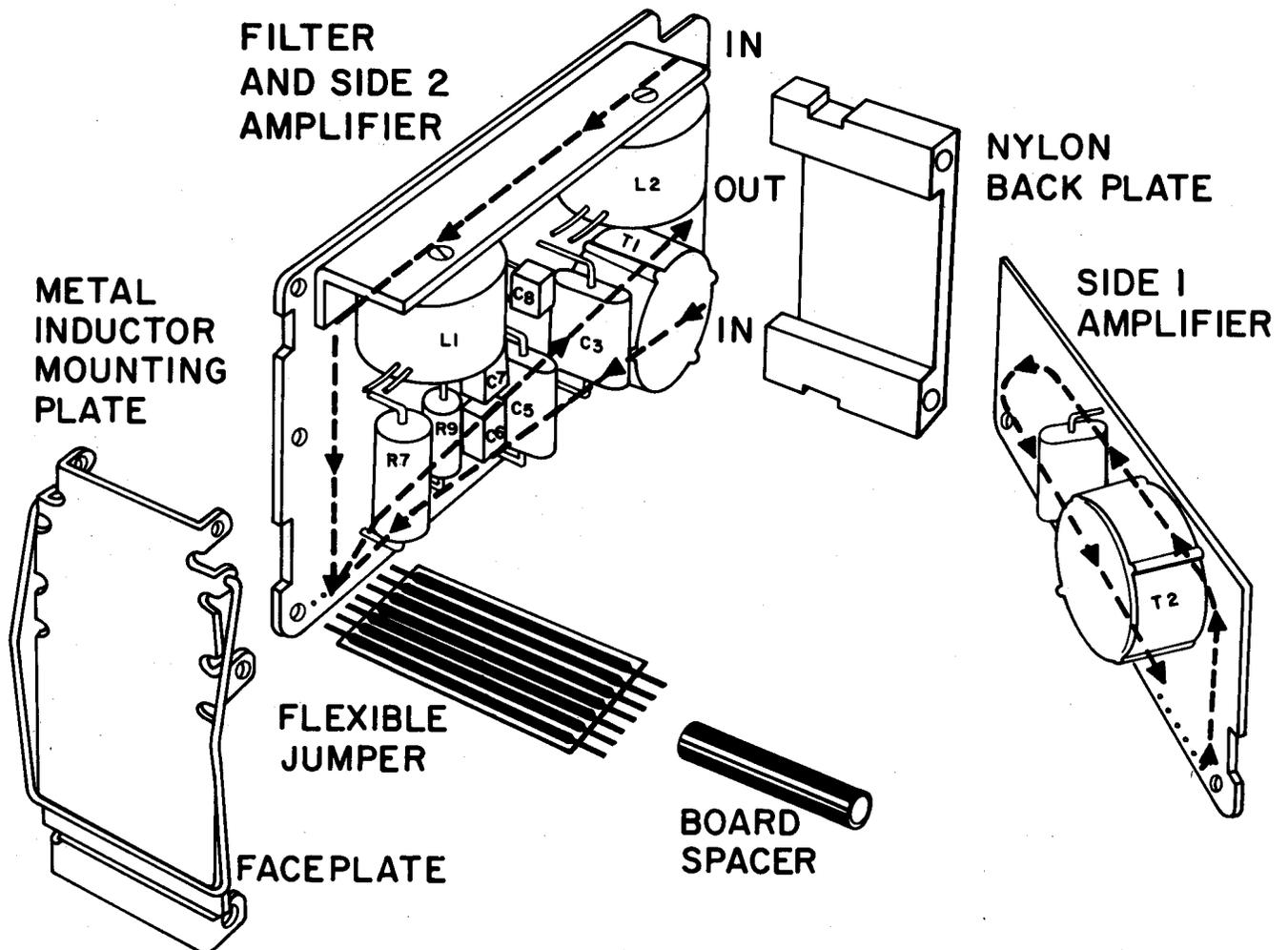


Fig. 12—One- or Two-Amplifier FL Filter for 475 Apparatus Case

in the apparatus case will accommodate a 184-type coil or a 939-type connector plug-in unit.

3.16 The 184-type coil is used to load voice frequency pairs looped through the apparatus cases including the order-wire and FL pairs. Where the apparatus case locations coincide with load points, using the 184-type plug-in coil is relatively simple and inexpensive. When the apparatus case locations are not at desired load point locations, loading can be placed in the cables at non-repeater positions. The 184-type coil cases are arranged for the installation of building-out capacitors and are shown in Fig. 13 (with and without building-out capacitors). The 184A1-type coil is compatible with the 475F-type apparatus case and the 184B1-type coil is compatible with the 468C6 and 475G-type apparatus cases. When a 468C6 apparatus case is used instead of the 475G-type, a 273A adapter is necessary for the proper installation of plug-ins, such as the 184-type coils.

3.17 The various codes of the 939-type connector (Fig. 14) provide pair continuity through the apparatus case or blocking capacitors for use in the order-wire circuit. The codes provided are listed below:

- (1) 939A pair continuity for use in 475F apparatus case
- (2) 939B blocking capacitor for use in 475F apparatus case
- (3) 939C pair continuity for use in 468C6 475G and 800-type apparatus cases
- (4) 939D blocking capacitor for use in 468C6 475G and 800-type apparatus cases.

3.18 The 939A and 939C connectors are devices for establishing continuity of conductors through an apparatus case (repeater, fault-locating, and order-wire plug-in positions) for the conductors that are not being used for T1/OS or not being loaded for interim use as voice-frequency facilities.

3.19 The 939B and 939D connectors provide blocking capacitors for use where the dial loop length of the order wire (Section 365-325-100) is terminated. In this circumstance, order-wire terminal equipment is provided at two STOs and the 939B or 939D connector is used at the junction of the two order wires. The 939B and 939D

connectors will pass voice currents but will not pass dial pulses. The location of plug-in units in all types of apparatus cases is given in Section 640-525-315.

4. OFFICE EQUIPMENT

4.01 The T1/OS system offers flexible office equipment arrangements suitable for small cross-section routes. The basic equipment is contained in the J98728 STB. Combinations of the J98728 bays with separate bays containing D3 or D4 channel banks can be used to establish large cross-section routes.

A. J98728 Span Terminating Bay (STB)

4.02 The J98728 STB for T1/OS with D3 channel banks is available in three standard heights of 11 feet 6 inches (Fig. 15), 9 feet (Fig. 16), and 7 feet (Fig. 17). The J98728 STB for T1/OS with D4 channel banks is also available in standard heights of 11 feet 6 inches (Fig. 18), 9 feet (Fig. 19), and 7 feet (Fig. 20). Each figure identifies four different bay configurations based on the bay code, the bay height, and the bay usage (T1, T1/D3 combined, or T1, T1/D4 combined). All are based on 1-inch by 23-inch panel modules on duct-type unequal flange bay framework. Front mounting on the wide flange, with 5-inch front guard rail and 2-inch rear guard rail, is employed throughout (total depth = 12 inches). As shown in the figures, the equipment is arranged to provide "free-standing" or self-contained building blocks that allow a maximum of the intrabay wiring to be completed by the factory. This approach is taken to maximize flexibility in the use of the building blocks and facilitate field additions to unassigned bay space. This approach is extended in the avoidance of bay terminal strips for external cabling, and therefore, most office cabling to the bays terminates on the building block terminals. Within the bay, standardized local cables (devoted primarily to power and alarm leads) have been provided for standard (list numbered) bay assemblies. Where optional use of bay space for different types of equipment (refer to Fig. 15 through 20) is anticipated (particularly for field additions), the bay local cables provide breakouts to cover the permitted choices.

4.03 A typical bay arrangement for a T1/OS STB is shown in Fig. 21. A 9-foot combined bay arrangement with T1 and D3 complements has been chosen to show the several building blocks utilized

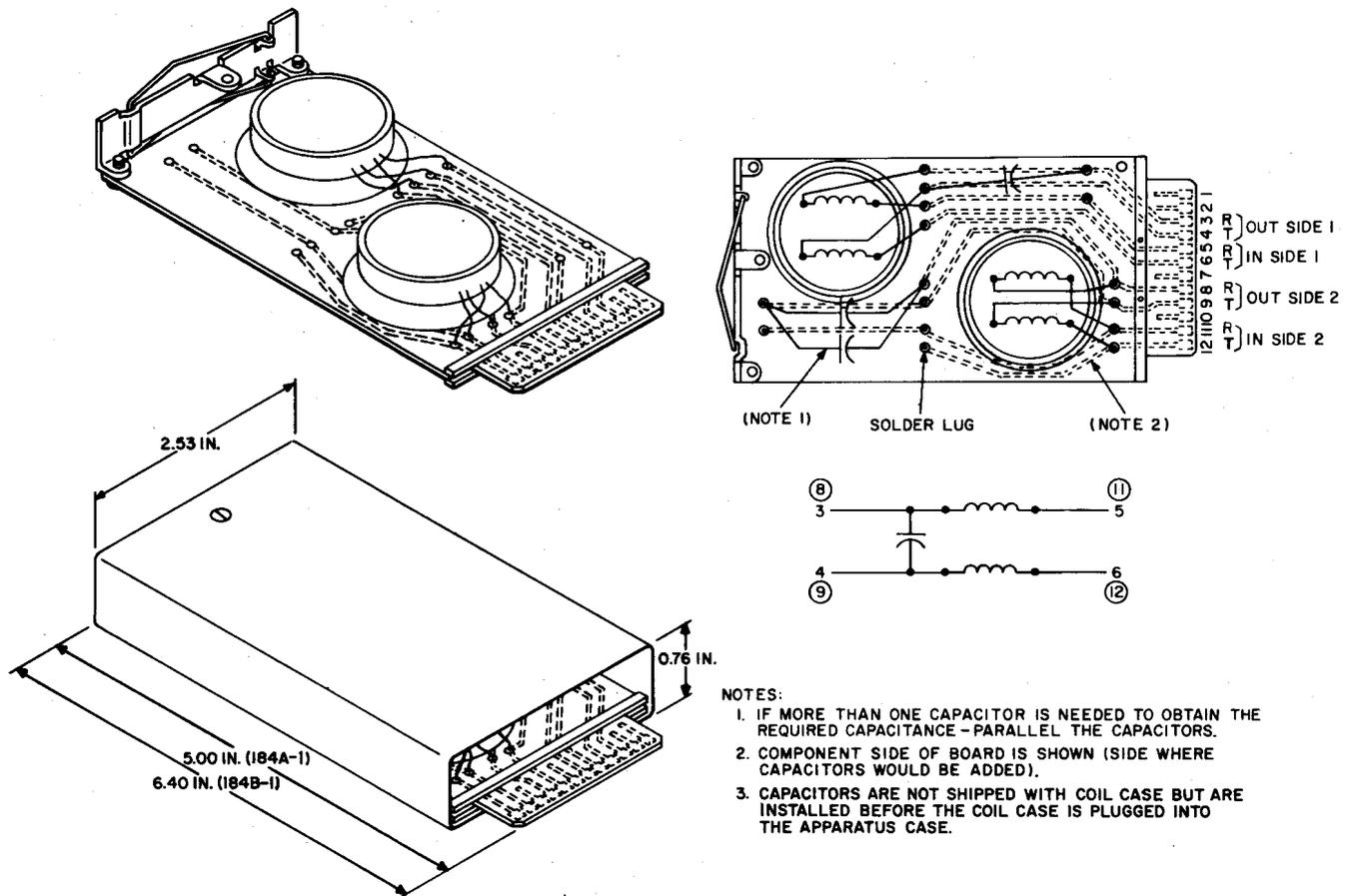


Fig. 13—184-Type Coil Case

in T1/OS STBs. Following is a list of these various building blocks:

- (a) Fuse and Alarm Panel
- (b) D3 Channel Bank
- (c) Hot Spare and Maintenance Shelf for D3 Banks
- (d) DS1 Jack and Cross-Connect Panel
- (e) Order-Wire Panel
- (f) Fault-Locating Panel
- (g) Line Terminating Module (LTM)
- (h) Protector Panel

(j) Filter Panel.

Figures 15 through 20 show the various positions of LTMs and D3 or D4 banks for all size bays.

4.04 All T1/OS building blocks involve supplementary notation of plant assignment information. This information is intended to be entered on designation strips affixed to the right side of the shelf assemblies. Thus, plug-in slots or switch positions can be correlated with actual service assignments and/or office line and bay locations.

(1) **Line Terminating Module (LTM)**

4.05 A number of office LTMs are available in T1/OS bays. The intermediate powering repeater shelf (IPRS) provides repeater and powering capability, without switching, for through systems. The terminating repeater shelf (TRS)

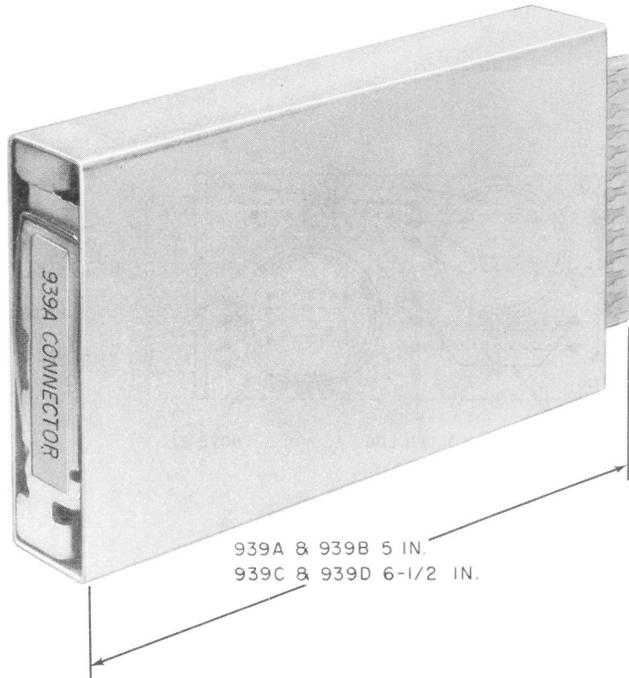


Fig. 14—939-Type Connector

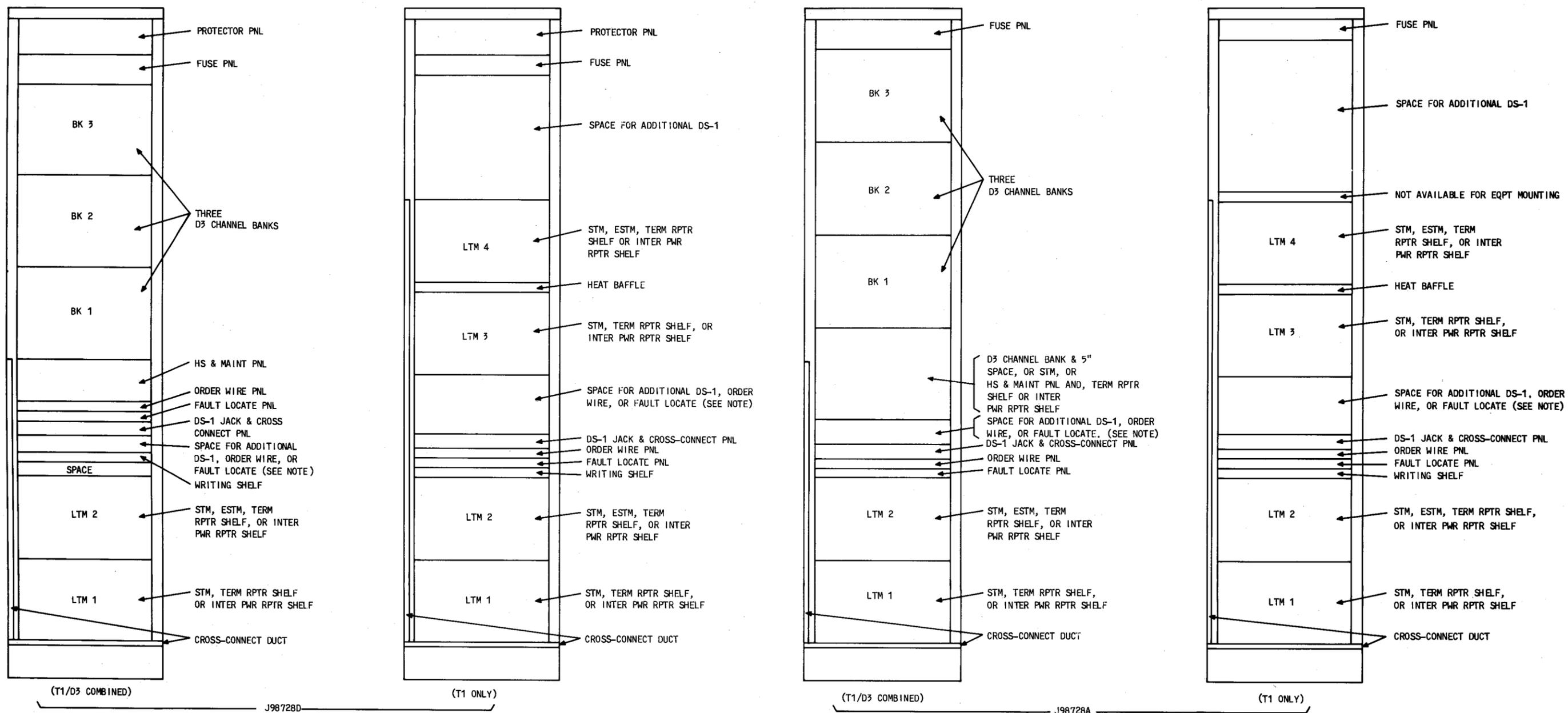
provides repeater and powering capability, without switching, for terminating systems. The two STMs provide repeater and powering plus switching and jack access in two configurations: a split shelf offering two 1×5 APS systems and a single shelf offering one 1×11 APS system. The numbers 1 and 5 in the 1×5 designation refer to a single protection line serving five service lines. Also, there is an expansion span terminating module (ESTM) which provides repeater, powering, switching, and jack access for an additional 13 service lines. All LTMs can be either factory or field installed.

4.06 The IPRS is an office repeater shelf which will terminate up to six through T1 lines (a complete 1×5 system). The shelf is divided electrically into two halves to accommodate the two directions of the route. Dissipation resistors are mounted on the back of the 10-foot high shelf. No office DS1 jacking or cross-connecting is provided; therefore, the unit, from the maintenance viewpoint, is similar to a manhole. The thirteenth repeater position can be used either for a specially wired bridging repeater or in conjunction with the thirteenth repeater of other IPRS to give added capability.

4.07 The TRS is physically identical to the IPRS but is wired electrically to terminate up to 13 T1 lines in one direction only. On the office side the lines are wired to a DS1 jack and cross-connect panel to provide maintenance and cross-connect capability.

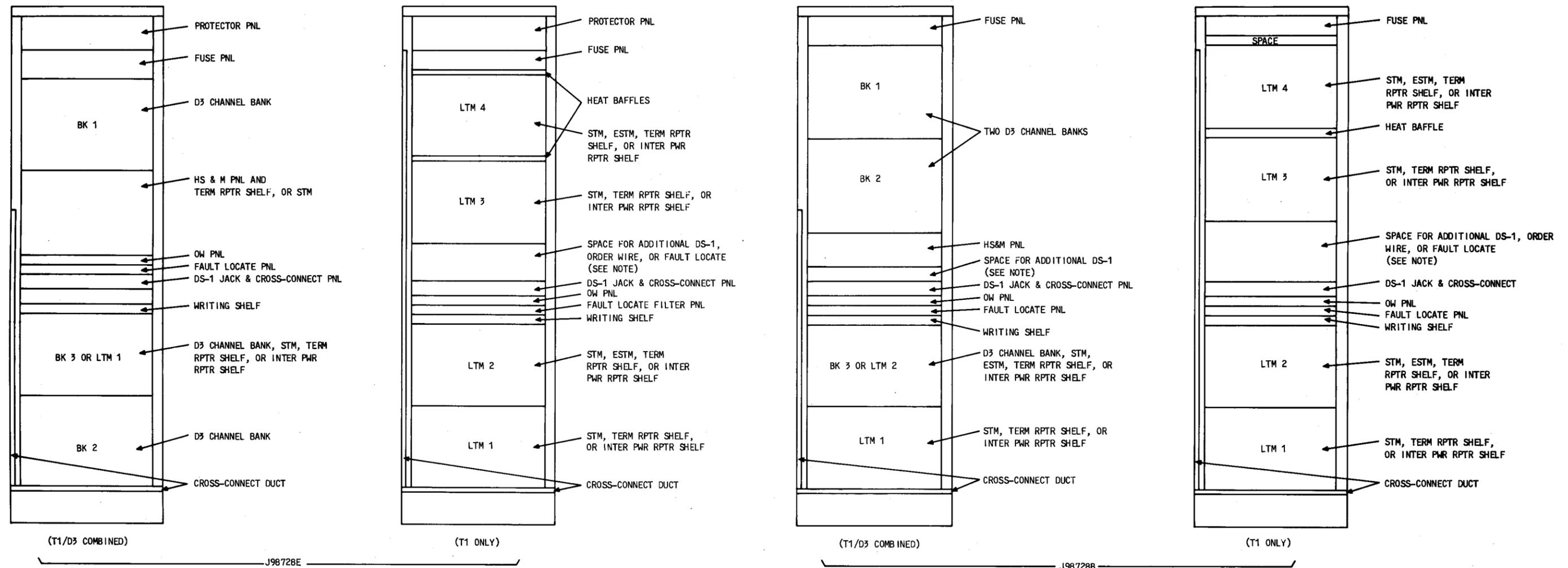
4.08 The STMs combine the line terminating and protection switching assemblies for the T1/OS lines. The STM as shown in Fig. 22 requires 17 inches of vertical mounting space in the STB and consists of an office repeater (OR) shelf and an APS shelf. The two are joined on unit mounting bars and are shop-wired to provide interconnection between an OR and an APS. Either 12 or 13 T1 lines can be terminated by an STM. Repeater slot assignments in the STMs should be coordinated with slot assignments in apparatus cases. The power dissipating resistors associated with line and office powering are mounted on the rear of the OR shelf. The APS contains DS1 jack circuits for each of the lines in the configuration. The jacks are permanently wired to a cross-connect terminal strip facing forward and positioned behind an access cover. As previously noted, this terminal strip provides connecting points for jumpers running to T1/OS lines within the same STM (split shelf), another STM, or to the DS1 jack and cross-connect panel(s). Connector pins on the rear of the STM receive bay or office cabling connections.

4.09 Three STMs are available: one places the 12 lines in a single protection group with one protection line to serve up to 11 service lines (ie, a 1×11 protection group). The second divides the STM into two complements of six lines each to provide two 1×5 protection groups, each essentially independent of the other. The third is an ESTM that provides protection for 12 service lines and is coupled with the 1×11 STM to form a 1×24 protection group. From left to right facing the STM, an APS card is hard-wired to its corresponding repeater in the repeater shelf. In all of these configurations a fixed, wired priority within the APS is provided and can be changed only by changing the DS1 cross-connects at the left-hand cross-connect terminal. In addition to plug-in switch cards and a common alarm card, positions are provided in the first two STMs for one or two SRC plug-ins, depending on whether one or two protection groups are involved. Where individual line alarm and status information is to be provided via an external telemetry system, an optional plug-in can be included in the APS equipment



NOTE:
 FOR APPLICATIONS WHERE A SECOND FAULT LOCATE, ORDER WIRE, AND/OR DS-1 PANEL ARE REQUIRED, IDENTICAL PANELS ARE MOUNTED ADJACENT TO EACH OTHER. THE WRITING SHELF MAY BE OMITTED.

Fig. 15—J98728A and J98728D—11-Foot 6-Inch Span Terminating Bays



NOTE:
 FOR APPLICATIONS WHERE A SECOND FAULT LOCATE, ORDER WIRE, AND/OR DS-1 PANEL ARE REQUIRED, IDENTICAL PANELS ARE MOUNTED ADJACENT TO EACH OTHER. THE WRITING SHELF MAY BE OMITTED.

Fig. 16—J98728B and J98728E—9-Foot Span Terminating Bays

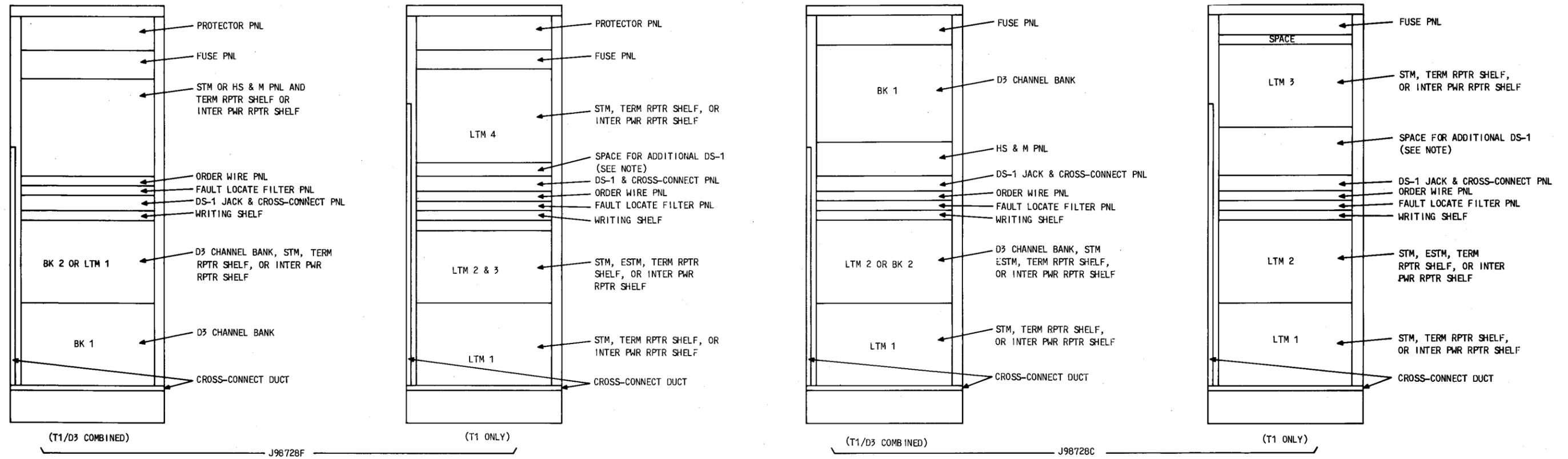
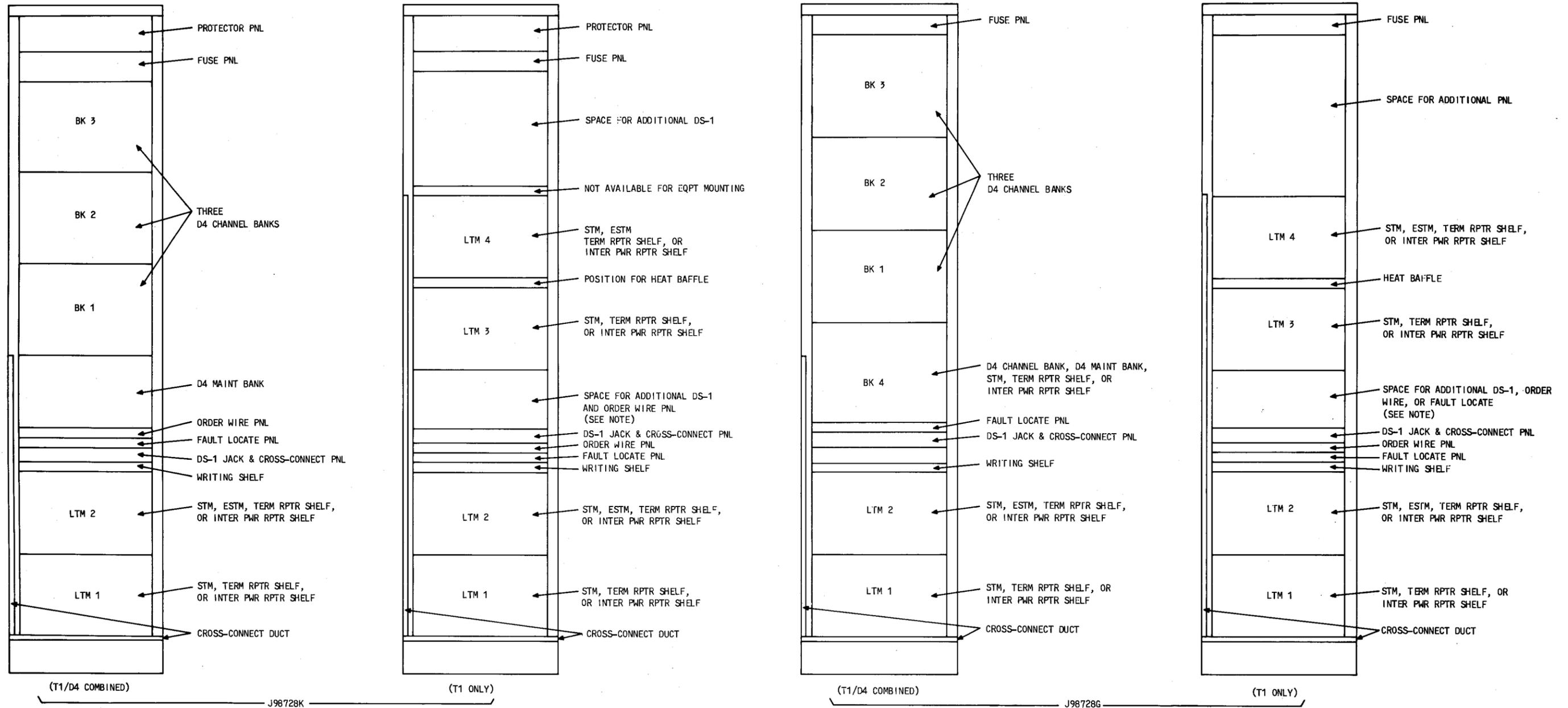
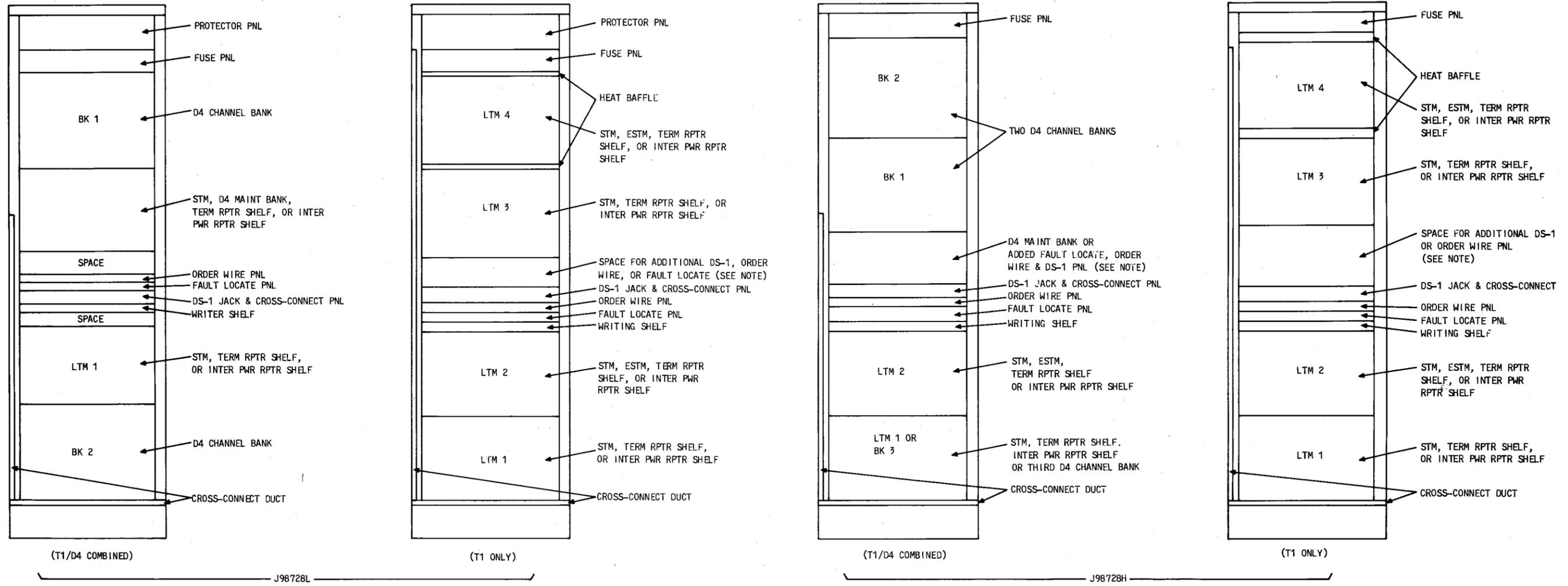


Fig. 17—J98728C and J98728F—7-Foot Span Terminating Bays



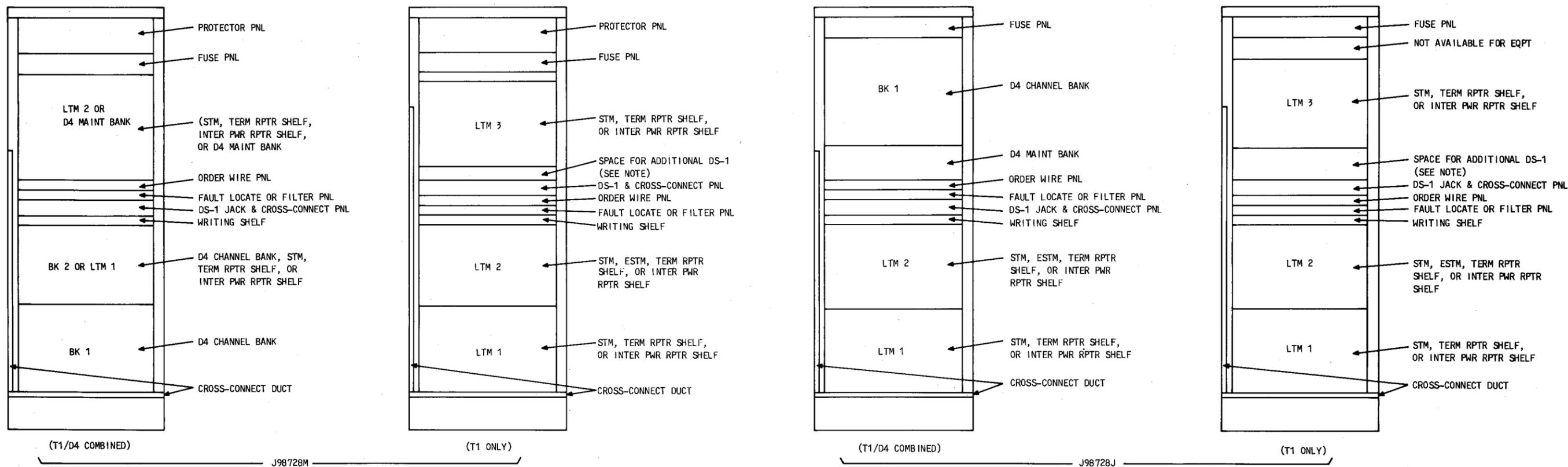
NOTE:
 FOR APPLICATIONS WHERE A SECOND FAULT LOCATE, ORDER WIRE, AND/OR DS-1 PANEL ARE REQUIRED, IDENTICAL PANELS ARE MOUNTED ADJACENT TO EACH OTHER. THE WRITING SHELF MAY BE OMITTED.

Fig. 18—J98728G and J98728K—11-Foot 6-Inch Span Terminating Bays



NOTE:
 FOR APPLICATIONS WHERE A SECOND FAULT LOCATE, ORDER WIRE, AND/OR DS-1 PANEL ARE REQUIRED, IDENTICAL PANELS ARE MOUNTED ADJACENT TO EACH OTHER. THE WRITING SHELF MAY BE OMITTED.

Fig. 19—J98728H and J98728L—9-Foot Span Terminating Bays



NOTE:

FOR APPLICATIONS WHERE A SECOND FAULT LOCATE, ORDER WIRE, AND/OR DS-1 PANEL ARE REQUIRED, IDENTICAL PANELS ARE MOUNTED ADJACENT TO EACH OTHER. THE WRITING SHELF MAY BE OMITTED.

Fig. 20—J98728J and J98728M—7-Foot Span Terminating Bays

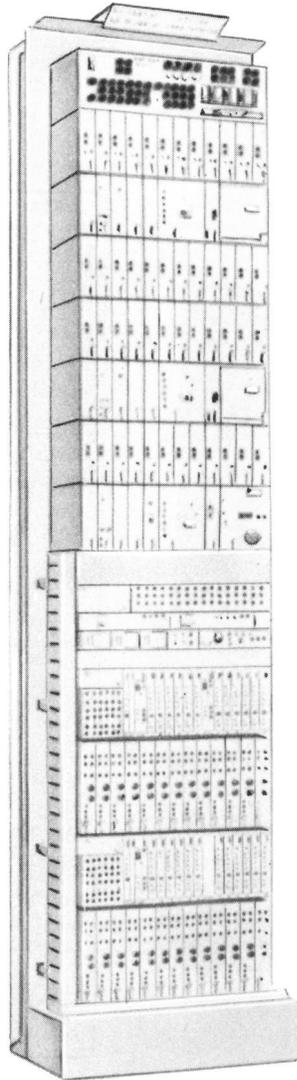


Fig. 21—T1/OS Span Terminating Bay—9-Foot STM/D3 Combined

to provide contact closure outputs. More details on the APS are given in Section 365-250-110.

4.10 Where the split (1×5 protection groups) STM is chosen, the design of the STM permits use of different line powering options for the two halves. Similarly, the FL output pairs (called collector pairs) of the ORs are combined in two groups (left and right halves) to be assigned to FL filters as required.

4.11 When a 1×11 STM is to be expanded into a 1×24 protection grouping, the extra 13

service lines are terminated on the ESTM which must be mounted immediately above the original 1×11 STM. The two STMs are joined electrically by a connectorized cable and the added 13 service lines share the protection line and alarming facilities of the 1×11 STM. An ESTM can be added in the field as growth warrants.

4.12 The ORs in the TRS, IPRS, and STMs are the 206- and 236-type with the code chosen to satisfy line powering and pad or build-out options as in the standard T1 systems. Bridging repeaters can be mounted in the 13th position on the 1×11 and split STM. The bridging repeaters can also be mounted in the ESTM, TRS, or by adding an output termination to the chosen bridging repeater position.

4.13 A power dissipation panel is associated with each LTM which houses the power dissipation resistors. The panel contains a terminal strip to accept the ABAM cable from the MDF or its equivalent, the power leads from the fuse panel, and provides terminals for selecting the line powering option (selected at the fuse panel in standard T1). A wiring duct is used for wiring between the repeater shelf and protection switch shelf. The panel is part of the repeater shelf equipment code.

4.14 Protection diodes are mounted on the APS shelf to keep positive voltages from appearing on the APS plug-ins in the event of a blown fuse. The necessary -48 volt power for the APS is wired to the diodes from the OR shelf.

(2) Fuse and Alarm Panel

4.15 All J98728-type STBs for T1/OS contain a fuse and alarm panel. The ED-2C373-30 fuse and alarm panel is used in the STBs, with various options depending upon the specific makeup of the bay. Essentially, the fuse and alarm panels can be put in three categories; first are those used in earlier versions of the T1/OS only bays; second are those used in combined T1/OS D3 bank bays; and third is a new series which is used for both T1/OS only and T1/OS with D4 banks.

4.16 The bays initially used for T1/OS only use a 4-inch panel, which contains fuse positions for $+130$ volt, -130 volt, and -48 volt supplies for up to four LTMs and associated order-wire and FL equipment. This panel also contains fuse and transmission alarm relays for interface with

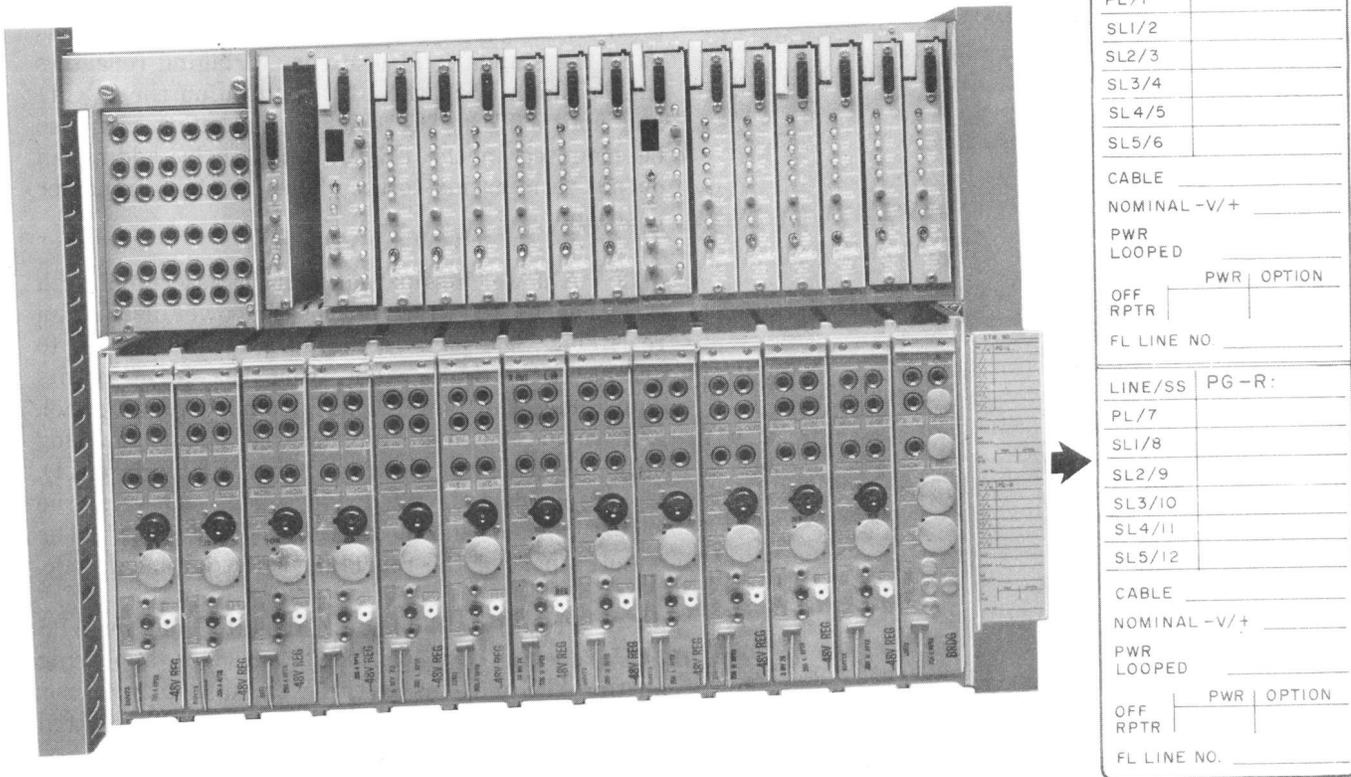


Fig. 22—T1/OS Span Terminating Module

central office alarm systems and/or alarm reporting systems, as required. Terminal strips on the rear of the panel receive wiring for power feeders and bay local cable.

4.17 The combined T1/OS and D3 bays utilize a 6-inch panel and an associated plug-in. The plug-in for this fuse panel contains miscellaneous components associated with alarm relay circuits on the panel. The combined panel provides fuse positions for -48 volt signal and filtered battery and 20-Hz ringing supply for up to four D3 banks or three D3 banks and a hot spare and maintenance panel. Also provided are +130 volt, -130 volt,

and -48 volt fuses for up to three LTMs and associated order-wire and FL equipment. Alarm interfaces and terminal block arrangements are similar to those for the T1 only panel.

4.18 The combined T1/OS and D4 bays utilize a 4-inch panel. This fuse and alarm panel does **not** contain battery filtering and 20 Hz ringing, as these services are supplied internally by the D4 channel bank. The panel is an improved version of the fuse panel initially used for T1/OS only bays. The original panel has been rated MFR DISC, and the new panel will be used for new T1/OS only and T1/OS with D4 banks. The

new panel displays D4 alarm indications and relays the information to the central office (CO) alarms or to the remote locations via E-type telemetry.

4.19 Some of the module configurations will result in surplus fuse positions. Office equipment arrangements may allow utilization of the surplus fuse positions for miscellaneous mounted equipment in an adjacent bay. This situation is most pertinent to 7-foot bay layouts wherein the fuse panel capacities can never be fully utilized in the basic bay.

(3) D3 Channel Bank

4.20 The D3 channel bank is used as a digital transmission network voice-frequency multiplexing terminal. The channel bank multiplexes the transmission and signaling information of 24 voice channels using PCM as described in Part 2B. Section 365-150-100 provides a general description of the D3 channel bank.

4.21 The T1/OS STBs (Fig. 15 through 20) can be arranged to receive a free-standing shelf assembly for the D3 channel bank that requires 19 inches of bay space. The features of this assembly are basically the same as those of the standard D3 bank shelves used in their own unitized bay. Terminal blocks are provided for all intrabay wiring (power, alarms, etc) and connectors are incorporated on the shelf local cable to receive external office cabling for the D3 bank. A 6-dB pad is mounted on the terminal block to lower the D3 output level. It is anticipated that all D3 signals generated in a T1/OS combined bay will be connected to a T1/OS office repeater in proximity through the DS1 jack panel and appropriate LTM. The STBs should be ordered with the expected ultimate D3 shelf complement. Although not mandatory, this procedure allows D3 shelf assemblies to be fully shop tested in place before shipment to the field.

(4) Hot Spare and Maintenance Shelf for D3 Banks

4.22 The hot spare and maintenance (HS&M) shelf contains a complete set of spare D3 common equipment plug-ins that are powered, operated in a looped condition, and alarmed. This arrangement ensures that the spare plug-ins are working units. The equipment of an HS&M panel can be expected to greatly facilitate the restoral of service in the event of channel bank equipment failures. The HS&M panel also has provisions for maintenance

and testing of plug-in equipment. Section 365-150-100 provides a general description of the HS&M shelf for D3 banks.

4.23 The HS&M shelf requires 7 inches of bay space in the T1/OS span terminating bay. The shelf is unitized with top and bottom castings and tie bars. Terminal blocks are included for bay cabling connections. The unit is fully shop-wired.

(5) D4 Channel Bank

4.24 The D4 channel bank is used as a digital transmission network voice frequency multiplexing terminal. The channel bank multiplexes the transmission and signaling information of 24-voice channels using PCM as described in Part 2B. Section 365-170-100 provides a general description of the D4 channel bank.

4.25 The T1/OS STBs (Fig. 18, 19, and 20) can be arranged to receive a free standing shelf assembly for the D4 channel bank that requires 19 inches of bay space. The features of this assembly are basically the same as those of the standard D4 bank shelves used in their own unitized bay. Terminal blocks are provided for all intrabay wiring (power, alarms, etc), and connectors are incorporated on the shelf local cable to receive external office cabling for the D4 bank. The bank output level is set by plug-in equalizers inserted into the trunk processing unit. It is anticipated that all D4 signals generated in a T1/OS combined bay will be connected to a T1/OS office repeater in proximity through the DS1 jack panel and appropriate LTM.

(6) D4 Maintenance Bank

4.26 The maintenance bank consists of plug-in test equipment and D4 channel bank plug-ins, most of which are kept operating in a looped arrangement. It serves as a source of known good replacement units and as a centralized D4 testing location. Section 365-170-100 provides a general description of the maintenance bank for D4 channel banks.

4.27 The maintenance bank is independent of the bay functions and may be mounted miscellaneous on any 23-inch bay with 10 inches of bay space. Terminal blocks are included for bay cabling connections. The unit is fully shop wired. It is recommended that the bank be provided on

a basis of not more than one per small office and not more than one per floor of D4 equipment in a large office.

(7) DS1 Jack and Cross-Connect Panel

4.28 The DS1 jack and cross-connect panel (Fig. 23) is the standard DSX-1 panel (with the IN, OUT, and MON jacks) except that the front panel portion has been shortened to permit a front-facing cross-connect terminal strip to be provided. The back of this strip is wired to tip and ring normals of the IN and OUT jacks, such that jumper connections (on the front) tie these normals to span lines IN and OUT as desired. Bridging resistors from OUT jack tip and ring connect to a third jack designated MON. Each 3-jack circuit, with tip and ring proper of the IN and OUT jacks cabled as required, provides access for patching, open or bridged, on the connecting DS1 facility. Cabling of pairs in suitable EU- or ABAM-type cables will be brought directly to the destined jack panel and enter via the rear shelf and fanning strip on the back of the panel. A designation strip on the face of the panel provides for identification of jack assignments.

4.29 All J98728 STBs for T1/OS usually contain a DS1 jack and cross-connect panel as part of the basic bay and additional panels may be added as required. The DS1 jack and cross-connect panel requires 3 inches of bay space and may be

ordered with the number of jack circuits initially required (up to 16 jack circuits per panel) with additional jacks added in the field as needed.

(8) Order-Wire Panel

4.30 The order-wire panel (Fig. 24) requires 2 inches of vertical mounting space in the T1/OS span terminating bay. This panel provides flexibility of the order-wire system configuration by accepting any two of four different type plug-in units provided. Wiring arrangements to the rear-side terminal block are provided accordingly. A general description of the T1/OS order-wire system is given in Section 365-325-100.

4.31 The four plug-in units are listed below with a brief description of each.

- (a) Tel Set Plug-In—Provides a talking circuit that can be patched to an order wire.
- (b) Order-Wire and Tel Set Plug-In—Contains circuits to access an order-wire line to a dial line at the office or to permit signaling an office via an audible alarm activation. A quiet termination may be effected from a field appearance or by operating an ACO key on the unit. The tel set circuit in this plug-in is normally connected to the associated order-wire line but may be patched to another line if desired.

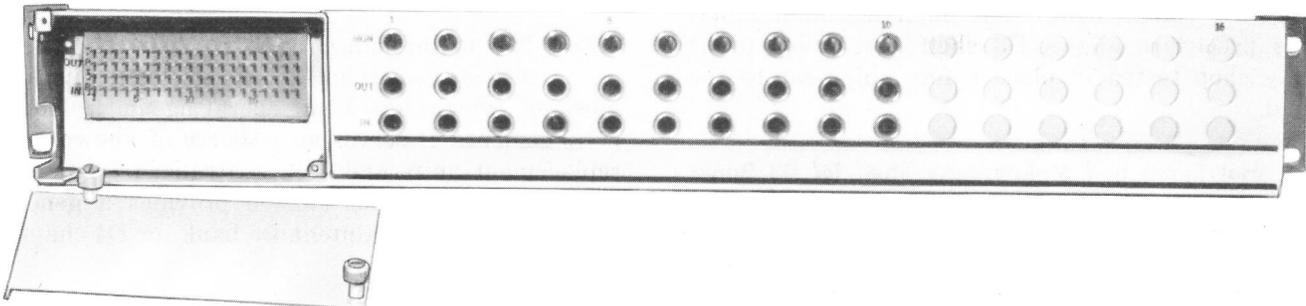


Fig. 23—DS-1 Jack and Cross-Connect Panel

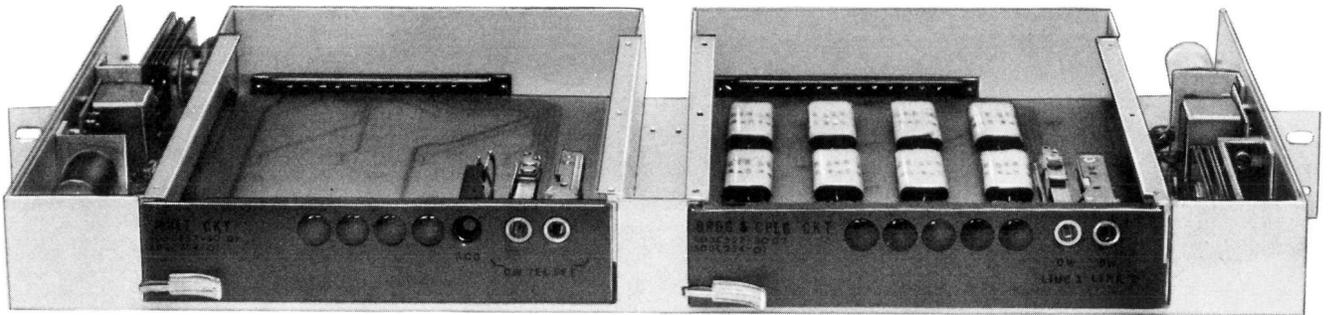


Fig. 24—Order-Wire Panel

- (c) Multiple Unit Plug-In—Provides remote access to another order-wire panel or tel set.
- (d) Bridging and Coupling Unit—Provides ac coupling of two order-wire pairs. Order-wire line jacks for each of the coupled order wires provide bridge taps for local access via a tel set.

(9) Fault-Locating Panel

4.32 The FL panel used in the T1/OS STB requires 1-3/4 inches of vertical mounting space but takes up 2 inches of space in the T1/OS bay. The panel is illustrated in Fig. 25. The panel provides front access plug-in positions for three 1114-, 1115-, or 1068-type filters and a fault-locate control unit (FLCU) plug-in. A 6-position jack mounting is provided in the center of the panel, two jacks being equipped for test set battery (-48 volts) and two jacks providing access to a 25-dB pad for use in conjunction with the FL test set. The remaining two positions are available for miscellaneous jacks that may be implemented on a job basis. On the rear of the panel, a terminal block is provided for connecting circuits and acts as a cross-connect block for assignment of connecting facilities as required. Provision is made for terminating inputs and outputs of the three filters, eight FL collector pairs (from office repeater groups), and six FL lines. Strapping at the block ties the fault-locating collectors to selected filter inputs and filter outputs to selected FL lines. The collector pairs which are assigned to a filter will be automatically shorted by switches when the associated filter is not in place.

4.33 The FLCU plug-in is a printed wiring board assembly containing power supply, control, and busy detection circuitry for up to six FL lines allowed at one panel. The front panel contains switches for selecting one of six lines and choosing polarity of power being applied to the selected line. When plugged in, a single FL line jack is automatically connected to the selected line unless inhibited by the busy detector finding voltage on the line from a distant point. The inhibit sequence will also light the BUSY lamp. The application of power to an FL pair makes it inaccessible from the opposite end. The line powering is +130 volts with +118 volts actually applied to the FL pair. Two jacks (FLT TST in-1 and FL TST IN-2) take over the FLCU to access and power FLT position 3 when it is to be used for verifying performance of filters to be tested. Selected pairs of FL lines may be connected through the office, being constrained to pairings of ports 1-2, 3-4, and 5-6. Clip options within the FLCU determine this mode condition by being placed on pairs of terminals designated THRU or TERM. Two clips are involved in each of the pairs. Relay circuits are so arranged that use of one leg of a pair of lines will cut a through-mode path, terminate, and busy out the unused leg.

(10) Protector Panel

4.34 A protector panel is available on J98728D, E, F, K, L, and M T1/OS bays that allows the tip cable from the cable vault to be brought directly to the T1/OS bays. The panel can accommodate one hundred 303-type protectors and has cross-connecting capability.

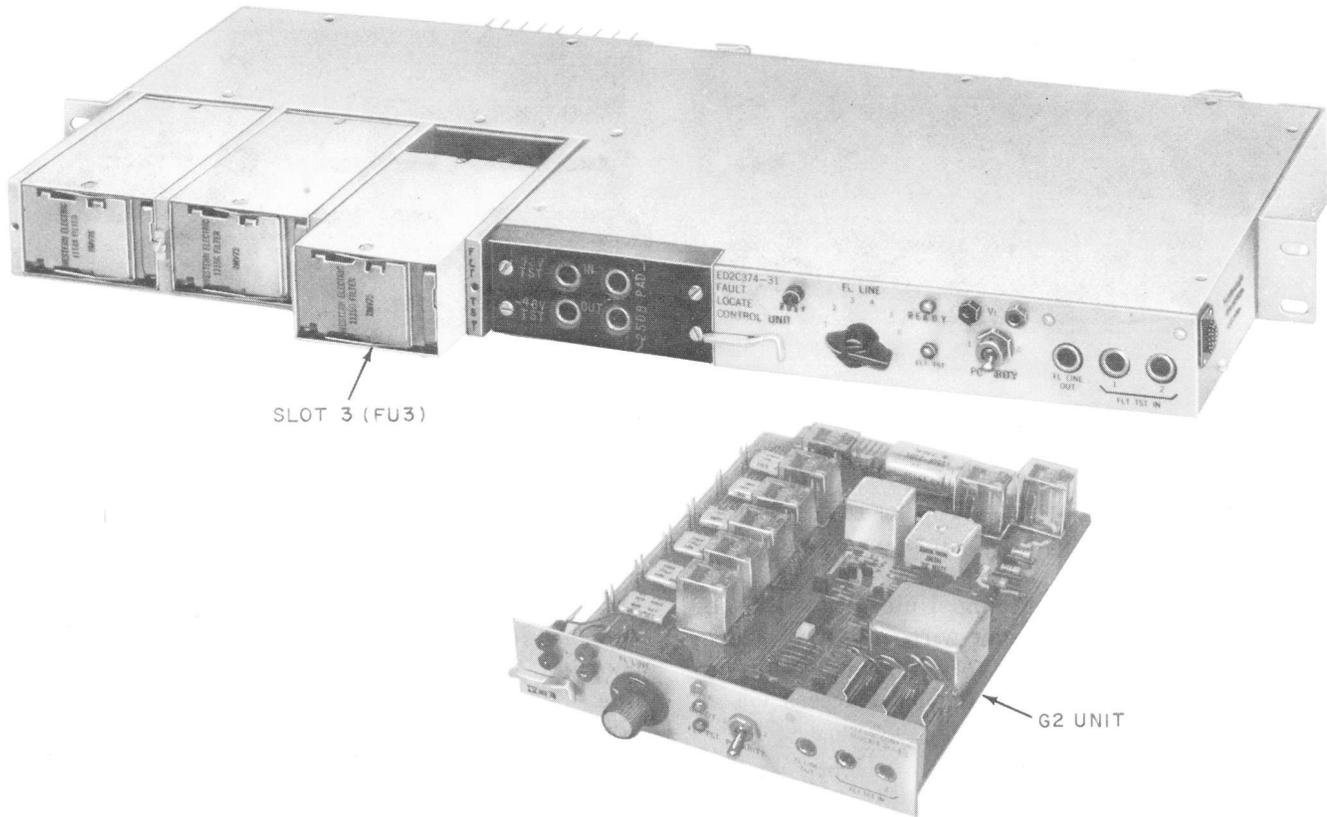


Fig. 25—FL Panel

(11) Filter Panel

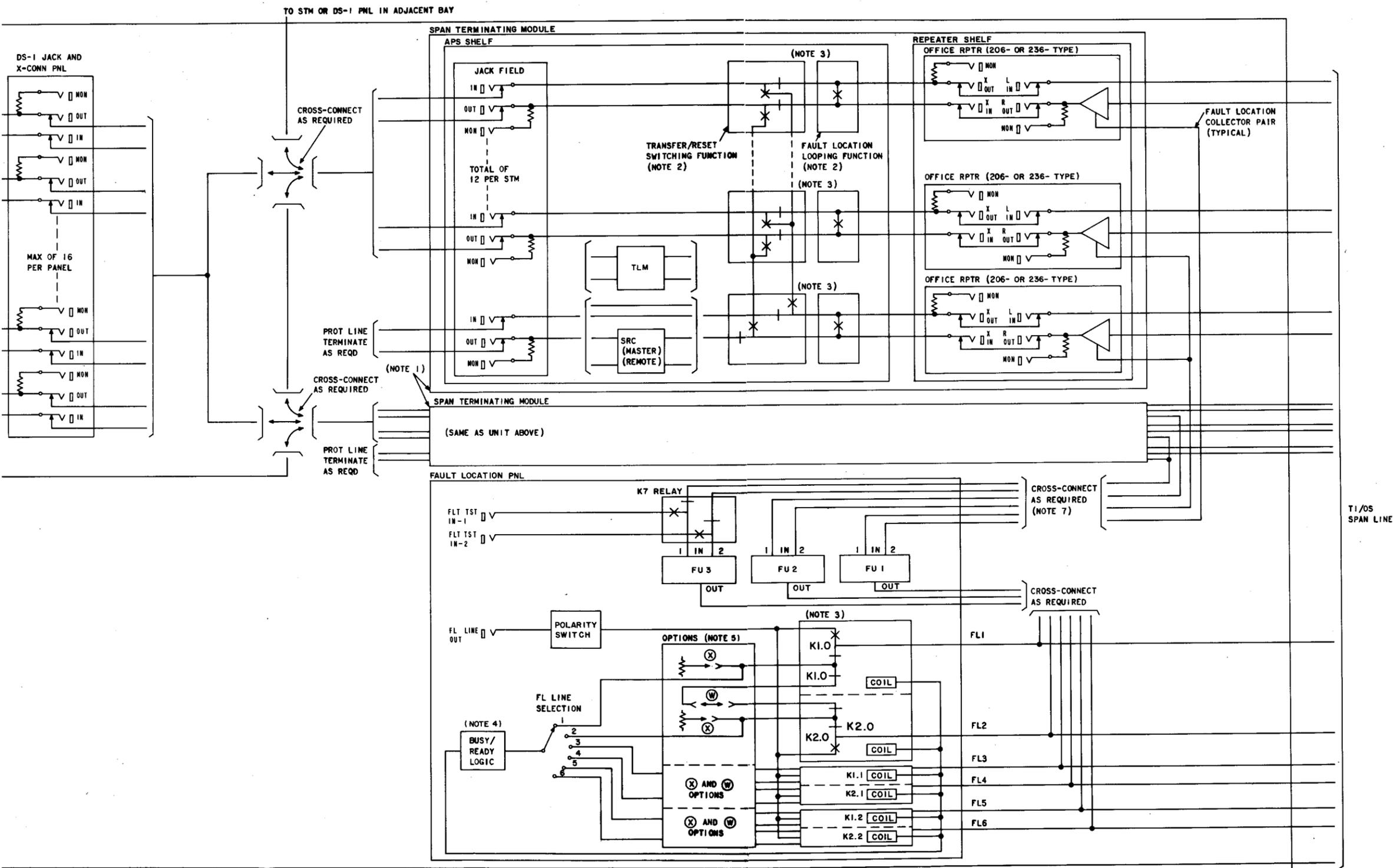
4.35 A filter panel is available as a replacement for the active FL panel when a passive FL system is used. This panel will provide space for additional filters in the STB which can be six 1068-, 1114-, or 1115-type FL filters. Each slot can be assigned to either type filter. A terminal strip on the back of the panel provides for access to the filters from the office repeaters and for cross-connecting the six filters to any of eight possible incoming lines. The lines can be terminated or connected through and each has jack access on the front of the panel. If active filters are assigned, they can be used for far end interrogation only since this panel does not provide the power and control features of the active FL panel.

B. Functional Diagram of J98728 Span Terminating Bay

4.36 Each end of a T1/OS system span is terminated in one of the various available configurations

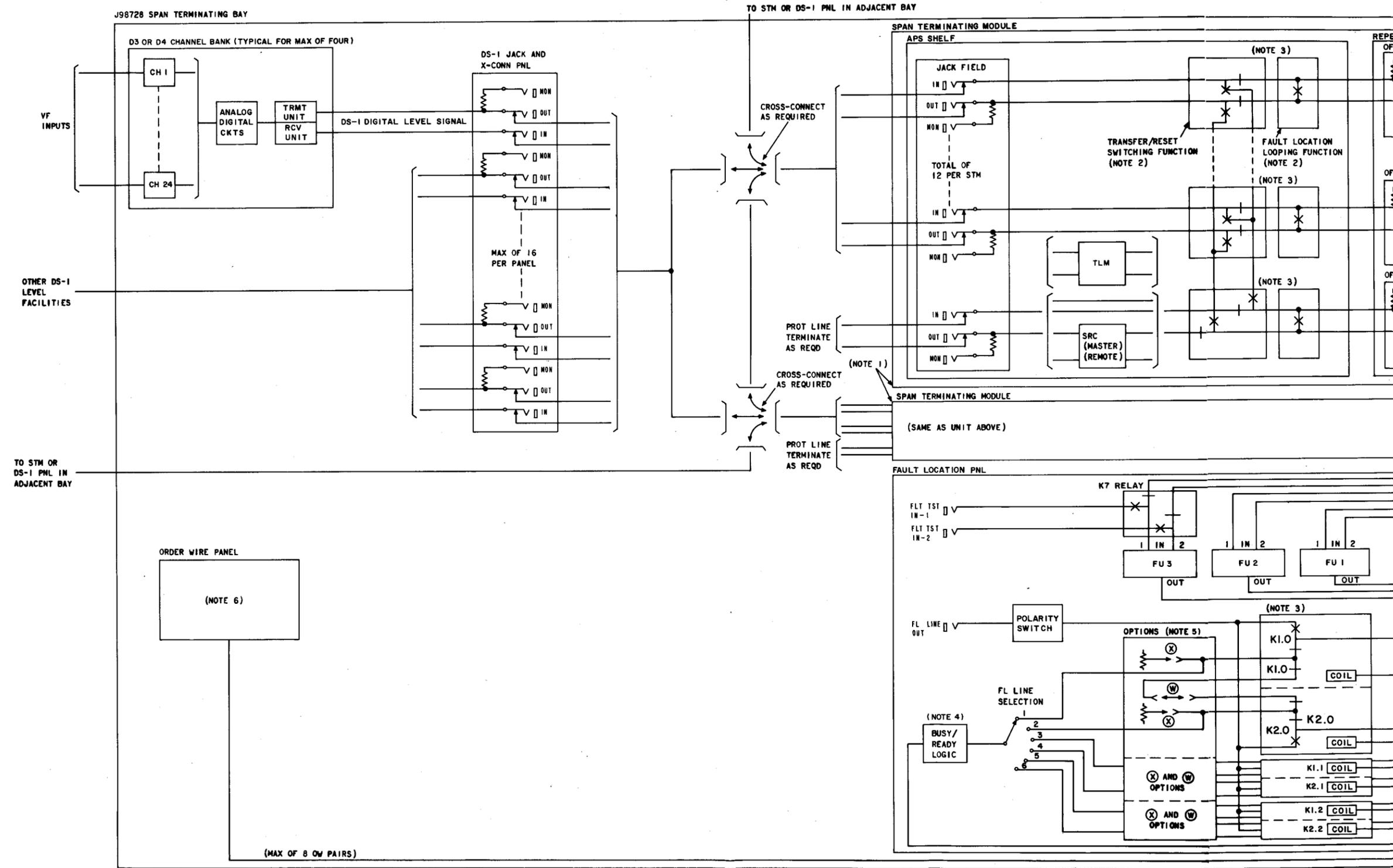
of the J98728 span terminating bay. A general functional diagram is shown in Fig. 26 to illustrate the flow of the DS1 level digital signals within the terminating bay and the interrelation between the major equipment panels. The power distribution within the bay has been omitted to aid clarity of signal flow.

4.37 The provision for cross-connection of DS1 interfaces is of particular interest in the bay arrangement. These will occur between span line sections or between span lines and D3 banks or other DS1 facilities (refer to Fig. 26). Cross-connect jumpers are run in the vertical ducts appearing at the face of the left upright as shown by Fig. 21. If the cross-connect is to be made to an adjacent STB, the horizontal duct at the base of the bay permits such an extension. In general, DS1 facilities external to the T1/OS STB, in addition to any D3 and D4 banks, will be made to appear on the DS1 jack and cross-connect panel. These remote sources may then be cross-connected via the vertical duct as described above. The terminals for the



- NOTES:
1. UP TO 3 STM'S CAN BE USED IN THE T1/D3 OR T1/D4 COMBINED CONFIGURATIONS UP TO 4 STM'S CAN BE USED IN THE T1/ONLY CONFIGURATIONS.
 2. THESE SWITCHING FUNCTIONS ARE PERFORMED BY SEMI-CONDUCTOR LOGIC CIRCUITRY. SEE BSP 365-250-110.
 3. LEGEND FOR INDICATED SWITCH CONTACTS:
 — CONTINUITY WHEN SW NOT OPERATED
 — CONTINUITY WHEN SW OPERATED
 4. BUSY/READY LOGIC SENSES FOR POWER ON SELECTED FL LINE. DENIES ACCESS IF POWER IS PRESENT BY CONTROLLING OPERATION OF ASSOCIATED ACCESS RELAY.
 5. OPTION (X) TERMINATES FAULT LOCATING LINES. OPTION (W) THROUGH CONNECTS TWO FAULT LOCATING LINES. OPTIONS MUST BE SELECTED ON THE BASIS OF PAIRS OF FAULT LOCATING LINES AS SHOWN FOR FL1 AND FL2. PAIRING OF FL LINES IS AS FOLLOWS: FL1 AND FL2; FL3 AND FL4; AND FL5 AND FL6.
 6. ORDER-WIRE PANEL ACCEPTS ANY TWO OF FOUR DIFFERENT PLUG-IN UNITS TO ESTABLISH VOICE FREQUENCY MAINTENANCE CIRCUIT(S) PER T1/OS SPAN REQUIREMENTS. A TOTAL OF 8 ORDER WIRES CAN BE ACCEPTED BY THE PANEL. REFER TO BSP 365-325-100.
 7. REFER TO SD-1C597-01 FOR OFFICE REPEATER GROUPINGS ASSIGNED TO FL COLLECTOR PAIRS.

Fig. 26—General Functional Diagram of J98728 STB



cross-connects are positioned in compartments adjacent to the vertical duct and at the left end of the affected panel or shelf assemblies. DS1 facilities remote from T1/OS STBs being introduced via a DS1 jack and cross-connect panel are governed by the standard T1 cable length restrictions. The T1/OS system is intended to be maintained independently with all necessary access and patching achievable at the T1/OS bays. A DSX-1 is not needed in the T1/OS system. Where a standard DSX-1 patch and cross-connect bay or the equivalent appears in an office, the T1/OS STB may be terminated in it and any facility appearing thereon may be cross-connected to the STB appearance so long as the 85-foot limitation on cable pair length (ABAM-22 or equivalent) is observed.

5. POWERING OF T1/OS DIGITAL LINES

5.01 Power from the STO batteries is connected to the simplex of the cable pairs in the LTM located in the T1/OS STB. The battery potential applied to a span line depends on the number of repeaters to be powered and is derived from combinations of the -48V, +130V, -130V office supplies and ground. The office repeaters are powered in the same power loop as the line repeaters unless powering from the -48 volt office supply is needed to achieve the optimum length of power loops. Because the dissipation resistors are mounted on the repeater shelf in T1/OS, the office repeater should be powered from the -48V local battery only when absolutely necessary. The T1/OS lines terminating at an LTM are divided into odd- and even-numbered lines (see SD-1C597-01) at the STB and the groupings are connected to separate battery feeds to minimize the effect of a blown main or feeder fuse. The assignment of D3 and D4 channel banks to the power feeders in combined bays is correlated with line powering to minimize loss of service on failure of a feeder fuse.

5.02 When only one office supplies a span, the power is looped at the other office. When both offices supply the span, power is looped back toward both offices at one of the line repeaters. The repeater at the looping point is powered from the office transmitting in the direction of side 1 of the repeater.

5.03 The T1/OS system uses the 206- or 236-type office repeater located in the LTM. In the 206-type repeater, the line current is held to 140 \pm 2 milliamperes by means of an automatic line

regulator. This current for powering line repeaters also serves as a sealing current for unsoldered splices in the line. The 236-type repeater powering low power 238 or 239 line repeaters will maintain a 60-milliamperes line current.

5.04 The power scheme for systems using bidirectional repeaters is shown in Fig. 27A. The one power loop consists of one office repeater and the bidirectional repeaters which serve one system. The office repeater is shown powered in series with the line and the power is looped at a line repeater. Options on the office repeaters could have been selected to power the repeater separately from a local battery or to power it from the other end. The battery potential applied to a power loop depends on the number of intervening repeaters before the looping point. Each power loop is uniquely related to one particular T1/OS system.

5.05 The powering scheme for systems using unidirectional repeaters is shown in Fig. 27B. The two power loops consist of two office repeaters and the unidirectional repeaters which serve two systems. The battery potential, which depends on the number of repeaters to be powered, is applied between the two office repeaters. The office repeaters are normally powered in series with the line. The power could have been looped from another STO by using the appropriate repeater or option. Removing any unidirectional line repeater or the office repeater in a power loop disrupts powering on two T1/OS systems.

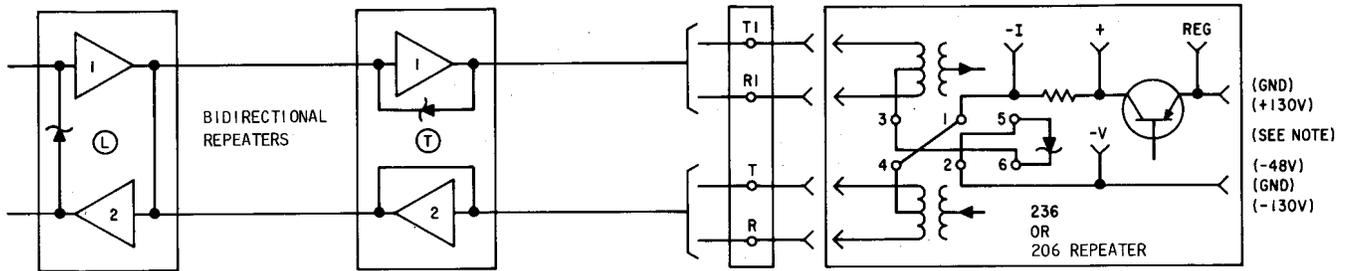
6. T1/OS SYSTEM MAINTENANCE

A. General

6.01 The T1/OS system maintenance plan provides for:

- (a) The immediate and automatic restoration of a failed span line by an APS
- (b) The reporting of the status of remote maintenance spans to a designated maintenance control office
- (c) The control of remote APS equipment for maintenance purposes from the control office
- (d) An active FL system that allows single-end (either end) fault location of a maintenance span

SECTION 365-010-110

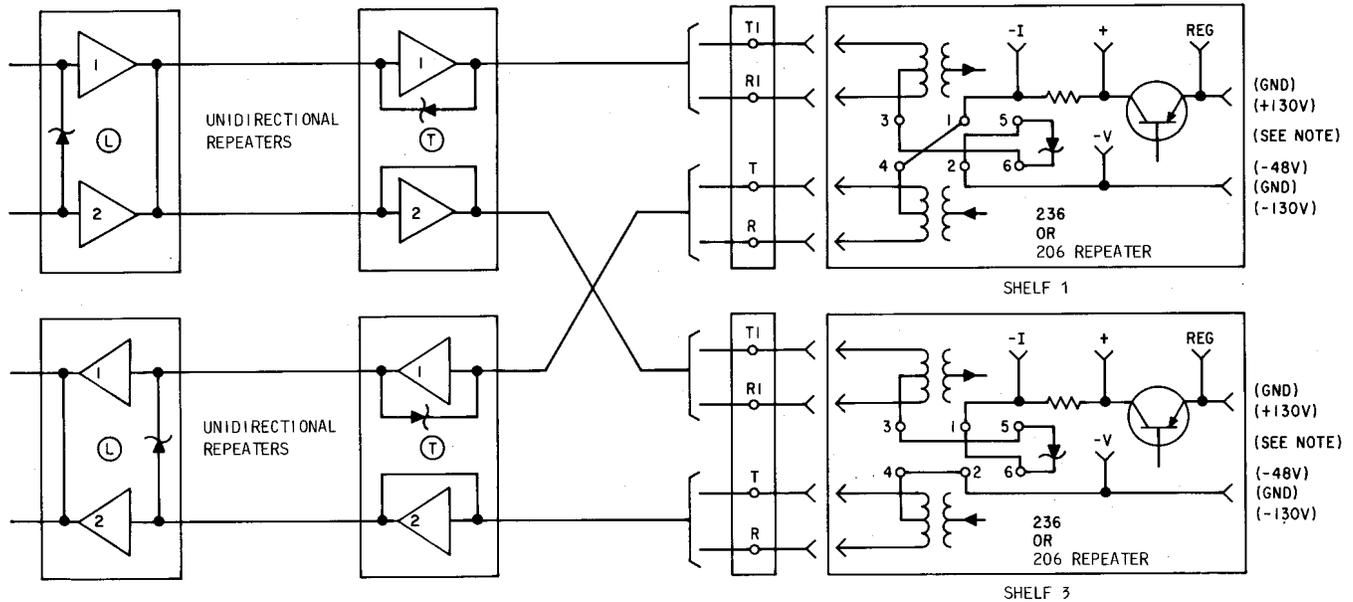


Ⓛ INDICATES POWER IS LOOPEL BY PROVIDING THE CORRECT CODE OF REPEATERS.

Ⓣ INDICATES POWER IS FED THROUGH BY PROVIDING THE CORRECT CODE OF REPEATERS.

NOTE:
REPEATERS MAY HAVE EITHER A 48-VOLT OR A 130-VOLT REGULATOR.

A. POWERING SCHEME FOR BIDIRECTIONAL LINE REPEATERS



Ⓛ INDICATES POWER IS LOOPEL BY PROVIDING THE CORRECT CODE OF REPEATERS.

Ⓣ INDICATES POWER IS FED THROUGH BY PROVIDING THE CORRECT CODE OF REPEATERS.

NOTE:
REPEATERS MAY HAVE EITHER A 48-VOLT OR A 130-VOLT REGULATOR.

B. POWERING SCHEME FOR UNIDIRECTIONAL LINE REPEATERS

Fig. 27—Powering T1/OS Digital Lines

(e) An improved 2-wire order-wire system.

6.02 A significant change from current T1 practices is the fact that bipolar violations are not a valid indication of end-to-end system performance when T1/OS systems consist of more than one maintenance span (Part 2C). The bipolar violations are removed by the APS equipment, terminating each end of a maintenance span. Removal of the bipolar violations on a maintenance span basis allows sectionalized maintenance of a T1/OS system using independent protection switching of each tandem-connected maintenance span. ***End-to-end T1/OS system error rates must therefore be measured using a quasi-random signal source (QRSS) signal with errors in the known data word being the measure of the system performance. Also it is impossible to fault locate for bipolar violations between maintenance spans.***

B. Facilities

(1) Automatic Protection Switching (APS) System

6.03 The equipment for the APS system is provided as an integral part of the STM as described in paragraphs 4.08 through 4.14.

6.04 The APS system is a maintenance span-by-maintenance span type switch. If T1/OS maintenance spans (Part 2C) are connected in tandem, a service-line failure occurring in one maintenance span will cause a transfer to occur only within that maintenance span and not on any tandem span. This allows sectionalized independent use of the protection span line by the protected service lines. Figure 28 illustrates a tandem connection of three maintenance spans to form a system of five service lines and one protection line (1 × 5). Two failures are illustrated in Fig. 2A and each failure causes independent transfer to the protection line. The section of protection line in maintenance span 2 could be used by a failure in any of the five service lines. Automatic reset to the service line is provided when proper operation of the service line is established by the APS monitoring and sensing equipment. Both the transfer and reset action of the APS equipment may be inhibited and controlled either manually by front panel controls or remotely by telemetry equipment. The APS equipment is designed not to transfer to the protection line if the failure occurs outside the maintenance span. A transfer

or reset action may cause momentary transmission of erroneous signals, but this occurrence should be too brief to cause either a carrier group alarm (CGA), a trunk disconnect, or an APS transfer on and adjacent maintenance span.

6.05 The service/protection line concept shown in Fig. 28 illustrates both directions of transmission in a T1/OS system. Since the APS equipment is also of the "two-way" type, both directions of transmission will always be transferred to the protection line if a failure occurs in either direction; and both directions will be reset back to the service line when the trouble clears.

6.06 The basic concept for automatic protection of T1/OS service lines provides for one protection line for up to N service lines (1 × N). The value of N is an engineering decision based on operational considerations. The T1/OS package provides for a 1 × 5 (shown in Fig. 28), a 1 × 11, and a 1 × 24 protection system. When T1/OS is implemented with unidirectional repeaters, the service lines must be arranged into two separate 1 × N groupings in order to avoid loss of service on a good T1 line when a two-regenerator (unidirectional) repeater is removed for maintenance. Most applications of T1/OS will employ bidirectional repeaters, in which case only one 1 × N APS system would be required.

6.07 The APS system has wired-in priority. That is, each service line has a designated priority, and, in the event of multiple failures, the failed service line having the highest priority will seize the protection line. The priority of a service line is associated with the physical location of the plug-in on the shelf. The higher priority lines are on the left and priority decreases in going from left to right. The protection line always receives highest priority; its failure inhibits all transfer; and it occupies the left-most location. Relative priority between service lines can be changed at the cross-connect without causing system hits through the use of the monitor jacks and bridging repeaters.

6.08 The APS equipment for T1/OS will initially be supplied by Lynch Communications Systems, Inc., and is designated by their code "B302". Other manufacturers' products will be considered for incorporation into the standard T1/OS equipment arrangement when and if it is appropriate to do so. Refer to Section 365-250-110 for the description, installation, operation, and use of the B302 switch.

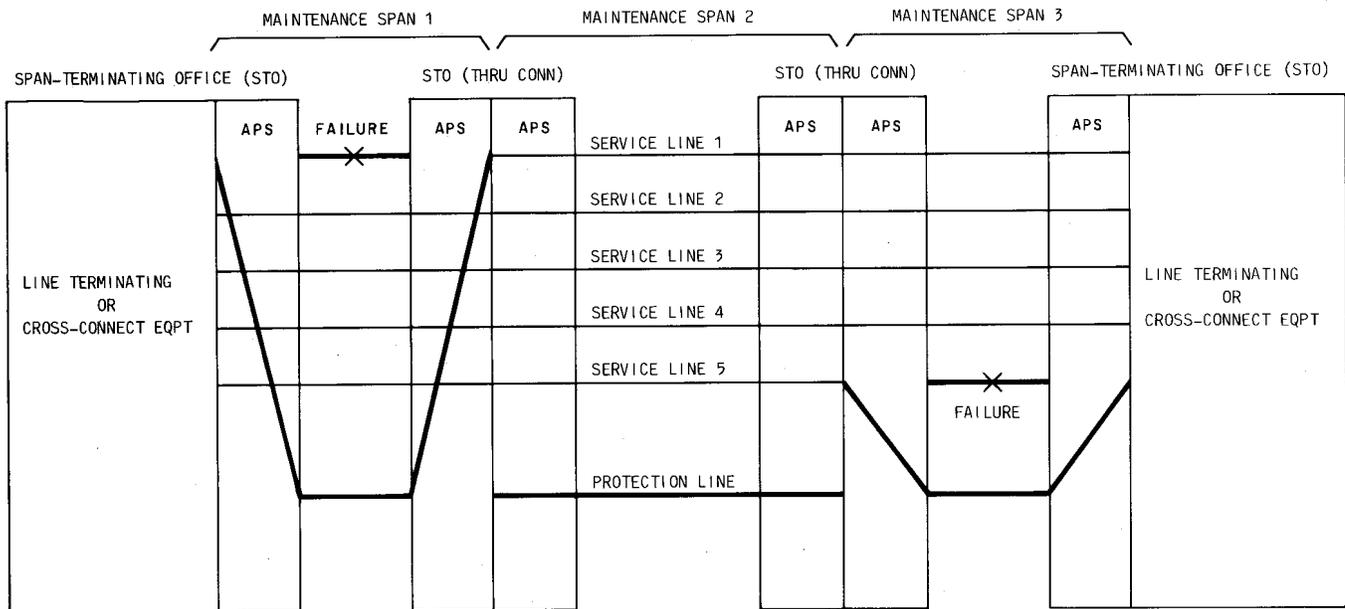


Fig. 28—Sectionalized Use of Protection Span Line

6.09 The APS card edge connectors that accept the per-channel plug-ins have normal through contacts so that a position without an APS card is still wired through the shelf. As a result, some systems terminating on an STM are in an APS system while others are not.

(2) Status Reporting and Control (SRC) External Telemetry System

6.10 The SRC external telemetry equipment, implemented with optional plug-ins on the APS shelf, is included as a part of the APS equipment design. The SRC system consists of master and remote plug-in units which are designed for optional mounting in an APS equipment shelf and dedicated to a particular protection group. Figure 29 shows the front panel appearance of the plug-in units. These units provide status and command over the *unused* protection line. The reports are received from the remote units at the individual maintenance spans by the master unit in a control office. The received reports (1) indicate the presence of a major or minor APS alarm, (2) provide a single unassigned status reporting input, and (3) report the status of the individual maintenance span transfer and reset control functions. The master unit initiates command functions to control the reset on/off and transfer on/off (protection line

switch card) modes of the APS equipment serving each individual maintenance span. A scan switch on the master unit allows the remotes to be monitored sequentially either automatically or manually. One master unit can monitor and control up to eight remote units.

6.11 The SRC system can be used in two modes.

Mode 1 operation places the remote units at each end of the remote maintenance span and at the far end of the first span. As a result, a protection line going through an office with APS can have two remote units; one for each of the two maintenance spans. Mode 2 operation places the remote units only at the head (or master office) end of the maintenance spans; thus, a through office will have only one remote SRC unit. The advantages of Mode 1 over Mode 2 are: the ability to *completely* control the APS systems because transfer on/off has to be accomplished at both ends of a maintenance span, and the capability of increased alarm reporting from the far offices of a maintenance span. The advantage of Mode 2 is that the limited number of remote units can be used over more maintenance spans.

6.12 A T1/OS network illustrating full use of an SRC system in the Mode 2 configuration is shown in Fig. 30. This configuration consists of

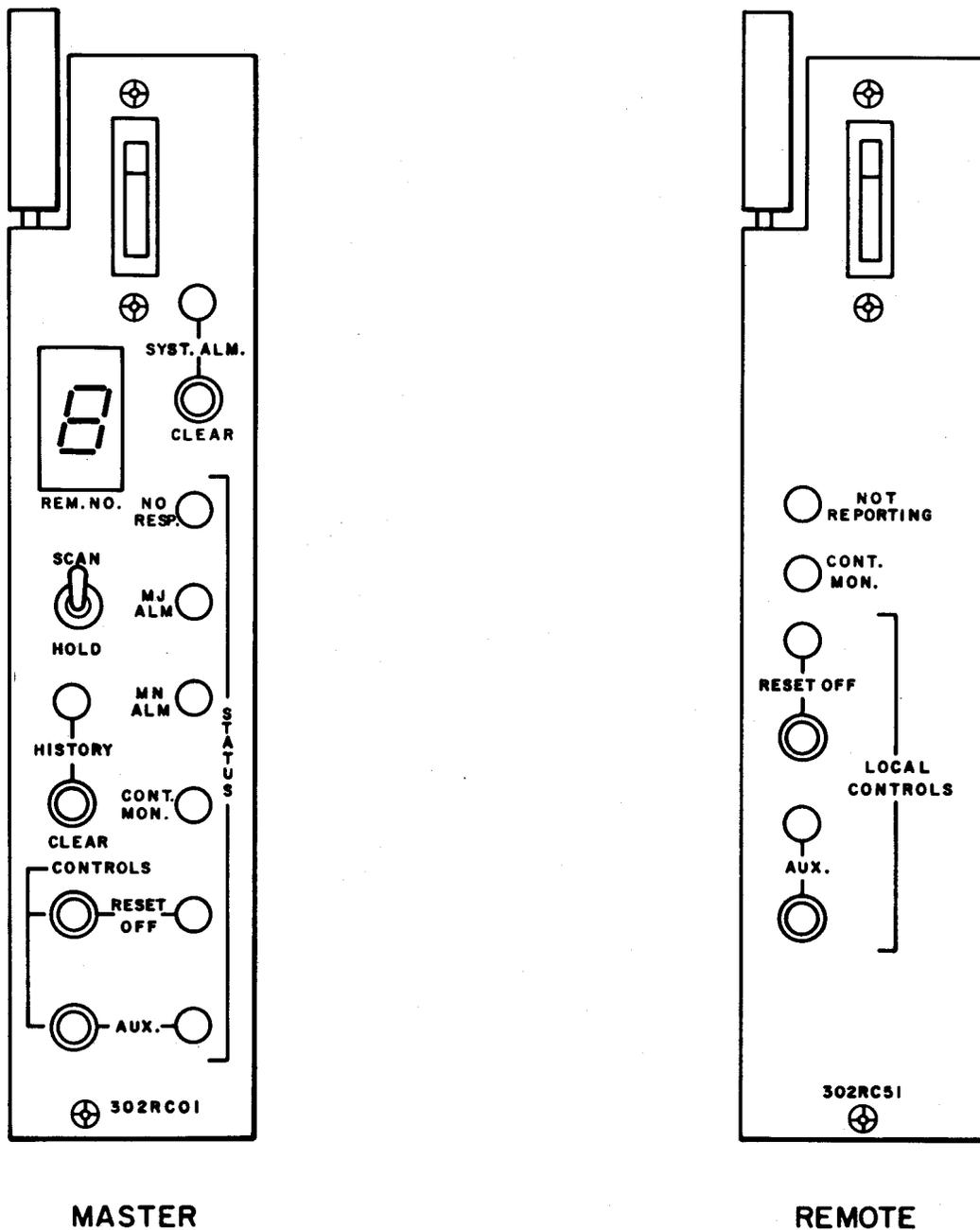


Fig. 29—SRC System Plug-in Units

one SRC master unit and eight SRC remote units serving a total of nine T1/OS maintenance spans. The capacity of nine spans is possible by reporting the first span (location of the master SRC unit) locally. Only three working lines are shown to enhance the clarity of the diagram but each span can consist of the design capacity of T1/OS system

as well as multiple protection lines. All communication for the SRC system is accomplished over the protection line (PL) of the APS and continuity is established by looping spans 3, 7, and 9 at the far end. This eliminates the significant expense of a separate channel, but since a service failure must have priority to the protection line, communication

is lost through a span in which the APS effects a transfer. The SRC remote units (Fig. 26) are arranged with reference to the STO containing the SRC master unit and are located at the near end of the spans that they control. This allows communications with a master unit even if its span is transferred. A further provision is made to loop the protection line at any remote unit when its span is transferred. Accordingly, a service line in spans 3, 7, and 9 in Fig. 30 could be transferred and reporting could be obtained by the master SRC from all remote units. Conversely, if a service line in span 4 has transferred, spans 5 through 9 are isolated and no reports from them may be received at the master SRC. In any case, there will always be communication with the span closest to the master unit which is transferred. The layout of the SRC system should be chosen to minimize any disadvantages this presents.

6.13 A telemetry interface unit is available for optional plug-in mounting on the APS shelves in place of the SRC units. In combination with external telemetry (not supplied) it provides all the capability for remote monitoring and control which the SRC does; and, in addition, allows the per-line failure indication to be removed. The telemetry card reports only on the APS terminated T1 lines in the shelf containing the telemetry plug-in.

6.14 When controlled remotely, three modes of operation are available for control: the normal or automatic mode, the reset-off mode, and the transfer-off (protection) mode. Under remote control, reset-off inhibits automatic reset for all service lines in a protection group, whereas each service line can be individually controlled in this respect locally. From a designated central maintenance position in the network that is remote from the span being controlled, an operator can inhibit all lines from resetting automatically (and conversely can allow automatic reset to occur by reversing the control). The remote transfer-off (protection) allows end-to-end testing through tandem spans without interference from inadvertent APS operation by inhibiting the APS from functioning.

6.15 The remote control functions described above can be implemented by use of either the SRC or an external telemetry system. If the transfer-off remote control is desired, the SRC remote or telemetry interface units must be placed at **both** ends of a maintenance span; hence the

eight SRC units (see Fig. 30) allow a maximum of four spans to be controlled and reported.

(3) Fault-Location System

6.16 A basic FL system for digital lines (Fig. 31) consists of a voice frequency pair (inductively loaded) connecting a group of unique frequency FL filters to control/jack panels in terminating offices located at the span ends of the repeatered transmission line. The filters are located in apparatus cases at the repeater locations and the control/jack panels allow test equipment access to the cable pair to receive test signals. Power application for filters with amplifiers is also controlled in the office. The test signals are applied to the carrier line at an access point provided in the line terminating equipment.

6.17 A unique identification of each repeater location between the terminating offices in the maintenance span is established using a combination of 12 individual FL filter frequencies, the FL lines, and the dc power switching action of the T1/OS fault-locating panels. The FL filter frequencies are provided by **four** codes of filter in T1/OS: 1068A through M (single-input passive filters and 1068AA through AM dual-input passive filters) (paragraph 3.14); 1115A through M dual-amplifier filters (paragraph 3.13); and 1114A through M single-amplifier filters (paragraph 3.12). The switching action of the T1/OS fault-locating panel provides test equipment access to the output of any selected FL line. Logic circuitry in the panel prevents dual access to the FL line. Integral to the fault line selection, the panel provides power to the FL line for the active filters selected for interrogation and power for activating the logic circuitry of other offices on the unused part of the FL line when it appears in other span terminating offices.

6.18 The active filters improve signal-to-noise (S/N) performance of the FL lines, and permit separation of fault identification in opposite directions of bidirectional repeaters. The latter is made possible by the use of the 1115-type filters, split fault output repeaters (paragraphs 3.05 through 3.09), and apparatus cases with split wiring (paragraphs 3.03 and 3.04). Selection of powering polarity to the FL line is determined by the polarity switch on the control panels and **the maintenance of T-R integrity to the filter locations**. The polarity sensitive 1115-type dual-amplifier filters

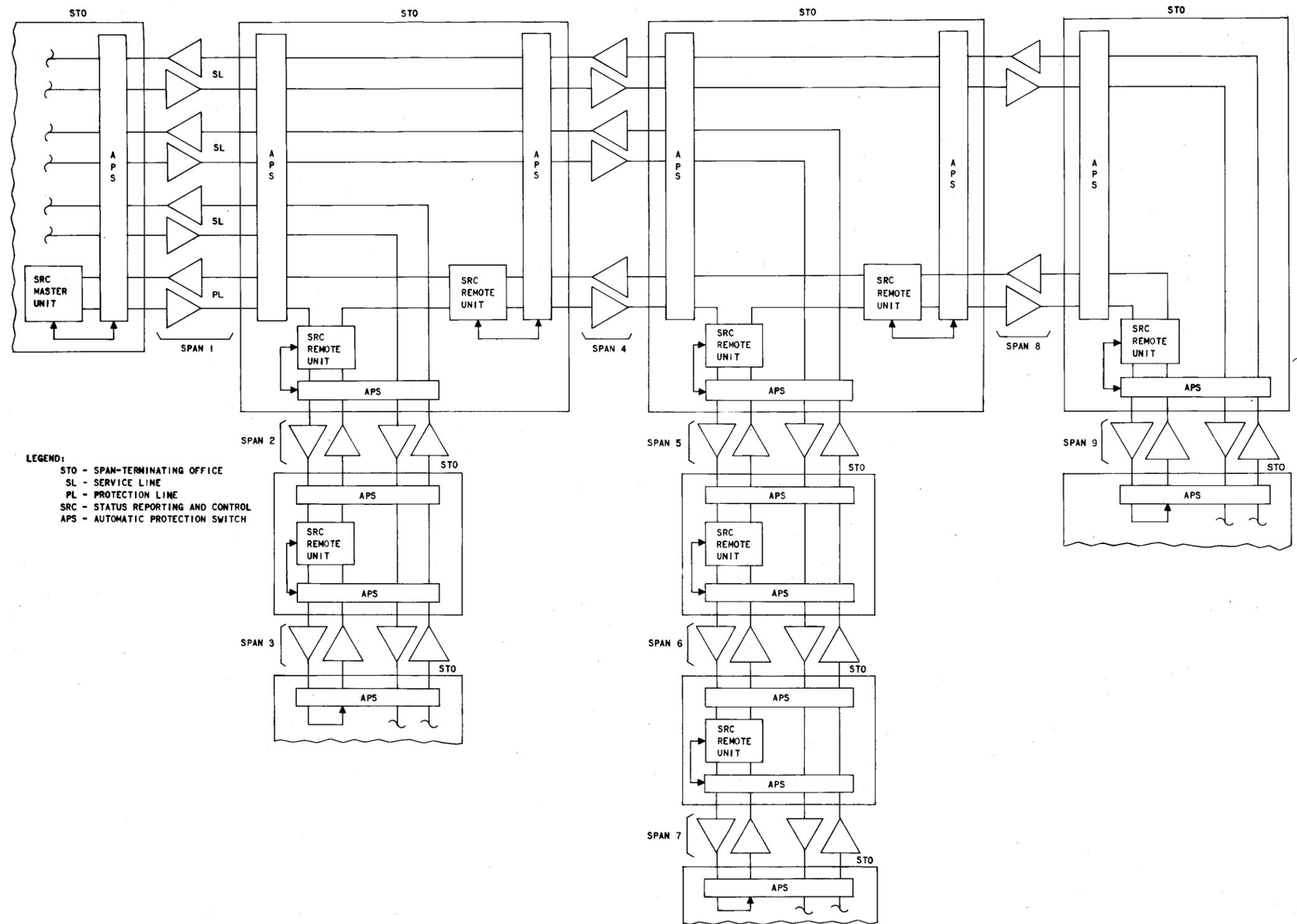


Fig. 30—T1/OS Network Illustrating Full Use of SRC System

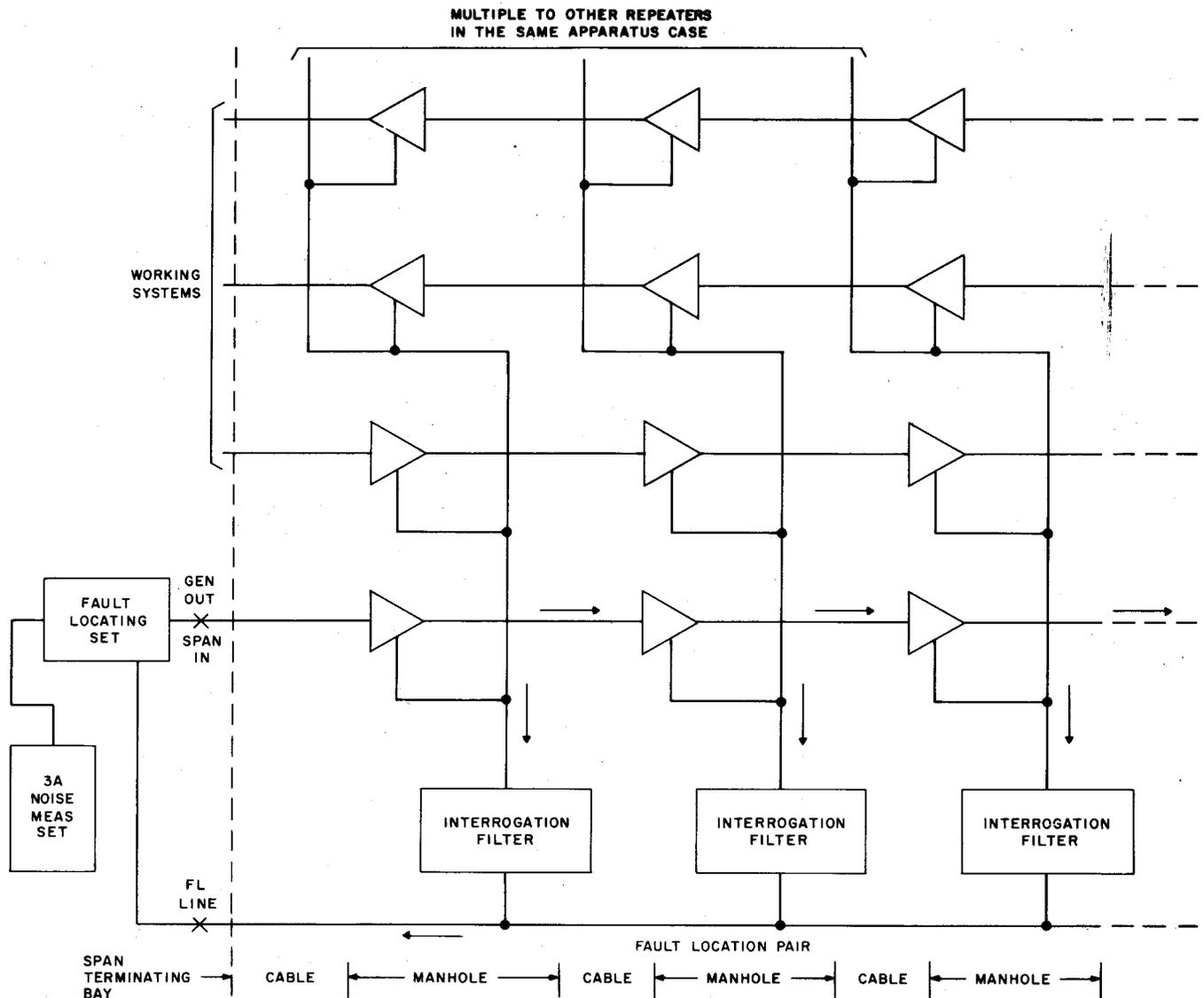


Fig. 31—FL of a Digital Carrier System

enable the return of FL signals from one or the other direction of digital transmission within the repeater. When this arrangement is combined with a loop-back capability in the automatic protection switch (paragraphs 6.03 through 6.09), single-end fault location of both directions of transmission can be accomplished within a maintenance span for the bidirectional mode of operation (Part 2D). The 1114-type single-amplifier filters are used in combination with the loop-back capability of the APS to provide single-end fault location for the unidirectional mode of operation (Part 2D). Dual use of the twelve 1114A through M codes may be

obtained by placing a tip-ring turnover between two filter groups. Reversing the polarity of the power at the control panels then activates one or the other group of filters and this, in effect, provides a maximum 24-filter configuration. The single-end FL techniques using the 1114-type and 1115-type filters can be extended by using additional FL lines. Also, it is general practice to use the 1114-type filter to serve the office repeaters in the terminating offices in both the bidirectional and unidirectional modes of operation. A detailed description of the active FL system used in T1/OS is contained in Section 365-200-160.

6.19 The unique advantage of the FL system described in paragraph 6.18 is the provision of single-end testing capability. This capability provides for isolating faults in both directions of digital transmission from measurements made at one end of the maintenance span and utilizes a far-end loopback of the digital line. Both-ends testing means that only one direction of T1 transmission, the outgoing direction, can be tested from a given office; thus the need to test a span from both ends. If unidirectional repeater operation is used, the FL system will be inherently directive because separate FL pairs are assigned to each direction of digital transmission. Both-ends testing in T1/OS can be accomplished by using the 1114-type active filters, or the 1068-type passive filters. The T1/OS fault-locating panel can accommodate both active and passive filters and fault lines using either active or passive filters. The two filter types should not be mixed on a given fault pair, however, and if a line of passive filters has the conventional resistor termination in one end office and the T1/OS panel in the other, a dc blocking capacitor must be added in series with the resistor. It is difficult to obtain adequate return S/N ratios in a passive FL system used in the extended ranges of the T1/OS system. Most T1/OS applications should utilize the active FL system because of the superior S/N ratio, interference rejection, and added testing capability.

6.20 The office panel provides the ability to terminate FL pairs or to wire them through. When wired through, two of the six possible terminations are used to look in the two directions from the office. This intermediate office has full testing capability in both directions and, when used, seizes the whole of the FL pair for the duration of the test.

6.21 Several apparatus codes can be used to establish the T1/OS fault-locating outside plant equipments configuration. They include the existing codes of regular T1 in addition to the new codes developed specifically for T1/OS. Most all outside plant equipments are compatible. It may be noted that the "split" fault leads apparatus cases, 475F and G, and the 818 and 819 types can be used in place of the 475A and B codes in all applications. Under Modes 4 and 5, three arrangements are shown for obtaining both-ends testing with active filter bidirectional repeater operation. Mode 5 has the advantage of conversion to single-end testing by simply changing the filter.

(4) Order-Wire System

6.22 A two-wire dial loop line order-wire system is provided for T1/OS with the range and sensitivity consistent with the longer T1/OS maintenance and powering spans (Part 2C). The order-wire system is designed to furnish voice capability between repeater locations and any telephone within the associated exchange area, between repeater locations and the controlling span terminating office, and between two or more individual repeater locations.

6.23 The STB (Part 4) provides for mounting the order-wire panel (paragraphs 4.25 and 4.26), and plug-in units in the panel establish the order-wire system. Typical order-wire systems are shown in Fig. 32 and a detailed description of the T1/OS order-wire system is given in Section 365-325-100.

7. AUXILIARY TEST EQUIPMENT

7.01 The KS-20775, L2 error rate test set and the DS1/DS1C/DS2 error rate test sets are required for acceptance and maintenance tests of T1/OS lines. In addition, auxiliary test equipment, designated T1C/T1 and coded J98725, will be used. When the J98725-type test equipment is not available, the commonly used J98710-type T1 test sets may be used.

A. KS-20775, L2 Error Rate Test Set

7.02 This error rate test set (Fig. 33) is used to test the operation of the APS. It is also used to measure the end-to-end system or maintenance span error rate on an out-of-service basis and to measure bipolar error rates for some in-service maintenance span tests. Refer to Section 103-493-109 for a detailed description of the test set.

B. DS1/DS1C/DS2 Error Rate Test Sets (KS-22331, L1 Transmitter and KS-22332, L1 Receiver)

7.03 The KS-22331, L1 error rate test set (ERTS) transmitter (Fig. 34) and KS-22332, L1, ERTS receiver (Fig. 35) are used jointly to perform acceptance and maintenance tests of the T1, T1C, T1/OS and T2 lines. These test sets are interchangeable with the KS-20775, L2 ERTS for performing DS1 tests. One feature of the KS-20775, L2 that is not included in the DS1/DS1C/DS2 ERTS is the facility to insert bipolar violations onto

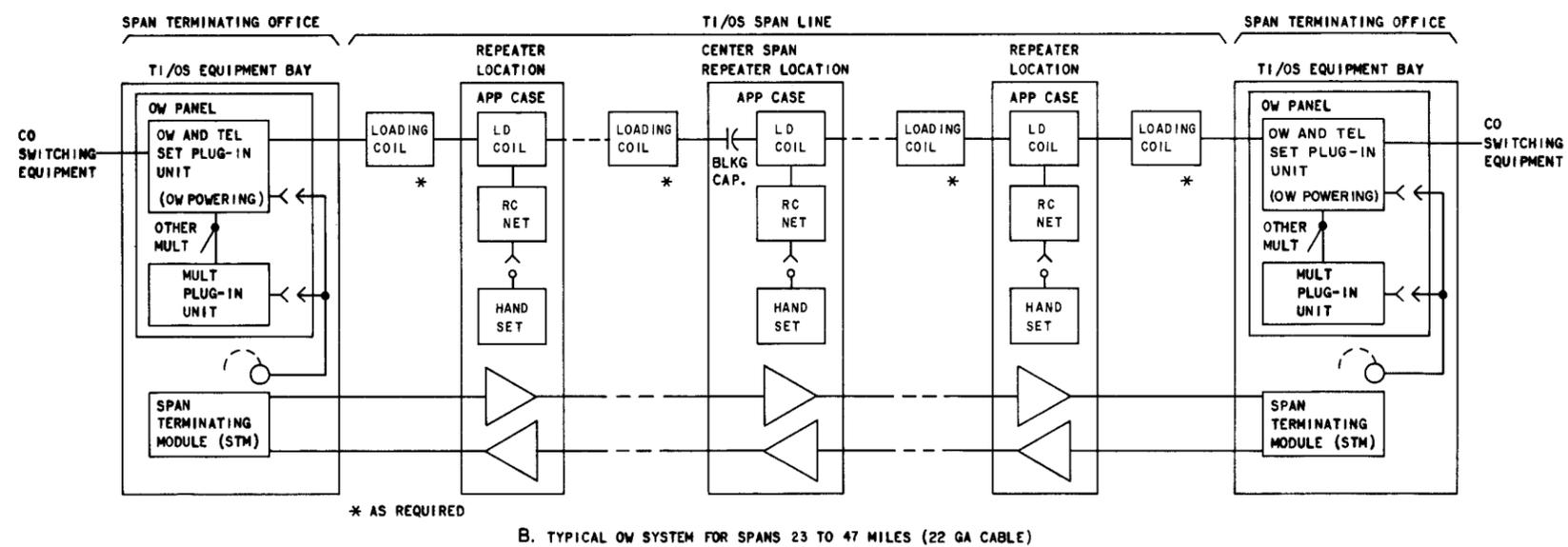
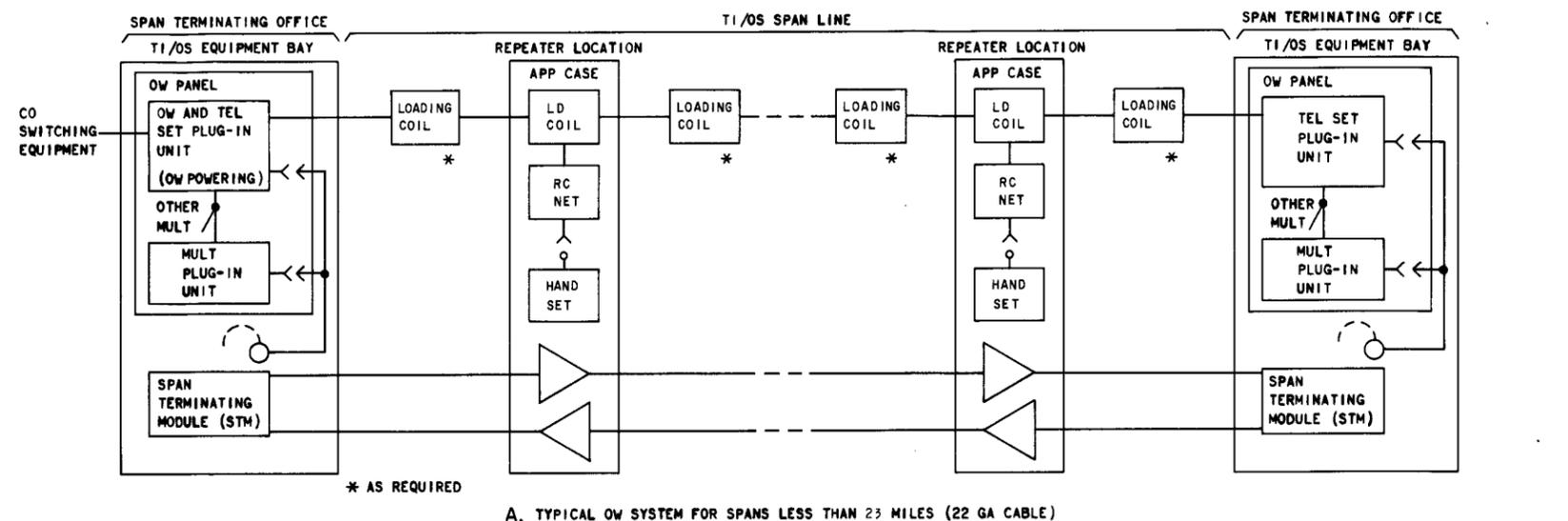


Fig. 32—Typical OW System Configurations

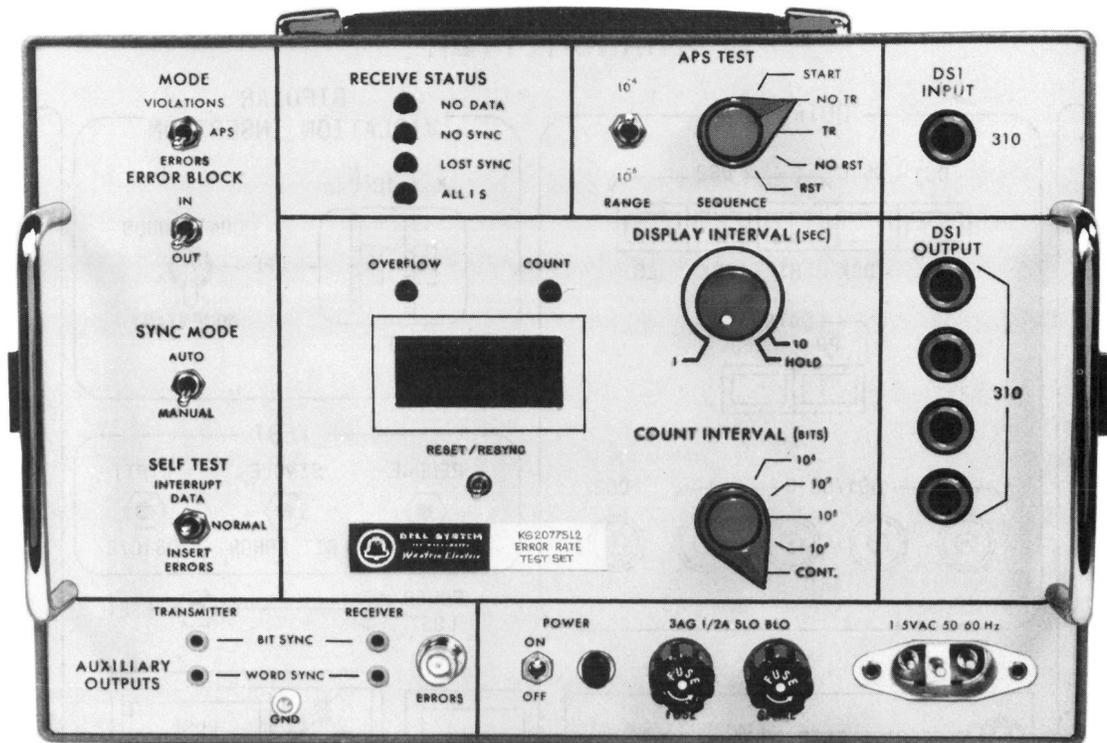


Fig. 33—KS-20775, L2 Error Rate Test Set

in-service signals. The description, operation, and maintenance of the test sets is covered in Section 103-493-120.♦

C. J98725AA T1C/T1 Pair Loss Test Set

7.04 Either during or after the installation of apparatus cases, J98725AA test sets are used at adjacent repeater locations to check out the installation. The J98725AA test set is shown in Fig. 36. Pair loss measurements are made to determine that the loss is within the limits of the ALBO of integrated circuit repeaters used in T1/OS. These measurements are also required between an STO and the first manhole to check out the installation. The test set is slightly larger than the 113B pair loss test set. It is 11-1/2 inches wide, 9-1/2 inches high, and 8-1/2 inches deep including the cover. It weighs approximately 14 pounds and is powered by six D cell batteries. The basic probe fits into the slot of the 475-type apparatus case. In addition, the 175A adapter (Fig. 37) allows insertion of the J98725AA test set connector into a repeater slot in the STM

(paragraphs 4.22 through 4.28) assigned to a 206- or 236-type repeater with built-in artificial line. The 175B adapter allows connection of the J98725AA set to a repeater slot in the STM assigned to a repeater with built-in 3-db pad. The 175B adapter is identical in appearance to the 175A adapter. Two adapters are also included with the test set which allow insertion of the probe into a 468-type apparatus case. Each J98725AA test set consists of a 650-kHz crystal oscillator and a detector, but a given measurement uses only the oscillator at one location and the detector at the other. The set also contains a 1300-kHz output for use with T1C. This set is used for tests previously made with the 113A and B test sets.

D. J98725AD T1C/T1 Fault-Locate Test Set

7.05 The J98725AD test set (Fig. 38), powered by the -48V office supply, is used to isolate line troubles to a specific repeater section. Bipolar violations are introduced in a variable-density bit stream at an audio rate. The audio tone is returned to the office from a manhole via an FL filter in

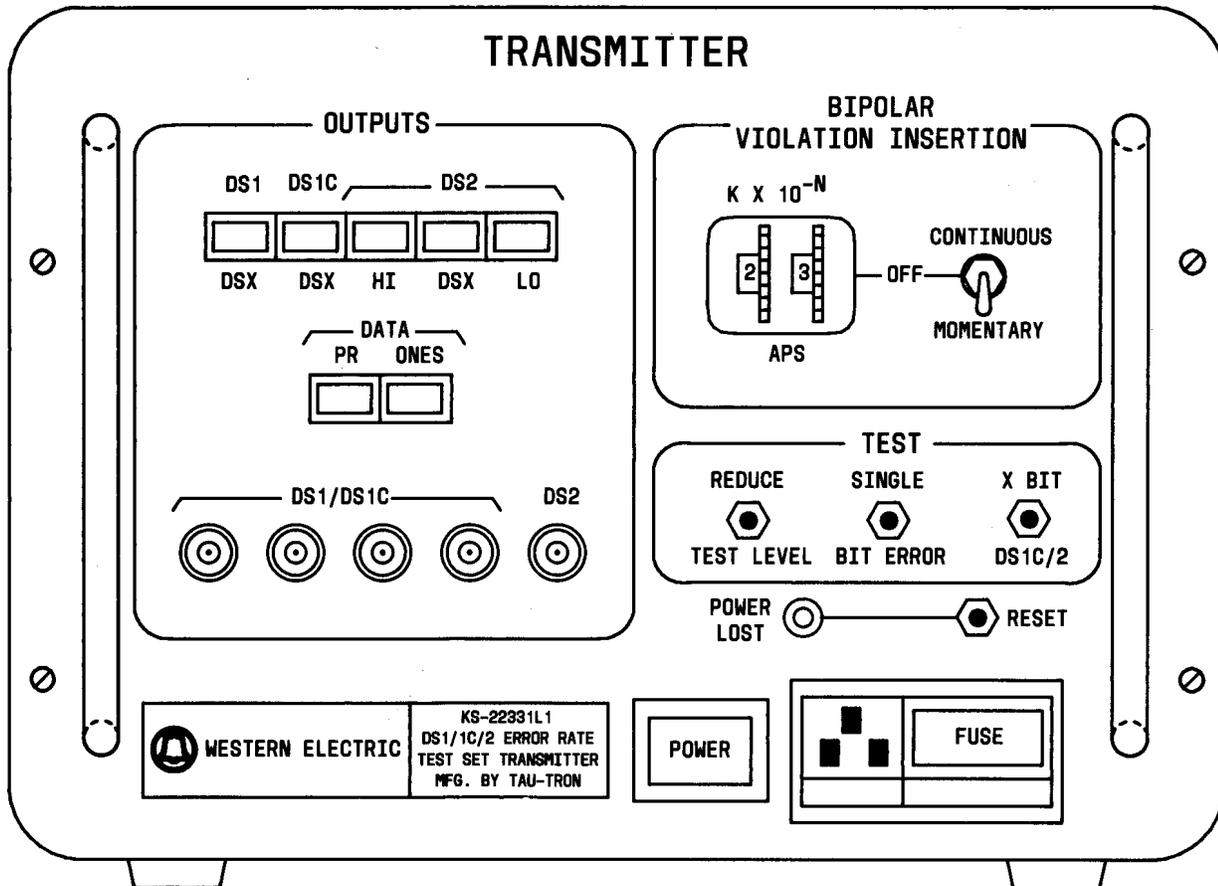


Fig. 34—DS1/DS1C/DS2 Error Rate Test Set Transmitter

the manhole and a loaded cable pair. The transmitter and selective receiver are contained in one package with all tuning fixed by switch positioning. The set has a built-in ohmmeter to verify the metallic integrity of the line as part of the FL procedure. The FL line noise is also measured by this test set. Section 103-494-106 provides a complete description and operation and maintenance information. Where this test set is not available, the J98710F test set may be used as described in Section 103-491-100.

E. J98725AC TIC/T1 Office Bipolar Violation Detector

7.06 The J98725AC test set (Fig. 39), powered by -48V office supply, is used for in-service performance testing, including an indication of the absence of a valid signal. It has a violation counter which can be stopped after a preset time interval, up to two hours, with a built-in electronic timer

to help isolate marginal systems. The counter counts either violations or violation-seconds, but not both simultaneously. Section 103-494-100 provides a complete description and operation and maintenance information. Where this test set is not available, the J98710G test set may be used as described in Section 103-490-101.

F. J98725AB TIC/T1 Manhole Bipolar Violation Detector

7.07 The J98725AB test set (Fig. 40), powered by four AA size penlight batteries, is portable and measures approximately 4-1/2 inches high, 3-3/8 inches wide, and 13-5/8 inches long. It is used to troubleshoot failed line repeaters, either confirming a remote fault-locating diagnosis or determining the location of a marginal repeater. It also indicates the presence or absence of a valid signal. It is equipped with adapters for use in

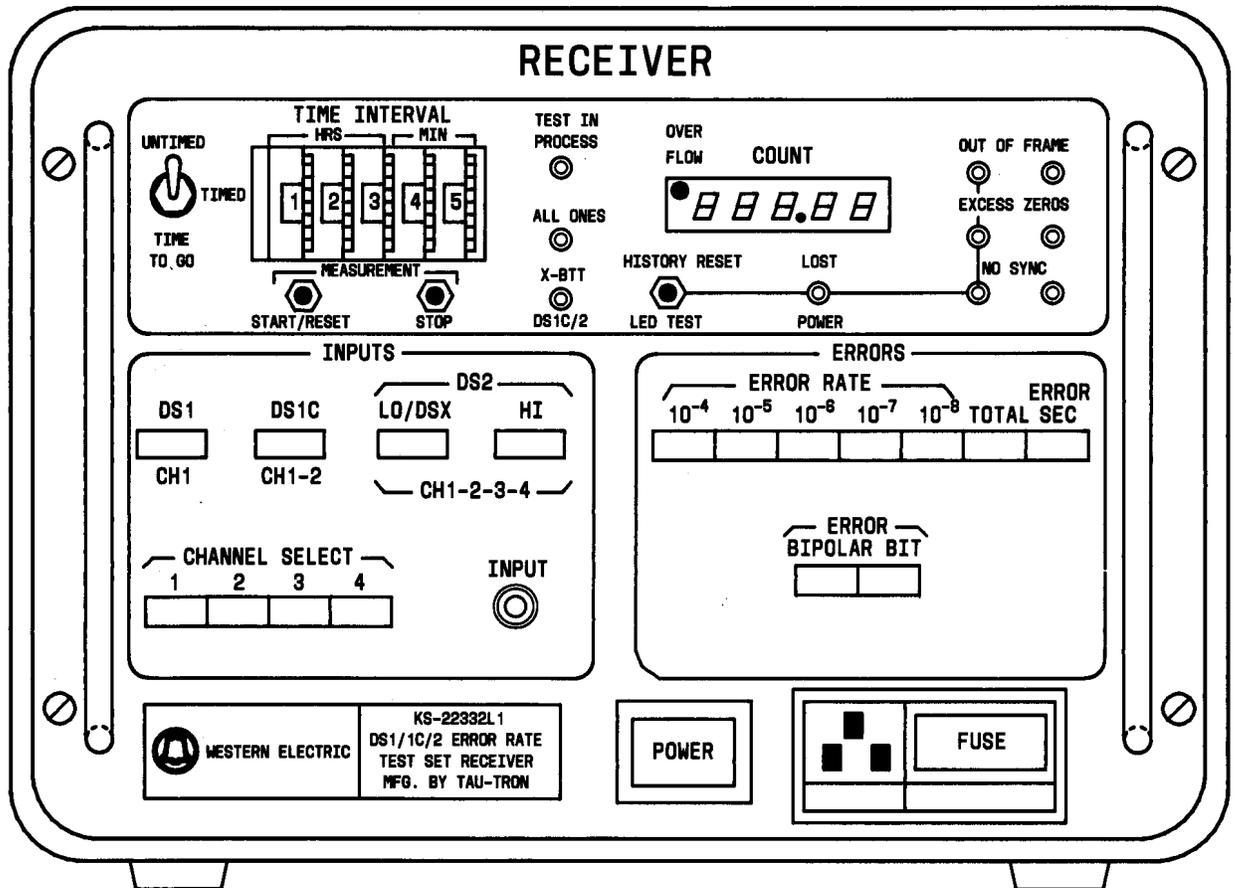


Fig. 35—DS1/DS1C/DS2 Error Rate Test Set Receiver

468- or 475-type apparatus cases for T1/OS as well as the 479-type for T1C. Section 103-494-101 provides a complete description and operation and maintenance information. Where this test set is not available, the J98710P test set may be used as described in Section 103-493-103.

G. KS-20599, L4 Digital Voltmeter

7.08 The digital voltmeter is a bipolar, 4 1/2 digit portable multimeter recommended for general purpose use. It is approximately 5 1/2 inches wide by 1 3/4 inches high by 3 1/2 inches deep. A description of the meter is given in Section 084-805-101.

8. REFERENCES

SECTION OR DRAWING	SUBJECT
SD-1C597-01	Digital Transmission Facilities, T1/OS Digital Transmission System Span Terminating Circuits
SD-3C254-01	T1C Digital Line Order-Wire Circuit
SD-1C603-01	Digital Transmission Facilities, T1/OS Digital Transmission System Fault-Locate Circuit
SD-3C104-01	Common Systems 24 Channel PCM Bank Type D3 Application Schematic



Fig. 36—J98725AA Pair Loss Test Set

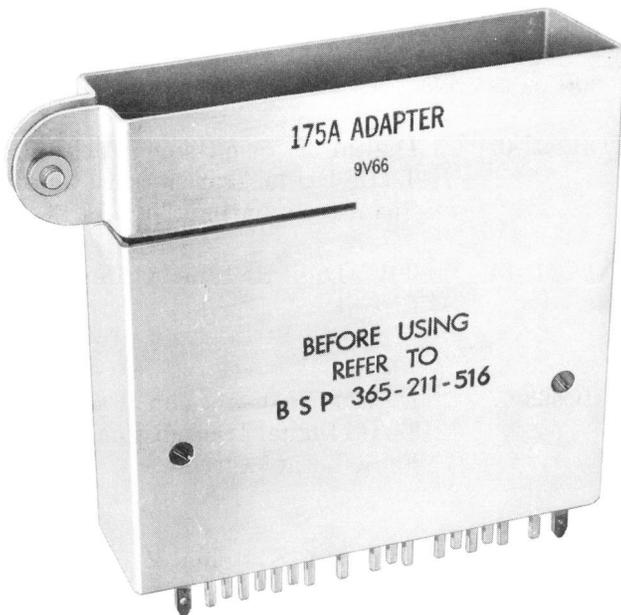


Fig. 37—175A Adapter

- SD-3C304-() Common Systems 24 Channel PCM Bank Type D4 Application
- 084-805-101 ♦KS-20599, List 4 Digital Voltmeter, Description♦
- 103-490-101 J98710G, List 2 Error Detector Set, Description, Operation and Maintenance
- 103-491-100 J98710F, List 1 and J98710F, List 2 Fault-Locating Test Sets—Description, Operation and Maintenance
- 103-492-100 J98710H Repeater Test Set, Description, Operation and Maintenance
- 103-493-100 113A Test Set, Description, Operation and Maintenance



Fig. 38—J98725AD Fault-Locate Test Set

103-493-101	113B Test Set, Description, Operation and Maintenance	103-493-120	◆DS1, DS1C/DS2 Error Rate Test Set (KS- 22331, L1 and KS-22332, L2) Description Operation, and Maintenance◆
103-493-103	J98710P T1 Line Error Detector, Description, Operation and Maintenance	103-494-100	J98725AC T1C/T1 Office Bipolar Violation Detector, Description and Maintenance
103-493-109	KS-20775, L1 and L2 Error Rate Test Set, Description and Maintenance	103-494-101	J98725AB T1C/T1 Manhole Bipolar Violation Detector, Description and Maintenance

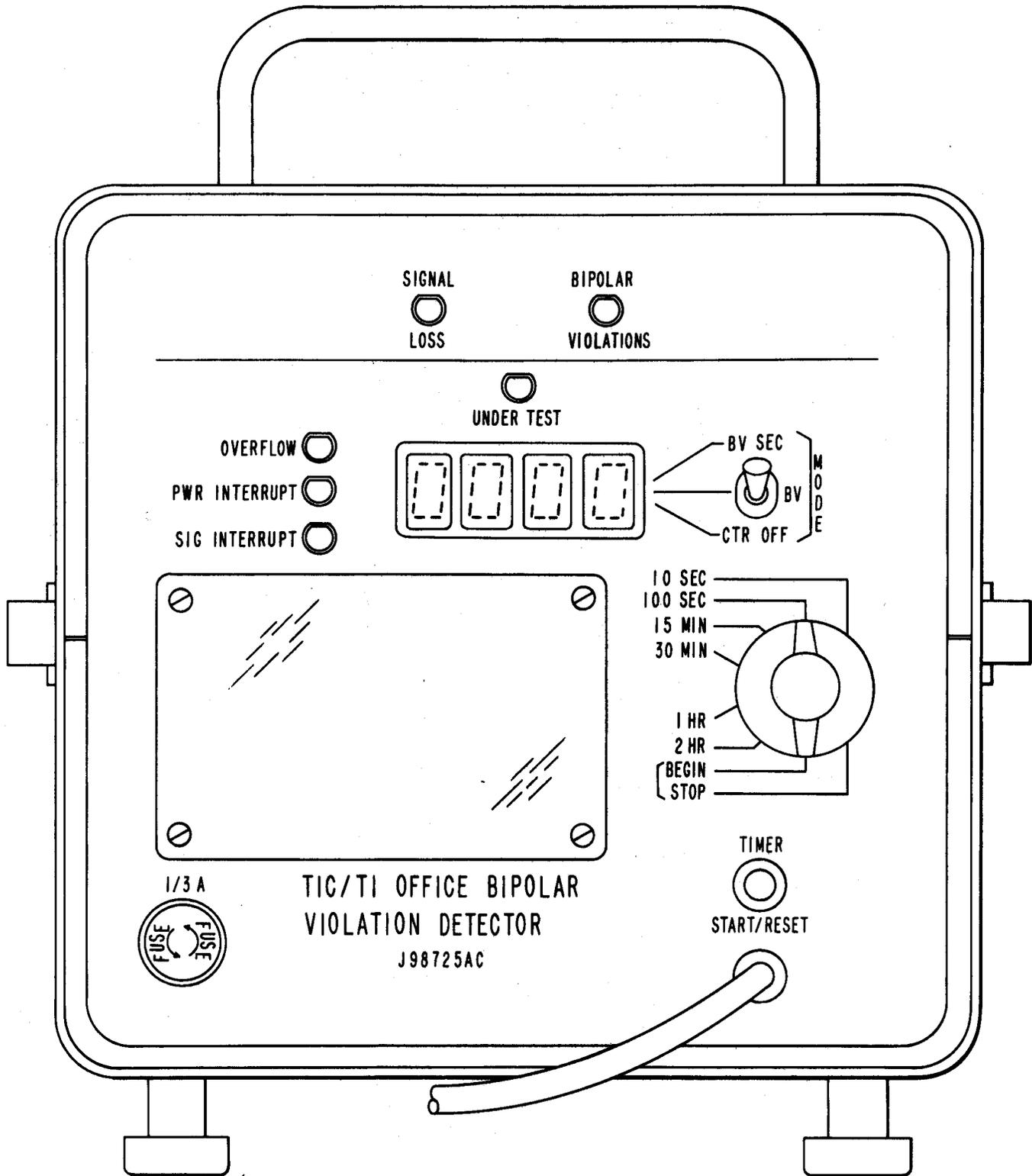


Fig. 39—J98725AC TIC/T1 Bipolar Violation Detector

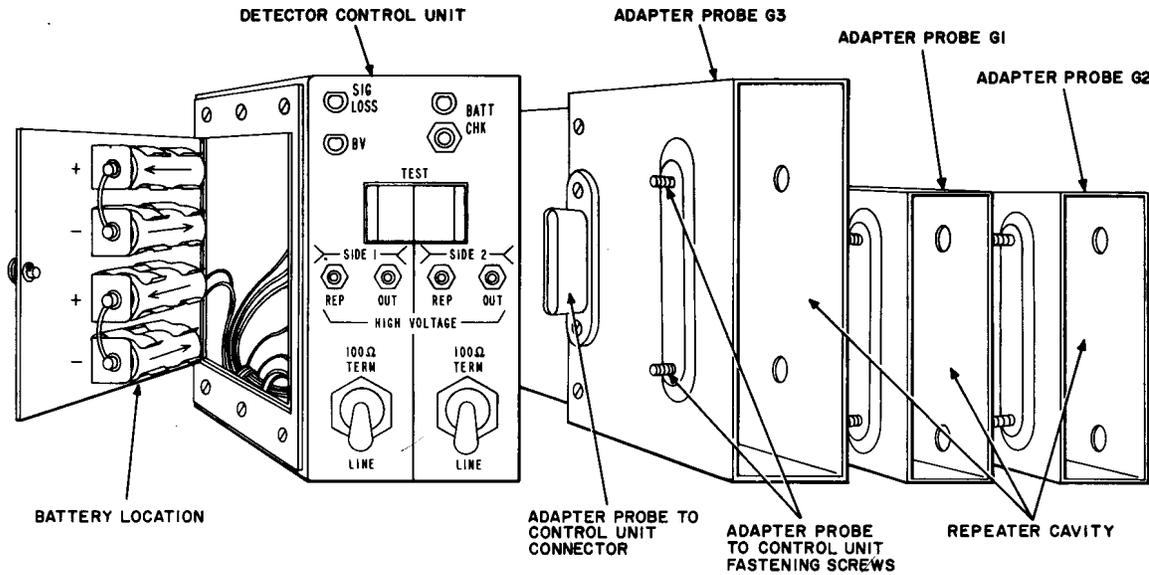


Fig. 40—J98725AB T1C/T1 Manhole Bipolar Violation Detector

103-494-104	J98725AA T1C/T1 Pair Loss Test Set, Description, Operation and Maintenance	365-325-100	T1/Outstate (T1/OS) Order-Wire Description, Initial Test, Maintenance, and Utilization
103-494-106	J98725AD T1C/T1 Fault-Locate Test Set, Description and Maintenance	640-525-220	Pair Loss Measurements Using 113A and/or 113B Test Sets
365-150-100	D3 Channel Bank General Description		
365-170-100	D4 Channel Bank Description	640-525-315	♦T1, T1C T1/OS and T1D Apparatus Cases and Associated Plug-In Equipment♦
365-200-160	T1 Outstate (T1/OS) Fault-Location System		
365-250-110	Lynch B302 Electronic Span Line Switch (T1/OS)	855-351-200	T1 Outstate Digital Line Transmission and Outside Plant Design Procedures