



# TS-520 OPERATING MANUAL

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# TS-520 SPECIFICATIONS

## FREQUENCY RANGE

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

**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

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

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 manufacturer's instructions should be fol

#### 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.

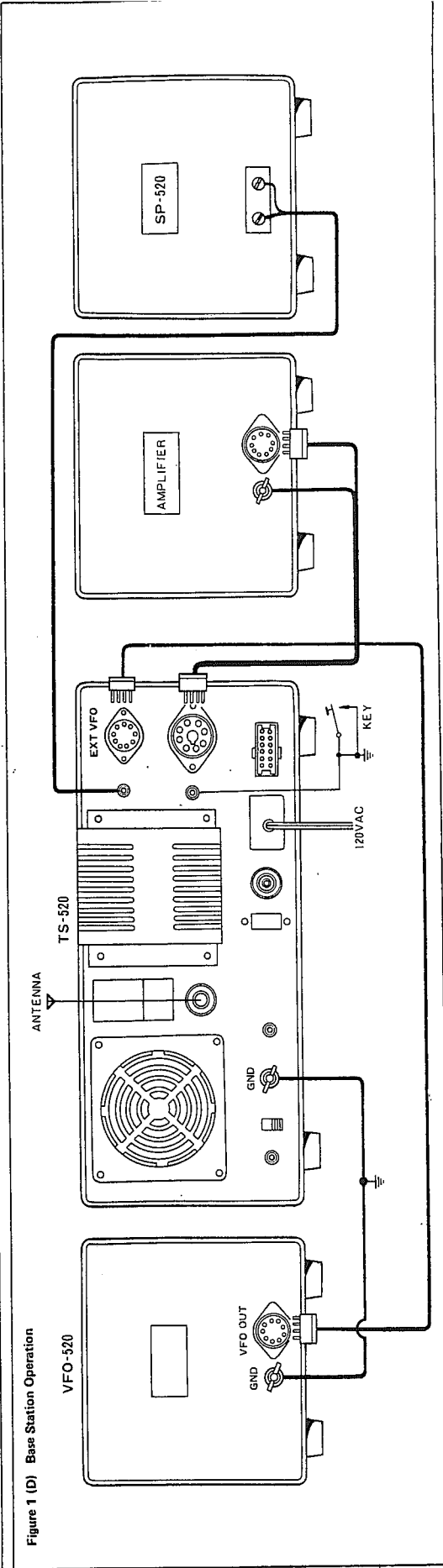
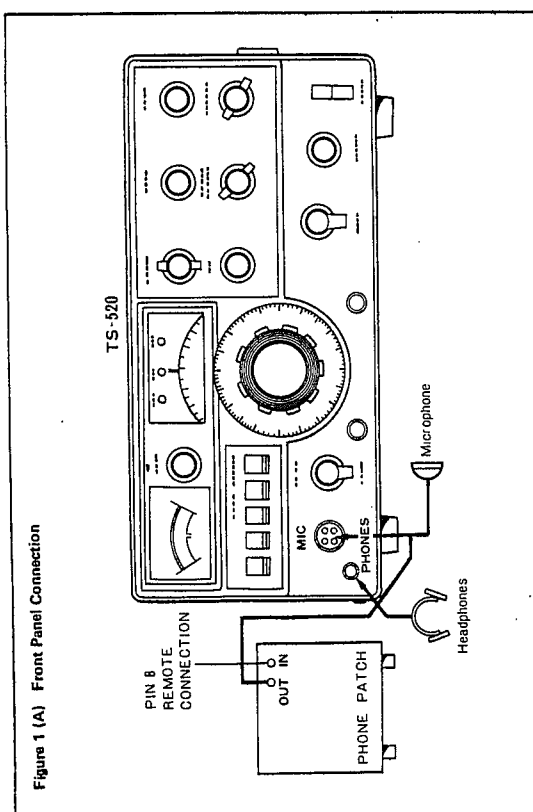
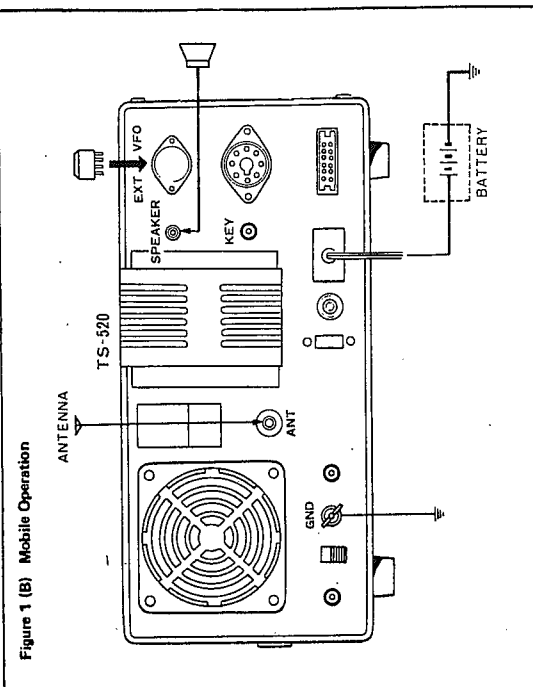
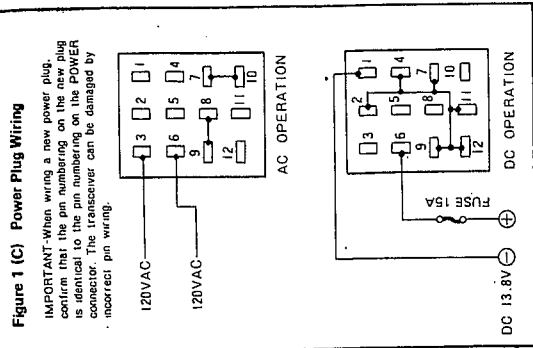
## SECTION 2. INSTALLATION

### 2.1 UNPACKING

Remove the TS-520 from its shipping box and packing material and examine it for visible damage. If the equip-

### POWER CONNECTIONS

Make sure the POWER switch on the front panel of the TS-520 is turned off, the standby switch is put in the REC





## SECTION 3. OPERATING CONTROLS

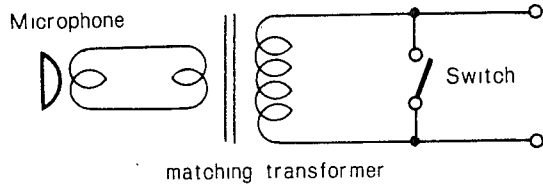
### 3.1 FRONT PANEL CONTROLS (See Figure 5)

#### METER (1 on Figure 5)

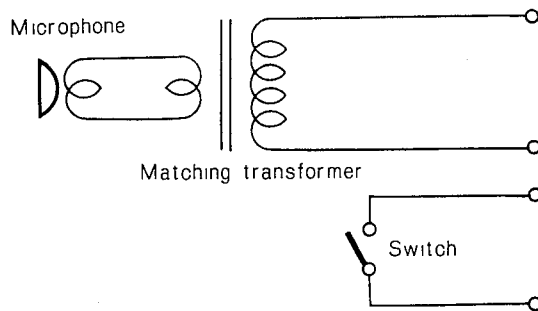
The meter monitors five different functions, depending on

The 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.

RECEIVED CHANNEL OPERATION INDICATOR

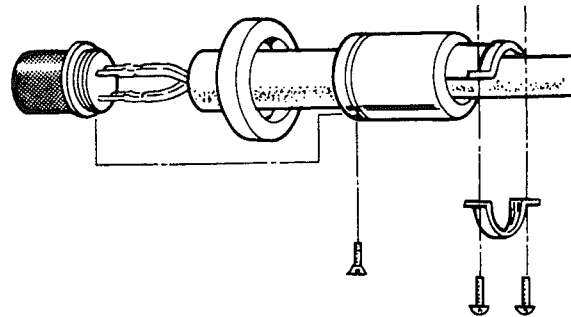


(a) Unsuitable for PTT operation.



(b) Suitable for PTT operation.

Figure 3 A Suitable PTT Microphone



seen from the cord.

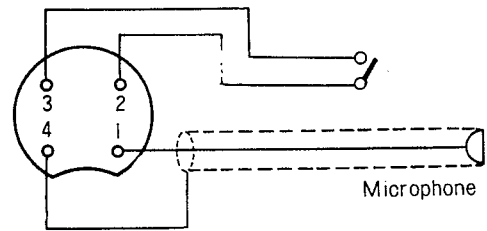
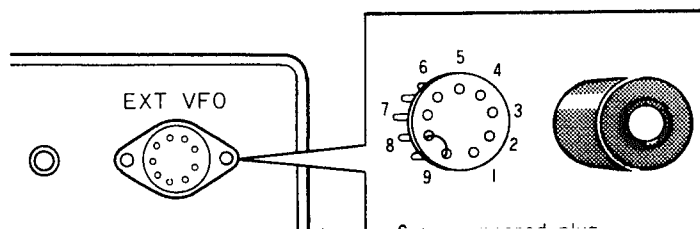
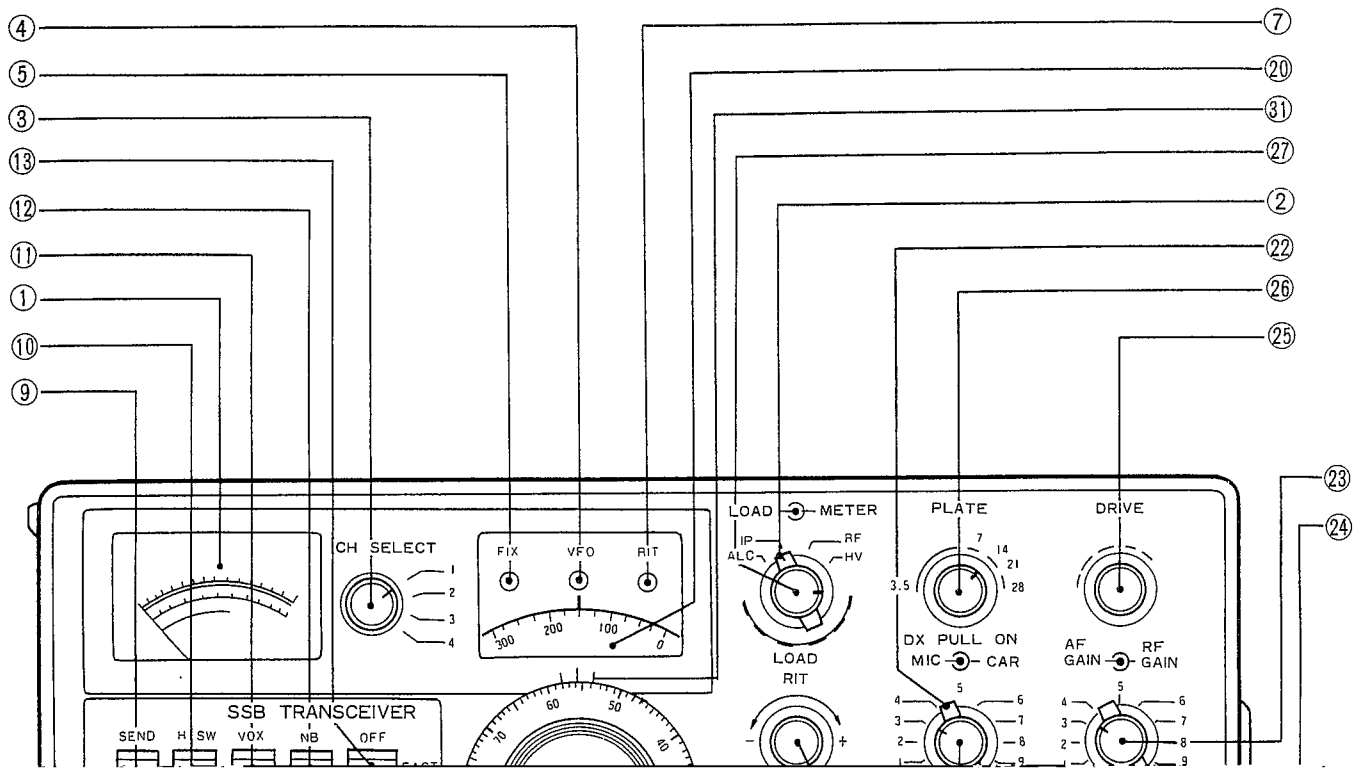


Figure 2 Microphone Connector Wiring





#### **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

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 turned to zero beat the calibration signal.

**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.

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

### 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

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.

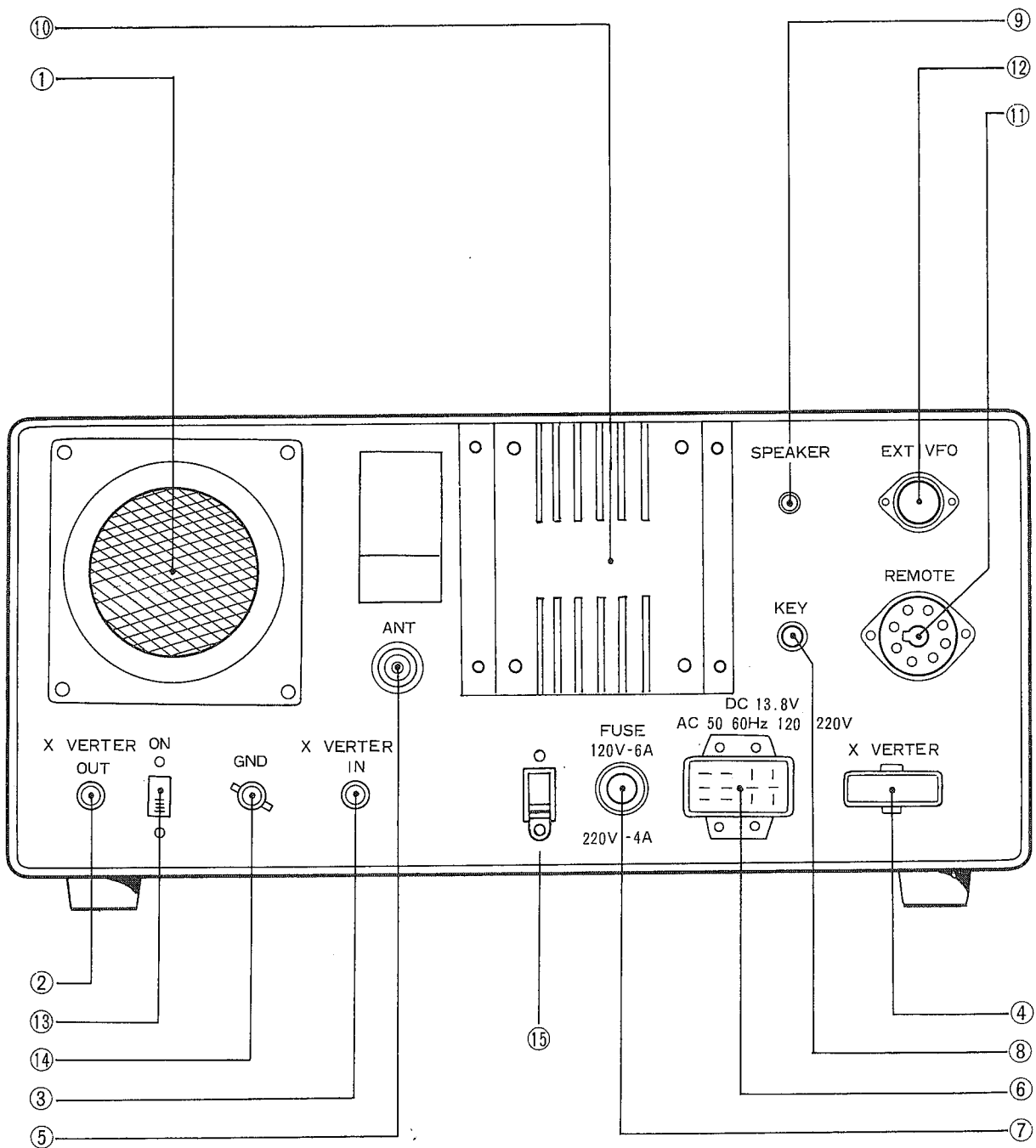
#### TRANSVERTER IN JACK (3 on Figure 7)

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.





- |                              |                    |                           |
|------------------------------|--------------------|---------------------------|
| 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

PIN	FUNCTION	PIN	FUNCTION

CC SWITCH (12 on Figure 7)

# SECTION 4. OPERATING INSTRUCTIONS

## 4.1 PRELIMINARY PROCEDURE

Set the MIC and GAB controls to zero and the MODE

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 with-

Example: BAND Switch - 14.0

For modification of the wiring disconnect the brown lead

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.

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 transceiver operation to prevent unintentionally transmitting.

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

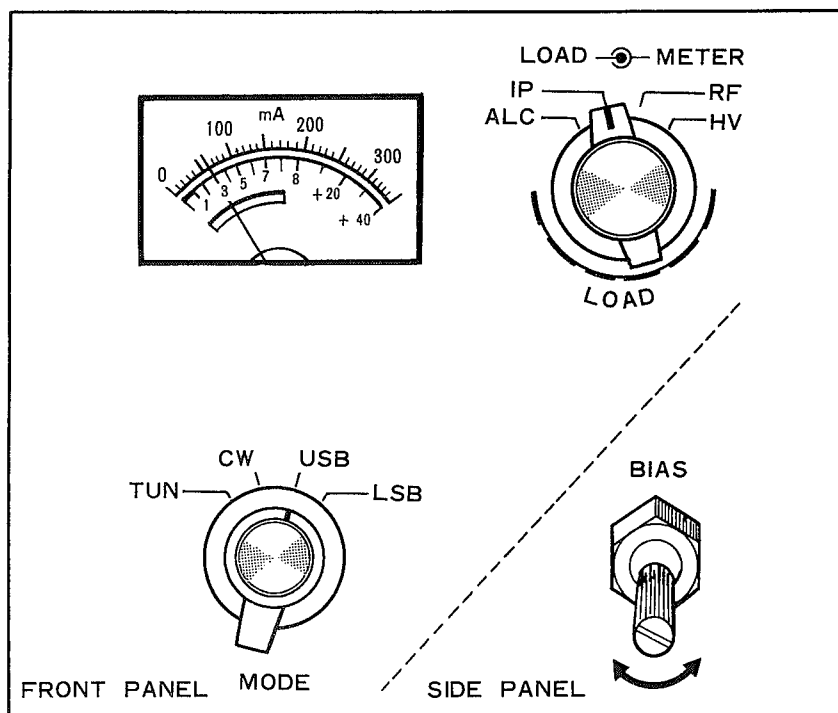
LOCATION	CONTROL	POSITION
FRONT PANEL CONTROLS	BAND Switch	Desired band
	POWER Switch	ON
	H. SW Switch	ON
	Stand-by Switch	REC
	MODE Switch	USB or LSB depending on selected band.
	VOX Switch	MAN
	MIC Control	Fully counter-clockwise
	CAR Control	Centered
	METER Switch	I <sub>p</sub>
	WWV Switch	OFF
	PLATE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

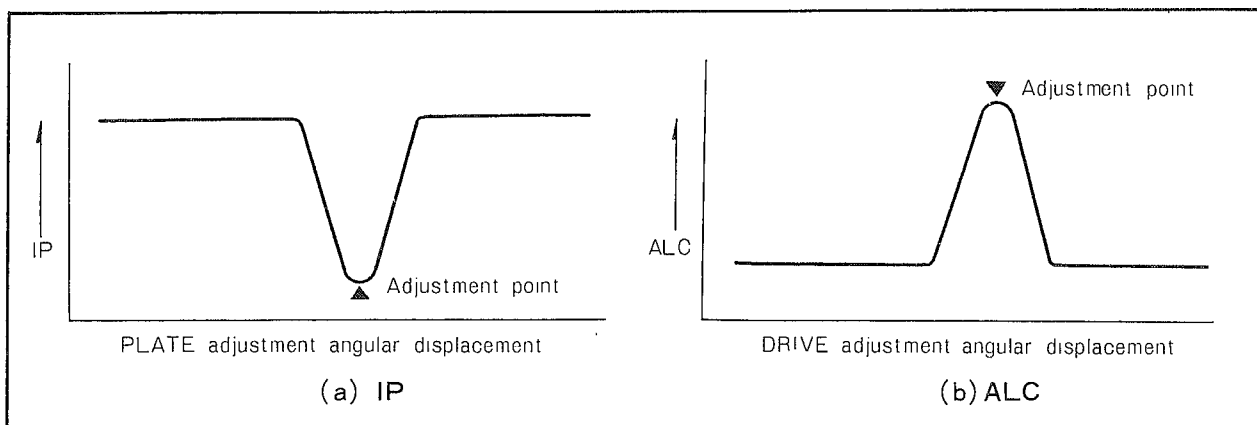


Figure 10 Plate and Drive Tuning

## 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

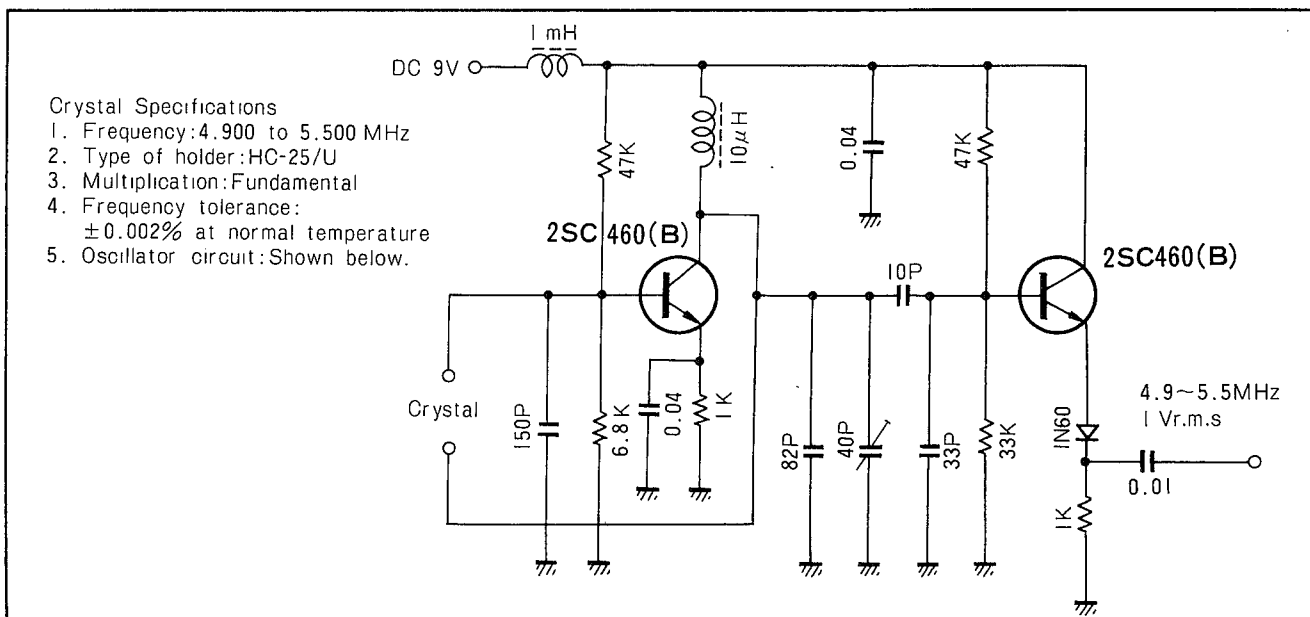


Figure 11 Crystal Oscillator Circuit

#### 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

#### 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

**MEMO**

## 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

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.

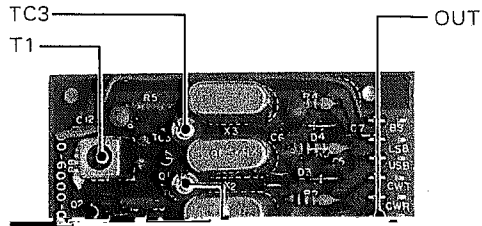


## 5.2 CARRIER BOARD (X50-0009-01)

(See 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.



## 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.

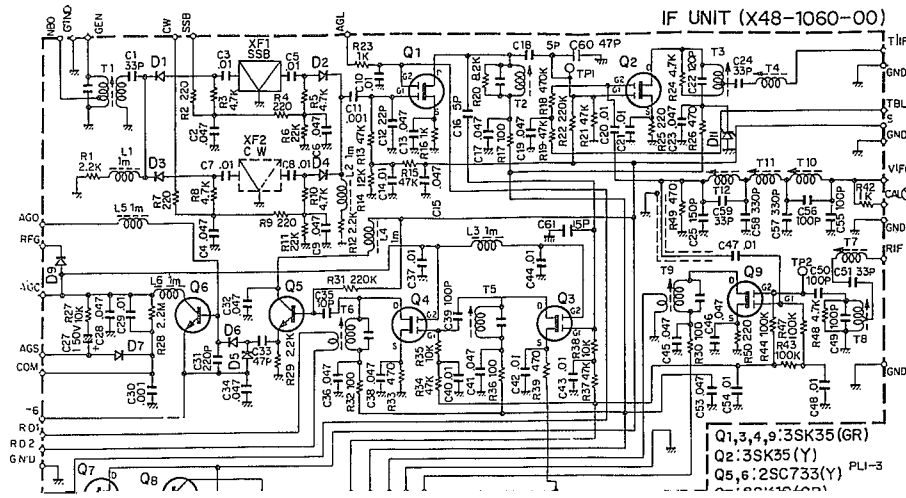
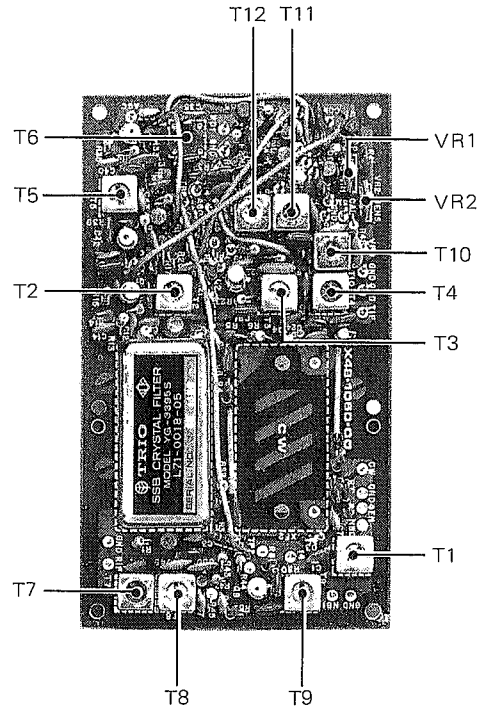
D 1 1

## 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.



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

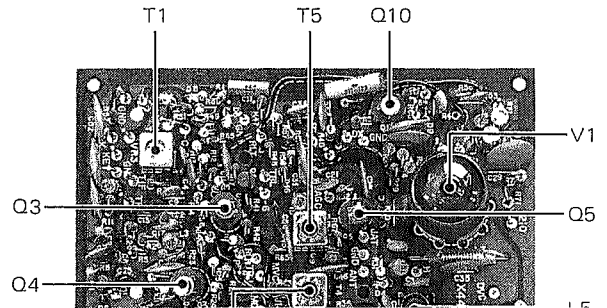
The noise blanker is designed to reduce pulse noises in received signals. The circuit switches closed during the

T7 T6  
| |

## 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.

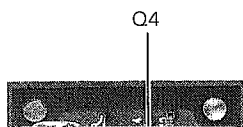
For transmission, the second IF signal from the IF board



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

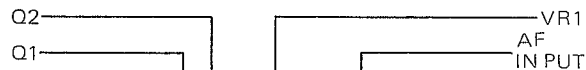
(See Figure 18)

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.



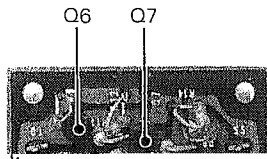
### 5.8 AF BOARD (X49-0008-01) (See Figure 19)

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 complimentary amplifier (Q3 and Q4) to the speaker. The sidetone oscillator (Q6) is also on the 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.



### 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).

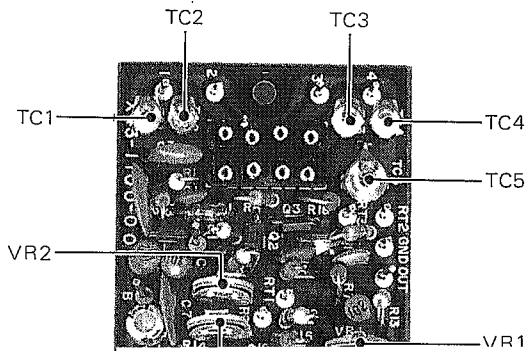
To enhance the reliability of the VFO, the TS-520 uses an FET (Q1) for oscillation and a buffer stage (Q2, Q3, and Q4) for buffer amplification. This design insures high frequency stability under load fluctuations. Also included in the circuit are protections against frequency fluctuations from temperature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

The oscillator frequency ranges from 4.9 to 5.5 MHz. The

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

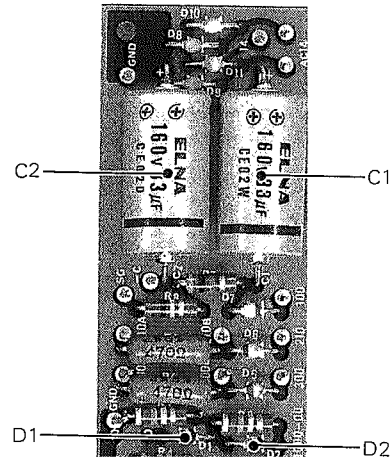
This board holds the crystal-controlled oscillator (Q1) and amplifiers (Q2 and Q3) which can be used in place of the VFO to operate the transceiver on a fixed channel. TC1 through TC4 can be used to net the channel crystals onto their exact frequency. Section 6 describes installation of the crystals.

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



### 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.



**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.

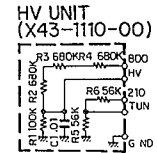
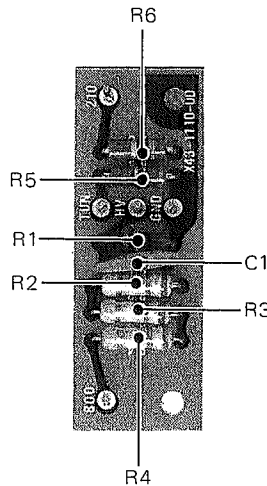


Figure 24 HV Board

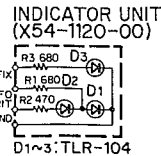
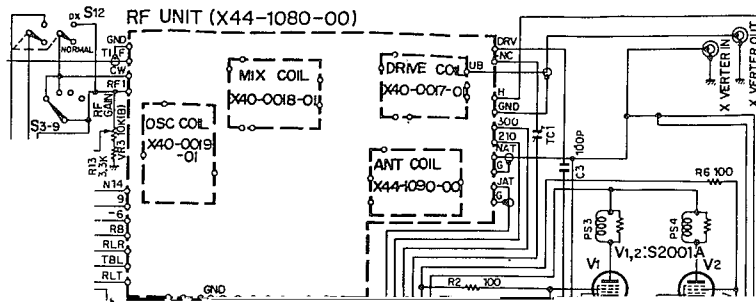


Figure 25 INDICATOR Board



SECTION 6 MAINTENANCE AND ALIGNMENT

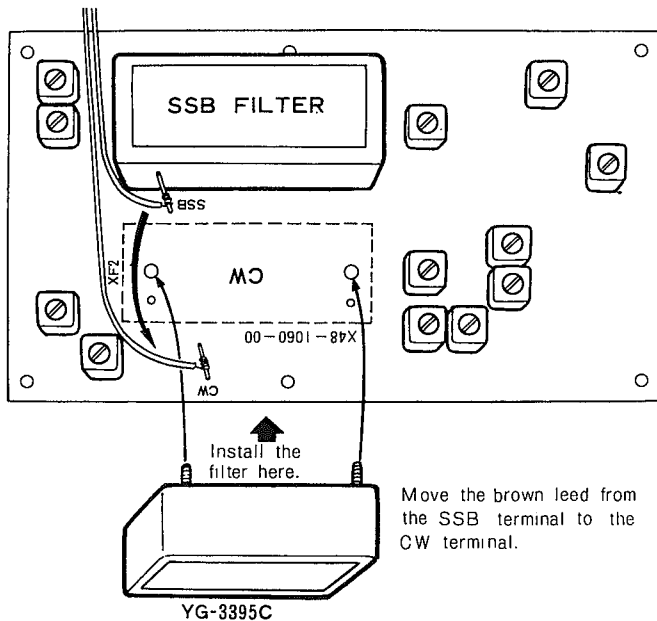
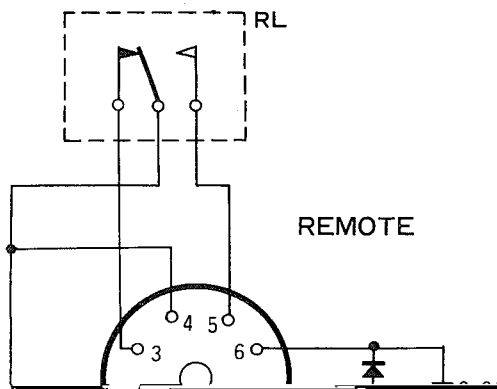


Figure 29 Installing the Accessory CW Filter

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.



#### 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.

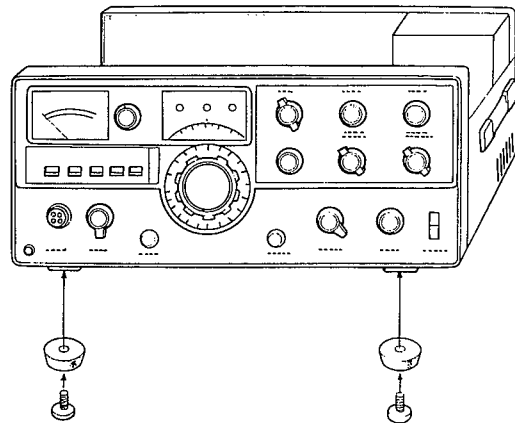


Figure 31 Attaching the Extension Feet

#### 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 transceiver's top cover and locate the FIXED CHANNEL - AVR board directly behind the VFO.

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

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.

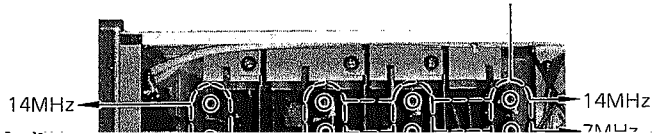
Adjusting Order*	Band	Alignment Frequency
1	3.5 MHz	3.750 MHz
2	28.5 MHz	28.800 MHz
3	21.0 MHz	21.225 MHz
4	14.0 MHz	14.175 MHz
5	7.0 MHz	7.150 MHz

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

#### CAUTION

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

DRIVE COIL UNIT (X40-0017-01)



#### 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.

## 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

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

*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.

# SECTION 7. TROUBLESHOOTING

## 7.1 GENERAL INFORMATION

The problems described in this table are failures caused in

general by improper operation or connection of the transceiver, not by defective components. There is a separate service manual for repair of the TS-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	1. Bad power cable or connections. 2. Blown power supply fuse	1. Check cables and connections. 2. Replace the fuse

#### .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> </ol>	<ol style="list-style-type: none"> <li>1. See Section 6.9.</li> <li>2. Check the power supply output.</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)

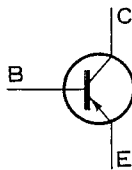
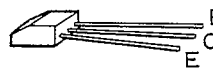

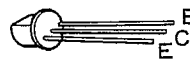
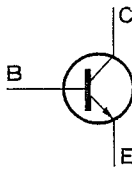

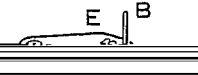
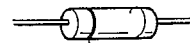
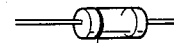
Unit	TR No.	Electrode		E	C	B	G2	
		Transistor		S	D	G1		
RF BOARD	Q1	2SK19	R	2.0	9.0	0		
			T					
	Q2	2SC460	R	1.4	12.8	1.5		
			T					
	Q3	3SK41	R	0	14.2	-3.2		-4.5
			T	1.4	14.0	1.7		2.4
	Q4	3SK35	R	1.5	13.4	1.4		2.2
			T	0	13.8	-2.2		-3.5
	Q5	3SK35	R	2.3	14.2	2.1		2.5
			T	2.5	14.0	-3.3		2.5
IF BOARD	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		
			T					
	Q4	3SK35	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		
	Q2	2SC460	R	2.3	8.9	3.0		

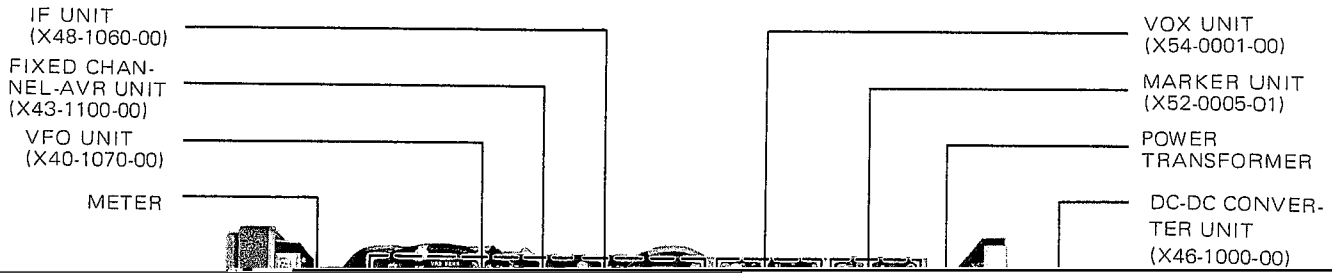
Unit	TR No.	Electrode		E	C	B	G2
		Transistor					
FIX CH-AVR BOARD	Q3	2SC460	R	1.0	8.9	2.3	
	Q4	2SA606	R	13.5	9.0	12.9	
	Q5	2SC372	R	5.3	12.9	5.9	
	Q6	2SC372	R	5.4	5.9	5.9	
	Q7	2SC372	R	5.4	9.0	6.0	
	Q8	2SC735	R	0	10.7	-2.4	
	Q1	2SC733	R T R	2.2	5.0	2.8	
	Q2	2SC734		0.3	7.4	0.9	

Unit	TR No.	Electrode		E	C	B	G2	
		Transistor						S
VOX BOARD	Q4	2SC373	R T	0	7.2 0.3	0 0.3		
	Q5	2SA562	R T	7.2 0.5	0	7.2 0.3		
	Q6	2SC373	R T	5.3 4.5	6.3 8.6	5.9 0.4		
	Q7	2SC373	R T	5.3 4.5	14.9 12.6	3.8 5.1		
	Q8	2SA562	R T	14.9 14.1	0 14.0	14.7 13.2		
	SER BOARD	Q1	2SC373	R	0.03	9.0	0.6	
		Q2	2SC373	R	0	1.8	0.3	

# TRANSISTOR BASE DIAGRAM (FIGURE 33)

SYMBOL	SHAPE	MODEL	SYMBOL	SHAPE	MODEL
<p>&lt;PNP&gt;</p> 		2SC460 2SC535			
		2SC856			
		2SA495 2SA562 2SC372 2SC373 2SC733 2SC734 2SC735 2SC1000			
<p>&lt;NPN&gt;</p> 		2SA606			
					
				 <p style="text-align: center;">Cathode</p>	IN60
			 <p style="text-align: center;">Cathode</p>	1S1555	

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



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

DRIVE COIL UNIT  
(X40-0017-01)

ANT COIL UNIT  
(X44-1090-00)

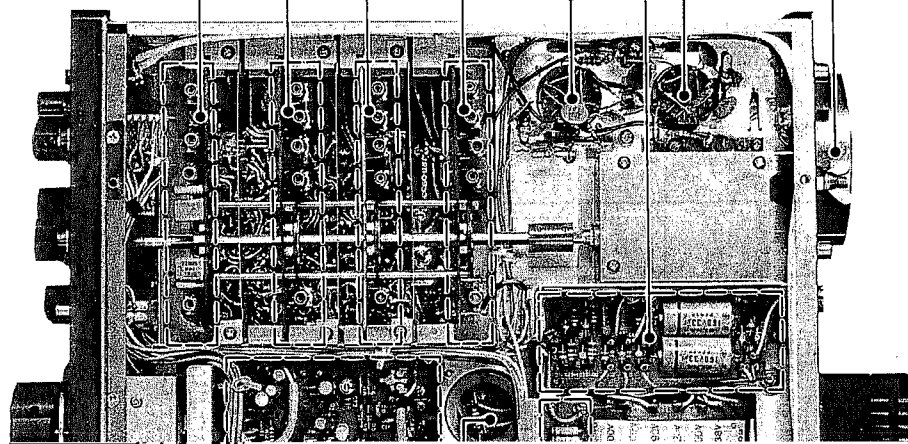
MIX COIL UNIT  
(X40-0018-01)

OSC COIL UNIT  
(X40-0019-01)

S2001A

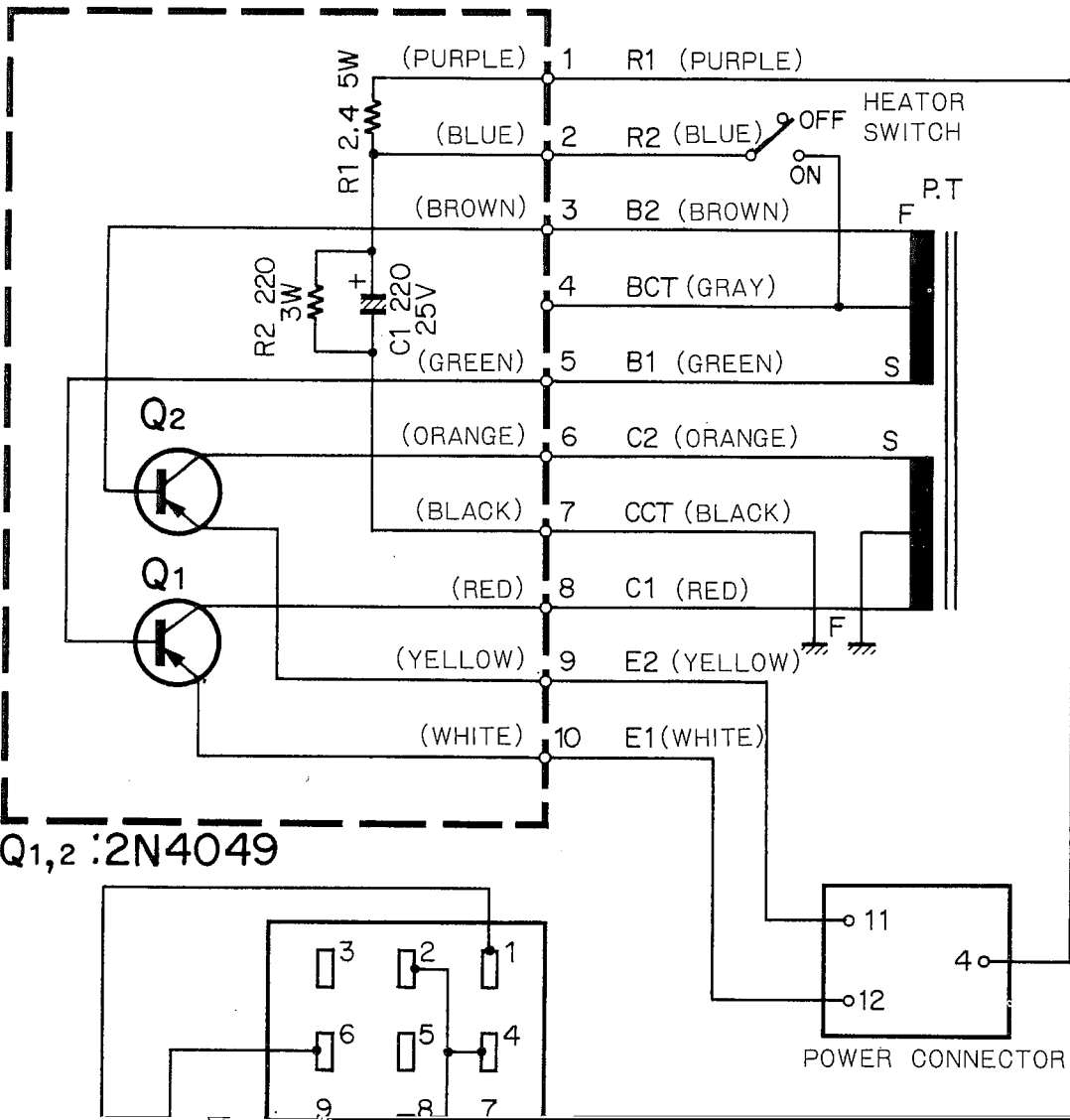
RECTIFIER UNIT  
(X43-1090-00)

FAN



# DC TO DC MODULE SCHEMATIC (FIGURE 36)

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







# RF SECTION SCHEMATIC (FIGURE 37)

ORV NC H GND 300 210 NAT GND NAT GND



