



## HAMMARLUND MODEL HX-50 TRANSMITTER/EXCITER

### SECTION I

#### INTRODUCTION

##### 1-1. DESCRIPTION

The Hammarlund Model HX-50 Transmitter/Exciter is capable of SSB (Single Sideband, Suppressed Carrier), AM (Amplitude Modulation), and CW (Continuous Wave) transmission in the 160, 80, 40, 20, 15, and 10 meter amateur bands. The only requirement for immediate ~~"on the air" operation is a 40-80 ohm terminated antenna system, key or microphone, and~~ a 115-volt, 50-60 cycle AC power source.

##### 1-2. SCOPE OF OPERATION

The HX-50 may be utilized as a completely self-contained transmitter, or as an exciter for a linear power amplifier such as the Hammarlund Model HXL-ONE. If some other type of linear amplifier is employed, it should be designed to be fed from the 40-80 ohm termination of the HX-50 Transmitter/Exciter's output to utilize the full capabilities of the HX-50. Minimum power output ratings of the HX-50 Transmitter/Exciter are:

SSB ----- 50-60 Watts  
CW ----- 50-60 Watts  
AM ----- 12-14 Watts

Prominent features of the HX-50 Transmitter/Exciter are:

Stable quartz crystal sideband filter - operating at approximately 3 Mc/s.

Built-in antenna change over relay.

Time sequenced, automatic break-in CW keying (VOX keying).

C.T.O. direct reading to 10 Kc/s points with less than 5 Kc/s error between adjacent 100 Kc/s calibration points after calibrating.

90 Watts plate input to the final amplifier on SSB, and CW.

Six band output 80, 40, 20, 15, and 10 meter bands supplied; 160 meter band output available on special order; 10 meter band coverage in three individually calibrated switched segments provide the same calibration accuracy as lower frequency bands.

##### 1-3. T.V.I. SUPPRESSION

The HX-50 Transmitter/Exciter has been designed and constructed to suppress spurious radiations that may cause television interference (T.V.I.). The T.V.I. problem was given full consideration in the design of every circuit as well as in the selection and layout of parts.



## SECTION II

### INSTALLATION

#### 2-1. UNPACKING

After unpacking the HX-50 Transmitter/Exciter, examine it closely for any possible damage which may have occurred during transit. Should any sign of damage be apparent, file a claim immediately with the carrier stating the extent of damage. Carefully check all shipping labels and tags for any special instructions before removing or destroying them.

#### 2-2. LOCATION

When installing the Model HX-50 Transmitter/Exciter, avoid excessively warm or drafty locations such as those near radiators and air conditioning or heating vents. The unit should be placed in a location where there is adequate space around it, to permit free circulation of clear air through the cabinet openings.

#### 2-3. POWER SOURCE

The HX-50 Transmitter/Exciter is designed to operate from 105-125 Volts, 50-60 Cycle AC power source; power consumption is 250 Watts.

**CAUTION:** If in doubt about your power source, contact your local power company prior to inserting the power cord into an AC power outlet. Plugging the power cord into the wrong power source can cause extensive damage to the unit, requiring costly repairs.

#### 2-4. REAR PANEL CONNECTIONS (refer to figure 2)

Receptacles and an eight terminal screw type terminal board are provided on the rear panel of the HX-50 Transmitter/Exciter to facilitate the connection of associated equipment.

##### 2-4-1. MICROPHONE RECEPTACLE (J101)

The Model HX-50 Transmitter/Exciter is designed to operate with a high impedance communications type microphone. The microphone cable should be fitted with an Amphenol type 75-MC1F connector, or equivalent.

##### 2-4-2. KEY JACK (J103)

This standard two-conductor phone jack is provided on the rear panel for hand key or "bug" operation. The key jack accepts a general purpose standard two-conductor phone plug. Wire the plug so that the key base is connected to the sleeve of the plug which is at chassis ground potential. During CW operation when the key is up, cutoff bias is maintained at the 2nd mixer and driver stages; closing the key removes the cutoff bias and applies signal excitation to the output RF stage.

#### 2-4-3. RF OUTPUT CONNECTOR (J105)

This is a coaxial connector through which the HX-50 Transmitter/Exciter is connected to the antenna system or a linear amplifier. The connecting cable (50-70 ohm coaxial type) should be fitted with an Amphenol type 83-1SP (PL-259) connector or equivalent. The selection of the type antenna and coupling will depend upon the frequencies used and the purpose of operation. Refer to the ARRL Antenna Handbook for detailed information concerning transmitting antennas.

#### 2-4-4. RECEIVER ANTENNA CONNECTOR (J104)

This is a phono type coaxial connector which connects the antenna system to the receiver through the HX-50 Transmitter/Exciter's antenna relay. The connecting cable (50-70 ohm coaxial type) should be fitted with a standard phono type connector or equivalent.

#### 2-4-5. STATION CONTROL TERMINAL BOARD (TB101)

An eight terminal screw type terminal board is provided at the rear of the chassis to connect the HX-50 Transmitter/Exciter into the station control system. The instructions which follow may be modified to suit your particular needs.

##### 2-4-5-1. ACCESSORY RELAY CONTACTS (Terminals 6, 7, and 8)

An external antenna change-over relay or any other switching function may be employed by utilizing terminals 6, 7, and 8 on the screw type terminal board. These terminals are connected internally to insulated contacts on the VOX Relay (K102) of the HX-50 Transmitter/Exciter. Figure 4 illustrates typical connections of an external change-over relay to these terminals.

Note: The maximum permissible contact current is 1 amp., 230 VAC.

During periods of transmission, the VOX relay connects terminal 7 to terminal 8 enabling an external power source to activate the external antenna change-over relay. For external applications where an open circuit is required when transmitting (closed circuit during periods of receive) terminal 6 and 7 may be used.

##### 2-4-5-2. RECEIVER OUTPUT AND SPEAKER (Terminals 3 and 4)

Connect the audio output of the station's receiver directly to terminals 3 and 4 (terminal 3 is ground or chassis side). The receiver speaker is also connected directly to terminal 3 and 4. Connecting the receiver and speaker in this manner prevents the actuating of the HX-50 Transmitter/Exciter's VOX circuit by incoming audio signals from the receiver during periods of transmission; and, also shorts the receiver output to the speaker when the HX-50 Transmitter/Exciter is on the air. (See figure 3 and 4 for typical station installation.)

##### 2-4-5-3. RECEIVER CUT-OFF BIAS (Terminals 3 and 5)

A high impedance bias source is available at terminal 5, with terminal 3 used as the return or ground connection. The bias is fixed at approximately -100VDC and is applied to terminal 5 thru a 1 megohm resistor during periods of transmission. Terminal 5 is returned to the chassis-ground during periods of reception by the internal VOX relay. (See figure 3 and 4 for typical station installation.)

#### 2-4-5-4. PUSH-TO-TALK (Terminals 1 and 2 of terminal strip TB101)

Closing terminals 1 and 2 by an external switch permits push-to-talk operation of the HX-50 Transmitter/Exciter in the VOX position of the OPERATION control. (See figure 3 and 4 for typical push-to-talk installations.)

NOTE: Terminal 1 is chassis ground.

Microphone push-to-talk circuits using a common ground return will function correctly.

#### 2-4-6. EXTERNAL VFO CONNECTOR (J102)

This is a phono type coaxial connector which connects an external VFO through the Crystal-VFO Selector Switch to the second mixer, allowing possible transceiver operation or external frequency control from any 6.0-6.5 Mc/s oscillator.

Note: Injection voltage required is 3 volts RF across 50 ohms.

The connecting cable (50 - 70 ohms coaxial type) should be fitted with a standard type phono connector.

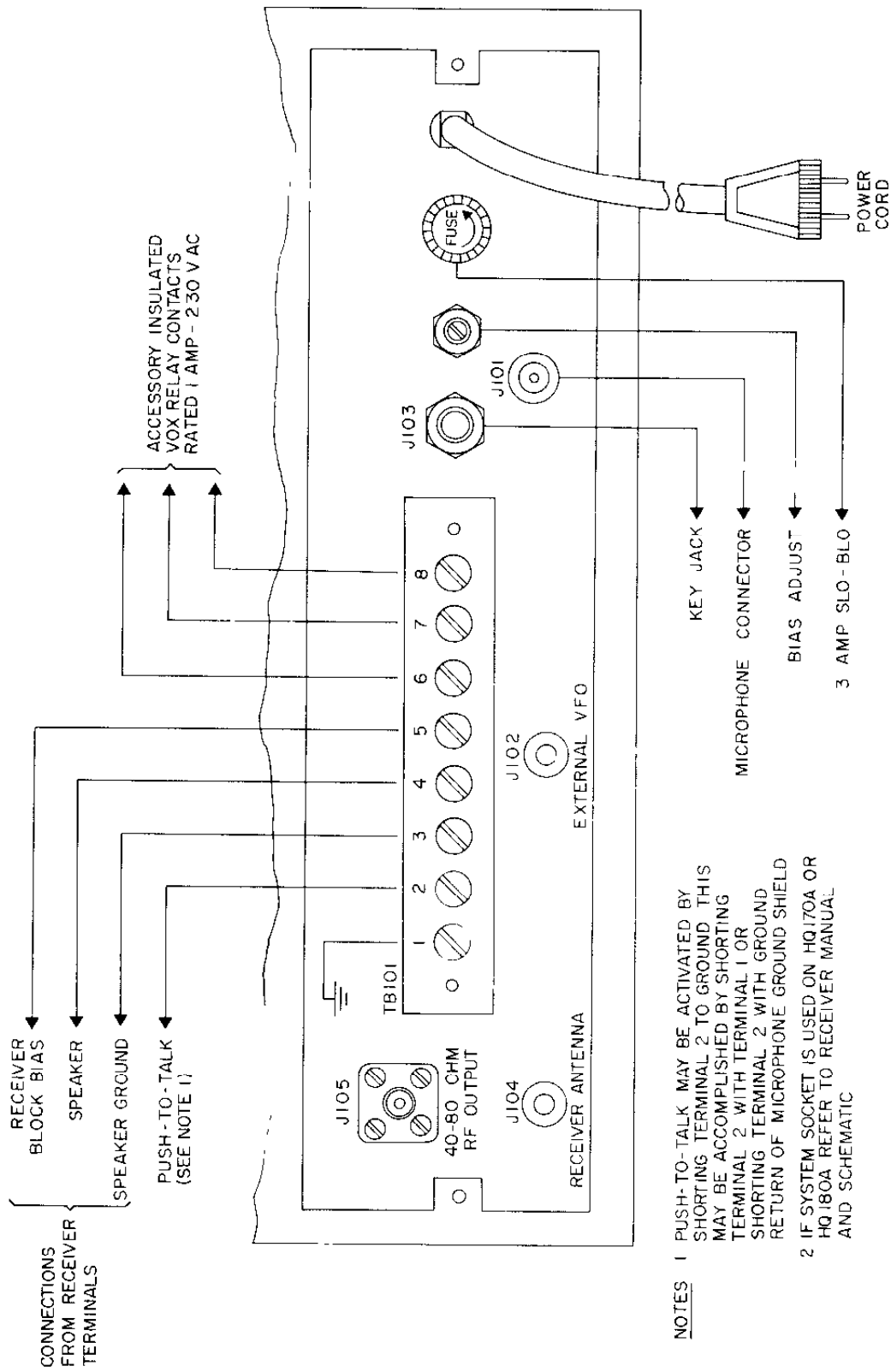
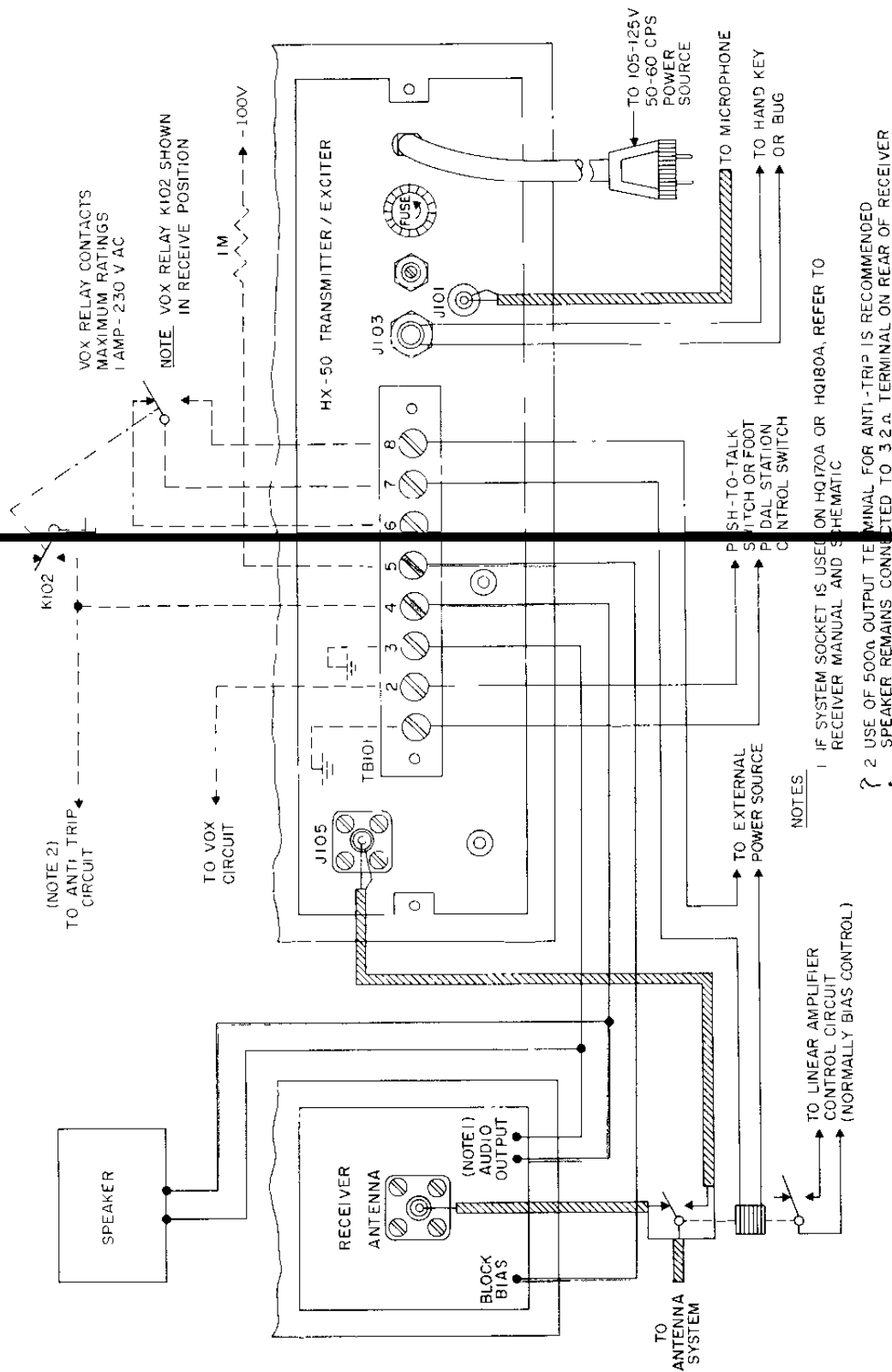
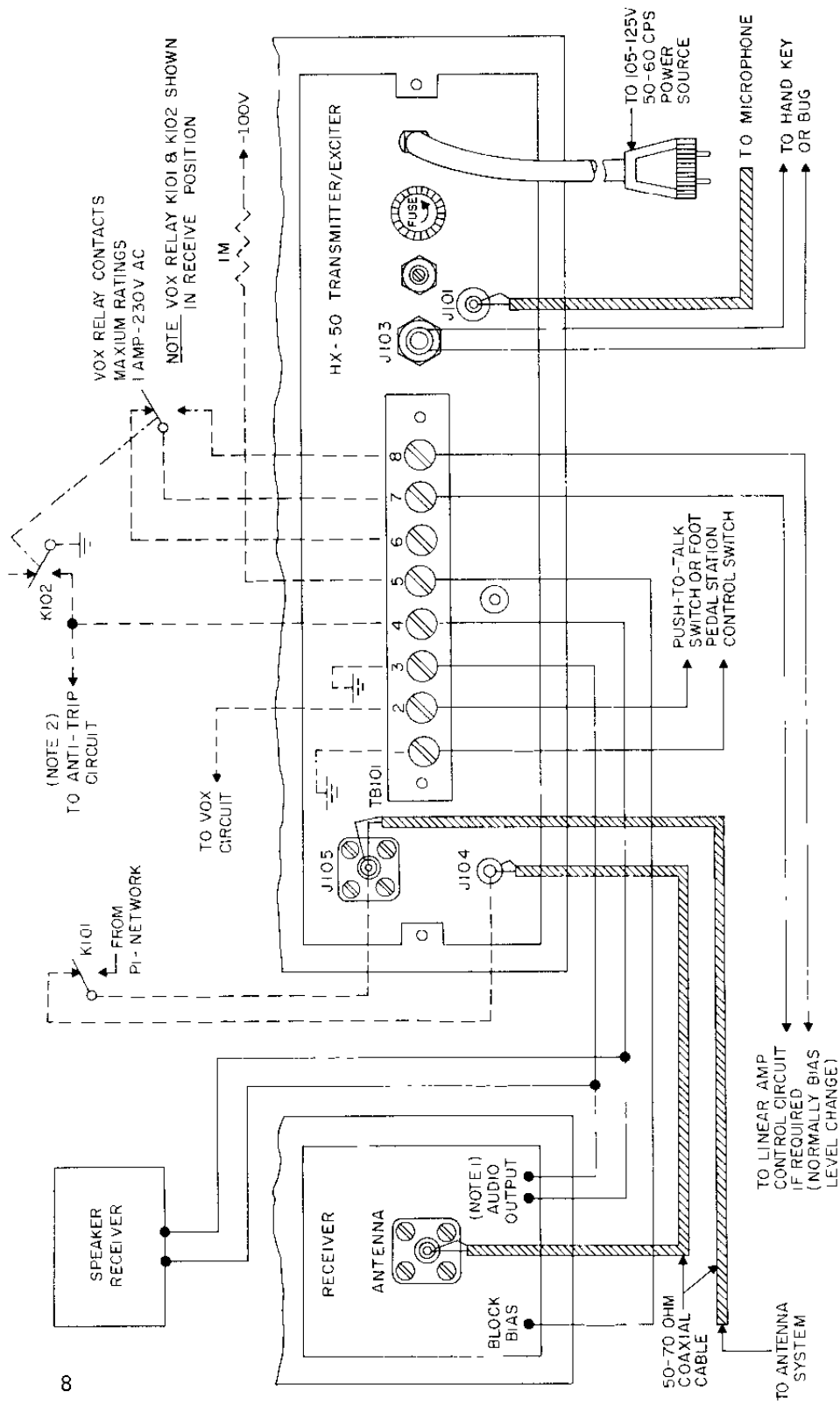


FIGURE 2. HX-50 CONNECTION POINTS AT REAR OF CHASSIS



**FIGURE 3. HX-50 TYPICAL STATION CONTROL (USING INTERNAL ANTENNA CHANGE-OVER RELAY)**





**FIGURE 4. HX-50 TYPICAL STATION CONTROL WIRING  
(USING EXTERNAL ANTENNA CHANGE-OVER RELAY)**

## SECTION III

### OPERATING CONTROLS (refer to photo on title page)

#### 3-1. FUNCTION

The FUNCTION Control is a four-position rotary switch for selecting the mode of transmission: USB (upper sideband), LSB (lower sideband), AM (amplitude modulation), or CW (continuous wave).

#### 3-2. OPERATION

The OPERATION Control is a five-position rotary switch for selecting the transmitter's operating condition: OFF, STANDBY, MOX, CALIBRATE, VOX.

In the OFF position, electrical power is disconnected from the transmitter.

In the STANDBY position, power is applied to the transmitter, but it is inoperative since blocking bias is applied to the 2nd mixer and driver stages.

In the MOX position, the transmitter is energized. To control the transmitter manually, set the OPERATION switch to MOX in order to transmit and to STANDBY when receiving.

In the CALIBRATE position the cut-off bias on the 2nd mixer and driver stages is reduced, allowing a calibrate signal to be generated. VOX relays K101 and K102 are de-energized, permitting normal receiving operation in this position. With the receiver in operation, the transmitter calibrate signal may be monitored.

In the VOX position, the transmitter VOX relays are operated by voice energy from the microphone. The relay tube is biased to cut-off and will not energize the relays until signal excitation is received from the audio amplifier and VOX amplifier stages. When push-to-talk operation is desired, turn the VOX sensitivity control (located behind the left panel door) fully counter clockwise and control the HX-50 Transmitter/Exciter with an external push-to-talk switch, or a push-to-talk microphone. (See figures 2, 3, and 4)

#### 3-3. CRYSTAL-VFO

The CRYSTAL-VFO Control is a five-position rotary switch (located behind the right panel door) used to select either the HX-50 Transmitter/Exciter's internal VFO (Variable Frequency Oscillator), an external VFO or Crystal Oscillator, or one of three crystals (not supplied with unit) plugged into the crystal socket located below the CRYSTAL-VFO Control. (Crystals used should be of the CR-18U type. See Section 5 for crystal frequency information).

#### 3-4. METER

The METER Control is a two-position rotary switch which connects the front panel meter to either the final amplifier cathode circuit (PA CATHODE) for observing final amplifier cathode current, or to the transmitter's output circuit where it serves as a relative RF output indicator, and/or as a carrier balance indicator in the OUTPUT LEVEL position.

### 3-5. BAND SELECTOR

The BAND SELECTOR Control is an eight-position rotary switch which selects the proper combination of tuned circuits and heterodyne crystals for the desired frequency band.

Associated with and directly above the BAND SELECTOR Control is the band indicating dial which has individual calibrated tuning scales for the following bands: 160, 80, 40, 20, 15, 10A, 10B, and 10C.

This control also selects the lamp which indicates the dial scale frequency range to which the transmitter is set.

### 3-6. FREQUENCY

The FREQUENCY Control operates a variable capacitor which tunes the VFO. The VFO frequency range is 5.975 to 6.525 Mc/s. In conjunction with heterodyning circuits, the VFO will set the HX-50 Transmitter/Exciter to the desired operating frequency as indicated by the large tuning dial in any of the six amateur bands (eight ranges). The transmitting frequency is read from the dial scale (range) indicated by the band-in-use indicator light

~~The BAND SELECTOR Control. Each scale is graduated into 100 Kc/s segments with 10 Kc/s points indicated by the smaller division markings, thus allowing the operator to interpolate the frequency to within two kilocycles.~~

### 3-7. METER SENSITIVITY

The METER SENS Control is a potentiometer connected in the meter circuit which enables the operator to set the meter at maximum deflection, (0 db), allowing the meter to be used as a carrier suppression indicator as well as a tune up aid.

### 3-8. AF LEVEL

The AF LEVEL Control is a potentiometer connected in the grid circuit of the audio amplifier stage for adjusting audio drive to the balanced modulator. This control has sufficient range to permit use of any high impedance microphone normally used for voice communications. (i.e. microphone output of -50DB $\pm$ 5DB)

### 3-9. RF DRIVE

The RF DRIVE Control is a potentiometer connected in the cathode circuit of the 3-Mc/s band pass amplifier stage and allows the operator to adjust the gain of the 3-Mc/s amplifier. For AM and CW, the amount of carrier (output signal) level is determined by the setting of the RF DRIVE control. With this type of carrier control the amount of audio level required for 100% modulation remains the same for all carrier level settings.

### 3-10. PA TUNING

This control is a variable capacitor in the final amplifier tank circuit. It enables the operator to resonate the final power amplifier plate circuit to the operating frequency in the selected band. The panel calibrations allow presetting the control for tune up.

### 3-11. PA LOAD

This control is a variable capacitor in the antenna section of the final tank circuit. It allows the operator to adjust the final amplifier loading while matching the HX-50 Transmitter/Exciter's output to the antenna system impedance.

### 3-12. VOX SENSITIVITY

The VOX SENS. Control is a potentiometer, located behind the left panel door, which is connected to the grid circuit of the VOX amplifier stage. It allows the operator to vary the audio drive to the VOX rectifier. This control has sufficient range to permit adjustment of the VOX circuit so that any high impedance microphone normally used for voice communications may be employed. (i.e. microphone out of  $-50\text{DB} \pm 5\text{DB}$ )

### 3-13. VOX DELAY

SSB-AM VOX DELAY. This control is a potentiometer, located behind the left panel door, which is connected in the grid circuit of the relay tube. It allows the operator to adjust the time lag required to de-energize the VOX relays when audio excitation is removed from

while speaking into the microphone and adjusted to a position which, during the time lapse between words, will not de-energize the VOX relays. This adjustment will eliminate the need for constant keying of the HX-50 Transmitter/Exciter at the beginning of each word.

CW DELAY. This control is a potentiometer connected in the grid circuit of the relay tube when the operation control is set to CW. It allows the operator to adjust the time lag required to de-energize the VOX relays when the key is opened. This control (inner shaft) should be adjusted to a position which, during the time lapse between characters, will not de-energize the VOX relays. This adjustment will eliminate the need for constant keying of the HX-50 Transmitter/Exciter's VOX relays, which would otherwise occur during normal CW transmission.

### 3-14. ANTI-TRIP SENSITIVITY

The ANTI-TRIP SENSITIVITY Control, located behind the left panel door, is a potentiometer in the grid circuit of the Anti-Trip amplifier stage which is used in conjunction with VOX operation of the HX-50 Transmitter/Exciter. When the station receiver and speaker are connected for VOX operation (refer to figures 2, 3, and 4), the speaker Anti-Trip control is advanced to a setting where the audio signal picked up by the microphone from the receiver's speaker will not energize the VOX relays. This prevents the re-transmission of the incoming audio signals from the receiver. It should be noted that excessive anti-trip voltage (gain) is capable of completely blocking normal VOX operation. Hence, the minimum anti-trip gain should be used. Occasionally, a strong heterodyne signal may block normal VOX operation. The operator may quickly regain control by momentarily reducing the receiver audio gain while verbally tripping the transmitter "on the air".

### 3-15. BIAS ADJ

The BIAS ADJ Control is a potentiometer in the bias circuit. It has been set at the factory for final amplifier idle cathode current of 50-60 MA with the transmitter operating from a 117V 50-60 CPS line. The control is located on the rear panel (refer to figure 2). An

### 3-15 - BIAS ADJ - con't.

occasional check of the final amplifier idle current will assure maximum tube life since the 6DQ5 final amplifier tube is operated close to rated plate dissipation for optimum performance.

To adjust the bias, set the Operation Control to the **STANDBY** position and adjust the **BIAS ADJ** Control for final amplifier idle current of 50 to 60 MA as indicated on the front panel meter (meter switch in the **PA CATHODE** position).

## SECTION IV

### TUNING PROCEDURE

#### 4-1. GENERAL

The tuning procedure for the Model HX-50 Transmitter/Exciter has been simplified by design to permit rapid adjustment by the operator. This does not mean that the HX-50 Transmitter/Exciter may be operated successfully if only roughly adjusted. A clean signal from any transmitter requires proper operating technique.

#### 4-2. INITIAL CONTROL SETTINGS

Set the front panel controls to the positions outlined below when initially adjusting the HX-50 Transmitter/Exciter.

<u>CONTROL</u>	<u>POSITION</u>	<u>CONTROL</u>	<u>POSITION</u>
FUNCTION	CW	METER SENS	Fully CW
OPERATION	STANDBY	PA TUNING	} see chart below
AF LEVEL	Fully CCW	PA LOAD	
RF DRIVE	1	BAND SELECTOR	Desired band
METER	PA CATHODE	FREQUENCY	Desired frequency

PA TUNING and PA LOAD control knob settings, when HX-50 is connected to an antenna or dummy load at approximately 50-ohm impedance are as follows:

#### APPROXIMATE SETTINGS

<u>BAND SELECTOR</u>	<u>PA TUNING</u>	<u>PA LOADING</u>
80 (3.5 Mc/s)	7	7-3/4
80 (4.0 Mc/s)	5-1/2	6
40	6-1/2	7-1/2
20	4-1/2	5-3/4
15	2	4
10A	3-1/4	4
10B	3	3-3/4
10C	2-3/4	3-3/4

#### 4-3. CW TUNING

The tuning procedure for CW operation is presented first since tuning procedures for all other modes are modifications of those required for CW operation.

4-3-1. Set the OPERATION control to MOX and FUNCTION control to CW.

4-3-2. Advance RF DRIVE control until PA CATHODE meter indicates 100 MA PA CATHODE current.

4-3-3. Set METER switch to OUTPUT LEVEL and adjust the PA TUNING and PA LOAD controls for maximum meter deflection. (As the final amplifier stage is tuned, it will be necessary to re-adjust the METER SENS. control to keep the pointer on scale). Return the METER control to PA CATHODE and adjust the RF DRIVE for 180 MA PA CATHODE current. (Note: If the indicated PA cathode current is greater than 180 MA, reduce the RF drive level until 180 MA is indicated; for 10-meter operation, limit the current to 150 MA).

4-3-4. If necessary, re-adjust the RF DRIVE level and repeat the above tuning procedure until the PA TUNING and PA LOAD controls are set for maximum output (meter switched to OUTPUT LEVEL) while maintaining the PA cathode current at 180 MA.

Note: Indicated nominal power input is 10B watts when operating on the 80 - 40 - 20 - 15 meter bands (600 volts DC X 180 MA), and 90 watts when operating on the 10-meter band (600 volts DC X 150 MA). The actual input to the final RF amplifier stage is the product of the plate voltage and the cathode current less the screen current (600 volts DC X 180 MA - 22 MA equals 95 watts DC input). Refer to 4-5-3 for F.C.C. Novice License Limitations.

4-3-5. Keep the HX-50 Transmitter/Exciter operating just below the saturation point and avoid flat top distortion. When driving a linear amplifier with the HX-50 Transmitter/Exciter, advance the RF DRIVE control until the required excitation is obtained for the amplifier. In either type of operation, do not operate beyond the saturation level. An oscilloscope should be used to check the transmitted wave pattern.

A convenient reference for this operating level may be obtained by adjusting the METER SENS control so that the meter reads 0 db RF output level at the 180 MA PA Cathode current point.

4-3-6. Insert the key into the Key Jack (J103) on the rear panel of the chassis (refer to Para. 2-4-2 and figure 2 for correct key wiring).

4-3-7. When manual CW operation is desired, set the OPERATION control to MOX for periods of transmission and to the STANDBY during periods of reception. (Note: In the MOX position the VOX relays are held in their transmit position when the OPERATION control is on MOX and the HX-50 Transmitter/Exciter is keyed on and off by removing and applying cut-off bias to the 2nd mixer and driver stages).

4-3-8. When timed sequenced automatic break-in keying is desired, set the OPERATION control to VOX. In this position, when the key is closed, the VOX relays will energize and immediate transmission will begin. A CW DELAY control (inner shaft) located behind the left panel door, adjusts the relay delay time between the time transmission ends and the receiver is re-activated. (Note: When the key is closed in this position, a positive voltage is applied to the grid circuit of the relay tube closing the antenna relay first, then the bias relay. When the bias relay closes, normal block bias keying of the 2nd mixer and driver stages is accomplished. When transmission is ended, the bias relay will open first; then the antenna relay opens. Time sequenced relay keying insures that the HX-50 Transmitter/Exciter is never keyed on prior to the antenna being connected to the final tank circuit, or receiver block bias applied to the receiver; and, that blocking bias is applied to the HX-50 Transmitter/Exciter prior to the antenna being connected to the receiver.

4-4. SSB TUNING

Assuming that the HX-50 Transmitter/Exciter has been correctly adjusted for CW operation on the desired operating frequency, (refer to Para. 4-3-1 through 4-3-6) the tuning procedure for SSB operation is as follows:

4-4-1. Set the METER SENS control for Odb reference on the OUTPUT LEVEL position.

4-4-2. Set the OPERATION Control to the desired sideband. The meter will now indicate the carrier suppression directly in db below maximum output.

4-4-3. While monitoring the transmission on the OUTPUT LEVEL meter, adjust the AF LEVEL control for the required audio gain which does not produce peak flattening or overload distortion of the output signal. Note: The output meter damping factor prevents the output level meter from indicating 0 db reference on voice peaks. The meter will indicate approximately 1/2 full scale with voice excitation. A higher reading may cause distortion.

For optimum SSB tuning, switch the OPERATION control alternately

4-4-4. If VOX operation is desired on SSB, switch the OPERATION control to VOX. Adjust

terminal board TB101. (Refer to figures 2, 3, or 4.)

#### 4-5. AM TUNING

Assuming that the HX-50 Transmitter/Exciter has been correctly adjusted for CW operation on the desired operating frequency, the tuning procedure for AM operation is as follows:



4-5-1. Set the FUNCTION switch to AM. Adjust the RF DRIVE control so that PA CATHODE current is 100 MA.

4-5-2. Turn the METER control to OUTPUT LEVEL. With the AF LEVEL control off (maximum counter-clockwise), set the METER SENS control for an indication of 6 db on the meter. Increase AF LEVEL control until voice peaks occasionally swing the meter to zero db.

This sets the maximum carrier level that the amplifier stage in the HX-50 transmitter/exciter can utilize and provides 100% modulation capabilities.

4-5-3. When operating the HX-50 transmitter under NOVICE CLASS License restrictions, crystal control operation of the transmitter must be used. See Section 5.6 Also, Maximum permissible power input is 75 watts.

Therefore LOADING procedures would remain unchanged. However, Maximum Cathode current would be 147 MA. As an example, 600 volts x 147 MA Less 22 MA screen current = 75 watts plate input power. CATHODE current is adjustable by the front panel RF DRIVE Control.

## SECTION V

### BASIC OPERATION THEORY

#### 5-1. BASIC OPERATING PRINCIPLES

The basic operating principles of the Model HX-50 Transmitter/Exciter are explained in the following sub-paragraphs. Figure 5 is a block diagram of the unit and figure 12 is the schematic diagram. The complete system is first discussed for SSB operation and a brief description of CW and AM operation follows:

#### 5-2. GENERAL DESCRIPTION

Tube V101c is a 3035-Kc/s (lower sideband) or a 3038-Kc/s (upper sideband) crystal controlled oscillator whose output is modulated and ultimately converted to the desired oper-

circuit is balanced and the carrier is suppressed approximately 50 db below the peak envelope power output. Balance is accomplished in the modulator circuit by balancing the output voltage of CR101 and CR102 with the balance control (potentiometer R112). Under balanced conditions, the output of the modulator consists of the upper and lower sidebands of the carrier oscillator (3035 Kc/s LSB or 3038 Kc/s USB) signal. The carrier oscillator frequency determines whether the upper or lower sideband is transmitted by placing the carrier frequency on the correct side of the crystal lattice filter (ZF101).

When the FUNCTION control is set to USB, the variable frequency oscillator (VFO) is shifted by the Vari-capacitor ZC101 in order to maintain the desired output frequency.

The crystal lattice filter in the sideband amplifier stage (V102) suppresses the upper sideband when operating on the lower sideband (FUNCTION control set to LSB, carrier oscillator frequency 3035-Kc/s). During operation on the upper sideband (FUNCTION control set to USB, carrier oscillator frequency 3038-Kc/s), the crystal lattice filter suppresses the lower sideband.

The desired sideband is amplified and its level is controlled by the RF DRIVE level control in the 3Mc/s band-pass amplifier stage (V102).

Up to the input of the first mixer stage (V103a), the operation of the HX-50 Transmitter/Exciter is identical on all bands. The remaining stages heterodyne and amplify the selected sideband to the desired operating frequency. Chart A shows the heterodyne frequencies for various output frequencies.

#### 5-3. 80 METER OPERATION

The selected sideband (upper or lower) signal from the 3Mc/s band-pass amplifier stage (V102) is fed to the 1st mixer stage (V103a) where it is combined with a 13,035 Mc/s signal from the heterodyne crystal controlled oscillator (V103b). Highly selective tuned circuits select the difference frequency and feed it to the 2nd mixer stage (V104) where it is combined with the output signal from the variable frequency oscillator (V105). Since

BLOCK DIAGRAM HAMMARLUND AMATEUR SINGLE SIDEBAND TRANSMITTER

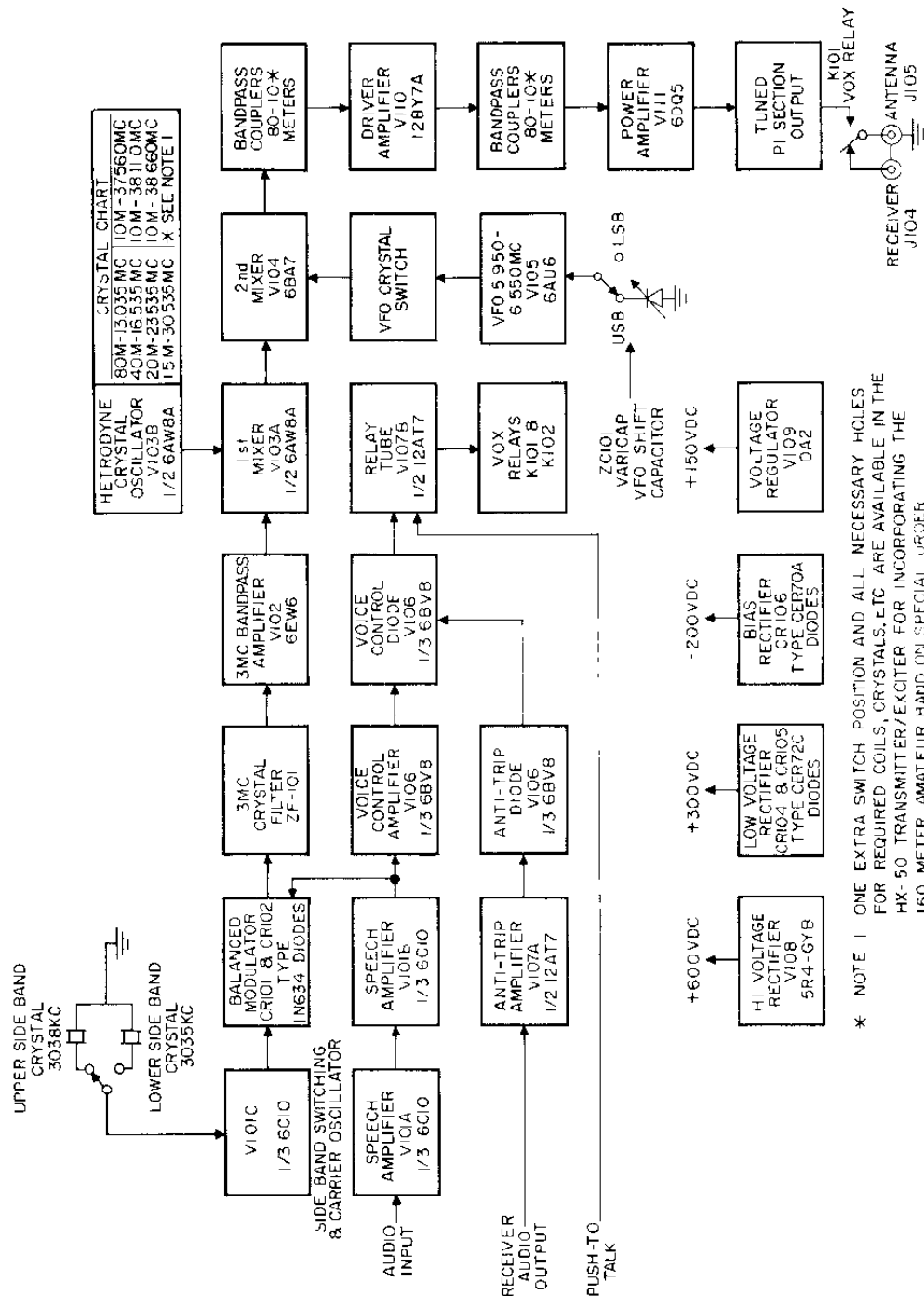


FIGURE 5. HX-50 TRANSMITTER/EXCITER BLOCK DIAGRAM

### 5-3 - 80 METER OPERATION - cont'd.

the VFO output frequency is tunable from 5975Kc/s to 6525Kc/s, the difference output of V104 is the sideband of a frequency between 3475Kc/s and 4025Kc/s.

Band-pass couplers covering the 80 meter band select this difference frequency and feed it to the driver amplifier (V110) where the desired output frequency is amplified and coupled through band-pass couplers to the final amplifier stage (V111), where the signal is

When the FUNCTION control is set to CW, the modulator circuit is unbalanced, audio modulation to the balanced modulator is cut off and the carrier frequency is coupled around the crystal lattice filter. This allows the carrier to be amplified and heterodyned to the desired output frequency. With these exceptions, CW operation is identical with SSB operation.

### 5-5. AM OPERATION

As in CW operation, the FUNCTION control, when set to AM causes the modulator circuit to be unbalanced and the carrier frequency to be coupled around the crystal lattice

### 5.6 CRYSTAL (FIXED FREQUENCY) OPERATION

It is possible to operate the HX-50 Transmitter/Exciter at fixed frequencies by setting the CRYSTAL-VFO switch (S103), located behind the right panel door, to one of the three crystal control settings and installing an appropriate crystal in one or more of the three crystal sockets. Chart B explains how to determine correct crystal frequencies.

### 5.7 OPERATION WITH EXTERNAL VFO

An external VFO or other source of RF energy at frequencies within the 5975 to 6525 Kc/s range may be connected to J102 at the rear of the chassis through a length of 50-75 ohm coaxial cable at a level of 3 volts RMS across 50 ohms. CRYSTAL-VFO switch must be set to position 4 when this type of operation is used.

CHART A  
HETERODYNE FREQUENCIES

BAND (meters)	First Heterodyne Crystal (Kc/s)	First Mixer Output (Kc/s)	VFO Frequency (Kc/s)	Second Mixer Output (Kc/s)
80	13,035	10,000	6,000 6,500	4,000 3,500
40	16,535	13,500	6,200 6,500	7,300 7,000
20	23,535	20,500	6,150 6,500	14,350 14,000
15	30,535	27,500	6,000 6,500	21,500 21,000
10A	37,560	34,525	5,975 6,525	28,550 28,000
10B	38,110	35,075	5,975 6,525	29,100 28,550
10C	38,660	35,625	5,975 6,525	29,650 29,100

CHART B  
CRYSTAL FREQUENCIES  
(fixed frequency operation)

Select band on which operation is desired and note required first mixer output frequency from Chart A.

fm=first mixer output frequency    fo=desired output frequency    fx=crystal frequency  
fd=difference frequency    fp=bandpass filter frequency \*

USB transmission

fm - fo = fx  
Example (operate on 3,711 Kc/s):

$$\begin{array}{r} 10,000 \text{ (fm)} \\ - 3,711 \text{ (fo)} \\ \hline 6,289 \text{ (fx)} \end{array}$$

LSB, AM or CW transmission

fm - fp = fd    fd - fp = fx  
Example (operate on 3,711 Kc/s):

$$\begin{array}{r} \text{Filter bandpass} \\ 3037.778 \\ -3034.603 \\ \hline 3.175 \end{array}$$

$$\begin{array}{r} 10,000 \text{ (fm)} \\ - 3,711 \text{ (fo)} \\ \hline 6,289.000 \text{ (fd)} \\ - 3.175 \text{ (fp)} \\ \hline 6,285.825 \text{ (fx)} \end{array}$$

All figures in Kc/s.

20    \*The filter band pass frequency will be noted on the crystal filter can ZF101.

## SECTION VI

### SERVICE DATA

#### 6-1. CHASSIS REMOVAL

The chassis and front panel assembly are removable as a unit from the cabinet by removing 2 screws at the rear panel.

#### 6-2. TUBE AND DIAL LAMP REPLACEMENT

Remove the chassis from the cabinet and refer to figure 6 for tube and dial lamp identification and arrangement.

#### 6-3. SERVICING THE HX-50 TRANSMITTER/EXCITER

Throughout the design of the Model HX-50 Transmitter/Exciter, full consideration was given to keeping maintenance problems at an absolute minimum. In all well designed communication equipment, maintenance and repair problems are generally confined to the checking and replacement of tubes which may have become defective. Malfunctions of this nature are easily isolated and corrected. However, it is entirely possible that a more obscure malfunction may arise. In this event, only thoroughly trained technical personnel should attempt servicing the unit.

A recommended aid for trouble shooting the HX-50 Transmitter/Exciter is a general coverage receiver. The receiver provides a quick check on various oscillator circuits in the unit. A lead connected to the antenna of the general coverage receiver, when placed near the oscillator tube in the circuit to be checked, can determine the presence or absence of signal from the stage in question.

Note: The frequency of the various crystals may vary somewhat from the frequency marked thereon. The frequencies of all mixer stages may also vary somewhat from that specified in the alignment section of this manual.

If a malfunction occurs when operating on one particular band and mode of operation, the unit should be checked on all bands and in all modes of operation to isolate the difficulty.

A careful study of the block diagram (figure 5) will give a quick clue as to which tubes should be checked. The schematic diagram (figure 12), plus the trouble-shooting chart, will provide a valuable aid in isolating and correcting a malfunction.





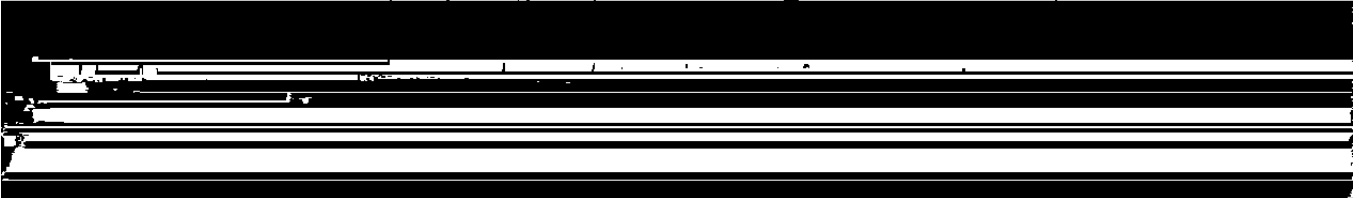


TROUBLE SHOOTING CHART	
SYMPTOM	POSSIBLE CAUSE
No output any band any mode	Check V101, V102, V103, V104, V105, V108, V109, V110, V111, K101, K102, CR101, CR102, CR104, CR105, and CR106
No output any band SSB only	Check ZF101
Off frequency USB only any band	Check ZC101
No output any band USB only	Check V101, Y101-303Kcs
No output any band LSB, AM, or CW	Check V101, Y102-3035Kcs
No output 80 Meters All modes	Check V101, V103, Y109-13.035Mcs
No output 40 Meters All modes	Check V101, V103, Y108-16.535Mcs
No output 20 Meters All modes	Check V101, V103, Y107-23.535Mcs
No output 15 Meters All modes	Check V101, V103, Y106-30.535Mcs
No output 10 Meters Band A, all modes	Check V101, V103, Y105-37.560Mcs
No output 10 Meters Band B, all modes	Check V101, V103, Y104-38.110Mcs
No output 10 Meters Band C, all modes	Check V101, V103, Y103-38.660 Mcs
No VOX operation	Check V101, V106, V107, K101, and K102
No Anti-Trip Operation	Check V101, V106, V107
VOX will not drop out	Check for Hum V101, V106, V107 Check V101, V106, V107

#### 6-4. RESTRINGING THE DIAL POINTER AND VFO DRIVE MECHANISM

Remove the chassis from the cabinet (refer to Para. 6-1). The procedure for restringing the drive cables is as follows:

1. Remove the front panel from the chassis by removing all knobs, mounting hardware appearing under each knob, meter leads from the panel meter.



4. Place the loop end of the VFO drive cable over pin 1 on the tuning drum. Following the lettered sequence shown in figure 8, string the VFO drive cable on the drum and anchor the spring over pin 2 of the tuning drum.
5. Place the loop end of the dial pointer cable over pin 1 on the dial drive drum. Following the lettered sequence shown in figure 10, string the dial pointer cord and anchor the spring over pin 2 on the dial drive drum.
6. Reassemble the dial backing plate, using the hardware removed when the backing plate was disassembled.
7. Rotate the VFO tuning capacitor until it is fully open (plates unmeshed). Place the dial pointer on the pointer track and engage the dial drive cable in the pointer clips. Align the top of the pointer with the calibration line located at the far left hand side of the dial calibration scale, and clinch the pointer clips over the dial drive cable. Apply a drop of household cement to each to prevent slippage. Check the pointer operation. If side play is evident, check the bearing points of the pointer saddle. Bearing pressure on all four points should be light and even for smooth operation. A thin coat of Vaseline applied to the pointer track will help prevent binding.
- B. Reassemble the front panel and install the unit into the cabinet with hardware removed during disassembly.

#### 6-5. RESTRINGING THE BAND SELECTOR MECHANISM

Remove the chassis from the cabinet (refer to Para. 6-1). The procedure for restringing the band selector cable is as follows:

1. Refer to Para. 6-4, Item 1 for front panel removal.
2. Make up band selector cable as shown in figure 9.
3. Dismount the CRYSTAL-VFO switch by removing the two mounting screws used to mount it to the top of the chassis.

#### 6-5 - RESTRINGING THE BAND SELECTOR MECHANISM - cont'd.

4. Place the loop end of the cable over pin 1 on drum "A". Following the lettered sequence shown in figure 9, string the band selector switching cable and anchor the spring over pin 2 on drum "A".
5. Check drum "B" for proper BAND SELECTOR indexing if index is off. Slip drum "B" through cable until correctly aligned. Clinch the cable under pin 1 to secure the cable positioning on the drum. Lift the cable up over idler pull "Z" as shown in figure 9.
6. Remount the CRYSTAL-VFO switch to the chassis making sure to mount the cable clamp and cable when mounting the switch.
7. Reassemble the front panel and install the unit in the cabinet.

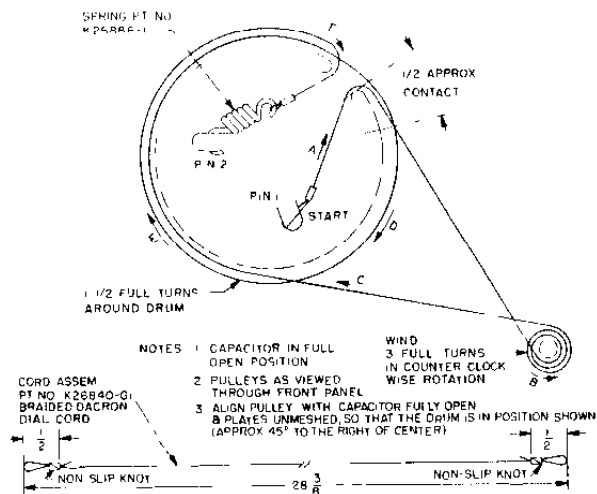


Figure 8. Restraining the VFO Drive Mechanism

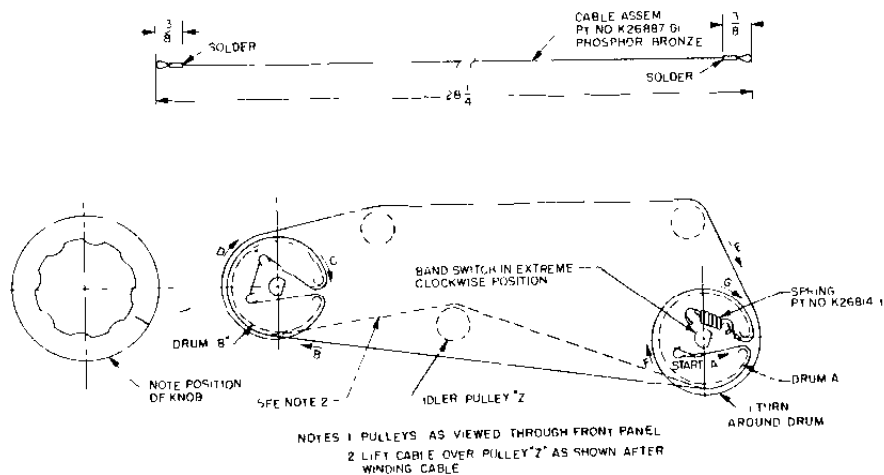


Figure 9. Restraining the Band Selector Mechanism

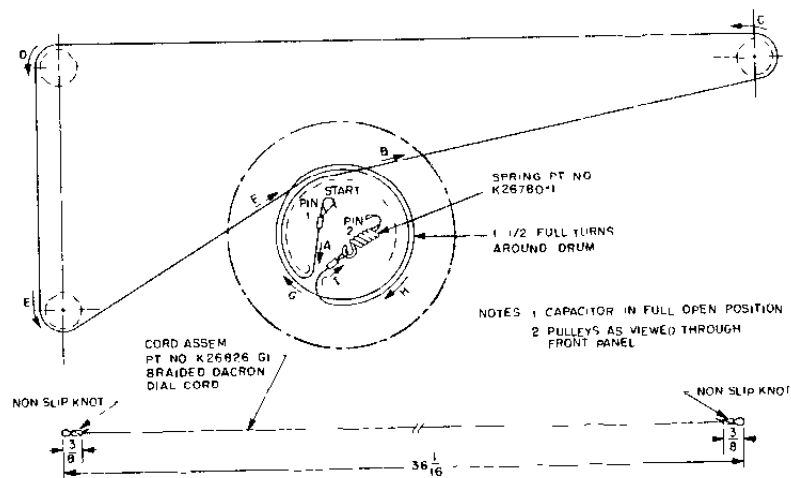


Figure 10. Restraining the Dial Pointer Mechanism

## SECTION VII

### ALIGNMENT PROCEDURE

**IMPORTANT:** The RF alignment of any stage should only be attempted when an HX-50 Transmitter/Exciter malfunction has been analyzed and definitely traced to the stage in question as an RF misalignment.

#### 7-1. EQUIPMENT REQUIRED

RF Signal Generator, Hewlett Packard Model 606A or equivalent having a 3-volt RMS output at an impedance of 50 ohms or less.

Vacuum Tube Voltmeter (VTVM), Hewlett Packard Model 410B or equivalent having an RF probe operable up to 40 Mc/s.

Dummy load, 50 ohm, 70-watt non-inductive, at 100 Mc/s or less.

DC voltmeter, 20,000 ohms-per-volt or greater sensitivity.

Receiver (3-40Mc/s range) with 1 Kc/s calibrations or a frequency counter, Hewlett Packard Model 524D or equivalent.

Crystal calibrator (1 Kc/s or 50 Kc/s) if receiver is used.

Audio voltmeter capable of reading 6 millivolt level.

Audio signal generator (1000 CPS).

#### 7-2. INITIAL CONTROL SETTINGS

OPERATION-----STANDBY

FUNCTION-----CW

RF DRIVE----- 1

FINAL TUNING----- 3

FINAL LOADING----- 5

BAND SELECTOR----- As instructed

FREQUENCY----- 4.0 Mc/s

AUDIO LEVEL----- Fully counterclockwise

#### 7-2. - INITIAL CONTROL SETTINGS - cont'd.

METER SENS -----Fully clockwise

METER SWITCH -----PA CATHODE

CRYSTAL - VFO-----EXT. VFO.

#### 7-3. BIAS ADJUSTMENT

Check the idle PA cathode current prior to performing any tests. The bias adjustment control should be set for final amplifier PA cathode current of 60 MA with the OPERATION switch in the MOX position and the RF DRIVE Control set at 1. (Refer to Para. 3-15 for additional comments on bias adjustment.)

#### 7-4. ALIGNMENT OF CARRIER OSCILLATOR STAGE (V101C sideband switching oscillator)

The carrier oscillator is provided with minor frequency correction trimmers which permit setting each oscillator to the correct frequency. The object of the oscillator frequency adjustment of the carrier frequency is to provide the required carrier signal frequency for the individually calibrated crystal lattice filter. (The crystal filter is calibrated for exact 20 db skirt selectivity points and the carrier frequency should be adjusted to these points.)

Ordinarily the carrier oscillator will not require adjustment in the field. However, if due to part replacement or normal aging of component parts realignment of the carrier oscillator is required, proceed as follows:

- 7-4-1. Set the OPERATION control to STANDBY and allow at least 1 hour warm-up time before beginning the alignment to stabilize component parts.
- 7-4-2. Set the FUNCTION control to USB and connect the VTVM RF probe to test point "A" (Fig. 12).
- 7-4-3. Connect a short lead to the general coverage receiver antenna input. Place this pick up lead near L101. If a frequency counter is used, connect the input cable to test point "A". The following procedure applies only if a general coverage receiver is used to measure frequency during the alignment of the HX-50 Transmitter/Exciter. Set the receiver to the frequency marked on the crystal lattice filter ZF101 for the USB carrier frequency approximately 3038 Kc/s. (The crystal filter is individually calibrated and marked for its correct frequency.)
- 7-4-4. Set the CARRIER BALANCE control (R112) to its maximum clockwise position.
- 7-4-5. After the set has warmed up, adjust the carrier balance coil (T102) for maximum deflection of the VTVM, then back off about 1% of the reading.

#### 7-4 - ALIGNMENT OF CARRIER OSCILLATOR STAGE - cont'd.

- 7-4-6. Set the receiver to the frequency marked on the crystal lattice filter (ZF101) for the USB carrier frequency and adjust the carrier frequency trimmer (C107) to the correct frequency as indicated by the receiver zero beat (refer to Para. 7-4-3).
- 7-4-7. Set the FUNCTION control to LSB.
- 7-4-8. Set the receiver to the frequency marked on the crystal lattice filter (ZF101) for the LSB carrier frequency (approximately 3035 Kc/s), and adjust the carrier frequency trimmer (C108) to the correct frequency as indicated by the receiver zero beat.
- 7-4-9. Set the carrier balance control (R112) to its mid position (rough carrier balance adjustment).
- 7-4-10. With the VTVM RF probe at test point "A", note the developed voltage. The correct voltage is approximately 0.45 volts RF. Switch the FUNCTION control between the USB and LSB positions. The carrier voltage at test point "A" for the two switch positions should be within 0.05 volts of each other. Should they vary more than this, it will be necessary to readjust the carrier balance coil (T102) for balance. Note: Adjustment of T102 may shift the USB and LSB carrier frequencies slightly. Recheck the carrier frequencies and rezero the carrier oscillators if necessary. (Refer to Para. 7-4-3 through 7-4-10).

#### 7-5 RF ALIGNMENT OF THE 3Mc/s BANDPASS AMPLIFIER STAGE (V102).

- 7-5-1. Disconnect the screen lead of the final amplifier stage (VIII)
- 7-5-2. Set the FUNCTION control to CW. Connect the VTVM RF probe to test point "B" and remove the 1st mixer (V103) from its socket.
- 7-5-3. Set the OPERATION control to MOX and the RF DRIVE control to B.
- 7-5-4. Adjust filter coil L101 and the 3 Mc/s bandpass coil (T103) for maximum VTVM meter deflection.
- 7-5-5. Set the RF DRIVE control to 1 and replace the 1st mixer tube (V103) into its socket.

#### 7-6 HETERODYNE CRYSTAL OSCILLATOR ALIGNMENT (V103b)

The heterodyne crystal oscillator alignment procedure for each band is identical except for the frequencies and the 10 meter-segment "C" band where the crystal oscillator plate coil (L105) may require adjustment. Therefore, the following alignment chart and the subsequent steps should be followed for each band omitting only item 7 pertaining to L105 adjustment.

HETERODYNE OSCILLATOR ALIGNMENT CHART				
STEP	BAND	TRIMMER ADJ.	COIL ADJ.	CRYSTAL FREQUENCY
1	10C	C152	L105	38.660 Mc/s
2	10B	C153	NONE	38.110 Mc/s
3	10A	C154	NONE	37.560 Mc/s
4	15	C155	NONE	30.535 Mc/s
5	20	C156	NONE	23.535 Mc/s
6	40	C157	NONE	16.535 Mc/s
7	80	C15B	NONE	13.035 Mc/s
8	*160	C1001	NONE	11.335 Mc/s

7-6-1. Set the BAND SELECTOR control to the band to be aligned.

7-6-2. Connect the VTVM RF probe to test point "B". - Not less than 0.8 volts should be available at the test point.

7-6-3. Set all controls as indicated in Para. 7-2.

7-6-4. Wrap the receiver pick up lead around the heterodyne crystal oscillator tube (V103) (Do not remove tube shield).

7-6-5. Set the receiver to the crystal frequency of the band being aligned.

7-6-6. Adjust the heterodyne oscillator trimmer capacitor to zero beat with the receiver frequency.

7-6-7. Check that the heterodyne oscillator fails to oscillate on the 10 "C" band. it will be



#### 7-7. RF ALIGNMENT OF THE FIRST MIXER STAGE V103a

The 1st mixer stage alignment procedure is identical for each band. Therefore the following alignment chart and the subsequent steps should be followed for each band.

ALIGNMENT CHART FOR FIRST MIXER STAGE			
STEP	BAND	COIL ADJ.	OUTPUT FREQUENCY
1	10C	T104	35.625 Mc/s
2	10B	T105	35.075 Mc/s
3	10A	T106	34.525 Mc/s
4	15	T107	27.500 Mc/s
5	20	T108	20.500 Mc/s
6	40	T109	13.500 Mc/s
7	80	T110	10.000 Mc/s
8	*160	T1001	B.300 Mc/s *If installed

- 7-7-1. Set the BAND SELECTOR control to the band to be aligned.
- 7-7-2. Connect the VTVM RF probe to test point "C" (at least 3V after adj.)
- 7-7-3. Set the OPERATION control to MOX.
- 7-7-4. Set the RF DRIVE control to 8.
- 7-7-5. Set all other controls as indicated in Para. 7-2.
- 7-7-6. Wrap the receiver pick up lead around V104. (Do not remove the tube shield).
- 7-7-7. Set the receiver to the output frequency of the band to be aligned.
- 7-7-8. Adjust the 1st mixer coil plate winding, then the output winding for maximum VTVM meter deflection. (Winding closest to the chassis is the plate winding.) Due to the highly selective resonant circuits used, it is possible to tune on a product "beat" other than the desired output frequency. The correct output frequency may be determined by the receiver "S" meter. The "S" meter will reach maximum deflection when the correct coil adjustments are reached. This adjustment may be further checked by reducing the RF DRIVE. Only the desired output frequency will be adjustable to zero output by the RF DRIVE Control.

#### 7-8. RF ALIGNMENT OF SECOND MIXER AND DRIVER STAGES (V104 and V110)

The 2nd mixer and driver stage alignment procedure for each band is identical. Therefore, the following alignment chart and the subsequent steps should be followed for each band.

7-8 cont.

ALIGNMENT CHART FOR 2ND MIXER AND DRIVER STAGES							
Band	Signal Gen. Freq.	2nd Mixer Primary (plate)	2nd Mixer Secondary (output)	RF Output Voltage	Driver Primary (plate)	Driver Secondary (output)	RF Output Voltage
10-A	2B.2 Mc/s	T111	T111	Adjust for Maximum	T11B	T118	Adjust for Maximum
10-C	29.5 Mc/s						
15	21.05 Mc/s	T112	T112	"	T119	T119	"
	21.4 Mc/s						
20	14.05 Mc/s	T113	T113	"	T120	T120	"
	14.4 Mc/s						
40	7.05 Mc/s	T114	T114	"	T121	T121	"
	7.4 Mc/s						
80	3.05 Mc/s	T115	T115	"	T122	T122	"
	3.9 Mc/s						
*160	1.8 Mc/s	T1002	T1002	"	T1003	T1003	"
	2.0 Mc/s						

Note: The correct coil core position will fall between the coil winding and the end of the coil form. Do not adjust cores so that they fall between the plate and output winding.

\* If installed

- 7-B-1. Set the BAND SELECTOR control to the band to be aligned.
- 7-B-2. Connect the VTVM RF probe to test point "D" for the 2nd mixer preliminary adjustments.
- 7-8-3. Set the OPERATION control to MOX.
- 7-B-4. Set all remaining controls as indicated in Para. 7-2.
- 7-8-5. Remove the heterodyne crystal oscillator tube (V103) from its socket, and disconnect screen resistor R1B2 - 100 ohm 1/2 watt from 6DQ5 Socket.
- 7-B-6. Connect the RF Signal Generator to the External VFO connector (J102).
- 7-8-7. Set the neutralization control (C1B9) to its mid-capacity if it has never been adjusted before.
- 7-B-B. Set the generator to the alignment frequency given in the alignment chart. Adjust the generator for an output level of 0.5 volt.
- 7-8-9. Adjust the 2nd mixer coil for the band to be aligned as indicated in the alignment chart, plate winding first, then the output winding for maximum meter deflection.  
~~Note: Make all preliminary 2nd mixer coil adjustments prior to attempting adjustment of the driver stage.~~

- 7-B-10. Connect the VTVM RF probe to test point "E".

- 7-8-11. Adjust the driver coil for the band to be aligned as indicated in the alignment chart, plate winding first, then the output winding for maximum VTVM meter deflection. (Refer to the RF alignment chart for the minimum required RF output voltage for correct operation of the HX-50 Transmitter/Exciter.)
- 7-8-12. Maintaining an output level of 0.5 volts RF from the signal generator, tune the signal generator across the frequency range of the band being aligned. The output voltage of the driver stage should remain relatively constant. (Maximum variation across any band permissible: 1 db over the VFO frequency range, -3 db over the total specified band coverage.) Should the driver stage output voltage variations be greater than specified, it will be necessary to readjust the 2nd mixer and/or driver coils slightly.
- 7-8-13. This completes the 2nd mixer and driver preliminary alignment adjustments, and the final amplifier screen grid lead may be reconnected. The final adjustments

ing as described in Para. 6-4.

- 7-9-1. Set the CRYSTAL-VFO Control to position 5.
- 7-9-2. Set all remaining controls as indicated in Para. 7-2.
- 7-9-3. Set the VFO trimmer capacitor (C138) for mid-capacity if these components have never been adjusted before.
- 7-9-4. Set the VFO-coil core (L102) so that the core lies between the chassis and the coil winding. (Tuning screws extended fully out of the coil).
- 7-9-5. Warm the receiver pick-up lamp and the VFO tube (V105). (Do not attempt to adjust the VFO trimmer capacitor (C138) until the VFO tube is warm.)
- 7-9-6. Place the HX-50 Transmitter/Exciter on a steel plate to simulate the metal cabinet effect on the VFO components.
- 7-9-7. Set the receiver frequency to 6.0 Mc/s (VFO set to 4.0 Mc/s) and adjust the VFO coil (L102) for zero beat.
- 7-9-8. Set the VFO tuning to 3.5 Mc/s, and adjust the receiver frequency to 6.5 Mc/s.
- 7-9-9. Adjust the VFO trimmer capacitor (C138) for zero beat.
- 7-9-10. Repeat steps 7-9-8 and 7-9-9 until the VFO zero beats the receiver at both alignment frequencies within a few cycles.
- 7-9-11. Check the VFO calibration on all 100 Kc/s points. If the frequency error is less than 1/2 pointer width, the VFO is back to normal. Should the frequency error be greater than 1/2 pointer width, the VFO tuning capacitor requires "knifing". This operation should not be attempted by other than highly qualified personnel thoroughly familiar with the technique.

#### 7-10. NEUTRALIZATION OF THE FINAL AMPLIFIER

The carrier on CW, generated by the HX-50 Transmitter/Exciter may be used on the 10C band as a signal source for this adjustment.

- 7-10-1. Connect the dummy load to the transmitter's output connector.
- 7-10-2. Connect a 0-300 milliammeter in series with the high voltage final amplifier plate lead (between pin 2 at HV rectifier tube V108 and shunt feed plate choke L116).
- 7-10-3. Set the OPERATION control to MOX and the FREQUENCY dial to 29.6 Mc/s.
- 7-10-4. Set the BAND SELECTOR control to the 10C segment (29.1-29.65 Mc/s), and adjust the final amplifier plate tuning and plate loading controls for maximum output. Adjust the RF DRIVE for between 130 and 150 MA PA cathode current.
- 7-10-5. Tune the PA TUNING control for plate current dip and observe the output meter. Adjust the neutralization control until the output meter passes through maximum deflection at the same time as the PA current passes through the resonant dip on the 0-300 MA meter.
- 7-10-6. Set the BAND SELECTOR control to the 15 position and repeat the above procedure for neutralization.
- 7-10-7. If the neutralization setting does not change, the adjustment is completed. If a small change in setting occurs, set the neutralization control halfway between the two settings and recheck with this compromise adjustment.

#### 7-11. FINAL ALIGNMENT PROCEDURE

The final alignment is accomplished using the HX-50 Transmitter/Exciter as a complete operating system.

- 7-11-1. Set the OPERATION control to MOX.
- 7-11-2. Set the CRYSTAL-VFO control to position 5.
- 7-11-3. Set all remaining controls as indicated in Para. 7-2.
- 7-11-4. Connect the VTVM RF probe and the dummy load to the output connector.
- 7-11-5. Place the receiver pick up lead near the output circuit.
- 7-11-6. Check the bias adjustment and readjust for 60 MA PA cathode current if necessary.
- 7-11-7. Check the VFO and carrier oscillator frequencies (Refer to Para. 7-4 and 7-9). Readjust if necessary.

- 7-11-8. The above set-up procedure is identical for each band and should precede the individual band alignment procedure except for item 7-18 which need only be checked prior to aligning the individual bands.
- 7-11-9. Should any band's output vary greater than the maximum allowable amount, it will be necessary to readjust that band's 2nd mixer and driver coils. (Refer to Para. 7-8 for alignment procedure for the 2nd mixer and driver stages.)
- 7-12. 10 METER SEGMENT "C" ALIGNMENT PROCEDURE
- 7-12-1. Set the BAND SELECTOR control to the 10 meter "C" segment position.
- 7-12-2. Set the RF DRIVE control to 8.
- 7-12-3. Adjust the final amplifier PA TUNING and PA LOAD controls for maximum VTVM meter deflection while maintaining a maximum PA cathode current of 150 MA, by adjusting the RF DRIVE control as required.
- 7-12-4. Set the receiver and the HX-50 Transmitter/Exciter to 29.6 Mc/s and adjust the heterodyne crystal oscillator adjustment trimmer capacitor (C152) for zero beat. (Refer to Para. 7-6.)
- 7-12-5. While maintaining PA cathode current at 150 MA with the RF DRIVE control, adjust the 3 Mc/s bandpass transformer (T103) for maximum gain. (Maximum gain of the 3 Mc/s amplifier corresponds to the minimum RF DRIVE control setting required to maintain the required input to the final amplifier stage.)
- 7-12-6. While maintaining the specified PA cathode current with the RF DRIVE control, adjust the first mixer coil (T104), for maximum gain.
- 7-12-7. Using the FREQUENCY Control, check the input across the band. The input across the band should not vary by more than  $\pm 10$  MA across the entire calibrated dial scale. Note: It will be necessary to readjust the final amplifier PA LOAD and PA TUNING controls every 100 Kc/s when making this test.
- 7-13. 10 METER SEGMENT "B" ALIGNMENT PROCEDURE
- 7-13-1. Set the BAND SELECTOR control to the 10 meter "B" segment position.
- 7-13-2. Refer to Para. 7-12-2.
- 7-13-3. Refer to Para. 7-12-3.
- 7-13-4. Set the receiver and the HX-50 Transmitter/Exciter to 29.05 Mc/s and adjust the heterodyne oscillator trimmer capacitor (C153) for zero beat.

7-14-5. While maintaining the specified PA cathode current with the RF DRIVE control, adjust the first mixer coil (T105) for maximum gain.

7-14-6. Refer to Para. 7-12-7.

#### 7-14. 10 METER SEGMENT "A" ALIGNMENT PROCEDURE

7-14-1. Set the BAND SELECTOR control to the 10 meter "A" segment position.

7-14-2. Refer to Para. 7-12-2.

7-14-3. Refer to Para. 7-12-3.

7-14-4. Set the receiver and the HX-50 Transmitter/Exciter to 28.5 Mc/s and adjust the heterodyne oscillator trimmer capacitor (C154) for zero beat.

7-14-5. While maintaining the specified PA cathode current with the RF DRIVE control, adjust the first mixer coil (T106) for maximum gain.

7-14-6. Refer to Para. 7-12-7.

#### 7-15. 15 METER ALIGNMENT PROCEDURE

7-15-1. Set the BAND SELECTOR control to the 15 meter position.

7-15-2. Refer to Para. 7-12-2.

7-15-3. Refer to Para. 7-12-3.

7-15-4. Set the receiver and the HX-50 Transmitter/Exciter to 21.5 Mc/s and adjust the

7-15-6. Refer to Para. 7-12-7.

#### 7-16. 20 METER ALIGNMENT PROCEDURE

7-16-1. Set the BAND SELECTOR control to the 20 meter position.

7-16-2. Refer to Para. 7-12-2.

7-16-3. Refer to Para. 7-12-3.

7-16-4. Set the receiver and the HX-50 Transmitter/Exciter to 14.5 Mc/s and adjust the

7-16-5. While maintaining the specified PA cathode current with the RF DRIVE control, adjust the first mixer coil (T10B) for maximum gain.

7-16-6. Refer to Para. 7-12-7.

#### 7-17 40 METER ALIGNMENT PROCEDURE

7-17-1. Set the BAND SELECTOR control to the 40 meter position.

7-17-2. Refer to Para. 7-12-2.

7-17-3. Refer to Para. 7-12-3.

7-17-4. Set the receiver and the HX-50 Transmitter/Exciter to 7.5 Mc/s and adjust the heterodyne oscillator trimmer capacitor (C157) for zero beat.

7-17-5. While maintaining the specified PA cathode current with the RF DRIVE control, adjust the first mixer coil (T109) for maximum gain.

7-17-6. Set the receiver frequency to 6.5 Mc/s and the transmitter to 7.0 Mc/s (VFO freq. 6.5 Mc/s) and adjust L104 for minimum "S" meter deflection.

7-17-7. Set the receiver frequency to 6.3 Mc/s and the transmitter to 7.2 Mc/s (VFO freq. 6.3 Mc/s) and adjust L121 for minimum "S" meter deflection.

7-17-B. Refer to Para. 7-12-7.

#### 7-18 80 METER ALIGNMENT PROCEDURE

7-18-1. Set the BAND SELECTOR control to the 80 meter position.

7-18-2. Refer to Para. 7-12-2.

7-18-3. Refer to Para. 7-12-3.

7-18-4. Set the receiver and the HX-50 Transmitter/Exciter to 4.0 Mc/s and adjust the heterodyne oscillator trimmer capacitor (C15B) for zero beat.

7-18-5. While maintaining the specified PA cathode current with the RF DRIVE control, adjust the first mixer coil (T110) for maximum gain.

7-18-6. Refer to Para. 7-12-7.

7-18-7. Set the receiver and the Transmitter frequency to 3.8 Mc/s.

7-18-8. Set the FUNCTION control to the USB position and adjust frequency shift control (OSC.ADJ.) R138 for zero beat.

## 7-19 PROCEDURES FOR CARRIER BALANCING OF HX-50 TRANSMITTER/EXCITER

- 7-19-1. Set BAND SELECTOR to 80 meters. Set FREQUENCY to 3.9 Mc/s. Set FUNCTION control to CW. Set OPERATION control to MOX.

Adjust T102 (adjustment hole located beneath the chassis) to permit setting the cathode current to a maximum of 180 MA by reducing the drive level if necessary. Detune T102 counter-clockwise, slightly, until the cathode current falls about 2 MA.

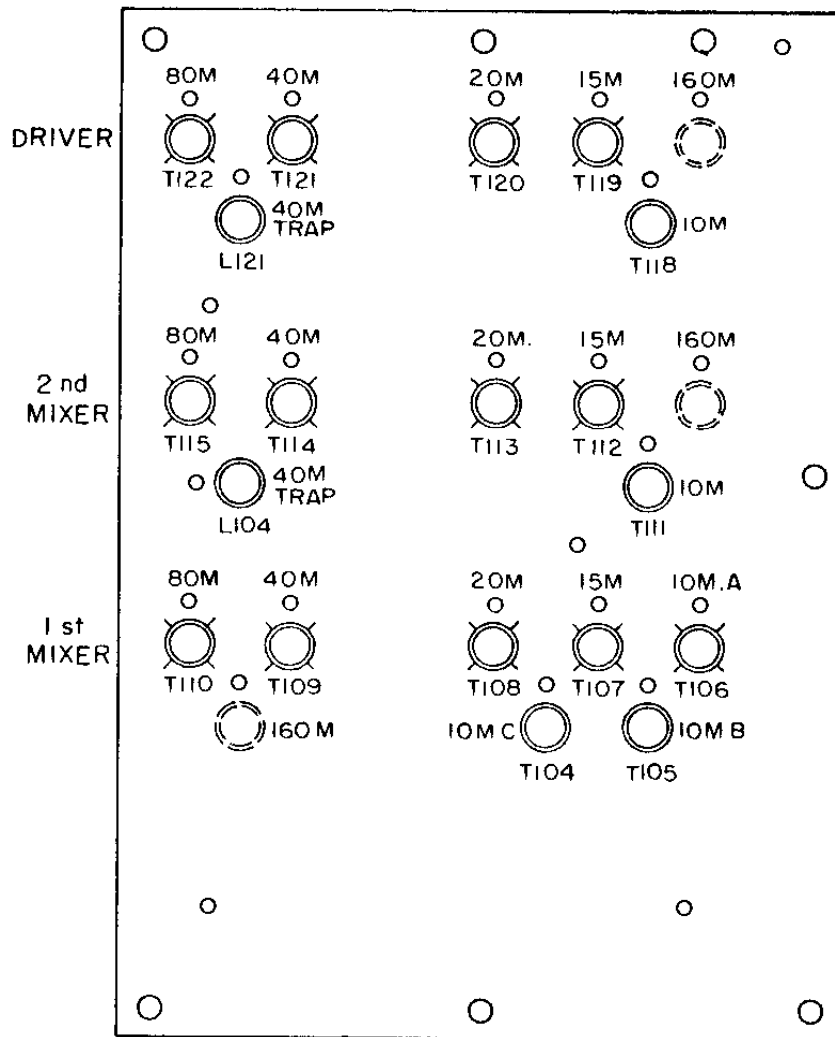
- 7-19-2. Set METER switch to "OUTPUT LEVEL" and adjust meter sensitivity to make meter

- 7-19-4. Make certain that the AF LEVEL control is at the maximum counter-clockwise position (off). Set FUNCTION control to USB, and then to LSB, and note the carrier suppression in both positions.
- 7-19-5. Leave the FUNCTION control in the position which indicates the least suppression and adjust CARRIER BALANCE (R112), located on top of chassis, for minimum meter indication.
- 7-19-6. Set FUNCTION control to the other sideband and note suppression. It may be necessary to readjust CARRIER BALANCE slightly. Strike a median adjustment for equal suppression on both sideband positions of the FUNCTION control.
- 7-19-7. Switch back to the CW position and reload to 180 MA cathode current. Set meter to OUTPUT LEVEL and recheck the 0 db setting; reset sensitivity if necessary.
- 7-19-8. Switch alternately to USB and LSB. The carrier suppression should now be 50 db and within specifications.
- 7-19-9. If at this time the suppression is not 50 db or better, T102 (under chassis) should be touched up VERY SLIGHTLY (not more than 1/8 turn.) Leave the FUNCTION control in the position which indicates the least suppression and adjust CARRIER BALANCE (R112), located on top of chassis, for minimum meter indication.

## 7-20 PROCEDURE FOR SETTING TRANSMITTER FOR SAME OUTPUT FREQUENCY ON USB AND LSB.

- 7-20-1. Tune up transmitter to 3.8 Mc/s for CW operation. (see 4-3)
- 7-20-2. Set FUNCTION control to LSB and tune a receiver to beat with the signal from the transmitter. Make sure the AF LEVEL control is fully off; (max. counter-clockwise).
- 7-20-3. Set FUNCTION control to USB and, without touching receiver tuning, listen for the difference in the beat note at the receiver.
- 7-20-4. Flip FUNCTION control alternately from USB to LSB and adjust the OSC. ADJ. potentiometer until the beat note from the receiver is the same when the FUNCTION control is set to USB or LSB.





BOTTOM VIEW OF PLATE R F COIL ASSEMBLY.

COILS SHOWN WITH DOTTED OUTLINE INDICATES THEIR POSITION WHEN INCORPORATING THE 160 METER AMATEUR BAND

Figure 11. R.F. Coil Position VS Schematic Designation

# HX-50 PARTS LIST

<u>SCHEMATIC DESIGNATION</u>	<u>DESCRIPTION</u>	<u>HAMMARLUND PART NO.</u>
	<u>CAPACITORS</u>	
C101, C130	Disc. Ceramic, 100MMF, $\pm 10\%$ , 1000V	M23034-34
C102	Electrolytic, 8 MF, 350V	K23934-1
C103, C104, C115, )		
C129, C131, C132, )		
C142, C144, C159, )		
C178, C179, C180, )		
C181, C204, C210, )		
C214, C224 )	Disc. Ceramic, .005 MF, +80-20%, 500V	M23034-37
C105, C133, C170, )		
C188, C212	Dur-Mica DM-15, 10MMF, $\pm .5$ MMF, 500V	K23006-22
C107, C108	Mica, Comp'r'n 1.5-20MMF	K23043-3
C109, C110, C111, )		
C112, C113, C114, )		
C148, C163, C164, )		
C165, C166, C167, )		
C168, C169, C172, )		
C173, C192, C198, )		
C203, C206, C215, )		
C238 )	Disc. Ceramic, .01 MF, +80-20%, 500V	M23034-49
C117, C126	Dur-Mica DM-15, 20MMF $\pm 5\%$ , 500V	K23006-114
C118, C119	Dur-Mica DM-15, 56MMF $\pm 2\%$ , 500V	K23006-127
C120, C121	Dur-Mica DM-15, 120MMF $\pm 2\%$ , 500V	K23006-119
C122, C123, C146	Dur-Mica DM-19, 400MMF $\pm 2\%$ , 500V	K23027-27
C124, C125	Dur-Mica DM-19, 420MMF $\pm 2\%$ , 500V	K23027-26
C127, C128	Disc. Ceramic, .001 MF, GMV, 500V	M23034-30
C134, C213, C225	Dur-Mica DM-15, 100MMF $\pm 2\%$ , 500V	K23006-112
C135	Dur-Mica DM-15, 240MMF, $\pm 1\%$ , 500V	K23006-99
C136	Variable, Oscillator Tuning Assembly	P20167-G2
C137, C140, C143	Dur-Mica DM-19, 500MMF $\pm 1\%$ , 500V	K23027-25
C138	Var. 1.9-15.8MMF (OSC. Trim.)	K34602-G48
C139, C221	Temp. Comp. 6MMF $\pm .25$ MMF, N/500	K23061-211C
C141	Dur-Mica DM-15, 20MMF $\pm 5$ MMF, 500V	K23006-17
C145	Mylar, .1 MF, $\pm 10\%$ , 200V	K23933-2
C147, C235, C239	Mylar, .22 MF, $\pm 10\%$ , 400V	K23933-1
C150, C220	Dur-Mica, DM-15, 6MMF $\pm .5$ MMF, 500V	K23006-63
C151	Disc. Ceramic, .01 MF, +80-20%, 500V	M23034-49
C155, C156, C157 )		
C158 )	Var. Mica Comp'r'n 1.5-20MMF	K23043-6
C160, C161, C185, )		
C186, C187 )	Disc. Ceramic, .01 MF, GMV, 1400V	M23034-26
C162	Electrolytic 40-80-40	K15504-65
C162A	40 MF -450V	(See C162)

# HX-50 PARTS LIST

<u>SCHEMATIC DESIGNATION</u>	<u>DESCRIPTION</u>	<u>HAMMARLUND PART NO.</u>
	<u>CAPACITORS - CONT'D.</u>	
C162B	80 MF -350V	(See C162)
C162C	40 MF -350V	(See C162)
C171	Dur-Mica DM-15, 4MMF, $\pm$ .5MMF, 500V	K23006-38
C174, C175	Electrolytic 90 MF, 500V	K15504-4B
C176, C177, C222	Electrolytic 20 MF, 250V	K23934-2
C184, C211	Dur-Mica DM-15, .320MMF $\pm$ 2%, 500V	K23006-121
C189	Variable 2.3-15MMF	K34454-G1
C193	Feed Thru, 1000MMF $\pm$ 10%	K23922-2
C199	Disc. Ceramic, .005MF, $\pm$ 20%, 1000V	M23034-45
C200, C202	Disc. Ceramic, .005MF, GMV, 3000V	M23034-4B
C201	Var. (Plate Tuning)	M4112-G7
C205	Electrolytic 5 MF, 6V	K23937-1
C207	Dur-Mica VDM-20, 100MMF, $\pm$ 5%, 1000V	K23095-1
C208A, B, C	Variable 40-1360MMF	M26750-1
C209	Dur-Mica VDM-20, 750MMF $\pm$ 5%, 1000V	K23095-3
C219	Disc. Ceramic, .04MF, $\pm$ 80-20%, 600V	M23034-12
C226	Metallized Paper, 2.0MF, 200V	K23055-4
C233	Disc. Ceramic, .002MFD GMV, 1000V	M23034-41
C234	Dur-Mica DM-15, 7MMF $\pm$ .5MMF, 500V	K23006-24
C236	Disc. Ceramic, .0005MFD $\pm$ 20%, 1000V	M23034-52
C237	Electrolytic 40MF, 350V	K23073-83
ZC101	Voltage Variable Capacitor	K23936-1

# HX-50 PARTS LIST

<u>SCHEMATIC DESIGNATION</u>	<u>DESCRIPTION</u>	<u>HAMMARLUND PART NO.</u>
CR101, CR102 CR104, CR105, CR109, CR110 ) CR106 CR107, CR108	Diode, Germanium (1N634)  Diode, Silicon Diode, Silicon Diode, Germanium (1N295)	K41206-1  M41215-4 M41215-2 K41209-1
F101	Fuse, SLO-BLO 3AG 3 AMP	K15888-7
I101 I102 I103 I104 I105 I106 I107, I108	Lamp, Neon 1/25W Lamp, Neon 1/25W Lamp, Neon 1/25W Lamp, Neon 1/25W Lamp, Neon 1/25W Lamp, Neon 1/25W Lamp, Incandescent No. 47	K51033-1 K51033-2 K51033-3 K51033-4 K51033-5 K51033-6 K16004-1
J101 J102 J103 J104 J105 J106 thru J110	Connector, Male (Mike) Connector, Female, 1 Contact Jack, Phone Connector, Female, 1 Contact Connector Receptacle Jack, Push Fit (Test Point "A" thru "E")	K41118-1 K41144-1 K41113-2 K41144-1 K16111-1 K41153-1
K101, K102	Relay (2P-DT)	K40410-1
L101 L102 L103 L104 L105 L106 L107 L108 L109 L110, L111 L112 L113 L114 L115 L116 L117 L119, L120 L121 L122	Coil, Inductance, Filter Output VFO Coil Assembly Choke, RF 2.5 MH Coil, 2nd Mixer 6.5 MC Trap Choke, RF 1.0 UH (OSC Plate 10M) Choke, RF 2.2 UH (OSC Plate 80M) Choke, RF 2.2 UH (OSC Plate 40M) Choke, RF 1.0 UH (OSC Plate 20M) Choke, RF .68 UH (OSC Plate 15M) Inductor (OSC Plate 10M) Choke, Filter Choke, RF 2.5 MH Choke, RF 560 UH Parasitic Suppressor Assem. (includes R181) Choke, (RF Plate) Coil, RF Tank Assem. Choke, RF 2.2 UH Coil, Driver, 6.5MC Trap Choke, RF 2.5 MH	M26741-G1 K26762-1 K26779-1 P26786-9 K26847-1 K26779-7 K26779-7 K26779-6 K42356-3 K26879-1 M26742-1 K26779-1 K26779-3 K26775-G1 K42353-1 K26776-G1 K26779-7 P26786-15 K26779-1

# HX-50 PARTS LIST

<u>SCHEMATIC DESIGNATION</u>	<u>DESCRIPTION</u>	<u>HAMMARLUND PART NO.</u>
	RESISTORS (cont'd.)	
R165	Fixed 220 ohms, $\pm 10\%$ , 10W	K19337-7
R166	Fixed 3K, $\pm 10\%$ ,	K19337-2
R167	Fixed 1K, $\pm 10\%$ ,	K19337-1
R168	Fixed 680 ohms, $\pm 10\%$ , 2W	K19304-14
R169	Fixed 47K, $\pm 10\%$ , 1W	K19310-B9
R170, R171	Fixed 40K, $\pm 10\%$ , 5W	K19339-2
R172	Fixed 15K, $\pm 10\%$ , 2W	K19304-46
R175	Fixed 47K, $\pm 10\%$ , 2W	K19304-58
R176	Fixed 10K, $\pm 10\%$ , 2W	K19304-42
R179	Fixed 47 ohms, $\pm 10\%$ , 2W	K19304-162
R181	Fixed 47 ohms, $\pm 10\%$ , 1W	(See L115)
R182	Fixed 100 ohms, $\pm 10\%$ , 1/2W	K19309-25
R183	Fixed 10 ohms, $\pm 5\%$ , 2W	K19304-231
R184	Fixed 4.8K, $\pm 1\%$ , 1W	K19329-2
R185	Var. 10K, 1/2W (Meter Sens.)	K15382-5
R188	Fixed 2.2K, $\pm 10\%$ , 1W	K19310-57
R189	Fixed 6.8K, $\pm 10\%$ , 1W	K19310-69
R196, R209, R210, )		
R211 )	Fixed 470K, $\pm 10\%$ , 1/2W	K19309-113
R200	Fixed 82K, $\pm 10\%$ , 1/2W	K19309-95
R205	Fixed 18K, $\pm 10\%$ , 1/2W	K19309-79
R206	Fixed 470 ohms, $\pm 10\%$ , 1/2W	K19309-41
R208	Fixed, 39K, $\pm 10\%$ , 1/2W	K19309-B7
R212	Fixed, 220 $\Omega$ , $\pm 10\%$ , 1/2W	K19309-33
R214	Fixed, 91K, $\pm 5\%$ , 2W	K19309-137
<hr/>		
S101	Function Switch Assem.	M26733-G2
S102A	Switch, Wafer (1st Mixer Plate)	K26728-2
S102B	Switch, Wafer (2nd Mixer Grid)	K26728-2
S102C	Switch, Wafer (2nd Mixer Plate)	K26728-3
S102D	Switch, Wafer (Driver Grid)	K26728-3
S102E	Switch, Wafer (Crystal osc. Grid)	K26728-2
S102F	Switch, Wafer (Crystal osc. Plate)	K26728-1
S102G	Switch, Wafer (Band Ind)	K26728-1
S102H	Switch, Wafer (Driver Plate)	K26728-3
S102J	Switch, Wafer (Final Grid)	K26728-3
S102L	Switch, Wafer (Final Tank)	K26760-1
S102M	Switch, Wafer (RF Loading)	K26728-5
S103	Switch, VFO Crystal	K26800-1

# HX-50 PARTS LIST

<u>SCHEMATIC DESIGNATION</u>	<u>DESCRIPTION</u>	<u>HAMMARLUND PART NO.</u>
S104	Switch (Operation)	K26746-1
S104A	Switch (Operation)	(See S104)
S104B	Switch (SP-ST) (On-Off)	(See S104)
S105	Switch (Meter)	K26759-1
T101	Transformer, Audio (Mod.)	M26729-1
T102	Transformer, Band Pass Input 3MC	M26730-1
T103	Transformer, Band Pass Output 3MC	M26731-1
T104	Coil, 1st Mixer 10M	P26748-2
T105	Coil, 1st Mixer 10M	P26748-1
T106	Coil, 1st Mixer 10M	P26786-14
T107	Coil, 1st Mixer 15M	P26786-13
T108	Coil, 1st Mixer 20M	P26786-12
T109	Coil, 1st Mixer 40M	P26786-11
T110	Coil, 1st Mixer 80M	P26786-10
T111	Coil, 2nd Mixer 10M	P26748-4
T112	Coil, 2nd Mixer 15M	P26786-17
T113	Coil, 2nd Mixer 20M	P26786-7
T114	Coil, 2nd Mixer 40M	P26786-6
T115	Coil, 2nd Mixer 80M	P26786-5
T116	Transformer, Audio (Ant. Trip)	M26806-1
T117	Transformer, Power	P26726-1
T117	Transformer, Power (Export Model)	P26726-2
T118	Coil, Driver 10M	P26748-3
T119	Coil, Driver 15M	P26786-4
T120	Coil, Driver 20M	P26786-16
T121	Coil, Driver 40M	P26786-2
T122	Coil, Driver 80M	P26786-1
TB101	Terminal Board	K51034-1
V101	Tube, Electron 6C10	K40915-1
V102	Tube, Electron 6EW6	K40895-1
V103	Tube, Electron 6AW8A	K40911-1
V104	Tube, Electron 6BA7	K40917-1
V105	Tube, Electron 6AU6	K16277-1
V106	Tube, Electron 6BV8	K16396-1
V107	Tube, Electron 12AT7	K16267-1
V108	Tube, Electron 5R4-GYB	K16205-2
V109	Tube, Electron 0A2	K16293-1
V110	Tube, Electron 12BY7A	K40897-1
V111	Tube, Electron 6DQ5	K40918-1

### HX-50 PARTS LIST

<u>SCHEMATIC DESIGNATION</u>	<u>DESCRIPTION</u>	<u>HAMMARLUND PART NO.</u>
Y101	Crystal, 3038KC $\pm$ .005%	K42510-4
Y102	Crystal, 3035KC $\pm$ .005%	K42510-5
Y103	Crystal, 38.660 MC	M26753-7
Y104	Crystal, 38.110 MC	M26753-6
Y105	Crystal, 37.560 MC	M26753-5
Y106	Crystal, 30.535 MC	M26753-4
Y107	Crystal, 23.535 MC	M26753-3
Y108	Crystal, 16.535 MC	M26753-2
Y109	Crystal, 13.035 MC	M26753-1
ZF101	Crystal Filter Assembly	M42544-G1

### MISCELLANEOUS PARTS

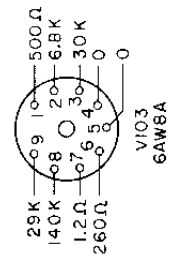
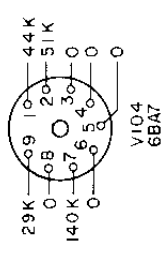
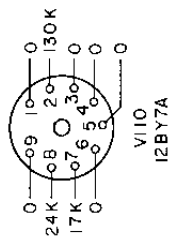
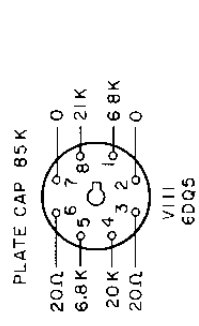
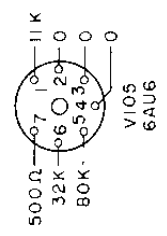
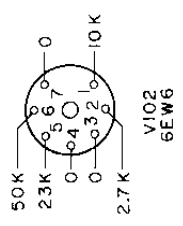
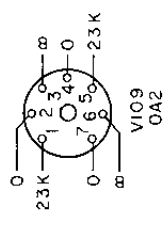
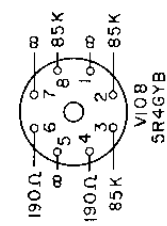
Knob, (3/4" Dia.)	M50087-1
Knob, (1-1/8" Dia.)	M50087-2
Knob, (1-1/4" Dia.)	M50087-3
Knob, (1-1/2" Dia.)	M50087-4
Knob, Bar	K26243-1
Pointer	K26825-1
Knob, (Red) 3/4"	K26216-1
Knob, Modified 1/2" (Stamped 1, 2, 3, 4, 5)	M26813-1
Door Assembly (Left Side)	K26805-G1
Door Assembly (Right Side)	K26812-G1
Instruction Manual, Issue (2)	41397-2
Sems. Fastener No. 10-32 5/8" Lg.	K10004-60
Metal Washer 13/64 I.D.	K10007-243
Dial Pointer Cord Assembly	K26826-1
Dial Pointer Spring	K26818-1
Dial Drive Cord Assembly	K26840-G1
Cable, Band Switch Drive Assembly	K26887-G1
Dial Drive Spring	K26886-1
Band Switch Spring	K26814-1



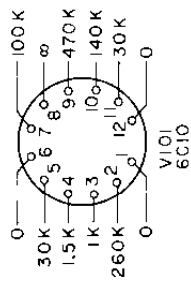
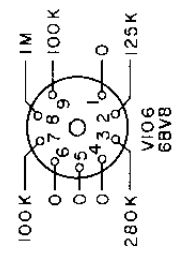
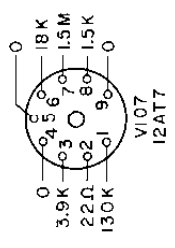


SETTING  
CLOCKWISE  
OFF  
80 M  
COUNTER CLOCKWISE  
P.A. CATHODE  
COUNTER CLOCKWISE

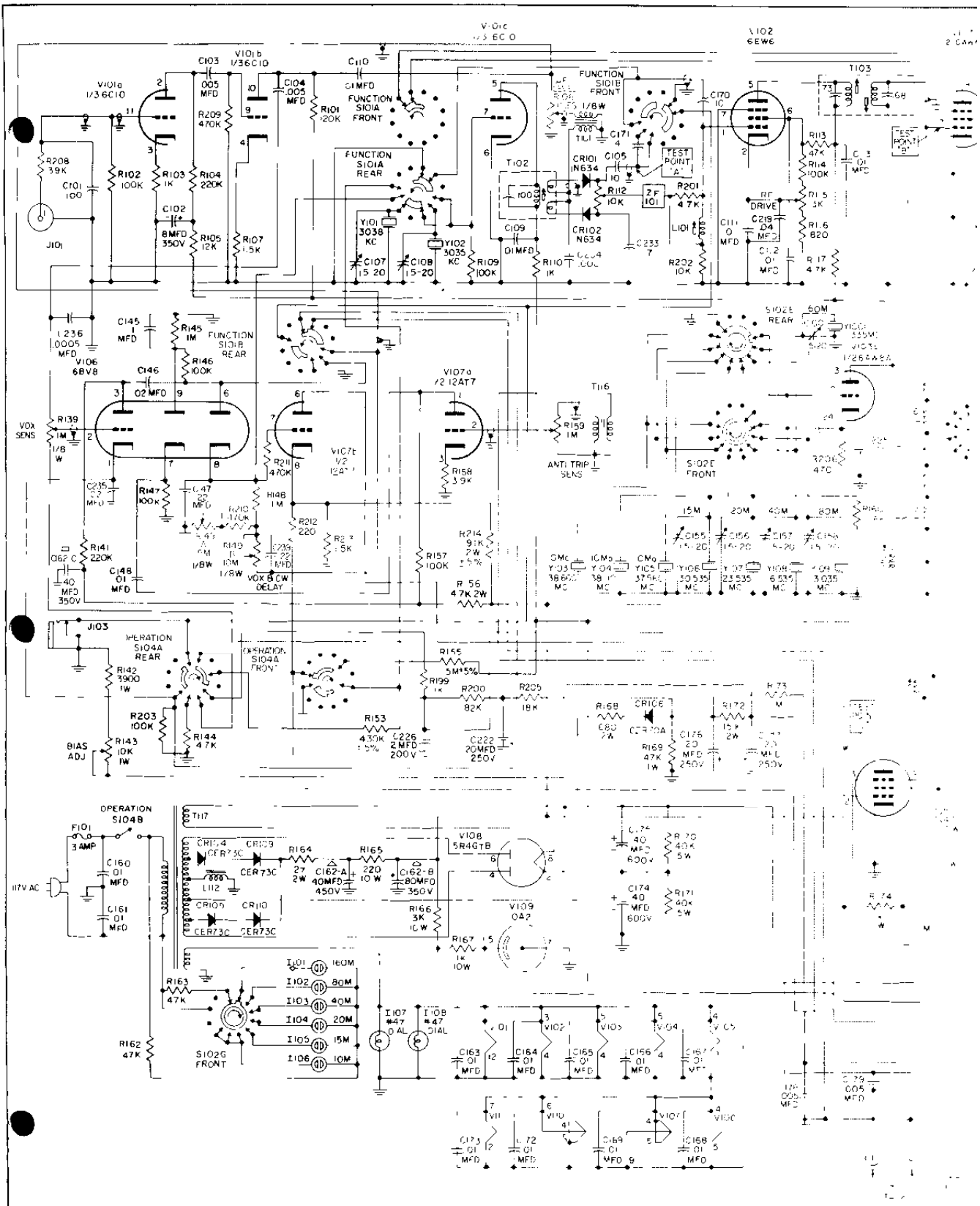
CONTROL  
FUNCTION  
OPERATION  
BAND SELECT  
AF LEVEL  
METER SENS  
RF DRIVE  
METER SWITCH  
VOX SENS  
ANTI TRIP  
VOX DELAY  
CW DELAY  
NO MIKE



NOTES:  
RESISTANCE MEASUREMENTS MADE WITH HP-410B FROM  
TUBE PIN TO CHASSIS  
TUBE SOCKETS AND LOCATIONS ARE SHOWN IN BOTTOM VIEW.



RESISTANCE CHART HX-50



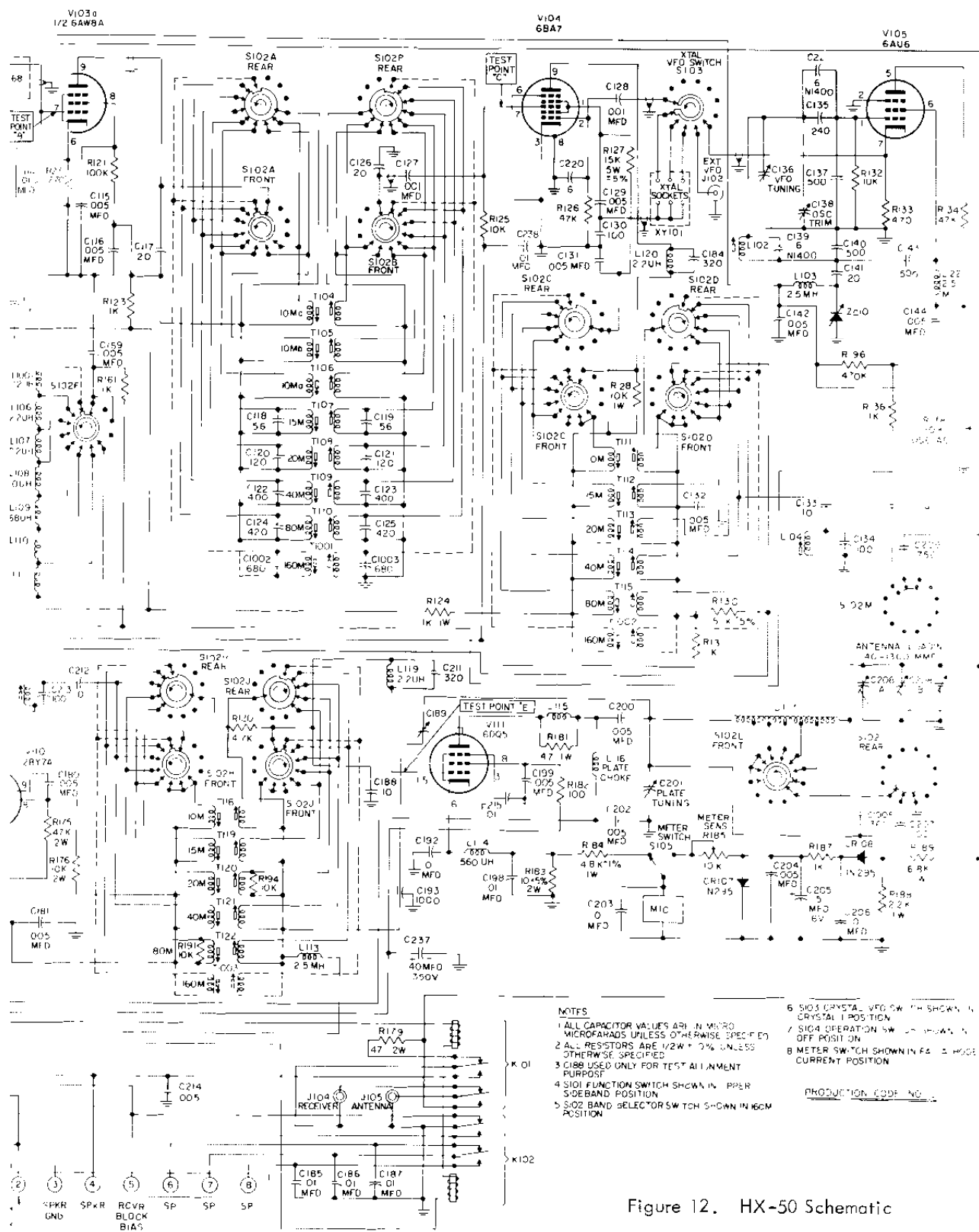


Figure 12. HX-50 Schematic