

UNCLASSIFIED

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TECHNICAL MANUAL  
for  
TRANSISTORIZED SSB  
TRANSMITTER/RECEIVER  
MODEL TTR-10



A Red Mike  
B Green PTT  
C White Equip  
D Shields  
+ Blk  
Ground

THE TECHNICAL MATERIEL CORPORATION  
MAMARONECK, N. Y.

OTTAWA, CANADA



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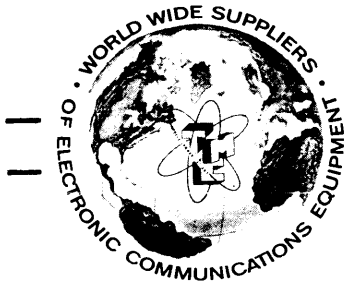


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**MAMARONECK, N. Y.** **OTTAWA, CANADA**

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# THE TECHNICAL MATERIEL CORPORATION

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700 FENIMORE ROAD

MAMARONECK, N. Y.

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The Technical Materiel Corporation, hereinafter referred to as TMC, warrants the equipment (except electron tubes,\*fuses, lamps, batteries and articles made of glass or other fragile or other expendable materials) purchased hereunder to be free from defect in materials and workmanship under normal use and service, when used for the purposes for which the same is designed, for a period of one year from the date of delivery F.O.B. factory. TMC further warrants that the equipment will perform in a manner equal to or better than published technical specifications as amended by any additions or corrections thereto accompanying the formal equipment offer.

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3. That the equipment has not been altered in any way either as to design or use whether by replacement parts not supplied or approved by TMC, or otherwise.
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\*Electron tubes also include semi-conductor devices.

### *PROCEDURE FOR RETURN OF MATERIAL OR EQUIPMENT*

Should it be necessary to return equipment or material for repair or replacement, whether within warranty or otherwise, a return authorization must be obtained from TMC prior to shipment. The request for return authorization should include the following information:

1. Model Number of Equipment.
2. Serial Number of Equipment.
3. TMC Part Number.
4. Nature of defect or cause of failure.
5. The contract or purchase order under which equipment was delivered.

### *PROCEDURE FOR ORDERING REPLACEMENT PARTS*

When ordering replacement parts, the following information must be included in the order as applicable:

1. Quantity Required.
2. TMC Part Number.
3. Equipment in which used by TMC or Military Model Number.
4. Brief Description of the Item.
5. The *Crystal Frequency* if the order includes crystals.

### *PROCEDURE IN THE EVENT OF DAMAGE INCURRED IN SHIPMENT*

TMC's Warranty specifically excludes damage incurred in shipment to or from the factory. In the event equipment is received in damaged condition, the carrier should be notified immediately. Claims for such damage should be filed with the carrier involved and not with TMC.

All correspondence pertaining to Warranty Claims, return, repair, or replacement and all material or equipment returned for repair or replacement, within Warranty or otherwise, should be addressed as follows:

THE TECHNICAL MATERIEL CORPORATION  
Engineering Services Department  
700 Fenimore Road  
Mamaroneck, New York



**CHANGE NO. 1 TTR-10**



**INSTRUCTION BOOK CHANGE NOTICE**

Date 3/10/66

Manual affected: Transistorized SSB Transmitter/Receiver IN -1004  
Model TTR-10 (Issue Date: 11 May 1965)

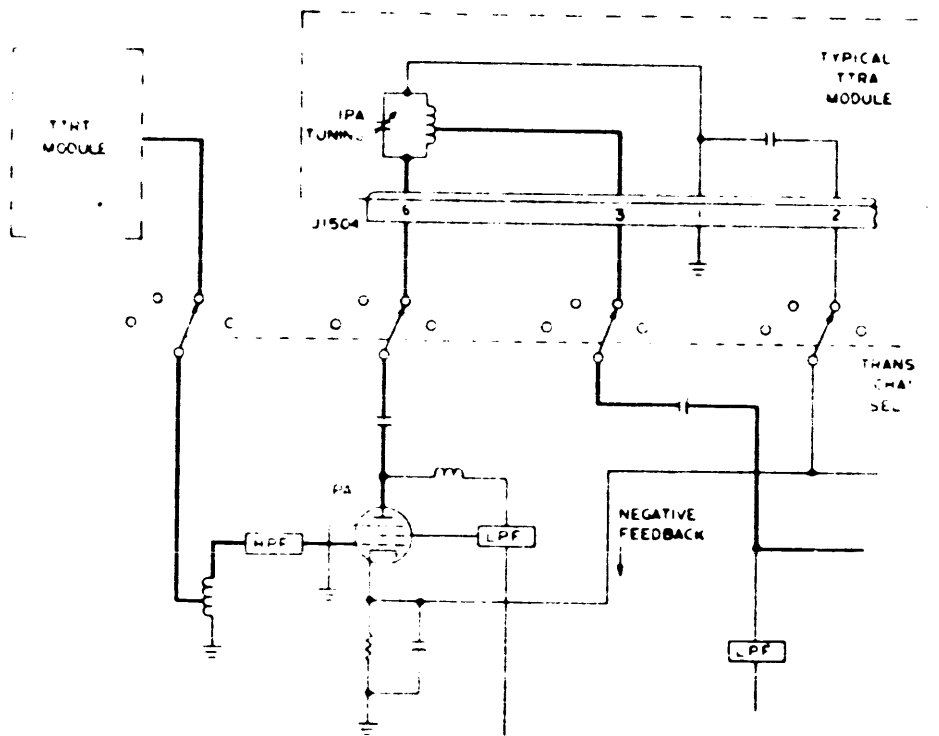
1. Page 4-17. Figure 4-7.

Change pin numbers of J1504 to comply with information given in figure 1 below.

2. Page 5-9.

Change step 16 to read as follows:

(16) Adjust control D on TTRT module until conditions set forth in step (15) are met with XMTR AF GAIN control at its fully clockwise position.



SHOULD ADDITIONAL COPIES OF THIS CHANGE NOTICE BE REQUIRED, PLEASE CONTACT:

THE TECHNICAL MATERIEL CORP., 700 Fenimore Road, Mamaroneck, New York

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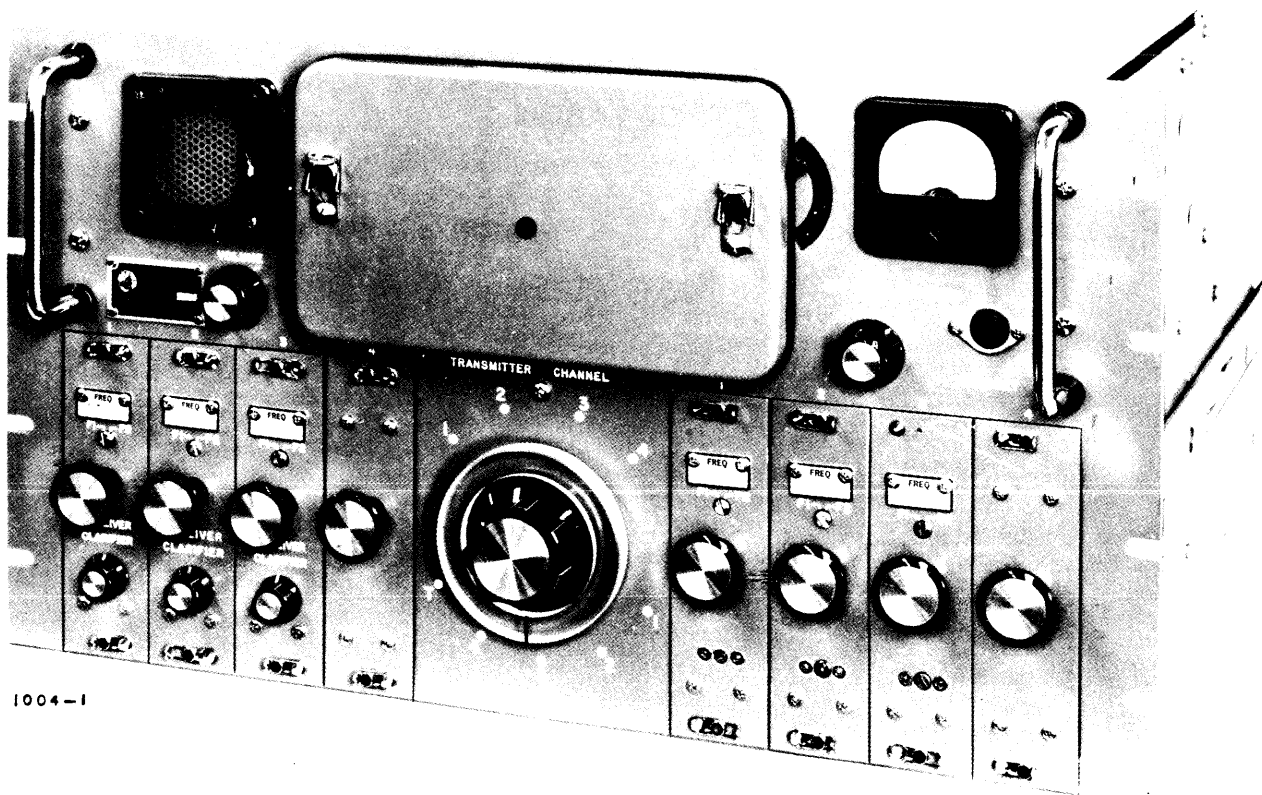
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1004-1

652.18-5

Figure 1-1. Transistorized SSB Transmitter/Receiver, Model TTR-10

# SECTION 1

## GENERAL DESCRIPTION

### 1-1. FUNCTIONAL DESCRIPTION.

a. GENERAL. - Transistorized SSB Transmitter/Receiver, Model TTR-10 (figure 1-1) is a four-channel transmitter/receiver covering the 2- to 32-mc frequency range and with the capability of simplex or duplex operation. The TTR-10 contains both a fully-transistorized superheterodyne receiver, and a fully transistorized transmitter that is coupled with a high-power vacuum-tube linear amplifier. Operating potentials for the TTR-10 are provided by one of six different plug-in power-supply modules; these power supplies are available for use with a-c or d-c input power (refer to paragraph 1-4). For information regarding any of the power-supply modules, refer to the TPS( )-1 manual.

Operating frequencies for the transmit and receive sections of the TTR-10 are obtained from fixed-tuned, crystal-controlled, plug-in modules (TTRR modules for receiver section; TTRT modules for transmitter section). Various combinations of these plug-in modules may be used to provide frequency coverage in accordance with operating requirements (refer to paragraph 1-4). Each TTRR and TTRT module employed in the TTR-10 has two selectable, crystal-controlled, local-oscillator frequencies that permit operation on either of two signals frequencies (F1 or F2) within the r-f bandpass of the module, without necessitating realignment. Field change to new operating frequencies is easily accomplished (refer to section 5 and the appropriate TTRR or TTRT manual.

The TTR-10 is designed so that remote selection of upper or lower sideband (receive and/or transmit) is possible. Remote selection of transmit and/or receive channels (TTRR and/or receive channels (TTRR and TTRT modules) and tuned antenna circuits is also possible upon special request at time of order or upon field modification.

b. RECEIVER SECTION. - The TTR-10 is capable of receiving amplitude modulation (AME), continuous wave (CW), facsimile (FAX), frequency shift keying (FSK), modulated continuous wave (MCW), and single sideband (SSB) transmission. It can also receive one sideband of amplitude modulation (AM) or independent sideband (ISB) transmission.

#### NOTE

Converter equipment is required to process FAX and FSK signals.

The receiver section uses one of four selectable, fixed-tuned, plug-in modules (TTRR-1, TTRR-2, TTRR-3, or TTRR-4) for its r-f section. For infor-

mation pertaining to any of the TTRR modules, refer to the TTRR manual. Performance specifications for the receiver section are given in paragraph 1-4; other features of the receiver section include:

- (1) High sensitivity for good reception under weak signal conditions.
- (2) A sharp cutoff bandpass filter for optimum selectivity.
- (3) Double conversion and three tuned r-f amplifier stages.
- (4) Manual selection of LSB or USB reception.
- (5) An adjustable squelch circuit that mutes the audio output (except for the 600-ohm line output) when no input signal is being received. This circuit also provided an external output (for alarm purposes) to indicate that the receiver is squelched.
- (6) The receiver section produces two separate audio outputs. These are 500 milliwatts into 4 ohm load (built-in or external speaker) and 1 milliwatt into a 600-ohm balanced load. The speaker output level can be varied by means of a VOLUME control.

c. TRANSMITTER SECTION. - The TTR-10 can transmit amplitude modulation equivalent (AME), continuous wave (CW), facsimile (FAX), frequency shift keying (FSK), modulated continuous wave (MCW), and single sideband (SSB) signals.

#### NOTE

Additional equipment is required to provide FAX and FSK input signals.

The transmitter section uses one of four selectable, fixed-tuned plug-in modules (TTRT-1, TTRT-2, TTRT-3, TTRT-4) for its exciter r-f section. The linear-amplifier tuning circuits employed in the transmitter section are also contained in plug-in modules (TTRA-1, TTRA-2, TTRA-3, TTRA-4). TTRT and TTRA modules are selected in pairs and must be of the same model number (TTRT-1 and TTRA-1, TTRT-2 and TTRA-2, etc.). Information concerning TTRA modules can be found in this manual; for information pertaining to the TTRT module, refer to the TTRT manual.

The transmitter section is designed to accept a wide variety of audio inputs including carbon microphone, high-impedance microphone, low-impedance microphone, and 600-ohm balanced line. Provision is also made for operation with a handset (also avail-

able from TMC). The transmitter section contains an audio oscillator that can be externally keyed for CW and MCW transmission. Performance specifications for the transmitter section are given in paragraph 1-4; other on page 1-4a features of the transmitter section include:

- (1) Double conversion and a sharp cutoff band-pass for optimum unwanted sideband rejection.
- (2) Manual selection of either LSB or USB transmission.
- (3) Built-in power compensation circuit to prevent transmitter overload when mode of operation is changed.
- (4) Automatic compression circuit for higher average power output.
- (5) Selectable voice or push-to-talk operation of transmitter with provision for disabling the receiver section while transmitting (for simplex operation).
- (6) A built-in meter for monitoring the linear amplifier excitation, plate current, drive and output.
- (7) An automatic high-voltage cutout circuit to protect the linear amplifier when overload occurs.

## 1-2. PHYSICAL DESCRIPTION.

a. EXTERNAL. - The TTR-10 is normally provided for mounting in a standard 19-inch rack, but can also be provided in a sturdy metal case for general use. Two handles are located on the front panel for ease of handling. Dust covers protect the unit when it is rack-mounted.

All operator's controls with the exception of the

MIKE/LINE and OVEN VOLTAGE switches are located on the front panel; the MIKE/LINE and OVEN VOLTAGE switches are located on the rear of the unit. All controls are described in section 3 and illustrated in figures 2-1 and 3-1. A removable control cover is provided to prevent inadvertent changing of front-panel control settings. Two terminal boards (TB1500 and TB1501), two BNC connectors (RCVR ANT and ANTENNA jacks), and two twist-lock plugs (EXTERNAL OVEN VOLTAGE and AC INPUT) on the rear of the unit provide for all input and output connections. Coaxial cable assembly W900 is provided for connecting the receiver section input to the transmitting antenna for simplex operation.

b. INTERNAL. - Most of the smaller components in the TTR-10 are located on printed circuit boards that are mounted to the chassis; the larger components are chassis mounted. There are six printed circuit boards (xmtr audio, xmtr i-f, receiver audio, receiver i-f, CW oscillator, and preamplifier) not including those in the TTRR and TTRT modules. The transmitter i-f and audio boards are mounted back-to-back on a hinged assembly that permits the boards to swing out so that the components of the audio board (normally facing the interior of the chassis) are exposed. The receiver i-f and audio boards are similarly mounted. All six printed circuit boards are located on the bottom side of the TTR-10 chassis. Four TTRA modules are located on the top side of the chassis. These are plug-in tuning modules for the linear amplifier. The two vacuum tubes for the linear amplifier are located in a compartment between the TTRA modules.

Figures 5-1 through 5-8 show the location of most of the components in the TTR-10.

The vacuum tube and semiconductor complement of the TTR-10 is given in table 1-1.

TABLE 1-1. VACUUM TUBE AND SEMICONDUCTOR COMPLEMENT

REFERENCE DESIGNATION	TYPE	FUNCTION
RECEIVER SECTION		
CR1601 through CR1604	1N34A	Audio detector
CR1605 through CR1607	1N68	AGC detector
Q1601	2N2084	I-f amplifier
Q1602	2N2084	Mixer
Q1603 and Q1604	2N1370-4	1st audio amplifier
Q1605	2N2084	Buffer amplifier
Q1606	2N2084	Beat frequency oscillator
Q1607	2N2084	Lower sideband oscillator
Q1608	2N2084	Upper sideband oscillator

TABLE 1-1. VACUUM TUBE AND SEMICONDUCTOR COMPLEMENT (CONT)

REFERENCE DESIGNATION	TYPE	FUNCTION
Q1609	2N2084	Buffer amplifier
Q1610	2N1190	I-f amplifier
Q1611	2N1308	1st agc amplifier
Q1612	2N697	2nd agc amplifier
Q1613	2N1370-4	2nd audio amplifier
Q1614 and Q1615	2N1370-4	3rd audio amplifier
Q1616 and Q1617	2N1032	Push-pull audio power amplifier
Q1618	2N1370-7	Line amplifier
Q1619 and Q1620	2N1370-4	Bistable amplifier
Q1621	2N2001	Relay driver
TRANSMITTER SECTION		
CR1500 and CR1501	1N463	Rf Detectors
CR1701 and CR1702	1N34A	Anti-vox detector
CR1703 and CR1704	1N34A	Vox detector
CR1705	1N34A	Relay suppressor
CR1706 through CR1709	1N34A	Balanced modulator
Q1500	2N1308	CW oscillator
Q1501	2N1308	Preamp
Q1701	2N214	Anti-vox amplifier
Q1702	2N1370-4	Audio amplifier
Q1703	2N1370-4	Line amplifier
Q1704	2N1370-4	Emitter follower
Q1705	2N1370-4	Vox amplifier
Q1706	2N1308	Dc amplifier
Q1707	2N1370-4	Dc amplifier
Q1708	2N2001	Relay driver
Q1709 and Q1710	2N2084	Balanced mixer
Q1711	2N2084	I-f amplifier
Q1712	2N2084	Xmitr 250 kc oscillator
Q1713, Q1714, and Q1715	2N2084	Buffer amplifiers
Q1716	2N2084	Lower sideband oscillator

TABLE 1-1. VACUUM TUBE AND SEMICONDUCTOR COMPLEMENT (CONT)

REFERENCE DESIGNATION	TYPE	FUNCTION
Q1717	2N2084	Upper sideband oscillator
V1500	6GK6	Intermediate power amplifier
V1501	8117	Power amplifier

1-3. EQUIPMENT SUPPLIED.

Table 1-2 lists the equipment supplied with the TTR-10.

TABLE 1-2. EQUIPMENT SUPPLIED

NAME	DESIGNATION	FUNCTION	QUANTITY
Transistorized SSB Transmitter/Receiver	TTR-10	Communications transmitter and receiver	1
Fanning strip		Aid for rear panel wiring	2
Rf connector		Antenna connection	1
Service extension module	AX-436	Aid for adjustment of TTRR and TTRT modules	1

1-4. TECHNICAL SPECIFICATIONS.

a. RECEIVER SECTION.

Frequency range

2 to 32 mc divided into four bands using the following TTRR modules.

Band 1: 2-4 mc, TTRR-1

Band 2: 4-8 mc, TTRR-2

Band 3: 8-16 mc, TTRR-3

Band 4: 16-32 mc, TTRR-4

Number of channels

4 (each having a separate TTRR module)

Tuning System

Each TTRR module is fixed-tuned to a particular frequency within its band. The receiver section is tuned by selecting one of the different TTRR modules (channels).

Frequency control

Crystal-controlled oscillators are used throughout the receiver section.

Types of signals

AME, CW, FAX, FSK, MCW, and SSB (upper or lower). AM and ISB signals can also be received, but this feature is generally not used.

Noise Figure

15 db or better

Sensitivity

1 microvolt input for 15 db signal-plus-noise to noise ratio.

1-4. TECHNICAL SPECIFICATIONS. (CONT)

Audio bandwidth	3 kc, $\pm 2$ db between 300 and 3300 cps.
I-f frequency	Double conversion from 1.75 mc to 250 kc on all bands.
Image rejection	A minimum of 50 db from 2 to 28 mc, a minimum of 40 db from 28 to 32 mc.
Intermodulation	Intermodulation products are at least 35 db below a 100 microvolt two tone input at the antenna.
AGC	With a 100 db increase in the signal input from 1 microvolt, the output level will not rise more than 6 db.
Hum and noise level	At least 40 db below full output.
Antenna input impedance	50 ohms (nominal) unbalanced.
Audio output	1. 500 milliwatts into 4 ohms for built in or external speaker. 2. 1 milliwatt in 600-ohm balanced load.

b. TRANSMITTER SECTION

Frequency range	2-32 mc divided into four bands using the following TTRT and TTRA modules:  Band 1: 2-4 mc, TTRT-1 and TTRA-1 Band 2: 4-8 mc, TTRT-2 and TTRA-2 Band 3: 8-16 mc, TTRT-3 and TTRA-3 Band 4: 16-32 mc, TTRT-4 and TTRA-4
Number of channels	4 (each having separate TTRT and TTRA modules).
Tuning system	Each TTRT and TTRA module is fixed-tuned to a particular frequency within its band. The transmitter section is tuned by selecting one of the different TTRT modules (channels); the corresponding TTRA module is selected automatically.
Frequency control	Crystal-controlled oscillators are used throughout the transmitter section.
Types of signals transmitted	AME, CW, FAX, FSK, MCW, and SSB (upper or lower)
Audio bandwidth	2.75 kc $\pm 2$ db between 250 and 3000 cps.
I-f frequency	Double conversion from 250 kc to 1.75 mc on all bands.
Power Output	100 watts PEP. 50 watts CW.
Signal-to-distortion ratio	35 db minimum at full PEP output.
Unwanted sideband rejection	40 db minimum at full PEP output.
Spurious signal level	Down a minimum of 50 db at full PEP output.
Noise level	Down a minimum of 40 db at full PEP output.

1-4. TECHNICAL SPECIFICATIONS. (CONT)

Carrier suppression Automatically preset at -50 db, -20 db, or -6 db from sideband envelope power depending upon operating mode selected as follows:

CW and SSB:	-50 db
-20 DB	-20 db
AME and MCW:	-6 db

Output impedance 50 ohms (nominal) unbalanced into a load with up to 3:1 VSWR.

c. OVERALL.

Primary power input Depends upon model of power supply module used.

- TPSA-1 - 115 VAC Single Phase
- TPSE-1 - 208 VAC Single Phase
- TPSF-1 - 230 VAC Single Phase
- TPSG-1 - 12 VDC
- TPSB-1 - 24 VDC
- TPSH-1 - 32 VDC

Power consumption

1. 230 watts when in XMIT/REC and transmitting.
2. 25 watts when in XMIT/REC but not transmitting.
3. 8 watts when in REC.
4. Crystal ovens require 6 watts each in addition to the above.

Dimensions

- Length: 16-1/2 inches
- Width: 19 inches
- Height: 10-1/2 inches

Weight, uncrated 65 pounds (rack mounted version only).



## SECTION 2 INSTALLATION

### 2-1. UNPACKING AND HANDLING.

The TTR-10 is shipped from the factory in a wooden crate to ensure maximum protection from damage in transit. The inside of the crate contains additional packing material to protect the unit not only from breakage due to shock, but also from the elements. The equipment supplied with the TTR-10 (table 1-3) is packed in the box as loose items.

As soon as the TTR-10 is unpacked, it should be visually inspected to make sure that it is not damaged. This examination should include the testing of each front panel control. All of the covers on the unit should be removed, and the inside of the unit checked carefully for damaged components and loose items.

With respect to damage to the equipment for which the carrier is liable, the Technical Materiel Corporation will assist in describing methods of repair and the furnishing of replacement parts.

### 2-2. POWER REQUIREMENT.

a. MAIN POWER. - Power consumption for the TTR-10 is given in paragraph 1-4. The TTR-10 can operate with either an a-c or d-c power input depending upon the type of power supply module (TPS( )-1) used in the unit. If the TTR-10 is to be operated from a source other than that for which the power-supply is wired, the power supply module must either be modified or replaced. Modification instructions are provided in the appropriate TPS( )-1 manual. Removal and replacement of the power supply module is described below.

#### (1) REMOVAL.

- (a) Deenergize TTR-10.
- (b) Disconnect main power and oven-power (if used) cables from rear of TTR-10.
- (c) Disconnect antenna from ANTENNA jack.
- (d) Disconnect W900 (at rear of TTR-10) from RCVR ANT jack J1502 (simplex hookup only).
- (e) Disconnect W901 (inside the power supply module, but accessible from the top of the TTR-10) from XMTR OUTPUT jack J1501.
- (f) Remove the four large Philips head screws on rear panel that secure power supply module to TTR-10 chassis. There are two screws on each side, located near the two handles.
- (g) Pull power supply module out of TTR-10 chassis. The handles are provided for this purpose.

### (2) REPLACEMENT.

#### CAUTION

Power supply modules should always be inserted with no power cables attached.

- (a) Pick up power supply module by handles and plug it into TTR-10 chassis.
- (b) Secure power supply module to TTR-10 chassis using the four Philips head screws removed in step (1) (f).
- (c) Connect W901 (inside power supply module) to XMTR OUTPUT jack J1501.
- (d) For simplex operation, connect W900 (at rear of TTR-10) to RCVR ANT jack J1502.
- (e) Connect antenna to ANTENNA jack.
- (f) Make sure power switch is set at OFF, and connect main-power and oven-power (if used) cables.

#### NOTE

If the power supply module inserted was not previously in use in the TTR-10, adjust the PA OVLD circuit breaker trip point according to paragraph 5-7 c.

b. OVEN POWER. - If ovens are used in the TTR-10 and TTRR modules, the voltage rating of the ovens must be the same as the main power input, or an external oven supply is required. It is most important to make sure the oven supply power is correct before energizing the unit.

### 2-3. EQUIPMENT LOCATION.

Before installing the TTR-10, consideration must be given to its location. Two factors are important:

- a. ACCESSIBILITY. - The TTR-10 should be located so that there is sufficient clearance for insertion and removal of plug-in modules (TTRR, TTRT, TTRA, and TPS( )-1). Also, sufficient space for fuse replacement and accessibility to rear-panel controls is required.
- b. VENTILATION. - Although the majority of TTR-10 components are solid-state and do not re-

quire ventilation, the vacuum tube linear amplifier requires that air flow is not restricted immediately above or below the unit. If the air flow is restricted, serious damage to the linear amplifier might result.

#### 2-4. ELECTRICAL INSTALLATION.

The only considerations for electrical installation are that the proper power-supply module is used (paragraph 2-2) and that external equipment is connected in accordance with paragraphs a through k below. Refer to figure 2-1.

a. ANTENNA. - The TTR-10 requires a 50-ohm unbalanced antenna with a coaxial-cable lead-in for simplex operation. This antenna is connected to the ANTENNA jack on the rear panel. In addition, coaxial-cable assembly W900 should be connected from jack J902 to the RCVR ANT jack J1502.

For duplex operation, two 50-ohm unbalanced antennas with coaxial-cable lead-in are required. The transmitting antenna is connected to the ANTENNA jack and the receiving antenna is connected to RCVR ANT jack J1502. Coaxial-cable assembly W900 is not used for duplex operation.

b. AUDIO INPUT (600-OHM LINE). - Terminals 1 and 3 of terminal board TB1500 are used to connect a 600-ohm input line. If the 600-ohm line is balanced, terminal 2 of TB1500 should be grounded.

c. MICROPHONE INPUTS. - Terminals 4, 5, and 6 of terminal board TB1500 are provided for various types of microphone inputs. Connect the microphone between ground and the appropriate terminal as identified by rear-panel markings (CAR, LO Z, and HI Z). Also, if a high-impedance microphone is used, a jumper must be connected between terminals 14 and 15 on the CW oscillator printed circuit board (refer to figure 5-2).

d. PUSH-TO-TALK. - Connect a push-to-talk switching device between ground and terminal 8 of TB1500.

e. KEY LINE. - Terminals 11 and 12 of terminal board TB1500 are provided for the attachment of a dry-keying device.

#### NOTE

An audio signal is used in the TTR-10 keying system. The keying line should be kept as short as possible, preferably under 50 feet.

#### f. REMOTE SIDEBAND CONTROL.

(1) TRANSMIT. - Connect a USB/LSB switching device (any SPST switch) between ground and terminal 10 of TB1500.

(2) RECEIVE. - Connect a USB/LSB switching device (SPST switch) between ground and terminal 10 of TB1501.

#### NOTE

Remote sideband control of both the transmit and receive section is possible from one SPST switching device. A similar switching arrangement is used in the TPC Remote Control Unit.

g. 600-OHM AUDIO OUTPUT. - Connect a 600-ohm audio load between terminals 1 and 3 of terminal block TB1501. If the load (telephone line, speaker, frequency shift converter, etc.) is balanced, ground should be connected to terminal 2.

h. 4-OHM AUDIO OUTPUT. - Remove the jumper between terminals 8 and 9 of terminal board TB1501; this disables the internal speaker. Connect a 4-ohm audio load between ground and terminal 8 of TB1501.

i. LOW-LEVEL AUDIO OUTPUT (HEADSET OR EARPIECE MONITORING DEVICE). - Connect the headset or earpiece (or other low-level monitoring device) between ground and terminal 12 of terminal board TB1500.

j. REMOTE XMTR ON/OFF CONTROL. - Connect a switching device between ground and terminal 9 of TB1500. Ground at terminal 9 energizes the high-voltage control relay in the power supply.

k. SQUELCH ALARM. - Terminals 4, 5, and 6 of TB1501 are provided for attachment of a squelch-indicating device. For an alarm indication when the receiver is squelched, make connections between terminals 4 and 5. For alarm indications when the receiver is not squelched, make connections between terminals 5 and 6.

#### 2-5. PERFORMANCE CHECK.

Immediately after the TTR-10 has been installed, it should be checked for proper operation as follows.

a. RECEIVER SECTION. - The receiver section is checked by attempting to receive signals on each of the four channels; LSB and USB reception should also be checked. When signals are received, the operation of the VOLUME and SQUELCH controls should be checked.

#### b. TRANSMITTER SECTION. -

#### NOTE

For the following tests, a 50 ohm 100 watt dummy load should be connected to the ANTENNA jack.

(1) Select the AME, -20DB CARRIER, or SSB mode, and check voice mode operation using all possible audio inputs. The EoRF scale of the front-panel meter can be used to indicate that the signal is present at the antenna output. The channel used is not important in this test. Check the XMTR AF GAIN control for proper operation as indicated by a variation in the meter reading.

(2) Repeat step (1) for each of two modes not selected in step (1) using any one of the audio inputs.

(3) Repeat step (1) for both upper and lower sideband operation.

(4) Check operation as in step (1) with an external key in both the CW and MCW modes.

(5) Check operation as in step (1) for each of the four channels on both the F1 and F2 frequencies.

(6) Check the VOX circuit as follows.

(a) Set PTT/VOX switch at VOX.

(b) Turn VOX GAIN control fully counterclockwise.

(c) Turn ANTI-VOX control fully counterclockwise.

(d) Select the AME, -20 DB CARRIER, or SSB mode.

(e) Apply the normal audio input; XMTR AF GAIN must be set for normal operation.

(f) Rotate the VOX GAIN control slowly clockwise. A point should be reached where a click will be heard, which is the transmit/receive relay energizing.

#### NOTE

Be sure to set the VOX GAIN and ANTI-VOX controls according to the applicable operating procedure given in section 3 before using the TTR-10 for transmitting.

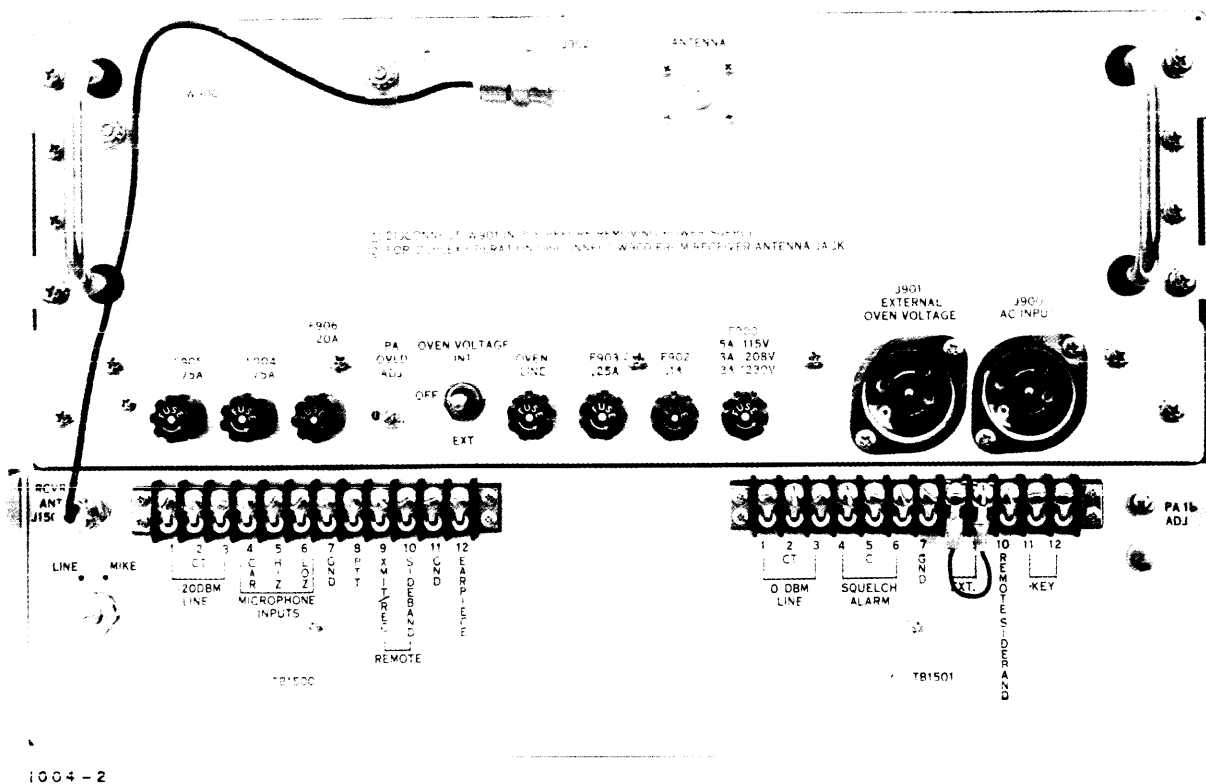


Figure 2-1. Rear Panel, TTR-10

## SECTION 3 OPERATOR'S SECTION

### 3-1. CONTROLS AND INDICATORS.

Before attempting to operate the TTR-10, the operator should become familiar with the controls and indicators listed in table 3-1. These are shown in figure 3-1. The type and purpose of each control is described in the table. It is important to stress that these descriptions are not operating instructions.

For Specific operating instructions, see paragraph 3-2.

#### NOTE

Operating instructions for the TTRR and TTRT modules are included in this section as part of the overall operating procedure for the TTR-10.

TABLE 3-1. CONTROLS AND INDICATORS

ITEM (See fig. 3-1)	DESIGNATION	FUNCTION
1	VOLUME control (R1515)	Controls the loudspeaker and ear-piece audio output of the receiver.
2	ANTI-VOX control (R1517)	Adjusts the anti-vox input to the transmitter from the receiver. The anti-vox circuits prevents receiver audio output from actuating the VOX circuit.
3	PA METER switch (S1511)	Permits the front panel meter (Item 15) to indicate power amplifier tube grid r-f voltage, power amplifier tube plate current, or transmitter output r-f voltage.
4	RCVR switch (S1503)	A two-position rotary switch that selects reception of either LSB or USB signals. When the RCVR switch is set at USB/REMOTE, either LSB or USB reception can be selected remotely.
5	SIMPLEX/DUPLEX switch (S1506)	When set at SIMPLEX, the receiver section of the TTR-10 is disabled when the transmitter is keyed; when set at DUPLEX, the receiver can operate even though the transmitter is keyed.
6	SQUELCH control (R1518)	Selects the r-f input level required to enable the speaker, earpiece, and anti-vox outputs of the receiver.
7	POWER lamp (DS1500)	Lights when primary power is applied to the low voltage power supply.
8	Mode switch (S1505)	Selects mode of operation of the transmitter. Operation in the CW, SSB (suppressed carrier), -20 DB (SSB with reduced carrier), AME, or MCW mode can be selected.

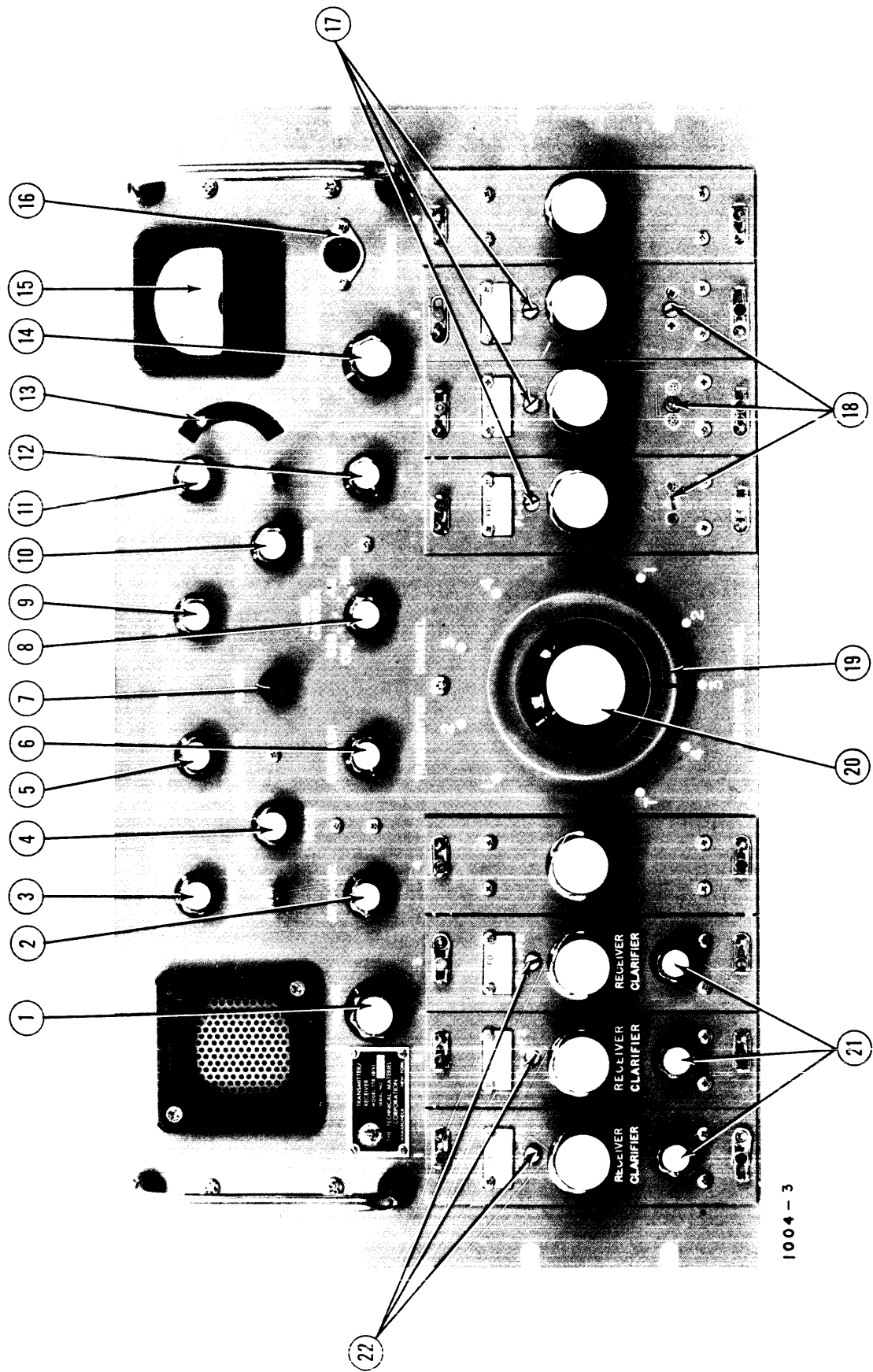


Figure 3-1. Front Panel Controls and Indicators, TTR-10

TABLE 3-1. CONTROLS AND INDICATORS (CONT)

ITEM (See fig. 3-1)	DESIGNATION	FUNCTION
9	PTT/VOX switch (S1501)	Selects either voice-actuated, or push-to-talk keying of the transmitter.
10	XMTR switch (S1502)	Selects either upper sideband or lower sideband transmission; when set at USB/REMOTE, the sideband to be transmitted may be selected at a remote location.
11	XMTR AF GAIN control (R1514)	Adjusts the gain of the audio amplifier stage of the transmitter.
12	VOX-GAIN control (R1513)	Selects audio level required to key transmitter when PTT/VOX switch (Item 5) is set at VOX.
13	PA OVLD circuit breaker (CB1500)	Controls application of power to the linear-amplifier stages; removes power to these stages when power-amplifier tube plate current is excessive.
14	OFF-REC-XMIT/ REC switch (S1500)	When set at OFF, removes power from all TTR-10 circuits except TTRR and TTRT ovens; when set at REC, turns on low voltage power supply, permits remote transmitter ON/OFF control; when set at XMIT/REC, turns on low voltage power supply and, in conjunction with PA OVLD circuit breaker (item 13), linear amplifier operating power.
15	Front panel meter (M1500)	Indicates power-amplifier tube grid r-f voltage, power amplifier tube plate current, or transmitter output r-f voltage as selected by PA METER switch (item 3).
16	HANDSET jack (J1515)	Permits connection of handset.
17	F1/F2 switch (one on each TTRT module)	A screwdriver controlled rotary switch that selects frequency of transmission in conjunction with TRANSMITTER CHANNEL switch (item 20). F1 and F2 frequencies on a particular module must be within a 0.5% bandpass.
18	(none, one on each TTRT module)	A screwdriver controlled trimmer capacitor that permits fine adjustment of transmitter output frequency.
19	RECEIVER CHANNEL switch (S1507)	Selects frequency of reception in conjunction with F1/F2 switch (item 22); when set at T, TRANSMITTER CHANNEL switch (item 20) selects frequency of reception.

TABLE 3-1. CONTROLS AND INDICATORS (CONT)

ITEM (See fig. 3-1)	DESIGNATION	FUNCTION
20	TRANSMITTER CHANNEL switch (S1508)	Selects frequency of transmission in conjunction with F1/F2 switch (item 17); selects frequency of reception when RECEIVER CHANNEL switch (item 19) is set at T.
21	RECEIVER CLARIFIER control (one on each TTRR module)	Permits fine tuning of receiver.
22	F1/F2 switch (one on each TTRR module)	Selects frequency of reception in conjunction with RECEIVER CHANNEL switch (item 19) or TRANSMITTER CHANNEL switch (item 20). F1 and F2 frequencies on a particular module must be within a 0.5% bandpass.
	MIKE/LINE switch (on rear of unit) (S1504)	When set at MIKE, clipper circuit of transmitter stage is operative; clipper circuit limits high modulation peaks permitting higher average output power for voice transmission.
	OVEN VOLTAGE switch (on rear of power supply module)	When set at EXTERNAL, oven heaters of TTRR and TTRT modules are connected to EXTERNAL OVEN VOLTAGE jack; when set at INTERNAL, oven heaters of TTRR and TTRT modules are connected to same primary power source as remainder of TTR-10.

3-2. OPERATING PROCEDURES.

NOTE

Almost all operating controls are protected by a control cover (see figure 1-1). To remove this cover, slide both catches up and lift off the cover. To prevent inadvertent changing of control settings, it is good practice to keep the cover on at all times except when adjusting the controls.

a. RECEIVING.

(1) TYPES OF RECEPTION. - The TTR-10 can receive AME, CW, FSK, MCW, and SSB signals and also one sideband of AM and ISB transmission. All of the above signals are received as if they were SSB transmissions. Procedures for receiving each of the signals are given in the following paragraphs.

(2) VOICE RECEPTION. - The following procedures describe the reception of voice signals that are transmitted as AME or SSB. It is possible also to receive one sideband of AM or ISB transmission using the same method.

(a) Set controls at positions given below.

<u>CONTROL</u>	<u>SETTING</u>
RCVR switch	Sideband to be received. If the sideband to be received is not known, set at USB/REMOTE. If the sideband is to be selected remotely, set at USB/REMOTE.
F1/F2 switch	At appropriate position to receive incoming signal.
RECEIVER CLARIFIER control	Any

<u>CONTROL</u>	<u>SETTING</u>
VOLUME control	Fully counterclockwise.
RECEIVER CHANNEL switch	Channel to be received unless position is desired so that the channel will be selected by the TRANSMITTER CHANNEL SWITCH.
SQUELCH control	Fully clockwise.
Power switch	REC or XMIT/REC depending upon type of operation desired.

(b) Turn VOLUME control clockwise until comfortable signal level is obtained.

NOTE

If no signal is obtained, reduce the volume and set RCVR switch at LSB. Repeat step (b).

(c) Adjust RECEIVER CLARIFIER control for maximum voice clarity.

(d) Adjust SQUELCH control by waiting until no signal is being received, and then turning the control slowly counterclockwise until the noise from the speaker disappears.

(3) CW AND MCW RECEPTION. - CW and MCW signals are received in exactly the same manner as voice signals (paragraph (2)). For these signals, however, the RECEIVER CLARIFIER control is used to vary the pitch of the audio tone.

NOTE

In CW operation, the receiver channel frequency (F1 or F2) must be displaced slightly (300- to 3300-cps) from the transmitted signal.

(4) FAX RECEPTION. - In receiving facsimile, the setting of the RECEIVER CLARIFIER control is critical. Proceed as follows:

(a) Turn receiver on and set controls at positions given below.

<u>CONTROL</u>	<u>SETTING</u>
RCVR switch	Sideband to be received. If sideband to be received is not known, set at USB/REMOTE. If the sideband is to be selected remotely, set at USB/REMOTE.
F1/F2 switch	At appropriate position to receive incoming signal.
RECEIVER CLARIFIER control	Any
VOLUME control	Fully counterclockwise.

<u>CONTROL</u>	<u>SETTING</u>
RECEIVER CHANNEL switch	Channel to be received unless position is desired so that the channel will be selected by the TRANSMITTER CHANNEL SWITCH.
SQUELCH control	Fully clockwise.
Power switch	REC or XMIT/REC depending upon type of operation desired.

(b) Turn VOLUME control clockwise until comfortable signal level is obtained.

NOTE

If no signal is obtained, reduce the volume and set RCVR switch at LSB. Repeat step (b).

(c) Connect 600-ohm line output of receiver to vertical input of an oscilloscope.

(d) Connect an audio oscillator to horizontal input of oscilloscope.

(e) Set oscillator frequency at 1500 cps.

(f) Adjust RECEIVER CLARIFIER control to obtain an unsteady, but circular (1:1) Lissajous pattern. This corresponds to the white or black areas of the picture, depending upon positive or negative reception.

NOTE

A similar pattern, corresponding to the other limit of shift of the picture, will be obtained if the oscillator frequency is set at 2300 cps.

(5) FSK RECEPTION. - In receiving frequency shift signals, the setting of the RECEIVER CLARIFIER control is critical. The procedure given below is one method of tuning the receiver for FSK reception. Most FSK converters have built-in indicating devices that allow accurate receiver tuning without the necessity for an external scope and oscillator.

(a) Turn receiver on and set controls at position given below.

<u>CONTROL</u>	<u>SETTING</u>
RCVR switch	Sideband to be received. If the sideband to be received is not known, set at USB/REMOTE. If the sideband is to be selected remotely, set at USB/REMOTE.
F1/F2 switch	At appropriate position to receive incoming signal.



CONTROL  
RECEIVER  
CLARIFIER  
control

SETTING  
Any

(e) Adjust RECEIVER CLARIFIER control to obtain an intermittent, but circular (1:1) Lissajous pattern. This corresponds to a mark.

- (b) Connect 600-ohm line output of receiver to vertical input of an oscilloscope.
- (c) Connect an audio oscillator to horizontal input of oscilloscope.
- (d) Set oscillator frequency at the mark frequency. This frequency is generally 2125 cps, but another is sometimes specified.

NOTE

A similar pattern can be obtained if the oscillator is set at the space frequency (generally 2975 cps).

- b. TRANSMITTING. - Proceed as follows:
  - (1) Set controls as shown in table 3-2.

TABLE 3-2. TRANSMITTER CONTROL SETTINGS

ITEM NO. (FIG. 3-1)	PANEL DESIGNATION	POSITION
15	TRANSMITTER CHANNEL switch	To correspond with TTRT that includes desired operating frequency.
5, 6, 7, or 8	F1/F2 switch	To correspond with desired operating frequency.
		NOTE
		For CW operation, the transmitted signal is displaced 1 kc from the F1 or F2 frequency. Direction of displacement is dependent upon the setting of the XMTR switch.
28	SIMPLEX/DUPLEX switch	To select type of operation desired.
31	CW/SSB/-20DB CARRIER/ AM/MCW switch	To select mode of operation desired.
32	XMTR switch	At LSB for locally controlled lower sideband operation; at USB REMOTE for locally controlled upper sideband operation or remote sideband control.
24	ANTI-VOX control	Maximum counterclockwise.
34	VOX-GAIN control	Maximum counterclockwise.
33	XMTR AF GAIN control	Maximum counterclockwise.
25	PA METER switch	Up
1	PA OVLD circuit breaker	Down.

#### NOTE

If audio clipping is desired, the MIKE/LINE switch on the rear of the TTR-10 should be set at MIKE. Audio clipping should not be employed for CW, MCW, FSK, or FAX transmissions.

(2) Set OFF/REC/XMIT/REC switch (3) at REC/XMIT.

(3) Set PTT/VOX switch (30) at PTT.

#### NOTE

If the microphone or other audio source does not have a push-to-talk switch, terminal 8 on TBI500 must be grounded. If this terminal has been permanently grounded, do not leave the PTT-VOX switch at its PTT position for more than a few minutes.

(4) Depress push-to-talk switch on microphone, and supply audio signal to the transmitter. For CW or MCW operation, close telegraph key.

(5) Adjust XMTR AF GAIN control (33) until meter (2) indicates 125 ma on peaks.

(6) If VOX operation (voice operated excitation) is desired, set PTT/VOX switch (30) at VOX, and adjust VOX-GAIN control (34) until transmitter is turned on when audio is applied.

#### NOTE

If audio from the loudspeaker actuates the VOX circuit, rotate ANTI-VOX control clockwise until transmitter is unkeyed when no external audio is applied.

(7) If remote transmitter on/off control is desired, set OFF-REC-XMIT/REC switch at REC.

### 3-3. CHANGING PLUG-IN MODULES.

#### a. CHANGING TTRR AND TTRT MODULES

#### NOTE

When a change in a TTRT module results in a change in the frequency band, the corresponding TTRA module must also be changed (refer to paragraph b).

#### CAUTION

Be sure to deenergize the unit before changing TTRT modules.

Serious damage to the modules can result if the unit is not deenergized.

(1) Deenergize TTR-10.

(2) Loosen snapslides located on top and bottom of module to release module (snapslides on TTRR slide to left; snapslides on TTRT slide to right).

(3) Pull module out of unit. A knob is provided in the center of the module for this purpose.

#### CAUTION

Before continuing, be sure that the voltage rating of the crystal oven (if used) in the module to be inserted is the same as the voltage rating for the crystal oven in the module just removed.

(4) Insert new module.

(5) Secure snapslides to lock module in place.

(b). CHANGING TTRA MODULES. - Each time a TTRT module is changed in one of the channels of the transmitter section, the TTRA module for that channel must also be changed unless the new TTRT module covers the same frequency band as the TTRT module it replaces. If the frequency band covered changes, a different model of TTRA module must be selected.

#### NOTE

In any case, the linear amplifier of the transmitter section must be aligned for the new frequency according to paragraph 5-7 c.

The following are the bands covered by each model of TTRA module.

TTRA-1: Band 1 (2-4 mc)

TTRA-2: Band 2 (4-8 mc)

TTRA-3: Band 3 (8-16 mc)

TTRA-4: Band 4 (16-32 mc)

To change a TTRA module, refer to figure 5-4 and proceed as follows:

(1) Deenergize the TTR-10.

#### WARNING

Dangerously high voltage is present near the TTRA modules whenever the transmitter section is energized. Be sure to

deenergize the unit and use a grounding stick before proceeding.

(2) Lift module out of unit using the two knurled knobs on module for handles.

(3) Carefully insert new module.

(4) Align linear amplifier in transmitter section for new TTRA module according to paragraph 5-7c.

## SECTION 4

### PRINCIPLES OF OPERATION

#### 4-1. GENERAL.

The TTR-10 comprises 5 major assemblies: main chassis assembly, linear amplifier, receiver converter module (TTRR), transmitter converter (TTRT), and power supply (TPS( )-1). Circuit analysis given in this section for the TTRR, TTRT, and TPS( )-1 modules is limited to inputs, outputs, and generalized information. Detailed circuit analysis for any of these units can be found in the appropriate TTRR, TTRT, or TPS( )-1 manual.

#### 4-2. RECEIVER SECTION THEORY (SEE FIGURES 4-1 AND 7-1).

a. INPUT CIRCUITS. - The rf input to the receiver section is supplied through RCVR ANT jack J1502 to the wiper of RECEIVER CHANNEL selector switch S1507. In duplex operation, this switch is used to connect the rf input to one of four TTRR plug-in rf modules, each of which is fixed-tuned to a different frequency. Thus, the TTR-10 can receive signals on any one of four frequencies (determined by the TTRR modules) as selected by S1507. Additional sections of S1507 provide operating voltages and a delayed agc voltage to the selected TTRR module.

In simplex operation, S1507 is set at T, so that the rf input is supplied to the wiper of TRANSMITTER CHANNEL selector switch S1508, which is part of the transmitter section also. Now, the TTRR module is selected by S1508. Because S1508 also selects the rf module in the transmitter section, both the transmitter and receiver frequencies are selected simultaneously. Additional sections of S1508 provide the operating voltages and the delayed agc voltage.

The operating voltages for the TTRR modules are +12V REC and -12V REC. These voltages originate in the transmitter section. (See paragraph 4-3).

b. TTRR PLUG-IN MODULES. - Each of the TTRR modules contains three rf amplifiers, a mixer and a local oscillator. The module amplifies the selected rf signal and converts it to the first i-f frequency. Figure 4-2 shows the input and the output of a TTRR module. Both sidebands are shown although only one might be received in actual practice. The bandwidth of the rf amplifiers is sufficient to pass both sidebands of a received signal (if both are present). The local oscillator is tuned 1.75 mc above the carrier frequency of the received signal. Thus, the spectrum of the received frequencies is inverted (the highest frequencies in the sideband(s) produce the lowest difference frequency) as shown in the illustration. The carrier frequency of the i-f output from a TTRR module is 1.75 mc.

c. I-F AND MIXER STAGES. - I-f amplifier Q1601 receives an i-f signal from one of the four TTRR modules as selected by either S1507 or S1508, amplifies it, and supplies the signal to mixer Q1602. The mixer is also supplied with the output of either the LSB oscillator (1.5 mc) or the USB oscillator (2.00 mc) depending upon the setting of the RCVR switch. Figure 4-2 shows the input and the two possible outputs of the mixer. If the LSB oscillator output is supplied to the mixer (250 kc below the carrier frequency of the i-f signal), the frequency spectrum of the input signal is not inverted. If the USB oscillator output is supplied to the mixer (250 kc above the carrier frequency of the i-f signal), the frequency spectrum of the input signal is inverted. Because the crystal filter passes only a band of frequencies above 250 kc, the selection of the desired sideband depends upon which oscillator output is supplied to the mixer.

LSB oscillator Q1607 and USB oscillator Q1608 are modified Colpitts oscillators. The LSB oscillator is tuned to exactly 1.5 mc by C1629. The USB oscillator is tuned to exactly 2.0 mc by C1631. The output of each oscillator is taken from its base. The position of receiver sideband relay K1501 determines which of the two oscillators supplies the mixer. If RCVR switch S1503 is at LSB, relay K1501 is energized, and +12V CONT is applied across LSB ADJ R1543. The positive voltage supplied by R1543 to the emitter of Q1607 forward biases Q1607. The USB oscillator transistor is not forward biased and is cutoff. The magnitude of the emitter voltage determines the magnitude of the oscillator output; maximum output occurs when the oscillator is biased at its maximum gain point. When S1503 is at USB/REMOTE, and no remote sideband input (from TB1501) is present, K1501 is deenergized and +12V CONT is applied across USB ADJ R1544. Thus, Q1608 is forward biased and the LSB oscillator is cutoff. If ground is supplied as a remote sideband input, K1501 is energized, and the LSB oscillator is activated. This is how the desired sideband is selected remotely.

The output of the selected oscillator is supplied to mixer Q1602 through buffer amplifier Q1609, which minimizes the loading of the oscillator. The output of this mixer, the second intermediate frequency, is supplied to crystal bandpass filter FL1601. This is a highly selective filter with a bandpass of 2.75 kc, which rejects frequencies below 250.25 kc and above 253.0 kc. Thus, only the sideband whose frequency range is above 250 kc will be passed by the filter, while all noise and signal frequencies outside of the selected sideband are eliminated. The output of the filter is supplied to two stages: detector CR1601-CR1604 and i-f amplifier Q1610 in the

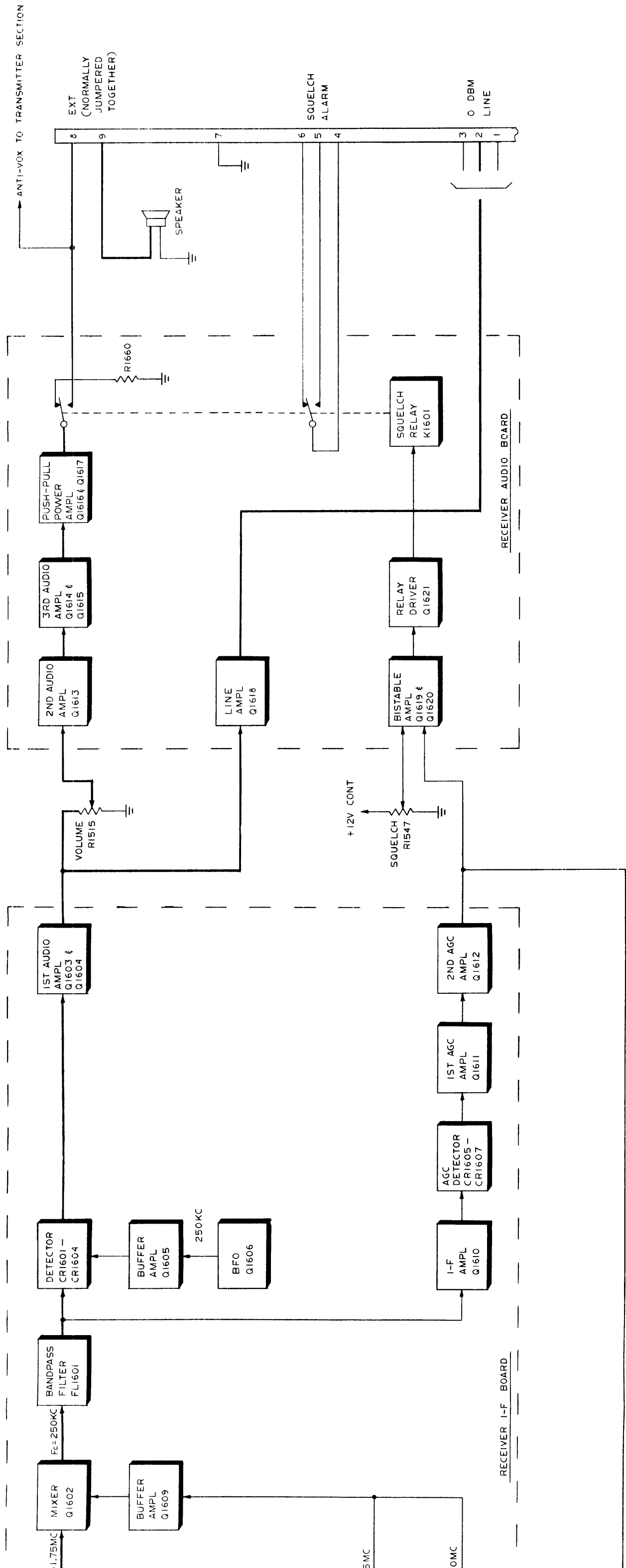
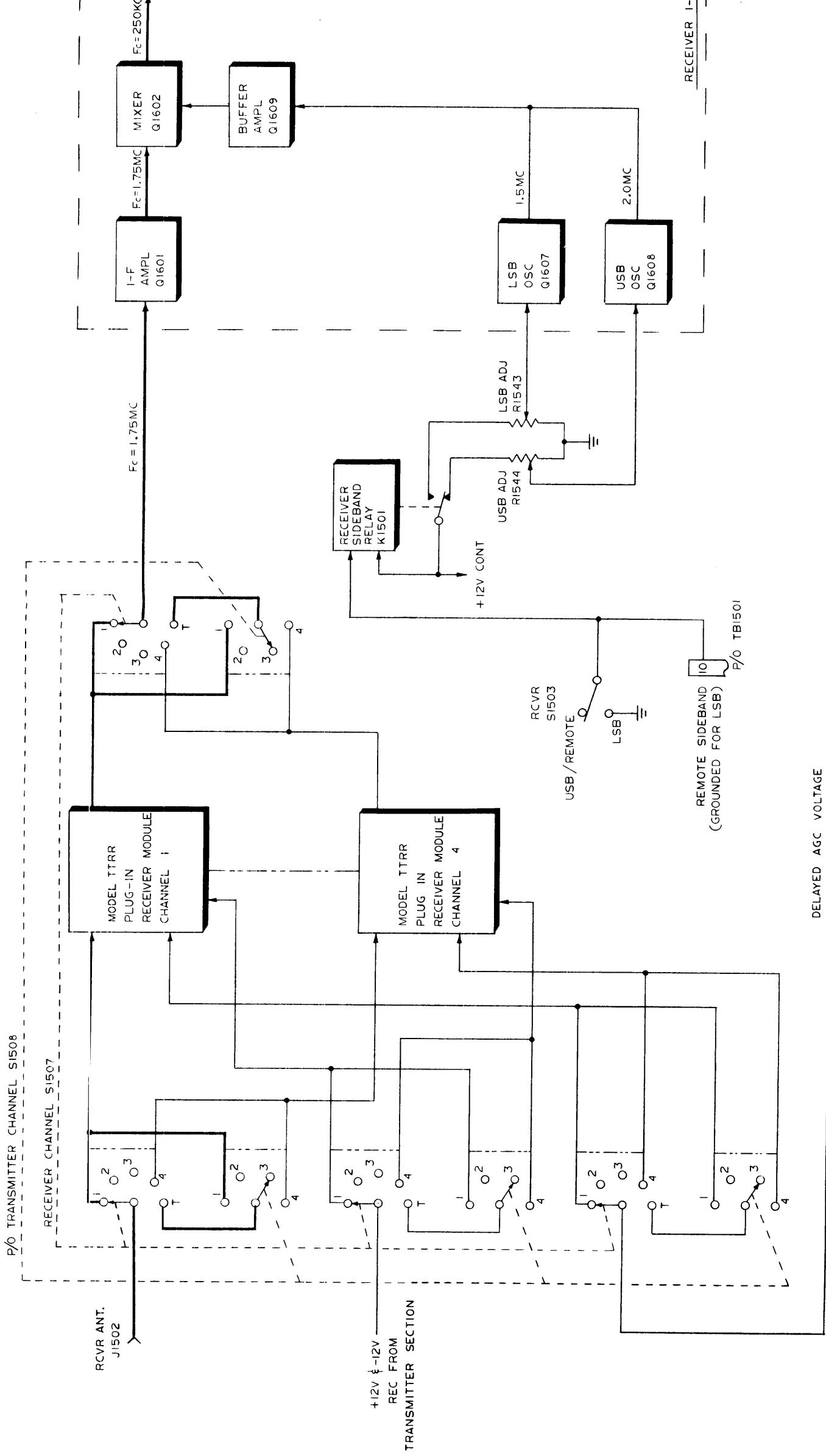
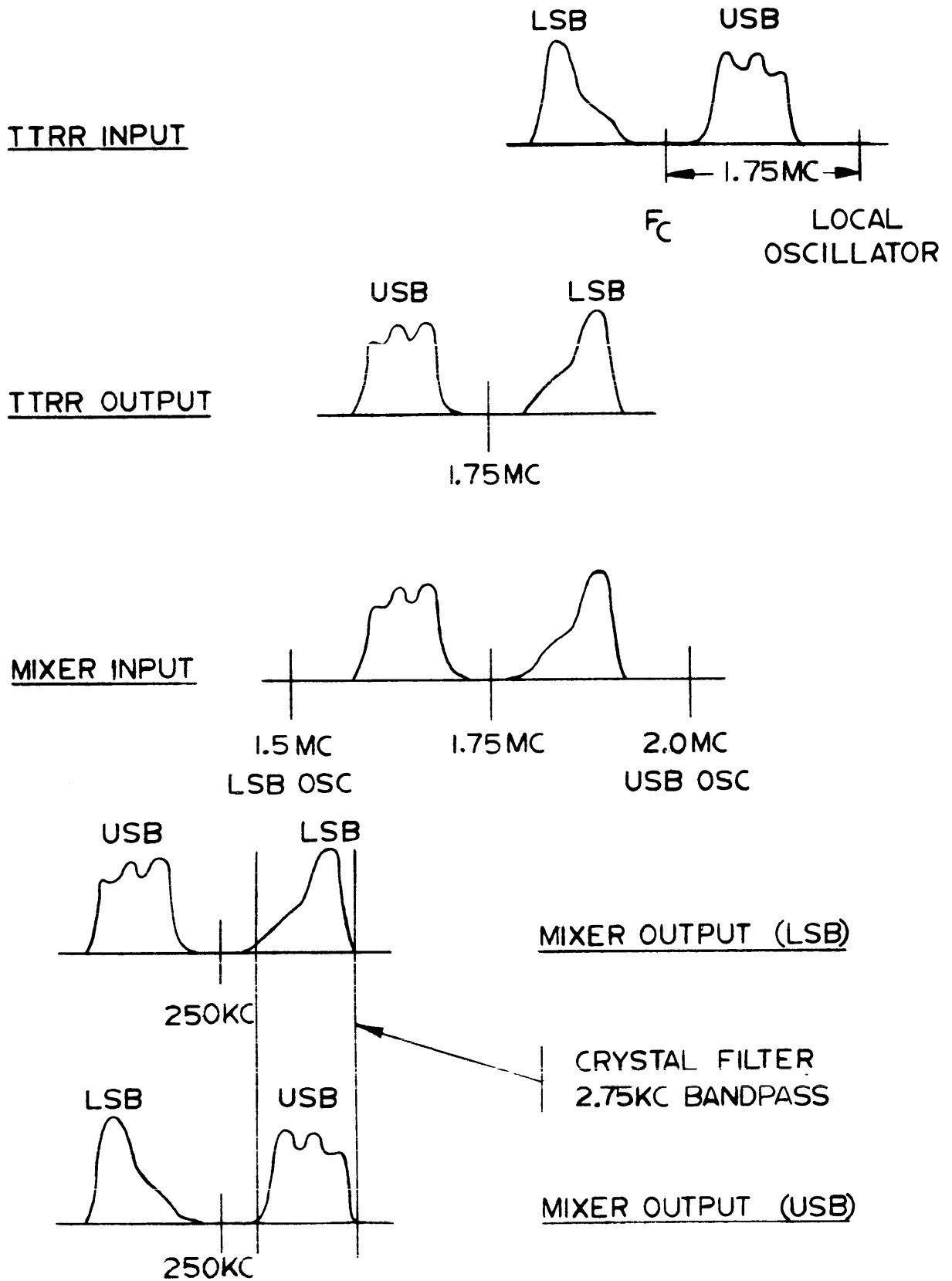


Figure 4-1. TTR-10 Receiver Section, Block Diagram

005651004



DELAYED AGC VOLTAGE



3014-6

Figure 4-2. Frequency Inversion in SSB Reception

## AGC circuit.

d. DETECTOR AND BFO. - The detector, CR1601 through CR1604, receives the selected sideband and the output of bfo (250 kc). The i-f signal and the bfo output beat together in the detector to derive the audio information from the i-f signal.

Bfo Q1606 (figure 7-1 sheet 2) is a modified Colpitts oscillator whose frequency is 250 kc. Its output is supplied through buffer amplifier Q1605 to potentiometer R1663. R1663 is adjusted so that the bfo signal is self-cancelling at the balanced output of the detector.

The bfo signal controls the switching of the diode network. For positive half-cycles of the bfo signal, CR1601 and CR1604 are forward biased and CR1602 and CR1603 are reverse biased. For negative half-cycles of the bfo signal, CR1601 and CR1604 are reverse biased and CR1602 and CR1603 are forward biased. The balanced i-f signal from FL1601 is supplied to the detector through C1610 and C1611. The amplitude of the i-f signal is small compared to the bfo signal so that the bfo signal so that the bfo signal does not lose control of the diode switching.

Figure 4-3 shows idealized waveforms for the detector. For this illustration, the i-f signal is a constant frequency in the passband of the filter. Assume that the output shown is taken across R1608 and the i-f input is applied at the anode of CR1601 and the cathode of CR1603. When the i-f and bfo signals are in phase (between T1 and T2), CR1601 is at maximum conduction and voltage across R1608 is at its maximum positive value. As the i-f signal begins to lead the bfo signal (between T2 and T7), CR1601 conducts less and CR1602 begins to conduct more. When the i-f and bfo signal are 180° out of phase (between T7 and T8), CR1602 is at its maximum conduction, and voltage across R1608 is at its maximum negative value. As the bfo signal begins to lead the i-f signal (between T8 and T14), CR1602 conducts less and CR1601 begins to conduct more. Between T14 and T15, the i-f and bfo signals are again in phase.

Since the i-f signal at the anode of CR1604 is 180° out of phase with the i-f signal at the anode of CR1601, the output across R1609 will always be a mirror image of the output across R1608.

Capacitors C1613 and C1614 remove the i-f and any residual bfo components from the detector output. The output of the detector is supplied to the first audio amplifier.

e. AUDIO AMPLIFIERS. - First audio amplifier Q1603 and Q1604 converts the balanced input from the detector to a single-ended signal, and amplifies it. This signal is developed across VOLUME control R1515, and is also supplied to line amplifier Q1618. The line amplifier supplies the balanced 600-ohm line output. The signal level determined by the setting of the VOLUME control is further amplified by second audio amplifier Q1613, third audio amplifier Q1614 and Q1615, and push-pull audio power amplifier Q1616 and Q1617. The third audio amplifier is a differential

amplifier that converts the single-ended signal to a balanced signal for the push-pull amplifier. The output of the push-pull amplifier is supplied through a contact of squelch relay K1601 (when K1601 is energized) to terminal 9 of TB1501 and to the transmitter section as anti-vox input. Terminals 8 and 9 of TB1501 are normally jumpered together so that the speaker of the TTR-10 is connected. If an external speaker is used, the jumper is removed and the speaker is connected between terminals 9 and 7 of TB1501. The anti-vox output is used in the transmitter section to prevent the speaker output from keying the transmitter.

f. AGC AND SQUELCH CIRCUITS. - I-f amplifier Q1610 amplifies the output of crystal filter FL1601. Agc detector CR1605-CR1609 produces a delayed dc agc voltage, which is supplied through first and second agc amplifiers Q1611 and Q1612 to the TTRR module and to the squelch circuit.

Bistable amplifier Q1619 and Q1620 controls relay driver Q1621, which controls squelch relay K1601. When a signal is being received, the bistable amplifier is held in its unsquelched state by the agc voltage and the relay driver is on. When the signal level decreases, the agc voltage drops. At a point selected by SQUELCH control R1547, the bistable amplifier changes to its squelched state and the relay driver turns off.

When the relay driver is on, K1601 is energized, and the output of the audio power amplifier is connected to the speaker terminal and anti-vox circuit. When the relay driver is off, K1601 is deenergized, and the output of the audio-power amplifier is disconnected from the speaker terminal and anti-vox circuit, and is connected instead to dummy load R1660. Thus, the receiver output is muted when a received signal is not present and only noise is being generated by the receiver. The other set of contacts of K1601 can be used to provide squelched and non-squelched indications for external alarm circuitry.

g. POWER SUPPLY. - The operating voltages for the receiver section of the TTR-10 are provided by a power supply module, which also supplies operating voltages for the transmitter section. Operating voltages for the receiver section are +12 V and -12 V. The TTRR modules operate with +12 V REC and -12 V REC. These voltages are always present in duplex operation, but are only present in simplex operation when the transmitter is not keyed. The receiver i-f board is also supplied with the same voltages. The receiver audio board is supplied with +12 V CONT and -12 V CONT, which are present continuously whenever TTR-10 is energized.

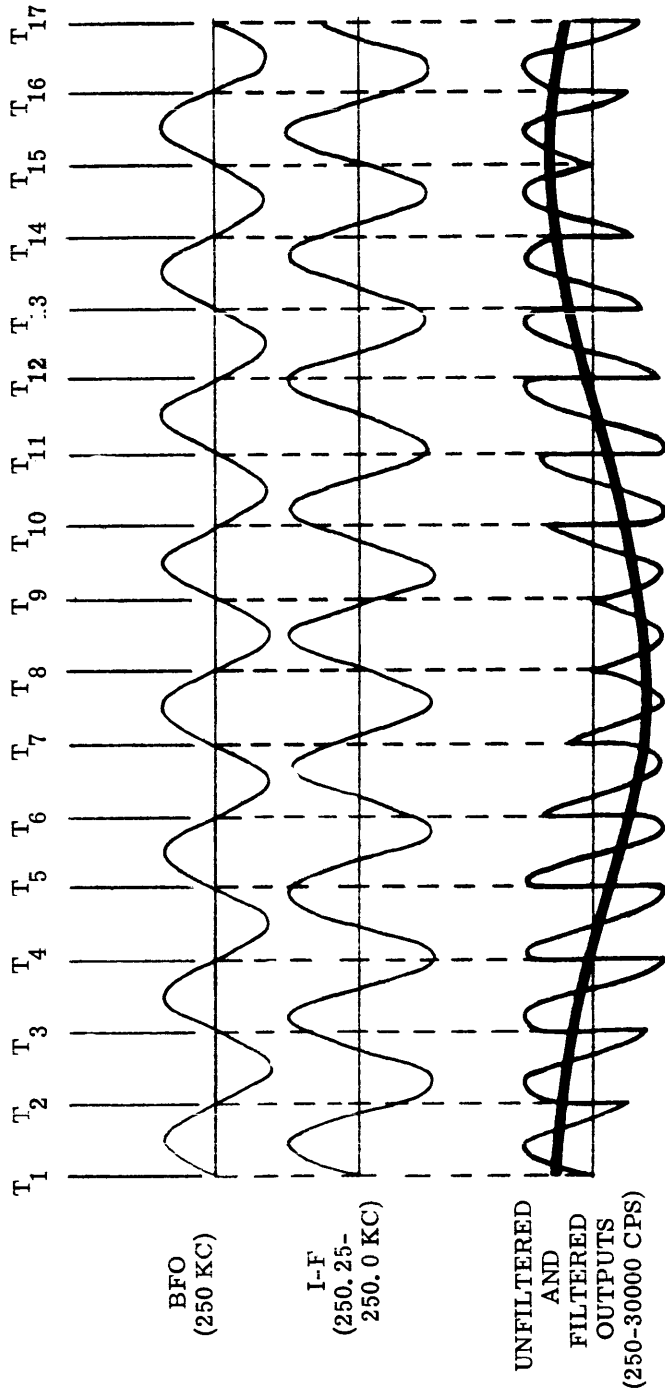
## 4-3. TRANSMITTER SECTION THEORY (SEE FIGURES 4-4 AND 7-1)

a. GENERAL. - The TTR-10 transmitter is a



NOTES

- 1. THE I-F SIGNAL HAS BEEN ENLARGED FOR CLARITY.
- 2. ONLY ONE HALF OF THE OUTPUT IS SHOWN.



3014-7

Figure 4-3. Demodulator, Idealized Forms

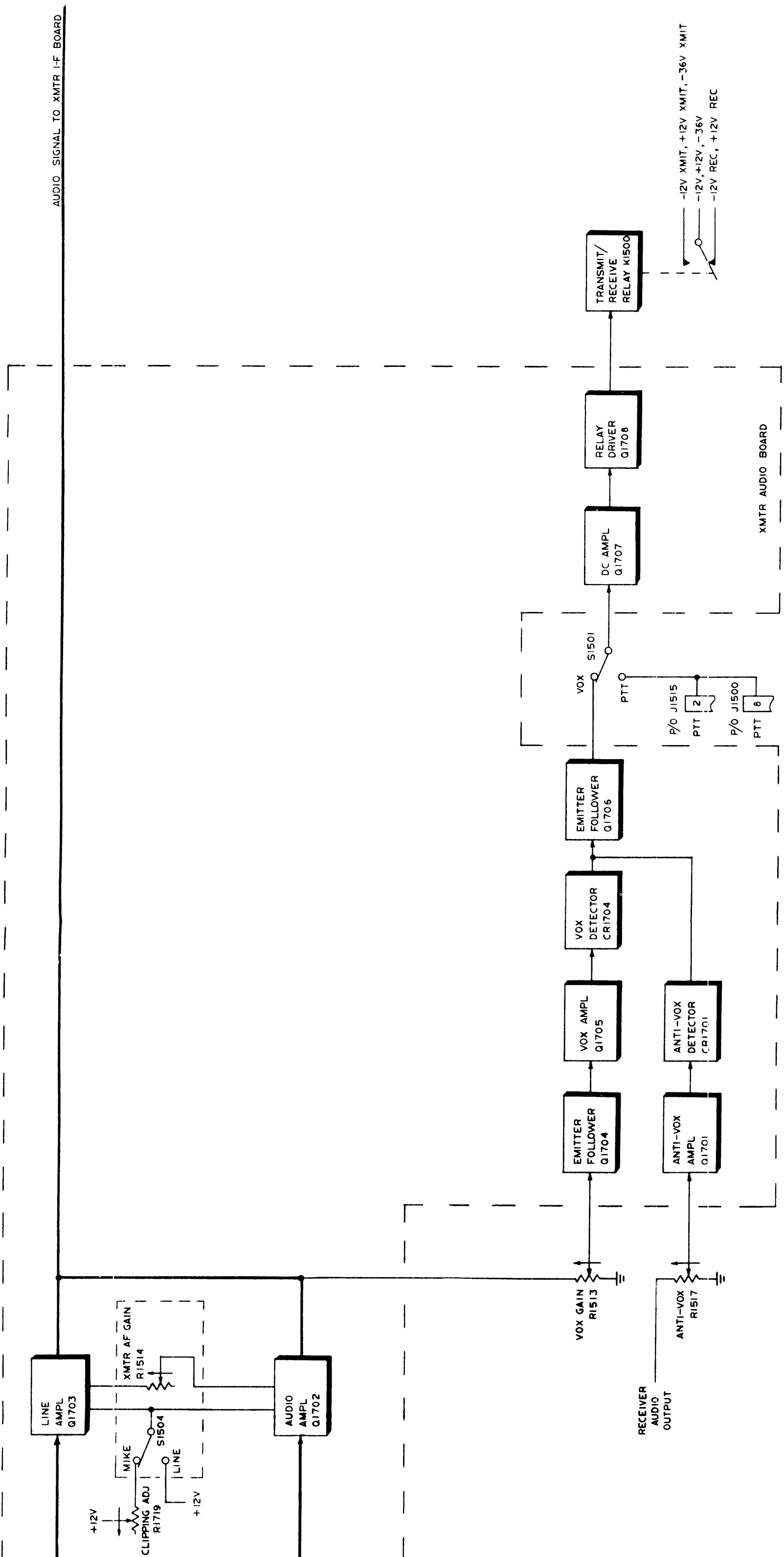
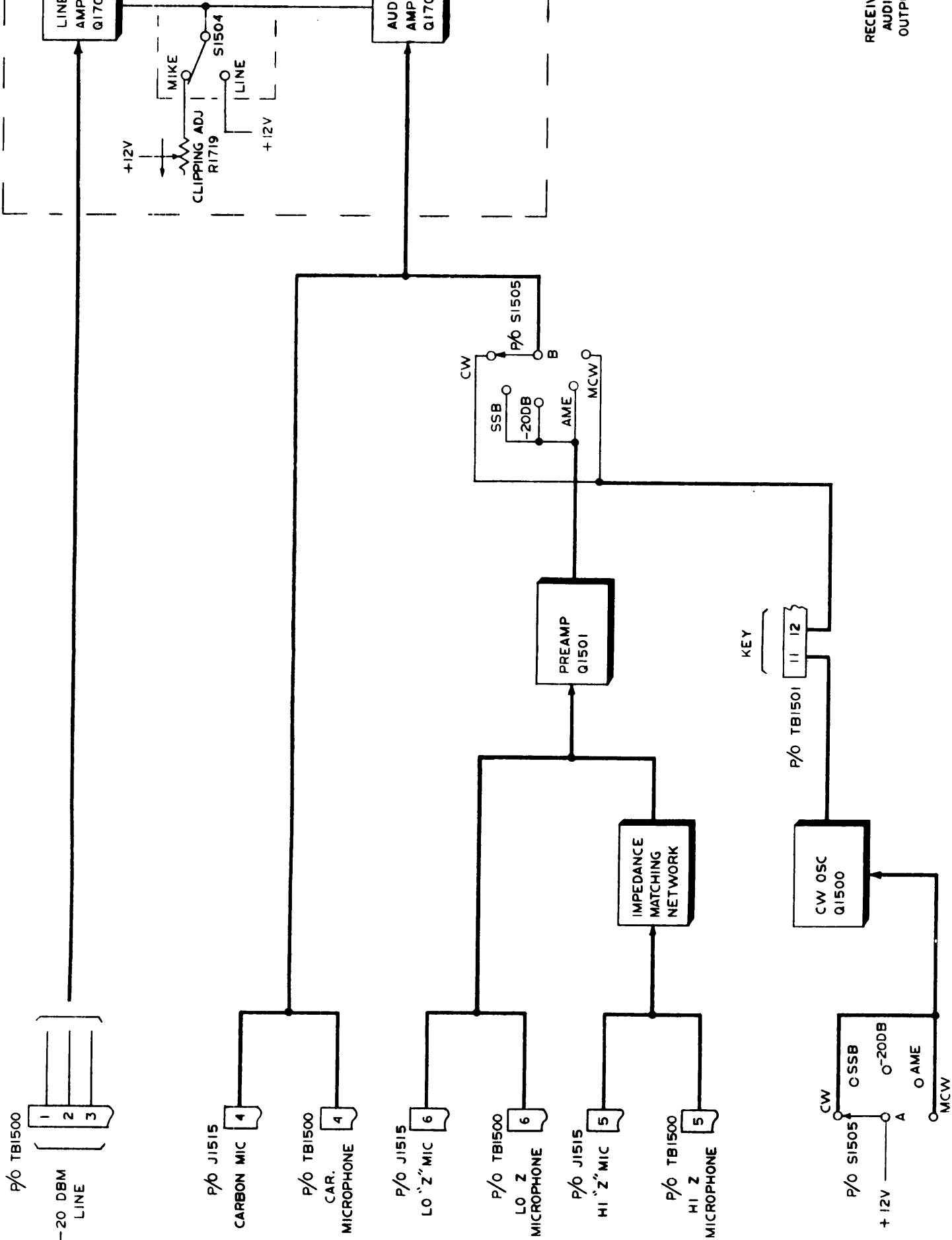


Figure 4-4. TTR-10 Transmitter Section, Block Diagram (Sheet 1 of 2)

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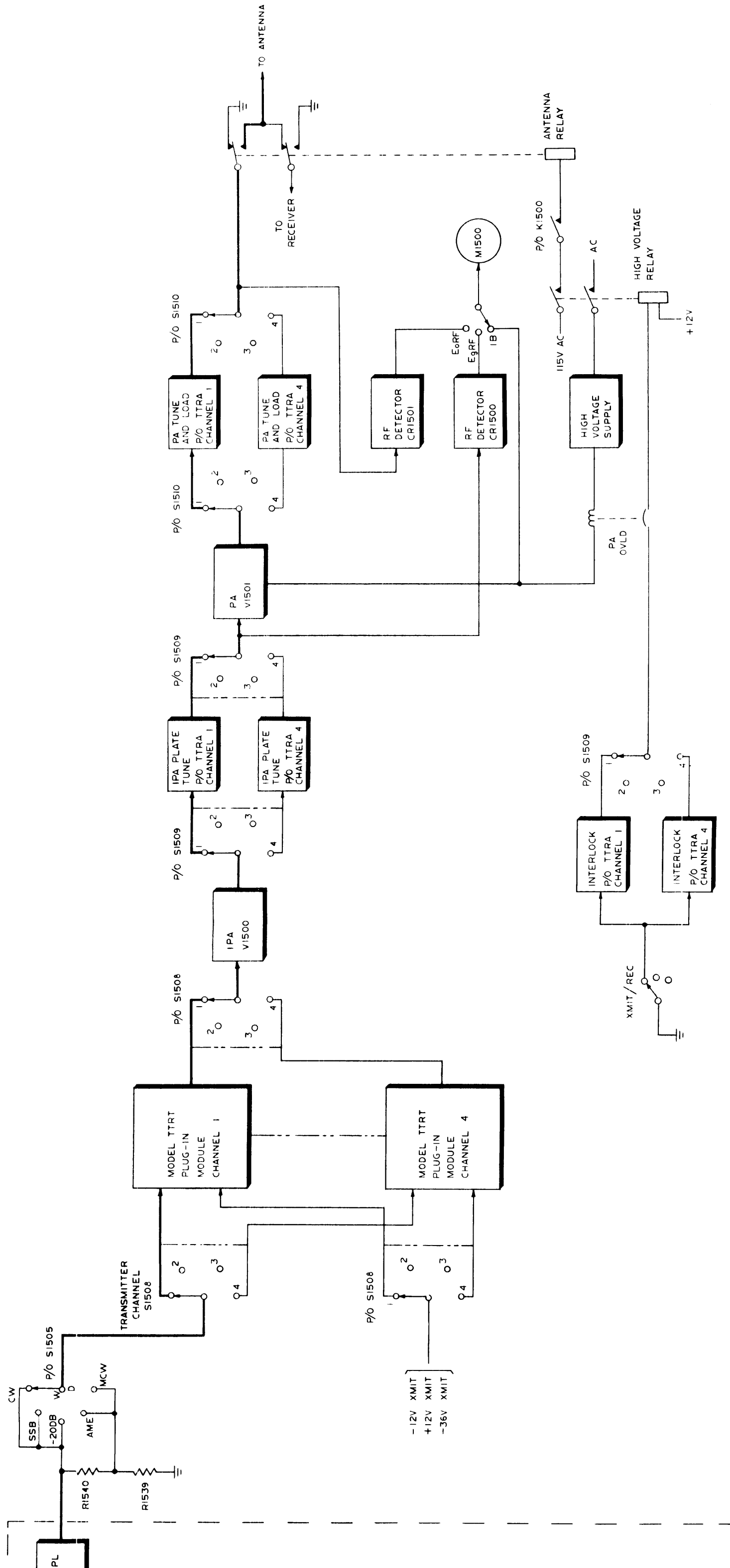
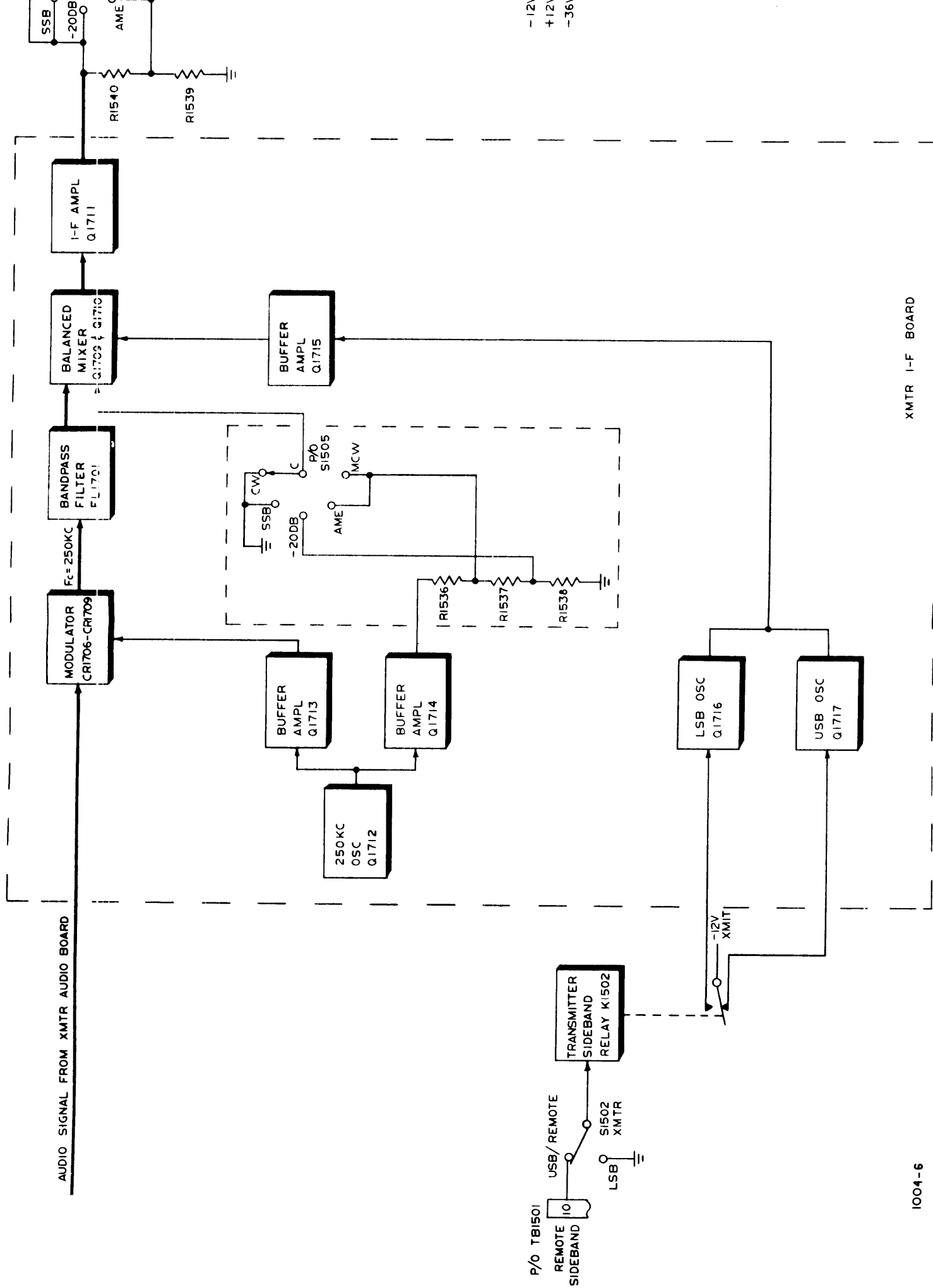


Figure 4-4. TTR-10 Transmitter Section, Block Diagram (Sheet 2 of 2)



single sideband instrument, and is designed to transmit AME, CW, FAX, FSK, MCW and SSB.

The transmitter section consisted of a completely transistorized superheterodyne exciter and a vacuum-tube linear amplifier. It also includes four model TTRA amplifier tuning modules for switch selected tuning of the linear amplifier. The exciter is described in paragraphs b. through g., the linear amplifier in paragraph h., the TTRA modules in i., the power supply and overload protection circuits in j., and antenna switching for simplex and duplex operation in k. A meter circuit for tuning the linear amplifier is described in paragraph l.

b. INPUT CIRCUITS. - The audio signal for the exciter can be provided from any one of the following sources: carbon microphoned, low-impedance microphone, high-impedance microphone, 600-ohm line, or internal CW oscillator. Any of the microphones can be wired to TB1502 or be incorporated in a handset plugged into J1515.

The carbon microphone and 600-ohm line inputs are supplied directly to the audio stages. The low-impedance and high-impedance microphone inputs are supplied to preamplifier Q1501 whose output is supplied to the audio stages through section B of S1505 in the SSB, -20DB, and AME modes. The audio tone for CW and MCW is supplied by CW oscillator Q1500, a phase-shift oscillator energized in the CW and MCW modes by +12V CONT from section A of S1505. The output of the CW oscillator is supplied through an external key (connected to TB1501) and section B of S1505 in the CW and MCW modes to the audio stages.

c. AUDIO STAGE. - Transistors Q1702 and Q1703 are connected as a push-pull amplifier and phase inverter whose gain is determined by the setting of XMTR AF GAIN control R1514. The output to this stage can be supplied to either transistor as shown. LINE/MIKE switch S1504 permits the insertion of a compression circuit, described below, that prevents abnormally high inputs from overmodulating the exciter. By flattening the sharp peaks of the input signal, the compression circuit permits increasing the average sideband power generated. The output of the differential amplifier is supplied to the modulator and to the VOX stages.

With S1504 set at LINE, +12V CONT is supplied directly to the emitter resistor of both transistors W1702 and Q1703. The emitter resistors establish an operating point for each transistor that is in the center of the transfer curve for each transistor. Thus, provided the input signal does not overdrive the stage, the amplification of the stage is linear. With S1504 set at MIKE, +12V CONT is supplied through CLIPPING ADJ R1719 to the emitter resistors of both transistors. The additional resistance shifts each operating point down the transfer curve towards the cutoff region. The amount that the operating point is shifted is determined by the clipping adjustment. The operating point is selected so that abnormally high input amplitudes and voice peaks drive the transistors into the nonlinear amplification region. As a result, these

signals are compressed. The amount of compression is determined by the setting of the clipping adjustment.

d. VOX AND ANTI-VOX STAGES. - The vox stages permit input-controlled operation of the transmitter by energizing the exciter output stages only when an audio input is present. The anti-vox stages prevent the receiver section output from keying the exciter if the output of the speaker is picked up by a microphone connected to the exciter.

The output of the audio stages is supplied to vox detector CR1704 through VOX GAIN control R1513, emitter follower Q1704, and vox amplifier Q1705. The vox detector produces a positive dc voltage that is proportional to the magnitude of the vox signal. In the CW and MCW modes, the oscillator signal produces the dc voltage. When a microphone is used, however, the dc voltage can be produced either by the signal intended for transmission, or by the output of the receiver speaker unintentionally picked up by the microphone.

To prevent the output of the speaker from keying the exciter, the output of the receiver section is supplied to the transmitter section as an anti-vox input. This signal is supplied to anti-vox detector CR1701 through ANTI-VOX control R1517, and anti-vox amplifier Q1701; the anti-vox signal can be monitored by phones connected to either J1515 or TB1500. The anti-vox detector produces a negative voltage that is proportional to the magnitude of the anti-vox signal.

The outputs of the vox and anti-vox detectors are added algebraically at the input to emitter follower Q1706. When the vox detector produces an output (positive) with no anti-vox present the output of the emitter follower is positive. When, however, the vox signal result from pick up from the speaker, and a negative anti-vox voltage is also present, the algebraic sum of the two results in a slightly negative output from the emitter follower.

When VOX/PTT switch S1501 is set at VOX, the output of the emitter follower is supplied through dc amplifier Q1707 to relay driver Q1708, which controls transmit/receive relay K1500. When the output of the emitter follower is negative, K1500 is deenergized, +12V XMIT, -12V XMIT and -36V XMIT voltages are disconnected from the exciter i-f and r-f stages, power amplifier tube V1501 is cut off, and +12V REC and -12V REC voltages are connected to the receiver r-f and i-f stages. When the output of the emitter follower goes positive, K1500 is energized, +12V XMIT, -12V XMIT, and -36V XMIT voltages are connected to the exciter i-f and r-f stages, V1501 is normally biased, and +12V REC and -12V REC voltages are disconnected from the receiver r-f and i-f stages.

#### NOTE

If SIMPLEX/DUPLEX switch S1506 is set at DUPLEX, the +12V REC and -12V REC voltages are continuously supplied to the receiver section.

In operation, the VOX GAIN control is adjusted so that the normal a microphone output or the output of the CW oscillator is sufficient to energize the transmit/receive relay. The ANTI-VOX control is then adjusted to prevent loudspeaker to microphone feedback from energizing the relay.

With S1501 is in the PTT position, the transmit/receive relay is controlled by the PTT (push-to-talk) input from either TB1502 or J1515. The relay is energized when the PTT input is grounded, and is de-energized when the PTT input is an open circuit.

e. MODULATOR AND 250 KC OSCILLATOR. - XMTR 250 KC oscillator Q1712 is a crystal-controlled modified Colpitts oscillator. Its output is supplied to two buffer amplifiers. Q1713 provides the switching signal for the modular. Q1714 provides a carrier output that can be inserted in the balanced mixer.

The modulator (Figure 7-1, sheet 8) is the diode network that includes CR1706 through CR1709 and R1736 through R1739. It receives a balanced audio input and the 250 kc input. One side of the audio input is applied at the junction of R1736 and R1737. The other is applied at the junction of R1738 and R1739. The 250 kc input is applied to the cathodes of CR1706 and CR1709. Adjustments to R1742 and C1715 provide equal magnitudes of the 250 kc signal at the two input points. The output of the modulator is taken across R1742.

The 250 kc signal controls the switching of the diodes in the modulator. The amplitude of the audio inputs is sufficiently low so that the 250 kc signal does not lose control of the diode switching. On positive half-cycles of the 250 kc signal, CR1706 and CR1709 are reverse-biased and CR1707 and CR1708 are forward-biased. On negatives half-cycles of the 250 kc signal, CR1706 and CR1709 are forward-biased and CR1707 and CR1708 are reverse-biased. Thus, each output of the detector is composed of alternate samplings of the two audio inputs.

Figure 4-5 illustrates diode switching for the modulator. It shows both audio inputs, the 250 kc switching signal, and the output. The 250 kc signal is not shown as part of the output waveform because it is in phase at both output points and will have no effect in the mixer. For this discussion, input A (solid curve) is at the junction of R1736 and R1737, input B (dashed curve) is at the junction of R1738 and R1739. Between T1 and T2, when the 250 kc signal is positive, CR1707 passes input A. Between T2 and T3 when the 250 kc signal is negative, CR1706 passes input B. This alternate sampling continues up to T13 when one complete cycle of the audio signal has been covered. The output is an audio modulated i-f signal that contains both the upper and lower sidebands. The output is shown in a more familiar form at the right of the illustration. The modulator output, is supplied to crystal bandpass filter FL1701. This is a highly selective filter with a bandpass of 3 kc; it rejects frequencies below 250.3 kc and above 253.3 kc. Thus, only the upper sideband of the modulator output is passed, while all noise and signal frequencies out-

side of the upper sideband are rejected. The output of the crystal filter is supplied to the balanced mixer. Figure 4-6 (both A and B) shows the output of modulator and the effect of the crystal filter in producing the balanced mixer input.

f. BALANCED MIXER AND I-F AMPLIFIER. - Balanced mixer Q1709 and Q1710 receives three inputs. The first is the upper sideband signal from FL1701. The second is the 250 kc carrier signal from section C of S1505; which is present in the -20 DB CARRIER, AME, and MCW modes only, at a level dependent upon the mode selected. The third is the output of either the LSB oscillator (1.5 mc) or the USB oscillator (2.0 mc) depending upon the position of transmitter sideband relay, K1502. The balanced mixer produces an i-f signal whose carrier frequency is 1.75 mc. This signal consists of a single sideband that is either above or below the carrier frequency depending upon which sideband oscillator output is supplied to the mixer.

Figure 4-6 shows the inputs and output of the balanced mixer for the two possible cases. In case A, the LSB oscillator output (250 kc below the center frequency of the mixer output) is supplied to the mixer; the frequency spectrum of the i-f input signal is not inverted. In case B, the USB oscillator output (250 kc above the center frequency of the mixer output) is supplied to the mixer; the frequency spectrum of the i-f input signal is inverted. Thus, the selection of upper or lower sideband transmission is determined by which oscillator output is supplied to the mixer.

#### NOTE

Beat frequencies below 1.5 mc and above 2.0 mc are also produced in the mixer. These are not shown because they are rejected by i-f amplifier Q1711.

The position of transmitter sideband relay K1501 determines which of the two oscillators supplies the mixer. If XMTR switch S1502 is at LSB, K1502 is energized, and +12 V CONT is supplied to LSB oscillator Q1716, a modified Colpitts circuit. USB oscillator Q1717, also a modified Colpitts circuit, is disabled at this time. The output of the LSB oscillator is supplied through buffer amplifier Q1715 to the mixer. The buffer amplifier minimizes the loading of the oscillator so that its frequency and output magnitude are very stable. When S1502 is at USB/REMOTE, and no remote sideband input is present, K1502 is de-energized and +12 V CONT is supplied to the USB oscillator to activate it; the LSB oscillator is cut off at this time. If ground is supplied as a remote sideband input, K1502 is energized, and the LSB oscillator is activated. This is how the desired sideband is selected remotely.

The carrier input to the mixer is taken from section C of S1505. In the CW and SSB positions, this input is grounded. In the AME, MCW, and -20DB CARRIER positions, the carrier level is determined by the voltage divider consisting of R1536, R1537, and R1538.

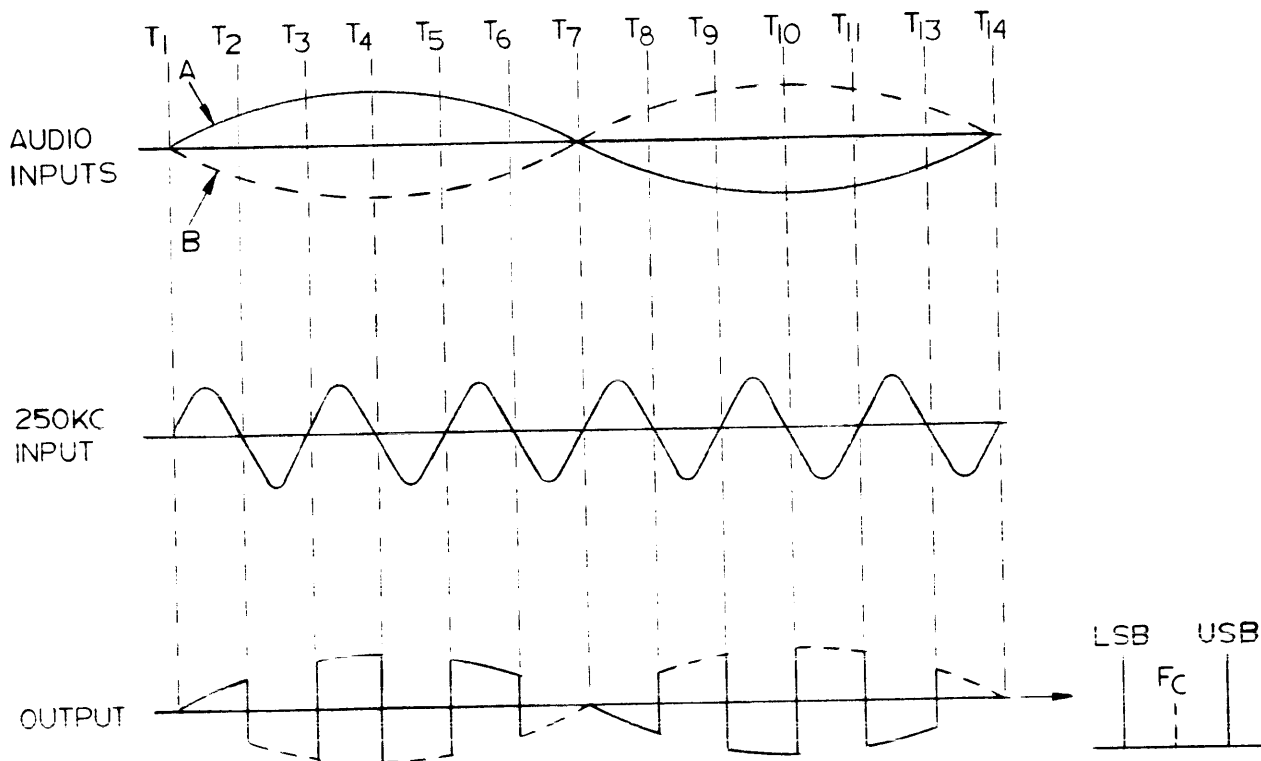
The output of the balanced mixer is supplied to i-f amplifier Q1711. This amplifier is tuned to 1.75 mc and rejects the undesirable beat frequencies produced in the balanced mixer. The output of the i-f amplifier is supplied through section D of S1505 to the TRANSMITTER CHANNEL selector switch S1508. In the CW, SSB, and -20DB modes, the signal is coupled directly through S1505. In the AME and MCW modes, the signal is attenuated by the voltage divider consisting of R1540 and K1539 to maintain the power output level in spite of increased carrier level. The sideband oscillator input (1.5 or 2.0 mc) is essentially self-cancelling at the balanced mixer output. Therefore, the undesired heterodyne products are removed at least 500 kc from the desired mixer output signal.

g. TTRT PLUG-IN MODULES. - The i-f signal from S1505 is supplied to one of four TTRT modules through S1508 depending upon the channel selected. In addition, the selected module is energized by -12 V XMIT, -12 V XMIT and -36 V XMIT through other sections of S1508 and contacts of relay K1500. Each TTRT module is fixed-tuned to a preselected frequency, and contains a crystal controlled local oscillator, a balanced mixer, and three rf amplifiers; the module converts the i-f input to an rf signal and amplifies it. Thus, the TRANSMITTER CHANNEL selector switch enables an operator to select any one of four transmission frequencies.

Figure 4-6 shows the input and output of a TTRT

NOTE

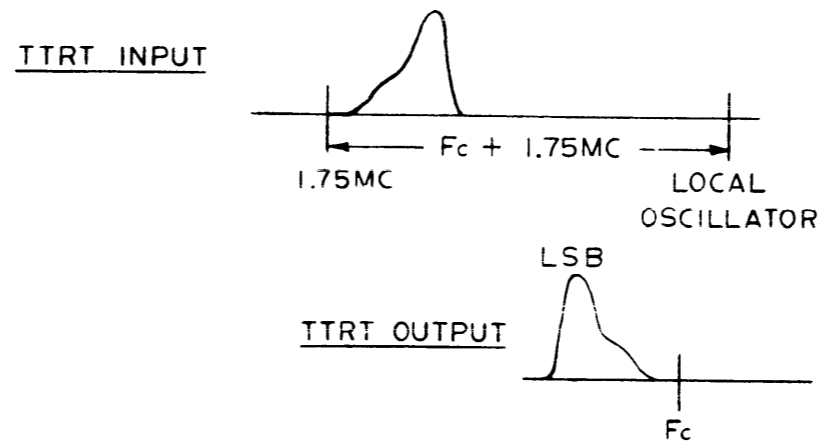
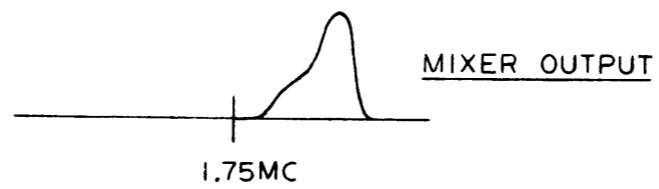
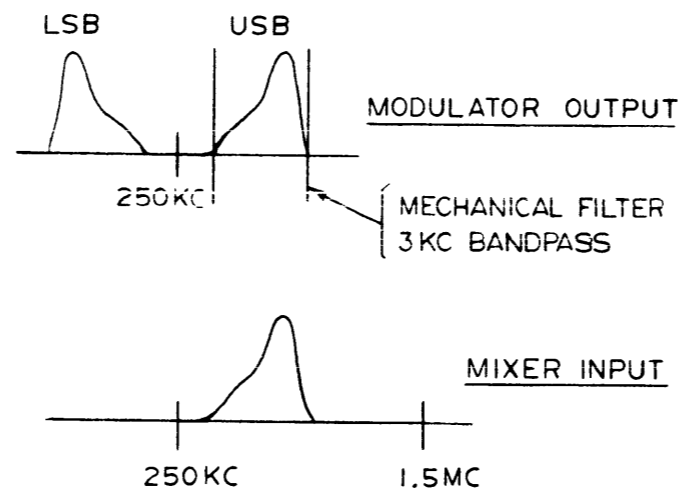
I. THE AUDIO SIGNAL HAS BEEN ENLARGED FOR CLARITY.



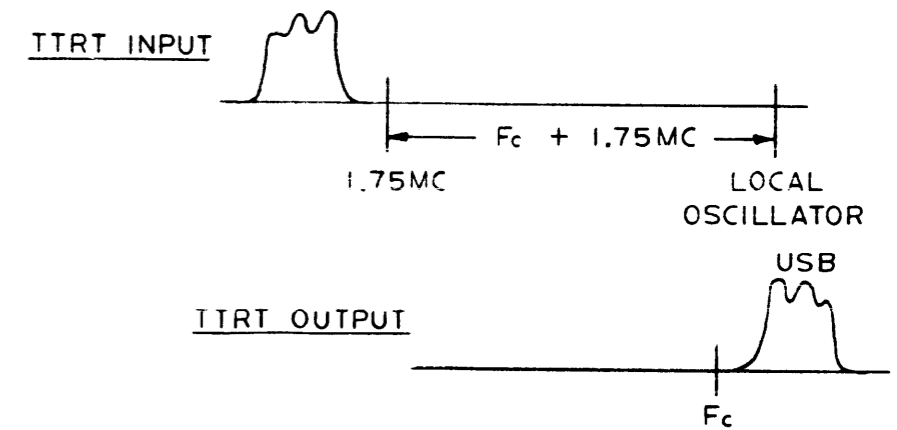
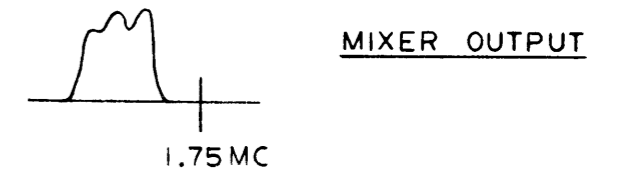
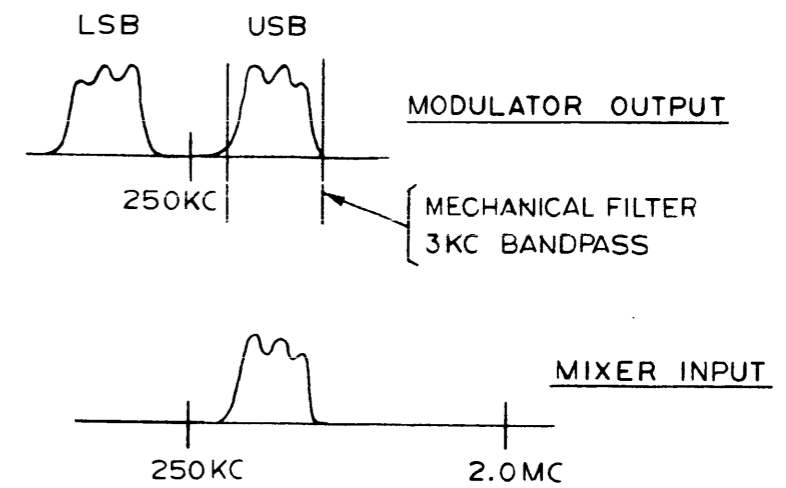
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Figure 4-5. Interval Study of Diode Switching, Balanced Modulator





CASE A



CASE B

1004-8

005351001

Figure 4-6. Frequency Inversion in SSB Transmission

module. In each case, the local oscillator in the module is tuned 1.75 mc above the carrier of the desired transmission frequency. Thus, the frequency spectrum of the i-f signal input is inverted as shown in the illustration. The bandpass of the rf amplifiers in the TTRT modules is sufficient to pass either the upper or lower sideband.

The output of the selected TTRT module is supplied through S1508 to intermediate power amplifier V1500 in the linear amplifier.

h. LINEAR AMPLIFIER. - The linear amplifier consists of two power-amplifier stages, switch-selected tuning networks, and overload protection circuits. The linear amplifier produces an output of 100 watts maximum peak envelope power from an input of 250 milliwatts.

The rf signal from S1508 is supplied to class AB1 intermediate power amplifier V1500. The tuned circuit for the plate is located in the TTRA module selected by TRANSMITTER CHANNEL selector switch S1500. Each of the four TTRA modules installed in the TTR-10 corresponds with one of the four TTRT module frequencies. The output of the selected TTRA module is supplied through S1508 to class AB2 power amplifier V1501. The control grid bias for V1501 is determined by the condition of the transmit-receive relay. When the transmitter is not keyed, the relay is deenergized, and -105 volts is applied to the grid to keep the tube completely cut off. When the transmitter is keyed, the relay is energized, and a voltage determined by the setting of PACb ADJ R1500 provides part of the class-AB2 bias. In addition, the TTRA contains the pi network for V1501 plate tuning and matching to the transmission line. The output of the selected TTRA module is supplied to XMTR OUTPUT jack J1501.

The power amplifier is protected from overload by a circuit that automatically interrupts the high voltage supply if overload occurs. See paragraph j. In addition, a front panel meter can indicate various parameters of the power output stage. See paragraph 1.

Figure 4-7 is a simplified schematic of the linear amplifier. It shows the plate tuning circuits for the intermediate power amplifier and the pi output network for the power amplifier, which are in the TTRA module selected by TRANSMITTER CHANNEL selector switch S1508; the tuned circuits are peaked for the frequency of the TTRT module output and the antenna loading. Filtering, biasing, and overload protection circuits are also shown.

i. TTRA MODULES. - There are four models of the TTRA module that may be used in the TTR-10. Each is designed to cover particular frequency range as follows:

TTRA-1 (Figure 7-2): 2-4mc

TTRA-2 (Figure 7-3): 4-8mc

TTRA-3 (Figure 7-4): 8-16mc

TTRA-4 (Figure 7-5): 16-32mc

The model of TTRA module used depends upon the model of TTRT module used. The TTRA model is selected to cover the frequency range of the TTRT which it is used.

Each TTRA module contains two basic circuits: a plate-tuning circuit for the intermediate power-amplifier circuit for the power amplifier, and a load tuning circuit. The tuning of the IPA circuit is variable over the entire frequency range of the module. Coarse tuning and loading of the PA circuits is accomplished by two switches that divide the frequency range of the module into narrow frequency bands; the switches select fixed tuning components. Fine tuning is then accomplished by means of variable capacitors. Thus, to tune and load the power amplifier, the PA TUNE switch and PA LOAD switch must be positioned to select the narrow band that includes the specified operating frequency of the TTRT module for the selected channel, and then the TTRA module must be fine tuned and loaded at the specified frequency.

Each TTRA module is interlocked to prevent operation of the linear amplifier if the module is removed (paragraph k).

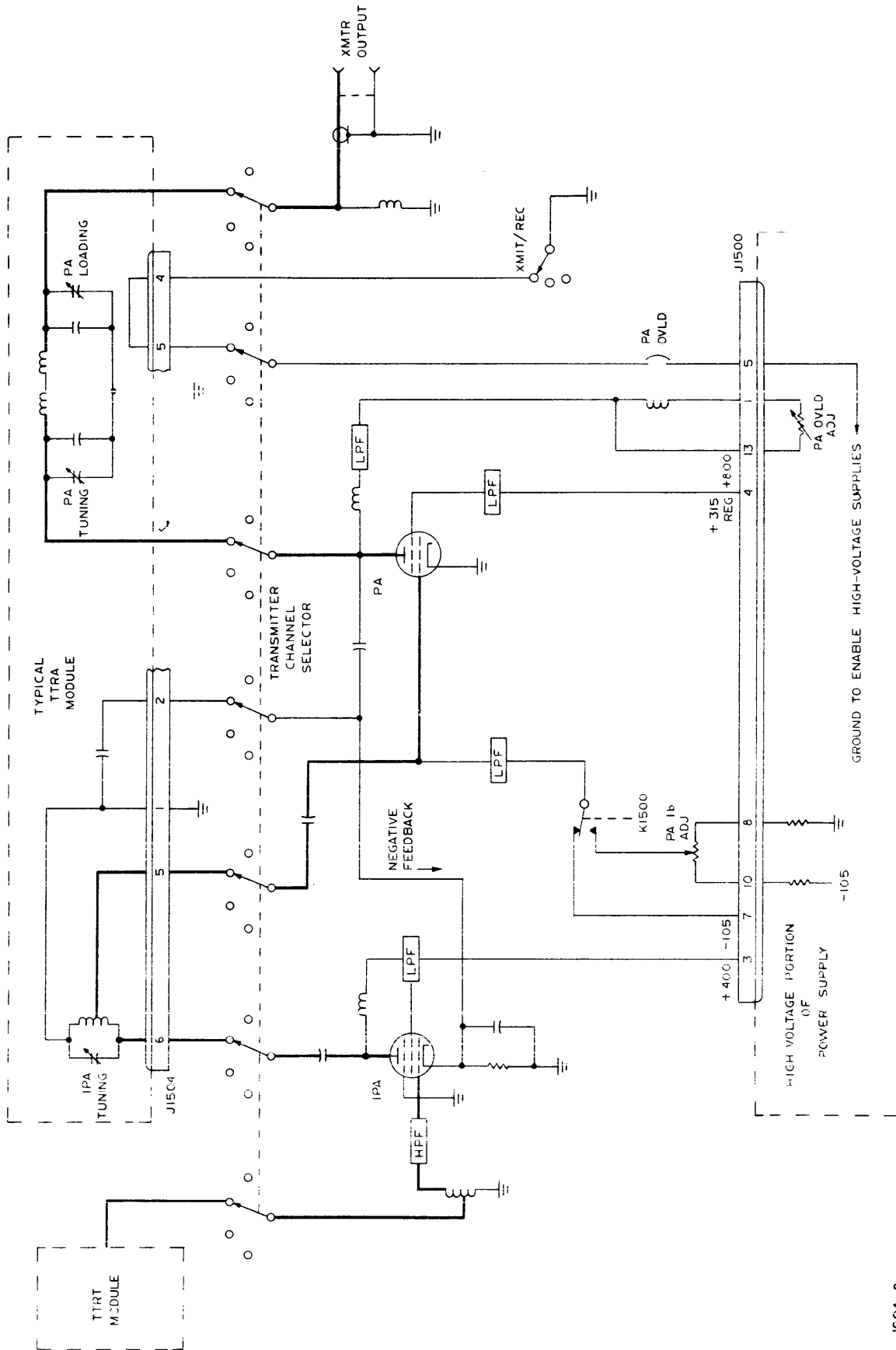
j. POWER SUPPLY AND OVERLOAD PROTECTION. - The power supply used in the TTR-10 is a plug-in module that can be any one of several types and is described in a separate book. However, the power supply is described here to the extent required for understanding the operation of the overload and interlock circuitry.

The power-supply module contains a low-voltage supply and a high-voltage supply. The low voltage outputs (+12 V, -12 V, and -36 V) are provided whenever power switch S1500 is set at either REC or XMIT/REC. The low voltage outputs are used in both the receiver section and in the exciter of the transmitter section.

The high-voltage power supply is energized only when power switch S1500 is set at XMIT/REC; other conditions described further on must also be met. The high voltage outputs are +800, +400, +315 and -105 volts; these are the supply and bias voltages for the linear amplifier.

The ac supply for the high voltage supply is connected through normally open contacts of a high voltage relay. This relay is energized by +12 V whenever the ground return is completed through the power switch, PA OVLD circuit breaker CB1500, and the interlock in the selected TTRA module, and is interrupted whenever the breaker is tripped or the TTRA module for the selected channel is not in place; the circuit breaker trips whenever excessive plate current is drawn by V1501.

k. ANTENNA SWITCHING. - The power-supply module also contains an antenna relay that provides



IC04-9

Figure 4-7. Linear Amplifier, Simplified Schematic

switching of the receiver input and transmitter output for operation with one antenna (simplex operation). The antenna relay is energized through normally open contacts of the high voltage relay and transmit/receive relay connected in series. Thus, the antenna relay is deenergized except when the transmitter is keyed and the high voltage relay is energized. When the TTRR-10 is wired for simplex operation and the antenna relay is deenergized, RCVR ANT jack J1502 is connected to the ANTENNA jack; the output of the transmitter through XMTR OUTPUT jack J1501 is grounded. When the antenna relay is energized, XMTR OUTPUT jack J1501 is connected to the ANTENNA jack and the input to the receiver section through RCVR ANT jack J1502 is grounded.

In duplex operation, the interconnection between the RCVR ANT jack is removed so that the receiver

input does not pass through the antenna relay. The transmitter connections are not changed so that the transmitter output to the ANTENNA jack is still switched by the antenna relay.

1. METER CIRCUIT. - PA METER switch S1511 can select any one of three power-amplifier parameters for indication on the front-panel meter. With the switch at Ib, the plate current of the power amplifier is measured. With the switch at EgRF, a portion of the rf signal input to the power amplifier is rectified by rf detector CR1500 and is indicated on the meter. With the switch at EoRF, a portion of the rf signal output at the antenna is rectified by rf detector CR1501 and is indicated by the meter.

## SECTION 5 MAINTENANCE

### 5-1. GENERAL.

As mentioned before, the TTR-10 comprises five major sections. Troubleshooting and repair procedures given in this section are limited to the main chassis assembly and to the linear amplifier (TTRA). For troubleshooting and repair information concerning the receiver converter (TTRR) transmitter converter (TTRT), and power supply (TPS( )-1), referred to the appropriate TTRR, TTRT or TPS( )-1 manual. Refer to figures 5-2 through 5-9 at the end of this section for aid in locating components.

### 5-2. TEST EQUIPMENT REQUIRED.

Test equipment required for procedures given in this section are listed in Table 5-1.

### 5-3. PREVENTIVE MAINTENANCE.

Preventive maintenance of the TTR-10 consists of routine visual inspection and cleaning. Cleaning is necessary because dust may accumulate on certain components and not only reduce the efficiency of the

TTR-10, but also increase component wear. Either a vacuum cleaner or a compressed air hose is the quickest and most effective method of cleaning the unit.

Visually checking the unit when it is opened for cleaning can prevent downtime due to component failure. Often a deteriorating component will look bad before it actually affects the operation of the unit. Some indications of trouble are: discolored components, dirty or pitted switch and relay contacts, warped printed circuit boards, and damaged wiring. Any components found in this condition should be replaced. In addition, all hardware should be checked for tightness.

### 5-4. RECEIVER SECTION TROUBLESHOOTING.

#### a. QUICK TESTS USING FRONT PANEL CONTROLS.

(1) CHANNEL TEST. - Try to receive signals on all four frequencies selected by RECEIVER CHANNEL switch. If reception is possible on some but not all of the channels, the TTRR module for the channel on which reception is not possible is defec-

TABLE 5-1. TEST EQUIPMENT REQUIRED.

ITEM	FUNCTION
600 ohm 1/2 watt resistor.	Used in receiver section troubleshooting and alignment.
R-f signal generator, Hewlett Packard Model 606A, or equivalent.	
50-ohm, 100 watt dummy load.	Used in transmitter section troubleshooting and alignment.
A-f signal generator, Hewlett Packard Model 606A, or equivalent.	
Vacuum tube voltmeter, Hewlett Packard Model 410B, or equivalent.	Used in transmitter section and receiver section troubleshooting and alignment.
Oscilloscope, Tektronix Type 545, or equivalent.	
Frequency counter, Hewlett Packard Model 524C, or equivalent.	
Volt-ohm-milliammeter, Simpson Model 260, or equivalent.	

tive. If reception is not possible on any channel, additional tests are required to isolate the trouble.

(2) SIDEBAND TEST. - Try to receive signals with RCVR switch set alternately at LSB and USB/REMOTE. If reception is possible in LSB only, the USB oscillator is probably defective. If reception is possible in USB only, the LSB oscillator is probably defective. If reception is not possible in either position of the switch, additional tests are required to isolate the trouble.

b. SYSTEMATIC TROUBLESHOOTING.

(1) Disconnect antenna from J1502 and all external wiring from TB1501.

(2) Connect a 600 ohm, 1 watt resistor across terminals 1 and 3 of TB1501. Set OFF-REC-XMIT/REC switch at REC.

(3) Set RCVR switch at LSB. Measure r-f signal at emitter of Q1602 on receiver i-f board; level should be between 0.5 and 1.0 v rms. If this signal was not obtained, check circuitry of LSB oscillator Q1607 and buffer Q1609.

(4) Set RCVR switch at USB/REMOTE. Measure r-f signal at emitter of Q1602; level should be between 0.5 and 1.0 v rms. If this signal is not obtained, check circuitry of USB oscillator Q1608.

(5) Measure r-f signal at arm of potentiometer R1663 on receiver i-f board; level should be between 1.0 and 1.5 v rms. If this signal is not obtained, check circuitry of BFO Q1606 and buffer Q1605.

(6) Remove channel 1 TTRR module; set RECEIVER CHANNEL switch at 1.

(7) Connect signal generator to terminal 1 of receiver i-f board; adjust signal generator to deliver 1 mv (1000 uv) at 1749 kc.

(8) Remove crystal Y1601. Measure r-f signal at output of filter FL1601; level should be approximately 0.28 v. If this signal was not obtained, check circuitry of i-f amplifier Q1601 and mixer Q1602.

(9) Replace crystal Y1601; reduce signal generator output to 30 uv. Measure a-f signal at terminal 11 of receiver i-f board; level should be at least 10 mv (0.01 v). If this signal was not obtained, check product detector and a-f amplifier Q1603/Q1604 circuitry.

(10) Adjust signal generator until level at terminal 11 is exactly 10 mv.

(11) Measure a-f signal at terminals 1 and 3 of terminal board TB1501 (across 600 ohm resistor); level should be approximately 0.78 v rms. If this signal was not obtained, check circuitry of line amplifier Q1618.

(12) Measure signal at ungrounded end of resistor R1660 on receiver a-f board (SQUELCH control

R1518 must be adjusted so that squelch relay K1601 is de-energized); adjust VOLUME control R1515 until level is approximately 1.3 v rms. If this signal was not obtained, check circuitry of audio amplifiers Q1613, Q1614/Q1615, and Q1616/Q1617.

(13) Connect signal generator to antenna jack J1502, adjust generator to deliver 1 uv at a frequency 1 kc above channel 1 frequency. Replace channel 1 TTR module.

(14) Measure a-f signal at terminals 1 and 3 on terminal board TB1501; level should be 0.78 v rms. Disconnect signal generator; noise level should be 0.13 v or lower. If this sensitivity check is not satisfactory, the TTRR module is defective; refer to the appropriate TTRR technical manual.

5-5. TRANSMITTER SECTION TROUBLESHOOTING.

a. QUICK TESTS USING FRONT PANEL CONTROLS.

(1) CHANNEL TEST. - Try to operate transmitter on all four frequencies selected by TRANSMITTER CHANNEL switch. If the transmitter section operates properly on some but not all channels, the TTRR module for the inoperative channel is probably defective.

(2) SIDEBAND TEST. - Try to transmit with the XMTR switch alternately set at LSB and USB/REMOTE. If transmission is possible on upper sideband only, the LSB oscillator is defective.

(3) VOX/PTT TEST. - Set PTT/VOX switch at PTT. Close push-to-talk switch on microphone. Transmitter should key as evidenced by increase of PA plate current (observe front panel meter with PA METER switch set at I<sub>b</sub>). If the transmitter does not key, the transmit/receive relay driver is defective. Set PTT/VOX switch at VOX; rotate VOX-GAIN control fully clockwise. Speak into microphone; transmitter should key as the XMTR AF GAIN is rotated clockwise. If the transmitter does not key, the VOX amplifier or detector is probably defective.

(4) CW/SSB TEST. - Alternately try to operate transmitter in the CW and SSB modes. If transmitter operates in CW mode only, the microphone pre-amplifier is probably defective. If transmitter operates in SSB mode only, the CW oscillator is probably defective.

b. SYSTEMATIC TROUBLESHOOTING.

(1) Disconnect antenna from ANTENNA jack. Disconnect all external wiring from TB1500 and TB1501.

(2) Connect r-f dissipator to ANTENNA jack.

(3) Connect jumper wire between terminals 7 and 8 on TB1500 to key transmitter. Set XMTR switch at LSB. Measure r-f signal at junction of capacitors

C1723 and C1724 on transmitter i-f board; level should be between 0.5 and 1.0 v rms. If this signal is not obtained, check LSB oscillator Q1716 and buffer Q1715.

(4) Set XMTR switch at USB/REMOTE. Measure r-f signal at junction of capacitors C1723 and C1724 on transmitter i-f board, level should be between 0.5 and 1.0 v rms. If this signal is not obtained, check USB oscillator Q1717.

(5) Measure r-f signal at arm of potentiometer R1742 on transmitter i-f board, level should be approximately 2 v rms. If this level is not obtained, check carrier oscillator Q1712 and buffer Q1713.

(6) Remove crystal Y1701. Connect signal generator to terminals 1 and 3 of terminal board TB1500, adjust generator to deliver 78 mv (0.078 v) at 1 kc.

(7) Measure a-f signal across terminals 1 and 2 on transmitter a-f board; level should be approximately 10 mv (adjust XMTR AF GAIN control as necessary). If this signal is not obtained, check audio amplifier Q1702/Q1703.

(8) Connect signal generator to terminal 6 on TB1500 and ground; adjust generator to deliver 14 mv (0.014 v) at 1 kc. Signal across terminals 1 and 2 on transmitter a-f board should be as noted in step (7) above. If this signal is not obtained, check audio pre-amplifier Q1501.

(9) Set CW/SSB/-20DB CARRIER/AM/MCW switch at CW. Connect jumper wire to terminals 11 and 12 on TB1501. Signal across terminals 1 and 2 on transmitter a-f board should be as noted in step (7) above. If this signal is not obtained, check CW oscillator Q1500.

(10) Replace crystal Y1701. Measure r-f signal at terminal 9 on transmitter i-f board; level should be approximately 45 mv (0.045 v). If this signal is not obtained, check balanced modulator, balanced mixer Q1709/Q1710, and i-f amplifier Q1711.

(11) Set CW/SSB/-20DB CARRIER/AM/MCW switch at MCW. Observe r-f signal at terminal 9 on transmitter i-f board.

If scope pattern does not comply with figure 5-1d, check buffer amplifier Q1714.

(12) Set CW/SSB/-20DB CARRIER/AM/MCW switch at CW. Measure r-f signal at pin 2 (grid) of V1500; level should be between 2.1 and 2.8 v rms. If this signal is not obtained, the TTRT module is defective; refer to appropriate TTRT Technical Manual.

#### NOTE

When performing steps 13 and 14 below, do not key transmitter for more than 1 minute at a time. Leaving the transmitter keyed for long periods of time will damage the power amplifier tube.

(13) Set PA OVLD circuit breaker down. Measure r-f signal at pin 2 or pin 6 (grid) of V1501; level should be between 15 and 18 v rms. If this signal is not obtained, check intermediate power amplifier V1500.

(14) Measure r-f signal at J1501, level should be 50 v rms. If this signal is not obtained, check power amplifier V1501.

#### 5-6. RECEIVER SECTION ALIGNMENT.

a. For change of receiver channel frequency, the i-f and a-f stage alignment procedure given in step b below need not be performed. For change of receiver channel frequency, perform TTRR alignment as outlined in the TTRR manual.

#### b. RECEIVER I-F AND A-F STAGES.

(1) Disconnect all external wiring from TB1501. Connect 600 ohm resistor between terminals 1 and 3 on TB1501. Remove channel 1 TTRR module. Set RECEIVER CHANNEL switch at 1.

(2) Connect VTVM to secondary (terminal 3) of T1602; set VTVM at lowest scale.

(3) Adjust R1663 to obtain minimum voltage indication.

(4) Connect r-f signal generator to terminal 1 on receiver i-f board. Adjust generator to deliver 1 mv at 1749 kc.

(5) Adjust R1544, C1604, C1602, C1655, and C1656 to obtain maximum signal at secondary of T1602; reduce signal generator output to obtain lowest usable indication on the VTVM while performing this step.

(6) Set RCVR switch at LSB, tune signal generator to 1751 kc; adjust R1543 to obtain maximum signal at secondary of T1602.

(7) Readjust C1604 and C1602, R1544 or 1543 until signal levels at secondary of T1602 are equal with upper sideband and lower sideband inputs applied (RCVR switch must be alternately set at USB and LSB respectively).

(8) Connect counter across 600 ohm resistor on TB1501. Make sure that signal generator output frequency is 1749 kc  $\pm$  2 cps. Set RCVR switch at USB/REMOTE. Adjust C1631 until counter indicates 1000 cps.

(9) Tune signal generator to 1751 kc  $\pm$  2 cps. Set RCVR switch at LSB. Adjust C1629 until counter indicates 1000 cps.

(10) Replace channel 1 TTRR module. Connect signal generator to J1502. Adjust signal generator to deliver 1 microvolt at a frequency of 1 kc below channel 1 frequency.

(11) Connect VTVM across 600 ohm resistor on TB1501. Adjust R1612 to obtain 0.78 v rms across 600 ohm resistor.

TABLE 5-2. TRANSISTOR AND TUBE VOLTAGE MEASUREMENTS

<u>NOTE</u>				
All voltages measured to chassis ground using 20 K ohms-per-volt meter.				
A. TRANSISTORS				
SYMBOL	EMITTER	BASE	COLLECTOR	REMARKS
Q1701	-5.5	-5.6	-4.2	
Q1702	+ .20	- .06	-9.0	
Q1703	+ .16	0	-9.5	
Q1704	-1.6 to +1.6	-.15 to +.15	-12.5	
Q1705		-1.6 to +1.6		
Q1706	+ .70 to -1.8	-2.0	+12.5	
Q1707	0	0	-12.5	Term. 8, TB1500 grounded
	0	-.22	0	Term. 8, TB1500 ungrounded
Q1708	0	-.30	0	Term. 8, TB1500 grounded and K1500 energized
	0	+ .5	+12.5	K1500 de-energized
Q1709	+ .15	0	-12.0	
Q1710	+ .15	0	-12.0	
Q1711	+ .30	0	-10.5	
Q1712	+ .28	+ .15	-6.0	
Q1713				
Q1714	+ .38	+ .15	-8.0	
Q1715	+ .18	0	-11.0	
Q1716	0	0	-6	K1502 energized
Q1716	0	0	-12.5	K1502 de-energized
Q1717	0	0	-6	K1502 de-energized
	0	0	-12.5	K1502 energized
Q1500	+1.1	+1.2	+9.4	S1505 set at CW or MCW
Q1601	+ .27	+ .02	-11.5	



TABLE 5-2. TRANSISTOR AND TUBE VOLTAGE MEASUREMENTS (CONT)

A. TRANSISTORS (CONT)				
SYMBOL	EMITTER	BASE	COLLECTOR	REMARKS
Q1602	-.32	0	-11.0	
Q1603	+.14	0	-11.7	
Q1604	+.17	0	-5.9	
Q1605	+.12	+.12	-7.7	
Q1606	+.29	+.12	-5.7	
Q1607	+.01	0	-5.4	K1501 de-energized
	0	0	-12.5	K1501 energized
Q1608	+.01	0	-5.4	K1501 energized
	0	0	-12.5	K1501 de-energized
Q1609	+.05	0	-11.5	
Q1610	+.12	0	-11.3	
Q1611	+3.0	+3.1	+12.5	NO SIGNAL
Q1611	+5.6	+5.9	+12.5	1 MV Signal at Base of Q1601
Q1612	+2.6	+2.6	+12.5	NO SIGNAL
	+5.5	+5.6	+12.5	1 MV Signal at Base of Q1601
Q1613	+.25	+.12	-7.1	
Q1614	+.20	+.06	-12.3	
Q1615	+.14	0	-12.3	
Q1616				
Q1617	+12.5	+12.5	-12.4	
Q1618	+.17	+.02	-10.0	
Q1619	+1.8	+1.65	-6.3	SQUELCH max. clockwise
	+5.1	+7.1	-12.6	SQUELCH max. counterclockwise
Q1620	-1.8	+2.8	-8.0	SQUELCH max. clockwise, NO SIGNAL
	+5.1	+2.8	+3.2	SQUELCH max. clockwise, NO SIGNAL
	+1.8	+5.0	-8.6	SQUELCH max. clockwise, 1 MV signal at base of Q1601.

TABLE 5-2. TRANSISTOR AND TUBE VOLTAGE MEASUREMENTS (CONT)

A. TRANSISTORS (CONT)					
SYMBOL	EMITTER	BASE	COLLECTOR	REMARKS	
Q1621	-7.8	-8.0	-8.2	SQUELCH max. clockwise, NO SIGNAL K1601 energized	
	0	+3.2	-12.6	SQUELCH max. counterclockwise, NO SIGNAL K1601 de-energized	
	-8.4	-8.6	-8.5	SQUELCH max. clockwise, 1 MV signal at base. Q1601, K1601 energized.	
B. ELECTRON TUBES					
SYMBOL	PLATE(S)	SCREEN	CONTROL GRID	CATHODE	FILAMENT
V1500	+300 pin 7	+300 pin 8	0 pin 2	+9 pin 1	6.3AC pin 5
V1501	+800 both caps	+320 pin 3	-50 to -30 pins 2 & 6 when keyed  -105 when not keyed	0	6.3AC pin 5

5-7. TRANSMITTER SECTION ALIGNMENT.

a. For transmitter channel frequency change, perform TTRT module alignment as outlined in the TTRT technical manual and steps (1) through (3), steps (8) through (17), and step (23) of paragraph c below (Linear Amplifier Alignment). Exciter alignment, paragraph b, and the remainder of the linear amplifier alignment are to be used for corrective maintenance purposes only.

b. EXCITER ALIGNMENT.

(1) Disconnect all external wiring from TB1500 and TB1501.

(2) Connect a jumper wire between terminals 11 and 12 on TB1501.

(3) Connect one end of a jumper wire to terminal 8 on TB1500.

(4) Set PA OVLD circuit breaker up.

(5) Connect the a-f signal generator to terminals 1 and 3 on TB1500; adjust signal generator to deliver 78 mv at 1 kc.

(6) Set OFF REC XMIT/REC switch at XMIT/REC.

(7) Rotate XMTR A-F GAIN control fully clockwise. Connect oscilloscope to terminals 1 and 2 on transmitter a-f board; adjust R1718 to obtain 10 mv rms between terminals 1 and 2.

(8) Set CW/SSB/-20DB CARRIER/AM/MCW switch at CW. Adjust R1533 (on CW OSCILLATOR board) to obtain 10 mv rms between terminals 1 and 2 on receiver audio board.

(9) Connect oscilloscope to terminal 9 on transmitter i-f board. Ground terminal 8 of TB1500 with clip lead.

(10) Adjust R1552, C1762, C1725, and C1730 to obtain maximum signal at terminal 9.

(11) Set XMTR switch at LSB. Adjust R1553 to obtain maximum signal at terminal 9.

(12) Remove jumper connected to terminals 11 and 12 of TB1501.

(13) Adjust R1742 and C1715 to obtain minimum voltage at terminal 9.

(14) Connect oscilloscope to base of Q1703; adjust R1748 to obtain minimum signal at this point.

(15) Re-connect jumper between terminals 11 and 12 on TB1501.

(16) Set CW/SSB/-20DB CARRIER/AM/MCW switch at MCW. Connect oscilloscope to terminal 9 on transmitter i-f board. Adjust R1533 slightly to obtain pattern shown in figure 5-1d.

(17) Set CW/SSB/-20DB CARRIER/AM/MCW switch at SSB. Make sure that the output of the a-f signal generator is exactly 1000 cps. Connect frequency counter to terminal 9 on transmitter i-f board; adjust C1746 until frequency of signal at terminal 9 is 1751 kc  $\pm$  2 cps.

(18) Set XMTR switch at USB Remote. Adjust C1749 until frequency of signal at terminal 9 is 1749 kc  $\pm$  2 cps.

(19) If necessary, align TTRT module(s) as outlined in the TTRT equipment manual.

c. LINEAR AMPLIFIER ALIGNMENT.

NOTE

Make sure that the exciter section of the transmitter has been properly aligned before attempting alignment of the linear amplifier section.

(1) Connect a dummy load to ANTENNA jack at rear of unit.

(2) Disconnect all external wiring from TB1500 and TB1501.

(3) Connect one end of a jumper wire to terminal 8 on TB1500.

(4) Set OFF-REC-XMIT/REC switch at OFF.

(5) Disconnect jumper between terminals 3 and 4 on CW oscillator board. Connect VOM between these terminals, - lead to terminal 4, and + lead to terminal 3. Select current scale on VOM in excess of 50 ma.

WARNING

Leathal voltage will be present in the circuit under test when performing step 6 below. Do not touch meter or meter leads.

(6) Set OFF-REC-XMIT/REC switch at XMIT/REC. Rotate XMTR AF GAIN control fully counterclockwise. Unground terminal 8 of TB1500. Set PA OVLD circuit breaker down (on). Set PA METER switch at Ib. After five minutes, ground terminal 8 of TB1500. Adjust R1500 (PA Ib ADJ) until VOM indicates 50 ma. Adjust R1507 until front panel meter indicates 50 ma.

(7) Set PA OVLD circuit breaker up (off). Ground terminals 3 and 4 on CW oscillator board to discharge capacitors, and remove meter leads. Replace jumper disconnected in step (5) above.

(8) Remove TTRT module of channel on which alignment is being performed; connect TTRT module to module extender and insert module extender into TTRT recepticle.

(9) Connect a jumper wire between terminals 11 and 12 on TB1501. Connect VTVM to J1501 (parallel with dummy load).

(10) Set PA OVLD circuit breaker down (on); set OFF-REC-XMIT/REC switch at XMIT/REC. Set PA METER switch at EgRF.

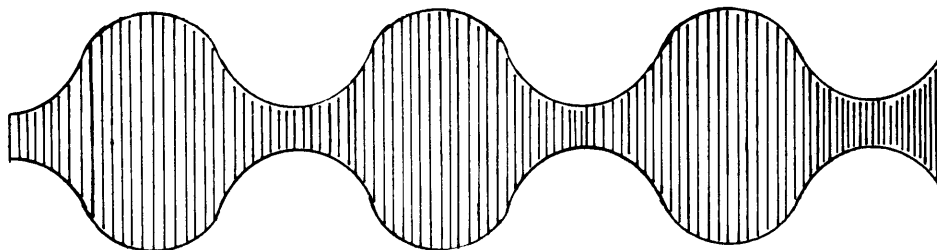
NOTE

When performing steps (11) through (18) below, refer to figure 5-10 for location of TTRA controls.

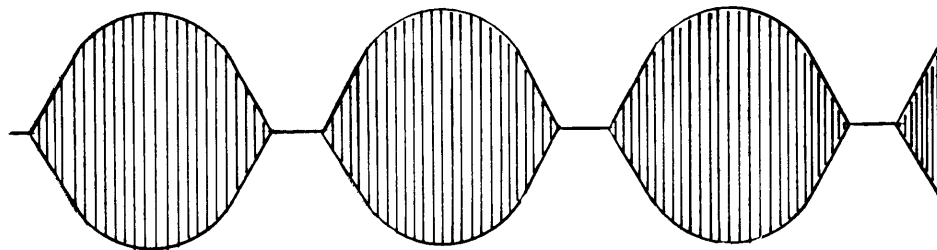
(11) Set PA TUNING switch on TTRA module as indicated in table 5-3 for appropriate channel frequency. Set PA LOADING switch at 1. Rotate PA LOADING control fully counterclockwise.

TABLE 5-3. PA TUNE SWITCH SETTING

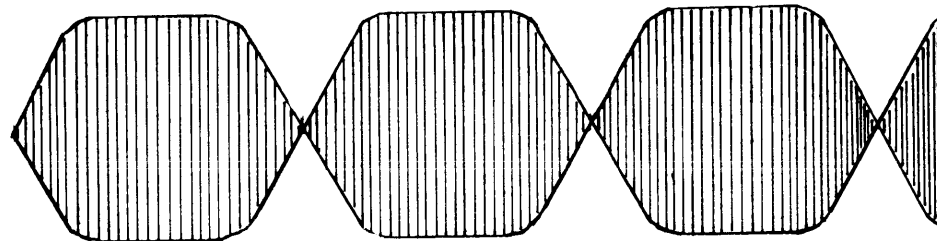
FREQ. (IN MC)	PA TUNE SWITCH SETTING	LINEAR AMPL. MODULE
2 - 2.2	1	TTRA-1
2.2 - 2.5	2	
2.5 - 3.1	3	
3.1 - 4.0	4	
4.0 - 5.0	1	TTRA-2
5.0 - 6.3	2	
6.3 - 8.0	3 & 4	
8.0 - 10.0	1	TTRA-3
10.0 - 12.6	2	
12.6 - 16.0	3 & 4	
16.0 - 20.0	1	TTRA-4
20.0 - 24.0	2	
24.0 - 28.0	3	
28.0 - 32.0	4	



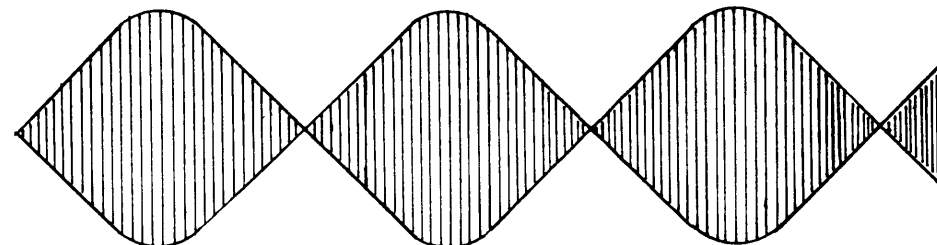
**(a) INCORRECT SIDEBAND/CARRIER POWER RATIO**



**(b) EXCESSIVE DISTORTION (NEGATIVE CLIPPING)**



**(c) EXCESSIVE DISTORTION (POSITIVE CLIPPING)**



**(d) CORRECT MODULATION ENVELOPE**

1004-10

Figure 5-1. Modulation Envelopes

(12) Ground terminal 8 of TB1500. Rotate XMTR AF GAIN control clockwise, and adjust IPA TUNING control on TTRA to obtain peak indication on front panel meter; keep meter indication as low as possible with XMTR AF GAIN.

(13) Set PA METER switch at Ib. Adjust XMTR AF GAIN control to obtain indication of approximately 75 ma on front panel meter. Adjust PA TUNING control to obtain dip on meter.

(14) Rotate PA LOADING switch clockwise until a sharp increase of PA plate current is indicated on front panel meter. Readjust PA TUNING control to obtain dip on front panel meter.

(15) Adjust PA TUNING control, PA LOADING control, and XMTR AF GAIN control until VTVM indicates 50 v rms at J1501, and front panel meter indicates approximately 125 ma.

(16) Adjust control D on TTRT module until conditions set forth in step (14) are met with XMTR AF GAIN control at its fully clockwise position.

(17) Set PA OVLD circuit breaker down; unground terminal 8 of TB1500. Connect oscilloscope probe to J1501. Set CW/SSB/-20DB CARRIER/AM/MCW switch at MCW.

(18) Set PA OVLD circuit breaker up; after five minutes, ground terminal 8 of TB1500. Oscilloscope pattern should conform with figure 5-1d. If necessary, adjust screw A on TTRT module, PA TUNING and PA LOADING controls on TTRA modules to minimize distortion. Adjust screw D on TTRT to keep r-f voltage at J1501 at approximately 70 v rms; front panel meter should indicate approximately 125 ma.

## NOTE

Slight re-adjustment of the PA LOADING controls may be necessary after the dummy load is disconnected and the TTR-10 is connected to its antenna.

(19) Set PA METER switch at EoRF. Adjust R1511 until front panel meter indicates same value as does VTVM connected to J1501.

(20) Set PA OVLD circuit breaker up; unground terminal 8 of TB1500. Connect VTVM to grid (pin 2 or 6) of V1501. Set PA METER switch at EgRF.

(21) Set PA OVLD circuit breaker down; ground terminal 8 of TB1500. Adjust R1509 until front panel meter indicates same value as does VTVM.

(22) Set PA OVLD circuit breaker up; unground terminal 8 of TB1501. Disconnect VTVM from equipment.

(23) Set PA OVLD circuit breaker down; ground terminal 8 of TB1501. Set PA METER switch at Ib. Adjust screw D on TTRT until front panel meter indicates 180 ma; adjust PA OVLD ADJ control on power supply module until PA OVLD circuit breaker trips. Reduce excitation with screw D on TTRT module, reset PA OVLD circuit breaker, and check the circuit breaker does not trip with approximately 175 ma plate current.

(24) Set OFF-REC-XMIT/REC switch at OFF. Disconnect all test equipment from the TTR-10 and jumper wires from the terminal boards. Remove module extender and re-insert TTRT module for normal operation; restore external wiring as required. This completes the alignment procedures.

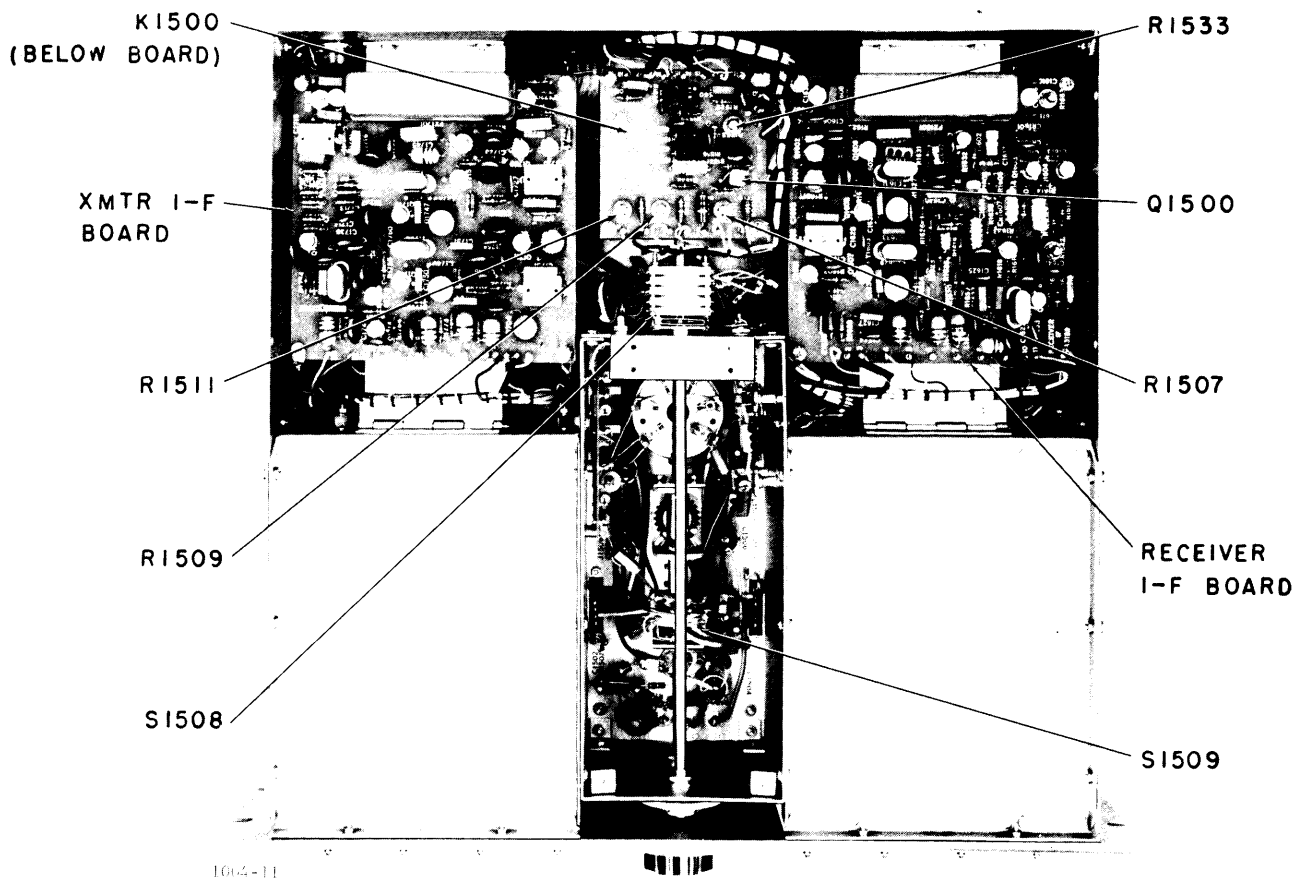


Figure 5-2. TTR-10, Bottom View

6411.23-5

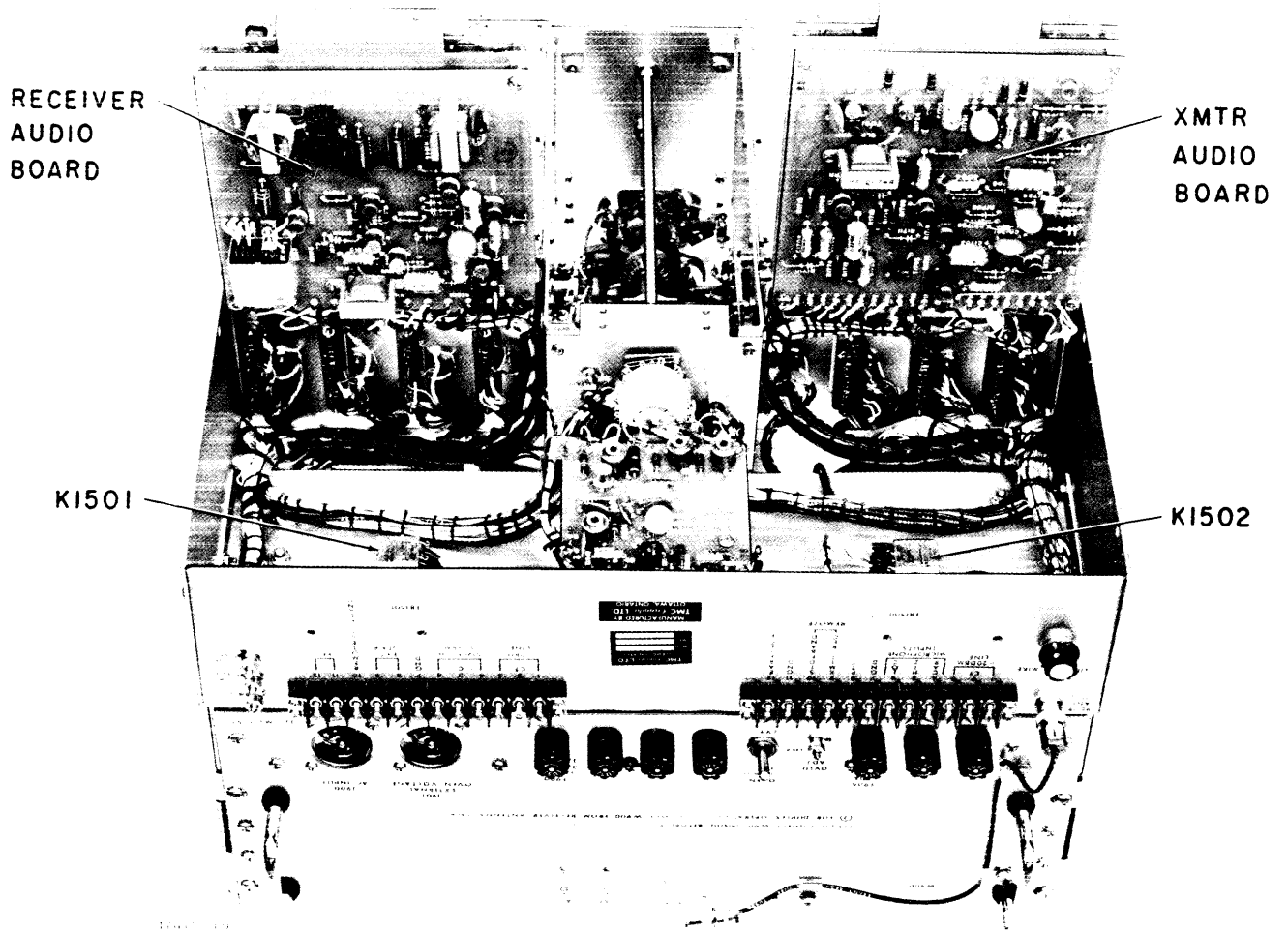


Figure 5-3. TTR-10, Bottom View With Underside of Hinged Board Assemblies Exposed

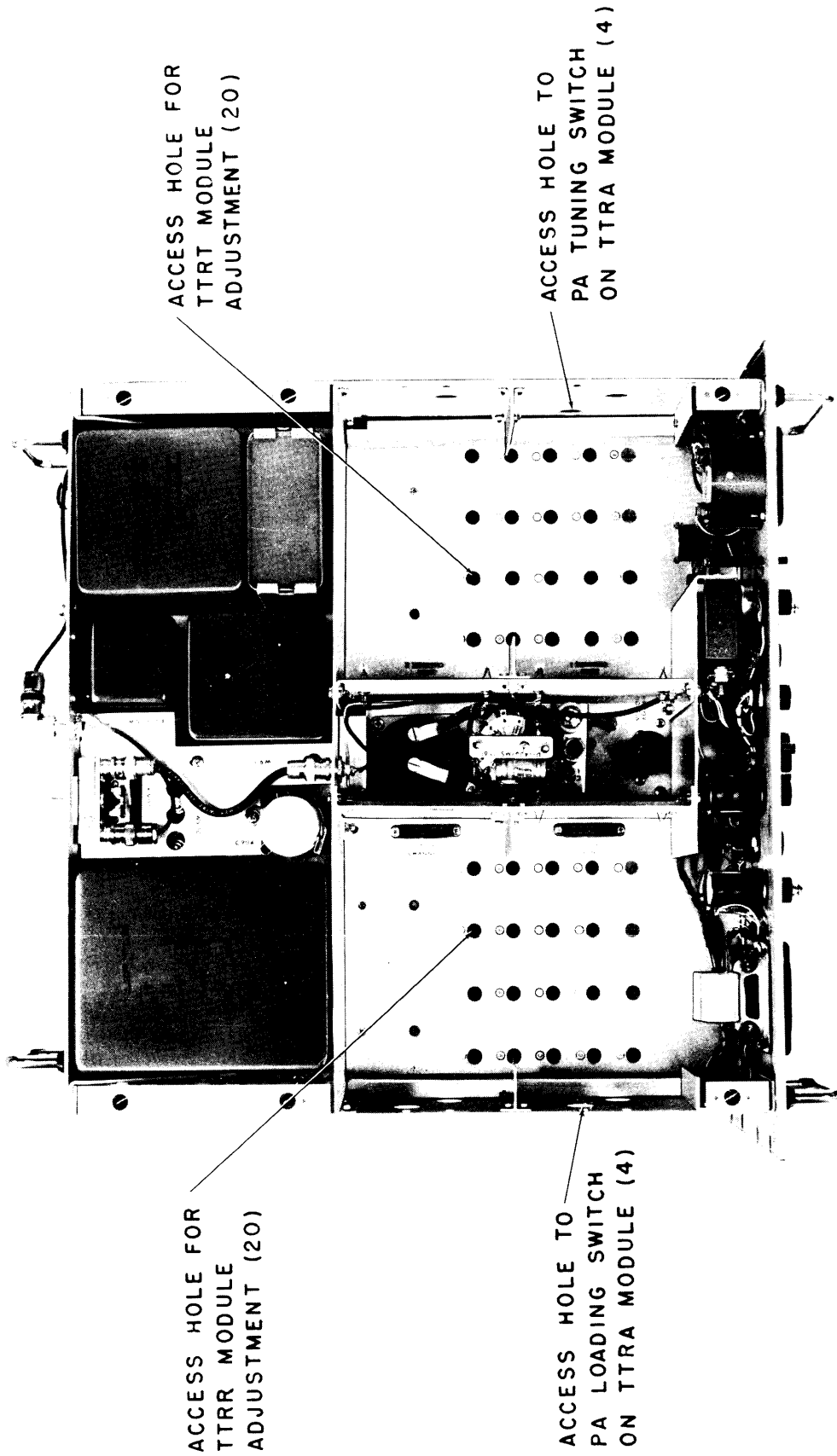


Figure 5-4. TTR-10, Top View With TTRA Modules Removed



652.18-6

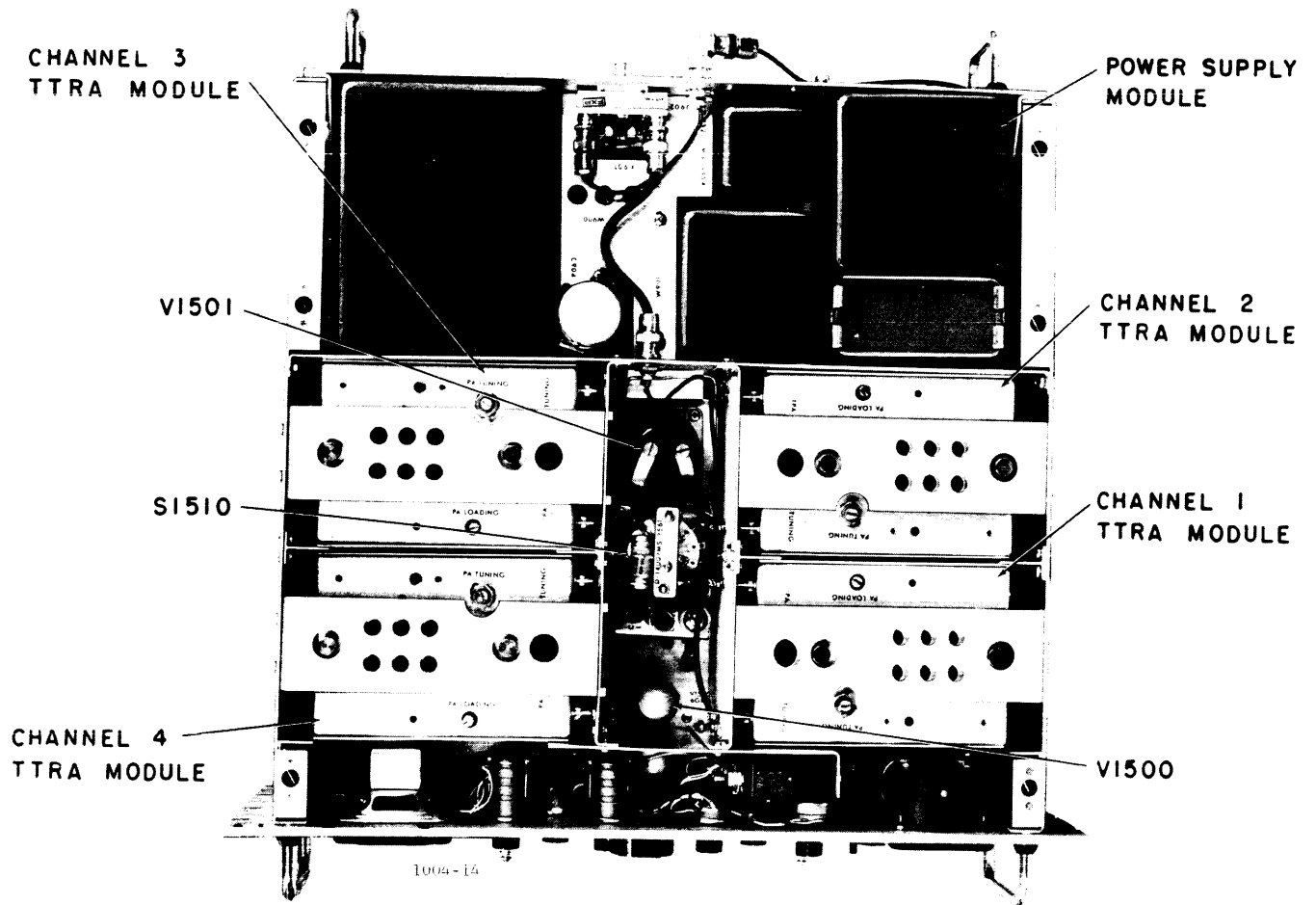


Figure 5-5. TTR-10, Top View

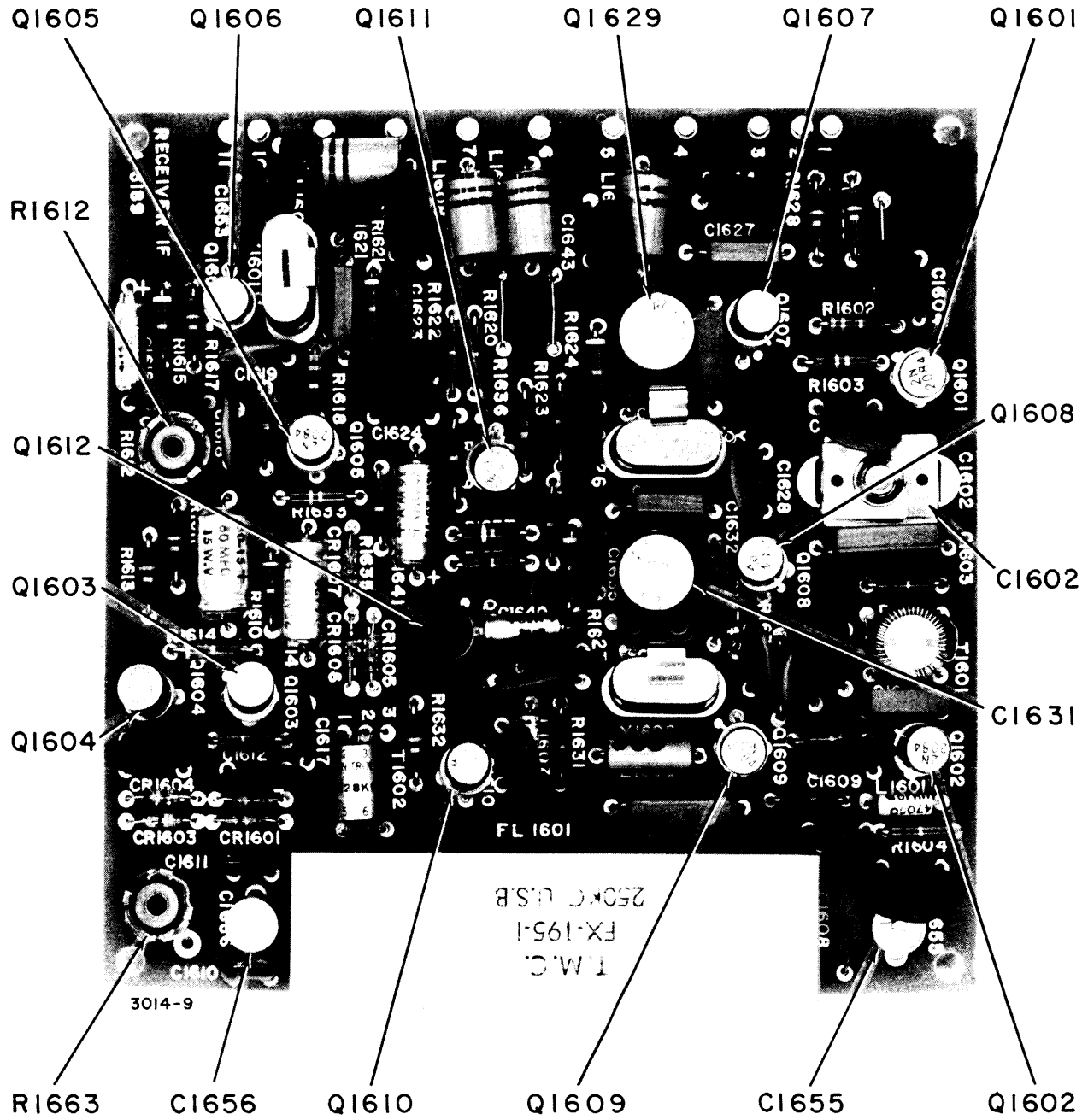


Figure 5-6. Receiver i-f Board, Top View

6412.16-3

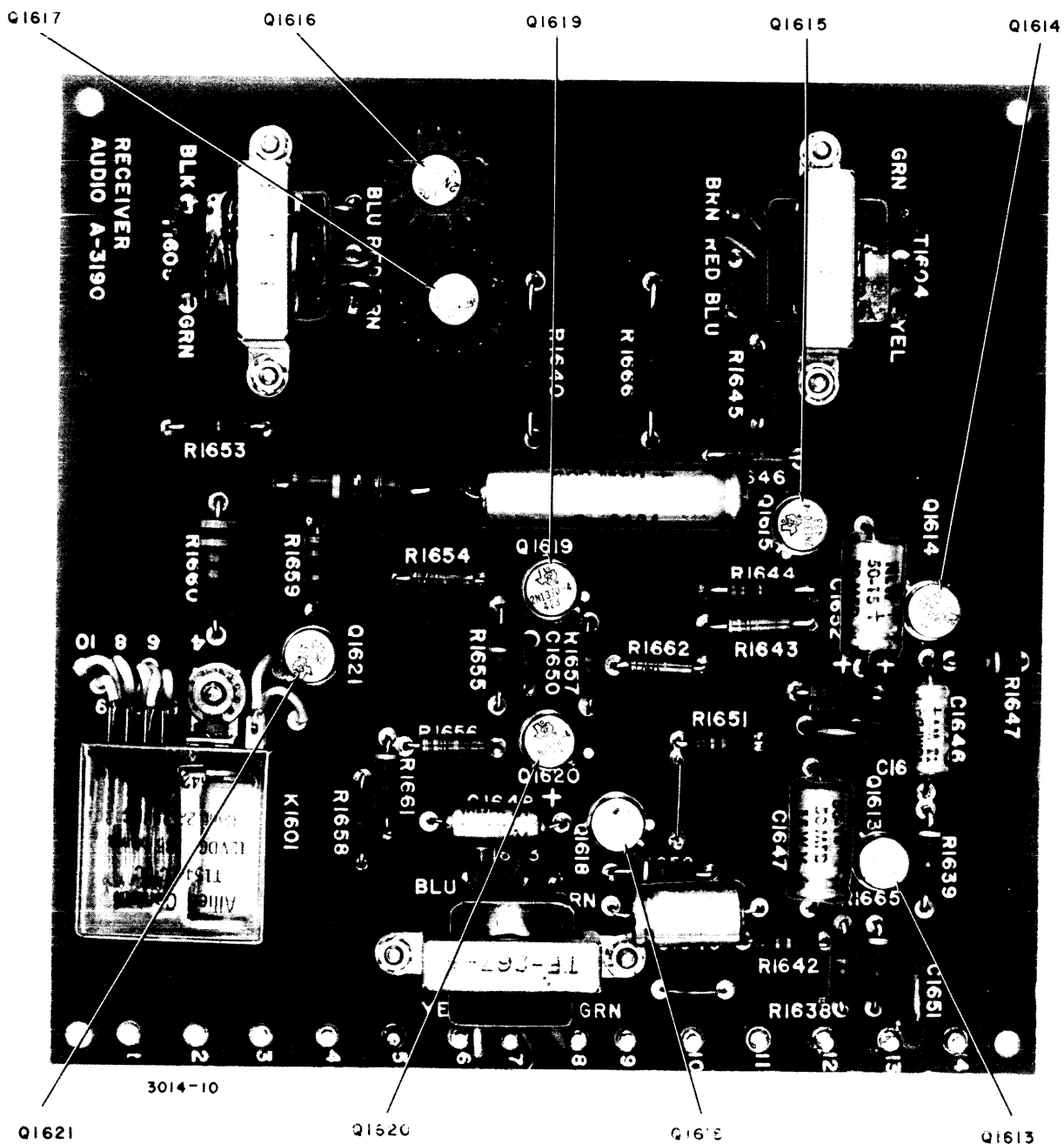


Figure 5-7. Receiver Audio Board, Top View

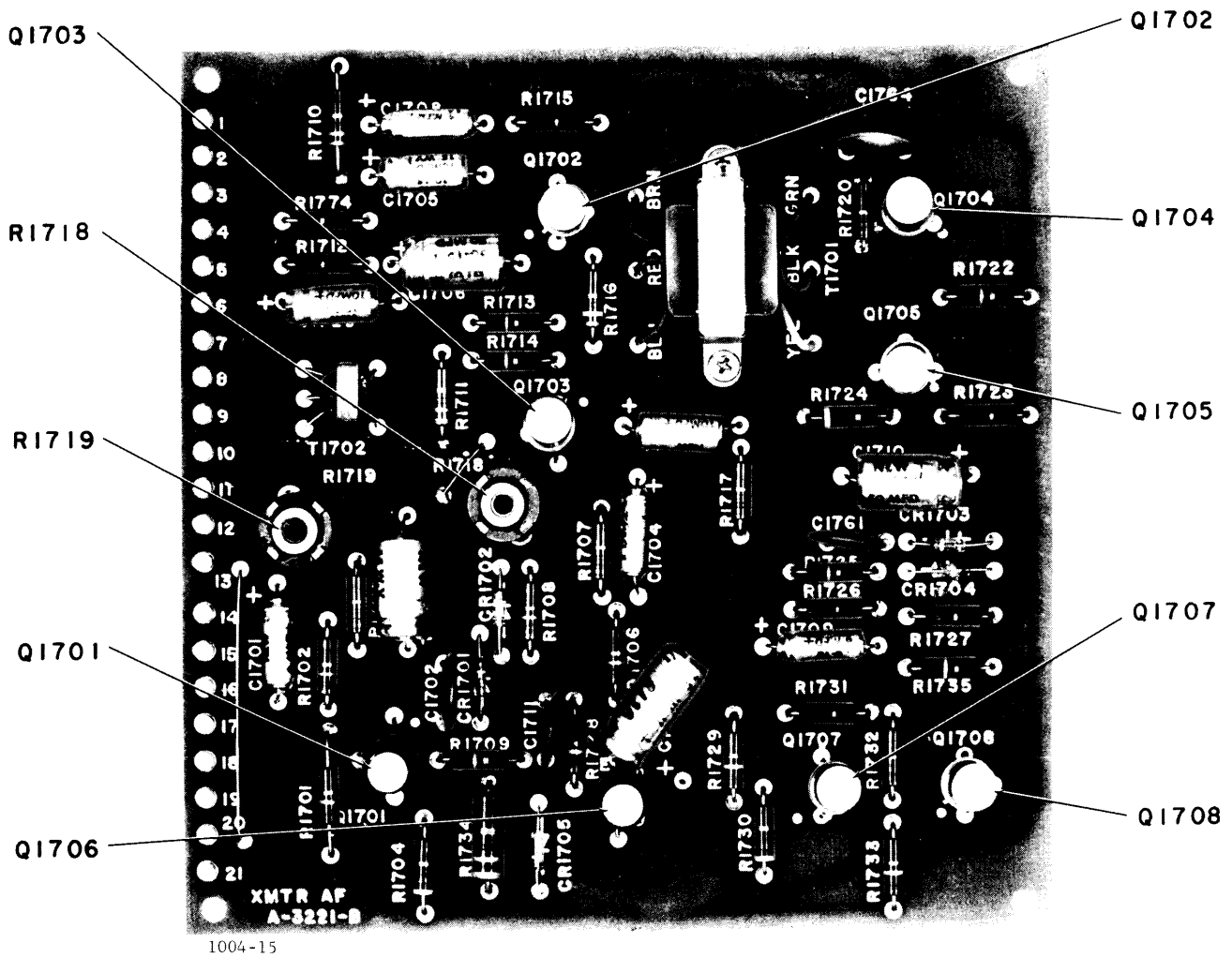
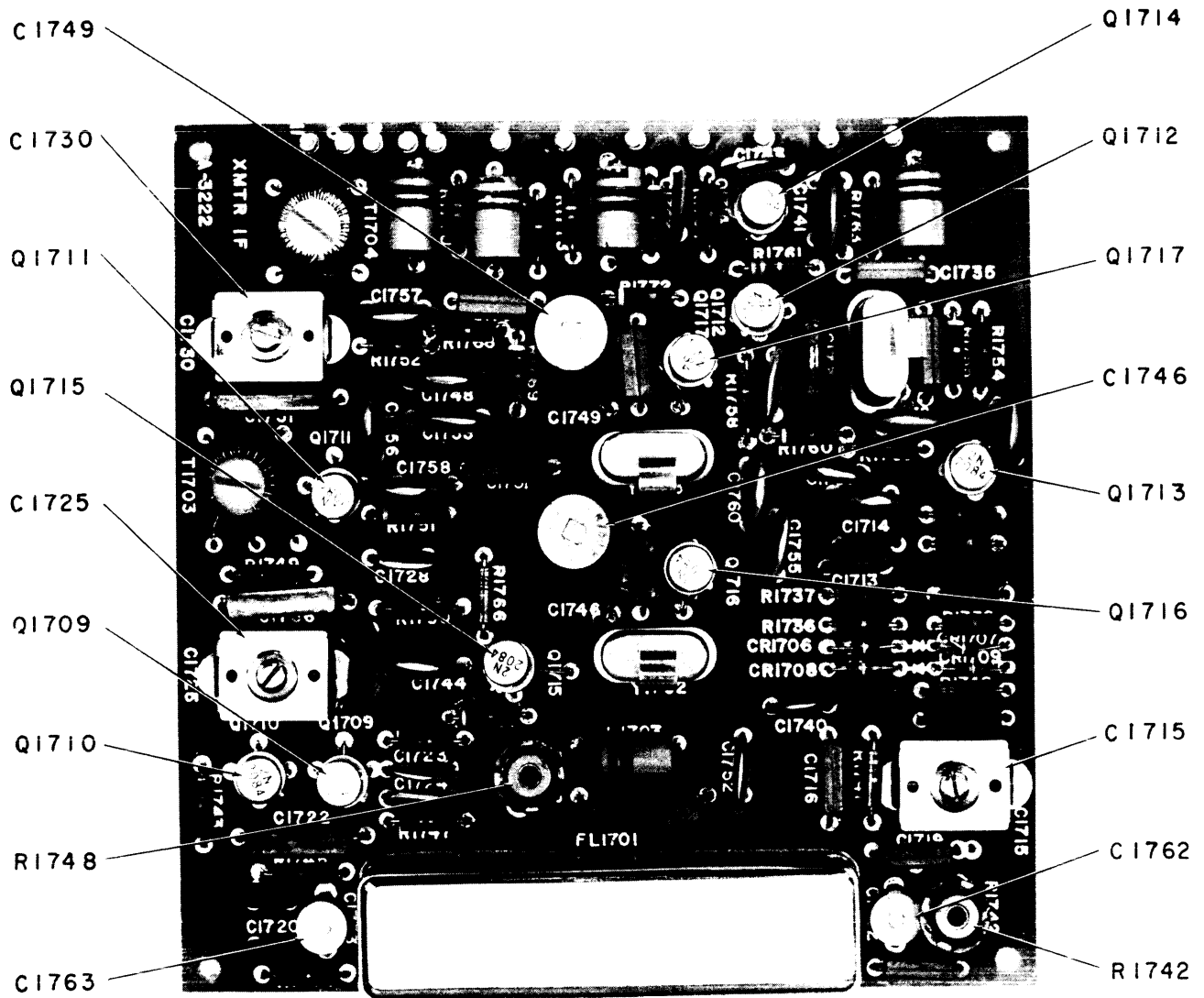


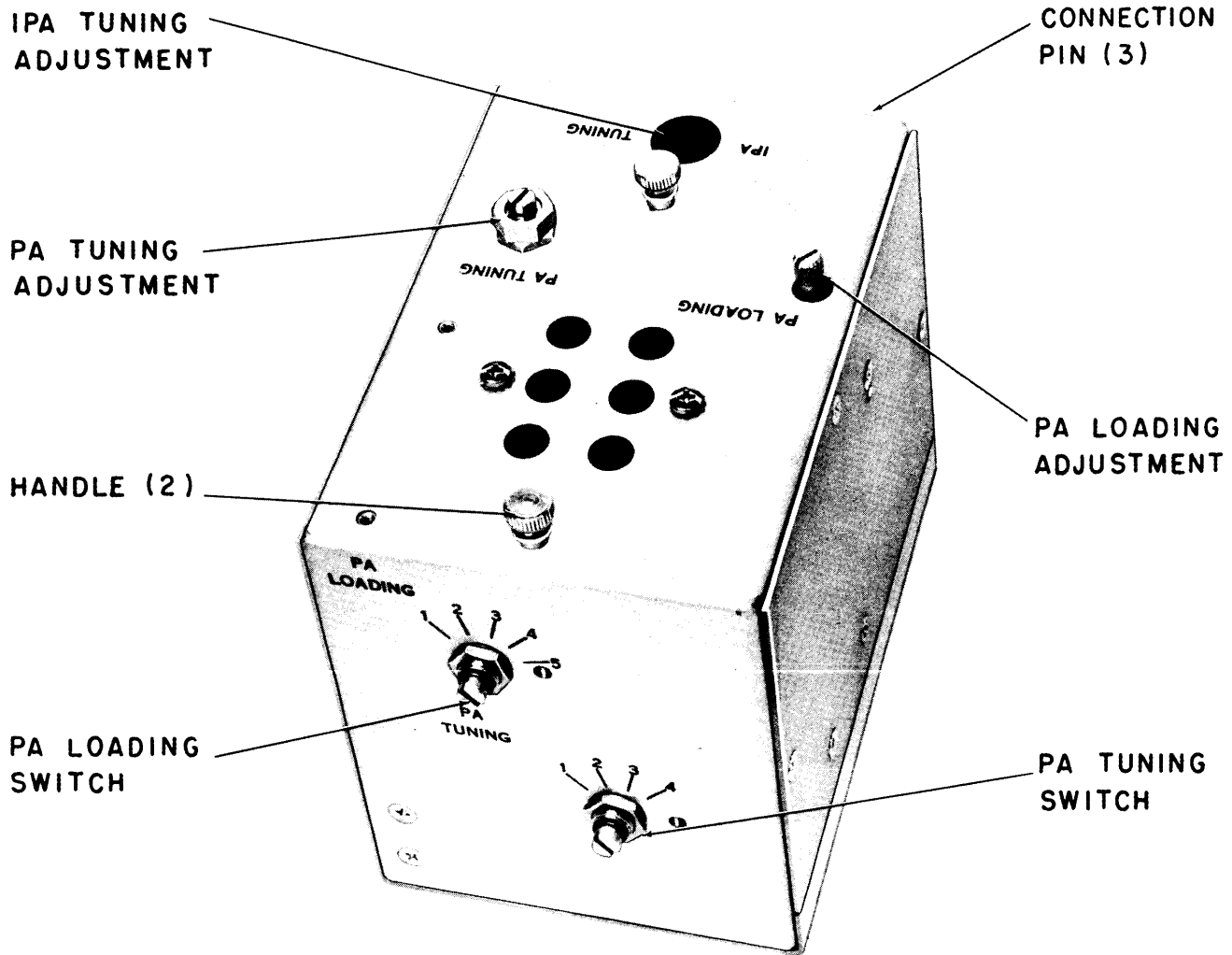
Figure 5-8. Xmtr Audio Board, Top View

6412.16-4



1904-15

Figure 5-9. Xmtr i-f Board, Top View



1004-17

Figure 5-10. TTRA Module

## **SECTION 6**

### **PARTS LIST**

#### 6-1 INTRODUCTION:

Reference designations have been assigned to identify all electrical parts of the equipment. These designations are used for marking the equipment (adjacent to the part they identify) and are included on drawings, diagrams and the parts list. The letters of a reference designation indicate the kind of part (generic group), such as resistor, capacitor, transistor, etc. The number differentiates between parts of the same generic group. Sockets associated with a particular plug-in device, such as transistor or fuse, are identified by a reference designation which includes the reference designation of the plug-in device. For example, the socket for crystal Y101 is designated XY101. To expedite delivery, when ordering replacement parts, specify the TMC part number and the model number of the equipment.

FINAL TUNE MODULE, 2-4 MC  
 SYMBOL SERIES 1100

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C1101	CAPACITOR, VARIABLE, MICA DIELECTRIC: 11 plates; 1,000 uuf min. when tight, 210 uuf max. at 3 turns; 175 WVDC.	CV113-4
C1102	CAPACITOR, FIXED, MICA DIELECTRIC: 1,500 uuf, $\pm 10\%$ ; 500 WVDC; char. B.	CM20B152K
C1103	CAPACITOR, VARIABLE, AIR DIELECTRIC: 12.9-342 uuf per sec.; 1 section, 59 plates per section; straight line capacity tuning; AC peak voltage 1,000 V.	CB168-1
C1104	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 10 uuf, $\pm 10\%$ ; 5,000 WVDC.	CC109-5
C1105	CAPACITOR, FIXED, MICA DIELECTRIC: 560 uuf, $\pm 10\%$ ; 2,500 WVDC; char. B.	CM45B561K
C1106	CAPACITOR, FIXED, MICA DIELECTRIC: 390 uuf, $\pm 10\%$ ; 2,500 WVDC; char. B.	CM45B391K
C1107	CAPACITOR, FIXED, MICA DIELECTRIC: 330 uuf, $\pm 10\%$ ; 2,500 WVDC; char. B.	CM45B331K
C1108	CAPACITOR, FIXED, MICA DIELECTRIC: 220 uuf, $\pm 2\%$ ; 2,500 WVDC; char. B.	CM45B221G
C1109	CAPACITOR, VARIABLE, MICA DIELECTRIC: 15 plates; 1,400 uuf min. when tight, 390 uuf max. at 3 turns; 175 WVDC.	CV113-8
C1110	CAPACITOR, FIXED, MICA DIELECTRIC: 1,000 uuf, $\pm 10\%$ ; 2,500 WVDC; char. B.	CM45B102K
C1111	Same as C1110.	
C1112	Same as C1110.	
C1113	Same as C1110.	
C1114	Same as C1108.	
J1101	CONNECTOR, RECEPTACLE, ELECTRICAL: 6 flat solid type male contacts, current rating 5 amps continuous, 600 VAC RMS.	JJ286-6
S1101	SWITCH, ROTARY: 1 section, 4 positions, 30° angle of throw; non-shorting type, silver alloy contacts.	SW330
S1102	SWITCH, ROTARY: 1 section, 5 positions, 30° angle of throw; shorting type, silver alloy contacts.	SW331
T1101	TRANSFORMER, RADIO FREQUENCY: operating frequency 2-4 MC; inductance, 8 uhy, $\pm 0.20$ uhy (BLK-BLU), 2.05 uhy, $\pm 0.2$ uhy (BLK-GRN); powdered iron coil form.	TZ117
T1102	TRANSFORMER, RADIO FREQUENCY: operating frequency 2-4 MC; total nom. inductance 9.5 uhy, $\pm 0.95$ uhy; phenolic coil form, 4 screw type terminals.	TZ120



REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C1201	CAPACITOR, VARIABLE, MICA DIELECTRIC: 6 plates; 480 uuf min. when tight, 80 uuf max. at 3 turns; 175 WVDC.	CV113-2
C1202	CAPACITOR, VARIABLE, AIR DIELECTRIC: 12.9-342 uuf per sec.; 1 section, 59 plates per section; straight line capacity tuning; AC peak voltage 1,000 V.	CB168-1
C1203	CAPACITOR, FIXED, MICA DIELECTRIC: 160 uuf, $\pm 10\%$ ; 2,500 WVDC; char. B.	CM45B161K
C1204	CAPACITOR, FIXED, MICA DIELECTRIC: 100 uuf, $\pm 10\%$ ; 2,500 WVDC; char. B.	CM45B101K
C1205	CAPACITOR, VARIABLE, MICA DIELECTRIC: 12 plates; 1,000 uuf min. when tight, 240 uuf max. at 3 turns; 175 WVDC.	CV113-7
C1206	CAPACITOR, FIXED, MICA DIELECTRIC: 560 uuf, $\pm 10\%$ ; 2,500 WVDC; char. B.	CM45B561K
C1207	Same as C1206.	
C1208	Same as C1206.	
C1209	Same as C1206.	
J1201	CONNECTOR, RECEPTACLE, ELECTRICAL: 6 flat solid type male contacts, current rating 5 amps continuous, 600 VAC RMS.	JJ286-6
S1201	SWITCH, ROTARY: 1 section, 4 positions, $30^\circ$ angle of throw; non-shorting type, silver alloy contacts.	SW330
S1202	SWITCH, ROTARY: 1 section, 5 positions, $30^\circ$ angle of throw; shorting type, silver alloy contacts.	SW331
T1201	TRANSFORMER, RADIO FREQUENCY: operating frequency 4-8 MC; inductance, 3.65 uhy, +0.10 uhy (BLK-BLU), 0.91 uhy, $\pm 0.05$ uhy (BLK-GRN); powdered iron coil form.	TZ118
T1202	TRANSFORMER, RADIO FREQUENCY: operating frequency 4-8 MC; total nom. inductance 4.5 uhy, $\pm 0.40$ uhy; phenolic coil form, 4 screw type terminals.	TZ121

FINAL TUNE MODULE, 8-16 MC  
 SYMBOL SERIES 1300

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C1301	CAPACITOR, VARIABLE, AIR DIELECTRIC: 3 plates; 180 uuf min. when tight, 9 uuf max. at 3 turns; 175 WVDC.	CV113-5
C1302	CAPACITOR, VARIABLE, AIR DIELECTRIC: 10-210 uuf per sec.; 1 section, 37 plates per section; straight line capacity tuning; AC peak voltage 1,000 V.	CB169-1
C1303	CAPACITOR, FIXED, MICA DIELECTRIC: 56 uuf, $\pm 10\%$ ; 2,500 WVDC; char. B.	CM45B560K
C1304	CAPACITOR, VARIABLE, AIR DIELECTRIC: 7 plates; 580 uuf min. when tight, 110 uuf max. at 3 turns; 175 WVDC.	CV113-6
C1305	CAPACITOR, FIXED, MICA DIELECTRIC: 390 uuf, $\pm 10\%$ ; 2,500 WVDC; char. B.	CM45B391K
C1306	Same as C1305.	
C1307	Same as C1305.	
C1308	CAPACITOR, FIXED, MICA DIELECTRIC: 160 uuf, $\pm 10\%$ ; 500 WVDC; char. B.	CM15B161K
C1309	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 5 uuf, $\pm 10\%$ ; 5,000 WVDC.	CC109-3
J1301	CONNECTOR, RECEPTACLE, ELECTRICAL: 6 flat solid type male contacts, current rating 5 amps continuous, 600 VAC RMS.	JJ286-6
S1301	SWITCH, ROTARY: 1 section, 4 positions, $30^\circ$ angle of throw; non-shorting type, silver alloy contacts.	SW330
S1302	SWITCH, ROTARY: 1 section, 5 positions, $30^\circ$ angle of throw; shorting type, silver alloy contacts.	SW331
T1301	TRANSFORMER, RADIO FREQUENCY: operating frequency 8-16 MC; inductance 1.46 uhy, $\pm 0.05$ uhy (BLK-BLU), 0.33 uhy, $\pm 0.05$ uhy (BLK-GRN); powdered iron coil form.	TZ116
T1302	TRANSFORMER, RADIO FREQUENCY: operating frequency 8-16 MC; inductance, 2.4 uhy, $\pm 0.24$ uhy; phenolic coil form; 4 screw type terminals.	TZ122

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C1401	CAPACITOR, VARIABLE, MICA DIELECTRIC: 4 plates; 280 uuf min. when tight, 25 uuf max. at 3 turns; 175 WVDC.	CV113-1
C1402	CAPACITOR, VARIABLE, AIR DIELECTRIC: 10-210 uuf per sec.; 1 section, 37 plates per section; straight line capacity tuning; AC peak voltage 1,000 V.	CB169-1
C1403	CAPACITOR, VARIABLE, MICA DIELECTRIC: 7 plates; 580 uuf min. when tight, 110 uuf max. at 3 turns; 175 WVDC.	CV113-6
C1404	CAPACITOR, FIXED, MICA DIELECTRIC: 220 uuf, $\pm 10\%$ ; 2,500 WVDC; char. B.	CM45B221K
C1405	Same as C1404.	
C1406	CAPACITOR, FIXED, MICA DIELECTRIC: 160 uuf, $\pm 10\%$ ; 2,500 WVDC; char. B.	CM45B161K
J1401	CONNECTOR, RECEPTACLE, ELECTRICAL: 6 flat solid type male contacts, current rating 5 amps continuous, 600 VAC RMS.	JJ286-6
S1401	SWITCH, ROTARY: 1 section, 4 positions, $30^{\circ}$ angle of throw; non-shorting type, silver alloy contacts.	SW330
S1402	SWITCH, ROTARY: 1 section, 5 positions, $30^{\circ}$ angle of throw; shorting type, silver alloy contacts.	SW331
T1401	TRANSFORMER, RADIO FREQUENCY: operating frequency 16-32 MC; inductance, 0.34 uhy, $+0.05$ uhy (BLK-BLU), 0.11 uhy, $+0.05$ uhy (BLK-GRN); powdered iron coil form.	TZ119
T1402	TRANSFORMER, RADIO FREQUENCY: operating frequency 16-32 MC; inductance, 1.21 uhy, $+0.12$ uhy; cellulose acetate support bars; 2 screw type terminals and 3 wire lead type terminals.	TZ123

MAIN CHASSIS ASSEMBLY  
 SYMBOL SERIES 1500

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C1500	CAPACITOR, FIXED, ELECTROLYTIC: 2,000 uf, 25 WVDC; polarized; hermetically sealed aluminum case with clear vinyl plastic sleeve.	CE116-5VN
C1501	CAPACITOR, FIXED, CERAMIC, FEEDTHRU: 2,000 uuf, $\pm 20\%$ ; 500 WVDC.	CK70AW202M
C1502	CAPACITOR, FIXED, MICA DIELECTRIC: 510 uuf, $\pm 5\%$ ; 500 WVDC; char. B.	CM15B511J
C1503	CAPACITOR, FIXED, MICA DIELECTRIC: 1,000 uuf, $\pm 5\%$ ; 500 WVDC; char. B.	CM20B102J
C1504	CAPACITOR, FIXED, MICA DIELECTRIC: 1,000 uuf, $\pm 5\%$ ; 500 WVDC/350 WVAC at 85°C.	CM113QE102J
C1505	CAPACITOR, FIXED, MICA DIELECTRIC: 2,000 uuf, $\pm 2\%$ ; 500 WVDC; char. F.	CM100-14
C1506	Same as C1504.	
C1507	CAPACITOR, FIXED, MICA DIELECTRIC: 3,000 uuf, $\pm 5\%$ ; 500 WVDC; char. B.	CM30B302J
C1508	Same as C1501.	
C1509	Same as C1501.	
C1510	CAPACITOR, FIXED, MICA DIELECTRIC: 8,100 uuf, $\pm 5\%$ ; 500 WVDC/350 WVAC at 85°C.	CM113QE812J
C1511	Same as C1503.	
C1512	Same as C1504.	
C1513	Same as C1510.	
C1514	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 5 uuf, $\pm 10\%$ ; 5,000 WVDC.	CC109-3
C1515	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 3.0 uuf, $\pm 0.5$ uuf; 500 WVDC; char. CJ.	CC21CJ030D
C1516	Same as C1510.	
C1517	CAPACITOR, FIXED, MICA DIELECTRIC: 15 uuf, $\pm 2\%$ ; 500 WVDC; char. G.	CM15C150G
C1518	CAPACITOR, FIXED, MICA DIELECTRIC: 1,000 uuf, $\pm 5\%$ ; 500 WVDC; char. D.	CM20D102J
C1519	Same as C1518.	
C1520	Same as C1501.	
C1521	Same as C1503.	
C1522 thru C1524	Same as C1504.	

MAIN CHASSIS ASSEMBLY  
SYMBOL SERIES 1500

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C1525	CAPACITOR, FIXED, PLASTIC DIELECTRIC: .001 uf, $\pm 5\%$ ; 3,000 WVDC; RF current carrying capacity 1 amp at 32 MC; hermetically sealed glass case, metalized ends.	CX109-1
C1526	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 1,000 $\mu$ uf, $\pm 20\%$ ; 5,000 WVDC.	CC109-38
C1527	Same as C1526.	
C1528	Same as C1515.	
C1529	Same as C1517.	
C1530	Same as C1501.	
C1531	Same as C1501.	
C1532	NOT USED	
C1533	Same as C1526.	
C1534	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 10,000 uuf, GMV; 500 WVDC.	CC100-16
C1535	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 200,000 uuf, $+80\%$ $-20\%$ ; 25 WVDC.	CC100-33
C1536	Same as C1534.	
C1537	Same as C1534.	
C1538	CAPACITOR, FIXED, ELECTROLYTIC: 50 uf, $-10\%$ $+150\%$ at 120 cps at $25^{\circ}\text{C}$ ; 15 WVDC; polarized; insulated tubular case.	CE105-50-15
C1539	NOT USED	
C1540	NOT USED	
C1541	CAPACITOR, FIXED, MICA DIELECTRIC: 39 uuf, $\pm 10\%$ ; 500 WVDC; char. B.	CM15B390K
C1542	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 5,000 uuf, GMV; 500 WVDC.	CC100-15
C1543	Same as C1535.	
C1544	CAPACITOR, FIXED, ELECTROLYTIC: 5 uf, $-10\%$ $+150\%$ at 120 cps at $25^{\circ}\text{C}$ ; 15 WVDC; polarized; insulated tubular case.	CE105-5-15
C1545	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 1,000 uuf, $+80\%$ $-20\%$ ; 500 WVDC.	CC100-32
CB1500	CIRCUIT BREAKER: SPST; magnetic and hydraulic combination blow-out; contacts rated at 250 VAC, 50/60 cps, 15 amps; coil rated at 0.06 amps DC; insulated for 1,500 V; shunt trip release; delay curve 5; toggle lever type; overload protection; manual reset.	SW262
CR1500	SEMICONDUCTOR DEVICE, DIODE: silicon; 175 V max. peak inverse voltage; 30 ma at $25^{\circ}\text{C}$ and 15 ma at $150^{\circ}\text{C}$ ; two axial wire lead	1N463

MAIN CHASSIS ASSEMBLY  
 SYMBOL SERIES 1500

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
CR1500 (Cont)	type terminals; hermetically sealed glass case.	
CR1501	Same as CR1500.	
DS1500	LAMP, GLOW: cartridge type; white, plastic, unfrosted, stovepipe type lens; 33,000 ohm, 1/3 watt internal resistor; NE-2H neon type lamp rated at 1/15 watt nom., starting voltage 65 VAC or 90 VDC, circuit voltage 100 to 125 VAC/VDC; aluminum clear anodize body.	BI112-2
EV1500	SHIELD, ELECTRON TUBE: heat dissipating; 2-3/4" high x 1" sq.; black cadmium plated finger insert liner.	TS128-7
J1500	CONNECTOR, RECEPTACLE, ELECTRICAL: 24 flat male contacts, rated at 5 amps, 750 WVDC; float mounted.	JJ296-1
J1501	CONNECTOR, RECEPTACLE, ELECTRICAL: RF; 1 round female contact; straight type; 52 ohms; series BNC to BNC.	UG625B/U
J1502	Same as J1501.	
J1503	CONNECTOR, RECEPTACLE, ELECTRICAL: 6 female, flat, solid face contacts, rated at 5 amps continuous, 600 V RMS; green, glass filed diallyl, phthalate.	JJ285-6
J1504 thru J1506	Same as J1503.	
J1507	CONNECTOR, RECEPTACLE, ELECTRICAL: PC board type; 20 female contacts, 5 amps continuous current rating; 600 V RMS.	JJ287-20
J1508 thru J1514	Same as J1507.	
J1515	SOCKET, PANEL MOUNT: 6 male type contacts.	JJ212
K1500	RELAY, ARMATURE: 6PDT; 185 ohms, +10% DC resistance; operating voltage 12 VDC; current rating 60 ma; 700 mw at 25°C; 20 contacts rated at 2 amps at 29 VDC resistance; clear high impact styrene dust cover case.	RL156-6
K1501	RELAY, ARMATURE: DPDT, miniature; (2 form C) contacts, 0.030 ohm max. per contact; contacts rated at 3 amps, 26.5 VDC; coil rated at 200 ohms DC resistance, 12.6 VDC nom., 0.034 min. operating amps; nom. coil operating power 250 mw; coil dissipation 1 watt at 125°C, 1.5 watts at 25°C; hermetically sealed.	RL143-3
K1502	Same as K1501.	
L1500	COIL, RADIO FREQUENCY: fixed; inductance, 2.55 uhy, +0.1 uh; 0.008 ohms DC resistance; current rating 3.5 amps at 60 cps; solid coil form.	CL318
L1501	COIL, RADIO FREQUENCY: fixed; 120.0 uh, +10%; 3.2 ohms DC resistance; molded case.	CL240-120
L1502 thru L1504	Same as L1501.	

MAIN CHASSIS ASSEMBLY  
SYMBOL SERIES 1500

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
L1505	Same as L1500.	
L1506	Same as L1501.	
L1507	COIL, RADIO FREQUENCY: fixed; 1.1 uhy nom. ; operating frequency 7.9 MC; powdered iron core.	CL139
L1508	CHOKER, RADIO FREQUENCY: inductance, 750 uh, +10%; current rated at 75 to 100 ma; approx. resistance 16.0 ohms; molded bakelite form.	CL100-5
L1509 thru L1513	Same as L1501.	
L1514	COIL, RADIO FREQUENCY: fixed; inductance, 180 uh (170-190 uh); operating frequency 790 KC; powdered iron core.	CL319
L1515	COIL, RADIO FREQUENCY: fixed; inductance, 180 uh (170-190 uh); operating frequency 790 KC; powdered iron core.	CL317
L1516	NOT USED	
L1517	Same as L1501.	
L1518	Same as L1501.	
L1519	Same as L1515.	
LS1500	LOUDSPEAKER, PERMANENT MAGNET: operating frequency range 200 to 5,000 cps; voice coil impedance 3.2 ohms; input wattage, nom. 1 watt, peak 2 watts; 2-17/32" square x 1-19/32" deep.	LS106
M1500	METER, ARB SCALE: 0-50 ua movement; approx. resistance 2,000 ohms; black molded phenolic case.	MR172
PS1500	SUPPRESSOR, PARASITIC	AX163
PS1501	SUPPRESSOR, PARASITIC	AX391
PS1502	Same as PS1501.	
Q1500	TRANSISTOR: germanium; NPN; JEDEC type 2N1308 transistor with a controlled hfe limit of 80-150; JEDEC type T05 case.	TX106
R1500	RESISTOR, VARIABLE, COMPOSITION: 50,000 ohms, +20%; continuous power rating 0.5 watt at 70°C; 350 V RMS; linear taper.	RV106UX8B503B
R1501	RESISTOR, FIXED, COMPOSITION: 220 ohms, +5%; 1 watt.	RC32GF221J
R1502	RESISTOR, FIXED, COMPOSITION: 10,000 ohms, +5%; 1/2 watt.	RC20GF103J
R1503	RESISTOR, FIXED, COMPOSITION: 47 ohms, +10%; 1/2 watt.	RC20GF470K
R1504	RESISTOR, FIXED, COMPOSITION: 180 ohms, +5%; 2 watts.	RC42GF181J
R1505	RESISTOR, FIXED, COMPOSITION: 4,700 ohms, +5%; 1 watt.	RC32GF472J
R1506	RESISTOR, FIXED, COMPOSITION: 10 ohms, +5%; 1 watt.	RC32GF100J

MAIN CHASSIS ASSEMBLY  
 SYMBOL SERIES 1500

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R1507	RESISTOR, VARIABLE, COMPOSITION: 50,000 ohms, $\pm 10\%$ ; nom. power rating 0.25 watt at 70°C; linear taper.	RV111U503A
R1508	RESISTOR, FIXED, COMPOSITION: 27,000 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF273J
R1509	RESISTOR, VARIABLE, COMPOSITION: 250,000 ohms, $\pm 10\%$ ; nom. power rating 0.25 watt at 70°C; linear taper.	RV111U254A
R1510	RESISTOR, FIXED, COMPOSITION: 1,000 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF102J
R1511	Same as R1509.	
R1512	Same as R1510.	
R1513	RESISTOR, VARIABLE, COMPOSITION: 10,000 ohms, $\pm 20\%$ ; 2 watts; taper A.	RV4NAYSA103BYY
R1514	RESISTOR, VARIABLE, COMPOSITION: 5,000 ohms, $\pm 20\%$ ; 2 watts; taper A.	RV4NAYSA502BYY
R1515	RESISTOR, VARIABLE, COMPOSITION: 5,000 ohms, $\pm 20\%$ ; 2 watts; taper A.	RV4NAYSC502BYY
R1516	NOT USED	
R1517	RESISTOR, VARIABLE, COMPOSITION: 500 ohms, $\pm 20\%$ ; 2 watts; taper A.	RV4NAYSA501BYY
R1518	Same as R1514.	
R1519	Same as R1510.	
R1520	RESISTOR, FIXED, COMPOSITION: 68 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF680J
R1521	Same as R1520.	
R1522	Same as R1502.	
R1523	Same as R1502.	
R1524	RESISTOR, FIXED, COMPOSITION: 3,900 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF392J
R1525	Same as R1524.	
R1526	Same as R1502.	
R1527	RESISTOR, FIXED, COMPOSITION: 43,000 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF433J
R1528	RESISTOR, FIXED, COMPOSITION: 4,700 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF472J
R1529 thru R1531	Same as R1528.	
R1532	RESISTOR, FIXED, COMPOSITION: 1,800 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF182J
R1533	RESISTOR, VARIABLE, COMPOSITION: 10,000 ohms, $\pm 10\%$ ; nom. power rating 0.25 watt at 70°C; counter clockwise modified log taper.	RV111B103A
R1534	Same as R1528.	



MAIN CHASSIS ASSEMBLY  
SYMBOL SERIES 1500

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R1535	RESISTOR, FIXED, COMPOSITION: 47,000 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF473J
R1536	Same as R1502.	
R1537	RESISTOR, FIXED, COMPOSITION: 110,000 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF114J
R1538	RESISTOR, FIXED, COMPOSITION: 680 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF681J
R1539	RESISTOR, FIXED, COMPOSITION: 47 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF470J
R1540	RESISTOR, FIXED, COMPOSITION: 75 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF750J
R1541	RESISTOR, FIXED, COMPOSITION: 330 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF331J
R1542	RESISTOR, FIXED, COMPOSITION: 1 megohm, $\pm 5\%$ ; 1/2 watt.	RC20GF105J
R1543	Same as R1500.	
R1544	Same as R1500.	
R1545 thru R1547	NOT USED	
R1548	RESISTOR, FIXED, COMPOSITION: 330,000 ohms, $\pm 10\%$ ; 1/2 watt.	RC20GF334K
R1549	RESISTOR, FIXED, COMPOSITION: 22 ohms, $\pm 10\%$ ; 1/2 watt.	RC20GF220K
R1550	RESISTOR, FIXED, COMPOSITION: 1,800 ohms, $\pm 10\%$ ; 1/2 watt.	RC20GF182K
R1551	RESISTOR, FIXED, COMPOSITION: 33,000 ohms, $\pm 10\%$ ; 1/2 watt.	RC20GF333K
R1552	Same as R1500.	
R1553	Same as R1500.	
R1554	NOT USED	
R1555	NOT USED	
R1556	RESISTOR, FIXED, COMPOSITION: 100,000 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF104J
S1500	SWITCH, ROTARY: tap; 3 decks, 3 non-shorting type contacts; AC current type; max. voltage 115 V; max. current switching capacity 1 amp resistive; 10 amps continuous current rating; solder lug type terminals.	SW336-4
S1501	SWITCH, ROTARY: tap; 1 deck, 2 non-shorting type contacts; AC current type; max. voltage 115 V; max. current switching capacity 1 amp resistive; 10 amps continuous current rating; solder lug type terminals.	SW336-1
S1502 thru S1504	Same as S1501.	
S1505	SWITCH, ROTARY: 2 sections, 5 positions, $30^\circ$ angle of throw; non-shorting type contacts and rotors.	SW340
S1506	SWITCH, ROTARY: tap; 2 decks, 2 non-shorting type contacts; AC current type; max. voltage 115 V; max. current switching capacity 1 amp resistive; 10 amps continuous current rating; solder lug type terminals.	SW336-2
S1507	SWITCH, ROTARY: 5 sections, 5 positions, $30^\circ$ angle of throw; non-shorting type contacts and rotors.	SW338
S1508	SWITCH, ROTARY: 5 sections, 4 positions, $30^\circ$ angle of throw; non-shorting type contacts and rotors.	SW337

MAIN CHASSIS ASSEMBLY  
 SYMBOL SERIES 1500

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
S1509	SWITCH, ROTARY: 5 sections, 4 positions, 30° angle of throw; non-shorting type contacts and rotors.	SW339
S1510	SWITCH, ROTARY: 3 sections, 4 positions, 30° angle of throw; non-shorting type, silver alloy, contacts and rotors.	SW334
S1511	SWITCH, ROTARY: tap; 2 decks, 3 non-shorting type contacts; AC current type; max. voltage 115 V; max. current switching capacity 1 amp resistive; 10 amps continuous current rating; solder lug type terminals.	SW336-3
S1512	SWITCH, ROTARY	SW393
S1513	SWITCH, SENSITIVE: with actuator; SPDT; current rating 5.0 amps at 125/250 VAC; 7 amps resistive; 4 amps inductive at 28 VDC; style 1 type, stainless steel actuator; plastic body.	SW353-2
T1500	TRANSFORMER, HIGH FREQUENCY: toroidal core; potted plastic compound.	TF173
T1501	TRANSFORMER, AUDIO FREQUENCY: miniature; frequency range 100 cps to 20 KC; primary impedance 200,000 ohms, 6,500 ohms DC resistance; secondary impedance 1,000 ohms, 245 ohms DC resistance; fully enclosed black molded epoxy case.	TF246-6X
TB1500	TERMINAL BOARD, BARRIER: 12 terminals; 6-32 thd. x 1/4" lg. binder head screws; phenolic black bakelite.	TM100-12
TB1501	Same as TB1500.	
TB1502	TERMINAL BOARD, BARRIER: 11 terminals; 6-32 thd. x 1/4" lg. binder head screws; phenolic black bakelite. (Supplied when Antenna Coupler, TTC-1 is required by customer)	TM100-11
V1500	TUBE, ELECTRON: power pentode; 9 pin miniature.	6GK6
V1501	TUBE, ELECTRON: twin tetrode; 7 pin miniature.	8117
W1500	CABLE ASSEMBLY: RF; consists of various lengths of RG188/U coaxial cable; no ferrules.	CA418-6
W1501	WIRING HARNESS, BRANCHED, ELECTRICAL: consists of various lengths and colors of MWC and LWC wire; RG174/U coaxial cable; insulation sleeving; cable clamps and hardware; 9 cable connectors, J1500, J1507 thru J1514.	CA833
W1502	LEAD, ELECTRICAL: consists of 2" length of MWC wire and terminal lugs.	CA409-32-2.00
XDS1500	LAMPHOLDER: accommodates TMC part No. BI112 type lamp; phosphor bronze, silver plated and gold finished contacts; black anodized aluminum body.	TS164
XV1500	SOCKET, ELECTRON TUBE: 9 pin miniature.	TS103P01
XV1501	SOCKET, ELECTRON TUBE: 7 pin contact.	TS168-1

IF AND AUDIO RECEIVER BOARD ASSEMBLIES  
MAIN CHASSIS (SYMBOL SERIES 1600)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C1601	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 100,000 uuf, +80% -20%; 100 WVDC.	CC100-28
C1602	CAPACITOR, VARIABLE, MICA DIELECTRIC: 280 uuf max. when tight, 25 uuf max. at 3 turns; 175 WVDC.	CV114-1
C1603	CAPACITOR, FIXED, MICA DIELECTRIC: 1,800 uuf, +2% WVDC.	CM100-13
C1604	CAPACITOR, VARIABLE, CERAMIC DIELECTRIC: 10-75 uuf, oper- ating temperature range -55°C to +85°C; 350 WVDC.	CV109-8
C1605	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 200,000 uuf, +80% -20%; 25 WVDC.	CC100-33
C1606	Same as C1601.	
C1607	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 25,000 uuf, +80% -20%; 500 WVDC.	CC100-25
C1608	CAPACITOR, FIXED, MICA DIELECTRIC: 68 uuf, +2% char. C.	CM15C680G
C1609	CAPACITOR, FIXED, MICA DIELECTRIC: 510 uuf, +5% char. B.	CM15B511J
C1610	CAPACITOR, FIXED, MICA DIELECTRIC: 180 uuf, +2% straight wire leads.	CM111D181G5S
C1611	Same as C1610.	
C1612	Same as C1607.	
C1613	Same as C1607.	
C1614	CAPACITOR, FIXED, ELECTROLYTIC: 25 uf, -10% +150% at 120 cps at 25°C; 15 WVDC; polarized; insulated tubular case.	CE105-25-15
C1615	CAPACITOR, FIXED, ELECTROLYTIC: 50 uf, -10% +150% at 120 cps at 25°C; 15 WVDC; polarized; insulated tubular case.	CE105-50-15
C1616	CAPACITOR, FIXED, ELECTROLYTIC: 4 uf, -10% +150% at 120 cps at 25°C; 15 WVDC; polarized; insulated tubular case.	CE105-4-15
C1617	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 10,000 uuf, GMV; 500 WVDC.	CC100-16
C1618	Same as C1605.	
C1619	Same as C1605.	
C1620	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 5,000 uuf, GMV; 500 WVDC.	CC100-15
C1621	CAPACITOR, FIXED, MICA DIELECTRIC: 270 uuf, +5% char. C.	CM15C271J
C1622	Same as C1617.	
C1623	CAPACITOR, FIXED, MICA DIELECTRIC: 47 uuf, +5% char. C.	CM15C470J

IF AND AUDIO RECEIVER BOARD ASSEMBLIES  
 MAIN CHASSIS (SYMBOL SERIES 1600)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C1624	Same as C1601.	
C1625	Same as C1601.	
C1626	Same as C1601.	
C1627	Same as C1621.	
C1628	Same as C1605.	
C1629	CAPACITOR, VARIABLE, CERAMIC DIELECTRIC: 8-50 uuf; operating temperature range -55°C to +85°C; 350 WVDC.	CV109-6
C1630	CAPACITOR, FIXED, MICA DIELECTRIC: 24 uuf, $\pm 5\%$ ; 500 WVDC; char. C.	CM15C240J
C1631	Same as C1629.	
C1632	Same as C1630.	
C1633	Same as C1621.	
C1634	Same as C1605.	
C1635	Same as C1601.	
C1636	Same as C1601.	
C1637	Same as C1617.	
C1638	Same as C1605.	
C1639	Same as C1617.	
C1640	CAPACITOR, FIXED, ELECTROLYTIC: 6 uf, $-10\%$ $+150\%$ at 120 cps at 25°C; 15 WVDC; polarized; insulated tubular case.	CE105-6-15
C1641	Same as C1614.	
C1642	Same as C1617.	
C1643	Same as C1601.	
C1644	Same as C1601.	
C1645	CAPACITOR, FIXED, MICA DIELECTRIC: 1,000 uuf, $\pm 2\%$ ; 500 WVDC; char. F.	CM20F102G
C1646	CAPACITOR, FIXED, ELECTROLYTIC: 10 uf, $-10\%$ $+150\%$ at 120 cps at 25°C; 15 WVDC; polarized; insulated tubular case.	CE105-10-15
C1647	Same as C1615.	
C1648	Same as C1646.	
C1649	Same as C1615.	
C1650	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 1,000 uuf, GMV; 500 WVDC.	CC100-29

IF AND AUDIO RECEIVER BOARD ASSEMBLIES  
MAIN CHASSIS (SYMBOL SERIES 1600)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C1651	Same as C1601.	
C1652	Same as C1615.	
C1653	Same as C1601.	
C1654	Same as C1605.	
C1655	CAPACITOR, VARIABLE, CERAMIC DIELECTRIC: 9-35 uuf; operating temperature range -55°C to +125°C; 100 WVDC.	CV112-2
C1656	Same as C1655.	
C1657	Same as C1601.	
C1658	CAPACITOR, FIXED, MICA DIELECTRIC: 10 uuf, $\pm 5\%$ ; 500 WVDC; char. C.	CM15C100J
C1659	NOT USED	
C1660	CAPACITOR, FIXED, ELECTROLYTIC: 200 uf, -10% +150% at 120 cps at 25°C; 15 WVDC; polarized; insulated tubular case.	CE105-200-15
C1661	CAPACITOR, FIXED, MICA DIELECTRIC: 680 uuf, $\pm 5\%$ ; 500 WVDC; straight wire leads.	CM111E681J5S
CR1601	SEMICONDUCTOR DEVICE, DIODE: germanium; max. peak inverse voltage 60 V; continuous average forward current 50 ma; max. peak forward current 150 ma; max. surge current 500 ma; max. inverse current 500 ua at 50 volts or 30 ua at 10 volts.	1N34A
CR1602 thru CR1604	Same as CR1601.	
CR1605	SEMICONDUCTOR DEVICE, DIODE: silicon; forward current 5 ma at 1 volt; reverse current 625 ua at 100 volts, 25°C.	1N68
CR1606	Same as CR1605.	
CR1607	Same as CR1605.	
EQ1601 thru EQ1615	NOT USED.	
EQ1616	HEAT SINK: transistor heat dissipating element.	HD101-1
EQ1617	Same as EQ1616.	
FL1601	FILTER, BANDPASS: operating frequency 250 KC; bandwidth, 250.3 KC to 253.3 KC; input and output impedance 100K ohms nom.; hermetically sealed brass case.	FX195-1
K1601	RELAY, ARMATURE: 4PDT; 185 ohms, +10% DC resistance; operating voltage 12 VDC; current rating 60 ma; 700 mu at 25°C; 14 contacts rated for 2 amps at 20 VDC resistance; clear high impact styrene dust cover case.	RL165-2
L1601	COIL, RADIO FREQUENCY: fixed; 47,000 uh, $\pm 5\%$ ; 452 ohms DC resistance; current rating 27 ma; molded case.	CL275-473

IF AND AUDIO RECEIVER BOARD ASSEMBLIES  
 MAIN CHASSIS (SYMBOL SERIES 1600)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
L1602	COIL, RADIO FREQUENCY: fixed; .220 uh, $\pm 10\%$ ; current rating 200 ma; molded case.	CL140-6
L1603	NOT USED.	
L1604	Same as L1602.	
L1605	Same as L1602.	
L1606	NOT USED.	
L1607	COIL, RADIO FREQUENCY: fixed; 1,000 uh, $\pm 5\%$ ; 1,600 ohms DC resistance; current rating 140 ma; molded case.	CL275-102
L1608	Same as L1602.	
L1609	NOT USED	
L1610	COIL, RADIO FREQUENCY: fixed; 150 uh, $\pm 5\%$ ; 3.3 ohms DC resistance; current rating 315 ma; molded case.	CL275-151
Q1601	TRANSISTOR: germanium; PNP; JEDEC type 2N2084 transistor with a controlled hfe limit of 100-150; JEDEC type TO33 case.	TX109
Q1602	Same as Q1601.	
Q1603	TRANSISTOR: germanium; PNP; JEDEC type 2N1370 transistor with a controlled hfe limit of 60-75; JEDEC type TO9 case.	TX107
Q1604	Same as Q1603.	
Q1605 thru Q1609	Same as Q1601.	
Q1610	TRANSISTOR: germanium; PNP; collector to base voltage 45 V; collector to emitter voltage 30 V; emitter to base voltage 15 V; collector current (continuous), 500 ma DC; collector dissipation 200 mw; junction-storage temperature range $-65^{\circ}\text{C}$ to $+100^{\circ}\text{C}$ .	2N1190
Q1611	TRANSISTOR: NPN; silicon mesa; collector to base voltage 60 V; collector to emitter voltage 40 V; emitter to base voltage 5 V; collector current 175 ma; power dissipation 2 watts at $25^{\circ}\text{C}$ ; junction temperature $175^{\circ}\text{C}$ ; hermetically sealed metal case.	2N697
Q1612	TRANSISTOR: germanium; NPN; JEDEC type 2N1308 transistor with a controlled hfe limit of 80-150; JEDEC type TO5 case.	TX106
Q1613 thru Q1615	Same as Q1603.	
Q1616	TRANSISTOR: germanium; PNP; collector to base and collector to emitter voltage 60 V; emitter to base voltage 20 V; collector current 3 amps, base current 1 amp; junction and storage temperature range $-55^{\circ}\text{C}$ to $+100^{\circ}\text{C}$ ; power dissipation 20 watts at $25^{\circ}\text{C}$ .	2N1039
Q1617	Same as Q1616.	
Q1618	TRANSISTOR: germanium; PNP; JEDEC type 2N1370-7 transistor with a controlled hfe limit of 120-150; JEDEC type TO5 case.	TX108

IF AND AUDIO RECEIVER BOARD ASSEMBLIES  
MAIN CHASSIS (SYMBOL SERIES 1600)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
Q1619	Same as Q1603.	
Q1620	Same as Q1603.	
Q1621	TRANSISTOR: germanium; PNP; max. collector dissipation 300 mw; Fab. = 6 MC; collector current 1 ma; collector cut-off current 100 ua; hfe limit 80.	2N2001
R1601	RESISTOR, FIXED, COMPOSITION: 1,000 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF102J
R1602	RESISTOR, FIXED, COMPOSITION: 220 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF221J
R1603	RESISTOR, FIXED, COMPOSITION: 10,000 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF103J
R1604	Same as R1601.	
R1605	Same as R1603.	
R1606	NOT USED.	
R1607	NOT USED.	
R1608	Same as R1601.	
R1609	Same as R1601.	
R1610	RESISTOR, FIXED, COMPOSITION: 470 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF471J
R1611	Same as R1603.	
R1612	RESISTOR, VARIABLE, COMPOSITION: 500 ohms, $\pm 10\%$ ; nom. power rating 0.25 watt at 70°C; linear taper.	RV111U501A
R1613	Same as R1603.	
R1614	RESISTOR, FIXED, COMPOSITION: 4,700 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF472J
R1615	Same as R1614.	
R1616	RESISTOR, FIXED, COMPOSITION: 22 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF220J
R1617	Same as R1603.	
R1618	RESISTOR, FIXED, COMPOSITION: 3,300 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF332J
R1619	Same as R1601.	
R1620	Same as R1601.	
R1621	Same as R1614.	
R1622	Same as R1601.	
R1623	Same as R1601.	
R1624	Same as R1614.	
R1625	Same as R1603.	
R1626	Same as R1601.	

IF AND AUDIO RECEIVER BOARD ASSEMBLIES  
 MAIN CHASSIS (SYMBOL SERIES 1600)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R1627	Same as R1614.	
R1628	Same as R1603.	
R1629	RESISTOR, FIXED, COMPOSITION: 560 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF561J
R1630	RESISTOR, FIXED, COMPOSITION: 6,800 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF682J
R1631	Same as R1601.	
R1632	Same as R1603.	
R1633	Same as R1603.	
R1634	RESISTOR, FIXED, COMPOSITION: 2,700 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF272J
R1635	Same as R1601.	
R1636	Same as R1602.	
R1637	RESISTOR, FIXED, COMPOSITION: 100,000 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF104J
R1638	Same as R1603.	
R1639	Same as R1614.	
R1640	RESISTOR, FIXED, COMPOSITION: 22 ohms, $\pm 5\%$ ; 2 watts.	RC42GF220J
R1641	Same as R1618.	
R1642	Same as R1603.	
R1643	Same as R1618.	
R1644	Same as R1618.	
R1645	RESISTOR, FIXED, COMPOSITION: 680 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF681J
R1646	RESISTOR, FIXED, COMPOSITION: 10 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF100J
R1647	Same as R1637.	
R1648	NOT USED.	
R1649	NOT USED.	
R1650	NOT USED.	
R1651	Same as R1603.	
R1652	RESISTOR, FIXED, COMPOSITION: 3,900 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF392J
R1653	RESISTOR, FIXED, COMPOSITION: 2,200 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF222J
R1654	Same as R1601.	
R1655	Same as R1637.	
R1656	Same as R1618.	



IF AND AUDIO RECEIVER BOARD ASSEMBLIES  
MAIN CHASSIS (SYMBOL SERIES 1600)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R1657	RESISTOR, FIXED, COMPOSITION: 22,000 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF223J
R1658	Same as R1653.	
R1659	RESISTOR, FIXED, COMPOSITION: 33 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF330J
R1660	RESISTOR, FIXED, COMPOSITION: 3.3 ohms, $\pm 5\%$ ; 1 watt.	RC32GF3R3J
R1661	Same as R1610.	
R1662	RESISTOR, FIXED, COMPOSITION: 1,800 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF182J
R1663	Same as R1612.	
R1664	NOT USED	
R1665	Same as R1614.	
R1666	Same as R1640.	
R1667	RESISTOR, FIXED, COMPOSITION: 27 ohms, $\pm 5\%$ ; 2 watts.	RC42GF270J
R1668	Same as R1601.	
T1601	TRANSFORMER, INTERMEDIATE FREQUENCY: fixed; operating frequency 1.75 mc; nom. primary inductance 4.5 uhy, $\pm .200$ uhy; 4 terminals, wire lead type.	TZ126
T1602	TRANSFORMER, PULSE: 3 windings; winding number one, 4.7 mh; turns ratio 5:5:1.	TF228K15
T1603	TRANSFORMER, AUDIO FREQUENCY: fixed; primary impedance 4,000 ohms, CT; DC resistance 370 ohms, $\pm 20\%$ ; secondary impedance 600 ohms, CT; DC resistance 60 ohms, $\pm 20\%$ ; operating frequency range 200-15,000 cps; frequency response $\pm 3$ db at 250 to 3,500 cps.	TF267-3
T1604	TRANSFORMER, AUDIO FREQUENCY: fixed; primary impedance 3,000 ohms, CT; DC resistance 260 ohms, $\pm 20\%$ ; secondary impedance 1,000 ohms, CT; DC resistance 105 ohms, $\pm 20\%$ ; operating frequency range 200-15,000 cps; frequency response $\pm 3$ db at 250 to 3,500 cps.	TF267-2
T1605	TRANSFORMER, AUDIO FREQUENCY: fixed; primary impedance 500 ohms, CT; DC resistance 26 ohms, $\pm 20\%$ ; secondary impedance 3.2 ohms; DC resistance 0.3 ohms, $\pm 20\%$ ; operating frequency range 150-45,000 cps; frequency response $\pm 0-2$ db at 1,000 cps, ref; 150-45,000 cps.	TF267-5
XY1601	SOCKET, CRYSTAL: 2 silver plated beryllium copper contacts; for crystals having a 0.050 pin dia. and 0.486 spacing between pins.	TS104-2
XY1602	Same as XY1601.	
XY1603	Same as XY1601.	
Y1601	CRYSTAL UNIT, QUARTZ: 250 KC, $\pm .002\%$ ; operating temperature range $75^{\circ}\text{C}$ , $\pm 5^{\circ}\text{C}$ ; parallel resonance; load capacitance 20 uuf, $\pm 0.5$ uuf; HC-6/U type holder.	CR47A/U250. 000KC

IF AND AUDIO RECEIVER BOARD ASSEMBLIES  
 MAIN CHASSIS (SYMBOL SERIES 1600)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
Y1602	CRYSTAL UNIT, QUARTZ: 2 MC, $\pm 0.005\%$ ; operating temperature range $-55^{\circ}\text{C}$ to $+30^{\circ}\text{C}$ ; max. capacitance 7.0 uuf; parallel resonance; load capacitance 32.0 uuf, $\pm 0.5$ uuf; HC-6/U type holder.	CR18A/U2.00-0000MC
Y1603	CRYSTAL UNIT, QUARTZ: 1.5 MC, $\pm 0.005\%$ ; operating temperature range $-55^{\circ}\text{C}$ to $+30^{\circ}\text{C}$ ; max. capacitance 7.0 uuf; parallel resonance; load capacitance 32.0 uuf, $\pm 0.5$ uuf; HC-6/U type holder.	CR18A/U1.500-0000MC

IF AND AUDIO TRANSMITTER BOARD ASSEMBLIES  
MAIN CHASSIS (SYMBOL SERIES 1700)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C1701	CAPACITOR, FIXED, ELECTROLYTIC: 6 uf, -10% +150% at 120 cps at 25°C; 15 WVDC; polarized; insulated tubular case.	CE105-6-15
C1702	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 200,000 uuf, +80% -20%; 25 WVDC.	CC100-33
C1703	CAPACITOR, FIXED, ELECTROLYTIC: 50 uf, -10% +150% at 120 cps at 25°C; 15 WVDC; polarized, insulated tubular case.	CE105-50-15
C1704	Same as C1701.	
C1705	CAPACITOR, FIXED, ELECTROLYTIC: 10 uf, -10% +150% at 120 cps at 25°C; 15 WVDC; polarized, insulated tubular case.	CE105-10-15
C1706	Same as C1703.	
C1707	Same as C1705.	
C1708	CAPACITOR, FIXED, ELECTROLYTIC: 4 uf, -10% +150% at 120 cps at 25°C; 15 WVDC; polarized; insulated tubular case.	CE105-4-15
C1709	Same as C1701.	
C1710	Same as C1703.	
C1711	Same as C1702.	
C1712	CAPACITOR, FIXED, ELECTROLYTIC: 20 uf, -10% +150% at 120 cps at 25°C; 15 WVDC; polarized; insulated tubular case.	CE105-20-15
C1713	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 10,000 uuf, GMV; 500 WVDC.	CC100-16
C1714	Same as C1713.	
C1715	CAPACITOR, VARIABLE MICA DIELECTRIC: 280 uuf max. when tight, 25 uuf max. at 3 turns; 175 WVDC.	CV114-1
C1716	CAPACITOR, FIXED, MICA DIELECTRIC: 160 uuf, +5%; 500 WVDC; char. F.	CM15F161J
C1717	CAPACITOR, FIXED, MICA DIELECTRIC: 100 uuf, +5%; 500 WVDC; char. F.	CM15F101J
C1718	CAPACITOR, FIXED, MICA DIELECTRIC: 180 uuf, +5%; 500 WVDC; char. B.	CM15B181J
C1719	Same as C1718.	
C1720	CAPACITOR, FIXED, MICA DIELECTRIC: 180 uuf, +2%; 500 WVDC; straight wire leads.	CM111D181G5S
C1721	Same as C1720.	
C1722	CAPACITOR, FIXED, MICA DIELECTRIC: 1,000 uuf, +5%; 500 WVDC; char. B.	CM20B102J
C1723	Same as C1702.	
C1724	Same as C1702.	

IF AND AUDIO TRANSMITTER BOARD ASSEMBLIES  
 MAIN CHASSIS (SYMBOL SERIES 1700)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C1725	Same as C1715.	
C1726	CAPACITOR, FIXED, MICA DIELECTRIC: 1,500 uuf, $\pm 2\%$ ; 500 WVDC; char. F.	CM100-10
C1727	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 100,000 uuf, $+80\%$ - $20\%$ ; 100 WVDC.	CC100-28
C1728	Same as C1702.	
C1729	Same as C1705.	
C1730	Same as C1715.	
C1731	Same as C1726.	
C1732	Same as C1727.	
C1733	CAPACITOR, FIXED, MICA DIELECTRIC: 47 uuf, $\pm 5\%$ ; 500 WVDC; char. B.	CM15B470J
C1734	NOT USED	
C1735	CAPACITOR, FIXED, MICA DIELECTRIC: 270 uuf, $\pm 5\%$ ; 500 WVDC; char. F.	CM15F271J
C1736	CAPACITOR, FIXED, MICA DIELECTRIC: 5,100 uuf, $\pm 10\%$ ; 300 WVDC; straight wire leads.	CM112E512K3S
C1737	Same as C1702.	
C1738	Same as C1727.	
C1739	Same as C1702.	
C1740	Same as C1713.	
C1741	Same as C1727.	
C1742	Same as C1702.	
C1743	Same as C1713.	
C1744	Same as C1727.	
C1745	Same as C1722.	
C1746	CAPACITOR, VARIABLE, CERAMIC DIELECTRIC: 8-50 uuf; operating temperature range $-55^{\circ}\text{C}$ to $+85^{\circ}\text{C}$ ; 350 WVDC.	CV109-6
C1747	CAPACITOR, FIXED, MICA DIELECTRIC: 24 uuf, $\pm 5\%$ ; 500 WVDC; char. C.	CM15C240J
C1748	Same as C1727.	
C1749	Same as C1746.	
C1750	Same as C1747.	
C1751	Same as C1735.	

IF AND AUDIO TRANSMITTER BOARD ASSEMBLIES  
MAIN CHASSIS (SYMBOL SERIES 1700)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C1752	Same as C1702.	
C1753	Same as C1727.	
C1754	Same as C1735.	
C1755	Same as C1702.	
C1756 thru C1760	Same as C1727.	
C1761	Same as C1702.	
C1762	CAPACITOR, VARIABLE, CERAMIC DIELECTRIC: 9-35 uuf; operating temperature range -55°C to +125°C; 100 WVDC.	CV112-2
C1763	Same as C1762.	
C1764	Same as C1702.	
CR1701	SEMICONDUCTOR DEVICE, DIODE: germanium; max. peak inverse voltage 60 V; continuous average forward current 50 ma; max. peak forward 150 ma; max. surge current 500 ma; max. inverse current 500 ua at 50 volts or 30 ua at 10 volts.	1N34A
CR1702 thru CR1709	Same as CR1701.	
FL1701	FILTER, BANDPASS: operating freq. 250 KC; bandwidth, 250.3-253.3 KC; input and output imped. 100 K ohms nom.; hermetically sealed brass case.	FX195-1
L1701	COIL, RADIO FREQUENCY: fixed; .220 uh, +10%; current rating 200 ma; molded case.	CL140-6
L1702 thru L1705	Same as L1701.	
Q1701	TRANSISTOR: germanium; NPN; JEDEC type 2N1308 transistor with a controlled hfe limit of 80-150; JEDEC type T05 case.	TX106
Q1702	TRANSISTOR: germanium; PNP; JEDEC type 2N1370 transistor with a controlled hfe limit of 60-75; JEDEC type T09 case.	TX107
Q1703 thru Q1705	Same as Q1702.	
Q1706	Same as Q1701.	
Q1707	Same as Q1702.	
Q1708	TRANSISTOR: germanium; PNP; max. collector dissipation 300 mw; fab. = 6 mc; collector current 1 ma; collector cut-off current 100 ua; hfe limit 80.	2N2001

IF AND AUDIO TRANSMITTER BOARD ASSEMBLIES  
 MAIN CHASSIS (SYMBOL SERIES 1700)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
Q1709	TRANSISTOR: germanium; PNP; JEDEC type 2N2084 transistor with a controlled hfe limit of 100-150; JEDEC type T033 case.	TX109
Q1710 thru Q1717	Same as Q1709.	
R1701	RESISTOR, FIXED, COMPOSITION: 22,000 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF223J
R1702	RESISTOR, FIXED, COMPOSITION: 10,000 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF103J
R1703	NOT USED	
R1704	RESISTOR, FIXED, COMPOSITION: 4,700 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF472J
R1705	RESISTOR, FIXED, COMPOSITION: 2,200 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF222J
R1706	Same as R1702.	
R1707	Same as R1705.	
R1708	RESISTOR, FIXED, COMPOSITION: 68,00 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF683J
R1709	Same as R1702.	
R1710	RESISTOR, FIXED, COMPOSITION: 3,300 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF332J
R1711	Same as R1710.	
R1712	RESISTOR, FIXED, COMPOSITION: 220 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF221J
R1713	Same as R1702.	
R1714	Same as R1702.	
R1715	RESISTOR, FIXED, COMPOSITION: 8,200 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF822J
R1716	RESISTOR, FIXED, COMPOSITION: 3,900 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF392J
R1717	RESISTOR, FIXED, COMPOSITION: 1,000 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF102J
R1718	RESISTOR, VARIABLE, COMPOSITION: 500 ohms, $\pm 10\%$ ; nom. power rating 0.25 watt at 70°C; linear taper.	RV111U501A
R1719	RESISTOR, VARIABLE, COMPOSITION: 250,000 ohms, $\pm 10\%$ ; nom. power rating 0.25 watt at 70°C; linear taper.	RV111U254A
R1720	RESISTOR, FIXED, COMPOSITION: 1.5 megohms, $\pm 5\%$ ; 1/2 watt.	RC20GF155J
R1721	NOT USED	
R1722	Same as R1702.	
R1723	RESISTOR, FIXED, COMPOSITION: 5,600 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF562J
R1724	Same as R1704.	
R1725	Same as R1702.	
R1726	Same as R1717.	

IF AND AUDIO TRANSMITTER BOARD ASSEMBLIES  
MAIN CHASSIS (SYMBOL SERIES 1700)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R1727	Same as R1723.	
R1728	RESISTOR, FIXED, COMPOSITION: 100,000 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF104J
R1729	RESISTOR, FIXED, COMPOSITION: 150,000 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF154J
R1730	Same as R1704.	
R1731	Same as R1705.	
R1732	Same as R1715.	
R1733	Same as R1729.	
R1734	RESISTOR, FIXED, COMPOSITION: 33 ohms, $\pm 5\%$ ; 1 watt.	RC32GF330J
R1735	Same as R1729.	
R1736 thru R1739	Same as R1717.	
R1740	RESISTOR, FIXED, COMPOSITION: 330 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF331J
R1741	Same as R1740.	
R1742	RESISTOR, VARIABLE, COMPOSITION: 10,000 ohms, $\pm 10\%$ ; nom. power rating 0.25 watt at 70°C; linear taper.	RV111U103A
R1743	RESISTOR, FIXED, COMPOSITION: 30,000 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF303J
R1744	Same as R1717.	
R1745	Same as R1717.	
R1746	Same as R1702.	
R1747	Same as R1702.	
R1748	Same as R1742.	
R1749	Same as R1702.	
R1750	Same as R1717.	
R1751	Same as R1704.	
R1752	Same as R1717.	
R1753	NOT USED	
R1754	Same as R1717.	
R1755	Same as R1704.	
R1756	Same as R1717.	
R1757	Same as R1717.	
R1758	Same as R1702.	

IF AND AUDIO TRANSMITTER BOARD ASSEMBLIES  
 MAIN CHASSIS (SYMBOL SERIES 1700)

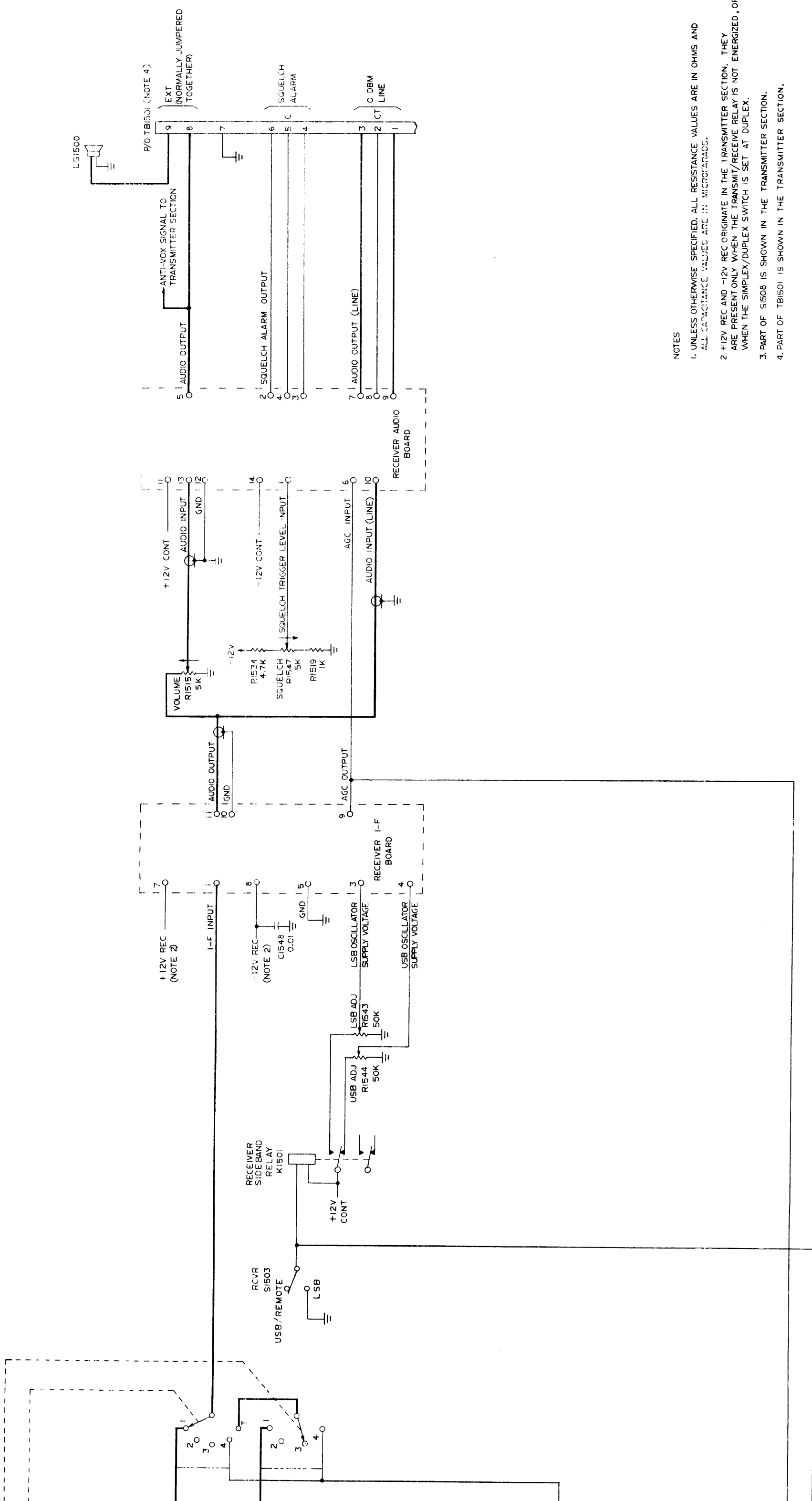
REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R1759	RESISTOR, FIXED, COMPOSITION: 22 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF220J
R1760	Same as R1704.	
R1761	Same as R1710.	
R1762	Same as R1717.	
R1763	Same as R1717.	
R1764	Same as R1759.	
R1765	Same as R1704.	
R1766	Same as R1717.	
R1767	Same as R1704.	
R1768	Same as R1717.	
R1769	Same as R1704.	
R1770	Same as R1702.	
R1771	Same as R1717.	
R1772	Same as R1704.	
R1773	Same as R1702.	
R1774	RESISTOR, FIXED, COMPOSITION: 100 ohms, $\pm 5\%$ ; 1/2 watt.	RC20GF101J
T1701	TRANSFORMER, AUDIO FREQUENCY: fixed; primary impedance 25,000 ohms, CT; DC resistance 1,550 ohms, $\pm 20\%$ ; secondary impedance 1,200 ohms, CT; DC resistance 88 ohms, $\pm 20\%$ ; operating frequency range 200 to 15,000 cps; frequency response $\pm 3$ db at 250 to 3,500 cps.	TF267-4
T1702	TRANSFORMER, AUDIO FREQUENCY: primary impedance 500 ohms, CT; DC resistance 60 ohms; secondary impedance 600 ohms; DC resistance 105 ohms; frequency range 100 cps to 20 KC; miniature open frame type, lacquer coated.	TF246-17Z
T1703	TRANSFORMER, INTERMEDIATE FREQUENCY: fixed; operating frequency 1.75 mc; nom. primary inductance 5.5 uh, $\pm 0.300$ uh; 5 terminals, wire lead type.	TZ124
T1704	TRANSFORMER, INTERMEDIATE FREQUENCY: fixed; operating frequency 1.75 mc; nom. primary inductance 5.0 uh, $\pm 0.250$ uh; 4 terminals, wire lead type.	TZ125
XY1701	SOCKET, CRYSTAL: 2 silver plated beryllium copper contacts; for crystals having a 0.050 pin dia. and 0.486 spacing between pins.	TS104-2
XY1702	Same as XY1701.	
XY1703	Same as XY1701.	
Y1701	CRYSTAL UNIT, QUARTZ: 250 KC, $\pm .002\%$ ; operating temperature range $75^{\circ}\text{C}$ , $+5^{\circ}\text{C}$ ; parallel resonance; load capacitance 20 uuf, $\pm 0.5$ uuf; HC-6/U type holder.	CU47A/U250.000 KC



IF AND AUDIO TRANSMITTER BOARD ASSEMBLIES  
MAIN CHASSIS (SYMBOL SERIES 1700)

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
Y1702	CRYSTAL UNIT, QUARTZ: 2 MC, $\pm 0.005\%$ ; operating temperature range $-55^{\circ}\text{C}$ to $+30^{\circ}\text{C}$ ; max. capacitance 7.0 uuf; parallel resonance; load capacitance 32.0 uuf, $\pm 0.5$ uuf; HC-6/U type holder.	CR18A/U2.000 000 MC
Y1703	CRYSTAL UNIT, QUARTZ: 1.5 MC, $\pm 0.005\%$ ; operating temperature range $-55^{\circ}\text{C}$ to $+30^{\circ}\text{C}$ ; max. capacitance 7.0 uuf; parallel resonance; load capacitance 32.0 uuf, $\pm 0.5$ uuf; HC-6/U type holder.	CR18A/U1.500 000 MC

**SECTION 7**  
**SCHEMATIC DIAGRAMS**



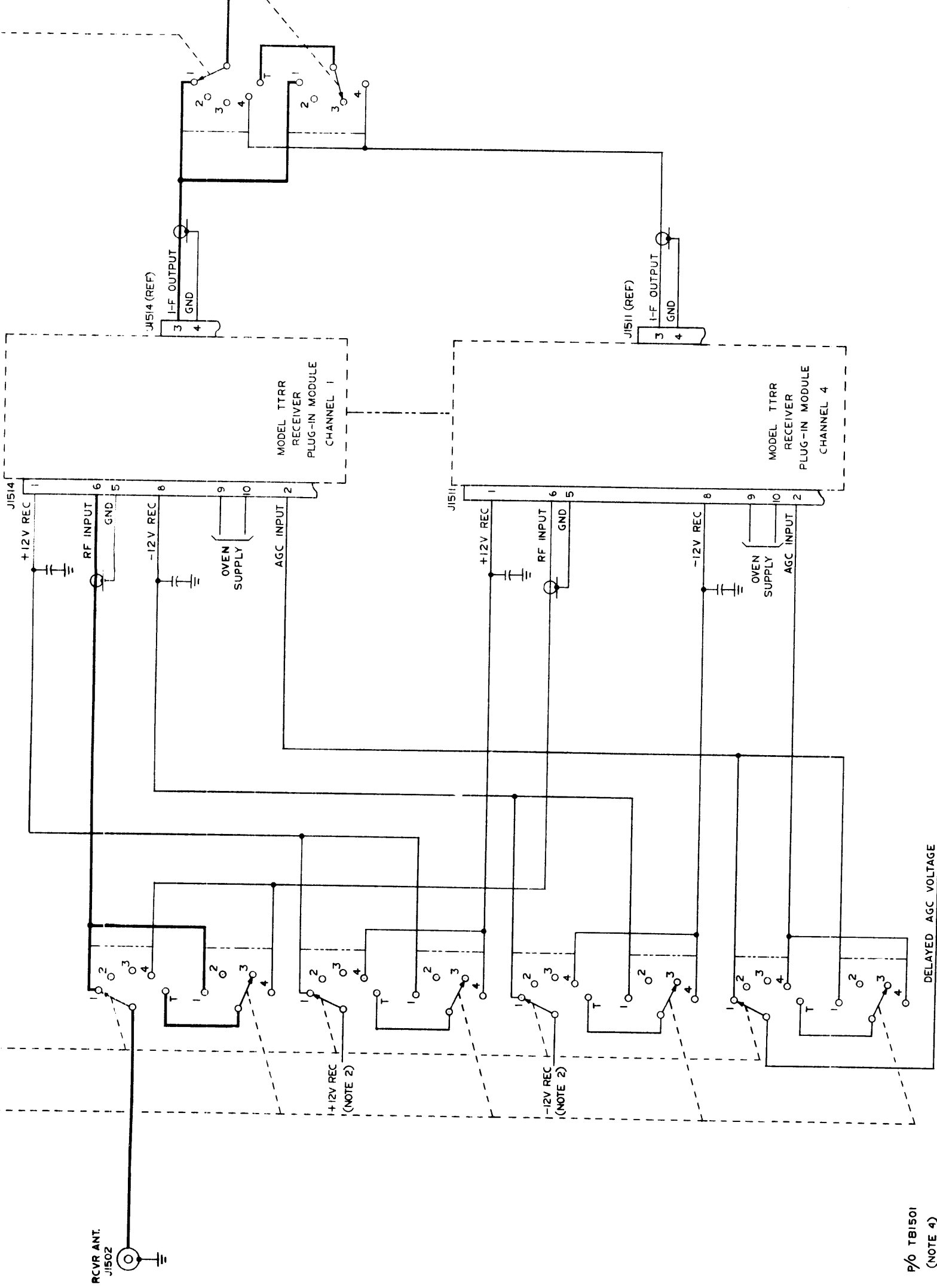
NOTES

1. UNLESS OTHERWISE SPECIFIED, ALL RESISTANCE VALUES ARE IN OHMS AND ALL CAPACITANCE VALUES ARE IN MICROFARADS.
2. +12V REC AND -12V REC ORIGINATE IN THE TRANSMITTER SECTION. THEY ARE PRESENT ONLY WHEN THE TRANSMIT/RECEIVE RELAY IS NOT ENERGIZED, OR WHEN THE SIMPLEX/DUPLEX SWITCH IS SET AT DUPLEX.
3. PART OF S1508 IS SHOWN IN THE TRANSMITTER SECTION.
4. PART OF TB1501 IS SHOWN IN THE TRANSMITTER SECTION.

Figure 7-1. TTR-10 Schematic Diagram (Sheet 1 of 8)

P/O TRANSMITTER CHANNEL S1508 (NOTE 3)

RECEIVER CHANNEL S1507

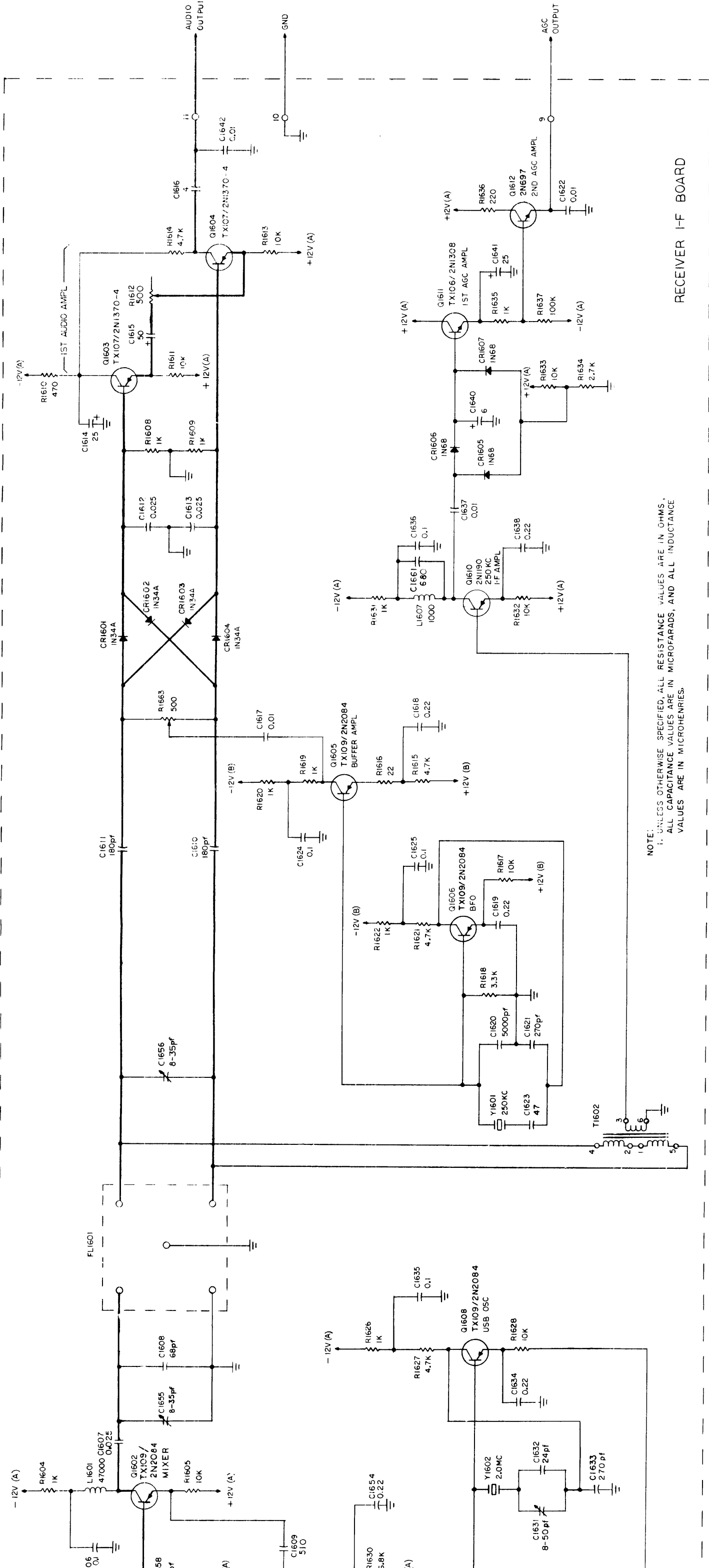


RCVR ANT.  
J1502

P/O TB1501  
(NOTE 4)

REMOTE SIDEBAND 10

1004-18 (CK693P)

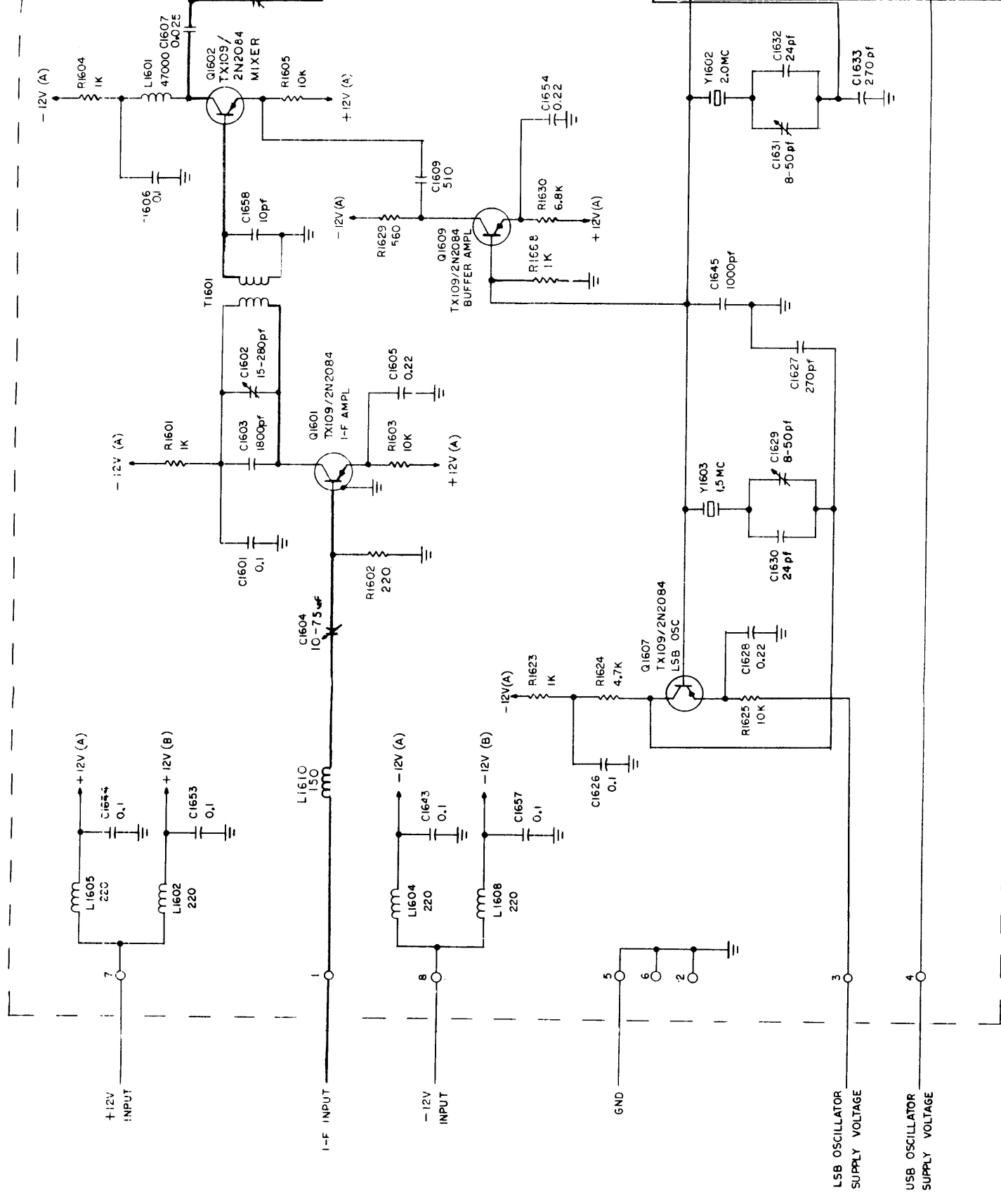


NOTE:  
 1. UNLESS OTHERWISE SPECIFIED, ALL RESISTANCE VALUES ARE IN OHMS,  
 ALL CAPACITANCE VALUES ARE IN MICROFARADS, AND ALL INDUCTANCE  
 VALUES ARE IN MICROHENRIES.

RECEIVER I-F BOARD

Figure 7-1. TTR-10 Schematic Diagram (Sheet 2 of 8)

005651004



3014-12 (CK-741D)

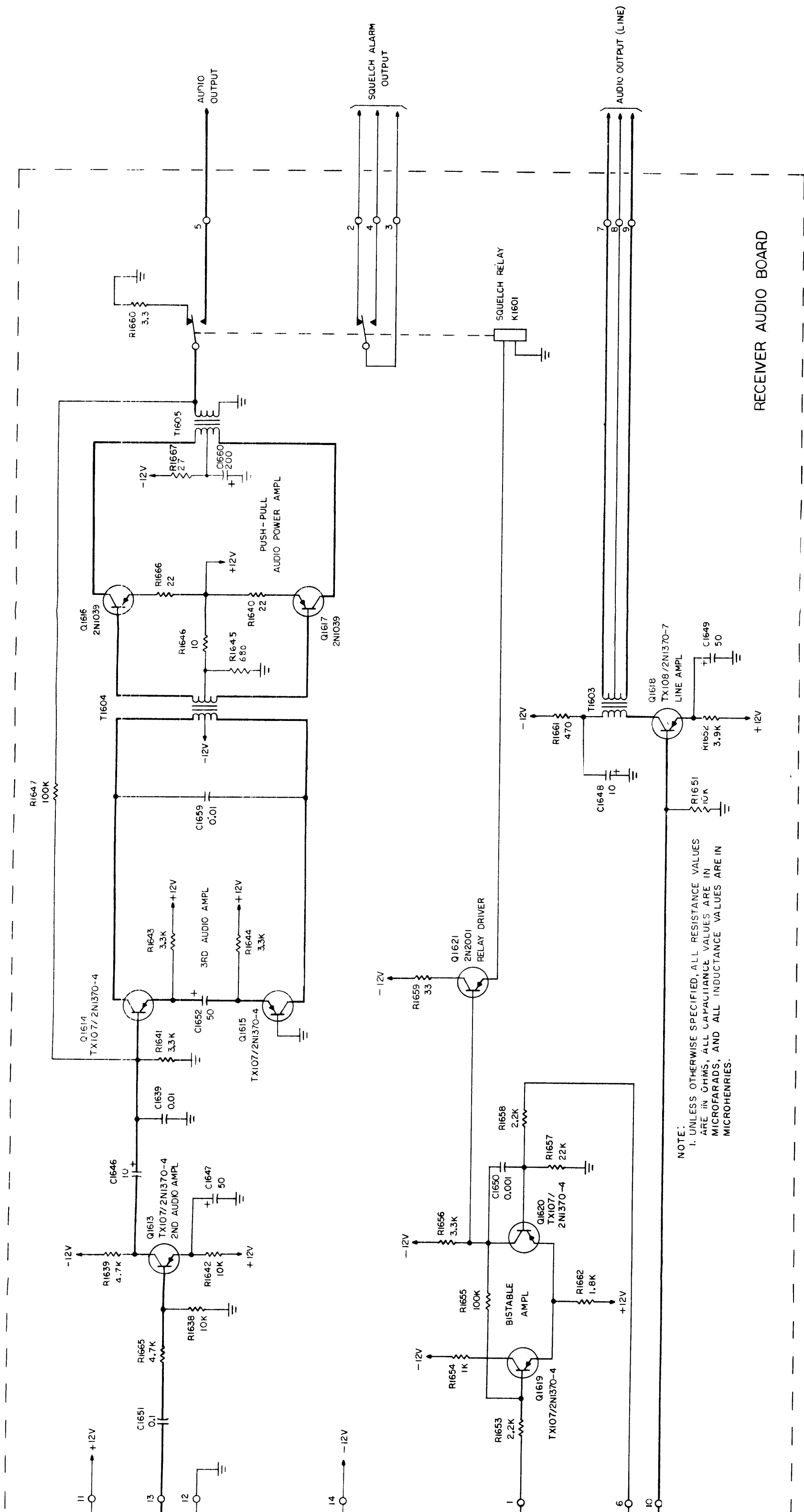
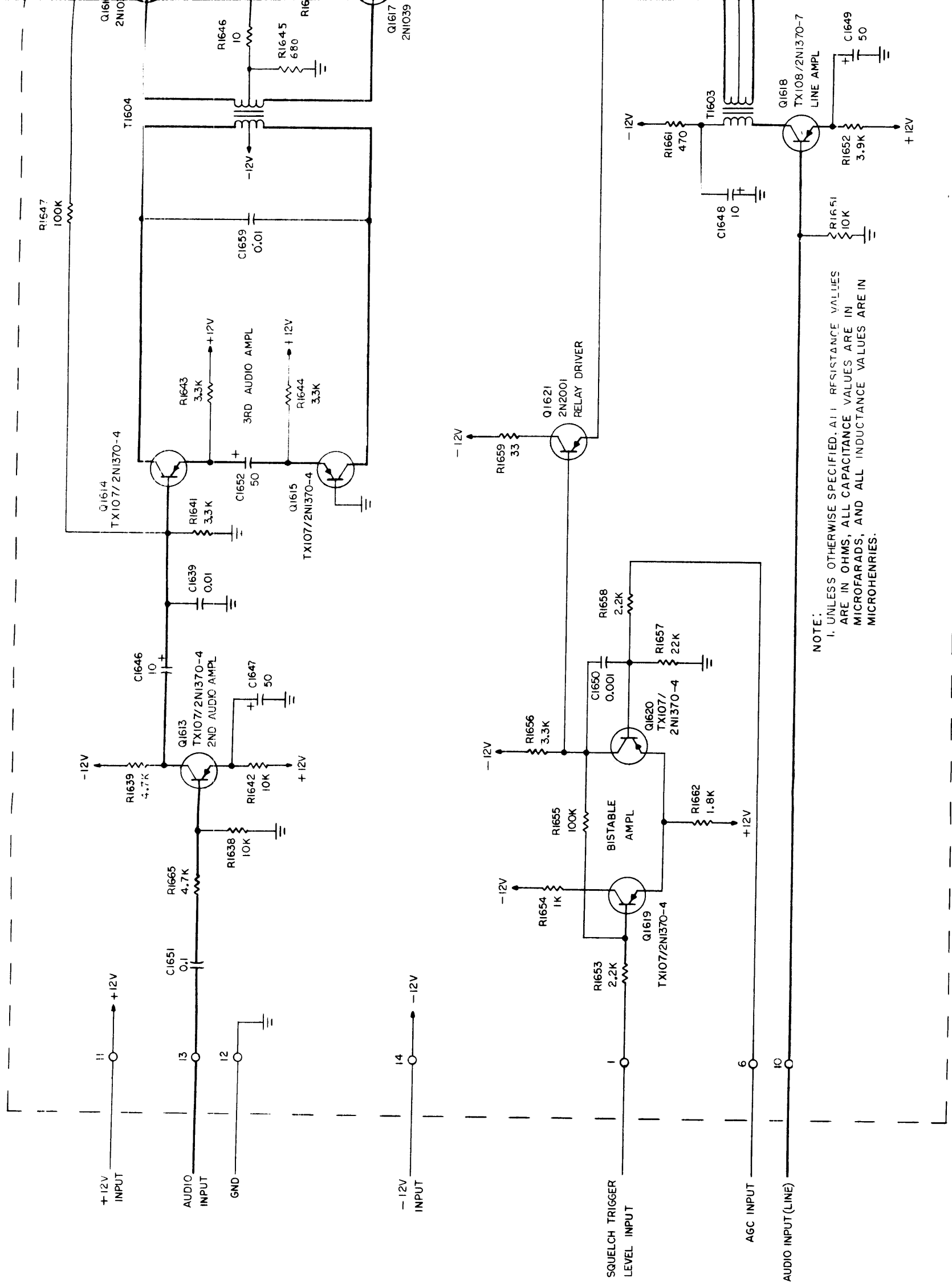


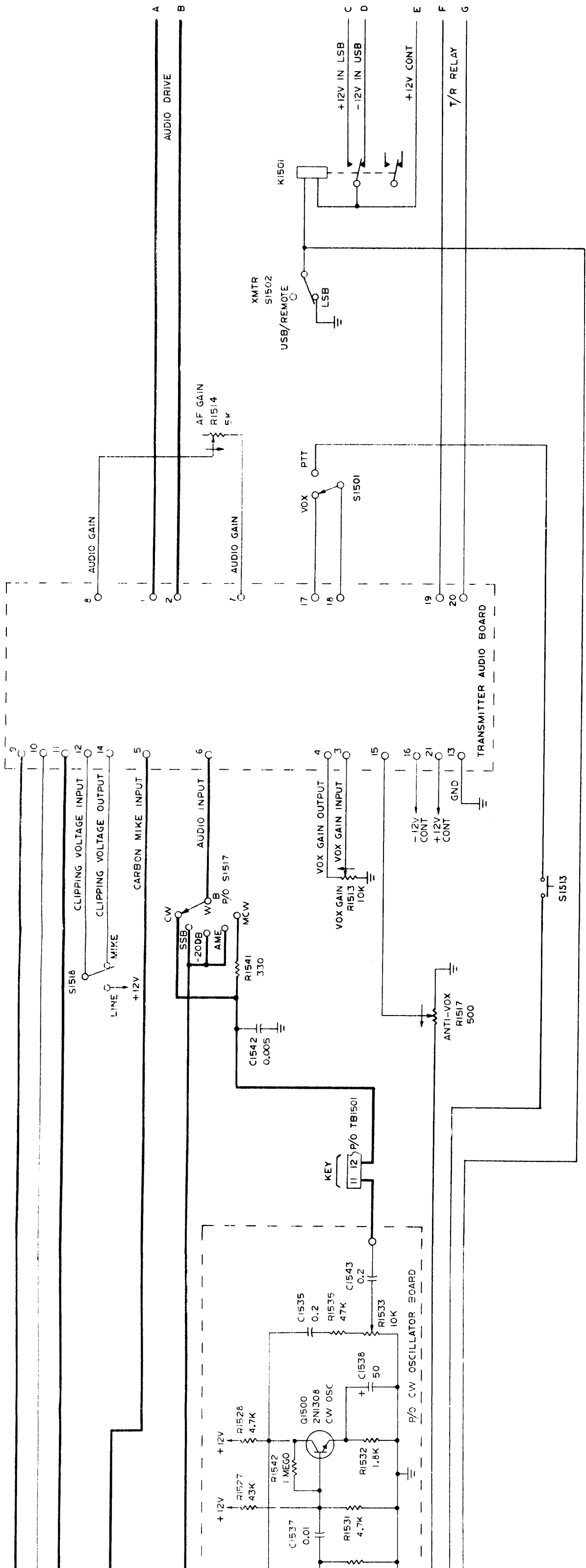
Figure 7-1. TTR-10 Schematic Diagram (Sheet 3 of 8)

005651004



NOTE:  
 1. UNLESS OTHERWISE SPECIFIED, ALL RESISTANCE VALUES ARE IN OHMS, ALL CAPACITANCE VALUES ARE IN MICROFARADS, AND ALL INDUCTANCE VALUES ARE IN MICROHENRIES.



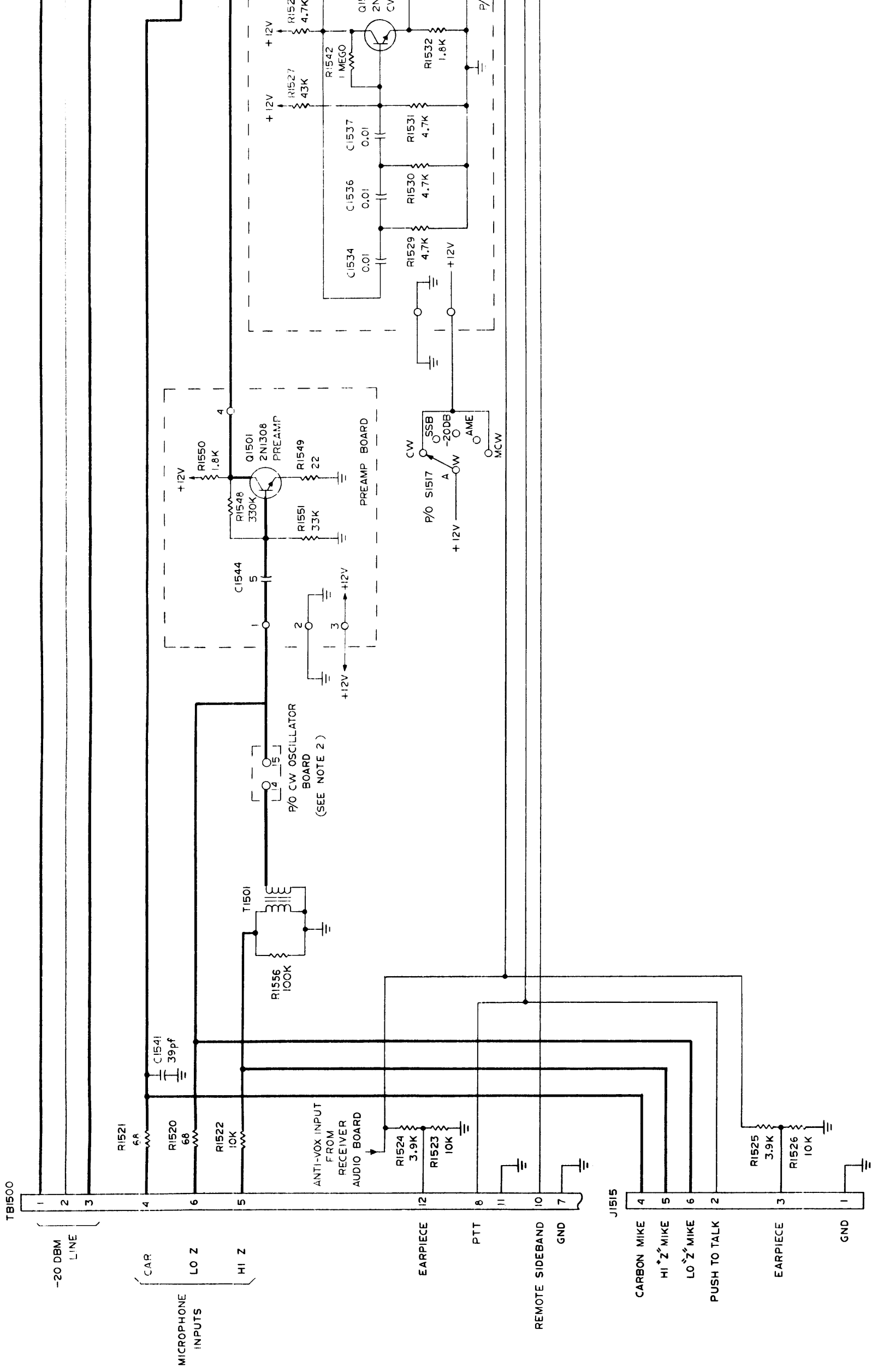


NOTES

1. UNLESS OTHERWISE SPECIFIED, ALL RESISTANCE VALUES ARE IN OHMS, ALL CAPACITANCE VALUES ARE IN MICROFARADS, AND ALL INDUCTANCE VALUES ARE IN MICROHENRIES.
2. THESE TERMINALS ARE CONNECTED TOGETHER ONLY WHEN A HIGH IMPEDANCE MICROPHONE IS USED.
3. TRANSMITTER CHANNEL SWITCHES S1508, S1509, AND S1510 ARE GANGED TOGETHER.

Figure 7-1. TTR-10 Schematic Diagram (Sheet 4 of 8)

005651004



1004-19 (CK633P)

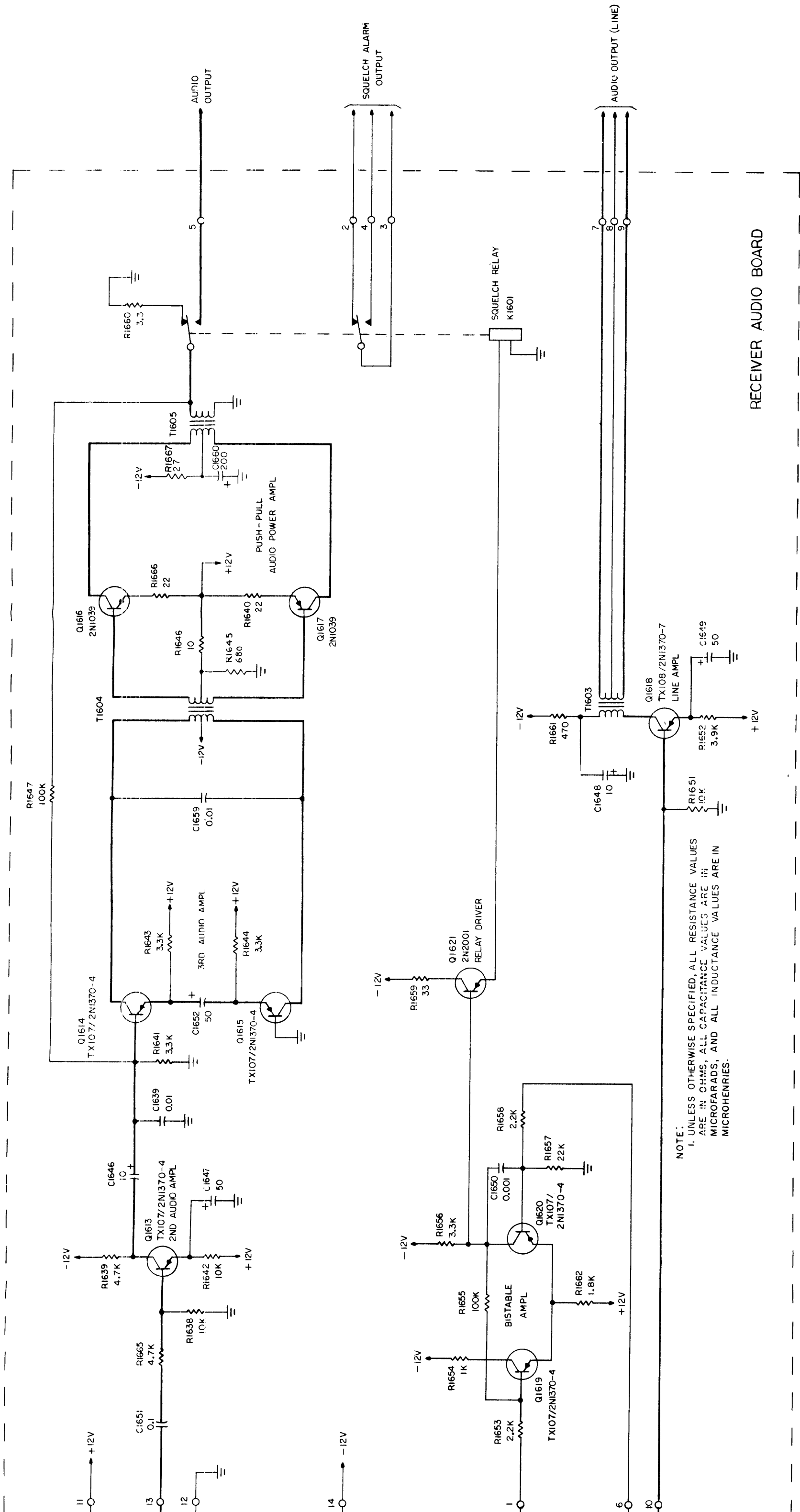
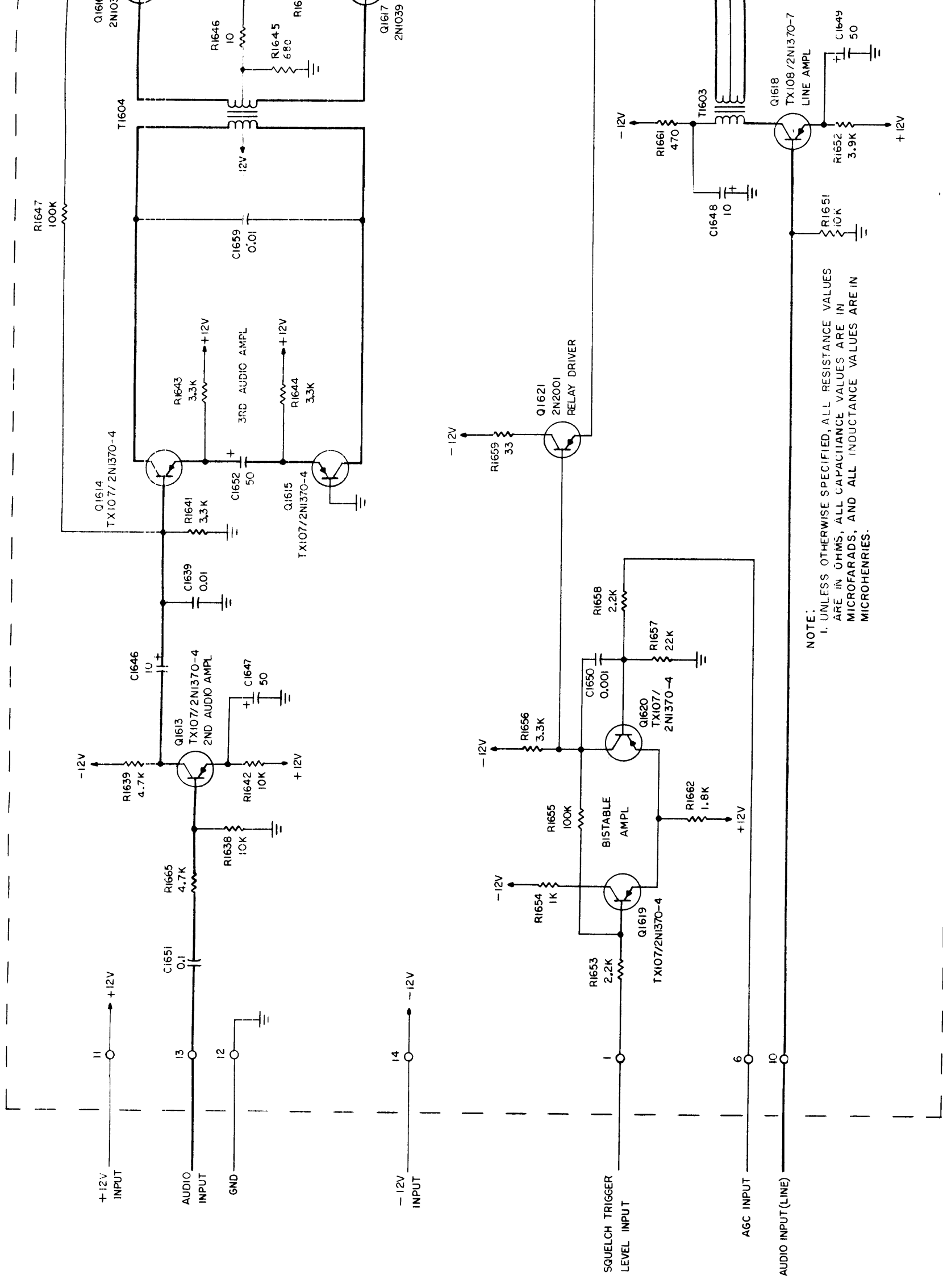


Figure 7-1. TTR-10 Schematic Diagram (Sheet 3 of 8)



NOTE:  
 1. UNLESS OTHERWISE SPECIFIED, ALL RESISTANCE VALUES ARE IN OHMS, ALL CAPACITANCE VALUES ARE IN MICROFARADS, AND ALL INDUCTANCE VALUES ARE IN MICROHENRIES.

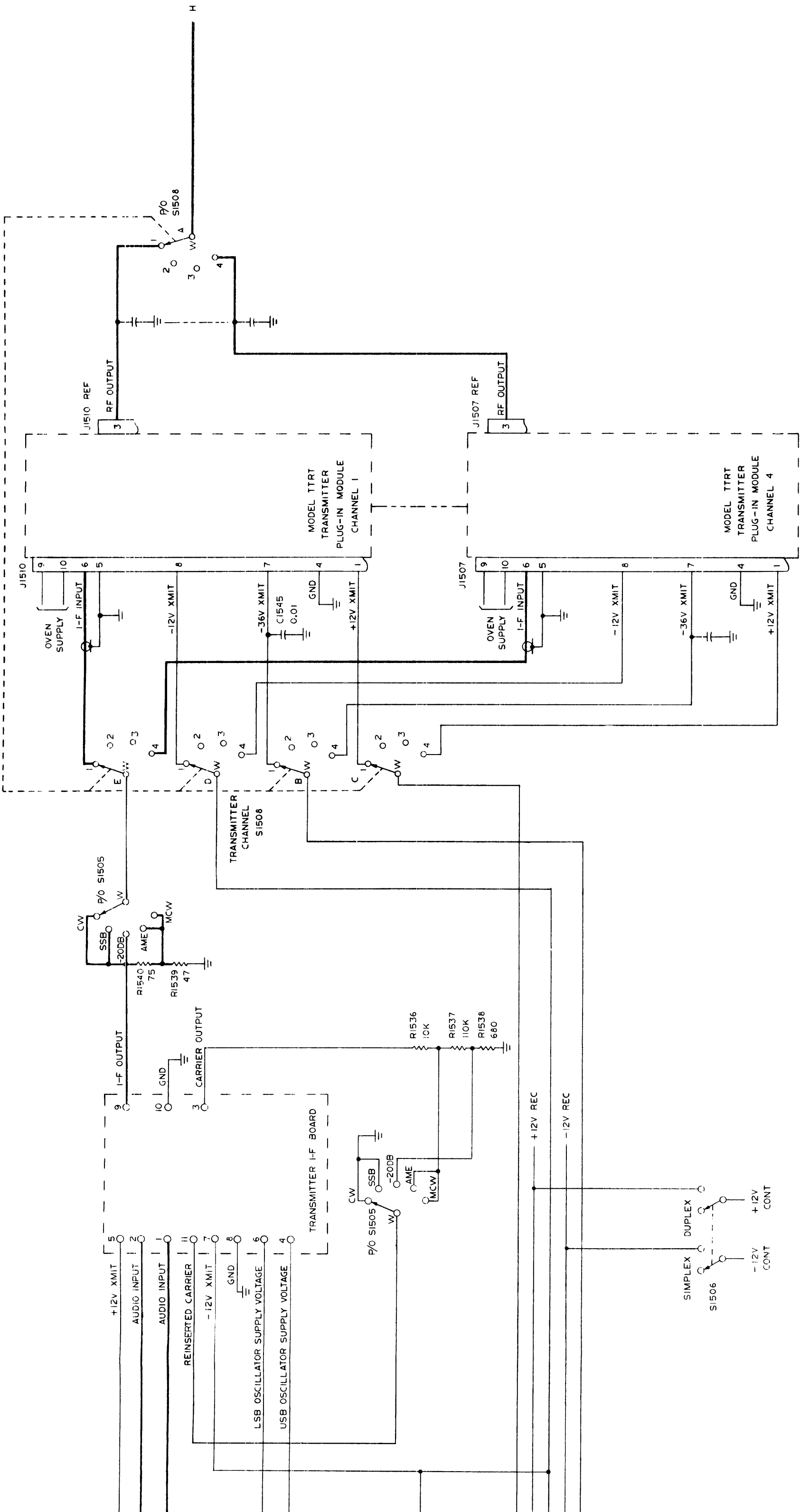
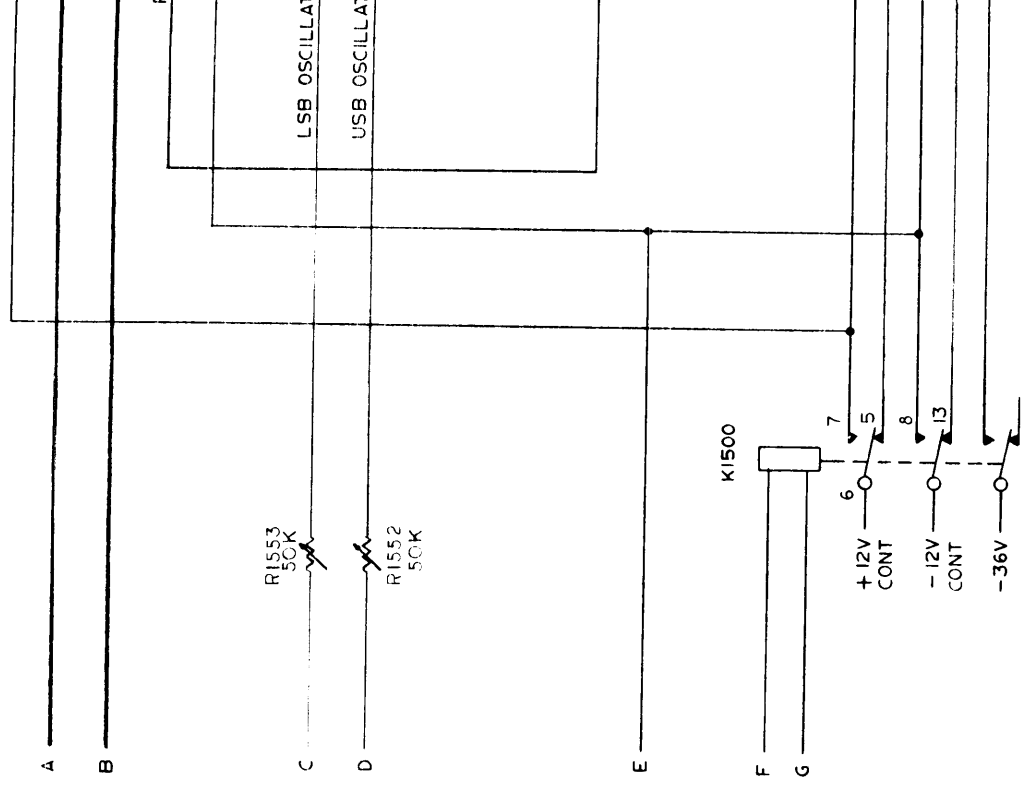


Figure 7-1. TTR-10 Schematic Diagram (Sheet 5 of 8)

005651004

7-9/7-10



1004-20 (CK693R)

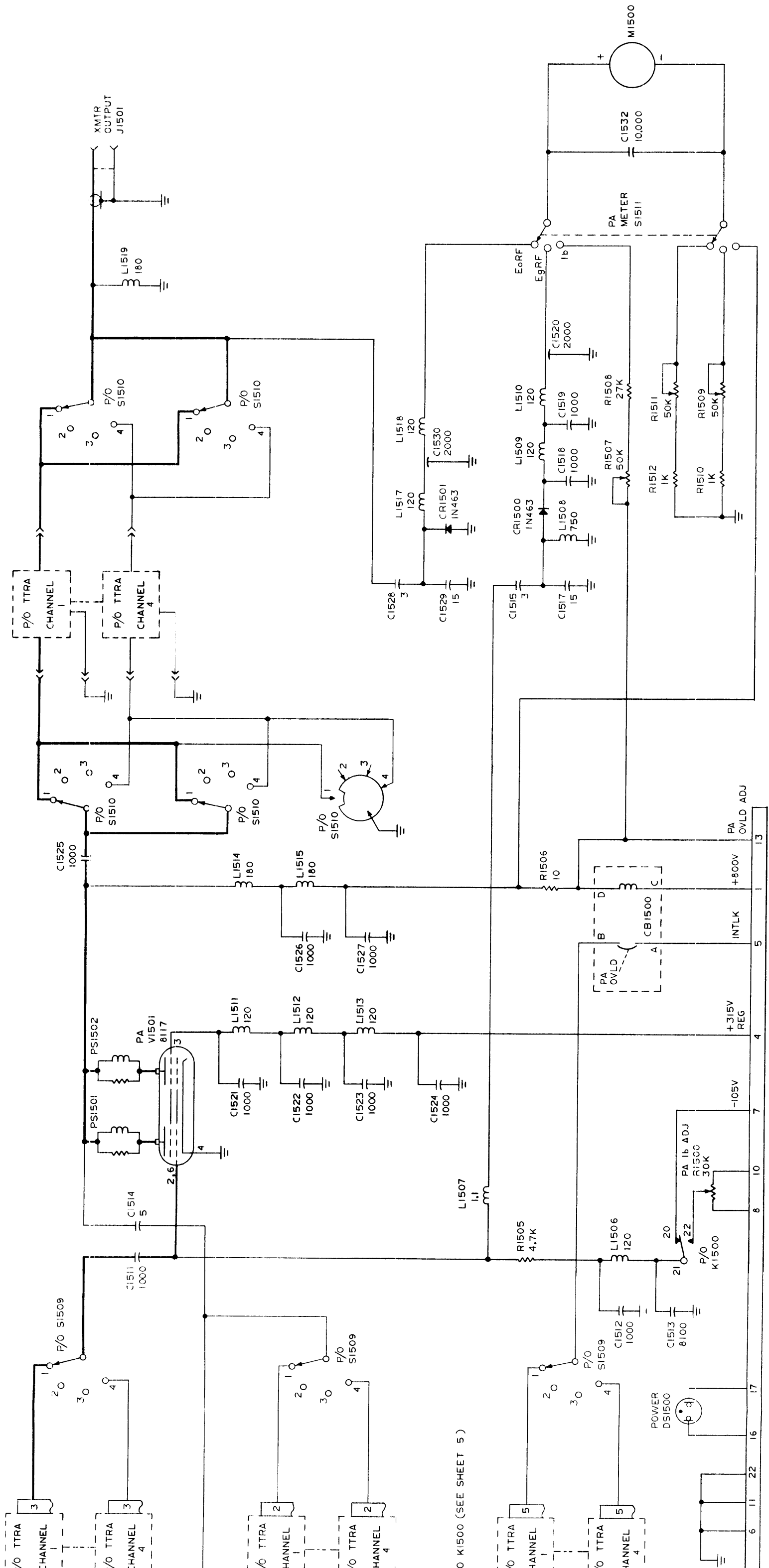
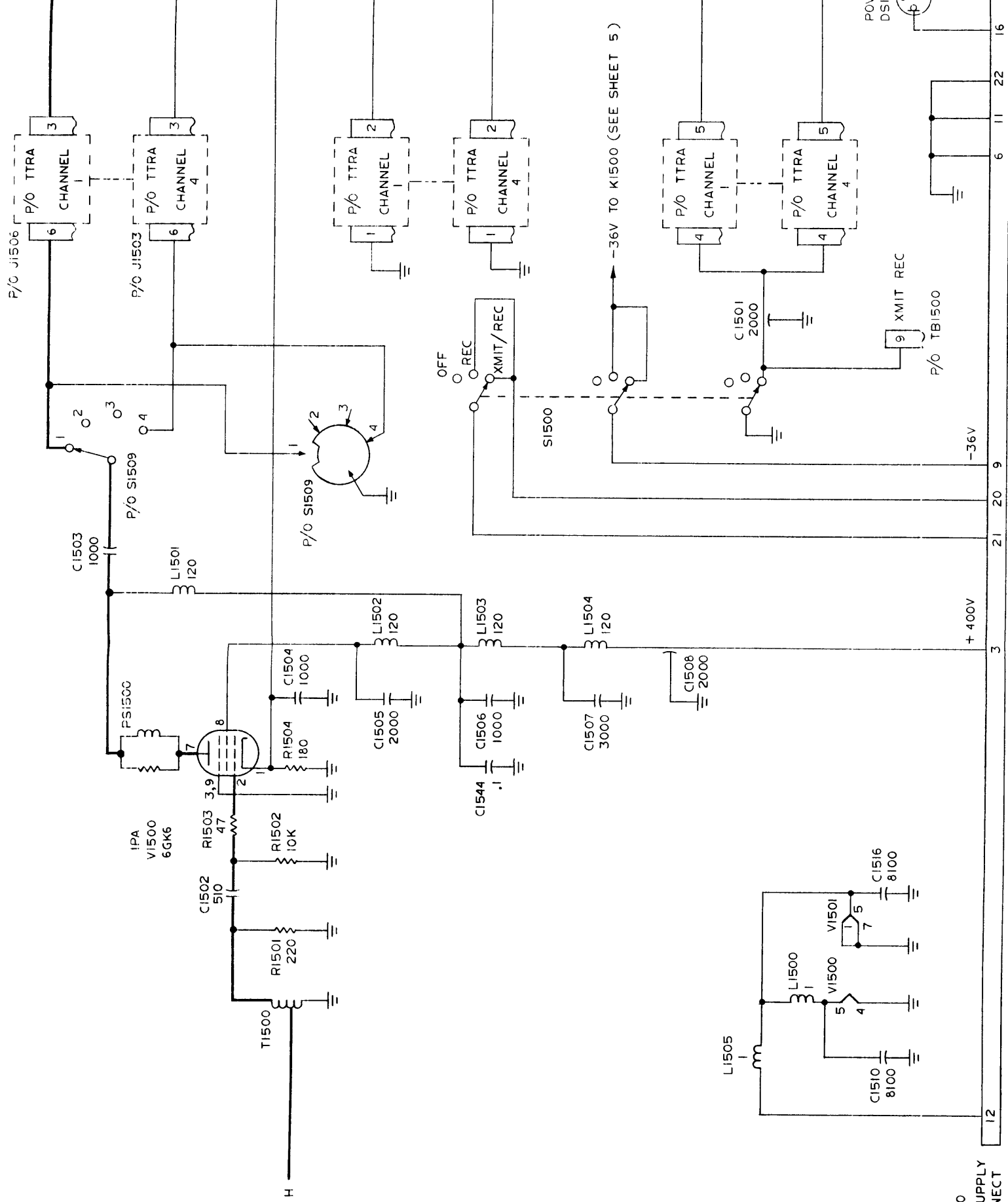


Figure 7-1. TTR-10 Schematic Diagram (Sheet 6 of 8)

005651004

7-11/7-12



1004 - 21 (CK693R)



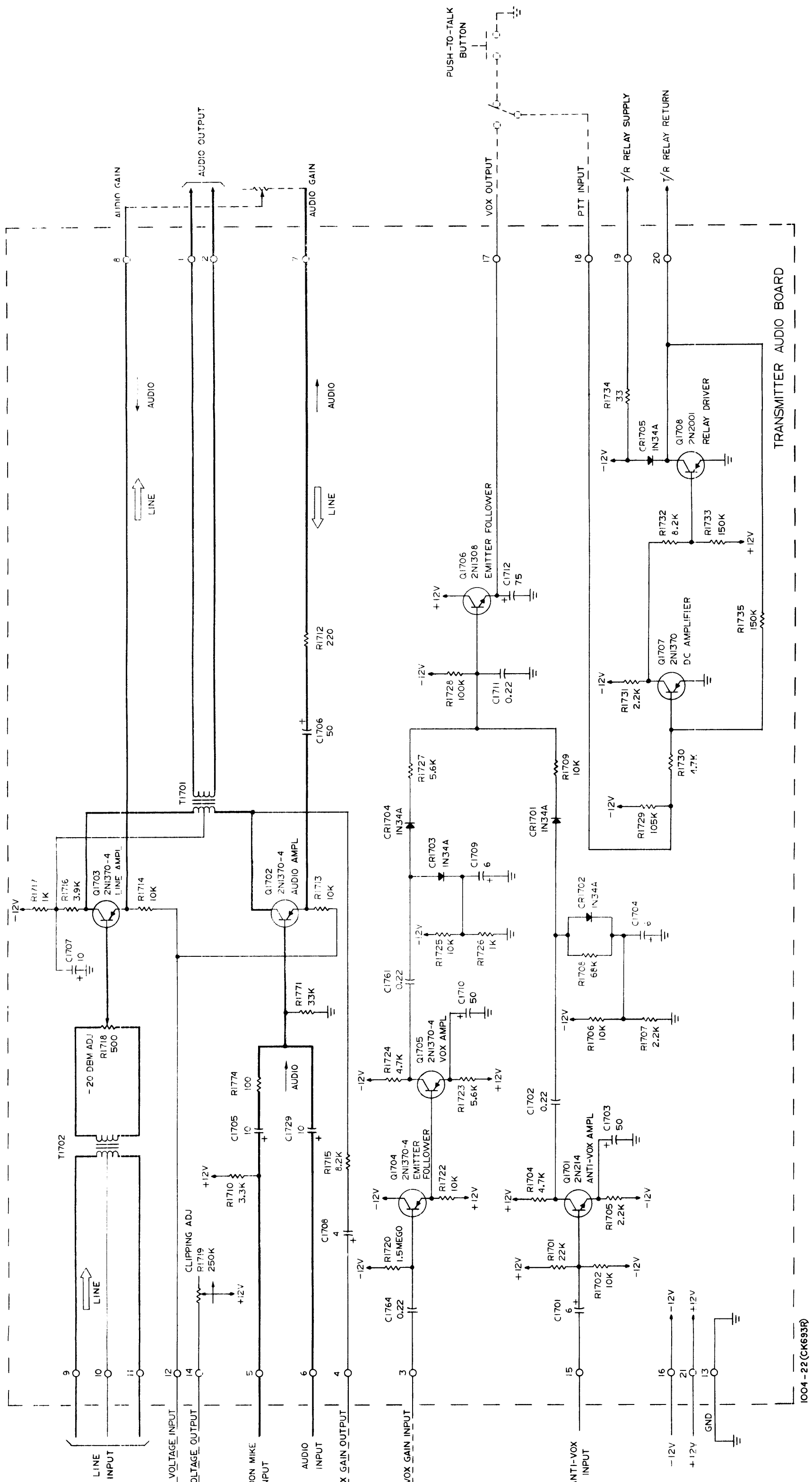
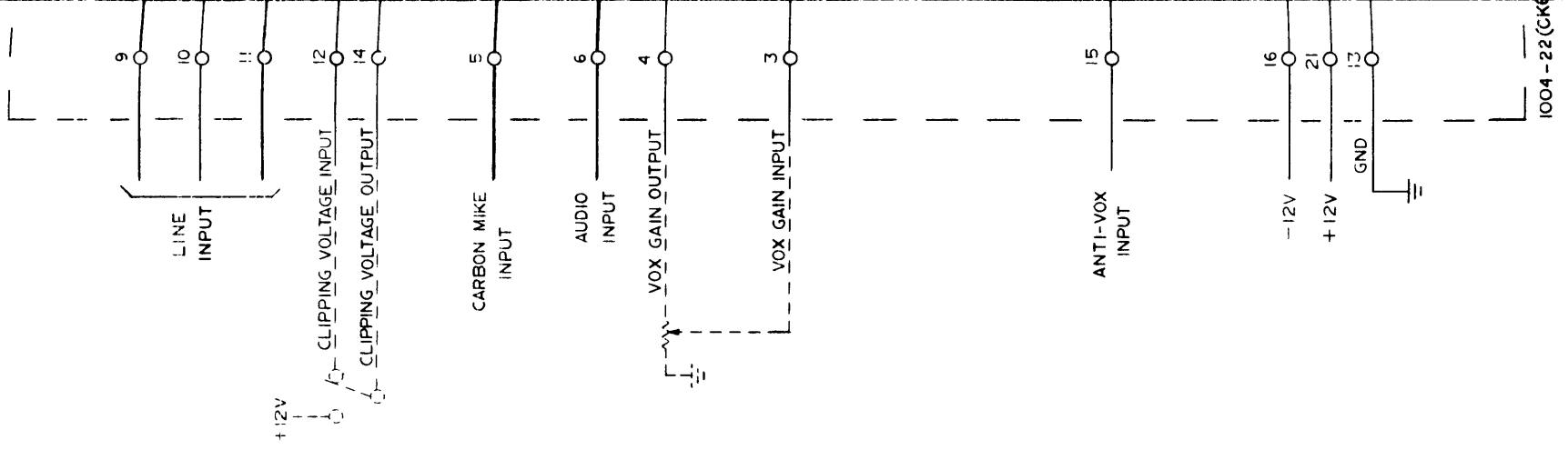
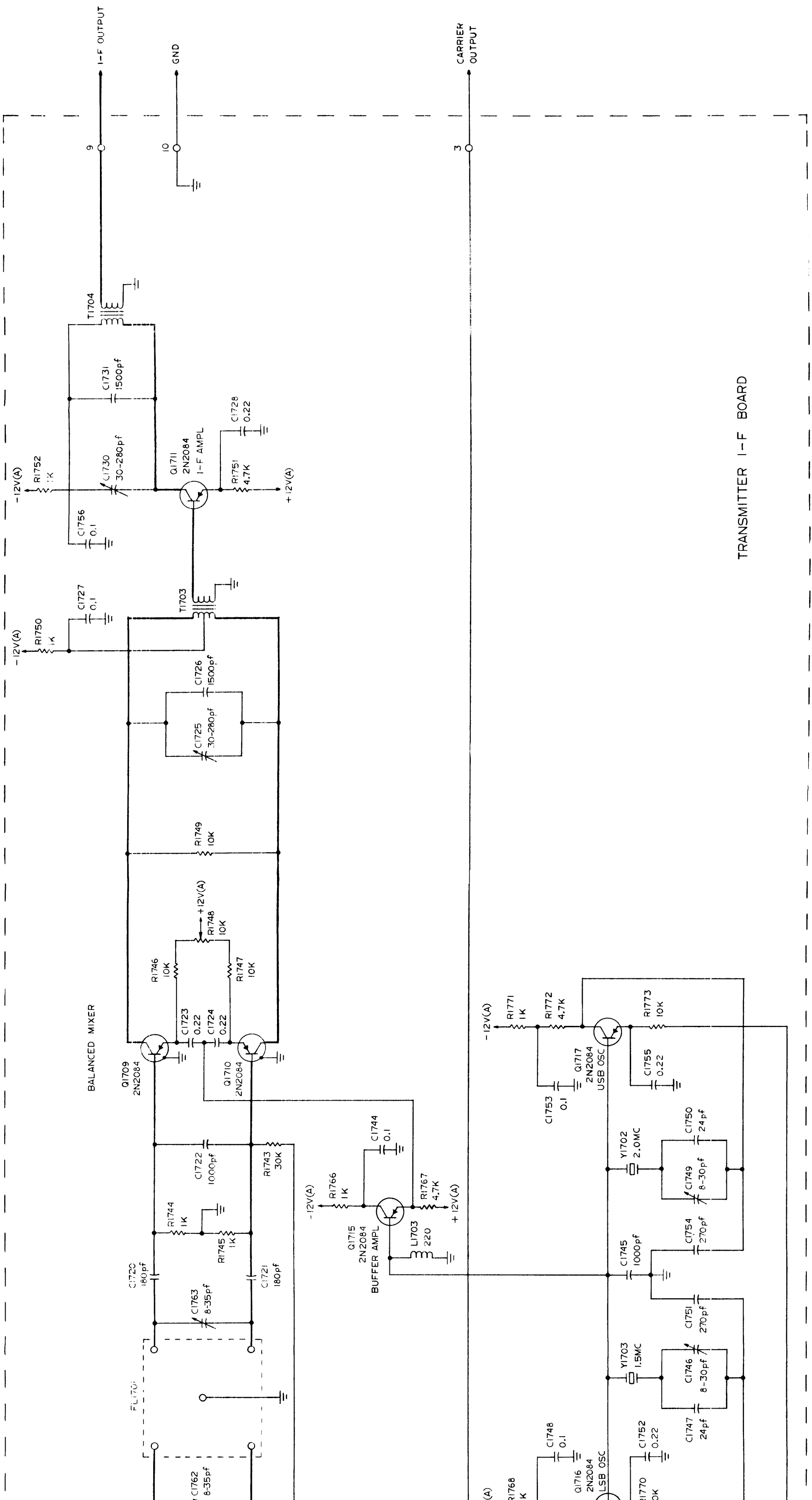


Figure 7-1. TTR-10 Schematic Diagram (Sheet 7 of 8)



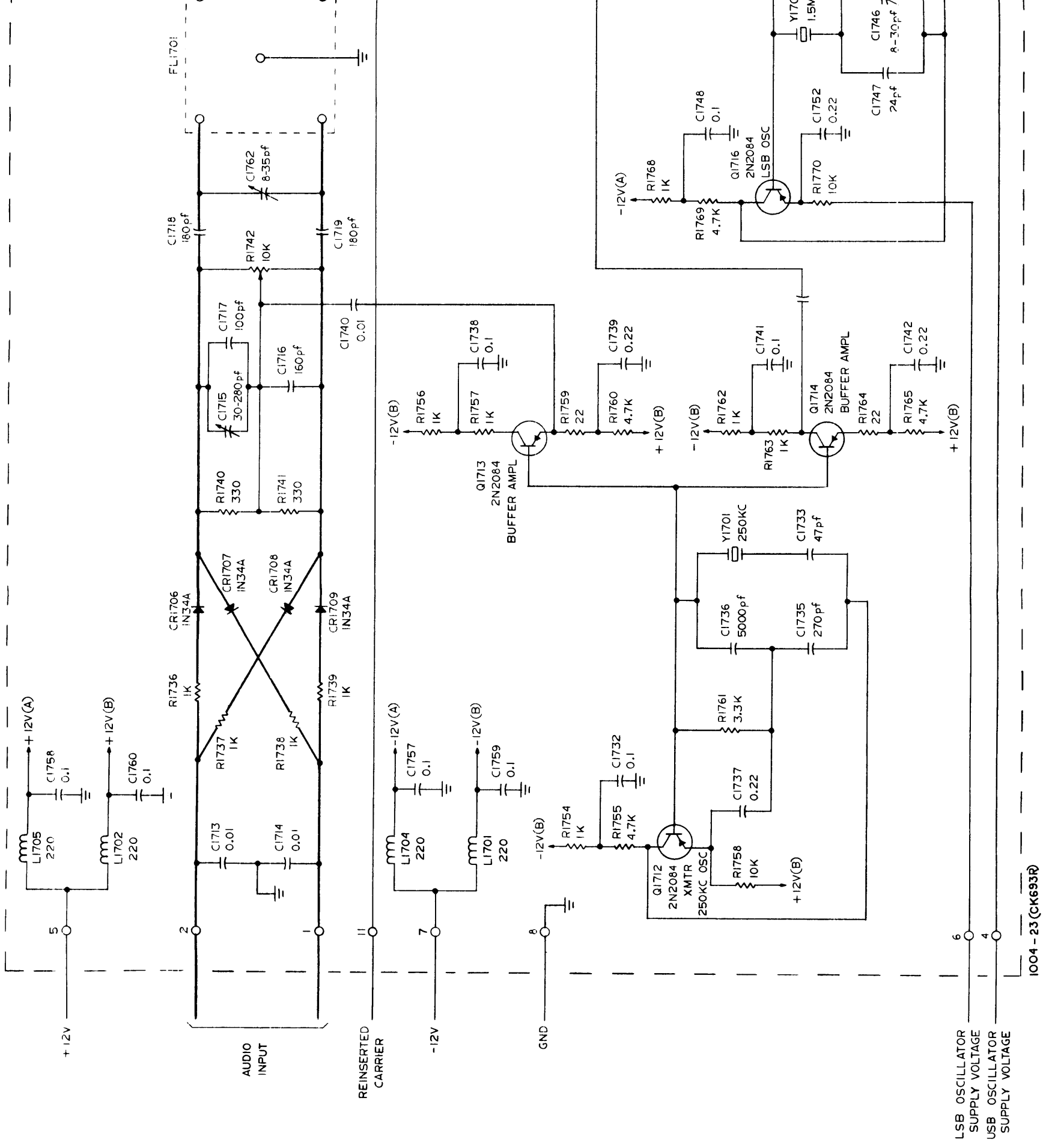


TRANSMITTER I-F BOARD

Figure 7-1. TTR-10 Schematic Diagram (Sheet 8 of 8)

005651004

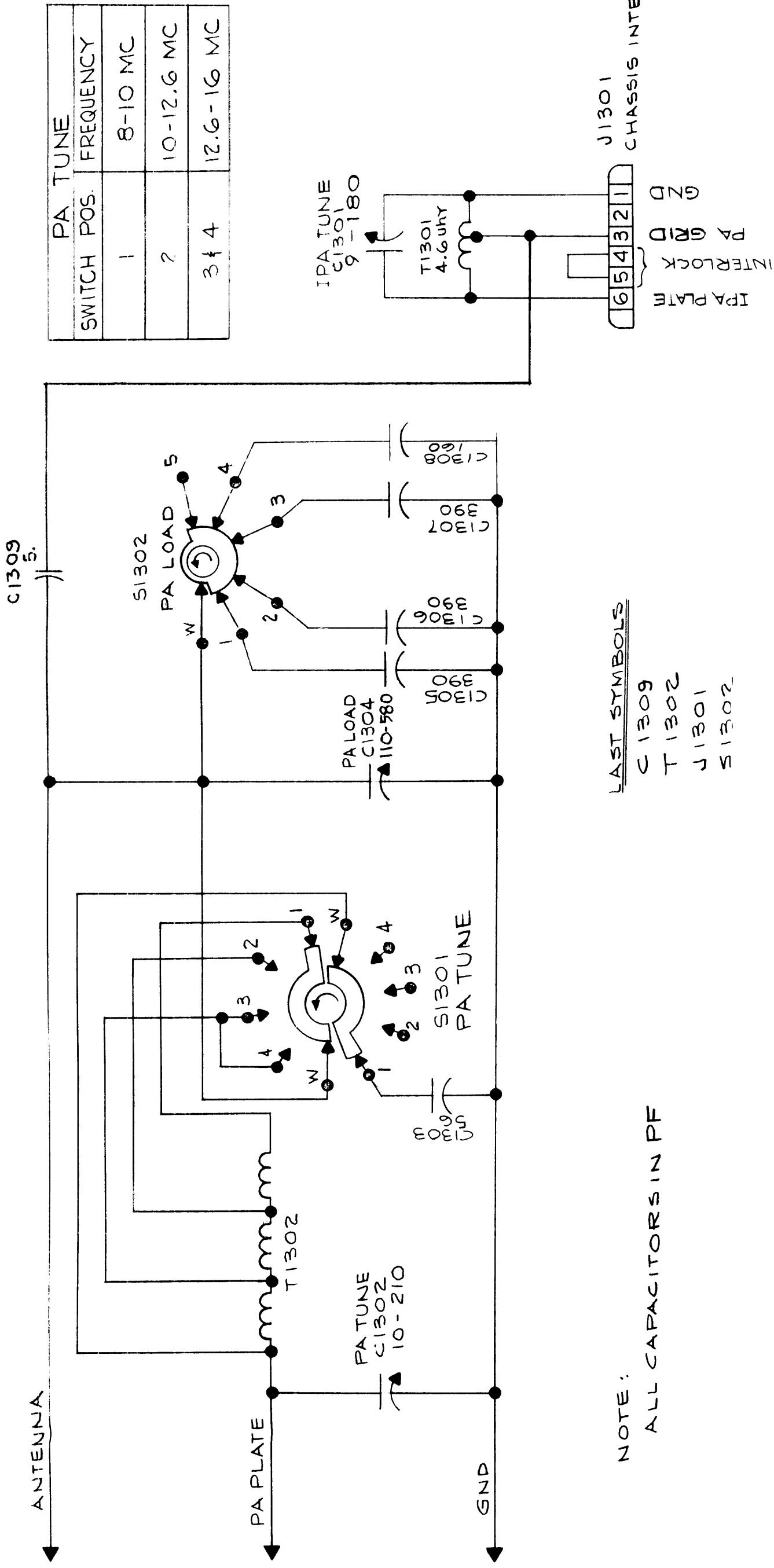
7-15/7-16



1004 - 23 (CK693R)







PA TUNE SWITCH POS.	FREQUENCY
1	8-10 MC
2	10-12.6 MC
3 & 4	12.6-16 MC

LAST SYMBOLS  
 C 1309  
 T 1302  
 J 1301  
 S 1302

NOTE:  
 ALL CAPACITORS IN PF

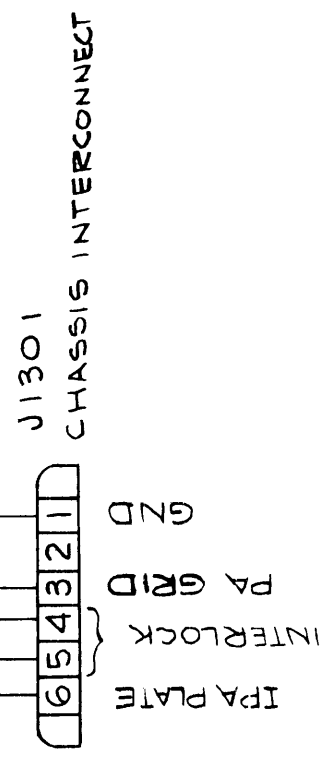
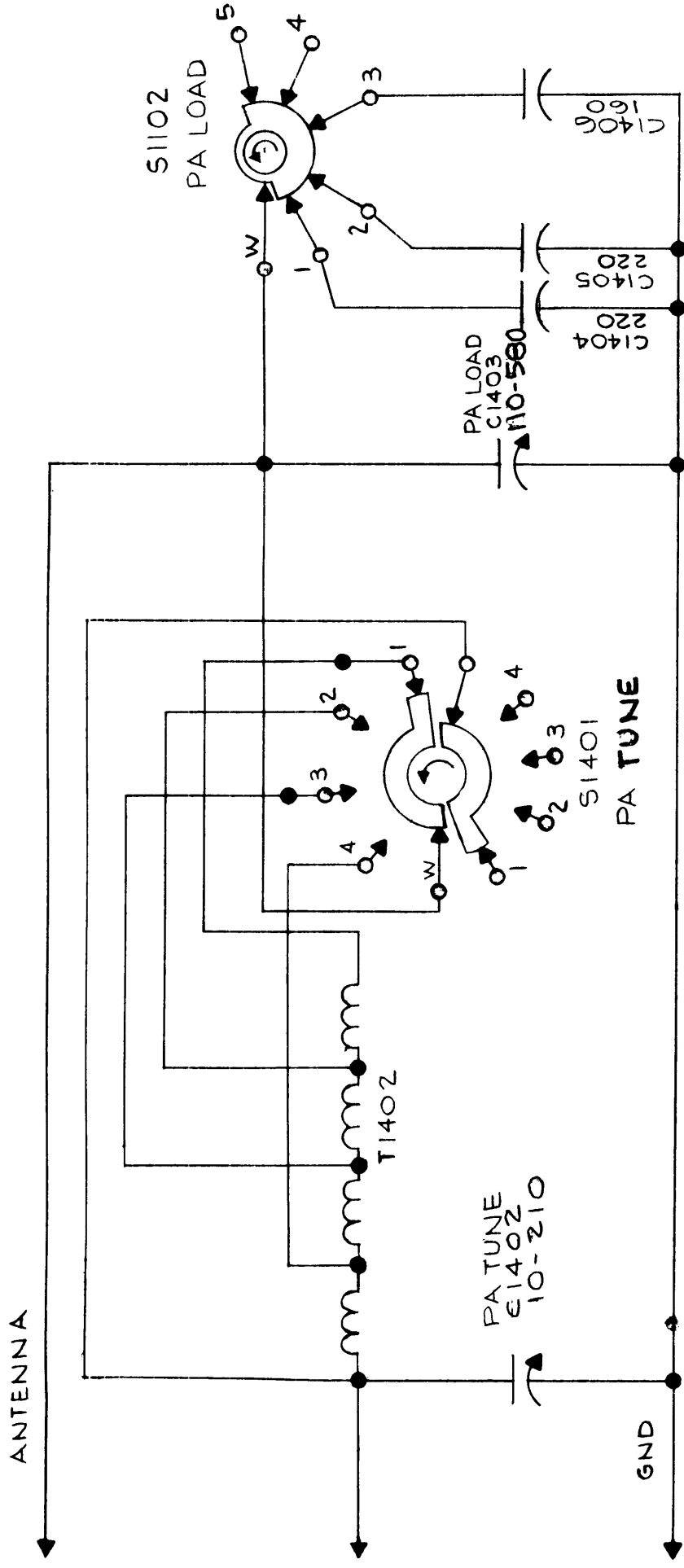
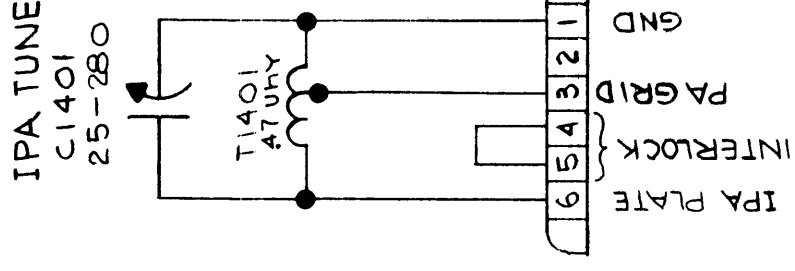


Figure 7-4. TTRA-3, Schematic Diagram  
 7-21/7-22

CK-655B  
 005651004



PA TUNE SWITCH POS	FREQUENCY
1	16-20 MC
2	20-24 MC
3	24-28 MC
4	28-32 MC



LAST SYMBOLS

- C1406
- T1402
- J1401
- S1402

NOTE:  
ALL CAPACITORS IN PF

Figure 7-5. TTRA-4, Schematic Diagram