ARMY
AIR FORCE

TM 11-5805-223-14
T. O. 31W1-2TCC3-1

OPERATOR, ORGANIZATIONAL, DIRECT SUPPORT
AND GENERAL SUPPORT MAINTENANCE MANUAL

TELEPHONE TERMINAL AN/TCC-3 AND TELEPHONE TERMINAL AN/TCC-23

DEPARTMENTS OF THE ARMY AND THE AIR FORCE
NOVEMBER 1973

CHANGE NO. 1

DEPARTMENTS OF THE ARMY
AND THE AIR FORCE
WASHINGTON, D. C., *6 August 1974*

Operator's, Organizational, Direct Support And General Support Maintenance Manual
TELEPHONE TERMINAL AN/TCC-3
AND
TELEPHONE TERMINAL AN/TCC-28

TM 11-5805-223-14/TO 31*W1-2TCC3-1*, *2* November 1973, is changed as follows:

1. New or changed material is indicated by a vertical bar in the margin.
2. Remove old pages and insert new pages as indicated below:

Remove pages	Insert pages
197 and 198	197 and 198
225 and 226	225 and 226
233 end 234	233 and 234
237 and 238	237 and 238
241 through 244	241 through 244
247 through 252	247 through 252
None	254 1/(254.2 blank)
255 through 276	255 through 276

3. File this change sheet in front of the manual for reference purposes.

*TM 11-5805-223-14
TO 31W1-2TCC3-1

TECHNICAL MANUAL
No. 11-5805-223-14
TECHNICAL ORDER
No. 31W1-2TCC3-1

DEPARTMENTS OF THE ARMY AND
THE AIR FORCE
WASHINGTON, D. C., 2 *November 1973*

Operator's, Organizational, Direct Support, and General Support Maintenance Manual

TELEPHONE TERMINAL AN/TCC-3 AND TELEPHONE TERMINAL AN/TCC-23

*This manual supersedes TM 11-2142, 20 April 1954, including all changes.

LIST OF ILLUSTRATIONS

CHAPTER 1

INTRODUCTION

NOTE

Telephone Terminals AN/TCC-3, bearing Order No. 24483-PC-61, are similar to Telephone Terminals AN/TCC-3 procured under previous orders. Information in this manual applies to all equipments unless otherwise specified.

Section I. GENERAL

1. Scope

This manual contains information for the installation, operation, maintenance, and theory of operation of Telephone Terminal AN/TCC-23 and Telephone Terminal AN/TCC-3. Telephone Terminal AN/TCC-3 the major component of Telephone Terminal AN/TCC-23. Except where otherwise specified, all information in this manual applies to Telephone Terminal AN/TCC-3 and Telephone Terminal AN/TCC-23.

1.1. Index of Publications

a. *DA Pam 310-4.* Refer to the latest issue o DA Pam 310-4 to determine whether there ar new editions, changes or additional publication pertaining to your equipment.

b. *DA Pam 310-7.* Refer to DA Pam 310-7 to determine whether there are modification work orders (MWO's) pertaining to the equipment.

2. Maintenance Forms and Records

a. *Reports of Maintenance and Unsatisfactory Equipment.* Use equipment forms and records in accordance with instructions given in TM 38-750.

b. *Report of Packaging and Handling Deficiencies.* Fill out and forward DD Form 6 (Report of Packaging and Handling Deficiencies) as prescribed in AR 700-58 (Army)/NAVSUP Publication 378 (Navy)/AFR 71-4 (Air Force)/and MCO P4030-29 (Marine Corps).

c. *Discrepancy in Shipment Report (DISREP) (SF 361).* Fill out and forward Discrepancy in Shipment Report (DISREP) (SF 361) as prescribed in AR 55-38 (Army)/ NAVSUP Publication 459 (Navy)/AFM 75-34 (Air Force)/ and MCO P4610.19 (Marine Corps).

d. *Reporting of Equipment Manual Improvements.* Reporting or errors, omissions, and recommendations for improving this publication by the individual user is encouraged. Reports should be submitted on DA Form 2028 (Recommended Changes to Publications) and forwarded direct to Commander, US Army Electronics Command, ATTN: AMSEL-MA-CW, Fort Monmouth, NJ 07703.

Section II. DESCRIPTION AND DATA

3. Purpose and Use

a. *Purpose.* Telephone Terminal AN/TCC-3 is a four-channel carrier telephone terminal. Its primary purpose is to provide either four channels for telephone communication or one channel for the transmission and reception of wideband signals.

b. *Use.*

(1) Telephone Terminal AN/TCC-3 is used to provide four channels of telephone communication over loaded spiral-four cable systems. An order wire (voice-frequency telephone maintenance) channel is also provided. Intelligence can be transmitted over loaded spiral-four cable for a distance of 25 miles when Telephone Terminal AN/TCC-3 is used without Telephone Repeater AN/TCC-5. Intelligence can be transmitted over a distance of 100 miles when Telephone Terminal AN/TCC-3 is used in conjunction with Telephone Repeater AN/TCC-5.

(2) Telephone Terminal AN/TCC-3 may also

be used for the transmission and reception of wide-band special service signals such as high-speed facsimile or data transmission. During these wide-band special service uses, the four channels for telephone communication cannot be used. When wide-band signals are not being transmitted, one or more of the channels may be used for the transmission of any signals within the 300- to 3,500-cycles per second (CPS) range without interfering with transmission over the other channels.

(3) Any channel of Telephone Terminal AN/TCC-3 may be used as the transmission facility for voice-frequency telegraph signals such as are produced by Telegraph Terminal AN/TCC-4.

(4) The AN/TCC-3 transmits over a frequency range of 300 to 19,700 cps.

NOTE

Throughout this manual, AN/TCC-3 refers to Telephone Terminal AN/TCC-23; similarly, AN/TCC-23 refers to Telephone Terminal AN/TCC-23, AN/TCC-5 refers to Telephone Repeater AN/TCC-5, TA-219/U refers to Telephone Modem TA-219/U, TA-219A/U refers to Telephone Modem TA-219A/U, AM-682/TCC-3 refers to Amplifier-Power Supply AM-682/TCC-3, AM-682A/TCC-3 refers to Amplifier-Power Supply AM-682A/TCC-3. The information herein is applicable to all models of the Telephone Modem and Amplifier-Power Supply unless otherwise noted. The term "spiral-four cable" refers to Cable Assembly CX-1065/G loaded with Telephone Loading Coil Assembly CU-260/G. Telephone Modems TA-219/U and TA-219A/U are interchangeable; however the substitution of the TA-219/U for the TA-219A/U will result in decreased capability. Likewise, Amplifier-Power Supply AM-682/TCC-3 and AM-682A/TCC-3 are interchangeable; however the substitution of AM-682/TCC-3 for the AM-682A/TCC-3 will result in decreased capability.

4. System Applications of Telephone Terminal AN/TCC-3

The AN/TCC-3 can be used alone or in conjunction with other equipment to form various communication systems. These systems and their capabilities are described in *a* through *d* below.

a. System Consisting of Two AN/TCC-3 Terminals Only. The AN/TCC-3 consists of TA-219/U and the AM-682/TCG-3 (fig. 1). Two AN/TCC-3 terminals interconnected by loaded spiral-four cable (fig. 2) can constitute either a four-channel carrier telephone system or a single channel wide-band system. The span of either of these systems is normally 25 miles. Under favorable conditions the length of these systems may be increased to 40 miles.

(1) When the AN/TCC-3 is used to provide 4 channels of communication, voice-frequency loop equipment is connected to the TA-219/U. At A, figure 2, signals originating in the voice-frequency loop equipment are applied to the TA-219/U and pass through the AM-682/TCC-3 to the loaded spiral-four cable. The signals are transmitted over loaded spiral-four cable to the AN/TCC-3 at B. At terminal B the signals pass through the AM-682/TCC-3 and the TA-219/U to the voice frequency loop equipments associated with terminal B.

(2) Signals originating in the voice frequency loop equipments, associated with terminal B are applied to the TA-219/U, and pass through the AM-682/TCC-3 to the loaded spiral-four cable. The signals are transmitted over the spiral-four cable to terminal A, where they pass through the AM-682/TCC-3 and the TA-219/U to the voice frequency loop equipments associated with terminal A.

(3) When special service equipment is used, the voice frequency equipments shown connected to the TA-219/U in figure 2 cannot be used. The special service equipment is connected to the AM-682/TCC-3. At A, signals from the special service equipment pass through the AM-682/TCC-3 to the loaded spiral-four cable. The signals are transmitted over the spiral-four cable to the AN/TCC-3 at B. Signals from the AN/TCC-3 at B are transmitted to the AN/TCC-3 at A, where they pass through the AM-682/TCC-3 to the special service equipment. Special service signals do not pass through the TA-219/U.

b. Systems Consisting of AN/TCC-3 Terminals and Telephone AN/TCC-5 Repeaters. Two AN/TCC-3 terminals and one or more intervening AN/TCC-5 repeaters using loaded spiral-four cable as a transmission medium (fig. 3) can constitute a system with a greater length than a system which uses only two Telephone Terminals AN/TCC-3. Each intervening telephone repeater will extend the length of the system 25 to 35 miles. Thus, to increase the length of a system to 100 miles, three telephone repeaters normally are

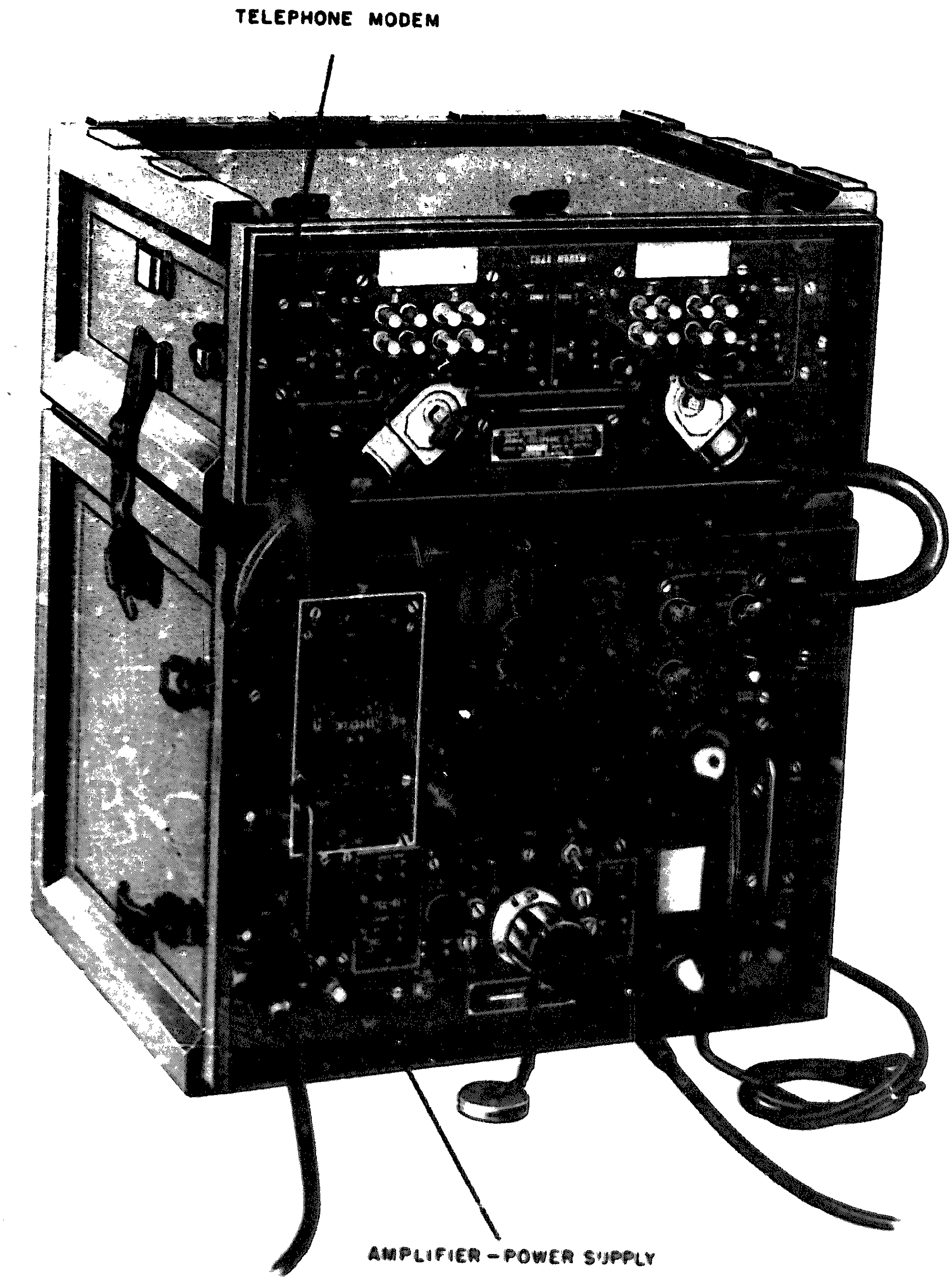


Figure 1. Telephone Terminal AN/TCC-3.

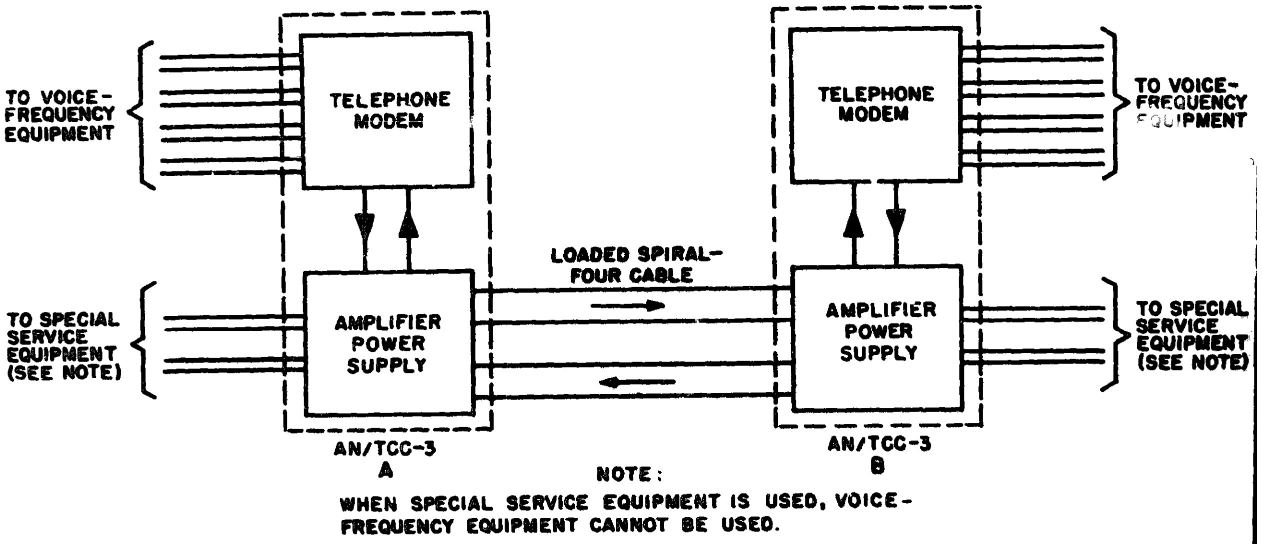


Figure 2. Carrier telephone system using Telephone Terminals AN/TCC-3 without repeaters.

Figure 3. Carrier telephone system using Telephone Terminals AN/TCC-3 and Telephone Repeater AN/TCC-5.

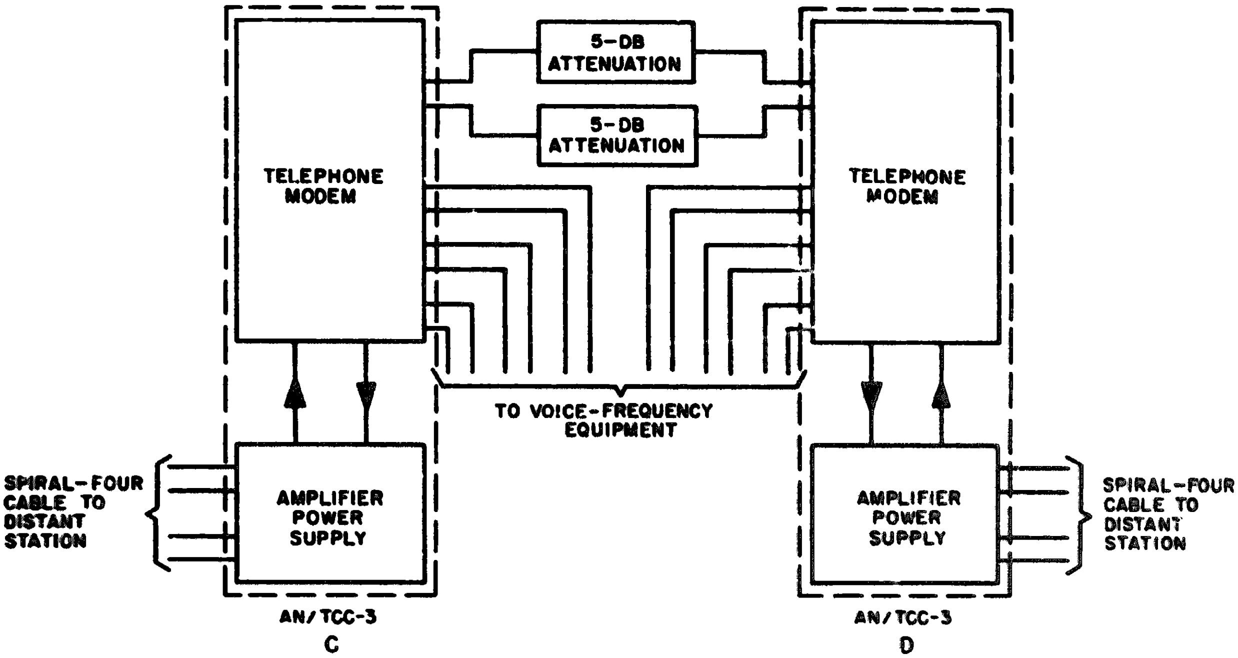


Figure 4. Portion of a carrier telephone system using Telephone Terminals AN/TCC-5, showing method of dropping channels and connecting through channels.

d. System Consisting of Telephone Terminals AN/TCC-3 and Radio Link. Topographical or other considerations may require the use of radio links between two Telephone Terminals AN/TCC-3 to complete a system (fig. 5). These links may consist of any one of various equipments such as Radio Sets AN/TRC-24 and AN/GRC-10. The considerations pertaining to the length of the connecting cables used in conjunction with the radio links and the distance that can be spanned by the system are given in paragraph 21.

5. inging Channels of Telephone Terminal AN/TCC-3

a. Telephone Terminal AN/TCC-3 will not accept 20 cps ringing signals. Voice frequency equipment using 20 cps ringing signals may be connected on the loop side of the AN/TCC-3 to a signal converter such as Telegraph-Telephone Signal Converter TA-182/U is inserted in the circuit between the AN/TCC-3 and the voice frequency loop equipment. The TA-182/U must be arranged for telephone operation A separate TA-182/U must be inserted in each AN/TCC-3

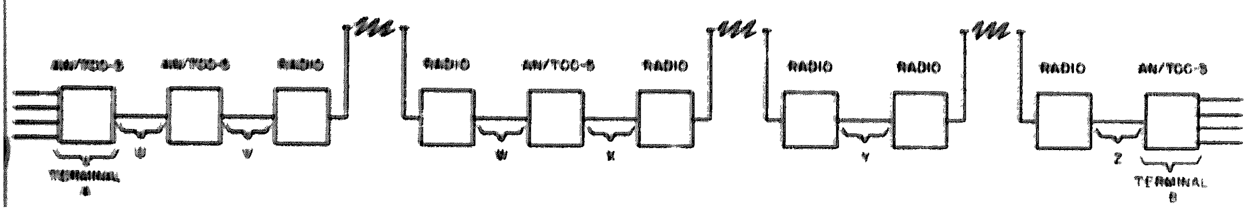


Figure 5. Carrier telephone system using Telephone Terminals AN/TCC-5. Telephone Repeaters AN/TCC-5 and radio links.

channel loop terminated in equipment using 20 cps ringing signals. Each loop may be operated on either a two-wire or four-wire basis.

b. Telegraph-Telephone Signal Converter TA-182/U converts 20 cps ringing signals received from the local voice-frequency circuit to 1,600 cps or 1,225 cps for transmission to the distant terminal. The frequency normally used on telephone circuits is 1,600 cps. The TA-182/U also converts incoming 1,600-cps or 1,225-cps ringing signals to 20 cps for application to local equipment.

c. The order wire of Telephone Terminal AN/TCC-3 is equipped with built-in 1,600-cps signaling circuits which permit signaling between terminals and repeaters. Provision is also made for the extension of the order wire circuit to local administration points for overall system control purposes. No self-contained signaling facilities are provided for signaling between extended order wire points. For this reason, it is necessary to install Telegraph-Telephone Signal Converter TA-182/U in each extension. The converter will be set to operate on 1,225 cps signaling frequency. This permits signaling between order wire extensions without calling in operating personnel at terminals and repeaters. Contact between the local extension and the local terminal attendant will be established by means of a separate circuit equipped with field telephones.

d. Refer to appendix A for information concerning the installation, operation, and maintenance of Telegraph-Telephone Signal Converter TA-182/U.

6. Technical Characteristics

Number of channels operated over loaded spiral-four cable or four-wire transmission circuit.
Four traffic channels plus order wire channel, or 1 wide-band special service channel.

Carrier frequencies:

Channel 1	8 kc ± 0.01%
Channel 2	12 kc ± 0.01%
Channel 3	16 kc ± 0.01%
Channel 4	20 kc ± 0.01%

Frequency bands allocated to channels:

Order wire	300 to 3,100 cps.
Channel 1	4,500 to 7,700 cps.
Channel 2	8,500 to 11,700 cps.
Channel 3	12,500 to 15,700 cps.
Channel 4	16,500 to 19,700 cps.

Frequency of order wire signaling circuit.	1,600 cps.
Frequency of system alarm signal	4,000 cps.
Transmission range, maximum	Dependent on characteristics of transmission medium (par. 12). About 100 miles with loaded spiral-four Cable Assemblies CX-1065/G equipped with Telephone Repeaters AN/TCC-5.
Type of modulation	Amplitude, single side-band, suppressed carrier.
Monitoring and talking	Monitoring and talking facilities on each channel and on order wire. Switch controlled.
Test facilities	Self-contained and capable of coordination with other standard test facilities.

Power at 0-db level points:

Input signal originating from	*0 db level point*	*Power*
Voice	2W binding posts	0 dbm.
16-channel telegraph terminal.	2W binding posts	−15 dbm.
Facsimile equipment. (Operating between 300 and 20,000 cps).	SPECIAL SERVICE TR binding posts.	0 dbm or −3 dbm, depending on type of facsimile equipment.
Other special service equipment (Operating between 300 and 20,000 cps).	SPECIAL SERVICE TR binding posts.	0 dbm.

NOTE

The level at any point in a system is defined as the gain (or loss) of power in db from some reference point (the 0-db level point) to the point under consideration. Power measurements at the 0-db level point are made with a 1,000 cps test signal.

Operating levels:

Vf side:

Input, 2-wire	6 db.
Output, 2-wire	−3 db.
Input, 4-wire	−4 db.
Output, 4-wire	+1 db.

Transmitting into line:

Normal line section	0 db.
Long line section	+10 db.

System performance:	
Noise on channels at 0-db level point, 100-mile system (except during periods of heavy static or with strong power exposures).	32 dba.
Far-end crosstalk loss between output of disturbing channel and output of disturbed channel should be expected to exceed.	50 db.
Near-end, or echo, crosstalk loss should be expected to exceed.	25 db.
Regulation for temperature effect on cable transmission.	Manual.
Power requirements	115 or 230 volts ac ±10%; 50 to 65 cps.
Power consumption	125 watts (approximately).
Number of vacuum tubes	
Channel modem units (four units per equipment).	1 tube per unit.
Amplifier-power	16.

7. Packaging Data

a. When packaged for export shipment, the components of Telephone Terminal AN/TCC-3 are placed in moisture-vaporproof containers and packed in two plywood export crates. The size, weight, and volume of each crate are indicated in the chart below:

Crate No.	Height (in.)	Width (in.)	Depth (in.)	Volume (cu ft)	Unit weight (lb)
1	26	15	25	5.6	122
2	26	22	25	8.2	174

b. The following chart lists the contents of each crate. See the packing list attached to each crate for the exact contents.

Crate No.	Contents
1	1 each Telephone Modem TA-219/U
2	7 ea Amplifier-Power Supply AM-682/TCC-3.

8. Table of Components of AN/TCC-23

The following table lists the dimensions and weights of the components of the AN/TCC-23. The dimensions and weights of the components of the AN/TCC-3 are included in this listing. The AN/TCC-3, the major component of the AN/TCC-23, is illustrated in figure 1. Minor components of the AN/TCC-23 are illustrated in figure 6, 7, and 8.

Component	Required No.	Height (in.)	Depth (in.)	Width (in.)	Volume (cu ft)	Weight (lb)
Telephone Terminal	1	--	--		--	
AN/TCC-3 Consisting of:						
Telephone Modem TA-219/U	1	9 1/8	18 1/16	20 5/8	2.0	68 or 73
Amplifier-Power Supply AM-682/TCC-3	1	17 1/16	18 1/16	20 5/8	3.7	103
Power Unit PE-75-( )	2	24 1/2	19	36	10.49	330
Ground Rod MX-148/G	1	72		5/4 (dia)		4
Junction Box J-85/G	1	4 1/8	4 3/8	5 1/2	0.06	8
Junction Box JB-110	1	2 1/4	4 1/2	12 1/4	0.0718	8 1/2
Clamp TM-106	1	--		--	--	
Cord CO-711	1	--	--	--	--	

9. Description of Telephone Modem TA-219/U

a. Telephone Modem TA-219/U (fig. 9) consists of four channel-modem assemblies which plug into the modem combining unit. The modem combining unit is the frame for the telephone modem assemblies and contains keys to assure the correct positioning of each of the four channel-modem assemblies. The interconnecting wiring is contained in the modem combining unit. Two captive screws secure the TA-219/U to its transit case. Rollers on the bottom of the frame and a handle on the front panel facilitate the removal of Telephone Modem TA-219/U from the transit case.

b. The telephone-modem unit contains circuits necessary to produce the single side-band, suppressed-carrier signals transmitted to the distant terminal, and to select, demodulate, and amplify signals received from the distant terminal.

c. The four channel modems have similar front panels differing only in physical arrangement (fig. 9). The arrangement of the controls on channel 1 modem and on channel 3 modem is identical. Similarly, the front panel arrangement of channel 2 modem is identical to that of channel 4 modem. Therefore, in (1) through (4) below, only the front panel arrangement of channel 1 and channel 2 modems is discussed.

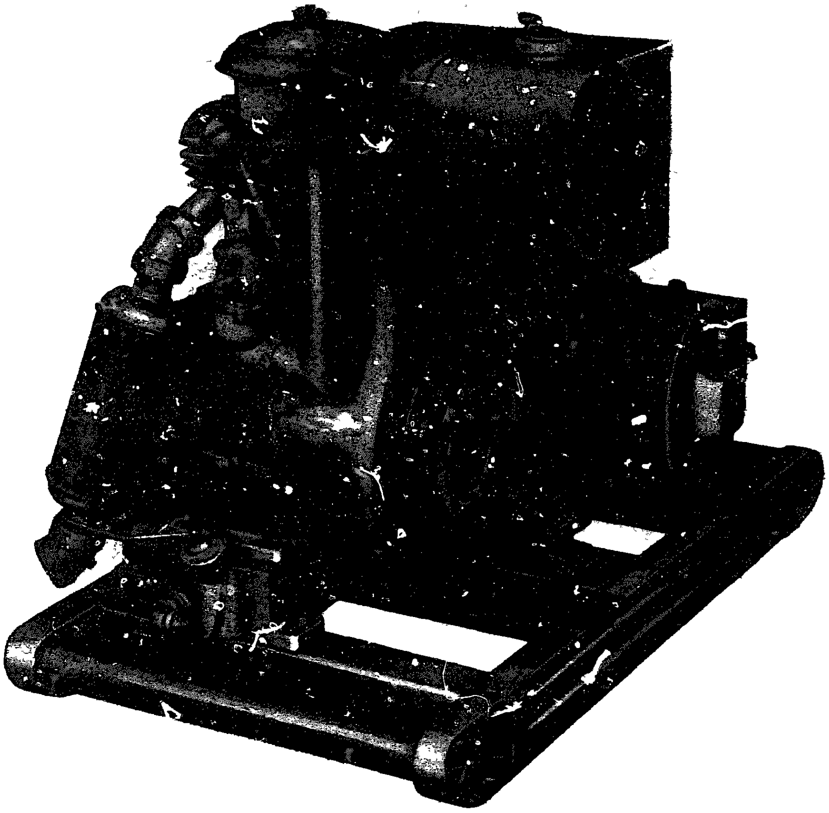


Figure 6. Power Unit PE-75-( ).

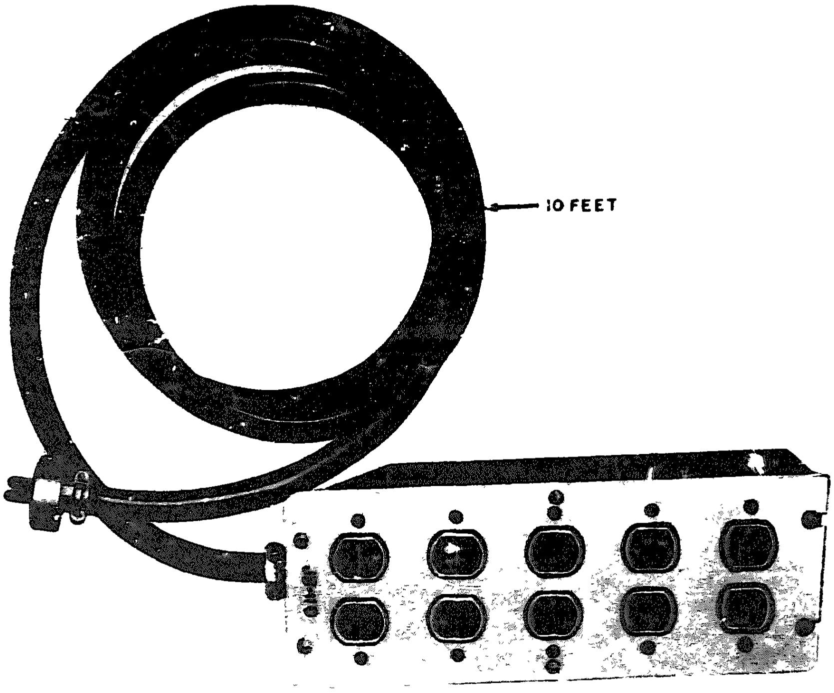


Figure 7. Junction Box JB-110.

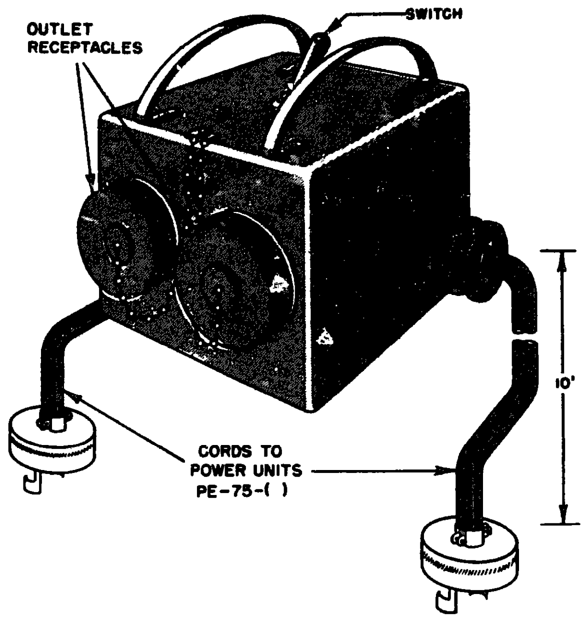


Figure 8. *Junction Box J-85/G.*

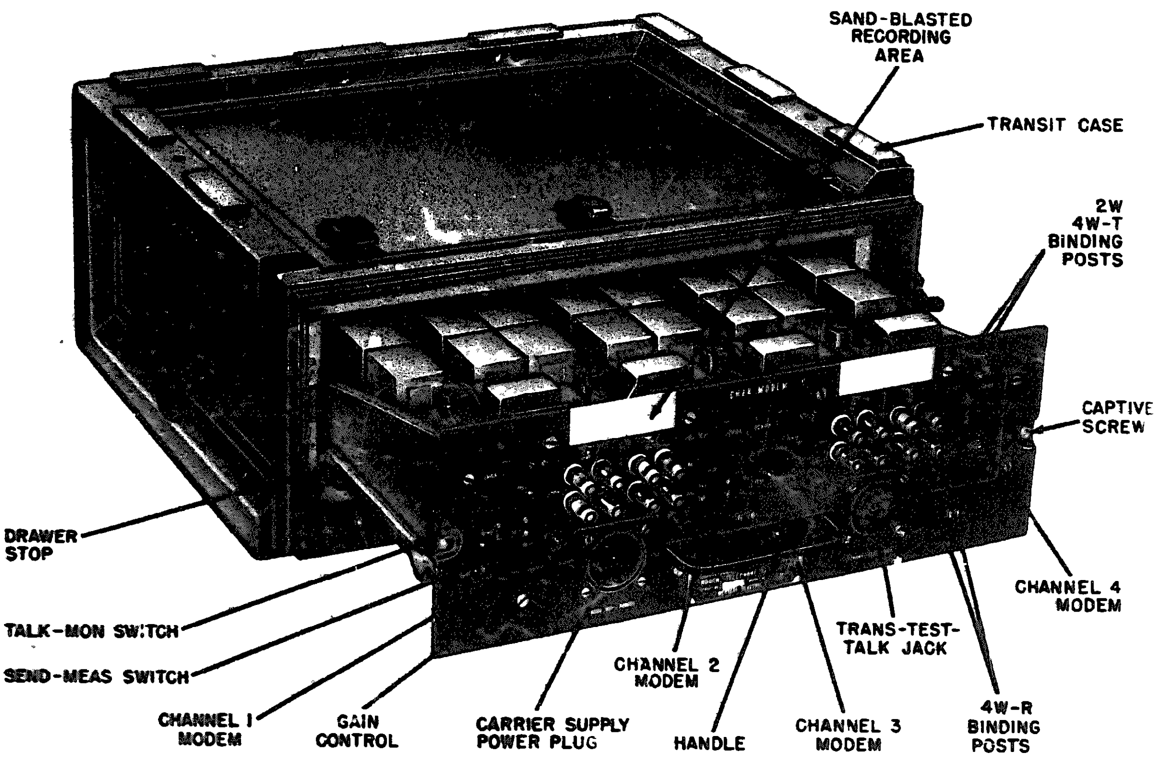


Figure 9. Telephone Modem TA-219/U showing the chassis extended from the carrying case

(1) 2W, 4W-T, and 4W-R binding posts, located at the upper right of the channel 1 modem (upper left of channel 2 modem), are used to connect two-wire or four-wire voice frequency equipment to that channel modem.

(2) The GAIN control, at the lower center of each channel modem, permits the amplitude of the received signal to be varied.

(3) The SEND-MEAS switch at the extreme left of channel 1 modem (at the extreme right of channel 2 modem) permits either the level of the received signal to be measured, or the substitution of a l-kc test signal for the normal input.

(4) The TALK-MON switch, located at the upper center of each channel modem, provides a means for an attendant to monitor the transmission.

d. The front panel of the modem combining unit mounts the CARR SUP-POWER jack at the lower left, and the TRANS-TEST-TALK jack at the lower right. All power and signal flow between the AM-682/TCC-3 and the TA-219/U is fed in or out through these jacks. Two etched areas are provided at the upper right and left for the attendant to record the channel assignments.

10. Description of Amplifier-Power Supply AM-682/TCC-3

a. General. Amplifier-Power Supply AM-682/TCC-3 is the lower of the two units shown in figure 1. It consists of two chassis on which a total of five bracket assemblies and four plug-in assemblies are mounted (c, *d, e, f,* and A below). One chassis occupies the left side and the other chassis occupies the right side of the amplifier-power supply. Three bracket assemblies are mounted between these two chassis (*g* below and *figs. 14 and 15).*

b. Description of Front Panel. The controls and instruments on the front panel of Amplifier-Power Supply AM-682/TCC-3 (fig. 10) are grouped functionally. In (1) through (14) below is given the location and function of each of these controls.

(1) At the upper left of the panel are the controls and instruments related to the measuring circuit. The MEASURE switch, in conjunction with the AMPLIFIER switch, connects the measuring circuit so as to permit measurement by the MEASURE meter of the magnitude of the test signals in the various circuits of the AN/TCC-3.

(2) Three EQUALIZER controls are located at the upper right of the panel. Each of these controls is adjusted during the system line-up to obtain an indication of 0 db on the MEASURE meter for a particular frequency.

(3) The white SPECIAL SERVICE indicator lamp is located under the right EQUALIZER control. It is lighted when the AN/TCC-3 is used for special service (providing a single wide-band channel).

(4) A telephone set holder, located under the EQUALIZER controls, is provided for the attendant's telephone set (not shown in fig. 10).

(5) An etched area located under the holder is provided for the attendant to make notations.

(6) Slightly below the center of the panel are the POWER toggle switch and green POWER indicator lamp. When the POWER switch is operated to the ON position, power from the external a-c voltage source is applied to the AN/TCC-3 and the green POWER indicator lamp is lighted.

(7) The TEL SET switches-the ORDER WIRE switch, and the CHANNEL TALK switch-are located at the lower left of the panel. The ORDER WIRE switch can be operated to allow the use of the attendant's telephone set *(not* shown in fig. 10) for order wire communication or to ring the distant stations of the system. The CHANNEL TALK switch, in conjunction with the TALK-MON switches of the TA-219/U, permits the use of the attendant's telephone set for communicating or monitoring over any one of the four channel moderns of the TA-219/U. These switches can also be operated to permit talking or monitoring of the local voice-frequency equipment.

(8) When ringing signals are transmitted or received, the yellow CALL indicator lamp located under the handle on the left side of the panel is lighted.

(9) The GND binding post is located next to the CALL indicator lamp.

(10) The TEST OSC OUTPUT control and SEND OW switch are located to the left of the ORDER WIRE and CHANNEL TALK switches. The TEST OSC OUTPUT control varies the magnitude of the output of a 1-kc test oscillator. When the SEND OW switch is operated to the

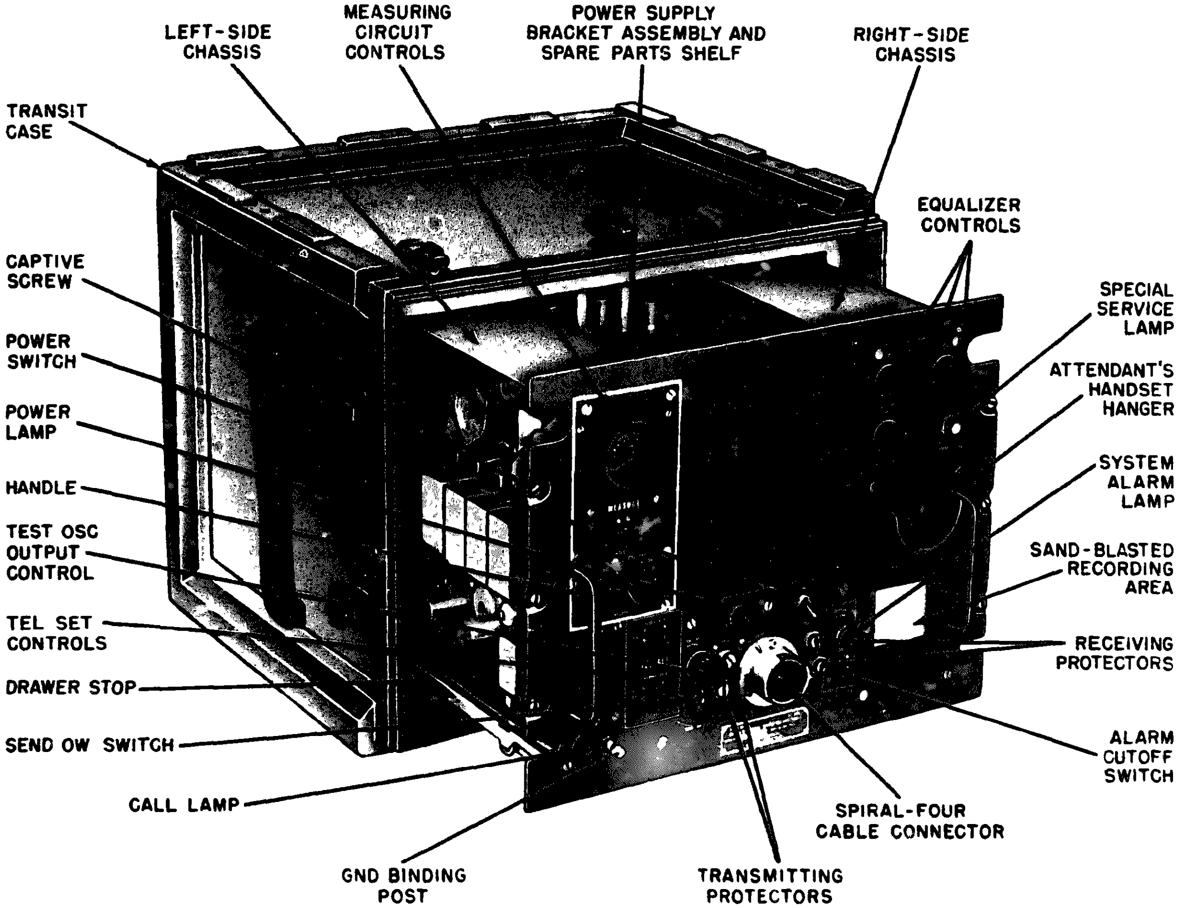


Figure 10. Amplifier-Power Supply AM-682/TCC-3 showing the chassis extended from the transit case.

horizontal position, the l-kc test signal is transmitted to the distant stations of the system

(11) The spiral-four cable connector is located under the POWER switch and indicator.

(12) The two protectors for the transmitting circuits of the AM-682/TCC-3 and the two protectors for the receiving circuits of the AM-682/TCC-3 are located to the left and right of the spiral-four cable connector.

(13) The red SYSTEM ALARM indicator lamp and the ALARM CUTOFF switch are at the right of the receiving circuit protectors. When the path for transmitting signals from the distant AN/TCC-3 is either opened or defective, the SYSTEM ALARM indicator lamp lights and a buzzer sounds. The ALARM CUTOFF switch is operated to silence the buzzer.

(14) Six captive screws secure the AM-682/TCC-3 to the transit case. Rollers on the bottom of the AM-682/TCC-3 and two handles on the panel permit the amplifier-power supply to be removed easily from the transit case.

c. Description of Ringer-Oscillator. The ringer-oscillator assembly is a plug-in assembly. It is mounted in the upper rear corner of the chassis at the left side of the AM-682/TCC-3 (fig. 11) as shown in figures 31 and 32. The ringer-oscillator has two functions. When used as an oscillator, it generates a 1,600 cps signal used as a ringing signal on the order wire circuit. When used as a ringing-signal detector, it detects 1,600 cps ringing signals from a distant station. A buzzer sounds and an indicator lamp lights when a ringing signal is received. The RING-TALK switch, mounted on the front panel of the AM-682/TCC-3, is the control for the ringer-oscillator.

d. Description of Carrier Supply. The carrier supply assembly is a plug-in assembly. It is

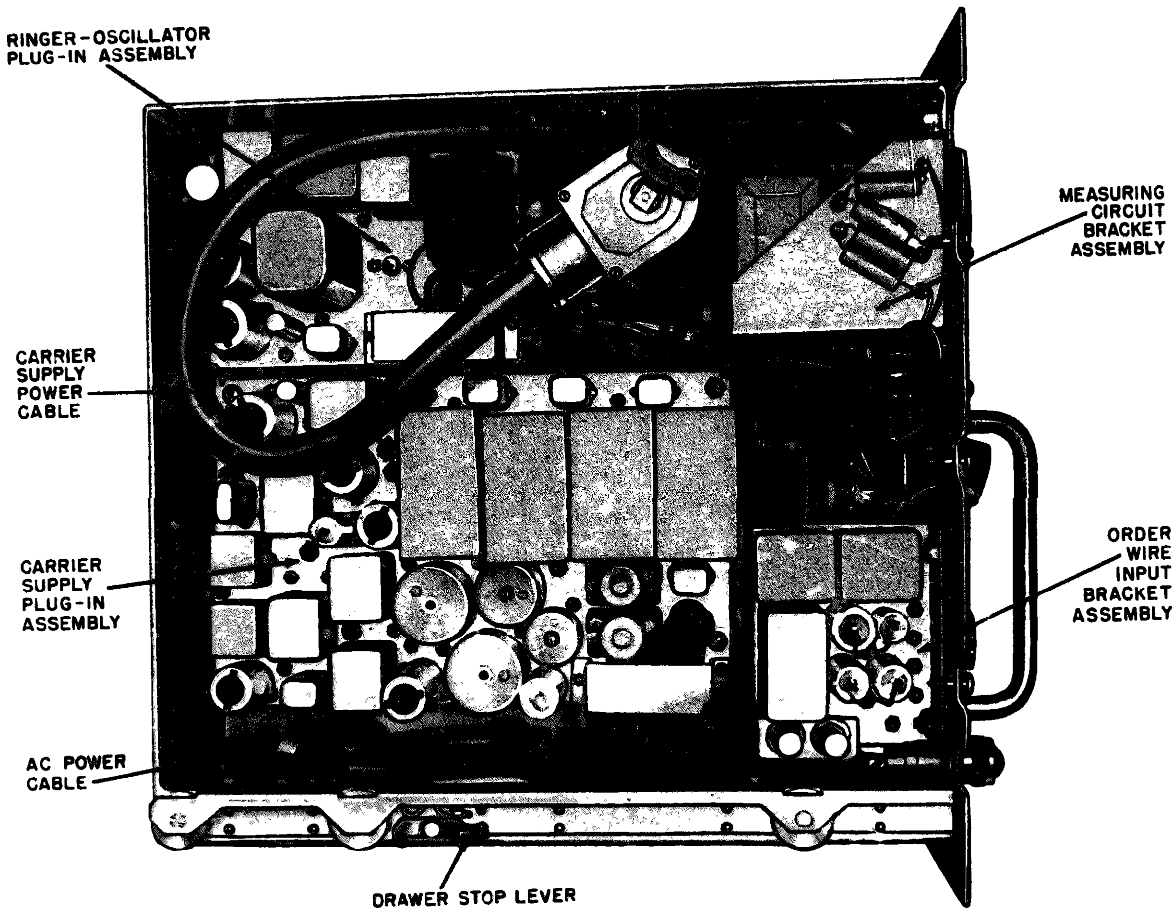


Figure 11. Amplifier-Power Supply AM-682/TCC-3 Order No. 1667-PH-51, serial numbers 1 through 1707, removed from transit case, showing left side chassis.

mounted directly below the ringer-oscillator assembly on the left-side chassis of the AM-682/TCC-3 (fig. 11). The carrier supply assembly supplies the four carrier frequencies (8, 12, 16, 20 kc) and the 4-kc system alarm pilot frequency for the AN/TCC-3. The carrier supply assembly contains no controls.

e. Description of Measuring Circuit. One of the bracket assemblies contains several of the parts of the measuring circuits. The remaining parts of the measuring circuit which are not mounted on the bracket assembly are located nearby. This assembly is mounted near the upper front corner of the left-side chassis of the AM-682/TCC-3 (figs. 11 and 12). The measuring circuit is used for lining up the system and aids in troubleshooting the telephone terminals. The controls associated in the measuring circuit are located on the front panel.

f. Description of the Transmitting Amplifier and the Receiving Amplifier. The transmitting amplifier and the receiving amplifier are identical, interchangeable, plug-in units. The location in which each is mounted determines its function as a transmitting or receiving amplifier. The amplifier assemblies are mounted at the rear of the chassis that occupies the right side of the amplifier-power supply (fig. 13). The transmitting amplifier is below the receiving amplifier. A gain control switch, marked AMP OUT, is located on each amplifier. Strapping at the plug-in receptacle for the receiving amplifier prevents the electrical functioning of the AMP OUT switch on the receiving amplifier. Amplification

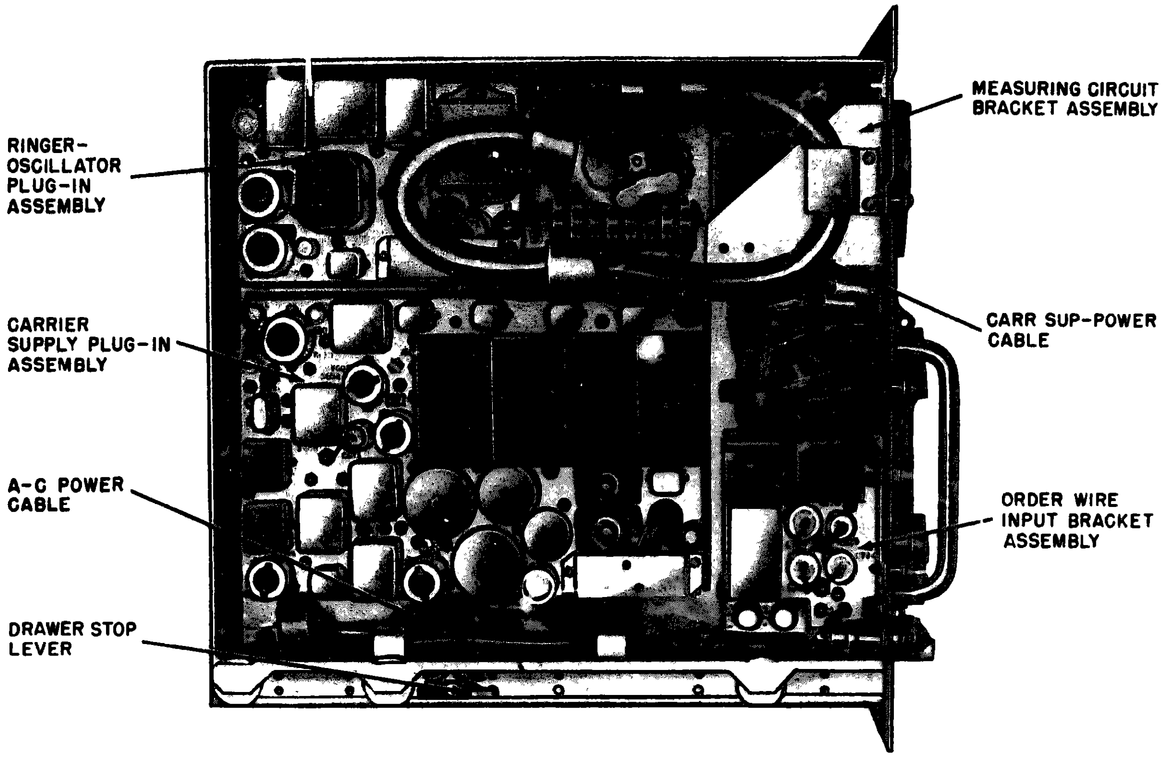


Figure 12. Amplifier-power Supply AM-682/TCC-3, serial number 1708 subsequent, removed from transit, showing left-side chassis.

for the outgoing and the incoming signals is provided by the transmitting and the receiving amplifiers respectively.

g. Description of Power Supply. The power supply bracket assembly is located between the left- and right-side chassis and directly behind the front panel of the AM-682/TCC-3 (fig. 14). The power supply provides five voltages for the operation of the AN/TCC-3. A 6.3-volt ac (alternating current) is supplied for the heaters of the vacuum tubes, for the buzzer, and for the indicator lamps in the terminal; +200 volt dc (direct current) is supplied for the plate and screen voltages for the vacuum tubes. A −5-volt dc is supplied as bias for the order wire limiter circuit. A −10-volt dc is supplied as bias for the ringer-oscillator limiter circuit. A −5-volt dc is supplied for the attendant's telephone set. The ON-OFF switch on the front panel connects the power supply circuits to the external source of a-c power. The 115V–230V switch, on the power supply bracket assembly, adjusts the power supply circuit for operation from a 115-volt or 230-volt source.

h. Description of Remaining Circuits and Features of AM-682/TCC-3. A series of bracket assemblies and panel mounting locations are used in combination to mount the remaining circuits of the AM-682/TCC-3. The remaining circuit locations and their functions are described in (1) through (4) below. Other features of the AM-682/TCC-3 are described in (5), (6) and (7) below.

(1) A bracket assembly located near the transmitting amplifier (f above) contains the parts of the 1-kc test osilator, the cable matching network, the system alarm circuit, and part of the order wire circuit.

(*a*) The test oscillator circuit generates a 1-kc signal which is used to line up the system. This signal is adjustable in amplitude.

(*b*) The cable matching network is used to match the output impedance of the transmitting amplifier to the impedance of the line.

(*c*) The system alarm circuit provides an overall system alarm to indicate transmission failure. The indications of the operation of the system alarm circuit are the sounding of the buzzer and the lighting of the SYSTEM ALARM

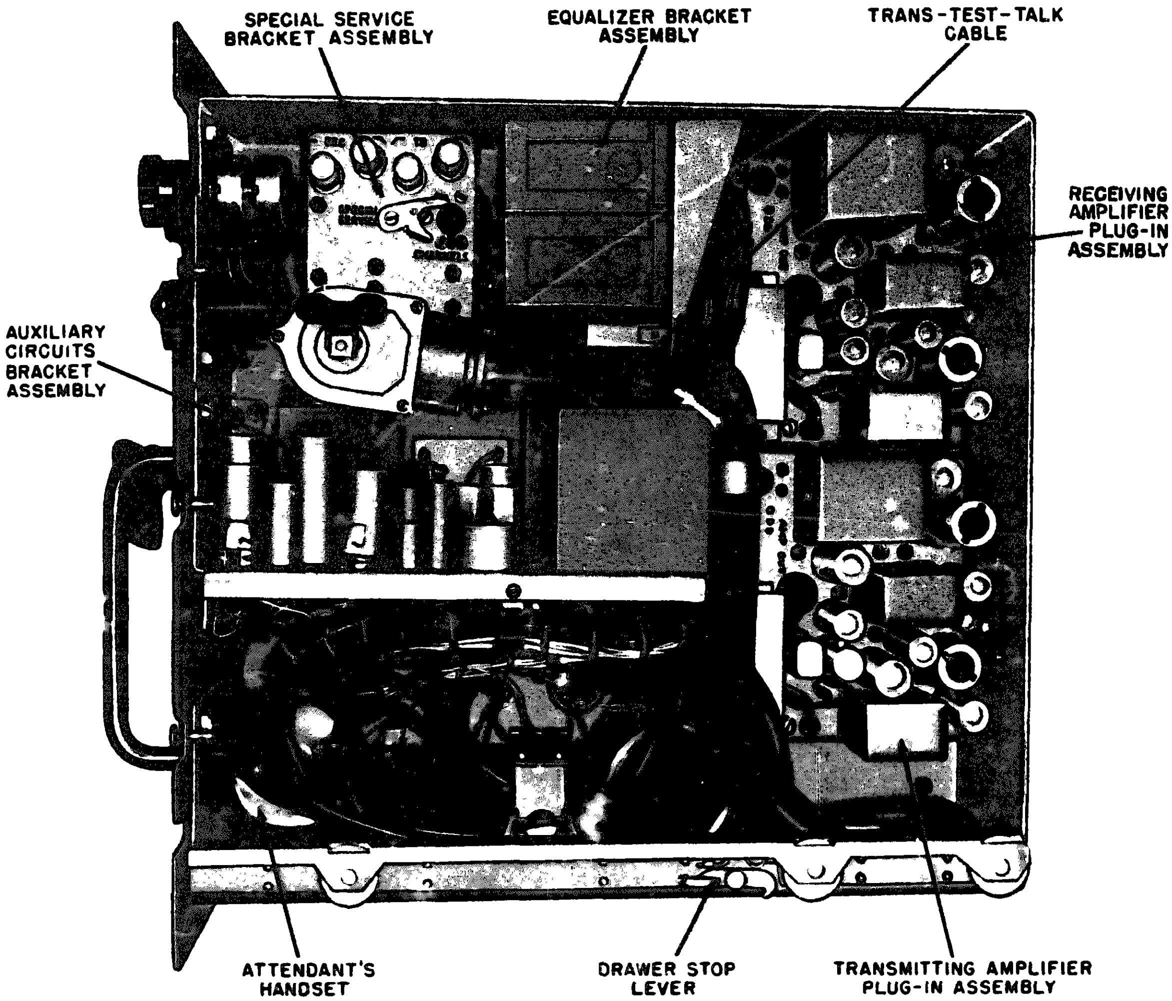


Figure 13. Amplifier Power Supply AM-682/TCC-3, right-side chassis removed from transit case showing bracket assemblies, and cable and handset stored for transit.

lamp. The audible alarm (buzzer) may be silenced by operation of the ALARM CUTOFF switch.

(d) The order wire circuit permits voice-frequency signals to be transmitted between stations without interference with transmission over the four carrier-channel circuits. A telephone set is associated with the order wire circuit. The order wire circuit may be extended from the terminal to a test board or switchboard location through the order wire binding posts on a two-wire basis. The order wire binding posts are located on the order wire input bracket assembly (figs. 11 and 27).

(2) The special service circuits are located in the upper left portion of the right-side chassis. The special service input and output transformers, pads, switch, and binding posts, are located on the special service bracket assembly (fig. 13). The special service circuits provide for the transmission and reception of intelligence which requires a frequency band wider than that which can be transmitted through a carrier channel.

(3) The input circuits for the order wire are mounted on a separate bracket assembly near the lower front corner of the left-side chassis (fig. 11).

(4) The parts of the equalizer circuit are mounted on a bracket to the rear of the upper right-hand portion of the front panel of the AM-682/TCC-3. The associated potentiometers are

Figure 14. Amplifier-Power Supply AM-682/TCC-3, bearing Order NO. *1667-PH-51 serial number 1 through 1707-top view*

mounted on the front panel of the AM-682/TCC-3. The equalizer consists of networks which may be adjusted so that the combined attention *of* the line and the equalizer will be nearly constant over the frequency range of the telephone terminal.

(5) Figures 11 and 13 show the CARR SUP-POWER cable, and the power cable stored for transit.

(a) The CARR SUP-POWER cable is stored in the left-side chassis. The cable applies the four carrier frequencies from the carrier supply (*d* above) to the TA-219/U. It also applies 6.3 volts ac and +200 volts dc from the power supply (*g* above) to the TA-219/U.

(*b*) The power cable is located on the bottom of the left-side chassis. It is connected to an a-c power source when AN/TCC-3 is placed into operation.

(*c*) Figure 11 shows the drawer-stop lever that is located on the left roller frame of the AM-682/TCC-3. It, and the drawer-stop lever on the right-side chassis, must be depressed in order to pull the AM-682/TCC-3 completely out of its transit case.

(6) Figure 13 shows the attendant's telephone set and the TRANS-TEST-TALK cable stored for transit. The right drawer-stop lever may also be seen in this illustration.

(*a*) The attendant's telephone set is stored in a space at the lower left-hand corner of the right-side chassis. The attendant's telephone set functions in conjunction with the TEL SET switch (b above).

(*b*) The TRANS-TEST-TALK cable stored in the right-side chassis connects to the TA-219/U. It applies the lower-side band signals, 1-kc test signals, and signals from the attendant's telephone set from the AM-682/TCC-3 to the TA-219/U. It also applies the lower side-band signals, the various test signals, and voice-frequency signals from the TA-219/U to the AM-682/TCC-3.

(7) In AM-682/TCC-3 bearing Order No. 1667-Phila-51, serial numbers 1 through 1707, the extension cable is held by clamps mounted directly below the power supply bracket assembly (fig. 15). In AM-682/TCC-3 bearing order numbers other than Order No. 1667-Phila-51, serial numbers 1 through 1707, the extension cable is mounted on the extension cable storage shelf (fig. 16). The extension cable is used for testing plug-in assemblies of the AN/TCC-3.

(8) A test probe used in conjunction with the MEASURE meter is included in the AM-682/TCC-3. In equipments bearing Order No. 1667-Phila-51, serial numbers 1 through 1707, the test probe is mounted on the left-side chassis near jack J551 (figs. 15 and 25). In equipments bearing order numbers other than Order No. 1667-Phila-51, serial numbers 1 through 1707, the test probe is located on the front edge of the extension cable storage shelf (fig. 17).

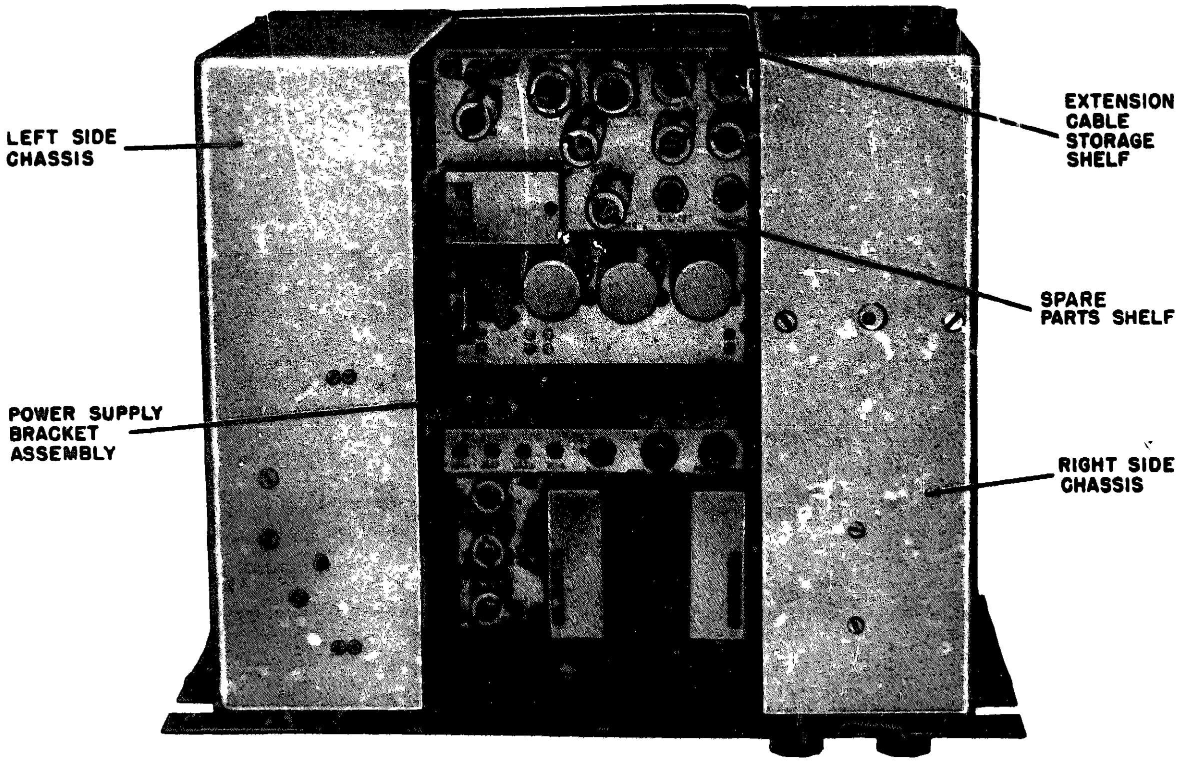


Figure 15. Amplifier-Power Supply AM-682/TCC-3 bearing order numbers Other than Order No. 1667-Phila-51, serial numbers 1 through 1707 top view.

11. Running Spares in TA-219/U

Two spare vacuum tubes 5654/6AK5W are located in each TA-219/U. The tubes are mounted in sockets with shield under the rear end of Channel 2 and channel 3 modems (figs. 89 and 91). These are the only spare parts in the TA-219/u.

12. Running Spares and Special Tools in AM-682/TCC-3

In AM-682/TCC-3 bearing Order No. 1667-Phila-51 serial numbers 1 through 1707, the running spares and special tools are located on two shelves, one above the other behind the power supply (figs. 14, 114, and 115). The contents of the individual shelves are listed in *a* and *b* below. In AM-682A/TCC-3 and AM-682/TCC-3 bearing Order No. 1667-Phila-51, serial numbers 1708 and subsequent, all the spare parts and tools listed in *a* and *b* below are located on one spare parts shelf (fig. 15).

a. Contents of Upper Spare Parts Shelf.

Quantity	Item	Description
3	Vacuum tube	5654/6AK5W.
2	Vacuum tube	5670.
1	Vacuum tube	6AW5W.
1	Vacuum tube	6X4W.
1	Vacuum tube	OB2.
5	Fuse	Cartridge type, 0.5 amp, 250 v.
5	Fuse	Cartridge type, 1 amp, 250 v.
2	Arrestors	Carbon block type.
1	Wrench, hex	1/16 inch.
1	Wrench, hex	1/8 inch.
1	Wrench, hex	5/64 inch.

Figure 16. Amplifier-Power supply AM-682/TCC-3 bearing order numbers other than Order No. 1667-Phila-51, serial numbers 1 through 1707.

NOTE

The three hexagonal wrenches are not provided in some equipment.

b. Contents of Lower Spare Parts Shelf. **(Supplied on serial numbers 1 through 1707 only.)**

Quantity	*Item*	*Description*
1	Vacuum tube	6X4W.
1	Lamp LM-52	Bayonet base, 6.3 v.

13. Circuit Labels

The circuit labels which apply to each unit are stored within the transit case for that unit. They are fastened under spring clamps at the inside bottom of the shock mounts and are accessible upon removal of the chassis.

14. Additional Equipment Required

Equipment not supplied as a part of the AN/TCC-3 but is required for its operation is listed in *a* through *e* below. Some of this equipment is supplied as part of the AN/TCC-23 (para 8).

a. The telephone terminal must be connected securely to ground for protection against lightning and other high voltages. The following equipment is required for grounding the telephone terminal: one clamp TM-106 and one Ground Rod MX-148/G. Any single-conductor copper or aluminum wire No. 14 or larger may be used to connect the telephone terminal to the grounding equipment.

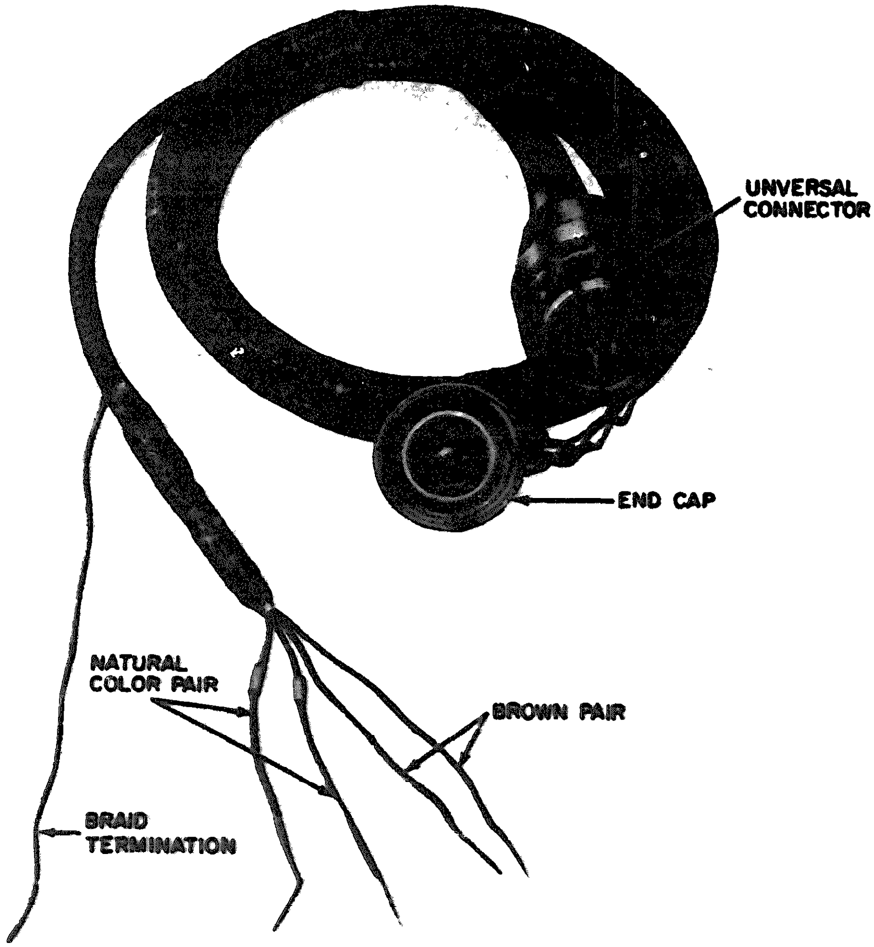


Figure 18. Telephone Cable Assembly -1512/U (spirel-four cable stub).

CHAPTER 2

OPERATING INSTRUCTIONS

NOTE

Section I. SYSTEM PLANNING CONSIDERATIONS

15. General

a. Two Telephone Terminals AN/TCC–3 interconnected by loaded spiral-four cable or other transmission media form a carrier system with four traffic channels and an order-wire channel. If necessary, the length of the system may be extended beyond that obtained with two Telephone Terminals AN/TCC–3 by inserting Telephone Repeaters AN/TCC–5 at intervening points in the system. This carrier system lends itself to various tactical applications because of the following characteristics: it is light in weight, quickly installed, quickly and easily moved, and easily maintained.

b. The main factors which determine the types and numbers of equipment used in this carrier system are the distance that is to be spanned by the system, the terrain between the end points of the system, and the types and quantity of traffic to be carried by the system. The considerations involved in planning the carrier system are discussed in detail in paragraphs 16 through 23.

c. If the traffic is heavy and cannot be handled by the four channels of the AN/TCC–3, it may be necessary to establish additional, paralleling systems.

16. Considerations Due to Length of Carrier System and Topography of Terrain

The normal length of a system without repeaters is approximately 25 miles (para 4*a*). If the distance to be spanned exceeds 25 miles (para 4*b*), repeaters may be placed at intervals of 25 miles to extend the system up to a maximum of approximately 100 miles. Locations for the intervening Telephone Terminals AN/TCC–5 should be chosen so that the cable spans between stations will be about 25 miles, consideration being given to availability of sources of power, proper shelter, etc. Provision is made both at the repeater and at the terminal for extending the span beyond 25 miles. Over ordinary terrain, loaded spiral-four cable is used as the transmission medium. Difficult terrain and other considerations may make it advisable to use a radio link in the system (para 4*c*).

17. Use of Loaded Spiral-four Cable

Spiral-four cable is used as the physical transmission medium for the AN/TCC–3 system. The spiral-four cable, Cable Assembly CX–1065/G is furnished in 1/4-mile reel lengths. Telephone Loading Coil Assemblies CU–260/G must be inserted between the connectors of the 1/4-mile cable sections to provide proper loading of the cable. One-hundred-foot lengths of spiral-four cable. Telephone Cable Assembly CX–1606/G, may be used where shorter lengths of spiral-four cable are needed to reach the carrier telephone equipment. In this case a loading coil assembly will not be inserted between the connectors of the CX–1606/G and CX–1065/G. Instructions for the use and handling of spiral-four cable are contained in TB SIG 233. Quantities of loaded spiral-four cable of older design, Cable Assembly CC–358, are in the field. The cable assemblies will not operate satisfactorily as part of an AN/TCC–3 system.

18. Use of Transmission Media Other Than Spiral-four Cable

The AN/TCC-3 and the AN/TCC-5 are designed primarily to form a four-channel carrier system for transmission over loaded spiral-four cable (para 17). However, the amplification of the AN/TCC-3 and the characteristics of the equalizers of the AN/TCC-3 and AN/TCC-5 make it possible to establish four-channel carrier systems that use transmission media other than spiral-four cable. These are alternative systems which can be used if it is impracticable to lay spiral-four cable, if it is found expedient to use existing lines, or if required by the tactical situation. Transmission media other than loaded spiral-four cable used with the AN/TCC-3 and the AN/TCC-5 must have a characteristic impedance of approximately 600 ohms. The attenuation versus frequency characteristics of these transmission media must be such that the equalizers of the AN/TCC-5 can line up the system (para 137, 138, and 139). Information pertaining to four types of open-wire lines which are suitable for use with the AN/TCC-3 and AN/TCC-5 is given in paragraph 19. In addition to these four types of open-wire lines, other open-wire lines may be suitable for use with the AN/TCC-3 and the AN/TCC-5. The considerations involved in determining the suitability of these other transmission media are given in paragraph 20.

19. Use of Four-Wire Open-Wire lines

Two configurations of four-wire open-wire lines are considered in this discussion. The characteristics of these configurations are outlined in *a* below. Data pertaining to the permissible lengths of four types of open-wire lines is given in *b* below. Considerations pertaining to the use of repeaters in open-wire lines are given in *c* and *d*. Connections to open-wire lines are described in paragraph 29.

a. Characteristics of Open-Wire Line.

(1) *Pole arrangement.* The configuration of four-wire open-wire lines considered in the table in *b*, below, has a maximum of four 8-inch spaced nonphantomed pairs placed on two 10-foot cross arms (fig. 19). The cross arms are 36 inches apart. The line considered is assumed to be properly transposed for frequencies between 300 and 20,000 cycles per second.

(2) *Arrangement of single system wire pairs.* When a single carrier system is placed on the line, the pairs assigned for the A-to-B direction of transmission should not be horizontally or vertically adjacent to the pairs assigned for the B-to-A direction of transmission (fig. 20). Separating the directions of transmission minimizes crosstalk between the two directions of transmission.

(3) *Arrangement of multiple system wire pairs.* When more than one carrier system is placed on adjacent pairs of open-wire lines, the A-to-B and B-to-A directions of transmission should be assigned to horizontally adjacent pairs, such as 1-2 and 3-4 (fig. 21). The directions of

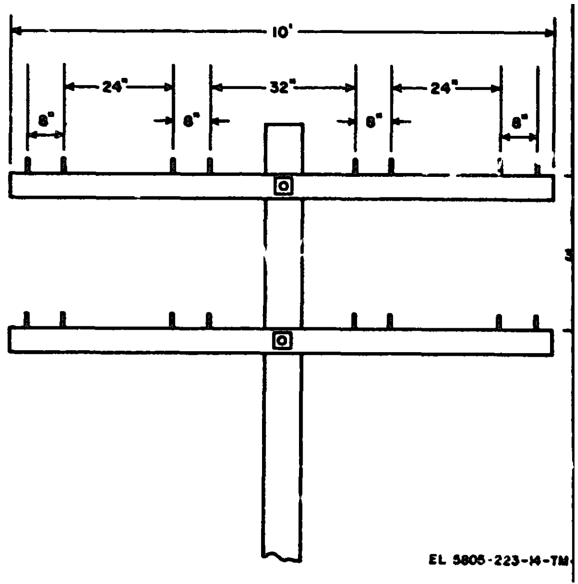


Figure 19. Configuration used for open-wire lines.

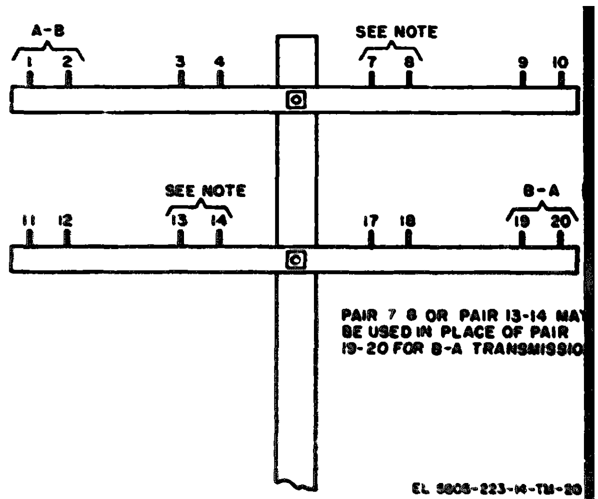


Figure 20. Configuration employed when only one AN/TCC-8 carrier telephone system is operating over an open-wire line.

transmission are then so coordinated that transmission on pairs 1–2, 9–10, 11–12, and 19–20 will be in the A–B direction, while transmission on pairs 3–4, 7–8, 13–14 and 17–18 will be in the B–A direction.

b. Permissible lengths of Open-Wire Lines. The following table lists permissible spacing between AN/TCC–5's and overall lengths of systems (length between two AN/TCC–3's) for four types of open-wire lines which are suitable for establishing one or more four-channel carrier systems. The data given in the table is for wet-weather conditions. The data in the table is given on the assumption that signals from another type of carrier system are not transmitted over lines on the same pole. The data is based on a system with a net loss of 3 db. If, for emergency operation, a net loss of 30 to 36 db can be tolerated, the permitted length of each of the four nonrepeatered systems listed in the table can be extended two to three times in indicated length. The information presented in this table is applicable to an open-wire system such as is described in *a* above. The maximum system lengths shown in the table were computed for a +10-db transmission level. The limiting factors considered were noise and crosstalk. If equalization difficulties are experienced, it may be necessary to operate the system at a 0-db transmission level rather than at a +10-db level.

Wire type and diameter in mils	Number of Telephone Repeaters AN/TCC–5	One system per open wire line		Two or more systems per open wire line	
		Telephone Repeater AN/TCC–5 spacing	Maximum length of system	Telephone Repeater AN/TCC–5 spacing	Maximum length of system
080 40% C–S	0	....	100	....	75
	1	90	180	65	130
	2	85	255	60	180
	4	80	400	55	275
104 40% C–S	0	....	140	....	110
	1	130	260	95	190
	2	120	360	90	270
	4	110	550	80	400
104 Copper	0	....	210	.	145
	1	190	380	130	260
	2	180	480	120	360
	4	165	660	105	525
128 Copper	0	....	230	.	70
	1	210	420	150	300
	2	200	600	135	405
	4	185	925	120	600

c. Location of Telephone Repeaters AN/TCC–5 in an Open-Wire System. When repeaters (AN/TCC–5) are placed in an open-wire installation that already employs voice-frequency repeaters, it is advisable to locate the carrier-frequency repeaters at the sites of the voice-frequency repeaters. This practice centralizes equipment and facilitates maintenance. The spacing between voice-frequency repeaters is normally greater than that required by carrier-frequency repeaters. Therefore, it may be necessary to place additional carrier-frequency repeaters between locations where both voice frequency and carrier frequency types are located. This arrangement also reduces crosstalk that may result from large level differences between systems.

d. Connections to Open-Wire Lines. Follow the procedure outlined in paragraph 29 when making the physical connections at a line pole between an open-wire line and an AN/TCC–3 or an AN/TCC–5 Figure 20 illustrates the completed connections.

20. Factors Governing Suitability of Open-Wire Lines as Transmission Media

Transmission media other than loaded spiral-four cable and the four types of open-wire lines discussed in paragraph 19 can be suitable for use with AN/TCC–5's to establish one or more four channel carrier systems. The factors which determine the suitability of such transmission media are discussed in *a* through *c* below.

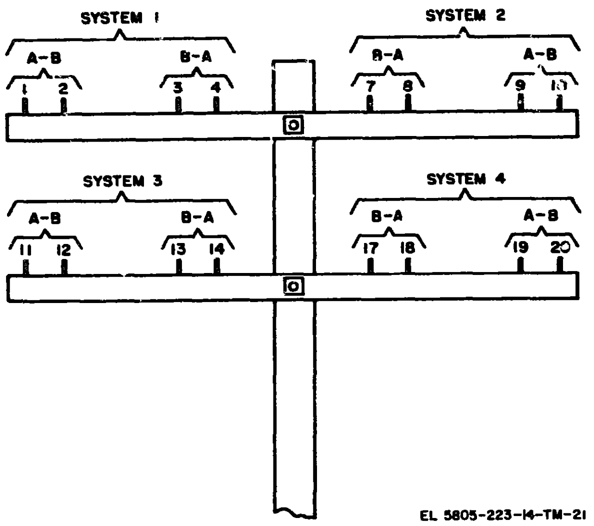


Figure 21. Configuration used when more than one AN/TCC-8 carrier telephone system is operating over an open-wire line.

a. Lines of Known Characteristics. The transmission media should have a characteristic impedance of approximately 600 ohms. Noise, crosstalk, and the attenuation versus frequency characteristic of a line limit the usable line length.

(1) Noise is the controlling factor in considering the suitability of a length of line over which only one system is to be established. The noise level in a line depends on the line length. Satisfactory transmission should be obtained with a noise level on system channels of about 38 dba (decibels adjusted, as measured by Transmission Measuring Set TS-559/FT) at a 0-db transmission level point.

(2) Crosstalk is the controlling factor in considering the suitability of a length of a line over which two or more systems are to be established. The level of crosstalk in a line depends upon the line length. The near-end (or echo) equal level crosstalk loss of a system intended for full duplex telegraph communication over a channel should be at least 25 db. The far-end equal level crosstalk loss should be at least 50 db.

(3) The attenuation versus frequency characteristic of a line limits the usuable line length. The attenuation versus frequency characteristic determines whether the equalizers of the AN/TCC-3 and AN/TCC-5 can line up a system using a line of known characteristics. The system performs in such a manner that a signal leaving a terminal transmitting amplifier or a repeater line amplifier, at either a 0-db or +10-db level, should enter the succeeding terminal receiving amplifier or repeater line amplifier at a -45-db level (para 133). The losses that affect the line signal consist of the line loss, cable matching network loss, and equalizer losses. The sum of these losses must total 45 db for a 0-db transmission level, and 55 db for a +10-db transmission level.

(a) The following detailed analysis is for a system operating into open wire when all amplifier AMP OUT switches are set to the 0-DB position. Figures 48, 49, and 50 show that at 1 kc the flat, slope, and bulge equalizers can be set for minimum attenuations of approximately 3.2 db, 15.8 db, and 5.3 db, respectively. This produces a total minimum equalizer attenuation of approximately 24.3 db at 1 kc. The cable matching network loss is approximately 0.7 db. Thus, the minimum equalizer and network loss is approximately 25 db. This loss subtracted from 45 db gives a permissible maximum line loss of approximately 20 db. The line loss can be readily expressed in line length if the line attenuation per mile is known.

(b) The loss of an open-wire line is much less than the loss of an equivalent length of loaded spiral-four cable. Noise and cross talk become controlling factors when using open wire. The permissible length of open-wire lines is discussed in paragraph 19b.

(4) The suitability of the spacings between the AN/TCC-5's and of the overall length of the system (distance between the two AN/TCC-3's) are estimated by considering the factors discussed in (1) through (3 *j* above. These spacings must be verified experimentally. The experimentation consists of attempting to line up the system or systems (para 43) established on the basis of these estimates. In addition, it must be determined experimentally that the levels of noise and cross-talk on the line allow satisfactory functioning of the system or systems.

(5) Estimates of the suitability of lengths of open-wire lines also can be obtained by comparing the attenuation versus frequency characteristics of these lines with those of the four types of military open-wire lines listed in the table, paragraph 19b. The suitability of these estimated systems must be verified experimentally as described in (4) above.

b. Lines of Unknown Characteristics. The suitability of lines with unknown attenuation versus frequency characteristics can be determined only experimentally. This is accomplished as described in a(4) above.

c. Short Lines. Almost any transmission media, up to approximately 10 miles in length, should be suitable for establishing one or more four-carrier channel systems that use AN/TCC-3's. This is possible because the attenuation of the equalizers of the AN/TCC-3's can be adjusted so that the system or systems can be lined up (paras 33 and 133) and because the short length of line results in low levels of noise and crosstalk.

21. Radio links

Radio systems can form links in a wire circuit. In a system using AN/TCC-3's and AN/TCC-5's, the distance between terminals may be spanned partly by cable and partly by radio links. Radio sets such as Radio Sets AN/TRC-24 and AN/GRC-10 can be used to form the radio links. Considerations affecting the distance over which the radio links may operate are discussed in a below. Limitations of the lengths of cable spans in a system using radio links are discussed in *b below.*

a The distance over which the radio equipment will operate satisfactorily depends primarily upon the character of the terrain between the radio transmitter and receiver, the choice of the antenna locations, and the characteristics of the radio set. The distances over which satisfactory operation may be expected vary from a few miles to more than 50 miles. Refer to the technical manual for the particular radio equipment used for further details.

b. The limitations of the lengths of cable sections used in systems employing radio links are outlined in (1) and (2) below.

(1) If a single radio link is used between two carrier equipments (AN/TCC-3 or AN/TCC-5), the maximum cable length between carrier equipment and radio set is 5 miles. Cable sections v and W, figure 5, thus have a maximum length of 5 miles each.

(2) If two radio links are used between two carrier equipments, the total length of cable between a carrier equipment and the second radio link is 5 miles. Cable sections X and Y, figure 5, thus have a maximum total length of 5 miles. Cable sections Y and Z, figure 5, also have a maximum total length of 5 miles.

(3) If a system employs radio links in one part of the system, but the distance between two particular carrier equipments of the system is spanned completely by cable, the maximum distance between these carrier equipments is 35 miles. Cable section U, figure 5, thus has a maximum length of 35 miles.

c. Special procedures are required to connect the spiral-four cable sections to the radio sets. The procedures for making connections to several radio sets are outlined in paragraph 30.

22. Connections to Voice-Frequency Loop Equipment

a. Each traffic channel of the AN/TCC-3 can be extended from the AN/TCC-3 to telephone sets, v-f telegraph terminals, test boards, switchboards, or other voice frequency terminating equipment. Each traffic channel of the AN/TCC-3 contains a terminating hybrid coil which permits the channel to be extended on a two-wire basis.

b. When the channel is arranged for two-wire operation, the input to the transmitting terminal will be designated as the 0-db transmission level point. The output of the receiving terminal, When the system is adjusted for 3-db net loss, is the -3-db transmission level point.

c. When the traffic channels of the AN/TCC-3 are extended on a four-wire basis, the input to the transmitting terminal will be designated as the -4-db transmission level point. The output of the receiving terminal, with the system under normal lineup conditions, is the + -db transmission level point.

23. Order Wire Channel

a. The order wire channel is a maintenance and administrative telephone circuit which provides talking and signaling facilities between the carrier terminals, the carrier repeaters, and intermediate radio link equipments.

b. The order wire circuit may be extended on a two-wire basis from the carrier terminal to a test board or switchboard location. When the order wire is extended to a switchboard or test board, the signaling between the switchboards at opposite ends of the system must be at a frequency other than 1,600 cps to avoid calling the carrier and radio equipment attendants who signal with 1,600 cps. V-f ringing signals at a frequency of 1,225 cps may be used satisfactorily to signal between switchboards over the order wire circuit. These signals may be obtained by inserting a signal converter such as Telegraph-Telephone Signal Converter TA-182/U in the order wire circuit at the switchboard location. The TA-182/U must be arranged for telegraph operation (TP-TG switch of the TA-182/U in the TG position). The installation, operation, and maintenance of Telegraph-Telephone Signal Converter TA-182/U are described in TM 11-5805-247-12 and TM 11-5805-247-35.

Section II. SERVICE UPON RECIEPT OF TELEPHONE TERMINAL AN/TCC-3

24. Siting

a. *External* Requirements. The best location for the AN/TCC-3 may depend on the tactical situation or local considerations, such as the following : the need to house the equipment where its shelter cannot be seen, the terrain, and the necessity of easy access to messengers.

b. Interior Requirements. Place the equipment in a shelter or in a sheltered location to assure protection against the weather.

(1) Provide a dry, secure footing which resists vibration and is capable of supporting the equipment safely and in a level position.

(2) If several terminals are to be located at the same point, provide sufficient space so that each carrier system can be maintained with a minimum of interference to other carrier systems.

(3) Make sufficient space available to permit satisfactory operation and maintenance.

(4) Provide adequate lighting for both day and night operation. Position the equipment so that panel designations may be read easily by the operating personnel. Artificial lighting should be installed so that light falls directly on the panels.

25. Uncrating, Unpacking, and Checking New Equipment

a. General.

(1) When new equipment is received, select a location where the equipment may be unpacked without exposure to the elements and which is convenient to the field or semipermanent installati f the equipment.

(2) Be careful when uncrating the equipment. Avoid thrusting tools into the interior of the shipping containers. When unpacking, do not damage packaging materials and containers any more than necessary. Stow the interior packaging materials inside the wooden shipping containers.

b. Step-by-Step Instructions for Uncrating and Unpacking.

(1) Two cases are used for packing the components of Telephone Terminal AN/TCC-3. The cases and their contents are listed in the following table:

Case	Contents
1	Amplifier-Power Supply AM-682/TCC-3.
2	Telephone Modem TA-219/U.

(2) Amplifier-power Supply AM-682/TCC-3 is individually packed. It is packed in a strapped, cleated plywood crate that contains a case liner, an outer corrugated fiberboard carton, a vapor barrier, and an inner corrugated fiberboard carton. The fiberboard carton contains the AM-682/TCC-3 and bags of desiccant.

(3) Telephone Modem TA-219/U is individually packed. It is packed in a strapped cleated plywood crate that contains a case liner, an outer corrugated fiberboard carton, a vapor barrier, and an inner corrugated fiberboard carton. The fiberboard carton contains the TA-219/U and bags of desiccant.

(4) The procedures followed for unpacking the two crates are similar. Subparagraphs (5) through (13) describe these procedures in detail. Figure 22 is an exploded view of the packing case and its contents.

(5) Place the packing case as close to the operating position as convenient. Be sure that the case is right side up before beginning the unpacking procedure.

(6) Cut and fold back the steel straps.

(7) Use a nail puller to remove the nails from the top of the packing case. Lift the top off the packing case. Do not attempt to pry off the top: the equipment may he damaged as a result.

(8) Remove the fiberboard wedges. Remove the case liner covers. Open the outer corrugated fiberboard carton. Open the vapor barrier.

(9) Cut the seals on the inner corrugated fiberboard carton carefully so that the equipment will not be damaged.

(10) Grasp the web carrying straps and lift the equipment from the inner box.

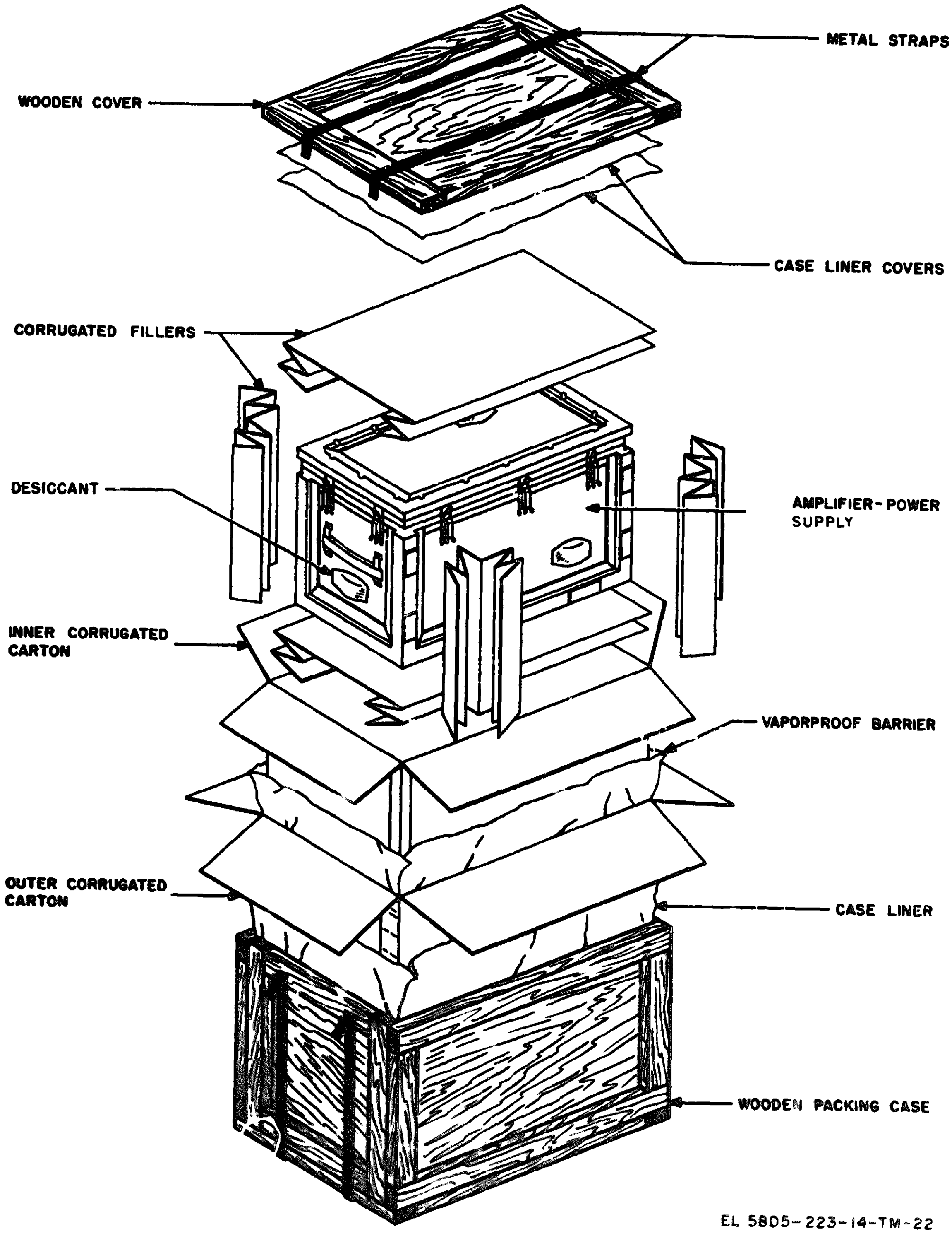


Figure 22. Packaging Diagram.

(11) Remove the bag or bags of desiccant from the corrugated fiberboard box. In the packaging for the TA-219/U, one 8-ounce bag of desiccant is used. In packaging the AM-682/TCC-3, seven l-ounce bags of desiccant are used.

(12) Inspect the equipment for possible damage incurred during shipping.

(13) Check the contents of the packing case against the master packing slip.

NOTE

Save all the packaging material. This material can be used again when the equipment is repacked for storage or shipment.

26. Installation of Telephone Terminal AN/TCC-3

Installation of the AN/TCC-3 consists of two major operations-positioning the equipment and components and establishing a ground for the terminal.

a. Positioning AN/TCC-S.

(1) Remove the covers of the transit cases of the AM-682/TCC-3 and the TA-219/U.

(2) Place the AM-682/TCC-3 on the footing provided (para 24).

(3) Place the TA-219/U on top of the AM-682/TCC-3 (fig. 1).

(4) Fasten the two cases together by means of the web carrying straps.

b. Installation of Ground. The AN/TCC-3 must be grounded to protect personnel and equipment from lightning and other sources of high voltage. Use a common ground for the protection of the AN/TCC-3 and for many other equipment at the same location. The conductors used for grounding the other equipment should be connected to the common ground. Do *not* connect the ground conductors of the other equipment to the CND binding post of the AN/TCC-3.

(1) If a buried water supply piping system is available, ground the AN/TCC-3 to the water system.

(2) If a buried water supply piping system is not available, buried gas pipes, underground tanks, or other grounded metallic structures may be used as the ground.

(3) If a grounded metallic structure is not available, a ground rod (para 14*a*) must be installed. The installation of the ground rod is described in (4) through (9) below.

(4) Select the lowest, dampest site in the vicinity, preferably in clay or loamy soil.

(5) Clean any paint or grease from the ground rod.

(6) Scoop out a small hole approximately 6 inches deep in the selected location.

(7) Drive the ground rod into the hole until the top of the rod is approximately 3 inches above the bottom of the hole.

(8) Connect Clamp TM-106 to the protruding portion of the ground rod.

(9) Saturate the ground around the rod with water.

27. Connections and Presetting of Controls

While making the various connections to the AN/TCC-3 and the interconnections between the AM-682/TCC-3 and the TA-219/U, it is convenient to preset certain internal controls on the AN/TCC-3. The instruction in a through *h* below outline the most convenient method of accomplishing the connections and the presetting of the internal controls. The various connections to be made to the AN/TCC-3 are illustrated in figure 23.

a. Release the captive screws on the front panel of the AM-682/TCC-3 (fig. 10). Grasp the two front panel handles and slide the AM-682/TCC-3 partially out of the carrying case.

b. Remove the a-c power cable and the CARR SUP-POWER cable from the storage space in the left-aide chassis (figs. 11 and 12).

c. Remove the attendant's handset and the TRANS-TEST-TALK cable from the storage space in the right-side chassis (fig. 18).

d. The proper settings of the AN/TCC-3 transmitting amplifier AMP OUT switch for operation into various types of transmission media are indicated in (1) through (4) below.

(1) If the AN/TCC-3 is connected to an AN/TCC-5 or another AN/TCC-3 by loaded spiral four cable, and the cable length is less than 25 miles, operate the transmitting amplifier AMP OUT switch (fig. 25) to the 0 DB position. If the cable length is greater than 25 miles, operate the AMP OUT switch to the 10 DB position.

(2) If the AN/TCC-3 is connected to an AN/TRC-1 (para 30*a*), AN/TCC-8 (para 30*b*),

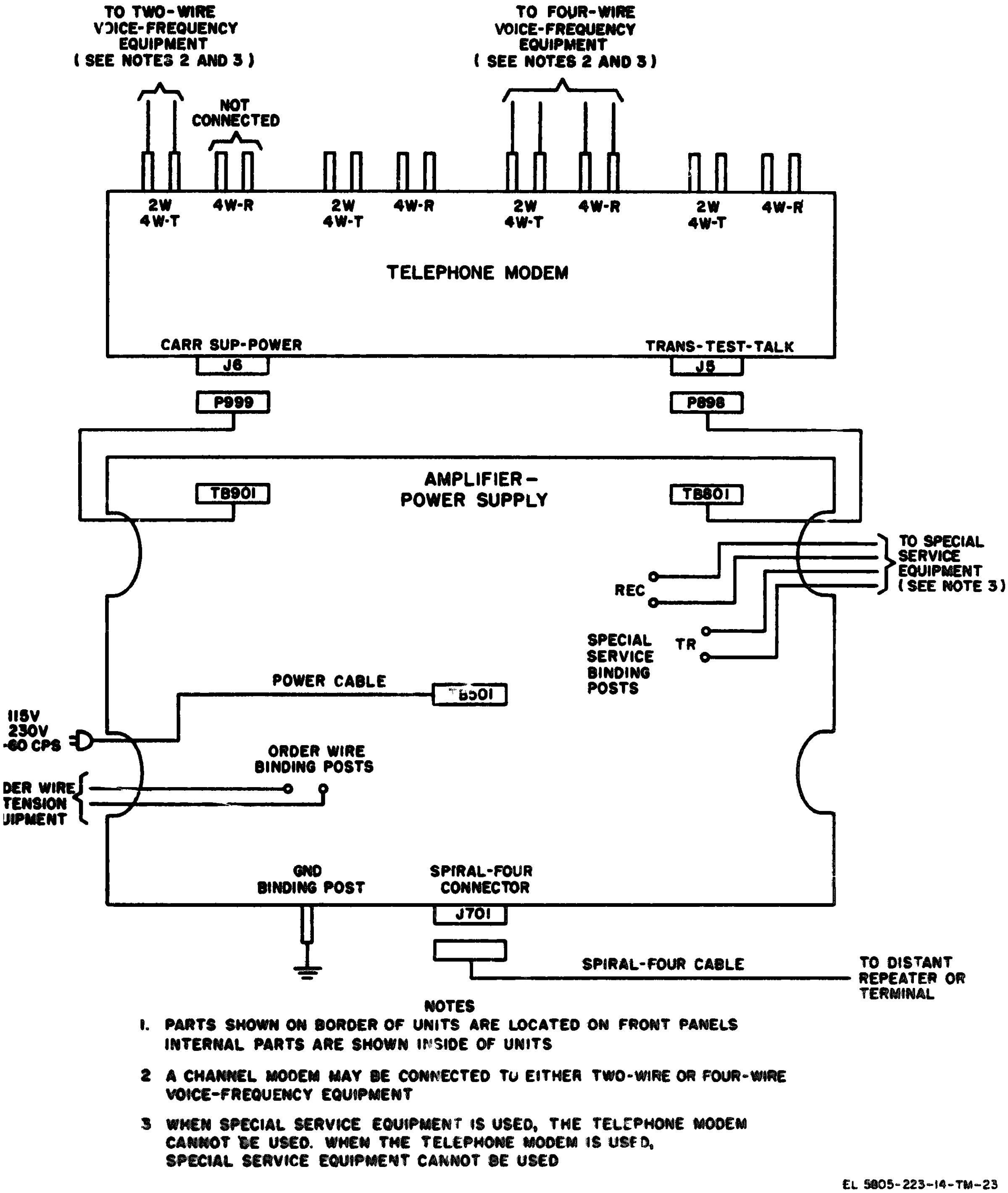


Figure 23. Telephone Terminal AN/TCC-3, cabling diagram.

or AN/GRC-10 (para 30c) radio link, operate the AN/TCC-3 transmitting amplifier AMP OUT switch to 0DB position.

(8) If the AN/TCC-3 is connected to an AN/TRC-24 radio link (para 30d), operate the AN/TCC-3 transmitting amplifier AMP OUT switch to the 10DB position.

(4) Paragraph 19b contains instructions for setting the AMP OUT switch for transmission over open wire.

e. Determine the voltage of the a-c power source and operate 115V-230V switch (fig. 26) to correspond to the voltage available.

***f.* Check fuses F551 and F552 to determine whether they are of the proper rating. *Fuse* F551 is a 1-amp fuse. Fuse F552 is a 0.5-amp fuse.**

CAUTION

Do not replace fuses F551 and F552 with fuses of higher ratings. Damage to the equipment may result.

g. If the AN/TCC-3 is to be used as a four-channel carrier telephone terminal, proceed as follows:

(1) Operate the CHANNELS-SPECIAL SERVICE switch to the CHANNELS position (fig. 25).

(2) If the order wire channel is to be extended, connections are made on a two-wire basis. Make connections to the ORDER WIRE extension binding posts (fig. 19).

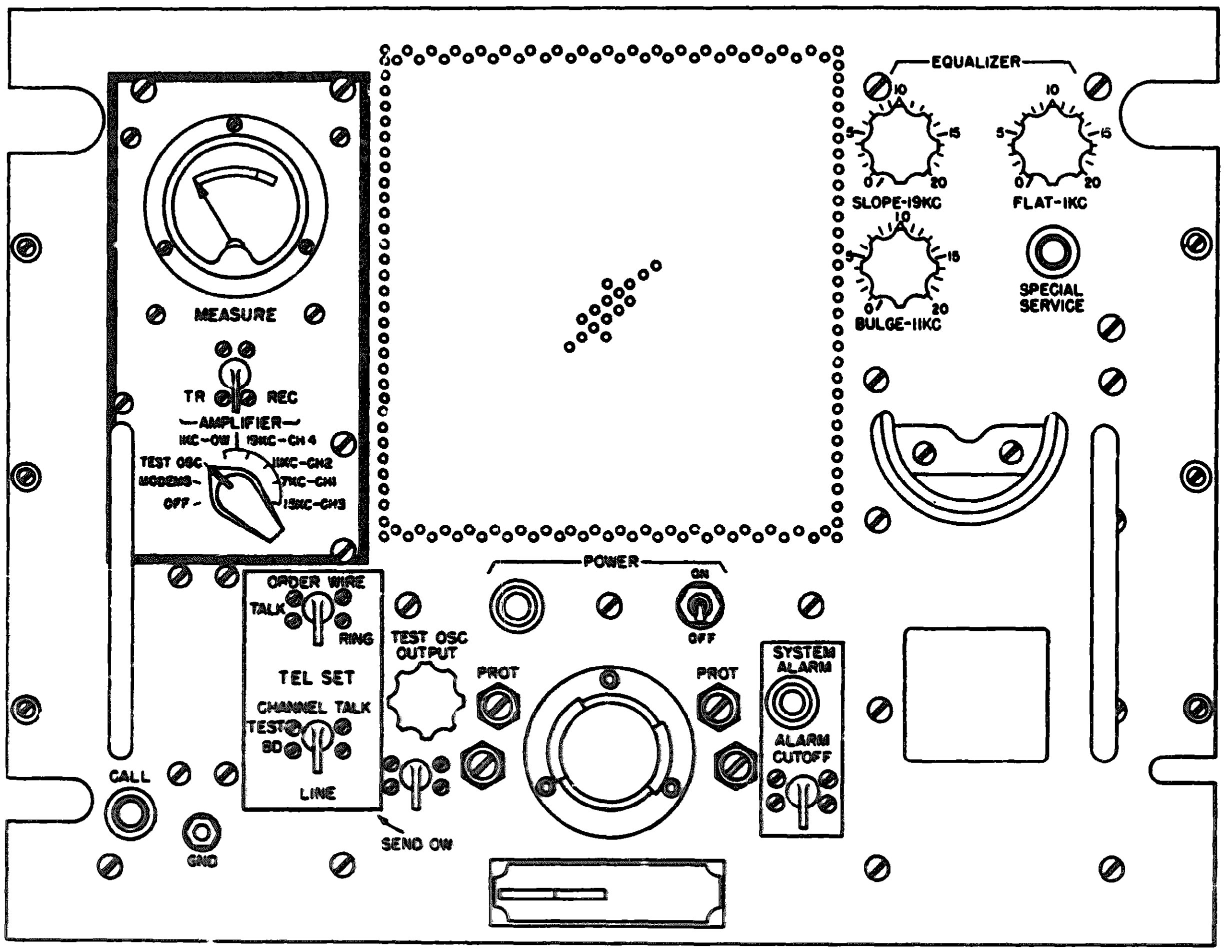


Figure 24. Amplifier-power supply, front panel.

(8) Slide the AM-682/TCC-3 back into the transit case. Make sure that all the cables pass through the proper front panel openings, and tighten the six captive screws securely (fig. 9).

(4) Release the two captive screws on the front panel of the TA-219/U and slide the unit partially out of the transit case by means of the panel handle (fig. 9).

(5) Operate the 2W-4W switch located on each modem channel to correspond with the type of equipment (two-wire or four-wire) connected to the modem channel (fig. 29).

(6) Slide the TA-219/U back into the transit case and tighten the two captive screws securely.

(7) Connect the left-hand side interconnecting cable (fig. 24) and the righthand side interconnecting cable of the AM-682/TCC-3 to the CARR SUP-POWER plug and the TRANS-TEST-TALK jack of the TA-219/U respectively (fig. 9).

(8) Connect the GND binding post on the AM-682/TCC-3 front panel (fig. 24) to clamp TM-106. Use No. 14 gage or larger size wire for this connection.

(9) Operate the POWER switch on the

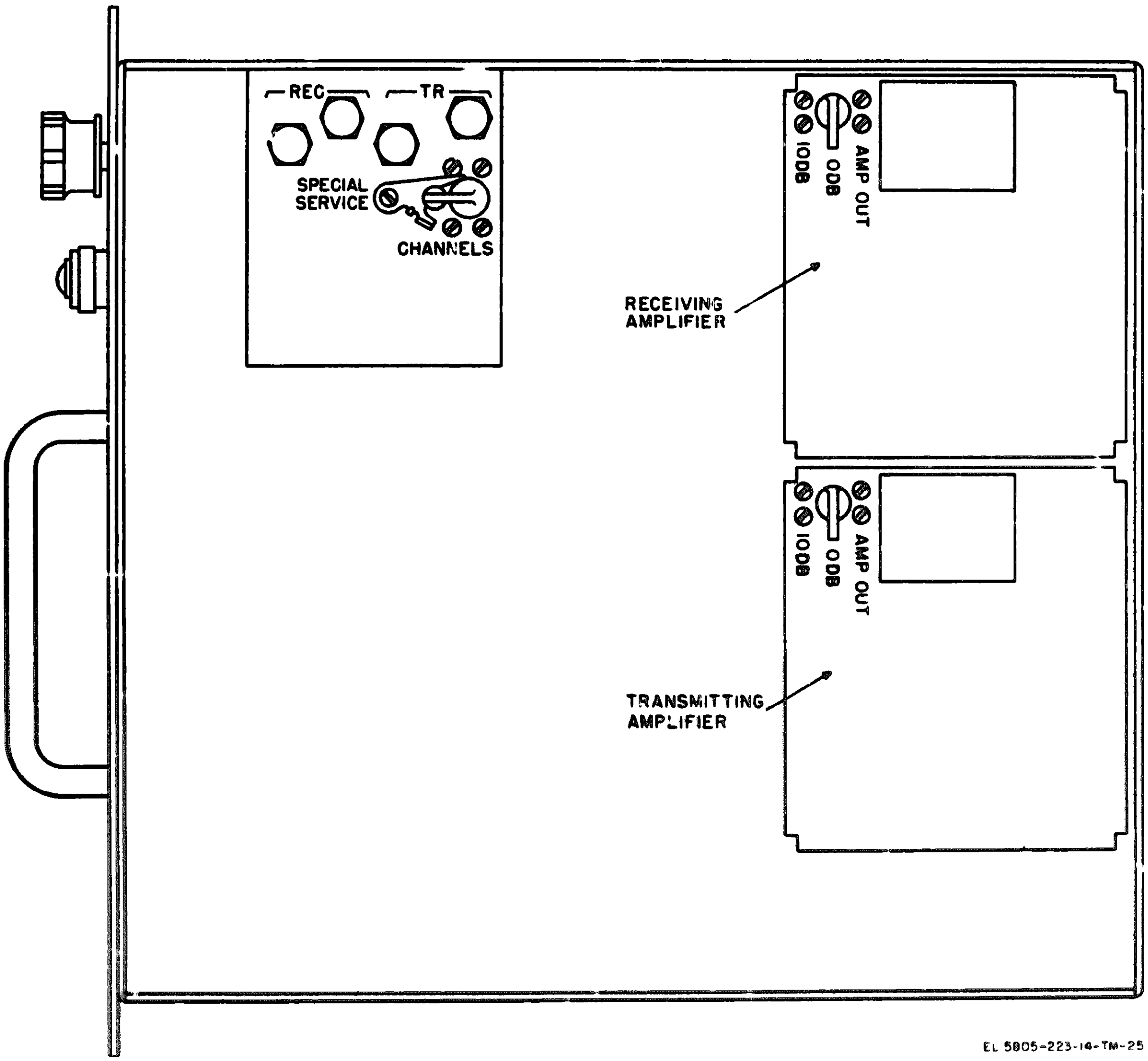


Figure 25. Amplifier-power supply, right-side chassis controls.

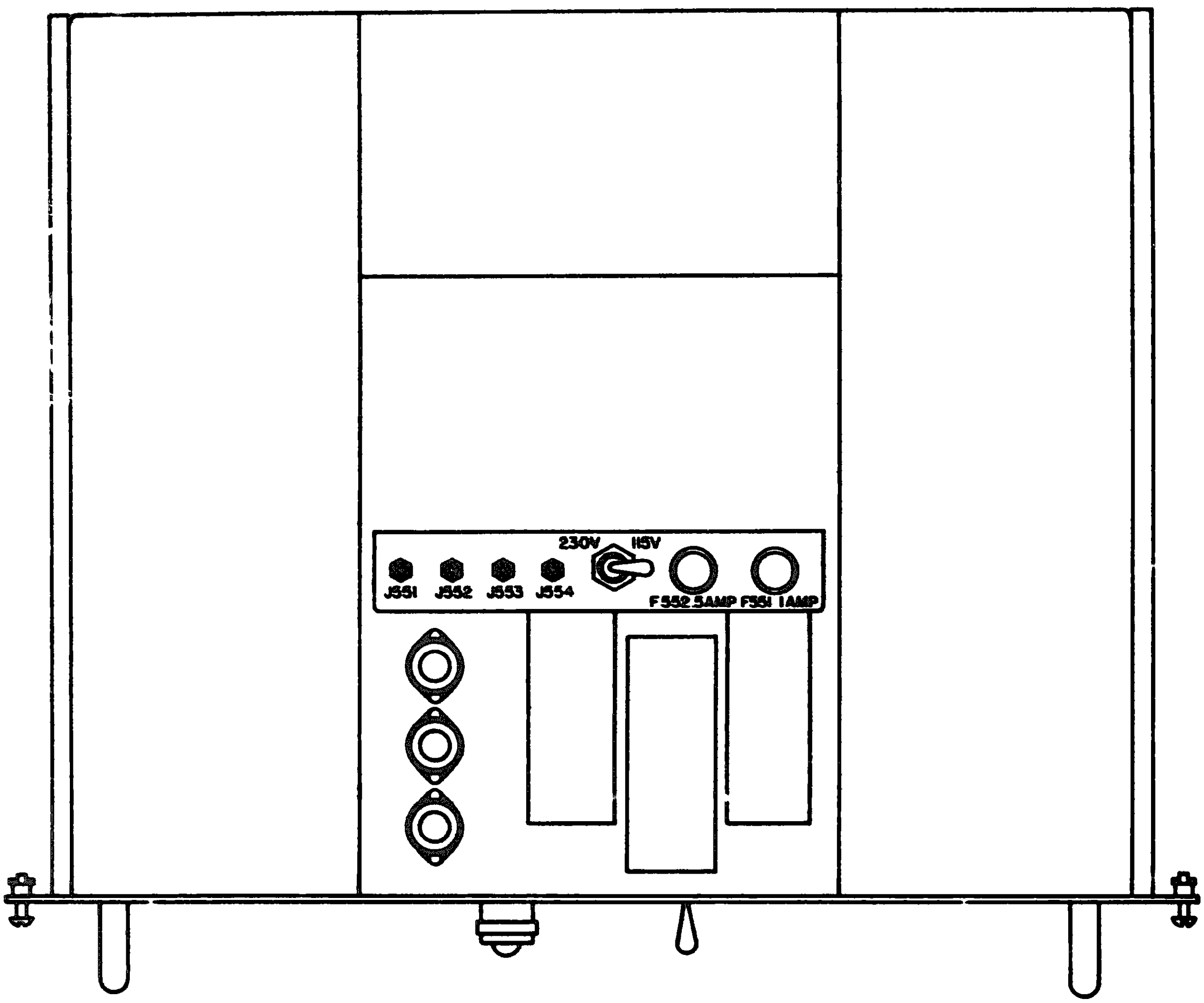


Figure 26. Amplifier-power supply, power-supply controls.

28. Back-to-Back Connections

a. General.

(1) When channels are dropped at a point between terminals A and B, two additional terminals, terminals C and D (fig. 4), are connected back to back at the point where the channels are dropped. The installation and connections of the back-to-back terminals are as described in paragraphs 26 and 27 with the exceptions noted in b and c below. One or more channels of the back-to-back terminals are connected in such a way that transmissions over these channels can be achieved between terminals A and B. These channels are called through channels. The remaining channels, the dropped channels, are connected from the back-to-back terminals to external voice-frequency equipment. The channel connections are described in b below.

(2) Connections must be made between the ORDER WIRE binding posts of the back-to-back terminals in order to permit ringing and order wire transmissions between terminals A and B. The order wire connections are described in c below.

b. Channel Connections. The dropped channels are connected on either a two-wire or four-wire basis to external voice-frequency equipment. The through channels must be connected between the back-to-back terminals on a four-wire basis as follows.

(1) Connect the 4W-R binding posts of a through channel of terminal C through 5-db attenuation to the 2W 4W-T binding posts of a through channel of terminal D. The channel of terminal D to which a through channel of terminal C is connected can be, but need not necessarily be, the correspondingly numbered channel.

(2) Connect the 4W-R binding posts of the through channel of terminal D through 5-db attenuation to the 2W 4W-T binding posts of the through channel of terminal C to which the connections in (1) above are made.

NOTE

The 5-db attenuation specified in these connections may be obtained by one of two methods.

1. When it is likely that the dropped and through channel will be switched at times, external 5-db pads will be employed. A balanced H type 5-db pad may be constructed from four 100-ohm resistors and one 1,000-ohm resistor.

2. When the channel assignments are expected to be of a permanent nature, a special line-up procedure may be used which will eliminate the need for external 5-db pads. The special lineup procedure (para 62) differs from the normal line-up procedure only in that the GAIN controls of the through channels are adjusted for a 5-db rather than a 0-db indication on the MEASURE meter at the back-to-back terminals. The effect of this adjustment is to insert an additional loss of 5 db in the receiving path of the through channels.

(3) Operate the 2W-4W switches of the through channels in terminals C and D to the 4W position.

(4) To connect the dropped channels to the voice-frequency equipment, follow procedures in (4), (5), (6), (10), and (11) of paragraph 27*g*.

c. *Order-Wire Connections*. Connect the ORDER WIRE binding posts of terminal C to the ORDER WIRE binding posts of terminal D. Order wire transmissions that pass through the back-to-back terminals are received at a level 12 db below normal.

29. Connections to Open-Wire Line

The connections required to use either an AN/TCC-3 or an AN/TCC-5 over open-wire lines are shown in figure 30. The equipment used in making these connections is listed in the following table. The procedures for performing the connections to open-wire lines are outlined in *a* through *n* below.

Item
Connector
Ring PF-74
Protector AR-6
Wire W-69-A
Wire W-119
Ground Rod MX-148/G
Telephone Cable Assembly CX-1512/U
Telephone Cable Assembly CX-1606/G

a. Secure two Protectors AR-6 to the side of the pole at a convenient height above the ground.

b. Install Ground Rod MX-148/G. Instructions for the installation of a ground rod are outlined in paragraph 26*b*.

c. Connect the protectors to the ground rod with Wire W-119.

d. Screw two Rings PF-74 into the cross arm on the pole.

e. Screw several Rings PF-74 into the pole at regular intervals so the rings lie in two vertical lines, one line extending above each protector.

f. Cut and strip the ends of two twisted pairs of Wire W-69-A. Each twisted pair should be sufficiently long to connect to the lines on the cross arms, pass through Rings PF-74 on the cross arms and on the side of the pole, and extend to the protectors.

g. Pass a twisted pair through each line of rings on the side of the pole and through the rings on the cross arm.

h. Use a connector to connect one wire of a twisted pair to each line on the cross arm. Be careful to connect the transmitting pair to the transmitting lines, and the receiving pair to the receiving lines.

i. Connect the stripped ends of each twisted pair to one of the protectors.

j. Use Multimeter TS-297/U to determine by continuity tests which leads of Telephone Cable Assembly CX-1512/U are associated with the male contacts and which with the female contacts of the cable assembly connector.

k. Connect the leads associated with the male contacts of the connector of the CX-1512/U to the protector associated with the transmitting pair of lines on the cross arm.

l. Connect the leads associated with the female contacts of the connector of the CX-1512/U to the protector associated with the receiving pair of lines on the cross arm.

m. Connect the CX-1606/G to the CX-1512/U.

n. Connect CX-1606/G to the spiral-four connector of either the AN/TCC-3 or the AN/TCC-5.

30. Connection to Radio Sets

Radio sets which can be used as radio links in a system are provided with binding posts to which a spiral-four cable stub, Telephone Cable Assembly CX/1512-U, may be connected. The connection procedures for radio sets are given in *a* and *b* below.

a. Connections to Radio Set AN/GRC-10. Connections are located on the front panel of Radio Set Control C-632/GRC-10 (part of Radio Set AN/GRC-10). These consist of two groups of three binding posts per group-one group for receiving, designated REC, and the other group for transmitting, designated XMTR. The REC group is located on the left, and the XMTR group on the right. Each group is arranged in a vertical row with 600-OHM LINE connections at the top and bottom posts, and a shield ground connection to the center post designated GND.

(1) Connect the pair of leads associated with the male contacts of the stub cable connector of Telephone Cable Assembly CX-1512/U to the XMTR 600-OHM LINE binding posts.

(2) Connect the pair of leads associated with the female contact to the REC 606-OHM LINE binding posts.

(3) Couple the stub cable connector to the connector on the front panel of Amplifier-Power Supply AM-662/TCC-3, or to the A or B connector on the front panel of Telephone Repeater AN/TCC-5, depending upon the system layout.

b. Connections to Radio Set AN/TRC-24. Five binding posts designated CABLE CONNECTIONS are arranged in a horizontal row on the lower part of the front panel of Radio Receiver R-417/TRC-24 (part of Radio Set AN/TRC-24). The pair of binding posts at the left end of the row, designated REC, are for receiving circuit connections. The third post from the left, designated GND, is provided for connection to ground. The right-hand pair of posts designated XMTG, is for connection to the transmitter circuit input. To the left of the binding posts is a two-position lever switch with an auxiliary lock; the positions are designated 600 OHMS and 135 OHMS.

(1) Connect the pair of leads associated with the male contacts of the stub cable connector, Telephone Cable Assembly CX-1512/U to the XMTG binding posts.

(2) Connect the pair of leads associated with the female contacts to the REC binding posts.

(3) Operate the lever switch to the 600-OHM position.

(4) Couple the stub cable connector to the connector on the front panel of Amplifier-Power Supply AM-682/TCC-3, or to the A or B connector on the front panel of Telephone Repeater AN/TCC-5, depending upon the system layout.

31. Service Upon Receipt of Used or Reconditioned Equipment

changes in the wiring of the equipment. If any changes have been made in the wiring, note the changes in this manual, preferably on the schematic diagram. Insert the serial number of the AN/TCC-3 with each change note or group of change notes to avoid confusion in the event that this manual becomes associated with another AN/TCC-3.

b. Perform the installations and connection procedures outlined in paragraphs 26 and 27.

Section III. CONTROLS AND INDICATORS

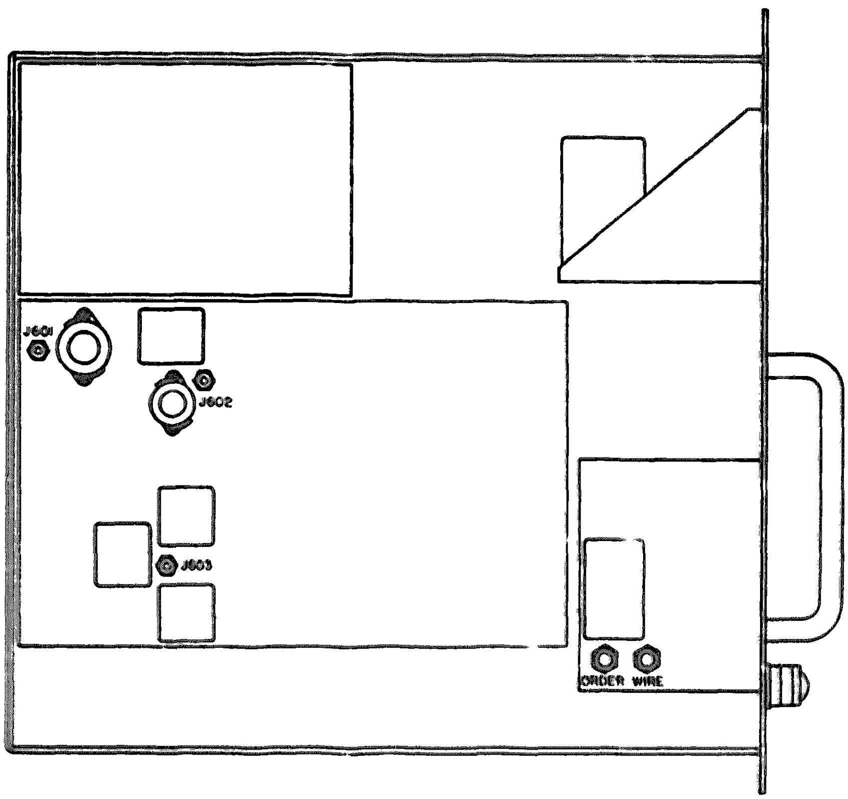
32. Controls of Telephone Teminal AN/TCC-3

The controls (switches and variable resistors) and indicators (meters and indicator lamps) for the AN/TCC-3 are located on the front panels of the chassis of the AM-682/TCC-3 and the TA-219/U. The controls and indicators of the AM-682/TCC-3 are listed and described in paragraph 33 those of the TA-219/U are listed and described *in paragraph 34.*

33. Controls of Amplifier-Power Supply AM-682/TCC-3

General. The controls and indicators of the AM-682/TCC-3 are listed separately in b and c below for the front panel (fig. 24) and for the right-side chasssis (fig. 25), the power supply unit (fig. 26), and the left-side chassis (fig. 27).

b. Front Panel Controls and Indicators. The following chart lists and describes the functions of the controls and indica'ors that are located on the front panel of the AM–682/TCC–3. These controls and indicatorr are shown in figure 24.



EL 5805-223-14-TM 27

Figure 27. Amplifier-power supply, left-side chassis controls.

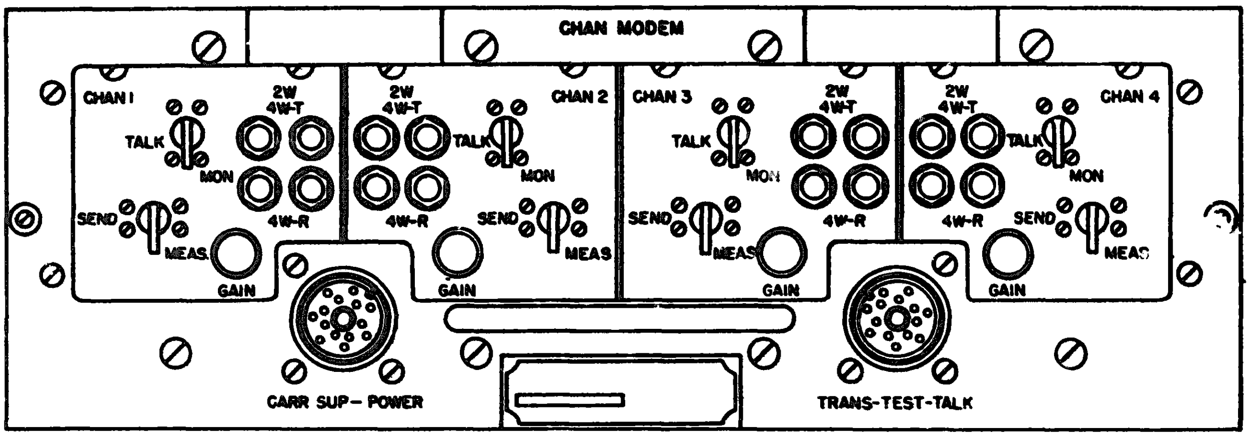


Figure 28. Telephone modem, front panel controls.

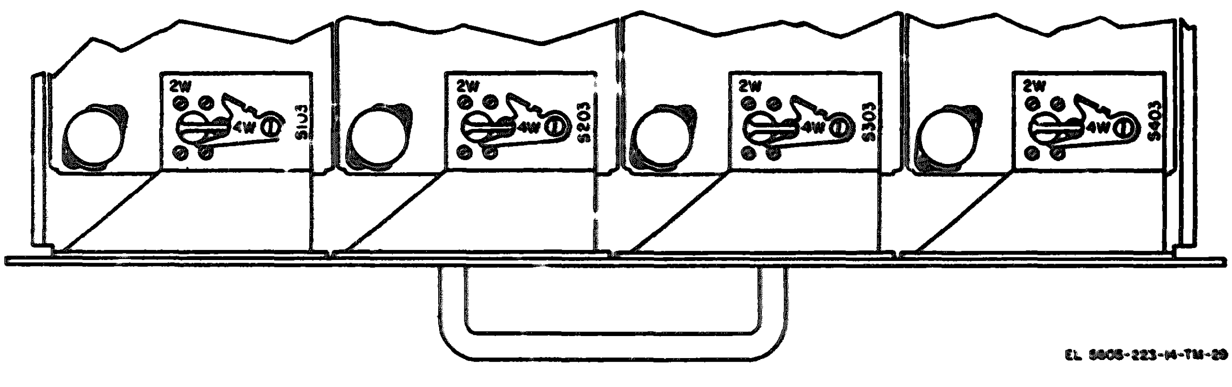


Figure 29. Telephone modem, two-wire and four-wire controls.

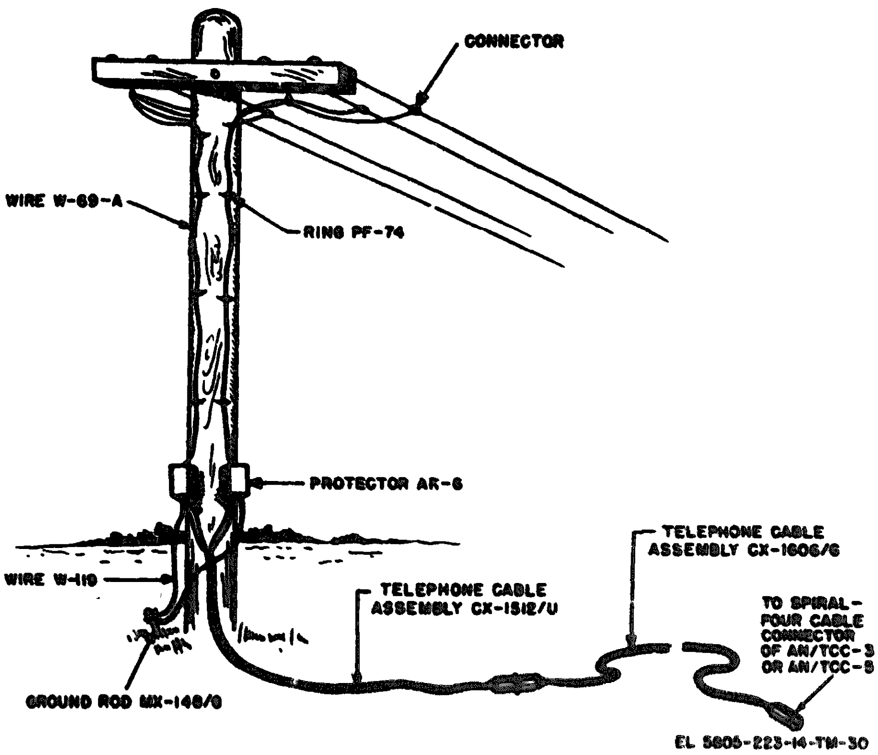


Figure 30. Connections between spiral-four cable and four-wire open-wire line.

Figure 31. Not used.

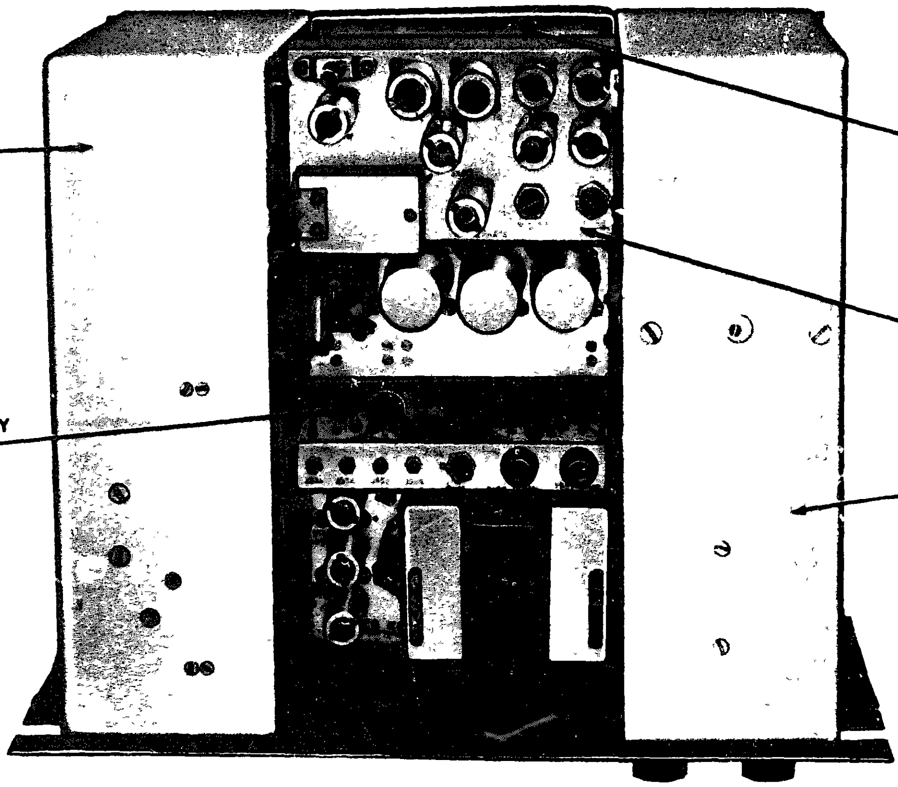


Figure 32. Amplifier-Power Supply AM-682A/TCC-3-top view.

Control or indicator	*Function*
POWER switch (S551)	A two-position toggle switch. In the ON position, applies a-c power supply. In the OFF position, disconnects a-c power from the power supply.
POWER indicator (I-551)	A green lamp which lights when a-c power is applied to the power supply and is extinguished when a-c power is disconnected from the power supply.
SYSTEM ALARM indicator (I-741).	Red lamp which lights to indicate- A cable break. Reduced level or absence of carrier from the distant terminal. A failure of power at the distant terminal. Failure of the transmitting amplifier at the distant terminal. Failure of the receiving amplifier at the local terminal. Failure of any intervening telephone repeater or radio link.
CALL indicator (I-742)	An amber lamp which lights when- A ringing signal is received from a distant station. A ringing signal is transmitted from the local terminal. The local +200 volt supply fails. The SYSTEM ALARM lamp lights (see SYSTEM ALARM indicator, above) provided the ALARM CUTOFF switch is in the normal (vertical) position.
Buzzer (I-l)	Sounds whenever the CALL lamp lights (see CALL indicator, above).
ALARM CUTOFF switch (S705)	A two-position, locking, lever switch. When operated counterclockwise, will silence the buzzer if the buzzer is sounding or will cause the buzzer to sound if it is silent.
SPECIAL SERVICE indicator (I-801).	A white lamp which lights when the CHANNELS-SPECIAL SERVICE switch (c below) is operated to the SPECIAL SERVICE position. The lamp is extinguished when the CHANNELS-SPECIAL SERVICE switch is operated to the CHANNELS position.
ORDER WIRE switch (S702)	A three-position lever switch, locking in the TALK position and nonlocking in the RING position. The normal position is vertical (nonoperated). In the TALK position— Connects the attendant's telephone set to the order wire to permit communications with attendants at distant stations.

Control or indicator	Function
	Connects the ringer oscillator as a ringing-signal detector. Connects ringing signals from other stations to the input of the ringer oscillator. In the RING position- Disconnects the attendant's telephone set, the ORDER WIRE extension telephone set, and the test oscillator from the order wire. Connects the ringer oscillator as an oscillator which generates 1,600-cps ringing signals. Connects the output of the oscillator to the order wire transmission path. Disconnects from the input of the ringer oscillator any ringing signals from other stations.
ORDER wire switch (5702)	In the normal position- Disconnects the attendant's telephone set from the order wire. Connects the ringer oscillator as a ringing-signal detector. Connects ringing signals from other stations to the input of the ringer-oscillator.
CHANNEL TALK switch (5701)	A two-position (LINE TEST BD), lever switch, used in conjunction with the TALK-MON switch of a traffic channel (para 34). In LINE position, the attendant's telephone set is connected to Telephone Modem TA-219/U. This connection permits the terminal attendant to talk over a traffic channel when the TALK-MON switch of that channel is operated to the TALK position. With the TALK-MON switch in the MON position, the attendant's telephone set may be used to monitor the traffic channel. In the TEST BD position, the attendant's telephone set is connected to Telephone Modem TA-219/U. This connection permits the terminal attendant to talk to the local test board attendant.
MEASURE meter (M771)	The measuring circuit meter. The meter scale is marked from -20 to +3 db. The measuring circuit is designed so that a normal signal causes 0-db indication on this meter. Used during system line-up to measure the magnitude of the test signals received from the distant terminal A meter reading other than 0 db indicates the need for line-up adjustment (para 43). Used for checking the operation of the circuits of Telephone Terminal AN/TCC-3. A meter reading, other than that which is normal for the particular measurement, indicates the presence of trouble (para 90).
AMPLIFIER switch (S771)	A three-position (TR-normal-REC) nonlocking, lever switch which is used in conjunction with the MEASURE switch. The TR position is used when a check is made on the transmission of test signals from the local telephone terminal. This check serves as a check on the operation of both the order wire transmission path and the telephone modem. Normal operation of these circuits is indicated by a reading of 0 db on the MEASURE meter. With the switch in the TR position, signals are fed from the output of the transmitting amplifier to the input of the measuring circuit. The REC position is used when a check is made on the adjustment of the equalizer controls. Signals are fed from the output of the receiving amplifier to the input of the measuring circuit. A 0-db reading on the MEASURE meter indicates that the equalizer controls are adjusted properly. In the normal (vertical) position, both amplifiers are disconnected from the measuring circuit.
MEASURE switch (S772)	An eight-position, rotary switch. This switch connects the measuring circuit so that the magnitude of test signals and signals in various circuits of the AN/TCC-3 can be measured. The OFF position connects the test probe (figs. 11 and 27) of the measuring circuit. The test probe is used for checking the output at test points J601, J602, and J603 of the carrier supply. Normal signals at these test points will produce a 0-db indication on the MEASURE meter. The MODEMS position is used when a check is made on the adjustment of the GAIN controls of the channel modems. In the MODEMS position, the MEASURE meter indicates the output of the demodulator amplifier of a channel modem if the SEND-MEAS switch of that modem is operated to the MEAS position. (See SEND-MEAS switch para 34.) The TEST OSC position is used during system line-up for adjusting the TEST OSC OUTPUT control of the 1-kc test oscillator. In the TEST OSC position, the output of the test oscillator is connected to the input of the measuring circuit. The proper adjustment of the TEST OSC OUTPUT control produces a 0-db indication on the MEASURE meter.

Control or indicator	Function
MEASURE switch (S772) _ _ _ _ _ _ _	The 1KC-OW position is used during system line-up. The AMPLIFIER switch (see AMPLIFIER switch, above) must be operated when the MEASURE switch is in the 1KC-OW position. When the MEASURE switch is in the 1KC-OW position and the AMPLIFIER switch is in the TR position, the measuring circuit measures only the l-kc output of the transmitting amplifier. This measurement provides a check on the operation of the order wire transmission path. Normal operation produces a 0-db indication on the MEASURE meter. When the MEASURE switch is in the 1 KC-OW position and the AMPLIFIER switch is in the REC position, the measuring circuit measure only the l-kc output of the receiving amplifier. The measurement provides a check of the adjustment of the FLAT-1KC equalizer control. Proper adjustment produces a 0-db indication on the MEASURE meter. The 19KC-CH4 position of the MEASURE switch is wed during system line-up. The AMPLIFIER switch must be operated when the MEASURE switch is in the 19KC-CH4 position. When the MEASURE switch is in the 19KC-CH4 position and the AMPLIFIER switch is in the TR position, the measuring circuit measures only the 19-kc output of the transmitting amplifier. This measurement provides a check on the operation of channel 4. Normal operation produces a 0-db indication on the MEASURE meter. When the MEASURE switch is in the 19KC-CH4 position and the AMPLIFIER switch is in the REC position, the measuring circuit measures only the 19-kc output of the receiving amplifier. This measurement provides a check on the adjustment of the SLOPE-19KC equalizer control. Proper adjustment produces a 0-db indication on the MEASURE meter. The 11KC-CH2 position is used during system line-up. The AMPLIFIER switch must be operated when the MEASURE switch is in the 11KC-CH4 position. When the MEASURE switch is in the 11KC-CH2 position and the AMPLIFIER switch is in the TR position, the measuring circuit measures only the 11-kc output of the transmitting amplifier. This measurement provides a check on the operation of channel 2. Normal operation produces a 0-db indication on the MEASURE meter. When the MEASURE switch is in the 11KC-CH2 position and the AMPLIFIER switch is in the REC position, the measuring circuit measures only the 11-kc output of the receiving amplifier. This measurement provides a check on the adjustment of the BULGE-11KC equalizer control. Proper adjustment produces a 0-db indication on the MEASURE meter. The 7KC-CH1 position is used for a check of either the operation of channel 1 or the adjustment *of* the equalizer controls. The AMPLIFIER switch mu per- ated when the MEASURE switch is *in* the 7KC-CH1 position. When the MEASURE switch is in the 7KC-CH1 position and the AMPLIFIER switch is in the TR position, the measuring circuit measures only the 7-kc output of the transmitting amplifier. This measurement provides a check on the operation of channel 1. Normal operation produces a 0-db indication on the MEASURE meter. When the MEASURE switch is in the 7KC–CH1 position and the AMPLIFIER switch is in the REC position, the measuring circuit measures only the 7-kc output of the receiving amplifier. This measurement provides a check on the line-up of the system. If the line-up procedures has been performed carefully, an indication of 0 db will be obtained on the MEASURE meter. The 15KC–CH3 position is used for a check of either the operation of channel 3 or the adjustment of the equalizer controls. The AMPLIFIER switch must be operated when the MEASURE switch is in the 15KC–CH3 position. When the MEASURE switch is in the 15KC–CH3 position and the AMPLIFIER switch is in the TR position, the measuring circuit measures only the 15-kc output of the transmitting amplifier. This measurement provides a check on the operation of channel 3. Normal operation produces a 0-db indication on the MEASURE meter. When the MEASURE switch is in the 15KC–CH3 position and the AMPLIFIER switch is in the REC position, the measuring circuit measures only the 15-kc output of the receiving amplifier. This measurement provides an additional check on the line-up of the system. If the line-up procedure has been performed carefully, an indication of 0 db will be obtained on the MEASURE meter.
FLAT–1KC control (R822)	The knob-controlled potentiometer in the 1-kc circuit of the equalizer. The dial of

Control or indicator	Function
	the FLAT-1KC control is divided arbitrarily into equal steps between 0 and 20. This control is adjusted during overall, daily, and monthly line-ups. The FLAT-1KC control varies the attenuation of the equalizer equally over the frequency range from 1 to 20 kc. The procedure for adjusting this control is given in paragraph 51.
SLOPE-19KC control (R823)	The knob-controlled potentiometer in the 19-kc circuit of the equalizer. The dial of this control is divided arbitrarily into equal steps between 0 and 20. This control is adjusted during overall and monthly line-ups. It is not necessary to adjust this control during the daily lineup. The SLOPE-19KC control varies the slope attenuation characteristics of the equalizer between 1 kc and 20 kc with no significant change at 1 kc. The procedure *for* adjusting this control is given in paragraph 51.
BULGE-11KC control (R821)	The knob-controlled potentiometer in the 11-kc circuit of the equalizer. The dial of this control is divided arbitrarily into equal steps between 0 and 20. This control is adjusted during initial and monthly line-ups. It is not necessary to adjust this control during the daily line-up. The BULGE-11KC control varies the bulge attenuation characteristics of the equalizer between 1 kc and 20 kc. The procedure for adjusting this control is given in paragraph 51.
TEST OSC OUTPUT control (R705).	A knob-controlled potentiometer which varies the output of the output of the l-kc oscillator. Clockwise rotation of the control increases the output of the oscillator. The TEST OCS OUTPUT control is adjusted to obtain the proper level of l-kc signal for use during the overall system line-up procedure (pan 48f). Proper adjustment of the TEST OSC OUTPUT control produces an indication of 0-db on the MEASURE meter when the MEASURE switch is in the TEST OSC position.
SEND OW switch (S708)	A two-position, locking, lever switch which is used during the system lineup. The switch is operated clockwise to transmit a l-kc test signal over the line. In the operated position, the SEND OW switch connects the output of the test oscillator to the order wire transmission path. The switch disconnects the attendant's telephone set and the order wire extension telephone set from the order wire transmission path. The switch is left in the nonoperated (vertical) position except when it is desired to transmit a 1-kc *test* signal *over* the line. In 'he nonoperated position, the SEND OW switch disconnects the teat oscillator from the order wire transmission path and connects the attendant's telephone set and the order wire extension telephone set to the order wire transmission path.

c. Internal Controls of Amplifier-Power Supply AM-682/TCC-3. The following table lists and describes the functions of the controls and instruments located internally in the AM-682,/TCC-3. These controls are shown in figures 17, 18, and 19.

Control or indicator	Function
115V-230V switch (S552)	A two-position toggle switch located on the power supply bracket assembly (fig. 26). When in the 115V or the 230V position, the primary windings of the power transformer are connected to receive either 115 volts ac or 230 volts ac, respectively.
AMP OUT switches (S51)	Two two-position, locking, lever switches. One switch is located in the transmitting amplifier and the other in the receiving amplifier. The transmitting and receiving amplifiers are mounted on the right-side chassis (fig. 25). When the AMP OUT switch in the transmitting amplifier is in the 10 DB position the amplifier gain is increased 10 db with respect to the amplifier gain obtained when this switch is in the 0 DB position. The AMP OUT switch in the transmitting amplifier also connects the measuring circuit to the amplifier in such a manner that the MEASURE meter will give the same indication when the AMP OUT switch is in either the 0 DB or 10 DB position. The AMP OUT switch of the receiving amplifier is made inoperative by external strapping on the receptacle for the amplifier plug. Consequently, the operation of this switch has no effect on the receiving amplifier performance.
CHANNELS-SPECIAL SERVICE switch (S801).	A two-position, locking, lever switch with auxiliary locking device. The switch is located on the special service bracket assembly in the right-side chassis of the AM-682/TCC-3 (fig. 25). In the CHANNELS position, the carrier frequency output and input signals of the four traffic channels or the TA-219/U are fed through the contacts of the CHANNELS-SPECIAL SERVICE switch to the transmitting and receiving circuits of the AM-682/TCC-3. In the SPECIAL SERVICE position, the transmitting and receiving circuits of the AM-682/TCC-3 are connected to the SPECIAL SERVICE TR and

Control or indicator	Function
	SPECIAL SERVICE REC binding posts, respectively. When the CHANNELS-SPECIAL SERVICE switch is in the SPECIAL SERVICE position, the SPECIAL SERVICE indicator on the front panel (fig. 24) will light, and the connections to the traffic channels are broken.
Test probe	The test probe is connected to the input of the measuring circuit when the MEASURE switch (5772) is in the OFF position (b above). The test probe is used for checking the output at test points J601, 5602, and J603. In equipments bearing Order No. 1667-Phila-51, serial numbers 1 through 1707, the test probe is located on the left-side chassis near jack J551 (fig. 26). In equipments bearing Order No. 1667-Phila-51, serial numbers 1708 and subsequent, the test probe is located on the front edge of the extension cable storage shelf (fig. 17).

34. Controls of Telephone Modem TA-219/U

a. General. The controls of the TA-219/U are shown in figures 28 and 29 and are listed in the following tables. Telephone Modem TA-219/U contains four similar channel modems with identical controls.

h Front Panel Controls The following table lists and describes the functjons of the controls located on the front panel of the TA-219/U. Since the controls of all the channels are identical, only the nomenclature of the controls of channel 1 are referred to in the table.

Control	Function
TALK-MON switch (S101)	A three-position lever switch, locking in the TALK positron and nonlocking in the MON position. When nonoperated, the switch is in the vertical position. It is used in conjunction with the CHANNEL TALK switch of the AM-682/TCC-3 (See SHANNEL TALK switch, para 336). When the TALK-MON switch is in the TALK position, the attendant's handset is connected to the channel. This permits the terminal attendant to talk over the traffic channel when the CHANNEL TALK switch is operated to the LINE position. With the CHANNEL TALK switch operated to the TEST BD position, the terminal attendant *may* talk with (but cannot ring) the local-channel-loop equipment attendant. When the TALK-MON switch is in the MON position, the terminal attendant may monitor both directions of transmission on the traffic channel. The sidetone obtained in the attendants handset from the intelligence permits this transmission to be monitored. When the TALK-&ION switch is nonoperated, the attendant's telephone circuit is not connected to the traffic channel.
SEND-MEAS switch (S102)	A three-position lever switch, locking in the SEND position and nonlocking in the MEAS position. The SEND position is used for transmission *of* a test signal during system line-up. With the switch in the SEND position: The v-f loop equipment is disconnected from the transmitting circuit of the channel. The 1-kc output of the test oscillator which produces the test signal is connected to the transmitting circuit of the channel. The receiving circuit of the channel remains connected to the loop equipment. The MEAS position is used during system line-up in conjunction with the measuring circuit for the adjustment of the GAIN control. When the SEND-MEAS switch is in the MEAS position and the MEASURE switch of the AM-682/TCC-3 in the MODEMS position: The v-f loop equipment is disconnected from the receiving circuit of the channel. The output of the demodulator amplifier is connected to the input of the measuring circuit. Proper adjustment of the GAIN control produces a 0-db indication on the MEASURE meter. The transmitting circuit of the channel remains connected to the external v-f equipment. The nonoperated (vertical) position of the switch is used for communication on the traffic channel. When nonoperated, the external v-f equipment is connected to both the transmitting and receiving circuits of the channel.
GAIN control	A knob-controlled potentiometer which is rotated to vary the output of the channel receiving circuit. Clockwise rotation of the GAIN control increases the output. The control is adjusted during the overall line-up procedure (para 43).

c. Internal Controls. The following table lists and describes the functions of the TA-219/U. The controls of the channel are shown in figure 29. Since the controls of all channels are identical, only the nomenclature of the control of channel 1 is referred to in the chart below.

control	Function
2W-4W switch (S103)	A two-position lever switch. An auxiliary locking device which holds the switch in either position. The switch is located at the top of the chassis of the channel modem. The 4W position is used when four-wire connections are made between binding posts 2W 4W-T and 4W-R, and the loop equipment. In the 4W position, the switch connects the transmitting circuits of the channel modem to the 2W 4W-T binding posts and the receiving circuits to the 4W-R binding posts. The 2W position is used when two-wire connections are made between binding posts 2W 4W-T and the loop equipment. The 4W-R binding posts are not used when the switch is in the 2W position. In the 2W position, the switch connects the transmitting and receiving circuits of the channel modem through a hybrid coil to the 2W 4W-T binding posts.

Section IV. OPERATION UNDER USUAL CONDITION5

35. Preliminary Starting Procedure

Follow the procedures outlined in *a* through *d* below, before placing the AN/TCC-3 in operation.

a. Operate all front-panel lever switches to the vertical position except the ALARM CUTOFF switch. Operate the ALARM CUTOFF switch to the right. Operate the POWER switch to the OFF position.

b. If the AN/TCC-3 is being placed into initial operation, operate all equalizer controls to control position 10. If the system has been operated previously and has been taken out of operation for a short period, operate all equalizer controls to the positions obtained in the last satisfactory system lineup. These positions are recorded on the white plate behind the attendant's handset.

c. If the system is to be lined up, or if the system is to be used as a four-channel telephone system, operate the CHANNELS-SPECIAL SERVICE switch to the CHANNELS position. If the system is already lined up, and the system is to be placed in special service operation, operate the CHANNELS-SPECIAL SERVICE switch to the SPECIAL service position.

d. Disconnect the spiral-four cable.

36. Starting Procedure

Follow the procedures outlined in *a* through *d* below to place the AN/TCC-3 in operation. If any abnormal indications are obtained while following the steps of the starting procedures, operate the POWER switch to the OFF position and refer to the equipment performance checklist (para 90) and apply the suggested corrective measures.

a. Operate the POWER switch to the ON position. The green POWER and amber CALL lamps should light, and the buzzer should sound. After approximately 30 seconds, the CALL lamp should go out, the buzzer should be silenced automatically, and the red SYSTEM ALARM lamp should light.

b. Connect the spiral-four cable as outlined below.

(1) Unscrew the metal cap covering the connector on the spiral-four cable.

(2) Aline plug and connector terminals.

(3) Fit the plug to the connector.

(4) Move the cable grip forward to the connector casting.

(5) Rotate the cable grip to the loch position.

c. When the distant AN/TCC-3 and the intervening line equipment are in operation, the SYSTEM ALARM lamp will go out. If the system is approximately lined up, the CALL lamp will light and the buzzer will sound. Operate the ALARM CUTOFF switch to the vertical position. The CALL lamp should go out and the buzzer should be silenced.

37. Types of Operation

The AN/TCC-3 may be used either to provide four v-f carrier channels of communication or to provide a single channel for the transmission and reception of broad-band signals, such as high-speed facsimile signals. These types of operation are known as channels operation and special service operation, respectively. If channels operation is desired, follow the procedure outlined in paragraph 27a through *f* for connections and presetting of controls. For special service operation, follow the procedure outlined in paragraph 27a through e and g. The preliminary starting and starting procedures used for channels operation and special service operation are similar. These procedures are outlined in paragraphs 35 and 36.

38. Stopping Procedures

To remove the AN/TCC-3 from operation, follow the procedure outlined in a through c below.

a. Operate the MEASURE switch to the OFF position. The MEASURE meter indicator should swing to the extreme left.

b. Operate the POWER switch to the OFF position. All indicator lamps should be extinguished.

c. Remove the a-c power-cord plug from the a-c power source.

Section V. USE OF ATTENDANTS TELEPHONE SET AND ORDER WIRE EXTENSION EQUIPMENT

39. Operation of Attendant's Telephone Set

a. General. The attendant's handset (figs. 1 and 13) is used primarily for direct communication over the order wire circuit between attendants at the stations of the system. It also may serve as an auxiliary telephone unit to permit communication over or monitoring on the four traffic channels of the AN/TCC-3. The operating procedure for these functions is given in b through d below. The controls referred to are illustrated in figure 23 and described in paragraphs 33 and 34.

b. Procedure for Use of Attendant's Telephone Set on Order Wire. The procedure for initiating a call from a terminal to another station in the system by using the attendant's telephone set is outlined in (1) through (3) below. The procedure at the terminal for answering a call from another station is outlined in (4) and (5) below.

(1) Operate the ORDER WIRE switch to the TALK position and listen to determine whether or not the circuit is idle If the circuit is in use, wait until it becomes idle before proceeding.

(2) To call in other stations, operate the ORDER WIRE switch momentarily to the RING position.

NOTE

When Telephone Terminals AN/TCC-3 are used in conjunction with intervening Telephone Repeaters AN/TCC-5 or with radio links, ringing signals transmitted from the local station are received simultaneously at all the intervening stations, as well as at the distant telephone terminal. It is possible to assign code calls to each of these stations so that a particular attendant may be called at will.

(3) After ringing, operate the ORDER WIRE switch to the TALK position. When the called station answers, operate the press-to-talk switch on the telephone and proceed with the message.

(4) When a ringing signal from a distant terminal or repeater is received, the buzzer in the terminal sounds and the amber CALL lamp lights.

(5) To answer an incoming call, operate the ORDER WIRE switch to the TALK position, operate the press-to-talk switch on the attendant's telephone set, and acknowledge receipt of the ringing signal.

c. Procedure for Use of Attendant's Handset for Monitoring Traffic Channels. The procedure for monitoring the traffic channels of the system is outlined in (1) through (5) below.

(1) Operate the TALK-MON switch of the traffic channel selected for monitoring to the MON position.

(2) Operate the CHANNEL TALK switch to the LINE position.

(3) Listen to incoming and outgoing intelligence. It should be noted that the sidetone obtained from the outgoing intelligence permits it to be monitored.

(4) To talk to personnel at the distant traffic channel loop equipment, operate the CHANNEL TALK switch in the LINE position and operate the TALK-MON switch to the TALK position. Operate the press-to talk switch on the attendant's handset and proceed with the message.

(6) To talk to personnel at the local traffic channel loop equipment, operate the CHANNEL TALK switch to the TEST BD position, and operate the TALK-MON switch to the TALK position.

d. Procedure for Use of Attendant's Telephone Set for Communication Over Trafic Channels. The attendant's telephone set may be used for communication over traffic channels for test purposes. The procedure for this use of the attendant's telephone set is outlined in (1) through (5) below.

(1) Establish contact with the attendant at the distant terminal over the order wire circuit (b, above). Arrange a definite time for communication over the selected channel.

(2) At the appointed time, determine by monitoring whether or not the selected channel is idle c ((1) through (5) above). If the channel is not idle, arrange another time or wait until the channel is idle before proceeding.

(3) Operate the TALK-MON switch of the selected channel to the TALK position.

(4) Operate the CHANNEL TALK switch to the LINE position.

(6) Operate the press-to-talk switch on the attendant's telephone set and proceeed with the message.

40. Procedure for Use of Order Wire Extension Equipment

The procedure for communication between personnel at the local order wire extension equipment and personnel at the distant order wire extension equipment is outlined in *a* and *b* below. Each order wire extension must include a Telegraph-Telephone Signal Converter TA-182/U with the TP-TG switches of the signal converter operated to the TG position.

a. Monitor the order wire circuit to determine whether or not the circuit is idle. If the circuit is in use, wait until it becomes idle before proceeding.

b. Ring the distant station equipment.

NOTE

The SEND OW switch at the local terminal must be in the nonoperated (vertical) position to permit conversation between the local extension equipment and the distant extension equipment.

41. Use of Order Wire During Special Service Operation

When special service connections have been made, it is possible for the terminal and repeater attendants to ring and maintain order wire communications. However, interference between the order wire and the special service facilities may limit the use of the order wire to designated idle periods unless the special service loop equipment contains special filtering.

42. Talking Test for Local Voice-Frequency Loop Equipment

A talking test of the local voice-frequency loop equipment may be performed from the terminal by using the attendant's telephone set. The procedure for this test is outlined in a through c below.

a. Contact the attendant at the local traffic channel loop equipment and arrange a time for the talking test. Contact must be made over an auxiliary local telephone circuit.

b. At the time arranged for the talking test, monitor the channel to determine whether or not it is idle. If it is in use, wait until it is idle before proceeding.

c. To talk to the local voice-frequency loop equipment, proceed in the following manner:

(1) Operate the CHANNEL TALK switch to the TEST BD position.

(2) Operate the TALK-MON switch to the TALK position.

(3) Operate the press-to-talk switch of the attendant's handset and proceed with the talking test.

Section VI. SYSTEM LINE-UP

43. General

a. After installation of the system, it is necessary to line up the system. The test facilities required for line-up are built into the AN/TCC-3. If one or more intervening station, such as Telephone Repeater AN/TCC-5, is used in the system, the test equipment built into each station also must be used for the system line-up procedure.

b Two system line-up procedures are described in these instructions. These are the overall system line-up and the daily system line-up. The overall system line-up (pars 48 through 54) is used when the system is first set up in a new location, and monthly thereafter. The overall system lineup is used also when parts of the equipment affecting transmission are changed. The daily system line-up (para 56) is performed daily or more often if necessary.

c. Use the same overall system line-up procedure whether the equipment is used for special service or for four-channel carrrier operation.

d. The four-channel daily system lineup may be performed while the system is in operation.

e. The special service daily lineup procedure may require that there be no transmission of special-service signals during the lineup (para 56c).

f. The procedures followed at the telephone terminal during the overall system line-up differ when the station being lined up is a repeater and when the station being lined up is a radio link. The procedures to be followed at the terminal when a repeater is being lined up are outlined in paragraph 48. The procedures to be followed at the terminal when a radio link is being lined up are outlined in paragraph 49.

44. Boris of Need for Line-Up

a. General.

(1) System lineup is required in order to assure the proper performance of the system whether the system is used to provide four traffic channels or one wide-band special service channel. The line-up consists of two phases. First, a broadband line-up is required to provide the proper amount of attenuation and to compensate for the non-linear attenuation-versus-frequency characteristics of the transmission media. Second, a line-up of the individual channels is required only when the system is used to provide four traffic channels in order to adjust the circuit net loss.

(2) Since the characteristics of the transmission media are not stable from day to day and month to month, periodic reinspection and readjustment of the system line-up are required to maintain system performance. In a system employing loaded spiral-four cable, stability of transmission characteristics is affected by cable temperature changes. Systems employing a radio link from terminal to terminal are affected primarily by variations in radio propagation conditions. Systems using a combination of loaded spiral-four cable and radio links are affected by both factors. It is not possible to set forth one rule for determining the lineup schedules for all systems. The lineup schedule must be determined by the performance of the specific system being maintained. Monthly and daily system line-ups will indicate the need for adjusting line-up schedules.

b. Monthly Overall Line-Up. During the monthly line-up, the MEASURE meter may be found to be above +1 db or below -1 db when the MEASURE switch is in either the 19KGCH4 or the 11KC-CH2 position. If this condition is noted, perform the overalll line-up more frequently than monthly. When a component is replaced or repaired the complete line-up must be performed.

c. Daily Line-Up. The daily system line-up is performed for the purpose of adjusting the terminals and repeaters to compensate for a small change in the attenuation of the cable. It may be necessary to perform the daily line-up more often than once a day if, for a 100-mile system using spiral-four cable, the temperature of the cable varies more than 15° F. from the temperature of the cable at the time the daily line-up was performed. The daily line-up is described in paragraphs 56 through 61.

45. Control of Line-Up

All line-ups, overall or daily, are supervised by the control terminal. The control terminal is designated terminal A, and is the higher echelon terminal. The repeater stations and the second terminal, designated terminal B, should report all readings to terminal A. The equipment at terminal B is identical to the equipment at terminal A.

CAUTION

Permission to make any line-up adjustments must be obtained from the control terminal. The control terminal will not grant permission to line up if telephoto, facsimile, or other signals that might be affected by level changes are being transmitted over the system. Adjustments will be allowed during the transmission of telegraph signals provided that the readjustment is made in steps of less than 2 db.

46. Communication During and Subsequent to Line-Up

a. Communication between attendants at stations where Telephone Terminal AN/TCC-3 and Telephone Repeater AN/TCC-5 equipment is located can be established over the order wire channel. It is possible to signal and talk during all lineup procedures except when the order wire channel is used for line-up. In a system containing a radio link, the radio link must be operating before communications can be established throughout the system.

b. Communication to attendants at the Radio Sets, if located remotely from the AN/TCC-3 or from AN/TCC-5 equipment, may be accomplished by use of WD-1 field wire and field telephone sets. Monitoring loudspeakers and microphones are provided at the radio sets, particularly for communication over the radio link, but not over the wire connecting circuits. With the equipment described above, the 1,600-cps ringing signal from the AN/TCC-3 or AN/TCC-5 would be heard on the monitoring speakers, but only the distant radio attendant could answer the call. No means is provided at the radio sets for signaling the AN/TCC-3 or AN/TCC-5 attendants.

c. Communication with attendants at Radio set AN/GRC-10 or AN/TRC-24, if located remotely from AN/TCC-3 or AN/TCC-5 equipment can be accomplished with monitoring and talking facilities provided at the radio sets. The radio attendants can hear the 1,600-cps ringing signal from other stations on a monitoring loudspeaker and can send a 1,600-cps signal into the order wire channel for signaling other stations. The radio attendants can talk either over the radio link or to the carrier terminal.

47. Outline the Line-up Procedure

NOTE

Prior to the system line-up, any radio link which is part of the system must be in operation and properly adjusted and lined up in accordance with the instructions furnished with the radio set. The radio link introduced into the carrier system usually will have a 0-db loss.

a. The overall line-up of the system is made under the direction of the control terminal, designated terminal A. The overall line-up consists of first adjusting the equalizers of the circuits carrying transmission in the A to B direction. After the equalizers of the circuits carrying transmission in the A to B direction have been completed, the equalizers of the circuits carrying transmission in the B to A direction are adjusted. After the equalizers have been adjusted, the circuit net loss in the A to B direction is adjusted. Then the circuit net loss in the B to A direction is adjusted. After completing the line-up, a ringing test must be performed between switchboards.

b. To permit equalization of the circuits carrying transmission in the A to B direction, terminal A transmits l-kc, ?-kc, 11-kc, 15-kc, and 19-kc test signals over the order wire channel and channels 1, 2, 3, and 4 respectively toward terminal B. The amplitude of the l-kc test signals is adjusted to the desired value. The amplitudes of the transmitted II-kc and 19-kc test signals are checked at the transmitting terminal, At each repeater, the knobs of the equalizers for the circuits carrying A to B transmission are adjusted until the l-kc, II-kc, and 19-kc test signals produce the desired indication (0 db) on the internal meter of the repeater. The repeaters are adjusted successively starting with the repeater nearest terminal A. After the equalization adjustment of the repeaters for the A to B direction has been completed, terminal B is adjusted. At terminal B, the equalizer knobs are adjusted until the 1-kc, 11-kc and 19-kc test signals produce the desired indication (0 db) on the internal meter of terminal B. After adjusting the equalizers of the circuits carrying transmission in the A to B direction, the equalizers of the circuits carrying transmission in the B to A direction must be adjusted. Terminal B assumes control of the system and test signals from terminal B are transmitted toward teminal A. The repeater equalization adjustments for the B to A direction of transmission are similar to the A to B direction adjustments. After the adjustment of the repeaters has been completed, the equalizers of terminal A are adjusted.

c. After the equalizers of all the circuits in the system have been adjusted, the circuit net loss, for both the A and B and B to A circuits of the system, is adjusted. For the A to B circuits this is accomplished by transmitting the 7-kc, 11-kc, 15-kc, and 19-kc test signals from terminal A toward terminal B. AT terminal B, the 7-kc, 11-kc, 15-kc, and 19-kc test signals are channeled to channel 1, 2, 3, and 4, respectively. The output produced at each of the channels by the received test signals is adjusted to obtain, for each channel, a circuit net loss of 3 db. When the net loss of 3 db has been obtained an indication of 0 db is obtained on the internal meter of the terminal. For adjusting the circuit net loss for the B to A circuits, terminal B transmits test signals. The circuit net loss is adjusted at terminal A.

d. A clear space is provided on the panel of Amplifier-Power Supply AM-682/TCC-3 at the terminals and on the repeater panel. The positions of the equalizer knobs after completion of the line-up are to be recorded in these clear spaces.

e. The daily he-up of the system is made by sending test power from each terminal on the order wire channel only and by adjusting the FLAT-IKC equalizer knobs at the repeaters and receiving terminal to obtain the desired output. Adjustments are made as described in *b* above.

48. Measurement of Test-Power Output of Terminal A, Overall System Line-Up, A to B Direction

The test-power output of terminal A is measured to check the continuity of the transmitting circuits of the channels of terminal A. The limits in the procedure below apply only when connections are to spiral-four cable. For these measurements, the equipment should be terminated in the cable. No adjustment of the transmitted test frequency signal-levels other than the 1KC signal is provided. Make the test as follows.

a. Perform starting procedure given in paragraph 35.

b. After all stations have reported readiness to line up notify them that the line-up will begin.

c. Operate the MEASURE switch to the TEST OSC position.

d Operate the SEND OW switch to the clockwise position in the direction of the arrow. This sends 1 kc toward the line.

e. Operate the SEND-MEAS switches on channel 1, 2, 3, and 4 modems to their SEND positions. This sends 7 kc, 11 kc, 15 kc, and 19 kc toward the line.

f. Adjust the TEST OSC OUTPUT knob to obtain a 0-db indication on the MEASURE meter.

g. Hold the AMPLIFIER switch in the TR position, and operate the MEASURE switch to the 1KC-OW position.

h. The MEASURE meter should indicate between −3.0 and +3.0 db.

i. Still holding the AMPLIFIER switch in the TR position, successively operate the MEASURE switch to the 19KV-CH4, 11KC-CH2, 7KC-CH1, and 15KC-CH3 positions. The MEASURE meter should indicate between -2.0 db and +3.0 db for each position.

j. Instruct the attendant at the next station along the line to proceed with the line-up.

NOTE

If the temperature exceeds 100° *F.*, repeater attendants may be unable to obtain a 0-db indication on the MEASURE meter when adjusting the FLAT equalizer control. If this condition occurs, the repeater attendant will report the condition to the control terminal. The control terminal will instruct the attendant at the station preceding the repeater to operate the AMP OUT switch on the line amplifier (if the preceding station is a repeater) or on the transmitting amplifier (if the preceding station is a terminal) to the 10 DB position. If the repeater attendant cannot obtain a 0-db indication on the MEASSURE meter with the AMP OUT switch in the 10 DB position, he will adjust the FLAT equalizer control for a maximum indication on the MEASURE meter, and adjust the SLOPE and BULGE equalizer controls to obtain the same reading as the maximum obtainable reading when adjusting the FLAT equalizer.

49. Adjustment of Terminal A Transmitting to Radio Link Not Equipped With Selective Measuring Circuit, Overall System Line-Up, A to B Direction

In a system that uses a radio link, the radio set may not be equipped with a selective measuring circuit which would enable it to pick out the desired frequency on the line from among the several that are used to line up the system. Therefore, only the one test frequency that is required at the radio set is sent into the line by terminal A when the radio link is lining up with the system in the A to B direction. This frequency is 1 kc. To send 1 kc only, after having made the measurements described in paragraph 48. perform the following steps.

a. Restore the SEND-MEAS switches of channels 1, 2, 3, and 4 to normal.

b. Operate the MEASURE switch to the TEST OSC position *c.* Check that the MEASURE meter indicates 0 db. If it does not, readjust the TEST OSC OUTPUT knob to obtain a 0-db indication.

50. Equalization Adjustment of Telephone Repeater AN/TCC-5, Overall System Line-Up, A to B Direction

The overall system line-up adjustments made at Telephone Repeater AN/TCC-5 are described in TM 11-2136. The repeater is lined up for the overall system line-up in the A to B direction by selecting and measuring 1-kc, 19-kc, and 11-kc test frequencies which are sent to it over the line from the transmitting terminal, and adjusting the flat, slope, and bulge equalizers.

51. Equalization adjustment of Output at Terminal B, Overall System Line-Up, A to B Direction

The receiving amplifier of terminal B is lined up with the 1-kc, 19-kc, and 11-kc test power transmitted on the order wire channel and channels 4 and 2 of terminal A. When instructed by the control terminal, terminal A, the adjustment of the output of the receiving amplifier of terminal B is made as follows.

a. Operate the MEASURE switch to the 1KC-OW position.

b. Hold the AMPLIFIER switch in the REC position.

c. Adjust the FLAT-1KC EQUALIZER knob to obtain a 0-db indication on the MEASURE meter.

d. Operate the MEASURE switch to the 19KC-CH4 position.

e. Adjust the SLOPE-19KC EQUALIZER knob to obtain a 0-db indication on the MEASURE meter.

f. Operate the MEASURE switch to the 11KC-CH2 position.

g. Adjust the BULGE-11KC EQUALIZER knob to obtain a 0-db indication on the MEASURE meter.

h. Release the AMPLIFIER switch.

i. Notify the control terminal that the adjustments are completed.

52. Equalization Adjustments, Overall System Line-Up, B to A Direction

After the attendant at terminal B has notified the control terminal that equalization in the A to B direction is complete, the attendant at the control terminal will instruct the attendant at terminal B to temporarily assume control of the system and proceed with equalization in the B to A direction. The attendant at terminal B will follow the same procedure as was followed at the control terminal during the A to B direction equalization (para 48 through 51). After all repeaters and radio links in the system have been lined up, the attendant at terminal A will adjust the receiving amplifier output of terminal A (para 51*a* through *h*). Upon completion of the receiving amplifier output adjustment at terminal A, the attendant at terminal A resumes control of the system and proceeds with the circuit net loss adjustment (para 53).

53. Adjustment of Circuit Net Loss, Overall System Line-Up, A to B Direction

a. Procedure at Terminal A. The attendant at terminal A will follow the procedure outlined in paragraph 48*c* and *e* through *h*.

b. Procedure at Terminal B.

(1) Operate the MEASURE switch to the MODEMS position.

(2) Operate and hold the SEND-MEAS switch on channel 1 in the MEAS position.

(3) Adjust the GAIN knob for CHAN 1 to obtain a 0-db indication on the MEASURE meter.

(4) Release the SEND-MEAS switch for CHAN 1.

(5) Repeat the procedure of (2), (3), and (4) above for channels 2, 3, and 4.

NOTE

The above procedure results in a circuit net loss of 3 db. If it is required that the net loss be other than 3 db, the GAIN control must be adjusted to obtain an indication other than 0 db on the MEASURE meter. The meter indication for a net loss other than 0 db is obtained by subtracting the desired net loss from 3 db. *For example,* if a net loss of 5 db is desired, subtract 5 db from 3 db. The result is −2 db. The meter indication for a net loss of 5 db will be −2 db.

54. Adjustment of Circuit Net Loss, Overall System Line-Up, B to A Direction

The circuit net loss adjustment for the B to A

direction is similar to the adjustment for the A to B direction.

a Procedure *at Terminal* B. Follow the procedure outlined in paragraph 48c and e through h.

***b. Procedure at Terminal A.* Follow the procedure outlined in paragraph *53b* (1) through** (5).

55. Check of Ringing Over Channels

a. Upon completion of the system line-up, a check should be made of the ringing units associated with each channel. This is accomplished by sending a ringing signal between switchboards in each direction.

***b.* Signal converters such as Telegraph-Telephone Signal Converter TA-182/U are used to ring over the channels of the system (para 5).**

56. Daily System Line-Up, General

a. The daily system line-up is performed by transmitting a l-kc test signal from each of the two terminals of the system. The FLAT-1KC controls at the repeaters and at the terminals of the system are adjusted by means of the received 1-kc test signal. This line-up is made once per day, or more often if necessary to compensate for variations in transmission caused by changes in cable temperature.

***b.* If possible, perform the line-up procedure about 1-hour after sunrise. Avoid lining up during the heat of the day. Do not line up in midafternoon on a clear sunny day unless a recheck of line-up is planned for early evening.**

NOTE

The time of day for line-up is chosen so that the spiral-four cable will be relatively cool. At the time of line-up, the transmission loss will be low as compared to its loss during the high-temperature part of the day. The greater circuit net loss due to a rise in cable temperature will not greatly impair the quality of transmission. If a system is lined up during the warmest part of the day a subsequent drop in cable temperature might cause the net circuit loss to be reduced to a value that would make the system sing.

***c.* If the AN/TCC-3 is in use as a four-channel carrier telephone terminal, the daily system line-up can be performed while the system is in operation. If the AN/TCC-3 is being used for special service transmission (para 3b (2)), it may be necessary to restrict the daily line-u; procedure to a time when the system is not in use, unless high-pass Alters are associated with the special service equipment to avoid interference from the order wire channel transmission.**

d. The daily system lineup procedures are given in paragraphs 57 through 60.

57. Measurement of Test-Power output of Terminal A, Daily line-up, A to B Direction

The test power output of the transmitting terminal is measured to check the continuity of the transmitting circuits. Make the test as follows.

a. Operate the MEASURE switch to the TEST OSC position.

b. **Operate the SEND OW switch to the clockwise position (in the direction of the arrow).**

c. Adjust the TEST OSC OUTPUT knob to obtain a 0-db indication on the MEASURE meter.

***d.* Operate the MEASURE switch to the 1KC-OW position.**

e. Hold the AMPLIFIER switch in the TR position.

***f.* The MEASURE meter should indicate 0** ±3.0 db.

***g.* Instruct the attendant at the next station along the line to proceed with the lineup.**

58. Adjustment of Telephone Repeater AN/TCC-5, Daily System Line-Up, A to B Direction

The daily system line-up adjustments made at Telephone Repeater AN/TCC-5 are described in TM 11-2136. The repeater is lined up for the daily system line-up in the A to B direction by selecting and measuring 1-kc test frequency which is sent to it over the line from terminal A and adjusting that the flat equalizer of the A to B circuit.

59. Checks at Radio Link, Daily Line-Up, A to B Direction

Checks of transmission to and through the radio link are required during the daily line-up in the A to B direction. These checks should be made in accordance with the instructions furnished with the radio equipment.

60. Adjustment of Output of Receiving Amplifier of Terminal B, Daily Line-Up, A to B Direction

The receiving amplifier of terminal B is lined up by adjusting the FLAT-1KC EQUALIZER at terminal B to obtain a 0-db indication on the MEASURE meter when a l-kc signal is received from terminal A. When instructed to line up by terminal A, the procedure at terminal B is as follows.

a. Operate the MEASURE switch to the 1KC-OW position.

b. Hold the AMPLIFIER switch in the REC position.

c. Adjust the FLAT-1KC EQUALIZER knob to obtain a 0-db indication on the MEASURE meter.

d. Release the AMPLIFIER switch and operate the MEASURE switch to the OFF position.

61. Daily System Line-Up, B to A Direction

The daily system lineup in the B to A direction is performed after the daily line-up in the A to B direction has been completed. The lineup in the B to A direction is made under the direction of control terminal B. Readiness for line-up and completion of line-up by stations in the system, are reported to terminal B. The procedures in the B to A direction are the same as procedures in the A to B direction (para 56 through 60) except that the operations performed at terminal A and terminal B are interchanged.

62. Line-Up Procedure When Channels Are Dropped at Intermediate Points

a. General. When channels are dropped at intermediate points (fig. 4) two terminals (AN/TCC-3) are required at the intermediate point. These terminals divide the system into two separate systems with respect to the channels which are dropped. The terminals at the intermediate point operate back-to-back as part of the overall system for the channels which are not dropped. Dropped channels operate on a two wire basis; through channels operate on a four wire basis. The order wire circuit of the overall system is split at the intermediate point. If a requirement exists for connecting the order wire through at the intermediate point, the order wire extension binding posts must be used at this point for the through connection. Special service connections shall be wired directly through without pads or modified lineup procedure when special service is specified.

b. Line-Up Procedure. Line up the overall system in sections. Line up section A–C, then section D–B. Repeat the line-up procedure in section B–D, then section C–A. Use the line-up procedure outlined in paragraphs 48 through 53 if 5-db pads are used in the through channels at the intermediate point. If pads are not used at the intermediate point, the line-up procedure of paragraph 53 must be changed so that the GAIN control of each through channel at terminal C and terminal D is adjusted to obtain a meter indication of −5 db. Upon completion of the sectional line-up, an overall adjustment of the through channels at terminals A and B will be made in accordance with paragraph 53. The GAIN control adjustment at each of these terminals will result in a meter indication of 0 db for each through channel.

Section VII. OPERATION UNDER UNUSUAL CONDITIONS

63. General

It may be necessary to operate systems employing Telephone Terminals AN/TCC-3 in regions where extreme cold, heat, humidity, moisture, sand conditions, etc., prevail. The terminals will operate in a temperature range from −65° F. to +150° F. Paragraphs 64 through 68 contains instructions for minimizing the effect of unusual operating conditions.

64. Operation in Arctic Climates

Subzero temperature and climatic conditions associated with cold weather affect the efficient operation of the system. Instructions and precautions for operation under such adverse conditions are as follows:

a. Handle the equipment carefully

b. Keep the equipment as warm and dry as possible.

c. Locate the equipment inside a heated inclosure where there is no danger of a cold draft striking the glass tubes when a door is opened. A sudden draft of cold air is often sufficient to shatter the glass envelope of a heated tube. If the inclosure is not constructed so as to prevent substituting a loading coil for the repeater, results in operation with an abnormally long, unrepeatered cable length. System performance then depends upon the additional gain available in the remaining repeaters and terminals, and upon the increase in noise that can be tolerated. To restore operation of the system when one repeater is inoperative:

(1) The defective repeater is bypassed (b below).

(2) Additional gain is inserted in the system if possible (c below).

(3) The system is lined up in both directions (d, e, and f below).

b. Bypassing the Inoperative Repeater. Remove the two cables from the A and B connectors on the panel of the defective repeater. Connect the spiral-four cables through a Telephone Loading Coil Assembly CU-260/G. This produces a long span of cable.

c. Amp Out Switches.

(1) If a terminal immediately precedes the inoperative repeater in either direction, operate the AMP OUT switch of the transmitting amplifier of that terminal to the 10 DB position, unless it is already so set.

(2) If a repeater immediately precedes the inoperative repeater in the A-B direction of transmission, operate the AMP OUT switch of the A-B line amplifier of that repeater to the 10 DB position, unless it is already so set.

(3) If a repeater immediately precedes the inoperative repeater in the B-A direction of transmission, operate the AMP OUT switch of the B-A line amplifier of that repeater to the 10 DB position, unless it is already so set.

(4) Operate the AMP OUT switches of all the line amplifiers that follow the long cable span to the 10 DB position, unless already so set.

d. Line-Up in the A-B Direction Proceed with the overall lineup as described in paragraphs 45 through 53 with modifications as follows:

(1) At the station immediately following the long cable span, whether it is a repeater or the B terminal, it may not be possible to adjust the MEASURE meter indicator to 0 db. The indication may be so low, because of the attenuation of the long span, that adjusting the FLAT-1KC control will produce very little change in indication. Under this condition, set the FLAT-1KC control to its scale 20 position (maximum clockwise); do not change the setting of either the SLOPE-19KC or the BULGE-11KC control.

(2) At the station immediately following the long cable span, or at succeeding stations, it may be possible to obtain a readable meter indication during the FLAT-1KC lineup. Even with the control set to scale 20, this indication may not be as high as 0 db. In this case adjust the FLAT-1KC control for maximum indication. Record the indication. Then during the SLOPE-19KC and BULGE-11KC lineups, adjust the controls to obtain the same indication as was obtained at 1kc.

(3) Proceed with the channel gain control lineup as described in paragraph 53. It may not be possible to, adjust to an indication of 0 db on the MEASURE meter even with the GAIN control turned maximum clockwise because the long cable span has introduced too great a transmission loss, and the lower output level must be used. In this case, adjust the GAIN control for maximum indication.

e. *Line-Up* in *the B-A Direction.* Proceed with the B-A lineup as described in paragraphs 45 through 53, with the modifications noted in *b* through d above.

f. *Subsequent Daily Line-Ups.* The missing repeater should be replaced in the system and the system returned to normal opeations as soon as possible. Meanwhile, make daily lineup measurements and adjustments, following the procedures of paragraphs 57 through 60. Where the MEASURE meter indication during the frequency response lineup of *d* and c above was not 0 db, adjust the FLAT-1KC control to the meter indication it was then possible to obtain.

CHAPTER 3

ORGANIZATIONAL MAINTENANCE

NOTE

The information in this chapter is applicable to all models of telephone modems TA-219/U and TA-219A/U and Amplifier-Power Supply AM-682/TCC-3 and AM-682A/TCC-3 unless otherwise noted. Telephone Modems TA-219/U and TA-219A/U are interchangeable, as are Amplifier-Power Supply AM-682/TCC-3 and AM-682A/TCC-3. It should be noted however that the substitution of an earlier model for an (A) unit will result in decreased capability.

Section I. PREVENTIVE MAINTENANCE

69. Scope of Preventive Maintenance

a. Preventive maintenance is scheduled, systematic work performed on equipment (usually when the equipment is not in use) to keep it in good working condition so that breakdowns and needless interruptions in service will be kept to a minimum. Preventive maintenance differs from troubleshooting and repair since its object is to prevent certain troubles from occurring.

b. The procedures given in paragraphs 70 through 72 cover systematic care essential to proper upkeep and operation of the equipment. The maintenance service and inspection charts (para 70b, 71b, and *72b)* outline inspections to be made at indicated intervals. These inspections are made to determine combat serviceability of the equipment; that is, to determine that the equipment is in good general (physical) condition, in good operating condition, and likely to remain combat serviceable. The maintenance services should be scheduled concurrently with the periodic service schedule of the carrying vehicle for all vehicular installations.

c. To assist the user in determining and maintaining the equipment combat serviceable, the maintenance service and inspection charts indicate what to inspect, how to inspect, and what the normal indications are; the *Reference* column lists paragraphs that contain additional or corrective information. All deficiencies or shortcomings observed during the servicing and inspection procedures will be recorded, and those not corrected during the periodic maintenance services and inspections will be reported immediately to higher echelon by the use of forms and procedures specified in TM 33-750. Equipment with a deficiency that cannot be corrected by the organizational repairman should be deadlined in accordance with procedures outlined in TM 38-750. Maintenance forms, records, and reports to be used and maintained on the equipment are specified in TM 38-750.

d. The tools and test equipment authorized for organizational maintenance personnel are listed in the maintenance allocation (app II).

70. Operator Daily Maintenance Checks and Services

a. General. Operator maintenance service and inspection procedures for the AN/TCC-3 *(b below)* are required daily and under the special conditions listed below:

(1) *In vehicular installation.*

(a) Before the vehicle starts on a mission.

(b) When the equipment is initially installed.

(c) When the equipment is reinstalled after removal for any reason.

(d) At least once each week if the equipment is maintained in stand-by condition (ready for immediate operation).

(2) *In transportable and mobile installations.* The conditions are the same as listed in (1)(*b*), (*c*), and (*d*) above.

b. Daily Maintenance Checks and Services

Chart. Refer to paragraph *69b* and c for information on the use of the chart below.

NOTE

Item numbers used in the following chart correspond to the item numbers in the quarterly maintenance service and inspection chart used by organizational maintenance personnel.

Item No.	Procedure: Item	Normal indication or result	Reference
1	COMPLETENESS: Inspect equipment for presence of all parts.	All parts are available	(App III):
2	PUBLICATIONS: Check to see that equipment publications are available and in usable condition.	a. Maintenance and parts manuals are available and in usable condition.	a. (APP I.)
		b. Changer for maintenance manuals (item a above) are available and in usable Condition.	b. DA Pam 310-4 (pars 1.1).
4	CLEANLINESS: Inspect for dirt, moisture, and grease on front panels, cables, and cases.	Parts are free of dirt, moisture, and grease.	See c below.
8	CABLES, CONNECTORS, AND RECEPTACLES: Inspect seating of spiral-four cable connector to receptacle on AM-682/TCC-3.	Spiral-four cable connector is tightened securely to receptacle.	
12	TERMINAL AND SYSTEM OPERATION: Check operation of equipment (para 55-68).	Equipment performance is satisfactory.	(Para 80-85.)

c. Cleaning. To remove dirt, moisture, and grease, use a clean cloth or brush. If necessary, dampen the cloth with cleaning compound (Federal stock No. 7930-395-9542). After cleaning, wipe the area with a clean cloth.

WARNING

Cleaning compound is flammable and its fumes are toxic. Do not use near a flame; provide adequate ventilation.

71. Organizational Monthly Maintenance Checks and Services

a. General. Organizational maintenance service and inspection for the AN/TCC-3 (*b* below) is required once each month. A month is defined as approximately 30 calendar days of 8-hour-per-day operation. If the equipment is operated 16 hours a day, the monthly maintenance service and inspection procedures should be performed at 15-day intervals. Adjustment of the maintenance interval must be made to compensate for any unusual operating conditions. Equipment maintained in a standby (ready for immediate operation) condition must have monthly maintenance performed on it. Equipment in limited storage does not require monthly maintenance but does require the services before operation (para 70).

b. Organizational Monthly Maintenance Checks and Services *Chart.* Refer to paragraph *69b* and c for information on the use of the chart below. Perform the procedures given in paragraph *70b* before performing the checks below.

NOTE

Rem numbers used in the following chart correspond to the item numbers used in the quarterly maintenance service and inspection chart for organizational maintenance personnel.

Item No.	Procedure: Item	Normal indication or result	Reference
1	COMPLETENESS: Inspect equipment for presence of all parts.	All parts are available.	(App. III.)
2	PUBLICATIONS: Check to see that equipment publications are available and in usable condition.	Maintenance and parts manuals are available and in usable condition.	(App. I.)
4	CLEANLINESS: Inspect for dirt, moisture, and grease on parts located on top and bottom of chassis, cables, and carrying straps.	Parts are free of dirt, moisture, and grease.	(Para 70c.)
5	PRESERVATION: Inspect for rust, corrosion, and unpainted surfaces.	Surfaces are free of rust, corrosion, and metal surfaces requiring painting are painted.	(Para 75.)
6	MOUNTING HARDWARE: Inspect for tightness screws, bolts, and nuts that hold plug-in assemblies and parts of chassis and front panel.	Screws, bolts, and nuts that hold parts in place are tight.	

Item No.	Item / Procedure	Normal indication or result	Reference
7	PLUCKOUT ITEMS : Inspect seating and condition of tubes, fuses lightning arrestors, and indicator lights.	Pluckout items are tightly seated in place; lightning arrestors show no signs of failure.	See c(1) below.
8	CABLES, CONNECTORS, AND RECEPTACLES: Inspect insulation *of* cables for cuts, kinks, or strain. Inspect condition of male and female connectors and receptacles.	Insulation *of* cables shows no signs of cute, kinks, or strain. Pins of male connectors, and receptacles are straight, free of corrosion, and unbroken; female connectors and receptacles are not plugged.	See *c(2)* below.
9	INSTALLATION and CONNECTIONS : Inspect equipment for proper installation and connections.	Equipment is properly installed and connected.	(Para 15-31.)

c. Maintenance Procedures.

(1) *Lightning arresters.* Use Multimeter AN/URM-105 arranged as an ohmmeter which is set for highest resistance readings. Press the test leads of the ohmmeter to the lightning arrestor case and the carbon that is inset in the porcelain. The ohmmeter should indicate infinity. Replace lightning arrestors that indicate less than infinity (app III).

(2) Touchup painting. Clean rust and corrosion from metal surfaces by lightly sanding them with fine sandpaper. Brush two thin coats of paint on the bare metal to protect it from further corrosion. Refer to the applicable cleaning and refinishing procedures specified in TM 9-213.

(3) *Repair.* To repair broken insulation on cables, use electrical insulation tape. To remove corrosion from male connector and receptacle pins, clean the pins with cleaning compound (para 70c).

72. Organizational Quarterly Maintenance Checks and Services

a. General. Organizational maintenance service and inspection of AN/TCC-3 (b below) is required on a quarterly basis in accordance with the requirement of TM 33-750 (para 69b and c). If the equipment is part of a vehicular installation, the quarterly maintenance service and inspections should be scheduled concurrently with the periodic service schedule of the carrying vehicle to reduce out-of-service time to a minimum.

b. *Organizational Quarterly Maintenance Checks and Service Chart.* Refer to paragraph *69b* and c for information on the use of the following chart.

Item No.	Item / Procedure	Normal indication or result	Reference
1	COMPLETENESS: Inspect equipment for presence of all parts.	All parts are available.	(App. III.)
2	PUBLICATIONS : Check to see that equipment publications are available and in usable condition.	*a.* Maintenance and parts manuals are available and in usable condition. *b.* Changes for maintenance and parts manuals (item *a* above) are available and in usable condition.	a. (App. I.) *b.* DA Pam 310-4 and (para 1.1).
3	MODIFICATION WORK ORDERS. Determine whether MWO's are required for AN/TCC-3 or parts of AN/TCC-3. (See DA Pam 310-4 for MWO's.) Check equipment to see if MWO's have been applied and MWO number is stamped as required.	MWO's have been applied or have been scheduled for application.	Applicable MWO.
4	CLEANLINESS: Inspect for dirt, moisture, and grease on front panel and on parts located on top and bottom of chassis, cables, case, and carrying straps.	Parts free of dirt, moisture and grease.	(Para 70*c*.)
5	PRESERVATION: Inspect for rust, corrosion, and unpainted metal surfaces.	Surfaces are free of rust and corrosion and unpainted metal surfaces have been painted.	(Para 71*c*(2))

Item No.	Procedure Item	Normal indication or result	Reference
6	MOUNTING HARDWARE : Inspect for tightness screws, bolts, and nuts that hold the *following* items : a. Switches and controls. *b.* Parts held to front panel. c. Parts held to chassis. d. Plug-in assemblies (such as ringeroscillator (fig. 94) and than modem (fig. 86)).	Screws, bolts, and nuts that hold parts in place are tight.	
7	PLUCKOUT ITEMS: Inspect seating and condition of tubes, fuses, lightning arrestors, and indicator lights.	Pluckout items are tightly seated and locked securely in place. Lightning arrestors show no sign of failure.	(Para 71*c*(1).)
8	CABLES, CONNECTORS and RECEPTACLES: a. Inspect seating of cable connectors to receptacles.	a. Cable connectors are firmly firmly locked to receptacles.	*a.* None
	b. Inspect insulation of cables.	*b.* Insulation of cables shows no signs of cuts, kinks, or strain.	*b.* (Para 71*c*(3).)
	c. Inspect attachment of cable connectors to cables. Inspect condition of male and female connectors and receptacles.	c. Cable connectors are firmly attached to cables. Pins of male connectors and receptacle are straight and unbroken, and are not corroded; female connectors and receptacles are not plugged with dirt, and spring areas are undistorted; screw clamps hold cable connectors firmly to receptacles.	*c.* (Para 70*c*.)
9	FUSES: Check fuses for proper rating (fig. 26).	Fuse F551 is rated at 1 amp, 250 volts; fuse F552 is rated at 1/2 amp, 250 volts. Sparer are available.	(App III.)
10	CHASSIS PARTS: Inspect attachment and condition of resistors, transformers, capacitors, wirer, wiring harness, cable receptacles, switches, and controls, storage facilities for cables, and attendant's handset.	Parts are securely attached to chassis. Resistors and capacitors show no signs of blistering and discoloration; capacitors are in cans, transformers show no signs of oil leakage or overheating. Wires show no bare spots and are firmly attached to parts terminals; wiring harnesses show no evidence of damage. Storage facilities for cables and attendant's handset (figs. 11–13) are in good condition.	
11	INSTALLATION and CONNECTIONS: Inspect equipment for proper installation and connections (pars. 13–31).	Equipment is properly installed and connected.	
12	TERMINAL and SYSTEM OPERATION: Check operation of terminal as part of communication system (pars. 55–68) or separated from communication system (paras 396 and 397).	Equipment performance is satisfactory.	(Para 76–89.)

Section II. WEATHERPROOFING

73. Weatherproofing

No special weatherproofing is required for this equipment.

74. Lubrication

None of the moving parts of the AN/TCC-3 require lubrication. Power Unit PE-75 ( ), part of the AN/TCC-23 requires lubrication.

75. Rustproofing and Painting

a. When the finish on the case or panels of the equipment has been scarred or damaged badly, rust and corrosion can be prevented by touching up the bared surfaces. Before touching up the surfaces, use No. 000 or No. 0000 sandpaper to clean the surfaces down to the bare metal. After obtaining a bright smooth finish on the metal, apply the paint with a small brush. Paint will be authorized and consistent with existing regulations.

CAUTION

Do not use steel wool. Minute particles frequently enter the case and cause harmful internal shorting or grounding of circuits.

b. When rust and corrosion make a touchup job necessary, remove rust from the case by cleaning corroded metal with cleaning compound. In severe cases, it may be necessary to use cleaning compound to soften the rust, and sandpaper to complete the preparations for painting Clean the surfaces down to the bare metal and then apply paint with a small brush. Paint used will be authorized and consistent with existing regulations.

Section III. TROUBLESHOOTING

76. General

a. Troubleshooting at the organizational level is performed while the equipment is functioning as part of a system. Troubleshooting at higher maintenance categories is performed after the equipment has been removed from the system as covered in chapter 5.

b. Troubleshooting at the organizational level is limited in scope by the tools, test equipment, and replaceable parts issued, and by the existing tactical situation. The paragraphs which follow in this section help in determining which of the components are at fault and in localizing the fault in that component to the defective stage or to a defective item, such as a tube, fuse, or plug-in assembly.

77. Illustrations for Use in Troubleshooting and Repair

Three types of illustrations are provided for use in organizational troubleshooting; schematic diagrams, wiring diagrams, and circuit element (part) location diagrams.

a. A complete schematic representation of the AN/TCC-3 appears in figures 145 through 161.

(1) Figure 145 is an interconnection schematic diagram of the TA-219/U This diagram shows the parts mounted on the modern combining frame and the connections between the parts. Blocks are used to represent the plug-in channel modems. Figures 146 through 149 are schematic diagrams of the individual channel modems.

(2) Figures 150 and 151 are interconnection schematic diagrams of the AM-682/TCC-3. These diagrams show the parts mounted on the main chassis and the connections between the parts. Blocks are used to represent the plug-in and bracket assemblies. Figures 152 through 161 are schematic diagrams of the plug-in and bracket assemblies.

b. Figures 163 through 174 are airline wiring diagrams of the AN/TCC-3. A separate wiring diagram is provided for each interconnection and schematic diagram.

c. Figures 78 through 103 are circuit element location diagrams. These figures show the location on the chassis of the various circuit elements which make up the circuits.

78. Test Equipment Required for Organizational Maintenance

The equipment required for testing Telephone Terminal AN/TCC-3 is listed as follows:

a. Multimeter AN/URM-105.

b. Test Set, Electron Tube TV-7/U.

c. Tool Equipment TE-123.

NOTE

If it is not possible to obtain the equipment indicated, other types of equipment having equal accuracy and corresponding characteristics may be used

79. Test Equipment for Continuity Tests

Some circuits in the AN/TCC-3 contain coils that may be damaged permanently if the cores are magnetiz by dc or by excessive ac flowing through the windings. Do not use dc buzzers or similar equipment to ring out circuits when making continuity tests. Use Multimeter AN/URM-105.

80. Troubleshooting Procedures

The first step in troubleshooting is to sectionalize the fault. Sectionalization means tracing the fault to the defective equipment (AN/TCC-3 or AN/TCC-5) in the system and then to the major component or circuit responsible for the abnormal operation of the equipment. The second step is to localize the fault Localization means ment has been operating for more than 30 seconds, the buzzer will be silent and only the POWER lamp will be lighted.

(3) Determine whether order wire communications can be established (para 39b). If so, request the attendant at the distant terminal to report all symptoms appearing at that terminal resulting from the fault in the system. If order wire communications can be established *only* as far as a particular repeater station, the fault in the system is not located in the local terminal or in any equipment between the terminal and that repeater station.

c. Test for Carrier Communication Trouble. Although the first report of the trouble may state that a particular channel is not working normally, it is important to check each channel to determine whether the trouble has affected more than one.

(1) Check of channel 1 transmissions Monitor channel 1 (para 39c) to determine whether or not the channel is in use. If it is in use, operate the MEASURE switch to the 7KC-CH1 position. Hold the AMPLIFIER switch at TR. When a transmission is heard, the MEASURE meter pointer should deflect noticeably. If the channel is not in use, operate the SEND-MEAS switch of the channel to the SEND position to transmit a test signal through the channel. Operate the MEASURE switch to the 7KC-CH1 position. Hold the AMPLIFIER switch at TR. Normal operation is indicated by an indication of approximately 0 db on the MEASURE meter. If this indication is obtained, transmission and reception can be assumed to be normal.

(2) *Check of channel 1 reception.* Continue to monitor the channel if the channel is in use. The MEASURE switch should be left in the 7KC–CH1 position. Hold the AMPLIFIER switch at REC. A meter deflection indicates that a received signal with a 7-kc component is being amplified in the receiving amplifier. As the meter needle deflects, a signal will be heard in the attendant's telephone set if reception on the channel is normal.

(3) *Check of channel 2 transmission and reception.* The procedure for checking channel 2 transmission and reception is the same as for channel 1 ((1) and (2) above) except that the MEASURE switch should be in the 11KC–CH2 position.

(4) *Check of channel 3 transmission and reception.* The procedure for checking channel 3 transmission and reception is the same as for channel 1 ((1) and (2) above) except that the MEASURE switch should be in the 15KC-CH3 position.

(5) Check of channel 4 transmission and reception. The procedure for checking channel 4 transmission and reception is the same as for channel 1 ((1) and (2) above) except that the MEASURE switch should be in the 19KC-CH4 position.

d. Test for Special Service Communication Trouble.

(1) By using an auxiliary telephone circuit that is connected the local special service equipment, determine when the local special service equipment is transmitting. Check to see that the CHANNELS-SPECIAL SERVICE switch is in the SPECIAL SERVICE position. Operate the MEASURE switch to the 7KC-CH1 position and hold the AMPLIFIER switch at TR. The MEASURE meter pointer will deflect noticeably when the local special service equipment is transmitting if the special service transmitting path is normal. The same indication should be obtained when the MEASURE switch is operated to the 11KC-CH2, 15KC-CH3, or 19KC-CH4 position. If no special filtering is provided in the special service equipment, the same indication should be obtained when the MEASURE switch is in the 1KC-OW position.

(2) Operate the MEASURE switch to the 7KC–CH1 position and hold the AMPLIFIER switch at REC. A meter deflection indicates that a received signal (with a 7-kc component) is being amplified in the receiving amplifier. By using the auxiliary telephone circuit that is connected to the local special service equipment, determine whether the signal is being received at the special service equipment. Repeat this procedure with the MEASURE switch in each of the following positions, in the order given: 11KC–CH2, 15KC–CH3, 19–KC–CH4, and, if special filtering is not provided in the distant special service equipment, 1KC–OW.

e. Test for Line-Up Trouble. Any of several troubles in the AN/TCC–3 may make system line-up impossible.

(1) Trouble may exist in the transmission of test signals from the channels. (This would make line-up of distant stations impossible.) Perform the test for transmission from the channels (*c* above).

(2) The test oscillator may be inoperative.

(This would make line-up of distant stations impossible.) Check the test oscillator as follows: Operate the MEASURE switch to the TEST OSC position and adjust the TEST OSC OUTPUT control to obtain a 0-db reading on the MEASURE meter. If a 0-db indication cannot be obtained, trouble exists in the test oscillator or in the measuring circuit.

(3) The measuring circuit may be faulty. (This will make line-up of the local terminal impossible.) Check the measuring circuit by using the circuit to measure signals which do not originate in the test oscillator Operate the MEASURE switch to the OFF position. Slide the AM-682/TCC-3 partially out of its transit case (para 87). With the test probe, measure the output at jack J601. Normal operation of the MEASURE meter and its associated circuit elements is indicated by a reading of approximately 0 db on the meter. Replace the AM-682/TCC-3 in its transit case. The filter and switches of the measuring circuit may be checked as follows: Operate the MEASURE switch to the 1KC-OW position and the ORDER WIRE switch to the TALK position. Hold the AMPLIFIER switch at TR, operate the press-to-talk switch on the attendant's headset, and talk into the telephone. Normal operation is indicated by a fluctuating reading on the MEASURE meter. The remainder of the measuring circuit Alter and switches can be checked by performing the tests for transmission and reception tkrough a channel (c above).

(4) The equalizer circuit or the receiving amplifier may be faulty. These cannot be checked without removing the AN/TCC-3 from the system. To check for a fault in either the equalizer circuit or the receiving amplifier, follow the procedure of the equipment performance checklist (para 90). If the equalizer circuit or the receiving amplifier is faulty, the equipment performance checklist willl indicate this fault.

f. Test for Ringing Trouble. If the difficulty encountered with ringing does not disturb traffic communications, the trouble exists in the ringer-oscillator plug-in assembly or in its external wiring.

(1) Operate the ORDER WIRE switch to the RING position. If the CALL lamp lights and the buzzer sounds, the ringer-oscillator is not faulty.

(2) Operate the MEASURE switch to the 1KC-OW position and hold the ORDER WIRE switch at RING and the AMPLIFIER switch at TR. If the MEASURE meter reads -5 ±2 db, the circuits that connect the output of the ringer-oscillator to the transmitting amplifier are operating normally.

g. Test for Order Wire Communication Trouble, If it is not possible to establish order wire communications but traffic communications are normal, the trouble exists in the order wire circuit or its connections to other circuits.

(1) *Check of order wire transmission.* Operate the MEASURE switch to the 1KC-OW position and the ORDER WIRE switch to the TALK position. Hold the AMPLIFIER switch at TR and operate the press-to-talk switch on the attendant's handset. Talk into the telephone. If the order wire circuit and the transmitting amplifier are normal, the MEASURE meter pointer will deflect noticeably.

(2) Check of order wire reception. Listen to the receiver of the attendant's handset. A low level of noise should be heard. Operate the MEASURE switch to the 1KC-OW position and hold the AMPLIFIER switch to REC. If order wire reception is normal the noise level at the handset receiver will reduce when the AMPLIFIER switch is operated.

83. System Trouble Localization

a. When troubles occur in a carrier system, it is necessary to determine whether the trouble exists in the local terminal or in the other equipment of the system. The system trouble localization chart (para 84) will aid in determining this ~~By following the procedures~~ of the chart, determine whether or not a component of the local terminal is at fault. If no components of the local terminal are defective, the trouble must exist in the other equipment of the system.

b. The troubleshooting chart (para 81) lists the symptoms that the repairman can observe while the terminal is connected in the system (para 82). To facilitate the use of the chart, major symptoms have been subdivided whenever practicable, into associated, additional symptoms. The chart lists also the trouble or troubles most likely to cause the observed symptoms. References are made to the paragraph which contains a functional description for the circuit that could be defective In addition, the chart indicates the corrective measures that the repairman should perform, references to the schematic diagram of the circuit to be checked, and the paragraphs in which the recommended troubleshooting procedure is outlined

c. The chart (para 84) indicates the symptoms of troubles occurring in a system consisting of two AN/TCC-3's connected by spiral-four cable. If the terminals are used with repeaters or radio links, troubles in the terminals will produce symptoms that are similar to those produced in the system consisting only of terminals.

84. System Trouble Localization Chart

Symptom	Probable trouble	Correction
1. No transmission through all channels in both directions.		
a. Order wire inoperative.		
(1) POWER lamp not lighted.	Power supply failure (para 233)	Check fuses F551 and *F552,* and replace if necessary. Check continuity of power and cable. Check switches S551 and S552 for continuity, and clean if necessary (fig. 160). Higher level maintenance may be reqired (para 249).
(2) POWER lamp lighted. (a) Call lamp lighted and buzzer sounding. Operational test (para 82) indicates lack of transmisdon.	+200 volt supply failure (para 234).	Check for +200 volts dc between jack J553 and ground (fig. 160). Check tubes V551, V552, and V553 and replace if necessary. Higher level maintenance (paras 249 and 266) may be required.
(b) SYSTEM ALARM lamp lighted. operational teat (para 82) indicates transmission through tranmitting amplifier. *of* carrier supply is normal (para 216).	Protectors shorted.	Remove protectors (para 85). If normal operation is restored, the protectors were shorted. Replace with good protectors.
	Power supply failure at distant station.	No action possible at local terminal.
	Break in spiral-four cable.	Cheek for break in cable.
b. Order wire operative.		
(1) SYSTEM ALARM lamp lights at distant terminal.	Failure in 4-kc oscillator of carrier supply (para 168).	Check output at jack J601 with test probe (para 216). Normal operation is indicated by a reading of 0±2 db on the MEASURE meter. If there is no output, check tube V601 and replace if faulty. If V601 is not faulty, replace carrier supply plug-in assembly with one from spares (para 87 and fig. 158).
	Failure in frequency division circuit of carrier supply (para 169).	Check output at jack H602 with test probe (para 216). Tormal operation is indicated by a reading of 0±2 db on the MEASURE meter. If there is no output, check tube V602 and replace if faulty. If V602 is not faulty, replace carrier supply plug-in assembly with one from spares (para 87 and fig. 158).
(2) SYSTEM ALARM lamp does not light at distant terminal.		
(a) Output at jack J602	Failure in 4-kc amplifier of carrier supply (para 173).	Check output at jack J603 with test probe (para 216). Normal operation is indicated by a reading of 0±2 db on the MEASURE meter If there is no output, check tubes V603 and V604, and replace if faulty. Determine whether or not tube V604 is glowing and replace tube V604 if it is not glowing. If V603, V604, and

Symptom	Probable trouble	Correction
1. Continued of carrier supply in normal (para 216).		V605 are not faulty replace carrier supply plug-in assembly with one from spares (para 87 and fig. 153).
	Failure in harmonic generator circuit of carrier supply (para 176).	If output at jack J603 is normal, check the voltage between terminals 1 and 2, 4 and 5, 6 and 7, and 9 and 10 of terminal board TB901 (figs. 150, 151 and 153). The voltage at each pair of terminals is 0.89 ±0.20 volts as when the carrier supply output is normal. If an abnormal reading is noticed, replace the carrier supply plug-in assembly with a good one from spares (para 37).
	Broken or disconnected CARR SUP-POWER cable.	Check tightness of cable connection. Check continuity of leads in cable (figs. 150 and 161).
(b) No output at jack J602 of carrier supply	Failure in either 16-kc oscillator or frequency division circuit of carrier supply at local terminal, and failure of system alarm circuit at distant terminal.	Notify distant attendant of the trouble in distant terminal. Proceed to troubleshoot local terminal as outlined for item 1b(1) above.
(3) SYSTEM ALARM lamp lights at local terminal.	Failure in carrier supply circuit of distant terminal.	Notify distant terminal attendant of this possible trouble.
2. No transmission through channels 2 and 4 in either direction. (Channels 1 and 3 and order wire operating normally)		
a. Operational test (par. 82) indicates lack of transmission through these channels.	Failure in 12-kc and 20-kc output circuits of carrier supply of local terminals (para 180).	Check voltages between terminals 4 and 5, and 9 and 10 of terminal board TB901 (figs. 150 and 151). The voltage at each pair of terminals is 0.89±0.20 volt ac when the carrier supply output is normal. If an abnormal reading is obtained, replace the carrier supply plug-in assembly with a good one from spares (para 87).
b. Operational test (para 82) does not indicate truble in these channels.	Failure in 12-kc and 20-kc output circuits of carrier supply in distant terminal.	Notify attendant at distant terminal of this probable trouble.
3. No transmission through channels 1 and 3 in either direction. (Channels 2 and 4 and order wire operating normally).		
a. Operational test (para 82) indicates lack of transmission through these channels.	Failure in 8-kc and 16-kc output circuits of carrier supply of local terminal (para 181).	Check voltages between terminals 1 and 2 and 6 and 7 of terminal board TB901 (figs. 150 and 151). The voltage at each pair of terminals is 0.89±0.20 volt ac when the carrier supply output is normal. If an abnormal reading is obtained, replace the carrier supply plug-in assembly with a good one from spares (para 87).
b. Operational test (para 82) does not indicate trouble in these channels.	Failure in 12-kc and 20-kc output circuits of carrier supply in distant terminal.	Notify attendant at distant terminal of this probable trouble.
4. No transmission through channel 1 in both directions. (Other channels and order wire operating normally.)		

Symptom	*Probable trouble*	*Correction*
4. Continued		
a. Operational tent (para 82) indicates lack *of* transmission through channel.	**Failure in 8-kc output circuit of *car*rier supply of local AM/TCC-3 (para 181).**	**Check for 0.89±0.20 volt ac between terminals 1 and 2 of terminal board TB901 (figs. 150 and 161). If an abnormal reading is obtained, replace the carrier supply plug-in assembly with a good one from spares** *(para 87).*
	Failure in CARR SUP-POWER cable.	**Check continuity between terminal 1 of terminal board TB901 and termina lC of plug P999 (figs. 150 and 161) and between terminal 2 of terminal board TB901 and terminal M of plug P999. If faulty, the cable is replaced at higher level** maintenance.
	Failure in carrier temperature-compensating pad in channel 2 modem (para 116).	***If* a spare channel 1 modem plug-in assembly is available from spares, replace channel 1 modem (para 87).**
***b.* Operational test does not indicate trouble in the channel.**	**Failure in 12-kc output circuit of** car**rier supply, in CARR SUP-POWER cable, in channel 1 modem of distant terminal.**	**Notify attendant** at distant terminal **of these possible troubles.**
5. No transmission through channel 2 in both directions (Other channels and order wire operating normally.)		
a. Operational teat indicates lack of transmission through channel.	**Failure in 12-kc output circuit of carrier supply *of* local AN/TCC-3 (para 180).**	**Cheek for 0.89±0.20 volt ac between terminals 4 and 5 of terminal board TB901 (figs. 150 and 151). If an abnormal reading is obtained, replace the carrier supply plug-in assembly with a good one from spares (para 87).**
	Failure in CARR SUP-POWER cable.	**Check continuity between terminal 4 of terminal 4 of terminal board TB901 and terminal D of plug P999 (figs. 150 and 151) and between terminal 5 of terminal board TB901 and terminal N of plug P999. If faulty, the cable is replaced at higher level maintenance.**
	Failure in carrier temperature-compensating pad in channel 2 modem (para 115).	**If a spare channel 2 modem plug-in assembly is available from spares, replace channel 2 modem (para 87).**
***b.* Operational test does not indicate trouble in the channel.**	**Failure in 8-kc output circuit of carrier supply, in CARR SUP-POWER cable, or in channel 2 modem of distant terminal.**	**Notify attendant at distant terminal of these possible troubles.**
6. No transmission through channel 3 in both directions. (Other channels and order wire operating normally.)		
***a.* Operational test indicates lack of transmission through channel.**	**Failure in 16-kc output circuit of carrier supply of local AN/TCC-3 (para 181).**	**Check for 0.89±0.20 volt ac between terminals 6 and 7 of terminal board TB901 (figs. 150 and 151). If an abnormal reading is obtained, replace the carrier supply plug-in assembly with a good one from spares (para 87).**
	Failure in CARR SUP-POWER cable.	**Check continuity between terminal 6 of terminal board TB901 and terminal E of plug P999 (figs. 150 and**

Symptom	Probable trouble	Correction
6. Continued		161) and between terminal 7 of terminal board TB901 and terminal P of plug P999. If faulty, the cable is replaced at higher level maintenance.
	Failure in carrier temperature-compending pad in channel 3 modem (para 115).	If a spare channel 3 modem plug-in assembly is available from spares, replace channel 8 modem (para 87).
b. Operational test (para 82) does not indicate trouble in the channel.	Failure in 16-kc output circuit of carrier supply, in CARR SUP-POWER cable, or in channel 3 modem of distant terminal.	Notify attendant at distant terminal of these possible troubles.
7. No transmission through channel 4 modem in both directions. (Other channels and order wire o g normally.)		
a. Operational test indicates lack of transmission through channel.	Failure in 20-kc output circuit of carrier supply of local AN/TCC-3 (para 180).	Check for 0.89±0.20 volt ac between terminals 9 and 10 of terminal board TB901 (figs. 150 and 161). If an abnormal reading is obtained, replace the carrier supply plug-in assembly with a good one from spares (para 87).
	Failure in CARR SUP-POWER cable.	Check continuity between terminal 9 of terminal board TB901 and terminal F of plug P999 (figs. 150 and 161) and between terminal 10 of terminal board TB901 and terminal R of plug P999. If faulty, cable is replaced at higher level maintenance.
	Failure in carrier temperature-compensating pad in channel 4 modem (para 115).	If a spare channel 4 modem plug-in assembly is available from spares, replace channel 4 modem (para 87).
b. Operational test (para 82) does not indicate trouble in the channel.	Failure in 20-kc output circuit of carrier supply, in CARR SUP-POWER cable, or in channel 4 modem of distant terminal.	Notify attendant at distant terminal of these possible troubles.
8. No transmission through all channels and order wire in transmitting direction. Reception normal.		
a. Operational test (para 82) indicates lack of transmission.	Failure in transmitting amplifier in local terminal (para 123).	Check tubes V51 and V52 of transmitting amplifier and replace if necessary. If a spare amplifier is available, replace the transmitting amplifier plug-in assembly (para 87).
b. Operational test (para 82) indicates that transmitting amplifier is amplifying signals.	Protectors E763 and E764 shorted.	Remove these protectors (para 85). If normal operation is restored, the protectors are shorted. Replace with good protectors.
	Failure in cable matching network (para 128).	Follow procedure given in equipment performance checklist (para 90). If cable matching network is defective, the equipment performance checklist will indicate the presence of trouble; higher level maintenance is required (para 275)
	Open conductor in spiral-four cable. Failure in receiving amplifier in distant terminal.	Check spiral-four cable for break. No action possible at local terminal.
9. No reception through all channels and order wire. SYSTEM	Failure in receiving amplifier (para 147), or in cable coupling network	Follow procedure given in equipment performance checklist (para 90).

Symptom	*Probable trouble*	*Correction*
9. Continued		
ALARM and CALL lamps light, buzzer sounds. Operation normal in transmitting direction.	(para 132) or equalizers (para 133) in local terminal.	The equipment performance checklist will indicate whether or not the trouble is located within the local terminal. If the trouble is located within the local terminal, perform the corrective measures immediately below. If the trouble is not located within the local terminal, perform the corrective measures given for the other probable troubles that could be responsible for these symptoms.
		Check tubes V51 and V52 of receiving amplifier, and replace if faulty. If a spare amplifier is available, replace the receiving amplifier plug-in assembly (para 87).
		Remove protectors E737 and E738 (para 85). If normal operation is restored, these protectors are shorted. Replace with good protectors. Higher level maintenance may be required (para 276).
	Open conductor in spiral-four cable.	Check spiral-four cable for break.
	Failure in transmitting amplifier in distant terminal.	Notify attendant at distant terminal of this probable trouble. (Order wire is operative to distant terminal but not from distant terminal.)
10. No reception through one channel. Order wire operating normally.	Failure in receiving circuit of that channel (para 153).	Check demodulator amplifier tube and replace if faulty. If that channel modem is available from spares, replace the channel modem plug-in assembly (para 87).
11. No transmission through one channel in transmitting direction. Order wire operating normally.	Failure in transmitting circuit of that channel modem (para 106).	If that channel modem is available from spares, replace the channel modem plug-in assembly (para 87)
12. Reception through one channel distorted. Other channels and order wire operating normally.	Failure in demodulator amplifier of that channel modem (para 159).	Check demodulator amplifier tube and replace if faulty. If that channel modem is available from spares, replace the channel modem plug-in assembly (para 87).
13. Transmissions through all channels and order wire in transmitted direction are distorted. Operation in receiving direction is normal.	Failure in transmitting amplifier (para 123).	If an amplifier plug-in assembly is available from spares, replace the transmitting amplifier (para 87).
	Cable matching network defective (para 128).	Higher level maintenance is required (para 275).
14. Reception through all channels and order wire distorted. Operation in transmitting direction is normal.	Failure in receiving amplifier (para 147).	If an amplifier plug-in assembly is available from spares, replace the receiving amplifier (para 87).
15. No special service transmissions in either direction.		
a. Order wire inoperative.	Same as item 1a.	Same as item 1a.
b. Order wire operative.	CHANNELS-SPECIAL SERVICE switch S801 faulty.	Check continuity through switch contacts. Clean switch if necessary
16. No special service and order wire transmissions in transmitting direction. Reception normal.	Same as item 8.	Same as item 8.

Symptom	Probable trouble	Correction
17. No special service transmission in transmitting direction. Order wire operating normally.	Failure in special service transmitting path.	Higher level maintenance is required (para 273 and figs. 150 and 161).
18. No special service and order wire reception. SYSTEM ALARM lamp lights, buzzer sounds. Operation normal in transmitting direction.	Same as item 9.	Same as item 9.
19. No Special service reception. Order wire operating normally.	Failure in special service receiving path.	Higher level maintenance is required (para 274 and figs. 150 and 161).
20. Special service and order wire transmissions in transmitted direction are distorted. Received signals are normal	Same as item 13	Same as item 13.
21. Special service and order wire transmissions in the received direction are distorted. Transmitted signals are normal.	Same as item 14.	Same as item 14.
22. On special service operation, all communication circuits operate ing normally. SYSTEM ALARM lamp lights at distant terminal.	Same as item lb (1).	Same as 1b(1).
23. Hum present on all transmitted and received signals.	Failure in filter of +200-volt supply (para 234).	Check filter capacitors C551 and C552 (pan 278) and filter choke L551 (para 279 and fig. 160).
24. Hum present on order wire signals transmitted from local AN/TCC-3. Received signals are normal	Failure in filter of negative power supply (para 236).	Check filter capacitors C555 (para 278) and resistor R560 (para 277 and fig. 160).
25. MEASURE meter gives no reading or incorrect readings for all specified measurements. Other circuits operate normally.	Failure in measuring circuit (para 216).	Higher level maintenance is required (para 272 and figs. 156 and 167).
26. MEASURE meter gives no reading or incorrect reading in one or more of these positions of MEASURE switch: 1KC-OW, 19KC–CH4, 11KC–CH2, 7KC–CH1, 15KC–CH3; AMPLIFIER switch in either TR or REC position. All other circuits operate normally.	*Failure* in measuring circuit (para 219 through 223).	Higher level maintenance is required (para 272 and figs. 156 and 167).
27. No output from test oscillator. All other circuits operating normally.	Failure in test oscillator (para 213).	Check tube V701 and replace if defective. Higher. level maintenance may be required (para 249 and 266).
28. Impossible to ring distant station when ORDER WIRE switch is in RING position.		
a. Order wire operative.		
(1) CALL lamp lights and buzzer sounds when ORDER WIRE switch is in RING position.	Break in connection between ringer-oscillator and order wire transmission path.	Check ORDER WIRE switch for continuity in RING position. Clean switch if necessary. Clean continuity between terminal 1 of terminal board TB902 and terminal 2 of transformer T722 in order wire circuit (figs. 150, 151, and 155).
(2) CALL lamp does not light and buzzer does not sound when ORDER WIRE switch is in RING position.	Failure in ringer-oscillator (para 190).	Check tube V1 and replace if faulty. Higher level maintenance may be required (para 267 and fig. 124).
	Failure in circuit between ringer-oscillator and ORDER WIRE switch.	Check ORDER WIRE switch for continuity in RING position. With OR-

Symptom	Probable trouble	Correction
28 Continued		DEB WIRE switch held in the RING position, check continuity between terminals 3 and *4* of terminal board TB902 and between terminals 2 and 6 of terminal board TB902 (figs. 150, 151, and 155).
b. Order wire can receive signals but cannot transmit signals.	Failure in negative voltage power supply (para 236).	In the power supply, check the voltage between jack J554 and ground and between terminal 9 of terminal board TB552 and ground. If the voltage at jack J554 is approximately -10 volts and no voltage is present at terminal 9, check resistor *R562* (fig. 160). If no voltage is present at either of these test points, check continuity in negative power supply (fig. 160). If voltage at jack F554 is approximately -10 volts and voltage at terminal 9 of terminal board TB552 is approximately -10 volts, check for a break in the circuit between terminal 9 of terminal board TB552 and test point *E728* in the order wire circuit (fig. 165). Check also for a break between test point *E728* and ground.
	Failure in order wire transmitting circuit (para 202).	Higher level maintenance is required (para 269 and fig. 155).
29. CALL lamp lights and buzzer sounds continuously. (No ringing signal received.)	Failure in ringer-oscillator (para 184 through 199).	Check tubes V1 and V2 and replace if faulty (fig. 145). If neither tube V1 nor tube V2 is faulty, replace the ringer-oscillator plug-in assembly (para *87)* with one from spares.
30. CALL lamp does not light and buzzer does not sound when ringing signal is transmitted or *received.*	Failure in ringer-oscillator (para 184 through 199).	Check tube *V2* and replace if faulty (figs. 154). If tube V2 is not faulty, replace the ringer-oscillator plug-m assembly (para 87) with one from spares.
31. Order wire can receive signals (such as 1,600-cps ringing signals) but cannot transmit signals. Traffic communications are normal.	Same as *28b.*	Same as 28b. In addition: Check voltage at J554 when the press-to-talk switch on the attendant's handset is operated. If voltage remains approximately -10 volts dc, there is a break in the circuit between terminal 7 of terminal board TB552 and ground. Check this circuit for location of breaks (figs. 150, 151, and 160).
		Check ORDER WIRE switch for continuity in TALK position and SEND OW switch for continuity in nonoperated position (fig. 155). Check transmitter of attendant's handset (para 290).
32. Order wire can transmit signals. Traffic communications are normal.		
a. Incoming ringing signals produce normal indications.	Failure in order wire receiving path between secondary winding of transformer T725 and receiver of attendant's handset.	Check for continuity in order wire receiving path between secondary winding of transformer T725 and receiver of attendant's telephone handset (fig. 155).
		Check receiver of attendant's handset (para 290).

Symptom	Probable trouble	Correction
32. Continued		
b. Incoming ringing signals do not cause the buzzer to sound and the CALL lamp to light.	Failure in circuit between output of receiving amplifier and output of receiver low-paw filter FL722.	Check for continuity (zero reading) *between* terminal *3 of* jack J802 (figs. 150 and 161) end terminal 1 of filter FL722 (fig. 155) when AMPLIFIER switch is in the normal (vertical) position, Check that terminal 10 of Jack J802 and terminal 2 of filter FL722 are grounded. Check filter FL722 (para 282).
	Failure in output circuit of receiving amplifier (para 147).	Replace the receiving amplifier plug-in assembly (pan 87) with an amplifier plug-in assembly from spares (fig. 152).
33. SYSTEM ALARM lamp and CALL lamp light and buzzer sounds. *Other* circuits operating normally.	Failure in system alarm circuit (para 226 through 232).	Higher level maintenance is required (para 269) (fig. 159).
34. Alarm indications are not present when spiral-four cable is either broken or removed from terminal.	Failure in system alarm circuit (para 226 through 232).	Check tube V741 and replace if faulty. Higher level maintenance may be required (para 149, 256, and 287) and (fig. 159).

85. Removal of Pluck-Out Parts

a. *Removal* of *Tubes.* All tubes are accessible from the top or sides of each unit (para 257) after the unit is rolled out of its transit case (para 87).

(1) Remove the shield of a tube by pressing down on the shield and rotating it counterclockwise until it releases.

(2) Use a tube puller to remove the tube.

(3) If a tube puller is not available, allow the tube to cool, grasp it, and pull the tube straight up. Rock the tube gently if the tube can not be extracted by a direct upward pull.

NOTE

Observe caution in removing a miniature tube from its socket. Incorrect removal usually results in bent tube pins.

(4) If the tube marking has become illegible, label the tube as soon as it is removed. This will facilitate replacing the tube. Before replacing a tube, check to see that the tube pins are straight. If pins are bent, use a tube-pin straightener.

b. Removal of Lamps. The four indicator lamps of the AN/TCC-3 are of the bayonet type and are located behind the front panel of the AM-682/TCC-3. To remove one of the indicator lamps, unscrew the lamp cap, press the lamp inward, rotate the lamp counterclockwise, and withdraw it from the socket.

c. Removal of Fuses. The two fuses of the AN/TCC-3 are of the cartridge type and are located on the power supply bracket assembly. The fuses are accessible after removal of the AM-682/TCC-3 from its transit case (para 87). To remove a fuse, press down the fuse-holder cap, turn it counterclockwise, and withdraw the fuse-holder cap. The fuse-holder cap will withdraw the fuse automatically.

d. *Removal* of *Protectors.* There are four lightning protectors in the AN/TCC-3. These are located on the front panel of the AM-682/TCC-3 and are marked PROT. The protector plug can be removed by turning counterclockwise with a screwdriver.

86. Inspecting, Cleaning, and Testing Pluck-Out Parts

After the pluck-out parts have been removed from the AN/TCC-3, check exposed electrical contacts for corrosion. If necessary, clean the elctrical contacts, using No. 0000 sandpaper and cleaning compound. Test the tubes, using a tube tester. If a tube is suspected of being defective, replace it with an identical tube known to be good. If the circuit operates normally, the old tube is faulty.

87. Removal of Plug-In Assemblies

a. General. Telephone Terminal AN/TCC-3 contains eight plug-in assemblies. Four channel modem plug-in assemblies are located in the TA-219/U. The transmitting and receiving amplifiers, the ringer-oscillator, and the carrier-supply plug-in assemblies are located in the AM-682/TCC-3.

The circuits of a plug-in unit are connected to other circuits of the AN/TCC-3 through a 21-pin connector. This permits the plug-in assembly to be removed from the AN/TCC-3 without requiring unsoldering of leads. The following subparagraphs outline the procedures for removing the plug-in assemblies of the AN/TCC-3.

b. Removal of a Channel Modem. To remove one of the channel modem plug-in assemblies, follow the procedure outlined below.

(1) Disconnect the cables from the CARR SUP-POWER and TRANS-TEST-TALK jacks of the TA-219/U (fig. 9).

(2) Loosen the two captive screws located on the front panel of the TA-219/U. Craps the handle on the front panel of the TA-219/U, and withdraw the unit from its transit case.

(3) A screw passes through the modem combining frame directly above each of the four channel modems. A nut on the screw holds the front plate of plug-in assembly securely against the combining frame. Loosen and remove the screw that is above the channel modem being removed.

(4) Two captive screws hold each channel modem plug-in assembly securely in place in the modem combining frame. Loosen the captive screws of the plug-in assembly being removed.

(5) Grasp the front panel binding posts and the rear of the plug-in assembly and raise the assembly until the binding posts line up with top of the opening in the front panel of the combining frame.

(6) Withdraw the plug-in assembly back and away from the front panel of the TA-219/U.

c. Removal of AM-682/TCC-3. To remove the plug-in assemblies located on an AM-682/TCC-3 chassis, it is necessary to remove the AM-682/TCC-3 from its transit case. The procedure for removing the AM-682/TCC-3 is given in (1) through (4) below.

(1) Loosen the six captive screws on the front panel of the AM-682/TCC-3 (fig. 10).

(2) Grasp the handles on the AM-682/TCC-3 and pull the AM-682/TCC-3 partially out of its transit case.

(3) Disconnect the CARR SUP-POWER and TRANS-TEST-TALK cables from the TA-219/U.

(4) Depress the drawer-stop levers at both sides of the AM-682/TCC-3 and carefully withdraw the unit from the transit case.

d. Removal of Transmitting Amplifier. The transmitting amplifier plug-in assembly is mounted on the rear of the right side chassis of the AM-682/TCC-3 directly below the receiving amplifier (fig. 13). To remove the transmitting amplifier plug-in assembly, follow the procedure outlined below:

(1) Remove the AM-682/TCC-3 from its transit case (c above).

(2) Two captive screws hold the amplifier plug-in assembly securely in place in the right-side chassis. Hold the chassis of the amplifier firmly and loosen these captive screws.

(3) Pull the plug-in assembly away from the chassis until the connecting plug clears the jack that is mounted on the chassis.

e. Removal of the Receiving Amplifier. The receiving amplifier plug-in assembly is mounted in the upper rear corner of the right-side chassis of the AM-682/TCC-3 (fig. 13). To remove this plug-in assembly, perform steps (1), (2)) and (3) of d above.

f. Removal of the Carrier Supply. The carrier supply plug-in assembly is mounted in the rear center of the left-side chassis of the AM-682/TCC-3 (fig. 11). To remove this plug-in assembly, follow the procedure outlined below.

(1) Remove the AM-682/TCC-3 from its transit case (*c* above).

(2) Three captive screws hold the carrier-supply plug-in assembly securely in place in the left-side chassis. Hold the carrier supply chassis firmly, and loosen these captive screws.

(3) Pull the plug-in assembly away from the chassis until the connecting plug clears the jack that is mounted on the chassis.

g. Removal of the Ringer-Oscillator. The ringer oscillator plug-in assembly is mounted in the upper rear corner of the left-side chassis of the AM-682/TCC-3 (fig. 10). To remove this plug-in assembly, follow the procedure outlined below.

(1) Remove the AM-682/TCC-3 from its transit case (*c* above).

(2) Two captive screws hold the ringer-oscillator plug-in assembly securely in place in the left-side chassis. Hold the ringer-oscillator chassis firmly, and loosen these captive screws.

(3) Pull the plug-in assembly away from

the chassis until the connecting plug clears the jack that is mounted on the chassis.

88. Inspecting and Cleaning Plug-In Assemblies

a. Test all moving parts for ease of motion. Binding and scraping may be eased by a light rubbing with No. 0000 sandpaper. Corrosion or dirt will interfere with electrical continuity and mechanical efficiency by shorting or insulating circuits or by jamming moving parts. Switches must work easily with no searching for contact positions. Examine and clean the following parts:

(1) Tube sockets.

(2) Switches.

(3) Variable capacitor.

(4) Lamp sockets.

(5) Binding posts.

(6) Control shafts.

(7) 21-pin connectors.

b. Inspect the plug-in assembly for loose or broken wires, and for burned or discolored resistors and capacitors. Tag the plug-in assembly and indicate what has been found by this inspection.

89. Troubleshooting (Using Equipment Performance Checklist)

a. General. The equipment performance checklist (para 90) will help to locate trouble in the equipment. The list gives the items to be checked, the normal indications and tolerances of correct operation, and the corrective measures that can be taken by the repairman. To use this list, follow the items in numerical sequence.

b. Action or Conditions. For some items, the information given in the *action or condition* column consists of various switch and control settings under which the item is to be checked. For other items, it represents an action that must be taken to check the normal indication given in the *normal indicaitons* column.

c. Normal Indications. The normal indications listed include the visible and audible signs that the operator should perceive when he checks the items. If the indications are not normal, the operator should apply the recommended corrective measures.

d. Corrective Measures. The corrective measures listed are those that the operator can make without turning in the equipment for repairs. Where the indications obtained are insufficient to localize the trouble, the *corrective measures* column indicates that troubleshooting is necessary. If the terminal is completely inoperative or if the recommended corrective measures do not yield results, troubleshooting is necessary. However, if the tactical situation requires that communications be maintained, and if the terminal is not completely inoperative, the attendant must keep the terminal in operation as long as it is possible to do so.

90. Equipment Performance Checklist

The equipment performance checklist is divided into four parts—preparatory, starting, equipment performance, and stopping. When using the checklist, follow the items in the order in which they are presented.

	No. item	Item	Action or condition	Normal indications	Corrective measures
PREPARATORY	1	AMP OUT switch on transmitting amplifier.	Operate to 0 db position.		
	2	115V–230V switch.	Operate to position that corresponds with voltage of ac power source.		
	3	2W–4W switches on channel modems.	Operate to 4W position.		
	4	Interconnection cables.	Connect to telephone modem unit.		
	5	All front panel switches except ALARM CUTOFF switch.	Operate to vertical position.		
	6	ALARM CUTOFF switch.	Rotate to right.		

	No. item	Item	Action or condition	Normal indications	Corrective measures
	7	Spiral-four cable.	Disconnect from amplifier-power supply unit.		
	8	Power cable.	Connect to source of ac power.		
	9	CHANNELS-SPECIAL SERVICE switch.	Operate to CHANNELS position.		
STARTING	10	POWER switch.	Operate to ON position.	POWER and CALL lamps light and buzzer sounds.	Check fuse F551 (and F552 if 230-volt operation). Check indicator lamps and buzzer. Check ac power source. Check for 6.3 volts ac between jacks J551 and J552.
				After rectifier tubes heat. CALL lamp goes out, buzzer is silenced and SYSTEM ALARM lamp lights. (This should occur approximately 30 seconds after POWER switch is operated to ON position.)	Check for +200 volts dc between jack J553 and ground. Check rectifier tubes V551, V552, and V553 with tube tester. Check tube V1 in ringer-oscillator and tube V741 is system alarm circuit. Check at terminals of relays K1 (ringer-oscillator circuit) and K741 (system alarm circuit) for proper continuity of contacts. Check SYSTEM ALARM lamp.
	11	FLAT-1KC, SLOPE-19KC, and BULGE-11KC controls.	Operate each control to 0 position.		
		Telephone Cable Assembly CX-1512/U.	Connect to the spiral-four cable connector of the AM-682/TCC-3. Connect one of the brown wires to one of the natural wires and the other brown wire to the other natural wire.	Disregard lamp indications at this point. If buzzer sounds, silence it by operating ALARM CUTOFF switch.	
EQUIPMENT	12	MEASURE switch.	Operate to TEST OSC position.	0 db (±1 db) on MEASURE meter.	Check tube V701.
		TEST OSC OUTPUT control.	Adjust to obtain normal indication.		Check MEASURE switch for continuity in TEST OSC position. Check meter and meter connections.
	13	MEASURE switch.	Operate to 1KC-OW position.	0 db (±1 db) on MEASURE meter.	Check transmitting amplifier tubes V51 and V52.
		SEND OW switch.	Operate.		Check MEASURE switch for continuity in 1KC-OW position.
		AMPLIFIER switch.	Hold at TR position.		Check SEND OW switch for continuity in operated position.

	No. item	Item	Action or condition	Normal indications	Corrective measures
EQUIPMENT PERFORMANCE	22	All switches mentioned in item 20.	Operate an for item 20 except that TALK-MON switch of channel 1 is operated to vertical position.	1,000-cps signal is heard in attendant's telephone set.	Check demodulator amplifier tube V301 with tube tester. Troubleshooting at higher maintenance level may be required.
		TALK-MON switch of channel 8.	Operate to *TALK* podtion.		
	23	All Switcher mentioned in item 20	Operate as for item 20 except that TALK-MON switch of channel is operated to vertical position.	1,000-cps signal is heard in attendant's telephone set.	Check demodulator amplifier tube V401 with tube tester. Troubleshooting at higher maintenance level may be required.
		TALK-MON switch of channel 4.	Operate to TALK position.		
	24	All switches except ORDER WIRE switch.	Operate to vertical positions.	MEASURE *meter* reads approximately -5 db.	Check tube V2 in ringer-oscillator with tube tester.
		Rotary MEASURE switch.	Operate to 1KC-OW position.		Check ORDER WIRE switch for continuity in RING poritíon.
		ORDER WIRE switch.	Operate to RING position.		Check to ascertain that plug P1 of ringer-oscillator is seated securely.
		AMPLIFIER switch.	Hold at TR position.		
STOPPING	25	POWER switch.	Operate to OFF position.	All indicator lamps extinguish. MEASURE *meter* pointer at extreme left.	Troubleshooting at higher maintenance level may be required.
	26	All lever switches.	Operate to vertical position.		
	27	MEASURE switch.	Operate to OFF position.		
	28	Power cable.	Disconnect from source of a-c power.		

CHAPTER 4

FUNCTIONING OF EQUIPMENT

NOTE

The information in this chapter is applicable to all models of Telephone Modem TA-219/U and TA-219A/U and Amplifier-Power Supply AM-682/TCC-3 and *AM-682A/TCC-3* unless otherwise noted. Telephone Modems TA-219/U and TA-219A/U are interchangeable, as Amplifier-Power Supply AM-682/TCC-3 and AM-682A/TCC-3. *It* should be noted however that the substitution of an earlier model for an (A) unit will result in decreased capability.

Section I. FUNCTIONING OF TELEPHONE TERMINAL AN/TCC-3

91. General

a. Telephone Terminal AN/TCC-3 provides four carrier channels and a voice-frequency order wire channel for transmission over loaded spiral-four cable, radio link or combined cable-radio link. It has an added feature whereby the four carrier channels may be cut off to permit transmission of special service data such as facsimile or telephoto. Bandwidths and frequency allocations appear in tabular form in paragraph 6.

b. For purposes of explanation, the AN/TCC-3 may be considered to consist of two types of circuits—traffic circuits and auxiliary circuits. The traffic circuits are those that carry the four-channel carrier traffic signals or those that carry special service traffic signals. The auxiliary circuits and their functions are given in (1) through (6) below.

(1) The carrier supply provides four carrier frequencies for four-channel operation and the 4-kc alarm pilot.

(2) The ringer-oscillator provides for 1,600-cps signaling over the order wire.

(3) The order wire circuit provides a voice-frequency maintenance channels.

(4) The built-in test facilities are used for system line up and for detection of trouble in the AN/TCC-3.

(5) The system alarm circuit provides detection of a failure in the transmission path in the system.

(6) The power supply provides the necessary operation voltages for the AN/TCC-3.

c. Paragraphs 91 through 99 contain a brief description of the functioning of all the major circuits of the AN/TCC-3. Paragraphs 100 through 161 contain a detailed analysis of the four-channel carrier circuits. Paragraphs 162 through 164 contain a detailed analysis of the special service circuits. Paragraph 165 through 236 contain a detailed analysis of each of the auxiliary circuits.

92. Functioning of the Four Channel Carrier Circuit

a. General. Figure 33 is a simplified block diagram of the AN/TCC-3. Telephone Modem TA-219/U is represented at the left side of the diagram. The TA-219/U contains the four carrier channels of the AN/TCC-3; all other circuits are contained in Amplifier Power Supply AM-682/TCC-3. A brief description of the functioning of the transmitting path and receiving path for the four-channel carrier signals is given in *b* and *c* below.

Figure 33. Telephone terminal AN/TCC-3, overall block diagram.
(Located in back of manual)

b. Transmitting Path.

(1) Figure 33 shows four basic divisions of the TA-219/U. Each division contains the modulating and demodulating circuits for one channel. All divisions are basically alike except for carrier frequency and frequency band. Channel 1 modem is shown in detail. The connections to local voice-frequency circuits are shown at the left-hand side. The diagram shows a four-wire connection, one transmitting pair and one

receiving pair. Circuits are included in the TA-219/U to combine the transmitting input and receiving output circuits for two-wire operation. This feature is not shown in figure 33 for reasons of simplification.

(2) A voice-frequency signal applied to the transmitting path of the channel 1 modem from the local VF Loop equipment is connected through the SENDMEAS switch to the modulator where it modulates the 8-kc carrier frequency obtained from the carrier supply circuits of the AM-682/TCC-3 (para 98). The carrier frequency is suppressed by the balance of the modulator, and the lower sideband is selected from the modulator output by a band pass Alter (not shown). A detailed analysis of the channel modem transmitting path is given in paragraphs 102 through 119.

(3) The lower sideband output of channel 1 modem is combined in the TA-219/U with the lower side band outputs of the channel 2, 3 and 4 modems. These output signals occupy four distinct and separate frequency bands because different carrier frequencies are employed. Because of this frequency separation, there is no crosstalk between adjacent channels.

(4) The four lower sideband signals are applied to the AM-682/TCC-3, through the CHANNELS-SPECIAL SERVICE switch (in the CHANNELS position), are amplified in the common transmitting amplifier, and pass through the cable matching network to the spiral-four cable. A detailed analysis of the transmitting circuit of the AM-682/TCC-3 is given in paragraphs 120 through 128.

c. Receiving Path.

(1) Carrier channel signals, formed in the distant terminal of the system as described in *b* above, enter the Amplifier-Power Supply AM-682/TCC-3 as shown at the right side of figure 33. Equalizers in the input of the receiving circuit of the AM-682/TCC-3 insert loss in the message path so that the incoming channel signals enter the common receiving amplifier at the proper power level. The signals are amplified and passed through the CHANNEL-SPECIAL SERVICE switch (in the CHANNELS position) to the TA-219/U. The detailed analysis of the receiving circuit of the AM-682/TCC-3 is given in paragraphs 129 through 148.

(2) All amplified signals are applied to each of the channel modem receiving paths. In the receiving path of channel 1 modem, a bandpass filter (not shown in fig. 33) selects the correct lower sideband signal. This signal is demodulated by the 8-kc carrier supplied by the carrier supply. The 8-kc carrier is suppressed by the balance of the demodulator. A low pass Alter (not shown) selects the difference frequency from the demodulator. The difference frequency is the original voice-frequency signal. This is applied to the de modulator amplifier, is amplified and passed through the SENDMEAS switch to the local voice-frequency equipment. A detailed analysis of the receiving path of the channel modem appears in paragraphs 149 through 159.

93. Functioning of the Special Service Circuit

a. General. When used for special service operation, the AN/TCC-3 provides a single wide-band channel in place of the four carrier channels. The wide-band channel occupies the same frequency band as do the four carrier channels. The use of this wide-band channel permits the transmission of telephoto facsimile or similar signals. Special service equipment, external to the AN/TCC-3, is connected to the binding posts on the special service bracket assembly of the AM-682/TCC-3 on a four-wire basis. The CHANNEL-SPECIAL SERVICE switch is operated to the SPECIAL SERVICE position to complete the circuits between the transmitting and receiving circuits of the AM-682/TCC-3 and the binding posts on the special service bracket assembly.

b Transmitting Path. Wide-band signals originating in the special service loop equipment are applied to the SPECIAL SERVICE TR binding posts (not shown in fig. 33) and pass through the special service transmitting path. The special service signals enter the AM-682/TCC-3 transmitting path through the CHANNELS-SPECIAL SERVICE switch in the SPECIAL SERVICE position. The special service signals are amplified in the transmitting amplifier of the AM-682/TCC-3 and are transmitted over the transmission medium to the distant AN/TCC-3. Note that the special service signals do not pass through the channel modems. The CHANNELS-SPECIAL SERVICE switch disconnects the channel modems from the AM-682/TCC-3 transmitting path when the switch is in the SPECIAL SERVICE position.

c. Receiving Path. Special service signals transmitted over the transmission medium by the distant AN/TCC-3 are appplied to the receiving circuit of the AM-682/TCC-3 where they are equalized and amplified. The amplified signals are applied through the CHANNELS-SPECIAL SERVICE switch to the special service receiving path. Filtering is required in the special service equipment to select the wide-band special service signal and to reject the 4-kc alarm pilot and order wire signals. Note that the special service signals do not pass through the channel modems. The CHANNEL-SPECIAL SERVICE switch disconnects the channel modems receiving paths when the switch is in the SPECIAL SERVICE position. A detailed analysis of the receiving path for special service signals is given in paragraph 164.

94. Functioning of Carrier Supply

a. The carrier supply produces four different carrier frequencies. These carrier frequencies are supplied to the channel modems, one carrier frequency to each of the four channels (fig. 33). An 8-kc carrier is supplied to channel 1 modem, a 12-kc carrier is supplied to channel 2 modem, a 16-kc carrier is supplied to channel 3 modem, and a 20-kc carrier is supplied to channel 4 modem. A detailed analysis of the carrier supply is given in paragraphs 166 through 182.

b. In addition to the four carrier frequencies, the carrier supply produces the 4-kc system alarm pilot signal. The absence of this signal actuates the system alarm circuit of the distant telephone terminal. The 4-kc pilot signal (fig. 33) is fed from the carrier supply, through the transmitting circuit of the AM-682/TCC-3, and the transmission media, to the receiving circuit of the AM-682/TCC-3 at the distant terminal. In the distant AN/TCC-3, the amplified signal is fed to the system alarm circuit. The functioning of the system alarm circuit is described briefly in paragraph 98.

95. Functioning of Ringer-Oscillator

a. General. The ringer-oscillator in the AN/TCC-3 performs two functions. These functions are described briefly in *b* and *c* below. The circuit is changed from one function to the other by the operation of the ORDER WIRE switch (para 204d). A detailed analysis of the ringer-oscillator circuit is given in paragraphs 184 through 199.

b. Ringer When the ORDER WIRE switch is in the normal (nonoperated) position, the ringer-oscillator operates as a device that detects the presence of ringing signals. A 1,600-cps ringing signal transmitted from a distant station over the transmission medium is received at the local AN/TCC-3. The 1,600-cps ringing signal is amplified in the receiving circuit of the AM-682/TCC-3. The amplified 1,600-cps ringing signal from the receiving amplifier is applied through the contacts of the AMPLIFIER switch of the measuring circuit to the order wire circuit, when the AMPLIFIER switch is in the nonoperated position. When the AMPLIFIER switch is in the REC position, the 1,600-cps ringing signal is removed from the order wire circuit and is applied to the measuring circuit (para 91c). In the order wire circuit, the ringing signal passes through the RING contacts of the ORDER WIRE switch and is applied to the ringer-oscillator (when the ORDER WIRE switch is either in the nonoperated or in the TALK position). In the ringer-oscillator, the ringing signal is rectified. The rectified voltage causes the closing of the circuit containing the CALL lamp and the buzzer. The buzzer sounds and the CALL lamp lights to notify the terminal attendant of the reception of the ringing signal.

c. Oscillator. When the ORDER WIRE switch is held in the RING position, the ringer-oscillator operates as an oscillator. The circuit generates the 1,600-cps ringing signal that is used to call a distant station. The ringing signal from the ringer-oscillator passes through the RING contacts of the ORDER WIRE switch through the contacts of the SEND OW switch (when this switch is in the vertical position, as shown in figure 33) and is applied to the transmitting circuit of the AM-682/TCC-3. In the transmitting circuit the signal is amplified. The signal then is transmitted over the transmission medium to the distant stations in the system.

96. Functioning of Order Wire Circuit

a. General. The main function of the order wire circuit is to provide a voice-frequency channel for use in the maintenance and installation of the system. This function is discussed briefly in *b* below. Other functions are discussed briefly in *c* below. A detailed analysis of the order wire circuit is given in paragraphs 200 through 210.

b. Voice-Frequency Order Wire Channel.

(1) The voice-frequency order wire channel permits the terminal attendant to communicate with the attendants at the other stations in the system. The order wire channel is used to facilitate installation, adjustment, and servicing of the AN/TCC-3 and of the other equipments in the system To permit use of the attendant's

telephone set for voice transmission, the ORDER WIRE switch must be operated to the TALK position, and the SEND OW switch must be in the vertical position (fig. 33). To receive voice signals on the attendant's telephone set. the ORDER WIRE switch must be operated to the TALK position. The SEND OW switch, however, can be in either of its two positions during reception.

(2) The order-wire circuit is represented near the center of figure 33. Voice signals from the transmitter of the attendant's telephone set pass through the TALK contacts of the ORDER WIRE switch and through the contacts of the SEND OW switch (when this switch is in the vertical position, as shown in fig. 33) to the transmitting circuit of the AM-682/TCC-3. The voice signals are amplified and transmitted to distant stations in the system.

(3) Voice signals transmitted from a distant station are received in the local AN/TCC-3. The signals are equalized and amplified in the receiving circuit of the AM-682/TCC-3. The equalizer and amplified voice signals are applied through the contacts of the AMPLIFIER switch to the order wire circuit. In the order wire circuit, the signals pass through the TALK contacts of the ORDER WIRE switch to the receiver of the attendant's telephone set.

c. Other Functions. The attendant's telephone set is connected to the TA-219/U through the contacts of the CHANNEL TALK switch in both positions of that switch. The connection of the attendant's telephonc set to the TA-219/U permits the telephone to be used to monitor incoming and outgoing conversations over the channels of the terminal. The connection also permits the terminal attendant either to communicate with the distant stations over the channels of the terminal or to communicate with the personnel at the local loop equipment.

(1) With the CHANNEL TALK switch operated to the LINE position and the TALK-MON switch of a channel modem in the TALK position, the circuit from the attendant's telephone set to that channel modem is completed. Voice signals from the attendant's telephone set pass through the contacts of the CHANNEL TALK and TALK-MON switches and are applied to the transmitting path of the channel modem. The voice signals pass through the transmitting path of the channel modem of the TA-219/U and the transmitting circuit of the AM-682/TCC-3 and are transmitted over the spiral-four cable to the distant stations (para 92b). Signals from distant stations that have passed through the receiving circuit of the AM-682/TCC-3 and the receiving path of the channel modem (para 92c) are applied through the contacts of the TALK-MON and CHANNEL TALK switches to the attendant's telephone set. When the TALK-MON switch of a channel modem is in the MON position, attenuating resistors are introduced into the path of the voice signals between that channel modem and the attendant's telephone set.

(2) With the CHANNEL TALK switch operated to the TEST BD position and the TALK-MON witch of a channel modem in the TALK position, the circuit from the attendant's telephone set to that channel is completed. Voice signals from the attendant's telephone set pass through the contacts of the CHANNEL TALK and TALK-MON switches and are applied to the voice-frequency-equipment connecting circuit of the channel modem. The voice signals pass through this circuit and are applied to the local v-f loop equipment. Signals from the local v-f loop equipment pass through the voice-frequency-equipment connecting circuit and the contacts of the TALK-MON and the CHANNEL TALK switches and is applied to the attendant's telephone set. When the TALK-MON switch is in the MON position, attenuating resistors are introduced into the path of the voice signals between the local v-f loop equipment and the attendant's telephone set.

(3) Voice communications from a point on the v-f loop side of the AN/TCC-3 can be established through the order wire circuit and the transmitting and receiving paths of the AM-682/TCC-3. The ORDER WIRE binding posts permit a remote two-wire telephone equipment to be connected to the order wire circuit for this purpose. The ORDER WIRE switch need not be operated to permit communications from the remote point. The voice-frequency signals originating at the two-wire telephone equipment connected to the ORDER WIRE binding posts pass through the hybrid coil and are applied to the SEND OW switch. When this switch is in the vertical position (fig. 33), the signals are applied to the transmitting circuit of the AM-682/TCC-3. The amplified signals from this circuit are transmitted over the spiral-four cable to the distant stations (para 92*b*). Signals from the distant stations pass through the receiving circuit of the AM-682/TCC-3 (para 92*c*). The

amplified and equalized voice-frequency signals from this circuit are applied through the contacts of the circuit (when the AMPLIFIER switch is in the unoporated position). The voice-frequency signals pass through the order wire circuit and are applied to the hybrid coil. The signals pass through the hybrid coil to the two-wire telephone equipment connected to the ORDER WIRE binding posts.

(4) When the SEND OW switch is operated to the horizontal position, a l-kc test signal is transmitted from the test oscillator (para *97)* through a portion of the order wire circuit to the transmitting circuit of the AM-682/TCC-3. The test signal is amplified and transmitted to distant stations. The 1-kc test signal is used during system lineup.

(5) The ORDER WIRE switch controls the operation of the ringer-oscillator. A brief description of the ringer-oscillator is given in *paragraph 95.*

97. Testing Facilities

a. General. The testing facilities of the AN/TCC-3 consist of a 1-kc test oscillator and a measuring circuit. These circuits provide the means for lining up the system and determining if it is operating properly. The functioning of the test oscillator is described briefly in *b* below. A detailed analysis of the test oscillator circuit is given in paragraph 213. The functioning of the measuring circuit is described briefly in *c* below. A detailed analysis of the measuring circuit is given in paragraphs 211 through 225.

b. Functioning of Test Oscillator. The test oscillator generates a 1-kc signal that is used to produce the five test signals required for lining up the system.

(1) The 1-kc output of the test oscilllator can be transmitted over the order wire channel (para 96*c*(3)) by operating the SEND OW switch (fig. 33).

(2) The 1-kc output of the test oscillator can be fed into the transmitting path of a channel modem (para 92*b*(1)) by operating the SEND-MEAS switch of that channel to the send position (fig. 33). The 1-kc signal modulates the carrier of that channel. The desired output of the channel modem is the lower side-band frequency produced by the modulation. The carrier frequencies applied to the channel modem are given in paragraph 94*a*. The frequencies of the test signals produced by the modulation of the carrier frequencies by the l-kc test signal are 7 kc in channel 1, 11 kc in channel 2, 15 kc in channel 3, and 19 kc in channel 4. The test signals from the channel modems are transmitted through the same circuits as the traffic signals from the channel modems.

c. Functioning of Measuring Circuit.

(1) The measuring circuit measures the magnitudes of signals at various points in the AN/TCC-3. The measuring circuit is arranged so that the MEASURE meter will indicate 0 db for all measurements taken under normal operating conditions. A reading other than 0 db indicates either the need for an adjustment of a control or the presence of trouble in the circuits of the AN/TCC-3.

(2) The measuring circuit may be connected to the test oscillator by operating the MEASURE switch to the TEST OSC position (fig. 33). When the measuring circuit is connected to the test oscillator, the measuring circuit permits the adjustment of the test oscillator. This adjustment is necessary so that test signals of the proper level will be transmitted from the AN/TCC-3.

(3) The measuring circuit may be connected to the transmitting circuit of the AM-682/TCC-3 by operating the AMPLIFIER SWITCH to the TR position (fig. 33). All the signals transmitted from the AN/TCC-3 pass through the transmitting circuit of the AM-682/TCC-3. The MEASURE switch permits the measuring circuit to select and measure individually each signal in the AM-682/TCC-3 transmitting circuit. Thus, the operation of the circuits through which the measured signal has passed can be checked. Normal operation of those circuits through which the measured signal has passed will be indicated by 0-db reading on the MEASURE meter.

(4) The measuring circuit may be connected to the receiving circuit of the AM-682/TCC-3 by operating the AMPLIFIER switch to the REC position (fig. 33). All the signals received by the AN/TCC-3 pass through the receiving circuit of the AM-682/TCC-3. The measuring circuit can select and measure any one of the five test signals that might be received. The measurement of the test signals permits adjustment of the equalizer controls. Proper adjustment of an equalizer control is indicated by a 0-db reading on the MEASURE meter.

(5) The measuring circuit may be con-

nected to any one of the channel modem receiving paths (para 92*c*) by operating the SEND-MEAS switch of that channel modem to the MEAS position (fig. 33). Measurement of the level of the demodulated received signal permits the correct adjustment of the GAIN control of that channel modem.

(6) A test probe is part of the measuring circuit. The test probe is used for checking the operation of the circuits of the carrier supply. Proper operation is indicated by a 0-db reading on the MEASURE meter.

98. Functioning of System Alarm

a. General. Each AM-682/TCC-3 contains a system alarm circuit which functions to indicate a low level or absence of incoming transmission. The carrier supply in the AM-682/TCC-3 generates a 4-kc system alarm pilot signal. The pilot signal is transmitted through circuits common to the transmission path for traffic signals. A complete or partial failure in any of these common circuits will either interrupt or seriously reduce the level of transmission at the receiving terminal. When the pilot is not received, or is received at greatly reduced level, the system alarm circuit at the receiving terminal sounds a buzzer and lights the SYSTEM ALARM lamp. A general description of the operation of the system alarm circuit in the local terminal appears in *b* and *c* below. A detailed analysis of the system alarm circuit appears in paragraphs 226 through 232.

b. Functioning of System Alarm Under Normal Conditions. Under normal conditions, the local AN/TCC-3 receives the 4-kc pilot signal that is transmitted from the distant AN/TCC-3. The signal is equalized and amplified in the receiving circuit of the AM-682/TCC-3 and fed to the system alarm circuit. The system alarm is represented in the lower center of figure 33. When no trouble exists in either the transmission medium or the circuits which carry the alarm pilot, the received signal will be or normal amplitude and no alarm will be given.

c. Functioning of System Alarm with Trouble in the System.

(1) When a trouble exists in either the transmission medium or the circuits that carry the alarm pilot and the traffic signals, the transmission of both the traffic signals and the alarm pilot will be interrupted or reduced in amplitude. When the system alarm circuit receives a reduced level 4-kc signal or no 4-kc signal, the relay in the alarm circuit closes the circuit of the SYSTEM ALARM lamp. In addition, with the ALARM CUTOFF switch in the normal (vertical) position, the relay closes the circuit of the buzzer and the CALL lamp.

(2) Operation of the ALARM CUTOFF switch to the horizontal position silences the buzzer and extinguishes the CALL lamp. The SYSTEM ALARM lamp will remain lighted. The ALARM CUTOFF switch should be left in the horizontal position until the trouble in the system is cleared ((3) below).

(3) When the trouble in the system has been corrected, a normal 4-kc signal once again will be applied to the system alarm circuit. This causes the relay to open the circuit of the SYSTEM ALARM lamp, and extinguishes the lamp. In addition, the buzzer will sound and the CALL lamp will light, indicating that the trouble has been corrected. After the trouble has been corrected, return the ALARM CUTOFF switch to the normal (vertical) position.

99. Functioning of Power Supply

The power supply operates from a 115 or 230 volts ac power source to produce the necessary ac and dc operating voltages for the AN/TCC-3. The 115V-230V switch permits the power supply to operate from either voltage source. A detailed analysis of the power supply circuit is given in paragraphs 233 through 236.

Section II. CARRIER CIRCUITS

100. General

The AN/TCC-3 contains four channel carrier circuits. These circuits are contained in both the TA-219/U and the AM-682/TCC-3. The TA-219/U contains four separate circuits, each of which contains a transmit and a receive path. The combined outputs of the four transmit paths of the TA-219/U are applied to a single transmit circuit in the AM-682/TCC-3 and the output of the receive circuits of the AM-682/TCC-3 is applied to the four receive paths of the TA-219/U. A general description of the functioning of these circuits is covered in paragraph 92. A detailed analysis of the transmit path is covered in paragraphs 101 through 128. A detailed analysis of the receive path is covered in paragraphs 129 through 160.

101. Four Channel Carrier Transmitting Paths

The four channel carrier transmitting paths consist of the transmitting paths of the TA–219/U and the transmitting circuit of the AM–682/TCC–3 (para 94). A general description of the functioning of these circuits is given in paragraph 92*b*. A detailed analysis of the transmitting path of the TA–219/U is given in paragraphs 102 through 119. A detailed analysis of the transmitting circuit of the AM–682/TCC–3 is given in paragraphs 120 through 128.

102. Transmitting Path of the TA-219/U

The transmitting path of the TA–219/U consists of the transmitting path of each of the four channel modems of the TA–219/U and the output combining circuit of the TA–219/U. Since the theory of the functioning of the transmitting path of the four channel modems is similar, only the transmitting path in the channel 2 modem will be discussed in the detailed analysis. This analysis is given in paragraphs 103 through 115. A detailed analysis of the output combining circuit of the TA–219/U is given in paragraph 116. Certain differences between the channel modems of the TA–219/U are analyzed in paragraphs 116 through 119.

103. Transmitting Path of Channel 2 Modem, Block Diagram Analysis of Functioning

The transmitting path of channel 2 modem (fig. 34) consists of the voice-frequency-connecting

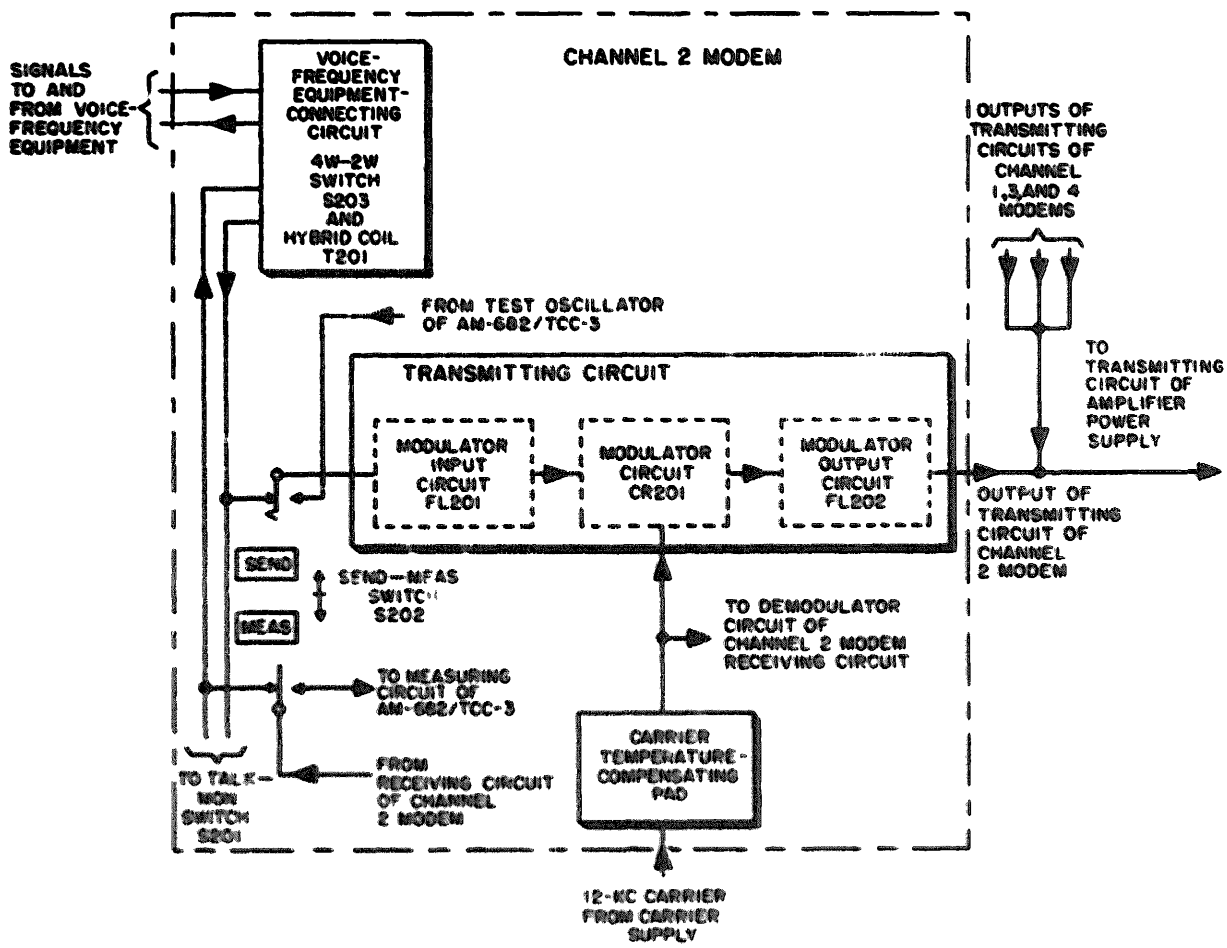


Figure 34. Transmitting path, channel 2 modem, block diagram.

circuit and the transmitting circuit of channel 2 modem

a. Voice-Frequency-Equipment Connecting Circuit of Channel 2 Modem. The v-f equipment connecting circuit consists of 2W–4W switch S203 and hybrid coil T201 with its associated circuit elements. Voice-frequency signals from external equipment are fed to the voice-frequency equipment connecting circuit. The 2W–4W switch, S203, can be operated to permit the use of either two-wire or four-wire voice-frequency equipment. For two-wire voice-frequency equipment, 2W–4W switch S203 is operated to the 2W position. The voice-frequency signal then is passed through hybrid coil T201. The hybrid coil prevents the output of the receiving circuit of channel 2 modem from entering the transmitting circuit of the channel 2 modem (para 151). Voice-frequency signals pass through the SEND contacts of SEND-MEAS switch S202 (SEND-MEAS switch in normal position) to the transmitting circuit of the channel modem. For use with four-wire, voice-frequency equipment, the 2W–4W switch S203 is operated so that the voice-frequency signal is bypassed around the hybrid coil and applied through the contacts of the SEND-MEAS switch to the transmitting circuit. The SEND-MEAS switch can be operated to remove the output of the voice-frequency equipment connecting circuit from the transmitting circuit and connnect the output from the 1-kc oscillator in its place (para 212*a*). In addition, the SEND-MEAS switch can be operated to disconnect the receiving circuit of the channel 2 modem (para 153) from the voice-frequency-equipment connecting circuit and to connect it to the measuring circuit (para 212*e*). The TALK-MON switch, which is in parallel with the voice-frequency-equipment connecting circuit but not a part of it, can be used to connect the channel modem to the order wire circuit (para 204*a*). The connection of the channel modem to the order wire circuit permits the attendant's telephone set to be used to monitor incoming and outgoing conversation on the channel. The connection to the order wire circuit also permits the terminal attendant either to communicate over the channel to the distant station or to communicate with the personnel at the local loop equipment. A detailed analysis of the voice-frequency-equipment connecting circuit is given in paragraph 105.

b. Transmitting Circuit of Channel 2 Modem. The transmitting circuit consists of the modulator input circuit, the modulator circuit and the modulator output circuit (fig. 34). The voice-frequency signal input to the transmitting circuit is attenuated and filtered in the modulator input circuit and passed to the modulator circuit. In the modulator circuit, the voice-frequency signals modulate the 12-kc carrier frequency, producing upper and lower side-band outputs. The 12-kc carrier, produced by the carrier supply (para 167*d*(2)), is applied to the carrier temperature compensating pad of channel 2 modem (para 115). The constant-level carrier from the pad output is applied to the modulator of the transmitting circuit and the demodulator of the receiving circuit (para 156) of the channel modem. The side-band outputs of the modulator enter the modulator output circuit where they are attenuated to a specific signal level The modulator output is applied to the band pass filter, which selects the lower sideband signal. The lower sideband signal is combined with the lower sideband signals from the other channel modems and applied to the transmitting circuit of the AM–682/TCC–3.

104. Transmitting Path of Channel 2 Modem, Detailed Analysis of Functioning

A detailed analysis of the functioning of the transmitting path in channel 2 modem is given in paragraphs 106 through 116. An analysis of certain other features of the TA–219/U is given in paragraphs 117 through 119. The schematic diagram for channel 2 modem of the TA–210/U appears in figure 147.

105. Voice-Frequency-Equipment Connecting Circuit, Detailed Analysis

The channel modem voice-frequency-equipment connecting circuit consists of switch S203 hybrid coil T201 and associated capacitors and resistors. The hybrid coil and its associated circuit constitute a four-wire terminating set. A detailed analysis of this circuit is given in *a* and *b* below. The schematic diagram of channel 2 modem is shown in figure 147.

a. Operation for Connection to Two-Wire Voice Equipment. When 2W–4W switch S203 is operated to the 2W position (fig. 35), terminals 7 and 10 of hybrid coil T201 are connected to the 2W 4W–T binding posts, E201 and E202. In the 2W position the switch also connects terminals 1 and 6 of hybrid coil T201 to the transmitting circuit through the contacts of SEND-MEAS switch S202 (SEND-MEAS in the normal position). Terminals 3 and 4 of hybrid coil T201 are connected through the contacts of the SEND-MEAS switch to the receiving circuit (pars 169). When 2W-4W switch S203 is in the 2W position, the connection from the 4W-R binding posts, E203 and E204, to the contacts of the 2W-4W switch are opened. When switch S202 is in the 2W position, signals to and from two-wire voice frequency equipment pass through hybrid coil T201. The hybrid coil prevents the application of the output of the demodulator amplifier of the receiving circuit of channel 2 modem (para 153 and 159) to the input of the transmitting circuit of the channel modem.

b. Opetration for Connection to Four-Wire Voice-Frequency Equipment. When 2W-4W switch S203 is in the 4W position, the 2W 4W-T binding posts, E201 and E202, are connected through the contacts of the 2W-4W and SEND-MEAS switches respectively (SEND-MEAS switch in normal position) to the transmitting circuit (fig. 35). The 2W-4W switch also connects the 4W-R binding posts, E203 and E204, to the receiving circuit of the channel when the SEND-MEAS switch is in the normal position. With 2W-4W switch S203 in the 4W position, hybrid coil T201 is disconnected from the rest of the circuit. When 2W-4W switch S203 is in the 4W position, four-wire voice-frequency facilities can be used for communication over the channel 2 modem transmitting and receiving paths.

106. Transmitting Circuit of Channel 2 Modem, General

The transmitting circuit of channel 2 modem consists of the modulator input circuit, the modulator circuit, and the modulator output circuit. A detailed analysis of these circuits is given in paragraphs 107 through 115. This analysis is given with the aid of the schematic diagram of channel 2 modem, figure 147.

107. Modulator Input Circuit, Detailed Analysis

a. The modulator input circuit consists of an attenuating pad,, a high-pass filter and a low-pass filter. Voice-frequency signals from the voice-frequency-equipment connecting circuit are

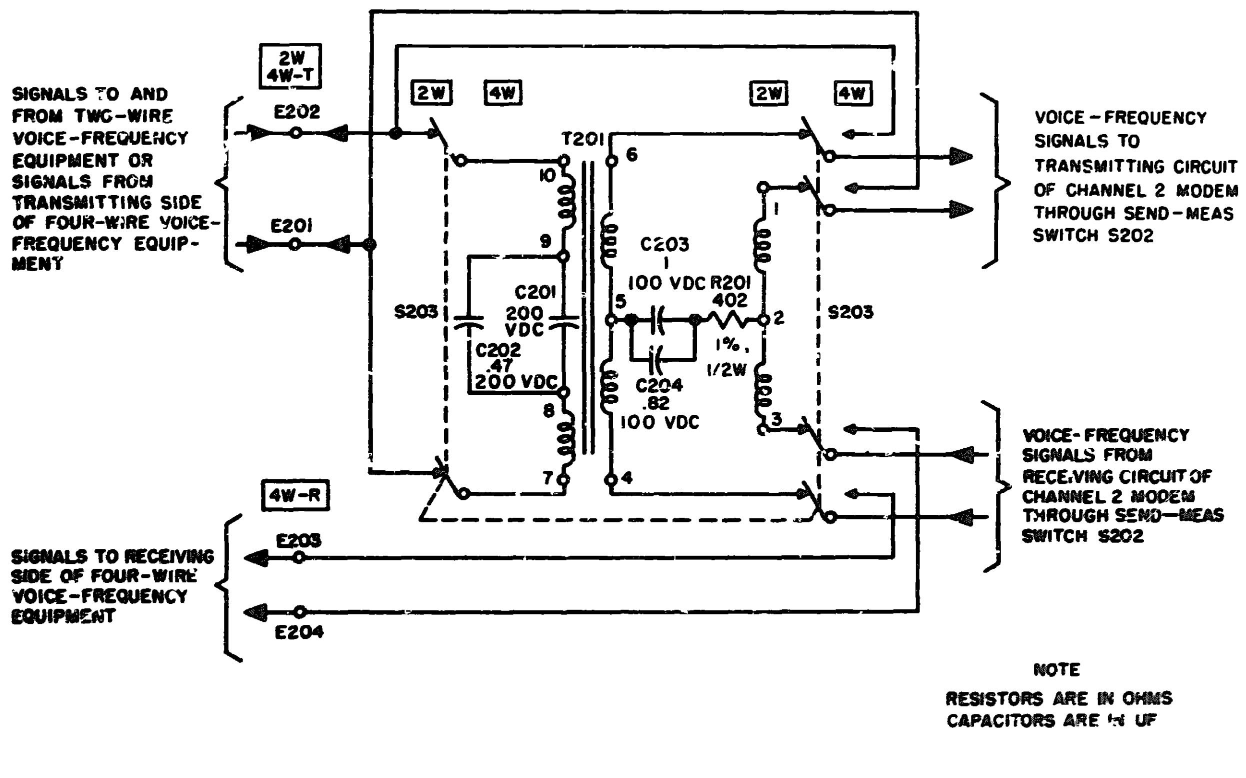


Figure 35. Voice-frequency-equipment connecting circuit, simplified schematic diagram showing switches arranged for two-wire connections.

passed through the contacts of SEND-MEAS switch S202, with this switch in the normal position, through an attenuating pad composed of resistors R206 through R209, to transformer T202.

NOTE

The SEND-MEAS S202 switch (fig. 147) is a three-position switch. The switch is represented in the normal position.

b. Transformer T202 and capacitors C205 and C206 form a high-pass filter for the suppression of low-frequency inputs, such as noise from switchhook operations, telegraph thump, and 20-cycle ringing. The signals then pass to low-pass filter, FL201 (para 108), which suppresses extraneous high-frequency inputs, such as carrier and side-band signals emitted from carrier systems of a previous link in multi-link connections. Filter FL201 also presents to the modulator the desired impedances to side-band frequencies. The filtered signals are coupled to the modulator circuit through transformer T204.

108. Low-Pass Filter FL201, Description and Functioning

A schematic representation of the arrangement of elements in low-pass filter FL201 of channel 2 modem appears in figure 30. This filter is of the T-pad configuration and consists of a capacitor connected between two symmetrical parallel-LC branches. The filter rejects all frequencies above 4,000 cps (approximately). Filters FL101, FL301 and FL401 in channel 1, 3, and 4 modems, perform the same functions as filter FL201.

109. Channel Modem Modulator Circuit, General

A simplified schematic diagram of the modulator circuit is shown in figure 37. The modulator circuit consists of varistor CR201, transformers T204 and T203 and resistors R210 through R213 (see note below). It is of the conventional double-balanced structure. Voice-frequency signals from low-pass filter FL201 are coupled to the modulator circuit through transformer T204. The carrier frequency is applied at the midpoint of windings of transformers T203, and T204 (terminals 2 and 3 of transformer T203 and terminals 2 and 3 of transformer T204). The carrier is modulated by the voice frequency signals, introduced at terminals 6 and 5 of transformer T204, producing an upper and lower side-band output, which is coupled through transformer T203 to the modulator output circuit where the upper side-band output is rejected. A detailed circuit analysis of the modulator is given in paragraphs 110 and 111.

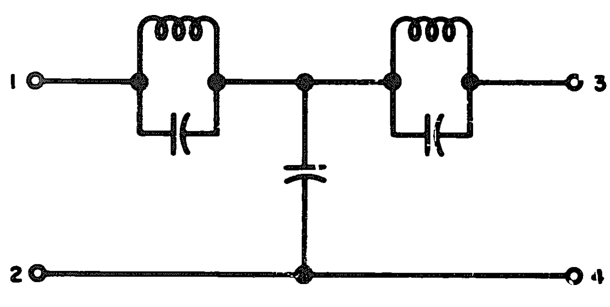


Figure 36. Filter FL201, simplified schematic representations

NOTE

Varistor symbols in the complete and simplified schematic diagrams in this manual are arranged so that the arrow points in the direction opposite to electron flow.

110. CHANNEL MODEM Modulator Circuit With No Modulating Signals

For purposes of explanation, in a through c below, no voice-frequency modulating signals are induced in winding 1-2-3-4 of transformer T204 and the 12-kc carrier is applied to the modulator circuit.

a. Positive Half-Cycles of 12-KC Carrier.

(1) It is assumed that the positive half-cycles of the 12-kc carrier make terminals 2 and 3 of transformer T204 positive and terminals 3 and 3 of transformer T203 negative (fig. 38). For this polarity of the carrier, the characteristic of the varistor is such that the resistance of the two branches of varistor CR201 between terminals 1 and 2 and terminals 4 and 5 is very low. The low resistance may be considered equivalent to a short circuit. Conversely, for this polarity of the 12-kc carrier, the resistance of the branches of varistor CR201 between terminals 2 and 3 and terminals 5 and 6 is very high. This resistance may be considered equivalent to an Open circuit.

(29 The voltage produced during the positive half-cycle of the 12-kc carrier causes electron flow through winding 3-4 of transformer T203, terminals 2 and 1 of varistor CR201, resistor

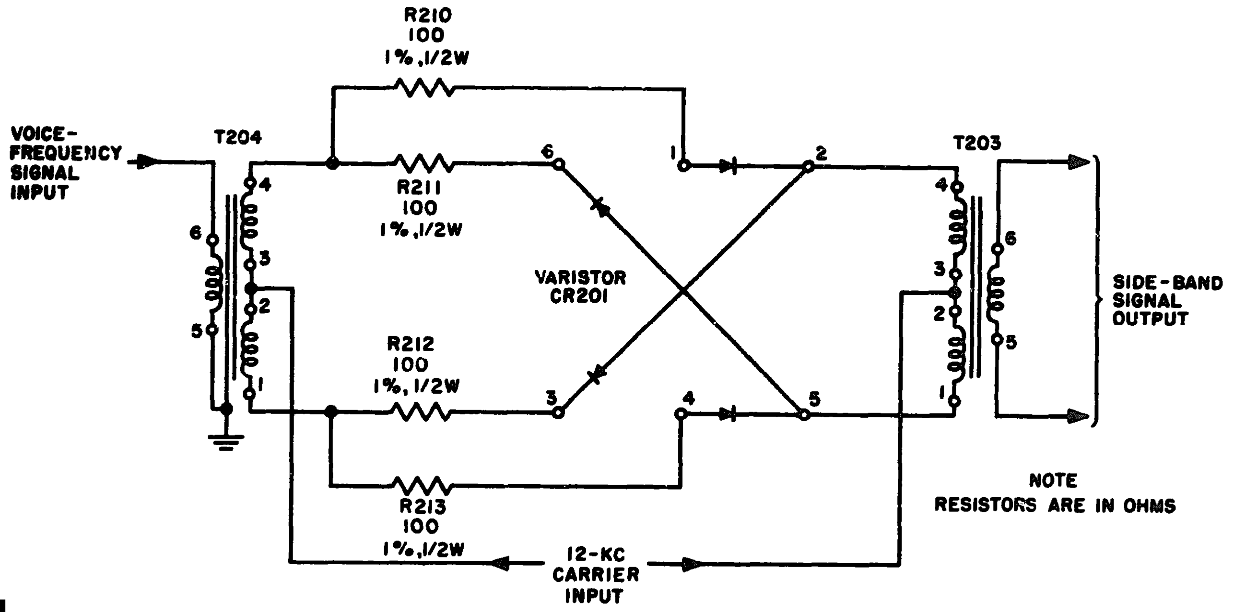


Figure 37. *Modulator,* simplified schematic *diagram.*

R210, and winding 4-3 of transformer T204. Electron flow also takes place through winding 2-1 of transformer T203, terminals 5 and 4 of varistor CR201, resistor R213, and winding 1-2 of transformer T204. The current that flows in winding 3-4 of transformer T203 is equal to the current that flows in winding 2-1 of transformer T203. However, since these two currents flow in opposite directions, the voltage developed in winding 2-1 of the transformer is 180° out of phase with the voltage developed in winding 3-4 of the transformer. Since the currents are of equal magnitude in each transformer half, the voltages developed cancel out. Consequently, no voltage is induced in winding 5-6 of transformer T203. Similarly, no voltage is induced in winding 5-6 of transformer T204.

b. Negative Half-Cycles of 12-KC Carrier.

(1) It is assumed that the negative half-cycles of the 12-kc carrier make terminals 2 and 3 of transformer T204 negative and terminals 2 and 3 of transformer T203 positive (fig. 39). For this polarity of the carrier, the resistance of the two branches of varistor CR201 between terminals 2 and 3 and terminals 5 and 6 is very low and may be considered a short-circuit. Con-

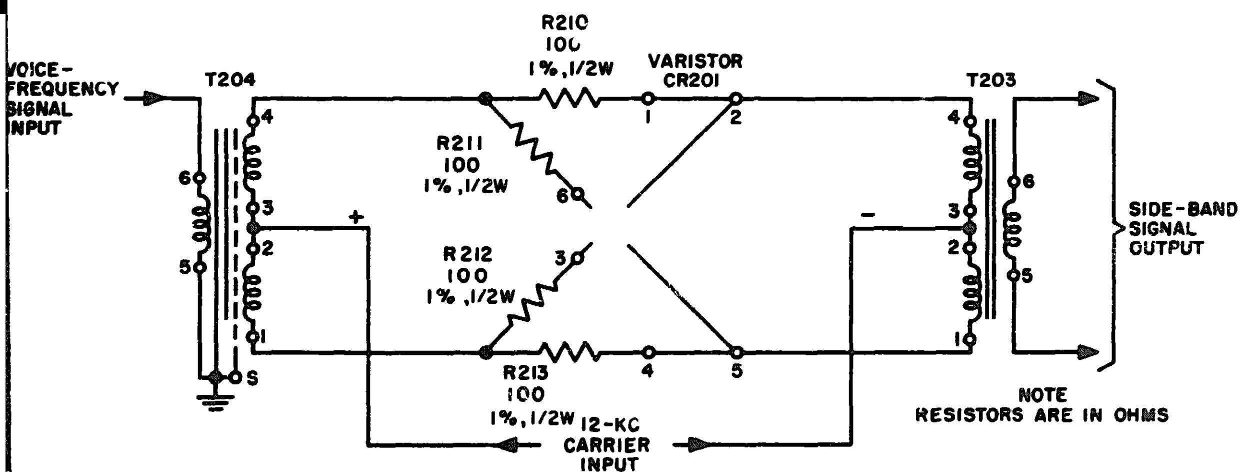


Figure *38. Equivalent* circuit *of modulator,* positive *half-cycle* or *carrier.*

versely, for the polarity of the 12-kc carrier discussed, the resistance of the two branches of varistor CR201 between terminals 1 and 2 and terminals 4 and 5 is very high, and may be considered equivalent to an open circuit.

(2) The negative half-cycles of the carrier cause electron flow through winding 3–4 of transformer T204, resistor R211, terminals 6 and 5 of varistor CR201 and winding 1–2 of transformer T203. Electron flow also takes place through winding 2–1 of transformer T204, resistor R212, terminals 3 and 2 of varistor CR201 and winding 4–3 of transformer T203. As explained previously, for the positive half-cycles of the 12-kc carrier the voltages developed in windings 1–2 and 3–4 of T203 are 180° out of phase. Therefore, no voltage is induced in winding 5–6 of transformer T203 (*a* above).

c. Suppression of Carrier. When the 12-kc carrier does not produce an output from transformer T203, the carrier is suppressed. The actual amount of suppression depends upon the balance between the elements of varistor CR201, resistors R210 through R213, and the transformer windings. Any carrier voltage which appears at terminals 5 and 6 of transformer T203 because of unbalance between the above elements in the circuit is referred to as carrier leak.

111. CHANNEL MODEM Modulator Circuit With Modulating Signals Present, Detailed Analysis

a. For the purpose of explanation in *b* through *d* below, sinusoidal modulating voltage is applied to winding 6–5 of transformer T204, inducing a sinusoidal modulating voltage in the secondary winding (1–4) of the transformer (fig. 40). When the first positive half-cycle of the carrier is applied to the center-tap of transformer T204, the positive half-cycle of the modulating voltage is also applied (fig. 40). The positive half-cycle of the modulating voltage makes terminal 1 and terminal 4 of transformer T204 negative and positive respectively.

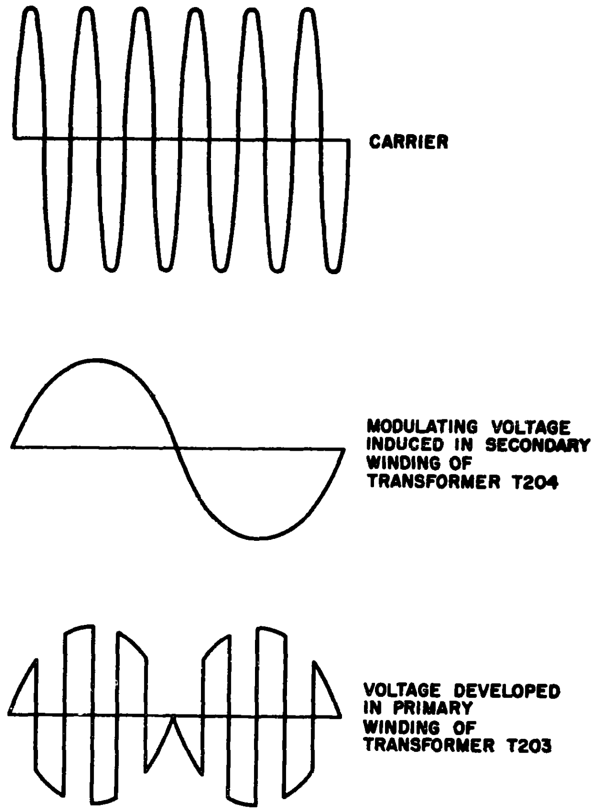


Figure 40. Wave shapes of modulation process

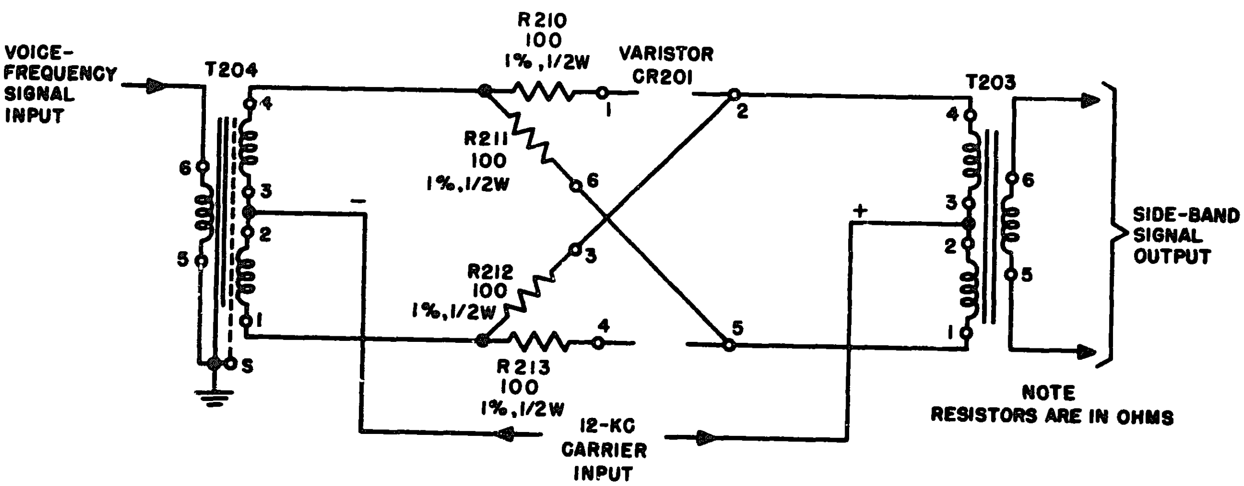


Figure 39. Equivalent circuit of modulator, negative half-cycle of carrier.

b. As may be seen from the equivalent circuit shown in figure 38 (para 110a), during the first positive half-cycle of the 12-kc carrier the positive modulating voltage appearing at terminal 4 of transformers T203 and terminal 4 of T204, and terminals 1-2 of varistor CR201 are negative and positive, respectively. Similarly, the negative modulating voltage appearing at terminal 1 of transformer T204 is applied through resistor R213 and terminals 4-5 of varistor CR-201 to terminal 1 of transformer T203. Similarly, the negative transformer T203 increases from zero sinusoidally until the start of the first negative half cycle of the carrier voltage.

c. At the start of the negative half-cycle of the carrier, the equivalent circuit for the modulator changes almost instantaneously from the equivalent circuit shown in figure 38 to that shown in figure 39 (para 110b). This change reverses the instantaneous modulating voltage applied to winding 1-4 of transformer T203. As may be seen from figure 39, the positive voltage appearing at terminal 4 of transformer T204 is now applied through istor R211 and branch 6 5 of varistor CR201 inal 1 of transformer T203. The negative voltage at terminal 1 of transformer T204 is now applied through resistor R212 and branch 3-2 of varistor CR201 to terminal 4 of transformer T203. The voltage applied to transformer T203 increases sinusoidally in the negative direction. When the second positive half-cycle of carrier voltage begins, the voltage applied to transformer T203 is again reversed.

d. From the discussion in *a* through c above, it may be seen that the action of varistor CR201 can be compared to that of a switch which reversed the polarity of the modulating voltage applied to terminals 1 and 4 of transformer T203 at the beginning of each half-cycle of the carrier. If the analysis given in *a* through c above is carried out for all the cycles of the carrier that occur during one full cycle of the modulating voltage, it can be shown that the wave shape of the resulting voltage developed in primary winding 1-4 of transformer T203 is as shown in figure 40. It can be demonstrated mathematically that this wave shape contains upper side-band signals (carrier frequency plus voice frequency) and lower side-band signals (carrier frequency minus voice frequency). It can be further demonstrated that both the carrier frequency and the voice frequency are not contained in the modulator output.

112. Modulator Circuit, Stability Characteristics

Resistors R210 through R213 in the arms of the varistor bridge CR201 assure nearly uniform performance of the modulator circuit in spite of variations in the characteristics of copper oxide of varistor CR201, as compared to other modulator circuits. This applies particularly to balancing out of the carrier so that it does not appear as carrier leak in the modulator output from transformer T203. The modulator also performs amplitude-limiting of the modulated output in transformer T203. This limiting function is controlled primarily by the value of the carrier voltage supplied to it. The level of the carrier voltage is controlled by a carrier temperature compensating pad. This pad reduces variations in the level of the carrier over the wide ambient temperature range to which the AN/TCC-3 can be subjected (para 115).

113. Modulator Output Circuit, Detailed Analysis

The modulator output circuit in channel modem consists of a resistor and thermistor pad and a bandpass filter (fig. 147). The side-band signals from the modulator circuit are fed through the resistor and thermistor pad, which consists of resistors R214, R215, R216, R242, R243, R244, and R245 and thermistors RT203 and RT204 to bandpass filter FL202. The pad compensates for variations in transmission loss in the modulator due to temperature changes. In addition, the pad provides the modulator with a resistive termination for all significant output frequencies. The attenuation of the pad is adjustable by strapping resistors R216 and R243. This strapping is performed in the factory and at higher maintenance categories. The output of the adjustable pad is applied to transmitting filter FL202 (para 114)) which passes the lower side-band frequencies and suppresses all others. Some discrimination is also provided in this filter to the carrier frequency (12 kc), thereby adding to the suppression obtained by the balance of the modulator. Proper operation of filter FL202 depends upon the shunting effects of the similar filters of the three other channels. The output of filter FL202 combines with the outputs of filters FL102 FL304, and FL402 in the modems for channels 1, 3 and 4 respectively of the TA-219/U (para 116). The combining circuit appears in figure 145.

114. Bandpass Filter FL202, Description and Functioning

A schematic representation of filter FL202 of channel 2 modem is shown in figure 41. The filter consists of LCR elements connected to form a circuit with very sharp frequency selectivity. Filter FL202 selects signals with a frequency spectrum between 8,500 and 11,700 cps. Filters FL102, FL302, and FL402 of channel 1, 3 and 4 modems respectively are identical in circuit configuration with filter FL202. The values of the circuit elements of filters FL102, FL302, and FL402 differ from those of filter FL202. Filters FL102, FL302, and FL402 select signals within frequency spectrums between (4,500 to 7,700 cps), (12,500 and 15,100 cps), and (16,500 and 19,700 cps), respectively.

115. Carrier Temperature Compensating Pad of Channel 2 Modem

The 12-kc carrier for the channel 2 modem is supplied through terminals 0 and 3 of plug P201 (figs. 145 and 147). The carrier is fed to the demodulator and modulator circuits of the channel 2 modem through a resistor and thermistor pad comprised of resistors R226 and R229 and thermistors RT201 and RT202. This pad compensates for resistance changes of varistors CR-201 and CR202 due to variations of temperature. Increases of temperature will decrease the resistance of the varistors and produce a decrease of carrier voltage across the branches of the varistors. This is not desirable, because the proper limiting action of the modulator (para 112) depends upon the carrier voltage across the varistor branches remaining fairly constant. However, the resistance of thermistors RT201 and RT202 also decreases with increases in temperature. This allows more carrier current to flow to varistor CR201 in the modulator. The increased current flowing to the modulator increases the voltage drop in the branches of varistor CR201 and tends to maintain the voltage across the varistor constant. The temperature compensation of the carrier is less important for the operation of the demodulator circuit than for the operation of the modulator circuit since the demodulator does not perform a limiting function (para 156).

116. Output Combining Circuit

The outputs of the band-pass filters in the transmitting circuit of each of the channels is applied to terminals 16 and 19 of plugs P101, P201, P301, and P401 (figs. 146 through 149). Jacks J1, 52, 53, and 54, which mate with these plugs, are connected in parallel. This applies the output of the four transmitting paths in the TA-219/U to terminals A and K of jack 55 (fig. 145). Jack 55 mates with plug P898 in the AM-682/TCC-3 (fig. 150).

117. Differences Between Channel Modems of the TA-219/U

The circuits of the channel modems are very similar; only the values of some of the circuit elements differ. However, the functioning of all the channel modems is identical. Channel 2 modem and channel 3 modem are electrically identical except for the carrier frequencies used and the characteristics of the band filters Channel 1 modem and channel 4 modem differ from each other and also differ from channel 2 modem and channel 3 modem. The differences existing between the circuits of channel 1 and 4 modems

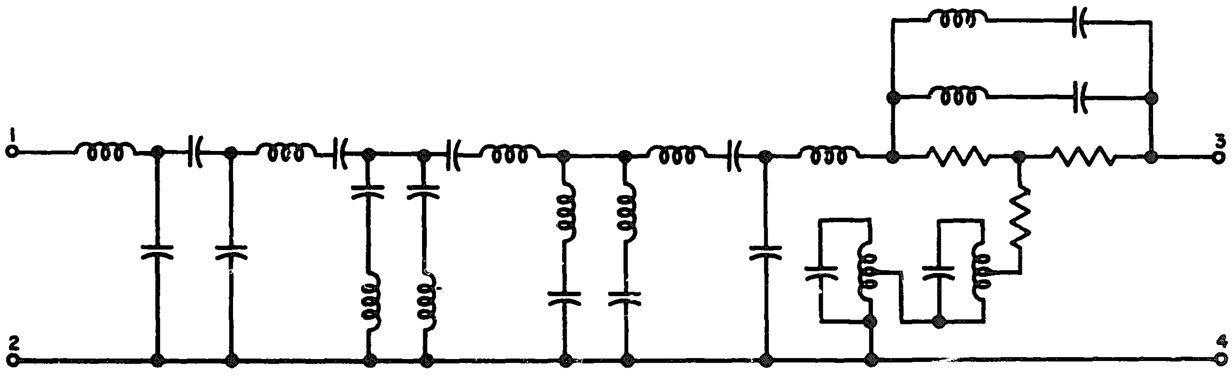


Figure 41. Filter FL202, simplified schematic representation.

and channel 2 and 3 modems are discussed in paragraphs 118 and 119, respectively.

118. Channel 1 Modem

As may be seen by comparing figures 147 and 148 with figure 146, the channel 1 modem differs slightly in the values of some of the circuit elements in the channel 2 and 3 modems. Band-pass filter FL102 in the transmitting circuit (para 113) and band-pass filter FL103 in the receiving circuit (para 152) are designed to operate in a 1,275-ohm impedance circuit at their terminals 3 and 4 in place of a 600-ohm impedance circuit used for the remaining channels. The associated temperature compensating pads in both the transmitting and receiving direction (para 113 and 153, respectively) are designed for 1,275-ohm impedances and the number of thermistors is doubled (RT103 through RT110). The associated modulator output impedance and demodulator input impedance are also altered by the turns ratio of transformers T103 and T106.

119. Channel 4 Modem

As may be seen by comparing figures 147 and 148 with figure 149, the channel 4 modem differs slightly in circuit components from the channel 2 and 3 modems. Band-pass filter FL402 in the transmitting circuit (para 114) and band-pass filter FL403 in the receiving circuit (para 155) have approximately 1 db more loss in the passed band than the corresponding Alters in the other channels. The greater loss produced by filter FL402 is compensated for by the reduction of the loss in the associated adjustable pad of the modulator output circuit (para 113). Consequently the values of the resistors in the adjustable pad are different from those in the corresponding adjustable pads of the other channel modems. The greater loss produced by filter FL403 is compensated for by the adjustment of the gain control pad (para 157).

120. Transmitting Circuit of AM-682/TCC-3, Block Diagram Analysis

a. Block Diagram.

(1) The transmittting circuit of the AM-682/TCC-3 is shown in block diagram form in figure 42.

(2) The transmitting circuit consists of CHANNELS-SPECIAL SERVICE switch S801, the attenuating network, the transmitting amplifier, the cable matching network, and protectors.

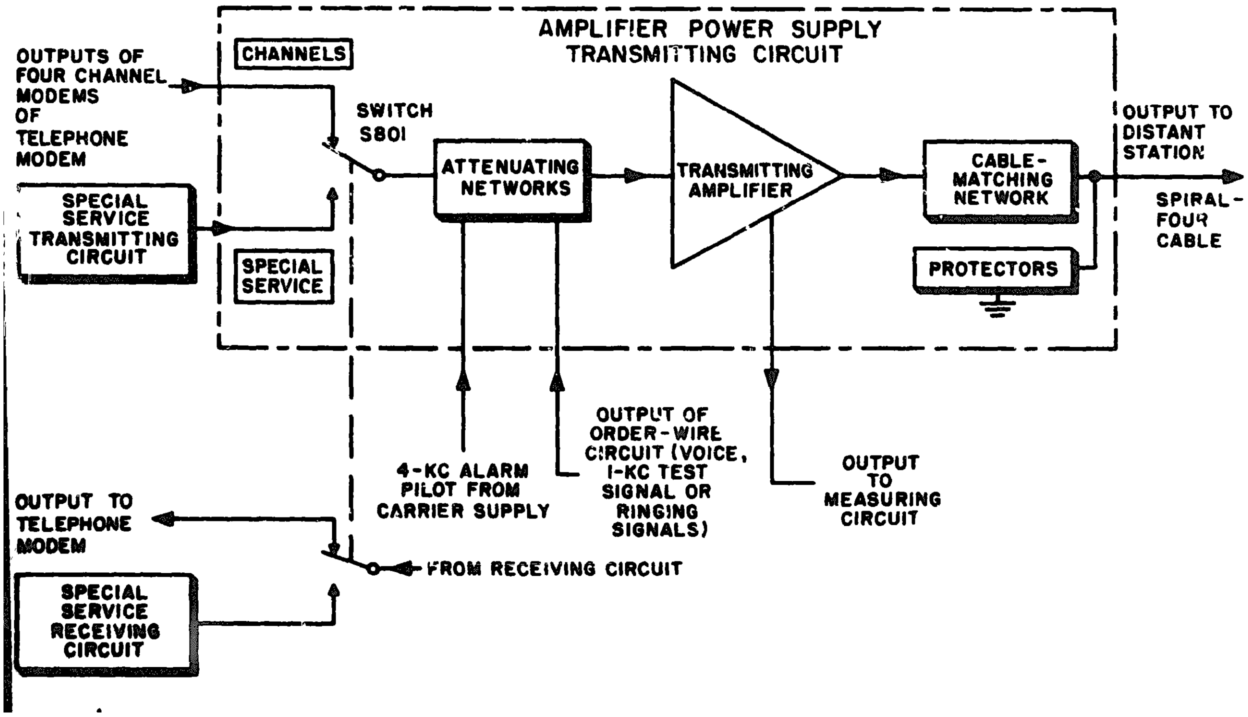


Figure **42. Amplilfer-power** supply transmitting circuit, ***block diagram.***

(3) An analysis of the transmitting circuit of the AM-682/TCC-3 based on the block diagram is given in b and c below.

b. CHANNELS-SPECIAL SERVICE Switch. The CHANNELS-SPECIAL SERVICE switch S801 is also part of the receiving circuit of the AM-682/TCC-3 (para 130b). When the switch is in the CHANNELS position, the lower side-band signals from the four channel modems of the TA-219/U are applied to the transmitting circuit of the AM-682/TCC-3. When the switch is operated to the SPECIAL SERVICE position, the transmitting circuit of the AM-682/TCC-3 is disconnected from the TA-219/U and is connected to the special service transmitting circuit (para 163). In the SPECIAL SERVICE position of the switch, the receiving circuit of the AM-682/TCC3 (para 130) is disconnected from the TA-219/U and is connected to the receiving path of the special service circuit (para 163).

c. Transmitting Circuit.

(1) The attenuating network of the transmitting circuit receives three different inputs. One input to the attenuating network consists of either the lower sideband signals from the TA-219/U, or the signals from the special service equipment (para 163)) as determined by the position of the CHANNELS-SPECIAL SERVICE switch *(b* above). The 4-kc system alarm pilot from the carrier supply (pars 167b) and the output of the order wire circuit (para 201a (2)) are also applied to the attenuating circuit. The output of the attenuating network is applied to the transmitting amplifier.

(2) The transmitting amplifier amplifies the signals received from the attenuating network, One of the outputs from the amplifier is passed through the cable matching network and is transmitted over the transmission medium to the distant stations. A second output from the amplifier is applied to the measuring circuit (para 206).

121. Transmitting Circuit of AM-682/ TCC-3, Detailed Analysis

The detailed analysis of the various parts of the transmitting circuit of the AM–682/TCC–3 is given in paragraphs 122 through 128. This analysis is given with the aid of the connection diagram of the AM–682/TCC–3 and the schematic diagram of the transmitting and receiving amplifier. These diagrams are shown in figures 150 and 152, respectively.

122. Attenuating Network

a, Attenuation for Inputs From TA-219/U and Special Service Circuits.

(1) Lower sideband signals from the TA-219/U are fed from terminals A and K of jack J5 (fig. 145) to plug P898 (fig. 150). When CHANNELS-SPECIAL SERVICE switch S801 is in the CHANNELS position, the signals from the TA-219/U which appear at terminals A and K of plug P898 pass through the contacts of the switch and are applied to an attenuating network consisting of resistors R811, R812, and R813. The output of this attenuating network is fed past the bridging networks (R816, R818, R817, R814, R815) to the transmitting amplifier.

(2) When the CHANNELS-SPECIAL SERVICE switch is in SPECIAL SERVICE position, the connection of the AM-682/TCC-3 to TA-219/U through Jack J5 and plug P898 is opened. The signals from the equipment connected to the SPECIAL SERVICE TR binding posts (E801 and E802) of the special service circuit are then applied through the closed contacts of the switch to the attenuating network (para 163 and fig. 150). The signals from the special service equipment pass through the attenuating network and are applied to the transmitting amplifier.

b. Attenuation for Other Inputs. The 4-kc system alarm pilot signal from the carrier supply is applied to the attenuating network between stand-off E816 and ground. The input from the order wire circuit is applied between the network at stand-off E814 and ground (para *201a).* The connections of inputs at these different points produce a different attenuation for each of the two input signals (a above). Note that attenuation for signals from either the TA-219/U or the transmitting path of the special service circuit (para 163) differs from the attenuation for the 4-kc signal and the order-wire signal.

123. Transmitting Amplifier

The transmitting amplifier consists of tubes V51 and V52 and the associated circuit components in a two&age, Wide-band amplifier. The amplifier gain can be changed from a normal 45 db to 55 db. A detailed analysis of the transmitter amplifier is given in paragraphs 124 through 127. A simplified schematic diagram of the transmitting amplifier is shown in figure 43.

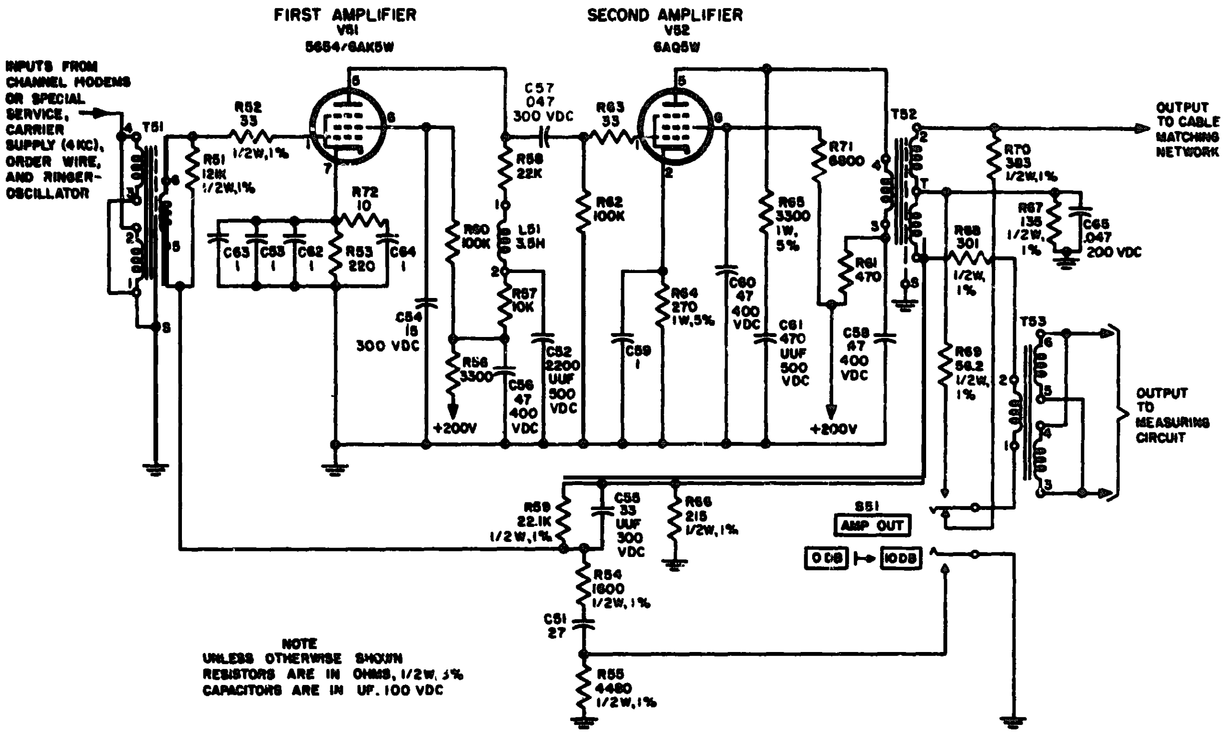


Figure 43. Transmitting amplifier, simplified schematic diagram.

124. First Amplifier Stage

a. The input signals from the attenuating network are stepped up by transformer T51 (fig. 43) and applied to the control grid of tube V51 through parasitic-suppressor resistor R52. As shown in figure 43, windings 1-2 and 3-4 of transformer T51 are connected in parallel. (The strap which places these windings in parallel is located in J801, fig. 150.) Windings 1-2 and 3-4 present an input impedance of 600 ohms to match the output impedance of the modulator band-pass filters (FL102, FL202, FL302, and FL402) of the TA-219/U. The input signal is developed across resistor R51, and is applied to the grid (pin 1) of tube V51 through parasitic-suppressor resistor R52. The amplified signals from tube V51 are developed across a plate load network consisting of resistors R57 and R58 and inductor L51. Inductor L51 provides a peaked gain centered in the 300-cps to 20-kc band.

b. Register R57 is used with capacitor C52 to form a low-frequency compensating network. The plate and screen voltages for tube V51 are supplied from the power supply through terminal 12 of plug PSI (fig. 150) and through drop-&g resistor R56. Capacitor C56 is the plate by-pass capacitor. The screen-grid voltage is tapped off at E54 (fig. 152) and is applied through dropping resistor R60. Capacitor C54 is the screen-grid by-pass capacitor. The cathode-bias circuit of tube V51 consists of resistors R53 and R72, and bypass capacitors C53, C62, C63, and C64. Resistor R72 lowers the Q of the resonant circuit that is formed by the capacitors in the cathode of tube V51 and the inductance of the leads. The low Q prevents high-frequency oscillations. The lead from the cathode of tube V51 to terminal 11 of plug P51 (fig. 152) is used for test purposes. The 6.3 volts ac for the tube heaters is supplied at terminals 6 and 9 of plug P51.

125. Second Amplifier Stage

a. The signals at the plate of tube V51 are coupled through capacitor C57 to grid resistor R62. The signals developed acrosss grid resistor R62 are fed to the control grid of tube V52 through parasitic-suppressor resistor R63. Resistor R62 returns the control grid (pin 1) of tube V52 to ground. The amplified output at the plate of tube V52 is developed in primary winding 3-4 of transformer T52. Winding T-2 of transformer T52 couples a part of the amplified signals from the plate of tube V52 to the main transmission path through terminals 5 and 8 of plug P51, which, in turn, is connected to the cable matching network of the transmitting circuit (para 128a).

b. The high-frequency gain of tube V52 is limited by resistor R65 in series with capacitor C61. This limiting action occurs because the impedance of capacitor C61 is lower to high frequencies than to low frequencies. The lower impedance to high frequencies permits increased current flow through R65 and C61 to ground, causing less current to flow in transformer T52. Reducing the high frequency current in transformer T52 reduces the high-frequency voltage produced in the transformer

c. The plate voltage is supplied to the plate of tube V52 through R61 and winding 3-4 of transformer T52. Resistors R61 and R71 are dropping resistors for the plate and screen-grid voltages respectively of tube V52. Capacitor C58 is a plate bypass capacitor and capacitor C60 is a screen-grid bypass capacitor. Resistor R64 and capacitor C59 comprise the cathode-bias circuit of tube V52. The lead from the cathode (pin 2) of tube V52 to terminal 2 of plug P51 is used for test purposes (not shown in figure 43, see figure 152). Resistor R67 and capacitor C65 form part of th impedance matching network connected at terminals 5 and 8 of plug P51 (para 128).

126. Negative Feedback Network

a. Part of the signal developed in winding T-l of transformer T52 appears across resistor R66 in parallel with the series-parallel network consisting of resistors R54, R55, and R59, and capacitors C51 and C55. When AMP OUT switch S51 is in the 0 DB position, the voltage developed across series-connected resistor R54, capacitor C51, and resistor R55 provides a negative feed-back signal that is applied to the control grid of tube V51. Capacitor C55 shunts resistor R59 of the divider network in parallel with R66. Capacitor C55 provides a safeguard against singing at high frequencies by providing increased negative feedback at these frequencies. Capacitor C51 serves to reduce the amplifier gain at low frequencies to compensate for the loss versus frequency characteristics of the spiral-four cable. The leads connecting from the transmitting amplifier to terminals 15 and 17 of plug P51 (fig. 152) are left unconnected at jack J801. This permits the use of identical interchangeable transmitting and receiving amplifiers.

b. When AMP OUT switch S51 is in the 10 DB position, resistor R55 is shorted to ground, thereby decreasing the feedback signal by IO db. This, in turn, increases the amplifier gain by 10 db. The 10-db gain change is relative to the gain existing when AMP OUT switch S51 is in the 0 DB position. The amplifier provides a 45-db gain when the AMP OUT switch is in the 0 DB position. The negative feedback in the amplifier circuit, in addition to providing a convenient means of changing the gain of the amplifier, also reduces distortion of the amplifier output.

127. Output to Measuring Circuit

a. With AMP OUT switch S51 in the 0 DB position, winding 1-2 of transformer T53 is bridged across terminals 1 and 2 of transformer T52 through resistors R68 and R70. Paralleled windings 3-4 and 5-6 of transformer T53 couple a portion of the amplifier output to the measuring circuit of the AM-682/TCC-3 (para 212e).

b. With AMP OUT switch S51 in the *10* DB position, winding 1-2 of transformer T53 is bridged across teminals T and 1 of transformer T52 through resistors R68 and R69. The amplifier output is increased 10 DB in this case; however, the output to the measuring circuit is kept the same as when the AMP OUT switch is in the 0 DB position due to the reconnection of transformer T52 and use of resistors R68 and R69.

128. Cable Matching Network and Protectors

a. The cable matching network (fig. 150) consists of resistors R761 and R762, capacitor C761, inductor L761, and transformer T761. This network which is connected to terminals 5 and 8 of plug P51 through jack J801 and terminal board TB801 provides the proper impedance required to match the spiral-four cable to the amplifier. The output of the cable matching network is fed to spiral-four cable connector J701.

b. Protectors E763 and E764 protect the AN/TCC-3 from damage caused by high voltages (exceeding 500 volts peak) due to lightning, power lines, or other sources. The protectors also prevent injury to personnel by the high voltages. These voltages are shorted to ground by the protectors.

129. Four Channel Carrier Receiving Path

The four channel carrier receiving path consists of the receiving circuit in the AM-682/TCC-3 and the receiving path in the TA-219/U. A general description of the functioning of these circuits is given in paragraph 92c. A detailed analysis of the receiving circuit in the AM-682/TCC-3 is given in paragraphs 130 through 148. A detailed analysis of the receiving path in the TA-219/U is given in paragraphs 149 through 160.

130. Receiving Circuit of the AM-682/ TCC-3, Block Diagram Analysis

a. Block Diagram.

(1) The receiving circuit of the AM-682/ TCC-3 is shown in block diagram form in figure 44.

(2) The receiving circuit consists of the protectors, the coupling network, the equalizers, the receiving amplifier, the attenuator pad, and CHANNELS-SPECIAL SERVICE switch S801.

(3) An analysis of the receiving circuit of the AM-682/TCC-3 based OR the block daigram is given in b and c below.

b. Receiving Circuit. Lower side-band signals received from the distant AN/TCC-3 are fed through the cable coupling network to the equalizer circuit. In this circuit, the signals are equalized and applied to the receiving amplifier. The amplifier outputs is connected to an attenuator pad and to the system alarm circuit (para 277a). A second output of the amplifier is supplied to the measuring circuit, the order wire circuit, and the ringer-oscillator.

c. CHANNELS-SPECIAL SERVICE Switch. The CHANNELS-SPECIAL SERVICE switch, which is also part of the transmitting circuit of the AM-682/TCC-3 (para 120b), can be operated so that the output of the attenuator pad is fed either to the TA-219/U or to the SPECIAL SERVICE REC binding posts.

131. Receiving Circuit in the AM-682- TCC-3, Detailed Analysis

The detailed analysis of the various parts of the receiving circuit of the AM-682/TCC-3 is given in paragraphs 130 through 148. This analysis is given with the aid of the connection diagram of the AM-682/TCC-3 (figs. 150 and 151) and the schematic diagram of the transmitting and receiving amplifier (fig. 152).

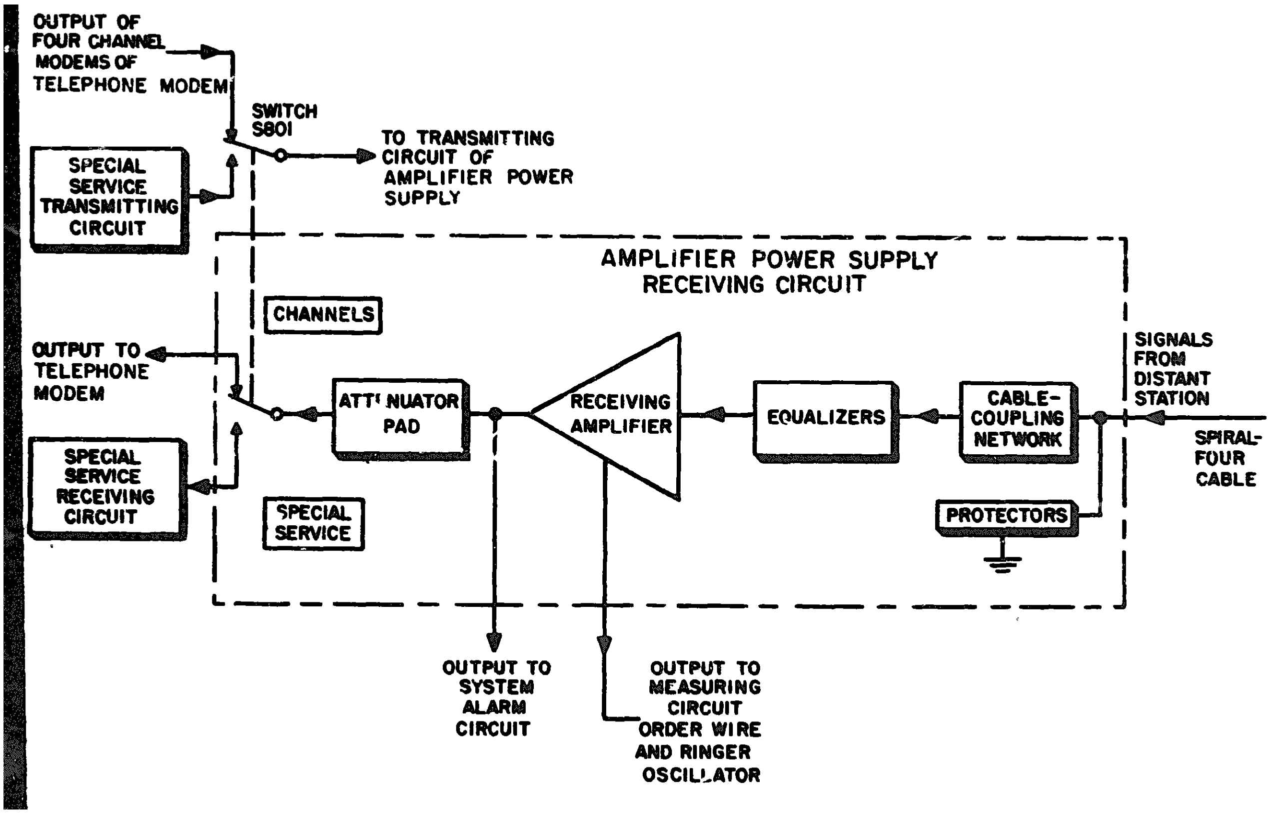


Figure 44. Amplifier-power supply receiving circuit, block diagram.

132. Protectors and Coupling Network

The incoming signals pass through spiral-four cable jack J701 (figs 150 and 151) and the coupling network composed of transformer T821 and capacitors C821 and C822 to the equalizer circuit. Protectors E737 and E738 serve to short to ground high voltages (exceeding 500 volts peak) due to lightning or other causes.

133. General Functioning of Equalizers

The output of the coupling network is applied to the equalizers. A general discussion of the functioning of equalizers EQ821 and EQ822 and their associated potentiometers and resistors (figs. 150 and 151) is given in *a* through d below.

a. The elements of the equalizers form three networks, which are called the flat equalizer, the slope equalizer, and the bulge equalizer. The attenuation of each of these three equalizers is variable. The sum of the adjustable attenuation of the equalizers and the fixed attenuation of the transmission medium represents the total attenuation to which signals are subjected between the transmitting side of one AN/TCC-3 (or intervening repeater or radio link) and the receiving amplifier of another AN/TCC-3 (or intervening repeater or radio link). The equalizer circuit is adjusted so that, for a particular' length of the transmission medium, the total attenuation will be equal to 45 db and will remain approximately constant for all frequencies transmitted by the distant AN/TCC-3. The total attenuation of 45 db between the transmitting side of the distant AN/TCC-3 and the input side of the receiving amplifier obtained by the system lineup is necessary in order to obtain the proper transmission level at the input side of the receiving amplifier. In addition, this constant attenuator of 45 db for all frequencies transmitted by the AN/TCC-3 prevents distortion that would result from unequal attenuation of the frequency components of the received signals. The gain of the receiving amplifier is 55 db. This gain compensates for the total attenuation of 45 db to which the transmitted signals are subjected between the output of the distant AN/TCC-3 and the input of the receiving amplifier of the local AN/TCC-3. A net gain of 10 db results at the output side of the receiving amplifier in the local AN/TCC-3. The circuits of the local AM-682/TCC-3, through which the output of the receiving amplifier passes, produces an additional attenuation of 10 db. Thus, the transmission level at the output side of the distant AN/TCC-3 and the output side of the local AM-682/TCC-3 is maintained at 0 db.

'*b.* A detailed analysis of the functioning of the equalizers in the system line-up will be made for the case in which a spiral four cable, 25 miles in length, is used, and the operating temperature is 50° F. This analysis is given in paragraphs 140 through 146. The analysis is made using the graphs of attenuation versus frequency for the spiral-four cable (para 30), the' flat equalizer (para 137), slope equalizer (para 138) and bulge equalizer (para 139).

c. In addition to permitting adjustment of broadband attenuation as part of the system lineup, the equalizer provides means for compensation of changes in attenuation of the spiral-four cable that are produced by temperature variations. Compensation is produced by occasional manual readjustments of the equalizer. A detailed analysis of the equalizer circuit in performing this function is given in paragraph 146.

134. Flat-Bulge Equalizer EQ821 and Associated FLAT-1KC and BULGE-11KC CONTROLS

A schematic representation of equalizer EQ82l is shown in figure 45. Equalizer EQ821 contains elements of the flat equalizer and the bulge equalizer (figs -1.50 and 151). These equalizers are networks that have variable attenuation-versus-frequency characteristics. The attenuation characteristics of the networks are varied by adjusting BULGE-11KC potentiometer R821 and

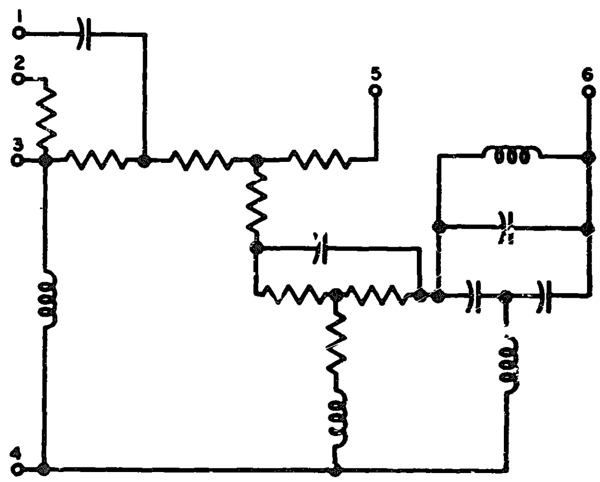


Figure 45. Fat-Bulge equalizer, simplified schematic diagram

FLAT-1KC potentiometer R822 (fig. 150). Typical curves of attenuation versus frequency for the flat equalizer and the Bulge equalizer, at various settings of their controls, are shown in figures 48 and 50.

135. Slope/Equalizer EQ822 and SLOPE-19KC control

A schematic representation of slope equalizer EQ822 is shown in figure 46. This equalizer has a variable attenuation-versus-frequency characteristic. The attenuation characteristic is varied by adjusting SLOPE-19KC potentiometer R823 (fig. 150). Typical curves of attenuation versus frequency for the slope equalizer at various settings of the corisponding equalizer control are shown in figure 50. All equalizers are contained in sealed cans. Therefore, no maintenance can be performed on the equalizers and no parts of the equalizers can be replaced. If an equalizer is defective, it must be replaced.

136. Characteristics of Spiral-Four Cable

Figure 47 shows theoretical curves of attenuation versus frequency for a spiral-four cable, 25 miles in length, at five values of temperature between -67°F. and +167°F. As may be seen from this figure, the shapes of all five curves are very similar. These curves show that the attenuation is greater at higher temperatures than at lower temperatures. In addition, it may be seen that, for any temperature, the attenuation of the

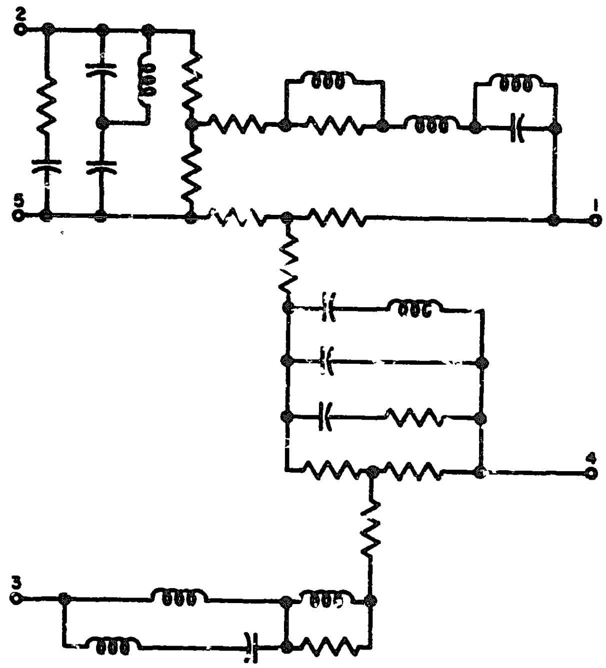


Figure 46. Slope equalizer, simplified schematic diagram.

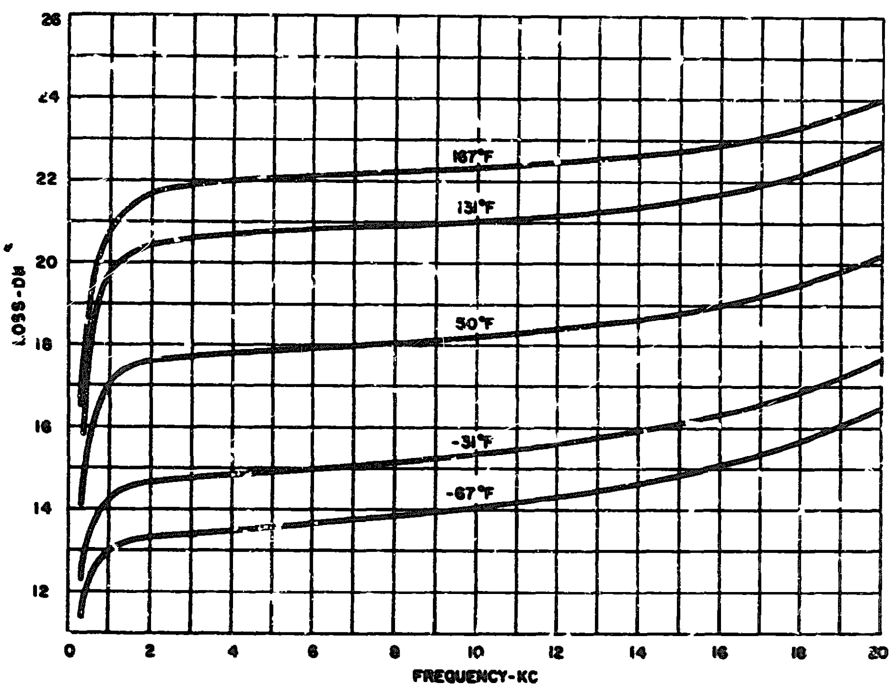


Figure 47. Graph of attenuation versus frequency of spiral-four cable

spiral-four cable increases abruptly for frequencies approximately between 300 and 1,200 cps. For values of frequency greater than approximately 1,200 cps, the attenuation increases gradually with rise in frequency to the maximum attenuation at 20,000 cps.

137. Characteristics of Flat Equalizer

Figure 48 shows typical curves of attenuation versus frequency for the flat equalizer at various settings of the FLAT-1KC equalizer control. As may be seen from this figure, the attenuation of the flat equalizer, for all settings of the FLAT-1KC equalizer control, is approximately constant for frequencies between 1,500 and 20,000 cps. For control settings of 0 to 6, the attenuation is very nearly constant between frequencies of 300 to 20,000 cps. For each control setting between approximately 8 and 20, the attenuation increases abruptly between approximately 1,500 cps and 300 cps.

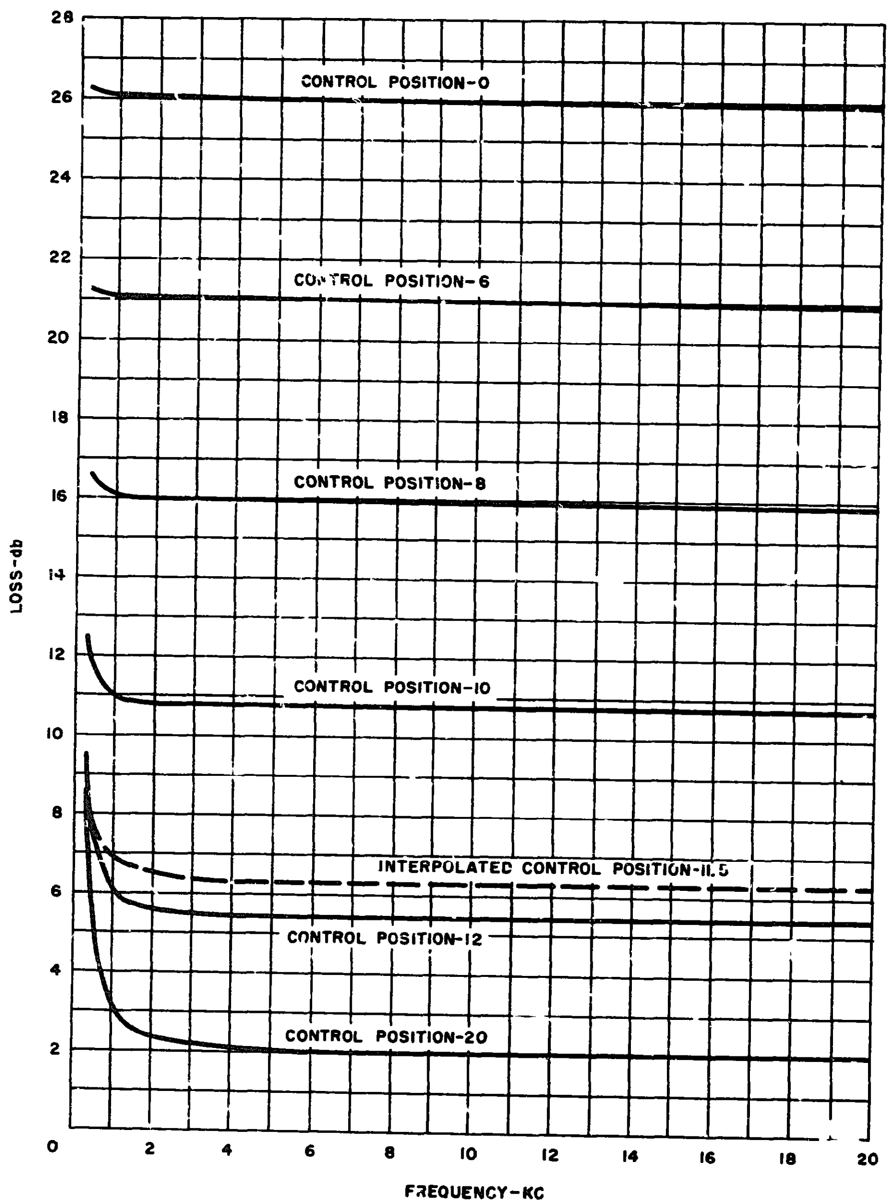


Figure 48. Graph of attenuati versus frequency of flat equalizer.

138. Characteristics of Slope Equalizer

Figure 49 shows typical curves of attenuation versus frequency for the slope equalizer at **various** settings of the SLOPE-19KC equalizer control. As may be seen from this figure, the attenuation of the slope equalizer is nearly constant for all frequencies between 0 cps and 20,000 cps when the corresponding equalizer control is set at 6. At settings between 6 and 20 of the equalizer control, the attenuation of the equalizer decreases with increasing values of frequency.

139. Characteristics of Bulge Equalizer

Figure 50 shows typical curves of attenuation versus frequency for the bulge equalizer at various settings of the BULGE-11KC equalizer control. As may be seen from figure 50, the **attenuation** of the bulge equalizer is nearly constant at all frequencies between 0 cps and 20,000 cps when the corresponding equalizer control is set at 9. At settings of the equalizer control lower than 9, the graphs of attenuation versus frequency for the bulge equalizer bulge upwards. Specifically, the attenuation of the equalizer increases for frequencies between approximately 2,500 cps and 13,500 cps. At frequencies greater than 13,500 cps, the attenuation decreases gradually and then fairly abruptly. At 20,000 cps, the attenuation is slightly smaller than at 0 cps. For settings of the equalizer control larger than 9, the curves of attenuation versus frequency for the bulge equalizer bulge downward. Specifically, the attenuation decreases with frequencies between approximately 2,500 cps and 13,500 cps and increases with frequencies above 13,500 cps. The attenuation of the bulge equalizer is approximately the same between 0 cps and about 2,500 cps for all the settings of the corresponding equalizer control. Similarly, the attenuation of the equalizer at 19,000 cps is approximately the same for all settings of the corresponding equalizer control.

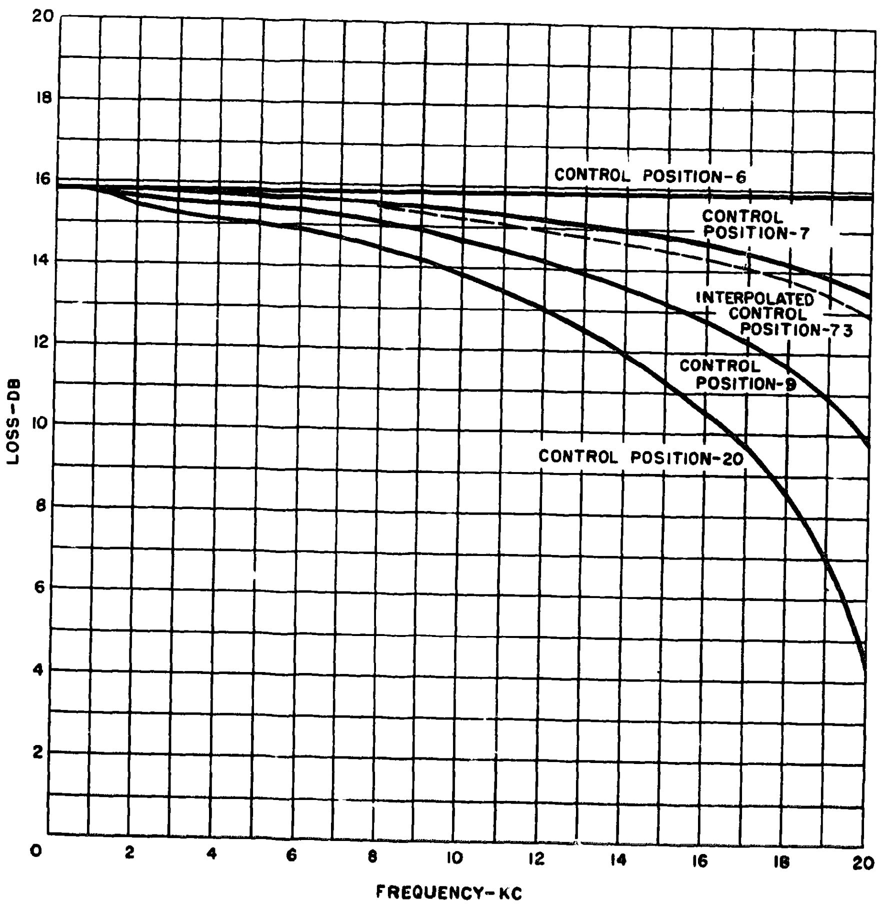


Figure 49. Graph of attenuation versus frequency of slope equalizer.

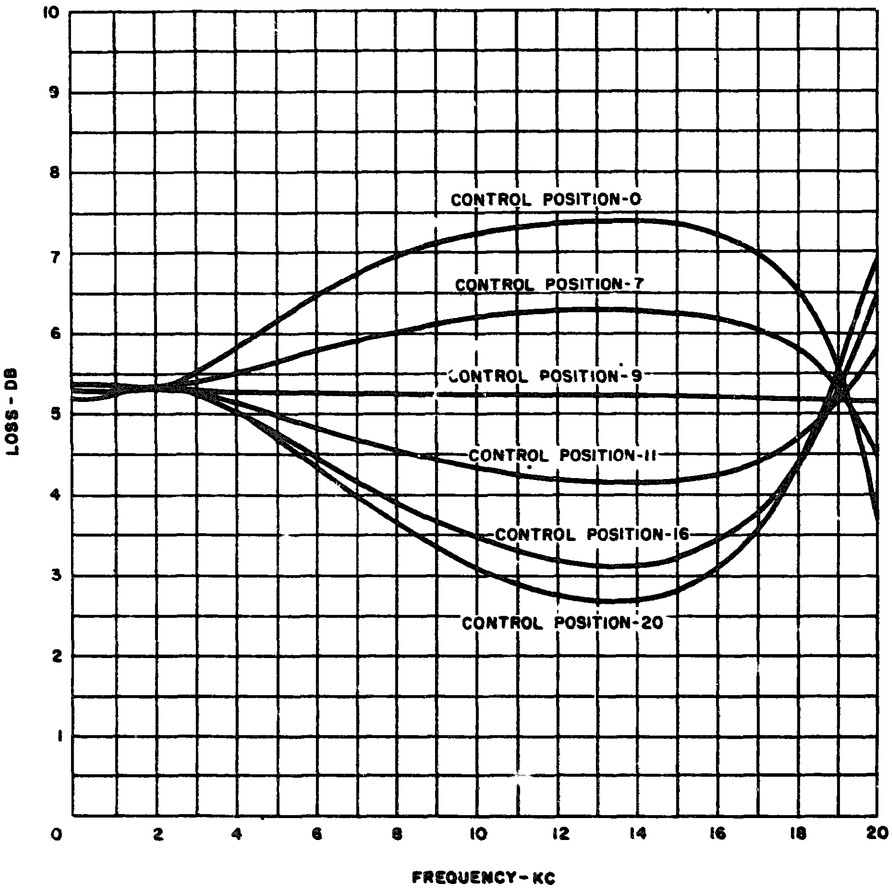


Figure 50. Graph of attenuation versus frequency of bulge equalizer.

140. Functioning of Equalizers to Perform System Line-Up

a. The system line-up consists of adjusting the attenuation of the equalizer circuit so that a total attenuation of 45 db is produced by the equalizer circuit and the transmission medium (para 133*a*). Before the system line-up is begun, the controls of the three equalizers are set to 10. The system lineup procedure is performed by first adjusting the attenuation of the flat equalizer when 1-kc test signals are received at the local AN/TCC–3 (para 212*d*). The second step of the procedure consists of adjusting the attenuation of the slope equalizer when 19-kc test signals are received by the local AN/TCC–3. The third and last step consists of adjusting the bulge equalizer when 11-kc test signals are received at the local AN/TCC–3.

b. An example of the system line-up procedure for a theoretical system which uses 25 miles of spiral-four cable at a temperature of 50°F. is discussed in paragraphs 141 through 145. This discussion is based on the curves in figures 47 through 50. It should be noted that these figures show typical curves for the spiral-four cable and the three equalizers. Consequently, the settings of the equalizer controls obtained in the example are only representative of actual settings in a specific case.

141. Adjusting Attenuation of Flat Equalizer

The first step of the system line-up procedure is to adjust the attenuation of the flat equalizer when 1-kc test signals are received at the local AN/TCC–3 (para 212*d*). It may be seen from figure 47, that, at 1 kc, the attenuation for 25 miles of spiral-four cable at 50°F. is approximately 17.1 db. It may be seen from figure 49 that, at 1 kc, the attenuation of slope equalizer is approximately 15.8 db for all settings of the corresponding equalizer control. Similarly, it may be seen from figure 50 that, at 1 kc, the attenuation of the bulge equalizer is approximately 5.3 db for all settings of the corresponding equalizer control. Thus, at 1 kc, the sum of the attenuations of the spiral-four cable of the slope equalizer, and of the bulge equalizer is approximately 38.2 db. Since it is desired to obtain a total attenuation of 45 db, the flat equalizer must introduce an additional attenuation of 6.8 at 1 kc. The attenuation of the flat equalizer at 1 kc is 6.8 db when the corresponding equalizer control is set at 11.5 (fig. 48). Thus, the attenuation of the flat equalizer is adjusted correctly when the corresponding equalizer control is set at 11.5. This is shown when the indication of MEASURE meter M771 is 0 db (para 219).

142. Adjusting Attenuation of Slope Equalizer

The second step of the system line-up procedure, the adjustment of the attenuation of the slope equalizer, is performed after the attenuation of the flat equalizer has been adjusted. The attenuation of the slope equalizer is adjusted when 19-kc test signals are received by the local AN/TCC-3 (para 212d). It may be seen from figure 47 that, at 19 kc and a temperature of approximately 50°F., the attenuation of the spiral-four cable is approximately 19.8 db. Since the control of the flat equalizer was set at 11.5, it may be seen from figure 48 that the attenuation of the flat equalizer is 6.3 db at 19 kc. It may be seen from figure 50 that the attenuation of the bulge equalizer is approximately 5.3 db (±0.5 db) for all settings of the bulge equalizer control. Since the control of the bulge equalizer is set to 10 at the beginning of the system line-up (para 140a) the attenuation is 5.3 db. Thus, at 19 kc the sum of the attenuations of the spiral-four cable, of the flat equalizer, and of the bulge equalizer, is approximately 31.4 db. Since it is desired to obtain a total attenuation of 45 db, the slope equalizer must introduce an additional attenuation of 13.6 db. By referring to figure 49 it may be seen that the slope equalizer produces an attenuation at 19 kc of 13.6 db when the corresponding equalizer control is set at 7.3. Thus, the attenuation of the slope equalizer has been adjusted correctly when the corresponding equalizer control is set at 7.3. This is shown when the indication on MEASURE meter M771 is 0 db (para 222).

143. Adjusting Attenuation of Bulge Equalizer

The third and last step of the system line-up procedure, the adjustment of the attenuation of the bulge equalizer, is performed when an 11-kc test signal is received by the local AN/TCC-3 (para 212d). It may be seen by referring to figure 47 that, at 11 kc, the attenuation of the spiral-four cable at 50°F. is approximately 18.27 db. Since the FLAT-1KC control was set at 11.5, the attenuation of the flat equalizer is approximately 6.3 at 11 kc (fig. 48). Similarly, since the SLOPE-19C control was set at 7.3, the attenuation of the slope equalizer at 11 kc is approximately 15.1 db (fig. 49). Thus, at 11 kc, the sum of the attenuations of the spiral-four cable, of the flat equalizer, and of the slope equalizer is approximately 39.7 db. Since it is desired to obtain a total attenuation of 45 db, the bulge equalizer must introduce an additional attenuation of 5.3 db. By referring to figure 50, it may be seen that the BULGE-11KC equalizer control produces an attenuation at 11 kc of 5.3 db when the corresponding equalizer control is set at 9. Thus, the attenuation of the bulge equalizer has been adjusted correctly when the corresponding equalizer control is set at 9. This is shown when the indication on MEASURE meter M771 is 0 db (para 221).

144. Effect of System Line-Up

The procedure which is followed in performing the system line-up or the adjustment of the equalizer and the theoretical considerations upon which the system line-up procedure is based were outlined in paragraphs 132 through 144. The procedure given in these paragraphs describes a means of obtaining a total attenuation of 45 db at frequencies of 1 kc, 11 kc, and 19 kc. However, it can b shown that, by following the steps given in paragraphs 132 through 144, the total of the attenuation of the equalizers and the attenuation of the spiral-four cable is adjusted to equal approximately 45 db for all frequencies between 300 cps and 20,000 cps. This can be demonstrated by adding the curves of attenuation versus frequency for the spiral-four cable (for 50°F.), the flat equalizer (FLAT-1KC control setting—11.5), the slope equalizer (SLOPE-19KC control setting—7.3), and the bulge equalizer (BULGE-11KC control setting—9). As shown in figure 51, the total attenuation from 300 to 20,000 cps is approximately 45 db.

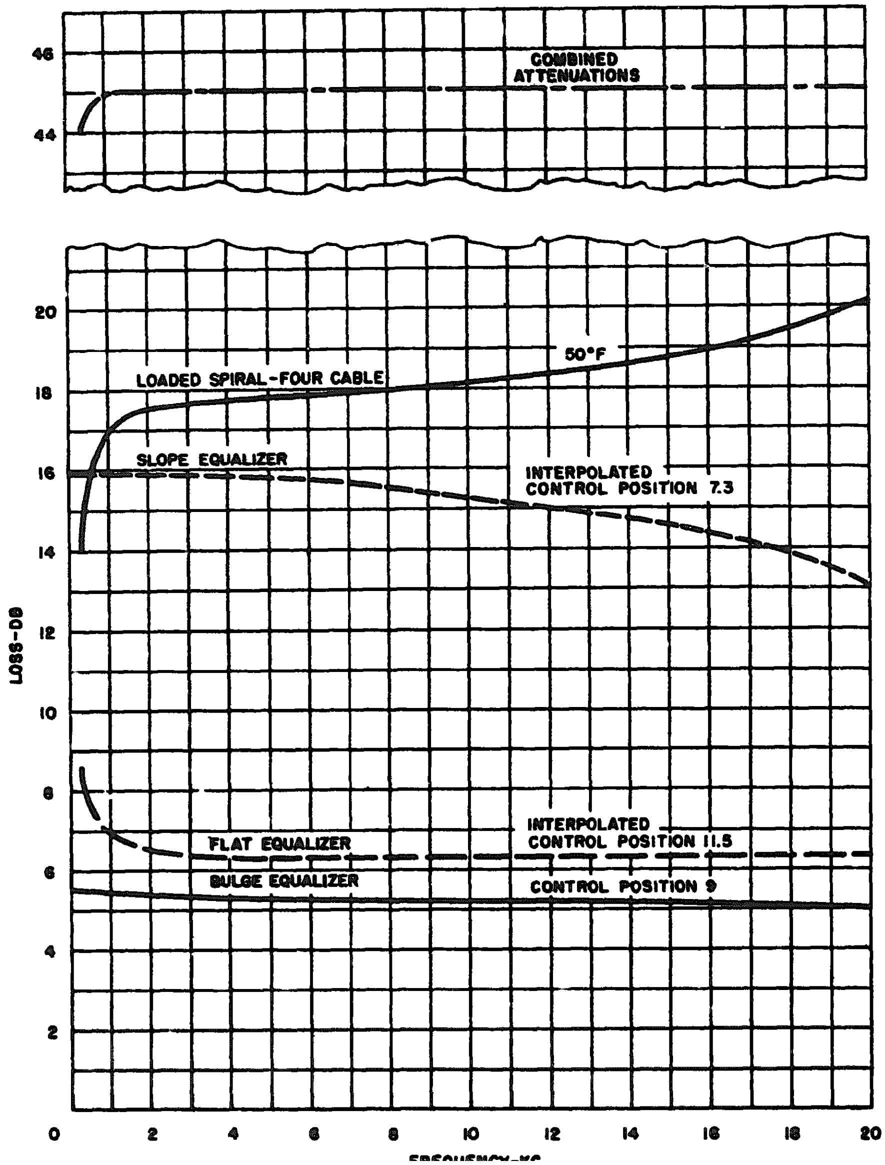


Figure 51. Graph of combined attenuation of line and equalizer.

145. Use of Measuring Circuit to Adjust Attenuation of Equalizers

Paragraphs 132 through 144 contain analysis of the adjustment of the equalizers. In order to explain the underlying theory, the analysis is graphical (figs. 47 through 51). In practice, however, the correct adjustment of the attenuation of the equalizer is determined by means of the measuring circuit (para 215). Each of the three equalizer controls is adjusted until an indication of 0 db is obtained on the MEASURE meter.

146. Use of FLAT-1KC Equalizer for Temperature Compensation

Only the FLAT-1KC control need be adjusted to compensate for daily temperature changes. As may be seen from figure 47, at temperatures greater than 50°F., the spiral-four cable attenuation is higher. At temperatures lower than

50°F., the spiral-four attenuation is lower than at 50°F. This is true for all frequencies between 300 and 20,000 cps. The shape of the curves of attenuation versus frequency does not vary considerably with differences in temperature. It is assumed for ease of explanation that a system has been lined up for a cable temperature of 50°F. and that the temperature of the cable increases to 131°F. It may be seen that the attenuation of the cable will be increased by approximately 2.8 db for all frequencies. This increase of 2.8 db in the attenuation of the spiral-four cable will be added to the combined attenuation of 45 db of the lined-up system (para 135a) resulting in a total attenuation of the spiral-four cable will be added to the combined attenuation of 45 db of the lined-up system (para 133a) resulting in a total attenuation of 47.8 db. It is desired to decrease this combined attenuation of 47.8 db by 2.8 for all values of frequencies between 300 cps and 20,000 cps. It may be seen from the shape of the curves in figure 48 that, by increasing the setting of the FLAT-1KC equalizer control, the attenuation of the flat equalizer can be decreased by approximately 2.8 db for all values of frequencies between 300 cps and 20,000 cps. Thus, the combined attenuation of the spiral-four cable and the equalizer circuit is brought back to 45 db, and the system is again lined up.

147. Receiving Amplifier

a. General. The internal circuits of the receiving amplifier are identical with the internal circuits of the transmitting amplifier. However, as is shown in figure 150, some of the external connections to these amplifiers differ. The general functioning of the receiving amplifier is described in b below. For a detailed analysis of the receiving amplifier, see the detailed analysis of the transmitting amplifier (para 123 through 127). The functioning of the receiving amplifier is essentially the same as that of the transmitting amplifier. The differences in functioning between the transmitting amplifier and the receiving amplifier are described in *c* below.

b. Functioning of Receiving Amplifier. The output of the equalizer circuit is applied to the receiving amplifier. One amplified output from the receiving amplifier is applied through the attenuator pad and CHANNELS-SPECIAL SERVICE switch to the TA-219/U. In addition, the amplified output is applied to the system alarm (para 226). A second output from the receiving amplifier is applied to the measuring circuit, and the ringer-oscillator (para 184, 201, and 212*e*).

c. Differences Between Functioning of a Receiving Amplifier and Transmitting Amplifier.

(1) The differences which exist between the functioning of the receiving amplifier and the transmitting amplifier are discussed with the aid of the simplified schematic diagram of the receiving amplifier (fig. 52).

(2) In the receiving amplifier, windings l-2 and 3-4 of input transformer T51 are connected in series to present an input impedance of 2,400 ohms as compared with 600 ohms in the transmitting amplifier (para 118). The 2,400-ohm input impedance matches the output impedance of the equalizers. The strap between terminals 15 and 17 of jack J802 (fig. 152) shorts out capacitor C51 and resistor R55 of the feedback network. Therefore, capacitor C51 and resistor R55 of the feedback network. Therefore, capacitor C51 and resistor R55 are not shown in figure 52. In the transmitting amplifier, the 600-ohm input impedance matches the output impedance of the channel modems. Effectively, only resistors R54, R59, and R66, and capacitor C55 are left in the feedback network (para 126). This increases the amplifier gain by 10 db. Therefore, an amplifier plugged into the receiving amplifier position is always operated at high gain (+ 10 db) and the external strap nullifies the effect of the gain-changing AMP OUT switch, S51. The strap connected between terminals 0 and 1 of jack J802 (figs. 150 and 151) bridges winding 1-2 of transformer T53 across winding T-l of transformer T52 through resistors R68 and R69. This strapping produces the same effect as in the case of the transmitting amplifier when switch S51 is operated in the 10 DB position (fig. 152). This provides the proper transmission level to the measuring and order wire circuits.

148. Attenuator Pad

Signals from the receiving amplifier are applied through terminals 5 and 8 of jack J802 (figs. 150 and 151) to the attenuator pad, which consists of resistors R801, R802, and R803. With CHANNELS-SPECIAL SERVICE switch S801 in the CHANNELS position, the output of the attenuator pad is applied through the closed contact of switch S801 and terminals E and P of plug P898 to the TA-219/U. With switch S801 in the SPECIAL SERVICE position, the connection to the TA-219/U is opened. The signals to the equipment connected to SPECIAL SERVICE REC binding posts (E803 and E804) of the receiving path of the special service circuit (para 162 and fig. 150), pass from the receiving cir-

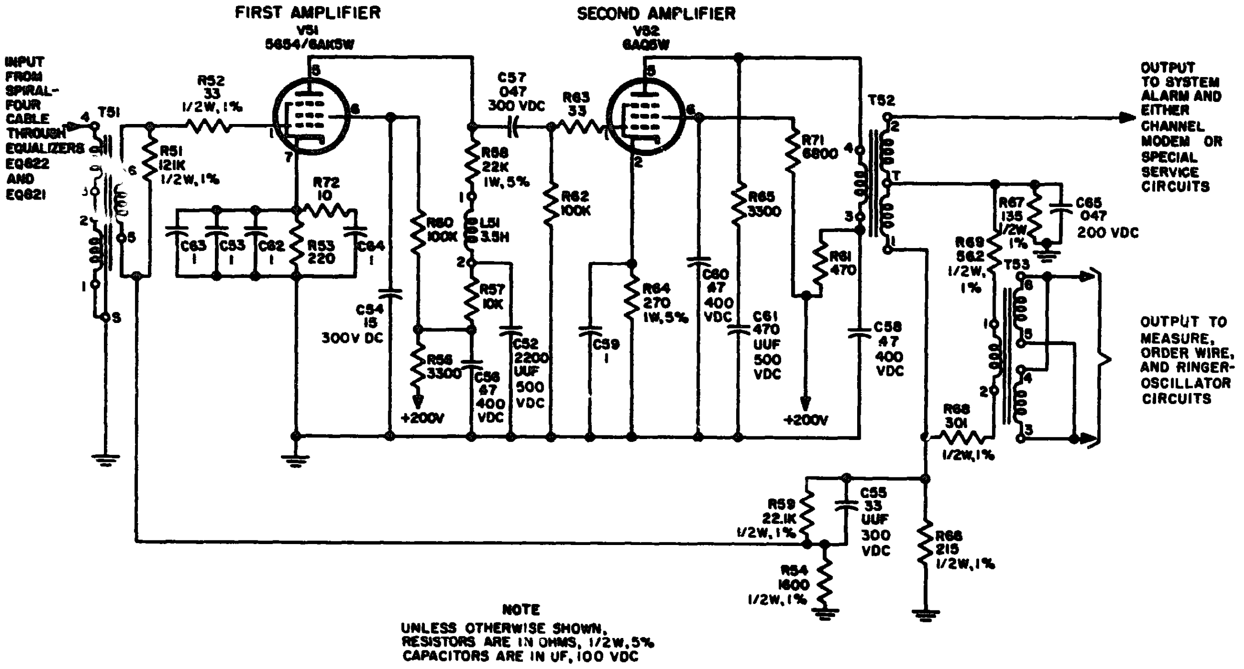


Figure 52. Receiving amplifier, simplified schematic diagram.

:uit of the AM-682/TCC-3 through the closed :ontacts of the switch.

149. Receiving Path in the TA-219/U, General

The receiving path in the TA-219/U consists of the input distribution circuit and the receiving path in each of the four channel modems of the TA-219/U. A detailed analysis of the input distribution circuit is given in paragraph 150. Since the functioning of the receiving path of all four channel modems of the TA-219/U is similar, only the receiving path in channel 2 modem will be discussed. A detailed analysis of the receiving path in channel 2 modem is given in paragraphs 153 through 160.

150. Input Distribution Circuit in TA-219/U

As shown in figure 53, the input from the receiving circuit in the AM-682/TCC-3 is passed to the input distribution attenuator pad in the TA-219/U. The output of this pad is applied to the receiving path of each of the four channel modems of the TA-219/U. As shown in figures 145 and 150, the output of the attenuator pad in the receiving circuit of the AM-682/TCC-3 (para 148) is passed through CHANNELS-SPECIAL SERVICE switch S801 and terminals E and P of plug P898 and jack J5 to the input distribution attenuator pad in the TA-219/U (resistors R1, R2, and R3). The output of the attenuator pad then is applied to terminals 17 and 14 of jacks J1, J2, J3 and J4, which are connected in parallel (fig. 145). These jacks mate with plugs P101, P201, P301 and P401 in channel 1, 2, 3, and 4 modems respectively, of the TA-219/U (figs. 146 through 149). A demodulator band-filter connected at terminals 17 and 14 of the plug (in each of the channel modems) blocks undesired signals and passes only those signals that are in the correct frequency range to the receiving path in each of the channel modems.

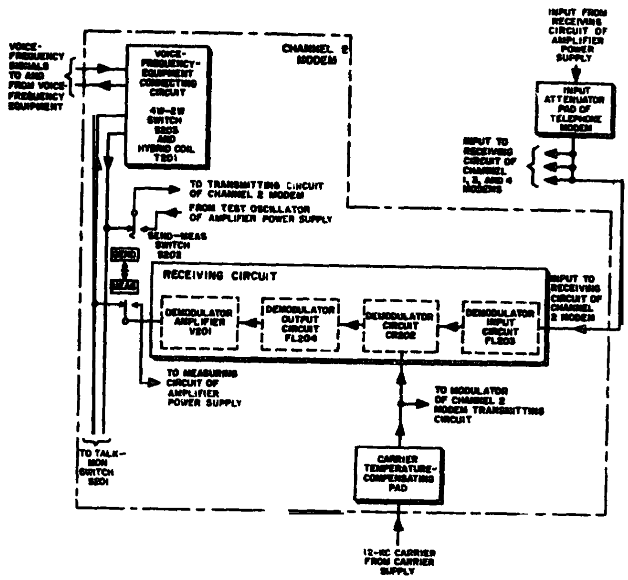


Figure 53. Receiving path in channel 2 modem, block diagram.

151. Receiving Path in Channel 2 Modem, Block Diagram Analysis

a. General. The block diagram of the receiving path in channel 2 modem is shown in figure *53*. The receiving path consists of the receiving circuit and the voice-frequency-equipment connecting circuit (which is also part of the transmitting path of channel *2* modem (para 103)). A block diagram analysis of the receiving circuit and the voice-frequency-equipment connecting circuit (as related to the receiving path in channel 2 modem) is given in *b* and c below.

b. Receiving Circuit. The receiving circuit consists of the demodulator input circuit, the de modulator circuit, the demodulator output circuit, and the demodulator amplifier. As shown in figures 145 and 150, the output from the AM-682/TCC-3 is applied through the attenuator pad in the input distribution circuit of the TA-219/U (para 150) to the channel modem receiving circuit. In the input circuit of the channel modem receiving circuit, the desired side-band signal is passed while the other signals are rejected. The desired side-band signal is attenuated in the input circuit and applied to the demodulator circuit. The side-band signals are demodulated by the 12-kc carrier frequency, producing a voice frequency output. The voice-frequency output is applied to a demodulator output circuit, where it is filtered and applied to a variable attenuator. The output of the variable attenuator applies an adjustable input to the demodulator amplifier. The amplified voice-frequency output of the amplifier is applied through the SEND-MEAS switch (in the normal position) to the voice-frequency-equipment connecting circuit. The SEND-MEAS switch can also be operated to remove the output of the receiving circuit from the voice-frequency-equipment connecting circuit and apply it to the measuring circuit (para 212e). A detailed analysis of the receiving circuit is given in paragraphs 153 through 159.

c. Voice-Frequency-Equipment Connecting Circuit of Channel 2 Modem If four-wire voice-frequency loop equipment is used, the voice-frequency signal is applied directly to the voice-frequency equipment (para 105a). If two-wire loop equipment is used, the voice-frequency signals from the demodulator amplifier are applied through the hybrid coil of the loop-equipment connecting circuit (para 105a). A detailed analysis of the voice-frequency equipment as related to the receiving path of channel *2* modem is given in paragraph *160.*

152. Receiving Path in Channel 2 Modem, Detailed Analysis

The detailed analysis of the receiving path in channel 2 modem is given in paragraphs 153 through 160. This analysis is given with the aid of the schematic diagram for channel 2 modem of the TA-219/U, figure 147.

153. Receiving Circuit of Channel 2 Modem

The receiving circuit of channel 2 modem consists of an input circuit, a demodulator circuit, and a demodulator amplifier. A detailed analysis of these circuits is given in paragraphs 154 through 159.

154. Demodulator Input Circuit

The demodulator input circuit of channel 2 modem consists of a band-pass filter and an attenuator pad. Filter FL203 (para 155) receives the side-band signals from the pad in the input distribution circuit in the TA-219/U. The filter suppresses unwanted frequencies and permits the desired frequencies to pass. These signals are fed to a pad composed of resistors R219, R220, R221, R246, and R247 and thermistors RT205 and RT206. This pad compensates for variations in transmission loss in the demodulator due to temperature changes. The output of this pad is fed to the demodulator circuit.

155. Band-pass Filter FL203

The schematic representation of receiving band filter FL203 in channel 2 modem is identical with the schematic representation of band filter FL202 (fig. 41). Similarly, the schematic representation of receiving band filters FL103, FL303, and FL403 in channel 1, 3, and 4 modems is identical with filter FL102, FL302, and FL402. The receiving filters select the same frequency spectrums as do the corresponding transmitting band filters (para 114). All filters are sealed units and maintenance or replacement of the parts in the units cannot be perfomed. If a filter is defective replace the entire unit.

156. Channel 2 Modem Demodulator Circuit

The demodulator circuit of channel 2 modem consists of varistor CR202 and transformers T205 and T206 (fig. 147). The lower side-band signals are coupled to the demodulator circuit through transformer T206. These signals are demodulated by the 12-kc carrier that is applied to the demodulator at the midpoints (terminal 3) of transformers T205 and T206. The demodulation of the side-band signal produces a voice-frequency output that is coupled through transformer T205 to the demodulator output circuit. The functioning of the demodulator circuit is essentially the same as that of the modulator circuit (para 110 and 111). In the demodulator, lower side-band signals are demodulated by the carrier and a voice-frequency output is produced. In the demodulator, the amplitude of the output is not limited as in the modulator (par 112), because the input signals to the demodu lator are of low amplitude, with respect to th carrier amplitude. Therefore, the output is al of low amplitude and is not limited by the actio of the demodulator circuit.

157. Demodulator Output Circuit

The demodulator output circuit consists of a low-pass filter and a variable attenuator. The output of the demodulator circuit is applied to low-pass filter FL204 of the demodulator output circuit (para 158). Filter FL204 passes the voice frequencies and suppresses the higher frequency components in the demodulator output. Filter FL204 also provides proper terminating impedances to the demodulator circuit. The voice-frequency output signals of Filter FL204 are applied to a variable attenuator that serves as a channel gain control. The attenuator is composed of resistors R240 and R241 and variable resistors R238A and R238B. The output of this attenuator is applied to primary winding 1-3 of transformer T207. The output of winding 4-6 of transformer T207 is applied to the grid of demodulator tube V201. The attenuator presents a constant resistance to both the output of the filter and the demodulator amplifier input.

158. Filter FL204

A schematic representation of low-pass filter FL204 in channel 2 modem is shown in figure 54. Filter FL204 consists of a capacitor placed across the input terminals (1 and 2) followed by a T-pad. The T-pad consists of a capacitor connected between two symmetrical parallel LC branches. Low-pass filters FL104, FL304, and

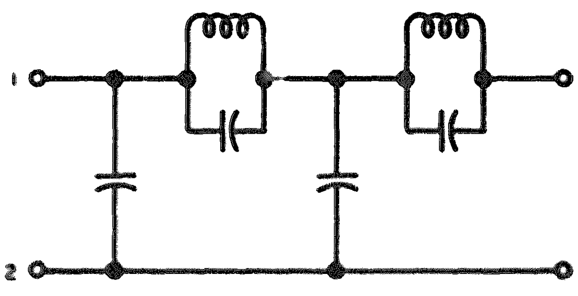


Figure 54. Filter FL204, simplified schematic representation.

FL404 in channel 1, 3, and 4 modems are similar to filter FL204. All filters are sealed units. Maintenance or replacement of the parts in the units cannot be performed. If a filter is defective, replace the entire unit.

159. Demodulator Amplifier

The demodulator amplifier consists of tube V201 in a single-stage amplifier with negative feedback. A detailed analysis of this circuit is given in *a* and *b* below with aid of the simplified schematic of the demodulator amplifier shown in figure 55.

a. Amplifier.

(1) The voice-frequency signals from the variable attenuator (GAIN control) of the demodulator output circuit are coupled through input transformer T207 to the demodulator amplifier tube V201. The voice-frequency signal from winding 4-6 of transformer T207 is developed across terminating resistor R230 and applied through parasitic-suppressor resistor R248 to the control grid of tube V201. The amplified signal at the plate of the tube is developed in the plate load. The plate load consists of primary winding 5-6 of transformer T208 shunted by resistor R231 and capacitor C210, connected in series with resistor R239. Primary winding 5-6 of transformer T208 couples the amplified signal to secondary winding 1-2 of the transformer, which is terminated by resistor R237.

(2) The voice-frequency signal from winding 1-2 of transformer T208 is applied to SEND-MEAS switch S202 (fig. 147). When this switch is in the normal position, the transformer output is applied to the voice-frequency-equipment connecting circuit. When the switch is in the MEAS position, the transformer output is applied to the measuring circuit (para 212d).

(3) Resistor R231 and capacitor C210 reduce the gain of the amplifier at frequencies above 3,500 cps. Resistor R231 also serves to lower

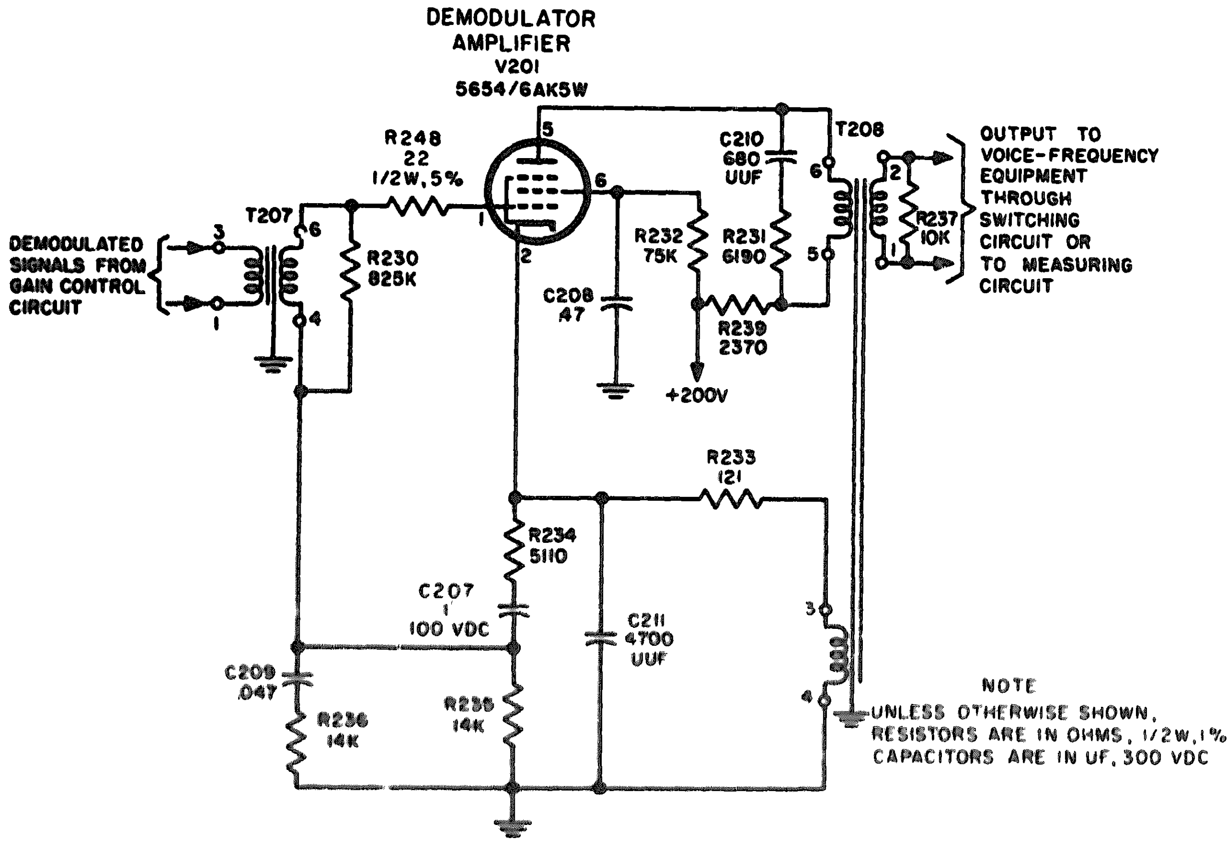


Figure 55. Demodulator amplifier, simplified schematic diagram.

the Q of the tuned circuit and thereby the prevent singing of the amplifier.

b. Feedback Circuit. **A feedback voltage is induced in winding 3-4 of transformer T208. This feedback voltage is passed through biasing resistor R233 and developed across capacitor C211. This feedback voltage is divided across a series-parallel RC network consisting of resistors R234, R235 and R236 and capacitors C207 and C209. The fraction of the feed-back voltage which is developed across resistor R234 in series with capacitor C207 provides a negative feedback to the stage. Resistor R232 is the screen-dropping resistor and capacitor C208 is the screen bypass capacitor.**

160. Voice-Frequency-Equipment Connecting Circuit

When 2W-4W switch S203 is in the 2W position, voice-frequency signals from the channel modem are applied to terminals 3 and 4 of hybrid coil T201 (fig. 35), and coupled to the windings 7-10 of the hybrid coil to the two-wire V-F equipment. In the 4W position of the 2W-4W switch the voice-frequency signals are applied through the switch contacts to the 4W-R binding posts, E203 and E204.

161. Characteristics of AN/TCC-3 System

Figures 56 and 57 show an attenuation versus frequency curve and a delay distortion versus frequency curve respectively. These curves are for transmission over one channel of two Telephone Terminals AN/TCC-3 interconnected by an artificial line. The delay distortion may affect some special service applications of the AN/TCC-3.

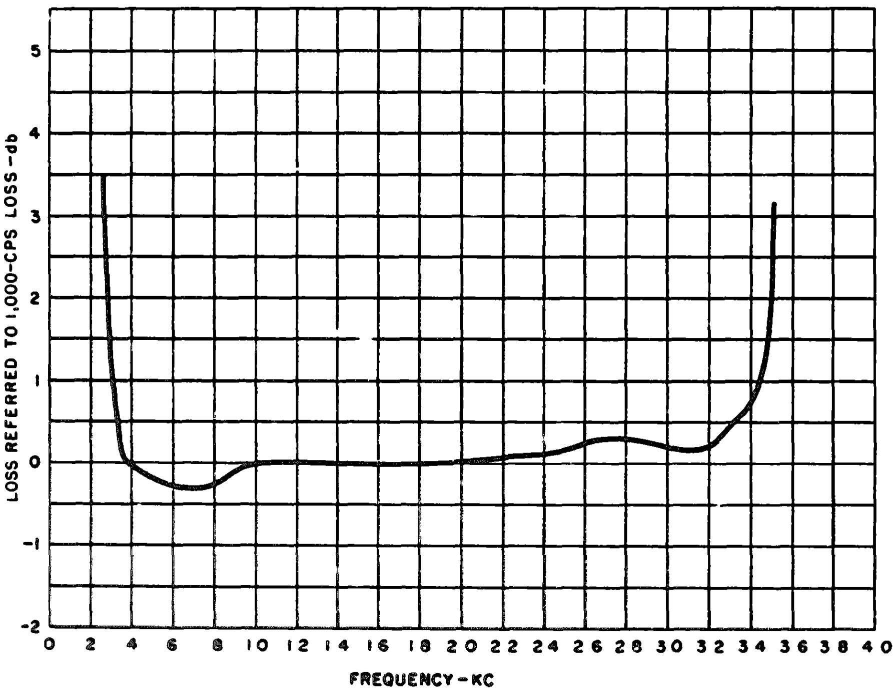


Figure 56. Attenuation versus frequency characteristics of AN/TCC-3 system.

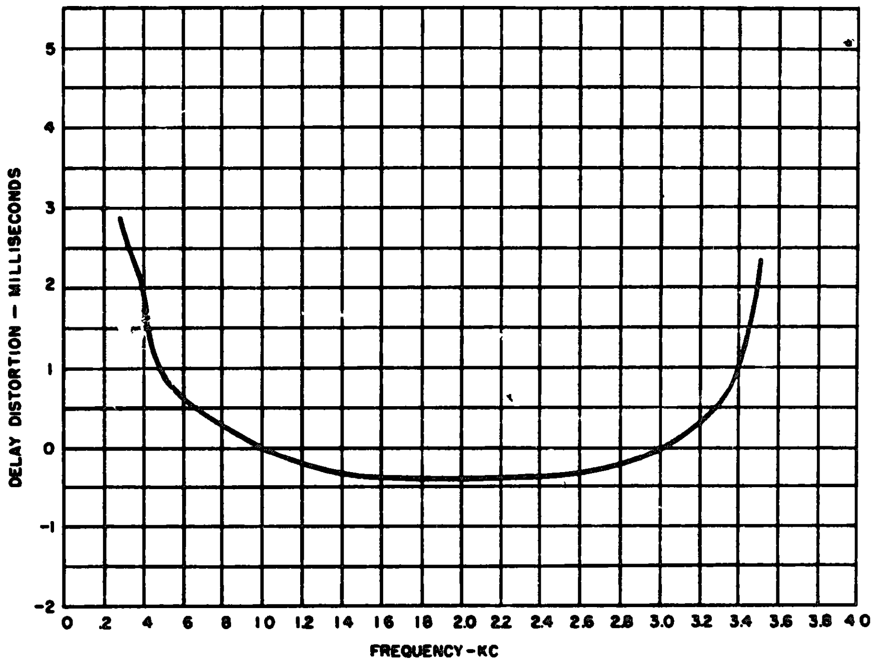


Figure 57. ***Delay distortion versus frequency*** characteristics ***of AN/TCC-3 system.***

Section III. SPECIAL SERVICE CIRCUITS

162. General

A general description of the functioning of the special service circuits is given in paragraph 93. The special service circuits consist of the transmitting path and thc receiving path. A detailed analysis is given in paragraphs 163 and 164.

163. Transmitting Path

As shown in figure 150, when CHANNELS–SPECIAL SERVICE switch S801 is in the SPECIAL SERVICE position, the connection from resistor R812 to terminal 1 of terminal board TB801 is open and resistor R812 is connected to resistor R841. This switching disconnects the TA–219/U from the transmitting circuit of the AM–682/TCC–3 (para 120*b*) and connects the special service transmitting circuit. This circuit consists of transformer T801 and the attenuating pad comprised of resistors R841, R842, and R843. The transmitting side of the special service facilities, such as facsimile or telephoto equipment, is connected to SPECIAL SERVICE TR binding posts E801 and E802. The wide-band signals from the SPECIAL SERVICE equipment are attenuated by the pad in the special service circuit and applied th[illegible]h the transmitting circuit of the AM–682/TCC–3 to piral-four cable.

164. Receiving Path

As shown in figure 150, operating CHANNELS–SPECIAL SERVICE switch S801 to the SPECIAL SERVICE position applies the output of the receiving circuit in the AM–682/TCC–3 (para 130*c*) to transformer T802. Transformer T802 is in the special service receiving circuit. The wide-band signal output of the transformer is coupled to the receiving side of the special service equipment (facsimile or telephoto) connected to SPECIAL SERVICE REC binding posts E803 and E804. The operation of the CHANNELS–SPECIAL SERVICE switch to the SPECIAL SERVICE position opens the connection from resistor R802 to terminal 4 of terminal board TB801. This disconnects the TA–219/U from the receiving amplifier of the AM–682/TCC–3. SPECIAL SERVICE lamp 1801 is energized by 6.3 volts ac when the CHANNELS–SPECIAL SERVICE switch is in the SPECIAL SERVICE position.

Section IV. AUXILIARY CIRCUITS

165. General

The auxiliary circuits consists of the carrier supply, the ringer-oscillator, the order wire circuit, the testing facilities, the system alarm circuit, and the power supply. A general description of the functioning of these circuits appears in paragraphs 99 through 104. A detailed description of the carrier supply appears in paragraphs 166 through 182. A detailed description of the ringer-oscillator appears in paragraphs 184 through 199. A detailed description of the order wire circuit appears in paragraphs 200 through 210. A detailed description of the testing facilities appears in paragraphs 226 through 232. A detailed description of the system alarm appears in paragraphs 233 through 236.

166. Carrier Supply

a. ***General.*** **A general description of the functioning of the carrier supply appears in paragraph 94. A detailed analysis of the carrier supply appears in paragraphs 167 through 180. This analysis is given with the aid of the schematic diagram of the carrier supply shown in figure 144.**

b. Block Diagram. **The block diagram of the carrier supply is shown in figure 58. The carrier supply is comprised of the 16-kc oscillator, the frequency division circuit, the 4-kc amplifier circuit, and the harmonic generator. An analysis based on the block diagram of the carrier supply appears in paragraph 167.**

167. Carrier Supply, Block Diagram Analysis

a. **16-KC** ***Oscillator.*** **The 16-kc oscillator (fig. 58) is a crystal-controlled, two-stage oscillator. The oscillator generates an output which is applied to the frequency division circuit. The output of the 16-kc oscillator can be measured at jack J601. A detailed analysis of the 16-kc oscillator is given in paragraph 168.**

b. Frequency Division Circuit.

(1) The frequency division circuit is comprised of two lattice-type modulators, an amplifier with two tuned plate circuits, and a selective filter.

(2) In the frequency division circuit, the 16-kc input from the oscillator is divided by the two modulators to produce a 4-kc signal. This 4-kc signal is then passed through the selective filter. One filtered 4-kc output is applied to a 4-kc amplifier. A second 4-kc output from the filter is applied through an attenuating network to the transmitting circuit of the AM-682/TCC-3 ***(para 122b).***

(3) A detailed analysis of the frequency division circuit appears in paragraphs 169 through 172.

c. 4-KC Amplifier Circuit.

(1) The 4-kc amplifier circuit consists of tubes V603 and V605 in a push-pull amplifier, and tube V604, which furnishes a regulated voltage.

(2) The 4-kc output of the frequency div-

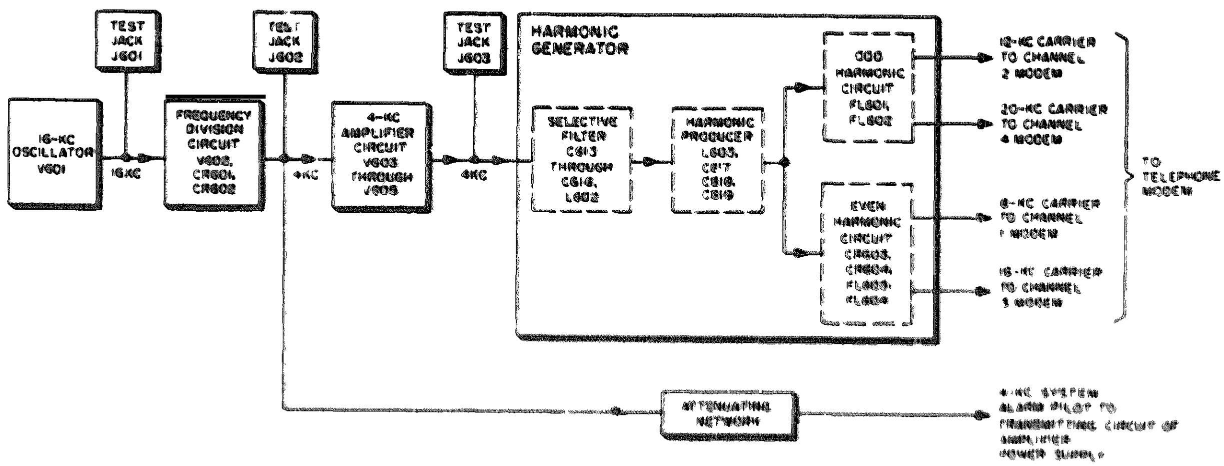


Figure 58. Carrier supply block diagram

ision circuit is applied to the push-pull amplifier. The amplified output of the push-pull amplifier is applied to the harmonic generator. Tube V604 is a gas-tube regulator that regulates the high voltage required for the operation of the push-pull amplifier.

(3) A detailed analysis of the 4-kc amplifier circuit is given in paragraphs 173 through 175.

d. Harmonic Generator.

(1) The harmonic generator consists of the selective filter, the 4-kc harmonic producer, the odd harmonic load circuit, and the even harmonic load circuit.

(2) The 4-kc input to the harmonic generator circuit from the push-pull amplifier is filtered by the selective filter and fed to the 4-kc harmonic producer. An output wave rich in odd harmonics of 4-kc is produced by the 4-kc harmonic producer and is fed to a 12-kc filter and a 20-kc filter in the odd harmonic load circuit. The& filters select the 12-kc and 20-kc frequencies from the odd harmonic input. In the even harmonic load circuit, the output from the harmonic producer is applied to a bridge rectifier circuit, which produces even harmonics of 4 kc. These even harmonics, in turn, are fed to an 8-kc selective filter and a 16-kc selective filter in the even harmonic load circuit. The four carrier frequencies are applied to the TA-219/U. The 8-kc, 12-kc, 16-kc and 20-kc carrier frequencies from the carrier supply are applied to channel 1 modem, channel 2 modem, channel 3 modem, and channel 4 modem, respectively.

(3) A detailed analysis of the harmonic generator appears in paragraphs 176 through 182.

168. 16-KC Oscillator, Detailed Analysis

In a vacuum-tube circuit, a broad band of noise is always present on the grid of the tube. Noise at the control grid (pin 3) of tube V601A (fig. 59) is developed across grid leak resistor R601. Tube V601A amplifies this noise signal. The amplified signals are developed across plate load resistor R603 and R604. The amplified signal is then coupled through capacitor C602, developed across grid leak resistor R605, and supplied to the grid of tube V601B (pin 7). The signal is amplified in tube V601B The amplified signal at the plate of V601B (pin 6) is developed across plate load resistor R607 and applied through capacitor C604 to voltage divider resistors R608 and R609. A portion of the amplified signal from tube V601B is tapped off at the junction of resistors R608 and R609 and applied through crystal Y601 to the grid (pin 3) of tube V601. Crystal Y601, which is electrically equivalent to a series resonant LCR circuit, allows the 16-kc component of the feed-back signal to pass to the grid (pin 3) of the first triode of tube V601 while blocking all other frequency components. Since crystal Y601 allows only 16-kc signals to be fed between the grid of the input stage and the output stage, the frequency of oscillation of the circuit is 16 kc. Primary winding 5-6 of step-down transformer T601 is tuned, by means of capacitor C605, to 16 kc. This tuned circuit prevents unwanted harmonics of 16 kc from appearing across the transformer primary. Secondary winding 1-4 of transformer T601 applies the 16-kc signal to the frequency division circuit of the carrier supply (para 169). The output of the 16-kc oscillator is applied to jack J601 through dropping resistor R648 for test purposes. Capacitor C603 is the plate-voltage bypass capacitor of the circuit.

169. Frequency Division Circuit, Detailed Analysis

A simplified schematic diagram of the frequency division circuit appears in figure 60. The frequency division circuit contains varistors CR601 and CR602 (see note, para 109) and their associated circuit elements connected as an 8-kc modulator circuit and a 4-kc modulator circuit, respectively In addition, the frequency division circuit contains tube V602 and a selective circuit which consists of capacitors C623, and C624, and reactor L605. Tube V602 is a reflexed amplifier with two tuned circuits in the plate circuit. A detailed analysis of the frequency division circuit is given in paragraphs 170 through 172.

170. 8-KC Modulator Circuit

Noise present on the grid of tube V602 is amplified by the tube, and the 8-kc component of the noise is selected in the plate circuit of the tube by the tuned circuit consisting of primary winding 5–6 of transformer T603 shunted by capacitor C606 and trimmer capacitors C626 and C627 (Trimmer capacitors C626 and C627 are not supplied with AM-682/TCC-3 bearing serial number 1 through 90.) The 8-kc noise selected by the tuned circuit is fed back by the 3–4 winding of transformer T603 through resistor R610 to a modulator consisting of varistor CR601 and resistors R611 through R614. This 8-kc noise modulates the 16 kc supplied to modulator CR601

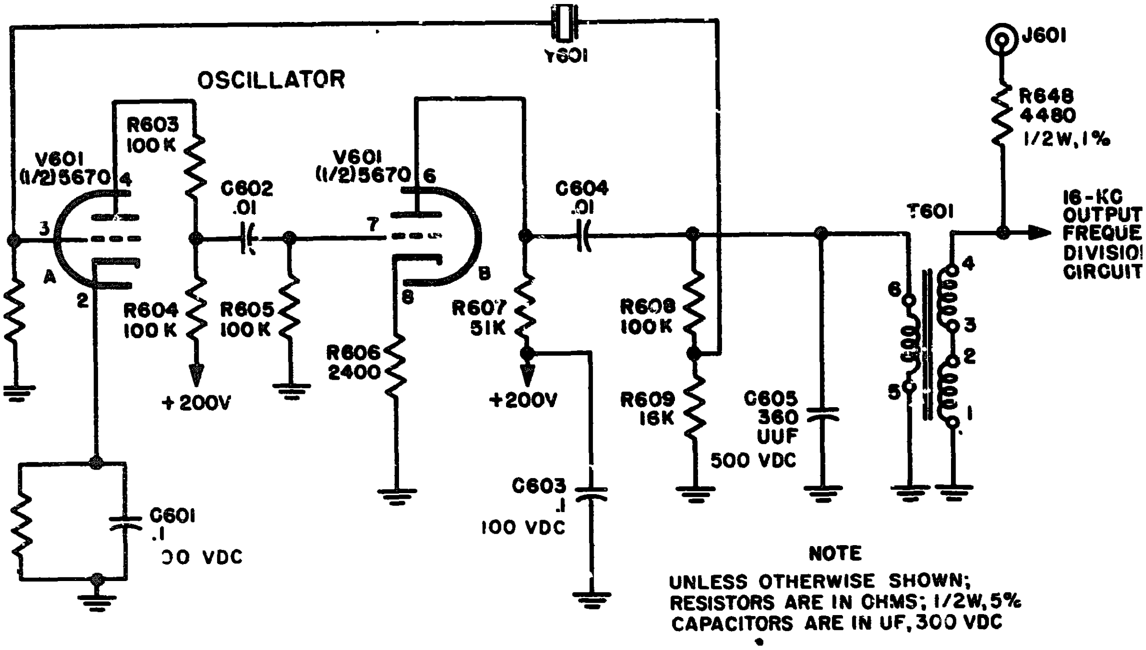
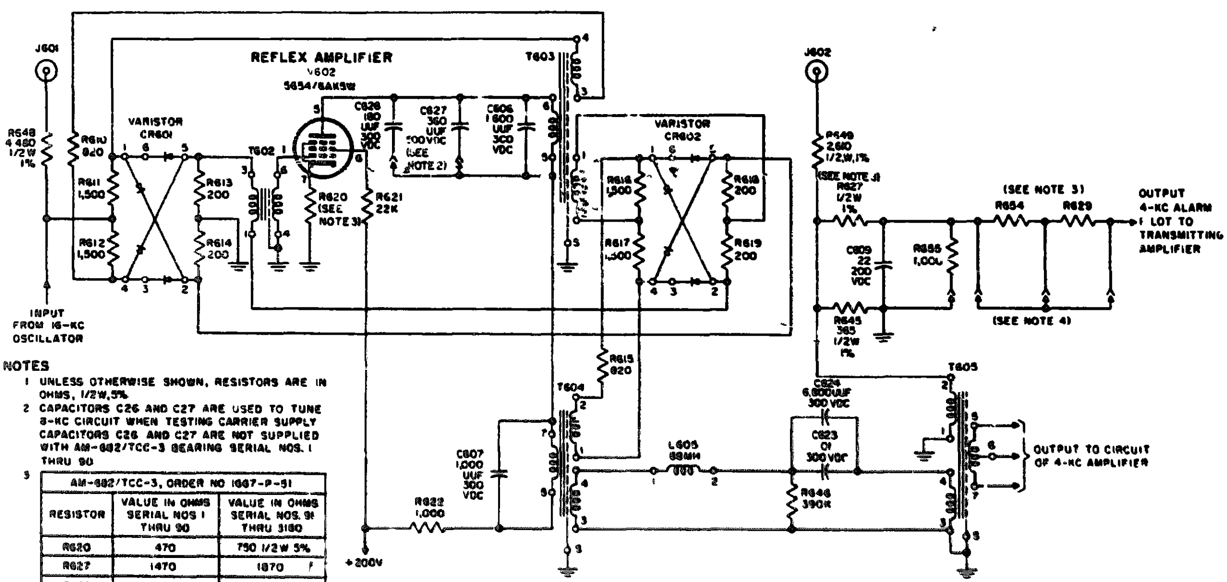


Figure 59. 18-kc oscillator, simplified schematic diagram.



NOTES

1 UNLESS OTHERWISE SHOWN, RESISTORS ARE IN OHMS, 1/2W,5%

2 CAPACITORS C26 AND C27 ARE USED TO TUNE 8-KC CIRCUIT WHEN TESTING CARRIER SUPPLY CAPACITORS C26 AND C27 ARE NOT SUPPLIED WITH AM-682/TCC-3 BEARING SERIAL NOS. 1 THRU 90

3

AM-682/TCC-3, ORDER NO 1667-P-51		
RESISTOR	VALUE IN OHMS SERIAL NOS 1 THRU 90	VALUE IN OHMS SERIAL NOS. 91 THRU 3180
R620	470	750 1/2W 5%
R627	1470	1870
R629	560	470
R654	390	240

4 RESISTORS R653, R654, AND R629 ARE USED TO ADJUST 4-KC OUTPUT LEVEL OF CARRIER SUPPLY WHEN ASSOCIATED CIRCUIT ELEMENTS ARE REPLACED

Figure 60. Frequency division circuit, simplified schematic diagram.

from the 16-kc oscillator to produce a greater 8-kc output. The 8-kc product is applied through transformer T602 to the grid of tube V602 and is amplified. The process of feeding back 8 kc and amplifying it continues until a stable condition of plate output and grid input is reached. This condition occurs when the magnitude of the grid signal is sufficiently large to cause plate saturation. At this point, a constant 8-kc output is produced. The plate voltage for tube V602 is supplied through plateload resistor R622, winding 5-7 of T604, and winding 5-6 of T603. Screen voltage is supplied through screen-voltage dropping resistor R621.

171. 4-KC Modulator Circuit

Winding 1-2 of transformer T603 couples the 8-kc output to a second modulator circuit consisting of varistor CR602 and resistors R615 through R619. Winding 5-7 of transformer T604, tuned to 4 kc by capacitor C607, selects the 4-kc component of the tube noises. This 4-kc component is applied by winding 1-2 of transformer T604 through attenuating resistor R615 to the modulator circuit which consists of varistor CR-602 and resistors R616 through R619. The 4-kc modulator circuit functions in the same manner as the 8-kc modulator, except that 4-kc tube noise modulates the 8 kc from the 8-kc modulator (para 170) and produces a constant 4-kc output across winding 3-4 of transformer T604.

172. 4-KC Output Circuit

The 4-kc output from winding 3-4 of transformer T604 passes to a selective filter consisting of inductor L605, resistor R646, capacitors C623 and C624, and winding 3-4 of transformer T605. Resistor R646 lowers the Q of this selective circuit and reduces the impedance it reflects into the plate circuit of tube V602. This filter circuit eliminates undesirable harmonics of the 4-kc output of the divider circuit. Transformer T605 couples the filtered 4-kc signal to the grids of the 4-kc amplifier through winding 5-6-7 of transformer T605. Transformer T605 also supplies a filtered 4-kc signal, through winding 1-2 of the transformer, which serves as the system alarm pilot signal (para *227a)*. This 4-kc signal is applied through an adjustable attenuation network consisting of resistors R645, R627, R655, R654, and capacitor C709 to the attenuating network of the transmitting circuit of the AM-682/TCC-3 (para 122b). Resistor R65 is not supplied as part of AM-682/TCC-3 bearing serial numbers 1 through 199. The 4 kc induced in winding 1-2 of transformer T605 is applied through dropping resistor R649 to jack J602 for test purposes.

173. 4-KC Amplifier Circuit, Detailed Analysis

A simplified schematic diagram of the 4-kc amplifier circuit appears in figure 61. The 4-kc amplifier circuit consists of tubes V603 and V605,

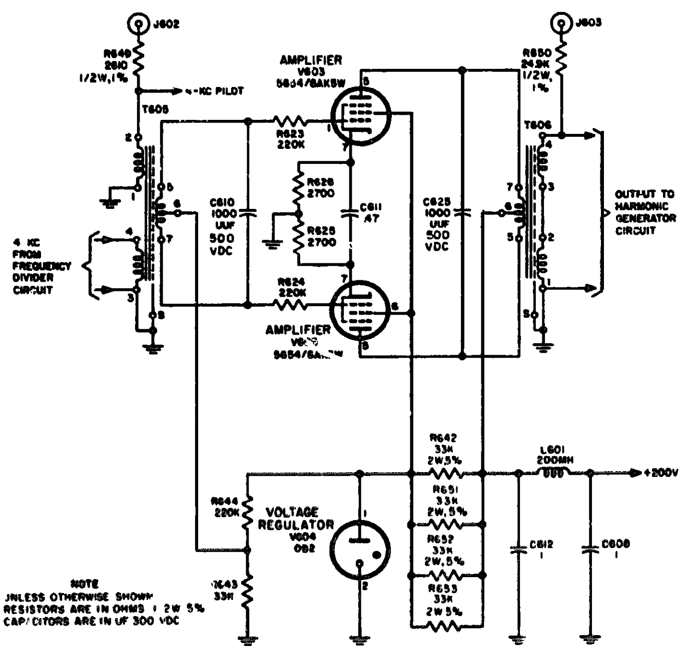


Figure 61. 4-kc amplifier, simplified schematic diagram.

which form a push-pull amplifier, and tube V604, which is part of a voltage regulating circuit. A detailed analysis of these circuits is given in paragraphs 174 and 175.

174. Push-Pull Amplifier

The 4-kc output of the selective filter in the frequency division circuit (para 172) is stepped up by input transformer T605. The stepped-up voltage is developed across winding 5-6-7 of transformer T605, which is tuned to 4 kc by capacitor C610. The 4 kc is applied through grid-current-limiting resistors R623 and R624 to the control grids (pin 1) of tubes V603 and V605. The amplified signals appear at the plates (pin 5) of the tubes. The grid-current-limiting resistors cause the negative peaks of the plate voltage to be clipped. Regulated voltage is applied to the screen-grids (pin 6) of tubes V603 and V605. A positive voltage, which is developed across resistor R643 (para 175) is applied to terminal 6 of transformer T605 and makes the control grids (pin 1) of tubes V603 and V605 positive. However, the positive d-c cathode voltage of tubes V603 and V605 produced by the tube current flow through cathode resistors R626 and R627, exceeds the positive potential on the grids of the tubes. Making the cathode positive with respect to the grid is equivalent to making the grid more negative than the cathode. Thus, a net negative grid bias results. This negative bias causes the positive peaks of the plate voltages to be clipped. Capacitor C611 and resistors R626 and R625 form a common degenerative feedback network for tubes V603 and V605. The clipping of the negative and positive peaks of the plate voltages of tubes V603 and V605 (over-loaded operation of the amplifier) reduces variations in their plate output voltages, which can be caused by fluctuation of the 4-kc input and fluctuations of the unregulated plate voltage. The plate voltage for tubes V603 and V605 is applied to the plates through inductor L601 and windings 6–7 and 6–5, respectively, of transformer T606. The 4-kc component of the clipped output voltage at the plates of tubes V603 and V605 is selected by the tuned circuits consisting of winding 5–6–7 of transformer T606 shunted by capacitor C625. Secondary winding 1–2–3–4 of transformer T606 couples the stepped-down 4-kc signals to the harmonic generator (para 176). The 4-kc signals are supplied, for test purposes, through resistor R650 to jack J603.

175. Regulated Voltage Circuit

The +200 volts d-c from the power supply (pars 234) is applied through terminals 13 and 16 of jack J901 (fig. 150) and to terminals 13 and 16 of plug P601 of the carrier supply (fig. 153). A constant voltage is maintained as the plate of regulator tubes V604; therefore, fluctuations of the d-c input voltage are dissipated across paralleled resistors R642, R651, R652, and R653 (the resistance of inductor L601 is negligible). Unregulated plate voltage for tubes V603 and V605 of the push-pull amplifier is obtained across capacitor C612 and applied to terminal 6 of transformer T606. A regulated voltage, taken at the plate (pin 1) of tube V604, is applied to the screen grids (pin 6) of tubes V603 and V605. The regulated voltage at the plate of tube V604 is divided across resistors R643 and R644. The voltage developed across resistor R643 is applied to terminal 6 of transformer T605. This voltage is applied through the transformer windings and the resistors, R623 and R624, to the control grids (pin 1) of tubes V603 and V605. Inductor L601 and capacitors C608 and C612 form a filter circuit which prevents 4 kc or any of the carrier frequencies from getting into the + 200-volt power SUPPLY.

176. Harmonic Generator, Detailed Analysis

A simplified schematic diagram of the harmonic generator appears in figure 62. The harmonic generator consists of a selective Alter, the harmonic producing circuit, the odd harmonic circuits, and the even harmonic circuit. A detailed analysis of these circuits appears in paragraphs 177 through 181.

177. Harmonic Generator Selective Filter

Step-down transformer T606 (fig. 62) feeds the 4 kc from the push-pull amplifier to the 4-kc series-tuned filter circuit comprised of capacitors C613 through C616, and inductor L602. Capacitors C615 and C616 can be strapped as required to adjust the tuning of the filter. The filter eliminates the unwanted frequency components of the amplified signal. This filtered signal is then applied to saturable inductor L603 (para 178).

178. 4-KC Harmonic Producer

The 4-kc harmonic producer, inductor L603, contains a core which becomes saturated at low levels of input signal. Thus, for the low voltage

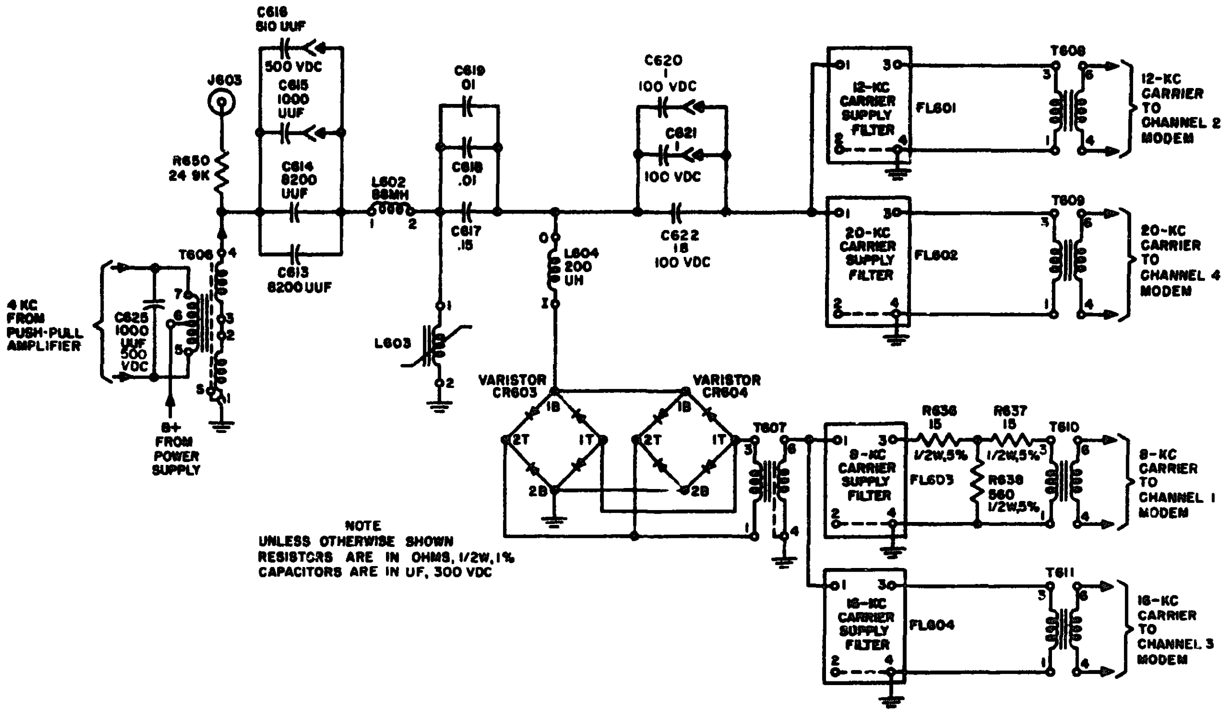


Figure 62. Harmonic generator, simplified schematic *diagram.*

at the start of the positive half-cycle of the 4-kc signal, a very low current flows through inductor L603, and the core is not saturated. Inductor L603 presents a high inductance during the early portion of the positive half cycle. This high inductance results in a high impedance. As the voltage increases during the positive half-cycle, the current through the core increases sufficiently to saturate the core. Throughout the major part of the positive half-cycle the core is saturated so that the inductance of the coil is very low. As the voltage decreases, and inductance of inductor L603 **increases. When the voltage reverses during the negative half-cycle of the 4-kc signal, the inductance and the resulting impedance are high for the low voltage part of the negative half-cyde and then decreases as the voltage increases.**

179. Functioning of Harmonic Producing Circuit

Figure 63, shows a simplified repre.entation of the harmonic producing circuit. In this figure, the harmonic producing circuit is shown as consisting of saturable inductor L603 in parallel with capacitors C617, C618, and C619 and an equivalent load circuit. This equivalent load circuit consists of the impedance presented by the odd harmonic circuit and the even harmonic circuit in parallel. During the low current portion of the positive half-cycle of Q-kc input, the inductance of L603 is high, little Q-kc current flows into inductor L603, and most of the current flows through the equivalent load, thereby charging

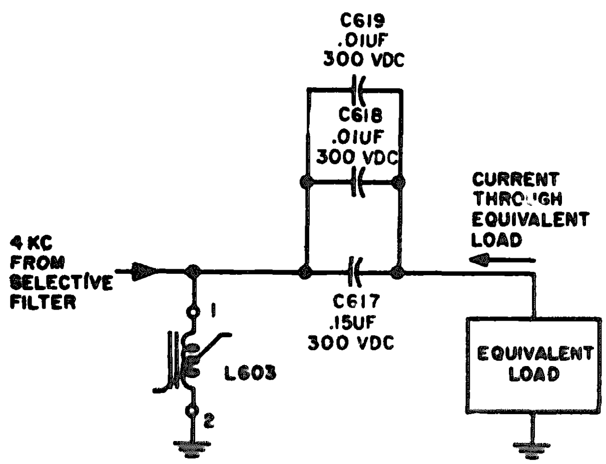


Figure 63. Harmonic productng circuit, equivalent circuit.

capacitors C617, C618, and C619. As shown in figure 64, the charge of the capacitors, which is shown to take place in the initial part of the half-cyle of the 4-kc input (point A to point B), produces a small positive current flow in the load circuit. When inductor L603 becomes saturated (at point B in figure 64). it acts as a low impedance shunt. The low impedance presented by inductor L603 shorts out the 4-kc input from the selective filter. This low impedance also causes capacitors C617, C618, and C619 to discharge through the equivalent load circuit and inductor L603. The dischange of the capacitors causes a sharply peaked negative surge of current through the equivalent load circuit following the discharge of the capacitors. Most of the 4-kc current flows through inductor L603, and very little current flows through the equivalent load circuit. This continues until the beginning of the negative half-cycle of the 4-kc input. During the negative half-cycle of the 4-kc input, capacitors C617 through C618 are alternately charged and discharged as during the positive half-cycle. However, the resulting current flow through the equivalent circuit is now the opposite of that for the positive half-cycle. Thus, the 4-kc input from the selective filter produces

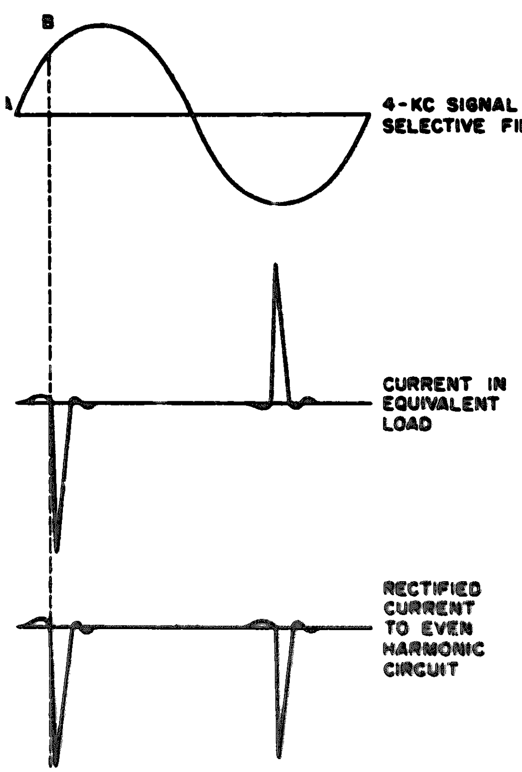


Figure 64. Waveshapes, harmonic generator

sharply peaked current surges that are alternately positive and negative in the equivalent load circuit. Such a waveshape is very rich in odd harmonics of 4 kc.

180. Odd Harmonic Circuit

In the odd harmonic circuit, the odd harmonics of the 4-kc contained in the sharply peaked input wave (fig. 64) are applies through shunted capacitors C620, C621, and C622 (fig. 62) to selective filters FL601 and FL602 (para 182). Filters FL601 and FL602 select the third and fifth harmonics, or 12 kc and 20 kc, respectively, from the large number of harmonics present. Transformers T608 and T609 couple the 12-kc and 20-kc carriers from the filters to terminals 9 and 12 and terminals 3 and 6, respectively, of plug P601 (fig. 153). Capacitors C620 and C621 can be strapped to vary the magnitude of the 12-kc and 20-kc carrier frequencies to obtain approximately equal outputs for the four carrier frequencies.

181. Even Harmonic Circuit

In the even harmonic circuit (fig. 62), two full-wave rectifiers, varistors CF603 and CR604 (see note, para 109), in series with an inductor L604, are bridged across shunted capacitors C617, C618, and C619 and inductor L603. Inductor L604 reduces the bridging effect of the varistors. In the rectifier output, alternate-pulses are reversed in polarity, so that all pulses have a negative polarity (fig. 64). The rectifier output thus has a fundamental frequency of 8 kc and hence contains all of the even harmonics of 4 kc. The dc component of the rectified output is bypassed by winding 1–3 of transformer T607. Filters FL603 and FL604 (para 182) select the second and fourth harmonics of 4 kc (8 kc and 16 kc) from the large number of even harmonics present in the output of the rectifiers. The output of the 8-kc filter FL603 is applied to plug P601 through a resistor pad (R635 through R638) and transformer T610. The outputs of the 12-kc, 16-kc, and 20-kc filters are applied to plug P601 through transformers T608, T611, and T609, respectively.

182. Filter FL601

A schematic representation of filter FL601 is shown in figure 65. This filter is the 12-kc carrier supply filter (fig. 153). The elements of the filter form a circuit with very sharp selectivity which selects frequencies only very close to 12 kc. Fil-

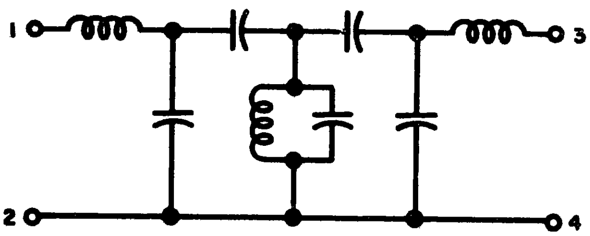


Figure 65. *Filter FL601, schematic representation.*

ters FL602, FL603, and FL604 are the 20-kc, 8kc, and 16-kc carrier supply filters, respectively. The schematic representation of these filters is identical with that for filter FL601. However, since filters FL602, FL603 and FL604 select frequencies near 20 kc, 8 kc and 16 kc, respectively, the value of their circuit elements differs from those of filter FL601. All filters are contained in sealed units; maintenance or replacement of parts cannot be performed on the filters. If a filter is defective, replace the entire unit.

183. Transmission of Carriers to Channel Modems of TA-219/U

The 8-kc, 12-kc, 16-kc, and 20-kc carriers are transmitted from the carrier supply to channel 1, 2, 3, and 4 modems, respectively. The transmission path for each of these carriers is given in a through d below.

a. Transmission Path of 8-kc Currier. The 8-kc carrier is applied through terminals 11 and 8 of plug P601 (fig. 153) and jack J901 (fig. 150 terminals 2 and 1 of terminal board TB901, and terminals M and C of plug P999 to the TA-219/U. In the TA-219/U, the 8-kc carrier passes through terminals M and C of jack J6 (fig. 145) and terminals 3 and 0 of jack J1, to terminals 3 and 0 of plug P101 of channel 1 modem.

b. Transmission Path of 12-kc Carrier. The 12-kc carrier is applied through terminals 9 and 12 of plug P601 (fig. 153) and jack J901 (fig. 150), terminals 5 and 4 of terminal board TB901, and terminals N and D of plug P999 to the TA-219/U. In the TA-219/U, the 12-kc carrier passes through terminals N and D of jack J6 (fig. 145) and terminals 3 and 0 of jack J2 to terminals 3 and 0 of plug P201 of channel 2 modem.

c. Transmission Path of 16-kc Carrier. The 16-kc carrier is applied through terminals 2 and 5 of plug (fig. 153) and jack J901 (fig. 150) terminals 7 and 6 of terminal board TB901 and terminals P and E of plug P999 to the TA-219/U. In the TA-219/U, the 16-kc carrier passes through terminals E and P of plug J6 (fig. 145) to terminals 0 and 3 of jack J3, to terminals 0 and 3 of plug P301 of channel 3 modem.

d. Transmission Path of 20-kc Carrier. The 20-kc carrier is applied through terminals 3 and 6 of plug P601 (rig. 153) and jack J90-1 (fig. 150), terminals 10 and 9 of terminal board TB-901, and terminals R and F of plug P999 to the TA-219/U. In the TA-219/U, the 20-kc carrier passes through terminals R and F of jack J6 (fig. 145) to terminals 3 and 0 of jack J4 to terminals 3 and 0 of plug P401 of channel 4 modem.

184. Ringer-Oscillator, Functioning

a. General. A general description of the functioning of the ringer-oscillator is given in paragraph 95a. A detailed analysis of the ringer-oscillator as a ringer is given in paragraph 185 through 194. A detailed analysis of the ringer-oscillator as an oscillator is given in paragraphs 196 through 199. The simplified schematic diagram of the ringer-oscillator is shown in figure 67. The schematic diagram of the ringer-oscillator is shown in figure 154.

b. Block Diagram.

(1) The block diagram of the ringer-oscillator and the circuits associated with it appear in fig 6.

(2) As shown in figures 66 and 68, the ringer-oscillator functions in (conjunction with AMPLIFIER switch S771 of the measuring circuit, low-pass filters FL721 and FL722, the limiter circuit comprised of varistors CR721 and CR722, ORDER WIRE switch S702 of the order wire circuit (para 202), and front-panel CALL lamp 1742.

(3) The ringer-oscillator contains tube V1A, which operates as an amplifier when the circuit functions as a ringer and as a 1,600-cps oscillator, when the circuit functions as an oscillator. The ringer-oscillator also contains the 1,600-cps response circuit (tube V2B), and the guard channel (tube V2A). These circuits provide a safeguard against false ringing (para 187*d*). In addition, the ringer-oscillator contains the relay control tube (V1P), call relay K1, and buzzer I1.

185. Ringer, Block Diagram, Analysis, General

When the ringer-oscillator functions as a ringer, it may be considered, for purposes of analysis, to consist of the ringer input path and the ringer

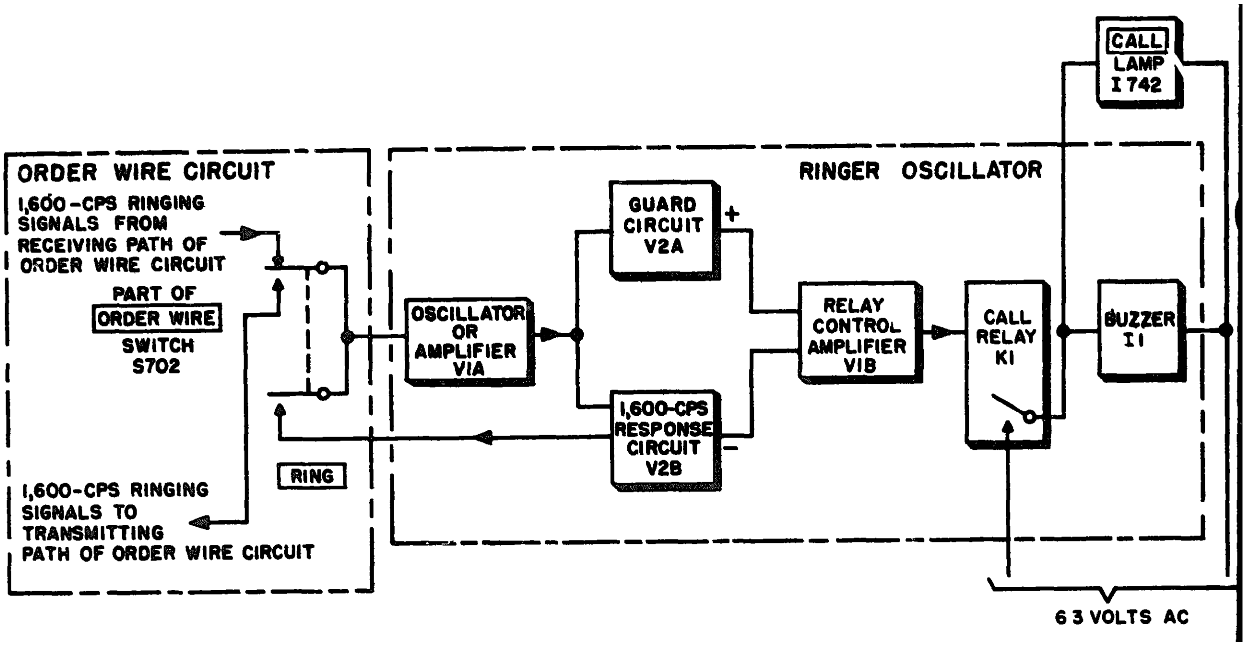


Figure 66. Ringer-oscillator, block diagram.

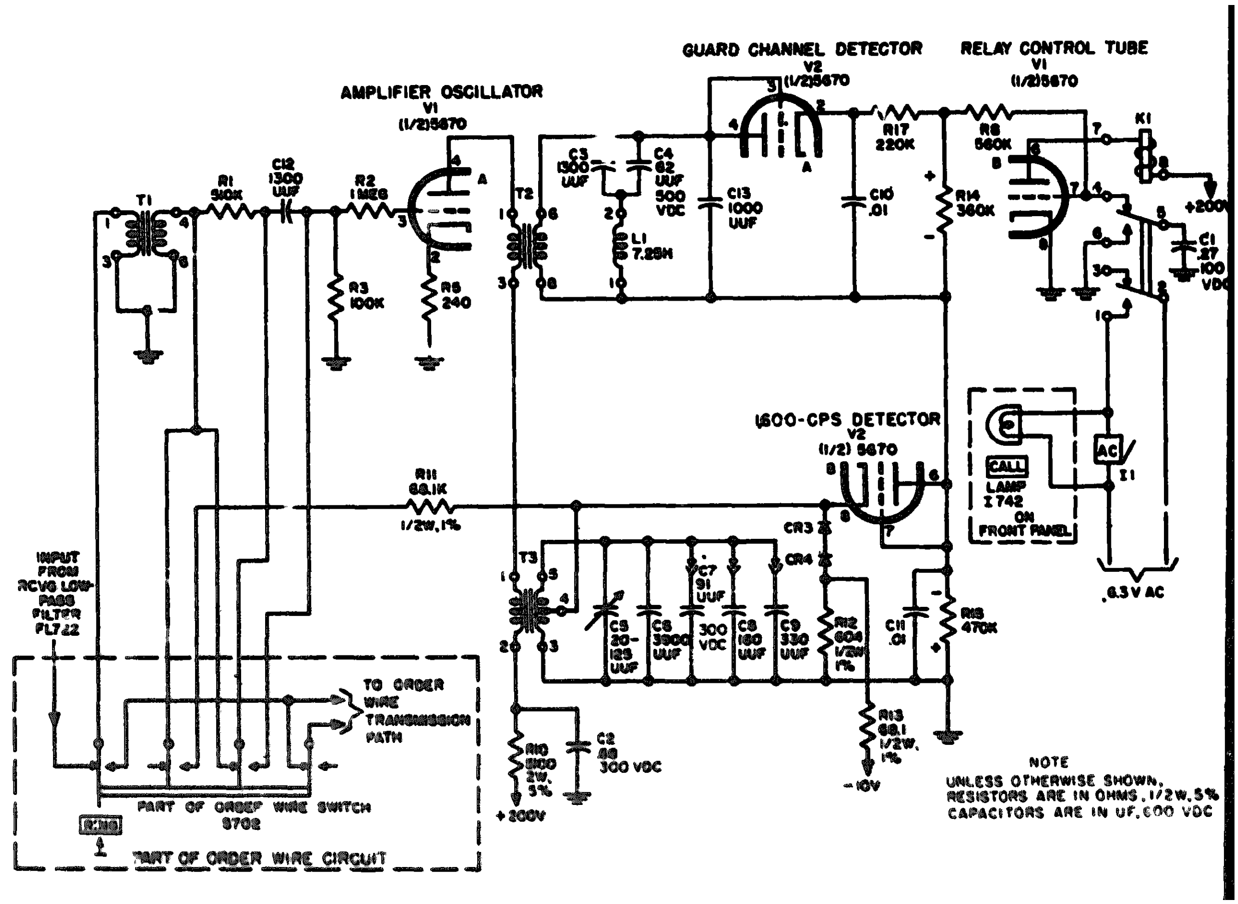


Figure 67. Ringer-oscillator, simplified schematic diagram.

proper. An analysis, based on the block diagram of the ringer-oscillator, of the circuits in the ringer input path and the ringer itself is given in paragraphs 186 and 187, respectively. A detailed analysis of the ringer-oscillator as a ringer is given in paragraphs 188 through 194.

186. Ringer Input Path, Block Diagram Analysis

The ringer-oscillator functions as a ringer when ORDER WIRE switch S702 (fig. 68) is either nonoperated or operated to the TALK position. When the ORDER WIRE switch is in either of these two positions, the output of the receiving amplifier (para 156) is passed through AMPLIFIER switch S771 of the measuring circuit to low-pass filter FL722 of the order wire circuit (para 201b). Filter FL722 rejects undesired high-frequency signals and allows low-frequency signals to pass. The output of filter FL202 is applied through ORDER WIRE switch S702 to the ringer-oscillator. This input to the ringer-oscillator (fig. 66) consists of 1,600-cps ringing signals from a distant station, speech from the order wire circuit at the distant station, and noise signals. A detailed analysis of the circuits in the input path to the ringer-oscillator appears in paragraph 188.

187. Ringer, Block Diagram Analysis

a. Amplifier Tube V1A. When ORDER WIRE switch S702 is in either the normal or TALK position, the input to the ringer-oscillator is applied to amplifier-oscillator tube V1A (fig. 66) and tube V1A operates as an amplifier. When the ORDER WIRE switch is in the RING position, tube V1A operates as an oscillator (para 195). The input signals are amplified in tube V1A, and applied to the 1,600-cps response circuit and to the guard channel. A detailed analysis of the functioning of the input amplifier is given in paragraph 190.

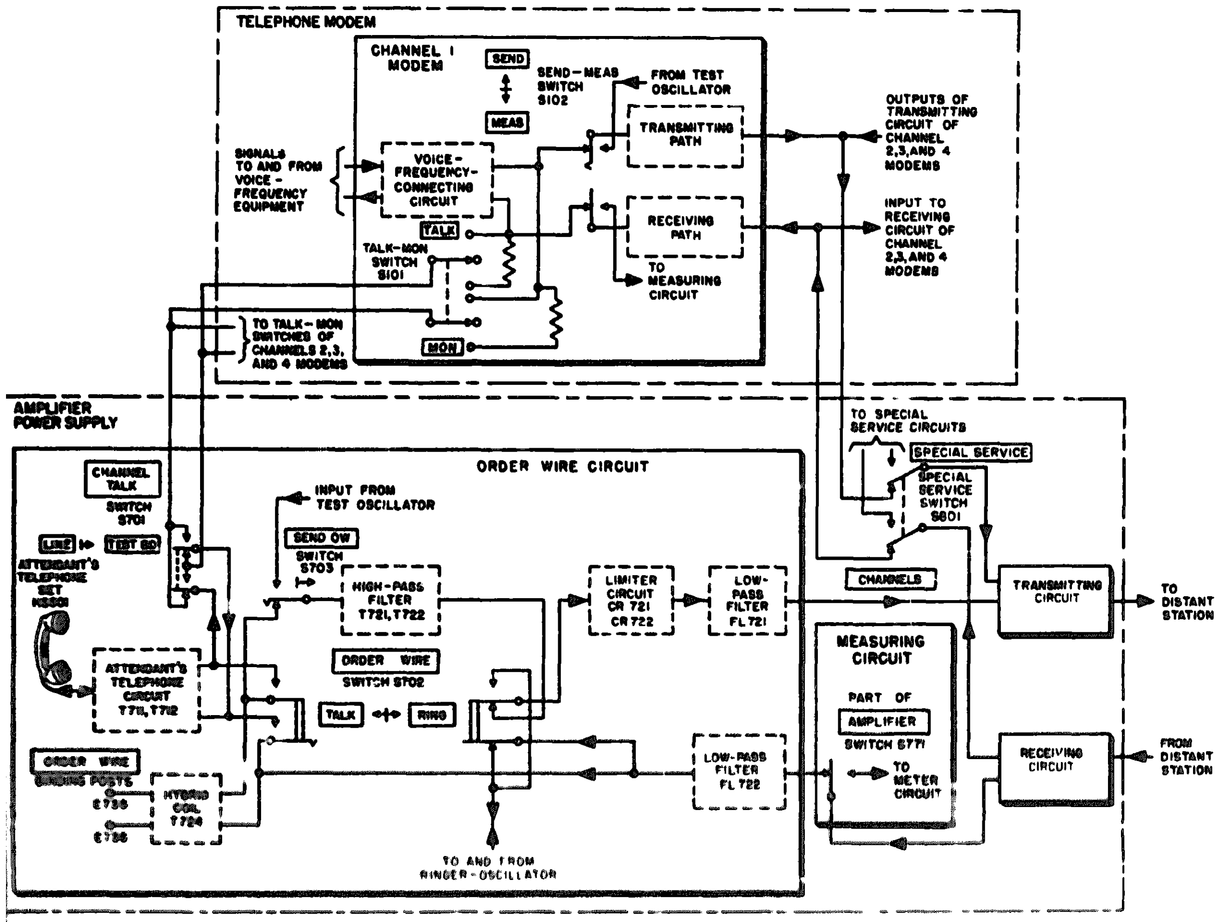


Figure 68. Order wire circuit, block diagram.

b. *1,600-cps* Response Circuit In the 1,600-cps response channel, the signals from amplifier-oscillator tube V1A are applied to a tuned-circuit which passes signals with frequencies in a narrow band centered around 1,600 cps and rejects all other signals. The passed signals are limited and rectified in the 1,600-cps response circuit. The rectified signals appear as a negative dc voltage. This negative dc voltage is applied to the control grid of relay control amplifier tube V1B. A detailed analysis of the 1,600-cps response circuit is given in paragraph 191.

c. Guard *Channel.* In the guard channel, the signals from amplifier-oscillator tube V1A are applied to a selective filter. This filter rejects all signals with frequencies in a narrow band centered around 1,600 cps, and passes all signals outside the narrow band. The passed signals are rectified in the guard channel and appear as a positive de voltage which is applied to the control grid of the relay control amplifier. A detailed analysis of the guard channel is given in paragraph 192.

d. Safeguard Against False Ringing. The guard channel and 1,600-cps response circuit provide a safeguard against false ringing which can be caused by signals other than the 1,600-cps ringing signals. The positive output of the guard channel counteracts the negative voltage produced by the 1,600-cps response circuit in such a manner that outputs due to 1,600-cps signals other than ringing signals are balanced out. The balancing of these two otuputs is such that when no ringing signals are received, the net positive dc voltage applied to the grid of relay control tube V1B causes the tube to conduct sufficient current to maintain relay K1 in an operated condition. When ringing signals are received, the negative output of the 1,600-cps response circuit overbalances the positive output of the guard channel, thereby applying a net negative voltage to the grid of relay control tube V1B. This negative voltage is sufficient to cut off the tube. When the relay control tube is cut off, the relay releases, and the buzzer is energized. A detailed analysis of the relay safeguard against false ringing appears in paragraph 193.

e. Relay Control Circuit. Relay control tube V1B, which is normally conducting heavily, is cut off by the net negative voltage applied to it by the 1,600-cps response circuit when a ringing signal is received. When tube V1B is cut off, it causes call relay K1 to release. This in turn applies 6.3 volts ac from the power supply (para 235) through the relay contacts to buzzer I1 and CALL lamp 1742. (The call lamp also operates in conjunction with the system alarm circuit (para 220).) A detailed analysis of the relay control circuit is given in paragraph 194.

188. Ringer Input Path, Detailed Analysis

When the ringer-oscillator is used as a ringer, the input to the ringer is applied from the receiving amplifier through the measuring and order wire circuits. A detailed analysis of the circuits that comprise the path of the input to the ringer appears in a and b below.

a. Path Through Measuring Circuit.

(1) The output of the receiving amplifier at terminals 3 and 10 of plug P51 (fig. 150) is applied through terminals 3 and 10 of jack J802 and terminals 3 and 4 of terminal board TB802 to the measuring circuit.

(2) As is shown in the schematic diagram of the measuring circuit (figs. 156 and 157), the output of the receiving amplifier is applied through AMPLIFIER switch S771 (with switch S771 in the normal position) to the order wire circuit.

b. Path Through Order *Wire Circuit.* After the signal passes through AMPLIFIER switch S771 (figs. 155, 156, and 157). it is applied to terminals 1 and 2 of receiving low-pass filter FL722 (para 202b) of the order wire circuit. The filter rejects undesired high-frequency signals and allows low-frequency signals, such as the voice signal and the 1,600-cps ringing signal, to pass. The output of filter FL722 is taken at terminal 3 of the filter and applied through resistor R732 to ORDER WIRE switch S702. With this switch in the normal position, the signal is applied through terminal 1 of terminal board TB902 (fig. 150) and terminal 1 of jack J902 to terminal 1 of plug P1 in the ringer-oscillator. In the ringer-oscillator, the signal is applied to terminal 1 of transformer T1 (fig. 154).

189. Ringer, Detailed Analysis

The detailed analysis of the ringer-oscillator as a ringer is given in paragraphs 190 through 194. This detailed analysis is given with the aid of the simplified schematic of the ringer-oscillator shown in figure 67.

190. Amplifier-Oscillator Stage

The amplifier consists of tube V1A, transformer T1, and associated components.

top limit of approximately 2,500 cps on the frequencies delivered by the transformer winding by greatly decreasing its response for frequencies above 2,500 cps.

b. Gum&Channel Detector Circuit. The output of secondary winding 6-3 of transformer T2 is rectified by diode-connected tube V2A. The rectified voltage is filtered by capacitor C10 and resistors R14 and R17. Tube V2A, capacitor C10, and resistors R14 and R17 from a detector circuit that produces a positive dc voltage across resistor R14 and is applied through resistor R8 to the grid (pin 7) of tube V1B.

193. Safeguard Against False Ringing

a. The negative voltage developed by the 1,600-cps signal response circuit appears across resistor R15 (para 191c and fig. 66). The positive voltage developed by the guard-channel circuit appears across resistor R14 (para 192b).

b. Because resistors R15 and R14 are in series, the algebraic sum of the voltages across these resistors is applied to the junction of resistors R14 and R8. The resulting voltage is applied through resistor R8 to the grid (pin 7) of relay control tube V1B (para *194a).*

c. If a speech signal is received, its frequency spectrum includes a 1,600-cps component. The 1,600-cps signal response circuit develops a negative output when such a signal is received. The guard-channel circuit develops a positive output from the voltages at frequencies other than 1,600-cps contained in the speech. The positive output opposes the negative output of the 1,600-cps response circuit, and a net positive output voltage appears at the junction of resistors R14 and R8. This positive voltage is applied to the grid (pin 7) of relay control tube V1B (para 194). The positive voltage keeps the tube conducting heavily. The current flow through the tube keeps call relay K1 operated. When call relay K1 is operated, buzzer I1 and CALL lamp I752 are not energized.

d. The limiter circuit in the 1,600-cps response circuit (para 191*b*) prevents high levels of speech input from producing an output of the 1,600-cps response circuit which would overbalance the output of the guard channel. Overbalance of the guard-channel output would cause false rings. A relatively long time-constant in the relay control circuit also provides a safeguard against false ringing (para 194) caused by noise surges of short duration.

e. The band of frequencies to which the guard channel responds is limited by capacitors C12 and C13 (para 190 and 192a). The limiting of the frequency band reduces the tendency of the guard channel to produce too large a positive output due to noise. Too large a positive output from the guard channel would overbalance the negative voltage output of the 1,600-cps response circuit resulting from an incoming ringing signal, If this were not prevented from happening, an incoming ringing signal would not produce the normal indications.

194. Relay Control Circuit, Detailed Analysis

The relay control circuit consists of relay control tube V1B, call relay K1, buzzer I1, and CALL lamp I742.

a. When no 1,600-cps ringing signals are received, a slightly positive output resulting from the algebraic addition of the outputs of the 1,600-cps response circuit and the guard channel is applied through resistor R8 to the grid (pin 7) of relay control tube V1B (para 193b and c). The relay-control tube V1B supplies the operating current for relay K1, the plate (pin 6) being connected through winding 7–8 of the relay to +200 volts (this voltage is taken from terminal 19 of plug P1, fig. 150 and 154). The positive voltage applied to the grid of tube V1B causes the plate current of tube V1B to be sufficient to keep relay K1 operated. When relay K1 *is* operated, the relay contacts keep the circuit of buzzer I1 and CALL LAMP I742 open.

b. The 1,600-cps signal response circuit develops a large negative voltage when a 1,600-cps ringing signal is received. This negative voltage overbalances the positive voltage from the guard channel. A net negative voltage is applied through resistor R8 to the grid (pin 7) of tube V1B (para 191*c*).

c. Resistor R8 is shunted to ground by capacitor C1. The grid of tube V1B becomes more and more negative as capacitor C1 is charged. The relatively long time-constant provided by resistor R8 and capacitor C1 requires the application of the 1,600-cps signal for more than about 0.2 second in order to make the grid sufficiently negative to reduce the plate current to a value at which relay K1 releases

d. When relay K1 releases, contact 5 breaks with contact 4 and makes with contact 6, dis

a. The signal obtained from low-pass filter FL722 is passed through ORDER WIRE switch S702 and applied to terminal 1 of input transformer T1 (para 188b). The input signal is stepped up by transformer T1, coupled through capacitor C12, developed across resistor R3 (terminating resistor for transformer T1) and applied through grid-current limiting resistor R2 to the grid (pin 3) of amplifier-oscillator tube V1A. Resistor R1 (used in the circuit when it functions as an oscillator) is shorted by the contacts of the ORDER WIRE switch when this switch is in the normal or the TALK position. Capacitor C12 limits the amplitude of signals having frequencies below 300 cps.

b. The amplified signals at the plate of tube V1A (pin 4) are developed across the plate load consisting of primary winding 1-3 of transformer T2 and primary winding 1-2 of transformer T3. Secondary winding 6-8 of transformer T2 couples the amplified signals from the plate of tube V1A to the guard channel. Secondary winding 3-4-5 of transformer T3 couples the amplified signals from the plate of tube V1A to the 1,600-cps response circuit.

c. Resistor R5 provides cathode-bias for tube V1A and also produces a small amount of negative feedback. The +200 volts plate voltage for tube V1A (which is applied from the power supply through terminals 18 and 19 of jack J902 to terminals 18 to 19 of plug P1 (fig. 150)) is applied to plate-voltage dropping resistor R10. Capacitor C2 is the plate supply bypass capacitor.

191. 1,600-cps Response Circuit

The 1,600-cps response circuits of the 1,600-cps tuned circuit, the limiter circuit, and the 1,600-cps detector circuit. A detailed analysis of these circuits is given in *a* through *c* below.

a. 1,600-cps Tuned Circuit. The input to the 1,600-cps response circuit is induced in secondary winding 3–4–5 of transformer T3. The secondary winding is shunt-tuned to 1,600 cps by capacitors C5 (which is adjustable), C6, C7, C8, and C9. The circuit can be accurately tuned by adjusting capacitor C5 and by altering the strapping of capacitors C7, C8, and C9. The output from this tuned circuit is taken from terminal 4 of transformer T3 and applied to the cathode (pin 8) of tube V2B, which is a triode connected to function as a diode.

b. Limiter Circuit. A limiter circuit, consisting of varistors CR3 and CR4 (see note, para 109) and resistors R12 and R13, is connected to the cathode of tube V2B. The circuit shorts out the tops of the negative peaks of the output developed by the 1,600-cps tuned circuit (*a* above), thus limiting the negative peaks applied to the cathode of tube V2B. This limiting of the negative peaks prevents unusually high inputs to the ringer-oscillator from causing false rings by overbalancing the guard channel output (para 192). A dc potential of -10 volts which is applied from the power supply through terminals 11 and 13 of jack J902 to terminals 11 and 13 of plug P1, (figure 150) is divided across resistors R12 and R13 to provide negative bias for the limiter circuit.

c. 1,600-cps *Detector Circuit.* The limited output of the limiter circuit (b above) is applied to the cathode (pin 8) of tube V2B. This tube rectifies the signals. The rectified signals are filtered by capacitor C11 and resistor R15. Tube V21 capacitor C11, and resistor R15 form a detector circuit, which produces a dc voltage, negative with respect to ground, across resistor R15 and capacitor C11. This negative d-c voltage is added in series with the positive dc voltage *pro*duced by the guard channel detector (para 192b). The sum of these voltages is applied through resistors R14. and R8 to the grid (pin 7) of relay control tube V1B. If 1,600-cps ringing signals are received by the ringer-oscillator, the negative output from the 1,600-cps response circuit overbalances the positive output of the guard channel (para 192 and 193). A net negative voltage is then applied to the grid (pin 7) of tube V1B.

192. Guard Channel

The guard channel consists of the 1,600-cps blocking filter circuit, and the guard channel detector circuit. A detailed analysis of these circuits is given in *a* and *b* below.

a. 1,600-cps Blocking Filter Circuit. The input to the guard channel is induced in secondary winding 6–8 of transformer T2. The secondary winding of the transformer is shunted by a 1,600-cps, series-resonant circuit composed of capacitors C3 and C4 and inductor L1. This series-resonant circuit acts as a filter that shorts out signals having frequencies in a narrow band centered around 1,600 cps. Consequently, winding 6–8 of transformer T2 applies signals to capacitor C13 which contain all frequencies except those close to 1,600 cps. However, capacitor C13 imposes a connecting the negatively charged capacitor from the grid, and discharging capacitor Cl to ground. Therefore, the relay will immediately reoperate when the 1,600-cps signal is removed. When contacts 1 and 2 of the relay make, buzzer I1 and CALL lamp 1742 are energized by 6.3 volts ac. CALL lamp 1742 is connected in parallel with buzzer I1 by terminals 7 and 17 of mating jack J902 and plug Pl (figs. 150 and 154). The 6.3 volts ac is applied to the ringer-oscillator through terminals 14 and 15 of jack J902 and plug Pl.

195. Functioning of Oscillator Circuits

A block diagram analysis of the oscillator and the circuits in the oscillator output path is given in paragraphs 196 and 197. A detailed analysis of the ringer-oscillator as an oscillator is given in paragraphs 198 and 199.

196. Oscillator, Block Diagram Analysis

a. Oscillator Stage.

(1) When ORDER WIRE switch S702 is in he RING position, the 1,660-cps response circuit para 191) is connected through the RING conacts of the ORDER WIRE switch to the transmit path of the ORDER WIRE circuit (fig. 66). In the RING position, the TALK contacts of the ORDER WIRE switch are opened and no signals are applied to the ringer-oscillator.

(2) Tube VIA and the tuned circuit of the 1,600-cps response circuit (para 191a) constitute an oscillator that generates the ringing signals The ringing signals are taken from the 1,600-cps response circuit and applied through the RING contacts of the ORDER WIRE switch to the oscillator output path (para 197). A detailed analysis of the oscillator stage is given in paragraph 198*a*.

b. 1,600-cps Response Circuit, Functioning With Oscillator. The 1,600-cps output of the oscillator causes the 1,600-cps response circuit to function as it would when it received 1,600-cps signals from sources external to the ringer-oscillator (para 191). Specifically, the 1,600-cps output of the oscillator produces a negative output voltage from the 1,600-cps response circuit. This negative voltage is applied to the relay control circuit thereby causing buzzer I1 to sound, and CALL lamp 1742 to light (para 194). A detailed analysis of the 1,600-cps response circuit when the ring-oscillator acts as an oscillator is given in paragraph 198*b*.

197. Oscillator Output Path, Block Diagram Analysis

The output; of the oscillator passes through the contacts of ORDER WIRE switch S702 when in RING position to a limiter circuit, which is part of the order wire circuit (fig. 68). The limiter circuit comprised of varistors CR721 and CR722 limits the amplitude of the signal applied to it. The limited signals are then applied to the transmitting circuit in the AM-682/TCC-3 (para 120). The output of the transmitting circuit is transmitted by the spiral-four cable to the distant station, where it causes the call relay of the ringer-oscillator to release. This in turn, results in the lighting of the CALL lamp and the sounding of the buzzer. A detailed analysis of the output path of the oscillator is given in paragraph 199.

198. Oscillator, Detail Analysis

a. Functioning of Oscillator Stage. As shown in the simplified schematic diagram of the ringer-oscillator (fig. 67), operation of ORDER WIRE switch S702 to the RING position provides a positive feedback path from terminal No. 4 of transformer T3 through resistor R11 through ORDER WIRE switch S702, resistor R1, capacitor C12 and resistor R2 to the grid (pin 3) circuit of tube V1A. This converts tube V1A from an amplifier to an oscillator. The frequency of oscillation is determined by the 1,600-cps tuned secondary winding (3-4-5) of transformer T3, and is controlled by adjustment of trimmer capacitor C5 and connections to capacitors C7, C8, and C9. Operation of the ORDER WIRE switch to the RING position removes the short circuit from resistor R1. Resistors R1, R3 and R11 form a voltage divider to provide proper positive feedback for oscillation. The amplitude of oscillation is limited by the bias of the limiter circuit and varistors CR3 and CR4. Capacitor C12, used when ringing signals are received, is by passed by operation of the ORDER WIRE switch to the RING position. The 1,600-cps feedback signal, which is applied to terminal No. 4 of transformer T1, is developed in winding 4-6 of the transformer and coupled to winding 1-3 of the transformer. The output of winding 1-3 of transformer T1 is applied through the contacts of switch S702 to the limiter circuit in order wire circuit (fig. 66).

b. Functioning of 1,600-cps Response Circuit When ORDER WIRE switch S702 is operated to the RING position, the 1,600-cps signal generated by the oscillator circuit is applied to the 1,600-cps response circuit and causes a negative d-c voltage to be developed across resistor R15 and capacitor C11 (para 191). This negative voltage causes buzzer I1 to sound and CALL lamp I742 to light (para 194). Lighting of the CALL lamp and sounding of buzzer I1 when switch S702 is operated to the RING position is used as an indication of proper operation of the oscillator circuit.

199. Oscillator Output Path, Detailed Analysis

When ORDER WIRE switch S702 is operated to the RING position, the output induced in winding 1–3 of transformer T1 is passed through terminals 1 of plug P1, jack J902, and terminal board TB902 to the order wire circuit (figs. 150, 154, and 155). In the order wire circuit, the output of the oscillator is applied to winding 1–2 of transformer T722. The signal is induced in secondary winding 3–4–5–6 of the transformer and passed through the limiter circuit (CR721 and CR722) and low-pass filter FL721 (para 203) to the transmitting circuit of the AM–682/TCC (para 120*b*). The output of filter FL721 is applied across resistor R815 and ground in the attenuating network of the transmitting circuit (fig. 150). The ringing signals pass through the transmitting circuit of the AM–682/TCC–3 and is transmitted to the distant station over the spiral-four cable.

200. Order Wire Circuit, General

a. General. A general description of the functioning of the order wire circuit is given in paragraph 96. The order wire provides a voice frequency channel in conjunction with the TA–219/U, permits extension of the order wire circuit on a two-wire basis, and transmits a 1-kc test signal during the system lineup. A detailed analysis of this circuit to provide a voice-frequency channel is given in paragraphs 201 and 202. A detailed analysis of the order wire circuit in performing its other functions is given in paragraphs 204 through 210. These analyses are given with aid of the simplified schematic diagram of the order wire circuit (fig. 69) and the simplified schematic diagram of the connection of the order wire circuit to channel modems (fig. 70). A schematic diagram of the order wire circuit appears in figure 155.

b. Block Diagram.

(1) The order wire circuit (fig. 68) functions in conjunction with the channel modems of the TA-219/U, the transmitting and receiving circuits of the AM-682/TCC-3 and the AMPLIFIER switch S771 of the measuring circuit of the AM-682/TCC-3.

(2) The order wire circuit consists of the attendant's telephone set, HS801, the attendant's telephone circuit, SEND OW switch S703, the high-pass filter circuit transformers T721 and T722, the limiter circuit comprised of varistors CR721 and CR722, low-pass filter FL721, low-pass Alter FL722, ORDER WIRE switch S702, CHANNEL TALK switch S701, hybrid coil T724, am-d ORDER WIRE binding posts E735 and E736.

(3) A block-diagram analysis of the functioning of the order wire circuit to provide a voice-frequency channel is given in paragraph 202. An analysis, based on the block diagram (fig. 68), of the functioning of the order wire circuit in performing its other function is given

201. Functioning of Order Wire Circuit to Provide a Voice-Frequency Channel, Block Diagram Analysis

When the order wire circuit is used to provide a voice-frequency channel, ORDER WIRE switch S702 is operated to the TALK position. For this position, voice signals from the attendant's telephone set of the local AN/TCC–3 are transmitted to the attendant's telephone set at the distant station. Similarly, signals from the distant station are transmitted to the telephone set of the local AN/TCC–3. A discussion of the transmitted and received signals are given in *a* and *b* below.

a. Transmitted Signals.

(1) When the ORDER WIRE switch is in the TALK position, signals originating at the transmitter of the attendant's telephone set, HS-801, pass though the attendant's telephone circuit, the contacts of ORDER WIRE switch S702 and SEND OW switch S703 (in the normal position) to the high-pass filter.

(2) When SEND OW switch S703 is in the operated (horizontal) position, the input from the test oscillator is applied to the high-pass filter (para 202*a*), and the circuit between the transmitter of telephone set HS801 to the high-pass filter is opened.

(3) Depending upon the position of the SEND OW switch, the signals from either the transmitter on handset HS801 or the test oscil-

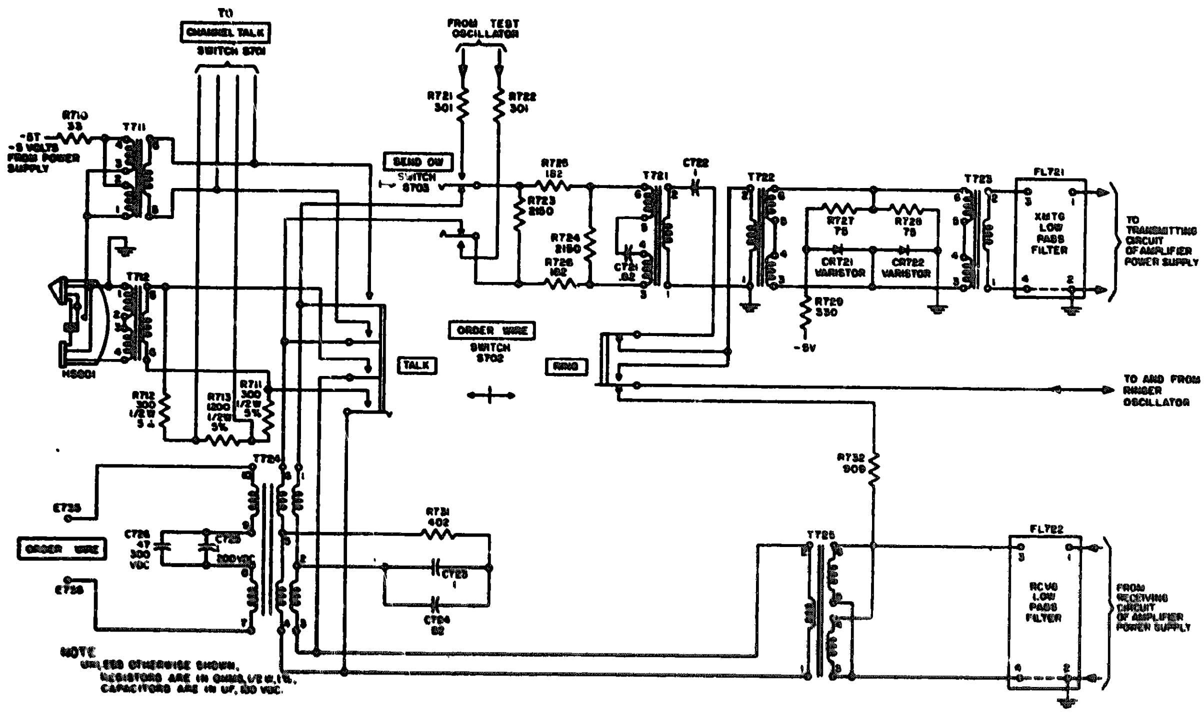


Figure 69. Order wire, simplified schematic diagram.

lator pass through the high-pass filter, composed of transformers T721 and T722, the limiter circuit, composed of varistors CR721 and CR722, low-pass filter FL721, and the transmitting circuit of the AM–682/TCC–3 (para 120*b*) to the spiral-four cable to the distant station.

b. Received Signals. When the ORDER WIRE switch is in the TALK position, responses from the distant station come to the receiver of the attendant's telephone over the spiral-four cable, through the receiving circuit of the AM–682/TCC–3 (para 131 and fig. 68), the contacts of AMPLIFIER switch S771 in the measuring circuit, low-pass filter FL22 and the ORDER WIRE switch to the receiver of telephone set HS801. A detailed analysis of the order wire circuit to provide a voice-frequency channel is given in paragraph 202.

202. Functioning of Order Wire Circuit to Provide a Voice-Frequency Channel, Detailed Analysis

A detailed analysis of transmitting and receiving when the order wire circuit provides a voice-frequency channel is given in *a* and *b* below.

a. Transmitted Voice-Frequency Signals.

(1) When the press-to-talk switch on the attendant's telephone set, HS801, is operated (fig. 69), the transmitter of HS801 is connected in series with windings 1–2 and 3–4 of transformer T711 and resistor R710 across the –5T dc voltage of the power supply (para 236). The –5T voltage from the power supply is applied between terminals 4 and 5 (ground) of terminal board TB702. Talking into the transmitter causes the resistance of the carbon granules in the tra-

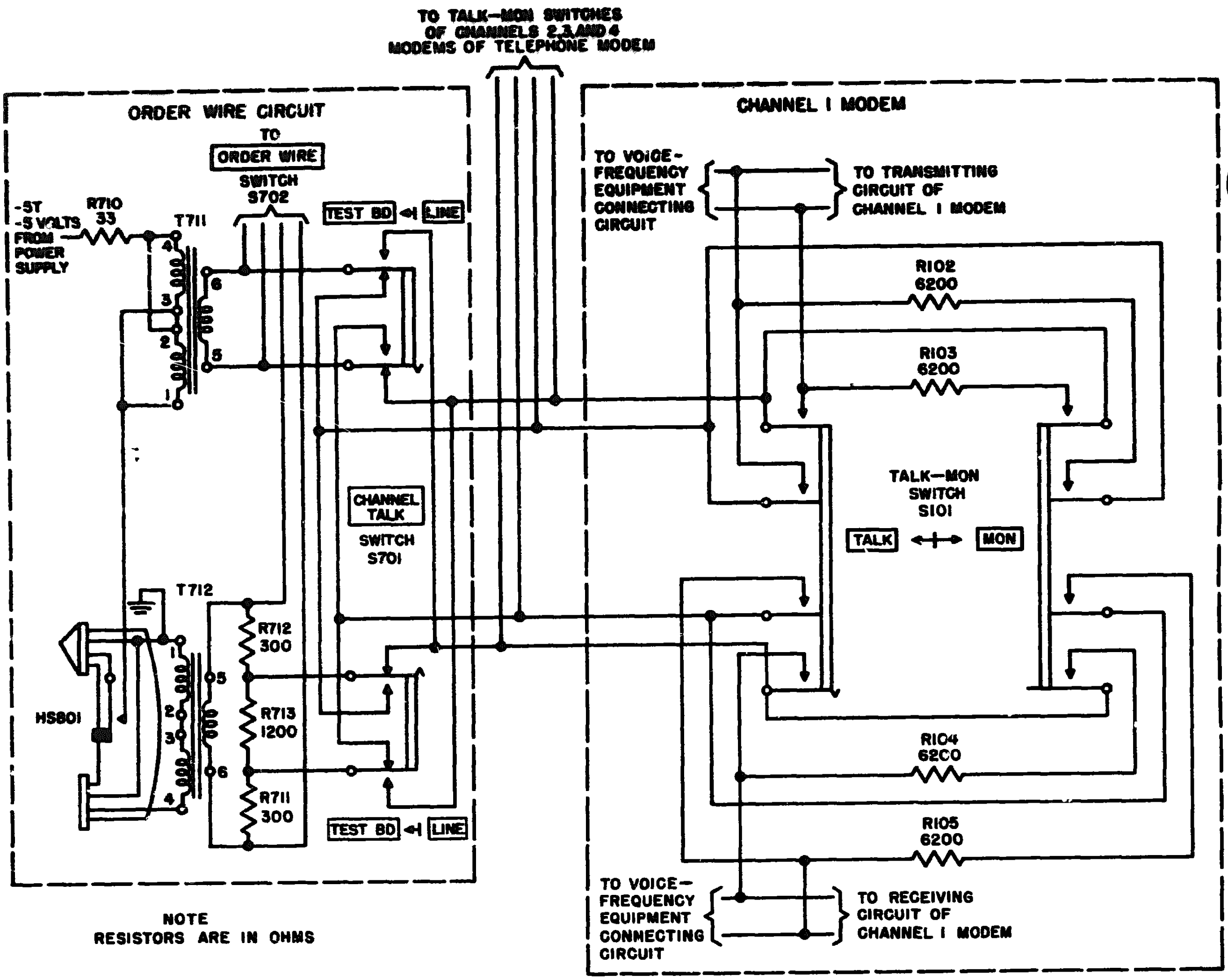


Figure 70. Connection of order wire circuit to channel modems, simplified schematic diagram.

mitter to vary. The varying resistance of the transmitter causes the voltages produced across windings 1-3 and 3-4 of transformer T711 to vary. These variations are stepped up by transformer T711. The output of secondary winding 5-6 of transformer T711 is applied to CHANNEL TALK switch S701. The signals pass through the CHANNEL TALK switch to the TALK-MON switch of the channel modems of the TA-219/U. This path is used when the terminal attendant communicates with a distant station over a traffic channel.

(2) When the ORDER WIRE switch is in the TALK position, the output of the secondary winding of transformer T711 is applied through two contacts of the ORDER WIRE switch, to SEND OW switch S703. When the SEND OW switch is nonoperated, the signals pass through the SEND OW switch to the attenuator pad consisting of resistors R723 through R726.

(3) The output of the secondary winding of transformer T711 is also applied to terminals 1 and 6 of hybrid coil T724 when the ORDER WIRE switch is in the TALK position. The low output appearing at terminals 3 and 4 of the hybrid coil is applied through the ORDER WIRE switch and transformer T712 to the receiver of telephone set HS801, thereby providing side tone.

(4) After the output of transformer T711 passes through the attenuator pad, resistors R723 through R726, it is applied to the primary windings of transformer T721, The secondary winding of transformer T721 connects through capacitor C722 and two closed contacts of ORDER

WIRE switch S702 to the primary winding of transformer T722. Capacitors C721 and C722 together with transformers T721 and T722 form a high-pass filter that rejects undesired low frequencies.

(5) A limiter circuit consisting of resistors R727 and R728 and varistors CR721 and CR722 (see note, para 109) is connected across the secondary windings of transform-jr T722. The limiter circuit is biased from the -5V supply of the power supply through resistor R729. When the instantaneous voltage at terminal 6 of transformer T722 is more positive than the voltage at terminal 3 by an amount that exceeds the normal voltage across resistor R727, varistor CR721 conducts, thereby limiting the positive amplitude of the signal. When the negative *swing* of voltage becomes excessive, varistor CR722 *con*ducts and limits the negative amplitude of the voltage. The limited signal is then stepped down by matching transformer T723 and applied to low-pass filter FL721 (para 203), which rejects the high frequency components of voice signals. The output of the low-pass filter is connected to the transmitting circuit of the AM-682/TCC-3 (para 120) and from there through the spiral-four cable to the distant terminal.

b. Received Voice-Frequency Signals. Signals from the distant station are transmitted over the spiral-four cable and through the receiving circuit of the AM-682/TCC-3 (pars 131) and AMPLIFIER switch S771 of the measuring circuit to low-pass filter FL722 (para 203). This filter passes the voice frequencies and applies them to the primary winding of transformer T725. The voice frequencies are coupled through transformer T725 and the contacts of ORDER WIRE switch S702 (in the TALK position) to transformer T712. The output of this transformer is applied to the receiver of telephone set HS-801.

203. Low-Pass Filters FL721 and FL722

The schematic representation shown in figure 71 represents either filter FL721 or FL722. These filters are identical low-pass filters that reject undesired high frequencies and allow voice-frequency signals to pass. Both filters are contained in sealed units. Therefore, maintenance or replacement of parts cannot be performed on the filters. If a filter is defective, replace the entire unit.

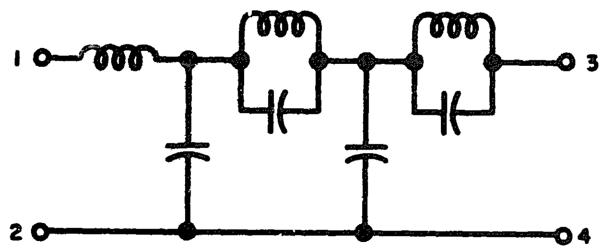


Figure 71. Filters FL721 and FL722, schematic representation.

204. Other Functions of Order Wire Circuit, Block Diagram Analysis

a. Functioning in Conjunction with the TA-219/U.

(1) Signals originating in the transmitter of the attendant's telephone set can be transmitted through the transmitting circuits of any of the four channel modems of the TA-219/U (para 106) and through the transmitting circuit in the AM-682/TCC-3 (para 120) to the distant station. This is accomplished by operating CHANNEL TALK switch S701 (fig. 68) to the LINE position and TALK-MON switch S101 to the TALK position. When the switches are thus operated, signals from the transmitter of the attendant's telephone set, HS801, are applied through the attendant's telephone circuit and the contacts of the switches to the transmitting circuit of the channel 1 modem through the normally closed contacts of the SEND-MEAS switch. The signals then pass through this circuit and the transmitting circuit of the AM-682/TCC-3, and over the spiral-four cable to the distant station (when CHANNELS-SPECIAL SERVICE switch S801 is in the CHANNELS position).

(2) Signals from the attendant's telephone set at a distant station can be made to pass through the receiving circuit in the AM-682/TCC-3 and the receiving circuit in any of the four channel modems of the TA-219/U to the receiver of the attendant's telephone set at the local AN/TCC-3. This is accomplished when the CHANNEL, TALK and the TALK-MON switches are operated as described in (1) above. Responses from the distant station pass through the receiving circuit of the AM-682/TCC-3 (para 130) to the receiving circuit of the channel 1 modem (para 149) when the CHANNELS-SPECIAL SERVICE switch is in the CHANNELS position. With SEND-MEAS switch S102 in the normal

(vertical) position, the responses are applied through the TALK-MON and CHANNEL TALK switches and the attendant's telephone circuit to the receiver of telephone set HS801.

(3) The attendant's telephone set can be used to communicate with personnel at the voice-frequency equipment connected to any of the four channel modems of the TA-219/U. This is accomplished by operating the CHANNEL TALK switch to the TEST BD position and the TALK-MON switch to the TALK position. In these positions of the switches, signals originating at the attendant's telephone set are transmitted through the attendant's telephone circuit and the voice-frequency connecting circuit to the local voice-frequency equipment. Responses from the local voice-frequency equipment pass through the voice-frequency-equipment connecting circuit, the switches, and the attendant's telephone circuit to the receiver of telephone set HS801.

(4) The attendant's handset can be used for monitoring the traffic channels. This is accomplished when the TALK-MON switch is operated to the MON position. The CHANNEL TALK switch S701 can be either in the LINE or the TEST BD position. In the LINE position, incoming signals to the receiving path of the channel modem are passed to the receiver of telephone set HS801 through attenuating resistor (fig. 68). Similarly, in the TEST BD position, outgoing signals from the voice-frequency equip ment are passed through the attenuating resistor to telephone set HS801.

(5) A detailed analysis of the order wire circuit in conjunction with the TA-219/U is given in paragraph 205.

b. Extended Order wire Circuit.

(1) A two-wire telephone set at a remote point can be connected to ORDER WIRE binding posts E735 **and E736. This telephone set is connec**ted to **hybrid coil T724, making it pos**sible to talk and **receive** over **the order wire** circuit.

(2) A detailed analysis of the extended order wire circuit is given in paragraph 209.

c. Functioning During System Lineup. **During the system lineup, SEND OW switch S703 is operated. This applies the 1-kc output of the test oscillator (para 213) through the transmitting circuits of the order wire and the transmitting circuit of the AM-682/TCC-3 to the distant station. A detailed analysis of the order wire circuit during system lineup is given in paragraph 210.**

d. Receiving and Transmitting Ringing Sign& Through **Order *Wire*. When ORDER WIRE switch S702 is in the normal (vertical) position, input from low-pass filter FL722 is fed to the ringer-oscillator and the ringer-oscillator functions as a ringer (para 189). When the ORDER WIRE switch is operated to the ring position, the ringer-oscillator functions as an oscillator (para 196), and a 1,600 cps ringing signal from the oscillator is applied through the ORDER WIRE switch to the limiter circuit. The signal is then transmitted through low-pass filter FL721 and through the transmitting circuit of the AM-682/TCC-3 to the distant station. A detailed analysis of the order wire circuit as related to the functioning of the ringer-oscillator is given in paragraphs 188 and 189.**

205. Functioning of Order Wire Circuit in Conjunction With the TA-219/U, Detailed Analysis

The CHANNEL TALK switch in the **order wire circuit and the TALK-MON switches of the channel modems permit the attendant's telephone set to be used for either communications or monitoring over any of the four channel modems of the TA-219/U In addition, these switches permit the attendant's telephone set to be used either for communication with, or monitoring of, the local voice-frequency equipments. A detailed analysis of these functions of the order wire circuit appears in paragraphs 206 through 210. This analysis is given with the aid of the simplified schematic of the connection of the order wire to the channel 1 modem (fig. 70). The functioning of the other three channel modems is identical**

206. Communications Over Channel 1 Modem Using Attendant's Telephone Set, Detailed Analysis

a. Transmitted Signals. **The signals produced in secondary winding 5–6 of transformer T711 by speaking into the transmitter of the attendant's telephone set are applied to the contacts of CHANNEL TALK switch S701 (fig. 70). This switch is connected to the TALK-MON switches of the channel modems of the TA-219/U (c below). When the CHANNEL TALK switch is in the LINE position and TALK-MON switch S101 of channel 1 modem is in the TALK position, the signals from the secondary winding of transformer T711 are applied through the contacts of the CHANNEL TALK switch, the TALK-MON switch (S101), and the SEND-MEAS switch (in the normal position) (figs. 33 and**

146) to the transmitting circuit of the channel 1 modem (para 106). The signals pass through the channel modem. With the CHANNELS-SPECIAL SERVICE switch in the CHANNELS position, the signals are applied to the transmitting circuit of the AM-682/TCC-3 (para 120). From the transmitting circuit, the signals are transmitted over the spiral-four cable to the distant station

b. Received Signals. When TALK-MON switch, S101, of channel 1 modem is in the TALK position and the CHANNEL TALK switch is in the LINE position (figs. 69 and 70), the voice-frequency signals from the receiving circuit of the channel modem (para 151) are applied through the contacts of the switches to resistors R711, R712, and R713, which are bridged across primary winding 5-6 of transformer T712. The voice-frequency signals are attenuated by these resistors and then stepped down by transformer T712. Secondary windings 1-2 and 3-4 of the transformer apply the signals to the receiver of the attendant's telephone set HS801.

c. Connections to TALK-MON Switches.

(1) The transmitting path from attendant's telephone set HS801 to the TALK-MON switch is through the CHANNEL TALK switch in the LINE position, through wires designated 9A and 10A (figs. 150, 151, and 155), and terminals 12 and 11 of terminal board TB801 to terminals M and C of plug P898. Plug P898 mat-es with jack J5 of TA-219/U (fig. 145). Terminals M and C of jack J5 are connected to terminals 9 and 12 of paralleled jacks J1, J2, J3 and J4, which mate with plugs P101, P201, P301, and P401 of channel 1, 2, 3, and 4 modems, respectively.

(2) The outputs of the receiving circuit of channel 1, 2, 3 and 4 modems of the TA-219/U are applied to terminals 10 and 7 of plugs P101, P201, P301, and P401 respectively (figs. 145 through 148). Mating jacks J101, J201, J301, and J401 are connected in parallel. Terminals 10 and 7 of these jacks are connected to terminals L and B of jack J5. Jack J5 mates with plug P898 of the AM-682/TCC-3. In the AM-682/TCC-3, terminals L and B of plug P898 are connected to terminals 14 and 13 of terminal board TB801. The wires connecting these terminals to the CHANNEL TALK switch are designated 7A and 8A (fig. 150, 151 and 155). The receiving path to the attendant's telephone set is completed through the contacts of the CHANNEL TALK switch.

207. Communications With Attendants at Local Voice-Frequency Equipment Using Attendant's Telephone Set

When CHANNEL TALK switch S701 is operated to the TEST BD position, the path from the transmitter and receiver of the attendant's telephone set, HS801, to TALK-MON switch S101 is reversed (fig. 70). Thus, when TALK-MON switch S101 is operated to the TALK position, signals from the attendant's telephone set pass through the voice-frequency equipment connecting circuit of channel 1 modem (para 105) and are received at the local voice-frequency equipment. Similarly, voice signals from the local voice-frequency equipment pass through the voice-frequency equipment connecting circuit and arc received at the attendant's handset, HS801. When 2W-4W switch S103 is in the 4W position, the voice frequency signals do not pass through the hybrid coil in the channel modem. This is illustrated for channel 2 modem in figure 35. As is shown for channel 4 modem, when the 2W-4W switch is in the 2W position, the voice-frequency signals pass through the hybrid coil.

208. Monitoring Conversation on the Traffic Channels

When TALK-MON switch S101 is in the MON position, the connections from CHANNEL TALK switch S701, to the TALK-MON switch described in paragraphs 206 and 207 above are made through resistors R102 through R105. These resistors attenuate the voice-frequency signals received and transmitted by telephone set HS801

209. Order Wire Extension, Detailed Analysis

The ORDER WIRE binding posts, E735 and E736, are connected to windings 9-10 and 7-8 of hybrid coil T721 (fig. 69). A two-wire telephone set at a remote location can be connected to these binding posts. The connection of the remote telephone set to the binding posts makes it possible to talk, when the SEND OW switch is in the normal (vertical) position, through the order wire circuit from the remote point. To monitor with the remote telephone set, the SEND OW switch can be in either of its positions. Thus, the hybrid coil permits extending the order wire on a two-wire basis. Capacitors C723, C724, C725, and C726, and resistor R731 are connected to the hybrid coil to provide correct impedance matching. The ORDER WIRE switch, S702, should be in the normal position, in order not to drain some of the energy that would pass through hybrid coil T724, to the attendant's telephone circuit.

210. Functioning of Order Wire Circuit During System Line-Up, Detailed Analysis

During the system lineup, the l-kc output of the test oscillator is transmitted through a portion of the order wire circuit. This is accompli&d by operating the SEND OW switch, S703. The l-kc signal from the test oscillator (para 213) is applied to wires 2A and 3A of the order wire circuit (figs. 150, 151, and 155). In the order circuit, the l-kc signal passes through resistors R721 and R722 and the contacts of switch 5703 to the transmitting circuits of the order wire. In the operated position, switch S703 disconnects from the order wire transmitting circuit, any signals originating at either the attendant's telephone set or the two-wire telephone set that can be connected to the order wire binding posts, E735 and E736 (para 209).

211. Testing Facilities

A general description of the testing facilities is given in paragraph 97. The testing facilities of the AN/TCC-3 consist of the test oscillator, the measuring circuit, and associated circuits. A detailed analysis of the testing facilities is given in paragraphs 212 through 225.

b. Block Diagram.

(1) A block diagram analysis of the testing facilities (pars 212) is given with the aid of the block diagram of the test oscillator and the circuits associated with it (fig. 72) and the block diagram of the measuring circuit (fig. 73),

(2) The testing facilities function in conjunction with the four channel modems of the TA-219/U and the order wire circuit, the transmitting circuit, and the receiving circuit of the AM-682/TCC-3. Figure 72 shows only the important parts of the circuits that function in conjunction with the test oscillator. The test oscillator consists of tube V701 and the associated circuit elements. The measuring circuit (fig. 73) consists of AMPLIFIER switch S771, filter FL-771, rotary MEASURE switch S772, the rectifier circuit comprised of transformer T771 and varistor CR771, and MEASURE meter M771.

212. Testing Facilities and Associated Circuits, Block Diagram Analysis

a. *Test* Oscillator. The test oscillator produces a l-kc output. The amplitude of the l-kc output may be varied by adjusting TEST OSC OUTPUT control potentiometer R705. The l-kc output

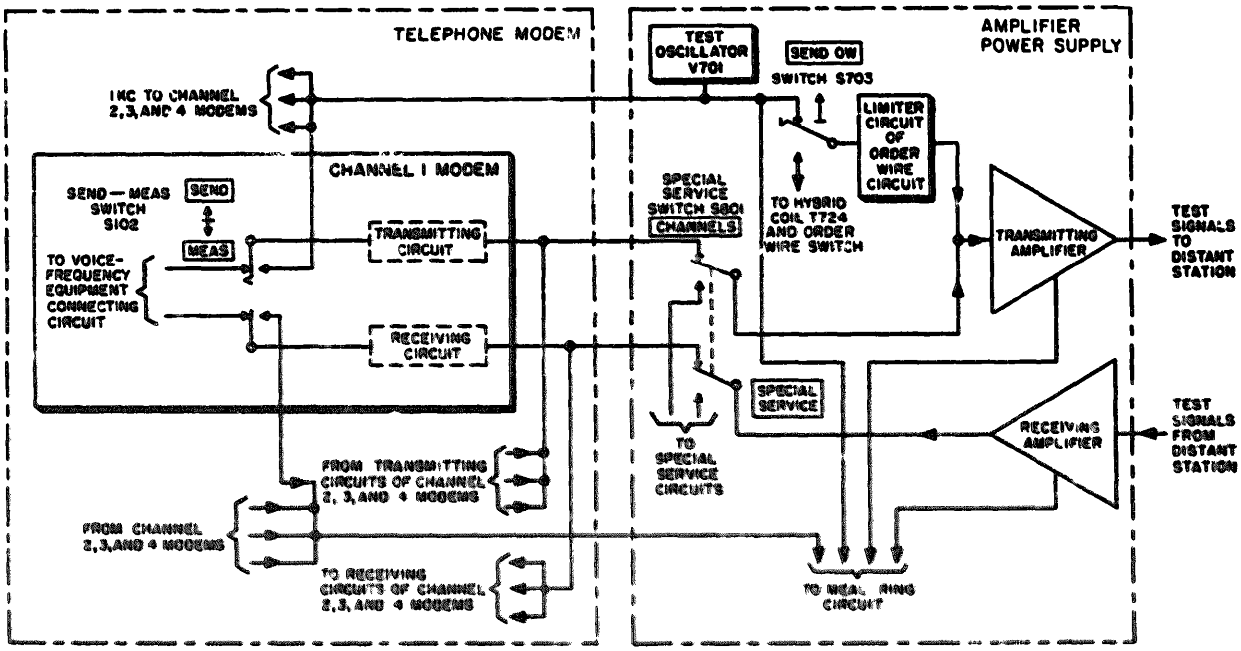


Figure 72. Test oscillator and associated circuits, block diagram.

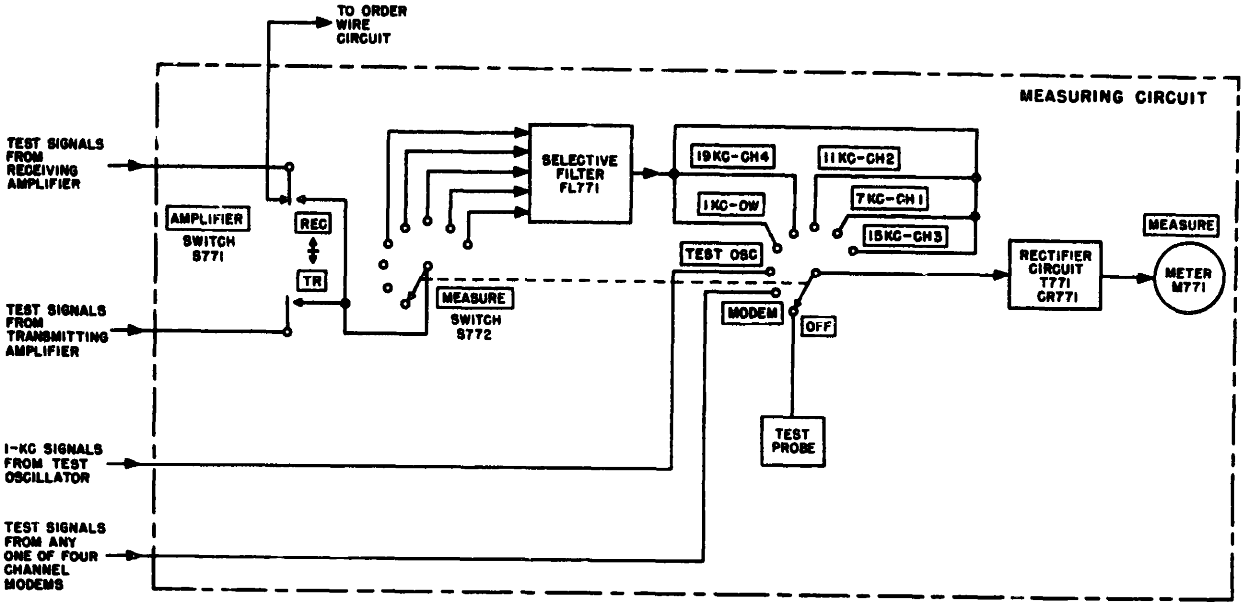


Figure 73. Measuring circuit; block diagram.

of the test oscillator is applied to the measuring circuit (fig. 72). The magnitude of this l-kc signal is indicated by MEASURE meter M771 when MEASURE switch S772 is in the TEST OSC position (e(3) below).

b. 1-kc Test Signal To Order Wire Circuit. When SEND OW switch S703 is operated from the normal (vertical) position to the horizontal position as is shown in figure 72, the l-kc output of the test oscillator is fed through the transmitting circuits of the order wire circuit (para 204c) to the transmitting circuit of the AM-682/TCC-3. In the transmitting circuit the 1-kc signal is amplified by the transmitting amplifier. The amplified 1-kc signal is transmitted to the distant station. The 1-kc signal at the output of the transmitting amplifier may also be applied to the measuring circuit. In the measuring circuit, MEASURE meter M771 indicates the magnitude of the amplified 1-kc signal when the amplifier switch is in the TR position and the MEASURE switch, S772, is in the 1KC-OW position (para 219).

c. 1-kc To Channel Modems.

(1) When the SEND-MEAS switches of any of the four channel modems of the TA-219/U are operated to the SEND position, the 1-kc signal from the test oscillator is applied to the transmitting circuit of the channel modem. The 1-kc signal applied to each channel modem produces a lower side-band test signal of a known magnitude (para 104). In channel 1, 2, 3 and 4 modems, the l-kc signal produces a 7-kc output, an 11-kc output, a 15-kc output, and a 19-kc output, respectively. These test signals are applied to the transmitting circuit of the AM-682/TCC-3 (para 120) where the test signals are amplified and transmitted to the distant station.

(2) The transmitting amplifier also applies the teat signals ((1) above) to the measuring circuit. In this circuit, MEASURE meter M771 indicates the magnitudes of the 7-kc, 11-kc, 15-kc, and 19-kc signals, when AMPLIFIER switch S77l is in the TR position and MEASURE switch S772 is operated successively to the 7KC-CH1 position, the 11KC-CH2 position, the 15KC-CH3 position and the 19KC-CH4 position (e below).

d. Received Test Signals.

(1) The 1-kc, 7-kc, 11-kc, 15-kc, and 19-kc test signals produced by the distant AN/TCC-3 are received by the local AN/TCC-3. The received signals pass through the equalizer circuit and the receiving amplifier of the receiving circuit of the AM-682/TCC-3. The receiving amplifier applies these test signals to the measuring circuit (fig. 72). The amplified test signals are measured by MEASURE meter M771 when AMPLIFIER switch S771 is operated to the REC position and MEASURE switch S772 is operated to the position corresponding to the frequency of test signals (e(4) below). The FLAT-1KC, SLOPE-19-KC, and BULGE-11KC controls (equalizers), are adjusted when AMPLIFIER

switch S771 is held in the REC position and the MEASURE switch S772 is operated successively to the 1KC-OW position, the 19KC-CH4 position and the 11KC-CH2 position ((2) *below*). This adjusts the level of the input to the receiving amplifier. The procedure for adjusting controls of the equalizers is known as the *system* lineup (para 133a).

(2) The amplified test signals from the receiving amplifier are applied to the four channel modems of the TA-219/U (with the CHANNEL SPECIAL SERVICE switch in the CHANNELS position). In the receiving circuit of each channel modem, the test signal with the desired frequency is selected by filtering and demodulated by the carrier frequency. The demodulation produces a l-kc output from the demodulator amplifier (para 159).

(3) When the SEND-MEAS switch of any one of the four channel modems is operated to the MEAS position, the l-kc output of the demodulator amplifier is applied to the measuring circuit. When MEASURE switch S772 is in the MODEMS position (with AMPLIFIER switch S771 nonoperated), the magnitude of this 1-kc signal is indicated by MEASURE meter M771. The GAIN control potentiometer of the channel modem may be adjusted to obtain a desired meter indication of 0 db.

e. ***Measuring Circuit.***

(1) As shown in figure 73, when MEASURE switch S772 is in the OFF position, the test probe in the AM-632/TCC-3 is connected to the rectifier circuit (transformer T771 and varistor CR771). The test probe can be applied to the test jacks of the carrier supply to measure the outputs of the carrier supply. These outputs are rectified and the resulting dc produces an indication on MEASURE meter M771. Normal conditions exist when indications of 0 db are obtained.

(2) In the MODEMS position, MEASURE switch S772 permits application of the l-kc output of the demodulator amplifier in the receiving circuit of one of the four channel modems to the measuring circuit (d (3) above).

(3) When MEASURE switch S772 is in the TEST OSC position, the l-kc output of the test oscillator is applied to the measuring circuit. The TEST OSC OUTPUT control of the test oscillator is properly adjusted when MEASURE meter M771 indicates 0 db (para 212).

(4) When AMPLIFIER switch S771 is in the TR position, the output of the transmitting amplifier is applied to filter FL771 (fig. 73). When the AMPLIFIER switch is in the REC position, the output of the receiving amplifier is applied to filter FL771. When rotary MEASURE switch S772 is operated to the 1KC-OW position, the 7KC-CH1 position, the 11KC-CH2 position, the 15KC-CH3 position, and the 19KC-CH4 position, Alter FL771 selects the l-kc, 7-kc, 11-kc, 15-kc, and 19-kc test signals. MEASURE meter M771 indicates the magnitude of the applied test signals.

213. Functioning of Test Oscillator, Detailed Analysis

A simplified schematic diagram of the test oscillator is shown in figure 74. The schematic

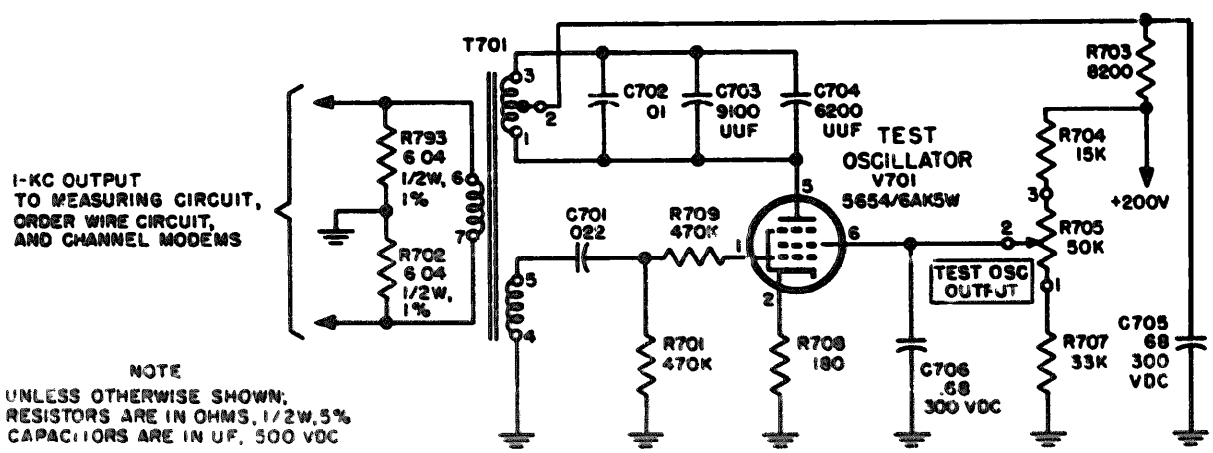


Figure 74. Test oscillator, simplified schematic diagram.

diagram of the test oscillator is shown in figure 159.

a. The test oscillator circuit consists of tube V701, transformer T701 and the associated circuit elements. Plate voltage is supplied to the tube through dropping resistor R703 and through the portion of the primary winding of transformer T701 between terminals 2 and 1. Capacitor C705 bypasses the plate supply to ground. Winding 1–2–3 of transformer T701 and shunting capacitors C702, C703, and C704 form a tank circuit tuned to 1 kc, which is connected in the plate circuit of tube V701. The plate current of tube V701 flows from ground through cathode-bias resistor R708, through the tube, and through the portion of the primary winding of transformer T701 between terminals 1 and 2.

b. Feedback between the plate circuit and the grid circuit of tube V701 of the proper phase and magnitude to produce oscillations is developed in winding 5–4 of transformer T701. This voltage appears across grid-leak resistor R701. Resistor R709 limits the flow of grid currents.

c. The 1-kc output of the oscillator is developed in secondary winding 6–7 of transformer T701. Resistors R793 and R702 shunt the output winding of transformer T701 to keep variations in the load from affecting the operation of the 1-kc oscillator.

d. Potentiometer R705, which is the TEST OCS OUTPUT front panel control, adjusts the screen-grid voltage and is used as an oscillator output control. Capacitor C706 is the screen-grid bypass capacitor. The 1-kc output of the test oscillator may be transmitted through the order wire circuit (para 210) or through one or more channel modems simultaneously (para 214). The transmitted test signals provide a means for lining up the system and for checking the operation of the circuits of the terminal.

214. Distribution of 1-Kc Signal From Test Oscillator

The 1-kc output of winding 6–7 of transformer T701 in the test oscillator circuit (fig. 158) is applied to wires 2A and 3A. These wires extend the measuring circuit and the order-wire circuit (figs. 150 and 151). The 1-kc is also applied through terminals 6 and 7 of terminal board TB801 to terminals D and N of plug P898 (figs. 150 and 151). This plug mates with jack J5 of the TA–219/U. In the TA–219/U (fig. 145), terminals D and N of jack J5 are connected in parallel with terminals 8 and 11 of jacks J1, J2, J3 and J4, which mate with plugs P101, P201, P301, and P401 of channels 1, 2, 3, and 4 modems, respectively. These plugs are connected to SEND-MEAS switches S102, S202, S302, and S402 of channels 1, 2, 3, and 4 modems, respectively (figs. 146 through 149).

215. Measuring Circuit, Detailed Analysis

A detailed analysis of the measuring circuit for the various positions of MEASURE switch S772 is given in paragraphs 216 through 223. The connections of the testing facilities to their associated circuits are discussed in paragraphs 224 and 225.

216. MEASURE Switch S772, OFF Position

a. Figure 75 shows the measuring circuit of AM-682/TCC-3 bearing serial numbers 1 through 198 with the MEASURE switch in the OFF position. In AM-682/TCC-3 bearing serial numbers 199 through 3180 a 400-ohm resistor has been added in series with resistors R790, R791, R792 and R780, and reference symbols have been reassigned (figs. 156 and 157). Except for the additional attenuation which may be obtained by the inclusion of the additional 400-ohm resistor, the circuit for serial numbers 199 through 3180 functions in the same manner as the circuit for serial numbers 1 through 198. The circuit for AM-682/TCC-3 bearing serial numbers 1 through 198 functions as described in b below.

b. The test probe is connected to transformer T771. The test probe is used to check the carrier amplitudes at jacks J601, J602, and J603 in the carrier supply. Transformer T771 steps up the signals it receives. The stepped-up signal is rectified by a bridge-type copper-oxide rectifier, CR771. The rectified signal is fed through attenuating resistors R780, R790, R791, and R792 to a 200-microampere, 660-ohm dc meter, M771. Resistors R780, R790, R791, and R792 may be strapped to adjust the sensitivity of the measuring circuit. When this circuit is adjusted correctly, the MEASURE meter will read 0 db for all measurements taken under normal operating conditions. Thermal resistor RT771 and resistors R781 and R782 form a temperature-compensating network that stabilizes the sensitivity of the measuring circuit throughout the operating temperature range. The input impedance of the measuring circuit is 600 ohms for each of the positions of the MEASURE switch.

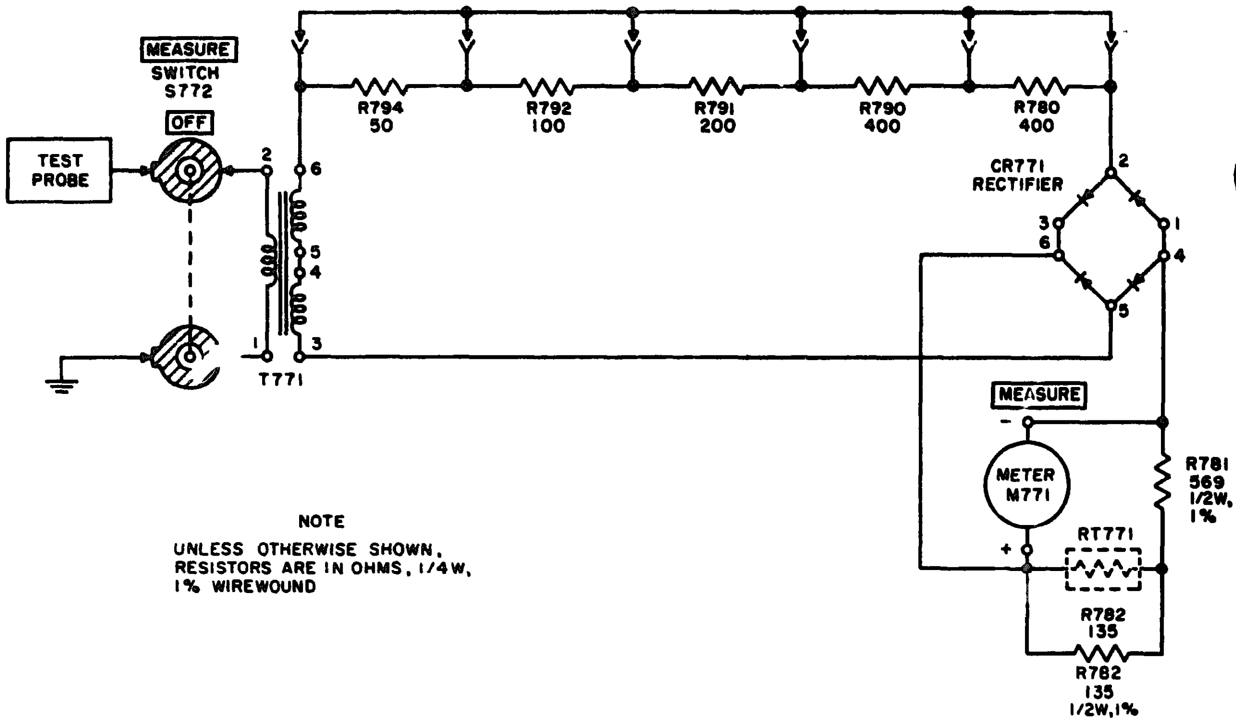


Figure 75. Measuring circuit, MEASURE switch in OFF position.

217. MEASURE Switch S772, MODEMS Position

Figure 76 shows the measuring circuit of AM-682/TCC-3 bearing serial numbers 1 through 198 (para 216*a*) with the MEASURE switch in the MODEMS position. When the SEND-MEAS switch of any one of the channel modems is operated to the MEAS position, the output of the demodulator amplifier of that channel modem is applied to the measuring circuit (para 212*d*). In the measuring circuit, the output of the demodulator amplifier passes through an attenuating pad comprised of resistors R776 through R779. This pad attenuates the input to transformer T771 so that meter M771 will indicate 0 db for normal conditions. The front panel GAIN control of the channel modem may be adjusted to obtain the proper meter indication.

218. MEASURE Switch S772, TEST OSC Position

Figure 77 shows the measuring circuit of AM-682/TCC-3 bearing serial numbers 1 through 198 (para 216*a*) with the MEASURE switch in the TEST OSC position. The l-kc output of the test oscillator is applied to the measuring circuit. In the measuring circuit, the 1 kc passes through an attenuating **pad comprised of resistors R771, R772, R773, R774, and R775. This pad attenuates the input to transformer** T771 so that meter **M771 will indicate 0 db for normal** conditions. The **TEST OSC OUTPUT front pan**el control **may be adjusted to obtain the correct** indication (**para** 213).

219. MEASURE Switch S772, 1KC-OW Position

Figure 78 shows the measuring circuit of AM-682/TCC-3 bearing serial numbers 1 through 198 (para 216*a*) with the MEASURE switch in the 1KC-OW position. The output of either the transmitting amplifier (when AMPLIFIER switch S771 is in the TR position) or the receiving amplifier (when the AMPLIFIER switch is in the REC position) is applied through the contacts of the AMPLIFIER and MEASURE switches and resistor R783 to terminal 1 of filter FL771. In filter FL771, the signal from the am-

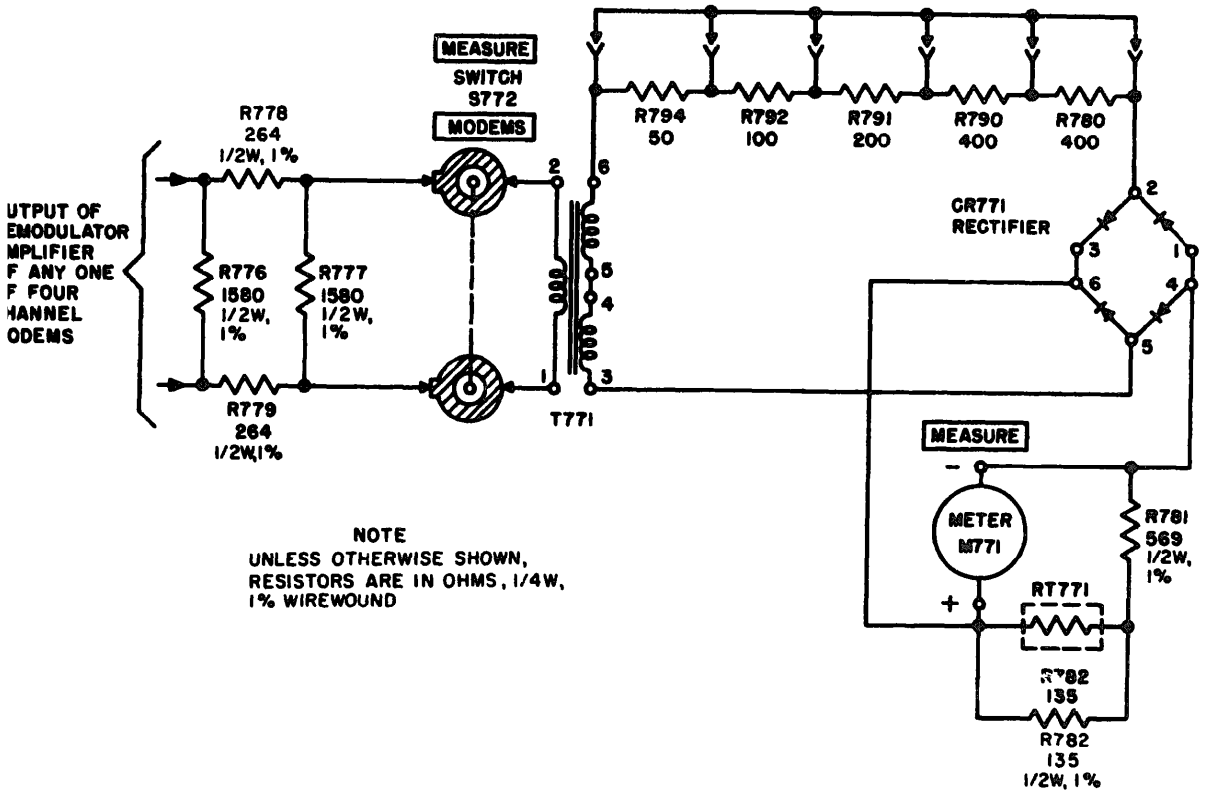


Figure 76. Measuring circuit, MEASURE switch in MODEMS position.

plider passes through the series-tuned circuit between terminals 1 and 6 of the filter to transformer T771. The other four series-tuned circuits of the filter (between terminals 2, 3, 4, 5, and 6) and their associated resistors, R784 through R786 are connected to ground through the contacts of the MEASURE switch. The 1-kc test signal from the order-wire circuit (para 212*b* and fig. 70) is selected by filter FL771. Thus, MEASURE meter M771 indicates the magnitude of only the 1-kc test signal of the order-wire circuit

220. MEASURE Switch S772, 7KC-CH1 Position

When the MEASURE switch is in the 7KC-CH1 position (fig. 77), the output of either the transmitting amplifier or receiving amplifier (as selected by the AMPLIFIER switch) is applied through resistor R784 and the series-tuned circuit between terminals 2 and 6 of filter FL771 to transformer T771. The other four series-tuned circuits and their associated resistors are shorted to ground. With the above-mentioned connection, only the 7-kc test signal from either of the amplifiers is selected by filter FL771. Thus, MEASURE meter M771 indicates the magnitude of only the 7-kc test signal.

221. MEASURE Switch S772, 11KC-CH2 Position

When the MEASURE switch is in the 11KC-CH2 position (fig. 77), the output of either the transmitting amplifier or receiving amplifier (as selected by the AMPLIFIER switch) is applied through resistor R785 and the series-tuned circuit between terminals 3 and 6 of filter FL771 to transformer T771. The other four series-tuned circuits and their associated resistors are shorted to ground. With the above-mentioned connection, only the 11-kc test signal from either of the amplifiers is selected by filter FL771. Thus, MEASURE meter M771 indicates the magnitude of only the 11-kc test signal.

222. MEASURE Switch S772, 15KC-CH3 Position

When the MEASURE swtich is in the 15KC-CH3 position (fig. 78), the output of either the

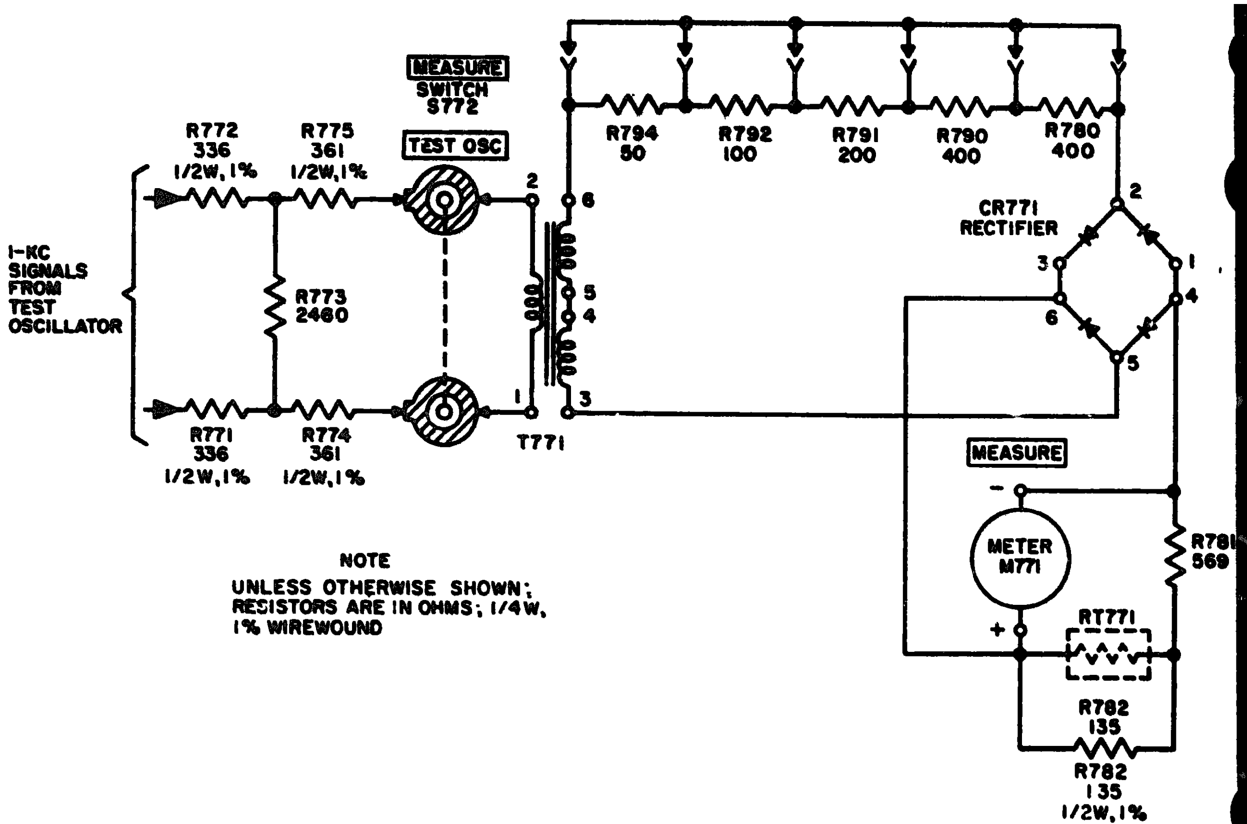


Figure 77. Measuring circuit, MEASURE switch in TEST OSC position.

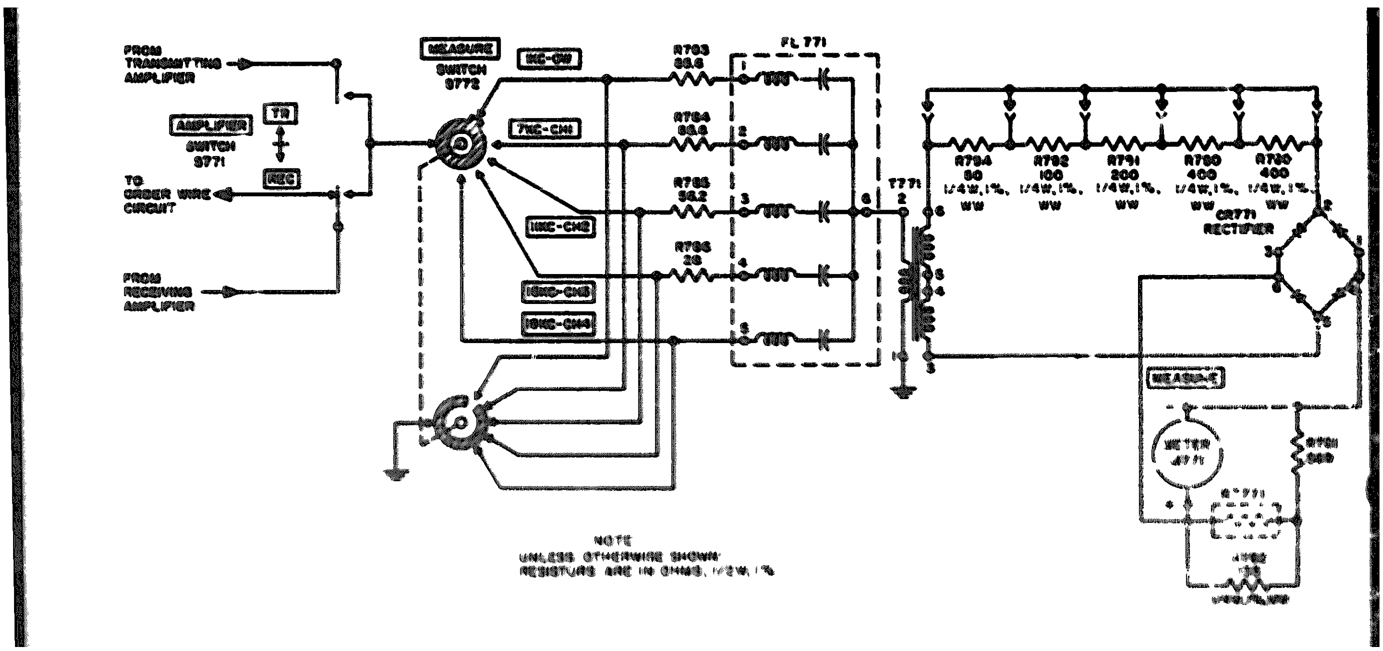


Figure 78. Measuring circuit, showing MEASURE switch positions for measuring amplifier outputs.

transmitting amplifier or receiving amplifier (as selected by the AMPLIFIER switch) is applied through resistor R786 and the series-tuned circuit between terminals 4 and 6 of Alter FL771 to transformer T771. The other four series-tuned circuits and their associated resistors are shorted to ground. With the above-mentioned connection, only the 15-kc test signal from either of the amplifiers is selected by Alter FL771. Thus, MEASURE meter M771 indicates the magnitude of only the 15-kc test signal.

223. MEASURE Switch S772, 19KC-CH4 Position

When the MEASURE switch is in the 19KC-CH4 position (fig. 78), the output of either the transmitting amplifier or receiving amplifier (as selected by the AMPLIFIER switch is applied through the series-tuned circuit between terminals 5 and 6 of filter FL771. The other four series-tuned circuits and their associated resistors are shorted to ground. With the above-mentioned connection, only the 19-kc test signal from either of the amplifiers is selected by filter FL771. Thus, MEASURE meter M771 indicates the magnitude of only the 19-kc teat signal.

224. Connection to Measuring Circuit

a. The output from the transmitting amplifier taken at terminals 3 and 10 of plug P51 of the amplifier (fig. 150), is applied to terminals 3 and 10 of mating jack J801. Terminals 3 and 10 of mating jack J801 are connected through terminals 6 and 5 of terminal board TB802 to wires 6 and 5 of the measuring circuit.

b. The output from the receiving amplifier taken at terminals 3 and 10 of plug P51 of the amplifier (fig. 150), is applied to terminals 3 and 10 of mating jack J802. Terminals 3 and 10 of jack J802 are connected through terminals 3 and 4 of terminal board TB802 to wires 3 and 4 of the measuring circuit.

225. Connections to SEND-MEAS Switches of Channel Modems

The outputs of the demodulator amplifiers of the channel 1, 2, 3, and 4 modems are applied to contacts of SEND-MEAS switches S102, S202, S302, and S402 respectively. When these switches are held in the MEAS position, the otuputs of the demodulator amplifiers are applied to contacts 15 and 18 of plugs P101, P201, P301 and P401 of channel 1, 2, 3, and 4 modems, respectively (fig. 135). Terminals 15 and 18 of paralleled mating jacks J1, J2, J3, and J4 are connected to terminals F and R of jack J5. This jack mates with plug P898 of the AM-682/TCC-3. Terminals F and R of plug P898 (figs. 150 and 151) are connected through terminals 9 and 10 of terminal board TB801 and terminals 5 and 4 of terminal board TB701 to wires 5A and 4A of the measuring circuit.

226. System Alarm Circuit

a. General. A general description of the functioning of the system alarm appears in paragraph 98. A detailed analysis of the functioning of the system alarm circuit appears in paragraphs 227 through 232. This analysis is given with the aid of the simplified schematic diagram of the system alarm shown in figure 80. The schematic diagram of the system alarm circuit is shown in figure 159.

b. Block Diagram.

(1) The block diagram analysis *of* the system alarm is given with the aid of the block diagram of the system alarm and the circuit associated with it. This block diagram appears in figure 79.

(2) The system alarm functions in conjunction with the carrier supply, the transmitting circuit of the distant terminal, and the receiving circuit of the local AM–682/TCC–3. Buzzer I1 and CALL lamp I742 function in conjunction with the system alarm circuit.

(3) The system alarm circuit, consists of 4-kc filter FL747, the system alarm amplifier, tube V741, the voltage doubler, alarm relay K741, ALARM CUTOFF switch S705, and SYSTEM ALARM lamp I741.

(4) An analysis of the functioning of the system alarm based on the block diagram is given in paragraph 227.

227. Transmission Path of 4-Kc System Alarm Pilot, Block Diagram Analysis

The circuits involved in the functioning of the system alarm are the circuits in the transmission path for the 4-kc system alarm pilot signal and the circuits of the system alarm itself. A block diagram analysis of the circuits in the transmission path of the 4-kc system alarm signal is given in *a* below. A block diagram analysis of the system alarm is given in *b* below.

a. A 4-kc system alarm pilot signal is generated in the carrier supply circuits of both the

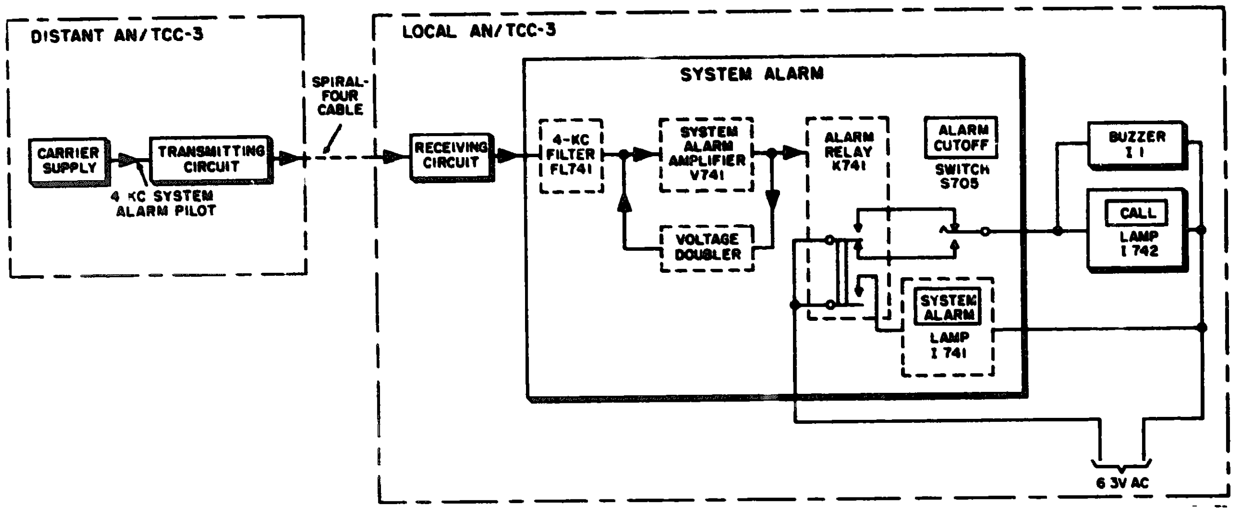


Figure 79. System alarm circuit, block diagram.

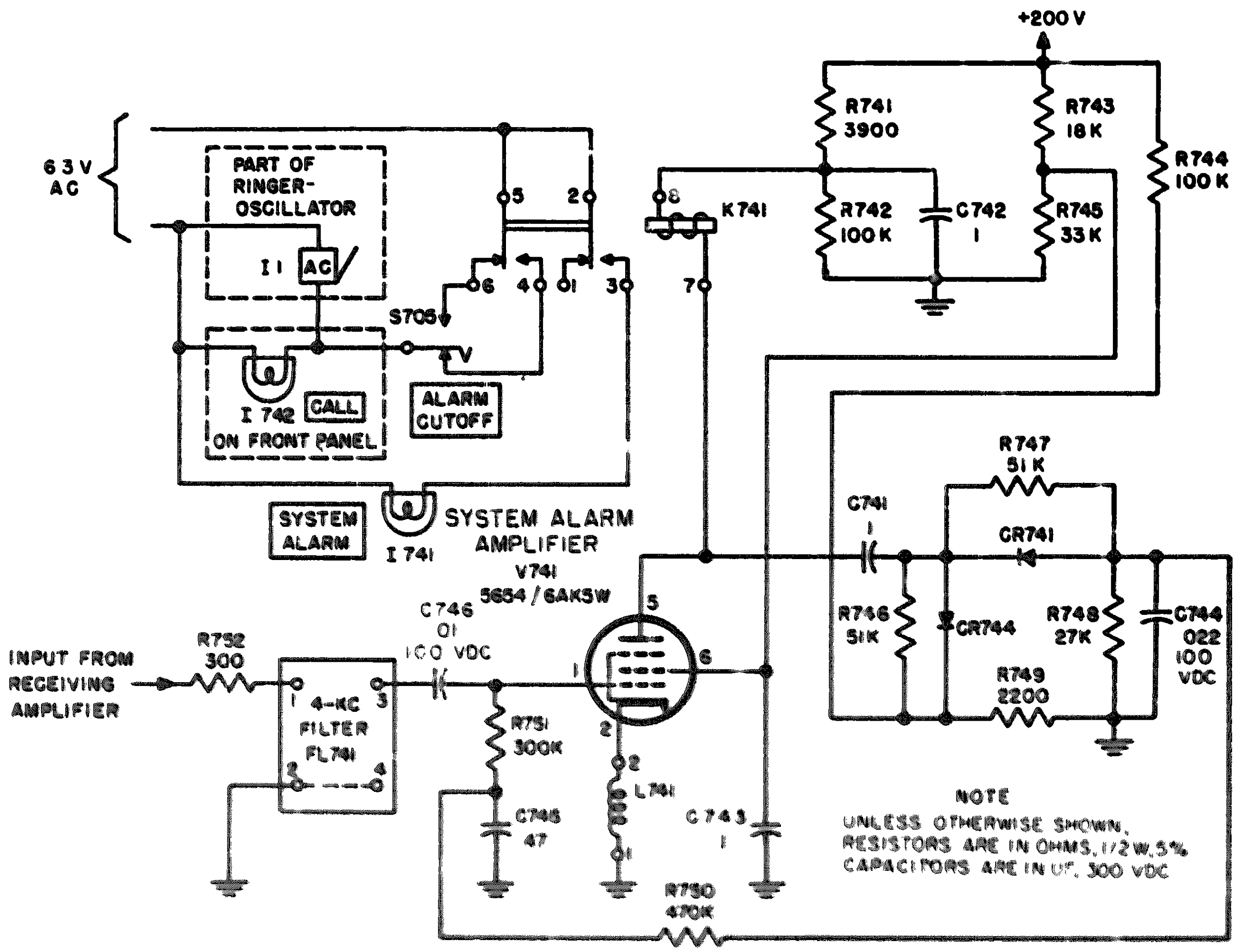


Figure 80. System alarm, amplified schematic diagram.

local and the distant terminal (para 172). The 4-kc system alarm pilots are transmitted through the transmitting circuits of the terminals at a level approximately 25 db below the level of test signals and communications.

b. The 4-kc system alarm signal and the communication (or test) signals from the distant terminal are transmitted over the transmission medium to the local terminal (fig. 79). In the local AN/TCC-3, the signals pass through the receiving circuit of the AN/TCC-3 and are applied to the system alarm. Similarly, a 4-kc system alarm pilot signal originating in the local AN/TCC-3 is transmitted to the system alarm of the distant AN/TCC-3.

228. Functioning of System Alarm Circuit, Block Diagram Analysis

a. Functioning of System Alarm When 4-kc System Alarm Pilot is Preset. The 4-kc system alarm pilot is selected from the output of the receiving circuit of the AM-682/TCC-3 by filter FL741 (fig. 79) and applied to the grid of the system alarm amplifier tube, V471. The amplified signal from the system alarm amplifier tube is rectified by a voltage doubler, which produces a negative dc output. This negative dc output is fed back to the grid of the system alarm amplifier. This negative bias voltage keeps the plate current of the system alarm amplifier at a low value. The coil of the alarm relay is in the plate circuit of the system alarm amplifier, and, as long as the plate current is maintained at a low value, the relay remains nonoperated. With the relay nonoperated, the circuit of the SYSTEM ALARM lamp is open. The circuit of the buzzer and CALL lamp is also open if the ALARM CUTOFF switch is in its vertical position. If the ALARM CUTOFF switch is in the cutoff position, the buzzer and CALL lamp circuit is completed when the alarm relay is nonoperated.

b. Functioning of System Alarm When 4-kc System Alarm Pilot Signal is Not Present or is of Low Magnitude. When trouble is present in the system, the system alarm circuit may not receive the 4-kc system alarm pilot, or may receive it at a reduced level. The absence or low level of the 4-kc system alarm pilot causes the system alarm circuit to function so that the presence of trouble in the system is indicated.

(1) The 4-kc system alarm pilot signal will not be received by the system alarm if the spiral-four cable is broken. When any of the circuits in the transmission path of the 4-kc system alarm pilot signal are defective, the 4-kc signal may not be received by the system alarm, or may be received at a very low amplitude.

(2) When the 4-kc signal is not received, the voltage doubler does not produce a negative output. If a 4-kc signal of a small magnitude is received, the voltage doubler produces a very small negative output. In either case, tube V741 is not cut off and a large plate current flows.

(3) The plate current causes alarm relay K741 to become operated. Operation of the alarm relay completes the circuit of the buzzer and CALL lamp when the ALARM CUTOFF switch is in the normal (vertical) position.

(4) When the ALARM CUTOFF switch is operated to its horizontal position, the operation of the alarm relay still lights the SYSTEM ALARM lamp. The circuit of the CALL lamp and buzzer, however, is opened.

(5) The ALARM CUTOFF switch normally is in the vertical position, and the loss or low amplitude of the 4-kc signal causes the buzzer to produce an audible alarm. To silence the buzzer, the ALARM CUTOFFF switch then is placed in the operated (horizontal) position.

(6) When the ALARM CUTOFF switch is in the operated (horizontal) position, the reestablishment of the 4-kc signal causes the buzzer to produce an audible alarm, which indicates normal operation To silence the buzzer after normal operation is restored, the ALARM CUTOFF switch is operated to the normal (vertical) position.

229. System Alarm Amplifier, Detailed ~~Analysis~~

a. The output signal of the receiving amplifier is applied through attenuating resistor R752 to input terminals 1 and 2 (ground) of 4-kc selective filter FL741 (fig. 80 and para 230) The 4-kc signal is coupled to the grid (pin 1) of tube V741 through capacitor C746. Tube V741 amplifies the 4-kc signal

b. The amplified signal voltage is developed partly across the coil of relay K741 and partly across inductance L741. Inductance L741 provides negative feedback, thereby stabilizing the gain of the amplifier stage *c.* Resistor R751 presents the proper terminating impedance for filter FL741. Screen-grid voltage for tube V741 is obtained from a voltage divider which is connected from B+ to ground. This voltage divider consists of resistors R743 and R745. The ac component of screen-grid current is bypassed to ground through capacitor C743. Plate voltage also is obtained from a voltage divider. The voltage divider for the plate voltage consists of resistors R741 and R742, and the ac component of plate current is bypassed to ground through capacitor C742.

230. Filter FL741

The schematic representation of filter FL741 appears in figure 81. Filter FL741 is a selective filter which passes frequencies near 4 kc and rejects other frequencies. This filter is contained in a sealed unit. Therefore, maintenance or replacement of parts cannot be performed on the filters. If the filter is defective, replace the entire unit.

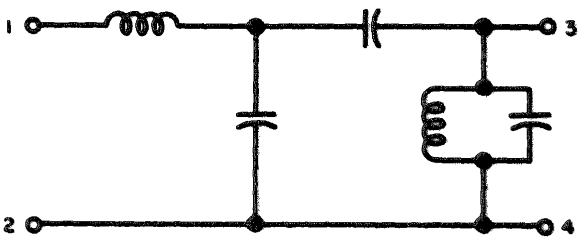


Figure 81. Filter FL741, schematic representation.

231. Voltage Doubler, Detailed Analysis

The voltage doubler circuit utilizes the 4-kc system alarm pilot received during normal operation to produce a negative voltage. This negative voltage is utilized by the system alarm circuit to prevent this circuit from producing indications of trouble in the system. The detailed analysis of the voltage doubler circuit in producing the negative voltage appears in *a* through *e* below. The detailed analysis of the system alarm circuit when the negative voltage is present, and when the negative voltage is not present, appears in paragraph 232.

a. The voltage doubler circuit connected to the plate of tube V741 utilizes the ac component of the plate voltage to produce a negative dc voltage. This negative voltage is used to bias tube V741.

b. During the negative half-cycle of the 4-kc system alarm pilot, the plate voltage of tube V741 increases. The increase in plate voltage causes capacitor C741 of the voltage doubler circuit to charge. The charge path (fig. 80), is from ground through resistor R749, rectifier CR744, capacitor C741, the coil of relay K741, resistor R741, and the positive power supply. During this positiver, half-cycle of the ac component of the plate voltage, the plate side of capacitor C741 becomes charged to the most positive voltage that the plate reaches.

c. During the positive half-cycle of the 4-kc system alarm pilot, the plate voltage of tube V741 decreases. The decrease in plate voltage causes capacitor C741 to discharge through rectifier CR741 and capacitor C744. As a result of the discharge of capacitor C741, capacitor C744 is charged negatively.

d. The voltage built up across C741 during the negative half-cycle adds to the voltage supplied by the plate during the positive half-cycle. Therefore, the voltage built up across C744 is nearly twice the plate voltage.

e. The absence of the 4-kc system alarm pilot C744.

232. Functioning of Alarm Relay and Associated Circuits, Detailed Analysis

a. When the 4-kc system alarm pilot is received, the negative voltage output of the voltage doubler (para 231) is connected from capacitor C744 to the grid circuit of tube V741 through a time delay circuit consisting of resistor R750 and capacitor C745. The purpose of the delay introduced by resistor R750 and capacitor C745 is to prevent a loss of the negative grid bias if a temporary absence of the 4-kc input signal occurs. When a prolonged absence of the 4-kc system alarm pilot occurs there is no negative voltage developed by the voltage doubler circuit (para 231*e*) Consequently, no negative voltage is applied to the grid of tube V741

b. The negative voltage applied to the grid of tube V741 results in a low average plate current. When the ALARM CUTOFF switch is in the normal (vertical) position, buzzer I1, CALL lamp I742, and SYSTEM ALARM lamp I741 are not energized (fig. 80)

c. When no negative voltage is produced by

the voltage doubler circuit (para 231*e*), capacitor C745 discharges through resistors R750 and R748. A voltage divider, consisting of resistors R744 and R749, is connected between B+ and ground. Capacitor C745 charges through resistors R746, R747 and R750 to the value of the positive voltage across resistor R749. Thus, in absence of a 4-kc signal, the grid voltage is positive, thereby causing a large plate current to flow and operate relay K741.

***d.* When relay K741 is operated, contacts 2 and 3 make, and contacts 4 and 5 make. SYSTEM ALARM lamp I741 becomes energized by 6.3 volts ac. Buzzer I1 and the CALL lamp are energized when the ALARM CUTOFF switch is in the nonoperated (vertical) position. When the ALARM CUTOFF switch is placed in the operated (horizontal) position an relay K741 is operated, the circuit of the buzzer and CALL lamp is broken.**

***e.* After the cause of the failure of the 4-kc signal has been eliminated, relay K741 releases (*b* above). The releasing of the relay removes the 6.3 volts as from the SYSTEM ALARM lamp by opening contacts 2 and 3. With the ALARM CUTOFF switch in the operated (horizontal) position (*d* above), the buzzer sounds and the CALL lamp lights, because contacts 5 and 6 make, completing the buzzer and lamp circuit through the ALARM CUTOFF switch. To silence the buzzer and extinguish the CALL lamp, the ALARM CUTOFF switch is operated to the normal position.**

233. Power Supply, Detailed Analysis

A general description of the functioning of the power supply appears in paragraph 99. The power supply contains circuits which produce a +220-volt d-c output, a 6.3-volt ac output, and three negative dc outputs. A detailed analysis of these circuits appears in paragraphs 234 through 236. The schematic diagram of the power supply is shown in figure 160.

234. 220-volt Supply, Detailed Analysis

***a.* Power is supplied to the primary windings 4–5 and 6–7 of power transformer T551 (fig. 160) through cable W551, terminals 1 and 2 on terminal board TB551, fuse F551, POWER switch S551 and 115V–230V switch S552. When switch S552 is in the 230V position, primary windings 4–5 and 6–7 are connected in series and are protected by fuse F552. When switch S552 is in the 115V position, primary windings 4–5 and 6–7 are connected in parallel and fuse F552 is not included in the circuit.**

***b.* Secondary winding 8–10 supplies ac voltage to the plates of rectifier tubes V551, V552, and V553, which are connected in parallel in a full-wave rectifier circuit. Each plate is connected in series with one of the limiting resistors R551 through R556. These resistors prevent surge voltages from overloading the rectifier tubes.**

***c.* Rectified voltage is developed between terminal 9 of transformer T551 and the cathodes of the rectifier tubes. The rectified voltage is applied through the voltage-dropping resistors, R557, R558, and R559, and through a single-section filter comprised of choke L551 and capacitors C551 and C552 to terminal 1 on terminal board TB522. To compensate for differences in tubes and tolerances in components, voltage-dropping resistors R557, R558, and R559 are adjusted during manufacture. Resistor R557 is tapped at 5, 10, 20, 30, and 40 ohms to permit adjustment of the +200-volt output of the power supply. The +200-volt dc supply provides the required potential for the plates and screens of the tubes in the AN/TCC-3.**

235. Ac Supply, Detailed Analysis

The indicator lamps, the buzzer, and the filaments of all the vacuum tubes are supplied with 6.3-volts ac from winding 11–13 of transformer T551. The center tap of winding 11–13 is grounded through terminal 12 and each half of the winding is shunted by a capacitor (C553 and C554) in order to reduce hum. POWER indicator lamp I551 is connected across the 6.3-volt winding, 11–13, and serves as an on-off indicator for the power supply.

236. Negative Supply, Detailed Analysis

The ac voltage from winding 14–15 of transformer T551 is rectified by copper-oxide rectifier CR551. The negative voltage is filtered by a single-section filter consisting of resistor R560 and dual capacitor C555. Resistors R563 and R564 are shunted across the output of the bias voltage supply and serve as a bleeder. The transmitter of the attendant's telephone set is energized with the negative five-volt (−5V) output of the bias supply when the press-to-talk switch is operated. This negative voltage is applied to terminal 7 of terminal board TB552 through dropping resistor R561 (figs. 150, 151, and 155). Another negative voltage of −5 volts is provided at terminal 9 of terminal board TB552

through dropping resistor R562. This voltage is used to bias the limiter circuit in the order wire circuit. The −10 volts dc is provided for biasing the limiter circuit in the ringer-oscillator. This −10 volts dc is connected to terminal 5 of terminal board TB552 (figs. 150, 151, and 154).

CHAPTER 5

DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE

NOTE

The information in this chapter is applicable to all models of Telephone Modem TA-219/U and TA-219A/U and Amplifier-Power Supply AM-682/TCC-3 and AM-682A/TCC-3 unless otherwise noted. Telephone Modems TA-219/U and TA-219A/U are interchangeable, as are Amplifier-Power Supply AM-682/TCC-3 and AM-682A/TCC-3. It should be noted however that the substitution of an earlier model for an (A) unit will result in decreased capability.

NOTE

The amount of repair that can be performed by units having maintenance responsibility is limited only by the tools and test equipment available, and by the skill of the repairman.

Section I. PREREPAIR PROCEDURES

237. Tests, Materials and Test Equipment

The tools, test equipment, and materials listed in paragraph 78 are required. Substitute Multimeter TS-352/U (or equal) for Multimeter AN/URM-105.

238. Removal of Punch-Out Parts and Plug-In Assemblies

a. The procedure for removing a pluck-out part, such as a tube, lamp, fuse, or protector, appears in paragraph 85. Paragraph 86 describes the procedure for inspecting, cleaning, and testing pluck-out parts. To remove one of the plug-in assemblies, such as a channel modem, an amplifier, the carrier supply, or the ringer-oscillator follow the procedure given in paragraph 87. Inspecting and cleaning plug-in assemblies are described in paragraph 88.

b. During the inspection of plug-in assemblies, resolder leads found to be loose or broken. Replace all items that appear to be broken. Carefully observe each fixed capacitor and resistor and replace any that appear discolored or burned. Use the troubleshooting procedures (para 240) to locate the cause of the burned capacitor or resistor.

Section II. TROUBLESHOOTING

239. General

a. The information contained in this and following sections of this chapter will aid the repairman to troubleshoot the AN/TCC-4. This section contains an outline of troubleshooting methods (para 240), the operational test (para 242) and a listing of the test equipment (para 241) and data (para 243) that will aid in troubleshooting. The troubleshooting chart (para 244) will be useful in locating the source of trouble in a complete AN/TCC-4.

b. Paragraphs 245 through 276 contain signal substitution tests for all the circuits of the AN/TCC-4 except the power supply and test oscillator. The power supply and test oscillator are checked by resistance and voltage measurements, and by circuit element checks. Paragraphs 277 through 292 contain the information related to checking any circuit element contained in the AN/TCC-4. Paragraphs 293 through 297 describe the tests and adjustments required before returning the AN/TCC-4 or a plug-in assembly to operation or prior to storing it as a spare.

240. Troubleshooting Procedures

a. If troubleshooting is to be performed on a a complete AN/TCC-3, follow the organizational troubleshooting procedures (para 80) with the following exceptions.

(1) If the AN/TCC-3 is connected in the system, use the organizational maintenance operational test (para 82). If the AN/TCC-3 is not connected in the system, use the equipment performance checklist (para 90).

(2) Use the troubleshooting chart in paragraph 244.

(3) Perform signal substitution (para 258 through 276) to check the operation of the major circuit suspected of containing the defective element.

(4) Perform trouble localization (c below).

b. When troubleshooting a plug-in assembly, perform signal substitution (*a*(3) above) on the assembly and then perform the trouble localization in paragraph *c* below.

c. After the trouble has been isolated to a single stage or circuit by the procedures of *a* or *b* above, localize the trouble to the defective part by following the procedures below in the order listed.

(1) Take voltage and resistance measurements in the portion of the circuit to which the trouble has beeen traced. Compare the measurements with those given for normal conditions (para 249 and 256). Differences between the actual and the normal measurements usually indicate which part in the circuit is faulty (para 255).

(2) Any part or parts which are suspected of being faulty can be checked by the procedures listed in paragraphs 277 through 292. These checks provide an accurate method for determining whether or not a particular part is defective. If the defective part has failed due to an overload, determine the cause of the overload and eliminate the cause before replacing the defective part.

241. Test Equipment Required for Troubleshooting

The measuring circuit, which is part of the AN/TCC-3, is useful for sectionalizing a trouble in the equipment. Additional items of test equipment required and related publications are listed below.

Item	Publication	Quantity
Signal Generator SG-15/PCM	TM 11-6625-251-15	1
Test Set TS-140/PCM	TM 11-6625-251-15	1
Frequency Meter AN/TSM-16	TM 11-6625-218-12	1
Multimeter ME-26A/U [1]	TM 11-6625-200-12	1
Multimeter TS-352B/U	TM 11-6625-366-15	1
Test Set, Electron Tube TV-7/U	TM 11-6625-274-12	1
Capacity Analyzer ZM-3/U	TM 11-6043-12	1
Battery BA-23 (1.5 volts dc)		1
Power supply (for 200 volts dc, 10 volts dc, and 6.3 volts ac) [2]		
Resistor, 50,000 ohms, 1 watt		1
Tool Equipment TE-123		1
Telephone Carrier System Test Facilities Kit MK-155/TCC, the following items are required:	TB SIG 358	1
Resistance networks: 527, 155, 2,078, 696, and 6,200 ohms [3]		
Resistor, fixed, 60.4 ohms		[illegible]
Resistor, fixed, 600 ohms		[illegible]
Resistor, variable, 25,000 ohms		1
Modem and amplifier test cable assembly [3]		1
Carrier supply test cable assembly [3]		1
Junction panel test cable assembly [3]		1
Extension test cable assembly [3]		1

[1] Use the ME-26A/U in those places in this manual where vacuum-tube voltmeter, Electronic Multimeter [illegible], and ME-6/U are indicated.

[2] Power Supply PP-687/U (part of Terminals, Telephone AN/TCC-7, AN/TCC-[illegible]) (TM 11-[illegible]) or Repeater, Telephone AN/TCC-8 (TM 11-2140-[illegible]) may be used to provide these voltages. If the PP-687/U is used, use the carrier supply test cable assembly in the MK-155/TCC to facilitate power connections. On the carrier supply test cable assembly, terminals A (positive) and B (negative) are for 200 volts dc, terminals C and F are for 6.3 volts ac, and terminals D (negative) and E (positive) are for 10 volts dc. To provide a suitable load for the 200-volt output of the PP-687/U, select the two 1,000-ohm resistors (27 watts each) from the MK-155/TCC and connect them in parallel to terminals A

and K of the carrier supply test cable assembly. Then adjust the dc output of the TS-827/U to obtain 200-volt indication at terminals A and K of the carrier supply test cable assembly.

[a] Combine resistors of various values to obtain the resistance networks required in the test setups.

[b] Use the modem and amplifier test cable assembly in those places where test cable is indicated.

[c] The junction panel test cable assembly is equivalent to Telephone Cable Assembly CX-1512/U (fig. 18) and may be used where spiral-four cable stub, spiral-four cable connector, and cable stub are mentioned in the test procedures. Terminals 1 and 2 of the junction panel test cable assembly correspond to the transmitting wires mentioned in the test procedures and terminals 3 and 4 correspond to the receiving wires mentioned in the test procedures.

[d] Use the extension cable assembly if the extention cable (fig. 16) is not provided in the AM-682/TCC-8.

242. General Procedures

Whenever the AN/TCC-8 is serviced, observe the following precautions very carefully.

a. Be careful when working with the power on. Remember that even with the POWER switch in the OFF position, line voltage is present in part of the power supply bracket assembly. To remove the power from the AN/TCC-8 completely, remove the power plug from the convenience outlet.

b. Make connections from test equipment to the terminal only when the POWER switch is in the OFF position.

c. Careless replacement of parts often makes new faults inevitable. Note the following points:

(1) Before a part is considered, note the position of the leads. If the part, such as a transformer, has a number of connections, tag each of the leads before unsoldering it.

(2) Be careful not to damage other leads by pulling or pushing them out of the way.

(3) Do not allow drops of solder to fall into the equipment, since they may cause short circuits.

(4) A carelessly soldered connection may create a new fault. It is very important to make well-soldered joints, since a poorly soldered joint is one of the most difficult faults to find.

243. Equipment Differences

Differences exist between certain components of the AN/TCC-8 procured on Order No. 1667-Phila-51. Subparagraphs *a* and *b* below describe these differences and specify the serial numbers of the components which contain these differences.

a. In TA-219/U bearing Order No. 1667-Phila-51, serial numbers 1180 through 2480, the cabling in the channel modem frame between jacks J4 and J5 is unshielded. Cabling between the other jacks is as shown in figures 140 and 164.

b. AM-682/TCC-8 bearing order numbers other than Order No. 1667-PH-51 (serial No. 1 through 1707) differs from those bearing Order No. 1667-PH-51 *(serial No. 1 through 1707)* in the following manner.

(1) Terminal board TB901 is located under the top surface of the left-hand chassis.

(2) Terminal board TB902 is mounted on a bracket which raises it off the chassis.

(3) The part of terminal board TB903 containing terminals 1, 2, and 3 (fig. 150) is eliminated (fig. 151). The remainder of TB903 (terminals 4, 5, and 6) is redesignated terminal board TB904. Terminal 6 of terminal board TB904 is used as a connecting point between the test probe lead and terminal 8 on section 2, rear, of MEASURE switch, S772. Access to terminals 4, 5, and 6 is provided through a hole in the bottom of the left-hand chassis.

NOTE

On equipment bearing order numbers other than Order No. 1667-PH-51, the terminals on terminal board TB904 are designated terminals 1, 2, and 3, and correspond to terminals 4, 5 and 6, respectively, on terminal board TB903 from which terminals 1, 2, and 3 were eliminated.

(4) The test probe is located on the front edge of the extension cable storage shelf (fig. 17).

(5) Terminal board TB771, used to mount resistors R771 through R779, is redesignated TB774. TB774 is located on the side of the left-hand chassis beneath the power supply bracket assembly (fig. 17).

(6) Terminal board TB772, used to mount resistors R780, R790, R791, R792, and R794, is redesignated TB773.

(7) Metal clips are used to hold the ac power cable in its stowed position. Storage instructions appear on the chassis in the storage area.

(8) In the carrier supply, the wires that connect plug P601 to the output sides of transformers T608, T609, T610 and T611 are unshielded (fig. 153).

(9) Terminal board TB701 (fig. 150) is eliminated (fig. 151). Maintenance information specifying the use of terminal board TB701 terminals as test points is changed to specify appropriate terminals on TB801.

(10) TB702 is located on the right-hand chassis beneath the power supply bracket assembly (fig. 17).

(11) Resistors R721 through R726 (part of the order wire circuit) are mounted on terminal board TB775. Terminal board TB775 is located on the left-hand chassis beneath the power supply bracket assembly (fig 17)

(12) All spare parts are mounted on a single spare parts shelf (para 12).

(13) An extension cable storage shelf is located below the spare parts shelf (fig. 16).

(14) Sufficient wiring slack is provided so that MEASURE switch S772, the order wire bracket, the special service bracket, and the measuring circuit bracket may be removed from the chassis for maintenance purposes without unsoldering the cabling to these parts.

244. Troubleshooting Chart

The troubleshooting chart below is supplied as an aid in sectionalizing trouble that exists in the AN/TCC-3. The chart lists the symptoms that the repairman can observe while the terminal is connected in the system. To facilitate the use of the chart, major symptoms have been subdivided wherever practicable, into associated, additional symptoms. The chart lists also the trouble or troubles most likely to cause the observed symptoms. References are made to the paragraph that contains a discussion of the theory of operation for the circuit that could be defective. In addition, the chart indicates the corrective measures that the repairman should perform. With the recommended corrective measures are references to the schematic diagram of the circuit to be checked, and to the paragraphs in which the recommended troubleshooting procedure is outlined. Following the performance of the recommended troubleshooting procedure, it may be necessary, in order to localize the trouble to the defective part, to check several circuit elements, any one of which could be the cause of the observed symptoms. The procedure for checking any type of circuit element is described in paragraph 277 through 292.

Symptom	Probable trouble	Correction
1. No transmission through all channels in both directions.		
a. Order wire inoperative.		
(1) POWER LAMP lighted.		
(a) Operational test (para 82) indicates lack of transmission.	200 volt d-c supply failure (para 234).	Check for +200 volts dc between jack J[illegible] and ground. Test tubes V[illegible], V[illegible], and V[illegible] and replace if necessary. Check voltage and resistance measurements in +200 volt power supply (para [illegible] and [illegible]) (fig. [illegible]).
(b) Operational test (para 82) indicates transmission through transmitting amplifier.	Protectors shorted.	With Ohmmeter, check for short between each contact of spiral-four cable connector and ground. Replace shorted protectors (figs. [illegible] and 151).
(2) POWER lamp not lighted.	Power supply failure (para [illegible]).	Check fuses F[illegible] and F[illegible] and replace if necessary. Check power cable W[illegible] and repair if open. Check switches S[illegible] and S[illegible] and clean, repair, or replace as necessary. Check resistance measurements in power supply (para [illegible]) (fig. [illegible])
b. Order wire operative.		
(1) SYSTEM ALARM lamp lights at distant terminal.	Failure in [illegible] oscillator of carrier supply (para [illegible]).	Check output at jack J[illegible] with [illegible] probe. If there is no output, check tube V[illegible] and replace if faulty. Replace crystal Y[illegible]. Check voltage and resistance measurements in [illegible]

Symptom	Probable trouble	Correction
		kc oscillator (para 249 and 255) (fig. 168).
	Failure in frequency division circuit of carrier supply (para 169).	Check outputs at jacks J601 and J602 with test probe. If output at jack J601 is normal but there is no output at 602, check tube V602 and replace if faulty. Check voltage and resistance measurements in frequency division circuit (para 249 and 256) (fig. 168).
(2) SYSTEM ALARM lamp does not light at distant terminal.		
(a) Output at jack J602 of carrier supply is normal.	Failure in 4-kc amplifier of carrier supply (para 173).	Check output at jack J603 with test probe. If there is no output, check tubes V603 and V605 and replace if faulty. Check voltage and resistance measurements in 4-kc amplifier (para 249 and 256) (fig. 168).
	Failure in harmonic generator circuit of carrier supply (para 176).	If output at jack J603 is normal, perform signal substitution (para 267). Check voltage and resistance measurements in harmonic generator circuit (fig. 168 and para 249 and 258).
(b) No output at jack J602 of carrier supply.	Failure of either 16-kc oscillator or frequency division circuit of carrier supply and failure of system alarm circuit at distant terminal.	Notify distant attendant of the trouble in distant terminal. Proceed to trouble shoot local terminal as outlined for item (1)(a) above.
2. No transmission through channels 2 and 4 in either direction. (Channels 1 and 3 and order wire operating normally.)	Failure in 12-kc and 20-kc output circuits of carrier supply (para 180).	Perform signal substitution (para 270) on 12-kc and 20-kc output circuits (fig. 168).
3. No transmission through channels 1 and 3 in either direction. (Channels 2 and 4 and order wire operating normally.)	Failure in 12-kc and 20-kc output circuits of carrier supply (para 181).	Perform signal substitution (para 270) on 8-kc and 16-kc output circuits (fig. 168).
4. No transmission through channel 1 in either direction. (Other channels and order wire operating operating normally.)	Failure in 8-kc output circuit of carrier supply (para 181).	Perform signal substitution (para 270) on 8-kc output circuit (fig. 168). Check continuity of wiring between terminals 6 and 11 of plug P601 and input to channel 1 modem (terminals 6 and 9 of plug P101).
	Failure in carrier temperature compensating pad in channel 1 modem (para 110).	Check resistors and thermistors in this pad (fig. 146).
5. No transmission through channel 2 in either direction. (Other channels and order wire operating normally.)	Failure of 12-kc output circuit of carrier supply (para 180).	Perform signal substitution (para 270) on 12-kc output circuit of carrier supply. Check continuity of wiring between terminals 6 and 1. of plug P601 and the 12-kc input to channel 2 modem (terminals 6 and 9 of plug P201).
	Failure in carrier temperature compensating pad in channel 2 modem (para 110).	Check resistors and thermistors in this pad (fig. 147).
6. No transmission through channel 3 in either direction. (Other channels and order wire operating normally.)	Failure in 16-kc output circuit of carrier supply (para 181).	Perform signal substitution (para 270) on 16-kc output circuit. Check continuity of wiring between terminals 5 and 6 of plug P601 and the 16-kc input to channel 3 modem

Symptom	Probable trouble	Correction
		(terminals 0 and 3 of plug P801) (fig. 153).
	Failure in carrier temperature compensating pad in channel 3 modem (para 115).	Check resistors and thermistors in this pad (fig. 148).
7. No transmission through channel 4 in either direction (Other channels and order wire operating normally.)	Failure in 20-kc output circuit of carrier supply (para 180).	Perform signal substitution (para 270) on 20-kc output circuit. Check continuity of wiring between terminals 3 and 6 of plug P601 and the 20-kc input to channel 4 modem (terminals 0 and 3 of plug P801) (fig. 153).
	Failure in carrier temperature compensating pad in channel 4 modem (para 115).	Check resistors and the thermistors in this pad (fig. 149).
8. No transmission through all channels and order wire in transmitting direction. Reception normal.		
a. Operational test (para 82) indicates lack of transmission.	Failure in transmitting amplifier (para 123).	Check tubes V51 and V52 of transmitting and amplifier and replace if faulty. Perform signal substitution on amplifier (para 271). Check voltage and resistance measurements in amplifier (para 249 and 256).
b. Operational test indicates that transmitting amplifier is amplifying signals.	Protectors E763 and E764 shorted.	With ohmmeter, check resistance between each female terminal of spiral-four cable connector and ground. Short indicates shorted protector. Replace shorted protectors.
	Failure in cable matching network.	Perform signal substitution on cable matching network (para 275)
9. No transmission through all channels and order wire in receiving direction. SYSTEM ALARM lamp lights, buzzer sounds. Operation normal in transmitting direction.	Failure in receiving amplifier (para 147)	Check tubes V51 and V52 of receiving amplifier and replace if faulty. Perform signal substitution on amplifier (para [illegible]). Check voltage and resistance measurements in amplifier (para 244 and [illegible]).
	Protectors E737 and E738 shorted.	With ohmmeter, check resistance between each male terminal of spiral-four cable connector and ground. A short indicates a shorted protector. Replace the shorted protector.
	Failure in equalizers or associated circuit (para 133).	Perform signal substitution on equalizers and associated circuits (para 276). Perform elements check (para 283).
10. No transmissions through one channel in receiving direction. Order wire operating normally.	Failure in receiving circuit of that channel (para 149).	Check demodulator amplifier tube in inoperative channel tube and replace if faulty. Perform signal substitution on receiving circuit of that channel (para [illegible] for channel 1, para [illegible] for channel 2, para [illegible] for channel 3, para [illegible] for channel 4).
11. No transmission through one channel in transmitting direction. Order wire operating normally.	Failure in transmitting circuit of that channel modem (para [illegible]).	Perform signal substitution on the transmitting circuit of that channel modem (para [illegible] for channel 1, para [illegible] for channel 2, para [illegible] for channel 3, para [illegible] for channel 4).

Symptom	Probable trouble	Correction
12. Transmissions through one channel in receiving direction are distorted. Other channels and order wire operating normally.	Failure in demodulator amplifier of that channel modem (para 159).	Check voltage and resistance measurements in demodulator amplifier of that channel (para 249 and 256).
13. Transmissions through all channels and order wire in transmitting direction are distorted. Operation in receiving direction is normal.	Failure in transmitting amplifier (para 128).	Perform signal substitution (para 271). Check voltage and resistance measurements in feedback circuit of transmitting amplifier (para 249 and 256).
	Cable matching network defective (para 128).	Perform signal substitution on cable matching network (para 275).
14. Transmissions through all channels and order wire in receiving direction are distorted. Operation in transmitting direction is normal.	Failure in receiving amplifier (para 128).	Check voltage and resistance measurements in feed-back circuit of receiving amplifier (para 249 and 256).
15. No special service transmissions in either direction.		
a. Order wire inoperative.	Same as item 1*a*.	Same as item 1*a*.
b. Order wire operative.	SPECIAL SERVICE switch S801 faulty.	Check continuity through switch contacts. Clean or replace switch as necessary.
16. No special service and order wire transmissions in transmitting direction. Reception normal.	Same as item 6.	Same as item 6.
17. No special service transmissions in transmitting direction. Order wire operating normally.	Failure in special service transmitting path.	Perform signal substitution on special service transmitting path (para 273) (figs. 150 and 151).
18. No special service and order wire transmissions in receiving direction. SYSTEM ALARM lamp lights, buzzer sounds. Operation normal in transmitting direction.	Same as item 6.	Same as item 6.
19. No special service transmissions in receiving direction. Order wire operating normally.	Failure in special service receiving path.	Perform signal substitution on special service receiving path (para 274) (figs. 150 and 151).
20. Special service and order wire transmissions in transmitted direction are distorted. Received signals are normal.	Same as item 13.	Same as item 13.
21. Special service and order wire transmissions in the received direction are distorted. Transmitted signals are normal.	Same as item 14.	Same as item 14.
22. On special service operation, all communication circuits operating normally. SYSTEM ALARM lamp lights at distant terminal.	Same as item 16(1).	Same as item 16(1).
23. Hum present on all transmitted and received signals.	Failure in filter of +200-volt supply (para [illegible]).	Check filter capacitors C[illegible] and C[illegible] (para [illegible]) and filter choke L[illegible] (para [illegible]).
24. Hum present on order wire signals transmitted from local AN/TCC-3.	Failure in filter of negative power supply (para [illegible]).	Check filter capacitor C[illegible] (para [illegible]) and resistor R[illegible] (para [illegible]).
25. MEASURE meter gives no reading or incorrect readings for all quant-	Failure in measuring circuit (para [illegible]).	Check resistors in portion of measuring circuit (fig 147) between trans-

Symptom	Probable trouble	Correction
fied measurements. Other circuits operate normally.		former T771 and meter M771. Check transformer T771 para 280).
26. MEASURE meter gives no reading or incorrect reading in one or more of these positions of MEASURE switch: 1KC–OW, 19KC–CH–4, 11KC–CH2, 7KC–CH1, 15-KC–CH3; AMPLIFIER switch in either TR or REC position. All other circuits operate normally.	Failure in measuring circuit (para 219 through 223).	Perform signal substitution on measuring circuit (para 272).
27. No output from test oscillator. All other circuits operating normally.	Failure in test oscillator (para 213).	Check tube V701 and replace if defective. Check voltage and resistance measurements in test oscillator (para 249 and 256) (fig. 158).
28. Impossible to ring distant station when ORDER WIRE switch is in RING position.		
a. Order wire operative.		
(1) CALL lamp lights and buzzer sounds when ORDER WIRE switch is in RING position.	Break in connection between ringer oscillator and order wire transmission path.	Check ORDER WIRE switch for continuity in RING position. Clean or replace if necessary. Check continuity between terminal 1 of plug P1 in ringer-oscillator and terminal 2 of transformer T722 in order wire circuit (figs. 154 and 155).
(2) CALL lamp does not light and buzzer does not sound when ORDER WIRE switch is in RING position.	Failure in ringer-oscillator (para 184).	Check tube V1 and replace if faulty. Perform signal substitution on ringer-oscillator (para 267) (fig. 154).
	Failure in circuit between ringer-oscillator and ORDER WIRE switch.	Check ORDER WIRE switch for continuity in RING position. With ORDER WIRE switch held in the RING position, check continuity between terminals 3 and 4 of terminal board TB903 and between terminals 2 and 6 of terminal board TB[illegible] (figs. 150, 151, and 155).
b. Order wire inoperative.	Failure in order wire transmitting circuit (para 202).	Perform signal substitution on order wire transmitting path (para [illegible]) (fig. 155).
	Failure in negative voltage power supply (para 236).	In the power supply, check the voltage between jack J[illegible] and ground and between terminal [illegible] of terminal board TB[illegible] and ground. If the voltage at jack J[illegible] is approximately −10 volts and no voltage is present at terminal [illegible], check resistor [illegible]. If no voltage is present at either of these test points, check resistance measurements in negative power supply. If voltage at jack J[illegible] is approximately −10 volts and voltage at terminal [illegible] of terminal board TB[illegible] is approximately −10 volts, check for a break in the circuit between terminal [illegible] of terminal board TB[illegible] and test point [illegible] in the order wire circuit (fig. [illegible]). Check also

Symptom	Probable trouble	Correction
		for a break between test point E728 and ground.
29. CALL lamp lights and buzzer sounds continuously. (No ringing signal received.)	Failure in ringer-oscillator (para 184 through 199).	Check tubes V1 and V2 and replace if faulty. Check relay K1 (para 287). Perform signal substitution on ringer-oscillator (para 267).
30. CALL lamp does not light and buzzer does not sound when ringing signal is transmitted or received.	Failure in ringer-oscillator (para 184).	Check tube V2 and replace if faulty. Perform signal substitution on ringer-oscillator (para 267).
31. Order wire can receive signals (such as 1600 cps ringing signals) but can not transmit signals. Traffic communications are normal.	Same as 28b.	Same as 28b. In addition: Check voltage at J55d when the press-to-talk switch on the attendant's handset is operated. If voltage remains approximately −10 volts, there is a break in the circuit between terminal 7 of terminal board TB552 and ground (fig. 160). Check this circuit for location of break (fig 168).
		Check ORDER WIRE switch for continuity in TALK position and SEND OW switch for continuity in non-operated position.
		Check transmitter of attendant's handset (para 290).
32. Order wire can transmit signals but can not receive signals. Traffic communications are normal.		
a. Incoming ringing signals are received normally.	Failure in order wire receiving path between secondary winding of transformer T725 and receiver of attendant's telephone handset.	Check for continuity in order wire receiving path between secondary winding of transformer T725 and receiver of attendant's telephone handset.
		Check receiver of attendant's handset (para 290).
b. Incoming ringing signals do not cause the buzzer to sound and the CALL lamp to light.	Failure in circuit between output of receiving amplifier and output of receiver low-pass filter FL772.	Check for continuity (zero reading) between terminal 8 of jack J807 (figs 160 and 161) and terminal 1 of filter FL722 (fig 166) when AMPLIFIER switch is in the normal (vertical) position.
		Check that terminal 10 of jack J808 and terminal 2 of filter FL722 are grounded. Check filter FL722 (para [illegible]).
	Failure in output circuit of receiving amplifier (para [illegible]).	Perform signal substitution in checking the output circuit of the receiving amplifier between transformer T[illegible] and terminals 8 and 10 of plug P801.
33. SYSTEM ALARM lamp and CALL lamp and buzzer sounds. Other circuits operating normally.	Failure in system alarm circuit (para [illegible]).	Perform signal substitution on system alarm circuit (para [illegible]). (Look for absence of signal at grid of tube V[illegible] and for failure in voltage doubler circuit.)
34. Alarm indications are not present when [illegible] cable to other [illegible] or removed from terminal.	Failure in system alarm circuit (para [illegible]).	Check tube V[illegible] and replace if faulty. Check relay K[illegible] (para [illegible]). Check voltage and resistance measurements in system alarm circuit.

245. Troubleshooting Data

The troubleshooting data provided in *a* and *b* below contain references to the paragraphs that pertain to the theory of operation, to the voltage and resistance measurements, and to the signal substitution tests. The troubleshooting data also include references to the schematic and wiring diagrams, to the tube location diagrams, and to the circuit element location diagrams. Subparagraphs *a* and *b* below lists the troubleshooting data for the circuits of Telephone Modem TA-219/U and Amplifier-Power Supply AM-682/TCC-3.

a. Telephone Modem TA-219/U, Troubleshooting Data. The chart below lists the troubleshooting data for locating faults in the TA-219/U. The list includes references to tests required for troubleshooting and to illustrations which aid in the location of test points and parts in the TA-219/U. The illustrations listed in the chart below show the location of circuit elements. The locations of hidden circuit elements, which are obscured because they are located between another circuit element and the chassis, are indicated with an arrow pointing to the circuit element that obscures the hidden part.

Fig. or para No.	*Caption or heading*
Fig. 145	Telephone Modem TA-219/U, connection diagram.
Fig. 9	Telephone Modem TA-219/U, front view.
Fig. 82	Telephone Modem TA-219/U, tube location diagram.
	CHANNEL 1 MODEM:
Para 102 and 149.	Theory of operation.
Para 249 and 256.	Voltage and resistance measurements.
Para 259	Transmitting path, signal substitution.
Para 260	Receiving path, signal substitution.
Fig. 146	Schematic diagram.
Fig. 86	Top view, circuit element location diagram.
Fig. 87	Bottom view, circuit element location diagram.
Fig. 165	Wiring diagram.
	ANNEL 2 MODEM:
Para 102 and 149.	Theory of operation.
Para 249 and 256.	Voltage and resistance measurements.
Para 261	Transmitting path, signal substitution.
Para 262	Receiving path, signal substitution.
Fig. 147	Schematic diagram.
Fig. 88	Top view, circuit element location diagram.
Fig. 89	Bottom view, circuit element location diagram.
Fig. 166	Wiring diagram.
	CHANNEL 3 MODEM:
Para 102 and 149.	Theory of operation.
Para 249 and 256.	Voltage and resistance measurements.
Para 263	Transmitting path, signal substitution.
Para 264	Receiving path, signal substitution.
Fig. 148	Schematic diagram.
Fig. 90	Top view, circuit element location diagram.
Fig. 91	Bottom view, circuit element location diagram.
Fig. 167	Wiring diagram.
	CHANNEL 4 MODEM:
Para 102 and 149.	Theory of operation.
Para 249 and 256.	Voltage and resistance measurements.
Para 265	Transmitting path, signal substitution.
Para 266	Receiving path, signal substitution.
Fig. 149	Schematic diagram.
Fig. 92	Top view, circuit element location diagram.
Fig. 93	Bottom view, circuit element location diagram.
Fig. 168	Wiring diagram.

b. Amplifier-Power Supply AM-682/TCC-3, Troubleshooting Data. The chart below lists the troubleshooting data for locating faults in the AM-682/TCC-3. The list includes references to tests required for troubleshooting and to illustrations which locate test points and parts in the AM-682/TCC-3.

Fig. or para No.	*Caption or heading*
	Amplifier-Power Supply AM-682/TCC-3:
Fig. 150	Connection diagram (serial numbers 1 through 1707).
Fig. 151	Connection diagram (serial numbers 1708 through [illegible]).
Fig. [illegible]	Right-side view.
Fig. [illegible]	Left-side view (serial numbers 1 through 1707).
Fig. [illegible]	Left-side view (serial numbers 1708 through [illegible]).
Fig. [illegible]	Top view (serial numbers 1 through 1707).
Fig. [illegible]	Top view (serial numbers 1708 through [illegible]).

Fig. or para No.	Caption or heading
Fig. 85	Right-side view, tube location diagram.
Figs. 84 and 84.1.	Left-side view, tube location diagram.
Figs. 83 and 83.1.	Top view, tube location diagram.
Fig. 169	Interconnection wiring diagram.
TRANSMITTING AMPLIFIER:	
Para 123	Theory of operation.
Para 249 and 256.	Voltage and resistance measurements.
Para 271	Signal substitution.
Fig. 152	Schematic diagram.
Fig. 102	Top view, circuit element location diagram.
Fig. 103	Bottom view, circuit element location diagram.
Fig. 85	Tube location diagram (part of larger figure).
Fig. 170	Wiring diagram.
RECEIVING AMPLIFIER:	
Para 147	Theory of operation.
Para 249 and 256.	Voltage and resistance measurements.
Para 271	Signal substitution.
Fig. 152	Schematic diagram.
Fig. 102	Top view, circuit element location diagram.
Fig. 103	Bottom view, circuit element location diagram.
Fig. 85	Tube location diagram (part of larger figure).
Fig. 17[illegible]	Wiring diagram.
CARRIER SUPPLY:	
Para [illegible]	Theory of operation.
Para 249 and 256.	Voltage and resistance measurements.
Para 270	Signal substitution.
Fig. [illegible]	Schematic diagram.
Fig. [illegible]	Top view, circuit element location diagram.
Fig. [illegible]	Bottom view, circuit element location diagram.
Figs. [illegible] and [illegible]	Tube location diagram (part of larger figure).
Fig. 17[illegible]	Wiring diagram.
MIXER-OSCILLATOR:	
Para [illegible]	Theory of operation.
Para 249 and 256.	Voltage and resistance measurements.
Para [illegible]	Signal substitution.
Fig. [illegible]	Schematic diagram.
Fig. [illegible]	Top view, circuit element location diagram.
Fig. 95	Bottom view, circuit element location diagram.
Figs. 84 and 84.1	Tube location diagram (part of larger figure).
Fig. 173	Wiring diagram.
ORDER WIRE:	
Para 200	Theory of operation.
Para 249 and 256.	Voltage and resistance measurements.
Para 269	Signal substitution.
Fig. 155	Schematic diagram.
Fig. 98	Order wire input bracket assembly, top view, circuit element location diagram.
Fig. 99	Order wire input bracket assembly, bottom view, circuit element location diagram.
Fig. 96	Auxiliary circuits bracket assembly, top view, circuit element location diagram.
Figs. 97 and 97.1.	Auxiliary circuit bracket assembly, bottom view circuit element location diagram.
Fig. 169	Amplifier-Power Supply AM-682/TCC-3, interconnection wiring diagram.
MEASURING CIRCUITS:	
Para 211	Theory of operation.
Para 249 and 256	Voltage and resistance measurements.
Para 272	Signal substitution.
Fig. 160	Schematic diagram.
Figs. 104 and 104.1	Measuring circuit bracket assembly, top view, circuit element location diagram.
Figs. 105 and 105.1	Measuring circuit bracket assembly, bottom view, circuit element location diagram.
Fig. 169	Amplifier-Power Supply AM-682/TCC-3, interconnection wiring diagram.
TEST OSCILLATOR:	
Para [illegible]	Theory of operation.
Para 249 and 256	Voltage and resistance measurements.
Fig. [illegible]	Schematic diagram.
Fig. 96	Auxiliary circuits bracket assembly, top view, circuit element location diagram.
Figs. [illegible] and 97	Auxiliary circuits bracket assembly, bottom view, circuit element location diagram.
Fig. 169	Amplifier-Power Supply AM-682/TCC-3, interconnection wiring diagram.

Fig. or para No.	Caption or heading
	SYSTEM ALARM:
Para 226	Theory of operation.
Para 249 and 256.	Voltage and resistance measurements.
Para 268	Signal substitution.
Fig. 159	Schematic diagram.
Fig. 96	Auxiliary circuits bracket assembly, top view, circuit element location diagram.
Figs. 97 and 97.1.	Auxiliary circuits bracket assembly, bottom view, circuit element location diagram.
Fig. 169	Amplifier-Power Supply AM-682/TCC-3, interconnection wiring diagram.
	POWER SUPPLY:
Para 233	Theory of operation.
Para 249 and 256.	Voltage and resistance measurements.
Fig. 160	Schematic diagram.
Fig. 110	Power supply, top view, circuit element location diagram.
Fig. 111	Power supply, bottom view, circuit element location diagram.
Fig. 173	Wiring diagram.

246. Voltage Measurements

Voltage measurements should be used when checking the power supply of the AN/TCC-3 for possible trouble. In order wire circuits, voltage measurements should be made only after the trouble has been localized to a particular circuit. Voltage measurements are easily taken, because they are always made between two points in a circuit and the circuit need not be interrupted. To perform voltage measurements, follow the procedures outlined below.

a. Use the complete information on normal operating voltages as given in table I (para 249). Unless otherwise specified, these voltages are measured between the indicated points and ground.

b. Always begin by setting the voltmeter on the highest range, so that the voltmeter will not be overloaded. Then, if it is necessary to obtain increased accuracy, set the voltmeter to a lower range.

c. In checking cathode voltage, remember that a reading can be obtained when the cathode resistor in actually open. The resistance of the meter may act as a cathode resistor. Thus, the cathode voltage may be approximately normal only as long as the voltmeter is connected between cathode and ground. Before the cathode voltage is measured, a resistance check should be made with the circuit deenergized to determine whether the cathode resistor is normal.

247. Precautions Against High Voltage

Certain precautions must be taken when measuring voltages above 100 volts. High voltages are dangerous and can be fatal. When it is necessary to measure high voltages, observe the following rules:

***a.* Connect the ground lead of the voltmeter to chassis ground.**

***b.* Place one hand in pocket.**

***c.* Connect the test lead to the test point. Be careful not to touch the test point with the hand.**

248. Voltmeter Loading

It is esssential that the voltmeter resistance be at least 10 times as large as the resistance of the circuit across which the voltage is measured. If the voltmeter resistance is comparable to the circuit resistance, the voltmeter will indicate a much lower voltage than the actual voltage present when the voltmeter is removed from the circuit.

a. The input resistance of the voltmeter on any range can always be calculated by the following simple rule: resistance of voltmeter equals the ohms-per-volt sensitivity times the full-scale voltage. For example, the resistance of a 1,000-ohms-per-volt voltmeter on the 250-volt range is R = 1,000 ohms per volt × 250 volts = 250,000 ohms; the resistance of a 20,000-ohms-per-volt-voltmeter on the 250-volt range is R = 20,000 ohms per volt × 250 volts = 5 megohms.

b. To minimize voltmeter loading in high-resistance circuits, always use the highest voltmeter range. Although only a small deflection will be obtained (possibly only 5 divisions on a 100-division scale), the accuracy of the voltage measurement will be increased. The decreased loading due to the voltmeter will more than compensate for the inaccuracy which results from reading only a small deflection on the scale of the voltmeter.

c. When a voltmeter is loading a circuit, the effect can always be noted by comparing the voltage reading on two successive ranges. If the voltage readings on the two ranges do not agree, voltmeter loading is excessive. The reading (not the deflection) on the highest range will be greater than on the lowest range.

249. Typical Voltage Measurements

Table I contains typical voltage readings taken at the pins of the tubes and at the terminals

of the power transformer of the AN/TCC-3. The readings are useful in localizing trouble to the particular circuit element at fault.

a. **A measurement in the AN/TCC-3 under test that is widely divergent from the measurements in the tables, when used with the appropriate schematic diagram, often will localize the trouble to a particular circuit element. Small variations in voltage values from the values given in the tables do not indicate necessarily that trouble exists in the circuit associated with the variant measurements. Readings in a particular circuit of the AN/TCC-3 may vary as much as 10 percent and the circuit still may operate properly.**

b. **The voltage readings in table I were obtained with all tubes in place. All measurements were made with a 20,000-ohms-per-volt meter. Measurements are dc or ac as indicated in the table. Only the voltage readings for tube V201 of channel 2 modem are given in table I. The voltage readings for the corresponding tubes of channel 1, 3, and 4 modems (tubes V101, V301, and V401) are identical with the voltage readings for tube V201.**

Table 1. Telephone Terminal AN/TCC-3. Voltage Measurements

Measure	Measure between	Volts	Setting
	CHANNEL 2 MODEM		
Voltage at tube V201	Pin 2 and ground	+1.3 v dc	
	Pin 6 and ground	+85 v dc	
	Pin 7 and ground	+1 8 v dc	
	Pin 5 and ground	+180 v dc	
	Pin 3 or 4 and ground	3.15 v ac	
	TRANSMITTING AND RECEIVING AMPLIFIERS		
Voltages at tube V51	Pin 2 or 7 and ground	+1.0 v dc	
	Pin 6 and ground	+70 v dc	
	Pin 5 and ground	+78 v dc	
	Pin 3 or 4 and ground	3.15 v ac	
Voltages at tube V52	Pin 2 and ground	+8.6 v dc	
	Pin 6 and ground	+180 v dc	
	Pin 5 and ground	+175 v dc	
	Pin 3 or 4 and ground	3.15 v ac	
	CARRIER SUPPLY		
Voltages at tube V601	Pin 2 and ground	+1.5 v dc	
	Pin 4 and ground	+76 v dc	
	Pin 6 and ground	+118 v dc	
	Pin 8 and ground	+4.2 v dc	
	Pin 1 or 9 and ground	3.15 v ac	
Voltages at tube V602	Pin 2 or 7 and ground:		
	Serial numbers 1 through 90.	+8.4 v dc	
	Serial numbers 91 through 2100.	+4.0 v dc	
	Pin 5 and ground	+187 v dc	
	Pin 6 and ground	+187 v dc	
	Pin 3 or 4 and ground	3.15 v ac	
Voltages at tube V603	Pin 2 or 7 and ground	+20 v dc	
	Pin 5 and ground	+197 v dc	
	Pin 6 and ground	+195 v dc	
	Pin 3 or 4 and ground	3.15 v ac	
Voltages at tube V604	Pin 2 or 7 and ground	+21 v dc	
	Pin 5 and ground	+190 v dc	
	Pin 6 and ground	+185 v dc	
	Pin 3 or 4 and ground	3.15 v ac	

Table I. Telephone Terminal AN/TCC-3, Voltage Measurements-Continued

Measure	Measure between	Volts	Setting
RINGER-OSCILLATOR			
Voltages at tube V1	Pin 2 and ground	+1.6 v dc	Switch S703 in normal position.
	Pin 4 and ground	+160 v dc	
	Pin 1 or 9 and ground	3.15 v ac	
	Pin 6 and ground	+115 v dc	
	Pin 6 and ground	+200 v dc	Switch S703 in RING position.
TEST OSCILLATOR			
Voltages at tube V701	Pin 2 or 7 and ground	+2 v dc	TEST OSC OUTPUT (R705) set to extreme clockwise position.
	Pin 3 or 4 and ground	3.15 v ac	
	Pin 5 and ground	+145 v dc	
	Pin 6 and ground	+132 v dc	
	Pin 6 and ground	+58 v dc	TEST OSC OUTPUT (R705) set to extreme counterclockwise position.
SYSTEM ALARM			
Voltages at tube V741	Pin 2 or 7 and ground	0 v dc	
	Pin 3 or 4 and ground	3.15 v ac	
	Pin 6 and ground	+90 v dc	
	Pin 5 and ground	+73 v dc	
POWER SUPPLY			
Power transformer T551	Terminal 8 or 10 to terminal 9.	241 v ac	
	Terminal 14 to terminal 15	12.1 v ac	
	Terminal 11 to terminal 13	6.65 v ac	
Resistor R551	Terminal E551 and pin 1 of tube V551.	The smallest and largest voltage drops measured across resistors R551 through R556 must be within 20 percent of each other.	
Resistor R552	Terminal E552 and pin 6 of tube V551.		
Resistor R553	Terminal E553 and pin 1 of tube V552.		
Resistor R554	Terminal E554 and pin 6 of tube V552.	The smallest and largest voltage drops measured across resistors R551 through R556 must be within 20 percent of each other.	
Resistor R555	Terminal E555 and pin 1 of tube V553.		
Resistor R556	Terminal E556 and pin 6 of tube V553.		

250. Resistance Measurements

When a fault develops in a circuit, its effect will very often show up as a change in the resistance values. After the trouble has been localized to a small portion of the circuit, resistance measurements assist in the isolation of such fault. Troubleshooting data include the normal resistance values measured at the tube sockets and at test points. These values are measured between the indicated points and ground, unless otherwise stated. Often it is desirable to measure the resistance from other points in the circuit in order to determine whether the particular points in the circuit are normal. The normal resistance values at any point can be determined by referring to the resistance values shown in the schematic diagram or by use of the color code.

251. Precautions

a. Before making any resistance measurements, turn off the power. An ohm-meter is essentially a low-range voltmeter and a battery. If the ohmmeter is connected to an energized circuit, the meter may be damaged.

b. Capacitors must always be discharged before resistance measurements are made. It is particularly important to discharge capacitors before checking power supplies that are disconnected from their load. The discharge of a filter capacitor through the meter will burn out the meter movement, and in some cases may endanger life.

252. Correct Use of low and High Ranges

It is important to know when to use the low-resistance range and when to use the high-resistance range of an ohmmeter. When checking the circuit continuity, the ohmmeter should be set on the lowest range. If a medium or high range is used, the pointer may indicate 0 ohm, even if the resistance is as high as 500 ohms. When checking high resistances or measuring the leakage resistance of capacitors or cables, the highest range should be used. If a low range is used, the pointer will indicate infinite ohms, even through the actual resistance is less than a megohm.

253. Parallel Resistance Connections

a. When a resistance is measured and the value is found to be less than expected, make a careful study of the schematic in order to be certain that there are no resistances in parallel with the one that has been measured. Before replacing a resistor because its resistance measures too low, disconnect one terminal of the resistor from the circuit and measure its resistance again to make sure that the low reading does not occur because some part of the circuit is in parallel with the resistor.

b. In some cases, a resistor is in parallel with a low-voltage transformer winding. If the resistor must be checked, disconnect one terminal of the resistor from the circuit before measuring its resistance.

c. Before checking transformer winding resistances, tag and remove all external connections from the terminals of the transformer winding. This permits the measurement of the winding resistance with no parallel path across the winding.

When checking grid resistance, a false reading may be obtained if the tube is still warm and the cathode is emitting electrons. Allow the tube to cool, or reverse the ohmmeter test leads so that the negative ohmmeter test lead is applied to the grid.

255. Tolerance Value for Resistance Measurements

a. Tolerance means the normal difference that is permitted between the rated value of the resistor and its actual value. Most resistors used in Telephone Terminal AN/TCC-8 have a tolerance of 10 percent. For example, the grid resistor of a stage might have a rated value of 1 megohm and a tolerance of 10 percent. If the resistor were measured and found to have a value between 0.9 megohm and 1.1 megohms, it would be considered normal. In general, the ordinary resistors used in circuits are not replaced unless their actual values differ by more than 20 percent from the rated values. Some precision resistors and potentiometers are used. A precision resistor is a resistor whose value must be very close to its rated value.

b. The tolerance values for transformer windings are generally between 1 and 5 percent. In general, a transformer which shows resistance deviating more than 5 percent from its rated value should be suspected of being faulty. Allow the transformer to cool before the resistance test is made.

256. Typical Resistance Readings

a. The resistance readings for plug-in units were taken with the plug-in units disconnected from the AN/TCC-8.

b. Only the resistance readings at the pins of tube V201 in channel 2 modem are given in table II (c below). The resistance readings at the pins of the corresponding tubes of channel 1, 3, and 4 modems (tubes V101, V301, and V401) are identical with the resistance readings at the pins of tube V201. The winding-resistance measurements for the corresponding transformers of channel 2, 3, and 4 modems are the same, with the exception of the measurements for transformers T103 and T106 (in channel 1 modem). Table II, therefore, lists only the winding-resistance readings for the transformers of channel 2 modem and for transformers T103 and T106 in channel 1 modem.

c. Some resistance measurements are across capacitance. In these measurements, the initial indication on the meter will be lower than the reading when the indicator comes to rest. Wait for the indicator to reach a steady state before taking the reading.

Table II. Telephone Terminal AN/TCC-3, Resistance Measurements

Measure from—	Measure to—	Ohms	Setting
CHANNEL 2 MODEM			
Tube V201:			
Pin 5	Ground	Open circuit	
Pin 1	Ground	22,000	
Pin 2 or 7	Ground	204	
Pin 6	Ground	Open circuit	
Transformer T201:			
Terminal 1	Terminal 2	24	
Terminal 2	Terminal 3	27	
Terminal 4	Terminal 5	24	
Terminal 5	Terminal 6	27	
Terminal 7	Terminal 8	27	
Terminal 9	Terminal 10	27	
Transformer T202:			
Terminal 1	Terminal 2	47	
Terminal 3	Terminal 4	34	
Terminal 5	Terminal 6	34	
Transformers T203 and T205:			
Terminal 1	Terminal 2	13	
Terminal 3	Terminal 4	13	
Terminal 5	Terminal 6	48	
Transformers T204 and T206:			
Terminal 1	Terminal 2	13	
Terminal 3	Terminal 4	13	
Terminal 5	Terminal 6	48	
Transformer T207:			
Terminal 1	Terminal 3	20	
Terminal 4	Terminal 6	7,500	
Transformer T208:			
Terminal 1	Terminal 2	100	
Terminal 3	Terminal 4	83	
Terminal 5	Terminal 6	1,720	
CHANNEL 1 MODEM			
Transformers T103 and T106:			
Terminal 1	Terminal 2	13	
Terminal 3	Terminal 4	13	
Terminal 5	Terminal 6	115	
TRANSMITTING OR RECEIVING AMPLIFIER			
Tube V51:			
Pin 1	Ground	24,000	
Pin 2	Ground	220	

Table II. Telephone Terminal AN/TCC-3, Resistance Measurements-Continued

Measure from—	Measure to—	Ohms	Setting
Pin 5	Ground	Open circuit	
Pin 6	Ground	Open circuit	
Pin 7	Ground	220	
Pin 5	E58	36,000	
Pin 6	E58	102,000	
Tube V52:			
Pin 1	Ground	100,000	
Pin 2	Ground	270	
Pin 5	Ground	Open circuit	
Pin 6	Ground	Open circuit	
Pin 5	E58	875	
Pin 1	E58	6,800	
Transformer T51:			
Terminal 1	Terminal 2	100	
Terminal 3	Terminal 4	105	
Terminal 5	Terminal 6	1,720	
Transformer T52:			
Terminal 1	Terminal T	12	
Terminal 2	Terminal T	42	
Terminal 3	Terminal 4	406	
Transformer T53:			
Terminal 1	Terminal 2	62	
Terminal 3	Terminal 4	76	
Terminal 5	Terminal 6	90	
AMP OUT switch S51:			
Stand off E51	Ground	4,480	S51 in 0 DB position.
Stand off E51	Ground	0	S51 in 10 DB position.
Plug P51:			
Pin 1	Pin 4	0	S51 in 0 DB position.
Pin 1	Pin 0	0	S51 in 10 DB position.
	CARRIER SUPPLY		
Tube V801:			
Pin 2	Ground	2,400	
Pin 3	Ground	47,000	
Pin 4	Ground	457,000	
Pin 5	Ground	0	
Pin 6	Ground	210,000	
Pin 7	Ground	[illegible]	
Pin 8	Ground	2,400	
Tube V802:			
Pin 1	Ground	1,870	
Pin 2 or 7	Ground		
Serial numbers 1 through 30.		470	
Serial numbers 31 through [illegible].		750	
Pin 5	Ground	262,000	
Pin 6	Ground	224,000	
Tube V803:			
Pin 1	Ground	255,000	
Pin 2 or 7	Ground	2,700	
Pin 5	Ground	200,000	
Pin 6	Ground	255,000	
Tube V804:			
Pin 1 or 5	Ground	250,000	
Pin 2, 4, or 7	Ground	0	
Tube V805:			
Pin 1	Ground	[illegible]	
Pin 2 or 7	Ground	4,700	
Pin 5	Ground	[illegible]	
Pin 6	Ground	[illegible]	

Table II. Telephone Terminal AN/TCC-3, Resistance Measurements-Continued

Measure from—	Measure to—	Ohms	Setting
Transformer T601:			
Terminal 1	Terminal 2	3.0	
Terminal 3	Terminal 4	3.2	
Terminal 5	Terminal 6	150	
Transformer T602:			
Terminal 1	Terminal 3	32	
Terminal 4	Terminal 6	1,370	
Transformer T603:			
Terminal 1	Terminal 2	3.0	
Terminal 3	Terminal 4	3.2	
Terminal 5	Terminal 6	150	
Transformer T604:			
Terminal 1	Terminal 2	8.5	
Terminal 3	Terminal 4	7.7	
Terminal 5	Terminal 7	1,580	
Transformer T605	Same as T604		
Transformer T606	Same as T604		
Transformer T607:			
Terminal 1	Terminal 3	0.57	
Terminal 4	Terminal 6	2.0	
Transformer T608:			
Terminal 1	Terminal 3	2.0	
Terminal 4	Terminal 6	2.0	
Transformer T609	Same as T608		
Transformer T610	Same as T608		
Transformer T611	Same as T608		
TEST OSCILLATOR			
Tube V701:			
Pin 1	Ground	940,000	TEST OSC OUTPUT control set to extreme counterclockwise position.
Pin 2 or 7	Ground	180	
Pin 5	Ground	22,000	
Pin 6	Ground	24,000	
Transformer T701:			
Terminal 1	Terminal 3	290	
Terminal 4	Terminal 5	12.5	
Terminal 6	Terminal 7	0.55	
RINGER-OSCILLATOR			
Tube V1:			
Pin 2	Ground	240	
Pin 3	Ground	1.1 megohms	
Pin 4	Ground	Open circuit	
Pin 4	E4	5,200	
Pin 5	Ground	0	
Pin 6	E4	8,000	
Pin 6	Ground	Open circuit	
Pin 7	Ground	1.20 megohms	
Pin 8	Ground	0	
Tube V2:			
Pin 2	Ground	1.05 megohms	
Pin 3	Ground	470,000	
Pin 4	Ground	470,000	
Pin 5	Ground	0	
Pin 6	Ground	470,000	
Pin 7	Ground	470,000	
Pin 8	Ground	100	
Transformer T1:			
Terminal 1	Terminal 3	100	
Terminal 4	Terminal 6	4,500	

Table II. Telephone Terminal AN/TCC-3, Resistance Measurements-Continued

Measure from—	Measure to—	Ohms	Setting
Transformer T2:			
Terminal 1	Terminal 3	54	
Terminal 4	Terminal 5	215	
Terminal 6	Terminal 8	2,570	
Transformer T3:			
Terminal 1	Terminal 2	25	
Terminal 3	Terminal 4	100	
Terminal 3	Terminal 5	310	
SYSTEM ALARM			
Tube V741:			
Pin 1	Ground	850,000	
Pin 2 or 7	Ground	4	
Pin 5	Ground	24,000	
Pin 6	Ground	18,000	
Pin 5	E747	12,000	
AMPLIFIER-POWER SUPPLY AM-682/TCC-3			
Transformers T761, T821:			
Terminal 1	Terminal 2	9	
Terminal 3	Terminal 4	9	
Terminal 5	Terminal 6	30	
Terminal 7	Terminal 8	33	
Transformers T801, T802:			
Terminal 1	Terminal 2	62	
Terminal 3	Terminal 4	76	
Terminal 5	Terminal 6	96	
ORDER WIRE			
Transformer T[illegible]:			
Terminal 1	Terminal 2	57	
Terminal 3	Terminal 4	56	
Terminal 5	Terminal 6	56	
Transformers T[illegible], T[illegible], T[illegible]:			
Terminal 1	Terminal 2	62	
Terminal 3	Terminal 4	76	
Terminal 5	Terminal 6	[illegible]	
Transformer T[illegible]:			
Terminal 1	Terminal 2	[illegible]	
Terminal 2	Terminal 3	27	
Terminal 4	Terminal 5	[illegible]	
Terminal 5	Terminal 6	27	
Terminal 7	Terminal 8	27	
Terminal 9	Terminal 10	27	
Transformer T[illegible]:			
Terminal 1	Terminal 2	10	
Terminal 3	Terminal 4	11.5	
Terminal 3	Terminal 6	46	
Transformer T[illegible]	Same as T[illegible]		
POWER SUPPLY			
Inductor L[illegible]:			
Terminal 1	Terminal 2	[illegible]	

257. Table Placement Diagram

To locate an electron tube in the AN/TCC-3, refer to the tube location diagrams. Locations of tubes in the TA-[illegible]/U are shown in figure [illegible]. Location of tubes in the AM-682/TCC-3 is shown in figures [illegible] through [illegible]; location of tubes in the AM-682A/TCC-3 is shown in figures [illegible] and [illegible].

257.1. Circuit Element Location Diagrams

To locate circuit elements in the TA-219/U refer to figures 86 through 93. Circuit elements in the AM-682/TCC-3 are shown in figures 94 through 111. Figures 97.1, 104.1, and 105.1 illustrate circuit element locations applicable to AM-682A/TCC-3.

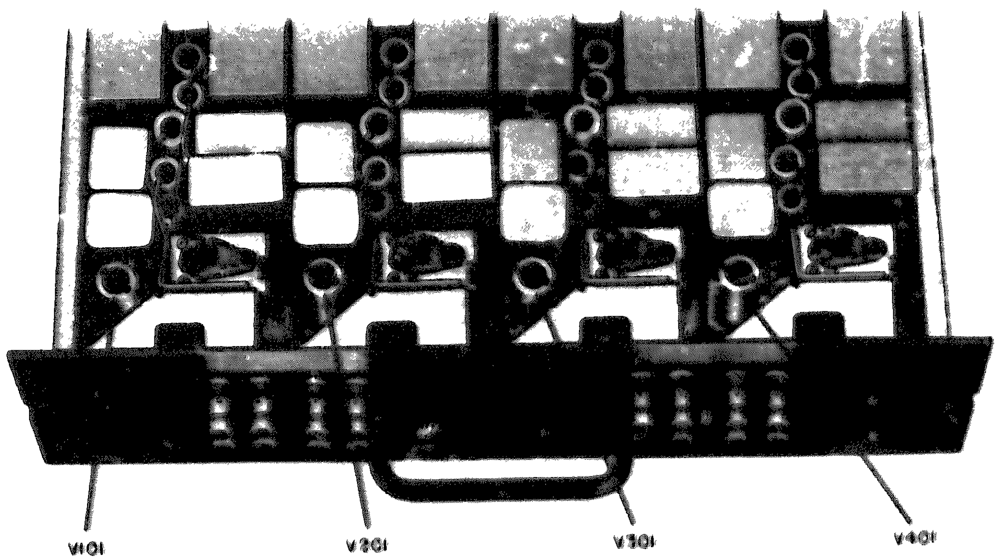


Figure 82. Telephone Modem TA-519/U, top view, tube location diagram

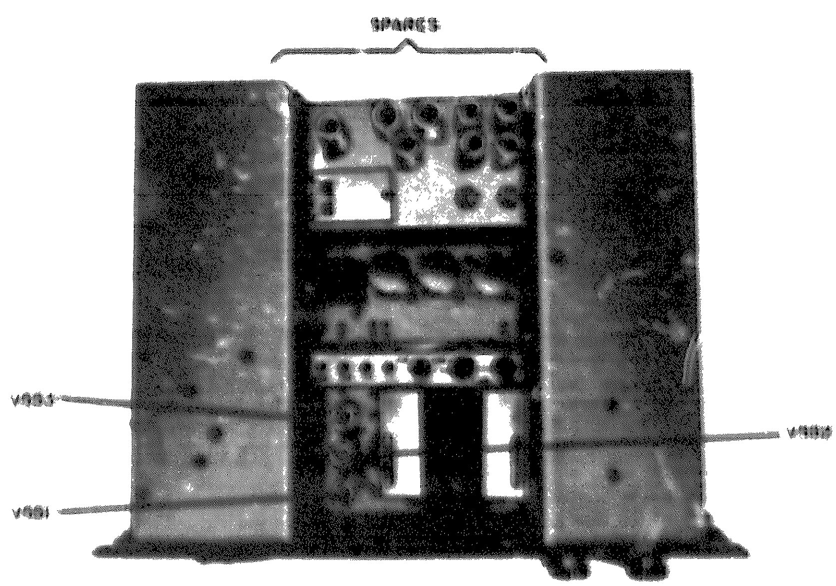


Figure 83. Amplifier Power Supply AM-682/TCC-3, top view, tube location diagram

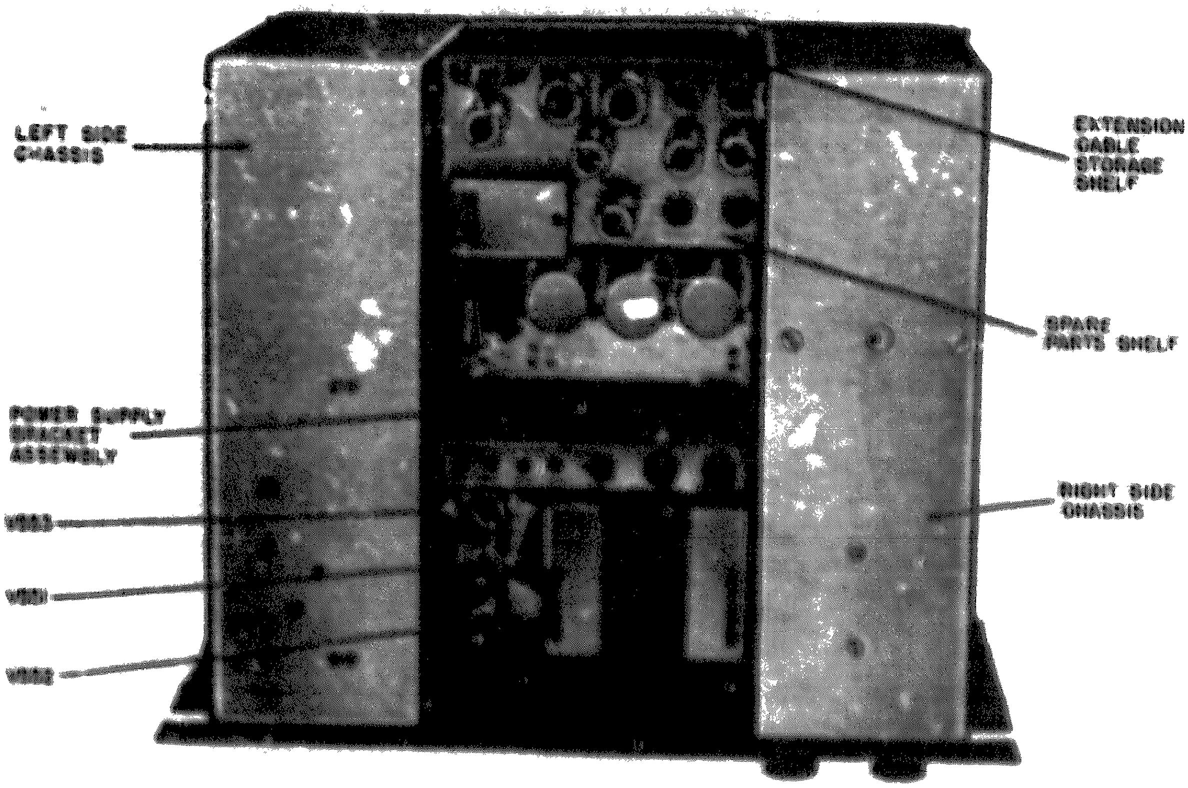


Figure 83.1 Amplifier-Power Supply AM-[illegible]A/TCC-4, top view, tube location diagram

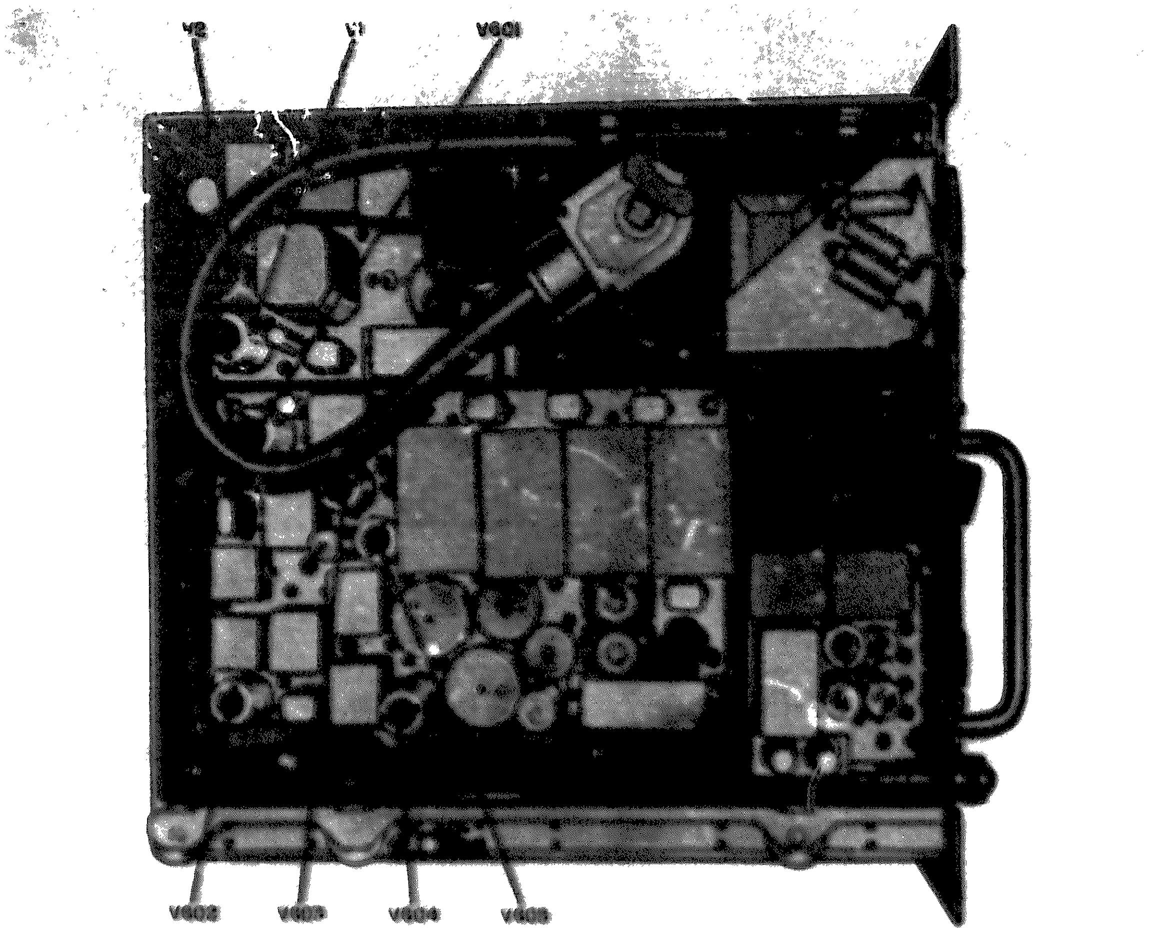


Figure 84. Amplifier Power Supply AM-[illegible]/TCC-4, left-side view, tube location diagram.

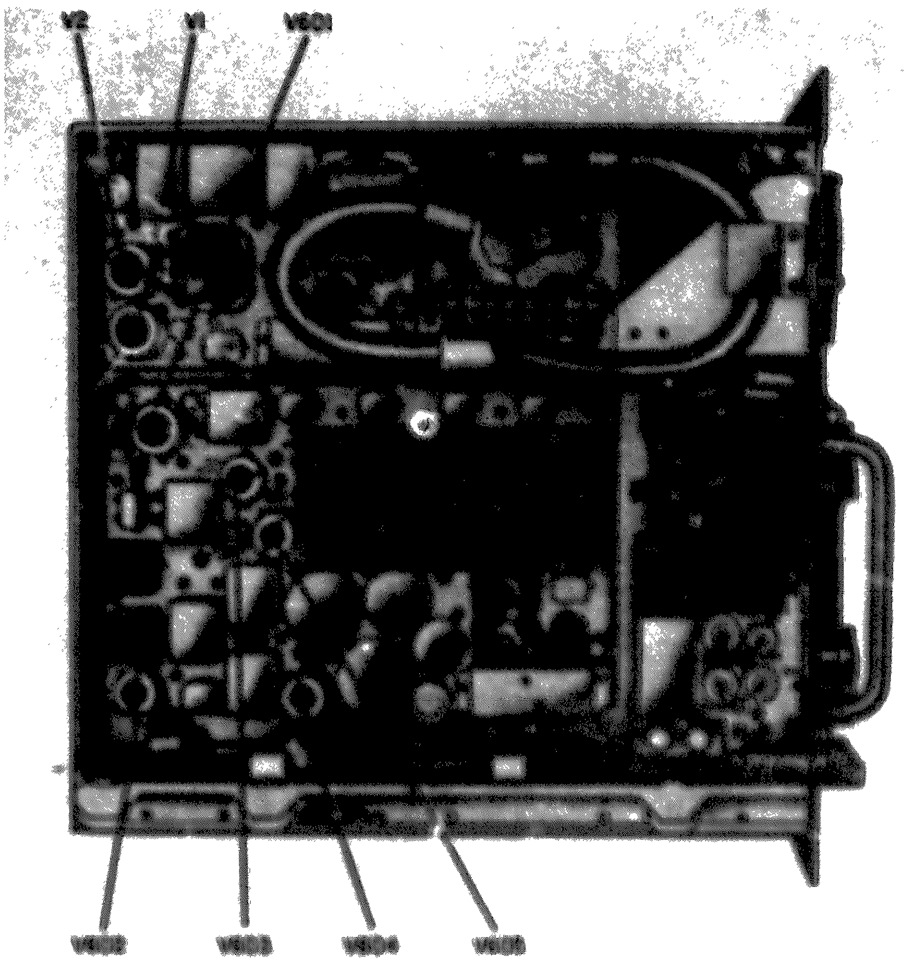


Figure 84.1 Amplifier-Power Supply AM-[illegible]/TCC-[illegible], left-side view, tube location diagram.

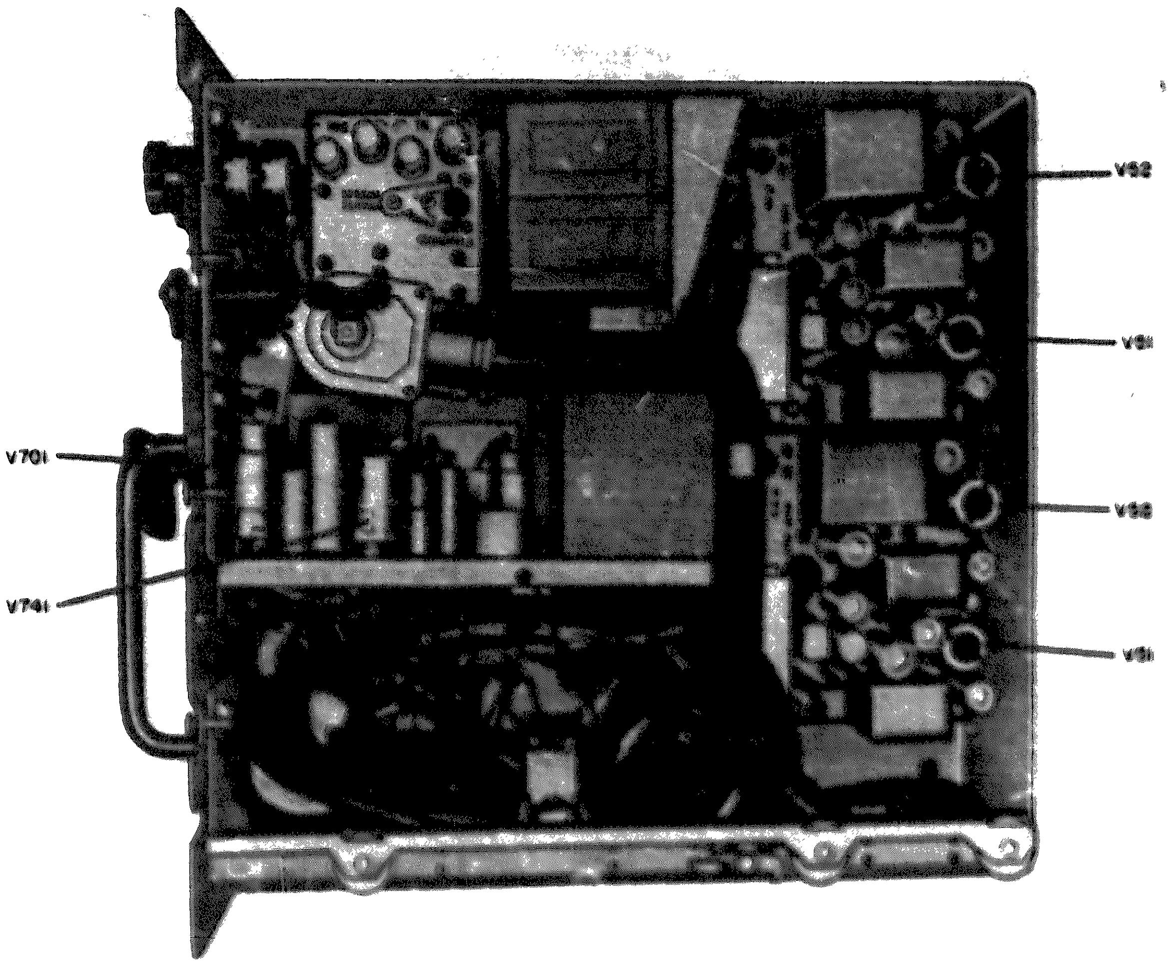


Figure 85. Amplifier Power Supply AM-[illegible]/TCC-3, right-side view, tube location diagram.

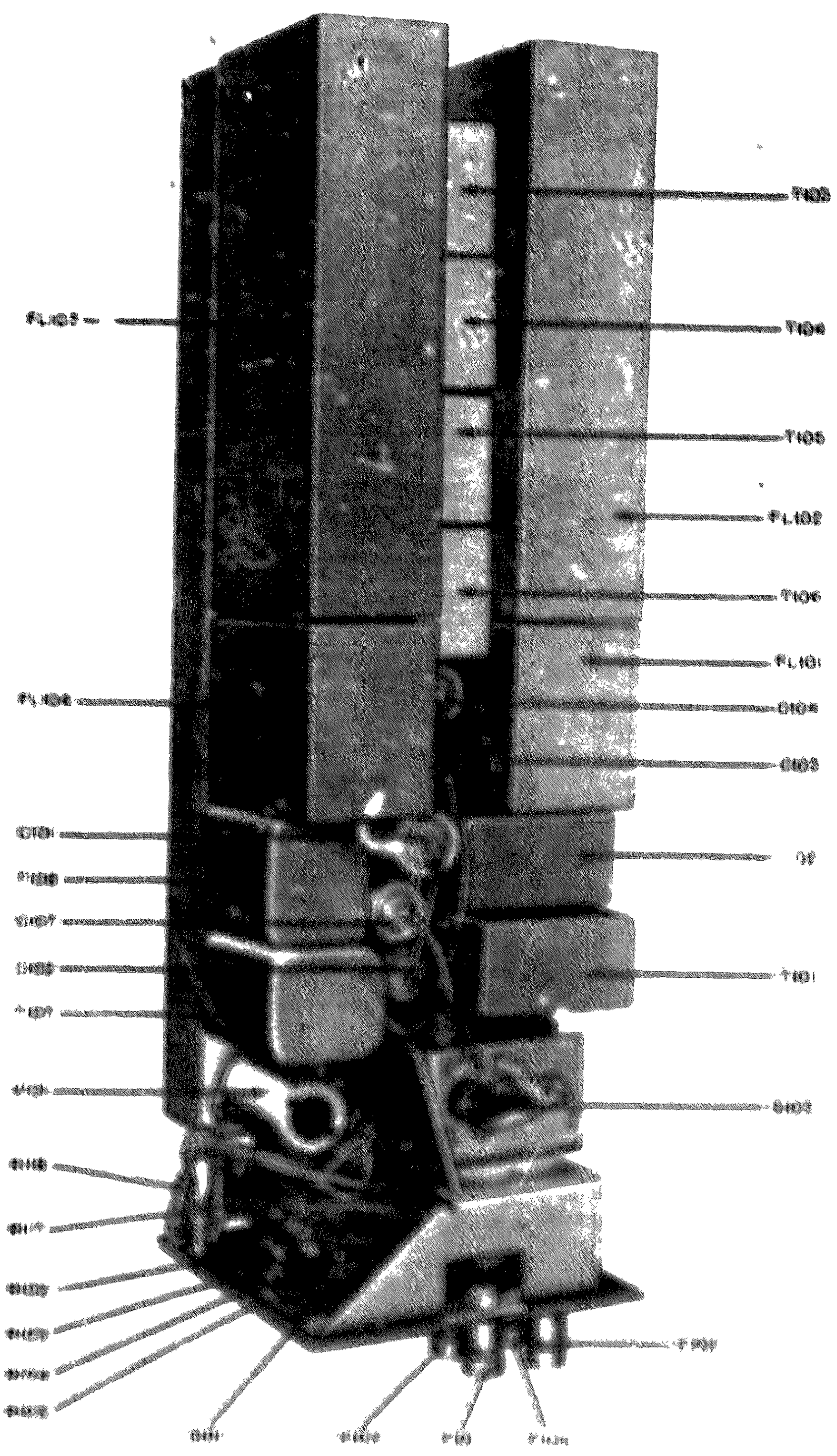


Figure 86. [illegible]

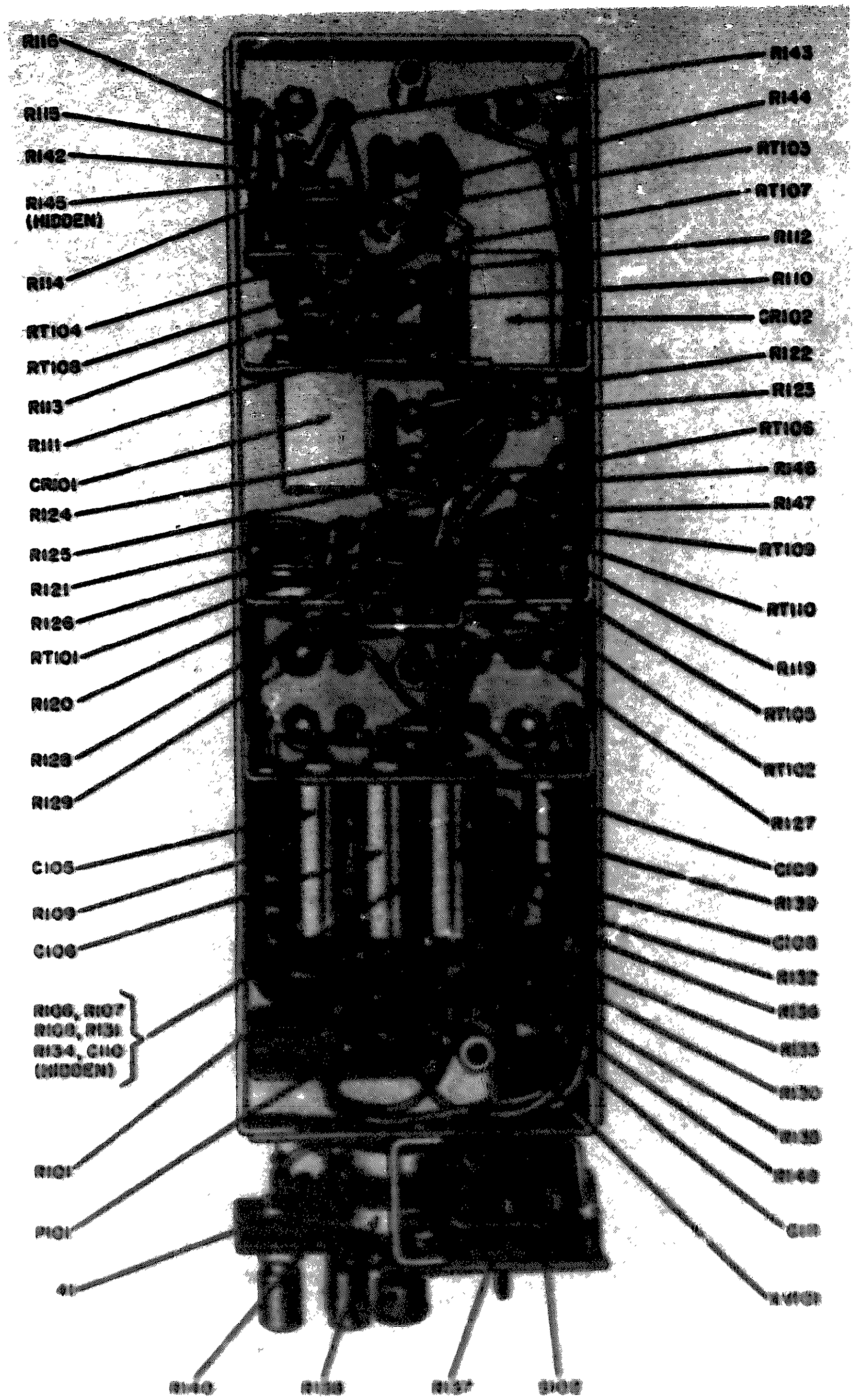


Figure 87. Channel 1 modem plug-in assembly, bottom view, circuit element location diagram.

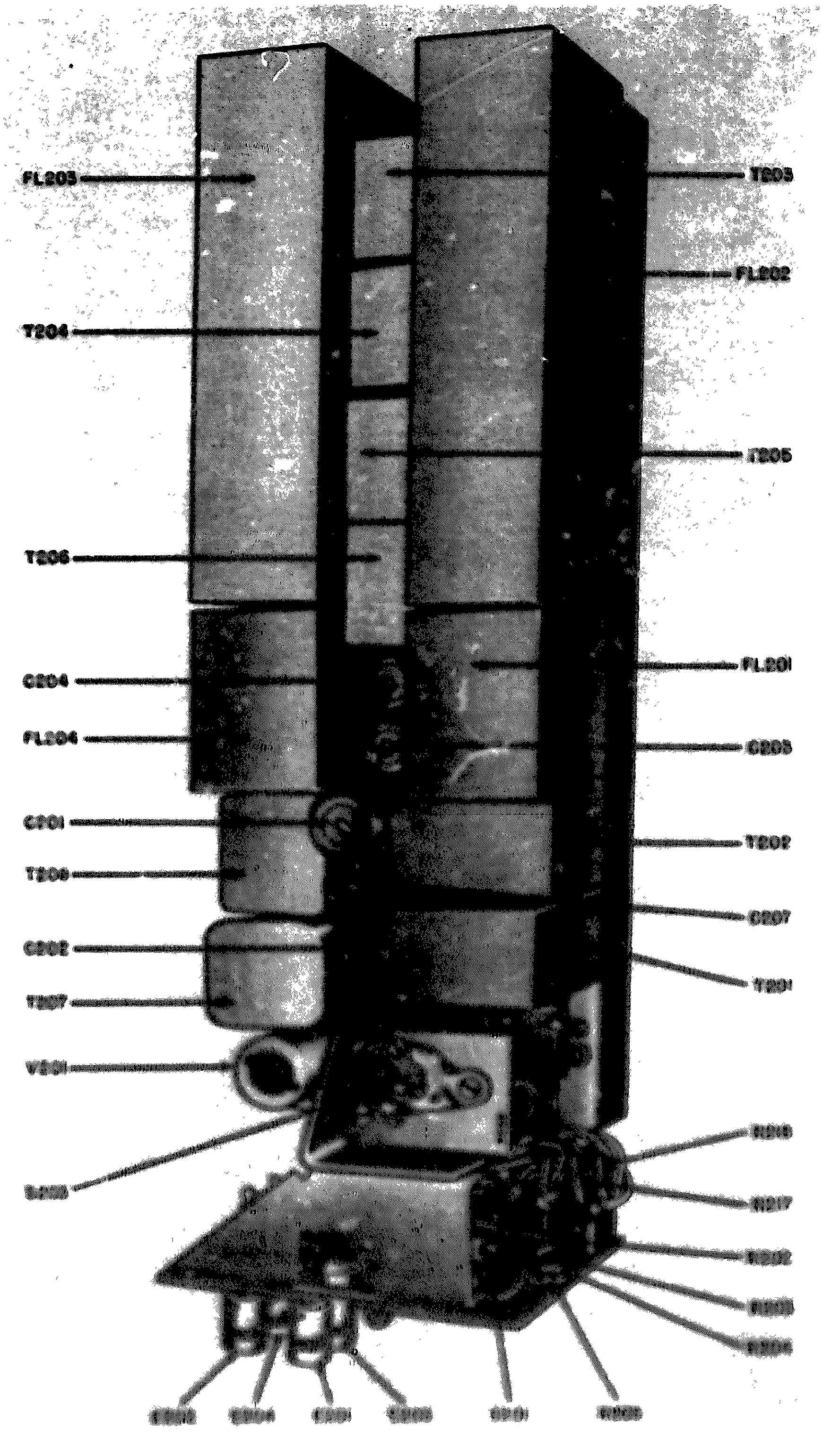


Figure 88. *Channel 2 modem plug-in assembly, top view, circuit element location diagram.*

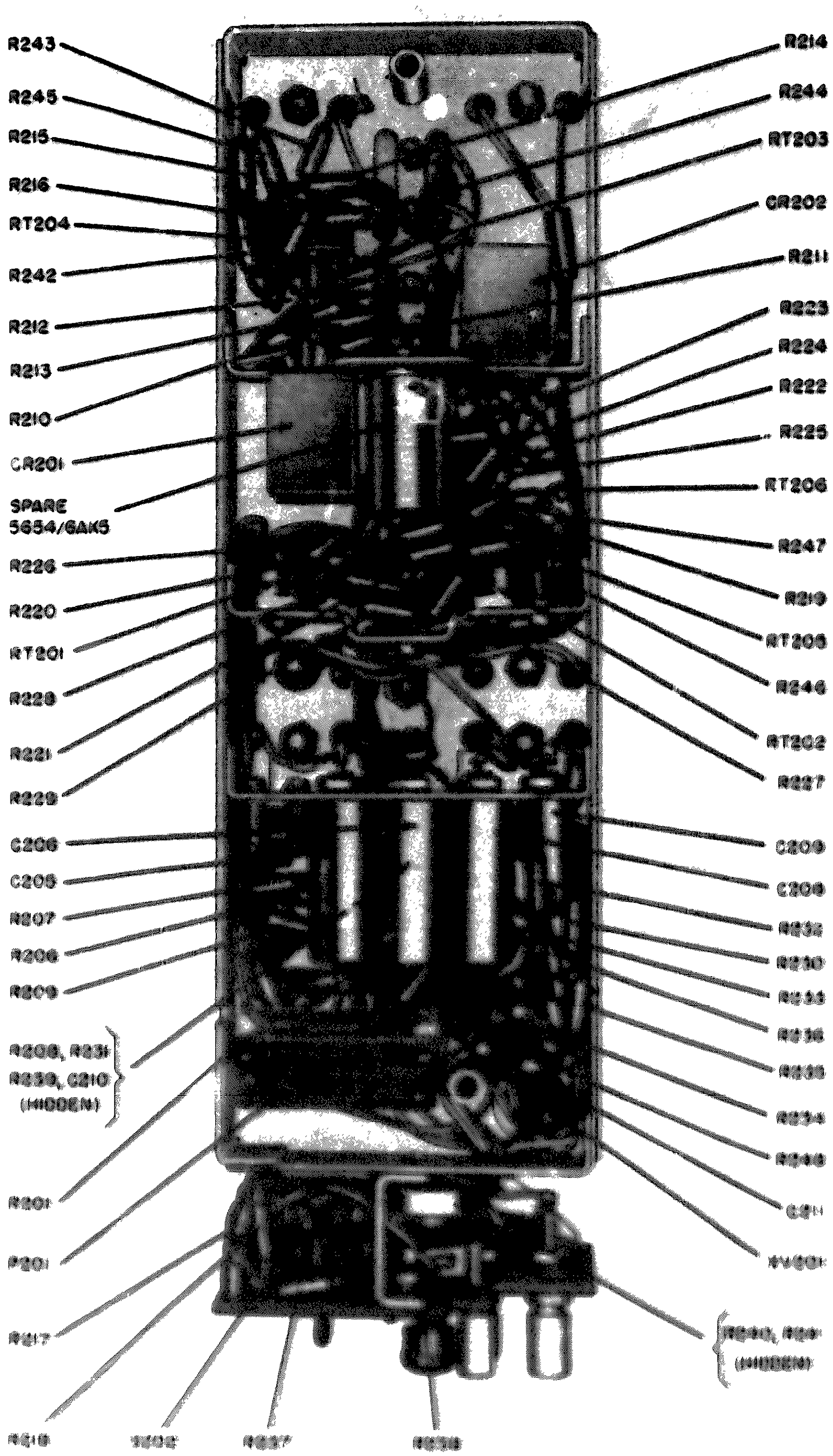


Figure 89. Channel 1 modem plug-in assembly, bottom view, circuit element location diagram.

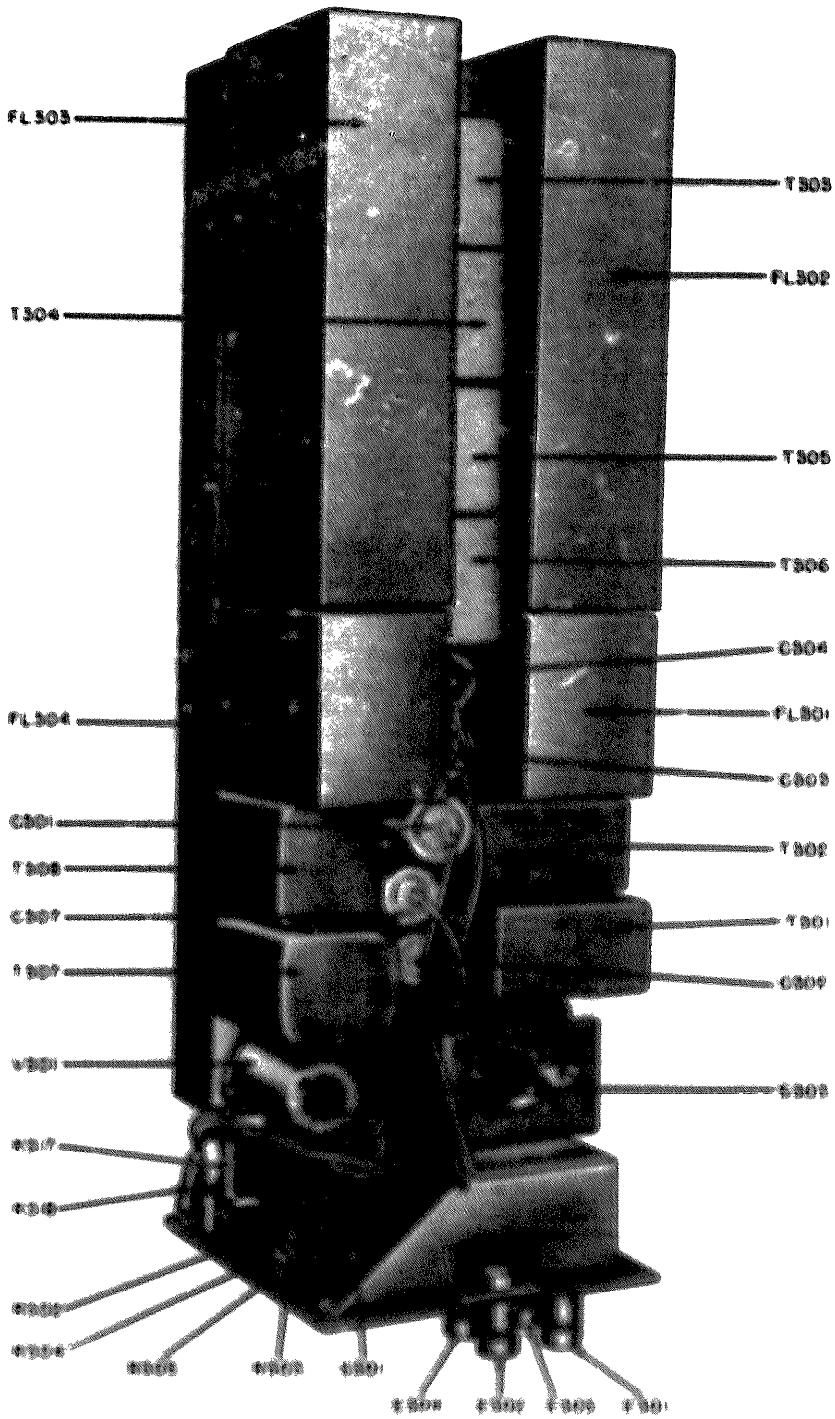

FL303
T304
FL304
C301
T308
C307
T307
V301
T303
FL302
T305
T306
C304
FL301
C303
T302
T301
C309
S301

Figure 90. [illegible]

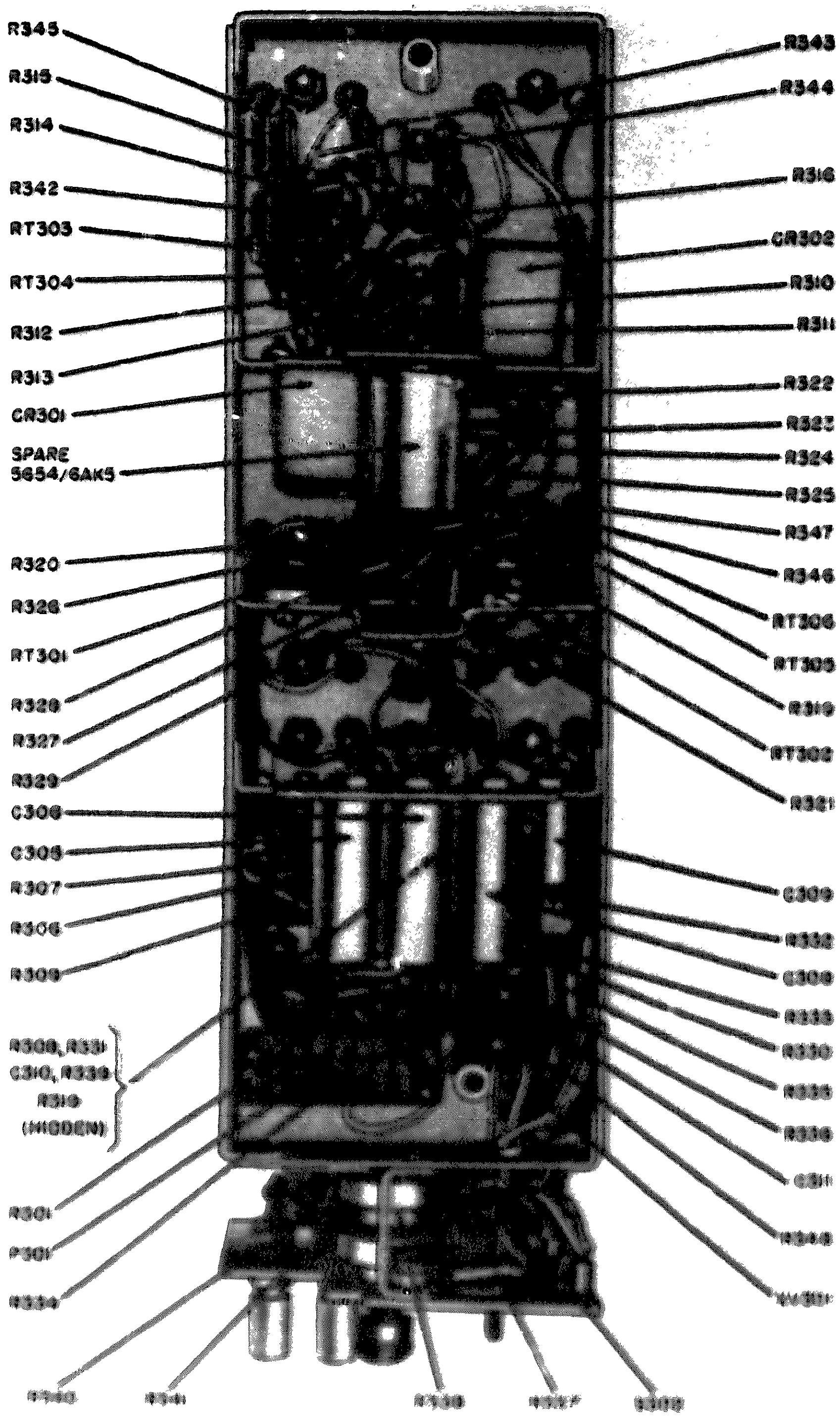


Figure 91. Channel 3 modem plug-in assembly, bottom view, circuit element location diagram.

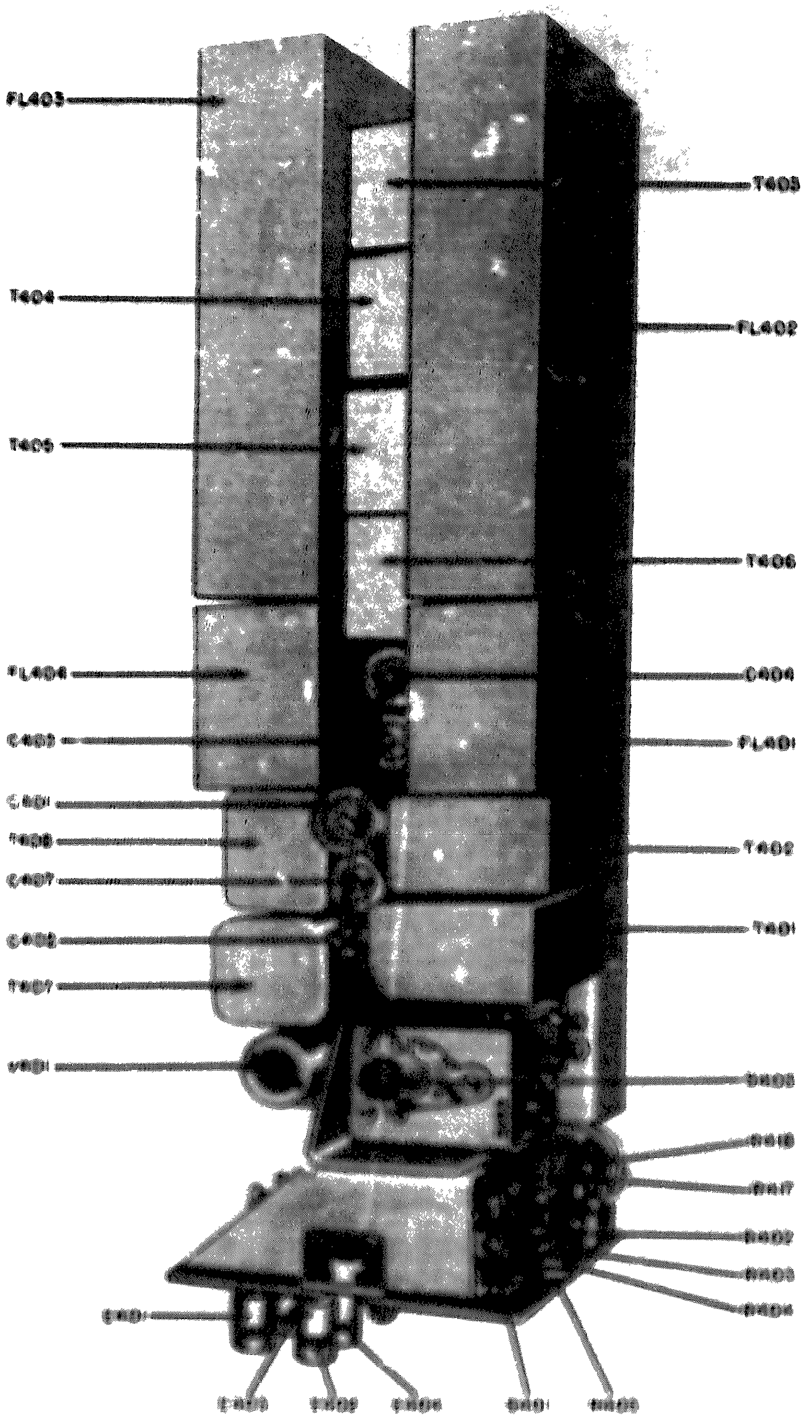


Figure 92. Channel x modem plug-in assembly, top view, circuit element location diagram.

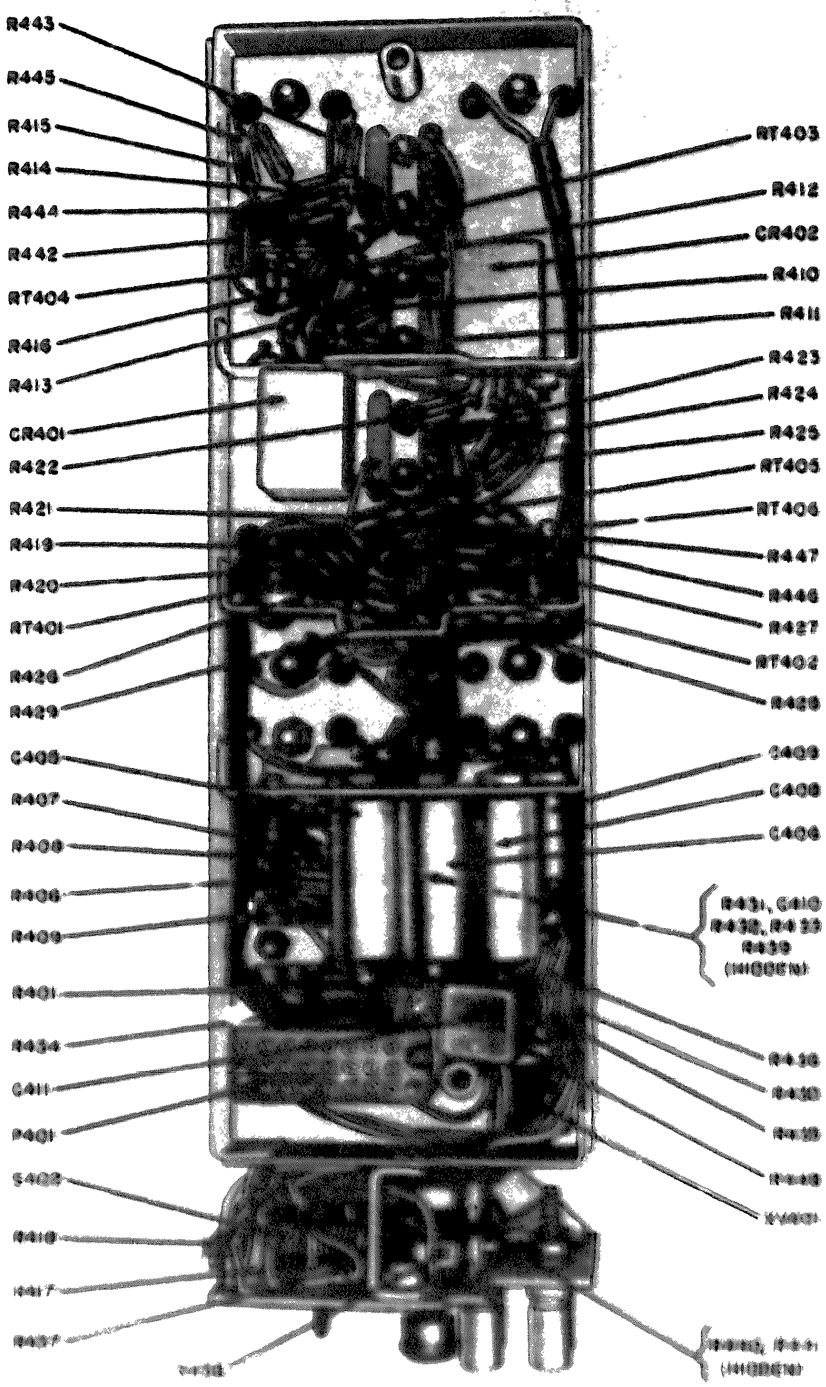


Figure 93. Channel [illegible] modem plug-in assembly, bottom view, circuit element location diagram.

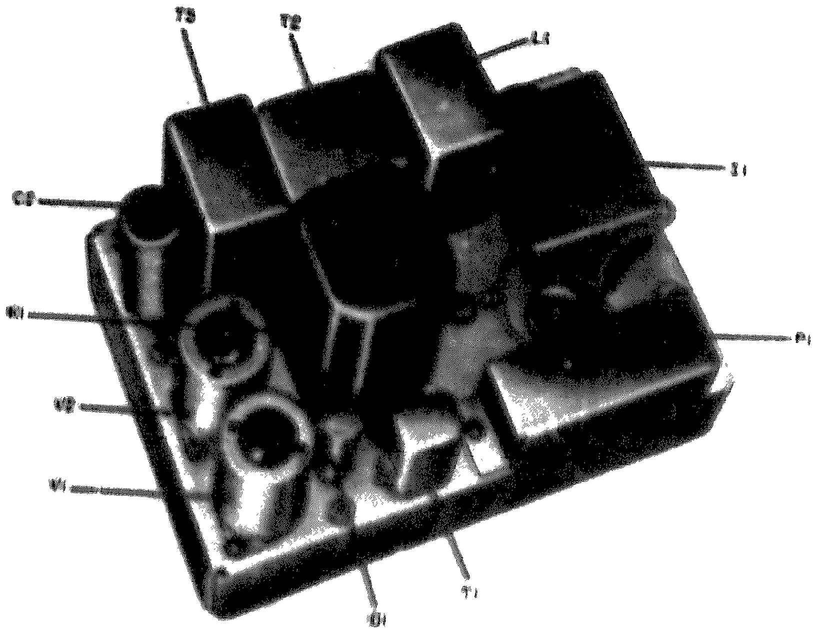


Figure 94. Ringer-oscillator plug-in assembly, top view, circuit element location diagram.

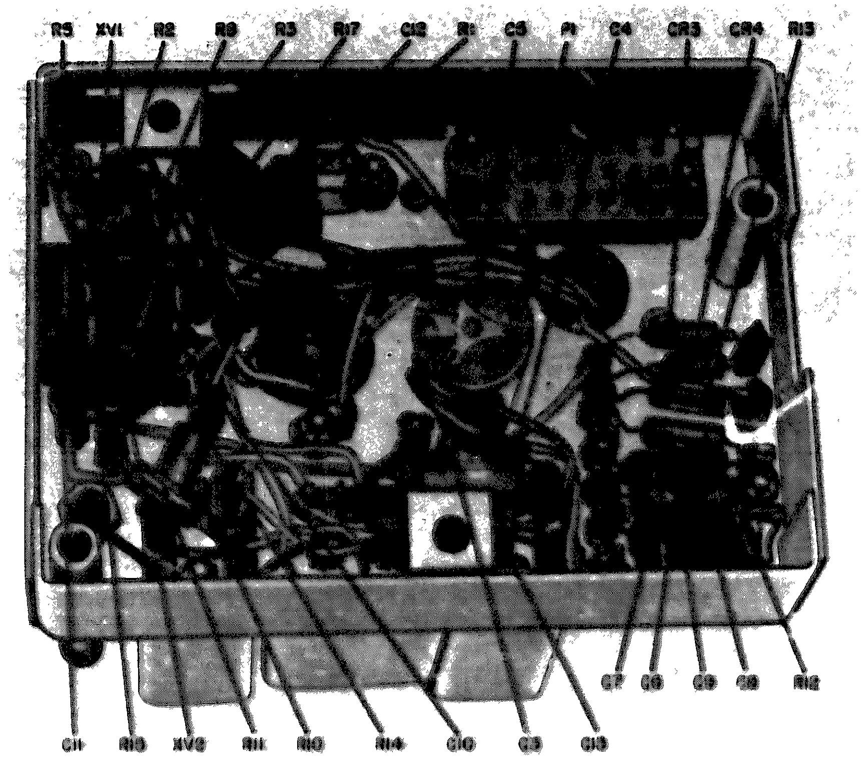


Figure 95. Ringer-oscillator plug-in assembly bottom view, circuit element location diagram.

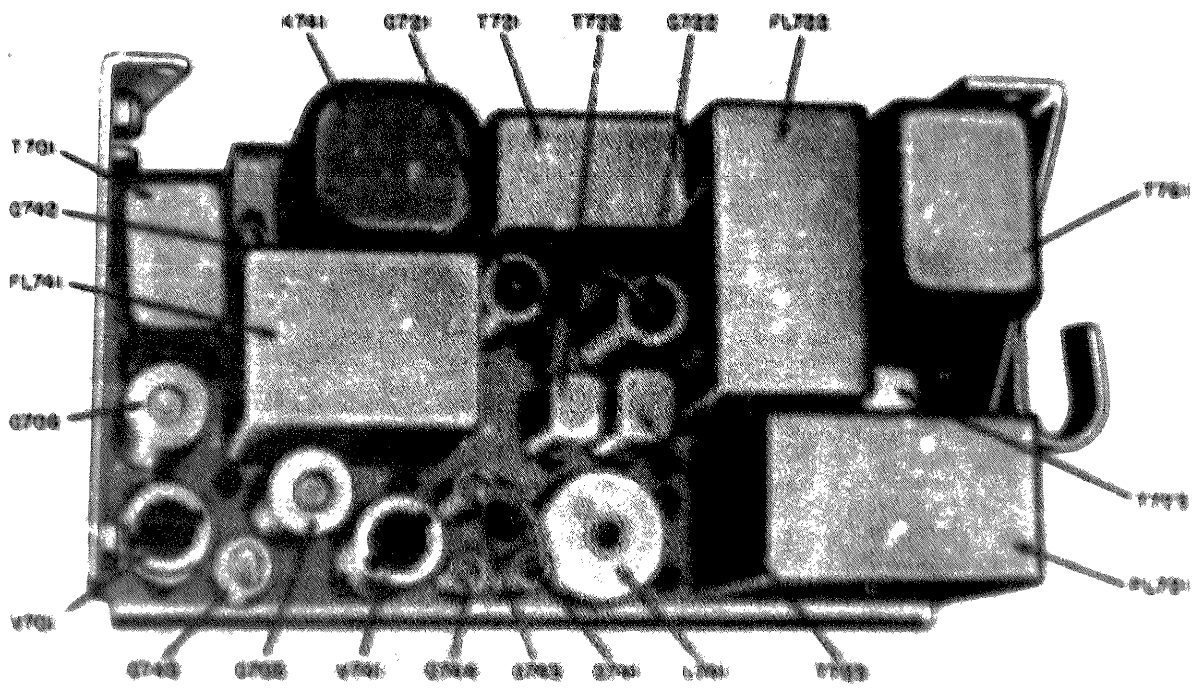


Figure 96. Auxiliary circuits bracket assembly, top view, circuit element location diagram.

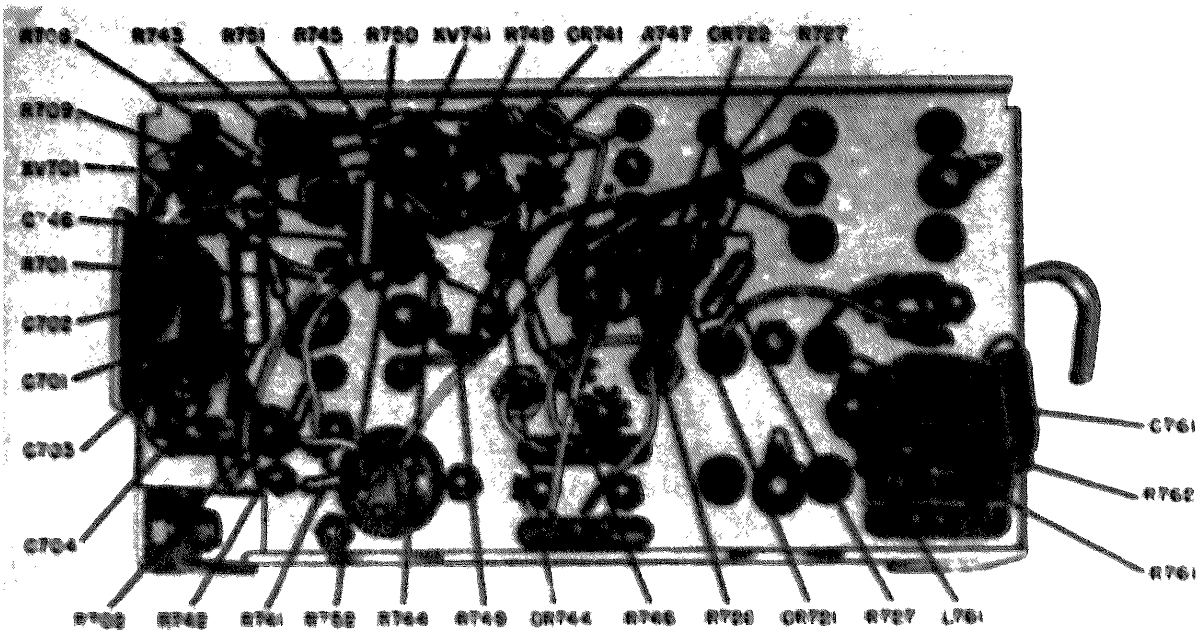


Figure 97. Auxiliary circuits bracket assembly, bottom view, circuit element location diagram (AM-688/TCC-3)

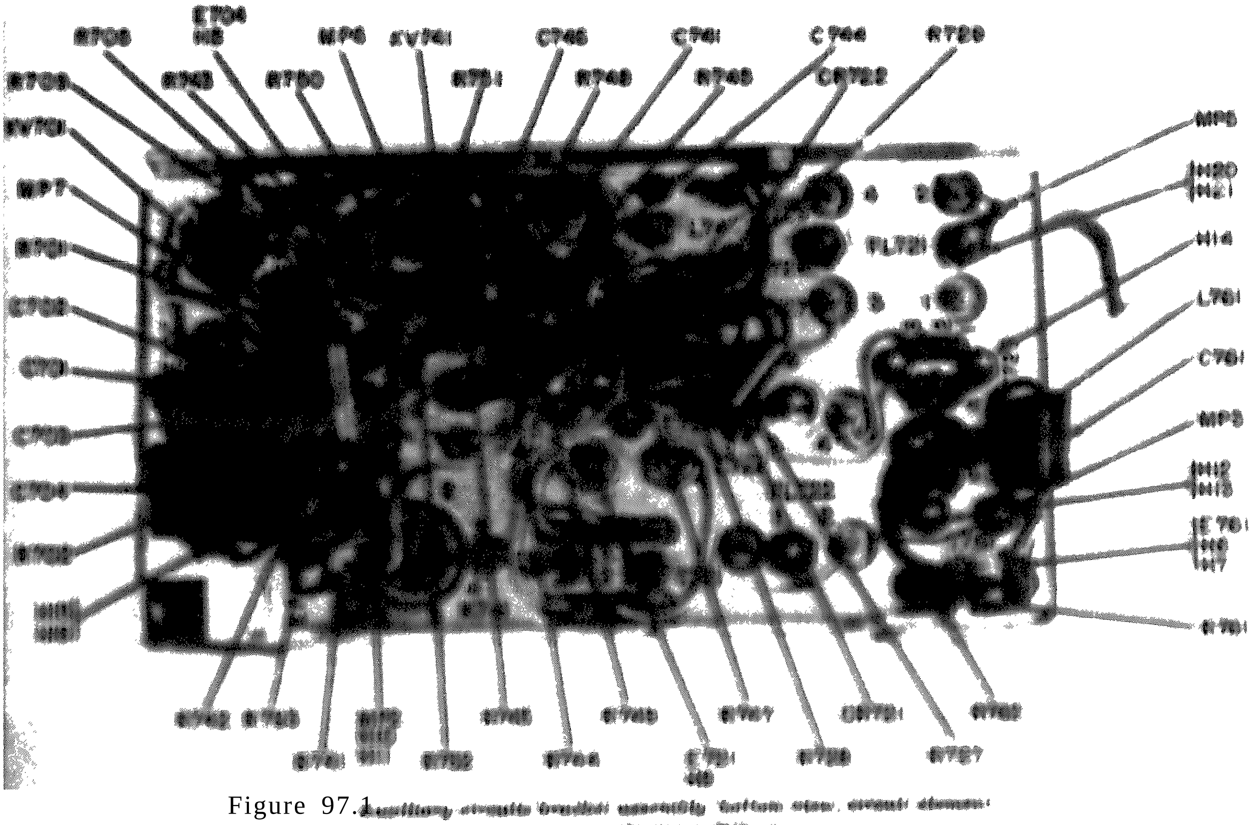


Figure 97.1 Auxiliary circuits bracket assembly, bottom view, circuit element location diagram ([illegible])

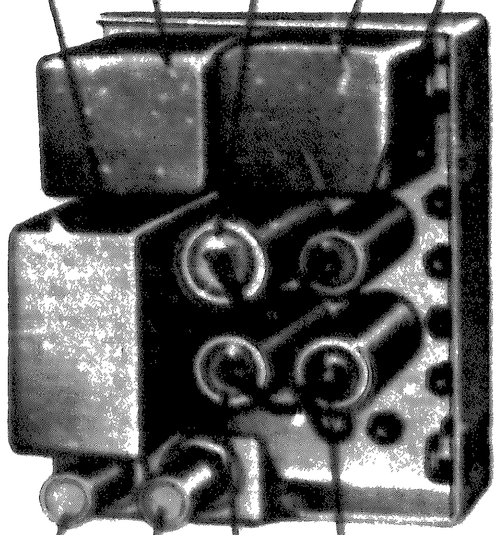


Figure 98. Order wire output bracket assembly top view, circuit element location diagram.

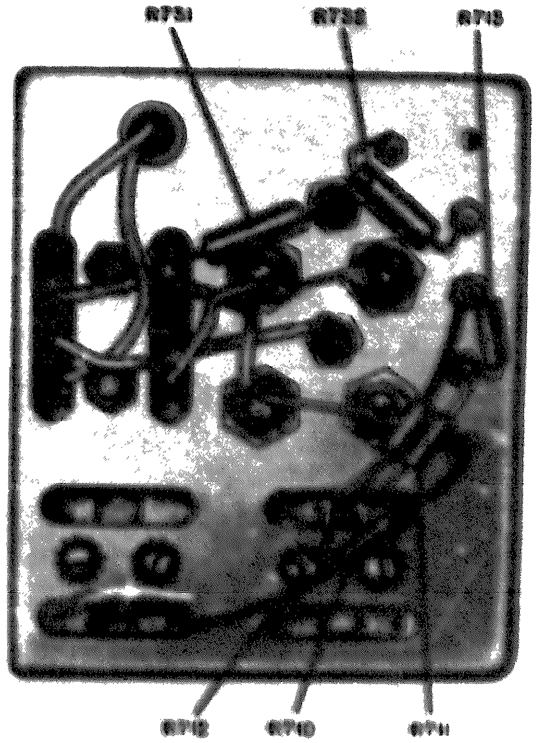


Figure 99. Order wire input bracket assembly, bottom view, circuit element location diagram.

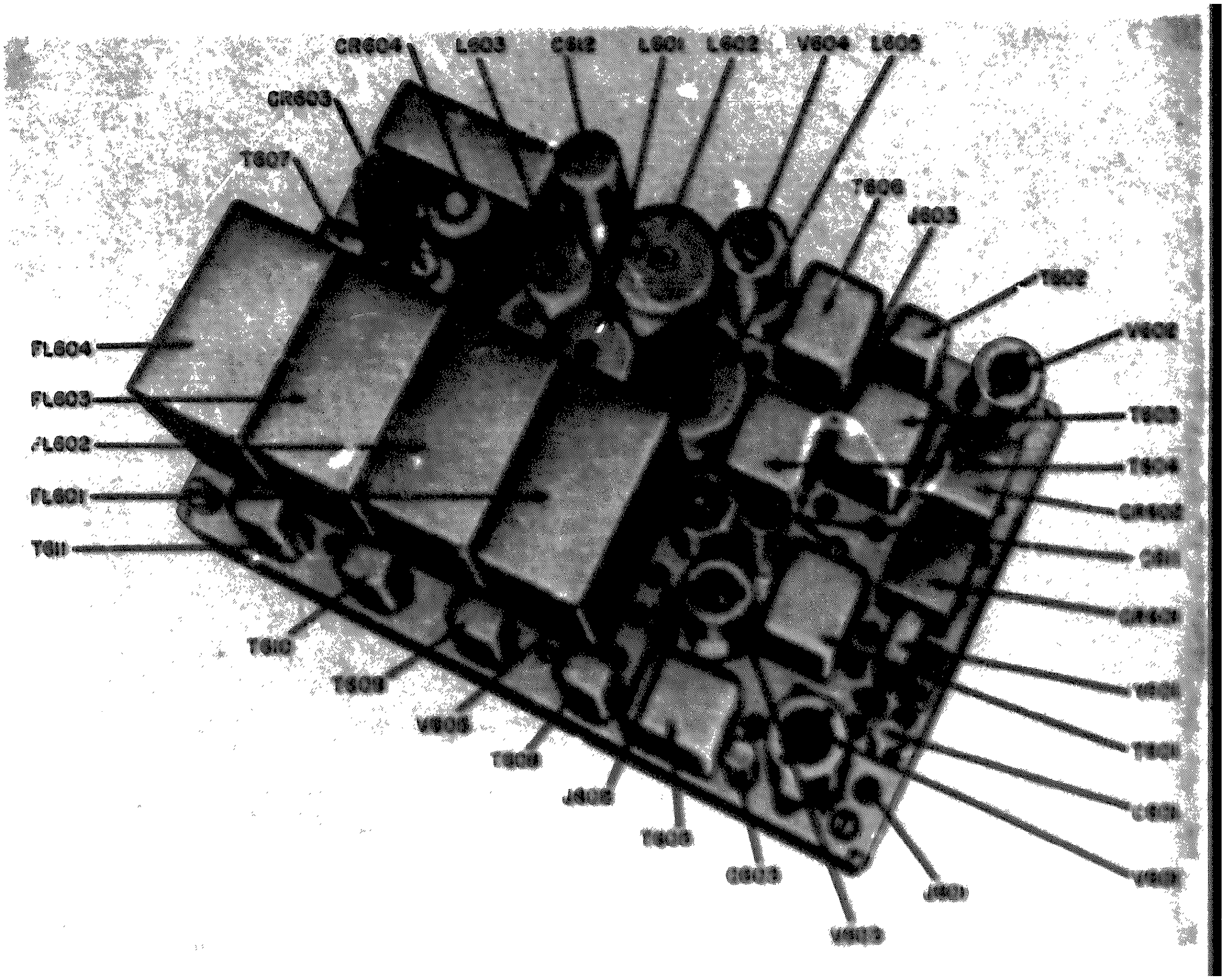


Figure 100. Carrier supply plug-in assembly, top view, circuit element location diagram.

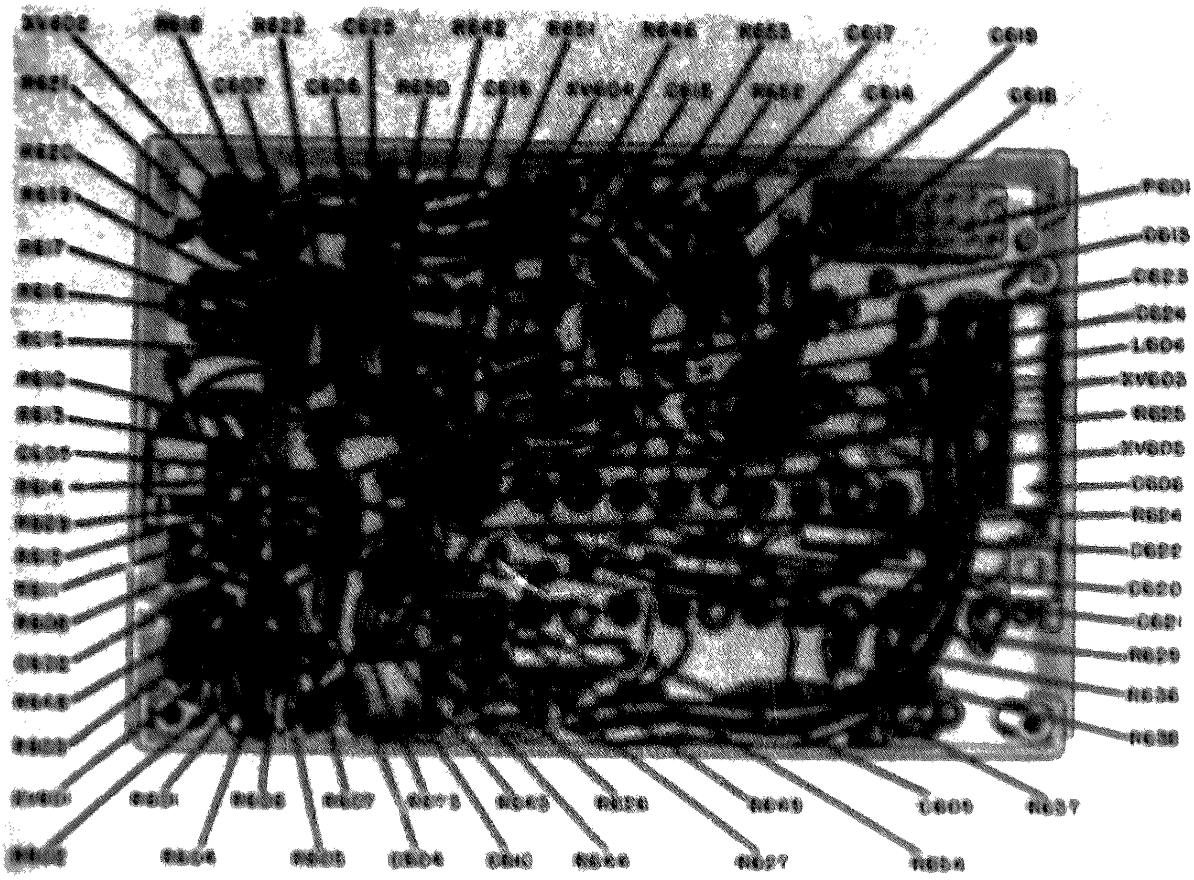


Figure 101. Carrier supply plug-in assembly, bottom view, circuit element location diagram.

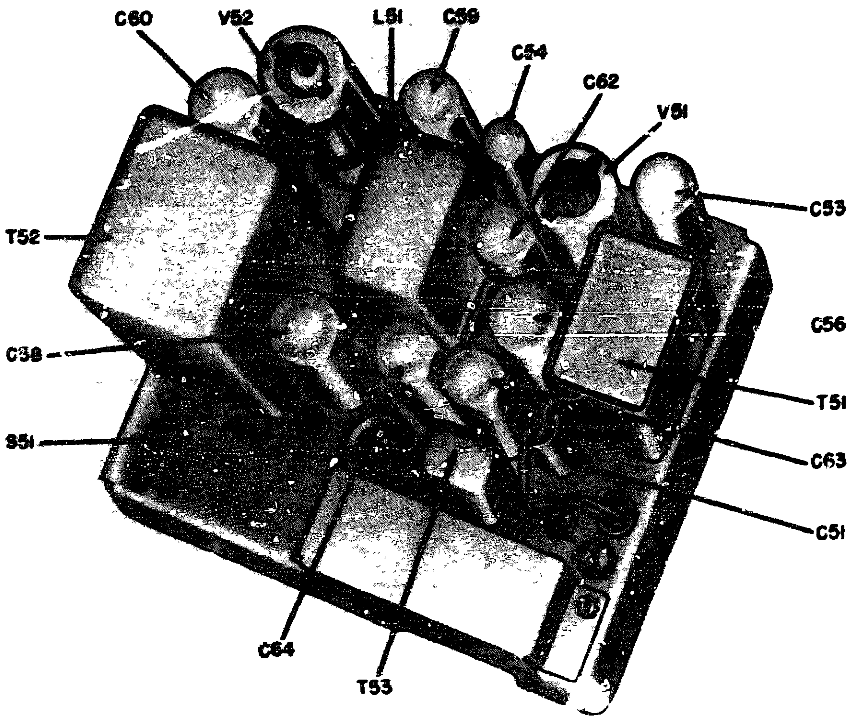


Figure 102. Transmitting or receiving amplifier plug-in assembly, top view, circuit element location diagram.

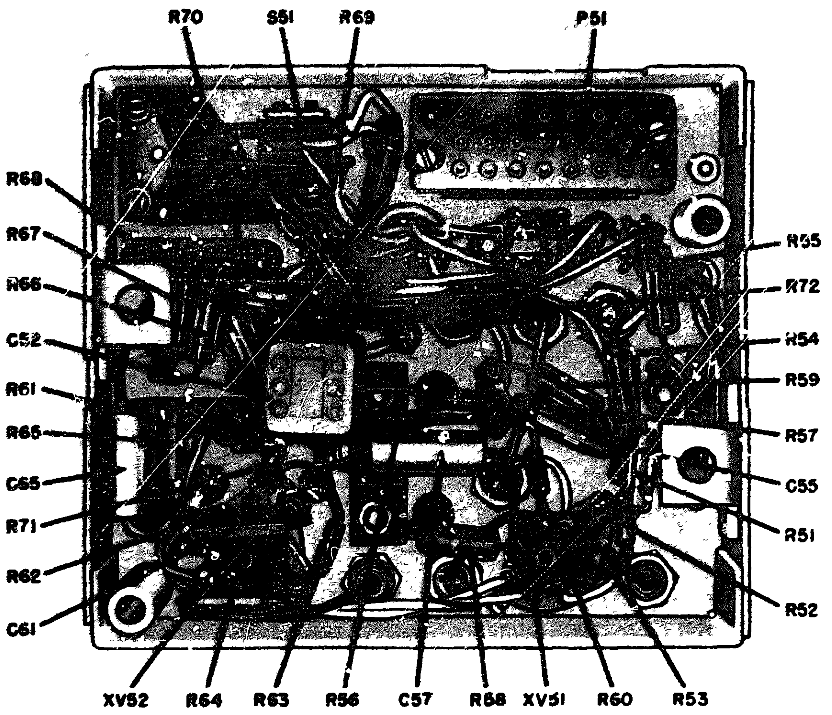


Figure 103. Transmitting or receiving amplifier plug-in assembly, bottom view, circuit element location diagram.

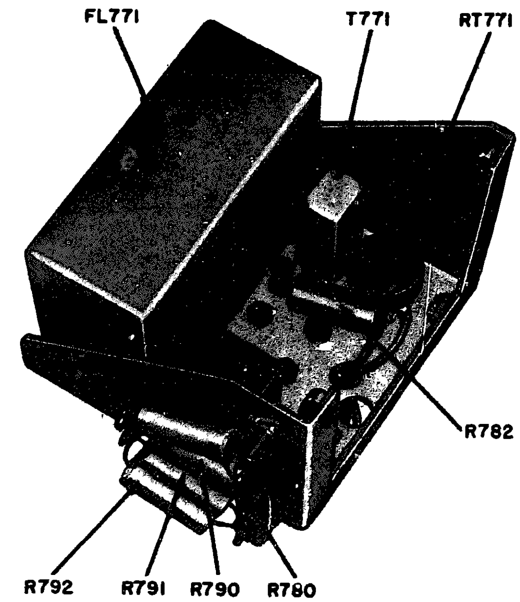


Figure 104. Measuring circuit bracket assembly, top view, circuit element location diagram (AM-682/TCC-3).

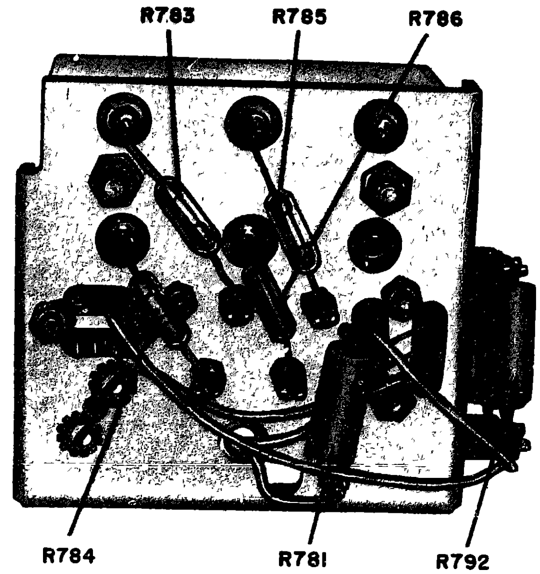


Figure 105. Measuring Circuit bracket assembly, bottom view, circuit element location diagram (AM-682/TCC-3).

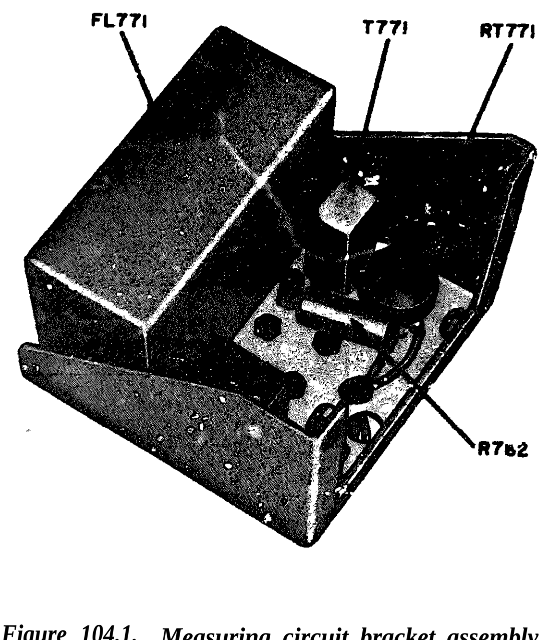


Figure 104.1. Measuring circuit bracket assembly, top view, circuit element location diagram (AM-682A, TCC-3).

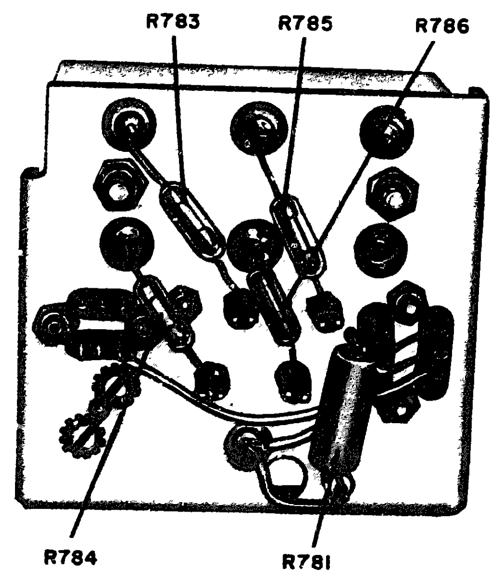


Figure 105.1 Measuring circuit bracket assembly, bottom view, circuit element location diagram (AM-682A/TCC-3).

Figure 106. Special service bracket assembly, top view, circuit element location diagram.

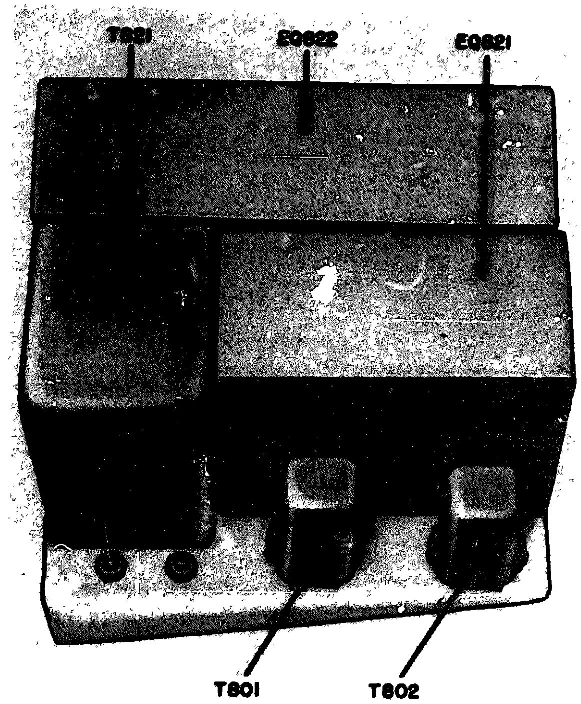


Figure 108. Equalizer bracket assembly, top view, circuit element location diagram.

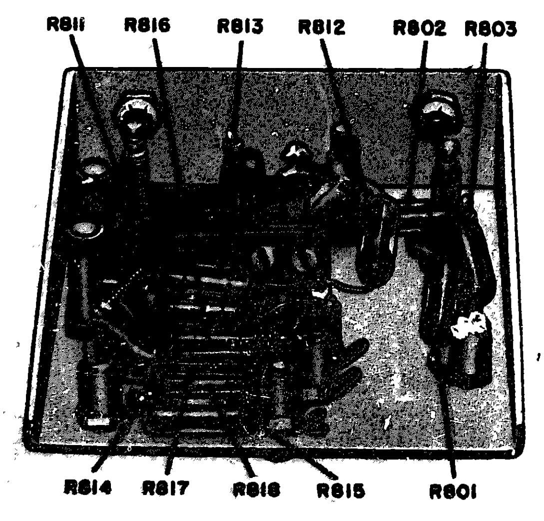


Figure 107. Special service bracket assembly, bottom view, circuit element location diagram.

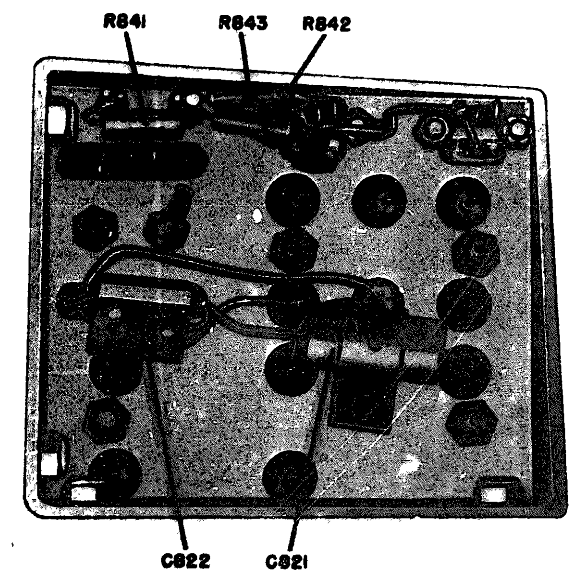


Figure 109. Equalizer bracket assembly, bottom view, circuit element location diagram.

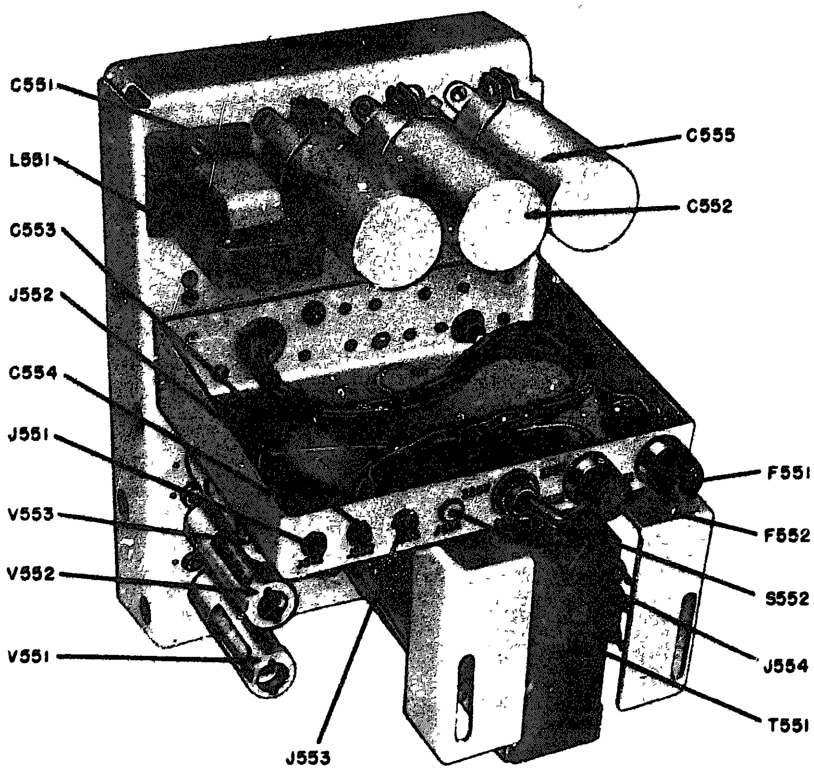


Figure 110. Power supply bracket assembly, top view, circuit element location diagram.

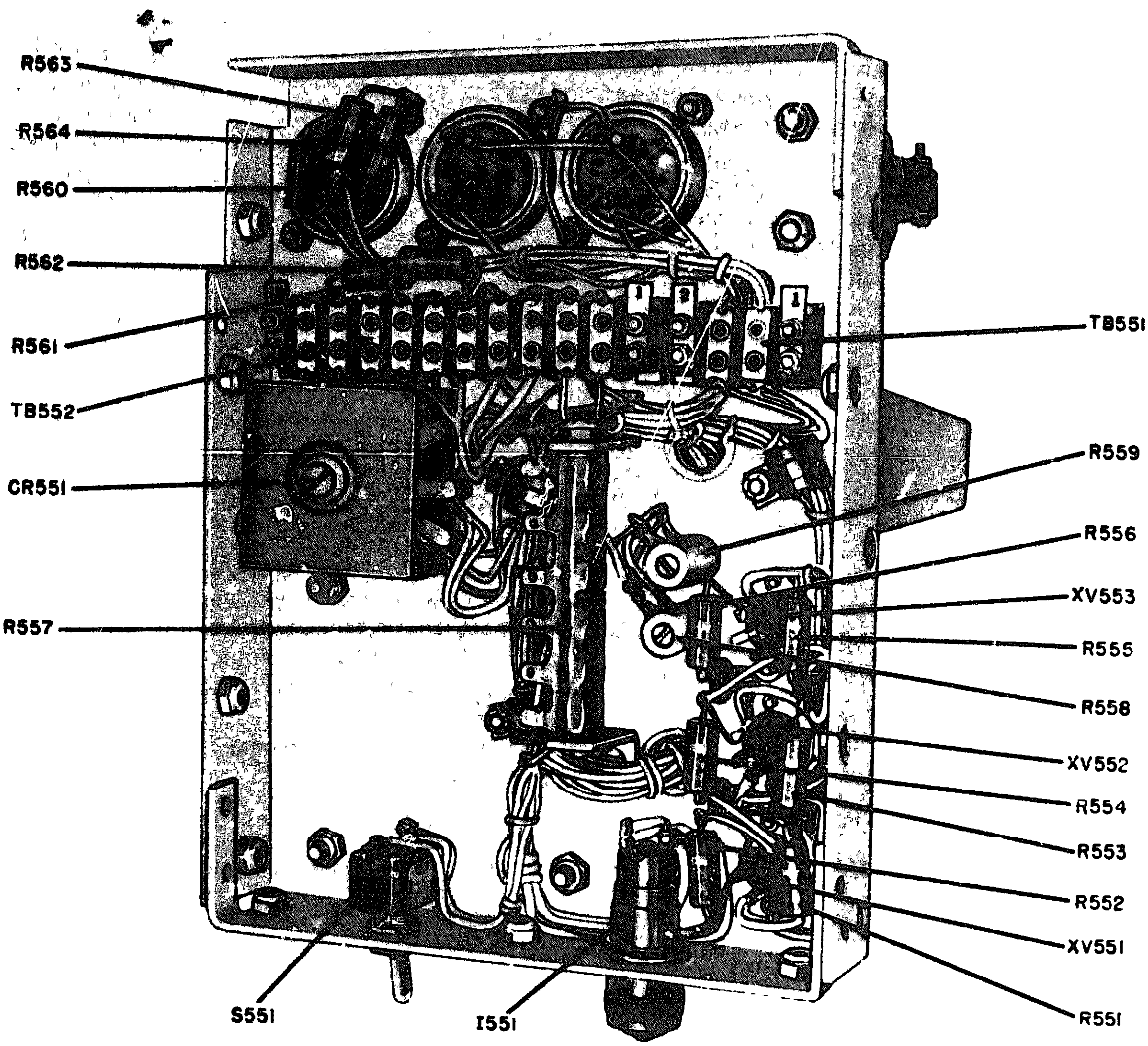


Figure *111.* ***Power supply bracket assembly, bottom view,*** **circuit** ***element location diagram.***

Section III. SIGNAL SUBSTITUTION

258. General

a. Signal Substitution Method.

(1) Signal substitution is a procedure that permits a circuit to be checked under conditions that simulate those encountered under normal operation. In a signal substitution test, a signal is applied to the circuit from a signal generator. The applied signal duplicates, in frequency and magnitude, a signal that is normally applied to the circuit. The dc and ac power required for the operation of the circuit also is applied. It is then possible to check a large or small portion of the circuit by checking the outp of that portion of the circuit and comparing the value of the measured output with the normal value. Marked differences between the measured and normal values indicate that the portion of the circuit from which the output was measured is not operating normal. A close agreement between measured and normal values indicates normal operation.

(2) The principal advantage of the signal substitution method is that it usually enables the repairman to localize a trouble accurately and quickly to a particular stage or circuit. A comparatively small number of test points is required in signal substitution in order to localize the trouble.

b. Use Of Signal Substitution

(1) It is desirable to use signal substitution when the trouble has been localized to a major circuit but has not been localized either to a small portion or to an element of that circuit. After the circuit is connected to duplicate operating conditions, the repairman checks the output of the portion of the circuit that is closest to the point of application of the signal. Each succeeding portion of the circuit is checked, progressing in sequence toward the portion on the circuit farthest from the point of application of the signal.

(2) An abnormal reading at one of the test points indicates that the trouble probably exists in the portion of the circuit between that test point and the last preceding test point that indicated normal operation. At each step in the procedure, it is assumed that all previous steps were completed satisfactorily. Isolate and clear any trouble located before proceeding with any succeeding steps. Examine the schematic diagram of the circuit to determine what could cause the abnormal reading. The schematic diagrams for the AN/TCC-3 are shown in figures 145 through 160.

(3) After the trouble has been localized to a portion of the circuit by the signal substitution method, take voltage and resistance measurements (para 249 through 266) and perform a check of questionable elements (para 277 through 292) in that portion of the circuit in order to determine the faulty part. Do not use voltage and resistance measurements in place of signal substitution for localizing the trouble to a particular portion of a circuit. In order to localize a trouble within a major circuit by using voltage and resistance measurements, it would be necessary to make an excessive number of measurements. Furthermore, not all troubles will cause changes in voltage and resistance measurements at test points.

(4) When signal substitution is to be performed in a circuit, refer to the paragraph that outlines the test for that circuit. The chart below lists the circuits for which signal substitution tests are given and the paragraphs that describe the tests for these circuits. Each paragraph that describes a test states whether the circuit is tested as part of the terminal or removed from the terminal, what test equipment is required for the test, how to connect the test equipment to the circuit under test, what adjustments are necessary, and what the normal measurements are at each test point.

Circuit	Paragraph
Channel 1 modem, transmitting path	259
Channel 1 modem, receiving path	260
Channel 2 modem, transmitting path	261
Channel 2 modem, receiving path	262
Channel 3 modem, transmitting path	263
Channel 3 modem, receiving path	264
Channel 4 modem, transmitting path	265
Channel 4 modem receiving path	266
Ringer-oscillator	267
System alarm	268
Order wire	269
Carrier supply	270
Transmitting and receiving amplifiers	271
Measuring circuit	272
Special service, transmitting path	273
Special service, receiving path	274
Cable matching network end associate circuits	276
Equalizers ond associated input circuit	276

259. Channel Modem Transmitting path

a Test *Conditions.* The transmitting path of channel 1 modem must be tested with the modem unit removed from the terminal when signal substitution is performed. Channel 1 modem is a plug-in unit and, therefore, can be removed easily from the terminal (para 82). Make all measurements at or near normal room temperature. Variations in temperature will result in variations in readings.

b. Equipment Required. The following equipment is required for the performance of the signal substitution tests on the transmitting path of channel 1 modem.

(1) Two signal generators are required. One signal generator supplies the carrier and is referred to as the carrier-frequency signal generator. The other signal generator supplies the modulating signal and is referred to as the signal-frequency signal generator.

(2) A vacuum-tube voltmeter.

(3) Extension cable used on plug-in assemblies is required for testing plug-in assemblies.

c. Connections. The following chart indicates the connections necessary for performing the tests. The first column lists the items to be connected and the second column lists the points to which the items are connected.

Item	*Connected to—*
Extension cable	Plug P101 of channel modem.
Carrier-frequency signal generator.	Terminals 0 to 3 of extension cable.
Signal-frequency signal generator.	4W–T 2W binding posts of channel modem.
Terminal 4 of filter FL102 chassis.	Ground.
600-ohm (±1%) resistor	Terminals 16 and 19 of extension cable.

d. Adjustments.

(1) Operate the 2W–4W switch of the channel modem to the 2W position.

(2) Adjust the carrier-frequency signal generator frequency to 8.00 kc and its output to 0.8 volt.

(3) Adjust the signal-frequency signal generator to 1 kc and its output to 0.8 volt.

e. Measurements. The chart below indicates the *normal* ac voltage reading obtained when the vacuum-tube voltmeter is connected between point A and point B. For the measurement of test number 5, disconnect the signal-frequency signal generator. The carrier signal only is applied. The readings obtained from the circuit under test should be *approximately* equal to the normal readings listed. Marked variations from these normal readings will indicate the presence of trouble and may suggest the nature of the trouble.

Test No	Point A	Point B	Normal readings (volts-ac)
1	Stand-off E107	Standoff E108	0.5
2	Terminal 3 of filter FL101.	Chassis ground	0.17
8	Terminal a of filter FL102.	Chassis ground	0.10
4	Terminal 1 of filter FL102.	Chassis ground	0.014 ± 0.0014
5	Terminal 2 of transformer T104.	Terminal 2 of transformer T103.	0.4

260. Channel 1 Modem Receiving path

a. Test Conditions. The test conditions for the modem receiving path are the same as those for the modem transmitting path. These conditions arc described in paragraph 259a.

b. Equipment Required, The equipment required for testing the modem receiving paths consists of the equipment listed in paragraph 259b for the transmitting path, plus a power supply to provide +200 volts dc and 6.3 volts ac.

c. Connections. The following chart indicates the connections necessary for performing the tests. The first column lists the items to be connected and the second column lists the points to which the items are connected.

Item	Connected to-
Extension cable	Plug P101 of channel modem.
+200 volts	Terminal 2 of extension cable.
Terminal 5 of extension cable.	Power supply ground.
6.3 volts ac	Terminals 1 and 4 of extension cable.
Carrier-frequency signal generator.	Terminals 0 and 3 of extension cable.
Signal-frequency signal generator.	Ternimals 14 and 17 of extension cable.
Terminal 4 of Alter FL102	Chassis ground.
600-ohm (±1%) resistance.	4W-R binding posts E103 and E104.

d. Adjustments.

(1) Operate the 2W-4W switch to the 4W position.

(2) Adjust the GAIN control to the extreme clockwise position.

(3) Adjust the carrier-frequency signal generator frequency to 8.00 kc and its output to 0.8 volt.

(4) Adjust the signal-frequency signal generator frequency to 7.00 kc and its output to 0.3 volt.

e. Measurements. The following chart indicates the *normal* ac voltage readings obtained when the vacuum-tube voltmeter is connected between point A and point B. The readings obtained from the circuit under test should be approximately equal to the normal readings listed. Marked variations from these normal readings will indicate the presence of trouble and may indicate the nature of the trouble. Disconnect signal-frequency signal generator before making the measurement of test number 4 in the chart below. Reconnect the signal-frequency signal generator for all subsequent measurements.

Test No	Point A	Point B	Normal readings (volts-ac)
1	Terminal 3 of Alter FL103.	Chassis ground	0.14
2	Terminal 6 of transformer T106.	Chassis ground	0.04
3	Terminal 6 of transformer T105.	Chassis ground	0.02
4	Terminal 3 of transformer T105.	Terminal 3 of transformer T106.	0.4
5	Terminal 3 of filter FL104.	Chassis ground	0.02
6	Terminal 3 of transformer T107.	Chassis ground	2.0
7	Terminal 1 of transformer T108.	Terminal 2 of transformer T108.	0.02
8	Binding post E103.	Binding post E104	2.0 ± 0.4

261. Channel 2 Modem Transmitting Path

a. *Test Conditions.* The test conditions for the channel 2 modem transmitting path are the same as those for the channel 1 modem transmitting path. These conditions are described in paragraph *259a.*

b. Equipment Required. The equipment required for testing the channel 2 modem transmitting path is the same as that required for testing the channel 1 modem transmitting path. This equipment is described in paragraph 259b.

c. Connections. The following chart shows the connections. necessary for performing the tests. The first column lists the items to be connected and the second column lists the points to which the items are connected.

Item	Connected to—
Entension cable	Plug P201 of channel modem.
Carrier-frequency signal generator.	Terminals 0 and 3 of extension cable.
Signal-frequency signal generator.	4W-T 2W binding posts of channel modem.
Terminal 4 of filter FL202	Chassis ground.
600-ohm (±1%) resistor	Terminals 16 and 19 of extension cable.

d. Adjustments.

(1) Operate the 2W-4W switch to the 2W position.

(2) Adjust the carrier-frequency signal generator to 12.00 kc and its output to 0.8 volt.

(3) Adjust the signal-frequency signal generator to 1 kc and its output to 0.8 volt.

e. Measurements. The following chart indicates the normal ac voltage readings obtained when the vacuum-tube voltmeter is connected between point A and point B. The readings obtained from the circuit under test should be approximately equal to the normal readings. Marked variations from these normal readings will indicate the presence of trouble and may indicate the nature of the trouble. Disconnect the signal-frequency signal generator when making the last measurement in the chart. The carrier signal only is applied.

Test No	Point A	Point B	Normal readings (volts-ac)
1	Stand-off E207	Stand-off E208	0.5
2	Terminal 3 of filter FL201.	Chassis ground	0.17
3	Terminal 3 of filter FL202.	Chassis ground	0.05
4	Terminal 1 of Alter FL202.	Chassis ground	0.014
5	Terminal 2 of transformer T204.	Terminal 2 of transformer T203.	0.4

262. Channel 2 Modem Receiving Path

a. Test Conditions. The test conditions for the channel 2 modem receiving path are the same as those for the channel 1 modem transmitting path. These conditions are described in paragraph 259*a.*

b. Equipment Required. The equipment required for testing the channel 2 modem receiving path is the same as that required for testing the channel 1 modem receiving path. This equipment is described in paragraph 259*b.*

c Connections. The following chart indicates the connections necessary for performing the test. The first column lists the items to be connected and the second column lists the points to which the items are connected.

Item	Connected to-
Extension cable	Plug P201 of channel modem.
+200 volts	Terminal 2 of extension cable.
Terminal 5 of extension cable.	Power supply ground.
6.3 volts ac	Terminal 1 and 4 of extension cable.
Carrier-frequency signal generator.	Terminals 0 and 3 of extension cable.
Signal-frequency signal generator.	Terminals 14 and 17 of extension cable.
Terminal 4 of filter FL203	Chassis ground.
600-ohm (±1%) resistor	Binding posts E203 and E204.

d. Adjustments.

(1) Operate the 2W-4W switch to the 4W position.

(2) Adjust the GAIN control to the extreme clockwise position.

(3) Adjust the carrier-frequency signal generator to 12.00 kc and its output to 0.8 volt.

(4) Adjust the signal-frequency signal generator to 11 kc and its output to 0.3 volt.

e. Measurements. The following chart indicates the normal ac voltage readings obtained when the vacuum-tube voltmeter is connected between point A and point B. The readings obtained from the circuit under test should be approximately equal to the normal readings. Marked variations from the normal readings will indicate the presence of trouble and may indicate the nature of the trouble. Disconnect the signal-frequency signal generator when making the measurement in test number 4. Reconnect the signal-frequency signal generator for all subsequent measurements.

Test No.	Point A	Point B	Normal readings (volts-ac)
1	Terminal 3 of Alter FL203.	Chassis ground	0.07
2	Terminal 6 of transformer T206.	Chassis ground	0.02
3	Terminal 6 of transformer T205.	Chassis ground	0.02
4	Terminal 3 of transformer T205.	Terminal 3 of transformer T206.	0.4
5	Terminal 3 of filter FL204.	Chassis ground	0.02
6	Terminal 3 of *transformer* T207.	Chassis ground	0.02
7	Terminal 1 of transformer T208.	Terminal 3 of transformer T208.	2.0
8	Binding post E203.	Binding post E204	2.0 ± 0.4

263. Channel 3 modem Transmitting Path

a. Teat Conditions. The test conditions for the channel 3 modem transmitting path are the same as those for the channel 1 modem transmitting path. These conditions are described in paragraph *259a.*

b. Equipment Required. The equipment required for testing the channel 3 modem transmitting path is the same as that required for testing the channel 1 modem transmitting path. This equipment is described in paragraph 259b.

c. Connections. The following chart indicates the connections necessary for performing the tests. The first column lists the items to be connected and the second column lists the points to which the items are connected.

Item	Connected to-
Extension cable	Plug P301 of channel modem.
Carrier-frequency signal generator.	Terminals 0 and 3 of extension cable.
Signal-frequency signal generator.	4W-T 2W binding posts of channel modem.
Terminal 4 of filter FL301.	Chassis ground.
600-ohm (±1%) resistor	Terminals 16 and 19 extension cable.

d. Adjustments.

(1) Operate the 2W-4W switch to the 2W position.

(2) Adjust the carrier-frequency signal generator to 16 00 kc and its output to 0.8 volt.

(3) Adjust the signal-frequency signal generator to 1 kc and its output to 0.8 volt.

e. Measurements. The following chart indicates the *normal* ac voltage readings obtained when the vacuum-tube voltmeter is connected between point A and point B. The readings obtained from the circuit under test should be approximately equal to the normal readings. Marked variations from these normal readings will indicate the presence of trouble and may indicate the nature of the trouble. Disconnect signal-frequency signal generator before making test number 5.

Test No	Point A	Point B	Normal readings (volts-ac)
1	Stand-off E307.	Stand-off E308	0.05
2	Terminal 3 of filter FL301.	Chassis ground	0.17
3	Terminal 3 of filter FL302.	Chassis ground	0.05
4	Terminal 1 of filter FL302.	Chassis ground	0.014 ±00014
5	Terminal 2 of transformer T304.	Terminal 2 of transformer T303.	0.4

264. Channel 3 Modem Receiving Path

a. Test Conditions. The test conditions for the channel 3 modem receiving path are the same as those for the channel 1 modem transmitting path. These conditions are described in paragraph 259a.

b. Equipment Required. The equipment require for testing the channel 3 modem receiving path is the same as that required for testing the channel 1 modem receiving path. This equipment is described in paragraph 259*b*.

c. Connections. The following chart indicates the connections necessary for performing the tests. The first column lists the items to be connected and the second column lists the point to which the items are connected.

Item	connected to-
Extension cable	Plug P301 of channel modem.
+200 volts	Terminal 2 of test cable.
Terminal 5 of extension cable.	Power supply ground.
6.3 volts are	Terminals 1 and 4 of extension cable.
Carrier-frequency signal generator.	Terminals 0 and 3 of extension cable.
Signal-frequency signal generator.	Terminals 14 and 17 of extension cable.
Terminal 4 of filter FL302.	Chassis ground.
600-ohm (±1%) resistor	Binding posts E303 and E304.

d. Adjustments.

(1) Operate the 2W-4W switch to the 4W position.

(2) Adjust the GAIN control to the extreme clockwise position.

(3) Adjust the carrier-frequency signal generator to 16.00 kc and its output to 0.8 volt.

(4) Adjust the signal-frequency signal generator to 15 kc and its output to 0.3 volt.

e. Measurements. The following chart indicates the *normal* ac voltage readings obtained when the vacuum-tube voltmeter is connected between point A and point B. The readings obtained from the circuit under test should be approximately equal to the normal readings. Marked variations from these normal readings will indicate the presence of trouble and may indicate the nature of the trouble. Disconnect signal-frequency signal generator before making the measurement in the fourth test in the chart. Reconnect the signal-frequency signal generator for the subsequent measurements.

Test No.	Point A	Point B	Normal readings (volts-ac)
1	Terminal 3 of filter FL 303.	Chassis ground -------	0.07
2	Terminal 6 of transformer T306.	Chassis ground	0.02
3	Terminal 6 of transformer T305.	Chassis ground ___	0.02
4	Terminal 3 of transformer T305.	Terminal 3 of transformer T306.	0.4
5	Terminal 3 of filter FL304.	Chassis ground _____	0.02
6	Terminal 3 of transformer T307.	Chassis ground ____	0.02
7	Terminal 1 of transformer T308.	Terminal 2 of transformer T308.	2.0
8	Binding post E303..	Binding post E304 __	2.0 ± 0.4

265. channel 4 Modem Transmitting Path

a. Test *Conditions.* The test conditions for the channel 4 modem transmitting path are the same as those for the channel 1 modem transmitting path. These conditions are described in paragraph 259a.

b. *Equipment Required.* The equipment required for testing the channel 4 modem transmitting path is the same as that required for testing the channel 1 modem transmitting path. This equipment is described in paragraph 259b.

c. *Connections.* The following chart indicates the connections necessary for performing the tests. The first column lists the items to be connected and the second column lists the points to which the items are connected.

Item	Corrected to-
Extension cable ______	Plug P401 of channel modem.
Carrier-frequency signal generator.	Terminals 0 and 3 of extension cable.
Signal-frequency signal generator.	4W-T 2W binding posts of channel modem.
Terminal 4 of filter FL402.	Chassis ground.
60-ohm (±1%) resistor	Terminal 16 and 19 of extension cable.

d. Adjustments.

(1) Operate the 2W-4W switch to the 2W position.

(2) Adjust the carrier-frequency signal generator to 29.00 kc and its output to 0.8 volt.

(3) Adjust the signal-frequency signal generator to 1 kc and its output to 0.8 volt.

e. Measurements. The following chart indicates the normal ac voltage readings obtained when the vacuum-tube voltmeter is connected between point A and point B. The readings obtained from the circuit under test should be approximately equal to the normal readings. Marked variations from these normal readings will indicate the presence of trouble and may indicate the nature of the trouble. Disconnect signal-frequency signal generator before making the last test in the chart.

Test No.	Point A	Point B	Normal readings (volts-ac)
1	Stand-off E407.	Stand-off E408	0.5
2	Terminal 3 of Alter FL401.	Chassis ground	0.17
3	Terminal 3 of filter FL402	Chassis ground	0.05
4	Terminal 1 of filter FL402.	Chassis ground	0.014 ±0.0014
5	Terminal 2 of transformer T404.	Terminal 2 of transformer T403.	0.4

266. Channel 4 Modem Receiving Path

a. Test Conditions. The test conditions for the channel 4 modem receiving path are the same as those for the channel 1 modem transmitting path. These conditions are described in paragraph *259a.*

b. Equipment Required. The equipment required for testing the channel 4 modem receiving path is the same as that required for testing the channel 1 modem receiving path. This equipment is described in paragraph 259b.

c. *Connectiona.* The following chart indicates the connections necessary for performing the tests The first column lists the items to be connected and the second column lists the points to which the items are connected.

Item	Connected to-
Extension Cable	Plug P401 of channel modem.
+200 volts	Terminal 2 of extension cable.
Terminal 5 of extension cable.	Power Supply ground.
6.3 volts ac	Terminals 1 and 4 of extension cable.
Carrier-frequency signal generator.	Terminal 0 and 3 of extension cable.
Signal-frequency signal generator.	Terminals 14 and 17 of extension cable.
Terminal 4 of filter FL403.	Chassis ground.
660-ohm (±1%) resistor	Binding posts E403 and E404.

6. Adjustments.

(1) Operate the 2W-4W switch to the 4W position.

(2) Adjust the GAIN control to the extreme clockwise position.

(3) Adjust the carrier-frequency signal generator to 20.00 kc and its output to 0.8 volt.

(4) Adjust the signal-frequency signal generator to 19 kc and its output to 0.3 volt.

e. *Measurements.* The chart below indicates the normal ac voltage readings obtained when the vacuum-tube voltmeter is connected between point A and point B. The readings obtained from the circuit under test should be approximately equal to the normal readings. Marked variations from these normal readings will indicate the presence of trouble and may indicate the nature of the trouble. Disconnect the signal-frequency signal generator when making the fourth test in the following chart. Reconnect it for the subsequent tests.

Test No	Point A	Point B	Normal readings (volts-ac)
1	Terminal 3 of Alter FL403.	Chassis ground	0.07
2	Terminal 6 of transformer T406.	Chassis ground	0.02
3	Terminal 6 of transformer T405.	Chassis ground	0.02
4	Terminal 3 of transformer T405.	Terminal 3 of transformer T406.	0.04
5	Terminal 3 of filter FL404.	Ground	0.02
6	Terminal 3 of transformer T407.	Ground	0.02
7	Terminal 1 of transformer T408.	Terminal 2 of transformer T408.	1.7
8	Binding post E403.	Binding post E404	1.7± 0.35

267. Ringer-Oscillator

a. Test Conditions. The ringer-oscillator is tested apart from the telephone terminal. The ringer-oscillator is a plug-in unit and can be removed from the terminal without difficulty (para 87g).

b. Equipment Required. Four items are required to test the ringer-oscillator. These items are a signal generator, extension cable, a power supply and a vacuum-tube voltmeter.

c. *Connections.* The following chart indicates the connections necessary for performing the tests. The first column lists the items to be connected and the second column lists the Points to which the items are connected.

Item	Connected to-
Extension cable	*Plug* P1 of ringer-oscillator.
Signal generator	Terminal 1 of extension cable and terminal 4 *of* chassis ground.
-10 volts	Terminal 13 of extension cable.
+200 volts	Terminal 19 of extension cable.
Power supply ground	Chassis ground (terminal 4 of extension cable).
6.8 volts ac	Terminala 12 and 15 of extension cable.
Short	Terminals 2 and 5 of extension cable.

d. Adjustments.

(1) Adjust the signal generator frequency accurately to 1,600 cps.

(2) Adjust the output of the signal generator for 0.025 volt.

e. *Measurements.*

(1) Using 16,000-cps signal. The following chart indicates the normal voltage readings obtained when the vacuum-tube voltmeter is connected between point A and point B. The first three voltage readings are ac; the last two readings are dc. The readings obtained from the circuit under test should be approximately equal to the normal readings. Marked variations from these normal readings will indicate the presence of trouble and may indicate the nature of the trouble.

Test No.	Point A	Point B	Normal readings
1	Stand-off El	Chassis ground	0.19 volt ac.
2	Pin 4 of tube V1.	Chassis ground	1.1 volts ac.
5	Stand-off E10	Chassis ground	4.9 ± 1.0 volts ac.
4	stand-off E6	Chassis ground	-6.1 volts dc.
5	Stand-off E2	Chassis ground	-6.1 volts dc.

(2) *Using* 1,000-cps signal. The following chart indicates the voltage readings obtained when tests are made using a 1,000-cps signal. Before making the tests indicated, it is necessary to change the frequency adjustment of the signal generator from 1,600 cps to 1,000 cps and adjust its voltage output from 0.025 volt to 0.10 volt. The readings obtained in tests 1 and 2 are ac. The readings obtained in tests 3 and 4 are dc. When making test 2, connect stand-off E6 to ground.

Test No.	Point A	Point B	Normal readings
1	Pin 4 of tube V1.	Chassis ground	1.5 volts ac.
2	Stand-off E15	Stand-off E6	9.4 volts ac.
3	Stand-off E6	Chassis ground	-2.6 ± 0.5 volts dc.
4	Stand-off E2	Chassis ground	+2.9 ± 0.5 volts dc.

268. System Alarm

a. Test Conditions. The system alarm is not *a* plug-in circuit. Do not attempt to remove it from the terminal.

b. *Equipment Required.* Two items of equipment are required for testing the system alarm. This test equipment consists of a signal generator and a vacuum-tube voltmeter.

c. *Connections.* The following chart indicates the connections necessary for performing the tests. The first column lists the item to be connected, and the second column lists the points to which the item is connected.

Item	Connected to-
Signal generator	Stand-off E744 and chassis ground.

d. Adjustments.

(1) Operate the terminal's POWER switch to the ON position.

(2) Adjust the signal generator frequency accurately to 4.00 kc and its output to 0.14 volt.

e. *Measurements.* The following chart indicates the normal ac voltage readings obtained when the vacuum-tube voltmeter is connected between point A and point B. The readings obtained from the circuit under test should be approximately equal to the normal readings. Marked variations from these normal readings will indicate the presence of trouble and may indicate the nature of the trouble. When the 4.00-kc signal is applied to the system, the SYSTEM ALARM and CALL lamps are extinguished and the buzzer does not sound.

Test No.	Point A	Point B	Normal readings (volts-ac)
1	Terminal 1 of filter FL741.	Chassis ground	0.07
2	Terminal 3 of filter FL741.	Chassis ground	0.8
3	Pin 1 (grid) *of* tube V741.	Chassis ground	0.8
4	Pin 5 (plate) of tube V741.	Chassis ground	5.0 ± 1
5	Junction *of* varistor CR741 and resistor R742	Chassis ground	1.0

269. Order Wire

a. *Test* Conditions. The order wire circuit is not a plug-in circuit. Do not attempt to remove it from the terminal.

b. Equipment Required Two items of equip ment are required for testing the order wire circuit. This test equipment consists of a signal generator and a vacuum-tube voltmeter.

c. Connections. The following chart indicates the connection necessary for performing tests. The first column lists the item to be connected and the second column lists the point to which the item is connected.

Item	connected to-
signal generator _ _ _ _	Binding posts E735 and E736.

d. Adjustments.

(1) Operate the terminal's POWER switch to the ON position.

(2) Adjust the signal generator frequency accurately to 1.00 kc and its output to 0.775 volt.

e. Measurements. The following chart indicates the normal ac voltage readings obtained when the vacuum-tube voltmeter is connected between point A and point B. The readings obtained from the circuit undet test should be approximately equal to the normal readings. Marked variations from these normal readings will indicate thy presence of trouble and may indicate the nature of the trouble. Before performing tests 11 through 13 in the chart. operate the ORDER WIRE switch to the TALK position.

Test No.	Point A	Point B	Normal readings (volts-ac)
1	Terminal 1 of transformer T724.	Terminal 6 of transformer T724.	0.5
2	Stand-off E723.	Stand-off E724 _ _ _	0.3
3	Terminal 2 of transformer T722.	Ground ___________	0.25
4	Terminal 3 of filter FL721.	Ground	0.24
5	Terminal 1 of filter FL721.	Ground _________	0.2 ± 0.02
6	Terminal 13 of jack J801.	Ground _________	0.01
7	Terminal 3 of transformer T724.	Terminal 4 of transformer T724.	0.5
8	Terminal 3 of filter FL722.	Ground .. .	0.4
9	Terminal 1 of filter FL722.	Ground	0.33 ±0.033
10	Terminal 3 of jack J802.	Ground ______ ___	0.33
11	Terminal 5 of transformer T711.	Terminal 6 of transformer T711.	0.5
12	Stand-off E710.	Terminal 1 of transformer T711,	0.2
13	Terminal 5 of transformer T712.	Terminal 6 of transformer T712.	0.32
14	Terminal 1 of transformer T712.	Terminal 4 of transformer T712.	0.23
15	Stand-off E711.	Stand-off E712	0.22

270. Carrier Supply

a. *Test Conditions.* The carrier supply is tested apart from the telephone terminal. The carrier supply is a plug-in unit and can be removed from the terminal without difficulty (para 87f).

b. Equipment Required. Ten items of test equipment are required to test the carrier supply. These items are a power supply, an extension cable, a vacuum-tube voltmeter, four 60-ohm resistors, and three 600-ohm resistors. No signal generator is required because the carrier supplies its own signal.

c. Connections. The following chart indicates the connections necessary for performing the *tests* The first column lists the items to be connected and the second column lists the points to which the items are connected.

Item	Connected to-
Extension cable	Plug P601 of carrier supply.
+200 volts _	Terminal 13 of extension cable.
Power supply ground	Terminal 16 of extension cable.
6.3 volts ac __________	Terminals 0 and 1 *of* extension cable.
60-ohm resistors:	
No. 1 ______	Pins 9 and 12 of extension cable.
No. 2 -- _____	Pins 6 and 3 of extension cable.
No. 3 ________	Pins 8 and 11 of extension cable.
No.4 ___	Pins 5 and 2 of extension cable.
600-ohm resistors:	
No. 1 _____	Jack J601 and chassis ground.
No. 2 ____	Jack J602 and chassis ground.
No. *3* ____ __	Jack J603 and chassis ground.

d. *Adjustments.* No adjustments are required for testing the carrier supply. When the 16-kc oscillator is operating normally, the frequency and amplitude of the output have the correct values.

e. *Measurements.* The following chart indicates the normal ac voltage readings obtained when the vacuum-tube voltmeter is connected between point A and point B. The readings obtained from the circuit under test should be approximately equal to the normal readings. Marked variations from these normal readings will indicate the presence of trouble and may indicate the nature of the trouble. Operation of the 16-kc oscillator is checked at jack J601.

Test No	Point A	Point B	Normal readings (volts-ac)
1	Jack J601 _ _ _ _ _	Chassis ground _	0.59 ± 0.1
2	Terminal 6 of transformer T602.	Chassis ground _	5.2
3	Terminal 4 of transformer T604	Chassis ground _ _ _	2.5
4	*Terminal 4* of transformer T605	Chassis ground _ _ _	2.0
5	Jack J602 _	Chassis ground _ _	0.4 ± 0.15
6	Terminal 19 of extension cable.	Chassis ground	0.1
7	Jack J603 -	Chassis ground _	0.59 ± 0.1
8	Terminal 1 of inductor L603.	Chassis ground - -	62
9	Terminal 3 of filter FL601.	Chassis ground _ _	1.39
10	Terminal 12 of extension cable.	Terminal 9 of extension cable.	0.69 to 1.1
11	Terminal 3 of filter FL602.	Chassis ground -	1.39
12	Terminal 6 of extension cable.	Terminal 3 of extension cable.	0 69 to 1.1
13	Terminal 3 of filter FL603.	Chassis ground	2.15
14	Terminal 3 of transformer T610.	Chassis ground -	_5
15	Terminal 8 of extension cable.	Terminal 11 of extension cable	0.69 to 1.1
16	Terminal 3 of filter YL604.	Chassis ground	1.2
17	Terminal 5 of extension cable.	Terminal 2 of extension cable.	0.69 to 1.1

271. Transmitting and Receiving Amplifiers

a. Teat Conditions. The transmitting and [re]ceiving amplifiers are tested apart from the t[ele]phone terminal. These smplifiers are plug-in [as]semblies and can be removed from the term[inal] without difficulty (para 87d, and e).

b. *Equipment Required.* Six items of equipmen[t] are required to test the transmitting and rece[iving] amplifiers. These items are a power supply, a [signal] generator, an extension cable, a vacuum-t[ube] voltmeter, and two 600-ohm resistors.

c. *Connections.* The following chart indicates the connections necessary for performing the tests. The first column lists the items to be connected and the second column lists the *mints to* which the items are connected.

Item	Connected to-
Extension cable _ _ _ _ _ _	Plug P51 of amplifier.
+200 volts _ _ _ _ _ _ _ _ _	Terminal 12 of extension cable.
Power supply ground _ _	Terminal 14 of extension cable.
6 3 volts ac ___________	Terminals 6 and 9 of extension cable.
Terminal 13 of extension cable.	Terminal 19 of extension cable.
Terminal 16 of extension cable.	Terminal 18 of extension cable.
Terminal 4 of extension cable.	Terminal 7 of extension cable.
Signal generator _ _ _	Terminal 19 of extension cable and chassis ground.
600-ohm (±1%) resistor	Terminals 3 and 10 of extension cable.
600-ohm (±1%) resistor _	Terminals 5 and 8 of extension cable.

d. *Adjustments.*

(1) Operate the AMP OUT switch to the positions indicated in the chart in e below.

(2) Adjust the siganl generator frequency accurately to 11.00 kc and its output to the voltages indicated in the chart.

e. *Measurements.* The following chart indicates *normal* ac voltage readings obtained when the vacuum-tube voltmeter is connected between point A and point B and the signal generator output voltage and the AMP OUT switch are adjusted as indicated for each test. The readings obtained from the circuit under test should be approximate;>- equal to the normal readings. Marked variations from these normal readings will indicate the presence of trouble and may indicate the nature of the trouble. When making test 8, ground terminal 5 of transformer T51. Test 8 is a feed-back circuit test.

Test No	Point A	Point B	Signal generator output adjustments (volts)	AMP. OUT switch positions	Normal readings (volts-ac)
1	Terminal 6 of transformed T51	Chassis ground	0.014	10 DB	0.012
2	Stand-off E55	Chassis ground	0.014	10 DB	1.25
3	Terminal 4 of transformer T52	Chassis ground	0.014	10 DB	15 0
4	Terminal 5 of extension cable	Chassis ground	0.014	10 DB	3.7
5	Terminal 5 of extension cable	Chassis ground	0.014	0 DB	1.25
6	Terminal 3 of extension cable	Terminal 10 of extension cable	0.014	0 DB	1.65
7	Terminal 3 of extension cable	Terminal 10 of extension cable	0.014	10 DB	1.15
8	Terminal 5 of extension cable	Chassis ground	0.0013	10 DB	0.88

272. Measuring Circuit

a. Test Conditions. The measuring circuit is not part of a plug-in assembly. Do not attempt to remove it from the terminal. Make all measurements at or near room temperature. Variations in temperature will cause variations in readings.

b. **Equipment** Required. TWO items of equipment are required to test the measuring circuit. This test equipment consists of a signal generator and a vacuum-tube voltmeter.

c. Connectors. Connections necessary for testing the measuring circuit are not the same for all tests. Make the connections for each test called for in the ***Meter*** connections and Signal generator connections columns in the chart in e below.

d. Adjustments. Adjustments necessary for testing the measuring circuit are not the same for all tests. Make the adjustments for each test called for in the ***Signal*** generator frequency and ***output*** column in the chart in e below.

e. Measurements. **The following chart indicates readings obtained on both the vacuum-tube voltmeter and the MEASURE meter The vacuum-tube voltmeter should be connected as indicated in the chart. The MEASURE meter is to be used as connected in the measuring circuit. When making test 3 in the chart, adjust the TEST OSC. OUTPUT control for 0-db reading on the MEASURE meter. When making tests 4 through 8, hold the AMPLIFIER switch in the REC. position.**

Test No.	Vacuum-tube voltmeter connections		Signal-generator connections		Signal generator frequency and output	Position of MEASURE switch	Measuring circuit meter readings (db)
	Point A	Point B	Point C	Point D			
1			Test probe	Chassis ground	1 kc at 0.42 V	OFF pos 1	0 ±1
2			Terminal 10 of TB801.	Terminal 9 of TB801.	1 kc at 0.90 V	MODEMS pos 2	0 ±1
3						TEST OSC pos 3	0 ±1
4	Terminal 6 of filter FL771.	Chassis ground	Terminal 3 of TB802.	Chassis ground	1 kc at 0.50 V	1KC-OW pos 4	0 ±1
5	Terminal 5 of filter FL771.	Chassis ground	Terminal 3 of TB802.	Chassis ground	19 kc at 0.41 V	19 KC-CH 4 pos 5	0 ±1
6	Terminal 3 of filter FL771.	Chassis ground	Terminal 3 of TB802	Chassis ground	11 kc at 0 47 V	11 KC-CH 2 pos 6	0 ±1
7	Terminal 2 of filter FL771.	Chassis ground	Terminal 3 of TB802.	Chassis ground	7 kc at 0 50 V	7 KC-CH 1 pos 7	0 ±1
8	Terminal 4 of filter FL771.	Chassis ground	Terminal 3 of TB802.	Chassis ground	15 kc at 0.45	15 KC-CH 3 pos 8	0

273. Special Service Transmitting Path

a. Test Conditions. The special service transmitting path is not part of a plug-in assembly Do not attempt to remove it from the terminal.

b. Equipment Required Two items of equipment are required for testing the special service transmitting path. This equipment consists of a signal generator and a vacuum-tube voltmeter.

c Connections The following chart indicates the connections necessary for performing tests The first column lists the item to be connected and the second column lists the points to which the item is connected

Item	*Connected to*
Signal generator	SPECIAL SERVICE TR binding posts

d. Adjustments.

(1) Adjust the CHANNELS--SPECIAL SERVICE switch to the SPECIAL SERVICE position.

(2) Adjust the signal generator frequency accurately to 1.00 kc and its output to 0.775 volt.

e. *Measurements.* The following chart indicates the normal ac voltage readings obtained when the vacuum-tube voltmeter is connected between the point A and point B. The readings obtained from the circuit under test should be approximately equal to the normal readings. Marked variations from these normal readings will indicate the presence of trouble and may indicate the nature of the trouble.

Test No	Point A	Point B	Normal readings (volts-ac)
I	Terminal 6 of transfomer T801.	Chassis ground -	0.60
3	Stand-off E806	Chassis ground	0.0044
3	Stand-off E813.	Chassis ground _ _	0.00245
4	Terminal 13 of of jack J801	Chassis ground	0.00245

274. Special Service Receiving Path

a. Test Conditions. The special service receiving path is not part of a plug-in assembly. Do not attempt to remove it from the terminal.

b. Equipment Requi red. Two items of equipment are required for testing the special service receiving path. This *equipment* consists of a signal generator and a vacuum-tube voltmeter.

c. *Connections.* The following chart indicates the connections to be made for performing tests. The first column lists the item to be connected and the second column lists the points to which the item is connected.

Item	Connected to—
Signal generator .	SPECIAL SERVICE REC. binding posts.

d. Adjustments.

(1) Adjust the CHANNELS-SPECIAL SERVICE switch to SPECIAL SERVICE.

(2) Adjust the signal generator frequency accurately to 1.00 kc and its output to 0.775 volt.

e. Measurements. The following chart indicates the *normal* ac voltage readings obtained when the vacuum-tube voltmeter is connected between point A and point B. The readings obtained from the circuit under test should be approximately equal to the normal readings. Marked variations from these normal readings will indicate the presence of trouble and may indicate the nature of the trouble.

Test No.	Point A	Point B	Normal readings (volts-ac)
1	Terminal 6 of transformer T802.	Chassis ground _ _	0.60
2	Stand-of? E808.	Chassis ground - - - -	0.19
8	Terminal 5 of jack J802.	Chassis ground _ -	0.19

275. Cable Matching Network and Associated Circuits

a. *Test Conditions.* The cable matching network and associated circuits are not part of a plug-in assembly. Do not attempt to remove them from the terminal.

b. Equipment Required. Two items of equipment are required for testing the cable matching network and associated circuits. This equipment consists of a signal generator and a vacuum-tube voltmeter.

c. *Connections. The* following chart indicates the connections to be made for performing tests. The first column lists the item to be connected and the second column lists the points to which the item is connected.

item	Connected to-
Signal generator _ _	Protectors E763 and E764.

d. *Adjustments.*

(1) Adjust the siganl generator frequency to 1.00 kc.

(2) Adjust the output of the signal generator to 0.775 volt.

e. Measurements. The following chart indicates *normal* ac voltage readings obtained when the vacuum-tube voltmeter is connected between point A and point B. The readings obtained from the circuit under test should be approximately equal to the normal readings. Marked variations from these normal readings will indicate the presence of trouble and may indicate the nature of the trouble.

Test No.	Point A	Point B	Normal readings (volts-ac)
1	Terminal 8 of transformer T761.	Chassis ground	0.775
2	Terminal 5 of jack J301.	Chassis ground . . .	0.775

276. Equalizers and Associated Input Circuit

a. *Test Conditions.* The equalizers and associated circuit are not part of a plug-in assembly. Do not attempt to remove them from the circuit.

b. Equipment Required Two items of equipment are required for testing the equalizers and associated circuit. This equipment consists of a signal generator and a vaccum-tube voltmeter.

c. *Connections.* The following chart indicates the connections to be made for performing tests. The first column lists the item to be connected and the second column lists the points to which the item is connected.

Item	Connected to-
Signal generator	Protectors E737 and E738.

d. Adjustments.

(1) Adjust the signal generator frequency to 1.00 kc.

(2) Adjust the output of the signal generator to 0.775 volt.

e. *Measurements.* The following chart indicates the *normal* ac voltage readings obtained when the vacuum-tube voltmeter is connected between point A and point B. The readings obtained from the circuit under test should be approximately equal to the normal readings. Marked variations from these normal readings will indicate the presence of trouble an may indicate the nature of the trouble.

Test No.	Point A	*Point B*	Normal readings (volts-ac)
1	Terminal 5 of transformer T821.	Terminal 8 of transformer T821	1.5
2	Terminal 5 of equalizer EQ822	Terminal 3 of equalizer EQ822	1.5
3	Terminal 2 of equalizer EQ822	Terminal 4 of equalizer EQ821	0.83
4	Terminal 13 of jack J802	Terminal 18 of jack J802	0.0027 (FLAT-1KC control in extreme counterclockwise position). 0.027 (FLAT-1KC control in extreme clockwise position).

Section IV. CHECKING CIRCUIT ELEMENTS

277. Resistors and Potentiometers

a. *Resistor.* When it is likely that a resistor is faulty, the resistor can be checked with an ohmmeter. To be certain that only the resistor is being checked, disconnect at least one lead of the resistor from the circuit.

b. *Potentiometers.* Potentiometers can become defective in several ways. They can open, change value, or become noisy.

(1) To test a potentiometer, tag and unsolder all connections to the potentiometer.

(2) Use an ohmmeter to measure the resistance between the outside terminals of the potentiometer. These terminals and the normal value of resistance are listed in the chart in (5) below.

(3) Connect the ohmmeter to one of the outside terminals and the center terminal. Rotate the front-panel control knob with a low and even motion from the extreme counterclockwise position to the extreme clockwise position. The indication on the ohmmeter should change steadily either from 0 ohm to the value listed in the chart of from the chart value to 0 ohm, depending on which of the outside terminals is connected to the ohmmeter. Any sudden jump or dip of the ohmmeter needle indicates that the control is noisy and should be replaced.

(4) Several of the controls of the AN/TCC-3 consist of two ganged potentiometers. The chart below identifies the two sections of each of these controls at the front and rear sections. The front section is the one that is closer to the front panel. When testing these controls, check each section independently. Where neither front nor rear is specified in the chart, the control consists of a single section.

(5) The GAIN controls of the four channel modems are identical. Therefore only one GAIN control is listed in the chart below. Each section of a GAIN control has only two terminals. Connect the ohmmeter between these two terminals and perform the procedure in (3) above.

Potentiometer	Section	Outside terminals	Center terminal	Resistance (ohms ±10%)
FLAT-1KC	Front	1 and 3	2	50,000
	Rear	4 and 6	5	10,000
SLOPE-19KC	Front	1 and 3	2	25,000
	Rear	4 and 6	5	25,000
BULGE-11 KC		1 and 3	2	50,000
TEST OSC OUTPUT		1 and 3	2	50,000
GAIN	Front		2	6,000
	Rear		4	5,500

278. Capacitors

To check a capacitor, discharge it, and remove at least one of its leads from the circuit. Check the capacitor with a capacity analyzer or by replacing the capacitor with one known to be good.

279. Indicators

Inductors may become faulty in several ways. The winding may open, several turns may become shorted and, in metal-core inductors, the winding may become shorted to the case. Use an ohmmeter to check the winding resistance of inductors. The resistances and the reference symbols are listed in the chart below. In metal-core inductors, check the resistance between the winding and the case. The chart below indicates whether an inductor has an air core (AC) or a metal core (MC).

Reference symbol	Core type	Winding resistance (ohms)
L1	AC	740
L51	MC	800
L551	MC	88
L601	AC	52
L602	AC	8.4
L603	MC	1.7
L604	AC	1.1
L605	AC	8.4
L761	AC	6.72

280. Transformers

Transformers may become defective in several ways. A winding could open, several turns of a winding could become shorted, one winding could become connected internally to another winding, or a winding could become shorted to the core of the transformer. Use an ohmmeter to check the insulation between windings and between a winding and the core. Check the schematics to determine whether any external connections are made between windings or between a winding and the shield, or core of the transformer. Use an ohmmeter to check the winding resistances of the transformer. The winding resistances for transformers are listed in table II.

NOTE

Power transformer T551 operates normally at a relatively high temperature. Apparent overheating of this transformer is not necessarily an indication of trouble in the transformer.

281. Hybrid Coils

Hybrid coils are subject to the same failures as transformers. Therefore, the checks performed on a hybrid coil are the same as those for transformers. The necessary resistance measurements are given in paragraph 253.

282. Filters

a. *General.* A filter is checked by removing it from the AN/TCC-3 and measuring its loss at different frequencies. Filters are manufactured as complete units. If one of these units is found to be defective, it must be replaced; it cannot be repaired. Four test arrangements are shown in figure 112, but only one of these is required for testing a particular filter. The test for filter FL741 is described in *b,* below. The test for filter FL771 is described in c, below. The tests for filters FL601 through FL604 are described in d, below. The tests for all the other filters in the AN/TCC-3 are described in e, below.

b. Test *Arrangement A.* Test arrangement A (fig. 112) is used for testing filter FL741. This filter has an output impedance of 300,000 ohms. For this reason, a vacuum-tube voltmeter is used as the measuring device. To test filter FL741, follow the procedure below.

(1) Connect the output of the signal generator to terminals 1 and 2 of filter FL471. Connect the vacuum-tube voltmeter to these terminals to measure the input voltage. Ground terminal 2 or 4 of the filter.

(2) Adjust the signal generator frequency to 4 kc. Adjust the signal generator voltage until 0.8 volt is read on the voltmeter.

(3) Disconnect the vacuum-tube voltmeter and reconnect it to terminals 3 and 4 to measure

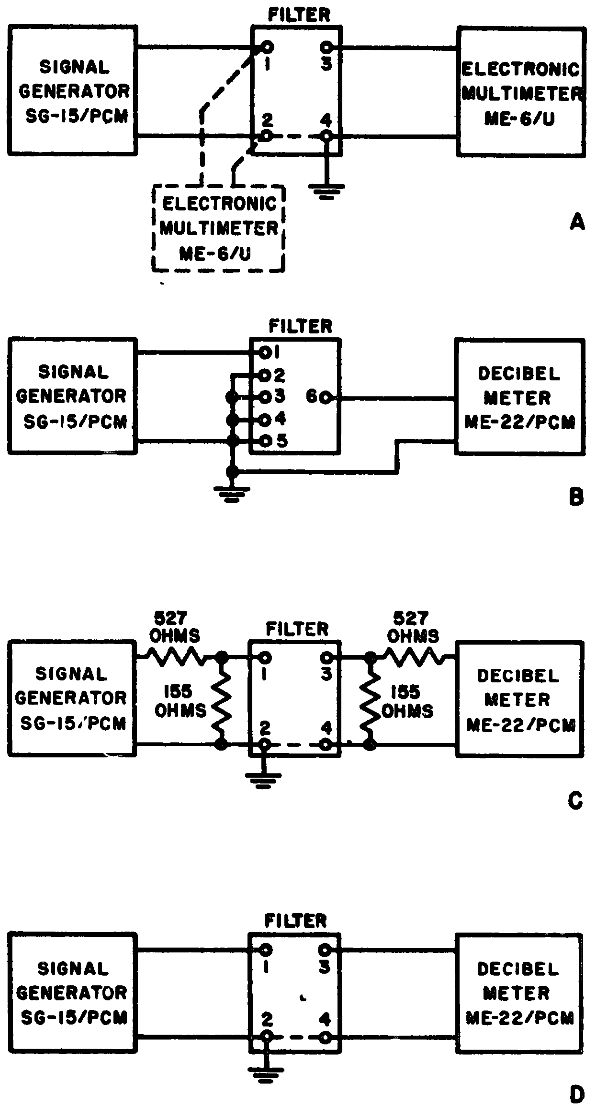


Figure 112. Test arrangement for filters.

the output voltage of the filter. The output voltage should be 6.0 volts or higher. Record the measured value.

(4) Reconnect the vacuum-tube voltmeter as in (1) above. Adjust the signal generator frequency to 5 kc and its output voltage to 0.8 volt. Disconnect the vacuum-tube voltmeter and reconnect it to terminals 3 and 4 and read the output voltage at 5 kc.

(5) Compare the new value of output voltage with the output voltage at 4 kc ((3) above). The output at 5 kc ((4) above), should not exceed a value greater than 0.04 times the reading recorder in ((3) above). This is a discrimination of at least 40 db.

c. Test Arrangement B. Test arrangement B (fig. 112) is used for testing selective filter FL771. Filter FL771 has a 600-ohm output impedance. Therefore, the 600-ohm ME–22/PCM is used in this test. To test this filter, follow the procedure below.

(1) Connect terminals 2, 3, 4, and 5 of the filter to ground. Connect the signal generator between terminal 1 of the filter and ground.

(2) Connect the ME–22/PCM between terminal 6 of the filter and ground.

(3) Adjust the signal generator frequency to 1.0 kc and its output to 0 dbm.

(4) The output, as indicated by the **ME-W** PCM should be less than 0.6 dbm. For example, a **reading** of -1.3 dbm is greater than -1.5 dbm.

(5) Connect terminals 1, 3, 4, and 5 of the filter to ground. Connect the signal generator between terminal 2 of the filter and ground.

(6) Adjust the signal generator frequency to 7.0 kc and its output power to 0 dbm. The reading on the ME-22/PCM should be less than 0.6 dbm

(7) Connect terminals 1, 2, 4, and 5 of the filter to ground. Connect the signal generator between terminal 3 of the filter and ground.

(8) Adjust the signal generator frequency to 11.0 kc and its output power to 0 dbm. The reading on the ME-22/PCM should be less than 0.6 dbm.

(9) Connect terminals 1, 2, 3, and 5 of the filter to ground. Connect the signal generator between terminal 4 of the filter and ground.

(10) Adjust the signal generator frequency to 15.0 kc and its output power to 0 dbm. The reading on the ME-22/PCM should be less than 0.6 **dbm.**

(11) Connect terminals 1, 2, 3, and 4 of the filter to ground. Connect the signal generator between terminal 5 of the filter ground.

(12) Adjust the signal generator frequency to 19.0 kc and its output power to 0 dbm. The reading on the ME-22/PCM should be greater than -1.5 dbm.

*d. **Test Arrangement*** C. Test arrangement C (fig. 112) is used for testing the output filters of the carrier supply. Resistors are used in the test circuit to match the 135-ohm input and output impedances of the filter to the 600-ohm impedances of the signal generator and the ME-22/PCM. To test filter FL601, FL602, FL603, or FL604, follow the procedure below.

(1) To provide a 527-ohm resistance network, use combinations of resistors provided in the MK-155/TCC (TB SIG 328).

(2) To provide a 155-ohm resistance network, use combinations of resistors provided in the MK-155/TCC.

(3) Connect a 527-ohm resistance network ((1) above) between terminal 1 of the filter and one of the terminals of the signal generator.

(4) Connect a 155-ohm resistance network ((2) above) between terminals 1 and 2 of the filter.

(5) Ground terminal 2 of the filter and the unconnected terminal of the signal generator.

(6) Connect a 527-ohm resistance network between terminal 3 of the filter and one terminal of the ME-22/PCM.

(7) Connect a 155-ohm resistance network between terminals 3 and 4 of the filter.

(8) Connect terminal 4 of the filter to the unconnected terminal of the ME-22/PCM.

(9) Adjust the signal generator to the frequency for test 1 as specified in the table below for the filter under test. Adjust the power output of the signal generator to +10 dbm.

(10) The reading obtained in the ME-22/PCM should be greater than -21.0 dbm. For example, 19.0 dbm is greater than -19.8 dbm.

(11) Adjust the signal generator to the frequency for test 2 as specified in the chart below. Adjust the power output of the signal generator **to** +10 dbm.

(12) The reading obtained on the ME-22/PCM should be less than -56.0 dbm. For example, -54.0 dbm is less than -53.8 dbm.

Filter	*Test*	*Frequency*
FL601	1	12.0 kc
FL601	2	15.0 kc
FL602	1	20.0 kc
FL602	2	24.0 kc
FL603	1	8.0 kc
FL603	2	11.0 kc
FL604	1	16.0 kc
FL604	2	19.0 kc

*e. **Test Arrangement D.*** Test arrangement D (fig. 112) is used for all filters that **have four** terminals and a 600-ohm impedance. To test one of these filters, follow the procedure below.

(1) Adjust the signal generator to the **frequency** specified in the chart in (4) below. Adjust the output power to 0 dbm.

(2) Connect the signal generator **output to terminals** 1 and 2 of the filter being tested. **Connect** the ME-22,/PCM to terminals 3 and 4 of the **filter. Connect terminal 2 or 4 of the filter to ground.**

(3) Compare the output measurement indicated on the ME-22/PCM with that specified in the chart. For most of the tests, the output is specified and the tolerance for the measurement is indicated. In other tests, a filter is acceptable if its output is either more than a minimum value or less than a maximum value. The term

"more than" in the chart means "more positive than." *For example,* -1.0 dbm is more positive than -2.0 dbm. Similarly, -2.1 dbm is less positive than -2.0 dbm.

(4) Repeat (2) and (3) above for each frequency listed for the filter under test. The filter is not acceptable if it fails to meet the output requirements for any test frequency.

Filter	*Frequency*	*Output requirements*
FL101	1.0 kc	More positive than -1.0 dbm.
FL102	5.0 kc	-8 ±1 dbm.
	7.0 kc	-8 ±1 dbm.
	7.5 kc	-8 ±1 dbm.
FL103	5.0 kc	-8 ±1 dbm.
	7.0 kc	-8 ±1 dbm.
	7.5 kc	-8 ±1 dbm.
FL104	7.0 kc	-22.0 dbm.
FL201	1.0 kc	More positive than -1.0 dbm.
FL202	9.0 kc	-8 ±1 dbm.
	11.0 kc	-8 ±1 dbm.
	11.5 kc	-8 ±1 dbm.
FL203	9.0 kc	-8 ±1 dbm.
	11.0 kc	-8 ±1 dbm.
	11.0 kc	-8 ±1 dbm.
FL204	7.0 kc	-22.0 dbm.
FL301	1.0 kc	More positive than -1.0 dbm.
FL302	13.0 kc	-8 ±1 dbm.
	15.0 kc	-8 ±1 dbm.
	15.5 kc	-8 ±1 dbm.
FL303	13.0 kc	-8 ±1 dbm.
	15.0 kc	-8 ±1 dbm.
	15.5 kc	-8 ±1 dbm.
FL304	7.0 kc	-22.0 dbm.
FL401	1.0 kc	More positive than -1.0 dbm.
FL402	17.0 kc	-10 ±0.6 dbm.
	19.0 kc	-10 ±0.6 dbm.
	19.5 kc	-10 ±0.6 dbm.
FL403	17.0 kc	-10 ±0.6 dbm.
	19.0 kc	-10 ±0.6 dbm.
	19.5 kc	-10 ±0.6 dbm.
FL404	7.0 kc	-22.0 dbm.
FL721	1.0 kc	More positive than 0.4 dbm.
	7.0 kc	Less positive than -37 dbm.
FL722	1.0 kc	More positive than 0.4 dbm.
	7.0 kc	Less positive than -37 dbm.

283. Equalizers

a. General. An equalizer is checked by removing it from the AN/TCC-3 and measuring its loss at various frequencies. Equalizers are manufactured as complete units. If an equalizer is proved defective, it must be replaced; it cannot be repaired. Three test arrangements are shown in figure 113, but only one of these is required for testing one equalizer. The test for the flat equalizer is described in b below, that for the bulge equalizer in c below, and that for the slope equalizer in d below.

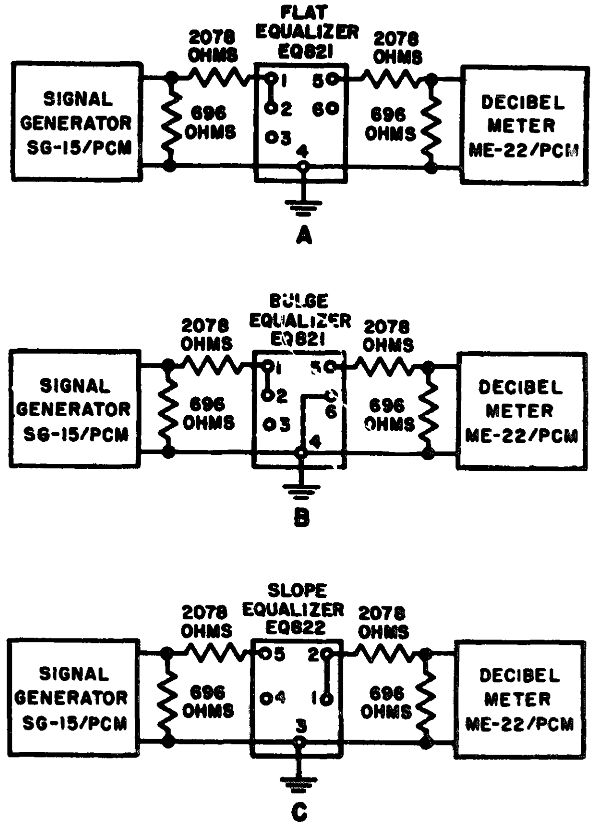


Figure 113. Test arrangement for equalizers.

b. Flat Equalizer Test. The flat equalizer is part of equalizer EQ821. Test arrangement A (fig. 113) is used for testing the flat equalizer. The resistors shown are required to match the 2,400-ohm input and output impedances of the equalizer to the 600-ohm impedances of the signal generator and measuring set. To test the equalizers, follow the procedures below.

(1) To provide a 2,078-ohm resistance network, use combinations of resistors provided in the MK-155/TCC (TB SIG 328).

(2) To provide a 696-ohm resistance network, use combinations of resistors provided in the MK-155/TCC.

(3) Connect a 2,078-ohm resistance network ((1) above) between one terminal of the signal generator and terminal 1 of equalizer EQ821.

(4) Connect the other terminal of the signal generator to terminal 4 of equalizer EQ821.

(5) Connect a 696-ohm resistance network ((2) above) between the output terminals of the signal generator.

(6) Connect a short length of wire between terminal 1 and 2 of equalizer EQ821.

(7) Connect ground to terminal 4 of the equalizer.

(8) Connect a 2,078-ohm resistance network between terminal 5 and the equalizer and one of the input terminals of the ME-22/PCM.

(9) Connect the other input terminal of the ME-22/PCM to terminal 4 of the equalizer.

(10) Connect a 696-ohm resistance network between the input terminals of the ME-22/PCM.

(11) Adjust the signal generator frequency to 300 cycles and its output power to +10 dbm.

(12) The ME-22/PCM should indicate a reading of -22.9 ±0.6 dbm.

(13) Adjust the signal generator frequency to 15.0 kc and its output power to ±10 dbm.

(14) The ME-22/PCM should indicate a reading of -12.8 ±0.2 dbm.

(15) Adjust the signal generator frequency. to 19.0 kc and its output power to +10 dbm.

(16) The ME-22/PCM should indicate a reading of -15.5 ±0 35 dbm.

c. Bulge Equalizer Test. The bulge equalizer is part of equalizer EQ821. Test arrangement B (fig. 113, is used for testing the bulge equalizer. The resistors shown are required to match the 2,400-ohm input and output impedances of the equalizer to the 600-ohm impedances of the signal generator and ME-22/PCM.

(1) Follow the procedures in b(1) and (2) above.

(2) Connect a short piece of wire between terminals 4 and 6 of equalizer EQ821.

(3) Adjust the signal generator frequency to 19.0 kc and its output power to +10 dbm.

(4) The ME-22/PCM should indicate a reading of −15.5 ±0.35 dbm.

(5) Adjust the signal generator frequency to 15.0 kc and its output power to +10 dbm.

(6) The ME-22/PCM should indicate a reading of −17.0 ±0.4 dbm.

d. Slope Equalizer Test. Equalizer EQ822 is the slope equalizer. Test arrangement C (fig. 113) is used for testing this equalizer. The resistors shown are required to match the 2,400-ohm input and output impedances of the equalizer to the 600-ohm impedances of the signal generator and ME-22/PCM. To test the slope equalizer, follow the procedure below.

(1) Follow the procedure in b (1) and (2) above.

(2) Connect a resistor or an equivalent resistor network of 2,078 ±21 ohms between one of the signal generator output terminals and terminal 5 of equalizer EQ822.

(3) Connect the other output terminal of the signal generator to terminal 3 of the equalizer.

(4) Connect a 696-ohm resistor network between the output terminals of the signal generator.

(5) Connect a short length of wire between terminals 1 and 2 of the equalizer.

(6) Connect ground to terminal 3 of the equalizer.

(7) Connect a 2,078-ohm resistor network between terminal 2 of the equalizer and one of the input terminals of the ME-22/PCM.

(8) Connect the other input terminal of the ME-22/PCM to terminal 3 of the equalizer.

(9) Connect a 696-ohm resistor network between the input terminals of the ME-22/PCM.

(10) Adjust the signal generator frequency to 1.0 kc and its output power to +10 dbm.

(11) The ME-22/PCM should indicate a reading of −25.8 ±0.2 dbm.

(12) Adjust the signal generator frequency to 5.0 kc and its output power to +10 dbm.

(13) The ME-22/PCM should indicate a reading of −24.9 ±0.2 dbm.

(14) Adjust the signal generator frequency to 19 kc and its output power to ±10 dbm.

(15) The ME-22/PCM should indicate a reading of −16.5 ±0.5 dbm.

(16) Adjust the signal generator frequency to 21 kc and its output power to +10 dbm.

(17) The ME-22/PCM should indicate a reading that is not more positive than −12.0 dbm. *For example,* −14.4 dbm does not exceed −14.2 dbm.

284. Varistor Test

When a varistor is suspected of being faulty, disconnect the varistor from the circuit. Note the polarity markings of the varistor being removed. Connect a new varistor into the circuit in such a manner that its polarity coincides with the polarity of the varistor which was removed. If the circuit operates normally with the new varistor, the replaced varistor was faulty.

285. Thermal Resistors (Thermistors)

Thermal resistors (thermistors) can be tested with an ohmmeter. Because the resistance varies with temperature, check at room temperatures between 70°F. and 80°F. The following chart lists the thermal resistors used in the AN/TCC-3 according to their reference symbols and lists the approximate resistance at room temperature.

Thermal resistors	*Approximate resistance (ohms)*
RT101	31.5
RT102	31.5
RT103	1,000
RT104	1,000
RT105	1,000
RT106	1,000
RT107	1,000
RT108	1,000
RT109	1,000
RT110	1,000
RT201	31.5
RT202	31.5
RT203	1,000
RT204	1,000
RT205	1,000
RT206	1,000
RT301	31.5
RT302	31.5
RT303	1,000
RT304	1,000
RT305	1,000
RT306	1,000
RT401	31.5
RT402	31.5
RT403	1,000
RT404	1,000
RT405	1,000
RT406	1,000
RT771	31.5

286. Switches

Check switches with an ohmmeter for continuity between contacts. Use the schematic diagrams (figs. 145–160) to determine points of continuity in each switch position.

287. Relays

To test a relay, it is necessary to check the resistance of the relay winding, and the continuity of the relay contacts in both the operated and the non-operated condition.

a. Winding Resistance Check. The two relays in the AN/TCC-3 are of the non-adjustable type. The winding resistance of each relay is 8,000 ohms. This winding resistance is checked by connecting an ohmmeter between terminals 7 and 8 of the relay. This resistance measurement can be made with the relay connected in its circuit.

b. Contact Continuity Check. When the relay under test is in the nonoperated condition, continuity between contacts is checked in the same manner as for switches (para 286). To check continuity when the relay is in the operated condition, follow the procedure outlined below. The POWER switch of the AN/TCC-3 must be in the OFF position.

(1) Connect the outside terminals of a 25K, 2-watt potentiometer (para 241) between +200 volts and ground of an external power supply.

(2) Connect terminal 7 of the relay to ground of the external power supply.

(3) With a voltmeter, measure the voltage between the center terminal of the potentiometer and ground. Adjust the potentiometer in order to obtain a minimum voltage reading.

(4) Connect terminal 8 of the relay to the center terminal of the potentiometer.

(5) Adjust the potentiometer until the voltmeter indicates 80 volts between the center terminal of the potentiometer and ground.

(6) The application of approximately 80 volts to the winding of the relay should cause the relay to operate. Measure continuity between contacts that are closed when the relay is operated. Relays K1 and K741 are shown in figures 154 and 159, respectively.

288. Meter

a. General. The accuracy of the MEASURE meter is checked in a dc test circuit in which a microammeter (Multimeter TS-352/U) is connected. The accuracy of the MEASURE meter is determined by comparing the reading of the MEASURE meter with that of the microammeter. Follow the procedure in *b* below for connecting the dc test circuit. The test procedure is described in *c* below.

b Dc Test Circuit.

(1) Remove the screws holding the MEASURE meter to the front panel. Carefully move

the meter outward through the front panel. Tag *and* unsolder the wires connected to the meter terminals. Remove the meter.

(2) Connect an outside terminal of a 500,000-ohm potentiometer to the negative terminal of the MEASURE meter. Connect the center terminal of the potentiometer to the outside terminal that is connected to the MEASURE meter. Connect the other outside terminal of the potentiometer to one side of a 6,200-ohm resistor.

(3) Connect the positive terminal of the MEASURE meter to the negative terminal of the microammeter. Connect the positive terminal of the microammeter to the positive terminal of a 1.5-volt dry cell.

(4) The dc test circuit is now complete except for the connection between the 6,200-ohm resistor and the dry cell. This connection is made as part of the test procedure given in c below.

c. Test Procedure.

(1) Until the dc test circuit is completed, no current flows. The needle of the MEASURE meter should rest at the marking at the left end of the scale. If the needle is not positioned properly, adjust the meter as described in (2) below. If the meter is of a sealed type without an adjustment, the meter must be replaced.

NOTE

Only authorized and qualified personnel are to make the adjustment described in (2) below.

(2) Adjust the screw on the front of the meter. Avoid turning the adjusting screw too far, because the pointer may be bent or the hairspring damaged. After adjusting the meter, determine that the needle will remain in or return to the adjusted position by tapping the meter case gently but firmly.

(3) Connect the free end of the 6,200-ohm resistor to the negative terminal of the 1.5-volt dry cell. This completes the dc test circuit.

(4) Adjust the potentiometer to obtain each of the microammeter readings listed in the following chart. At each setting of the potentiometer, the reading on the MEASURE meter should be as indicated in the chart below.

Microammeter reading (a)	*MEASURE meter reading (db)*
3	−20
28	−10
62	−5
84	−3
130	0
199	+3

289. Protector Test

A protector can become shorted when a large discharge takes place through it. Use an ohmmeter to check the protectors. Operate the terminal POWER switch to the OFF position, and connect the ohmmeter between each contact of the spiral-four cable connector J701 and ground. Zero resistance between a contact and ground indicates a shorted protector.

290. Attendant's Handset Test

a. Transmitter Test. If the transmitter of the attendant's handset is suspected of being faulty, test as described below.

(1) Unscrew the transmitter mouthpiece and remove the transmitter element.

(2) Connect an ohmmeter of the two contact electrodes of the transmitter element. If the transmitter is open or if the contacts are dirty, the ohmmeter will indicate infinite resistance.

(3) Speak into the transmitter element. If the transmitter is not faulty, the ohmmeter will indicate fluctuating resistance.

b. Receiver Test. If the receiver of the attendant's handset is suspected of being faulty, test it as described below.

(1) Disconnect the lead of transformer T712 from terminal 5 of terminal board TB702.

(2) Connect an ohmmeter between terminals 5 and 7 of terminal board TB702. If the circuit to the handset is complete and the receiver is not open, the ohmmeter will indicate approximately 50 ohms.

(3) If a reading of 50 ohms is not obtained in (2) above, remove the receiving element from the handset receiver.

(4) Connect an ohmmeter to the contact electrodes. The resistance should be about 50 ohms. If the ohmmeter indicates more than 50 ohms, check the contacts for dirt and for proper tension.

291. Crystal Test

The only crystal in the AN/TCC-3 is in the carrier supply circuit. When a trouble in the carrier supply indicates that the crystal is defective, check the crystal by replacing it with a crystal known to be good. If the new crystal restores normal operation, the replaced crystal was defective.

292. Rectifier Test

The elements that are marked "rectifiers" on schematic diagrams are varistors whose function is to provide rectification. These elements are checked by replacement with new varistors. If normal operation is restored by the new varistor, the replaced varistor was defective.

Section V. REPAIRS AND ADJUSTMENTS

293. Replacement of Parts Not Readily Accessible

Methods of removing parts from components of the AN/TCC-3 bearing Order No. 1667-Phila-51, serial numbers 1 through 1707, are described in a and *b* below. These instructions cover the removal of those parts that are not readily accessible. In components of the AN/TCC-3 bearing Order No. 1667-Phila-51, serial numbers 1708 and subsequent, the parts are positioned so that no special procedures are necessary to gain access to them. To replace parts in the AN/TCC-3, reverse the procedure used to remove them. The spare parts shevles are illustrated in figures 114, 114.1 and 115.

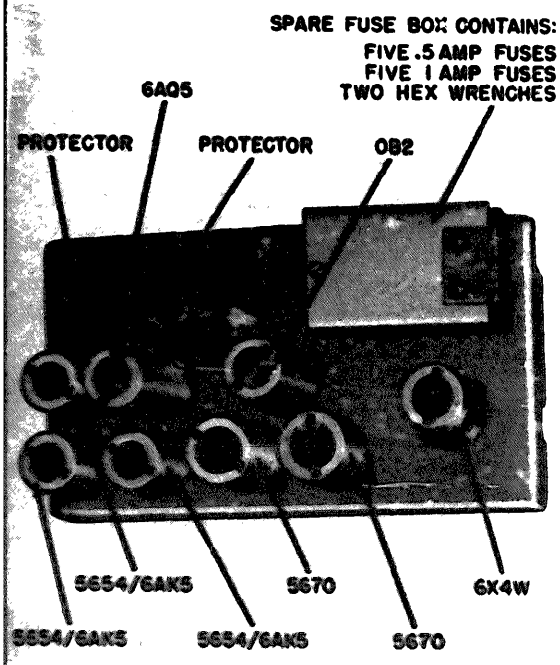


Figure 114. Upper spare parts shelf, AM-682/TCC-3 bearing serial numbers 1 through 1707.

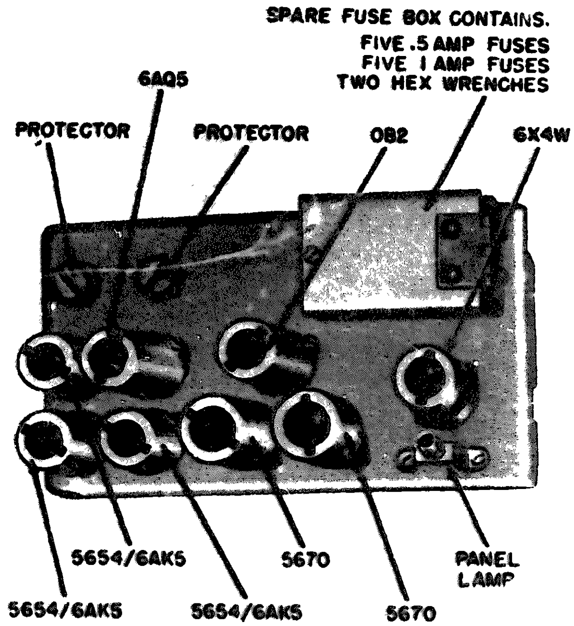


Figure 114.1. Spare parts shelf, AM-682/TCC-3 bearing serial number 1708 and subsequent, and TM-682A/TCC-3.

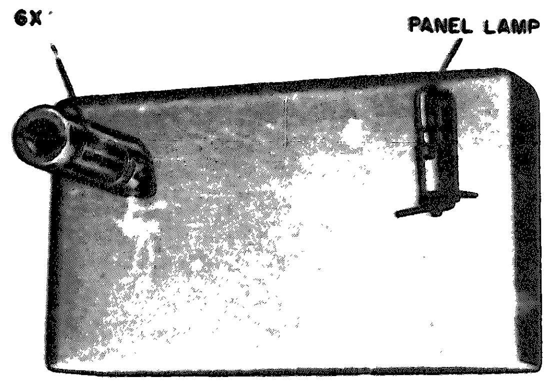


Figure 115. Lower spare parts shelf, AM-682/TCC-3 bearing serial numbers 1 through 1707.

a. Removal of Channel Modem Parts.

(1) To remove the TALK-MON switch, the SEND-MEAS switch or the GAIN control potentiometer of one channel modem, first remove that channel modem plug-in assembly from the combining frame of the TA-219/U (para 238*b*). Then unscrew the three screws which hold the front plate of the channel modem in place. Use a small hex wrench to loosen the knob on the

switch or potentiometer: Remove the knob. Remove the screws holding the switch or potentiometer to the rear of the front plate. Tag each wire connected to the switch or potentiometer and then unsolder the wires.

(2) To gain access to the underside of a 21-pin connector on the modem combining frame, remove all four channel modems (para 238b). Two screws hold each of the 21-pin connectors in place in the frame. Remove the screws from all the connectors and withdraw the connectors from the frame as f r as the attached cables will permit. The underside of any 21-pin connector now is accessible.

b. Removal of AM-682/TCC-3 Parts.

(1) In order to remove either the CHANNEL TALK switch or the ORDER WIRE switch, it is necessary to move the order wire input bracket assembly (fig. 11). To release the bracket asssembly, unscrew the four screws located on the front panel between the GND binding post and the MEASURE switch. Move the bracket assembly away from the front panel. Unscrew the four screws that hold the switch to the front panel. Remove the knob of the switch using the small hex wrench provided with the AN/TCC-3. Tag the leads on the switch and unsolder them. The switch can be removed from behind the front panel.

(2) In order to remove the AMPLIFIER switch, it is necessary to remove the measuring circuit bracket assembly (fig. 11). To remove this bracket assembly, remove the six screws located on the front panel near the MEASURE meter. Move the bracket assembly away from the front panel. Remove the four screws that hold the AMPLIFIER switch to the panel. With the small hex wrench provided with the AN/TCC-3, loosen the knob of the AMPLIFIER switch and remove the knob. Tag and unsolder the leads that are connected to the switch. The switch can then be removed from behind the front panel.

(3) In order to remove the CHANNELS-SPECIAL SERVICE switch, it is necessary to remove the special service bracket assembly (fig. 13). Withdraw the AM-682/TCC-3 from its shock-mounted transit case. Remove the screws that hold the measuring circuit bracket assembly in place in the right side chassis. Disengage the locking device from the CHANNELS-SPECIAL SERVICE switch. Remove the four screws that hold the switch to the bracket assembly. With the small hex wrench, loosen and remove the knob of the switch. Tag and unsolder the leads connected to the switch. Carefully remove the switch from below the bracket assembly.

(4) An equalizer should be removed only after tests indicate that it is defective. In order to remove an equalizer, it is necessary to remove either the special service bracket assembly ((3) above) or the equalizer bracket assembly (fig. 13). After one of these bracket assemblies has been removed, tag and unsolder the leads that are connected to the equalizer. Remove the four nuts which hold the equalizer. Remove the equalizer from the equalizer bracket assembly.

(5) In order to gain access to measuring circuit components not readily accessible, remove the screws holding the meter to the front panel of the AM-682/TCC-3. Carefully move the meter outward through the front panel. Tag and unsolder the wires connected to the meter terminals. If some parts are not accessible after removal of the meter, remove the measuring circuit bracket assembly ((2) above).

294. Circuit Adjustment

a. General. The following circuits of the AN/TCC-3 require adjustment after being repaired: the our channel modems; the carrier supply: the ringer-oscillator; the measuring circuit; the power supply. The four channel modems, the carrier supply, and the ringer-oscillator are plug-in assemblies. Plug-in assemblies may be adjusted either while they are connected to the AN/TCC-3 by using the extension cable (fig. 16, if the extension cable is part of the AN/TCC-3 or use the extension test cable assembly from the MK-155/TCC, para 241) or when disconnected from the AN/TCC-3 by applying the required power and making the necessary external connections. The measuring circuit and the power supply are not plug-in assemblies. These units must be adjusted while connected as part of the AN/TCC-3.

b. Channel Modems. The output voltage of the transmitting path of any of the four channel modems may require adjustment after the channel modem has been repaired. If the output voltage requires adjustment while the channel modem is connected as part of the AN/TCC-3, follow the adjustment procedure described in paragraph 323. If the output voltage is to be adjusted while the channel modem is not connected as part of the AN/TCC-3, follow the adjustment procedure described in paragraph 371.

c. Carrier Supply. The output voltages of the carriers of the carrier supply may require adjustment after the carrier supply has been repaired. If the output voltages are to be adjusted while the carrier supply is connected as part of the AN/TCC-3, follow the adjustment procedure described in paragraph 317. If the output voltages are to be adjusted while the carrier supply is not connected as part of the AN/TCC-3, follow the adjustment procedure described in paragraph 376.

d Riger-Oscillator. If the tuning circuit of the ringer-oscillator has been repaired, or if a part of the ringer-oscillator that affects the tuning circuit has been replaced, it may be necessary to adjust the frequency of the ringer-oscillator. If the frequency is to be adjusted while the ringer-oscillator is connected as part of the AN/TCC-3, follow the adjustment procedure described in paragraph 339. If the frequency is to be adjusted while the ringer-oscillator is not connected as part of the AN/TCC-3, follow the adjustment procedure described in paragraph 385.

e. Measuring Circuit. If the measuring circuit has been repaired, it may be necessary to adjust the sensitivity of the measuring circuit. To adjust the sensitivity of the measuring circuit, follow the adjustment procedure described in paragraph 308.

f. Power Supply. If the power supply has been repaired, it may be necessary to adjust the B+ voltage of the power supply. To adjust the B+ voltage, follow the adjustment procedure described in paragraph 302.

Section V.1. GENERAL SUPPORT TESTING PROCEDURES

294.1. General

Testing procedures are prepared for use by electronics field maintenance shops and electronics service organizations responsible for General Support maintenance of electronics equipment to determine the acceptability of repaired equipment. These procedures set forth specific requirements that repaired equipment must meet before it is returned to the using organization. The testing procedures may also be used as a guide for testing equipment repaired at Direct Support if proper tools and test equipments are available. A summary of the tests and performance standards is given in paragraph 294.10.

a. Testing Modem, Telephone TA-219/U.

(1) *Test Connections and Conditions.*

(*a*) Interconnect, test, and calibrate an AN/TCC-3. After the AN/TCC-3 has been calibrated do not change switch settings or control adjustments.

(*b*) Calibrate the SG-15/PCM and ME-22/PCM.

(*c*) Operate the AC POWER switch on the 200 VOLT POWER SUPPLY to OFF. Substitute the CHAN MODEM to be tested for CHAN MODEM 1 in the AN/TCC-3. Connect the equipment as shown in A, figure 115.1.

(2) *Procedure.*

Step No.	Test equipment control settings	Equipment under test control settings	Test procedures	Performance standards
			Transmitting branch loss, channels 1, 2, 3, and 4, CHAN MODEM 1	
1	*SUBGROUP PANEL* SPECIAL SERVICE: CHAN MODEM *GROUP PANEL* 12-60 KC: REGULAR *60-108* KC (internal) : REGULAR *CARRIER SUPPLY PANEL* CARRIER SYNC: LOCAL *TEST PANEL* MEASURE : TRANSMISSION MEASURE SELECTIVE : OFF MEASURE NONSELECTIVE: OFF *200 VOLT POWER SUPPLY* AC POWER: ON ME-30B/U Power: ON (up). DB VOLTS : -40, DB. *SG-15/PCM* ON-OFF : ON. COARSE DBM: -10. FREQUENCY: rotate until FR-115/u counts 1,000 cps. FINE DBM: rotate until OUTPUT LEVEL meter indicates 0 (-10 dbm). *FR-114/U* POWER-STANDBY-OFF: POWER (Begin adjustments when XTAL OVEN ON lamp cycles on and off.) TIME-SECONDS: 1 AUTO-MANUAL: AUTO DISPLAY TIME: 5 SENSITIVITY: meter needle at left in green area.	*CHAN MODEM 1* (under test) (CHAN 1, CHAN 2, CHAN 3, and CHAN 4) TALE-MON: vertical SEND-MEAS: vertical 2W-4W (internal) : 4W	a. Note ME-30B/U meter indication. 5. Disconnect hookup wires of SG-15/PCM from CHAN 1 (A, fig. 115.1) and reconnect to 2W 4WT binding posts on CHAN 2, CHAN 3, and CHAN 4, in turn, and note ME-30B/U meter indication *for* each channel connection. c. Disconnect hookup wires of SG-15/PCM from binding posts of CHAN 4 and reconnect to 2W 4WT binding posts on CHAN 1 (fig. 115.1).	a. -45.5 dbm ±1. b. Same as a above. c. None.

Step	Test equipment control settings	Equipment under test control settings	Test procedure	Performance standard
	TRIGGER VOLTAGE: clockwise from full counterclockwise until numerical indicators start to count; note control position. Continue clockwise until counting stops; note control position. Set midway between two positions. Reset SENSITIVITY control until INPUT LEVEL meter indicates in center of green area.			
			Transmitting branch overload loss, channels 1, 2, 3, and 4, CHAN MODEM 1	
2	Unchanged except : *ME-30B/U* DB VOLTS: -30 DB *SG-15/PCM* COARSE DBM: +10 FINE DBM: rotate until OUTPUT LEVEL meter indicates +5 (+15 dbm).	Unchanged.	a. Note ME-30B/U meter indication. *b*. Disconnect hookup wires from CHAN 1 (A, fig 115.1) and reconnect to 2W 4WT binding posts on CHAN 2, CHAN 3, and CHAN 4, in turn, and note ME-30B/U meter indication for each channel connection. c. Disconnect hookup wires from binding posts on CHAN 4, and reconnect to 2W 4WT binding posts on CHAN 1 (A, fig. 115.1).	a. -27 dbm ±2. *b*. Same as a above. c. None
			Transmitting branch, order ware circuit, channels 1, 2, 3, and 4, CHAN MODEM 1	
3	Unchanged except : SG-15/PCM FREQUENCY: rotate until FR-114/U counts 1,000 cps. DBM FINE: rotate until OUTPUT LEVEL meter indicates 0 (-10 dbm). *ME-30B/U* DB VOLTS: -40 DB	Unchanged.	a. Connect equipment as shown in B, figure 115.1. *b*. Operate TALK-MON switch on CHAN 1, CHAN 2, CHAN 3, and CHAN 4, in turn, to TALK and record ME-30B/U meter indication as each TALK-MON switch is operated; operate TALK-MON switch to vertical position after each measurement is obtained.	a. None. *b*. -45 dbm ±2.
			Transmitting branch, test frequency circuit, *channels* 1, 2, 3, and 4, *CHAN MODEM 1*	
4	Unchanged.	Unchanged.	a. Disconnect hookup wires of SG-15/PCM from terminals C and *M*, and reconnect to terminals D and N (B, fig. 115.1).	a. None

Step No.	Test equipment control settings	Equipment under test control settings	Test procedures	Performance standards
			b. Operate SEND-MEAS switch on CHAN 1, CHAN 2, CHAN 3, and CHAN 4, in turn, to SEND position and record ME-30B/U meter indication as each switch is operated. Operate SEND-MEAS switch to vertical position after each measurement is obtained.	*b.* -45 dbm ±2.
			c. Disconnect hookup wires of ME-30B/U from terminals A and K (B, fig. 115.1).	c. None.
			Receiving branch, channel 1, *GAIN control adjustment, CHAN MODEM 1*	
5	Unchanged except: SG-15/PCM FREQUENCY: rotate until FR-114/U counts 7,000 cps. COURSE DBM: 0 FINE DBM: rotate until OUTPUT LEVEL meter indicates -4 dbm. *ME-22/PCM* ON-OFF : ON. INPUT IMPEDANCE : 600 OHM. DBM: 0 on SCALE A.	Unchanged except : *CHAN 1* GAIN: fully clockwise 2W-4W : 4W	a. Connect equipment as shown in C, figure 115.1 and adjust equipment controls as given in Test equipment control settings column. *b.* Record ME-22/PCM db meter indication. c. Operate GAIN control on GAIN 1 fully counterclockwise. Operate DBM switch on ME-22/PCM to -10 or -20 on SCALE B to obtain meter indication in center or meter scale. Note ME-22/PCM db meter indication. d. Operate DBM switch on ME-22/PCM to 0 on SCALE B. e. Adjust GAIN control on CHAN 1 until ME-22/PCM db meter indicates 0 on SCALE B.	a None. *b.* Between +3 and +8 dbm. c. At least 20 db less than indication obtained in b above. d. None. e. 0 dbm.
			Receiving branch, channel 2, GAIN control adjustment, CHAN MODEM 1	
6	Unchanged except: *ME-22/PCM* DB VOLTS: 0 on SCALE A. *SG-15/PCM* FREQUENCY: rotate until FR-114/U counts 11,000 cps.	Unchanged except: *CHAN 2* 2W-4W: 4W GAIN: fully clockwise.	a. Disconnect hookup wires of ME-22/PCM from CHAN 1 and reconnect to 4WR binding post-on CHAN 2 (C, fig. 115.1). Ad just equipment controls. *b.* Note ME-22/PCM db meter indication. e. Operate GAIN control on CHAN 2 fully counterclockwise. Operate DBM switch on ME22/PCM to -10 or -20 on SCALE B to	a. None. *b.* Between +3 and +8 dbm. e. At least 20 db less than indication obtained in b above.

			obtain meter indication in center of meter scale and note ME-22/PCM db meter indication.	
			d. Operate DBM switch on ME-22/PCM to 0 on SCALE B.	*d.* None.
			e. Adjust GAIN control on CHAN 2 until ME-22/PCM db meter indicates 0 on SCALE B.	e. 0 dbm.
			Receiving *branch, channel 3, GAIN control adjustment, CHAN MODEM 1*	
7	Unchanged except: *ME-22/PCM* DBM : 0 on SCALE A. *SG-l5/PCM* FREQUENCY: rotate until FR-114/U counts 15,000 cps.	Unchanged except: *CHAN 3* *2W-4W : 4w* GAIN : fully clockwise.	a. Disconnect hookup wires of ME-22/PCM from CHAN 2, and reconnect to 4WR binding posts on CHAN 3 (C, fig. 115.1). Adjust equipment controls.	a. None.
			b. Note ME-22/PCM db meter indication.	*b.* Between +3 and +8 dbm.
			c. Operate GAIN control on CHAN 3 fully counterclockwise. Operate DBM switch on ME-22/PCM to -10 *or* -20 on SCALE B to obtain meter indication in center of meter scale and note ME-22/PCM db meter Indication.	c. At least 20 db less than indication obtained in *b* above.
			d Operate DBM switch on ME-22/PCM to 0 on SCALE B.	*d. None.*
			e. Adjust GAIN control on CHAN 3 until ME-22/PCM db meter indicates 0 on SCALE B.	e. 0 dbm.
			Receiving branch, channel 4, GAIN control adjustment, CHAN MODEM 1	
8	unchanged except : *SG-15/PCM* FREQUENCY: rotate until FR-114/U counts 19,000 cps.	Unchanged except : *CHAN 4* *2W-4W: 4W.* GAIN : fully clockwise.	a Disconnect hookup wires from CHAN 3 and reconnect to 4WR binding posts on CHAN 4 (C, fig. 115.1). Adjust equipment controls.	a. None.
			b. Note ME-22/PCM db meter indication.	*b.* Between +3 and +8 dbm.
			c. Operate GAIN control on CHAN 4 fully counterclockwise. Operate DBM switch on *ME-22/PCM* to -10 or -20 on SCALE B to obtain meter indication in center of meter scale and note ME-22/PCM db meter indication.	c. At least 20 db less than indication obtained in *b* above.
			d. Operate DBM switch on ME-22/PCM to 0 *on* SCALE B.	d. None.

Step No.	Test equipment control settings	Equipment under test control settings	Test procedures	Performance standards
			e. Adjust GAIN control on CHAN 4 until ME-22/PCM db meter indicates 0 on SCALE B.	e. 0 dbm.
			Receiving branch, channel 1, teat frequency circuit, *CHAN MODEM 1*	
9	Unchanged except: SG-15/PCM FREQUENCY: rotate until FR-114/U counts 7,000 cps.	Unchanged.	a. Disconnect hookup wires of ME-22/PCM from CHAN 4, and reconnect to terminals R and F on transmission test cable assembly (C, fig. 115.1).	a. None.
			b. Operate SEND-MEAS switch on CHAN 1 to MEAS, and note ME-22/PCM db meter indication. Release SEND-MEAS switch.	*b. 0* dbm ±0.5.
			Receiving branch, channel 2, teat frequency circuit, CHAN MODEM 1	
10	Unchanged except : SG-15/PCM FREQUENCY: rotate until FR-114/U counts 11,000 cps.	Unchanged.	Operate SEND-MEAS switch on CHAN 2, to MEAS, and note ME-22/PCM db meter indication. Release SEND-MEAS switch.	0 dbm ±0.5.
			Receiving branch, channel 3, test frequency circuit, CHAN MODEM 1	
11	Unchanged except : SG-15/PCM FREQUENCY: rotate until FR-114/U counts 15,000 cps.	Unchanged.	Operate SEND-MEAS switch on CHAN 3 to MEAS, and note ME-22/PCM db meter indication. Release SEND-MEAS switch.	0 dbm ±0.5.
			Receiving branch, channel 4, test frequency circuit, CHAN MODEM 1	
12	Unchanged except : SG-15/PCM FREQUENCY: rotate until FR-114/U counts 19,000 cps.	Unchanged.	Operate SEND-MEAS switch on CHAN 4 to MEAS, and note ME-22/PCM db meter indication. Release SEND-MEAS switch.	0 dbm ±0.5.
			Receiving brunch, channel 1, order wire circuit, CHAN MODEM 1	
13	Unchanged except: SG-15/PCM FREQUENCY: rotate until FR-114/U counts 7,000 cps.	Unchanged.	a. Disconnect hookup wires of ME-22/PCM from terminals F and R, and reconnect to terminals B and L (C, fig. 115.1).	a. None.
			b. Operate TALK-MON switch on CHAN 1 to TALK and note ME-22/PCM db meter indication.	b. 0 dbm ±0.5.

			o. Operate DBM switch on ME-22/PCM to --20 on SCALE B. Operate TALK-MON switch on CHAN 1 to MON and note ME-22/PCM db meter indication. Release TALK-MON switch.	o. *-21* dbm ±1.
			Receiving branch, channel 2, order wire circuit, CHAN MODEM 1	
14	Unchanged except: *SG-15/PCM* FREQUENCY: rotate until FR-114/U counts 11,000 cps. *ME-22/PCM* DBM: 0 on SCALE B.	Unchanged.	a. Operate TALK-MON switch on CHAN 2 to TALK and note ME-22/PCM db meter indication. *b.* Operate DBM switch on ME-22/PCM to -20 on SCALE B. Operate TALK-MON switch on CHAN 2 to MON, and note ME-22/PCM db meter indication. Release TALK-MON switch.	a. 0 dbm ±0.5. *b.* -21 dbm ±1.
			Receiving branch, channel 3, order wire circuit, CHAN MODEM 1	
15	Unchanged except: *SG-15/PCM* FREQUENCY: rotate until FR-114/U counts 15,000 cps. *ME-22/PCM* DBM: 0 on SCALE B.	Unchanged.	a. Operate TALK-MON switch on CHAN 3 to TALK and note ME-22/PCM db meter indication. *b.* Operate DBM switch on ME-22/PCM to -20 on SCALE B. Operate TALK-MON switch on CHAN 3 to MON, and note ME-22/PCM db meter indication. Release TALK-MON switch.	a. 0 dbm ±0.5. *b.* -21 dbm ±1.
			Receiving *branch, channel 4, order wire eireuit, CHAN MODEM 1*	
16	Unchanged except: *SG-15/PCM* FREQUENCY: rotate until FR-114/U counts 19,000 cps. *ME-22/PCM* DBM: 0 on SCALE B.	Unchanged.	a. Operate TALK-MON switch on CHAN 4 to TALK and note ME-22/PCM db meter indication. *b.* Operate DBM switch on ME-22/PCM to -20 on SCALE B. Operate TALK-MON switch on CHAN *4* to MOW and note MB-22/PCM db meter indication. Release TALK-MON switch.	a. 0 dbm ±0.5. *b.* -21 dbm ±1.
			Hybrid balance. channel 1, CHAN MODEM 1	
17	Unchanged except: *SG-15/PCM* FREQUENCY: 1kc	Unchanged except: 2W-4W (on CHAN 1, CHAN 2, CHAN 3, and CHAN 4) : *2W.*	a. Connect equipment as shown in D, figure 115.1. *b.* Operate SEND-MEAS switch on	a. None. *b.* None.

Step No.	Test equipment control settings	Equipment under test control settings	Test procedures	Performance stadards
	FINE DBM : rotate until OUTPUT LEVEL meter indicates -4 dbm. *ME-22/PCM* DBM : -30 on SCALE B.		CHAN 1 to SEND, and TALK-MON switch on CHAN 1 to TALK.	
			c. Note ME-22/PCM db meter indication.	*c.* -40 dbm *or* less.
			d. Operate switches (b above) to vertical position.	*d.* None.
			Hybrid balance, channel 2, CHAN MODEM 1	
18	Unchanged.	Unchanged.	*a.* Disconnect 600-ohm resistor and 1-uf capacitors from CHAN 1 and reconnect to 2W-4WT binding posts on CHAN 2 (D, fig. 115.1).	a. None.
			b. Operate SEND-MEAS switch on CHAN 2 to SEND, and TALK-MON switch on CHAN 2 to TALK.	*b.* None.
			c. Note ME-22/PCM db meter indication.	c. *-40* db or less.
			d. Operate switches *(b* above) vertical position.	d. None.
			Hybrid balance, channel 3, CHAN MODEM 1	
19	Unchanged.	Unchanged.	a. Disconnect 600-ohm resistor and 1uf capacitors from CHAN 2 and reconnect to 2W-4WT binding posts on CHAN 3 (D, fig. 116.1).	a. None.
			b. Operate SEND-MEAS switch on CHAN 3 to SEND, and TALK-MON switch on CHAN 3 to TALK.	b. None.
			c. Note ME-22/PCM db meter indication.	*c.* −40 dbm or less.
			d. Operate switches (b above) to vertical position.	
			Hybrid balance, channel 4, CHAN MODEM 1	
20	Unchanged.	Unchanged.	*a.* Disconnect 600-ohm resistor and 1μf capacitors from CHAN 3 and reconnect to 2W–4WT binding posts on CHAN 4 (D, fig. 115.1).	*a.* None.

b. Operate SEND-YEAS switch to CHAN 4 to SEND, and TALK-MON switch to CHAN 4 to TALK.	*b.* None.
c. Note ME-22/PCM db meter indication.	c. *-40* dbm or less.
d. Remove test equipment connections (D, fig. 115.1). Remove CHAN MODEM 1 (being tested) from AN/TCC-7 and substitute original CHAN MODEM 1 in AN/TCC-3. Reconnect AN/TCC-3 cables to CHAN MODEM 1.	*d.* None.

b. chart of Tests and Performance Standards, CHAN MODEM

NOTE

The Item numbers correspond with **the *step* numbers of the test procedures in paragraph 294.1a.**

Item	Test	Performancc standard	Test indication
1	TRANSMITTING BRANCH LOSS, CHANNELS 1, 2, 3, AND 4, CHAIN MODEM 1:		
	Channel 1	-45.5 dbm +1.	
	Channel 2	Same.	
	Channel 3	Same.	
	Channel 4	Same.	
2	TRANSMITTING BRANCH OVERLOAD LOSS, CHANNELS 1, 2, 3, AND 4, CHAN MODEM 1:		
	Channel 1	-27 dbm ±2.	
	Channel 2	Same.	
	Channel 3	Same.	
	Channel 4	Same.	
3	TRANSMITTING BRANCH, ORDER WIRE CIRCUIT, CHANNELS 1, 2, 3, AND 4, CHAN MODEM 1:		
	Channel 1	-45 dbm ±2.	
	Channel 2	Same.	
	Channel 3	Same.	
	Channel 4	Same.	
4	TRANSMITTING BRANCH, TEST FREQUENCY CIRCUIT, CHANNELS 1, 2, 3, AND 4, CHAN MODEM 1:		
	Channel 1	-45 dbm ±2.	
	Channel 2	Same.	
	Channel 3	Same.	
	Channel 4	Same.	
5	RECEIVING BRANCH, CHANNEL 1. GAIN CONTROL ADJUSTMENT, CHAN MODEM 1:		
	GAIN control clockwise	a Between +3 and +8 dbm.	
	GAIN control counterclockwise	*b.* 20 db less than indication obtained in a above.	
	GAIN control adjusted	c. 0 dbm.	
6	RECEIVING BRANCH, CHANNEL 2, GAIN CONTROL ADJUSTMENT, CHAN MODEM 1:		
	GAIN control clockwise	a Between +3 and +8 dbm.	
	GAIN control counterclockwise	*b. At* least 20 db less than indication obtained in a above.	
	GAIN control adjusted	c. 0 dbm.	
7	RECEIVING BRANCH, CHANNEL 3. GAIN CONTROL ADJUSTMENT, CHAN MODEM 1:		
	GAIN control clockwise	*a. Between +3* and +8 dbm.	
	GAIN control counterclockwise	*b.* At least 20 db less than indication obtained in *a* above.	
	GAIN control adjusted	*c.* 0 dbm.	
8	RECEIVING BRANCH, CHANNEL 4, GAIN CONTROL ADJUSTMENT, CHAN MODEM 1:		
	GAIN control clockwise	*a.* Between +3 and +8 dbm.	

Item	Test	Performance standard	Test indication
	GAIN control counterclockwise	b. At least 20 db less than indication obtained in a above.	
	GAIN control adjusted _ _	c. 0 dbm.	
9	RECEIVING BRANCH, CHANNEL 1, TEST FREQUENCY CIRCUIT, CHAN MODEM 1.	0 dbm ±0.5.	
10	RECEIVING BRANCH, CHANNEL 2, TEST FREQUENCY CIRCUIT, CHAN MODEM 1.	0 dbm ±0.5.	
11	RECEIVING BRANCH, CHANNEL 3, TEST FREQUENCY CIRCUIT, CHAN MODEM 1.	0 dbm ±0.5.	
12	RECEIVING BRANCH, CHANNEL 4, TEST FREQUENCY CIRCUIT, CHAN MODEM 1.	0 dbm ±0.5.	
13	RECEIVING BRANCH, CHANNEL 1, ORDER WIRE CIRCUIT, CHAN MODEM 1:		
	TALK switch operated ____________________	0 dbm ±0.5.	
	MON switch operated ___________ _______	-21 dbm ±1.	
14	RECEIVING BRANCH, CHANNEL 2, ORDER WIRE CIRCUIT, CHAN MODEM 1:		
	TALK switch operated __________________	0 dbm ±0.5.	
	MON switch operated __________	-21 dbm ±1.	
15	RECEIVING BRANCH, CHANNEL 3, ORDER WIRE CIRCUIT, CHAN MODEM 1:		
	TALK switch operated _	0 dbm ±0.5.	
	MON switch operated _ _ _ _	-21 dbm ±1.	
16	RECEIVING BRANCH, CHANNEL 4, ORDER WIRE CIRCUIT, CHAN MODEM 1:		
	TALK switch operated	0 dbm ±0.5.	
	MON switch operated _____________	-21 dbm ±1.	
17	HYBRID BALANCE, CHANNEL 1, CHAN MODEM 1 ________________	-40 dbm or less.	
18	HYBRID BALANCE, CHANNEL 2, CHAN MODEM 1 _	-40 dbm or less.	
19	HYBRID BALANCE, CHANNEL 3, CHAN MODEM 1	-40 dbm or less.	
20	HYBRID BALANCE, CHANNEL 4, CHAN MODEM 1 _ _ _	-40 dbm or less.	

c. Test Procedures for AM-682/TCC-3.

(1) Perform in turn, the test procedures given in paragraphs 294.5 through 294.9.

(2) Prepare a chart to summarize the tests, performance standards, and teat indications (para 294.10).

(3) For the test procedures given in each paragraph.proceed as follows:

(a) Obtain the test equipment and material required (para 294.2).

(b) Comply with the requirements for the test connections and conditions.

(c) Follow in sequence the step-by-step instructions for each test procedure; do not vary the sequence.

(d) For each step in the test procedure, perform all the actions required in the Test equipment control settings and Equipment under test control settings columns; then perform each of the actions required in the Test procedures column and verify the results obtained; use the corresponding data in the Performance standards column as a standard. Record the test results in the Test indication column of the applicable test and performance standards chart (para 294.10).

294.2. Test Equipment and Material Repair

All test equipment and material required to perform the testing procedures are listed in the following chart.

NOTE

Specific models and type of test equipment were used to establish the testing procedures. If the testing procedures are performed with other models or types of test equipment, make allowances for test

connections and equipment control settings that may differ from those specified in the testing procedures.

Item	Publication
Signal Generator SG-15(*)/PCM.	TM 11-6625-251-15
Decibel Meter ME-22(*)/PCM [b]	TM 11-6625-251-15
Voltmeter, Electronic ME-30(*)/	TM 11-6625-320-12
Multimeter TS-352(*)/U[d]	TM 11-6625-366-15
Variable Power Transformer CN-16(*)/U.	TM 11-5950-205-15P
Telephone Carrier System Test Facilities Kit MK-155/TCC: one each of the following items are required:	TB SIG 328
Junction panel test cable assembly.	
Carrier supply test cable assembly.	
Subgroup test cable assembly.	
Resistor, 60.4 ohms.	
Resistor, 600 ohms.	
Capacitor, 2uf.	

Signal Generator SG-15(*)/PCM indicates Signal Generator SG-15/PCM or SG-15A/PCM.

[b] Decibel Meter ME-22(*)/PCM indicates Decibel Meter ME-22/PCM or ME22A/PCM.

[c] Voltmeter, Electronic ME-30 (*)/U indicates Voltmeter, Electronic ME-SOB/U, ME-30C/U, or Voltmeter, Meter ME-30A/U.

[d] Multimeter TS-352(*)/U indicates Multimeter TS-352/U, TS-352A/U, or TS-352B/U.

[e] Variable Power Transformer indicates Variable Power Transformer CN-16A/U or CN-16B/U.

294.3. Calibration of SG-15/PCM and ME-22/PCM

Calibrate the SG-15/PCM (a below) and the ME-22/PCM (b below) when required during the testing procedures. After the calibration procedures are complete, do not remove the ac power cords from the ac power source until the testing procedures are completed.

a. SG-15/PCM.

(1) Connect the ac power cable to the ac power source and operate the ON-OFF switch to ON; allow a 15-minute warmup period before proceeding.

(2) Set the FREQUENCY control to 200 cps as indicated on the KILOCYCLES dial.

(3) Set the COARSE DBM control to its 0 position.

(4) Set the FIN DBM control for an indication of approximately +6 on the OUTPUT LEVEL meter.

(5) Adjust the FREQUENCY control for a 0 indication on the KILOCYCLES dial.

(6) Adjust the ZERO BEAT ADJ. control for a zero beat, indicated by no deflection of the needle on the OUTPUT LEVEL meter.

NOTE

As the FREQUENCY control is varied above and below 0 indication on the KILOCYCLES dial, note that the zero beat region is about 1/8 inch wide. Set the ZERO BEAT ADJ. control so that zero frequency is in the center of this region.

b. ME-22/PCM.

(1) Connect the ac power cable to the ac power source and operate the ON-OFF switch to ON; allow a 15-minute warmup period before proceeding.

(2) Connect the SG-15/PCM (calibrated as given in a above) to the ME-22/PCM as shown in figure 115.2.

(3) Operate the INPUT IMPEDANCE switch of the ME-22/PCM to 600 OHM, and the DBM switch to 0 on SCALE B.

(4) Adjust the FREQUENCY control of the SG-15/PCM to 1,000 cps on the KILOCYCLES dial, and operate the COARSE DBM to 0. Adjust the FINE DBM control until the OUTPUT LEVEL meter indicates 0 db.

(5) Adjust the CAL ADJ. control of the ME-22/PCM until the DECIBELS meter indicates 0 on SCALE B.

(6) Operate the DBM switch of the ME-22/PCM to 0 on SCALE A. The DECIBELS meter should indicate 0 dbm ±0.5 on SCALE A. If this indication is not obtained, repeat the procedures given in (4) and (5) above.

(7) Disconnect the test leads from the OUTPUT terminals of the SG-15/PCM and the INPUT terminals of the ME-22/PCM.

294.4. Modification Work Orders

The performance standards for the AM-682/TCC-3 assume that all modification work orders (MWO's) have been performed. A listing of current MWO's will be found in DA Pam 310-7.

294.5. Physical Tests and Inspection

a. Test Equipment. None required.

b. Conditions. Remove the chassis assembly of the AM-682/TCC-3 from its transit case.

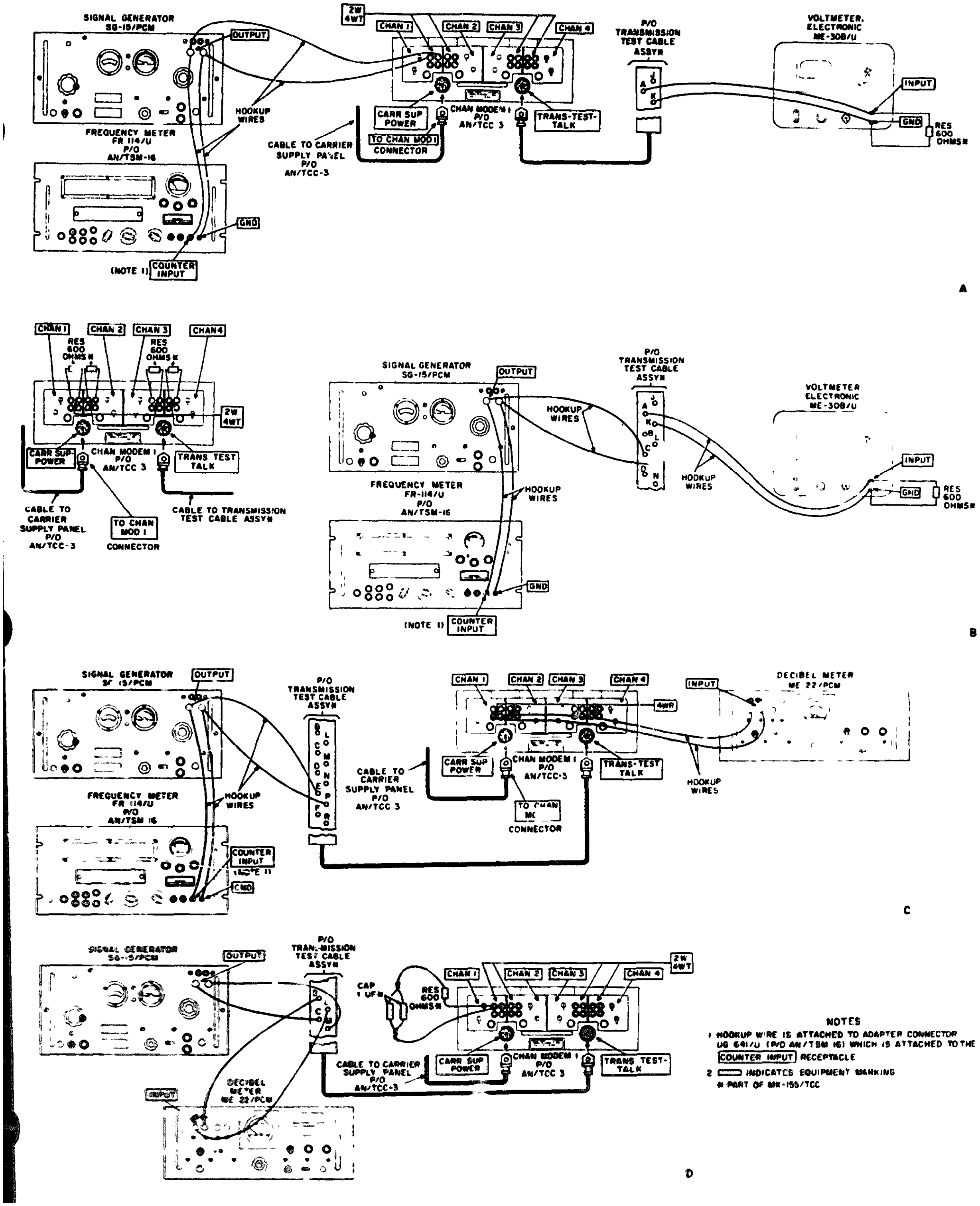


Figure 115.1. Test Setups, tests of CHAN MODEM.

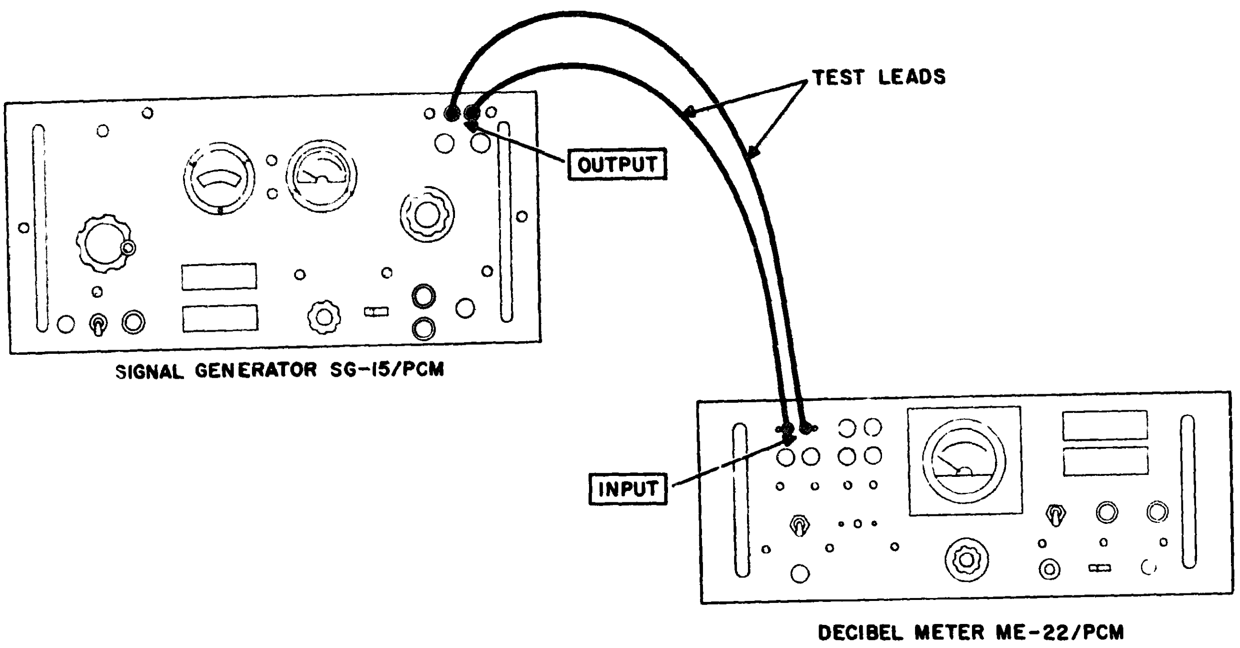


Figure 115.2. Calibration test setup for ME-22/PCM.

c. Procedure.

Test equipment control settings	Equipment under test control settings	Test and inspection procedures	Perfomance standards
N/A - - - - - -	*Controls* may be in any position	a. Inspect front panel. Look for damaged, loose, or missing screws, knobs, or other parts.	a. No evidence of damaged, loose, or missing screws, knobs, or parts is found.
		b. Inspect front panel and chassir (top, aides, and bottom). Look *for* dirt, signs of excessive wear or damage, loose or missing components and hardware.	*b.* Front panel and chassis are clean. No evidence of excessive wear, damage, or loose or damaged components or hardware is found.
		c. Inspect condition of finish. Look for rust, corrosion, and spots where bare metal is exposed.	e. Painted surfaces do not show bare metal spots and no evidence of rust or corrosion is seen. NOTE Touchup painting instead of refinishing is recommended whenever practicable. Do not polish with abrasives or paint screwheads, binding posts, and plated fasteners.
		d. Operate each switch and control on front panel and internal subassemblies.	*d.* Switches and controls operate smoothly with positive action to indicate position.
		e. Inspect condition of all jacks and binding posts. Look for cracks and broken parts, and note condition of jack spring contacts.	*e.* No evidence of cracks or broken parts on jacks and binding posts. Jack contact springs are straight and show positive action in opening and closing.

Test equipment control settings	*Equipment under test control settings*	Test and inspection procedures	*Performance standards*
		f. Inspect condition of **all cables, cable connctor, and cable connector receptacles. Look for broken cable insulation, cracked connector and receptacle insulation, and missing or bent** connector pins.	**f. No evidence of broken cable insulation, cracked connector and receptacle insulation, or missing or bent connector pins.**
		g. Inspect fuseholders, look for burns, breaks, and insufficient spring tendon. Check rating of each **fuse.**	**g. Fuseholders show no sign of burning** or **being broken, and spring tension is strong. Refer to panel marking on equipment for proper fuse ratings.**
		A. Inspect chassis. Check to be sure tubes, tube shields, and clamps are in proper places.	**h. Tubes, tube shields, and clamps are in proper place.**
		i. Check equipment for applicable MWO.	**i. Equipment marked to indicate MWO, if applicable.**

294.6. Testing Power Circuits

a. Test Equipment and Material.

(1) Multimeter T-352/U.

(2) Variable Power Transformer CN-16A/u.

(3) Telephone Carrier System Test Facilities Kit MK-155/TCC; the following items are required:

(a) Junction panel test cable assembly.

(b) **Carrier supply test cable assembly.**

(c) Subgroup test cable assembly.

b. Test Connections and Conditions.

(1) Operate the ON-OFF switch of the CN-16A/U to OFF.

(2) Operate the AM-682/TCC-3 POWER switch to OFF and the 230V-115V switch to 115v.

(3) Connect the equipment as shown in A, figure 115.3.

(4) Connect the ac power cord of the CN-16A/U to the ac power source.

c. Procedure.

NOTE

1. A summary chart of the tests and performance standards is given in paragraph 294.10a.
2. The parenthetical letters (example. (A), (B)) refer to the indicated portion of figure 115.3.

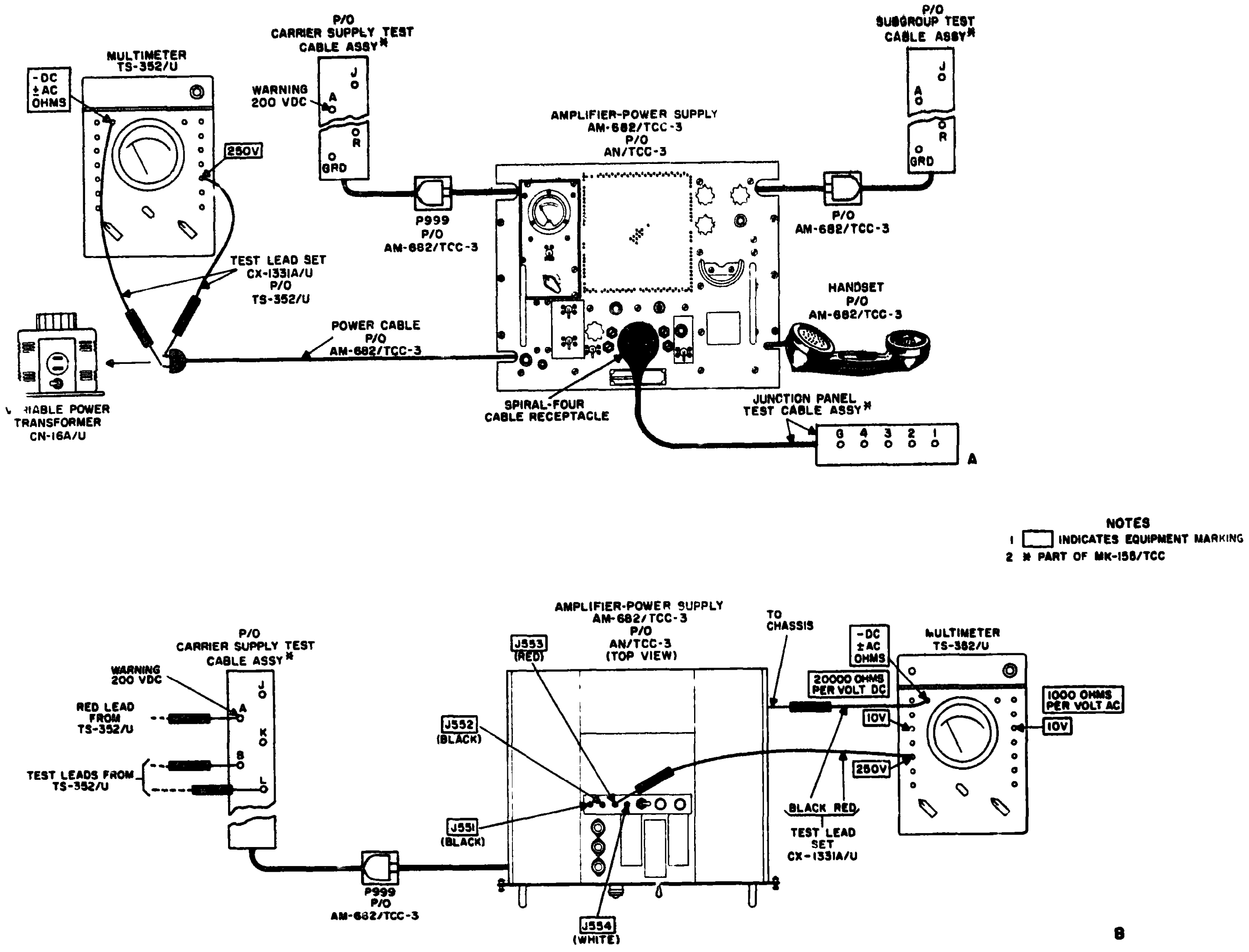


Figure 115.3. Power Circuits test setup.

Step No.	Test equipment control settings	Equipment under test control settings	Test procedures	Performance standards
			Initial indications	
1	*TS-352/U* FUNCTION: AC VOLTS *CN-16A/U* ON-OFF: ON Control: fully counterclockwise	*AM-682/TCC-3* POWER: ON SEND OW: vertical SPECIAL SERVICE-CHANNELS (internal, right side): CHANNELS AMP OUT (in receiving amplifier subassembly on right side): ODB AMP OUT (in transmitting amplifier subassembly on right side): ODB ALARM CUTOFF, CHANNEL TALK, and SEND OW switches: vertical EQUALIZER controls: fully counterclockwise	*a.* Note AM-682/TCC-3 alarm indications.	*a.* POWER, CALL, and SYSTEM ALARM indicators should light and buzzer should sound for approximately 15 to 30 seconds.
			b. Operate AM-682/TCC-3 ALARM cutoff switch to right and note indications.	*b.* POWER and SYSTEM ALARM indicators should remain lighted, buzzer should be silenced, and and CALL indicator should be extinguished.
			c. Partly remove ac power cable plug from CN-16A/U receptacle (A) and connect TS-352/U test leads to plug prongs. Adjust CN-16A/U control until TS-352/U voltmeter indicates 115 volts ac. Remove TS-352/U test leads from plug prongs, and reinsert plug into CN-96A/U receptacle.	*c.* None.
			d. Repeat procedures given in *c* above except adjust CN-16A/U control until TS-253/U voltmeter indicates 103 volts ac and note AM-682/TCC-3 alarm indications.	*d.* Same indications as obtained in *b* above.
			e. Repeat procedures given in *c* above.	*e.* None.
			DC voltage circuits	
2	*TS-352/U* FUNCTION: 20000μ/VDC DIRECT *CN-16A/U* ON-OFF: ON Control: fully counterclockwise	Same as Step No. 1.	*a.* Connect TS-352/U as shown in B, figure 115.2 and note dc voltmeter indication.	*a.* 215 volts dc ±15 (200 volts dc ±15 when TA-219/U is connected to AM-682/TCC-3.
			b. Remove TS-352/U red test lead from AM-682/TCC-3 pin jack J553 and reconnect to terminal A of carrier supply test cable assembly. Note TS-352/U voltmeter indication.	*b.* Same indication as obtained in *a* above.
			c. Remote TS-352/U red test lead from terminal A of carrier supply test cable assembly and from TS-352/U 250V pin jack.	*c.* None.
			d. Operate TS-352/U FUNCTION switch to 20000μ/VDC REV. Connect TS-352/U red test lead to TS-352-U 10V pin jack (20000 OHMS PER VOLT DC) and to AM-682/TCC-3 pin jack J554 (B). Note dc voltmeter indication.	*d.* 10 volts dc ±0.8

Step No.	Test equipment control settings	Equipment under test control settings	Test procedures	Performance standards
			e. Operate AM-682/TCC-3 order wire handset push-to-talk switch several times and note TS-352-U voltmeter indication. Note lowest voltage indication obtained and release push-to-talk switch.	*e.* 5 volts dc ±2.
			Filament voltage circuits	
3	Same as Step No. 1. *TS-352/U* FUNCTION: AC VOLTS	Same as Step No. 1.	*a.* Remove red test lead probe of TS-352/U from AM-682/TCC-3 pin jack J554 (B) and from TS-352/U 10V jack (20000 OHMS PER VOLT DC). Insert red test lead into TS-352/U 10V jack (1000 OHMS PER VOLT AC). Connect test lead probes to AM-682/TCC-3 pin jacks J551 and J552.	*a.* None.
			b. Note TS-352/U ac voltmeter indication.	*b.* 6.3 volts ac ±0.5.
			c. Operate AM-683/TCC-3 230V-115V switch (internal) to 230V and note TS-352/U ac voltmeter indication.	*c.* 3.2 volts ac ±0.2.
			d. Operate AM-682/TCC-3 230V-115V switch to 115V.	*d.* None.
			e. Remove TS-352/U test leads from AM-682/TCC-3 pin jacks (B) and reconnect to terminals B and L of carrier supply test cable assembly.	*e.* None.
			f. Note TS-352/U ac voltmeter indication.	*f.* Same idication as obtained in *b* above.
			g. Remove TS-352/U test leads from terminals B and L (*e* above).	*g.* None.
			h. Proceed to test procedures given in paragraph 294.7.	*h.* None.

294.7 Test Oseillator end Carrier Supply Circuits, test Procedures

Perform the test procedures given in paragraph 294.6 before performing the procedures given in *b* and c below.

a. Teat Equipment and Material **Use the same test equipment and material listed in paragraph 294.6a except delete the TS-352/U. The following items are also required:**

(1) Signal Generator SG-15/PCM.

(2) Decibel Meter ME-22/PCM.

(3) Voltmeter, Electronic ME-30B/U.

(4) Resistor, 60.4 ohms (part of the MK-155/TCC).

b. Test Connections and Conditions.

(1) The test connections of the AM-682/TCC-3 shown in A, figure 115.3 (less the TS-352/U) are unchanged.

(2) Calibrate the SG-15/PCM and ME-22/PCM (para 294.3).

(3) Connect the test equipment as shown in solid lines in A, figure 115.4.

(4) Connect the power cord of the ME-30B/U to the ac power source.

c. Procedure.

NOTE

1. A summary chart of the **tests and performance standards is given in paragraph 294.10b.**

2. The parenthetical letters *(example:* (A), (B)) refer to the indicated portion of figure 115.4.

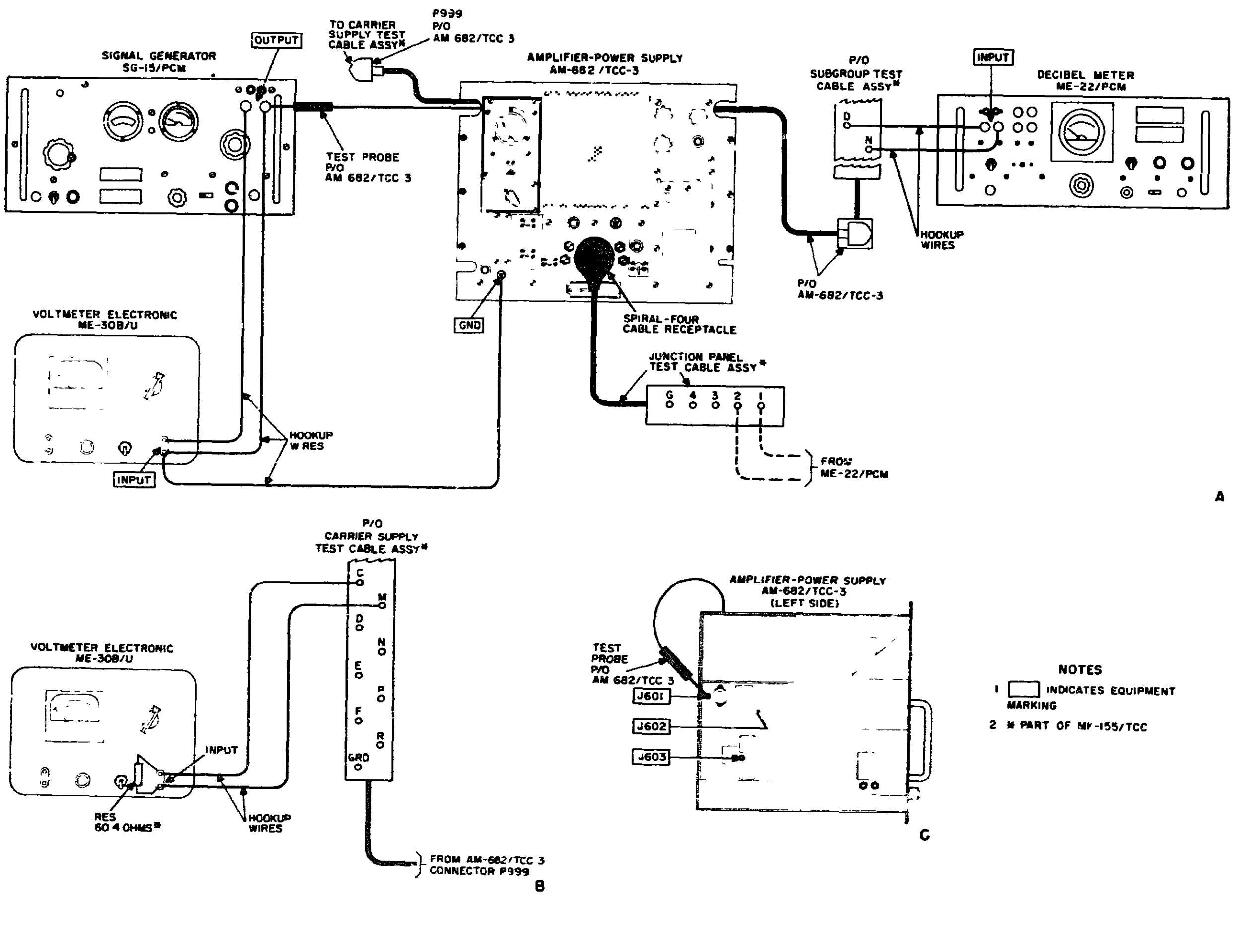


Figure 115.4. **Test oscillator and *carrier supply circuits* test setups.**

Step No.	Test equipment control settings	Equipment under test control settings	Test procedures	Performance standards
			Meter circuit	
1	*CN-16A/U* ON-OFF: ON CONTROL: fully counterclockwise SG-15/PCM ON-OFF: ON FREQUENCY: 1,000 cps COARSE DBM: 0 FINE DBM: fully counterclockwise *ME-30B/U* ON-OFF: ON DB VOLTS: 0 DB	*AM-682/TCC-3* Unchanged from last settings given in paragraph 294c, except : MEASURE: OFF POWER: ON SEND OW: Vertical SPECIAL SERVICE-CHANNELS: CHANNELS AMP OUT (Rec Amp): 0DB AMP OUT (Xmit Amp) : 0DB ALARM CUTOFF, CHANNEL TALK, and SEND OW switches; Vertical EQUALIZER controls: fully counterclockwise	a. Adjust SG-15/PCM FINE DBM control until AM-383/TCC-3 MEASURE meter indicates 0 db. Note ME-SOB/U meter indication. b. Disconnect SG-15/PCM and ME-30B/U from AM-682/TCC-3 (A).	a -5 dbm ±0.5. b. None.
			Test oscillator circuit	
2	Same as Step 1 except: *ME-22/PCM* *ON-OFF: ON* INPUT IMPEDANCE: 600 OHM DBM: 0 SCALE A	Same as Step 1 except: TEST OSC OUTPUT; fully clockwise MEASURE: TEST OSC	a. Note ME-22/PCM DECIBELS meter indication. b. Operate ME-22/PCM DEM switch to 0 scale B. c. Rotate AM-682/TCC-3 TEST OSC OUTPUT control fully counterclockwise and note ME-22/PCM DECIBELS meter indication. d. Adjust AM-682/TCC-3 TEST OSC OUTPUT control until MEASURE meter indicates 0 db and note indication. e. Operate ME-22/PCM DBM switch to 0 SCALE A and note DECIBELS meter indication.	a. Not more negative than +4 dbm. *b.* None. c. Note more positive than -4 dbm. d. 0 db. e. +3.5 dbm ±1.
			4-kc supply output	
3	Same as Step 2, except: *ME-22/PCM* DBM: -20	same as step 2.	a Disconnect ME-22/PCM hookup wires from terminals D and N (A) and reconnect to terminals 1 and 2 of junction panel test cable assembly. b. Note ME22/PCM DECIBELS meter indication. c. Disconnect ME-22/PCM hookup *wires from* junction panel test cable assembly terminals (a above).	a. None. *b.* -25 dbm ±1.5. c. None.

			Carrier supply output	
4	**Same as Step 3, except:** ***ME-30B/U*** **ON-OFF: ON** **DB VOLTS: 1 VOLT**	**Same as Step 3, except:** **MEASURE: OFF**	***a.*** **Connect equipment as shown in B, figure 115.3.**	***a.*** **None.**
			b. **Note ME-30B/U voltmeter indication.**	***b.*** **0.89 volt ac ±0.15.**
			c. **Disconnect ME-30B/U hookup wires from terminals C and M (B) and reconnect to terminals D and N, E and P, and F and R, in turn. Note ME-30B/U voltmeter indication for each connection.**	***c.*** **Indications are:** **(1) At terminals D and N: 0.08 volt ±0.04 less than indication obtained in *b* above.** **(2) At terminals E and P: 0.08 volt ±0.04 less than indication obtained in *b* above.** **(3) At terminals F and R: Same as indication obtained in *b* above ±0.04.**
			d. **Disconnect ME-30B/U hookup wires from terminals F and R (B).**	***d.*** **None.**
			e. **Insert AM-682/TCC-3 test probe (C) into pin jacks J601 and J602, in turn, and note AM-682/TCC-3 MEASURE meter indications.**	***e.*** **At each jack connection, MEASURE meter indicates 0 db ±3.**
			f. **Insert AM-682/TCC-3 test probe into pin jack J603 (D) and note MEASURE meter indication.**	***f.*** **+1.5 db ±3.**
			g. **Remove AM-682/TCC-3 test probe from pin jack J603 (C).**	***g.*** **None.**
			h. **Proceed to test procedures given in paragraph 294.8.**	***h.*** **None.**

294.8. Testing Transmitting and Receiving Circuits

Perform the procedures given in paragraphs 294.6 and 294.7 before performing the procedures in b and c below.

a. *Test* ***Equipment and Material. Use the same*** **test equipment and material given in paragraph 294.7a except that the 60.4-ohm resistor (part of the MK-155/TCC) is not required.**

b. Test Connections and ***Conditions.***

(1) The test connections of the AM-682 TCC-3 shown in A, figure 115.3 (less the TS-352/U) are unchanged.

(2) Recalibrate the SG-15/PCM (para 294. 3a).

(3) Connect the equipment as shown in A and B, figure 115.5.

c. Procedure.

NOTE

1. A summary chart of the tests and performance standards is given in paragraph 294.10c.

2. The parenthetical letters *(example:* (A), (B)) refer to the indicated portion of figure 115.5.

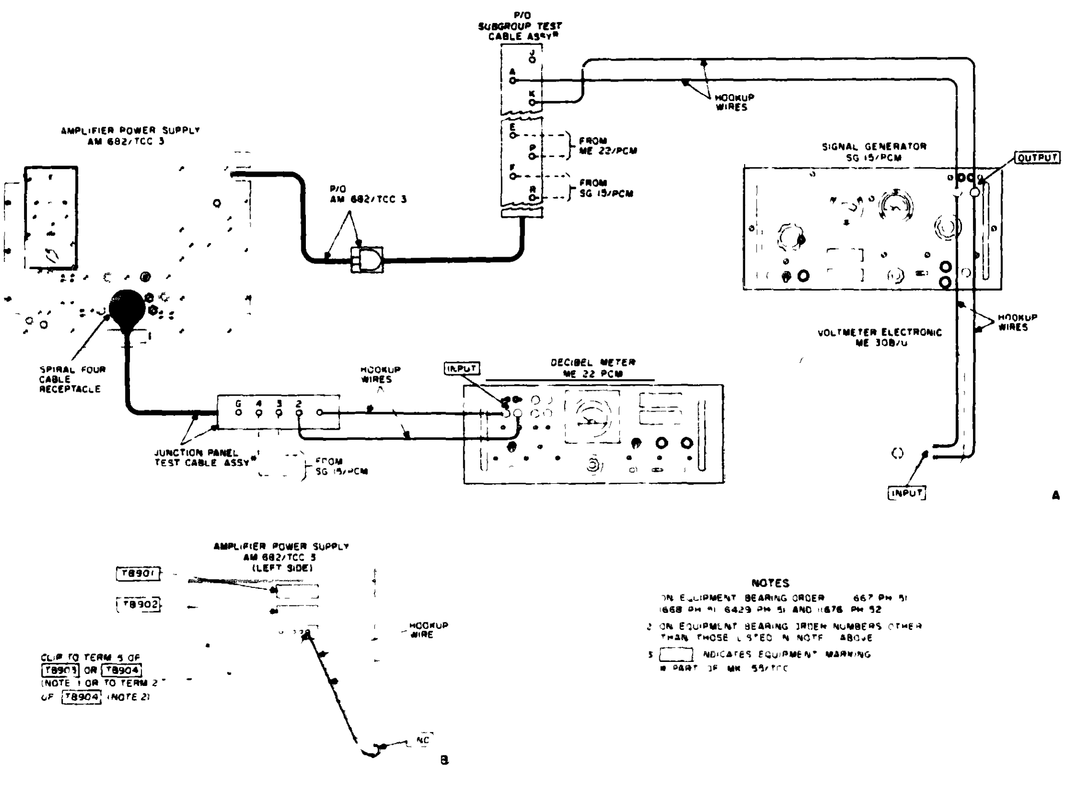


Figure 115.5. Transmitting and receiving circuits test setups.

Step No.	Test equipment control settings	Equipment under test control settings	Test procedures	Performance standards
			1 kc signal transmission	
		AM-682/TCC-3		
1	unchanged from setting last used in procedure given in paragraph 294.7c except: *SG-15/PCM* FREQUENCY: 1 kc COARSE DBM: -40 FINE DBM: fully counterclockwise *ME-22/PCM* INPUT IMPEDANCE: 600 OHM DBM: 0 SCALE B *ME-30B/U* DB VOLTS: --30 DB	*Switches* and controls: unchanged from last settings used in paragraph 294.7c except: MEASURE: 1KC-OW	a. Adjust SG-15/PCM FINE DBM control until ME-30B/U db meter indicates -5 (-35 dbm). b. Note ME-22/PCM DECIBELS meter indication. c. Operate AM-682/TCC-3 AMPLIFIER switch to TR and note MEASURE meter indication. Release AMPLIFIER switch. d. Operate AM-682/TCC-3 AMP OUT switch on transmitting amplifier subassembly (located on center of right chassis) to 10 DB. e. Operate ME-22/PCM DBM switch to 0 SCALE A and note DECIBELS meter indication. f. Operate AM-682/TCC-3 AMPLIFIER switch to TR and note MEASURE meter in ion. Release AMPLIFIER switch. g. Operate AMP OUT switch (d above) to ODB.	a. None. b. -1 dbm ±1. c. -1 db ±1.5. *d.* None. e. +9 dbm ±1.5. *f.* 1 db less than indication obtained in c above ±0.5. g. None.
			Channel 1 signal transmission	
2	Same as Step 1, except: *SG-15/PCM* FREQUENCY: 7 kc FINE DBM : fully counterclockwise *ME-22/PCM* DBM: 0 SCALE B	*Same* as Step 1, except: MEASURE: 7 KC-CH1	a. Adjust SG-15/PCM FINE DBM control until ME-SOB/U db meter indicates -6 (-35 dbm). b. Note ME-22/PCM DECIBELS meter indication. c. Operate AM-682/TCC-3 AMPLIFIER switch to TR and note MEASURE meter indication. Release AMPLIFIER switch. d. Operate AM-682/TCC-3 AMP OUT switch on transmitting amplifier subassembly to 10 DB. e. Operate ME-22/PCM DBM switch to 0 SCALE A and note DECIBELS meter indication. f. Operate AM-682/TCC-3 AMPLIFIER switch to TR and note MEASURE meter indication Release AMPLIFIER switch. g. Operate AMP OUT switch *(d* above) to ODB.	a. None. *b.* -1 dbm ±1.5. c. 0 db ±1. *d.* None. e. +9 dbm ±1.5. *f.* Same as indication obtained in c above ±0.5. g. None.

Step No.	Test equipment control settings	Equipment under test control settings	Test procedure	Performance standards
			Channel 2 signal transmission	
3	Same as Step 2, except: SG-15/PCM FREQUENCY: 11 kc FINE DBM : fully counterclockwise. *ME-22/PCM* DBM: 0 SCALE B	Same as Step 2, except: MEASURE: 11KC-CH2	a. Adjust SG-15/PCM FINE DBM control until ME-SOB/U db meter indicates -6 (-35 dbm).	a None.
			b. Note ME-22/PCM DECIBELS meter indication.	b. -1 dbm ±1.5.
			c. Operate AM-682/TCC-3 AMPLIFIER switch to TR and note MEASURE meter indication. Release AMPLIFIER switch.	e. 0 db ±1.5.
			d. Operate AM-682/TCC-3 AMP OUT switch on transmitting amplifier subassembly to 10DB.	d. None.
			e. Operate ME-22/PCM DBM switch to 0 SCALE A and note DECIBELS meter indication.	e. +9 dbm ±1.
			f. Operate AM682/TCC-3 AMPLIFIER switch to TR and note MEASURE meter indication. Release AMPLIFIER switch.	*f.* Same as indication obtained in c above ±0.5.
			g. Operate AM-682/TCC-3 AMP OUT switch *(d above) to* ODB.	g. None.
			Channel 3 signal transmission	
4	Same as Step 3, except: SG-15/PCM FREQUENCY: 15 kc FINE DBM: fully counterclockwise *ME-22/PCM* DBM: 0 SCALE B	Same as Step 3, except: MEASURE : 15KC-CH3	a Adjust SG-15/PCM FINE DBM control until ME-SOB/U db meter indicates -5 (-35 dbm).	a. None.
			b. Note ME-22/PCM DECIBELS meter indication.	b. -1.5 dbm ±1.
			c. Operate AM-682/TCC-3 AMPLIFIER switch to TR and note MEASURE meter indication. Release AMPLIFIER switch.	*c. +0.5* db ±1.5.
			d. Operate AM-682/TCC-3 AMP OUT switch on transmitting amplifier to 10DB.	d. None.
			e. Operate ME-22/PCM DBM switch to 0 SCALE A and note DECIBELS meter indication.	*e. +8.5* dbm ±1.
			f. Operate AM-682/TCC-3 AMPLIFIER switch to TR and note MEASURE meter indication. Release AMPLIFIER switch.	f. 1 db less than indication obtained in c above ±0.5.
			g Operate AM-682/TCC-3 AMP OUT switch *(d above) to* ODB.	*g.* None.

5	Same as Step 4, except: *SG-15/PCM* FREQUENCY: 19 kc FINE DBM: fully counterclockwise *ME-22/PCM* DBM: 0 SCALE B	Same as Step 4, except: MEASURE: 19KC-CH4	*a.* Adjust SG-15/PCM FINE DBM control until ME-30B/U db meter indicates −5 (−35 dbm). *b.* Note ME-22/PCM DECIBELS meter indication. *c.* Operate AM-682/TCC-3 AMPLIFIER switch to TR and note MEASURE meter indication. Release AMPLIFIER switch. *d.* Operate AM-682/TCC-3 AMP OUT switch on transmitting amplifier to 10DB. *e.* Operate ME-22/PCM DBM switch to 0 SCALE A and note DECIBELS meter indication. *f.* Operate AM-682/TCC-3 AMPLIFIER switch to TR and note MEASURE meter indication. Release AMPLIFIER switch. *g.* Operate AM-682/TCC-3 AMP OUT switch (*d* above) to ODB.	*a.* None. *b.* −1.5 dbm ±1. *c.* +0.5 db ±1. *d.* None. *e.* +8 dbm ±1. *f.* Same as indication obtained in *e* above +0.5. *g.* None.
6	Same as Step 5, except: *SG-15/PCM* FREQUENCY: 1 kc COARSE DBM: 0 FINE DBM: fully counterclockwise *ME-30B/U* DB VOLTS: 0 DB	Same as Step 5, except: MEASURE: MODEMS	*1-kc test signal transmission* *a.* Disconnect SG-15/PCM hookup wires from terminals A and K (A) of subgroup test cable assembly and reconnect to terminals F and R. *b.* Adjust SG-15/PCM FINE DBM control until ME-30B/U db meter indicates +1 dbm. *c.* Note AM-682/TCC-3 MEASURE meter indication.	*a.* None. *b.* None. *c.* 0 db ±1.
7	Same as Step 6, except: *SG-15/PCM* COARSE DBM: −20 FINE DBM: fully counterclockwise *ME-30B/U* DB VOLTS: −10 DB *ME-22/PCM* DBM: −20	Same as Step 6, except: MEASURE: 1KC-OW FLAT-1KC: fully counterclockwise SLOPE-19KC: fully counterclockwise BULGE-11KC: fully counterclockwise	*1-kc signal reception* *a.* Disconnect SG-15/PCM hookup wires from terminals F and R of subgroup test cable assembly (A) and reconnect to terminals 3 and 4 of junction panel test cable assembly. *b.* Disconnect ME-22/PCM hookup wires from terminals 1 and 2 of junction panel test cable assembly (A) and reconnect to terminals E and P of subgroup test cable assembly. *c.* Adjust SG-15/PCM FINE DBM control until ME-30B/U db meter indicates −8 (−18 dbm).	*a.* None. *b.* None. *c.* None.

Step No.	Test equipment control settings	Equipment under test control settings	Test procedures	Performance standards
			d. Note ME-22/PCM DECIBELS meter indication.	*d.* Between −20 and −24 dbm.
			e. Operate ME-22/PCM DBM switch to 0 SCALE A.	*e.* None.
			f. Rotate AM-682/TCC-3 FLAT-1KC control fully clockwise and note ME-22/PCM DECIBELS meter indication.	*f.* Between +2 and +4 dbm.
			g. Operate ME-22/PCM DBM switch to 0 SCALE B.	*g.* None.
			h. Rotate AM-682/TCC-3 FLAT-KC control counterclockwise until ME-22/PCM DECIBELS meter indicates 0 dbm.	*h.* None.
			i. Operate AM-682/TCC-3 AMPLIFIER switch to REC and note MEASURE meter indication. Release AMPLIFIER switch.	*i.* −1.5 db ±1.5.
			19-kc signal reception	
8	Same as Step 7, except: *SG-15/PCM* FREQUENCY: 19 kc FINE DBM: fully counterclockwise *ME-22/PCM* DBM: 0 SCALE B	Same as Step 7, except: MEASURE: 19KC-CH 4	*a.* Adjust SG-15/PCM FINE DBM control until ME-30B/U db meter indicates −8 (−18 dbm).	*a.* None.
			b. Note ME-22/PCM DECIBELS meter indication.	*b.* Between −5 and −2.5 dbm.
			c. Operate ME-22/PCM DBM switch to 0 SCALE A.	*c.* None.
			d. Rotate AM-682/TCC-3 SLOPE-19KC control fully clockwise and note ME-22/PCM DECIBELS meter indication.	*d.* More than 5.9 dbm.
			e. Operate ME-22/PCM DBM switch to 0 SCALE B.	*e.* None.
			f. Rotate AM-682/TCC-3 SLOPE-19KC control counterclockwise until ME-22/PCM DECIBELS meter indication 0 dbm.	*f.* None.
			g. Operate AM-682/TCC-3 AMPLIFIER switch to REC and note MEASURE meter indication. Release AMPLIFIER switch.	*g.* −1.5 db ±1.
			11-kc signal reception	
9	Same as Step 8, except: *SG-15/PCM* FREQUENCY: 11 kc FINE DBM: fully counterclockwise	Same as Step 8, except: MEASURE: 11KC-CH2	*a.* Adjust SG-15/PCM FINE DBM control unit ME-30B/U db meter indication −8 (−18 dbm).	*a.* None.
			b. Note ME-22/PCM DECIBELS meter indication.	*b.* Between −0.5 and −2.5 dbm.

			e. Operate ME-22/PCM DBM switch to 0 SCALE A.	c. None.
			d. Rotate AM-682/TCC-3 BULGE-11KC control fully clockwise and note ME-22/PCM DECIBELS meter indication	d. Between +2 and +4.5 dbm.
			e. Operate ME22/PCM DBM switch to 0 SCALE B.	e. None.
			f. Rotate AM-682/TCC-3 BULGE-11KC control counterclockwise until ME-22/PCM DECIBELS meter indicates 0 dbm.	*f.* None.
			g. Operate AM-682/TCC-3 AMPLIFIER switch to REC and note MEASURE meter indication. Release AMPLIFIER switch.	*g.* -1 db ±1.5.
			g-kc pilot signal sensitivity	
10	Same as Step 9, except: SG-15/PCM FREQUENCY: 4 kc COARSE DBM: -40 FINE DBM: fully counterclockwise *ME-30B/U* DB VOLTS: -49 DB	Same as Stop 9, except: ALARM CUTOFF : horizontal (to right)	a. Note AM-682/TCC-3 alarm indications.	a. SYSTEM ALARM indicator lamp should he lighted and buzzer should be silent.
			b. Operate AM-682/TCC-3 ALARM CUTOFF switch to vertical position and note alarm indications.	b. CALL and SYSTEM ALARM indicator lamps should he lighted and buzzer should sound.
			c. Rotate SG-15/PCM FINE DBM control clockwise until no alarm indications are obtained. Note indications.	e. CALL and SYSTEM ALARM indicator lamps should be extinguished and buzzer should be silent.
			d. Note ME-30B/U db meter indication.	*d.* Between -48 and -56 dbm.
			e. Operate SG-15/PCM COARSE DBM switch to ZERO OUTPUT. Operate AM-682/TCC-3 ALARM CUTOFF switch to horizontal position.	e. None.
			f. Proceed to test procedures given in paragraph 294.9.	*f.* None.

294.9. Order Wire Circuits, Test Procedures

Perform the test procedures given in paragraphs 294.6 through 294.8 before proceeding with the following tests.

a. Test Equipment and Material. **Use the same test equipment and materials listed in paragraph *294.7a.* One resistor, 600 ohms and one capacitor, 2 uf (part of the MK-155/TCC) are also required.**

b. Test Connections and Conditions.

(1) Connect the equipment as shown in A, figure 115.6.

(2) The test connections of the A TCC-3 shown in A, figure 115.3 (less th 352/U) are unchanged. The ground con to the terminal of terminal board TB9(TB903) (B, fig. 115.5) is unchanged.

c. Procedure.

NOTE

1. A summary chart of the tests a performance standards is given in par graph 294.10d.

2. The parenthetical letters (examp (A) (B)) refer to the indicated p tion of figure 115.6.

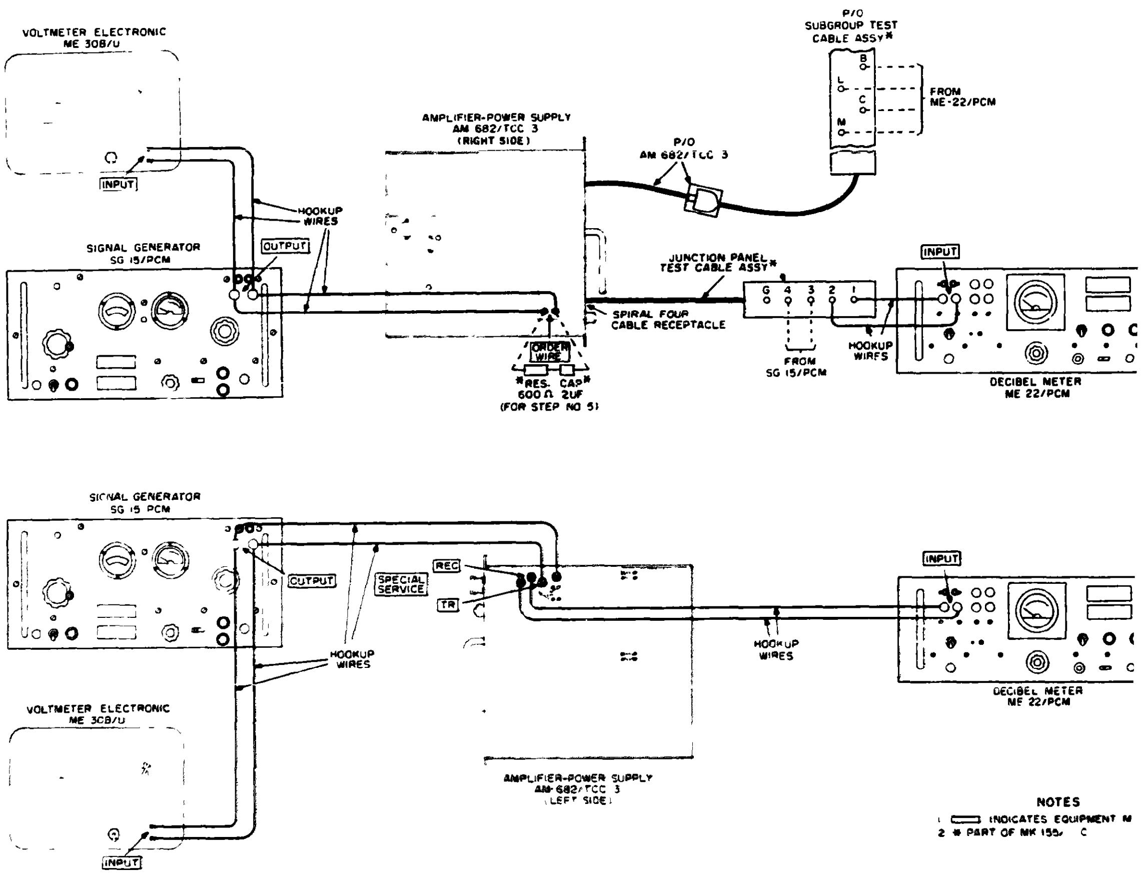


Figure 115.6. Order wire circuits tests setups.

Step No.	Test equipment control settings	Equipment under test control settings	Test procedures	[illegible]
1	**unchanged from last settings** used in paragraph 224.8c except: ***SG-15/PCM*** FREQUENCY - 300 cps COARSE DBM: 0 FINE DBM : fully counterclockwise. ME-30B/U DB VOLTS: 0 DB ME-22/PCM DB_M : 0 SCALE B	***AM-682/TCC-3*** Switches and controls; unchanged from last settings used in procedures given in paragraph 294.8c except: **MEASURE:** 1KG-OW ORDER WIRE: vertical CHANNEL TALK: LINE SEND OW: vertical	Signal transmission and measurement a. Adjust SG-15/PCM FINE DBM control until ME-30P/U db meter indicates 0 dbm. *b.* Note ME-22/PCM DECIBELS meter indication. c. Adjust SG-15/PCM FREQUENCY dial to 1,000 cps and FINE DBM control until ME-SOB/U db meter indicates 0 dbm. d Note ME-22/PCM DECIBELS meter indication. e. Operate AM-682/TCC-3 AMPLIFIER switch to TR and note MEASURE **meter** indication. Release AMPLIFIER switch. f. Adjust SG-15/PCM FREQUENCY dial to 4,000 cps and FINE **DRM control until ME-30B/H**	***a.*** **None.** ***b.*** **−2.5 dbm ±1.** ***c.*** **None.** ***d.*** **−1 dbm ±1.5.** ***e.*** **Same as indication obtained in *d* above ±0.5.** ***f.*** **None.**

Step No.	Test equipment control settings	Equipment under test control settings	Test procedures	Performance standards
			o. Note AM-682/TCC-3 alarm indications and **release ORDER** WIRE switch.	o. CALL indicator should light and buzzer should sound.
			Handset circuits	
2	Same as step 1, except: SG-15/PCM **FREQUENCY:** 1 kc COARSE DBM: 0 **FINE** DBM: fully counterclockwise ***ME-30B/U*** DB VOLTS: 0 DB ME-22/PCM DBM: **0 SCALE** B	Same as **Step 1, except:** **ORDER WIRE: TALK** SEND OW: horizontal (to left) CHANNEL TALK: TEST BD MEASURE: 1 KC-OW	a. Disconnect hookup wires **of ME-**22/PCM from junction panel test cable assembly (A) and reconnect to terminals B and L of subgroup test cable assembly.	a. None,
			b. Adjust SG-15/PCM DBM control until ME-30B/U meter indicates 0 dbm.	***b.*** None.
			c. Operate AM-682/TCC-3 handset push-to-talk **switch *(A)*** and **note** ME-22/PCM **DECIBELS switch** meter **indication,**	**c.** *-4.5* dbm ±1.
			d. **Release AM-682/TCC-3** handset push-to-talk switch. Listen for test tone in handset receiver and note indication.	***d.* Test tone should be** heard in hand**set receiver**
			e. Disconnect ME-22/PC**M hookup** wires from terminals **B and L of** subgroup test cable assembly (A) and reconnect to terminals C and M.	*6. None.*
			f. Operate **AM-682/TCC-3** CHAN**NEL** TALK switch to **LINE.**	***f.* None.**
			g. Note *ME-22/PCM* DECIBE**LS meter** indication.	***g.* −3 dbm ±1.5.**
			***h.* Operate ME-22/PCM DBM switch to −10.**	***h.* None.**
			***i.* Operate AM-682/TCC-3 CHANNEL TALK switch to TEST BD** and SEND OW **switch to vertical position.**	***i.* None.**
			***j.* Note ME-22/PCM DECIBELS meter indication.**	***j.* −16 dbm ±1.5.**
			***k.* Operate SG-15/PCM COARSE DBM control to ZERO OUTPUT.**	***k.* None.**
			***l.* Simultaneously, operate AM-682/TCC-3 AMPLIFIER switch to TR, operate handset push-to-talk switch. Speak into handset transmitter, and note MEASURE meter peaking indications.**	***l.* MEASURE meter needle should show peaking indications corresponding to speech variations.**

		m. Repeat procedures given in 1 above and note ME-22/PCM DECIBELS meter indications.	m. DECIBELS meter needle should show peaking indications corresponding to speech variations.
		n. Release AM-682/TCC-3 AMPLIFIER switch and handset push-to-talk switch.	n. None.
		Signal reception and measurement	
Same as Step 2, except: *SG-15/PCM* FREQUENCY: 300 cps COARSE DBM: -20 FINE DBM: fully counterclockwise *ME-30B/U* DB VOLTS: -10 DB *ME-22/PCM* DBM: -10	Same as Step 2, except: ORDER WIRE : vertical CHANNEL TALK: LINE SEND OW: vertical	a. Disconnect hookup wires of SG-15/PCM from AM-682/TCC-3 ORDER WIRE terminals (A) and reconnect to terminals 3 and 4 of junction panel test cable assembly.	a None.
		b. Disconnect hookup wires of ME-22/PCM from terminals C and *M* of subgroup test cable assembly (A) and reconnect to *AM-682/*TCC-3 ORDER WIRE terminals.	b. None.
		c. Adjust SC-15/PCM FINE DBM control until ME-30B/U db meter indicates -8 (-18 dbm).	c. None.
		d. Note ME-22/PCM DECIBELS meter indication,	d. -15 dbm ±2.
		e. Adjust SG-15/PCM FREQUENCY dial to 1,000 cps and FINE DBM control until ME-30B/U db meter indicates -8 (-18 dbm).	e. None.
		f. Operate ME-22/PCM DBM switch to 0 SCALE B and note DECIBELS meter indication.	*f.* -11 dbm ±1.5.
		g. Adjust SG-15/PCM FREQUENCY dial to *4,000* cps and adjust FINE DBM control until ME-30B/U db meter indicates -8 (-18 dhm).	g. None.
		h. Operate ME-22/PCM DBM switch to -30 and note DECIBELS meter indication.	h. Less negative than *-45* dbm.
		i. Note AM-682/TCC-3 alarm indications.	i. CALL indicator should light and buzzer should sound, and SYSTEM ALARM indicator should be extinguished.
		j. Operate SG-15/PCM COARSE DBM switch to ZERO OUTPUT.	i. None.

Step No.	Test equipment control settings	Equipment under test control settings	Test procedures	Performance standards
			Ringing signal sensitivity	
	Same as step 3, except: *SG-15/PCM* FREQUENCY: 1,600 cps COARSE DBM: -40 FINE DBM : fully counterclockwise *ME-30B/U* DB VOLTS: -40	Same as Step 3, except: ALARM CUTOFF: horizontal (to right)	a Adjust SG-15/PCM FINE DBM control until AM-682/TCC-3 CALL indicator lights and buzzer sounds. *b.* Note ME-30B/U db meter indication. c. *Operate* SG-15/PCM COARSE DBM switch to ZERO OUTPUT.	a. None. *b.* Less negative than -40 dbm. C. None.
			Hybrid coil balance	
	Same as Step 4, except: *SG-15/PCM* FREQUENCY: 1,000 cps COARSE DBM : -10 FINE DBM: fully counterclockwise *ME-30B/U* DB VOLTS : -10 DB *ME-22/PCM* DBM -30	Same as Step 4.	a. Disconnect hookup wires of *ME-*22/PCM from AM-682/TCC-3 ORDER WIRE terminals (A) and reconnect to terminals 1 and 2 of junction panel test cable assembly. b, Connect resistor and capacitor to AM-682/TCC-3 ORDER WIRE terminals (A). c. Adjust SG-15/PCM DBM control until ME-30B/U db meter indicates -8 (-18 dbm). *d.* Note ME-22/PCM DECIBELS meter indication.	a None. *b.* None. *c.* None. *d.* Less negative than -86 dbm.
			Special service *transmission circuit*	
	Same as Step 5, except: SG-15/PCM FREQUENCY: 11 kc COARSE DBM: 0 FINE DBM: fully counterclockwise *ME-30B/U* DB VOLTS: 0 DB *ME-22/PCM* DBM: 0 SCALE B	*Same a* Step 5, except: SPECIAL SERVICE-CHANNELS (right side of chassis) : SPECIAL SERVICE	a. Disconnect hookup wires of SE 15/PCM from terminals 1 and 2 of junction panel test cable assembly (A) and reconnect to AM--682/TCC-3 SPECIAL SERVICE TR terminals (B). b. Note SPECIAL SERVICE indicator indication. c. Adjust SC-15/PCM FINE DBM control until ME-SOB/U meter indicates 0 dbm. *d.* Note ME-22/PCM DECIBELS meter indication,	*a.* None. *b.* SPECIAL SERVICE indicator should light. *c.* None. *d.* 0 dbm ±1.
			Special service reception circuit	
	Same as Step 6, except: SG-15/PCM *COARSE* DBM: —10 FINE DBM: fully counterclockwise *ME-30B/U* DB VOLTS: -10 DB	Same as Step 6.	a Disconnect hookup wires of SG-15/PCM from TR terminals (B) and reconnect to terminals 3 and 4 of junction panel test cable assembly (A). Disconnect hookup wires of ME-22/PCM from junction panel test cable assembly	*a.* None.

ME-22/PCM
DBM: 0 SCALE B

(A) and reconnect to AM-682/TCC-3 SPECIAL SERVICE REC terminals (B).	
b. Adjust SG-15/PCM FINE DBM control until ME-30B/U db meter indicates −8 (−18 dbm).	*b.* None.
c. Note ME-22/PCM DECIBELS meter indication.	*c.* −1 dbm ±1.5.
d. Disconnect all test equipment connections, and strap from TB903 (or TB904) (B, fig. 155.4).	*d.* None.

294.10. Summary Charts of Test and Performance Standards

Typical summary charts that can be prepared to record the test indications of the tests covered in paragraphs 294.6 through 294.9 are given in *a* through *d* below.

a. Power Circuits.

NOTE

The item numbers correspond to the step numbers of the test procedures given in paragraph 294.6c.

Item No.	Test	Performance standard	Test indication
1	INITIAL INDICATIONS:		
	a. Power applied ------	a. POWER, CALL, and SYSTEM ALARM indicators should light and buzzer should sound for approximately 15 to 30 seconds.	
	b. SYSTEM ALARM switch operated.	*b.* POWER AND SYSTEM ALARM indicators should remain lighted, buzzer should be silenced, and CALL indicator should be extinguished.	
	c. At 103 volts at	e. Same indications as obtained in *b* above.	
2	DC VOLTAGE CIRCUITS :		
	a. At J553 ------	a. 215 volts dc ±15 (200 volts de ±15 when TA-219/U is connected to AM-682/TCC-3).	
	b. At terminal A of carrier supply test cable assembly.	b. Same indication as obtained in a above.	
	c. At J554	10 volts dc ± 0.8.	
	d. Using handset switch - -	d. 5 volts dc ±2.	
3	FILAMENTS VOLTAGE CIRCUITS :		
	a At J551 and J552	*a.* 6.3 volts ac ±0.5.	
	b. 230V-115V switch at 230V .	*b.* 3.2 volts ac ±0.2.	
	c. At terminals B and L of carrier supply test cable assembly.	*c.* Same indication as obtained in a above.	

b. Test Oscillator and Carrier Supply Circuits.

NOTE

The item numbers correspond to the step numbers of the test procedures given in paragraph 294.7c

Item No.	Test	Performance standard	Test indication
1	METER CIRCUIT	−5 dbm ±0.5.	
2	TEST OSCILLATOR CIRCUIT:		
	a. TEST OSC OUTPUT clockwise	*a.* Not more negative than +4 dbm.	
	b. TEST OSC OUTPUT counterclockwise.	*b.* Not more positive than −4 dbm.	
	c. TEST OSC OUTPUT adjusted	*c.* 0 db.	
	d. ME-22/PCM indicator	*d.* +3.5 dbm ±1.	
3	4-KC SUPPLY OUTPUT	−25 dbm ±1.5.	
4	CARRIER SUPPLY OUTPUT:		
	a. At terminals C and M	*a.* 0.89 volt ac ±0.15.	
	b. At terminals D and N	*b.* 0.08 volt ac ±0.04 less than indication obtained in *a* above.	
	c. At terminals E and P	*c.* 0.08 volt ac ±0.04 less than indication obtained in *a* above.	
	d. At terminals F and R	*d.* Same as indication obtained in *a* above ±0.04.	
	e. At J601 and J602	*e.* 0 db ±3.	
	f. At J603	*f.* ±1.5 db ±3.	

c. Transmitting and Receiving Circuits.

NOTE

The item numbers correspond to the step numbers of the test procedures given in paragraph 294.8*c*.

Item No.	Test	Performance standard	Test indication
1	1-KC SIGNAL TRANSMISSION:		
	a. ME-22/PCM indication	*a.* −1 dbm ±1.5.	
	b. MEASURE meter indication	*b.* −1 db ±1.5.	
	c. AMP OUT switch operated to 10DB:		
	(1) ME-22/PCM indication	(1) +9 dbm ±1.5.	
	(2) MEASURE meter indication	(2) 1 db less than indication obtained in *b* above ±0.5.	
2	CHANNEL 1 SIGNAL TRANSMISSION:		
	a. ME-22/PCM indication	*a.* −1 dbm ±1.5.	
	b. MEASURE meter indication	*b.* 0 db ±1.	
	c. AMP OUT switch operated to 10DB:		
	(1) ME-22/PCM indication	(1) +9 dbm ±1.5.	
	(2) MEASURE meter indication	(2) Same as indication obtained in *b* above ±0.5.	
3	CHANNEL 2 SIGNAL TRANSMISSION:		
	a. ME-22/PCM indication	*a.* −1 dbm ±1.5.	
	b. MEASURE meter indication	*b.* 0 db ±1.5.	
	c. AMP OUT switch operated to 10DB:		
	(1) ME-22/PCM indication	(1) +9 dbm ±1.	
	(2) MEASURE meter indication	(2) Same as indication obtained in *b* above ±0.5.	
4	CHANNEL 3 SIGNAL TRANSMISSION:		
	a. ME-22/PCM indication	*a.* −1.5 dbm ±1.	
	b. MEASURE meter indication	*b.* +0.5 db ±1.5.	
	c. AMP OUT switch operated to 10DB:		
	(1) ME-22/PCM indication	(1) +8 dbm ±1.	
	(2) MEASURE meter indication	(2) 1 db less than indication obtained in *b* above ±0.5.	
5	CHANNEL 4 SIGNAL TRANSMISSION:		
	a. ME-22/PCM indication	*a.* −1.5 dbm ±1.	
	b. MEASURE meter indication	*b.* +0.5 db ±1.	
	c. AMP OUT switch to 10DB:		
	(1) ME-22/PCM indication	(1) +8 dbm ±1	
	(2) MEASURE meter indication	(2) Same as indication obtained in *b* above ±0.5.	
6	1-KC TEST SIGNAL TRANSMISSION.	0 db ±1.	
7	1-KC SIGNAL RECEPTION:		
	a. ME-22/PCM indications:	*a.* Indications are:	
	(1) FLAT-1KC counterclockwise	(1) Between −20 and −24 dbm.	
	(2) FLAT-1KC clockwise	(2) Between +2 and +4 dbm.	
	b. MEASURE meter indication	*b.* −1.5 db ±1.5	
8	19-KC SIGNAL RECEPTION:		
	a. ME-22/PCM indications:	*a.* Indications are	
	(1) SLOPE-19KC counterclockwise.	(1) Between −5 and −2.5 dbm	
	(2) SLOPE-19KC clockwise	(2) More than 5.9 dbm.	
	b MEASURE meter indication	*b* −1.5 db ±1	

No. Item	Test	Performance standard	Test indication
9	11-KC SIGNAL RECEPTION:		
	a. ME-22/PCM indication:	*a.* Indications are:	
	(1) BULGE-11KC counterclockwise.	(1) Between −0.5 and −2.5 dbm.	
	(2) BULGE-11KC clockwise	(2) Between +2 and +4.5 dbm.	
	b. MEASURE meter indication	*b.* −1 db ±1.5.	
10	4-KC PILOT SIGNAL SENSITIVITY:		
	a. Initial alarm indications	*a.* SYSTEM ALARM indicator lamp should be lighted and buzzer should be silent.	
	b. ALARM CUTOFF switch operated.	*b.* CALL and SYSTEM ALARM indicator lamps should be lighted and buzzer should sound.	
	c. SG-15/PCM adjusted	*c.* CALL and SYSTEM ALARM indicator lamps should be extinguished and buzzer should be silent.	
	d. ME-30B/U indication	*d.* Between −48 and −56 dbm.	

d. Order Wire Circuits.

NOTE

The item numbers correspond to the step numbers of the test procedures given in paragraph 294.9*c*.

Item No	Test	Performance standard	Test indication
1	SIGNAL TRANSMISSION AND MEASUREMENT:		
	a. At 300 cps	*a.* −2.5 dbm ±1.	
	b. At 1,000 cps	*b.* −1 dbm ±1.5.	
	c. MEASURE meter indication	*c.* Same as indication obtained in *b* above ±0.5.	
	d. At 4,000 cps	*d.* Between −25 and −45 dbm.	
	e. SEND OW switch operated.	*e.* Indications are:	
	(1) ME-22/PCM indication	(1) 0 dbm ±1.5.	
	(2) MEASURE meter indication	(2) Same indication as obtained in (1) above ±0.5.	
	f. ORDER WIRE switch operated to RING	*f.* Indications are:	
	(1) ME-22/PCM indication	(1) 0 dbm ± 2.	
	(2) AM-682/TCC-3 indications	(2) CALL indicator should light and buzzer should sound.	
2	HANDSET CIRCUITS		
	a. At terminals B and L	*a.* Indications are:	
	(1) ME-22/PCM indication	(1) −4.5 dbm ±1.	
	(2) AM-682/TCC-3 handset indication.	(2) Test tone should be heard in handset receiver.	
	b At terminals C and M	*b.* Indications are:	
	(1) First indication	(1) −3 dbm ±1.5.	
	(2) Second indication	(2) −16 dbm ±1.5.	
	c. Speech indications	*c.* Indications are:	
	(1) MEASURE meter indication	(1) Meter needle should show peaking indications corresponding to speech variations.	
	(2) ME-22/PCM indication	(2) Same as (1) above.	
3	SIGNAL RECEPTION AND MEASUREMENT:		
	a. At 300 cps	*a.* −15 dbm ±2.	
	b. At 1,000 cps	*b.* −11 dbm ±1.5.	
	c. At 4,000 cps	*c.* Indications are	
	(1) ME-22/PCM indication	(1) Less negative than −45 dbm.	
	(2) AM-682/TCC-3 indications	(2) CALL indicator should light and buzzer should sound, and SYSTEM ALARM indicator should be extinguished.	

Item No.	Test	Performance standards	Test indication
4	RINGING SIGNAL SENSITIVITY -	Less negative than -40 dbm.	
5	HYBRID COIL BALANCE _________	Less negative than -35 dbm.	
6	SPECIAL SERVICE TRANSMISSION CIRCUIT :		
	a. Indicator __________________	a SPECIAL SERVICE indicator should light.	
	b. ME-22/PCM indication _______	b. 0 dbm ±1.	
7	SPECIAL SERVICE RECEPTION CIRCUIT.	-1 dbm ±1.5.	

Section VI. FINAL TESTING

295. General

This section contains information that will aid the repairman in testing a Telephone Terminal AN/TCC-3 when all the plug-in assemblies are in place in the terminal. In addition, tests are provided for the individual plug-in assemblies when they are not in place in a terminal. Tests of the complete terminal are described in paragraphs 298 through 369. Tests of plug-in assemblies are described in paragraphs 370 through 387.

a. Simplified functional schematics have ‘been included in this section to help the repairman in connecting the equipment and in checking the transmission path through the electrical parts of primary interest in the tests. Dotted lines are used to indicate that circuit elements have been omitted for simplicity. Heavy lines indicate connections that neeed to be made in the test to which the illustration pertains. In order to trace the transmission path in detail, it is necessary to refer to the schematic diagram applicable to

AN/TCC-3 should be performed in the sequence in which they are described in this section. Electrical values, connections, and adjustments given in paragraph 297 apply to all tests unless other values are specified in the description of a particular test.

b. All the circuits of the AN/TCC-3 should be checked before the AN/TCC-3 is placed in operation. The following chart indicates each of the circuits that need to be checked and the first paragraph describing the checks on that circuit. Perform the tests in the order that they are presented.

Circuit	First paragraph
Power supply	298
Measuring circuit	306
Test oscillator	311
Carrier supply _	313
Transmitting circuits _	318
Order wire transmitting circuits	331
Ringer-oscillator as an oscillator _	336
Receiving circuits	340
Order wire receiving circuit	350
Ringer-oscillator as a ringer _	354
Noise tests (overall circuit) _ _ _	358
Attendant’s telephone set	360

296. Test Equipment Required

The test equipment required for testing the AN/TCC-3 terminal is listed below. This test equipment is referred to in the paragraphs describing tests in which it iused.

Item	Publication	Quantity
Signal Generator SG-15/PCM	TM 11-6625-251-15	1
Test Set TS-140/PCM	TM 11-6625-251-15	1
Frequency Meter AN/TSM-16	TM 11-6625-218-12	1
Multimeter ME-26A/U [a]	TM 11-6625-200-12	1
Multimeter TS-352/U	TM 11-6625-366-15	1
Attenuator TS-402/U	TM 11-2044	1
Transmission Measuring Set TS-559/FT	TM 11-6625-356-12	1
Variable Power Transformer CN-16A/U		1
Power supply (for 200 volts dc, 6.3 volts ac, and 10 volts dc) [b]		1
Telephone Carrier System Test Facilities Kit MK-155/TCC; the following items are required:	TB SIG 328	1
Capacitor, 1µf [c]		2
Resistance networks; 2,400, 2,078, 696, 527, and 155 ohms [d]		

Item	Publication	Quantity
Resistor, 60.4 ohms		4
Resistor,600 ohms		2
Carrier supply test cable assembly		1
Extension test cable assembly		1
Junction panel test cable assembly'		1
Modem and ampliller test cable assembly[E]		1

[A]Use the ME-26A/U in those places in this manual where vacuum-tube voltmeter, Electronic Multimeter ME-6/U, and ME-6/U are indicated.

'Power Supply PP-827/U (part of Terminals, Telephone AN/TCC-7, AN/TCC-50 (TM 11-2139-35) or Repeater, Telephone AN/TCC-8 (TM 11-2140-35)) may be used to provide these voltagee. If the PP-827/U is used, use the carrier supply test cable assembly in the MK-155/TCC to facilitate the power connections. On the carrier supply test cable assembly, terminals A (positive) and K (negative) *are for* 200 volts dc, terminals M and N are *for 6.3* volts ac, and terminals D (negative) and H (positive) are for 10 *volts* dc. To provide a suitable load of the 200-volt output of the PP-827/U, select two 1,600-ohm resistors (37 watts each) from the MK-155/TCC and connect them in parallel to terminals A and K of the carrier supply test cable assembly. Adjust the dc output of the PP-827/U to obtain 200 volts dc indication at terminals A and K *of* the carrier supply test cable assembly.

[c] Connect the two 1uf capacitors in parallel to provide 2-uf required for the tests.

[d] Combine resistors *of* various values to obtain the resistance networks required in the test setups.

[e] The extension test cable assembly may be used instead *of* the extension cable provided in the AM-682/TCC-3 (fig. 16) and mentioned in the test procedures.

The junction panel test cable assembly is equivalent to Telephone Cable Assembly CX-1512/U (fig. 18) and may be used where spiral-four cable stub, spiral-four cable connector, and cable stub are mentioned in the test procedures. Terminals 1 and 2 of the junction panel test cable correspond to the transmitting wires mentioned in the test procedures and terminals 3 and 4 correspond to the receiving wires mentioned in the test procedures.

Use the modem and amplifier test cable assembly in those places where test cable is indicated in the test procedures.

297. Test Procedure

Before testing the entire AN/TCC-3 equipment, certain preliminary procedures should be followed. These procedures are described in detail below.

a. Inspection. The equipment should be inspected for broken or shorted wires and terminals, and for broken vacuum tubes or other apparatus. Any damage discovered during this inspection should be repaired before testing begins.

b. Preliminary Adjustments.

(1) The chart below indicates the adjustments that must be made before the tests described in this section are begun. The chart lists the controls to be adjusted, their location *in the* AN/TCC-3, and the setting for each control.

(2) In performing any particular test in this section, it is assumed that all previous tests and adjustments have been performed, and all necessary corrective action taken. It is also assumed in any particular test, that switches have been left in the positions they occupied at the conclusion of the preceding test.

c. Connections.

(1) Connect the test set ground to the GND binding post of the AM-682/TCC-3.

(2) Connect the CARR SUP-POWER and TRANS-TEST-TALK cables to Telephone Modem TA-219/U.

(3) Connect a spiral-four cable stub (Telephone Cable Assembly CX-1512/U) to the spiral for connector of the amplifier-power supply unit. Set Attenuator TS-402 for a loss of 18 db. Connect the transmitting wires of the cable stub to the input terminals of the attenuator and the receiving wires to the output terminals of the attenuator.

(4) Connect a 600-ohm resistor across the ORDER WIRE extension binding posts.

(5) During the tests covered in this section, it is required that the TA-219/U be connected to the AM-682/TCC-3 (pars 27g(7)) unless otherwise specified. The connection of the cable from the left side of the AM-682/TCC-3 to the CARR SUP-POWER receptacle of the TA-219/U provides the necessary load for the AM-682/TCC-3 power supply. If this connection is not made, the B+ voltage of the AM-682/TCC-3 (para 301) is increased 15 volts.

d. Continuity Tests. Before beginning any test, it is necessary to check that all terminals are properly connected and that the continuity in the test leads is satisfactory. The simplified functional schematic diagrams provided in this section will be helpful in making continuity tests.

Control	Location	Setting
POWER switch	Front panel	OFF.
All front panel switches except POWER switch	Front panel	Vertical position.
AMP OUT switch of transmitting amplifier	Right side of AM-682/TCC-3 accessible after equipment is removed from transit case.	Vertical position.
2W-4W switches	Inside the modem unit	2W.

e. Precautions To Be Observed During Testing.

(1) If a test involves the use of the extension cable supplied with the equipment, the POWER switch should be operated to the OFF position before the plug-in assembly to be tested is removed from the terminal. After the extension cable is installed, the POWER switch should be operated to the ON position.

(2) The acceptable operating voltage values given for the tests in this section are based upon an ambient temperature of 60° to 90°F. Temperatures lower than 60°F. or higher than 90° will affect the measured values to a certain extent. It is, therefore, important to take the ambient temperature into acccount when making tests.

(3) During the tests covered in this section, the buzzer should not sound unless specified for a particular test.

298. Testing Power Supply

It is necessary to perform several checks when testing the power supply. The checks required for testing the power supply and the paragraphs describing these checks are listed in the following chart.

Check	Paragraph
POWER switch and POWER lamp	299
Filament voltage check	300
B+ check	301
B+ adjustment	302
Negative voltage checks	303
Low limit line voltage check	304
115V-230V switch circuit check	305

299. POWER Switch and POWER Lamp Check

a. Perform the procedures given in paragraph 304*a* and *b*. Adjust the variac so that the input voltage to the AN/TCC-3 is 115 volts ac (para 294.6*b*, and *c*, step No. 1*c*).

b. Operate the 115V-230V switch, S552, to the 115V position.

c. Operate the POWER switch, S551, to the ON position.

d. If the POWER switch and the POWER lamp are operating properly, the green POWER lamp should light. The buzzer should sound and the amber CALL lamp should light and remain lighted only until the unit warms up.

300. Filament Voltage Check

Use a voltmeter to check the filament voltage between jack J551 and jack J552. The voltage between these jacks should be 6.4 ±0.3 volts ac.

301. B+ Voltage Check

Use a voltmeter to check the voltage between jack J553 and ground. Make this measurement after the power supply has been operating for a half hour so that stability due to heating has been achieved The voltage should be +200 ±15 volts dc. If the voltage is not correct, check the voltage of the ac power source. The voltage of the ac power source should be within the tolerance limits (para 6). If the B+ voltage is not correct, and if the voltage of the ac power source is within the tolerance limits, refer to paragraph 302.

302. B+ Adjustment

If the B+ voltage is not correct (para 301), use strapping resistors R557, R558, and R559 (fig 160) to adjust the voltage Before strapping any or all of these resistors, operate the POWER switch to the OFF position After strapping has been completed, operate the POWER switch to the ON position Use clip leads when shorting out resistors R557, R558, and R559 The voltage of the ac power source must be either 115V ac or 230V ac when the B+ adjustment is made Since this is an unregulated power supply, departures in the voltage of the ac power source will cause proportional departures in the dc output voltage

a The strapping procedure is used to raise or lower the voltage in a circuit To raise the voltage, resistors are shorted out of the circuit; to lower the voltage, shorting straps are removed from resistors that have been shorted out of the circuit If all applicable resistors are shorted out and the voltage is not increased to the correct value or above, adjustments or repairs elsewhere in the circuit are indicated Likewise, if all applicable shorting straps have been removed and voltage is still higher than the correct value, further adjustments or repairs are indicated *b. When* the B+ voltage check is made (para 301 above), the B+ voltage may be either too high or too low. If the voltage is too high an increase of the resistance in the circuit is necessary. To increase the voltage remove straps from any of the three resistors, R557, R558, and R559, that may be shorted (see figure 111).

e. If the voltage is too high after all) shorting straps have been removed trouble exists in the circuit or in the voltage of the ac power source. Proceed with the resistance and voltage checks described in paragraphs 249 through 256. If the voltage is correct after the shorting straps have been removed, no further adjustments are necessary. If removing all shorting straps results in too low a voltage, it is necessary to decrease the amount of resistance in the circuit by strapping.

d. After all shorting straps have been removed, it is found that the voltage is too low. Correct this condition, by shorting out one of the two 100-ohm resistors R558 (R559). Check the B+ voltage between jack J553 and ground.

e. If shorting out resistor R559 has increased the voltage approximately three quarters of the difference between the incorrect voltage and the correct voltage (200 volts), shorting out the 100-ohm resistor, R558, will increase the voltage by an approximately equal amount. This increase would raise the voltage considerably above 200 volts, therefore, an additional resistance of less than 100 ohms must be shorted out. Short out the 40-ohm portion of resistor R557 and check the B+ voltage with the voltmeter.

f. If shorting out the 40-ohm portion of resistor R557 raised the voltage slightly above the correct value, a total of slightly less than 140 ohms should be shorted out of the circuit. Unstrap the 40-ohm portion of resistor R557 and strap the 30-ohm portion of resistor R557. Check the B+ voltage with the voltmeter.

g. If the voltage is lower than 200 volts, the total resistance to be shorted out is between 130 and 140 ohms. Short out the 5-ohm portion of resistor R557 and check the B+ voltage with the voltmeter.

h. If the voltage now is slightly higher than 200 volts, but is closer to 200 volts than at any previous step, this is as close as it is possible to come to the correct value. The circuit is satisfactorily adjusted.

i. Operate the POWER switch to the OFF position. Solder wires in place of the clip leads. Operate the POWER switch to the ON position and check the B+ voltage between jack J553 and ground.

303. Negative voltage Checks

a. −10V Bias Voltage Check. Using a voltmeter, check the voltage between jack J554 and ground. This voltage should be -10 ±0.8 volts dc.

b. -5V Talk Voltage Check. Operate the press-to-talk switch on the handset. Using a voltmeter, check the voltage between jack J554 and ground, This voltage should be -5 ±2 volts dc.

c. −5V Bias Voltage Check. Operate the press-to-talk switch on the handset. Using a voltmeter, check the voltage between terminal 9 of terminal board TB552 and ground. This voltage should be −5 ±0.5 volts dc.

304. Low-Limit voltage Check

a. Connect a variac (Transformer CN-16/U) to a 115-volt ac outlet.

b. Connect the power cable of the AM/TCC-3 to the variac.

c. Operate the POWER switch to the ON position. Adjust the variac so that the input voltage to the AN/TCC-3 is 103 volts. The buzzer should not sound. An input voltage of less than 103 volts may produce a B+ voltage that is insufficient for normal operation of the AN/TCC-3. Sounding of the buzzer is an indication that the B+ voltage has dropped an excessive amount below +200 volts.

305. 115V-230V Switch Circuit Test

Connect the POWER cable of the AN/TCC-3 to a 115-volt ac outlet. Operate the 115V-230V switch S552, to the 230V position. The CALL lamp should light. The buzzer may or may not sound, but this indication is not relevant to this check. Using a voltmeter, check the voltage between jack J551 and jack J552. This voltage should be 3.2 ±.5 volts ac. Operate the 115V-230V switch to the 115V position. This should extinguish the CALL lamp and cause the buzzer to stop sounding if it had been sounding.

306. Testing Measuring Circuit

It is necessary to perform several checks when testing the measuring circuit. The checks required for testing the measuring circuit and the paragraphs describing these checks are listed in the following chart.

Check	Paragraph
Meter accuracy check	307
Meter accuracy adjustment	308
Selective filter check	309
Modem measure-pad check	310

307. Meter Accuracy Check

a. Connect the signal generator between the test probe and ground of the AN/TCC-3 (fig. 116).

b. Operate the MEASURE switch to the OFF position.

c. Adjust the frequency of the signal generator to 1 kc and its output for a reading of 0 db on the MEASURE meter. The output of the signal generator should be between −5.8 and −6.0 dbm when the MEASURE meter reads 0 db.

308. Meter Accuracy Adjustment

If the MEASURE meter does not indicate 0 db, adjust the signal generator to obtain a 0-db indication on the MEASURE meter. If the signal generator output is not between the limits of −5.8 and −6.0 db when the 0-db indication is obtained on the MEASURE meter, restrap the meter adjusting resistors. The meter adjusting resistors are resistors R780, R790, R791, R792, and R794. If the signal generator output is more than −5.8 dbm (−5.6 is more than −5.8) for a 10-db MEASURE meter reading, as presently strapped, short out the necessary resistors until the output of the signal generator is between −5.8 and −6.0 dbm for the 0-db MEASURE meter reading. If the signal generator output is less than −6.0 dbm (−6.2 dbm is less than −6.0 dbm) for a 0-db MEASURE meter reading, remove straps from applicable resistors until the output of the signal generator is between −5.8 and −6.0 dbm for the 0-db MEASURE meter reading.

309. Selective Filter Check

a. Connect the signal generator output between terminal 11 on the rear of section 3 of the MEASURE switch and ground (fig. 117). Operate the MEASURE switch to the 1 KC-OW position.

b For test 1 in the chart (*d* below) adjust the frequency of the signal generator to 1 kc and its output to −5 dbm.

c. The MEASURE meter should read 0 ±0.5 db.

d. Perform tests 2 through 5 in the chart,

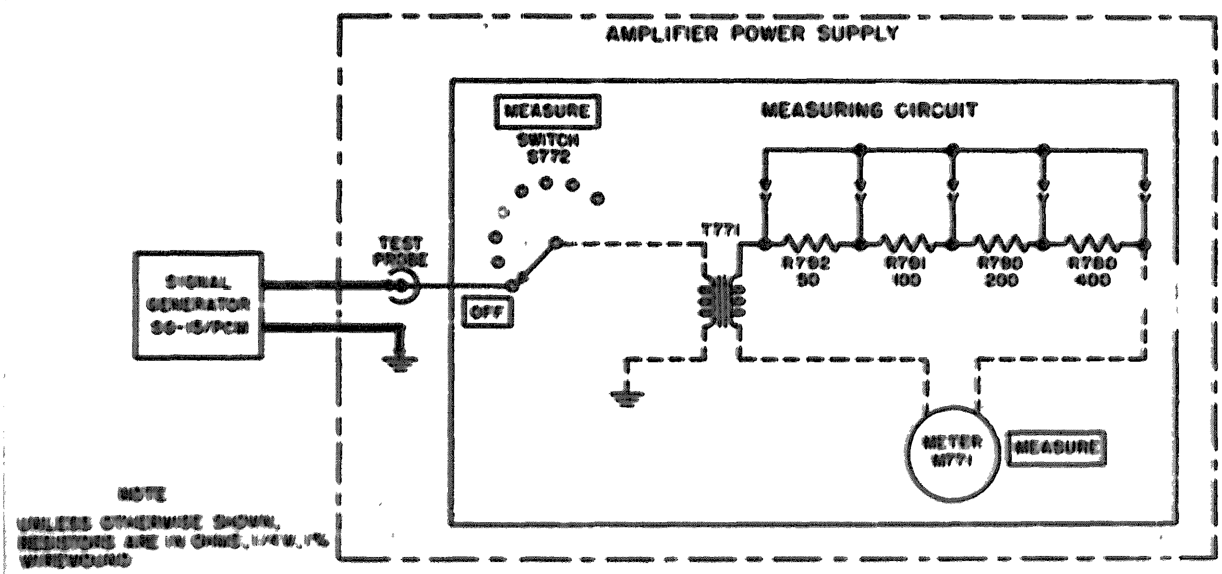


Figure 116. Meter accuracy check and adjustment, test arrangement.

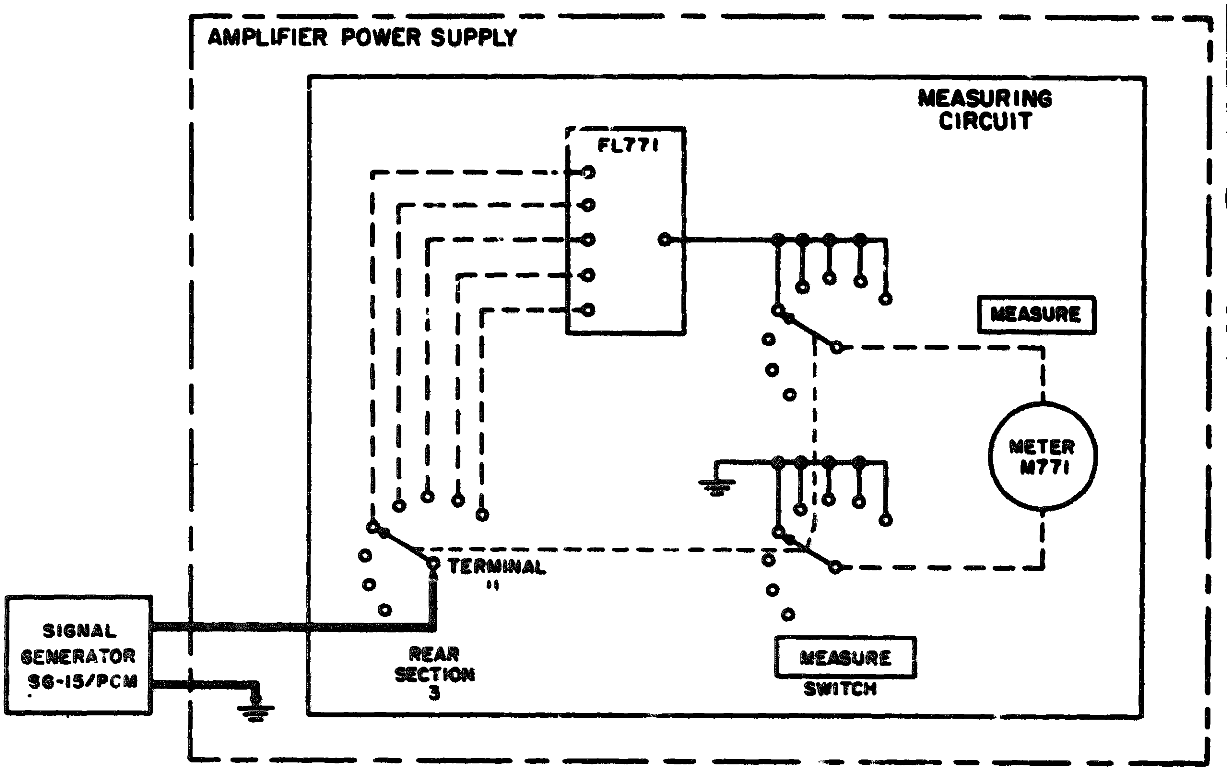


Figure 117. Selective filter check, test arrangement.

using the same procedure as described in *a* through *c* above. For tests 2 through 5, use the correct signal generator frequency and the correct position of the MEASURE switch as indicated in the chart.

Test No.	MEASURE switch position	Frequency of signal generator (output -5.0 dbm)
1	1 KC-OW	1.00 kc
2	19 KC-CH4	19.00 kc
3	11 KC-CH2	11.00 kc
4	7 KC-CH1	7.00 kc
5	15 KC-CH3	15.00 kc

310. Modem Measure-Pad Check

a. Connect the signal generator to terminals 9 and 10 of terminal board TB801 as shown in figure 118.

b. Operate the MEASURE switch to the MODEMS position.

c. Adjust the signal generator frequency to 1 kc and its output to +1 dbm.

d. The MEASURE meter should read 0 ±0.75 dbm.

311. Testing Test Oscillator

It is necessary to perform two checks when testing the test oscillator. The checks required and the paragraphs describing the checks are listed in the following chart.

Check	Paragraph
Test oscillator output check	312a, b, c.
Test oscillator output circuit check	312d.

312. Test Oscillator Output Check

a. Rotate the TEST OSC OUTPUT knob completely clockwise.

b. Operate the MEASURE switch to the TEST OSC position. The MEASURE meter should read at least +1.5 dbm.

c. Adjust the TEST OSC OUTPUT knob so that the MEASURE meter reads 0 dbm.

d. Connect the ME-22/PCM to terminals 6 and 7 of terminal board TB801 (fig. 119). The ME-22/PCM should read +2.2 ±0.75 dbm.

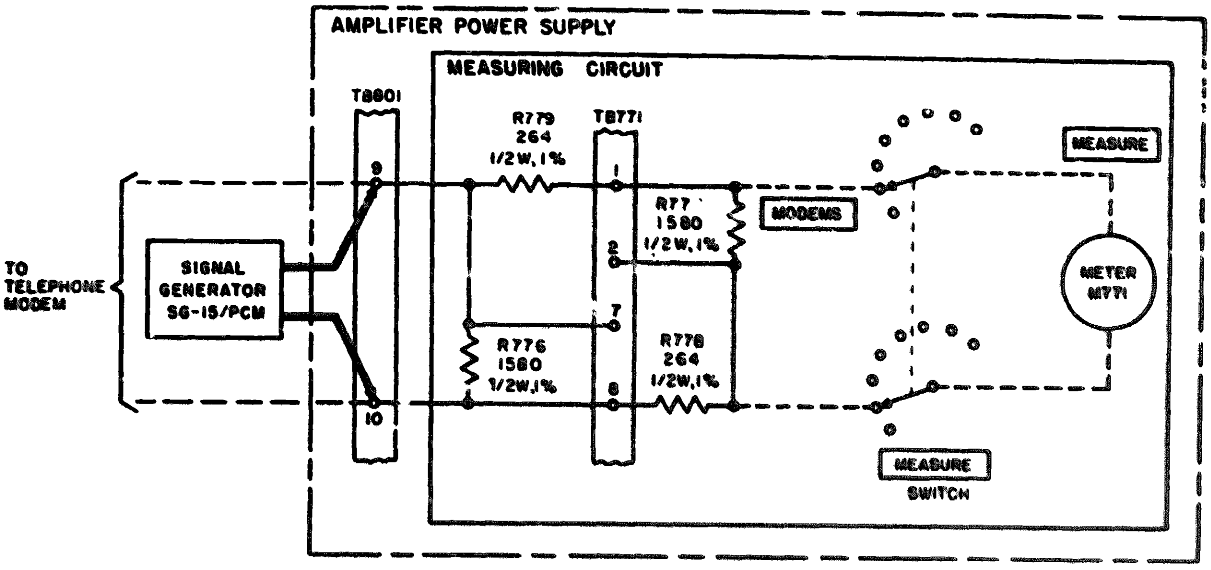


Figure 118. Modem measure-pad check, test arrangement.

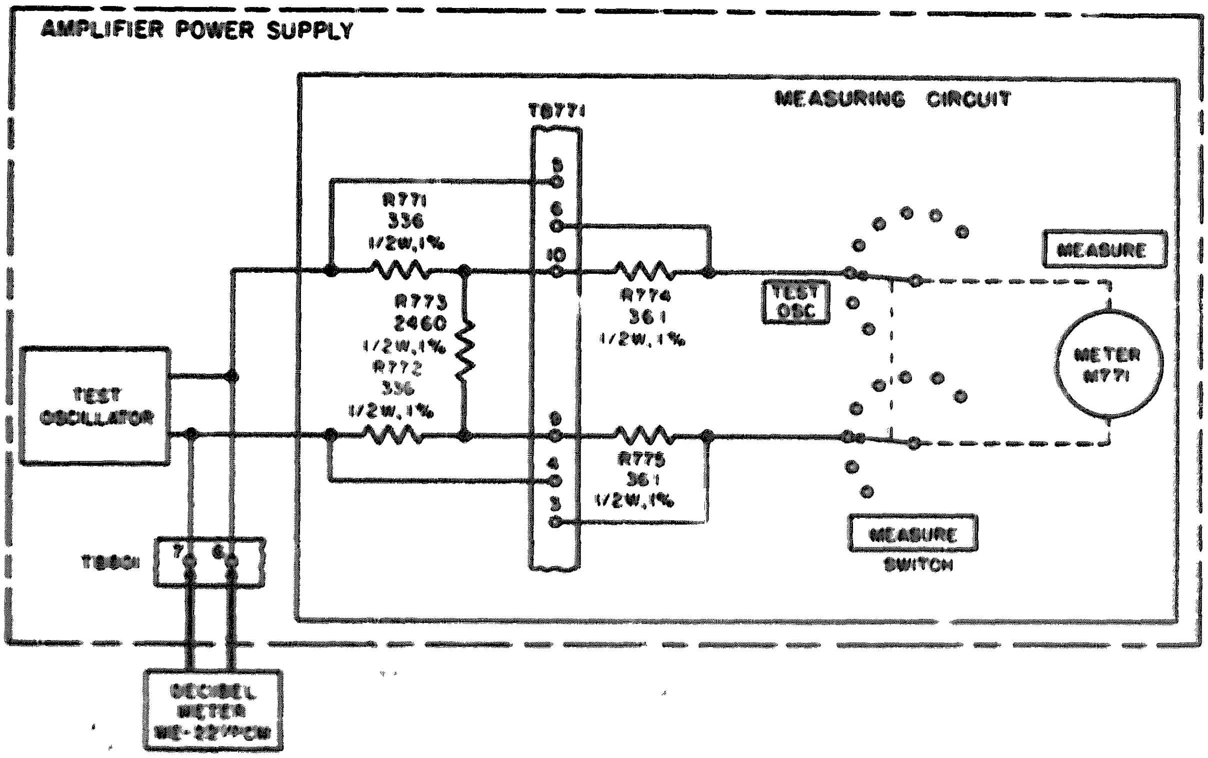


Figure 119. Test oscillator checks, test arrangements.

313. Testing Carrier Supply

It is necessary to perform several checks when testing the carrier supply. The checks required and the paragraphs describing these checks are listed in the following chart.

Check	Paragraph
Carrier supply output check	314
Carrier supply frequency check	315
Carrier supply circuits check	316
Carrier supply output adjustment	317
System alarm pilot output check	322
System alarm pilot output adjustment	323

314. Carrier supply output Check

a. Check to see that the CARR SUP-POWER cable is connected to the TA-219/U (fig. 120).

b. Connect a vacuum-tube voltmeter successively to each of the following pairs of terminals on terminal board TR901: 1 and 2, 4 and 5, 6 and 7, and 9 and 10. The voltmeter should read 0.69 to 1.1 volt at each of these pairs of terminals.

315. Carrier Supply Frequency Check

Connect a frequency meter to each of the following pairs of terminals on terminal board TB901: 1 and 2, 4 and 5, 6 and 7, and 9 and 10 (fig. 120). The frequencies measured on the frequency meter should be 8.00, 12.00, 16.00, and 20.00 kc, ±2 cps respectively. If the readings vary by more than ±2 cycles, check the 16-kc oscillator (para 249).

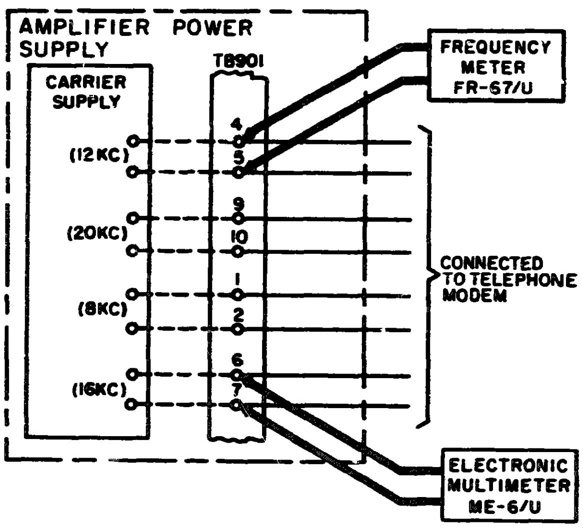


Figure 120. Carrier supply output and frequency checks, test arrangement.

316. Deleted.

317. Carrier Supply Output Adjustment

If the carrier supply output is not 0.69 to 1.1 volt (para 314), and the carrier supply circuits are operating normally, the carrier supply output should be adjusted. The adjustment procedure is described in a through g below.

a Remove the carrier supply plug-in assembly from the AM-682/TCC-3 (para 238).

b. Connect the carrier supply plug-in assembly to the AM-682/TCC-3 with the extension cable provided with the AN/TCC-3.

c. Connect the vacuum-tube voltmeter to terminals 4 and 5 of terminal board TB901 (figs. 150 and 151). Strap capacitors C615 and C616 (fig. 101) to obtain a maximum output as measured by the vacuum-tube voltmeter. The strap= ping procedure is described in d through g below.

d. Remove the strap from both capacitora C615 and C616. If the voltmeter reads 0.69 to 1.1 volt, the circuit is properly adjusted. If output voltage is not within the specified limits, follow the procedure given in e through *h* below.

e. Construct a chart similar to the chart below. Arrange the strapping of capacitors C615 and C616 with clip leads so that each strapping condition specified in the chart is obtained. For each strapping condition, record the output voltage. The strapping condition that produces the maximum output voltage is correct strapping for these capacitors. Solder wires in place of the clip leads in order to duplicate the correct strap ping condition..

Capacitors strapped	*Output voltage (to be recorded)*
Neither C615 or C616	
C615	
C616	
C615 and C616	

f. After the atrapping of capacitors C615 and

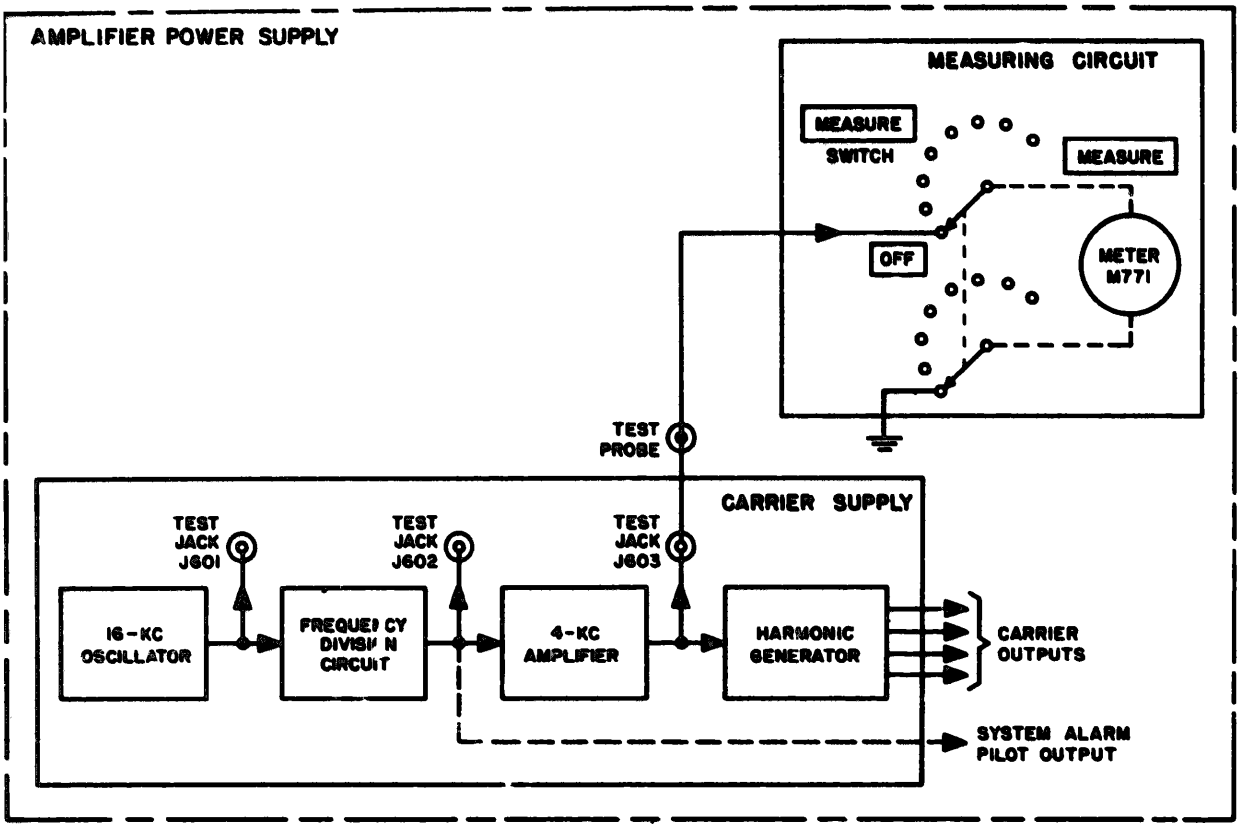


Figure 121. Carrier supply circuits check, test arrangement.

C616 has been completed (*e* above), strap capacitors C620 and C621 to obtain a minimum difference between the output voltages across terminals 4 and 5 and across terminals 9 and 10 of terminal board TB901. The procedure for strapping these capacitors is described in *g* below.

g. Construct a chart similar to the chart below. Arrange the strapping of capacitors C620 and C621 with clip leads so that each condition specified in the chart is obtained. For each strapping condition, record the output voltages. The strapping condition which produces the minimum difference between output voltages is the correct strapping for these capacitors. After determining the correct strapping, remove the clip leads and solder permanent straps in place.

Capacitors connected	Output voltages at TB901: Terminals 4, 5 (to be recorded)	Output voltages at TB901: Terminals 9, 10 (to be recorded)
Neither C620 nor C621		
C620		
C620 and C621		

h. Repeat the procedure in paragraph 314*b*. When a reading of 0.69 to 1.1 volt is not obtained at each specified measuring point, restrap C615 and C616 until a reading of 0.69 to 1.1 volt is obtained at each of the four measuring points.

318. Testing Transmitting Circuits

It is necessary to perform several checks when testing the transmitting gain. The checks required and the paragraphs describing these checks are listed in the chart below.

Check	Paragraph
System alarm cutoff check	319
Transmitting amplifier check	321
Check of 2W modem transmitting path	324
Modem transmitting path output adjustment	325
Check of SEND-MEAS switch in send position	326
Check of 4W modem transmitting path	327
4W Overload check	328
4W Frequency response check	329
Carrier leak check	330

319. System Alarm Cutoff Check

a. Remove the transmitting wires of the spiral-four cable stub from the 18-db attenuator. The red SYSTEM ALARM lamp and the amber CALL lamp should light and the buzzer should sound.

b. Operate the ALARM CUTOFF switch to the horizontal position. The buzzer should cut off, the CALL lamp should extinguish and the SYSTEM ALARM lamp should remain lighted.

c. Connect the transmitting wires of the cable stub to the ME-22/PCM (fig. 122).

320. Transformer Type Variations

a. In equipment bearing Order No. 1667-PH-51, transformer T761 may be either of two types. In some of the tests that follow, the type of transformer used affects the measurements taken. The transformers may be differentiated by the presence or absence of a black star at the end of the other markings on the transformer. In the tests which follow, two columns of measurements are provided, one for the starred transformer, and one for the transformer without a star.

b. Transformer T821 may be either of two types of transformers. These two types are differentiated in the same manner as are the two types used as transformer T761 (a above). The differences between the two types of transformers used as transformer T821 will not affect any of the tests in this or other sections. A third column is provided under "Readings on measuring set (dbm)" for equipment bearing order numbers other than Order No. 1667-PH-51.

321. transmitting Amplifier Check

a. Disconnect the TRANS-TEST-TALK cable from the AN/TCC-3.

b. Connect the signal generator to terminals 1 and 2 of terminal board TB801 (fig. 123).

c. Perform each of the six tests listed in the appropriate chart in *h* below. The procedure for the tests is described in *d* through h below.

d. Operate the AMP OUT switch of the transmitting amplifier to the position indicated for test 1 in the chart below.

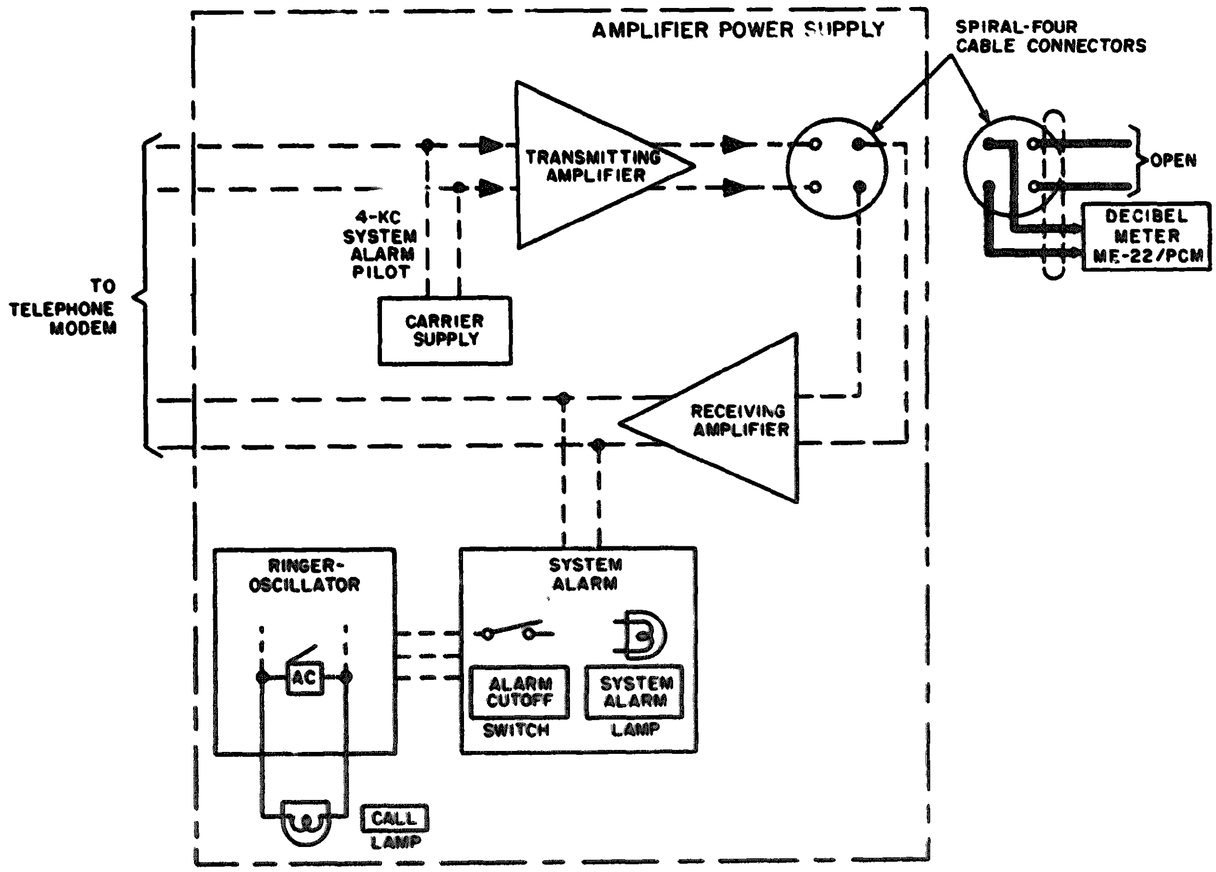


Figure 122. System alarm cutoff check, test arrangement.

Transmitting Amplifier Check Chart.

Test No.	AMP OUT switch positions	Signal generator setting		Reading on measuring set (dbm)				Measuring circuit	
		Frequency (KC)	Output Power (dbm)	T761 plain	T761 starred	Equipment bearing order numbers other than order No. 1667-PH-51	Equipment manufactured by General Instruments order No. 24483-TC-61-4	Position of MEASURE switch	Readings on MEASURE meter (db)
1	0 DB	1.00	−35.0	-0.6 ±.7	−0.8 ±.7	+1.3 ±0.5	-0.3 to -1.3	1KC–OW	0 ±2
2	0 DB	7.00	−35.0	-0.6 ±.7	−0.9 ±.7	+1.0 ±0.5	0 to -1.0	7KC–CH1	0 ±2
3	0 DB	11.00	−35.0	-0.8 ±.7	−1.3 ±.7	+1.1 ±0.5	-0.1 to -1.1	11KC–CH2	1 ±2
4	0 DB	15.00	−35.0	-1.3 ±.7	−2.0 ±.7	+1.3 ±0.5	-0.3 to -1.3	15KC–CH3	1 ±2
5	0 DB	19.00	−35.0	-1.7 ±.7	−2.7 ±.7	+1.6 ±0.5	-0.6 to -1.6	19KC–CH4	1 ±2
6	10 DB	19.00	−35.0	+8.3 ±.7	+7.3 ±.7	+8.5 ±0.5	+8.5 to +9.5	19KC–CH4	1 ±2

C

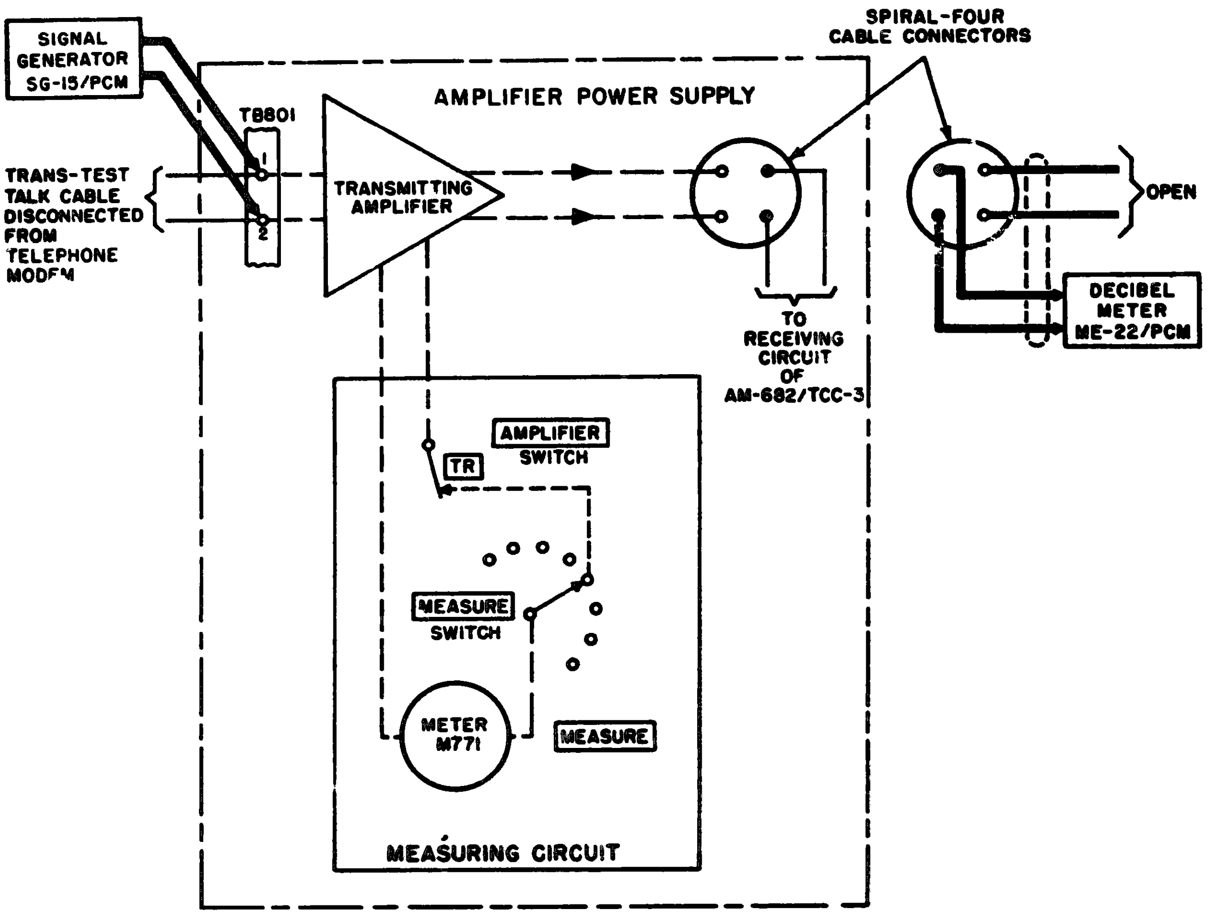


Figure 123. Test of transmitting amplifier, test arrangement.

e. Set the signal generator frequency and its output to the values indicated for test 1 in the chart below.

f. Check to see that the ME-22/PCM is connected to the transmitting wires of the cable stub. Check that the output reading on the ME-22/PCM is within the limits indicated for test 1 in the chart below. Record the measured reading.

g. Operate the MEASURE switch to the position indicated for test 1 in the chart below Hoid the AMPLIFIER switch in the TR position. Check that the reading on the MEASURE meter is as indicated for test 1 in the chart below.

h. Repeat *d* through *g* above for each of tests 2 through 6. Chart is on page 254.1.

322. 4-kc System Alarm Pilot Output Check

a. Disconnect the signal generator from terminals 1 and 2 of terminal board TB801 (fig. 124).

b. Operate the transmitting amplifier AMP OUT switch to the 0 DB position.

c. The reading on the ME–22/PCM should be −25 dbm ±2. If the reading is not correct, perform the adjustment in paragraph 323.

323. 4-kc System Alarm Pilot Output Adjustment

If the reading on the MEASURE meter is not as indicated in paragraph 322, the output of the 4-kc pilot of the carrier supply should be adjusted as indicated in *a* through *c* below.

a. Remove the carrier supply plug-in assembly from the amplifier-power supply unit (para 238).

b. Connect the carrier supply plug-in assembly to the amplifier-power supply unit with the extension cable.

c. Strap resistors R629 and R654 on the carrier supply subpanel so that the correct reading on the ME–22/PCM (para 322) is obtained. The general principles of the strapping procedure are described in paragraph 302*a*. If the correct reading on the ME–22/PCM is not obtained, connect resistor R655, 100 ohms, between standoff E609 and ground.

324. Check of Channel Modem Transmitting Paths

a. Connect the TRANS-TEST-TALK cable to the TA–219/U.

b. Operate the AMP OUT switch of the transmitting amplifier of the channel modems to the 0 DB position.

c. Operate the 2W–4W switch to the 2W position.

d. Connect the ME–22/PCM to the transmitting wires of the spiral-four cable stub.

e. Connect the signal generator to the 2W 4W–T binding posts of channel 1 modem.

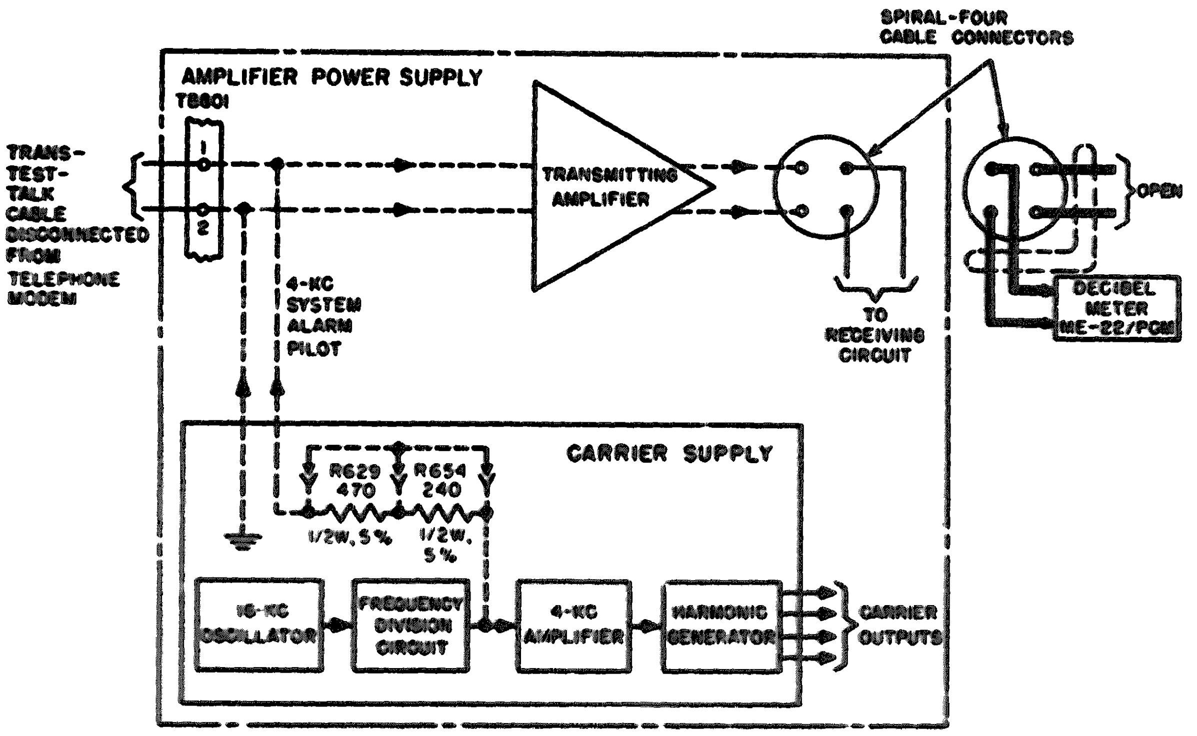


Figure 124. 4-kc system alarm pilot check, test arrangement.

f. Adjust the signal generator frequency to 1 kc and its output to 0 dbm.

g. Check the reading obtained on the ME-22/PCM. The reading for channel 1 should be within 0.5 dbm of the reading obtained on the ME-22/PCM for test 2 of paragraph 321. Record this reading.

h. Repeat the procedure of e through g above for each of the other channel modems. The readings obtained for channels 2, 3, and 4 modems should be within 0.5 dbm of the readings obtained on the ME-22/PCM in tests 3, 4, and 5, respectively (para 321). Record these readings.

325. 2W Modem Transmitting Path Output Adjustment

a. If the readings on the ME-22/PCM do not conform to the values specified for one channel in paragraph 324, the following resistors should be strapped: resistors R116 and R143 in channel 1, resistors R216 and R243 in channel 2, resistors R316 and R343 in channel 3, and resistors R416 and R443 in channel 4. Because these resistors are in parallel with the output circuit (fig. 125), shorting out these resistors decreases the output voltage. The strapping procedure used *for* channel 1 is described in detail. The procedure used for adjusting the other three channels is similar. For purposes of explanation the output voltage initially is too low. It is necessary to add resistance to the circuit to increase the output voltage.

b. Construct a chart for the channel under test similar to the chart below. The chart shown is used with channel 1 modem. A similar chart must be constructed for each of the other channels. Arrange the strapping of resistors R116 and R143 so that each strapping condition specified in the chart is obtained. For each strapping condition, record the output power (dbm) as indicated on the ME-22/PCM. The strapping condition that produces the output power closest to that specified in paragraph 324 is the correct strapping for these resistors. After determining the correct strapping, remove the clip leads and solder permanent straps in place.

Resistors strapped	Output power (to be recorded)
Neither R116 nor R143	
R116	
R143	
R116 and R143	

326. Check of SEND-MEAS Switch in SEND Position

The chart below indicates the procedure to be followed in testing the four SEND-MEAS switches on the four channels when these switches are operated to the SEND position. The test procedure for the four switches is the same.

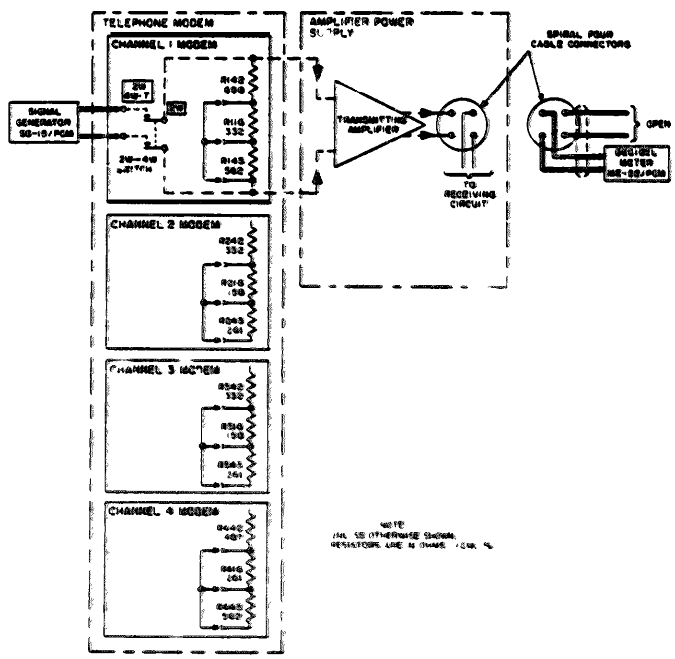


Figure 125. Check of modem transmitting path, test arrangement.

The switches should be tested in the order indicated in the chart below.

a. Operate the SEND-MEAS switch of the channel modem being tested to the SEND position. Operate the SEND-MEAS switches of the other channel modems to the vertical position.

b. Operate the MEASURE switch to TEST OSC position. Adjust the TEST OSC OUTPUT knob for a 0 db reading on the MEASURE ma ter.

c. Operate the MEASURE switch to the position indicated in the third column of the chart.

d. Hold the AMPLIFIER switch in the TR position.

e. The reading on the MEASURE meter should be as indicated in the fourth column of the chart.

f. The reading on the ME-22/PCM should be as indicated in the fifth, sixth, or seventh column of the chart, depending on the type of transformer used as transformer T761 in the particular AN/TCC-3 under test (para 320).

Test No.	CHANNEL modems tested	MEASURE switch position	MEASURE meter reading (db)	ME-22/PCM reading (dbm) T761, plain WECO	T761, starred WECO	Equipment bearing order numbers other than order No. 1667-PH-51
1	1	7KC-CH1	+0.8 ±1.5	-0.6 ±1	−0.9 ±1	+1.0 ±0.5
2	2	11KC-CH2	+1.2 ±1.5	-0.8 ±1	−1.3 ±1	+1.1 ±0.5
3	3	15KC-CH3	+1.6 ±1.5	-1.3 ±1	−2.0 ±1	+1.3 ±0.5
4	4	19KC-CH4	+1.7 ±1.5	-1.9 ±1	−2.9 ±1	+1.6 ±0.5

NOTE: All other equipment should read between +0.5 and -1.0 dbm on the ME-22/PCM.

327. Check of 4W Modem Transmitting Path

a. Operate all four of the SEND-MEAS switches to the normal (vertical) position.

b. The TRANS-TEST-TALK cable should remain connected to the modem unit.

c. Operate the AMP OUT switch of the transmitting amplifier to the 0 DB position.

d. Operate the 2W-4W switch to the 4W position.

e. Connect the ME-22/PCM to the transmitting wires of the spiral-four cable stub.

f. Connect the signal generator to the 2W 4W-T binding posts of channel 1 modem.

g. Adjust the signal generator frequency to 1 kc and its output to −3.8 dbm.

h. Check the reading obtained on the ME-22/PCM. It should be within 0.3 dbm of the final reading recorded for channel 1 modem in paragraph 326. Record this reading.

i. Repeat the procedure in *f* above for each of the other channel modems. The readings obtained for channels 2, 3, and 4 modems should be within 0.3 dbm of the readings obtained for these channel modems in paragraph 326. Record the readings.

328. 4W Overload Check

Change the output of the signal generator to +11.2 dbm and repeat the procedure described in paragraph 327*a* through *f* for each of the four channels. The readings on the ME-22/PCM should be not more than 8 dbm greater than the corresponding reading obtained in paragraph 327. Record these readings.

329. 4W Frequency Response Check

a. Connect the signal generator to the 2W 4W-T binding posts of channel 1 modem.

b. Adjust the signal generator frequency to 325 cps and its output power to −3.8 dbm. The output reading as indicated on the ME-22/PCM should be less than the output reading for channel 1 modem (para 327*i*) by an amount equal to that given in the chart below. Record the obtained output reading.

Test No	Channel modem to which signal is applied	Difference in readings in dbm: With 325-cps input	With 3450-cps input
1	1	0.8 ±1 7	0.6 ±1.7
2	2	0.8 ±1.7	0.6 ±1.7
3	3	0.8 ±1.7	0.6 ±1.7
4	4	0.8 ±1.7	0.6 ±1.7

c. Adjust the signal generator frequency to 3,450 cps and its output power to −3.8 dbm. The output reading as indicated on the ME-22/PCM should be less than the output reading for channel 1 modem (para 327*h*) by an amount equal to that given in the chart above. Record the obtained output reading.

d. Repeat a through c above for each of the other channel modems. The output readings must be compared to the recorded output reading obtained for the same channel modem in paragraph 327*i*.

330. Carrier Leak Check

In an ideal situation, there is no carrier frequency output from any channel modem transmitting path. In a practical situation, each channel modem does have a small output at the carrier frequency. Any output at the carrier frequency is known as a carrier leak. The power level of the carrier leak must not exceed a predetermined level. The carrier leak check measures the level of the carrier leak. In making the carrier leak check for any one channel modem (fig. 126), the other three carrier frequencies are shorted out. In this manner, the carrier leak of only one channel is measured on the ME-22/PCM. The procedure for making the carrier leak test is explained in a through d below.

a Disconnect the signal generator.

b. Operate the AMP OUT switch of the transmitting amplifier to the 10 DB position.

c. Short out the three carrier frequencies not being measured by shorting out the terminals for these carrier frequencies on terminal board TB901. The terminals to be shorted out in each test are listed in the chart (d below). Short out the system alarm pilot as follows:

(1) In AM-682/TCC-3 bearing Order No. 1667-Phila-51, aerial numbers 1 through 1701, strap terminals 4 and 5 of terminal board TB908.

(2) In AM-682/*TCC-3* bearing Order No. 1667-Phila-51, serial numbres 1708 through 3180, strap terminals 4 and 5 of terminal board TB904,

(3) On equipment bearing order numbers other than Order No. 1667-Phila-51, strap terminals 1 and 2 of terminal board TB904.

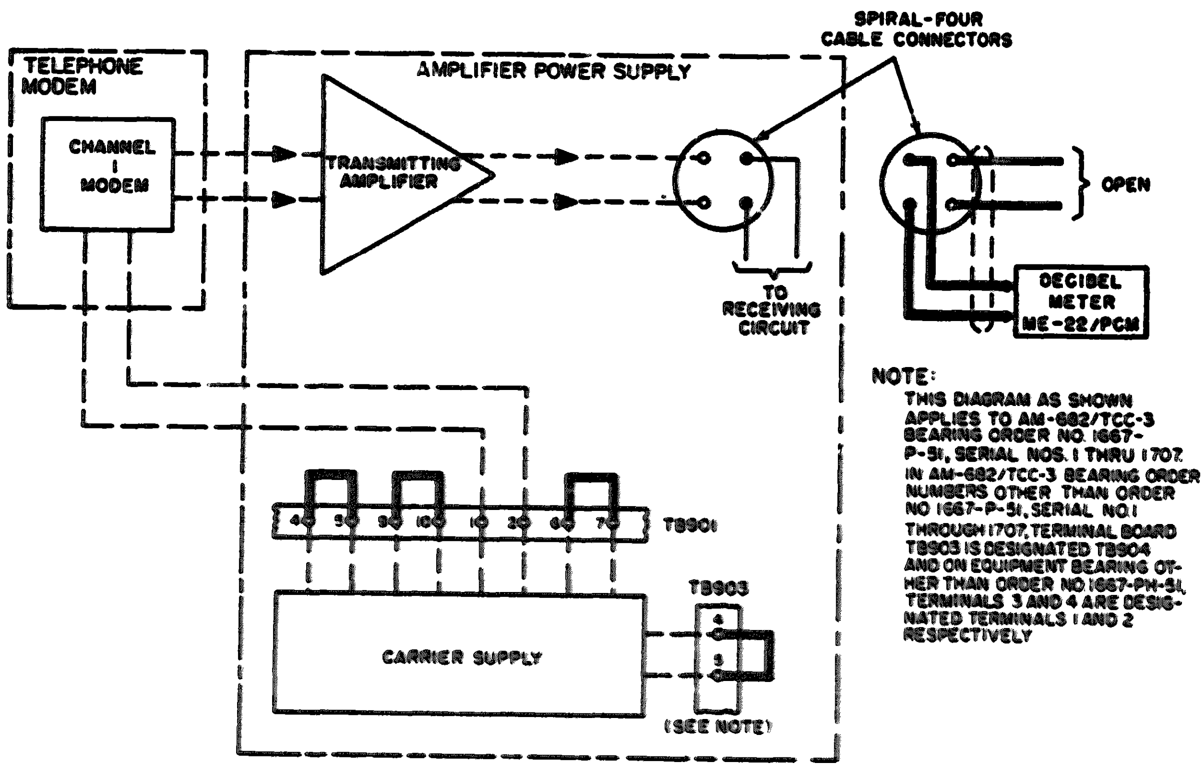


Figure 126. Carrier lock check, channel 1 modem, test arrangement.

d. Check the reading on the ME-22/PCM. This reading should not exceed the readings given in the chart below.

Test No.	Channel modem	Terminals shorted	Maximum reading (dbm)
1	1	4-5, 6-7, 9-10	-30
2	2	1-2, 6-7, 9-10	-30
3	3	1-2, 4-5, 9-10	-30
4	4	1-2, 4-5, 6-7	-30

331. Order Wire Transmitting Circuit Tests

It is necessary to perform several checks when testing the order wire transmitting circuit. The checks required and the paragraphs describing these checks are listed in the chart below.

Check	Paragraph
Order wire transmitting circuit check	332
SEND OW switch check	333
Check of 4-kc loss of filter FL721	334
Overload check	335

332. Order Wire Transmitting Circuit Check

a. Loosen the six, front-panel, captive screws of the AM-682/TCC-3 and pull the AM-682/TCC-3 part way out of the transit case. Connect the signal generator to the ORDER WIRE binding posts. Operate the AMP OUT switch of the transmitting amplifier to the 0 db position.

b. Adjust the signal generator frequency to 300 cps and its output to 0 dbm. Check the reading on the ME-22/PCM. The reading should be -2.5 ±1 dbm.

c. Adjust the signal generator frequency to 1 kc and its output to 0 dbm (fig. 127). Check the reading on the ME-22/PCM. The reading should be 1.0 ±1.5 dbm. Operate the MEASURE switch to the 1KC-OW position and hold the AMPLIFIER switch at TR. The reading on the MEASURE meter should be -1 ±1.5 dbm.

333. SEND OW Switch Check

a. Disconnect the signal generator from the ORDER WIRE binding posts (fig. 127).

b. Operate the MEASURE switch to TEST OSC position. Adjust the TEST OSC OUTPUT control to obtain a reading of 0 db on the MEASURE meter.

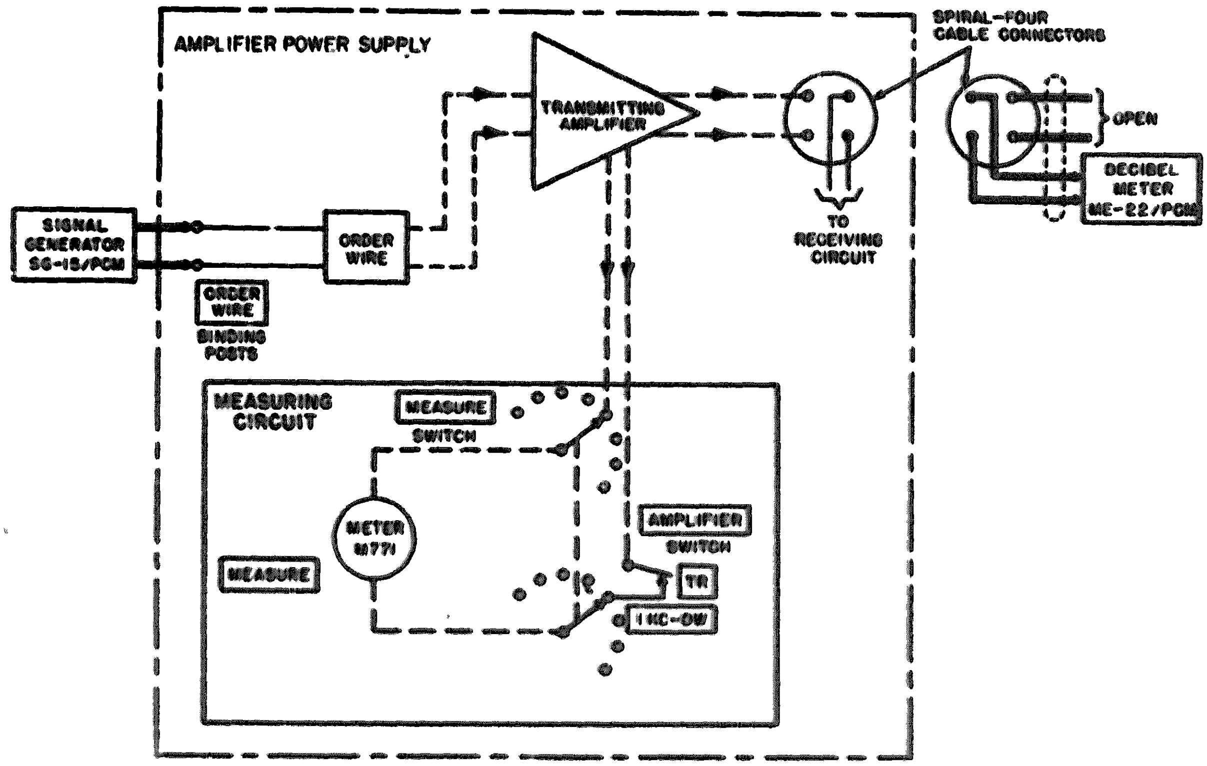


Figure 127. Order wire transmitting circuit check, test arrangement.

c. Operate the SEND OW switch to the horizontal position. Check the reading on the ME-22/PCM. The reading should be 0 ±1.5 dbm.

d. Return the SEND OW switch to the vertical position.

334. Check of 4-kc Loss of Filter FL721

a Connect the signal generator to the ORDER WIRE binding posts. Disconnect the TRANS-TEST-TALK cable from the TA-219/U. In *AM*-682/TCC-3 bearing Order No. 1667-Phila-51, serial numbers 1 through 1707, connect a clip lead across terminals *4* and 5 of terminal board TB903. In AM-682/TCC-3 bearing Order No. 1667-Phila-51, serial numbers 1708 through 3180, connect a clip lead across terminals 4 and 5 of terminal board TB904 (fig. 129). On equipment bearing order numbers other than Order No. 1667-Phila-51, connect a clip lead across terminals 1 and 2 of terminal board TB904.

b. Adjust the signal generator frequency to 4 kc and its output power to 0 dbm. Check the *reading* on the ME-22/PCM. This reading should be at least -25 or more negative.

335. Overload Check

a Remove the strap *from the* terminals of TB903 or TB904 (para 334a) as applicable. The signal generator is connected the same as for the test in paragraph 334.

b. Adjust the signal generator frequency to 1.00 kc and its output power to +15 dbm. Check the reading on the ME-22/PCM. This reading should not be more than + 8.0 dbm.

336. Testing Ringer-Oscillator as an Oscillator

It is necessary to check the output power and frequency when checking the ringer-oscillator

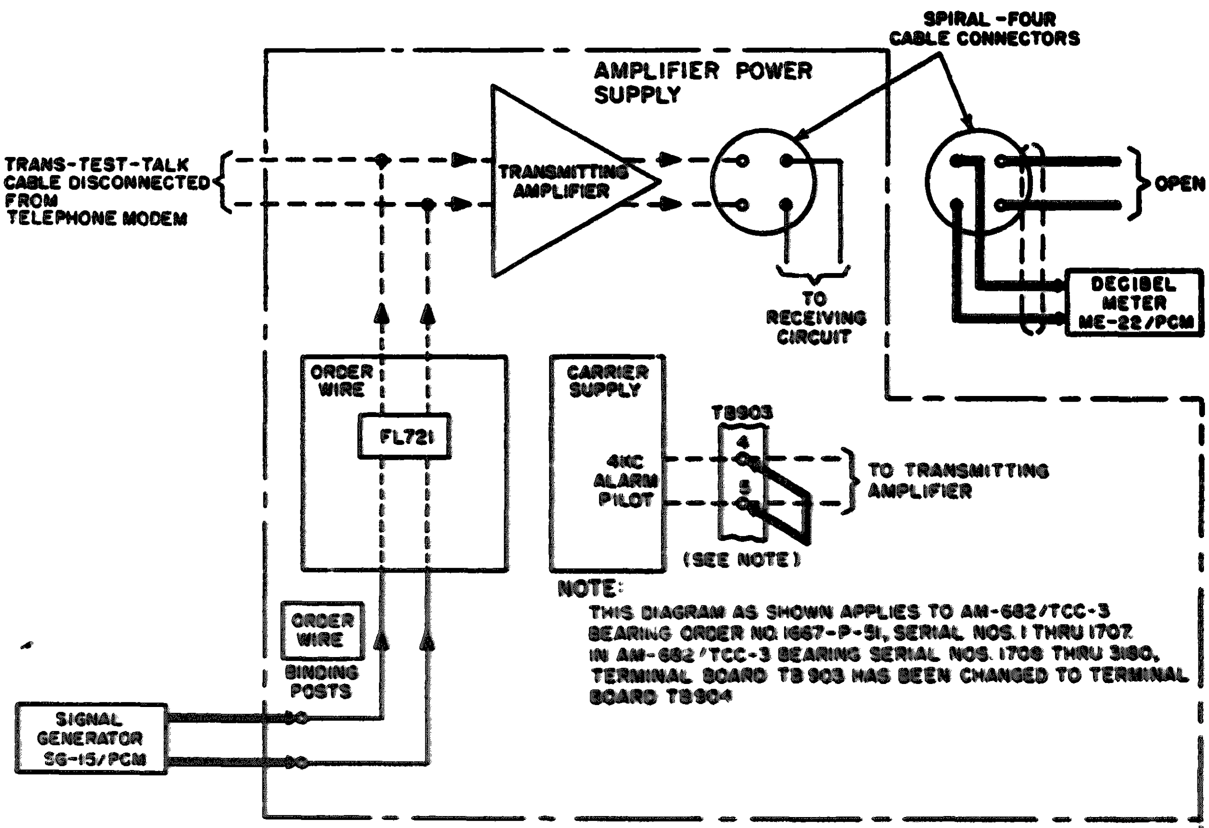


Figure 128. Check of 4-kc loss of filter FL721, test arrangement.

(para 337 and 338). If the frequency is not accurate, follow the procedure of paragraph 339 to adjust the ringer-oscillator frequency.

337. Ringer-Oscillator Output Power Check

a. **Disconnect the signal generator from the ORDER WIRE binding posts.**

b. **Hold the ORDER WIRE switch in the RING position. The buzzer should sound and the CALL lamp should light.**

c. **Check the reading on the ME–22/PCM. On equipment that uses transformer T761 that is not starred (Order No. 1667–Phila–51), the reading should be 0 dbm ±2; on equipment that uses transformer T761 that is starred (same order number), the reading should be −0.1 dbm ±2 ; on equipment bearing order numbers other than Order No. 1667–Phila–51, the reading should be 0 dbm ±1.5.**

338. Ringer-Oscillator Frequency Check

a. **Disconnect the ME–22/PCM from the spiral-four cable stub and connect the frequency meter to the transmitting wire of the stub.**

b. **Hold the ORDER WIRE switch in the RING position. The buzzer should sound and the CALL lamp should light.**

c. **Check the reading on the frequency meter. The reading should be 1,600 ±1.6 cycles.**

339. Ringer-Oscillator Frequency Adjustment

If the correct reading is not obtained on the frequency meter (para 338), the frequency of the ringer-oscillator must be adjusted. The general procedure for adjusting the ringer-oscillator frequency is described in *a* and *b* below.

a. General Procedure.

(1) Hold the ORDER WIRE switch in the RING position and adjust variable capacitor C5 while observing the reading on the frequency meter. If the correct reading is not obtained by adjusting capacitor C5, remove the ringer-oscillator plug-in assembly from the AM–682/TCC–3.

(2) Connect the ringer-oscillator to the AM–682/TCC–3 with the extension cable supplied with the AN/TCC–3.

(3) The ringer-oscillator frequency is adjusted by strapping the correct combination of capacitors C7, C8, and C9 into the tuned circuit which consists of winding 3–5 of transformer T3, fixed capacitor C6, and variable capacitor C5 (fig. 154). Connecting one or more of capacitors C7, C8, and C9 into the circuit increases the total capacitance and reduces the frequency of the tuned circuit. Disconnecting one or more of these capacitors from the remainder of the tuned circuit decreases the total capacitance and increases the frequency of the tuned circuit.

(4) After each strapping arrangement is connected, adjust variable capacitor C5. Several strapping arrangements may need to be tried before the correct combination of capacitors is found. If clip leads have been used to obtain the correct strapping procedure, replace these clip leads with soldered connections.

(5) Disconnect the extension cable and replace the ringer-oscillator in the AM–682/TCC–3. Readjust variable capacitor C5 to bring the ringer-oscillator frequency to 1,600 ±1.6 cps. Seal the adjusting screw with glyptol.

b. Detailed Procedure.

(1) The chart below indicates the capacitor combination strapped (connected in parallel) in the tuned circuit that determines the frequency of the ringer-oscillator. The chart also indicates the range through which the total capacitance for each strapping arrangement can be varied by adjusting capacitor C5 from its minimum to its maximum values. Variable capacitor C5 is adjustable between 20 and 125 μμf. This range of 105 μμf and the strapping of capacitors C7, C8, and C9 makes it possible to obtain any value of capacitance between 3920 μμf and 4626 μμf. The ringer-oscillator frequency can be accurately adjusted within this range of capacitance.

Capacitor combination	*Range of total capacitance (μμf)*
C5 and C6	3920 to 4025
C5, C6, and C7	4011 to 4116
C5, C6, and C8	4100 to 4205
C5, C6, C7, and C8	4191 to 4296
C5, C6, and C9	4250 to 4355
C5, C6, C7, and C9	4341 to 4446
C5, C6, C8, and C9	4430 to 4535
C5, C6, C7, C8, and C9	4521 to 4626

(2) After the ringer-oscillator plug-in assembly has been removed from the AM–682/TCC–3 (para 238), and the extension cable has been connected in place, examine the ringer-oscillator circuit to determine which capacitor combination is connected in the tuned circuit.

(3) If the reading on the frequency meter is too low, it is necessary to decrease the total capacitance in the tuned circuit. Reconnect the

tuned circuit so that the strapping arrangement with the next lowest value of total capacitance is connected in the circuit. If the reading on the frequency meter is too high, it is necessary to increase the total capacitance in the tuned circuit. Reconnect the tuned circuit so that the strapping arrangement with the next highest value of total capacitance is connected in the circuit.

(4) Hold the ORDER WIRE switch in the RING position and again read the frequency as indicated on the frequency meter. Adjust variable capacitor C5 and if the correct reading of 1,600 ±1.6 cps cannot be obtained, repeat (3) above until the correct reading is obtained.

(5) Disconnect the extension cable from the ringer-oscillator and from the AM–682/TCC–3. Replace the ringer-oscillator plug-in assembly in the AM–682/TCC–3. After the ringer-oscillator has been replaced, readjust capacitor C5 and seal the adjusting screw with glyptol.

(6) If the correct reading cannot be obtained by this procedure, it is necessary to repair the circuit.

340. AM-682/TCC-3 Receiving Circuit Tests

It is necessary to perform several checks when testing the receiving circuits of the AM–682/TCC–3. The checks required and the paragraphs describing these checks are listed in the chart below.

Check	Paragraph
1-kc equalizer range check	341
AMPLIFIER SWITCH in REC position	342
19-kc equalizer range check	343
11-kc equalizer range check	344
4-kc system alarm sensitivity check	345
Demodulator GAIN control range check	346
Check of SEND-MEAS switch in MEAS position	347
Channel receiving frequency response check on 4W	348
Channel receiving 1000-cycle response check on 2W	349
Modem hybrid coils balance check	367

341. 1-kc Equalizer Range Check

a. Connect the signal generator to the input terminals of the spiral-four connector (fig. 129). Disconnect the TRANS-TEST-TALK cable connector, P898, from the modem unit. Connect ME–22/PCM across terminals 3 and 4 of terminal board TB801. Operate the FLAT-1KC, BULGE-11KC, and SLOPE-19KC controls fully counterclockwise.

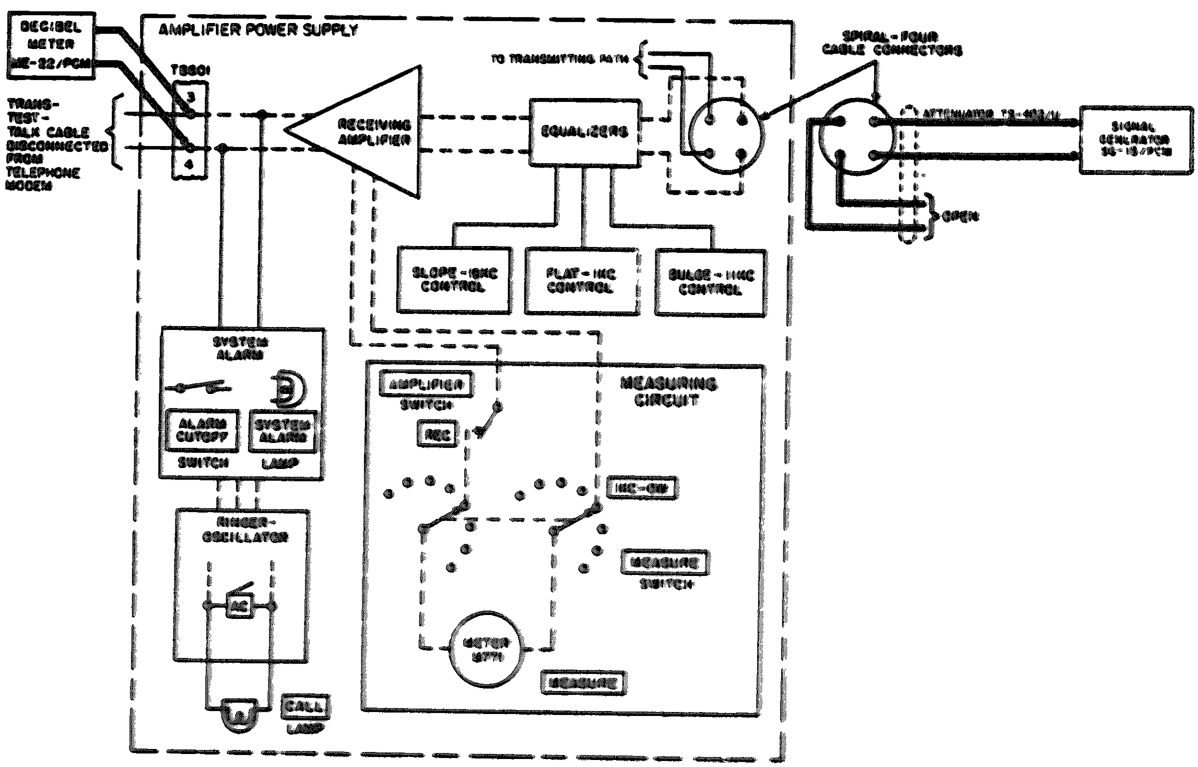


Figure 129. 1-kc equalizer check, test arrangement.

b. Adjust the frequency of the signal generator to 1 kc. Adjust its output to −18 dbm.

c. Operate the ALARM CUTOFF switch to the horizontal position. The red SYSTEM ALARM lamp should light. The CALL lamp should be extinguished and the buzzer should not sound.

d. Operate the FLAT-1KC control to its extreme clockwise position. The ME-22/PCM should read between +2 and +4 dbm.

e. Operate the FLAT-1KC control to the extreme counterclockwise position. The ME-22/PCM should read less than −19.8 dbm.

f. Adjust the FLAT-1KC equalizer control so that the ME-22/PCM reads 0 dbm.

342. AMPLIFIER SWITCH Check in REC Position

After the procedures of paragraph 341 have been performed, operate the MEASURE switch to the 1KC-OW position and hold the AMPLIFIER SWITCH in the REC position. Check the reading on the MEASURE meter. This reading should be 0 ±1.5 dbm.

343. 19-kc Equalizer Range Check

The connections for this check are the same as those for paragraph 341. The procedure for the check is given in *a* through *d* below.

a. Adjust the signal generator frequency to 19 kc. Adjust its output to −18 dbm.

b. Operate the SLOPE-19KC control to its extreme clockwise position. The ME-22/PCM should read more than +5.9dbm.

c. Operate the SLOPE-19KC control to its extreme counterclockwise position. The ME-22/PCM should read between -2.5 and -5.0 dbm.

d. Adjust the SLOPE-19KC control so that ME-22/PCM reads 0 dbm.

344. 11-kc Equalizer Range Check

The connections for this check are the same as those for paragraph 341. Follow the procedure in *a* through *d* below.

a. Adjust the signal generator frequency to 11 kc. Adjust its output to −18 dbm

b. Operate the BULGE-11KC control to its extreme clockwise position. The ME-22/PCM should read more than +2.0 dbm.

c. Operate the BULGE-11KC control to its extreme counterclockwise position. The ME-22/PCM should read between -0.5 and -2.5 dbm.

d. Adjust the BULGE-11KC equalizer control so that the ME-22/PCM reads 0 dbm.

345. 4-kc System Alarm Sensitivity Check

a. Connect the TRANS-TEST-TALK cable to the modem unit. Check to see that the ALARM CUTOFF switch is in the horizontal position.

b. Connect the signal generator as shown in figure 129. Adjust the signal generator frequency to 4 kc and its output to −51 dbm. The CALL lamp should light. The red SYSTEM ALARM lamp should be extinguished. The buzzer should sound.

c. Operate the ALARM CUTOFF switch to the normal (vertical) position. The CALL lamp should be extinguished. The buzzer should not sound. The red SYSTEM ALARM lamp should remain extinguished.

d. Connect an attenuator between the signal generator and the spiral-four cable stub. Adjust the output of the signal generator and set the db loss of the TS-402/U so that −63 dbm signal is applied to the spiral-four cable stub. The red SYSTEM ALARM lamp should light. The CALL lamp should light. The buzzer should sound.

e. Operate the ALARM CUTOFF switch to the horizontal position. The CALL lamp should be extinguished. The buzzer should not sound, and the SYSTEM ALARM lamp should stay lighted.

346. Demodulator GAIN Control Range Check

The chart below lists the data for the checks to be made on each of the four channel modems. The procedure for making these tests is described in *a* through *d* below.

a. Connect the signal generator as shown in figure 130. Set the signal generator output to −18 dbm. Adjust the frequency of the signal generator to the value indicated in the chart for the channel modem being checked.

b. Operate the 2W-4W switches to the 4W position. Connect the ME-22/PCM to the 4W-R binding posts of the channel modem being checked (fig. 130).

c. Operate the GAIN control of the channel modem being checked to its extreme counterclockwise and extreme clockwise positions. Note the reading on the ME-22/PCM for each position of the GAIN control. With the GAIN control in

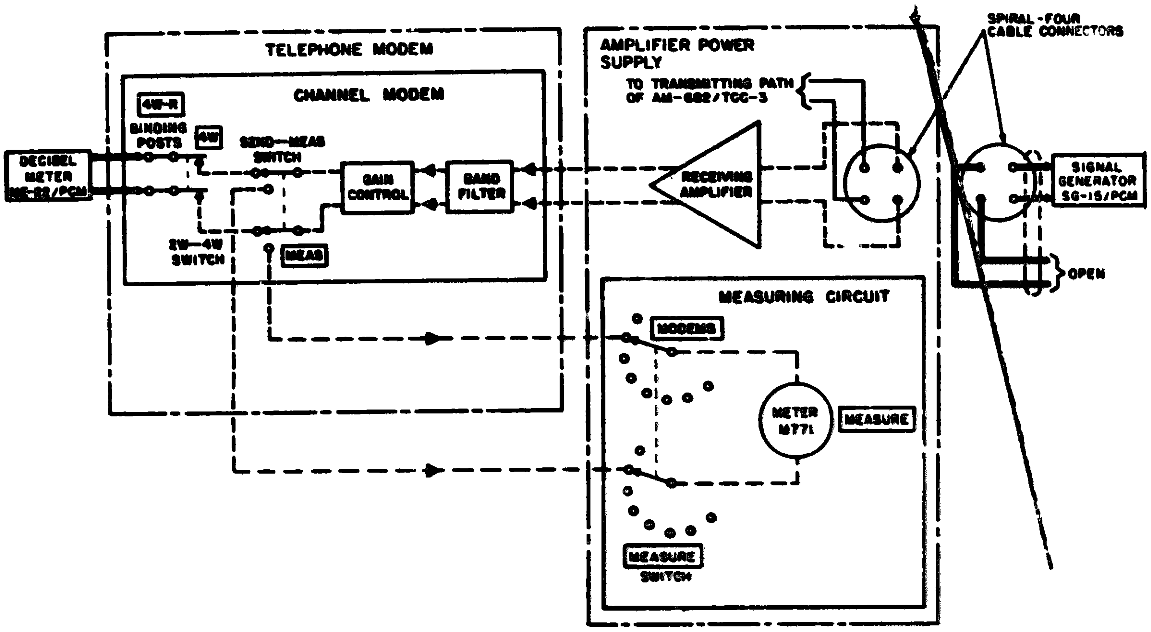


Figure 130. Channel receiving checks, test arrangement.

one position, a maximum reading should be obtained. With the GAIN control in the other position, a minimum reading should be obtained. The maximum readings should be not less than the values of output listed in the chart below. The minimum reading for any channel should be at least 20 dbm lower than the maximum reading for that channel.

Channel modem	*Signal generator frequency (kc)*	*Minimum output (dbm)*
1	7	+8
2	11	+8
3	15	+8
4	19	+7

d. After testing a channel modem, and before proceeding to test the next channel modem, adjust the GAIN control of that channel so that the output of the channel modem will be +1 dbm as read on the ME-22/PCM.

347. Check of SEND-MEAS Switch in MEAS Position

This check is performed after the GAIN controls of the four channels have been adjusted to +1 dbm (para 346). The connections for this check are the same as those for paragraph 346.

a. Adjust the signal generator successively to the frequencies indicated in the chart of paragraph 346. Adjust the signal generator output to −18 dbm at each of the frequencies.

b. Operate the MEASURE switch to the MODEMS position.

c. Hold the SEND-MEAS switch of each channel being tested in the MEAS position.

d. Check the reading on the MEASURE meter. The reading should be 0 ±0.5 db.

348. Channel Receiving Frequency Response Check on 4W

The connections for this check are the same as those for paragraph 346.

a. Connect the ME-22/PCM to the 4W-R binding posts of the channel 1 modem.

b. Adjust the signal generator to the frequency that will produce an output frequency of 325 cps at the 4W-R binding posts. For channel modem, the signal generator frequency is 7,675 cps. Adjust the signal generator output power to −18 dbm.

c. Check the output reading on the ME-22/PCM. The reading should be +0.3 ±2.4 dbm.

d. Adjust the signal generator to the frequency that will produce an output frequency 3,450 cps at the 4W-R binding posts. For channel 1 modem, the signal generator frequency is 4,550 cps. If necessary, readjust the signal generator output power to −18 dbm.

e. Check the output reading on the ME-22/PCM. The reading should be +0.3 ±1.5 dbm.

f. Repeat the procedures in a through e above for each of the other channel modems. The signal generator frequencies to be used with each channel are given in the chart below.

Channel	'requency (cps) for 325-cps output	Frequency (csp) for 3,450-cps output
1	7,675	4,550
2	11,675	8,550
3	15,675	12,550
4	19,676	16,550

349. Channel Receiving 1000-Cycle Check on 2W

The connections for this check are the same as those for paragraph 346, with the exception of the changes indicated below.

a. Operate the 2W-4W switch to the 2W position.

b. Connect the ME-22/PCM to the 2W-4W-T binding posts of the channel.

c. For modems 1, 2, 3, and 4 *adjust* the signal generator frequency to 7, 11, 15, and 19 kc respectively.

d. Adjust the output of the signal generator to -18.2 dbm.

e. Check the reading on the ME-22/PCM. The reading should be -3 ±0.3 dbm.

350. Testing Order Wire Receiving Circuit

It is necessary to perform several checks when testing the order wire, receiving circuits. The checks required and the paragraphs describing these checks are listed in the chart below. The test arrangement for the order wire receiving circuit is shown in figure 131.

	Paragraph
Order wire receiving check	351
Filter FL722 check	352
Order wire hybrid coil balance check	353

351. Order Wire Receiving Circuit Check

a. Connect the ME-22/PCM to the ORDER WIRE binding posts (fig. 131).

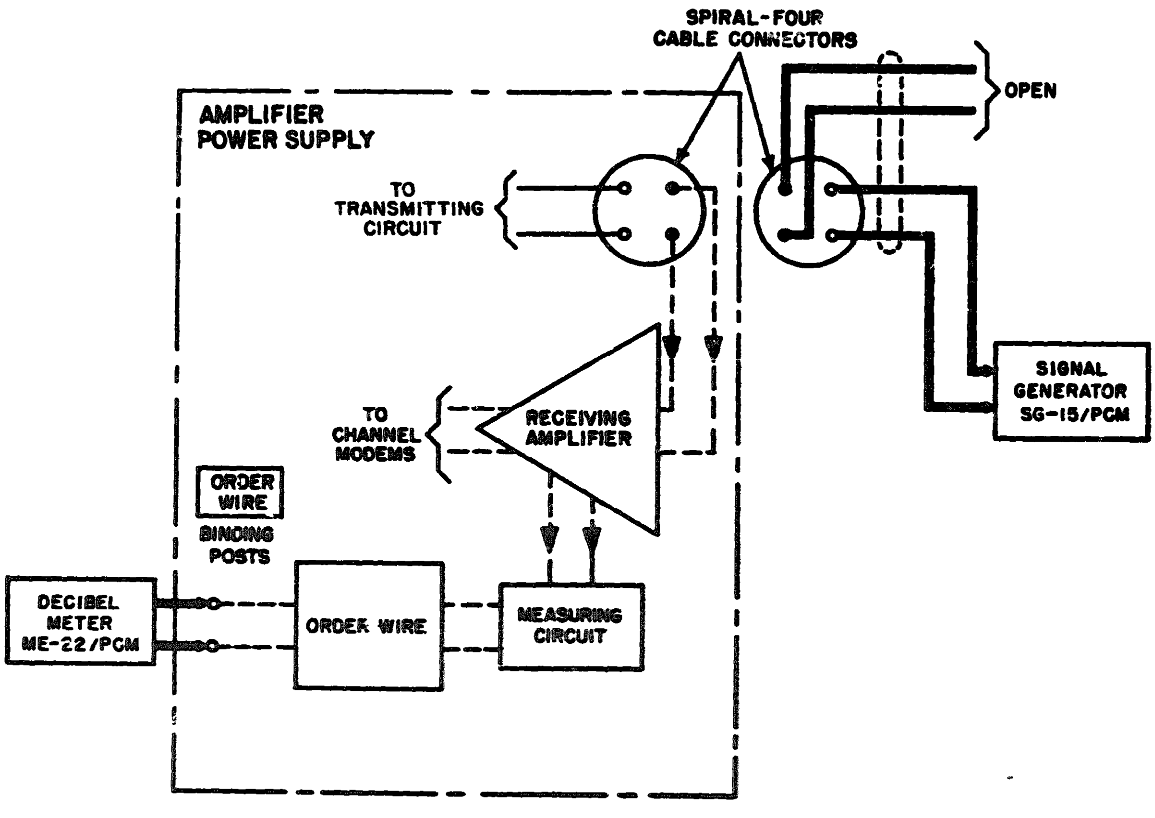


Figure 131. Order wire receiving circuit, test arrangement.

b. Adjust the signal generator
kc and its output to -18 dbm. Check the reading on the ME-22/PCM. The reading should be -11.4 ±1.5 dbm.

c. Adjust the signal generator frequency to 300 cps and its output to -18 dbm. Check *the* reading on the ME-22/PCM. The reading should be -15 ±2.0 dbm.

352. Filter FL722 Check

The connections are the same as those for paragraph 351. Adjust the signal generator frequency to 4 kc and its output to -18 dbm. Check the reading on the ME-22/PCM. The reading should be -39 dbm or more negative.

353. Order Wire Hybrid Coil Balance Check

a. Check to see that the ME-22/PCM is connected to the transmitting wires of the spiral-four cable. Connect a 600-ohm resistor in series with a 2uf capacitor or an equivalent capacitive network across the ORDER WIRE binding posts (fig. 132). On terminal board TB901, connect together terminals 1 and 2, terminals 4 and 5, terminals 6 and 7, and terminals 9 and 10. In AM-682/TCC-3 bearing Order No. 1667-Phila-51, serial numbers 1 through 1707, connect together terminals 4 and 5 of terminal board TB903. In AM-682/TCC-3 bearing Order No. 1667-Phila-51, serial numbers 1708 through 3180, connect together terminals 4 and 5 of terminal board TB904. On equipment bearing order numbers other than Order No. 1667-Phila-51, connect together terminals 1 and 2 of terminal board TB904. This eliminates the possibility of carrier leak and 4-kc alarm pilot from affecting the hybrid coil balance reading.

b. Adjust the signal generator frequency to 1 kc and its output to -18 dbm.

c. Check the reading on the ME-22/PCM. The reading should be -37.5 dbm more negative.

354. Testing Ringer-Oscillator as a Ringer

It is necessary to perform two checks when testing the ringer oscillator. The checks required and

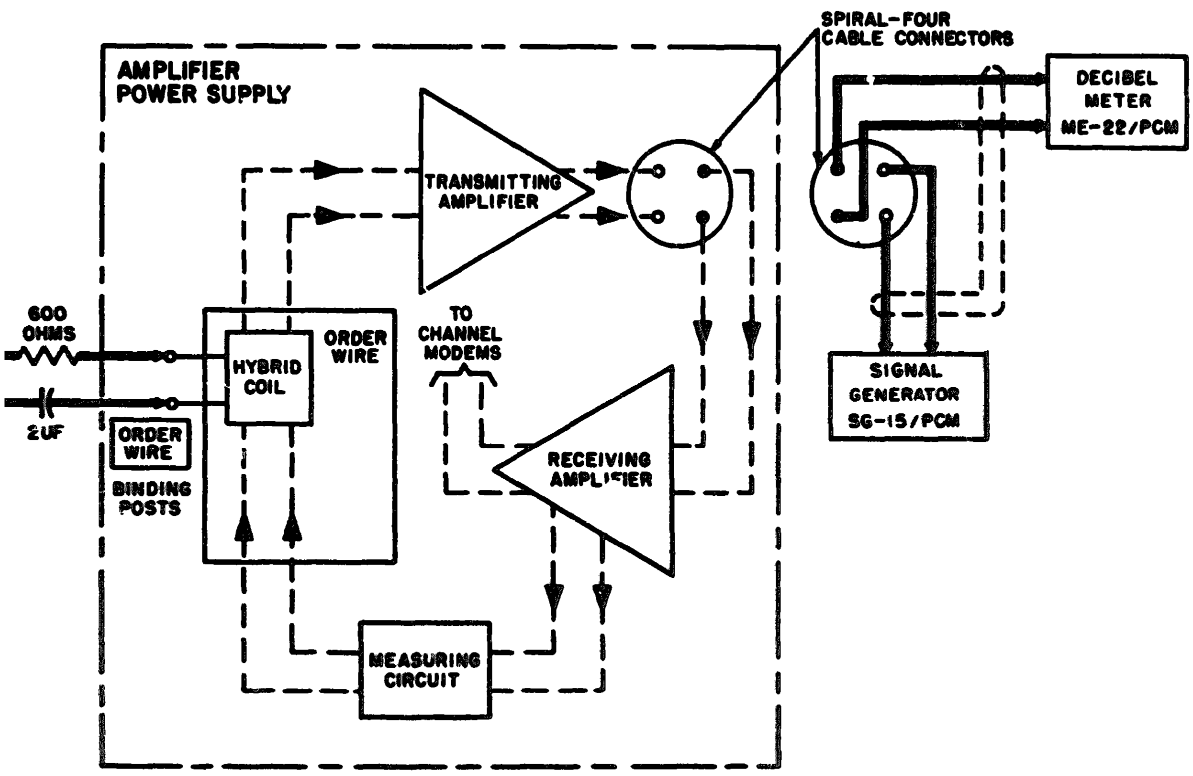


Figure 132. Test arrangement, order-wire hybrid coil balance check.

the paragraphs describing these checks are listed in the chart below.

Check	Paragraph
Sensitivity and ringer time response check	355
Guard circuit check	356

355. Ringer Sensitivity and Response-Time Check

a. Adjust the signal generator frequency to 1,600 ±4 cps and its output to −41 dbm. Connect the receiving wires of the spiral-four cable stub to the signal generator (fig. 133).

b. After a slight delay (approximately 0.2 second) the buzzer should sound and the CALL lamp should light.

c. Disconnect one of the spiral-four cable leads from the signal generator. The buzzer should be silenced without delay as soon as the signal generator lead is disconnected.

356. Guard Circuit Check

a. Connect the 18-db attenuator to the two receiving wires and the two transmitting wires of the spiral-four cable connector (fig. 134). Operate the MEASURE switch to the 1KC-OW position. Hold the AMPLIFIER switch to the TR position.

b. Operate the ORDER WIRE switch to the TALK position. Talk into the handset transmitter and check the reading on the MEASURE meter. Talk into the handset transmitter loudly enough to make the peaks on the MEASURE meter reach a value of 0 db.

c. The buzzer should not sound. The CALL lamp should not light.

357. Overall Testing

It is necessary to perform two checks when performing noise tests for the overall circuit. The

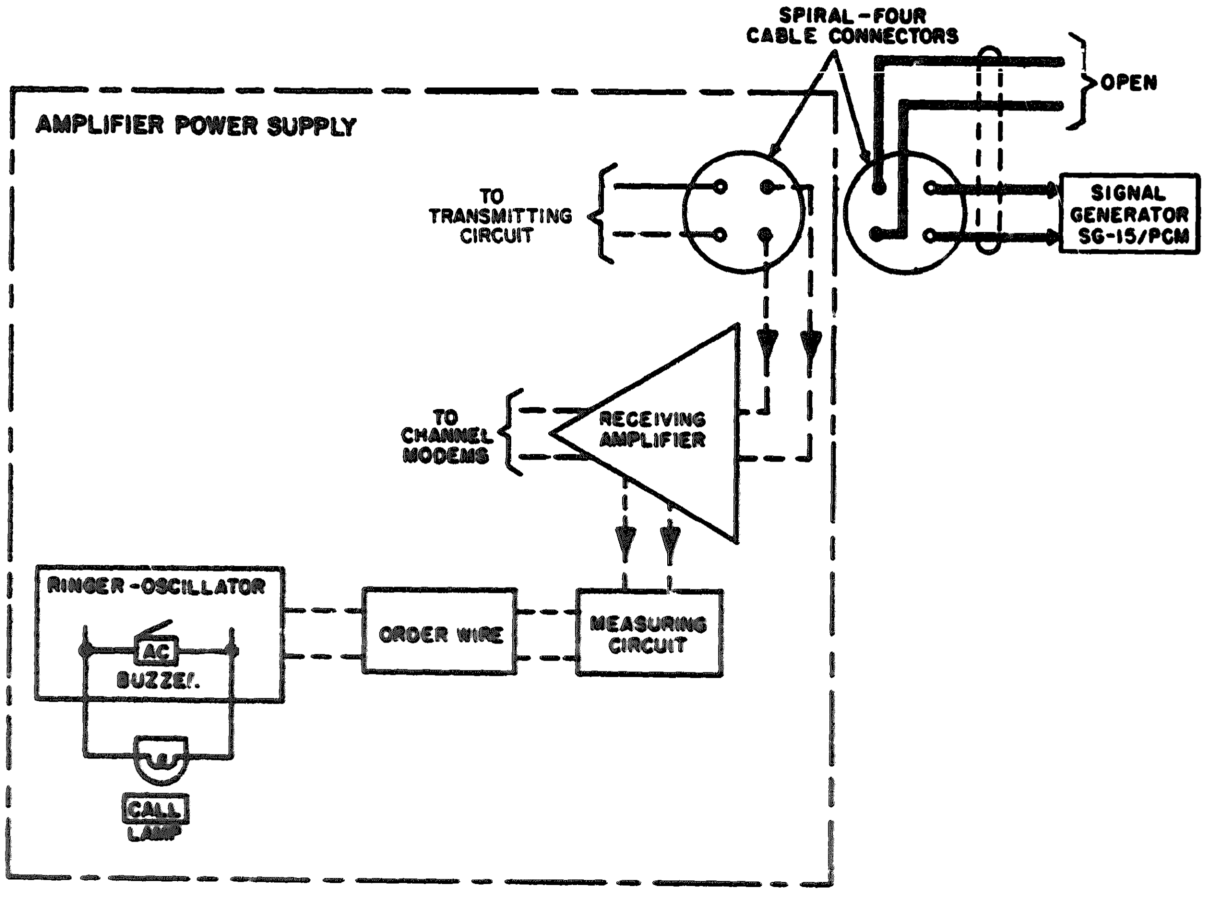


Figure 133. Ringer sensitivity and response-time check. test arrangement.

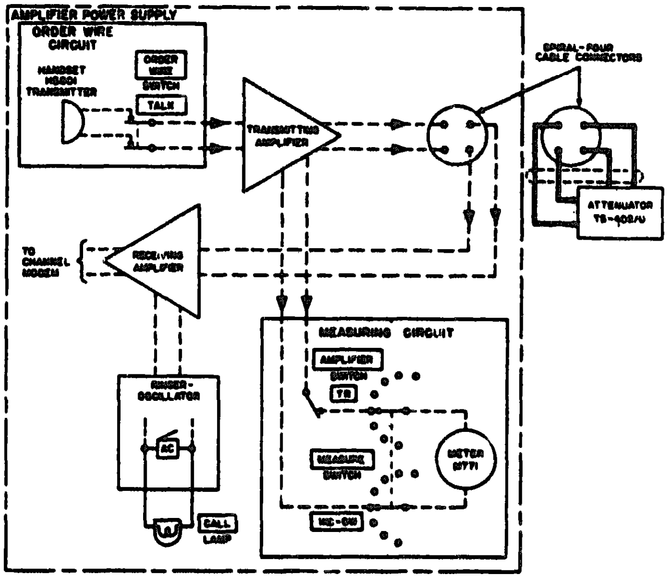


Figure 134. Guard circuit check, test arrangement.

checks required and the paragraphs describing these checks are listed in the chart below.

Check	*Paragraph*
Noise check	358
Special service transmit and receive check	359

358. Noise Check

a. Connect the 18-db attenuator between the transmitting and receiving wires of the spiral-four cable connector (fig. 135). Follow the procedure in *b* below to adjust the equalizer controls.

b. Operate the SEND OW switch.

(1) Operate the SEND-MEAS switches of channel 2 and 4 modems to the SEND position.

(2) Operate the MEASURE switch to the TEST OSC position. Adjust the TEST OSC OUTPUT control to obtain a reading of 0 db on the MEASURE meter.

(3) Operate the MEASURE switch to the 1KCM-OW position. Operate the AMPLIFIER SWITCH to REC. Adjust the FLAT-1KC control to obtain a reading of 0 db on the MEASURE meter.

(4) Operate the MEASURE switch to the 19KC-CH4 position. Adjust the SLOPE-19KC control to obtain a reading of 0 db on the MEASURE meter.

(5) Operate the MEASURE switch to the 11KC-CH2 position. Adjust the BULGE-11KC control to obtain a reading of 0 db on the MEASURE meter.

c. Return the SEND OW switch and the two SEND-MEAS switches to their normal positions. Connect the transmission measuring set to the 2W 4W-T binding posts of one of the channel modems and operate the 2W-4W switch of the corresponding channel modem to the 2W position. Use F1A weighting on Transmission Measuring Set TS-559/FT. The indication on the noise meter should be less than 15 dba Repeat this procedure for each of the other channel modems.

d. Connect the transmission measuring set to the ORDER WIRE binding posts Use F1A weighting. The indication on the noise meter should be less than 20 dba.

a. Connect the 18-db attenuator between the transmitting and receiving wires of the spiral-four cable connector (fig. 136). Check to see that the equalizer controls are adjusted correctly as described in paragraph 358.

b. Operate the CHANNELS-SPECIAL SERVICE switch to the SPECIAL SERVICE position. The white SPECIAL SERVICE lamp should light. Connect the signal generator to the SPECIAL SERVICE TR binding posts. Connect the ME-22/PCM to the SPECIAL SERVICE REC binding posts.

c. Observe the reading on the ME-22/PCM when the signal generator frequency is adjusted to 5 kc, then to 11 kc, and finally to 19 kc The

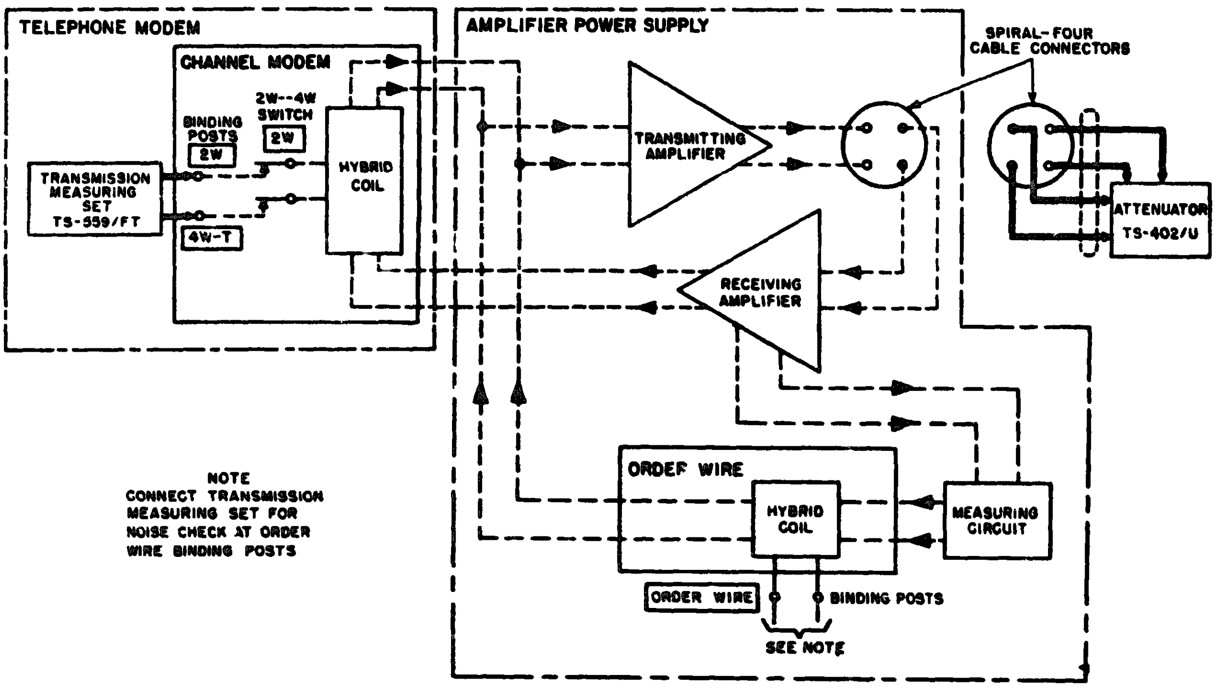


Figure 135. Noise check, test arrangement.

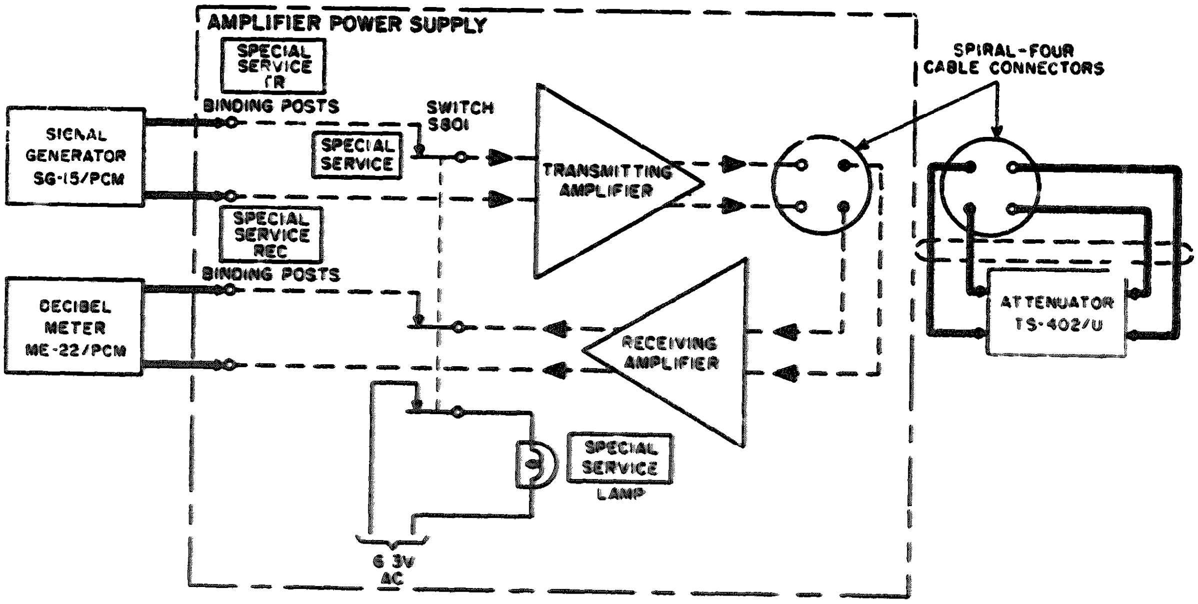


Figure 136. Special service circuit check, test arrangement.

output of the signal generator is adjusted to 0 dbm for all frequencies. The reading on the ME-22/PCM for all three adjustments of the signal generator should be as listed in the chart below.

Signal generator frequency (kc)	*Maximum reading (dbm)*
5	+0.4 ∓27-1
11	+0.3 ±1.0
19	+0.3 ±1.0

360. Testing Attendant's Telephone Set

a. It is necessary to perform several checks when testing the attendant's telephone set. The checks required for testing the telephone set and the paragraphs describing these checks are listed in the chart below.

Check	*Paragraph*
Transmitter and CHANNEL TALK switch	361
Transmitting check toward test board	362
Receiver and CHANNEL TALK switch check	363
Cheek of CHANNEL TALK switch in TEST BD position	364
TALK-MON switch transmitting check	365
TALK-MON switch receiving check	366
Modem hybrid coil balance check	367
ORDER WIRE switch transmitting check	368
ORDER WIRE switch receiving check	369

b. Before performing any of the following tests on attendant's telephone set HS801, connect the 18-db attenuator to the receiving wires and to the transmitting wires of the spiral-four cable stub (fig. 137). The procedure in paragraphs 361 through 369 should be performed for each of the four channel modems successively.

361. Transmitter and CHANNEL TALK Switch Check

a. Operate the TALK-MON switch of the channel modem to the TALK position. Operate the 2W-4W switch to the 4W position. Operate the MEASURE switch to the position corresponding to the channel being tested (fig. 137).

b. Operate the press-to-talk switch on the handset HS801. Talk into the transmitter of HS801. Hold the AMPLIFIER switch in the TR position. Note that the deflections of the MEASURE meter should be proportional to the voice input.

c. Operate the CHANNEL TALK switch to the TEST BD position.

d. Repeat the procedure described in *a* and *b*

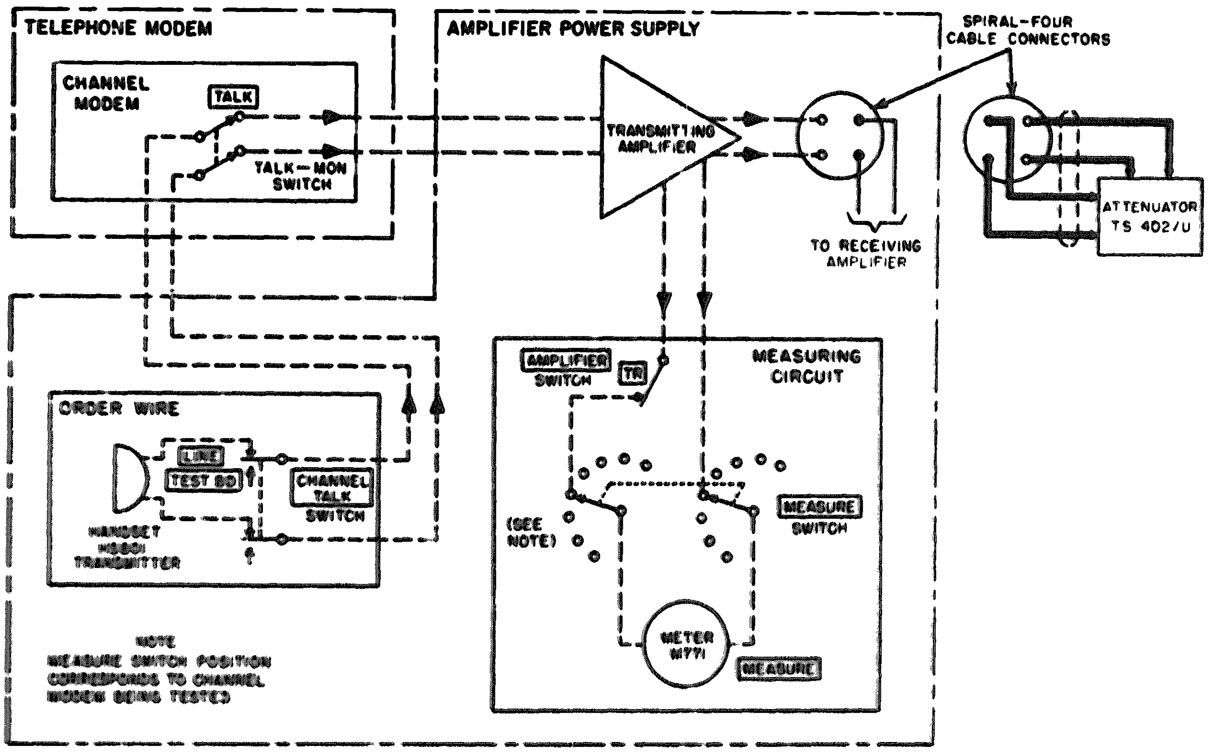


Figure 137. Transmitter and CHANNEL TALK switch check, test arrangement.

above. The needle on the measure meter should not deflect.

362. Transmitting Check Toward Test Board

a. Operate the CHANNEL TALK switch to the TEST BD position, Operate the 2W-4W switch to the 2W position (fig. 138). Hold the AMPLIFIER switch' in the TR position. The modem binding posts should not be terminated.

b. Operate the press-to-talk switch on handset HS801 and talk into the transmitter. The MEASURE meter needle should deflect, but less than in para. 361,b.

c. Operate the CHANNEL TALK switch to the LINE position. Hold the AMPLIFIER switch at TR, operate the press-to-talk switch of handset HS801 and talk into the transmitter. The MEASURE meter needle should not deflect.

363. Receiver and CHANNEL TALK Switch Check

a. Operate the 2W-4W switch of the channel modems to the 4W position (fig. 139). Operate the SEND-MEAS switch to the SEND position. Operate the TALK-MON switch of channel 1 modem to, the TALK position.

b. A 1,000-cps tone should be heard in the receiver

c. Operate the CHANNEL TALK switch to the TEST BD position.

d. Repeat the procedure described in a above. The 1,000-cps tone should not be heard.

e. Repeat the procedure described in a through d above for each of the other channel modems.

364. Check of CHANNEL TALK Switch in TEST BD Position

Check to see that the CHANNEL TALK switch is in the TEST BD position. Operate the 2W-4W switch to the 2W position (fig. 139). The SEND-MEAS switch and TALK-&ION switch remain in the positions shown on figure 139. The 1,000-cycle tone should be heard at a lower level than during the receiver and CHANNEL TALK switch check (para 363b).

365. TALK-MON Switch Transmitting Check

a. Operate the CHANNEL TALK switch to the LINE position. Operate the 2W-4W switch to the 4W position. Operate the MEASURE switch to the MODEMS position. Operate the TALK-MON switch to the TALK position.

b. Operate the press-to-talk switch on the handset. Hold the SEND-MEAS switch to the *MEAS* position. Talk into the transmitter. The deflect ions on the MEASURE meter needle should be proportional to the voice input.

c. Operate the TALK-MON switch to the MON position. Talk into the transmitter. Note the deflections on the MEASURE meter. They now should be at a reduced level.

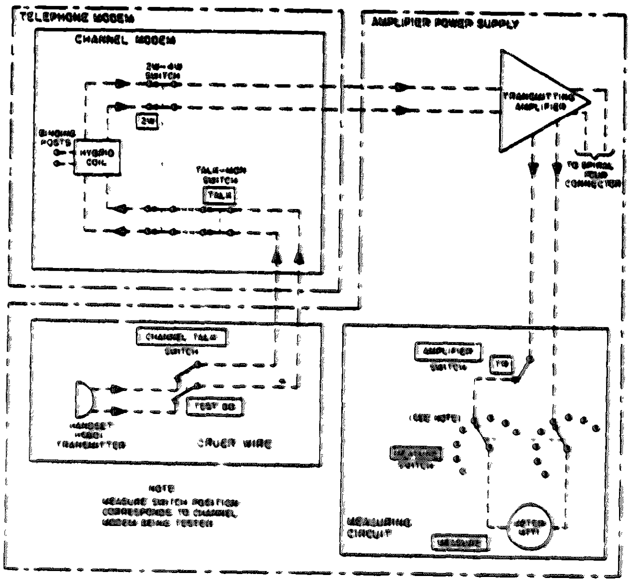


Figure 138. transmitter check toward test board, test arrangement.

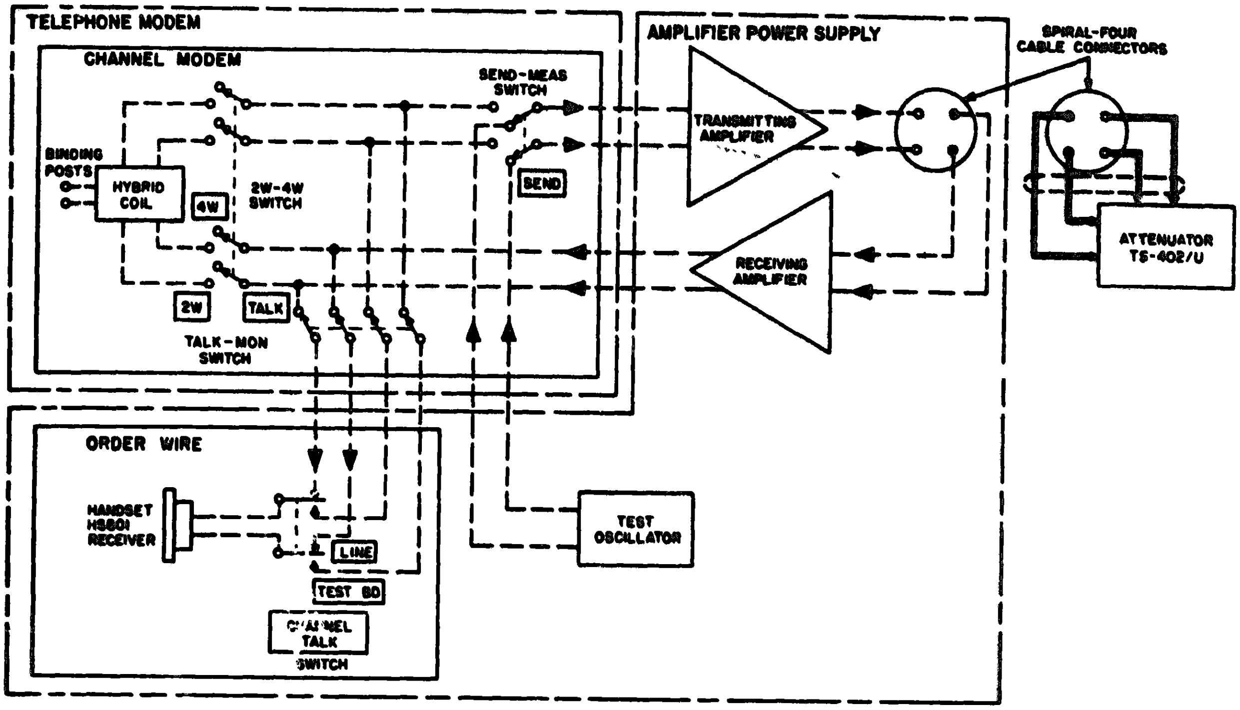


Figure 139. Receiver and CHANNEL TALK switch checks, test arrangement.

366. TALK-MON Switch Receiving Check

a. Operate the TALK-MON switch to the TALK position (fig. 140).

b. Operate the SEND-MEAS switch to the SEND position. Check that the CHANNEL TALK switch is in the LINE position. A 1,000-cps tone should be heard in the receiver.

c. Operate the TALK-MON switch to the MON position. Follow the procedure of subparagraph *b* above. The 1,000-cps tone should be heard, but at a lower level than that in *b* above.

367. Modem Hybrid-Coil Balance Check

The procedures in *a* and *b* below describe the check for balance of the hybrid coil of any channel modem. The switches of the channel modem being tested are to be operated as described below while the switches of the other channel modems must be in the normal (vertical) positions.

a. Signal Generator Adjustment.

(1) Disconnect the transmitting wires of the spiral-four cable stub from the signal generator. The SYSTEM ALARM and CALL lamps should light and the buzzer should sound.

(2) Operate the ALARM CUTOFF switch to the horizontal position. The SYSTEM ALARM lamp should remain lighted but the CALL lamp should go out and the buzzer should be silenced.

(3) Connect the signal generator to the input leads of the cable stub (fig. 141).

(4) Operate the SEND-MEAS switch to the MEAS position.

(5) Adjust the signal generator frequency to 7 kc for channel 1 modem, to 11 kc for channel 2 modem, to 15 kc for channel 3 modem, and to 19 kc for channel 4 modem.

(6) Operate the MEASURE switch to the MODEMS position.

(7) Adjust the signal generator output to obtain a reading of 0 db on the MEASURE meter.

b. Test Adjustment.

(1) Operate the TALK-MON switch to the TALK position (fig. 142).

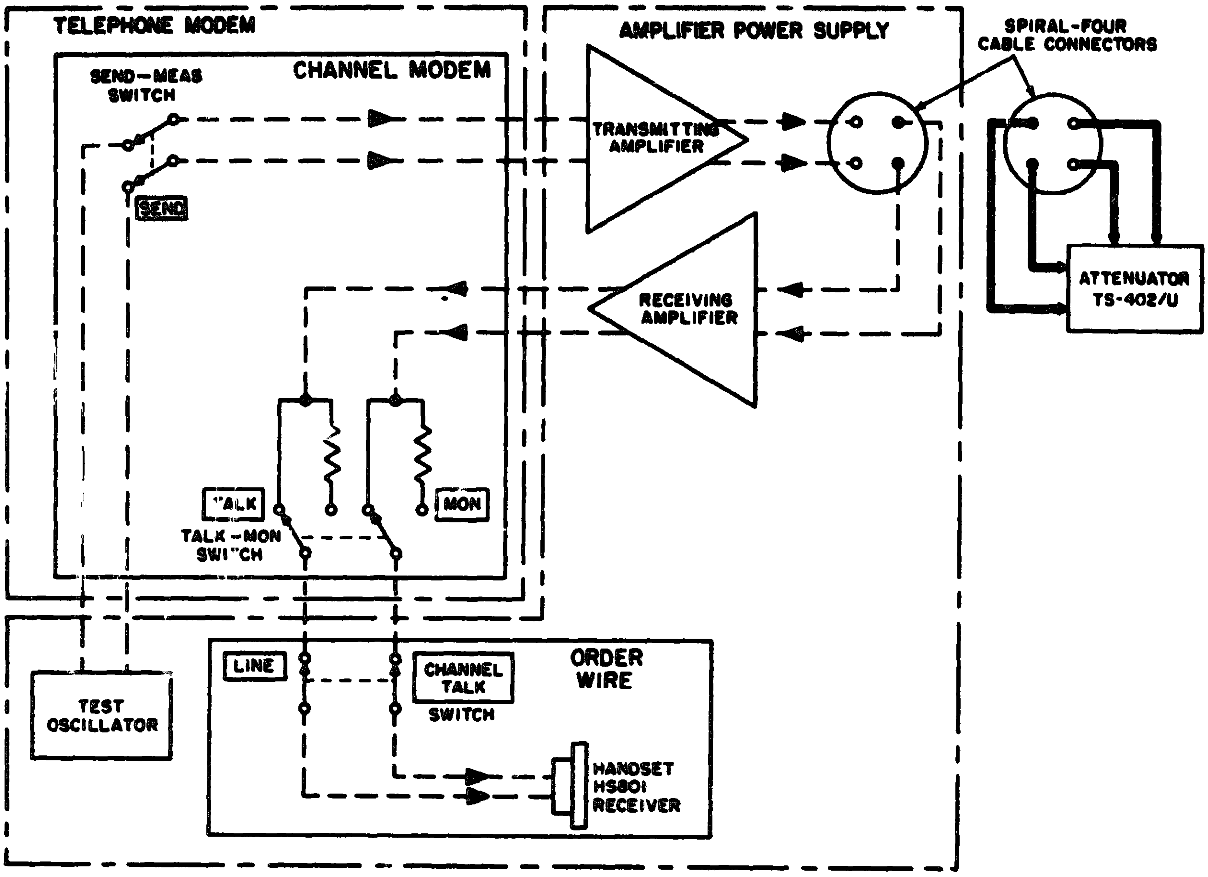


Figure 140. TALK-MON switch receiving check, test arrangement.

(2) Operate the SEND-MEAS switch to the SEND position in order to open the path from the hybrid coil to the transmitting amplifier.

(3) Operate the 2W-4W switch to the 2W position.

(4) Connect a 600-ohm resistor in series with a 2-μf capacitor across the 2W 4W-T binding posts.

NOTE

Use the two 1-μf capacitors from the MK-155/TCC (para 296) and connect them in parallel to provide a 2-μf capacitor.

(5) Connect the ME-22/PCM to terminals 11 and 12 of TB801.

(6) Check to see that the CHANNEL TALK switch is in the LINE position.

(7) The reading on the ME-22/PCM should be -34.5 dbm or more negative.

368. ORDER WIRE Switch Transmitting Direction Check

a. Connect the receiving wires of the spiral-four cable stub to the output terminals of the attenuator. Connect the transmitting wires of the spiral-four cable stub to the input terminals of the attenuator. Adjust the attenuator for 18-db loss.

b. The buzzer should sound. The CALL lamp should light. The SYSTEM ALARM lamp should go out.

c. Operate the ALARM CUTOFF switch to the normal (vertical) position.

d. Operate the ORDER WIRE switch to the TALK position.

e. Operate the MEASURE switch to the 1KC-OW position.

f. Hold the AMPLIFIER switch in the TR

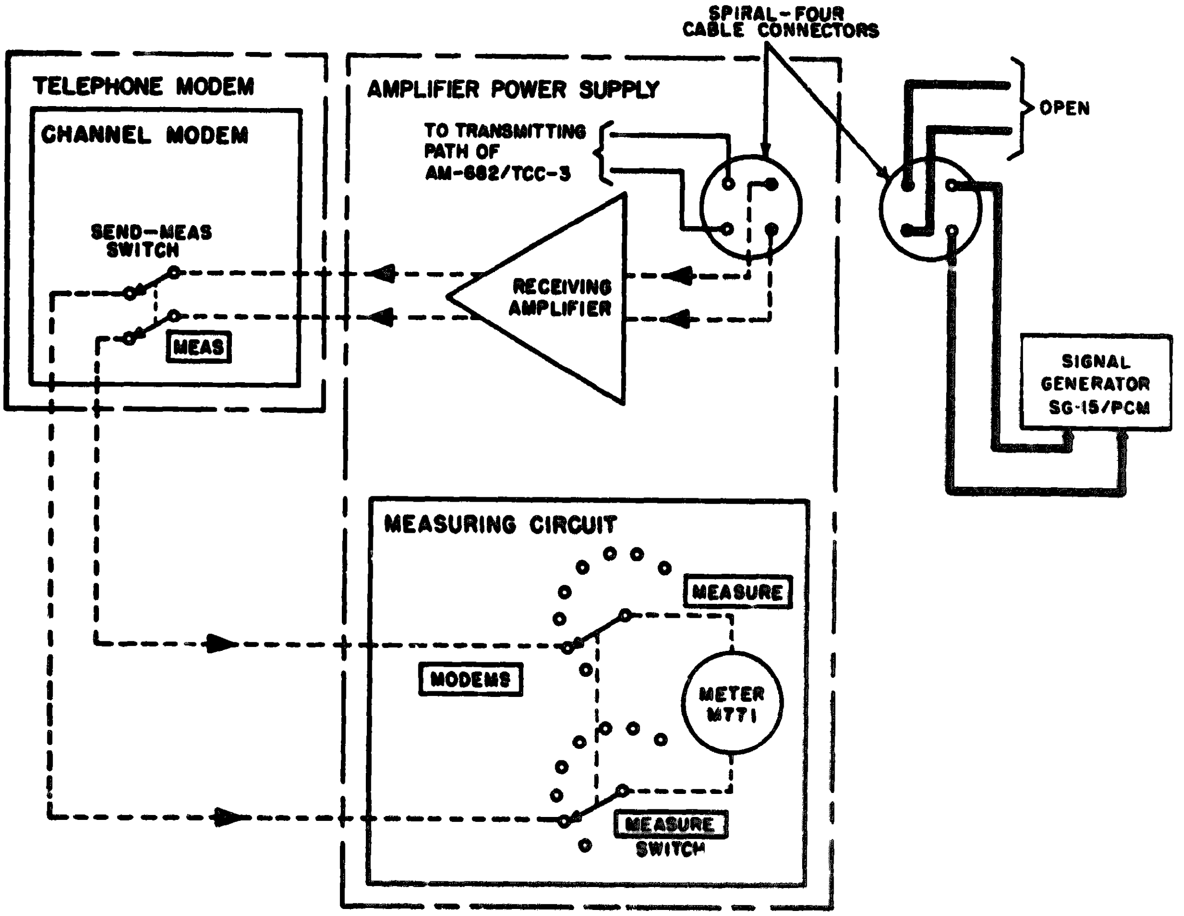


Figure 141. Signal generator adjustments, test arrangement.

position and operate the press-to-talk switch on the handset.

g. Talk into the transmitter and note that the MEASURE meter needle deflections are proportional to the sound.

369. ORDER WIRE Switch Receiving Check

a. Check to see that the ORDER WIRE switch is in the TALK position (fig. 143). Operate the SEND OW switch to the horizontal position. The 1,000-cps tone should be heard in the receiver of the attendant's handset.

b. Check to see that the MEASURE switch is in the 1KC-OW position. Operate and hold the AMPLIFIER switch in the TR position. An indication should be obtained on the MEASURE meter. The 1,000-cps tone should be heard in the receiver of the attendant's handset.

c. Hold the AMPLIFIER switch in the REC position. The 1,000-cps tone should not be heard. An indication should be obtained on the MEASURE meter. This is last check for final test.

370. Repaired Plug-in Assemblies, Test Procedures; General

A plug-in assembly that has been repaired after its removal from a Telephone Terminal AN/TCC-3 must be tested for proper operation before it is replaced in a terminal. The procedures for testing the plug-in assemblies when they are separate from an AN/TCC-3 appear in paragraphs 371 through 387. A test cable is required in making these tests. Use the modem and amplifier test cable assembly (part of the MK-155/TCC (para 296)) in the test connections given in paragraphs 371 through 386 whenever the test cable is required.

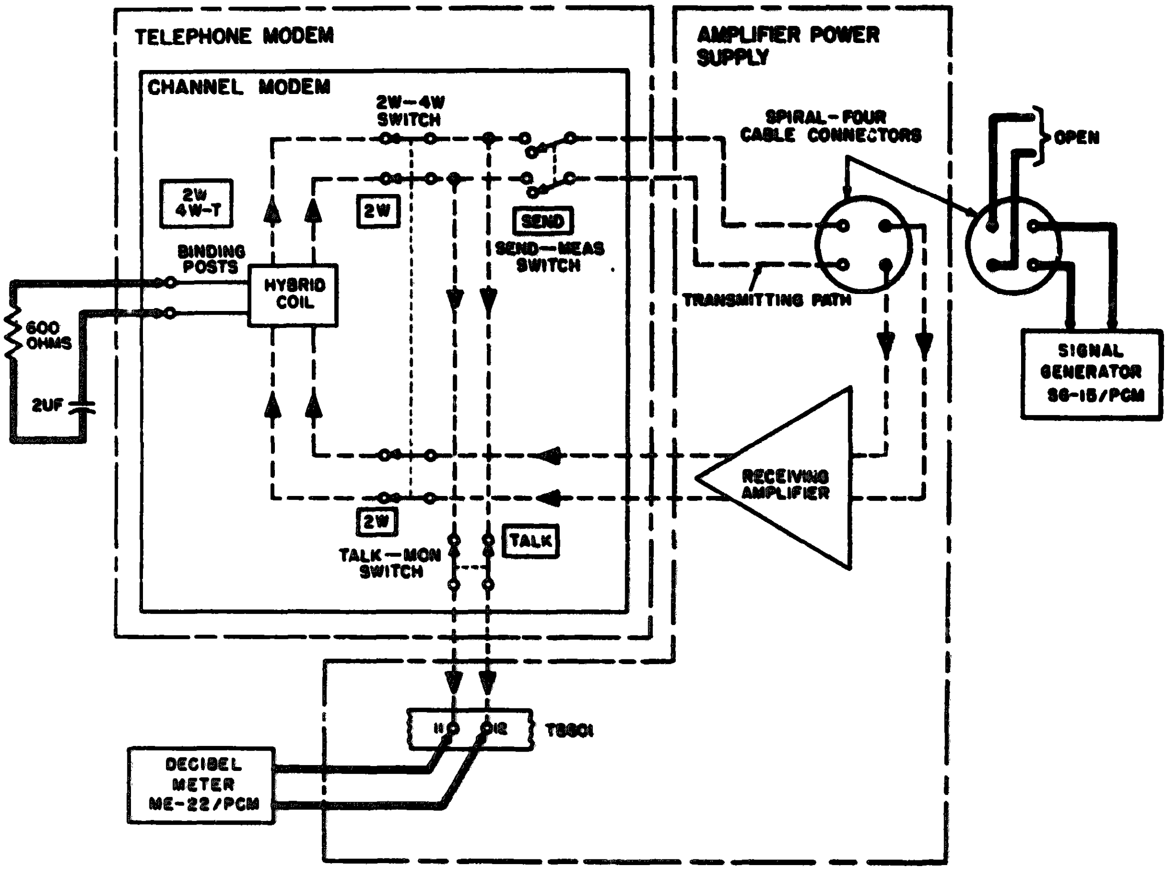


Figure 142. Modem hybrid coil balance check, test arrangement

CAUTION

The test cable will fit all the plug-in assemblies. However, connections to the terminal board are different for each plug-in assembly that is tested. Be certain that the terminal board connections are correct for the assembly being tested before applying power to the test cable.

371. Testing Channel Modems

Paragraphs 372 through 375 describe the checks for testing the four channel modems. Two types of checks are described: checks of the outputs of all the transmitting paths and checks of carrier leak.

372. Carrier Leak Check

a. Connections.

(1) Connect the ME-22/PCM across terminals 16 and 19 of the test cable.

(2) Connect the signal generator to terminals 0 and 3 of the test cable.

(3) Connect a 600-ohm (±1%) resistor across the 2W 4W-T binding posts.

b. Adjustments.

(1) Operate the 2W-4W switch to the 4W position.

(2) To test a channel 1 modem, adjust the signal generator frequency to 8 kc and its output to 0.8 volt.

(3) To test a channel 2 modem, adjust the signal generator frequency to 12 kc and its output to 0.8 volt.

(4) To test a channel 3 modem, adjust the signal generator frequency to 16 kc and its output to 0.8 volt.

(5) To test a channel 4 modem, adjust the signal generator frequency to 20 kc and its output to 0.8 volt.

c. Measurements. Check the reading on the ME-22/PCM. The reading should be -50 or more negative.

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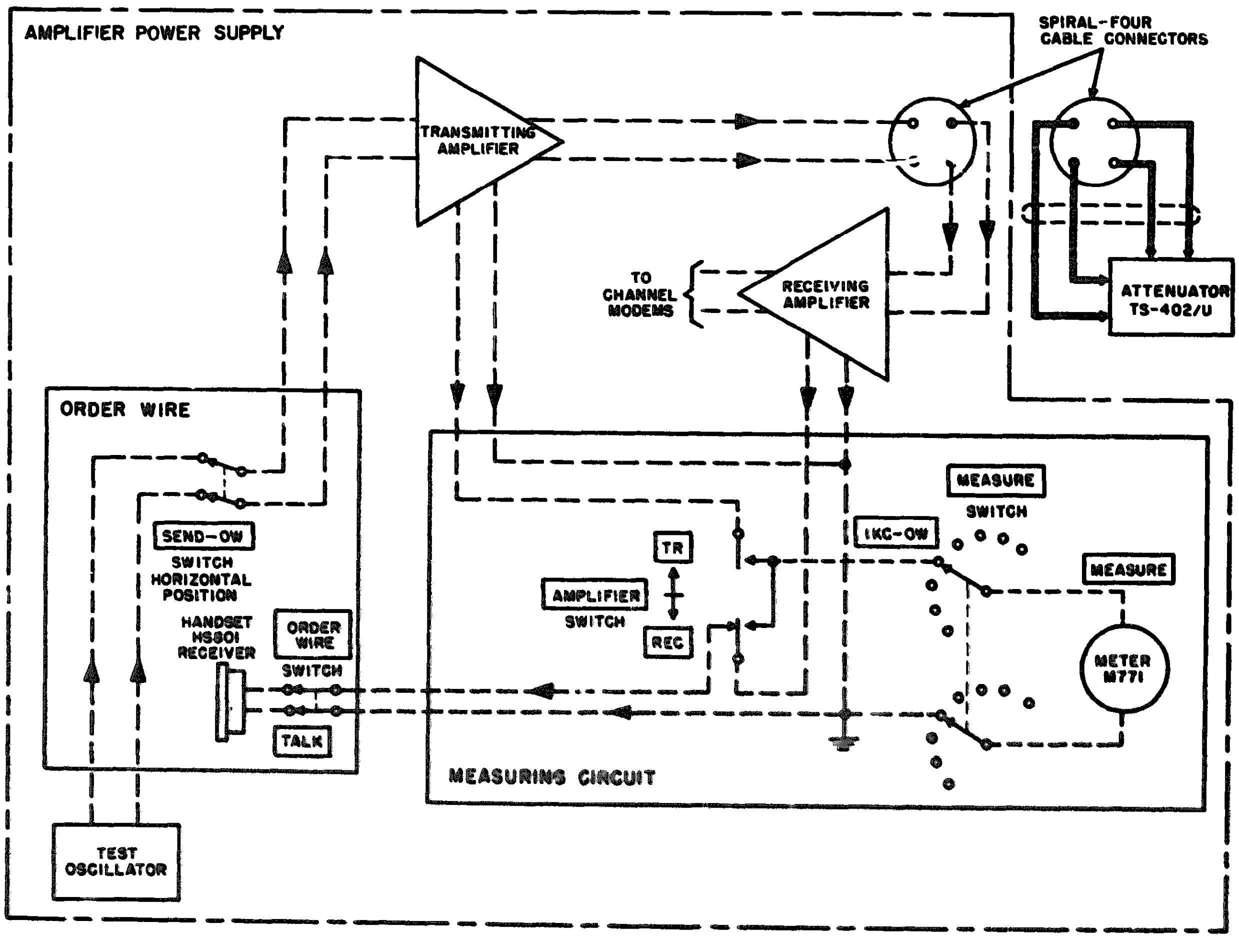


Figure 143. ORDER-WIRE switch receiving check, test arrangement.

373. Transmitting Check, Channel 1 Modem

a. Connections. Before the connections described below are made, check that all switches are in their normal positions.

(1) Connect a signal generator (carrier-frequency) to terminals 0 and 3 of the test cable.

(2) Connect a signal generator (signal-frequency) to the 2W-4W-T binding posts, E101 and E102.

(3) Connect terminal 4 of Alter FL102 to terminal 13 of the test cable.

(4) Check to see that the 600-ohm resistor is connected across terminals 16 and 19 of the test cable.

b. Adjustments.

(1) Operate the 2W-4W switch to the 2W position.

(2) Adjust the carrier-frequency signal generator to 8 kc and its output to 0.8 volt.

(3) Adjust the signal-frequency signal generator to 1 kc and its output to 0.8 volt.

c. Measurements.

(1) Connect the vacuum-tube voltmeter to terminals 16 and 19 of the test cable. Check the reading on the meter. The reading should be between 0.0133 volt and 0.0147 volt.

(2) If the reading on the vacuum-tube voltmeter is not correct, it is necessary to adjust the circuit by strapping resistors R116 and R143. The strapping procedure is similar to the procedure described in paragraph 325.

374. Receiving Check, Channel Modem I

a. Connections. Before the connections described below are made, check that all switches are in their normal positions.

(1) Connect +200V to terminals 2 and 5 (ground) of the test cable.

(2) Connect 6.3 volts ac to terminals 1 and 4 of the test cable.

(3) Connect the signal-frequency generator to terminals 14 and 17 of the test cable.

(4) Connect the carrier-frequency generator to terminals 0 and 3 of the test cable.

(5) Connect a 600-ohm resistor across the 4W-R binding posts, E103 and E104.

b. Adjustments.

(1) Operate the 2W-4W switch to the 4W position.

(2) Adjust the signal-frequency generator to 7 kc and its output to 0.3 volt.

(9) Adjust the carrier-frequency generator to, 8 kc and its output to 0.8 volt.

(4) Operate the CAIN control to its completely clockwise position.

c. Measurements. Connect the vacuum-tube voltmeter across the 4W-R binding posts. Check the reading on the meter. The reading should be at lea& 1.95 volts.

375. Transmitting and Receiving Checks, Channel 2, 3, and 4 Modems

The procedure for performing the transmitting and receiving checks for channel 2, 3, and 4 modems is the same as the procedure given for channel 1 modem with the following exceptions:

a. Transmitting Checks.

(1) The 2W 4W-T binding posts to which the signal-frequency generator is connected are numbered E201 and E202 in channel 2 modem, E301 and E302 in channel 3 modem, and E401 and E402 in channel 4 modem.

(2) The carrier-frequency generator should be adjusted to 12 kc when checking channel 2 modem, 16 kc when checking channel 3 modem, and 20 kc when testing channel 4 modem.

(3) The filter that is equivalent to filter FL102 in channel 1 modem is FL202 in channel 2 modem, FL302 in channel 3 modem, and FL402 in channel 4 modem. The resistors that are equivalent to resistors R116 and R143 in channel 1 modem are R216 and R243 in channel 2 modem, R316 and R343 in channel 3 modem, and R416 and R443 in channel 4 modem.

b. Receiving Checks.

(1) The binding posts to which the 600-ohm resistor is connected are numbered E203 and E204 in channel 2 modem, E303 and E304 in channel 3 modem, and E403 and E404 in channel 4 modem.

(2) The signal-frequency generator should be adjusted to 11 kc when testing channel 2 modem, 15 kc when testing channel 3 modem and 19 kc when testing channel 4 modem.

(3) The reading on the vacuum-tube voltmeter connected across 4W-R binding posts should be the same for channel 1, 2, and 3 modems. The reading on the meter for channel 4 modem should be at least 1.73 volts.

376. Testing Carrier Supply

a. General. Testing of the carrier supply consists of measuring the frequencies and levels of the various outputs and measuring the total current drawn from the +200V supply. Where it is possible to adjust the carrier supply to obtain the correct outputs, adjustment procedures are provided.

b. Connections.

(1) Connect 60.4-ohm resistors (para 296) across terminals 8-11, 9-12, 2-5, and 3-6 of the test cable.

(2) Connect the ground of the +200V power supply to terminal 14 of the test cable.

(3) Connect 6.3 volts ac to terminals 0-1 of the test cable.

(4) Connect negative terminal of the milliammeter to terminal 13 of the test cable.

(5) Connect +200V to the positive terminal of milliammeter.

c. *Total Current* Check. Check the reading on the milliammeter after all connections described in b above have been made. The meter should read 31 ±4 ma.

d. Frequency Check.

(1) Connect the frequency meter to terminals 3-6 of the test cable.

(2) Check the reading on the frequency meter. The reading should be 20,000 ±2 cycles. Connect the frequency meter successively to the terminals of the test cable indicated in the first column of the chart below. The reading for each pair of terminals is indicated in the second column of the chart below.

Terminals	*Frequency (kc)*
8-11	8.00
9-12	12.00
2-5	16.00

e. Carrier Supply Circuits Tests. If either transformer T603 or capacitor C606 is replaced during a carrier supply plug-in assembly repair, perform the tests in (1) through (6) below: if neither transformer T603 nor capacitor C606 has been replaced, omit the procedure in (1) below and perform the procedures in (2) through (6) below.

(1) If the cathode resistor (R620) of tube V602 is not a 750-ohm resistor, insert one in place of the resistor already installed. Connect the ME-22/PCM between jack J602 and terminal 14 (ground) of the test cable. Record the reading on the ME-22/PCM. Connect the following capacitors across winding 5-6 of T603 and record the ME-22/PCM reading for each check. Permanently connect across winding 5-6 of T603, the capacitor or capacitor combination that gives the maximum reading at test jack J602.

(a) C606 (1600 uuf).

(b) C626 (180 uuf) in parallel with C606.

(c) C627 (360 uuf) in parallel with C606.

(d) C626 and C627, both connected in parallel with C606.

(2) Connect the ME-22/PCM successively to jack J601 of the carrier supply and terminal 14 (ground) of the test cable, to jack J602 and terminal 14, and to jack J603 and terminal 14. Note the reading on the ME-22/PCM for each connection. The reading at jacks J601, J602 and J603 should be -5.8 ±1.5 dbm.

(3) Connect the vacuum-tube voltmeter successively across terminals 8-11, 9-12, 2-5, and 3-6 of the test cable. Note the reading on the meter each time it is connected. The reading should be 0.69 ±1.1 volts.

(4) If the value of the carrier supply output is not correct, the carrier supply output at terminals 8-11 of the test cable should be adjusted for maximum output by strapping capacitors C615 and C616. The procedure for strapping these capacitors is similar to the procedure described in paragraph 317e.

(5) Adjust the outputs of the 12-kc and 20-kc supplies to be as near alike as possible by strapping capacitors C620 and C621. The procedure for strapping these capacitors is given in paragraph 317g.

(6) Repeat the procedure in (3) above. If readings of 0.69 ±1.1 volts are not obtained at each of four points, restrap capacitors C615 and C616 to obtain these readings.

f. 4-kc Output Check.

(1) Connect the ME-22/PCM to terminals 19 and 14 (ground) of the test cable. Check the reading on the ME-22/PCM. The reading should be 17.5 ±1.0 dbm.

(2) If the reading on the ME-22/PCM is not correct, adjust the 4-kc output power by strapping resistors R629 and R654 as described in paragraph 323. If the correct reading is still not obtained on the ME-22/PCM, connect resistor R655 (1,000 ohms) between standoff E609 and ground.

377. Testing Amplifiers

Paragraphs 378 through 387 describe checks made on the transmitting and receiving amplifiers are not connected as part of the AN/TCC-3. The transmitting and receiving amplifiers are identical. Therefore, the test procedure is the same for both amplifiers. For testing, all connections made to the amplifiers through the tes The test cable is connected to the amplifiers are plug P51.

378. Space Current Check

a. Connections.

(1) Connect a 2,400-ohm resistor (fig. 144) (obtained by using resistors provided in the MK–155/TCC) (para 296) to terminals 13 and 18 of the test cable. Connect together terminals 16 and 19 of the test cable.

(2) Connect a 600-ohm resistor to terminals 5 and 8 of the test cable, and another 600-ohm resistor to terminals 3 and 10 of the test cable.

(3) Connect 6.3 volts ac to terminals 6 and 9 of the test cable.

(4) Connect the power supply ground to terminal 14 of the test cable.

(5) Connect the negative terminal of the milliammeter to terminal 12 of the test cable.

(6) Connect the positive terminal of the milliammeter to +200 volts.

b. Measurements. **Note the reading on the milliammeter. The reading should be 36 ±4 ma.**

379. Bias Voltage Check

a. Cathode Bias to Ground, Tube V51.

(1) Connect the vacuum-tube voltmeter to terminals 11 and 14 of the test cable.

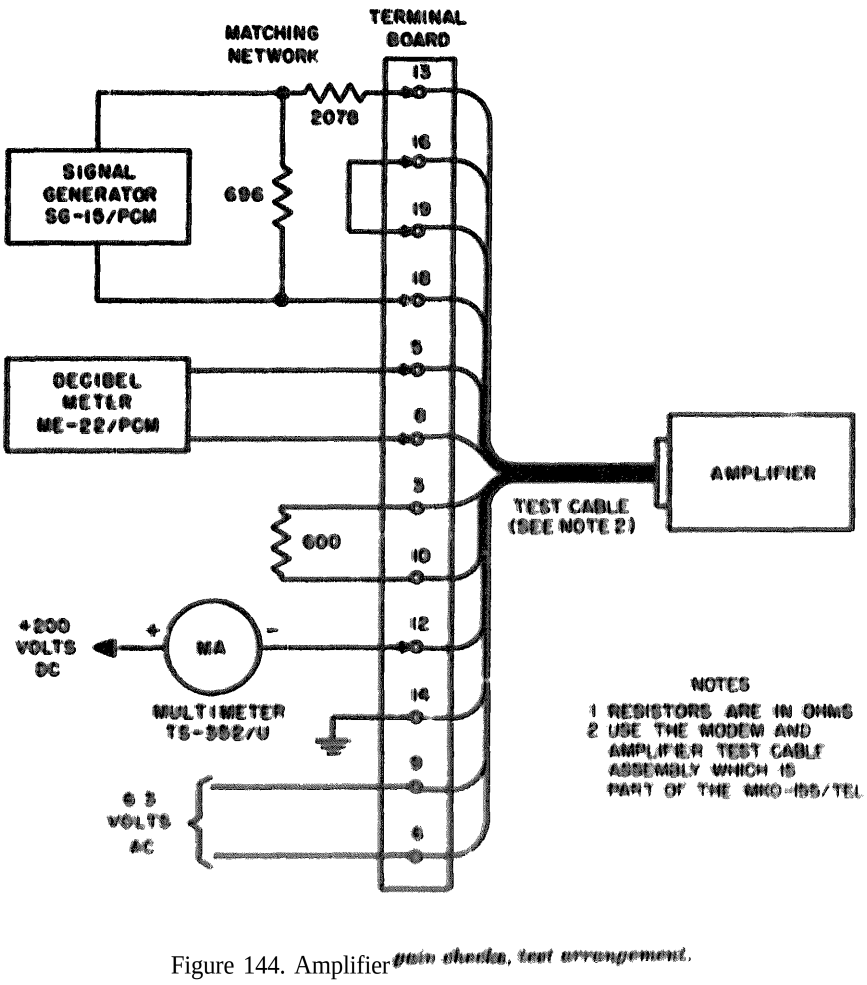


Figure 144. Amplifier gain checks, test arrangement.

(2) Check the reading on the vacuum-tube voltmeter The reading should be 1.0 ±0.2 volts.

b. Cathode Bias to Ground, Tube V52.

(1) Connect the vacuum-tube voltmeter to pins 2 and 14 of the test cable.

(2) Check the reading on the vacuum-tube voltmeter. The reading should be + 8.6 ±1.0 volts.

380. Gain With Feedback Check

a. Disconnect the 2,400-ohm resistor from terminals 13 and 18 of the test cable. Disconnect the 600-ohm resistor from terminals 5 and 8 of the test cable. Check to see that terminal 16 of the test cable is connected to terminal 19 of the test cable (fig. 144).

b. It is necessary to use a resistive network in order to match the 600-ohm output impedance of signal generator to the 2,400-ohm input impedance of the amplifier. The 11.3-db loss of this matching network has been included in the normal readings of the ME-22/PCM indicated in the following paragraphs on the amplifier test.

c. Connect a 2,078 ±21-ohm resistive network (para 283*b*(1)) between one of the output terminals of the signal generator and terminal 13 of the test cable.

d. Connect the other output terminal of the signal generator to terminal 18 of the test cable.

e. Connect a 696-ohm resistive network (para 283*b*(2), across the output terminals of the signal generator.

f. Connect the ME–22/PCM to terminals 5 and 8 of the test cable. Operate the AMP OUT switch to the 0 DB position. Adjust the signal generator frequency successively to the values given in the first column of the chart below.

g. Each time the signal generator is adjusted to one of the frequencies listed in the first column of the chart below, adjust the output power level of the signal generator so that the ME–22/PCM reads 0 dbm. After adjusting the output power of the signal generator to produce the 0 dbm reading on the ME–22/PCM, note the level of the signal generator output. The output level of the signal generator should be of the value listed in the second column of the chart below for each frequency.

Frequency adjustment	*Signal generator output (dbm)*
300 cps	34 ±0.6
1 kc	33.7 ±0.5
19 kc	34.3 ±0.3

h. Adjust the signal generator frequency to 1 kc and its output to obtain a reading of +5.3 dbm on the ME-22/PCM.

i. Disconnect the ME-22/PCM from terminals 5 and 8 of the test cable and connect a 600-ohm resistor across these terminals. Disconnect the 600-ohm resistor from terminals 3 and 10 of the test cable, and connect the ME-22/PCM across these terminals.

j. Check the reading on the ME-22/PCM. The reading should be 0 ±0.3 dbm.

k. Disconnect the 600-ohm resistor from terminals 5 and 8 of the test cable. Disconnect the ME–22/PCM from terminals 3 and 10 of the test cable and connect it to terminals 5 and 8. Connect the 600-ohm resistor across terminals 3 and 10 of the test cable.

l. Operate the AMP OUT switch to the 10 DB position. Adjust the signal generator frequency successively to the values given in the first column of the table (*m* below).

m. Each time the signal generator frequency is adjusted to one of the values listed in the first column of the chart below, adjust the signal generator output power so that the ME–22/PCM reads 0 dbm. After adjusting the output power of the signal generator to produce the 0 dbm reading on the ME–22/PCM, note the level of the signal generator output. The output level of the signal generator should be of the values listed in the second column of the table below for each frequency.

Frequency adjustment	*Signal generator output (dbm)*
300 cps	−38.1 ±1.0
1 kc	−43.1 ±0.5
19 kc	−44.1 ±0.5

n. Adjust the signal generator frequency to 300 cps and its output until the ME–22/PCM at terminals 5 and 8 reads 0 dbm. Connect terminals 15 and 17 of the test cable together. The reading on the ME–22/PCM should increase to +6 ± 1.0 dbm.

o. Disconnect terminal 15 from terminal 17 of the test cable. Adjust the signal generator frequency to 1 kc and its output to obtain a reading of +15.6 dbm on the ME–22/PCM. Perform *j* above. The reading on the ME–22/PCM at terminals 3 and 10 should be 0 ±0.7 dbm.

p. Repeat the procedure in *j* above.

381. Singing Test

a. The milliammeter should still be connected as described in paragraph 378*a*. Note and record the reading on the milliammeter.

b. Connect terminal 1 of transformer T52 to ground. Check the reading on the milliammeter. There should be no change from the reading recorded in *a* above. A change in current reading indicates singing.

382. Amplifier Gain Check Without Feedback

a. Operate the AMP OUT switch to the 0 DB position.

b. Check to see that terminal 1 of transformer T52 is grounded.

c. Connect the test circuit as given in paragraph 380*k*. Adjust the signal generator frequency successively to the values listed in the first column of the chart below. Each time the signal generator frequency is adjusted to one of the values listed in the first column of the chart below, adjust the signal generator output so that the ME-22/PCM reads 0 dbm. Each time the reading on the ME-22/PCM is checked, check the output reading of the signal generator. The readings of the signal generator output should be of the values listed in the second column of the chart below.

Frequency adjustment	*Signal generator output (dbm)*
300 cps	−48.1 ±3.5
1 kc	−50.2 ±3.5
10 kc	−78.4 ±3.5

383. Testing Ringer-Oscillator

The following paragraphs describe the checks necessary for testing the ringer-oscillator. These checks consist of measuring the oscillator frequency and output, the sensitivity, the ringer response, and the guard channel.

384. Ringer-Oscillator Space Current Measurement

a. Connect the test cable to plug P1 of the ringer-oscillator. Connect terminal 2 of the test cable to terminal 6 of the test cable. Use shielded wire having a capacity to ground of 100 ±10 μμf for this connection. Ground the shield. Connect terminal 5 of test cable to terminal 8 of the test cable.

b. Connect 6.3 volts ac to terminals 12 and 14 of the test cable. Connect −10 volts to terminal 13 of the test cable. Connect the −10 volt power supply ground to terminal 11 of the test cable. Connect the negative terminal of the milliammeter to terminal 19 of the test cable. Connect the positive terminal of the milliammeter to +200 volts. If the +200 volts is taken from a power supply separate from the one that supplies the −10 volts, connect the +200 volt power supply ground to terminal 11 of the test cable.

c. Check the reading on the milliammeter. The reading should be 8.0 ±2.0 ma. This reading is the value of the space current drawn from the +200 volt power supply by the ringer-oscillator.

385. Ringer-Oscillator Frequency and Output Checks

a. Allow the ringer-oscillator to warm up.

b. Connect the frequency meter to terminals 1 and 0 of the test cable.

c. Check the reading on the frequency meter. The reading should be 1,600 ±1.6 cycles.

d. If the reading on the frequency meter is not correct, adjust variable capacitor C5 until the reading on the frequency meter is correct.

e. If the correct frequency cannot be obtained by adjusting variable capacitor C5, follow the strapping procedure described in paragraph 336.

f. After finishing the strapping procedure, seal the adjusting screw of variable capacitor C5 with glyptol.

g. Disconnect the frequency meter and connect the ME-22/PCM to terminals 0 and 1 of the extension cable. The ME-22/PCM set should read −9.2 ±0.5 dbm

386. Sensitivity and Ringer Response Check

a. Remove the connections between terminals 2 and 6 and between terminals 5 and 8 of the test cable. Connect terminals 2 to terminal 5 of the test cable.

b. Adjust the signal generator frequency to 1,600 ±4 cps and its output to −39 ±0.5 dbm.

c. Connect one lead of the signal generator to terminal 0 (ground) of the test cable. Connect the other lead of the signal generator to terminal 1 of the test cable. After a slight delay of about 0.2 second, the buzzer should sound.

d. Adjust the output of the signal generator to −10 ±0.5 dbm. The buzzer should continue to sound.

e. Disconnect one of the leads of the signal generator from the test cable. The buzzer should stop sounding without delay.

387. Guard Channel Check

a. With the signal generator connected as in paragraph 386c, adjust the frequency of the signal generator, successively, to the value listed in the first column of the chart below.

b. Adjust the output of the signal generator to -15 dbm for each frequency.

c. Connect a vacuum-tube voltmeter to standoff E2 and chassis ground.

d. Each time the frequency and output of the signal generator is adjusted, check the reading on the vacuum-tube voltmeter. The readings should be as indicated in the second column of the chart below.

Frequency adjustment	Signal generator output (dbm)
300	+9.6 ±3.0
1,000	+7.6 ±1.0
3,000	+10.7 ±1.4

CHAPTER 6

SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE

NOTE

The information in this chapter is applicable to all models of Telephone Modem TA-219/U and TA-219A/U and Amplifier Power Supply AM-682/TCC-3 and AM-682A/TCC-3 unless otherwise noted. Telephone Modems TA-219/U and TA-219A/U are interchangeable, as are Amplifier-Power Supply AM-682/TCC-3 and AM-682A/TCC-3. It should be noted however that the substitution of an earlier model for an (A) unit will result in decreased capability.

Section I. SHIPMENT AND LIMITED STORAGE

388. Disassembly

The circumstances involved in shipment and storage vary; therefore, no definite procedure can be given. The following instructions are intended as a guide for preparing the AN/TCC-3 for shipment and storage.

a. Remove the following outside leads:

(1) The spiral-four cable.

(2) The ground wire.

(3) The external connections to the channel modem binding posts.

(4) Order-wire extension wires (if present).

(5) Special service wires (if present).

b. Replace all cables and equipment which are supplied as part of the AN/TCC-3 in their respective storage spaces.

(1) Fold the power cable and replace it in its storage space in the lower left-hand side of the chassis.

(2) Replace the attendant's telephone set in the storage space in the lower right hand side of the chassis.

(3) Disconnect the CARR SUP-POWER and TRANS-TEST-TALK cables from the TA-219/U and place them into the left- and the right-hand sides of the chassis respectively.

c. Check all spare and pluck-out parts to see that they are securely in place.

d. Slide the AM-682/TCC-3 back into the transit case and tighten the six panel fasteners securely. Slide the TA-219/U into its transit case and tighten the two panel fasteners securely.

e. Replace the front covers of both the AM-682/TCC-3 and the TA-219/U. Be sure that the snapcatches are fastened securely.

389. Repacking for Shipment of Limited Storage

a. The exact procedure in repacking for shipment or limited storage depends on the materials available and the conditions under which the equipment is to be shipped or stored.

b. Whenever practicable, place a dehydrating agent, such as silica gel, inside the packing boxes. Protect the boxes with a waterproof paper barrier. Seal the seams of the paper barrier with waterproof sealing compound or with tape. Pack the equipment in boxes. Use interior bracing and provide excelsior padding or some similar material between the equipment and the box.

Section II. DEMOLITION TO PREVENT ENEMY USE

390. Authority for Demolition

Demolition of the equipment will be accomplished only upon the order of the commander. The destruction procedures outlined in paragraph 391 will be used to prevent further use of the AN/TCC-3.

391. Destruction of Components

When ordered by your commander, destroy all

equipment to prevent its being used or salvaged by the enemy.

a. Smash the controls, tubes, switches, transformers, and relays.

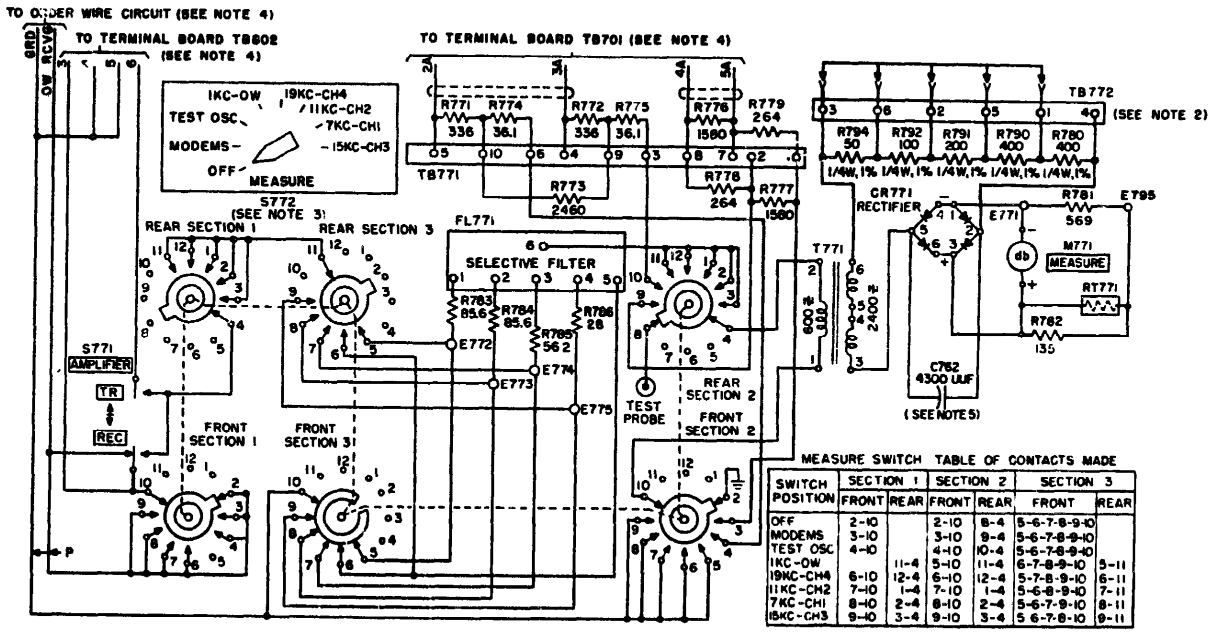
***b.* Cut cords, wiring, and cabling.**

c. Bum cords, resistors, capacitors, and wiring,

d. Bend the panels and cabinet.

e. Bury or scatter all smashed pieces after destroying their usefulness.

f. Destroy everything.

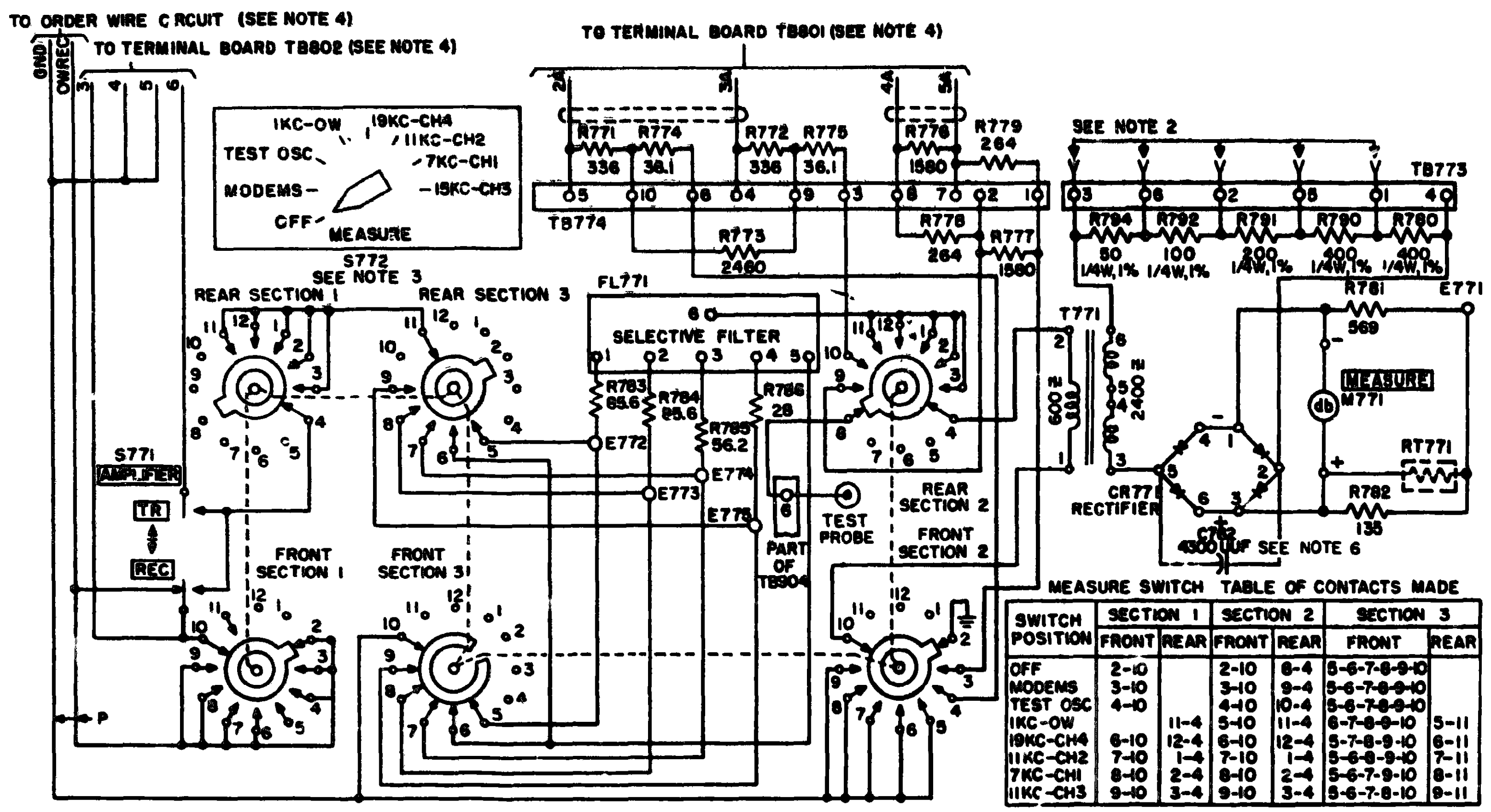


MEASURE SWITCH TABLE OF CONTACTS MADE

SWITCH POSITION	SECTION 1		SECTION 2		SECTION 3	
	FRONT	REAR	FRONT	REAR	FRONT	REAR
OFF	2-10		2-10	8-4	5-6-7-8-9-10	
MODEMS	3-10		3-10	9-4	5-6-7-8-9-10	
TEST OSC	4-10		4-10	10-4	5-6-7-8-9-10	
1KC-OW		11-4	5-10	11-4	6-7-8-9-10	5-11
19KC-CH4	6-10	12-4	6-10	12-4	5-7-8-9-10	6-11
11KC-CH2	7-10	1-4	7-10	1-4	5-6-8-9-10	7-11
7KC-CH1	8-10	2-4	8-10	2-4	5-6-7-9-10	8-11
15KC-CH3	9-10	3-4	9-10	3-4	5 6-7-8-10	9-11

NOTES
1 UNLESS OTHERWISE SHOWN RESISTORS ARE IN OHMS, 1/2W, 1%.
2 STRAP THESE RESISTORS TO OBTAIN PROPER SENSITIVITY WHEN METER CIRCUIT ELEMENTS ARE REPLACED
3 SWITCH VIEWED FROM KNOB SIDE NUMBERS INDICATE LUG POSITIONS ON SWITCH WAFER
4 FOR INTERCONNECTIONS SEE AMPLIFIER-POWER SUPPLY AM-682/TCC-3, CONNECTION DIAGRAM
5 C762 USED ONLY IN EQUIPMENTS BEARING ORDER NO 24483-PC-61

Figure 156. Measuring circuit of AM-682/TCC-3 on order No. 1667-PH-51 bearing serial numbers 1 through 1707, schematic diagrtam

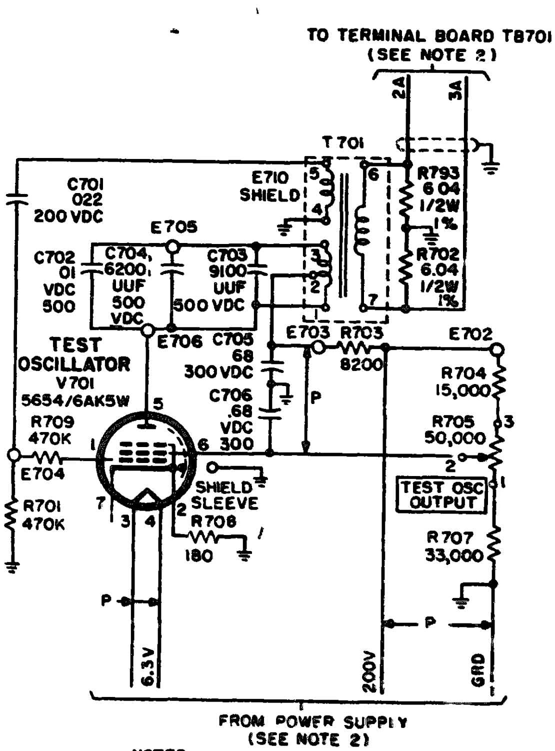


MEASURE SWITCH TABLE OF CONTACTS MADE

SWITCH POSITION	SECTION 1		SECTION 2		SECTION 3	
	FRONT	REAR	FRONT	REAR	FRONT	REAR
OFF	2-10		2-10	8-4	5-6-7-8-9-10	
MODEMS	3-10		3-10	9-4	5-6-7-8-9-10	
TEST OSC	4-10		4-10	10-4	5-6-7-8-9-10	
1KC-OW		11-4	5-10	11-4	6-7-8-9-10	5-11
19KC-CH4	6-10	12-4	6-10	12-4	5-7-8-9-10	6-11
11KC-CH2	7-10	1-4	7-10	1-4	5-6-8-9-10	7-11
7KC-CH1	8-10	2-4	8-10	2-4	5-6-7-9-10	8-11
11KC-CH3	9-10	3-4	9-10	3-4	5-6-7-8-10	9-11

NOTES:
1. UNLESS OTHERWISE SHOWN, RESISTOR ARE IN OHMS; 1/2W, 1%.
2. STRAP THESE RESISTORS TO OBTAIN PROPER SENSITIVITY WHEN METER CIRCUIT ELEMENTS ARE REPLACED.
3. SWITCH VIEWED FROM KNOB SIDE. NUMBERS INDICATE LUG POSITIONS ON SWITCH WAFER.
4. FOR INTERCONNECTIONS, SEE AMPLIFIER-POWER SUPPLY
5. ON EQUIPMENT BEARING ORDER NUMBERS OTHER THAN ORDER NO.1667-PH-51, TERMINAL 6 OF TB904 IS DESIGNATED TERMINAL 3.
6. C762 USED ONLY ON EQUIPMENTS BEARING ORDER NO 24483-PC-61.

Figure 157. Measuring circuit of AM-088/TCC-3 bearing order Numbers other than order No.1667-PH-51 (serial numbers 1 through (1707) schematic diagram.



NOTES
1. UNLESS OTHERWISE SHOWN RESISTORS ARE IN OHMS, 1/2W, 5% CAPACITORS ARE IN UF, VOLTAGE ARE AS SHOWN.
2. FOR INTERCONNECTIONS SEE AMPLIFIER-POWER SUPPLY CONNECTION DIAGRAM.

Figure 158. Tester oscillator, schematic diagram.

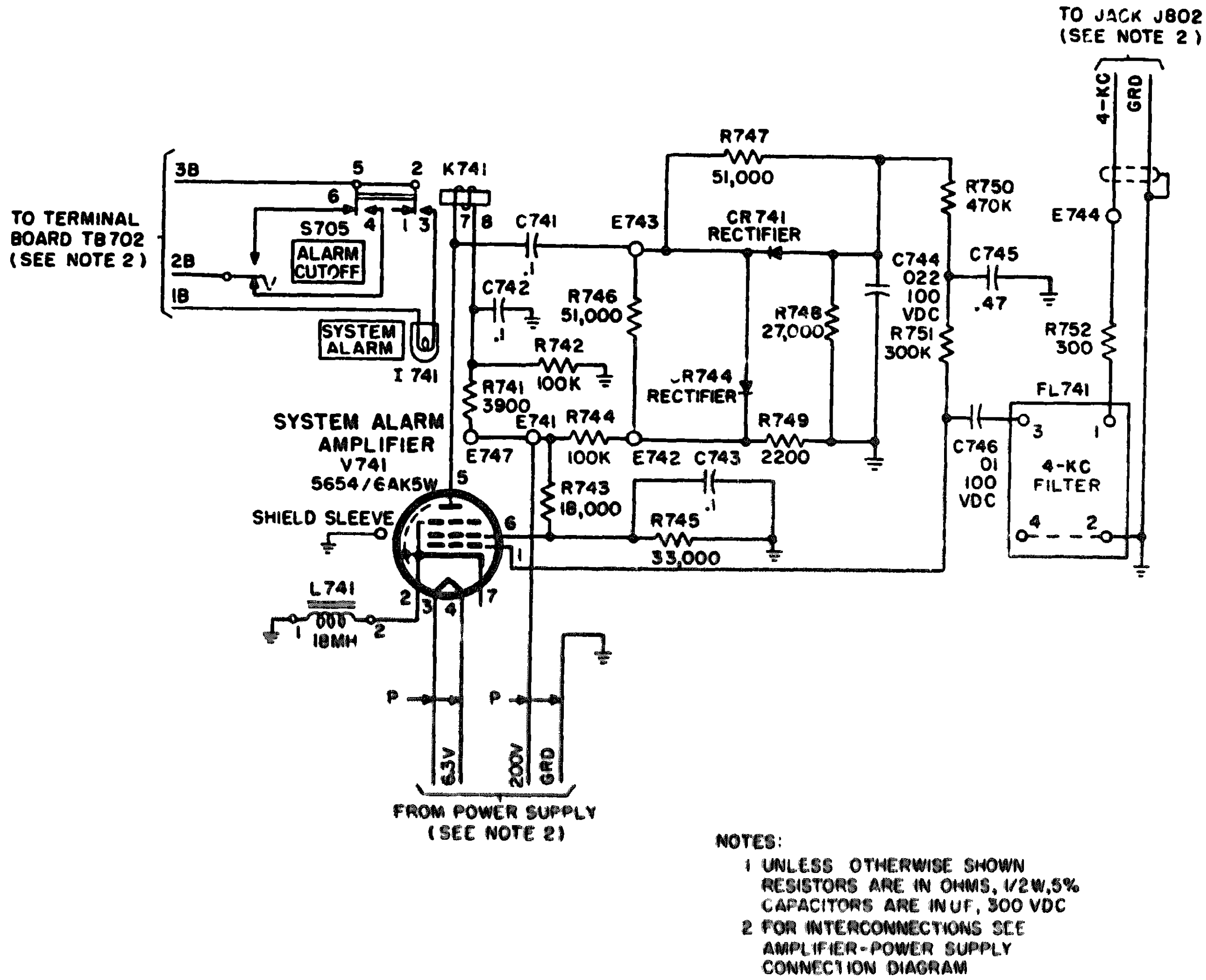


Figure 159. System alarm, schematic diagram.

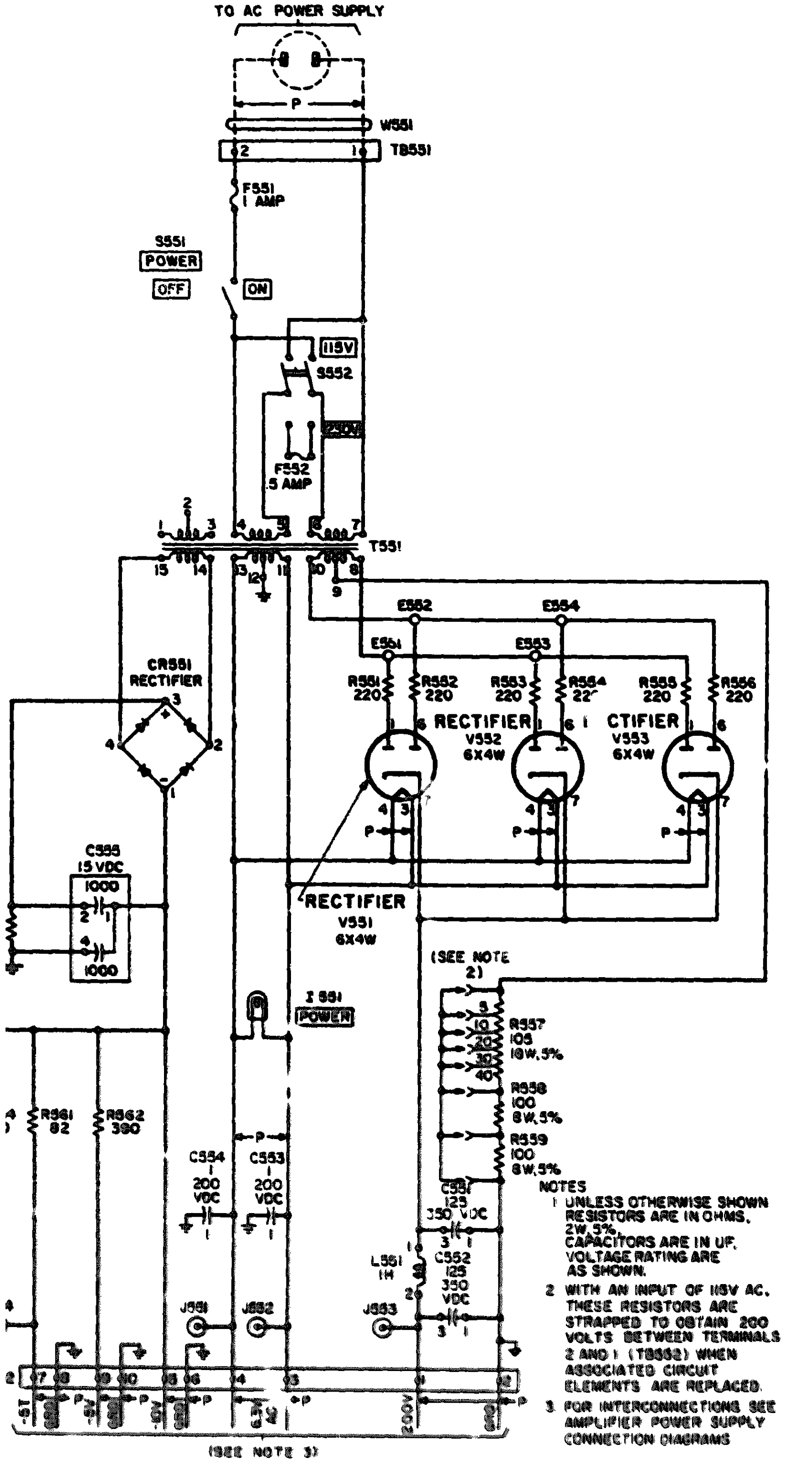
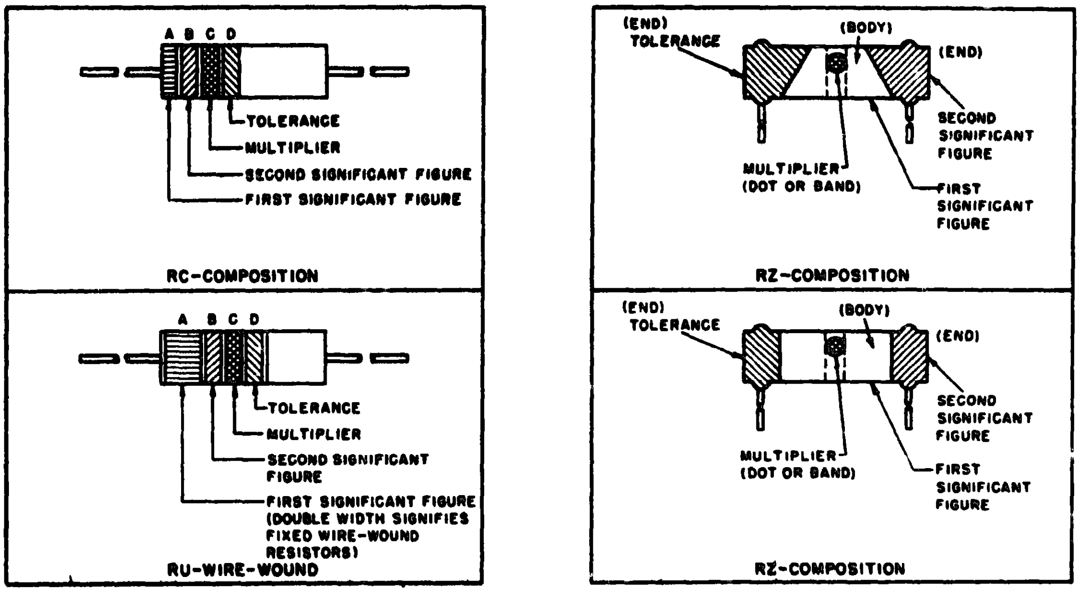


Figure 160. Power supply, schematic diagram.

RESISTOR COLOR CODE MARKING (MIL-STD RESISTORS)

AXIAL-LEAD RESISTORS (INSULATED) | **RADIAL-LEAD RESISTORS (UNINSULATED)**



RESISTOR COLOR CODE

BAND A OR BODY*		BAND B OR END*		BAND C OR DOT OR BAND*		BAND D OR END*	
COLOR	FIRST SIGNIFICANT FIGURE	COLOR	SECOND SIGNIFICANT FIGURE	COLOR	MULTIPLIER	COLOR	RESISTANCE TOLERANCE (PERCENT)
BLACK	0	BLACK	0	BLACK	1	BODY	± 20
BROWN	1	BROWN	1	BROWN	10	SILVER	± 10
RED	2	RED	2	RED	100	GOLD	± 5
ORANGE	3	ORANGE	3	ORANGE	1,000		
YELLOW	4	YELLOW	4	YELLOW	10,000		
GREEN	5	GREEN	5	GREEN	100,000		
BLUE	6	BLUE	6	BLUE	1,000,000		
PURPLE (VIOLET)	7	PURPLE (VIOLET)	7				
GRAY	8	GRAY	8	GOLD	0.1		
WHITE	9	WHITE	9	SILVER	0.01		

*FOR WIRE-WOUND-TYPE RESISTORS, BAND A SHALL BE DOUBLE-WIDTH WHEN BODY COLOR IS THE SAME AS THE DOT (OR BAND) OR END COLOR, THE COLORS ARE DIFFERENTIATED BY SHADE, GLOSS, OR OTHER MEANS

EXAMPLES (BAND MARKING).
10 OHMS ±20 PERCENT: BROWN BAND A; BLACK BAND B, BLACK BAND C; NO BAND D.
4.7 OHMS ±5 PERCENT: YELLOW BAND A, PURPLE BAND B; GOLD BAND C; GOLD BAND D.

EXAMPLES (BODY MARKING)
10 OHMS ±20 PERCENT BROWN BODY, BLACK END, BLACK DOT OR BAND, BODY COLOR ON TOLERANCE END
3,000 OHMS ±10 PERCENT ORANGE BODY, BLACK END, RED DOT OR BAND; SILVER END

STD-R1

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Figure 161. Resistor color code chart.

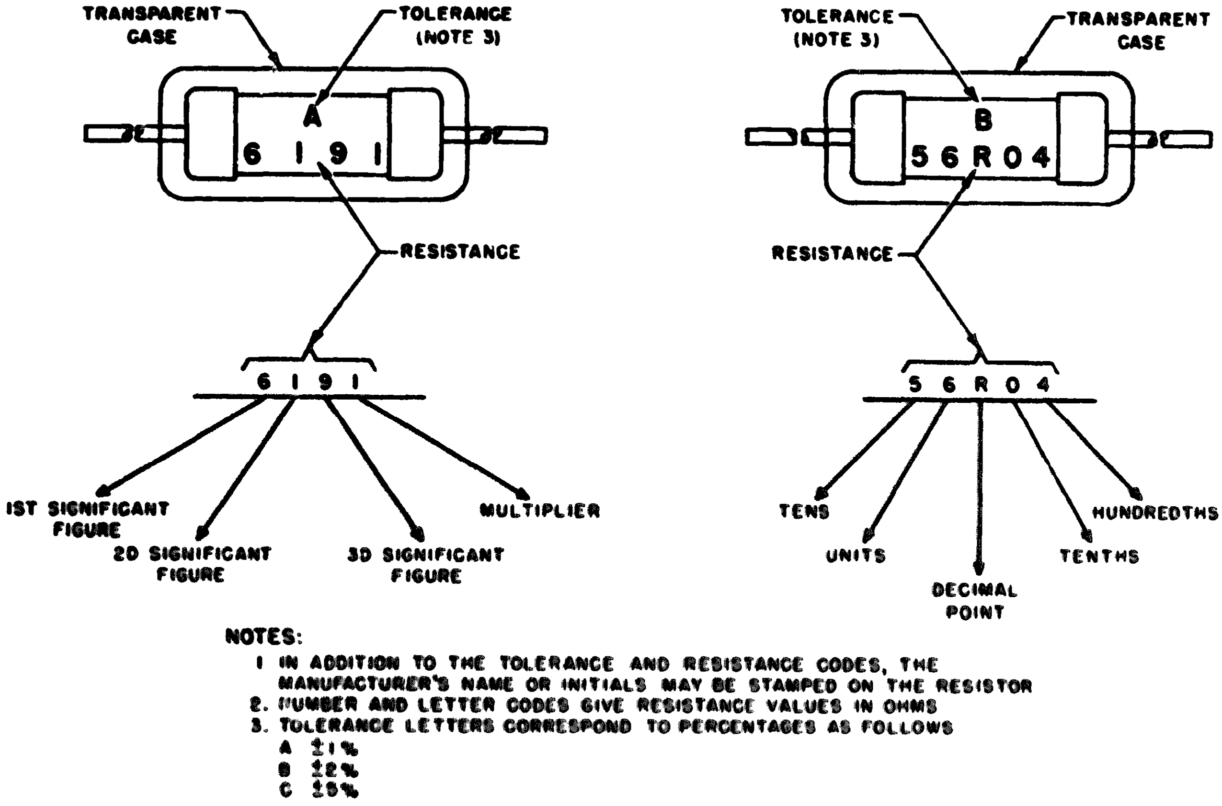
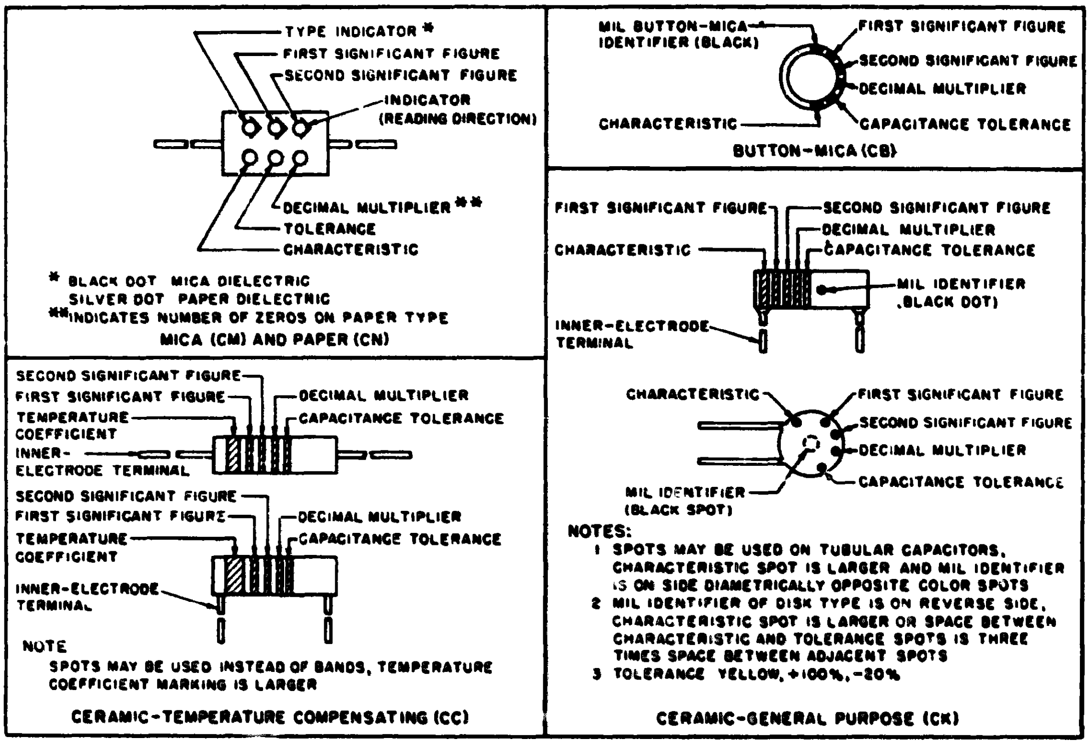


Figure 162. Film resistor code chart.

CAPACITOR COLOR CODE MARKING
(MIL-STD CAPACITORS)



CAPACITOR COLOR CODE

COLOR	SIG FIG.	MULTIPLIER		CHARACTERISTIC[1]				TOLERANCE[2]					TEMPERATURE COEFFICIENT (UUF/UF/°C)
		DECIMAL	NUMBER OF ZEROS	CM	CN	CB	CK	CM	CN	CB	CC OVER 10UUF	CC 10UUF OR LESS	CC
BLACK	0	1	NONE		A			20	20	20	20	2	ZERO
BROWN	1	10	1	B	E	B	W				1		-30
RED	2	100	2	C	H		X	2		2	2		-80
ORANGE	3	1,000	3	D	J	D			30				-150
YELLOW	4	10,000	4	E	P								-220
GREEN	5		5	F	R						5	0.5	-330
BLUE	6		6		S								-470
PURPLE (VIOLET)	7		7		T	W							-750
GRAY	8		8			X						0.25	+30
WHITE	9		9								10	1	-330(±500)[3]
GOLD		0.1						5		5			+100
SILVER		0.01						10	10	10			

1 LETTERS ARE IN TYPE DESIGNATIONS GIVEN IN MIL-C SPECIFICATIONS.
2 IN PERCENT, EXCEPT IN UUF FOR CC-TYPE CAPACITORS OF 10 UUF OR LESS.
3. INTENDED FOR USE IN CIRCUITS NOT REQUIRING COMPENSATION

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Figure 163. *Capacitor color code chart.*

APPENDIX A

REFERENCES

DA Pam 310-4	Index of Technical Manuals, Technical Bulletins, Supply Manuals (Types 7 8, and 9), Supply Bulletins, and Lubrication Orders.
DA Pam 310-7	US Army Equipment Index of Modification Work Orders.
SB 38-100	Preservation, Packaging, Packing and Marking Materials, Supplies and Equipment Used by the Army.
TB SIG 222	Solder and Soldering.
TB SIG 328	Telephone Carrier System Facilities Kit MK–155/TCC.
TB 746–10	Field Instructions for Painting and Preserving Electronics Command Equipment.
TM 9-213	Painting Instructions for Field Use.
TM 11-381	Cable Assembly CX–1065/C, Telephone Cable Assemblies CX-1606/G and CX–1512/U, Telephone Loading Coil Assembly CU–260/G, Electrical Connector Plugs U–176/G and U–226/G, and Maintenance Kit, Cable Splicing MK–640/G.
TM 11–614	Radio Set AN/GRC–10, Radio Terminal Set AN/GRC–39, and Radio Repeater Set AN/GRC–40.
TM 11–2136	Telephone Repeater AN/TCC–5 and Telephone Repeater AN/TCC–22.
TM 11–2139–10	Operator's Manual, Terminals Telephone AN/TCC–7 and AN/TCC–50.
TM 11–2139–20	Organizational Maintenance Manual, Terminals Telephone AN/TCC–7 and AN/TCC–50.
TM 11–2139–35	DS, GS, and Depot Maintenance Manual Including Repair Parts and Special Tool Lists: Terminals, Telephone AN/TCC–7 and AN/TCC–50.
TM 11–2140–35	Field and Depot Maintenance Manual, Telephone Repeater AN/TCC–8 and Telephone Repeater AN/TCC–21.
TM 11–5043–12	Operator's and Organizational Maintenance Manual: Analyzers ZM–3/U and ZM–3A/U.
TM 11–5805–223–20P	Organizational Maintenance Repair Parts and Special Tools List: Telephone Terminal AN/TCC–23 and Telephone Terminal AN/TCC–23.
TM 11–5805–223–35P	Field and Depot Maintenance Repair Parts and Special Tools List: Telephone Terminal AN/TCC–23 and Telephone Terminal AN/TCC–23.
TM 11–5805–247–12	Organizational Maintenance Manual (including repair parts and special tools list): Converter, Telegraph-Telephone Signal TA–182/U.
TM 11–5805–247–35	DS, GS, and depot Maintenance manual including repair parts and special tools list: Converter, Telegraph-Telephone Signal TA–182/U.
TM 11–5820–287–12	Organizational maintenance manual: Radio Sets AN/TRC–24, AN/GRC–75, AN/GRC–78, AN/GRC–79, AN/GRC–81 and AN/GRC–81A; radio terminal sets AN/TRC–35, AN/GRC–76, AN/GRC–79, and AN/GRC–82; radio relay set AN/TRC–36; radio repeater sets AN/GRC–77, AN/GRC–80, and AN/GRC–83; and radio set groups AN/TRA–25 and AN/TRA–25A.
TM 11–5820–308–12P	Operator's and Organizational Maintenance Repair Parts and Special Tools List and Maintenance Allocation Chart for Junction Box J–85/G.
TM 11–5820–308–35P	DS, GS, and Depot Maintenance Repair Parts and Special Tools Lists: Interconnecting Box J–85/G.

TM 11-5950-205-14P	Operator's, Organizational, Direct Support, and General Support Maintenance Repair Parts and Special Tools Lists (Including Depot Maintenance Repair Parts and Special Tools): Transformer, Variable, Power CN-16/U, CN-16A/U, and CN-16B/U, FSN 5950-235-2086.
TM 11-5965-216-15P	Operator's, Organizational, Field, and Depot Maintenance Repair Parts and Special Tools List, and Maintenance Allocation Chart: Handset TS-9-F.
TM 11-6115-206-20P	Organizational Maintenance Repair Parts and Special Tools List: Power Units PE-75-C, -D, -J, -K, -T, -U, -W, -AA, -AB, -AC, -AD, -AE, and -AF.
TM 11-6115-206-35P	Field and Depot Maintenance Repair Parts and Special Tools List: Power Units PE-75-C, -D, -J, -K, -T, -U, -W, -AA, -AB, -AC, -AD, -AE, and AF.
TM 11-6625-200-15	Operator's, Organizational, DS, GS, and Depot Maintenance Manual: Multimeters ME-26A/U, ME-26B/U, ME-26C/U, and ME-26D/U.
TM 11-6625-200-24P	Organizational, Direct Support, and General Support Maintenance Repair Parts and Special Tools Lists (Including Depot Maintenance Repair Parts and Special Tools): Multimeters ME-26A/U (FSN 6625-360-2493), ME-26B/U, ME-26C/U (FSN 6625-646-9409), and ME 26D/U FSN 6625-913-9781).
TM 11-6625-203-12	Operator and Organizational Maintenance: Multimeter AN/URM-105 including Multimeter ME-77/U.
TM 11-6625-203-24P	Organizational, Direct Support, and General Support Maintenance Repair Parts and Special Tools Lists (Including Depot Maintenance Repair Parts and Special Tools) Multimeter AN/URM-105 (Including Multimeter ME-771U).
TM 11-6625-203-35	Field and Depot Maintenance Manual: Multimeter AN/URM-105 including Multimeter ME-77/U.
TM 11-6625-203-45P	Field (fourth echelon) and Depot Maintenance Repair Parts and Special Tools List: Multimeter AN/URM-105.
TM 11-6625-218-12	Organizational Maintenance Manual: Frequency Meter AN/TSM-16.
TM 11-6625-218-20P	Organizational Maintenance Repair Parts and Special Tool Lists: Frequency Meter AN/TSM-16.
TM 11-6625-218-35	Direct Support, General Support, and Depot Maintenance Manual: Frequency Meter AN/TSM-16.
TM 11-6625-218-45P	General Support and Depot Maintenance Repair Parts and Special Tools List: Frequency Meter AN/TSM-16.
TM 11-6625-[illegible]-15	Organizational, DS, GS, and Depot Maintenance Manual: Test Set TS-140/PCM, Signal Generator SG-15/PCM, and SG-15A/PCM, and Decibel Meter ME-22/PCM and ME-22A/PCM.
TM 11-6625-251-20P	Organizational Maintenance Repair Parts and Special Tool Lists: Decibel Meter ME-22/PCM and ME-22A/PCM.
TM 11-6625-251-45P	Field (fourth echelon) and Depot Maintenance Repair Parts and Special Tool Lists: Decibel Meter ME-22/PCM, and ME-22A/PCM.
TM 11-6625-274-12	Operator's and Organizational Maintenance Manual: Test Sets, Electron Tube TV-7/U, TV-7A/U, TV-7B/U, and TV-7D/U.
TM 11-6625-274-25P	Organizational, DS, GS, and Depot Maintenance Repair Parts and Special Tool Lists: Test Sets, Electron Tube TV-7/U, TV-7A/U, TV-7B/U and TV-7D/U.
TM 11-6625-274-35	DS, GS, and Depot Maintenance Manual: Test Sets, Electron Tube TV-7/U, TV-7A/U, TV-7B/U, and TV-7D/U.
TM 11-6625-320-12	Operator and Organizational Maintenance Manual: Voltmeter, Meter ME-30A/U and Voltmeters, Electronic ME-30B/U, ME-30C/U and ME-30E/U.

TM 11-6625-320-25P	**Organizational, DS, GS, and Depot Maintenance Repair Parts and Special Tools List: Voltmeters, Electronic ME-30A/U, ME-SOB/U, ME-30C/U and ME-30E/U.**
TM 11-6625-320-35	**DS, GS, and Depot Maintenance Manual: Voltmeter, Meter ME-30A/U and Voltmeters, Electronic ME-30B/U, ME-30C/U.**
TM 11-6625-356-12	**Operator, and Organizational Maintenance Manual: Transmission measuring sets TS-599A/FT, TS-599B/FT, TS-599C/FT and TS-599D/FT.**
TM 11-6625-356-20P	**Organizational maintenance Repair Parts and Special tools lists: Transmission measuring sets TS-599A, B, C, D/FT.**
TM 11-6625-356-34P	**Direct Support and General Support Maintenance Repair Parts and Special Tools** Lists **(Including** Depot Maintenance Repair Parts **and Special Tools) :** Transmission **Measuring Sets TS-559A/FT, TS-559B/FT, TS-559C/FT, and TS559D/FT FSN 6625-504-9051.**
TM 11-6625-356-40	**General Support Maintenance Manual: Transmission Measuring sets TS-599A/FT, TS-599/FT. TS-599C/FT and TS-599D/FT.**
TM 11-6626-366-15	**Operator's, Organizational, DS, GS, and Depot Maintenance Manual: Multimeter TS-352R/U.**
TM 11-6625-366-25P	**Organizational, DS, GS, and** Depot **Maintenance Repair Parts: Multimeter TS-352B/U.**
TM 38-750	**The Army Maintenance Management System (TAMMS).**

SECTION II. MAINTENANCE ALLOCATION CHART

(1) GROUP NUMBER	(2) FUNCTIONAL GROUP COMPONENT ASSEMBLY NOMENCLATURE	(3) MAINTENANCE FUNCTIONS											(4) TOOLS AND EQUIPMENT	(5) REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	REBUILD		
	TELEPHONE TERMINAL AN/TCC-3 & AN/TCC-23	C 0.3		C 0.3										Preventive maintenance
				O 0.5									14	
			C 0.5											System operation using built-in facilities
			O 0.3		O 0.3			O 0.5	O 1.0	O 0.4			5,11,13,14,17	
			F 0.8							F 1.0			1,3,4,6,7,11, 13,14,17,18	
			H 1.5							H 1.5			1 thru 4,6 thru 11,13thru 18	
			D 3.[illegible]							D 4.0	D 100.0	D 150.0	1 thru 4,6 thru 18	
	AMPLIFIER-POWER SUPPLY AM-682()/TCC-3	C 0.2		C 0.2										Preventive maintenance
				O 0.3									14	
			C 0.3											Operation using built-in facilities
			O 0.2		O 0.2			O 0.3	O 0.5	O 0.3			5,11,13,14,17	
			F 0.5							F 0.7			1,3,4,6,7,11, 13,14,17,18	
			H 1.0							H 1.0			1 thru 4,6 thru 11,13 thru 18	
			D 1.5							D 2.0	D 40.0	D 60.0	Depot facilities	

SECTION II. MAINTENANCE ALLOCATION CHART

(1) GROUP NUMBER	(2) FUNCTIONAL GROUP COMPONENT ASSEMBLY NOMENCLATURE	(3) MAINTENANCE FUNCTIONS: INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	REBUILD	(4) TOOLS AND EQUIPMENT	(5) REMARKS
	TELEPHONE MODEM TA-219()/U	C 0.2		C 0.2										Preventive maintenance
				O 0.2									14	
			C 0.2											Operation using built-in facilities
			O 0.2		O 0.2			O 0.2	O 0.5	O 0.3			5,11,13,14,17	
			0.4							**0.6**			**1,3,4,6,7,11 13,14,17,18**	
			H **0.8**							H **0.8**			**1 thru 4,6 thru 11,13 thru 18**	
			D 1.0							D 1.5	D 30.0	D 40.0	Depot facilities	
	JUNCTION Box J-85/G									#				See TM 11-5820-308-12P
	POWER UNIT PE-75()									#				See **TM** 11-6115-206-20P
	JUNCTION BOX JB-110	0.1		C 0.1				C 0.1	0.1					
			O 0.1							O 0.1			5,14	
														# Indicates that maintenance guidance can be found in the publications referenced in the "Remarks column.

TOOL TEST EQUIPMENT REQUIREMENTS

MAINTENANCE CATEGORY	NOMENCLATURE	FEDERAL STOCK NUMBER	TOOL NUMBER
F,H,D	TEST SET SUBASSEMBLY TS-402/U	6625-230-5149	
H,D	COUNTER, ELECTRONIC, DIGITAL READOUT AN/USM-207	6655-911-6368	
F,H,D	GENERATOR, SIGNAL SG-71/FCC	6625-669-0255	
F,H,D	METER, AUDIO LEVEL ME-71/FCC	6625-545-7949	
O	MULTIMETER AN/URM-105	6625-581-2036	
F,H,D	MULTIMETER TS-352B/U	6625-553-0142	
F,H,D	MULTIMETER, METER ME-26/U	6625-913-9781	
H,D	OSCILLOSCOPE OS-8/U	6625-643-1740	
H,D	POWER SUPPLY PP-827/U	5805-500-4436	
H,D	TEST FACILITIES KIT, TELEPHONE CARRIER MK-155/TCC	6625-603-9523	
O,F,H,D	TEST SET TS-190/U	6625-553-0932	
D	TEST SET, ELECTRON TUBE TV-2/U	6625-669-0263	
O,F,H	TEST SET, ELECTRON TUBE TV-7D/U	6625-820-0064	
O,F,H,D	TOOL EQUIPMENT TE-123	5180-408-1881	
H,D	TRANSFORMER, VARIABLE CN-16B/U	5950-688-5722	
H,D	TRANSMISSION MEASURING SET TS-559/FT	6625-540-9051	
O,F,H,D	TUBE SOCKET ADAPTER KIT MX-1258/U	6625-301-0815	
F,H,D	MULTIMETER ME-30/U	6625-643-1670	

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USAINTS (3)
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USACDCEC (10)
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MAAG (1)
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Units org under *for* TOE: 1 cy ea
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NG: State AG (3); Units—Same as Active Army.
USAR: None
For explanation of abbreviations used, see AR 310-50.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1973— 714-[illegible]

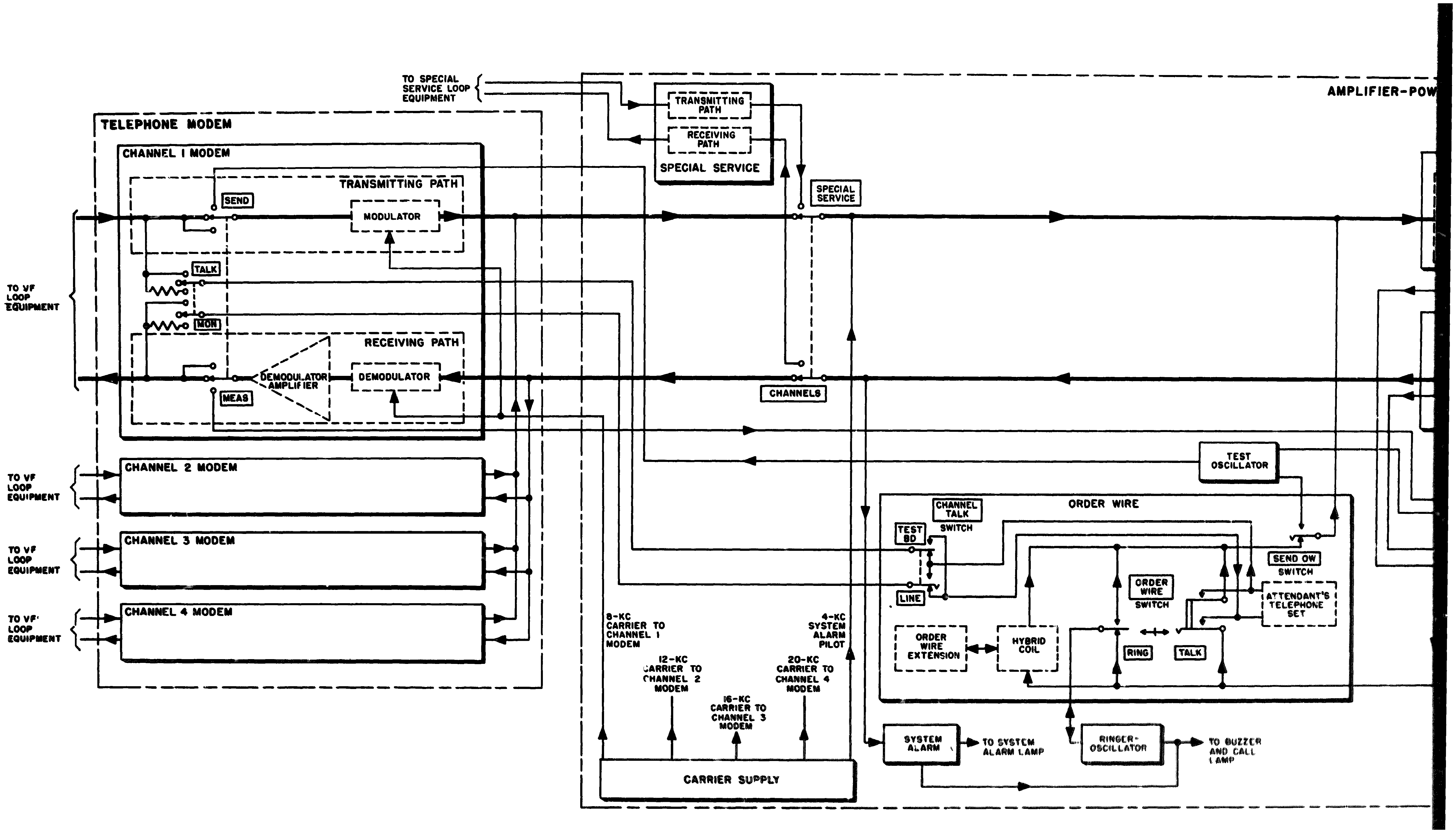
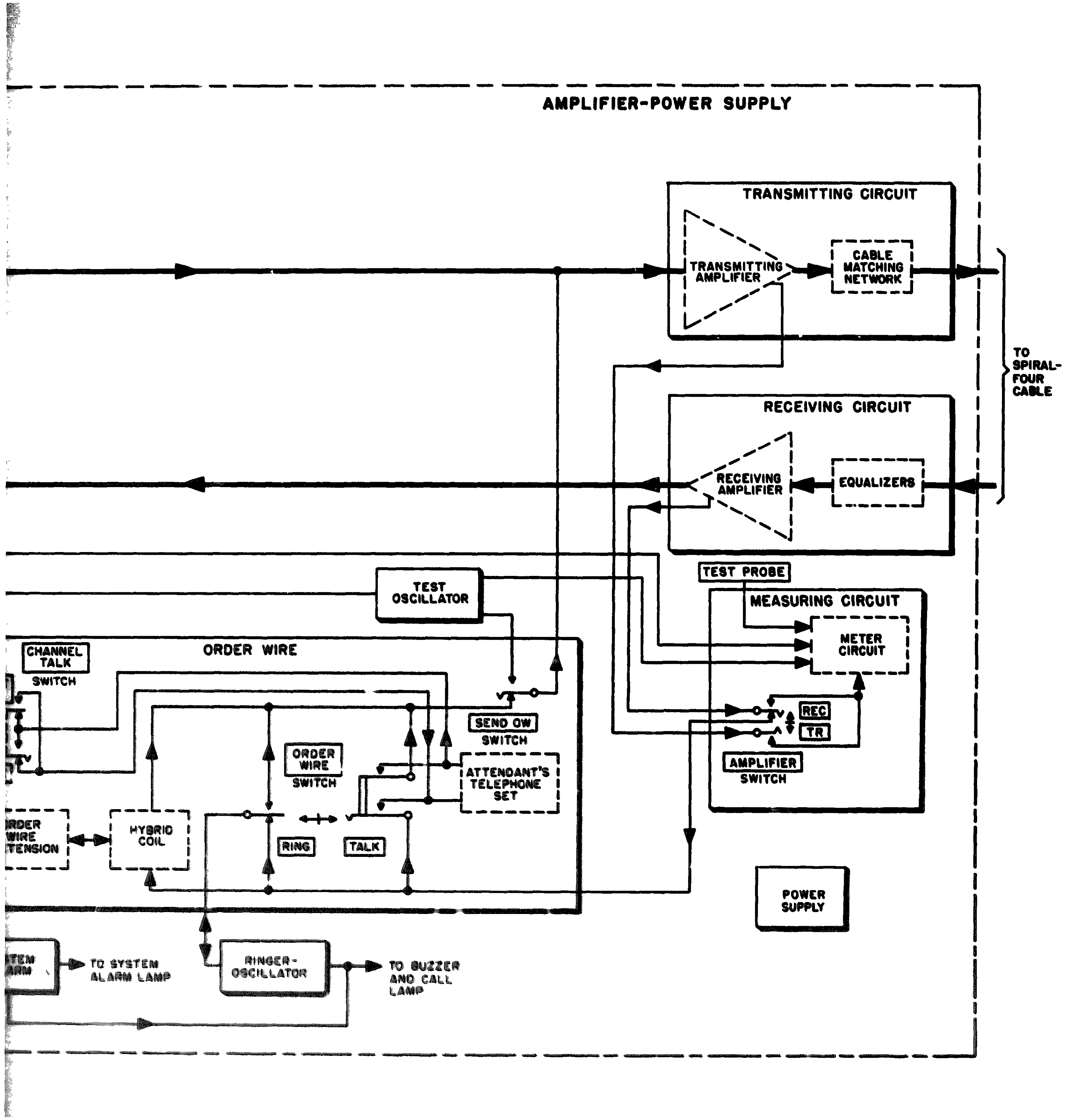


Figure 31. Telephone terminal AN/TCC-1 overall block diagram.



overall block diagram.

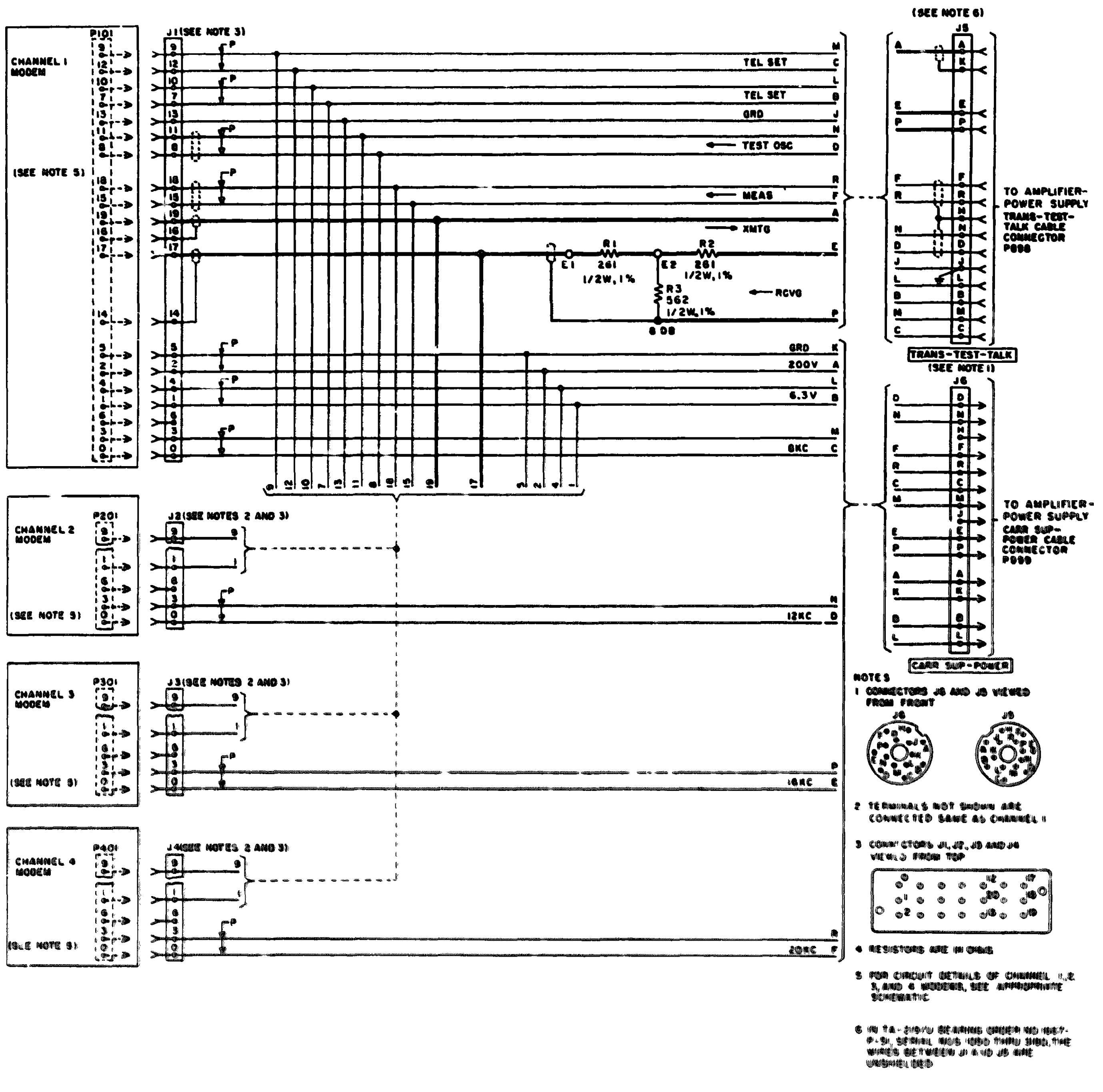


Figure 145. Telephone modem TA-819/U, connection diagram.

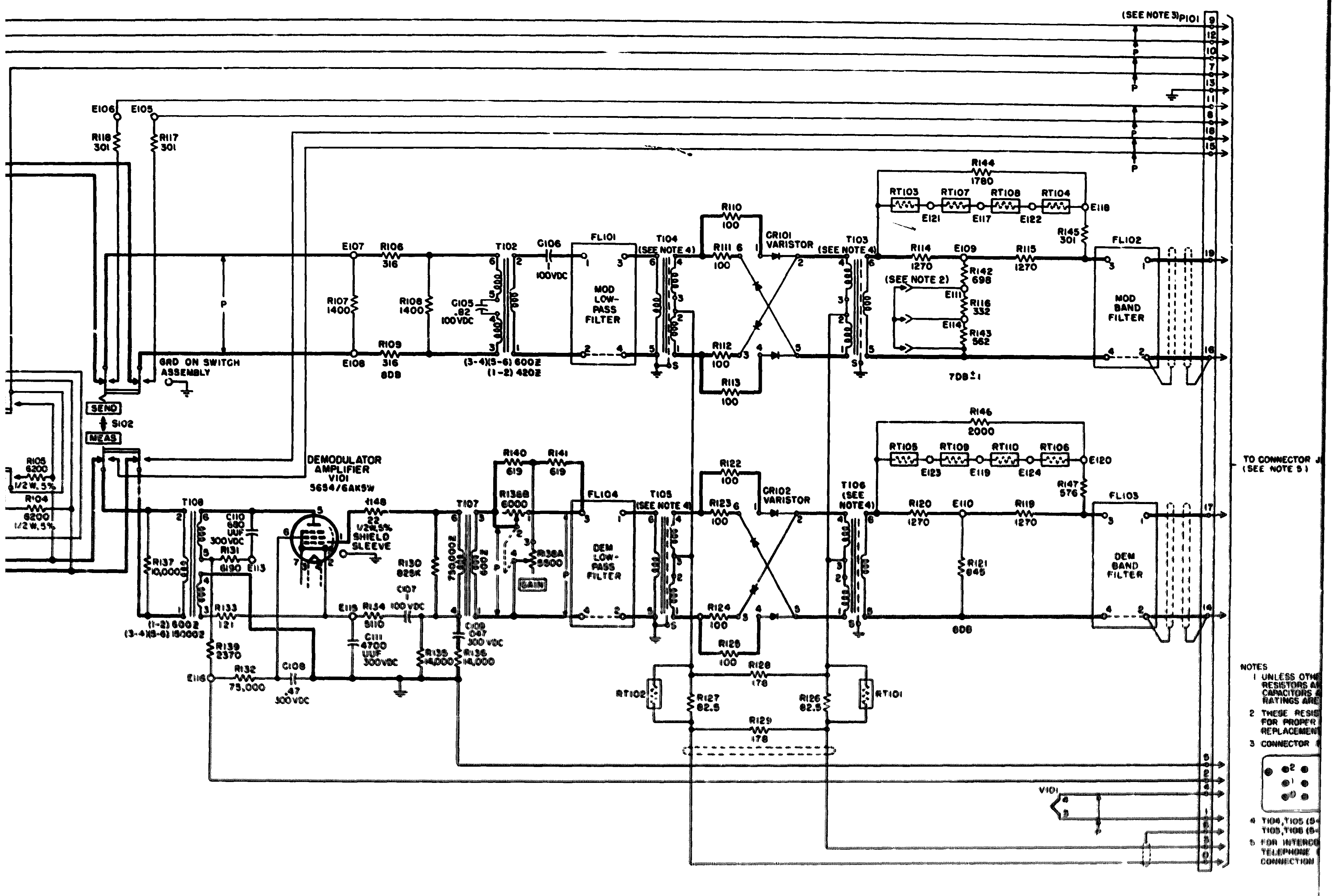
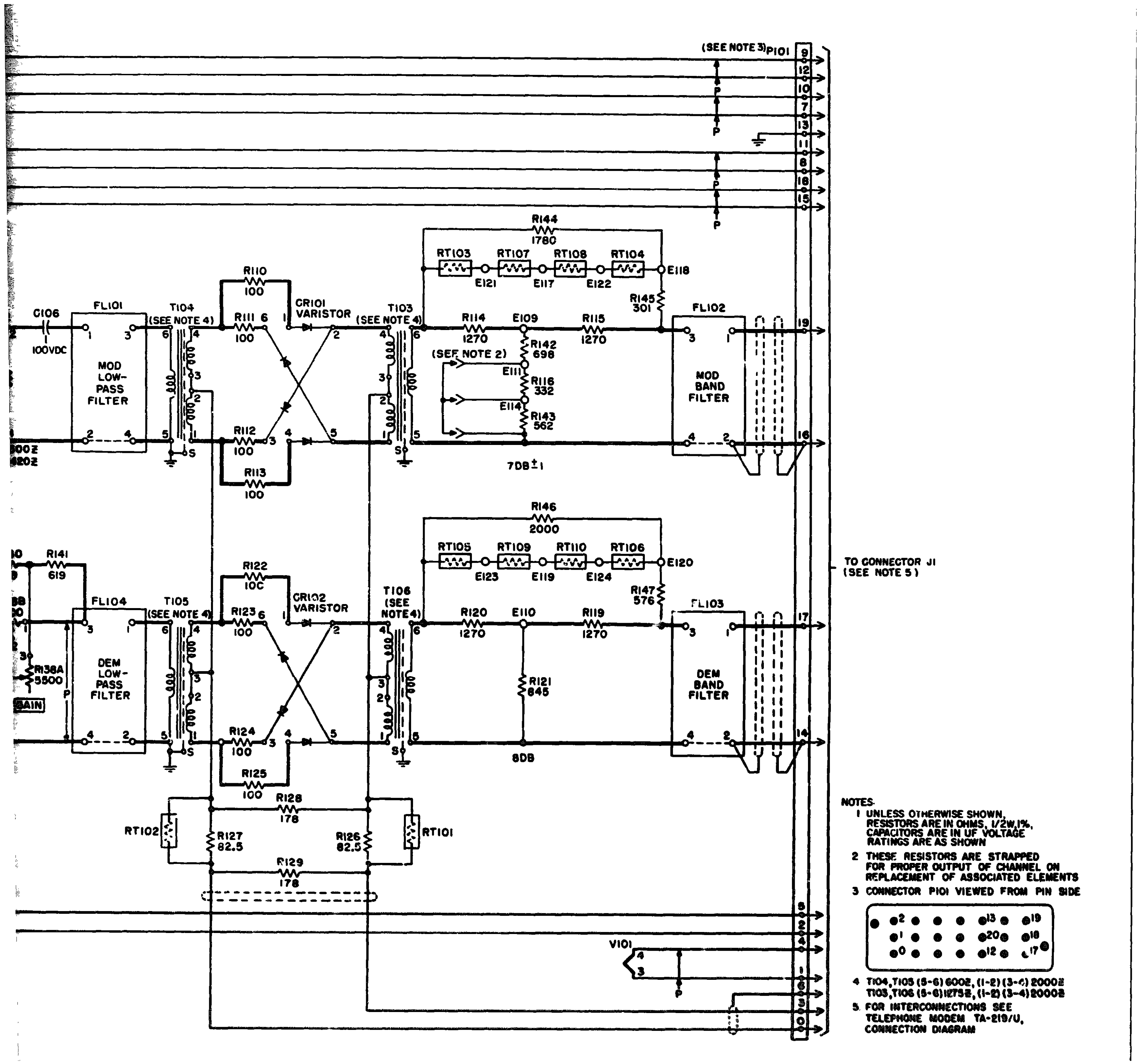


Figure 146. Channel 1 modem, schematic diagram.



modem, schematic diagram.

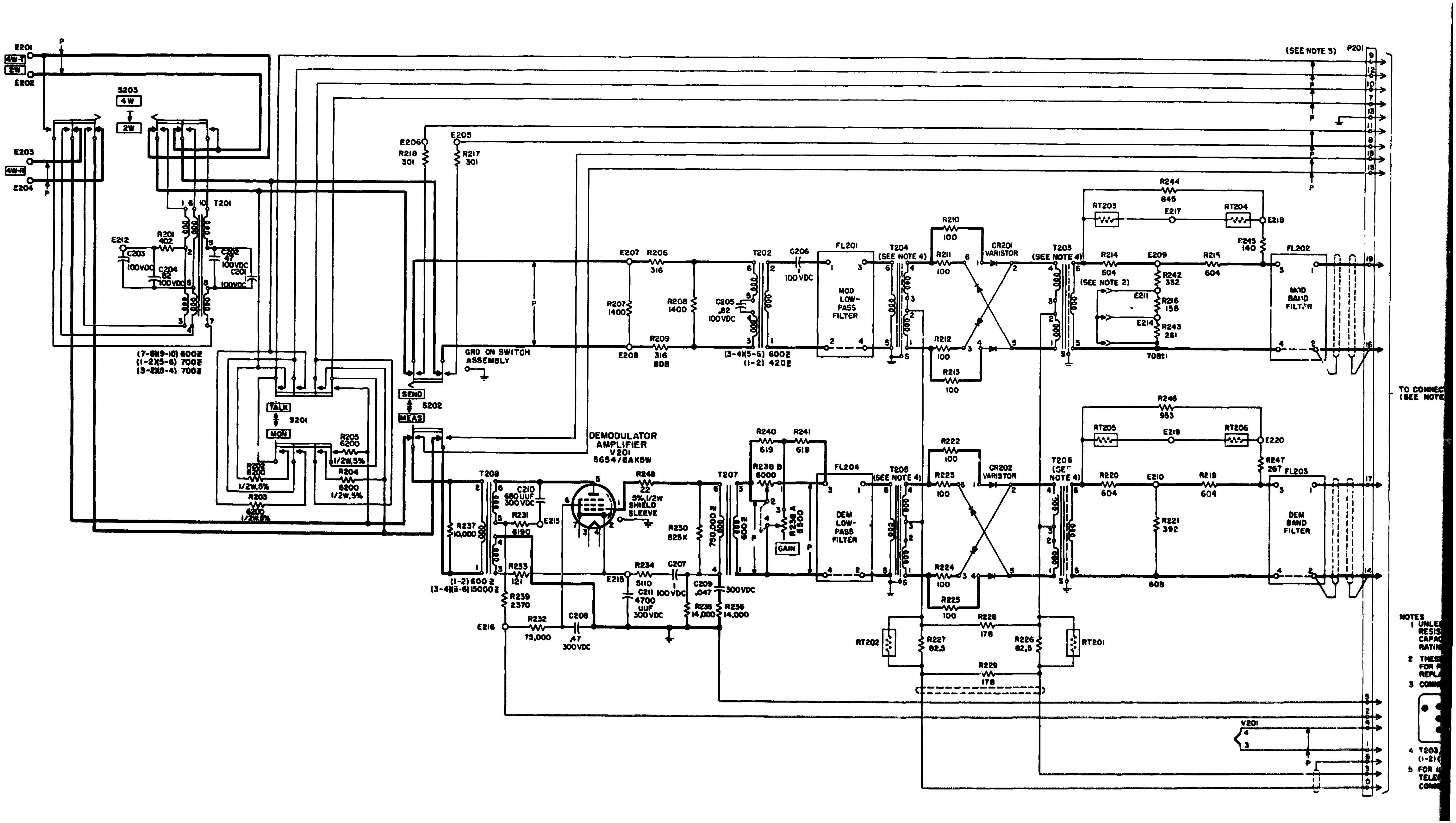
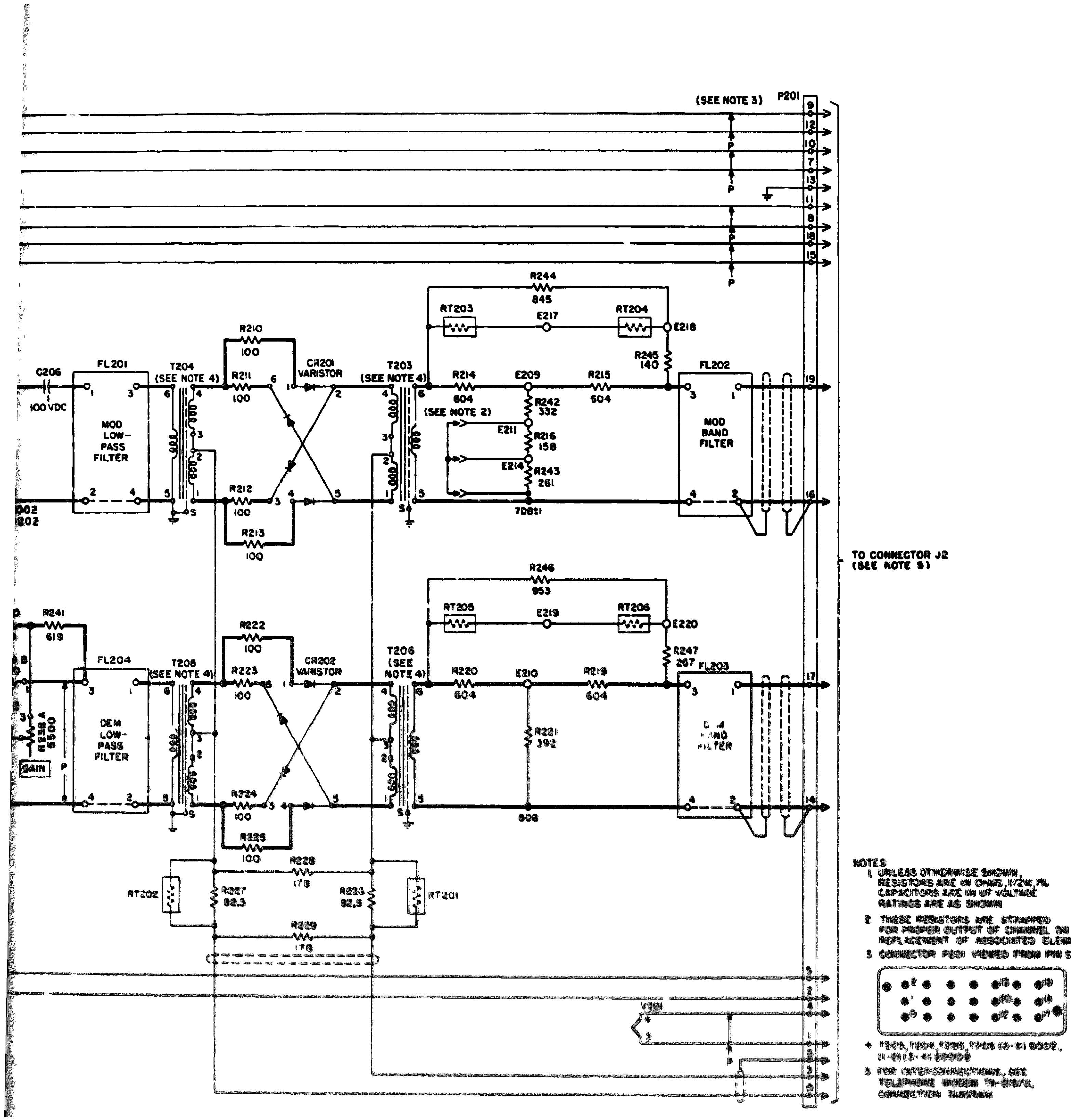


Figure 147. Channel 2 modem, schematic diagram.



NOTES

1. UNLESS OTHERWISE SHOWN, RESISTORS ARE IN OHMS, 1/2W, 1%. CAPACITORS ARE IN UF VOLTAGE RATINGS ARE AS SHOWN
2. THESE RESISTORS ARE STRAPPED FOR PROPER OUTPUT OF CHANNEL ON REPLACEMENT OF ASSOCIATED ELEMENTS
3. CONNECTOR P201 VIEWED FROM PIN SIDE

modem, schematic diagram.

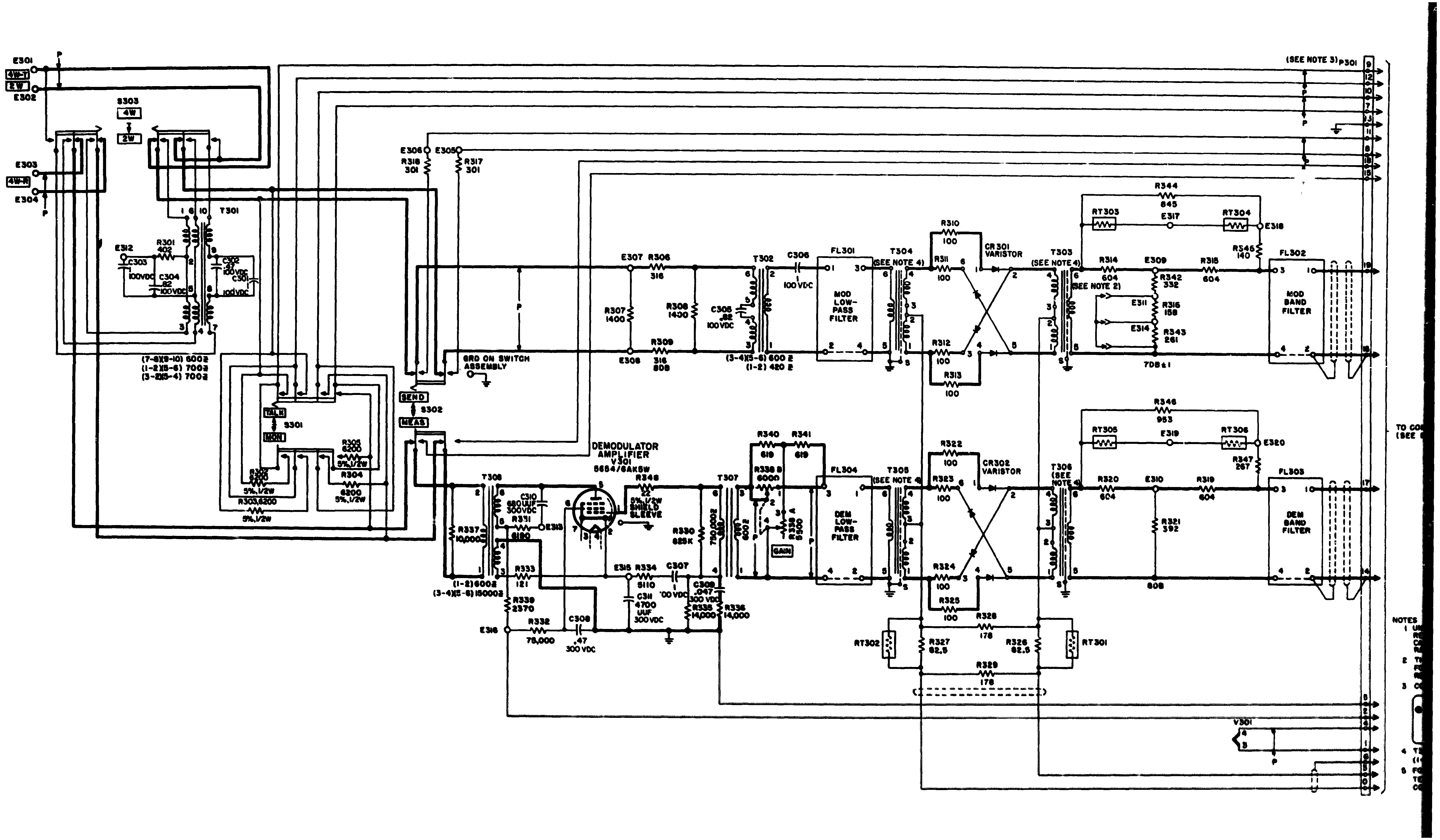
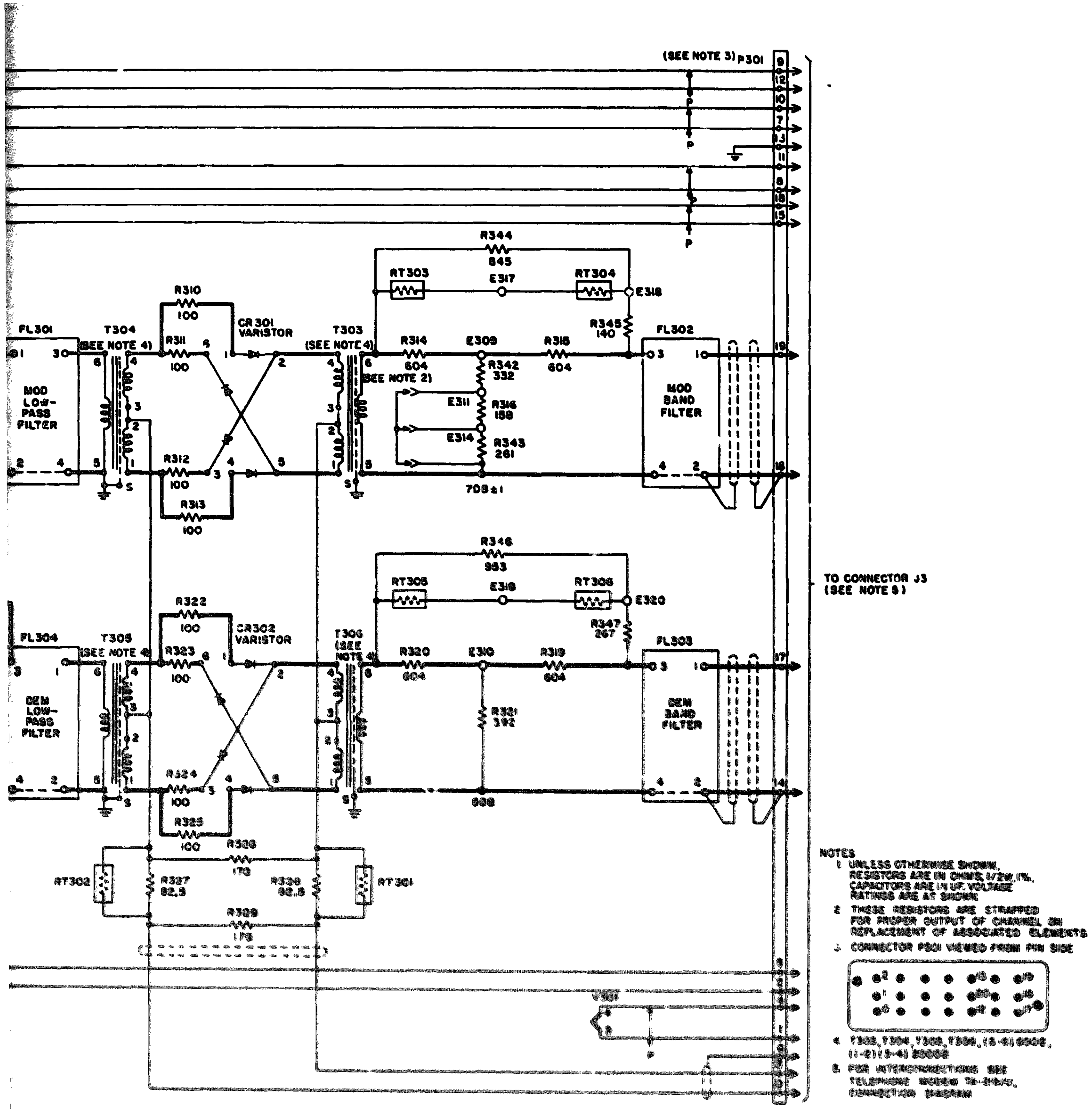


Figure 148. Channel 3 modem, schematic diagram.



schematic diagram.

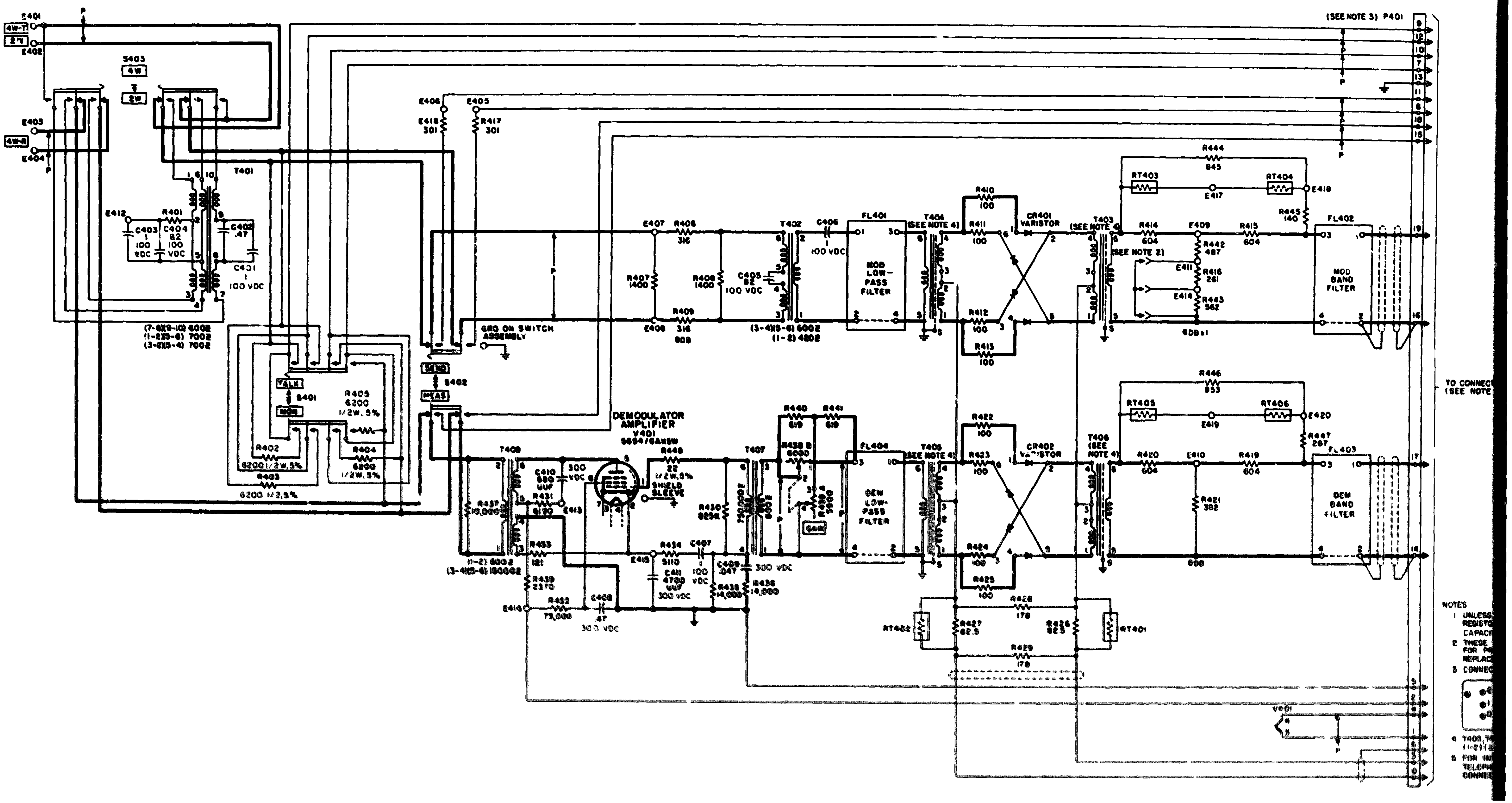
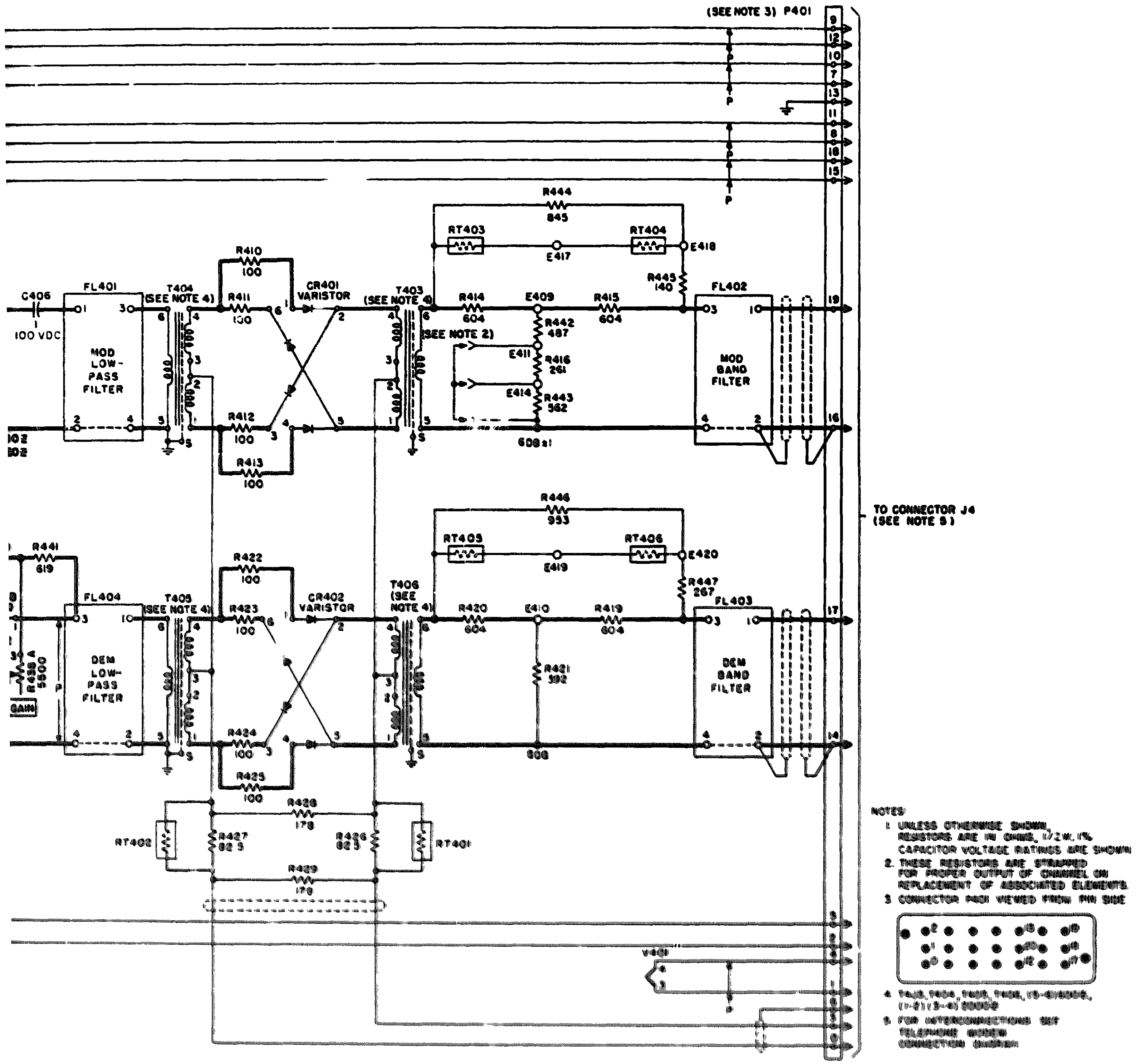


Figure 149. Channel 4 modem, schematic diagram.



modem, schematic diagram.

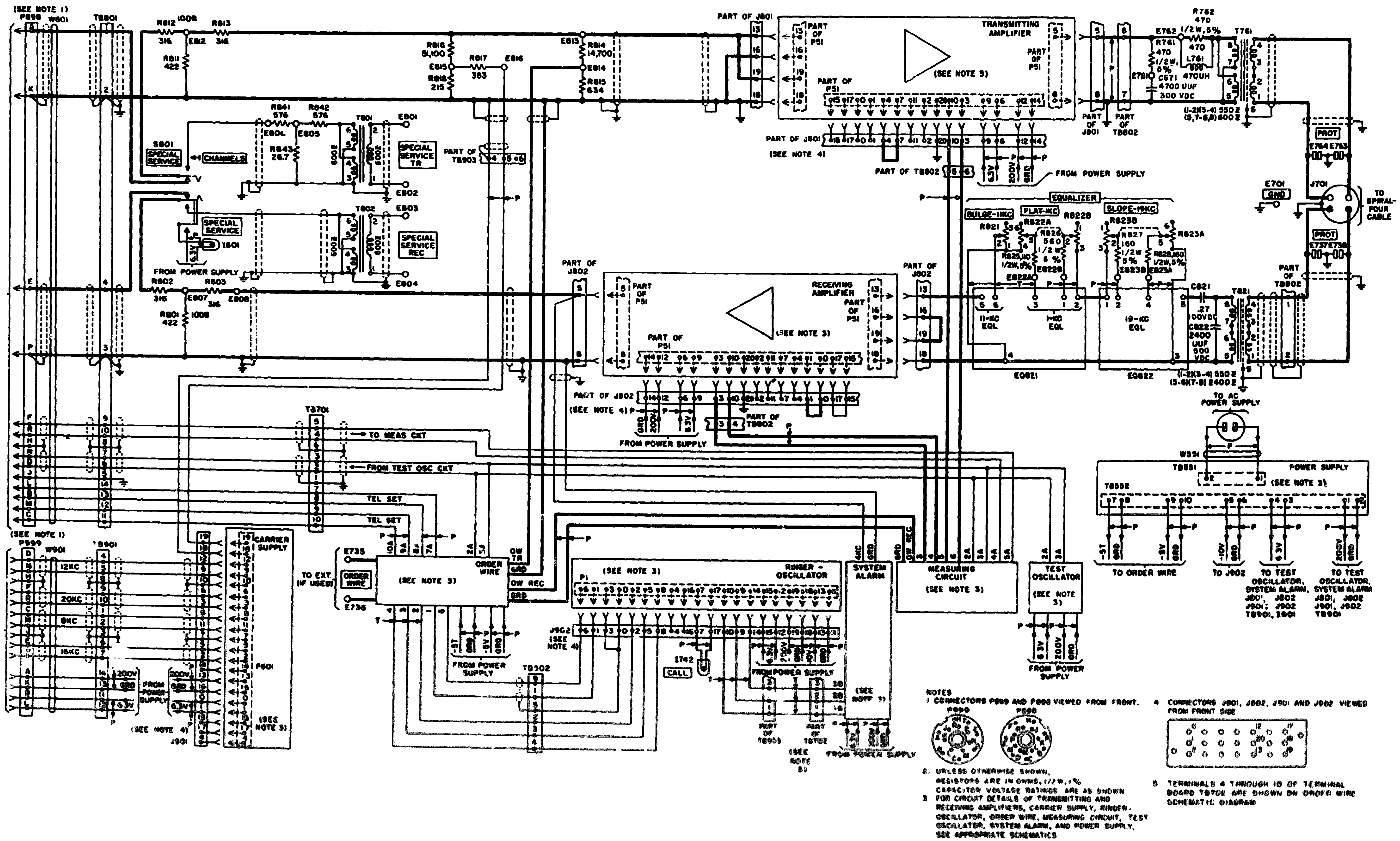


Figure 150. Amplifier-power supply AM-682/TCC-2 connection diagram for AM-682/TCC on Order No. 1667-PH-15 bearing serial numbers 1 through 1707.

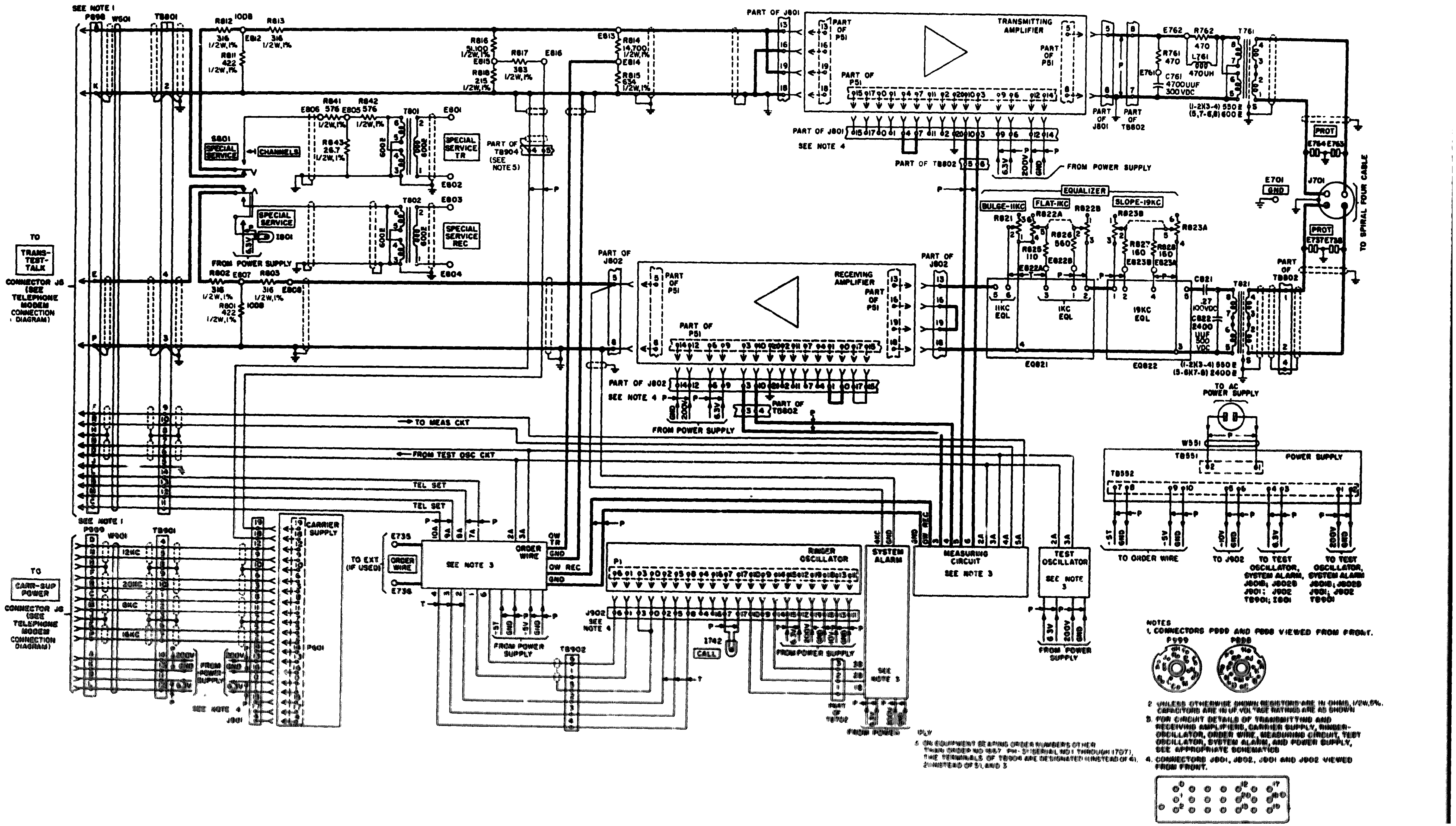


Figure 151. Amplifier-power supply AM-652/TCC-3 connection diagram for AM-651/TCC-4 on equipment bearing numbers other than Order No. 1667-PN-57 (Serial Nos. 1 through 1707).

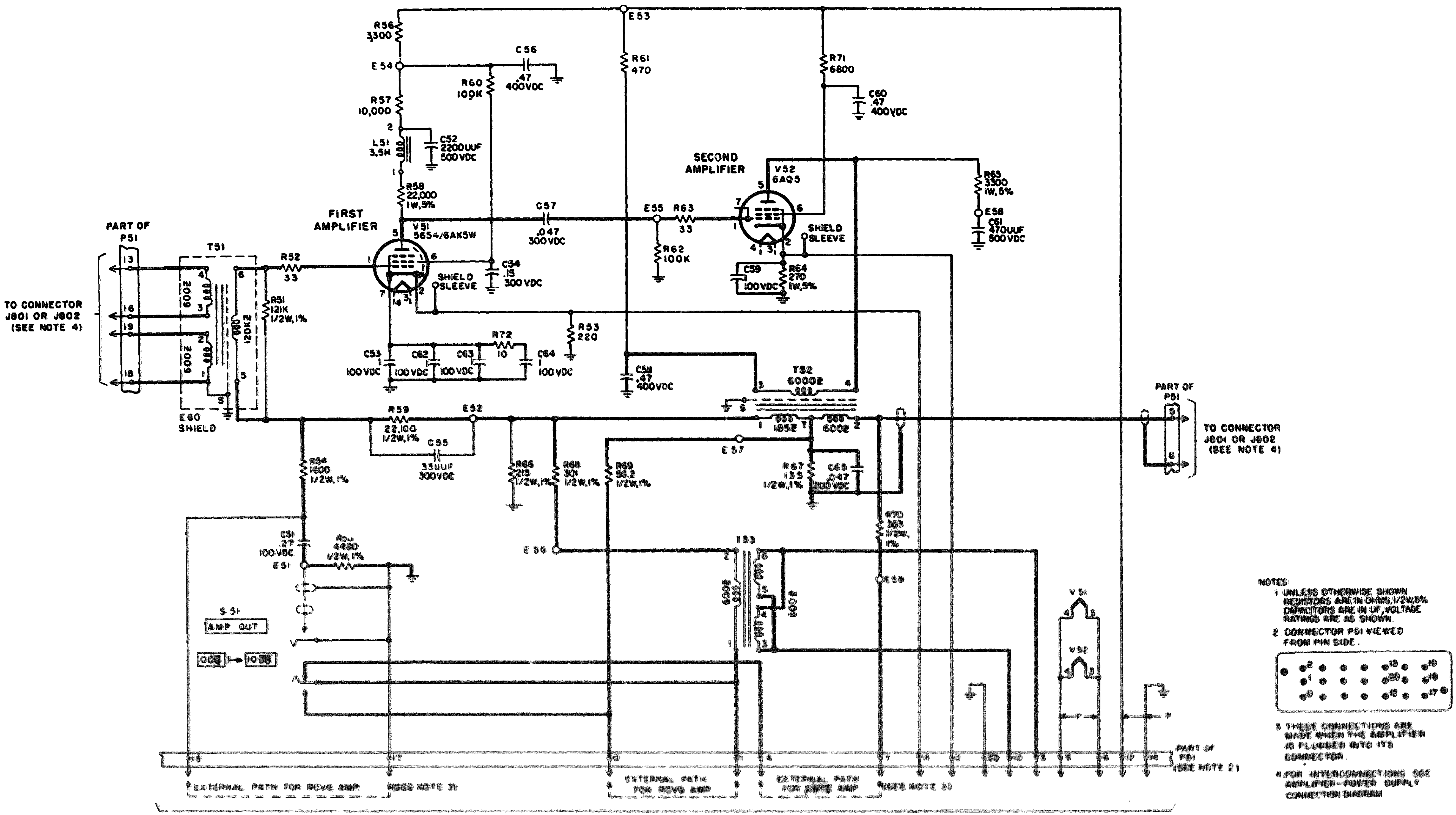


Figure 152. Transmitting and receiving amplifier, schematic diagram.

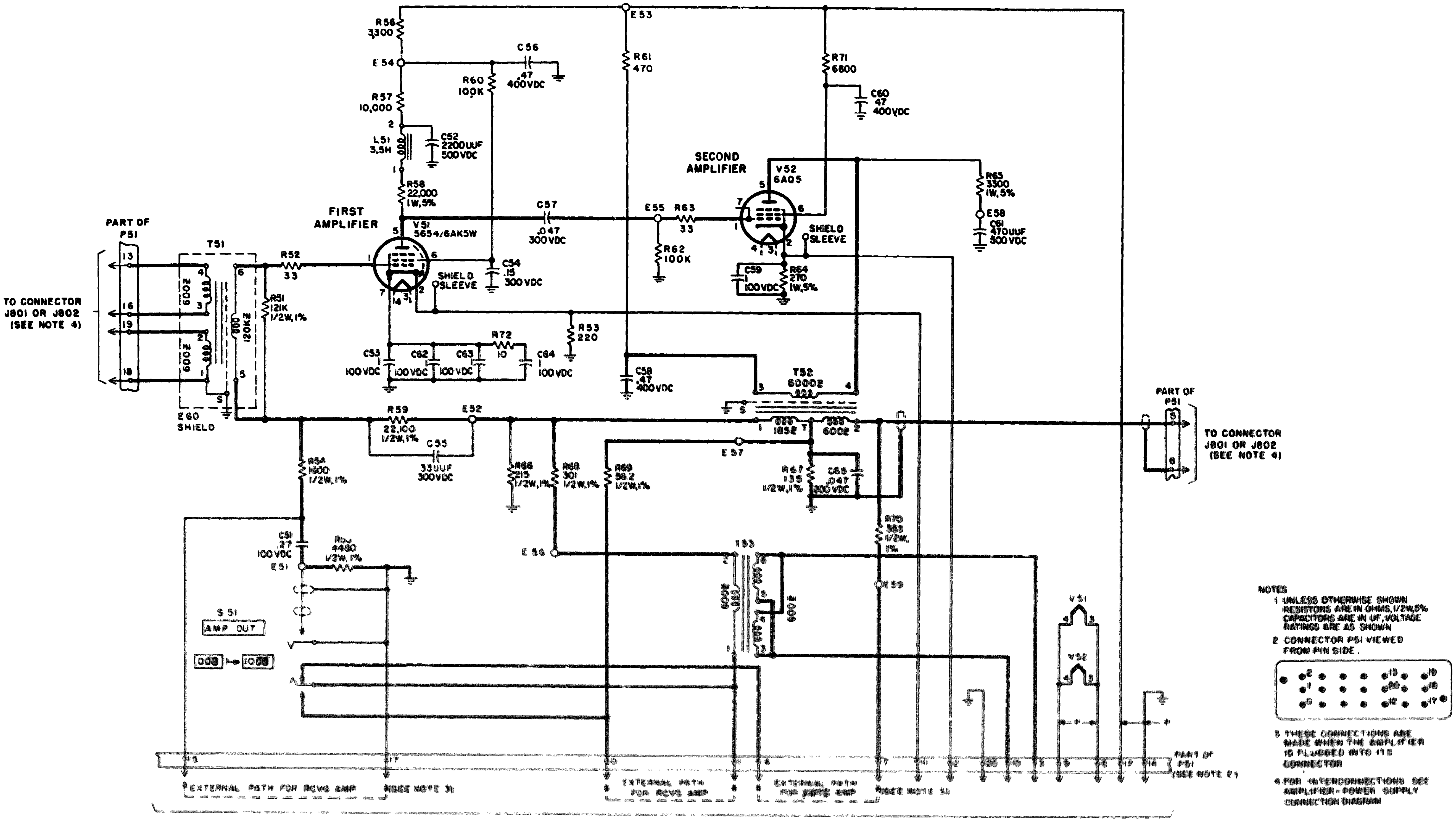
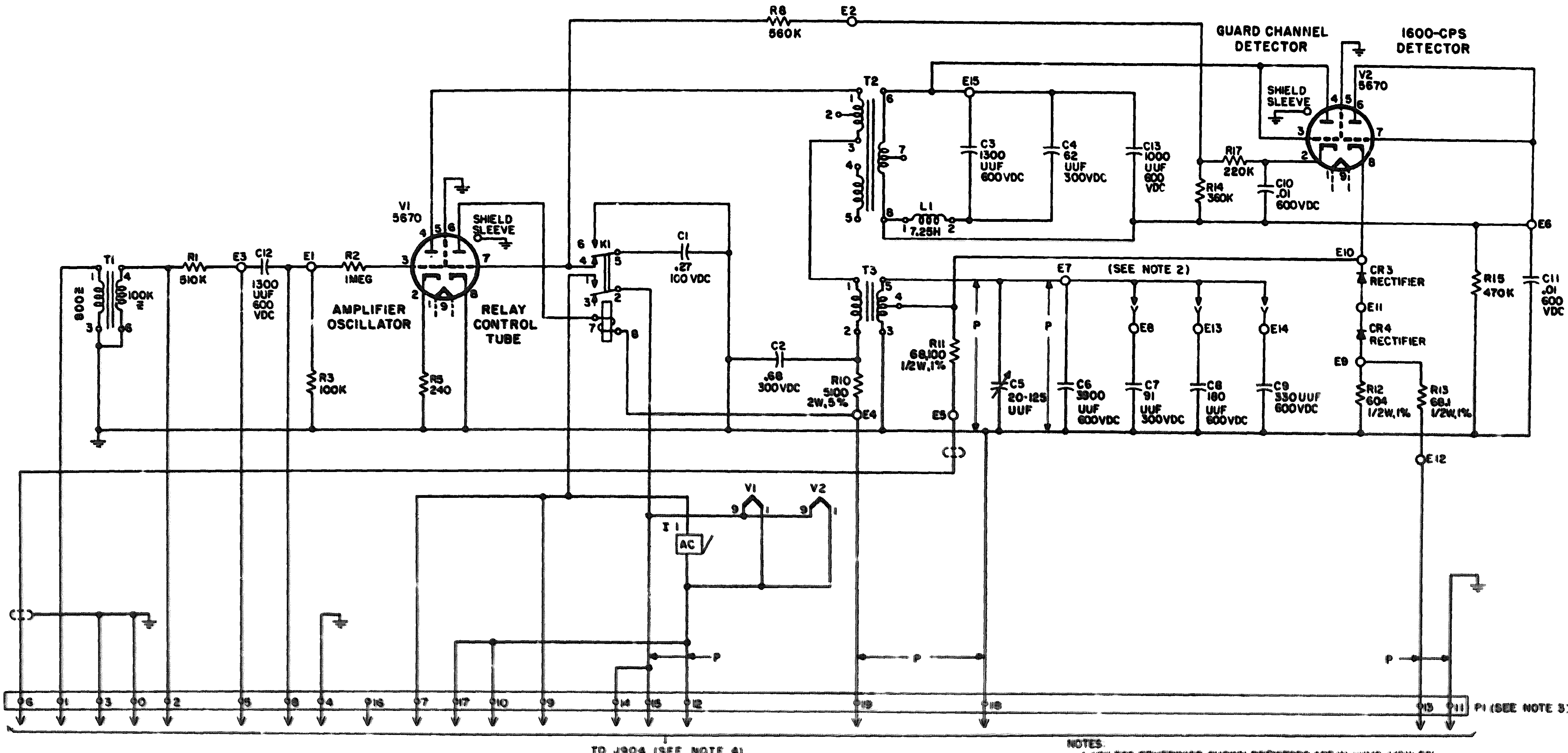
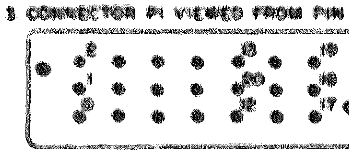


Figure 153. Transmitting and receiving amplifier, schematic diagram.



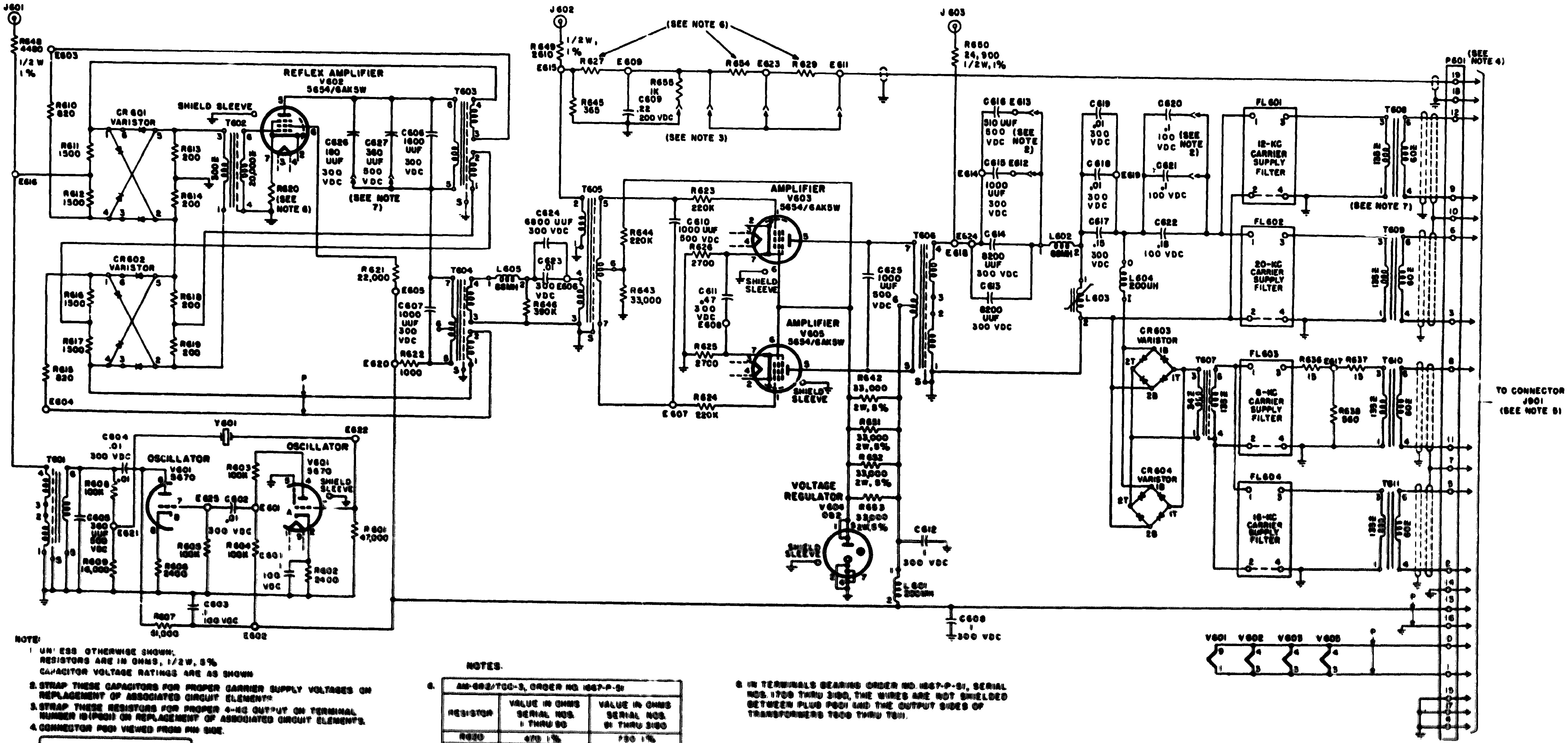
NOTES:

1. UNLESS OTHERWISE SHOWN, RESISTORS ARE IN OHMS; 1/2W, 5%. CAPACITORS ARE IN UF, VOLTAGE RATING ARE AS SHOWN.
2. THESE CAPACITORS ARE STRAPPED FOR PROPER TUNING ON REPLACEMENT OF CIRCUIT ELEMENTS.
3. CONNECTOR P1 VIEWED FROM PIN SIDE.



4. FOR INTERCONNECTIONS, SEE AMPLIFIER-POWER SUPPLY AM-682/TCC-3, CONNECTION DIAGRAM.

Figure 154. Ringer-oscillator, schematic diagram.



NOTE:

1. UNLESS OTHERWISE SHOWN; RESISTORS ARE IN OHMS, 1/2 W, 5% CAPACITOR VOLTAGE RATINGS ARE AS SHOWN
2. STRAP THESE CAPACITORS FOR PROPER CARRIER SUPPLY VOLTAGES ON REPLACEMENT OF ASSOCIATED CIRCUIT ELEMENTS.
3. STRAP THESE RESISTORS FOR PROPER 4-KC OUTPUT ON TERMINAL NUMBER 19 (P601) ON REPLACEMENT OF ASSOCIATED CIRCUIT ELEMENTS.
4. CONNECTOR P601 VIEWED FROM PIN SIDE.
5. FOR INTERCONNECTIONS SEE AMPLIFIER-POWER SUPPLY CONNECTION DIAGRAM.

NOTES.

6.

AM-692/TCC-3, ORDER NO. 1667-P-51		
RESISTOR	VALUE IN OHMS SERIAL NOS. 1 THRU 50	VALUE IN OHMS SERIAL NOS. 51 THRU 3160
R620	470 1%	750 1%
R627	1470 1%	1470 1%
R629	180 1%	470 1%
R654	390 1%	240 1%

7. STRAP CAPACITORS C26 AND C27 TO TUNE OSC CIRCUIT WHEN TESTING CARRIER SUPPLY. CAPACITORS C26 AND C27 ARE NOT SUPPLIED WITH AM-692/TCC-3 BEARING SERIAL NOS. 1 THRU 50.

8. IN TERMINALS BEARING ORDER NO. 1667-P-51, SERIAL NOS. 1700 THRU 3160, THE WIRES ARE NOT SHIELDED BETWEEN PLUG P601 AND THE OUTPUT SIDES OF TRANSFORMERS T608 THRU T611.

Figure 155. Carrier supply schematic diagram.

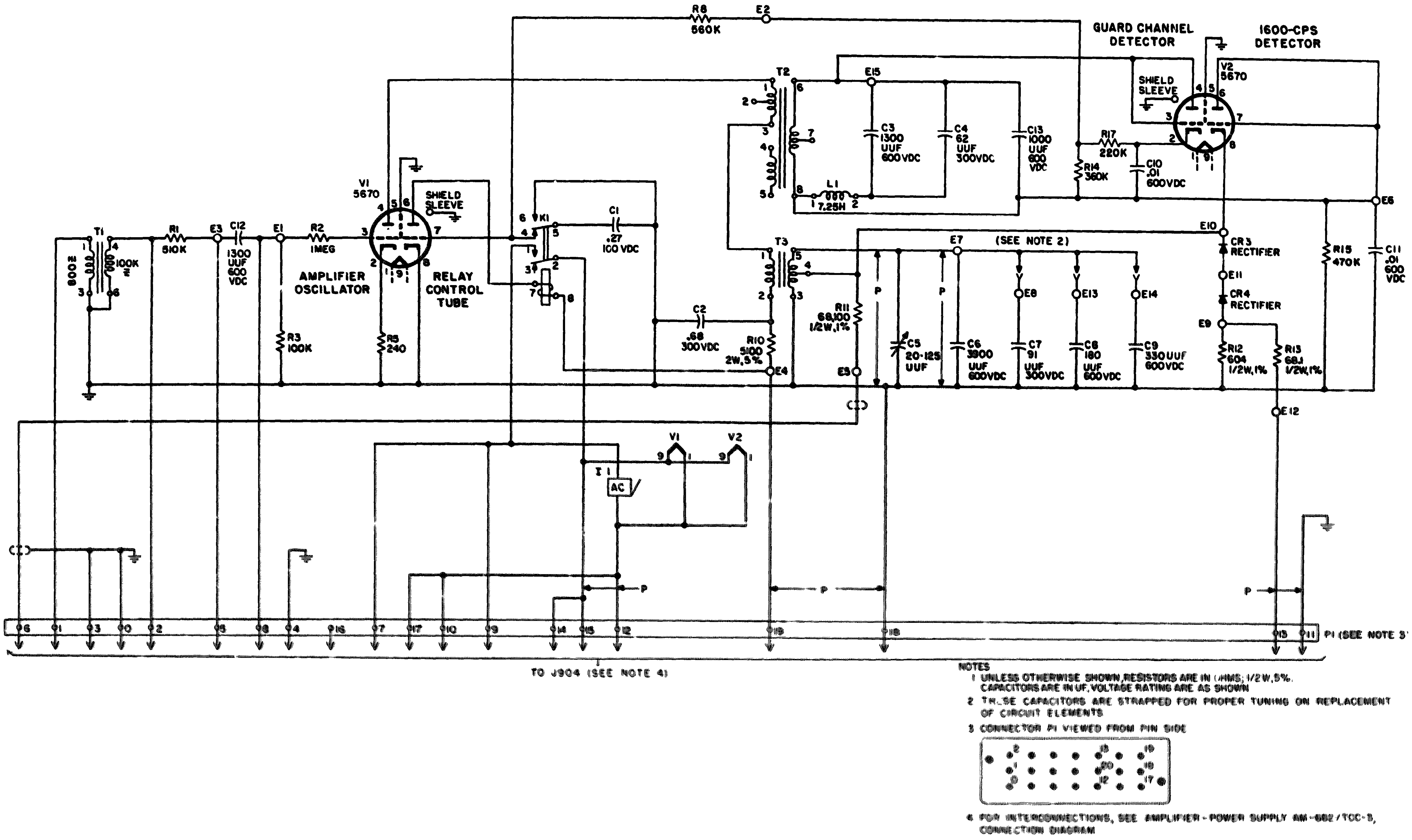


Figure 156. Ringer-oscillator, schematic diagram.

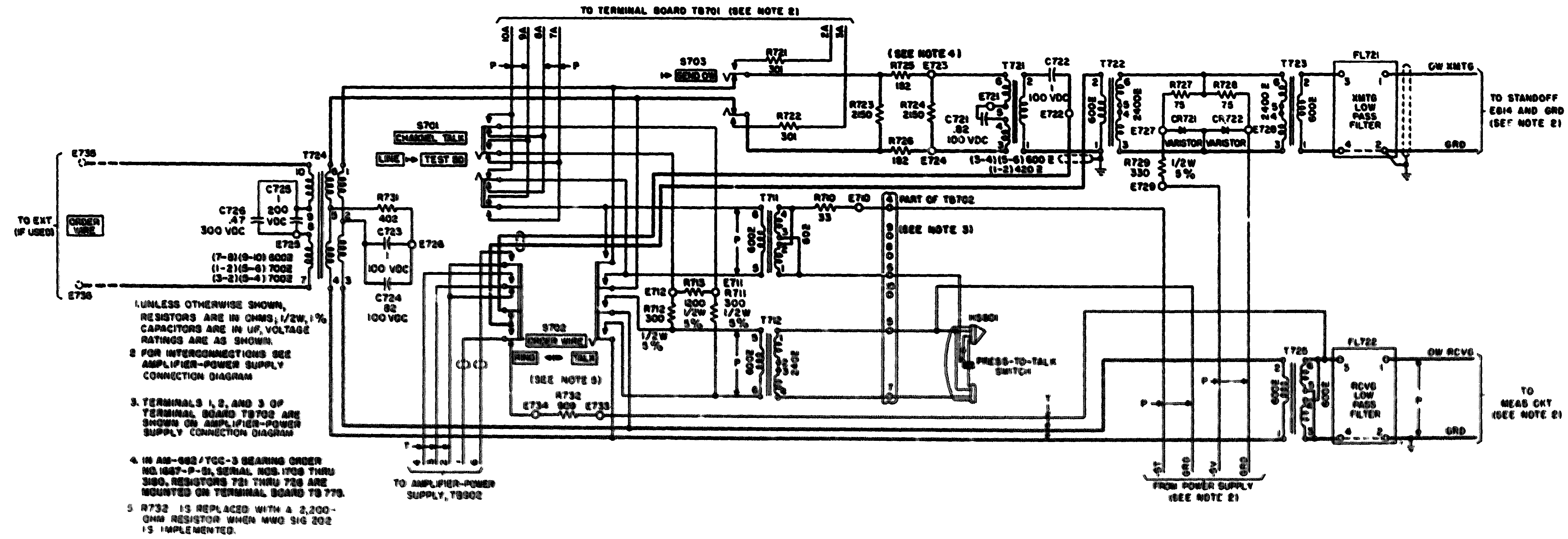
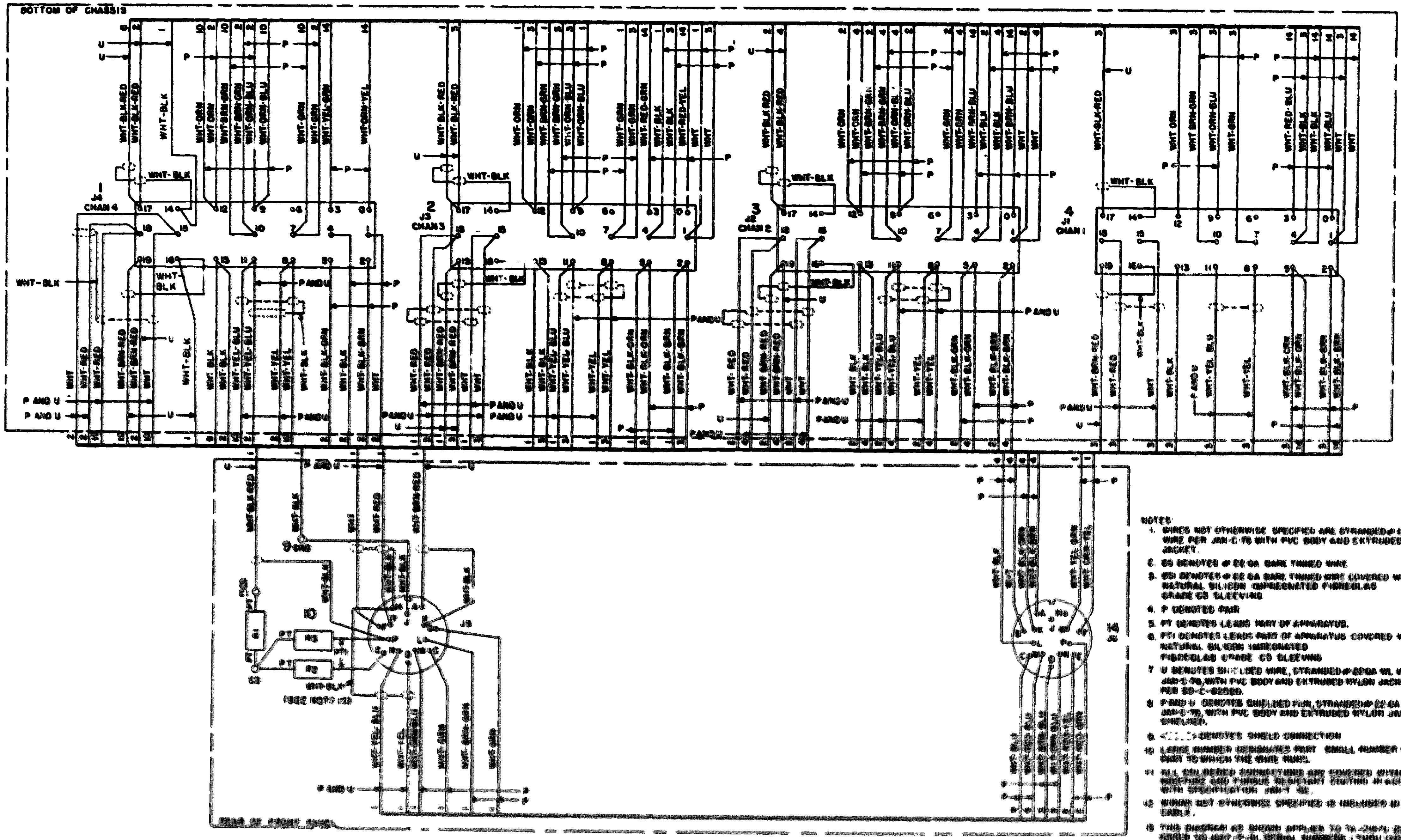


Figure 156. Order wire schematic diagram.



NOTES:

1. WIRES NOT OTHERWISE SPECIFIED ARE STRANDED #22 GA WL WIRE PER JAN-C-76 WITH PVC BODY AND EXTRUDED NYLON JACKET.
2. BS DENOTES #22 GA BARE TINNED WIRE.
3. BSI DENOTES #22 GA BARE TINNED WIRE COVERED WITH NATURAL SILICON IMPREGNATED FIBREGLAS GRADE C3 SLEEVING
4. P DENOTES PAIR
5. PT DENOTES LEADS PART OF APPARATUS.
6. PTI DENOTES LEADS PART OF APPARATUS COVERED WITH NATURAL SILICON IMPREGNATED FIBREGLAS GRADE C3 SLEEVING
7. U DENOTES SHIELDED WIRE, STRANDED #22 GA WL WIRE PER JAN-C-76, WITH PVC BODY AND EXTRUDED NYLON JACKET, SHIELDED PER [illegible].
8. P AND U DENOTES SHIELDED PAIR, STRANDED #22 GA WL WIRE PER JAN-C-76, WITH PVC BODY AND EXTRUDED NYLON JACKET, SHIELDED.
9. <...> DENOTES SHIELD CONNECTION
10. LARGE NUMBER DESIGNATES PART. SMALL NUMBER DESIGNATES PART TO WHICH THE WIRE RUNS.
11. ALL SOLDERED CONNECTIONS ARE COVERED WITH A MOISTURE AND FUNGUS RESISTANT COATING IN ACCORDANCE WITH SPECIFICATION JAN-T-152.
12. WIRING NOT OTHERWISE SPECIFIED IS INCLUDED IN LOCAL CABLE.
13. THIS DIAGRAM AS SHOWN APPLIES TO TA-219/U BEARING ORDER NO [illegible], SERIAL NUMBERS 1 THRU [illegible]. IN TA-219/U BEARING SERIAL NOS [illegible] THRU [illegible], ALL WIRES CONNECTED TO STATION [illegible] JACK [illegible] ARE UNSHIELDED

Figure 164. Telephone station TA-[illegible] combining unit, wiring diagram.

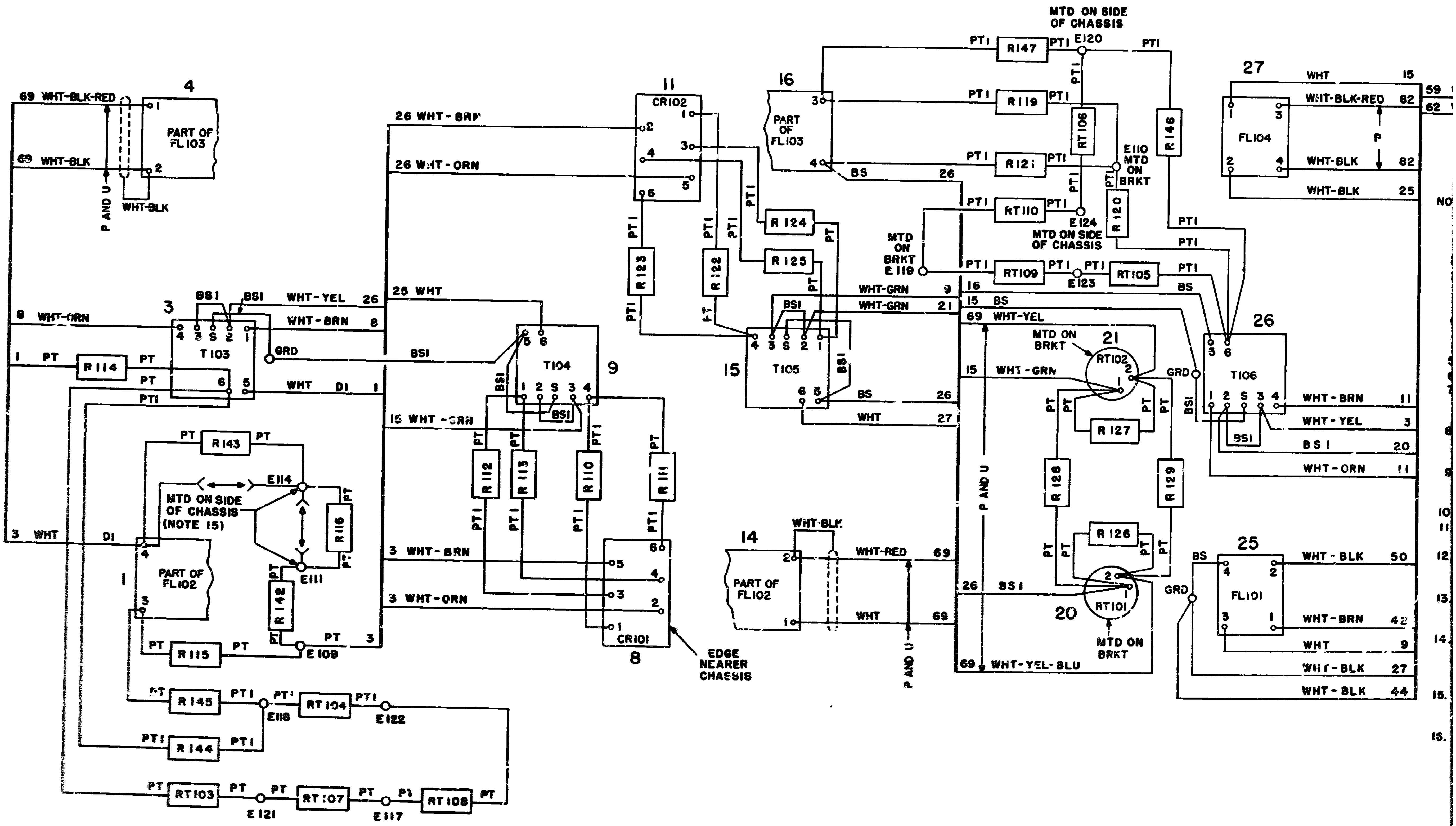


Figure 165①. Part of channel 1 modem wiring diagram.

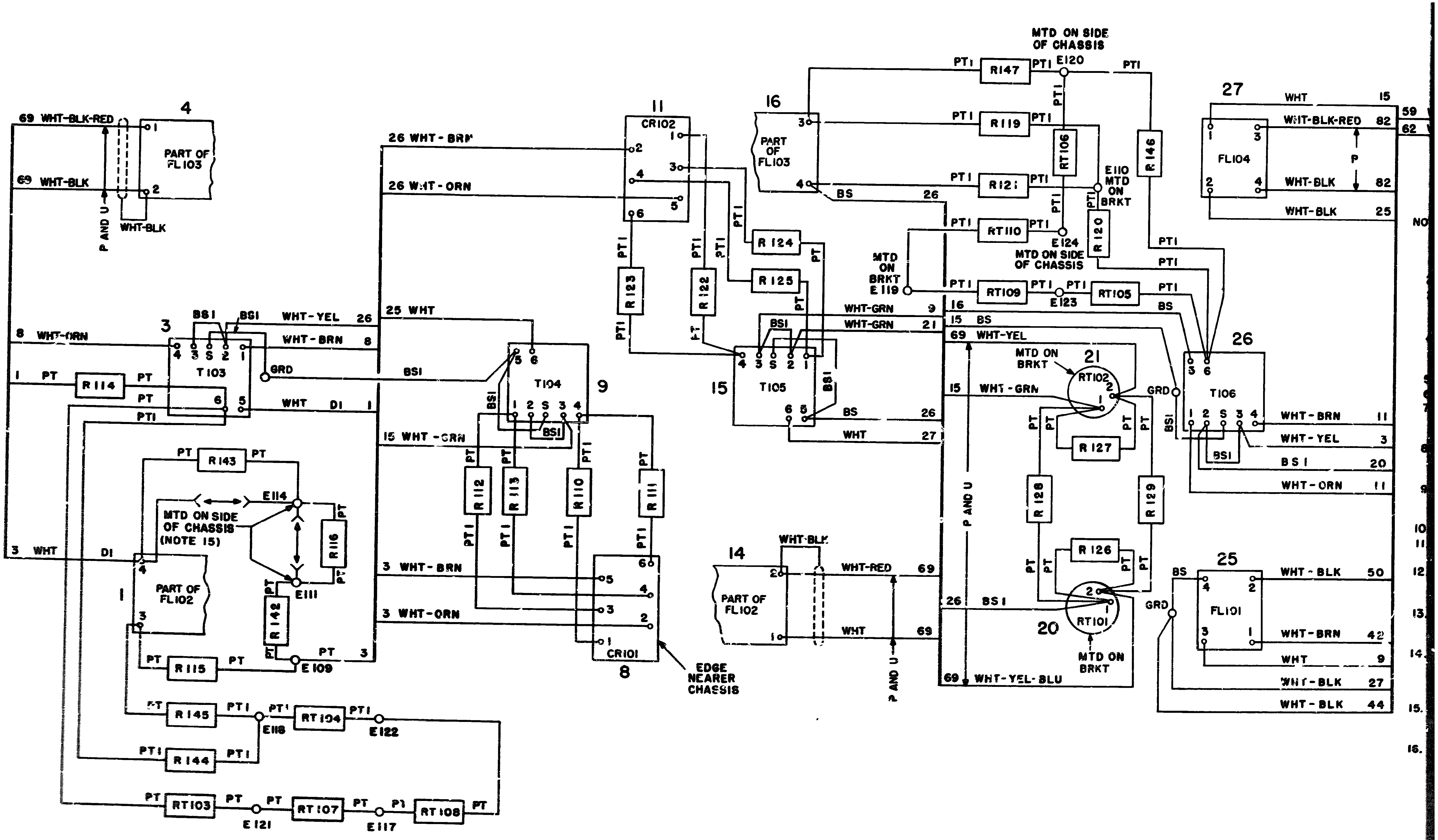


Figure 165©. Part of channel 1 modem wiring diagram.

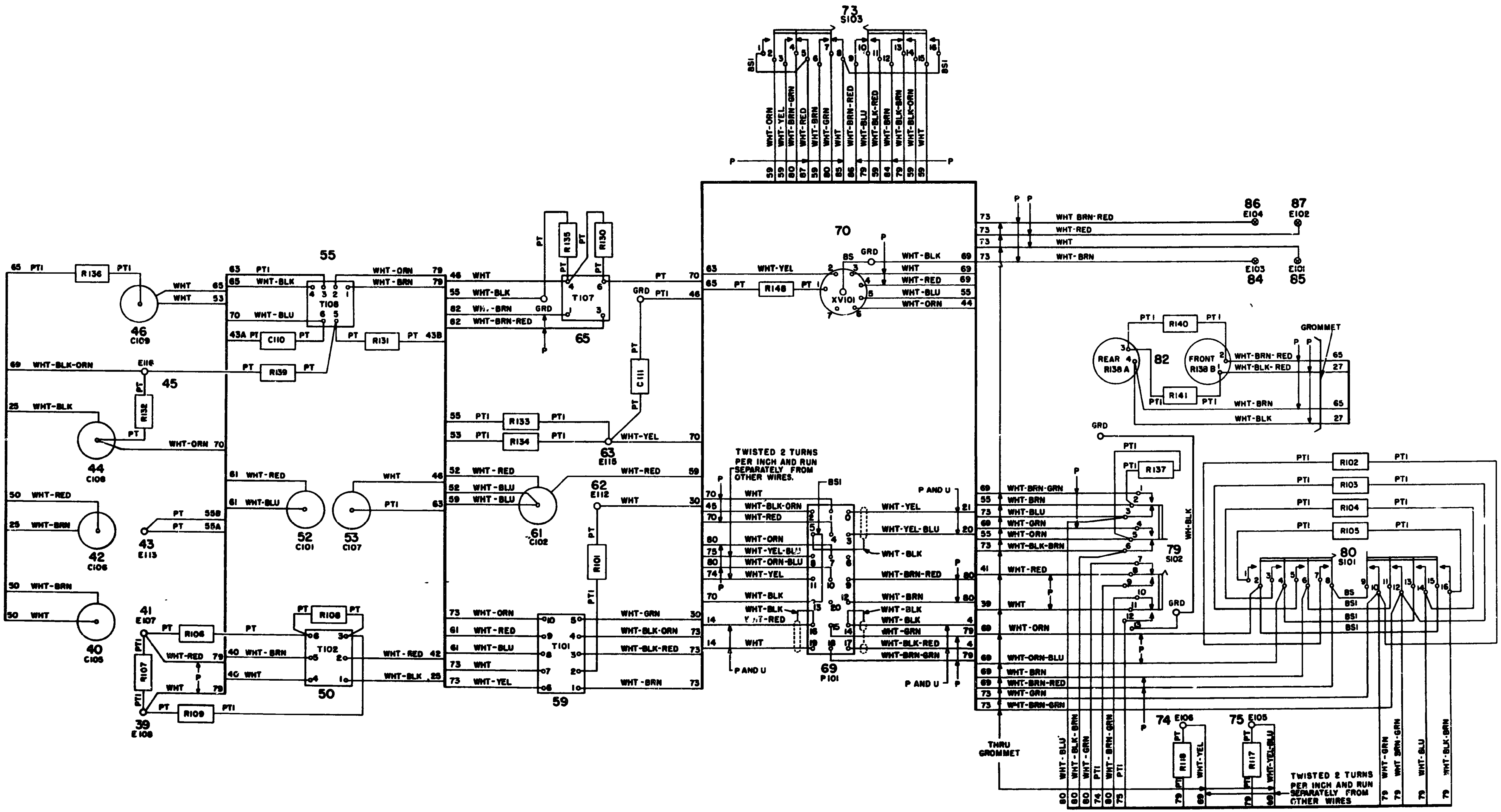
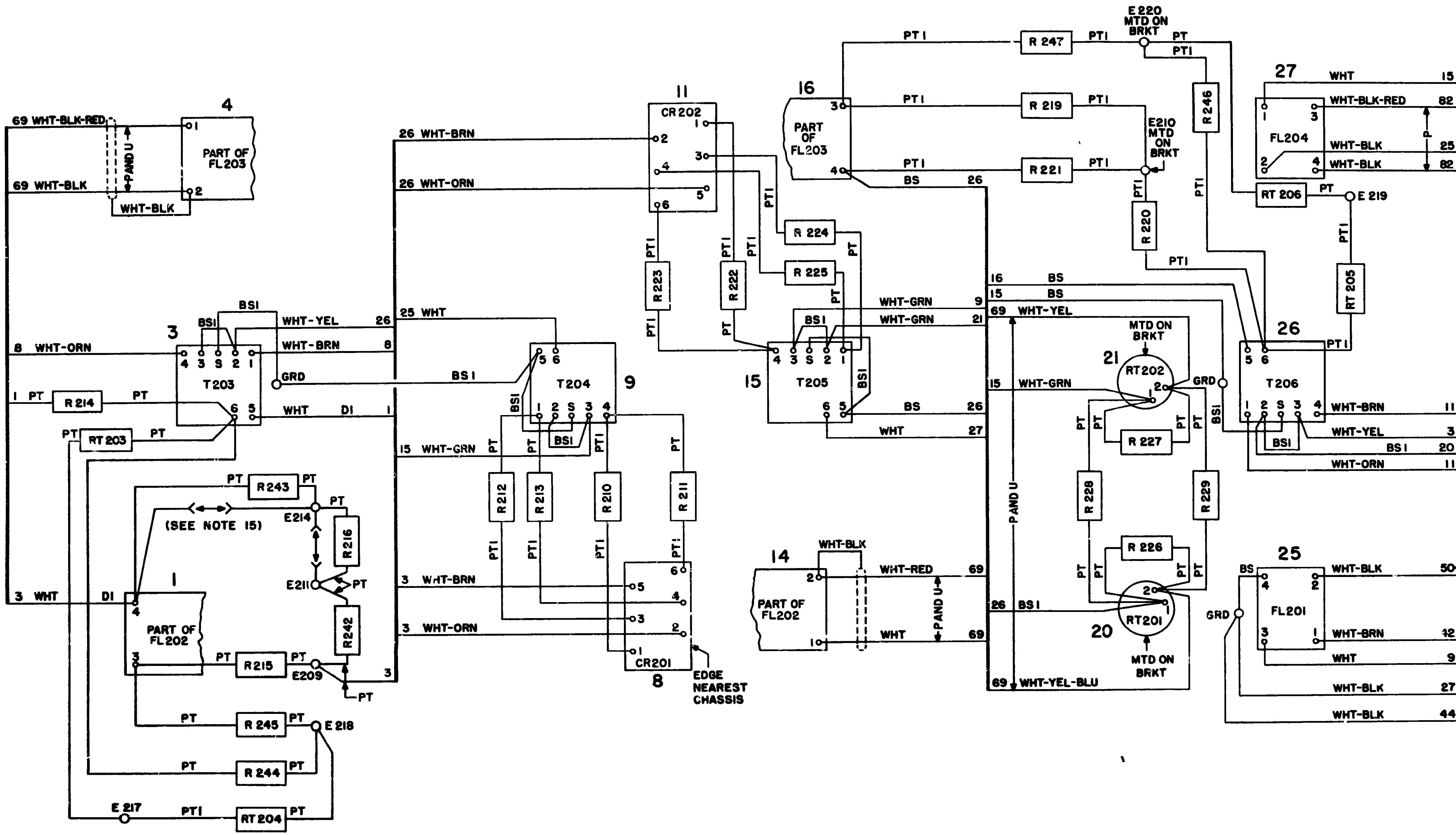
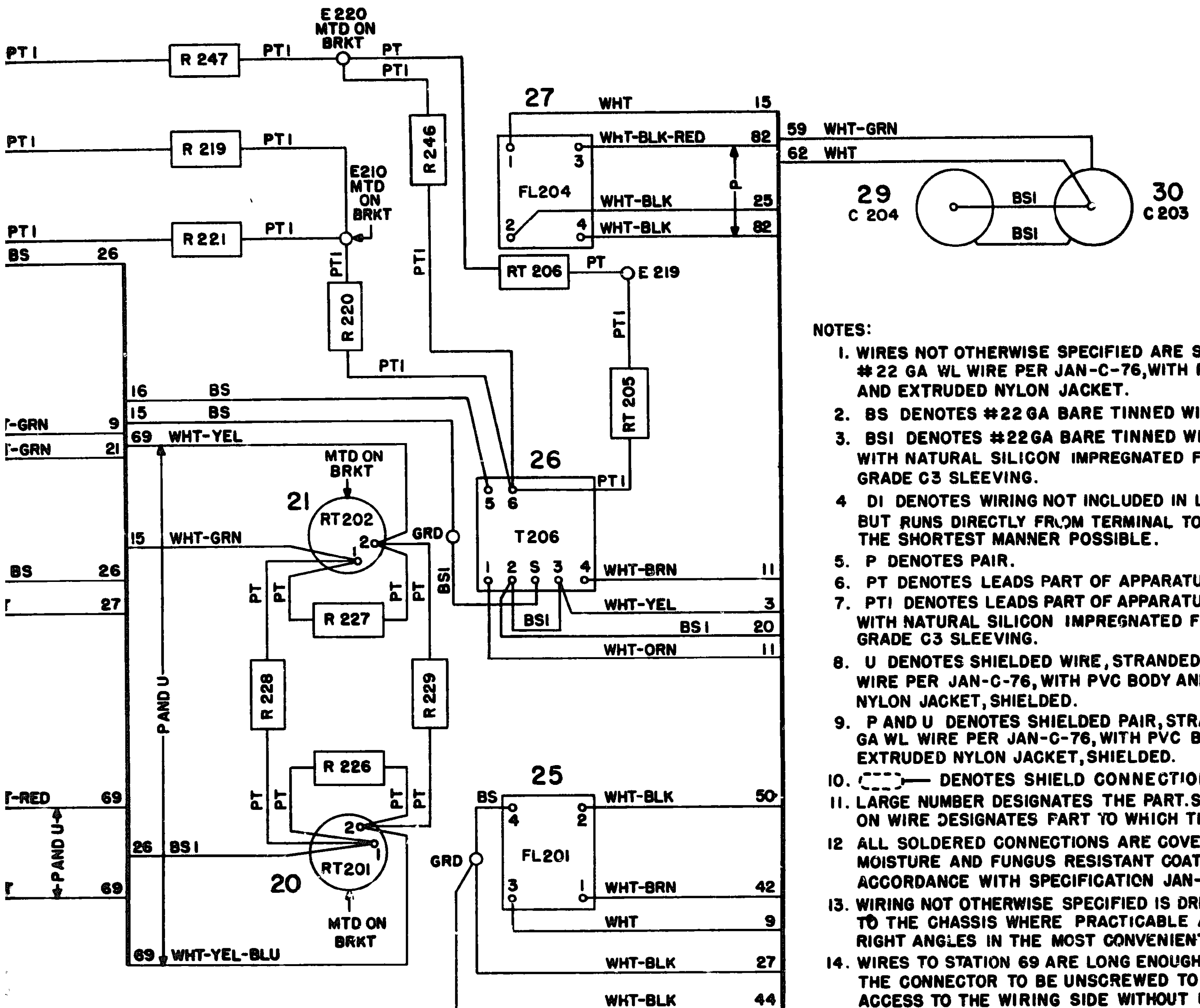


Figure 165(2). Part of channel 1 modem wiring diagram.



NOTES:
1. WIRES NOT OTHE
#22 GA WL WIR
AND EXTRUDED
2. BS DENOTES #
3. BSI DENOTES #
WITH NATURAL S
GRADE C3 SLEEV
4 DI DENOTES WI
BUT RUNS DIREC
THE SHORTEST
5. P DENOTES PAI
6. PT DENOTES LE
7. PTI DENOTES L
WITH NATURAL S
GRADE C3 SLEEV
8. U DENOTES SHI
WIRE PER JAN-C
NYLON JACKET, S
9. P AND U DENOT
GA WL WIRE PER
EXTRUDED NYLO
10. DENOTE
11. LARGE NUMBER D
ON WIRE DESIGNA
12 ALL SOLDERED C
MOISTURE AND F
ACCORDANCE WI
13 WIRING NOT OTHE
TO THE CHASSIS
RIGHT ANGLES IN
14 WIRES TO STATIO
THE CONNECTOR
ACCESS TO THE
CONNECTIONS.
15. STRAP RESISTOR
PROPER CHANNE
REPLACEMENT C
16. ⊗ DENOTES BIN

Figure 166(1). Part of channel 2 modem wiring diagram.



NOTES:

1. WIRES NOT OTHERWISE SPECIFIED ARE STRANDED #22 GA WL WIRE PER JAN-C-76, WITH PVC BODY AND EXTRUDED NYLON JACKET.
2. BS DENOTES #22 GA BARE TINNED WIRE.
3. BSI DENOTES #22 GA BARE TINNED WIRE COVERED WITH NATURAL SILICON IMPREGNATED FIBREGLAS GRADE C3 SLEEVING.
4. DI DENOTES WIRING NOT INCLUDED IN LOCAL CABLE BUT RUNS DIRECTLY FROM TERMINAL TO TERMINAL IN THE SHORTEST MANNER POSSIBLE.
5. P DENOTES PAIR.
6. PT DENOTES LEADS PART OF APPARATUS.
7. PTI DENOTES LEADS PART OF APPARATUS COVERED WITH NATURAL SILICON IMPREGNATED FIBREGLAS GRADE C3 SLEEVING.
8. U DENOTES SHIELDED WIRE, STRANDED #22 GA WL WIRE PER JAN-C-76, WITH PVC BODY AND EXTRUDED NYLON JACKET, SHIELDED.
9. P AND U DENOTES SHIELDED PAIR, STRANDED #22 GA WL WIRE PER JAN-C-76, WITH PVC BODY AND EXTRUDED NYLON JACKET, SHIELDED.
10. (-----)— DENOTES SHIELD CONNECTION.
11. LARGE NUMBER DESIGNATES THE PART. SMALL NUMBER ON WIRE DESIGNATES PART TO WHICH THE WIRE RUNS.
12. ALL SOLDERED CONNECTIONS ARE COVERED WITH A MOISTURE AND FUNGUS RESISTANT COATING IN ACCORDANCE WITH SPECIFICATION JAN-T-152.
13. WIRING NOT OTHERWISE SPECIFIED IS DRESSED BACK TO THE CHASSIS WHERE PRACTICABLE AND RUNS AT RIGHT ANGLES IN THE MOST CONVENIENT MANNER.
14. WIRES TO STATION 69 ARE LONG ENOUGH TO PERMIT THE CONNECTOR TO BE UNSCREWED TO OBTAIN ACCESS TO THE WIRING SIDE WITHOUT UNSOLDERING CONNECTIONS.
15. STRAP RESISTORS R216 AND R243 TO PROVIDE PROPER CHANNEL OUTPUT LEVEL UPON REPLACEMENT OF ASSOCIATED COMPONENTS.
16. ⊗ DENOTES BINDING POST.

channel 2 modem wiring diagram.

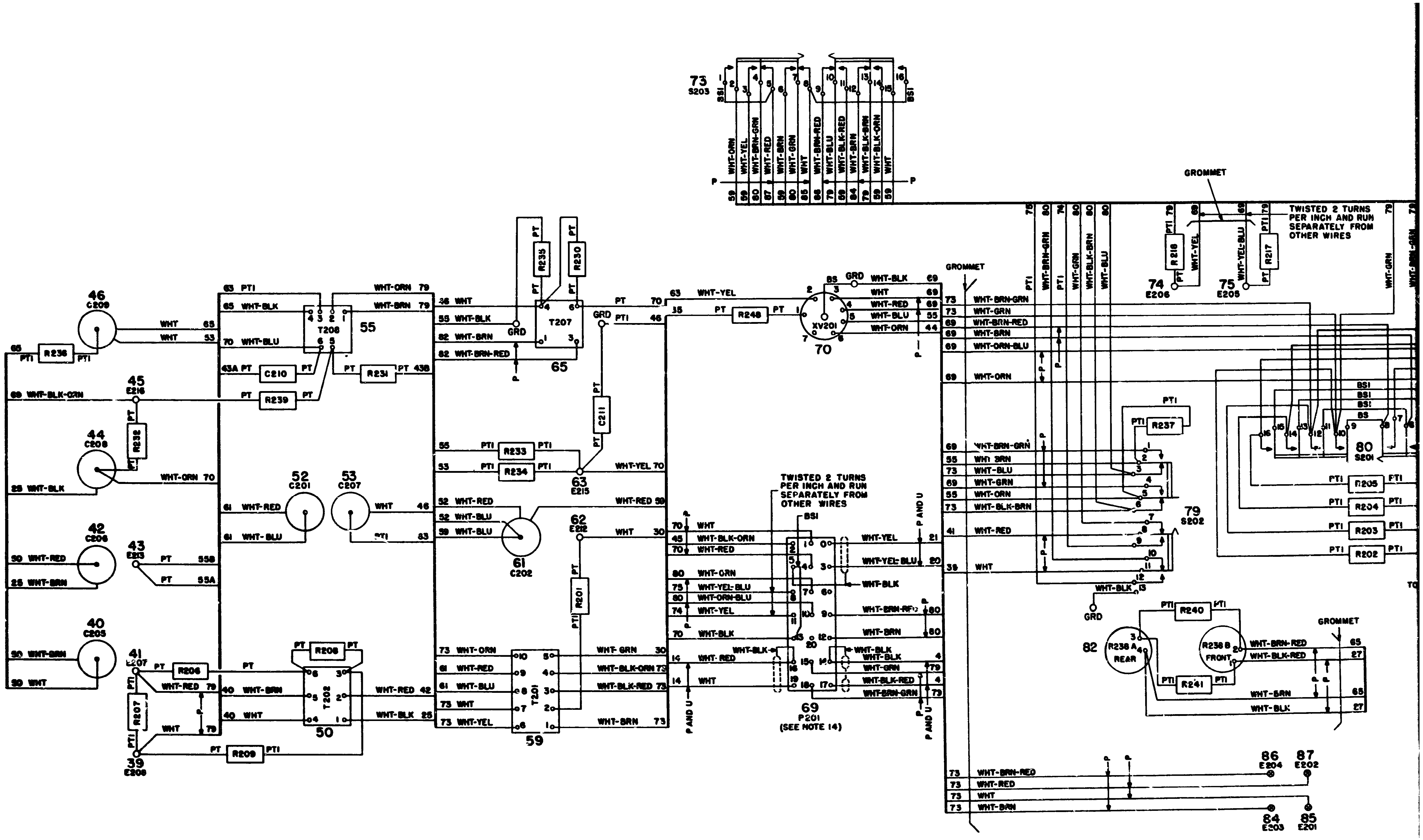
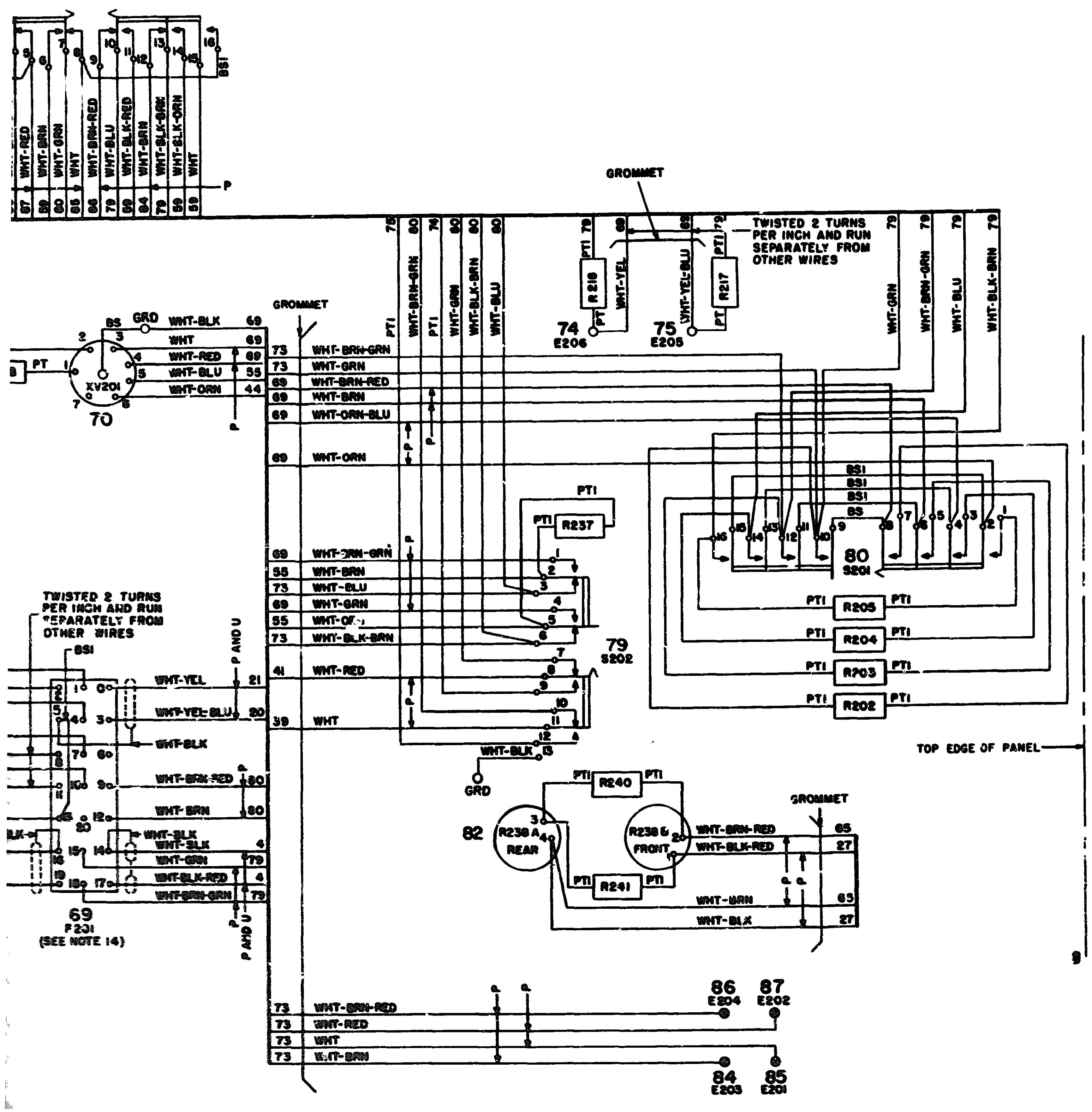
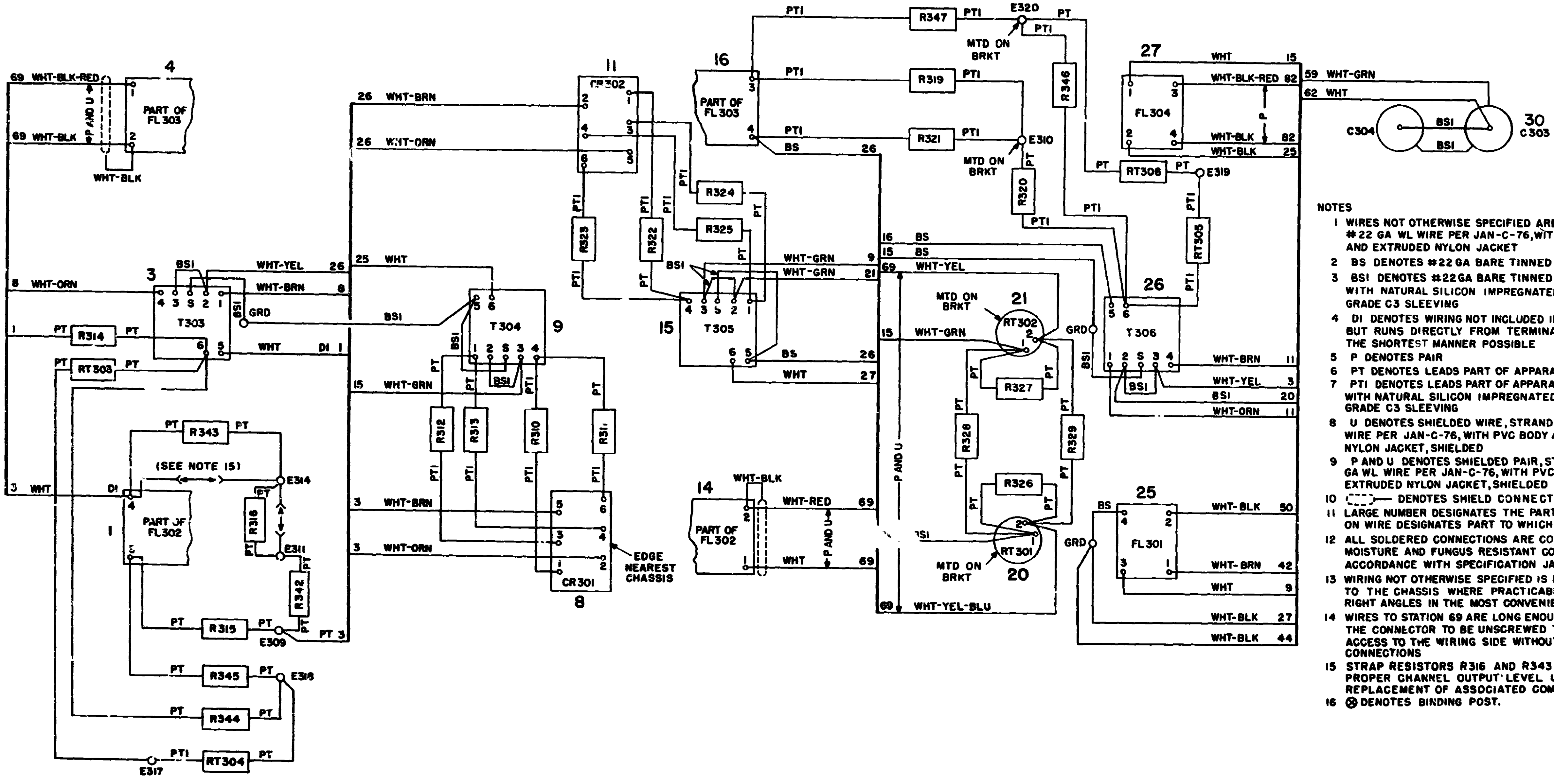


Figure 166(2). Part of channel 2 modem wiring diagram.



channel 2 modem wiring diagram.



NOTES

1. WIRES NOT OTHERWISE SPECIFIED ARE STRANDED #22 GA WL WIRE PER JAN-C-76, WITH PVC BODY AND EXTRUDED NYLON JACKET
2. BS DENOTES #22 GA BARE TINNED WIRE
3. BSI DENOTES #22 GA BARE TINNED WIRE COVERED WITH NATURAL SILICON IMPREGNATED FIBREGLAS GRADE C3 SLEEVING
4. DI DENOTES WIRING NOT INCLUDED IN LOCAL CABLE BUT RUNS DIRECTLY FROM TERMINAL TO TERMINAL THE SHORTEST MANNER POSSIBLE
5. P DENOTES PAIR
6. PT DENOTES LEADS PART OF APPARATUS
7. PTI DENOTES LEADS PART OF APPARATUS COVERED WITH NATURAL SILICON IMPREGNATED FIBREGLAS GRADE C3 SLEEVING
8. U DENOTES SHIELDED WIRE, STRANDED #22 GA WL WIRE PER JAN-C-76, WITH PVC BODY AND EXTRUDED NYLON JACKET, SHIELDED
9. P AND U DENOTES SHIELDED PAIR, STRANDED #22 GA WL WIRE PER JAN-C-76, WITH PVC BODY AND EXTRUDED NYLON JACKET, SHIELDED
10. (dashed loop symbol) DENOTES SHIELD CONNECTION
11. LARGE NUMBER DESIGNATES THE PART SMALL NUMBER ON WIRE DESIGNATES PART TO WHICH THE WIRE RUNS
12. ALL SOLDERED CONNECTIONS ARE COVERED WITH A MOISTURE AND FUNGUS RESISTANT COATING IN ACCORDANCE WITH SPECIFICATION JAN-T-152.
13. WIRING NOT OTHERWISE SPECIFIED IS DRESSED BACK TO THE CHASSIS WHERE PRACTICABLE AND RUNS AT RIGHT ANGLES IN THE MOST CONVENIENT MANNER
14. WIRES TO STATION 69 ARE LONG ENOUGH TO PERMIT THE CONNECTOR TO BE UNSCREWED TO OBTAIN ACCESS TO THE WIRING SIDE WITHOUT UNSOLDERING CONNECTIONS
15. STRAP RESISTORS R316 AND R343 TO PROVIDE PROPER CHANNEL OUTPUT LEVEL UPON REPLACEMENT OF ASSOCIATED COMPONENTS.
16. ⊗ DENOTES BINDING POST.

Figure 167(1). Part of Channel 3 modem wiring diagram.

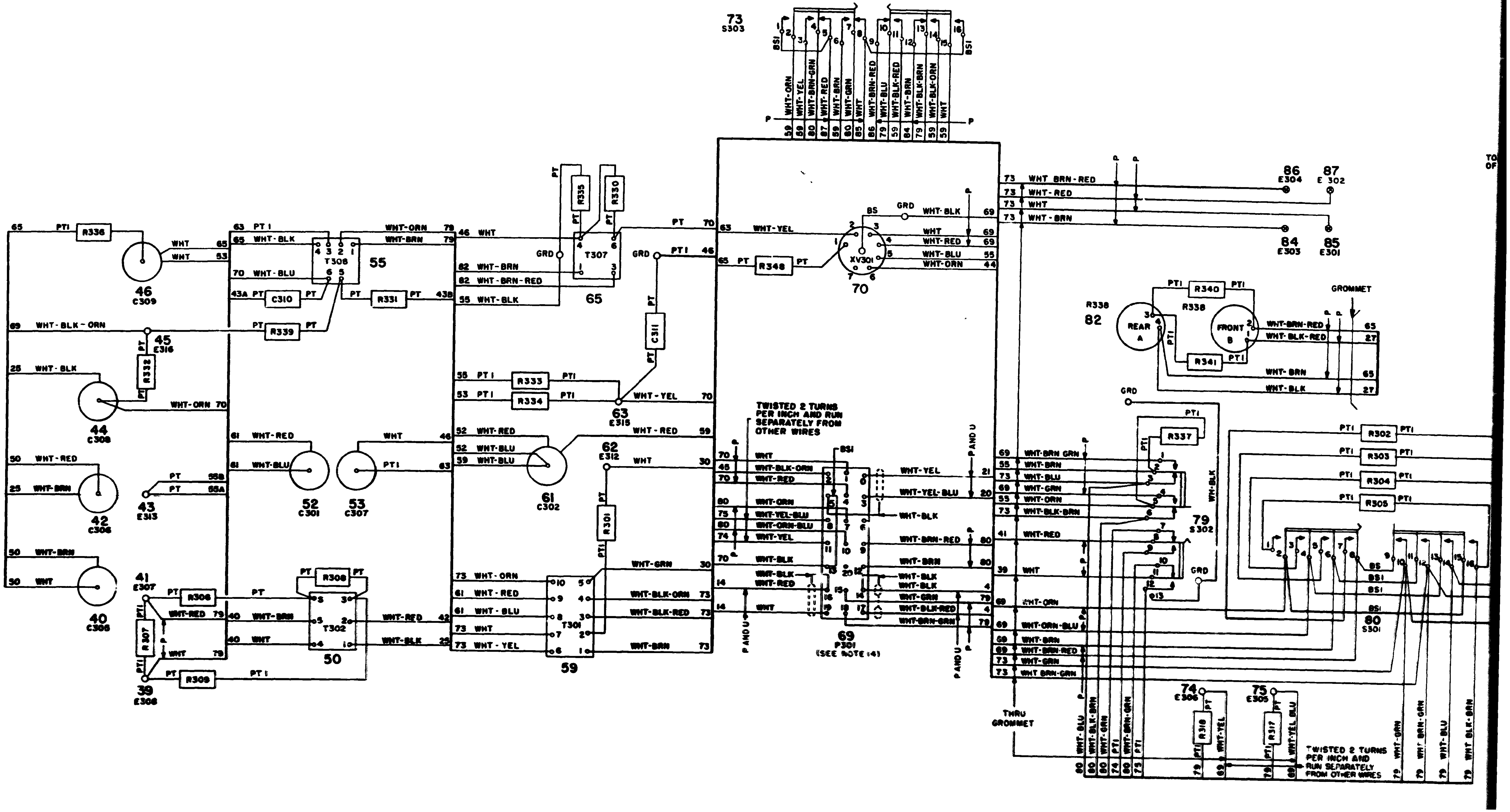
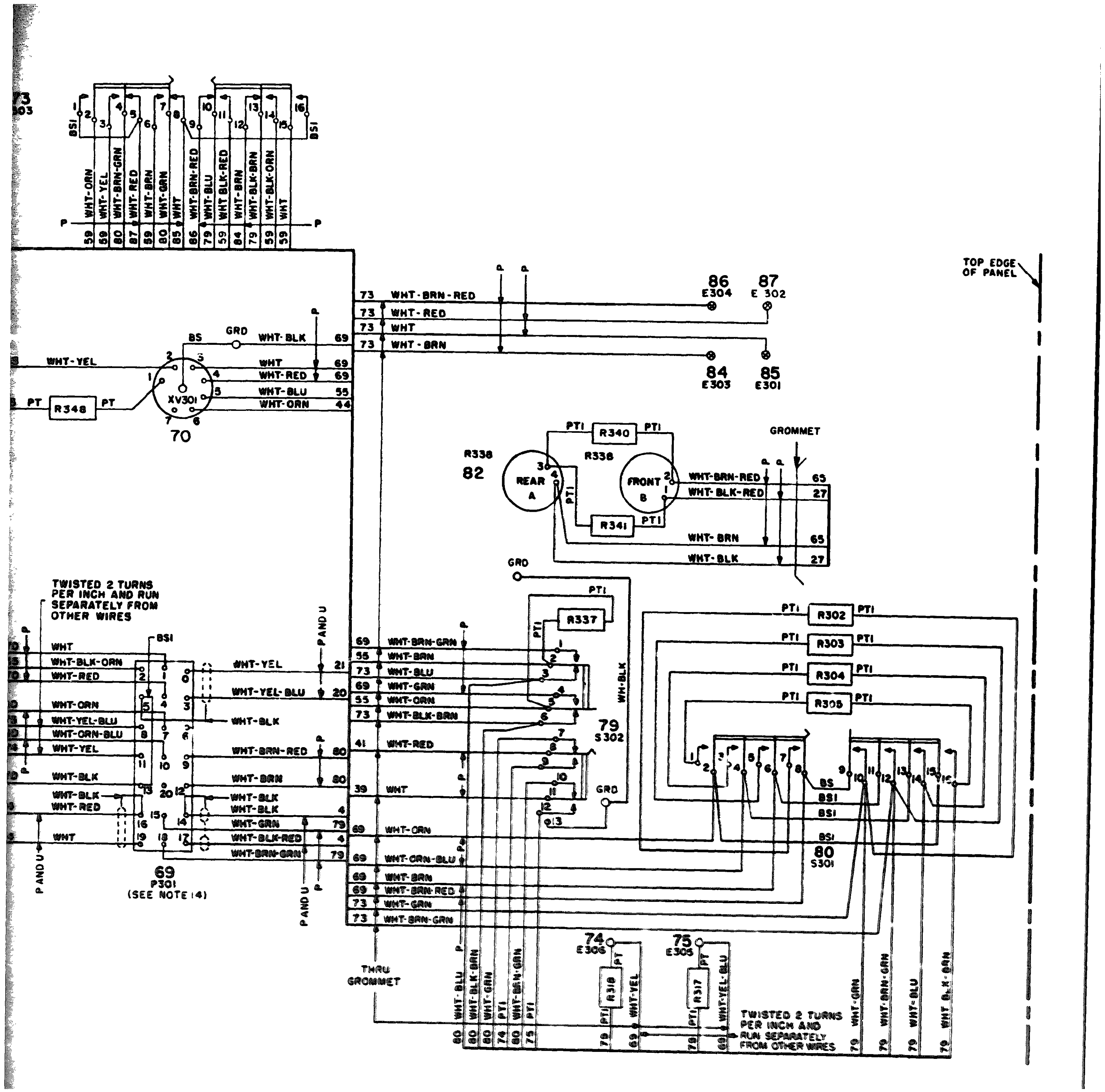
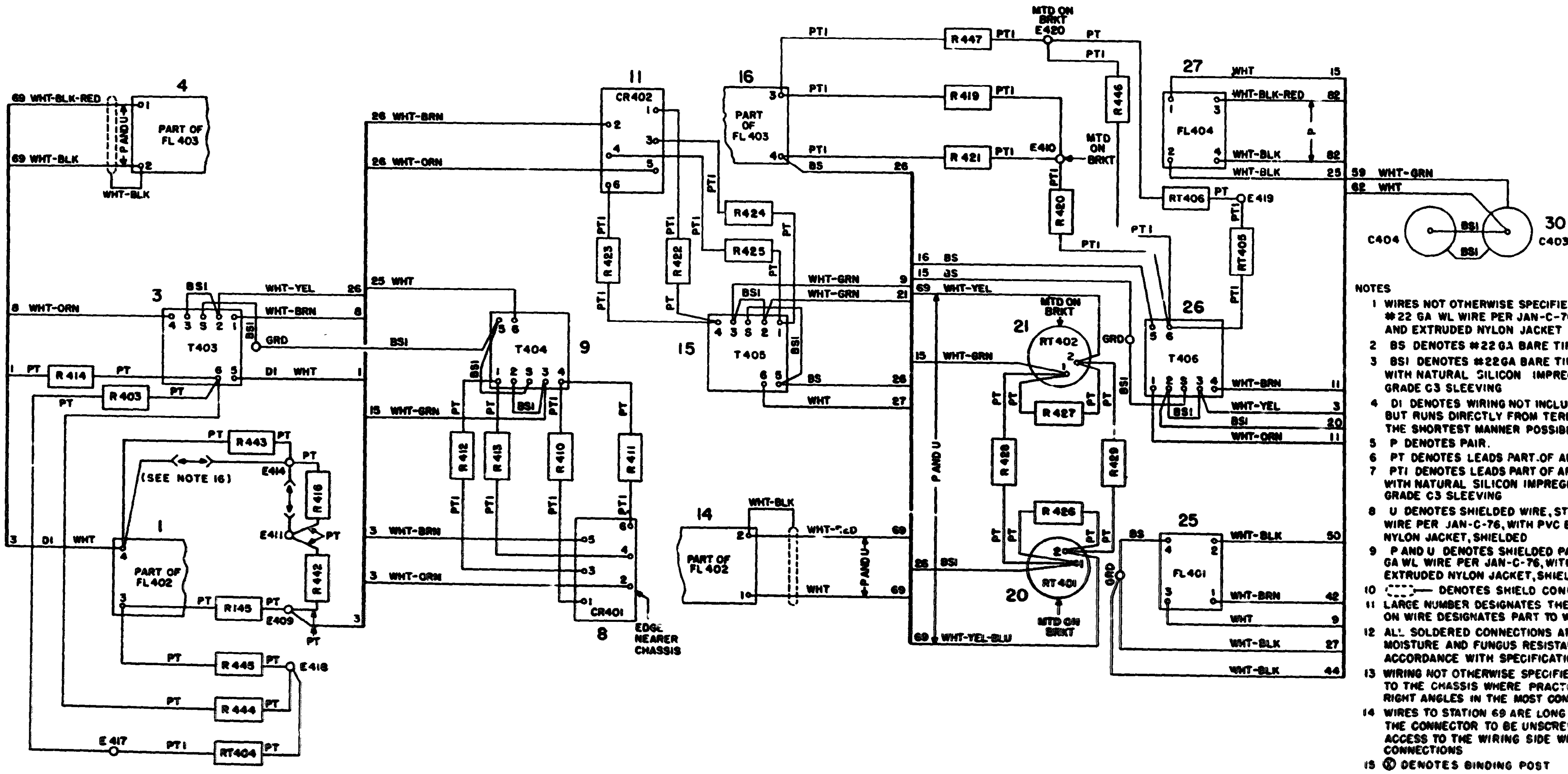


Figure 167(4). Part of channel 3 modem wiring diagram.



rt of channel 3 modem wiring diagram.



NOTES

1 WIRES NOT OTHERWISE SPECIFIED ARE STRANDED #22 GA WL WIRE PER JAN-C-76, WITH PVC BODY AND EXTRUDED NYLON JACKET

2 BS DENOTES #22 GA BARE TINNED WIRE

3 BSI DENOTES #22GA BARE TINNED WIRE COVERED WITH NATURAL SILICON IMPREGNATED FIBREGLAS GRADE C3 SLEEVING

4 DI DENOTES WIRING NOT INCLUDED IN LOCAL CABLE BUT RUNS DIRECTLY FROM TERMINAL TO TERMINAL IN THE SHORTEST MANNER POSSIBLE

5 P DENOTES PAIR.

6 PT DENOTES LEADS PART OF APPARATUS

7 PTI DENOTES LEADS PART OF APPARATUS COVERED WITH NATURAL SILICON IMPREGNATED FIBREGLAS GRADE C3 SLEEVING

8 U DENOTES SHIELDED WIRE, STRANDED #22 GA WL WIRE PER JAN-C-76, WITH PVC BODY AND EXTRUDED NYLON JACKET, SHIELDED

9 P AND U DENOTES SHIELDED PAIR, STRANDED #22 GA WL WIRE PER JAN-C-76, WITH PVC BODY AND EXTRUDED NYLON JACKET, SHIELDED

10 (shield symbol) DENOTES SHIELD CONNECTION

11 LARGE NUMBER DESIGNATES THE PART SMALL NUMBER ON WIRE DESIGNATES PART TO WHICH THE WIRE RUNS

12 ALL SOLDERED CONNECTIONS ARE COVERED WITH A MOISTURE AND FUNGUS RESISTANT COATING IN ACCORDANCE WITH SPECIFICATION JAN-T-152

13 WIRING NOT OTHERWISE SPECIFIED IS DRESSED BACK TO THE CHASSIS WHERE PRACTICABLE AND RUN AT RIGHT ANGLES IN THE MOST CONVENIENT MANNER

14 WIRES TO STATION 69 ARE LONG ENOUGH TO PERMIT THE CONNECTOR TO BE UNSCREWED TO OBTAIN ACCESS TO THE WIRING SIDE WITHOUT UNSOLDERING CONNECTIONS

15 (binding post symbol) DENOTES BINDING POST

16 STRAP RESISTORS R416 AND R443 TO PROVIDE PROPER CHANNEL OUTPUT LEVEL UPON REPLACEMENT OF ASSOCIATED CIRCUIT ELEMENTS

Figure 168①. Part of channel 4 modem wiring diagram.

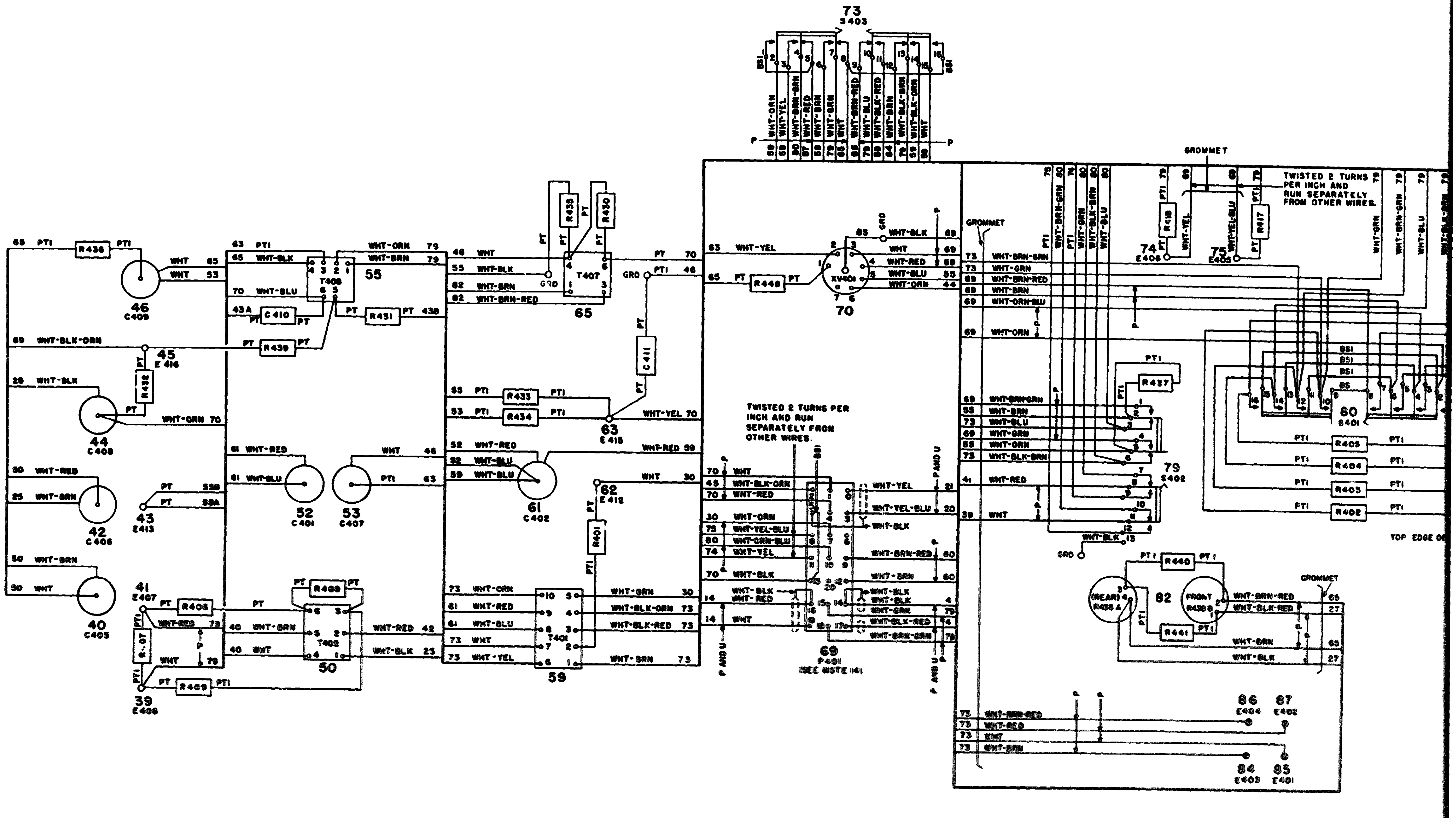
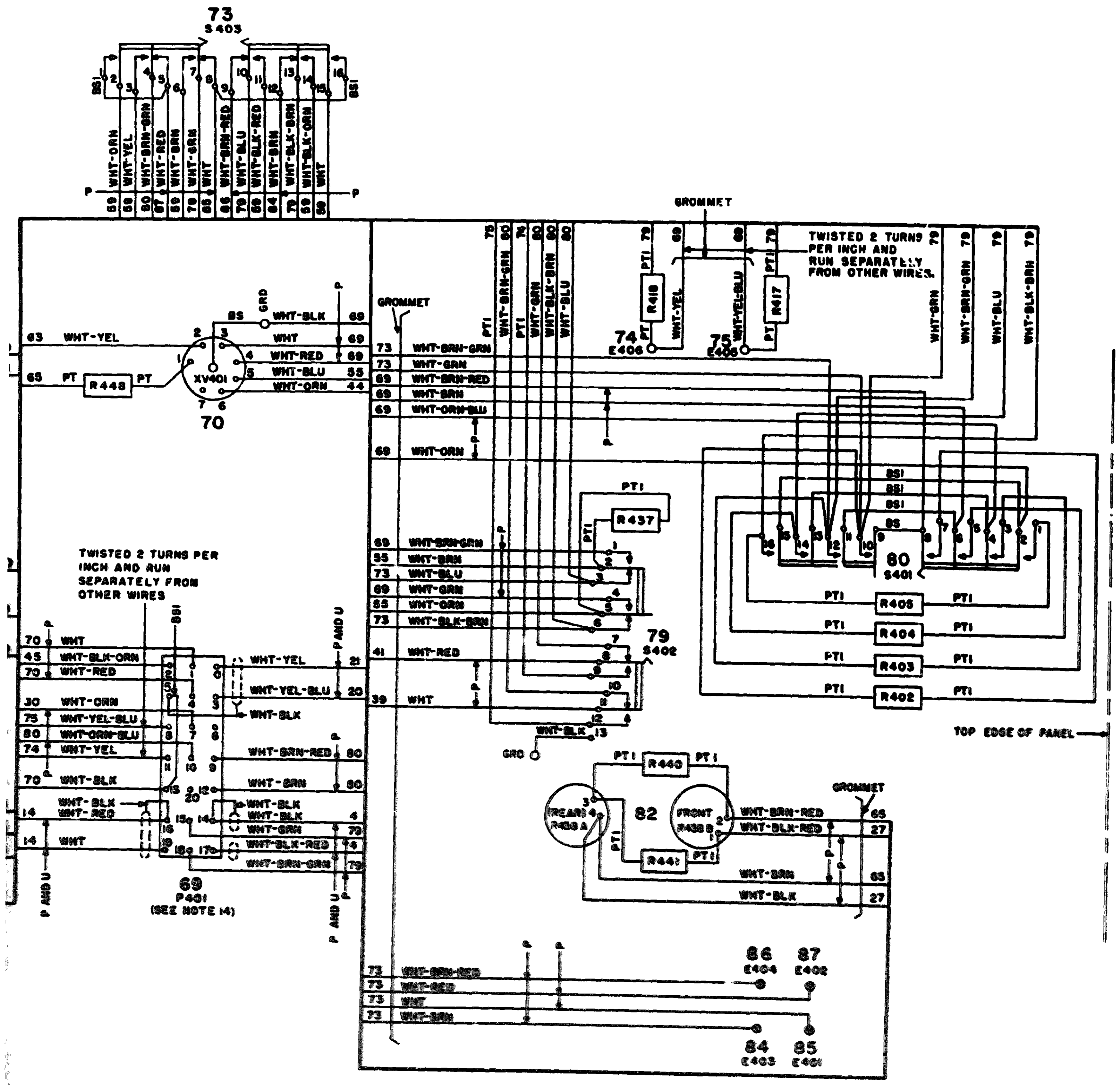


Figure 168(2). Part of channel 4 modem wiring diagram.



rt of channel 4 modem wiring diagram.

TO BE PRINTED AT A LATER DATE

Figure 169(1). Part of amplifier-power supply AM-632 TCC-3 interconnection wiring diagram for AM-632/TCC-3 bearing Order No. [illegible] serial numbers 1 through 1707.

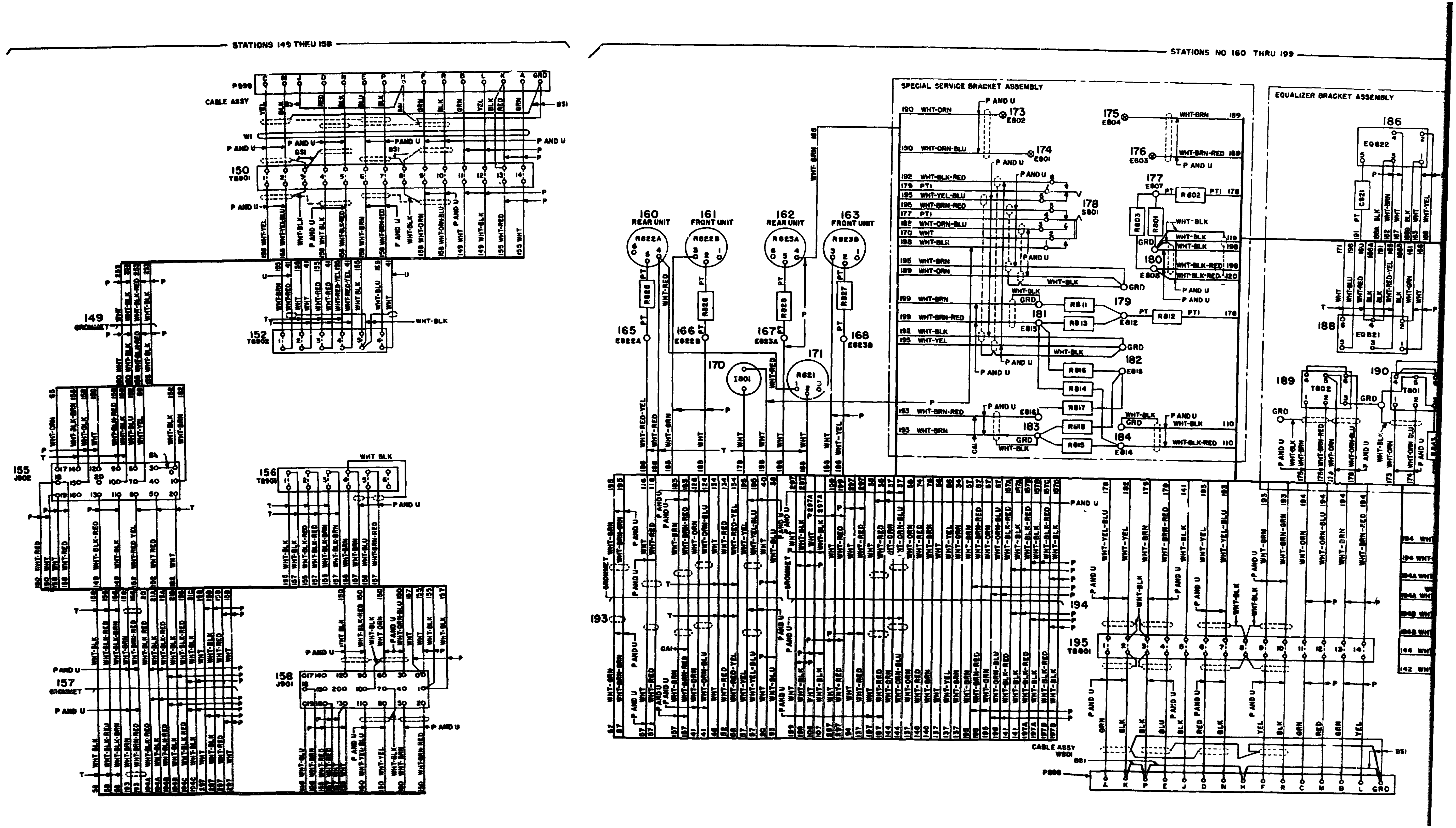
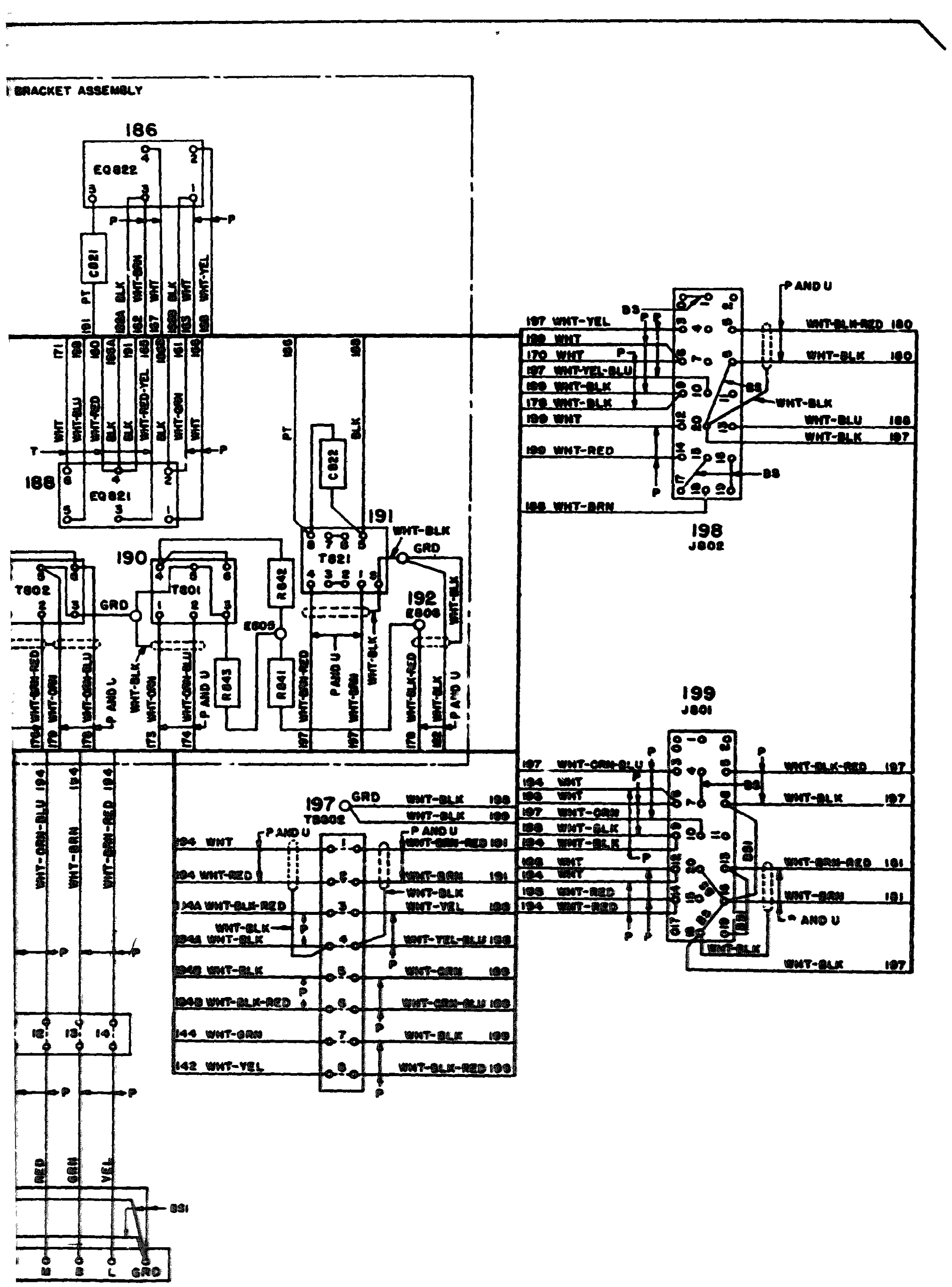
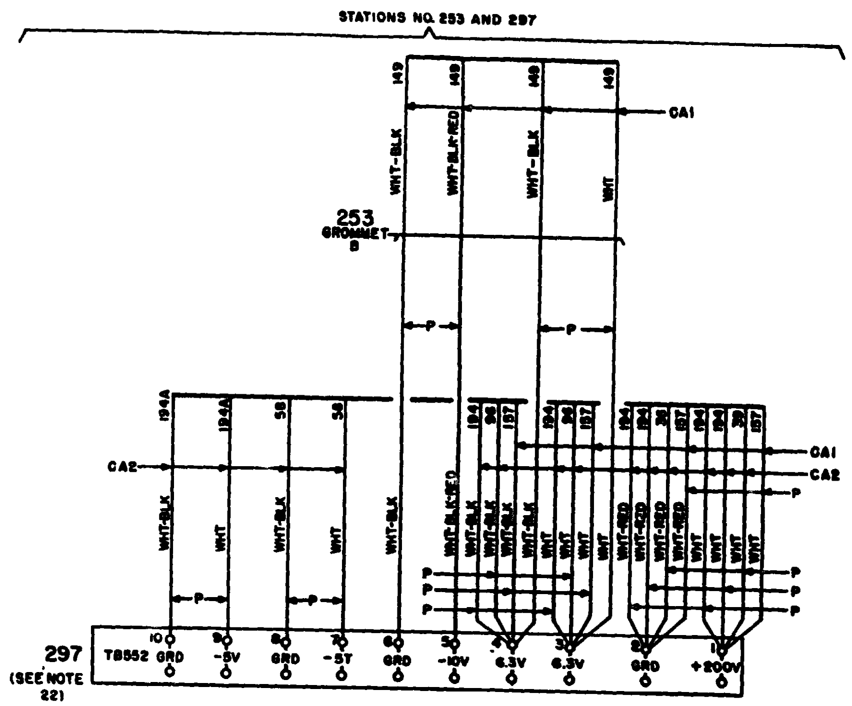


Figure 169⑧. Part of amplifier-power supply AM-682/TCC-3 interconnection wiring diagram for AM-682/TCC-3 bearing Order No. 1667-PH-51 serial numbers through 1707.





NOTES

1 WIRES NOT OTHERWISE SPECIFIED ARE STRANDED #22GA WL WIRE PER JAN-C-76, WITH PVC BODY AND EXTRUDED NYLON JACKET.

2 BS DENOTES #22 GA BARE TINNED WIRE

3 BSI DENOTES #22 GA BARE TINNED WIRE COVERED WITH NATURAL SILICON IMPREGNATED FIBREGLAS GRADE C3 SLEEVING.

4 P DENOTES PAIR

5 PT DENOTES LEADS PART OF APPARATUS

6 PTI DENOTES LEADS PART OF APPARATUS COVERED WITH SILICON IMPREGNATED FIBREGLAS GRADE C3 SLEEVING.

7 U DENOTES SHIELDED WIRE STRANDED #22 GA WL WIRE PER JAN-C-76, WITH PVC EXTRUDED NYLON JACKET, SHIELDED

8 P AND U DENOTES SHIELDED PAIR, STRANDED #22 GA WL WIRE PER JAN-C-76, WITH PVC BODY AND EXTRUDED NYLON JACKET, SHIELDED

9 (---)- DENOTES SHIELD CONNECTION

10 LARGE NUMBER DESIGNATES THE PART SMALL NUMBER ON THE WIRE DESIGNATES PART TO WHICH THE WIRE RUNS

11 T DENOTE TRIPLE

12 TERMINALS ON INSIDE OF CIRCLE ARE ON SIDE OF DISK FARTHEST FROM KNOB END AND TERMINALS ON OUTSIDE OF CIRCLE ARE ON SIDE OF DISK NEAREST TO KNOB END.

13 ——x—— DENOTES SPLICE

14 ALL SOLDERED CONNECTIONS ARE COVERED WITH A MOISTURE AND FUNGUS RESISTANT COATING IN ACCORDANCE WITH SPECIFICATION JAN-T-152.

15. D3 DENOTES WIRING WHICH IS DRESSED BACK TO THE CHASSIS AND RUN AT RIGHT ANGLES IN THE MOST CONVENIENT MANNER.

16. WIRES TO STATIONS 158, 159, 198, & 199 ARE LONG ENOUGH SO THE CONNECTOR MAY BE UNSCREWED AND ACCESS OBTAINED TO THE WIRING SIDE WITHOUT UNSOLDERING CONNECTIONS.

17 F DENOTES WIRING BROUGHT FROM CABLE FORM AT SEPARATE STITCH.

18 AT STATIONS 1 THROUGH 146 AND 160 THROUGH 199 WIRING DESIGNATED CA1 IS IN THE FIRST OF TWO LOCAL CABLES. WIRING NOT OTHERWISE SPECIFIED IS IN THE OTHER LOCAL CABLE.

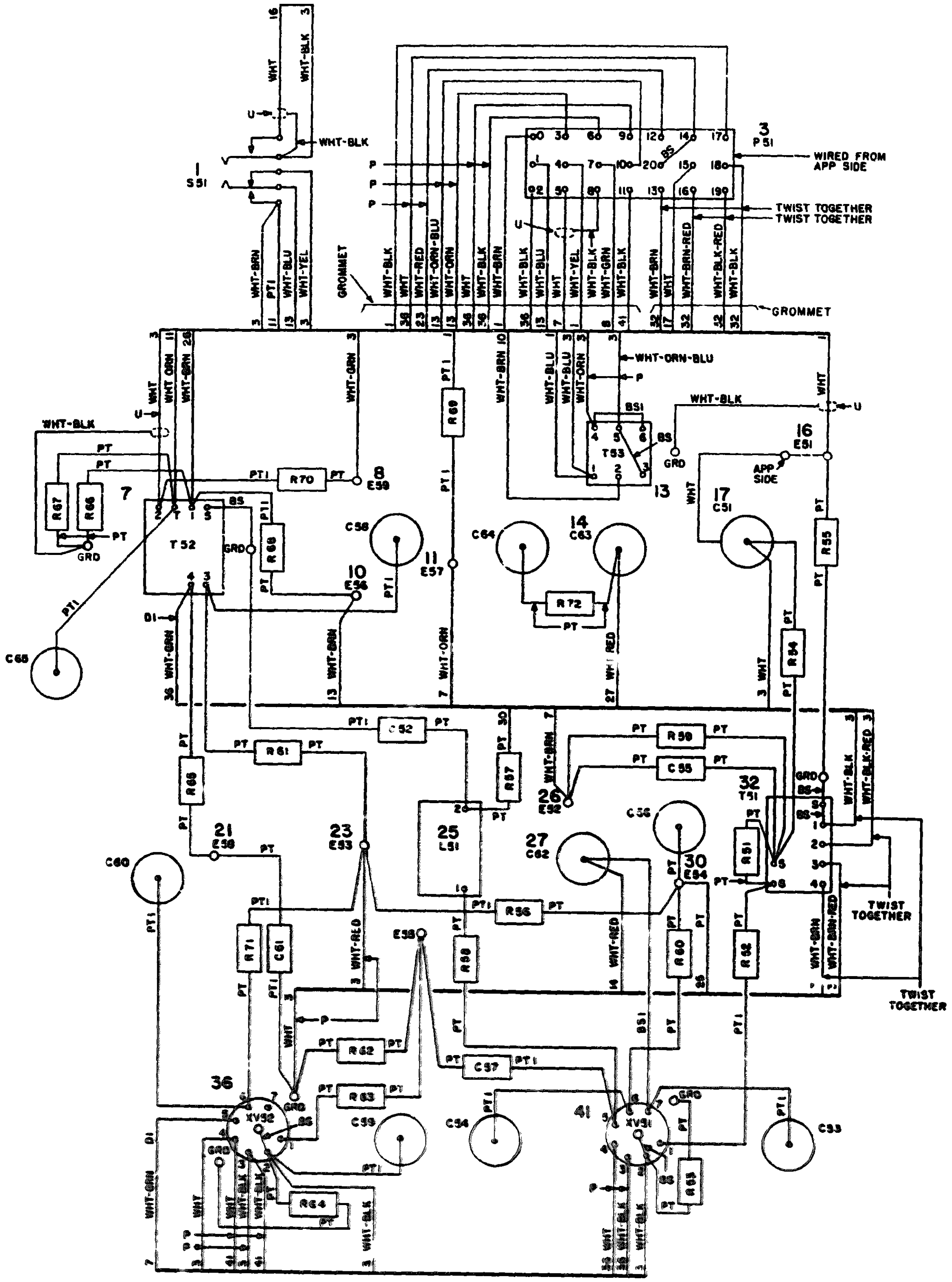
19 AT STATIONS 140 THROUGH 158 WIRING NOT OTHERWISE SPECIFIED IS INCLUDED IN A LOCAL CABLE.

20. AT STATIONS 253 AND 297 WIRING DESIGNATED CA1 IS IN LOCAL CABLE 1. WIRING DESIGNATED CA2 IS IN LOCAL CABLE 2.

21. RELOCATE THESE RESISTORS TOGETHER WITH ANOTHER RESISTOR (R794) AS SHOWN IN FIGURE 174 ①

22. LEADS EXTERNAL TO THE POWER SUPPLY CIRCUIT AND CONNECTED TO TERMINAL BOARD TB552 ARE SHOWN IN THIS DIAGRAM. LEADS WHICH ARE PART OF THE POWER SUPPLY CIRCUIT AND CONNECTED TO TERMINAL BOARD TB552 ARE SHOWN IN THE POWER SUPPLY WIRING DIAGRAM.

...ation wiring
...umbers



NOTES

1 WIRES NOT OTHERWISE SPECIFIED ARE STRANDED # 22GA WL WIRE PER JAN-C-76, WITH PVC BODY AND EXTRUDED NYLON JACKET

2. BS DENOTES # 22GA BARE TINNED WIRE

3. BS1 DENOTES # 22GA BARE TINNED WIRE COVERED WITH NATURAL SILICON IMPREGNATED FIBREGLAS GRADE C3 SLEEVING.

4 D1 WIRING NOT INCLUDED IN LOCAL CABLE BUT RUNS DIRECTLY FROM TERMINAL TO TERMINAL IN THE SHORTEST MANNER POSSIBLE

5 P DENOTES PAIR

6 PT DENOTES LEADS PART OF APPARATUS

7 PT1 DENOTES LEADS PART OF APPARATUS COVERED WITH NATURAL SILICON IMPREGNATED FIBREGLAS GRADE C3 SLEEVING

8 U DENOTES SHIELDED WIRE, STRANDED # 22GA WL WIRE PER JAN-C-76, WITH PVC BODY AND NYLON EXTRUDED JACKET, SHIELDED

9 —— DENOTES SHIELD CONNECTION

10 LARGE NUMBER DESIGNATES THE PART, SMALL NUMBER DESIGNATES PART TO WHICH THE WIRE RUNS

11 ALL SOLDERED CONNECTIONS ARE COVERED WITH A MOISTURE AND FUNGUS RESISTANT COATING IN ACCORDANCE WITH SPECIFICATION JAN-T-152

12 WIRING NOT OTHERWISE SPECIFIED IS DRESSED BACK TO THE CHASSIS AND RUN AT RIGHT ANGLES IN THE MOST CONVENIENT MANNER

Figure 170. Transmitting or receiving amplifier, wiring diagram.

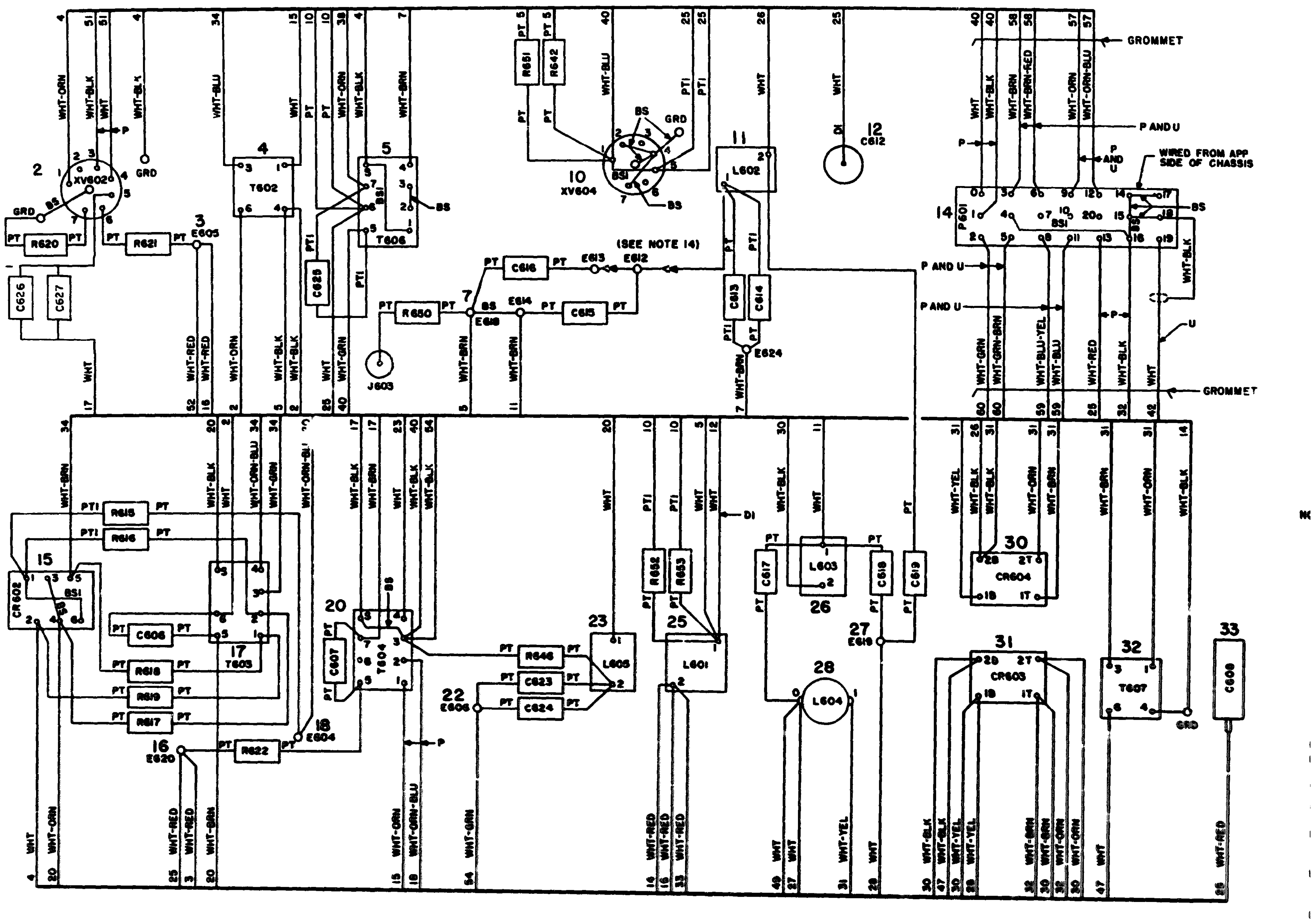


Figure 17(1). Part of carrier supply wiring diagram.

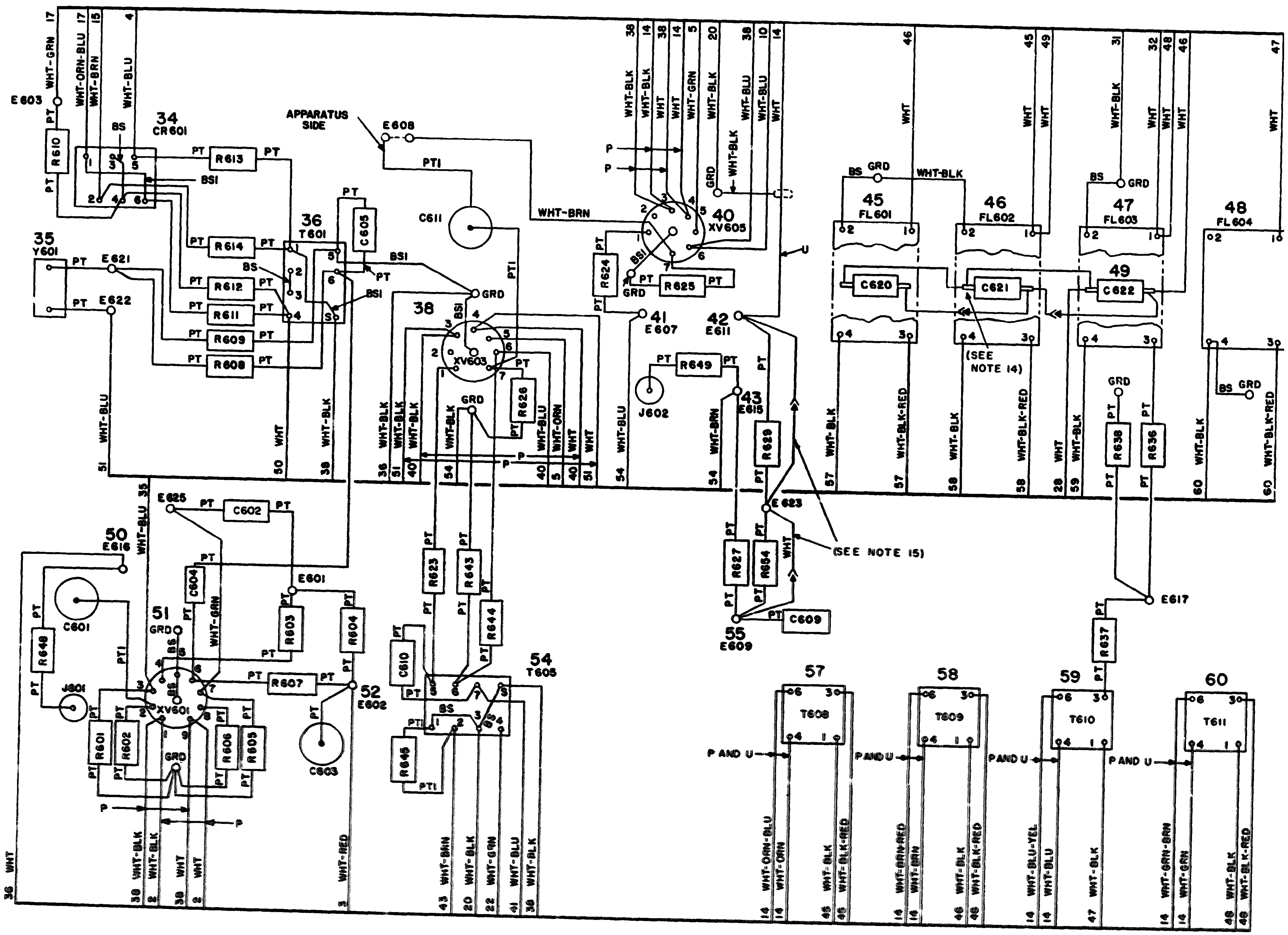
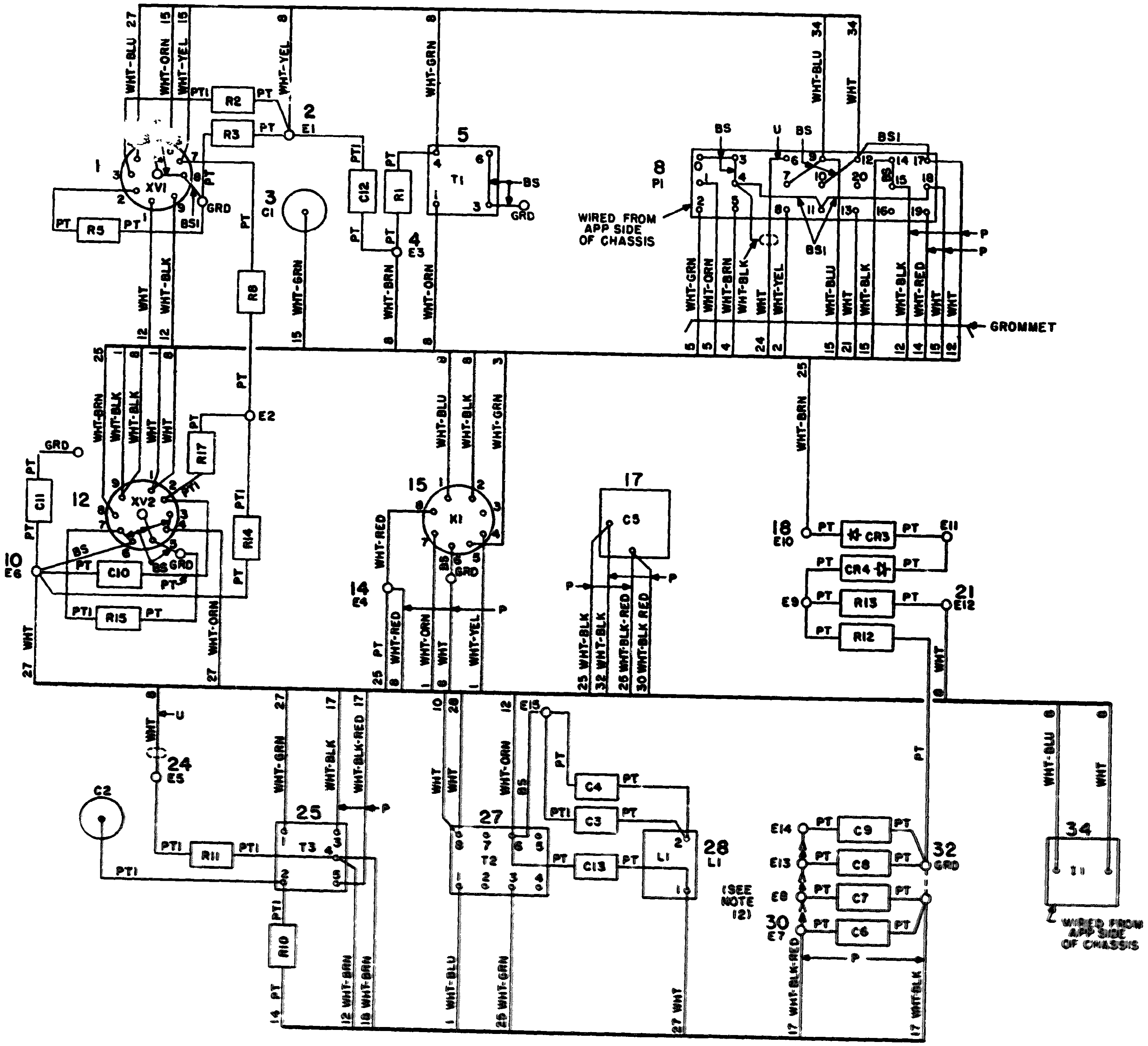


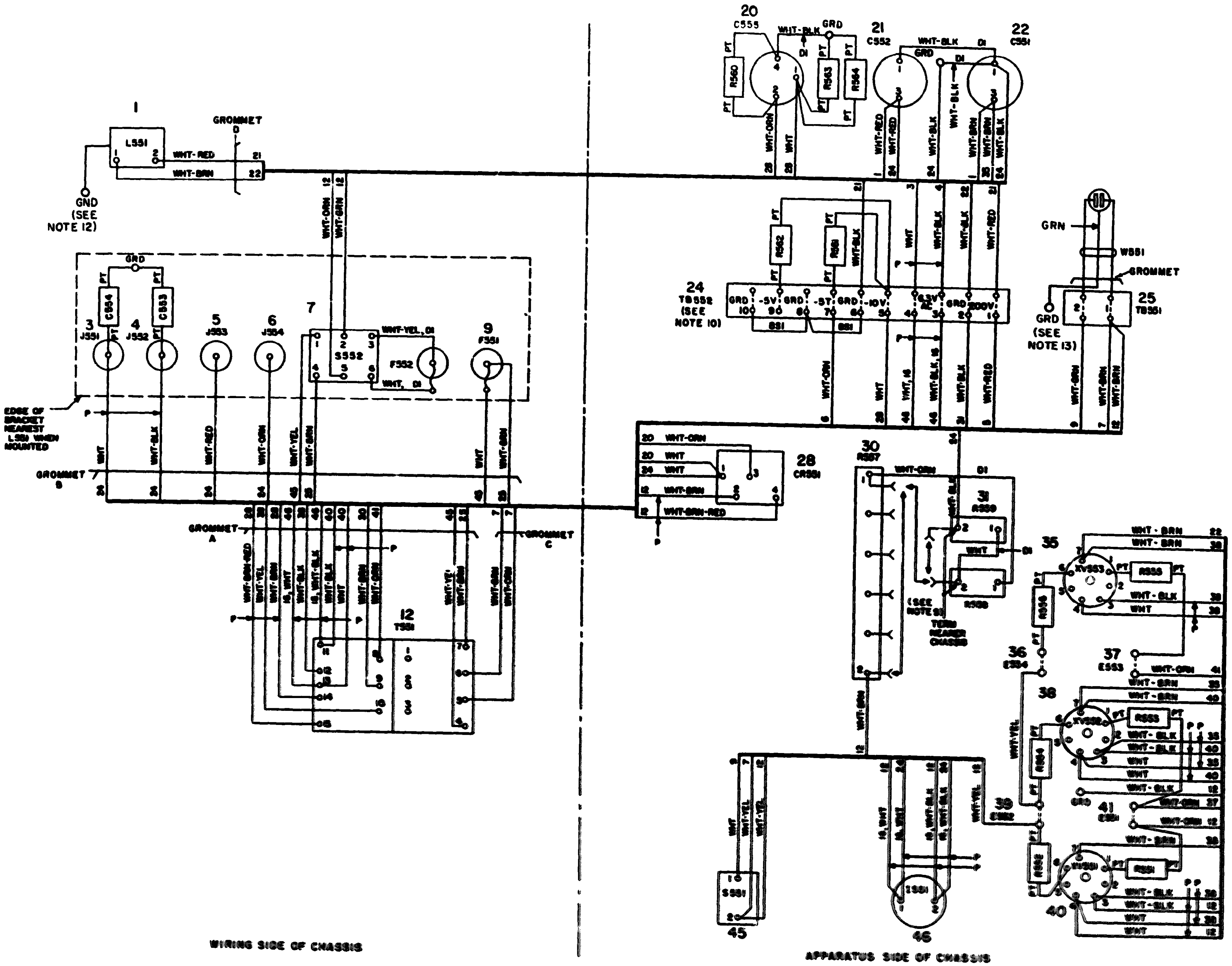
Figure 171(2). Part of carrier supply wiring diagram.



NOTES:

1. WIRES NOT OTHERWISE SPECIFIED ARE STRANDED #22 GA WL WIRE PER JAN-C-76 WITH PVC BODY AND EXTRUDED NYLON JACKET.
2. BS DENOTES #22 GA TINNED ANNEALED COPPER WIRE, ASTM B33.
3. BS1 DENOTES #22 GA TINNED ANNEALED COPPER WIRE, ASTM B33, COVERED WITH NATURAL SILICON IMPREGNATED FIBREGLAS GRADE C3 SLEEVING.
4. P DENOTES PAIR.
5. PT DENOTES LEADS PART OF APPARATUS.
6. PT1 DENOTES LEADS PART OF APPARATUS COVERED WITH NATURAL SILICON IMPREGNATED FIBREGLAS GRADE C3 SLEEVING.
7. U DENOTES SHIELDED WIRE, STRANDED #22 GA WL WIRE PER JAN-C-76 WITH PVC BODY AND EXTRUDED NYLON JACKET, SHIELDED
8. (symbol) DENOTES SHIELD CONNECTION.
9. LARGE NUMBER DESIGNATES THE PART, SMALL NUMBER DESIGNATES PART TO WHICH THE WIRE RUNS.
10. ALL SOLDERED CONNECTIONS ARE COVERED WITH A MOISTURE AND FUNGUS RESISTANT COATING IN ACCORDANCE WITH SPECIFICATION JAN-T-152
11. WIRING NOT OTHERWISE SPECIFIED IS DRESSED BACK TO THE CHASSIS AND RUNS AT RIGHT ANGLES IN THE MOST CONVENIENT MANNER
12. STRAP CAPACITORS C7, C8, AND C9 AS REQUIRED TO ADJUST OSCILLATOR FREQUENCY.
13. (symbol) DENOTES A TWO-TERMINAL TERMINAL STUD

Figure 172. Ringer oscillator, wiring diagram.



NOTES:

1. WIRES NOT OTHERWISE SPECIFIED ARE STRANDED #22 GA WL WIRE PER JAN-C-76 WITH PVC BODY AND EXTRUDED NYLON JACKET.
2. WIRES NOT OTHERWISE SPECIFIED ARE INCLUDED IN LOCAL CABLE.
3. DI WIRING RUNS DIRECTLY FROM TERMINAL TO TERMINAL IN THE SHORTEST MANNER POSSIBLE
4. BSI DENOTES #22 GA TINNED ANNEALED COPPER WIRE, ASTM B33, COVERED WITH NATURAL SILICON IMPREGNATED FIBREGLAS GRADE 3 SLEEVING
5. P DENOTES PAIR.
6. PT DENOTES LEADS PART OF APPARATUS.
7. LARGE NUMBER DESIGNATES THE PART SMALL NUMBER ON WIRE DESIGNATE PART TO WHICH THE WIRE RUNS.
8. ALL SOLDERED CONNECTIONS ARE COVERED WITH MOISTURE AND FUNGUS RESISTANT COATING IN ACCORDANCE WITH SPECIFICATION JAN-T-152.
9. STRAP RESISTORS R557, R558, AND R559 AS REQUIRED TO PROVIDE PROPER B+ VOLTAGE.
10. LEADS WHICH ARE PART OF THE POWER SUPPLY AND CONNECTED TO TERMINAL BOARD TB552 ARE SHOWN IN THIS DIAGRAM. LEADS WHICH ARE EXTERNAL TO THE POWER SUPPLY CIRCUIT AND CONNECTED TO TERMINAL BOARD TB552 ARE SHOWN IN THE AMPLIFIER-POWER SUPPLY AM-682/TCC-3 WIRING DIAGRAM.
11. O DENOTES A CHASSIS FEED-THROUGH TERMINAL STUD OR A TWO-TERMINAL TERMINAL STUD.
12. CONNECT WIRE SC-D-62694-6 (GREEN COLOR) BETWEEN SOLDER LUGS INSTALLED ON GROUND POST L201 AND MOUNTING SCREW FOR REACTOR SC-C-62822-1.
13. CONNECT GREEN WIRE FROM POWER CORD (SC-B-62712) TO LUG UNDER MOUNTING SCREW FOR REACTOR SC-C-62822-1

Figure 173. Power supply, wiring diagram.

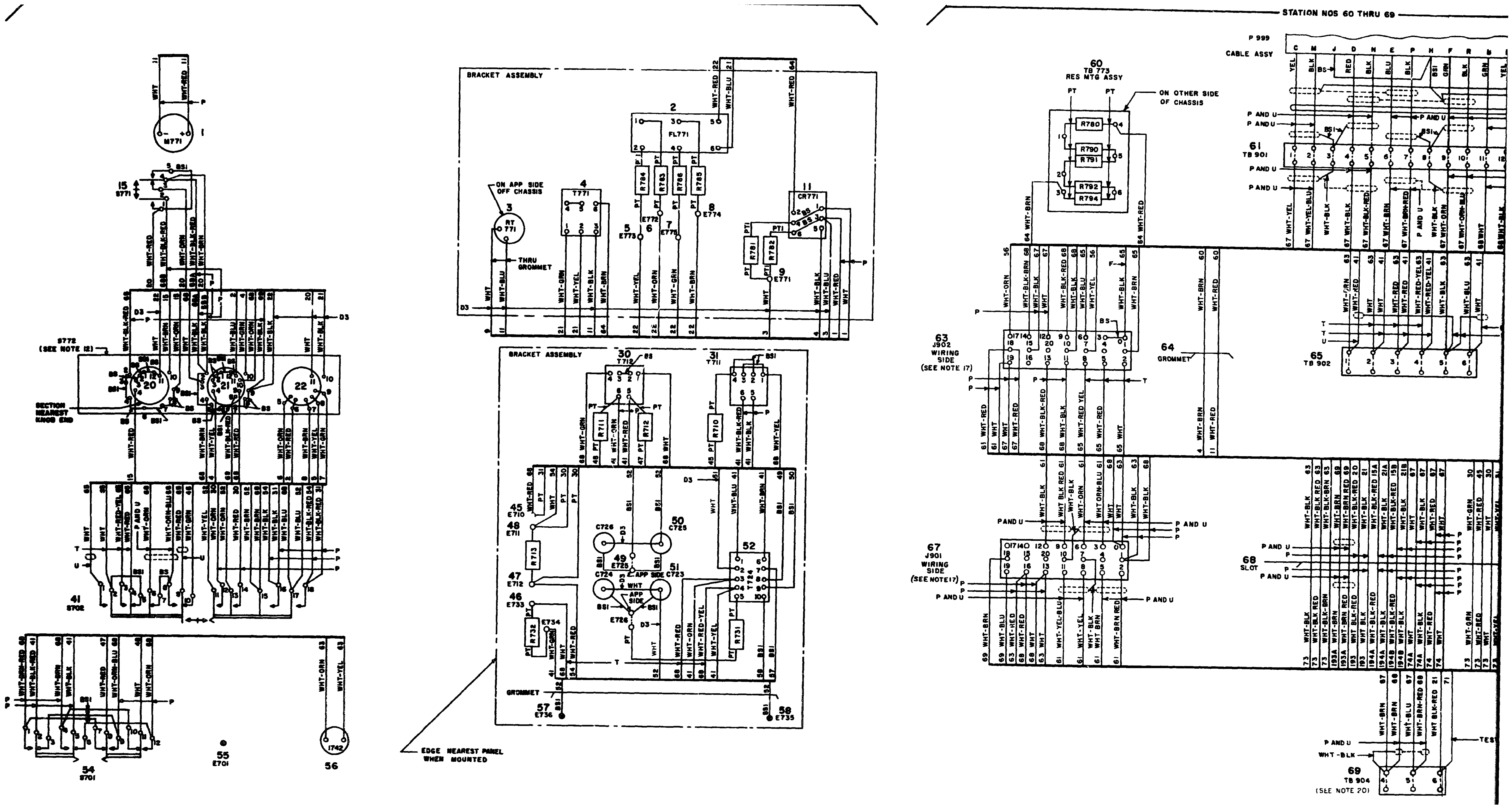
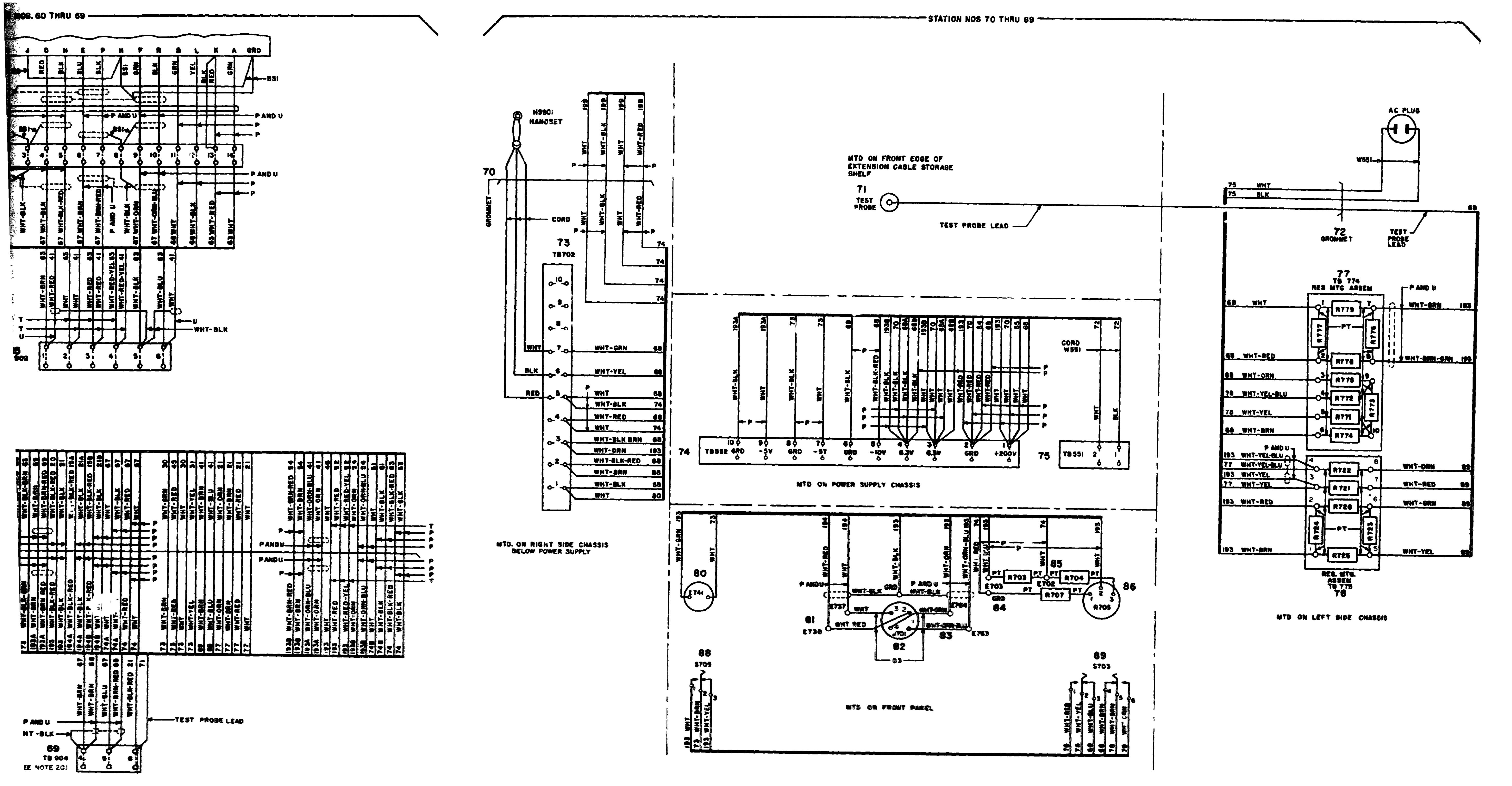


Figure 174(1). Part of amplifier power supply AM-682/TCC- diagram for AM-682/TCC-3 bearing order numbers other 51 (serial numbers 1 through 1707)



er-power supply AM-682/TCC-3 interconnection wiring bearing order numbers other than Order No. 1647-PH-1707).

NOTES:

1 WIRES NOT OTHERWISE SPECIFIED ARE STRANDED 22 GA WITH NYLON JACKET.

2. BS DENOTES 22 GA BARE TINNED WIRE

3. BSI DENOTES 22 GA BARE TINNED WIRE COVERED WITH FIBREGLAS SLEEVING.

4. DI WIRING RUNS DIRECTLY FROM TERMINAL TO TERMINAL IN THE SHORTEST POSSIBLE MANNER

5. D3 DENOTES WIRING DRESSED BACK TO THE CHASSIS AND RUN AT RIGHT ANGLES IN THE MOST CONVENIENT MANNER.

6. P DENOTES PAIR.

7. PT DENOTES LEADS PART OF APPARATUS.

8 PTI DENOTES LEADS PART OF APPARATUS COVERED WITH FIBREGLAS SLEEVING.

9. U DENOTES SHIELDED, STRANDED, 22 GA WIRE WITH NYLON JACKET

10. P AND U DENOTES SHIELDED PAIR.

11. T DENOTES TRIPLE

12. TERMINALS ON INSIDE OF CIRCLE ARE ON SIDE OF DISK FARTHEST FROM KNOB END. TERMINALS ON OUTSIDE OF CIRCLE ARE ON SIDE OF DISK NEAREST TO KNOB END

13. —⊩— DENOTES SPLICE.

14. ⊂⊃— DENOTES SHIELDED CONNECTION.

15. THE SMALL NUMBER ON EACH WIRE (ADJACENT TO THE COMMON OR BASE LINE) CORRESPONDS TO THE LARGE NUMBER ADJACENT TO THE STATION TO WHICH THE WIRE RUNS

16. ALL SOLDERED CONNECTIONS ARE COVERED WITH A MOISTURE AND FUNGUS RESISTANT COATING

17 WIRES TO STATIONS 63, 67, 198, AND 199 ARE LONG ENOUGH SO THE CONNECTOR MAY BE UNSCREWED AND ACCESS OBTAINED TO THE WIRING SIDE WITHOUT UNSOLDERING CONNECTIONS.

18. FOR STATION NOS. 1 THRU 89, ALL WIRING NOT OTHERWISE SPECIFIED IS INCLUDED IN LOCAL CABLE.

19. FOR STATION NOS. 90 THRU 199, ALL WIRING DESIGNATED CAI IS INCLUDED IN ONE LOCAL CABLE. ALL WIRING NOT DESIGNATED DI, D3, OR CAI IS INCLUDED IN OTHER LOCAL CABLE

20 ON EQUIPMENT BEARING ORDER NUMBERS OTHER THAN ORDER NO.1667-PH-51, THE TERMINALS OF TB904 ARE DESIGNATED 1 (INSTEAD OF 4), 2 (INSTEAD OF 5), AND 3 (INSTEAD OF 6)

21 C762 USED ONLY IN EQUIPMENTS BEARING ORDER NO.24485-PC-61

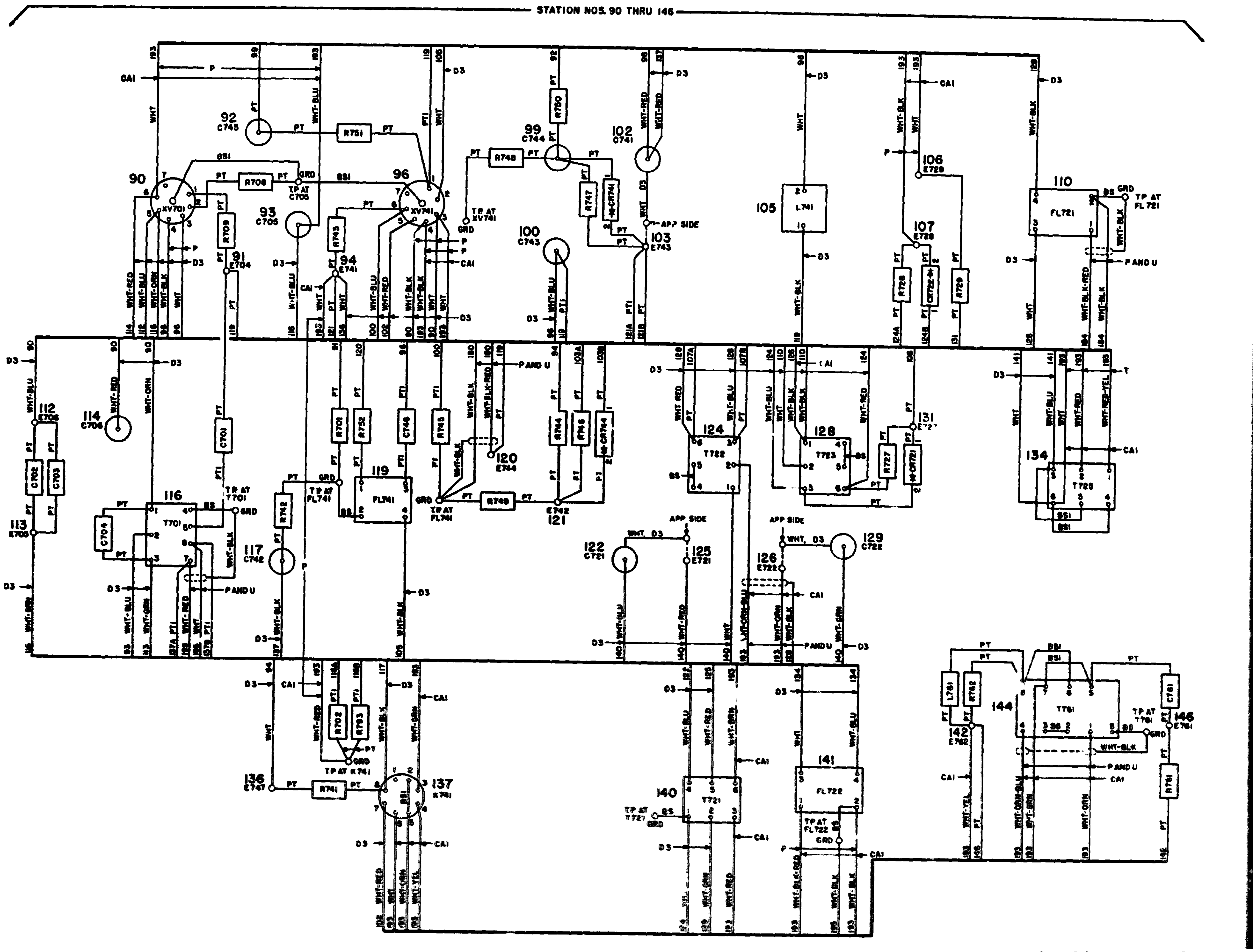
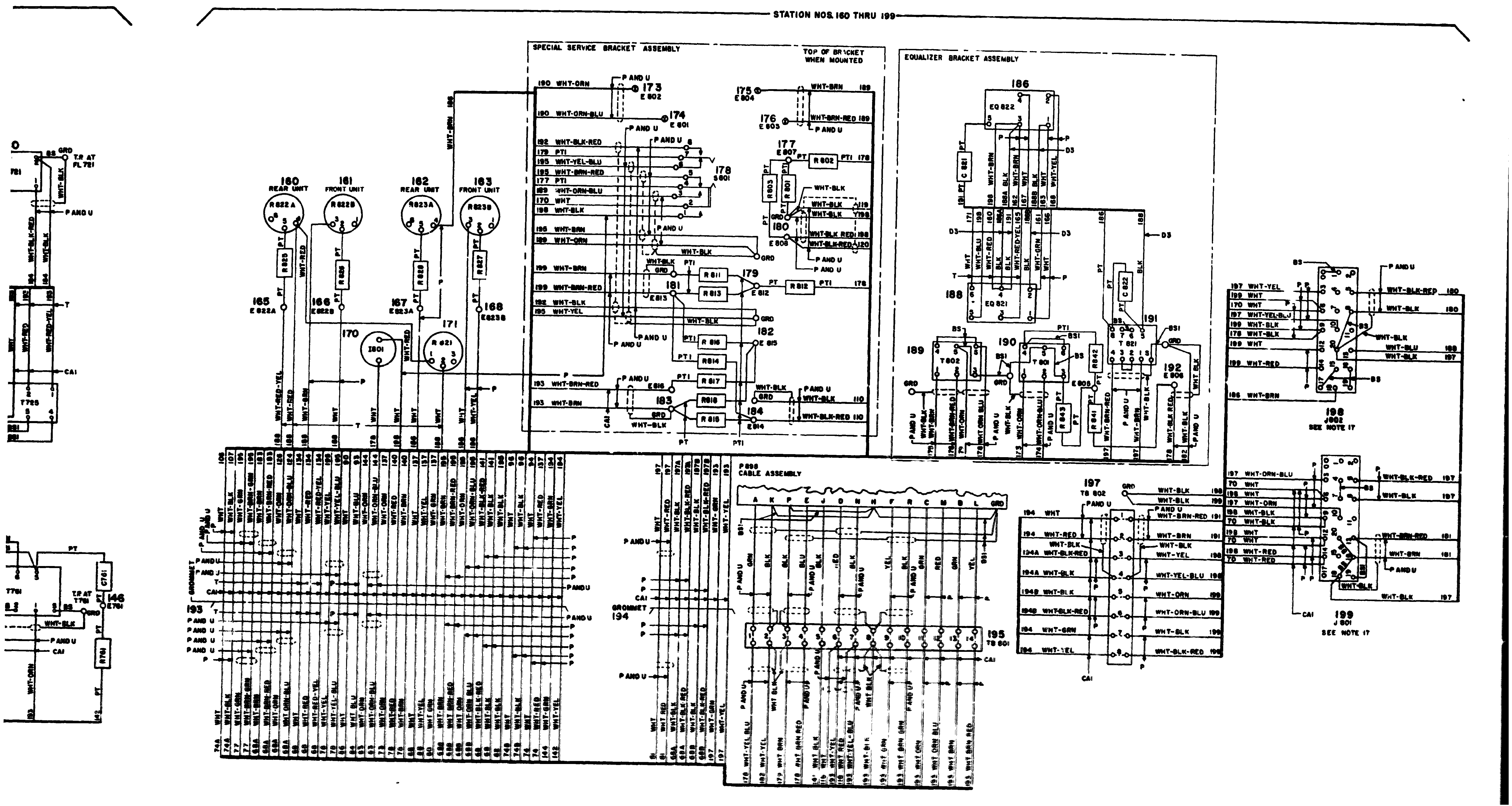


Figure 174(2). Part of amplifier-power supply AM-682/T diagram for AM-682/TCC-3 bearing order numbers other 51 (serial numbers 1 through 1707)

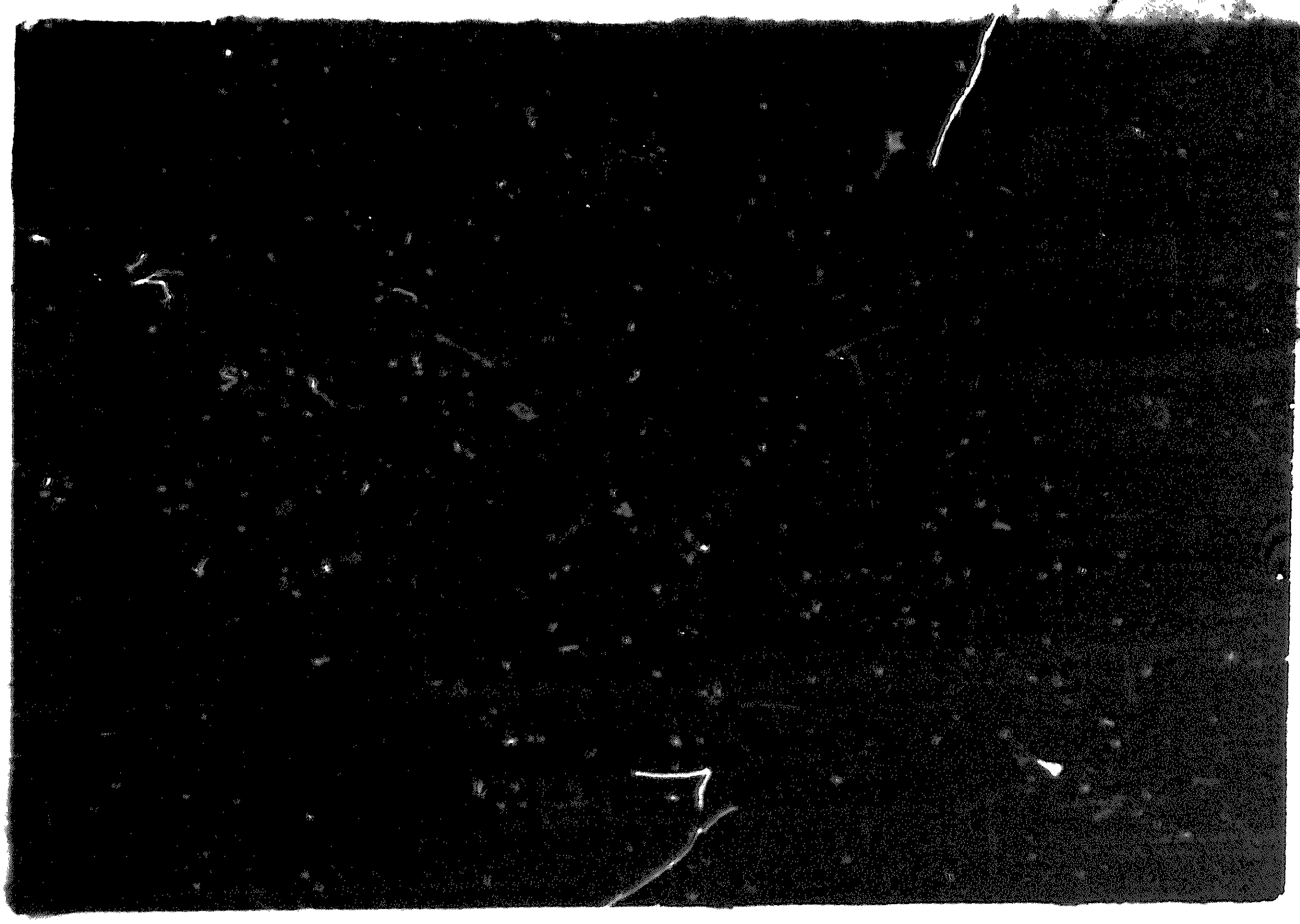


amplifier-power supply AM-682/TCC-3 interconnection wiring
TCC-3 bearing order numbers other than Order No. 1667-PH-
through 1707).

END

7-18-83

DATE



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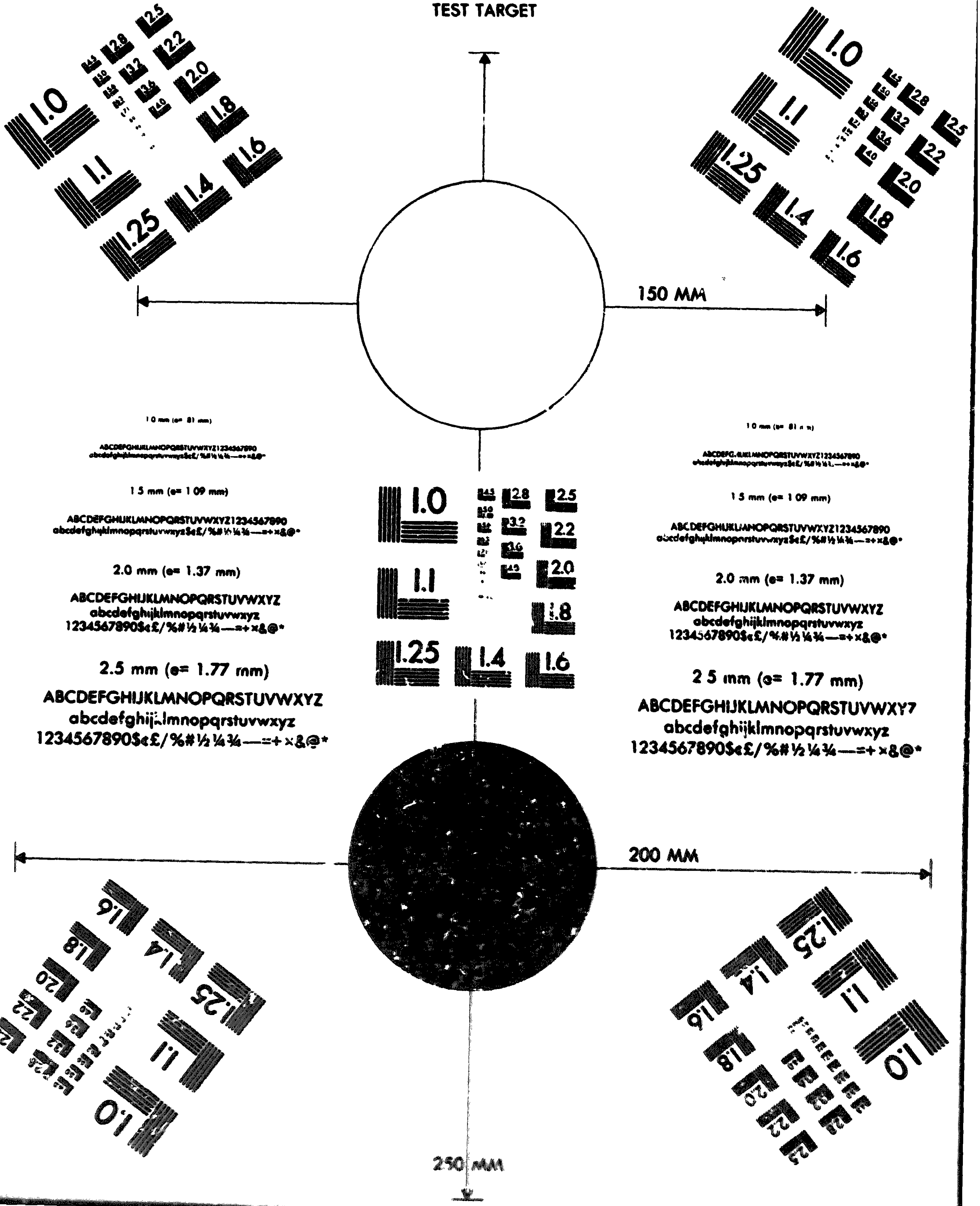

1.0 mm (e= .81 mm)

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abcdefghijklmnopqrstuvwxyz$¢£/%#½¼¾—=+×&@*

1.5 mm (e= 1.09 mm)

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abcdefghijklmnopqrstuvwxyz$¢£/%#½¼¾—=+×&@*

2.0 mm (e= 1.37 mm)

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abcdefghijklmnopqrstuvwxyz
1234567890$¢£/%#½¼¾—=+×&@*

2.5 mm (e= 1.77 mm)

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1.0 mm (e= .81 mm)

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2.0 mm (e= 1.37 mm)

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