

# SOMMERKAMP SSB TRANSCEIVER

TS 288A w/24-ch. CB



## INSTRUCTION MANUAL

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# TS 288A SSB TRANSCEIVER

## I. GENERAL DESCRIPTION

The model TS 288A SSB Transceiver is a precision built, compact, high performance transceiver of advanced design providing SSB (USB, LSB selectable), CW and AM modes of operation. The TS 288A operates at an input of 260 watts SSB, 180 watts CW and 80 watts AM on all bands, 80 to 10 meter, and on 11 meter CB band. An auxiliary band is provided for the use of other frequency than amateur bands.

All circuits, except transmitter linear amplifier, are transistorized and composed of standard computer type built-in modules, permit easy maintenance.

The TS 288A is self-contained, requiring only a microphone and an antenna for operation at home, portable or mobile, and operates from either 100/110/117/200/220/234 volts AC or 12 volts DC (negative ground) power source; the two-way solid state power supply is an integral part of the unit. Selection between two power sources is automatically made when the proper line cord is connected.

A separate power switch is provided to turn off tube heaters when in receive, and the TS 288A draws only 0.5 amp., less than your auto dash lights.

All accessories, such as built-in VOX, break-in CW with sidetone, 25 and 100 Khz calibrators, noise blanker and 10 Mhz WWV are built in. In addition, dual VFO adaptor, crystal control adaptor, speaker and clarifier is an integral part of the unit. Provision is made for the installation of 600 Hz crystal filter for expert CW operation. CW filter will be selected automatically when the transceiver mode switch is placed in the CW position.

The entire transceiver package is 34.0 cm wide, 15.3 cm high, 28.5 cm deep and weights approximately 15 kg. Construction of heavy gauge steel provides an extremely rugged package, virtually immune to the effect of vibration and shock.

## II. SPECIFICATIONS

Frequency Range	1.8 – 30 MHz amateur bands 27.0 – 27.5 MHz 23 fixed CB channels (26.965 – 27.255 KHz) 10.0 – 10.5 KHz (160m band crystal optional)
Type of Emission	SSB & AM.
Power Input	SSB 260 Watts PEP CW 180 Watts, 50% duty cycle AM 80 Watts (slightly lower on 10 meter)
Carrier Suppression	– 40 db or more
Sideband Suppression	– 40 db or more at 1000 Hz
Spurious Radiation	– 40 db or more
Transmitter Frequency Response	300 Hz - 2700 Hz $\pm$ 6 db
Intermodulation distortion	– 30 db or more
Antenna Output Impedance	50 – 75 ohm unbalanced
Frequency Stability	100 Hz, 30 minutes after warm up
Sensitivity	SSB & CW: 0.5 $\mu$ V S/N 10 db or more AM: 2 $\mu$ V, S/N 10 db or more (at 30 % modulation)

Microphone Impedance	50K ohm
Selectivity	SSB & AM: 2.4 KH at 6 db 4.4KH at 60 db CW (option): 600 Hz at 6 db 1.2 KH at 60 db
Image Rejection	- 50 db or more
Aduio Output	3 Watts 4 ohm at 10% distortion
Power Consumption	AC Receive 35 Watts Transmit 300 Watts Max.  DC 12V Standby 0.5 Amp. Transmit 21 Amp.
Active Component Complement	38 Tr's, 7 Fet's, 3 IC's, 3 Tubes & 76 diodes.
Dimensions	34.0 cm (W) 15.3 cm (H) 28.5 cm (D)
Weight	Approx 15 Kg

### III. INSTALLATION

#### 1. General:

The TS 288A Transceiver is designed to provide a complete single-unit installation for fixed, portable, or mobile operation. It is recommended to avoid excessively warm location, such as car heater outlet, however, no special precaution be observed in the choice of location, provided adequate ventilation space is available. A minimum of two inches of air space above the cabinet top and on all sides is recommended to allow proper air flow around the cabinet. Never stack other units above or below the cabinet since the accumulated heat from both units could cause permanent damage.

#### 2. Home Station:

Plugging the AC power cord into the receptacle at the rear of the transceiver connects all power circuits for AC operation. Prior to connecting AC cord to power outlet, be sure the voltage marked on the rear of the transceiver should be same as your line voltage. The different line voltage will cause permanent damage to the transceiver. The transceiver has been designed for 100/110/117/200/220/234 volts, 50/60 cps AC operation, and wired for one of these voltage at factory. If the line voltage is different from your transceiver voltage, the rewiring of the transformer is necessary prior to connecting AC code to power line.

The transceiver should be connected to a good water pipe ground. It is not recommended to use gas or electrical conduit pipes. The grounding lead should be kept as short as possible.

The ground may be connected to the terminal marked GND.

#### 3. Mobile Installation:

The TS 288A Transceiver will operate satisfactorily from any 12 volts negative-ground battery source by connecting the DC power cord to the rear panel receptacle. For under-dash mounting, a special mounting bracket is available from your dealer. The transceiver can be used in boat as well as car.

The transceiver requires an average of 14 amps at transmit and 25 amps on voice peaks. The fuse in the DC power cable should be 20 amps. When making connections to the car battery, be certain that the RED lead is connected to the positive (+) terminal and the BLACK lead to the negative (-) terminal of the battery; reversed connections could permanently damage the transceiver. The BLACK lead should run directly to the negative terminal of the battery. Using the car frame as a negative connection or connecting the positive lead at a point such as the ignition switch

places the devices creating the noise in the same current path as the transceiver and fails to take advantage of the filtering action of the battery. The power cable should be kept away from ignition wires and be as short as possible to minimize voltage drop and to provide a low impedance path from the transceiver to the battery which acts as filter.

Prior to operating the transceiver in a mobile or marine installation, the automobile voltage regulator setting should be checked. In many vehicles, the voltage regulation is very poor and in many cases, the regulator is adjusted for an excessively high charging voltage. As the battery and regulator age, the maximum voltage while charging can increase to a very surprising level which is injurious to the battery and also this high voltage could cause heavy damage to the transceiver.

The transceiver will operate from a source voltage of 11 volts to 14 volts. It is necessary to carefully set the charging system so that the limit of 14 volts is not exceeded.

Under no circumstances, should the transceiver ever be operated from a vehicle electrical system that cannot regulate the voltage well below 15 volts.

The same precaution should be taken for not only the transceiver but also any other radio equipment used in a vehicle.



Lethal voltages are present in several areas of the transceiver whenever the set is on. Do not attempt to work inside the set with power applied.

Never transmit without having proper antenna or dummy load connected to the transceiver.

#### 4. Antenna:

The transceiver is designed for use with resonant antenna having the impedance of 50 – 100 ohm resistive.

The antenna is usually the most critical part of a station installation. Results both in receiving and transmitting will depend on how well an antenna is installed and adjusted. Any of the common antenna systems designed for use on the high frequency amateur bands may be used with the transceiver, provided the input impedance of the antenna system is within the capability of the transceiver pi-matching network (50 – 100 ohms).

If a tuned-open wire transmission line or a long wire antenna is used, a suitable antenna tuner must be used between the antenna and the transceiver to provide an impedance match between the unbalanced coaxial output of the transceiver and the balanced open-wire feeder or a long wire.

For mobile operation, most of the commonly used mobile antennas in the market will give good results with the transceiver. Make certain that the outer braid of coaxial cable is securely grounded to the chassis of the vehicle at the antenna mount. The length of such a mobile antenna will effect highly on SWR of the transmission output. It is recommended to adjust the antenna length carefully for minimum SWR after installation.

### IV. OPERATION

The TS 288A Transceiver has been specifically designed to provide the ease of operation and versatility. All controls have been thoroughly tested before shipment from the factory. Several of the controls are unusual in operation, however, improper adjustment may result in signals of poor quality in both transmit and receive. The various front panel controls and their functions are described in the following section. Be certain that you understand thoroughly the function of each control before operating the transceiver.

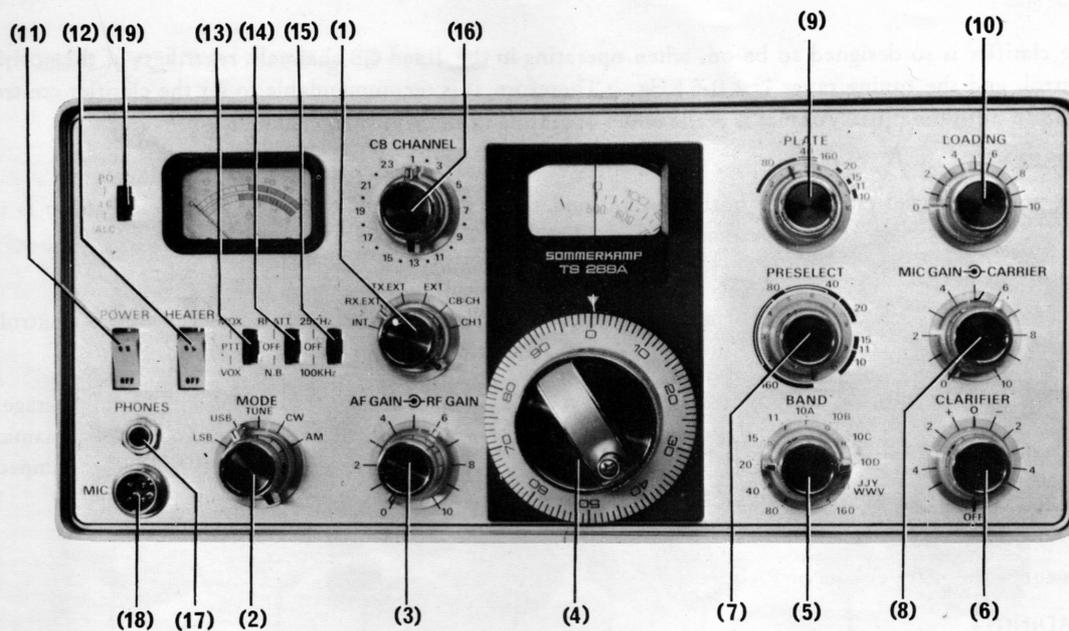


FIG. A

1. CONTROLS & SWITCHES : See Fig. A.

(1) VFO Select Switch:

This switch sets the transceiver to receive or transmit on either internal VFO or external VFO.

- INT – Internal VFO for both receive and transmit.
- RX EXT – External VFO for receive and internal VFO for transmit.
- TX EXT – External VFO for transmit and internal VFO for receive.
- EXT – External VFO for both receive and transmit.
- CB CH – for 23 fixed CB channel operation.
- CH1 – for an optional, additional fixed frequency operation  
(See Page 17 for detailed explanation)

(2) Mode Switch: (LSB-USB-TUNE-CW-AM)

The mode switch is a five-position switch. This switch is used to select the mode of operation; LSB, USB, AM, CW or TUNE position. At AM, CW and TUNE position, a separate crystal is used to shift carrier frequency into the filter passband.

(3) RF GAIN/AF GAIN:

The RF GAIN and AF GAIN controls are two controls mounted on concentric shafts. RF GAIN control (outside knob) varies the gain of the receiver RF and IF amplifier. Maximum sensitivity is obtained with the control set at 10 (fully clockwise).

The AF GAIN control (inside knob) adjusts the audio output level at the speaker and phone jack. Clockwise rotation increases the audio output.

(4) Tuning knob:

The large knob directly below the dial window controls the actual frequency of operation after the desired band has been selected. A precise double gear and a ball driver mechanism are incorporated to provide a slow tuning rate and, at the same time, to read out 1 KHz on 100 KHz dial. Since the tuning rate is 14 KHz per revolution, there is no critical tuning on SSB signal. As an additional feature, the 100 KHz skirt vernier dial may be adjusted for the calibration.

(5) BAND Switch:

The band switch is an eleven-position switch used to select the desired band for receiving or transmitting. The band indication is made in black or red to read on the dial for direct frequency determination.

(6) CLARIFIER:

The clarifier control provides a means for tuning the receiver frequency  $\pm 5$  KHz to either side of the transmitting frequency. Thus, it is possible to set the pitch of the voice you are receiving to the most readable point without affecting your transmitting frequency. Its use is particularly valuable in "net" operation where several participants may be transmitting slightly off frequency. The clarifier control may be switched off and the receiver locked to the transmitting frequency by setting the clarifier control to the OFF position. Normally, you will want to keep the clarifier turned off until the initial contact is made. After the contact is made, the clarifier control may be used to zero-in for any drift at the other end of contact.

The clarifier is so designed to be on, when operating in the fixed CB channels, regardless of the position of clarifier control, and the tuning range is  $\pm 0.5$  KHz. Therefore, it is recommendable to set the clarifier control at the zero position until the initial contact is made when operating in the fixed CB channels.

(7) PRESELECT:

This pretunes signal circuits for both transmit and receive condition. New slug tuned mechanism is used to cover all bands even outside of amateur bands except IF and VFO frequencies.

(8) MIC GAIN/CARRIER:

The MIC GAIN/CARRIER control is two controls mounted on concentric shafts. The carrier control (the outside control) varies the amount of the carrier in the CW, AM and TUNE modes of operation.

The MIC GAIN control (the inside knob) varies the audio level from the microphone amplifier stage. The control has sufficient range to permit adjustment of any high level crystal microphone or low level dynamic microphone normally used for voice communications. The accessory microphone is of dynamic type, and the impedance is 50 K ohms. Both controls have maximum value with the control set at 10 (fully clockwise).

(9) PLATE:

This tunes the plate circuit of PA tubes.

(10) LOADING:

This tunes the output circuit of pi-network to match output impedance to antenna or feeder impedance.

(11) POWER SWITCH:

This tunes the transceiver on for both AC and DC operation.

(12) HEATER SWITCH:

With this switch in the lower position, the transmitter tube heaters and the high-voltage supply are turned off when the transceiver is in receive only. This reduces battery drain to 0.5 amps and thus permits long period of listening without fear of excessive battery drain. Pushing the rocker switch to the upper position actuates the high-voltage supply and the tube heaters. After 30 seconds of warm-up for the transmitter is ready for operation. This switch operates for both DC and AC.

(13) MOX/PTT/VOX:

In the MOX position (upper position), the transceiver is set to the constant transmit condition.

In the PTT position (mid position), the receiver portion of the transceiver is in operation, and the transmitter is operated by a Push-To-Talk switch on the microphone. In the VOX position (lower position), the transmitter is energized by voice or part of the first character of CW transmission and in the absence of voice or keying the transceiver is automatically placed in the receive mode.

(14) RF ATT (RF ATTENUATOR)/N.B. (NOISE BLANKER)

In the upper position a 20 db attenuator is inserted in the incoming signal path. This may be used to minimize cross modulation.

In the lower position the noise blanker is actuated and shuts off ignition noise pulse.

(15) 25 KHz/100KHz (CALIBRATOR):

The 100 KHz crystal oscillator is used to calibrate the receiver. In the 25 KHz position, 25 KHz multivibrator generates a marker signal at every 25 KHz point.

(16) CB CHANNEL SWITCH

This switch operates only when the VFO Select Switch (1) is set at the CB CH position. The 23-Position switch provides 23 CB channels ranging from 26.965MHz to 27.255 MHz, as in the frequency table in Page 16.

(17) PHONE:

This is a PHONE Jack for headphone. The internal speaker will be disabled with the headphone plugged in.

(18) MIC:

The Microphone Jack. Three-pole plug is used for microphone input, push-to-talk and ground.

(19) METER SWITCH:

Select the meter to read PA cathode current, relative power output, or ALC level.

## 2. REAR PANEL LAYOUT : See Fig. B

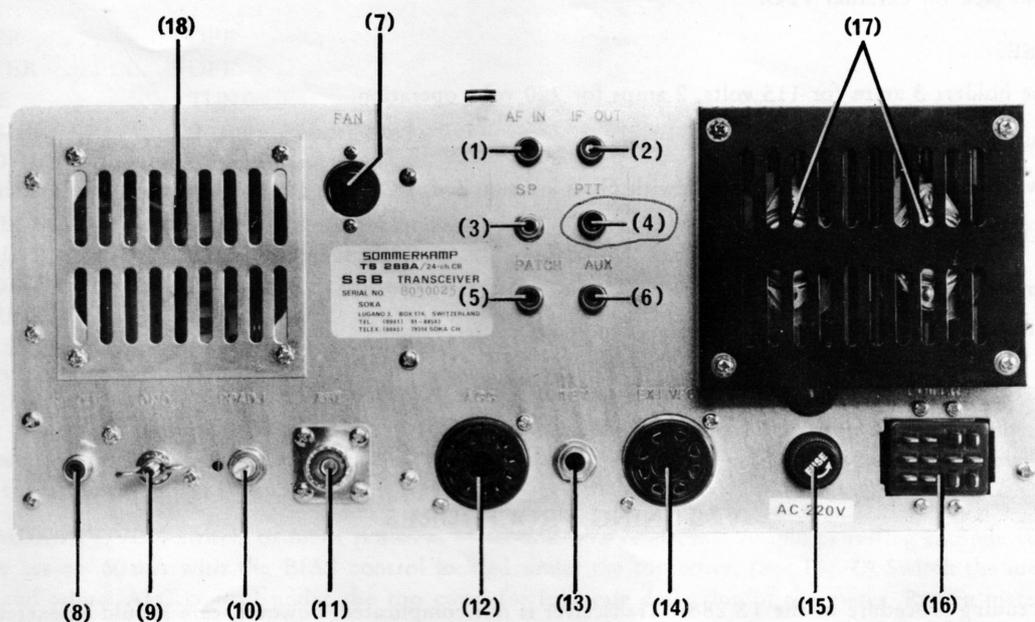


FIG. B (REAR VIEW)

- (1) AF-IN:  
Audio input from the other optional equipment, such as FM detector unit.
- (2) IF OUT:  
3,180 KHz IF signal may be taken from the jack for use by panoramic adaptor.
- (3) SP:  
Audio output jack for an external speaker. The output impedance is 4 ohms, and the internal speaker will be disabled with a plug inserted.
- (4) PTT:  
Push-to-talk jack. The transceiver may be controlled with the external circuit. When this terminal is grounded, the transceiver activates into transmitting condition.
- (5) PATCH:  
Speech input terminal for phone patch connection. Impedance is 50 kilo ohms.
- (6) AUX:  
This jack is connected to receiver output (4 ohms) to be used for phone patch.
- (7) FAN:  
4-P socket for connection of cooling fan.
- (8) RF OUT:  
Output from driver stage may be obtained for use of a transverter.
- (9) GND:  
For ground connection.
- (10) PO ADJ:  
For adjustment of the meter functioning as RF meter.
- (11) ANT:  
Coaxial connector for antenna.
- (12) ACC:  
Accessory socket: Accessory plug (pin 1 and 2 connected) should be plugged in for normal transceiver operation. For use with a transverter, see schematic diagram for proper connection of the plug.
- (13) KEY:  
Key jack for code operation.

- (14) EXT VFO:  
Input jack for external VFO.
- (15) FUSE:  
Fuse holder: 3 amps for 115 volts, 2 amps for 220 volts operation.
- (16) POWER:  
Power receptacle. AC and DC cords with plugs are supplied. DC cords are provided with fuse holder for a 20A fuse.
- (17) DC-DC convertor transistors
- (18) Ventilation guard grill:  
Remove the grill for mounting a cooling fan.

## V. TUNING PROCEDURES

The tuning procedure of the TS 288A Transceiver is not complicated, however, care should be exercised when tuning to ensure peak performance of the equipment. The following paragraphs describe the procedure for receiver and transmitter tuning.

### 1. INITIAL CHECK:

To ensure proper operation and to prevent damage to the equipment, the following initial check by the owner is recommended, although the unit has been thoroughly pre-tested before shipment from factory.

Before connecting to an AC power output or 12 volts DC source, carefully examine the unit for any visible damage; check that all printed modules and crystals are firmly in place and that all controls and switches are operating normally. Ensure that voltage specifications marked on rear apron match the supply voltage.

### 2. RECEIVING OPERATION:

Preset the controls and switches as follows:

VFO Selector . . . . . INT (internal)  
 MOX/PTT/VOX . . . . . PTT  
 POWER . . . . . ON (upper position)  
 RF GAIN . . . . . Maximum  
 AF GAIN . . . . . As required  
 BAND . . . . . Desired band  
 MODE . . . . . Desired mode  
 TUNING . . . . . 100 KHZ point nearest desired frequency  
 PRESELECTOR . . . . . Desired band segment  
 CLARIFIER . . . . . OFF  
 RF ATT . . . . . OFF  
 CALIBRATOR . . . . . 100 KHz

To calibrate, set the TUNING control to the 100 KHz point on the dial nearest the desired frequency. Tune the receiver to the 100 KHz calibrator signal for zero beat. Two calibrator signals may be heard near the 100 KHz point. One of them is a signal through IF stage. Zero beat against the stranger signal. To calibrate, hold tuning knob firmly at zero beat point and rotate skirt vernier dial to zero position. The skirt vernier dial surrounds the tuning knob and is held in position by a friction locking device. This dial is easily movable by hand but will retain its position after calibration. The transceiver must be calibrated when changing mode of operation to LSB, USB, AM or CW.

With calibration switch at 25 KHz position, calibrator signal can be heard at every 25 KHz point. The calibration switch should be in the OFF position in normal use of the receiver.

### 3. BASIC TUNE-UP FOR TRANSMISSION:

Connect dummy load to the coaxial antenna output, and preset the controls as follows:

POWER . . . . . OFF  
HEATER . . . . . OFF  
MODE . . . . . TUNE  
CARRIER . . . . . 0 (fully counter-clockwise)  
BAND . . . . . Desired band  
TUNING . . . . . Desired frequency  
PRESELECTOR . . . . . Desired band segment  
PLATE . . . . . Desired band segment  
LOADING . . . . . 0 (9 o'clock position)  
METER . . . . . IC  
VFO SELECT . . . . . INT  
MOX/PTT/VOX . . . . . PTT

With the power and heater switches turned on, allow 60 seconds for warm-up of the transmitter tube. Be certain that accessory plug is in the accessory socket. The heater voltage to the final tubes is supplied through pin 1 and pin 2 of the accessory plug.

Set the MOX/PTT/VOX switch to MOX position. Meter will now read Final Amplifier resting cathode current. This should be set at 60 mA with the BIAS control located under the top cover. (See Fig. C) Switch the meter to ALC position and adjust ALC control under the top cover for full scale deflection of the meter. Return meter switch to IC position.



The importance of short "ON" cycles and limiting IC current to the lowest level consistent with positive tuning indications in the following sequence cannot be overemphasized. An indicated current of 100 mA is usually sufficient to provide positive indication of drive maximums and final plate dips. Excessive "OFF-Resonance" currents for extended periods of time will result in destruction of the final amplifier tubes.

Advance CARRIER control until the cathode current starts to increase. Peak the PRESELECTOR for maximum IC reading. Adjust CARRIER control until meter reading indicates 100 mA, and quickly tune PLATE for dip. Advance LOADING in small increments and re-dip with the PLATE control until the dip is broad and IC current becomes about 80% of maximum non-resonance current, i.e. 80 mA.

Momentarily advance CARRIER control until the meter shows approximately 400 mA. Momentarily advance the CARRIER control for maximum output (ten seconds maximum), and re-adjust PLATE and LOADING for IC dip at maximum output. At dip the cathode current will be approximately 300 mA. (slightly lower on 10 meter band). Return MOX/PTT/VOX switch to PTT or VOX position.



EXCEEDING THE TIME LIMITS NOTED FOR MAXIMUM POWER INPUT DURING FINAL TUNING MAY RESULT IN DESTRUCTION OF THE FINAL OUTPUT TUBES.

#### NOTE:

Insertion of key plug automatically disconnects bias supply to PA tubes, therefore, with key plug installed idling current will not be indicated on meter.

### 4. SSB OPERATION

After completion of tuning, set MODE switch to LSB or USB. Set the METER switch to ALC position. Set the MOX/PTT/VOX switch to MOX position and advance the MIC GAIN control until the meter kicks up to mid scale of green colored portion when speaking into the microphone normally.

For VOX operation, set the MOX/PTT/VOX switch to VOX position. and adjust VOX GAIN potentiometer under the top cover until voice actuates the transceiver. Set the ANTITRIP potentiometer to the minimum point to prevent the speaker output from tripping. Do not turn VOX gain or ANTITRIP gain controls more than necessary.

Adjust the DELAY potentiometer under the top cover for suitable release time.

#### NOTE:

When meter is set to IC, voice modulation peaks will indicate 150 – 200 mA. Actual peak current, however, is approximately 2 times the indicated value.

### 5. CW OPERATION

After the Basic Tune-up for Transmission procedure, set the MODE switch to CW position. The IC reading on meter will be zero when the key is not depressed, and the meter reading should not exceed 350 mA when the key is depressed.

### 6. AM OPERATION

The basic tune-up procedure is same as for CW OPERATION, and set the MODE switch to AM position after the tune-up procedure. Adjust the CARRIER control to limit the IC reading on meter to 150 mA max.

## VI. PRINCIPLES OF OPERATION

The block diagram and the circuit description provide you with a better understanding of this transceiver.

The transceiver consists of a double conversion receiver and a double conversion exciter-transmitter. Receiver and transmitter circuits use common oscillator, crystal filter and IF stages. The low frequency IF is 3.180 KHz. The high frequency IF is passband tuned to cover 5,520 KHz to 6,020 KHz.

All circuits, except driver and final amplifier stages, are assembled in the computer type printed board modules.

### 1. MAIN SIGNAL FLOW

In receive, the HF signal from the antenna is routed through the antenna relay to the RF amplifier stage. Front end selectivity is provided by slug tuned circuits at the input and output of the RF stage. The signal is then converted from the HF frequency to the IF frequency of 5,520 – 6,020 KHz in mixer stage. The IF frequency is the mixer product resulting from injection from heterodyne oscillator stage of a signal 6,020 KHz higher in frequency than lower end frequency of the band. The high frequency IF signal from receiver 1st mixer is applied to the high IF passband network. Output from this network is applied to receiver 2nd mixer Q2. When the signal is applied to 2nd mixer, the VFO injection signal from VFO unit produces the 3,180 KHz difference product. Output from the 2nd mixer is fed to the crystal filter through noise blanker. Output from the crystal filter is coupled to integrated circuit IF amplifier chain and then fed to the AM detector, the product detector and the AGC and S meter circuit. The output of a crystal controlled BFO is also fed to the product detector. The front panel MODE switch then selects AM or product detector as desired by the operator. The signal is finally processed through the audio amplifier and into the built-in speaker or an external speaker.

In transmit, audio developed in the microphone amplifier circuit is applied to the balanced modulator stage along with injection from the carrier oscillator stage. A diode-ring modulator, when balanced properly, provides modulated output with sidebands above and below the carrier frequency; the carrier is suppressed. The desired sideband is selected by a crystal filter of which passband is centered at 3,180 KHz. This passes either the upper or lower sideband, depending upon the sideband selected when the MODE switch is set to sideband carrier crystal of 3,178.5 KHz or 3,181.5 KHz.

For AM and CW, a separate crystal of 3,179.3 KHz is used. The AM signal is generated by a separate AM modulator which works as buffer stage for CW. The output from crystal filter or AM modulator/CW buffer is coupled to transmitter first mixer together with the output of the VFO oscillator. The sum of two signals produce the higher frequency IF signal of 5,520 to 6,020 KHz. This IF signal is fed to the transmitter second mixer through bandpass network which is so designed that it provides excellent spurious reduction. With the signal from the heterodyne oscillator, the mixer converts the high frequency IF signal to the desired transmitting frequency.

Output from the transmitter second mixer is amplified by the driver tube to a level sufficient to drive the final linear amplifier tubes.

Final output from amplifier tubes is fed to a pi-network consisting of coil and PLATE and LOADING capacitors. A section of band switch adjusts the inductance of coil to the correct value for each band, and adds fixed amount of capacity to the PLATE and LOADING capacitors on the lower bands. Output from the pi-network is fed to the antenna through the contacts of the antenna relay.

The ALC circuit is placed in the grid circuit of the final tubes. When RF driving voltage to the final tubes becomes sufficient to drive the grid positive, the grid begins to draw current and the signal is detected. This produces an audio envelop and then rectified to DC voltage which controls gain of younger stages to prevent distortion caused by overdrive.

A part of the output from the microphone amplifier is coupled to the VOX amplifier. Amplifier signal is then rectified and applied to the relay control transistor which activates the transceiver.

## 2. METER FUNCTION

The meter circuit is designed to measure signal strength in receive and cathode current, relative Power Output, and the level of automatic level control in transmit. Switching of the meter is automatically made by means of relay contacts for transmit and receive.

The Multipurpose Meter in the transceiver has a three position selector switch which provides for metering the system in transmit.

When the transceiver is in the transmit mode, the ALC switch position connects the meter to the source of ALC controlled IF amplifier, MK-10, on PCB No. PO4-006.

The meter then measures current of MK-10 which decreases when the ALC controlled voltage is applied to its gate. This control voltage is developed when the final amplifier stage is driven into the grid current levels during SSB operation.

In the IC switch position, the meter is connected to the cathodes of final tubes in parallel with shunt resistor, and measures total cathode current of the tubes. This current includes screen grid current of the tubes which is negligible against plate current.

The meter is connected in the cathode circuit to avoid an operational chock hazard which is often experienced when the meter is placed in the high potential point such as plate circuit.

The meter scale carries a 0 – 0.5 amp calibration to monitor the cathode current of the final tubes.

In switch position PO, the relative power output is measured by reading the rectified DC current at the pi output circuit.

When the transceiver is in the receive mode, the AGC voltage developed on signal is fed to the meter amplifiers, Q4 and Q5, on PCB P04-004A to provide a long scale deflection for metering antenna signal strength. The meter is calibrated in the customary "S" units up to S-9 and in db over S-9, representing approximately 100 microvolts at the antenna terminals for S-9.

### CAUTION

A semi-fixed resistor, VR-9, is switched in parallel with the meter as a shunt resistor for measuring the plate current of the final tubes (See Fig. C). This resistor is factory-adjusted and should not be tampered with.

## VII. ALIGNMENT

### WARNING

DANGEROUS VOLTAGES ARE PRESENT, THEREFORE EXTREME CARE IS ESSENTIAL. BE SURE THAT ALL POWER IS DISCONNECTED BEFORE WORKING ON THE CHASSIS. CHECK THE HIGH VOLTAGES IN THE CAPACITORS BY SHORTING THE HIGH VOLTAGE LINE TO GROUND WITH AN INSULATED SCREW DRIVER.

### CAUTION

Never operate the transceiver as a transmitter without a matched antenna or adequate dummy load termination. The power amplifier tubes and Pi-network components can be damaged if the transceiver is operated as a transmitter unloaded.

## 1. GENERAL

The transceiver has been carefully aligned and tested at the factory and, with normal usage, should not require other than the usual attention given to electronic equipment. Service or replacement of a major component may require subsequent realignment, but under no circumstance should realignment be attempted unless the operation of the transceiver is fully understood, and as the malfunction has been analyzed and definitely traced to misalignment.

Service work should only be performed by persons experienced in this work, using the proper test equipment.

## 2. EQUIPMENT REQUIRED

- (1) RF signal Generator; Hewlett-Packard Model 606A, or equivalent having up to one volt output at an impedance of 50 to 75 ohms and a frequency coverage to 30 MHz.
- (2) A Vacuum Tube Voltmeter (VTVM); Hewlett-Packard Model 410B, or equivalent with an RF probe usable up to 40 MHz.
- (3) A dummy Load; Bird Model 43 or equivalent 50 ohms non-reactive rated for 300 watts average power.
- (4) AF Signal Generator; Hewlett-Packard Model 200 AB, or equivalent.
- (5) A general coverage receiver covering the frequency range from 3 to 30 MHz with a 100 KHz calibrator.
- (6) Frequency counter (up to 35.520 Mhz)

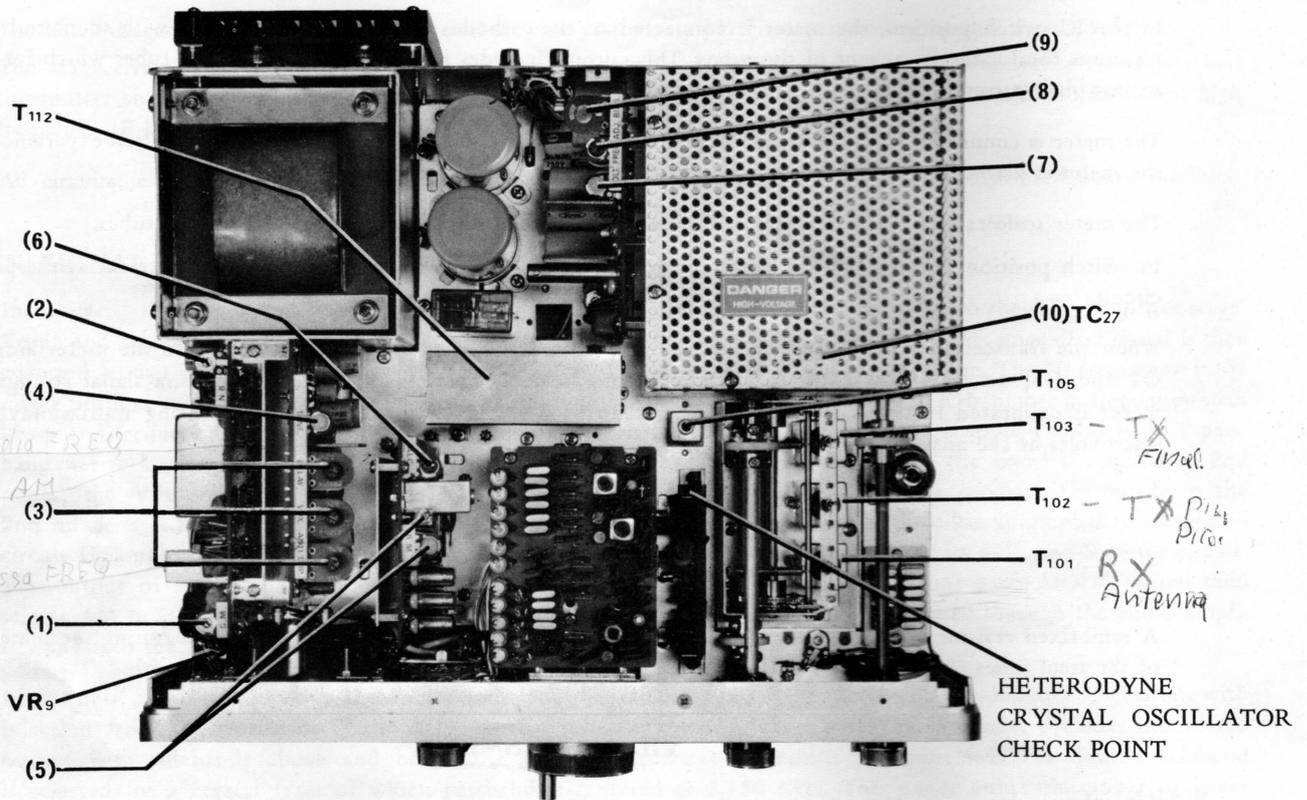


FIG. C (TOP VIEW)

### 3. S-METER SENSITIVITY ADJUSTMENT : See Fig. C -(1)

The S-meter will require a sensitivity adjustment if it does not indicate signal strength properly. Place the transceiver in the receive mode and connect the signal generator to pin 15 of MJ-3. Set the signal generator at 3180 KHz, 30% modulated and adjust the generator signal level for 78 db. The S-meter should read S-9. If not, adjust S-meter control VR4 on PCB No. P04-004A for an S-meter reading at just S-9.

### 4. NOISE BLANKER THRESHOLD: See Fig. C -(2)

The operating level of the noise blanker is determined by the THRESHOLD control VR1 on P04-004A. Counter-clockwise rotation of the control increases the effectiveness of the blanker, however extreme setting of this control reduces a receiver sensitivity. Receive a proper signal of S-6 or 8 S-meter reading.

Adjust the control for one S-unit decrease with the Noise Blanker switch on.

Extremely strong signals may cause distortion on the derived signal due to mixing at the switching diode. This effect can be reduced by decreasing the threshold control or by switching the Noise Blanker to OFF.

## 5. VOX ADJUSTMENT : See Fig. C - (3)

VOX controls are located on P04-005A; VR1, VOX Gain; VR2, Delay; and VR4, Antitrip Gain.

Set MIC GAIN to center of travel. Speak into the microphone normally, adjust VOX control VR1 to just activate VOX relay.

Receive a proper signal and adjust the AF GAIN control to a comfortable listening level. Set the ANTITRIP control VR4 to the minimum point to prevent the speaker output from tripping the VOX.

Adjust the DELAY control VR2 for suitable release time.

## 6. CW SIDETONE LEVEL ADJUSTMENT : See Fig. C - (4)

CW sidetone level may be adjusted by rotating TONE-level potentiometer (VR3) located on P04-005A.

## 7. CARRIER BALANCE : See Fig. C - (5)

The transceiver should be allowed to reach operating temperature before making the carrier balance adjustment.

Tune up the transceiver for SSB operation using an antenna or dummy load for transmitter. Turn the MIC GAIN control fully counterclockwise to remove all audio from the modulator stage.

With the MODE switch set at either of the LSB/USB positions, turn MOX/PTT/VOX switch to MOX position and adjust the carrier balance controls (VR1 and TC1) on PCB No. P04-006A for minimum PO meter reading.

A more exacting balance may be obtained by connecting the VTVM RF probe across the transceiver antenna terminal and observing the RF voltage on the one volt RMS scale or by tuning a receiver, having an S-meter, to the transmitted frequency. In either case, adjust the balance controls for minimum meter reading while switching the MODE switch back and forth between the two sideband positions to obtain good carrier suppression for both sidebands.

## 8. ALC LEVEL ADJUSTMENT : See Fig. C - (6)

The ALC meter will require a zero adjustment when METER switch on the front panel is set to ALC position where the meter will indicate limiting action. To adjust meter to zero (full scale for this case), set controls as follows;

MODE	USB
MIC GAIN	Fully counterclockwise
OPERATION	MOX

If meter reads other than zero (full scale), adjust ALC control VR2 on PCB No. P04-006A for zero indication. Return OPERATION switch to PTT or VOX position.

## 9. VOLTAGE REGULATOR ADJUSTMENT : See Fig. C - (7)

Connect VTVM DC probe between pin 13 of MJ-6 (for PCB No. P04-007A) and ground. Adjust REG potentiometer VR3 for exactly 6 Volt reading on VTVM.

## 10. CLARIFIER ADJUSTMENT : See Fig. C - (8)

The transmitting and the receiving frequencies shall be in coincidence at the CLARIFIER control OFF position. If not, adjust the CLARIFIER control VR4 on PCB No. P04-007A.

Also both transmit and receive frequencies coincide at CLARIFIER control 0 position. If not, adjust a potentiometer VR4 located near the CLARIFIER control under the main chassis.

## 11. BIAS ADJUSTMENT : See Fig. C - (9)

The final amplifier bias must be checked to insure linearity and normal operating plate dissipation for the final tubes. Adjust the BIAS control VR2 on PCB No. P04-007A as follows; Set the transceiver at receive mode and allow the transceiver time to reach operating temperature.

Set MODE switch to USB, METER to IC and the OPERATION switch to MOX for transmit condition. The meter will indicate PA plate current (idle or rest current). Idle plate current is 60 MA if the bias is correct. If the idle plate current is other than 60 MA, adjust BIAS control for 60 MA with zero transmitter output.

There is a little difference in the idle current between AC and DC operation. Adjust the idle current to 60MA for each operation.

## 12. FINAL AMPLIFIER NEUTRALIZATION : See Fig. C - (10)

When replacing the final amplifier tubes, it may be necessary to reset the bias to give correct idle current and check neutralization. Using the procedure outlined below will guarantee maximum output and long tube life.

### CAUTION

HIGH VOLTAGES ARE PRESENT ON UNDERSIDE OF CHASSIS AND INSIDE OF FINAL COMPARTMENT. USE GREAT CARE WHILE MAKING ADJUSTMENTS WITH WIRING EXPOSED.

- (1) Connect a dummy load to antenna, and set meter to IC.
- (2) Locate TC-27, the neutralization variable capacitor shaft on the underside of chassis near the driver stage band switch wafer, in the final amplifier section.
- (3) Check final amplifier idle current in USB or LSB position and adjust as described before.
- (4) Tune up the transceiver at 29 MHz, 10B or 10C band with MODE switch at TUNE position, and advance MIC GAIN CARRIER until meter IC reads 100 MA.
- (5) Rotate PLATE tuning control and observe dip as indicated on the meter. If the dip is not prominent, reduce loading control slightly for better indication. As the PLATE control is rotated the meter should rise equally and smoothly on either side of maximum dip indication.
- (6) Determine which side of the dip rises abruptly. Set PLATE control slightly to this side of dip keeping the meter reading below 100 MA.
- (7) Using no metallic tuning wand, rotate neutralization capacitor shaft very slightly in the direction which reduces the current shown on the meter. Repeat Steps 6 and 7 until the meter indicates a smooth and equal rise on either side of the maximum dip point.

The final compartment cover must be in place to supply the RF shielding required during the neutralization procedure.

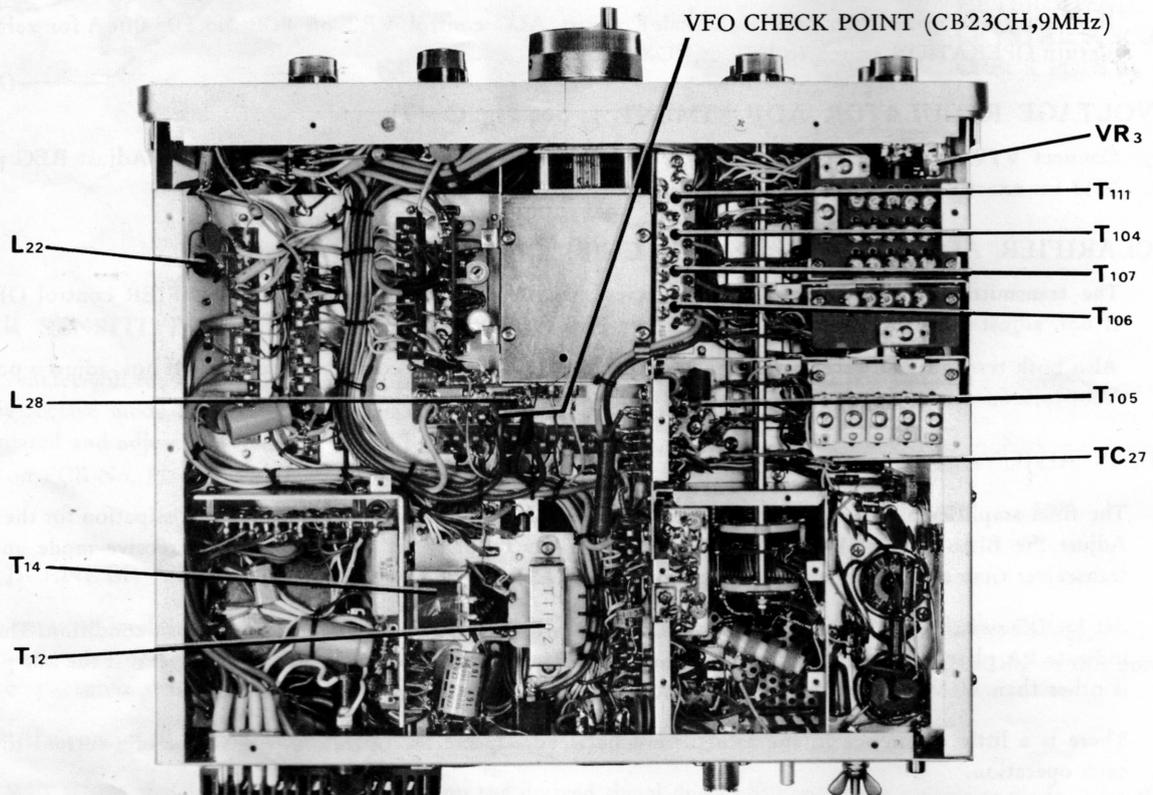


FIG.D (BOTTOM VIEW)

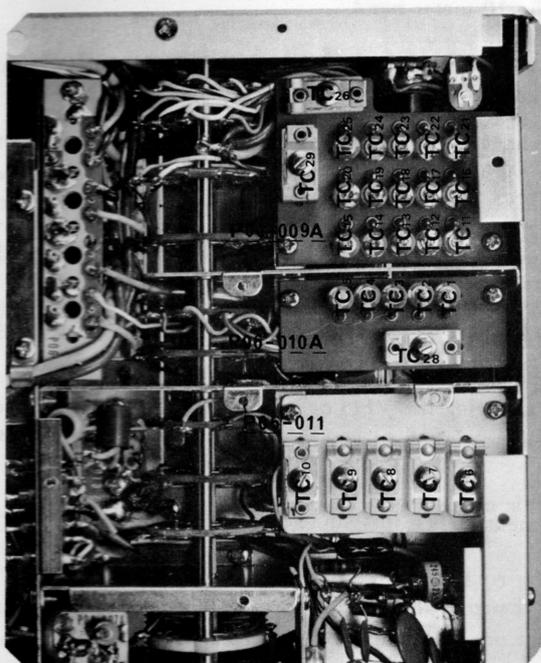


FIG. E

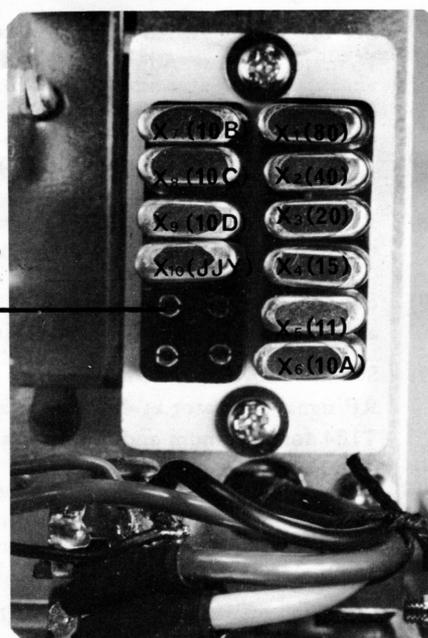


FIG. F

160m BAND  
(option)

### 13. ALIGNMENT OF TRANSMITTER MIXER/DRIVER AND RECEIVER FRONT END STAGES

(Refer to Fig. C, D, E & F)

The final amplifier bias adjustment must be properly set per paragraph 9 before extensive operation of the transmitter is attempted. When it is assumed that the signal generating stages of the transceiver are functioning properly, use the internally generated signal of the transceiver to align the transmitter mixer and driver stages and RF signal generator to align the receiver front end stage.

#### CAUTION

Be always sure that a 50-ohm dummy load is connected to the antenna jack for alignment of transmitter.

- (1) Connect the 50-ohm dummy load to the antenna jack. Set the BAND switch at 10D and tune up the transceiver at 30,000 KHz and the MOX/PTT/VOX switch at MOX.

Advance the CARRIER control and tune the final amplifier. Maintain the meter reading IC 100 MA at resonance with the CARRIER control. Set trimmer TC5 at mid-capacitance position adjust slugs of T102 and T103 for maximum output at the dummy load. Reduce the transmitter output to zero with the CARRIER control.

- (2) Set the MOX/PTT/VOX switch at PTT mode, RF and AF GAIN control at maximum, CLARIFIER control at OFF, and NOISE BLANKER at OFF. Do not change VFO setting and PRESELECTOR control setting set up in Step 1. Connect the SSG, tuned to 30,000 KHz, to the antenna jack and adjust it for approximately 1,000 Hz beat tone.

Use just enough signal generator output (approximately 1 microvolt for an aligned unit) to keep from developing AGC voltage (no S-meter indication). Set trimmer TC15 at mid capacitance position. Adjust a slug of T-101 for maximum audio output without developing AGC voltage.

- (3) Set the BAND switch at 10A and tune up the transceiver at 28,000KHz with the MOX/PTT/VOX switch at MOX.

Advance the CARRIER control and tune the final amplifier. Maintain the meter reading 100 MA with the CARRIER control as described in Step 1.

Set the PRESELECTOR control at the lower end of 10 and 11 meter segment and adjust trimmer TC5 for maximum output at the dummy load. Reduce the transmitter output to zero with the CARRIER control.

- (4) Set the MOX/PTT/VOX switch at PTT mode, and without changing the VFO or PRESELECTOR control settings, tune the RF signal generator to 28,000 KHz and obtain 1,000 Hz beat note. Control the signal generator output and adjust trimmer TC15 for maximum audio output as described in Step 2.

- (5) Repeat step 1, 2, 3 and 4 to peak the coil adjustments for the 10 meter band.
- (6) Set the BAND switch at 15 and tune up the transceiver at 21,000 KHz with the PRESELECTOR at lower edge of 15 meter segment. Adjust trimmer TC4 and TC9 for maximum transmitter output at dummy load.
- (7) Set the MOX/PTT/VOX switch at PTT mode, and without changing the VFO or PRESELECTOR settings, tune the RF signal generator at 21,000 KHz and obtain the 1,000 Hz beat note, and adjust trimmer TC14 for maximum audio output as described in Step 2.
- (8) Repeat the procedures given in Step 6 and 7 at 20 meter band. The trimmers, TC3 and TC8, are used for maximum transmitter output and TC13 for maximum audio output in receive.
- (9) Set the BAND switch at 80, VFO at 4,000 KHz, and the PRESELECTOR at 12 o'clock position. Set TC1 and TC6 at mid-capacitance point and adjust T105 and T106 for maximum transmitter output at dummy load.
- (10) Set the MOX/PTT/VOX switch at PTT mode, and without changing the VFO or PRESELECTOR settings, tune the RF signal generator at 4,000 KHz and obtain the 1,000 Hz beat note, and set TC11 at mid-capacitance point. Adjust T104 for maximum audio output as described in Step 2.
- (11) Set the PRESELECTOR at the lower edge of 80 meter segment, VFO at 3,500 KHz, and adjust TC1 and TC6 for maximum transmitter output at dummy load.
- (12) Set the MOX/PTT/VOX switch at PTT mode, and without changing the VFO or PRESELECTOR setting, tune the RF signal generator at 3,500 KHz and obtain 1,000 Hz beat note. Adjust TC11 for maximum audio output as described in Step 2.
- (13) Repeat Step 9, 10, 11 and 12 to peak the coil adjustments for 80 meter band.
- (14) Set the BAND switch at 40, VFO at 7,000 KHz and the PRESELECTOR at lower edge of 40 meter segment. Adjust TC2 and TC7 for maximum transmitter power output at dummy load.
- (15) Set the MOX/PTT/VOX switch to PTT mode, and without changing the VFO or PRESELECTOR settings, tune the RF signal generator at 7,000 KHz and obtain 1,000 Hz beat note. Adjust TC12 for maximum audio output as described in Step 2.
- (16) Set the BAND switch at 160, VFO at 1,800 KHz and the PRESELECTOR at lower edge of 160 meter segment, and adjust TC10 and TC28 for maximum transmitter output at dummy load.
- (17) Set the MIX/PTT/VOX switch to PTT mode, and without changing the VFO or PRESELECTOR settings, tune the RF signal generator at 1.8 MHz and obtain 1,000 Hz beat note. Adjust TC29 for maximum audio output as described in Step. 2.

#### 14. HETERODYNE CRYSTAL OSCILLATOR ALIGNMENT (Refer to Fig. D, E & F)

The heterodyne crystal oscillation injection may be checked in the following manner. Connect the VTVM RF probe to test point. Injection is normal, if the injection voltage measures 0.3 - 0.4 volt RMS on all bands. If not, the alignment is required. Set the BAND switch at 10D, TC24 at 1/3 capacitance position, and adjust T111 for 0.3 - 0.4 volt RMS reading on VTVM. Then adjust TC23, TC22, TC21, ..., TC17 and TC16 for each of the bands to read 0.3 - 0.4 volt RMS on VTVM.

**CAUTION**

For setting the trimmers (TC24 .... TC16) turn them in the direction in which the capacitance is increased and set them at the specified voltage reading.

For setting the T111 (oscillator coil), be aware that there are two oscillation points. Turn the core clockwise and set it at the farthestmost oscillation point.

#### 15. TRAP COIL ALIGNMENT (Refer to Fig. C & D)

L28 on PCB No.PO4-006A is used to eliminate spurious radiation on 15 meter band. For alignment, tune the transceiver at 21,200 KHz for maximum output at dummy load. To measure spurious radiation, use the S-meter of another receiver and tune it to 21,180 KHz or 21,200 KHz where a spurious signal can be heard. Adjust L28 for minimum S-meter reasing without decreasing power output of the transceiver.

L22 is used to eliminate internal beat interference. For alignment, set the transceiver for 10B band in USB mode. Sweep around 28,605 KHz to locate beat tone. Adjust L22 for minimum S-meter reading.

T107 is used to eliminate an external interference in band 40 such as a strong short wave broadcasting fed into the 1st IF (5,520 – 6,020 KHz) through the RF amplifier. Adjust T107 so that the interference is reduced to minimum.

## 16. SYNTHESIZED CB CHANNEL HETERODYNE CRYSTAL OSCILLATOR ALIGNMENT

(Refer to Fig. C, D & G)

### A. FOR 9 MHz synthesizing crystals (X1 – X4, CH1)

1. Connect VTVM and frequency counter at VFO check point (See Fig. D).
2. Set BAND switch at 11, VFO SELECTOR switch at CB CH, CB CHANNEL switch at 1, or Channel 1.
3. Set POWER switch only on.
4. Set MOX/PTT/VOX switch at MOX mode.
5. Adjust TC1 for X1 to read the frequency per the frequency table below on the frequency counter: the optimum output level is 0.15 – 0.25V rms.
6. The same procedure should be followed to adjust TC2, TC3 & TC4 for X2, X3 & X4 with the CB CHANNEL switch set at 2, 3 & 4 respectively.
7. Set VFO SELECTOR switch at CH1 and adjust TC11 for an optional channel crystal CH1.

### B. For 30 MHz synthesizing crystals (X5 – X10)

1. Connect VTVM and frequency counter at HETERODYNE CRYSTAL OSCILLATOR CHECK POINT (See Fig. C).
2. Follow the above procedures, A.2 & 3.
3. Set MOX/PTT/VOX switch at PTT mode.
4. Adjust TC5 for X5 to read the frequency per the frequency table below on the frequency counter.
5. The same procedure should be followed to adjust TC6, TC7, TC8, TC9 & TC10 for X6, X7, X8, X9 & X10 with the CB CHANNEL switch set at 5, 9, 13, 17 & 21. respectively.
6. Set MOX/PTT/VOX switch at MOX mode and adjust L303 (See Fig. G) for maximum VTVM reading. Then adjust VR1 to set VTVM reading at 0.38V ( $\pm 0.02V$ ).
7. Repeat the procedures 4 and 5.

CHANNEL NO.	TRANSMIT & RECEIVE FREQUENCIES (MHZ)	9MHZ SYNTHESIZING CRYSTALS	30MHZ SYNTHSIZING CRYSTALS
1	26,965	X1; 9184.3 KHz	X5; 32.97 MHz
2	26,975	X2; 9174.3 KHz	
3	26,985	X3; 9164.3 KHz	
4	27,005	X4; 9144.3 KHz	
5	27,015	X1	X6; 33.02 MHz
6	27,025	X2	
7	27,035	X3	
8	27,055	X4	
9	27,065	X1	X7; 33.07 MHz
10	27,075	X2	
11	27,085	X3	
12	27,105	X4	
13	27,115	X1	X8 33.12 MHz
14	27,125	X2	
15	27,135	X3	
16	27,155	X4	
17	27,165	X1	X9; 33.17 MHz
18	27,175	X2	
19	27,185	X3	
20	27,205	X4	
21	27,215	X1	X10; 33.22 MHz
22	27,225	X2	
23	27,255	X4	

## 17. HOW TO MAKE USE OF OPTIONAL, FIXED CHANNEL

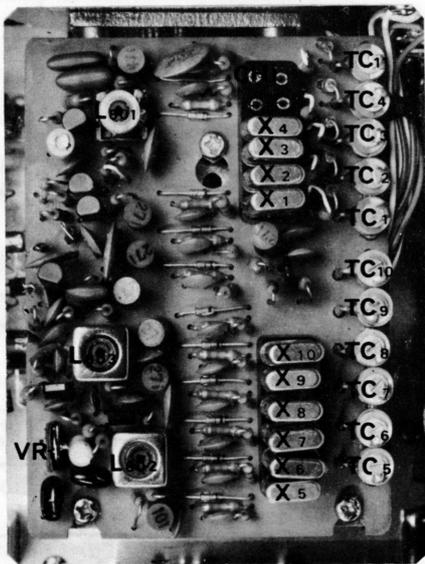
Any one of the frequencies out of 1.8 – 30 MHz amateur bands and CB band can be operated as fixed channel by adding proper crystal to the socket provided on PCB P06-014. The size of the crystal is HC-25/u, and the formula for calculation of crystal frequency is as follows:

$$X = f1 - \text{Desired channel frequency}$$

X ..... Crystal frequency

f1 ..... to be chosen from the table below according to the band and the mode.

- Remarks:
1. X should be within 8.7 – 9.2 Mhz.
  2. It should be noted that this crystal operates with the BAND switch set at any position, which means for instance that the crystal of 3758.5 KHz for 21.440 MHz (USB) in the 15 meter band functions at 7.443 MHz (LSB), if operated with the BAND switch set at 40 position. Therefore, care should be taken that the BAND switch should be set at 15 in this case.
  3. The frequency alignment for this channel should be followed as in Paragraph 16. A (Page 16).



Unit : KHz

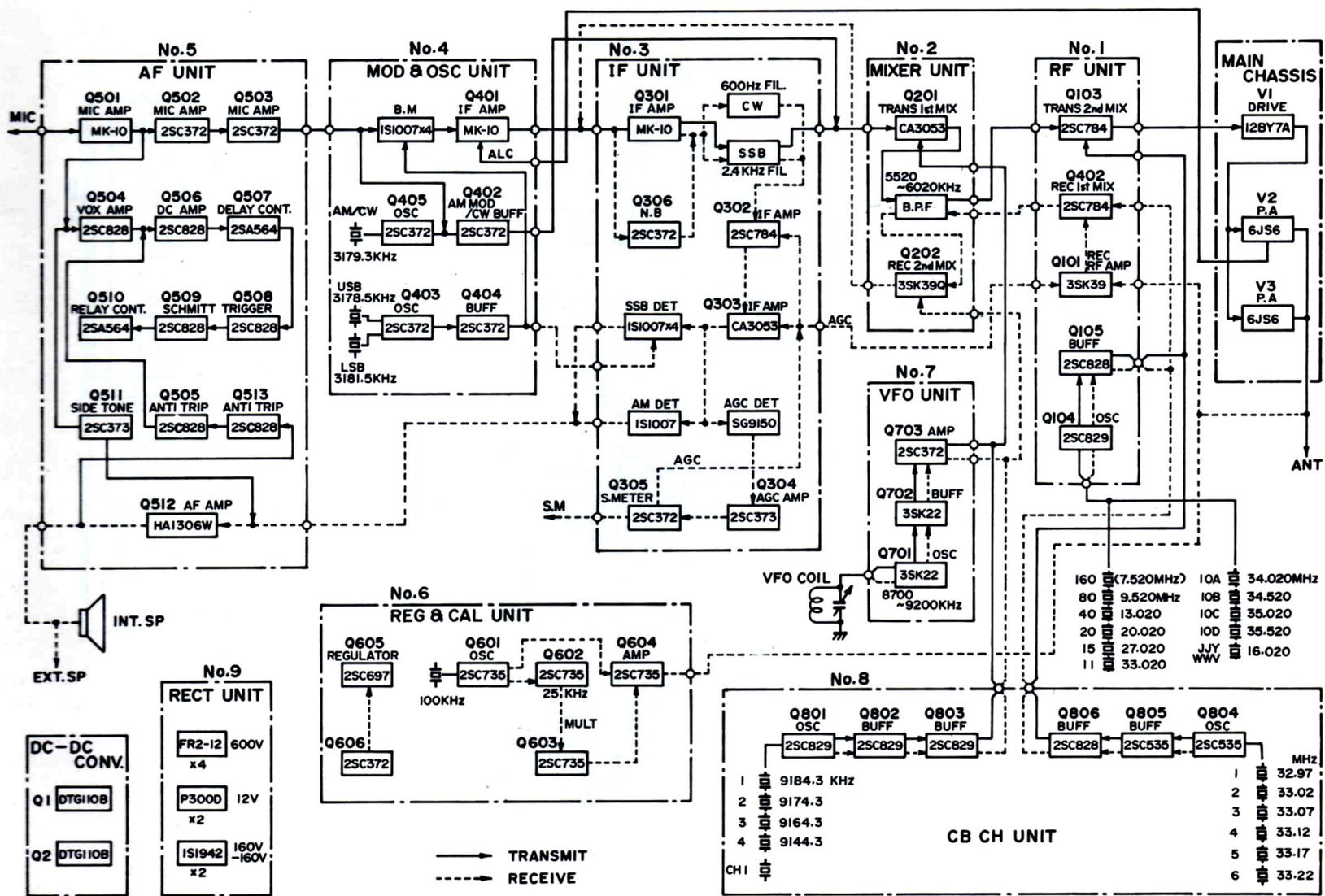
BAND	LSB	USB	AM/CW
80	12,701.5	12,698.5	12,699.3
40	16,201.5	16,198.5	16,199.3
20	23,201.5	23,198.5	23,199.3
15	30,201.5	30,198.5	30,199.3
11	36,201.5	36,198.5	36,199.3
10A	37,201.5	37,198.5	37,199.3
10B	37,701.5	37,698.5	37,699.3
10C	38,201.5	38,198.5	38,199.3
10D	38,701.5	38,698.5	38,699.3

### Calculation examples:

1. For a fixed channel of 7.055 MHz, LSB (40 meter band):  
 $X = 16,201.5 \text{ KHz} - 7,055 \text{ KHz} = 9,146.5 \text{ KHz}$
2. For a fixed channel of 14.250 MHz, USB (20 meter band):  
 $X = 23,198.5 \text{ KHz} - 14,250 \text{ KHz} = 8,948.5 \text{ KHz}$

# VIII DIAGRAMS

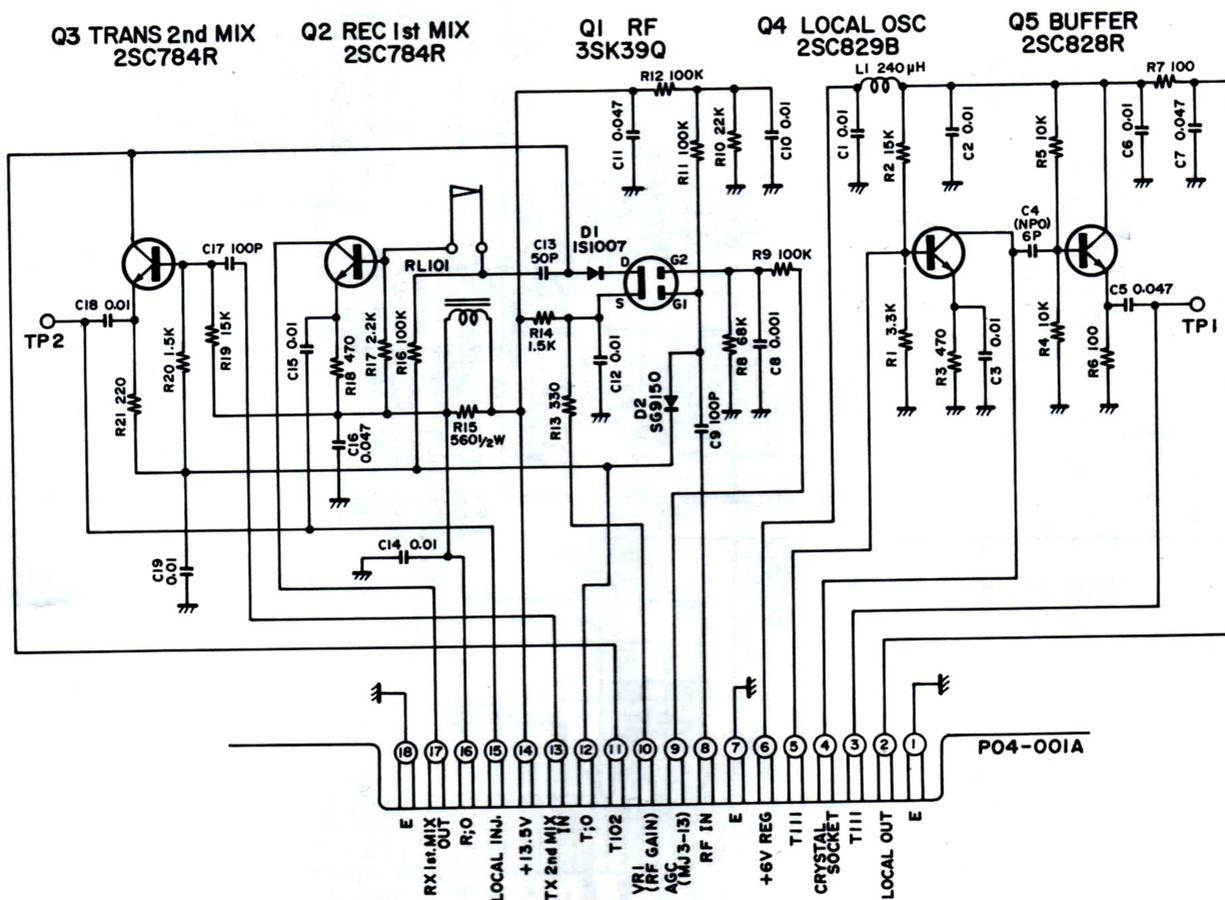
## VIII-1 BLOCK DIAGRAM



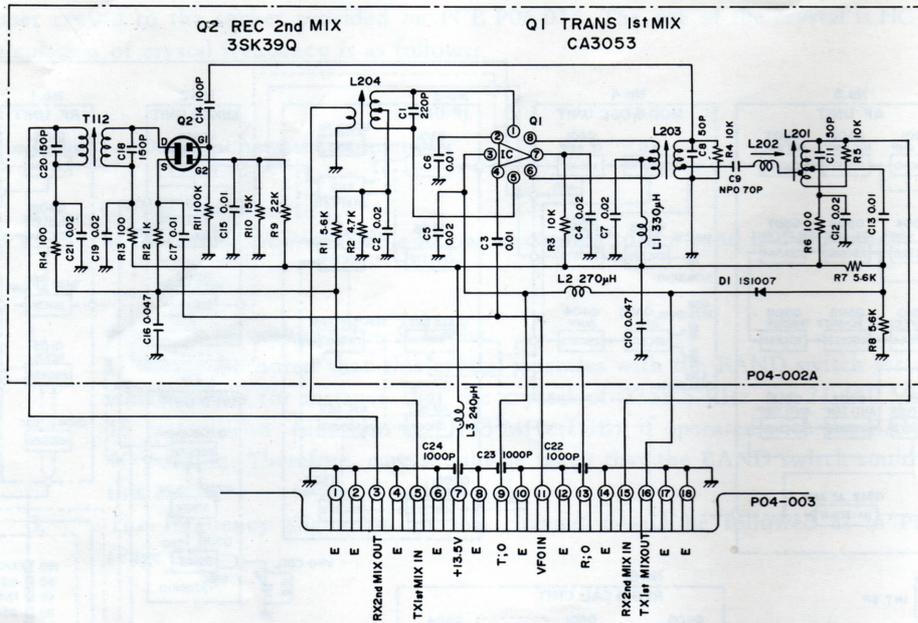
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## VIII-2 PCB DIAGRAM

### NO.1 RF UNIT



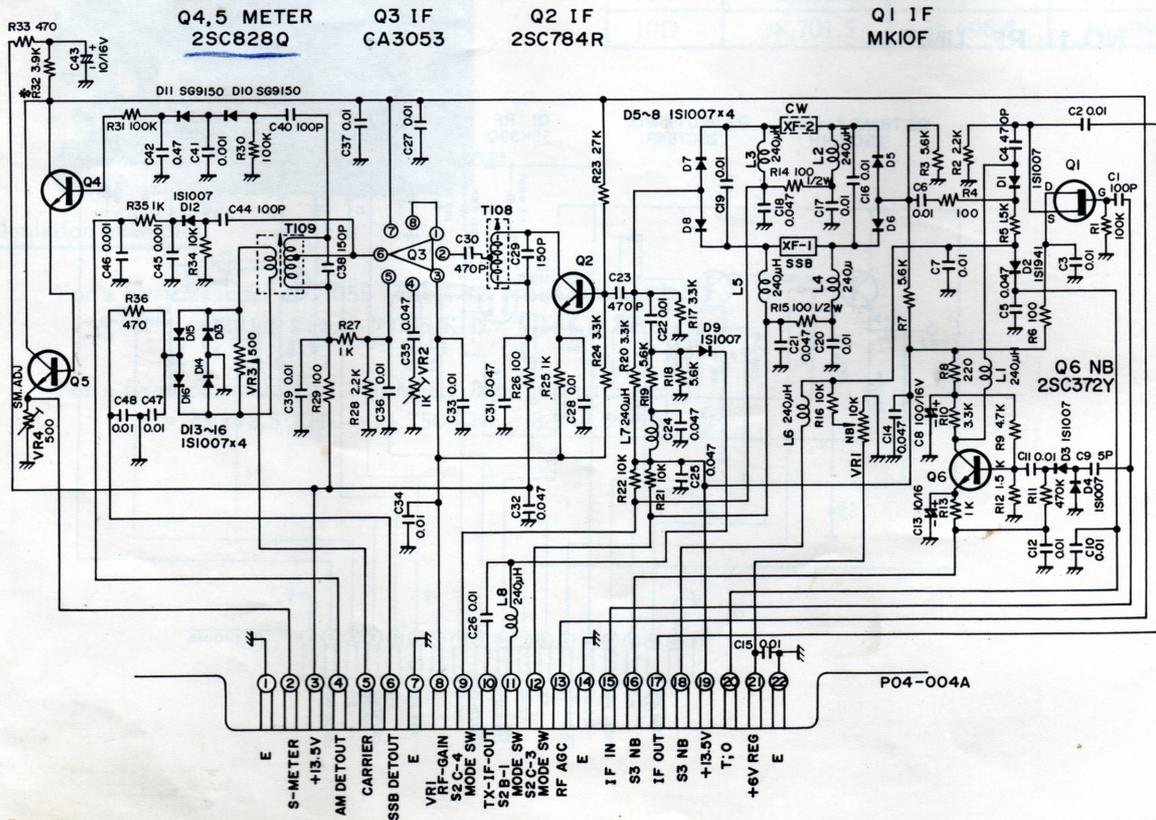
NO.2 MIXER UNIT



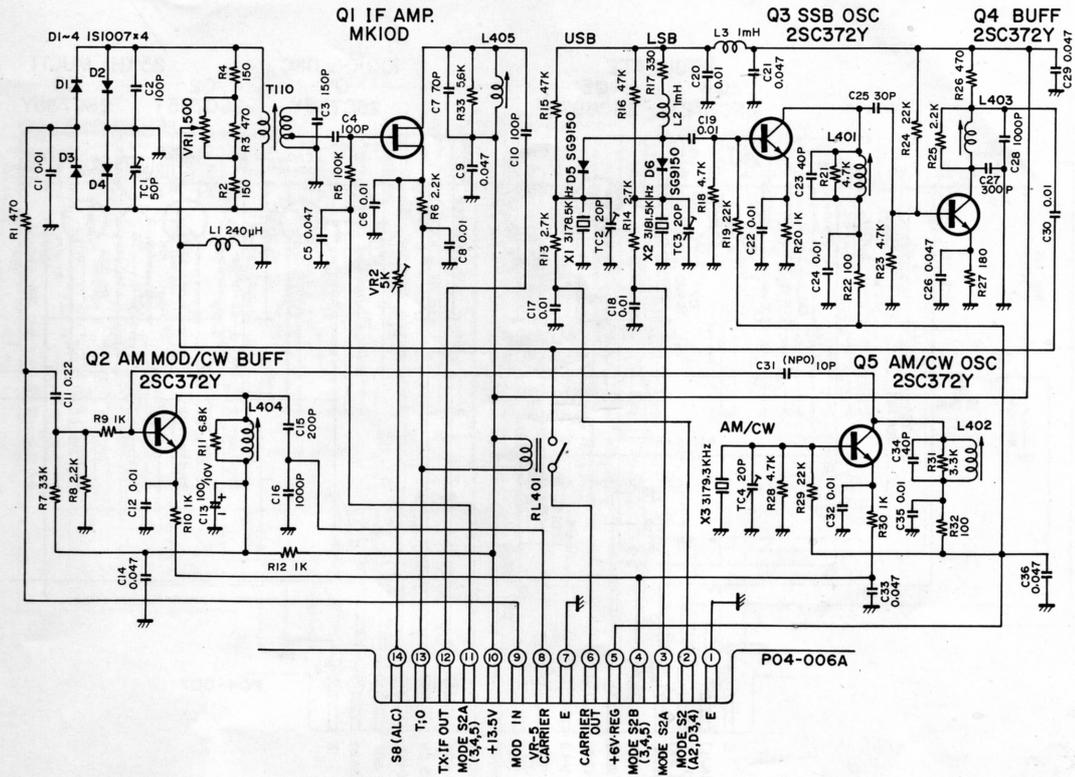
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NO.3 IF UNIT

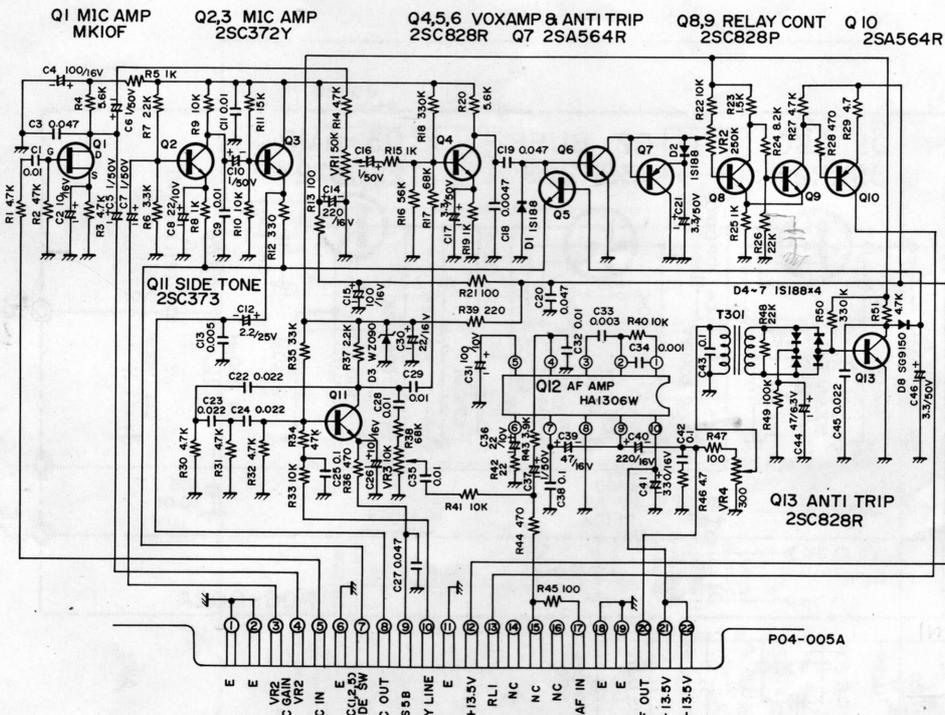
BC 182

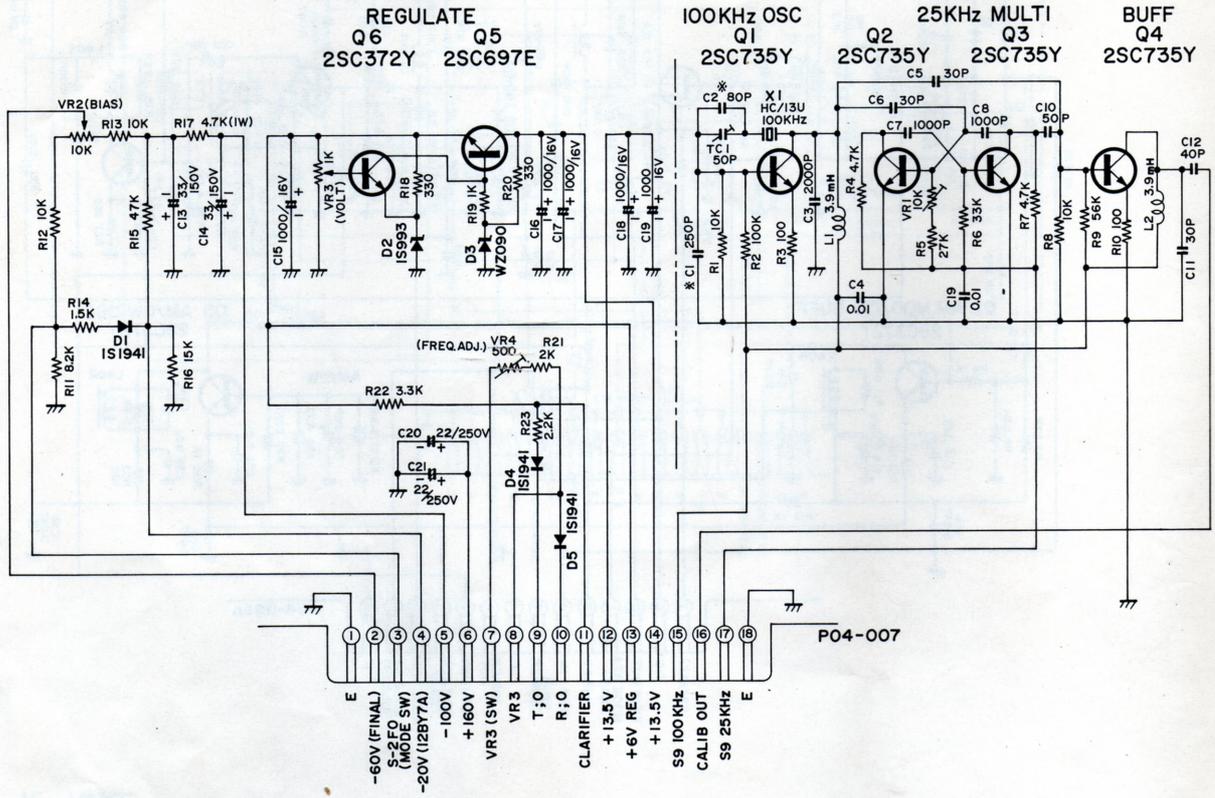


NO.4 MOD. & OSC. UNIT

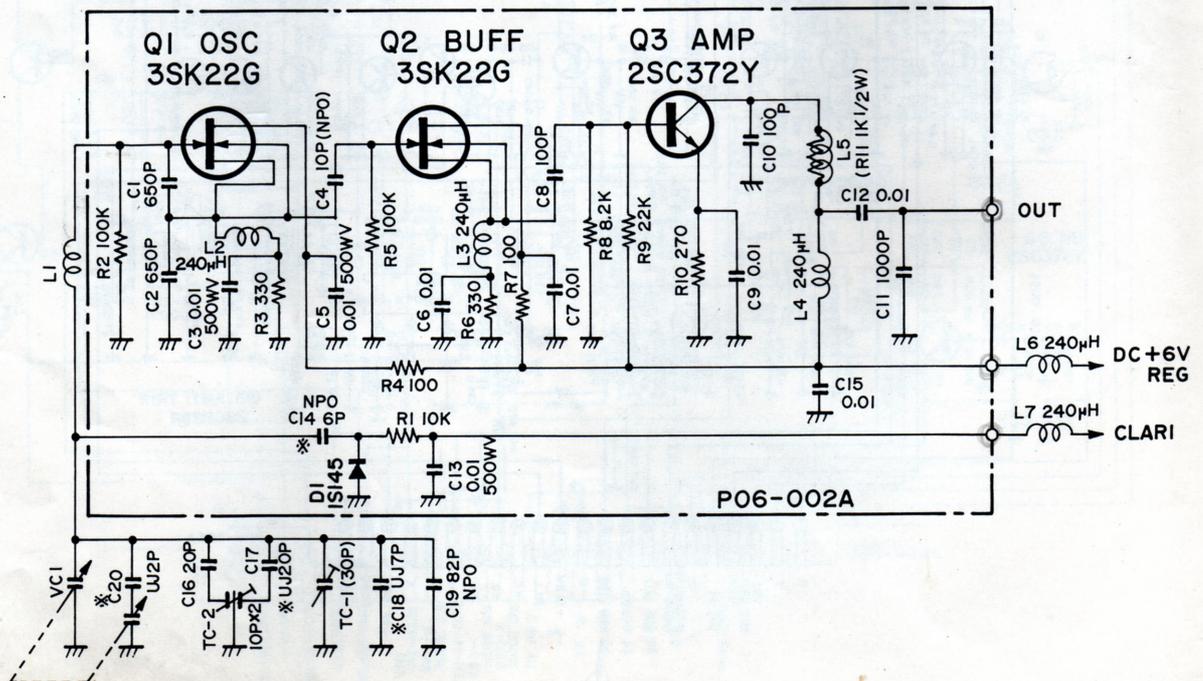


NO.5 AF UNIT

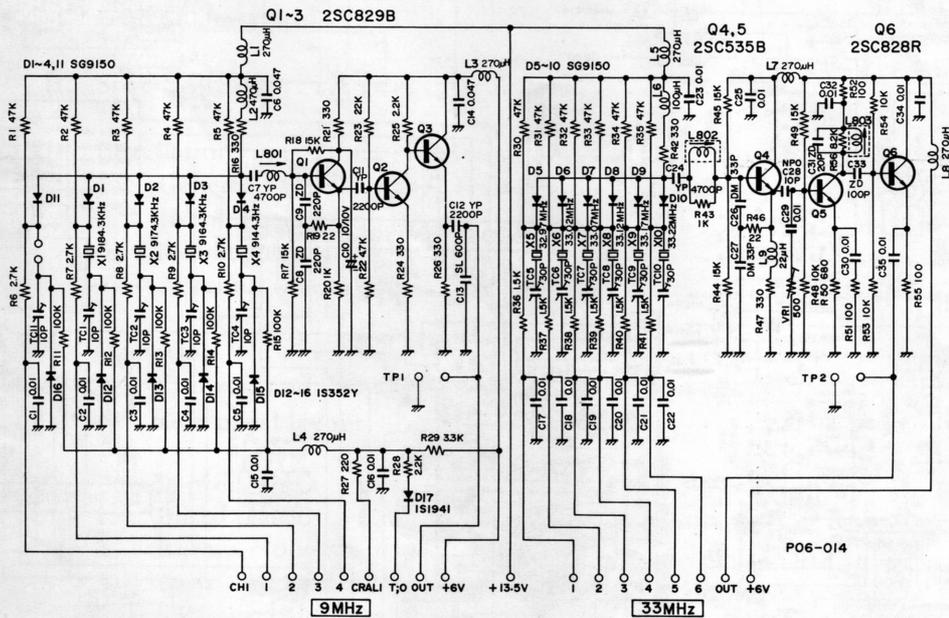




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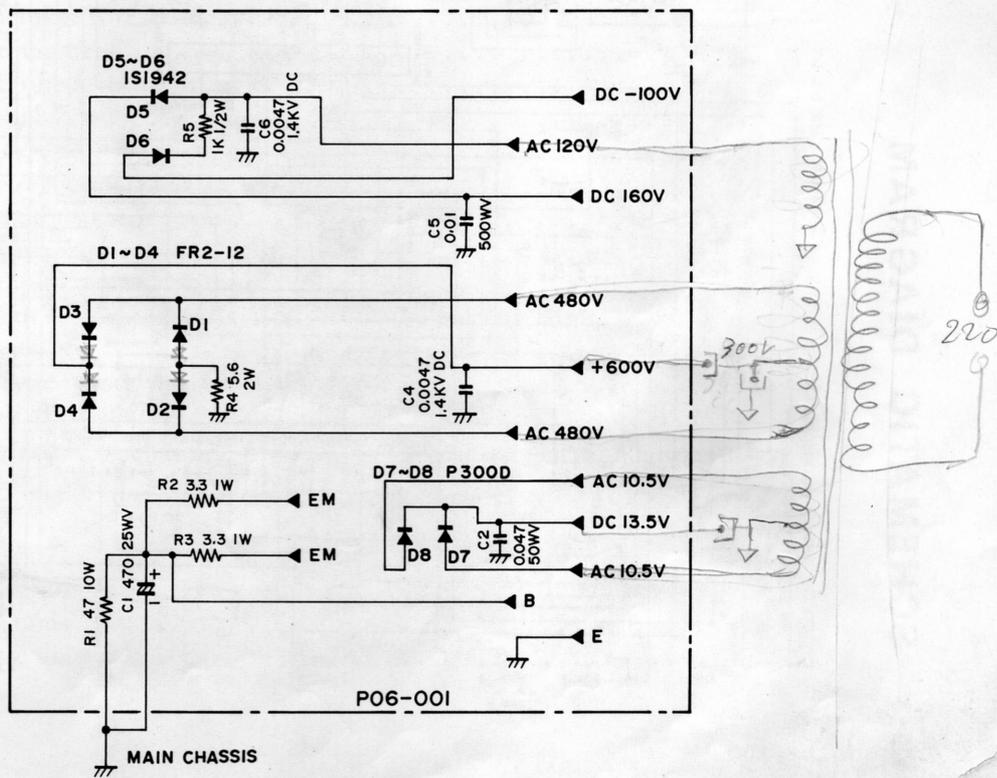


NO.8 FIX OSC UNIT

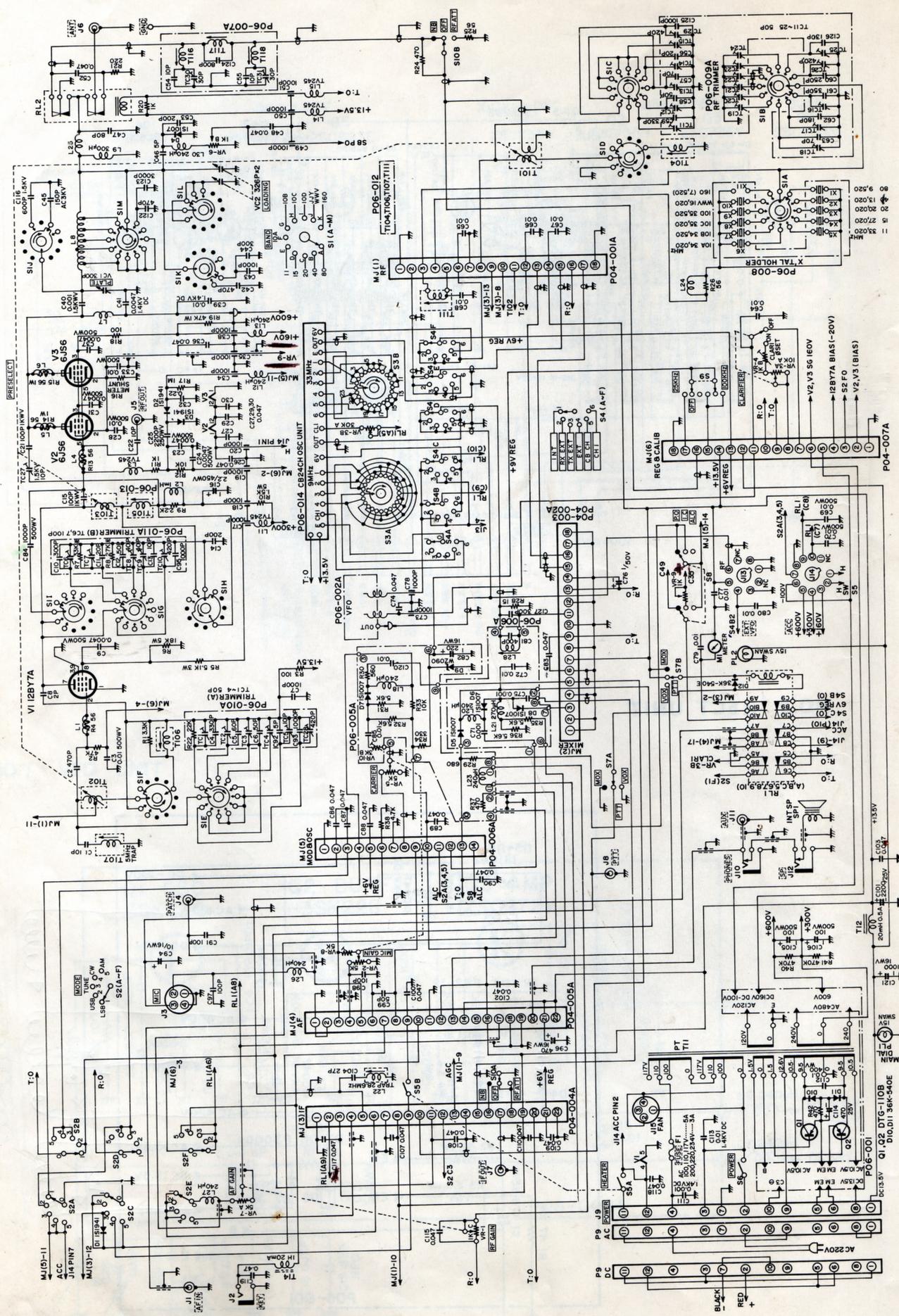


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NO.9 RECT UNIT



# VIII-3 SCHEMATIC DIAGRAM



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