CHANGE

T.O. 31W1-2FCC-102

See Supp C.

TECHNICAL MANUAL

SERVICE

MULTIPLEXER SET AN/FCC-17, AN/FCC-21, AN/FCC-22, AND ASSOCIATED EQUIPMENT

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BASIC AND ALL CHANGES HAVE BEEN MERGED TO MAKE THIS A COMPLETE PUBLICATION.

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LIST OF EFFECTIVE PAGES

Insert latest changed pages; dispose of superseded pages in accordance with applicable regulations.

NOTE: On a changed page, the portion of the text affected by the latest change is indicated by a vertical line, or other change symbol, in the outer margin of the page. Changes to illustrations are indicated by miniature pointing hands. Changes to wiring diagrams are indicated by shaded areas.

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T.O. 31W1-2FCC-102C

SUPPLEMENT

TECHNICAL MANUAL

SERVICE

MULTIPLEXER SET AN/FCC-17

AN/FCC-21, AN/FCC-22,

AND ASSOCIATED EQUIPMENT

THIS PUBLICATION SUPPLEMENTS T.O. 31W1-2FCC-102 DATED 15 MAY 1969. Reference to this supplement will be made on the title page of the basic manual by personnel responsible for maintaining the publication in current status.

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2 SEPTEMBER 1976

NOTE

Reference this supplement
adjacent to the affected area
on each of the following pages.

1. PURPOSE.

The purpose of this supplement is to reflect corrective action of AFTO Form(s) 22 against the basic manual.

2. INSTRUCTIONS.

a. On page 5-41, paragraph 5-110.d. is amended to read as follows:

d. Connect multimeter to DET OUT and COM test points.

b. On page 5-42, paragraph 5-110.j. is amended to read as follows:

j. Transfer multimeter to DET OUT and COM test points. Meter should read 0 volts ± 0.5 volts. (Without mechanical memory, reading should be between -2 and +2 volts.)

c. On page 5-43, paragraph 5-112.c. (1) is amended to read as follows:

(1) Connect multimeter to DET OUT and COM test points.

THE END

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INTRODUCTION

This publication is the service manual for the AN/FCC-17 class of frequency-division multiplex equipment, which can combine as many as 600 4-kc wide communication channels into a baseband signal for transmission over a point-to-point radio link.

This manual covers three standard multiplexer sets having different maximum channel capacities: AN/FCC-21, 60 channels; AN/FCC-22, 240 channels; and AN/FCC-17, 600 channels. (In this manual, data for the three multiplexer sets will usually be given in order of channel capacity rather than nomenclature.) The manual also covers some special variations of major components which were designed for nonstandard configurations of the multiplex equipment.

The service manual consists of five chapters bound in one volume. Chapter 1 contains general information, the installation phase is covered in Chapter 2, and operating instructions are found in Chapter 3. The principles of operation are described in Chapter 4, and Chapter 5 provides instructions for maintenance at the organizational/field level.

The following additional multiplexer set publications should be used in support of the data in this manual:

Alignment manual,
T.O. 31W1-2FCC-109

Circuit Diagrams manual,
T.O. 31W1-2FCC-103

Illustrated Parts Breakdown manual
T.O. 31W1-2FCC-104

Preventive Maintenance Workcard set,
T.O. 31W1-2FCC-106WC-1

Publications for the transmission test set (Telephone Test Set AN/GCM-2 or AN/FCM-8), which is part of the multiplexer set, are as follows:

Service, Circuit Diagrams, and IPB manual, T.O. 33A1-15-1-142 (TM 11-6625-1779-15, NAVSHIPS 0967-337-7040)

Preventive Maintenance Workcard set,
T.O. 33A1-15-1-146WC-1
(NAVSHIPS 0967-337-7050)

Publications governing the use of abbreviations, symbols, reference designations, and terms used in the preparation of this manual are as follows:

MIL-T-9941, Technical Manuals: Ground C-E Equipment, Facility, Site, and System, Preparation of

MIL-STD-12, Abbreviations for Use on Drawings and in Technical-Type Publications

MIL-STD-15-1, Graphic Symbols for Electrical and Electronics Diagram

MIL-STD-16, Electrical and Electronic Reference Designations

MIL-STD-188, Military Communication System Technical Standards

AFM 100-39, Communications-Electronics Terminology

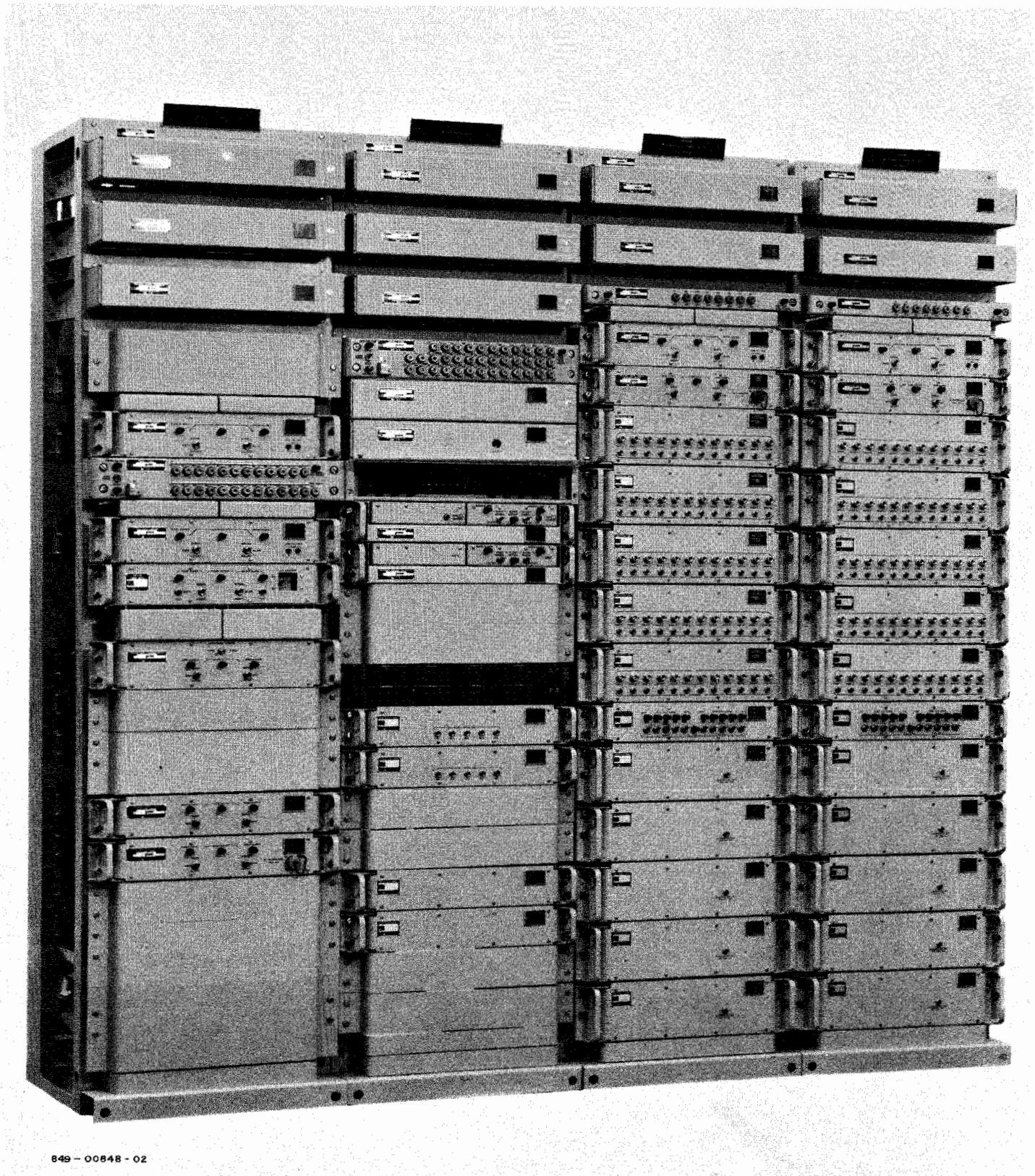

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Figure 1-1. Typical Multiplexer Set

CHAPTER 1
GENERAL INFORMATION

1-1. DESCRIPTION AND PURPOSE.

1-2. EQUIPMENT FUNCTION.

1-3. The AN/FCC-17 class of multiplex equipment is principally used as a carrier telephone terminal in a communications system that employs line-of-sight (microwave) or tropospheric scatter radio transmission. It may also be adapted to coaxial cable systems by the use of suitable line equipment.

1-4. Although the primary application of the multiplex equipment is in a permanent location such as a telephone office, the equipment is capable of operation in other installations (a tactical shelter, for example) where a suitable environment can be maintained.

1-5. By the frequency-division multiplexing process, the equipment combines as many as 600 voice frequency channels into a composite baseband signal (with 4-kc channel spacing) for application to the radio transmitter; by the reciprocal process of demultiplexing, the individual vf channels are recovered from the baseband signal output of the radio receiver. The translation between voice frequency and baseband frequency is accomplished by three successive steps of amplitude modulation (or demodulation), each step utilizing one sideband while suppressing the carrier frequency and the other sideband.

1-6. The message information that can be transmitted over the multiplex channels includes speech, signaling, high-speed teletype, digital data, and graphics. All channels may be loaded with data signals at -5 dbm0 per channel.

1-7. EQUIPMENT CONFIGURATIONS.

1-8. In the AN/FCC-17 class of multiplex equipment, the three standard types of multiplexer sets and their maximum channel capacities are:

a. AN/FCC-21: 60 channels

b. AN/FCC-22: 240 channels

c. AN/FCC-17: 600 channels

Each type has a basic configuration providing a minimum of channels. By adding components or racks of equipment to the basic configuration, the channel complement can be increased incrementally up to the maximum capacity.

1-9. Figure 1-1 shows a typical multiplexer set. Equipment racks making up the three standard multiplexer sets in their maximum configurations are identified in figure 1-2, and the major components on the racks are called out in figures 1-3, 1-4, and 1-5.

1-10. MULTIPLEXER SET AN/FCC-21. The basic multiplexer set has 12 vf channels and is expandable in increments of 12 transmit or receive channels to its maximum capacity of 60 duplex channels. Two 7-foot equipment racks are required; a transmission test set is mounted on one of the racks.

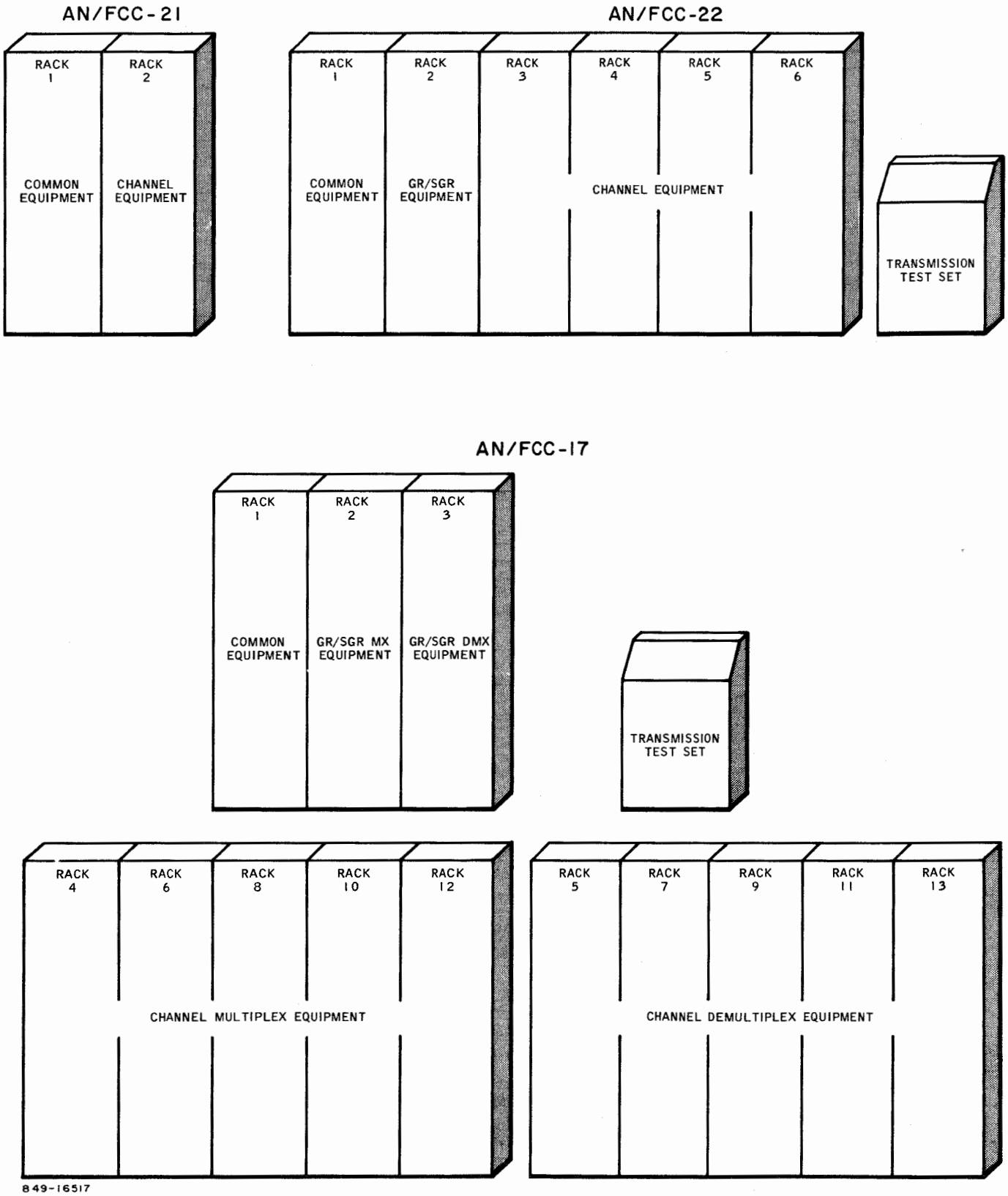


Figure 1-2. Identification of Equipment Racks

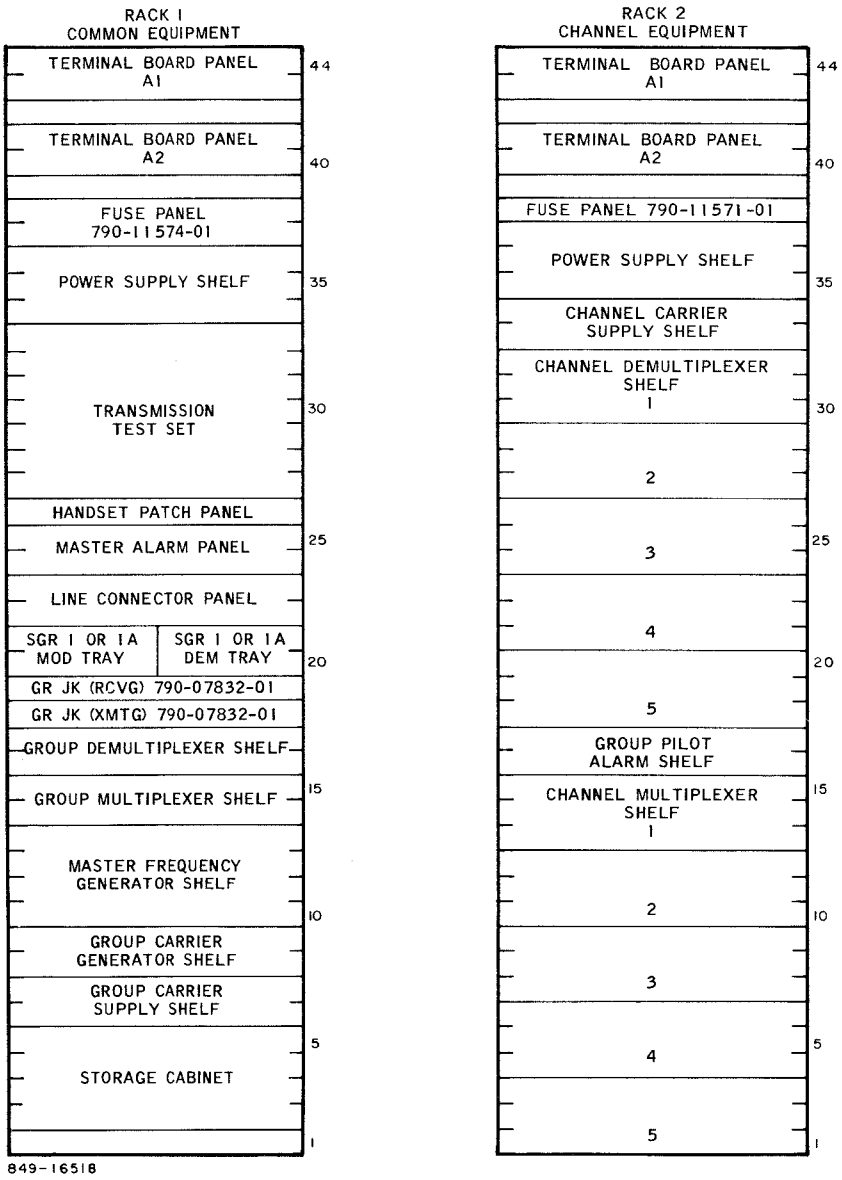
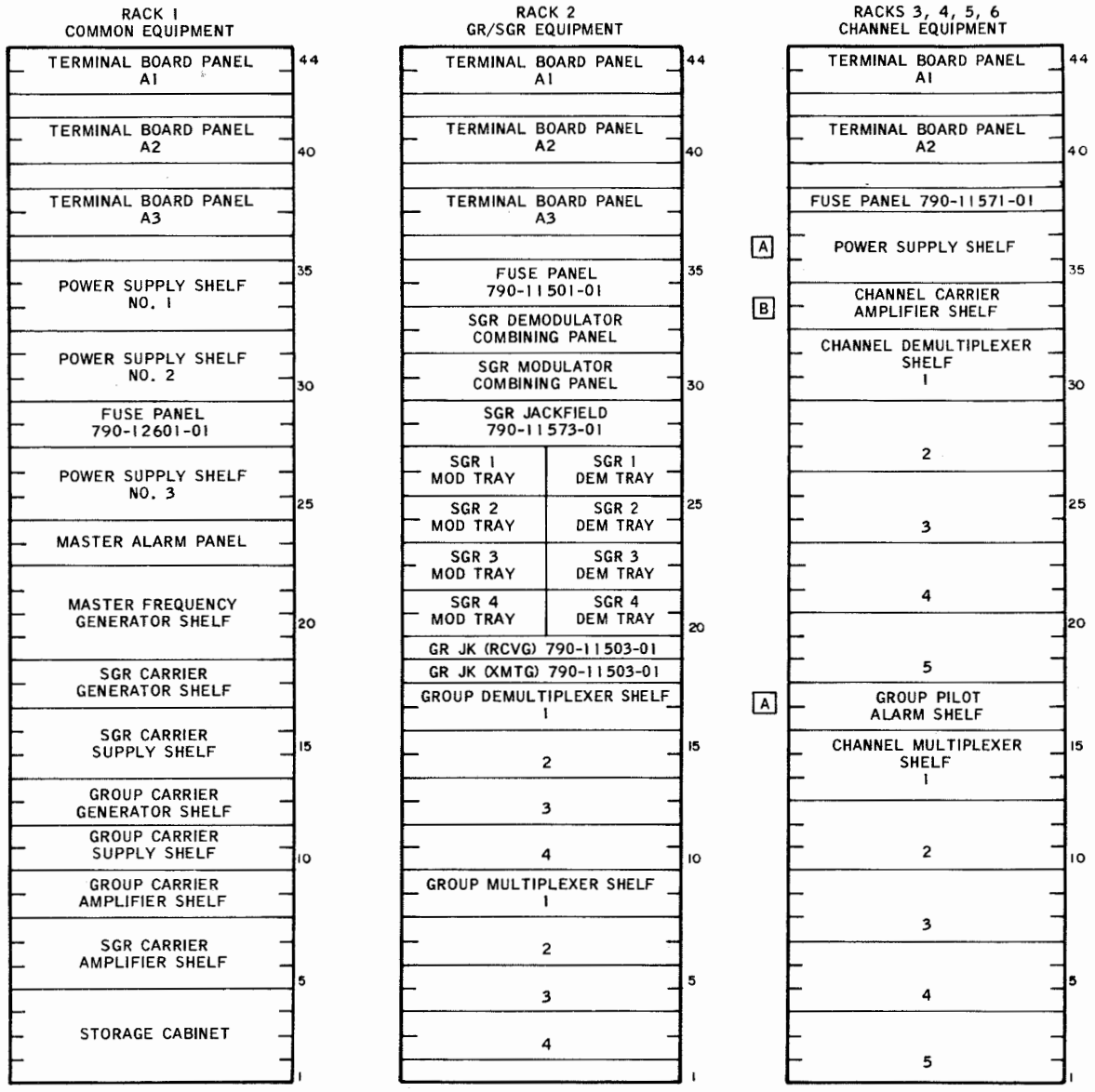


Figure 1-3. Identification of Major Components on Multiplexer Set AN/FCC-21



A RACKS 3 AND 5 ONLY.

B RACK 3 HAS A CHANNEL CARRIER SUPPLY SHELF INSTEAD OF A CHANNEL CARRIER AMPLIFIER SHELF.

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Figure 1-4. Identification of Major Components on Multiplexer Set AN/FCC-22

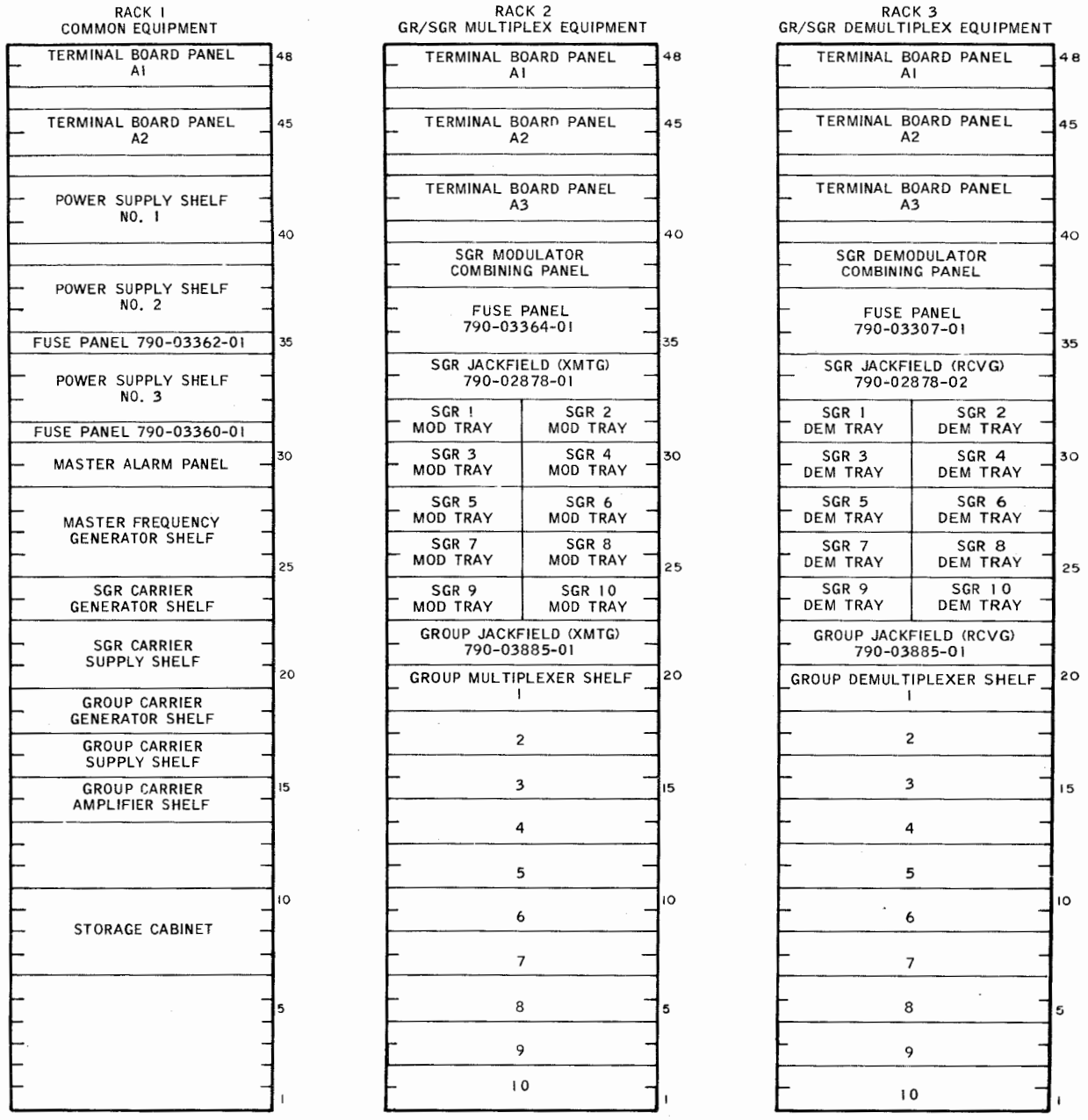

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Figure 1-5. Identification of Major Components on Multiplexer Set AN/FCC-17 (Sheet 1 of 2)

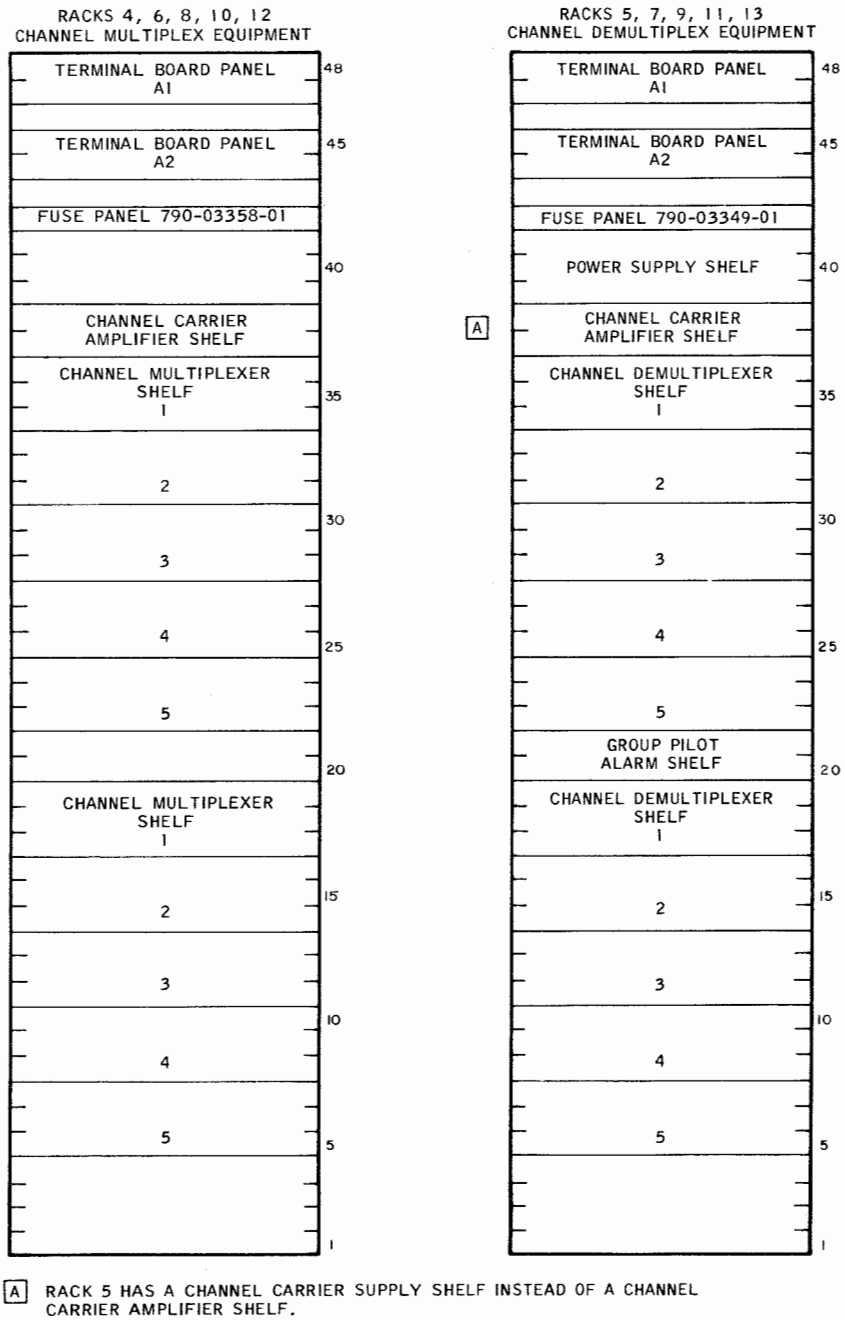


Figure 1-5. Identification of Major Components on Multiplexer Set AN/FCC-17 (Sheet 2 of 2)

1-11. The AN/FCC-21 has two optional line frequency basebands: one is 12-252 kc (supergroup 1A) at a -20 dbm transmitting level (channel test tone), and the other is 60-300 kc (supergroup 1) at a -40 dbm transmitting level.

1-12. The usual applications of the AN/FCC-21 are in tropo systems or low density microwave links.

1-13. MULTIPLEXER SET AN/FCC-22. The basic multiplexer set provides 12 vf channels in the 60-108 kc portion of the line frequency baseband. Channel capacity is expandable in increments of 12 transmit or receive channels to a maximum of 240 duplex channels (supergroups 1 through 4). The complete baseband is 60-1052 kc and the transmitting level (channel test tone) is -40 dbm.

1-14. The AN/FCC-22 occupies three 7-foot equipment racks in the basic configuration and six in the maximum configuration. A dolly-mounted transmission test set is also required.

1-15. Applications of the AN/FCC-22 include intersite links and trunk systems, and wideband tropo systems.

1-16. MULTIPLEXER SET AN/FCC-17. The basic multiplexer set provides 60 vf channels in the 60-300 kc portion of the line frequency baseband. Expansion is in increments of 60 transmit or receive channels to the maximum of 600 duplex channels (supergroups 1 through 10). The complete baseband is 60-2540 kc and the transmitting level (channel test tone) is -40 dbm.

1-17. In its basic configuration, the multiplexer set requires five 7-1/2 foot racks and a dolly-mounted transmission test set; expansion to the maximum configuration increases the number of racks to 13.

1-18. The principal applications of the AN/FCC-17 are in high-density trunk systems and satellite communications systems.

1-19. TRANSMISSION TEST SET.

1-20. The transmission test set (Telephone Test Set AN/GCM-2 or AN/FCM-8) which is part of the multiplexer set, is covered in separate technical manuals T.O. 33A1-15-1-142 (TM 11-6625-1779-15, NAVSHIPS 0967-337-7040) and T.O. 33A1-15-1-146WC-1 (NAVSHIPS 0967-337-7050).

1-21. MULTIPLEXER SET AN/UCC-4(V).

1-22. Multiplexer Set AN/FCC-17 (also -21 and -22) is similar to Multiplexer Set AN/UCC-4(V) and uses many of the same components. The distinctive difference between them is the method of channel modulation. The AN/FCC-17 has a twin-channel modulation plan requiring only 6 channel carrier frequencies: two adjacent channels use the same carrier, and the lower sideband is selected for one channel and the upper sideband for the other. The AN/UCC-4(V) has a lower-sideband modulation plan requiring 12 channel carrier frequencies: each channel uses a different carrier and the lower sideband is always selected.

1-23. Another important difference between the two types of multiplexer sets is the frequency and transmission level of the group pilot: the AN/FCC-17 pilot is 64 kc at -16 dbm0, whereas the AN/UCC-4(V) pilot is 104.08 kc at -20 dbm0.

1-24. REFERENCE TABLES.

1-25. EQUIPMENT CHARACTERISTICS.

1-26. Table 1-1 gives leading particulars and table 1-2 covers capabilities and limitations of Multiplexer Sets AN/FCC-21, -22, and -17.

Table 1-1. Leading Particulars

PRIMARY AC POWER	
Type	Single phase
Voltage	120 volts ±10%
Frequency	50 or 60 cps ±5% (47 to 63 cps)
Maximum load (with all alarm lamps lighted)	
AN/FCC-21	3.0 amperes
AN/FCC-22	7.5 amperes
AN/FCC-17	13.5 amperes
Maximum current to individual ac-operated components	
Power supply shelf	1.5 amperes
Master alarm panel	1.5 amperes
Master frequency generator shelf	0.6 ampere
***DC POWER**	
Voltage	48 volts (+4, -2 volts)
Ripple	0.5% maximum
Maximum load	
AN/FCC-21	2.5 amperes
AN/FCC-22	7.5 amperes
AN/FCC-17	15.5 amperes
***DC ALARM CIRCUIT POWER**	
Voltage	48 volts (30 to 50 volts)
Maximum current	
AN/FCC-21	1 ampere
AN/FCC-22	3 amperes
AN/FCC-17	6 amperes

*When multiplexer set operates from office battery instead of primary ac power.

Table 1-1. Leading Particulars (Cont)

SPACE REQUIRED TO OPERATE EQUIPMENT	
Ceiling height	10 feet
Rack height	
AN/FCC-21	7 feet
AN/FCC-22	7 feet
AN/FCC-17	7-1/2 feet
Floor area (including clearances)	
AN/FCC-21	20 square feet maximum (2 racks)
AN/FCC-22	70 square feet maximum (6 racks and test set)
AN/FCC-17	140 square feet maximum (13 racks and test set)
EQUIPMENT WEIGHT UNCRATED	
AN/FCC-21	1500 pounds (2 racks)
AN/FCC-22	5000 pounds (6 racks and test set)
AN/FCC-17	11,000 pounds (13 racks and test set)
Heaviest equipment rack	960 pounds
Lightest equipment rack	540 pounds
Dolly-mounted transmission test set	225 pounds
TRANSPORTABILITY	
Surface	Rail, truck, or ship
Air	Rotary or fixed-wing aircraft
CABLING	Overhead cable rack and cabling fabricated on site
STORAGE	Crated equipment may be stored in any position for two years.
	Periodic maintenance is not required during storage.

Table 1-2. Capabilities and Limitations

CHANNEL CAPACITY	
AN/FCC-21	60
AN/FCC-22	240
AN/FCC-17	600
TYPE OF MODULATION	Single sideband, suppressed carrier, amplitude modulation
TYPE OF MULTIPLEXING	Frequency-division multiplexing
FREQUENCY BAND	
Channel	300-3500 cps
Group (12 channels)	60-108 kc
Supergroup (60 channels)	312-552 kc
Line (baseband)	
AN/FCC-21	
High level	12-252 kc
Low level	60-300 kc
AN/FCC-22	60-1052 kc
AN/FCC-17	60-2540 kc
TRANSMISSION LEVELS	
Transmitting branch	
Vf input	0, -4, or -16 dbm
Group (60-108 kc)	-34.5 dbm
Supergroup (312-552 kc)	-18 dbm
Hf output	
AN/FCC-21	
High level	-20 dbm (adjustable in 0.5-db steps to -23.5 dbm)
Low level	-40 dbm (adjustable in 0.5 db steps between -40.5 and -37 dbm)
AN/FCC-22 and -17	-40 dbm

Table 1-2. Capabilities and Limitations (Cont)

Receiving branch	
Hf input	
AN/FCC-21	-26 dbm (adjustable in 0.5-db steps to -22.5 dbm)
AN/FCC-22 and -17	-24.5 to -9.5 dbm (adjustable in 1.0-db steps)
Supergroup (312-552 kc)	-28 dbm
Group (60-108 kc)	-12 dbm
Vf output	0, +1, or +7 dbm (adjustable from -20 to +10 dbm)
IMPEDANCES	
Vf input and output	600 ohms balanced
Group (60-108 kc)	135 ohms balanced
Supergroup (312-552 kc)	75 ohms unbalanced
Hf input and output	75 ohms unbalanced
LOAD CAPABILITY	-5 dbm0 data loading on all channels
GROUP PILOT	
Frequency in group band	64 kc
Transmission level	-16 dbm0
CARRIER SYNCHRONIZING PILOT	
Frequency	96 kc
Transmission level	-16 dbm0
CARRIER OSCILLATOR	
Type	Master (convertible to slave)
Frequency	128 kc
Initial setting accuracy	1 part in 10^6
Stability	1 part in 10^6 per month
	5 parts in 10^7 per hour

Table 1-2. Capabilities and Limitations (Cont)

END-TO-END CHANNEL CHARACTERISTICS (Multiplexer set looped at hf line)	
Insertion loss relative to 1000 cps	
325 to 3450 cps	±1.5 db
300 to 3500 cps	+1.5, -3.0 db
Envelope delay distortion	
1000 to 2600 cps	130 μsec maximum
600 to 3200 cps	225 μsec maximum
Single harmonic distortion	At least 40 db below fundamental
Idle channel noise	15 dba0 maximum (135 pwp0)
Loaded channel noise (-5 dbm0 white noise per channel)	20 dba0 maximum (400 pwp0)
Accuracy of a single frequency in the 300 to 3500 cps band	±0.1 cps
Adjacent channel crosstalk (twin channel loaded with 0 dbm0 white noise)	20 dba0 maximum (400 pwp0)
Channel transmit limiting	
Vf input +3.5 dbm0	0.35 db maximum
Vf input +12.0 dbm0	4.0 db minimum
ENVIRONMENTAL CONDITIONS	
Ambient temperature	
Operating	-29°C to +52°C (-21°F to +125°F)
Nonoperating and storage	-62°C to +71°C (-80°F to +160°F)
Relative humidity	
Operating	Up to 95%
Nonoperating and storage	Up to 100%
Altitude	
Operating and nonoperating	Sea level to 10,000 feet
Shipment	Sea level to 50,000 feet

1-27. EQUIPMENT IDENTIFICATION.

1-28. EQUIPMENT SUPPLIED. Table 1-3 lists major components (shelves, trays, and panels) and plug-in modules comprising the three standard multiplexer sets in their maximum channel configurations. Major components are in alphabetical order by common name with trays and modules indented to show their subordination to the shelves.

1-29. For the transmission equipment listed below, the part numbers and type designations appearing in table 1-3 identify the options appropriate for the number of active groups or supergroups in the maximum channel configurations of the multiplexer sets. As an example, the group pilot alarm shelf listed for AN/FCC-21 is Control-Monitor Group OA-4106/MCC-12 (pn 790-01351-01), and for AN/FCC-22 and -17 it is Control-Monitor Group OK-16/FCC; the difference in the two shelves is that the former is equipped to monitor five groups and the latter, ten groups. Additional options providing for different numbers and combinations of groups or supergroups may be found in the Circuit Diagrams manual and the Illustrated Parts Breakdown (IPB) manual.

a. Group pilot alarm shelf

b. Group multiplexer shelf

c. Group demultiplexer shelf

d. Supergroup modulator combining panel

e. Supergroup demodulator combining panel.

1-30. The high-level supergroup 1A modulator tray and all of the supergroup demodulator trays listed in table 1-3 have alarm control modules that monitor the group 1 pilot. Other options are available in which the monitored pilot is in group 2, 3, 4, or 5. The part numbers and type designations for these other options are in the Circuit Diagrams manual and IPB manual.

1-31. ASSOCIATED EQUIPMENT. The equipment described in table 1-4 was designed for special applications of the AN/FCC-17 class of equipment that could not be provided by the standard multiplexer sets. Most of these items are variations of standard components: for example, a power supply shelf and master frequency generator shelf that operate from 400-cps power instead of the standard 50-60 cps power.

1-32. MODULES. In numerical order by part number, table 1-5 lists modules that are covered in separate technical manuals. These modules are all classified as reparable, and unless otherwise specified, they are of the plug-in type.

1-33. AUXILIARY EQUIPMENT. Table 1-6 identifies auxiliary equipment (used with the multiplexer set but not part of it) and gives the applicable technical publication.

1-34. TEST EQUIPMENT AND TOOLS.

1-35. Table 1-7 lists test equipment and special tools that are not supplied with the multiplexer sets, but which are needed for installation and maintenance at the organizational and field level.

1-36. TERMINOLOGY.

1-37. COMPONENT NAMES.

1-38. Components of the multiplexer set are classified by size, method of mounting, and type of electrical interface according to the terms defined below. These terms appear in many of the common names of components; on diagrams, they may be omitted from the name where space is limited.

a. Rack. This term may refer to the rack as a mounting frame, but when used with modifiers, it means the rack and its complement of equipment (channel equipment rack, for example).

b. Shelf. A shelf is a rack-mounted drawer of equipment that can be extended outward on a slide-rail mechanism without interrupting its operation. The height of the shelf is a multiple of 1-3/4 inches (standard rack mounting space); weights are in the range of 15 to 90 pounds. Intra-rack wiring enters through one or more electrical receptacles at the rear of the shelf.

c. Panel. A panel is an immobile rack-mounted chassis; panel heights are in multiples of 1-3/4 inches. Intra-rack wiring is soldered to terminals on the electrical components of the panel.

d. Jackfield. A jackfield is a rack-mounted chassis, similar to a panel, on which groups of telephone jacks or coaxial jacks are mounted. The jacks provide access to the transmitting and receiving circuits of the multiplexer set.

e. Tray. The multiplexer set has two types of trays. One type (power supply tray and master frequency generator tray) is the major subassembly of a shelf; two identical trays are mounted side-by-side and plug into the shelf. The second type (supergroup modulator tray and supergroup demodulator tray) is similar to the first in size but uses a different electrical interface. Two of these supergroup trays are mounted on an equipment support, which has slide rails like a shelf but no electrical circuitry; intra-rack wiring enters through electrical receptacles at the rear of the tray.

f. Module. A module is an enclosed (usually hermetically-sealed) electrical subassembly of a shelf, panel, or tray. Most modules have 7-pin or 9-pin headers, which plug into mating sockets on the chassis; others (usually filters and networks) have header terminals to which soldered connections are made.

1-39. PART NUMBERS.

1-40. The prime manufacturer's part number has 10 digits in the form of the following three examples: 790-12345-01, 720-23456-05, or 791-34567-02. The last two digits in the part number are known as the dash number. In this manual, if the part number of an item of equipment is specified with "-xx" as a dash number, it means the item has optional configurations and more than one dash number may be applicable.

1-41. ABBREVIATIONS.

1-42. Because of their frequent use in this and associated manuals, the following abbreviations are defined below:

BE	Band elimination
DEM	Demodulator
DMX	Demultiplexer
COND	Conductor
EQ	Equalizer
EQUIP.	Equipment
FIL	Filter
GR	Group
GRD	Ground
JK	Jackfield
MFG	Master frequency generator
MX	Multiplexer
NET.	Network
SGR	Supergroup
SUP.	Supply
PAR	Parallel
XMFR	Transformer

1-43. TRANSMITTING AND RECEIVING.

1-44. In references to circuits or equipment in this and associated manuals, and in markings on the equipment, the words transmit and transmitting have the same meaning; receive and receiving are also used interchangeably.

Table 1-3. Equipment Supplied

NOTES:
1. This table includes major components (shelves, trays, panels, and jackfields) and plug-in modules. Major components are in alphabetical order by common name. Indention is used to show the relationship between the items listed.
2. The equipment listed and the quantities shown are for the three standard multiplexer sets fully equipped for their maximum channel capabilities. When quantities are not the same, the following letter symbols are used: (A) 60-channel AN/FCC-21, (B) 240-channel AN/FCC-22, and (C) 600-channel AN/FCC-17.
3. Multiplexer Set AN/FCC-21 has optional baseband frequencies and transmitting levels. Equipment applicable to the two options is designated by these symbols in the quantity column: (A-1) supergroup 1 and low transmitting level, (A-1A) supergroup 1A and high transmitting level.

COMMON NAME AND MFR PART NO.	NOMENCLATURE	QTY	DESCRIPTION AND FUNCTION
Channel carrier amplifier shelf 790-01261-01	Amplifier-Control Group OA-6119/MCC-13	3(B) 9(C)	Amplifies the six channel carriers and supplies them to a maximum of 10 channel multiplexer and/or de-multiplexer shelves.
. Alarm control 790-01152-01	. Alarm Control C-4286/UCC	2	
. Channel carrier amplifier 790-01833-01	. Radio Frequency Amplifier AM-3488/UCC	12	
Channel carrier supply shelf 790-01150-01	Telephone Carrier Frequency Supply Group OA-4126/GCC	1	From an 8-kc input pulse, extracts the six channel carriers. Amplifies the carriers and supplies them to a maximum of 10 channel multiplexer and/or de-multiplexer shelves. Drives a maximum of nine channel carrier amplifier shelves.
. Alarm control 790-01152-01	. Alarm Control C-4286/UCC	2	
. Channel carrier amplifier 790-01833-01	. Radio Frequency Amplifier AM-3488/UCC	12	

Table 1-3. Equipment Supplied (Cont)

COMMON NAME AND MFR PART NO.	NOMENCLATURE	QTY	DESCRIPTION AND FUNCTION
Channel demultiplexer shelf 790-01149-01	Demultiplexer Group OA-4104/GCC	5(A) 20(B) 50(C)	Demultiplexes a 60-108 kc group into 12 vf channels. Supplies a sample of the input signal to the group pilot alarm shelf for monitoring.
• Channel demodulator 790-01071-01	• Carrier Frequency Demodulator MD-489/UCC	12	
. Channel 1 bandpass filter 792-05101-01	. Band Pass Filter F-757/UCC	1	
. Channel 2 bandpass filter 792-05102-01	. Band Pass Filter F-758/UCC	1	
. Channel 3 bandpass filter 792-05103-01	. Band Pass Filter F-759/UCC	1	
. Channel 4 bandpass filter 792-05104-01	. Band Pass Filter F-768/UCC	1	
. Channel 5 bandpass filter 792-05105-01	. Band Pass Filter F-760/UCC	1	
. Channel 6 bandpass filter 792-05106-01	. Band Pass Filter F-761/UCC	1	
. Channel 7 bandpass filter 792-05107-01	. Band Pass Filter F-762/UCC	1	
. Channel 8 bandpass filter 792-05108-01	. Band Pass Filter F-763/UCC	1	
. Channel 9 bandpass filter 792-05109-01	. Band Pass Filter F-764/UCC	1	
. Channel 10 bandpass filter 792-05110-01	. Band Pass Filter F-765/UCC	1	

Table 1-3. Equipment Supplied (Cont)

COMMON NAME AND MFR PART NO.	NOMENCLATURE	QTY	DESCRIPTION AND FUNCTION
. Channel 11 bandpass filter 792-05111-01 . Channel 12 bandpass filter 792-05112-01	. Band Pass Filter F-766/UCC . Band Pass Filter F-767/UCC	1 1	
Channel multiplexer shelf 790-01148-01 . Channel modulator 790-01095-01 . Bandpass filters (channels 1 through 12, same as channel demultiplexer shelf)	Multiplexer Group OA-4103/GCC . Telephone Carrier Modulator MD-485/UCC	5(A) 20(B) 50(C) 12	Multiplexes 12 vf channels into a 60-108 kc group. Injects a 64-kc group pilot.
Equipment rack 790-02270-01 Equipment rack 790-11337-01	Electrical Equipment Rack MT-2512/FCC-17 Electrical Equipment Rack MT-3480/FCC	13(C) 2(A) 6(B)	Box-type rack 7-1/2 feet high with 48 mounting spaces. Box-type rack 7 feet high with 44 mounting spaces.
Fuse panel 790-03307-01 Fuse panel 790-03349-01 Fuse panel 790-03358-01 Fuse panel 790-03360-01	Fuse Panel SB-1298/FCC-17 Fuse Panel SB-1296/FCC-17 Fuse Panel SB-1276/FCC-17 Fuse Panel SB-1297/FCC-17	1(C) 5(C) 5(C) 1(C)	Distributes dc power through 58 0.18-ampere fuses. Distributes dc power through 12 0.25-ampere fuses. Distributes dc power through two 0.25-ampere fuses. Distributes dc power through 13 fuses.

Table 1-3. Equipment Supplied (Cont)

COMMON NAME AND MFR PART NO.	NOMENCLATURE	QTY	DESCRIPTION AND FUNCTION
Fuse panel 790-03362-01	Fuse Panel SB-1294/FCC-17	1(C)	Distributes alarm circuit power through 13 fuses.
Fuse panel 790-03364-01	Fuse Panel SB-1295/FCC-17	1(C)	Distributes dc power through 38 0.18-ampere fuses.
Fuse panel 790-11501-01	Fuse Panel SB-2932/FCC	1(B)	Distributes dc power through 36 0.18-ampere fuses and alarm circuit power through one 0.75-ampere fuse.
Fuse panel 790-11571-01	Fuse Panel SB-2924/FCC	1(A) 4(B)	Distributes dc power through seven 0.25-ampere fuses and alarm circuit power through one 0.75-ampere fuse.
Fuse panel 790-11574-01	Fuse Panel SB-2921/FCC	1(A)	Distributes dc power through 19 fuses (various sizes) and alarm circuit power through one 1.33-ampere fuse.
Fuse panel 790-12601-01	Fuse Panel SB-2931/FCC	1(B)	Distributes dc power through 24 fuses and alarm circuit power through one fuse.
Group carrier amplifier shelf 790-04072-01	Radio Frequency Amplifier Group AM-3157/FCC-17 (same as OG-49/UCC-4(V))	1(B) 1(C)	Amplifies the five group carriers and the supergroup 1 (or 1A) carrier. Supplies the group carriers to a maximum of 10 group multiplexer and/or demultiplexer shelves.
. Alarm control 790-02295-01	. Alarm Control C-4276/UCC	2	
. Carrier amplifier (group or supergroup) 790-02098-01	. Radio Frequency Amplifier AM-3466/UCC	12	

Table 1-3. Equipment Supplied (Cont)

COMMON NAME AND MFR PART NO.	NOMENCLATURE	QTY	DESCRIPTION AND FUNCTION
Group carrier generator shelf 790-02152-01	Telephone Carrier Frequency Supply Group OA-4110/GCC	1	From an 8-kc input pulse, generates three output signals from which the group and supergroup carriers are derived.
. Alarm control 790-02096-01	. Alarm Control C-4277/UCC	2	
. 124-kc amplifier 790-02098-01	. Radio Frequency Amplifier AM-3466/UCC	2	
. Frequency divider 790-02109-01	. Frequency Divider CV-1400/UCC	1	
. Group carrier amplifier 790-02082-01	. Radio Frequency Amplifier AM-3465/UCC	4	
Group carrier supply shelf 790-02199-01	Telephone Carrier Frequency Supply Group OA-4113/GCC	1	Produces the five group carriers and the supergroup 1 (or 1A) carrier. Supplies group carriers to a maximum of 10 group multiplexer and/or demultiplexer shelves. Drives the group carrier amplifier shelf.
. Alarm control 790-02295-01	. Alarm Control C-4276/UCC	2	
. Carrier amplifier (group or supergroup) 790-02098-01	. Radio Frequency Amplifier AM-3466/UCC	12	
Group demultiplexer shelf 790-01640-01	Demultiplexer Group OA-4105/GCC	1(A) 4(B) 10(C)	Demultiplexes a 312-552 kc supergroup into five 60-108 kc groups.
. Group demodulator 790-01648-01	. Carrier Frequency Demodulator MD-488/UCC	5	

Table 1-3. Equipment Supplied (Cont)

COMMON NAME AND MFR PART NO.	NOMENCLATURE	QTY	DESCRIPTION AND FUNCTION
Group jackfield (transmitting or receiving) 790-03885-01	Telephone Jack Assembly TA-417/FCC-17	2(C)	Provides access to the 60-108 kc transmitting or receiving circuits of groups 1 thru 5 in supergroups 1 thru 10.
Group jackfield (transmitting or receiving) 790-07832-01	Telephone Jack Assembly TA-574/FCC	2(A)	Provides access to the 60-108 kc transmitting or receiving circuits of groups 1 thru 5.
Group jackfield (transmitting or receiving) 790-11503-01	Telephone Jack Assembly SB-2934/FCC	2(B)	Provides access to the 60-108 kc transmitting or receiving circuits of groups 1 thru 5 in supergroups 1 thru 4.
Group multiplexer shelf 790-02062-01	Multiplexer Group OA-4114/GCC	1(A) 4(B) 10(C)	Multiplexes five 60-108 kc groups into a 312-552 kc supergroup.
. Group modulator 790-02061-01	. Telephone Carrier Modulator MD-486/UCC	5	
Group pilot alarm shelf 790-01351-01	Control-Monitor Group OA-4106/MCC-12	1(A)	In the receiving direction, monitors the 64-kc pilot in each of the five 60-108 kc groups.
. Alarm control 790-01322-01	. Alarm Control C-4278/UCC	5	

Table 1-3. Equipment Supplied (Cont)

COMMON NAME AND MFR PART NO.	NOMENCLATURE	QTY	DESCRIPTION AND FUNCTION
Group pilot alarm shelf 790-01351-02 • Alarm control 790-01322-01	Control-Monitor Group OK-16/FCC • Alarm Control C-4278/UCC	2(B) 5(C) 10	In the receiving direction, monitors the 64-kc pilot in each of ten 60-108 kc groups.
Handset 747-00418-01	Handset H-222/MCC-12	1	Sound-powered, four-wire telephone handset.
Handset patch panel 790-03354-01	Communication Patching Panel TA-420/MCC-12	1(A)	Facilitates patching Handset H-222/MCC-12 to separated vf transmitting and vf receiving jacks.
Handset patch panel 790-11714-01	Communication Patching Panel SB-3080/UCM-1	1(B) 1(C)	Same as pn 790-03354-01 except mounted on test equipment dolly with transmission test set.
Line connector panel 790-03029-01	Impedance Matching Network CU-936/MCC-12	1(A-1A)	Couples the supergroup 1A modulator and demodulator trays to the hf line. In the transmitting direction, injects the 96-kc carrier sync pilot. In the receiving direction, picks off the 96-kc carrier sync pilot. Provides 3.5 db level adjustment in each direction. Hf line levels are -20 dbm transmitting and -26 dbm receiving.

Table 1-3. Equipment Supplied (Cont)

COMMON NAME AND MFR PART NO.	NOMENCLATURE	QTY	DESCRIPTION AND FUNCTION
Line connector panel 790-03029-03		1(A-1)	Same as pn 790-03029-01 except used with supergroup 1 and has nominal hf line levels of -40 dbm transmitting and -26 dbm receiving.
Master alarm panel 790-02506-01	Indicator-Power Supply ID-1077/MRC-98	1	Indicates minor and major alarm conditions in the multiplexer set and controls external alarm equipment. Supplies alarm circuit power.
Master frequency generator shelf 790-05685-01	Telephone Carrier Frequency Supply TA-495/MRC-98	1	From an internal 128-kc crystal-controlled oscillator, generates the 8-kc pulse from which all carriers are derived. May be operated in the master or slave mode. In the slave mode, provides mechanical memory of the frequency synchronizing voltage.
. Master frequency generator tray 790-05683-01	. Telephone Carrier Frequency Supply Group OA-6791/FCC	2	
. . Alarm control 790-05001-01	. . Alarm Control C-4287/UCC	1	
. . Local 96-kc amplifier 790-04890-01	. . Radio Frequency Amplifier AM-3489/UCC	1	
. . 128-kc oscillator 790-02262-01	. . Radio Frequency Oscillator O-1041/UCC	1	
. . Phase detector 790-05113-01	. . Radio Frequency Detector RF-156/GCC	1	
. . Pilot amplifier 790-05020-01	. . Radio Frequency Amplifier AM-3491/UCC	1	

Table 1-3. Equipment Supplied (Cont)

COMMON NAME AND MFR PART NO.	NOMENCLATURE	QTY	DESCRIPTION AND FUNCTION
. . Pulse generator 790-05105-01	. . Frequency Divider-Pulse Generator CV-1399/UCC	1	
. . Servo 790-05695-01	. . Tuning Capacitor Servo-mechanism TG-143/FCC	1	
. . Servo amplifier 790-05115-01	. . Electronic Control Amplifier AM-4100/FCC	1	
Power supply shelf 790-07975-01	Power Supply Assembly OA-6445/FCC	2(A) 5(B) 8(C)	Generates a 48-volt dc supply from a 120-volt, 50-60 cps input.
. Power supply tray 790-07974-01	. Power Supply PP-3965/FCC	2	
Storage cabinet 790-04014-01	Storage Cabinet CY-3146/MCC-12	1	Provides storage space approximately 15 in. wide by 6 in. high by 20 in. deep.
Supergroup carrier amplifier shelf 790-04971-01	Amplifier-Relay Group OA-7320/UCC-4(V)	1(B)	Supplies carriers to supergroup modulator and demodulator trays on adjacent multiplexer sets. May be equipped with a maximum of six amplifier circuits, each having two amplifiers and one paralleling network.
. Supergroup carrier amplifier (sgr 1 or 1A) 790-02330-01	. Radio Frequency Amplifier AM-3458/UCM		
. 564-kc paralleling network 790-04973-01	. Amplifier Redundancy Network TA-512/ACC-2		
. 612-kc paralleling network 790-04972-01	. Amplifier Redundancy Network TA-649/FCC		
. Supergroup carrier amplifier (sgr 3-10) 790-04660-01	. Amplifier-Control AM-3656/ACC-2		

Table 1-3. Equipment Supplied (Cont)

COMMON NAME AND MFR PART NO.	NOMENCLATURE	QTY	DESCRIPTION AND FUNCTION
. 1116-kc paralleling network 790-04236-01 . 1364-kc paralleling network 790-04237-01 . 1612-kc paralleling network 790-04238-01 . 1860-kc paralleling network 790-04239-01 . 2108-kc paralleling network 790-04240-01 . 2356-kc paralleling network 790-04241-01 . 2604-kc paralleling network 790-04242-01 . 2852-kc paralleling network 790-04243-01	. Amplifier Paralleling Network CU-1740/UCC-4(V) . Amplifier Paralleling Network CU-1741/UCC-4(V) . Amplifier Paralleling Network CU-1732/UCC-4(V) . Amplifier Paralleling Network CU-1733/UCC-4(V) . Amplifier Paralleling Network CU-1734/UCC-4(V) . Amplifier Paralleling Network CU-1735/UCC-4(V) . Amplifier Paralleling Network CU-1736/UCC-4(V) . Amplifier Paralleling Network CU-1737/UCC-4(V)		
Supergroup carrier generator shelf 790-02881-01 . Alarm control 790-02623-01 . 124-kc amplifier 790-02571-01	Telephone Carrier Frequency Supply Group TA-418/FCC-17 (same as OA-8368/UCC-4(V)) . Alarm Control C-7447/UCC-4(V) . Radio Frequency Amplifier AM-4881/UCC-4(V)	1(B) 1(C) 2 2	From a 124-kc input signal, generates the eight carriers for supergroups 3 thru 10. Drives the supergroup carrier supply shelf.

Table 1-3. Equipment Supplied (Cont)

COMMON NAME AND MFR PART NO.	NOMENCLATURE	QTY	DESCRIPTION AND FUNCTION
. Phase changing network 790-02541-01	. Phase Changing Network CV-2377/UCC-4(V)	1	
. Pulse forming network 790-02600-01	. Pulse Forming Network CU-1727/UCC-4(V)	1	
Supergroup carrier supply shelf 790-02880-01	Radio Frequency Amplifier Group AM-2995/FCC-17 (same as OG-48/UCC-4(V))	1(B) 1(C)	Supplies supergroup carriers to the modulator and demodulator trays for supergroups 3 thru 10. Drives the supergroup carrier amplifier shelf (when required).
. Supergroup carrier amplifier 790-02330-01	. Radio Frequency Amplifier AM-3458/UCM	16	
. 1116-kc paralleling network 790-04236-01	. Amplifier Paralleling Network CU-1740/UCC-4(V)	1	
. 1364-kc paralleling network 790-04237-01	. Amplifier Paralleling Network CU-1741/UCC-4(V)	1	
. 1612-kc paralleling network 790-04238-01	. Amplifier Paralleling Network CU-1732/UCC-4(V)	1	
. 1860-kc paralleling network 790-04239-01	. Amplifier Paralleling Network CU-1733/UCC-4(V)	1	
. 2108-kc paralleling network 790-04240-01	. Amplifier Paralleling Network CU-1734/UCC-4(V)	1	
. 2356-kc paralleling network 790-04241-01	. Amplifier Paralleling Network CU-1735/UCC-4(V)	1	
. 2604-kc paralleling network 790-04242-01	. Amplifier Paralleling Network CU-1736/UCC-4(V)	1	
. 2852-kc paralleling network 790-04243-01	. Amplifier Paralleling Network CU-1737/UCC-4(V)	1	

Table 1-3. Equipment Supplied (Cont)

COMMON NAME AND MFR PART NO.	NOMENCLATURE	QTY	DESCRIPTION AND FUNCTION
Supergroup demodulator combining panel 790-03533-01	Combining Network MX-3569/FCC-17	1(C)	Distributes the incoming hf line signal to the inputs of the 10 supergroup demodulator trays. Picks off the 96-kc carrier sync pilot.
. Annulling network 792-05331-01	. Impedance Matching Network CU-1804/FCC-17	1	
. Annulling network 792-05332-01	. Impedance Matching Network CU-1805/FCC-17	1	
Supergroup demodulator combining panel 790-03533-04		1(B)	Same as pn 790-03533-01 except equipped to operate with supergroups 1 through 4 only.
. Annulling network 792-05335-01		1	
. Annulling network 792-05336-01	. Impedance Matching Network CU-1806/FCC-17	1	
Supergroup 1 demodulator tray 790-03931-01	Signal Data Translator OM-5/FCC-64	1(A-1) 1(B) 1(C)	Translates supergroup 1 from 60-300 kc in the line frequency band to 312-552 kc.
Supergroup 2 demodulator tray 790-03932-01	Amplifier-Filter AM-3182/FCC-17	1(B) 1(C)	Extracts supergroup 2 (312-552 kc) from the line frequency band.
Supergroup 3 demodulator tray 790-03933-01	Signal Data Translator MD-439/FCC-17	1(B) 1(C)	Translates supergroup 3 from 564-804 kc in the line frequency band to 312-552 kc.
Supergroup 4 demodulator tray 790-03934-01	Signal Data Translator MD-440/FCC-17	1(B) 1(C)	Translates supergroup 4 from 812-1052 kc in the line frequency band to 312-552 kc.

Table 1-3. Equipment Supplied (Cont)

COMMON NAME AND MFR PART NO.	NOMENCLATURE	QTY	DESCRIPTION AND FUNCTION
Supergroup 5 demodulator tray 790-03935-01	Signal Data Translator MD-441/FCC-17	1(C)	Translates supergroup 5 from 1060-1300 kc in the line frequency band to 312-552 kc.
Supergroup 6 demodulator tray 790-03936-01	Signal Data Translator MD-442/FCC-17	1(C)	Translates supergroup 6 from 1308-1548 kc in the line frequency band to 312-552 kc.
Supergroup 7 demodulator tray 790-03937-01	Signal Data Translator MD-443/FCC-17	1(C)	Translates supergroup 7 from 1556-1796 kc in the line frequency band to 312-552 kc.
Supergroup 8 demodulator tray 790-03938-01	Signal Data Translator MD-444/FCC-17	1(C)	Translates supergroup 8 from 1804-2044 kc in the line frequency band to 312-552 kc.
Supergroup 9 demodulator tray 790-03939-01	Signal Data Translator MD-445/FCC-17	1(C)	Translates supergroup 9 from 2052-2292 kc in the line frequency band to 312-552 kc.
Supergroup 10 demodulator tray 790-03940-01	Signal Data Translator MD-446/FCC-17	1(C)	Translates supergroup 10 from 2300-2540 kc in the line frequency band to 312-552 kc.
NOTE The following plug-in modules are used on the above-listed supergroup demodulator trays as indicated in parentheses:			
. Alarm control (all sgr) 790-02282-01	. Alarm Control C-4280/UCC	2	

Table 1-3. Equipment Supplied (Cont)

COMMON NAME AND MFR PART NO.	NOMENCLATURE	QTY	DESCRIPTION AND FUNCTION
. Supergroup receiving amplifier (all sgr) 790-01841-01	. Radio Frequency Amplifier AM-3464/UCC	2	
. Supergroup demodulator (sgr 1) 790-02580-01	. Telephone Carrier Demodulator MD-496/UCC	1	
. Supergroup receiving pad (sgr 2) 790-02603-01	. Fixed Attenuator CN-969/MCC-13	1	
. Supergroup demodulator (sgr 3 thru 10) 790-02611-01	. Telephone Carrier Demodulator MD-749/UCC-4(V)	1	
Supergroup 1A demodulator tray 790-03273-01	Telephone Carrier Demodulator Group OA-4111/MCC-12	1(A-1A)	Translates supergroup 1A from a line frequency of 12-252 kc to 312-552 kc.
. Alarm control 790-02282-01	. Alarm Control C-4280/UCC	2	
. Supergroup receiving amplifier 790-01841-01	. Radio Frequency Amplifier AM-3464/UCC	2	
. Supergroup demodulator 790-02580-01	. Telephone Carrier Demodulator MD-496/UCC	1	
Supergroup equipment support 790-02316-01	Telephone Modem Support MT-2478/GCC	1(A) 4(B) 10(C)	Chassis for mounting two supergroup modulator trays or two supergroup demodulator trays, or one of each.
Supergroup jackfield (transmitting) 790-02878-01	Telephone Jack Assembly J-1276/FCC-17	1(C)	Provides access to the 312-552 kc transmitting circuits of supergroups 1 through 10.

Table 1-3. Equipment Supplied (Cont)

COMMON NAME AND MFR PART NO.	NOMENCLATURE	QTY	DESCRIPTION AND FUNCTION
Supergroup jackfield (receiving) 790-02878-02	Telephone Jack Assembly J-1276/FCC-17	1(C)	Provides access to the 312-552 kc receiving circuits of supergroups 1 through 10.
Supergroup jackfield 790-11573-01	Telephone Jack Assembly SB-2933/FCC	1(B)	Provides access to the 312-552 kc transmitting and receiving circuits of supergroups 1 through 4.
Supergroup modulator combining panel 790-03532-01	Combining Network MX-3570/FCC-17	1(C)	Combines the outputs of the 10 supergroup modulator trays into a composite hf line transmitting signal. Injects the 96-kc carrier sync pilot.
. Annulling network 792-05331-01	. Impedance Matching Network CU-1804/FCC-17	1	
. Annulling network 792-05332-01	. Impedance Matching Network CU-1805/FCC-17	1	
Supergroup modulator combining panel 790-03532-04		1(B)	Same as pn 790-03532-01 except equipped to operate with supergroups 1 through 4 only.
. Annulling network 792-05335-01		1	
. Annulling network 792-05336-01	. Impedance Matching Network CU-1806/FCC-17	1	
Supergroup 1 modulator tray 790-03901-01	Signal Data Translator MD-428/FCC-17	1(A-1) 1(B) 1(C)	Translates supergroup 1 from 312-552 kc to 60-300 kc in the line frequency band.
Supergroup 2 modulator tray 790-03902-01	Band Pass Filter F-642/FCC-17	1(B) 1(C)	Prepares supergroup 2 (312-552 kc) for inclusion in the line frequency band.

Table 1-3. Equipment Supplied (Cont)

COMMON NAME AND MFR PART NO.	NOMENCLATURE	QTY	DESCRIPTION AND FUNCTION
Supergroup 3 modulator tray 790-03903-01	Signal Data Translator MD-429/FCC-17 (same as OM-18/UCC-4(V))	1(B) 1(C)	Translates supergroup 3 from 312-552 kc to 564-804 kc in the line frequency band.
Supergroup 4 modulator tray 790-03904-01	Signal Data Translator MD-430/FCC-17 (same as OM-19/UCC-4(V))	1(B) 1(C)	Translates supergroup 4 from 312-552 kc to 812-1052 kc in the line frequency band.
Supergroup 5 modulator tray 790-03905-01	Signal Data Translator MD-431/FCC-17 (same as OM-20/UCC-4(V))	1(C)	Translates supergroup 5 from 312-552 kc to 1060-1300 kc in the line frequency band.
Supergroup 6 modulator tray 790-03906-01	Signal Data Translator MD-432/FCC-17 (same as OM-21/UCC-4(V))	1(C)	Translates supergroup 6 from 312-552 kc to 1308-1548 kc in the line frequency band.
Supergroup 7 modulator tray 790-03907-01	Signal Data Translator MD-433/FCC-17 (same as OM-22/UCC-4(V))	1(C)	Translates supergroup 7 from 312-552 kc to 1556-1796 kc in the line frequency band.
Supergroup 8 modulator tray 790-03908-01	Signal Data Translator MD-434/FCC-17 (same as OM-23/UCC-4(V))	1(C)	Translates supergroup 8 from 312-552 kc to 1804-2044 kc in the line frequency band.
Supergroup 9 modulator tray 790-03909-01	Signal Data Translator MD-435/FCC-17 (same as OM-24/UCC-4(V))	1(C)	Translates supergroup 9 from 312-552 kc to 2052-2292 kc in the line frequency band.
Supergroup 10 modulator tray 790-03910-01	Signal Data Translator MD-436/FCC-17 (same as OM-25/UCC-4(V))	1(C)	Translates supergroup 10 from 312-552 kc to 2300-2540 kc in the line frequency band.

Table 1-3. Equipment Supplied (Cont)

COMMON NAME AND MFR PART NO.	NOMENCLATURE	QTY	DESCRIPTION AND FUNCTION
NOTE The following plug-in modules are used on the above-listed supergroup modulator trays as indicated in parentheses:			
. Supergroup modulator (sgr 1) 790-02581-01	. Telephone Carrier Modulator MD-487/UCC	1	
. Supergroup transmitting pad (sgr 2) 790-02588-01	. Fixed Attenuator CN-968/MCC-13	1	
. Supergroup modulator (sgr 3-10) 790-02610-01	. Telephone Carrier Modulator MD-748/UCC-4(V)	1	
Supergroup 1A modulator tray 790-06980-02	Telephone Carrier Modulator Group OA-6442/FCC	1(A-1A)	Translates supergroup 1A from 312-552 kc to a line frequency of 12-252 kc. Amplifies the signal to an output level of -19.5 dbm.
. Alarm control 790-02344-01	. Alarm Control C-4279/UCC	2	
. Line supergroup amplifier 790-02138-01	. AF-RF Amplifier AM-3467/UCM	2	
. Supergroup modulator 790-02581-01	. Telephone Carrier Modulator MD-487/UCC	1	
Terminal board panel 790-02634-01	Terminal Board Assembly J-1244/GCC	4(A) 14(B) 28(C)	Provides 300 terminals on three blocks (one 6 x 10 and two 6 x 20) for terminating external, inter-rack, and intra-rack wiring.

Table 1-3. Equipment Supplied (Cont)

COMMON NAME AND MFR PART NO.	NOMENCLATURE	QTY	DESCRIPTION AND FUNCTION
Test equipment dolly 790-11279-01	Test Equipment Dolly V-301/FCC	1(B) 1(C)	Provides mounting facility for transmission test set.
Transmission test set 790-03056-01 or 790-07959-01	Telephone Test Set AN/GCM-2 or AN/FCM-8	1	Test equipment used for alignment and performance monitoring of the multiplexer set.

Table 1-4. Associated Equipment

COMMON NAME AND MFR PART NO.	NOMENCLATURE	DESCRIPTION AND FUNCTION
Fuse panel 790-11502-01	Fuse Panel SB-2922/FCC	Distributes dc power through 13 fuses and alarm circuit power through one fuse.
Fuse panel 790-12604-01	Fuse Panel SB-3078/UCC-4(V)	Distributes dc power through 10 fuses and alarm circuit power through one fuse.
Line connector panel 790-03029-02	Impedance Matching Network CU-1154/MRC-98	Same as pn 790-03029-01 (table 1-3) except the nominal hf line levels are -23 dbm transmitting and -23 dbm receiving.
Master alarm panel 790-03319-01	Control-Indicator C-3668/MCC-12	Indicates minor and major alarm conditions in the multiplexer set and controls external alarm equipment. Generates 40-volt dc alarm circuit power from 120-volt 400-cps input.
Master frequency generator shelf 790-05155-01 . Master frequency generator tray 790-05112-01 . . Servo (400-cps) 790-05114-01 . . Servo amplifier (400-cps) 790-06622-01	Telephone Carrier Frequency Supply Group OA-4127/MCC-12 . Telephone Carrier Frequency Supply Group OA-4128/MCC-12 . . Tuning Capacitor Servomechanism TG-127/MCC-12 . . Electronic Control Amplifier AM-3490/MCC-12	Same as pn 790-05685-01 (table 1-3) except the ac supply is 400-cps instead of 60-cps. Same as pn 790-05683-01 except the servo and servo amplifier modules are 400-cps instead of 60-cps.

Table 1-4. Associated Equipment (Cont)

COMMON NAME AND MFR PART NO.	NOMENCLATURE	DESCRIPTION AND FUNCTION
Master frequency generator shelf 790-05155-03 . Master frequency generator tray 790-05112-03 . . Dummy servo 790-07217-01		Same as pn 790-05155-01 except it does not provide mechanical memory in the slave mode. Same as pn 790-05112-01 except the servo module is replaced by a dummy servo module.
Master frequency generator shelf 790-05155-05 . Master frequency generator tray 790-05112-05 . . Dummy phase detector 790-05432-01	. . Band Frequency Dummy Detector DA-330/ACC-2	Same as pn 790-05155-01 except it cannot operate in the slave mode. Same as 790-05112-01 except the phase detector module is replaced by a dummy phase detector module and the servo, servo amplifier, and pilot amplifier modules are not used.
Master frequency generator shelf 790-05685-03 . Master frequency generator tray 790-05683-03 . . Dummy servo 790-07217-01		Same as pn 790-05685-01 (table 1-3) except it does not provide mechanical memory in the slave mode. Same as pn 790-05683-01 except the servo module is replaced by a dummy servo module.
Master frequency generator shelf 790-05685-05		Same as pn 790-05685-01 except it cannot operate in the slave mode.

Table 1-4. Associated Equipment (Cont)

COMMON NAME AND MFR PART NO.	NOMENCLATURE	DESCRIPTION AND FUNCTION
. Master frequency generator tray 790-05683-05 . . Dummy phase detector 790-05432-01	. . Band Frequency Dummy Detector DA-330/ACC-2	Same as pn 790-05683-01 except the phase detector module is replaced by a dummy phase detector module, and the servo, servo amplifier, and pilot amplifier modules are not used.
Power supply shelf 790-01855-01 . Power supply tray 790-01866-01	Power Supply Set OA-6830/FCC . Power Supply PP-4115/FCC	Generates a 48-volt dc supply from a 120-volt 60-cps input. Superseded by pn 790-07975-01 (table 1-3).
Power supply shelf 790-01855-03	Power Supply PP-3613/MRC-98	Same as pn 790-01855-01 except it has only one power supply tray.
Power supply shelf 790-02963-01 . Power supply tray 790-02964-01	Power Supply Set OA-4109/MCC-12 . Power Supply PP-3498/MCC-12	Generates a 48-volt dc supply from a 120-volt 400-cps input.
Power supply shelf 790-07975-03		Same as pn 790-07975-01 (table 1-3) except it has only one power supply tray.
Supergroup demodulator combining panel 790-07211-01	Frequency Divider CU-1273/MCC-13	Distributes the incoming hf line signal to the inputs of the demodulator trays for supergroups 1 and 2. Picks off the 96-kc carrier sync pilot. Nominal input level is -10 dbm.

Table 1-4. Associated Equipment (Cont)

COMMON NAME AND MFR PART NO.	NOMENCLATURE	DESCRIPTION AND FUNCTION
Supergroup demodulator combining panel 790-07211-02		Same as pn 790-07211-01 except the nominal input level is -15 dbm.
Supergroup demodulator combining panel 790-07211-03		Same as pn 790-07211-02 except the operating frequency range is 12-552 kc, covering supergroups 1A and 2.
Supergroup 1 demodulator tray 790-07226-01	Telephone Carrier Demodulator Group OA-6122/MCC-13	Translates supergroup 1 from 60-300 kc in the line frequency band to 312-552 kc. Uses same modules as pn 790-03931-01 (table 1-3).
Supergroup 2 demodulator tray 790-07227-01	Amplifier-Attenuator Group OA-6123/MCC-13	Extracts supergroup 2 (312-552 kc) from the line frequency band. Uses same modules as pn 790-03932-01 (table 1-3).
Supergroup modulator combining panel 790-07210-01	Radio Frequency Combiner CU-1274/MCC-13	Combines the outputs of the modulator trays for supergroups 1 and 2 into a composite hf line transmitting signal. Injects the 96-kc carrier sync pilot. Nominal input level is -36.5 dbm. Output level is adjustable between -40 and -55 dbm.
Supergroup modulator combining panel 790-07210-02		Same as pn 790-07210-01 except the nominal input level is -19.5 dbm and the output level is adjustable between -23 and -38 dbm.

Table 1-4. Associated Equipment (Cont)

COMMON NAME AND MFR PART NO.	NOMENCLATURE	DESCRIPTION AND FUNCTION
Supergroup modulator combining panel 790-07210-03		Same as pn 790-07210-01 except the operating frequency range is 12-552 kc, covering supergroups 1A and 2.
Supergroup modulator combining panel 790-07210-04		Same as pn 790-07210-02 except the operating frequency range is 12-552 kc, covering supergroups 1A and 2.
Supergroup 1 modulator tray 790-07259-01 . Alarm control 790-07258-01		Translates supergroup 1 from 312-552 kc to 60-300 kc in the line frequency band. Output level is -19.5 dbm. Uses same modules as pn 790-06980-02 (table 1-3) except for the alarm control module, which monitors the group 1 pilot at 256 kc.
Supergroup 1 modulator tray 790-07259-02 . Alarm control 790-05173-02	Telephone Carrier Modulator Group OM-8/FCC-17 . Alarm Control C-4647/MRC-98	Same as pn 790-07259-01 except for the alarm control module, which monitors the group 5 pilot at 64 kc.
Supergroup 1A modulator tray 790-03077-01	Telephone Carrier Modulator Group OA-4112/MCC-12	Translates supergroup 1A from 312-552 kc to a line frequency of 12-252 kc. Output level is -19.5 dbm. Uses same modules as pn 790-06980-02 (table 1-3). Requires dc alarm circuit power.

Table 1-4. Associated Equipment (Cont)

COMMON NAME AND MFR PART NO.	NOMENCLATURE	DESCRIPTION AND FUNCTION
Supergroup 2 modulator tray 790-06999-01 . Supergroup transmitting pad 790-06998-01	Telephone Attenuator-Filter CN-1157/FCC-60 . Fixed Attenuator CN-1158/FCC-60	Prepares supergroup 2 for inclusion in the line frequency band. Output level is -24.5 dbm.
Terminal board panel 790-00206-01	Terminal Board Assembly J-2758/FCC-17	Provides 400 terminals on three blocks (one 8 x 10 and two 8 x 20) for terminating external, inter-rack, and intra-rack wiring.

Table 1-5. List of Modules Covered in Other Technical Publications

PART NO. 790-	COMMON NAME NOMENCLATURE	TECHNICAL PUBLICATION
01071-01	Channel demodulator Carrier Frequency Demodulator MD-489/UCC	T.O. 31W1-2UCC-272
01095-01	Channel modulator Telephone Carrier Modulator MD-485/UCC	T.O. 31W1-2UCC-262
01152-01	Alarm control Alarm Control C-4286/UCC	T.O. 31W1-2UCC-102 TM 11-5805-546-15 NAVSHIPS 0967-337-7380
01322-01	Alarm control Alarm Control C-4278/UCC	T.O. 31W1-2UCC-282
01648-01	Group demodulator Carrier Frequency Demodulator MD-488/UCC	T.O. 31W1-2UCC-112 TM 11-5805-538-15 NAVSHIPS 0967-337-7390
01833-01	Channel carrier amplifier Radio Frequency Amplifier AM-3488/UCC	T.O. 31W1-2UCC-122 TM 11-5805-547-15 NAVSHIPS 0967-337-7400
01841-01	Supergroup receiving amplifier Radio Frequency Amplifier AM-3464/UCC	T.O. 31W1-2UCC-132 TM 11-5805-544-15 NAVSHIPS 0967-337-7410
02061-01	Group modulator Telephone Carrier Modulator MD-486/UCC	T.O. 31W1-2UCC-142 TM 11-5805-548-15 NAVSHIPS 0967-337-7420
02082-01	Group carrier amplifier Radio Frequency Amplifier AM-3465/UCC	T.O. 31W1-2UCC-152 TM 11-5805-545-15 NAVSHIPS 0967-337-7430
02096-01	Alarm control Alarm Control C-4277/UCC	T.O. 31W1-2UCC-162 TM 11-5805-543-15 NAVSHIPS 0967-337-7440

Table 1-5. List of Modules Covered in Other Technical Publications (Cont)

PART NO. 790-	COMMON NAME NOMENCLATURE	TECHNICAL PUBLICATION
02098-01	Amplifier; group carrier, supergroup carrier, or 124-kc Radio Frequency Amplifier AM-3466/UCC	T.O. 31W1-2UCC-172 TM 11-5805-542-15 NAVSHIPS 0967-337-7450
02109-01	Frequency divider Frequency Divider CV-1400/UCC	T.O. 31W1-2UCC-182 TM 11-5805-523-15 NAVSHIPS 0967-337-7460
02138-01	Line supergroup amplifier AF-RF Amplifier AM-3467/UCM	T.O. 31W1-2UCM-102
02169-01	Paralleling network	Same as pn 790-02138-01
02262-01	128-kc oscillator Radio Frequency Oscillator O-1041/UCC	T.O. 31W1-2UCC-192 TM 11-5805-508-15 NAVSHIPS 0967-337-7470
02282-01	Alarm control Alarm Control C-4280/UCC	T.O. 31W1-2UCC-302
02295-01	Alarm control Alarm Control C-4276/UCC	T.O. 31W1-2UCC-202 TM 11-5805-537-15 NAVSHIPS 0967-337-7480
02330-01	Supergroup carrier amplifier (sgr 1) Radio Frequency Amplifier AM-3458/UCM	T.O. 33A1-2-130-2 TM 11-6625-1778-15 NAVSHIPS 0967-337-7060
02344-01	Alarm control Alarm Control C-4279/UCC	T.O. 31W1-2UCC-292
02571-01	124-kc amplifier Radio Frequency Amplifier AM-4881/UCC-4(V)	T.O. 31W1-2UCC4-152 TM 11-5805-541-15 NAVSHIPS 0967-337-7370
02580-01	Supergroup demodulator (sgr 1) Telephone Carrier Demodulator MD-496/UCC	T.O. 31W1-2UCC-212 TM 11-5805-509-15 NAVSHIPS 0967-337-7490

Table 1-5. List of Modules Covered in Other Technical Publications (Cont)

PART NO. 790-	COMMON NAME NOMENCLATURE	TECHNICAL PUBLICATION
02581-01	Supergroup modulator (sgr 1) Telephone Carrier Modulator MD-487/UCC	Same as pn 790-02580-01
02610-01	Supergroup modulator (sgr 3-10) Telephone Carrier Modulator MD-748/UCC-4(V)	Same as pn 790-02580-01
02611-01	Supergroup demodulator (sgr 3-10) Telephone Carrier Demodulator MD-749/UCC-4(V)	Same as pn 790-02580-01
02623-01	Alarm control Alarm Control C-7447/UCC-4(V)	T.O. 31W1-2UCC4-22 TM 11-5805-522-15 NAVSHIPS 0967-337-7240
02999-01	516-kc modulator (wired-in module)	T.O. 31W1-4-198-2 TM 11-5805-525-15 NAVSHIPS 0967-337-7620
03009-01	Frequency generator (wired-in module)	T.O. 31W1-4-197-2 TM 11-5805-526-15 NAVSHIPS 0967-337-7610
04660-01	Supergroup carrier amplifier (sgr 3-10) Amplifier-Control AM-3656/ACC-2	T.O. 31W1-2ACC2-2 TM 11-5805-532-15 NAVSHIPS 0967-337-7550
04890-01	Local 96-kc amplifier Radio Frequency Amplifier AM-3489/UCC	T.O. 31W1-2UCC-222 TM 11-5805-536-15 NAVSHIPS 0967-337-7500
05001-01	Alarm control Alarm Control C-4287/UCC	T.O. 31W1-2UCC-232 TM 11-5805-535-15 NAVSHIPS 0967-337-7510
05020-01	Pilot amplifier Radio Frequency Amplifier AM-3491/UCC	T.O. 31W1-2UCC-242 TM 11-5805-534-15 NAVSHIPS 0967-337-7520
05088-01, -02, -05, -06	Alarm control Alarm Control C-4581/ACC-2 (-01) Alarm Control C-7118/FCC-63 (-02)	T.O. 31W1-4-211-2

Table 1-5. List of Modules Covered in Other Technical Publications (Cont)

PART NO. 790-	COMMON NAME NOMENCLATURE	TECHNICAL PUBLICATION
05105-01	Pulse generator Frequency Divider-Pulse Generator CV-1399/UCC	T.O. 31W1-2UCC-252 TM 11-5805-510-15 NAVSHIPS 0967-337-7530
05113-01	Phase detector Radio Frequency Detector RF-156/GCC	T.O. 31W1-2GCC-102 TM 11-5805-527-15 NAVSHIPS 0967-337-7600
05114-01	Servo (400-cps) Tuning Capacitor Servomechanism TG-127/MCC-12	T.O. 31W1-2FCC-122 TM 11-5805-531-15 NAVSHIPS 0967-337-7560
05115-01	Servo amplifier (60-cps) Electronic Control Amplifier AM-4100/FCC	T.O. 31W1-2-112 TM 11-5805-533-15 NAVSHIPS 0967-337-7540
05173-01 thru -04	Alarm control Alarm Control C-4580/ACC-2 (-01) Alarm Control C-4647/MRC-98 (-02)	T.O. 31W1-4-209-2
05695-01	Servo (60-cps) Tuning Capacitor Servomechanism TG-143/FCC	Same as pn 790-05114-01
06622-01	Servo amplifier (400-cps) Electronic Control Amplifier AM-3490/MCC-12	Same as pn 790-05115-01
06961-01	Voltage monitor (wired-in module) Monitor-Regulator	T.O. 31W1-4-199-2 TM 11-5805-524-15 NAVSHIPS 0967-337-7630
07258-01	Alarm control	T.O. 31W1-4-207-2

Table 1-6. Auxiliary Equipment

PART NO. 790-	COMMON NAME NOMENCLATURE	FUNCTION	TECHNICAL PUBLICATION
06923-01	Four-wire termination shelf Hybrid Circuit Network Group OA-7424/FCC-17	Converts 12 vf channels from two-wire to four-wire circuits	T.O. 31W1-4-112-2
05417-01	Transmit signal converter shelf Signal Data Converter Group OA-7319/FCC-17	For 12 vf channels, converts dc signaling (ground and battery) on the M lead to inband tone (2600 cps) signaling	T.O. 31W1-4-110-2
04615-01	Receive signal converter shelf Telephone Signal Converter Group OA-7423/FCC-17	For 12 vf channels, converts inband tone (2600 cps) signaling to dc signaling (open and ground) on the E lead	T.O. 31W1-4-110-2
06800-01	Compressor shelf Waveform Compressor TA-619/FCC-17	Compresses the range of levels in the transmitting branches of 12 vf channels	
11891-01	Expandor shelf Waveform Restorer TA-620/FCC-17	Expands the range of levels in the receiving branches of 12 vf channels	
07576-xx	Group interconnect panel Interconnecting Group OA-7181, OA-7182, and OA-7183/FCC-17	Transfers a 60-108 kc group from the receiving branch of a multiplexer set to the transmitting branch of another or the same multiplexer set	T.O. 31W1-4-111-2

Table 1-6. Auxiliary Equipment (Cont)

PART NO. 790-	COMMON NAME NOMENCLATURE	FUNCTION	TECHNICAL PUBLICATION
11622-xx	Supergroup interconnect shelf Interconnecting Group ON-60, OA-7151, and OA-7152/FCC-17	Transfers a 312-552 kc supergroup from the receiving branch of a multiplexer set to the transmitting branch of another or the same multiplexer set	T.O. 31W1-4-254-2
11791-xx	Hybrid branching panel Hybrid Branching Network TA-618, TA-640, TA-641, TA-642, TA-643, and TA-644/FCC-17	Transfers a baseband signal from the output of a radio receiver to the input of a radio transmitter while dropping and/or inserting groups or supergroups.	T.O. 31R2-4-409-2

Table 1-7. Equipment Required But Not Supplied

NOTE: For additional description of items listed in this table, refer to Section I of Chapter 5.

Test Equipment	Qty
Vacuum Tube Voltmeter, Hewlett-Packard model 400H	1
Oscilloscope, Tektronix type 310A	1
Multimeter AN/PSM-6	1
Noise Measuring Set, Western Electric type 3A, equipped with type 497A Weighting Network; or Northeast Electronics model TTS-37B	1
Electronic Counter, Hewlett-Packard model 5532A	1
Cords and Plugs	
633A Cord or Electrical Cord Assembly CX-9443/U (Lenkurt)	4
647A Cord (Lenkurt)	1
651C Cord (Lenkurt)	1
665A Plug or Terminating Plug 790-07812-01 (Lenkurt)	4
666A Plug (Lenkurt)	12
669A Plug (Lenkurt)	2
670A Plug (Lenkurt)	2
673A Cord (Lenkurt)	2
674A Cord (Lenkurt)	2
676C Plug or Terminating Plug 790-07813-01 (Lenkurt)	2
684D Cord (Lenkurt)	2
696A Plug (Lenkurt)	2
699A Cord (Lenkurt)	2
708A Adapter Plug (Lenkurt)	1
013-009 Binding Post Adapter (Tektronix)	1
Special Tools	
Manual Contact Crimping Tool, Burndy part no. M8ND	1
Contact Crimping Die Set, Burndy part no. N16RT-15	1
Contact Crimping Die Set, Burndy part no. N20RT-20	1

Table 1-7. Equipment Required But Not Supplied (Cont)

Special Tools (Cont)	Qty
Contact Crimping Die Set, Burndy part no. N22RVMT-30	1
Contact Extraction Tool, Burndy part no. RX8-1	1
Contact Extraction Tool, Burndy part no. RX16-5	1
Contact Extraction Tool, Burndy part no. RX20-13	1
Contact Extraction Tool, Burndy part no. RX20-20	1

CHAPTER 2
INSTALLATION

2-1. INTRODUCTION. This chapter contains information about installation of the multiplexer set. Section I covers installation planning, Section II provides logistic data, and Section III gives the installation procedures. Section IV contains information about preparing the multiplexer set for reshipment.

SECTION I
INSTALLATION PLANNING

2-2. This section is intended to assist field engineering personnel in site adapting and planning for the installation of the multiplexer set. The leading particulars of the equipment are given in table 1-1 and the building requirements are in Section II of this chapter.

2-3. EQUIPMENT ROOM.

2-4. FLOOR SPACE. Including allowances for clearances around the equipment, about 10 square feet of floor space will be needed for each rack and for the transmission test set. Where two rows of racks utilize the same aisle, less floor space will be needed. The following minimum clearances shall be provided:

a. Front of equipment: 48-inch aisle

b. Between racks and a permanent wall: 6 inches

c. Between racks mounted back-to-back: 1 inch

d. Between racks mounted side-to-side: 1/8 inch

2-5. OVERHEAD. The ceiling height should be at least 10 feet, and the space above the equipment should be clear of heating or ventilating ducts, plumbing, conduit, or light fixtures. If such obstructions are necessary, they should be at least 10 feet above the floor level where they will not interfere with the routing of cable rack or cable duct.

2-6. For the support of the cable rack that will serve the multiplexer set and associated equipment, unistrut channels on four-foot centers should be installed on the ceiling.

2-7. ENVIRONMENTAL CONDITIONS. In most geographical locations, the normal heating and ventilating facilities for personnel will provide a suitable environment for the multiplexer set. The heat emission from the equipment is very low (500 to 1500 Btu per hour). Although the multiplexer set will operate under much more severe conditions, when environmental control is

provided, the following limits should be imposed:

a. Temperature: 77°F (±18°)

b. Relative humidity: 80% maximum

2-8. RF SHIELDING. If the multiplexer set is to be located near high power radio transmitting equipment, the equipment room may have to be completely enclosed by rf shielding material. However, the presence of a radiated electromagnetic field up to the following limits (MIL-STD-461, test method RS03) should not cause any degradation in the performance of the multiplexer set:

a. 14 kc to 2.6 mc: 0.1 volt/meter

b. 2.6 mc to 100 mc: 0.3 volt/meter

2-9. EQUIPMENT ROOM LAYOUT. The layout of the equipment room will depend on the configuration of the multiplexer set and its ultimate planned channel capacity. A typical floor plan for a 480-channel terminal is shown in figure 2-1. Also to be considered is the associated equipment (in the same room or other areas) with which the multiplexer set will be interconnected; for example:

a. Radio transmitter and receiver

b. Vf termination equipment

c. Signaling equipment

d. Test board

e. Distribution frames

f. Group and supergroup interconnecting or regulating equipment

g. Office alarm equipment

h. Ac power distribution cabinet

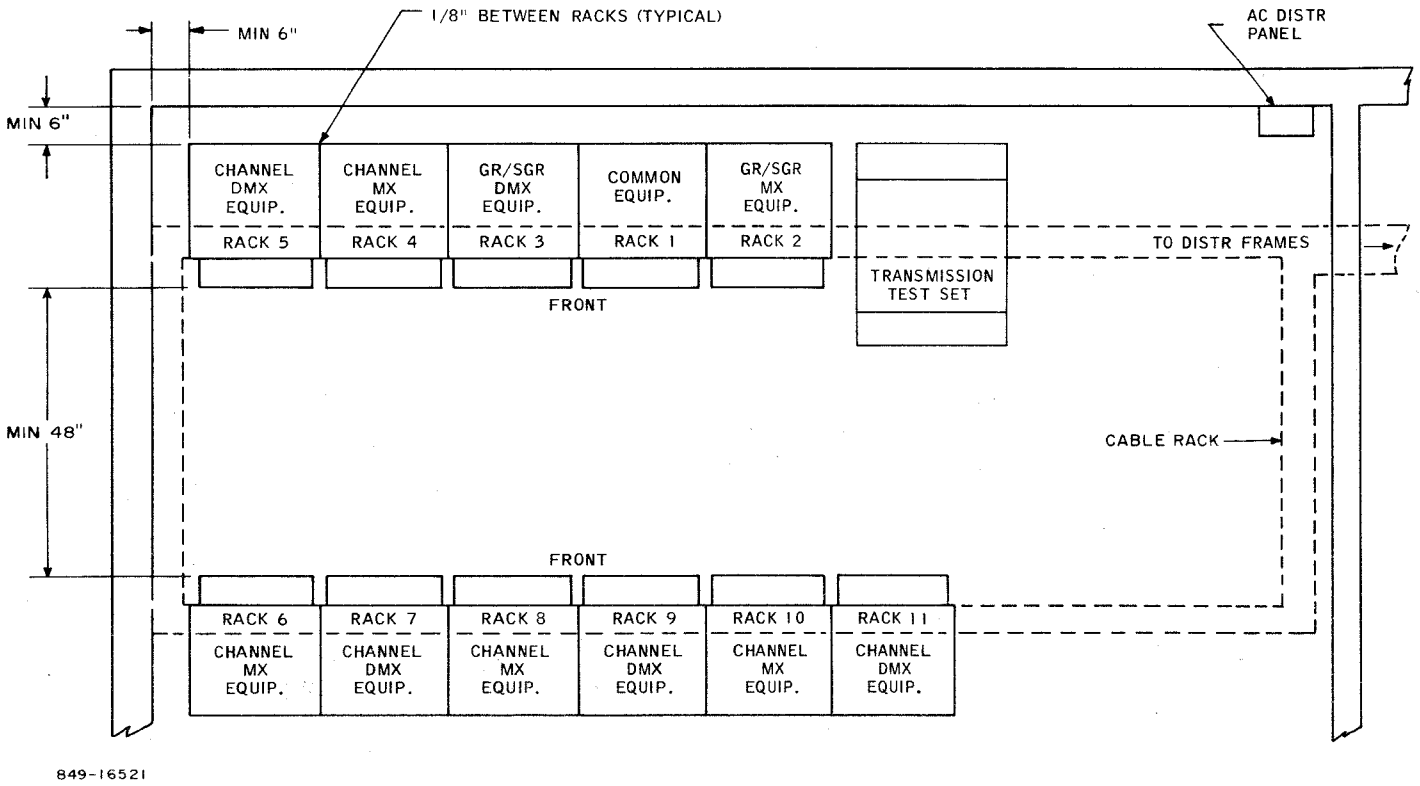


Figure 2-1. Typical Floor Plan

2-10. In the layout, the common equipment rack should be next to the group/supergroup equipment rack, or between the group/supergroup multiplex equipment rack and the group/supergroup demultiplex equipment rack. The placement of the channel equipment racks is not critical but the possibility of future additions to increase the channel capacity should be considered.

2-11. Because of the attenuation at higher frequencies, cable runs between racks or to external equipment should not exceed the following maximum lengths for carrier distribution and transmission circuits:

a. Channel carriers, group transmitting and receiving: 200 feet

b. Group and supergroup carriers, supergroup and hf line transmitting and receiving: 100 feet

2-12. AC POWER.

2-13. The multiplexer set operates from single-phase 120-volt, 50- or 60-cps primary ac power as described in table 2-1 Customarily, this is obtained from a 120/208-volt, three-phase, four-wire service. From external circuit breakers, two 20-ampere distribution circuits on separate phases should be run in conduit to the multiplexer set with branches to the ac power distribution box at the top of each rack requiring ac power. Convenience outlets on a separate 15-ampere circuit should be installed near the multiplexer set for operation of power tools and test equipment.

2-14. In the multiplexer set, primary ac power is used by the power supply shelves, the master frequency generator shelf, and the master alarm panel. In order to maintain redundant circuit operation, the two types of shelves require an input from both ac power distribution circuits; the master alarm panel needs only one ac input.

2-15. POWER SUPPLY SHELF. The maximum rated output of the power supply shelf is 2 amperes at 48 volts dc; the corresponding maximum input is 1.5 amperes at 120 volts ac. In normal operation, the dc load of a power supply shelf is shared by its two redundant trays, but if one tray fails, the other will assume the full load.

2-16. MASTER FREQUENCY GENERATOR SHELF. Ac power is used by the crystal oven heater and the servomotor in each master frequency generator tray. The maximum power input to each tray is 300 milliamperes at 120 volts ac.

2-17. MASTER ALARM PANEL. A step-down transformer in the 60-cps master alarm panel (pn 790-02506-01) produces the 40-volt (nominal voltage) alarm circuit power. The total load on the transformer is variable according to the number of lighted indicator lamps. When lighted, a lamp draws about 40 ma current; normally, all lamps are out and the load is negligible.

2-18. The maximum ac power requirement of the master alarm panel is specified in table 1-1 as 1.5 amperes. This is the maximum continuous current rating of the circuit breaker in the 120-volt, 60-cps input to the alarm circuit step-down power transformer.

2-19. OFFICE BATTERY.

2-20. For special applications of the multiplexer set, 48-volt dc power and alarm circuit power both can be obtained from a 48-volt office battery. A small amount of 120-volt ac power, which could be supplied by an inverter, will still be required for the oven heater and servo (slave mode only) in the master frequency generator shelf. The office battery (positive side grounded) should maintain the input voltage to the multiplexer set between 46 volts and 52 volts, with ripple voltage from the battery-charging equipment less than 0.5%.

Table 2-1. Power Requirements of Major Components

EQUIPMENT	NOTE	MAXIMUM LOAD, MA	
		48-VOLT DC POWER	40-VOLT ALARM CIRCUIT POWER
Channel carrier amplifier shelf		220	120
Channel carrier supply shelf		220	120
Channel demultiplexer shelf		130	–
Fuse panel	1	40	120
Group carrier amplifier shelf		300	120
Group carrier generator shelf		120	120
Group carrier supply shelf		300	120
Group demultiplexer shelf	2	50	–
Group multiplexer shelf	2	110	–
Group pilot alarm shelf	3	180	440
Master alarm panel		–	120
Master frequency generator shelf		500	120
Power supply shelf		–	120
Supergroup carrier amplifier shelf	2	350	120
Supergroup carrier generator shelf		250	120
Supergroup carrier supply shelf		420	120
Supergroup demodulator tray	4	125	120
Supergroup modulator tray (low-level)	5	40	–
Supergroup modulator tray (high-level)		150	120
Transmission test set	6	210	–

NOTES:

1. The fuse panel load is 40 ma for each alarm lamp; the maximum number of lamps is three. Lamp current is usually obtained from the 40-volt alarm circuit power source, but some panels utilize the 48-volt dc power source.
2. Dc power load will be proportionally less for a partially equipped shelf.
3. Dc power to the group pilot alarm shelf is routed through the associated channel demultiplexer shelves; the load is 18 ma for each monitored group. The maximum alarm circuit power load is 40 ma plus 40 ma for each monitored group.
4. Dc power load for the supergroup 2 demodulator tray is 90 ma.
5. The supergroup 2 modulator tray does not require dc power.
6. Dc power to the dolly-mounted transmission test set is routed through the group carrier supply shelf.

2-21. Power requirements of major components of the multiplexer set are listed in table 2-1.

2-22. FAILURE OF AC POWER. If ac power to a master frequency generator shelf fails, a slave oscillator will continue to synchronize with the master until cooling of the oven heater has caused the applicable oscillator (slave or master) to drift beyond the correction range of the sync circuit. However, this will take at least one hour, by which time ac power should have been restored or a standby generator placed in service.

2-23. OFFICE ALARMS.

2-24. The master alarm panel on the common equipment rack provides two sets of normally-open relay contacts (2-ampere rating) for controlling the office alarms; one set is for the minor alarm and the other for the major alarm.

2-25. CABLING.

2-26. Connections between racks and to external equipment are to be made on the site by installing point-to-point wiring. Except for ac power, ground, and the hf line transmitting and receiving circuits, all connections are made on the terminal board panels at the top of the racks.

2-27. Equipment racks are furnished completely wired for the maximum configuration. Therefore, optional shelves and trays that are not required initially can be added later without disturbing the wiring within the rack.

2-28. CABLE RACKS. For large installations, cable racks or cable ducts are recommended to support between-rack wiring and cable runs from the main distribution frame.

2-29. GROUNDING. Grounding at the multiplex terminal stations is necessary for equipment protection and the prevention of noise. A single ground of 0.1 ohm or less for each multiplex terminal cable sheath and protectors is normally acceptable. In any case, the ground should be checked to see if it is adequate.

2-30. All equipment rack ground lugs (at the top rear of each rack) should be connected together, and then grounded at a common point to the office ground.

2-31. LIGHTNING PROTECTION. Standard lightning protection in accordance with fixed plant installations is recommended for this type of equipment.

2-32. NOISE. The multiplex equipment may be installed adjacent to most office equipment, with the exception of large power plant rectifiers and power switching equipment. Six feet or more separation should be maintained from such equipment.

2-33. The breaking of switch contacts in dial offices generates carrier-frequency transients which may be coupled into the hf circuits. The total of such transients in a busy office may be heard as background noise in the communications system. Office interference may originate in other sources, such as signaling circuits and test equipment, plus others external to the office but coupled into it by open-wire circuits.

2-34. Optimum noise suppression is aided by the proper treatment of office cabling and grounding of the multiplex terminal. Vf, hf, and inter-rack cabling should not be run adjacent to primary ac power cables.

2-35. INSTALLATION MATERIAL.

2-36. The following types of installation material are not supplied with the multiplexer set and must be ordered or obtained

locally according to the particular site requirements:

a. Bulk quantities of wire and cable (Refer to Section III of this chapter for types and number of runs.)

b. Wiring material (insulating tape, lacing twine, etc.)

c. Circuit breakers, conduit, and fittings (for ac power distribution)

d. Cable rack and associated hardware

e. Hardware for securing the racks to the floor (Refer to Section III.)

2-37. TOOLS AND TEST EQUIPMENT.

2-38. No special tools are needed for the installation of the multiplexer set. All electrical testing and alignment can be performed using the transmission test set (which is part of the multiplexer set) and Multimeter AN/PSM-6.

SECTION II
LOGISTICS

2-39. This section provides data on receiving, handling, and storing the multiplexer set, and the requirements for the building in which it will be installed.

2-40. RECEIVING DATA.

2-41. EQUIPMENT RACKS. The multiplexer set comprises from two to thirteen equipment racks, each of which is shipped completely assembled in a separate plywood container. Multiplexer Sets AN/FCC-22 and AN/FCC-17 also include a dolly-mounted transmission test set. Table 2-2 lists the dimensions and maximum weights for each type of rack and the test set, and figure 2-2 illustrates how the racks are packaged for shipment.

Table 2-2. Weights and Dimensions of Equipment Racks

EQUIPMENT	*DIM.	MAX. WT, LB	
		CRATED	UNCRATED
Multiplexer Set AN/FCC-21			
Common equipment (rack 1)	A	720	540
Channel equipment (rack 2)	A	1110	930
Multiplexer Set AN/FCC-22			
Common equipment (rack 1)	A	820	640
Gr/sgr equipment (rack 2)	A	750	570
Channel equipment (rack 3, 5)	A	1110	930
Channel equipment (rack 4, 6)	A	1020	840
Transmission test set	B	365	225
Multiplexer Set AN/FCC-17			
Common equipment (rack 1)	C	790	610
Gr/sgr multiplex equip. (rack 2)	C	820	640
Gr/sgr demultiplex equip. (rack 3)	C	840	660
Channel multiplex equip. (rack 4, 6, 8, 10, 12)	C	970	790
Channel demultiplex equip. (rack 5, 7, 9, 11, 13)	C	1140	960
Transmission test set	B	365	225

*Dimensions, inches:
- A Crated 91-1/2 x 33-3/4 x 28-1/8; uncrated 84 x 23-1/4 x 20-1/8
- B Crated 53 x 44 x 31; uncrated 43 x 35 x 24
- C Crated 97-1/2 x 33-3/4 x 28-1/8; uncrated 90 x 23-1/4 x 20-1/8

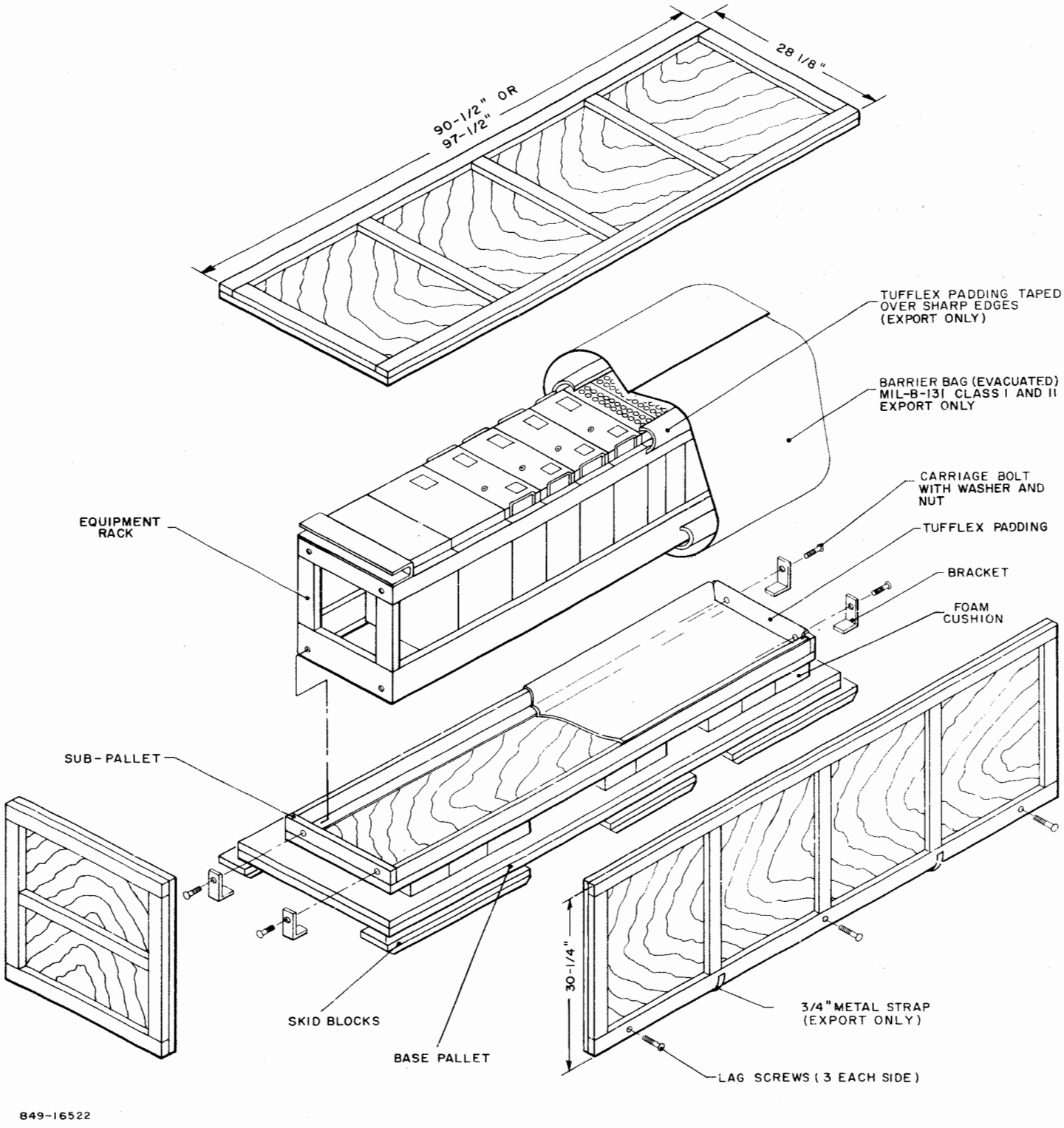


Figure 2-2. Shipping Container for Equipment Rack

2-42. SHELVES AND TRAYS. If an existing installation is to be expanded, or if a replacement is needed, equipment shelves or trays may be shipped in individual containers. The weights and dimensions of these items are listed in table 2-3.

2-43. MATERIAL HANDLING. There are no special handling devices needed for the multiplexer set. The shipping containers can be transported by light truck and moved by fork-lift, dollies, or rollers.

2-44. STORAGE. The equipment may be stored in a sheltered, unheated facility. The containers may be placed in any convenient position, but the horizontal position as shown in figure 2-2 is preferable for storage. As many as three containers may be stacked, one upon the other, in the horizontal position.

2-45. BUILDING REQUIREMENTS.

2-46. The specification requirements for the building that will house the multiplexer set are listed in table 2-4.

Table 2-3. Weights and Dimensions of Shelves and Trays

EQUIPMENT	WEIGHT, LB (CRATED) UNCRATED	DIMENSIONS, INCHES (CRATED) UNCRATED
Channel carrier amplifier shelf	(78), 38	(26 x 24 x 7)
Channel carrier supply shelf	(78), 38	22-1/8 x 20-1/4 x 3-1/2
Group carrier amplifier shelf	(78), 38	
Group carrier generator shelf	(71), 31	
Group carrier supply shelf	(76), 36	
Group demultiplexer shelf	(66), 26	
Group multiplexer shelf	(65), 25	
Group pilot alarm shelf	(60), 22	
Supergroup carrier generator shelf	(66), 26	
Supergroup equipment support	(49), 9	
Channel demultiplexer shelf	(107), 65	(26 x 24 x 9)
Channel multiplexer shelf	(104), 62	22-1/8 x 20-1/4 x 5-1/4
Power supply shelf	(133), 91	
Supergroup carrier amplifier shelf	(78), 38	
Supergroup carrier supply shelf	(86), 44	
Master frequency generator shelf	(108), 63	(26 x 24 x 10) 22-1/8 x 20-1/4 x 7
Supergroup demodulator tray	(44), 14	(22 x 11 x 7)
Supergroup modulator tray	(43), 13	18-1/4 x 8 x 3-1/2
Power supply tray	(73), 41	(22 x 11 x 9) 17-3/4 x 8 x 5-1/4
Master frequency generator tray	(62), 27	(21 x 11 x 10) 18 x 8 x 7

Table 2-4. Specification Requirements for Building

Equipment floor space (including clearances)	20 sq ft maximum (AN/FCC-21) 70 sq ft maximum (AN/FCC-22) 140 sq ft maximum (AN/FCC-17)
Minimum ceiling height	10 feet
Floor loading	150 lb/sq ft average 420 lb/sq ft peak
Heating and ventilating	As required for personnel comfort
Equipment heat emission	500 to 1500 Btu/hour
Cable support	Overhead cable rack
Lighting	Fixtures above aisles and clear of cable rack paths.

SECTION III
INSTALLATION PROCEDURES

2-47. This section provides mounting and wiring data peculiar to the multiplexer set. Equipment and wiring options are described and procedures are given for placing the equipment in operation.

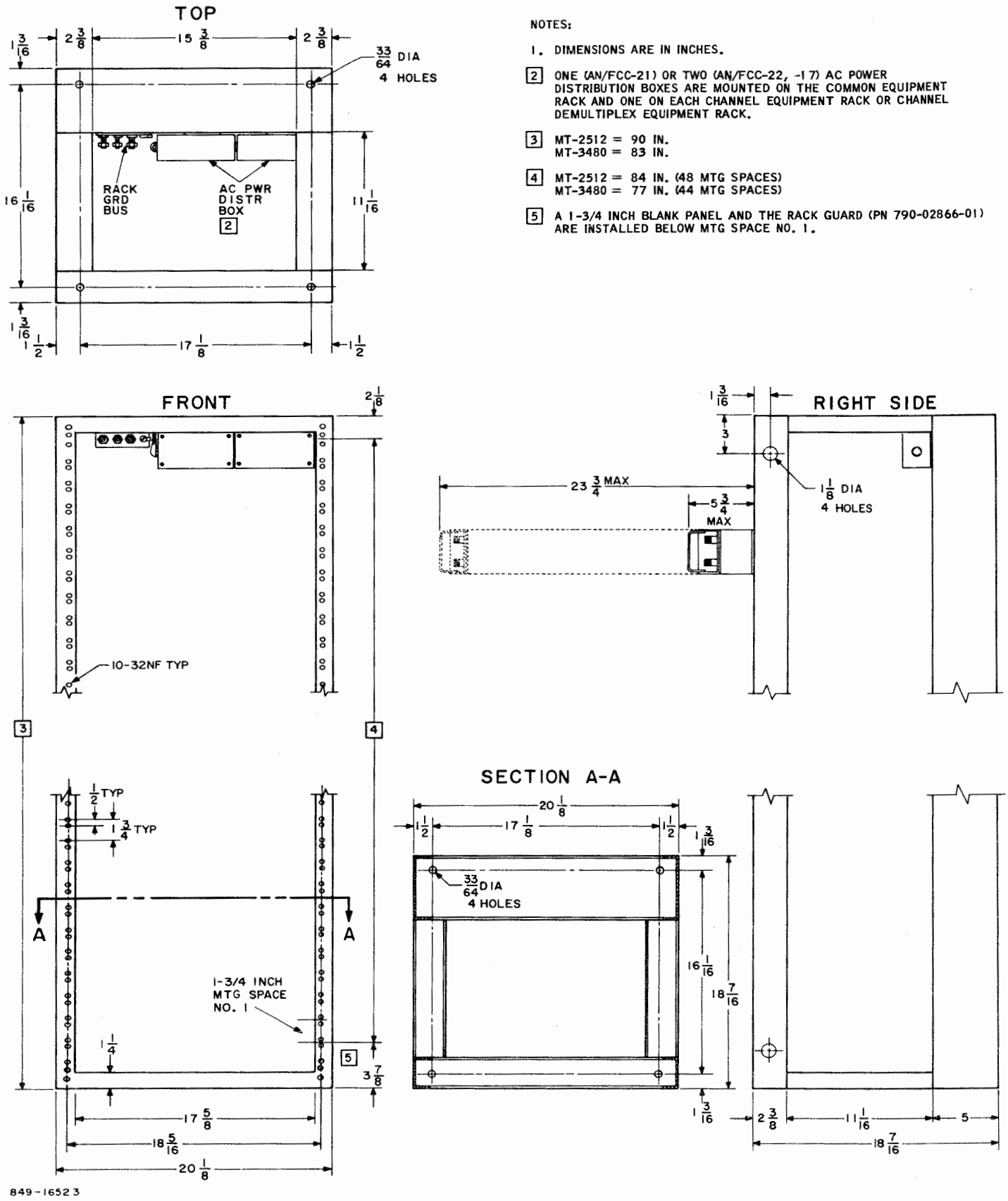
2-48. REFERENCE DATA.

2-49. Installation procedures shall be in accordance with the applicable technical manual for standard installation practices:

T.O.	TITLE
31-10-2	Fanning and Forming Conductors for Ground C-E Equipment
31-10-6	Cable Racks, Troughs and Their Supports
31-10-9	Marking Site Layout
31-10-10	Anchoring Devices for Ground C-E Equipment
31-10-12	Metal Ducts and Conduit
31-10-13	Cabling for Fixed Ground C-E Equipment
31-10-16	Strapping of Fixed Ground C-E Components
31-1-57	Electrical Wire Connectors Used With C-E Equipment
31-1-162	Erection and Assembly of Equipment
31-1-168	Terminating and Soldering
31-1-169	Cross-Connections
31-1-170	Equipment Designations

2-50. ALLIED CONSTRUCTION.

2-51. Before the multiplexer set is brought into the equipment room, the installation of overhead equipment (cable rack) should be completed, and mounting holes for the racks should be drilled in accordance with figure 2-3 and the clearances specified in Section I of this chapter. Locate holes with an accuracy of ±1/16 inch and by a method that will avoid accumulation of tolerances in successive measurements.



NOTES:

1. DIMENSIONS ARE IN INCHES.
2. ONE (AN/FCC-21) OR TWO (AN/FCC-22, -17) AC POWER DISTRIBUTION BOXES ARE MOUNTED ON THE COMMON EQUIPMENT RACK AND ONE ON EACH CHANNEL EQUIPMENT RACK OR CHANNEL DEMULTIPLEX EQUIPMENT RACK.
3. MT-2512 = 90 IN.
   MT-3480 = 83 IN.
4. MT-2512 = 84 IN. (48 MTG SPACES)
   MT-3480 = 77 IN. (44 MTG SPACES)
5. A 1-3/4 INCH BLANK PANEL AND THE RACK GUARD (PN 790-02866-01) ARE INSTALLED BELOW MTG SPACE NO. 1.

Figure 2-3. Rack Dimensions

2-52. EQUIPMENT MOUNTING.

WARNING

Don't pull out equipment shelves until the rack is securely mounted; the change in the center of gravity could cause the rack to tip over.

2-53. RACKS. Figure 2-4 illustrates the method of securing the racks to the floor and bracing them together at the top with unistrut channels. Additional support to walls or ceiling should be considered, especially in earthquake areas.

2-54. SHELVES. Although optional shelves are not needed in all configurations, equipment racks are usually furnished with all wiring harnesses, cable retrieving arms, and cabinet sections of the slide rails in place. Hence, to add a shelf to an existing configuration, it is only necessary to remove the blank panel covering the mounting space, mate the shelf with the slide rails on the rack, and plug in the wiring harnesses at the rear of the shelf.

2-55. If you have to install a shelf in a mounting space that has not been equipped or wired to receive it, refer to figure 2-5 for mounting details and table 2-5 for installation material that may be needed. Wiring harnesses for each type of shelf are called out by part number on the wiring diagrams in the Circuit Diagrams manual, T.O. 31W1-2FCC-103. Replacement wiring harnesses, which are made extra long, are to be cut to the proper length when they are installed on the equipment rack.

2-56. If necessary, wiring harnesses can be fabricated locally using the information on the wiring diagram and the component parts identified in the Illustrated Parts Breakdown manual, T.O. 31W1-2FCC-104. The length of the wiring harness has to be determined for each particular rack configuration.

2-57. The brackets that attach the cabinet section of the slide rails to the equipment rack have slotted mounting holes and should be adjusted laterally so that the shelf slides in and out smoothly and easily. Refer to Section I of Chapter 5 for instructions on how to install the shelf on its slide mechanism.

2-58. The cable retrieving arms must be mounted on the opposite side of the rack from the vertical channel in which the wiring will be run to the terminal board panels. For example, a left-hand cable retrieving arm is used if the wiring is run in the right-hand channel.

2-59. Clamp the wiring harnesses to the cable support and cable retrieving arm as shown in figure 2-5. Be sure there is no strain on the wiring harnesses when the shelf is extended or retracted, and that slack in the wiring harnesses does not interfere with any adjacent shelves.

2-60. TRAYS AND MODULES. Refer to Section I of Chapter 5 for mounting procedures.

2-61. WIRING.

2-62. Wiring to external equipment and between racks is summarized in figures 2-6, 2-7, and 2-8 for Multiplexer Sets AN/FCC-21, -22, and -17, respectively. Circuits are classified by function and for each class, the required type of wire or cable, the number of runs, and the terminating equipment are identified. The specific terminal at which the wire or cable is to be connected

Table 2-5. Shelf Installation Material

PART NUMBER	DESCRIPTION	QTY
790-04525-01	Bracket, front (Lenkurt)	2
790-02527-01	Bracket, rear (Lenkurt)	2
790-02694-	Cable retrieving arm, rh -01, or lh -02 (Lenkurt)	1
790-02906-01	Cable support (Lenkurt)	1
NMC-CL326	Loop clamp, adjustable (Nylon Molding Corp.)	5
150157A-L	Slide rail, cabinet section, lh (Jonathan Mfg. Co.)	1
150157A-R	Slide rail, cabinet section, rh (Jonathan Mfg. Co.)	1
150311A-L	*Slide rail, cabinet section, lh (Jonathan Mfg. Co.)	1
150311A-R	*Slide rail, cabinet section, rh (Jonathan Mfg. Co.)	1
79NM-62	Nut, hexagon, self-locking, 6-32 thd (ESNA)	2
MS35249-71	Screw, machine, flathead, 10-24 thd by 5/8 in. lg	10
MS35233-27	Screw, machine, panhead, 6-32 thd by 5/16 in. lg	8
MS35233-30	Screw, machine, panhead, 6-32 thd by 1/2 in. lg	1
MS35233-31	Screw, machine, panhead, 6-32 thd by 5/8 in. lg	1
MS35233-46	Screw, machine, panhead, 8-32 thd by 5/8 in. lg	3
MS35234-64	Screw, machine, panhead, 10-32 thd by 5/8 in. lg	8
MS15795-306	Washer, flat, no. 6	2
MS15795-307	Washer, flat, no. 8	3
MS35338-79	Washer, lock, no. 6	8

*Used with shelves that do not have tilt-up feature.

should be determined from the cabling diagrams in the Circuit Diagrams manual.

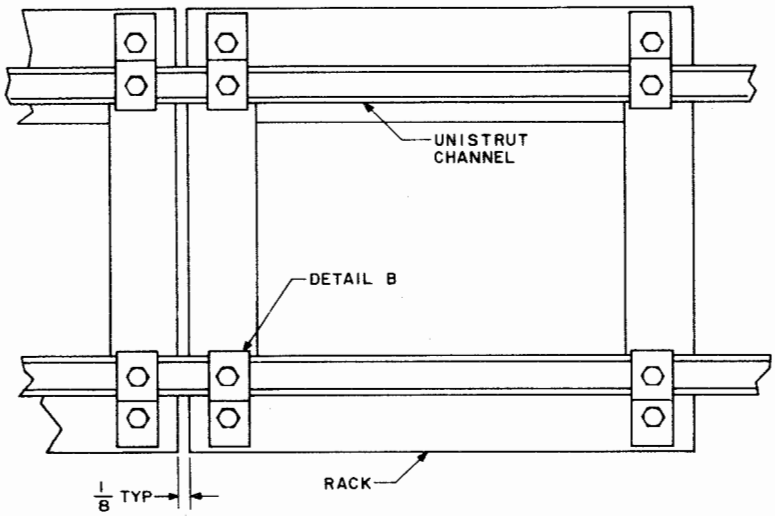
NOTE

Unless otherwise indicated on the cabling diagrams, in a two-conductor cable run between two terminal boards, the mate (tracer wire) of the pair should be connected to the lower-numbered terminal at each end.

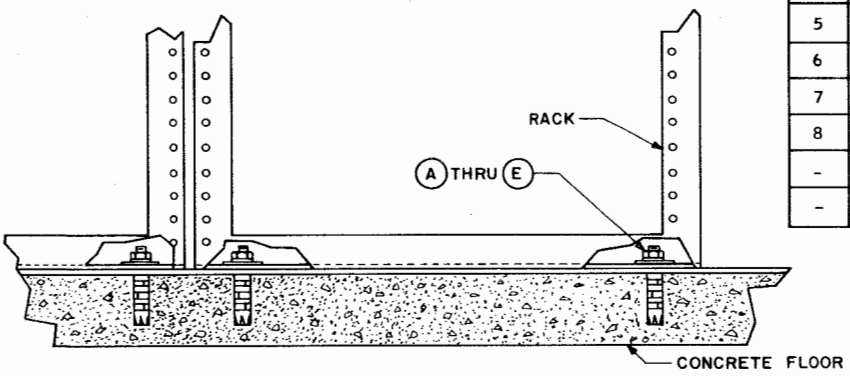
2-63. Recommended types of wire and cable are listed, but equivalent types may be substituted. Minimum wire sizes, based on normal equipment loads and rack arrangements are specified; for unusual situations, larger gages may be used where necessary to prevent excessive voltage drop in power distribution circuits.

2-64. Conduit, which is recommended for primary ac power wiring, should be installed before other wiring is run. Ac power on two distribution circuits is to be routed to the common equipment rack and to each channel equipment rack (AN/FCC-21 or -22) or channel demultiplex equipment rack (AN/FCC-17).

TOP VIEW



FRONT VIEW



NOTES:

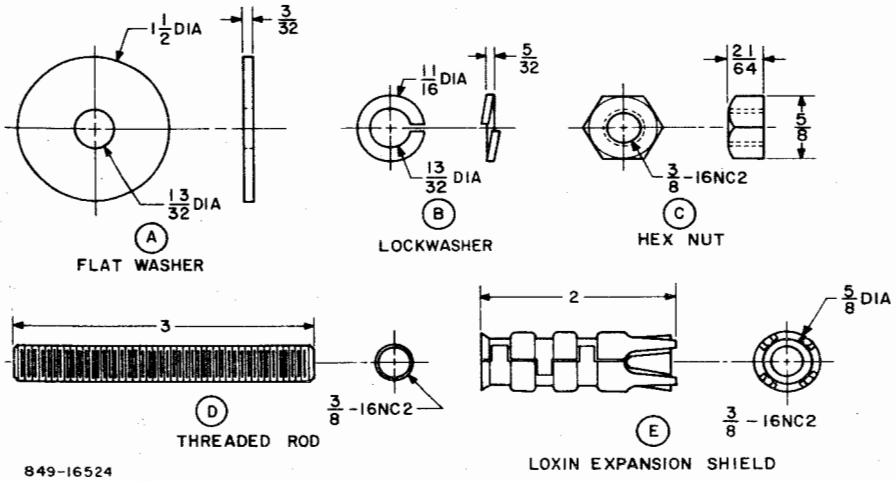
1. THIS DRAWING SHOWS METHODS FOR BOLTING RACKS TO A CONCRETE FLOOR AND BRACING RACKS TOGETHER AT THE TOP.
2. DIMENSIONS ARE IN INCHES.
3. DRILL HOLES IN CONCRETE FLOOR 5/8 IN. DIA BY 2-1/8 IN DEEP FOR EXPANSION SHIELDS.
4. ADJACENT RACKS SHOULD BE LEVEL WITH EACH OTHER AT THE TOP WITHIN 1/32 INCH. IF SHIMS ARE USED, THEY SHOULD BE STAINLESS STEEL OR PAINTED MALLEABLE STEEL. ZINC OR CADMIUM PLATING IS NOT RECOMMENDED.
5. A BOLT-DOWN KIT AS SHOWN IN DETAIL A IS REQUIRED FOR EACH RACK. MATERIAL SHALL BE STAINLESS STEEL WHERE POSSIBLE.

LIST OF MATERIAL
FOR INSTALLATION OF UNISTRUT CHANNEL

ITEM	DESCRIPTION	GEEIA BOM NO.
1	UNISTRUT CHANNEL, P1000	825
2	UNISTRUT NUT 1/2-13NC2, P1010	514
3	UNISTRUT U-CLAMP, P1046A	-
4	HEX HD CAP SCREW 1/2-13NC2 X 1 IN. LG	645
5	HEX HD CAP SCREW 1/2-13NC2 X 1-1/4 IN. LG	747
6	SPLIT LOCKWASHER 1/2 IN.	1571
7	FLAT WASHER 1/2 IN.	853
8	HEX NUT 1/2-13NC2	505
-	UNISTRUT CLOSURE STRIP, P3184	-
-	UNISTRUT CHANNEL END CAP, P1180	-

DETAIL A

BOLT-DOWN KIT (4 OF EACH ITEM PER KIT)



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DETAIL B

METHOD OF BOLTING UNISTRUT CHANNEL TO TOP OF RACK

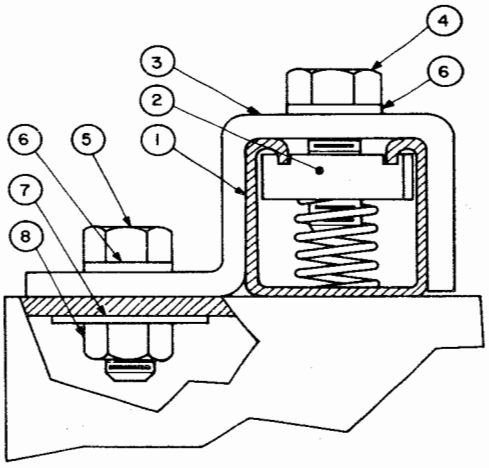
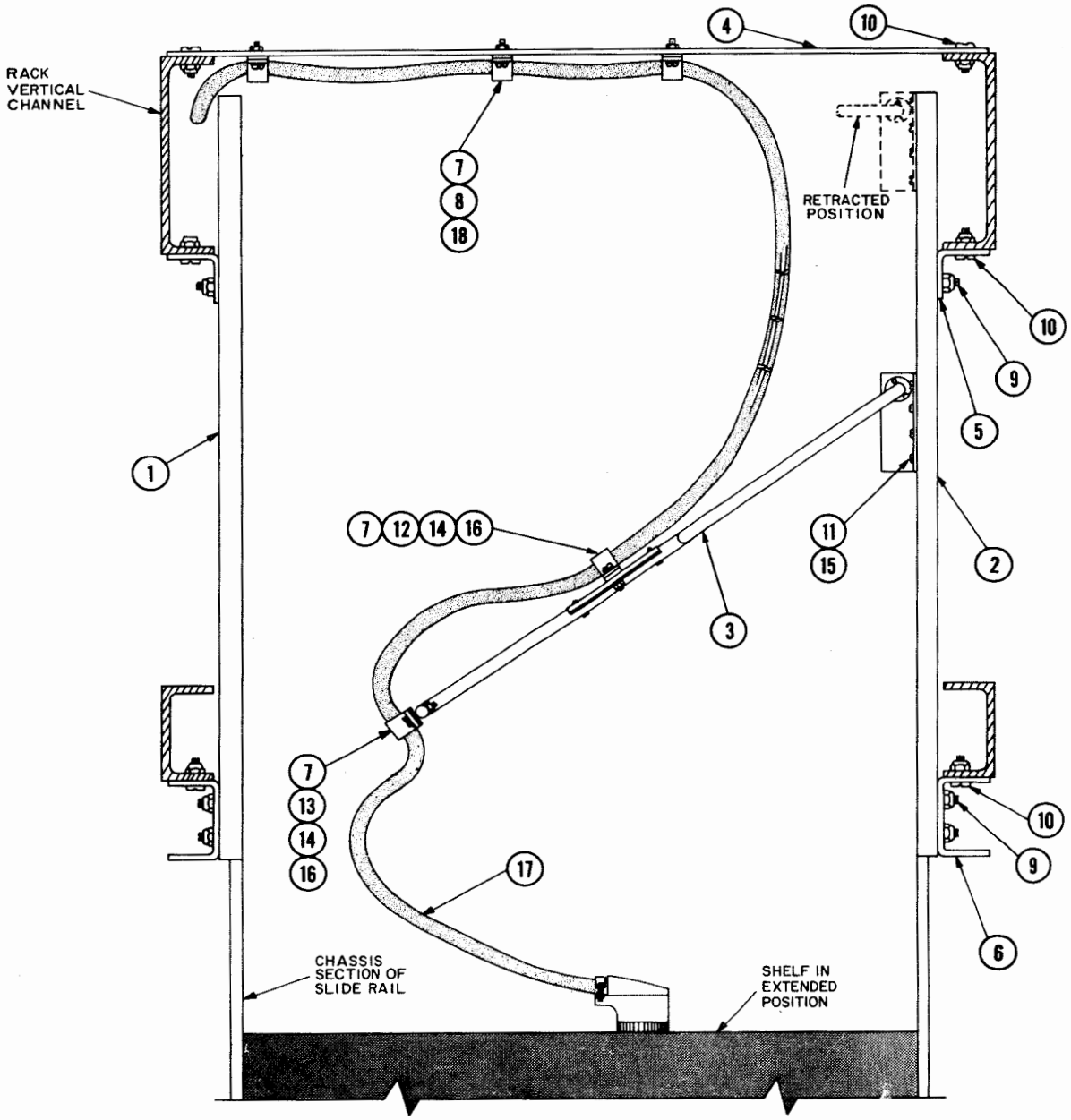


Figure 2-4. Rack Installation



1. LEFT-HAND SLIDE RAIL, CABINET SECTION
2. RIGHT-HAND SLIDE RAIL, CABINET SECTION
3. CABLE RETRIEVING ARM
4. CABLE SUPPORT
5. REAR BRACKET
6. FRONT BRACKET
7. LOOP CLAMP, ADJUSTABLE
8. FLAT WASHER, NO. 8
9. FLATHEAD MACHINE SCREW, 10-24 X 5/8
10. PANHEAD MACHINE SCREW, 10-32 X 5/8
11. PANHEAD MACHINE SCREW, 6-32 X 5/16
12. PANHEAD MACHINE SCREW, 6-32 X 1/2
13. PANHEAD MACHINE SCREW, 6-32 X 5/8
14. SELF-LOCKING NUT, 6-32
15. LOCKWASHER, NO. 6
16. FLAT WASHER NO. 6
17. WIRING HARNESS
18. PANHEAD MACHINE SCREW, 8-32 X 5/8

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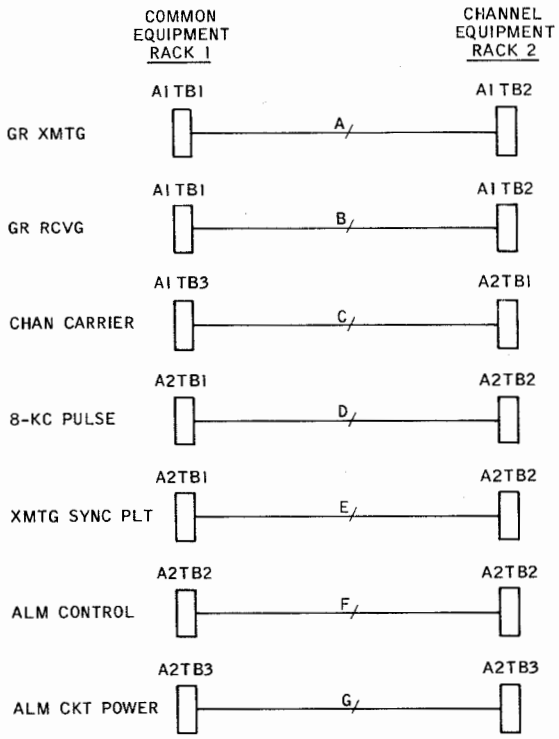
Figure 2-5. Plan View of Equipment Rack Showing Shelf Installation



NOTES:

1. UNLESS OTHERWISE SPECIFIED UNSHIELDED WIRE IS TYPE B PER MIL-W-16878.
2. SHIELDED SINGLE-CONDUCTOR CABLE IS TYPE TX22-1934-STJ AND SHIELDED TWISTED-PAIR CABLE IS TYPE 2TX22-1934-STJ AS SUPPLIED BY HITEMP INC (FSCM 09794) OR EQUIVALENT.
3. EXTERNAL DC POWER AND ALARM CIRCUIT POWER (TABLE B) ARE NOT REQUIRED WHEN THE MULTIPLEXER SET OPERATES FROM AC POWER.
4. EXTERNAL AC POWER (TABLE B) IS NOT REQUIRED ON CHANNEL EQUIPMENT RACK 2 WHEN THE MULTIPLEXER SET OPERATES FROM OFFICE BATTERY.
5. TABLE B DOES NOT INCLUDE OPTIONAL CIRCUITS THAT MIGHT BE RUN TO AUXILIARY EQUIPMENT OR ADJACENT MULTIPLEXER SETS. THESE CIRCUITS ARE SHOWN ON THE CABLING DIAGRAMS IN THE CIRCUIT DIAGRAMS MANUAL.
6. EACH INTER-RACK WIRING SYMBOL REPRESENTS A QUANTITY OF WIRES OR CABLES IN ACCORDANCE WITH TABLE A. FOR EXAMPLE C/ REPRESENTS 6 SHIELDED SINGLE-CONDUCTOR CABLES.

TABLE A.
WIRING BETWEEN RACKS

SYMBOL	CIRCUIT FUNCTION	LEAD DESIGNATION	WIRE OR CABLE	
			QTY	DESCRIPTION
A	GROUP TRANSMITTING	GR XMTG, GR 1 THRU GR 5	5	22 AWG SHIELDED TWISTED-PAIR
B	GROUP RECEIVING	GR RCVG, GR 1 THRU GR 5	5	22 AWG SHIELDED TWISTED-PAIR
C	CHANNEL CARRIER	104, 96, 88, 80, 72, AND 64 KC	6	22 AWG SHIELDED SINGLE-COND
D	MFG OUTPUT	8-KC PULSE	1	RG-187A/U
E	CARRIER SYNC PILOT	XMTG SYNC PILOT	1	RG-187A/U
F	ALARM CONTROL	MIN ALM, MAJ ALM	1	22 AWG TWISTED-PAIR
G	ALARM CIRCUIT POWER	40V, COM	1	20 AWG TWISTED-PAIR

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Figure 2-6. AN/FCC-21 Inter-Rack and External Wiring (Sheet 1 of 2)

TABLE B.

WIRING TO EXTERNAL EQUIPMENT

	CIRCUIT FUNCTION	LEAD DESIGNATION	FROM MULTIPLEXER SET		TO EXTERNAL EQUIP.	WIRE OR CABLE	
			RACK	PANEL		QTY	DESCRIPTION
	AC POWER	CKT 1, CKT 2, AND NEUTRAL	COMMON EQUIPMENT RACK 1	AC POWER DISTR BOX	AC DISTR PANEL	3	12 AWG TYPE TW
[3]	ALM CKT POWER	-48V, GRD		A2TB3	OFFICE BATTERY DISTR PANEL	2	14 AWG SINGLE-COND
	ALARM	MAJ ALM, MIN ALM		A2TB2	OFFICE ALARM PANEL	2	22 AWG TWISTED-PAIR
	HF TRANSMITTING	LINE XMTG		A2TB1	RADIO XMTR	1	RG-59B/U
	HF RECEIVING	LINE RCVG		A2TB1	RADIO RCVR	1	RG-59B/U
[4]	AC POWER	CKT 1, CKT 2 AND NEUTRAL	CHANNEL EQUIPMENT RACK 2	AC POWER DISTR BOX	AC DISTR PANEL	3	12 AWG TYPE TW
	VF TRANSMITTING	VF XMTG		A1TB1	VF EQUIPMENT	60	22 AWG TWISTED-PAIR
	VF RECEIVING	VF RCVG		A1TB3	VF EQUIPMENT	60	22 AWG TWISTED-PAIR
	GROUND	GRD	RACKS 1 AND 2	GRD LUG AT TOP OF RACK	OFFICE GROUND	1	6 AWG SINGLE-COND
[3]	DC POWER	-48V, GRD		A2TB3	OFFICE BATTERY DISTR PANEL	2	14 AWG SINGLE-COND

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SH 2

Figure 2-6. AN/FCC-21 Inter-Rack and External Wiring (Sheet 2 of 2)

If the multiplexer set is to operate from a 48-volt office battery, only the common equipment will require ac power.

2-65. Complete inter-rack wiring as shown on figures 2-6, 2-7, or 2-8 should be installed between all equipment racks furnished with the multiplexer set even though some circuits may be inactive; this will facilitate future expansion of a terminal to its maximum channel capacity.

2-66. The wiring listed in figures 2-6, 2-7, and 2-8 does not include optional circuits that might be run to auxiliary equipment or to adjacent multiplexer sets. These circuits, which are identified on the cabling diagrams in the Circuit Diagrams manual by a special symbol, are in the following categories:

a. Carrier sync pilot

b. Channel, group, and supergroup carriers

c. Dc power and alarm circuit power

d. Alarm controls (minor and major)

2-67. STRAPPING AND EQUIPMENT OPTIONS.

2-68. Although all optional strapping and optional equipment applicable to a particular configuration of the multiplexer set are normally installed at the factory, complete description and instructions for this work are given in paragraphs that follow. You may need this information to verify the condition of the multiplexer set as it is being installed, or to prepare it for operation in a different configuration.

2-69. OPTIONS IN THE POWER SUPPLY AND ALARM EQUIPMENT.

2-70. POWER SUPPLY SHELF.

2-71. There are no strapping or equipment options in the power supply shelves, although

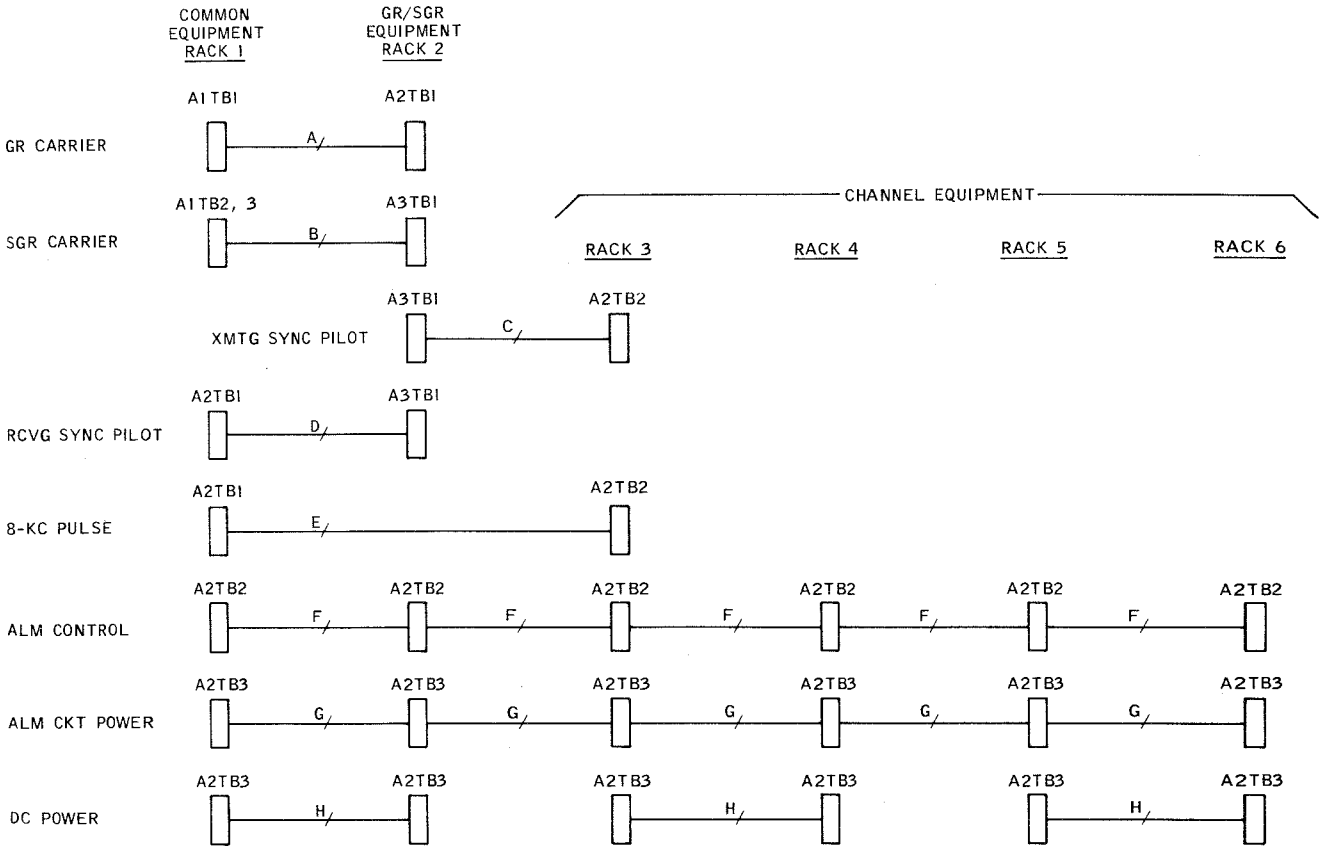

TABLE A.

WIRING BETWEEN RACKS

SYMBOL	CIRCUIT FUNCTION	LEAD DESIGNATION	WIRE OR CABLE	
			QTY	DESCRIPTION
A	GROUP CARRIER	420, 468, 516, 564, AND 612 KC	5	RG-187A/U
B	SGR CARRIER	612, 1116, AND 1364 KC	3	RG-187A/U
C	CARRIER SYNCHRONIZING PILOT	XMTG SYNC PILOT	1	RG-187A/U
D		RCVG SYNC PILOT	1	RG-187A/U
E	MFG OUTPUT	8-KC PULSE	1	RG-187A/U
F	ALARM CONTROL	MIN ALM, MAJ ALM	1	22 AWG TWISTED-PAIR
G	ALARM CIRCUIT POWER	40V, COM	1	20 AWG TWISTED-PAIR
[8] H	DC POWER	-48V, GRD	2	14 AWG SINGLE-COND

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SH 1

Figure 2-7. AN/FCC-22 Inter-Rack and External Wiring (Sheet 1 of 3)

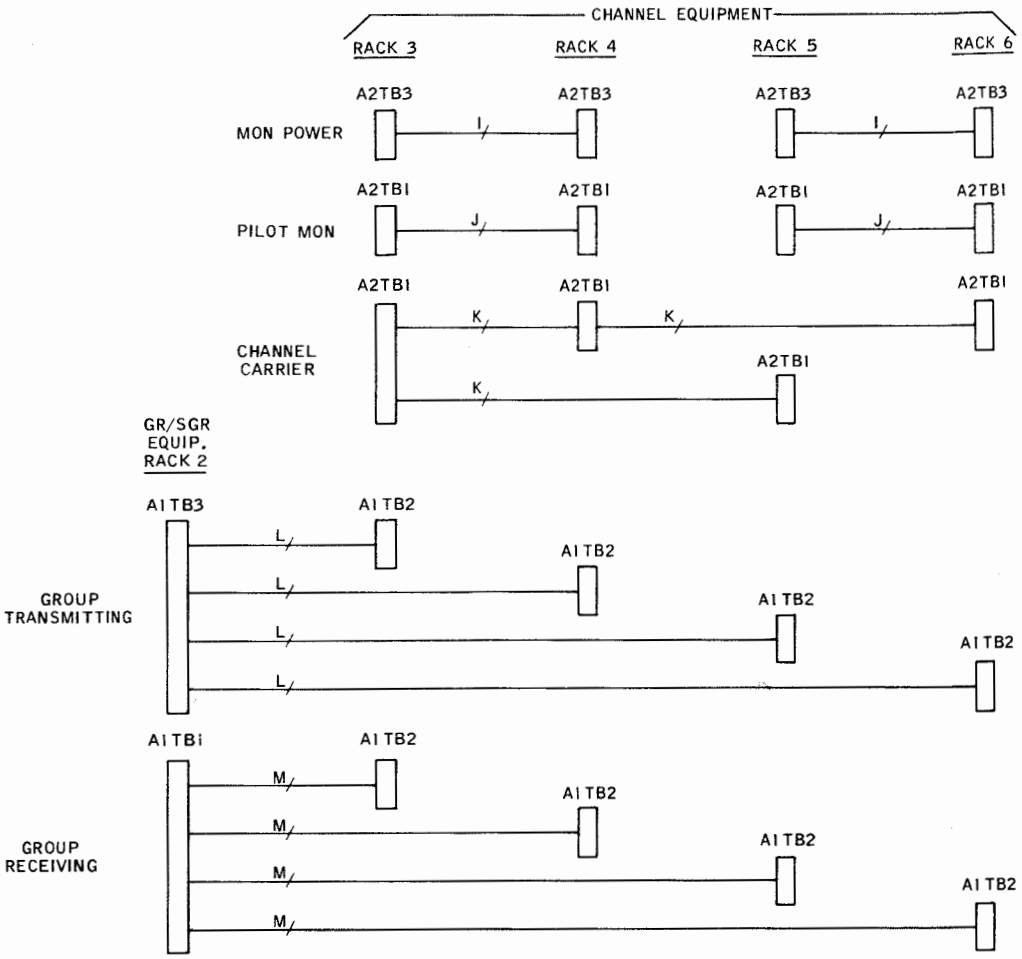

TABLE A.

WIRING BETWEEN RACKS (CONT)

SYMBOL	CIRCUIT FUNCTION	LEAD DESIGNATION	WIRE OR CABLE	
			QTY	DESCRIPTION
I	DC POWER FROM CHAN DMX SHELF TO GR PLT ALM SHELF	MON POWER: -48V/P AND GRD/P	5	22 AWG TWISTED-PAIR
J	GR PLT ALM INPUT	PILOT MON	5	22 AWG SHIELDED SINGLE-COND
K	CHANNEL CARRIER	104, 96, 88, 80, 72, AND 64 KC	6	22 AWG SHIELDED SINGLE-COND
L	GROUP TRANSMITTING	GR XMTG, GR 1 THRU GR 5	5	22 AWG SHIELDED TWISTED-PAIR
M	GROUP RECEIVING	GR RCVG, GR 1 THRU GR 5	5	22 AWG SHIELDED TWISTED-PAIR

NOTES:

1. UNLESS OTHERWISE SPECIFIED, UNSHIELDED WIRE IS TYPE B PER MIL-W-16878.
2. SHIELDED SINGLE-CONDUCTOR CABLE IS TYPE TX22-1934-STJ AND SHIELDED TWISTED-PAIR CABLE IS TYPE 2TX22-1934-STJ, AS SUPPLIED BY HITEMP INC (FSCM 09794) OR EQUIVALENT.

[3] EXTERNAL DC POWER AND ALARM CIRCUIT POWER (TABLE B) ARE NOT REQUIRED WHEN THE MULTIPLEXER SET OPERATES FROM AC POWER.

[4] EXTERNAL AC POWER (TABLE B) IS NOT REQUIRED ON CHANNEL EQUIPMENT RACKS 3 AND 5 WHEN THE MULTIPLEXER SET OPERATES FROM OFFICE BATTERY.

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5. TABLE B DOES NOT INCLUDE OPTIONAL CIRCUITS THAT MIGHT BE RUN TO AUXILIARY EQUIPMENT OR ADJACENT MULTIPLEXER SETS. THESE CIRCUITS ARE SHOWN ON THE CABLING DIAGRAMS IN THE CIRCUIT DIAGRAMS MANUAL.
6. EACH INTER-RACK WIRING SYMBOL REPRESENTS A QUANTITY OF WIRES OR CABLES IN ACCORDANCE WITH TABLE A. FOR EXAMPLE, K/ REPRESENTS 6 SHIELDED SINGLE-CONDUCTOR CABLES.

[7] LINE XMTG (ALT) AND LINE RCVG (ALT) ARE OPTIONAL.

[8] OMIT "H" INTER-RACK WIRING (TABLE A) WHEN THE MULTIPLEXER SET OPERATES FROM OFFICE BATTERY. FURNISH -48V AND GRD TO EACH RACK FROM THE OFFICE BATTERY DISTRIBUTION PANEL AS LISTED IN TABLE B.

Figure 2-7. AN/FCC-22 Inter-Rack and External Wiring (Sheet 2 of 3)

TABLE B.
WIRING TO EXTERNAL EQUIPMENT

	CIRCUIT FUNCTION	LEAD DESIGNATION	FROM MULTIPLEXER SET		TO EXTERNAL EQUIP.	WIRE OR CABLE	
			RACK	PANEL		QTY	DESCRIPTION
	ALARM	MIN ALM, MAJ ALM	COMMON EQUIPMENT RACK 1	A2TB2	ALARM PANEL	2	22 AWG TWISTED-PAIR
[3]	ALM CKT POWER	-48V, GRD		A2TB3	OFFICE BATTERY DISTR PANEL	2	14 AWG SINGLE-COND
	AC POWER	CKT 1, CKT 2, AND NEUTRAL		AC POWER DISTR BOX	AC DISTR PANEL	3	12 AWG TYPE TW
	HF TRANSMITTING	LINE XMTG (MAIN) LINE XMTG (ALT) [7]	GR/SGR EQUIPMENT RACK 2	SGR MOD COMBINING PANEL	RADIO XMTR	2	RG-59B/U
	HF RECEIVING	LINE RCVG (MAIN) LINE RCVG (ALT) [7]		SGR DEM COMBINING PANEL	RADIO RCVR	2	RG-59B/U
	VF TRANSMITTING	VF XMTG	RACKS 3, 4, 5 AND 6 (CHAN EQUIP.)	A1TB1	VF EQUIPMENT	60	22 AWG TWISTED-PAIR
	VF RECEIVING	VF RCVG		A1TB3	VF EQUIPMENT	60	22 AWG TWISTED-PAIR
[4]	AC POWER	CKT 1, CKT 2 AND NEUTRAL	RACKS 3 AND 5 (CHAN EQUIP.)	AC POWER DISTR BOX	AC DISTR PANEL	3	12 AWG TYPE TW
	GROUND	GRD	EACH RACK	GROUND LUG AT TOP OF RACK	OFFICE GROUND	1	6 AWG SINGLE-COND
[3]	DC POWER	-48V, GRD		A2TB3	OFFICE BATTERY DISTR PANEL	2	14 AWG SINGLE-COND

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Figure 2-7. AN/FCC-22 Inter-Rack and External Wiring (Sheet 3 of 3)

for some special applications, the B tray has been omitted from the shelf. The standard shelf uses 50-60 cps power, but there is a special shelf that operates on 400-cps power.

2-72. FUSE PANELS.

2-73. Fuse ratings are indicated adjacent to the fuseholders, either by marking or by a colored rivet that matches the bead color of the fuse. On a partially equipped multiplexer set, fuses may be omitted from inactive distribution circuits. The ampere rating, type number (Western Electric, or equivalent), and bead color of alarm-type fuses used in the multiplexer set are as follows:

*AMPERES	COLOR	TYPE
0.18	Yellow	70E
0.25	Violet	70F
0.25	Violet-white	70K
0.50	Red	70G
0.75	Tan	70H
1.33	White	70A
2.00	Orange	70B
3.00	Blue	70C
5.00	Green	70D
6.00	Green-white	71A

*Fuse will carry 100% of rated current continuously. At 150% of rated current, fuse will blow within 90 seconds (300 seconds for type 70K).

2-74. MASTER ALARM PANEL.

2-75. In the standard applications of the multiplexer set, the 60-cps master alarm panel (pn 790-02506-01) derives alarm circuit power from the primary 120-volt ac source; strap terminals A-B and D-E on subassembly A3 to activate the alarm circuit power distribution circuits (designated 40V and COM). If an external 48-volt dc source is to supply alarm circuit power, strap terminals B-C and E-F instead. To reach subassembly A3, remove the front panel secured by eight panhead screws; don't loosen the knurled-head captive screws.

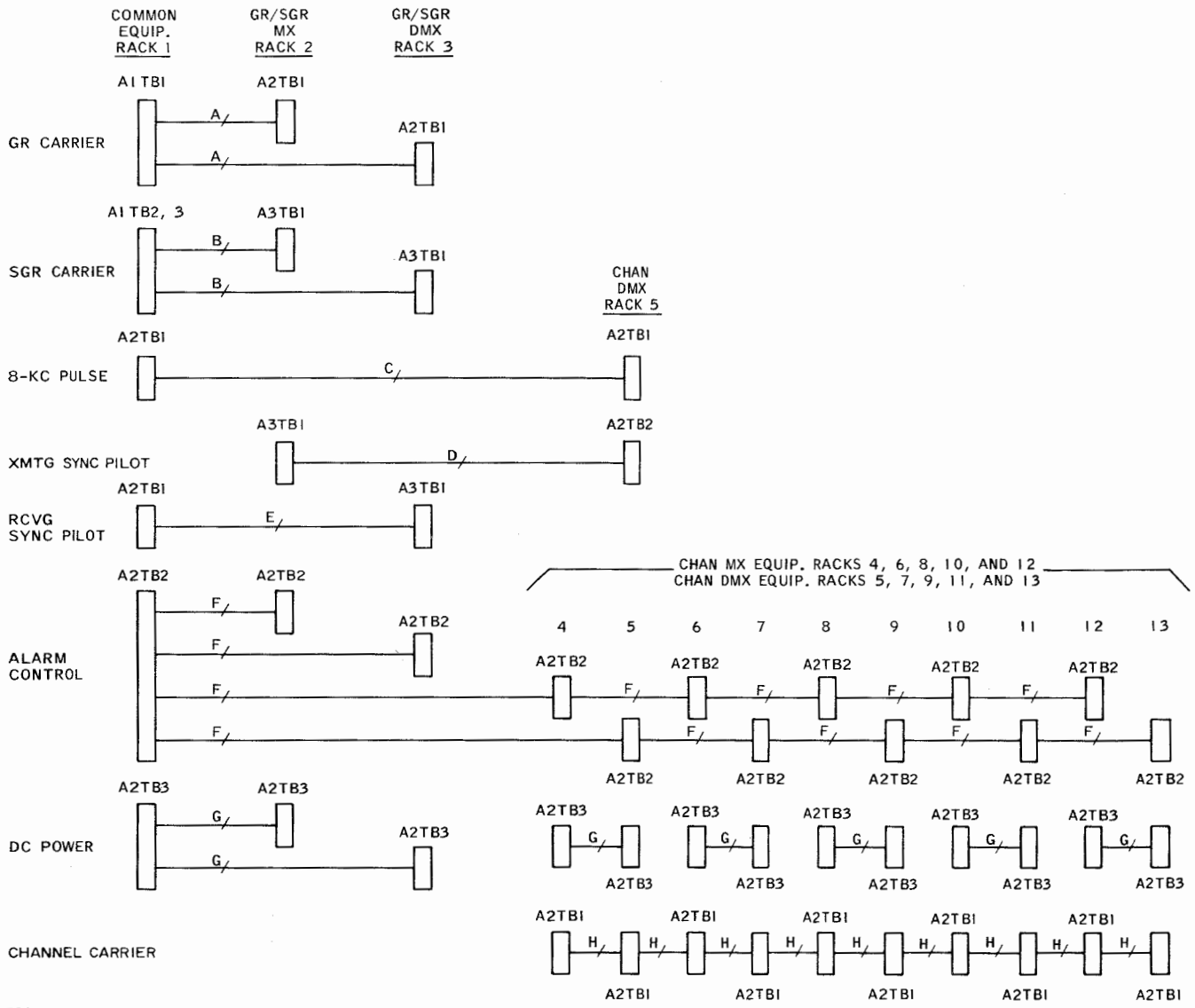

TABLE A.
WIRING BETWEEN RACKS

SYMBOL	CIRCUIT FUNCTION	LEAD DESIGNATION	WIRE OR CABLE	
			QTY	DESCRIPTION
A	GROUP CARRIER	420, 468, 516, 564, AND 612 KC	5	RG-187A/U
B	SGR CARRIER	612, 1116, 1364, 1612, 1860, 2108, 2356, 2604, AND 2852 KC	9	RG-187A/U
C	MFG OUTPUT	8-KC PULSE	1	RG-187A/U
D	CARRIER SYNCHRONIZING PILOT	XMTG SYNC PILOT	1	RG-187A/U
E		RCVG SYNC PILOT	1	RG-187A/U
F	ALARM CONTROL	MIN ALM, MAJ ALM	1	22 AWG TWISTED-PAIR
[8] G	DC POWER	-48V, GRD	2	14 AWG SINGLE-COND
[9] H	CHANNEL CARRIER	104, 96, 88, 80, 72, AND 64 KC	6	22 AWG SHIELDED SINGLE-COND

Figure 2-8. AN/FCC-17 Inter-Rack and External Wiring (Sheet 1 of 3)

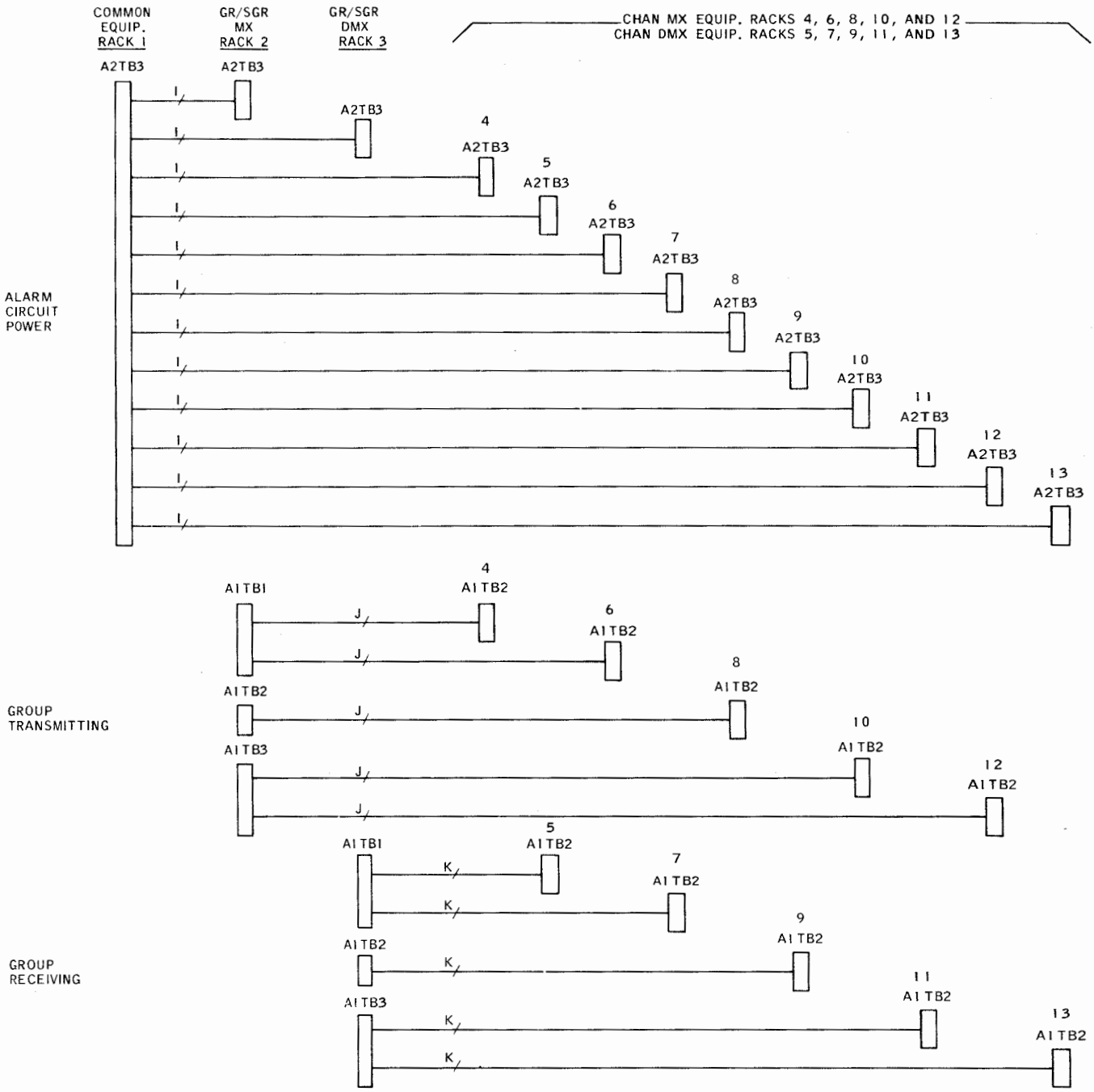

TABLE B.

WIRING BETWEEN RACKS (CONT)

SYMBOL	CIRCUIT FUNCTION	LEAD DESIGNATION	WIRE OR CABLE	
			QTY	DESCRIPTION
I	ALARM CIRCUIT POWER	40V, COM	1	20 AWG TWISTED-PAIR
J	GROUP TRANSMITTING	GR XMTG (GR 1 THRU 5 OF TWO SGR)	10	22 AWG SHIELDED TWISTED-PAIR
K	GROUP RECEIVING	GR RCVG (GR 1 THRU 5 OF TWO SGR)	10	22 AWG SHIELDED TWISTED-PAIR

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Figure 2-8. AN/FCC-17 Inter-Rack and External Wiring (Sheet 2 of 3)

TABLE B

WIRING TO EXTERNAL EQUIPMENT

	CIRCUIT FUNCTION	LEAD DESIGNATION	FROM MULTIPLEXER SET		TO EXTERNAL EQUIP.	WIRE OR CABLE	
			RACK	PANEL		QTY	DESCRIPTION
	ALARM	MIN ALM, MAJ ALM	COMMON EQUIPMENT RACK 1	A2TB2	ALARM PANEL	2	22 AWG TWISTED-PAIR
[3]	ALM CKT POWER	-48V, GRD		A2TB3	OFFICE BATTERY DISTR PANEL	2	14 AWG SINGLE-COND
	AC POWER	CKT 1, CKT 2 AND NEUTRAL		AC POWER DISTR BOX	AC DISTR PANEL	3	12 AWG TYPE TW
	HF TRANSMITTING	LINE XMTG (MAIN) LINE XMTG (ALT) [7]	RACK 2 (GR/SGR MX)	SGR MOD COMBINING PANEL	RADIO XMTR	2	RG-59B/U
	HF RECEIVING	LINE RCVG (MAIN) LINE RCVG (ALT) [7]	RACK 3 (GR/SGR DMX)	SGR DEM COMBINING PANEL	RADIO RCVR	2	RG-59B/U
	VF TRANSMITTING	VF XMTG	RACKS 4, 6, 8, 10, AND 12 (CHAN MX)	A1TB1, A1TB3	VF EQUIPMENT	120	22 AWG TWISTED-PAIR
[4]	AC POWER	CKT 1, CKT 2, AND NEUTRAL	RACKS 5, 7, 9, 11, AND 13 (CHAN DMX)	AC POWER DISTR BOX	AC DISTR PANEL	3	12 AWG, TYPE TW
	VF RECEIVING	VF RCVG		A1TB1, A1TB3	VF EQUIPMENT	120	22 AWG TWISTED-PAIR
	GROUND	GRD	EACH RACK	GROUND LUG AT TOP OF RACK	OFFICE GROUND	1	6 AWG SINGLE-COND
[3] [8]	DC POWER	-48V, GRD		A2TB3	OFFICE BATTERY DISTR PANEL	2	14 AWG SINGLE-COND

NOTES:

1. UNLESS OTHERWISE SPECIFIED, UNSHIELDED WIRE IS TYPE B PER MIL-W-16878.
2. SHIELDED SINGLE-CONDUCTOR CABLE IS TYPE TX22-1934-STJ AND SHIELDED TWISTED-PAIR CABLE IS TYPE 2TX22-1934-STJ AS SUPPLIED BY HITEMP INC (FSCM 09794) OR EQUIVALENT.
3. [3] EXTERNAL DC POWER AND ALARM CIRCUIT POWER (TABLE B) ARE NOT REQUIRED WHEN THE MULTIPLEXER SET OPERATES FROM AC POWER.
4. [4] EXTERNAL AC POWER (TABLE B) IS NOT REQUIRED ON CHANNEL DEMULTIPLEX EQUIPMENT RACKS 5, 7, 9, 11, AND 13 WHEN THE MULTIPLEXER SET OPERATES FROM OFFICE BATTERY.
5. TABLE B DOES NOT INCLUDE OPTIONAL CIRCUITS THAT MIGHT BE RUN TO AUXILIARY EQUIPMENT OR ADJACENT MULTIPLEXER SETS. THESE CIRCUITS ARE SHOWN ON THE CABLING DIAGRAMS IN THE CIRCUIT DIAGRAMS MANUAL.
6. EACH INTER-RACK WIRING SYMBOL REPRESENTS A QUANTITY OF WIRES OR CABLES IN ACCORDANCE WITH TABLE A. FOR EXAMPLE, H/ REPRESENTS 6 SHIELDED SINGLE-CONDUCTOR CABLES.
7. [7] LINE XMTG (ALT) AND LINE RCVG (ALT) ARE OPTIONAL.
8. [8] OMIT "G" INTER-RACK WIRING (TABLE A) WHEN THE MULTIPLEXER SET OPERATES FROM OFFICE BATTERY. FURNISH -48V AND GRD TO EACH RACK FROM THE OFFICE BATTERY DISTRIBUTION PANEL AS LISTED IN TABLE B.
9. [9] THE ROUTING OF CHANNEL CARRIERS BETWEEN RACKS AS ILLUSTRATED IN THIS FIGURE MAY BE ALTERED TO REDUCE THE LENGTH OF THE DISTRIBUTION CIRCUITS. (CHANNEL CARRIERS ORIGINATE ON RACK 5.)

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Figure 2-8. AN/FCC-17 Inter-Rack and External Wiring (Sheet 3 of 3)

2-76. OPTIONS IN THE CARRIER SUPPLY EQUIPMENT.

2-77. MASTER FREQUENCY GENERATOR SHELF.

2-78. OPERATING MODE (MASTER OR SLAVE). Strap both master frequency generator trays (identically) for master operation or slave operation according to system requirements:

WARNING

Before you install or remove straps on a master frequency generator tray, throw the AC BREAKER switch on the tray to OFF position, and remove the applicable 0.75-ampere fuse on the fuse panel.

a. Power transformer A6. For slave operation, strap terminals 2-10 on the header of power transformer A6; omit the strap for master operation or slave operation with dummy servo module A10 (pn 790-07217-01). The header is beneath the chassis and is covered by an insulating plate.

b. Alarm control module A1. On socket XA1-A, strap terminals 1-2-3 and terminals 6-7 for slave operation; omit the straps for master operation.

CAUTION

If 48-volt dc power to the master frequency generator tray is on, grounding certain pins on socket XA1... may damage alarm control module A1.

c. 128-kc oscillator module A5.

(1) Take off the oscillator module's top cover by removing four screws.

(2) Remove three screws securing the oscillator within the module.

(3) Pull the oscillator out by the plastic knobs.

(4) On the oscillator, strap terminals A-B for master operation or A-C for slave operation.

(5) Reassemble the oscillator module.

NOTE

Be sure that the instruction plates on the oscillator modules and the master frequency generator trays identify the operating mode for which the equipment has been strapped. The MASTER and SLAVE designations are engraved on opposite sides of the plates.

2-79. SERVO AMPLIFIER MODULE A7. Terminals A and B on the servo amplifier module appear beneath the chassis and adjacent to socket XA7. If the module is the 60-cps type (pn 790-05115-01), strap A to B; if the module is a 400-cps type (pn 790-06622-01), remove the strap between A and B.

2-80. SYNC PILOT LEVEL. At a slave terminal, the carrier synchronizing pilot for a multiplexer set may be obtained from its own receiving branch at a low level or from the carrier supply of a nearby multiplexer set at a high level. On subassembly A3 of the master frequency generator shelf, strap header terminals 9-10 for a low-level pilot or terminals 1-10 for a high level pilot. The subassembly is mounted within the structural channel at the rear of the shelf; the header is accessible from below.

2-81. CHANNEL CARRIER SUPPLY SHELF.

2-82. The channel carrier supply shelf furnishes carrier voltages on two sets of distribution circuits. One set supplies a maximum load of 10 channel multiplexer and/or demultiplexer shelves, and the other set supplies a maximum load of nine channel carrier amplifier shelves. On subassemblies A28 and A29 beneath the chassis, a separate group of terminals (A through K) for each carrier frequency are to be strapped according to the load on the distribution circuits.

2-83. Except under the special circumstance when the total load is only one channel multiplexer or demultiplexer shelf (paragraph 2-85), always strap terminals A-C and B-D for each frequency.

2-84. CHANNEL SHELVES. If the load on the distribution circuits to the channel multiplexer and/or demultiplexer shelves is five shelves or less, strap terminals B-D-E on A28 and A29 instead of just B-D as specified in paragraph 2-83. (Extending the

strap to include terminal E adds a 26.1-ohm dummy load, which is equivalent to five shelves.)

2-85. If the distribution circuits to the channel carrier amplifier shelves are idle, and the load on the distribution circuits to the channel multiplexer and/or demultiplexer shelves is only a single shelf, a special strapping option may be used to furnish carriers to this shelf. By strapping terminals A-B on A28 and A29, and omitting all other straps, the amplifier modules will be bypassed and the load will be fed directly from the output of the bandpass filters in the shelf. With the amplifier modules idle, minor and major alarms will have to be deactivated by unplugging the shelf's alarm relays.

2-86. AMPLIFIER SHELVES. Strap terminals F through K on A28 and A29 according to the load on the distribution circuits to the channel carrier amplifier shelves:

*LOAD	STRAP A28 AND A29
0	F-G-H-J
1	F-G-H-K
2	F-G-H
3	F-G-J
4	F-G-K
5	F-G
6	F-H
7	F-J
8	F-K
9	No straps on F thru K

*Quantity of channel carrier amplifier shelves

2-87. CHANNEL CARRIER AMPLIFIER SHELF.

2-88. The full load on the output of a channel carrier amplifier shelf is 10 channel multiplexer and/or demultiplexer shelves. If the load is between one and five shelves, on subassemblies A28 and A29 beneath the chassis, strap terminals A-B for each channel carrier frequency; omit these straps if the load is six or more shelves.

2-89. GROUP CARRIER GENERATOR SHELF.

2-90. When the multiplexer set does not have a supergroup carrier generator shelf, the 124-kc output circuit of the group carrier generator shelf must be terminated. On terminal board panel A2 of the common equipment rack, connect a 133-ohm resistor (1% tolerance, 1/4 watt, per MIL-R-10509) between terminals 37 and 38 on the top side of terminal board TB1.

2-91. GROUP CARRIER SUPPLY SHELF.

2-92. GROUP CARRIER LOAD. The full load on each group carrier distribution circuit is 10 group modulators and demodulators, one modulator and one demodulator in each of five 60-channel supergroups. On subassembly A22 beneath the chassis, strap terminals A through E for each group carrier frequency in accordance with the following:

*LOAD	STRAP A22
1	A-D-E
2	A-B-C-E
3	A-B-C-D
4	A-C-D
5	A-E
6	A-D
7	A-B-C
8	A-C
9	A-B
10	No straps on A thru E

*Quantity of group modulators and/or demodulators.

NOTE

When the multiplexer set includes both shelves, the group carrier supply shelf feeds carriers to the group modulators, and the group carrier amplifier shelf feeds carriers to the group demodulators. Alternate routing of carriers is accomplished by strapping on the terminal board panel at the top of the rack. Refer to cabling diagrams in the Circuit Diagrams manual.

2-93. SUPERGROUP 1 CARRIER FREQUENCY. By strapping terminals G through M on subassembly A22, either 612 kc or 564 kc may be selected as the supergroup 1 carrier. On the AN/FCC-22 and -17, strap terminals J-K and L-M to obtain 612 kc (supergroup 1); for the AN/FCC-21, strap terminals J-H and L-G to obtain 564 kc (supergroup 1A).

2-94. SUPERGROUP 1 CARRIER LOAD. The full load on the supergroup 1 carrier supply circuit is one supergroup modulator tray and one supergroup demodulator tray; when only one tray is connected to the supply circuit, strap terminals N-P on subassembly A22.

NOTE

When the multiplexer set includes both shelves, the group carrier supply shelf and the group carrier amplifier shelf each furnishes supergroup 1 carrier to one tray.

2-95. GROUP CARRIER AMPLIFIER SHELF.

2-96. The group carrier amplifier shelf, which is required in Multiplexer Set AN/FCC-17 when it is equipped with more than 300 channels, has the same strapping options described in preceding paragraphs for the group carrier supply shelf. The reference designation of the subassembly on which strapping is performed is A28 instead of A22.

2-97. SUPERGROUP CARRIER GENERATOR SHELF.

2-98. The supergroup carrier generator shelf, which is required when the multiplexer set operates with supergroups above supergroup 2, has no strapping or equipment options. If the shelf is being added to an existing configuration, the optional termination described in paragraph 2-90 has to be removed.

2-99. SUPERGROUP CARRIER SUPPLY SHELF.

2-100. The supergroup carrier supply shelf is required only when the multiplexer set operates with supergroups above supergroup 2.

2-101. LOAD. The full load on each supergroup carrier supply circuit is one supergroup modulator tray and one supergroup demodulator tray. In simplex operation of a supergroup, only one tray is used and the supply circuit feeds a half-load; strap subassembly A41 in accordance with the following:

SGR CARRIER FREQ, KC	FOR HALF-LOAD, STRAP A41
1116	C-D
1364	E-F
1612	G-H
1860	J-K
2108	L-M
2356	N-P
2604	R-S
2852	T-V

2-102. ALARM CIRCUITS. Normally, the supergroup carrier supply shelf is fully equipped to furnish carriers for supergroups 3 through 10. However, if any of the eight circuits in the shelf is unequipped, disable its alarm function by strapping terminals

A-B and C-D on the small terminal board between the A and B alarm relay sockets.

2-103. SUPERGROUP CARRIER AMPLIFIER SHELF.

2-104. The supergroup carrier amplifier shelf has six optional amplifier circuits (numbered 1 through 6), each consisting of two plug-in amplifiers, a plug-in paralleling network, and two plug-in alarm relays. The part number of the amplifier is 790-04660-01 for a supergroup 1 carrier (564 or 612 kc) and 790-02330-01 for any other supergroup carrier. The paralleling network is different for each carrier frequency.

2-105. INPUT CIRCUITS. Input signals are cross-connected to the shelf through jumpers on the terminal board panels at the top of the rack. The shelf has six separate inputs (one for each amplifier circuit) and two combined inputs that may be used to feed the same signal to two or three amplifier circuits. On subassemblies A19 and A20 on top of the chassis, strap terminals A, B, C, and D for each amplifier circuit as follows:

NOTE

The terminal's letter designation is prefixed by the applicable amplifier circuit number (1A, for example).

a. To feed the amplifier circuit from a separate input, strap terminals A-B. (A separate input has the same number as its associated amplifier circuit.)

b. To feed the amplifier circuit from a combined input, strap terminals C-B. (Respectively, combined inputs 1 and 2 are associated with amplifier circuits 1, 2, 3, and 4, 5, 6.)

c. If the combined input is used, strap terminals C-D of any of the three associated amplifier circuits that is not feed by the combined input.

2-106. LOAD. On subassembly A27 beneath the chassis, each amplifier circuit has a pair of terminals, J and K. If the load on an amplifier circuit is only one supergroup tray (modulator or demodulator), strap J to K.

2-107. ALARM CIRCUITS. Disable the alarm function of each unequipped amplifier circuit by strapping terminals E-F and G-H on the small terminal board next to the fuseholder. The terminal boards are designated A21 through A26 for amplifier circuits 1 through 6, respectively.

2-108. OPTIONS IN THE TRANSMISSION EQUIPMENT.

2-109. CHANNEL MULTIPLEXER SHELF.

2-110. VF TRANSMITTING LEVEL. Strap the sockets for channel modulators A13 through A24 for the applicable vf transmitting level:

LEVEL, DBM	STRAP XA13 THRU XA24
0	1B-2B, 3B-5B-6B, 8B-9B
-4	9A-4B, 2B-5B-6B, 8B-9B
-16	9A-7B, 2B-9B

2-111. GROUP PILOT. On subassembly A27, accessible from the back of the shelf, strap terminals J-K to inject a 64-kc group pilot into the 60-108 kc group transmitting signal. (By strapping terminals G-H instead of J-K, a 104-kc group pilot will be injected, but this option is not normally used.)

2-112. CHANNEL DEMULTIPLEXER SHELF.

2-113. There are no strapping options or equipment options on the channel demultiplexer shelf.

2-114. GROUP PILOT ALARM SHELF.

2-115. The plug-in alarm control module and alarm relay for each group are optional and may be omitted if the group is inactive. There are no strapping options on the shelf, but if the alarm control module and alarm relay are furnished for an inactive group, the resultant major alarm condition is negated by strapping on the terminal board panel at the top of the rack as described on the cabling diagrams in the Circuit Diagrams manual. The strapping supplies the alarm control module with the dc power and 64-kc pilot frequency normally obtained from the channel demultiplexer shelf.

2-116. GROUP MULTIPLEXER SHELF.

2-117. The group modulator for any inactive group may be omitted from the shelf. There are no strapping options.

2-118. GROUP DEMULTIPLEXER SHELF.

2-119. The group demodulator for any inactive group may be omitted from the shelf. There are no strapping options.

2-120. SUPERGROUP MODULATOR TRAY.

2-121. HIGH-LEVEL SUPERGROUP 1A. In the high-level supergroup 1A modulator trays (pn 790-06980-xx) used with Multiplexer Set AN/FCC-21, the outputs of amplifier modules A4 and A5 are monitored by alarm control modules A6 and A7. In accordance with system requirements, select and install alarm control modules A6 and A7 to monitor one of the five group pilots in the 12-252 kc supergroup 1A line frequency band as follows:

GROUP PILOT	A6 AND A7 PART NO
1 (208 kc)	790-02344-01
2 (160 kc)	790-05173-04
3 (112 kc)	790-05173-03
4 (64 kc)	790-05173-02
5 (16 kc)	790-05173-01

2-122. HIGH-LEVEL SUPERGROUP 1. For special applications, there is a high-level supergroup 1 modulator tray (pn 790-07259-xx). Alarm control modules A6 and A7 for monitoring the group pilots in the 60-300 kc supergroup 1 line frequency band are as follows:

GROUP PILOT	A6 AND A7 PART NO.
1 (256 kc)	790-07258-01
2 (208 kc)	790-02344-01
3 (160 kc)	790-05173-04
4 (112 kc)	790-05173-03
5 (64 kc)	790-05173-02

2-123. STRAPPING OPTIONS. There are no strapping options on the supergroup modulator trays.

2-124. SUPERGROUP DEMODULATOR TRAY.

2-125. In accordance with system requirements, select and install alarm control modules A8 and A9 to monitor one of the five group pilots in the 312-552 kc supergroup band as follows:

GROUP PILOT	A8 AND A9 PART NO.
1 (356 kc)	790-02282-01
2 (404 kc)	790-05088-05
3 (452 kc)	790-05088-06
4 (500 kc)	790-05088-02
5 (548 kc)	790-05088-01

2-126. There are no strapping options on the supergroup demodulator trays.

2-127. LINE CONNECTOR PANEL.

2-128. The line connector panel, used in Multiplexer Set AN/FCC-21, has no strapping options or equipment options. Attenuator switches are set according to the hf transmitting and receiving line levels;

refer to the alignment procedures in Section I of Chapter 5.

2-129. SUPERGROUP MODULATOR COMBINING PANEL.

2-130. The supergroup modulator combining panel is used on the AN/FCC-22 and -17. For access behind the front panel, remove three screws at each side and pull the front panel out of the chassis.

2-131. SYNCHRONIZING PILOT. On subassembly A5, strap terminals A-B if the multiplexer set is to transmit a 96-kc carrier synchronizing pilot; otherwise omit this strap. The subassembly is on the back of the front panel; terminals A and B are close to terminals 11 and 12 of TB1.

2-132. GROUND. Channel noise levels may be affected by the presence or absence of ground on the coaxial cable shield of the external hf line. If ground is required, strap terminal X to terminal Y. The terminals are on the back of the front panel at the center and near the bottom. Terminal X is on the mounting plate for the supergroup jacks and terminal Y is on the mounting plate for the line jacks.

2-133. ACTIVE SUPERGROUPS. Annulling networks A1 and A2 are plug-in modules mounted at the back of the chassis and secured by knurled-head captive screws. The networks required for a particular application of the multiplexer set depend on which supergroups are active and which are unequipped. The available options are listed on the schematic diagram of the panel in the Circuit Diagrams manual.

2-134. COAXIAL JACKS. Using coaxial U-links, connect the COMBINING HYBRID IN jack of each supergroup to the SGR MOD OUT jack (active supergroup) or to the SIMULATING NET. jack (unequipped supergroup), as applicable.

2-135. Also, connect the XMTG EQUIP. jack to the NORM LINE jack with a U-link, unless special circumstances require the use of the ALT LINE jack.

2-136. SPECIAL PANELS. A special supergroup modulator combining panel (pn 790-07210-xx) is available for nonstandard applications of the multiplexer set requiring only two supergroups. This panel has the same options described in the preceding paragraphs for the standard panel with the following exceptions:

a. Annulling networks are not used.

b. A span pad enables the hf line transmitting level to be adjusted in 1-db steps over a range of 15 db. Refer to the alignment procedures in Section I of Chapter 5.

2-137. SUPERGROUP DEMODULATOR COMBINING PANEL.

2-138. The supergroup demodulator combining panel is used on the AN/FCC-22 and -17. For access behind the front panel, remove three screws at each side and pull the front panel out of the chassis.

2-139. GROUND. Channel noise levels may be affected by the presence or absence of ground on the coaxial cable shield of the external hf line. If ground is required, strap terminal X to Y. The terminals are on the back of the front panel at the center and near the bottom. Terminal X is on the mounting plate for the supergroup jacks and terminal Y is on the mounting plate for the line jacks.

2-140. ACTIVE SUPERGROUPS. Annulling networks A1 and A2 are plug-in modules mounted at the back of the chassis and secured by knurled-head captive screws. The networks required for a particular application of the multiplexer set depend on which supergroups are active and which are unequipped. The available options are listed

on the schematic diagram of the panel in the Circuit Diagrams manual.

2-141. COAXIAL JACKS. Using coaxial U-links, connect the COMBINING HYBRID OUT jack of each supergroup to the SGR DEM IN jack (active supergroup) or to the SIMULATING NET. jack (unequipped supergroup), as applicable.

2-142. Also, connect the RCVG EQUIP. jack to the NORM LINE jack with a U-link, unless special circumstances require the use of the ALT LINE jack.

2-143. HF LINE LEVEL. Strap the span pad (on the front panel above the line jacks) in accordance with the hf line level assigned to the system. Refer to the alignment procedure in Section I of Chapter 5.

2-144. SPECIAL PANEL. A special supergroup demodulator combining panel (pn 790-07211-xx) is available for nonstandard applications of the multiplexer set requiring only two supergroups. This panel has the same options described in the preceding paragraphs for the standard panel except that annulling networks are not used.

2-145. PREPARATION FOR SERVICE.

2-146. After all installation work has been completed and verified, prepare the multiplexer set for service in accordance with the following procedure:

a. On the master alarm panel, set the MINOR and MAJOR toggle switches in the CUTOFF position.

b. Throw all AC BREAKER switches on the multiplexer set to the OFF position. (There are two switches on the master frequency generator shelf, two on each power supply shelf, and one on the master alarm panel.)

c. Verify that the multiplexer set will be supplied with single-phase 120-volt (±10%) ac power on two independent distribution circuits when the external circuit breakers are closed; measure the voltages, if necessary.

d. Close the external circuit breakers (or fuses) supplying primary ac power or dc power to the multiplexer set.

e. On the power supply shelves and the master frequency generator shelf, throw the AC BREAKER switches to ON.

f. On the master alarm panel, throw the AC BREAKER switch to ON.

g. With a multimeter (50-volt dc range), check the voltage at the LOAD VOLTAGE test points on each power supply shelf. The meter should read between 44 and 52 volts.

h. Inspect the equipment carefully for any signs of overheating, particularly the power supply and master frequency generator shelves (pull out the shelves) and the master alarm panel. Also, check the terminal board panels where inter-rack and external wiring has been connected, particularly the power distribution circuits.

i. Keep the equipment under continuous surveillance for at least an hour; thereafter, inspect it periodically until the alignment begins.

j. Check the temperature of the 128-kc oscillator in each master frequency generator tray. The top of the module should never get so hot that you can't hold your hand against it comfortably (even though the operating temperature of the oven inside the oscillator module is 167°F).

k. Verify that there are no lighted red indicator lamps on the multiplexer set except as explained in paragraph 3-11.

l. At a slave terminal, if the carrier synchronizing pilot is being received, the 128-kc oscillator in the master frequency generator shelf will probably go in or out of synchronism as the oven heater comes up to operating temperature and the oscillator stabilizes. The effect will be noted as a change in the alarm status of the master frequency generator shelf.

m. Check that U-links for all active supergroups are plugged into the jacks on the supergroup jackfields.

n. Check that U-links are properly installed on the supergroup modulator combining panel and the supergroup demodulator combining panel.

o. After a minimum warmup period of 24 hours, perform the complete alignment procedure for the multiplexer set as described in Section I of Chapter 5.

p. After alignment, all red lamps on the multiplexer set should be out. Restore all alarm cutoff switches to normal and the amber lamps should go out.

q. In coordination with the distant terminal, the multiplexer set may now be turned over to traffic.

SECTION IV
PREPARATION FOR RESHIPMENT

2-147. This section gives you information needed to prepare a multiplexer set for reshipment.

2-148. SPECIAL INSTRUCTIONS.

2-149. During preparation of the equipment for reshipment, leave all fasteners (such as bolts and nuts) attached to the components with which they belong. Otherwise, accumulate all small hardware used for a single assembly operation, package into cloth bags, and secure to the equipment. Label all packages of hardware and miscellaneous equipment clearly and take precautions against loss during loading.

WARNING

Before starting any disassembly procedures, make certain that all power has been removed and all power cables have been disconnected.

2-150. REMOVAL OF EQUIPMENT.

2-151. The equipment should be disassembled in the reverse order of assembly. The equipment racks are normally shipped completely assembled with their respective components. It is not necessary to remove any shelf, panel, or plug-in modules for reshipment separately.

2-152. PACKING OF EQUIPMENT.

2-153. Shipping containers shall be fabricated in accordance with applicable Air Force regulations using the dimensional data in Section II of this chapter.

CAUTION

Pack all equipment securely to minimize shock and vibration during shipment. Be sure that the four captive screws that attach each shelf to the rack are tight.

2-154. Moisture-proofing and preservation shall be accomplished in accordance with applicable Air Force regulations and in consideration of the destination of the equipment.

2-155. All shipping containers shall be clearly marked with sufficient information to enable the rapid and accurate reassembly of each unit in its proper location.

CHAPTER 3
OPERATION

3-1. INTRODUCTION. This chapter gives instructions you will need for operation of the multiplexer set. The instructions are limited to what you can do without using test equipment or performing corrective maintenance. The chapter has three sections: Section I identifies the controls and indicators that may be used in operation, Section II gives the operating instructions, and Section III covers emergency operation.

SECTION I
CONTROLS AND INDICATORS

3-2. The switches, circuit breakers, and indicator lamps (there are no audible indicators) in the multiplexer set are illustrated in figures 3-1 through 3-13 and described in tables 3-1 through 3-13. All other controls are the variable, screwdriver-operated type used for alignment. Do not change the settings of these variable controls except in accordance with an authorized maintenance procedure.

3-3. EQUIPMENT INTERLOCKS. The multiplexer set does not include any electrical interlock switches. Equipment shelves are mounted on slide rails and may be withdrawn from the rack without interrupting electrical circuits.

Table 3-1. High-Level Supergroup Modulator Tray, Controls and Indicators (See figure 3-1.)

NAME	REFERENCE DESIGNATION	FUNCTION
MINOR ALARM A	DS1	Lights to indicate failure of the A amplifier module.
MINOR ALARM B	DS2	Lights to indicate failure of the B amplifier module.
ALARM CUTOFF	DS3	Lights to indicate that the MINOR or MAJOR switch is in CUTOFF position.
MINOR	S1	In CUTOFF position, disables the minor alarm circuit to the master alarm panel.
MAJOR	S2	In CUTOFF position, disables the major alarm circuit to the master alarm panel.

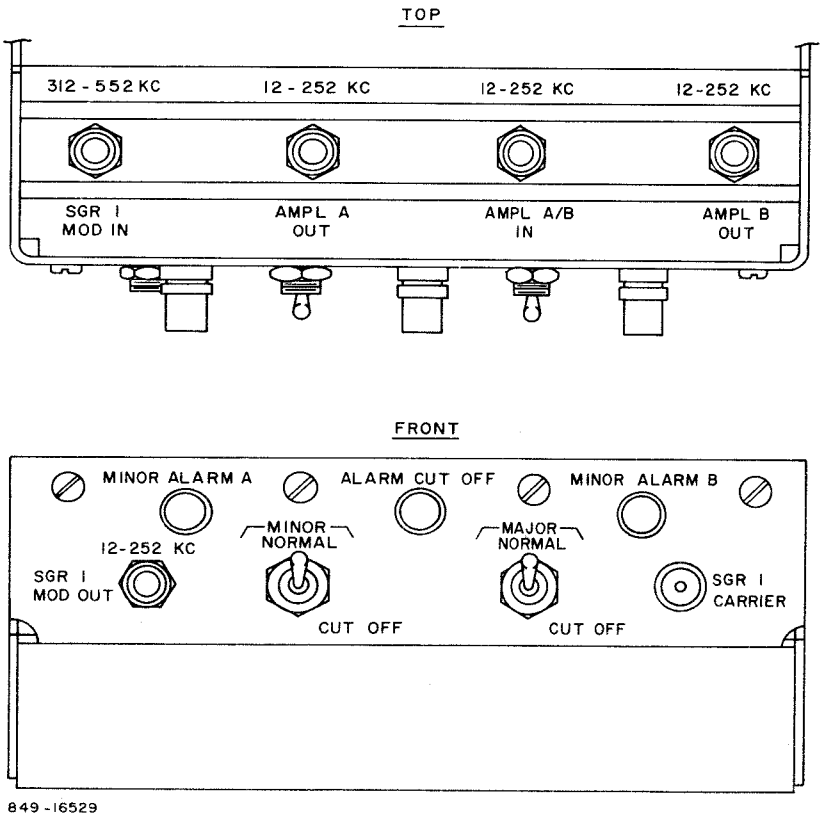


Figure 3-1. High-Level Supergroup Modulator Tray, Controls and Indicators

Table 3-2. Supergroup Demodulator Tray, Controls and Indicators (See figure 3-2.)

NAME	REFERENCE DESIGNATION	FUNCTION
MINOR ALARM A	DS1	Lights to indicate failure of the A amplifier module.
MINOR ALARM B	DS2	Lights to indicate failure of the B amplifier module.
ALARM CUTOFF	DS3	Lights to indicate that the MINOR or MAJOR switch is in CUTOFF position.
MINOR	S1	In CUTOFF position, disables the minor alarm circuit to the master alarm panel.
MAJOR	S2	In CUTOFF position, disables the major alarm circuit to the master alarm panel.

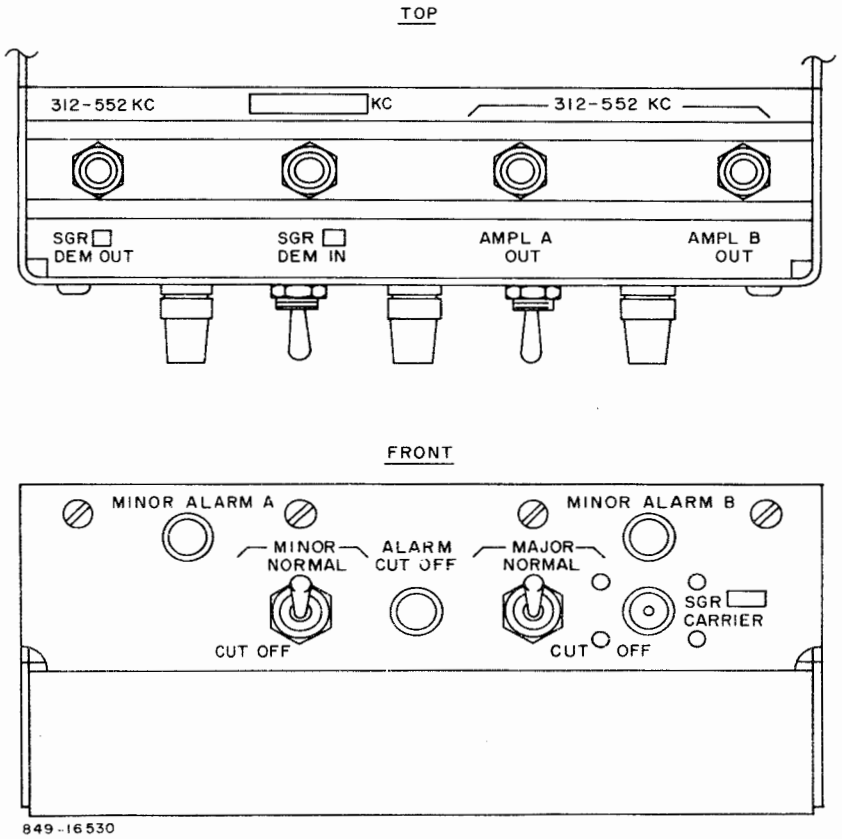


Figure 3-2. Supergroup Demodulator Tray, Controls and Indicators

Table 3-3. Group Pilot Alarm Shelf, Controls and Indicators (See figure 3-3.)

NAME	REFERENCE DESIGNATION	FUNCTION
GROUP PILOT ALARMS, GR1 thru GR5	DS1 thru DS10	Lights to indicate loss of signal in the receiving branch of the applicable group.
ALARM CUTOFF	DS11	Lights to indicate that an ALARM CUTOFF switch is in CUTOFF position.
ALARM CUTOFF, GR1 thru GR5	S1 thru S10	In CUTOFF position, for the applicable group, disables the major alarm circuit to the master alarm panel.

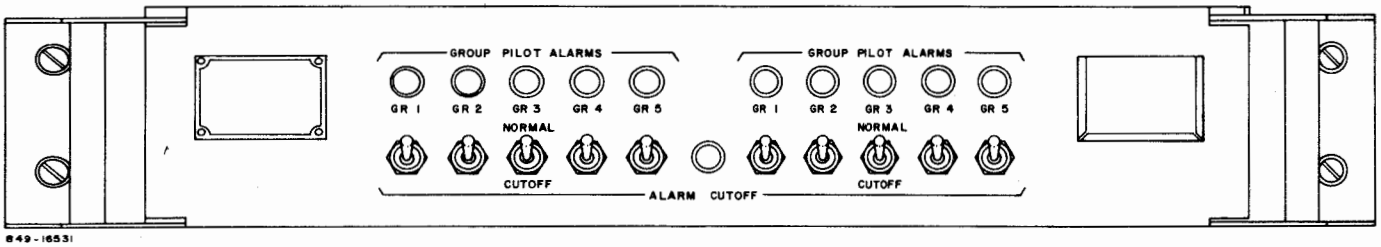


Figure 3-3. Group Pilot Alarm Shelf, Controls and Indicators

Table 3-4. Master Frequency Generator Shelf, Controls and Indicators (See figure 3-4.)

NAME	REFERENCE DESIGNATION	FUNCTION
MINOR ALARM A	DS1	Lights to indicate a failure in the A tray.
MINOR ALARM B	DS2	Lights to indicate a failure in the B tray.
ALARM CUTOFF	DS3	Lights to indicate that the MINOR or MAJOR switch is in CUTOFF position.
MINOR	S1	In CUTOFF position, disables the minor alarm circuit to the master alarm panel.
MAJOR	S2	In CUTOFF position, disables the major alarm circuit to the master alarm panel.
MAIN STANDBY SELECTOR	S3	Selects the 8-kc pulse output of the A tray (A MAIN position) or the B tray (B MAIN position).
AC BREAKER (top of each tray)	CB1	Controls ac power to the tray.

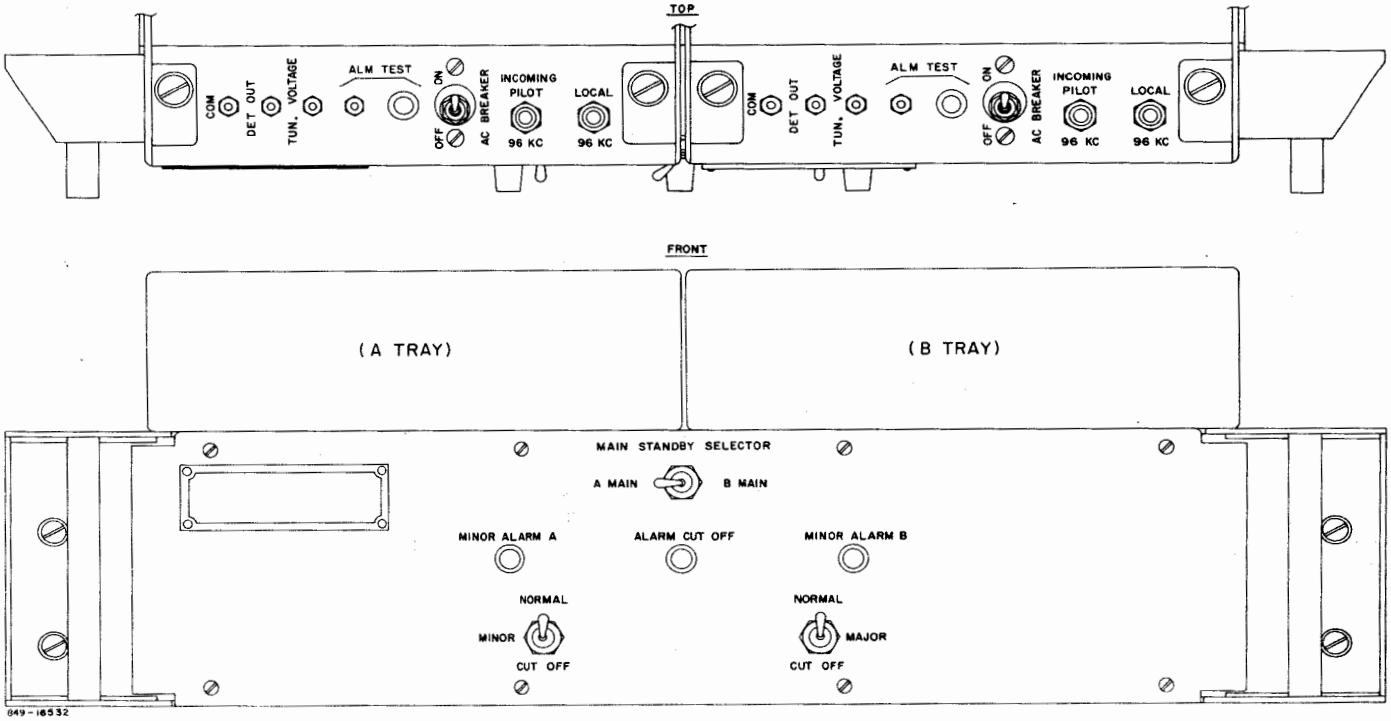


Figure 3-4. Master Frequency Generator Shelf, Controls and Indicators

Table 3-5. Channel Carrier Supply Shelf and Channel Carrier Amplifier Shelf, Controls and Indicators (See figure 3-5.)

NAME	REFERENCE DESIGNATION	FUNCTION
MINOR ALARM A	DS1	Lights to indicate failure of an A amplifier module.
MINOR ALARM B	DS2	Lights to indicate failure of a B amplifier module.
ALARM CUTOFF	DS3	Lights to indicate that the MINOR or MAJOR switch is in CUTOFF position.
MINOR	S1	In CUTOFF position, disables the minor alarm circuit to the master alarm panel.
MAJOR	S2	In CUTOFF position, disables the major alarm circuit to the master alarm panel.

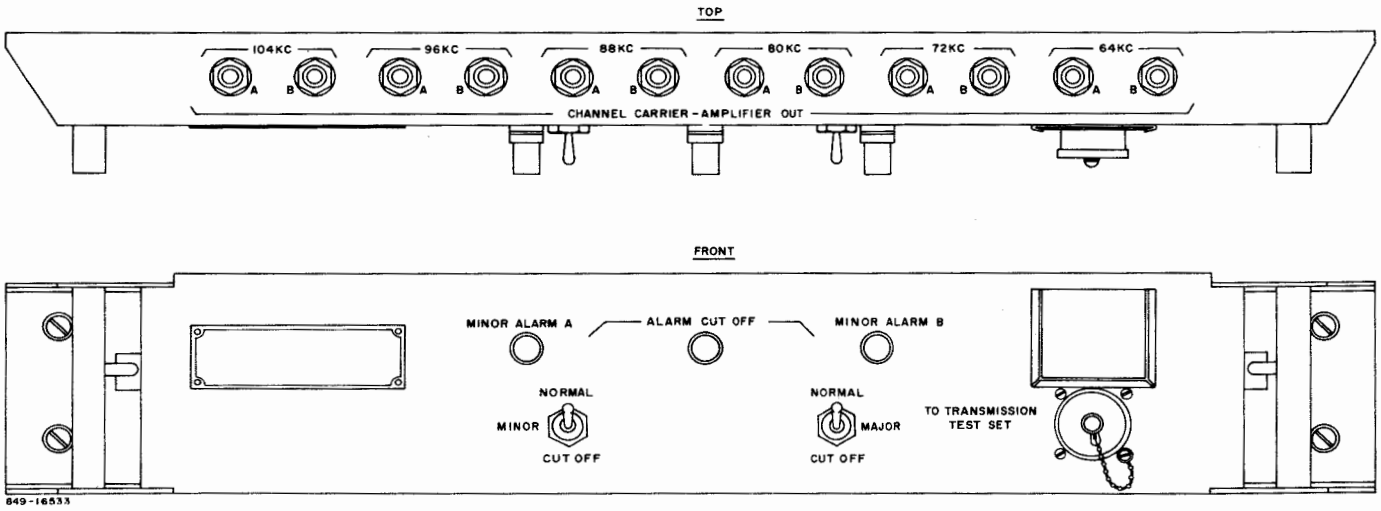


Figure 3-5. Channel Carrier Supply Shelf and Channel Carrier Amplifier Shelf, Controls and Indicators

Table 3-6. Group Carrier Generator Shelf, Controls and Indicators (See figure 3-6.)

NAME	REFERENCE DESIGNATION	FUNCTION
MINOR ALARM A	DS1	Lights to indicate failure of an A amplifier module.
MINOR ALARM B	DS2	Lights to indicate failure of a B amplifier module.
ALARM CUTOFF	DS3	Lights to indicate that the MINOR or MAJOR switch is in CUTOFF position.
MINOR	S1	In CUTOFF position, disables the minor alarm circuit to the master alarm panel.
MAJOR	S2	In CUTOFF position, disables the major alarm circuit to the master alarm panel.

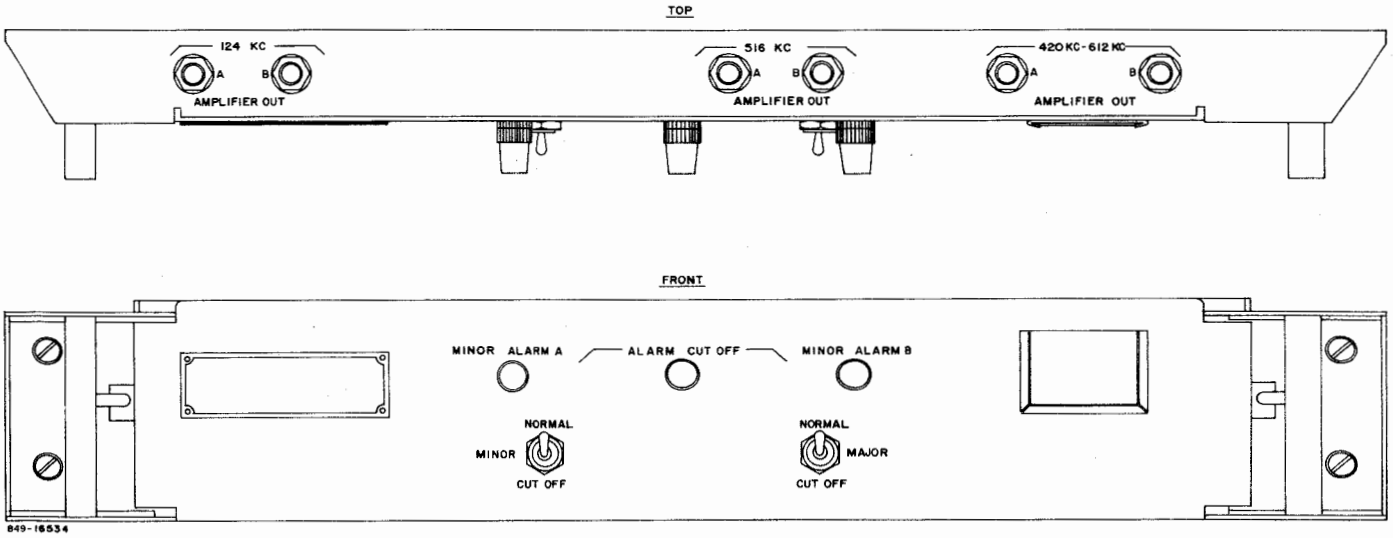


Figure 3-6. Group Carrier Generator Shelf, Controls and Indicators

Table 3-7. Group Carrier Supply Shelf and Group Carrier Amplifier Shelf, Controls and Indicators (See figure 3-7.)

NAME	REFERENCE DESIGNATION	FUNCTION
MINOR ALARM A	DS1	Lights to indicate failure of an A amplifier module.
MINOR ALARM B	DS2	Lights to indicate failure of a B amplifier module.
ALARM CUTOFF	DS3	Lights to indicate that the MINOR or MAJOR switch is in CUTOFF position.
MINOR	S1	In CUTOFF position, disables the minor alarm circuit to the master alarm panel.
MAJOR	S2	In CUTOFF position, disables the major alarm circuit to the master alarm panel.

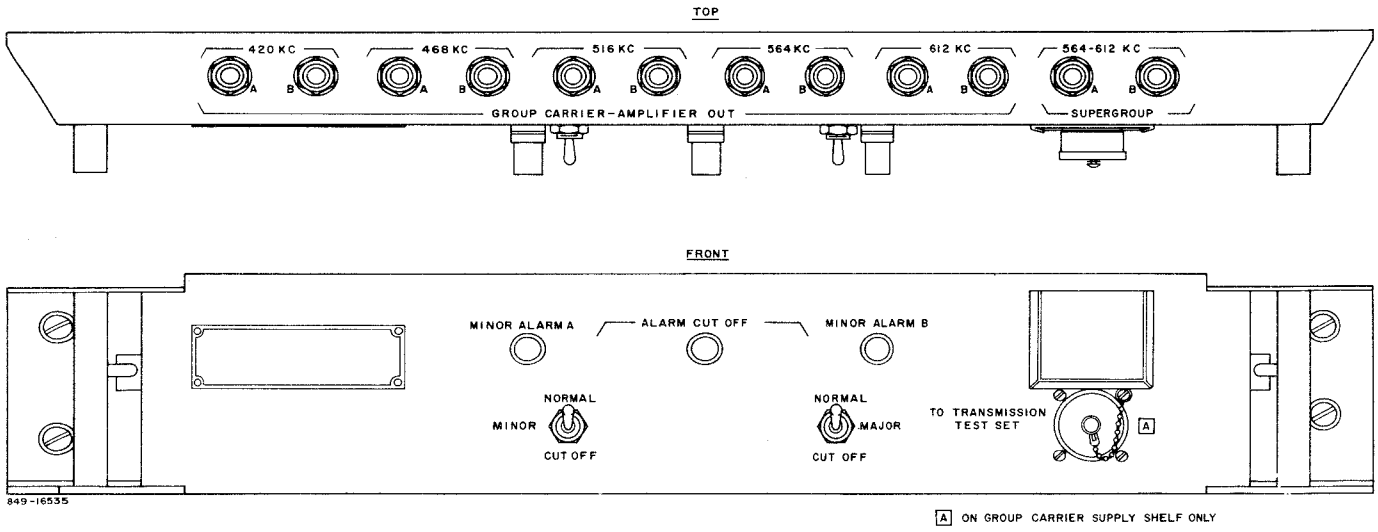


Figure 3-7. Group Carrier Supply Shelf and Group Carrier Amplifier Shelf, Controls and Indicators

Table 3-8. Supergroup Carrier Generator Shelf, Controls and Indicators (See figure 3-8.)

NAME	REFERENCE DESIGNATION	FUNCTION
MINOR ALARM A	DS1	Lights to indicate failure of the A amplifier module.
MINOR ALARM B	DS2	Lights to indicate failure of the B amplifier module.
ALARM CUTOFF	DS3	Lights to indicate that the MINOR or MAJOR switch is in CUTOFF position.
MINOR	S1	In CUTOFF position, disables the minor alarm circuit to the master alarm panel.
MAJOR	S2	In CUTOFF position, disables the major alarm circuit to the master alarm panel.

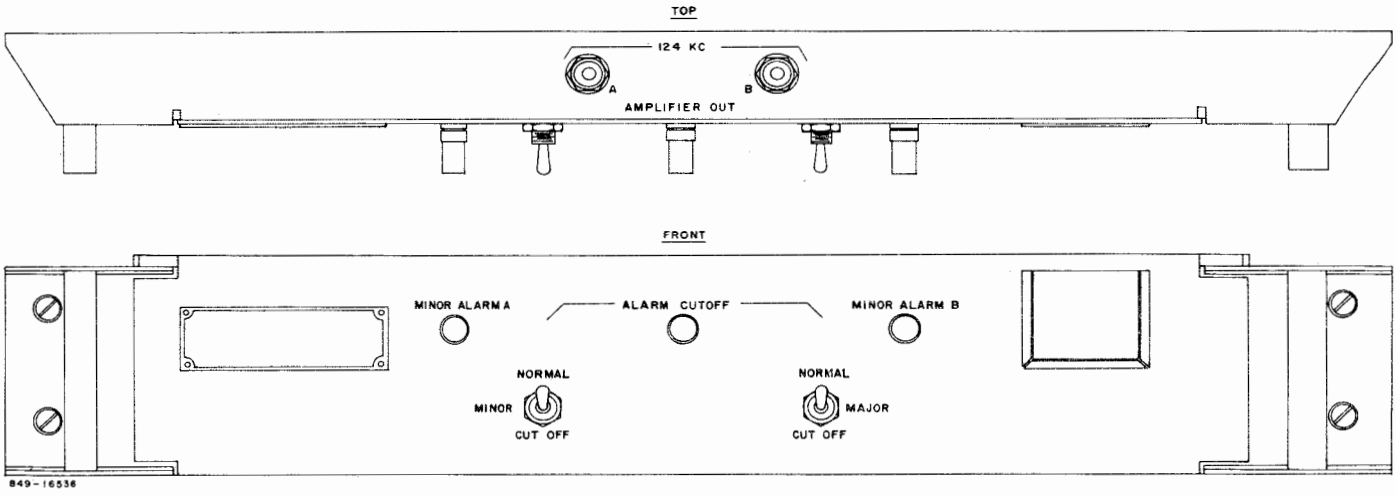


Figure 3-8. Supergroup Carrier Generator Shelf, Controls and Indicators

Table 3-9. Supergroup Carrier Supply Shelf and Supergroup Carrier Amplifier Shelf, Controls and Indicators (See figure 3-9.)

NAME	REFERENCE DESIGNATION	FUNCTION
MINOR ALARM A	DS1	Lights to indicate failure of an A amplifier module.
MINOR ALARM B	DS2	Lights to indicate failure of a B amplifier module.
ALARM CUTOFF	DS3	Lights to indicate that the MINOR or MAJOR switch is in CUTOFF position.
MINOR	S1	In CUTOFF position, disables the minor alarm circuit to the master alarm panel.
MAJOR	S2	In CUTOFF position, disables the major alarm circuit to the master alarm panel.

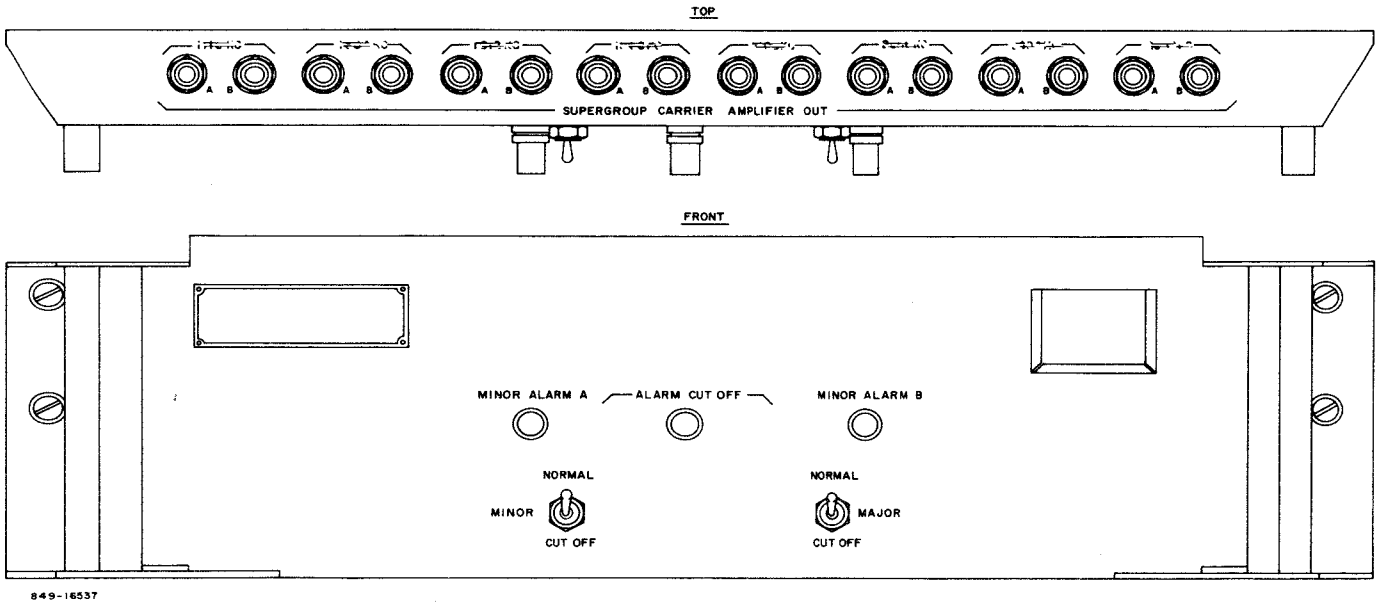


Figure 3-9. Supergroup Carrier Supply Shelf and Supergroup Carrier Amplifier Shelf, Controls and Indicators

Table 3-10. Power Supply Shelf, Controls and Indicators (See figure 3-10.)

NAME	REFERENCE DESIGNATION	FUNCTION
MINOR ALARM A	DS1	Lights to indicate failure of the A tray.
MINOR ALARM B	DS3	Lights to indicate failure of the B tray.
ALARM CUTOFF	DS2	Lights to indicate that the MINOR or MAJOR switch is in CUTOFF position.
MINOR	S1	In CUTOFF position, disables the minor alarm circuit to the master alarm panel.
MAJOR	S2	In CUTOFF position, disables the major alarm circuit to the master alarm panel.
AC BREAKER (top of each tray)	CB1	Controls ac power to the tray.

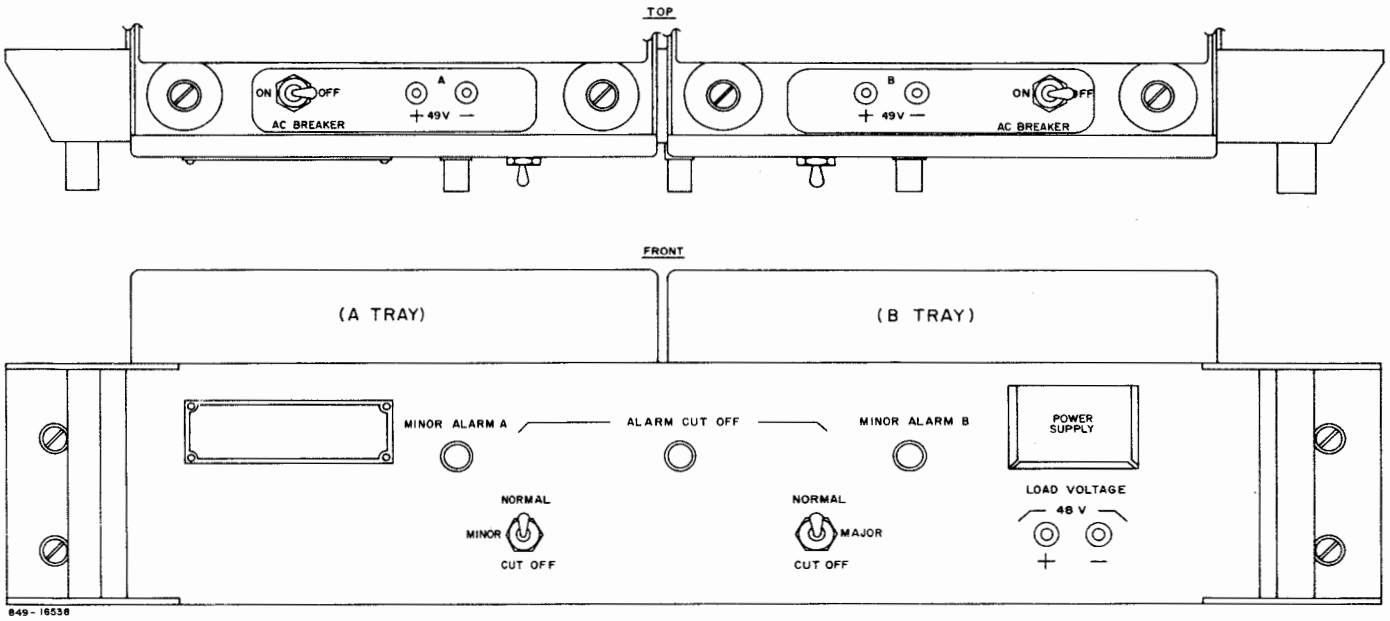


Figure 3-10. Power Supply Shelf, Controls and Indicators

Table 3-11. Typical Fuse Panel With Alarm Cutoff, Controls and Indicators (See figure 3-11.)

NAME	REFERENCE DESIGNATION	FUNCTION
MINOR ALM FUSE	DS1	Lights to indicate a blown dc power fuse.
ALM CUTOFF	DS2	Lights to indicate that the ALARM CUTOFF switch is in CUTOFF position.
*PILOT LAMP FUSE FAILURE	DS3	Lights to indicate a blown alarm circuit power fuse.
ALARM CUTOFF	S1	In CUTOFF position, disables the minor alarm circuit to the master alarm panel.

*On some fuse panels, DS3 is designated LAMP POWER FUSE FAILURE or is not used.

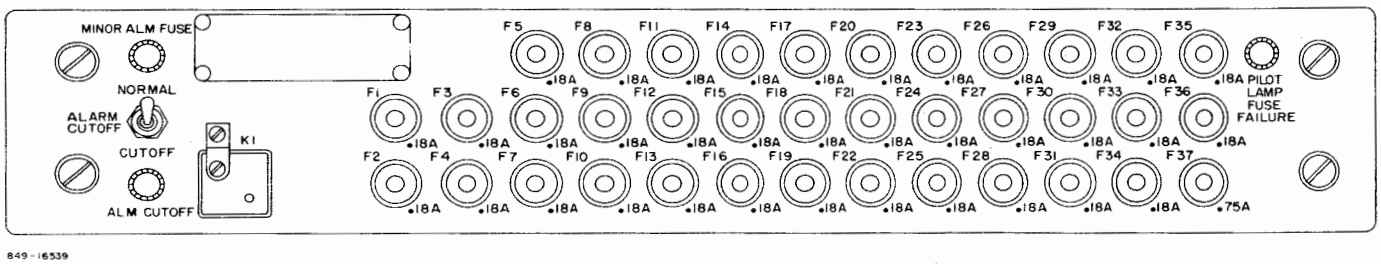


Figure 3-11. Typical Fuse Panel With Alarm Cutoff, Controls and Indicators

Table 3-12. Typical Fuse Panel Without Alarm Cutoff, Indicators (See figure 3-12.)

NAME	REFERENCE DESIGNATION	FUNCTION
FUSE FAILURE	DS1	Lights to indicate a blown dc power fuse.
*PILOT LAMP FUSE FAILURE	DS2	Lights to indicate a blown alarm circuit power fuse.

* DS2 is not used on some fuse panels.

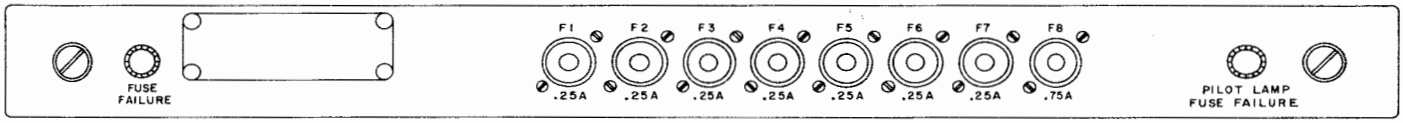


Figure 3-12. Typical Fuse Panel Without Alarm Cutoff, Indicators

Table 3-13. Master Alarm Panel, Controls and Indicators (See figure 3-13.)

NAME	REFERENCE DESIGNATION	FUNCTION
AC BREAKER	CB1	Controls alarm circuit power.
MAJOR ALARM	DS1	Lights to indicate a major alarm condition in the multiplexer set.
ALARM CUTOFF	DS2	Lights to indicate that the MAJOR or MINOR switch is in CUTOFF position.
MINOR ALARM	DS3	Lights to indicate a minor alarm condition in the multiplexer set.
MAJOR	S1	In CUTOFF position, disables the major alarm circuit to external equipment.
MINOR	S2	In CUTOFF position, disables the minor alarm circuit to external equipment.
MAJOR TEST	S3	When pressed, simulates a major alarm condition in the multiplexer set.
MINOR TEST	S4	When pressed, simulates a minor alarm condition in the multiplexer set.

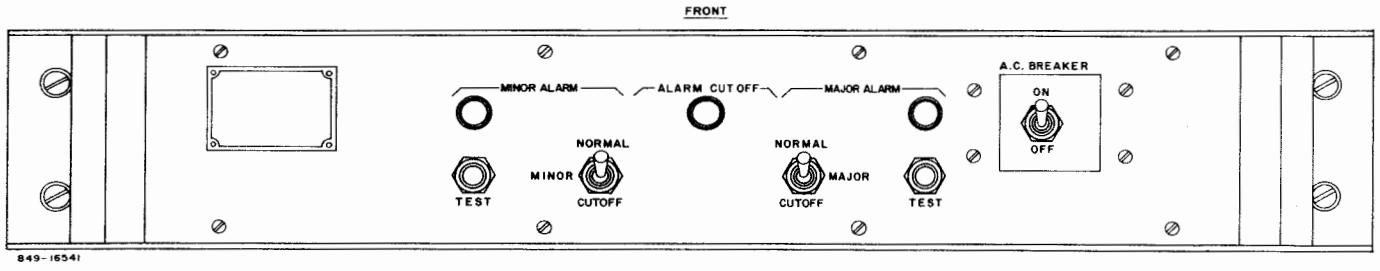


Figure 3-13. Master Alarm Panel, Controls and Indicators

SECTION II
OPERATING INSTRUCTIONS

3-4. During normal conditions, the multiplexer set operates without the adjustment of any controls, and constant attendance by an operator is not necessary. The instructions in this section pertain to starting and stopping the equipment, responding to alarm indications, and talking over a traffic channel.

3-5. STARTING THE EQUIPMENT.

3-6. Prior to the application of power, no special control settings are necessary for the safety of the operator or for protection of the equipment. However, if the multiplexer set has not been aligned and in operation previously, refer to the instructions in Chapter 2 on preparation for service.

3-7. POWER TURN-ON.

3-8. The multiplexer set is designed for continuous operation and does not contain a universal control for starting and stopping. To turn the equipment on, close the external circuit breakers (normally, there are two) that supply ac power. Then, close the switches that control ac power within the multiplexer set as follows:

a. Power supply shelves on the common equipment rack and channel equipment racks. Pull the shelf partly out of the rack and throw the two AC BREAKER switches to ON.

b. Master frequency generator shelf on the common equipment rack. Pull the shelf partly out of the rack and throw the two AC BREAKER switches to ON.

c. Master alarm panel on the common equipment rack. Throw the AC BREAKER switch on the front panel to ON.

3-9. If the multiplexer set obtains dc power from a 48-volt office battery power supply shelves are omitted from the equipment racks. Alarm circuit power may be derived from an ac source or from the office battery; in the latter case, the AC BREAKER switch on the master alarm panel will be ineffective. The only major component that will always be supplied with ac power is the master frequency generator shelf.

3-10. PREPARATION FOR OPERATION.

3-11. If the multiplexer set is not receiving a signal from the distant terminal, the following red lamps will be lighted:

a. MINOR ALARM A and B lamps on each supergroup demodulator tray.

b. GROUP PILOT ALARM lamps on each group pilot alarm shelf.

c. MINOR ALARM A and B lamps on the master frequency generator shelf at a slave terminal that obtains 96-kc carrier sync pilot from the incoming signal.

d. MINOR ALARM and MAJOR ALARM lamps on the master alarm panel. (These lamps will be dark if alarms on the equipment have been disabled by alarm cutoff switches.)

3-12. If any other red lamps on the multiplexer set are lighted, alignment or corrective maintenance is probably needed. The ALARM CUTOFF lamps are amber and, when lighted, indicate that an associated switch is in CUTOFF position.

3-13. The alarm lamps on the supergroup demodulator trays and group pilot alarm shelves should go out when the incoming signal is received at the proper level.

3-14. At a slave terminal, if the master frequency generator shelf remains in an alarm condition despite normal carrier synchronizing pilot level, the 128-kc oscillator may be out of synchronization; refer to Chapter 5.

3-15. When all red lamps are out, the multiplexer set is ready for operation. Restore the alarm cutoff switches to NORMAL position; the amber lamps will go out. Before turning the equipment over to traffic, allow at least one hour warmup time.

3-16. OPERATING THE EQUIPMENT.

3-17. ALARM INDICATIONS.

3-18. The significance of the alarm indicators on the multiplexer set can be summarized by the following:

a. Failure of the A and B devices (amplifiers, for example) of a redundant pair is indicated by the MINOR ALARM A and B lamps, respectively. Failure of one device produces a minor alarm, and failure of both produces a major alarm.

NOTE

Failure of the A device of one redundant pair and the B device of another redundant pair in the same shelf will produce a false major alarm.

b. The GROUP PILOT ALARM lamps on the group pilot alarm shelf indicate trouble affecting 12-channel groups. The number of such lamps that are lighted is a clue to the extent of the failure, which could be at the local terminal, at the distant terminal, or in the intervening transmission equipment.

c. If both the MINOR ALARM A and B lamps on a supergroup demodulator tray are lighted, it could be because the group pilot monitored in the tray has been interrupted elsewhere in the system.

d. A blown dc power fuse lights an alarm lamp on the fuse panel. On some fuse panels, it also directly produces a minor alarm.

e. A blown alarm circuit power fuse lights an alarm lamp on the fuse panel but does not directly produce a minor or major alarm. But because the interruption of power will release relays in the shelves and trays of the multiplexer set, alarms will occur.

f. A major alarm warns that service may have failed on one or more 12-channel groups.

g. A minor alarm that is not accompanied by a major alarm at either terminal in the system indicates trouble that has not affected service. (A blown fuse could result in a minor alarm at the local terminal, but a major alarm at the distant terminal.)

NOTE

The alarm system of the multiplexer set is not intended to detect trouble affecting individual channels.

3-19. OPERATING PROCEDURES.

3-20. An alarm condition in the multiplexer set will be indicated by the audible or visual office alarm, by red lamps on the master panel, and by red lamps on the equipment

(shelf, panel, or tray) in which a failure has occurred or in which the effect is felt of a failure elsewhere. The following procedure should be used in response to an alarm condition:

a. On the master alarm panel, set the alarm cutoff switch (MINOR or MAJOR) associated with the lighted red lamp to CUTOFF. This will release the office alarms from control by the master alarm panel.

NOTE

If the equipment is displaying only a few lighted red lamps, you may prefer to disable the alarms directly (as in step b) and omit the preceding step.

b. On each equipment that has a lighted MINOR ALARM A or MINOR ALARM B lamp, set the MINOR switch to CUTOFF. If both MINOR ALARM lamps are lighted, also set the MAJOR switch to CUTOFF.

c. On each group pilot alarm shelf that has a lighted GROUP PILOT ALARM lamp, set the associated ALARM CUTOFF switch to CUTOFF.

d. On each fuse panel that has a lighted MINOR ALARM FUSE lamp, set the ALARM CUTOFF switch to CUTOFF.

NOTE

All of the alarm circuit power fuses and many of the dc power fuses light a red lamp on the fuse panel when they blow but don't directly activate the multiplexer set's minor or major alarm circuits. But the equipment deprived of power will initiate an appropriate alarm.

e. When all alarms on the equipment have been disabled, return the alarm cutoff switches (MINOR and MAJOR) on the master alarm panel to NORMAL. As the trouble on each equipment is cleared, return its alarm cutoff switch to NORMAL.

3-21. TALKING OVER A TRAFFIC CHANNEL.

3-22. During servicing routines, or when performing maintenance procedures on an in-service basis, it may be necessary for you to converse with the operator at the distant terminal over one of the traffic channels by using Handset H-222/MCC-12 and the handset patch panel mounted on the multiplexer set or transmission test set.

3-23. In order to establish communications, the channel to be used must be taken out of service. Before a channel is taken out of service, it may be necessary for you to notify the channel and traffic control unit, or an equivalent agency, for approval.

3-24. The handset is a sound-powered telephone and doesn't provide signaling capability, so initial contact with the distant terminal must be established by some other means or over another facility, such as an order wire.

3-25. To use the handset, plug it into the TELEPHONE SET jack on the handset patch panel. Then, patch the VF XMTG jack and VF RCVG jack to the applicable normalled-through four-wire vf jacks associated with the multiplexer set. A typical patch cord is Electrical Cord Assembly CX-9443/U (pn 746-00502-02), which has tip-ring-sleeve telephone plugs. If you only want to monitor a channel, patch the VF RCVG jack to the applicable bridging vf jack on the multiplexer set or jackfield.

3-26. STOPPING THE EQUIPMENT.

3-27. The operation of the multiplexer set is stopped simply by turning off the power. Normally, you should turn off power in the reverse of the power turn-on sequence described in paragraph 3-7: first, throw the AC BREAKER switches to OFF on the master alarm panel, master frequency generator shelf, and power supply shelves; then, open the two external circuit breakers.

NOTE

In some locations, harmful voltage transients may appear on the 120-volt ac supply leads while power is being restored after a failure. To protect the multiplexer set, external circuit breakers should be opened immediately after power has failed. Then, throw the AC BREAKER switches on the equipment to OFF in preparation for the normal turn-on procedure (paragraph 3-7) to be used after power has been restored.

3-28. External alarms will operate when the ac power is removed. Open the control circuits from the multiplexer set to these alarms by setting the MINOR and MAJOR switches on the master alarm panel to CUTOFF.

SECTION III
EMERGENCY OPERATION

3-29. In the multiplexer set, redundant or standby circuits are provided where a failure or partial malfunction might affect service on more than one 12-channel group, but these circuits work automatically and no action by an operator is required.

3-30. In an emergency, if alternate circuits have been provided, patching to bypass a failed circuit in the transmission equipment may be appropriate.

3-31. CHANNEL FAILURE.

3-32. A failed channel can be restored to service if an alternate channel is available. The alternate channel must be arranged for the same vf drop levels as the failed channel. Cross-connecting of channels is accomplished by making appropriate patching on channel jackfields (if supplied) or on the main distribution frame. The procedure below is applicable only to multiplex terminals which are equipped with channel jackfields. Patch cords are not supplied with a multiplex terminal for cross-connection purposes. Use two-conductor shielded patch cords that are equipped with tip-ring-sleeve telephone plugs, such as type CX-9443/U. Exact patching arrangements must be accomplished at each terminal in the system.

a. On the channel transmitting jackfield, patch the XMTG EQUIP jack of the failed channel to the CHAN MX IN jack of the alternate channel.

b. On the channel receiving jackfield, patch the CHAN DMX OUT jack of the alternate channel to the RCVG EQUIP jack of the failed channel.

3-33. GROUP FAILURE.

3-34. A failed group (12 channels) can be restored to service if an alternate group is available. To cross-connect groups, perform the following at each terminal of the system using two-conductor shielded patch cords with tip-ring-sleeve telephone plugs, such as type CX-9443/U.

a. On the group transmitting jackfield, patch the CHAN MX OUT jack of the failed group to the GR MX IN jack of the alternate group.

b. On the group receiving jackfield, patch the GR DMX OUT jack of the alternate group to the CHAN DMX IN jack of the failed group.

3-35. SUPERGROUP FAILURE.

3-36. A failed supergroup (60 channels) can be restored to service if an alternate supergroup is available. To cross-connect supergroups, perform the following at each terminal of the system using coaxial patch cords.

a. On the supergroup transmitting jackfield, patch the GR MX OUT jack on the failed supergroup to the SGR MOD IN jack of the alternate supergroup.

b. On the supergroup receiving jackfield, patch the SGR DEM OUT jack of the alternate supergroup to the GR DMX IN jack of the failed supergroup.

3-37. TRANSMISSION LINE FAILURES.

3-38. Multiplexer Sets AN/FCC-22 and AN/FCC-17 are equipped so that a main or alternate hf transmitting (or receiving) line can be used. If the main line fails, the alternate line is placed into service by moving the coaxial U-link from the NORM LINE jack to the ALT LINE jack on the supergroup modulator combining panel. If the main receiving line fails, a similar operation is performed on the supergroup demodulator combing panel.

CHAPTER 4
PRINCIPLES OF OPERATION

4-1. INTRODUCTION. This chapter contains information that will aid you in understanding the operation of the electrical and electronic circuits of the multiplexer set. Section I describes systems operation, including signal flow through the major components. Section II gives details on the operation of electronic circuits peculiar to the multiplexer set and not covered in other technical manuals. Section III, Functional Operation of Mechanical Assemblies, is not applicable to this equipment. For basic circuit principles of operation, refer to T.O. 31-1-141.

SECTION I
FUNCTIONAL SYSTEM OPERATION

4-2. Multiplexer Sets AN/FCC-21, -22, and -17 employ the frequency-division technique to create a composite baseband containing up to 60, 240, and 600 4-kc spaced channels, respectively. The equipment and its configurations are identified in Chapter 1; the functional operation of the equipment is described in this chapter under the following system headings beginning at the paragraph number listed in parentheses:

a. Transmission system (4-3)

b. Carrier supply system (4-140)

c. Alarm system (4-262)

d. Ac power system (4-287)

e. Dc power system (4-290)

f. Transmission test set (4-316)

4-3. TRANSMISSION SYSTEM.

4-4. FREQUENCY TRANSLATION. The transmission system of the multiplexer set is divided into three blocks of frequency translating equipment (channel, group, and supergroup), each block having a transmitting branch and a receiving branch. The three steps of frequency translation are shown in figure 4-1; from left to right, the diagram represents signal flow in the transmitting branch, and from right to left, signal flow in the receiving branch.

4-5. Each step of frequency translation reverses the relative positions of the channels in the spectrum. Channels may be either upright (low channel frequency at the low end of the spectrum) or inverted (low channel frequency at the high end of the spectrum). The upright or inverted condition of the channels is shown symbolically in figure 4-1.

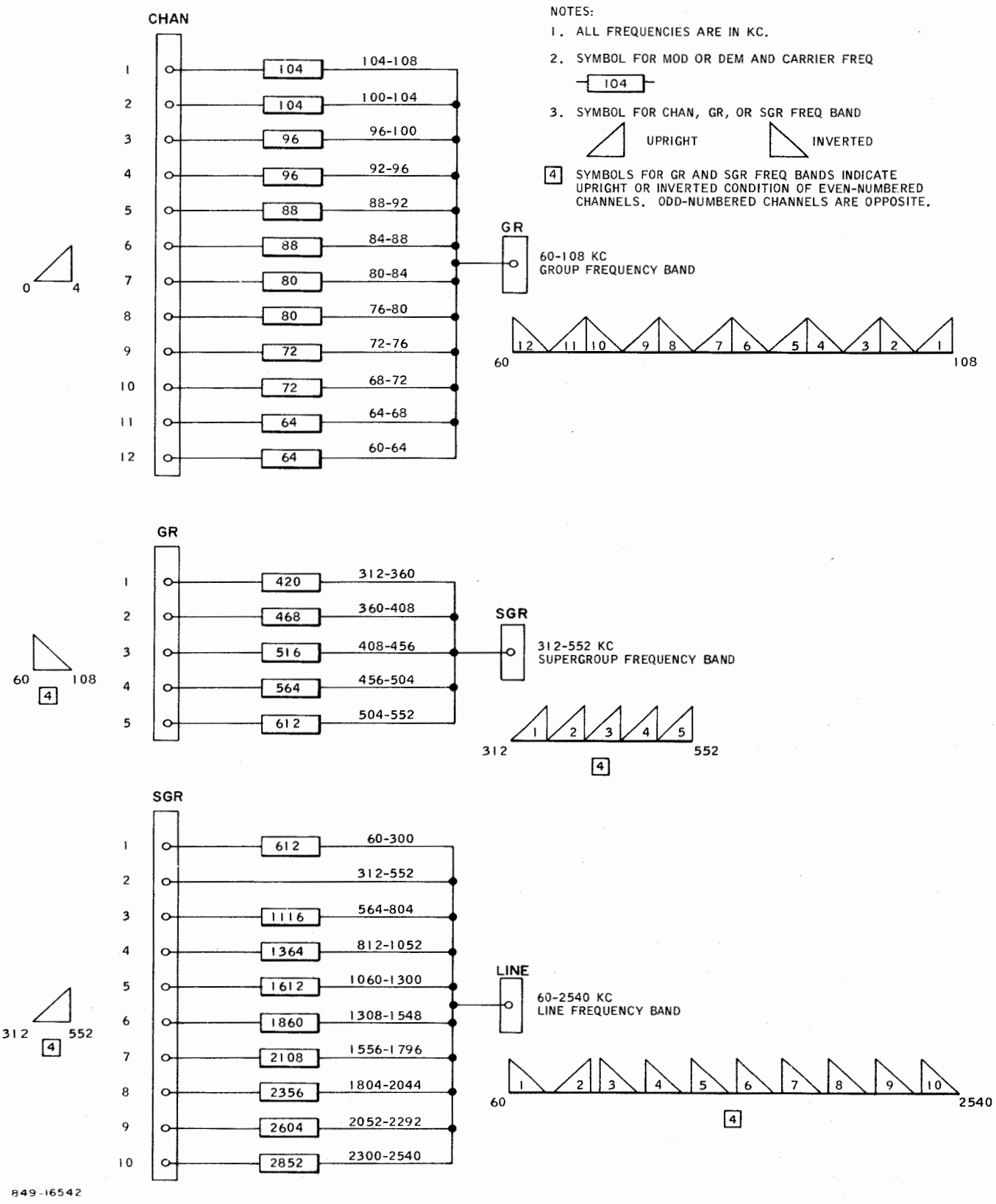


Figure 4-1. Frequency Translation Plan

4-6. Frequency translation is performed by double-balanced transistor modulators (and demodulators) in which both the signal frequency and the carrier frequency are suppressed from the output. The principal products of the modulator are the first-order upper sideband (sum of carrier and signal frequencies) and lower sideband (difference between carrier and signal frequencies). By filtering, one sideband is selected for use while the other sideband and any higher-order modulation products are discarded.

4-7. From the output of a channel modulator, the upper sideband is selected if the channel is odd-numbered and the lower sideband if it is even-numbered. In all the other stages of modulation and demodulation, the lower sideband is chosen.

4-8. As shown in figure 4-1, 612 kc and 60-300 kc are the carrier and the line frequency band for supergroup 1. On Multiplexer Set AN/FCC-21 only, an optional 564-kc carrier may be used, instead, to create a 12-252 kc line frequency band usually identified as supergroup 1A.

NOTE

In this and associated manuals, in some contexts supergroup 1 may refer to either of the line frequency bands, but supergroup 1A always means the 12-252 kc band.

4-9. SIGNAL FLOW. Figures 4-2, 4-3, and 4-4 are simplified block diagrams showing the equipment in the transmitting and receiving branches of the transmission system for Multiplexer Sets AN/FCC-21, -22, and -17. Although only one shelf and tray of each type is shown, the diagram can be construed to represent a multiplexer set of any channel capacity up to the maximum. (A more detailed block diagram is given in the Circuit Diagrams manual.)

4-10. In progressing from vf drop to the line, signal processing in the transmitting branch consists of the following steps:

a. Twelve vf channels are multiplexed to form a 60-108 kc group.

b. At the output of the channel multiplexer shelf, a 64-kc group is injected into the group signal at a level of -16 dbm0.

c. Five groups are multiplexed to form a 312-552 kc basic supergroup.

d. In a supergroup modulator tray, each basic supergroup is translated to an assigned 240-kc wide band in the line frequency range.

e. Without further frequency translation, multiple supergroups are joined together into a composite hf transmitting signal. (The AN/FCC-21 has only one supergroup.)

4-11. Signal processing in the receiving branch consists of these steps:

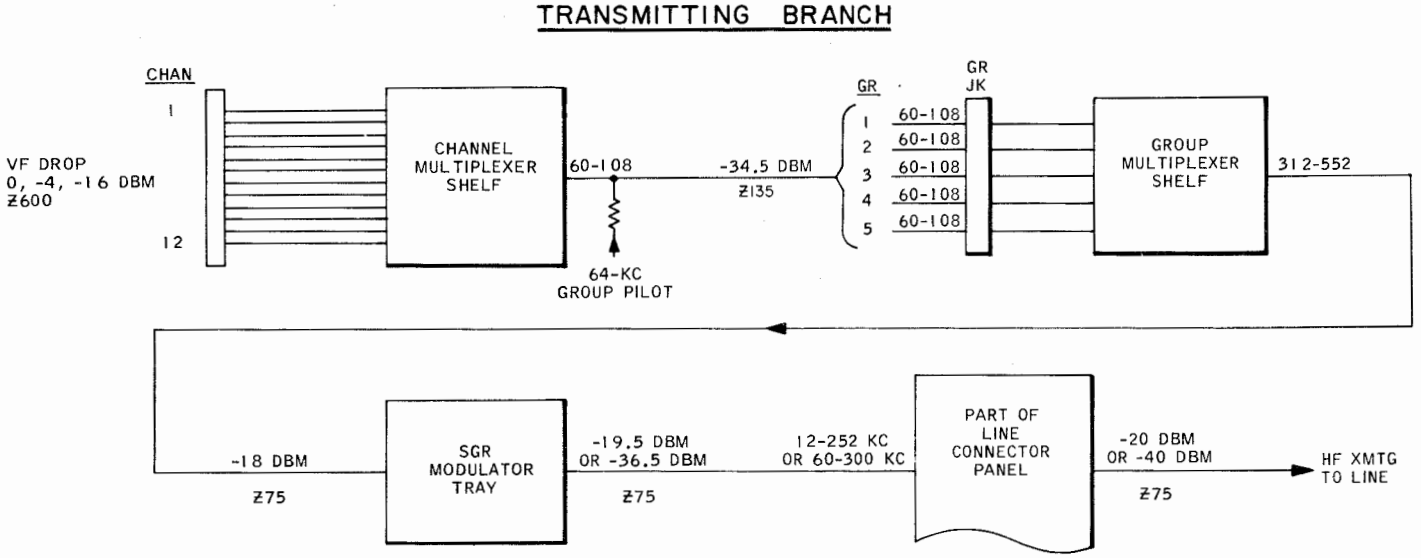
a. The hf receiving signal is distributed to the supergroup demodulator trays.

b. Each tray accepts its assigned 240-kc wide band and translates it to the 312-552 kc basic supergroup band.

c. The basic supergroup is demultiplexed to recover the five 60-108 kc groups.

d. The 64-kc pilot in each group signal is monitored at the input of the channel demultiplexer shelf.

e. Each group is demultiplexed to recover the 12 vf channels.



NOTES:

1. FREQUENCIES ARE IN KC.
2. JK = JACKFIELD.

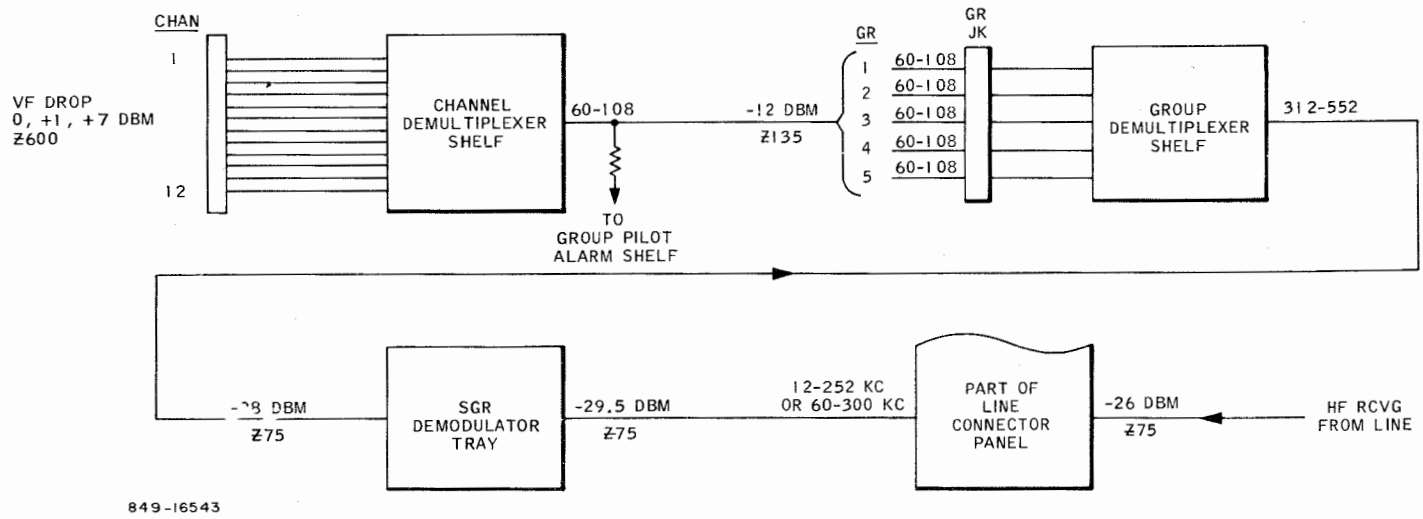
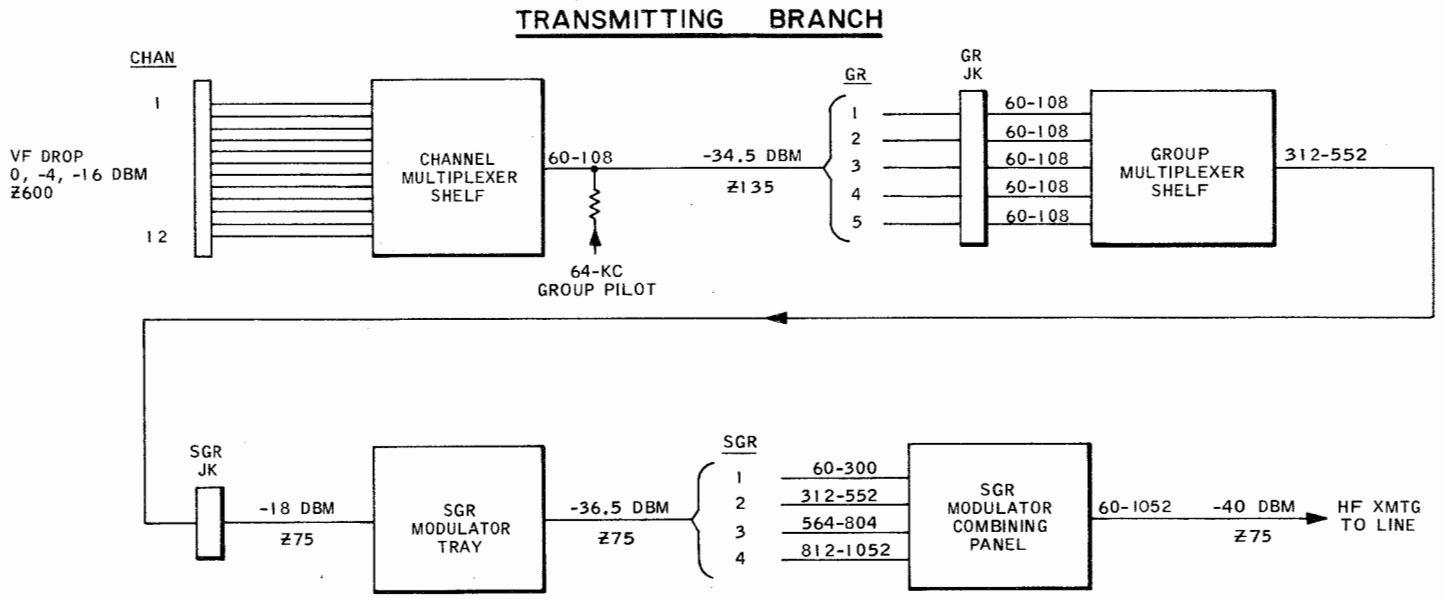


Figure 4-2. AN/FCC-21 Transmission System



NOTES:

1. FREQUENCIES ARE IN KC.
2. JK = JACKFIELD.

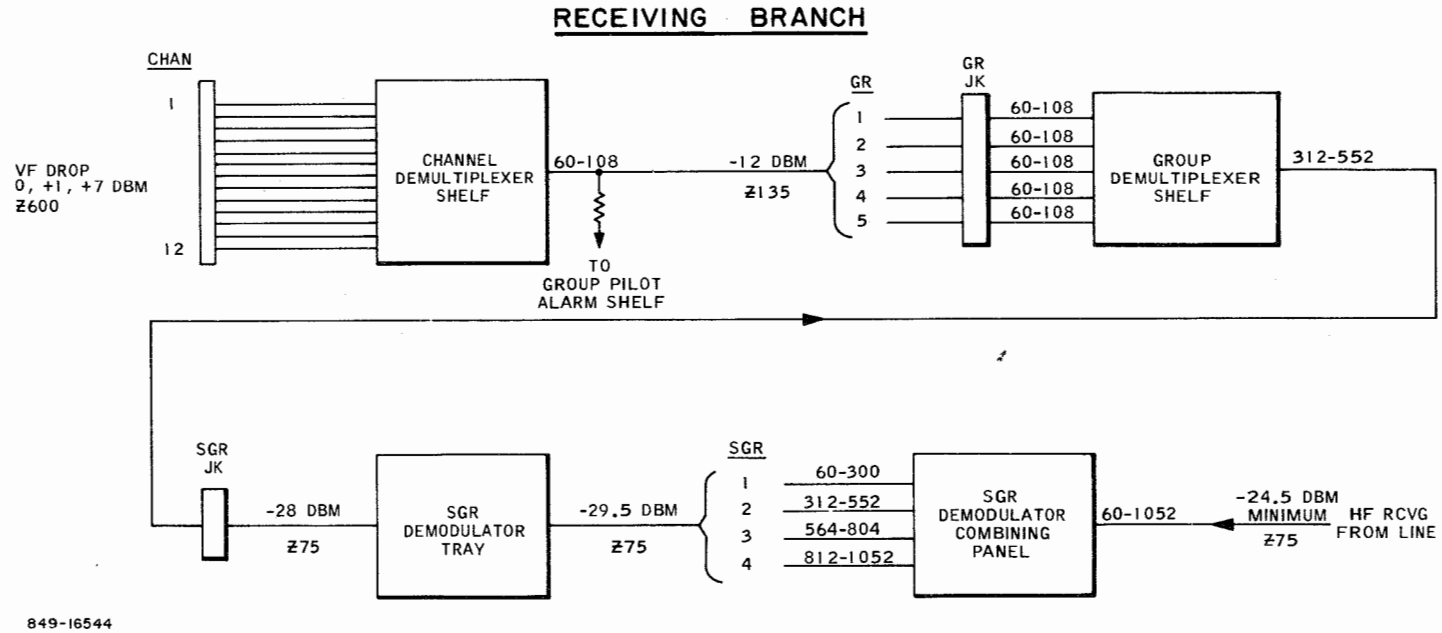


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Figure 4-3. AN/FCC-22 Transmission System

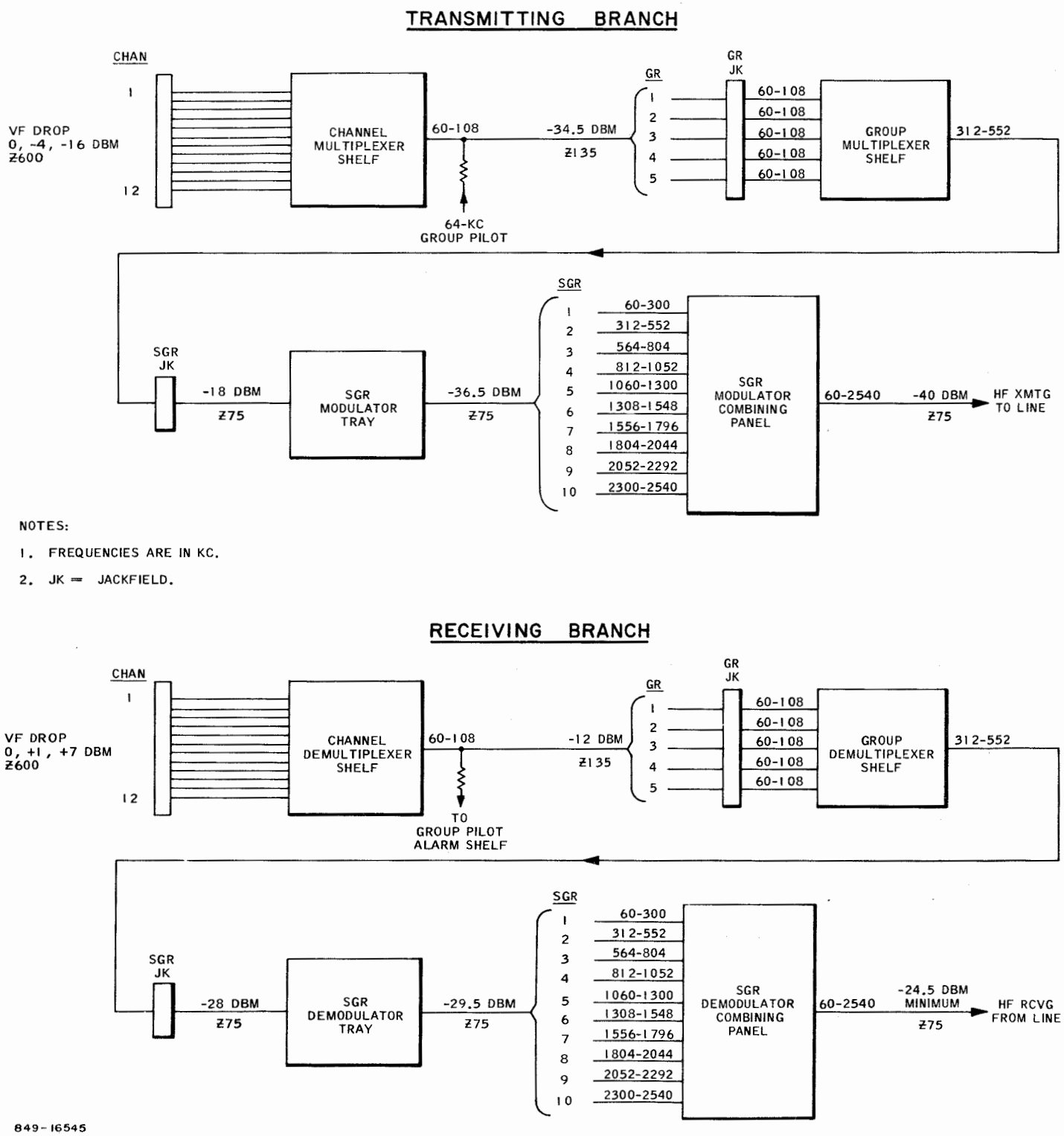


Figure 4-4. AN/FCC-17 Transmission System

4-12. CHANNEL MULTIPLEXER SHELF. (See figure 4-5.)

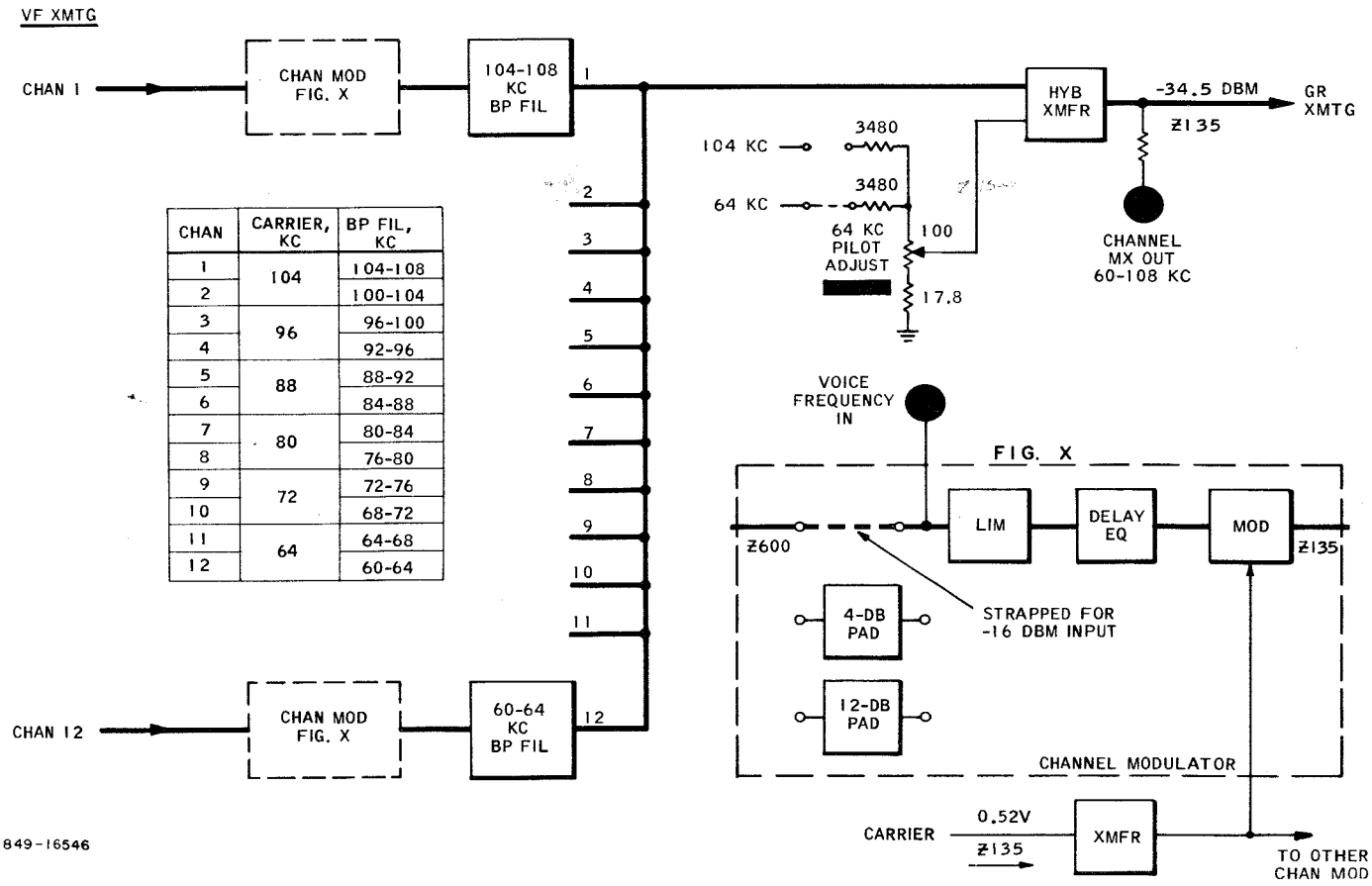
4-13. The channel multiplexer shelf (pn 790-01148-01) combines 12 vf channels into a 60-108 kc group band and injects a 64-kc pilot into the band. The multiplexing circuit for each channel is contained in two plug-in modules: a modulator and a bandpass filter.

4-14. The modulators, which are interchangeable, use one of six carrier frequencies to translate the vf signal (300 to 3500 cps) to an assigned 4-kc band in the 60-108 kc spectrum. The bandpass filter selects one sideband from the modulator output while blocking the other sideband and lower order modulation products.

4-15. The modulation scheme is called twin-channel: two adjacent channels use the same carrier frequency, with the upper sideband selected for one channel and the lower sideband for the other. For example, 104 kc is the carrier for channels 1 and 2. A 3-kc tone applied to channel 1 would appear at 107 kc (104 plus 3) in the group band, while the same frequency tone applied to channel 2 would appear at 101 kc (104 minus 3).

4-16. Because odd-numbered channels utilize the upper sideband, they appear upright in the 60-108 kc group band, whereas even-numbered channels are inverted.

4-17. The outputs of the 12 bandpass filters are joined together directly and connected to the 135-ohm input leg of an asymmetrical hybrid transformer. The insertion loss through this branch of the hybrid is only about 0.5 db. The 64-kc pilot is connected to the other leg, which has a 15-ohm input impedance.



CHAN	CARRIER, KC	BP FIL, KC
1	104	104-108
2		100-104
3	96	96-100
4		92-96
5	88	88-92
6		84-88
7	80	80-84
8		76-80
9	72	72-76
10		68-72
11	64	64-68
12		60-64

Figure 4-5. Channel Multiplexer Shelf

4-18. The pilot is obtained from the carrier distribution circuits in the shelf through a voltage divider that includes a potentiometer for setting pilot level in the group band at -16 dbm0 (16 db below test tone level). Optional straps permit the injection of a 64-kc pilot, a 104-kc pilot, or both. However, 64 kc is the standard pilot frequency for the AN/FCC-17 class of multiplex equipment.

4-19. The secondary of the hybrid feeds the composite group transmitting signal to the balanced 135-ohm output circuit at a test tone level of -34.5 dbm. Channel test tone or group pilot level can be measured at the CHANNEL MX OUT jack with the transmission test set.

4-20. CHANNEL MODULATOR. The first circuit elements in the signal path through the channel modulator are balanced 4-db and 12-db pads. By strapping on the mating socket for the plug-in module on the shelf, the pads are inserted or removed from the circuit to accommodate standard vf transmitting levels of 0 dbm, -4 dbm, or -16 dbm. For either of the three standard transmitting levels, the level at the VOICE FREQUENCY IN jack on the shelf and at the input of the limiter in the module will be -16 dbm.

4-21. The function of the limiter is to prevent overloading of the succeeding equipment by reducing voltage peaks that may appear in the vf signals. Limiting (the increase of insertion loss at higher signal levels) begins at about +3.5 dbm0; at +12 dbm0 input, limiting will be at least 4 db.

4-22. The delay equalizer compensates for the envelope delay distortion produced by the channel bandpass filters (and other networks) in the channel multiplexer shelf as well as the channel demultiplexer shelf at the other end of the system.

4-23. The modulator is a double-balanced type using two transistors, which are switched on and off by the carrier voltage. The principal modulation products are the first-order upper and lower sidebands; both the carrier and signal frequencies are suppressed. Four-db pads (not shown in figure 4-5) at the input and output of the modulator isolate it from the delay equalizer and the channel bandpass filter.

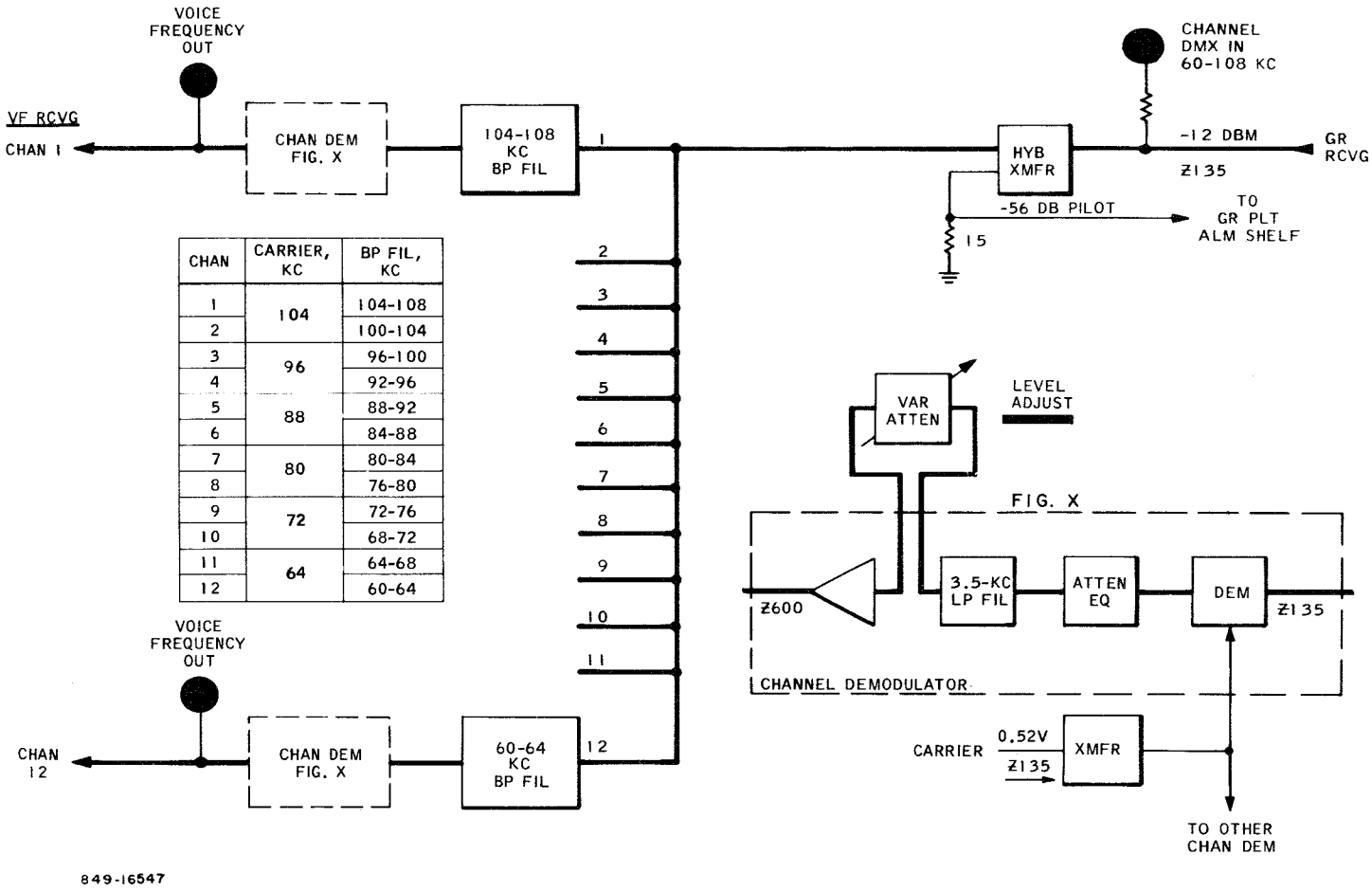
4-24. CHANNEL DEMULTIPLEXER SHELF. (See figure 4-6.)

4-25. The channel demultiplexer shelf (pn 790-01149-01) recovers the vf signals of the 12 channels included in the 60-108 kc group band. The same carrier frequency that was used at the other end of the system to translate a channel signal into the group band is now used to restore the signal to its original voice frequencies. The demultiplexing circuit for each channel consists of two plug-in modules: a demodulator and a bandpass filter.

4-26. The balanced 135-ohm input circuit is coupled to the unbalanced channel bandpass filters through a 135-ohm output leg of a hybrid transformer. The insertion loss in this path is only about 0.5 db. A low-impedance (15-ohm) output leg of the hybrid diverts a sample of the 60-108 kc signal to the group pilot alarm shelf where the 64-kc pilot is monitored. Terminated by a 15-ohm resistor, this leg of the hybrid becomes a 7.5-ohm source supplying group signal with the pilot at a level of -56 db (1.2 millivolts).

4-27. The plug-in bandpass filters, which are the same types used in the channel multiplexer shelf, select their assigned 4-kc wide segment of the 60-108 kc group signal and apply it to the channel demodulator.

4-28. With the transmission test set, measurements can be made of pilot level at the CHANNEL DMX IN jack and test tone level at the VOICE FREQUENCY out jacks.



CHAN	CARRIER, KC	BP FIL, KC
1	104	104-108
2		100-104
3	96	96-100
4		92-96
5	88	88-92
6		84-88
7	80	80-84
8		76-80
9	72	72-76
10		68-72
11	64	64-68
12		60-64

Figure 4-6. Channel Demultiplexer Shelf

4-29. CHANNEL DEMODULATOR. In the plug-in demodulator modules, which are all of the same type, the vf signal is recovered, amplified, and sent to the output on a balanced 600-ohm circuit.

4-30. The demodulating circuit is a double-balanced type (same as in the channel modulator) with two transistors switched on and off by the carrier voltage. The principal demodulation products are the first-order upper and lower sidebands. A 4-db pad (not shown in figure 4-6) isolates the demodulator input from the channel bandpass filter.

4-31. The attenuation equalizer compensates for irregular frequency response in the channel equipment at both ends of the system to achieve a vf drop signal with relatively flat response between 300 and 3500 cps. Most of the need for equalization is created by the bandpass filters in the channel multiplexer and demultiplexer shelves.

4-32. The 3.5-kc lowpass filter selects the lower sideband from the output of the demodulator while blocking all other products.

4-33. The LEVEL ADJUST control is a bridge-T attenuator with a range of about 30 db. The vf amplifier has three transistor stages with an overall 40-db gain. In alignment, the attenuator is adjusted to set the vf drop level at 0 , +1 , or +7 dbm, according to system requirements.

4-34. GROUP PILOT ALARM SHELF. (See figure 4-7.)

4-35. The group pilot alarm shelf (pn 790-01351-xx) has the capability of monitoring the receiving branches of five groups in each of two supergroups. The monitor responds to the 64-kc pilot in the 60-108 kc group signal.

4-36. Figure 4-7 illustrates one of the ten identical monitor circuits, each consisting mainly of a plug-in alarm control module and a plug-in alarm relay. The shelf's front panel includes an alarm indicator lamp and alarm cutoff switch for each group.

4-37. The group signal is received from a 7.5-ohm source in the channel demultiplexer shelf, which is bridged by the relatively high (135-ohm) input impedance of the alarm control module. The normal level of the group pilot in the signal is -56 db (1.2 millivolts).

4-38. The first stage in the alarm control module is a tuned amplifier whose gain is maximum at 64 kc and falls off rapidly at lower and higher frequencies. For example, at 62 kc or 66 kc, the gain is about 15 db less than at 64 kc.

4-39. The second amplifier stage is not frequency-selective and its output goes to a voltage-doubler rectifier. At normal level, the rectified pilot turns on a transistor switch, energizing the alarm relay.

4-40. Loss of pilot in a monitored group will release the alarm relay, lighting the associated GROUP PILOT ALARM lamp and closing the common (COM) side of the alarm circuit power to the major alarm bus leading to the master alarm panel.

4-41. Each of the ten circuits has an ALARM CUTOFF switch. When a group is in an alarm condition, its switch is thrown to CUTOFF position, releasing the

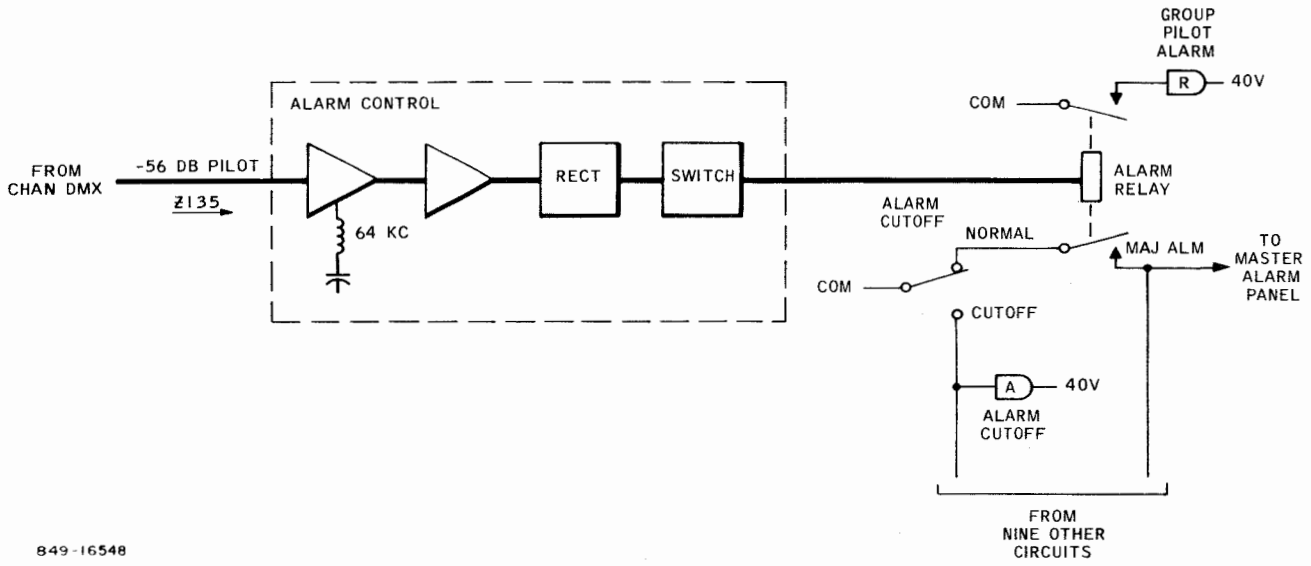


Figure 4-7. Group Pilot Alarm Shelf

major alarm on the master alarm panel. A common ALARM CUTOFF lamp lights when any switch is not in NORMAL position.

4-42. Separately, each circuit obtains its supply of 48-volt dc power from its associated channel demultiplexer shelf. Consequently, if power to a channel demultiplexer shelf fails, a major alarm will be initiated by release of the alarm relay in the group pilot alarm shelf.

4-43. GROUP JACKFIELDS.

4-44. The 60-108 kc group transmitting and receiving circuits pass through the jackfields on balanced 135-ohm shielded-pair cables. Access to the circuits is provided by dual telephone jacks (Western Electric type 482A, or equivalent), which are normalled-through in either direction, toward the line and toward the drop. The mating plug for each side of the jack is MIL-J-642 type PJ-051, or an equivalent tip-ring-sleeve telephone plug with a 0.250-inch finger diameter.

4-45. Where space is available, group and supergroup jackfields include a telephone jack terminated by a 133-ohm resistor and a coaxial jack terminated by a 75-ohm resistor. In testing or alignment of the multiplexer set, these jacks may be patched to a group or supergroup circuit to terminate it in its characteristic impedance.

4-46. GROUP MULTIPLEXER SHELF. (See figure 4-8.)

4-47. The group multiplexer shelf (pn 790-02062-xx) combines five 12-channel groups into a 60-channel supergroup. A plug-in group modulator and a wired-in bandpass filter comprise the basic multiplexing circuit for each of the five groups. In the modulator, the 60-108 kc group signal is translated to a 48-kc segment of the 312-552 kc supergroup band. The output of the modulator is amplified and the bandpass filter selects the lower sideband.

4-48. In a hybrid transformer, signals from the five groups are combined into a 312-552 kc band and coupled to the unbalanced 75-ohm supergroup transmitting circuit. To isolate filters with adjacent bandpass frequencies, odd-numbered groups are connected to one input leg of the hybrid and even-numbered groups to the other leg.

4-49. Group pilot levels can be measured with the transmission test set in the group band at the five 60-108 KC IN jacks and in the supergroup band at the GR MX OUT jack.

4-50. GROUP MODULATOR. The balanced 135-ohm input circuit is coupled through a transformer to the unbalanced 135-ohm LEVEL ADJUST attenuator, a bridged-T type with an adjustment range of about 30 db. The modulator is a ring circuit using four transistors, which are switched on and off in pairs by the carrier voltage. The principal modulation products are the sum and difference frequencies of the carrier and group signal. A bridge-feedback amplifier with a gain of about 33 db amplifies the entire output of the modulator.

4-51. GROUP DEMULTIPLEXER SHELF. (See figure 4-9.)

4-52. The group demultiplexer shelf (pn 790-01640-xx) recovers five 60-108 kc groups from the 312-552 kc signal it receives from a supergroup demodulator tray. Each of the five groups has a demultiplexing circuit that includes a wired-in bandpass filter and a plug-in demodulator module.

4-53. The 75-ohm unbalanced input circuit is coupled to the bandpass filters through a hybrid transformer. (The filters are the same types used in the group multiplexer shelf.) To isolate filters with adjacent bandpass frequencies, odd-numbered groups are connected to one output leg of the hybrid and even-numbered groups to the other leg. From the 312-552 kc signal, each filter selects its assigned 48-kc segment and

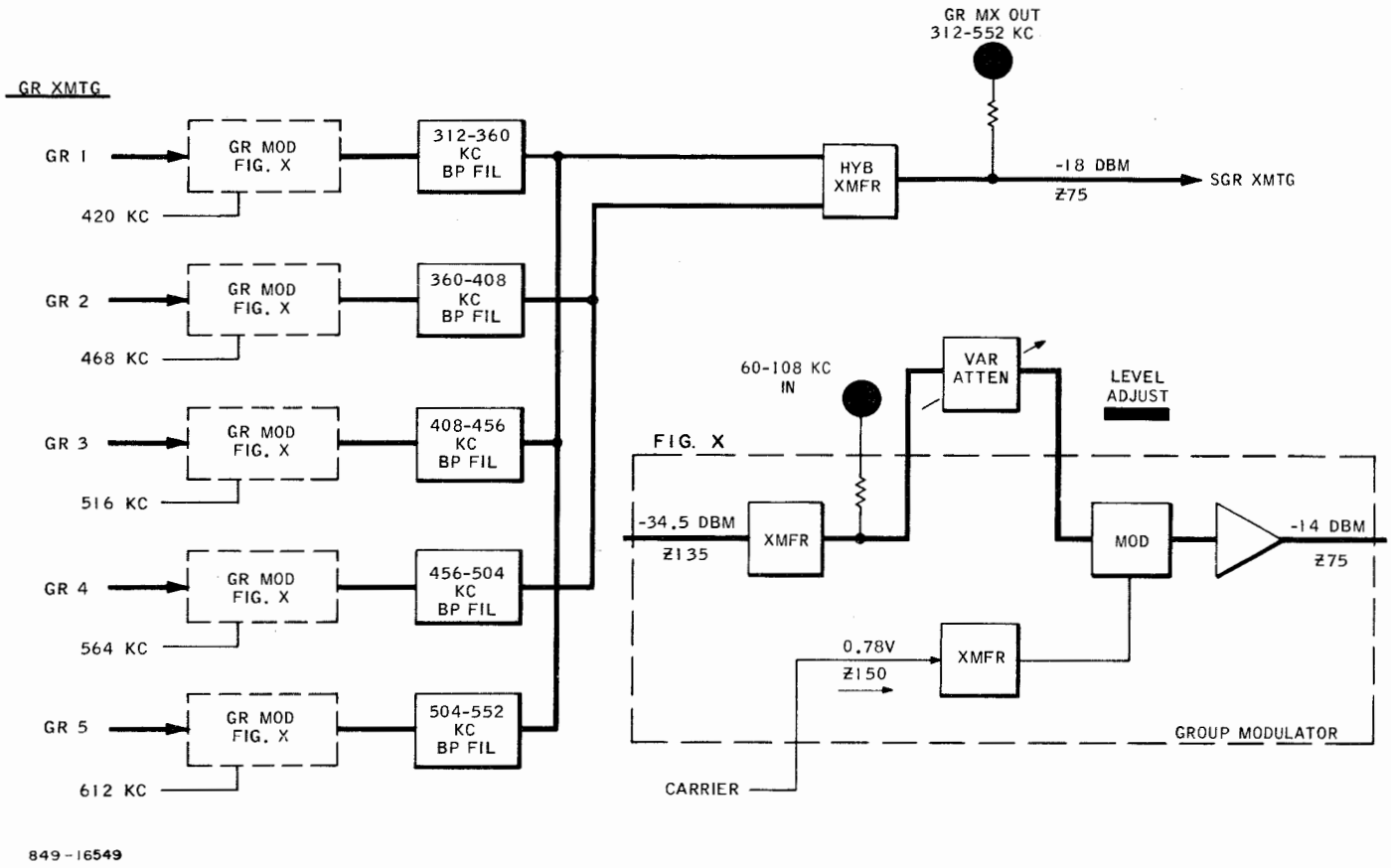


Figure 4-8. Group Multiplexer Shelf

sends it through the LEVEL ADJUST attenuator to the group demodulator. The attenuator, which has an adjustment range of about 30 db, is used in alignment to establish a -12 dbm group receiving level.

4-54. With the transmission test set, group pilot levels can be measured in the supergroup input signal at the GR DMX IN jack and in the five group output signals at the 60-108 KC OUT jacks.

4-55. GROUP DEMODULATOR. The demodulator is a ring circuit with four transistors that are switched on and off in pairs by the carrier voltage. The lower sideband is selected by the 108-kc lowpass filter and then boosted 34 db in a bridge-feedback amplifier. The amplifier's output transformer creates a balanced 135-ohm circuit and couples the 60-108 kc signal to the output of the shelf.

4-56. SUPERGROUP JACKFIELDS.

4-57. The supergroup jackfields provide access to the basic 312-552 kc, 75-ohm supergroup transmitting and receiving circuits. Each circuit through the jackfield consists of a pair of coaxial jacks connected together by a twin coaxial plug (U-link). By unplugging the U-link, the circuit can be entered for testing or patching in either direction, toward the line or toward the drop.

4-58. Multiplexer Set AN/FCC-17 has separate supergroup transmitting and supergroup receiving jackfields. Multiplexer Set

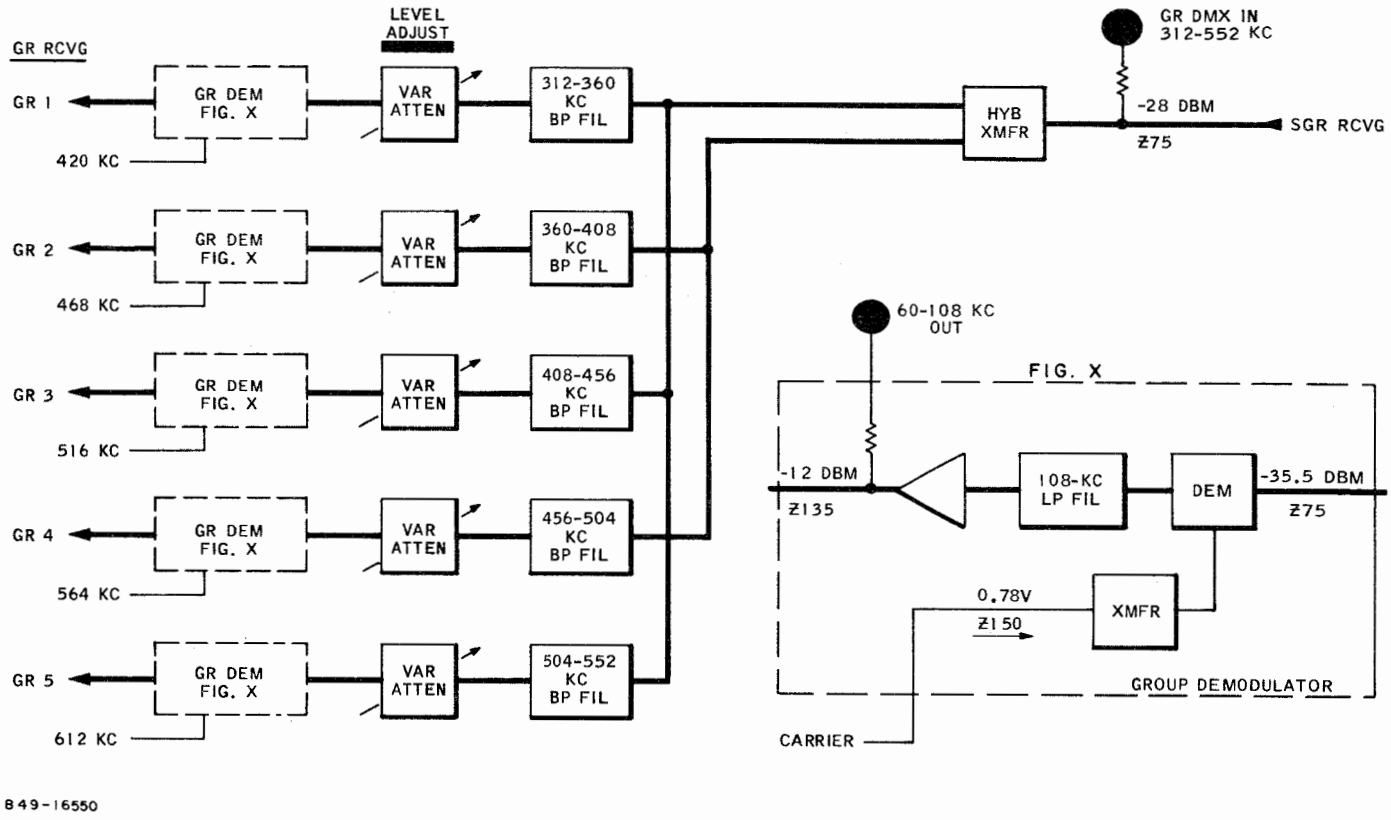


Figure 4-9. Group Demultiplexer Shelf

AN/FCC-22 has a single supergroup jackfield that includes both transmitting and receiving circuits. Multiplexer Set AN/FCC-21, with only one supergroup, doesn't have a jackfield.

4-59. SUPERGROUP MODULATOR TRAYS.

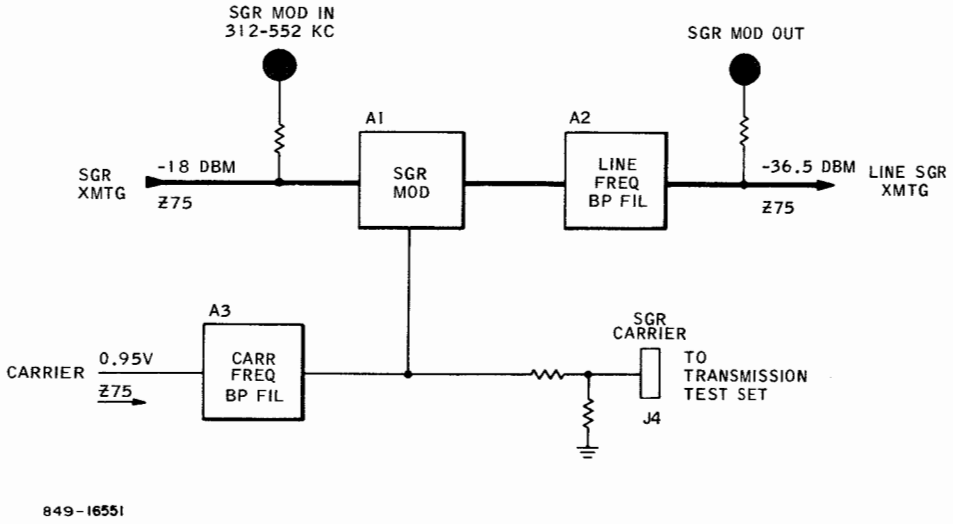
4-60. Supergroup modulator trays are classified according to their output signal level as low-level (-36.5 dbm) or high-level (-19.5 dbm). Both types of trays have the same input level of -18 dbm. But the high-level trays, operating in supergroup 1 or 1A, include paralleled amplifiers to obtain a 17 db higher output level. Only one type of tray can be used in the same multiplexer set.

4-61. Low-level supergroup modulator trays are described in paragraph 4-62, high-level trays in paragraph 4-67, and some special trays in paragraph 4-91.

4-62. LOW-LEVEL SUPERGROUP MODULATOR TRAYS. (See figure 4-10.)

4-63. A low-level supergroup modulator tray takes the 312-552 kc output of a group multiplexer shelf and translates it to an assigned 240-kc slot in the line frequency band of 60-2540 kc. A different tray is used for each of the 10 supergroups, but except for supergroup 2, each tray consists of a plug-in modulator and two wired-in bandpass filters. The trays for supergroups 1 through 10 are pn 790-03901-01 through pn 790-03910-01, respectively.

4-64. The modulator is a ring circuit with the four transistors switched on and off in pairs by a square-wave voltage. A square-wave generator, which is part of the circuits in the module, is triggered by the sinusoidal supergroup carrier. This method



SGR	CARRIER FREQ, KC	LINE FREQ, KC
1	612	60-300
2	—	312-552
3	1116	564-804
4	1364	812-1052
5	1612	1060-1300
6	1860	1308-1548
7	2108	1556-1796
8	2356	1804-2044
9	2604	2052-2292
10	2852	2300-2540

Figure 4-10. Low-Level Supergroup Modulator Tray

of carrier drive reduces the power required from the carrier supply equipment. The bandpass filter selects the lower sideband from the modulator output. (For supergroup 1, the filter is a 300-kc lowpass type.)

4-65. A bandpass filter in the carrier input lead rejects any stray frequencies acquired in the supergroup carrier distribution circuits. The output of the filter is sent to the modulator and through a voltage divider to a SGR CARRIER jack on the front panel. From the jack, supergroup carrier is patched to the transmission test set when needed; the unterminated level at the jack is 0.123 volt. (Although this level is not checked as part of a regular performance test, 0.123 volt will indicate 0 db when measured by the transmission test set with the FUNCTION switch in NON SELECTIVE position.)

4-66. Because the line frequency assigned to supergroup 2 is 312-552 kc, frequency translation is not applicable. Therefore, the carrier bandpass filter is eliminated from the supergroup 2 modulator tray, and the modulator module is replaced by a plug-in pad. The pad has the same insertion loss (14 db) as a supergroup modulator, and the resultant line level is -36.5 dbm, the same as the other supergroups.

4-67. HIGH-LEVEL SUPERGROUP MODULATOR TRAYS. (See figure 4-11.)

4-68. The standard high-level supergroup modulator trays used on Multiplexer Set AN/FCC-21 (pn 790-06980-02 through -06) translate the 312-552 kc supergroup to the 12-252 kc line frequency band of supergroup 1A.

4-69. Supergroup modulator A1 functions in the same manner described in paragraphs 4-64 and 4-65. Carrier at 564 kc is supplied through bandpass filter A3, and 300-kc lowpass filter A2 selects the lower sideband modulator output for amplification.

4-70. The A and B line supergroup amplifiers A4 and A5, in conjunction with paralleling network A8, boost the 12-252 kc signal to an output level of -19.5 dbm, a power gain of about 17 db. The amplifiers are monitored by alarm control modules A6 and A7, which activate the shelf alarm circuits if an amplifier fails.

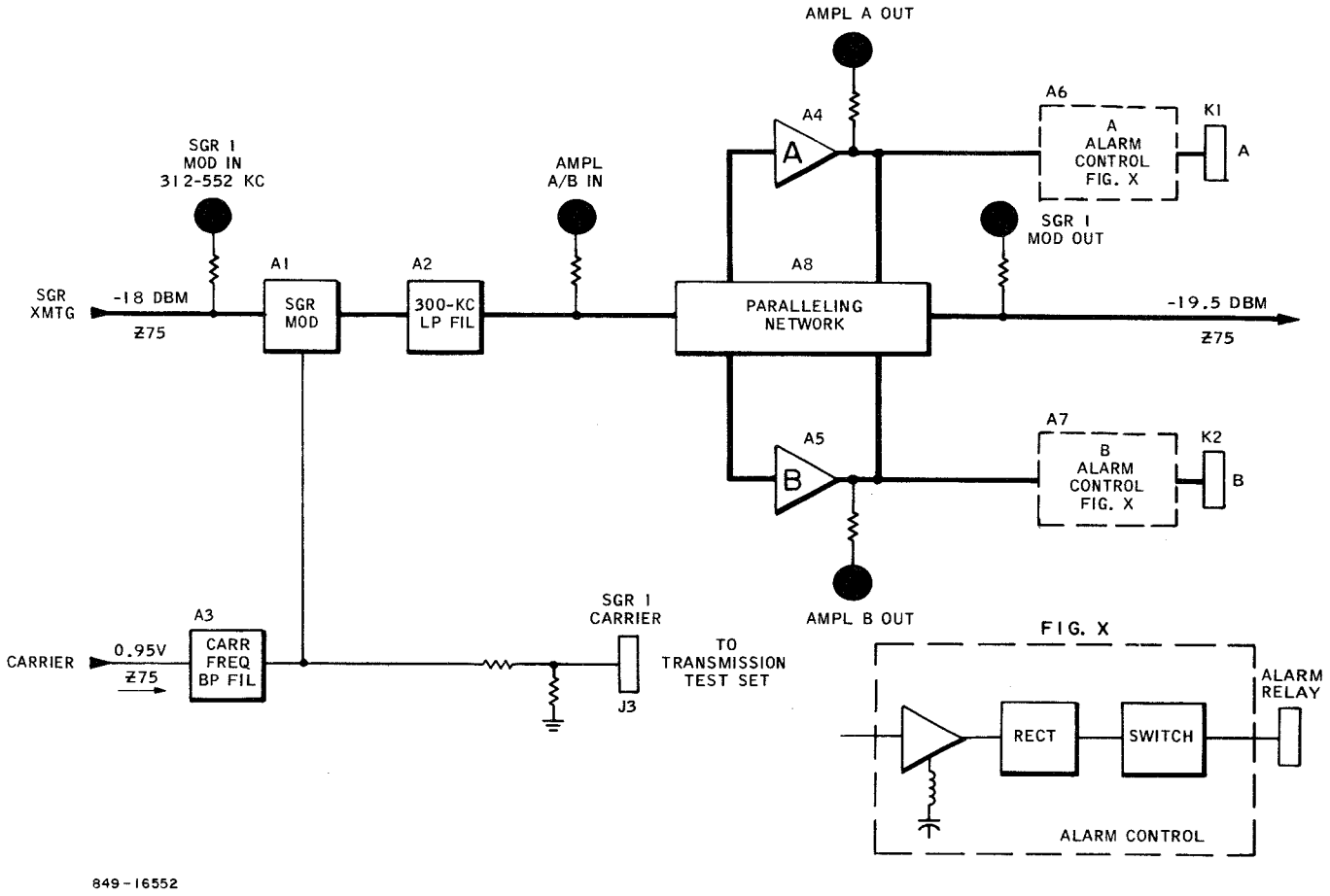


Figure 4-11. High-Level Supergroup Modulator Tray

4-71. SIGNAL DIAGRAM. Figure 4-12 is a diagram of signal flow in paralleling network A8 and through amplifiers A4 and A5. For simplification, a minus 38-volt dc supply and dc bias for the input transistor stage of each amplifier are not shown on this diagram. Also, some resistors and capacitors have been left out of the signal circuits; the resistors feed signal samples to the AMPL OUT test jacks, and the capacitors are for signal bypassing or controlling high-frequency response.

4-72. AMPLIFIER MODULE. The amplifier module itself has three capacitor-coupled transistor amplifier stages. The first two are common-emitter and the output stage is a pair of complementary transistors in a compound connection, common collector to common emitter. This type of connection has the same high current gain as the more familiar Darlington or super-alpha compound, but better frequency response and less input distortion.

4-73. The feedback loop around each amplifier is connected (through capacitor C7 or C12) between balanced resistive bridges in the paralleling network module A8. This type of feedback not only reduces distortion and stabilizes gain, but also stabilizes input impedance and output impedance.

4-74. BRIDGE FEEDBACK. Consider just the A amplifier circuit in figure 4-12, and ignore the cross connection through R17 shown in dash lines, using instead the direct connection labeled AA.

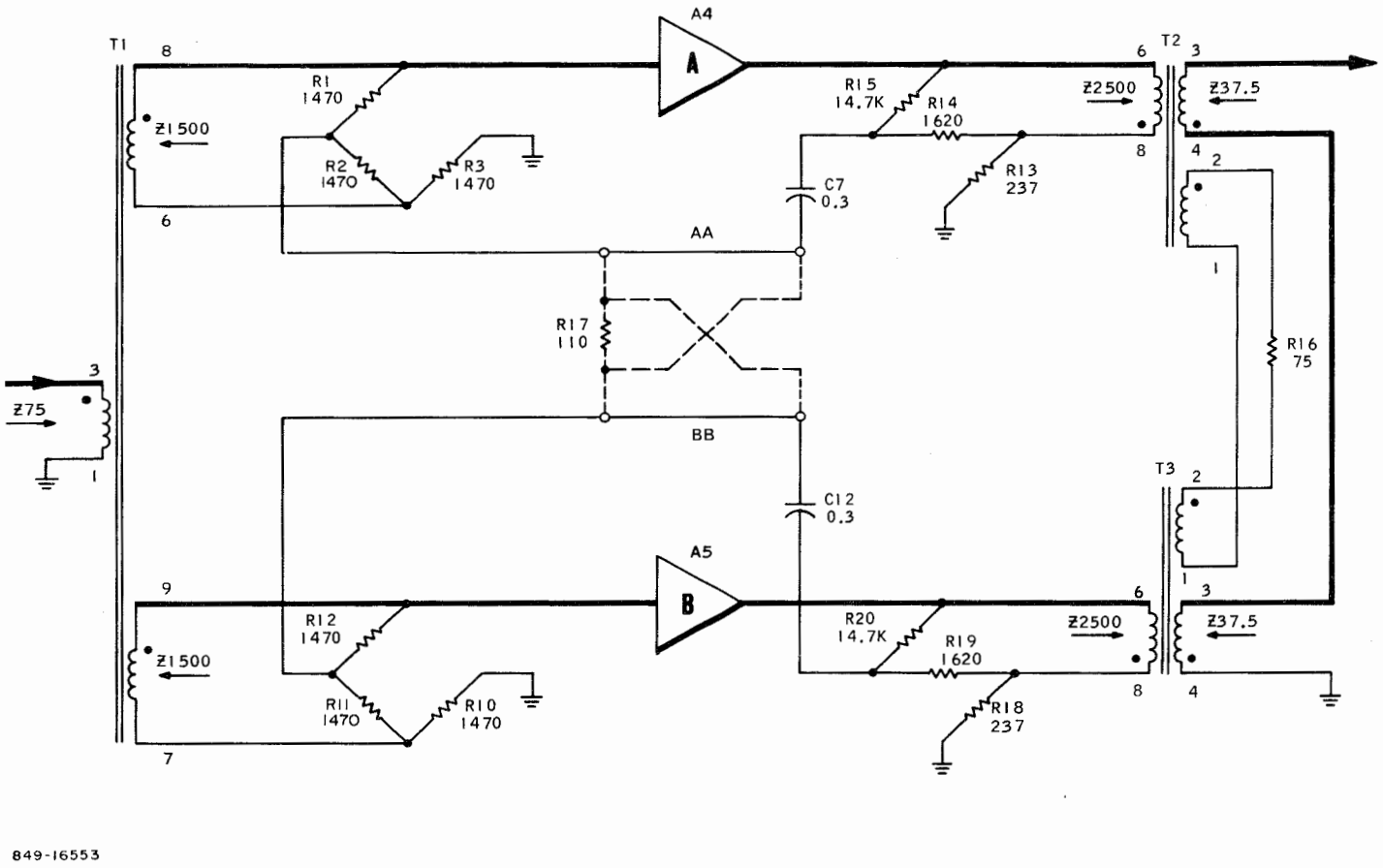


Figure 4-12. Paralleled Supergroup Amplifiers

4-75. The feedback voltage from the output bridge is derived from the sum of the voltage across the 6-8 winding of transformer T2 and the voltage across R13, the latter being proportional to output current. The output impedance, which is lowered by voltage feedback and raised by current feedback, is stabilized by this combination of both types.

4-76. The feedback voltage and hence the gain of the amplifier, is determined by the input impedance of the first transistor stage (about 1500 ohms) relative to the resistance of R15. Output impedance is controlled by the resistance of R14, which does not affect the amount of feedback because it is connected between balanced points on the bridge. Thus, the gain and output impedance of the amplifier are established without interaction.

4-77. The feedback is injected at balanced points on the input bridge and produces two currents. One current through R1 enters the first transistor stage in parallel with the input signal current and lowers the input impedance. The other current through R2 creates a voltage drop across R3 that is in series with the input signal voltage and raises the input impedance. The combination of shunt current and series voltage stabilizes the impedance and makes it independent of variables in the amplifier itself.

4-78. NORMAL OPERATION. (See figure 4-12.) Transformer T1 supplies equal and in-phase signals to the A and B amplifiers. The signals undergo 180-degree phase shift in the amplifiers and arrive in phase at transformers T2 and T3.

4-79. The 3-4 windings of the transformers are connected series-aiding, giving the total output signal twice the amplitude of either signal alone. Because the 1-2 windings of the transformers are connected series-opposing, no current flows through them or through resistor R16. The impedance looking into each 3-4 winding is 37.5 ohms, making the output impedance of the paralleled amplifiers 75 ohms.

4-80. In the previous description of bridge feedback, the two A and B amplifiers were considered as independent of each other, whereas their feedback loops are actually cross-connected through resistor R17. In figure 4-12, this connection is made by using the circuit shown in dash lines and omitting the leads labeled AA and BB.

4-81. If the amplifiers are identical, feedback voltages at C7 and C12 will be equal and the connections through R17 will have no effect on either amplifier. Suppose, however, that because of aging and changes in transistor parameters, one amplifier deteriorates so that it has a smaller open-loop gain and poorer performance quality. Now, the feedback voltages will be unequal and the better amplifier will supply a higher feedback voltage to the poorer amplifier than to itself. Thus, in the output signal, the contribution of the better amplifier will be enhanced and the poorer amplifier suppressed.

4-82. OPERATION WITH A FAILED AMPLIFIER. (See figure 4-12.) Upon complete failure of either amplifier, the loss of one-half the output signal voltage would be expected to cause a 6-db drop in output power. Nevertheless, because of the cross-connection in the feedback loops and the hybrid arrangement of transformers T2 and T3, the remaining amplifier will compensate for the failed amplifier and no change in output level or impedance will take place.

4-83. Assuming the B amplifier fails, the feedback signal from the A amplifier's output bridge will see the A amplifier's input bridge paralleled by the B amplifier's input bridge and output bridge. This additional load will produce a 6-db reduction in feedback voltage and a 6-db increase in the A amplifier's gain, doubling the signal voltage at the primary of transformer T2 and in each secondary winding.

4-84. The doubled signal voltage in the 3-4 winding of T2 will make up for the loss of signal voltage in the 3-4 winding of the failed B amplifier's output transformer T3.

4-85. Although the A amplifier was only called upon to double the power it originally supplied to the external load, its output power has actually increased four times (6 db). But because the 1-2 and 3-4 windings of T2 supply equal voltages to equal impedances, the power divides and half is dissipated in 75-ohm resistor R16. (With the B amplifier failed, there is no voltage in the 1-2 winding of T3 to oppose the voltage in the 1-2 winding of T2.)

4-86. The output impedance is now determined only by what is seen looking into the 3-4 winding of T2. Originally, when the 1-2 winding of T2 was not effective in the circuit, the impedance was 37.5 ohms. But with the 1-2 and 3-4 windings carrying equal currents in the same sense, the total secondary winding can be considered as having twice as many turns as before. When the turns ratio between primary and secondary is reduced by one-half, the impedance of the secondary (inversely proportional to turns ratio squared) goes up four times. For each secondary winding, the increase is two times. Thus the 37.5-ohm output impedance of T2 becomes 75 ohms, which is the required output impedance for the paralleled amplifiers.

4-87. ALARM CONTROL MODULE. (See figure 4-11.) Each amplifier module's output is bridged by the relatively high

input impedance (42 kilohms) of an alarm control module that monitors one of the five group pilot frequencies in the 12-252 kc band:

GROUP	PILOT
1	208 kc
2	160 kc
3	112 kc
4	64 kc
5	16 kc

4-88. There are five types of alarm control modules available, one for each group. By equipping the supergroup modulator tray with the applicable alarm control module, any one of the group pilots may be monitored.

4-89. The alarm control module includes a tuned amplifier that has substantial gain only at the group pilot frequency. The amplified pilot is rectified and at normal signal levels, turns on a transistor switch through which the alarm relay is energized.

4-90. Failure of the line supergroup amplifier, as evidenced by loss of signal to the alarm control module, releases the alarm relay. The A and B alarm relays control the minor and major alarm circuits of the tray as illustrated in figure 4-37.

4-91. SPECIAL SUPERGROUP MODULATOR TRAYS.

4-92. PN 790-03077-01. This high-level supergroup 1A modulator tray is the same as the standard (pn 790-06980-02) except it requires dc alarm circuit power.

4-93. PN 790-06999-01. This special supergroup 2 modulator tray operates the same as the standard described in paragraph 4-63, except the plug-in pad attenuates the signal 2 db instead of 14 db, so that the transmitting level is -24.5 dbm instead of -36.5 dbm.

4-94. PN 790-07259-01 AND -02. These two high-level supergroup modulator trays use a 612-kc supergroup carrier to produce a 60-300 kc supergroup 1 line frequency signal at a transmitting level of -19.5 dbm. The alarm control module on one tray (pn 790-07259-01) monitors the group 1 pilot at 256 kc and, on the other tray (pn 790-07259-02), it monitors the group 5 pilot at 64 kc.

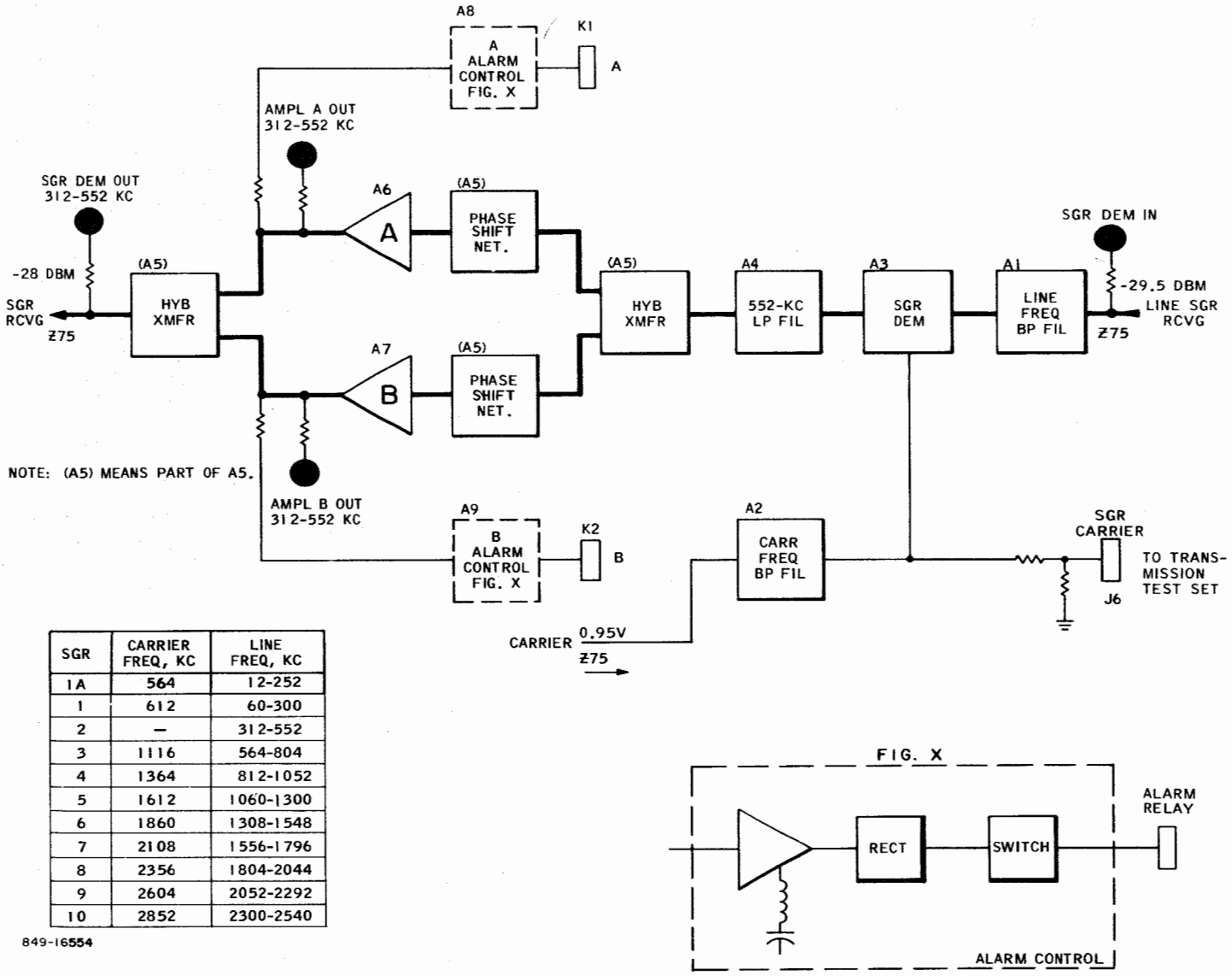
4-95. SUPERGROUP DEMODULATOR TRAYS. (See figure 4-13.)

4-96. The supergroup demodulator tray translates a supergroup from the line frequency band to the basic supergroup band of 312-552 kc. A different tray is used for each supergroup, but except for supergroup 2, they all operate in the same way. The standard trays are pn 790-03273-xx (supergroup 1A) and pn 790-03931-xx through pn 790-03940-xx (supergroups 1 through 10).

4-97. The applicable supergroup signal is extracted from the line frequency signal by a bandpass filter. (For supergroup 1 or 1A, the filter is a 300-kc lowpass type.) Like the supergroup modulator, the demodulator is a ring circuit driven by an internally generated squarewave voltage. The lower sideband is selected by a 552-kc lowpass filter and amplified in two paralleled 32.5-db amplifier modules. Paralleling of amplifiers is described in paragraph 4-329.

4-98. Supergroup carrier is distributed to the demodulator and to the SGR CARRIER jack on the front panel just as in the supergroup modulator tray. The transmission test set may be patched to the jack on either tray to obtain a supply of supergroup carrier.

4-99. In the demodulator tray for supergroup 2, which does not undergo frequency translation, the carrier bandpass filter is not required and the supergroup demodulator module is replaced by a plug-in pad having the same insertion loss (12 db).



SGR	CARRIER FREQ, KC	LINE FREQ, KC
1A	564	12-252
1	612	60-300
2	—	312-552
3	1116	564-804
4	1364	812-1052
5	1612	1060-1300
6	1860	1308-1548
7	2108	1556-1796
8	2356	1804-2044
9	2604	2052-2292
10	2852	2300-2540

849-16554

Figure 4-13. Supergroup Demodulator Tray

4-100. ALARMS. A sample of the amplifier module's output is connected to an alarm control module that selectively monitors one of the five group pilot frequencies in the 312-552 kc band:

GROUP	PILOT	GROUP	PILOT
1	356 kc	4	500 kc
2	404 kc		
3	452 kc	5	548 kc

4-101. There are five types of alarm control modules available, one for each group. By equipping the supergroup demodulator tray with the applicable alarm control module, any one of the five group pilots may be monitored.

4-102. The alarm control module includes a tuned amplifier that has substantial gain only at the group pilot frequency. The amplified pilot is rectified, and at normal signal levels, turns on a transistor switch through which the alarm relay is energized.

4-103. Failure of the amplifier interrupts the monitored signal and releases the relay. The A and B alarm relays control the minor and major alarm circuits of the tray as illustrated in figure 4-37.

4-104. SPECIAL SUPERGROUP DEMODULATOR TRAYS.

4-105. PN 790-07226-01 AND 790-07227-01. Respectively, these trays are identical to pn 790-03931-01 (supergroup 1) and 790-03932-01 (supergroup 2) except the 48-volt distribution circuit to each alarm control module has a decoupling network consisting of a 1-millihenry choke and a 0.1-microfarad capacitor.

4-106. LINE CONNECTOR PANEL. (See figure 4-14.)

4-107. In Multiplexer Set AN/FCC-21, the line connector panel (pn 790-03029-xx) processes the single-supergroup hf signal and the 96-kc carrier sync pilot in both the transmitting and receiving directions. Each branch includes a normalled-through jack and a bridging test jack for measurements with the transmission test set. Three switchable span pads (0.5, 1, and 2 db) permit adjustment of transmitting and receiving levels in 0.5-db steps over a 3.5-db range. Transformers isolate the grounded circuits of the multiplexer set from the external coaxial cable lines.

4-108. In the transmitting branch, the 96-kc carrier sync pilot is bridged across the signal path. The pilot, obtained from the channel carrier supply shelf at 0.52 volt, is reduced through resistor A1R13 to a level of -16 dbm0 in the hf transmitting signal.

4-109. In the receiving branch, a resistance hybrid diverts a portion of the signal to a 96-kc bandpass filter, which extracts the carrier sync pilot for use by the master frequency generator shelf at a slave

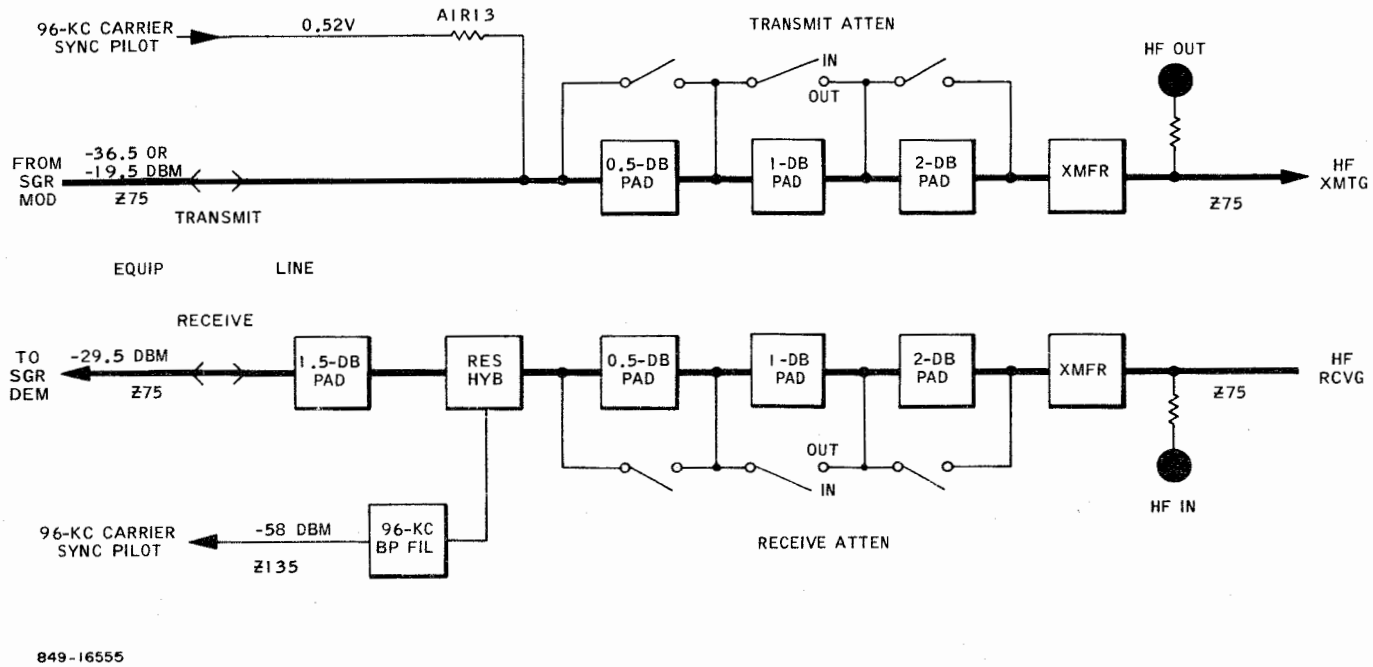


Figure 4-14. Line Connector Panel

terminal. The insertion loss of the hybrid is about 14 db in the pilot path but only about 1.5 db in the main path.

*4-110. HF LINE LEVELS. The three configurations of the line connector panel (pn 790-03029-01, -02, and -03) differ only in the voltage dividers (or pads) between the test jacks and the main signal path. These pads are designed so that the transmission test set will read 0 db at nominal signal level. For the three configurations, the nominal transmitting/receiving line levels are: -01, -20/-26 dbm; -02, -23/-23 dbm; and -03, -40/-26 dbm.

4-111. SUPERGROUP MODULATOR COMBINING PANEL. (See figure 4-15.)

4-112. The supergroup modulator combining panel (pn 790-03532-xx) has facilities for joining together the outputs of ten supergroup modulator trays. At a master terminal, the 96-kc carrier sync pilot may also be added to the composite hf transmitting signal.

4-113. In the panel, odd-numbered supergroups are connected to one leg of a hybrid transformer and even-numbered supergroups

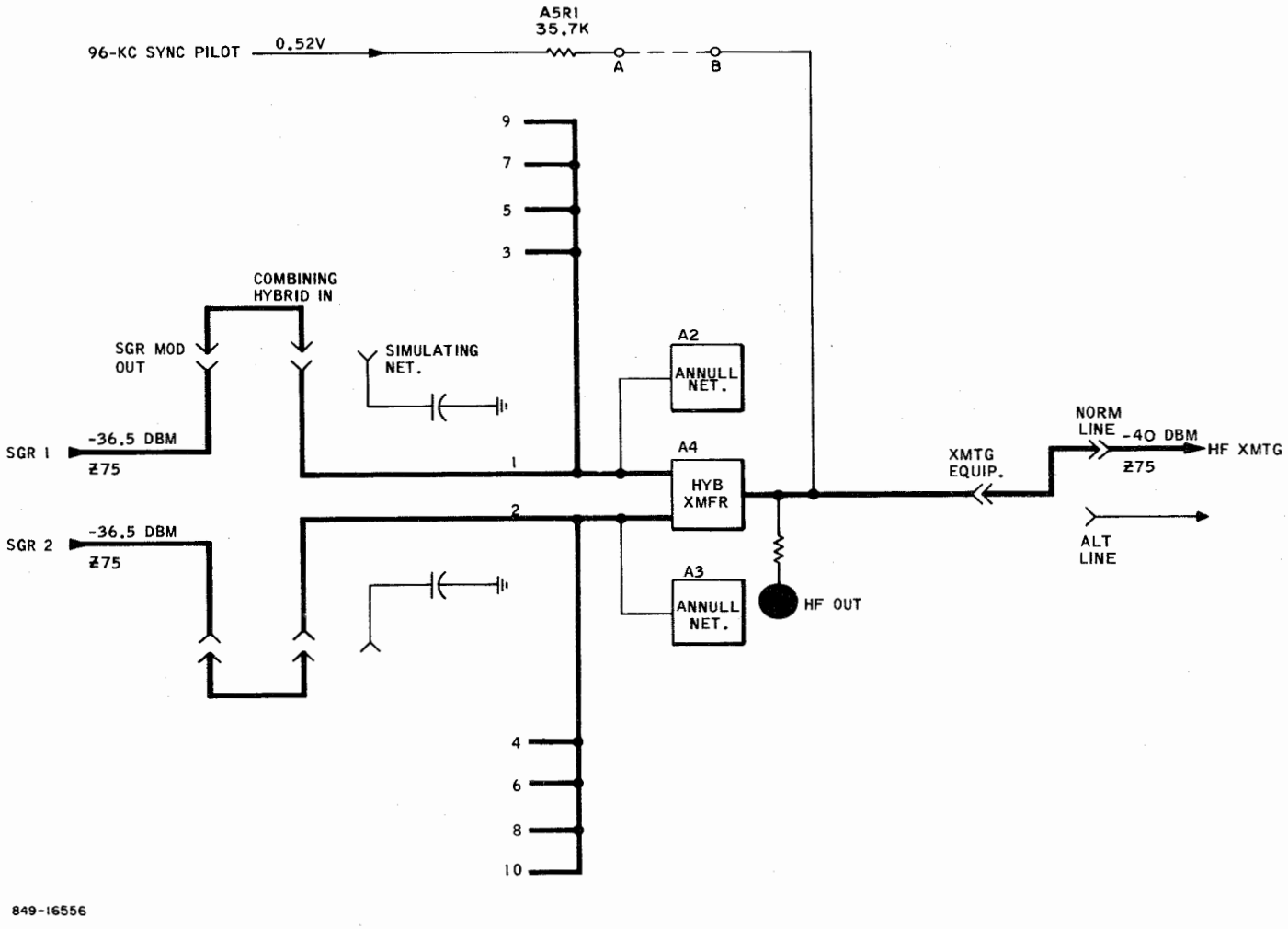


Figure 4-15. Supergroup Modulator Combining Panel

to the other leg. Because of the hybrid, bandpass filters (in the supergroup modulator trays) for adjacent supergroups are isolated from each other.

4-114. Each active supergroup passes through a U-link connecting the SGR MOD OUT jack to the COMBINING HYBRID IN jack. When a supergroup is unequipped, the U-link is installed between the COMBINING HYBRID IN jack and the SIMULATING NET. jack, terminating the associated leg of the hybrid with a 60-uuf capacitor.

4-115. By strapping terminals A-B on subassembly A5, the 96-kc carrier sync pilot is bridged across the hf transmitting circuit at the output of the hybrid. The pilot, obtained from the channel carrier supply shelf at 0.52 volt, is connected through resistor A5R1, which drops the level to about 0.5 millivolt. This pilot level is equivalent to -16 dbm0 with respect to the channel test tone level of -40 dbm at the point of connection.

4-116. Group pilots are also at a -16 dbm0 level and can be measured with the transmission test set at the HF OUT jack. However, the test set doesn't have the capability of measuring the 96-kc carrier sync pilot at this jack.

4-117. The output impedance of the supergroup modulator combining panel is 75 ohms, unbalanced. The hf transmitting signal can be connected through a pair of coaxial jacks and a U-link to either of two output circuits.

4-118. ANNULLING NETWORKS. An ideal bandpass filter would pass all frequencies in the band without attenuation and completely suppress all other frequencies. To achieve this, the characteristic impedance of the filter must be made completely resistive inside the passband and completely reactive outside. In practical filters, only the center of the passband can be made completely resistive; the filter's reactance becomes increasingly capacitive toward the low frequency end of the band and increasingly inductive toward the high frequency end.

4-119. Filters which are to be used in parallel connection are designed so that the reactance of one filter will cancel or annull the reactance of the adjacent filter. The passbands of both filters are thereby made more resistive and the corner response is improved. This is known as the flanking effect.

4-120. The filters in the supergroup modulator trays have been designed for parallel operation in two sets, odd supergroups in one and even supergroups in the other. Because of the overlapping reactances, if one filter is disconnected, the frequency response of the other filters in the same set (particularly the adjacent filters) may be degraded. However, plug-in annulling networks A2 and A3 provide the capacitive or inductive reactance needed at particular frequencies to compensate for any combination of active and unequipped supergroups.

4-121. The part numbers of the annulling networks used with each option of the supergroup modulator combining panel are listed in the Circuit Diagrams and IPB manuals.

4-122. SPECIAL SUPERGROUP MODULATOR COMBINING PANEL.

4-123. A special supergroup demodulator combining panel (pn 790-07210-xx) combines only supergroups 1 and 2. Annulling networks are not used. A span pad enables the output level to be adjusted in 1-db steps through a 15-db range. Four variations of the panel differ in signal level and frequency range.

1-124. PN790-07210-01. The input signals are from low-level supergroup modulator trays at -36.5 dbm. The frequency range is 60-552 kc, and the output level is adjustable between -40 and -55 dbm.

4-125. PN-790-07210-02. The input signals are from high-level supergroup modulator trays at -19.5 dbm. The frequency range is 60-552 kc and the output level is adjustable between -23 dbm and -38 dbm.

4-126. PN 790-07210-03 AND -04. Respectively, these panels are the same as pn 790-07210-01 and -02 except the frequency range is 12-552 kc, which includes the supergroup 1A frequency band.

4-127. SUPERGROUP DEMODULATOR COMBINING PANEL. (See figure 4-16.)

4-128. The supergroup demodulator combining panel (pn 790-03933-xx) and the supergroup modulator combining panel (paragraph 4-111) have similar circuits, but signals flow through them in opposite directions. In the receiving branch of the multiplexer set, the supergroup demodulator combining panel distributes the incoming

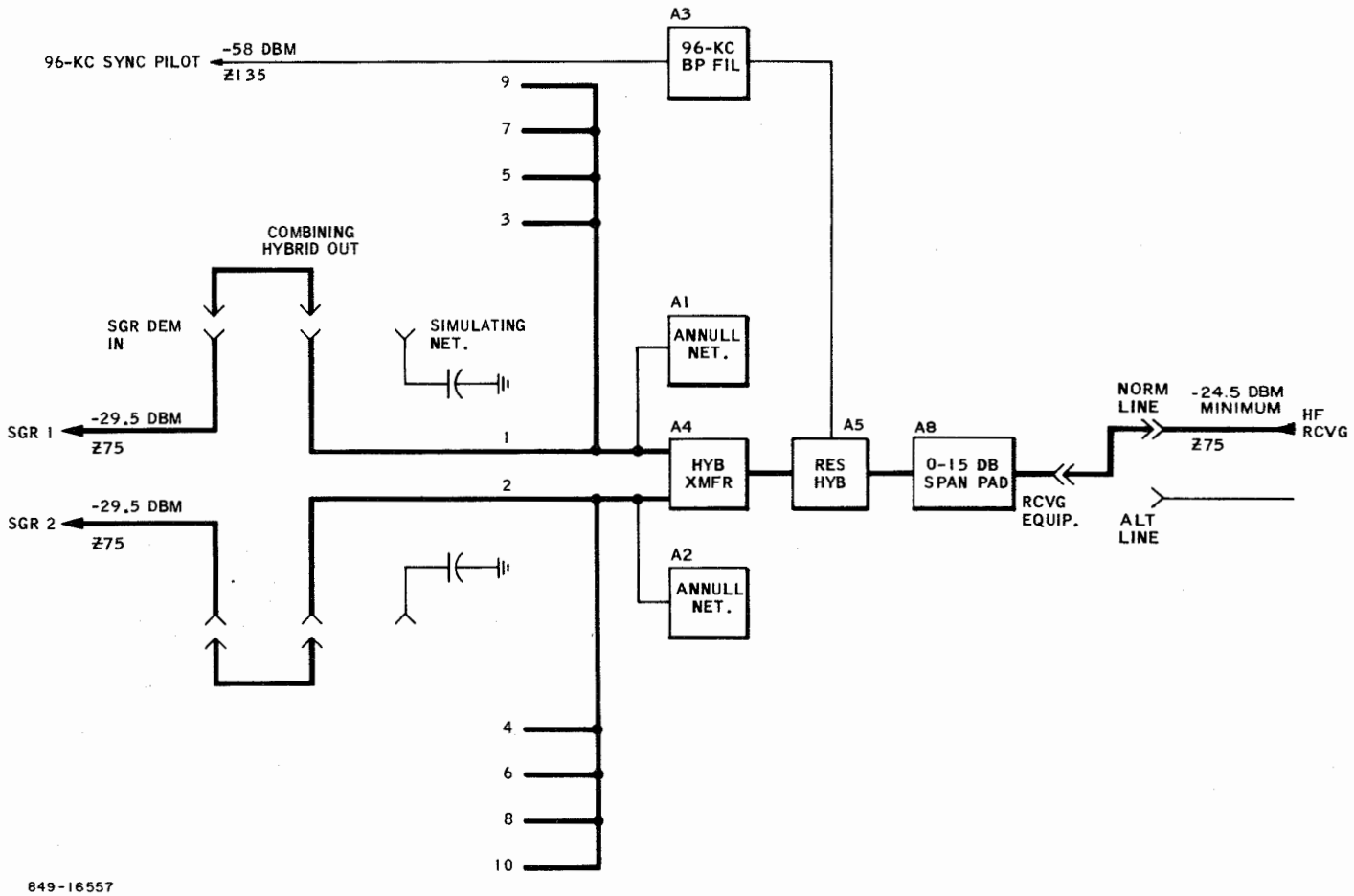


Figure 4-16. Supergroup Demodulator Combining Panel

hf signal to the inputs of 10 supergroup demodulator trays. A hybrid transformer creates separate paths to the trays for odd-numbered and even-numbered supergroups.

4-129. Through a resistance hybrid, a portion of the incoming signal is diverted to a crystal bandpass filter, which extracts the 96-kc carrier sync pilot for use by the master frequency generator shelf at a slave terminal. The insertion loss of the hybrid is about 14 db in the path to the filter but only 1.5 db in the main path.

4-130. ANNULLING NETWORKS. Annuling networks A1 and A2 are the same types used in the supergroup modulator combining panel and perform the same function.

4-131. SPAN PAD. The span pad is strappable from 0 db to 15 db in 1-db steps, enabling the multiplexer set to accommodate an hf receiving line level (test tone) between -24.5 dbm and -9.5 dbm.

4-132. SPECIAL SUPERGROUP DEMODULATOR COMBINING PANEL.

4-133. A special supergroup demodulator combining panel (pn 790-07211-xx) distributes the incoming hf signal to just two supergroups (1 and 2). Annulling networks are not used. There are three variations of the panel with differences in operating frequency range and in nominal input level.

4-134. A test jack (HIGH FREQ IN) is provided for measurement of input level on the transmission test set; when the input level is nominal, the test set reads 0 db.

4-135. PN 790-07211-01. The frequency range is 60-552 kc, covering supergroups 1 and 2, and the nominal input level is -10 dbm. The span pad has sections of 1, 2, 4, and 12 db. With the 12-db section strapped in, the attenuation can be adjusted in 1-db steps to allow operation with an input level between -12.5 and -5.5 dbm.

4-136. PN 790-07211-02. The frequency range is 60-552 kc, the nominal input level is -15 dbm, and the span pad has a 0-15 db adjustment range.

4-137. PN 790-07211-03. The frequency range is 12-552 kc (encompassing supergroup 1A), the nominal input level is -15 dbm, and the span pad has a 0-15 db adjustment range.

4-138. AUXILIARY EQUIPMENT.

4-139. Auxiliary transmission equipment used with the multiplexer set is identified in table 1-6 and some typical applications are shown by block diagrams in figure 4-17. For further description, refer to the applicable technical order listed in table 1-6.

4-140. CARRIER SUPPLY SYSTEM. (See figures 4-18, 4-19, and 4-20.)

4-141. The source of all carrier frequencies in the multiplexer set is an 8-kc pulse developed in the master frequency generator shelf from the output of a 128-kc crystal oscillator. The pulse is fed to the channel carrier supply shelf and to the group carrier generator shelf.

4-142. CHANNEL CARRIERS.

4-143. In the channel carrier supply shelf, six harmonics are filtered from the 8-kc input pulse to become the channel carrier frequencies. For each carrier, the shelf produces three different voltage outputs: 0.52 volt, 100 millivolts, and 12 millivolts. (Multiplexer Set AN/FCC-21 utilizes only the 0.52-volt outputs.)

4-144. The 0.52-volt outputs are distributed directly to a maximum of 10 channel shelves (multiplexer and/or demultiplexer), while the 100-millivolt outputs are used to drive a maximum of nine channel carrier amplifier shelves. The amplifier shelves provide the additional carrier power needed

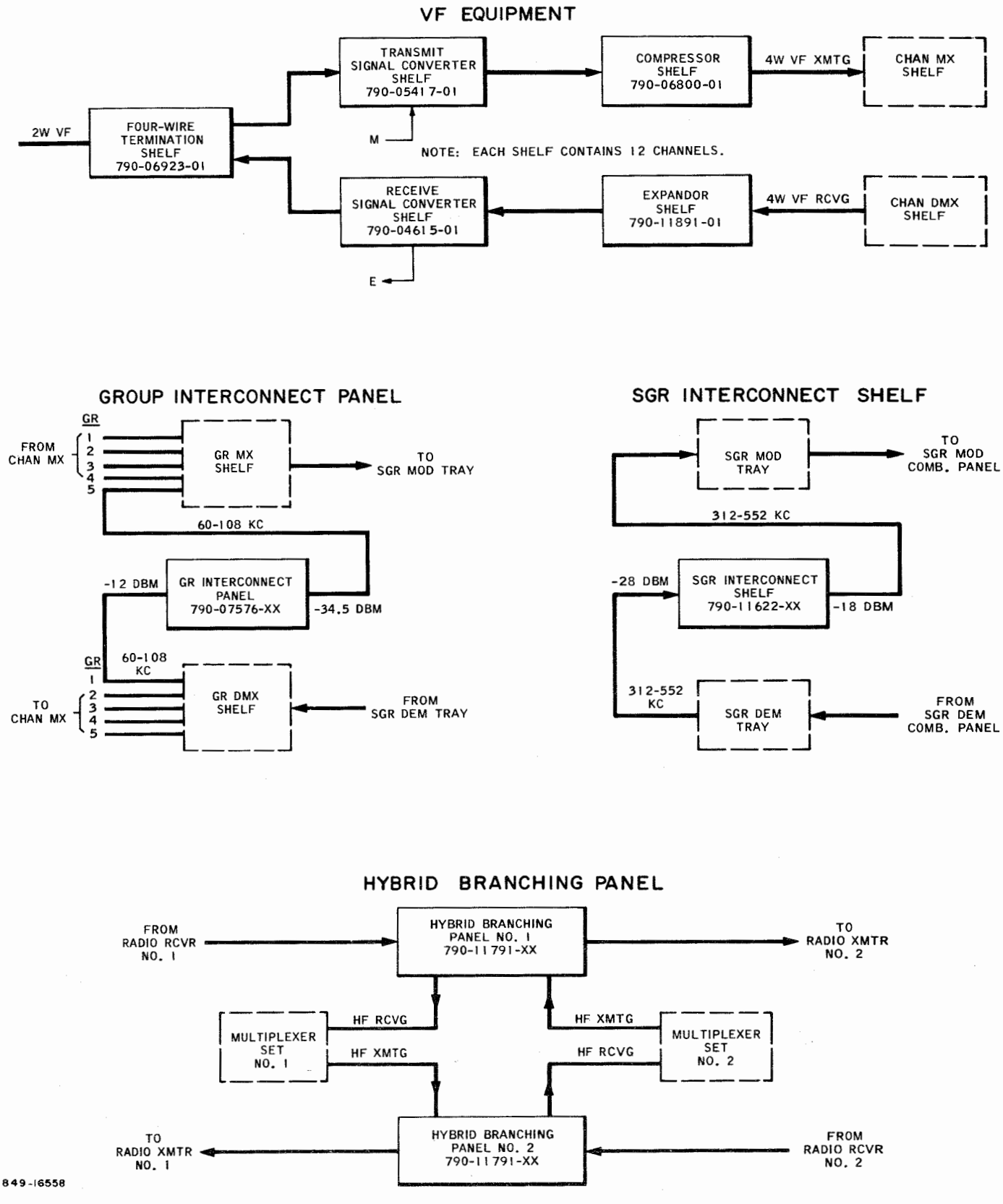
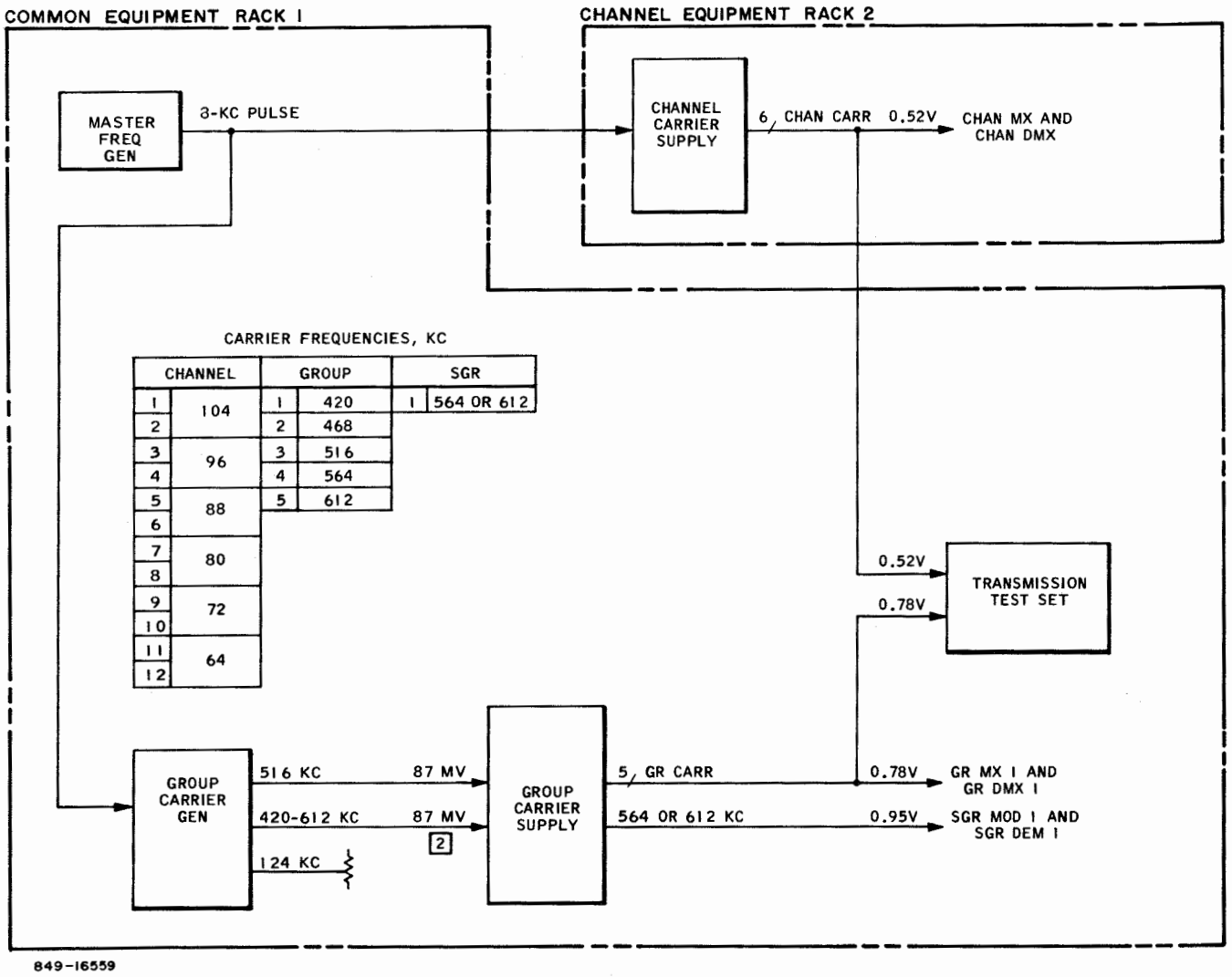


Figure 4-17. Application of Auxiliary Equipment

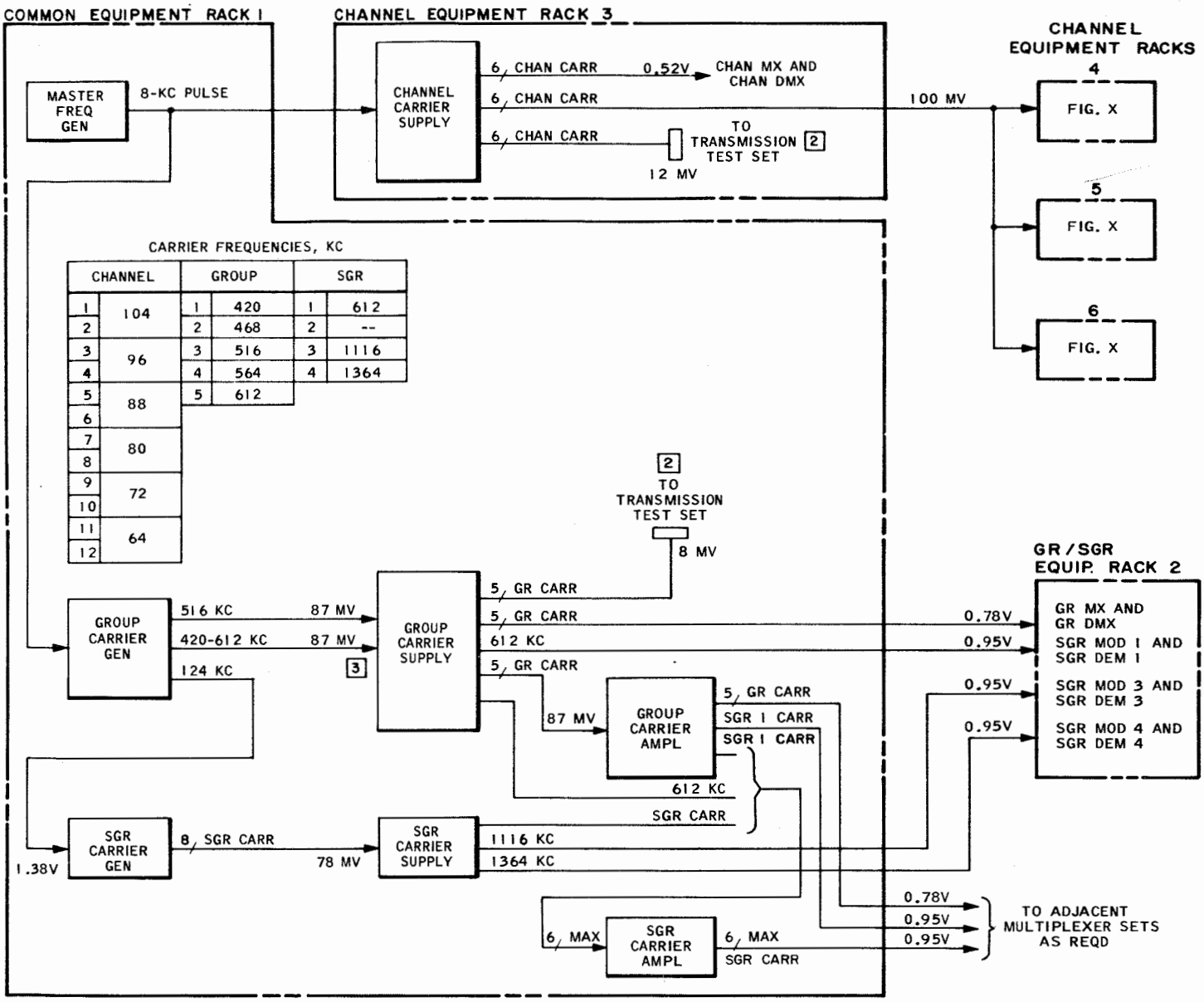


NOTES:

1. TYPICALLY, THE SYMBOL 6/ MEANS THAT THE SINGLE LINE REPRESENTS 6 INDIVIDUAL CIRCUITS.

[2] THE 420-612 KC SIGNAL INCLUDES THE 420, 468, 564, AND 612 KC GROUP CARRIER FREQUENCIES, EACH AT A LEVEL OF 87 MILLIVOLTS.

Figure 4-18. AN/FCC-21 Carrier Supply System



NOTES:

1. TYPICALLY, THE SYMBOL 6/ MEANS THAT THE SINGLE LINE REPRESENTS 6 INDIVIDUAL CIRCUITS.

[2] THE CONNECTORS LABELED "TO TRANSMISSION TEST SET" ARE MOUNTED ON THE FRONT OF THE ASSOCIATED SHELF, NOT EXTERNALLY AS SHOWN.

[3] THE 420-612 KC SIGNAL INCLUDES THE 420, 468, 564, AND 612 KC GROUP CARRIER FREQUENCIES, EACH AT A LEVEL OF 87 MILLIVOLTS.

FIG. X

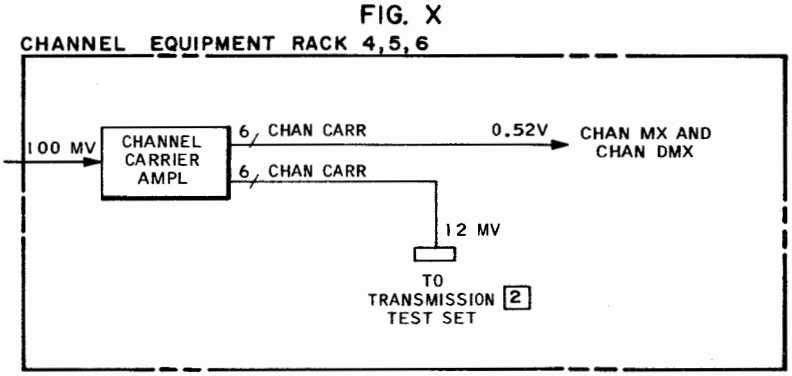


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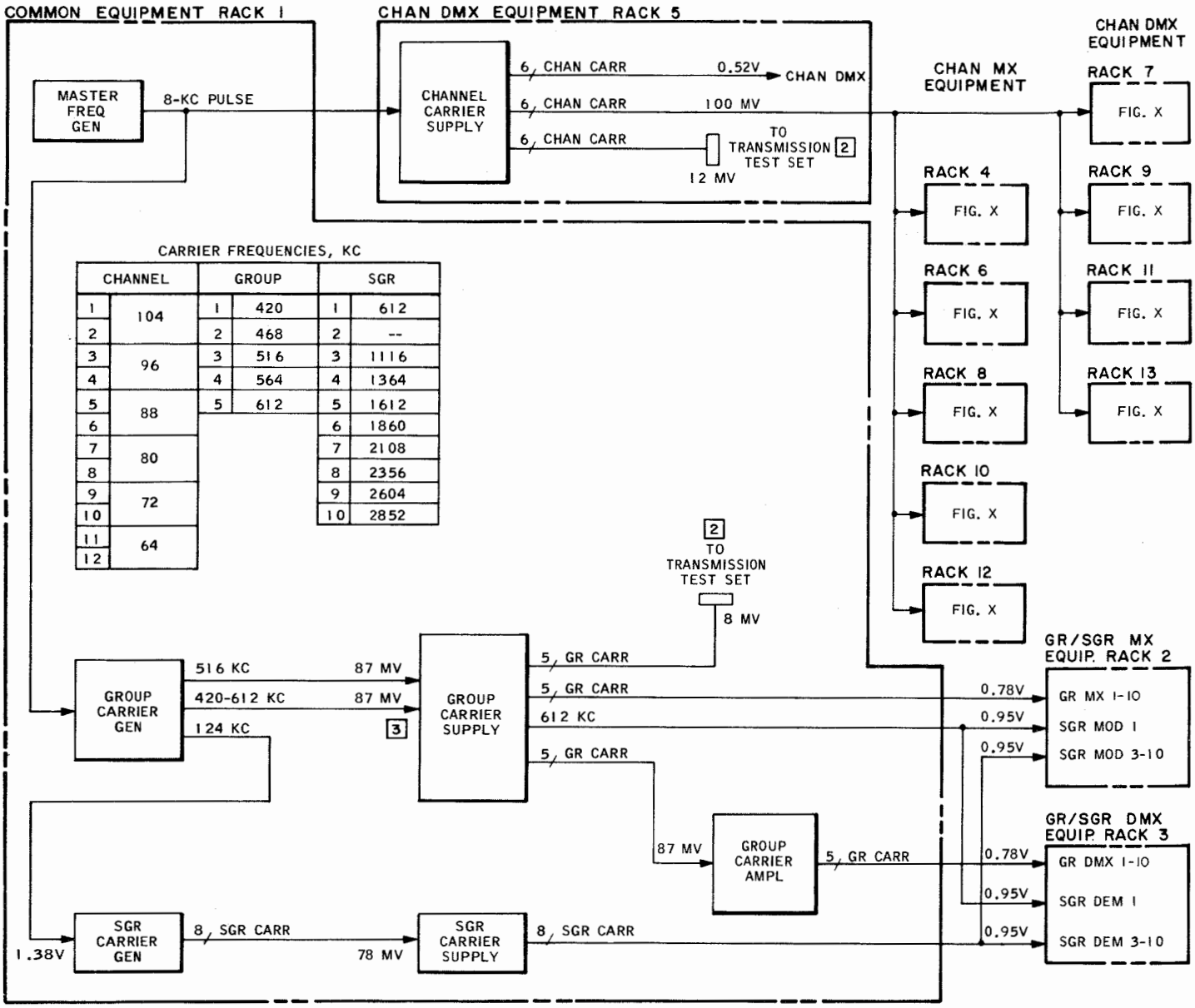
Figure 4-19. AN/FCC-22 Carrier Supply System



NOTES:

1. TYPICALLY, THE SYMBOL 6/ MEANS THAT THE SINGLE LINE REPRESENTS 6 INDIVIDUAL CIRCUITS.

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3. THE 420-612 KC SIGNAL INCLUDES THE 420, 468, 564, AND 612 KC GROUP CARRIER FREQUENCIES, EACH AT A LEVEL OF 87 MILLIVOLTS.

FIG. X

CHAN MX AND CHAN DMX EQUIP. RACKS 4 AND 6 THRU 13

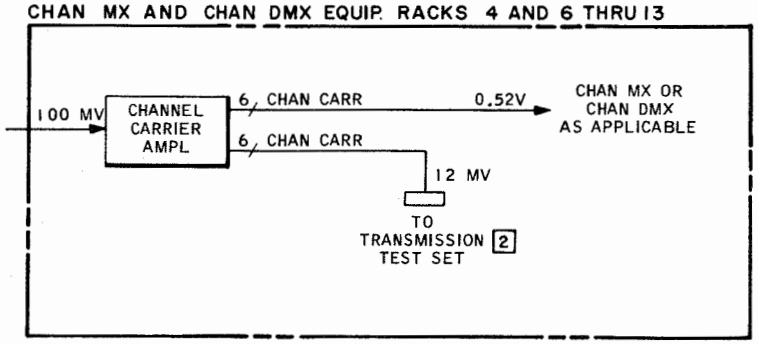

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Figure 4-20. AN/FCC-17 Carrier Supply System

when the multiplexer set has more than 60 channels. The maximum load on an amplifier shelf is also 10 channel shelves.

4-145. Through front panel receptacles on the channel carrier supply shelf or on the channel carrier amplifier shelf, the dolly-mounted transmission test set is supplied with carriers at 12 millivolts. Either carrier source, whichever is more convenient, may be patched to the test set. If the test set is rack-mounted, as in Multiplexer Set AN/FCC-21, it obtains carriers through the rack wiring from the regular 0.52-volt distribution circuits.

4-146. GROUP CARRIERS.

4-147. From the 8-kc pulse output of the master frequency generator shelf, the group carrier generator shelf creates five group carriers, plus a 124-kc frequency from which eight of the supergroup carriers will be derived. The group 3 carrier (516 kc) is on one output circuit and the carriers for groups 1, 2, 4, and 5 are combined as a complex signal on another (420-612 kc). The level of each group carrier frequency is 87 millivolts.

4-148. In the group carrier supply shelf, the group carriers are separated and amplified, and reappear individually at three different output levels. The 8-millivolt outputs are supplied through a front panel receptacle to the dolly-mounted transmission test set. The 0.78-volt outputs are distributed directly to the group equipment. The 87-millivolt outputs are used to drive the group carrier amplifier shelf, which is required when the load can't be handled by the group carrier supply shelf alone.

4-149. The maximum load on either the group carrier supply shelf or the group carrier amplifier shelf is 10 group shelves (multiplexer and/or demultiplexer). For a terminal with 300 duplex channels, this load would consist of five group shelves of each type, and the group carrier amplifier shelf would not be needed.

4-150. SUPERGROUP CARRIERS.

4-151. SUPERGROUP 1. Usually, the supergroup 1 carrier is obtained from the group carrier supply shelf but it is also available as an output of the group carrier amplifier shelf. The frequency is selected as 564 kc or 612 kc by strapping on the shelf.

4-152. Although the supergroup 1 carrier has the same frequency as the group 4 carrier (564 kc) or group 5 carrier (612 kc), the group and supergroup carrier distribution circuits are at different voltage levels.

4-153. SUPERGROUPS 3 THROUGH 10. If the multiplexer set operates with supergroup 3 or higher, it will be equipped with a supergroup carrier generator shelf and a supergroup carrier supply shelf. In the generator shelf, the 124-kc input frequency is processed to create carriers for supergroups 3 through 10. These eight carriers are then amplified individually in the supply shelf and distributed at 0.95 volt to the supergroup modulator and demodulator trays as required.

4-154. SUPPLYING CARRIERS TO ADJACENT TERMINALS.

4-155. Channel, group, or supergroup carriers can be supplied by a central terminal to other terminals at the same station. By this method, the carrier supply equipment at the other terminals can be reduced or almost entirely eliminated.

4-156. CHANNEL CARRIERS. The 100-millivolt channel carrier distribution circuits of the central terminal can be extended to drive channel carrier amplifier shelves on other terminals. The maximum length of a distribution circuit is 200 feet and the load can't exceed nine amplifier shelves.

4-157. GROUP CARRIERS. The 0.78-volt group carrier distribution circuits of the

central terminal can also supply carriers to group shelves (multiplexer and/or demultiplexer) on adjacent terminals, subject to the limitations of 10 shelves maximum load and 100 feet maximum circuit length.

4-158. SUPERGROUP CARRIERS. If supergroup carriers are to be furnished to adjacent terminals, the central terminal will be equipped with a supergroup carrier amplifier shelf. This shelf has six amplifier circuits, each capable of furnishing a 0.95-volt supergroup carrier to two supergroup trays. The maximum length of a distribution circuit is 100 feet.

NOTE

The supergroup carrier amplifier shelf is an optional item of equipment on Multiplexer Set AN/FCC-22.

4-159. The input signals to the amplifier circuits are obtained from the group carrier supply shelf or group carrier amplifier shelf (supergroup 1) at 0.13 volt and from the supergroup carrier supply shelf (supergroups 3 through 10) at 0.23 volt. By strapping, the amplifier circuits can be set up to operate independently, or one input signal can be fed in parallel to two or three circuits. Many different configurations are possible; figure 4-21 shows one.

4-160. CARRIER SYNCHRONIZATION.

4-161. To prevent the introduction of frequency error in signals transmitted over the multiplex channels, complete synchronization of all corresponding carrier frequencies throughout the system is necessary. This is accomplished by operating the 128-kc oscillators, from which all carriers are ultimately derived, in a master-slave relationship.

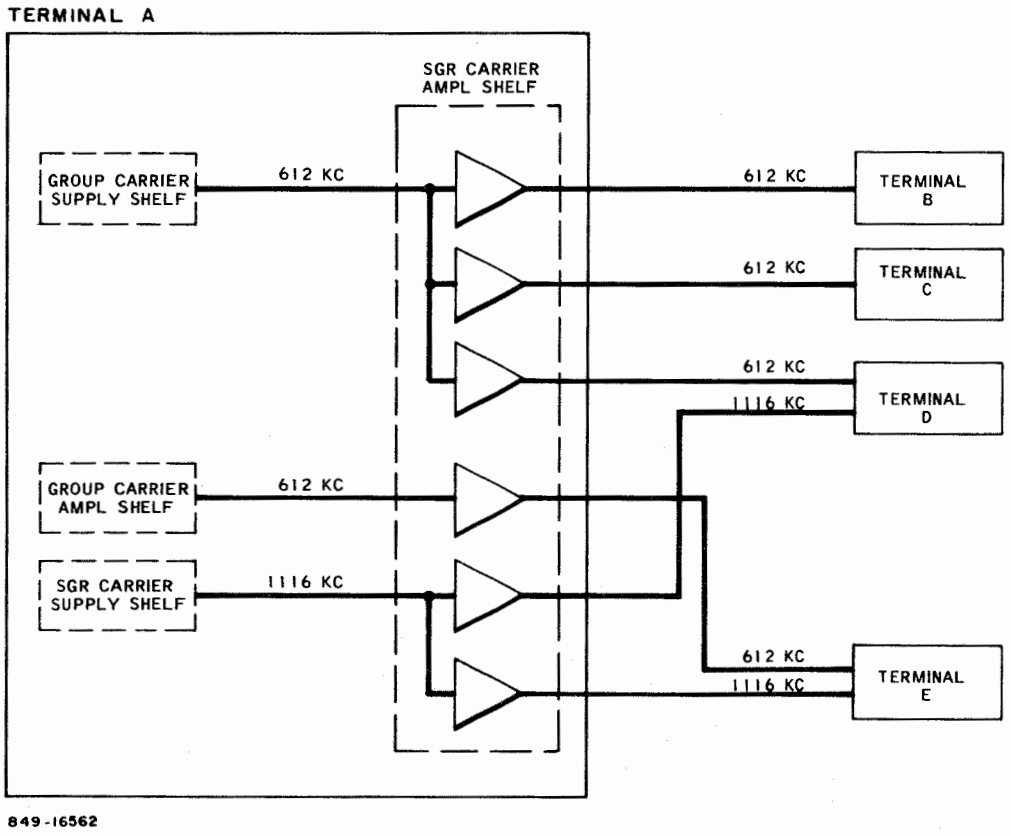


Figure 4-21. Typical Application of Supergroup Carrier Amplifier Shelf

4-162. Figure 4-22 shows a typical synchronizing scheme between two terminals at opposite ends of a system. At the master terminal, using a 96-kc frequency from the channel carrier supply shelf, a synchronizing pilot is injected into the transmitting signal at a level of -16 dbm0. At the slave terminal, the pilot is filtered from the receiving signal and sent to the master frequency generator shelf. Here, the incoming pilot frequency and a local 96-kc frequency frequency are compared, and if there is an abnormal phase difference, a correction voltage is generated to shift the frequency of the 128-kc slave oscillator.

4-163. If the pilot is interrupted, a memory circuit continues to supply the correction voltage to the slave oscillator so that it will remain at its last synchronized frequency.

4-164. In more complex systems, a master terminal may directly control more than one slave terminal, and a slave terminal may control other slave terminals. The synchronizing pilot may be sent over the transmission facility to a distant terminal or over a local cable to another terminal at the same station.

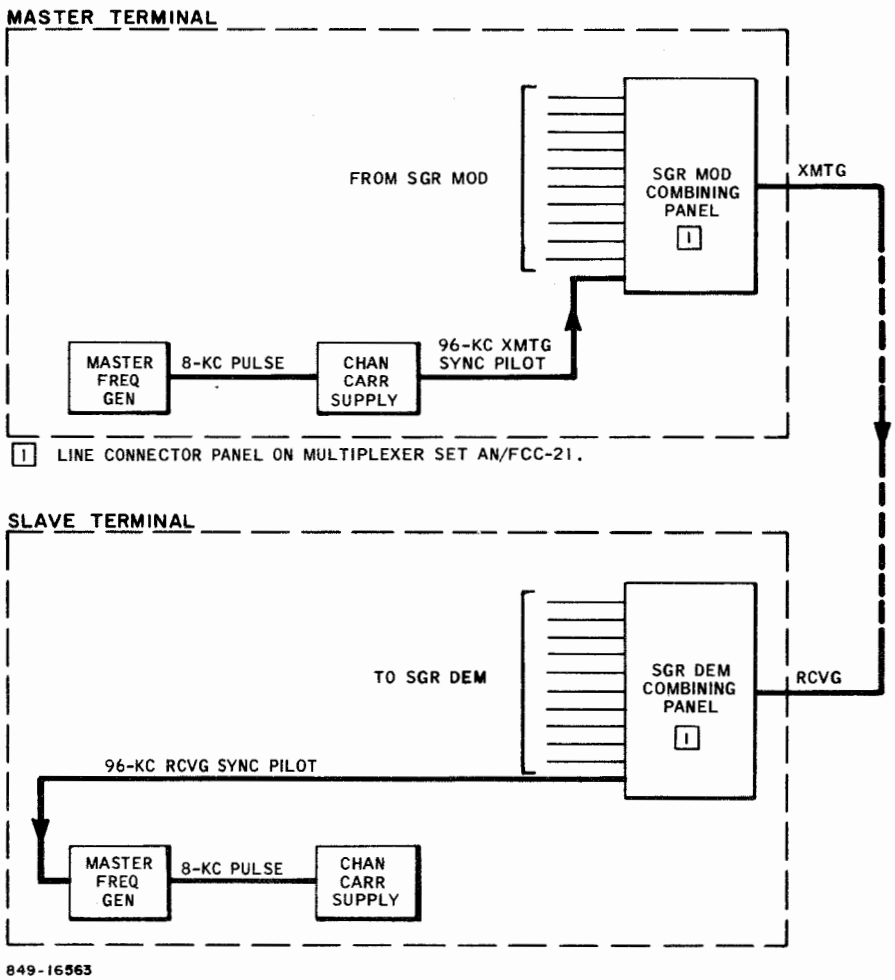


Figure 4-22. Carrier Synchronization

4-165. MASTER FREQUENCY GENERATOR SHELF.

4-166. The master frequency generator shelf (pn 790-05685-01) has two identical master frequency generator trays (pn 790-05683-01), A on the left and B on the right; each tray continuously generates the special 8-kc pulse from which all carrier frequencies in the multiplexer set are ultimately derived. As shown in figure 4-23, the 8-kc pulses are routed through alarm relays K1 and K2 and MAIN/STANDBY SELECTOR switch S3. According to the setting of S3, one tray is selected as "main" and the other is "standby". If the main tray goes into an alarm condition, its relay will release and transfer the load to the standby tray.

4-167. If both trays are normal, or if both are in alarm, the load can be connected to either tray by operating S3. But if only one tray is in alarm, the normal tray will feed the load regardless of the setting of S3.

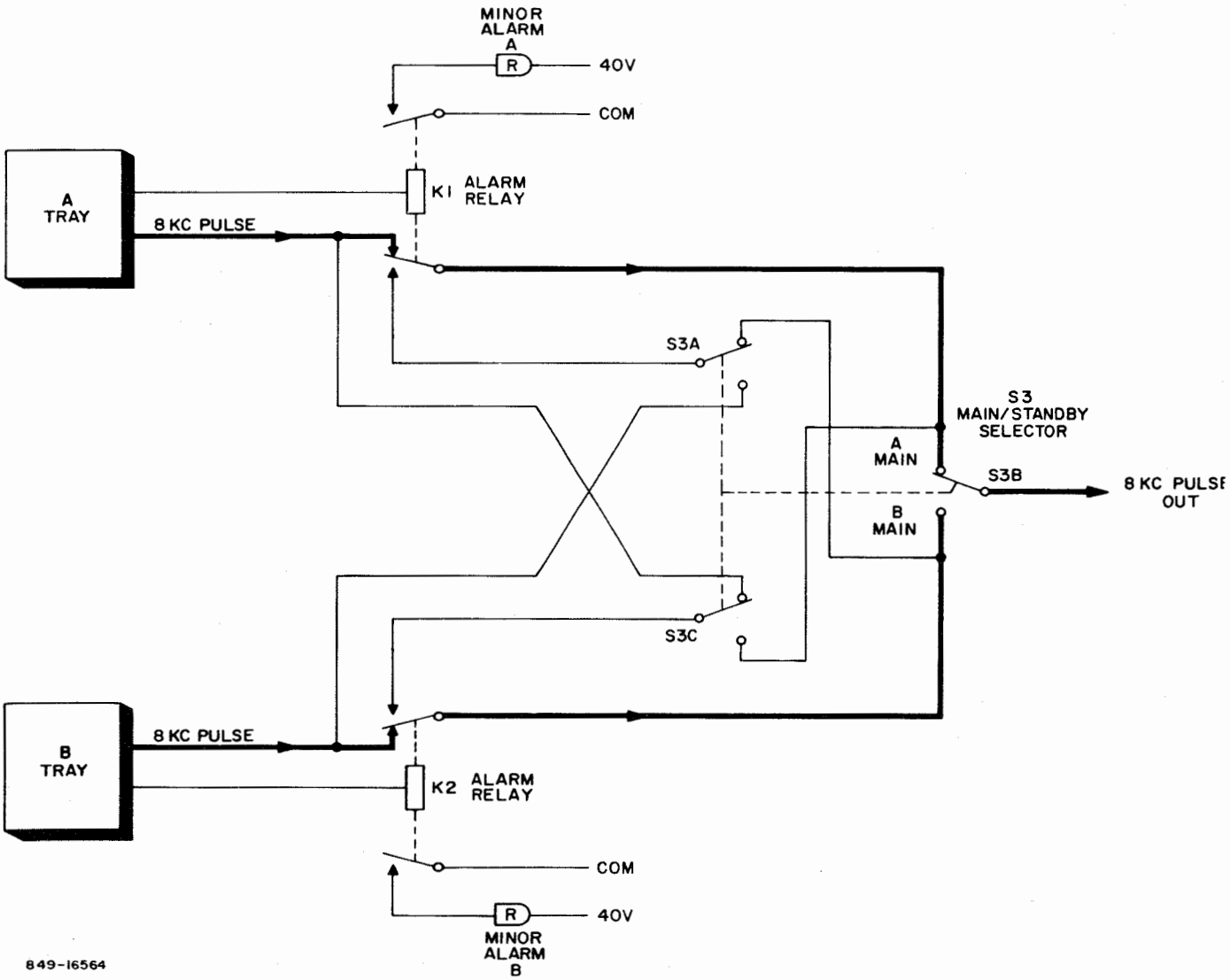


Figure 4-23. Master Frequency Generator Shelf

4-168. The MINOR ALARM A and B lamps indicate an alarm condition in the A and B tray, respectively. If both lamps are lighted, the alarm is major. The minor and major alarm indications are passed on to the master alarm panel of the multiplexer set.

4-169. MASTER FREQUENCY GENERATOR TRAY. (See figure 4-24.)

4-170. The primary frequency source for the carrier supply system of the multiplexer set is the 128-kc oscillator in module A5. In pulse generator A4, the 128-kc oscillator output is divided down to 8-kc and then converted to a harmonically rich 8-kc pulse. By strapping, the 128-kc oscillator can be set up to operate as a slave or a master. Labels, visible when the master frequency generator shelf is extended from the rack, indicate the operating mode.

4-171. SYNCHRONIZATION. At a slave terminal, the 128-kc oscillator is synchronized with its counterpart at a master terminal by comparing the phase of a 96-kc signal derived from the output of each oscillator. The signal representing the oscillator frequency at the master terminal is the 96-kc synchronizing pilot. Depending on system layout, the pilot may be obtained from the receiving branch of the transmission path at a low level (0.46 millivolt), or from the channel carrier supply shelf of an adjacent terminal at a high level (0.52 volt). A resistance network in the master frequency generator shelf is strapped according to the level, and a hybrid transformer distributes the incoming pilot to both trays.

4-172. The local signal representing the slave oscillator frequency is extracted from the 8-kc pulse by 96-kc bandpass filter A3. The two 96-kc signals, local and incoming pilot, are amplified and enter phase detector A9. The polarity and amplitude of the phase detector's dc output voltage (detector voltage) represents the relative phase of the two 96-kc signals. The approximate range of detector voltages is from +5.5 volts at 0 degrees phase difference to -7.5 volts at 180 degrees; at 90 degrees the detector voltage is zero.

4-173. To maintain synchronism, the slave oscillator is tuned automatically by controlling the reverse bias on four variable capacitance diodes. The capacitance of the diodes, and hence the frequency of oscillation, is a function of the reverse bias voltage, which is equal to the difference between the detector voltage and a reference potential designated as the tuning voltage.

4-174. Assume that the tuning voltage is a fixed value and that the master and slave oscillators are synchronized. Now, if the two oscillators start to drift apart, the phase detector output will change and at some phase difference, the detector voltage will reach a new value that synchronizes the slave with the master.

4-175. MECHANICAL MEMORY. In the preceding paragraph, the tuning voltage was assumed to be fixed, but actually it is obtained from a variable potentiometer driven by the servomotor in A10. The setting of the potentiometer constitutes a mechanical memory.

4-176. The control voltage for the servo is the amplified output of a modulator in A9. In the modulator, the polarity of the detector voltage establishes the phase of the servo control voltage and hence the direction of rotation of the servo. Through the action of the modulator and servo, a positive detector voltage increases the tuning voltage while a negative detector voltage decreases it. The change in tuning voltage always shifts the frequency of the slave oscillator in a sense that reduces the detector voltage. When the detector voltage reaches zero, the servo stops and holds the tuning voltage constant. (As previously mentioned, zero detector voltage is achieved when the phase difference of the two 96-kc signals is 90 degrees.)

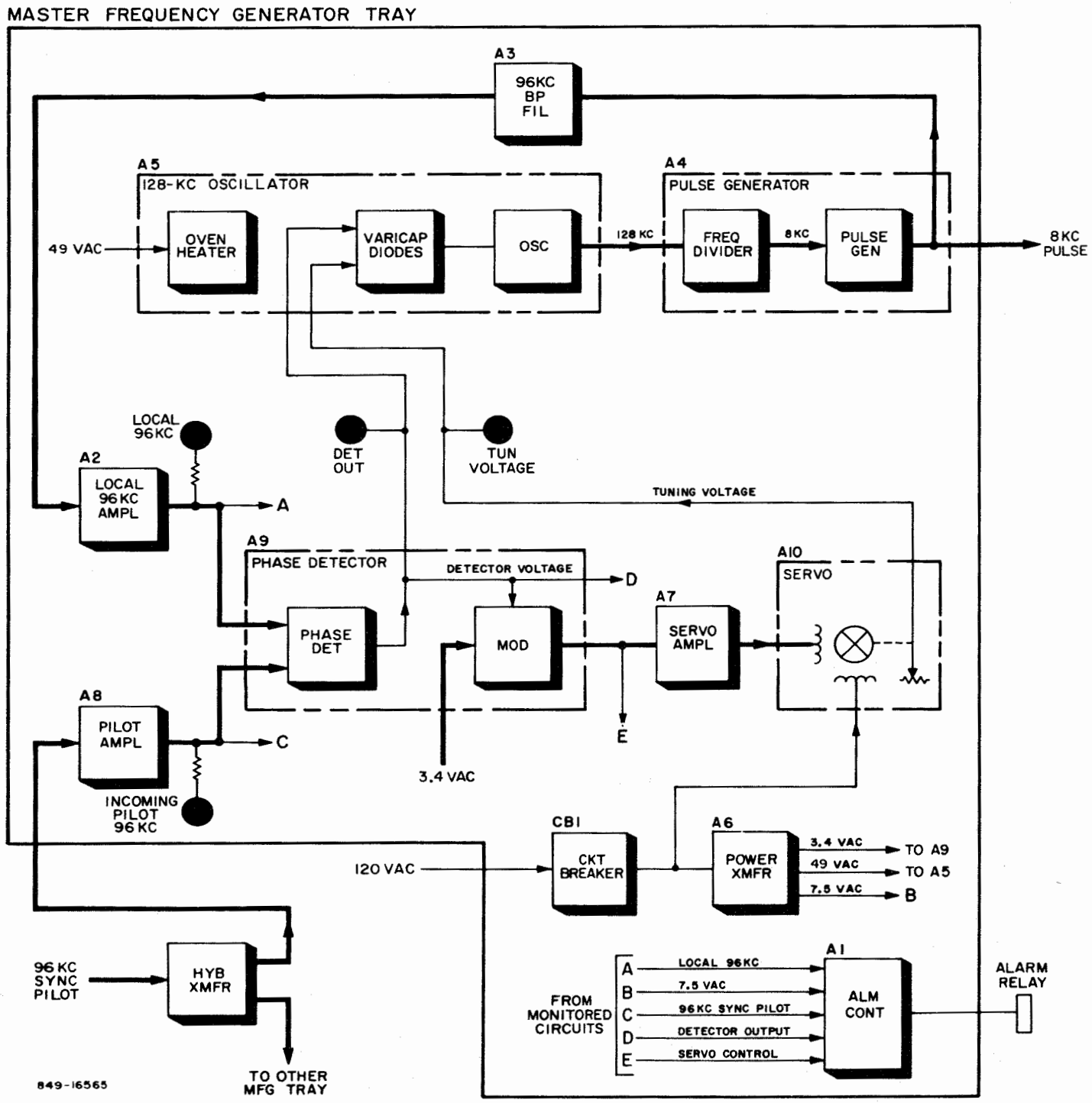


Figure 4-24. Master Frequency Generator Tray

4-177. The detector voltage also goes to zero if the 96-kc sync pilot is interrupted, and if the synchronizing circuit did not include mechanical memory, the slave oscillator would revert to its uncorrected frequency. But with mechanical memory, the tuning voltage stored in the servo-operated potentiometer will continue to maintain the slave oscillator at the last frequency with which it was synchronized.

4-178. The relationship between detector voltage and tuning voltage is illustrated by the following experiment. With the tuning voltage at -11 volts and zero detector voltage, disable the servo by turning off the ac power to its reference winding. Next, detune the slave oscillator so that a detector voltage of +2 volts is developed in maintaining synchronism with the master oscillator. The total voltage applied to the varicap diodes is the difference between the detector voltage and the tuning voltage, or 13 volts. Now, restore ac power to the servo. The servo will turn until the detector voltage is zero, at which point the tuning voltage will be 13 volts. The voltage on the varicap diodes will still be 13 volts, but all of it will be represented by the tuning voltage and none by the detector voltage.

4-179. A steady tuning voltage and a detector voltage of zero (±0.5 volt) indicates synchronism. If synchronism is lost, the detector voltage will fluctuate several volts positive and negative at a rate approximately equal to the difference in the two oscillator frequencies. The maximum difference in the frequencies of the two 96-kc signals at which the slave will automatically sync with (capture) the master is about ±0.75 cps; this is equivalent to a difference of about ±1.0 cps in the frequencies of the 128-kc oscillators. Normally, the maximum variation in the frequency of a master oscillator over a 24-hour period is ±0.05 cps. The predicted long-term change (principally caused by crystal aging) over a 20-year period is +11 cps.

4-180. 128-KC OSCILLATOR. (See figure 4-25.) The 128-kc oscillator is crystal-controlled and operates inside an oven maintained at 75°C (167°F). The FREQUENCY ADJUST control is a 25-turn piston capacitor by means of which the oscillator frequency can be adjusted over a range of about 30 cps. This control is used in alignment to synchronize the slave oscillator to the master. Ordinarily, the frequency of the master oscillator should not be changed unless it can be measured and set to an accuracy of at least ±0.3 cps.

4-181. In the slave mode of the oscillator, capacitor C9 is strapped out of the collector load of Q1 and replaced by the four variable-capacitance diodes CR1 through CR4. When reverse biased by 11 volts, the diodes have about the same capacitance as C9. Capacitors C5 and A10C1 are in series with the diodes, but because they are comparatively large they have no effect on the net capacitance of the circuit.

4-182. With the oscillator frequency adjusted to 128.000 kc, increasing the reverse bias from 11 volts to 17 volts will reduce the capacitance and raise the oscillator frequency about 1.3 cps; decreasing the bias to 5 volts will lower the frequency about 2.0 cps. However, these frequency changes are greater than the capture range of the sync circuit, and so in routine maintenance, the slave oscillator is retuned by the FREQUENCY ADJUST control if the reverse bias (tuning voltage) is outside the range of -9 to -13 volts.

4-183. The tuning voltage range of -7 to -18 volts is obtained from potentiometer R3 driven by servomotor B1 through a 52.4:1 reduction gear. Because the potentiometer can be turned continuously, resistor R4 is used to prevent the tuning voltage from dropping to zero when the wiper arm of the potentiometer moves across the gap between the ends of the resistance winding.

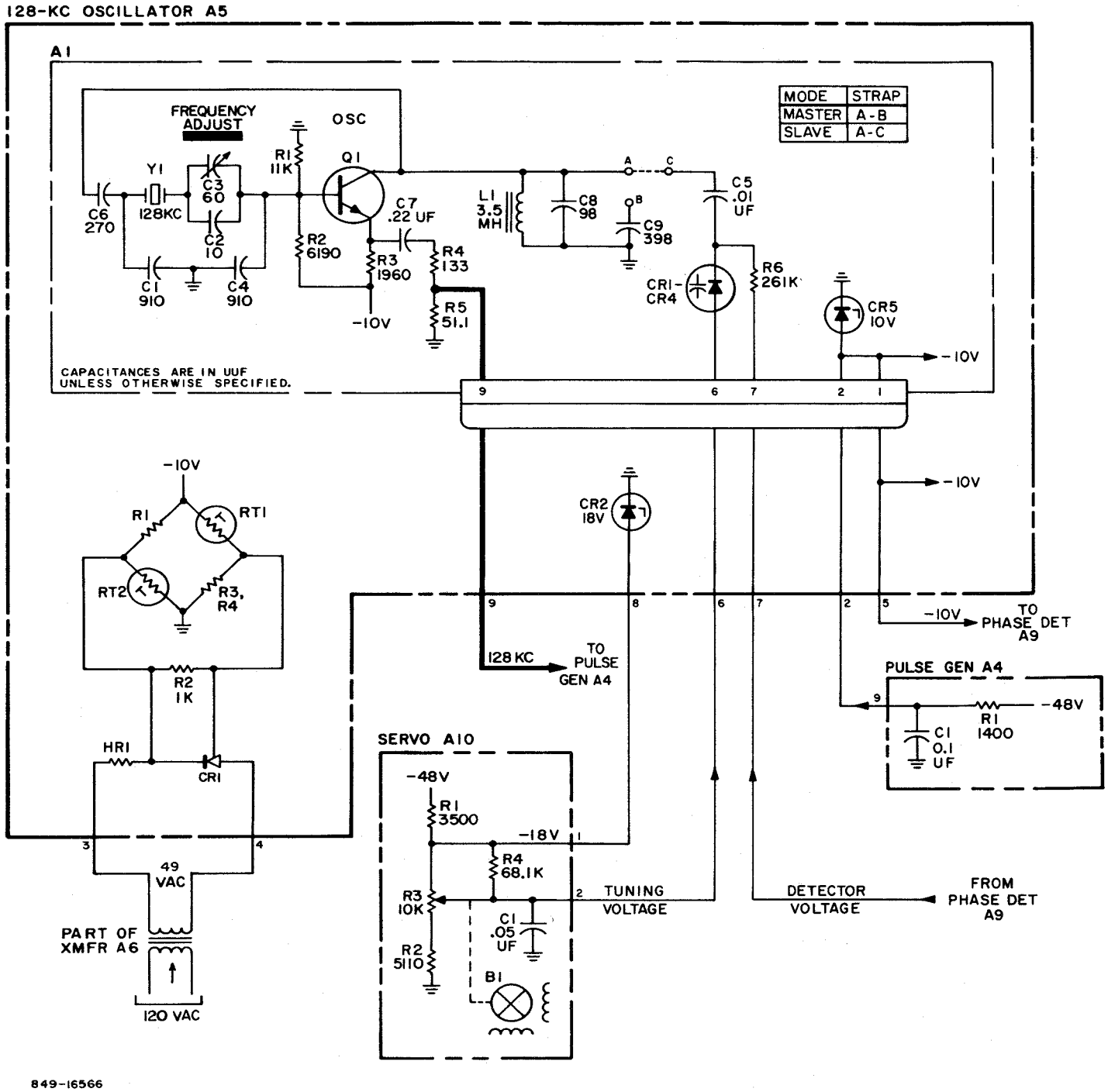


Figure 4-25. 128-Kc Oscillator

4-184. The negative 10-volt supply used in modules A5 and A9 is developed by the 10-volt zener diode CR5 in module A5 and a 1400-ohm resistor R1 in module A4.

4-185. The oscillator oven temperature is maintained by heater HR1 under the control of a temperature-sensitive bridge that includes thermistors RT1 and RT2. At temperatures below 75°C, the bridge is unbalanced and the dc voltage across resistor R2 turns on silicon-controlled rectifier CR1, allowing half-wave ac current to flow through the heater. As the temperature increases, thermistor resistance decreases and the bridge approaches balance. At precisely 75°C, the dc voltage from the bridge is insufficient to keep CR1 conducting, and the heater turns off.

4-186. ALARM CIRCUIT. (See figure 4-26.) In the master mode of the master frequency generator tray, alarm control module A1 monitors the local 96-kc signal and the 60-cps ac power. In the slave mode, three more circuits are monitored: the incoming 96-kc sync pilot, the phase detector output, and the servo control voltage. If each monitored circuit is normal, the applicable alarm relay (A or B) in the master frequency generator shelf will be energized; an abnormal condition in any monitored circuit will release the relay and initiate an alarm.

4-187. The alarm relay is controlled by transistor switch Q2 in the alarm control module. Normally, Q2 is turned on by positive voltage (ground) applied to its base

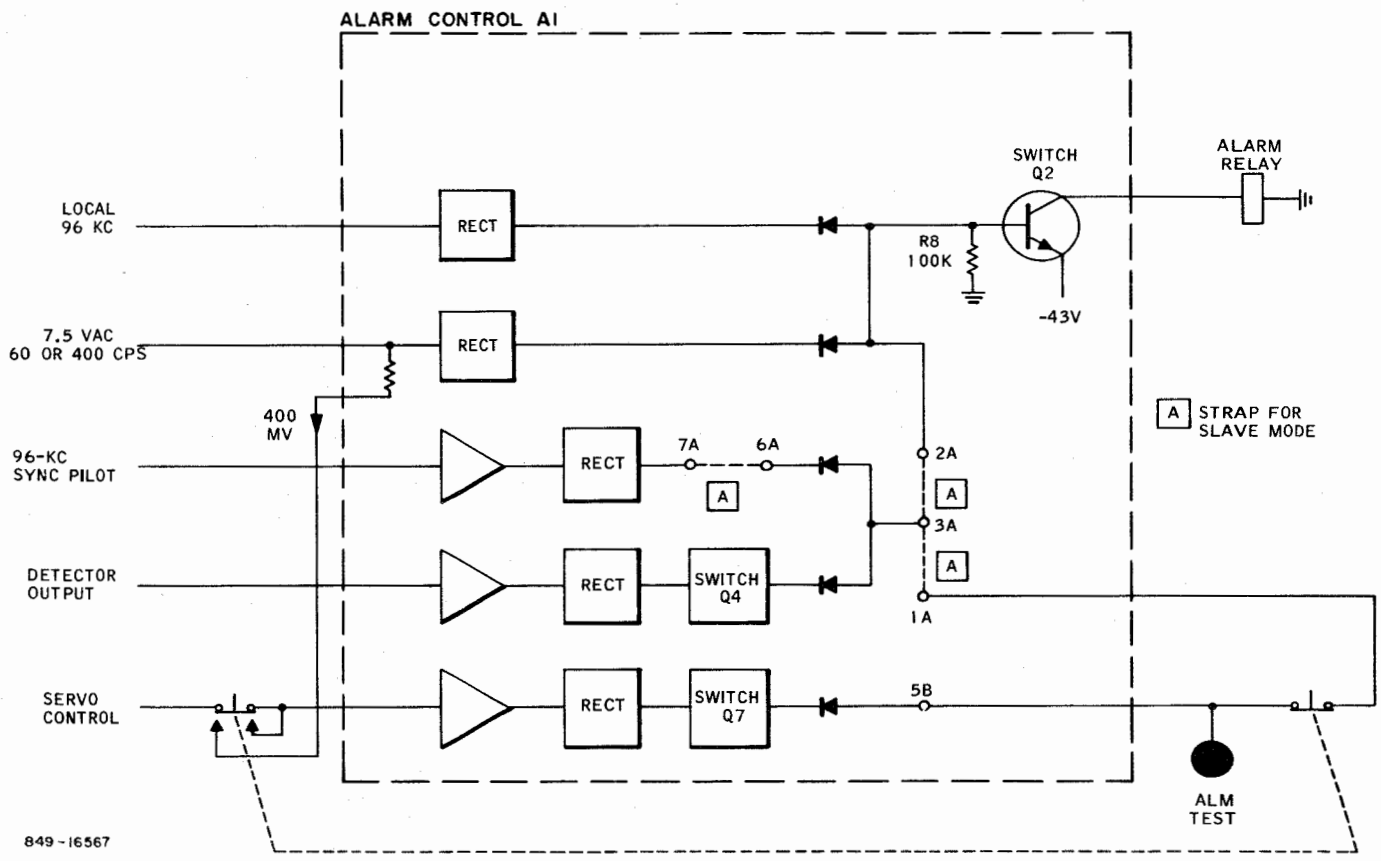


Figure 4-26. Master Frequency Generator Alarm Control

through resistor R8, and the relay is energized. The five monitors have various circuit configurations, but each has a dc voltage output that normally reverse biases a diode connected to the base of transistor Q2. If a monitor detects an abnormal condition, it will cause its diode to conduct and connect a negative voltage to the base of Q2, turning off the transistor and releasing the alarm relay.

4-188. The abnormal conditions in the monitored circuits that will release the alarm relay are as follows:

a. Local 96-kc signal: level 7 db or more below normal

b. Ac power: loss of voltage

c. Incoming 96-kc sync pilot: level 10 db or more below normal

d. Phase detector output: large voltage fluctuations (4 volts or more) for longer than 5 seconds, indicating loss of synchronism

e. Servo control: sustained level of 400 millivolts for longer than 14 seconds, indicating failure to synchronize

4-189. Because the monitor for the servo control voltage is not fail-safe, the ALM TEST pushbutton and test point are used to verify its operation. Pressing the pushbutton isolates the monitor and connects a 400-millivolt ac signal to its input. If the monitor is in good order, a meter at the test point should read about -24 volts (indicating transistor switch Q7 is on) and then should increase slowly to about -46 volts, indicating that Q7 has turned off.

4-190. One of the circuits through contacts of the alarm relay (not shown in figure 4-26) is from the emitters of the push-pull transistors in the output stage of servo amplifier A7. Release of the relay opens the circuit to prevent the servomotor from hunting or turning continuously.

4-191. SPECIAL MASTER FREQUENCY GENERATOR SHELVES.

4-192. Variations of the standard master frequency generator shelf and tray, which have been developed for special applications, are listed in table 1-4 and described below.

4-193. AC POWER. When equipped with two special modules, servo amplifier A7 (pn 790-06622-01) and servo A10 (pn 790-05114-01), the master frequency generator shelf can operate with 400-cps power instead of the standard 50-60 cps power.

4-194. MASTER MODE. Normally, the master frequency generator shelf is operable in either the master or slave mode; conversion from one mode to the other requires only changes in strapping. The shelf can also be equipped to operate only in the master mode by omitting three modules (servo amplifier A7, servo A10, and pilot amplifier A8) and replacing phase detector A9 with a dummy phase detector (pn 790-05432-01). The sole function of the dummy phase detector is to terminate the main output of local 96-kc amplifier A2 so that signal level will be normal on the auxiliary output monitored by alarm control A1.

4-195. SLAVE MODE. The mechanical memory feature of the master frequency generator shelf in the slave mode can be eliminated by replacing servo A10 with a dummy servo (pn 790-07217-01). The dummy servo is simply a voltage divider supplying a fixed tuning voltage of -11 volts, and synchronization is achieved as described in paragraphs 4-174. Without mechanical memory, if the 96-kc sync pilot is interrupted the detector voltage will go to zero, and the slave oscillator will revert to its natural, unsynchronized frequency.

4-196. CHANNEL CARRIER SUPPLY SHELF. (See figure 4-27.)

4-197. The channel carrier supply shelf (pn 790-01150-01) obtains six channel carriers by filtering the 8th through 13th harmonics from the 8-kc pulse output of the master frequency generator shelf. The output of each bandpass filter goes through a carrier supply circuit which distributes different voltages to the transmission test set (dolly-mounted), the channel carrier amplifier shelves, and the channel multiplexer and demultiplexer shelves.

4-198. From the 96-kc bandpass filter only, an additional branch supplies 96 kc at 0.52 volt for use as the carrier sync pilot. The voltage is fed to the line connector panel (AN/FCC-21) or supergroup modulator combining panel (AN/FCC-22 and -17) or to the master frequency generator shelf of an adjacent terminal. The load impedance is greater than 35 kilohms.

4-199. To compensate for variations in the insertion loss of the bandpass filters, a resistor across the 135-ohm filter output is selected at the factory to set the level at precisely -3.2 db (approximately 0.52 volt).

4-200. TRANSMISSION TEST SET. The first branch in the carrier supply circuit feeds carrier through a 2870-ohm resistor to a receptacle on the front panel, and from there through an interconnecting cable to the dolly-mounted transmission test set. The level is 12 millivolts when the circuit is terminated by the 67-ohm input impedance of the test set.

4-201. AMPLIFIER SHELVES. Through terminals A and C, which are normally strapped together, and a 110-ohm resistor, carrier is distributed to a maximum of nine channel carrier amplifier shelves. Each amplifier shelf has an input impedance of 245 ohms, so the maximum load is 27 ohms. In series with the 110-ohm resistor, the load impedance forms a voltage divider that produces 100 millivolts.

4-202. If the actual load is less than the maximum, it is built out to the equivalent of nine shelves by strapping in dummy load resistors at terminal F. Respectively, the four resistors connected to terminals G, H, J, and K provide loads equivalent to four shelves, three shelves, two shelves, and one shelf.

4-203. CHANNEL SHELVES. Except as described in paragraph 4-207, the 0.52-volt carrier to the channel multiplexer and demultiplexer shelves is obtained by amplifying the same 100-millivolt signal that drives the channel carrier amplifier shelves.

4-204. The amplifier circuit consists of two 37-db amplifier modules (A and B) and a paralleling network. All amplifier modules in the shelf are interchangeable but the paralleling networks are different for each carrier frequency.

4-205. The paralleling network is the single-frequency type and includes the two hybrid transformers and phase-shift network shown on figure 4-27. Its operation is described in paragraph 4-334.

4-206. The distribution circuit feeds the 0.52-volt carrier to a maximum of 10 channel multiplexer and/or demultiplexer shelves. Because of the twin-channel modulation scheme, the load in each shelf is two modulators or demodulators, and the resultant carrier input impedance of the shelf is 135 ohms. Consequently, 10 shelves connected to the distribution circuit creates a load impedance of 13.5 ohms, matching the source impedance. If the load is five shelves or less, a 26.1-ohm dummy load is strapped in at terminal E.

4-207. In normal operation, terminals A-C and terminals B-D are strapped to

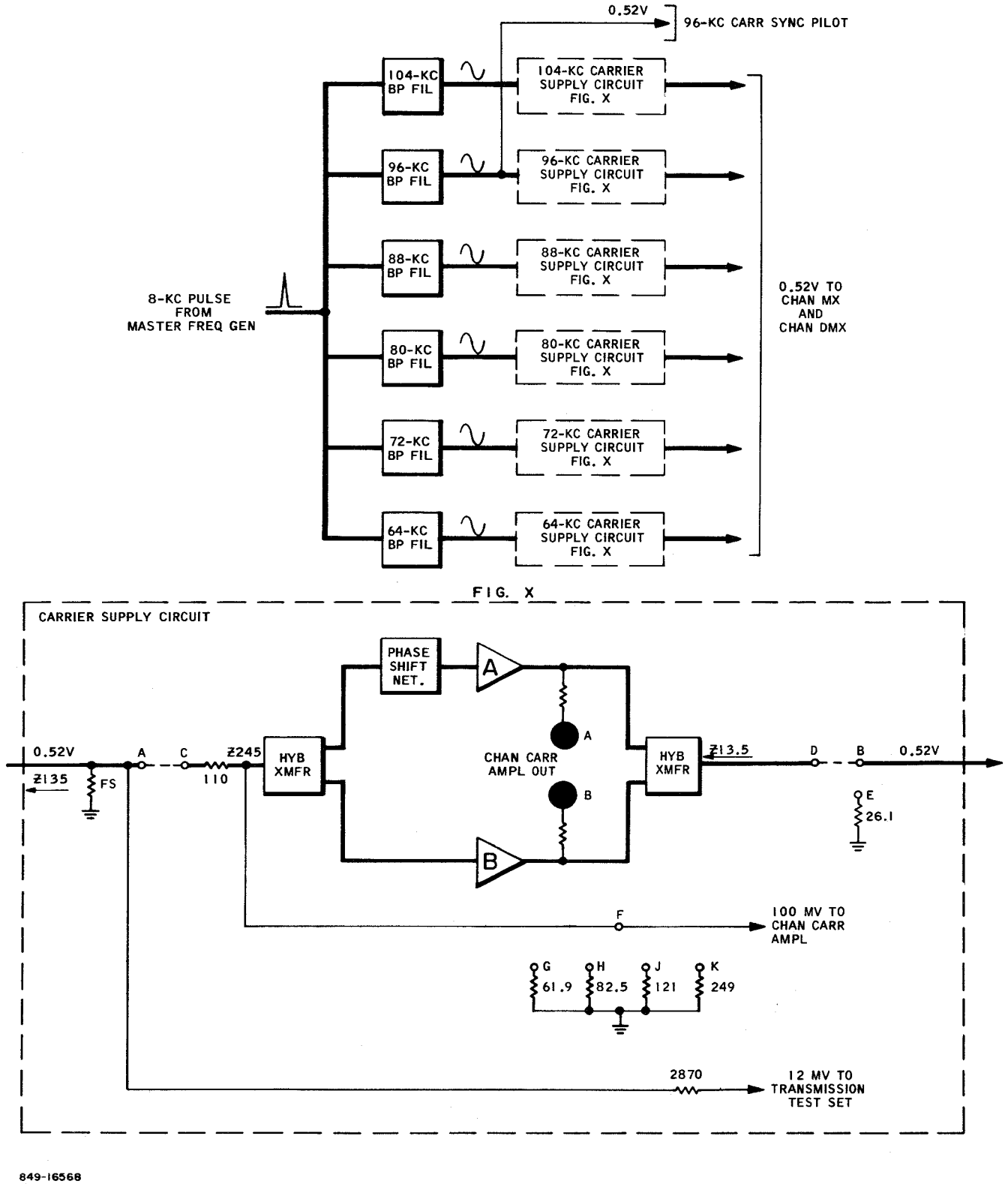


Figure 4-27. Channel Carrier Supply Shelf

complete the input and output of the amplifier circuit. Under the special condition that the load is only one channel multiplexer or demultiplexer shelf, and that no channel carrier amplifier shelves are to be driven, then strapping terminals A-B and removing all other straps connects the 0.52-volt output of the bandpass filter directly to the distribution circuit.

4-208. MONITOR. The output of each A and B amplifier module is monitored and the shelf alarm circuits are activated if any amplifier fails. These circuits are described in paragraph 4-283.

4-209. The amplifier outputs are also connected through voltage dividers to the CHAN CARR AMPL OUT test jacks where carrier levels can be checked on the transmission test set.

4-210. CHANNEL CARRIER AMPLIFIER SHELF. (See figure 4-28.)

4-211. AMPLIFIER CIRCUITS. The channel carrier amplifier shelf (pn 790-01261-01) has six independent amplifier circuits, one for each of the six 100-millivolt carrier signals it receives from the channel carrier supply shelf.

4-212. Each amplifier circuit consists of two 37-db amplifier modules (A and B) and a single-frequency paralleling network operating together as described in paragraph 4-334. The modules and networks are the same types used in the channel carrier supply shelf.

4-213. The main output of the amplifier circuit is a 0.52-volt carrier signal which is distributed to a maximum of 10 channel multiplexer and/or demultiplexer shelves. Each shelf has a carrier input impedance of 135 ohms, so that the maximum load on the distribution circuit (13.5 ohms) matches the source impedance. If the load is five shelves or less, a 26.1-ohm dummy load (equivalent to a load of five shelves) is added by strapping terminals A-B.

4-214. Through a 2870-ohm resistor, carrier is fed to a receptacle on the front panel for use in the dolly-mounted transmission test set. (The test set may obtain carriers from this shelf or from the channel carrier supply shelf.) When terminated by the 67-ohm input impedance of the test set, the carrier level is 12 millivolts.

4-215. MONITOR. As described in paragraph 4-283, the output of each A and B amplifier is monitored and the shelf alarm circuits are activated if any amplifier fails. Also, the amplifier outputs can be checked at the CHAN CARR AMPL OUT test jacks with the transmission test set.

4-216. GROUP CARRIER GENERATOR SHELF. (See figure 4-29.)

4-217. In the group carrier generator shelf (pn 790-02152-01), the 8-kc pulse received from the master frequency generator shelf drives three carrier generator circuits. Two of the circuits generate single frequencies (124 kc and 516 kc), while the third produces a complex output signal containing frequencies of 420, 468, 564, and 612 kc.

4-218. 124-KC GENERATOR CIRCUIT. The 31st harmonic of the 8-kc pulse is selected by 248-kc bandpass filter A6 and applied to a modulator in A3. Through resistor A3R1, a weak 124-kc noise component or transient bypasses the modulator and goes through 124-kc bandpass filter A7 to the amplifier circuit. Part of the amplified signal is returned to the modulator where it mixes with the 248-kc signal, producing a 124-kc frequency that reinforces the original 124-kc noise. This regenerative action rapidly builds up a strong, steady 124-kc output from the modulator.

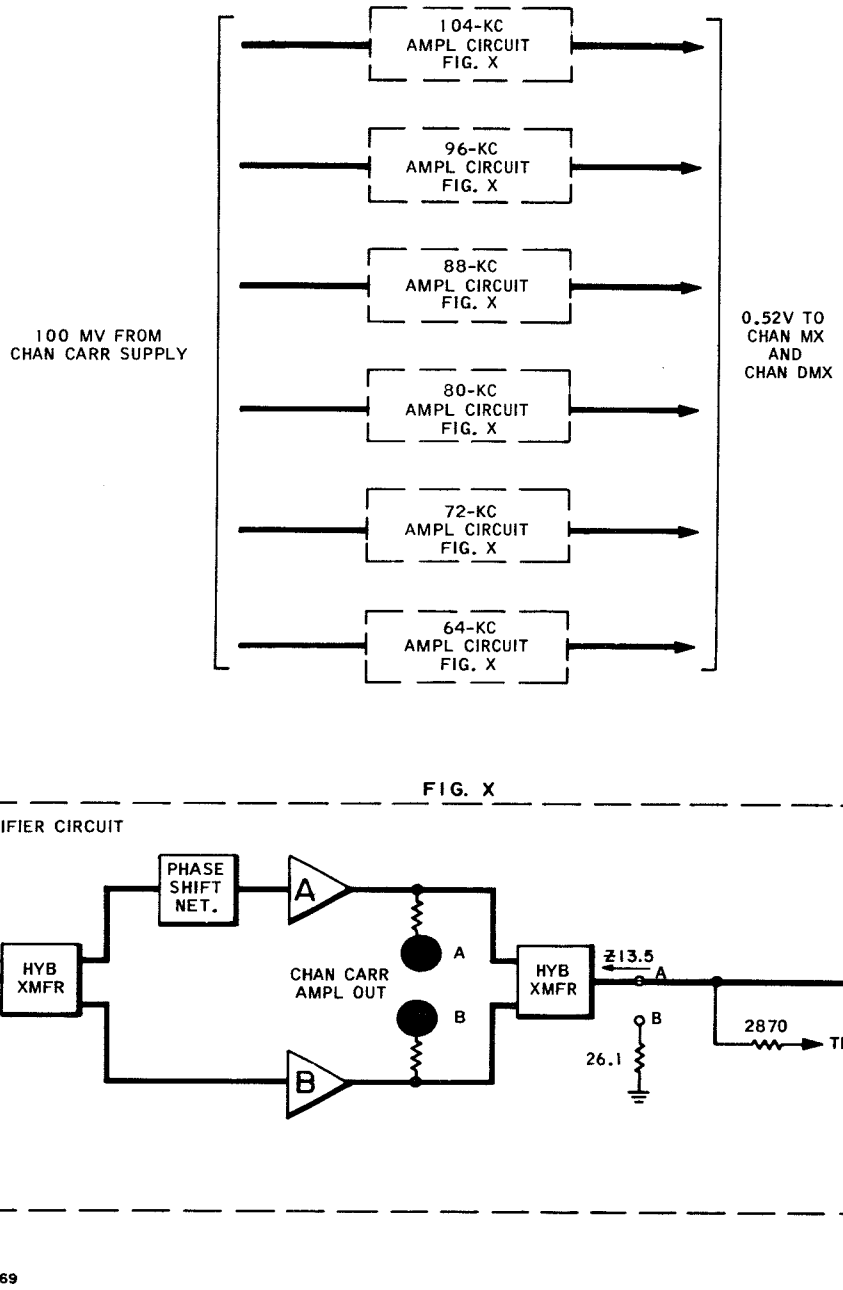


Figure 4-28. Channel Carrier Amplifier Shelf

4-219. The remainder of the amplified 124-kc signal is sent through 124-kc bandpass filter A8 to hybrid transformer A3T4 where it divides into two paths, one to the 516-kc generator circuit and the other to the supergroup carrier generator shelf.

4-220. 516-KC GENERATOR CIRCUIT. The 18th harmonic of the 8-kc pulse is selected by 144-kc bandpass filter A9 and mixed with 124-kc in modulator A12. The 516-kc modulation product, which is equal to 144 kc plus three times 124 kc, is picked off by crystal filter A10 and sent to the amplifier circuit. The amplified 516 kc is divided by a resistance hybrid in A13, one part going to the 420-612 kc generator circuit and the other to the group carrier supply shelf.

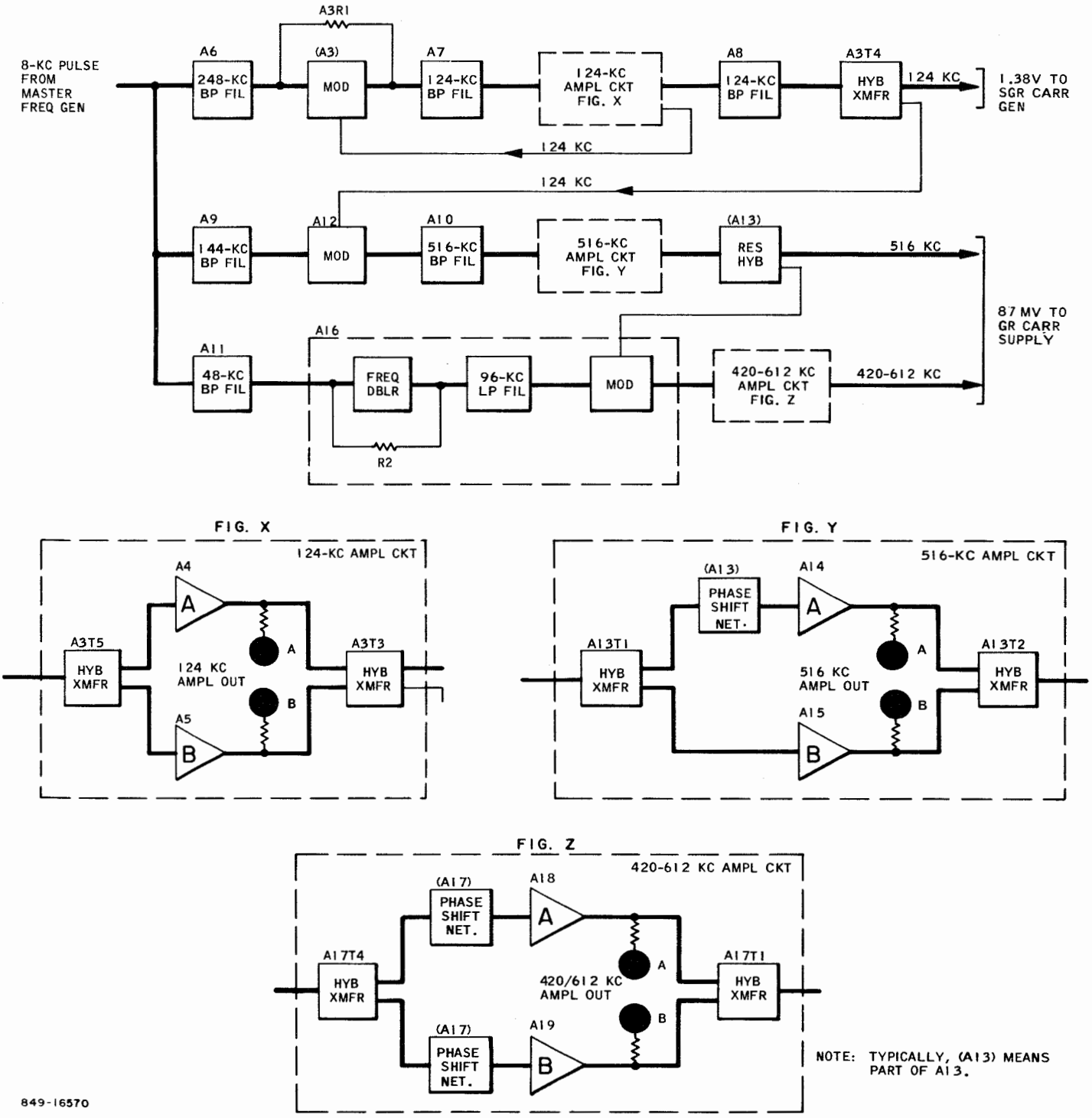


Figure 4-29. Group Carrier Generator Shelf

4-221. 420-612KC GENERATOR CIRCUIT. The 6th harmonic of the 8-kc pulse is selected by 48-kc bandpass filter A11. In module A16, the 48-kc signal splits into two paths, one through resistor R2 and the other through a frequency doubler. The paths recombine so that both 48 kc and 96 kc are applied to one input of a modulator that has 516 kc at its other input.

4-222. The desired products of the modulator are the sum and difference of 516 and 48 kc, and the sum and difference of 516 and 96 kc. These four frequencies (420, 468, 564, and 612 kc) as well as other unwanted modulation products are amplified and sent out to the group carrier supply shelf.

4-223. AMPLIFIER CIRCUITS. In the 124-kc amplifier circuit, the 36-db A and B amplifiers (A4 and A5) are paralleled by means of hybrid transformers A3T5 and A3T3. Because phase-shift networks are not used, the amplifier output signals are 180 degrees out of phase and the combined level is 6 db higher than the level of the A and B signal alone. However, the circuits that utilize the 124-kc frequency can tolerate the 6-db level change that will occur if one amplifier fails. Transformer A3T3 has a hybrid connection in its secondary winding (as well as its primary) that provides two equal 124-kc output signals.

4-224. The 516-kc amplifier circuit uses two 38-db amplifiers (A14 and A15) and a single-frequency paralleling network. The 420-612 kc circuit also uses two of the same type amplifiers (A18 and A19) but the paralleling network is the multiple-frequency type. Paralleling of amplifiers is described in paragraph 4-326.

4-225. ALARM CIRCUITS. The shelf has two alarm control modules: A1 monitors the three A amplifiers and A2 monitors the three B amplifiers. The shelf alarm circuits are the same as described in paragraph 4-283.

4-226. GROUP CARRIER SUPPLY SHELF. (See figure 4-30.)

4-227. In the group carrier supply shelf (pn 790-02199-01), the two signals (516 kc and 420-612 kc) received from the group carrier generator shelf are filtered and amplified to yield the five group carriers and the supergroup 1 carrier (564 or 612 kc).

4-228. GROUP CARRIERS. Bandpass filter A23 admits the 516-kc input signal, and bandpass filters A24 through A27 select the other four group carrier frequencies from the 420-612 kc input signal. Each carrier goes through an amplifier circuit that includes two 36-db amplifier modules operating in parallel by means of a single-frequency network as described in paragraph 4-334. The amplifier circuit has three outputs.

4-229. The main output of the amplifier circuit is a 0.78-volt carrier signal which is distributed to a maximum of 10 group multiplexer and/or demultiplexer shelves. The carrier input impedance of each shelf is 150 ohms. Therefore, 10 shelves connected to the distribution circuit yield a load impedance of 15 ohms, which matches the source impedance. To maintain the 0.78-volt level in the distribution circuit, dummy load resistors can be strapped in various combinations to compensate for different loads. The carrier input power to one shelf is +6 dbm, so that the total carrier power in the main output is +16 dbm, consumed either in the shelves or in the dummy load.

4-230. From voltage dividers, the second output circuit obtains an 87-millivolt signal to drive the group carrier amplifier shelf (when required), and the third circuit connects an 8-millivolt signal through the receptacle on the front panel to the 75-ohm impedance of the transmission test set.

4-231. SUPERGROUP 1 CARRIER. The source of the supergroup 1 carrier is the

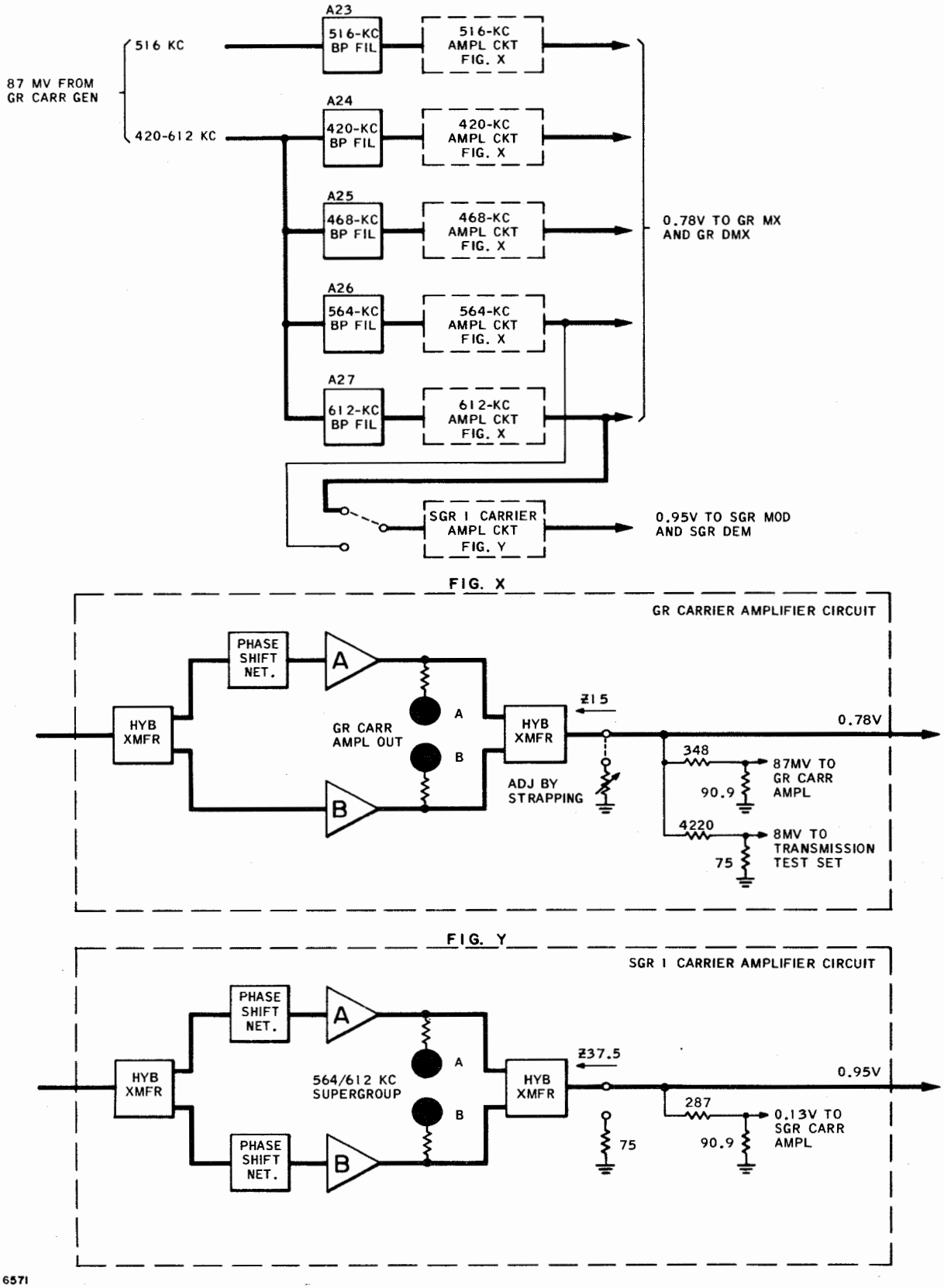


Figure 4-30. Group Carrier Supply Shelf

0.78-volt output of the 564-kc or 612-kc amplifier circuit. By strapping, the applicable frequency is connected to the input of the supergroup 1 carrier amplifier circuit. This circuit consists of a multiple-frequency paralleling network (paragraph 4-329) and two 36-db amplifiers, and has two outputs. The main output distributes a 0.95-volt carrier to two supergroup 1 trays (modulator and demodulator); when only one tray is connected to the distribution circuit, a 75-ohm dummy load is strapped in. Through a voltage divider, a second output sends a 0.13 volt signal to the supergroup carrier amplifier shelf, when required.

4-232. ALARM CIRCUITS. The A and B amplifier modules are monitored as described in paragraph 4-283.

4-233. TRANSMISSION TEST SET. Through receptacle J15 on the front panel, the dolly-mounted transmission test set is supplied with 48-volt dc power and system ground connection.

4-234. GROUP CARRIER AMPLIFIER SHELF. (See figure 4-31.)

4-235. GROUP CARRIERS. In the group carrier amplifier shelf (pn 790-04072-01), the five 87-millivolt group carrier frequencies received from the group carrier supply shelf are filtered and amplified to provide five 0.78-volt group carrier distribution circuits to a maximum of 10 group multiplexer and/or demultiplexer shelves. The modules are the same used in the group carrier supply shelf, the only circuit differences being that each group carrier frequency has a separate input and only one output circuit.

4-236. SUPERGROUP 1 CARRIER. The supergroup 1 carrier of 564 kc or 612 kc is processed exactly as in the group carrier supply shelf.

4-237. ALARM CIRCUITS. The alarm circuits are the same as in the group carrier supply shelf.

4-238. TRANSMISSION TEST SET. The receptacle on the front panel of the group carrier supply shelf through which the dolly-mounted transmission test set obtains group carriers and dc power is not duplicated on this shelf.

4-239. SUPERGROUP CARRIER GENERATOR SHELF. (See figure 4-32.)

4-240. The 124-kc signal from the group carrier generator shelf is admitted to the supergroup carrier generator shelf (pn 790-02881-01) by crystal bandpass filter A18, which provides at least 50 db rejection to signals 250 cps or more removed from 124 kc. In phase-changing network A1, the signal splits into separate paths to the A and B amplifier circuits, and the relative phase of the two signals is shifted 120 degrees.

4-241. In pulse forming network A4, the A and B signals are combined and a sharp 124-kc pulse is generated. From the pulse, bandpass filters select the 9th through 23rd odd-harmonics as the carrier frequencies for supergroups 3 through 10. The output level of each carrier is 78 millivolts across 75 ohms (-11 dbm).

4-242. AMPLIFIER CIRCUIT. Each amplifier circuit includes an amplifier module, an alarm control module, and an alarm relay. The amplifier module's second stage has a push-pull configuration generating a square-wave signal with a peak-to-peak amplitude of about 8 volts. The output signal passes through contacts of the alarm relay so that a failed amplifier will be disconnected from the load.

4-243. The alarm control module monitors the input as well as the output of the amplifier's second stage. Through a 124-kc bandpass filter, a sample of the output is rectified and turns on transistor switch Q2 to energize the alarm relay. The input is

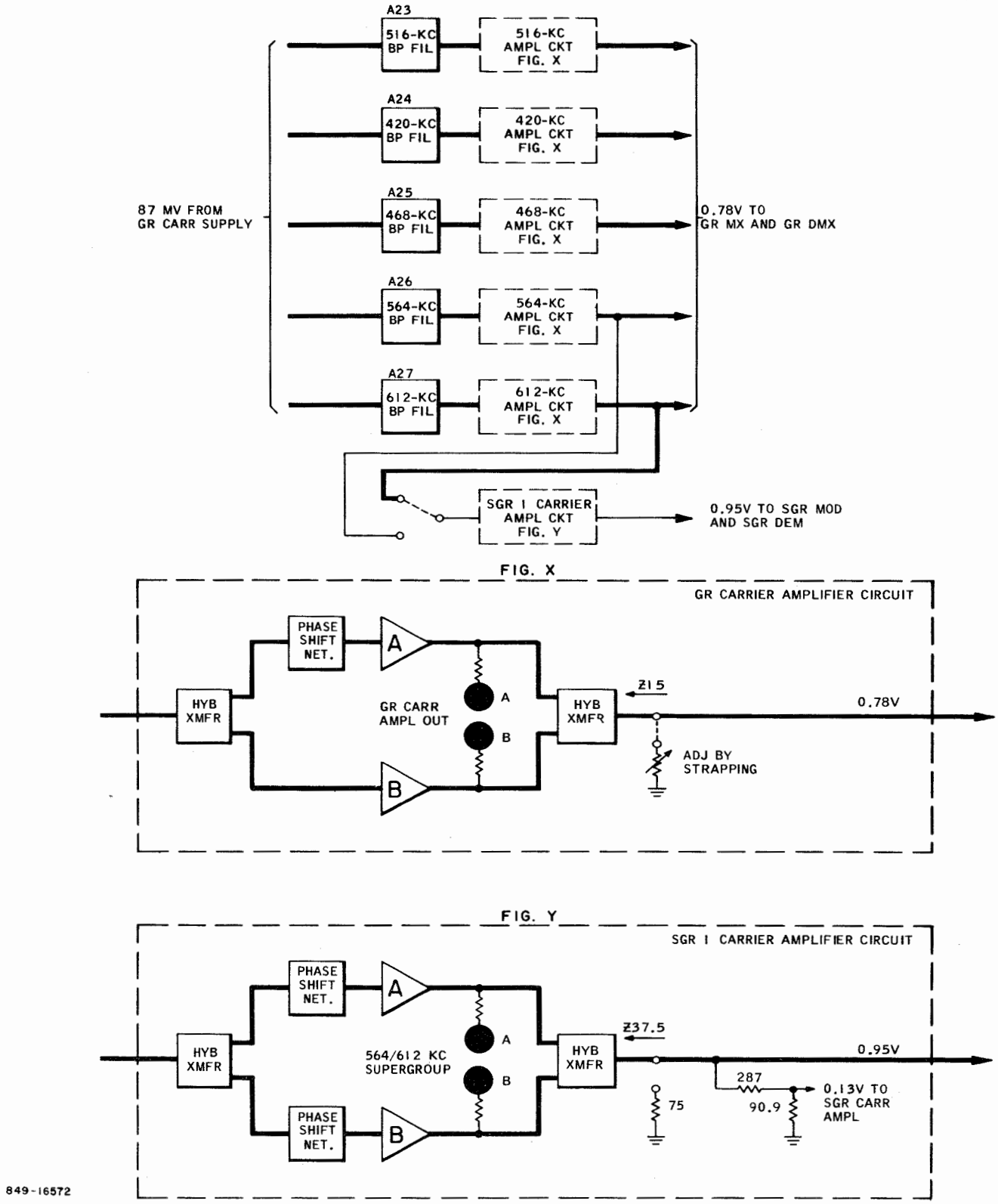


Figure 4-31. Group Carrier Amplifier Shelf

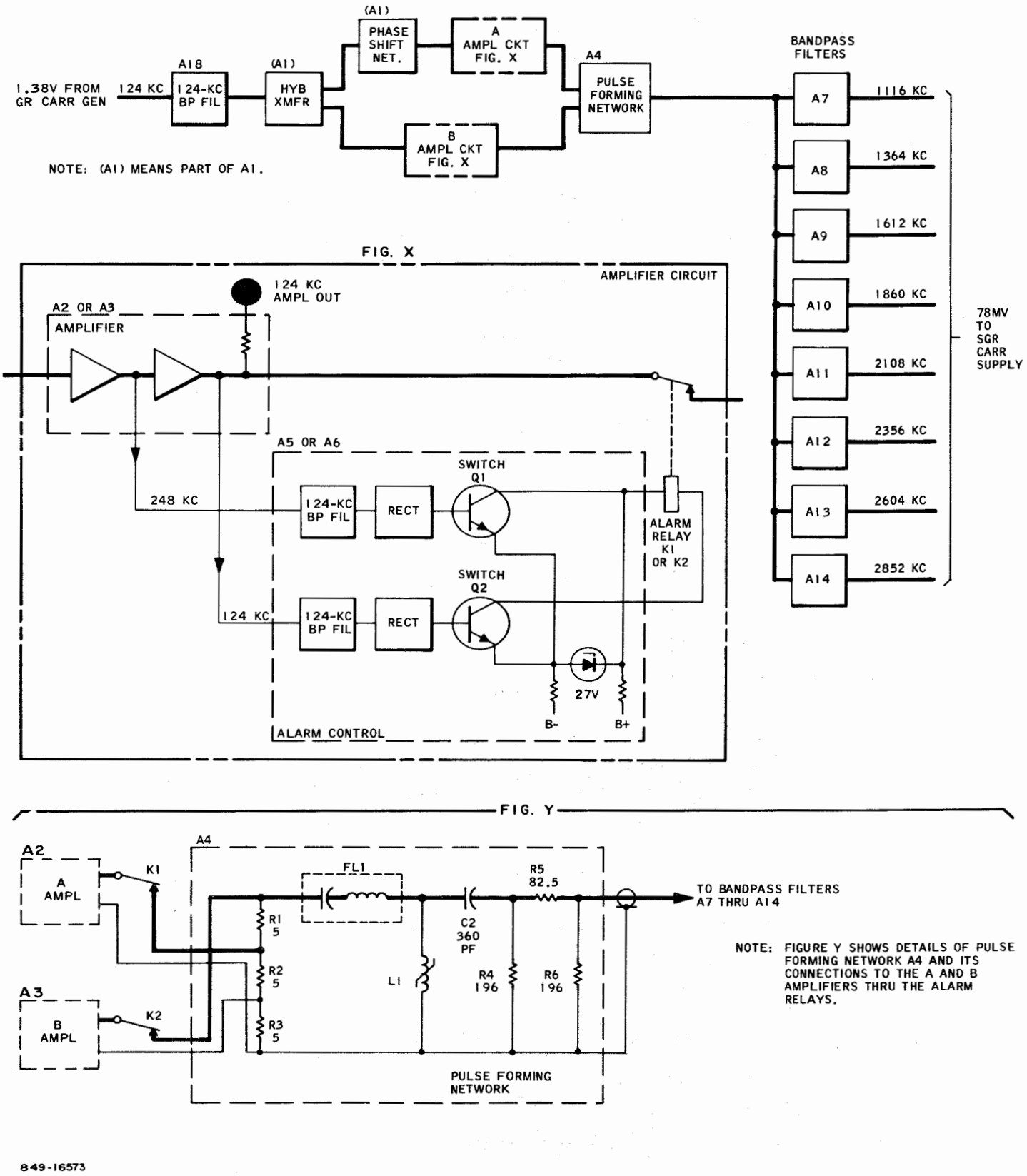


Figure 4-32. Supergroup Carrier Generator Shelf

monitored to detect possible failure of one of the two transistors in the push-pull circuit. At the monitored point, the frequency is normally 248 kc (twice the signal frequency), but drops to 124 kc if one transistor fails. This frequency is admitted through a 124-kc bandpass filter, and the rectified signal turns on transistor Q1. Through Q1, the alarm relay coil is shorted and the relay releases.

4-244. PULSE FORMING NETWORK. The A and B signals are combined in a hybrid circuit consisting of three 5-ohm resistors. Because the signals differ in phase by 120 degrees, their combined amplitude is the same as either signal alone; therefore, the level won't change if one amplifier should fail.

4-245. The square-wave voltage causes sinusoidal current to flow through 124-kc resonant circuit FL1 into saturable reactor L1 and capacitor C2. The reactor is driven into saturation by the sinusoidal current during most of each half-cycle. When the core is not saturated, current flows into capacitor C2. When the core saturates, L1 switches to low inductance, suddenly discharging C2 and creating a sharp pulse with large amplitude. On the next half-cycle, a similar pulse of opposite polarity is generated.

4-246. The shape of the output pulse, determined by the parameters of L1 and C2, is such that odd-harmonics of 124 kc between the 9th and 23rd all have about the same amplitude, which is at least 25 db higher than the even-harmonics in the same spectrum. Resistors R4, R5, and R6 form a 10-db pad that isolates the pulse generator from the succeeding bandpass filters.

4-247. SUPERGROUP CARRIER SUPPLY SHELF. (See figure 4-33.)

4-248. The supergroup carrier supply shelf (pn 790-02880-01) has eight independent amplifier circuits, one for each of the carrier frequencies for supergroups 3 through 10. Each amplifier circuit receives a 78-millivolt input signal from the supergroup carrier generator shelf and produces 0.95-volt and 0.23-volt output signals. The 0.95-volt signal feeds a 37.5-ohm load consisting of two supergroup trays (modulator and demodulator); a 75-ohm dummy load is strapped across the output when the signal is distributed to only one tray. The 0.23-volt signal is used to drive the supergroup carrier amplifier shelf, when required.

4-249. AMPLIFIER CIRCUIT. Each amplifier circuit has two 33-db amplifier modules, a single-frequency paralleling network (paragraph 4-334), and an alarm relay. All the amplifier modules are the same type, but the paralleling networks are different for each carrier frequency.

4-250. The amplifier module includes a monitor circuit in which a sample of the output signal operates a transistor switch controlling the alarm relay. The relay is energized when the amplifier output level is at least +10 dbm, but releases if the level falls below +8 dbm.

4-251. ALARM CIRCUIT. A chain circuit through the normally-closed contacts of the alarm relays for the A amplifiers energizes relay K17; a similar circuit for the B amplifiers energizes relay K18. These two relays, in turn, control the minor and major alarm circuits of the shelf as illustrated in figure 4-37.

4-252. SUPERGROUP CARRIER AMPLIFIER SHELF. (See figure 4-34.)

4-253. The supergroup carrier amplifier shelf (pn 790-04971-01) is divided into two identical functional sections, each comprised of three amplifier circuits. The amplifier circuits can be operated independently of each other, or one input signal can be fed to two or three amplifier circuits in the same section.

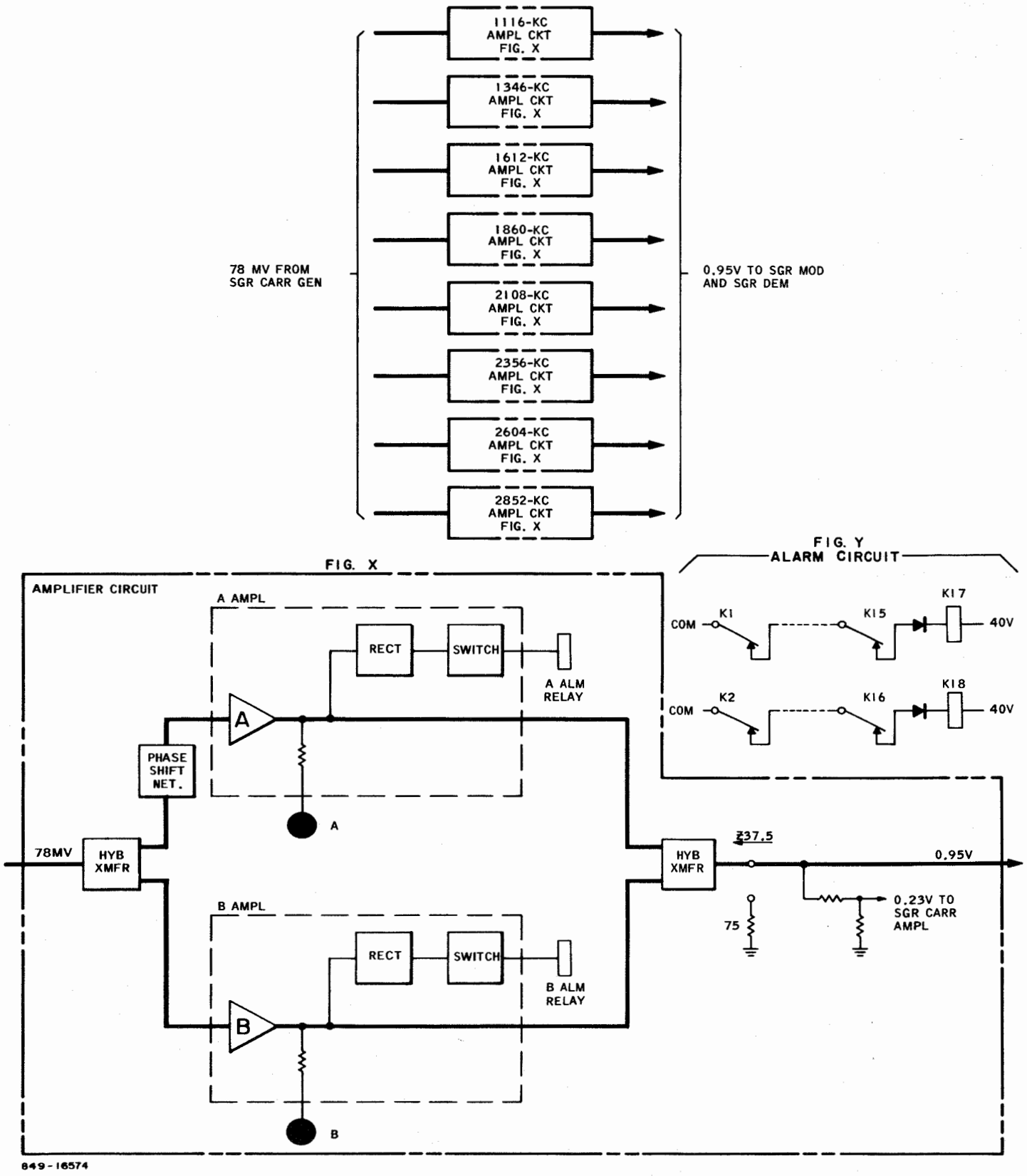


Figure 4-33. Supergroup Carrier Supply Shelf

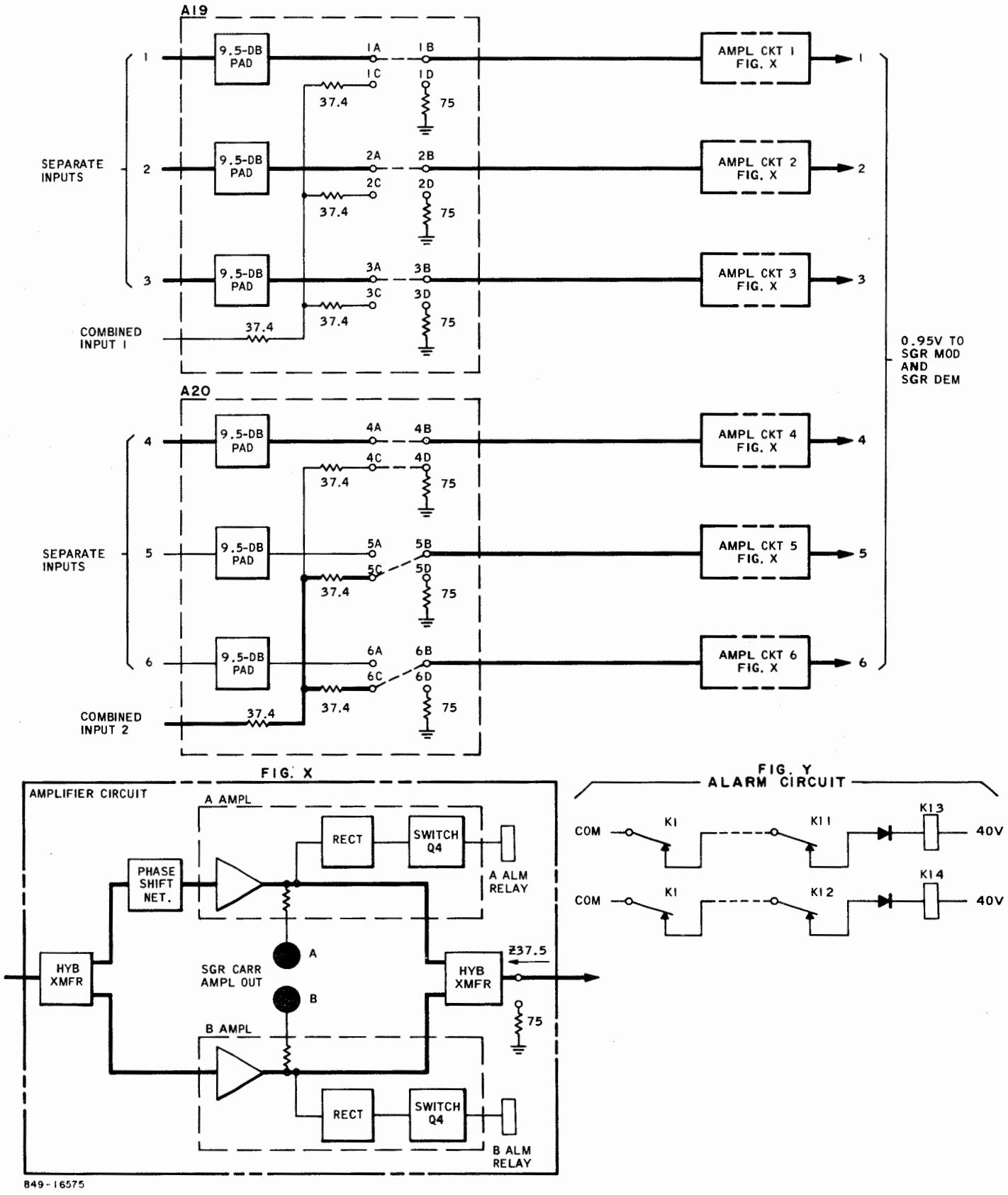


Figure 4-34. Supergroup Carrier Amplifier Shelf

4-254. The supergroup 1 carrier frequency is obtained at a level of -6.5 dbm (0.13 volt into 75 ohms) from the group carrier supply shelf or the group carrier amplifier shelf. The other carrier frequencies come from the supergroup carrier supply shelf and their level is -1.5 dbm (0.23 volt into 75 ohms). Each of the six independent output circuits supplies a supergroup carrier at 0.95 volt to a supergroup modulator tray and a supergroup demodulator tray.

4-255. INPUT CIRCUITS. By strapping the applicable A, B, C, and D terminals on subassemblies A19 and A20, the amplifier circuits are set up to operate from separate inputs or combined inputs. Each separate input circuit enters through a 9.5-db pad and the circuit is completed by strapping terminal A to B. The combined input circuit enters through a 37.4-ohm resistor; strapping terminal B to C sends the signal through another 37.4-ohm resistor to one of the three amplifier circuits. To maintain the same input impedance (75 ohms) and signal levels on the combined input circuit for different configurations, a 75-ohm dummy load resistor is substituted (by strapping terminal C to D) for any of the three amplifier circuits that is operating from a separate input or is not being used. The loss in the resistor network used with the combined input circuit is 9.5 db, the same as in the pad used with the separate input circuits.

4-256. In figure 4-34, the typical strapping shows amplifier circuits 1, 2, 3 and 4 operating from separate inputs and circuits 5 and 6 being driven by the same input signal.

4-257. AMPLIFIER CIRCUIT. Each amplifier circuit consists of five plug-in components as follows: two amplifier modules, a paralleling network (paragraph 4-334), and two relays. There are two types of amplifier modules: the first type has 36 db gain and is used only for the supergroup 1 carrier; the second type has 33 db gain and is used for any of the other supergroup carriers. The paralleling networks are the single-frequency type, and each is usable only with one particular supergroup carrier.

NOTE

Part number 790-04971-01 and type designation OA-7320/UCC-4(V) identify the supergroup carrier amplifier shelf without plug-in components.

4-258. In the amplifier module, a monitor circuit samples the output signal, rectifies it, and through transistor switch Q4, energizes an alarm relay. A drop of about 10 db in the signal level releases the relay.

4-259. The output signal level is 0.95 volt into a 37.5 ohm load. When only one supergroup tray is connected to the distribution circuit, a 75-ohm dummy load is strapped across the output.

4-260. ALARM CIRCUIT. A chain circuit through the normally-closed contacts of the alarm relays for the A amplifiers energizes relay K13; a similar circuit for the B amplifiers energizes relay K14. These two relays, in turn, control the minor and major alarm circuits of the shelf. (See figure 4-37.)

4-261. By strapping, the chain circuit is routed around the alarm relay contacts for any amplifier module that is unequipped or not in operation.

4-262. ALARM SYSTEM.

4-263. Trouble in the multiplexer set is indicated by the office alarms, by a lighted red lamp on the master alarm panel, and by a lighted red lamp on each equipment that is in an alarm condition. If the nature of the trouble means that service may be interrupted

on one or more 12-channel groups, the alarm is major; otherwise, it is minor.

4-264. A failure in one equipment may interrupt a signal that is monitored or processed elsewhere in the multiplexer set and thus produce alarm conditions in equipment that has not actually failed. For example, an interruption of the hf signal in one direction between two terminals in a system will produce a major alarm condition at the receiving terminal in each supergroup demodulator tray as well as in each group pilot alarm shelf; if the receiving terminal is a slave, a major alarm in the master frequency generator shelf will also result because of loss of synchronization in both the A and B trays.

4-265. Alarm conditions in the equipment are relayed to the master alarm panel over the minor alarm bus or the major alarm bus. Figure 4-35 shows the types of equipment that might be connected to the alarm buses. On each equipment that has an alarm function, cutoff switches are provided so that an alarm condition can be isolated from the applicable alarm bus.

4-266. MASTER ALARM PANEL. (See figure 4-36.)

4-267. POWER. Power for operation of the alarm circuits in the multiplexer set is usually derived from primary 120-volt ac power by a step-down transformer in the master alarm panel (pn 790-02506-01). The output of the transformer is nominally 40 volts, but the measured value may be between 30 and 45 volts, depending on the load. The two sides of the power distribution circuit are designated as 40V and COM (40 volts and common); neither side is grounded in the multiplexer set.

4-268. For some installations of the multiplexer set, a 48-volt office battery

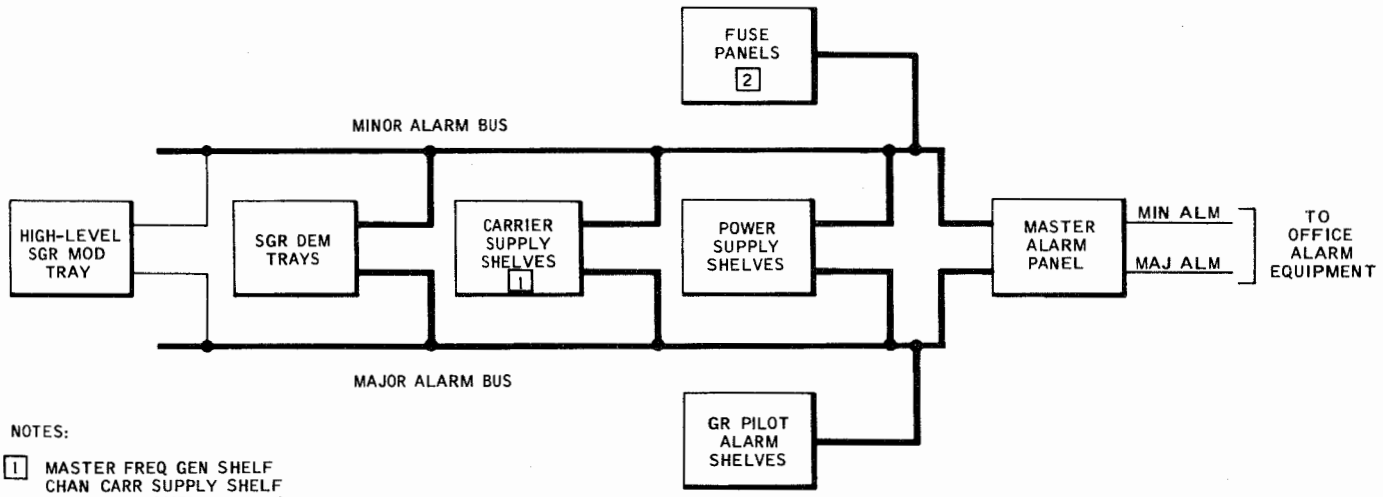


Figure 4-35. Alarm System

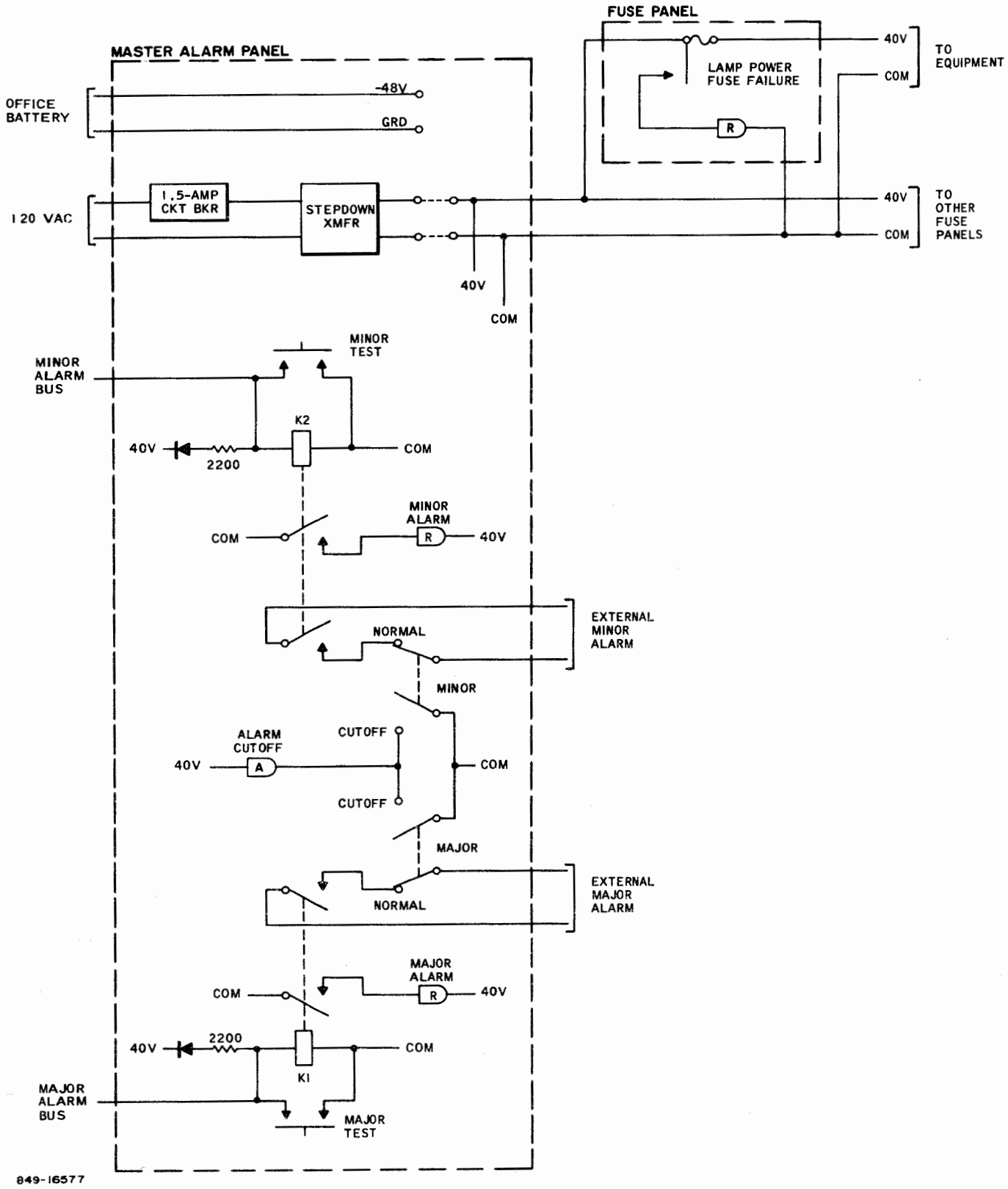


Figure 4-36. Master Alarm Panel

may be used as the source of alarm circuit power. By strapping terminals on the master alarm panel, negative battery can be connected to the 40V side of the alarm circuit power distribution circuit and positive ground to the COM side.

4-269. To enable operation from either ac or dc, each relay in the multiplexer set that is energized by alarm circuit power has a half-wave rectifier (a series diode and a shunt capacitor) connected to its winding.

4-270. ALARMS. When a shelf, panel, or tray of the multiplexer set goes into an alarm condition, it connects the COM side of the alarm circuit power to the applicable alarm bus. This amounts to a short across the winding of the corresponding alarm relay in the master alarm panel; release of the relay lights an alarm lamp and closes an external circuit to the office alarm equipment.

4-271. For testing, a minor or major alarm condition can be simulated by pressing the applicable pushbutton on the front of the master alarm panel.

4-272. SPECIAL MASTER ALARM PANEL.

4-273. A special master alarm panel (pn 790-03319-01) is used if the multiplexer set operates from 400-cps power. This panel has essentially the same circuits as the standard 60-cps panel (pn 790-02506-01) but includes a full-wave bridge rectifier that produces 40-volt dc alarm circuit power.

4-274. MINOR OR MAJOR ALARM.

4-275. Failures in the multiplex equipment that will directly result in minor or major alarm conditions can be classified as follows:

a. Blown dc power fuse on a fuse panel that is equipped with an alarm relay: minor alarm

b. Loss of a group pilot as monitored in the group pilot alarm shelf: major alarm

c. Interruption of dc power to a channel demultiplexer shelf: major alarm

d. Failure of one circuit device in a redundant pair: minor alarm

e. Failure of both circuit devices in a redundant pair: major alarm

4-276. FUSE PANEL. The fuse panels in the multiplexer set are equipped with alarm-type fuses; when the fuse blows, a colored indicator pops out of the fuseholder and an auxiliary contact on the fuse activates the alarm circuits. If the bown fuse is in the alarm circuit power distribution circuit, a red lamp on the fuse panel lights, but no other indication is given.

4-277. On fuse panels that include an alarm relay, a blown dc power fuse will directly produce a minor alarm. On others, a blown fuse will only light a red lamp on the fuse panel; however, minor alarms will be initiated by the equipment deprived of dc power.

4-278. GROUP PILOT ALARM SHELF. A failure that drastically reduces the multiplex signal level anywhere in the system will be detected by the group pilot alarm shelves at the receiving terminals. An alarm lamp will light for each affected group and a major alarm will be initiated.

4-279. CHANNEL DEMULTIPLEXER SHELF. Because the group pilot is monitored at the input to the channel demultiplexer shelf, failure of dc power to the shelf will disable 12 channels without being detected by the pilot monitor. However, in the group pilot alarm shelf, the alarm circuit of each group receives its dc power from the same source as the associated channel demultiplexer shelf, and failure of this dc power will release

the alarm relay and give a major alarm indication.

4-280. REDUNDANT CIRCUIT DEVICES. Where the failure of a functional circuit device (an amplifier, for example) could interrupt service on more than one 12-channel group, redundancy is provided by operating a pair of the devices, either in parallel or in a main/standby arrangement. For parallel operation, the two devices (designated A and B) share the load and if one fails, the other takes over without any degrading of performance; this type of circuit is used by the high-level supergroup modulator tray, the supergroup demodulator trays, the carrier supply shelves, and the power supply shelf.

NOTE

Some of the carrier supply shelves have several pairs of redundant amplifiers, and a false major alarm indication will be given if the A amplifier of one pair and the B amplifier of another pair in the same shelf should be failed at the same time.

4-281. In the main/standby operation used by the master frequency generator shelf, the standby device of the redundant pair is normally idle but is automatically switched into operation if the main device fails.

4-282. In both types of redundant circuits, each device of the pair is monitored independently. A major alarm is initiated by failure of both devices, and a minor alarm by failure of either one.

4-283. TYPICAL SHELF ALARM CIRCUIT.

4-284. An alarm circuit that is most typical for a shelf or tray in the multiplexer set is shown in figure 4-37. The shelf illustrated has six pairs of redundant amplifiers; one alarm control module monitors the A amplifiers and another monitors the B amplifiers. In the alarm control module, a sample of the amplifier's output signal is rectified and applied to a transistor switch. A series circuit through six switches controls the associated A or B alarm relay. Operating voltage for the relay control circuit is produced by a 27-volt zener diode. Another diode quenches inductive voltages originating in the relay winding.

4-285. Under normal conditions, all transistor switches are turned on and both alarm relays are energized. If the output of an amplifier decreases, at some level determined by the requirements of the particular circuit, the associated transistor switch will turn off and deenergize the alarm relay. Usually, the monitor is only required to detect gross failure of the amplifier.

4-286. Release of the A or B alarm relay lights a minor alarm lamp and closes the common side of the alarm circuit power (COM) to the minor alarm bus; release of both the A and B relays will drop relay K3, closing COM to the major alarm bus.

4-287. AC POWER SYSTEM. (See figure 4-38.)

4-288. Primary ac power (120 volts, single-phase) is furnished to Multiplexer Set AN/FCC-17 on two distribution circuits with 20-ampere capacity. One circuit feeds the master alarm panel and the A trays in the power supply shelves and master frequency generator shelf, and the other feeds the B trays in the same shelves. Branch circuits in the equipment are protected by circuit breakers of the following ratings: master frequency generator tray, 0.5 ampere; master alarm panel, 1.5 amperes; and power supply tray, 2.5 amperes.

4-289. Multiplexer Sets AN/FCC-21 and AN/FCC-22 have ac power distribution circuits similar to AN/FCC-17 but their maximum number of power supply shelves is less.

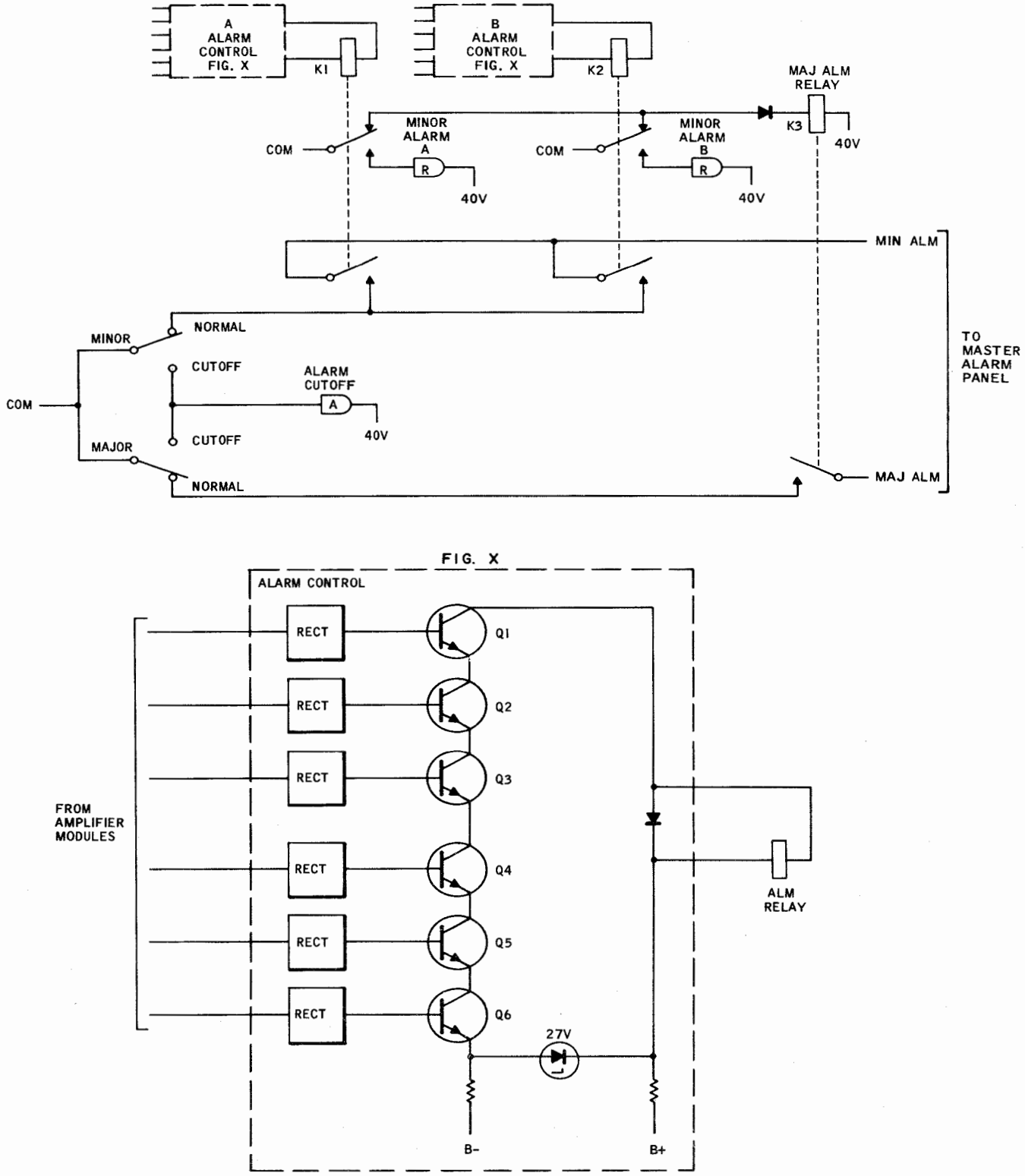


Figure 4-37. Typical Shelf Alarm Circuit

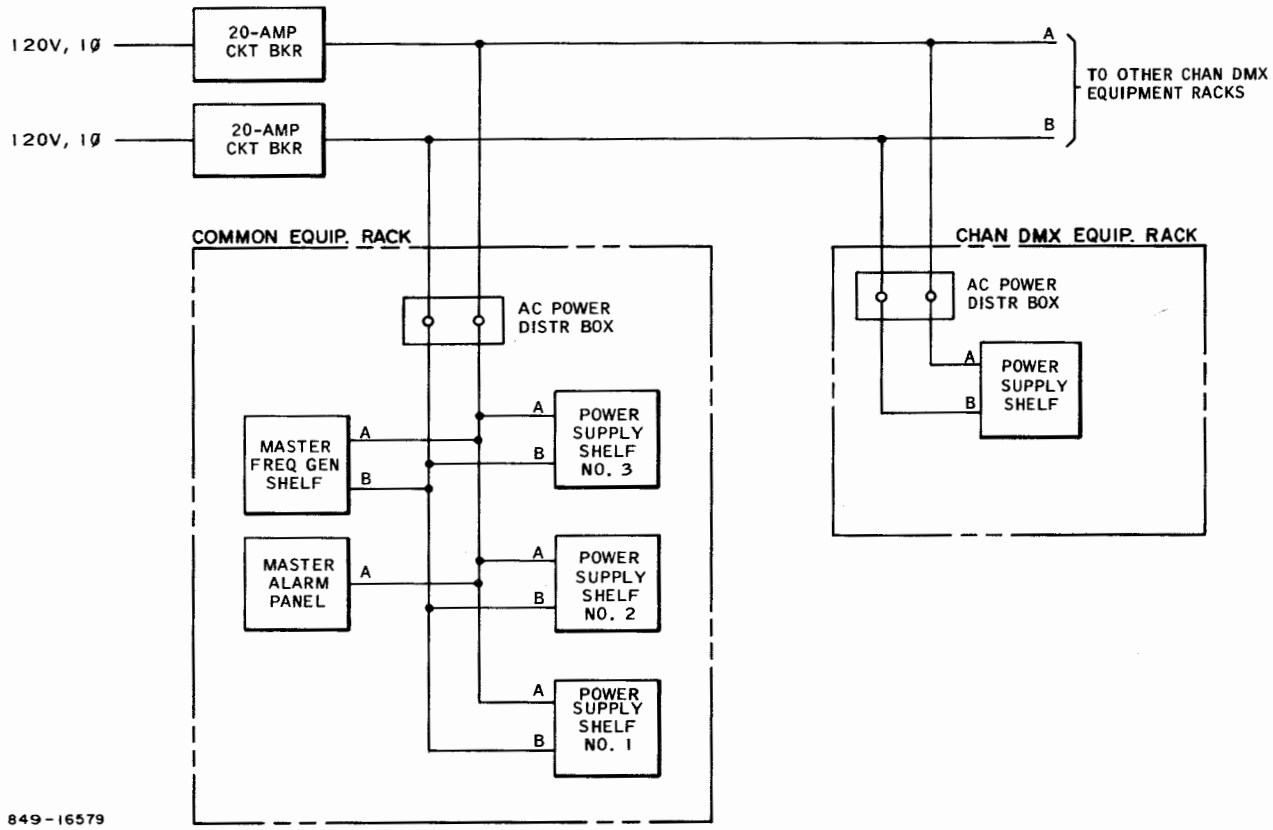


Figure 4-38. AN/FCC-17 AC Power Distribution

4-290. DC POWER SYSTEM.

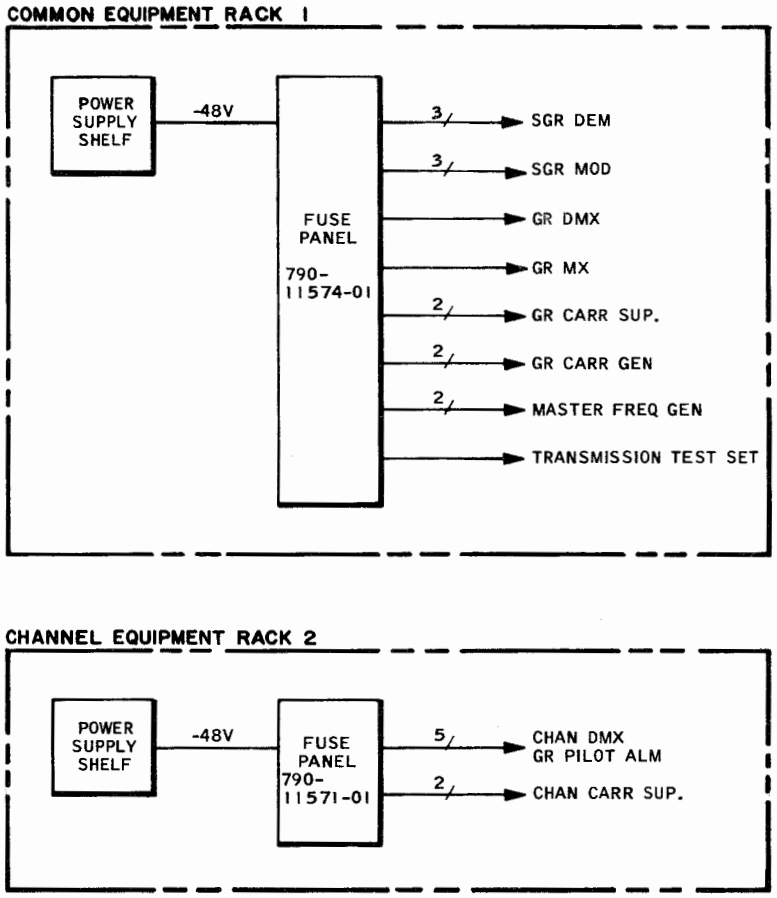
4-291. Normally, dc power (48 volts, positive side grounded) for operation of the multiplexer set is provided by the power supply shelves on the common equipment rack and on each channel or channel demultiplex equipment rack. If dc power is obtained from an office battery instead, the power supply shelves are omitted, but the same distribution circuits are utilized.

4-292. POWER DISTRIBUTION.

4-293. For the three multiplexer sets, figures 4-39, 4-40, and 4-41 are block diagrams showing the power supply shelves and fuse panels and the maximum number of 48-volt distribution circuits emanating from the fuse panels. (Some of these fuse panels also distribute alarm circuit power obtained from the master alarm panel.) In figure 4-42, a typical section of the power distribution network reveals some details of how -48 volts and ground are routed through the multiplexer set and how the leads are designated on the circuit diagrams.

4-294. DC POWER. The negative side of the 48-volt dc power is designated -48V. As the distribution circuits fan out, other symbols may be added to the designation to distinguish one circuit from another; as an example, -48V/A and 48V/B identify the circuits supplying dc power to the A and B modules of a shelf.

4-295. The main distribution circuits for -48 volts are protected by alarm-type fuses in the fuse panels. Where the failure of a fuse could disable more than one 12-channel group, two fuses are paralleled. Within each equipment (shelf or tray), branch circuits to



NOTE: TYPICALLY, THE SYMBOL 3/ MEANS THAT THE SINGLE LINE REPRESENTS 3 INDIVIDUAL CIRCUITS.

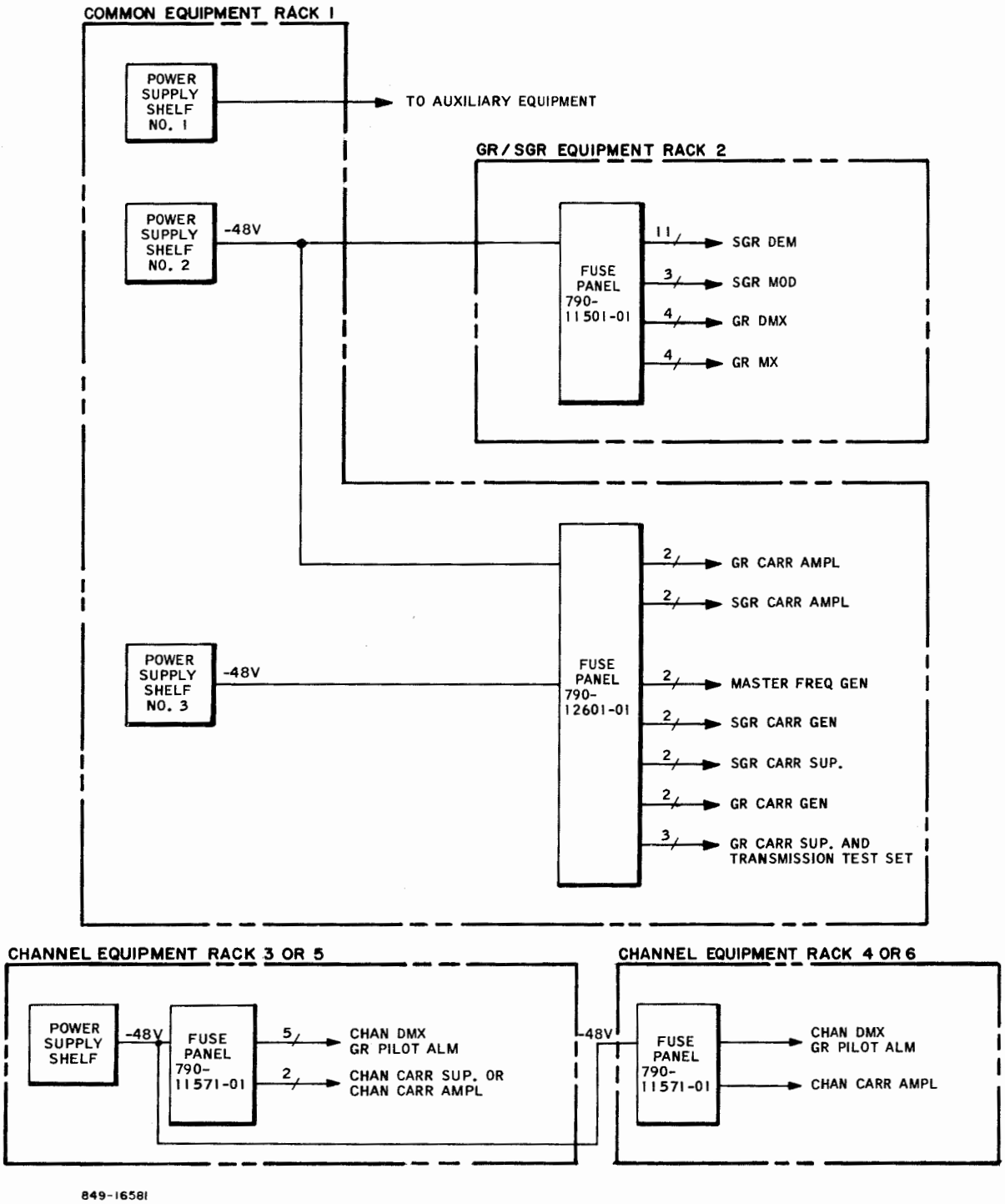
Figure 4-39. AN/FCC-21 DC Power Distribution

individual modules often include nonindicating glass cartridge fuses beneath the chassis.

4-296. The positive side of the 48-volt dc power is designated GRD. Although there is no connection to ground within the power supply shelves, each GRD distribution circuit to an equipment utilizing 48-volt dc power is connected to the grounded chassis of the equipment.

4-297. Within the equipment modules, the -48V and GRD leads become B- and B+, respectively. Frequently there will be a decoupling network at this point in the circuit. To avoid ground loops, the B+ lead is not connected to the module's metal enclosure, which becomes grounded by contact with the main chassis through the mounting screws.

4-298. RACK GROUND. From the office ground, a heavy conductor (6 AWG) is run to each equipment rack in the multiplexer set; the conductor is terminated at a solderless connector on a small steel plate attached to the structural channel at the top of the rack. The plate is then wired to a perforated, tinned copper bus at the rear of the terminal board panels. Individual circuits requiring connection to ground are jumpered from the terminal boards to the



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NOTE: TYPICALLY, THE SYMBOL 3 MEANS THAT THE SINGLE LINE REPRESENTS 3 INDIVIDUAL CIRCUITS.

Figure 4-40. AN/FCC-22 DC Power Distribution

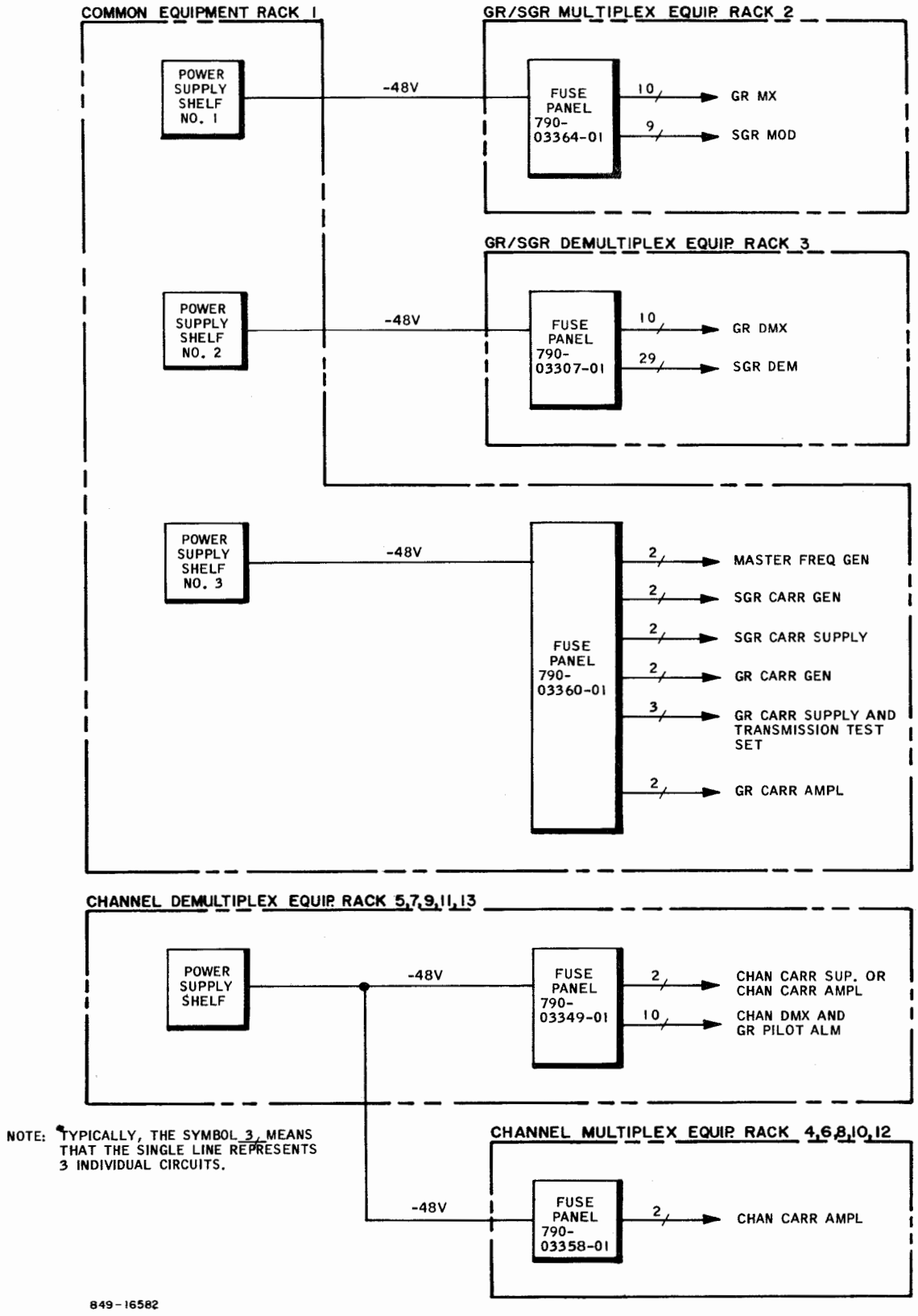


Figure 4-41. AN/FCC-17 DC Power Distribution

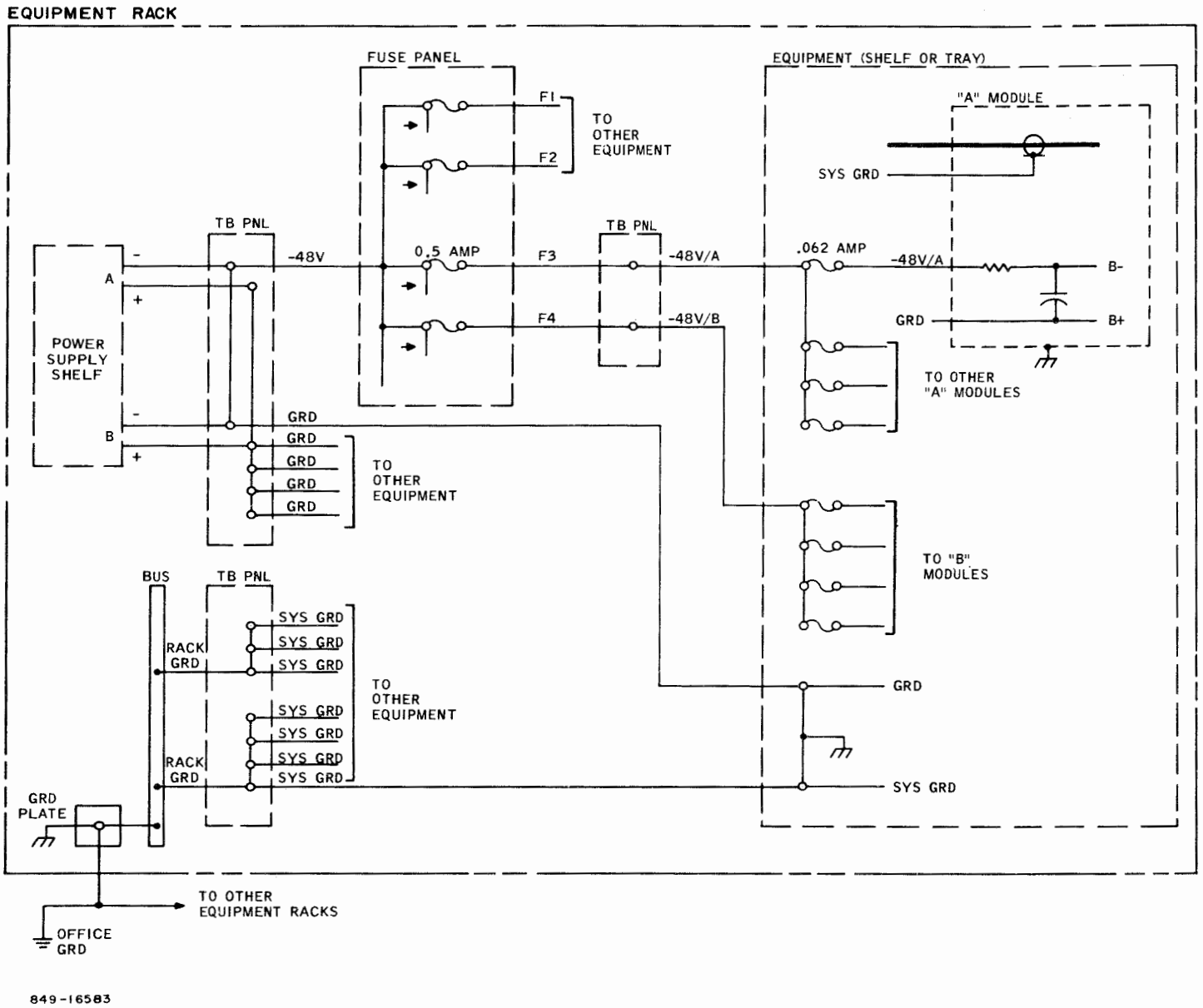


Figure 4-42. Typical Section of 48-Volt DC Power Distribution

bus; at this point the circuit is designated as RACK GRD.

4-299. SYSTEM GROUND. Grounding of signal circuits in the multiplexer set is done by a lead designated as SYS GRD (system ground, or circuit ground). One or more SYS GRD leads are run from one of the terminal board panels at the top of the rack to each equipment (shelf, tray, or panel) in which signal voltages are processed. At the terminal board panel, the SYS GRD leads are connected to the rack ground bus, and in each equipment they are connected to the chassis and to signal circuits requiring ground.

4-300. POWER SUPPLY SHELF. (See figure 4-43.)

4-301. The power supply shelf (pn 790-07975-01) consists of two identical trays,

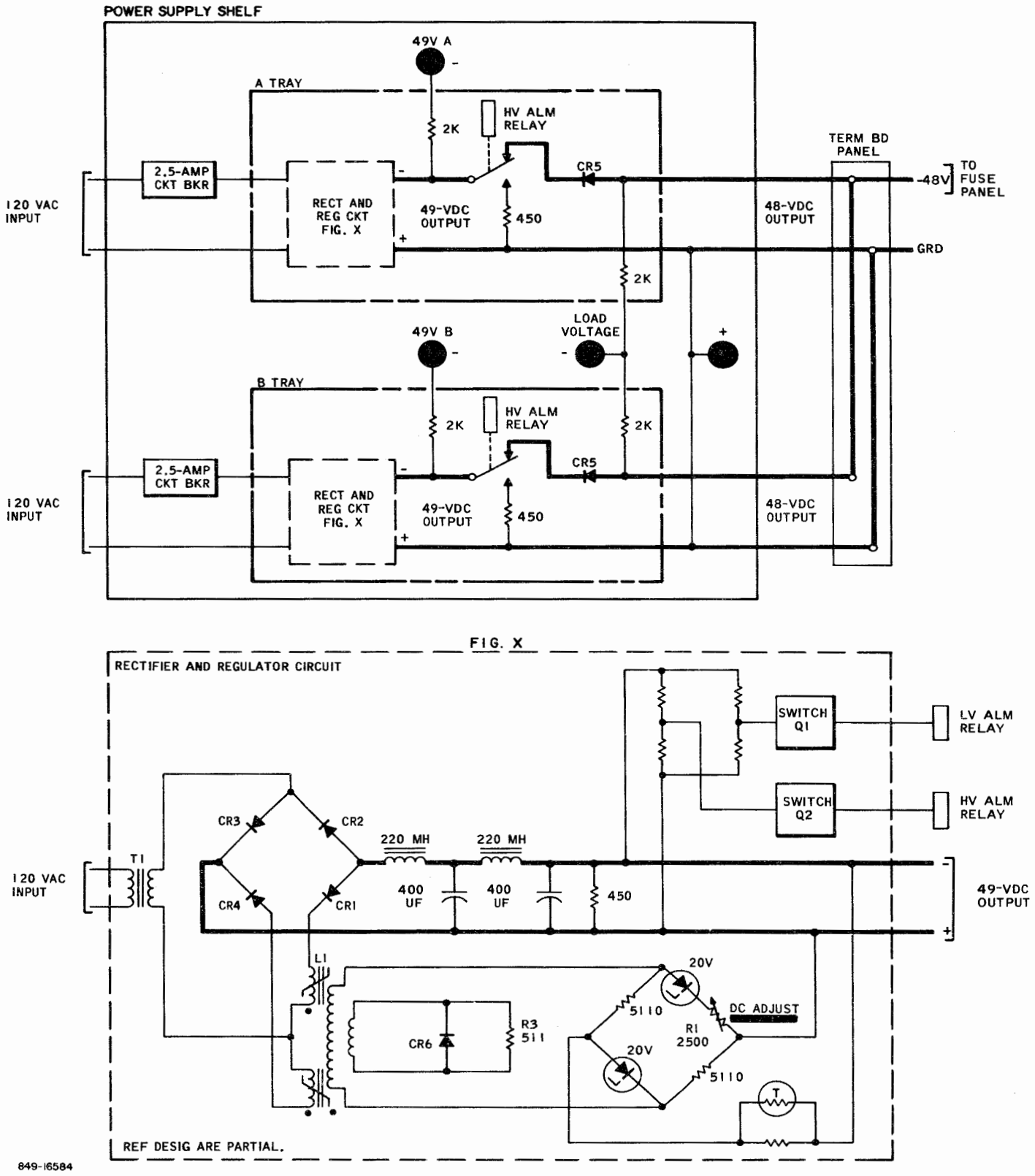


Figure 4-43. Power Supply Shelf

A on the left and B on the right. Each tray converts a 120-volt ac input to a regulated 48-volt dc output. The trays operate independently of each other, but their dc outputs are connected together on the terminal board panel at the top of the rack.

4-302. LOAD. The load on the power supply shelf (2.0 amperes maximum) is shared by the two trays, but if one tray should fail, the other will take over the entire load without degradation of the dc output. Diode CR5 is placed in the minus 48-volt output lead to block reverse current and prevent one tray from loading the other.

4-303. REGULATION. The regulator circuit of the power supply tray maintains the output of the tray at 48 volts ±1.3 volts (46.7 to 49.3) for loads between 0.5 and 2.0 amperes and ac supply voltages between 108 and 132 volts.

4-304. MONITORS. The voltage at the output of the rectifier and regulator circuit (49 volts, normally) is connected to separate low voltage and high voltage monitor circuits, each controlling a normally-energized alarm relay. If the monitored voltage drops below 47 volts, the low voltage alarm relay releases and initiates a minor alarm. (The voltage at the output of the power supply tray is about 1 volt less than the monitored voltage because of the drop across diode CR5.)

4-305. If the monitored voltage exceeds 52.5 volts, the high voltage alarm relay will release; this will not only initiate a minor alarm, but will also disconnect the dc output from the load and terminate it in a 450-ohm resistor. The high voltage alarm relay will also release if the power supply output drops very low, as in a complete failure.

4-306. In alignment of the power supply tray, with a voltmeter connected to the 49V test point, dc output voltage is reduced until the low voltage alarm relay just drops out, and then increased exactly 2.0 volts as indicated on the meter. This method is used instead of adjusting directly to the required voltage (49 volts) because the low voltage alarm circuit is calibrated to release the relay at 47 volts with a tolerance less than ±1%, whereas the meter authorized for use in maintenance (Multimeter AN/PSM-6) has an accuracy of only ±3%.

4-307. RECTIFIER AND REGULATOR CIRCUIT. The primary ac supply voltage is applied through step-down (120 volts to 90 volts) power transformer T1 and through the two load windings of saturable reactor L1 to a full-wave bridge rectifier. The output of the rectifier passes through a two-section filter, at which point it is designated as the 49-vdc output.

4-308. The saturable reactor is constructed on two matched toroidal cores. After a load coil has been wound on each core, the cores are stacked concentrically and a control winding is added. Thereby, the load windings are magnetically coupled to the control windings but not to each other.

4-309. Without any dc current in the control winding, the cores would be held in continuous saturation by the half-wave load currents. But the control winding does have a dc current and it flows in a direction that opposes saturation of the cores by the load currents. Nevertheless, at some time in each half-cycle of load current, the effect of the control current will be overcome and the cores will saturate. Until the core is saturated, the load winding has a very high impedance and practically no voltage is applied to the bridge rectifier; but once the core saturates, almost the full voltage is applied for the remainder of the half-cycle.

4-310. The time during the half-cycle at which saturation occurs ("the firing angle") is determined by the value of control current. Decreasing the control current from the normal operating point means that the

core will be saturated for a greater part of each half-cycle; consequently, the average voltage delivered to the rectifier bridge will be greater, and the dc output voltage will increase. Increasing the control current produces an opposite effect.

4-311. The voltage applied to the control winding is derived from the 49-vdc output through a normally unbalanced bridge that includes two 20-volt zener diodes. An increase or decrease in the dc output voltage will cause corresponding changes in control voltage, but through the bridge, the percentage change will be magnified.

4-312. Changes in the ac supply voltage or the dc load will tend to change the dc output voltage, but by the action of the control current in the saturable reactor as previously described, a compensating increase or decrease in the average voltage fed to the rectifier will occur.

4-313. In alignment of the multiplexer set, the operating point of the saturable reactor, and hence the normal dc output voltage of the power supply tray, is set by the DC ADJUST potentiometer R1. Clockwise adjustment increases the resistance of R1, decreasing the control current and increasing the dc output voltage.

4-314. The gain of the saturable reactor (magnetic amplifier) is established at the desired operating point by the 511-ohm resistor R3 shunting a third winding. Diode CR6 suppresses a tendency for the magnetic amplifier to oscillate at low load currents.

4-315. ALARMS. (See figure 4-44.) The power supply shelf has the usual indicator lamps and alarm cutoff controls, with external connections to the master alarm panel via the minor and major alarm buses. In the alarm circuits within the power supply tray, each pair of normally-open contacts on the low voltage alarm relay is paralleled by a similar pair on the high voltage alarm relay. The relay contacts are also connected in parallel with normally-open contacts of a microswitch on the power supply shelf; if the tray is removed from the shelf, the switch contacts close and maintain an alarm condition for the tray.

4-316. TRANSMISSION TEST SET.

4-317. The transmission test set (Telephone Test Set AN/GCM-2 or AN/FCM-8 is used for alignment, performance testing, and troubleshooting in the carrier supply and transmission equipment of the multiplexer set.

NOTE

Complete coverage of the transmission test set is contained in T.O. 33A1-15-1-142 (TM 11-6625-1779-15, NAVSHIPS 0967-337-7040).

4-318. Basically, the transmission test set consists of a signal generator circuit and a measuring circuit. According to the setting of a six-position FUNCTION switch, the generator circuit can produce either channel test tones or group pilots, and the measuring circuit can be set up for selective response to individual group pilot frequencies or for flat response.

4-319. To check the levels of 1-kc test tones at vf points in the transmission equipment, the flat measuring circuit of the test set is used. The test set is patched to test jacks that are wired directly to the vf signal path. The measuring circuit may be set for high impedance or 600 ohms impedance, according to whether the test jack is bridging or normalled-through.

4-320. Group pilots in the group, supergroup, or line frequency bands are measured with the test set operating in the frequency-selective mode. In the multiplexer

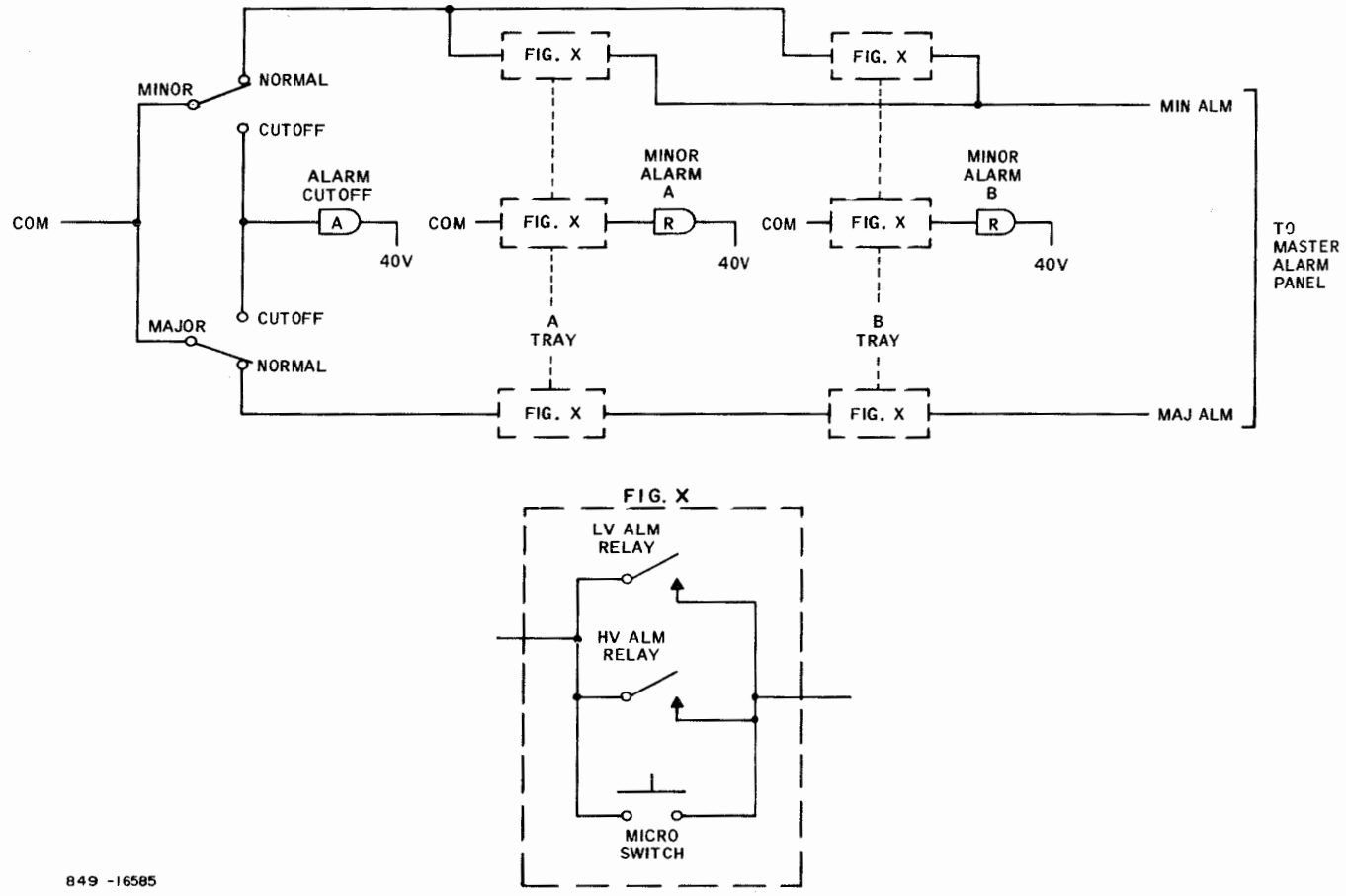


Figure 4-44. Power Supply Shelf Alarm Circuits

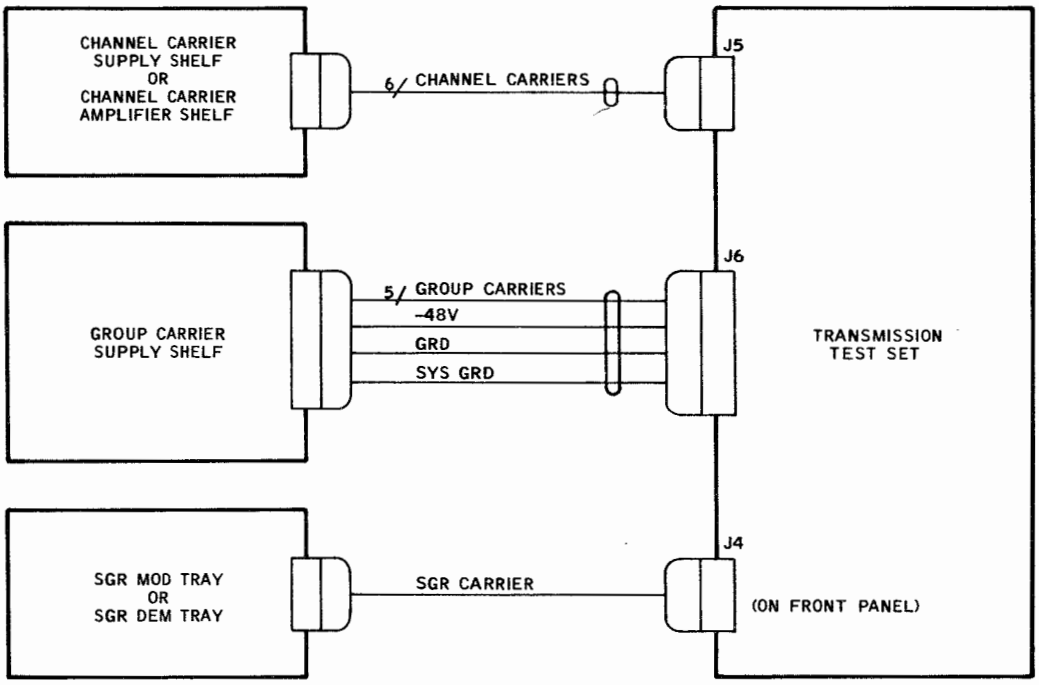
set, the test jacks at which pilots can be measured are wired to the signal path through a fixed pad. The loss in the pad reduces the normal transmission level to yield a pilot level of -76 dbm into the 75-ohm input impedance of the test set.

4-321. In the carrier supply equipment of the multiplexer set, the test jacks are wired to the supply circuits through pads that reduce the normal signal voltage to 0.123 volt at the test jack. For measurement at these jacks, the test set is arranged for flat measurement and has a high (7000 ohms) input impedance.

4-322. On the test set meter, the level of the measured signal is indicated in decibels (db) relative to the normal level, which is represented by a meter reading of 0 db.

4-323. In Multiplexer Sets AN/FCC-22 and -17, the transmission test set is dolly-mounted and receives dc power and carrier supply voltages through cables plugged into receptacles on the front panels of the equipment as shown in figure 4-45. The cable to the group carrier supply shelf is always required (for dc power), but the need for the other two cables depends on the particular function of the test set being utilized.

4-324. In Multiplexer Set AN/FCC-21, the test set is rack-mounted. All necessary supply voltages except supergroup carrier are furnished through two wiring harnesses connected between receptacles J5 and J6 at the back of the test set and the terminal board panels at the top of the rack.



NOTE:

TYPICALLY, THE SYMBOL 6/ MEANS THAT THE SINGLE LINE REPRESENTS 6 INDIVIDUAL CIRCUITS.

849-16586

Figure 4-45. Transmission Test Set

SECTION II
FUNCTIONAL OPERATION OF ELECTRONIC ASSEMBLIES

4-325. For detailed description of the operation of electronic circuits within modules, refer to the applicable technical order listed in table 1-5.

4-326. PARALLELING NETWORKS.

4-327. In the phase-shift method of paralleling two amplifiers, their output signals are combined 120 degrees out of phase. The combined signal has the same power as either signal alone, and a complete failure of one amplifier will not affect system operation.

4-328. In the multiplexer set, the circuit for splitting the input signal, creating the necessary phase shift, and combining the output signals is called a paralleling network. There are two types of paralleling networks: one processes a signal consisting of multiple frequencies, and the other processes only a single frequency. Simplified diagrams of both types are shown in figure 4-46. Throughout the diagrams, angles are given to indicate the relative phase (with respect to 0° at the input) of an illustrative single-frequency signal.

4-329. MULTIPLE-FREQUENCY PARALLELING NETWORK. (See figure 4-46.)

4-330. The input signal is divided into separate paths to the A and B amplifiers by hybrid transformer T1; the B signal is inverted by the transformer while the phase of the A signal is unchanged. Each signal passes through a phase-shift network consisting of an inductor, capacitor, and transformer. The lagging inductor current and the leading capacitor current combine in the center-tapped winding of the transformer with a resultant change from the phase of the applied signal.

4-331. For the frequency used as an example in figure 4-46, the phase shift imparted to the A and B signals is +15° and -45°, respectively. For a lower or higher frequency, the amount of phase shift will be proportionally different, but throughout the frequency band of interest, the relative change produced in the phase of the A and B signals will always be 60°.

4-332. At the primary of transformers T2 and T3, the difference between the A and B signals is 120°. The transformers are wired to the amplifiers so that the A signal is inverted, making the amplifier input signals 60° apart.

4-333. The phase shift in the amplifiers is the same (0° or 180°) and the A and B signals are still 60° apart as they enter hybrid transformer T4. Through the transformer, the B signal is inverted so that the two signals are combined in the secondary winding 120° out of phase. As shown by the vector diagram in figure 4-46, the combined signal has the same amplitude as either signal by itself; consequently, the output level won't change if one amplifier fails.

4-334. SINGLE-FREQUENCY PARALLELING NETWORK. (See figure 4-46.)

4-335. The principle of operation for the single-frequency paralleling network is the same as the multiple-frequency type except only one phase-shift network is needed. At the frequency of interest, the network produces a 120° phase shift in the A signal.

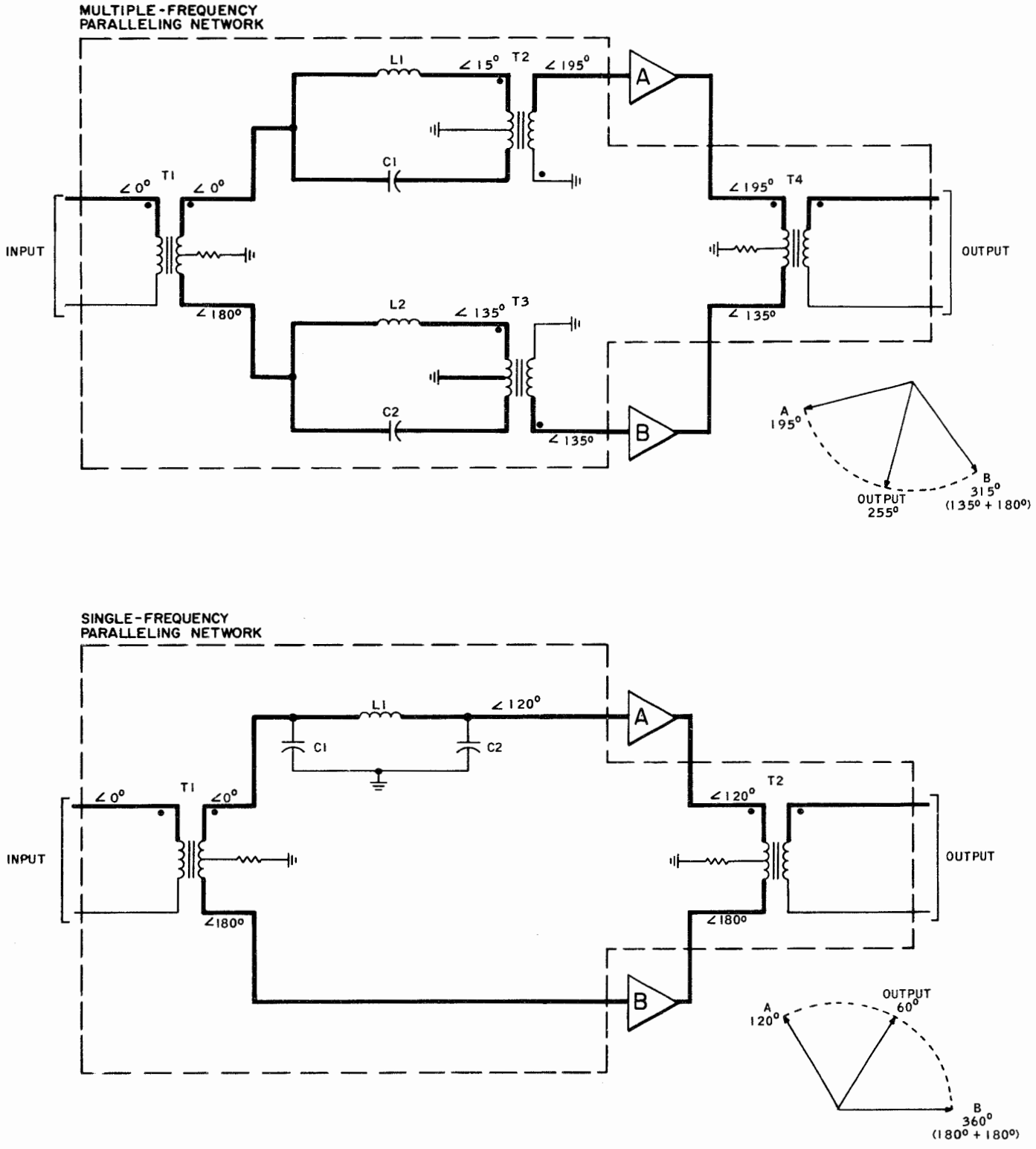


Figure 4-46. Paralleling Networks

SECTION III
FUNCTIONAL OPERATION OF MECHANICAL ASSEMBLIES

NOT APPLICABLE

CHAPTER 5
MAINTENANCE

5-1. INTRODUCTION. Section I of this chapter contains the information you will need for testing, aligning, and repairing the multiplexer set at the organizational/field level. The instructions are based on the understanding that you have had experience and are fully qualified on this equipment. Section II, Special Maintenance, is not applicable: the procedures for bench testing and repair of equipment modules, which would normally be found in Section II, are contained in the technical publications listed in table 1-5.

SECTION I
ORGANIZATIONAL/FIELD MAINTENANCE

5-2. This section provides instructions on a system level and supplements the procedures contained in the Preventive Maintenance Workcard Set T.O. 31W1-2FCC-106WC-1. Wherever possible, circuit testing is arranged so that the system is kept in an operating condition; however, in some tests one or more channels must be taken out of service.

5-3. During the performance of organizational/field maintenance, you may also need to refer to the schematic diagrams and block diagrams in the Circuit Diagrams manual T.O. 31W1-2FCC-103 and to the simplified diagrams in Chapter 4 of this manual.

5-4. Complete alignment of the multiplexer set is covered by the Alignment manual T.O. 31W1-2FCC-109, but equivalent procedures are contained in this manual or in the workcard routines.

5-5. TEST EQUIPMENT AND TOOLS.

5-6. TEST EQUIPMENT AND TOOLS SUPPLIED.

5-7. TEST EQUIPMENT. Most of the tests you will be required to make on the multiplexer set will involve using Telephone Test Set AN/GCM-2 or AN/FCM-8 (transmission test set). The test set includes patch cords and cables needed to interconnect it with the multiplexer set. Complete instructions on operating the test set are in T.O. 33A1-15-1-142 (TM 11-6625-1779-15, NAVSHIPS 0967-337-7040), but applicable instructions are included with the individual test procedures in this manual; also, a placard of abbreviated instructions is on the front of the test set.

5-8. TOOLS. A special alignment tool (pn 790-04206-01) is required for adjusting the frequency of the oscillator in the master

frequency generator tray; one tool is mounted in a clip at the rear of each tray.

5-9. TEST EQUIPMENT AND TOOLS REQUIRED BUT NOT SUPPLIED.

5-10. TEST EQUIPMENT. Table 5-1 lists test equipment that is not supplied with the multiplexer set, but which you will need for organizational/field maintenance. The only item in the table that is called for in any of the routine maintenance procedures is Multimeter AN/PSM-6.

5-11. The electronic counter listed in table 5-1 may be needed if the 128-kc oscillator at a master terminal has to be restored to its precise operating frequency; the ac vtvm, oscilloscope, and noise measuring set are listed because they could be helpful in troubleshooting.

5-12. In table 5-1, the required characteristics of test equipment are usually not the maximum performance capabilities, but only what is needed for checking the multiplexer set. Alternate test equipment that has equivalent characteristics may be substituted.

5-13. CORDS AND PLUGS. Table 5-2 describes cords and plugs that you may need in working on the multiplexer set. Any item not available can be fabricated locally from the description given in the table.

Table 5-1. Test Equipment Required for Organizational/Field Maintenance But Not Supplied

NOTE: Refer to paragraph 5-10 for applications of test equipment.

COMMON NAME	NOMENCLATURE OR MFR IDENTIFICATION	REQUIRED CHARACTERISTICS
Ac vtvm	Vacuum Tube Voltmeter, Hewlett-Packard model 400H	Ac voltage, full scale: 1.0 mv to 100 v Frequency range: 10 cps to 2.5 mc Accuracy (% of full scale): ±2%, 20 cps to 1 mc; ±3% to 2 mc; ±5% to 4 mc Calibration: rms value of sine wave; dbm referenced to 600 ohms Input impedance: 10 megohms shunted by 15 or 25 $\mu\mu$f
Counter	Electronic Counter, Hewlett-Packard model 5532A	Time base accuracy: ±1 part in 10^6 Range: to 1.0 mc

Table 5-1. Test Equipment Required for Organizational/Field Maintenance But Not Supplied (Cont)

COMMON NAME	NOMENCLATURE OR MFR IDENTIFICATION	REQUIRED CHARACTERISTICS
Counter (Cont)		Gate times: 1 and 10 sec Input voltage: 0.5 volt rms minimum
Multimeter	Multimeter AN/PSM-6	Ac voltage, full scale: 0.5 to 250 v Dc voltage, full scale: 0.5 to 100 v Dc current, full scale: 0.5 ma to 2.5 a Resistance, full scale: to 10 megohms Sensitivity: 1,000 Ω/vac; 20,000 Ω/vdc Accuracy: ±4% (ac) and ±3% (dc)
Noise measuring set	Noise Measuring Set, Western Electric type 3A, equipped with type 497A Weighting Network; or Northeast Electronics model TTS-37B	Input impedance: 600 ohms Range: 0 to 90 dbrn Accuracy: ±1 db Weighting: C-message
Oscilloscope	Oscilloscope, Tektronix type 310A	Frequency response: 10 cps to 2.5 mc Transient response: 90 nsec rise time Vertical deflection: 0.05 v/div to 20 v/div Sweep rates: 0.5 μsec/div to 5 msec/div Input impedance: 1 megohm shunted by 40 μμf Calibration accuracy: within 3%

Table 5-2. Cords and Plugs Required But Not Supplied

*MFR IDENTIFICATION	DESCRIPTION	APPLICATION
647A Cord 035-11302-01	Six feet of coaxial cable terminated with: a. Twin banana plug b. Alligator clips	Connecting test equipment to multiplexer set for troubleshooting
651C Cord 035-28741-01	Six feet of coaxial cable terminated with: a. Twin banana plug b. Test prod and alligator clip	
699A Cord 035-25706-01	Six feet of coaxial cable terminated with: a. Twin banana plug b. PJ-051 telephone plug (tip and ring)	
674A Cord 035-20710-01	Six feet of coaxial cable terminated with: a. Twin banana plug b. Coaxial plug (Trimm pn 530-1)	
684D Cord 035-35066-01	Three feet of coaxial cable terminated with twin banana plug on each end	Interconnecting test equipment
633A Cord 135-10621-01	Six feet of shielded two-conductor cable terminated with PJ-051 telephone plug on each end	Patching on group jackfields
Electrical Cord Assembly CX-9443/U (pn 746-00502-02)	Same as 633A Cord	
673A Cord 035-20709-01	Two feet of coaxial cable terminated with coaxial plug (Trimm pn 530-1) on each end	Patching on supergroup jackfields

*Lenkurt Electric Co. unless otherwise specified.

Table 5-2. Cords and Plugs Required But Not Supplied (Cont)

*MFR IDENTIFICATION	DESCRIPTION	APPLICATION
696A Plug 087-24965-01	Twin banana plug terminated with 75-ohm resistor	Terminating ac vtvm
669A Plug 087-16612-01	Twin banana plug terminated with 130-ohm resistor	
670A Plug 087-16613-01	Twin banana plug terminated with 600-ohm resistor	
676C Plug 035-47135-01	Coaxial plug (Trimm pn 530-1) terminated with 75-ohm resistor	Terminating circuits on supergroup jackfields
Terminating Plug 790-07813-01	Same as 676C Plug	
665A Plug 087-16250-01	PJ-051 telephone plug terminated with 130-ohm resistor between tip and ring	Terminating circuits on group jackfields
Terminating Plug 790-07812-01	Same as 665A Plug except resistor is 133 ohms	
666A Plug 035-16251-01	PJ-051 telephone plug terminated with 600-ohm resistor between tip and ring	Terminating circuits on channel jackfields
708A Adapter Plug 087-41114-01	Converts twin banana plug to UG-88/U BNC male connector	Connecting test cords to counter
013-009 Binding Post Adapter (Tektronix)	Converts twin banana plug to uhf male connector	Connecting test cords to oscilloscope

*Lenkurt Electric Co. unless otherwise specified.

5-14. Some of the group and supergroup jackfields include a telephone jack terminated with a 133-ohm resistor and a coaxial jack terminated with a 75-ohm resistor. By patching, these jacks may be used to terminate circuits or test equipment in place of the terminating plugs called out in the procedures. For example, to terminate the TRANSMIT EQUIP jack on the line connector panel, patch it to the 75 ohm RES TERM jack on one of the group jackfields; use a CG-2543/U cord furnished with the transmission test set.

5-15. Two terminating plugs for 135-ohm circuits are listed in table 5-2, but the resistors in these plugs have standard values of 130 and 133 ohms with ±1% tolerance. However, the error in level caused by terminating a 135-ohm circuit in 130 ohms instead of 135 ohms is less than 0.2 db.

5-16. TOOLS. Special tools used in the replacement of contacts in electrical connectors are illustrated in figures 5-1 and 5-2.

5-17. GENERAL MAINTENANCE DATA.

5-18. INSTALLATION AND REMOVAL OF COMPONENTS.

5-19. SHELVES. The equipment shelves are mounted on slide mechanisms (figure 5-3) by means of which they can be extended forward from the rack for maintenance. In the forward position, the shelves can also be tilted up at an 80-degree angle to make the underside of the chassis more accessible. Because of their heaviness, the master frequency generator shelf and the power supply shelf do not have the tilt-up feature in their slide mechanisms.

5-20. The following procedures cover the manipulation of the shelves as normally required in routine maintenance; refer to figure 5-4 for identification of parts of the shelf and slide mechanism.

a. To extend shelf, loosen four knurled-head captive screws and pull forward on handles. For maximum access to shelf or if shelf is to be tilted up, pull fully forward to locked position.

b. To tilt shelf, pull triggers with your forefingers and lift up on handles; release triggers after upward movement has started. When shelf reaches 80-degree angle, triggers will spring back and lock shelf in this position.

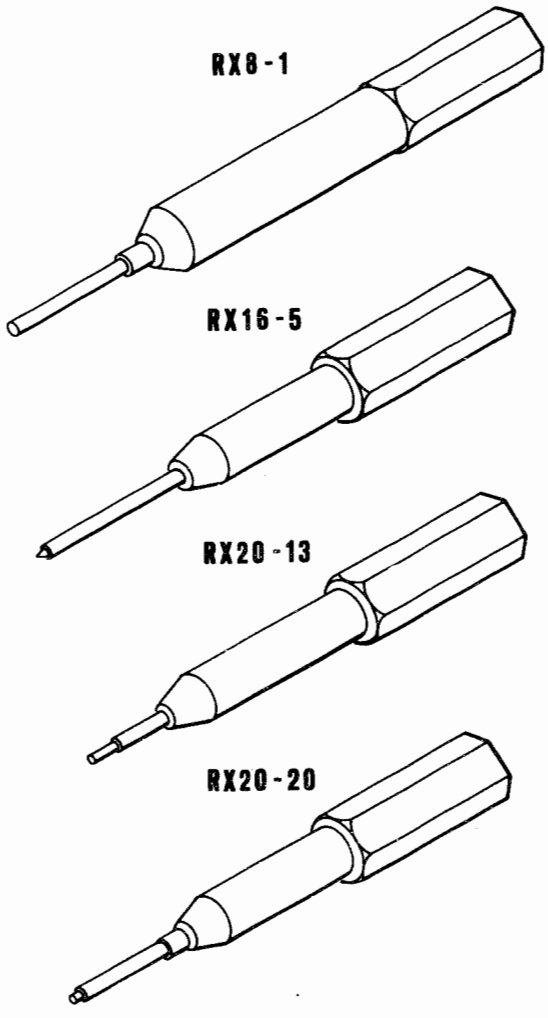


Figure 5-1. Extraction Tools for Replaceable Connector Contacts

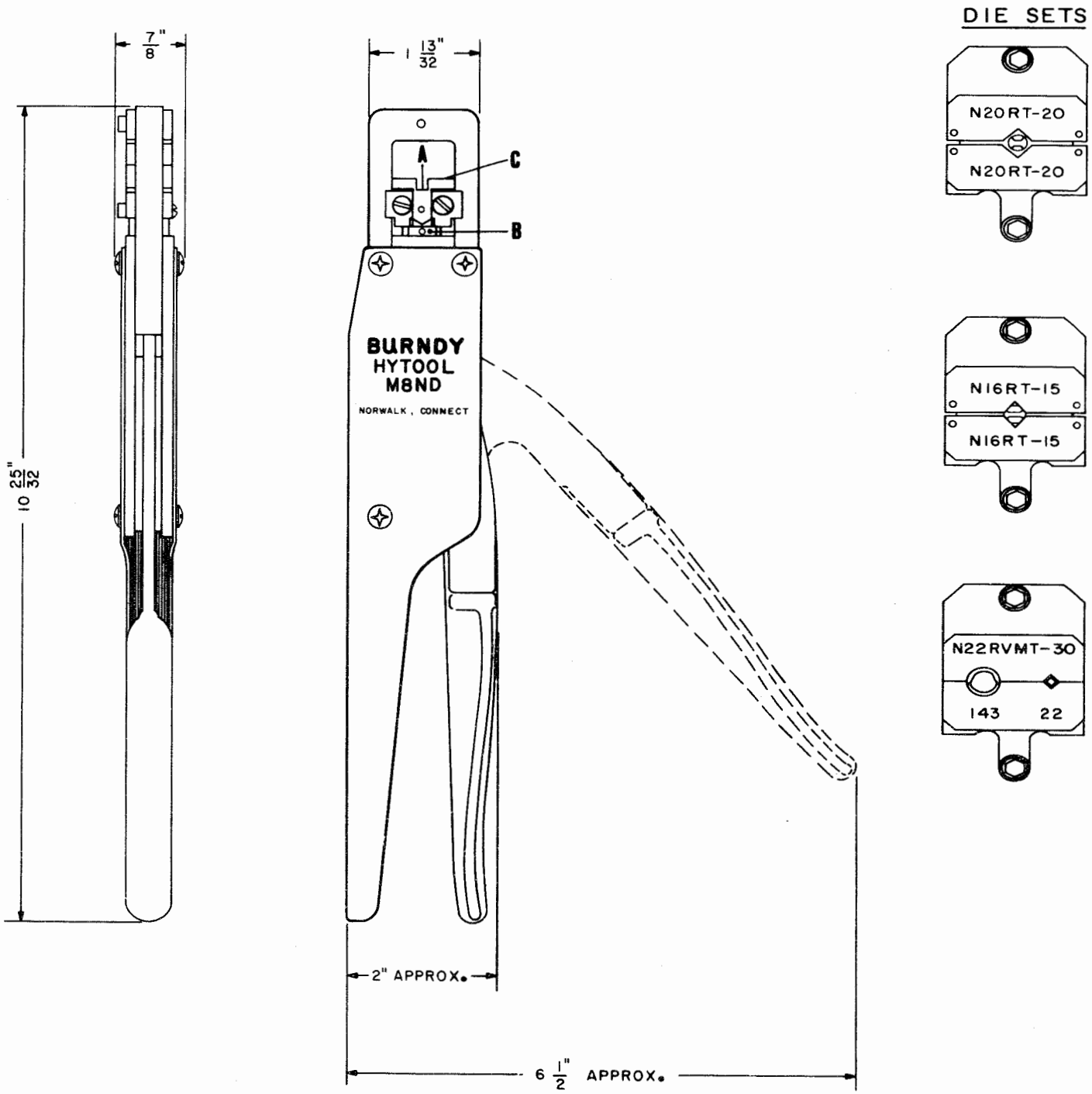


Figure 5-2. Crimping Tool and Die Sets for Replaceable Connector Contacts

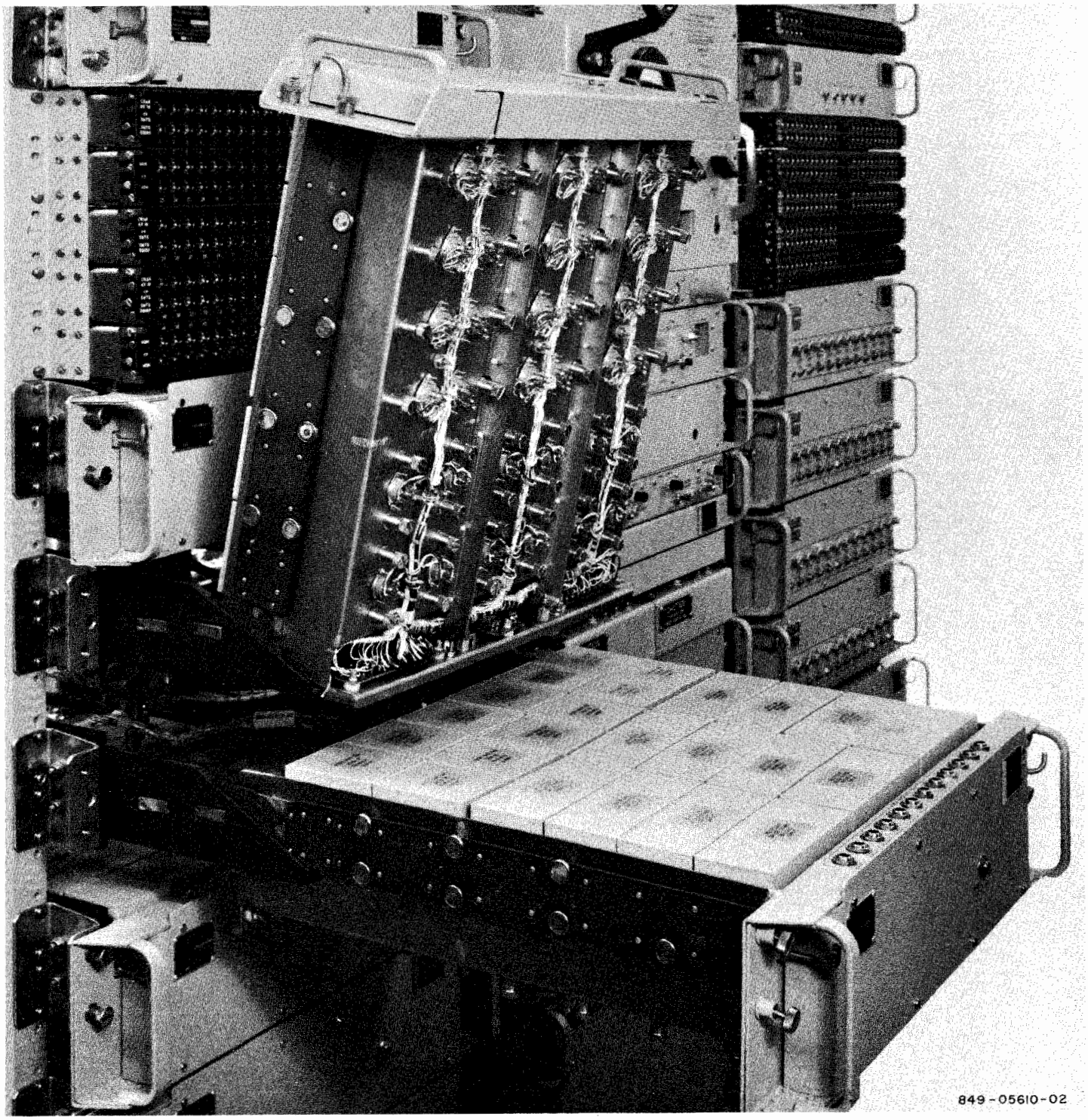


Figure 5-3. Typical Equipment Shelf

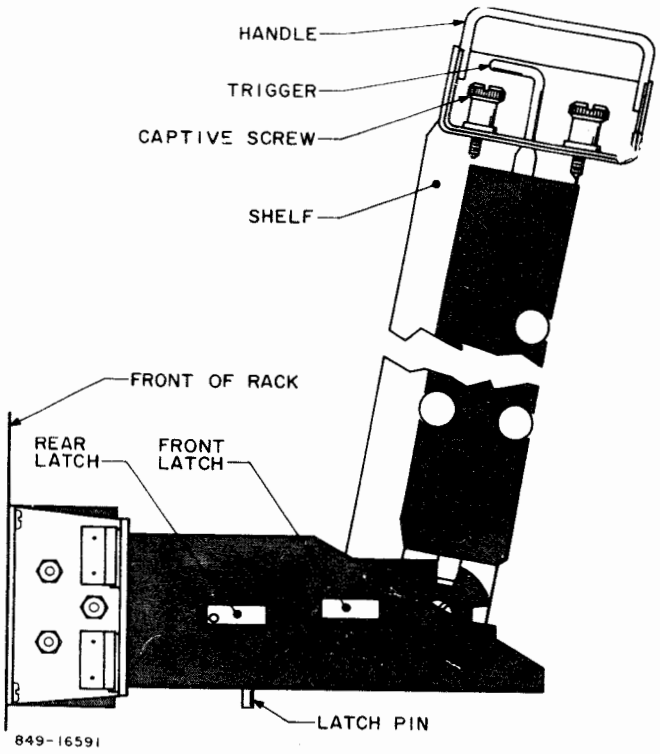


Figure 5-4. Side View of Shelf Showing Slide Mechanism

WARNING

Be sure the shelf is locked on both sides before you release the handles.

c. To return shelf to horizontal position, pull triggers while supporting shelf by handles. Lower shelf carefully, releasing triggers after downward movement has started.

d. To retract shelf if it is locked in forward position, depress rear latch on each side by pushing latch pins back. Then slide shelf into rack and secure it by four captive screws. Don't use a screwdriver; tighten screws with your fingers.

NOTE

While the rear latch is depressed, the shelf cannot be locked in the forward position. The rear latch releases automatically when the shelf is fully retracted, or it can be released manually by pulling the latch pin forward.

5-21. To completely remove a shelf from the rack:

a. Extend shelf to forward position.

b. Unplug electrical connectors at rear of shelf.

c. While pressing front latch on each side, slide shelf out very slightly so that leading edge of front latch is just forward of rectangular opening.

d. Support shelf strongly from underneath (a shelf may weigh as much as 90 pounds), and slide it forward out of rack.

NOTE

When a shelf has been removed, the inner channel of the slide mechanism will be left protruding from the rack. It is locked in this position but can be released by pushing down on the locking trigger (not shown in figure 5-4) at the rear of the inner channel.

5-22. To replace a shelf in the rack:

a. Depress rear latch on each side of shelf by pushing latch pin to rear.

b. Carefully engage slides on shelf with mating channels on rack. Slide shelf into rack.

c. Extend shelf to forward position and plug in electrical connectors at rear of shelf.

5-23. TRAYS. A tray is attached to its shelf by four knurled-head captive screws, one in each corner on top of the tray. The master frequency generator tray and the power supply tray plug directly into the shelf; electrical circuits enter the supergroup trays through connectors at the rear.

5-24. PLUG-IN MODULES. Most modules are secured from beneath the chassis by one or more knurled-head captive screws. One or two 7-pin or 9-pin headers on the base of the module mate with miniature electron tube sockets on the chassis. A guide pin on the module prevents misalignment with the sockets. In removing a plug-in module, after you have entirely loosened the captive screws, push up on the screws or guide pin to unseat the module from its socket.

5-25. In the master frequency generator tray, two of the modules (servo amplifier A7 and servo A10) are fastened to a heat sink on the side of the tray. Because of the interference of screwheads protruding from the servo module, the phase detector module A9 must be removed first before you can remove or install the servo.

5-26. Three of the plug-in modules (oscillator A5, servo amplifier A7, and servo A10) in the master frequency generator tray are not hermetically sealed and can be easily disassembled without special tools or equipment. However, the maintenance concept for this equipment is that repair of modules is limited to depot-level activities.

5-27. LAMPS. To remove an indicator lamp, unscrew the lens and pull the lamp straight out from its socket.

5-28. FUSES. To remove an indicating fuse of the type used on the fuse panels, turn the fuseholder cap 1/8-turn counterclockwise and withdraw the cap and fuse.

5-29. Cartridge fuses are mounted under the chassis of group shelves (multiplexer and demultiplexer) and carrier supply shelves. These fuses should be removed with a fuse puller to prevent damage to the mounting clips.

5-30. RELAYS. Relays in the multiplexer set are of the plug-in type. To remove a relay, loosen or remove the retainer and pull the relay out of its socket.

5-31. REPARABLE CONNECTORS.

5-32. Many of the connectors providing electrical interface between rack wiring and the equipment have removable contacts that can be replaced if they are damaged or if a wire breaks. The old contact is pressed out of the connector with an extraction tool, and the new contact is fastened to the wire by a special crimping tool and die set. The tools and contacts to be used with various types of wire and cable are listed in table 5-3; replacement procedures are in figure 5-5.

5-33. INSTALLATION OF DIE SET IN CRIMPING TOOL. (Refer to figure 5-2.) Keep tool adjusted so that normal hand force (45 to 55 pounds) is required to butt dies (no crimp), and release ratchet.

a. Select die set in accordance with table 5-3.

b. Loosen sockethead lock screw A using 3/32-inch Allen wrench.

c. Turn coupler bushing B so that ram die holder C moves to full down position.

d. With stamped lettering on die set facing you, place dies in tool so that holding prongs straddle the head and ram. Hand tighten holding screws in each die.

Table 5-3. Data for Replaceable Contacts on Burndy Connectors

WIRE	*CONTACT	EXTRACTION TOOL	DIE SET
16 or 18 AWG stranded	RM16M-11 pin	RX20-20	N16RT-15
	RC16M-11 socket	RX16-5	N16RT-15
20 or 22 AWG stranded	RM20W-20 pin	RX20-13	N20RT-20
	RC20W-20 socket	RX20-13	N20RT-20
RG-187/U coaxial cable	RMM26W-1 inner pin, RCMX143-1 outer female body, and Y1RX069 ferrule ("hyring")	RX8-1	N22RVMT-30
	RFM26W-1 inner socket, RMMX143-1 outer male body, and Y1RX069 ferrule ("hyring")	RX8-1	N22RVMT-30

*Add suffix F65 to all part numbers except Y1RX069; F65 denotes hard gold over silver plating.

e. Close handles and align both parts of die set. Turn coupler bushing B so that ram die holder C moves up until dies butt.

f. Release handles slightly and turn coupler bushing B 1/4 turn more to move ram die holder C upward.

g. Remove lower die and tighten socket-head lock screw A. Replace lower die. Actuate tool and check hand force.

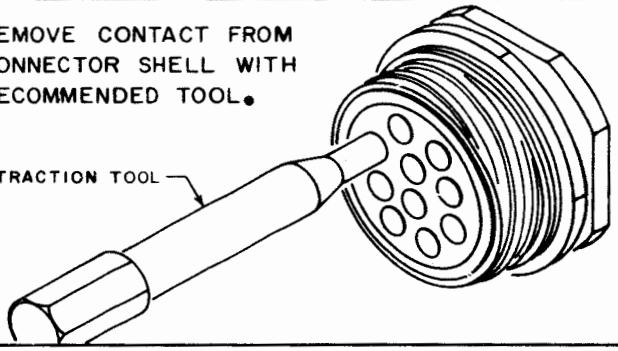
h. If force is too light, loosen socket-head lock screw A and repeat steps f and g. Back off coupler bushing B if force is too great.

5-34. OPERATION OF CRIMPING TOOL. Place contact into proper nest so that the indentor portion of the dies will hit the center of the barrel, then close handle all the way. The tool controls the depth of indent and the handle will not release until the operation is completed.

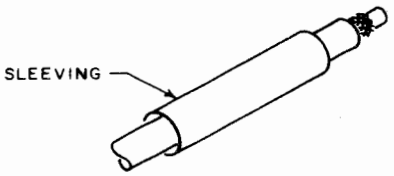
5-35. CONTACT INSULATION. The procedure in figure 5-5 for replacement of connector contacts refers to heat-shrinkable electrical insulation sleeving. This material (Rayclad type RT-800) is supplied in an expanded state; when heated for a few seconds (usually, by a hot air blast), it shrinks to about one-half its expanded diameter. Another heat source, such as a lighted match, may be used; but first experiment with some extra pieces of sleeving to determine the best procedure.

5-36. If the heat shrinkable sleeving is not available, some other means should be employed to insulate and protect the assembled joint. One satisfactory method is to wrap vinyl electrical insulating tape around the joint up to the shoulder of the

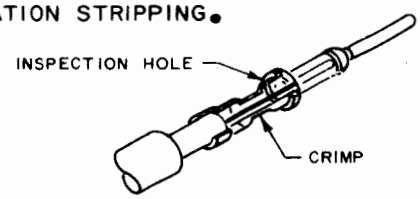
1. REMOVE CONTACT FROM CONNECTOR SHELL WITH RECOMMENDED TOOL.



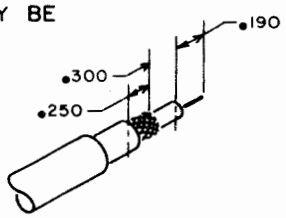
2. SLIP ELECTRICAL INSULATION SLEEVING ON CABLE.



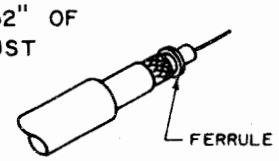
3. FOR WIRE OTHER THAN COAXIAL CABLE USE THIS ILLUSTRATION AS A GUIDE FOR INSULATION STRIPPING.



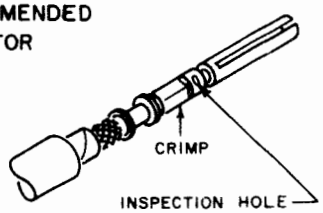
4. STRIP COAXIAL CABLE TO DIMENSIONS SHOWN. (DIMENSIONS MAY BE ALTERED TO SUIT CHARACTERISTICS OF CABLE.)



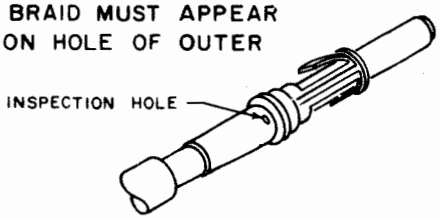
5. ASSEMBLE FERRULE. POSITION BETWEEN BRAID AND INNER CONDUCTOR INSULATION WITH BRAID COVERING FERRULE TO WITHIN 1/32" OF FLANGE AND SOLDER JUST ENOUGH TO JOIN BRAID TO FERRULE KEEPING BRAID ENDS SMOOTH.



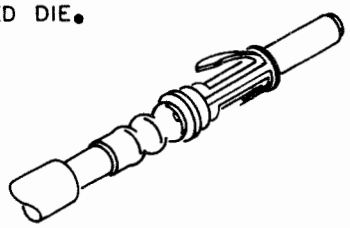
6. ASSEMBLE INNER PIN/SOCKET TO INNER CONDUCTOR AND CRIMP BARREL WITH RECOMMENDED DIE. INNER CONDUCTOR MUST APPEAR IN INSPECTION HOLE.



7. ASSEMBLE OUTER BODY. INNER PIN/SOCKET MUST SNAP-LOCK IN POSITION. BRAID MUST APPEAR IN INSPECTION HOLE OF OUTER BODY.



8. CRIMP OUTER BODY BARREL WITH RECOMMENDED DIE.



9. SLIDE ELECTRICAL INSULATION SLEEVING BACK DOWN CABLE TO SHOULDER OF OUTER BODY. APPLY HEAT TO SHRINK INSULATION AROUND COAXIAL CABLE.

10. THE COMPLETED CONTACT CAN NOW BE SNAP-LOCKED INTO CONNECTOR SHELL.

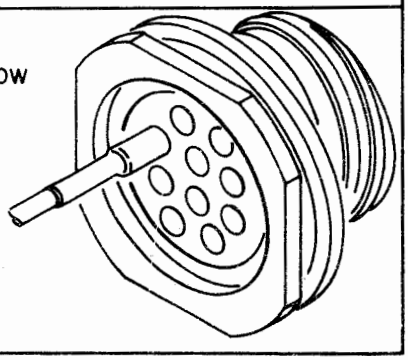


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Figure 5-5. Procedures for Replacement of Connector Contacts

contact and overlapping the insulation on the wire or coaxial cable.

5-37. INOPERATIVE TRANSMISSION TEST SET.

5-38. If the transmission test set should be inoperative, individual items of test equipment may be substituted temporarily to provide most of the test set's functions.

5-39. VF SIGNALS. If an alignment procedure or performance test calls for a channel test tone, use a 600-ohm oscillator (Hewlett-Packard model 200CD, for example) set at 1000 cps. To measure vf signal levels, use a flat ac vtvm (Hewlett-Packard model 400H, for example); terminate the vtvm in 600 ohms when you are using it to set the output level of the oscillator or to measure test tone at a normalled-through vf jack.

5-40. CARRIER SUPPLY LEVELS. The flat ac vtvm may also be used to measure levels at test jacks in the carrier supply equipment. With the vtvm unterminated, a reading of -16 db (0.123 volt) corresponds to 0 db on the transmission test set.

NOTE

At the 420KC-612KC A and B test jacks on the group carrier generator shelf, there is a complex waveform to which the vtvm and test set respond differently. On the vtvm, the normal readings are -18 db at the A jack and -19 db at the B jack.

5-41. PILOT LEVELS. To measure group pilot levels at bridging test jacks on the transmission equipment, a frequency-selective voltmeter (Sierra model 128A, for example) is required. With the frequency-selective voltmeter set for a 75-ohm terminating measurement, a reading of -76 dbm is equivalent to 0 db on the transmission test set. (At the same test jack, a channel test tone should read 16 db higher than the associated group pilot.) Tables 5-4 and 5-5 list the translated frequencies of 1-kc channel test tones and 64-kc group pilots in the group, supergroup, and line frequency bands.

5-42. FAILURE OF SLAVE OSCILLATOR.

5-43. In a master frequency generator shelf operating in the slave mode, under some rather unusual circumstances, a 128-kc oscillator may refuse to start oscillating. The most likely incident to trigger this failure is interruption of dc supply voltage to the shelf; after the voltage is restored, the oscillator may fail to restart. (With the oscillator disabled, all carrier supply equipment shelves will be in major alarm.)

5-44. The condition that prevents oscillation is a forward bias on the varicap diodes in the slave oscillator's automatic sync circuit. The cathodes of these diodes are connected to the output of the phase detector (detector voltage) and the anodes are connected to the output of the servo (tuning voltage). Normally, the detector voltage is zero and the tuning voltage is between -9 and -13 volts; thus, the varicap diodes are reverse biased.

5-45. If the oscillator is disabled, the local 96-kc input to the phase detector disappears. Now, the phase detector acts as a full-wave rectifier for the incoming 96-kc pilot and the output goes several volts negative. If the pilot level is unusually high and the tuning voltage low, the detector voltage may be more negative than the tuning voltage, and the varicap diodes will become forward biased.

5-46. A simple remedy for the situation is to remove the detector voltage until the oscillator restarts. This can be done by

Table 5-4. Frequencies of 1-Kc Channel Test Tones in the Group, Supergroup, and Line Frequency Bands

GROUP	CHAN	TRANSLATED TEST TONE FREQUENCY, KC											
		GR BAND	SGR BAND	SGR IN THE LINE FREQUENCY BAND									
				1A	1	2	3	4	5	6	7	8	9	10
1	1	105	315	249	297	315	801	1049	1297	1545	1793	2041	2289	2537
	2	103	317	247	295	317	799	1047	1295	1543	1791	2039	2287	2535
	3	97	323	241	289	323	793	1041	1289	1537	1785	2033	2281	2529
	4	95	325	239	287	325	791	1039	1287	1535	1783	2031	2279	2527
	5	89	331	233	281	331	785	1033	1281	1529	1777	2025	2273	2521
	6	87	333	231	279	333	783	1031	1279	1527	1775	2023	2271	2519
	7	81	339	225	273	339	777	1025	1273	1521	1769	2017	2265	2513
	8	79	341	223	271	341	775	1023	1271	1519	1767	2015	2263	2511
	9	73	347	217	265	347	769	1017	1265	1513	1761	2009	2257	2505
	10	71	349	215	263	349	767	1015	1263	1511	1759	2007	2255	2503
	11	65	355	209	257	355	761	1009	1257	1505	1753	2001	2249	2497
	12	63	357	207	255	357	759	1007	1255	1503	1751	1999	2247	2495
2	1	105	363	201	249	363	753	1001	1249	1497	1745	1993	2241	2489
	2	103	365	199	247	365	751	999	1247	1495	1743	1991	2239	2487
	3	97	371	193	241	371	745	993	1241	1489	1737	1985	2233	2481
	4	95	373	191	239	373	743	991	1239	1487	1735	1983	2231	2479
	5	89	379	185	233	379	737	985	1233	1481	1729	1977	2225	2473
	6	87	381	183	231	381	735	983	1231	1479	1727	1975	2223	2471
	7	81	387	177	225	387	729	977	1225	1473	1721	1969	2217	2465
	8	79	389	175	223	389	727	975	1223	1471	1719	1967	2215	2463
	9	73	395	169	217	395	721	969	1217	1465	1713	1961	2209	2457
	10	71	397	167	215	397	719	967	1215	1463	1711	1959	2207	2455
	11	65	403	161	209	403	713	961	1209	1457	1705	1953	2201	2449
	12	63	405	159	207	405	711	959	1207	1455	1703	1951	2199	2447
3	1	105	411	153	201	411	705	953	1201	1449	1697	1945	2193	2441
	2	103	413	151	199	413	703	951	1199	1447	1695	1943	2191	2439
	3	97	419	145	193	419	697	945	1193	1441	1689	1937	2185	2433
	4	95	421	143	191	421	695	943	1191	1439	1687	1935	2183	2431
	5	89	427	137	185	427	689	937	1185	1433	1681	1929	2177	2425
	6	87	429	135	183	429	687	935	1183	1431	1679	1927	2175	2423

Table 5-4. Frequencies of 1-Kc Channel Test Tones in the Group, Supergroup, and Line Frequency Bands (Cont)

GROUP	CHAN	TRANSLATED TEST TONE FREQUENCY, KC											
		GR BAND	SGR BAND	SGR IN THE LINE FREQUENCY BAND									
				1A	1	2	3	4	5	6	7	8	9	10
3	7	81	435	129	177	435	681	929	1177	1425	1673	1921	2169	2417
	8	79	437	127	175	437	679	927	1175	1423	1671	1919	2167	2415
	9	73	443	121	169	443	673	921	1169	1417	1665	1913	2161	2409
	10	71	445	119	167	445	671	919	1167	1415	1663	1911	2159	2407
	11	65	451	113	161	451	665	913	1161	1409	1657	1905	2153	2401
	12	63	453	111	159	453	663	911	1159	1407	1655	1903	2151	2399
4	1	105	459	105	153	459	657	905	1153	1401	1649	1897	2145	2393
	2	103	461	103	151	461	655	903	1151	1399	1647	1895	2143	2391
	3	97	467	97	145	467	649	897	1145	1393	1641	1889	2137	2385
	4	95	469	95	143	469	647	895	1143	1391	1639	1887	2135	2383
	5	89	475	89	137	475	641	889	1137	1385	1633	1881	2129	2377
	6	87	477	87	135	477	639	887	1135	1383	1631	1879	2127	2375
	7	81	483	81	129	483	633	881	1129	1377	1625	1873	2121	2369
	8	79	485	79	127	485	631	879	1127	1375	1623	1871	2119	2367
	9	73	491	73	121	491	625	873	1121	1369	1617	1865	2113	2361
	10	71	493	71	119	493	623	871	1119	1367	1615	1863	2111	2359
	11	65	499	65	113	499	617	865	1113	1361	1609	1857	2105	2353
	12	63	501	63	111	501	615	863	1111	1359	1607	1855	2103	2351
5	1	105	507	57	105	507	609	857	1105	1353	1601	1849	2097	2345
	2	103	509	55	103	509	607	855	1103	1351	1599	1847	2095	2343
	3	97	515	49	97	515	601	849	1097	1345	1593	1841	2089	2337
	4	95	517	47	95	517	599	847	1095	1343	1591	1839	2087	2335
	5	89	523	41	89	523	593	841	1089	1337	1585	1833	2081	2329
	6	87	525	39	87	525	591	839	1087	1335	1583	1831	2079	2327
	7	81	531	33	81	531	585	833	1081	1329	1577	1825	2073	2321
	8	79	533	31	79	533	583	831	1079	1327	1575	1823	2071	2319
	9	73	539	25	73	539	577	825	1073	1321	1569	1817	2065	2313
	10	71	541	23	71	541	575	823	1071	1319	1567	1815	2063	2311
	11	65	547	17	65	547	569	817	1065	1313	1561	1809	2057	2305
	12	63	549	15	63	549	567	815	1063	1311	1559	1807	2055	2303

Table 5-5. Frequencies of Group Pilots in the Supergroup and Line Frequency Bands

GROUP	TRANSLATED GROUP PILOT FREQUENCY, KC										
	SGR BAND	SGR IN THE LINE FREQUENCY BAND									
		1A	1	2	3	4	5	6	7	8	9	10
1	356	208	256	356	760	1008	1256	1504	1752	2000	2248	2496
2	404	160	208	404	712	960	1208	1456	1704	1952	2200	2448
3	452	112	160	452	664	912	1160	1408	1656	1904	2152	2400
4	500	64	112	500	616	864	1112	1360	1608	1856	2104	2352
5	548	16	64	548	568	816	1064	1312	1560	1808	2056	2304

grounding the DET OUT test point on the master frequency generator tray for a few seconds. On Multiplexer Set AN/FCC-22 or -17, an alternate method is to kill the incoming 96-kc pilot by unplugging the U-link from the RCVG EQUIP. jack on the supergroup demodulator combining panel.

CAUTION

Be very careful not to ground the nearby ALM TEST test point by mistake. Transistors in alarm control module A1 will be damaged.

5-47. CHANNEL CARRIER LEVELS.

5-48. The 8-kc pulse from the master frequency generator shelf is applied to a group of nine flanked bandpass filters, six in the channel carrier supply shelf and three in the group carrier generator shelf. Each filter is tuned to a harmonic of 8 kc, the lowest being the 6th (48 kc) and the highest the 31st (248 kc).

5-49. In the pulse, the harmonic levels are a function of pulse shape (amplitude, width, etc.) and typically may cover a 6-db range between -1 db at 48 kc and -7 db at 248 kc. For the six channel carriers, the range of levels is about 1 db between 64 kc and 104 kc, but not necessarily with uniform slope.

5-50. After the channel carriers have been extracted from the pulse by the bandpass filters, the range of levels may be increased further because of the manufacturing tolerance on the insertion loss of the filters (2.0 db ±0.6 db).

5-51. To compensate for pulse shape and variations in filter insertion loss, a resistor is shunted across the output of each filter in the channel carrier supply shelf, reducing the outputs to a uniform level. By selecting the resistance values, channel carrier levels at the filter outputs are equalized to -3.2 db with a tolerance of ±0.2 db.

5-52. Shunt resistors have values between 500 ohms and 6000 ohms, the smallest

value causing the largest reduction in level. Typically, a 1000-ohm shunt will reduce the output level about 0.5 db.

5-53. SELECTION OF RESISTORS. Because the succeeding equipment can stand a much larger variation in level than the ±0.2 db mentioned in paragraph 5-51, a minor change in pulse shape (perhaps caused by aging of components) should not require reselection of resistors. However, if one of the bandpass filters is replaced, you may have to change its shunt resistor to compensate for a different insertion loss in the new filter.

5-54. Ordinarily, the existing shunt resistor can be left in place (or removed) if you change out a filter, and the reselection procedure postponed until you are able to turn down the system for 1/2 hour or more. The procedure follows:

a. Withdraw and tilt up the channel carrier supply shelf.

b. On subassemblies A28 and A29, for each of the six channel carriers, remove the strap at terminal A (to terminal B or C), and temporarily connect a 133-ohm resistor (1/8 watt or larger) from terminal A to a ground terminal on the subassembly. Refer to the Circuit Diagrams manual for terminal numbers.

c. The output of each filter should now see only a 133-ohm terminating resistor and a shunt resistor. (The 96-kc bandpass filter has an additional high-impedance load that will not affect the procedure.)

d. With an ac vtvm, measure and record the level (nominally -3.2 db) across the 133-ohm termination of each filter except the subject filter. Calculate the average of the five levels.

e. For the subject filter, remove the existing shunt resistor from A28 or A29 and temporarily connect a resistance decade box in its place. (If you don't have a decade, a 10,000-ohm variable resistor can be used instead.)

f. With the ac vtvm connected across the 133-ohm termination of the subject filter, adjust the decade box to obtain a meter reading of the average level calculated in step d.

g. Replace the decade box with a fixed, film resistor (type RN65C----F per MIL-R-10509) of the nearest standard value to the setting of the decade box.

h. Again measure the output level of the subject filter to be sure it is within 0.1 db of the average value.

i. For each of the six carriers, remove the 133-ohm terminating resistor and restore the original strapping at terminal A.

j. Return the system to normal operation.

5-55. TEST POINTS.

5-56. Some of the test points in the multiplexer set are on the face of the equipment but most are on the top, forward lip of the shelves and trays. To use the latter, you have to withdraw the equipment from the rack at least partially.

5-57. POWER DISTRIBUTION.

5-58. Dc power (48 volts) originates in several power supply shelves. Each channel

equipment rack or channel demultiplex equipment rack has its own power supply shelf; all the other racks obtain dc power from the two or three power supply shelves on the common equipment rack. Alarm circuit power (40 volts ac) originates in the master alarm panel on the common equipment rack. Distribution of dc power is shown in figures 5-6, 5-7, and 5-8 for Multiplexer Sets AN/FCC-21, -22, and -17, respectively. Figure 5-9 illustrates alarm circuit power distribution.

5-59. CHECKOUT OF THE MULIPLEXER SET AFTER REPAIR.

5-60. After any repair of the multiplexer set that involves replacement of modules or parts (but not including simple items such as lamps and fuses), the repaired equipment should be checked out completely. Although you may have worked on only one part of a shelf or tray, it takes only a few minutes to check out the entire circuit.

5-61. Using the transmission test set, measure the level at all test jacks on the repaired shelf or tray. If there is no test jack where the output signal can be measured, go to the succeeding equipment where you can measure either the signal itself or another signal derived from it. The performance test standards in this chapter give you the procedures and the block diagrams in Chapter 4 show the test jacks.

5-62. Some of the equipment may require additional checks or adjustments and these are pointed out in following paragraphs.

5-63. POWER SUPPLY SHELF. After any repairs to the power supply shelf, the output voltage of each tray should be readjusted; refer to paragraph 5-102.

5-64. MASTER FREQUENCY GENERATOR SHELF. After measuring levels with the transmission test set at a slave terminal, also check carrier synchronization using a multimeter as described in paragraph 5-81. If the shelf that has been repaired is at a master terminal, then the associated slave terminal should be checked for proper synchronization.

5-65. If alarm control module A1 is replaced at a slave terminal, it should be checked out using the procedure in paragraph 5-97.

5-66. CHANNELS. Repairs to the transmission equipment that affect individual channels should always be concluded by measuring the vf drop level at the receiving terminal; see paragraph 5-85.

5-67. PREVENTIVE MAINTENANCE.

5-68. Routine test procedures to help you prevent troubles that would interfere with the performance of the multiplexer set are contained in the Preventive Maintenance Workcard set, T.O. 31W1-2FCC-106WC-1.

5-69. PERFORMANCE TEST STANDARDS.

5-70. The performance test standards for organizational/field maintenance are provided under these categories beginning at the paragraph number listed in parentheses.

a. Power supply equipment (5-75)

b. Carrier supply equipment (5-77)

c. Transmission equipment (5-83)

d. Alarm circuits (5-94)

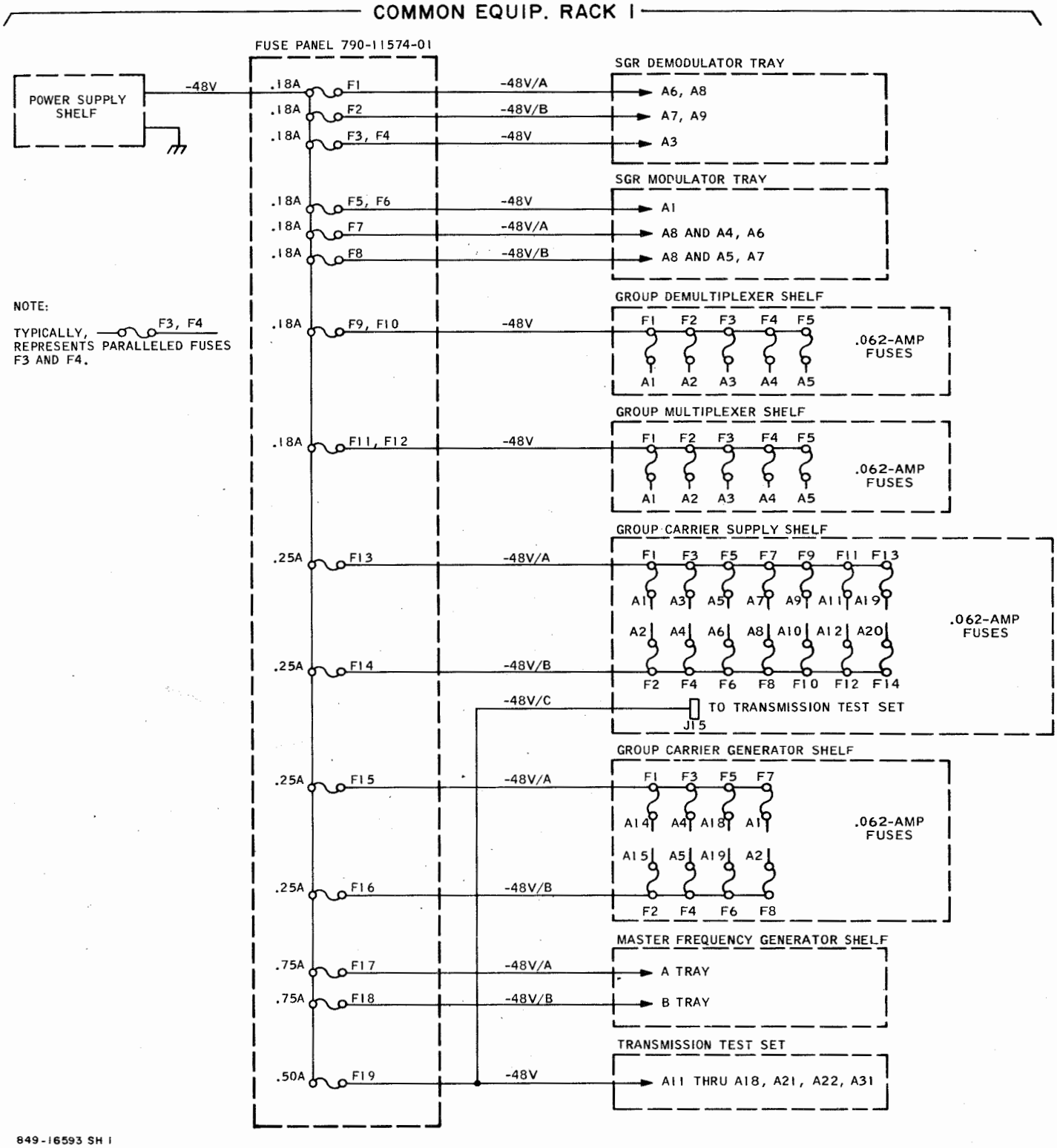

Figure 5-6. AN/FCC-21 DC Power Distribution (Sheet 1 of 2)

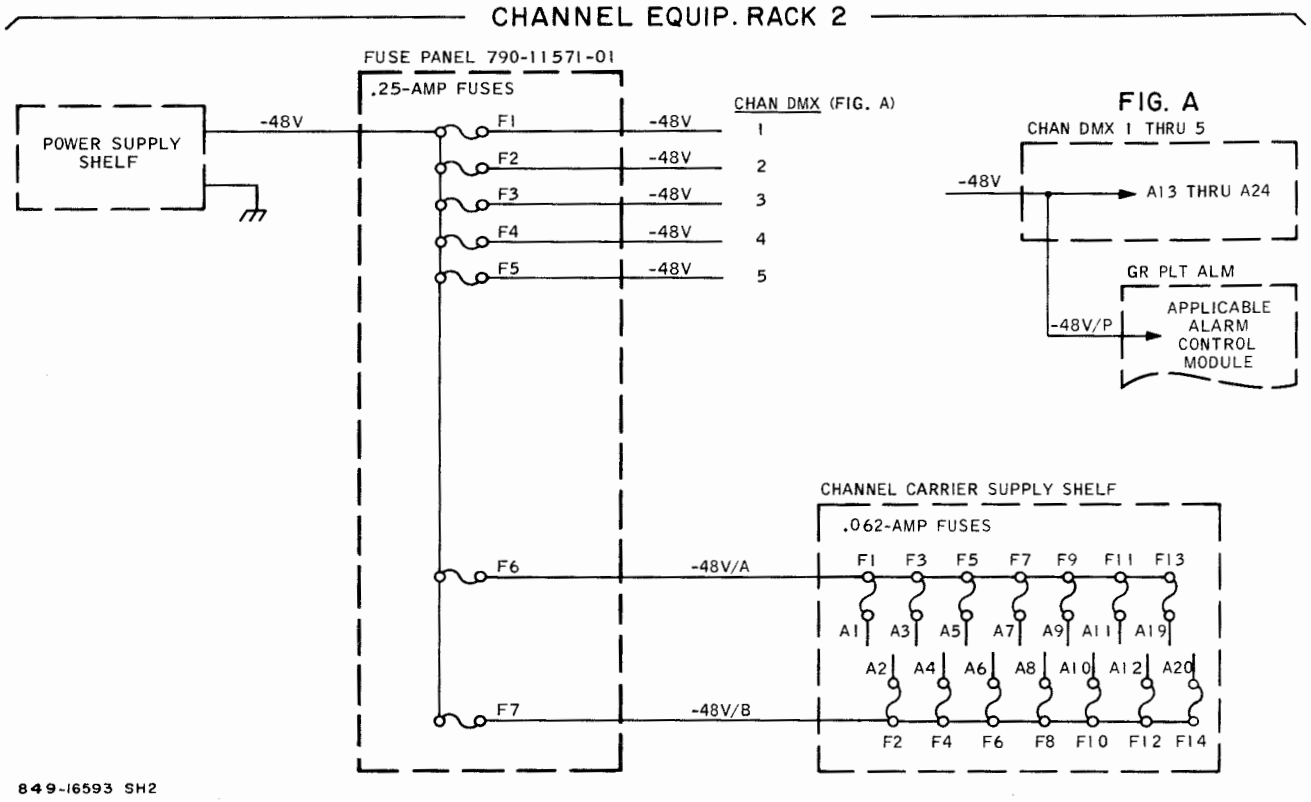

Figure 5-6. AN/FCC-21 DC Power Distribution (Sheet 2 of 2)

5-71. There are several conditions that would cause you to make use of some part of the performance test standards. For example:

a. An alarm occurs.

b. A preventive maintenance routine doesn't produce the required results.

c. A repaired component or a replacement requires checkout.

d. An operator or a "subscriber" reports an unsatisfactory channel.

5-72. Under any of these conditions, your first step would be to localize the problem to a particular category of equipment. Next, refer to the tests given under that category and, by reference to the appropriate diagram in Chapter 4 or in the Circuit Diagrams manual, select a test jack where a significant measurement can be made.

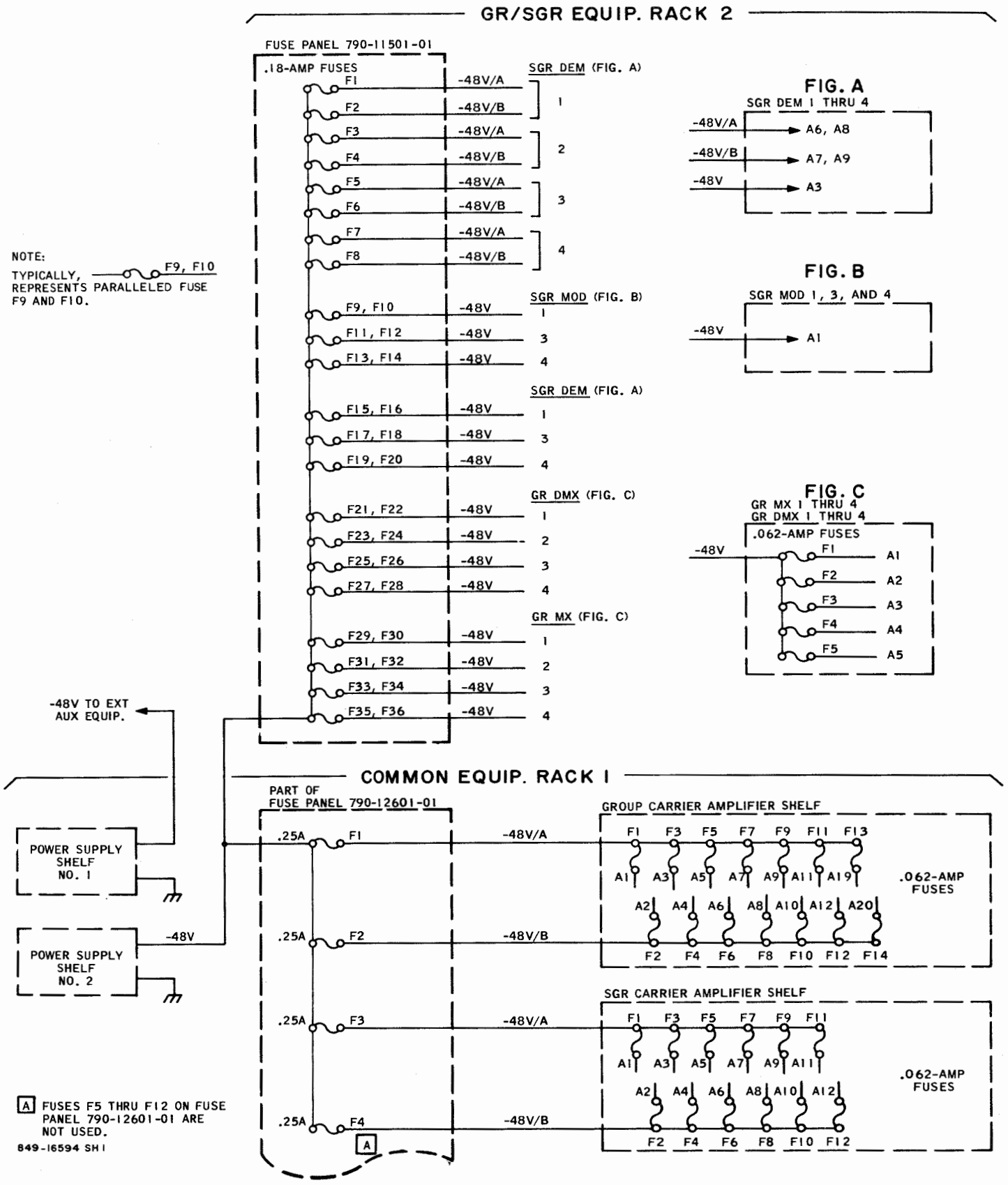

Figure 5-7. AN/FCC-22 DC Power Distribution (Sheet 1 of 3)

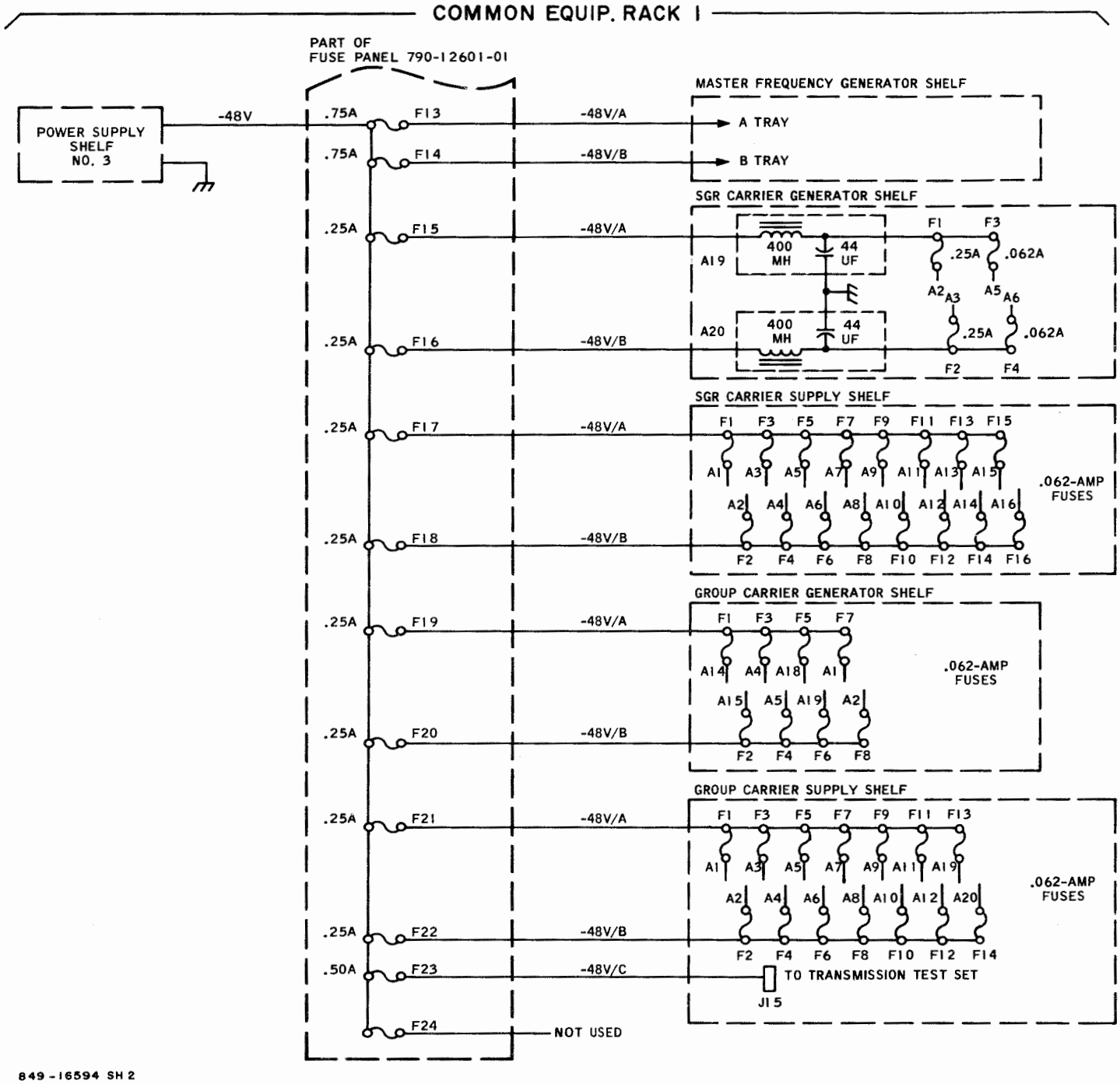

Figure 5-7. AN/FCC-22 DC Power Distribution (Sheet 2 of 3)

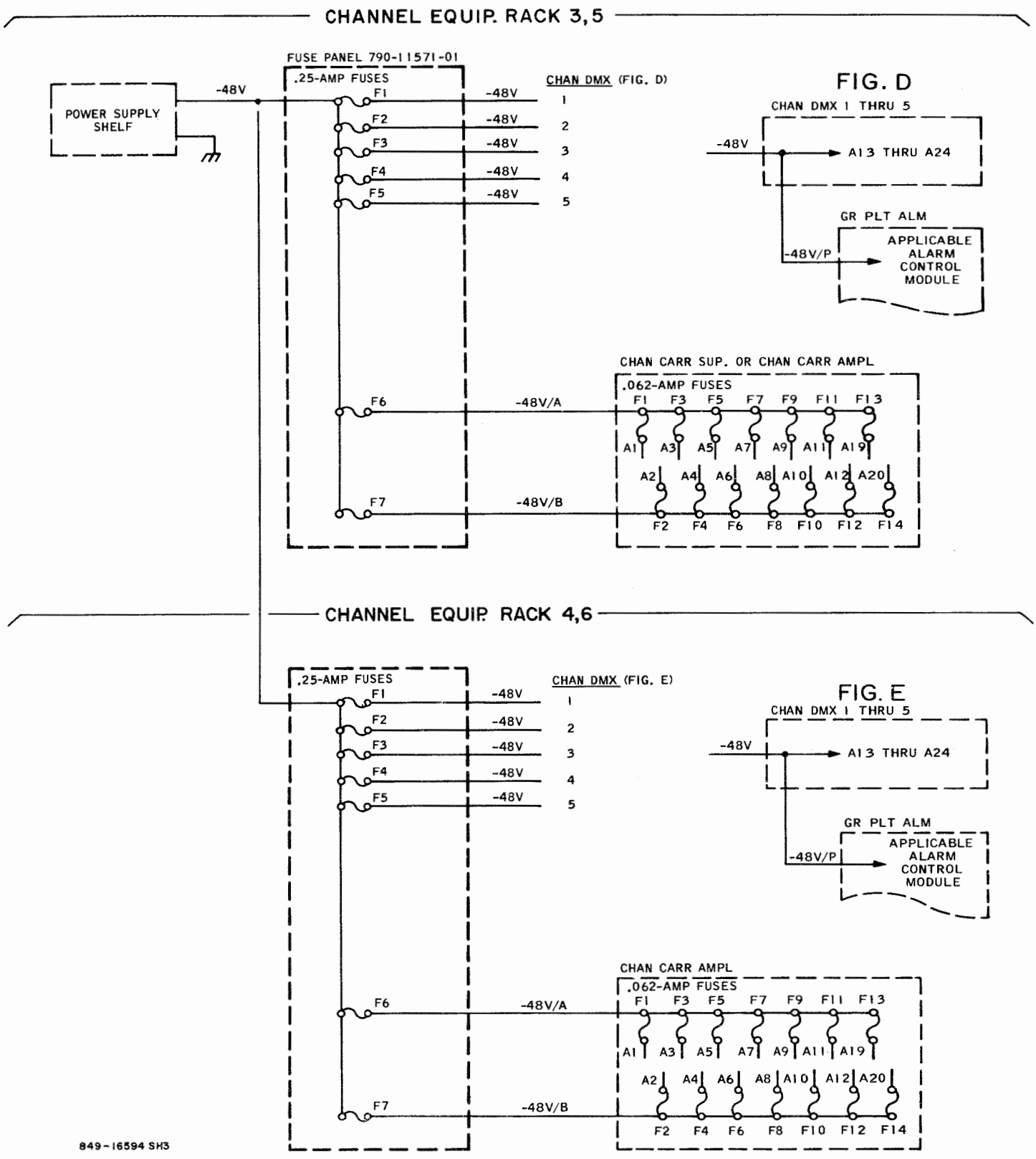

Figure 5-7. AN/FCC-22 DC Power Distribution (Sheet 3 of 3)

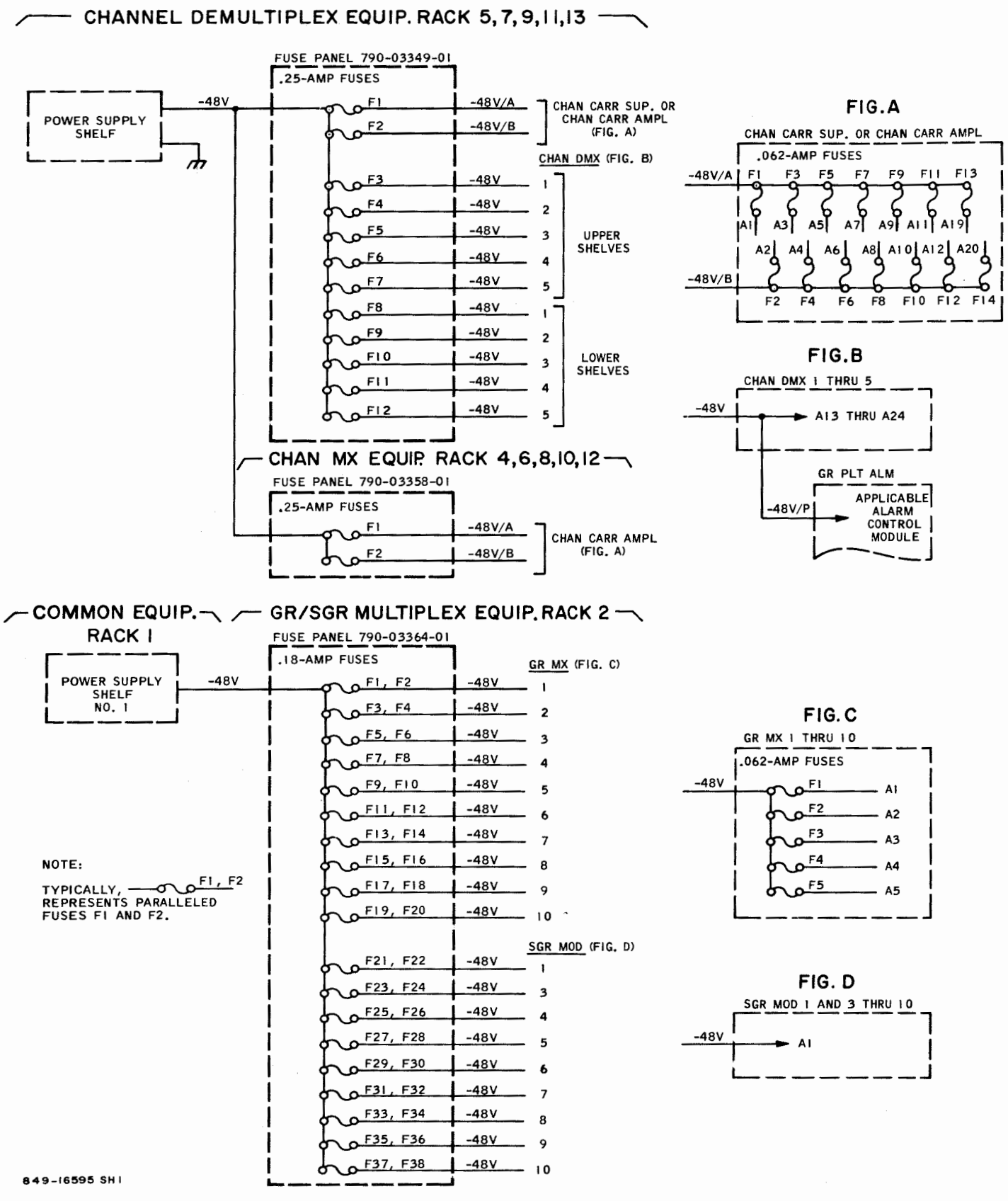

Figure 5-8. AN/FCC-17 DC Power Distribution (Sheet 1 of 3)

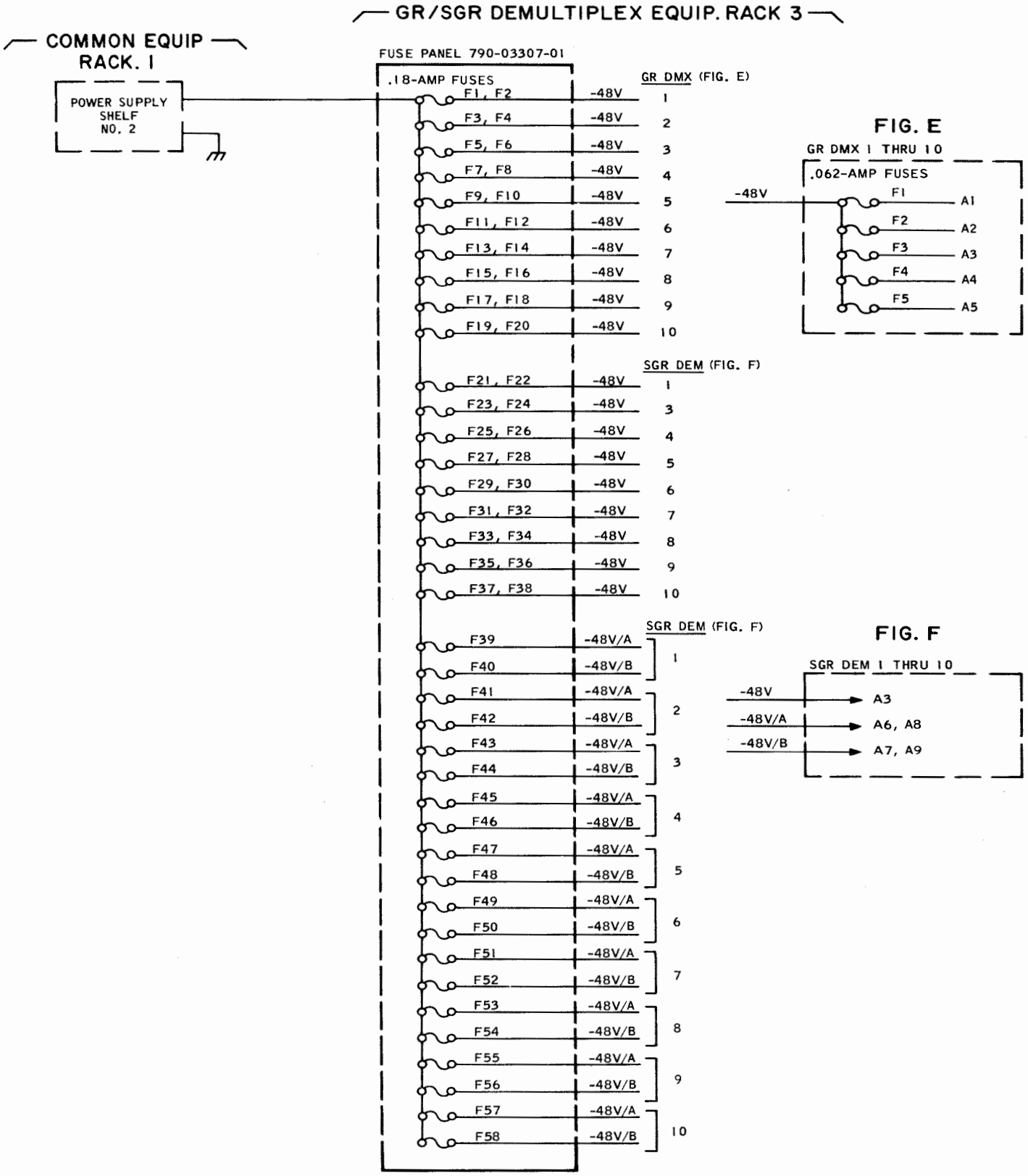

Figure 5-8. AN/FCC-17 DC Power Distribution (Sheet 2 of 3)

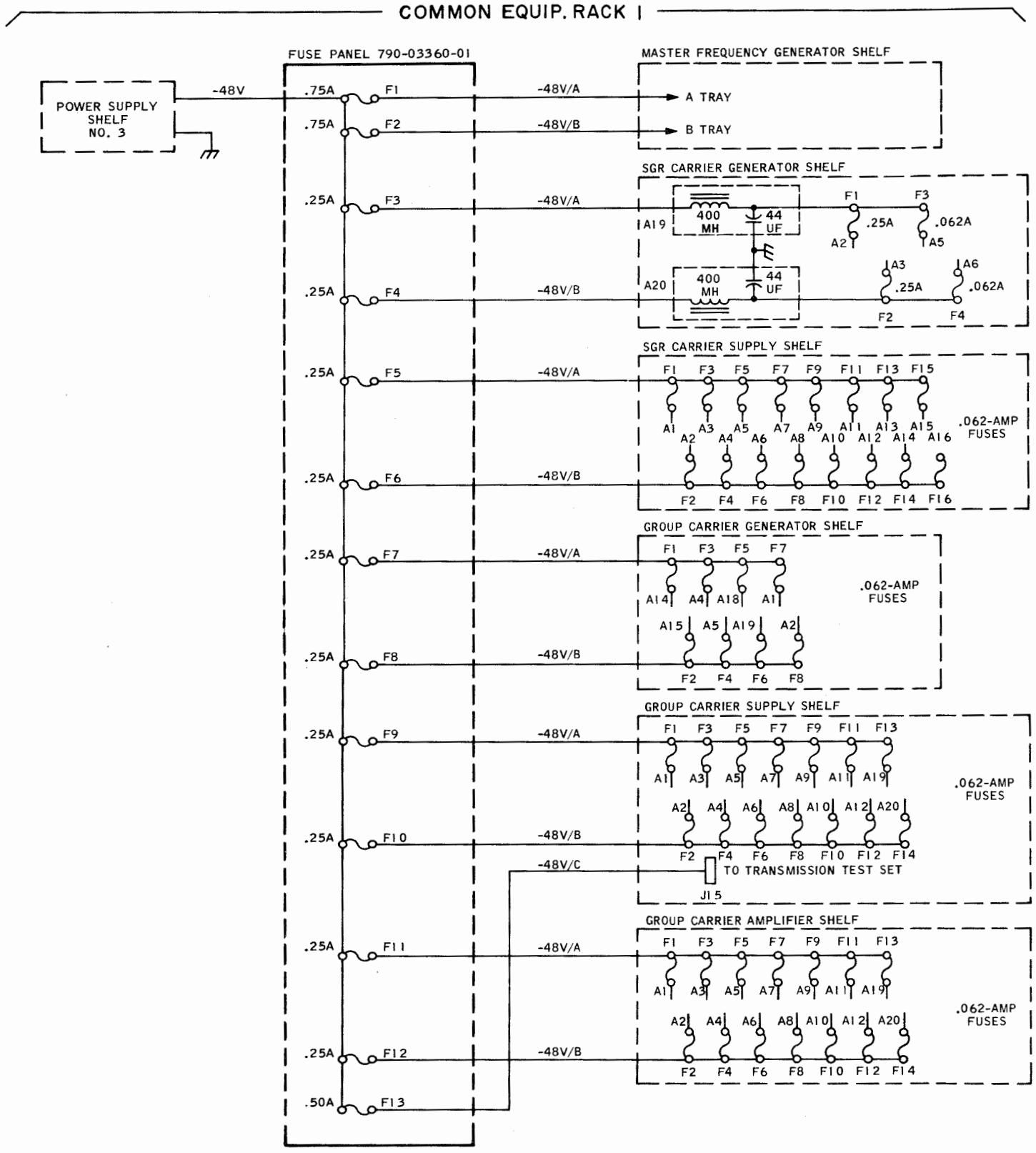

Figure 5-8. AN/FCC-17 DC Power Distribution (Sheet 3 of 3)

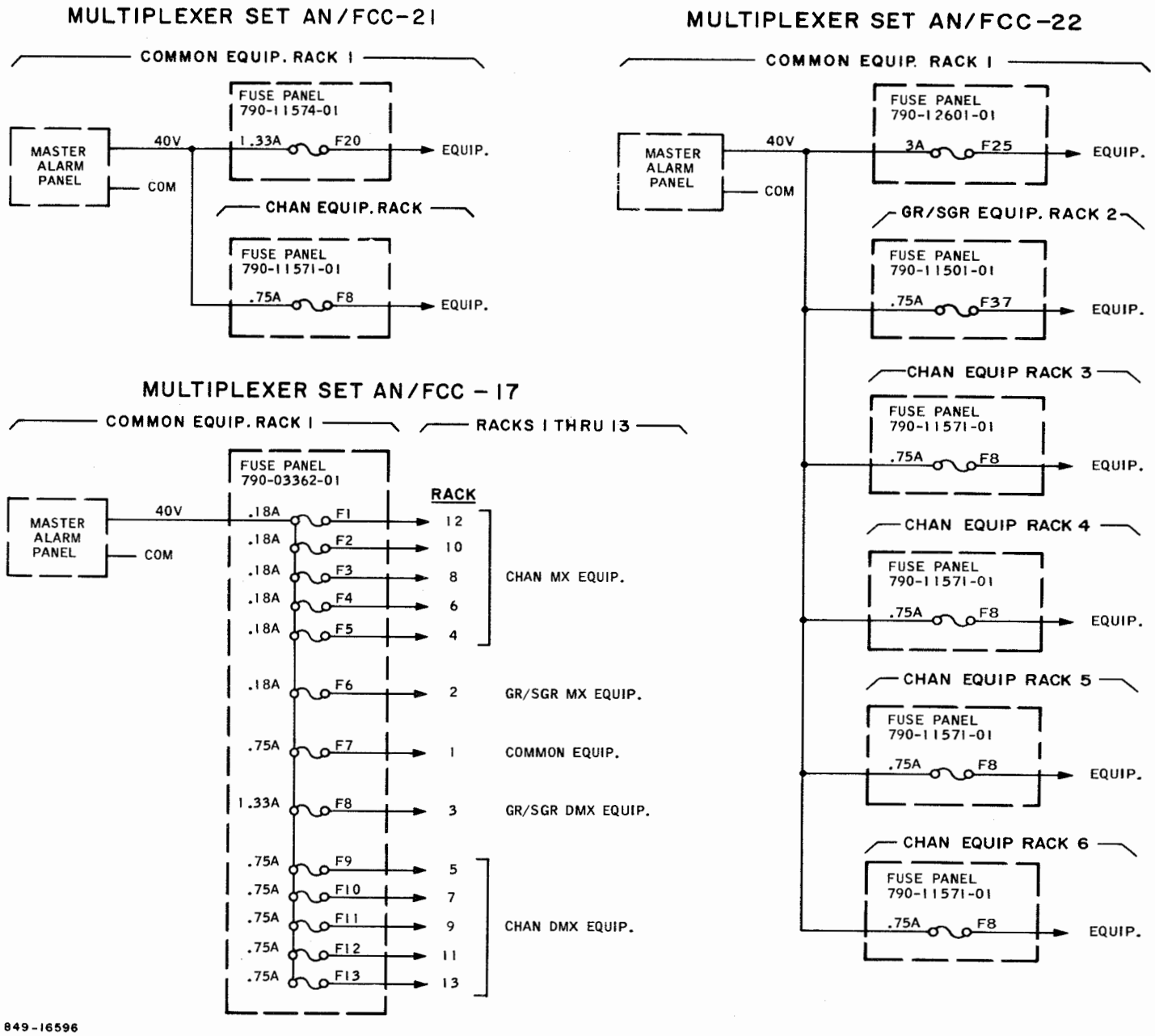

Figure 5-9. Alarm Circuit Power Distribution

5-73. Except for channel test tones, the signals that you will measure in the performance tests are also monitored automatically within the multiplexer set itself. Nevertheless, most monitors are designed to give alarm indication only upon catastrophic failure, and performance tests in this chapter and in the Preventive Maintenance Workcard set will enable you to detect troubles before they start interfering with service.

5-74. Performance testing may be accomplished with the equipment in an operating configuration; except in tests on individual channels, service does not have to be interrupted.

5-75. POWER SUPPLY EQUIPMENT.

5-76. POWER SUPPLY SHELF. The output of each power supply tray is checked continuously by a voltage monitor. If the output of a tray (normally 49 volts) goes below 47 volts or above 52.5 volts, an alarm will be given. The combined dc output voltage of the two trays in a power supply shelf (normally 48 volts) can be checked at the LOAD VOLTAGE test points on the front of the shelf and should be between 44 and 52 volts, when measured with Multimeter AN/PSM-6.

5-77. CARRIER SUPPLY EQUIPMENT.

5-78. CARRIER LEVELS. Throughout the carrier supply system, test jacks are provided at key points where circuit performance can be verified by measurements with the transmission test set. The test jacks on each equipment shelf (table 5-6) are accessible when the shelf is withdrawn from the rack. Measure the level with the FUNCTION switch on the test set in position 3 and the test cord (CG-2542/U) inserted in

Table 5-6. Test Jacks in the Carrier Supply Equipment

NOTE: Unless otherwise specified, the normal meter reading on the transmission test set at each jack is 0 db ±2 db.

SHELF	TEST JACKS
Master frequency generator	LOCAL 96 KC (A and B). INCOMING PILOT 96 KC (A and B). Don't measure here at a master terminal.
Channel carrier supply and channel carrier amplifier (Exceptions to the 0-db normal meter readings are described in paragraphs 5-79 and 5-80.)	CHANNEL CARRIER AMPLIFIER OUT 104 KC (A and B) 80 KC (A and B) 96 KC (A and B) 72 KC (A and B) 88 KC (A and B) 64 KC (A and B)

Table 5-6. Test Jacks in the Carrier Supply Equipment (Cont)

SHELF	TEST JACKS
Group carrier generator	AMPLIFIER OUT 124 KC (A and B). Test set should read between -3 db and +2 db. 420 KC-612 KC (A and B) 516 KC (A and B)
Group carrier supply and group carrier amplifier	GROUP CARRIER AMPLIFIER OUT 420 KC (A and B) 564 KC (A and B) 468 KC (A and B) 612 KC (A and B) 516 KC (A and B) SUPERGROUP 564-612 KC (A and B)
Supergroup carrier generator	AMPLIFIER OUT 124 KC (A and B)
Supergroup carrier supply	SUPERGROUP CARRIER AMPLIFIER OUT. Test set should read between -2 db and +3 db at each jack. 1116 KC (A and B) 2108 KC (A and B) 1364 KC (A and B) 2356 KC (A and B) 1612 KC (A and B) 2604 KC (A and B) 1860 KC (A and B) 2852 KC (A and B)
Supergroup carrier amplifier	SUPERGROUP CARRIER AMPLIFIER OUT XXXX KC (A and B) XXXX KC (A and B) XXXX KC (A and B) XXXX KC (A and B) XXXX KC (A and B) XXXX KC (A and B) NOTE See figure 5-10 for location of test jacks in amplifier circuits no. 1 through no. 6. The designation XXXX is replaced on the equipment by the applicable supergroup carrier frequency.

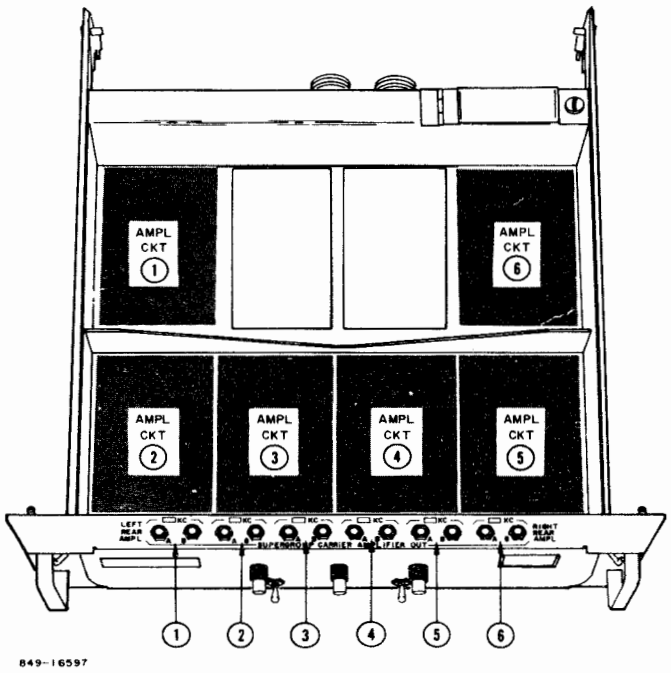

Figure 5-10. Supergroup Carrier Amplifier Shelf, Location of Test Jacks

the TEST TONE OR CARRIER INPUT jack J2; calibration of the test set is not required. Except as specified in table 5-6, the meter on the test set should read 0 db ±2 db at each jack.

5-79. CHANNEL CARRIERS. On the channel carrier supply shelf and on the channel carrier amplifier shelves, a 26.1-ohm resistor is strapped into each carrier distribution circuit on which the load is between one and five channel shelves (multiplexer and/or demultiplexer); if the load is between six and ten shelves, the resistor is disconnected. The 26.1-ohm resistor is a dummy load equivalent to five shelves, so the combination of actual load and dummy load will always be the equivalent of between six and ten shelves. If the equivalent load is ten shelves, the carrier voltage is 0.52 volt and the transmission test set measures 0 db at the CHANNEL CARRIER AMPLIFIER OUT test jack.

5-80. If the equivalent load is fewer than ten shelves, the carrier voltage will be high. In the extreme case, when the load is only six shelves, the carrier voltage goes up to 0.63 volt and the test set measures about +1.8 db at the test jack. For configurations where the normal reading on the test set is not 0 db, the reading obtained at the first alignment should be recorded as the reference level for periodic performance routines.

5-81. CARRIER SYNCHRONIZATION. At a slave terminal, the carrier synchronization circuit can be checked by dc voltage measurements at test points on the master frequency generator trays. Pull out the master frequency generator shelf and make the following dc voltage measurements with Multimeter AN/PSM-6 on each master frequency generator tray, in turn.

a. Connect multimeter to DET OUT and COM test points. The meter should read 0 volt ±0.5 volt.

b. Transfer multimeter to TUN VOLTAGE (negative) and COM test points. Meter should read between 9 and 13 volts; if it doesn't, alignment (paragraph 5-108) is needed.

c. At master terminal, throw MAIN STANDBY SELECTOR switch on master frequency generator shelf to alternate position and repeat steps a and b.

d. Restore switch at master terminal to original position.

5-82. Some master frequency generator shelves are not equipped with "mechanical memory" and module A10 at the left rear of each tray is a dummy servo pn 790-07217-01. Normal voltages at the test points on these trays are as follows:

a. DET OUT and COM: Between -2 and +2 volts.

b. TUN VOLTAGE (negative) and COM: 11 volts ±0.5 volt

5-83. TRANSMISSION EQUIPMENT.

5-84. GROUP AND SUPERGROUP. Since a pilot is transmitted in each 12-channel group, the level of the pilot may be used as a performance index for the transmission equipment in the circuits between the output of the channel multiplexer shelf and the input of the channel demultiplexer shelf. Table 5-7 gives a series of measurements with the transmission test set that you can use to trace the group pilot in signal flow sequence through the transmitting branch of one terminal and the receiving branch of the associated terminal.

Table 5-7. Performance Test of Transmission Equipment by Measurement of Group Pilot Level

PRELIMINARY INSTRUCTIONS:

a. Turn FUNCTION switch on transmission test set to position 1, and insert test cord (CG-2542/U) in PILOT MONITORING OR TEST TONE INPUT jack J1.

b. When directed in the procedures of this table to calibrate meter with ZERO SET controls:

(1) Turn ZERO SET switch to ZERO SET 1 and adjust ZERO SET 1 control for meter reading of 0 db.

(2) Turn ZERO SET switch to ZERO SET 2 and adjust ZERO SET 2 control for meter reading of 0 db.

(3) Turn ZERO SET switch to TEST.

c. With the FREQ RANGE switch in any position except 60-108, you can quickly monitor all pilots in the supergroup by turning the GROUP switch to each of its five positions. For precise measurement, the meter should be recalibrated with the ZERO SET controls for each setting of the GROUP switch. The meter must be recalibrated if you change the FREQ RANGE switch to another supergroup.

d. When directed in the procedures of this table to patch supergroup carrier into test set, with coaxial test cord (CG-2541/U), patch SGR CARRIER jack J4 on test set to SGR CARRIER jack on modulator or demodulator tray for supergroup in which group pilots are to be measured. This step is not applicable to supergroup 2.

e. On the supergroup modulator trays, the tolerance of ±2 db at AMPL OUT and SGR MOD OUT depends on the multiplexer set being connected to transmission equipment with a 75-ohm input impedance. Deviations from this impedance through the baseband frequency range may be responsible for abnormal group pilot levels measured on the transmission test set.

f. The large tolerance (-5 db, +2 db) at 60-108 KC OUT on the group demultiplexer shelf is necessary because of variations in the channel demultiplexer shelf's input

Table 5-7. Performance Test of Transmission Equipment by Measurement of Group Pilot Level (Cont)

impedance. If the group is terminated in 135 ohms on the group receiving jackfield, the tolerance becomes ±2 db.

NOTE

Each step in this table is independent and may be performed without regard to preceding or following steps.

STEP	POINT OF TEST		OPERATION OF TRANSMISSION TEST SET
	EQUIPMENT	JACK	
1	Channel multiplexer shelf	CHANNEL MX OUT	Turn FREQ RANGE switch to 60-108. Calibrate meter with ZERO SET controls. Connect test cord to point of test. Meter should read 0 db ±2 db.
2A	Group multiplexer shelf	60-108 KC IN, GR 1 thru GR 5	Same as step 1.
2B		GR MX OUT	Turn FREQ RANGE switch to 312-552 SGR 2. Turn GROUP switch to applicable group. Calibrate meter with ZERO SET controls. Connect test cord to point of test. Meter should read 0 db ±2 db.
3A	Low-level supergroup modulator tray	SGR MOD IN	Same as step 2B.
3B		SGR MOD OUT	Patch supergroup carrier into test set. Turn FREQ RANGE switch to applicable supergroup. Turn GROUP switch to applicable group.

Table 5-7. Performance Test of Transmission Equipment by Measurement of Group Pilot Level (Cont)

STEP	POINT OF TEST		OPERATION OF TRANSMISSION TEST SET
	EQUIPMENT	JACK	
3B		SGR MOD OUT (Cont)	Calibrate meter with ZERO SET controls. Connect test cord to point of test. Meter should read 0 db ±2 db. (Refer to paragraph e of preliminary instructions).
4A	High-level supergroup modulator tray	SGR 1 MOD IN	Same as step 2B.
4B		AMPL A + B IN	Same as step 3B.
4C		AMPL A OUT	Same as step 3B.
4D		AMPL B OUT	Same as step 3B.
4E		SGR 1 MOD OUT	Same as step 3B.
5	Supergroup modulator combining panel	HF OUT	Refer to alignment procedure in paragraph 5-129.
6A	Line connector panel	HF OUT	Same as step 5.
6B		HF IN	Refer to alignment procedure in paragraph 5-135.
7	Supergroup demodulator combining panel (pn 790-07211-01 and -02 only)	HF IN	Same as step 6.
8A	Supergroup demodulator tray	SGR DEM IN	Patch supergroup carrier into test set. Turn FREQ RANGE switch to applicable supergroup. Turn GROUP switch to applicable group.

Table 5-7. Performance Test of Transmission Equipment by Measurement of Group Pilot Level (Cont)

STEP	POINT OF TEST		OPERATION OF TRANSMISSION TEST SET
	EQUIPMENT	JACK	
8A	Supergroup demodulator tray (Cont)		Calibrate meter with ZERO SET controls. Connect test cord to point of test. Meter should read between -2 db and +3 db.
8B		AMPL A OUT	Turn FREQ RANGE switch to 312-552 SGR 2. Turn GROUP switch to applicable group. Calibrate meter with ZERO SET controls. Connect test cord to point of test. Meter should read 0 db ±2 db.
8C		AMPL B OUT	Same as step 8B.
8D		SGR DEM OUT	Same as step 8B.
9A	Group demultiplexer shelf	GR DMX IN	Same as step 8B.
9B		60-108 KC OUT, GR 1 thru GR 5	Turn FREQ RANGE switch to 60-108. Calibrate meter with ZERO SET controls. Connect test cord to point of test. Meter should read between -5 db and +2 db. (Refer to paragraph f of preliminary instructions.)
10	Channel demultiplexer shelf	CHANNEL DMX IN	Same as step 9B.

5-85. CHANNEL. The performance of the transmission equipment for an individual channel can be evaluated by sending a 1-kc test tone over the channel and measuring the vf receiving level. Because the multiplexer set does not include normalled-through vf jacks, the test tone should be inserted and measured at the external vf patch bay or four-wire test board. The optional four-wire vf transmitting/receiving levels are -16/+7 dbm, -4/+1 dbm, and 0/0 dbm. On a 600-ohm terminated meter, the measured vf receiving level should be within ±1 db (or as specified in facility or system standards) of the applicable optional level.

NOTE

If the transmission test set is to be used to generate and measure the 1-kc test tone, refer to the alignment procedures in paragraph 5-144.

5-86. CHANNEL NOISE. The noise performance of a 4-kc wide channel in a microwave communications system is the sum of the noise contributed by the multiplex equipment and the radio equipment; it is affected by system layout as well as equipment design. For a short-haul system (under 200 miles), a typical standard for maximum per-channel noise is 2000 pwp0, with 1600 pwp0 allotted to the radio and 400 pwp0 to the multiplex equipment. These are system design values and they can be verified only with the equipment out of service and in a precise test configuration.

5-87. Three of the most common units for specifying noise are dba (F1A weighting), dbrnc (C-message weighting), and pwp (picowatts psophometrically weighted). At the zero transmission level point, the units are written as dba0, dbrnc0, and pwp0. Approximate conversions between units, which are accurate enough for most purposes, are given in table 5-8 and by the following:

a. $\text{dba} = -6 + 10 \log_{10} \text{pwp}$

b. $\text{dbrnc} = \text{dba} + 6$

c. $\text{dbrnc} = 10 \log_{10} \text{pwp}$

d. dba = 82 + F1A-weighted noise in dbm

Table 5-8. Conversion Between Noise Units

DBA	PWP	DBA	PWP	DBA	PWP
-6	1.0	14	100	34	10,000
-5	1.3	15	126	35	12,600
-4	1.6	16	159	36	15,900
-3	2.0	17	200	37	20,000
-2	2.5	18	252	38	25,200
-1	3.0	19	316	39	31,600
0	4.0	20	398	40	39,800
1	5.0	21	502	41	50,200
2	6.3	22	631	42	63,100
3	7.9	23	794	43	79,400
4	10.0	24	1,000	44	100,000
5	12.6	25	1,260	45	126,000
6	15.9	26	1,590	46	159,000
7	20.0	27	2,000	47	200,000
8	25.2	28	2,520	48	252,000
9	31.6	29	3,160	49	316,000
10	39.8	30	3,980	50	398,000
11	50.2	31	5,020	51	502,000
12	63.1	32	6,310	52	631,000
13	79.4	33	7,940	53	794,000

NOTE: Dbrnc = dba + 6

5-88. The combined effect of noise from more than one source can be calculated by simple addition if the noise is expressed in picowatts, but if it is in one of the logarithmic units, a graph such as figure 5-11 must be used. For example, 400 pwp0 + 1600 pwp0 = 2000 pwp0 is equivalent to 20 dba0 + 26 dba0 = 27 dba0.

5-89. Channel noise consists of intermodulation noise, which increases directly with loading by traffic, and idle noise, which is thermal in nature and unaffected by loading. Some of the idle noise originates in the antenna and front-end of the microwave radio receiver and varies inversely with the strength of the incoming rf signal.

5-90. Usually, before a system is turned up to traffic, the noise performances of the multiplex and radio equipment are measured separately as part of the operational tests. Because of the complexity of the test configuration that simulates loading on the multiplexer set, it is not practicable to repeat the measurements as a periodic routine. (Yet, it is quite easy to measure the noise performance of the radio under simulated load.)

5-91. If the noise performance of the radio has been determined previously, the noise contribution of the multiplex terminals may be calculated (as in paragraph 5-88) from channel noise measurements made with the system in an operating configuration at periods of peak traffic. The results may not be very accurate, however, because the load imposed by a large number of channels varies from moment to moment and may never reach a value that can be identified as peak load.

5-92. Although noise measurement on a single channel may not give an accurate indication of the performance of the transmission equipment, if the performance of many channels is checked and recorded

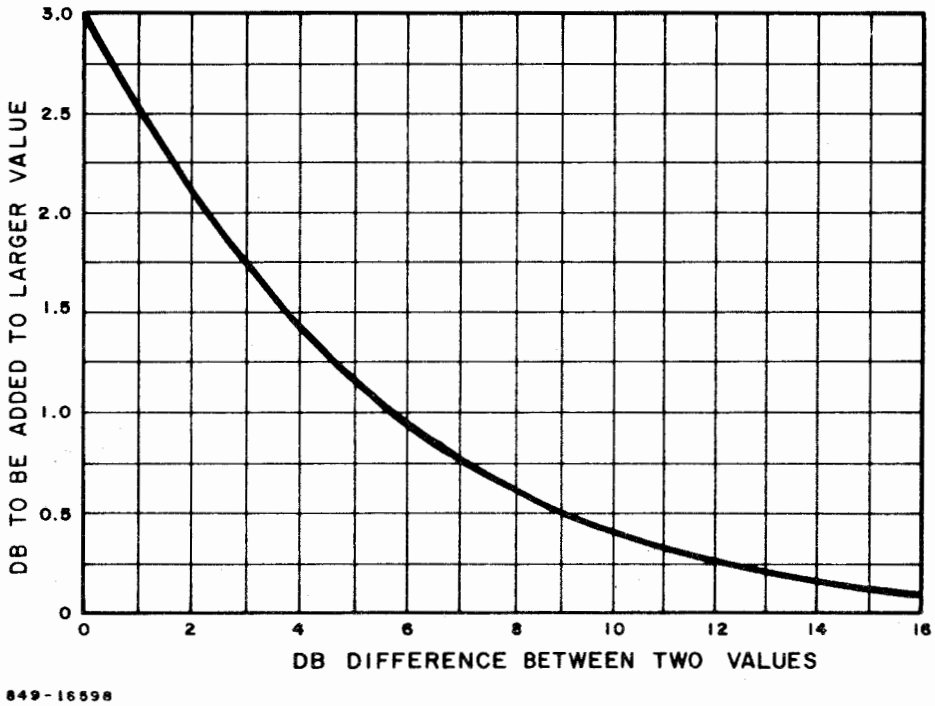

Figure 5-11. Addition of Powers Expressed in Db or Other Logarithmic Units

periodically, some meaningful conclusions may be derived by comparison with previously recorded data and by comparisons between corresponding channels on different groups and supergroups. For example, if all the channels on one group are consistently noisier (by several db) than the channels on other groups, a defective group amplifier or modulator may be suspected.

5-93. Channel noise should be measured at the external normalled-through jacks in the four-wire vf receiving circuit. Set the noise measuring set (Western Electric 3A, or equivalent) for a 600-ohm terminating measurement; also, terminate in 600 ohms the input to the channel at the other end of the system.

5-94. ALARM CIRCUITS.

5-95. On the master alarm panel and the master frequency generator shelf, test circuits for simulating an alarm condition have been provided.

5-96. MASTER ALARM PANEL. With the ALARM CUTOFF toggle switches in NORMAL position, press the MINOR TEST and MAJOR TEST pushbuttons, in turn. The applicable alarm lamp should light and the corresponding external alarm should operate until you release the pushbutton.

5-97. MASTER FREQUENCY GENERATOR SHELF. Withdraw the shelf and perform this test on each tray, in turn.

CAUTION

Be very careful not to accidentally ground the ALM TEST test point. Transistors in alarm control module A1 will be damaged.

a. Connect multimeter (dc volts) to ALM TEST (negative) and COM test points. Meter should read about 42 volts.

b. Continuously press ALM TEST pushbutton. Meter reading should drop, then slowly increase to about 46 volts.

c. Release pushbutton. MINOR ALARM lamp should light momentarily and meter reading should return to about 42 volts.

5-98. ALIGNMENT OF MULTIPLEXER SET.

5-99. The procedures used in the alignment of the multiplexer set are arranged in four categories; for a complete system alignment, perform the procedures at both terminals in the sequence listed below:

a. Power supply equipment, paragraph 5-101.

b. Carrier supply equipment, paragraph 5-104.

c. Transmitting branch (of the transmission equipment), paragraph 5-113.

d. Receiving branch (of the transmission equipment), paragraph 5-130.

5-100. STRAPPING AND ADJUSTMENT. Table 5-9 summarizes changes in the operation of the multiplexer set that can be made by strapping or by adjustment of controls. Detailed instructions for strapping are given in Section III of Chapter 2; adjustments are covered in the alignment procedures which follow.

5-101. ALIGNMENT OF POWER SUPPLY EQUIPMENT.

5-102. POWER SUPPLY SHELF.

5-103. The power supply shelf has two trays, A on the left and B on the right.

Table 5-9. Summary of Equipment Strapping and Adjustment

EQUIPMENT	VARIANT	STRAP OR ADJUST
POWER SUPPLY EQUIPMENT		
Master alarm panel	Alarm circuit power source (120 vac or 48 vdc)	Strap subassembly A3.
Power supply tray	Dc output voltage	Adjust DC ADJUST control.
CARRIER SUPPLY EQUIPMENT		
Master frequency generator tray	Master or slave mode	Strap power transformer A6, alarm control A1, and oscillator A5.
	Frequency of ac power	Strap servo amplifier A7.
	Sync pilot level at slave terminal	Strap subassembly A3.
	Carrier frequency sync	Adjust FREQUENCY ADJUST control.
Channel carrier supply shelf	Load	Strap subassemblies A28 and A29.
Channel carrier amplifier shelf	Load	Strap subassemblies A28 and A29.
Group carrier generator shelf	None	
Group carrier supply shelf	Group carrier load	Strap subassembly A22.
	Sgr 1 carrier load	Strap subassembly A22.
	Sgr 1 carrier frequency	Strap subassembly A22.
Group carrier amplifier shelf	Group carrier load	Strap subassembly A28.
	Sgr 1 carrier load	Strap subassembly A28.
	Sgr 1 carrier frequency	Strap subassembly A28.
Supergroup carrier generator shelf	None	

Table 5-9. Summary of Equipment Strapping and Adjustment (Cont)

EQUIPMENT	VARIANT	STRAP OR ADJUST
CARRIER SUPPLY EQUIPMENT (Cont)		
Supergroup carrier supply shelf	Load	Strap subassembly A41.
Supergroup carrier amplifier shelf	Amplifier circuit configuration	Strap subassemblies A19 and A20, and A21 thru A26.
	Load	Strap subassembly A27.
TRANSMISSION EQUIPMENT		
Channel multiplexer shelf	Vf transmitting level	Strap sockets for modulators A13 through A24.
	Group pilot frequency	Strap subassembly A27.
	Group pilot transmitting level	Adjust 64KC PILOT ADJUST control.
Channel demultiplexer shelf	Vf receiving level	Adjust LEVEL ADJUST controls.
Group pilot alarm shelf	None	
Group multiplexer shelf	Group transmitting levels	Adjust LEVEL ADJUST controls.
Group demultiplexer shelf	Group receiving levels	Adjust LEVEL ADJUST controls.
Supergroup modulator trays	None	
Supergroup demodulator trays	None	
Supergroup modulator combining panel	Sync pilot	Strap subassembly A5.
	Line transmitting level (pn 790-07210-xx only)	Strap attenuator A8 (span pad).
	Grounded output cable	Strap terminals X and Y.

Table 5-9. Summary of Equipment Strapping and Adjustment (Cont)

EQUIPMENT	VARIANT	STRAP OR ADJUST
TRANSMISSION EQUIPMENT (Cont)		
Line connector panel	Line transmitting level	Set TRANSMIT ATTEN switches.
	Line receiving level	Set RECEIVE ATTEN switches.
Supergroup demodulator combining panel	Line receiving level	Strap attenuator A8 (span pad).
	Grounded input cable	Strap terminals X and Y.

This procedure sets the dc output voltage of each tray independently, and then checks the voltage across the load with both trays operating in parallel. For a complete alignment of the multiplexer set, perform the procedure on all power supply shelves.

WARNING

When you raise the covers on the power supply trays, dangerous voltages are exposed.

a. Pull out power supply shelf and raise covers on trays.

b. On the B tray, throw AC BREAKER switch to OFF.

NOTE

With one power supply tray turned off, you must be extremely careful in adjusting the output voltage of the other tray. Turning the DC ADJUST control clockwise raises the output voltage. At about 52 volts, a high-voltage alarm will disconnect the load, thus causing a complete loss of dc voltage to part of the multiplexer set.

c. On the A tray:

(1) Connect multimeter (50 vdc range) to 49V test points.

(2) With a screwdriver, very slowly turn DC ADJUST control (at the rear of the tray on the left) counterclockwise until MINOR ALARM A lamp just lights. Meter reading should be approximately 47 volts. Record the exact voltage.

(3) Slowly turn DC ADJUST control clockwise until multimeter reads exactly 2.0 volts higher than recorded in preceding step. MINOR ALARM A lamp should go out during the adjustment.

d. On the B tray, throw AC BREAKER switch to ON; on the A tray, throw AC BREAKER switch to OFF.

e. Perform the same procedure as in step c, except on the B tray.

f. On the A tray, throw AC BREAKER switch to ON.

g. Connect multimeter (50 vdc scale) to LOAD VOLTAGE test points. Meter reading should be 0.5 to 1.5 volts above the

higher of the voltages recorded in steps c and e. (Recorded voltage was approximately 47 volts.)

h. Close covers on trays and retract shelf.

5-104. ALIGNMENT OF CARRIER SUPPLY EQUIPMENT.

5-105. CARRIER LEVELS.

5-106. The carrier distribution circuits do not have variable controls for setting levels. However, they do include load resistors which are strapped in accordance with equipment configuration; improper strapping could cause large errors in carrier supply voltages. In a complete alignment of the multiplexer set, make the performance tests described in paragraphs 5-78 to verify that carrier levels are normal.

5-107. MASTER FREQUENCY GENERATOR SHELF.

5-108. FREQUENCY ADJUSTMENT OF SLAVE OSCILLATOR. At a slave terminal, the natural frequency of the 128-kc oscillator is corrected by an automatic tuning circuit to maintain synchronization with the 128-kc oscillator at the master terminal. If the oscillator frequencies drift apart by more than about 1-1/2 cps, the necessary correction will be out of the range of the automatic tuning circuit, synchronization will be lost, and an alarm will be given. This alignment procedure adjusts the frequency of the oscillator at the slave terminal to achieve synchronization and sets the automatic tuning circuit at the center of its correction range.

5-109. In the synchronization procedure, the required meter readings depend on whether the master frequency generator shelf is equipped with mechanical memory. If you don't know, check the identification markings on module A10 at the left, rear of each tray. With mechanical memory, A10 is a 60-cps servo (pn 790-05695-01) or 400-cps servo (pn 790-05114-01). Without mechanical memory, A10 is a dummy servo (pn 790-07217-01).

5-110. For a complete alignment, perform the procedure on each master frequency generator tray (A on the left and B on the right), in turn. You will need a multimeter and an alignment tool, as well as the transmission test set. The alignment tool is mounted in a clip at the back of the tray.

a. Pull out master frequency generator shelf.

b. On the transmission test set, turn FUNCTION switch to position 3 and insert one end of a test cord in TEST TONE OR CARRIER INPUT jack J2.

c. With the test set, check level at LOCAL 96 KC and INCOMING PILOT 96 KC jacks on master frequency generator tray. At each jack, the meter should read 0 db ±2 db. Extreme fluctuations in level is evidence that the oscillators are not synchronized.

NOTE

Make measurements with the multimeter set at the lowest range that will accommodate the dc voltages encountered; the maximum in this procedure is 18 volts.

d. Connect multimeter (ac volts) to DET OUT and COM test points.

e. Throw AC BREAKER switch to OFF. MINOR ALARM lamp will light, if it is not already on.

CAUTION

The FREQUENCY ADJUST control is a piston capacitor; it has a recessed hexagon head of relatively soft metal which could be damaged easily by the alignment tool. When you insert the tool, don't apply any downward force; let the weight of the tool cause it to seat. Turn the tool lightly, using only your thumb and forefinger, and be careful not to force the control at the limits of its travel.

f. With the alignment tool, slowly turn FREQUENCY ADJUST control to obtain a steady meter reading of 0 volts. (If the 128-kc oscillators at the master terminal and slave terminal are not synchronized, the meter will fluctuate at a rate equal to the difference in the frequencies of the two oscillators; if the difference is small, the meter will swing several volts.)

g. Throw AC BREAKER switch to ON. MINOR ALARM lamp should go out.

h. If the shelf is equipped with mechanical memory, connect multimeter (dc volts) to TUN VOLTAGE (negative) and COM test points. Slowly turn FREQUENCY ADJUST control for a meter reading of 11.0 volts.

i. On the master frequency generator shelf at the master terminal, throw MAIN STANDBY SELECTOR switch to its alternate position.

See Supp C

j. Transfer multimeter (ac volts) to DET OUT and COM test points. Meter should read 0 volts ±0.5 volts. (Without mechanical memory, reading should be between -2 and +2 volts.)

NOTE

If in the preceding step, the meter persistently fluctuates, it indicates that the oscillator at the slave terminal will not synchronize with the alternate oscillator at the master terminal. This can happen if there is too much difference in the frequencies of the two oscillators at the master terminal. To achieve synchronization, you may have to change the setting of the FREQUENCY ADJUST control on one or both of the oscillators at the master terminal; refer to paragraph 5-111.

k. Connect multimeter (dc volts) to TUN VOLTAGE (negative) and COM test points. Meter reading should be between 9 and 13 volts. (Without mechanical memory, reading should be 11 volts ±0.5 volts.)

l. On the master frequency generator shelf at the master terminal, restore MAIN STANDBY SELECTOR switch to its original position.

5-111. FREQUENCY ADJUSTMENT OF MASTER OSCILLATOR. As explained in paragraph 5-108, the oscillators at a slave terminal will not synchronize with both the A and B oscillators at a master terminal if the A and B frequencies differ by more than about 1-1/2 cps. This difference may develop from long-term (several months) frequency drift, or it may occur if one oscillator is replaced, or if the oscillators are tuned haphazardly. If you have an electronic counter with an accuracy of at least one part in 10^6, the following procedure may be used when it is necessary to tune the oscillators at the master terminal to the exact required frequency.

a. Connect counter to output circuit of group carrier supply shelf feeding 612-kc group carrier to group multiplexer and demultiplexer shelves. This circuit, which

has carrier level of almost 1 volt, can be measured on terminal board panel A1 of the common equipment rack. Refer to the cabling diagram in the Circuit Diagrams manual for terminal numbers.

b. Pull out master frequency generator shelf.

c. For adjustment of the A oscillator frequency, throw MAIN STANDBY SELECTOR switch to A MAIN.

d. On the A master frequency generator tray, with the alignment tool, slowly turn FREQUENCY ADJUST control for a counter reading equivalent to 612,000.0 cps (±0.5 cps). Use a 10-second count.

e. To adjust B oscillator frequency, throw MAIN STANDBY SELECTOR switch to B MAIN and perform step d on B master frequency generator tray.

f. Restore MAIN STANDBY SELECTOR switch to A MAIN and secure equipment at master terminal.

g. At slave terminal, adjust frequency of oscillators using procedure in paragraph 5-108.

5-112. If an electronic counter is not available, you can select one master oscillator as the standard and tune the other to the same frequency. If one of the oscillators is known to be more accurate than the other, use it as the standard; in the following procedure, the A oscillator is assumed to be the standard and the B oscillator will be tuned to its frequency.

a. At master terminal, throw MAIN STANDBY SELECTOR switch to A MAIN.

b. Using procedure in paragraph 5-108, synchronize each oscillator at slave terminal to the A oscillator at master terminal. (Omit steps in procedure that test for synchronism with alternate master oscillator.)

c. At slave terminal, on either master frequency generator tray:

(1) Connect multimeter (ac volts) to DET OUT and COM test points.

(2) Throw AC BREAKER switch to OFF.

d. At master terminal:

(1) Throw MAIN STANDBY SELECTOR switch to B MAIN.

(2) On B master frequency generator tray, turn FREQUENCY ADJUST control to obtain steady meter reading of 0 volts on multimeter at slave terminal.

e. At slave terminal, restore AC BREAKER switch to ON.

f. On each tray at slave terminal, for both positions of MAIN STANDBY SELECTOR switch at master terminal, check that voltage between test points is within the following limits:

(1) DET OUT and COM: -0.5 to +0.5 volt (without mechanical memory, -2 volts to +2 volts)

(2) TUN VOLTAGE (negative) and COM: 9 to 13 volts (without mechanical memory, 11 volts ±0.5 volt)

5-113. ALIGNMENT OF TRANSMITTING BRANCH.

5-114. CHANNEL MULTIPLEXER SHELF.

5-115. PRELIMINARY CHECK OF CHANNEL TRANSMITTING LEVEL. This

procedure is not essential to the alignment of the transmitting branch, but may be used for a preliminary checkout of the vf equipment and the channel multiplexer shelf. In this portion of the transmitting branch, there are no variable controls, but the channel multiplexer shelf has optional strapping that affects transmission levels.

5-116. In the following procedure, the transmission test set sends a 1-kc tone into one channel and measures the level of the resultant tone in the 60-108 kc group band; other channels of the same group must be idle.

a. On the transmission test set, turn FUNCTION switch to position 1 and FREQ RANGE switch to 60-108.

b. Calibrate meter on test set at 0 db with ZERO SET controls, first in ZERO SET 1 and then in ZERO SET 2 position. Restore switch to TEST.

c. Turn FUNCTION switch to position 2.

d. While pressing CHAN TEST TONE CAL pushbutton, set meter at 0 db with CHAN TEST TONE ADJ control.

e. Turn VF LEVEL switch to applicable vf transmitting level.

f. Turn FUNCTION switch to position 4.

g. Patch TEST TONE OR TEST PILOT OUTPUT jack J3 to an external four-wire vf transmitting jack that "looks" toward multiplexer set.

h. Insert a 135-ohm termination plug in applicable CHAN MX OUT jack on group transmitting jackfield.

i. Patch PILOT MONITORING OR TEST TONE INPUT jack J1 to CHANNEL MX OUT jack on channel multiplexer shelf.

j. With ZERO SET switch in TEST position, meter should read 0 db ±2 db.

k. Other channels in the same group or another group can be checked without further adjustment or calibration of the transmission test set. Transfer test cords and termination plug to applicable jacks.

5-117. GROUP PILOT LEVEL. This procedure sets the transmitting level of the group pilot. For a complete alignment of the multiplexer set, adjust the pilot level in each channel multiplexer shelf.

a. On the transmission test set, turn FUNCTION switch to position 1 and FREQ RANGE switch to 60-108.

b. Calibrate meter on test set at 0 db with ZERO SET controls, first in ZERO SET 1 and then in ZERO SET 2 position. Restore switch to TEST.

c. Insert one end of a test cord in PILOT MONITORING OR TEST TONE INPUT jack J1 on test set.

d. Pull out channel multiplexer shelf.

e. Plug test cord into CHANNEL MX OUT jack on front of channel multiplexer shelf.

f. Insert a 135-ohm termination plug in applicable CHAN MX OUT jack on group transmitting jackfield.

g. Adjust 64 KC PILOT ADJUST control on top of channel multiplexer shelf for meter reading of 0 db.

h. Remove 135-ohm termination plug.

i. To adjust the transmitting level of another group pilot, return to step d.

5-118. GROUP MULTIPLEXER SHELF.

5-119. GROUP TRANSMITTING LEVEL. In this procedure, you adjust the transmitting level in the group multiplexer shelf while monitoring the group pilot at the line side of the supergroup modulator tray. For a complete alignment of the multiplexer set, adjust the level of the five groups in each group multiplexer shelf.

5-120. The most accurate adjustment is made with the output of the tray terminated in 75 ohms as specified in the procedure; because this opens the transmission path, the supergroup must be removed from service. However, if the multiplexer set is connected to a load which presents an accurate 75-ohm termination, an in-service adjustment can be made by omitting procedural step d or e, as applicable.

a. Pull out group multiplexer shelf.

b. On the transmission test set, turn FUNCTION switch to position 1 and FREQ RANGE switch to applicable supergroup.

c. Patch PILOT MONITORING OR TEST TONE INPUT jack J1 on test set to SGR MOD OUT jack on supergroup modulator tray.

d. Except if the group is in supergroup 2, patch SGR CARRIER jack J4 on test set to SGR CARRIER jack on supergroup modulator tray.

e. If the multiplexer set uses a line connector panel, remove cover and insert a 75-ohm telephone termination plug in TRANSMIT EQUIP jack. (Refer to paragraph 5-14 for an alternate method of terminating.)

f. If the multiplexer set uses a supergroup modulator combining panel, open the cover. Remove coaxial U-link between applicable SGR MOD OUT and COMBINING HYBRID IN jacks, and insert a 75-ohm coaxial termination plug in vacated SGR MOD OUT jack.

g. Turn GROUP switch on test set to applicable group.

h. Calibrate meter on test set at 0 db with ZERO SET controls, first in ZERO SET 1 and then in ZERO SET 2 position. Restore switch to TEST.

i. Adjust applicable LEVEL ADJUST control on top of group multiplexer shelf for meter reading of 0 db.

j. To adjust the transmitting level of another group in the same supergroup, return to step g. If the group is in another supergroup, begin again at step a.

NOTE

After you have finished with a supergroup, be sure to remove the 75-ohm termination plug. Also, on the supergroup demodulator combining panel, replace the coaxial U-link.

5-121. HF TRANSMITTING LINE LEVEL.

5-122. The preceding alignment procedures for the transmitting branch established a channel test tone level of -36.5 dbm at the output of the low-level supergroup modulator trays or -19.5 dbm at the output of the high-level supergroup modulator tray. There are no further variable controls in the transmitting branch, but the line connector panel and the special supergroup modulator combining panel (pn 790-07210-xx) have fixed pads that you can insert or remove to establish a line level in the ranges specified in table 5-10.

5-123. In the first alignment of the multiplexer set, the hf transmitting line level is set in accordance with system requirements.

Table 5-10. HF Transmitting Line Levels

EQUIPMENT	PART NO.	TEST TONE LEVEL, DBM		
		MAXIMUM	MINIMUM	*0 DB ON TEST SET
Line connector panel	790-03029-01	-20	-23.5	-20
	-02	-20	-23.5	-23
	-03	-37	-40.5	-40
Supergroup modulator combining panel	790-03532-xx	-40	-40	-40
	790-07210-01, -03	-40	-55	#-40
	790-07210-02, -04	-23	-38	#-23

*This column lists the equivalent test tone level at the line when a group pilot indicates 0 db on the transmission test set at the HF OUT jack.

#Does not include the loss in the span pad. See paragraph 5-128.

Thereafter, changes should not be required unless the system is altered.

5-124. LINE CONNECTOR PANEL. The minimum insertion loss of the line connector panel is about 0.5 db, hence the maximum output level to the line is either -37 dbm or -20 dbm. By setting the three TRANSMIT ATTEN switches on the panel, insertion loss can be increased in 0.5 db steps through a 3.5-db range, reducing the line level correspondingly. In the IN POSITION of a switch, the designated insertion loss is inserted in the transmission path; in the OUT position, it is removed.

5-125. SUPERGROUP MODULATOR COMBINING PANEL. The standard panel (pn 790-03532-xx) has an insertion loss of 3.5 db. Its input signals are from the low-level supergroup modulator trays at -36.5 dbm, so that the line level is fixed at -40 dbm.

5-126. The special supergroup modulator combining panel (pn 790-07210-xx) operates with low-level or high-level supergroup modulator trays. It has a fixed insertion loss of 3.5 db, but output level to the line can be adjusted in 1-db steps by strapping a 0-15 db span pad. Strapping details are given on the schematic diagram in the Circuit Diagrams manual.

5-127. TEST JACK. Group pilot level can be measured with the transmission test set at the HF OUT test jack on the line connector panel or supergroup modulator combining panel. The equivalent test tone level at the line can then be determined from table 5-10.

5-128. On the line connector panel and the standard supergroup modulator combining panel (pn 790-03532-xx), the HF OUT jack is at the transmitting line but on the special supergroup modulator combining panel (pn 790-07210-xx), the HF OUT jack precedes the 15-db span pad so the actual line level will be lower than the measured level by the loss strapped into the pad.

5-129. LEVEL MEASUREMENT. The following procedure, which checks group pilot level at the HF OUT test jack, may be used in alignment of the multiplexer set to verify signal continuity to the line. Because levels are affected by the impedance characteristics of the transmission equipment to which the multiplexer set is connected, a reading that is out of tolerance does not necessarily indicate trouble in the multiplexer set. A record of the level measured for each group at the HF OUT test jack may be useful for future performance testing or troubleshooting.

a. Remove cover on line connector panel or supergroup modulator combining panel.

b. Turn FUNCTION switch on transmission test set to position 1.

c. Patch PILOT MONITORING OR TEST TONE INPUT jack J1 on test set to HF OUT jack on panel.

d. Turn FREQ RANGE switch on test set to applicable supergroup.

e. Except for supergroup 2, patch SGR CARRIER jack J4 on test set to SGR CARRIER jack on applicable supergroup modulator or demodulator tray.

f. Turn GROUP switch on test set to applicable group.

g. Calibrate meter on test set at 0 db with ZERO SET controls, first in ZERO SET 1 and then in ZERO SET 2 position. Restore switch to TEST.

h. Meter should read approximately 0 db or as calculated from table 5-10 for a particular system transmission level.

i. To check another group in the same supergroup, return to step f. For another supergroup, begin again at step d.

5-130. ALIGNMENT OF RECEIVING BRANCH.

5-131. HF RECEIVING LINE LEVEL.

5-132. The hf receiving line level is determined by the transmission equipment to which the multiplexer set is connected, but must be in the applicable range specified in table 5-11. In the first alignment of the multiplexer set, fixed pads in the line connector panel or supergroup demodulator combining panel are set in accordance with the line level to yield a test tone level of -29.5 dbm at the input to the supergroup demodulator trays. Thereafter, changes in the pads should not be required unless the system is altered.

5-133. LINE CONNECTOR PANEL. The minimum insertion loss of the line connector panel is 3.5 db, hence the minimum input level from the line is -26 dbm. By setting the three RECEIVE ATTEN switches on the panel, insertion loss can be increased in 0.5-db steps through a 3.5 db range to accommodate input levels between -26 and -22.5 dbm.

5-134. SUPERGROUP DEMODULATOR COMBINING PANEL. The minimum insertion loss of the supergroup demodulator combining panel is 5 db, hence the minimum input level from the line is -24.5 dbm. By strapping the span pad on the panel, insertion loss can be increased in 1-db steps to accommodate a level within the range shown in table 5-11. The span pad usually has a 15-db range, strappable in 1-db steps. One of the special supergroup demodulator combining panels (pn 790-07211-01) has a 19-db span pad, strappable in 1-db steps between 0 and 7 db and between 12 and 19 db. Strapping details are given on the applicable schematic diagram in the Circuit Diagrams manual.

Table 5-11. HF Receiving Line Levels

EQUIPMENT	PART NO.	TEST TONE LEVEL, DBM		
		MAXIMUM	MINIMUM	*0 DB ON TEST SET
Line connector panel	790-03029-01	-22.5	-26	-26
	-02	-22.5	-26	-23
	-03	-22.5	-26	-26
Supergroup demodulator combining panel	790-03533-xx	-9.5	-24.5	#
	790-07211-01	-5.5	-24.5	-10
	790-07211-02, -03	-9.5	-24.5	-15

*This column lists the equivalent test tone level at the line when a group pilot indicates 0 db on the transmission test set at the HF IN jack.

#HF IN jack not provided.

5-135. LEVEL MEASUREMENT. On the line connector panel and on the special supergroup demodulator combining panel (pn 790-07211-xx), there is an HF IN jack where group pilot levels can be checked with the transmission test set. Equivalent test tone levels at the receive line can be calculated from table 5-11. Measurements at the HF IN jack are useful only to verify the continuity of the transmission path from the distant terminal; use the procedure described in paragraph 5-129 except measure at the HF IN jack and determine levels from table 5-11.

5-136. SUPERGROUP RECEIVING LEVEL.

5-137. After the transmission equipment has been aligned and the multiplex baseband signal is being received at its assigned level, measure and record the supergroup receiving level of at least one group in each supergroup. This will verify that the line level is correct and that the fixed pads in the line connector panel or supergroup demodulator combining panel have been set properly. If the meter readings on the transmission test set are uniformly above or below 0 db, reset the fixed pads accordingly. Proceed as follows:

a. On the transmission test set, turn FUNCTION switch to position 1 and FREQ RANGE switch to 312-552 SGR 2.

b. Patch PILOT MONITORING OR TEST TONE INPUT jack J1 on test set to SGR DEM OUT jack on supergroup demodulator tray.

NOTE

If the supergroup is out of service, the accuracy of the measurement may be improved by removing the U-link and inserting a 75-ohm coaxial terminating plug in the SGR DEM OUT jack on the supergroup receiving jackfield. (This jackfield is not part of Multiplexer Set AN/FCC-21.)

c. Turn GROUP switch on test set to applicable group.

d. Calibrate meter on test set at 0 db with ZERO SET control, first in ZERO SET 1 and then in ZERO SET 2 position. Restore switch to TEST.

e. Meter should read 0 db ±2 db.

f. To measure the level of another group in the same supergroup, return to step c. For another supergroup, begin again at step b.

5-138. GROUP DEMULTIPLEXER SHELF.

5-139. PRELIMINARY ADJUSTMENT OF GROUP RECEIVING LEVEL. If the transmission path between terminals has not been established, the group receiving level may be adjusted tentatively using the transmission test set to supply the necessary group pilots; final adjustment must be made as described in paragraph 5-140. In the following procedure, the pilot from the test set is inserted in the supergroup demodulator combining panel or line connector panel and monitored at the output of the group demultiplexer shelf.

a. On the transmission test set, turn FUNCTION switch to position 1 and FREQ RANGE switch to 60-108.

b. Calibrate meter on test set at 0 db with ZERO SET controls, first in ZERO SET 1 and then in ZERO SET 2 position. Restore switch to TEST.

c. If the supergroup demodulator combining panel is used, open its cover. Remove coaxial U-link between applicable COMBINING HYBRID OUT and SGR DEM IN jacks, and patch TEST TONE OR TEST PILOT OUTPUT jack J3 on test set to vacated SGR DEM IN jack.

d. If the line connector panel is used, remove its cover. Patch TEST TONE OR TEST PILOT OUTPUT jack J3 on test set to RECEIVE EQUIP jack on panel.

e. Except if the group is in supergroup 2, patch SGR CARRIER jack J4 on test set to SGR CARRIER jack on applicable supergroup demodulator tray.

f. On the test set, turn FUNCTION switch to position 6 and FREQ RANGE switch to applicable supergroup.

g. Calibrate test set as follows:

(1) Turn GROUP switch to applicable group.

(2) Turn ZERO SET switch to ZERO SET 1 and adjust ZERO SET 1 control for meter reading of 0 db.

(3) Turn ZERO SET switch to TEST.

h. On the group receiving jackfield, insert a 135-ohm termination plug in the applicable GR DMX OUT jack.

i. Pull out the group demultiplexer shelf.

(1) Patch PILOT MONITORING OR TEST TONE INPUT jack J1 on test set to applicable 60-108 KC OUT jack.

(2) Adjust corresponding LEVEL ADJUST control for meter reading of 0 db.

j. Remove 135-ohm termination plug.

k. To adjust the receiving level of another group in the same shelf, return to step g. For another supergroup, start over at step c.

NOTE

After you have finished with each supergroup, be sure to replace the coaxial U-link on the supergroup demodulator combining panel.

5-140. GROUP RECEIVING LEVEL. In this procedure, you will set the group receiving level while monitoring a pilot transmitted from the distant terminal. Because the group receiving signal will be terminated on the jackfield, the group must be taken out of service. For a complete alignment of the multiplexer set, adjust the level in the five groups on each group demultiplexer shelf.

a. On the transmission test set, turn FUNCTION switch to position 1 and FREQ RANGE switch to 60-108.

b. Calibrate meter on test set at 0 db with ZERO SET controls, first in ZERO SET 1 and then in ZERO SET 2 position. Restore switch to TEST.

c. On the group receiving jackfield, insert a 135-ohm termination plug in the applicable GR DMX OUT jack.

d. Pull out the group demultiplexer shelf.

(1) Patch PILOT MONITORING OR TEST TONE INPUT jack J1 on test set to applicable 60-108 KC OUT jack.

(2) Adjust corresponding LEVEL ADJUST control for meter reading of 0 db.

e. Remove 135-ohm termination plug.

f. To set the level in another group, return to step c.

5-141. CHANNEL DEMULTIPLEXER SHELF.

5-142. PRELIMINARY ADJUSTMENT OF VF RECEIVING LEVEL. An experimental alignment of the channel demultiplexer shelf can be made using test tones generated by the transmission test set; the final level adjustment must be made as described in paragraph 5-143. In the following procedure, a channel test tone in the 60-108 kc band is inserted at the group receiving jackfield and monitored as a 1-kc tone on the vf jackfield external to the multiplexer set.

a. On the transmission test set, turn FUNCTION switch to position 5 and calibrate as follows:

(1) While pressing CHAN TEST TONE CAL pushbutton, adjust CHAN TEST TONE ADJ control for meter reading of 0 db.

(2) Release pushbutton.

b. Patch TEST TONE OR TEST PILOT OUTPUT jack J3 on test set to CHAN DMX IN jack of associated group on group receiving jackfield.

c. On the transmission test set:

(1) Turn CHANNEL switch to applicable channel. (Each position of the switch selects two adjacent channels.)

(2) Turn VF LEVEL switch to RCVG level (+7, 0, or +1) assigned to channel.

d. Patch TEST TONE OR CARRIER INPUT jack J2 on test set to external four-wire vf jack that "looks" toward channel receiving circuit in the multiplexer set.

e. On the channel demultiplexer shelf, adjust applicable LEVEL ADJUST control for meter reading of 0 db on test set.

f. To adjust the level in another channel on the same shelf, return to step c. For another shelf, begin at step b.

5-143. VF RECEIVING LEVEL. In this final part of the alignment, you will set the vf receiving level while monitoring a

1-kc test tone transmitted from the distant terminal. For a complete alignment of the multiplexer set, adjust the 12 channels on each channel demultiplexer shelf. Both directions can be aligned at the same time by performing all steps at each terminal.

5-144. This procedure uses the transmission test set to generate and measure the 1-kc test tone. However, if the four-wire vf transmitting and receiving jacks are not adjacent to the multiplexer set, you may have to use external test equipment. Many multiplex facilities will have a vf patch bay or four-wire test board, including a test tone generator and level meter that will be more suitable than the transmission test set for precise setting of vf drop levels.

a. At each terminal, turn FUNCTION switch on test set to position 2.

b. At the transmitting terminal, while pressing CHAN TEST TONE CAL pushbutton on test set, adjust CHAN TEST TONE ADJ control for meter reading of 0 db.

c. At the transmitting terminal:

(1) Turn VF LEVEL switch S7 on test set to XMTG level (-16, 0, or -4) assigned to channel.

(2) Patch TEST TONE OR TEST PILOT OUTPUT jack J3 on test set to external four-wire vf jack that "looks" toward channel transmitting circuit in multiplexer set.

d. At the receiving terminal:

(1) Turn VF LEVEL MEAS switch S8 on test set to TERMINATING position (+7, 0, or +1) that corresponds to vf receiving level assigned to channel.

(2) Patch TEST TONE OR CARRIER INPUT jack J2 on test set to external four-wire vf jack that "looks" toward channel receiving circuit in multiplexer set.

(3) Adjust LEVEL ADJUST control on channel demultiplexer shelf for meter reading of 0 db on test set.

e. To adjust other channels, move the test cords at both terminals to the applicable external vf jacks. If a channel has different assigned levels, set switches S7 and S8 on the test set accordingly; the test set does not need to be recalibrated.

SECTION II
SPECIAL MAINTENANCE

NOT APPLICABLE

CROSS-REFERENCE INDEX

(Prefix each Reference Number with the Chapter Number denoted by the column.)
(KEY: Numbers preceded by "f" are illustrations; "t" are tables; other are paragraphs.)

OFFICIAL NOMENCLATURE Common Name	Chapter 2 Installation	Chapter 3 Operation	Chapter 4 Principles of Operation	Chapter 5	
				Org/Field Maintenance	Alignment
AMPLIFIER-ATTENUATOR GROUP OA-6123/MCC-13 Supergroup 2 demodulator tray	124	f2, t2	104	84, t7	
AMPLIFIER-CONTROL GROUP OA-6119/MCC-13 Channel carrier amplifier shelf	87	f5, t5	210, f28	78, 79, t6	106, t9
AMPLIFIER-FILTER AM-3182/FCC-17 Supergroup 2 demodulator tray	124	f2, t2	95, f13	84, t7	
AMPLIFIER-RELAY GROUP OA-7320/UCC-4(V) Supergroup carrier amplifier shelf	103	f9, t9	252, f34	78, f10, t6	106, t9
BAND PASS FILTER F-642/FCC-17 Supergroup 2 modulator tray			62, f10	84, t7	
Channel carrier amplifier shelf AMPLIFIER-CONTROL GROUP OA-6119/MCC-13	87	f5, t5	210, f28	78, 79, t6	106, t9

CROSS-REFERENCE INDEX (Cont)

OFFICIAL NOMENCLATURE Common Name	Chapter 2 Installation	Chapter 3 Operation	Chapter 4 Principles of Operation	Chapter 5	
				Org/Field Maintenance	Alignment
Channel carrier supply shelf TELEPHONE CARRIER FREQUENCY SUPPLY GROUP OA-4126/GCC	81	f5, t5	196, f27	47, 78, 79, t6	106, t9
Channel demultiplexer shelf DEMULTIPLEXER GROUP OA-4104/GCC	112		24, f6	84, t7	141, t9
Channel multiplexer shelf MULTIPLEXER GROUP OA-4103/GCC	109		12, t7	84, t7	114, t9
COMBINING NETWORK MX-3569/FCC-17 Supergroup demodulator combining panel	137	38	127, f16		131, t9, t11
COMBINING NETWORK MX-3570/FCC-17 Supergroup modulator combining panel	129	38	111, f15	84, t7	121, t9, t10
COMMUNICATION PATCHING PANEL TA-420/MCC-12, SB-3080/UCM-1 Handset patch panel		21			
CONTROL-INDICATOR C-3668/MCC-12 Master alarm panel		f13, t13	272	96	

OFFICIAL NOMENCLATURE Common Name	Chapter 2 Installation	Chapter 3 Operation	Chapter 4 Principles of Operation	Chapter 5	
				Org/Field Maintenance	Alignment
CONTROL-MONITOR GROUP OA-4106/MCC-12, OK-16/FCC Group pilot alarm shelf	114	f3, t3	34, f7		
DEMULTIPLEXER GROUP OA-4104/GCC Channel demultiplexer shelf	112		24, f6	84, t7	141, t9
DEMULTIPLEXER GROUP OA-4105/GCC Group demultiplexer shelf	118		51, f9	84, t7	138, t9
FREQUENCY DIVIDER CU-1273/MCC-13 Supergroup demodulator combining panel	144	38	132	84, t7	131, t9, t11
Fuse panel FUSE PANEL SB-1276, -1294, -1295, -1296, -1297, -1298/FCC-17; SB-2921, -2922, -2924, -2931, -2932/FCC; SB-3078/UCC-4(V)	72	f11, f12	276		
Group carrier amplifier shelf RADIO FREQUENCY AMPLIFIER GROUP AM-3157/FCC-17	95	f7, t7	234, f31	78, t6	106, t9
Group carrier generator shelf TELEPHONE CARRIER FREQUENCY SUPPLY GROUP OA-4110/GCC	89	f6, t6	216, f29	78, t6	106

CROSS-REFERENCE INDEX (Cont)

OFFICIAL NOMENCLATURE Common Name	Chapter 2 Installation	Chapter 3 Operation	Chapter 4 Principles of Operation	Chapter 5	
				Org/Field Maintenance	Alignment
Group carrier supply shelf TELEPHONE CARRIER FREQUENCY SUPPLY GROUP OA-4113/GCC	91	f7, t7	226, f30	78, t6	106, t9
Group demultiplexer shelf DEMULTIPLEXER GROUP OA-4105/GCC	118		51, f9	84, t7	138, t9
Group jackfield (transmitting or receiving) TELEPHONE JACK ASSEMBLY SB-2934/FCC, TA-417/FCC-17, TA-574/FCC		34	43		
Group multiplexer shelf MULTIPLEXER GROUP OA-4114/GCC	116		46, f8	84, t7	118, t9
Group pilot alarm shelf CONTROL-MONITOR GROUP OA-4106/MCC-12, OK-16/FCC	114	f3, t3	34, f7		
Handset HANDSET H-222/MCC-12		21			
Handset patch panel COMMUNICATION PATCHING PANEL TA-420/MCC-12, SB-3080/UCM-1		21			

OFFICIAL NOMENCLATURE Common Name	Chapter 2 Installation	Chapter 3 Operation	Chapter 4 Principles of Operation	Chapter 5	
				Org/Field Maintenance	Alignment
IMPEDANCE MATCHING NETWORK CU-936/MCC-12, CU-1154/MRC-98 Line connector panel	127		106, f14	84, t7	121, 131, t9, t10, t11
INDICATOR-POWER SUPPLY ID-1077/MRC-98 Master alarm panel	17, 74	f13, t13	266, f36	96	t9
Line connector panel IMPEDANCE MATCHING NETWORK CU-936/MCC-12, CU-1154/MRC-98	127		106, f14	84, t7	121, 131 t9, t10, t11
Master alarm panel CONTROL-INDICATOR C-3668/MCC-12		f13, t13	272	96	
Master alarm panel INDICATOR-POWER SUPPLY ID-1077/MRC-98	17, 74	f13, t13	266, f36	96	t9
Master frequency generator shelf TELEPHONE CARRIER FREQUENCY SUPPLY TA-495/MRC-98 TELEPHONE CARRIER FREQUENCY SUPPLY GROUP OA-4127/MCC-12	16, 77	f4, t4	165, 169 f23, f24 f25, f26	25, 26, 42, 64, 78, 81, 97, t6	107, t9
MULTIPLEXER GROUP OA-4103/GCC Channel multiplexer shelf	109		12, f5	84, t7	114, t9

CROSS-REFERENCE INDEX (Cont)

OFFICIAL NOMENCLATURE Common Name	Chapter 2 Installation	Chapter 3 Operation	Chapter 4 Principles of Operation	Chapter 5	
				Org/Field Maintenance	Alignment
MULTIPLEXER GROUP OA-4114/GCC Group multiplexer shelf	116		46, f8	84, t7	118, t9
Power supply shelf POWER SUPPLY ASSEMBLY OA-6445/FCC POWER SUPPLY SET OA-6830/FCC POWER SUPPLY PP-3613/MRC-98 POWER SUPPLY SET OA-4109/MCC-12	15, 70	f10, t10	300, f43, f44	63, 76	102, t9
RADIO FREQUENCY AMPLIFIER GROUP AM-2995/FCC-17 Supergroup carrier supply shelf	99	f9, t9	247, f33	78, t6	106, t9
RADIO FREQUENCY AMPLIFIER GROUP AM-3157/FCC-17 Group carrier amplifier shelf	95	f7, t7	234, f31	78, t6	106, t9
RADIO FREQUENCY COMBINER CU-1274/MCC-13 Supergroup modulator combining panel	136	38	122	84, t7	121, t9, t10
SIGNAL DATA TRANSLATOR MD-428 and MD-429 thru MD-436/FCC-17 Supergroup modulator tray (sgr 1 and sgr 3 thru 10)			62, f10	84, t7	

OFFICIAL NOMENCLATURE Common Name	Chapter 2 Installation	Chapter 3 Operation	Chapter 4 Principles of Operation	Chapter 5	
				Org/Field Maintenance	Alignment
SIGNAL DATA TRANSLATOR MD-439 thru MD-446/FCC-17 Supergroup demodulator tray (sgr 3 thru 10)	124	f2, t2	95, f13	84, t7	
SIGNAL DATA TRANSLATOR OM-5/FCC-64 Supergroup 1 demodulator tray	124	f2, t2	95, f13	84, t7	
Supergroup carrier amplifier shelf AMPLIFIER-RELAY GROUP OA-7320/UCC-4(V)	103	f9, t9	252, f34	78, f10, t6	106, t9
Supergroup carrier generator shelf TELEPHONE CARRIER FREQUENCY SUPPLY GROUP TA-418/FCC-17	97	f8, t8	239, f32	78, t6	106
Supergroup carrier supply shelf RADIO FREQUENCY AMPLIFIER GROUP AM-2995/FCC-17	99	f9, t9	247, f33	78, t6	106, t9
Supergroup demodulator combining panel COMBINING NETWORK MX-3569/FCC-17	137	38	127, f16		131, t9, t11
Supergroup demodulator combining panel FREQUENCY DIVIDER CU-1273/MCC-13	144	38	132	84, t7	131, t9, t11

CROSS-REFERENCE INDEX (Cont)

OFFICIAL NOMENCLATURE Common Name	Chapter 2 Installation	Chapter 3 Operation	Chapter 4 Principles of Operation	Chapter 5	
				Org/Field Maintenance	Alignment
Supergroup 1 demodulator tray SIGNAL DATA TRANSLATOR OM-5/FCC-64	124	f2, t2	95, f13	84, t7	
Supergroup 1 demodulator tray TELEPHONE CARRIER DEMODULATOR GROUP OA-6122/MCC-13	124	f2, t2	104	84, t7	
Supergroup 1A demodulator tray TELEPHONE CARRIER DEMODULATOR GROUP OA-4111/MCC-12	124	f2, t2	95, f13	84, t7	
Supergroup 2 demodulator tray AMPLIFIER-ATTENUATOR GROUP OA-6123/MCC-13	124	f2, t2	104	84, t7	
Supergroup 2 demodulator tray AMPLIFIER-FILTER AM-3182/FCC-17	124	f2, t2	95, f13	84, t7	
Supergroup demodulator tray (sgr 3 thru 10) SIGNAL DATA TRANSLATOR MD-439 thru MD-446/FCC-17	124	f2, t2	95, f13	84, t7	
Supergroup jackfield TELEPHONE JACK ASSEMBLY SB-2933/FCC		36	56		

OFFICIAL NOMENCLATURE Common Name	Chapter 2 Installation	Chapter 3 Operation	Chapter 4 Principles of Operation	Chapter 5	
				Org/Field Maintenance	Alignment
Supergroup jackfield (transmitting or receiving) TELEPHONE JACK ASSEMBLY J-1276/FCC-17		36	56		
Supergroup modulator combining panel COMBINING NETWORK MX-3570/FCC-17	129	38	111, f15	84, t7	121, t9, t10
Supergroup modulator combining panel RADIO FREQUENCY COMBINER CU-1274/MCC-13	136	38	122	84, t7	121, t9, t10
Supergroup 1 modulator tray SIGNAL DATA TRANSLATOR MD-428/FCC-17			62, f10	84, t7	
Supergroup 1 modulator tray TELEPHONE CARRIER MODULATOR GROUP OM-8/FCC-17	122	f1, t1	94	84, t7	
Supergroup 1A modulator tray TELEPHONE CARRIER MODULATOR GROUP OA-4112/MCC-12		f1, t1	92	84, t7	
Supergroup 1A modulator tray TELEPHONE CARRIER MODULATOR GROUP OA-6442/FCC	121	f1, t1	67, f11	84, t7	

OFFICIAL NOMENCLATURE Common Name	Chapter 2 Installation	Chapter 3 Operation	Chapter 4 Principles of Operation	Chapter 5	
				Org/Field Maintenance	Alignment
Supergroup 2 modulator tray BAND PASS FILTER F-642/FCC-17			62, f10	84, t7	
Supergroup 2 modulator tray TELEPHONE ATTENUATOR-FILTER CN-1157/FCC-60			93	84, t7	
Supergroup modulator tray (sgr 3 thru 10) SIGNAL DATA TRANSLATOR MD-429/FCC-17 thru MD-436/FCC-17			62, f10	84, t7	
TELEPHONE ATTENUATOR-FILTER CN-1157/FCC-60 Supergroup 2 modulator tray			93	84, t7	
TELEPHONE CARRIER DEMODULATOR GROUP OA-4111/MCC-12 Supergroup 1A demodulator tray	124	f2, t2	95, f13	84, t7	
TELEPHONE CARRIER DEMODULATOR GROUP OA-6122/MCC-13 Supergroup 1 demodulator tray	124	f2, t2	104	84, t7	
TELEPHONE CARRIER FREQUENCY SUPPLY TA-495/MRC-98 Master frequency generator shelf	16, 77	f4, t4	165, 169, f23, f24, f25, f26	25, 26, 42 64, 68, 81, 97, t6	107, t9

OFFICIAL NOMENCLATURE Common Name	Chapter 2 Installation	Chapter 3 Operation	Chapter 4 Principles of Operation	Chapter 5	
				Org/Field Maintenance	Alignment
TELEPHONE CARRIER FREQUENCY SUPPLY GROUP OA-4110/GCC Group carrier generator shelf	89	f6, t6	216, f29	78, t6	106
TELEPHONE CARRIER FREQUENCY SUPPLY GROUP OA-4113/GCC Group carrier supply shelf	91	f7, t7	226, f30	78, t6	106, t9
TELEPHONE CARRIER FREQUENCY SUPPLY GROUP OA-4126/GCC Channel carrier supply shelf	81	f5, t5	196, f27	47, 78, 79, t6	106, t9
TELEPHONE CARRIER FREQUENCY SUPPLY GROUP OA-4127/MCC-12 Master frequency generator shelf	16, 77	f4, t4	165, 169, f23, f24, f25, f26	25, 26, 42, 64, 78, 81, 97, t6	107, t9
TELEPHONE CARRIER FREQUENCY SUPPLY GROUP TA-418/FCC-17 Supergroup carrier generator shelf	97	f8, t8	239, f32	78, t6	106
TELEPHONE CARRIER MODULATOR GROUP OA-4112/MCC-12 Supergroup 1A modulator tray		f1, t1	92	84, t7	
TELEPHONE CARRIER MODULATOR GROUP OA-6442/FCC Supergroup 1A modulator tray	121	f1, t1	67, f11	84, t7	

OFFICIAL NOMENCLATURE Common Name	Chapter 2 Installation	Chapter 3 Operation	Chapter 4 Principles of Operation	Chapter 5	
				Org/Field Maintenance	Alignment
TELEPHONE CARRIER MODULATOR GROUP OM-8/FCC-17 Supergroup 1 modulator tray	122	f1, t1	94	84, t7	
TELEPHONE JACK ASSEMBLY J-1276/FCC-17 Supergroup jackfield (transmitting or receiving)		36	56		
TELEPHONE JACK ASSEMBLY SB-2933/FCC Supergroup jackfield		36	56		
TELEPHONE JACK ASSEMBLY SB-2934/FCC, TA-417/FCC-17, TA-574/FCC Group jackfield (transmitting or receiving)		34	43		
TELEPHONE TEST SET AN/GCM-2 or AN/FCM-8 Transmission test set			316, f45	37	
Transmission test set TELEPHONE TEST SET AN/GCM-2 or AN/FCM-8			316, f45	37	

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