KENWOOD

Technical Information

HF SSB TRANSCEIVER

Model TS-120S

INCORPORATING KENWOOD'S HIGHLY SOPHISTICATED TECHNOLOGY

A NEW LINE WITH A VARIETY OF OPERATIONAL ENJOYMENT

HF SSB TRANSCEIVER MODEL TS-120S

The new model TS-120S transceiver is an exciting addition to Kenwood's HF SSB line. It is expected to be very popular with novices and advanced Amateurs for a variety of reasons.

In developing the TS-120S, the following goals were achieved:

1. Compactness and light weight, and yet incorporating up-to-date technology for best performance, functions, and mobility in any fixed, mobile, or portable (such as Field Day) applications.
2. High cost-performance ratio with more enjoyable HF operation, introducing up-to-date technology in the smallest possible package.
3. Easier operation so that all Amateurs, including newcomers, can enjoy HF communications without complex tune-up and operating procedures.

As a result, a compact size (only 241 mm (9½ W) X 94 mm (3-3/4 H) X 235 mm (11-9/16 D) and light weight (only 5.6 kg or 12.32 lbs. approx.) was achieved without sacrificing basic performance and pratical features required in an HF SSB transceiver.

The following basic features were retained without compromise:

1. Frequency coverage of 80m, 40m, 20m, 15m, and 10m bands for both transmitting and receiving.
2. Single-conversion system with advanced PLL circuit.
3. Built-in digital display with 100-Hz readability.
4. Analog dial readable to 1 kHz.
5. Same effective built-in IF shift circuit as in the TS-820, to eliminate interference.

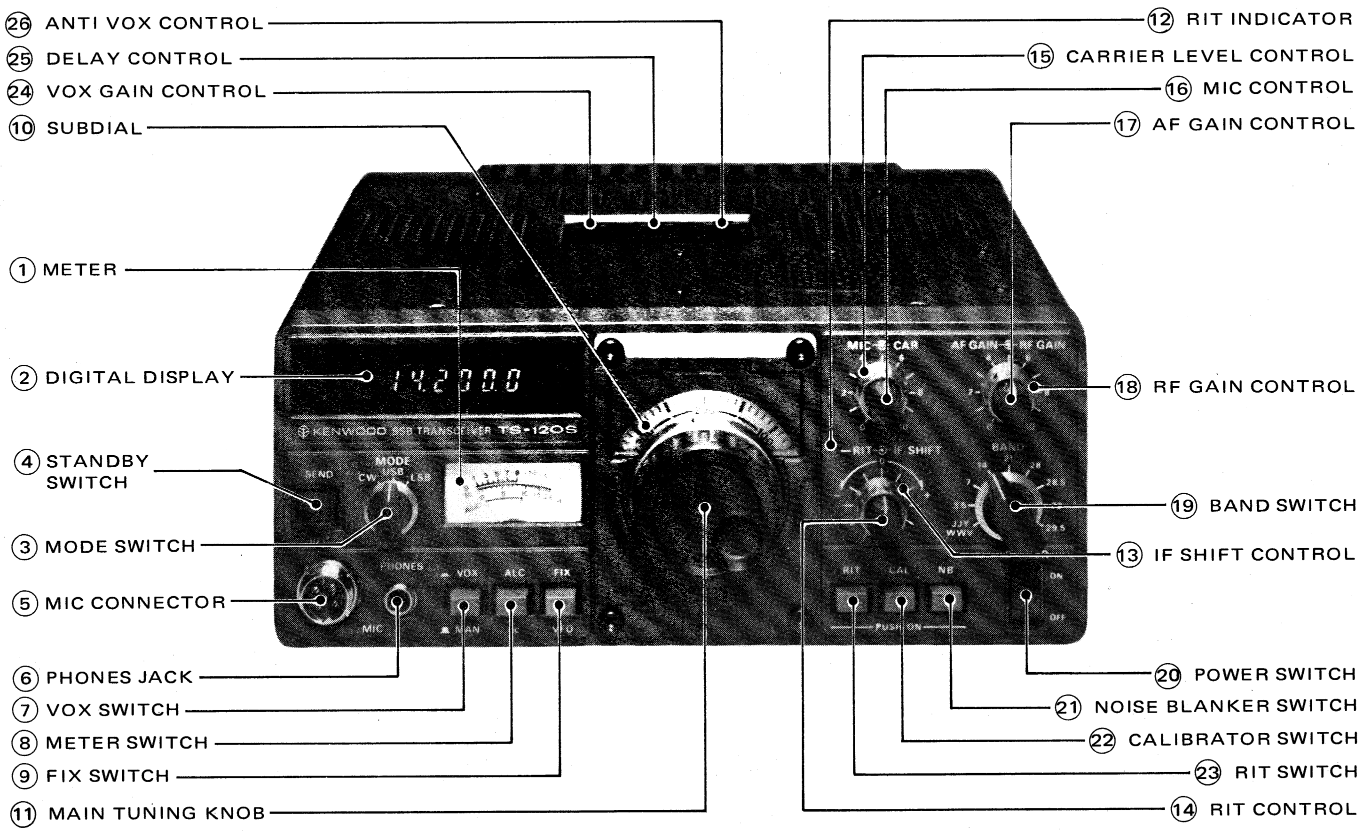
FEATURES of the TS-120S

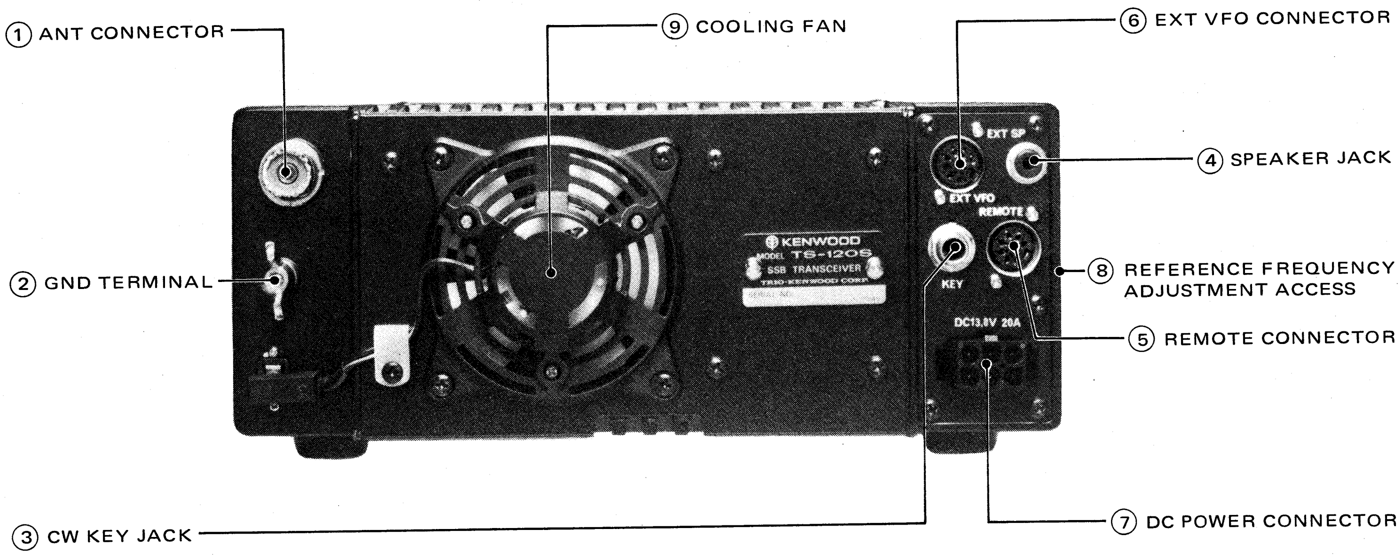
1. Easy operation
   The TS-120S has been designed so that even Amateurs who have no HF SSB operating experience can enjoy such communications with ease. Also, the TS-120S is a suitable HF SSB transceiver for exclusively mobile operation. Cumbersome tuning procedures

such as peaking the drive, dipping the final plate current, antenna loading, and preselector tuning, as required on conventional HF SSB transceivers, are completely eliminated from the TS-120S. All the Amateur has to do is set the band switch to his desired frequency, and operate!

2. Extremely Compact
The extremely compact TS-120S HF SSB transceiver offers performance that would be expected only in larger, more expensive transceivers. Newcomers and advanced operators will be fully satisfied with the performance of the TS-120S. Whether used as a fixed or mobile station, the TS-120S does not require much space, and many Amateurs will consider it to be the ultimate HF transceiver for their requirements.

3. Built-in Digital Display
The digital frequency display, which until now was found only on large, expensive transceivers, is built into the TS-120S as a standard feature. The display uses a blue fluorescent tube for fatigue-free viewing over long operating sessions. The operating frequency can be read without error. Furthermore, the analog subdial helps the operator determine at a glance the operating frequency.





4. IF Shift System
The same advanced IF shift (passband tuning) system as used in the TS-820 series transceivers is also provided in the TS-120S. This system removes adjacent frequency interference and "sideband splatter." Kenwood's advanced PLL engineering efforts have made it possible to build the IF shift system in such a compact rig as the TS-120S. Besides removing adjacent frequency interference, the IF shift system makes it possible to adjust the pitch of CW signals being received.

5. Built-in VOX Circuit
A built-in VOX system is provided in the compact TS-120S. Also, the built-in CW sidetone oscillator circuit and VOX system makes semi-break-in operation available in the CW mode.

6. Innovative M.C.F.
The monolithic crystal filter has the same outstanding characteristics as the normal eight pole crystal filter but occupies a much smaller space. Fig. 1 shows the characteristics of the SSB filter and CW filter. In addition to the built-in SSB filter, a sharp CW filter (YK-88CW) is also available as an option.

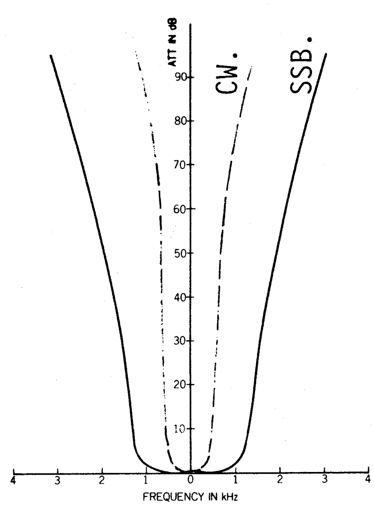


Fig.1

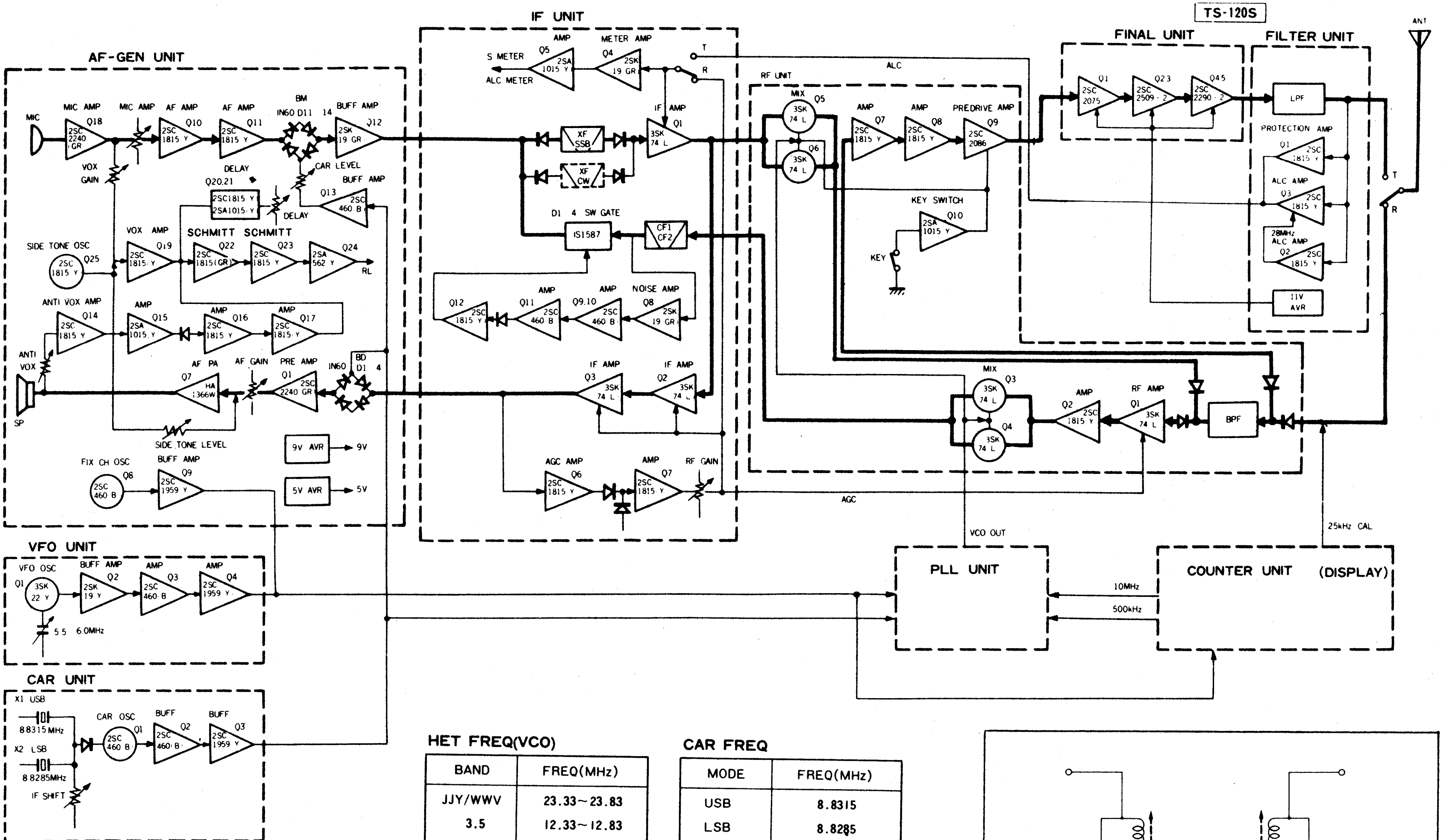
7. All Solid-State Construction
The TS-120S is a high-performance transceiver with all solid-state design, including the transmit final power amplifier stage. The transmit final amplifier stage includes a protection circuit that detects VSWR and temperature, automatically reducing output to 1/10 of normal output when either parameter is too high. Extra consideration is given to the radiation of final-transistor heat. A specially designed die-cast aluminum heatsink and a quiet fan with a temperature-detection device allow high, yet stable power output, while retaining compactness.
8. Built-in Noise Blanker
The same effective noise-blanker circuit as used in the TS-520 and TS-820 series is also a standard feature in the TS-120S. This eliminates pulse-type interference generated by car ignition systems, particularly on the higher HF bands. A new type of filter in the input circuit of the noise blanker minimizes the effect of adjacent-frequency signals on the operation of the blanker.
9. Built-in Fixed Channels
Four fixed channels are available, with one channel on each of the 7, 14, 21 and 28 MHz bands. Fixed channel operation on the 3.5 MHz band is possible by changing an inside connector, which changes the position of the crystal from 28 MHz to 3.5 MHz. Operation can be changed from VFO to fixed channels by selecting the VFO-FIX switch on the pannel.
10. Built in 25-kHz Marker
The 25-kHz marker signals are derived from the 10-MHz master oscillator and provide an accurate frequency reference for the TS-120S or other rig.

Circuit Configuration

Shown in the block diagram (Fig. 2), the TS-120S uses a single-conversion system with a new PLL circuit which does not require a crystal element for each band.

1. Receiver Station
The incoming signals from the antenna are, after passing through the IF trap circuit, boosted by about 10dB by the wideband transformer and supplied to the bandpass filter (B.P.F.) for each band. The B.P.F. is composed of three coils and Fig. 3 shows its circuit configuration, of which typical characterisitics are shown in Fig. 4. A preselector is unnecessary with the B.P.F. and therefore the RF

BLOCK DIAGRAM Fig.2



HET FREQ(VCO)

BAND	FREQ(MHz)
JJY/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

CAR FREQ

MODE	FREQ(MHz)
USB	8.8315
LSB	8.8285
CW(R)	8.8315
CW(T)	8.8307

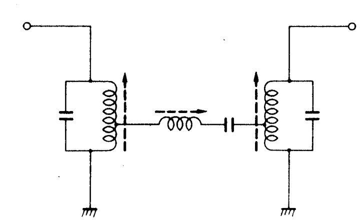


Fig.3

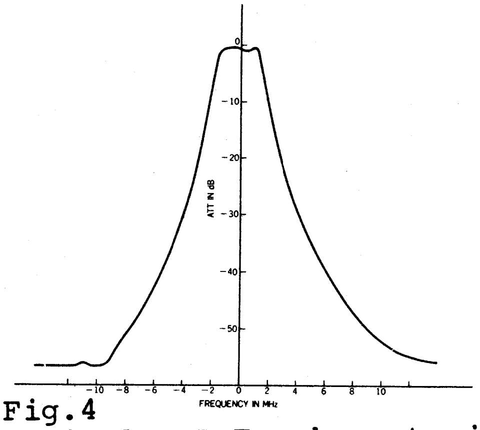


Fig.4
Typical B.P.F. characteristic

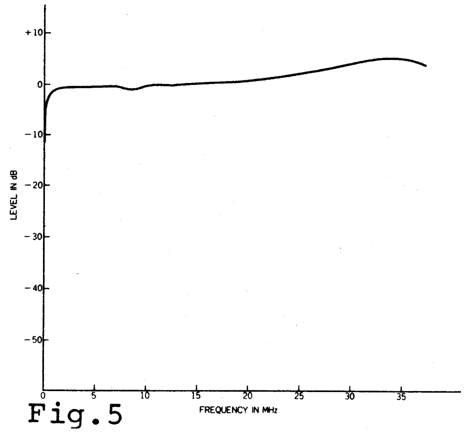


Fig.5
RF Amp stage frequency response

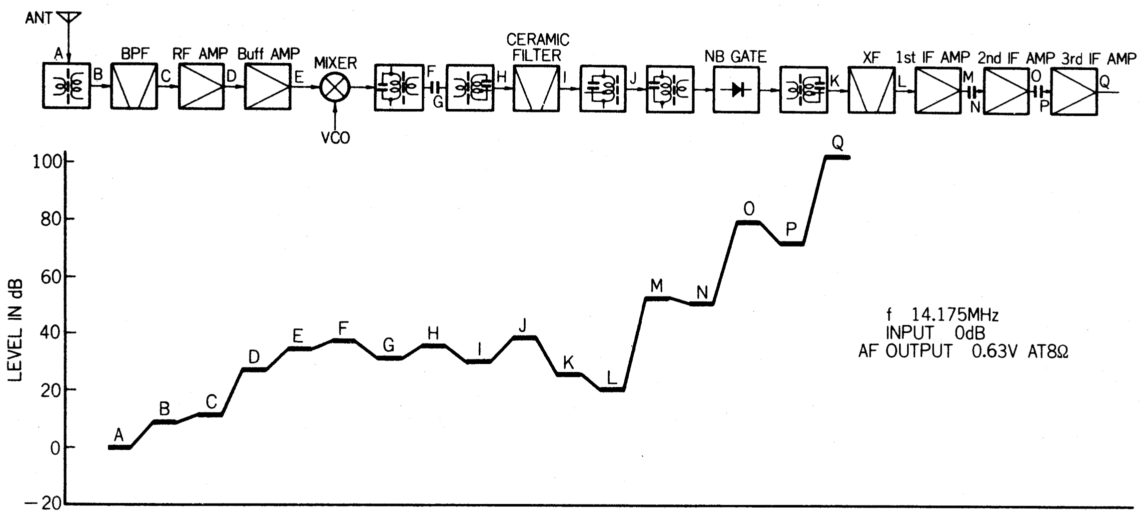


Fig.6
Receiver level diagram

section including the coil pack is very compact. This B.P.F. circuit is used in common both for transmission and reception. The signals through the B.P.F. go into the wideband RF amplifier, composed of 3SK74 and 2SK1815 dual-gate MOSFETs. This amplifier boosts the signals by about 20dB between 2 MHz and 35 MHz. Fig. 5 shows the frequency characteristics of the wideband RF amplifier. The RF amplifier-output is fed to the balanced mixer (made up of two 3SK74 dual-gate MOSFETs) through a wideband transformer and is then converted to the 8.83 MHz after being mixed with the VCO output from the PLL circuit. The converted signals proceed into the

IF unit and are applied to the crystal filter through the gate circuits of the ceramic filter and noise blanker. The gate of the noise blanker is turned on or off by blanking pulses that are amplified, detected, and ordered, with noise separated by changing AGC threshhold levels. In actuality, the noise blanker works effectively to eliminate the pulse-type interference generated by car ignition systems. As a result, even weak signals can be received clearly with no noise. The noise blanker is operated by the NB switch on the front panel. The signals coming through the crystal filter are amplified by about 90dB by the three-stage IF amplifier (3SK74 MOSFETs), and are demodulated into audio signals by the four-diode ring detector. The AGC circuit detects and amplifies the signal from the last IF stage through the buffer amplifier, with the time constant determined by a 2.2 Mohm resistor and a 1 μF capacitor, and controls gain by applying that signal as the AGC voltage to the second gate of the RF amplifier stage and three-stage IF amplifier. The level of gain controlled is indicated on the S-meter, as the S-meter circuit measures AGC voltage directly. The S-meter circuit also functions as the ALC meter circuit when in transmit mode. The antenna input levels of approximately 2 dB (0.6 μV) and 34 dB (25 μV) are set at S1 and S9 respectively. The level diagram of each receive stage is shown in Fig. 6. The signal received, now transformed into an audio signal, is amplified by one stage and again voltage-amplified by the MA1366W IC after coming through the AF volume control, and then drives the speaker. A portion of the AF output is used as a signal for ANTI VOX, which prevents the VOX from being activated by the output from the speaker. Fig. 7 shows receiver sensitivity. Receiver IF spurious response and image rejection are shown in Fig. 8. Fig. 9 and Fig. 10 show two-signal response characteristics in the receiver.

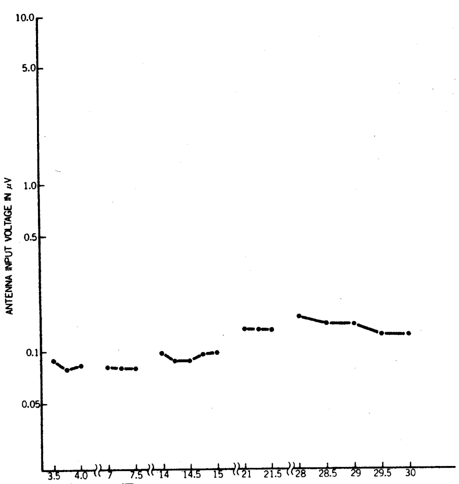


Fig.7
Receive sensitivity

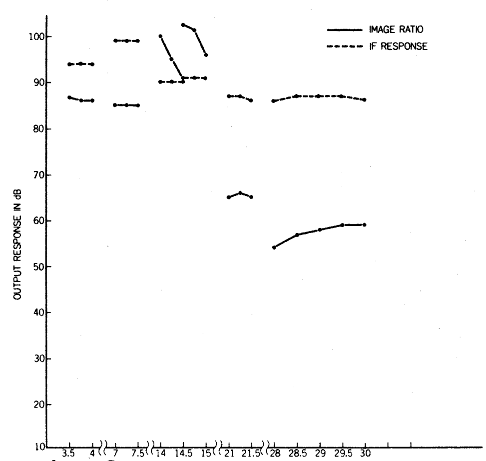


Fig.8
Receiver spurious response

Receiver two signal response charaeteristic

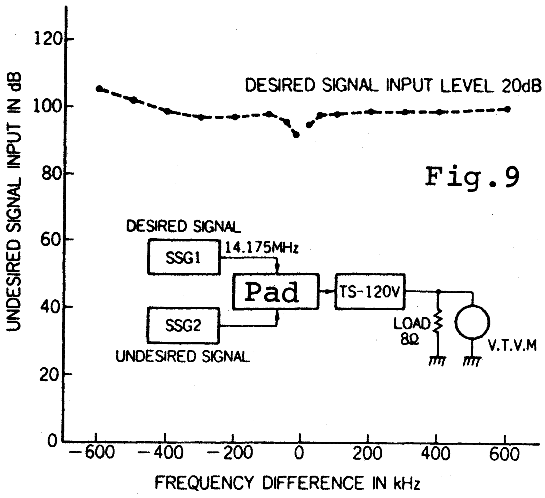


Fig.9

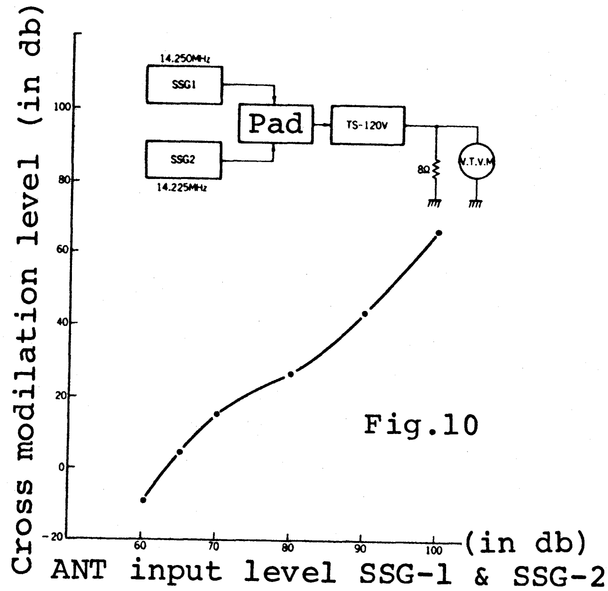


Fig.10

2. Transmit Section

Signals from the microphone are amplified by the three-transistor phone amplifier and applied to the four-diode ring modulator. The matching impedance range is between 500 ohms and 50 kilohms, and it is designed so as not to affect microphone characteristics. When microphones with unusually high output level are used, it would be possible to saturate the input circuit. In such cases a suitable attenuation circuit should be used. The input signal now transformed by the ring modulator into the DSB signal of 8.83 MHz is, after being amplified by about 10dB by the 2SK19 FET, applied to the IF unit, and becomes as SSB signal with the undesired sideband removed by the crystal filter. The protection-circuit voltage, which is generated when any abnormality occurs, thereby lowering the output power continously, is applied to the gate circuit after the 2SK19 buffer amplifier following the ring modulator. The SSB signal, now transformed by the crystal filter from the original input signal, is mixed, after being amplified by about 30dB by the IF amplifier, with the VCO output by the transmit balanced mixer (in the RF unit) consisting of two 3SK74 MOSFETs, and converted to the transmit frequency desired. This signal proceeds into the final unit as a predrive output through the three-stage wideband amplifier, with undesired spurious waves eliminated by the B.P.F. circuit used in common both for transmission and reception. In the final unit, the signal is amplified by the 2SC2075, which drives two 2SC2509 push-pull amplifiers

to a high enough level to drive the final stage consisting of two 2SC2290's providing power output to the antenna, after passing through a harmonic filter. Antenna output is toroid-sampled to detect forward and reflected power. The forward wave is used of ALC and the reflected wave for protection.
The ALC rectifies and amplifies the forward wave, which is applied to the second
gate of the common IF amplifier (in the IF unit) by the time constant determined by the 1 megohm resistor and a 0.47 µF capacitor. Consequently a clean signal can be transmitted with quick response, as a result of amplifier-type ALC, and with little splatter. The keying circuit (CW operation) controls the voltages of the first and second transmit mixers and the base voltage of the predriver stage by the block bias keying, which controls the base circuit of the switching transistor.

Frequency Configuration

The TS-120S employs a unique signgle conversion PLL system. Fig. 11 shows its configuration. Basically the same frequency configuration as that of the TS-820 is used for the VCO output, IF and CAR frequencies, etc., although the PLL design is different. The only difference is the range of the WWV receiving frequencies, between 14.5 MHz and 15.0 MHz, and the range of the VCO frequencies is changed to 23.33 MHz to 23.83 MHz accordingly. Also, the design of the PLL system makes available mono-dial indication and IF shift operation.

1. PLL Circuit
   One of the biggest differences between the PLL circuit of the TS-120S and that of the TS-820 is that the TS-120S does not have a heterodyne crystal oscillator circuit for each band. The VCO frequency is obtained from the PLL circuit by synthesizing the VFO and CAR frequencies and reference oscillating frequencies of 10 MHz and 500 kHz supplied by the counter. Bandswitching is accomplished by changing the preset value of the programmable divider in the PLL. Therefore, when switching bands, the frequency (except, of course, the 1-MHz and 10-MHz order digits) remains the same. The frequencies for each band and PLL stage are shown in Table 1. First, MIX (3) mixes the CAR and VFO frequencies, using a double balanced mixer to reduce spurious signals. The output of MIX (3), after passing through a bandpass filter (BPF3), is applied to the input of MIX (1) on the 3.5 and

7.0-MHz bands. On the 4-MHz and WWV bands, MIX (2) mixes the output of MIX (3) with a 10-MHz signal from the counter-unit oscillator. On the 21 and 28-MHz bands, MIX (2) mixes the output of MIX (3) with a 20-MHz signal from a doubler connected to the counter-unit oscillator. The output of MIX (2) - or MIX (3) on the 3.5 and 7.0 MHz bands--is mixed with the VCO output at MIX (1), providing output frequencies shown in the Table 1. They are put through LPF (1) and amplified, and the resulting digital signal is divided by the programmable divider, producing an output of 500 kHz. "Information" from the band switches is converted into BCD signals in the counter and the division ratio as shown in the table is preset. The loop filter consists of transistors mounted on the outside to minimize signals. A Morotola MC4044P functions as the phase comparator. Five VCO circuits with high-output transistors cover all of the bands. If the output of the phase comparator unlocks, VCO output is switched off to prevent emission at unwanted frequencies and, at the same time, the digital display blanks to warn the operator. Photo 1 shows the spectrum of the VCO output on the 14 MHz band.

2. Car Oscillator

The CAR oscillator of the TS-120S is made up of one oscillator and crystal element for LSB, USB and CW. The oscillator frequencies for each mode are in Table 1. The oscillator frequency can be varied by the IF SHIFT control in the receiving mode.

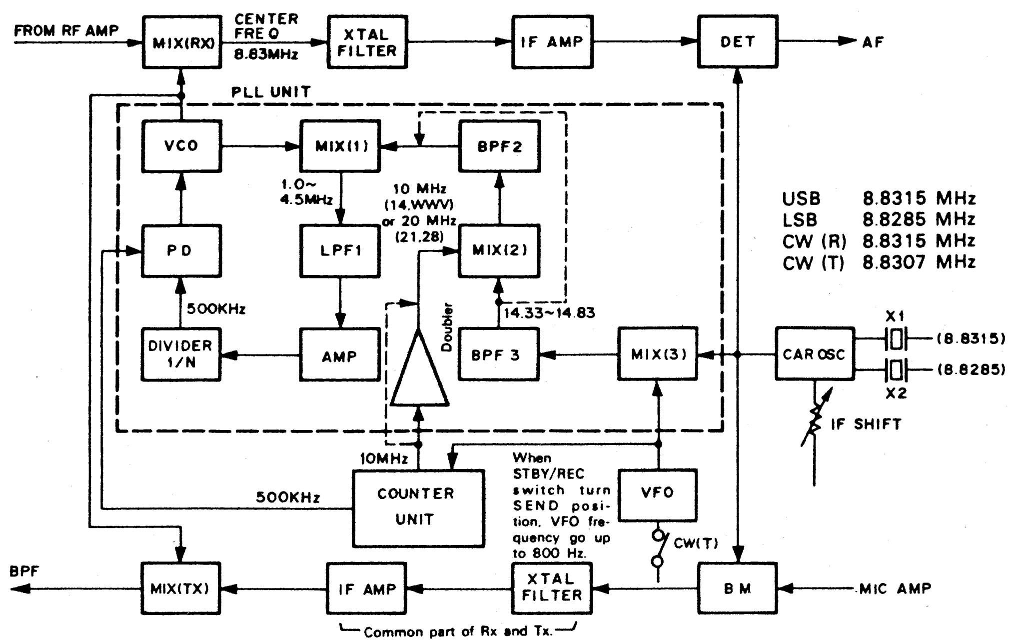
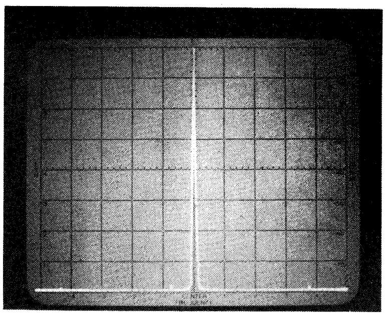


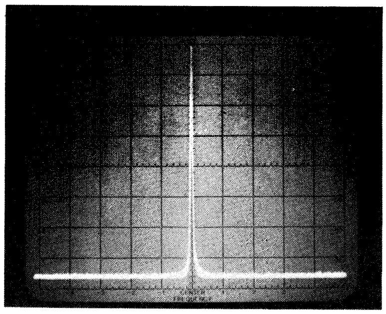
Fig.11 TS-120 Frequency configuration

Table 1

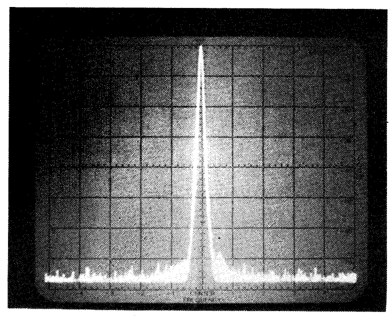
Band	TX-RX F (MHz)	VCO (MHz)	MIX-1 in (MHz)	MIX-1 out (MHz)	Divider	DCBA
JJY	14.5~15.0	23.33~23.83	24.33~24.83	1.0	1/2	1 1 1 0
3.5	3.5~ 4.0	12.33~12.83	14.33~14.83	2.0	1/4	1 1 0 0
7	7.0~ 7.5	15.83~16.33	14.33~14.83	1.5	1/3	1 1 0 1
14	14.0~14.5	22.83~23.33	24.33~24.83	1.5	1/3	1 1 0 1
21	21.0~21.5	29.83~30.33	34.33~34.83	4.5	1/9	0 1 1 1
28	28.0~28.5	36.83~37.33	〃	2.5	1/5	1 0 1 1
28.5	28.5~29.0	37.33~37.83	〃	3.0	1/6	1 0 1 0
29	29.0~29.5	37.83~38.33	〃	3.5	1/7	1 0 0 1
29.5	29.5~30.0	38.33~38.83	〃	4.0	1/8	1 0 0 0



Band Width 30kHz
Scan Width 2MHz/div



Band Width 3kHz
Scan Width 200kHz/div



Band Width 30kHz
Scan Width 0.5kHz/div

Photo 1 VCO Output Spectrum
(VCO F:23.08MHz, TX-RX F:14.250MHz)

3. VFO Oscillator

The compact VFO, designed especially for the TS-120S, is based on the TS-820 and TS-520 VFO design. However, the operating frequencies have been changed to cover 5.5 MHz to 6.0 MHz. A special feature of this VFO is a shift of the transmitting frequency in the CW mode by 800 Hz higher than the receiving frequency. The VFO is used to obtain a frequency difference between CW transmission and reception. (This function is performed by the CAR oscillator in the TS-820.) As detailed later, the digital counter of the TS-120S counts VFO frequencies, and thus displays exact CW operating frequencies both for transmission and reception. Also, the frequency changes 25 kHz per rotation of the main tuning dial, which is calibrated at 1 kHz intervals, A 10 kHz subscale is also provided. Operating frequencies can be read easily with either the analog or digital display.

4. Digital Counter

The TS-120S digital counter employs a VFO frequency counting system as shown in Fig. 12. First, the VFO frequency is mixed with a 5 MHz signal obtained from the reference oscillator chain and is converted to 0.5 MHz to 1 MHz. This signal passes through a low-pass filter, is amplified, buffered, and shaped into a digital (square) wave, passes through a 0.1 second gate circuit and is applied to a four-digit counter. The signal is counted from 10 Hz to 100 kHz and is fed to a preset counter to derive the carrier output. The 100kHz order digit presets at 5 to display the operating frequency on the 3.5 MHz, 28.5 MHz, 29.5 MHz and WWV bands, and at 0 for display on 7.0 MHz, 14.0 MHz, 21.0 MHz, 28.0 MHz and 29.0 MHz. The 1-MHz and 10-MHz order digits are determined by a matrix operating with bandswitch information. The counter outputs are switched by the multiplexer and converted from BCD to seven-segment information by the decoder to light the fluorescent display tubes. The large digits have good luminous intensity and a dark filter, providing fatigue-free viewing over long operating periods. The display can be read easily even in the car and other sunlit locations. The reference oscillator produces a 10 MHz signal and performs time base division, and generates gate pulses, latch pulses, and reset pulses, which are applied to the counter. The counter produces 10 MHz and 500 kHz outputs, which are fed to the PLL circuit.

The marker circuit produces a 100 kHz signal which synchronizes the 25 kHz multivibrator to obtain a marker signal as accurate as the reference frequency. The analog dial can be calibrated accurately with the marker signal. The 1/10 division at the first stage of the count-down chain utilizes low-power Schottky TTL, and the other divisions use CMOS ICs for low power consumption and minimum spurious emission. With the IF shift circuit, the CAR frequency is independent of both transmitting and receiving frequencies. When the VFO frequency is counted, the operating frequency is indicated as accurately as the reference oscillator frequency, provided that the 10 MHz reference is calibrated to WWV. True operating frequencies are displayed accurate to three digits (100-Hz order), regardless of CW transmitting and receiving frequencies or the position of the band switch or mode switch. When the VFO is tuned to the extent that the 1 MHz and 10 MHz orders are switched (beyond the band edge), these indications disappear and a blanking signal is produced.

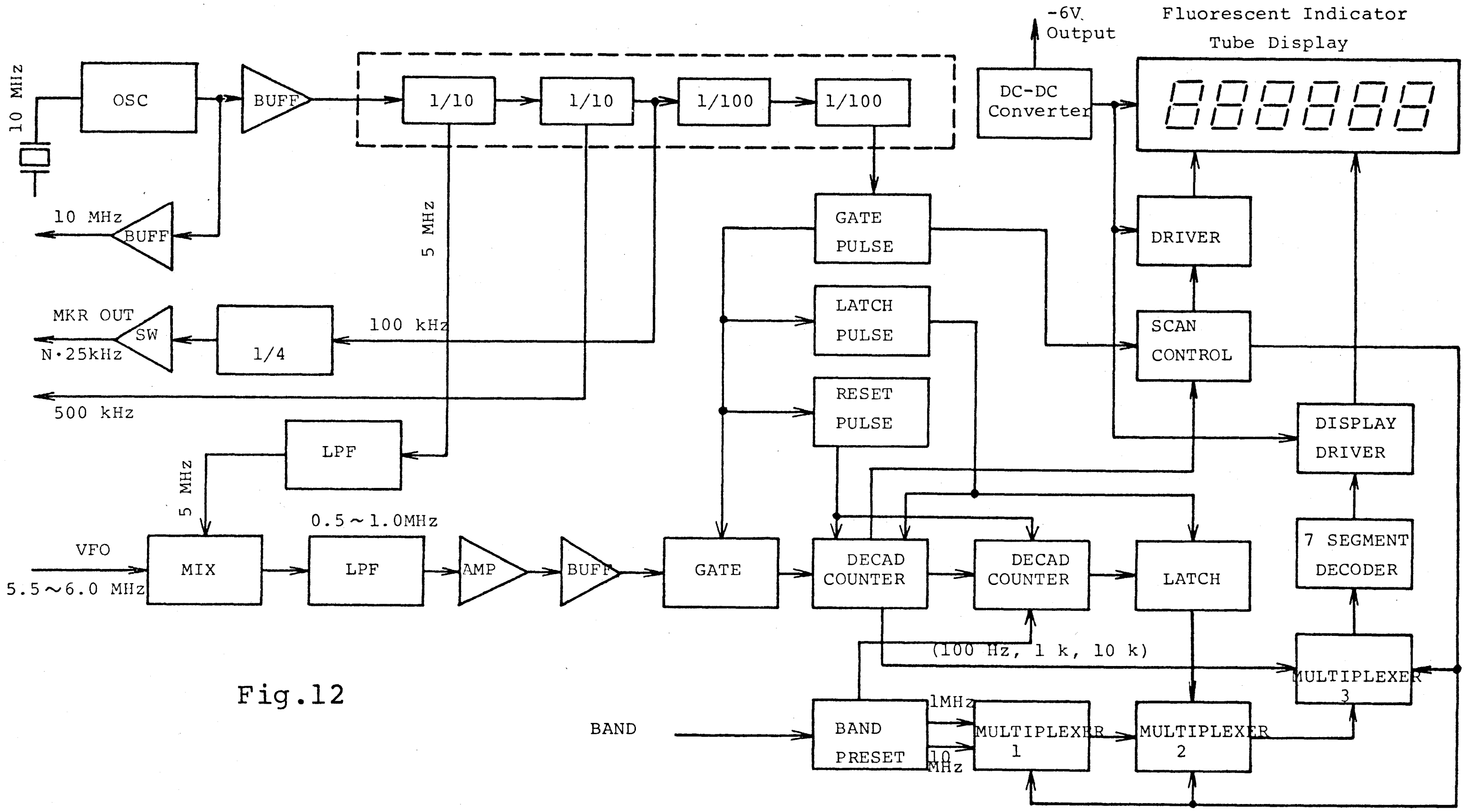
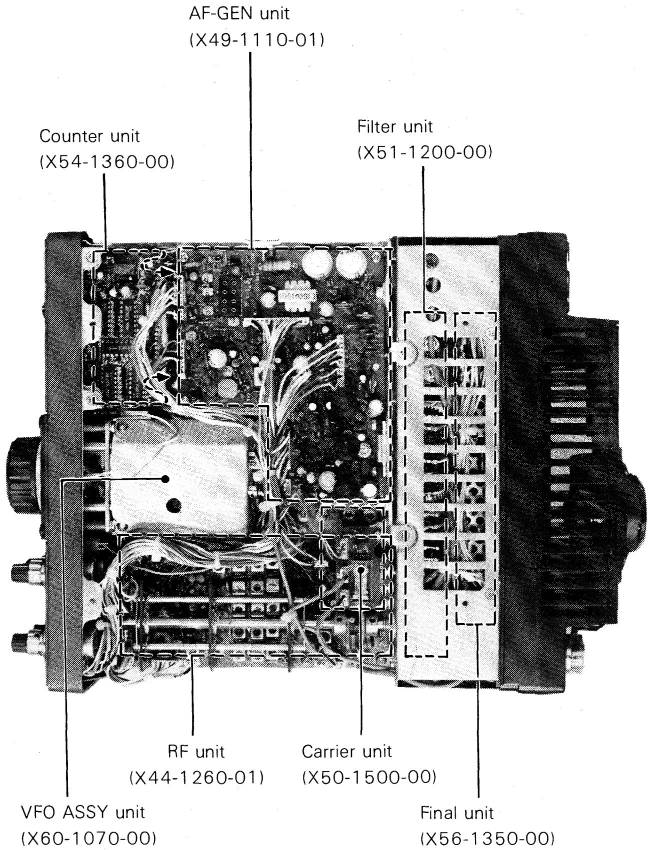
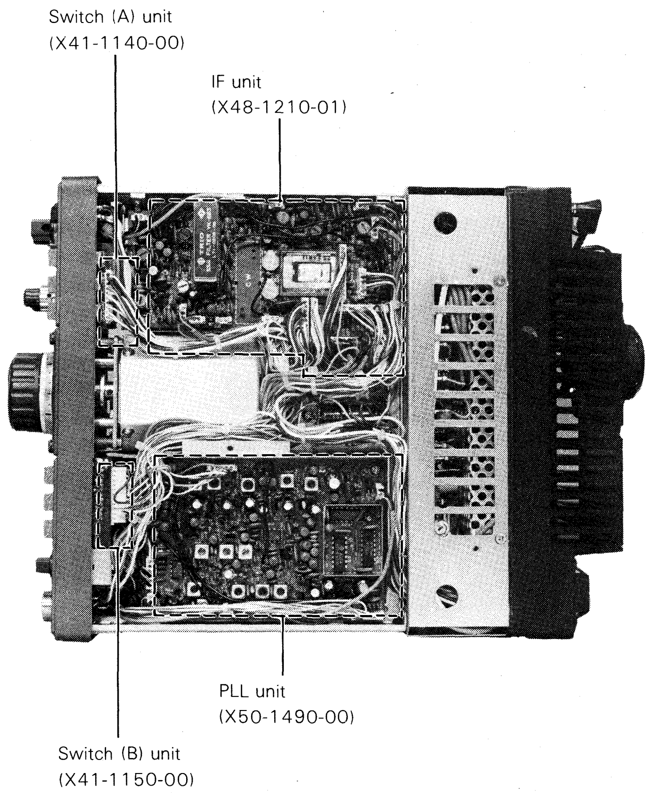


Fig.12



Bottom View



Top view

5. Final Circuit
The TS-120S is all solid-state, including the drive and final amplifier. The RF unit's bandpass filter and Q7, Q8 and Q9 apply a signal to the final unit, consisting of the drive amplifier and final amplifier. The wideband amplifier requires no tuning from 3.5 MHz to 29.7 MHz, which is especially convenient for mobile and contest operation. Mobile environments are often rather severe, requiring the final transistor to have high reliability. For this reason, the TS-120S uses transistors with excellent IMD, maximum-loss, linearity, power-gain and other characteristics. Repeated tests for reliability have been conducted under worst case conditions, checking for possible damage from mismatched load, power-source voltage fluctuations, and high temperature. In the final unit, the signal is amplified by a 2SC2075, and then amplified further by a wideband push-pull amplifier consisting of two 2SC2509s to a level high enough to drive the final stage, consisting of two 2SC2290s. The base bias for the predrive, drive, and final stages is regulated, for stable operation in the event of power-source voltage fluctuations.

6. Output Filter and Related Circuits
A constant-k π -section low-pass filter circuit eliminates harmonics from the output signal.
As shown in Fig. 13, three sections are used on the 3.5-MHz band and two sections on the higher bands.
Photos 2 show RF spurious data for each band.

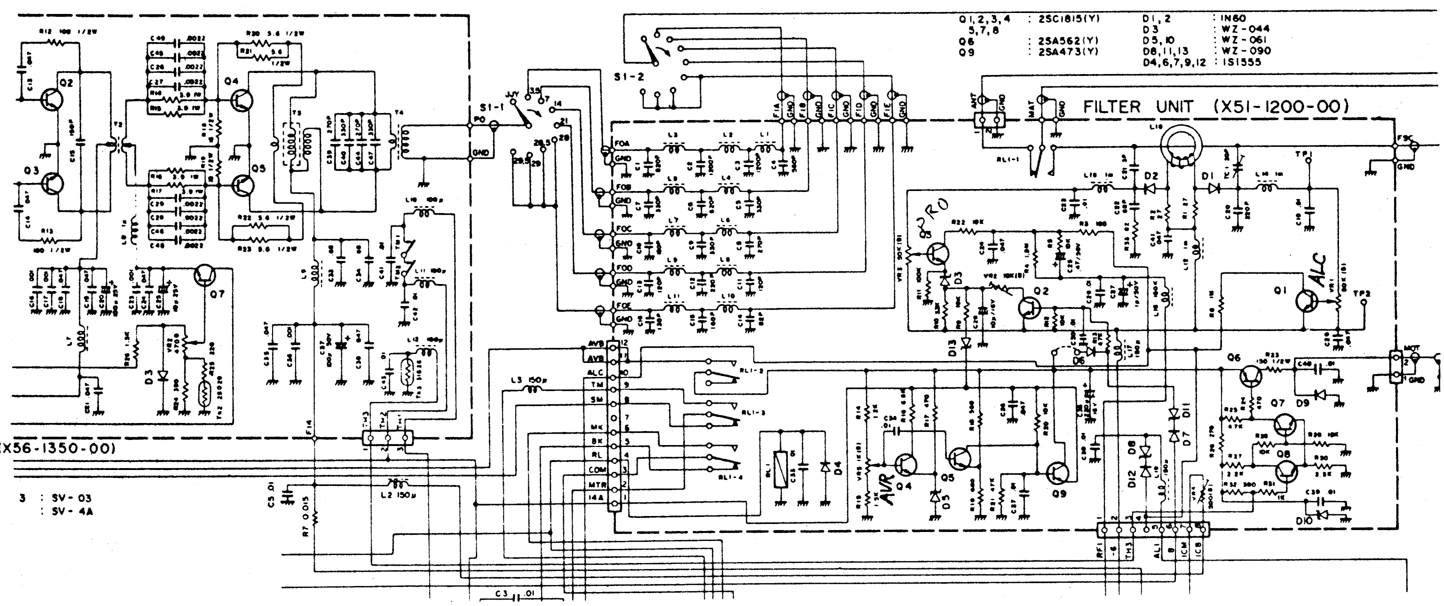
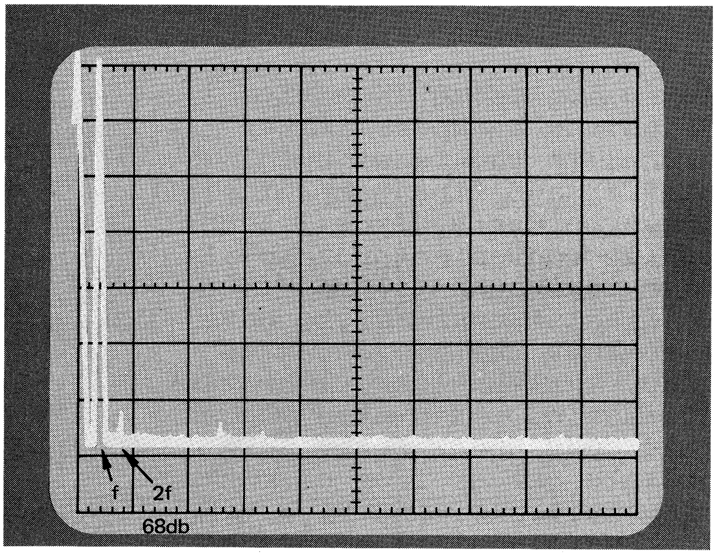
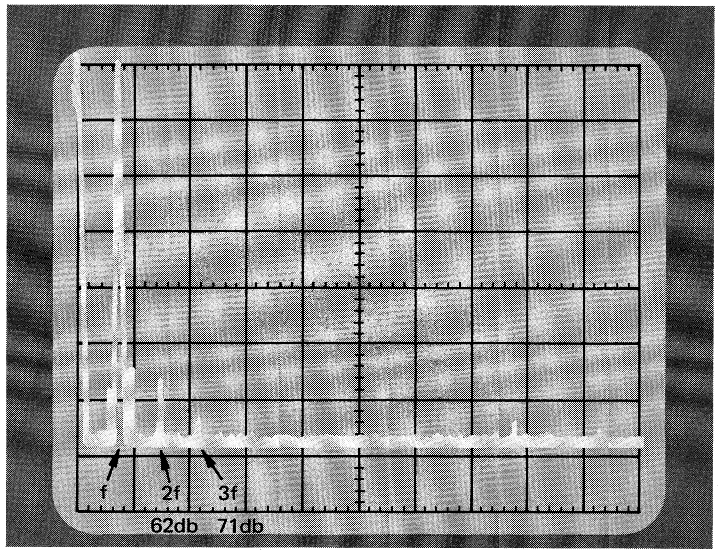


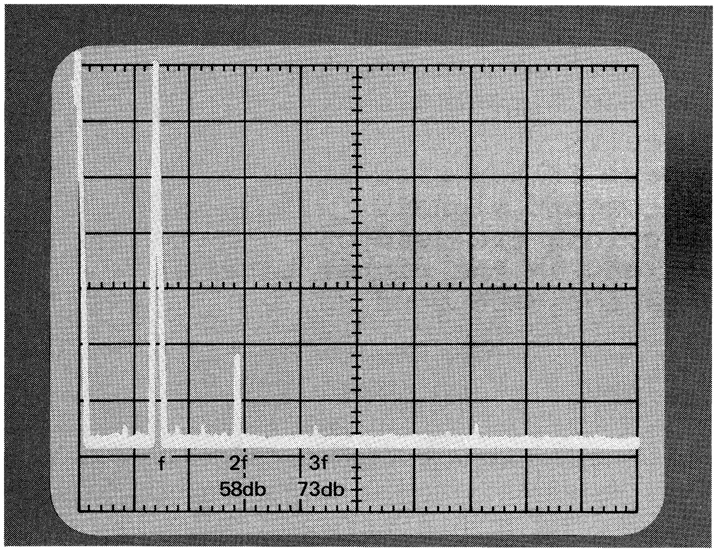
Fig-13



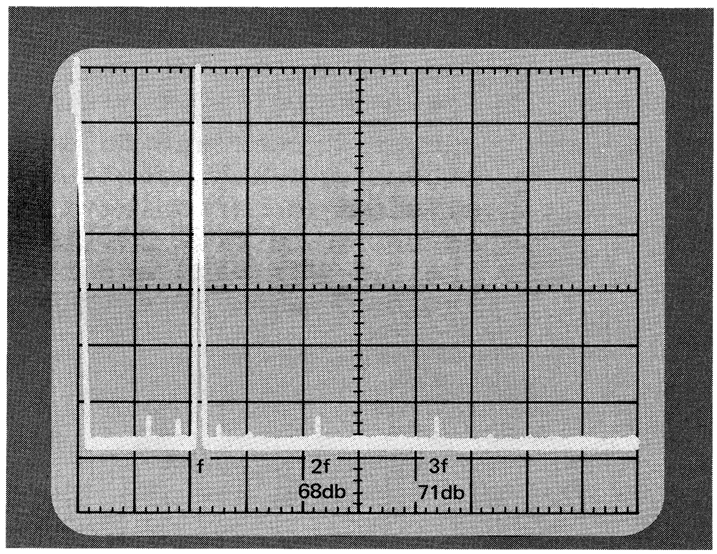
3.75 MHz



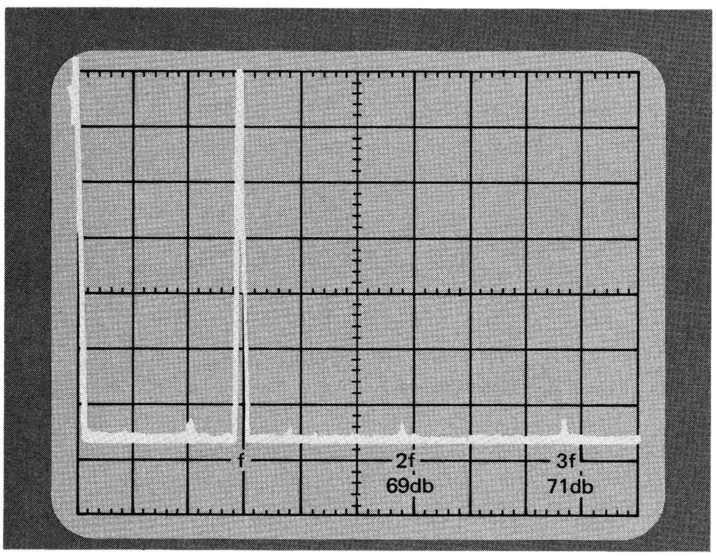
7.15 MHz



14.175 MHz



21.225 MHz



28.85 MHz

Photos 2

Band Width 300 KHz
Scan Width 10 MHz/Div

Photos 2 through 6 show harmonic spurious data for each band. The fundamental signal from the filters passes through a CM-type SWR detection circuit. In this circuit, detection sensitivity is relatively flat between 3.5 MHz and 29.7 MHz because the current transformer utilizes a toroidal core, with very little insertion loss. Forward power is detected at one end of this toroidal coil and reflected power at the other. If standing waves are present, the reflected-wave voltage detected at one end of the coil is amplified and applied to the ALC circuit as a protective voltage to control power output. The second gate of the common FET in the IF is controlled by the ALC voltage produced by amplifying the voltage detected at the forward-power end of the toroidal coil. The cooling fan begins to operate when the final-unit heatsink temperature rises because of operating conditions and/or ambient temperature, etc., whether in transmit or receive mode. Heatsink temperature may rise abnormally high during long transmissions if cooling efficiency deteriorates because of air-flow blockage by surrounding objects. In this case, the TM 1, 2 thermostat activates, disabling the transmitter and placing the transceiver in receive mode. Normal operation resumes when the heatsink temperature is lowered to the ambient level. Fig. 14 shows power output characteristics for each band. Fig. 15 shows output power and ALC voltage characteristics for mic input level.

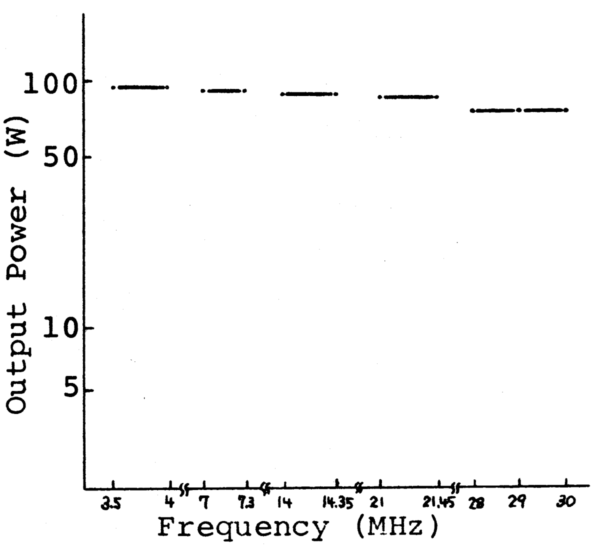


Fig-14

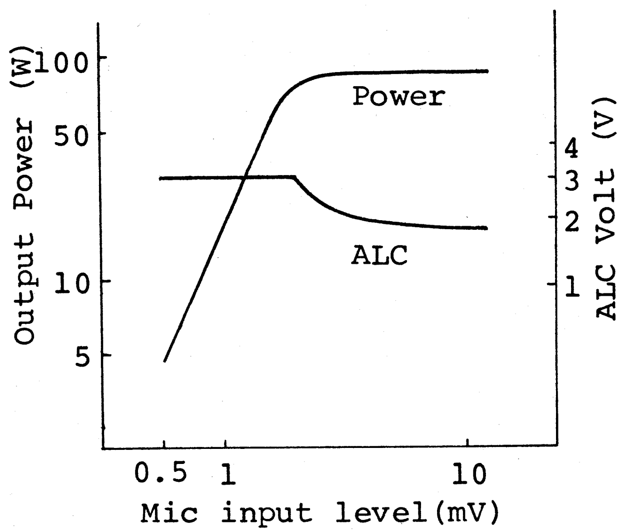


Fig-15

Physical Design of the TS-120S

The TS-120S has been made as compact as possible while retaining all functions formerly found only in much larger transceivers. As a result, HF mobile activity and portable operations, including DX-peditions, are expected to increase in popularity.

In designing the TS-120S, the following goals were achieved:

- Ruggedness, compactness, and light weight
- High cost/performance ratio
- Easy-to-operate panel layout and construction
- Attractive appearance

Compactness was achieved with absolutely no sacrifice in high performance. For convenient mobile installation as well as desk-top operation in a limited space, the transceiver's depth was kept as short as possible. Dimensions are only 9½ inches wide by 3-3/4 inches high by 11-9/16 inches deep. Weight is only 12.32 pounds. Such compactness was achieved by:

- Advanced circuit design, using the latest solid-state technology
- External power source (transceiver operates on 13.8 VDC)
- Compact VFO design and improved installation
- New panel layout and smaller parts

Internal Construction

A single (monolithic) chassis is used, because there are no heavy parts such as transformers. The low-pass filter and the final stage are installed lengthwise on the rear. Single-chassis construction is achieved by a new technique that provides both transmission and reception simply by switching the bandswitch, using a bandpass filter for each band. Variable tuning capacitors for dipping and loading are unnecessary, thus simplifying the RF stage configuration.

Switching low-pass filters is necessary with the transistorized final stage. The filters and switch are located on the printed-circuit board. Differential gears on the subpanel mechanically connect this switch to the shaft of the rotary band switch. This configuration allowed greater flexibility in the design of the panel layout and internal construction, resulting in a high cost/performance monolithic chassis. VOX controls are located on top of the cabinet, in the center. The AF GEN unit is floated by the heatsink mounting hardware and, therefore, VOX controls come direct from the unit. A 3-inch speaker is installed on top of the cabinet, front right. The cabinet is finished in an attractive dark gray color with a metallic tone. A metal stand that mounts flush with the cabinet bottom pivots down to tilt the TS-120S when used as a base station.

Panel

An aluminum die-cast panel provides additional ruggedness and light weight. The VFO, operating controls, and indicators (digital frequency display and meter) are laid out at the center, right, and left, respectively. The microphone connector, send/receive switch, and mode switch are located at the lower left. Push-button switches provide easy operation. The frequency display consists of large multidigit fluorescent tubes.

The VFO at the center of the panel is installed from the front by four bolts with hexagonal holes. Installing the VFO unit from the front provides the most efficient use of internal space, and simplifies assembly and wiring. Also, this allows the dial escutcheon and pointer to be assembled on the front glass of the VFO unit, and the unit to be assembled and tuned independently, thereby reducing size considerably. The control knobs are designed for easiest use with the compact transceiver. The VFO knob is indented for fast tuning. The control knobs are made from synthetic resin and are mounted on the control shaft with a spring. The VFO analog dial and the meter are back-lit for easy mobile operation. They are printed in black on white also using red and orange, for easy viewing even in daylight.

The rear panel, which also functions as a heatsink, is made of die-cast aluminum with black baked-on finish. Terminals such as DC IN, EXT VFO, REMOTE, SPEAKER, and KEY are provided on the right side as viewed from the rear. Because of its compactness and mobility, a cooling system is necessary. Air is blown across the heatsink fins from behind by means of a helical fan with a quiet DC motor, activated when the heatsink temperature rises to a specific level.

VFO Dial Mechanism

The VFO unit has been designed for more compactness and improved linearity. The circuit is based on the highly stable design used in existing models, and its oscillating frequency is 5.5 - 6.0 MHz. The new dial mechanism is designed to occupy the smallest space possible when the VFO unit is connected to the mainframe. The centers of the VFO knob, dial scale, and oscillator unit are aligned on the same shaft. (It is difficult to reduce the size of existing VFO units because the knob and dial shafts are out of line.) The variable capacitor and oscillator unit are installed directly to the aluminum shaft on the dial mechanism's rear panel. This procedure increases assembly accuracy as well as linearity. The dial escutcheon is installed on the VFO unit during assembly, which is tuned according to the same procedures as when connected to the mainframe. Therefore, mechanical deviation can be checked against generated frequencies to the smallest variation. The VFO unit is aluminum and octagonally shaped. The dial mechanism's reduction ratio is 60:1, and one rotation of the knob moves the shaft of the variable capacitor 6°. The analog display is graduated in 1-kHz steps by dividing the scale on the rear of the knob into 25 increments. The calibrated scale is connected directly to the control shaft. Furthermore, a 500 kHz frequency change is displayed on an analog subdial, within a 120° turn of the variable capacitor. The subdial shaft is installed in the middle of the dial-mechanism gear, and the subdial is graduated in 10-kHz steps. This mechanism uses a four-stage gear reduction instead of a vernier reduction system, to place the subdial and knob shafts in the same line.

TS-120S SPECIFICATIONS

Frequency Range:	80m Band 3.5—4.0MHz 40m Band 7.0—7.3MHz 20m Band 14.0—14.35MHz 15m Band 21.0—21.45MHz 10m Band 28.0—29.7MHz WWV(15MHz)
Mode:	SSB/CW
Power Requirements:	R: 0.7A 13.8VDC T: 18A 13.8VDC
Final Power Input:	80—15m Band 200W PEP for SSB operation 160W DC for CW operation 10m Band 160W PEP for SSB operation 140W DC for CW operation
Audio Input Impedance:	500Ω—50kΩ
RF Output Impedance:	50Ω
Frequency Stability:	Within 100Hz during any 30-minute period after warmup Within ±1kHz during the first hour after 1 minute of warmup
Carrier Suppression:	Better than 40dB
Sideband Suppression:	Better than 50dB
Spurious Radiation:	Better than 40dB
Harmonic Radiation:	Better than 40dB
Audio Freq. Response:	400 to 2,600Hz, within −6dB
Receiver Sensitivity:	0.25μV at 10dB S/N
Image Ratio:	Better than 50dB
IF Rejection:	Better than 70dB
Receiver Selectivity:	SSB: 2.4kHz(−6dB) 4.2kHz(−60dB) *CW: 0.5kHz(−6dB) 1.8kHz(−60dB)
Audio Output Impedance:	4—16Ω
Audio Output:	1.5W
Dimensions:	241(9-1/2)W×94(3-3/4)H×293(11-9/16)D mm(inch)
Weight:	5.6kg(12.32lbs)

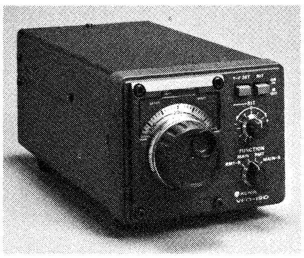
*(CW Filter Option)

OPTIONAL ACCESSORIES

TL-120

SPECIFICATIONS

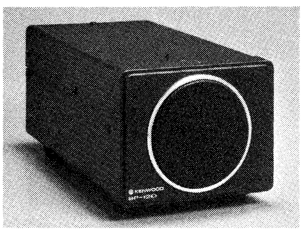
Frequency Range	3.5MHz-30MHz
Drive Power	10watts
Rated Collector Input	
3.5-21MHz	SSB 200W PEP, CW 160W DC
28MHz	SSB 160W PEP, CW 140W DC
Input Impedance	50ohms
Power Consumption (at 13.8VDC)	15A
Power Source Voltage	DC12V-16V (Reference voltage 13.8VDC)
Semiconductors	Transistors 20, Diodes 22
Dimensions	123(4-7/8)W × 97(3-13/16)H × 235(9-1/4) D mm (inch)
Weight	2.3kg (5.1lbs.)



VFO-120

This is almost like adding a second rig to your station since it allows the operator to use split frequency working when DX chasing, net monitoring, finding free channels whilst holding the original frequency: in short, a valuable addition to the station.

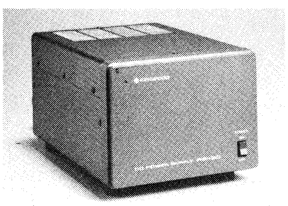
The VFO-120 also incorporates new features such as the T.F. set switch which prevents missoperation in double split frequency working and also aids quick setting of transmit frequency. A further feature is positive indication of VFO functions at a glance.



SP-120

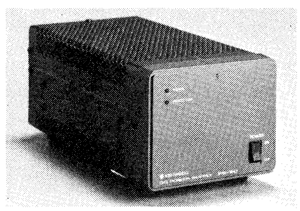
A good looking compact speaker matching the TS-120S (TS-120V) styling and designed for home station use. A low distortion speaker unit provides clear reproduction of the TS-120S (TS-120V) high quality audio.

PS-30 (TS-120S)



Supplies regulated 13.8V DC at 15A (4A: PS-20) continuous, 20A (4.5A: PS-20) intermittent load with complete ease and safety due to the use of generous heat sinks and an automatic reset electronic overload trip.

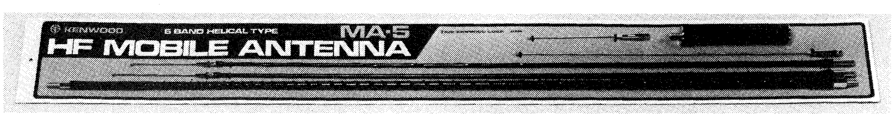
PS-20 (TS-120V)



AT-120

The AT-120 is a compact and lightweight antenna tuner design for base or mobile use.

MA-5 5Band Helical Type HF Mobile Antenna

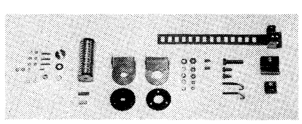


The MA-5 is a multi-purpose handy antenna for field operation as well as for fixed stations. It can be easily installed on the veranda of buildings or guardrails of the roof, etc.

SPECIFICATIONS

Band	3.5, 7, 14, 21, 28MHz
Impedance	50ohms
VSWR	3.5, 7, 14MHz 1.5:1 21, 28MHz 1.3:1
Max. Power Input	200W pep

VP-1 Bumper Mount

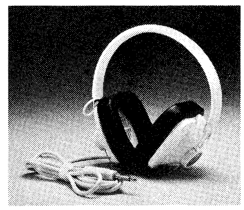


PC-1

Phone Patch

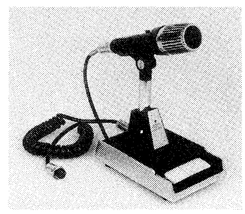
HS-5

Deluxe Headphones



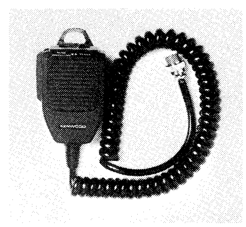
HS-4

Headphones



MC-50

50kΩ/500Ω Desk Microphone

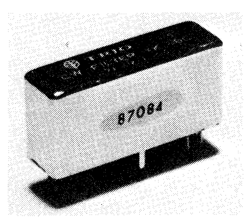


MC-30S

(500Ω)

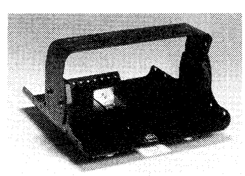
MC-35S

Noise-(50kΩ) Cancelling Hand Microphone



YK-88C

CW Crystal Filter



MB-100

Mobile Mount

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