

 **KENWOOD**

## **SSB TRANSCEIVER**

# **Model TS-520SE**



**INSTRUCTION MANUAL**

## AFTER UNPACKING

It is advisable to save all original packing cartons (inner and outer) to protect your valuable transceiver from damage should you wish to transport it for remote operation or ship it for after-sales service.

The following explicit definitions apply in this manual. Be sure to read these definitions:

**NOTE:** If disregarded, inconvenience only — no damage or personal injury.

**CAUTION:** Equipment damage may occur, but not personal injury.

**WARNING:** Personal injury may occur — **do not disregard.**

**CAUTION:** \_\_\_\_\_  
Read Operating Manual Section 4.11, 12, 13 before placing transmitter in service.  
\_\_\_\_\_

**WARNING:** \_\_\_\_\_  
**HIGH VOLTAGES PRESENT.**  
\_\_\_\_\_

**NOTE:** \_\_\_\_\_  
This manual covers both the 120/220V versions and the 220/240V versions of TS-520SE. Please disregard those sections not pertaining to your model.  
\_\_\_\_\_

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# TS-520SE SPECIFICATIONS

## GENERAL

**FREQUENCY RANGE** ..... 160 meter band — 1.80 to 2.00 MHz  
 80 meter band — 3.50 to 4.00 MHz  
 40 meter band — 7.00 to 7.30 MHz  
 20 meter band — 14.00 to 14.35 MHz  
 15 meter band — 21.00 to 21.45 MHz  
 10 meter band — 28.00 to 28.50 MHz (A)  
 — 28.50 to 29.10 MHz (B)  
 — 29.10 to 29.70 MHz (C)  
 WWV — 15.0 MHz (receive only)

**MODE** ..... SSB (USB, LSB) or CW

**ANTENNA IMPEDANCE** ..... 50 ~ 75 ohms

**FREQUENCY STABILITY** ..... Within 100 Hz during any 30 minute period after warmup  
 Within  $\pm 1$  kHz during the first hour after 1 minute of warmup

**TUBES AND SEMICONDUCTORS** ..... Tubes 3  
 Transistors 49  
 FETs 19  
 IC 1  
 Diodes 95

**POWER REQUIREMENTS** .....

|          |   |
|----------|---|
|          | 120/220 VAC, or 220/240 VAC<br>50/60 Hz operation |
| Receive  | 45 watts  |
| Transmit | 280 watts (maximum)                               |

**DIMENSIONS** ..... 333 (13-1/8") wide  $\times$  153 (6.0") high  $\times$  335 (13-3/16") deep mm

**WEIGHT** ..... 16 kg (35.2 lbs)

## TRANSMITTER

**RF INPUT POWER** .....

|  |
|--|
| 120/220 VAC, or 220/240 VAC<br>50/60 Hz operation                |
| 200 watts PEP for SSB operation<br>160 watts DC for CW operation |

**CARRIER SUPPRESSION** ..... Better than 40 dB

**SIDEBAND SUPPRESSION** ..... Better than 50 dB

**SUPERIORITY RADIATION** ..... Better than 40 dB

**MICROPHONE** ..... High impedance (50k ohms)

**AUDIO INPUT SENSITIVITY** ..... -60 dB (-50 dB maximum)

**AF RESPONSE** ..... 400 to 2,600 Hz, within -6 dB

## RECEIVER

**SENSITIVITY** .....  $0.25\mu\text{V}$  S+N/N 10 dB or more

**SELECTIVITY** ..... SSB — 2.4 kHz (-6 dB)  
 — 4.4 kHz (-60 dB)  
 CW\* — 0.5 kHz (-6 dB)  
 — 1.5 kHz (-60 dB)  
 \* (with optional CW filter installed)

**IMAGE RATIO** ..... Better than 50 dB

**IF REJECTION** ..... Better than 50 dB

**AF OUTPUT POWER** ..... 1 Watt (8 ohms load, with less than 10% distortion)

**AF OUTPUT IMPEDANCE** ..... 4 to 16 ohms



# SECTION 1. INTRODUCTION

## 1.1 KENWOOD TS-520SE

The TS-520SE is a highly sophisticated solid state amateur band transceiver employing only three vacuum tubes.

Operating on all amateur bands between 1.8 and 29.7 MHz, this unit is constructed modularly. The TS-520SE includes many built-in features usually found as extras on other transceivers. Included are VOX, 25 kHz crystal calibrator, RIT, RF attenuator, and an effective noise blanker. The TS-520SE also includes automatic gain control (AGC), automatic level control (ALC), semi-break-in CW with sidetone, a speech processor, speaker and built-in AC power supply.

The TS-520SE also accepts a Digital Display, Model DG-5, (optional). The DG-5 is useful for reading the TS-520SE operating frequency (precise to 100 Hz order).

Designed for operation on SSB or CW, the TS-520SE delivers more than 200 watts PEP input.

Any complicated electronic device will be damaged if operated incorrectly, and this transceiver is no exception. Please read all of the operating instructions before putting the TS-520SE on the air.

## 1.2 REQUIREMENTS FOR OPERATION

### ■ AC Power

For fixed station operation, the TS-520SE operates from any 120/220 VAC or 220/240 VAC, 50/60 Hz power source capable of supplying 280 watts or more.

### ■ ANTENNA

Any of the common antenna systems designed for use on the high frequency amateur bands may be used with the TS-520SE, provided the input impedance of the transmission line is not outside the capability of the pi-output matching network. The transmission line should be of the coaxial cable type. An antenna system which shows a standing wave ratio of less than 2 : 1 when using 50 or 75 ohm coaxial transmission line, or a system that results in a transmission line input impedance that is essentially resistive, and between 15 and 200 ohms will take power from the transceiver with little difficulty. If openwire or balanced type transmission line is used with the antenna, a suitable antenna tuner is recommended between the transceiver and the feed line. Methods of construction and operating such tuners are described in detail in the ARRL Antenna Handbook, and similar publications. For operation on the 160, 75 and 40 meter bands, a simple dipole antenna, cut to resonance in the most used portion of the bands, will perform satisfactorily. For operation of the transceiver on the 10, 15, and 20 meter bands, the efficiency of the station will be greatly increased if a good directional rotary antenna is used. Remember that even the most powerful transceiver is useless without a proper antenna.

### ■ MICROPHONE

The microphone input is designed for high impedance (50K ohm) microphones only. The choice of microphone is important for good speech quality, and should be given serious consideration. The crystal lattice filter in the transceiver provides all the restriction necessary on audio response, and further restriction in the microphone is not required. It is more important to have a microphone with a smooth, flat response throughout the speech range.

The microphone manufacture's instructions should be followed in connecting the microphone cable to the plug. With many microphones, the push-to-talk button must be pressed to make the microphone operative. For VOX operation, this feature may be disabled, if desired, by opening the microphone case and permanently connecting the contacts which control the microphone.

Standard microphone sensitivity is within the range of -50 dB to -60 dB. If a microphone having a higher sensitivity is used, the ALC and compressor circuits will not function properly. In this case, insert in the mike line an attenuator as shown in Fig. 2-2B, or connect a resistor (10k ~ 33k ohms) in parallel with capacitor C13 (100 pF) in the generator unit (X52-1090-00).

### ■ EXTERNAL SPEAKER AND HEADPHONES

Receiver audio output is 1 watt at 4 to 16 ohms. The TS-520SE has a built-in speaker. However, if an external speaker is desired for fixed station, simply connect it to the SPEAKER jack on the rear panel. The speaker may be any good 8 ohm permanent magnet type, 4 inches larger. The internal speaker is disconnected when an external speaker is used. The SP-520 speaker is designed for use with the TS-520SE. Headphones should also be 8 ohms impedance. When the headphones are connected to the front panel PHONES jack the speaker is disabled.



# SECTION 2. INSTALLATION

## 2.1 UNPACKING

Remove the TS-520SE from its shipping container and packing material and examine it for visible damage. If the equipment has been damaged in shipment, notify the transportation company immediately, save the boxes and packing material for future shipping or moving.

The following accessories should be included with the transceiver.

|  |   |
|--|---|
| Instruction Manual.....                          | 1 |
| Microphone Plug .....                            | 1 |
| Jumpered 9-pin Plug (Installed).....             | 1 |
| RCA Phono Plugs.....                             | 1 |
| Alignment Tool.....                              | 1 |
| Plastic Extension Feet with Screws .....         | 2 |
| Speaker Plug 1/8".....                           | 1 |
| 8P Octal Plug.....                               | 1 |
| Fuse   |   |
| 120V-220V Version (6A × 2, 4A × 2, 2A × 1) ..... | 5 |
| 220V-240V Version (4A × 2, 2A × 1) .....         | 3 |

## 2.2 OPERATING LOCATION

As with any solid state electronic equipment, the TS-520SE should be kept from extremes of heat and humidity. Choose an operating location that is dry and cool, and avoid operating the transceiver in direct sunlight. Also, allow at

least 3 inches clearance between the back of the equipment and any object. This space allows an adequate air flow from the ventilating fan to keep the transceiver cool.

## 2.3 CABLING (See Figure 2-1.)

### ■ GROUND

To prevent electric shock, and reduce the possibility of TVI and BCI, connect the transceiver to a good earth ground, through as short a lead as possible.

### ■ ANTENNA

Connect through a 50 ohm antenna feedline to the coaxial connector on the rear panel.

### ■ KEY

If CW operation is desired, connect a key to the KEY jack, use shielded line.

### ■ POWER CONNECTIONS

Make sure the POWER switch on the front panel is turned off, the stand-by switch is in the REC position, and the voltage switch on the rear panel is set to the correct line voltage. Then connect the POWER cord to the line source.

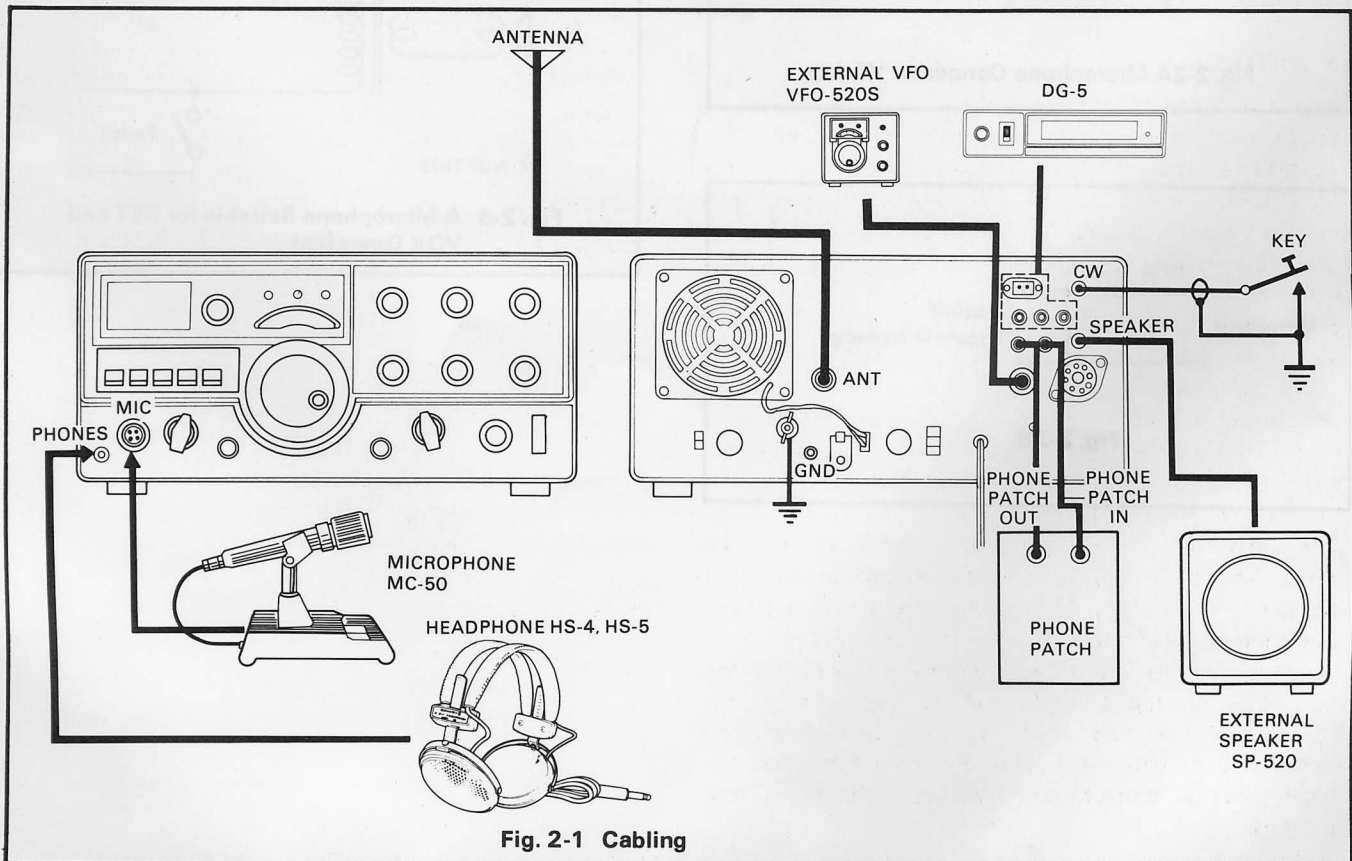
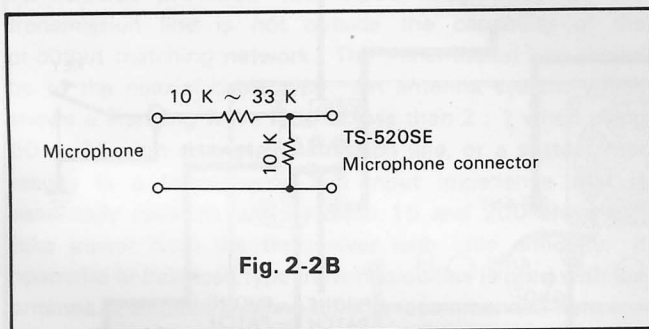
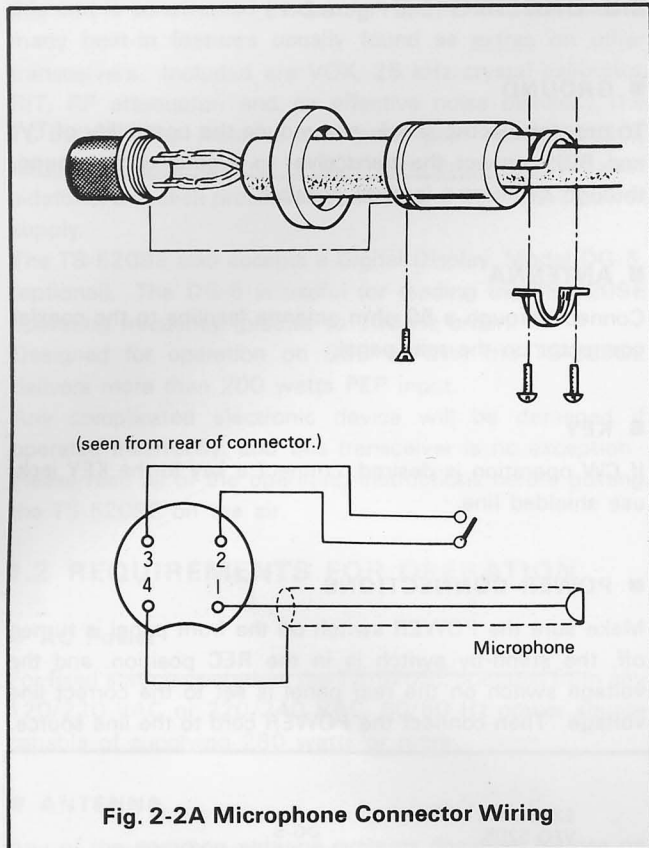


Fig. 2-1 Cabling

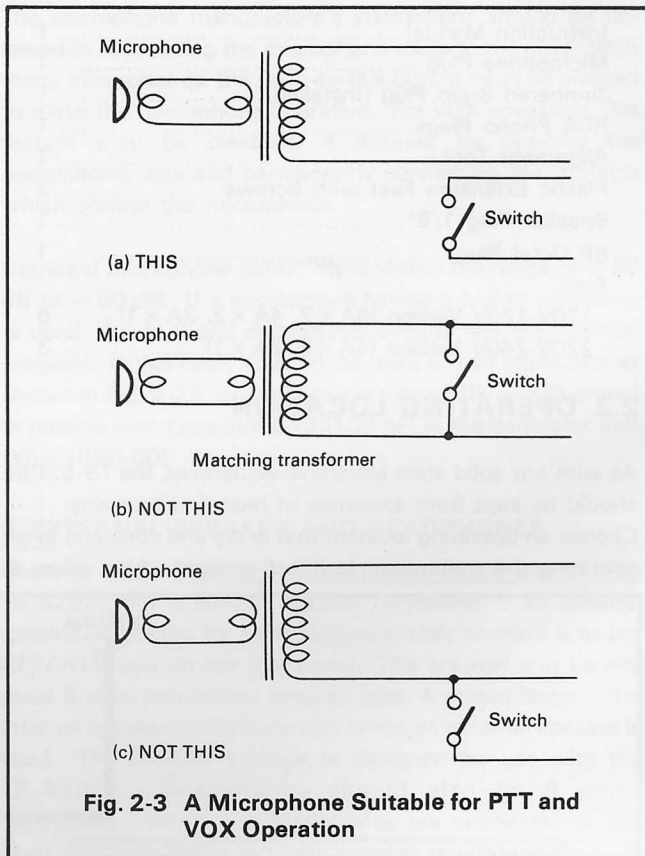
■ **SPEAKER**

If an external speaker is desired, connect to the **SPEAKER** jack on the rear panel.



■ **MICROPHONE**

Attach the microphone connector to a suitable microphone as shown in Fig. 2-2. Be sure the PTT switch is separate from the microphone circuit, as shown in Fig. 2-3. It should be noted that a microphone with a 3P plug having a common ground terminal cannot be used.



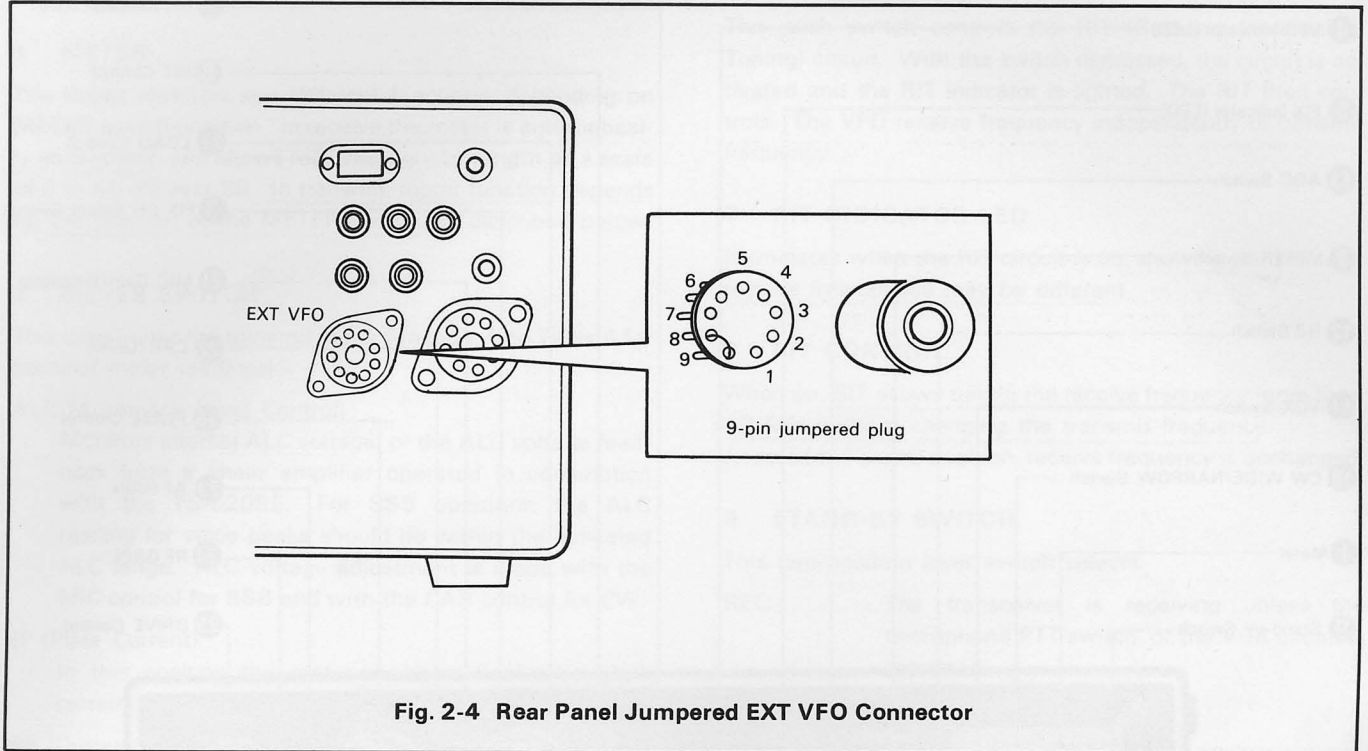


Fig. 2-4 Rear Panel Jumpered EXT VFO Connector



# SECTION 3. OPERATING CONTROLS

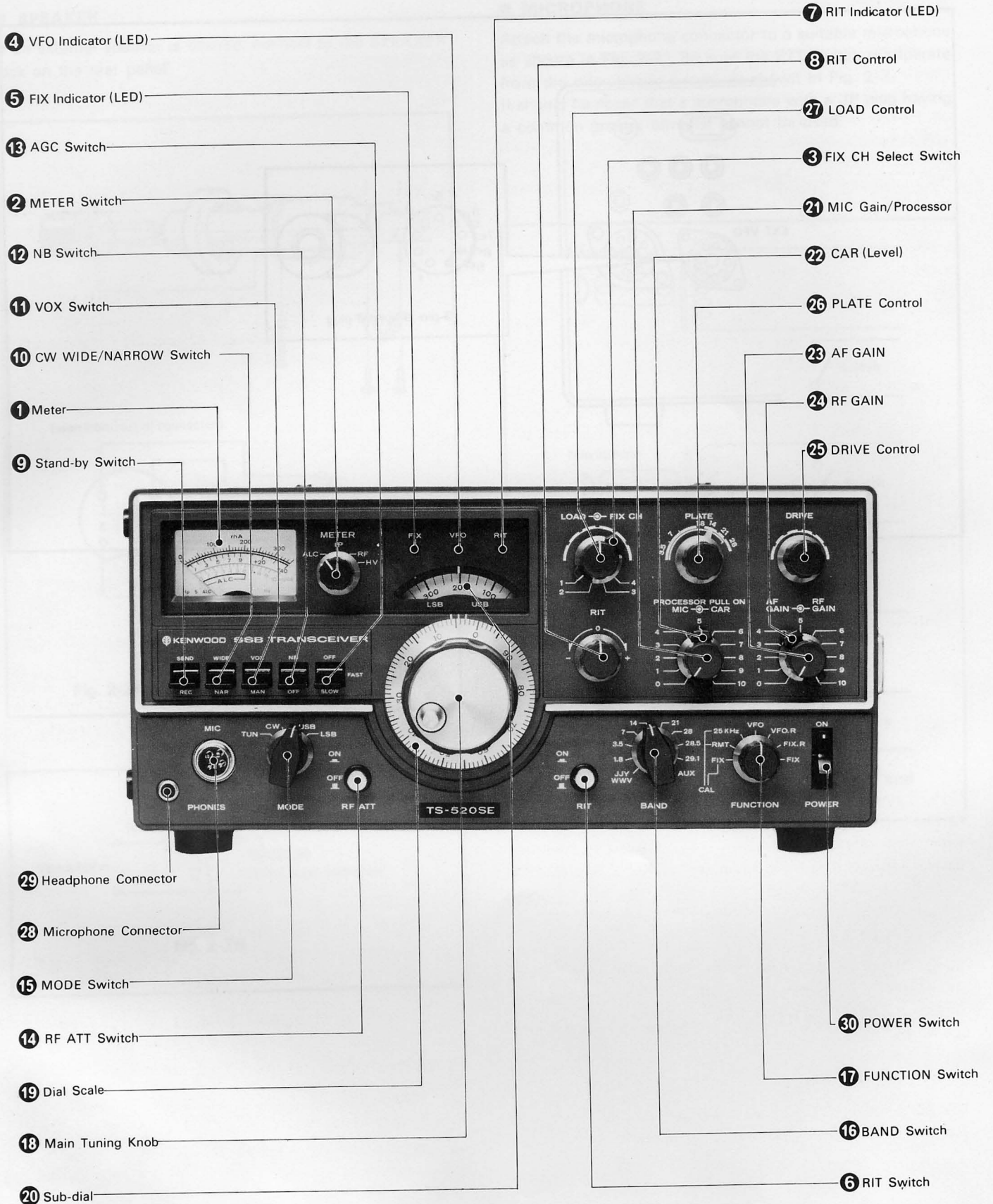


Fig. 3-1 Front Panel Controls

## 3.1 FRONT PANEL CONTROLS (See Figure 3-1.)

### 1 METER

The meter monitors five different functions, depending on METER switch position. In receive the meter is automatically an S-meter, and shows received signal strength on a scale of 0 to 40 dB over S9. In transmit, meter function depends on the position of the METER switch, as described below.

### 2 METER SWITCH

This determines the transmit meter function: (see Table 4 for nominal meter readings):

#### ALC (Automatic Level Control)

Monitors internal ALC voltage, or the ALC voltage feedback from a linear amplifier operated in conjunction with the TS-520SE. For SSB operation the ALC reading for voice peaks should be within the indicated ALC range. ALC voltage adjustment is made with the MIC control for SSB and with the CAR control for CW.

#### IP (Plate Current)

In this position the meter monitors final tube plate current. The scale is calibrated from 0 to 350 ma.

#### RF (Output Power)

This monitors relative output power of the transceiver. There is no meter scale for this position. Normally the reading should be adjusted (with the RF VOLT control) for a 2/3 scale reading.

#### HV (High Voltage)

This position monitors the high voltage power supply. The meter scale is calibrated from 0 to 10, indicating 0 to 1000 volts.

### 3 FIX CH. (FIXED CHANNEL) SELECT SWITCH

This rotary switch selects between four fixed channels which can be installed in the transceiver. Fixed operation is convenient for often used frequencies. The fixed channel oscillator replaces the VFO when the FUNCTION switch is placed in the FIX position.

### 4 VFO INDICATOR LED

The VFO indicator (a light emitting diode) illuminates when the internal VFO controls transceiver operation. The indicator is not lighted during fixed channel or remote VFO operation.

### 5 FIX (FIXED CHANNEL) INDICATOR LED

The FIX indicator illuminates when the internal fixed frequency oscillator controls transceiver operation.

### 6 RIT SWITCH

This push switch controls the RIT (Receiver Incremental Tuning) circuit. With the switch depressed, the circuit is activated and the RIT indicator is lighted. The RIT then controls the VFO receive frequency independently of transmit frequency.

### 7 RIT INDICATOR LED

Illuminates when the RIT circuit is on, showing transmit and receive frequencies may be different.

### 8 RIT CONTROL

When on, RIT allows tuning the receive frequency more than  $\pm 2$  kHz without changing the transmit frequency.  
At zero (mid-point) position, receive frequency is unchanged.

### 9 STAND-BY SWITCH

This two-position lever switch selects:

REC ..... The transceiver is receiving unless the microphone PTT switch, or the VOX circuit is activated.

SEND ..... Locks the unit in transmit.

### 10 WIDE/NARROW CW SWITCH

This switch selects between the (optional) Narrow CW filter, or Wide SSB filter when operating in CW mode.

### 11 VOX SWITCH

This two-position lever switch selects:

MAN ..... The transceiver is switched into transmit or receive by the stand-by switch, or microphone PTT.

VOX ..... The VOX circuit is readied for voice operated transmit in SSB or semi-break-in CW.

### 12 NB SWITCH

With the lever switch up, the noise blanker circuit is turned on receiving pulse type noise.

### 13 AGC SWITCH

This controls the AGC (Automatic Gain Control) circuit:

OFF ..... AGC disabled (no AGC).

FAST ..... Normally used for CW operation.

SLOW ..... Normally used for SSB operation.

### 14 RF ATT SWITCH

With this switch ON, A 20 dB attenuator is inserted in the antenna circuit, protecting the RF amplifier and mixer from overload on input strong signals.

## 15 MODE SWITCH

This switch selects type of emission, and the position.

- TUN ..... This position provides reduced carrier and shorted key line for transceiver tuning. (Input power to the final section is reduced to prevent tube damage during tune-up.) The mode switch is also used for calibration during CW operation.
- CW ..... Used for CW operation.
- USB ..... Selects upper sideband. International amateur practice dictates the use of USB on the 14, 21, and 28 MHz bands.
- LSB ..... Selects lower sideband. International amateur practice dictates the use of LSB on the 1.8, 3.5 and 7 MHz bands.

## 16 BAND SWITCH

This 10-position switch selects all the necessary circuits to place the transceiver on the desired band.

## 17 FUNCTION SWITCH

The 7-position rotary switch selects one of the following transceive functions:

- CAL-FIX ..... This position allows calibration of the internal VFO to one of the transceiver's fixed frequency channels (if optional crystals are installed). Fixed channel frequency and the VFO can be zero beat for calibration.
- CAL-RMT ..... This position allows calibration of the VFO-520S (remote VFO) to the transceiver's operating frequency: tune for zero-beat.
- CAL-25 kHz . In this position, the transceiver's calibrator generates a signal every 25 kHz for calibration of the internal VFO.
- VFO ..... The switch is kept in this position for normal transceive operation.
- VFO.R ..... The internal VFO controls the receive frequency, while the fixed channel oscillator controls the transmit frequency (if crystals are installed).
- FIX.R..... The internal VFO controls the transmit frequency while the fixed channel oscillator controls the receive frequency (if crystals are installed). The VFO.R and FIX.R allow cross-channel operation without an external VFO.
- FIX..... The fixed channel oscillator controls the transmit and receive frequency of the transceiver (if crystals are installed).

## 18 MAIN TUNING KNOB

This controls the VFO, selecting the transceiver's operating frequency.

## 19 DIAL SCALE

The dial scale provides direct frequency readout, calibrated at 1 kHz intervals, from 0 to 100 kHz. Operating frequency equals the band frequency, plus sub dial, plus dial frequency.

## 20 SUB-DIAL

The sub-dial turns with the main tuning knob to display the operating frequency of the transceiver at 25 kHz intervals, from 0 to 600 kHz.

## 21 MIC GAIN/PROCESSOR

This control adjusts microphone amplifier gain for SSB operation as well as switching the speech processor on for DX operation. For normal operation, this remains in and the MIC GAIN is adjusted for an ON scale ALC reading on voice peaks.

For DX operation, pull the control out and readjust the MIC GAIN for an ON scale ALC reading on voice peaks. (Turn the processor off for normal operation.)

## 22 CAR LEVEL

This controls carrier level during CW operation. Adjust for approximately 250 mA of plate current. *(See para 4.11)*

## 23 AF GAIN

This adjusts receiver audio level. Volume increases clockwise.

## 24 RF GAIN

This controls the gain of the receiver's RF amplifier. Turn fully clockwise for maximum gain and a correct S-meter reading.

## 25 DRIVE CONTROL

This control tunes the plate tank circuit of the 12BY7A driver as well as the receiver's antenna and mixer coils. In receive the DRIVE control is tuned for maximum sensitivity (maximum S-meter deflection), and in transmit for a maximum ALC reading. These points occur concurrently. Tuning for one also achieves the other.

## 26 PLATE CONTROL

This controls the plate tuning of the final amplifiers calibration is approximate.

## 27 LOAD CONTROL

This controls the loading of the network between the final section and the antenna. Adjustment is described in Section 4.

## 28 MIC CONNECTOR

The four pin connector allowing use of a PTT microphone. Figure 2-2A shows plug wiring.



### 29 PHONE JACK

The headphones jack allows use of a 4 to 16 ohm headphone through a 1/4" phone plug. When phones are used, the speaker is disconnected.

### 30 POWER SWITCH

This switches all power to the transceiver.

## 3.2 SIDE PANEL CONTROLS (see Figure 3-2.)

The 5 controls located on the left side of the transceiver are covered by a protective panel, which is removed by pulling the two snap fasteners.

### 1 RF VOLT CONTROL

This adjusts the RF output meter reading. Set for 2/3 scale reading during CW transmission.

### 2 BIAS

This adjusts the bias voltage to the S2001A (6146B) amplifier tubes. Clockwise rotation increases the idling plate current. Section 4 describes adjustment.

### 3 DELAY

The DELAY control adjusts the hold time for VOX or break-in CW operation. Adjust for individual preference.

### 4 ANTI VOX

Adjust the control to prevent speaker feedback from tripping the VOX.

### 5 VOX GAIN

This controls sensitivity of the VOX (Voice Operated Transmit) circuit.

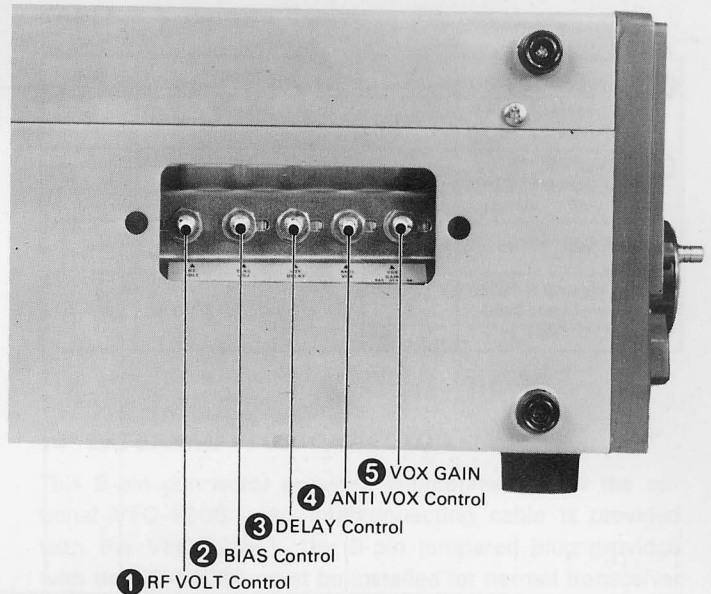


Fig. 3-2 Side Panel Controls

## 3.3 REAR PANEL CONTROLS (See Figure 3-3.)

### 1 COOLING FAN

This fan cools the RF amplifier section to insure reliable and conservative operation.

### 2 ANTENNA CONNECTOR

This SO-239 coax connector should be attached to a suitable antenna for transmitting and receiving. See Section 1.2 for discussion of appropriate antennas.

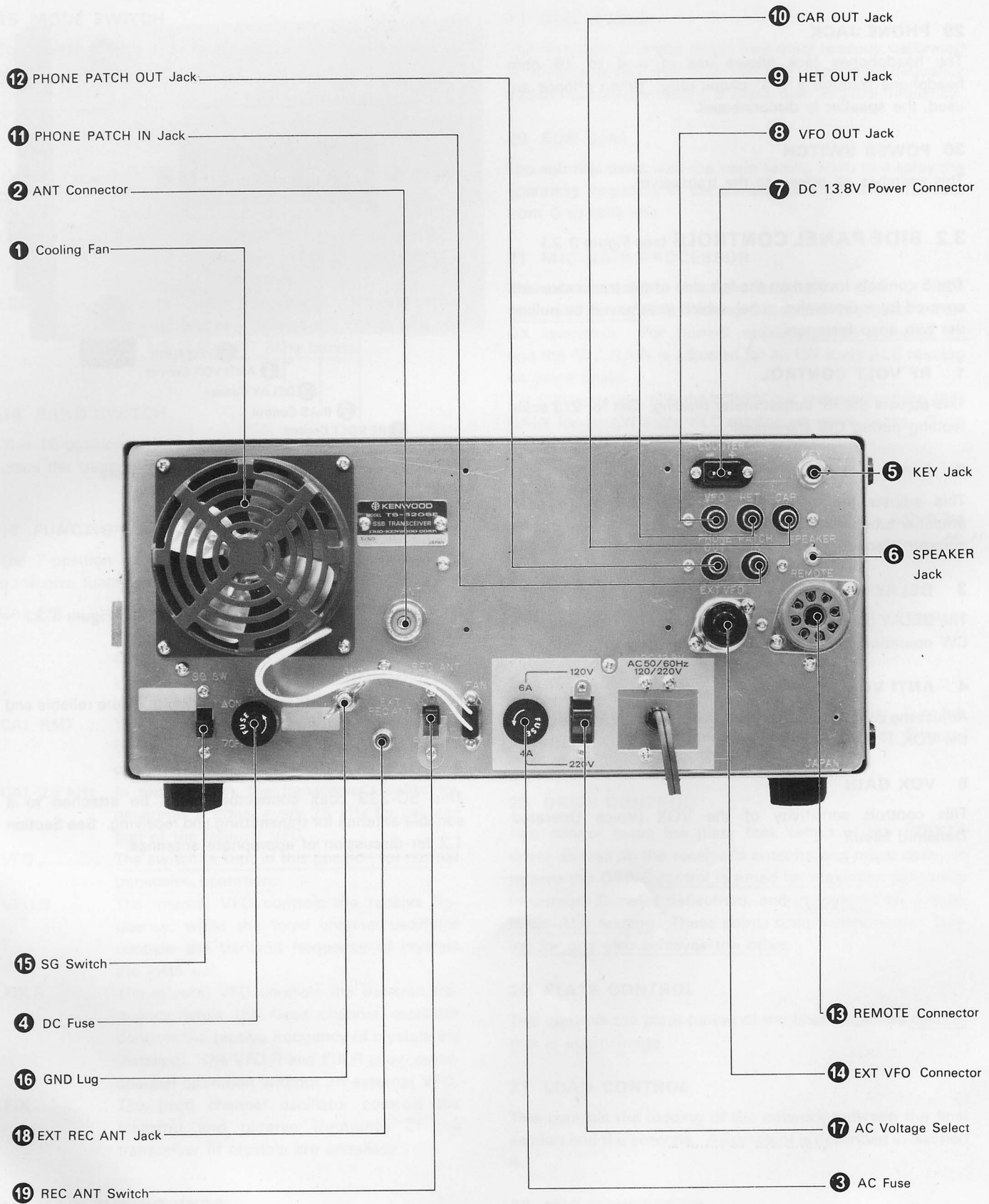


Fig. 3-3 Rear Panel Controls

### 3 AC FUSE

This fuse protects the transmitter power supply against short circuits. Never use a higher amperage fuse than specified, it will eventually cause extensive damage. If the fuse blows, try to determine the cause before replacing.

When resetting the AC Voltage Selector, it is also necessary to change the power fuse. For 120 volt operation use a 6 ampere fuse, for 220 or 240 volt operation use a 4 ampere fuse.

### 4 DC FUSE

This is a 2A fuse placed in the 13.8V DC power supply.

### 5 KEY JACK

Using shielded line, connect a key to this 1/4" phone jack for CW operation. Key open terminal voltage approximately -65V.

### 6 SPEAKER JACK

Supplies audio output to an external 4 to 16 ohm speaker. The internal speaker is disconnected when used.

### 7 13.8V DC POWER OUT CONNECTOR

This connector is provided specifically to supply 13.8 VDC at 1A for the DG-5 Digital Display.

#### NOTE:

Power output has high ripple content. Do not use for other than the DG-5.

### 8 VFO OUT JACK

### 9 HET OUT JACK

### 10 CAR OUT JACK

These feed oscillator outputs to the DG-5 Digital Display.

### 11 PHONE PATCH IN JACK

This audio input terminal accepts phone, SSTV or other line inputs.

### 12 PHONE PATCH OUT JACK

This is a 4-16Ω line output terminal for phone patch FSK demodulator SSTV, or recording.

### 13 REMOTE CONNECTOR

Use this 8-pin octal socket for inter-connecting a linear amplifier, an external speaker, or other accessory item. (See Figure 6-5, and Table 3-3.)

TABLE 3-3 Remote Connector Pin-out

| PIN | FUNCTION                      | PIN | FUNCTION  |
|-----|-------------------------------|-----|---|
| 1   | Ground                        | 5   | Normally open relay contact                     |
| 2   | No connection                 | 6   | ALC feedback<br>ALC threshold level approx. -6V |
| 3   | Normally closed relay contact | 7   | No connection                                   |
| 4   | Ground                        | 8   | External speaker<br>Load impedance 4 ~ 16Ω      |

(See also Fig. 6-5.)

### 14 EXTERNAL VFO CONNECTOR

This 9-pin connector provides interconnective for the optional VFO-520S. (An interconnecting cable is provided with the VFO-520S.) The 9-pin jumpered plug provided with the TS-520SE must be installed for normal transceiver operation. (See Fig. 2-4, and Table 3-4.)

TABLE 3-4 EXT VFO Connector Pin-out

| PIN | FUNCTION                      | PIN | FUNCTION                      |
|-----|-------------------------------|-----|-------------------------------|
| 1   | VFO signal                    | 6   | Calibrator signal (9V DC)     |
| 2   | VFO signal shield             | 7   | No connection                 |
| 3   | Ground                        | 8   | 9V DC to internal VFO (pin 9) |
| 4   | 12.6V AC                      | 9   | 9V DC to external VFO         |
| 5   | Relay voltage (+ on transmit) |     |                               |

### 15 SG SWITCH

This slide switch controls the screen grid voltage to the final tubes. For tuning or neutralizing, switch OFF (down). The switch remains ON (up) for normal operation.

### 16 GND (Ground) LUG

To prevent electric shock, RFI and BCI, connect the transceiver to a good earth ground.

### 17 AC VOLTAGE SELECT SWITCH

This switches the power transformer primary, selecting 120 or 220 VAC and 220 or 240 VAC windings. (See Fig. 3-4.)

### 18 EXTERNAL RECEIVER ANTENNA JACK

An external receiver, (for example, R-S990) may be connected for transmit/receive operation.

### 19 RECEIVER ANTENNA SWITCH

This connects the antenna to the TS-520SE at the NORMAL position and to an external receiver at the REC ANT position.

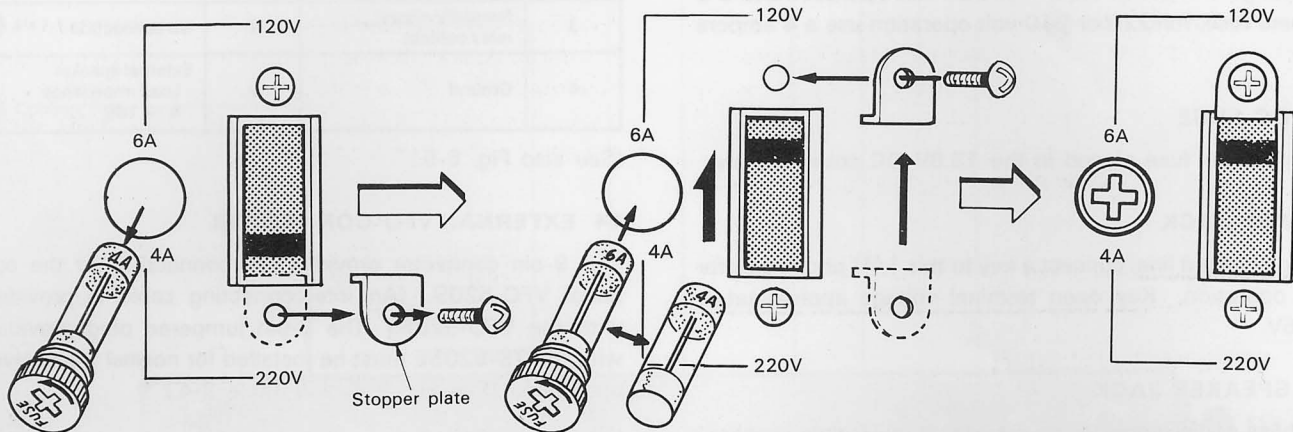


**Example:** Changing power voltage from 220V to 120V.

Remove fuse holder.  
Remove screw and  
stopper plate.

Replace fuse from  
4A type to 6A one.  
Switch stopper  
to opposite side

Install fuse holder  
again.  
Lock lever by attaching  
stopper plate to opposite  
side screw



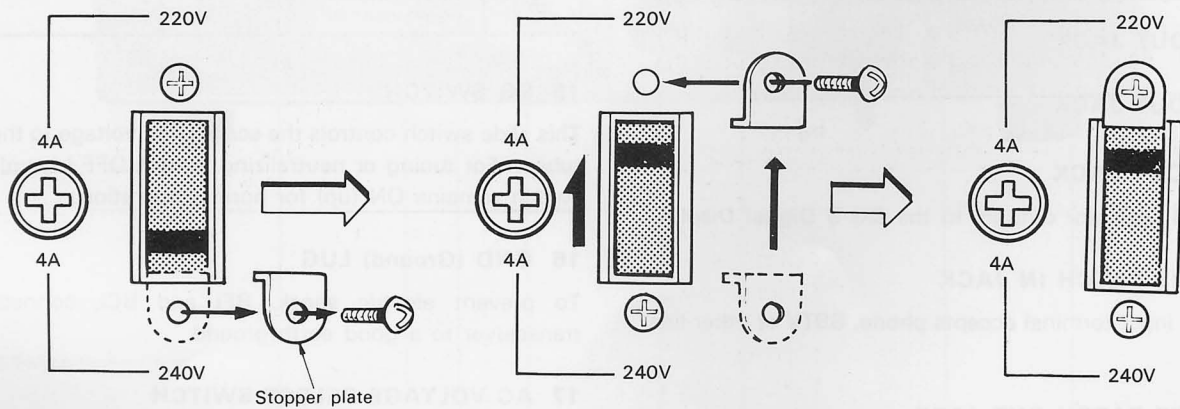
**Fig. 3-4 (A) Changing Power Voltage**

**Example:** Changing power voltage from 240V to 220V.

Remove screw and  
stopper plate

Switch stopper  
to opposite side

Lock lever by attaching  
stopper plate to opposite  
side screw



**Fig. 3-4 (B) Changing Power Voltage**

There are two versions of the TS-520SE.  
A 240/220V line model and a 220/120V line model. The  
input voltage in either version can be changed either up or  
down as required, by changing the AC voltage select switch.

**NOTE:** \_\_\_\_\_  
The 240/220V version was set in 220V position and the  
220/120V version in the 120V position.  
\_\_\_\_\_

# SECTION 4. OPERATING INSTRUCTIONS

## 4.1 PRELIMINARY PROCEDURE

Set the MIC and CAR controls to minimum to prevent accidental transmission before tune-up is completed. The TS-520SE must be operated into a 50 ohm antenna or dummy load with an SWR less than 2 : 1. Random length wire antennas or light-bulb dummy loads cannot be used. Conventional half-wave dipoles and beam antennas should only be used at or near their resonant frequency. Exceeding an SWR of 2 : 1 can damage the output stage of the transceiver. (Refer to Section 1.2.)

Be sure to have complete all required cabling, as described in Section 2.3.

With a suitable antenna and microphone or key connected to the transceiver, set the controls as described in Table 4-1.

## 4.2 RECEIVER TUNING

Turn the POWER switch on. The meter, dial scale, and VFO indicator will light, indicating the transceiver is operating. Advance the AF GAIN control clockwise until some receiver noise is heard in the speaker. Turn the main tuning dial within the frequency range of the amateur band chosen until a signal is heard. Tune the signal for clearest reception, and then adjust the DRIVE control for maximum S-meter deflection. *or band noise.*

The RF GAIN control varies the AGC feedback voltage which effects the S-meter reading. With the RF GAIN control fully clockwise, the S-meter gives a proper signal strength reading. Turning the control counter-clockwise reduces the RF gain, reducing signal strength and band noise.

**TABLE 4-1. Initial Switch Settings for Receiving**

| CONTROL LOCATION | CONTROL         | POSITION                          |
|------------------|-----------------|-----------------------------------|
| FRONT PANEL      | BAND Switch     | Desired band                      |
|                  | POWER Switch    | OFF                               |
|                  | Stand-by Switch | REC                               |
|                  | NB Switch       | OFF                               |
|                  | RIT Switch      | OFF                               |
|                  | FUNCTION Switch | VFO                               |
|                  | AGC Switch      | SLOW or FAST                      |
|                  | MODE Switch     | To the appropriate sideband or CW |
|                  | RF ATT Switch   | OFF                               |
|                  | PLATE Control   | Middle of band                    |
|                  | DRIVE Control   | Centered                          |
|                  | RIT Control     | Centered                          |
|                  | AF GAIN Control | Fully counter-clockwise           |
|                  | RF GAIN Control | Fully clockwise                   |
|                  | REAR PANEL      | EXT VFO Connector                 |
|                  | SG Switch       | ON (up position)                  |
|                  | REC ANT Switch  | NORMAL                            |

The remaining controls do not affect reception and may be in any position.

## 4.3 READING THE OPERATING FREQUENCY (See Figure 4-1.)

The operating frequency is the sum of three readings — the band frequency (1.8, 7.0, .....), the sub-dial reading (0, 100, 200, .....), and the dial scale reading (0, 10, 20, .....)

The sub-dial is calibrated in 25 kHz intervals from 0 to 600. The dial scale is calibrated in 1 kHz intervals from 0 to 100. Four revolutions of the main tuning knob turns the dial scale once, covering 100 kHz. Six turns of the dial scale covers the entire band from 0 to 600 kHz.

Example: BAND Switch — 14.0  
 Sub-dial — between 200 and 300  
 Dial Scale — 80  
 Operating Frequency —  
     14.0 MHz + 200 kHz  
     + 80 kHz = 14.280 MHz

When the TS-520SE is correctly calibrated, (as described below,) the center dial pointer shows the operating frequency for CW. The left dial pointer shows the operating frequency for LSB operation and the right dial pointer shows the operating frequency for USB operation.

TUNE ..... Receive and transmit frequencies are the same — zero beat the incoming marker or CW signal at the center (CW) pointer.

**NOTE:**

The TS-520SE is factory wired for easy installation of the optional YG-3395C CW filter, requiring only one lead change on the IF PCB X48-1060-01. (Reference Section 6.2, Accessories installation, CW Filter.) Although the transceiver may be operated on CW as wired, a simple wiring change to the Carrier PCB X50-0009-00 will afford more convenient operation. Reference Section 6.1, CW wiring option.

- CW (optional wiring) ..... Frequency readings are the same as CW (standard wiring). However, since CW reception is now at the edge, and not the center of the IF bandpass, only one receive point (beat point) is available. Mistuning to the alternate sideband is no longer possible.
- CW ..... Optional YG-3395C filter installed; Frequency readings are the same as CW (standard wiring). Tune for maximum S-meter reading. Received pitch will be approximately 700 Hz, and transmit frequency will be zero beat to the opposite station.

**4.4 CALIBRATION**

**■ NORMAL TRANSCEIVER CALIBRATION**

To read frequencies accurately, the dial must first be calibrated using the 25 kHz marker. Set the FUNCTION switch to CAL-25 kHz and the RIT switch OFF. Depress the RF ATT switch, reducing incoming signals so the marker can

be heard more easily. For greatest accuracy calibrate nearest the desired operating frequency.

- LSB ..... Set the MODE switch to LSB and adjust the main tuning knob to zero beat the marker signal. If the dial scale reading under the left-hand LSB dial pointer is not on an even 25 kHz mark, hold the main tuning knob with one hand and adjust the dial scale for a correct reading.
- USB ..... Perform the calibration procedure in the USB MODE, using the USB (right-hand) dial pointer.
- CW ..... Set the mode switch to TUNE to zero beat the marker signal. Calibrate the dial scale to the center pointer.

If the TS-520SE has a CW filter installed, tune the VFO for maximum S-meter deflection, not for zero-beat. Calibrate the dial scale to the center pointer as described above.

**■ CALIBRATING THE FIXED CHANNELS**

Turn the FUNCTION switch to CAL-FIX to calibrate the TS-520SE's VFO to a fixed channel frequency. Tune the VFO to the channel frequency selected and zero beat the generated marker signal. At zero beat the VFO and crystal frequencies coincide.

By calibrating the VFO for normal operation, as described above, the VFO can be used as a frequency standard for netting accessory fixed channel crystals.

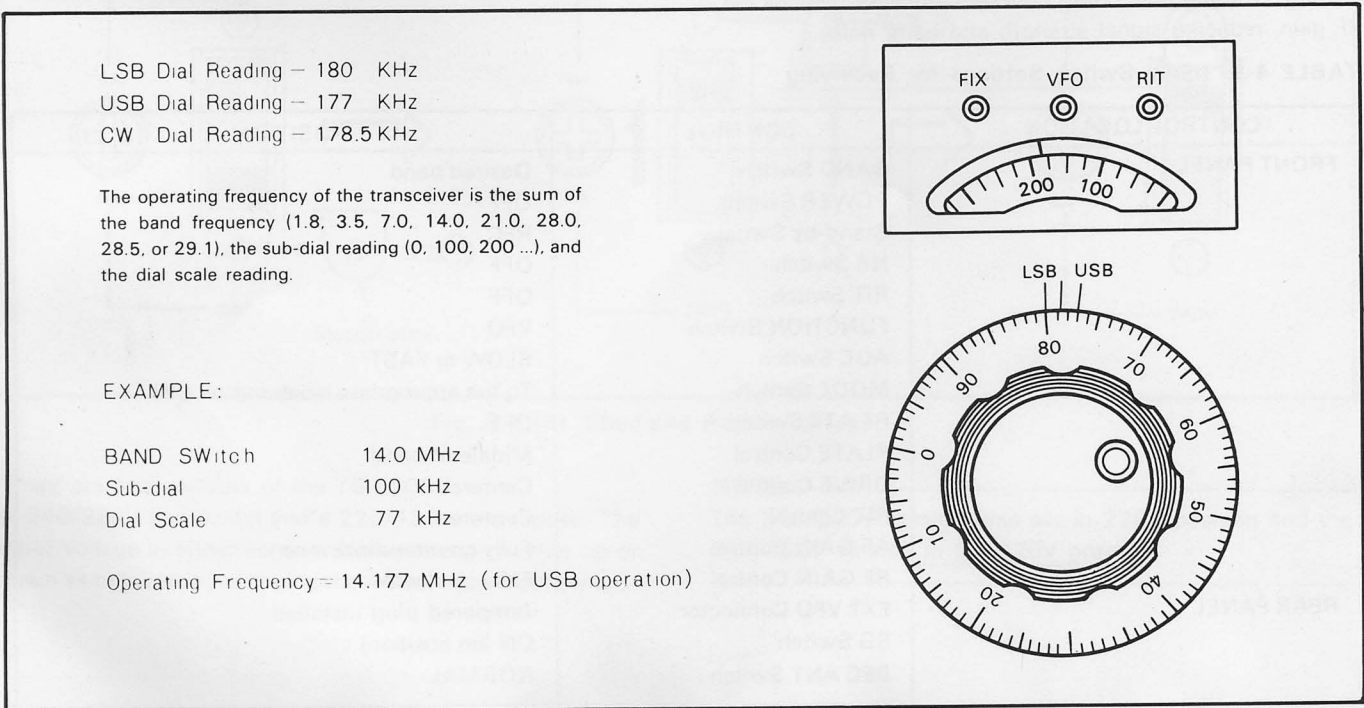


Fig. 4-1 Reading the Operating Frequency (Refer to Section 4.3)



#### ■ CALIBRATING THE TS-520SE WITH THE VFO-520S

Turn the FUNCTION switch to CAL-RMT to calibrate the TS-520SE with the VFO-520S a receiver, or another remote VFO. Tune the remote VFO to the frequency selected on the TS-520SE and zero beat the generated marker signal. At zero beat, the TS-520SE and remote VFO frequencies coincide.

By calibrating the TS-520SE for normal operation, as described previously, the TS-520SE can be used as a frequency standard for calibrating the remote VFO.

#### ■ CALIBRATING THE TS-520SE MARKER TO WWV

To check that the marker signals are correctly adjusted, best the calibrator signal against WWV at 15 MHz. Receive WWV at 15 MHz as described in Section 4.5. Turn the FUNCTION switch to CAL-25 kHz and the MODE SWITCH to TUN and CW NARROW/WIDE switch to WIDE. The calibrator signal and WWV signal should overlap and zero beat at the zero marking on the sub-dial. If they do not, adjust the calibrator to zero beat with TC1 on the MARKER (X50-1600-00) board.

### 4.5 WWV RECEPTION

15 MHz WWV is available with the BAND switch set to WWV, and the sub-dial and dial scale set at zero.

#### NOTE:

The DRIVE control does not peak the transceiver for WWV reception.

### 4.6 RF GAIN

RF GAIN is controlled by changing the voltage of the AGC circuit. Adjust the RF GAIN so the S-meter does not excessively deflect. This also reduces noise during reception. For normal operation, this control should be turned fully clockwise for maximum sensitivity.

### 4.7 NOISE BLANKER

The TS-520SE has a sophisticated built-in noise blanker designed to reduce ignition type pulse noise. When necessary, activate the noise blanker by flipping the NB switch up.

### 4.8 AGC (AUTOMATIC GAIN CONTROL)

Set the AGC switch to the appropriate position: Generally for SSB, SLOW, for CW FAST, and for very weak signals, the AGC may be turned OFF.

### 4.9 RIT (RECEIVER INCREMENTAL TUNING)

Using the RIT control, the VFO receive frequency can be shifted approximately  $\pm 3$  kHz, without changing the transmit frequency. The RIT switch activates both the LED indicator, and the RIT control.

### 4.10 RF ATT

The input to the receive RF amplifier is attenuated approximately 20 dB, providing distortionless reception. This feature may be used in cases of receiver overload, caused either by a strong local signal, or during weak signal reception when a strong adjacent signal may blank the receiver.

### 4.11 TRANSMITTER TUNING

Connect the TS-520SE to a 50 ohm dummy load or a 50 ohm antenna with an SWR of less than 2 : 1 before making any transmitter adjustments. The life of the final tubes is directly related to the SWR of the antenna, and to the length of tuning periods.

Refer to Table 4-2 for initial transmitter switch settings. Set the main tuning to the desired operating frequency. (Refer to Tables 4-3 and 4-5 for a summary of the following.)

#### ■ PLATE IDLING CURRENT (See Figure 4-2)

Flip the stand-by switch to SEND and check that the plate current (IP) is 60 mA. If the plate current is not correct, adjust the side panel BIAS control for 60 mA of idling current and return the stand-by switch to REC.

#### CAUTION:

If the plate current is higher than 60 mA do not leave the stand-by switch on for more than a few seconds. Excessive plate current shortens the life of the final tubes.

#### ■ DRIVE TUNING (See Figure 4-3.)

Shift the METER switch to ALC, the MODE switch to TUN, the stand-by switch to SEND and peak the ALC (maximum meter deflection) with the DRIVE control. *Turn standby switch to REC. (See page 10, para 22.)*

#### NOTE:

If there is no ALC reading indicated, increase the CAR control until there is an ALC reading. If the meter runs OFF-scale, reduce the car level. *250ma.*

■ **PLATE TUNING** (See Figure 4-3.)

Turn the METER switch back to IP, leave the MODE switch at TUN and the stand-by switch to SEND. Quickly adjust the PLATE control to dip the plate current (a minimum meter reading). Return the stand-by switch to REC.

**NOTE:**

The TUNE position permits tuning of the final tank circuit at reduced power without danger to the tubes. In the TUN position, the screen voltage to the finals is reduced approximately 50% and the keying circuit is closed.

Turn the MODE switch to CW, turn the METER switch to RF, and set the stand-by switch to SEND. Quickly adjust the PLATE control and then the LOAD control alternately to peak (maximum meter deflection) the power output. If necessary, adjust the RF VOLT control on the side panel to bring the output reading to about a 2/3 scale reading.

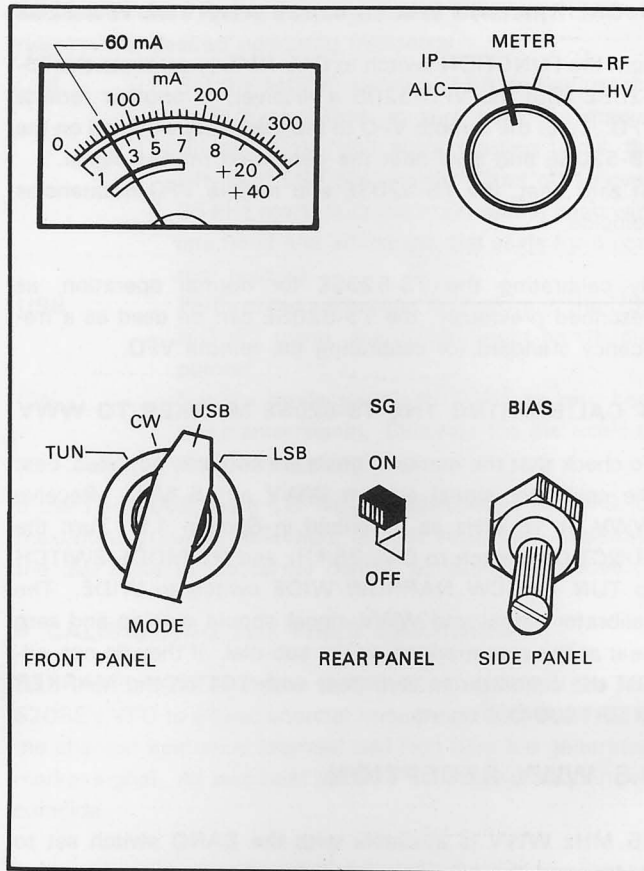
*Turn stand by switch to REC.*

**4.12 SSB OPERATION**

Tune the TS-520SE as described in Sections 4.1 to 4.11. Set the MODE switch per Table 4-4, to USB or LSB and connect a microphone to the MIC input.

**NOTE:**

International amateur practice dictates using USB or LSB as TABLE 4-4. *page 19.*



**Fig. 4-2 Plate Idling Current Adjustment**

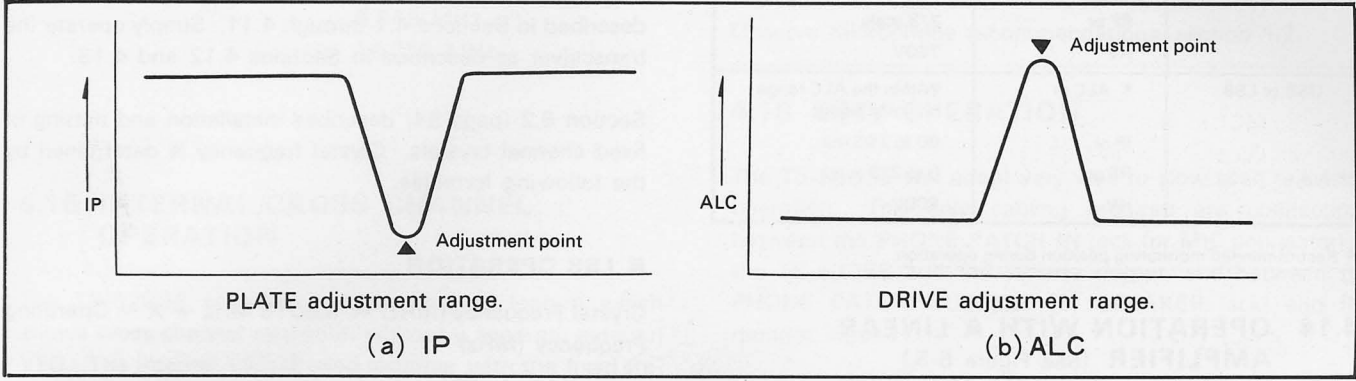
**TABLE 4-2. Initial Switch Settings for Transmission** (Controls not listed should be set as described in Table 4-1.) *page 15.*

| LOCATION    | CONTROL           | POSITION  |
|-------------|-------------------|---|
| FRONT PANEL | BAND Switch       | Desired band  |
|             | POWER Switch      | ON  |
|             | Stand-by Switch   | REC   |
|             | MODE Switch       | USB or LSB depending on selected band<br>(See Table 4-4.) |
|             | VOX Switch        | MAN   |
|             | MIC Control       | Fully counter-clockwise                                   |
|             | CAR Control       | Centered  |
|             | METER Switch      | IP  |
|             | PLATE Control     | Middle of the range for the band selected                 |
|             | DRIVE Control     | Centered  |
| REAR PANEL  | FUNCTION Switch   | VFO   |
|             | RIT Switch        | OFF   |
|             | SG Switch         | UP (ON)   |
|             | EXT VFO Connector | Jumpered plug installed                                   |

*Turn stand-by switch back to REC position before operating except when the key is plugged in for CW operation.*

**TABLE 4-3. Summary of Transmitter Tuning Procedures**

| MODE Switch | METER Switch | Stand-by Switch | Procedure  |
|-------------|--------------|-----------------|--|
| USB or LSB  | IP           | SEND            | Adjust BIAS control for 60 ma.                                       |
| TUN         | ALC          | SEND            | Peak the ALC reading with the DRIVE control.                         |
| TUN         | IP           | SEND            | Dip the plate with PLATE control.                                    |
| CW          | RF           | SEND            | Peak RF output by alternately adjusting the PLATE and LOAD controls. |



**Fig. 4-3. Plate and Drive Tuning**

**TABLE 4-4.**

|               |     |
|---------------|-----|
| 1.8 MHz Band  | CW  |
| 3.5 MHz Band  | LSB |
| 7.0 MHz Band  | LSB |
| 14.0 MHz Band | USB |
| 21.0 MHz Band | USB |
| 28.0 MHz Band | USB |

key the transmitter and speak into the microphone in a normal tone of voice. With the METER switch in the ALC position, adjust the MIC control until voice peaks are just within the top limit of the ALC range on the meter scale. If the transmitter is driven beyond this range, the transmitted signal will be distorted.

**■ PTT (Push to talk) OPERATION**

By using a microphone equipped with a PTT switch, the transceiver is ready for PTT operation to key, depress the PTT switch with the stand-by switch left in the REC position.

**■ VOX (Voice Operated Transmit) OPERATION**

Adjust the transceiver as described in the previous paragraph. Flip the VOX switch on and while speaking into the microphone, increase the VOX GAIN control (on the side panel) until the VOX relay just operates. For VOX

operation it is sometimes desirable to close-talk the microphone to prevent background noises from tripping the transmitter.

Check that the ALC reading for voice peaks is still within range on the meter. If necessary, adjust the MIC control for proper ALC reading.

If the VOX circuit is activated by speaker output, adjust the ANTI-VOX control (on the side panel) as necessary for proper VOX operation.

Do not use excessive VOX or ANTI VOX gain more than necessary to control VOX operation. If the VOX circuit transfers between words, or holds too long, adjust the release time constant by the DELAY control (on the side panel).

**4.13 CW OPERATION**

Tune and load the TS-520SE as described in Sections 4.1 through 4.11. Using shielded line, connect a key to the rear panel KEY jack, set the MODE switch to CW, and set the stand-by switch to SEND for transmitting.

CW transmission is automatically monitored through the transceiver's speaker. Audio gain of the sidetone can be adjusted by VR1 on the AF board (X50-0009-01).

For semi-break-in operation, turn only the VOX switch on. Adjust the DELAY control for desired hold.

**TABLE 4-5. Meter Switch Positions for Different Modes**

| MODE       | METER Switch                         | Approx. Readings   |
|------------|--------------------------------------|--|
| TUN        | * ALC or<br>* IP or<br>* RF or<br>HV | Peaked<br>75 ma<br>1/3 scale<br>800V   |
| CW         | ALC or<br>* IP or<br>RF or<br>HV     | None or within<br>ALC range<br>220 mA<br>2/3 scale<br>750V                       |
| USB or LSB | * ALC or<br>IP or<br>RF or<br>HV     | Within the ALC range<br>on voice peaks<br>60 to 250 ma<br>0 to 2/3 scale<br>800V |

\* Recommended monitoring position during operation.

#### 4.14 OPERATION WITH A LINEAR AMPLIFIER (See Figure 6-5.)

Tune and load the TS-520SE as described in Sections 4.1 through 4.11 and set it for the desired mode.

The REMOTE connector on the rear panel is provided for interconnection with an amplifier. Consult the amplifier instruction manual to determine whether the linear requires a normally opened or a normally closed (during receive) relay contact. Connect either pin 3 (closed to ground during receive) or pin 5 (open to ground during receive) of the REMOTE connector to the control jack on the amplifier. Connect ALC feedback from the amplifier to pin 6 of the REMOTE connector. Output of the TS-520SE is quite adequate to drive most amplifiers to full rated power.

#### 4.15 FIXED FREQUENCY OPERATION

The TS-520SE has a built-in crystal controlled oscillator for fixed frequency operation. This feature is most useful for commonly used frequencies, nets, or similar situation where crystal controlled operation is required. To use the fixed frequency oscillator crystals (optional) must first be installed. Turn the FUNCTION switch to the FIX position and select one of the four available channels with the fixed channel selector switch tune and load the TS-520SE as described in Sections 4.1 through 4.11. Simply operate the transceiver as described in Sections 4.12 and 4.13.

Section 6.2 (page 34) describes installation and netting of fixed channel crystals. Crystal frequency is determined by the following formulas.

##### ■ LSB OPERATION

$$\text{Crystal Frequency (MHz)} = 5.5015 \text{ MHz} + X - \text{Operating Frequency (MHz)}$$

##### ■ USB OPERATION

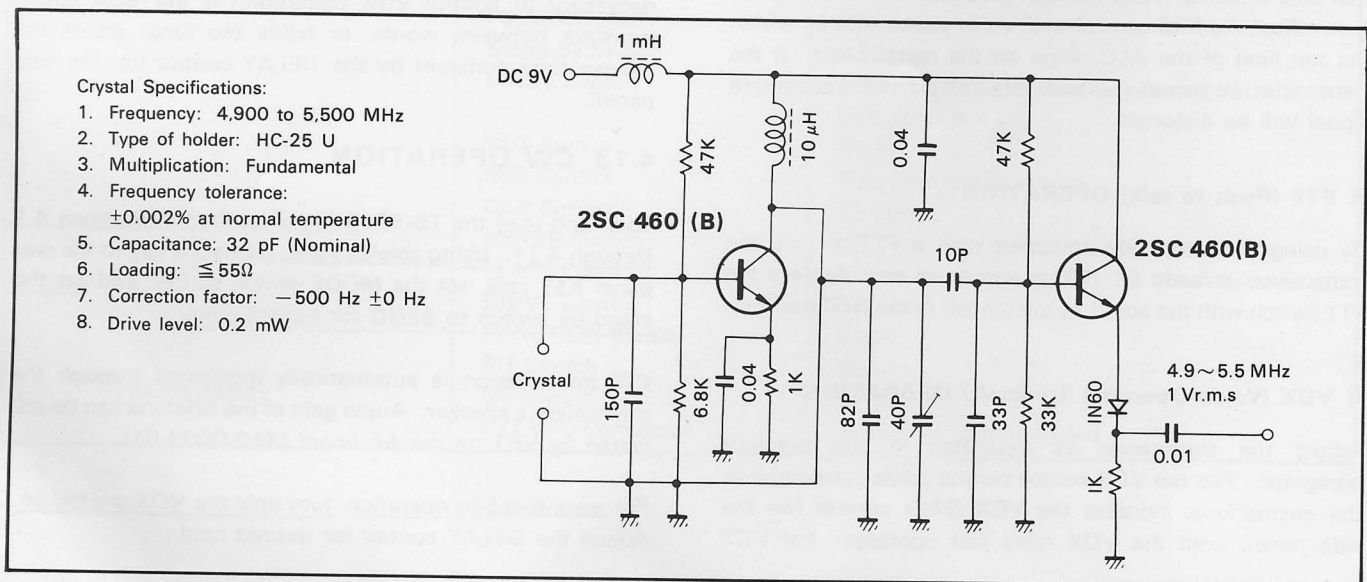
$$\text{Crystal Frequency (MHz)} = 5.4985 \text{ MHz} + X - \text{Operating Frequency (MHz)}$$

##### ■ CW OPERATION

$$\text{Crystal Frequency (MHz)} = 5.5 \text{ MHz} + X - \text{Operating Frequency (MHz)}$$

In an cases, X = The BAND switch frequency (1.8, 3.5, etc.).

Crystal Specifications: See Figure 4-4.



**Fig. 4-4. Crystal Oscillator Circuit**



Example: Desired Operating Frequency = 7.255 MHz  
 Crystal Frequency (for CW) = 5.5 MHz + 7.0 MHz -  
 7.255 MHz = 5.245 MHz

This same crystal will operate on each band.  
 Operating Frequency (CW) = 5.5 MHz + X (in MHz) -  
 Crystal Frequency (in MHz)

Example: Crystal Frequency = 5.245 MHz  
 On the 14 MHz band the crystal will oscillate at  
 Operating Frequency (CW) = 5.5 MHz + 14.0 MHz -  
 5.245 MHz  
 = 14.255 MHz

#### 4.16 INTERNAL CROSS CHANNEL OPERATION

The TS-520SE contains a unique design feature which allows cross channel operation without a separate external VFO. The internal VFO is used together with the fixed frequency oscillator to allow reception and transmission on different frequencies. (The fixed channel oscillator must have accessory crystals installed for this feature to work.) Refer to Table 4-6 for switch settings.

TABLE 4-6. Cross Channel Operation

| FUNCTION SWITCH | TRANSMIT CONTROL         | RECEIVE CONTROL          |
|-----------------|--------------------------|--------------------------|
| VFO             | VFO                      | VFO                      |
| VFO.R           | Fixed channel oscillator | VFO                      |
| FIX.R           | VFO                      | Fixed channel oscillator |
| FIX             | Fixed channel oscillator | Fixed channel oscillator |

#### 4.17 SPEECH PROCESSOR

In DX (long distance) operation, it may be desirable to increased talk-power by using the speech processor. To activate, pull the MIC gain control forward, and readjust gain for an ON-scale ALC reading on voice peaks. When operated as described, distortion will be minimal, however, tone quality will be affected, it is therefore advisable to conduct normal operation with the processor disabled.

**NOTE:** \_\_\_\_\_  
 Observe microphone recommendations, section 1.2.

#### 4.18 SSTV OPERATION

The TS-520SE will adapt very well to slow scan television operation. The only cabling required are connections between the PHONE PATCH IN jack (or MIC connector) of the TS-520SE and the camera output, and between the PHONE PATCH OUT jack (or SPEAKER jack) and the monitor input.

When transmitting, adjust camera output so that final input power is less than 100W (less than 125 mA Ip).

#### 4.19 PHONE PATCH OPERATION

The TS-520SE has rear panel jacks for phone patch connection. The PHONE PATCH OUT jack has an impedance of 8 ohms and the PHONE PATCH IN jack requires a high impedance input. Consult the instruction sheet of your phone patch for cabling requirements.

#### 4.20 CARRYING YOUR TS-520SE

When being transported, repack the unit in its original shipping container, as it was delivered upon purchase.



# SECTION 5. CIRCUIT DESCRIPTION

## 5.1 GENERAL DESCRIPTION

Figure 5-1 shows the block diagram of the TS-520SE. To better understand the transceiver's circuit, refer to the block diagram as you read this circuit description. The transceiver is totally solid state, except for the two final tubes and the driver, utilizing 19 FETs, 49 transistors, and 95 diodes.

Modular construction techniques place all circuitry on printed circuit boards. These modules greatly simplify trouble shooting and repair procedures.

Receiver circuitry is designed in a double superheterodyne configuration. The transmitter section employs a dual conversion configuration using a filter type SSB generator.

Dual gate MOS FET's are used throughout the transmit/receive amplifier, except for the three power tubes and the AF amplifier. The used of these transistors allows excellent two-signal performance as well as excellent AGC (and ALC) characteristics.

### ■ TRANSMITTER SECTION (Refer to Figure 5-1)

Audio generated at the microphone is amplified by the microphone amplifier (located on the GENERATOR board). The output from the microphone amplifier is injected, along with a 3.395 MHz carrier, into the four diodes which form the balanced modulator. The DSB output produced by the balanced modulator is fed to the first IF amplifier and then through the crystal filter (on the IF board) resulting in an SSB signal.

The 3.395 MHz SSB signal is mixed with the output of the VFO (5.5 to 4.9 MHz) by the first transmit mixer creating the second transmit IF signal (8.895 to 8.295 MHz). This signal is mixed with the output of the heterodyne crystal controlled oscillator, by the second transmit mixer, to produce the final transmitted SSB frequency.

The SSB signal is amplified by the 12BY7A driver tube to drive the two S2001A (6146B) amplifier tubes in the final stage. They operate in class AB1. The output signal is transmitted through a pi-network to the antenna. The impedance of the pi-network is 50 ohms.

### ■ RECEIVER SECTION (Refer to Figure 5-1.)

The incoming signal from the antenna is fed through the antenna coil to the RF section, where it is one-stage amplified. The amplified signal is passed to the first receiver mixer for conversion to the first IF signal (8.895 to 8.295 MHz). The first IF signal is mixed with the VFO output by the second receive mixer to generate the second IF signal.

The AGC voltage is extracted at the output of the second mixer. The signal passes to the NB board where it is amplified and passes through the blanking gate. The blanking gate is turned on, or open, when the noise blanker switch is turned to the OFF position. When the noise blanker switch is turned on, the gate opens and closes as controlled by the noise components separated from the signal by the input filter of the noise blanker circuit.

The signal then feeds through the crystal filter to be amplified by the two-stage amplifier on the IF board and detected by the detector on the GENERATOR board. Here the RF signal is transformed to AF.

The AF signal is amplified by the complimentary amplifier. The AF output impedance is 4 to 16 ohms.

## 5.2 CARRIER BOARD (X50-0009-01)

The Carrier Board produces a carrier signal during transmission and acts as the BFO for the ring detector during reception. The transistor Q1 comprises a Pierce B-E oscillator. The buffer amplifier, Q2, delivers a steady output signal. The oscillation frequency switching for a desired mode of operation is made by diode switchings, D1 through D4. Each diode forms the respective oscillator circuit when a forward voltage is applied across it to reduce its internal resistance. If the forward voltage is not applied, the diode resistance becomes so high in the resistance that it is isolated from the circuit. This disables the oscillation. The oscillation frequency is 3396.5 kHz for both USB transmit and receive modes, 3393.5 kHz for both LSB transmit and receive modes, 3394.3 kHz for CW receive mode, and 3395.0 kHz for CW transmit mode.

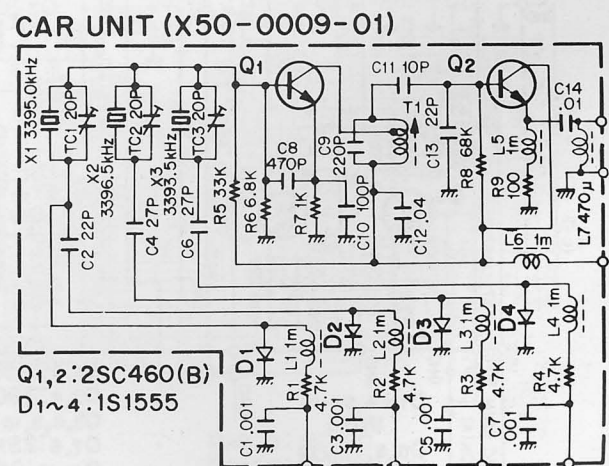


Fig. 5-2 Carrier Board



### 5.3 GENERATOR BOARD (X52-1090-00)

The Generator Board, which is a heart of this SSB transceiver, produces a DSB (double side band) signal. The operation is as follows.

The AF signal coming from the microphone is amplified through Q3, Q6, and Q5. The amplified signal is applied to the ring modulator, comprised of four diodes, which produces a carrier-suppressed DSB signal. This DSB signal is amplified through the buffer amplifier, Q1 (FET), and is delivered to the succeed IF Board. The crystal filters contained in the IF Board, then, further suppresses the carrier and undesirable side band of the DSB signal to create a complete SSB signal.

In the CW mode of operation, a DC voltage is applied at the ring modulator to unbalance it to obtain the required carrier.

The Generator Board, also, has a microphone compressor

circuit, which is activated by the PROCESSOR switch located on the front panel. The AF signal output of Q3 is further amplified through Q4, Q8, Q9, and Q10. The amplified signal is delivered to Q6 through the diode switching, which is activated by the PROCESSOR switch. Gain control is made in the manner that the output of Q10 is phase-inverted by Q11, is bridge-rectified by the four diodes, and is DC-amplified through the control amplifier, Q12, to produce a pinch-off voltage which controls the attenuator, Q7 (FET). The desired time constant is obtained at the output of Q12. The actual microphone compression is around 20 db for 10 mV microphone input. The microphone gain can be set irrespective of the PROCESSOR switch as the MIC GAIN control is placed at the input end of Q6.

In addition, the Generator Board has a transistor switching circuit which prevents the carrier from entering the receive ring detector and transmit ring modulator during transmission and reception, respectively.

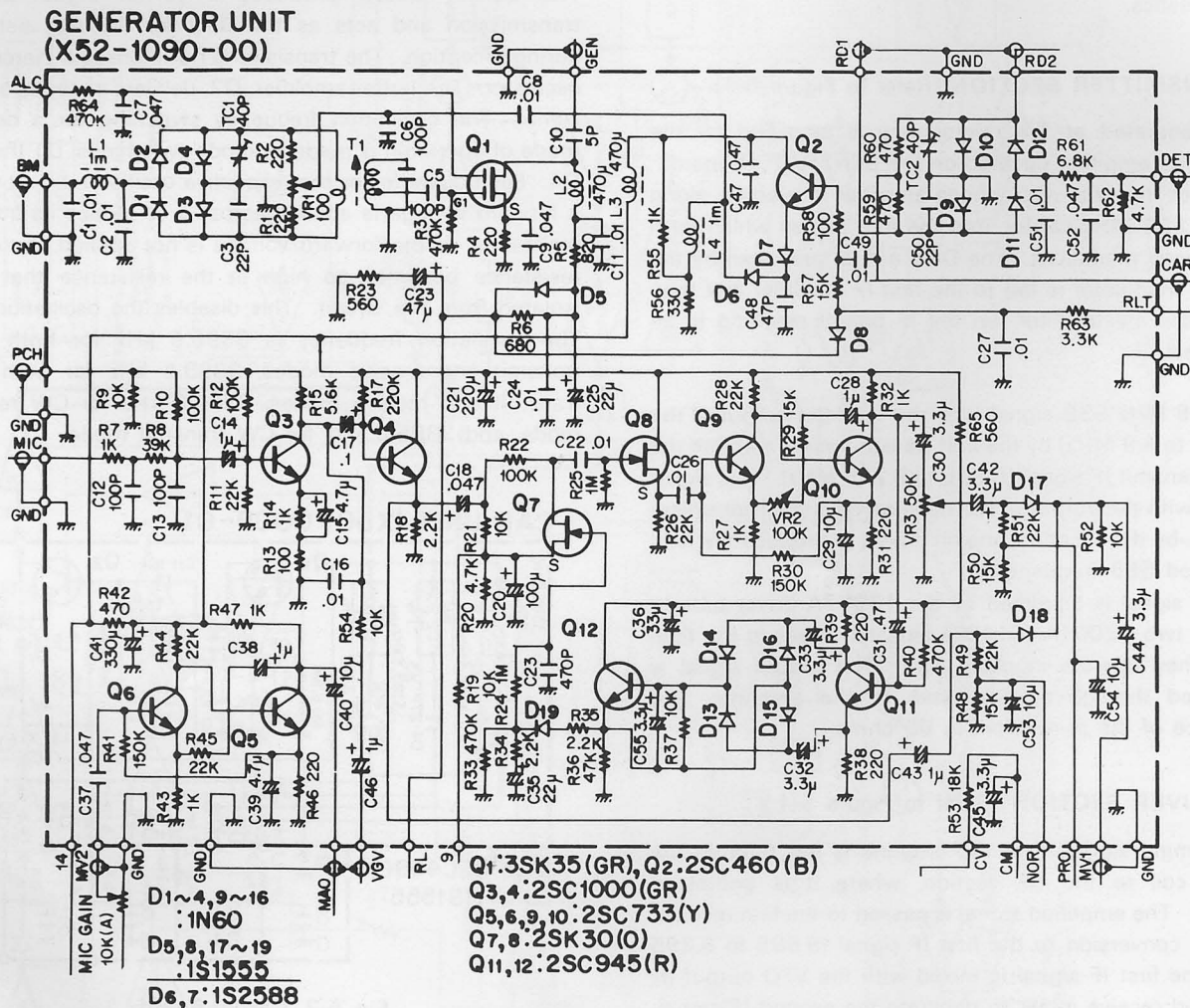


Fig. 5-3 Generator Board



## 5.4 RF BOARD (X44-1200-00)

The RF Board provides the most functions as compared with the other boards of the TS520SE. It consists mainly of a transmit system, a receive system, an ALC circuit, control circuits, and a local oscillator circuit.

### ■ TRANSMIT SYSTEM

The second IF signal from the IF Board passes through the bandpass filter and is frequency-converted to a desired RF signal in a given amateur band by the transmit second mixer, Q1. The RF signal, in turn, is amplified by the exciter, V1, to a level enough to excite the final power tube.

### NOTE:

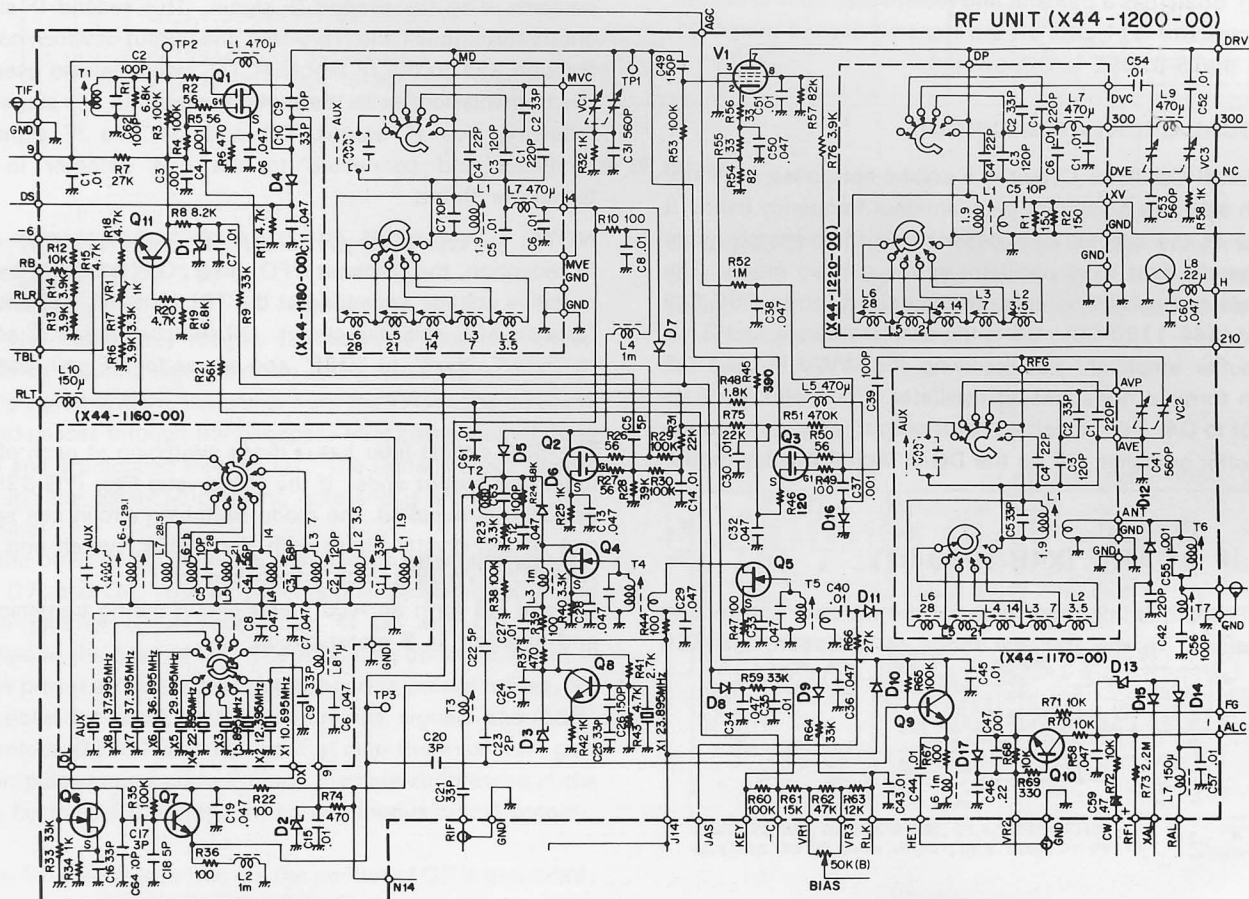
To the anode of V1 is connected the Drive Coil Board (X44-1220-00).

### ■ RECEIVE SYSTEM

An amateur band signal coming into the ANT connector enters the ANT Coil Board (X44-1170-00) through the 8 MHz IF trap coil. The signal, then, is stepped up by the frequency band coil and is applied to G2 of the receive first mixer, Q2, where it is converted to the receive first IF signal. The IF signal is fed through the bandpass filter to the IF Board.

### NOTE:

The MIX Coil Board (X44-1180-00) connected to the drain of Q3 is also used with the Transmit System.



Q1,2 : 3SK41(L) or 3SK40(L)  
 Q3 : 3SK35 (GR)  
 Q4 : 3SK22 (GR)  
 Q5,6 : 2SK19 (GR)  
 Q7,9 : 2SC460 (B)  
 Q10 : 2SC1515 (K)  
 Q11 : 2SC733 (Y)

D1~3,13 : WZ090  
 D4,11,12 : 1S2588  
 D5,6,16 : 1S1587  
 D7,10,17 : 1S1555  
 D8,9,14,15 : VOC  
 V1 : 12BY7A

Fig. 5-4 RF Board

## ■ WWV RECEIVE CIRCUIT

The TS-520SE has a converter circuit for specific use of receiving the WWV wave. The 15 MHz standard wave coming into the antenna passes through the diode switch interlocked with the BAND switch and is applied to T5 where it is stepped up. The signal, then, is RF amplified through Q5 and is frequency-converted to the receive first IF signal by Q4. The IF signal is fed to the IF Board through the same bandpass filter as in the usual RF signal reception.

## ■ ALC CIRCUIT

The ALC (Automatic Level Control) Circuit, which uses a transistor, Q10 of rather high breakdown voltage, produces the ALC voltage when a current around 30 $\mu$ A flows to the grid of the final power tube. The ALC time constant is set "slow" in the SSB mode and "fast" in the CW and PROCESSOR-ON modes.

## ■ CONTROL CIRCUITS

The RF Board has a transmit and receive bias control circuit. The transistor Q11 cuts off the transmit second mixer, Q1, when the TS-520SE is DC powered.

## ■ LOCAL OSCILLATOR CIRCUIT

The Local Oscillator Circuit is a crystal-controlled oscillator which selects a crystal for each amateur frequency band. It serves as the second local oscillator in the transmit mode and as the first local oscillator in the receive mode. The crystals and oscillation coils are contained in the OSC Coil Board (X44-1160-00). Q6 is the oscillator diode and Q7 is the buffer amplifier. For receiving the WWV is used Q8 which forms a nonadjusting oscillator circuit and feeds its output to Q4. Each local oscillator output is fed out through the buffer amplifier, Q9, to the DG-5 Digital Display (optional).

## 5.5 IF BOARD (X48-1060-01)

The IF Board is important both for the transmit and receive operations. In the transmit mode of operation, the SSB

crystal filter, XFI, suppresses the undesirable sideband and carrier of the DSB signal fed from the Generator Board to make a complete SSB signal. This SSB signal is amplified through G1 of the IF amplifier, Q1, which is also used for the reception and enters the transmit mixer, Q2. The local oscillator signal delivered from the VFO Board, on the other hand, passes through the lowpass filter around 7 MHz cut-off frequency, T10, T11, and T12, to G2 of Q2. The two signals, the SSB signal and local oscillator signal, are mixed by Q2, that is, the SSB signal is converted to the second IF signal. The second IF signal is delivered through the bandpass filter to the RF Board.

### NOTE:

In transmission, the receive IF amplifier, Q3 and Q4, and the receive VFO mixer, Q9, are cut off by the negative voltage appearing at the RB terminal.

On the other hand, in the receive mode of operation, the first IF signal delivered from the RF Board passes through the bandpass filter to the VFO mixer, Q9, which frequency-converts it to the second IF signal. This second IF signal enters through IFT the NB Board, the output of which comes through XF1 to the IF amplifier, Q1, which is also used for the transmission, as in the transmit state. In this stage and following two IF stages, Q3 and Q4, the IF signal is amplified and connected to the ring detector in the Generator Board.

### NOTE:

In reception, the transmit VFO mixer, Q2, is cut off by the negative voltage appearing at the TBL terminal. Q5 and Q6 form an AGC amplifier circuit. Q6 switches the AGC action to "slow", "fast", or "OFF" and serves for RF gain control.

The SSB crystal filter has a diode switching at each of the input and output ends. If the CW crystal filter (YG-3395C, optional) is installed, the diode switching circuit can select one of the crystal filters with the MODE switch and CW NARROW/WIDE switch interlocked to it.

Q7 and Q8 form an ALC meter circuit during transmission and function as S-meter circuit.

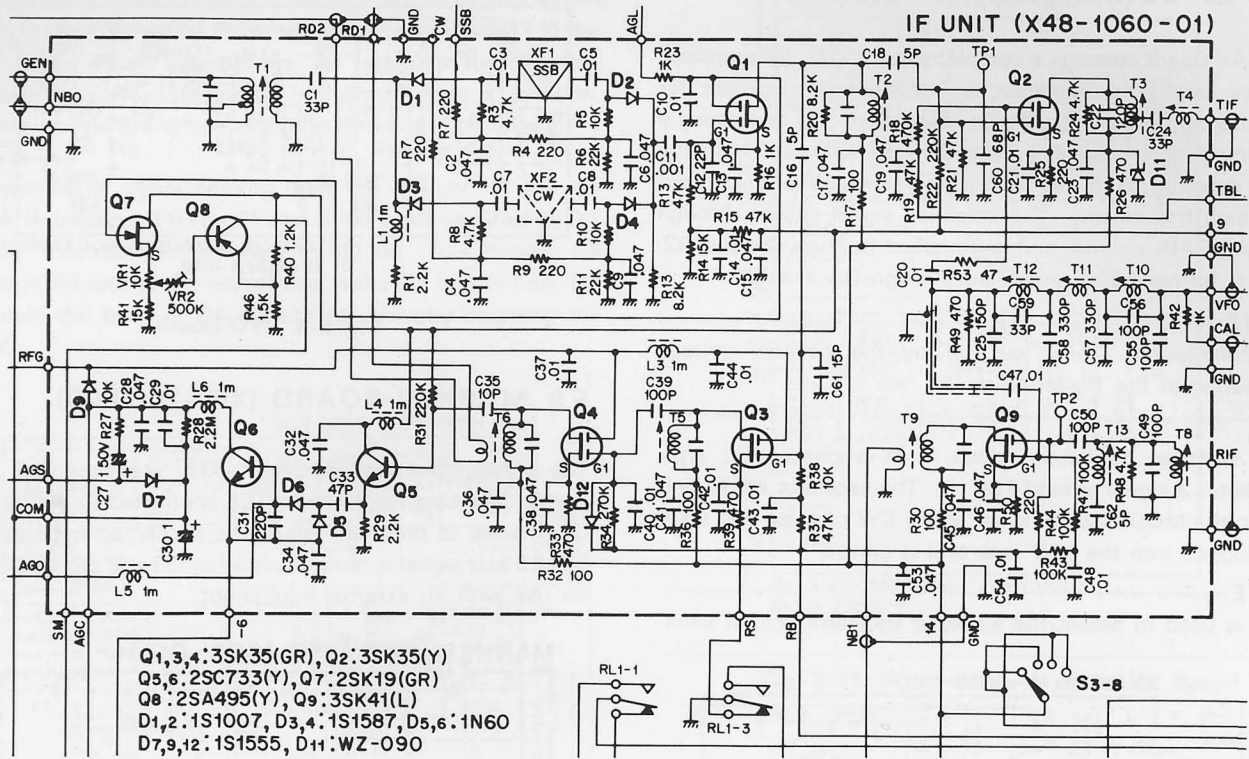


Fig. 5-5 IF Board

### 5.6 NB (NOISE BLANKER) BOARD (X54-1080-10)

The NB Board may roughly be classified into two circuit systems: a sound signal system and a noise signal system. In the signal system, the signal from the VFO mixer on the IF Board passes through the bandpass filter comprised of three IFTs and is amplified through Q1. The signal, in turn, passes through the balanced blanking gate and is led to the NBO terminal.

On the other hand, the noise signal is amplified through Q2, Q3, Q7, and Q4. The amplified signal passes through the noise rectifier circuit, comprised of D5 and D6, and is applied to the base of Q6. The AGC time constant circuit of Q6 is preset so that it may not respond to pulsed noises, but functions for short period, continuous signals like SSB. Therefore, Q3, Q7, and Q4 work at near the maximum gain when pulsed noise comes in and they are suppressed in the gain by the AGC voltage when continuous signal enters.

If the NB switch is turned on, the emitter of Q5 is grounded. When pulsed noise comes in, Q5 is turned on, which grounds its collector. The blanking gating diode connected to the collector of Q5, then, is inverse-biased for a certain period of time determined by the time constant circuit

comprised of R3 and C7. This opens the signal line, thereby eliminating the noise. The audio signal from which the pulsed noise has been removed can be produced as if a clear signal is received.

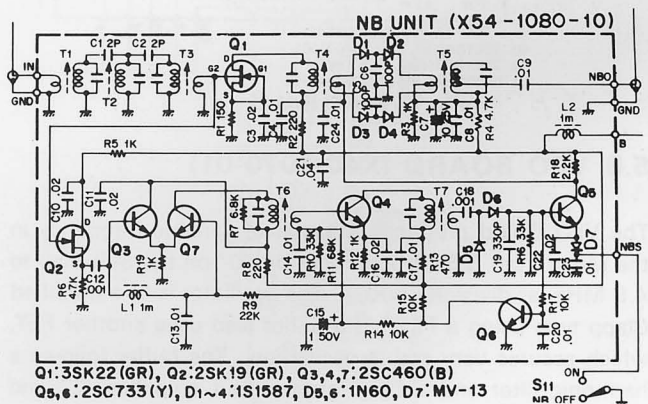


Fig. 5-6 NB Board



## 5.7 AF BOARD (X49-0008-01)

The AF Board contains a complementary, OTL AF amplifier, a CW semi-break-in circuit, a CW sidetone oscillator for monitoring, and a detector for calibration. Q5 comprises a preamplifier for amplifying audio signal delivered from the ring detector. C15 and C18 in the preamplifier circuit cut out high frequencies. The amplified signal passes through the AF GAIN control, and is amplified through Q1 and Q2, and is further power-amplified through Q3 and Q4.

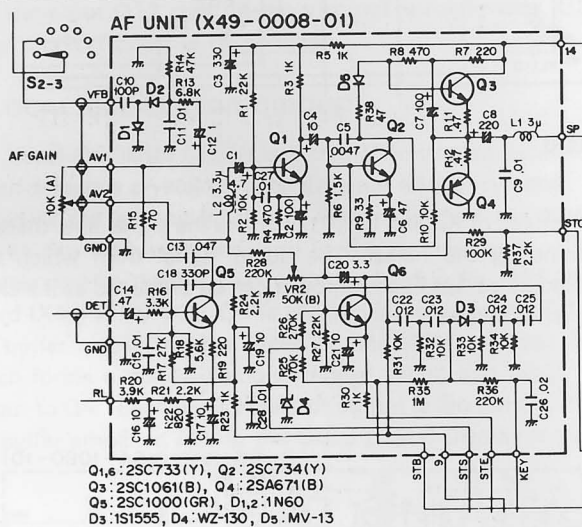
### NOTE:

In transmission, Q5 is cut off by the positive voltage appearing at the RL terminal.

The sidetone oscillator, which is of a phase-shift type, oscillates a signal around 750 Hz. The oscillator works only when the MODE switch is set to the CW position and a key is plugged into the KEY jack and is closed.

### NOTE:

VR2 is used to preset the sidetone oscillator output level.



Q1,6: 2SC733(Y), Q2: 2SC734(Y)  
Q3: 2SC1061(B), Q4: 2SA671(B)  
Q5: 2SC1000(GR), D1,2: 1N60  
D3: 1S1555, D4: WZ-130, D5: MV-13

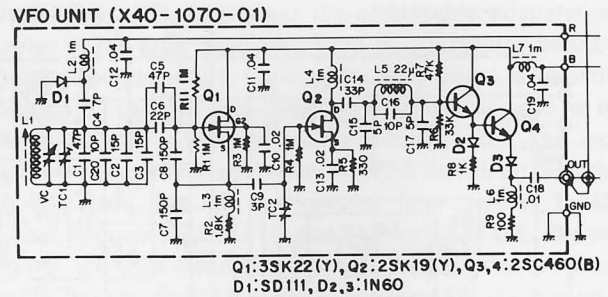
Fig. 5-7 AF Board

## 5.8 VFO BOARD (X40-1070-01)

The VFO Board produces a signal of variable frequency in the range from 5.5 MHz (at division "0" on the Sub-dial) to 4.9 MHz (at division "600"). The oscillator is of a modified Clapp type using a FET. The buffer also uses another FET, which assures very stable oscillation. The buffer follows a harmonic filter and a Darlington output amplifier, Q3 and Q4, which also assures stable operation against load change.

### CAUTION:

Do not change VFO Board mechanisms and circuits. If repairs are effected by anyone other than an authorized personnel, the performance warranty will become void.

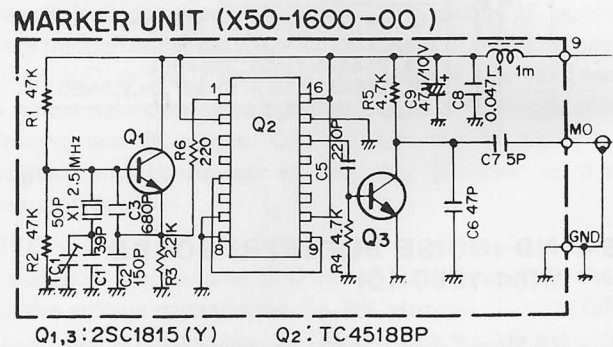


Q1: 3SK22(Y), Q2: 2SK19(Y), Q3,4: 2SC460(B)  
D1: SD111, D2,3: 1N60

Fig. 5-8 VFO Board

## 5.9 MARKER BOARD (X50-1600-00)

The crystal-controlled oscillator, Q1, produces 2.5 MHz signal. The ceramic trimmer, TC1, connected to the base of Q1 is used to precisely adjust the oscillation frequency. The 25 kHz signal is phaseinverted by Q3 and can be fed out for use with an external equipment.



Q1,3: 2SC1815(Y) Q2: TC4518BP

Fig. 5-9 Marker Board

## 5.10 VOX BOARD (X54-0001-00)

In the SSB mode of operation, the voice signal coming from the microphone amplifier (or the sidetone signal in CW) enters the MV terminal. The signal is amplified through Q3 and is rectified by D6 to a DC voltage in proportion to the input level. When the DC voltage is applied to the base of Q4, this is turned on and lowers the base potential of Q6 down.

If Q4 is cut off with no input signal, the base and emitter of Q5 are at the same potential, thus turning Q5 off. Therefore, C10 is charged through D7 by the voltage preset with the delay control. If Q4 is turned on with the voice signal coming into the MV terminal, on the other hand, it also turns on Q5, through which C10 discharges.

### NOTE:

The hold time of the VOX is when the voice signal exists at the MV terminal.



Transistors Q6 and Q7 form a Schmitt trigger circuit. When Q4 is in the "off" state, Q6 is in the "on" state and Q7 in the "off" state. When Q4 is in the "on" state, on the contrary, Q6 is in the "off" state and Q7 in the "on" state; in addition, Q8 also turns on, which activates the stand-by relay.

The anti-VOX signal coming from the AF unit to the AV terminal is stepped up by T1 and is full-wave-rectified by D1 to D4. The rectified voltage cuts Q1 off. This charges C5 through R4 and at the same time, turns Q2 on. In turn, Q2 grounds the base of Q4 to turn off, thereby stopping the VOX.

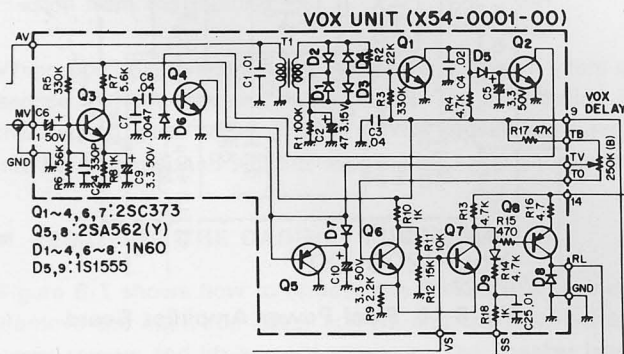


Fig. 5-10 VOX Board

### 5.11 FIXED CHANNEL-AVR BOARD (X43-1100-11)

This board consists of a fixed channel crystal-controlled oscillator, a 9V AVR (automatic voltage regulator). The crystal-controlled oscillator, comprised of Q1, is of a Pierce C-B type. Q2 and Q3 form a Darlington buffer amplifier, which feeds the oscillation signal out. TC1 through TC4 are trimmers for precisely adjusting the oscillation frequency.

The 9V AVR supplies with 9V DC the main oscillator circuits and control circuits in the TS-520SE. The transistor Q4 controls the current Q5 and Q6 magnify an error voltage. Q7 compensates the temperature characteristic of Q6. D3, a zener diode, gives a reference voltage.

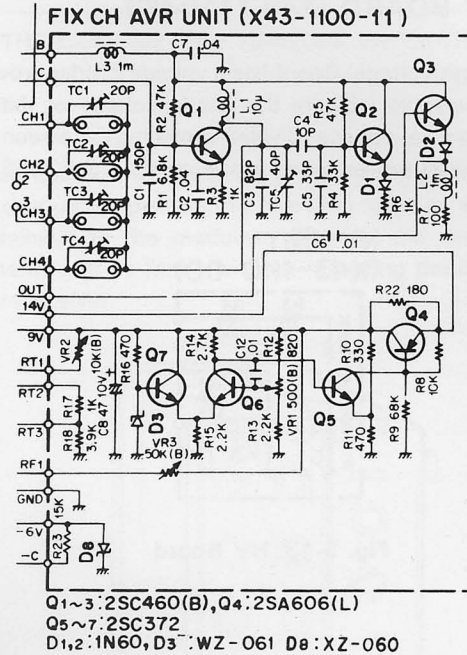


Fig. 5-11 Fixed Channel and AVR Board

### 5.12 RECTIFIER BOARD (X43-1090-02)

This board has all the rectifiers used with the TS-520SE. The 800V high voltage is obtained by a voltage doubler rectifier, the 300V, 210V, and C-voltage by a half-wave rectifier, and the 14V voltage by a bridge rectifier.

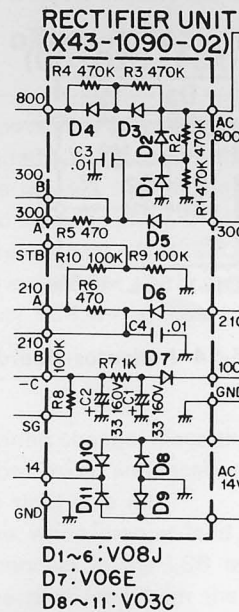


Fig. 5-12 Rectifier Board

### 5.13 HV BOARD (X43-1110-00)

The HV (High Voltage) Board has a voltage divider providing a voltage used to indicate the anode voltage of the final power tubes, a voltage divider providing a screen grid voltage of final power tubes in tuning the TS-520SE.

HV UNIT  
(X43-1110-00)

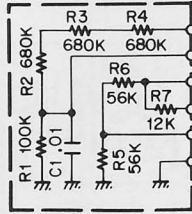


Fig. 5-13 HV Board

### 5.15 FINAL POWER AMPLIFIER BOARD (X56-1200-00)

This board contains all final power amplifier circuits except the pi output tank, which is placed at the power output end.

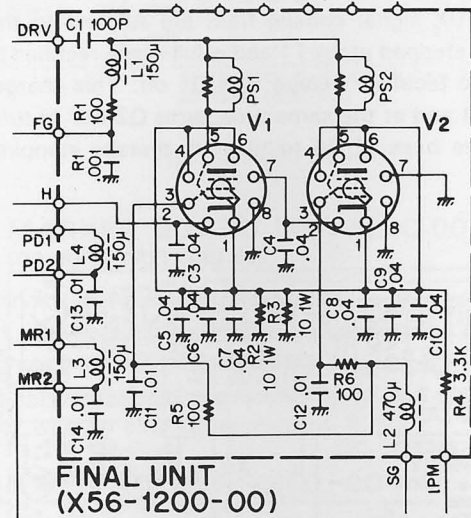


Fig. 5-15 Final Power Amplifier Board

### 5.14 INDICATOR BOARD (X54-1120-00)

This board has light-emitting diodes "VFO", "FIX", and "RIT" located above the Sub-dial scale. Each diode indicates the turn-on states of the respective functional boards.

INDICATOR UNIT  
(X54-1120-00)

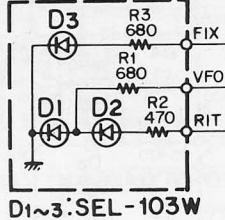


Fig. 5-14 Indicator Board

## SECTION 6. MAINTENANCE AND ALIGNMENT

### CAUTION:

DANGEROUS HIGH VOLTAGES ARE PRESENT WITHIN THE CASE OF THE TS-520SE WHEN THE TRANSCEIVER IS TURNED ON.

EXERCISE EXTREME CAUTION TO AVOID ELECTRIC SHOCK.

### 6.1 GENERAL INFORMATION

The TS-520SE has been factory aligned and tested to specifications before delivery to the customer. Under normal circumstances the transceiver will be properly adjusted to operate in accordance with these operating instructions. In fact, the equipment owner can void the transceiver's warranty by attempting service or alignment without permission from the factory.

When operated properly, the transceiver can give years of service without requiring realignment. The information in this section gives some general service procedures which can be accomplished without sophisticated test equipment.

#### ■ REMOVING THE CABINET (See Figure 6-1.)

Figure 6-1 shows how to remove the TS520SE's cabinet. Remove the eight top cover screws and the nine bottom cover screws and lift away the panels. The speaker leads will still be attached to the chassis so be careful when removing the top cover. The leads can be unplugged, if necessary.

#### ■ SERVICE POSITION (See Figure 6-2)

The TS-520SE should be placed on its side, with the final

section up, for any alignment or service. This position permits adequate ventilation for the final tubes as well as easy accessibility to the modules. Most of the described adjustments can be made without removing the boards from the transceiver.

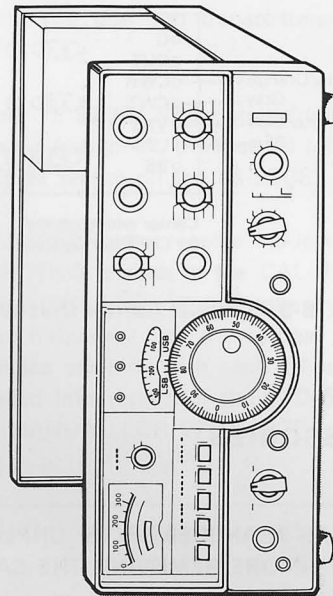


Fig. 6-2 Service Position for the TS-520SE

#### ■ CW WIRING OPTION

##### NOTE:

To eliminate the possibility of tuning the alternate sideband (700 Hz beat) during CW reception, the Carrier PCB (X50-0009-00) may be rewired to shift the CW receive position from the center, to the edge of the IF bandpass. This change is useful when the optional YG-3395C filter is not used. If the filter option is installed at a later date, this change MUST be reversed (Carrier PCB wiring must be returned to original factory configuration.)

To execute the wiring change, place the unit upside down. Remove the bottom cover, and locate the Carrier unit along the center of the right side rail.

1. Disconnect the white/orange lead from the CWR terminal, and reconnect to the LSB terminal.
2. Disconnect the gray lead from the CWT terminal, and reconnect to the CWR terminal. (CWT terminal is now empty.)

This completes the wiring change, no adjustments are necessary.

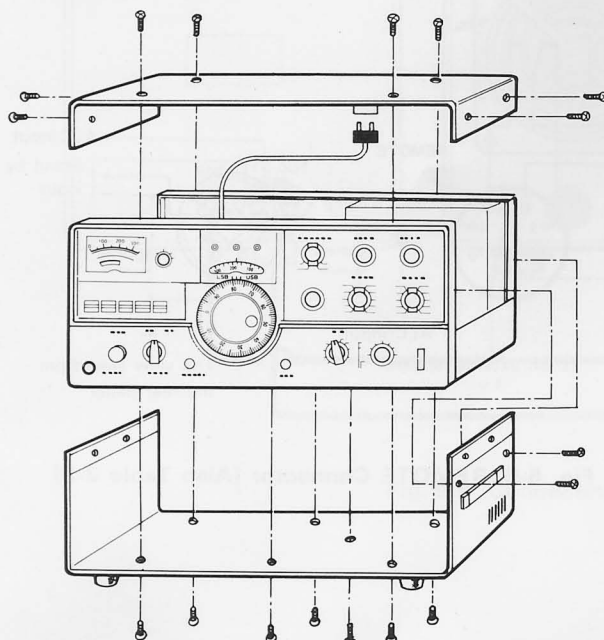
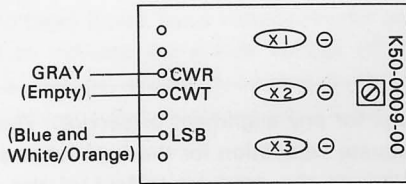
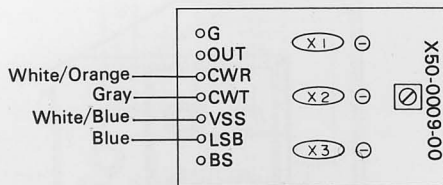


Fig. 6-1 Removing the TS-520SE's Case

CW Option Wired



Carrier P.C.B.  
Optional wiring



Carrier wiring normal  
for CW Filter Operation

Fig. 6-3 Optional Carrier Unit Wiring

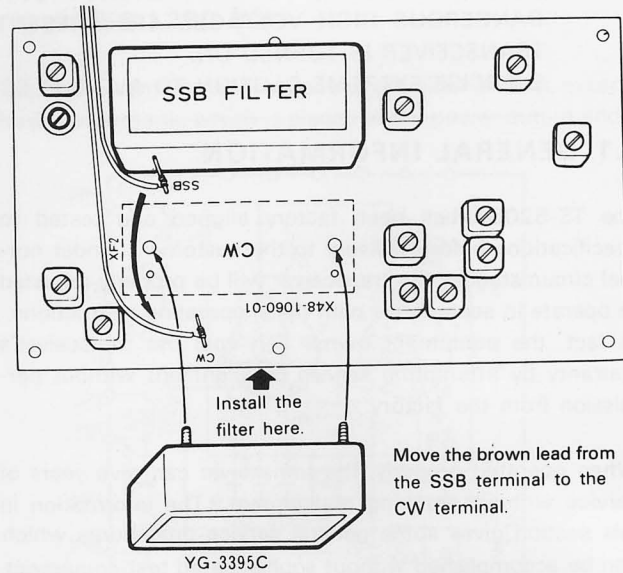


Fig. 6-4 Installing the Accessory CW Filter

## 6.2 ACCESSORIES

**CAUTION:**

BE SURE THE TRANSCEIVER IS UNPLUGGED AND TURNED OFF BEFORE REMOVING THE CASE.

■ **INSTALLING THE CW FILTER** (See Figure 6-4.)

Remove the top and bottom covers from the transceiver (be careful of the speaker leads) and place the unit on its right side. Locate the IF board (holding the SSB crystal filter) and move the brown lead from the SSB terminal to the CW terminal, as shown in Figure 6-3.

Remove the three screws securing the side control panel and tilt the panel down about 90 degrees from its normal position. Tighten the filter to the board (with the nut provided) be certain not to pinch any of the surrounding leads under the filter, solder the filter's pins to the board. Use a low power iron (45W or less.) for a short time only. Too much heat will damage the crystal filter! Check for solder bridges, and for good filter ground.

Replace the side control panel, and replace the covers. (If the speaker lead was disconnected, be sure to reconnect.)

■ **REMOTE CONNECTIONS**

Figure 6-5 shows the REMOTE connector. This 8-pin plug can be used for attaching linear amplifiers, or other external accessories to the transceiver.

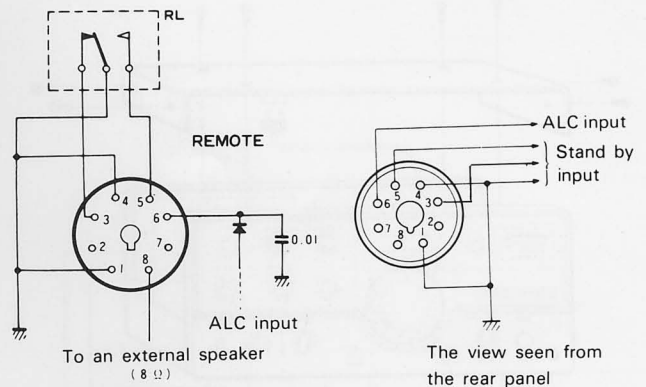


Fig. 6-5 REMOTE Connector (Also Table 3-3)



## ■ EXTENSION FEET

The TS-520SE is provided with two extra feet which can be used to raise the front panel of the transceiver. In some operating positions the tilt makes it easier to read the dial and meter. Figure 6-6 shows how to install the feet.

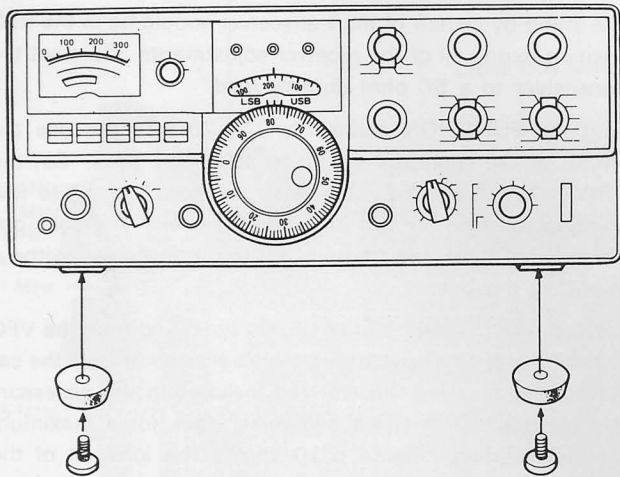


Fig. 6-6 Attaching the Extension Feet

## ■ CONNECTION OF VFO-520S

The VFO-520S is developed for further enhancing the capabilities of your TS-520SE. Figure 6-8 shows a connection of the VFO-520S to the TS-520SE. Keep the 9-pin MT plug put in the EXT VFO connector on the TS-520SE until the VFO-520S is connected to it. The VFO interconnecting cable is supplied as an accessory with the VFO-520S.

Only by controlling the FUNCTION switch on the VFO-520S you can enjoy highly advanced and comprehensive operations as if you use two transmitters and receivers each.

To calibrate your TS-520SE VFO output frequency with the VFO-520S output frequency, proceed as follows:

1. The FUNCTION switch on the TS-520SE may be at any position.
2. Set the TS-520SE in the receive mode of operation.
3. Set the FUNCTION switch to the CAL-RMT position.
4. Tune the TS-520SE VFO output frequency and the VFO-520S output frequency until a zero beat is heard when two frequencies coincide with each other.

For more detailed information of the VFO-520S, read the "OPERATING MANUAL FOR VFO-520S".

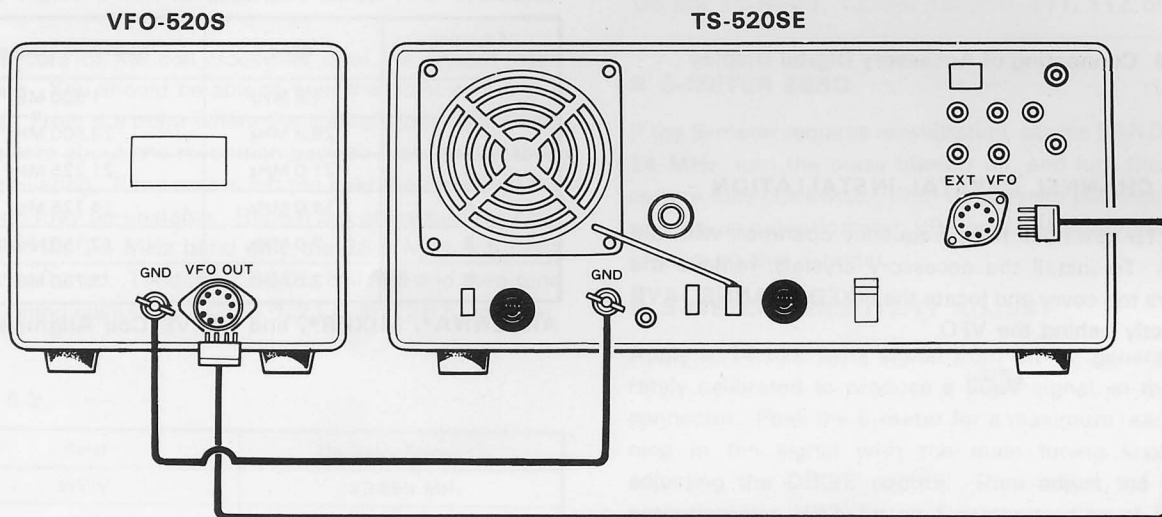


Fig. 6-8 Connecting of Accessory Remote VFO

### ■ CONNECTION OF DG-5 DIGITAL DISPLAY

Your TS-520SE can connect the DG-5 by plugging the signal cable and power cable only as illustrated in Figure 6-9. Notice that the connectors on the two units are different in the arrangement. Be careful of inserting each pin plug-equipped coaxial cable of the same color into the connector jacks of the same reference. Now, turn on the POWER switch on the TS-520SE, which will allow the DG-5 to run. The DG-5 is capable of reading the TS-520SE operating frequencies as precise as an order of 100 Hz. For more detailed information, read the "OPERATING MANUAL FOR DG-5 DIGITAL DISPLAY".

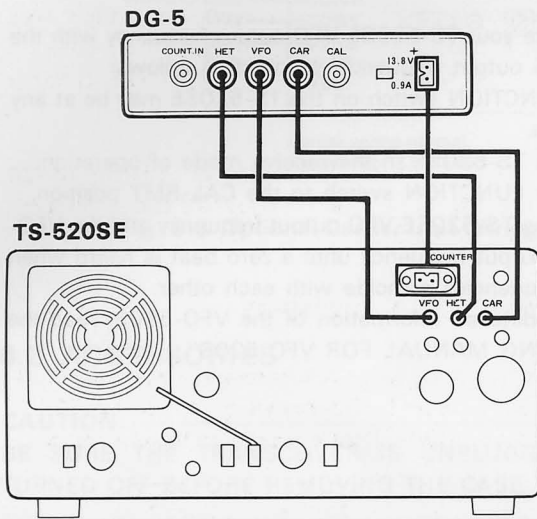


Fig. 6-9 Connecting of Accessory Digital Display

### ■ FIXED CHANNEL CRYSTAL INSTALLATION

Section 4.15 describes fixed frequency operation with the TS-520SE. To install the accessory crystals, remove the transceiver's top cover and locate the FIXED CHANNEL-AVR board directly behind the VFO.

Insert the crystal in the desired channel position (the positions are labeled on top of the VFO case) and use the appropriate trimmer (TC1 through TC4) to net the crystal. The CAL-FIX feature of the TS-520SE can be used to net the crystals as described in Section 4.4.

### 6.3 RECEIVER RF SECTION ALIGNMENT

The stand-by switch of the transceiver should be in the REC position during all of the receiver adjustments. Connect the transceiver to a 50 ohm dummy load.

Turn the FUNCTION switch to CAL-25 kHz and use the output of the calibrator circuit to adjust the coils. Set the DRIVE control to the 12 o'clock position (the white line pointing towards the top of the transceiver). The coils can be aligned from the bottom of the transceiver without removing the boards.

Set the BAND switch to the correct band and tune the VFO to the frequency shown in the table below to receive the calibrator signal. Use the test rod included in the accessory bag to tune the antenna and mixer coils for a maximum S-meter reading. Figure 6-10 shows the location of the coils. Adjust the coils for each band as described below. When you finish, turn the calibrator off. Adjust only the antenna and mixer coils for a maximum S-meter reading. Adjustment of the heterodyne oscillator coils is described in the next paragraph and adjustment of the drive coils is described in Section 6.7.

TABLE 6-1.

| Adjusting Order* | Band     | Alignment Frequency |
|------------------|----------|---------------------|
| 1                | 1.8 MHz  | 1.900 MHz           |
| 2                | 28.5 MHz | 28.800 MHz          |
| 3                | 21.0 MHz | 21.225 MHz          |
| 4                | 14.0 MHz | 14.175 MHz          |
| 5                | 7.0 MHz  | 7.150 MHz           |
| 6                | 3.5 MHz  | 3.750 MHz           |

ANTENNA\*, MIXER\*, and DRIVE Coil Alignment

**CAUTION:**

The Antenna cores are fragile. Be careful not to break them during alignment.

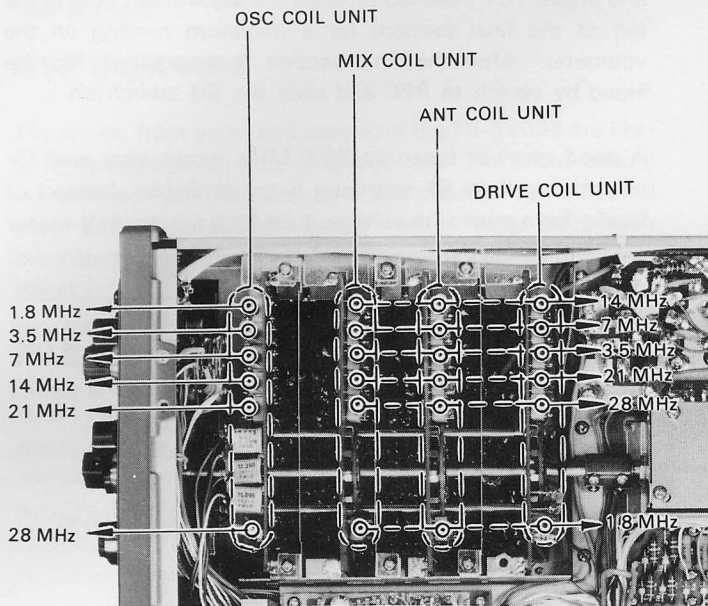


Fig. 6-10 RF Section Coil Diagram

**■ HETERODYNE CRYSTAL OSCILLATOR**

Adjust the heterodyne crystal oscillator's coils by switching the BAND switch to each band and tuning the appropriate coil (see Figure 6-10.) as described below.

Turn the core of the coil clockwise until the crystal stops oscillating. You should be able to hear the point where this happens. From the point where the crystal stops oscillating, turn the core about one revolution back so that the crystal is again oscillating. If the core is left too near the threshold the oscillation may be unstable. Repeat the procedure for each band. For the 28 MHz band only the 28.5 MHz sub-band needs to be tuned. Tune the 1.8 MHz coil first and then tune the remaining coils (3.5, 7.0, 14.0, 21.0, and 28.5) in order.

TABLE 6-2.

| Band     | Oscillator Frequency |
|----------|----------------------|
| WWV      | 23.895 MHz           |
| 1.8 MHz  | 10.695 MHz           |
| 3.5 MHz  | 12.395 MHz           |
| 7.0 MHz  | 15.895 MHz           |
| 14.0 MHz | 22.895 MHz           |
| 21.0 MHz | 29.895 MHz           |
| 28.0 MHz | 36.895 MHz           |
| 28.5 MHz | 37.395 MHz           |
| 29.1 MHz | 37.995 MHz           |

**■ WWV ALIGNMENT**

Turn the BAND switch to WWV and tune the sub-dial to zero to receive the calibrator signal. Tune T4 and T5 on the RF board for a maximum S-meter reading. T3 is the WWV oscillator coil. Tune it for a maximum S-meter reading and then turn 1/4 turn counter-clockwise. The oscillator frequency is 23.895 MHz.

**CAUTION:**

Do not attempt to tune coils T1 and T2.

**6.4 NOISE BLANKER BOARD ALIGNMENT**

Tune in a calibrator signal on any band and adjust the DRIVE control for a maximum S-meter reading. Align coils T1 through T5 (on X54-1080-10) for a maximum S-meter reading.

Attach a 10V DC meter between the collector of Q6 (2SC733) and the chassis and tune coils T6 and T7 for a minimum voltage reading on the volt meter.

**6.5 IF BOARD ALIGNMENT**

Tune in a calibrator signal on any band and adjust the DRIVE control for a maximum S-meter reading. Adjust T2, T5, T6, and T9 (on X48-1060-01) for a maximum S-meter reading.

**CAUTION:**

Do not adjust T1, T3, T4, T8, T10, T11, T12 or T13.

**■ S-METER ZERO**

If the S-meter requires recalibration, set the BAND switch to 14 MHz, turn the noise blanker off, and turn the RF GAIN control fully clockwise. With no antenna connected, set the zero adjust potentiometer, VR1 on the IF board, for a reading of zero on the S-meter.

**■ S-METER SENSITIVITY ADJUST**

Apply a 14.175 MHz signal from an RF generator, accurately calibrated to produce a 50µV signal, at the antenna connector. Peak the S-meter for a maximum reading by tuning in the signal with the main tuning knob and by adjusting the DRIVE control. Then adjust the sensitivity potentiometer, VR2, for an S-meter reading of S9.

**6.6 FIXED CHANNEL-AVR BOARD ALIGNMENT**

**■ AVR CIRCUIT**

Connect a 15V DC voltmeter between the 9 terminal (on X43-1100-11) and the chassis. Adjust VR1 for a 9 volt reading. k2ncc

## ■ RIT ZERO

When the RIT circuit is turned on, and the RIT control is set to zero, the receive frequency should be exactly the same as the transmit frequency. If the frequency is not the same, use the RIT zero control, VR2 to adjust it.

To zero the RIT, turn on the calibrator and tune the VFO for about a 1000 Hz calibrator tone. Turn the RIT control to zero. Turn on the RIT switch and adjust VR2 for the same 1000 Hz tone. Push the RIT switch on and off to be sure the tones are identical.

## ■ AGC BIAS

Connect a 5V DC voltmeter between terminal RF1 and the chassis. Adjust VR3 for a meter reading of 3.3 volts. This adjustment may affect the S-meter readings so the meter will have to be recalibrated.

## 6.7 DRIVE COIL ALIGNMENT

Slide the back panel SG switch off (down), center the DRIVE control, and turn the METER switch to ALC. Be certain to connect a 50 ohm dummy load to the antenna connector. Turn the MODE switch to TUN or CW and flip the stand-by switch to SEND. Align the DRIVE coils (on X44-1190-00 in the RF section) at the frequencies and in the sequence shown in Section 6.3. Tune the coils for a maximum ALC reading. Slide the SG switch on.

## 6.8 CARRIER BALANCE ADJUSTMENT

Turn the TS-520SE into a 50 ohm dummy load for operation at 14,175 MHz. Turn the MODE switch to LSB, set the METER switch to RF, and turn the RF VOLT control to its maximum level. If the ring modulator is out of balance, the meter will show output when the stand-by switch is set to SEND.

To balance the carrier, alternately adjust TC1 and VR2 on the GENERATOR board for a minimum RF meter reading. Switch back and forth between LSB and USB to minimize both readings.

## 6.9 TRANSMITTER NEUTRALIZATION

The TS-520SE requires neutralization every time either of the final tubes is changed.

Tune up the TS-520SE into a 50 ohm dummy load at 28.5 MHz for CW operation as described in Section 4. Set the SG switch to off (down) and place a sensitive RF voltmeter across the dummy load. Flip the stand-by switch to SEND and adjust TC1 (reached through the adjustment hole in the top of the final section) for a minimum reading on the voltmeter. After the final section is neutralized, flip the stand-by switch to REC and slide the SG switch on.

A good receiver tuned to 28.5 MHz, works very well for neutralizing if an RF voltmeter is not available. Instead of tuning for a minimum voltage, tune for a minimum S-meter reading.

### CAUTION:

Neutralization of the final section should be carried out with the chassis shield in place. Dangerous high voltages are present in the final section when the transceiver is turned on. Use an insulated tool to make this adjustment.

## 6-10. SIDE TONE LEVEL (AF-AVR UNIT)

Adjust VR1 to your desired level.

## 6.11 VFO CALIBRATION

The VFO should be calibrated with the dial scale. However if for some reason the VFO is too far off calibration for proper adjustment, there is an internal VFO adjustment.

Remove the TS-520SE's case and locate TC1 on the VFO section. Turn the FUNCTION switch to CAL-25 kHz and tune the main tuning knob so that the dial pointer points to an even 25 kHz frequency. Adjust TC1 to zero beat the calibrator frequency.

## 6.12 CRYSTAL CALIBRATOR ALIGNMENT

The crystal calibrator is factory aligned and should need no further adjustment. If it should drift out of calibration, find TC1 on the MARKER board. Tune the receiver to WWV at 15 MHz and turn on the calibrator by switching the FUNCTION switch to CAL-25 kHz. Adjust TC1 until the calibrator signal is zero beat with WWV.

## 6.13 REPLACEMENT FUSE

When the fuse blows, there is some cause. Be sure to find the cause before attempting operation. Use a 6 amp fuse



for 120 VAC operation, and a 4 amp fuse for 220 VAC or 240 VAC operation. Under no circumstances use a higher amperage fuse than those specified. Extensive damage can be caused. Also, the warranty can be voided if an improper fuse is used.

### 6.14 CLEANING

The knobs, front panel and cabinet of the TS-520SE are likely to become soiled after extended use. The knobs should be removed from the transceiver and cleaned with a neutral soap and warm water. Use a neutral soap (not harsh chemicals) and a damp cloth to clean the cabinet and front panel.

### 6.15 ORDERING SPARE PARTS

When ordering replacement or spare parts for your equipment, be sure to specify the following information: Model and serial number of the equipment. Schematic number of the part. Printed circuit board number on which

the part is located. Part number and name, if known, and Quantity desired.

### 6.16 SERVICE

Should it ever become necessary to return the equipment for repair, pack in its original boxes and packing, and include a full description of the problems involved. Also include your telephone number. You need not return accessory items unless directly related to the service problem.

Please mention the model and serial number of your radio in any correspondence, whether phone or written. For future reference, record this information in the space provided on the back cover of this manual.

**NOTE:** \_\_\_\_\_  
 When claiming warranty service, please include a photocopy of the bill of sale, or other proof of purchase showing the date of sale.  
 \_\_\_\_\_

| Problem      | Check                              | Corrective Action                  |
|--------------|------------------------------------|------------------------------------|
| Power supply | 1. Check AC line voltage           | 1. Use correct AC line voltage     |
| Power supply | 2. Check fuse                      | 2. Use correct fuse                |
| Power supply | 3. Check power transformer         | 3. Replace power transformer       |
| Power supply | 4. Check power supply filter       | 4. Replace power supply filter     |
| Power supply | 5. Check power supply capacitor    | 5. Replace power supply capacitor  |
| Power supply | 6. Check power supply diode        | 6. Replace power supply diode      |
| Power supply | 7. Check power supply PCB          | 7. Replace power supply PCB        |
| Power supply | 8. Check power supply components   | 8. Replace power supply components |
| Power supply | 9. Check power supply connections  | 9. Check power supply connections  |
| Power supply | 10. Check power supply ground      | 10. Check power supply ground      |
| Power supply | 11. Check power supply fuse        | 11. Check power supply fuse        |
| Power supply | 12. Check power supply PCB         | 12. Check power supply PCB         |
| Power supply | 13. Check power supply components  | 13. Check power supply components  |
| Power supply | 14. Check power supply connections | 14. Check power supply connections |
| Power supply | 15. Check power supply ground      | 15. Check power supply ground      |
| Power supply | 16. Check power supply fuse        | 16. Check power supply fuse        |
| Power supply | 17. Check power supply PCB         | 17. Check power supply PCB         |
| Power supply | 18. Check power supply components  | 18. Check power supply components  |
| Power supply | 19. Check power supply connections | 19. Check power supply connections |
| Power supply | 20. Check power supply ground      | 20. Check power supply ground      |
| Power supply | 21. Check power supply fuse        | 21. Check power supply fuse        |
| Power supply | 22. Check power supply PCB         | 22. Check power supply PCB         |
| Power supply | 23. Check power supply components  | 23. Check power supply components  |
| Power supply | 24. Check power supply connections | 24. Check power supply connections |
| Power supply | 25. Check power supply ground      | 25. Check power supply ground      |
| Power supply | 26. Check power supply fuse        | 26. Check power supply fuse        |
| Power supply | 27. Check power supply PCB         | 27. Check power supply PCB         |
| Power supply | 28. Check power supply components  | 28. Check power supply components  |
| Power supply | 29. Check power supply connections | 29. Check power supply connections |
| Power supply | 30. Check power supply ground      | 30. Check power supply ground      |
| Power supply | 31. Check power supply fuse        | 31. Check power supply fuse        |
| Power supply | 32. Check power supply PCB         | 32. Check power supply PCB         |
| Power supply | 33. Check power supply components  | 33. Check power supply components  |
| Power supply | 34. Check power supply connections | 34. Check power supply connections |
| Power supply | 35. Check power supply ground      | 35. Check power supply ground      |
| Power supply | 36. Check power supply fuse        | 36. Check power supply fuse        |
| Power supply | 37. Check power supply PCB         | 37. Check power supply PCB         |
| Power supply | 38. Check power supply components  | 38. Check power supply components  |
| Power supply | 39. Check power supply connections | 39. Check power supply connections |
| Power supply | 40. Check power supply ground      | 40. Check power supply ground      |
| Power supply | 41. Check power supply fuse        | 41. Check power supply fuse        |
| Power supply | 42. Check power supply PCB         | 42. Check power supply PCB         |
| Power supply | 43. Check power supply components  | 43. Check power supply components  |
| Power supply | 44. Check power supply connections | 44. Check power supply connections |
| Power supply | 45. Check power supply ground      | 45. Check power supply ground      |
| Power supply | 46. Check power supply fuse        | 46. Check power supply fuse        |
| Power supply | 47. Check power supply PCB         | 47. Check power supply PCB         |
| Power supply | 48. Check power supply components  | 48. Check power supply components  |
| Power supply | 49. Check power supply connections | 49. Check power supply connections |
| Power supply | 50. Check power supply ground      | 50. Check power supply ground      |
| Power supply | 51. Check power supply fuse        | 51. Check power supply fuse        |
| Power supply | 52. Check power supply PCB         | 52. Check power supply PCB         |
| Power supply | 53. Check power supply components  | 53. Check power supply components  |
| Power supply | 54. Check power supply connections | 54. Check power supply connections |
| Power supply | 55. Check power supply ground      | 55. Check power supply ground      |
| Power supply | 56. Check power supply fuse        | 56. Check power supply fuse        |
| Power supply | 57. Check power supply PCB         | 57. Check power supply PCB         |
| Power supply | 58. Check power supply components  | 58. Check power supply components  |
| Power supply | 59. Check power supply connections | 59. Check power supply connections |
| Power supply | 60. Check power supply ground      | 60. Check power supply ground      |
| Power supply | 61. Check power supply fuse        | 61. Check power supply fuse        |
| Power supply | 62. Check power supply PCB         | 62. Check power supply PCB         |
| Power supply | 63. Check power supply components  | 63. Check power supply components  |
| Power supply | 64. Check power supply connections | 64. Check power supply connections |
| Power supply | 65. Check power supply ground      | 65. Check power supply ground      |
| Power supply | 66. Check power supply fuse        | 66. Check power supply fuse        |
| Power supply | 67. Check power supply PCB         | 67. Check power supply PCB         |
| Power supply | 68. Check power supply components  | 68. Check power supply components  |
| Power supply | 69. Check power supply connections | 69. Check power supply connections |
| Power supply | 70. Check power supply ground      | 70. Check power supply ground      |
| Power supply | 71. Check power supply fuse        | 71. Check power supply fuse        |
| Power supply | 72. Check power supply PCB         | 72. Check power supply PCB         |
| Power supply | 73. Check power supply components  | 73. Check power supply components  |
| Power supply | 74. Check power supply connections | 74. Check power supply connections |
| Power supply | 75. Check power supply ground      | 75. Check power supply ground      |
| Power supply | 76. Check power supply fuse        | 76. Check power supply fuse        |
| Power supply | 77. Check power supply PCB         | 77. Check power supply PCB         |
| Power supply | 78. Check power supply components  | 78. Check power supply components  |
| Power supply | 79. Check power supply connections | 79. Check power supply connections |
| Power supply | 80. Check power supply ground      | 80. Check power supply ground      |
| Power supply | 81. Check power supply fuse        | 81. Check power supply fuse        |
| Power supply | 82. Check power supply PCB         | 82. Check power supply PCB         |
| Power supply | 83. Check power supply components  | 83. Check power supply components  |
| Power supply | 84. Check power supply connections | 84. Check power supply connections |
| Power supply | 85. Check power supply ground      | 85. Check power supply ground      |
| Power supply | 86. Check power supply fuse        | 86. Check power supply fuse        |
| Power supply | 87. Check power supply PCB         | 87. Check power supply PCB         |
| Power supply | 88. Check power supply components  | 88. Check power supply components  |
| Power supply | 89. Check power supply connections | 89. Check power supply connections |
| Power supply | 90. Check power supply ground      | 90. Check power supply ground      |
| Power supply | 91. Check power supply fuse        | 91. Check power supply fuse        |
| Power supply | 92. Check power supply PCB         | 92. Check power supply PCB         |
| Power supply | 93. Check power supply components  | 93. Check power supply components  |
| Power supply | 94. Check power supply connections | 94. Check power supply connections |
| Power supply | 95. Check power supply ground      | 95. Check power supply ground      |
| Power supply | 96. Check power supply fuse        | 96. Check power supply fuse        |
| Power supply | 97. Check power supply PCB         | 97. Check power supply PCB         |
| Power supply | 98. Check power supply components  | 98. Check power supply components  |
| Power supply | 99. Check power supply connections | 99. Check power supply connections |
| Power supply | 100. Check power supply ground     | 100. Check power supply ground     |

# SECTION 7. TROUBLESHOOTING

## 7.1 GENERAL INFORMATION

The problems described in this table are failures caused in

general by improper operation or connection of the transceiver, not by defective components. There is a separate service manual for repair of the TS-520SE.

## 7.2 TRANSMITTER AND RECEIVER CIRCUITS

| SYMPTOMS   | CAUSE   | REMEDY   |
|--|---|--|
| Pilot lights do not light and there is no receiver noise when the POWER switch is turned on. | <ol style="list-style-type: none"> <li>1. Bad power cable or connections.</li> <li>2. Blown power supply fuse.</li> <li>3. Wrong polarity connection for DC operation.</li> </ol>                               | <ol style="list-style-type: none"> <li>1. Check cables and connections.</li> <li>2. Replace the fuse.</li> <li>3. Check for a negative ground power connection.</li> </ol> |
| Frequency difference between transmit and receive.<br><br>FMing on sideband operation.       | <ol style="list-style-type: none"> <li>1. 9V DC supply not adjusted.</li> <li>2. Short circuit in 9 volt power supply or line.</li> <li>3. Improper battery voltage in mobile or portable operation.</li> </ol> | <ol style="list-style-type: none"> <li>1. See Section 6.6. (page 35)</li> <li>2. Check the 9 volt supply.</li> <li>3. Check battery or alternator voltage.</li> </ol>      |
| VFO (or FIX) indicator does not light.   | <ol style="list-style-type: none"> <li>1. Rear panel VFO plug not inserted.</li> </ol>  | <ol style="list-style-type: none"> <li>1. Insert the jumpered plug.</li> </ol>   |
| The relays operate with the stand-by switch in the REC position.                             | <ol style="list-style-type: none"> <li>1. Improper microphone connection.</li> </ol>  | <ol style="list-style-type: none"> <li>1. Require the microphone connector.</li> </ol>   |
| Signal reports of off frequency operation even though the dial scale is calibrated.          | <ol style="list-style-type: none"> <li>1. Calibrator requires alignment.</li> </ol>   | <ol style="list-style-type: none"> <li>1. See Section 6.11. (page 36)</li> </ol>   |

## 7.3 RECEIVER SECTION

| SYMPTOMS  | CAUSE   | REMEDY  |
|---|---|---|
| Accessory CW filter is installed but selectivity and intelligibility are poor.                              | <ol style="list-style-type: none"> <li>1. Wire on IF board not moved to CW.</li> <li>2. Bad CW filter.</li> </ol>   | <ol style="list-style-type: none"> <li>1. See Section 6.2. (page 32)</li> <li>2. Replace the CW filter.</li> </ol>  |
| An antenna is connected but no signals are heard.   | <ol style="list-style-type: none"> <li>1. Inoperative VFO or FC oscillator.</li> <li>2. Microphone PTT switch (or stand-by switch) is in the transmit position.</li> </ol>                    | <ol style="list-style-type: none"> <li>1. Insert the shunt plug into back panel.</li> <li>2. Release the PTT switch.</li> </ol>   |
| An antenna is connected and the calibrator signal is received, but no signals are heard.                    | <ol style="list-style-type: none"> <li>1. Bad T/R relay.</li> </ol>   | <ol style="list-style-type: none"> <li>1. Replace the relay.</li> </ol>   |
| One or more bands are operating but some are not.   | <ol style="list-style-type: none"> <li>1. The heterodyne oscillator is not operating on the defective band.</li> <li>2. The antenna coil of the defective band requires alignment.</li> </ol> | <ol style="list-style-type: none"> <li>1. See Section 6.3. (page 34)</li> <li>2. See Section 6.3. (page 34)</li> </ol>  |
| S-meter deflects without a received signal.   | <ol style="list-style-type: none"> <li>1. Balanced detector is out of adjustment.</li> <li>2. IF board is out of adjustment.</li> <li>3. Low AC line voltage.</li> </ol>                      | <ol style="list-style-type: none"> <li>1. See Section 6.8. (page 36)</li> <li>2. See Section 6.5. (page 35)</li> <li>3. Use a step-up transformer to raise the line voltage.</li> </ol> |
| S-meter reads too high or too low.  | <ol style="list-style-type: none"> <li>1. IF board is out of adjustment.</li> <li>2. RF gain control closed causing low sensitivity.</li> </ol>   | <ol style="list-style-type: none"> <li>1. See Section 6.5. (page 35)</li> <li>2. Open RF GAIN control.</li> </ol>   |
| Lack of sensitivity on one or more bands.   | <ol style="list-style-type: none"> <li>1. Receiver section requires realignment.</li> </ol>   | <ol style="list-style-type: none"> <li>1. See Section 6.3. (page 34)</li> </ol>   |
| The RIT control is at zero with the RIT circuit on, but the receive and transmit frequencies are different. | <ol style="list-style-type: none"> <li>1. The RIT control is out of adjustment.</li> </ol>  | <ol style="list-style-type: none"> <li>1. See Section 6.6. (page 35)</li> </ol>   |
| RIT control inoperative.  | <ol style="list-style-type: none"> <li>1. RIT circuit off.</li> </ol>   | <ol style="list-style-type: none"> <li>1. Push RIT button.</li> </ol>   |
| SSB signal unintelligible.  | <ol style="list-style-type: none"> <li>1. MODE switch is set to wrong sideband.</li> </ol>  | <ol style="list-style-type: none"> <li>1. Turn MODE switch to correct sideband.</li> </ol>  |

## 7.4 TRANSMITTER SECTION

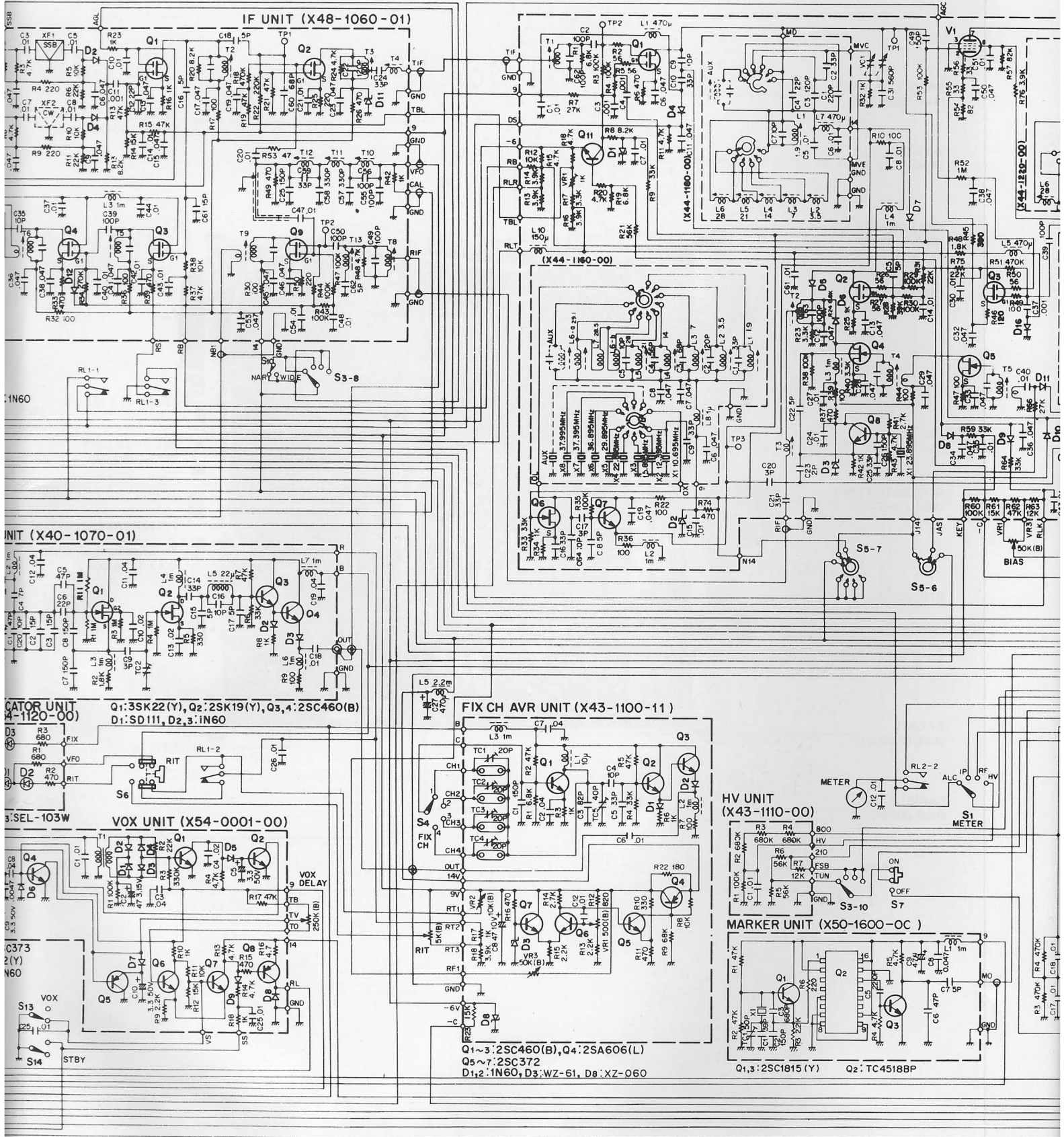
| SYMPTOMS   | CAUSE   | REMEDY   |
|--|---|--|
| ALC meter deflects with no output (no plate current).  | <ol style="list-style-type: none"> <li>1. No high voltage (+800V) on the final tubes.</li> <li>2. Bad final tubes.</li> <li>3. SG switch is turned off.</li> </ol>                                      | <ol style="list-style-type: none"> <li>1. Check the HV power supply.</li> <li>2. Replace the tubes.</li> <li>3. Slide the switch up.</li> </ol>                    |
| ALC meter does not deflect and there is output.  | <ol style="list-style-type: none"> <li>1. Too little MIC gain.</li> </ol>   | <ol style="list-style-type: none"> <li>1. Increase the MIC GAIN control.</li> </ol>  |
| The TS-520SE will not operate on SSB.  | <ol style="list-style-type: none"> <li>1. Open microphone plug or bad microphone.</li> <li>2. Too little microphone gain.</li> <li>3. Defective microphone amplifier on the GENERATOR board.</li> </ol> | <ol style="list-style-type: none"> <li>1. Check the microphone.</li> <li>2. Increase the MIC control.</li> <li>3. Repair the circuit.</li> </ol>                   |
| There is output, but the RF meter shows no output.   | <ol style="list-style-type: none"> <li>1. RF VOLT control not adjusted correctly</li> </ol>   | <ol style="list-style-type: none"> <li>1. Adjust control for 2/3 scale reading at full output.</li> </ol>  |
| RF meter deflects too far.   | <ol style="list-style-type: none"> <li>1. RF VOLT control not adjusted correctly.</li> </ol>  | <ol style="list-style-type: none"> <li>1. Adjust control for 2/3 scale reading at full output.</li> </ol>  |
| VOX does not operate.  | <ol style="list-style-type: none"> <li>1. VOX GAIN control is closed.</li> <li>2. VOX switch is OFF.</li> </ol>   | <ol style="list-style-type: none"> <li>1. See Section 4.12. (page 18)</li> <li>2. Turn the switch on.</li> </ol>   |
| VOX trips with AF sound from the speaker.  | <ol style="list-style-type: none"> <li>1. ANTI VOX control requires adjustment.</li> </ol>  | <ol style="list-style-type: none"> <li>1. See Section 4.12. (page 18)</li> </ol>   |
| VOX circuit releases between words or holds too long.  | <ol style="list-style-type: none"> <li>1. VOX time hold control requires adjustment.</li> </ol>   | <ol style="list-style-type: none"> <li>1. See Section 4.12. (page 18)</li> </ol>   |
| Excessive plate current.   | <ol style="list-style-type: none"> <li>1. Detuned final section.</li> <li>2. Low negative power supply voltage.</li> <li>3. Idling current requires adjustment.</li> </ol>                              | <ol style="list-style-type: none"> <li>1. See Section 6.9. (page 36)</li> <li>2. Check the power supply output.</li> <li>3. See Section 4.11. (page 17)</li> </ol> |
| Plate current is too high or too low for CW.   | <ol style="list-style-type: none"> <li>1. Carrier requires adjustment.</li> </ol>   | <ol style="list-style-type: none"> <li>1. Adjust CAR control.</li> </ol>   |
| Low drive on one or more bands but not on all bands.<br>Broad DRIVE tuning on one or more bands. | <ol style="list-style-type: none"> <li>1. Transmitter section requires alignment.</li> </ol>  | <ol style="list-style-type: none"> <li>1. See Section 6.7. (page 36)</li> </ol>  |
| No drive or intermittent drive on one or more bands.   | <ol style="list-style-type: none"> <li>1. Heterodyne oscillator requires adjustment.</li> </ol>   | <ol style="list-style-type: none"> <li>1. See Section 6.3. (page 34)</li> </ol>  |
| Low drive and broad DRIVE tuning on all bands.   | <ol style="list-style-type: none"> <li>1. Bad driver tube.</li> </ol>   | <ol style="list-style-type: none"> <li>1. Replace the tube.</li> </ol>   |
| Signal reports of carrier.   | <ol style="list-style-type: none"> <li>1. Carrier requires balancing.</li> </ol>  | <ol style="list-style-type: none"> <li>1. See Section 6.8. (page 36)</li> </ol>  |
| Signal reports of distortion.  | <ol style="list-style-type: none"> <li>1. Too much microphone gain.</li> </ol>  | <ol style="list-style-type: none"> <li>1. Reduce MIC control.</li> </ol>   |
| Plate current is too low.<br>Tuning becomes very broad.<br>Idling current increases.             | <ol style="list-style-type: none"> <li>1. Bad final tubes.</li> </ol>   | <ol style="list-style-type: none"> <li>1. Replace the tubes.</li> </ol>  |
| Every time either of the final tubes is replaced, the TS-520SE requires neutralization.          |   | <ol style="list-style-type: none"> <li>1. See Section 6.9. (page 36)</li> </ol>  |







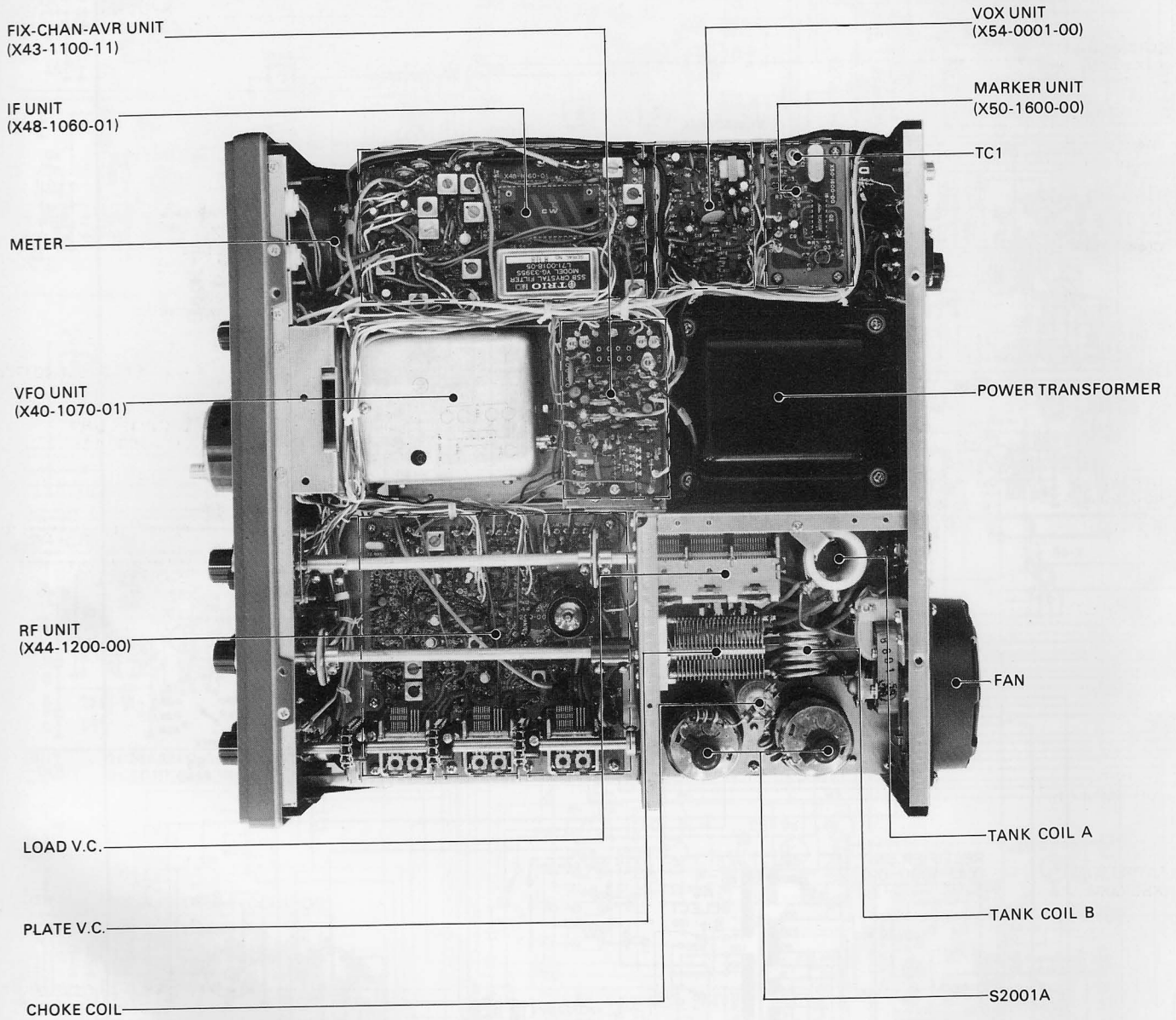
# TS-520SE SCHEMATIC (FIGURE 8-1)







# TOP VIEW OF THE TS-520SE (FIGURE 8-2)





# BOTTOM VIEW OF THE TS-520SE (FIGURE 8-3)

DRIVE COIL UNIT  
(X44-1220-00)

ANT COIL UNIT  
(X44-1170-00)

MIX COIL UNIT  
(X44-1180-00)

OSC COIL UNIT  
(X44-1160-00)

GENERATOR UNIT  
(X52-1090-00)

C19, 20

VR1  
SIDE TONE LEVEL

AF UNIT  
(X49-0008-01)

CARRIER UNIT  
(X50-0009-01)

FINAL UNIT  
(X56-1200-00)

FAN

RELAY RL2 (S51-4017-15)

RECTIFIER UNIT  
(X43-1090-02)

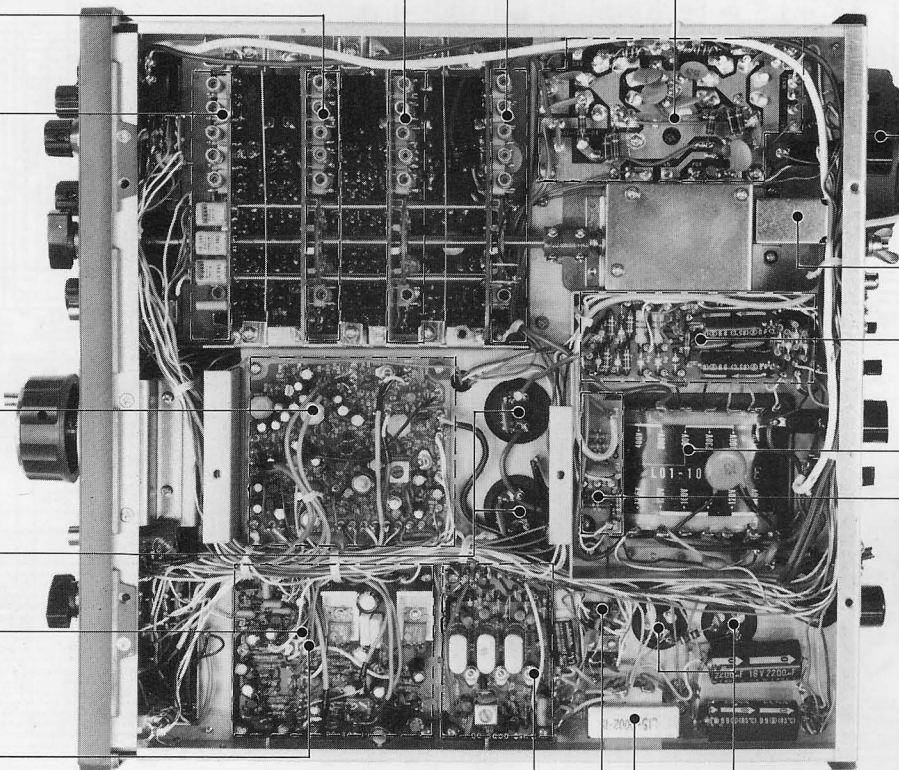
POWER TRANSFORMER

HV (High Voltage) UNIT  
(X43-1110-00)

C15, 16

CHOKE COIL

RELAY RL1 (S51-4016-15)



Model TS-520SE

Serial No. 0100270

Date of Sales 8/12/80

Dealer MODRY ELECTRONICS

BOX 506

DEWITT,

ARKANSAS 72042

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