

 **KENWOOD**

**SSB TRANSCEIVER**

**Model TS-520**



**OPERATING MANUAL**

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# TS-520 OPERATING MANUAL



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# TS-520 SPECIFICATIONS

<b>FREQUENCY RANGE</b>	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 — 10.0 MHz (receive only)
<b>MODE</b>	USB, LSB, or CW
<b>*POWER REQUIREMENTS</b>	120/220 VAC, 50/60 Hz or 13.8 VDC Receive: 45 watts (5 A) (heaters on) 26 watts (0.6 A) (heaters off) Transmit: 280 watts (15 A) (maximum)
<b>*PLATE POWER INPUT</b>	200 (120) watts PEP for SSB operation 160 (90) watts DC for CW operation * Figures in ( ) show 138 V DC operation
<b>AUDIO INPUT IMPEDANCE</b>	50 k ohms (high impedance)
<b>AUDIO OUTPUT IMPEDANCE</b>	4 to 16 ohms (speaker or headphones)
<b>AUDIO OUTPUT</b>	More than 1 watt (with less than 10% distortion) into an 8 ohm load
<b>RF OUTPUT IMPEDANCE</b>	50 ~ 75 ohms
<b>FREQUENCY STABILITY</b>	Within 100 Hz during any 30 minute period after warmup Within $\pm 2$ kHz during the first hour after 1 minute of warmup
<b>AUDIO FREQUENCY RESPONSE</b>	400 to 2600 Hz, within -6 db
<b>CARRIER SUPPRESSION</b>	Carrier better than 40 db down from the output signal
<b>SIDEBAND SUPPRESSION</b>	Unwanted sideband is better than 40 db down from the output signal
<b>IMAGE RATIO</b>	Image frequency better than 50 db down from the output signal
<b>HARMONIC RADIATION</b>	Better than 40 db down from output signal
<b>IF REJECTION</b>	IF frequency is 50 db or more down from output signal
<b>RECEIVER SENSITIVITY</b>	0.25 $\mu$ V S+N/N 10 db or more
<b>RECEIVER SELECTIVITY</b>	SSB — 2.4 kHz bandwidth (-6 db down) — 4.4 kHz bandwidth (-60 db down) CW* — 0.5 kHz bandwidth (-6 db down) — 1.5 kHz bandwidth (-60 db down) *(with optional CW filter installed)

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**TUBE AND SEMICONDUCTOR  
COMPLEMENT**

3 Tubes  
17 FET's  
47 Transistors  
84 Diodes

**DIMENSIONS**

13.2" wide x 5.9" high x 13.2" deep

**WEIGHT**

37.4 lbs.

# SECTION 1. INTRODUCTION

## 1.1 KENWOOD TS-520

The TS-520 is a highly sophisticated solid state amateur radio transceiver employing only three vacuum tubes. Operating on all amateur bands between 3.5 and 29.7 MHz, this unit is constructed modularly. All major electronic circuits are wired on easily removed or installed circuit boards. The TS-520 includes many built-in features usually found as extras on other transceivers. Included in the equipment are a VOX circuit, a 25 kHz crystal calibrator, an RIT circuit, and an effective noise blanker. The TS-520 also includes automatic gain control (AGC), automatic level control (ALC), provisions for break-in CW with sidetone, a speech processor, and built-in power supplies.

Designed for operation on SSB or CW, the TS-520 delivers more than 200 watts PEP input. The low power consumption of the TS-520, resulting from its solid state design, makes the transceiver ideal for portable and mobile operation. Any complicated electronic equipment will be damaged if operated incorrectly, and this transceiver is no exception. Please read all of the operating instructions before putting the TS-520 on the air.

## 1.2 REQUIREMENTS FOR OPERATION

### AC OPERATION

The TS-520 requires no external power supply for operation. For fixed station operation, the TS-520 operates from any 120/220 VAC, 50/60 Hz power source capable of supplying 280 watts or more. The transceiver has a built-in 8 ohm speaker.

### DC OPERATION

The TS-520 is built-in a DC-DC converter for operation from a 13.8V DC power source.

### ANTENNA

Fixed Station — Any of the common antenna systems designed for use on the high frequency amateur bands may be used with the TS-520, 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 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.

Mobile Station — Mobile antenna installations are critical, since any mobile antenna for use on the high frequency bands represents a number of compromises. Many amateurs lose the efficiency of their antenna through improper tuning. Remember the following points when using the TS-520 with a mobile antenna.

The "Q" of the antenna loading coil should be as high as possible. There are several commercial models available which use high "Q" coils.

The loading coil must be capable of handling the power of the transceiver without overheating. In the CW mode the power output of the transceiver will exceed 80 watts.

The SWR bridge is a useful instrument, but unfortunately it is quite often misunderstood, and overrated in importance. Basically, the SWR bridge will indicate how closely the antenna load impedance matches the transmission line. With long transmission lines, such as will be used in many fixed station installations, it is desirable to keep the impedance match fairly close in order to limit power loss. This is particularly true at the higher frequencies. The longer the line, and the higher the frequency, the more important SWR becomes. However, in mobile installations the transmission line seldom exceeds 20 feet in length, and an SWR of even 4 to 1 adds very little to power loss. The only time SWR will indicate a low figure is when the antenna presents a load close the 50 ohms, but many mobile antennas will have a base impedance as low as 15 or 20 ohms at their resonant frequency. In such a case, SWR will indicate 3 or 4 to 1, and yet the system will be radiating efficiently.

The really important factor in your mobile antenna is that it should be carefully tuned to resonance at the desired frequency. The fallacy in using an SWR bridge lies in the fact that it is sometimes possible to reduce the SWR reading by detuning the antenna. Field strength may actually be reduced in an effort to bring SWR down. Since field strength is the primary goal, we recommend a field strength meter for antenna tuning.

For antenna adjustments, the transceiver may be loaded lightly, using the TUN position instead of operating at full power output. This will limit tube dissipation during adjustments, and will also help to reduce interference on the frequency. In any case, do not leave the transmitter on for very long at one time. Turn it on just long enough to tune and load, and get a field strength reading. Start out with the antenna whip at about the center of its adjustment range. Set the VFO to the desired operating frequency and then adjust the PLATE control for a dip, and then the LOAD control. Then observe the field strength reading. The field strength meter may be set on top of the dash, on the hood, or at an elevated location some distance from the car.

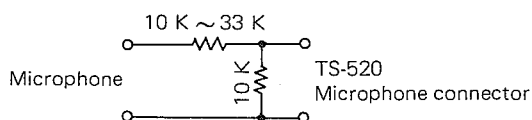
Change the whip length a half inch, or so at a time, retune the finals each time, and again check the field strength at the antenna. Continue this procedure until the point of maximum field strength is found. This adjustment will be most critical on 75 meters, somewhat less critical on 40, until on 10 meters the adjustment will be quite broad. After tuning the antenna to resonance, the finals can be loaded to full power.

### MICROPHONE

The microphone input is designed for high impedance (50 K ohms) 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.

The standard microphone sensitivity is within the range of -50 dB to -60 dB. If a microphone having a higher sensitivity is used, the ALC circuit will not function properly. In this case, insert an attenuator as shown in the illustration at right or connect a resistor (10 k ~ 33 k ohms) in parallel with the capacitor 100 pF (C2) in the generator unit (X52-0010-01) of the transceiver.



### EXTERNAL SPEAKER AND HEADPHONES

Receiver audio output from the TS-520 is 1 watt at 4 to 16 ohms. The TS-520 has a built-in speaker. However, if an external speaker is desired for fixed station or mobile operation, simply connect it to the SPEAKER jack on the rear panel. The speaker may be any good 8 ohm permanent magnet type in the 4 inch or larger size. The internal speaker is disconnected when an external speaker is used. The SP-520 is a speaker designed for use with the TS-520. 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-520 from its shipping box and packing material and examine it for visible damage. If the equipment has been damaged in shipment, save the boxes and packing material and notify the transportation company immediately. It is a good idea to save the boxes and packing material in any case because they are very useful for shipping or moving the equipment.

The following accessories should be included with the transceiver:

- |                                         |                                     |
|-----------------------------------------|-------------------------------------|
| 1 Operating Manual                      | 1 AC Power Cord                     |
| 1 Microphone Plug                       | 1 DC Power Cord                     |
| 1 Jumpered 9-pin Plug                   | 1 Speaker Plug                      |
| 2 RCA Phono Plugs                       | 1 8P US Plug                        |
| 1 Alignment Tool                        | 4 Fuse (6A x 2, 4A x 2,<br>20A x 1) |
| 2 Plastic Extension Feet<br>with Screws |                                     |

## 2.2 OPERATING LOCATION

As with any solid state electronic equipment the TS-520 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 1)

### GROUND

So preventing to receive an electric shock, TVI and BCI, select a good, effective ground for installation and then connect an earthing wire to the backside of GND terminal. Use a heavy earth line as big as possible, it is because short-line wiring is regarded as most effective for operation.

### ANTENNA

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

### KEY

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

## POWER CONNECTIONS

Make sure the POWER switch on the front panel of the TS-520 is turned off, the stand-by switch is put in the REC position, and that the voltage switch on the back of the TS-520 is switched to the correct line voltage (120 or 220). Connect the POWER cord to an appropriate external power source.

## SPEAKER

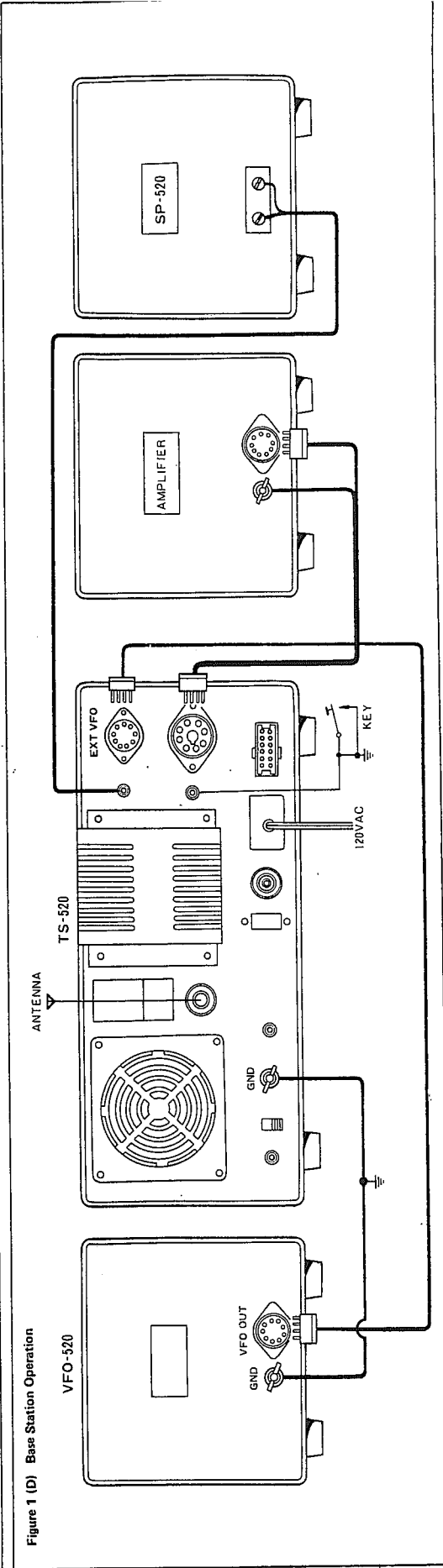
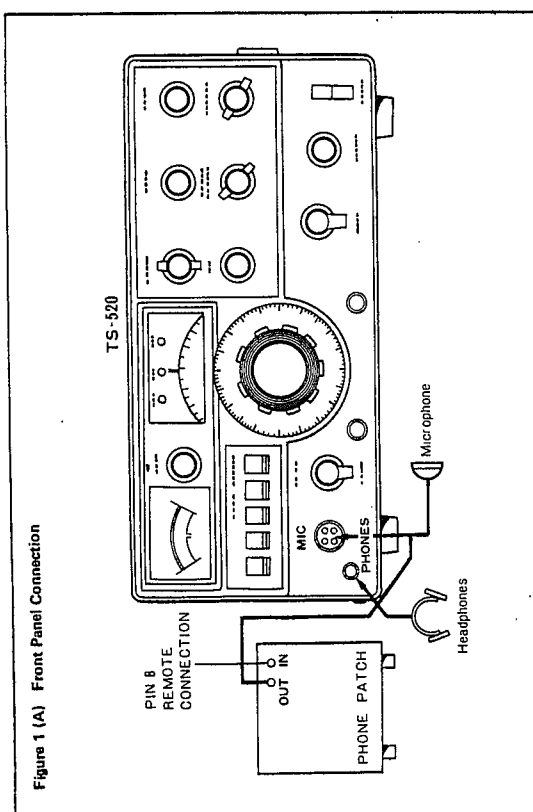
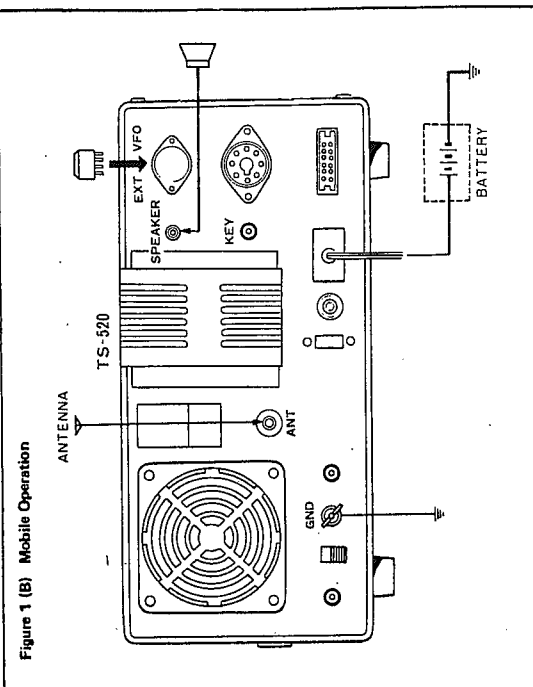
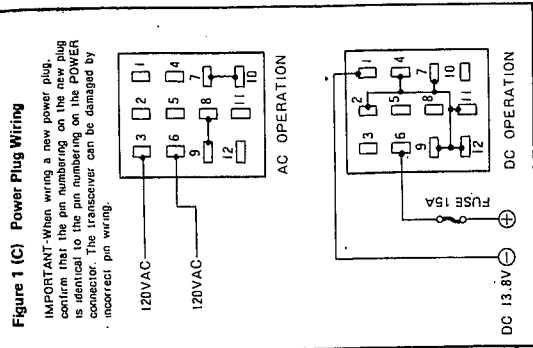
If an external speaker is desired, connect a cord to the SPEAKER jack on the back of the TS-520 and to the SPEAKER jack on the back of the SP-520 (or to an external 8 ohm speaker).

## MICROPHONE

Attach the microphone connector to a suitable microphone as shown in Figure 2. Be sure that the PTT switch of the microphone is separate from the microphone circuit, as shown in Figure 3.

It should be noted that a microphone with a 3P plug having a common earth terminal cannot be used.





## SECTION 3. OPERATING CONTROLS

### 3.1 FRONT PANEL CONTROLS (See Figure 5)

#### METER (1 on Figure 5)

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

#### METER SWITCH (2 on Figure 5)

The position of the METER switch determines the function of the meter. The switch selects one of the following functions (see Table 4 for nominal meter readings):

**ALC (Automatic Level Control)** — In this position the meter monitors the ALC voltage of the internal ALC circuit (or the ALC voltage feedback from a linear amplifier operated in conjunction with the TS-520). For SSB operation the ALC reading for voice peaks should be within the indicated ALC range of the meter. The 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 the plate current of the final tubes. The meter scale is calibrated from 0 to 350 ma.

**RF (Output Power)** — In this position the meter monitors the 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 meter reading.

**HV (High Voltage)** — In this position the meter monitors the high voltage from the power supply. The meter scale is calibrated from 6 to 10, indicating 600 to 1000 volts.

#### CH.(FIXED CHANNEL) SELECT SWITCH (3 on Figure 5)

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

#### VFO INDICATOR LIGHT (4 on Figure 5)

The VFO indicator is a light emitting diode which illuminates whenever the TS-520's internal VFO is controlling the transceiver's operation. The indicator is not lighted during fixed channel, or remote VFO, operation.

#### FIX (FIXED CHANNEL OPERATION) INDICATOR LIGHT (5 on Figure 5)

The FIX indicator is a light emitting diode which illuminates whenever the TS-520's internal fixed frequency oscillator is controlling the transceiver's operation.

#### RIT SWITCH (6 on Figure 5)

This push-button switch turns the RIT (Receiver Incremental Tuning) circuit on and off. With the switch depressed, the circuit is activated and the RIT indicator is lighted. The RIT control can then adjust the receiver frequency independently of the transmit frequency for VFO operation.

#### RIT INDICATOR (7 on Figure 5)

This light emitting diode is illuminated when the RIT circuit is turned on, showing that the transmit and receive frequencies may be different.

#### RIT CONTROL (8 on Figure 5)

When the RIT switch is pressed on, this potentiometer tunes the TS-520's receiver. The RIT circuit allows the operator to tune the receive frequency more than  $\pm 2$  kHz without changing the transmit frequency.

At the zero (mid-point) position the receive frequency is the same as when the RIT circuit is turned off.

#### STAND-BY SWITCH (9 on Figure 5)

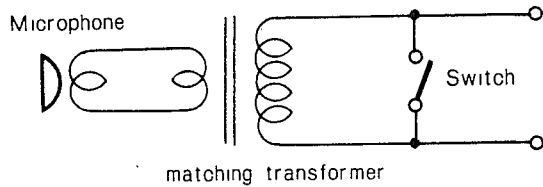
This two-position lever switch selects one of the following functions:

**REC** — The transceiver is receiving unless the microphone PTT switch is switched to transmit, or the VOX circuit is activated.

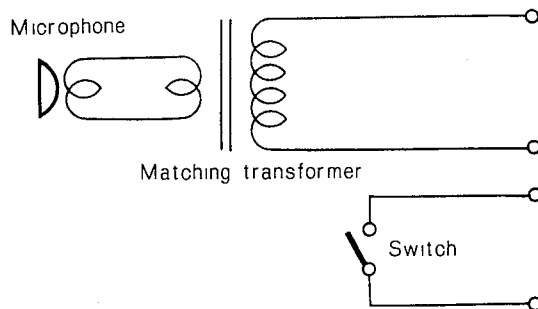
**SEND**— The TS-520 is locked into the transmit mode in this switch position.

#### H. SW (Heater) SWITCH (10 on Figure 5)

This switch turns the heater circuits of the three transmitting tubes on and off. The heaters would normally be turned to OFF to reduce power consumption in mobile or portable receiving.

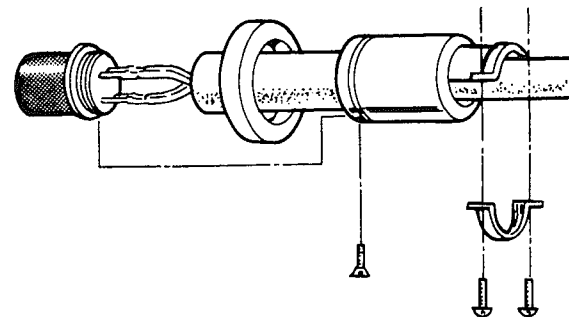


(a) Unsuitable for PTT operation.



(b) Suitable for PTT operation.

Figure 3 A Suitable PTT Microphone



seen from the cord.

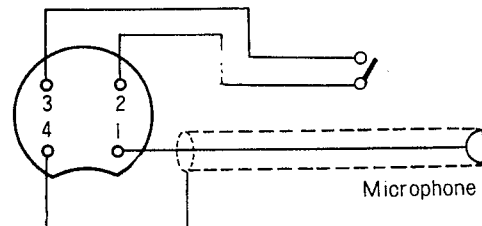
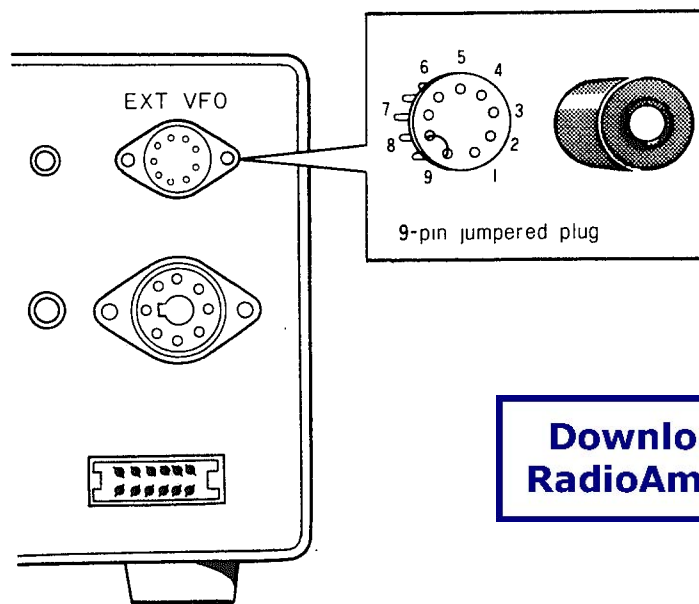
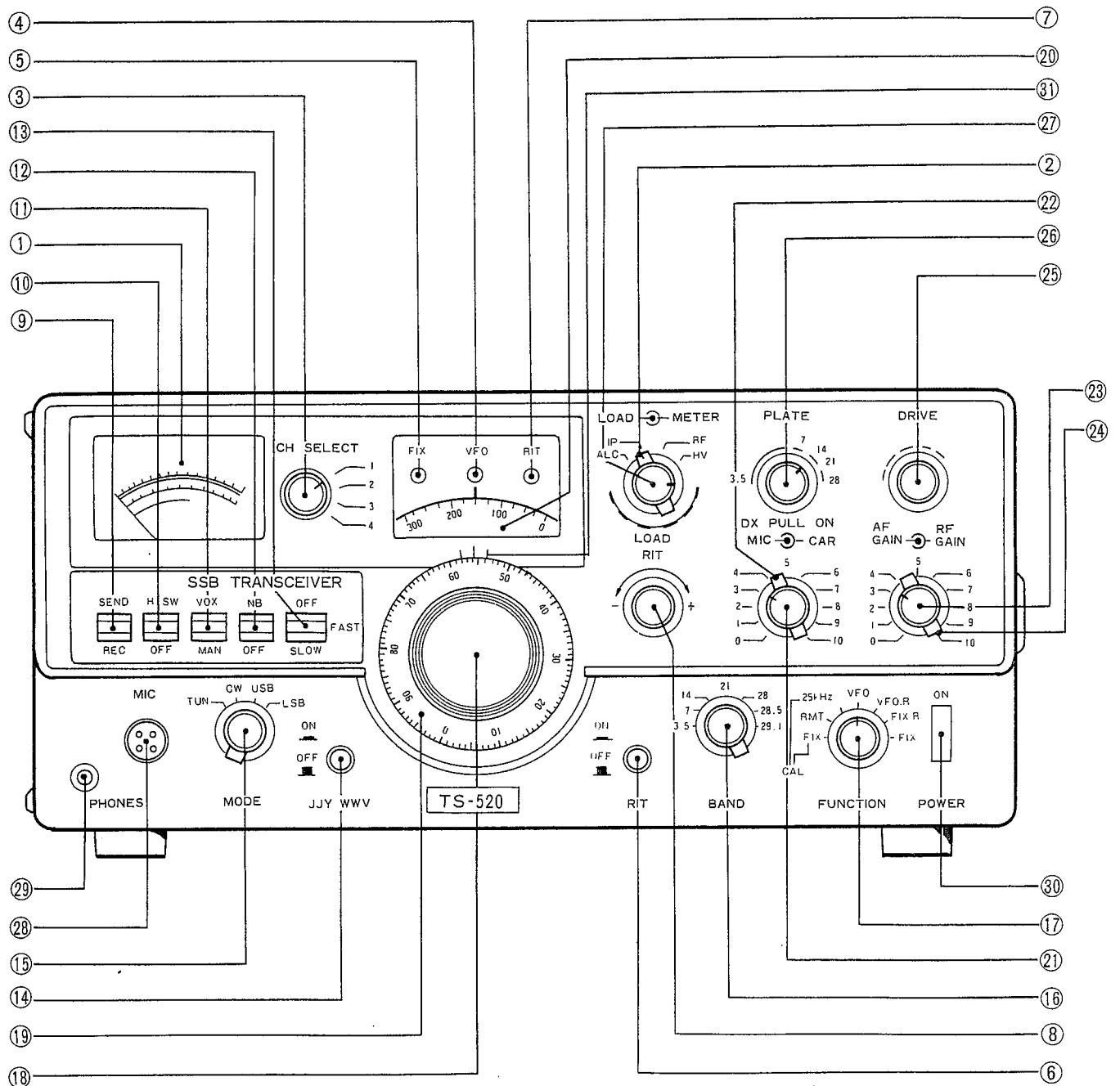


Figure 2 Microphone Connector Wiring



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Figure 4 Back\_Panel Jumpered EXT VFO Connector



- |                        |                      |                          |
|------------------------|----------------------|--------------------------|
| 1. Meter               | 11. VOX Switch       | 21. MIC Control          |
| 2. METER Switch        | 12. NB Switch        | 22. CAR Control          |
| 3. CH. SELECT Switch   | 13. AGC Switch       | 23. AF GAIN Control      |
| 4. VFO Indicator Light | 14. WWV Switch       | 24. RF GAIN Control      |
| 5. FIX Indicator Light | 15. MODE Switch      | 25. DRIVE Control        |
| 6. RIT Switch          | 16. BAND Switch      | 26. PLATE Control        |
| 7. RIT Indicator Light | 17. FUNCTION Switch  | 27. LOAD Control         |
| 8. RIT Control         | 18. Main Tuning Knob | 28. Microphone Connector |
| 9. Stand-by Switch     | 19. Dial Scale       | 29. Headphone Connector  |
| 10. H. SW Switch       | 20. Sub-dial         | 30. POWER Switch         |
|                        |                      | 31. Dial Pointers        |

Figure 5 TS-520 Front Panel Controls

### **VOX SWITCH (11 on Figure 5)**

This two-position lever switch selects one of the following functions.

**MAN** — With the switch in this position, the transceiver is switched into transmit or receive by the stand-by switch or the PTT switch on the microphone.

**VOX** — With the switch in this position, the VOX circuit is turned on for voice operated transmit on SSB semi-automatic break-in operation on CW.

### **NB SWITCH (12 on Figure 5)**

The NB switch turns the built-in noise blanker circuit on and off. The noise blanker is designed to reduce pulsating ignition type noises. When the lever switch is flipped up, the circuit is turned on.

### **AGC SWITCH (13 on Figure 5)**

The AGC switch controls the AGC (Automatic Gain Control) circuit giving the operator three choices:

**OFF** — It may be desirable to turn the AGC off when receiving a very weak signal.

**FAST**— The FAST AGC position is designed for use in CW operation.

**SLOW**— Use the SLOW AGC position for SSB operation.

### **WWV SWITCH (14 on Figure 5)**

This switch is a push-button control for the reception of WWV at 10 MHz. The signal is received at zero on the transceiver's sub-dial when the switch is pushed in.

### **MODE SWITCH (15 on Figure 5)**

This switch selects one of the following modes of operation.

**TUN** — Turn the MODE switch to this position to generate a low power carrier for tuning the transceiver. The mode switch is also used for frequency setting and calibration during CW operation. In the TUN position the input power into the final section is reduced to prevent tube damage during tuning. Normal operation is not possible in this mode.

**CW** — This position is used for operating the TS-520 in the CW mode.

**USB** — This switch position selects the USB circuits for

operating on upper sideband. International amateur practice dictates the use of USB on the 14, 21, and 28 MHz bands.

**LSB** — This switch position selects the LSB circuits for operating on lower sideband. International amateur practice dictates the use of LSB on the 3.5 and 7 MHz.

### **BAND SWITCH (16 on Figure 5)**

This 7-position switch selects all the necessary circuits to tune the transceiver to the desired 600 kHz band.

### **FUNCTION SWITCH (17 on Figure 5)**

This 7-position rotary switch selects one of the following transceiver functions.

**CAL-FIX** — This position allows calibration of the TS-520's internal VFO to one of the transceiver's fixed frequency channels (if an optional fixed channel crystal is installed). With the switch in this position a signal is generated at the selected fixed channel frequency and the main tuning knob can be tuned to zero beat the calibrating signal.

**CAL-RMT** — This position allows calibration of the VFO-520 (remote VFO) to the transceiver's operating frequency. With the switch in this position, the transceiver generates a calibrating signal and the VFO-520 can be tuned to zero-beat the calibrating signal.

**CAL-25kHz** — With the switch in this position, the transceiver's calibrator circuit generates a marker signal at every 25 kHz for normal calibration of the internal VFO.

**VFO** — The switch is kept in this position for normal transceiver operation.

**VFO.R** — With the switch in this position, the TS-520's internal VFO controls the receive function and the internal fixed channel oscillator controls the transmit function (if fixed channel crystals are installed in the oscillator).

**FIX.R**— With the switch in this position, the TS-520's internal VFO controls the transmit function and the built-in fixed channel oscillator controls the receive function (if fixed channel crystals are installed in the oscillator). The VFO.R and FIX.R allow cross-channel operation without an external VFO.

**FIX** — With the switch in this position, the TS-520's fixed channel oscillator controls the transmit and receive function of the transceiver (if accessory fixed channel crystals are installed in the transceiver).

#### **MAIN TUNING KNOB** (18 on Figure 5)

This control turns the VFO and dial scale to select the frequency to be added to the band frequency to establish the transceiver's operating frequency.

#### **DIAL SCALE** (19 on Figure 5)

The dial scale provides a direct frequency readout, calibrated to 1 kHz from 0 to 100 kHz. The sub-dial is calibrated to display the frequency every 25 kHz. The frequency displayed on the dial scale, when added to the base frequency of the chosen band and the frequency shown on the sub dial, shows the exact operating frequency of the transceiver. One revolution of the dial scale is 100 kHz.

#### **SUB-DIAL** (20 on Figure 5)

The sub-dial is turned with the main tuning knob to select the operating frequency of the transceiver. It is calibrated at 25 kHz intervals from 0-600 kHz. The operating frequency of the TS-520 is determined by adding the frequency shown on the BAND switch, this sub-dial, and the dial scale.

#### **MIC CONTROL** (21 on Figure 5)

The MIC gain control adjusts the gain of the microphone amplifier for SSB operation as well as switching a speech processor for DX operation. For normal operation, push the knob in and adjust the MIC GAIN for an in scale ALC meter reading on voice peaks. Adjusted in this way, the transceiver generates a natural sounding transmission.

For difficult DX operation however, pull the control out and readjust the MIC GAIN for an in scale ALC reading on voice peaks. Turn the speech processor off for normal operation.

#### **CAR CONTROL** (22 on Figure 5)

This control turns a variable resistor that adjusts the output carrier level during CW operation. The control is adjusted for 200 ma of plate current for CW operation.

#### **AF GAIN CONTROL** (23 on Figure 5)

This control adjusts the gain of the receiving audio amplifier. The audio volume of the received signal increases as

the control is turned clockwise.

#### **RF GAIN CONTROL** (24 on Figure 5)

This control adjusts the gain of the receiver section's RF amplifier. Turn the knob fully clockwise for maximum gain and for a correct S-meter reading. Turn the control counter-clockwise to reduce the gain.

#### **DRIVE CONTROL** (25 on Figure 5)

The DRIVE tuning 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). In transmit the DRIVE control is tuned for a maximum ALC reading. When the control is correctly tuned for transmission it will be correctly tuned for reception.

#### **PLATE CONTROL** (26 on Figure 5)

The PLATE control adjusts the plate tuning of the two final amplifier tubes.

#### **LOAD CONTROL** (27 on Figure 5)

The LOAD control adjusts the loading of the pi-circuit between the final section and the antenna. The control is adjusted as described in Section 4 for impedance matching.

#### **MIC CONNECTOR** (28 on Figure 5)

The microphone connector is four pronged, allowing use of the PTT microphone. Figure 2 shows how to wire the plug on the microphone cable.

#### **PHONES JACK** (29 on Figure 5)

The headphones jack allows use of a 4 to 16 ohm set of headphones with a 1/4" phone plug attached. When the phones are plugged into the transceiver, the speaker is disconnected.

#### **POWER SWITCH** (30 on Figure 5)

The POWER switch turns all the power on and off in the TS-520.

#### **DIAL POINTERS** (31 on Figure 5)

These pointers serve as the reference for reading the operating frequency from the dial scale. Choose the correct pointer for the mode used. The side pointers are used for sideband, and the center pointer is used for CW.

### 3.2 SIDE PANEL CONTROLS

The 5 controls located on the left side of the transceiver are covered by a protective panel. The cover is removed by simply pulling the two black fasteners.

#### RF VOLT CONTROL (1 on Figure 6)

Use the RF VOLT control to adjust the sensitivity of the RF output function of the meter. Adjust it for a 2/3 scale reading during CW transmission.

#### BIAS CONTROL (2 on Figure 6)

The BIAS control adjusts the bias voltage of the two S2001A (6146B) amplifier tubes. Turning the control clockwise increases the idling plate current of the tubes. Section 4 describes adjustment of the bias current.

#### DELAY CONTROL (3 on Figure 6)

The DELAY control adjusts the holding time of the VOX circuit for VOX or break-in CW operation. The control will have to be adjusted to the preference of the individual operator.

#### ANTI VOX CONTROL (4 on Figure 6)

This control adjusts the level of the anti VOX signal fed in

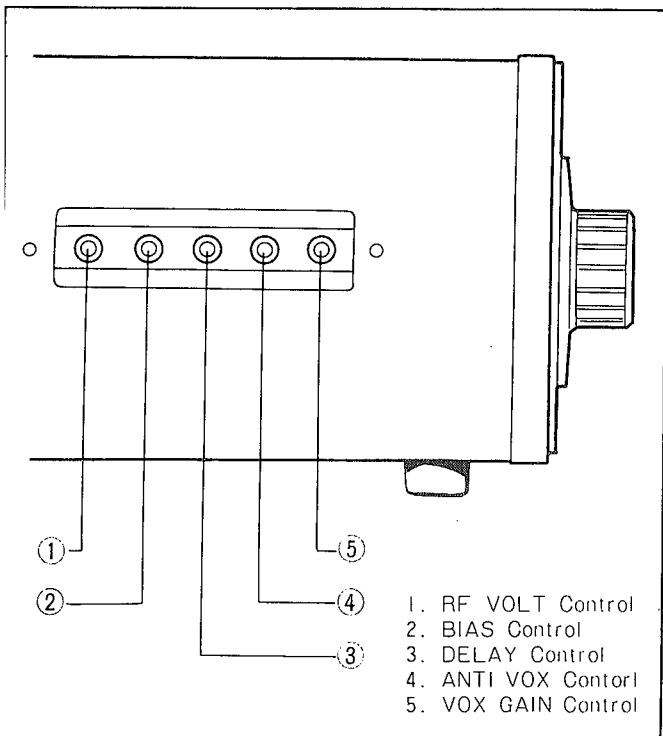


Figure 6 TS-520 Side Panel Controls

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

#### VOX GAIN CONTROL (5 on Figure 6)

This control adjusts the sensitivity of the VOX circuit by adjusting the gain of the VOX amplifier, for voice controlled operation.

### 3.3 REAR PANEL CONTROLS (See Figure 7)

#### COOLING FAN (1 on Figure 7)

This fan cools the RF amplifier section of the TS-520 to insure reliable and efficient operation.

#### TRANSVERTER OUT JACK (2 on Figure 7)

This is the low level RF output jack for use with a VHF transverter.

#### TRANSVERTER IN JACK (3 on Figure 7)

This is the RF input jack for input from a VHF transverter.

#### TRANSVERTER CONNECTOR (4 on Figure 7)

This 12-pin connector is used to control an accessory VHF transverter.

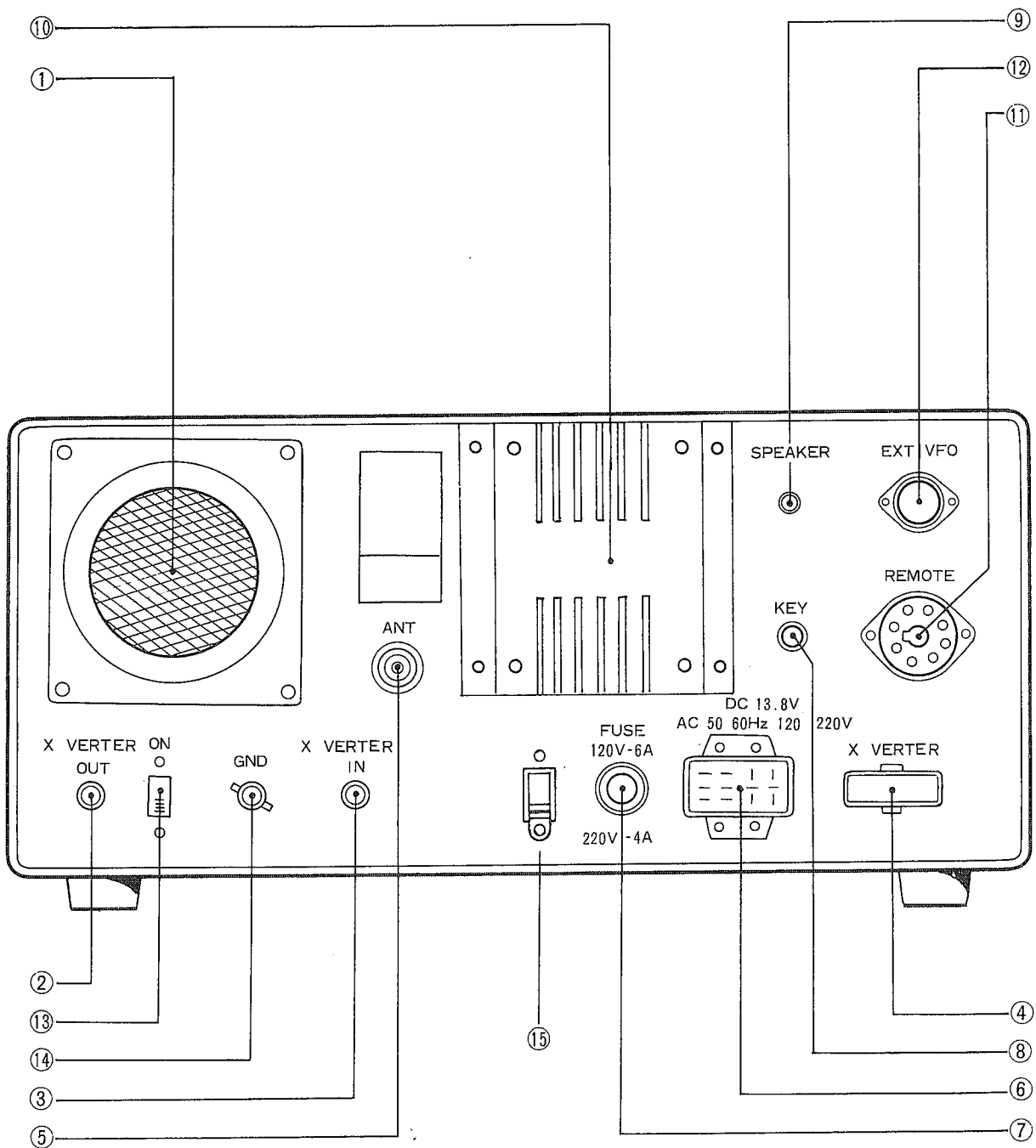
PIN	FUNCTION	PIN	FUNCTION
1	ALC	7	Transverter in
2	+14 VDC	8	Normally closed relay contact
3	+210 VDC	9	Ground
4	No connection	10	+210 VDC
5	-100 VDC	11	No connection
6	Transverter in	12	Ground

#### ANTENNA CONNECTOR (5 on Figure 7)

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

#### POWER SUPPLY CONNECTOR (6 on Figure 7)

This 12-pin connector is used to connect an AC or DC power source to the transceiver.



- |                              |                    |                           |
|------------------------------|--------------------|---------------------------|
| 1. Cooling Fan               | 6. Power Connector | 11. REMOTE Connector      |
| 2. XVERTER OUT Jack          | 7. Fuse            | 12. EXT VFO Connector     |
| 3. XVERTER IN Jack           | 8. KEY Jack        | 13. SG Switch             |
| 4. XVERTER Control Connector | 9. SPEAKER Jack    | 14. GND Stud              |
| 5. ANT Connector             | 10. DC-DC Module   | 15. Voltage Select Switch |

Figure 7 TS-520 Rear Panel Controls



PIN	FUNCTION	CONNECTION FOR AC OPERATION	CONNECTION FOR DC OPERATION
1	Ground	No connection	⊖13.8 VDC
2	Power direct (Connect to pin 3 for remote AC power switching)	No connection	Jumper to 4, 7, 9, 11, and 12
3	AC power common	120/220 VAC	No connection
4	+13.8 VDC to control DC module	No connection	Jumper to 2, 7, 9, 11, and 12
5	No connection	No connection	No connection
6	Power switching	120/220 VAC	⊕13.8 VDC
7	12.6 VAC (or 13.8 VDC) to heaters	Jumper to 10	Jumper to 2, 4, 9, 11, and 12
8	13.8 VDC to pin 9 in AC operation	Jumper to 9	No connection
9	13.8 VDC to operate solid state circuits	Jumper to 8	Jumper to 2, 4, 7, 11, and 12
10	12.6 VAC to pin 7 in AC operation	Jumper to 7	No connection
11	+13.8 VDC to DC Module	No connection	Jumper to 2, 4, 7, 9, and 12
12	+13.8 VDC to DC Module	No connection	Jumper to 2, 4, 7, 9, and 11

The power plug wiring is shown in Figure 1C.

#### FUSE (7 on Figure 7)

This fuse is a 3AG, 4 amp fuse which protects the power supply of the transmitter against short circuits. Never use a higher amperage fuse than the one specified. An improper one can cause extensive damage to the transmitter. When the fuse blows out, try to determine the cause before replacing it.

When the position of the AC Voltage Selector Switch is changed, it is also necessary to change the power fuse. For 120 volt operation a 6 ampere fuse, for 220 volt operation a 4 ampere fuse provided with the TS-520 should be used.

#### KEY JACK (8 on Figure 7)

Connect a key to this 1/4" phone jack for CW operation.

#### SPEAKER JACK (9 on Figure 7)

The receiver audio output can be connected through this jack to the SP-520 or another external 4 to 16 ohm speaker. The internal speaker is disconnected when an external speaker is connected.

#### DC TO DC CONVERTER (10 on Figure 7)

This cover is the heat sink for a DC-DC converter.

#### REMOTE CONNECTOR (11 on Figure 7)

The REMOTE connector is an 8-pin socket for use in interconnecting a linear amplifier, an external speaker, or another accessory item. (See Figure 30)

PIN	FUNCTION	PIN	FUNCTION
1	Ground	5	Normally open relay contact
2	No connection	6	ALC feedback
3	Normally closed relay contact	7	No connection
4	Ground	8	External speaker

#### EXTERNAL VFO CONNECTOR (12 on Figure 7)

This 9-pin connector provides a means of interconnecting the KENWOOD VFO-520, another external VFO, or an external receiver. The interconnecting cable is provided with the VFO-520. The 9-pin jumpered VFO plug provided with the TS-520 must be inserted in this socket for normal transceiver operation.

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

### SG SWITCH (13 on Figure 7)

The SG slide switch controls the screen grid voltage on the final tubes. For tuning or neutralizing the TS-520 you can set the switch to the OFF position. Turn the switch back to the ON position for normal operation. The SG voltage is on when the switch is up and off when the switch is down.

### GND (Ground) LUG (14 on Figure 7)

To prevent accidental shocks from the chassis, as well as interference, connect a good earth ground to this lug.

### AC VOLTAGE SELECT SWITCH (15 on Figure 7)

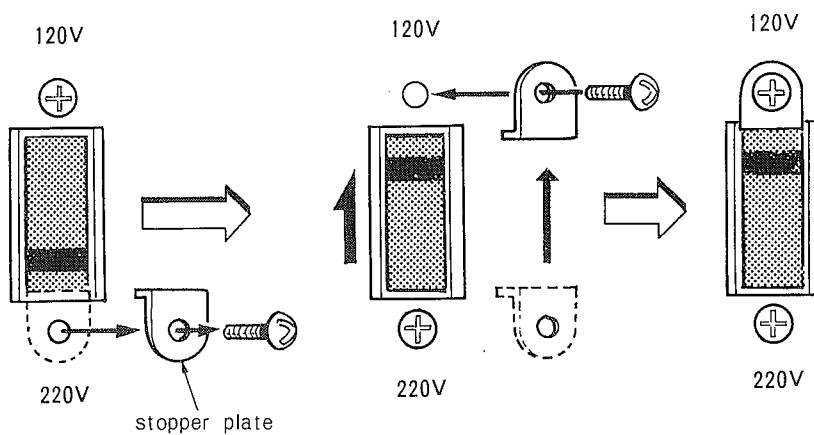
This slide switch switches the primary of the power transformer to select 120 or 220 VAC operation.

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

Remove screw and stopper plate

Switch stopper to opposite side

Lock lever by attaching stopper plate to opposite side screw



# SECTION 4. OPERATING INSTRUCTIONS

## 4.1 PRELIMINARY PROCEDURE

Set the MIC and CAR controls to zero and the MODE switch to LSB, USB, or CW to prevent accidental transmit conditions before tuning. The TS-520 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 components in the output stage of the transmitter. Refer back to Section 1.2.

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

With a suitable antenna and microphone (or key) connected to the transceiver, set the TS-520 switches to the positions described in Table 1.

## 4.2 RECEIVER TUNING

Refer to Table 1 for the initial switch settings of the TS-520 for receiving, and then continue with the described procedure.

Push the POWER switch on. The meter, dial scale, and VFO indicator will light, indicating that the transceiver is operating. The receiver section is fully solid-state allowing

reception with the H. SW switch turned to OFF. 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 the clearest possible reception, and then adjust the DRIVE control for maximum deflection of the S-meter.

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.

## 4.3 READING THE OPERATING FREQUENCY

(See Figure 8)

The operating frequency of the TS-520 is the sum of three different readings – the base frequency of the band (3.5, 7.0, . . . .), the reading of the sub-dial (0, 100, 200, . . . .) and the reading of the dial scale (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.

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

CONTROL LOCATION	CONTROL	POSITION	
FRONT PANEL CONTROLS	BAND Switch	Desired band	
	POWER Switch	OFF	
	H.SW 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	
	PLATE Control	Middle of the range for the band	
	DRIVE Control	Centered	
	RIT Control	Centered	
	AF GAIN Control	Fully counter-clockwise	
	RF GAIN Control	Fully clockwise	
	WWV Switch	OFF	
	REAR PANEL CONTROLS	EXT VFO Connector	The jumpered plug must be in this socket.
		SG Switch	ON (up position)

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

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-520 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.

During CW operation, the center dial pointer provides two different readings, one for transmission and the other for reception.

In transmitting mode, the reading on the center dial pointer is the transmit frequency. In receiving mode, however, the mode switch should be set to TUNE and the main dial of VFO adjusted to zero beat the desired receive frequency. Then, the reading on the center dial pointer is the receive frequency.

Under such a condition, the receiving signal can be clearly heard as a 700 Hz tone by setting the mode switch to CW. The transmit/receive frequency of the transceiver will now be set to the operating frequency of the other station.

If a modification is made on the wiring of the carrier unit, no beat tones will appear on either side of the zero beat. In this case, the reading at the mid-position between the LSB pointer and the center dial pointer, which is obtained when the beat tone of receiving signal is about 800 Hz, is the transmit/receive frequency.

For modification of the wiring, disconnect the brown lead from the CWR terminal and connect it to the LSB terminal; similarly, disconnect the gray lead from the CWT terminal and connect it to the CWR terminal.

For CW operation, tune the desired frequency to zero beat and then tune the VFO to receive a 700 Hz tone on the higher frequency side of the zero beat frequency. The operating frequency then is directly under the center dial pointer. The 700 Hz beat appears above and below the zero point. Be sure to use the higher frequency beat to insure reception and transmission on the same frequency. The S-meter will show a much stronger signal on the high frequency beat.

#### 4.4 CALIBRATION

##### NORMAL TRANSCEIVER CALIBRATION

Turn the FUNCTION switch to CAL-25 kHz to activate the crystal calibrator. Be sure the RIT switch is OFF. Turn the main tuning knob to receive one of the marker signals which are generated at 25 kHz intervals. For greatest accuracy choose a calibrator signal near the desired operating frequency.

LSB – Set the MODE switch to LSB and tune the main tuning knob to zero beat one of the marker signals. If the dial scale reading under the left-hand LSB dial pointer is not on an even 25 kHz marking, hold the main tuning knob with one hand and turn the dial scale with the other hand until the dial scale shows the correct reading.

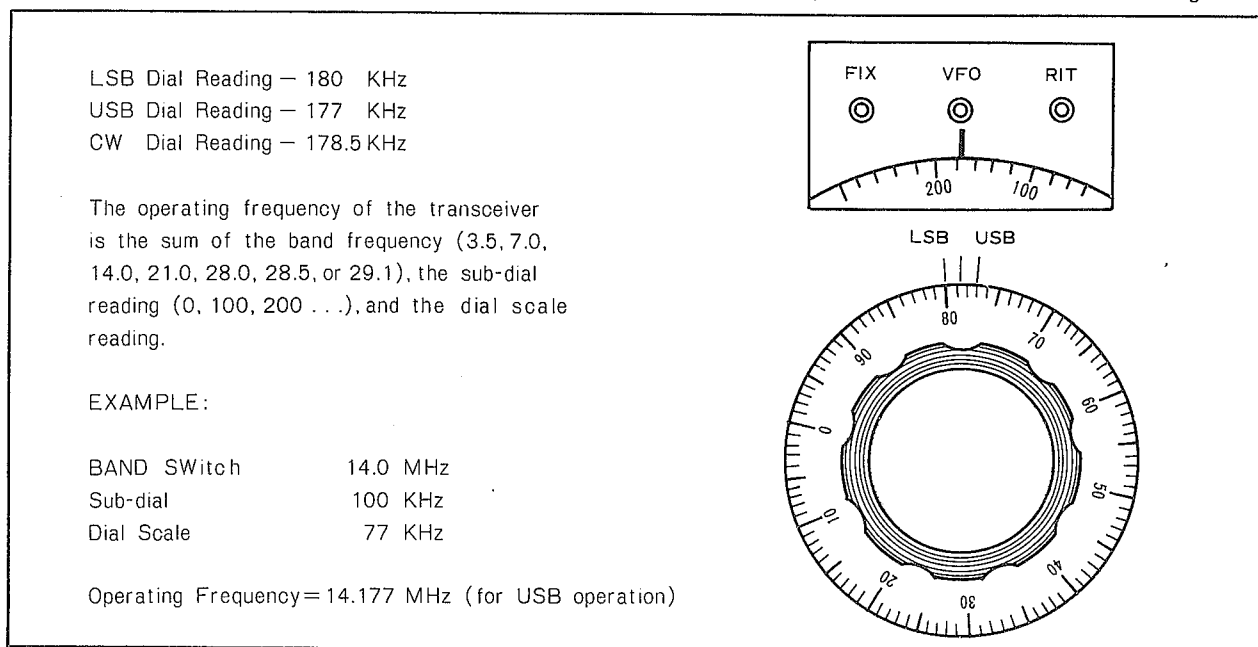


Figure 8 Reading the Operating Frequency (Refer to Section 4.3)

USB — Use the procedure described above with the MODE switch turned to USB. Use the USB (right-hand) dial pointer.

CW — Set the mode switch to TUNE to zero beat the marker signal. Then, turn the main dial and calibrate the frequency using the center dial pointer.

If the TS-520 has a CW filter installed, tune the VFO for maximum S-meter deflection when receiving the marker signal. Calibrate the dial scale to the center pointer as described above.

#### **CALIBRATING THE TS-520 TO A FIXED CHANNEL FREQUENCY**

Turn the FUNCTION switch to CAL-FIX to calibrate the TS-520'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.

#### **CALIBRATING THE TS-520 WITH THE VFO-520**

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

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

#### **CALIBRATING THE TS-520 MARKER TO WWV**

To check that the marker signals are correctly adjusted, beat the calibrator signal against WWV at 10 MHz. Receive WWV at 10 MHz as described in Section 4.5. Turn the FUNCTION switch to CAL-25 kHz and the MODE SWITCH to TUN. 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 board.

### **4.5 WWV RECEPTION**

The TS-520 will receive WWV at 10 MHz when the WWV

push-button is pushed on and the sub-dial is turned to zero. The DRIVE control does not tune the transceiver for WWV reception.

### **4.6 NOISE BLANKER**

The TS-520 has a sophisticated built-in noise blanker designed to reduce ignition type impulse noise. The noise blanker is particularly important for mobile operation. When necessary, activate the noise blanker circuit by flipping the NB switch up.

### **4.7 AGC (AUTOMATIC GAIN CONTROL)**

Set the AGC switch to the position appropriate for the received signal. Generally for SSB reception set the AGC switch to SLOW, for CW reception set the AGC switch to FAST, and for reception of a very weak signal the switch may be set to off.

### **4.8 RIT (RECEIVER INCREMENTAL TUNING)**

With the RIT switch turned off the TS-520 receives and transmits at the same frequency. At times the received signal may drift off frequency and become less intelligible. When this happens, flip the RIT switch up to activate the RIT circuit and return the received signal to an intelligible state using the RIT control. The RIT control varies the receive frequency about  $\pm 3$  kHz. The RIT circuit has no effect on the transmit frequency. When the RIT switch is turned on the RIT light is illuminated. Be careful to turn the RIT to the OFF position when returning to normal transceive operation to prevent unintentionally transmitting and receiving on different frequencies.

VR2 on the FIXED CHANNEL - AVR board adjusts the zero point of the RIT control (see Section 6.6).

### **4.9 TRANSMITTER TUNING**

Connect the TS-520 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 2 for the initial switch settings of the TS-520 for transmitting. Tune the main tuning knob to the desired operating frequency.

**TABLE 2. Initial Switch Settings for Transmission** (The controls not described should be set as described in Table 1)

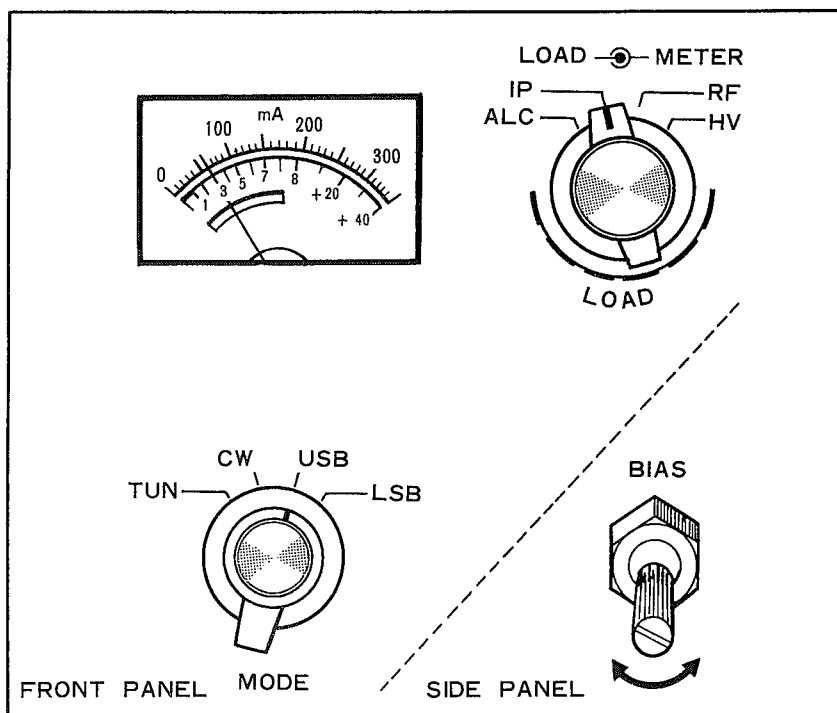
LOCATION	CONTROL	POSITION
FRONT PANEL CONTROLS	BAND Switch	Desired band
	POWER Switch	ON
	H. SW Switch	ON
	Stand-by Switch	REC
	MODE Switch	USB or LSB depending on selected band.
	VOX Switch	MAN
	MIC Control	Fully counter-clockwise
	CAR Control	Centered
	METER Switch	I <sub>p</sub>
	WWV Switch	OFF
	PLATE Control	Middle of the range for the band
	DRIVE Control	Centered
	FUNCTION Switch	VFO
	RIT Switch	OFF
REAR PANEL CONTROLS	SG Switch	UP (ON)
	Ext VFO Connector	Jumpered plug inserted

**PLATE IDLING CURRENT** (See Figure 9)

Turn the main tuning knob to the desired operating frequency within the amateur band selected. 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 a correct 60 ma of idling current and return the stand-by switch to REC.

**CAUTION**

*If the plate current is very much 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.*



**Figure 9 Adjustment of the Plate Idling Current**

### DRIVE TUNING (See Figure 10)

Shift the METER switch to ALC and the MODE switch to TUN and peak the ALC reading (maximum meter deflection) with the DRIVE control. The stand-by switch is in the SEND position for adjustment.

#### NOTE

*If there is no ALC reading indicated, increase the CAR control until there is an ALC reading.*

### PLATE TUNING (See Figure 10)

Turn the METER switch back to IP, leave the MODE switch at TUN and flip 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. With the MODE switch in the TUN position, the screen voltage of the finals is reduced to approximately 50% and the keying circuit is shorted.*

### PLATE AND LOAD TUNING

#### CAUTION

*When the MODE switch is in the CW position the final tubes draw full plate current in transmit. Final tube life is directly related to the length of tune-up periods. Do not transmit with the tubes out of resonance for more than 10 seconds at a time.*

Turn the MODE switch to CW, turn the METER switch to RF, and set the stand-by switch to the SEND position. 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.

## 4.10 SSB OPERATION

### PTT OPERATION

Tune the TS-520 as described in Sections 4.1 to 4.9. Set the MODE switch to USB or LSB and connect a microphone to the MIC connector.

TABLE 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 plate current with PLATE control.
CW	RF	SEND	Peak RF output by alternately adjusting the PLATE AND LOAD controls.

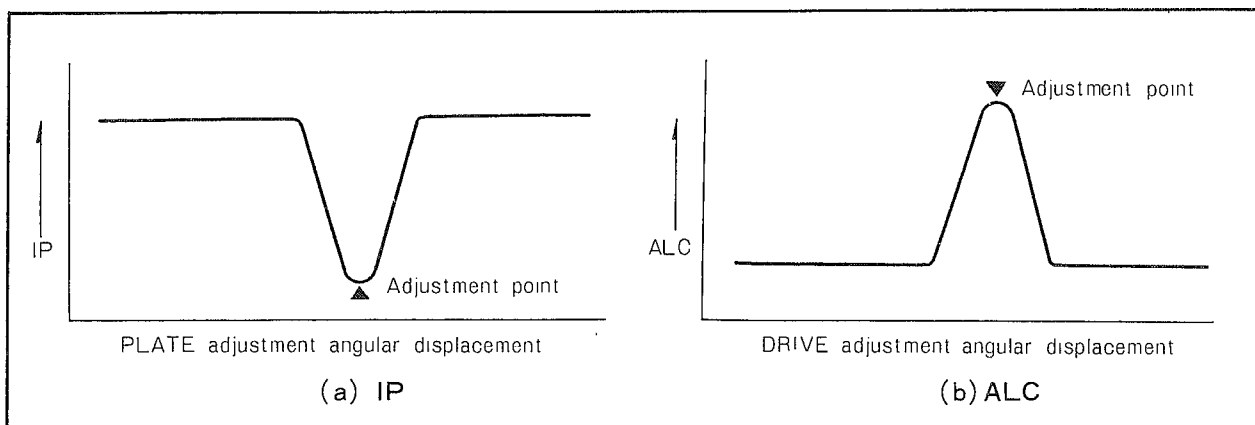


Figure 10 Plate and Drive Tuning

**NOTE**

*International amateur practice dictates using USB or LSB on the following bands.*

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 with the tone of voice used in normal operation. Adjust the MIC control until voice peaks are just within the top limit of the ALC range printed on the meter scale. The METER switch is in the ALC position. If the transmitter section is driven beyond this range, the transmitted signal will be distorted.

**VOX OPERATION**

Adjust the transceiver as described in the previous paragraph. Flip the VOX switch on and close-talk into the microphone, increasing the VOX GAIN control (on the left side of the TS-520) until the VOX relay just operates. For VOX operation it is desirable to close-talk the microphone to prevent background noises from tripping the TS-520 into transmission.

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

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

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

**4.11 CW OPERATION**

Tune and load the TS-520 as described in Sections 4.1 through 4.9. Connect a key to the back panel KEY jack, set the MODE switch to CW, and set the stand-by switch to SEND for transmitting.

**NOTE**

*See Section 4.4 for information on dial calibration for CW operation.*

CW transmissions are automatically monitored through the speaker of the transceiver. The audio gain of the sidetone can be adjusted with VR2 on the AF board.

For semi-break-in operation, turn the VOX switch on. Hold the key down and increase the VOX GAIN control, on the left side of the transceiver, until the VOX relay just operates. It is desired to change the release time constant of the VOX circuit, adjust the DELAY control, also on the left of the transceiver.

The plate current for CW operation should be about 200 ma. Use the CAR control to adjust the carrier level for CW operation. At 200 ma of IP there may be no ALC reading.

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

MODE	METER Switch	Approx. Readings
TUN	* ALC or * IP or * RF or HV	Peaked 100 ma 1/3 scale 800 v
CW	ALC or * IP or RF or HV	None or within ALC range 200 ma 2/3 scale 750 v
USB or LSB	* ALC or  IP or RF or HV	Within the ALC range on voice peaks 60 to 250 ma 0 to 2/3 scale 800 v

\* Recommended monitoring position during operation.

**4.12 OPERATION WITH A LINEAR AMPLIFIER (See Figure 30)**

Tune and load the TS-520 as described in Sections 4.1 through 4.9 and adjust it for the selected mode.

The REMOTE connector on the back panel is provided for interconnections with an amplifier. See the instruction manual of the amplifier to determine whether the linear requires a normally open (during receive) or a normally closed (during receive) relay contact. Connect either pin 3 (normally closed to ground during receive) or pin 5 (normally open to ground during receive) of the REMOTE connector to the control jack on the amplifier.

Connect the ALC feedback from the amplifier to pin 6 of the REMOTE connector. The output of the TS-520 is quite adequate to drive most amplifiers to full rated output.



### 4.13 FIXED FREQUENCY OPERATION

The TS-520 has a built-in crystal controlled oscillator for fixed frequency operation. This feature is most useful for commonly used frequencies, nets, or any situation where crystal controlled operation is required. To use the fixed frequency oscillator, turn the FUNCTION switch to the FIX position. Select one of the four available channels with the fixed channel selector switch and tune and load the TS-520 as described in Sections 4.1 through 4.9. Simply operate the transceiver as described in Sections 4.10 and 4.11.

Section 6.2 describes installation and netting of fixed channel crystals. The crystal frequency is determined by the following formulas.

#### LSB OPERATION

Crystal Frequency (MHz) = 5.5015 MHz + X - Operating Frequency (MHz)

#### USB OPERATION

Crystal Frequency (MHz) = 5.4985 MHz + X - Operating Frequency (MHz)

### CW OPERATION

Crystal Frequency (MHz) = 5.5 MHz + X - Operating Frequency (MHz)

- X = 3.5 for the 80 meter band
- X = 7.0 for the 40 meter band
- X = 14.0 for the 20 meter band
- X = 21.0 for the 15 meter band
- X = 28.0 for the 10 meter band or
- X = 28.5 for the 10 meter band or
- X = 29.1 for the 10 meter band

Crystal Specifications: HC-25/U holder, 4.9 to 5.5015 MHz oscillation frequency, and see Figure 11 for type of oscillation 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

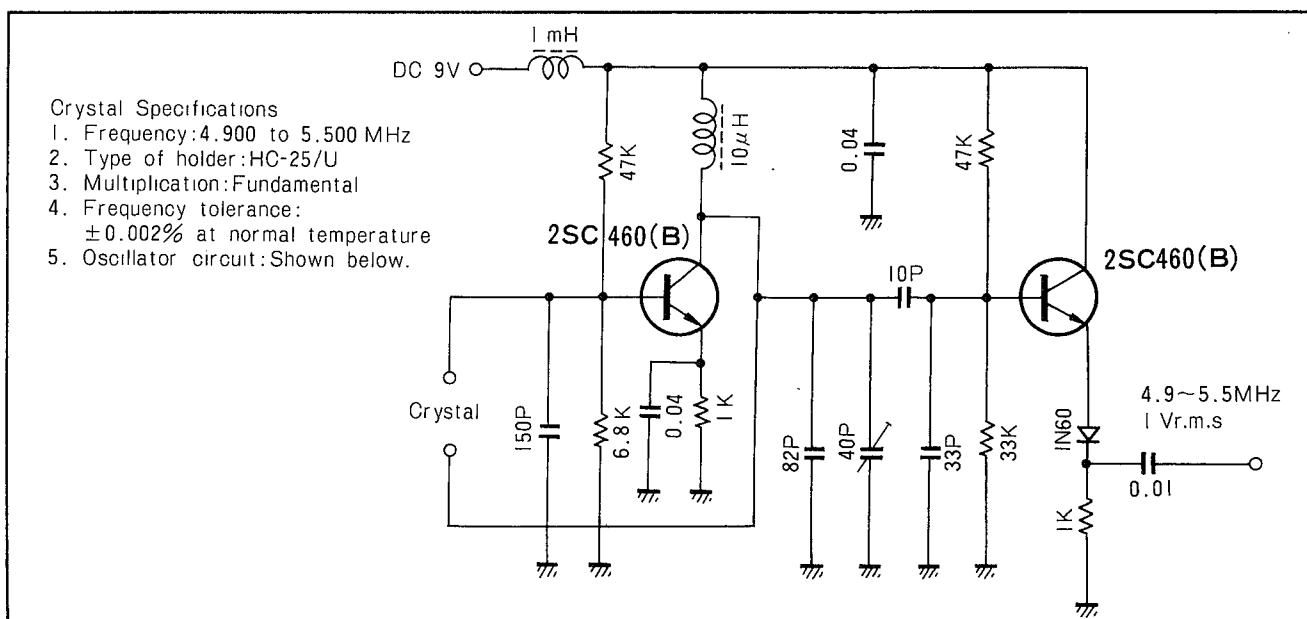


Figure 11 Crystal Oscillator Circuit

#### 4.14 INTERNAL CROSS CHANNEL OPERATION

The TS-520 contains a unique design feature which allows cross channel operation without a separate external VFO. The TS-520's internal VFO is used together with the fixed frequency oscillator to allow reception and transmission on different frequencies. The fixed channel oscillator must have one or more accessory crystals installed for this feature to work.

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

#### 4.15 MOBILE OPERATION

The compact size and solid-state design of the TS-520 make it ideal for mobile use.

Be sure to use a mobile antenna which meets the requirements described in Section 1.

The normal operating procedures, described previously, apply to mobile operation. The noise blanker should be used to reduce ignition and impulse noises for clear reception. Remember that during transmission the transceiver draws about 20 amps so be careful not to drain the car's battery.

#### 4.16 DX OPERATION

The DX PULL ON control changes the ALC action of the transceiver for speech processing for communication in weak signal or high QRM operation. The audio quality of the transmitted signal will be more natural without this control operating. Therefore, for normal operation push this control in.

#### 4.17 SSTV OPERATION

The TS-520 will adapt very well to slow scan television operation. The only cabling required are connections between the MIC connector of the TS-520 and the output of the television console, and between the SPEAKER jack of the TS-520 and the input of the television console.

Be careful to keep the input power of the transceiver down to a safe level with the MIC control. If you exceed the plate power dissipation capability of the tubes, they will be damaged.

#### 4.18 OPERATION WITH A PHONE PATCH

The TS-520 has an audio output pin on the REMOTE connector (see Figure 30 on page 39) which can be used for the audio input to the phone patch. The impedance is 4 to 16 ohms.

The audio from the phone patch must be connected to the microphone connector on the front panel. The required impedance is 50 K ohms.

#### 4.19 NOVICE OPERATION

The Kenwood TS-520 offers the unique opportunity to the beginning amateur of buying a top quality ham rig which adapts to novice operation at very little cost. So the initial equipment investment is good for what ever level of license to which the operator advances.

For the novice to operate the Kenwood within the legal power limitation, all he has to do is remove one of the final tubes from the final RF section and replace it with a low cost module available from your dealer. Alternately adjust the carrier level control to keep the plate input power below 75 watts (approximately 90 ma). Adjusting the carrier level yields much less power output because it reduces the efficiency of the tubes.

# MEMO

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## SECTION 5. CIRCUIT DESCRIPTION

### 5.1 GENERAL DESCRIPTION

Figure 12 shows the block diagram of the TS-520. 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 17 FET, 47 transistors, and 84 diodes.

Modular construction techniques place all circuitry, except the final RF section, on printed circuit boards. These modules greatly simplify trouble shooting and repair procedures.

Receiver circuitry is designed in a double superheterodyne configuration. The transistorized 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 12)

The current generated by audio 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 12)

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.

# TS-520 BLOCK DIAGRAM (FIGURE 12)

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RadioAmateur.EU

TABLE 3. FIX X'tal

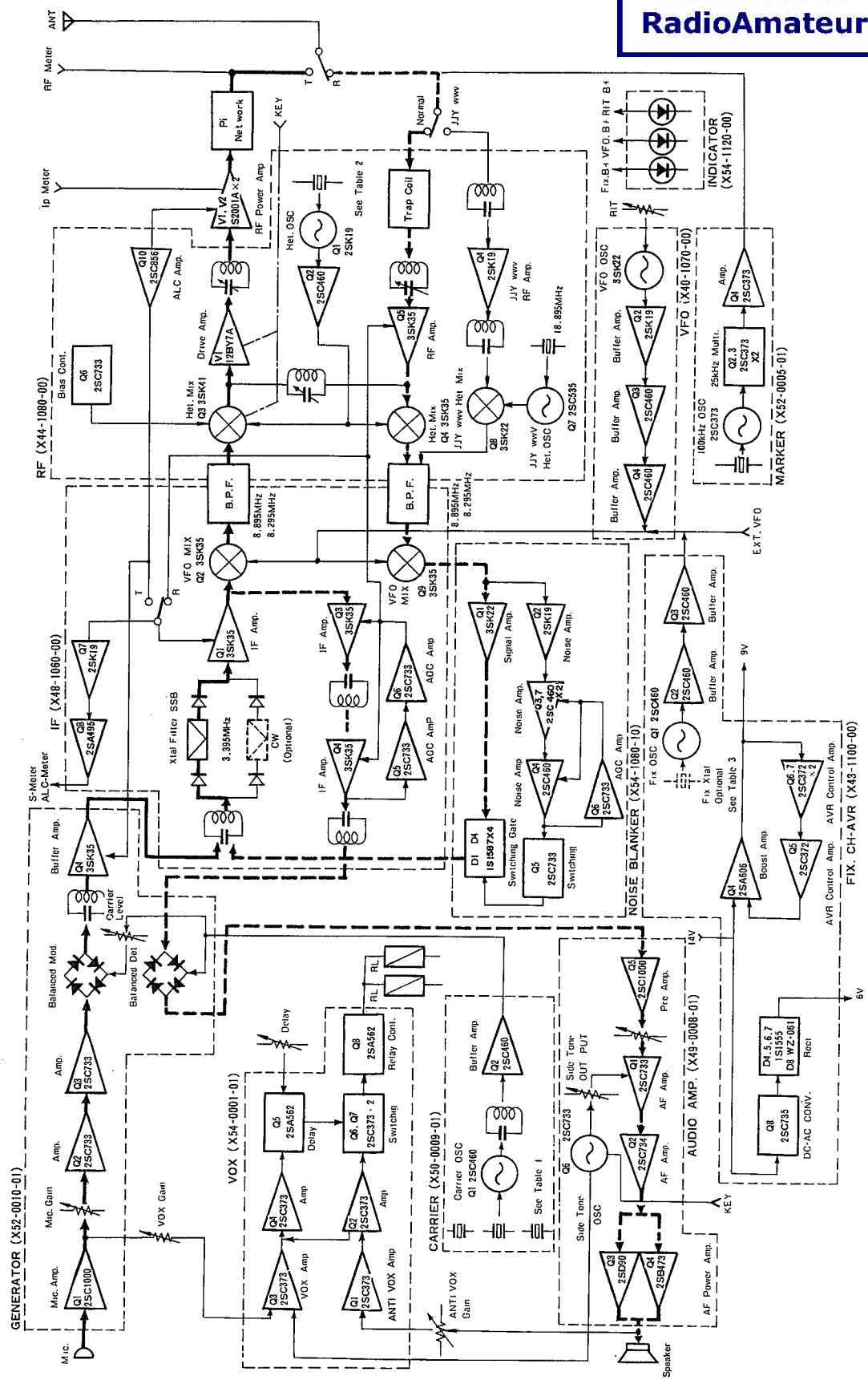
TYPE	HC-25U
FREQ.	5.5-4.9MHz

TABLE 2. HET FREQUENCY

BAND	FREQ.	BAND	IF FREQ.
3.5MHz	12.395MHz	28 MHz	36.895MHz
7	15.895	28.5	37.395
14	22.895	29.1	37.895
21	29.895		

TABLE 1. CARRIER FREQUENCY

MODE	RECEIVE	TRANSMIT
L S B	3.3935MHz	3.3935MHz
U S B	3.3965M	3.3965
C W	3.3943	3.3950



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

(Sée Figure 13)

The crystal controlled oscillator (Q1) produces a carrier signal during transmission and acts as the BFO for balanced product detection during reception.

The circuit uses a diode switch to select the oscillator crystal used.

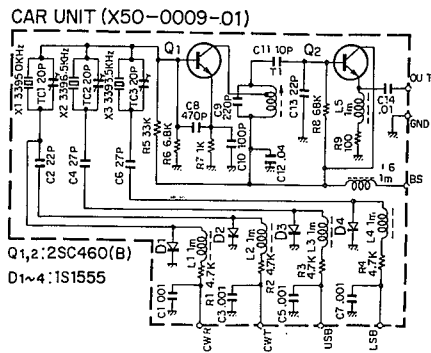
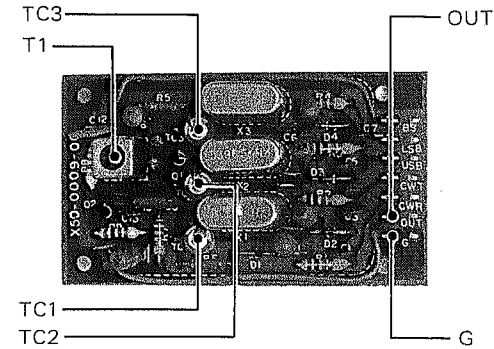


Figure 13 CARRIER Board

## 5.3 GENERATOR BOARD (X52-0010-01)

(See Figure 14)

The GENERATOR circuit, with the carrier signal from the CARRIER board, generates a DSB signal during transmission. The circuit includes the microphone amplifier (Q1, Q2, and Q3), a ring modulator (D1 through D4), and a buffer amplifier (Q4). For sideband operation, the circuit generates a DSB signal to be filtered to SSB on the IF board. For CW operation, a DC voltage is used to unbalance the ring modulator to produce the required carrier.

During reception the ring detector (D5 through D8) acts as the balanced detector.

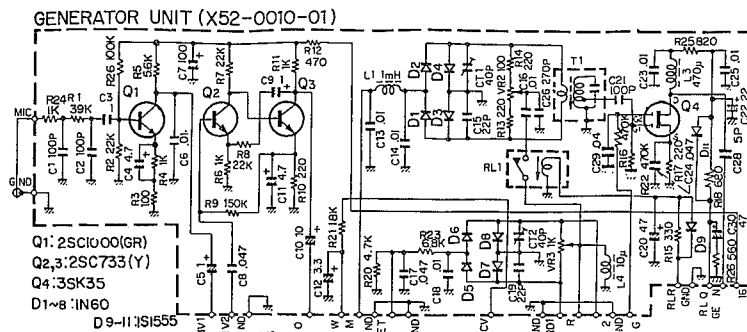
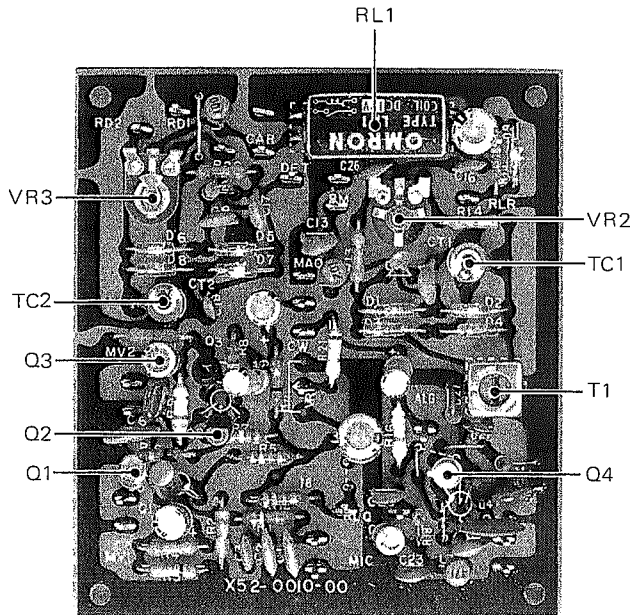


Figure 14 GENERATOR Board

## 5.4 IF BOARD (X48-1060-00) (See Figure 15)

The IF circuit is common to transmission and reception. During transmission, the crystal filter (XF1) filters the 3.395 MHz DSB signal from the GENERATOR board to an SSB signal. The SSB signal is amplified by Q1 and mixed with the VFO output (or the fixed channel oscillator output) by Q2 to the second IF frequency (8.895 to 8.295 MHz). The second IF signal passes through a band pass filter to the RF section.

During reception, the first receive IF signal from the RF section (8.895 to 8.295 MHz) passes through a band pass filter to Q9 where it is mixed with the VFO (or the fixed channel oscillator) output to the second receive IF (3.395 MHz). The signal leaves the IF board to the noise blanker board. The signal reenters the IF board to pass through XF1 and is amplified by Q1, Q3, and Q4. The received signal leaves the IF board to the balanced detector on the GENERATOR board.

Q5 and Q6 are a two-stage AGC amplifier. FET Q7 and Q8 are a two-stage S-meter amplifier. The board has space for an optional CW filter. The filters are switched by diode switches interlocked with the MODE switch.

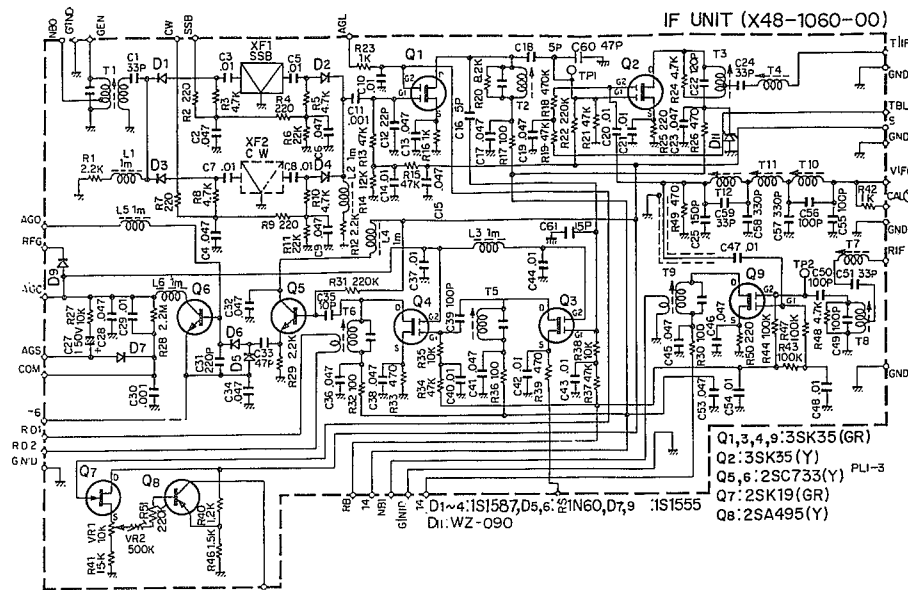
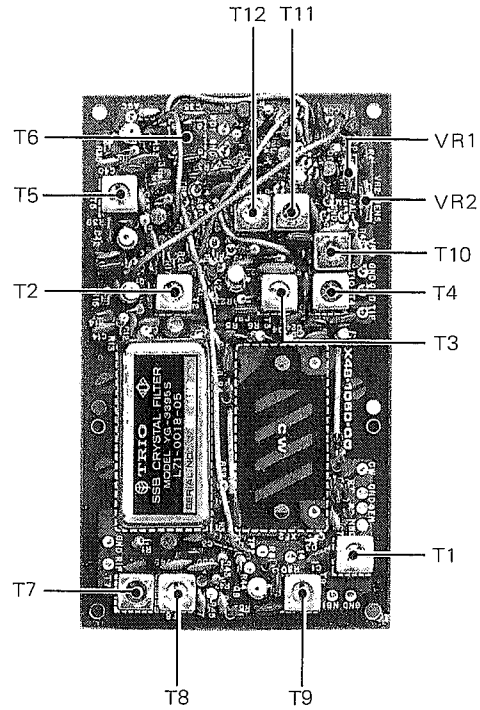


Figure 15 IF Board



## 5.5 NB (Noise Blanker) BOARD (X54-1080-10) (See Figure 16)

The noise blanker is designed to reduce pulse noises in received signals. The circuit switches closed during the noise impulses and switches open when noise impulses are not present. The gate opens and closes fast enough so that the ear hears an uninterrupted signal.

The receiver's second IF signal, from the IF board, passes through the input filter of the NB board and is amplified by transistor Q1.

When the NB switch is turned on, the signal is separated into signal and noise components. The noise component (shaped into a suitable waveform by Q2, Q3, Q4, and switching transistor Q5) triggers the blanking gate diodes, D1 through D4. When the diodes are triggered, the signal path is closed. In this manner most of the impulse noise is blocked out, leading to higher receiver intelligibility.

Transistor Q6 is an AGC amplifier for the NB circuit to maintain an overall IF gain of 0 db.

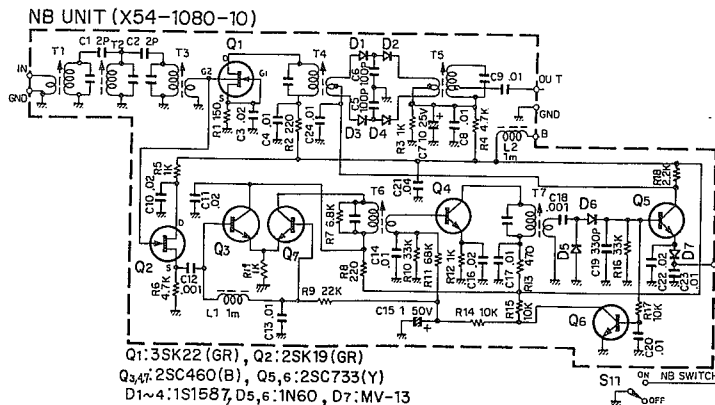
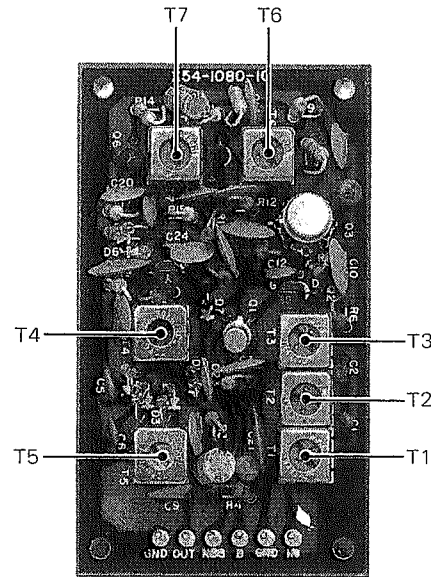


Figure 16 Noise Blanker Board

## 5.6 RF SECTION (X44-1080-00) (See Figure 17)

The RF section holds the transmitter heterodyne mixer (Q3), the receiver heterodyne mixer (Q4), the transmit/receive heterodyne oscillator (Q1 and Q2), the transmitter driver stage (V1), the receiver RF amplifier (Q5), the WWV RF amplifier (Q9), the WWV heterodyne mixer (Q8), the WWV heterodyne oscillator (Q7), the transmitter ALC detector (Q10), and the bias control switching (Q6). The RF board, with four coil boards, is shielded in a metal chassis.

For transmission, the second IF signal from the IF board is heterodyned by Q3 with the heterodyne oscillator output to produce the final output frequency. This amateur band frequency is amplified by V1 to drive the final amplifier section.

During reception, the received signal is amplified by Q5 and mixed with the heterodyne oscillator output by Q4 to produce the first receiver IF frequency (8.295 to 8.895 MHz). The IF signals are fed to the IF board.

- DRIVE COIL BOARD (X40-0017-01),
- MIXER COIL BOARD (X40-0018-01),
- OSCILLATOR COIL BOARD (X40-0019-01),
- AND ANTENNA COIL BOARD (X44-1090-00)

These boards are mounted inside the RF section. Each holds a BAND switch section and the coils for each band function.

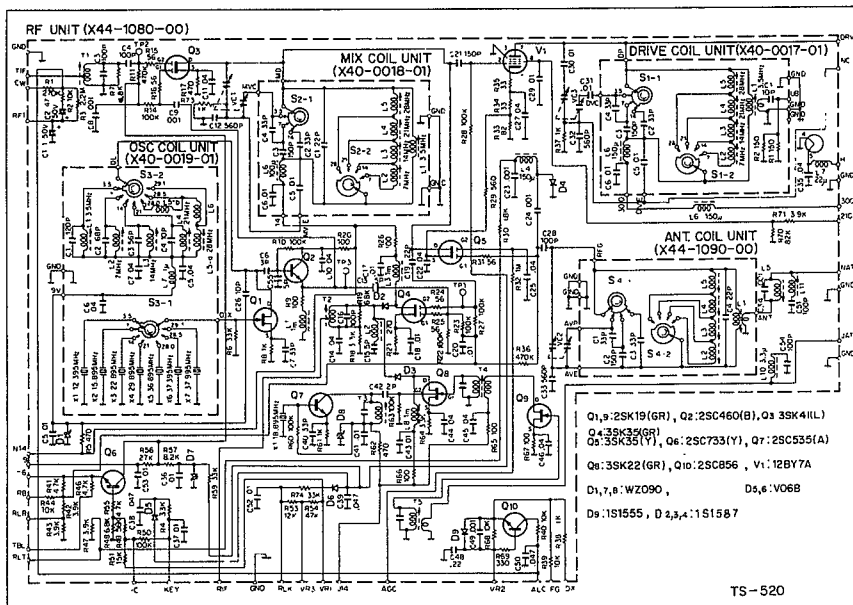
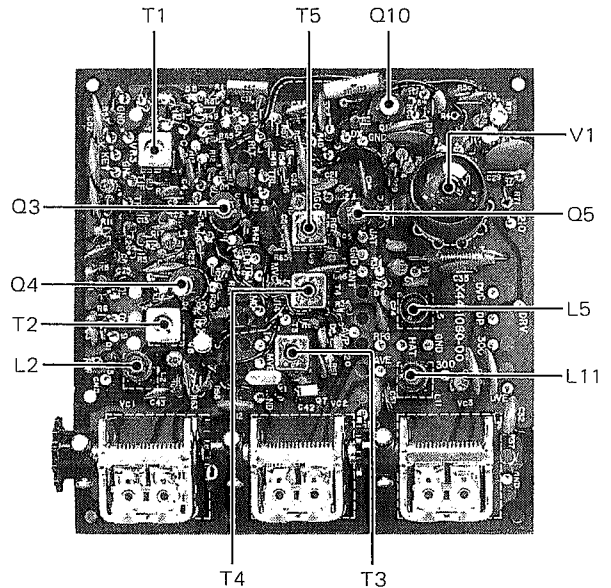


Figure 17 RF Section

### 5.7 MARKER BOARD (X52-0005-01)

(See Figure 18)

The MARKER board holds the 100 kHz crystal oscillator (Q1) and a 25 kHz multivibrator (Q2 and Q3) to produce marker signals at 25 kHz intervals to calibrate the TS-520. Q4 amplifies the calibrator signal.

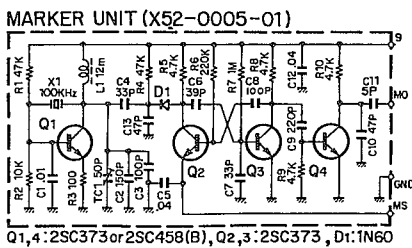
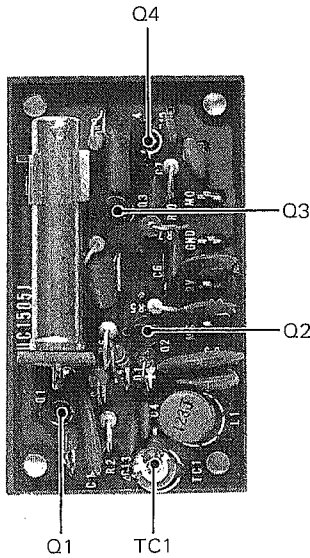


Figure 18 MARKER Board

### 5.8 AF BOARD (X49-0008-01) (See Figure 19)

The AF signals from the GENERATOR board go to the AF board where they pass through a three-stage audio amplifier (Q1, Q2, and Q5). That output is amplified by a two-stage complementary amplifier (Q3 and Q4) to the speaker. The sidetone oscillator (Q6) is also on the AF board.

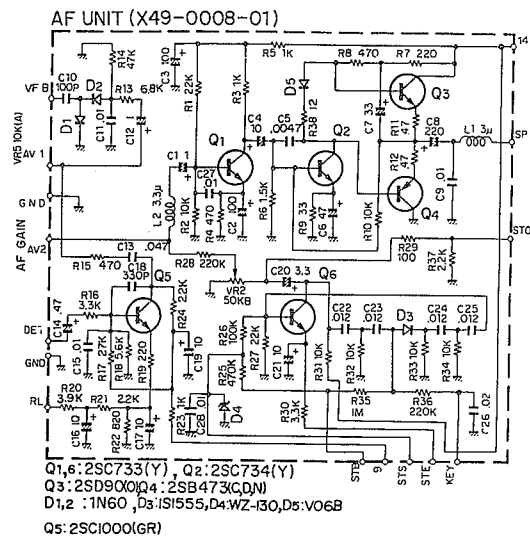
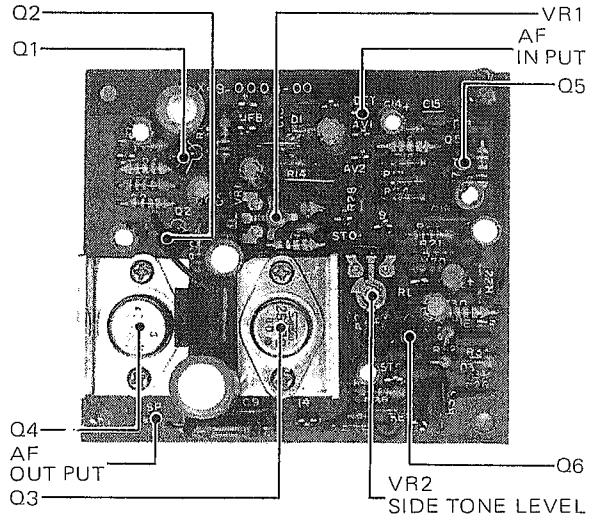


Figure 19 AF Board

### 5.9 VOX BOARD (X54-0001-00) (See Figure 20)

The VOX circuit controls voice operated transmission. The circuit is a Schmidt trigger design giving a fast reaction time. Audio signals from the GENERATOR board are amplified by Q3 and Q4. Q5 controls the release time constant of the circuit. Q6 and Q7 are switching transistors to control Q8, the relay control transistor. Q1 and Q2 are ANTI-VOX amplifiers for audio feedback from the speaker terminals.

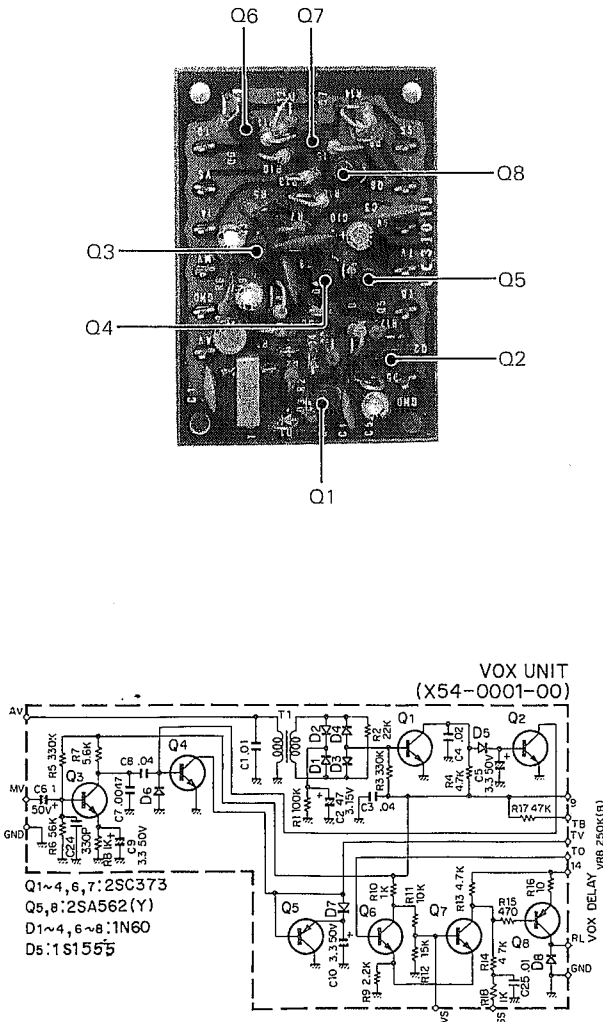


Figure 20 VOX Board

### 5.10 VFO BOARD (X40-1070-00) (See Figure 21)

The inherent frequency stability and readout accuracy of the TS-520 results from the care and quality of the design and components of the VFO (Variable Frequency Oscillator).

To enhance the reliability of the VFO, the TS-520 uses an FET (Q1) for oscillation and a buffer stage (Q2, Q3, and Q4) for buffer amplification. This design insures high frequency stability under load fluctuations. Also included in the circuit are protections against frequency fluctuations from temperature changes and mechanical variations.

The oscillator frequency ranges from 4.9 to 5.5 MHz. The angular displacement of the variable capacitor is reduced from the displacement of the main tuning knob through a series of gears. One revolution of the main tuning knob tunes through 25 kHz of the band.

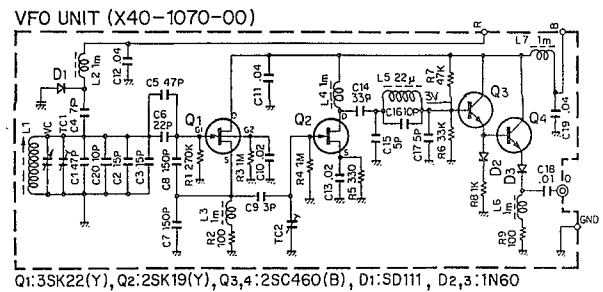


Figure 21 VFO Board

### 5.11 FIXED CHANNEL - AVR BOARD (X43-1100-00) (See Figure 22)

This board holds the crystal-controlled oscillator (Q1) and amplifiers (Q2 and Q3) which can be used in place of the VFO to operate the transceiver on a fixed channel. TC1 through TC4 can be used to net the channel crystals onto their exact frequency. Section 6 describes installation of the crystals.

The AVR circuit (Q4 through Q8) senses and stabilizes the -6 and 9 volt power supplies.

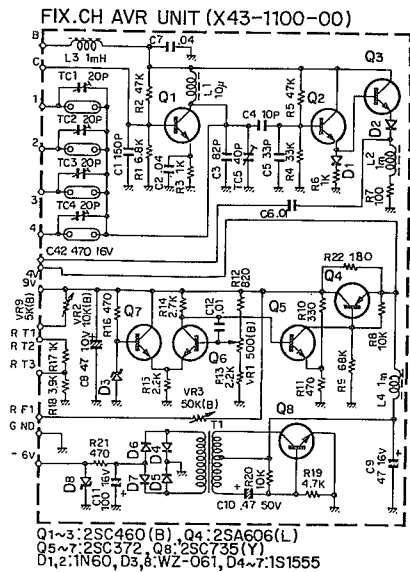
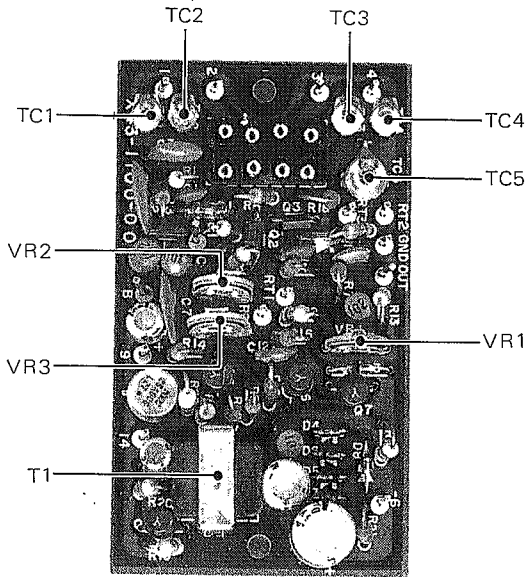
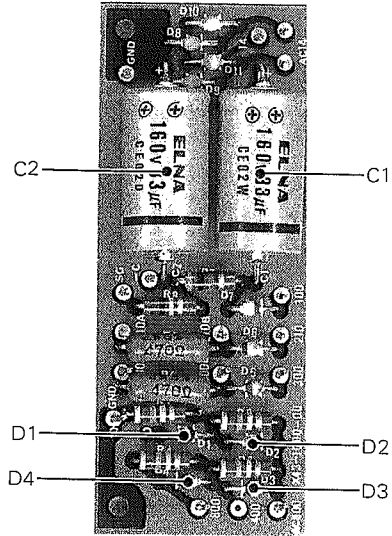


Figure 22 FIXED CHANNEL - AVR Board

### 5.12 RECTIFIER BOARD (X43-1090-00) (See Figure 23)

This board holds all of the diode rectifiers for the power supply section of the transceiver. D1 through D4 rectify the high voltage, D5 rectifies the 300 volt supply, D6 rectifies the 210 volt supply, D7 rectifies the 90 volt supply, and D8 through D11 rectify the 13.8 VDC supply.



**RECTIFIER UNIT  
(X43-1090-00)**

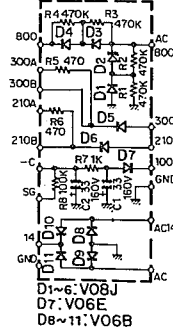


Figure 23 RECTIFIER Board

### 5.13 HV (High Voltage) BOARD (X43-1110-00) (See Figure 24)

This voltage divider circuit supplies a high voltage metering signal for the HV meter reading and also a low voltage screen source used in the TUN mode of operation.

### 5.14 INDICATOR BOARD (X54-1120-00) (See Figure 25)

This circuit controls the light emitting diodes which indicate when the RIT circuit is on, when the fixed frequency oscillator is operating, or when the VFO is oscillating.

### 5.15 FINAL POWER AMPLIFIER SECTION (See Figure 26)

The final amplifier circuit includes two S2001A (6146B) tubes operating in parallel for class AB1 operation. The rated input power is 200 watts PEP. This stage requires neutralization whenever new tubes are used.

Power output is tuned through a pi-network and coupled to the antenna through the antenna relay.

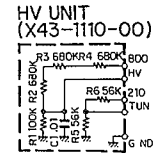
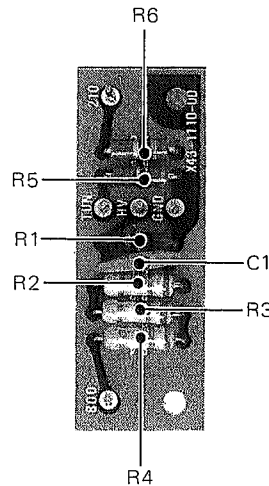


Figure 24 HV Board

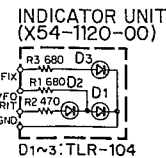


Figure 25 INDICATOR Board

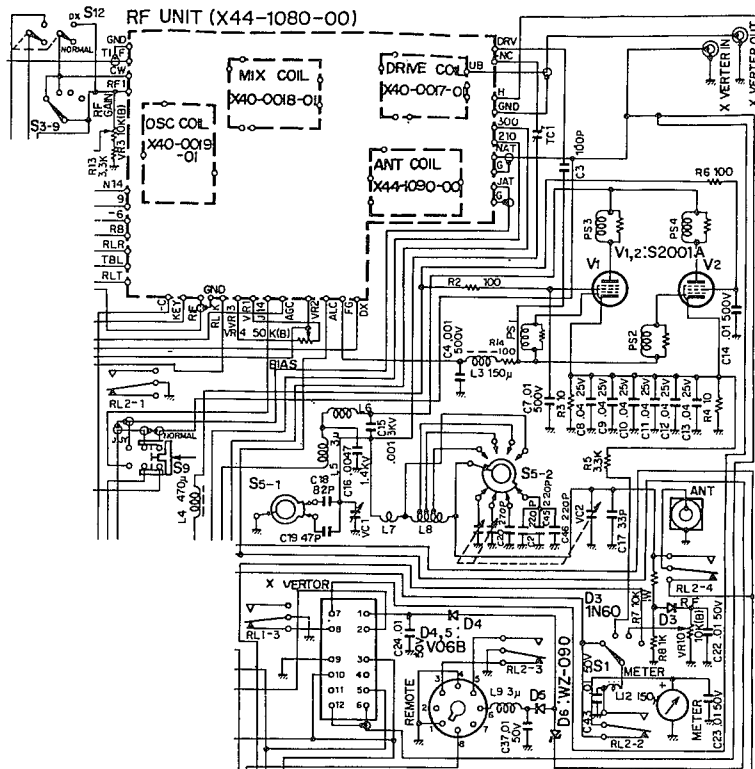


Figure 26 Final Section

# SECTION 6. MAINTENANCE AND ALIGNMENT

## CAUTION

*DANGEROUS HIGH VOLTAGES ARE PRESENT WITHIN THE CASE OF THE TS-520 WHEN THE TRANSCEIVER IS TURNED ON. EXERCISE EXTREME CAUTION TO AVOID ELECTRIC SHOCK.*

## 6.1 GENERAL INFORMATION

The TS-520 has been factory signed 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 27)

Figure 27 shows how to remove the TS-520'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 28)

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

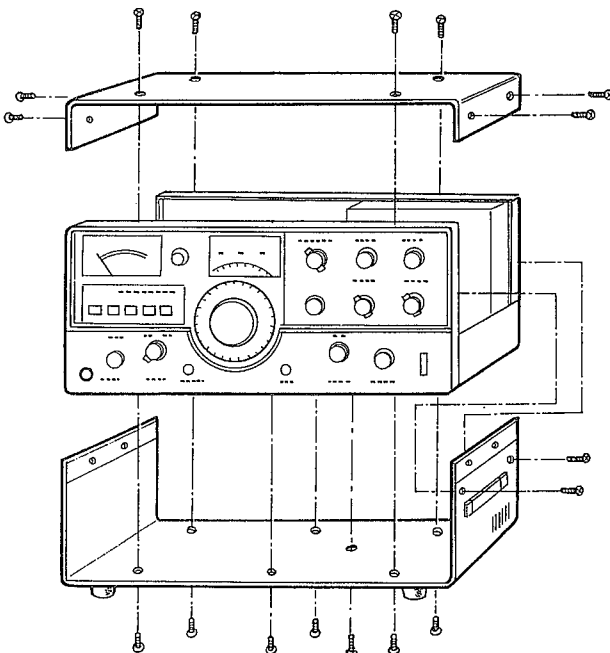


Figure 27 Removing the TS-520's Case

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.

## 6.2 ACCESSORIES

### CAUTION

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

### INSTALLING THE CW FILTER (See Figure 29)

Remove the top and bottom covers from the transceiver (be careful of the speaker leads). Locate the IF board (it holds the SSB crystal filter) and move the brown wire from the SSB terminal to the CW terminal, as shown in Figure 29.

Remove the three screws securing the VR mounting hardware on the side panel and tilt the board down about 90 degrees from its normal position. Screw the filter onto the board with the provided nut and solder the filter's pins to the board. Be careful to use a low power soldering iron for only a short time. Too much heat will damage the crystal filter!

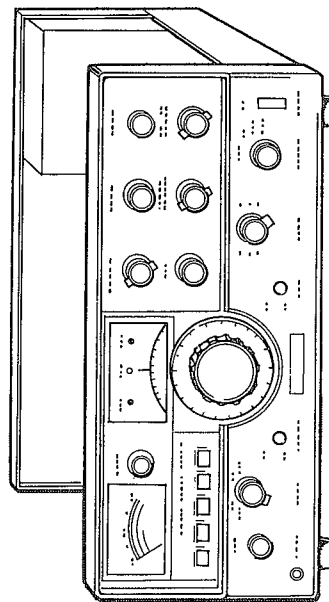


Figure 28 Service Position for the TS-520

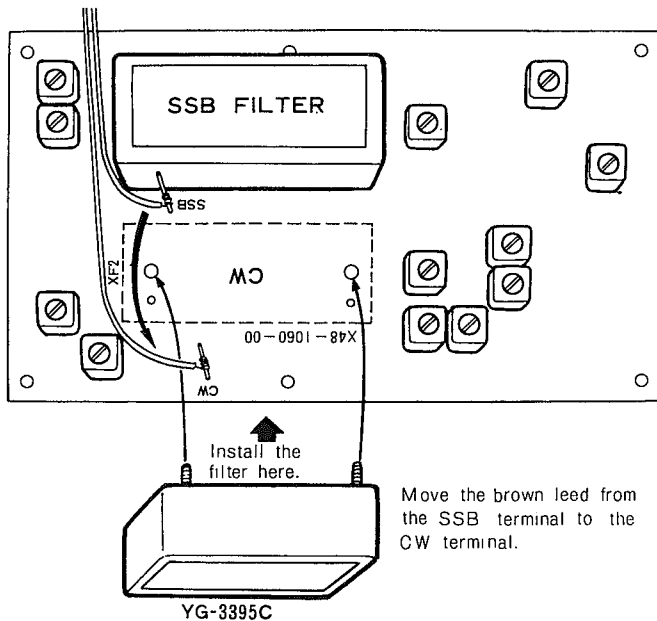


Figure 29 Installing the Accessory CW Filter

Reconnect the VR mounting hardware and replace the covers. If the speaker lead was disconnected, be sure to reattach that also.

**REMOTE CONNECTIONS**

Figure 30 shows the REMOTE connector. This 8-pin plug can be used for attaching linear amplifiers, external speakers (or the audio for a phone patch), or other external accessories to the transceiver.

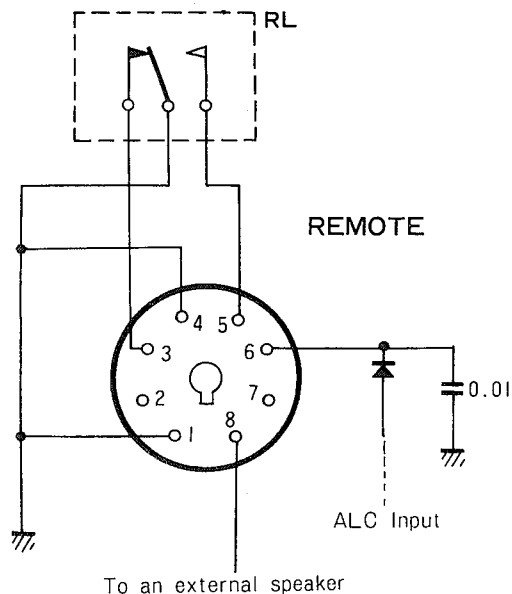


Figure 30 REMOTE Connector

**EXTENSION FEET**

The TS-520 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 31 shows how to install the feet.

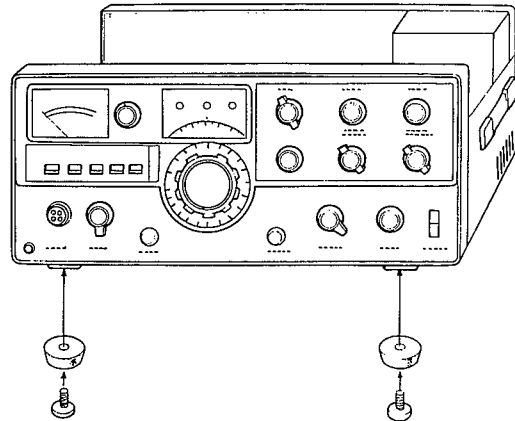


Figure 31 Attaching the Extension Feet

**TRANSVERTER**

The 12-pin transverter control plug, and the transverter in and transverter out plugs can be used with an external accessory transverter (TV-502).

The pin connections are described in Section 3.3. The transverter out plug provides low power output from the driver stage at whatever frequency the transceiver is operating. The band selected for operation with the transverter would depend on the IF frequency of the accessory transverter.

**FIXED CHANNEL CRYSTAL INSTALLATION**

Section 4.14 describes fixed channel operation with the TS-520. To install the accessory crystals, remove the transceivers 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-520 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 32 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.

Adjusting Order*	Band	Alignment Frequency
1	3.5 MHz	3.750 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

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

#### CAUTION

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

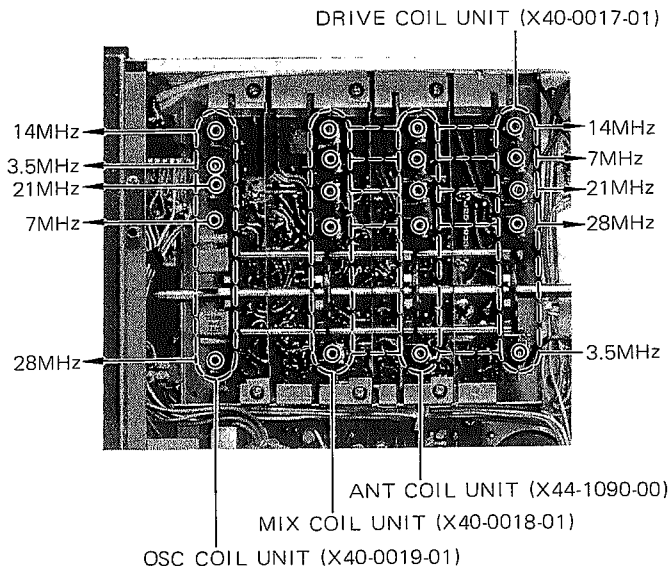


Figure 32 RF Section Coil Diagram

#### 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 32) 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 3.5 MHz coil first and then tune the remaining coils (7.0, 14.0, 21.0, and 28.5) in order.

Band	Oscillator Frequency
WWV	18.895 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

Push the WWV switch on 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 it 1/4 turn counter-clockwise. The oscillator frequency is 18.895 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 10 VDC meter between the collector of Q6 (2SC-733) 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 T1, T2, T5, T6, and T9 (on X48-1060-00) for a maximum S-meter reading.

### CAUTION

*Do not adjust T3, T4, T7, T8, T10, T11 or T12.*

### 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 ATT 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 50  $\mu\text{v}$  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 15 VDC voltmeter between the 9 terminal (on X43-1100-00) and the chassis. Adjust VR1 for a 9 volt reading.

### 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 5 VDC 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 X40-0017-01 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

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

Tune up the TS-520 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 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-520'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.

## 6.11 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 10 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.

## 6.12 REPLACING THE 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 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.

## 6.13 CLEANING

The knobs, front panel and cabinet of the TS-520 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.

Use an air blower or a soft brush to keep the interior clean and dust free.

## 6.14 REPLACEMENT PARTS

### TUBES AND TRANSISTORS

Operation of the TS-520 without proper tuning, or operation of the transceiver with a high voltage in excess of 1000 volts, will significantly reduce the life of the final amplifier tubes. A bad tube or tubes should be replaced with S2001A (6146B) tubes. Matched tubes are not required, however neutralization is required with new tubes. The driver is a 12BY7A.

The transistors in the TS-520 can easily be damaged by being shorted or shocked by metallic tools. Be very careful during service operations, and when possible, use insulated tools.

### SERVICE PARTS

Be sure to use replacement parts of equal or better ratings when servicing the transceiver.

When ordering replacement or spare parts for your equipment, be sure to specify the following information:

Model number and serial number of the equipment — Schematic number of the part — and the board number on which the part is located.

Should it ever be necessary to return the equipment for repair be sure to pack it very carefully and include a full description of the problems involved.

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# 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 transmitter, not by defective components. There is a separate service manual for repair of the TS-520.

## 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>
<p>Frequency difference between transmit and receive.</p> <p>F.Ming on sideband operation.</p>	<ol style="list-style-type: none"> <li>1. 9 VDC 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.</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.</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.</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.</li> <li>2. See Section 6.3.</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.</li> <li>2. See Section 6.5.</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.</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.</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.</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>

#### .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-520 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 4.10.</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 4.10.</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 4.10.</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.</li> <li>2. Check the power supply output.</li> <li>3. See Section 4.9.</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. 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.</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.</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.</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. Tuning becomes very broad. 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-520 requires neutralization.		<ol style="list-style-type: none"> <li>1. See Section 6.9.</li> </ol>

# SECTION 8. VOLTAGE MEASUREMENTS

## 8.1 TUBE VOLTAGE MEASUREMENTS

### FINAL AMPLIFIER SECTION

(In volt)

		Pin no.		1	2	3	4	5	6	7	8
V1	S2001A	R	0.05	(12.6)	246	0.05	-76	0.05	(6.3)	0	
		T	1.3		208	1.3	-55	1.3			
V2	S2001A	R	0.05	(6.3)	246	0.05	-76	0.05	0	0	
		T	1.3		208	1.3	-55	1.3			

### RF BOARD

		Pin No.		1	2	3	4	5	6	7	8	9
V1	12BY7A	R	0.3	-37	0	0	(12.6)	0	328	236	180	0
		T	3.8	0.3								

## 8.2 TRANSISTORS

(In volt)

Unit	TR No.	Electrode		E	C	B	G2	
		Transistor		S	D	G1		
RF BOARD	Q1	2SK19	R	2.0	9.0	0		
			T					
	Q2	2SC460	R	1.4	12.8	1.5		
			T					
	Q3	3SK41	R	0	14.2	-3.2		-4.5
			T	1.4	14.0	1.7		2.4
	Q4	3SK35	R	1.5	13.4	1.4		2.2
			T	0	13.8	-2.2		-3.5
	Q5	3SK35	R	2.3	14.2	2.1		2.5
			T	2.5	14.0	-3.3		2.5
IF BOARD	Q6	2SC733	R	-6.0	-4.8	-12.6		
			T		2.5			
	Q7	2SC535	R	2.4	9.0	4.0		
			WWW					
	Q8	3SK22	R	1.3	14.1	0		
			WWW					
	Q9	2SK19	R	0.4	14.0	0		
			WWW					
	Q10	2SC856	R	-76	3.2	-76		
			T	-55	2.1	-55		
IF BOARD	Q1	3SK35	R	2.8	14.1	1.8	2.7	
			T	2.6	13.9		2.2	
	Q2	3SK41	R	0	9.0	1.6	-3.6	
			T	1.6			1.8	
	Q3	3SK35	R	2.6	14.0	2.0	2.7	
		T	3.3	14.3	-3.2			
IF BOARD	Q4	3SK35	R	2.6	14.0	2.0	2.7	
			T	0	14.3	-3.2		
	Q5	2SC733	R	5.1	9.0	5.6		

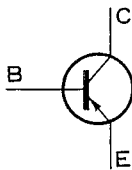
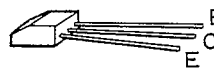
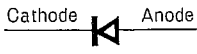
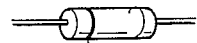

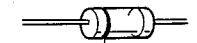




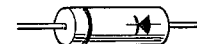
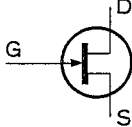
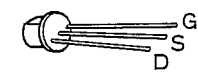
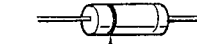
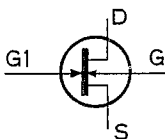
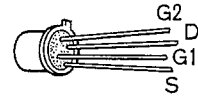
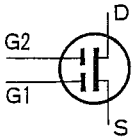
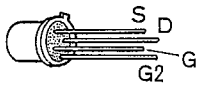
Unit	TR No.	Electrode		E	C	B	G2
		Transistor		S	D	G1	
IF BOARD	Q6	2SC733	R	-6.0	2.7	-5.8	
			T				
	Q7	2SK19	R	5.5	9.0	2.7	
			T	4.4		2.2	
	Q8	2SA495	R	5.8	0	5.3	
		T	5.7	0.4	5.0		
NB BOARD	Q9	3SK35	R	0.7	2.0	0.2	
			T	0	14.1	-3.2	
	Q1	3SK22	R	0.8	13.0	0.8	
			T				
	Q2	2SK19	R	2.3	13.6	0	
			T				
GEN BOARD	Q4	2SC460	R	2.1	13.1	2.8	
			T				
	Q5	2SC735	R	0	6.2	0	
			T				
	Q6	2SC733	R	0	12.2	0	
			T				
FIX CH-VR BOARD	Q1	2SC1000	T	1.2	4.5	1.9	
			T				
	Q2	2SC733	T	0.30	1.8	0.9	
			T				
	Q3	2SC733	T	1.2	3.6	1.8	
		R	0	0	0	3.0	
		T	0.6	6.6	0	2.1	
FIX CH-VR BOARD	Q1	2SC460	R	0.99	8.9	1.3	
			R	2.3	8.9	3.0	

Unit	TR No.	Electrode Transistor		E	C	B	G2
				S	D	G1	
FIX CH-AVR BOARD	Q3	2SC460	R	1.0	8.9	2.3	
	Q4	2SA606	R	13.5	9.0	12.9	
	Q5	2SC372	R	5.3	12.9	5.9	
	Q6	2SC372	R	5.4	5.9	5.9	
	Q7	2SC372	R	5.4	9.0	6.0	
	Q8	2SC735	R	0	10.7	-2.4	
AF BOARD	Q1	2SC733	R	2.2	5.0	2.8	
	Q2	2SC734	T	0.3	7.4	0.9	
	Q3	2SD90	R	7.5	14.2	8.1	
	Q4	2SB473	T	7.5	0	7.4	
	Q5	2SC1000	R	0.7	3.7	1.3	
	Q6	2SC733	T	1.7	8.7	1.5	
VOX BOARD	Q1	2SC373	R	0	0.2	0.7	
	Q2	2SC373	T	0	0	0.1	
	Q3	2SC373	T	0.6	1.3	1.2	

Unit	TR No.	Electrode Transistor		E	C	B	G2
				S	D	G1	
VOX BOARD	Q4	2SC373	R	0	7.2	0	
			T	0	0.3	0.3	
	Q5	2SA562	R	7.2	0	7.2	
			T	0.5	0	0.3	
	Q6	2SC373	R	5.3	6.3	5.9	
			T	4.5	8.6	0.4	
	Q7	2SC373	R	5.3	14.9	3.8	
			T	4.5	12.6	5.1	
MARKER BOARD	Q8	2SA562	R	14.9	0	14.7	
			T	14.1	14.0	13.2	
	Q1	2SC373	R	0.03	9.0	0.6	
	Q2	2SC373	R	0	1.8	0.3	
VFO BOARD	Q3	2SC373	R	0	6.7	0.1	
	Q4	2SC373	R	0	7.9	0.1	
	Q1	3SK22	R	0.2	8.8	0	0
	Q2	2SK19	R	0.6	8.8	0	
CAR BOARD	Q3	2SC460	R	2.3	8.8	3.0	
	Q4	2SC460	R	1.6	8.8	2.3	
CAR BOARD	Q1	2SC460	R	0.7	8.2	1.3	
	Q2	2SC460	R	0.9	8.2	1.6	

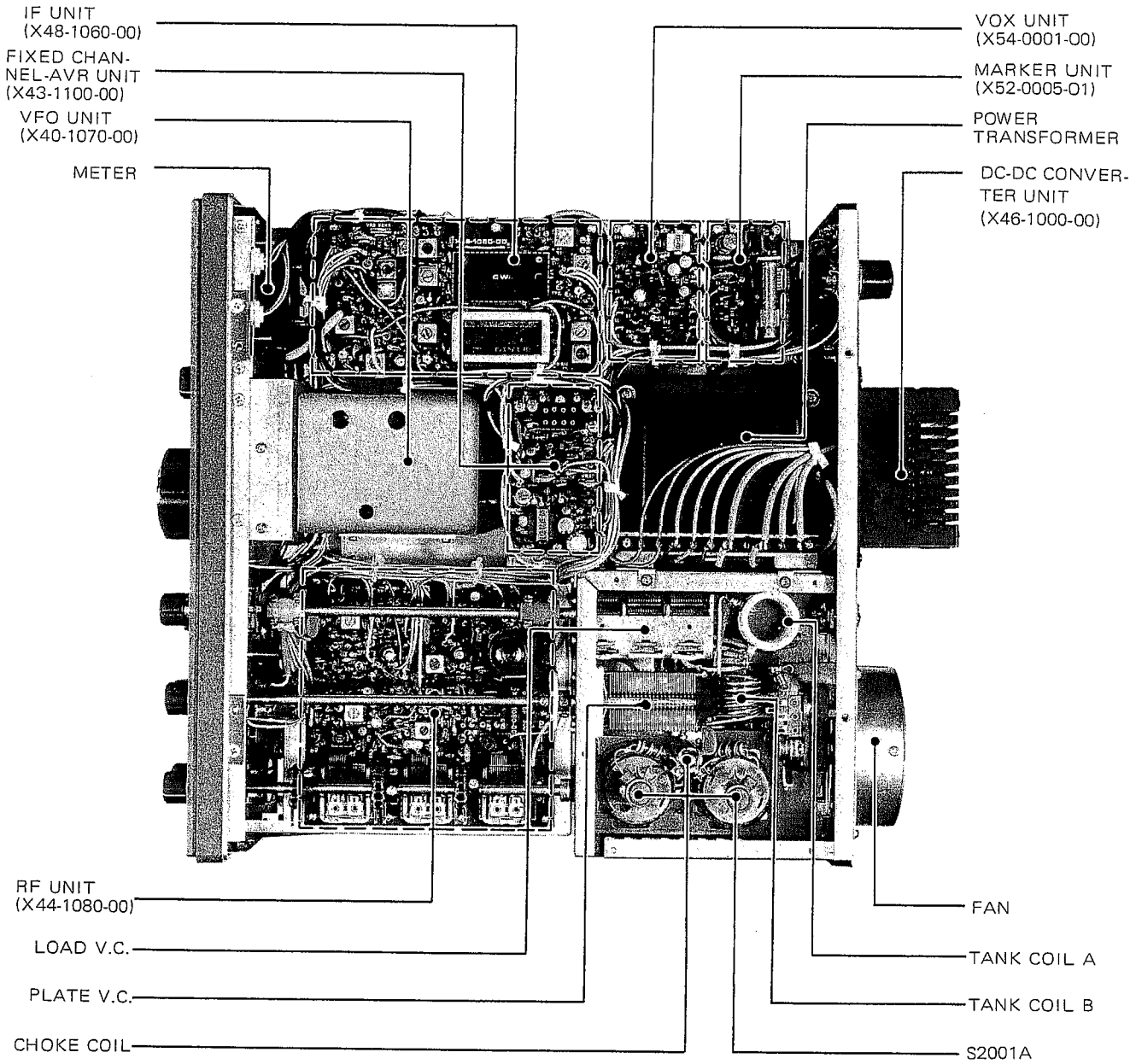
- NOTES:**
1. Measurement is made using a vacuum tube voltmeter (input impedance 11 MΩ).
  2. T : Under maximum CW transmitting output  
R : Under standby condition
  3. VOX BOARD VOLTAGE  
VOX SWITCH → VOX  
CW transmitting condition.

# TRANSISTOR BASE DIAGRAM (FIGURE 33)

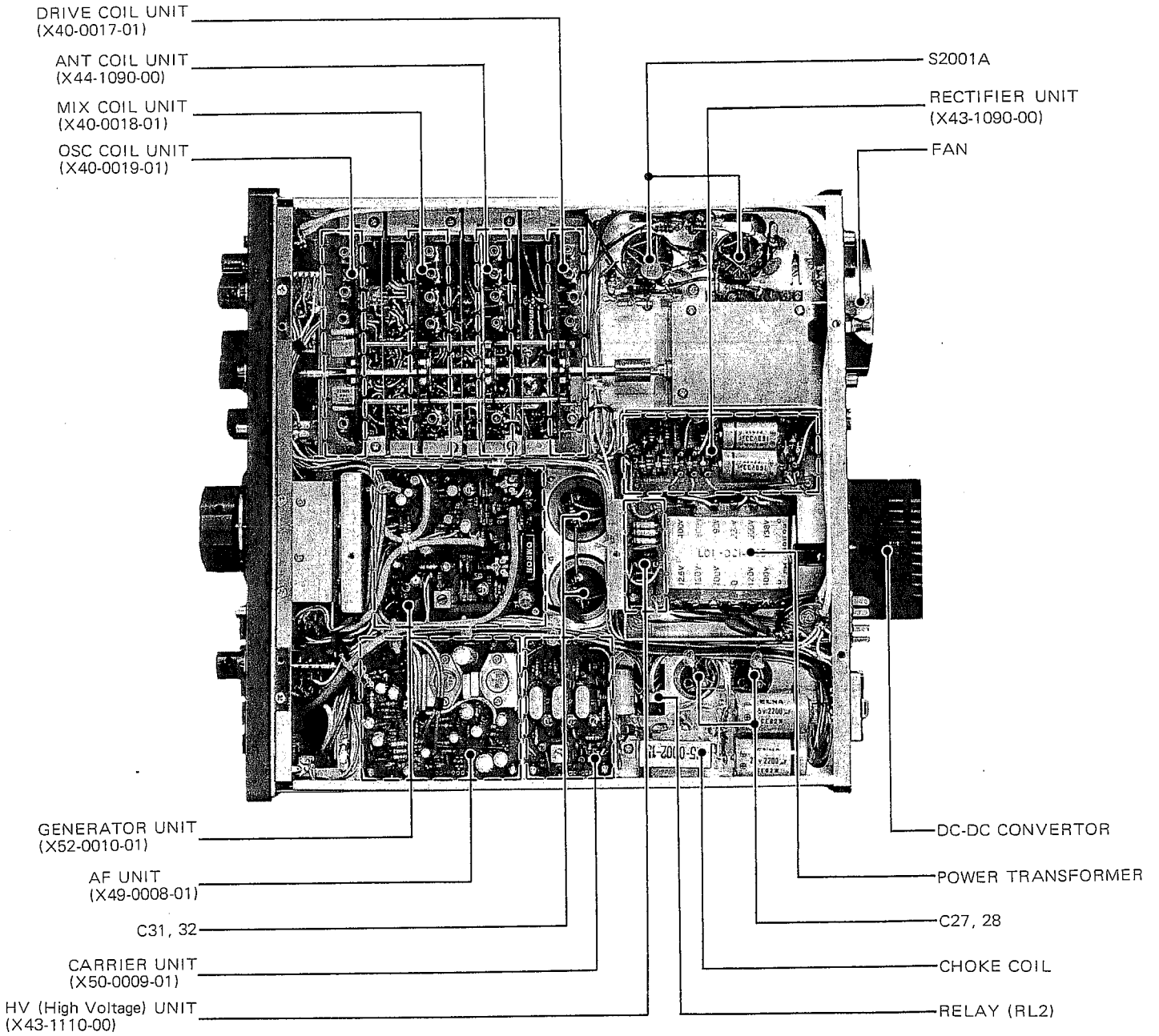
SYMBOL	SHAPE	MODEL	SYMBOL	SHAPE	MODEL		
<p style="text-align: center;">〈PNP〉</p> 		2SC460 2SC535		 <p style="text-align: center;">Cathode</p>	IN60		
		2SC856				 <p style="text-align: center;">Cathode</p>	IS1555
		2SA495 2SA562 2SC372 2SC373 2SC733 2SC734 2SC735 2SC1000					
	2SA606	 <p style="text-align: center;">Cathode (Marked in Color Specified)</p>	V06B : Yellow V08J : Green V06E : Red				
	2SD90 2SB473			 <p style="text-align: center;">Cathode (Marked in Color Specified)</p>	SD111		
						2SK19	 <p style="text-align: center;">Cathode</p>
		3SK22					
		3SK41 3SK35					



# TOP VIEW OF THE TS-520 (FIGURE 34)

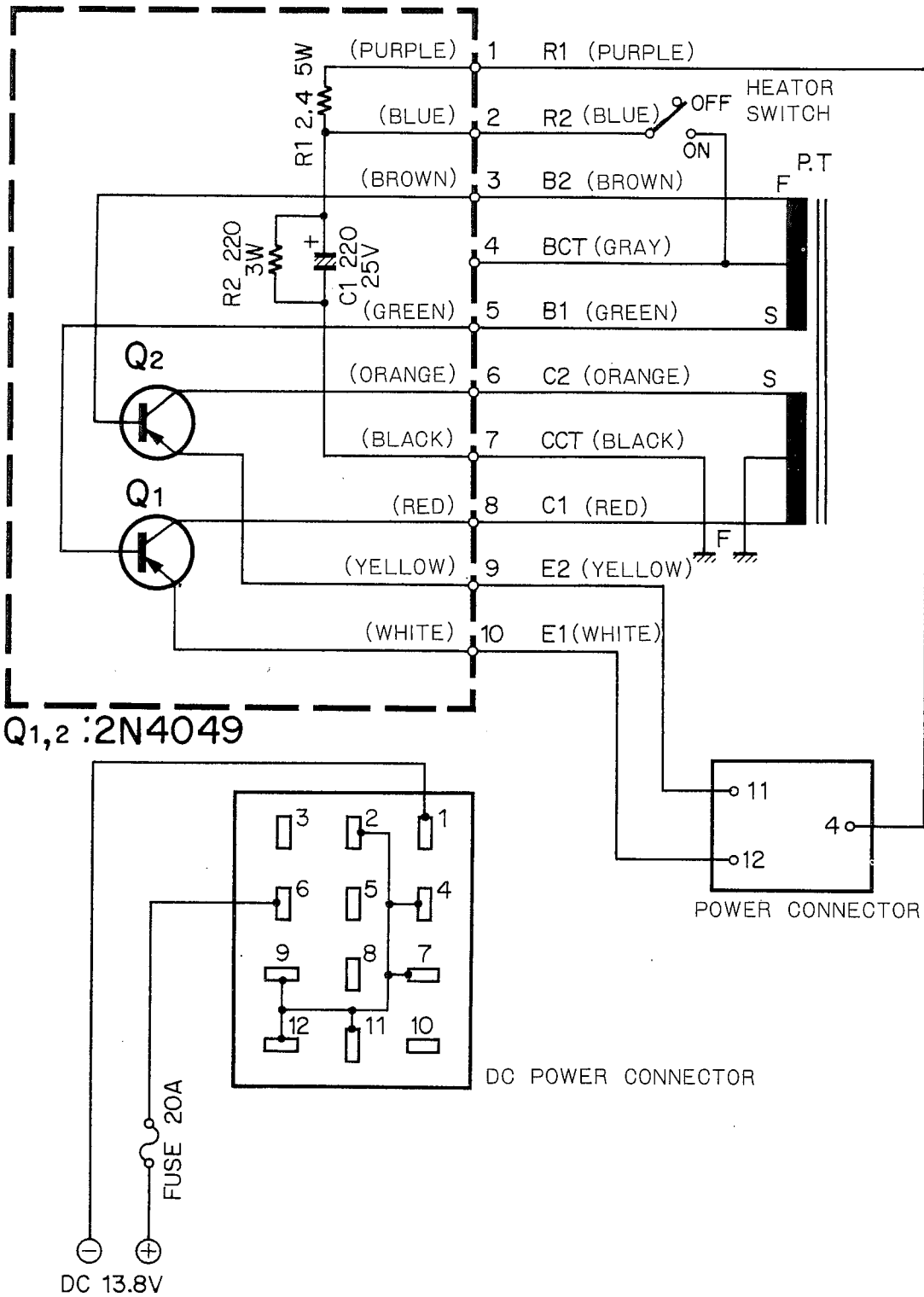


# BOTTOM VIEW OF THE TS-520 (FIGURE 35)

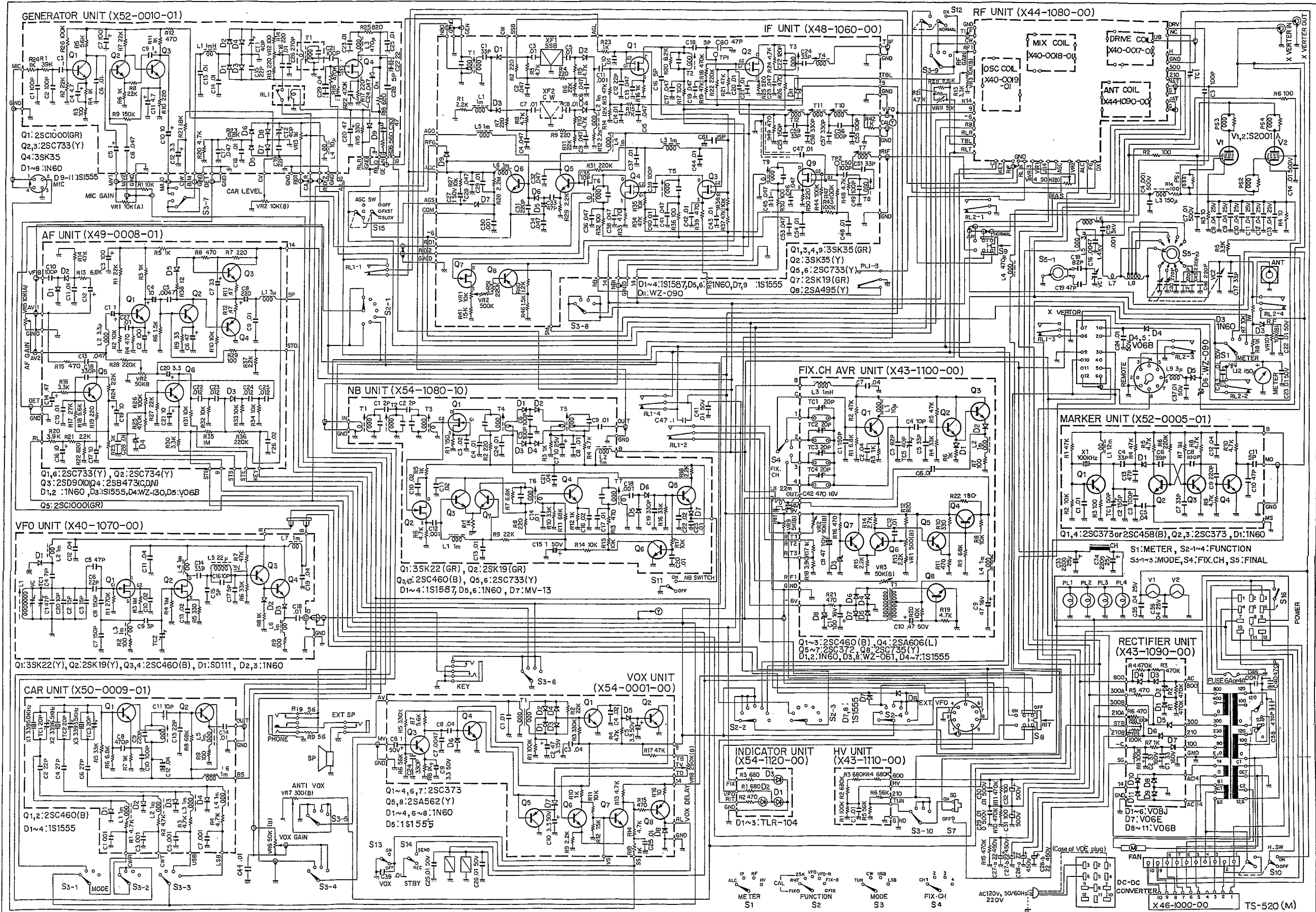


# DC TO DC MODULE SCHEMATIC (FIGURE 36)

DC-DC CONVERTER UNIT  
(X46-1000-00)

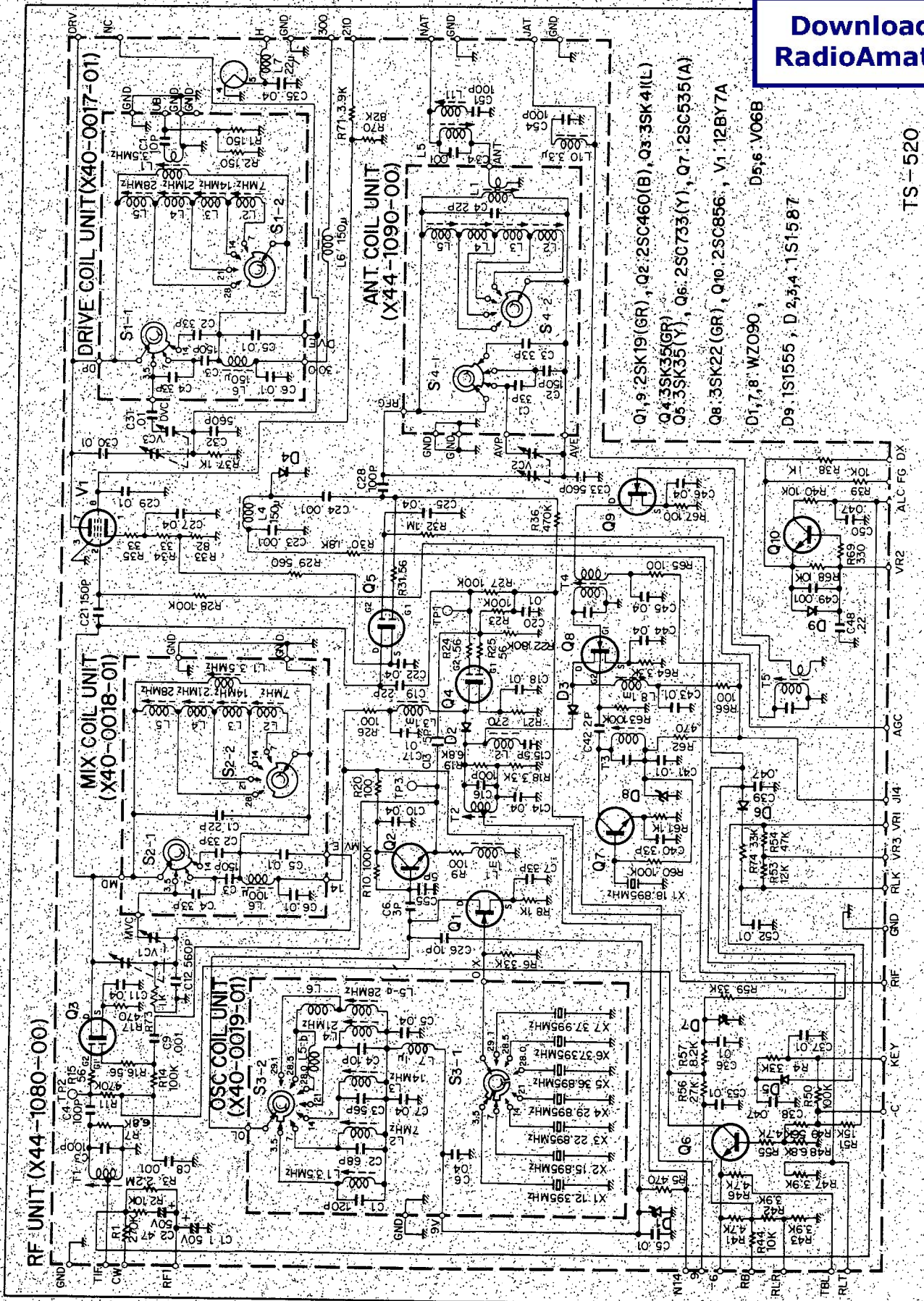


# TS-520 SCHEMATIC (FIGURE 38)



# RF SECTION SCHEMATIC (FIGURE 37)

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TS-520