

# KENWOOD

## HF SSB TRANSCEIVER

# Model TS-120S TS-120V



## OPERATING MANUAL

# INTRODUCTION

You are the owner of our latest product, the new TS-120S(V) transceiver. Please read this instruction manual carefully before placing your transceiver in service. The unit has been carefully engineered and manufactured to rigid quality standards, and should give you satisfactory and dependable operation for many years.

## AFTER UNPACKING:

- Shipping container:  
Save the boxes and packing in the event your unit needs to be transported for remote operation, maintenance, or service.
- The following explicit definitions apply in this manual:  
**Note:** If disregarded inconvenience only, no risk of equipment damage or personal injury.  
**Caution:** Equipment damage may occur, but not personal injury.

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# TS-120S, TS-120V SPECIFICATIONS

**Frequency Range** ..... 80 meter band: 3.50 ~ 4.00 MHz  
 40 meter band: 7.00 ~ 7.30 MHz  
 20 meter band: 14.00 ~ 14.35 MHz  
 15 meter band: 21.00 ~ 21.45 MHz  
 10 meter band: 28.00 ~ 29.70 MHz  
 WWV: 15.0 MHz

**Mode** ..... SSB/CW

**Grounding** ..... Negative ground only

**Power Requirements** .....

	TS-120S	TS-120V
Receive	0.7A 13.8 VDC	0.7A 13.8 VDC
Transmit	18A 13.8 VDC	4A 13.8 VDC

**Final Power Input** .....

	TS-120S	TS-120V
80~15m band	200W PEP for SSB operation 160W DC for CW operation	25W PEP for SSB operation 20W DC for CW operation
10m band	160W PEP for SSB operation 140W DC for CW operation	25W PEP for SSB operation 20W DC for CW operation

**Audio Input Impedance** ..... 500Ω ~ 50 kΩ  
**Audio Output Impedance** ..... 4Ω ~ 16Ω  
**Audio Output** ..... More than 1.5 watts (with less than 10% distortion) into an 8-ohm load.  
**RF Output Impedance** ..... 50Ω  
**Frequency Stability** ..... Within 100 Hz during any 30 minute period after warmup.  
 Within ±1 kHz during the first hour after 1 minute of warmup

**Carrier Suppression** ..... Carrier better than 40 dB down from the output signal  
**Sideband Suppression** ..... Unwanted sideband is better than 50 dB down from the output signal.  
**Spurious Radiation** ..... Better than 40 dB down from output signal.  
**Harmonic Radiation** ..... Better than 40 dB down from output signal  
**Image Ratio** ..... Image frequency better than 50 dB down from the output signal  
**IF Rejection** ..... IF frequency is 70 dB or more down from output signal  
**Receiver Sensitivity** ..... 0.25 μV at 10 dB S+N/N or better  
**Receiver Selectivity** ..... SSB 2.4 kHz (−6 dB)  
 4.2 kHz (−60 dB)  
 \*CW 0.5 kHz (−6 dB)  
 1.5 kHz (−60 dB)  
 \* Optional CW filter installed.

**Semiconductors** .....

	TS-120S	TS-120V
IC	26	26
FET	16	16
Transistor	90	85
Diode	142	137

**Dimensions:**  
**TS-120S** ..... 241W × 94H × 293D mm  
 (9-1/2W × 3-3/4H × 11-9/16D inch)

**TS-120V** ..... 241W × 94H × 235D mm  
 (9-1/2W × 3-3/4H × 9-1/4D inch)

**Weight** ..... TS-120S: 5.6 kg (12.3 lbs.)  
 TS-120V: 4.9 kg (10.8 lbs.)

# SECTION 1. FEATURES

## 1. SINGLE-CONVERSION SYSTEM USING ALL CIRCUITRY

The single-conversion system, with a unique Phase Locked Loop circuit, FET balanced mixers and MOS FET's, assures excellent spurious and intermod characteristic.

## 2. BUILT-IN DIGITAL DISPLAY

The digital display affords easy reading of operating frequency to an accuracy of 100 Hz on any band and any mode.

## 3. BUILT-IN IF SHIFT CIRCUIT (Passband Tuning)

An IF SHIFT system is built into the transceiver to allow shifting of the IF passband, thereby eliminating adjacent-channel interference.

## 4. 3.5 ~ 29.7 MHZ AND WWV BANDS

The transceiver is designed to operate on LSB/USB/CW in the 3.5 ~ 29.7 MHz bands. WWV (14.5 ~ 15 MHz) is also built into the transceiver to permit accurate frequency calibration.

## 5. COMPACT, LIGHTWEIGHT DESIGN

The TS-120S(V) has many advanced features, yet it is compact and lightweight, suitable for mobile and field operations as well as fixed-station operation.

## 6. EASY OPERATION

All controls and switches are carefully arranged for easy of operation, ensuring convenience and versatility.

## 7. ALL SOLID-STATE DESIGN

The all solid-state, compact unit features a wide-band final stage, eliminating the need for peaking controls.

## 8. FOUR FIXED CHANNELS

Four FIXED channels can be installed, one for each of 7, 14, 21 and 28 MHz bands. The 3.5 MHz and 28 MHz FIXED XTAL position can be exchanged by simply moving a connector on the AF-GEN unit.

## 9. FULL RANGE OF AUXILIARY FUNCTIONS

The TS-120S(V) is equipped with VOX, balanced gate system noise blanker and a 25-kHz marker.

## 10. OPTIONAL CW FILTER YK-88C

The TS-120S(V) permits use of the optional YK-88C CW filter. CW semi-break-in operation is provided using the built-in VOX and CW side-tone circuits.

## 11. WIDE VARIETY OF OPTIONAL ACCESSORIES

The following optional accessories are available: Regulated Power Supply (PS-30, PS-20), Mobile Mount (MB-100), CW Filter (YK-88C), External VFO (VFO-120) External Speaker (SP-120).

# SECTION 2. PREPARATION FOR USE

## 2.1 ACCESSORIES

The following accessories are furnished with the TS-120S(V):

- Instruction manual..... 1
- External speaker plug ..... 1
- 7P DIN remote plug..... 1
- DC power cord..... 1
- Fuse, 20A (TS-120S) ..... 1
- 4A (TS-120V) ..... 1

## 2.2 INSTALLATION

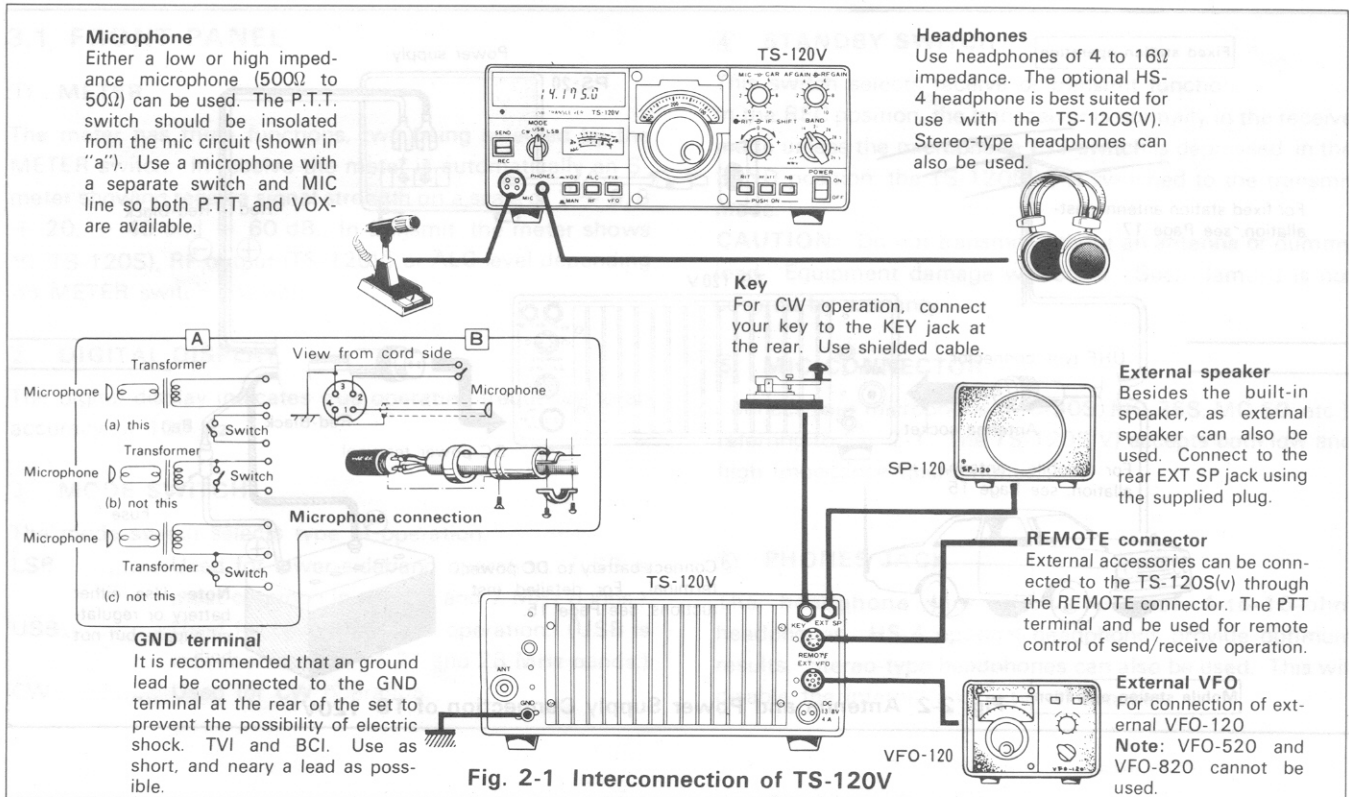
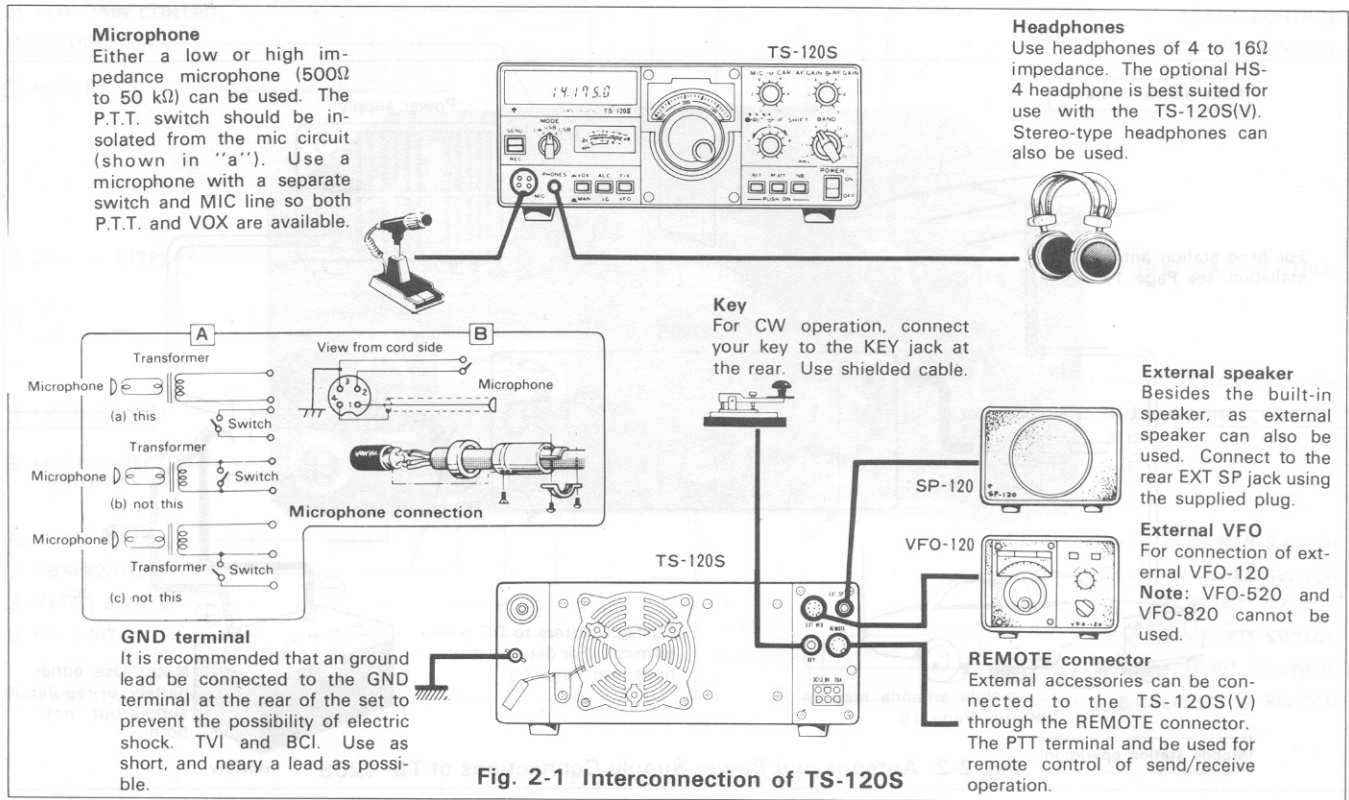
It is preferable to choose an operating location that is dry and cool, and to avoid operating the transceiver in direct sunlight.

Allow adequate ventilation, particularly during mobile operation.

# SECTION 3 CONTROLS

## 2.3 INTERCONNECTION

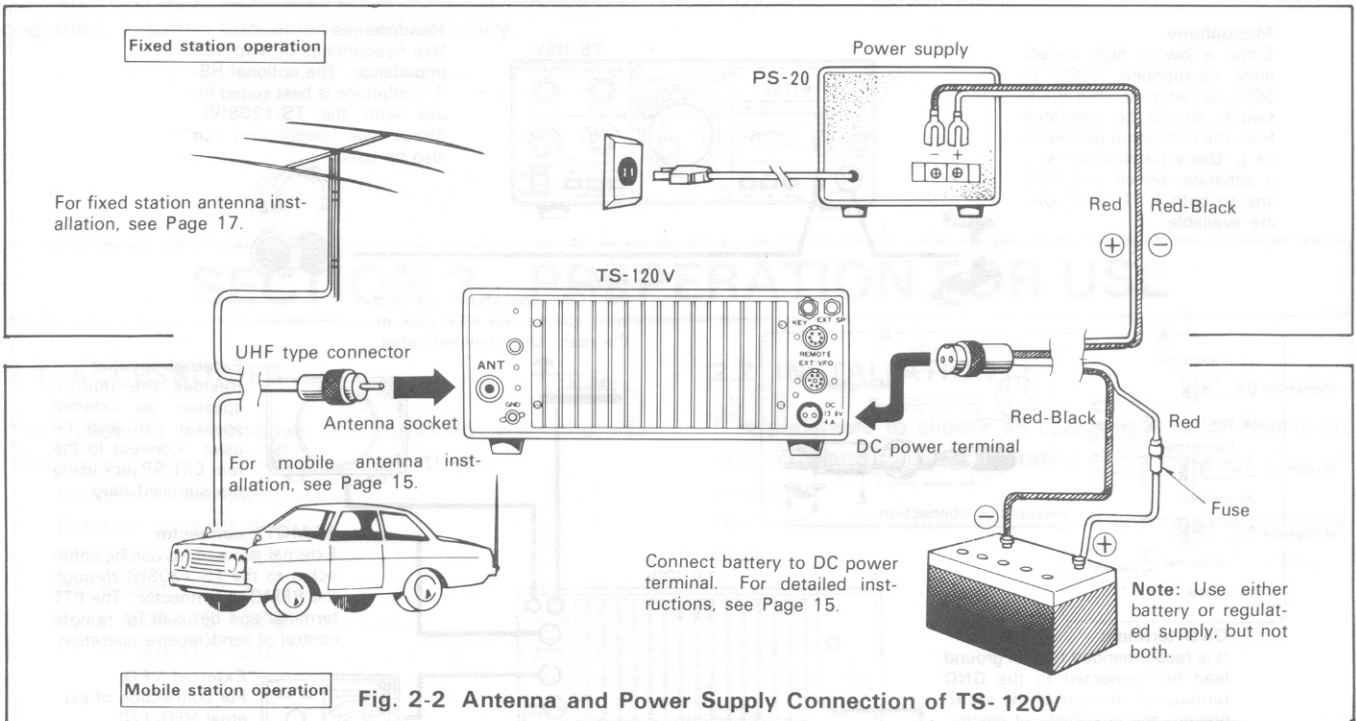
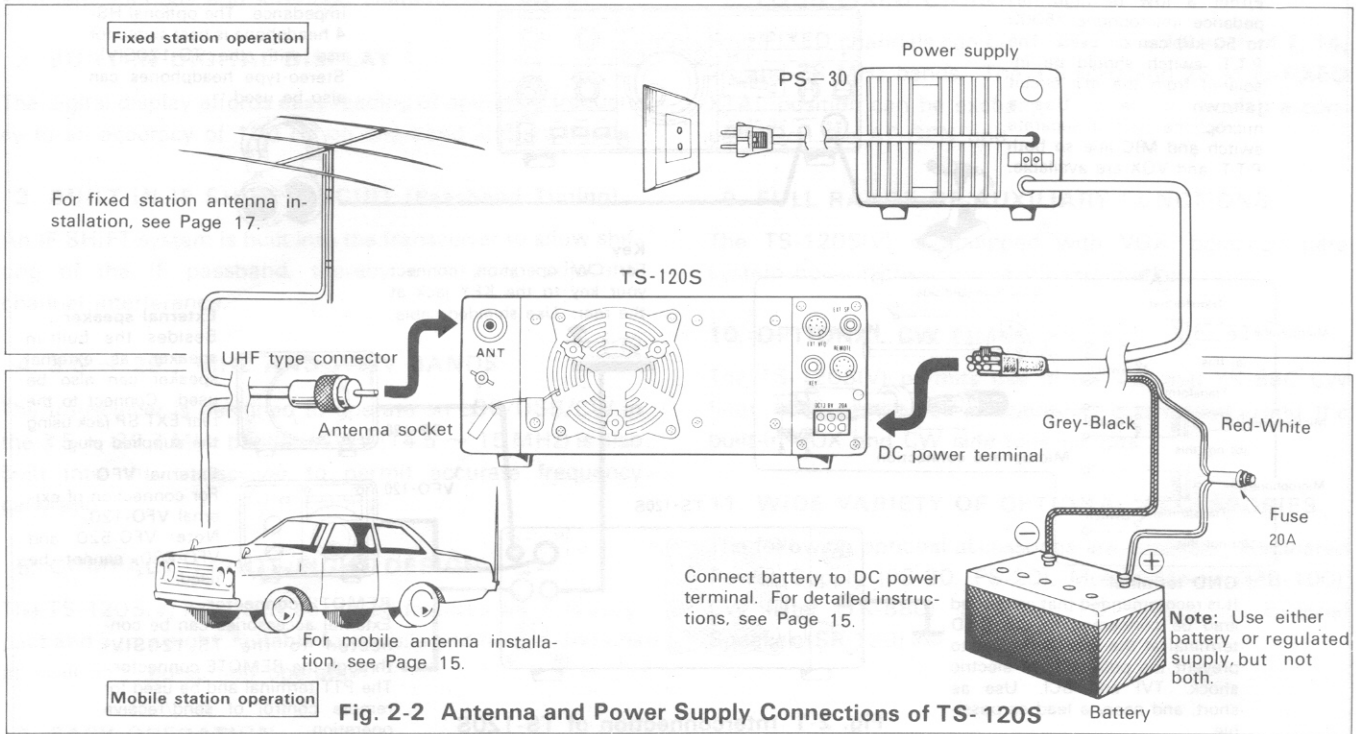
Connect the transceiver as illustrated in Fig. 2-1.



# SECTION 1. FEATURES

## 2.4 ANTENNA AND POWER SUPPLY

Connect the antenna and power supply as shown in Fig. 2-2 for fixed-station or mobile operation:



# SECTION 3. CONTROLS

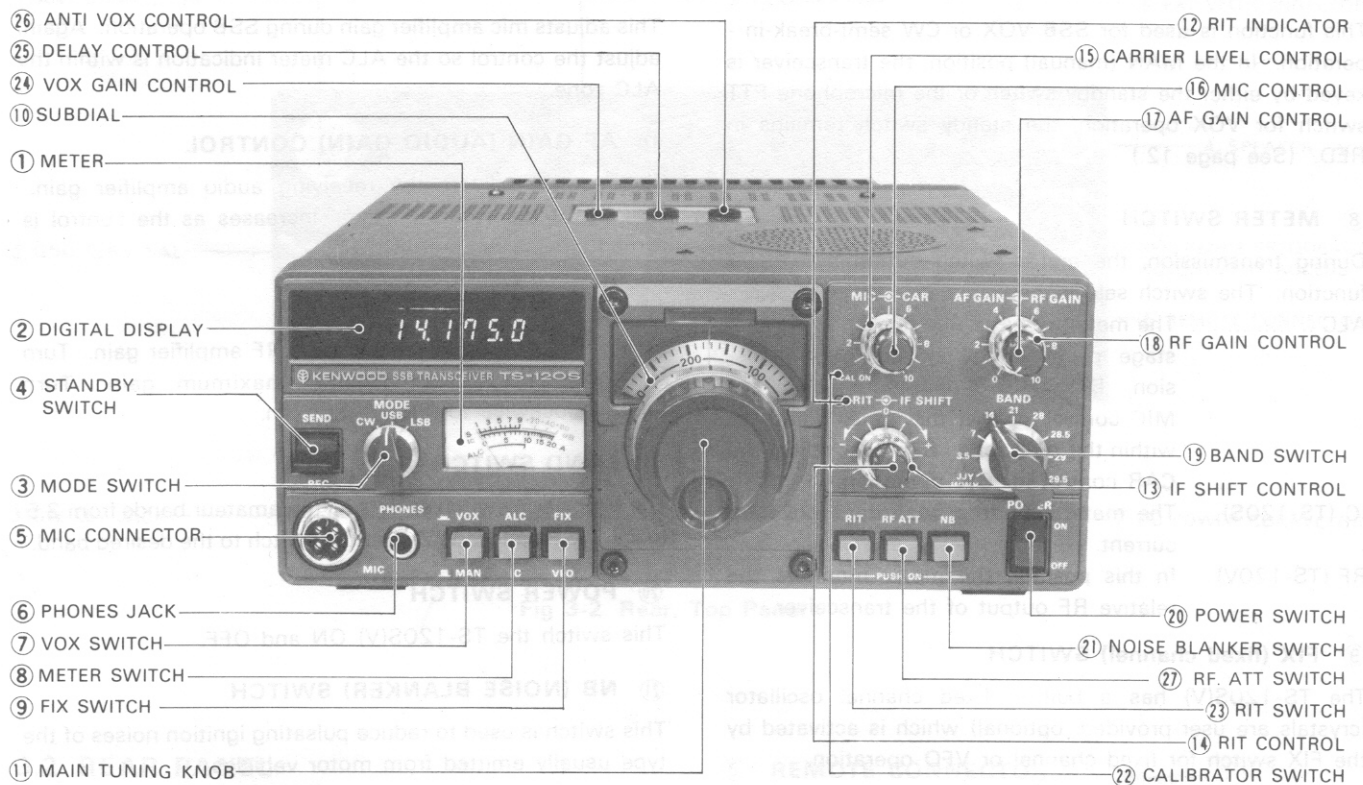


Fig. 3-1 Front Panel

## 3.1 FRONT PANEL

### 1 METER

The meter has three functions, two being selected by the METER switch. In receive the meter is automatically an S-meter showing receive signal strength on a scale of 1 ~ 9, + 20, + 40 and + 60 dB. In transmit, the meter shows IC (TS-120S), RF output (TS-120V) or ALC level depending on METER switch position.

### 2 DIGITAL DISPLAY

The digital display indicates true operating frequency to an accuracy of 100 Hz.

### 3 MODE SWITCH

The mode switch selects type of operation.

LSB ..... Used for lower-sideband operation. (LSB is most common in the 3.5 and 7 MHz bands.)

USB ..... Used for upper-sideband operation. (USB is most common in 14.21 and 28 MHz bands.)

CW ..... Used for CW operation.

### 4 STANDBY SWITCH

This switch selects receive or transmit function. In the REC position, the transceiver is normally in the receive mode unless the microphone PTT switch is depressed, in the SEND position, the TS-120S(V) is switched to the transmit mode.

**CAUTION:** Do not transmit without an antenna or dummy load. Equipment damage will occur. Such damage is not covered by warranty.

### 5 MIC CONNECTOR

Connect your microphone (MC-30S, MC-35S, MC-50, etc.), referring to Fig. 2-1. The TS-120S(V) accepts both low and high impedance microphones.

### 6 PHONES JACK

The headphone jack allows use of 4-to-16-ohm headphones. HS-4 optional headphones provide optimum results. Stereo-type headphones can also be used. This will disable the internal and external speaker.

**⑦ VOX (VOICE OPERATED TRANSMIT) SWITCH**

This function is used for SSB VOX or CW semi-break-in operation. In the MAN (manual) position, the transceiver is keyed by either the standby switch or the microphone PTT switch for VOX operation, the standby switch remains in RED. (See page 12.)

**⑧ METER SWITCH**

During transmission, the meter switch determines meter function. The switch selects between:

ALC ..... The meter monitors the output of the final stage power amplifier during transmission. During SSB operation, adjust the MIC control so that the meter pointer is within the ALC zone. Similarly, adjust the CAR control for CW operation.

IC (TS-120S).... The meter monitors final stage collector current.

RF (TS-120V)... In this position the meter monitors the relative RF output of the transceiver.

**⑨ FIX (fixed channel) SWITCH**

The TS-120S(V) has a built-in fixed channel oscillator (crystals are user-provided, optional) which is activated by the FIX switch for fixed channel or VFO operation.

**⑩ SUBDIAL**

The subdial is calibrated from 0 to 500. It is driven from the main tuning knob to indicate the transceiver's operating frequency.

**⑪ MAIN TUNING KNOB**

This control is used to select the desired operating frequency. The scale on the control knob is calibrated at 1 kHz intervals, allowing accurate tuning. For exact frequency, read the Digital Display.

**⑫ RIT INDICATOR**

This light emitting diode indicates the RIT circuit is ON.

**⑬ IF SHIFT CONTROL**

By using this control, the IF crystal filter center frequency can be shifted  $\pm 1$  kHz, allowing adjustment of tone quality, or eliminating interference from adjacent frequencies.

For normal operation, this control should be set to the center "0" position (detent).

**⑭ RIT CONTROL**

When the RIT circuit is ON, this will vary receive frequency by about  $\pm 1.5$  kHz. When the control is set to the "0" center position, there is no frequency shift.

**⑮ CAR (CARRIER LEVEL) CONTROL**

This control is used to adjust the carrier output level only during CW operation. Adjust the control so the ALC meter indication is within the ALC zone.

**⑯ MIC (MICROPHONE GAIN) CONTROL**

This adjusts mic amplifier gain during SSB operation. Again, adjust the control so the ALC meter indication is within the ALC zone.

**⑰ AF GAIN (AUDIO GAIN) CONTROL**

This control adjusts the receiving audio amplifier gain. Volume of the received signal increases as the control is turned clockwise.

**⑱ RF GAIN CONTROL**

This adjusts the receiver section's RF amplifier gain. Turn the knob fully clockwise for maximum gain. Turn counterclockwise to reduce the gain.

**⑲ BAND SWITCH**

The 9-position switch selects all the amateur bands from 3.5 to 29.7 MHz and WWV. Set the switch to the desired band.

**⑳ POWER SWITCH**

This switch the TS-120S(V) ON and OFF.

**㉑ NB (NOISE BLANKER) SWITCH**

This switch is used to reduce pulsating ignition noises of the type usually emitted from motor vehicles.

**㉒ CAL (CALIBRATOR) SWITCH**

Fully turning the MIC control enables the CAL SWITCH to operate. This switch energizes the built-in 25 kHz marker circuit.

**㉓ RIT SWITCH**

This push switch turns the RIT (Receiver Incremental Tuning) circuit ON and OFF. With the switch depressed, the circuit is activated and the RIT indicator is illuminated, allowing the receive frequency to be shifted by about  $\pm 1.5$  kHz independent of the transmit frequency by using the RIT control. The RIT circuit is turned OFF when the switch is out.

**㉔ VOX GAIN CONTROL**

This control adjusts VOX circuit sensitivity for both SSB and CW operation.

**㉕ DELAY CONTROL**

This control is used to adjust the "Hold" time of the VOX circuit. Clockwise adjustment gives longer hold-time.

**㉖ ANTI-VOX CONTROL**

This control is used to adjust the VOX system so that it is not tripped by sound from the speaker.

**㉗ RF ATT SWITCH**

Turning this switch ON attenuates antenna input by approx. 20dB to protect the RF amplifier and mixer circuit from too strong signals.



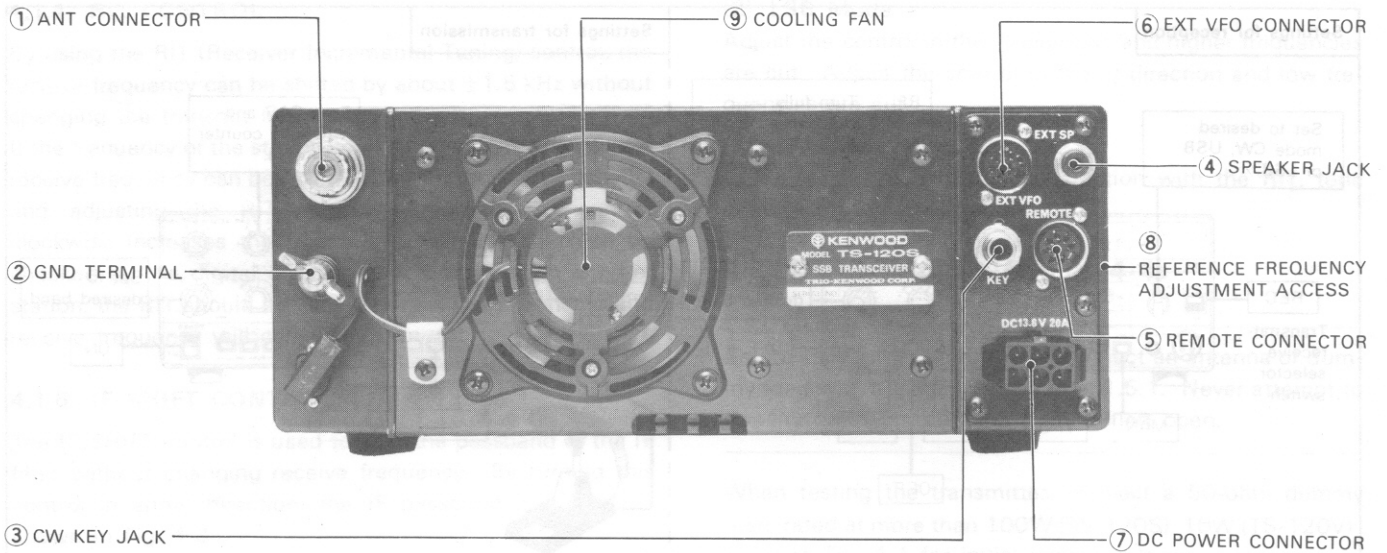


Fig 3-2 Rear, Top Panel

### 3.2 REAR PANEL

#### ① ANT (ANTENNA) CONNECTOR

This UHF connector should be attached to a suitable antenna for transmitting and receiving. The antenna cable should be of a 50-ohm unbalanced type, terminated in a PL-259 plug.

#### ② GND (GROUND) TERMINAL

The TS-120S(V) should be grounded through this terminal to avoid the possibility of TVI and BCI. Use as short, and heavy a lead as possible.

#### ③ CW KEY JACK

For CW operation, connect your key to this terminal using a two conductor phone plug and shielded cable.

#### ④ SPEAKER (EXTERNAL SPEAKER) JACK

An external speaker of 4 ~ 16 ohms impedance (such as the SP-120) can be connected here. This will disable the internal speaker.

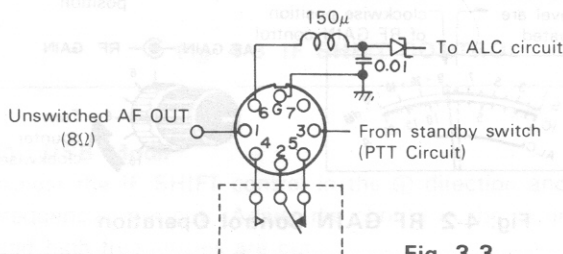


Fig. 3-3

#### ⑤ REMOTE CONNECTOR

This is used for interconnecting a linear amplifier or other equipment. For connection, refer to the illustration below, fig. 3-3.

#### ⑥ EXT VFO (EXTERNAL VFO) CONNECTOR

This is for connection of an external VFO-120. (Note: the VFO-520 and VFO-820 cannot be used, since their operating frequency is incorrect.)

#### ⑦ DC POWER CONNECTOR

This is used to connect the DC power supply.

#### ⑧ REFERENCE FREQUENCY ADJUSTMENT

For PLL reference oscillator adjustment. Use WWV signal for calibration.

#### ⑨ COOLING FAN

The cooling fan operates when the heat-sink temperature rises.

# SECTION 4. OPERATION

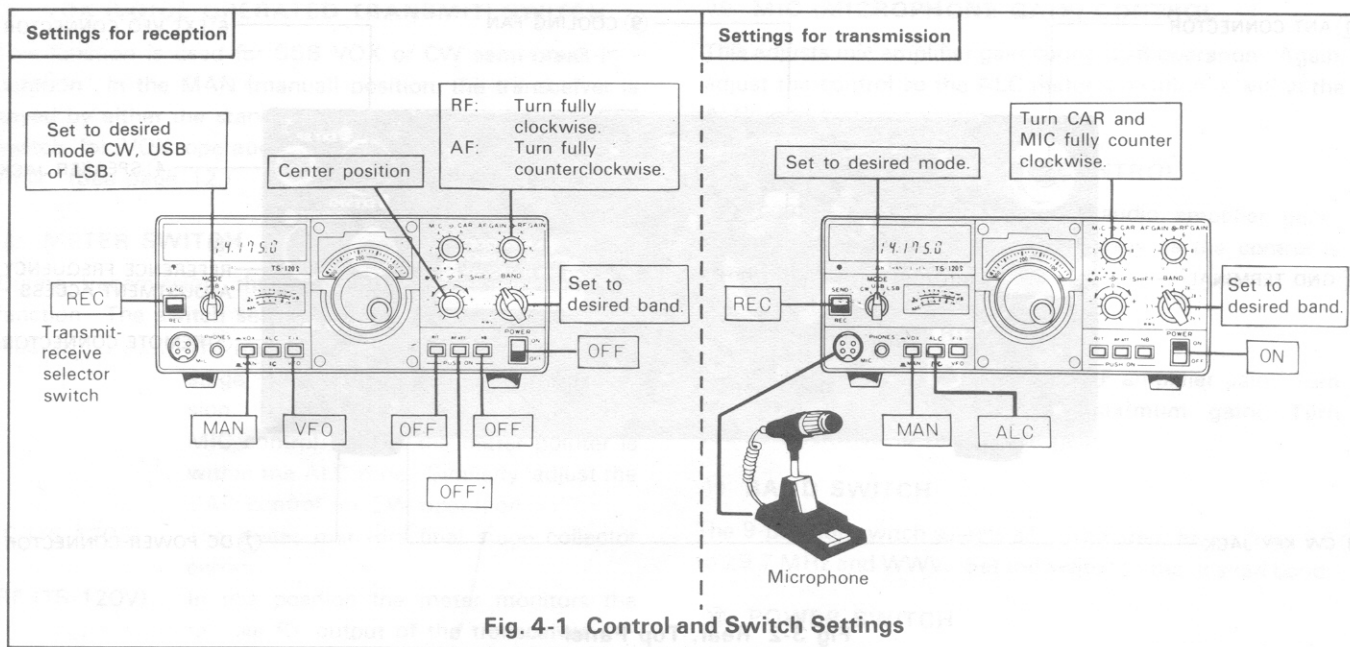


Fig. 4-1 Control and Switch Settings

## 4.1 RECEPTION

First connect the antenna, microphone and key. Then, set the controls and switches referring to Fig. 4-1. For SSB operation the MODE switch should be set to comply with common operating practice; that is, it should be set to LSB for the 3.5 and 7 MHz bands and to USB for the bands above 14 MHz.

Ascertain that the TS-120S(V) is ready for operation, then turn the POWER switch ON. The meter, dial scale and digital display will illuminate, indicating the transceiver is in operation. The transceiver is fully solid-state, allowing reception as soon as the POWER switch is turned ON.

Advance the AF GAIN control clockwise until some receiver noise is heard from the speaker. Turn the main tuning knob so the desired signal can be heard clearly.

While turning the main tuning knob, the frequency (MHz digits) reading on the digital display will change at the edge of each band (for example, from 28.999.9 to 29.000.0 MHz). When tuning above or below a band edge, the 1 MHz and 10 MHz digits are blanked, as shown below.

3.999.9	7.000.0	14.000.0	21.000.0	28.000.0	29.999.9
000.0	999.9	999.9	999.9	999.9	000.0

### 4.1.1. WWV RECEPTION

To receive WWV at 15 MHz, set the BAND switch to JYJ/WWV and turn the main tuning knob until the subdial reads "500". The digital display indicates ".000.0" instead of 15.000.0.

### 4.1.2. NB SWITCH

The TS-120S(V) has a sophisticated noise blanker designed to reduce ignition-type pulse noise. The noise blanker is particularly important for mobile operation. When necessary, activate the noise-blanker by depressing the NB switch ON.

### 4.1.3. RF GAIN CONTROL (Fig. 4-2)

For normal operation, this control should be turned fully clockwise for maximum sensitivity. Receive sensitivity is reduced by turning the control counterclockwise.

Adjust the RF GAIN so the S-meter does not show excessive deflection. This minimizes noise during reception and allows the S-meter to indicate signal peak (or a little below that point), noise is markedly reduced when the signal is absent.

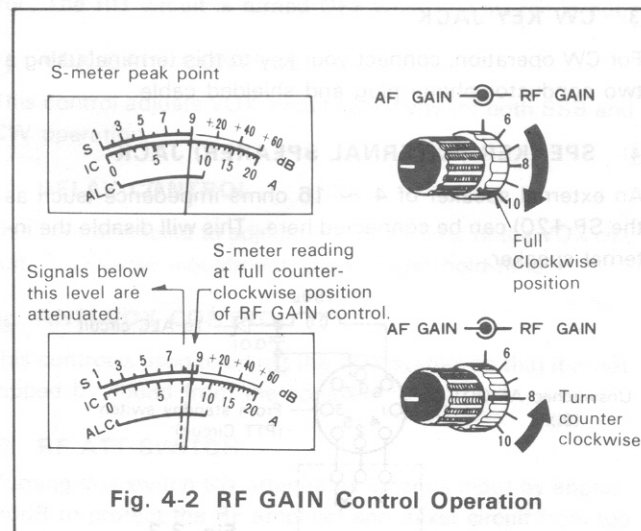


Fig. 4-2 RF Gain Control Operation

#### 4.1.4. RIT CONTROL

By using the RIT (Receiver Incremental Tuning) control, the receive frequency can be shifted by about  $\pm 1.5$  kHz without changing the transmit frequency.

If the frequency of the station you are working changes, your receive frequency can be reset by turning the RIT switch ON and adjusting the RIT control. Adjusting the control clockwise increases the frequency. The RIT shift can be checked by the digital display. When first calling another station, the RIT should be OFF, otherwise your transmit and receive frequency will coincide.

#### 4.1.5. IF SHIFT CONTROL

The IF SHIFT control is used to shift the passband of the IF filter without changing receive frequency. By turning this control in either direction, the IF passband is shifted as shown in Fig. 4-3.

The IF SHIFT is effective in eliminating interference when the receive signal is superimposed on nearby signals during operation in USB, LSB or CW mode.

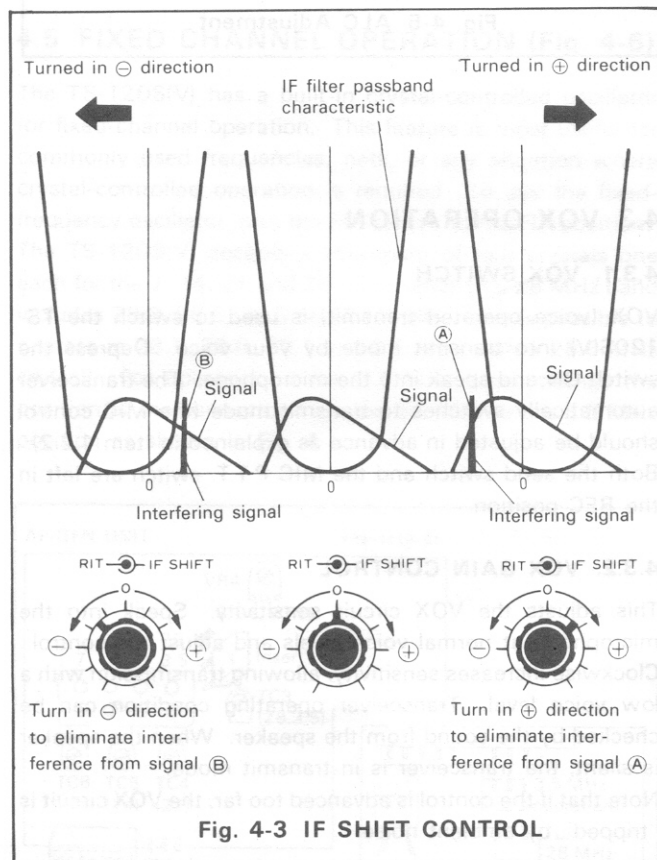


Fig. 4-3 IF SHIFT CONTROL

#### (1) USB Mode

Adjust the IF SHIFT control in the  $\oplus$  direction and lower frequencies are cut. Adjust the control in the  $\ominus$  direction and high frequencies are cut.

#### (2) LSB Mode

Adjust the control in the  $\oplus$  direction and higher frequencies are cut. Adjust the control in the  $\ominus$  direction and low frequencies are cut.

#### (3) CW Mode

By using the IF SHIFT in conjunction with the RIT, tone quality can be adjusted.

### 4.2 TRANSMISSION (Fig. 4-4)

#### CAUTION:

Before transmitting, be sure to connect an antenna or dummy load with a VSWR of less than 1.5:1. Never attempt to transmit with the antenna terminal left open.

When testing the transmitter, connect a 50-ohm dummy load, rated at more than 100W (TS-120S), 10W (TS-120V). Refer to Fig. 4-1 for initial control settings.

When the TS-120S(V) is ready for transmission, use the following procedure:

#### ● SSB Operation

- 1 Set the MODE switch to LSB or USB.
- 2 Meter switch to ALC.
- 3 Standby switch to SEND.
- 4 Speak into the microphone and adjust the MIC GAIN for meter deflection within the ALC zone at signal peaks.

#### ● CW Operation

- 1 Set the MODE switch to CW and the meter switch to ALC.
- 2 Set the standby switch to SEND and adjust the CAR control so the meter deflects within the ALC zone. If a key is connected, it should be depressed during the adjustment.

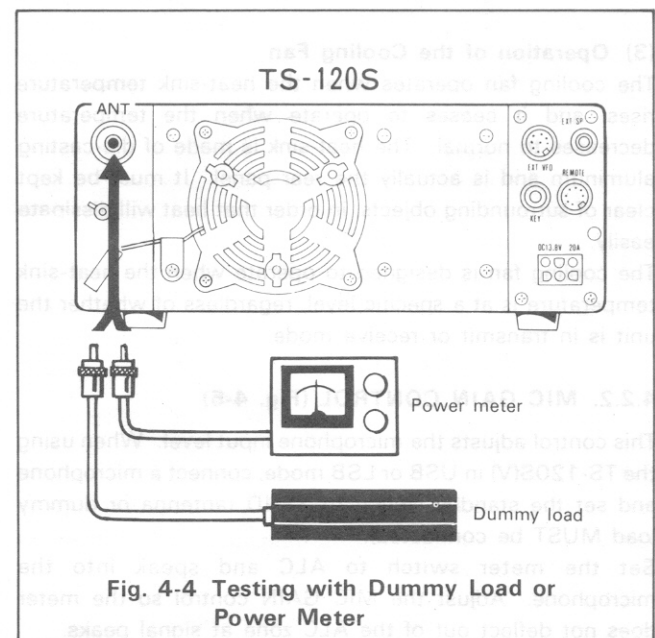


Fig. 4-4 Testing with Dummy Load or Power Meter

**4.2.1. FINAL STAGE PROTECTION**

The TS-120S(V) features a VSWR protection circuit to protect the final-amplifier transistors. The circuit in the TS-120V is different than the circuit in the TS-120S.

**(1) TS-120V**

If the VSWR increases because of improper antenna impedance, the protection circuit activates to prevent the final-stage transistors from being overloaded. In this case, transmitter output power is reduced.

**(2) TS-120S**

Three different protection circuits are designed into the TS-120S.

- i) The same VSWR protection method as used in the TS-120V is used in the TS-120S. That is, the final-stage transistors are protected by detecting VSWR of the antenna system and automatically lowering transmitter output power if the VSWR is too high.
- ii) When the heat-sink temperature rises, a detection circuit activates a cooling fan. Under normal conditions, this cooling fan sufficiently cools off the heat sink radiator.
- iii) The heat-sink temperature could rise abnormally during long transmissions, if the area adjacent to the heat-sink is blocked. In this case, the TS-120S automatically returns to the receiving mode, and transmitting is not possible until the heat-sink cools to the proper temperature.

**NOTES:**

- 1. If transmitter output decreases due to activation of the protection circuit caused by high VSWR, recheck and retune the antenna system carefully.
- 2. When the cooling fan starts to turn, determine that adequate air flow is possible in the heat-sink area.

**(3) Operation of the Cooling Fan**

The cooling fan operates when the heat-sink temperature rises, and it ceases to operate when the temperature decreases to normal. The heat-sink is made of die-casting aluminum and is actually the rear panel. It must be kept clear of surrounding objects, in order that heat will dissipate easily.

The cooling fan is designed to operate when the heat-sink temperature is at a specific level, regardless of whether the unit is in transmit or receive mode.

**4.2.2. MIC GAIN CONTROL (Fig. 4-5)**

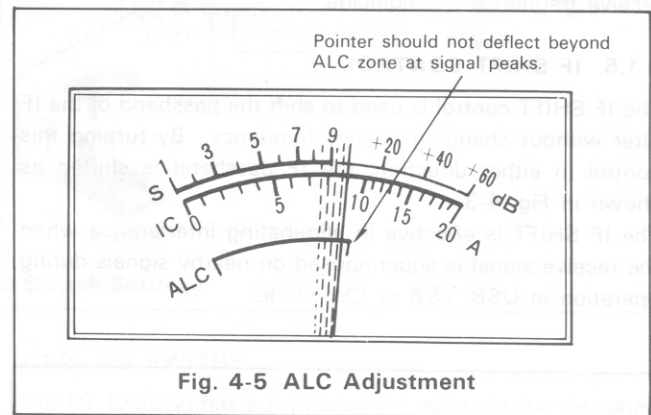
This control adjusts the microphone input level. When using the TS-120S(V) in USB or LSB mode, connect a microphone and set the standby switch to SEND (antenna or dummy load MUST be connected).

Set the meter switch to ALC and speak into the microphone. Adjust the MIC GAIN control so the meter does not deflect out of the ALC zone at signal peaks.

The TS-120S(V) accepts either a low or high impedance microphone (500 Ω to 50 kΩ). When using a low impedance microphone (500 Ω) the MIC GAIN control should be advanced higher than when a high impedance microphone is used, while observing the ALC meter.

**● ALC (Automatic Level Control)**

The ALC monitors the transmitter final stage output to minimize distortion in your transmitted signal. It automatically adjusts output to an optimum level.



**Fig. 4-5 ALC Adjustment**

**4.3 VOX OPERATION**

**4.3.1. VOX SWITCH**

VOX (voice operated transmit) is used to switch the TS-120S(V) into transmit mode by your voice. Depress the switch ON and speak into the microphone. The transceiver automatically switches to transmit mode (the MIC control should be adjusted in advance as explained in Item 4.2.2). Both the send switch and the MIC P.T.T. switch are left in the REC position.

**4.3.2. VOX GAIN CONTROL**

This adjusts the VOX circuit sensitivity. Speak into the microphone at normal voice levels and adjust the control. Clockwise increases sensitivity, allowing transmission with a low voice level. Transceiver operating condition can be checked by the sound from the speaker. When the speaker is silent, the transceiver is in transmit mode.

Note that if the control is advanced too far, the VOX circuit is "tripped" by ambient noise.

**4.3.3. ANTI-VOX CONTROL**

This prevents the VOX circuit from being "tripped" by sound from the speaker.

Adjust the control so the VOX will not operate at the desired speaker volume level.

#### 4.3.4. VOX DELAY CONTROL

This control adjusts the transmit hold time of the VOX circuit. If the hold time is too short, the transceiver will return to receive mode as soon as you stop talking into the microphone. This can be eliminated by turning the control clockwise. Adjust the control comfortable operation at a normal rate of speech.

#### 4.4 SEMI-BREAK-IN OPERATION

The TS-120S(V) has a built-in side-tone oscillator to permit semi-break-in operation, besides the normal CW operation. During semi-break-in operation, the transceiver is placed in transmit mode when the key is depressed, returns to and receive mode when the key is released. The VOX circuit is activated by the side-tone.

For semi-break-in operation, set the VOX switch ON and the MODE switch to CW.

For semi-break-in operation, adjust the VOX GAIN to insure that the transceiver is set in transmit mode whenever the key is depressed. Also, adjust the VOX DELAY for desired hold-in. VOX and ANTI VOX adjustments are not required.

#### 4.5 FIXED CHANNEL OPERATION (Fig. 4-6)

The TS-120S(V) has a built-in crystal-controlled oscillator for fixed-channel 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 FIX switch to the FIX position. The TS-120S(V) accepts a maximum of four crystals one each for the 7, 14, 21 and 28 MHz bands (the 28 MHz band includes 28.0, 28.5, 29.0 and 29.5 MHz, so it is possible to operate in 28.1, 28.6, 29.1 or 29.6 MHz with a 28.6 MHz crystal). For operation in the 3.5 MHz band, change the position of the connector from the 28 MHz to the 3.5 MHz position as shown in Fig. 4-6.

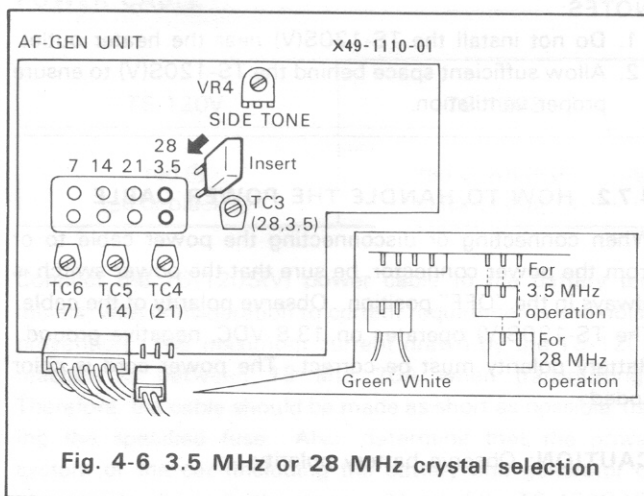


Fig. 4-6 3.5 MHz or 28 MHz crystal selection

The crystal frequency is determined by the following formula:

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

- X = 3.5 (80m band)
- X = 7.0 (40m band)
- X = 14.0 (20m band)
- X = 21.0 (15m band)
- X = 28.0 (10m band)
- X = 28.5 (10m band)
- X = 29.0 (10m band)
- X = 29.5 (10m band)

#### Crystal Specifications:

- Type of crystal holder: HC-25/U
- Oscillation frequency: 5.5 ~ 6.0 MHz
- Multiplication: Fundamental
- Frequency tolerance: ±0.002% at normal temperature
- Oscillation circuit: See Fig. 4-7

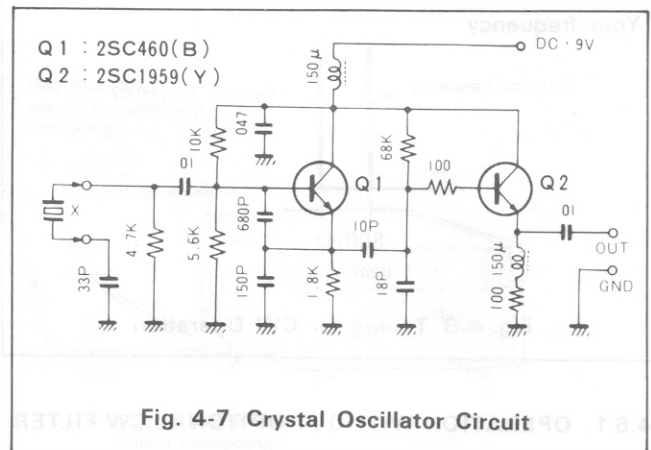
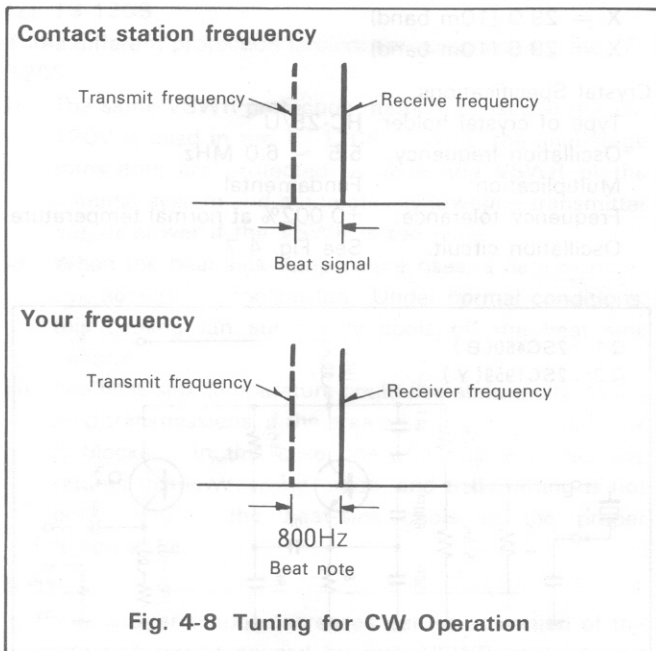


Fig. 4-7 Crystal Oscillator Circuit

## 4.6 CW OPERATION (Fig. 4-8)

For CW operation, your transmit frequency should be "zeroed" to the transmit frequency of your contact station. Receive frequency is 800 Hz lower than the transmit frequency of your contact station, so that his signal is received as a 800-Hz beat note. This also allows your contact to receive your signal without having to retune receiver. Tuning methods are detailed in the following paragraphs.



### 4.6.1. OPERATION WITHOUT OPTIONAL CW FILTER

Set the IF SHIFT control to its center position and the RIT switch OFF. Adjust the main tuning knob for an 800-Hz beat note and your transmit frequency will then coincide with that of your contact station ("zeroed"). During reception, the side-tone monitor is activated by pressing down the key (VOX OFF). In this case, listen to the side-tone superimposed on the receive signal and adjust the main tuning for similar side-tone and incoming CW avoid tone. By so doing, transmit frequencies will be zeroed.

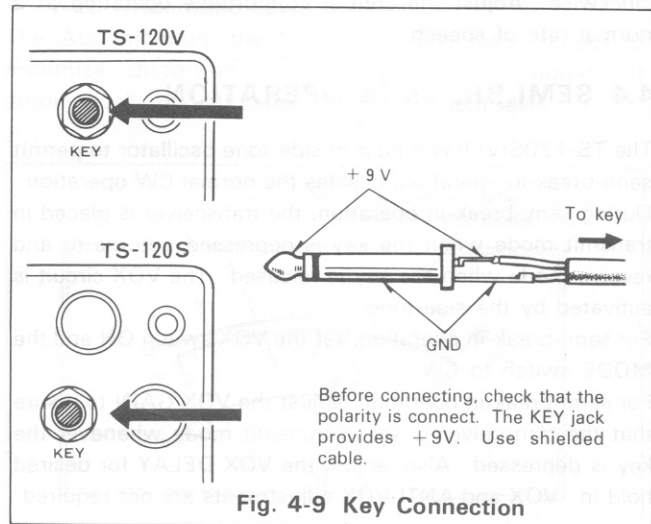
You may now adjust the RIT for a pitch which suits your preference. If interference is encountered, adjust the IF SHIFT. For more convenient and effective CW operation, use of the optional YK-88C CW crystal filter is recommended.

### 4.6.2. OPERATION WITH CW FILTER (YK-88C)

Set the IF SHIFT to its center position and the RIT to OFF. Adjust the main tuning knob for maximum deflection of the S-meter. Receive signal pitch will be about 800 Hz, indicating correct tuning.

## 4.6.3 KEY CONNECTION (Fig. 4-9)

Your key should be connected as illustrated in Fig. 4-9 when using an electronic keyer, make sure that polarity is correct. Always use shielded line from the key to transceiver.



## 4.7 MOBILE OPERATION (Fig. 4-10)

The TS-120S(V), being compact in design, is ideal for mobile operation. Satisfactory mobile operation is achieved through proper power and antenna connection, and thoughtful transceiver installation and adjustment.

### 4.7.1. TS-120S(V) INSTALLATION

Secure the TS-120S(V) under the dashboard using an optional MB-100 mounting bracket as shown in Fig. 4-10. As an alternative, use strapping, making sure that the TS-120S(V) will not slip out of place while driving the vehicle.

#### NOTES:

1. Do not install the TS-120S(V) near the heater outlet.
2. Allow sufficient space behind the TS-120S(V) to ensure proper ventilation.

### 4.7.2. HOW TO HANDLE THE POWER CABLE

When connecting or disconnecting the power cable to or from the power connector, be sure that the power switch is always in the "OFF" position. Observe polarity of the cable. The TS-120S(V) operates on 13.8 VDC, negative ground. Battery polarity must be correct. The power cord is color coded:

**CAUTION:** Observe battery polarity.

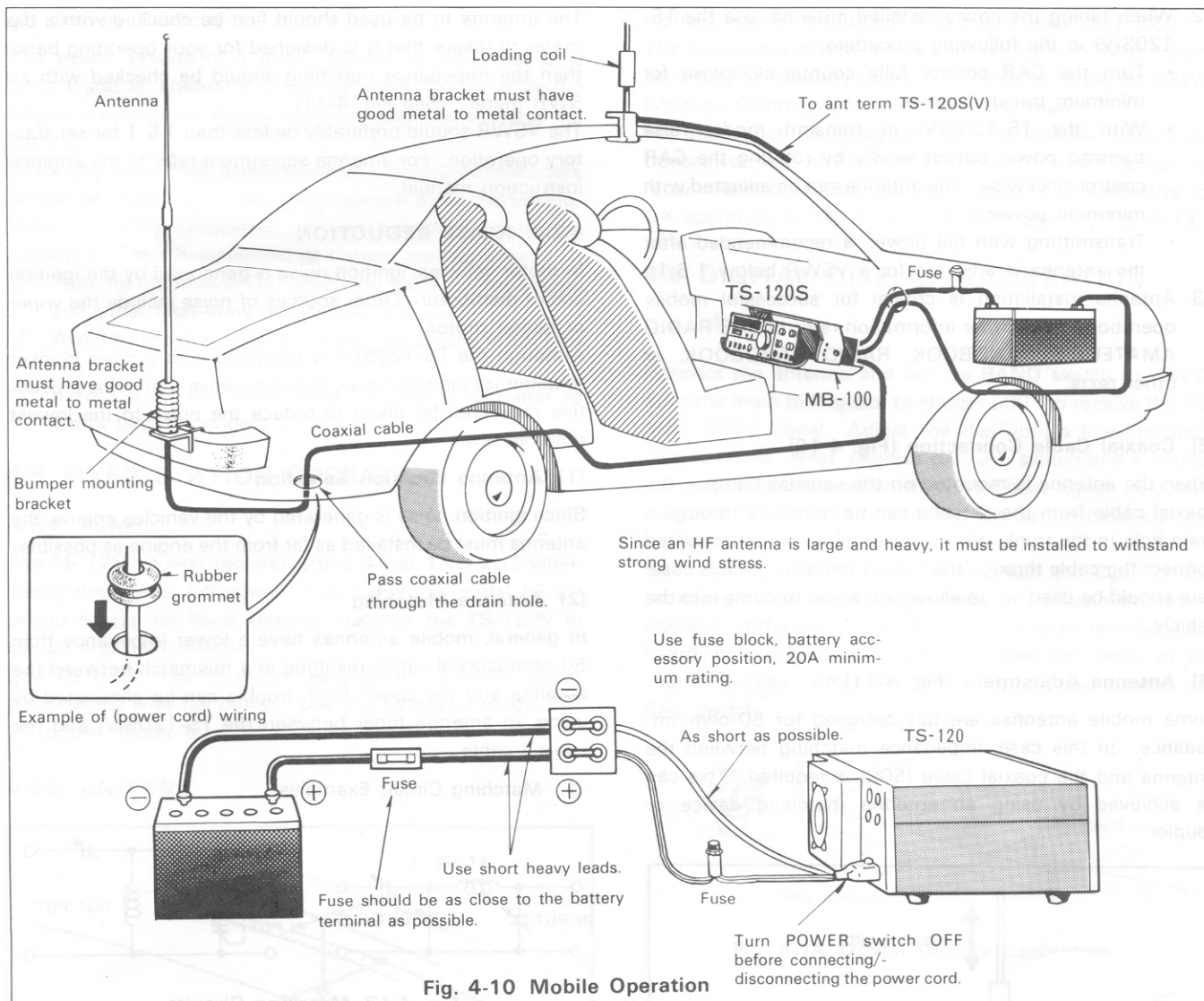


Fig. 4-10 Mobile Operation

**POWER CABLE**

TS-120V	TS-120S
red ⊕	red or white ⊕
red or black ⊖	black or gray ⊖

Connect the TS-120S(V) power cable to the battery terminals, with consideration to current requirements and noise prevention. The maximum current drawn by the TS-120S reaches to between 18 and 20A when transmitting. Therefore, the cable should be made as short as possible, using the specified fuse. Also, determine that the power system of the car (including the battery and generator or alternator) will handle the increased load of the TS-120S(V).

Route battery and ANTENNA leads away from all high

voltage secondary circuits to prevent ignition noise interference.

**4.7.3. MOBILE ANTENNA**

**(1) Antenna Installation**

Use a rugged mount for the mobile antenna because HF antennas are larger (and have more wind load) and heavier than VHF antennas. A bumper mount is recommended for general use. The ground side of the mount must be grounded perfectly to the body of the car since the body itself functions as the ground plane for the mobile antenna. (Refer to Fig. 4-10.)

**NOTES:**

1. Some cars have a urethane bumper. For such cars, ground the antenna mount to the body.

2. When tuning the newly installed antenna, use the TS-120S(V) in the following procedure:
  - Turn the CAR control fully counter-clockwise for minimum transmit power.
  - With the TS-120S(V) in transmit mode, raise transmit power output slowly by rotating the CAR control clockwise. The antenna can be adjusted with minimum power.
  - Transmitting with full power is recommended after the antenna is adjusted for a VSWR below 1.5:1.
3. Antenna installation is critical for successful mobile operation. For further information refer to THE RADIO AMATEUR'S HANDBOOK, RADIO HANDBOOK, or other texts.

### (2) Coaxial Cable Connection (Fig. 4-10)

When the antenna is mounted on the vehicles bumper, the coaxial cable from the antenna can be routed to through a drain hole in the trunk. When the antenna is roof mounted connect the cable through the hole in the door. In this case, care should be used not to allow rain water to come into the vehicle.

### (3) Antenna Adjustment (Fig. 4-11)

Some mobile antennas are not designed for 50-ohm impedance. In this case, impedance matching between the antenna and the coaxial cable (50Ω) is required. This can be achieved by using an antenna matching device or coupler.

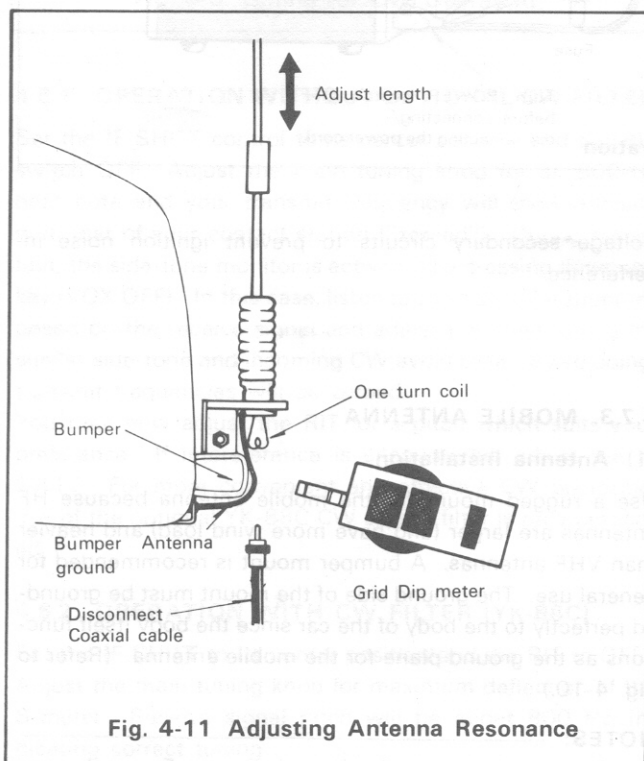


Fig. 4-11 Adjusting Antenna Resonance

The antenna to be used should first be checked with a dip meter to insure that it is designed for your operating band, then the impedance matching should be checked with an SWR meter. (See Fig. 4-11)

The VSWR should preferably be less than 1.5:1 for satisfactory operation. For antenna adjustment refer to the antenna instruction manual.

### 4.7.4. NOISE REDUCTION

In motor vehicles, ignition noise is generated by the ignition coil or distributor. Other sources of noise include the wiper or heater motor.

Although the TS-120S(V) is equipped with a noise blanker to minimize ignition noise, it is imperative that some preventive measures be taken to reduce the noise to the lowest possible level.

#### (1) Antenna Location Selection

Since ignition noise is generated by the vehicles engine, the antenna must be installed as far from the engine as possible.

#### (2) Antenna Matching

In general, mobile antennas have a lower impedance than 50-ohm coaxial cable, resulting in a mismatch between the antenna and the coax. Such trouble can be eliminated by using an antenna tuner between the TS-120S(V) and the coaxial cable.

#### ○ Matching Circuit Examples

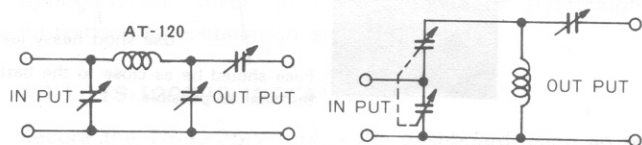


Fig. 4-12 Matching Circuits

#### (3) Bonding

The component parts of motor vehicles, such as the engine, transmission, muffler system, accelerator, etc., are coupled to one another at DC and low frequencies, but are isolated at high frequencies. By connecting these parts using heavy, braided ground, straps, ignition noise can be reduced. This connection is called "bonding".

#### (4) Use Ignition Suppressor Cable or Suppressor Spark Plugs

Noise can be reduced by using spark plug with internal resistors, or resistive suppressor ignition cable.

#### (5) Battery Power Connection

It is recommended that battery power be supplied directly to the TS-120S(V) from the battery terminals.



**(6) Battery Capacity**

The power system of a motor vehicle is comprised of a battery and an alternator (when generates power while the engine is running) to supply current to loads or to charge the battery.

Since the transceiver draws hi current, during transmit care should be excersised so the power system is not overloaded. When using the transceiver, the following points should be observed from the viewpoint of battery maintenance:

- ① Turn the transceiver OFF when the lights, heater, wipers and other high-draw accessories are used.
- ② Avoid transceiver operation when the engine is not running.
- ③ If necessary, use an ammeter and/or a voltmeter to check battery condition.

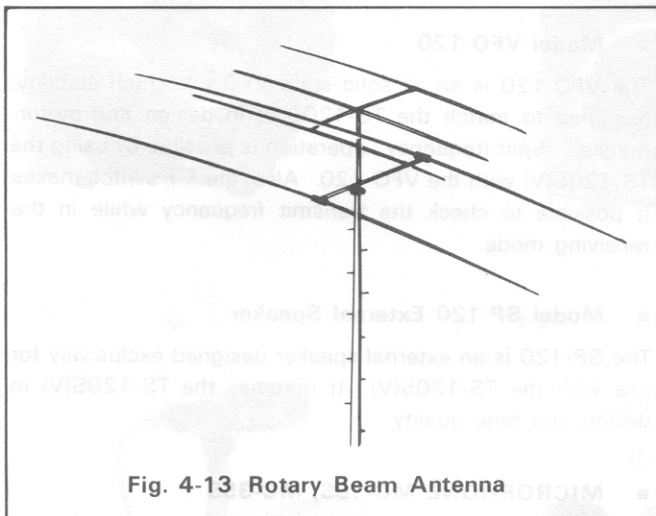
**4.8 FIXED STATION OPERATION**

**4.8.1. Power**

The TS-120V power requirement is 4A at 13.8 VDC when transmitting with full power. The Kenwood model PS-20 power supply for fixed stations matches the TS-120V in design and performance.

The TS-120S requires more than 18A at 13.8 VDC when transmitting with full power. Use the Kenwood model PS-30 power supply for fixed stations.

**4.8.2. ANTENNA**



**Fig. 4-13 Rotary Beam Antenna**

For HF fixed-station operation, an antenna specifically designed for amateur operation is recommended. Antenna types include the wire antennas, verticals, rotary beam, and other antennas. HF antennas are quite large and must be installed to withstand strong wind, heavy rain, etc. Any antenna used with the TS-120S(V) should be of 50-ohm impedance and should be connected using an appropriate coaxial cable such as RG-8/U. Impedance matching is important. Impedance mismatching will result in a high VSWR and power loss, or can cause un-

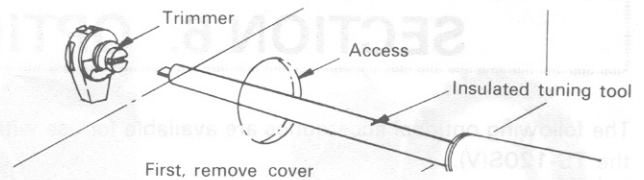
wanted harmonic radiation and interference (TVI, BCI). The impedance match can be checked with an SWR meter. Generally satisfactory operation is assured when the VSWR (Voltage Standing Wave Ratio) is less than 1.5:1. For impedance matching between the antenna system and transceiver, use of the AT-120 Antenna Tuner (option) is recommended. A rotary beam antenna is very effective for DX operation in 14, 21 and 28 MHz bands. (Fig. 4-13)

**4.9 DIGITAL DISPLAY CALIBRATION**

**4-14)**

Connect the antenna and set the BAND switch to WWV. Turn the main tuning dial to about "500" to receive the 15-MHz WWV signal. Adjust the dial until a low-frequency beat is heard. Next, depress the CAL switch and a marker signal is superimposed on the WWV beat signal. A double beat (two beat signals of high and low frequencies) will now be heard.

While receiving this double beat, adjust the Counter unit trimmer through the reference frequency adjustment access opening (at the side of the TS-120S(V)) so the two beats are heard as a single beat. This completes calibration of the Digital Display. After calibration depress and release the CAL switch.

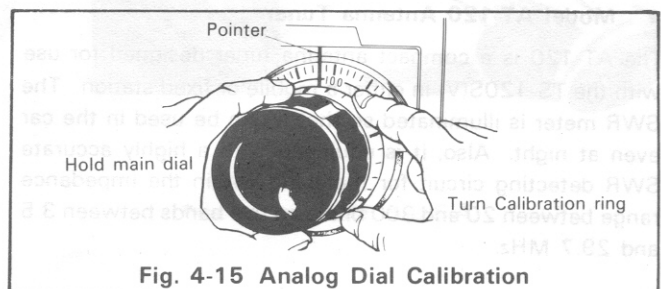


**Fig. 4-14 Digital Display Calibration**

**4.10 ANALOG DIAL CALIBRATION (Fig. 4-15)**

The main dial scale is graduated at 1-kHz intervals. One revolution of the main dial covers 25 kHz. To calibrate the scale, turn the CAL switch ON and in SSB mode zero-beat, or in CW mode tune for an 800 Hz beat. Hold the main tuning knob from rotating and slip the calibration ring to the nearest major (5 kHz) graduation. The dial is now calibrated.

**Note:** For exact frequency, read the Digital Display.



**Fig. 4-15 Analog Dial Calibration**

## SECTION 5. ADDITIONAL INFORMATION

### 5.1 GENERAL INFORMATION

Your TS-120S(V) has been factory aligned and tested to specification before shipment. Under normal circumstances, the transceiver will operate in accordance with these operating instructions.

If your transceiver fails to work, contact the authorized dealer from which you purchased it for quick, reliable repair. All adjustable trimmers and coils in your transceiver were preset at the factory and should only be readjusted by a qualified technician with proper test equipment.

Attempting service or alignment without factory authorization can void the transceiver's warranty.

### 5.2 HOW THE TX FINAL TRANSISTORS ARE PROTECTED

Final transistor protection is provided by sampling the reflected power. As the reflected power is increased (higher SWR) transmitter drive is reduced, thus decreasing input to the final transistors. This in turn reduces collector loss, protecting the final transistors.

### 5.3 ORDERING SPARE PARTS

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

- Model and serial number of your transceiver, Schematic number of the part, Printed circuit board number on which the part is located, Part number and name, if known, and Quantity desired.

### 5.4 SERVICE

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

#### NOTES:

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

## SECTION 6. OPTIONAL ACCESSORIES

The following optional accessories are available for use with the TS-120S(V).

#### ■ \* Model PS-20 Regulated DC Power Supply

Perfectly matches the design and characteristics of the TS-120V. Equipped with a protection circuit which guards transceiver against damage due to shorts or overload.

#### ■ Model PS-30 Regulated DC Power Supply

The PS-30 is a regulated DC power supply with a large capacity. The output is 13.8 VDC/20A (Intermittent). Since terminals for 13.8 VDC/5A are also provided, in addition to output power cables for use with the TS-120S, the PS-30 can be used as a power source for other mobile transceivers (such as 2-meter rigs).

#### ■ Model AT-120 Antenna Tuner

The AT-120 is a compact antenna tuner designed for use with the TS-120S(V) in either a mobile or fixed station. The SWR meter is illuminated so that it can be used in the car even at night. Also, it is equipped with a highly accurate SWR detecting circuit for matching within the impedance range between 20 and 300 ohms on five bands between 3.5 and 29.7 MHz.

#### ■ Model VFO-120

The VFO-120 is an all solid-state VFO with high stability, designed to match the TS-120S(V) in design and performance. "Split frequency" operation is possible by using the TS-120S(V) with the VFO-120. Also, the T-F switch makes it possible to check the transmit frequency while in the receiving mode.

#### ■ Model SP-120 External Speaker

The SP-120 is an external speaker designed exclusively for use with the TS-120S(V). It matches the TS-120S(V) in design and tone quality.

#### ■ MICROPHONE MC-30S, MC-35S

Dynamic microphone with PTT switch specifically designed for mobile operation.

Impedance: 50 k $\Omega$  (MC-30S)  
500  $\Omega$  (MC-35S)

#### ■ MICROPHONE MC-50

Unidirectional dynamic microphone with locking PTT switch provides excellent performance for VOX operation.

Impedance: 50 k $\Omega$  and 600 $\Omega$  (switchable)

■ HEADPHONE HS-4

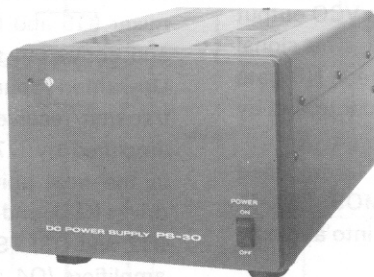
High-performance dynamic headphones with specially designed ear pads for listening.  
Impedance: 8Ω

■ YK-88C CW CRYSTAL FILTER

High selectivity (500 Hz at -6 dB, 1.5 kHz at -60 dB) crystal filter for CW operation. Easily installed in the TS-120S(V).

\* PS-20

PS-20

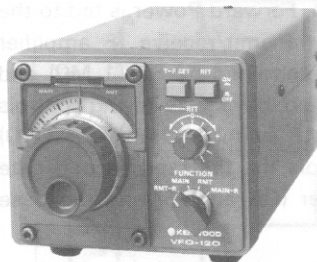


AT-120

VFO-120

SP-120

MC-30S, MC-35S

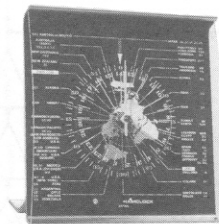


MC-50

HS-4

\* HC-2

\* HS-5



\* is not available in U.S.A.

# SECTION 7. CIRCUIT DESCRIPTION

## RECEIVING CIRCUIT

The signal from the antenna is fed to the 8.83 MHz IF trap circuit. This signal is stepped up about 10 dB and impedance-converted by a wide-band transformer before it is applied to the bandpass filter (BPF). The BPF is common to transmission and reception, eliminates the need for a preselector, and makes the RF section compact in design. The signal from the BPF is fed to the dual-gate MOS FET wideband RF amplifiers consisting of a 3SK74 (Q1) and a 2SC1815 (Q2), where the 2 MHz to 35 MHz signal is amplified about 20 dB.

The RF amplifier output is through a wide-band transformer to the input balanced transformer of the balanced mixer (two 3SK74s, Q3 and Q4), where it is mixed with the VCO output from the PLL and converted to the 8.83 MHz IF. This signal is applied to the IF unit through the ceramic filters, NB gate circuit and the crystal filter. The NB circuit is controlled by the NB switch on the front panel.

The signal, passing through the crystal filter, is amplified about 90 dB by the three-stage 3SK74 MOS FET IF amplifier (Q1, Q2, and Q3) and is demodulated into audio by the four-diode ring detector.

From the final IF stage, the signal also passes through a buffer amplifier and is fed to the AGC circuit where it is detected and amplified. Receiver gain is controlled by this AGC voltage applied to the second gates of the RF and IF amplifiers, with the time constant determined by R38 (2.2 M $\Omega$ ) and C40 (1  $\mu$ F). Input levels of 2 dB and 34 dB are indicated as S1 and S9 on the S-meter. The AF signal is amplified by Q1, a 2SC2240 (GR), gain controlled, and further amplified by an HA1366W (Q7, the power-amplifier IC, to drive the speaker. This signal, which is transistor-coupled with Q14, a 2SC1815(Y), and Q15, a 2SA1015(Y), is sampled for ANTI-VOX control, so the VOX circuit is not tripped by the speaker output. This new system is a departure from the conventional transformer-coupled sampling systems.

## TRANSMITTING CIRCUIT

The microphone signal is amplified by transistors Q18, a 2SC2240(GR), Q10, and Q11, each a 2SC1815(Y), and is fed to the four-diode balanced modulator (BM) circuit. Microphone impedance is 500  $\Omega$  to 50 k $\Omega$ .

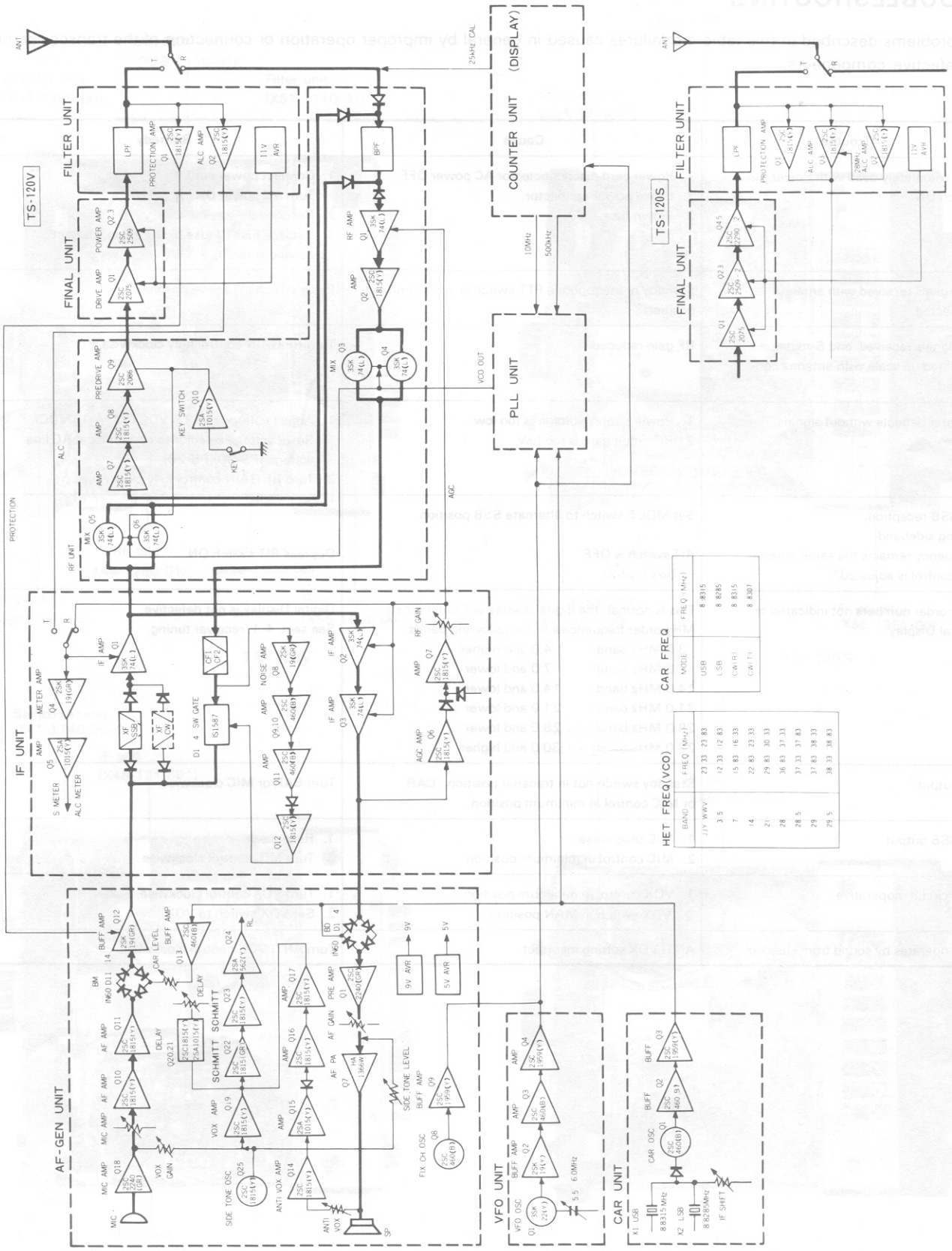
The 8.83 MHz DSB signal from the BM is amplified about 10 dB by Q12, a 2SK19 FET, and is fed to the IF unit where the unwanted sideband is removed by the crystal filter to produce an SSB signal. The gate of Q12 is also controlled by the protection voltage which is developed when the transmitter output locks into an incorrect load, continuously reducing output power. The SSB signal from the crystal filter is amplified about 30 dB by the 3SK74 IF amplifier (Q1), and is fed to the transmit 3SK74 MOS FET balanced mixer (Q5 and Q6), where it is mixed with the VCO output and converted to the final transmit frequency.

Unwanted spurious components are eliminated by the transmit/receive BPF circuit, and the signal is wideband-amplified by Q7, Q8 (2SC1815), and Q9 (2SC2086).

In the final unit, the signal is amplified by the 2SC2075 driver (Q1), and by the 2SC2509 push-pull power amplifiers (Q2 and Q3) TS-120V, and plus 2SC2290 push-pull power amplifiers (Q4 and Q5) (TS-120S). The signal then passes through an RF filter and is fed to the antenna.

Antenna output is toroid-sampled to detect the forward and reflected power. The forward power is used for ALC and the reflected power for protection. Forward Power is fed to the second gate of the 3SK74 transmit/receive IF amplifier (Q1), with a time constant determined by R7 (1 M $\Omega$ ) and C40 (0.47  $\mu$ F). For CW operation, block bias keying controls the base circuit of the 2SA1015 switching transistor (Q10) in the RF circuit. Q10 controls the first and second gate voltages of the transmit mixer (Q5 and Q6) and the base voltage of the predriver (Q9).

# BLOCK DIAGRAM



MODE	FREQ (MHz)
USB	8.8315
LSB	8.8385
COM(4)	8.8315
COM(1)	8.8307

BRAND	FREQ (MHz)
JYY WWV	23.33 23.83
3 5	12.33 12.83
7	15.83 16.33
14	22.83 23.33
21	29.83 30.33
28	36.83 37.33
28.5	37.33 37.83
29	37.83 38.33
29.5	38.33 38.83

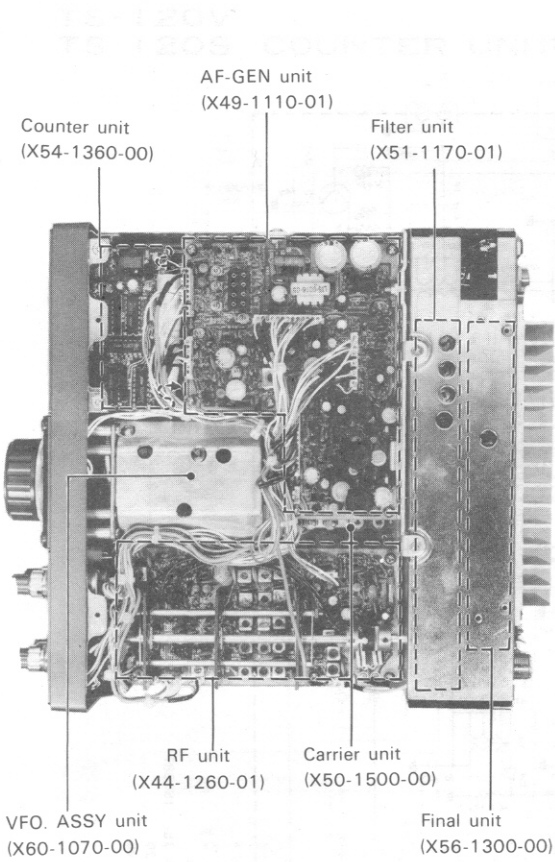
# SECTION 8. TROUBLESHOOTING

## TROUBLESHOOTING

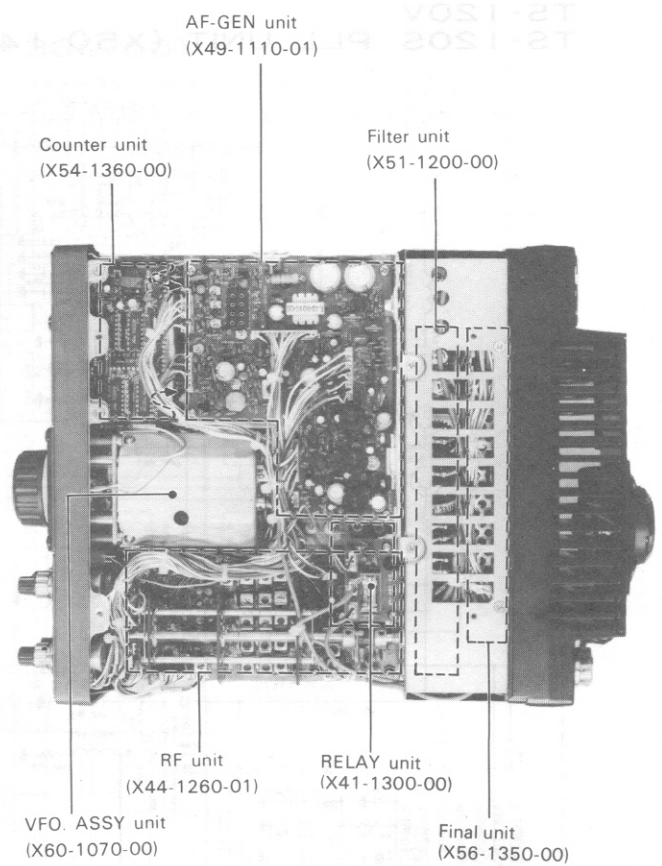
The problems described in this table are failures caused in general by improper operation or connection of the transceiver, not by defective components.

Trouble	Cause	Remedy
Unit completely dead with Power switch ON.	<ol style="list-style-type: none"> <li>1. Power cord disconnected or AC power OFF.</li> <li>2. Loose power connector.</li> <li>3. Blown fuse.</li> </ol>	<ol style="list-style-type: none"> <li>1. Connect power cord. Turn AC power ON.</li> <li>2. Reconnect.</li> <li>3. Replace fuse (If fuse blows again, contact service station).</li> </ol>
No signals received with antenna connected.	Standby or microphone PTT switch is in transmit position.	Place switch in receive position.
No signals received, and S-meter is deflected up scale with antenna connected.	RF gain reduced.	Turn RF GAIN control fully clockwise.
S-meter deflects without signals.	<ol style="list-style-type: none"> <li>1. Power supply voltage is too low.</li> <li>2. RF circuit gain is too low.</li> </ol>	<ol style="list-style-type: none"> <li>1. Adjust voltage to 13.8 VDC (12 ~ 16 VDC). Reset voltage selector to correct local AC line voltage (PS-30)(PS-20).</li> <li>2. Turn RF GAIN control fully clockwise.</li> </ol>
No SSB reception. Wrong sideband. Frequency remains the same when RIT control is adjusted.	Set MODE switch to alternate SSB position.  RIT switch is OFF.	Depress RIT switch ON.
MHz order numbers not indicated on Digital Display.	This is normal; the digital display will not indicate MHz order frequencies in the following bands: 3.5 MHz band      4.0 and higher 7.0 MHz band      7.0 and lower 14.0 MHz band     14.0 and lower 21.0 MHz band     21.0 and lower 28.0 MHz band     28.0 and lower 29.0 MHz band     30.0 and higher	Digital Display is not defective. See sect. 4-1, receiver tuning.
No output.	Standby switch not in transmit position. CAR or MIC control in minimum position.	Turn CAR or MIC clockwise.
No SSB output.	<ol style="list-style-type: none"> <li>1. MIC plug loose.</li> <li>2. MIC control in minimum position.</li> </ol>	<ol style="list-style-type: none"> <li>1. Reconnect.</li> <li>2. Turn MIC control clockwise.</li> </ol>
VOX circuit inoperative.	<ol style="list-style-type: none"> <li>1. VOX control in minimum position.</li> <li>2. VOX switch in MAN position.</li> </ol>	<ol style="list-style-type: none"> <li>1. Turn VOX control clockwise.</li> <li>2. Set VOX switch to VOX.</li> </ol>
VOX operates by sound from speaker.	ANTI VOX setting incorrect.	Turn ANTI VOX control clockwise.

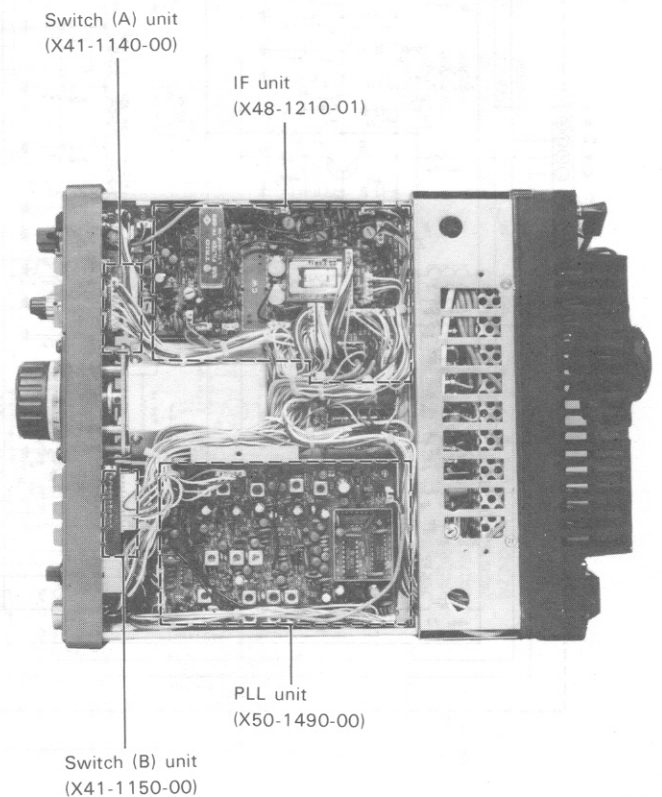
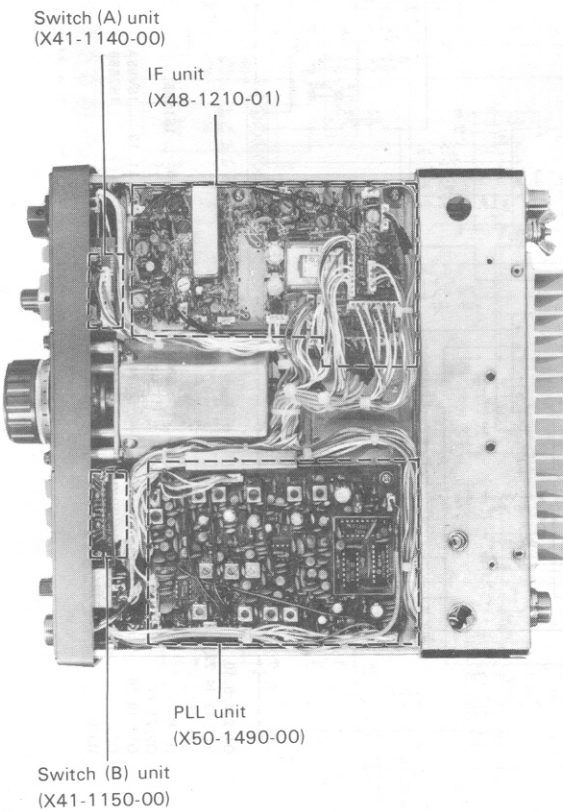
# INTERNAL VIEWS



TS-120V

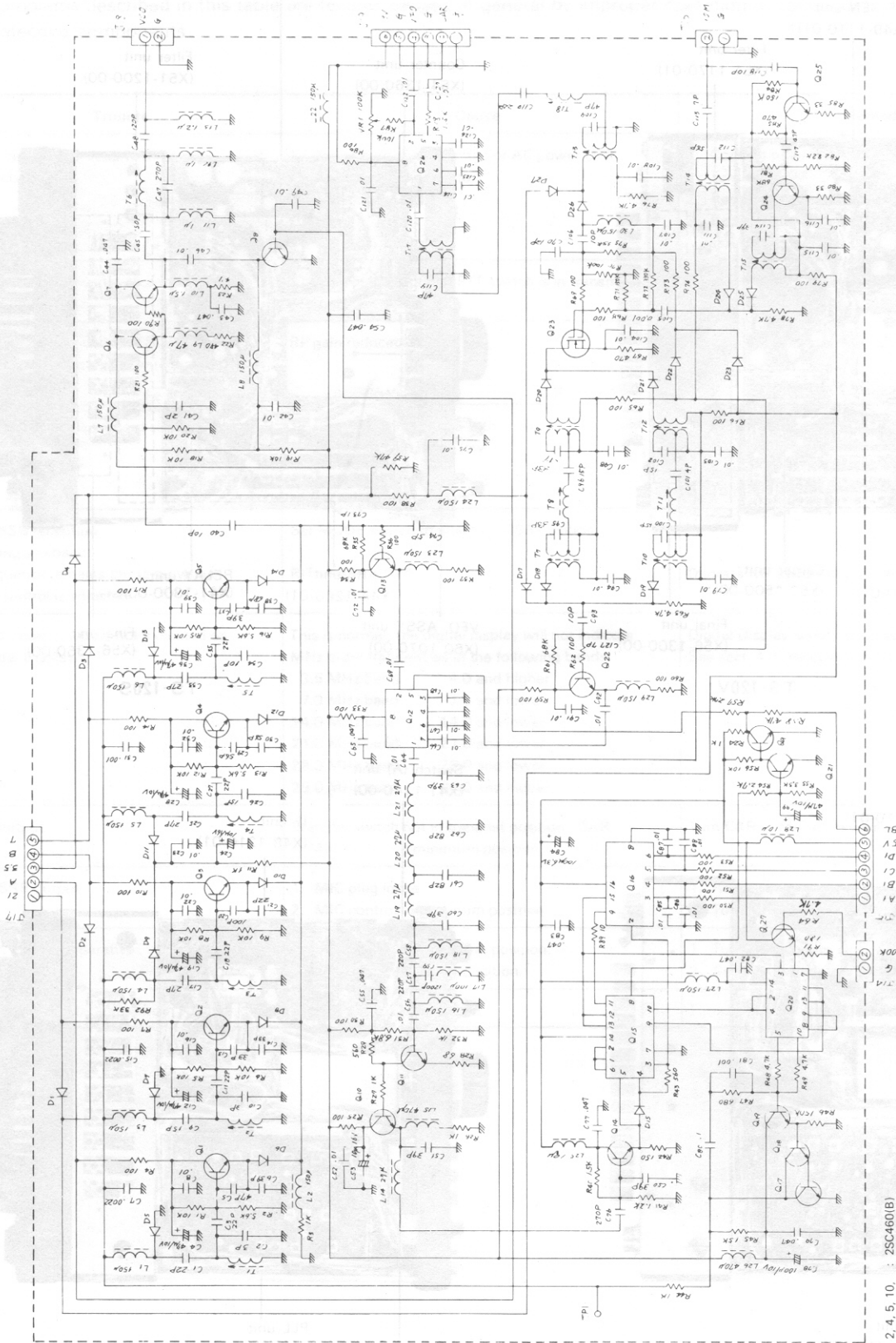


TS-120S



# SCHEMATIC DIAGRAM

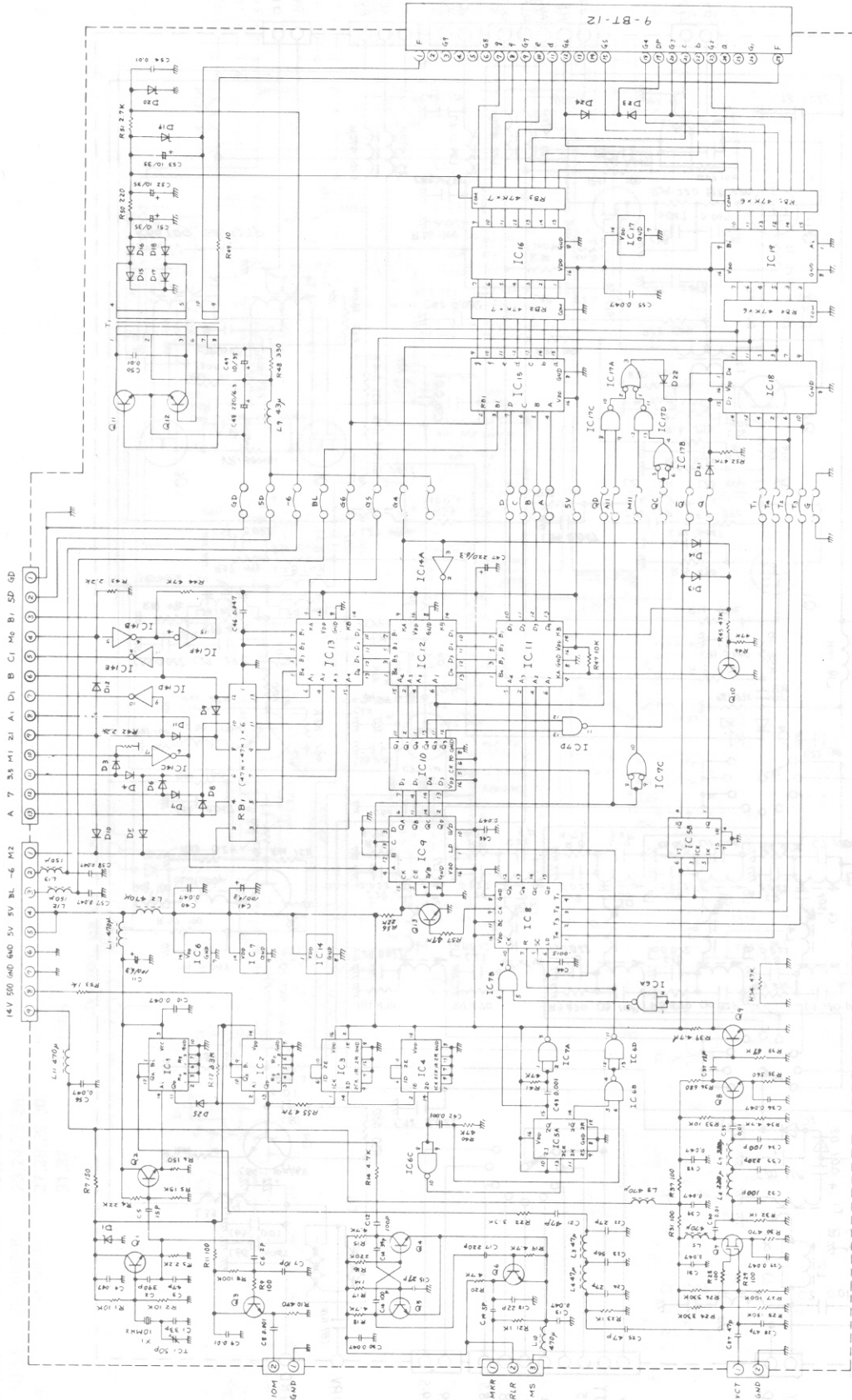
TS-120V  
TS-120S PLL UNIT (X50-1490-00)



- Q1, 2, 4, 5, 10, 11, 13, 14, 22, 24, 25
- Q7, 8
- Q9, 21, 27
- Q17, 18, 19
- Q23
- Q3, 6
- Q12, 26
- Q15
- Q16
- Q20
- D1, 2, 3, 4, 22, 23
- D5, 7, 9, 11, 13
- D10
- D6, 8, 12, 14, 15, 17, 18, 19, 20, 21, 24, 25, 26, 27
- D1, 2, 6
- D11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27
- D10
- 25C460(B)
- 25C1959(Y)
- 25C1815(Y)
- 25C1775(E)
- 35K40(L)
- 25C784(O)
- SN16913P
- HD74LS00P
- 74LS163N
- MC4044P
- 1S1555
- 1S1587
- 1S153A
- 1S2588



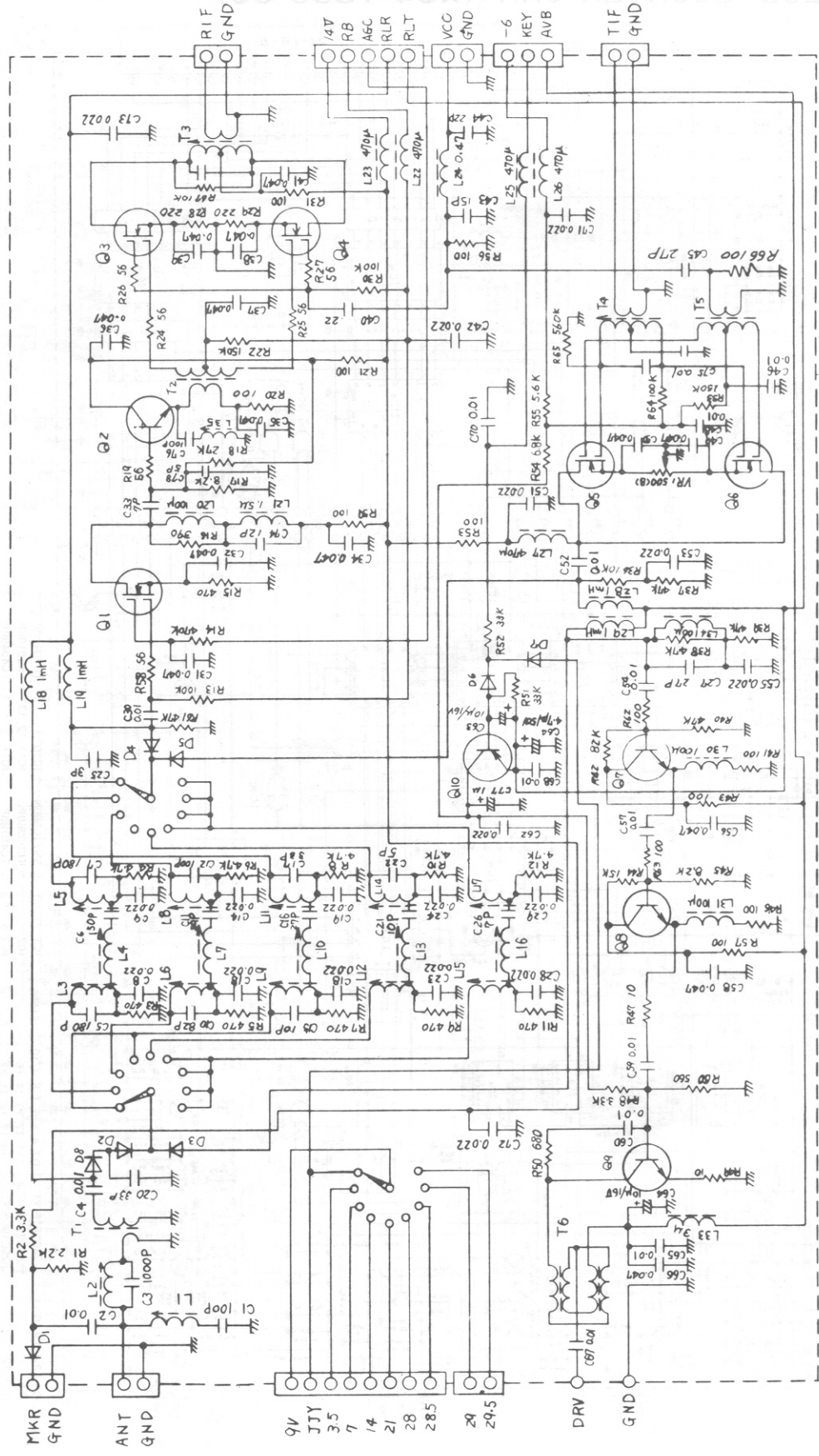
TS-120V  
TS-120S COUNTER UNIT (X54-I360-00)



Q1, 2, 3, 4, 8, 9, 10, 13	: 2SC1815(Y)	D3, 4, 5, 6, 7, 8, 9, 10	: 1S1555	IC1	: SN74LS90N	IC10	: TC4042BP
Q7	: 3SK73(GR)	11, 12, 13, 14, 15		IC2	: TC5028BP	IC11, 12, 13	: TC4019BP
Q6	: 2SC1959(Y)	16, 17, 18, 21, 22		IC3, 4	: TC4518BP	IC14	: TC4049BP
Q5	: 2SC785(O)	23, 24		IC5	: TC4027BP	IC15	: TC5022BP
D1, 19	: 2SC1815(GR)	D20	: XZ-060	IC6, 7, 17	: TC4011BP	IC16	: TC5066BP
	: WZ-030	D25		IC8	: TC5051BP	IC18	: TC5012BP
				IC9	: TC4029BP	IC19	: TC5064BP

# SCHEMATIC DIAGRAM

TS-120V  
TS-120S RF UNIT (X44-1260-01)

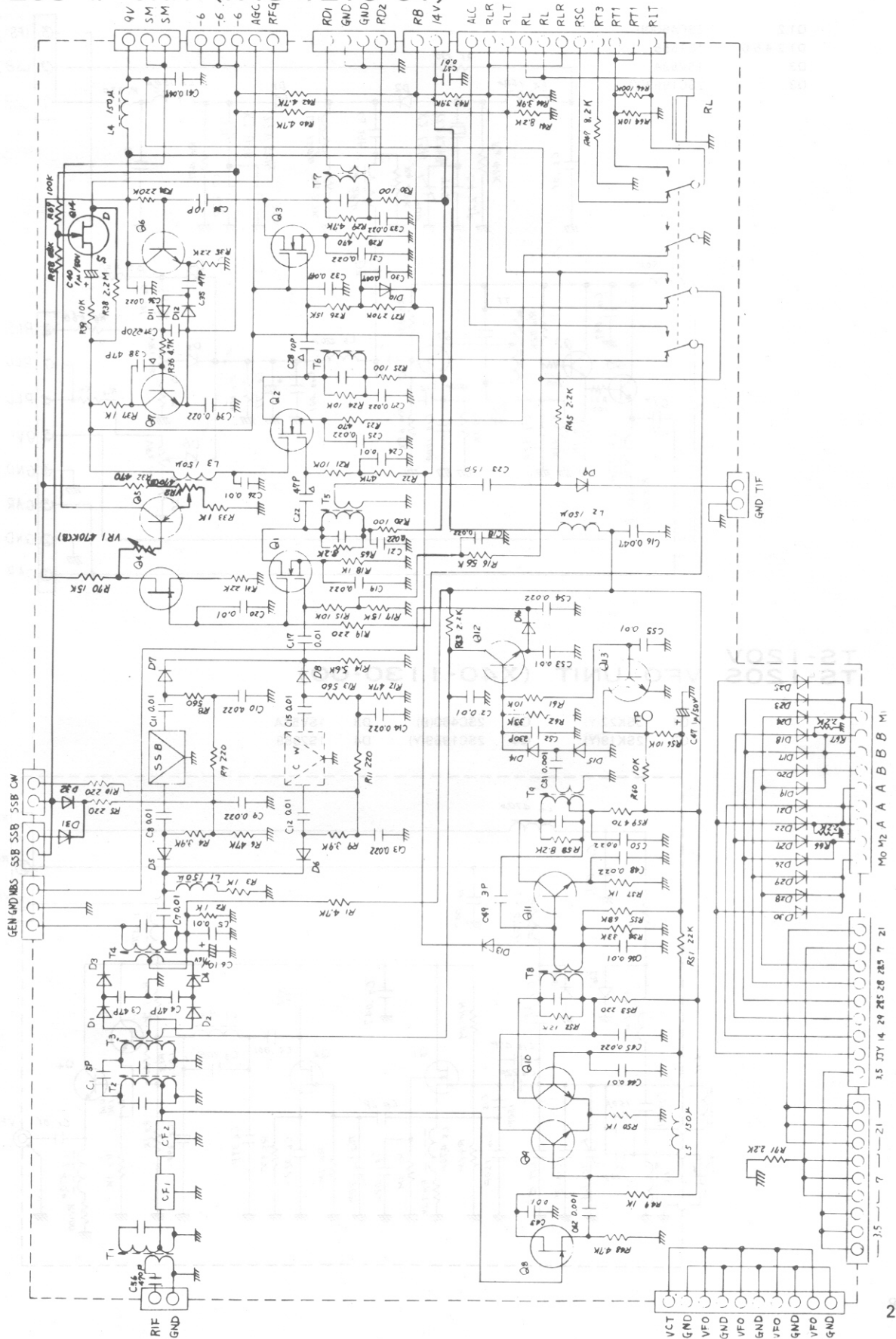


D1, 3.5 : 1S1587  
D2, 4 : 1S2588  
D6, 7 : 1S1555  
D8 : 1S1585

Q1, 3, 4, 5, 6 : 3SK74(L)  
Q2, 7, 8 : 2SC1815(Y)  
Q9 : 2SC2086  
Q10 : 2SA1015(Y)

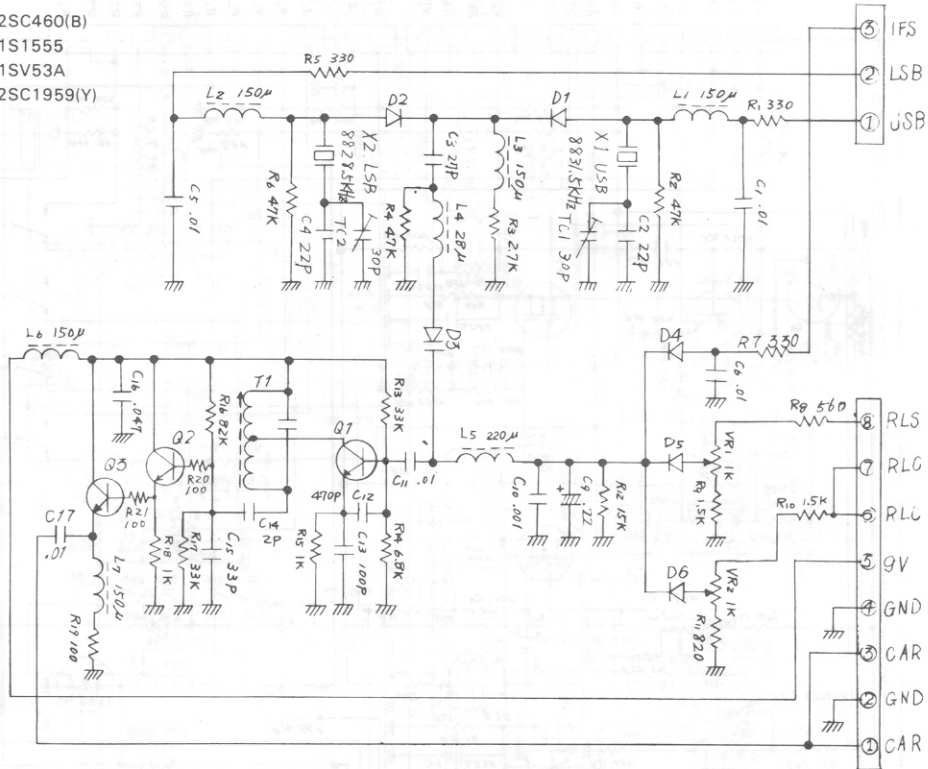
TS-120V  
TS-120S IF-UNIT (X48-1210-01)

- Q1,2,3 : 3SK74(L) 1S1587 D11,12,14,15 :1N60
- Q4,8 : 2SK19(GR) D5,7 1S1007 D13,16 :MV13
- Q5 : 2SA1015(Y) D9,10,17,18,
- Q6,7,12,13 : 2SC1815(Y) 19,20,21,22,
- Q9,10,11 : 2SC460(B) 23,24,25,26,
- Q14 : 2SK30(A) 27,28,29,30,
- 31,32 1S1555



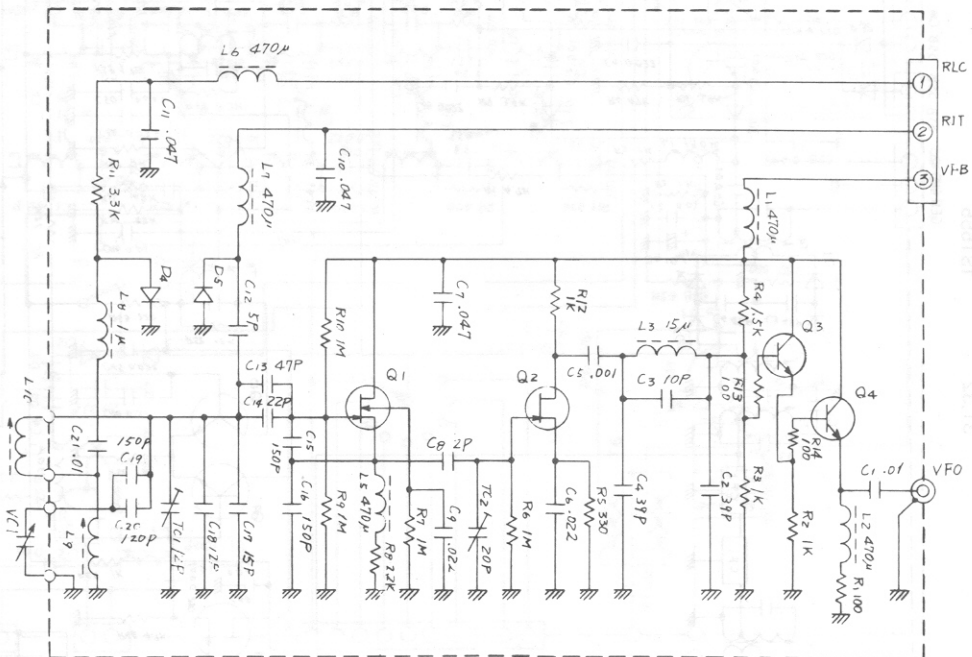
TS-120V  
TS-120S CAR UNIT (X50-1500-00)

- Q1,2 : 2SC460(B)  
D1,2,4,5,6 : 1S1555  
D3 : 1SV53A  
Q3 : 2SC1959(Y)

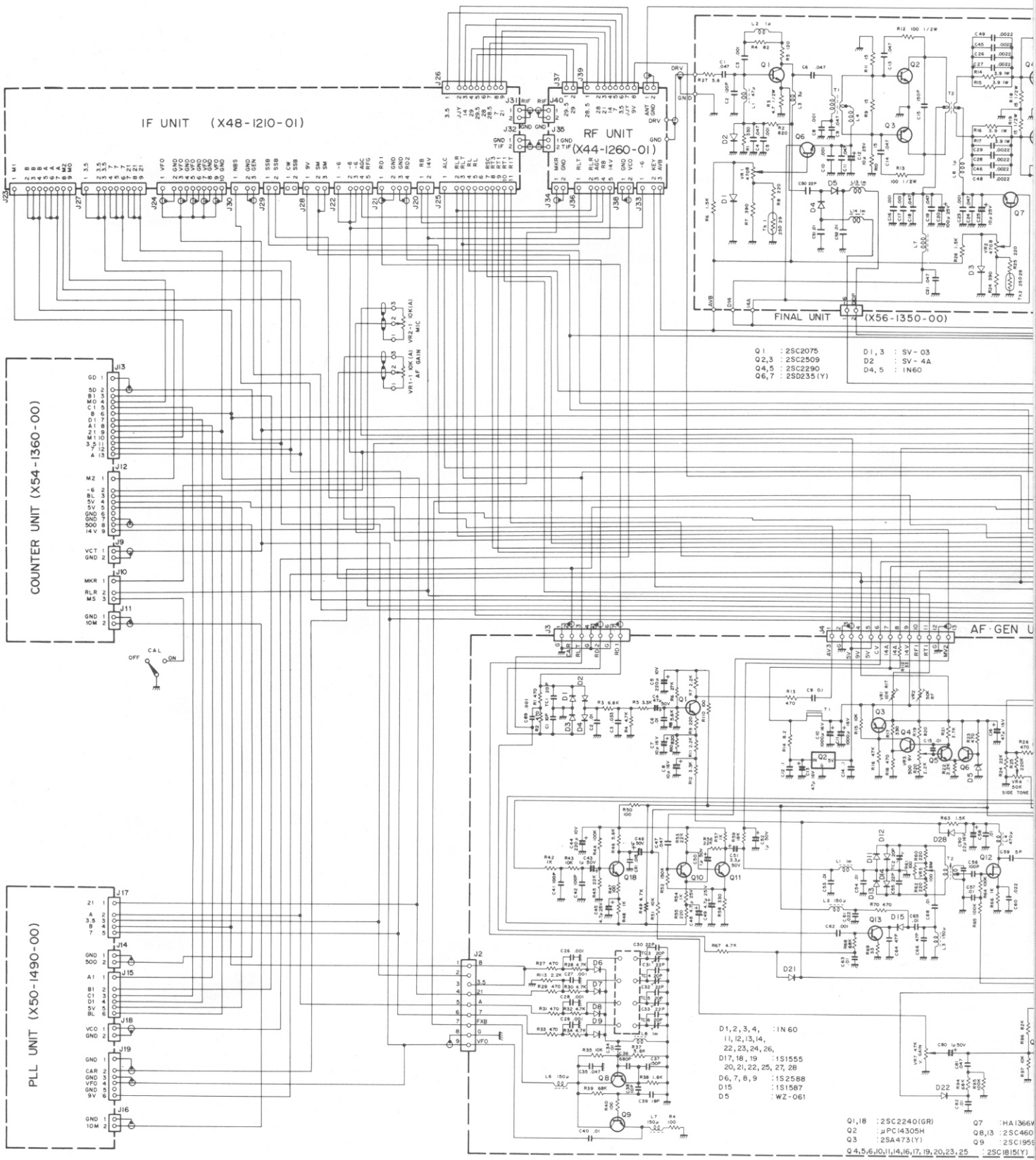


TS-120V  
TS-120S VFO UNIT (X40-1130-00)

- Q1 3SK22(Y)    Q3 2SC460(B)    D3 1SV53A  
Q2 2SK19(Y)    Q4 2SC1959(Y)    D4 1S2588



# TS-120S SCHEM

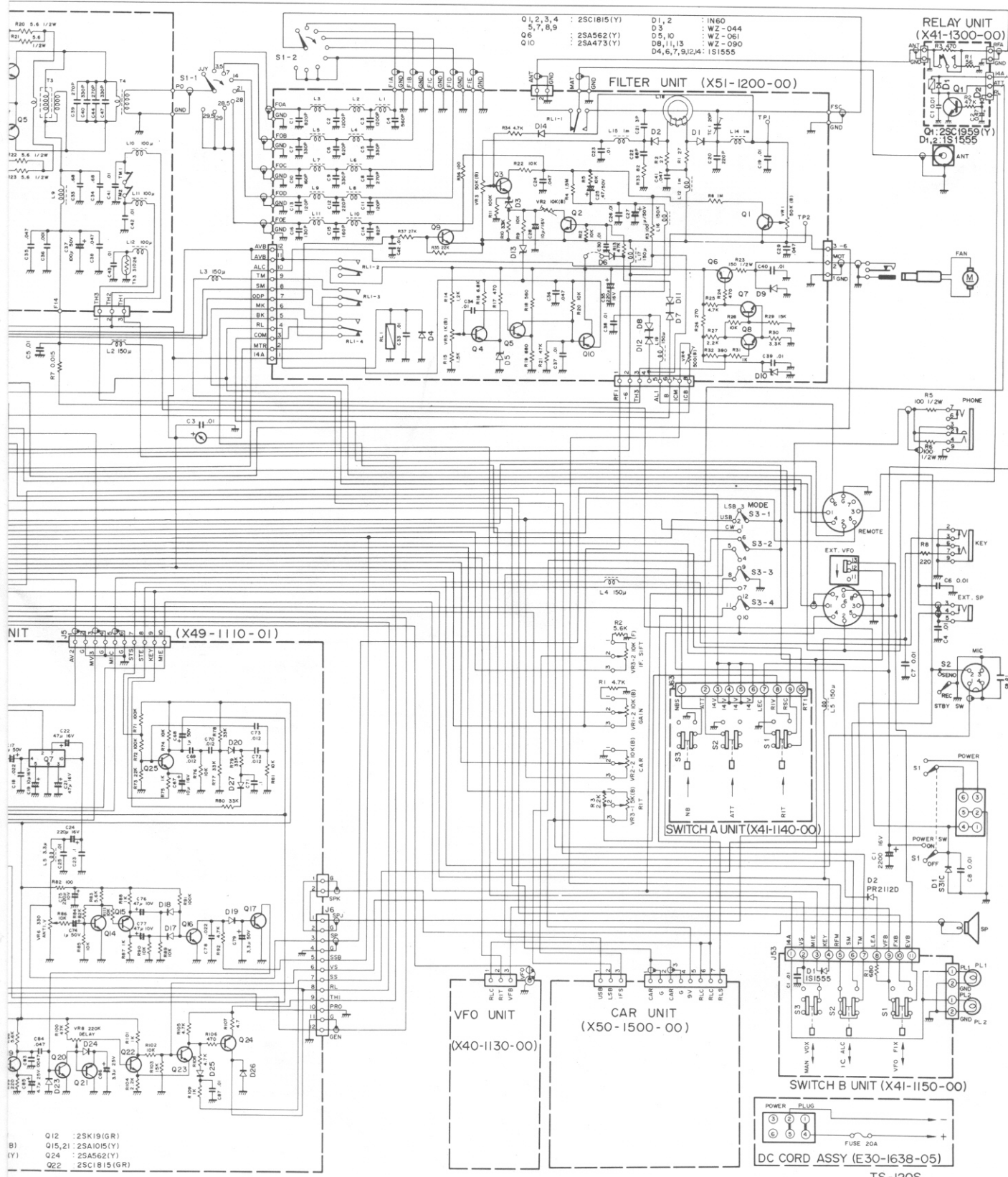


- Q1 : 2SC2075
- Q2,3 : 2SC2509
- Q4,5 : 2SC2290
- Q6,7 : 2SD235(Y)
- D1,3 : SV-03
- D2 : SV-4A
- D4,5 : IN60

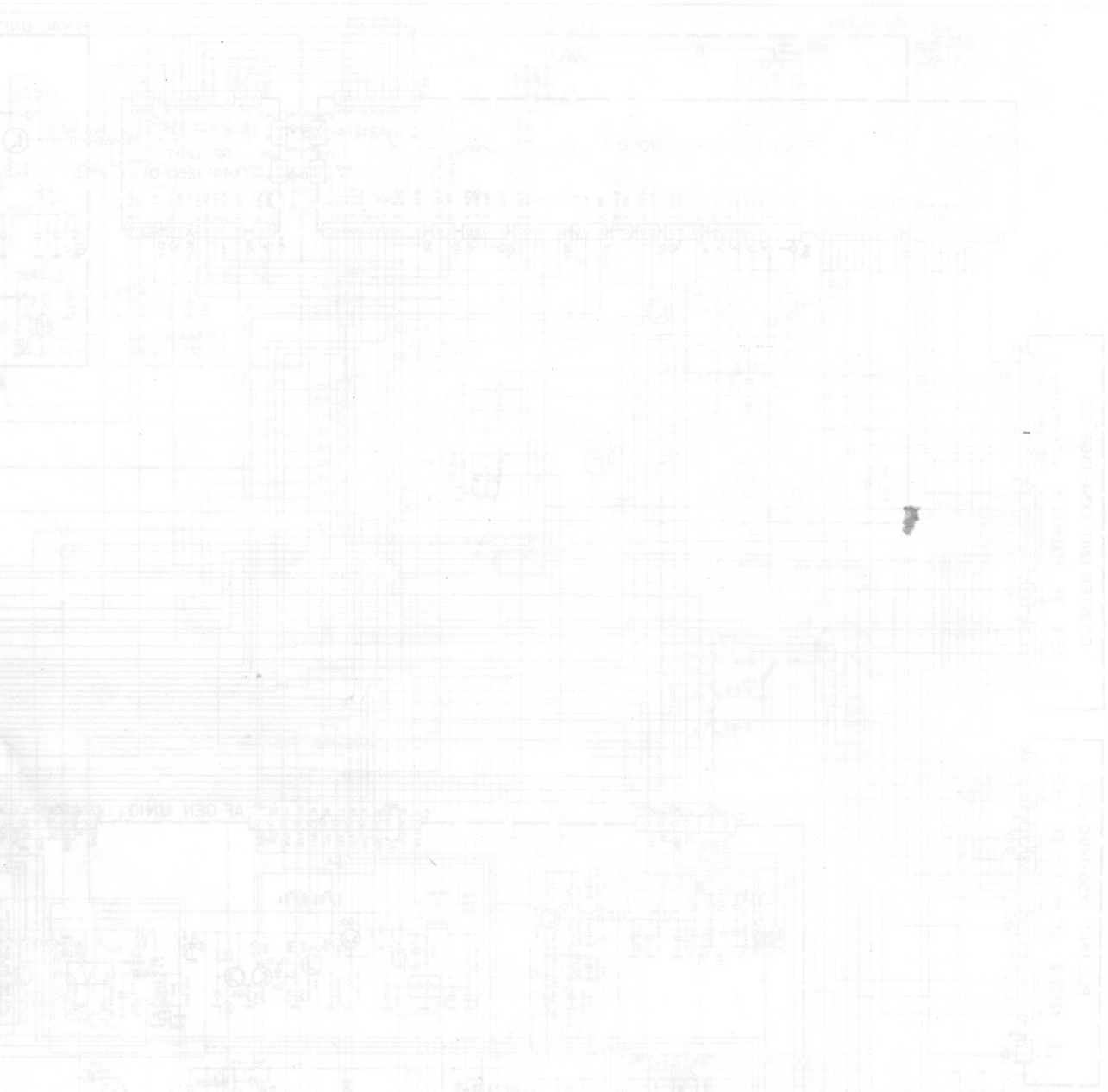
- D1,2,3,4 : IN60
- 11,12,13,14, 22,23,24,26,
- D17,18,19 : 1S1555
- 20,21,22,25,27,28
- D6,7,8,9 : 1S2588
- D15 : 1S1587
- D5 : WZ-061

- Q1,8 : 2SC2240(GR)
- Q2 :  $\mu$ PC14305H
- Q3 : 2SA473(Y)
- Q4,5,6,10,11,14,16,17,19,20,23,25 : 2SC1815(Y)
- Q7 : HA1366V
- Q8,13 : 2SC460
- Q9 : 2SC1956

# ATIC DIAGRAM



TRIO-KENWOOD CORPORATION



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