

**COMMON SYSTEMS**  
**N AND ON CARRIER TELEPHONE**  
**COMBINING AND MULTIPLEX CIRCUITS**  
**FOR USE WITH TL RADIO**

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ON2 System Frequency Allocation . . . . .	3	<b>1.01</b> This section describes the equipment used for combining and multiplexing up to 96 voice channels from ON or N3 carrier systems or 48 voice channels from N1 or N2 carrier systems. These channels may be terminated (i.e. brought down to voice frequencies) by carrier terminals located at radio terminal sites, or they may be extended over cable facilities at carrier fre- quency. Means for dropping, or for dropping and adding, channels at intermediate radio repeaters are provided. The equipment to be described con- sists of the following basic units.	
N1 and N2 System Frequency Allocation . . . . .	3	(a) Combining panel (J98706AD) used in cen- tral offices to combine 20 channels of ON1, 24 channels of ON2 or N3, or 12 channels of N1 or N2 carrier.	
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<b>A. General . . . . .</b>	<b>4</b>	(d) Multiplex equipment (J98706U) used with two combining filter panels or with com- binations of the combining filter panel, com- bining panel, or combining unit to obtain 80	
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channels of ON1, 96 channels of ON2 or N3, or 48 channels of N1 or N2 carrier.

(e) 96-channel combining panel (J98706AH) used at radio sites for combining up to 80 channels of ON1, 96 channels of ON2 or N3, or 48 channels of N1 or N2 carrier.

*Note:* Equipment identified by channel capacity is based on use of complete ON2 or N3 systems. When ON1, N1, N2, or partially equipped systems are used the actual channel capacity is reduced. For example, a 96-channel multiplex system would carry only 80 ON1 channels or 48 N1 or N2 channels.

**1.02** This section is reissued to add pad value information to various figures used with TL2 radio, and to update for N3 carrier on TL radio. Since this reissue covers a general revision, arrows ordinarily used to indicate changes have been omitted.

### B. Purpose of Equipment

**1.03** The 48-channel combining and 96-channel multiplex equipment combines and separates groups of voice channels from one to four N or ON carrier systems so that the TL radio capacity can be used more efficiently. Arrangements of the equipment may be mounted in bays along with N or ON terminals, ON junctions, radio terminals, or repeater points, or in cabinets at radio terminal or repeater points.

#### 24-Channel Combining Equipment

**1.04** The channel groups from one N or ON system may be connected to the TL radio using a J98706AD panel or, if the combining equipment is located at a radio repeater cabinet, a J98706AF unit. It is not necessary to use combining filters or active multiplexing equipment with only one N or ON system.

#### 48-Channel Combining Equipment

**1.05** The 48-channel multiplex equipment may be used alone when channel groups from two N or ON systems are transmitted by radio or with the 96-channel equipment when three or four N or ON systems use the radio system. In the transmitting direction, the carrier groups are

combined, using passive elements, into a composite signal. The composite signal may be fed directly to the TL radio or to the 96-channel multiplex equipment. In the receiving direction, a composite signal is separated, with passive elements, and connected to the individual carrier systems.

#### 96-Channel Multiplex Equipment

**1.06** When channel groups from three or four N or ON systems are to be connected to the TL radio system, two combining filter panels and the 96-channel multiplex equipment are used. In the transmitting direction with this configuration, each combining filter panel combines channel groups of two carrier systems and feeds the two composite signals to the 96-channel multiplex equipment. The 96-channel multiplex equipment modulates the composite signal from one combining filter panel to a higher frequency band and combines the modulated signal with the composite signal from the second combining filter panel. The output of the 96-channel equipment is then connected to the radio system. In the receiving direction, signals from the radio system are separated, the higher frequency band is modulated to the lower frequency band, and both composite signals are connected to the carrier systems through the combining filter panels.

#### Combining and Multiplex Equipment at Radio Repeaters

**1.07** At radio repeaters, various groupings of combining equipment provide the through paths plus the dropping and adding paths. This combining equipment may be mounted in two radio repeater cabinets located at outdoor sites. The cabinets are mounted together and are characterized as being far or near. A typical grouping consists of two combining units (J98706AF) and one combining filter panel (J98706AE) in the far radio cabinet and one panel (J98706AH) in the near radio cabinet. This equipment provides the facilities for connecting a portion of the transmitted carrier channels to a spur radio system link or to an N or ON terminal at the radio repeater locations. These connections can be made directly or over a repeated line. When the radio repeaters are located in a central office, combining panels (J98706AD) are used instead of combining units (J98706AF).

**C. System Descriptions**

**1.08** The voice channels are combined into composite signals by carrier terminal equipment and are connected to the combining filter panel in the form of low- and high-group frequency bands. The low- and high-group signals may be directly connected to the combining equipment from N1, N2, ON1, N3, or ON2 terminal equipment or from a terminal over an N-type line.

**ON1 System Frequency Allocation**

**1.09** The ON1 system employs a low-group frequency band of 40 to 136 kc for transmission in one direction and a high-group frequency band of 168 to 264 kc for transmission in the other direction. Each frequency band is used for the transmission of 20 one-way message channels. The high-group band is obtained by translating a low-group band to the 168- to 264-kc frequency range. Both the low-group band and the high-group band consist of five groups of four message channels each. When ON1 carrier is used on radio networks, a 20-channel system may be assigned at a given station to high-group transmitting and low-group receiving positions on the radio or, alternately, the assignment can be low-group transmitting and high-group receiving. When two ON1 systems are combined to provide 40-channel operation, the systems must have opposite transmitting and opposite receiving assignments since the combining equipment is passive and cannot translate frequencies. When four ON1 systems are used, the 96-channel multiplex equipment translates one high-low combined group to the higher frequency range of the *s* and *t* bands as shown in Table A. The *s* and *t* bands can be multiplexed with a high- and low-frequency band to provide up to 80 message channels (four ON1 systems) for transmission over a TL radio system.

**TABLE A**

ON1 GROUP	FREQUENCY LIMITS IN KC
Low	40 to 136
High	168 to 264
<i>s</i>	320 to 416
<i>t</i>	448 to 544

**ON2 System Frequency Allocation**

**1.10** In the ON2 system, the 4-kc spacing between groups characteristic of the ON1 system has been eliminated to provide for an additional group of four message channels. The ON2 system thus uses six groups of four message channels each. A complete ON2 system consists of 24 message channels in a low-group frequency band of 36 to 132 kc or a high-group frequency band of 172 to 268 kc. Normally a system transmits 24 channels in one of the frequency bands and receives in the other. The high-group frequency band is obtained by translating a low-group band to the 172- to 268-kc range. ON2 systems can be combined and multiplexed in the same manner as ON1 systems to provide up to 96 message channels (four ON2 systems) for transmission over a TL radio network. The limits of the various frequency bands are listed in Table B.

**TABLE B**

ON2 GROUP	FREQUENCY LIMITS IN KC
Low	36 to 132
High	172 to 268
<i>s</i>	316 to 412
<i>t</i>	452 to 548

**N1 and N2 System Frequency Allocation**

**1.11** The N1 and N2 carrier telephone systems are 12-channel systems designed for short-haul use on toll and exchange plan cables. They employ double sideband transmission with channels spaced every 8 kc. Plug-in units are provided for 13 channels (12 active and 1 spare) which are numbered 1 through 13. Channels 2 through 13 are used as the active channels, under normal circumstances, and occupy the frequency band of 36 to 132 kc for transmission in one direction and 172 to 268 kc for transmission in the other direction. Channel 1 is available for use in place of any other channel in the system which may be unsatisfactory as a result of radio or other interference. Channel 1 occupies a low-group frequency band of 132 to 140 kc for transmission in one direction and a high-group frequency band of 164 to 172 kc for transmission in the other direction. All carrier channels are generated in the high-group frequency band (172 to 268 kc) to

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simplify the filters and other circuit elements. The low-group frequency band (36 to 132 kc) is obtained by translating a high-group band to the lower frequency. N-type systems can be combined and multiplexed in the same manner as ON1 systems to provide up to 48 channels (four N systems) for transmission over a TL radio network. The limits of the various frequency bands are listed in Table C.

**TABLE C**

N1 OR N2 GROUP	FREQUENCY LIMITS IN KC
Low (2-13)	36 to 132
Low (1-12)	44 to 140
High (2-13)	172 to 268
High (1-12)	164 to 260
s	316 to 412
t	452 to 548

**N3 System Frequency Allocation**

**1.12** The N3 system is similar to the ON2 system in that they both provide 24 single-sideband channels with 12 channel carriers transmitted over the carrier line. However, two basic differences exist. The first is the use of two 12-channel groups rather than six 4-channel groups as in ON2. The second difference is the utilization of upper sideband orientation for all N3 channels in the first step of modulation. Because of these differences, N3 terminals must be used at both ends of the system. Different frequency bands are used for the two directions of transmission. A low-group band of 36 to 132 kc is used in one direction of transmission and a high-group band of 172 to 268 kc is used in the other. N3 systems can be combined and multiplexed in the same manner as ON1 systems to provide up to 96 message channels (four N3 systems) for transmission over a TL radio network. The limits of the various frequency bands are listed in Table D.

**TABLE D**

N3 GROUP	FREQUENCY LIMITS IN KC
Low	36 to 132
High	172 to 268
s	316 to 412
t	452 to 548

**2. EQUIPMENT DESCRIPTION**

**A. General**

**2.01** The 48- and 24-channel combining equipment, and the 96-channel multiplex and combining equipment are constructed so that they can be mounted with the associated N or ON terminal equipment or, in the case of the combining equipment, with the TL radio equipment. Facilities are provided on the combining and multiplex panels for mounting optional apparatus on a plug-in basis to maintain system flexibility.

**B. 48-Channel Combining Equipment**

**2.02** The 48-channel combining equipment mounted in N or ON terminal bays consists of one J98706AE ON/TL combining filter panel and two J98706AD combining panels (see Fig. 1).

**2.03** The J98706AE panel contains filters, pads, and transformers used to combine or separate up to 48 channels. The basic panel, List 1, contains wiring, mounting facilities, terminal strips, and other apparatus common to all configurations of the panel. This panel may be arranged in seven electrical configurations and may be mounted in a TL radio cabinet or on a bay framework in a central office.

**2.04** The J98706AE panel occupies three 1-3/4 inch mounting spaces in a standard 19-inch bay framework or in framework in a TL radio repeater cabinet. The panel is fabricated from sheet metal and is drilled to mount the apparatus and equipment provided with the panel.

**2.05** The J98706AD combining panel contains the transformers, filters, pads, and networks that are required to terminate leads from N or ON terminal equipment or to terminate the N-type lines. Two basic panels are provided, List 1 to accommodate systems transmitting high group and receiving low group, and List 2 to ac-

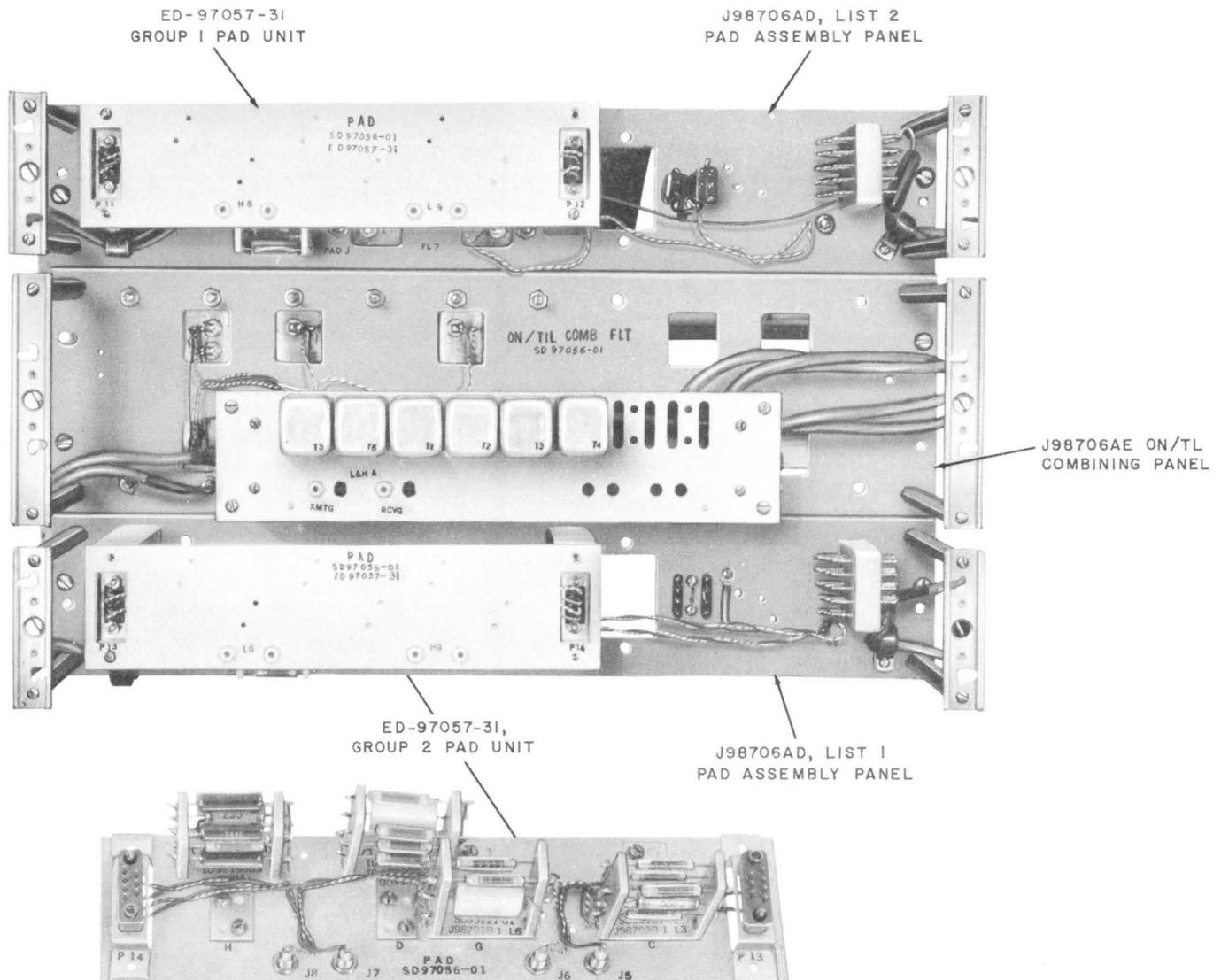


Fig. 1 — 48-Channel Combining Equipment, Location of Major Units

commodate systems transmitting low group and receiving high group. The basic panels include mounting facilities for ED-97057-31 plug-in pad units. Two basic pad units are also provided: one for systems transmitting high group and receiving low group and one for transmitting low group and receiving high group.

**2.06** The J98706AD panel has provisions for adding optional equipment to meet flexibility requirements. This panel occupies two 1-3/4 inch mounting plate spaces on a standard 19-inch bay framework. The ED-97057-31 pad unit mounts on brackets fastened to the combining panel and is secured in place with four screws.

Connections between the pad unit and the combining panel are made with two multipin connectors.

### C. 96-Channel Multiplex Equipment

**2.07** The 96-channel multiplex equipment consists of a J98706U, List 4 multiplex mounting, a J98706AA receiving amplifier and demodulator plug-in unit, a J98706AB transmitting amplifier and modulator plug-in unit, and a J98706AC power supply and alarm plug-in unit (see Fig. 2). The basic multiplex mounting consists of a die-cast aluminum shelf and a supplementary fabricated jack mounting, and including

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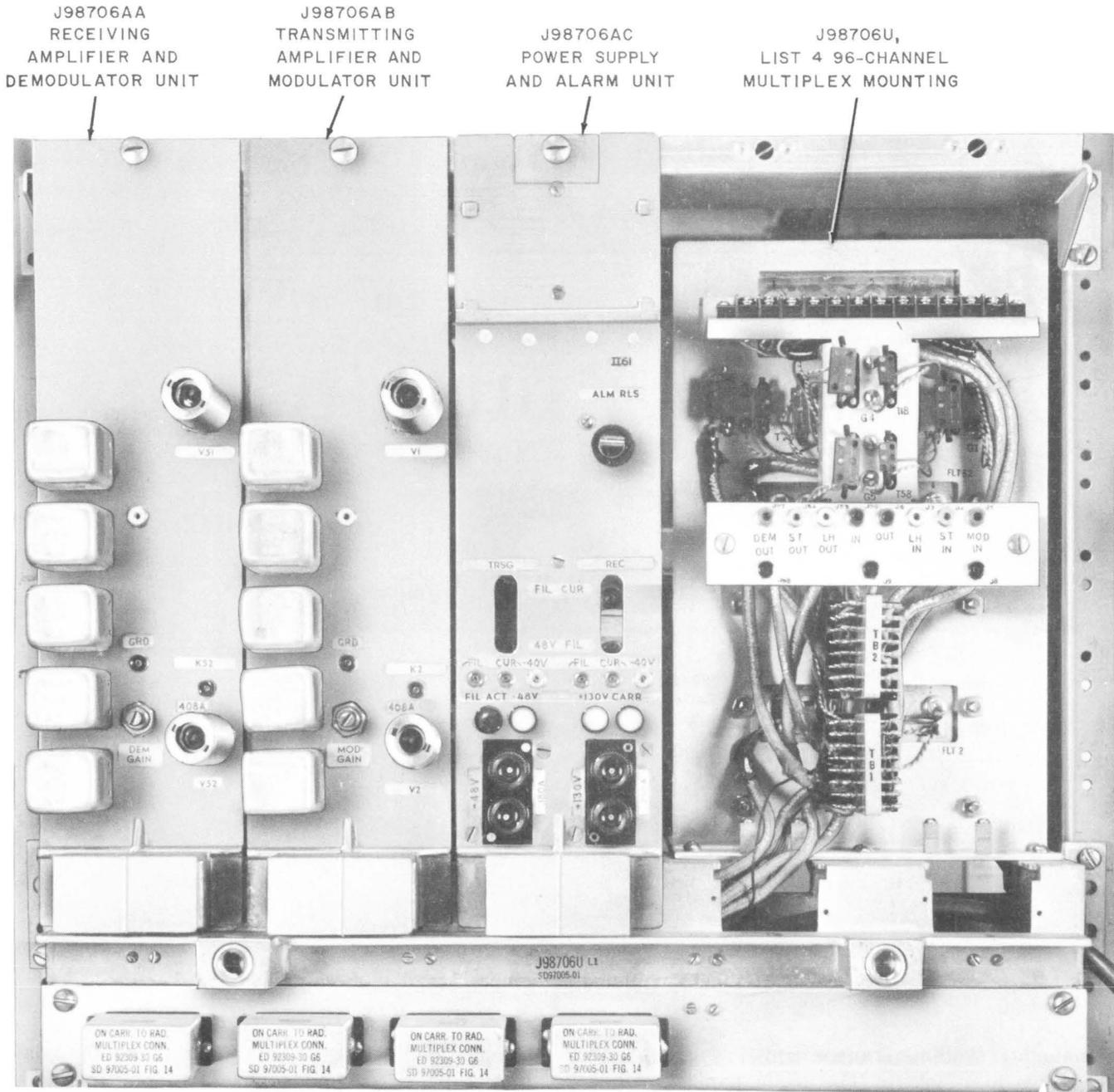


Fig. 2 — 96-Channel Multiplex Equipment, Location of Major Units

the top support, occupies nine 1-3/4 inch mounting plate spaces on a standard 19-inch bay framework. The aluminum shelf is provided with three jacks for connection to the plug-in units which are required where N1, N2, ON1, ON2, or N3 channel groups are to be transmitted or received in the *s* and *t* frequency bands. Where the plug-

in units are not employed, the jacks for the receiving and transmitting units require strapped plug-in connectors. An upright panel is provided in the remaining shelf space for apparatus that is part of the multiplex mounting. This apparatus includes impedance matching transformers, filters, monitoring jacks, and terminal strips.

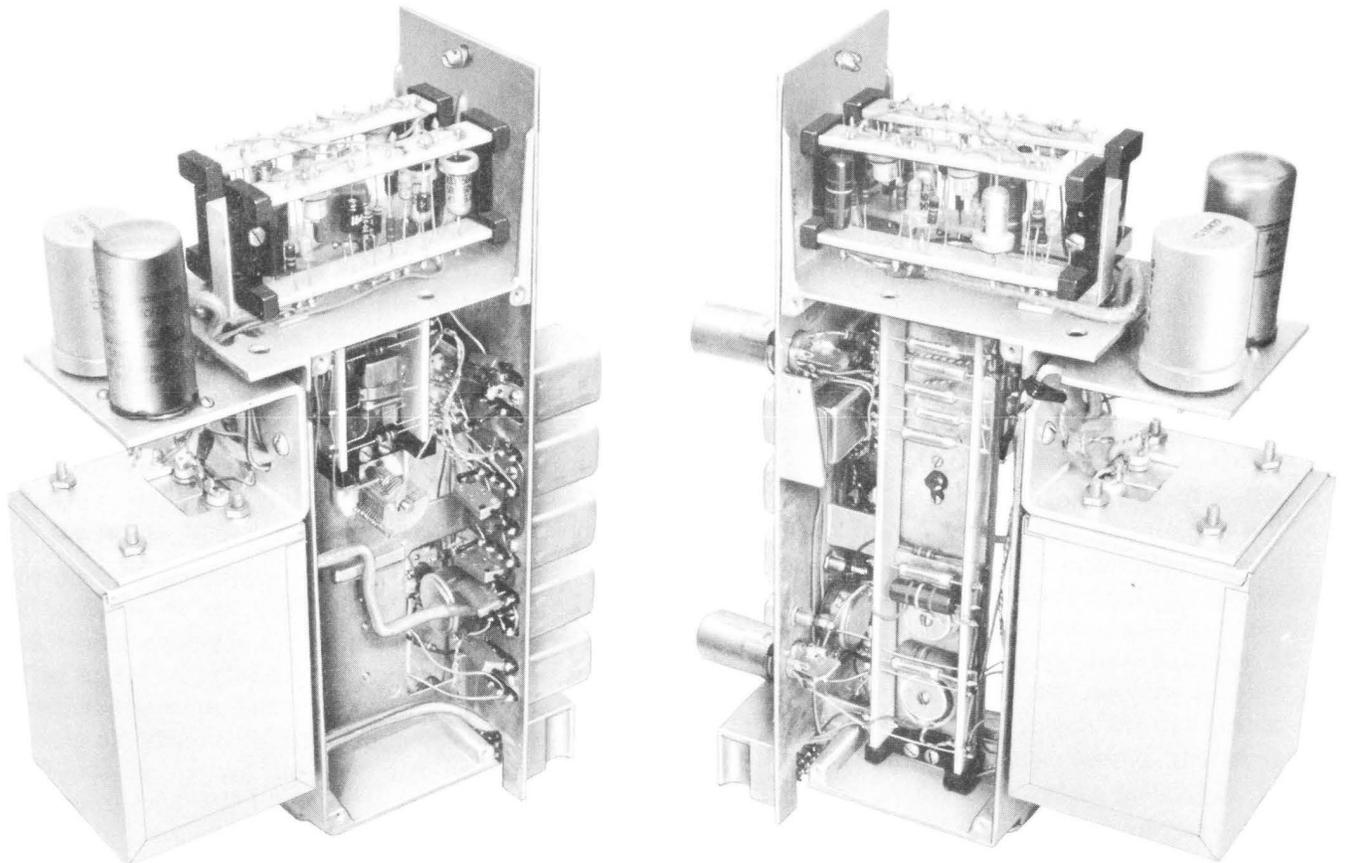
**2.08** The J98706AA receiving amplifier and demodulator unit (see Fig. 3) contains a 584-kc oscillator, a demodulator, a low-pass filter, a receiving amplifier, and a transistorized alarm circuit. The function of this unit is to translate the received *s* and *t* frequency bands to the high- and low-frequency bands and to provide a monitoring circuit to indicate the loss of the carrier-frequency power. This unit plugs into the jack provided in the multiplex mounting and is secured to the top support by a quick-acting fastener.

**2.09** The J98706AB transmitting amplifier and modulator unit (see Fig. 4) contains a 584-kc oscillator, a modulator, a low-pass filter, and a transmitting amplifier. The function of this unit is to translate the transmitted high- and low-frequency bands to the *s* and *t* frequency bands. This unit also plugs into the multiplex mounting and is secured to the top support by a quick-acting fastener.

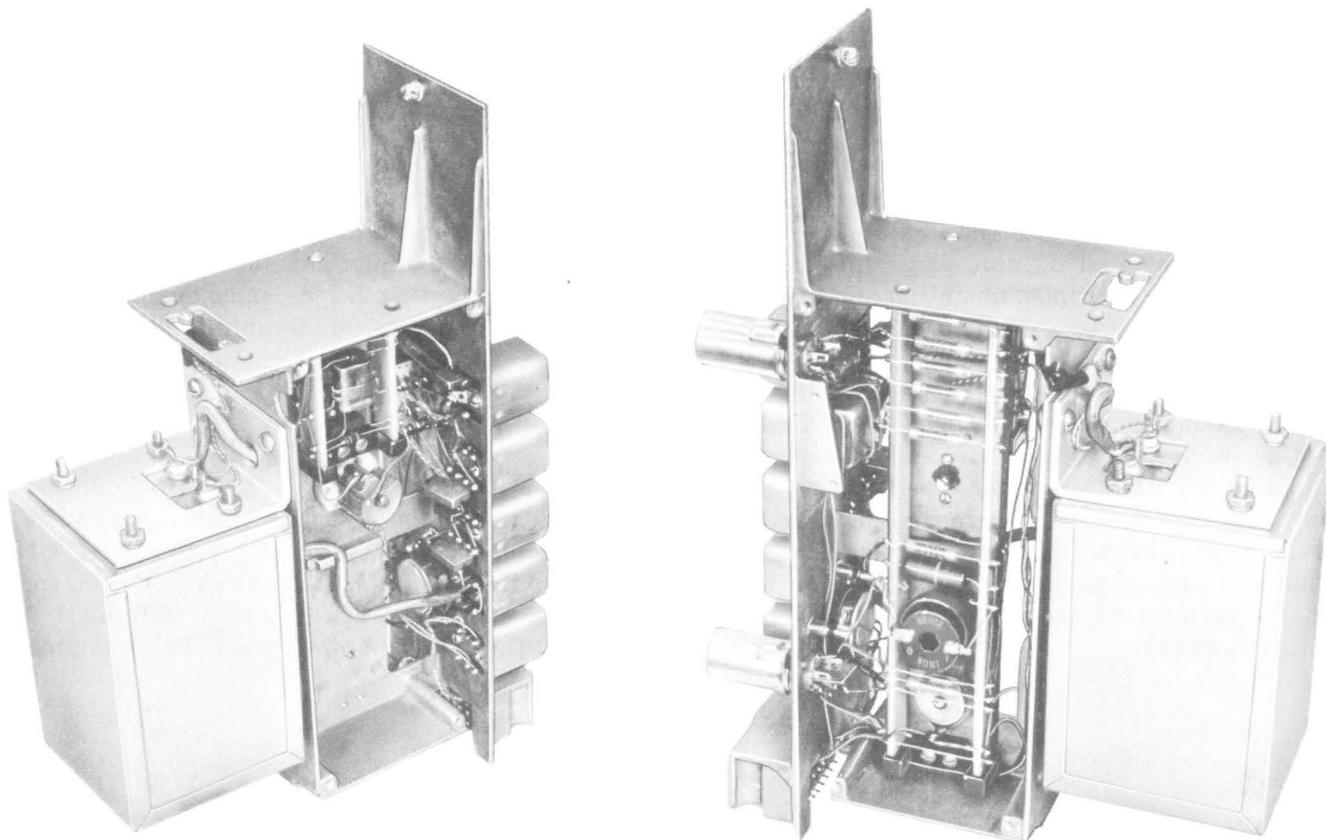
**2.10** The J98706AC power supply and alarm unit (see Fig. 5) provides a means of connecting the J98706AA and J98706AB units to +130 volt and -48 volt power, or to +130 volt power only. Potentiometers are provided on the unit for adjusting the voltages to the required values. Alarm lamps, alarm-type fuses, and an alarm relay for energizing the office alarms are included in the unit. This unit plugs into the multiplex mounting in the same manner as the J98706AA and J98706AB units. Connection to the external power is through a 3-conductor Hubbell plug and receptacle.

#### D. Combining Equipment for Use in a TL Radio Cabinet

**2.11** The combining equipment for use in a TL radio cabinet consists of a J98706AF ON/TL combining unit and a J98706AE ON/TL combining panel (see Fig. 6) and a J98706AH 96-channel ON/TL combining panel. This equipment



**Fig. 3 — J98706AA Receiving Amplifier and Demodulator Unit**



**Fig. 4— J98706AB Transmitting Amplifier and Modulator Unit**

is mounted in back-to-back radio cabinets as shown in Fig. 6. The J98706AF unit mounts in the TL radio cabinet on the repeater shelf of the ED-97058-30, List 1 mounting frame. This unit serves the same purpose and contains the same equipment configurations for the different list numbers as the J98706AD ON/TL combining panel that is used in central office. The J98706AE ON/TL combining filter panel mounts below the mounting frame containing the repeaters. The J98706AH 96-channel ON/TL combining panel is used at radio repeaters for dropping and adding in the low and high groups only, and passing on the *s* and *t* groups, when the radio system carries more than the low and high groups. This unit contains only passive elements and is used primarily at outdoor radio sites where power is not available for operating the modulator and demodulator of a multiplex unit. The modulator and demodulator are required for dropping *s* and *t* groups. The J98706AH panel is mounted

on the channel supports in the cabinet which does not contain the repeaters. This panel occupies three 1-3/4 inch mounting plate spaces on a standard 19-inch bay framework and may be equipped with a cover per List 2 for a duct-type bay installation or List 3 when mounted in a TL radio cabinet or on a channel-type bay. In TL2 radio systems, the combining equipment must be mounted in a separate cabinet at outdoor sites.

**2.12** The order-wire and alarm equipment for N-type lines (6 of Fig. 6) is provided at radio repeater sites which do not have power for the repeaters. This equipment provides a voice path between the site and the central office for maintenance personnel and a simplex dc power circuit for the 2M repeater switching set. The equipment consists of a TST PWR socket and an ADJ VOLTS potentiometer to connect and adjust the dc voltage to the switching set and two TLK binding posts to connect a telephone set to the order-wire pair.

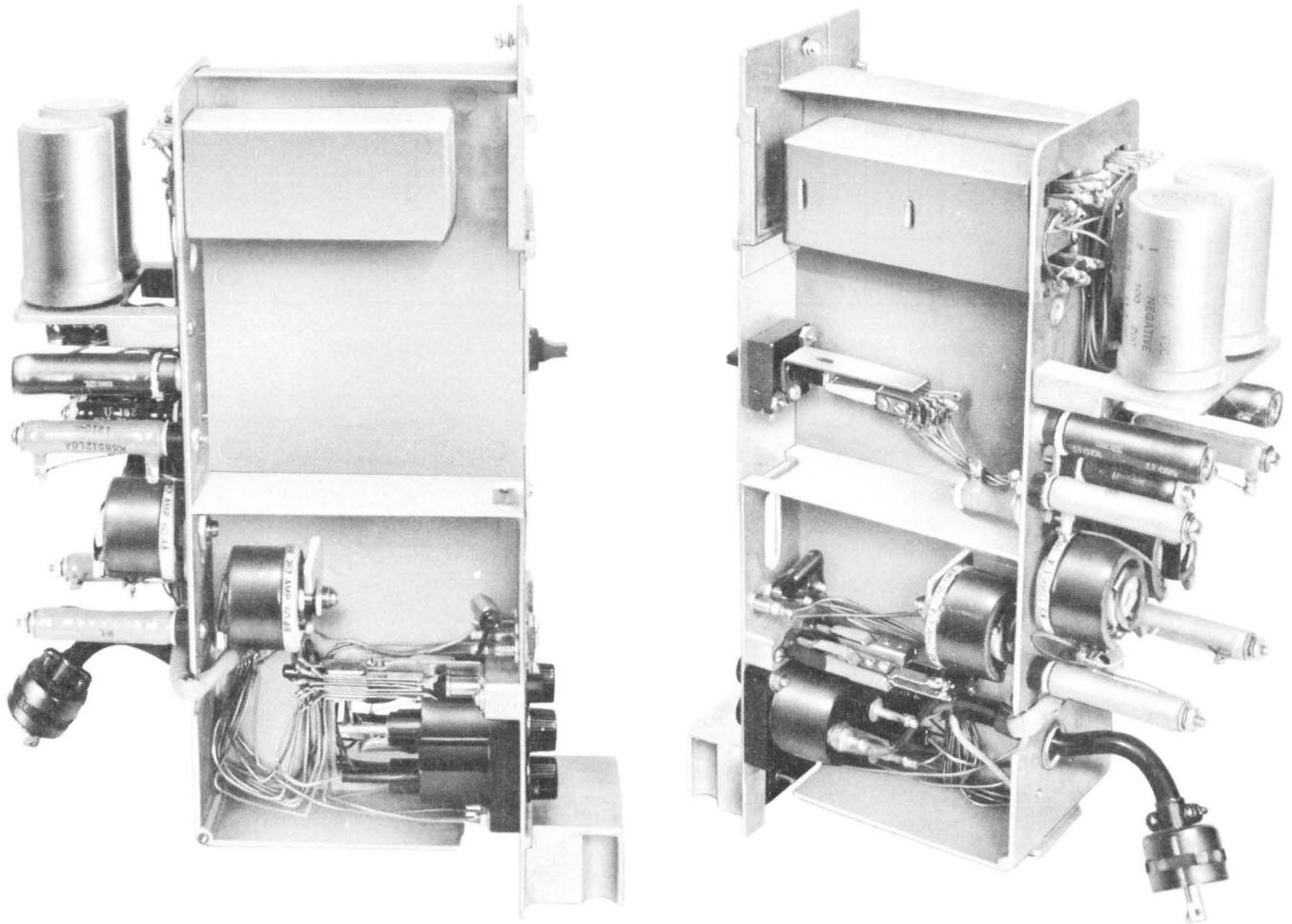


Fig. 5 — J98706AC Power Supply and Alarm Unit

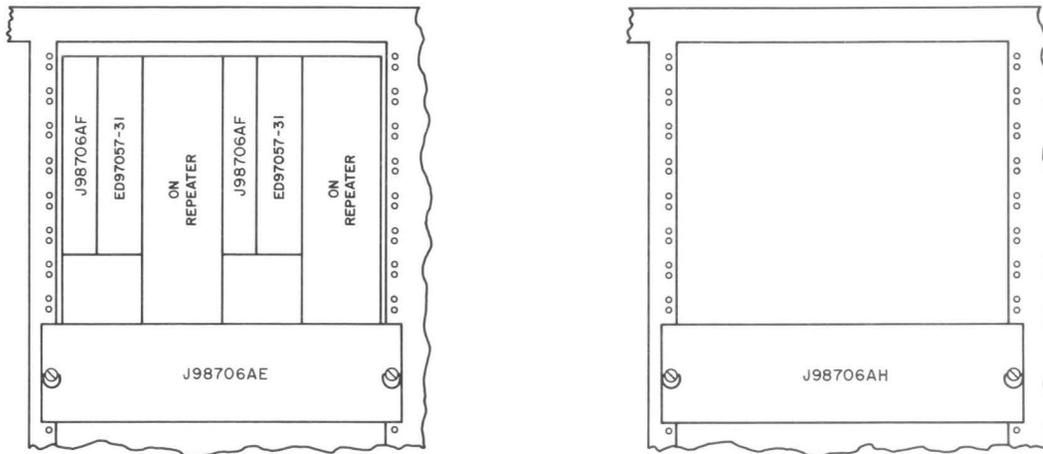
### 3. CIRCUIT DESCRIPTION

#### A. General

**3.01** Combinations of up to 48 N1 or N2, 80 ON1, or 96 ON2 or N3 carrier message channels can be transmitted over the TL radio system. These channels may come from N terminals, ON or N3 terminals, or N-type lines. Provisions have been made with split pads and filters for adding channels at a radio terminal and blocking or bridging at radio repeater points to connect channel groups between the radio system and wire lines, carrier terminals, or spur radio systems. The block diagram shown in Fig. 7 illustrates a possible TL-ON2 or N3 network configuration consisting of ON2 or N3 terminals A through G and radio repeaters 1 through 6.

Ninety-six ON2 or N3 message channels are combined into a composite signal by the 48-channel combining and 96-channel multiplex equipment of ON2 or N3 location A and transmitted by the TL radio to radio repeater 1. Forty-eight message channels are blocked in the main path at radio repeater 1 by equipment contained in the 96-channel combining panel and transmitted on spur radio lines to radio repeater 2 and then to the 48-channel combining filter panel at radio repeater 3. Equipment on the combining filter panel transmits all 48 message channels over the TL radio to the ON2 or N3 terminal at location C, but only 24 of these message channels are selected and used. The other 24 are selected in a bridge-type drop at repeater 3 and transmitted over an N line to ON2 or N3 terminal location B. At radio repeater 4 the through message channels from

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ED-97057-31  
PLUG-IN PAD UNIT

J98706AF PAD  
ASSEMBLY PANEL

ED-97057-31  
PLUG-IN PAD UNIT

ORDER-WIRE AND  
ALARM EQUIPMENT  
FOR N-TYPE LINE

J98706AF PAD  
ASSEMBLY PANEL

J98706AE ON/TL  
COMBINING FILTER

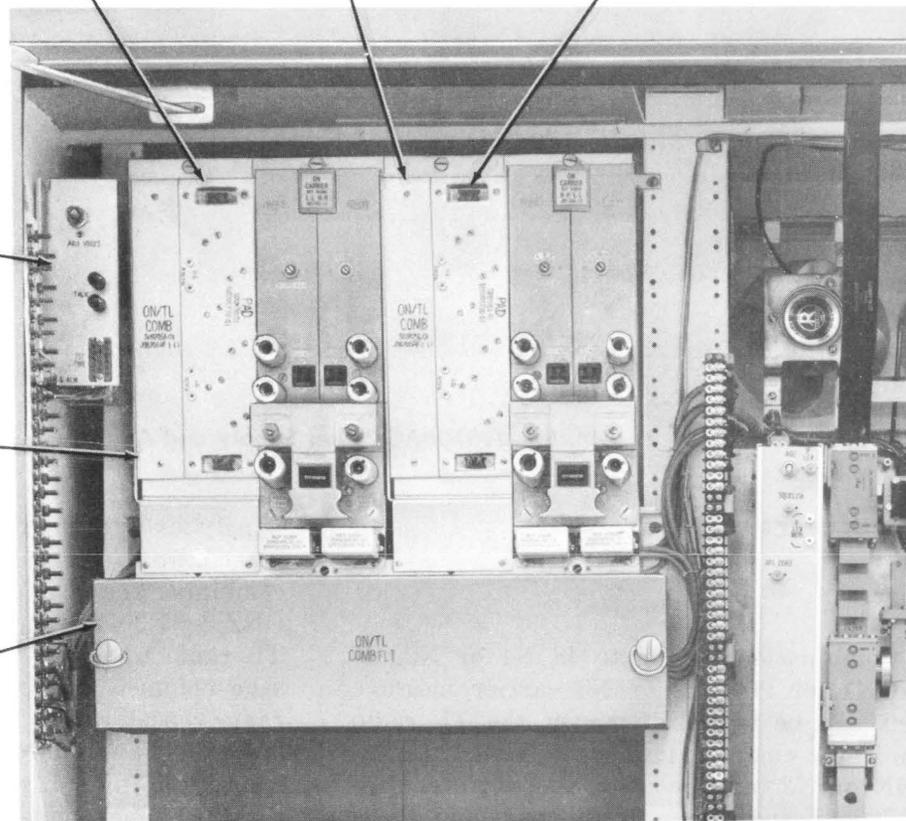


Fig. 6 — Combining Equipment Used in TL Radio Cabinet

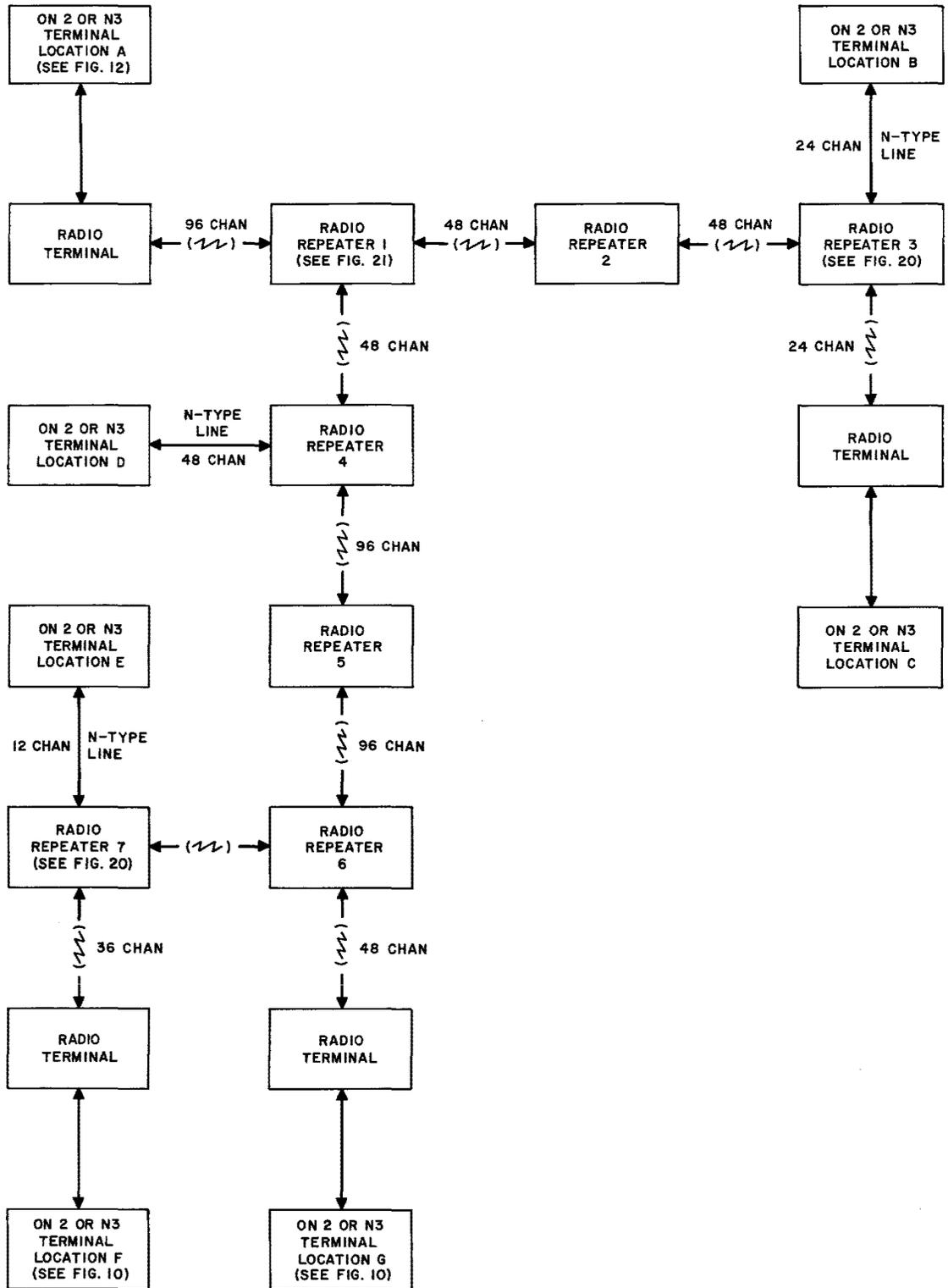


Fig. 7 — ON or N3 Over TL, Illustrative System Arrangement

radio repeater 1 are combined with 48 message channels from ON2 or N3 terminal location D by the 96-channel combining panel and transmitted through radio repeater 5 to radio repeater 6. The 96-channel combining panel at radio repeater 6 separates the composite 96-message channel input signal into two 48-channel groups. One 48-channel group is transmitted over the TL radio to ON2 or N3 terminal location G and the other 48-channel group is transmitted to radio repeater 7. The combining filter panel at radio repeater 7 sends 24 message channels to location E through the N-line, but terminal equipment is provided to use only 12 of these channels. In the reverse direction, location E sends only 12 channels to be combined at repeater 7. Similarly, all 48 channels are actually sent to location F by the radio system, but only 36 channels are demodulated to voice frequencies. In the reverse direction only 36 channels are sent from location F, to be combined at repeater 7 with the 12 channels from location E. Each of the terminal and radio-repeater blocks contains a reference to a

functional diagram which shows the equipment configuration of the combining or 96-channel multiplex equipment at that particular terminal or radio repeater.

**B. Equipment Arrangements**

**3.02** Connections to the 48-channel combining equipment from ON terminals or N-type lines are made through repeaters containing a 304-kc oscillator and modulator circuits. These repeaters are necessary to provide gain and the frequency translation required for the correct signal frequency relationship (transmitting low band and receiving high band or transmitting high and receiving low band) for utilization by the combining and multiplex equipment. Table E lists the various repeaters used with the TL radio and their operating bands when the TL radio is at the east end or west end of the repeater. The table also includes references to functional diagrams which illustrate typical equipment configuration for some of the repeaters.

**TABLE E**

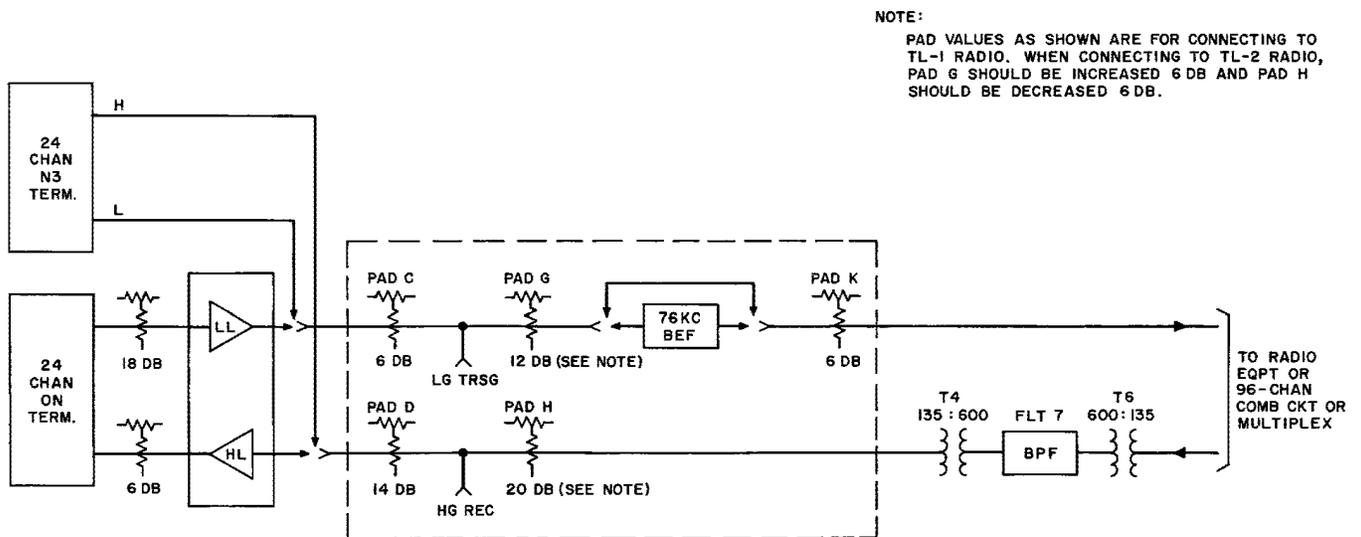
REPEATER	SCHEMATIC (SD NO.)	FIG. REF	REPEATER TRANSMITS TO:		REPEATER RECEIVES FROM:	
			CARRIER	RADIO	CARRIER	RADIO
<b>TL RADIO SYSTEM AT EAST END OF REPEATER</b>						
LL-HH	95189-01	—	High	Low	Low	High
HH-LL	95221-01	19	Low	High	High	Low
HL	95178-01	19	Low	Low	High	High
LH	95179-01	20	High	High	Low	Low
LL-LH	95215-01	18	Low	High	Low	Low
HL-LL	95218-01	—	Low	Low	Low	High
<b>TL RADIO SYSTEM AT WEST END OF REPEATER</b>						
LL-HH	95189-01	—	Low	High	High	Low
HH-LL	95221-01	19	High	Low	Low	High
HL	95178-01	11	Low	Low	High	High
LH	95179-01	9	High	High	Low	Low
LL-HL	95216-01	8	Low	Low	Low	High
LH-LL	95217-01	10	Low	High	Low	Low

*Note:* The first pair of letters designating the repeater indicates group frequency translation in the West to East (W-E) direction of transmission. The second pair of letters indicates group frequency translation in the East to West (E-W) direction of transmission. When there is only one pair of letters, the translation is the same in both directions.

**3.03** The functional diagrams shown in Fig. 8 through 12 contain equipment configurations for various radio terminal arrangements. In the discussion of these diagrams, references to ON2 systems (24 channels) apply equally to ON1 systems (20 channels). Figures 8 and 9 show how 12 N1 or N2, or 24 ON2 or N3 message channels are applied to the 48-channel combining, 96-channel multiplex, or TL radio equipment. Figures 10 and 11 show the configuration for combining 24 N1 or N2 or 48 ON2 or N3 message channels into a composite signal for connection to the 96-channel multiplex or TL radio equipment, while Fig. 12 shows how up to 48 N1 or N2 or 96 ON2 or N3 message channels are multiplexed into a composite signal for connection to the TL radio terminal. Each of these illustrations represents a particular situation that is determined by the type of connection, frequency band relationship, and number of message channels involved.

**3.04** A typical arrangement for applying 24 message channels to the radio system from the ON2 terminal or an N3 terminal is illustrated in Fig. 8. In this case, the transmitted band is the low group and is connected through the pad to the TL radio, the 48-channel combining equipment, or the 96-channel multiplex equipment. The received information is in the high-group band and is connected from the TL radio, 48-channel combining equipment, or 96 channel multiplex

equipment through the transformer (T6), filter (FLT 7), and pad networks to the high-low half of the repeater. Pad networks C and G (see Fig. 28) in the transmitting branch have been selected to provide carrier power of approximately -15 dbm at the transmitting jacks (LG TRSG). An N-type line may also furnish signals to combining arrangements similar to Fig. 8. When fewer than six ON2 or N3 channel groups are sent over an N line, a 76-kc tone is also sent so that the line repeaters will regulate the carrier to desired amplitudes. This tone must not be sent over the radio since it may cause overloading and interference with a channel group bridged into a partially filled frequency band at a radio repeater. Where the low-group band appears at the radio as in Fig. 8, the frequency of the level control tone is 76-kc. The 568E band elimination filter (76 kc BEF) provides about 45 db of attenuation at 76 kc and is provided on a plug-in basis when a partially loaded line is connected to the radio. Pad network K provides a resistive impedance for terminating the side of the filter that connects to the TL radio terminal. The 564E band-pass filter (FLT 7) in the receiving branch passes the high-group band (172 to 268 kc) and is used primarily to suppress image-frequencies (340 to 436 kc) that are produced in the ON repeaters used in the combining arrangements (see Fig. 39). This additional filtering prevents objectional beats from appearing in the output of a high-low



**Fig. 8 — 24 Channels from ON or N3 Terminal to Radio Terminal, Transmitting Low Group and Receiving High Group**

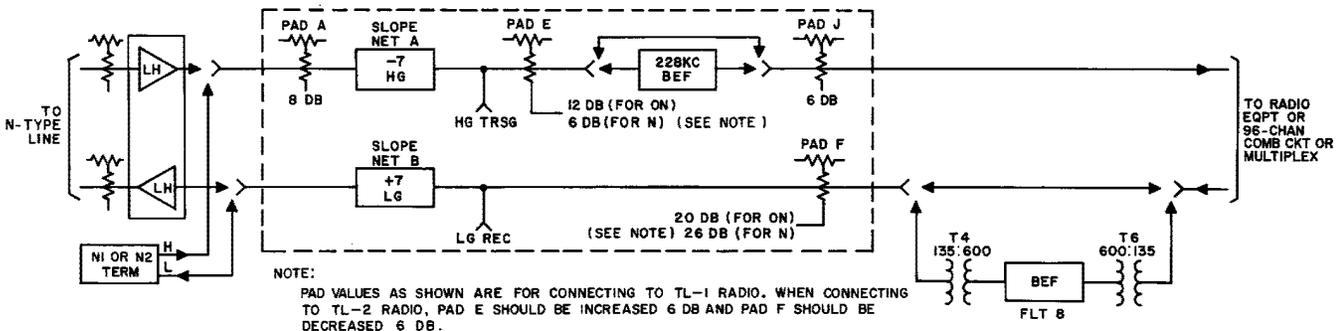
repeater that is fed from the TL radio. Impedance matching transformers T4 and T6 match the 600-ohm impedance of the filter to the 135-ohm impedance of the TL radio and pad networks. Pad networks G and H (see Fig. 28) are selected to provide carrier power of approximately -40 dbm at the receiving jacks.

**3.05** Figure 9 illustrates 12 N or 24 ON2 message channels from an N-type line or 12 N message channels from an N terminal transmitting high group and receiving low group. The circuitry contained in this illustration is basically the same as and serves the same function as that contained in Fig. 8 with the exception of the slope networks and band elimination filter (FLT 8). Slope network A (see Fig. 34) adjusts the carrier levels received from the N-type line by -7 db over the frequency band so that the carriers are essentially flat over the frequency spectrum while slope network B (see Fig. 36) imparts a slope of +7 db, over the frequency spectrum, to the essentially flat carrier output of the radio receiver for correct transmission to the N-type line. The 226Y band elimination filter (FLT 8), which is provided on an optional basis in the receiving branch, is used between the input to the low-high repeater and the output of the receiving multiplex to prevent a 304-kc leak from the low-high repeater from causing the carrier alarm relay to remain energized under a legitimate carrier alarm condition. This filter is not used when a high-high or low-low section is used, when enough suppression is provided in other filters, or when the input does not come from the 96-channel multiplex equipment. The 568F band elimination filter (228 kc BEF) suppresses the level control tone from a

partially loaded N line. In Fig. 9, the high-group band appears at the radio, and the frequency of the level control tone is 228 kc instead of 76 kc as in the case of Fig. 8. The 568F filter provides approximately 45 db of suppression at 228 kc.

**3.06** Other combining arrangements are provided in addition to those illustrated in Fig. 8 and 9. Eight different repeaters furnish the combinations of low and high groups that are required for frequency coordination between the radio and carrier systems. When an N line or N1 terminal is used, plus (+) and minus (-) slope networks are required in the combining equipment as shown in Fig. 9. The types of networks and pads required depend on whether the transmitted and received groups are low and high or high and low. Table E lists the repeaters that are used for various conditions.

**3.07** Figure 10 illustrates 48 ON2 or N3 message channels from an ON or N3 terminal combined into a composite signal and connected to the 96-channel multiplex equipment or TL radio. These message channels are applied to the equipment in the form of two 24-channel groups, one group being transmitted high and received low and the other group transmitted low and received high as discussed in 3.04. The high group being transmitted is coupled through impedance matching transformer T1 to the high side of combining filter FLT 1, and the low group being transmitted is coupled through impedance matching transformer T3 to the low side of the combining filter FLT 1. The high and low sides of the combining filter are arranged to form a common path to enable the high and low signals to be combined into



**Fig. 9 — ON or N System, 24 ON or 12 N Channels from N-Type Line or 12 Channels from N Terminal, Transmitting High Group and Receiving Low Group at Radio Terminal**

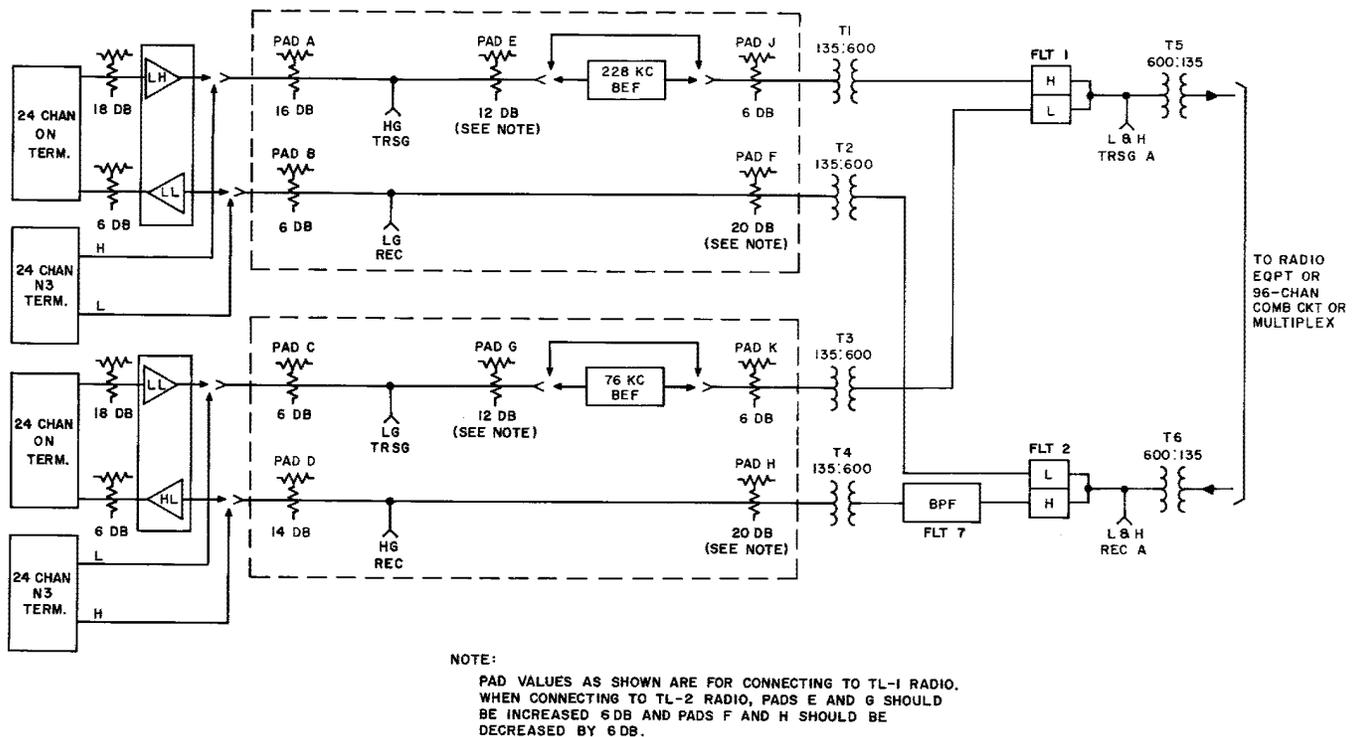


Fig. 10—48 Channels from ON or N3 Terminals to Radio Terminal

a composite signal for connection to the 96-channel multiplex equipment or TL radio. The composite signal received from the 96-channel multiplex equipment or TL radio is separated into the high and low components by separating filter FLT 2 in the reverse procedure of the combining process and coupled to the ON or N3 terminal. Impedance matching transformers T1 through T6 match the 600-ohm impedance of the combining and separating filters to the 135-ohm impedance of the pad networks and multiplex or radio equipment.

**3.08** The circuits shown in Fig. 11 function in the same manner as those described in 3.07. This figure illustrates the application of 48 ON or 24 N channels from N-type lines or 24 channels from N terminals to radio or multiplex equipment. Other circuit arrangements are possible in addition to those illustrated. The types of networks and pads required depend on whether the transmitted and received groups are low and high or high and low. Table E lists the repeaters that are used for various conditions.

**3.09** Figure 12 illustrates the multiplexing of 96 ON2 or N3 message channels or 48 N1 or N2 message channels to form a composite signal for connection to the TL radio terminal. The 48-channel combining equipment that is associated with the multiplex equipment has been discussed in previous paragraphs. Figure 12 contains references to the figures that illustrate the 48-channel combining equipment configurations which can be used in conjunction with the multiplex equipment. The transmitted 24 N1 or N2 or 48 ON2 or N3 message channels in the high- or low-group are coupled through impedance matching transformer T18 to the low side of combining filter FLT 2. The transmitted 24 N1 or N2 or 48 ON2 or N3 message channels in the high and low band are coupled through impedance matching transformer T58 to the modulator circuit where they are translated to the *s* and *t* bands (frequency limits shown in Tables A, B, and C) and coupled to the high-pass side of combining filter FLT 2. The two transmitted signals are combined into a composite signal containing 48 N1 or N2 or 96 ON2 or N3 message channels and coupled through impedance matching trans-

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NOTE:

PAD VALUES SHOWN ARE FOR CONNECTING TO TL-1 RADIO. WHEN CONNECTING TO TL-2 RADIO, PADS E AND G SHOULD BE INCREASED 6 DB AND PADS F AND H SHOULD BE DECREASED BY 6 DB.

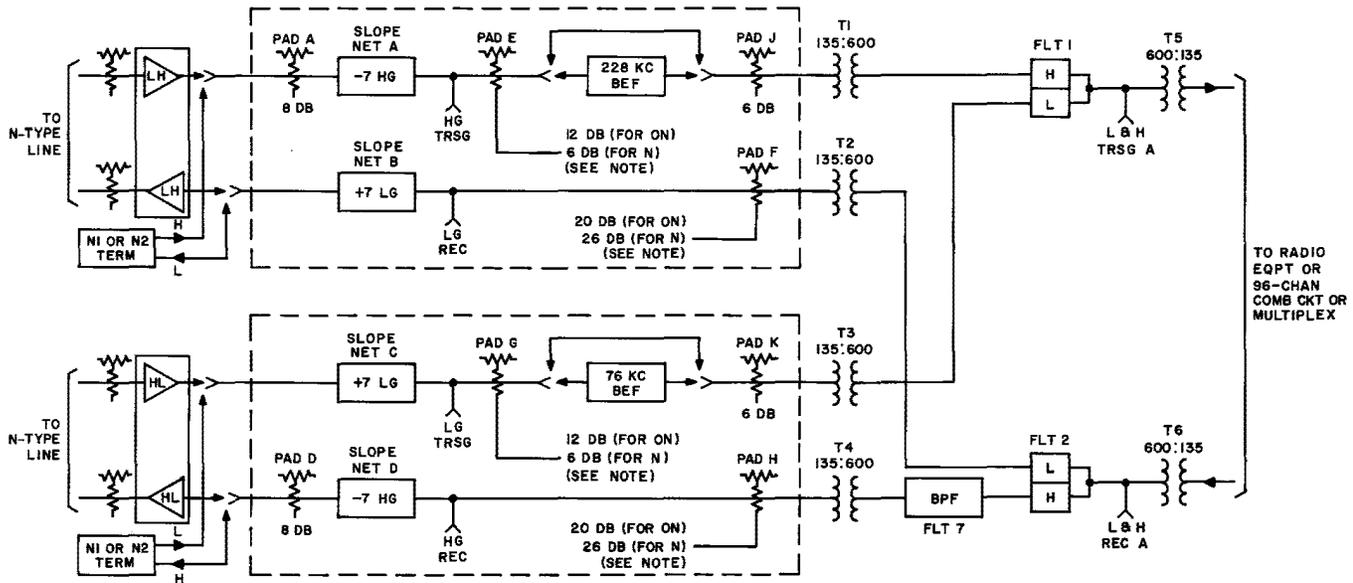


Fig. 11 — ON or N System to Radio Terminal (48 ON or 24 N1 or N2 Channels from N-Type Lines or 24 Channels from N Terminals at Radio Terminal)

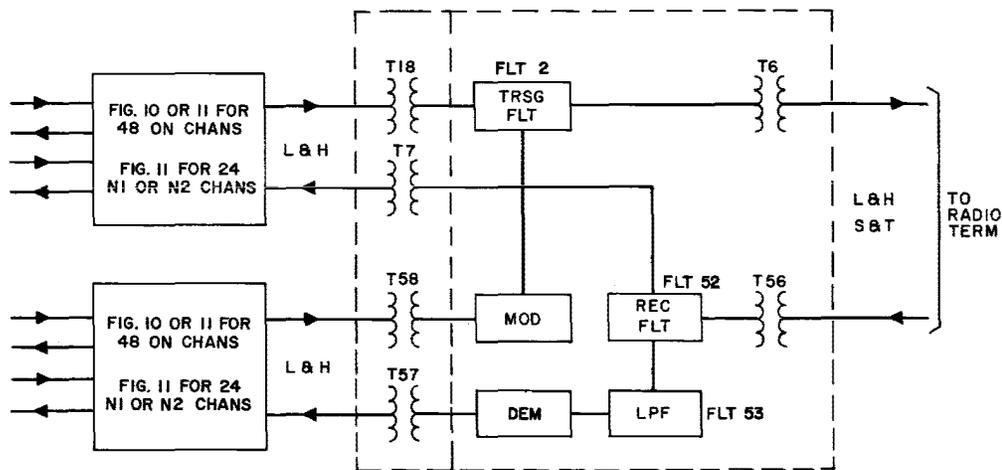


Fig. 12 — ON or N Systems Combining 48 ON or N3 Channels with 48 ON or N3 Channels or Combining 24 N1 or N2 Channels with 24 N1 or N2 Channels at Radio Terminal

former T6 to the TL radio. The received composite signal is applied to separating filter FLT 52 and separated into two components for demodulation and connection to the 48-channel combining equipment.

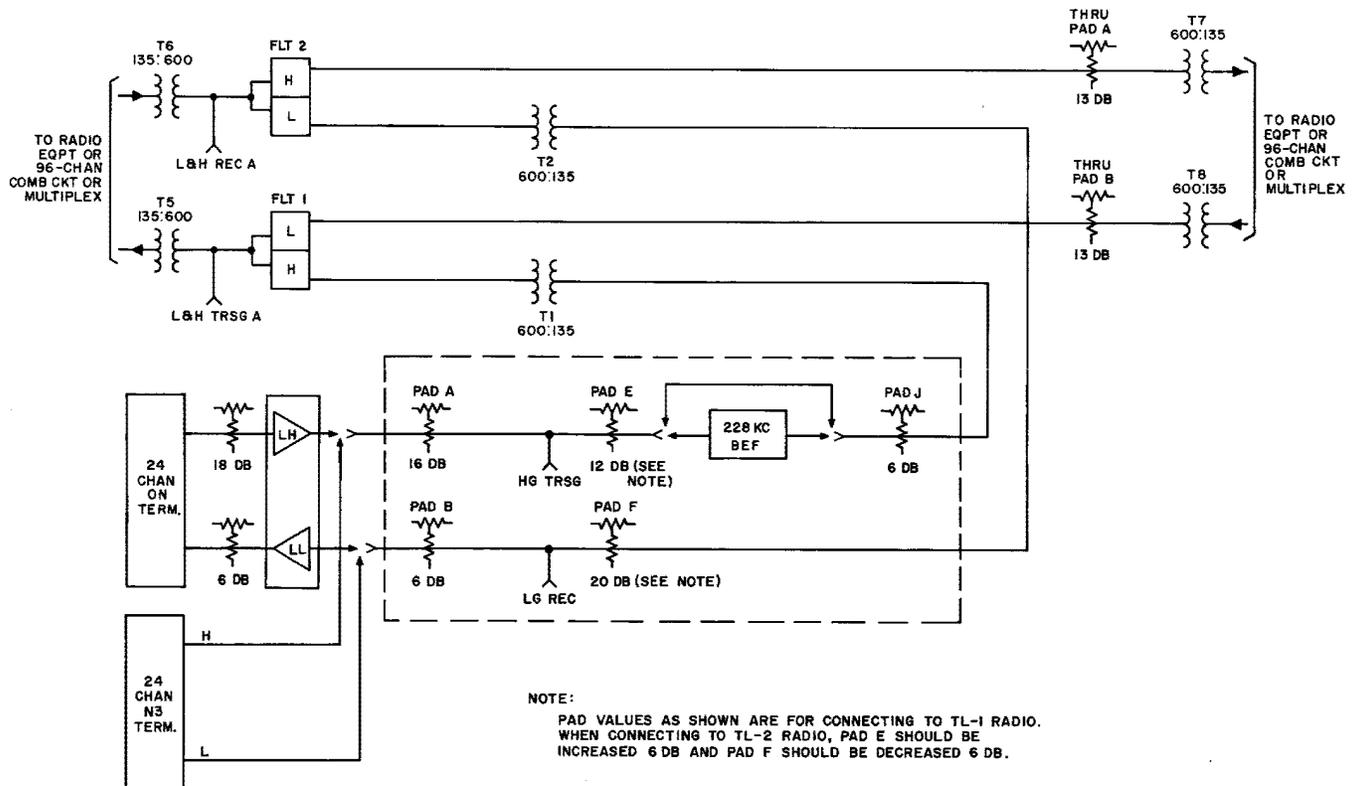
**3.10** The functional diagrams in Fig. 13 through 27 show equipment configurations at radio repeater points. These configurations permit dropping, adding, and bridging to or from ON terminals, N terminals, and N-type lines. The apparatus used in these configurations is the same as and serves the same purpose as the apparatus shown in Fig. 8 through 12 except for the through and split pads.

**3.11** The through pads provide stable resistive loads for filters and transformers to prevent interaction between reactive components. The split pads, in addition to isolating reactive components, provide the multiple output or combining paths that are required when channels are dropped or added by bridging.

**3.12** Figures 13 and 14 show the equipment configurations used when groups of 24 ON or N3 or 12 N1 or N2 channels are dropped or added. The channels may originate or terminate at ON or N terminals or may be transmitted over N-type lines. Figures 15 and 16 illustrate how 24 ON or 12 N channels may be dropped to and added from ON terminals, N terminals, or N-type lines. Other configurations are possible than those shown in Fig. 15 and 16, each requiring different types of networks, pads, and repeaters. The various repeaters used are listed in Table E.

**3.13** The wye connections between three radio equipments is shown in Fig. 17. This configuration permits 48 ON or N3 or 24 N1 or N2 channels to be dropped to a spur radio link.

**3.14** Figures 18 and 19 show the methods of bridging partially equipped *l* and *h* groups to drop to, or add from, an ON terminal or an N-type line. In these figures the bandpass filter FLT 7 is used in the *h* group receiving path to



**Fig. 13 — Blocking or Adding 24 Channels from ON or N3 Terminal at Radio Repeater**

## NOTE:

PAD VALUES AS SHOWN ARE FOR CONNECTING TO TL-1 RADIO. WHEN CONNECTING TO TL-2 RADIO, PAD G SHOULD BE INCREASED 6 DB AND PAD H SHOULD BE DECREASED 6 DB.

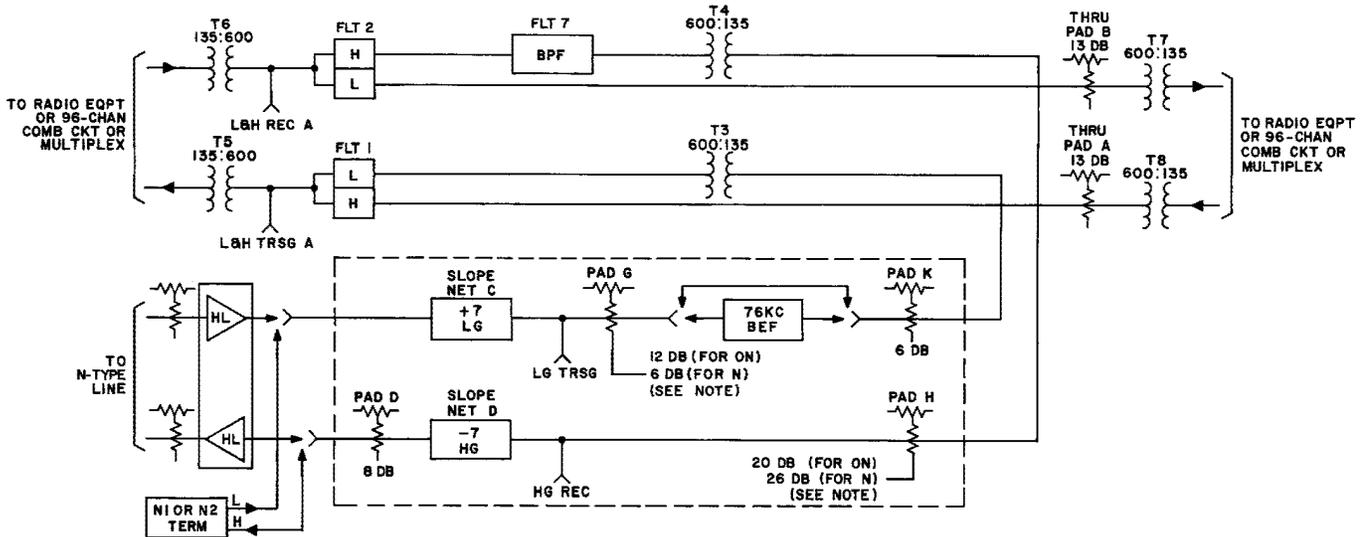


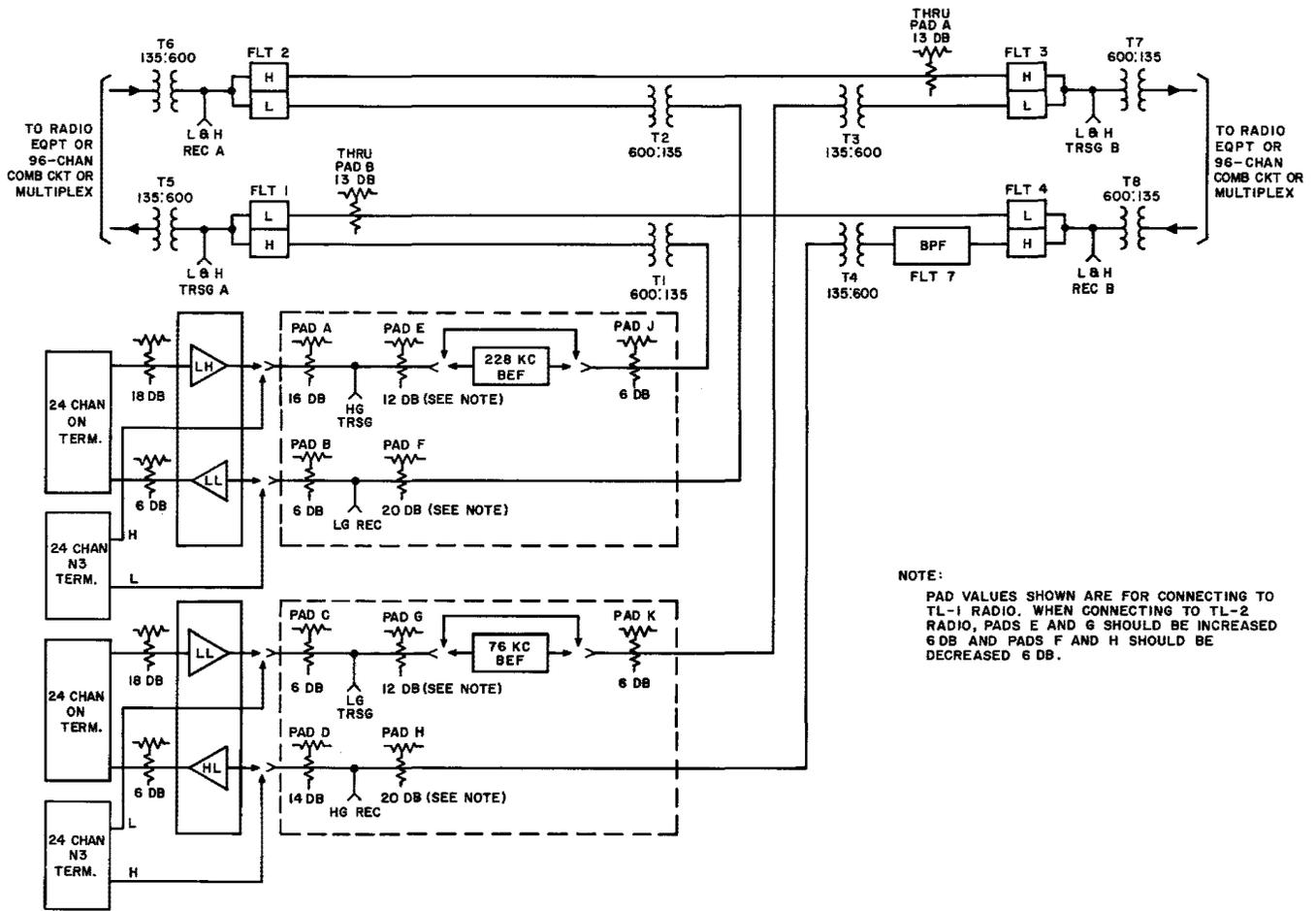
Fig. 14—Blocking or Adding 24 ON or 12 N Channels from N-Type Line or 12 Channels from N1 or N2 Terminal at Radio Repeater

suppress image frequencies that are produced in some of the ON repeaters. Figure 20 shows the method for dropping, by bridging, *l* and *h* groups to an ON terminal or an N-type line. In Fig. 20 the filter FLT 7 is used in the *h* group transmitting path to provide low-group suppression in addition to that furnished in the LH repeater section. This prevents the possibility of the low group leaking through in the LH repeater section and interfering with the desired *l* group in the through radio path. In each of the configurations shown in Fig. 18, 19, or 20, the frequencies occupied by the channels that are bridged out may not be reused at the radio repeater when the bridging occurs, or at other following points until those frequencies are blocked.

**3.15** Bridging arrangements similar to those of Fig. 18 and 19 may also be used in radio systems that are arranged to carry the *l*, *h*, *s*, and *t* frequency bands. Bridging is of course permissible only in those frequency bands that are not completely filled. The filters and multiplex and bridging facilities such as those shown in

Fig. 18 and 19 must be arranged so that the actual bridging is always accomplished at the *l* or *h* band of frequencies. In many cases these bands may then be translated to the *s* or *t* band for transmission along the radio system. The frequencies of the dropped channels may not be reused until the bands are blocked.

**3.16** Figures 21 and 22 show the configurations used to drop or add up to 48 ON or N3 or 24 N1 or N2 channels at a radio repeater. When the channels are in the low- and high-frequency bands, the channels are dropped through filters associated with the desired direction of transmission. The filters for the other directions are terminated with resistors. Dropping or adding in the *s* and *t* groups require that the signals be modulated or demodulated before they are connected to the terminal or line equipment. Figures 23 and 24 show how 48 ON or N3 or 24 N1 or N2 channels, in either the *l* and *h* or *s* and *t* bands, are dropped or added. Figures 25 and 26 show the equipment arranged to drop and add 24 ON or N3 or 12 N1 or N2 channels



**Fig. 15 — Blocking and Adding 24 Channels to and from ON or N3 Terminals at Radio Repeater**

from the complete complement of 96 channels. These channels may be in the *l*, *h*, *s*, or *t* frequency band.

**3.17** Figure 27 shows the equipment arranged to drop or add the channels in the *l* and *h* bands and to translate the channels in the *s* and *t* bands to the *l* and *h* frequencies.

**C. Schematic Diagram Analysis**

**48-Channel Combining Equipment**

**3.18** The 48-channel combining circuit contains apparatus required to handle two groups of 24-message channels between ON or N3 terminals or N-type lines and either the TL radio or 96-channel multiplex equipment (see Fig. 28).

The 24-channel group that is being transmitted toward the TL radio in the frequency band of 172 to 268 kc is coupled through span pads A, E, and J, slope network A, and jack J9 to the J98706AE combining filter panel. Jack J9 is provided to enable a 568F band elimination filter to be inserted in the circuit when fewer than five 4-channel groups of an ON1 system or six 4-channel groups of an ON2 system are transmitted to the radio system. This filter furnishes about 45 db of attenuation at 228 kc and is required to remove a 228-kc tone which is introduced on the line to ensure that the regulators of the repeaters will control the carriers to the desired amplitudes. When the filter is not required, an ED-92309-30 connector is inserted in J9 to provide a through path for the input signal. Span adjust pads A, E,

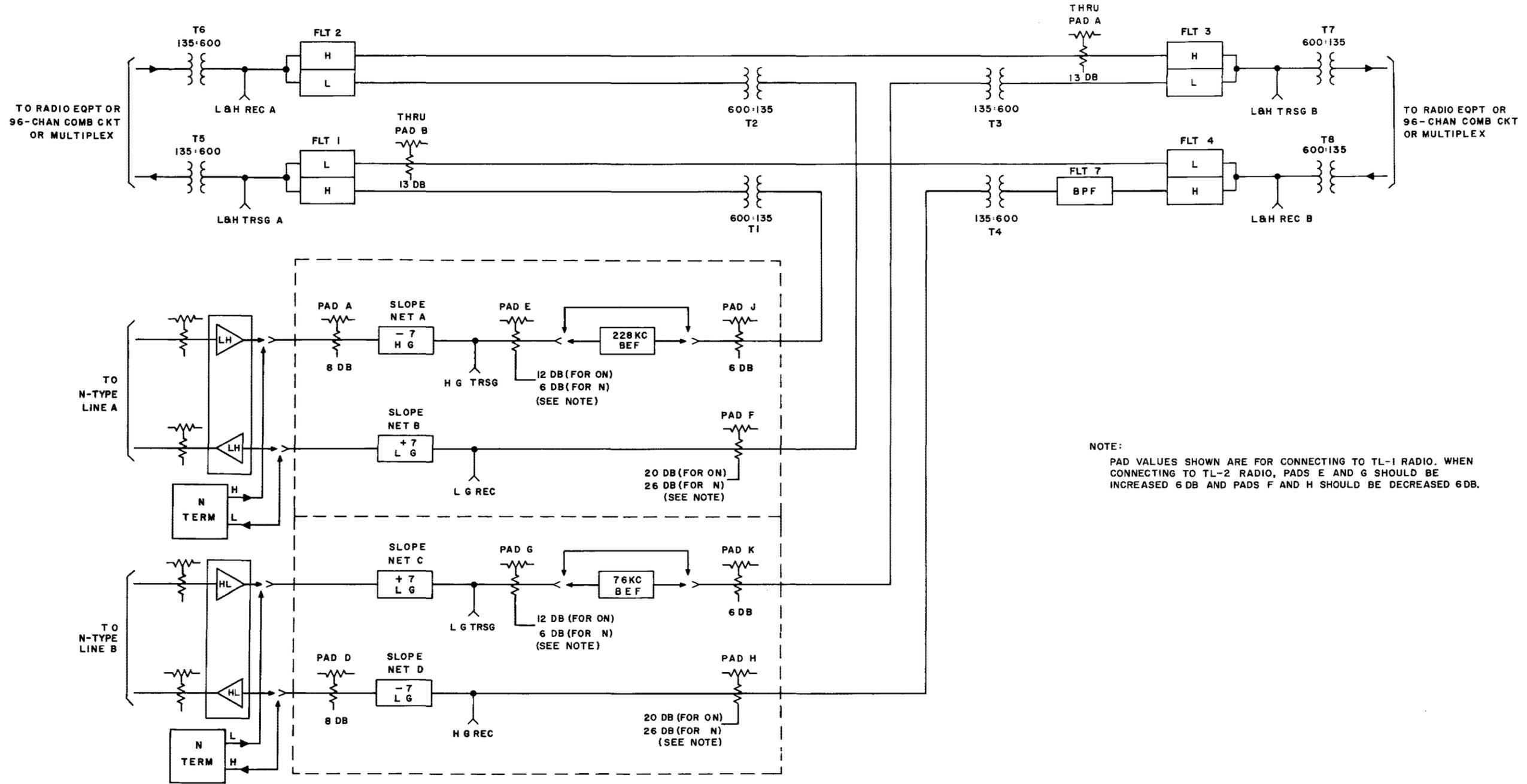


Fig. 16—Blocking and Adding 24 ON Channels to and from N-Type Lines or 12 N Channels to and from N-Type Lines or Terminals at Radio Repeater

and J are selected to provide power of about  $-15$  dbm per carrier at the HG TRSG pin jacks. Pad J also provides a resistive impedance for terminating the side of the 568F band elimination filter that connects to the radio. The 24-channel group that is transmitted toward the TL radio in the frequency band of 36 to 132 kc is coupled through span adjust pads C, G, and K, slope network C, and jack J10 to the J98706AE panel. As in the case of the transmitted high group, jack J10 is provided to enable a 568E band elimination filter to be inserted in the circuit when fewer than four 4-channel groups of an ON system are transmitted to the radio system. This filter furnishes about 45 db of attenuation and is required to remove a 76-kc tone which is introduced on the line to ensure that the regulators of the repeaters will control the carriers to the desired amplitudes. When this filter is not required, an ED-92309-30 connector is inserted in J10. Span pads C, G, and K are selected to provide power of about  $-15$  dbm per carrier at the LG TRSG pin jacks. Pad K also provides a resistive impedance for terminating the side of the 568E band elimination filter that connects to the radio. The two transmitted groups are coupled through impedance matching transformers T1 and T3 on the J98706AE panel and applied to the high and low sides of combining filter (564A) FLT 1. These high and low sides are arranged to form a common path, which provides a composite signal consisting of the transmitted high and low groups for connection through impedance matching transformer T5 to the 96-channel multiplex equipment or TL radio. The characteristic curves for the 564A filter are shown in Fig. 37. The composite signal that is received from the 96-channel multiplex equipment or TL radio is coupled through impedance matching transformer T6 to the input side of separating filter (564A) FLT 2 where it is separated into the high- and low-group frequency bands. The high-group frequency band is transmitted through bandpass filter FLT 7 (Fig. 39), impedance matching transformer T4, span adjust pads D and H, and slope network D to the ON or N3 terminal equipment. Span adjust pads D and H have been selected to provide carrier power of about  $-40$  dbm at the HG RCVG pin jacks. The low-group frequency band is transmitted through impedance matching transformer T2, span adjust pads B and F, and slope network B to the ON or N3 terminal equipment. As in the case of the received high group, span adjust pads

B and F have been selected to provide a level of about  $-40$  dbm at the LG RCVG pin jacks.

**3.19** Figure 28 contains a level diagram that provides nominal carrier powers at various points in the 48-channel combining equipment. The actual levels at most of these points have been established through use of fixed pads that are available in 2-db steps. Use of fixed pads is a coarse method of setting levels which may result in errors of nominal levels of up to 1 db. These errors and others caused by deviations from desired characteristics in the carrier lines should be corrected by the regulators in the N and ON terminals. Some of the carrier power received from the radio may be less than nominal when the multiplex or J98706AH 96-channel combining panel are used because of small losses in associated transformers and filters. Table F provides the approximate passband loss characteristics of several components used in these circuits.

**3.20** The combining circuits are arranged so that the power of each channel carrier is nominally the same if the radio system is partially or completely loaded.

TABLE F

PASSBAND LOSS CHARACTERISTICS OF CIRCUIT COMPONENTS	
ITEM	LOSS, DB
564A Filter (low-pass section)	0.05
(high-pass section)	0.09
564B Filter (low-pass section)	0.04
(high-pass section)	0.1
564E	0.1
534C	1.3
565A	2.8
565B	0.8
2507S	0.2
Transmitting Amplifier Modulator	0 (adj $\pm 2$ db)
Receiving Amplifier Modulator	0 (adj $\pm 2$ db)



NOTE:  
 PAD VALUES SHOWN ARE FOR CONNECTING TO TL-1 RADIO.  
 WHEN CONNECTING TO TL-2 RADIO, PADS E AND G SHOULD  
 BE INCREASED 6 DB AND PADS F AND H SHOULD BE  
 DECREASED 6 DB.

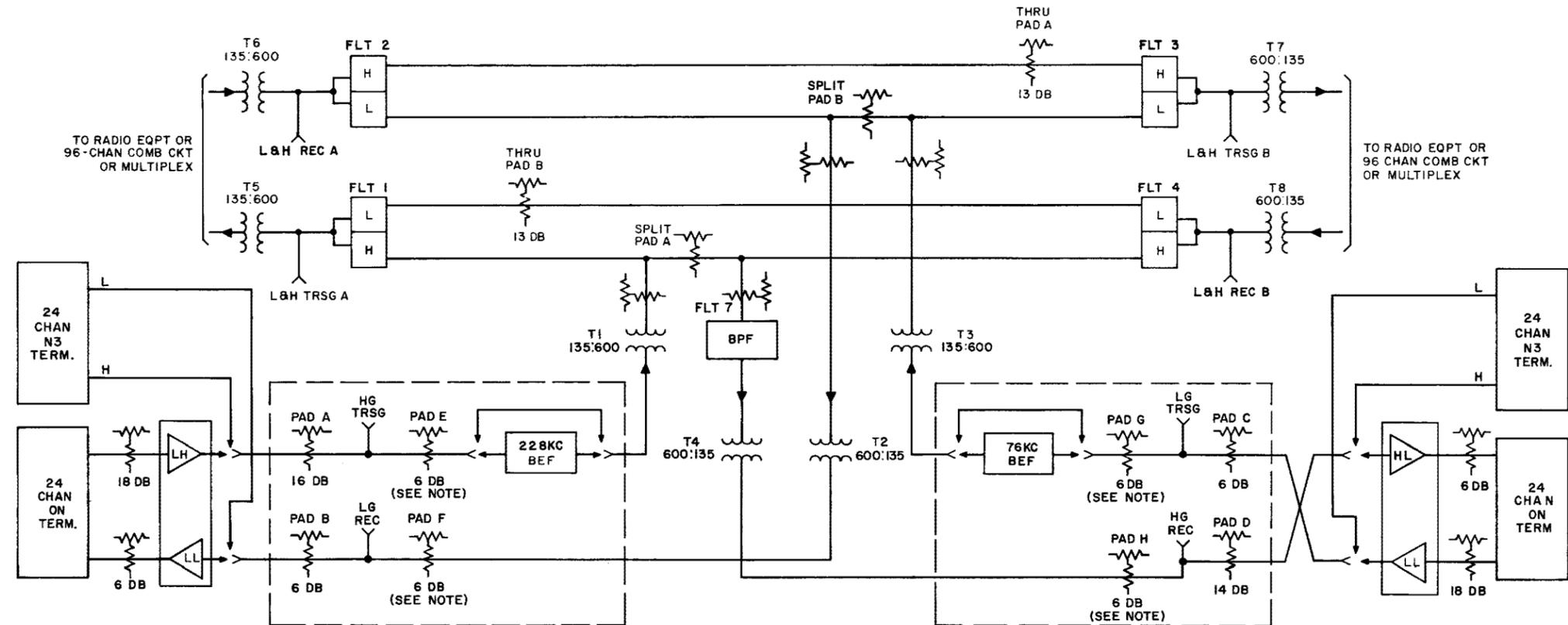
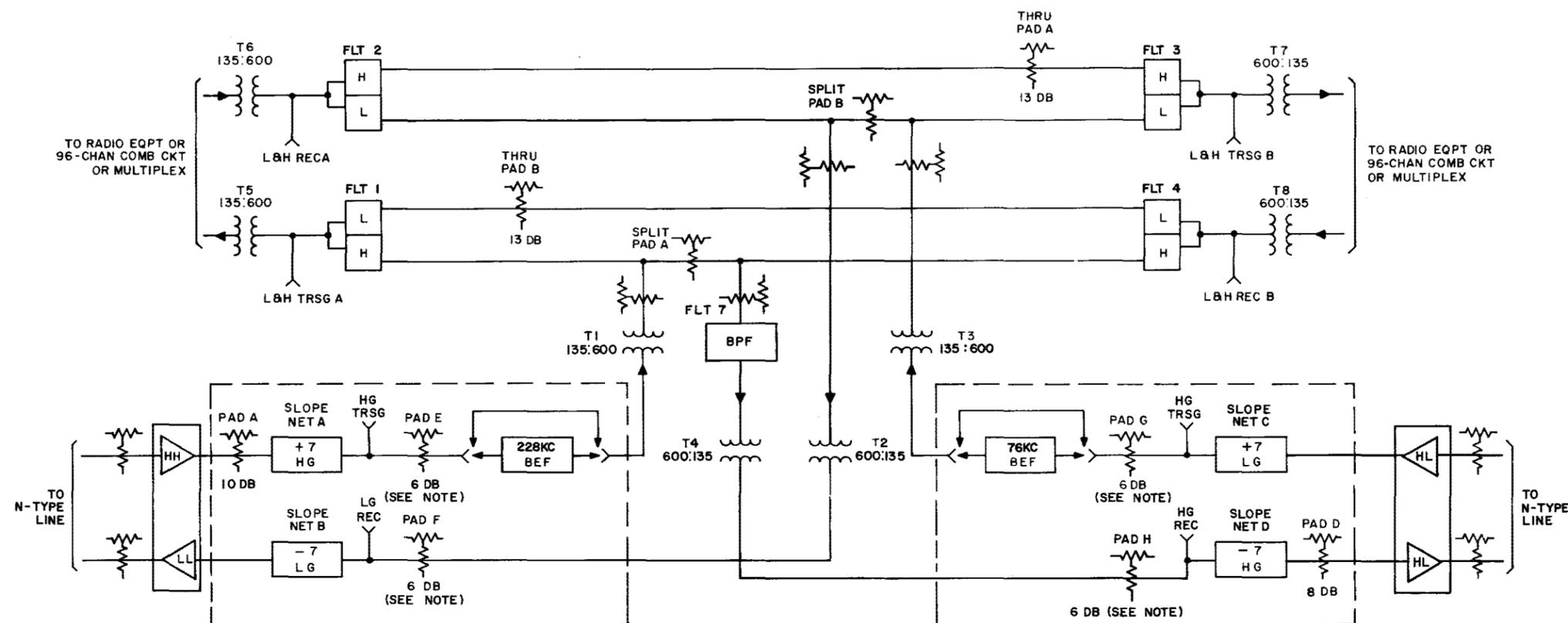


Fig. 18— Bridging in Low or High Group,  
 Dropping and Adding to and from  
 ON or N3 Terminals at Radio  
 Repeater



NOTE:  
 PAD VALUES SHOWN ARE FOR CONNECTING TO TL-1 RADIO.  
 WHEN CONNECTING TO TL-2 RADIO, PADS E AND G SHOULD  
 BE INCREASED 6 DB AND PADS F AND H SHOULD BE DECREASED 6 DB.

Fig. 19— Bridging in Low or High Group,  
 Dropping and Adding to and from  
 N-Type Lines at Radio Repeater

TABLE G

CODE	SLOPE NETWORK	LOSS INCREASES WITH	APPLICATION	FIG. REF
J98706L	-7 LG	Decreasing frequency	Used where cable connects to radio, ON terminal, or ON1 junction from LL repeater output or input.	33
J98706M	-7 HG	Increasing frequency	Used where cable connects to radio from LH repeater output or HL repeater input	34
J98706N	+7 HG	Decreasing frequency	Used where cable connects to radio from HH repeater output or input	35
J98706T	+7 LG	Increasing frequency	Used where cable connects radio, ON terminal, or ON1 junction from HL repeater output or LH repeater input	36

NOTE:

PAD VALUES SHOWN ARE FOR CONNECTING TO TL-1 RADIO. WHEN CONNECTING TO TL-2 RADIO, PAD E SHOULD BE INCREASED 6 DB AND PAD F SHOULD BE DECREASED 6 DB.

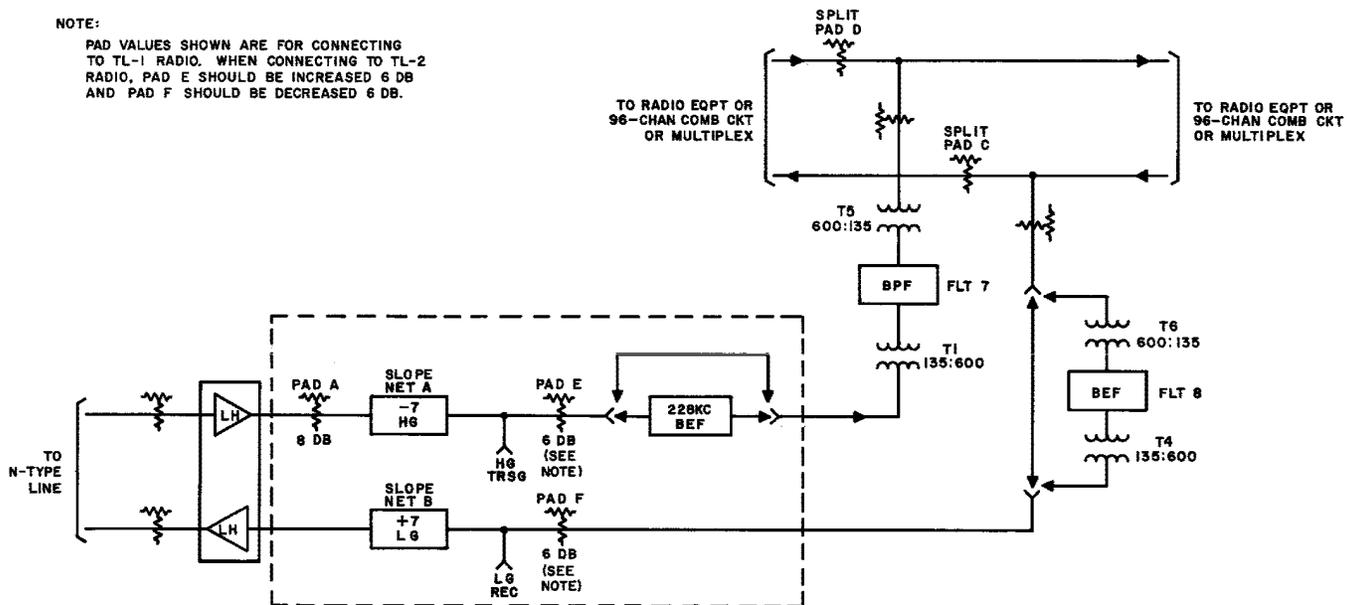
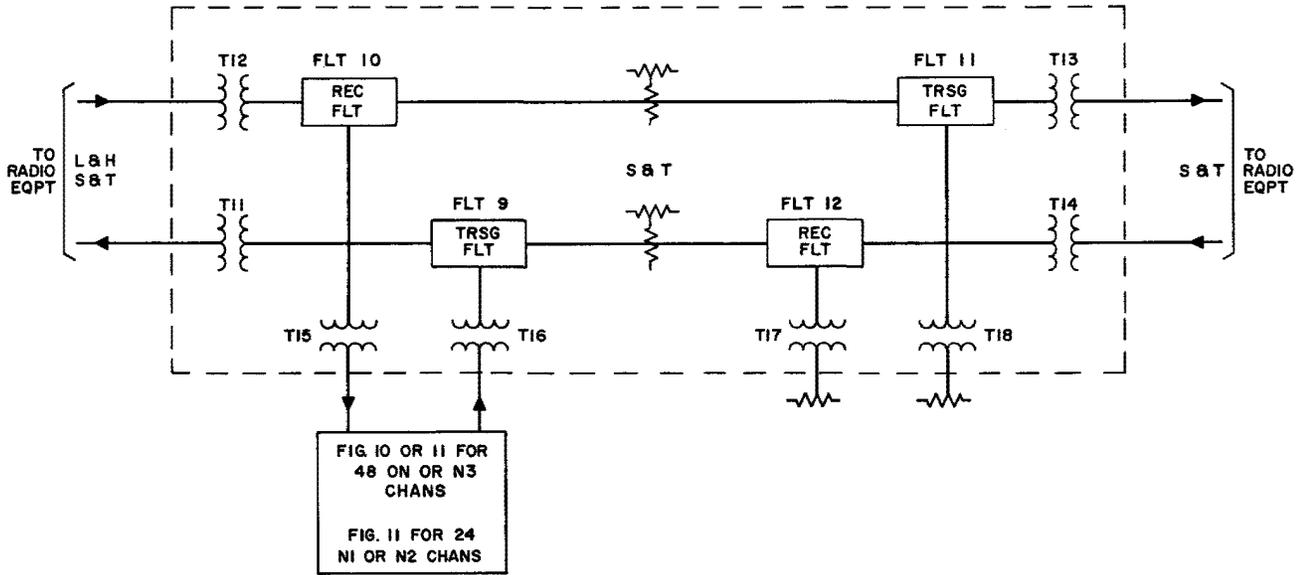
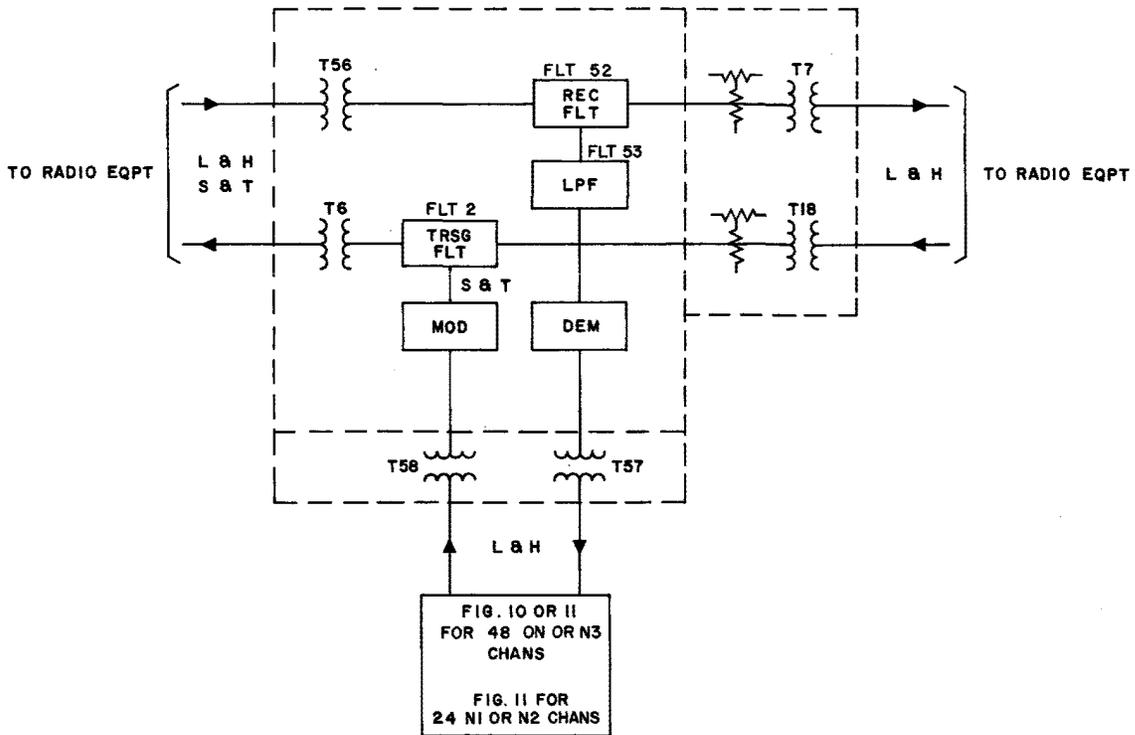


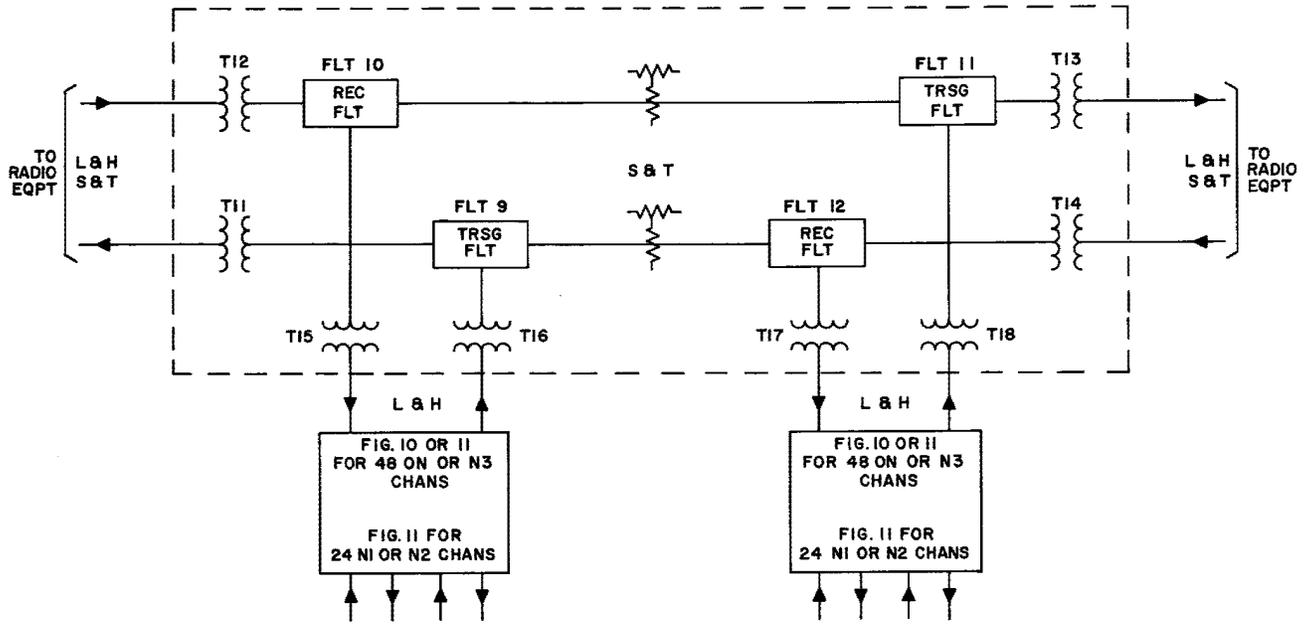
Fig. 20— Bridging in Low and High Groups, Dropping to N-Type Line at Radio Repeater



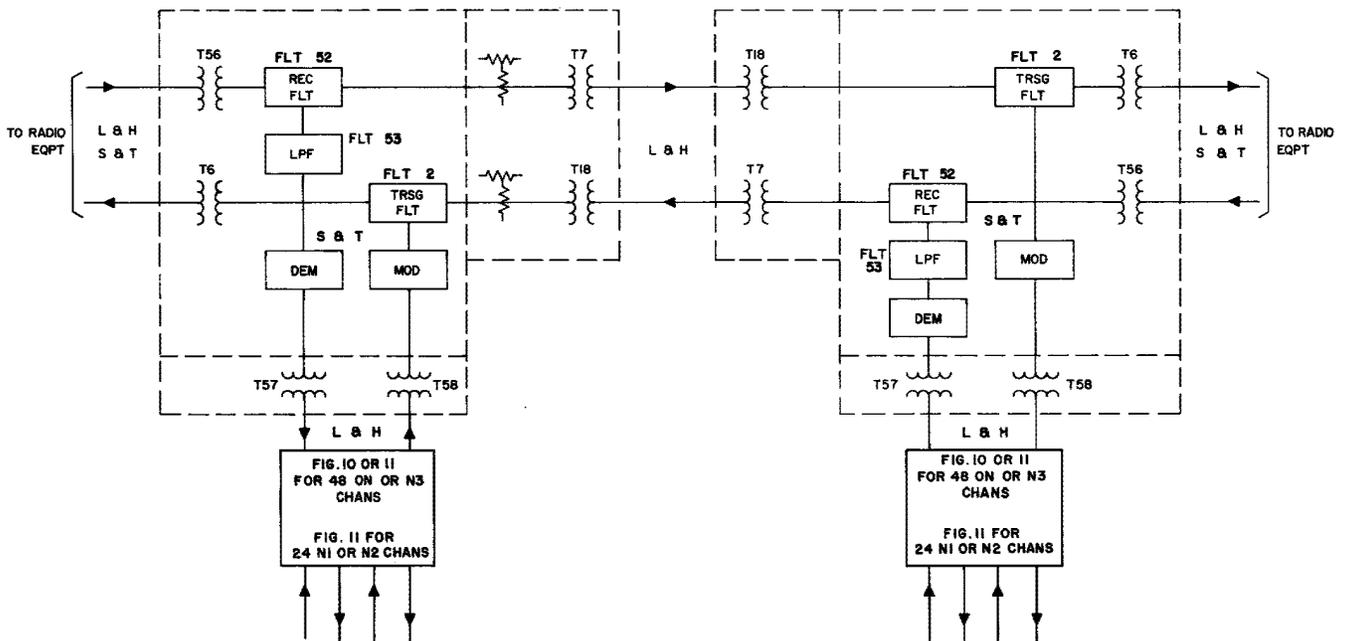
**Fig. 21 — Blocking or Adding 48 ON or N3 or 24 N1 or N2 Channels (Low and High Groups) at Radio Repeater**



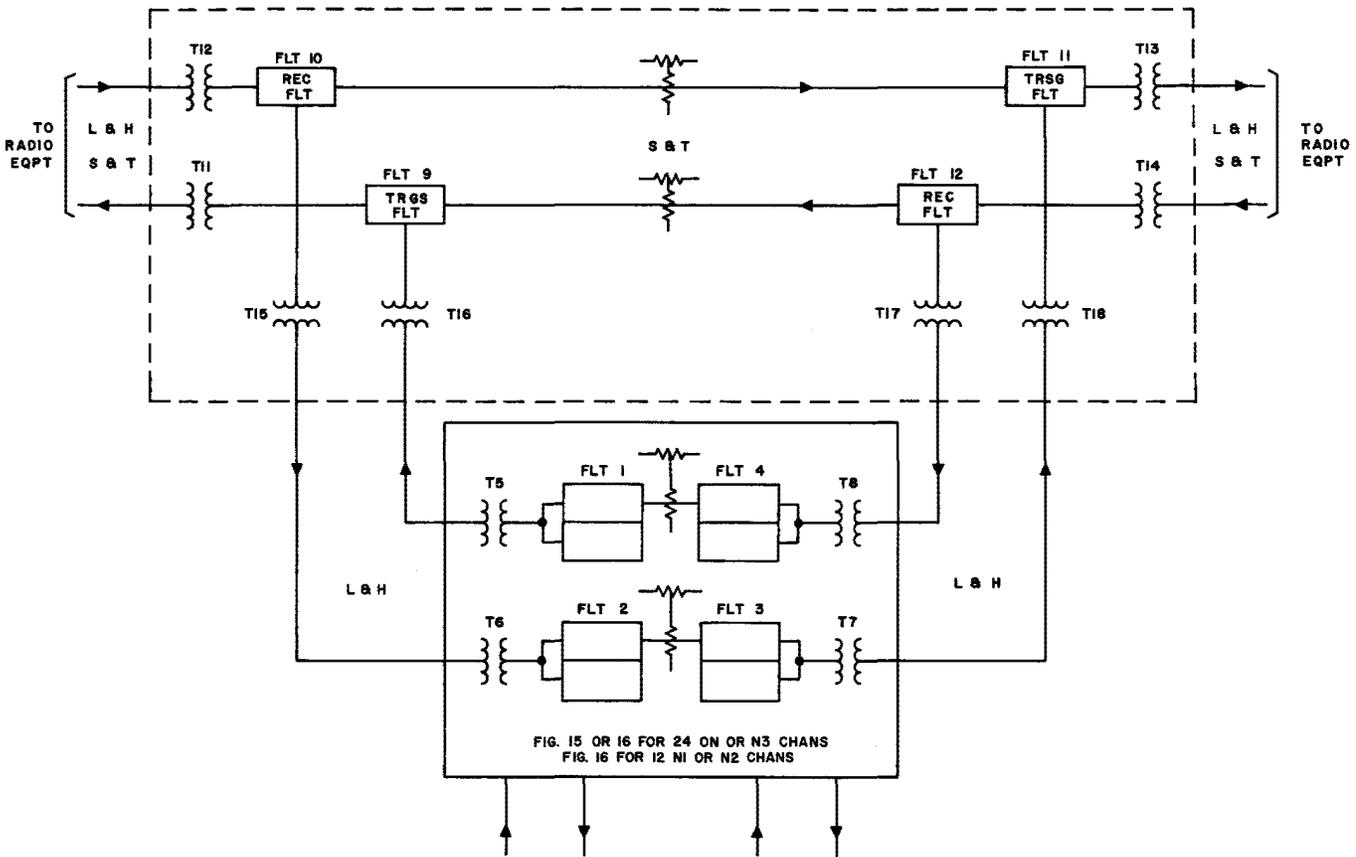
**Fig. 22 — Blocking or Adding 48 ON or N3 or 24 N1 or N2 Channels (s and t Groups) at Radio Repeater**



**Fig. 23 — Blocking or Adding 48 ON or N3 or 24 N1 or N2 Channels (Low and High Groups) at Radio Repeater**



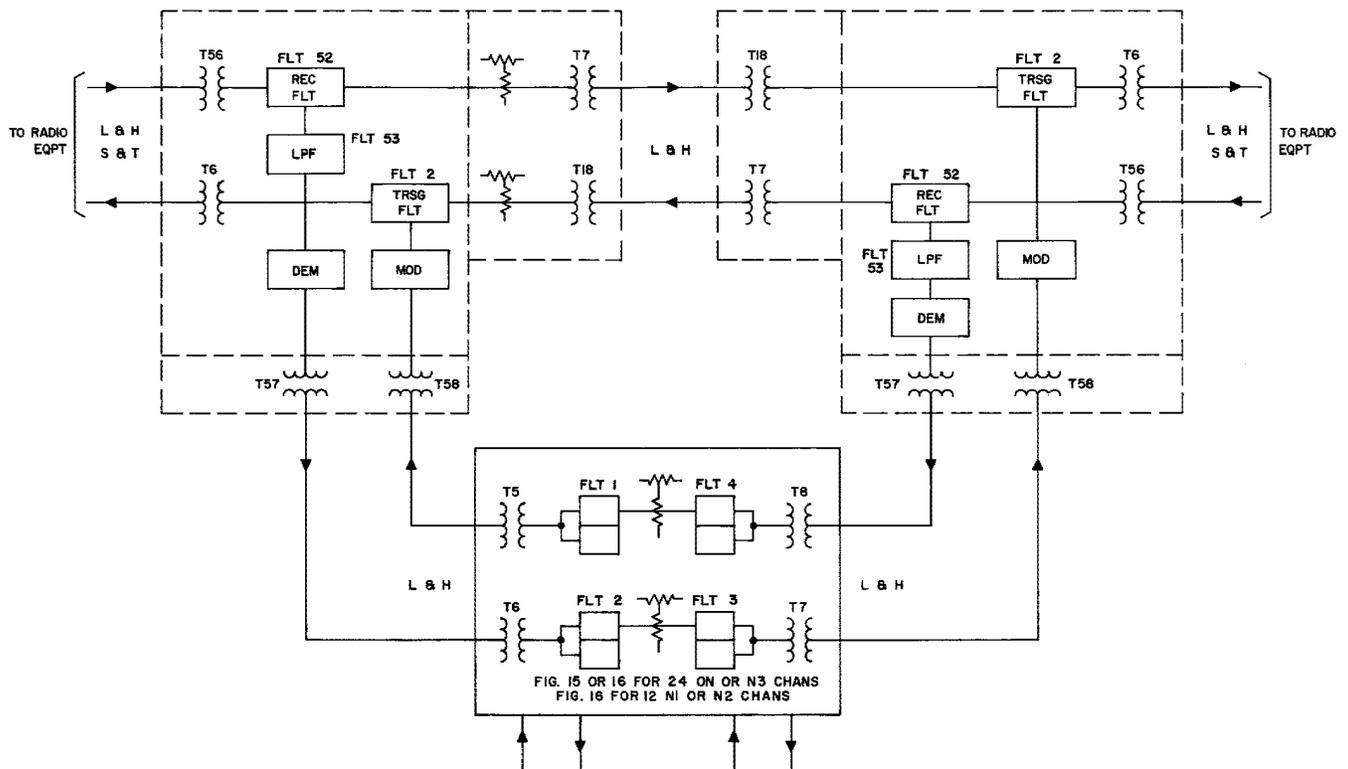
**Fig. 24 — Blocking or Adding 24 ON or N3 or 12 N1 or N2 Channels (s and t Groups) at Radio Repeater**



**Fig. 25 — Blocking and Adding 24 ON or N3 or 12 N1 or N2 Channels (Low and High Groups) at Radio Repeater**

demodulator unit, transmitting amplifier and modulator unit, and power supply and alarm unit. Inputs to the multiplex mounting are in the form of two groups of 48 message channels, each of which is in the frequency band of 36 to 268 kc (*h* and *l* group). One of the 48-channel groups that is being transmitted toward the TL radio is coupled directly to the low-pass side of the 564B combining filter (FLT 2) (see Fig. 38). The remaining 48-channel group is coupled to the transmitting amplifier and modulator unit where it is modulated with 584 kc and translated to the frequency range of 316 to 548 kc. The translated high group (*s* group) extends from 316 to 412 kc and translated low group (*t* group) extends from 452 to 548 kc. The combined *s* and *t* group is connected from the transmitting amplifier and modulator unit to the high-pass side of the 564B combining filter (FLT 2) where it is combined with the *l* and *h* group band to provide a composite signal combining 96-message

channels for application through impedance matching transformer T6, to the TL radio. In the receiving direction, the frequency band from 36 to 548 kc is coupled from the TL radio through impedance matching transformer T56 to the 564B separating filter (FLT 52) where it is separated into an *l* and *h* group and *s* and *t* group. The *l* and *h* group is coupled directly to the 48-channel combining equipment and the *s* and *t* group is coupled through the 534C low-pass filter (FLT 53) to the receiving amplifier and demodulator unit. The 534C low-pass filter suppresses frequencies above 584 kc to reduce image band noise and crosstalk. The insertion loss characteristic curve for the 534C filter is shown in Fig. 40. The *s* and *t* group is modulated with 584 kc and translated to the frequency range of the *l* and *h* group (36 to 268 kc) for connection to the 48-channel combining equipment.



**Fig. 26—Blocking and Adding 24 ON or N3 or 12 N1 or N2 Channels (s and t Groups) at Radio Terminals**

### J98706AB Transmitting Amplifier and Modulator Unit

**3.24** The transmitting amplifier and modulator unit consists of an oscillator, modulator, amplifier, and associated circuitry (see Fig. 30). Input to this unit consists of a composite signal containing up to 48 message channels in the frequency band of 36 to 268 kc. This signal is applied to the modulator through transformer T2 and translated to the frequency band of 316 to 548 kc. The modulator, consisting of copper oxide varistor CR1, is of the double balanced type in which the input signals and carrier are essentially balanced out, producing an output consisting almost entirely of sideband frequencies. The oscillator circuit consists of a single-stage crystal-controlled 584-kc oscillator whose output is ap-

plied longitudinally to the modulator through transformers T2 and T3. The frequency of oscillation is determined by crystal Y1 and by variable capacitor C2 which permits adjustment of the frequency over a limited range. The input and output of the modulator are provided with 2-db pads to improve impedance matching. Output signals from the modulator are coupled through a 565A low-pass filter (FLT 1), output transformer T4, and modulator gain potentiometer R13 to the control grid of amplifier stage V2. The 565A low-pass filter (FLT 1) eliminates the unwanted upper sideband of modulation (see Fig. 41). The modulator gain (MOD GAIN) potentiometer R13 controls the gain of the amplifier so that the overall gain of the modulator and amplifier is approximately unity.

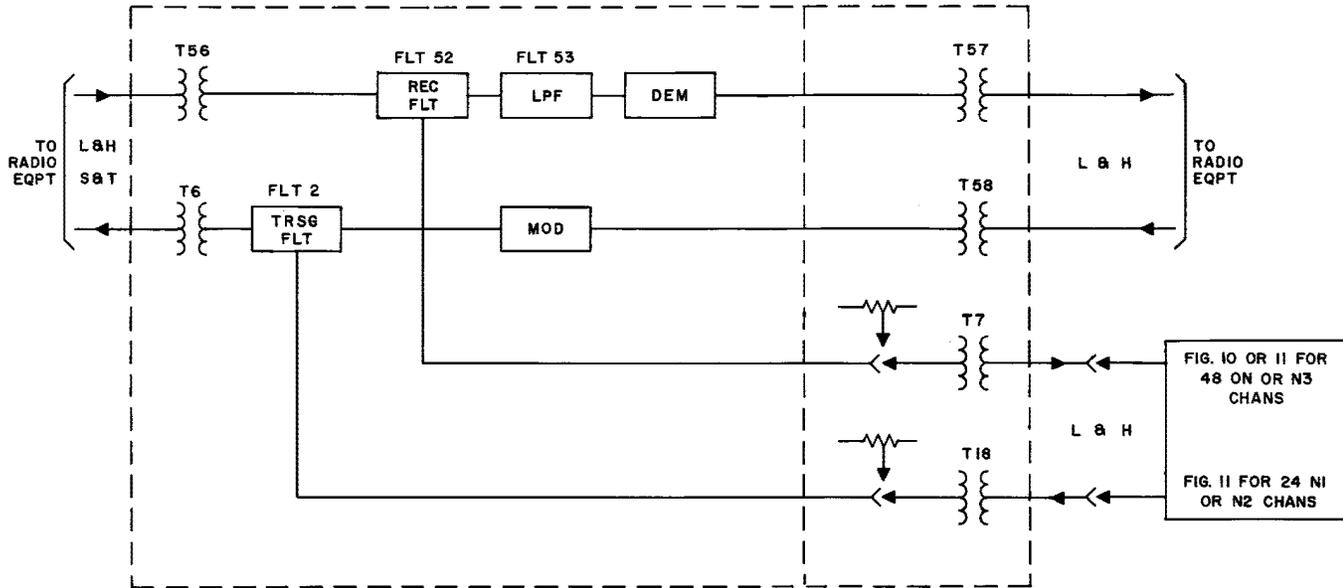


Fig. 27 — Translating *s* and *t* Groups to Low and High Groups, Blocking and Adding 48 ON or N3 or 24 N1 or N2 Channels at Radio Repeater

**3.25** Amplifier stage V2 increases the signal level to compensate for losses introduced by the modulator and filter. The signal voltage at the output of filter FLT 1 is stepped up by transformer T4 and applied to the grid of amplifier tube V2 through a portion of potentiometer R13. The potentiometer and resistor R14 in series approximately match the secondary impedance of transformer T4. The amplified signal is coupled to the combining filter through transformer T5 which matches the plate circuit impedance to the 600-ohm filter. The primary winding of transformer T5 is tapped (terminal 5) to provide feedback in the amplifier for gain stabilization. The amount of feedback is determined by the transformer winding, resistors R16 and R17, and the cathode impedance of V2. Resistor R17 also serves as a screen voltage dropping resistor.

**3.26** Space current stabilization for V2 is provided by the series combination of inductor L1 and resistor R15 in the cathode circuit. The dc resistance of L1 is low, causing most of the dc current in the cathode circuit to flow through L1 and R15. Resistor R15, therefore, largely determines the amount of dc feedback in the cathode circuit for space current stabilization.

#### 198706AA Receiving Amplifier and Demodulator Unit

**3.27** The receiving amplifier and demodulator unit consists of an oscillator, demodulator, amplifier, alarm circuit, and associated circuitry (see Fig. 31). Inputs to this unit consist of a composite signal containing up to 48 message channels in the frequency band of 316 to 548 kc. This signal is applied to the demodulator through the primary of transformer T52 and translated to the 36- to 268-kc frequency band. The demodulator is the same type of circuit as the modulator described in 3.22 and operates in a similar manner. As in the transmitting amplifier modulator unit, the oscillator circuit consists of a single-stage crystal-controlled 584-kc oscillator whose output is applied longitudinally to the demodulator through transformers T52 and T53. The input and output of the demodulator are provided with 2-db pads to improve impedance matching. Output signals from the demodulator are coupled through a 565B low-pass filter (FLT 51), transformer T54, and demodulator gain potentiometer R63 to the control grid of amplifier stage V52. The amplifier stage operates in the same way as the transmitting amplifier described in 3.25. The 565B low-pass filter (FLT 51) eliminates the unwanted upper side band of modulation (see Fig. 42). Gain from the input to the output of the

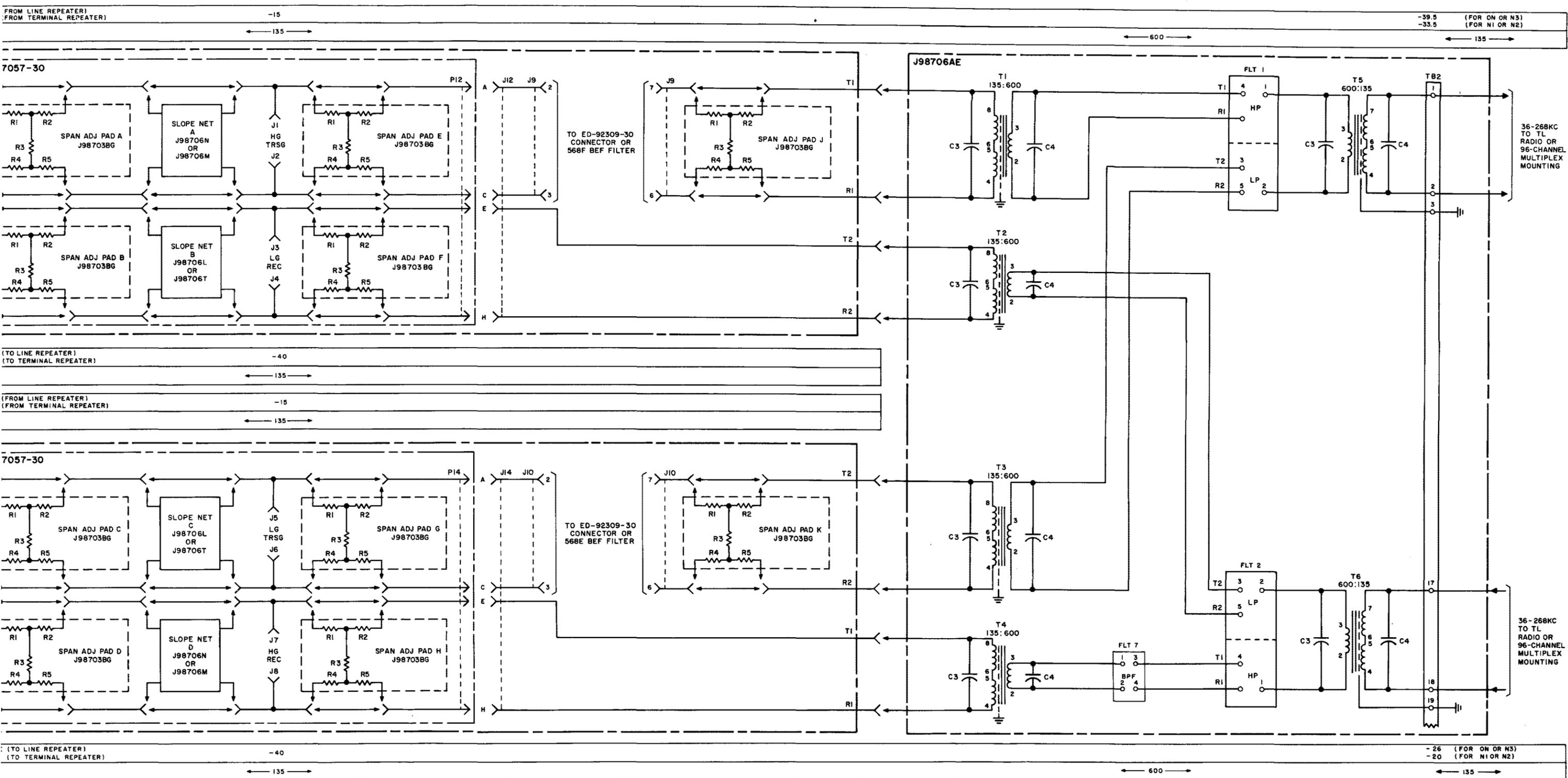
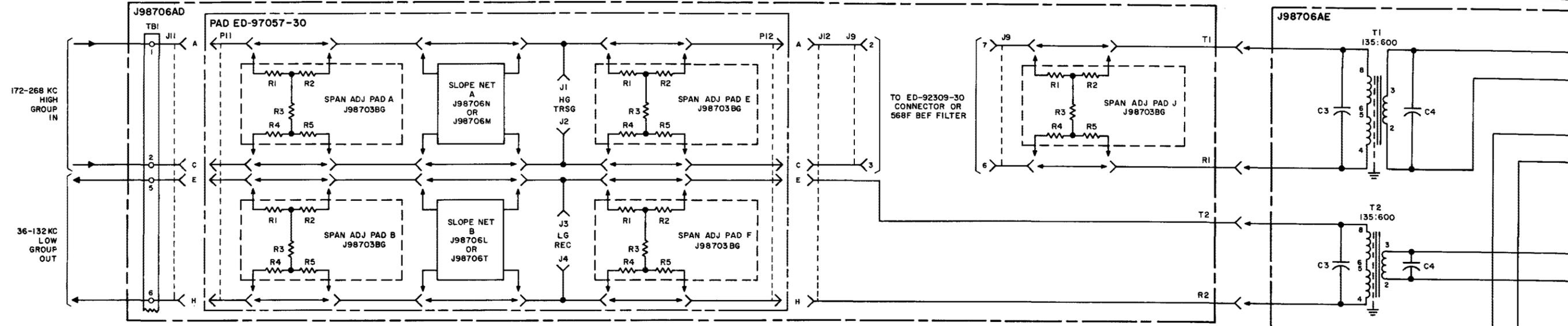


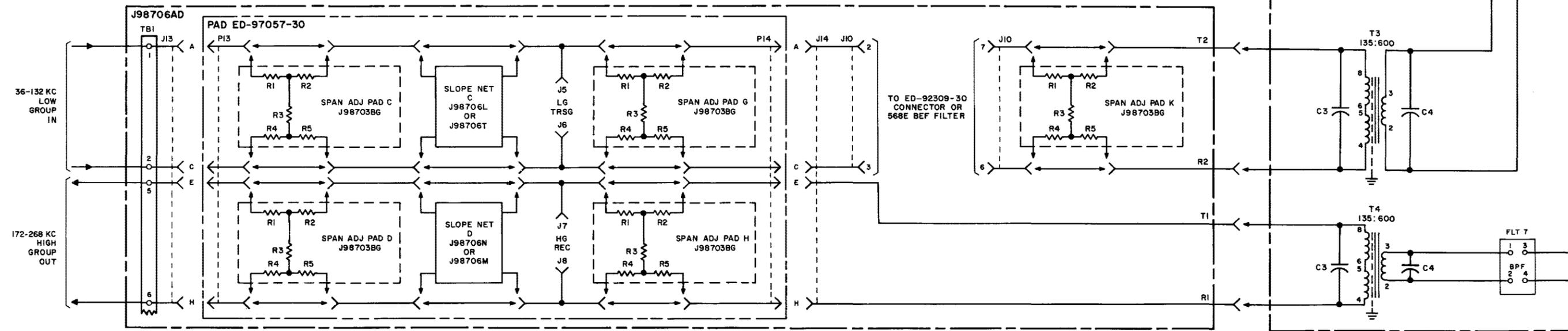
Fig. 28 — 48-Channel Combining Equipment, Schematic and Level Diagram

NOMINAL CARRIER DBM	+4 TO -3 SLOPE (FROM LINE REPEATER) +1	-15	
IMPEDANCE OHMS	← 135 →	← 135 →	← 600 →

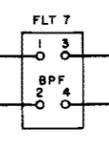


NOMINAL CARRIER DBM	-43 TO -50 SLOPE (TO LINE REPEATER) -46	-40
IMPEDANCE OHMS	← 135 →	← 135 →

NOMINAL CARRIER DBM	-5 TO -12 SLOPE (FROM LINE REPEATER) -8	-15
IMPEDANCE OHMS	← 135 →	← 135 →



NOMINAL CARRIER DBM	-52 TO -59 SLOPE (TO LINE REPEATER) -55	-40	
IMPEDANCE OHMS	← 135 →	← 135 →	← 600 →



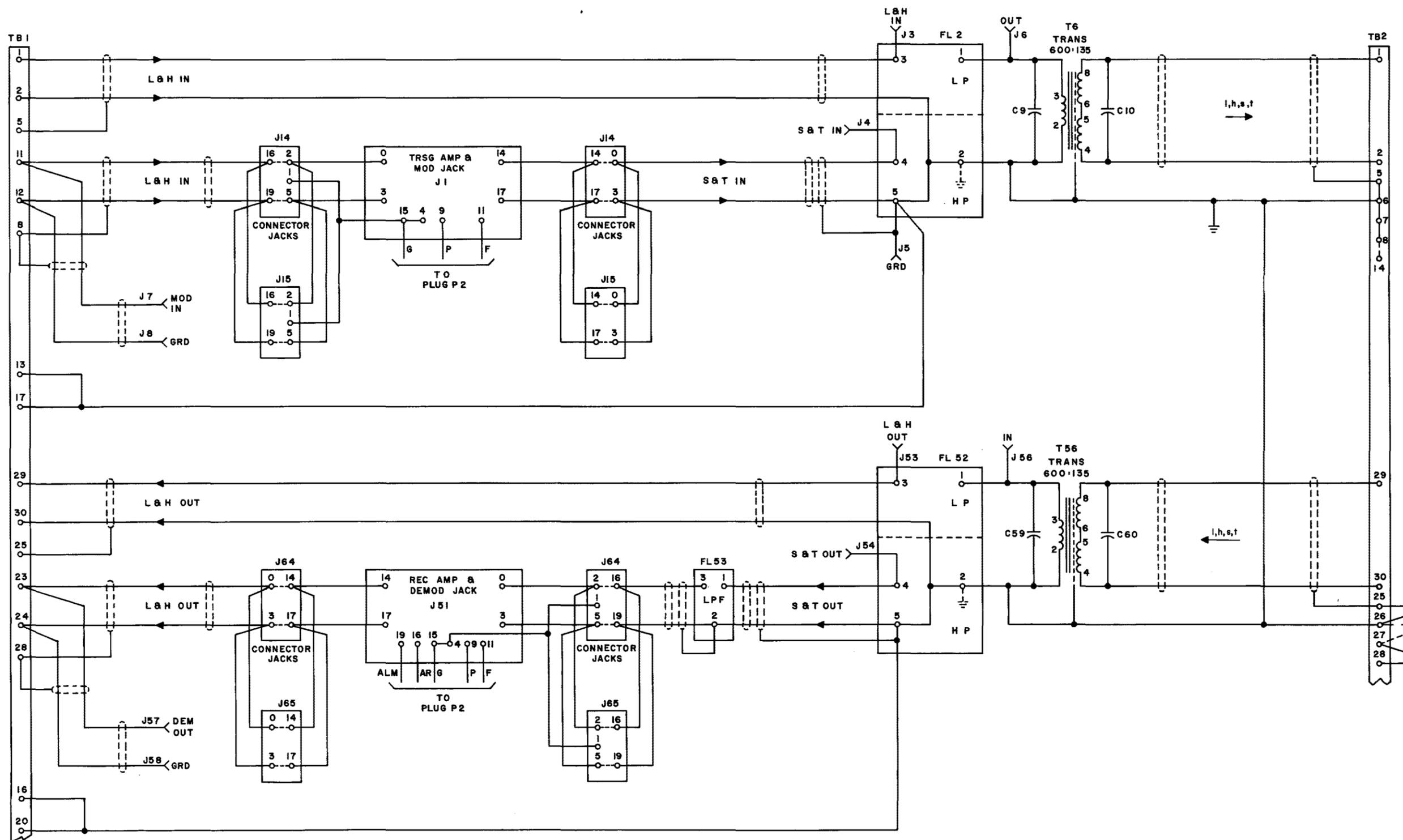


Fig. 29—J98706U, List 4 96-Channel Multiplex Mounting, Schematic

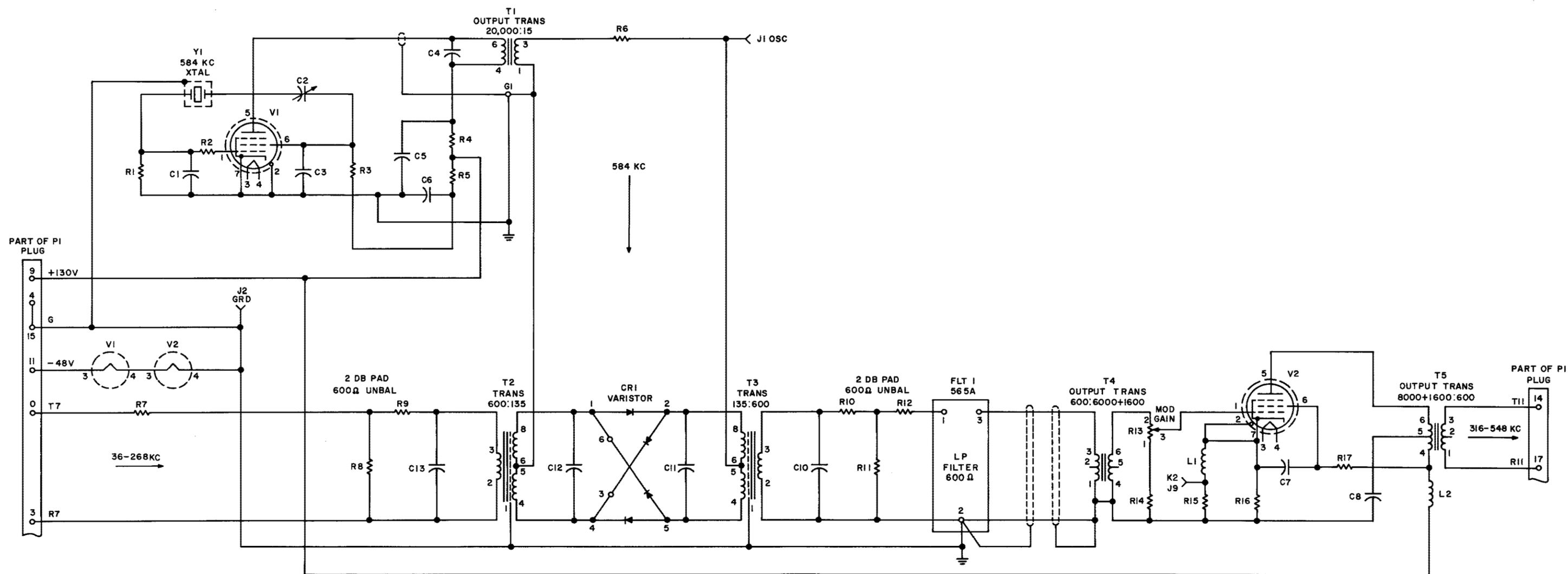


Fig. 30 — J98706AB Transmitting Amplifier and Modulator, Schematic

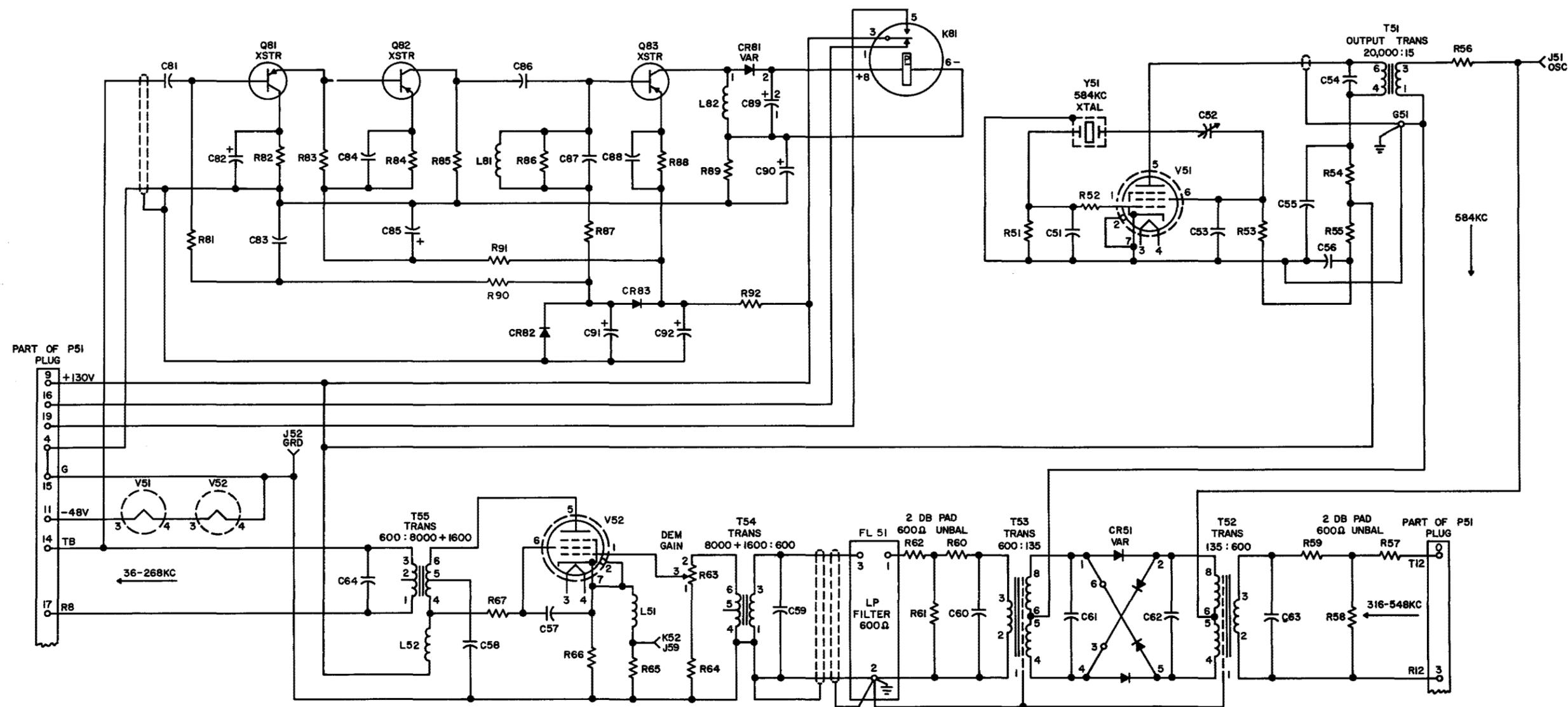


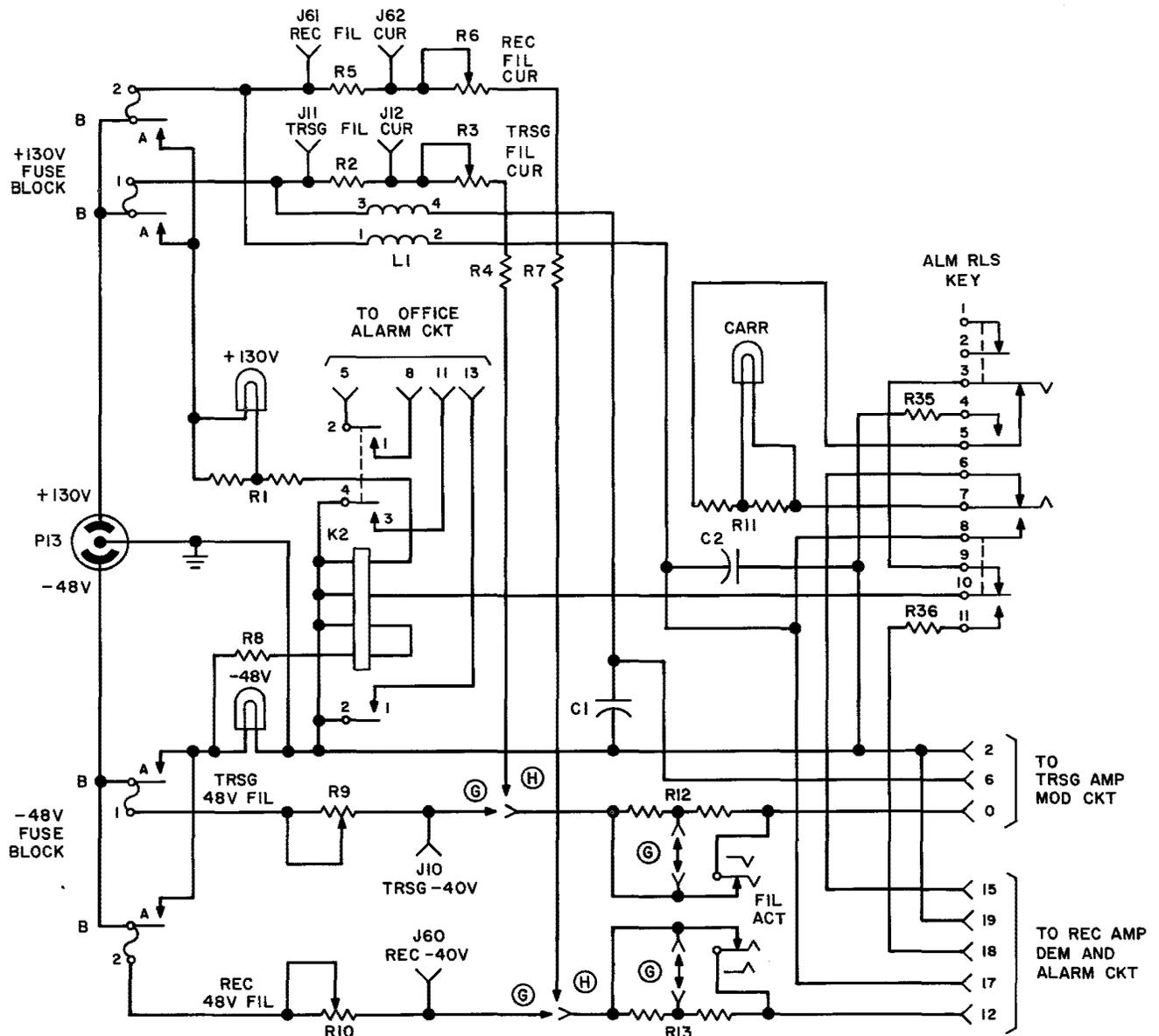
Fig. 31 — J98706AA Receiving Amplifier and Demodulator, Schematic

receiving amplifier and demodulator unit may be adjusted to approximately unity by means of the DEMOD GAIN potentiometer. The alarm circuit is a monitoring arrangement that indicates the presence or absence of the carrier signal and consists of a relay and a 3-stage direct-coupled transistorized amplifier. The carrier signal is monitored at the output of transformer T55 and applied to the first stage of the amplifier. This signal is amplified and the resulting output is used as coil voltage to hold relay K81 in the energized position. Loss of the carrier signal removes the hold voltage, allowing K81 to become

de-energized and apply +130 volts battery from the power supply to the portion of the carrier alarm circuit contained in the power supply and alarm unit.

**J98706AC Power Supply and Alarm Unit**

**3.28 Power Circuits:** The power supply and alarm unit consists of two fuse blocks, an alarm relay, and associated circuitry (see Fig. 32). Power is applied to the power supply circuit from either a -48 and +130 volt supply or



**Fig. 32 — J98706AC Power Supply and Alarm Unit, Schematic**

from a +130 volt supply only, through connector P13. When the +130 volt supply is used for plate voltage and the -48 volt supply is used for heater voltage, "G" wiring option is used. The TRSG 48V FIL potentiometer R9 and REC 48V FIL potentiometer R10 in the -48 volt circuit are provided to adjust the heater voltage to -40 volts. Inductor L1 and capacitors C1 and C2 in the +130 volt plate voltage circuit provide power supply filtering for the transmitting and receiving circuits. When +130 volt power is used for both plate and heater voltages, "H" wiring option is used. Resistors R4 and R7, in the heater circuit, are used as voltage dropping resistors to reduce the +130 volts for use as heater voltage. The TRSG potentiometer R3 and REC potentiometer R6 are provided to adjust the heater voltage in each circuit.

**3.29 Alarm Circuits:** Loss of the carrier signal causes relay K81 in the receiving amplifier and demodulator unit to become de-energized and apply +130 volts through contacts of the alarm release (ALM RLS) key and resistor R11 to a winding of relay K2. Relay K2 becomes energized and sounds the office alarm giving the indication that the carrier signal is no longer being received. When an alarm condition occurs, the ALM RLS key is manually operated to release K2, which turns off the office alarm. However, the carrier (CARR) lamp remains lighted and is now under control of the ALM RLS key. The CARR lamp indicates visually that the circuit has been alarmed. When the alarm condition is cleared, alarm relay K81 in the receiving amplifier demodulator unit operates and applies +130 volt battery through contacts of the ALM RLS key and resistor R36 to operate K2 and sound the office alarm. The ALM RLS key is then manually restored to normal to extinguish the CARR lamp and release K2, thus turning off the office alarm.

**3.30** Both the +130 and the -48 volt supply circuits contain fuse blocks and fuse alarm circuitry. Operation of a fuse in the +130 or -48 volt fuse block will supply +130 volt battery to the winding of K2, energizing the alarm circuitry. Lamps are also provided in both the +130 and -48 volt circuits to give a visual indication that a fuse has operated.

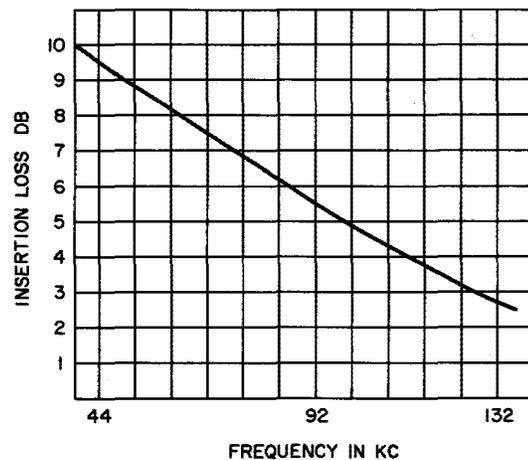
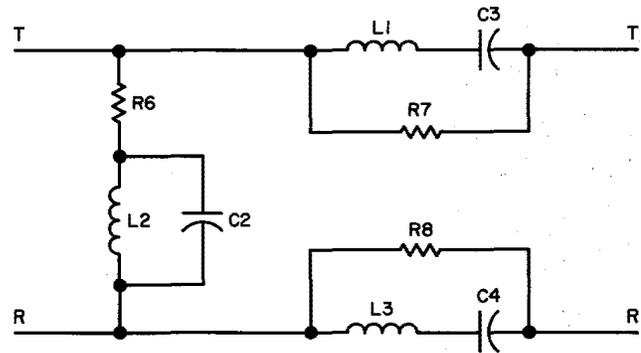
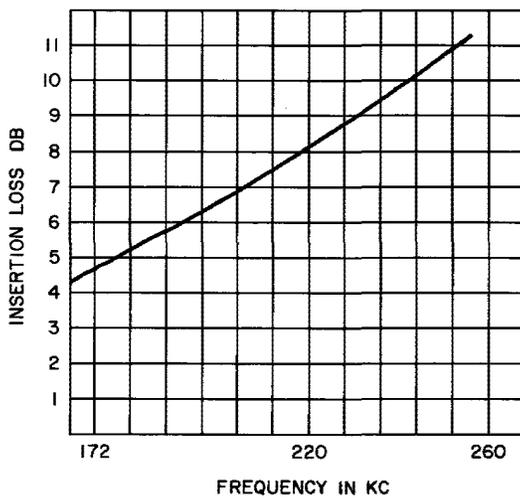
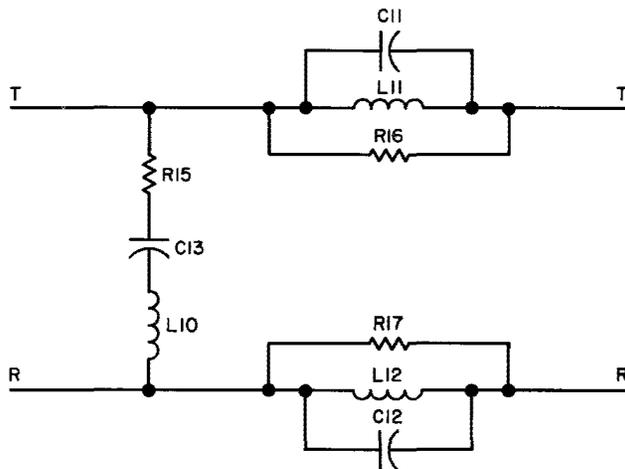


Fig. 33 — J98706L —7 db Slope Network (Low Group), Schematic and Insertion Loss Characteristic

#### Pad Circuits

**3.31** The pad circuit shown in Fig. 43, which is a combination of a splitting pad and an attenuator pad, is used at radio repeaters. The impedance of the pad is 600 ohms and presents about 13 db of loss in the through radio path. This circuit is used in the 24-channel paths to connect ON or N3 systems on a bridging basis for adding and dropping channels.

**3.32** The pad circuit shown in Fig. 44 is a splitting pad that is used at radio repeaters. The impedance of the pad is 135 ohms and presents about 13.4 db of loss in the through radio path and the dropping or adding path. These circuits are used in the 48-channel paths to connect



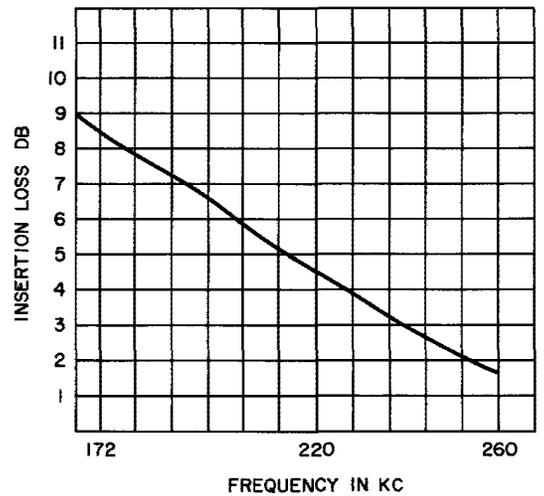
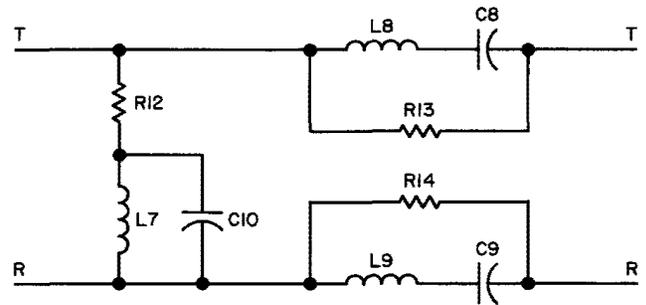
**Fig. 34 — J98706M —7 db Slope Network (High Group), Schematic and Insertion and Loss Characteristic**

ON or N3 systems on a bridging basis for adding or dropping channels.

**3.33** The through pad circuit shown in Fig. 45 is a 600-ohm pad that is used at radio repeaters in through paths where channels are not dropped or added. Each pad presents about 13.0 db of loss.

**4. TESTING AND MAINTENANCE FEATURES**

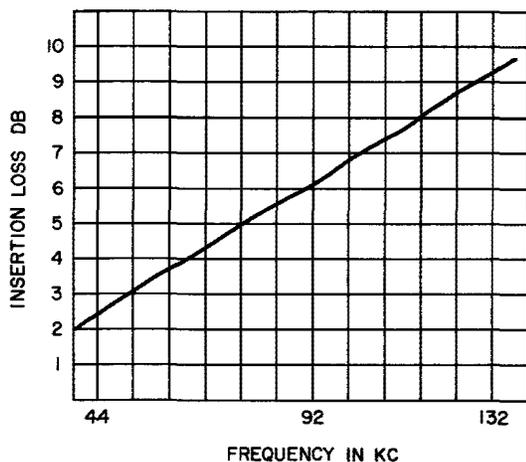
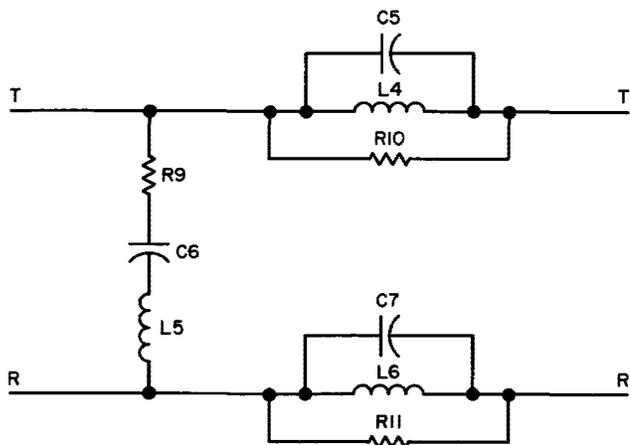
**4.01** The 48-channel combining and 96-channel multiplex equipment contain test points which permit periodic checks facilitating maintenance



**Fig. 35 — J98706N +7 db Slope Network (High Group), Schematic and Insertion Loss Characteristic**

nance of the equipment. The 96-channel multiplex equipment also contains controls and indicators which enable adjustments and alarm indications within the equipment.

**4.02** The alarm and order-wire equipment mounted with the combining equipment and ON repeaters in outdoor TL radio cabinets provides test power and facilities for communications between the radio site and the central office. The voice path permits coordination of maintenance activities at the two sites. Alarms are not originated at these nonpowered repeater sites; however, the alarm pair is extended to the site to complete the test power transmission circuit. Powered repeater sites in the line toward the central office use the alarm pair to transmit power or fuse failure alarms to the central office.



**Fig. 36 — J98706T +7 db Slope Network (Low Group), Schematic and Insertion Loss Characteristic**

**4.03** The test power appearing at the repeater site is transmitted over the order-wire and alarm pairs by means of a simplex connection. This power is used to operate the 2M repeater switching set which allows in-service replacement of the operating ON repeaters. When necessary, the switching set is connected in the circuit so that the operating repeater is multiplied by an identical repeater in the switching set. The operating repeater may then be removed and a new one installed without interrupting service.

## 5. DRAWINGS

### A. SD Drawings (Not Attached)

- SD-95189-01 — LL and HH ON Repeater Circuit for Radio Applications
- SD-95196-01 — Group 1 ON1 Junction, Application Schematic
- SD-95215-01 — LL and HH ON Repeater Circuit
- SD-95216-01 — LL and HL ON Repeater Circuit
- SD-95217-01 — LH and LL ON Repeater Circuit
- SD-95218-01 — HL and LL ON Repeater Circuit
- SD-95221-01 — HH and LL ON Repeater Circuit for Radio Applications
- SD-95178-01 — HL N Repeater Circuit
- SD-95179-01 — LH N Repeater Circuit
- SD-95224-01 — Slope Networks, Span Pads, and Artificial Line Circuits
- SD-97056-01 — N and ON Carrier Telephone Combining and Multiplex Circuits, Application Schematic
- SD-97005-01 — Carrier to Radio Multiplex, Application Schematic
- SD-97006-01 — Transmitting and Receiving Amplifier-Modulator Circuits for 96-Channel Carrier to Radio Multiplex

### B. ED Drawings (Not Attached)

- ED-92719-30 — N1 Carrier Telephone — HL Repeater Equipment
- ED-92720-30 — N1 Carrier Telephone — HL Repeater Equipment
- ED-92721-30 — N1 Carrier Telephone — LH Repeater Equipment
- ED-92722-30 — N1 Carrier Telephone — LH Repeater Equipment

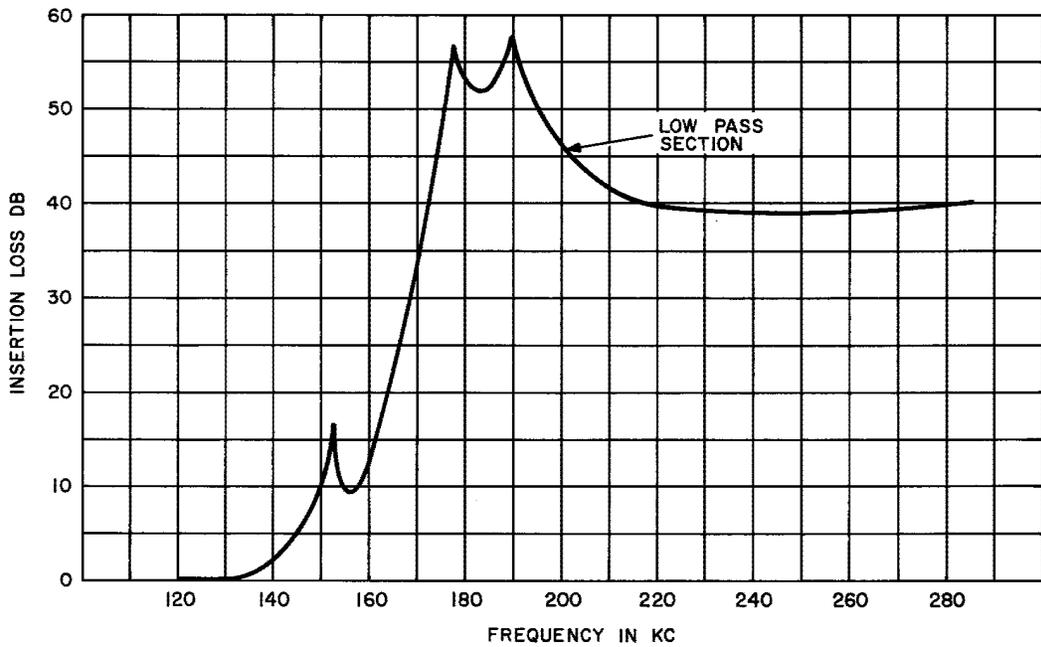
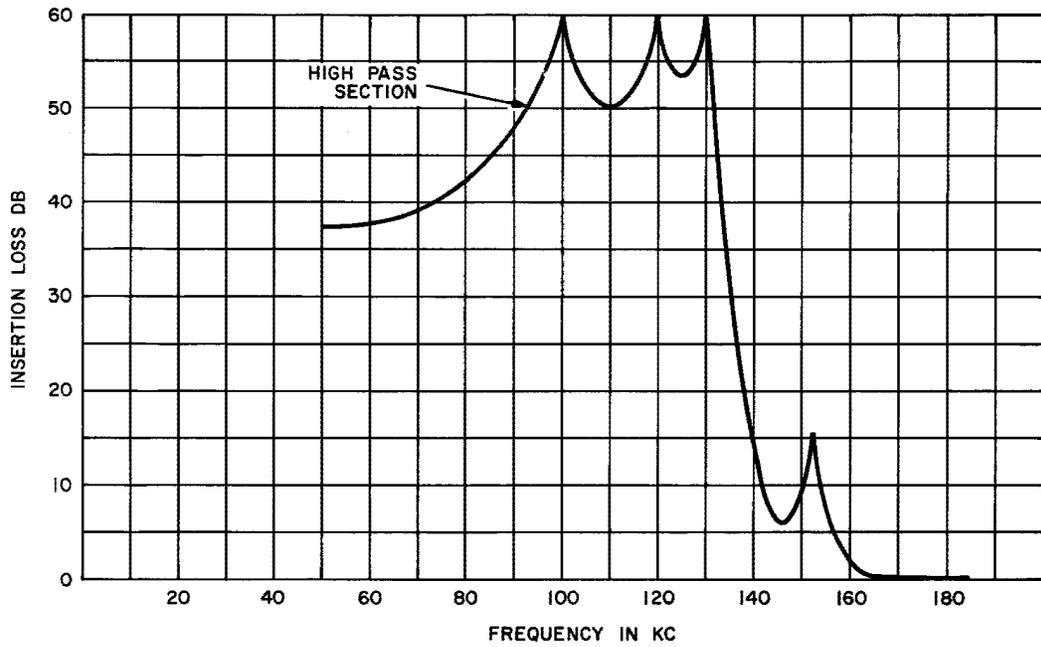


Fig. 37 — 564A Filter (FLT 1 through FLT 6), Insertion Loss Characteristic

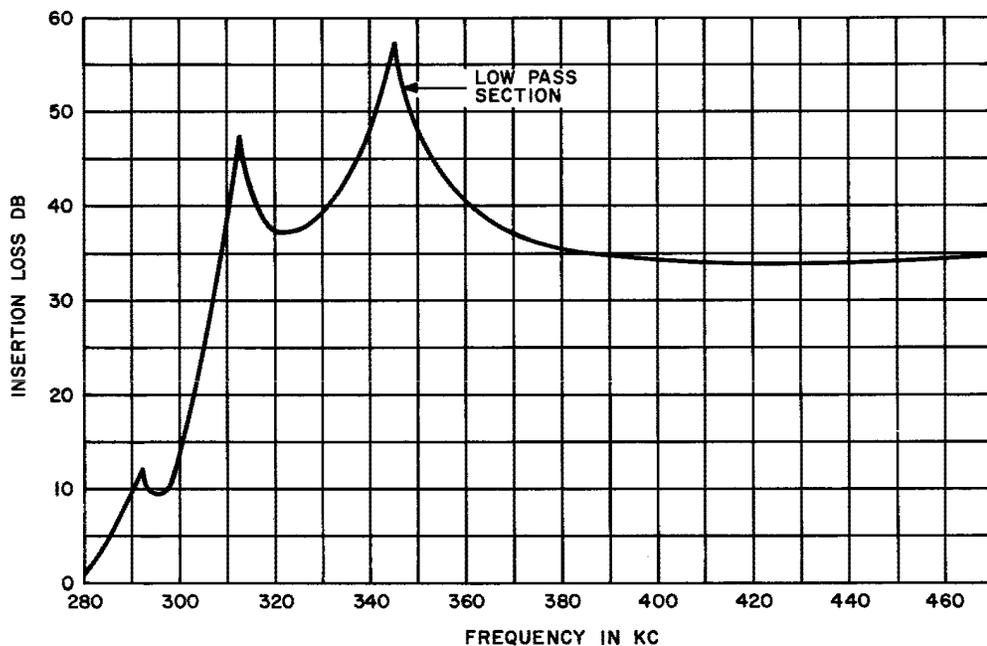
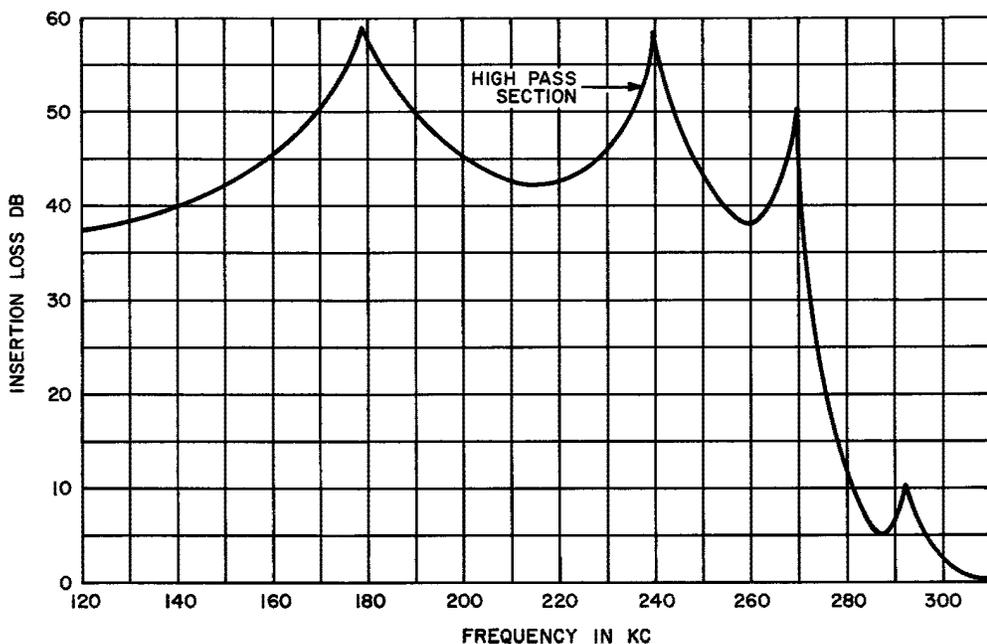


Fig. 38 — 564B Filter (FLT 2, FLT 9, FLT 10, FLT 11, FLT 12, and FLT 52), Insertion Loss Characteristic

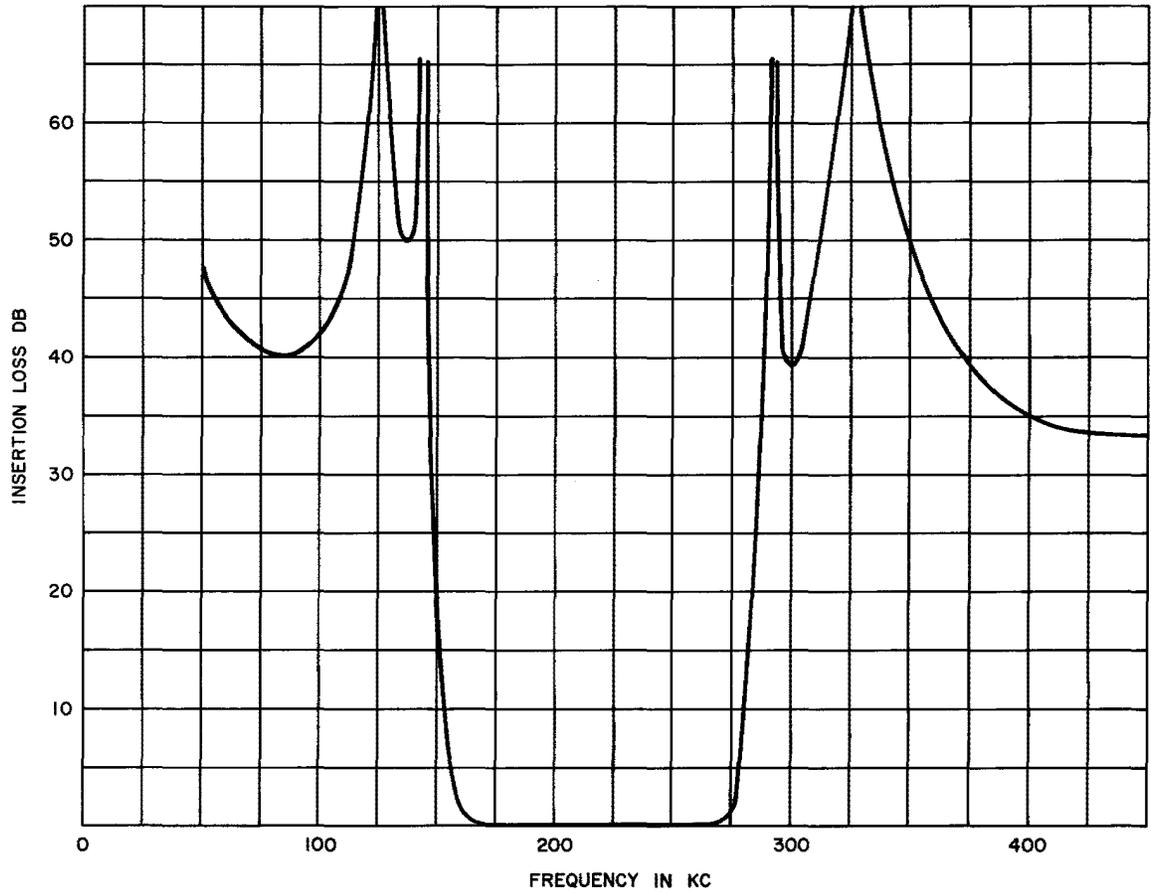


Fig. 39 — 564E Filter (FLT 7), Insertion Loss Characteristic

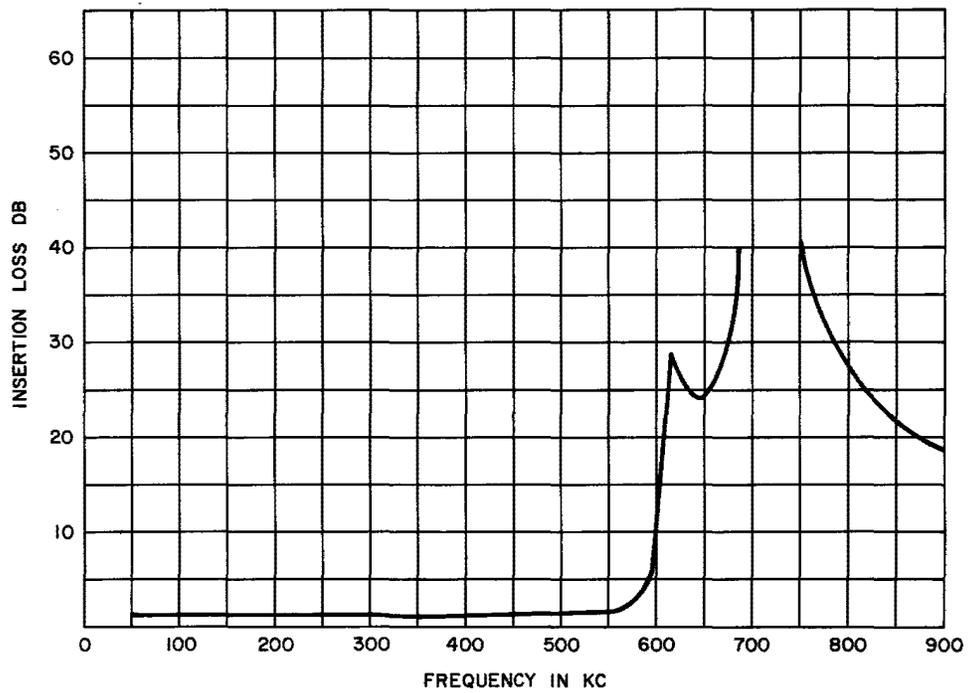


Fig. 40 — 534C Filter (FLT 53), Insertion Loss Characteristic

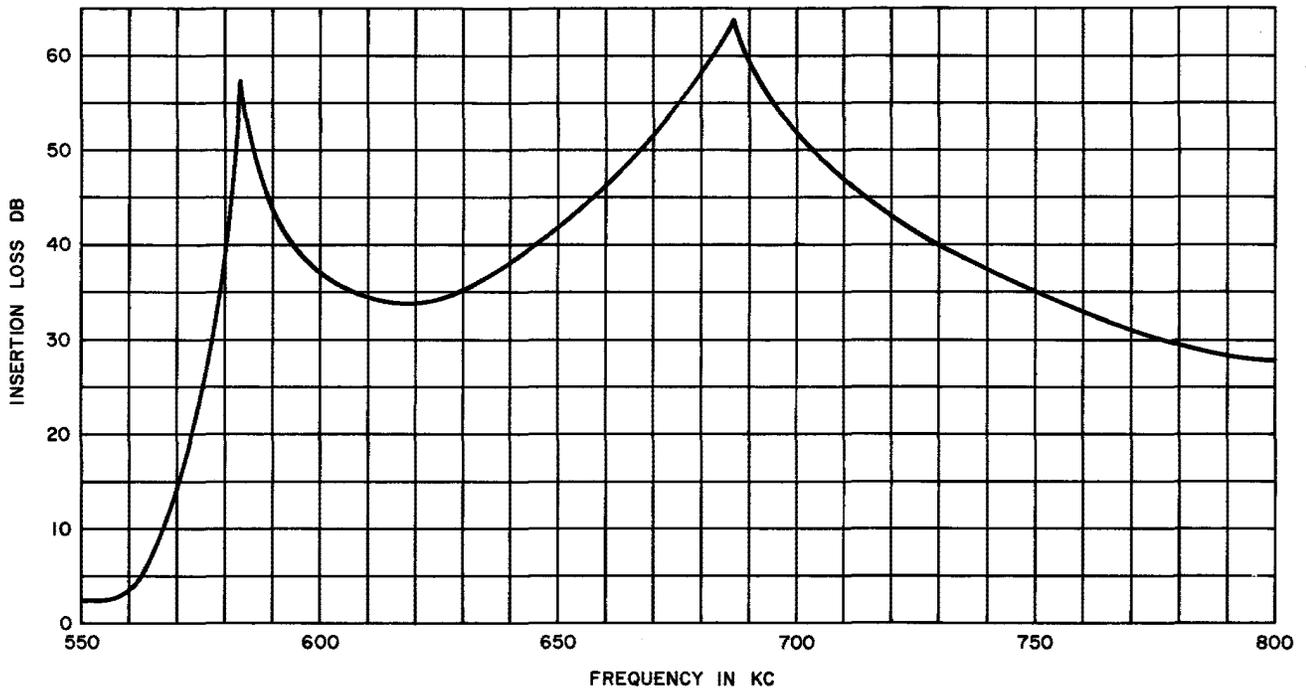


Fig. 41 — 565A Filter (FLT 1), Insertion Loss Characteristic

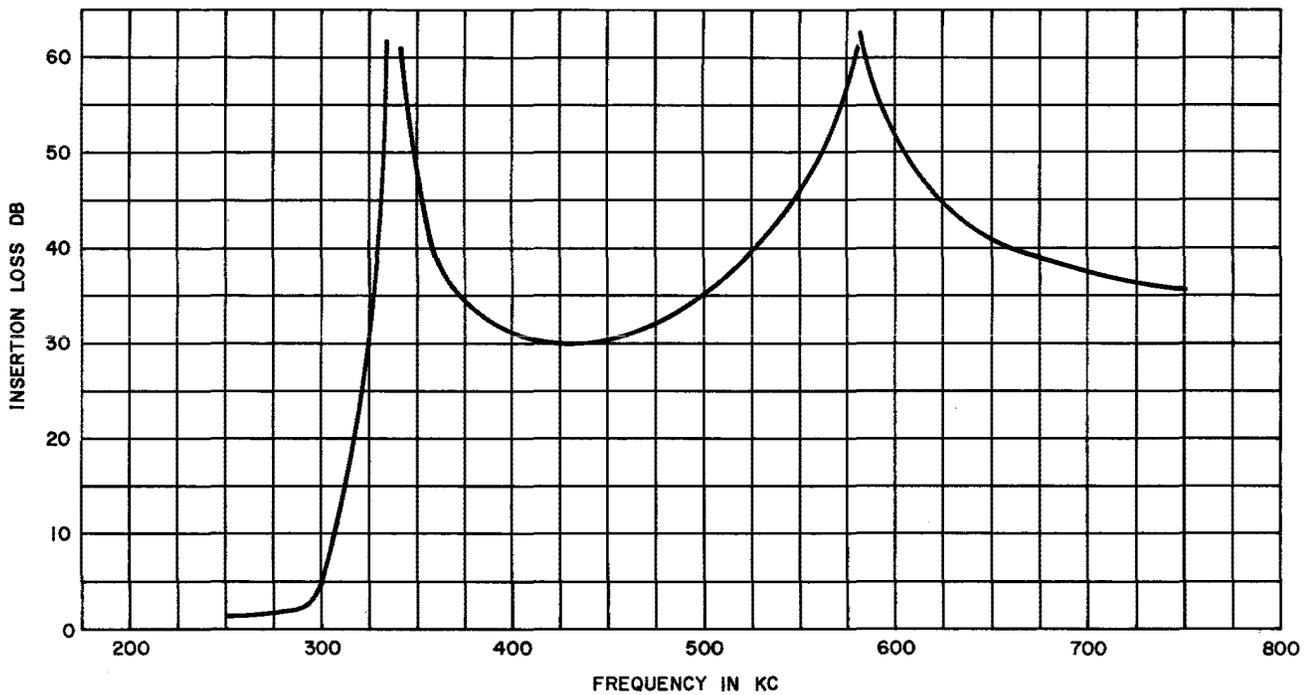


Fig. 42 — 565B Filter (FLT 51), Insertion Loss Characteristic

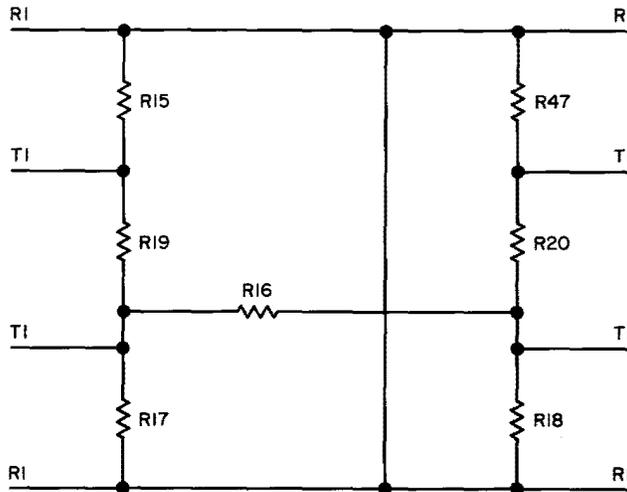


Fig. 43 — Split Pad Network for Dropping and Adding Circuits by Bridging

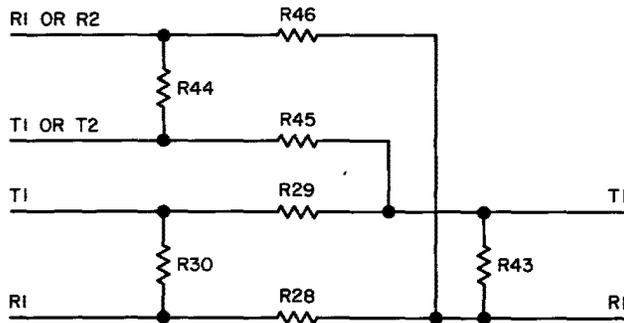


Fig. 44 — Split Pad Network for Adding Circuits by Bridging

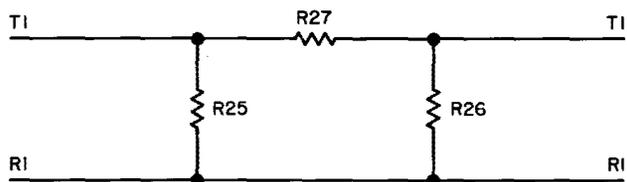


Fig. 45 — Through Pad Network

ED-92742-30 — O and ON Carrier Telephone — O1 Carrier Repeater Equipment — ON1 Carrier Junction Equipment

ED-92764-30 — LL W-E Repeater Subassembly

ED-92765-30 — LL E-W Repeater Subassembly

ED-92844-30 — HH W-E Repeater Subassembly

ED-92845-30 — HH E-W Repeater Subassembly

ED-92846-30 — LL W-E Repeater Subassembly

ED-92860-30 — LL E-W Repeater Subassembly

ED-95073-31 — Oscillator-Power Regulator Subassembly

ED-97011-10 — 96-Channel Carrier-to-Radio Multiplex, Typical Bay Arrangements

ED-97010-10 — 96-Channel Multiplex Bay Cabling

ED-97084-30 — Common System N or ON Carrier Telephone Specifications for N or ON Carrier to TL Radio Combining Equipment for use in Central Offices

ED-97058-30 — Common System N or ON Carrier Telephone Specification for 12- or 24-Channel N or 24- or 48-Channel ON ON/TL Combining Equipment

ED-97091-30 — Common Systems N-Type Carrier Telephone Specification for Order-Wire Equipment for Use in a TL Radio Cabinet

ED-97057-30 — Common Systems N or ON Carrier Telephone Specification for N or ON Carrier to TL Radio Combining Panel Pad Unit