TYPE ON CARRIER TELEPHONE SYSTEMS

MULTIPLEXING CIRCUITS FOR USE WITH RADIO SYSTEMS

DESCRIPTION

CONTENTS

1. GENERAL

A. Scope

1.01 This section describes the equipment used for combining and multiplexing up to 96 voice channels from ON carrier systems on a TJ or similar radio system. 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 frequencies. Means are provided for dropping and adding one or more 24-channel ON2 groups or 20-channel ON1 groups at intermediate radio repeaters. The equipment described in this section consists of the following basic units.

(a) A J98706W 48-Channel Combining Panel used at radio terminals or radio repeater points to combine or separate up to 48 channels of ON2, or 40 channels of ON1.

(b) The J98706U 96-Channel Multiplex Equipment used with combining panel to combine or separate up to 80 channels of ON1 or 96 channels of ON2.

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

B. Purpose of Equipment

1.02 The 48-channel combining equipment and 96-channel multiplex equipment combine and separate the outputs of up to four ON carrier systems to make more efficient use of TJ radio system capacity. The equipment is mounted in bays at ON-type terminals, ON junctions, or at radio repeater sites and provides two

directions of transmission simultaneously. In one direction of transmission the 48-channel combining panel combines carrier information from ON systems and applies the composite signal directly to radio equipment or to the 96-channel multiplex equipment. The 96-channel multiplex equipment combines and modulates the output of two 48-channel combining panels and applies the composite signal to a TJ radio system. In the opposite direction of transmission the multiplex equipment separates and demodulates the output of a TJ radio system and applies the resultant signals to two 48-channel combining panels. The two 48-channel combining panels further separate the signals from the multiplex equipment or signals from a radio and apply the resultant signals to an N-type cable or ON terminal via repeaters which provide the necessary frequency coordination between the carrier and radio systems.

C. System Descriptions

1.03 The message channels from ON carrier systems are combined into composite signals by the carrier terminal equipment and are connected to the 48-channel equipment in the form of low- and high-group frequency bands. The low- and high-group signals may be connected directly to the 48-channel equipment from ON1 or ON2 terminal equipment or from a terminal over an N-type line.

ON1 Carrier System

1.04 The ON1 carrier system employs a low-frequency band of 40 to 136 kc and a high-frequency band of 168 to 264 kc. The low band is made up of five groups, each containing four message channels. The high band comprises five similar groups modulated and inverted into the 168- to 264-kc frequency band. The high- and low-frequency bands each provide a frequency band for the transmission of 20 two-way message channels. When the ON1 system is used in radio applications, a 20-channel system may be assigned at a given station to high-group transmitting and low-group receiving positions on the radio, or alternatively, the assignment can be low-group transmitting and high-group receiving. When two ON1 systems are combined to provide 40-channel capability, one 20-channel system will be transmitted in the low group and the other 20-channel system will be transmitted in the high group. The systems must have opposite transmitting and opposite receiving assignments because the combining equipment is passive and cannot modulate the frequency groups. When four ON1 systems are combined, 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 then be multiplexed with another high-low combined group to provide up to 80 message channels for transmission over a TJ radio system.

TABLE A

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

ON2 Carrier System

1.05 In the ON2 carrier 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, each comprising four message channels. A complete ON2 system consists of 24 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. ON2 systems can be combined and multiplexed in the same manner as ON1 systems, enabling transmission of up to 96 message channels (four ON2 systems) over a TJ radio system. The limits of the various frequency bands in the ON2 system are listed in Table B.

TABLE B

ON2 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-channel combining equipment and 96-channel multiplex equipment are normally mounted together on a bay framework near the ON terminal equipment at radio terminals and repeaters. To maintain system flexibility, facilities are provided to wire in optional apparatus in the combining panels and some optional plug-in equipment for the multiplex units. A photograph of this equipment is shown in Fig. 1.

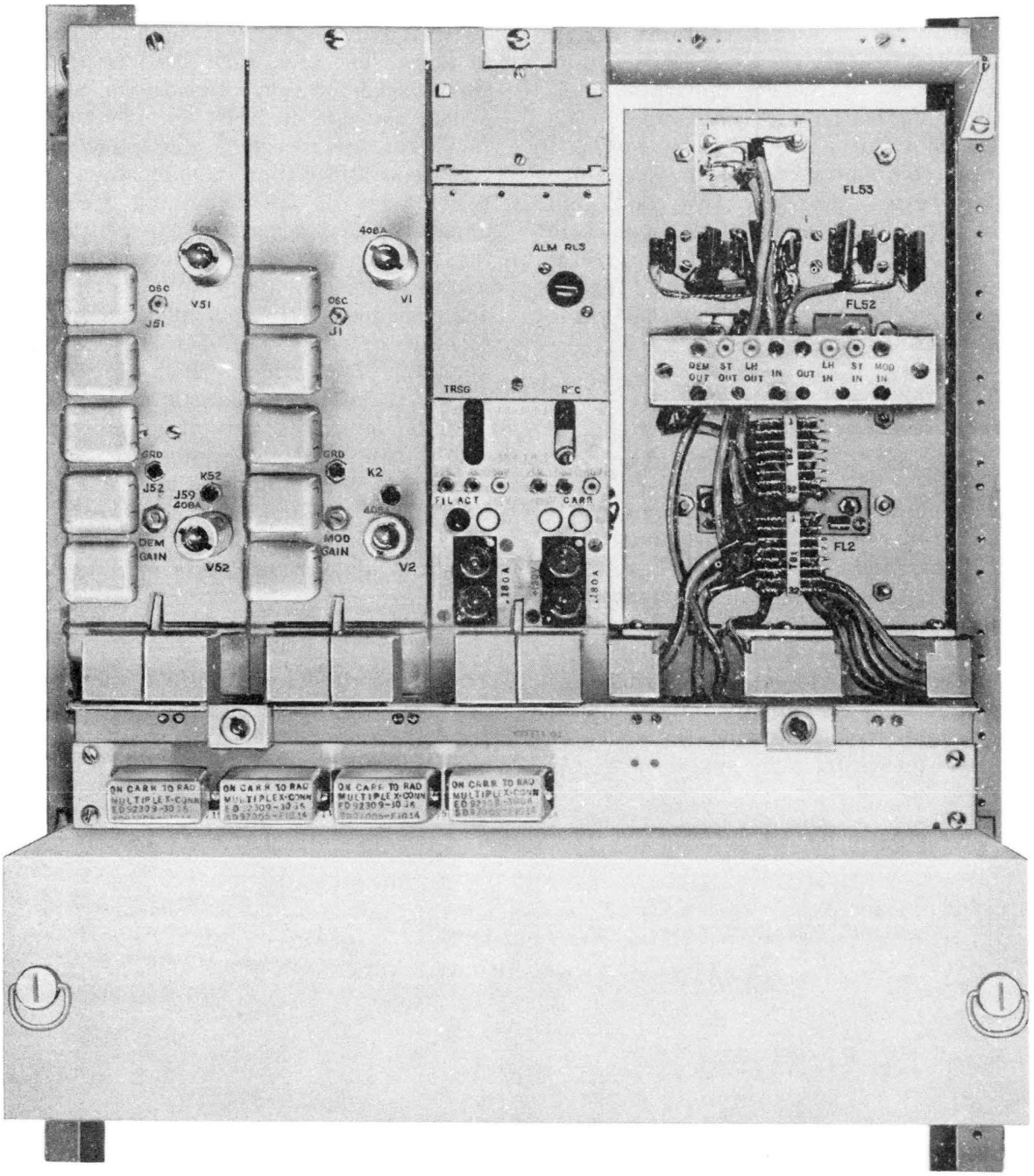


Fig. 1 — 48-Channel Combining Panel and 96-Channel Multiplex Equipment Mounted in Typical Bay Framework (Covers Removed)

B. 48-Channel Combining Panel

2.02 The J98706W 48-channel combining panel (see Fig. 2) contains filters, pads, and transformers used to combine or separate up to 48 channels associated with ON carrier systems. When an N-type line is connected to the radio system, slope networks are also mounted on this unit. The basic panel, List 1 contains wiring terminal strips, mounting facilities, cover, cover supports, test jacks, and other apparatus common to all configurations of the panel. The 48-channel combining panel may be equipped with different combinations of pads and slope networks to provide necessary level and gain slope coordination between the carrier and radio systems. The panel is constructed of sheet metal and is mounted on a standard 19-inch bay framework. The equipment occupies the space of three 1-3/4 inch mounting plate spaces.

C. 96-Channel Multiplex Equipment

2.03 The 96-channel multiplex equipment is made up of the J98706U 96-channel multiplex mounting and three plug-in units: a J98706AA receiving amplifier and demodulator, a J98706AB transmitting amplifier and modulator, and a J98706AC power supply and alarm circuit. The multiplex equipment is constructed of die-cast aluminum and is mounted on a standard 19-inch bay framework occupying the space of nine 1-3/4 inch mounting plate spaces.

96-Channel Multiplex Mounting

2.04 The 96-channel multiplex mounting contains apparatus for connecting ON1 or ON2 signals to a radio system. The basic J98706U, List 1 mounting comprises a die-cast aluminum shelf and a supplementary fabricated jack mounting. The supplementary jack mounting provides switching jacks for in-service switching of the transmitting and receiving plug-in units. The aluminum shelf is provided with three jacks for connection to the plug-in units. Where the plug-in units are not employed, the jacks for the receiving and transmitting units require strapped plug-in connectors. An upright panel takes up the remaining shelf space for apparatus that is part of the multiplex mounting. Behind this panel are transformers, filters, monitoring jacks, and terminal strips. Facilities are provided on the multiplex mounting for attaching optional J98706U, List 2 impedance matching transformers which are required when part of the message channels are carried through a single multiplex unit at a radio repeater or where two multiplex units are connected together but not mounted in the same or adjacent bays. Two J98706U, List 3, 600-ohm resistors may also be ordered for terminating unused low- and high-group inputs or outputs.

Receiving Amplifier and Demodulator

2.05 The receiving amplifier and demodulator demodulates the *s* and *t* frequency band from the radio system into a low- and high-frequency band for transmission to a 48-channel

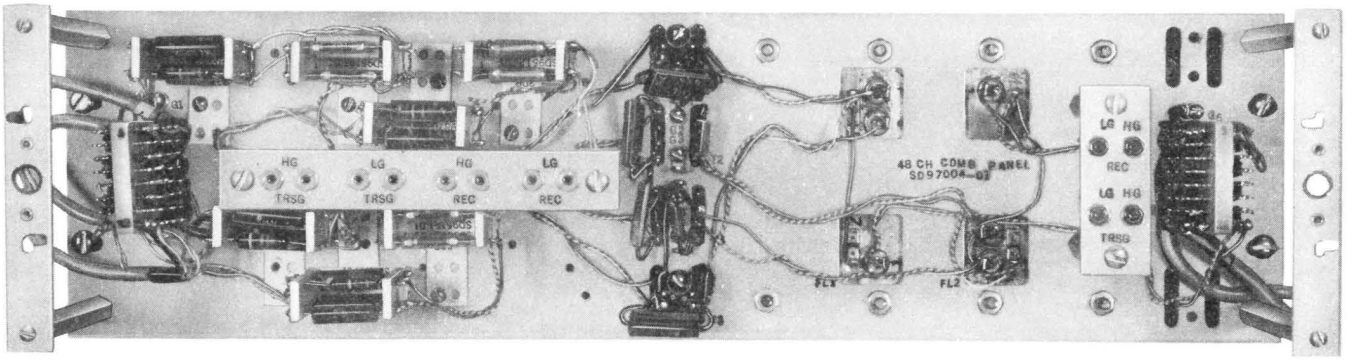


Fig. 2 — 48-Channel Combining Panel (Cover Removed)

combining panel. The unit contains a 584-kc oscillator, a demodulator, a low-pass filter, and an amplifier. Also included in the receiving amplifier and demodulator is a 3-stage transistorized alarm circuit, which monitors the received carrier power, and if there is a transmission failure, operates a relay alarm circuit.

2.06 The receiving amplifier and demodulator is shown in Fig. 3. The chassis is die-cast aluminum, approximately 3-3/8 inches wide, 13 inches high, and 7-9/16 inches deep. The front panel provides three test jacks and a demodulator gain control.

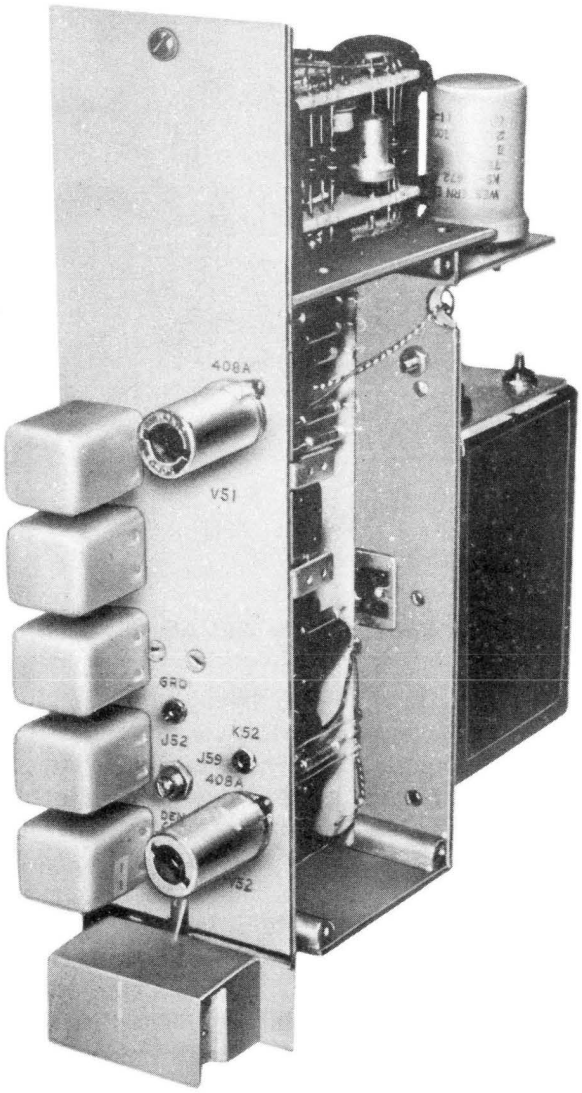


Fig. 3 — Receiving Amplifier and Demodulator

Transmitting Amplifier and Modulator

2.07 The transmitting amplifier and modulator modulates the incoming low- and high-frequency band from a 48-channel combining panel into an *s* and *t* frequency band for transmission to a radio system. The circuit is very similar to the receiving amplifier and demodulator and contains a 584-kc oscillator, a modulator, and an amplifier.

2.08 The transmitting amplifier and modulator is shown in Fig. 4. The chassis is die-cast aluminum, approximately 3-3/8 inches wide, 13 inches high, and 7-9/16 inches deep. The front panel provides three test jacks and a modulator gain control.

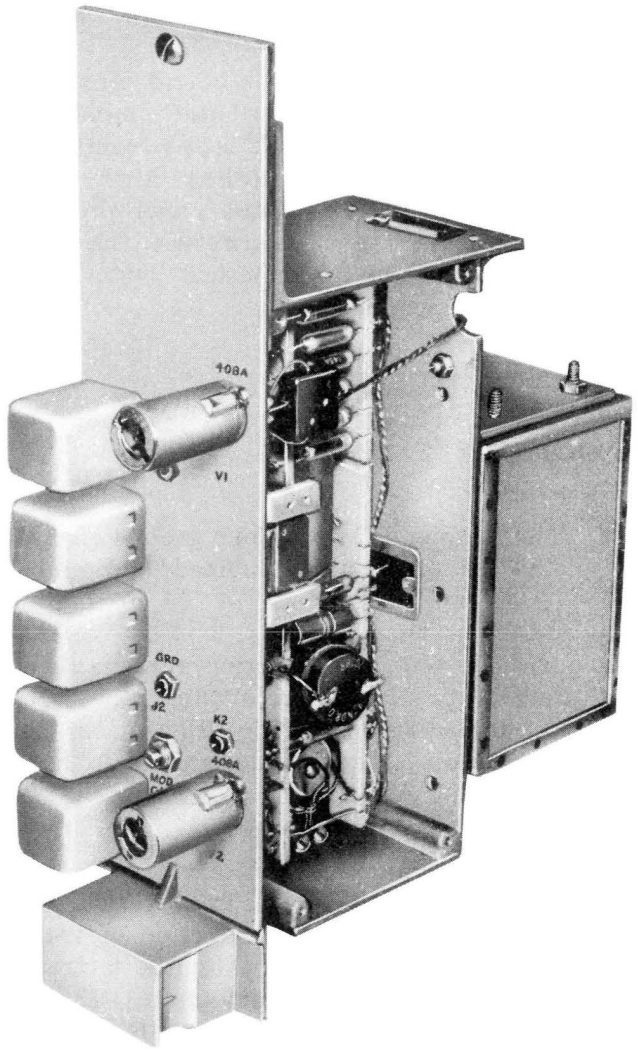


Fig. 4 — Transmitting Amplifier and Modulator

Power Supply and Alarm Circuit

2.09 The power supply and alarm circuit provides +130 volt and −48 volt or +130 volt power only, for the transmitting and receiving units. Connection to external power is through a 3-conductor plug and receptacle. Included in this unit is an alarm circuit for activating office alarms.

2.10 The power supply and alarm circuit is shop wired for both +130 volt and −48 volt operation (G wiring). In applications where −48 volt power is unavailable, +130 volts may be employed for both plate and filament circuits. Optional connections for this purpose (H wiring) can be provided by the installer.

2.11 The power supply and alarm circuit is shown in Fig. 5. The unit employs a die-cast aluminum chassis, approximately 3-3/8 inches wide, 13 inches high, and 6-5/16 inches deep. The front panel provides test jacks, alarm lamps, alarm-type fuses, an alarm release key, a filament test switch, and filament adjustments.

3. CIRCUIT DESCRIPTION

A. General

3.01 The manner in which four groups of message channels are combined and multiplexed for transmission over a TJ or similar radio system is shown in Fig. 6. For explanation purposes, four ON2 carrier systems, each containing up to 24 message channels, are used as typical input signals in the illustration. For convenience the systems are designated A, B, C, and D.

3.02 The two systems connected to each combining panel must be in different frequency groups for the same direction of transmission. In Fig. 6, carrier system A is transmitted toward the radio system as an ON2 high group and is designated A_h. System B is transmitted as an ON2 low group and is designated B_l. The third and fourth ON2 groups are transmitted as C_h and D_l.

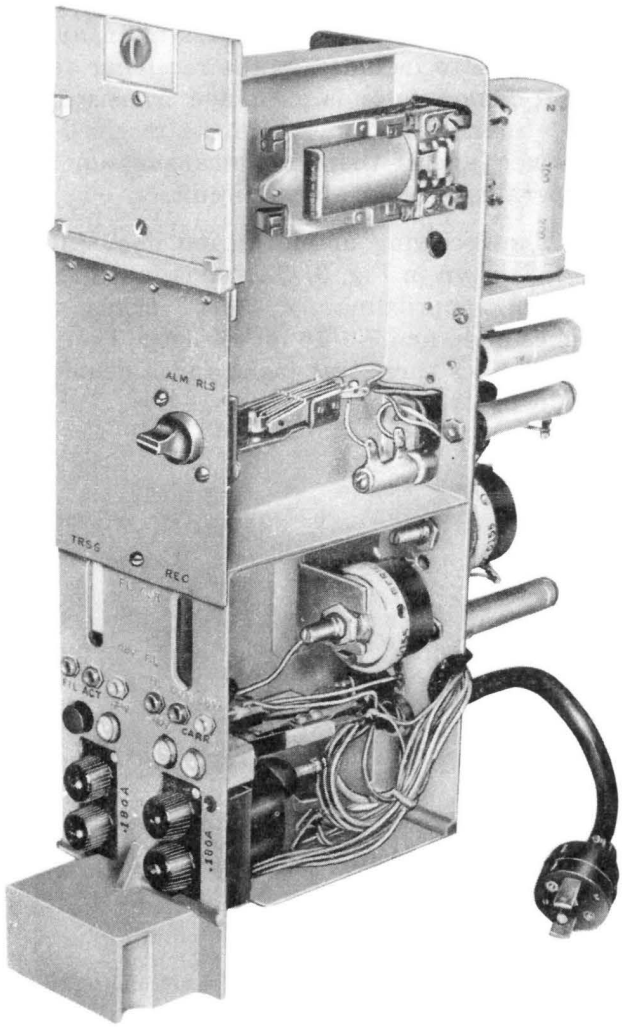


Fig. 5 — Power Supply and Alarm Circuit

3.03 Connections to the 48-channel combining panel from ON terminals or N-type lines are made through repeaters, which provide gain and frequency translations if required. Each repeater contains an amplifier for each direction of transmission, and, for repeaters that provide frequency translation, a 304-kc oscillator plus a modulator. For example, a low low-high high (LL-HH) repeater does not contain any modulators or 304-kc oscillator, whereas the low low-low high (LL-LH) contains the 304-kc oscillator and a modulator in the low high (LH) section. In addition, the various sections contain low- and high-pass filters for suppressing out-of-band signals. Table C lists the various repeaters associated with N and ON/TJ carrier systems

TABLE C

REPEATER	SCHEMATIC (SD NO.)	FIG. REF	REPEATER TRANSMITS TO:		REPEATER RECEIVES FROM:	
			CARRIER	RADIO	CARRIER	RADIO
RADIO SYSTEM AT EAST END OF REPEATER						
LL-HH*	95189-01	19	High	Low	Low	High
HH-LL	95221-01	10	Low	High	High	Low
HL	95178-01	9	Low	Low	High	High
LH	95179-01	9	High	High	Low	Low
LL-LH	95215-01	—	Low	High	Low	Low
HL-LL	95218-01	—	Low	Low	Low	High
RADIO SYSTEM AT WEST END OF REPEATER						
LL-HH	95189-01	10	Low	High	High	Low
HH-LL	95221-01	—	High	Low	Low	High
HL	95178-01	9	Low	Low	High	High
LH	95179-01	19	High	High	Low	Low
LL-HL	95216-01	7	Low	Low	Low	High
LH-LL	95217-01	8	Low	High	Low	Low

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

and their operating bands when the TJ radio system is at the east end or west end of the repeater. The table also includes references to functional diagrams which illustrate typical equipment configurations for some of the repeaters.

3.04 The carrier systems are applied to each J98706W 48-channel combining panel. The signals from the carrier systems pass through appropriate span pads and slope networks and are combined into a composite signal in a high-pass (HP), low-pass (LP) filter network. The output of one 48-channel combining panel is connected to the J98706AB transmitting amplifier and modulator unit which plugs into the J98706U multiplex mounting. In this unit for example, with ON2 signals, the ***h*** group (172 to 268 kc) and the ***l*** group (36 to 132 kc) are modulated by a 584-kc crystal oscillator to shift the frequency range to a 316- to 548-kc frequency band. The A_h and B_l groups thus appear at the output of the modulator as the A_s and B_t groups, respectively.

3.05 The A_s and B_t groups are combined with the output of the second 48-channel combining panel in the high-pass and low-pass sections of filter FL2 in the multiplex mounting. The combining filter connects to the radio through an impedance matching transformer. The output of the circuit thus comprises four

groups A_s, B_t, C_h, and D_l which provide a total capability of 96 channels for transmission over the radio system. In the opposite direction, the four groups received from the radio are in the inverse frequency order A_t, B_s, C_l, and D_h. In the multiplex mounting, these groups are connected through an impedance matching transformer, T56, to a separating filter, FL52. From the filter the *s* and *t* groups are connected to the J98706AA receiving amplifier and demodulator unit which plugs into the multiplex mounting. (The auxiliary low-pass filter, FL53, at the input of this unit suppresses unwanted signals in the frequency spectrum above the *s* and *t* groups). In the demodulator the *s* and *t* groups are demodulated into the *h* and *l* groups, respectively. The output of the demodulator groups A_l and B_h is applied to the first 48-channel combining panel. The C_l and D_h groups are applied from the separating filter to the second combining panel. In the combining panels, the groups are further separated into individual 24-channel groups for transmission to the carrier equipment. If only one 48-channel combining panel is connected to a 96-channel multiplex, the unused input and output of the multiplex are terminated in resistors.

B. Functional Description

3.06 Functional block diagrams are shown in Fig. 7 through 19. These diagrams illustrate typical equipment configurations for the 48-channel combining panel and the 96-channel multiplex equipment.

3.07 The circuit in Fig. 7 illustrates the application of 24 channels of ON carrier from a carrier terminal directly to a radio system or through multiplex equipment. The 24 channels can be either in the low (l) group (36 to 132 kc) or in the high (h) group (172 to 268 kc). Fig. 7 shows 24 channels of ON carrier applied to a radio system or to a 96-channel combining circuit, when the ON carrier terminal is at the radio site. The repeater arrangement of Fig. 7 applies the ON carrier group to the radio or 96-channel multiplex equipment at low-group frequencies and receives from the radio or multiplex equipment at high-group frequencies. Span pads C and D provide attenuation to adjust transmission level. Transformers T3 and T4 match the impedance of the combining panel circuit to that of the 96-channel multiplex. The 304-kc band elimination filter shown in Fig. 7 is optional equipment and is used to prevent 304-kc carrier leak (which appears at the input of an HL or LH repeater) from falsely holding the carrier alarm relay in the receiving amplifier and demodulator unit during a legitimate carrier alarm condition.

3.08 The circuits in Fig. 8 and 9 illustrate the application of 48 channels of ON carrier information from an ON terminal and/or N-type line. The filters FL shown in these illustrations combine and separate up to 48 message channels. The 48 channels can then be applied to radio through impedance matching transformers T5 and T6 or can be multiplexed with other 24- or 48-channel information at the 96-channel multiplex equipment. In the application of 48 channels to a radio system or multiplex equipment, one 24-channel system transmits in the low group and the other 24-channel system transmits in the high group.

3.09 At radio repeater points, dropping and adding one of two 24-channel systems is accomplished as shown in Fig. 10 and 11. Fig. 10 illustrates an arrangement where 24 of the 48 channels from radio terminal W are transmitted to radio terminal E, while the remaining 24 channels are dropped for application to an ON terminal or N-type line. Fig. 11 illustrates a "wye" configuration in which channels are distributed among three radio systems. When this arrangement is used, 48 channels in the east-west route can be divided at a radio repeater point, so that 24 channels from the east link plus 24 channels from the west link are transferred to a north-south route.

3.10 The circuits in Fig. 12 through 18 illustrate various applications which may be used at a radio repeater point. The possible combinations are not completely covered, but the more typical ones are illustrated. When the 96-channel multiplex equipment is used in an application that does not require the modulator and demodulator plug-in units, strapped plug-in connectors are required.

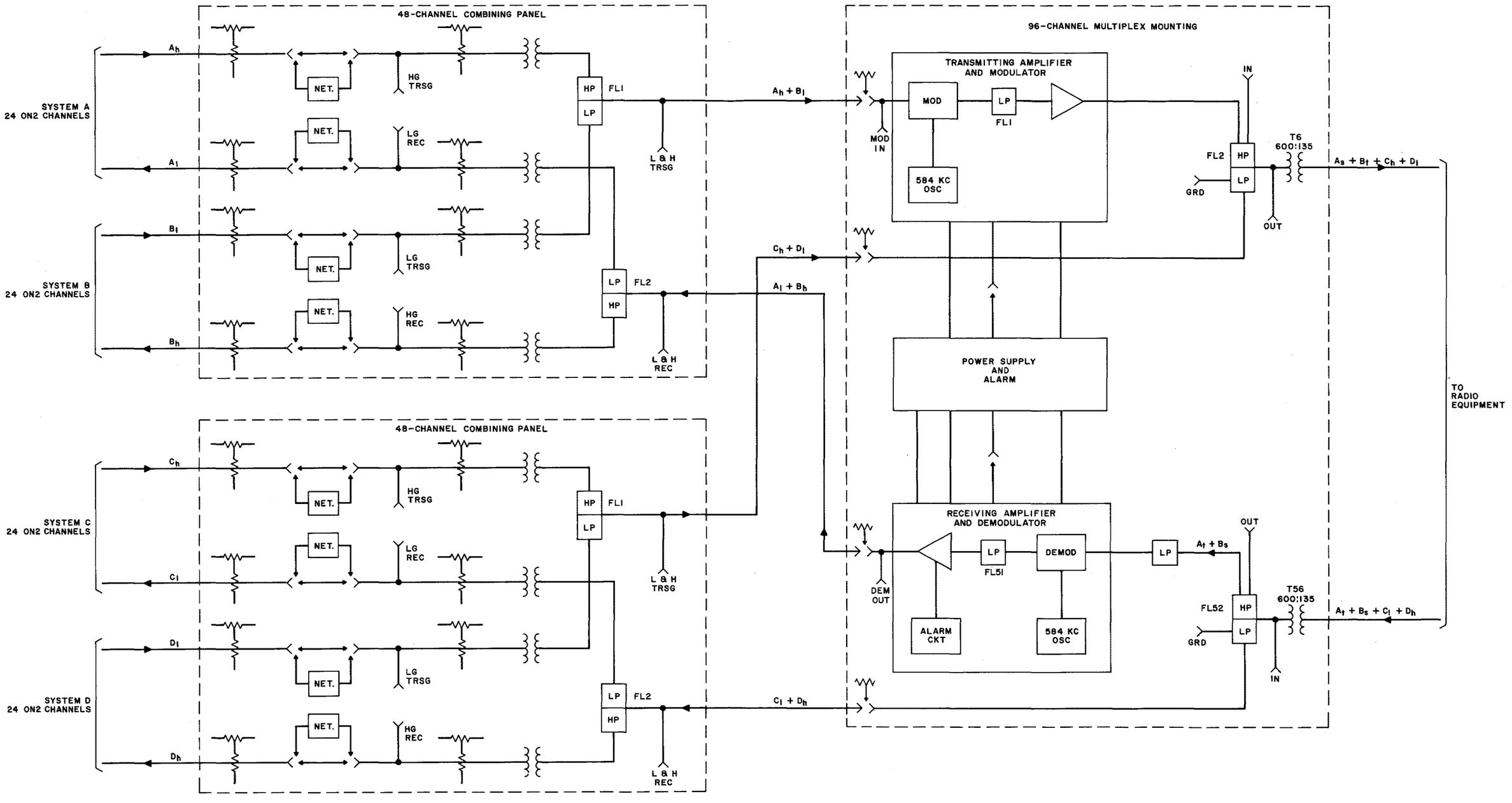


Fig. 6 — Combining and Multiplexing 96 Channels for Transmission to Radio System

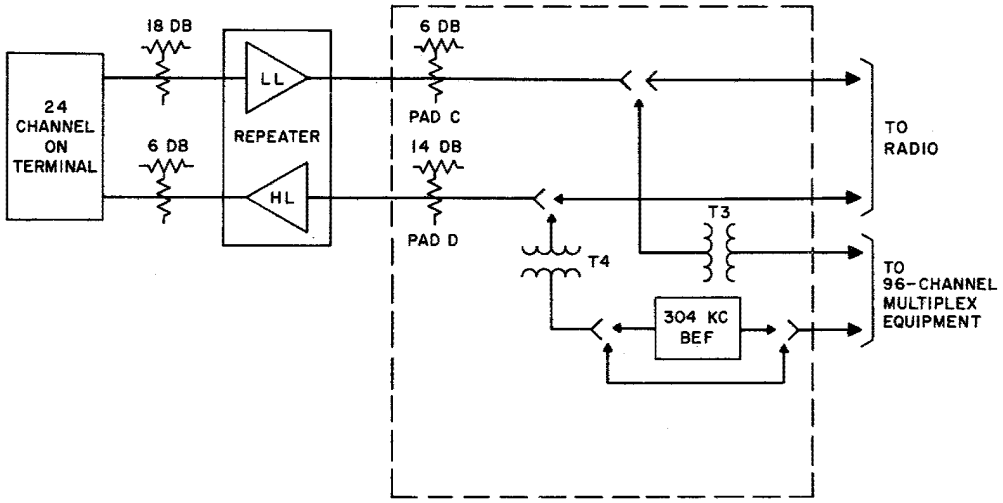


Fig. 7 — Application of 24 Channels from ON Terminal to Radio System or Multiplex Equipment

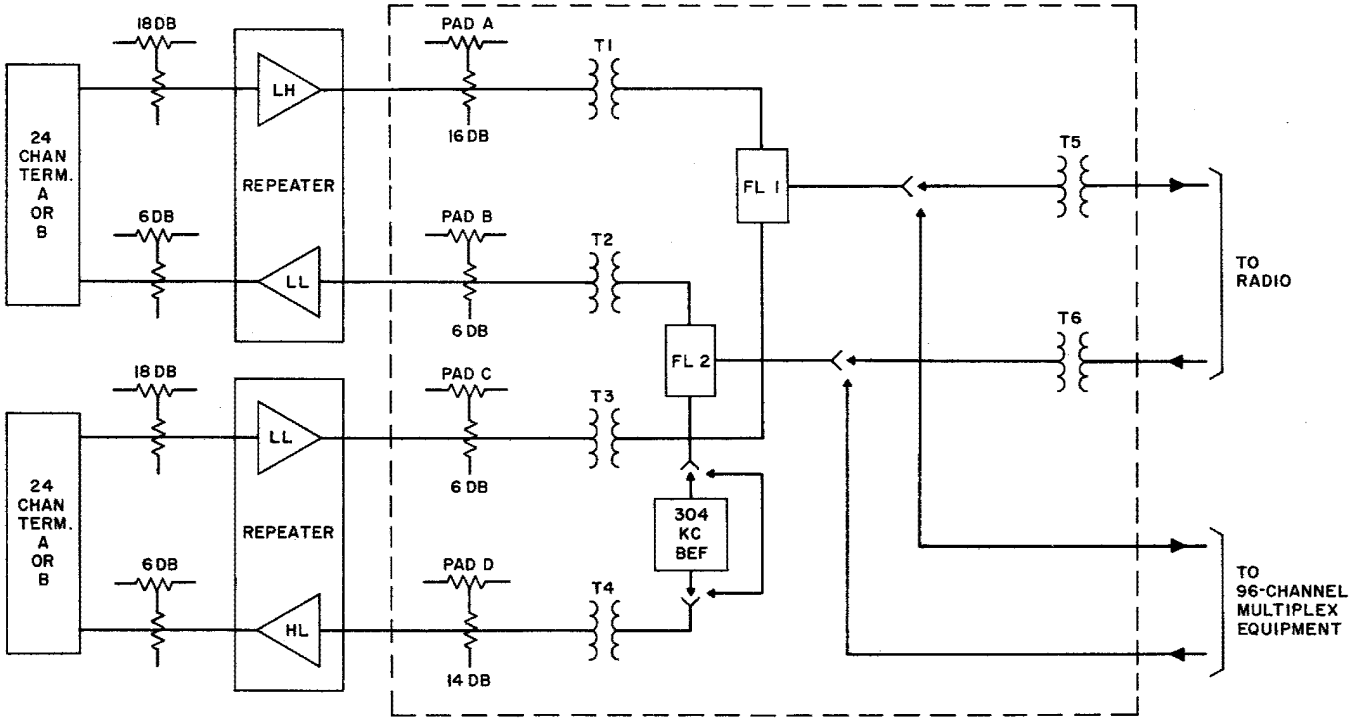


Fig. 8 — Application of 48 Channels from ON Terminal to Radio System or Multiplex Equipment

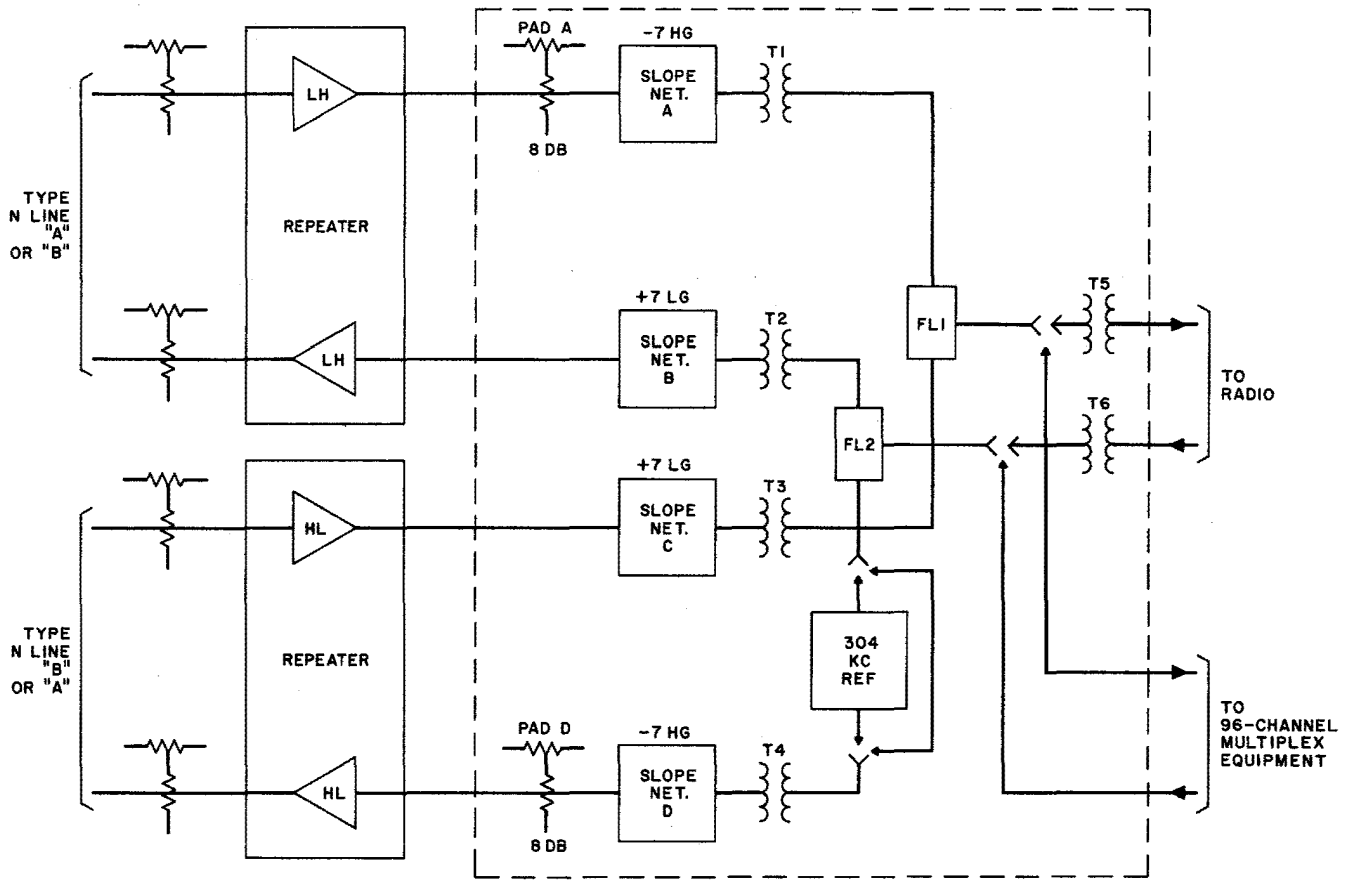


Fig. 9 — 48 Channels from N-type Lines to Radio System or Multiplex Equipment

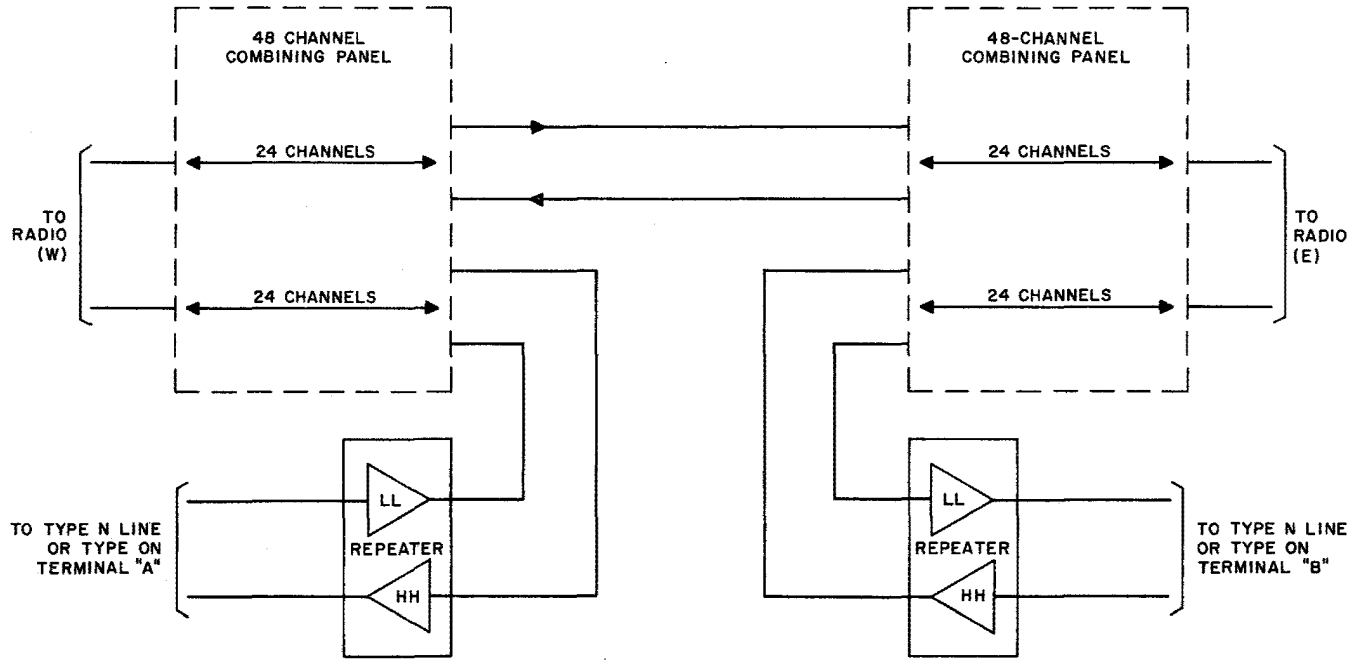


Fig. 10 — 48 Channels at Radio Repeater — Dropping 24 Channels and Picking up 24 Channels

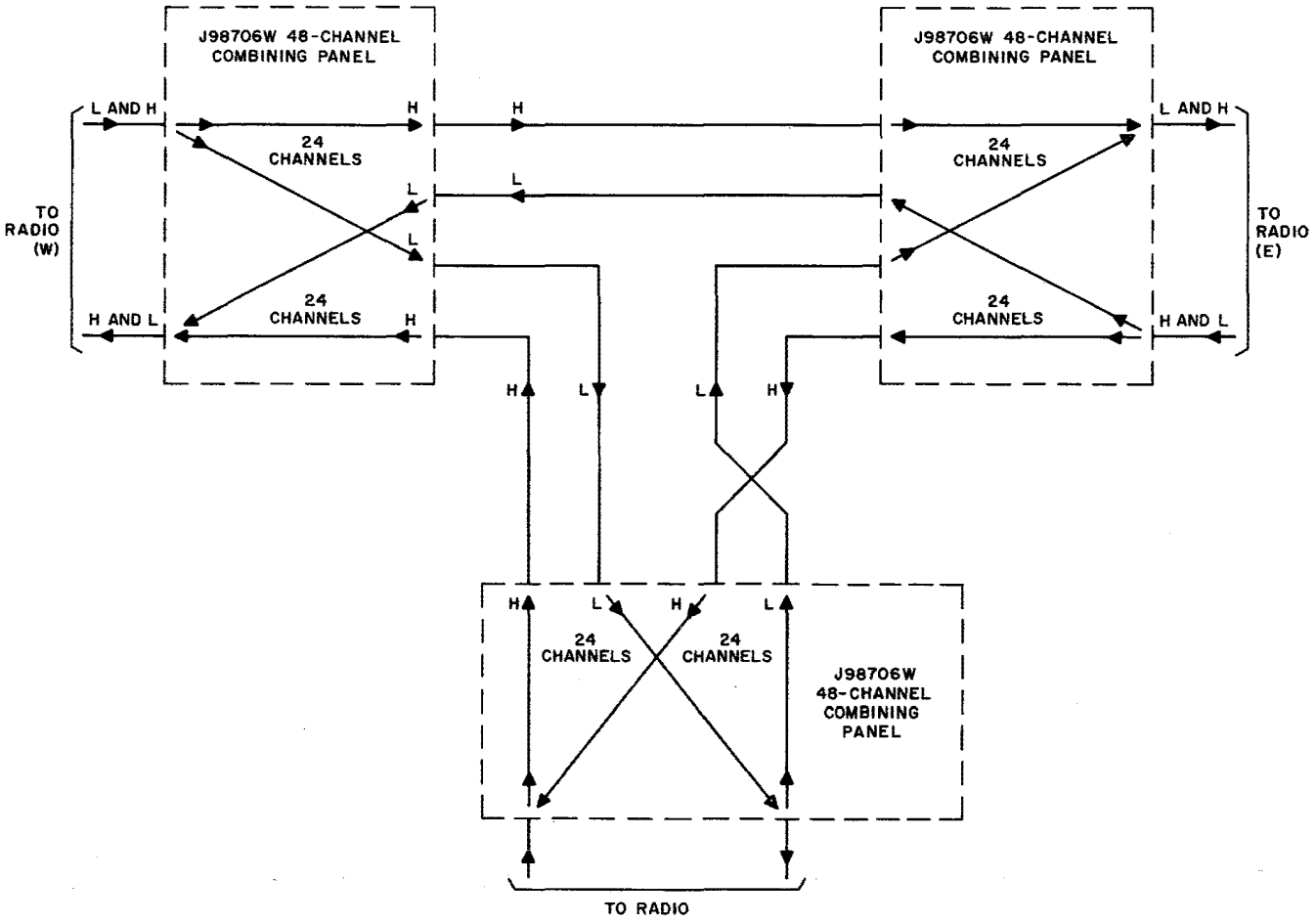


Fig. 11 — 48 Channels at Radio Repeater — Wye Configuration

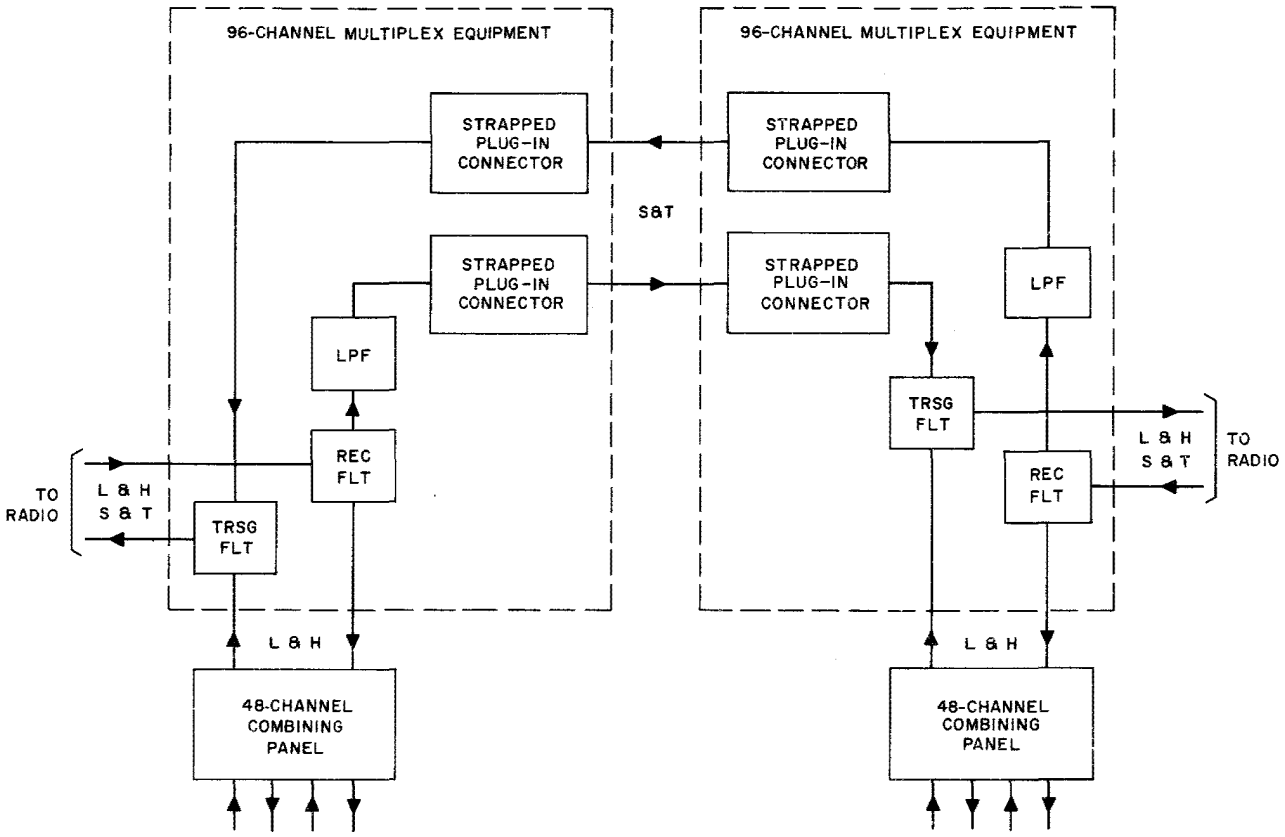


Fig. 12 — 96 Channels at Radio Repeater — Dropping 48 Channels (L and H) and Picking up 48 Channels (L and H)

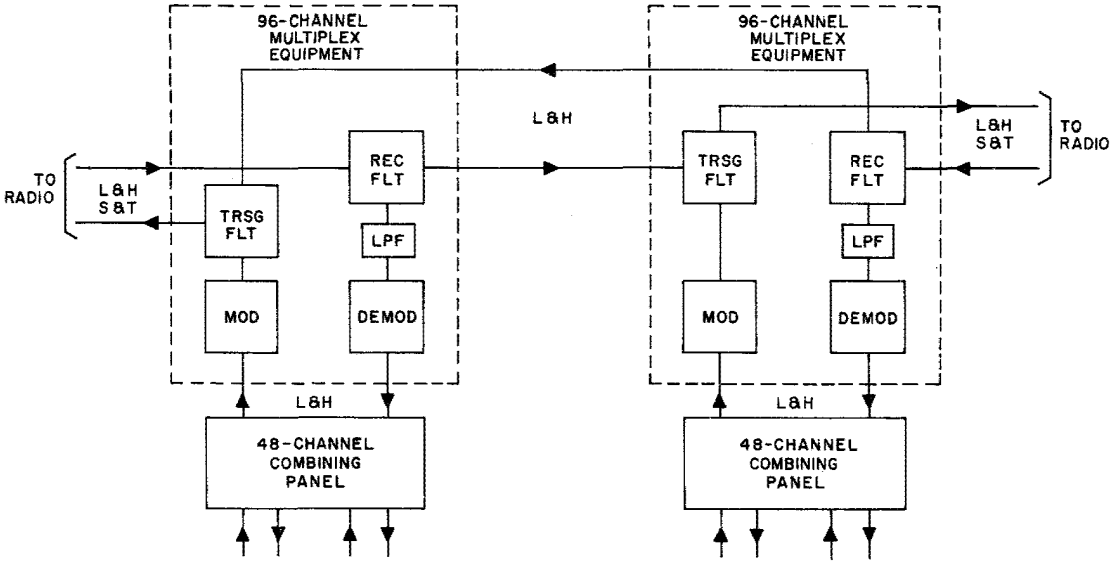


Fig. 13 — 96 Channels at Radio Repeater — Dropping 48 Channels (S and T) and Picking up 48 Channels (S and T)

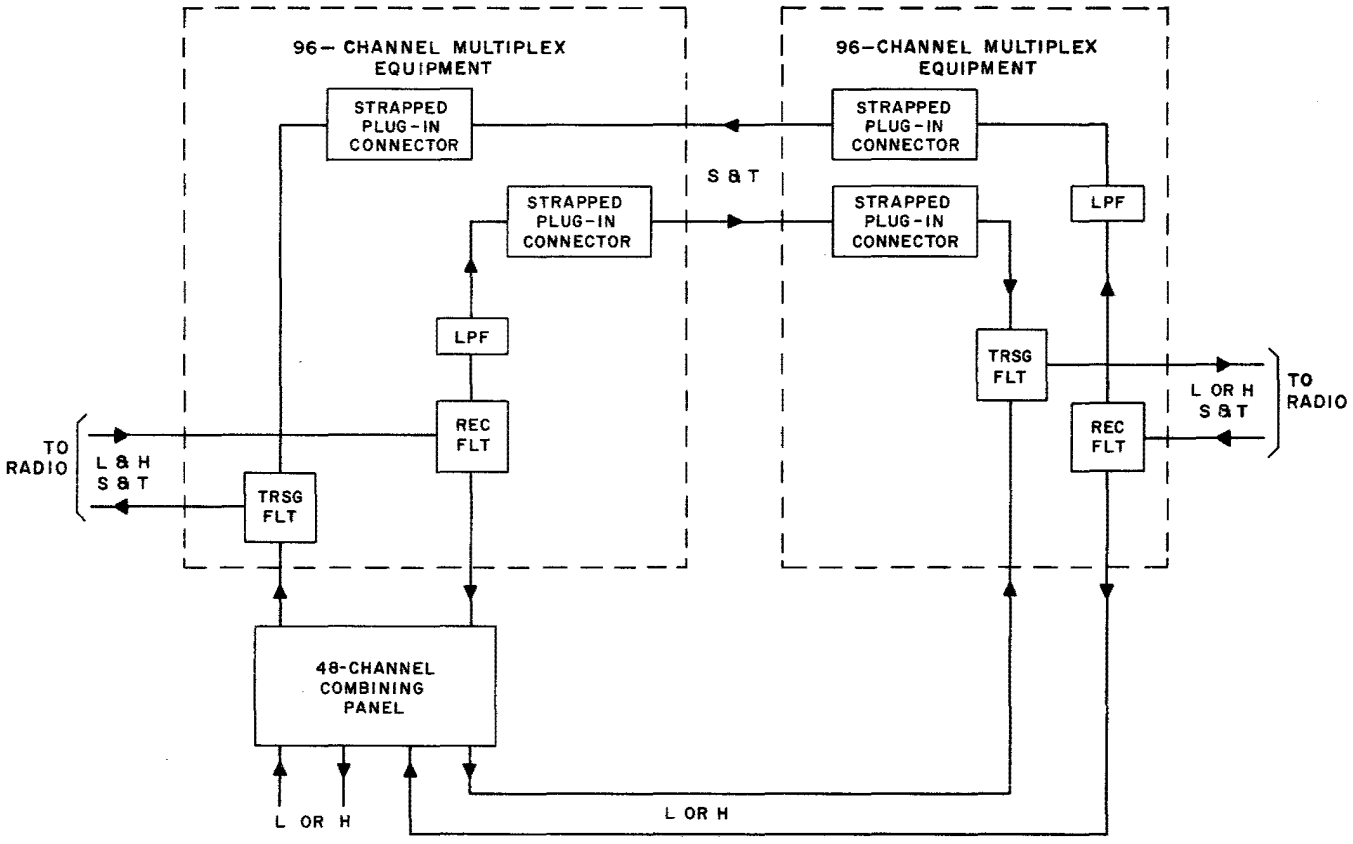


Fig. 14 — 96 Channels at Radio Repeater — Dropping 24 Channels (L or H)

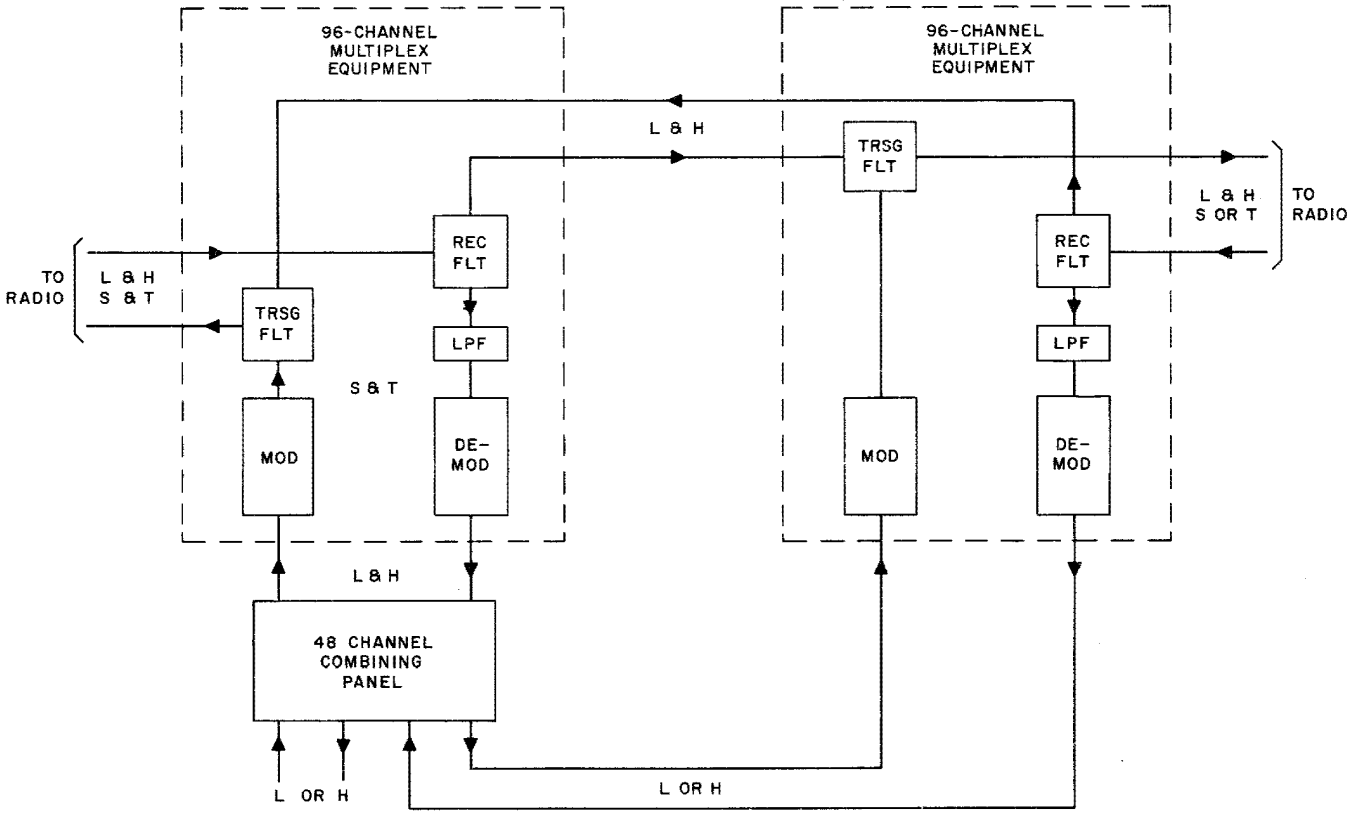


Fig. 15 — 96 Channels at Radio Repeater — Dropping 24 Channels (S or T)

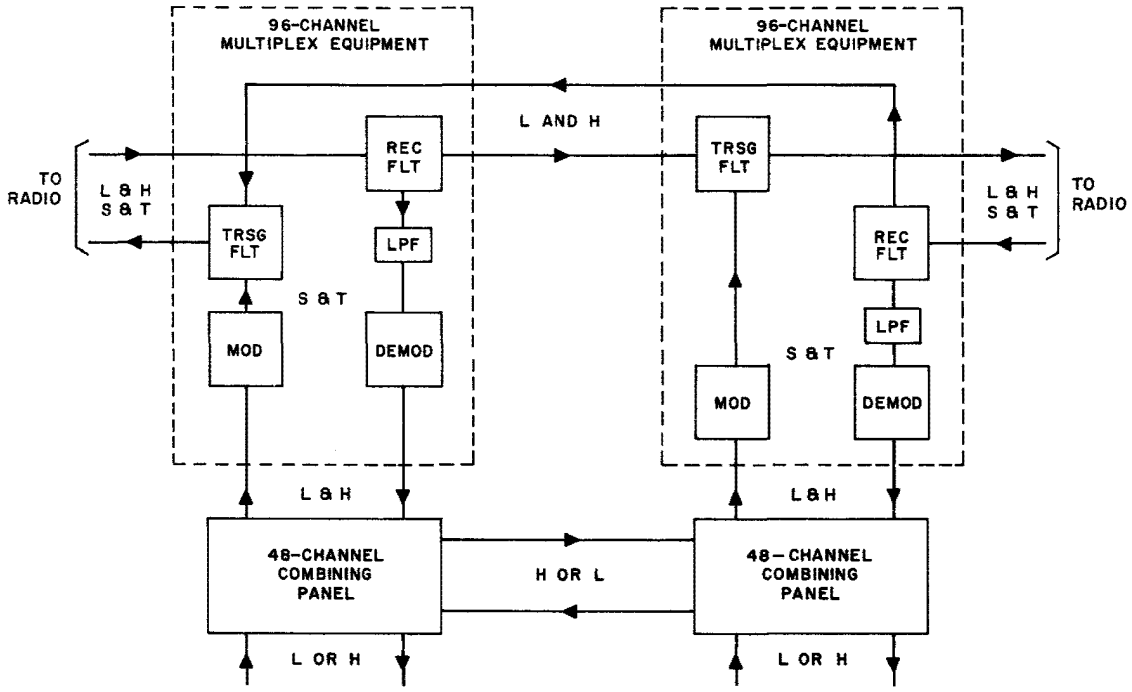


Fig. 16 — 96 Channels at Radio Repeater — Dropping 24 Channels (S or T) and Picking up 24 Channels (S or T)

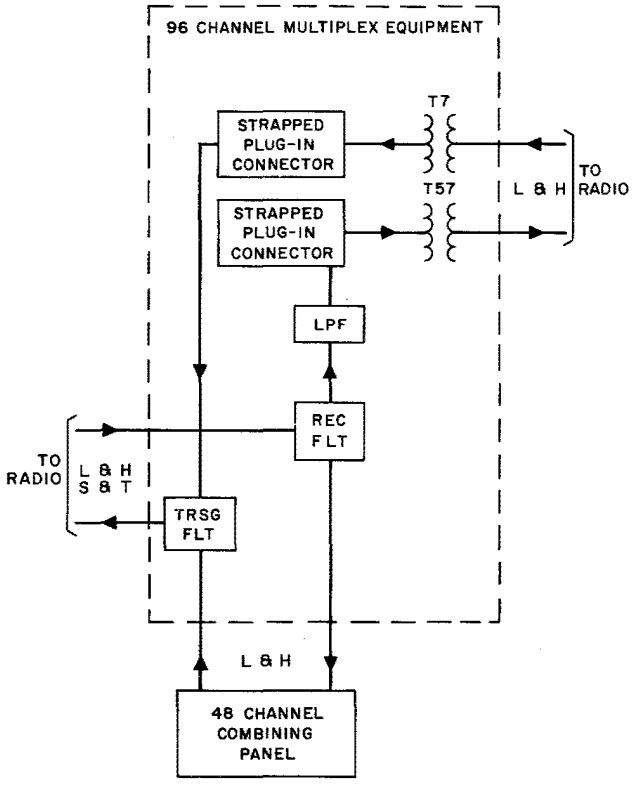


Fig. 17 — 96 Channels at Radio Repeater — Dropping 48 Channels (L and H)

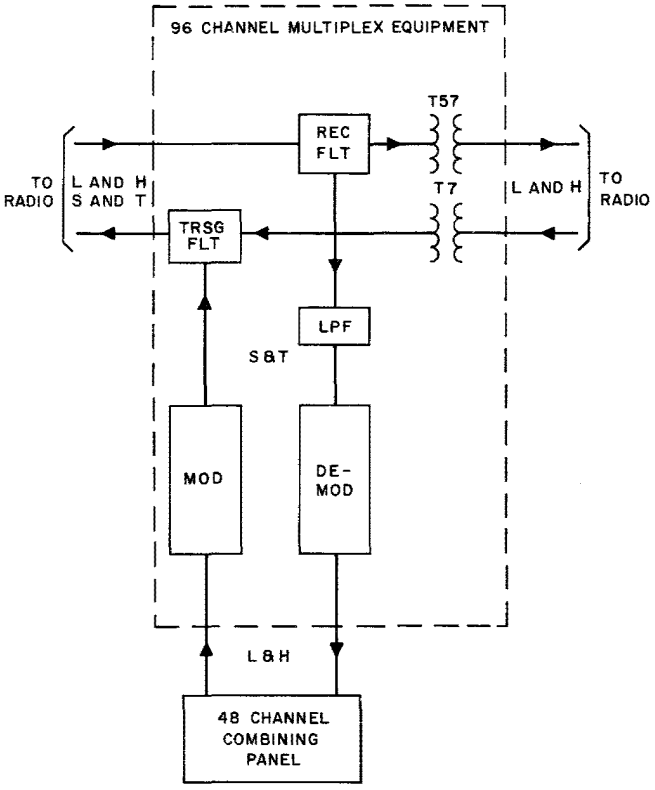


Fig. 18 — 96 Channels at Radio Repeater — Dropping 48 Channels (S and T)

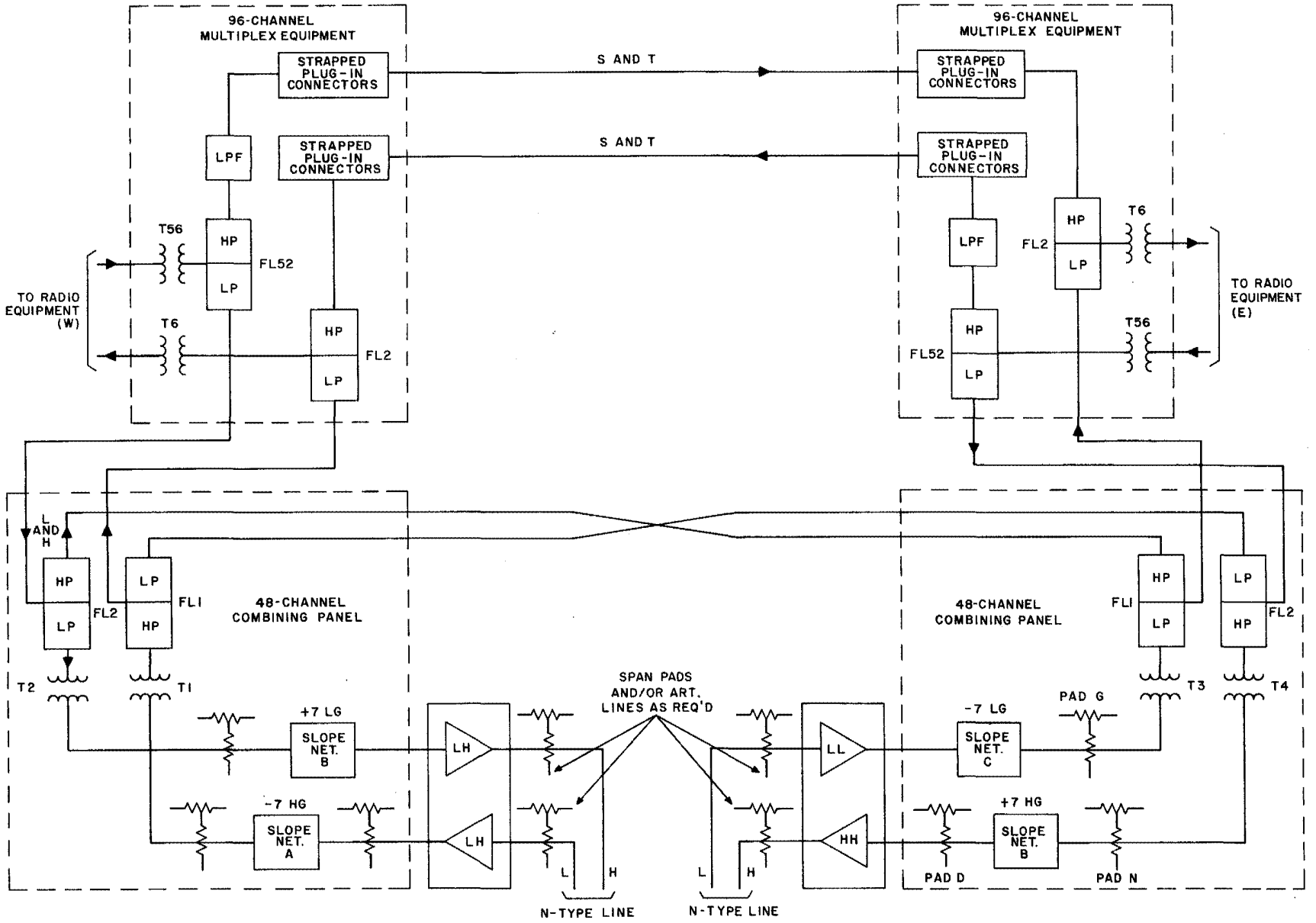


Fig. 19 — Dropping and Inserting 24-Channel ON2 Groups at Radio Repeater

3.11 The circuit in Fig. 19 illustrates a typical case of dropping and reinserting 24 channels at a 96-channel radio repeater point.

C. 48-Channel Combining Panel

3.12 The 48-channel combining panel contains span pads, slope networks, transformers, and filters in various configurations as required by the associated repeaters. This equipment is required to combine or separate two systems, each containing up to 24 message channels, between ON terminals or N-type lines and either a radio system or 96-channel multiplex equipment. A schematic and level diagram of the 48-channel combining panel is shown in Fig. 20. A typical system, transmitted in the frequency band of 172 to 268 kc, is applied through terminal board TB1 to span pads A and E and slope network A to impedance matching transformer T1. Transformer T1 matches the 135-ohm line to the 600-ohm filter FL1. Span adjust pads A and E provide a power level of approximately −15 dbm per carrier at jacks J1 and J2 (HG TRSG). A 24-channel system that is transmitted toward the radio in a frequency band of 36 to 132 kc is applied through span adjusts pads C and G and slope network C to impedance matching transformer T3. Span adjust pads C and G provide a power level of approximately −15 dbm per carrier at jacks J5 and J6 (LG TRSG). The two transmitted systems are coupled through transformers T1 and T3 and combined in a 564A high-pass, low-pass filter FL1. The insertion loss characteristics of the 564A filter are shown in Fig. 21. The output of the combining filter consists of a composite signal with a frequency range of 36 to 268 kc. The composite signal may be applied to a radio system or to 96-channel multiplex equipment. The signal received from a radio system or 96-channel multiplex equipment is applied to separating filter FL2 where it is separated into the high- and low-group frequency bands. The high-group frequency band is applied through impedance matching transformer T4, span adjust pads D and H, and slope network D, to the N-type line or ON terminal equipment. Span adjust pads D and H provide a power level of approximately −40 dbm at jacks J7 and J8 (HG REC). The low-group frequency band is applied through transformer T2, span adjust pads B and F, and slope network B to the N-type line or ON terminal equipment. As in the case of the received high group, span pads B and F provide a power level of approximately −40 dbm at jacks J3 and J4 (LG REC). Connections are made between the 48-channel combining panel and the multiplex at a 600-ohm impedance level. When the combining panel connects directly to the radio system, two additional transformers are wired in to provide a 600- to 135-ohm impedance transformation between the FL1 and FL2 filters and the radio system.

3.13 A level diagram illustrating nominal carrier powers at various points in the 48-channel combining panel is shown in Fig. 20. 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 should be corrected by regulators in the ON terminals. Some of the carrier power received from the radio may be less than nominal when the 96-channel multiplex equipment is used because of small losses in associated transformers and filters.

3.14 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.

3.15 Slope networks A through D, used in the 48-channel combining panel, provide the equalization required for transmission of carrier between ON repeaters and radio equipment. The slope networks impart to the essentially flat carrier output of a radio receiver a slope of 7 db across the carrier spectrum for correct transmission to an N-type line. The slope networks also adjust the carrier levels received from an N-type line so that the carriers are essentially flat over the carrier spectrum for application to the input of a radio transmitter. The characteristics and applications of the slope networks are shown in Table D. Also included in Table D is a reference to the illustration which contains the schematic diagram and insertion loss characteristic curves.

TABLE D

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.	22
J98706M	−7 HG	Increasing frequency	Used where cable connects to radio from LH repeater output or HL repeater input.	23
J98706N	+7 HG	Decreasing frequency	Used where cable connects to radio from HH repeater output or input.	24
J98706T	+7 LG	Increasing frequency	Used where cable connects to radio, ON terminal, or ON1 junction from HL repeater output or LH repeater input.	25

D. 96-Channel Multiplex Mounting

3.16 The 96-channel multiplex mounting (see Fig. 26) provides facilities for connecting four ON1 or ON2 systems (up to 96 message channels) to radio. Signals from two 48-channel combining panels are applied through terminal board TB1 in the multiplex mounting. The output of one combining panel is applied directly to a 564B low-pass, high-pass filter FL2 which is part of the multiplex mounting. The output of the second combining panel is applied through jack J1 to the J98706AB transmitting amplifier and modulator unit. The output of the transmitting amplifier and modulator unit is also applied through jack J1 and combined with the output of the first 48-channel combining panel in the 564B filter. The insertion loss characteristics of the 564B filter are shown in Fig. 27. The 564B filter connects to the radio through a 600:135-ohm impedance matching transformer and terminal board TB2.

3.17 In the opposite direction a composite signal containing up to 96 message channels is received from the radio and applied to terminal board TB2, through an impedance matching transformer to a 564B low-pass, high-pass separating filter FL52. From the separating filter a composite signal containing up to 48 message channels is connected directly to one 48-channel combining panel through terminal board TB1. The remaining signal is applied through a 534C low-pass filter FL53 and through jack J51 to the receiving amplifier and demodulator unit. The 534C low-pass filter FL53 keeps unwanted modulation products and image-band noise out of the demodulator. The insertion loss characteristics of this filter are shown in Fig. 28. The output of the receiving amplifier and demodulator is applied through jack J51 and terminal board TB1 to a second 48-channel combining panel. In-service bridging measurements can be made at multiple jacks J15 or J65 if the strapped connectors are removed from these locations.

E. Receiving Amplifier and Demodulator

3.18 The receiving amplifier and demodulator contains a crystal oscillator, a demodulator, a low-pass filter, an amplifier, and a transistorized alarm circuit. A schematic diagram

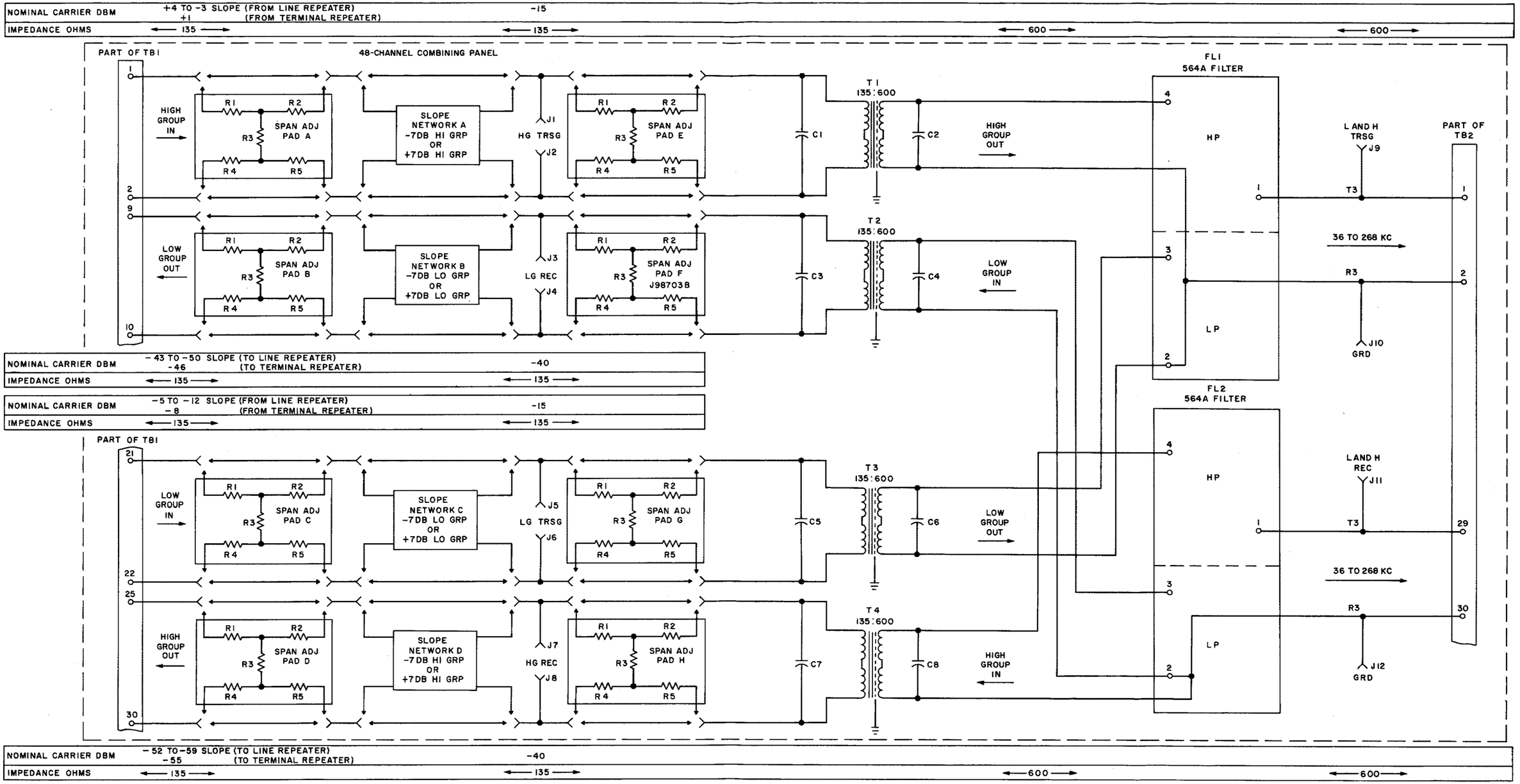


Fig. 20 — 48-Channel Combining Panel, Schematic and Level Diagram

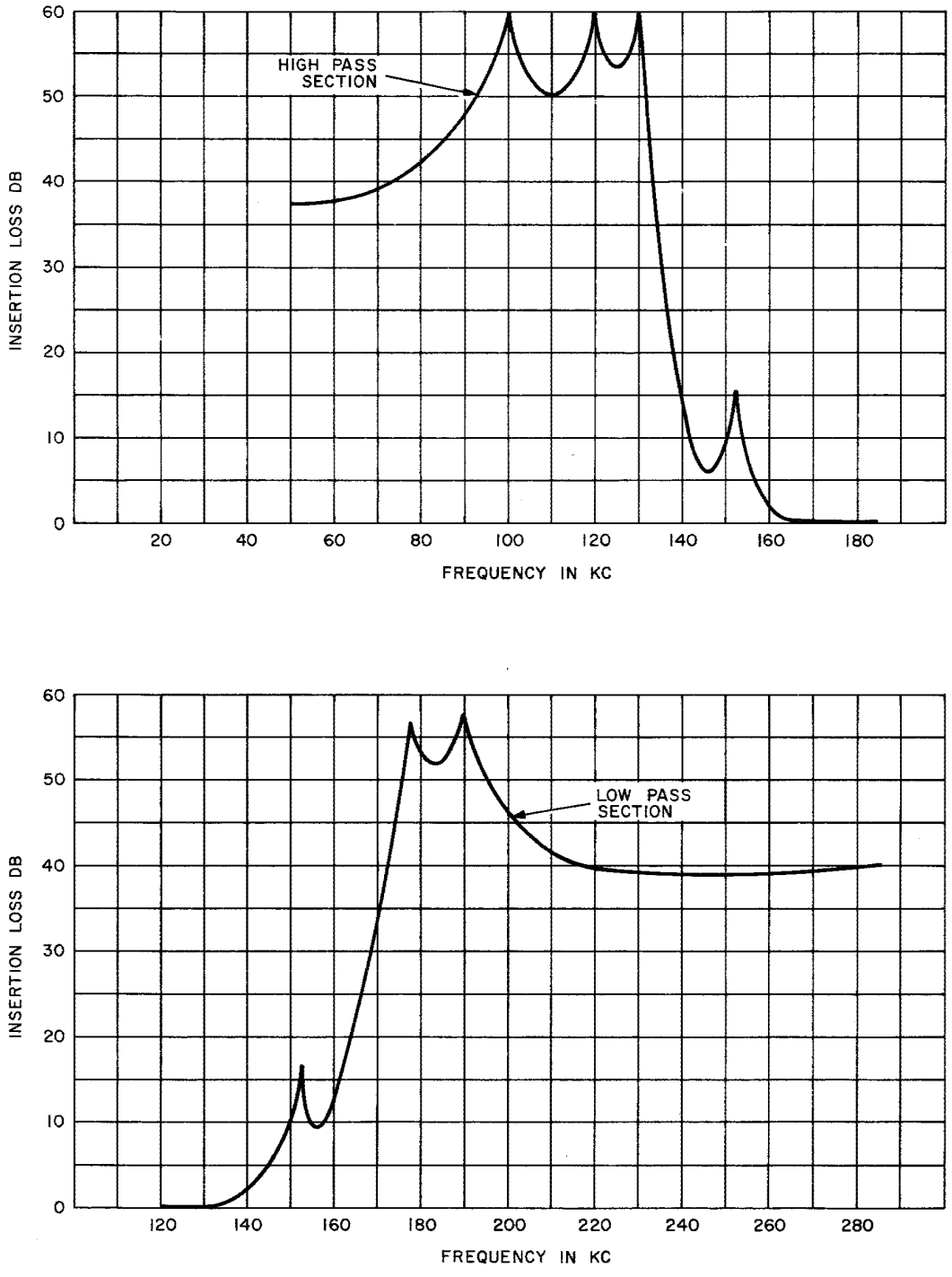
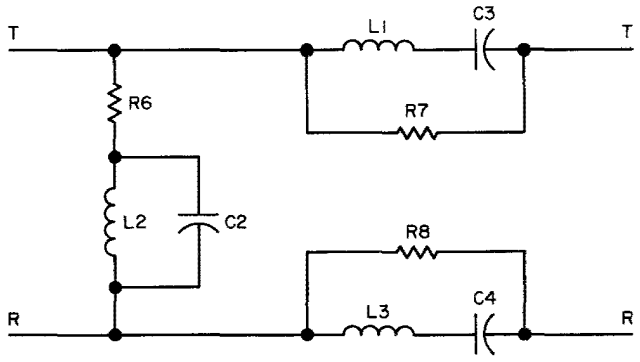


Fig. 21 — Insertion Loss Characteristics of 564A Filter (FL1, FL2)

of this circuit is shown in Fig. 29. A typical incoming signal is applied through plug P51 to the demodulator where the incoming signals beat against the output of a 584-kc oscillator. The demodulator, consisting of copper oxide varistor CR51, is a double balanced type in which the input signals and carrier are essentially balanced out to produce an output consisting almost entirely of sideband frequencies. 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 frequency of oscillation is determined by crystal Y51 and by variable capacitor C52 which permits adjustment of the frequency over a limited range. The 2-db pad at the input and output of the demodulator improves impedance matching. The signal is applied from the demodulator through a 565B low-pass filter FL51, which eliminates the high-frequency products of modulation (see Fig. 30). From the low-pass filter, the signal is coupled through transformer T54 and a demodulator gain control R63 to a single-stage amplifier V52. The demodulator gain (DEM GAIN) potentiometer controls the gain of the amplifier so that the over-all gain of the modulator and amplifier is approximately unity.

3.19 Amplifier stage V52 increases the signal level to compensate for losses introduced by the demodulator and filter. The signal voltage



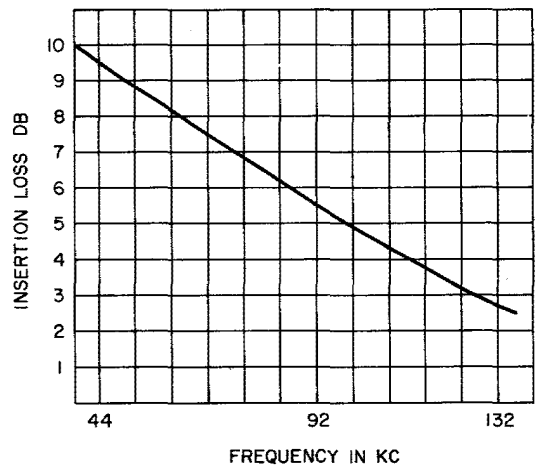
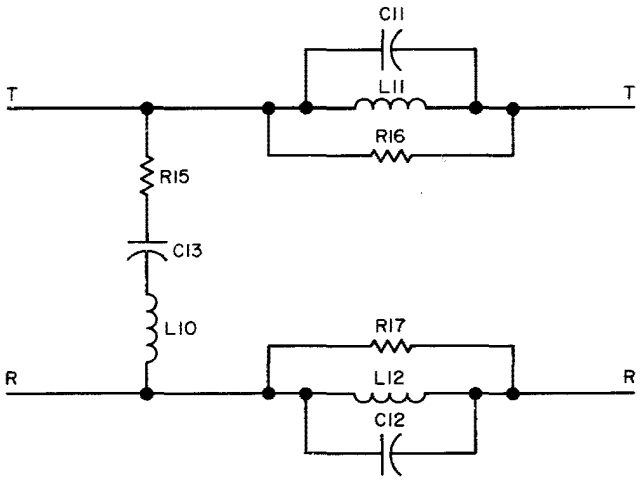


Fig. 22 — J98706L –7 db Slope Network (Low Group)



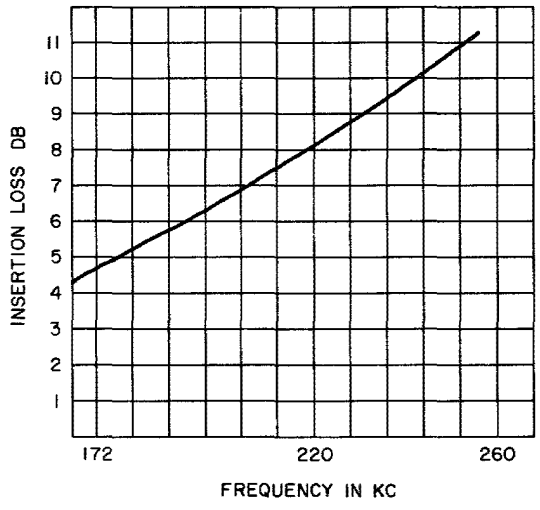
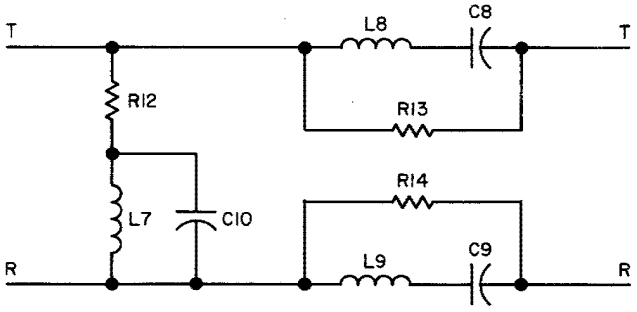


Fig. 23 — J98706M –7 db Slope Network (High Group)

at the output of filter FL51 is stepped up by transformer T54 and applied to the grid of amplifier tube V52 through a portion of potentiometer R63. The potentiometer and resistor R64 in series approximately match the secondary impedance of transformer T54. The amplified signal is coupled to the combining filter through transformer T55, which matches the plate circuit impedance to the 600-ohm filter. The primary winding of transformer T55 is tapped (terminal 5) to provide feedback in the amplifier for gain stabilization. The amount of feedback is determined by the transformer winding, resistors R66 and R67, and the cathode impedance of V52. Resistor R67 also serves as a screen voltage dropping resistor.

3.20 Space current stabilization for V52 is provided by the series combination of inductor L51 and resistor R65 in the cathode circuit. The dc resistance of L51 is low, causing most of the dc current in the cathode circuit to flow through L51 and R65. Resistor R65, therefore, largely determines the amount of dc feedback in the cathode circuit for space-current stabilization.

3.21 Incorporated into the receiving amplifier and demodulator is an alarm circuit consisting of a 3-stage transistorized amplifier and



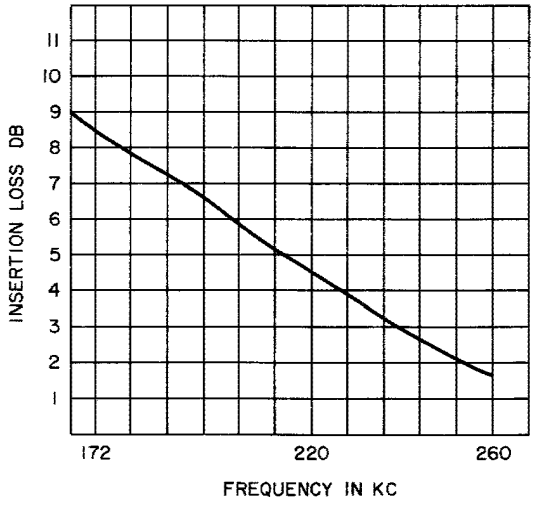
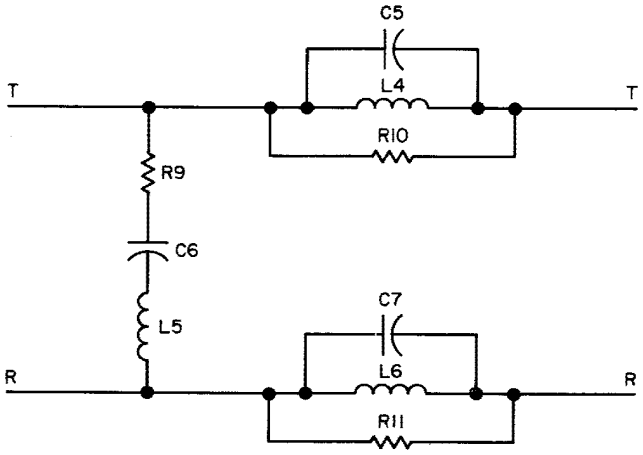


Fig. 24 — J98706N +7 db Slope Network (High Group)



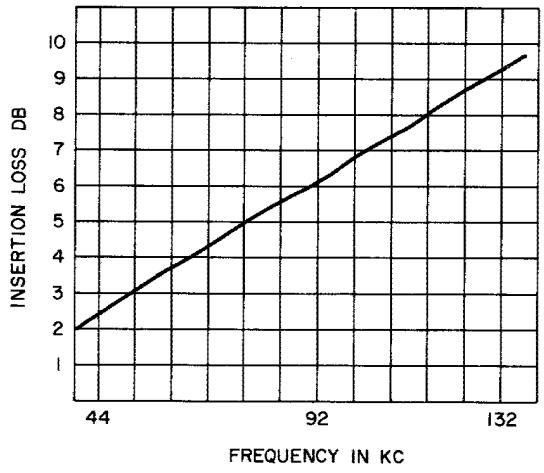


Fig. 25 — J98706T +7 db Slope Network (Low Group)

a relay. A portion of the carrier signal from the receiving amplifier and demodulator is monitored and applied through the three stages of amplification to relay K81. This amplified signal maintains relay K81 in an energized state. Should the carrier signal fail, relay K81 would de-energize and close contacts 1 and 3, applying +130 volts to the J98706AC power supply and alarm circuit. The power supply and alarm circuit activate office alarms.

F. Transmitting Amplifier and Modulator

3.22 The transmitting amplifier and modulator consists of a crystal oscillator, a modulator, a low-pass filter, and an amplifier. This unit modulates input signals from a 48-channel combining panel to shift the frequency range of the signal to a higher level. A schematic diagram of the transmitting amplifier and modulator is shown in Fig. 31. A typical incoming signal is applied through plug P1 to the modulator when incoming signals beat against the output of a 584-kc oscillator. The modulator is the same type of circuit as the demodulator described in 3.18 and operates in a similar manner. As in the receiving amplifier and demodulator unit, the oscillator circuit consists of a single-stage crystal-controlled 584-kc oscillator whose output is applied longitudinally to the modulator through transformers T2 and T3. The 2-db pad at the input and output of the modulator improves impedance matching. The signal is applied from the modulator through transformer T3 to a 565A low-pass filter FL1 which eliminates the high-frequency products of modulation (see Fig. 32). From the low-pass filter the signal is coupled through transformer T4 and a modulator gain control to a single-stage amplifier, V2. The amplifier stage operates in the same manner as the receiving amplifier described in 3.19. The signal is then applied through output transformer T5 and plug P1 to the J98706U 96-channel multiplex mounting.

G. Power Supply and Alarm Circuit

3.23 The power supplied to the power supply and alarm unit through connector P13 is derived from either a −48 volt and +130 volt supply or from a +130 volt supply only. In Fig. 33 when +130 volt and −48 volt power supplies are used for plate and heater voltages, respectively, "G" wiring is used. Potentiometers R9 (TRSG 48V FIL) for the transmitting circuit and R10 (REC 48V FIL) for the receiving circuit are provided to adjust the heater voltage to −40 volts. The heater voltage may be measured between ground and jack J10 (TRSG −40V) for the transmitting circuit and ground and jack J60 (REC −40V) for the receiving circuit. The plate voltage may be measured between jack J11 (TRSG FIL CUR) or J61 (REC FIL CUR) and ground.

3.24 When a +130 volt power supply is used for both plate and heater voltages, "H" wiring is used. R4 and R7 are dropping resistors to reduce the +130 volts for use as heater voltage. Potentiometers R3 (TRSG) and R6 (REC) are provided to adjust the heater current in each circuit. This current may be read by measuring the voltage drops across R2 (TRSG FIL CUR) and R5 (REC FIL CUR). Each circuit draws 50 milliamperes, which is equivalent to reading 2 volts across the FIL CUR jacks. The plate voltage may be measured between J11 (+TRSG FIL CUR) or J61 (+REC FIL CUR) and ground. Inductor L1 and capacitors C1 and C2 provide power supply filters for the +130 volt supply.

3.25 The alarm portion of the power supply and alarm unit operates in the following manner. An operated fuse in the +130 volt or −48 volt fuse blocks will supply +130 volts through resistor R1 or −48 volts through resistor R8 to windings of relay K2. The +130V lamp is in parallel with a portion of resistor R1 to provide a visual indication that the +130 volt fuse has operated and the −48V lamp is in parallel with the series combination of R8 and a winding of K2 to provide a visual indication that the −48 volt fuse has operated. The operation of relay K2 applies ground to office alarm circuits.

3.26 Release of relay R81 in the receiving amplifier and demodulator unit applies +130 volts through contacts 6 and 7 of the alarm release key (ALM RLS) and resistor R11 to a winding of relay K2. The CARR lamp is in parallel with a portion of resistor R11 to

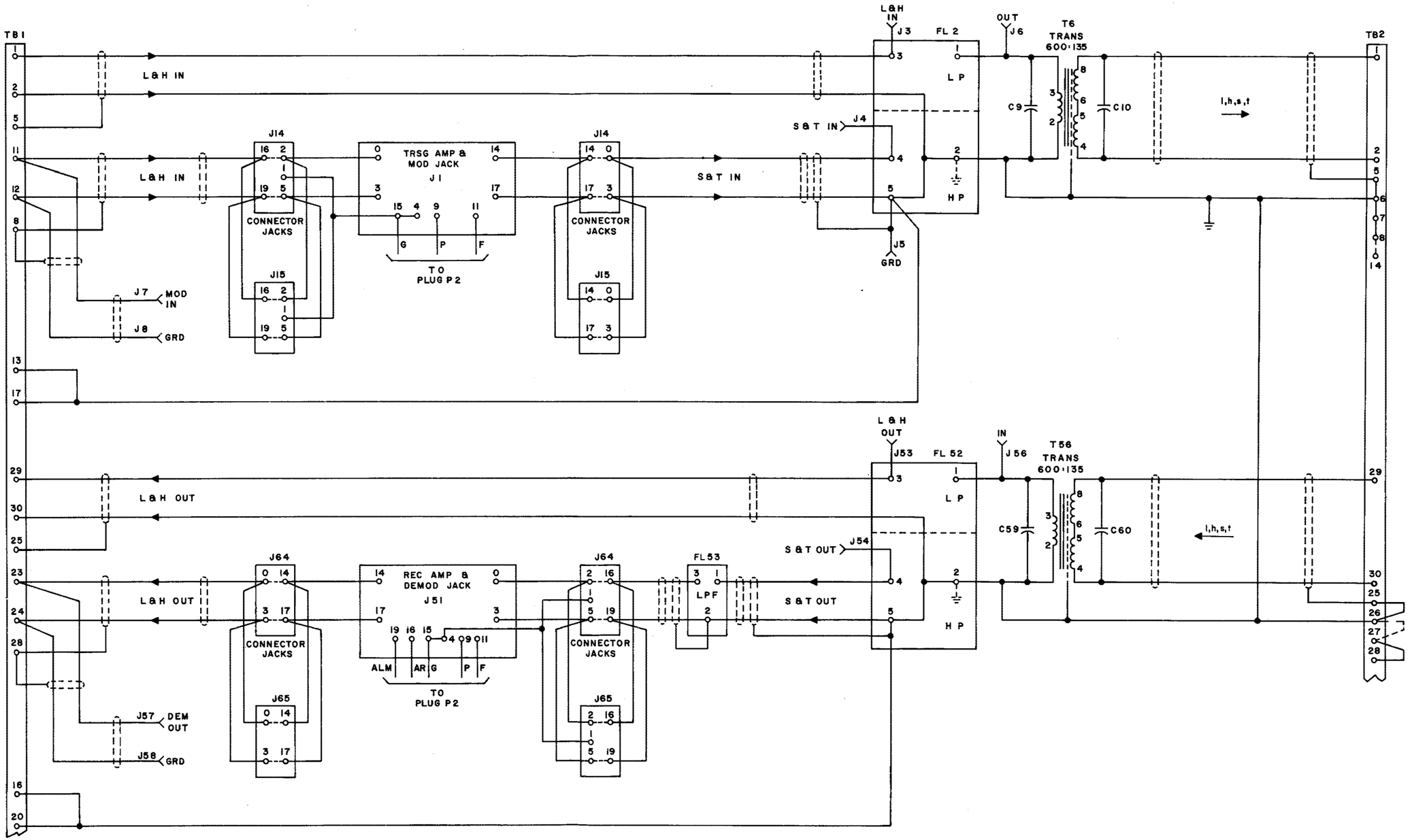


Fig. 26 — 96-Channel Multiplex Mounting, Schematic Diagram

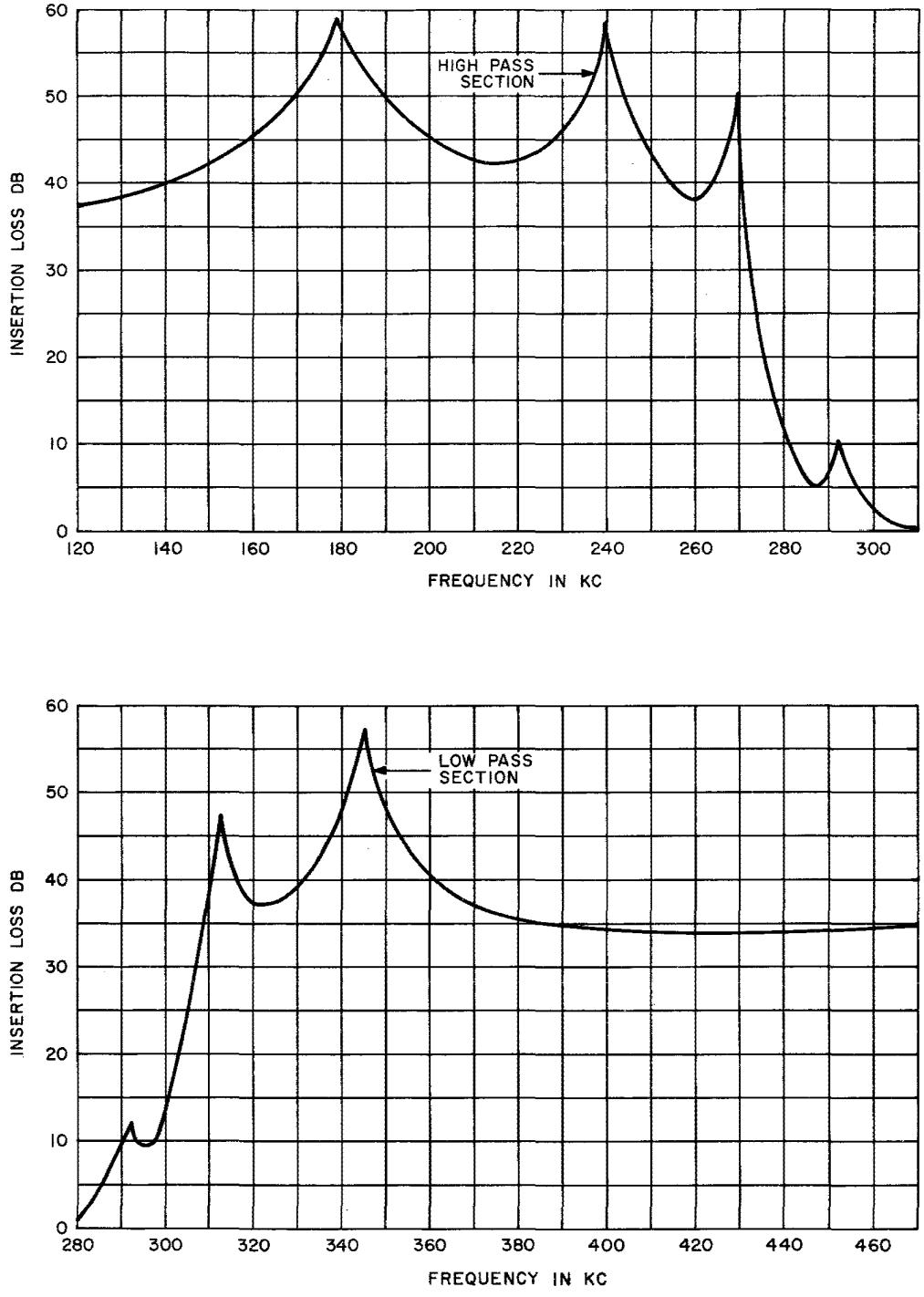


Fig. 27 — Insertion Loss Characteristics of 564B Filter (FL2, FL52)

provide a visual indication of carrier failure. When an alarm condition occurs, the ALM RLS key is manually operated to release relay K2 which turns off the office alarms. However, the CARR lamp remains lighted because +130 volts is applied to resistor R11 through contact 8 of the ALM RLS key. When the alarm condition is cleared, relay K81 in the receiving amplifier and demodulator unit operates, causing +130 volts to be applied through resistor R36 and contact 11 of the ALM RLS key. This voltage reoperates relay K2 and activates the office alarms. The ALM RSL key is then manually restored to normal to extinguish the CARR lamp and release relay K2, thus turning off the office alarm.

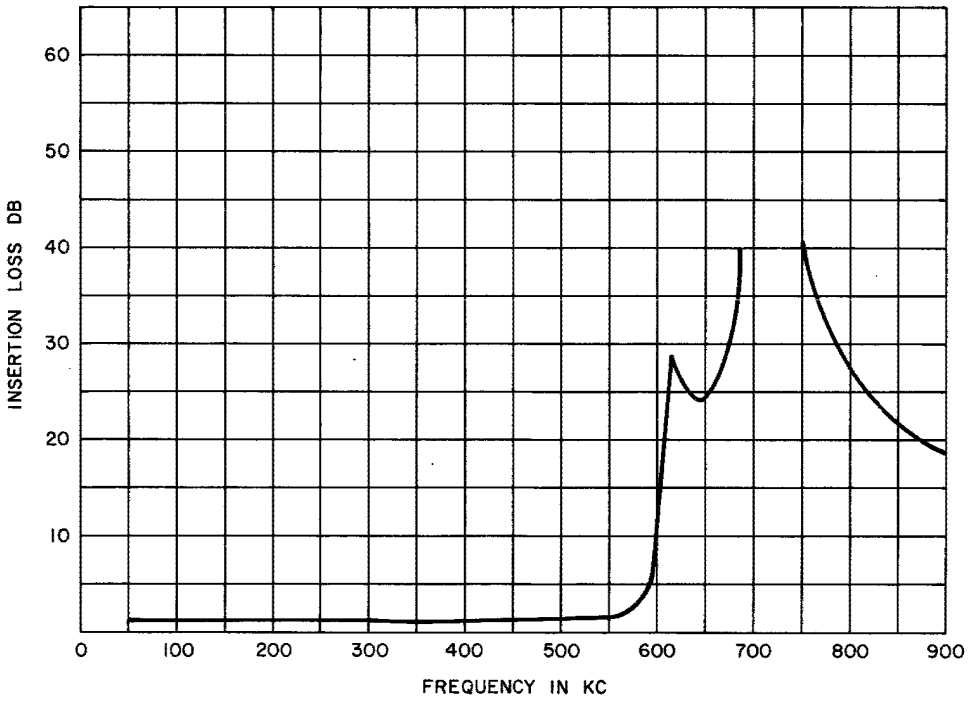


Fig. 28 — Insertion Loss Characteristics of 534C Filter (FL53)

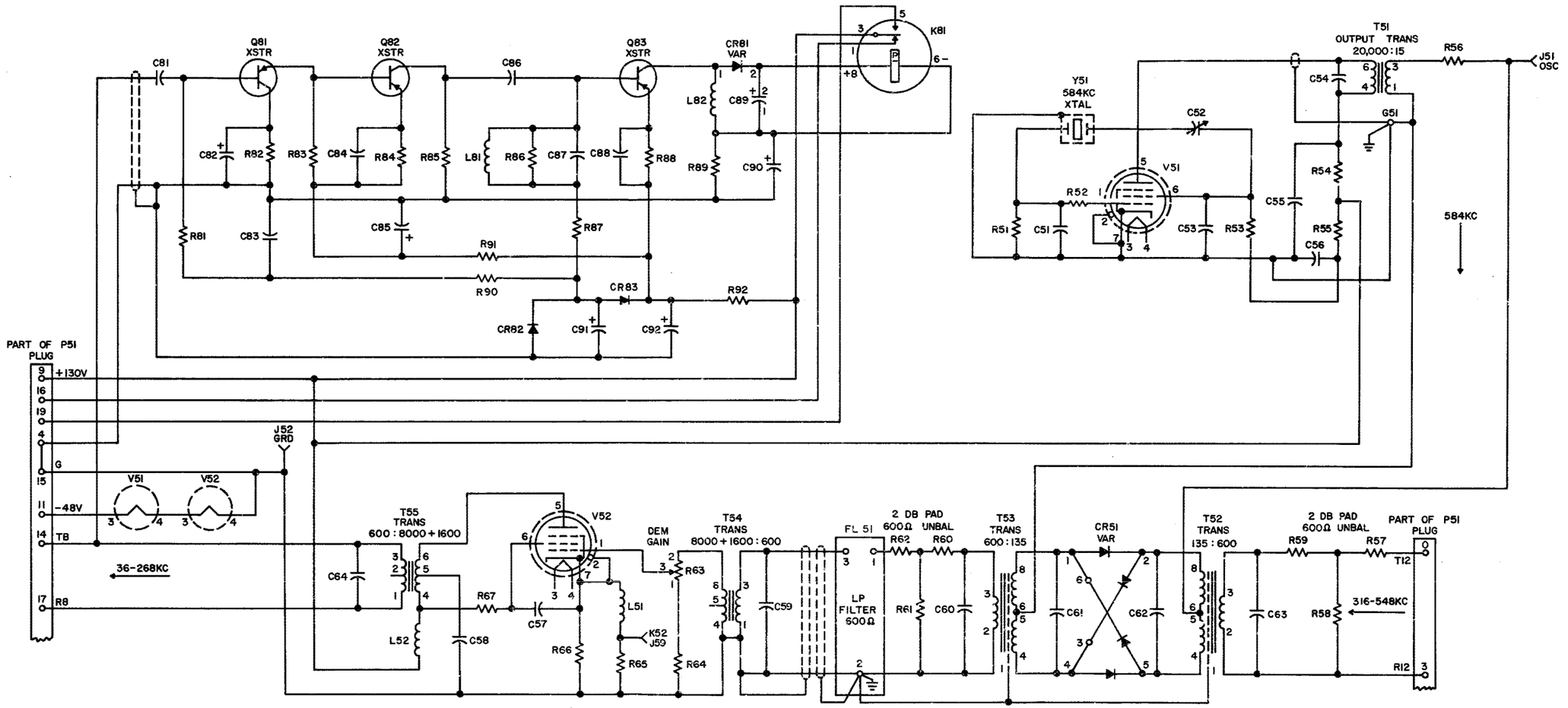


Fig. 29 — Receiving Amplifier and Demodulator, Schematic Diagram

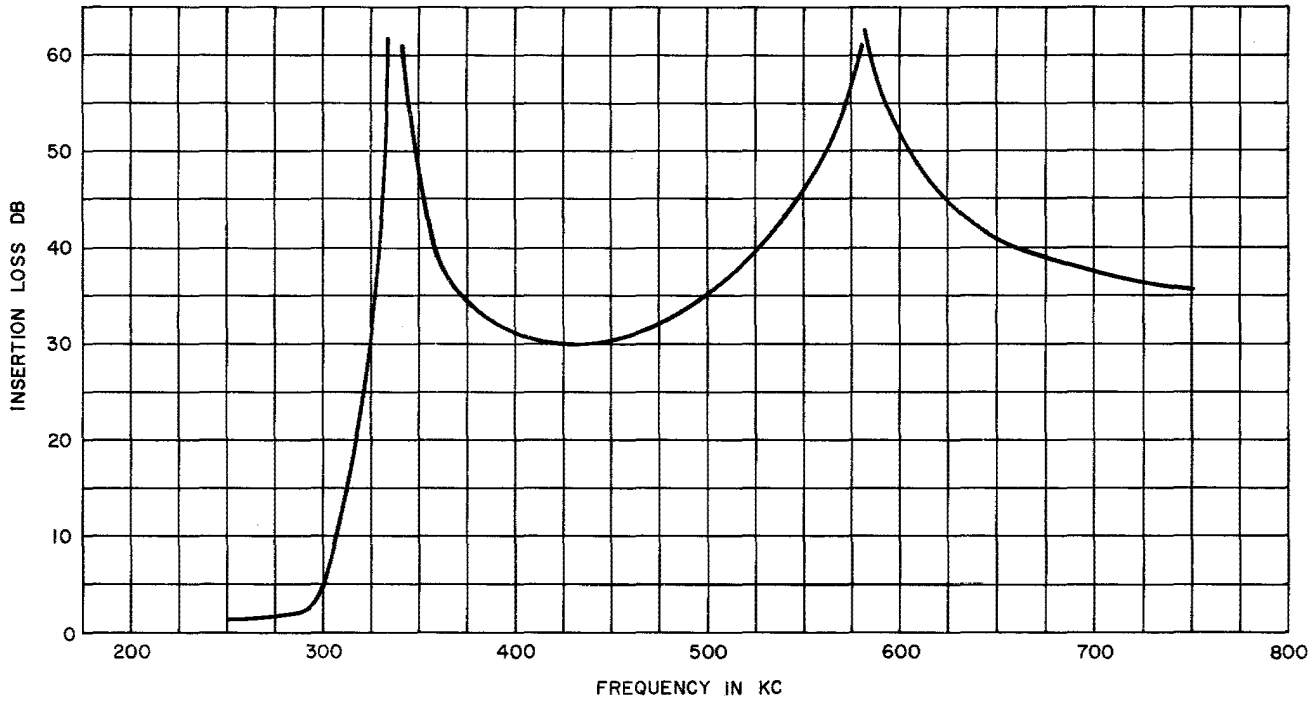


Fig. 30 — Insertion Loss Characteristics of 565B Filter (FL51)

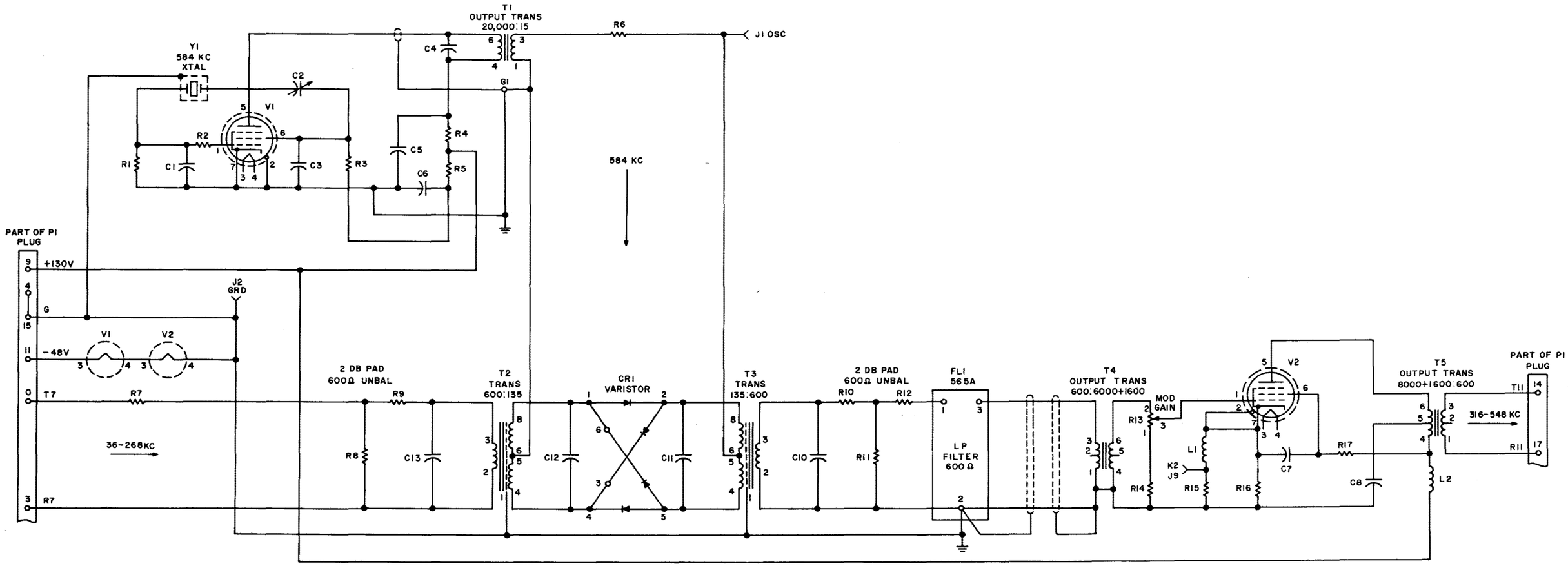


Fig. 31 — Transmitting Amplifier and Modulator, Schematic Diagram

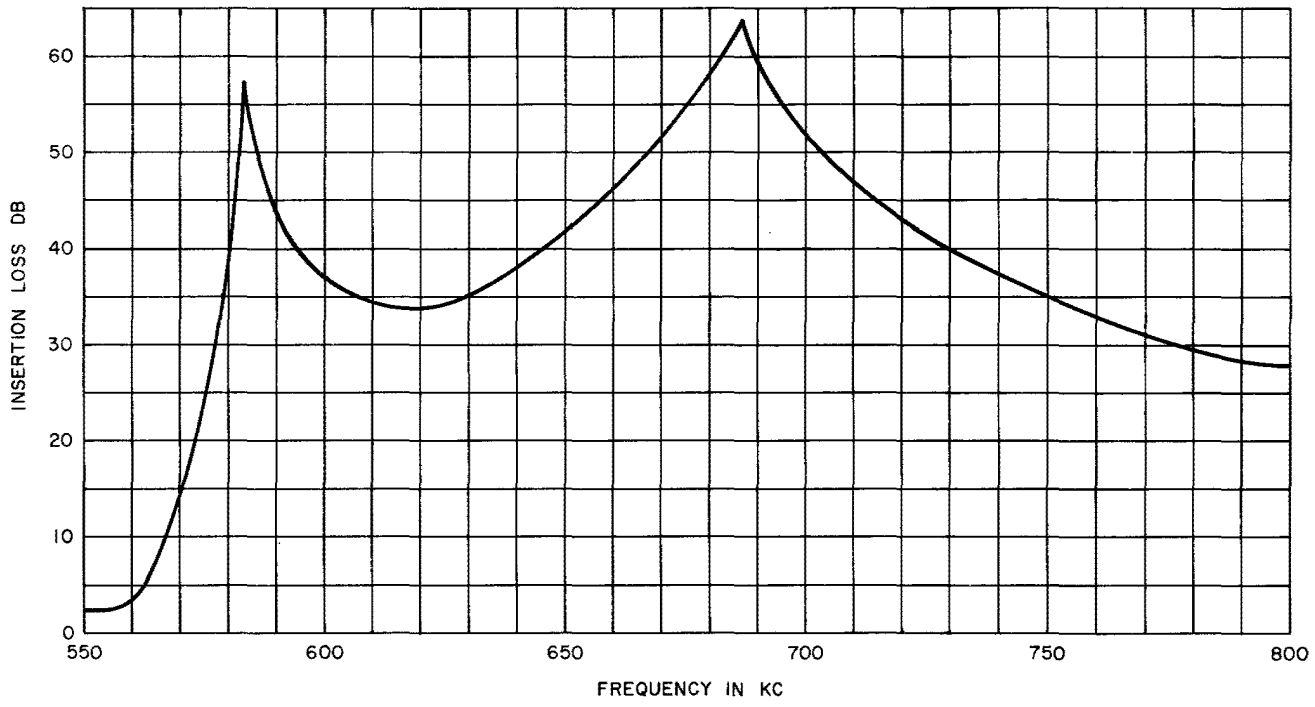


Fig. 32 — Insertion Loss Characteristics of 565A Filter (FL1)

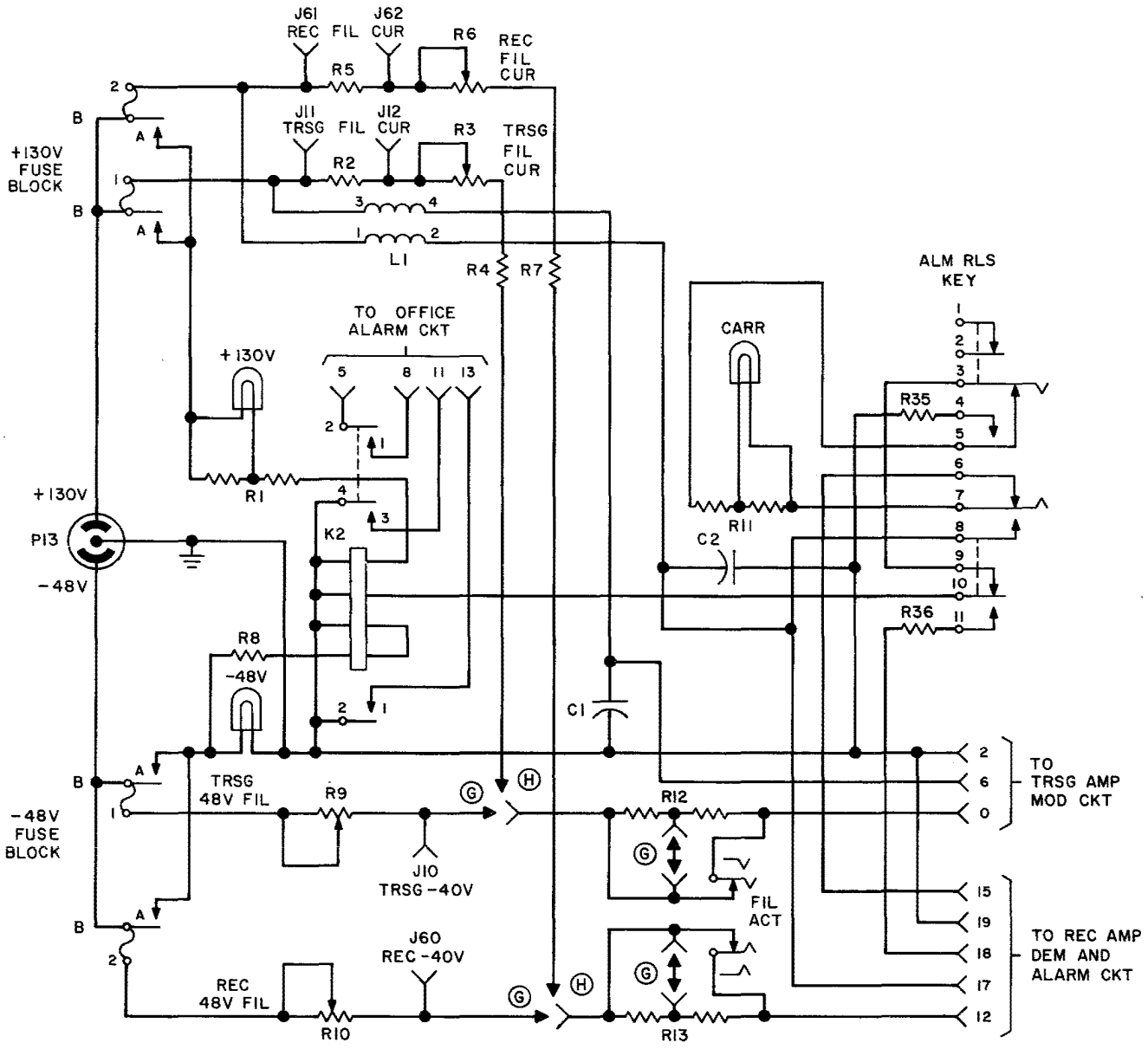


Fig. 33 — Power Supply and Alarm Circuit

4. TESTING AND MAINTENANCE FEATURES

4.01 The 96-channel multiplex equipment is provided with test points, controls, and indicators which enable periodic checks, adjustments, and alarm indications within the 96-channel multiplex mounting and its associated plug-in units. The 48-channel combining panel is provided with test points only.

4.02 When the 96-channel multiplex mounting is used in an application that does not require the J98706AA and J98706AB plug-in units, jacks J1 and J51 require strapped plug-in connectors per ED-92309-30, Group 6. Strapped plugs per ED-92309-30, Group 6, are normally inserted in multiple jacks J14 and J15 and J64 and J65 whether or not the modulator and demodulator plug-in units are used. If desired, in-service bridging measurements can be made at multiple jacks J15 or J65 by removing the strapped plugs.

5. DRAWINGS (NOT ATTACHED)

5.01 The following schematic and equipment drawings (not attached) provide detailed information.

A. SD Drawings

SD-97004-01 — 48-Channel Combining Circuit for Carrier-to-Radio Multiplex

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

SD-95178-01 — HL N Repeater Circuit

SD-95179-01 — LH N Repeater Circuit

SD-95189-01 — LL and HH ON Repeater Circuit for Radio Applitions

SD-95196-01 — Group 1 ON1 Junction, Application Schematic

SD-95197-01 — Groups 2, 3, 4, and 5 ON1 Junction, Application Schematic

SD-95215-01 — LL and LH Repeater Circuit for Radio Applications

SD-95216-01 — LL and HL Repeater Circuit for Radio Applications

SD-95217-01 — LH and LL Repeater Circuit for Radio Applications

SD-95218-01 — HL and LL Repeater Circuit for Radio Applications

SD-95221-01 — HH and LL Repeater Circuit for Radio Applications

SD-95224-01 — Slope Networks, Span Pads, and Artificial Line Circuits

B. J Drawings

J98706U — 96-Channel ON Carrier-to-Radio Multiplex Mounting

J98706W — 48-Channel Combining Panel for Carrier-to-Radio Multiplex

J98706AA — Receiving Amplifier and Demodulator for Carrier-to-Radio Multiplex

J98706AB — Transmitting Amplifier and Modulator for Carrier-to-Radio Multiplex

J98706AC — Power Supply and Alarm Unit for Carrier-to-Radio Multiplex

C. ED Drawings

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