INSTRUCTION MANUAL

FT-221R

YAESU MUSEN CO., LTD.

TOKYO JAPAN

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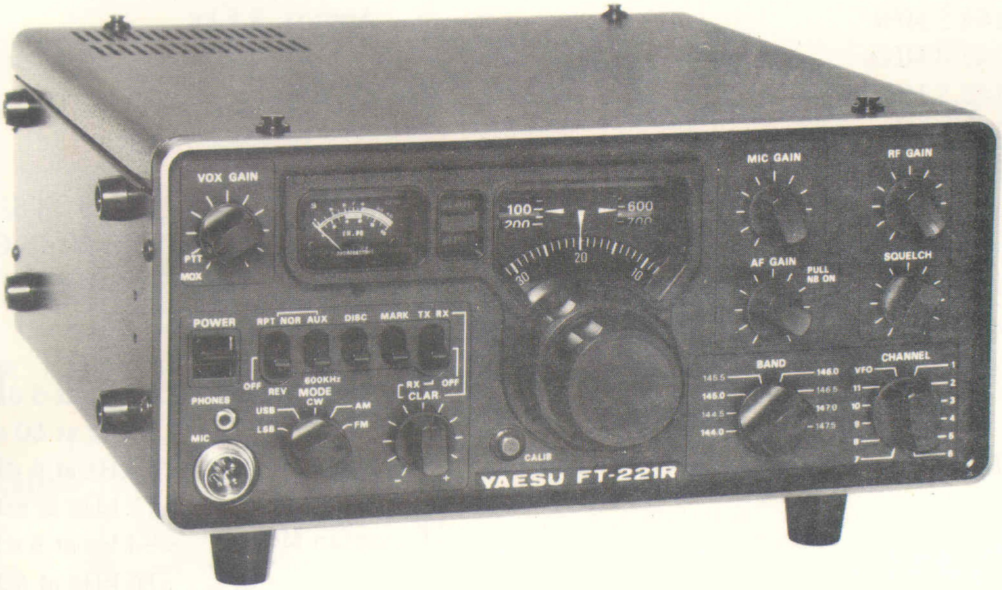
FT-221R VHF TRANSCEIVER



GENERAL DESCRIPTION

The model FT-221R two meter transceiver is a precision built, compact, high performance transceiver of advanced design, providing all mode operation: SSB (LSB or USB selectable), AM, CW and FM with repeater offset capability. Advanced PLL (Phase-Lock Loop) circuitry offers unsurpassed stability and clean, spurious free signals. The transceiver operates at an input of 20 watts on 144 through 148 MHz, in eight 500 kHz segments permitting 1 kHz accurate dial readout. All circuits are fully transistorized and computor type plug-in modules are used for increased reliability and service ability.

Adoption of pre-set passband tuning and wide band amplifier techniques, provide the optimum selectivity and performance needed on today's active 2 meter band.

The transceiver is self contained, requiring only an antenna and power source for home, portable or mobile operation. The transceiver may be operated from 100/110/117/200/220 or 234 volt AC when the power transformer is appropriately wired. The FT-221 is normally supplied for 117 volt AC and 12 volt DC operation. Two power cords are supplied with the transceiver. Selection of AC or DC operation is automatically made when the proper line cord plug is inserted into the receptacle on the rear panel.

Deluxe features such as VOX, break-in CW with side tone, 100 kHz calibrator, noise blanker and squelch are built-in. In addition to continuous VFO coverage, 88 crystal-controlled channels (11 channels x 8 bands = 88 channels), clarifier and speaker are all integral parts of the unit. For "tone burst" actuated repeater operation, an adjustable "tone burst" generator with automatic tone actuation circuit (patent pending) is included.

The entire transceiver weighs approximately 8.5 kg, and is 280 m/m wide, 125 m/m high, and 295 m/m deep. Construction of heavy-gage steel provides an extremely rugged package, virtually immune to the effects of vibration and shock encountered in rugged mobile service.

SPECIFICATIONS

GENERAL

Frequency Range:

144.0 ~ 144.5 MHz
144.5 ~ 145.0 MHz
145.0 ~ 145.5 MHz
145.5 ~ 146.0 MHz
146.0 ~ 146.5 MHz
146.5 ~ 147.0 MHz
147.0 ~ 147.5 MHz
147.5 ~ 148.0 MHz

Frequency Readout:

Better than 1 kHz

Emission:

SSB (LSB or USB selectable), AM, FM and CW.

Power Output:

SSB	12 Watts PEP
FM, CW	14 Watts
AM	2.5 Watts

Frequency Stability:

Within 100 Hz during any 30 minute period after warm up. Not more than 20 Hz with a 10% line voltage variation.

Antenna Impedance:

50 ohms unbalanced

Repeater Burst Signal:

1500 to 2000 Hz adjustable

Repeater Split

600 kHz and any frequency up to 1 MHz

Power Requirement:

AC 100/110/117/200/220/234 volts
50/60 Hz
DC +12 ~ 14.5 Volts, negative ground

Power Consumption:

AC	Receive	30VA
	Transmit	90VA at 10 watts output
DC	Receive	0.6A
	Transmit	3A at 10 watts output

Size:

280 (W) x 125 (H) x 295 (D) m/m

Weight:

Approx. 8.5 kg

RECEIVER

Sensitivity:

SSB/CW	0.5 μV for 10 dB S/N
FM	0.75 μV for 20 dB QS
AM	1.0 μV for 10 dB S/N

Selectivity:

SSB/CW/AM	2.4 kHz at 6 dB
	4.1 kHz at 60 dB
FM	±6 kHz at 6 dB
(US Model)	±12 kHz at 60 dB
(European Model)	±8 kHz at 6 dB
	±16 kHz at 60 dB

Image Ratio:

Better than − 60 dB

Spurious Response:

Better than 1 μV at antenna input

Speaker Impedance:

4 ohms

Audio Output:

2 Watts at 10% distortion

TRANSMITTER

Audio Response:

300 ~ 2700 Hz ±3 dB

Carrier Suppression:

40 dB or better

Unwanted Sideband Suppression:

40 dB or better at 1 kHz

Spurious Radiation:

Down 60 dB or better

FM Deviation:

Maximum 12 kHz: Factory set at ±5 kHz

SEMICONDUCTOR COMPLEMENT

Transistors:

2SD114	1	2SC735Y	3
2SD313D	3	2SC711	1
2SC372Y	34	2SA695	1
2SC784R	5	2SD359	1
2SC373	3	2SB529	1
MPSA13	1	2SC1000GR	2
2SC741	1	BAM-20	1
2SC730	1	BAM-40	1

FETs:

2SK19GR	15	3SK51	1
2SK19Y	2		

Integrated Circuits:

μA703HC	2	TP4011AN	4
LD3001	2	SN7490	1
TA7061AP	1	TA7045M	1
TP4049AN	1	TP4027AN	1

Programmable Unijunction Transistor:

N13T1	1

Diodes:

DS-130YD	1	WZ-110	1
1S1555	57	1N4740	1
10D1	7	GD-1	1
M4B-5	1	RD-1	1
1S188FM	13	TLR-108	1
1S1007	12	1SV50	3
1S330	1	1S2209	12
WZ-061	2	1S2687	1
WZ-090	1		

Thyristor:

CW-01B	1

Varistor:

MV-5W	1

The FT-221R is supplied complete with all cables, connectors, fuses and microphone as shown below.

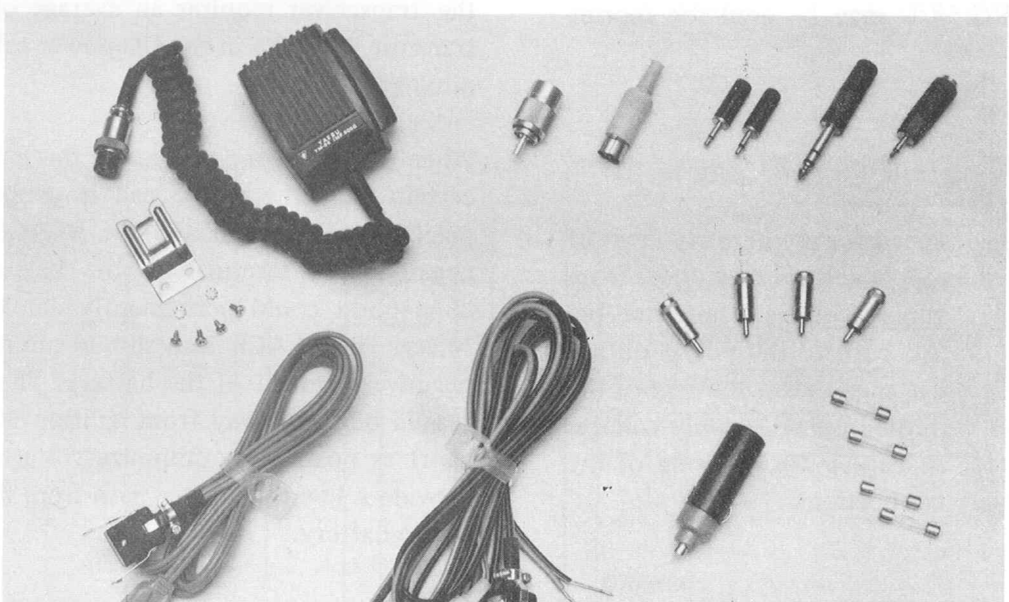


Figure 1

INSTALLATION

GENERAL

The FT-221R transceiver has been designed primarily for base service, requiring only an antenna. However, the transceiver provides for efficient mobile service. The transceiver has been factory pre-tuned and requires no adjustment for normal operation into a matched 50 ohm load.

The antenna and its location are the most important consideration in both base and mobile installations, where effective communication range is directly related to antenna height. The antenna should always be as high and in the clear as possible, and a minimum distance of 5 feet should be maintained between the VHF and other antennas. In a mobile installation, it is advisable to locate the antenna as far from the engine as practical in order to minimize any ignition noise pickup. In all installations, the most popular antenna types are either a 1/4 wave length whip with unity gain or a 5/8 wave length whip with a base matching device affording approximately 3.5 dB gain. Our mobile antenna, RSL-145, is available through your dealer.

To minimize loss in the antenna system, use the shortest length of coaxial cable that is practical, avoiding any sharp angles or kinks. Use type RG-8/U cable if the transmission line length exceeds 25 feet, while RG-58/U may be used for shorter lengths.

BASE STATION INSTALLATION

The transceiver is designed for use in many areas of the world where the supply voltage may differ from the operator's local supply voltage. Therefore, before connecting the AC cord to the power outlet, be sure that the voltage marked on the rear of the transceiver agrees with the local AC supply voltage. If not, please refer to Page 5 for rewiring of the transformer primary connections.

CAUTION

PERMANENT DAMAGE WILL RESULT IF IMPROPER AC SUPPLY VOLTAGE IS APPLIED TO THE TRANSCEIVER. OUR WARRANTY DOES NOT COVER THE DAMAGE CAUSED BY SUCH AN IMPROPER SUPPLY VOLTAGE.

Be sure that a proper fuse is used according to the local supply voltage: 2 amps for 117 volts and 1 amp for 220 volts. The transceiver should be connected to a good ground. The ground lead should be connected to the terminal marked GND located on the rear panel of the transceiver.

It is recommended that excessively warm locations be avoided. The transceiver should be placed in a location that has adequate space to permit free air circulation through the cabinet openings.

MOBILE INSTALLATION

The transceiver will operate satisfactorily from any 12 volt negative ground battery source by connecting the DC power cord to the rear panel receptacle. In the car, a location should be selected that is clear of heater ducts to protect it from excessive heat. No special mounting precautions need to be observed if adequate ventilation space is available. A minimum of two inches air space above the cabinet top and on all sides is recommended to allow proper air flow around the cabinet. You may put it on the seat but be sure that there is clearance between the transceiver bottom and seat. Since the transceiver requires an average of 3 amps on transmit, the fuse in the DC power cable should be rated at 5 amps.

When making connections to the car battery, be certain that the RED lead is connected to the positive (+) terminal and the BLACK lead to the negative (–) terminal of the battery. Reversed connection could permanently damage the transceiver. The BLACK lead should run directly to the negative terminal of the battery. The power cable should be kept away from ignition wires and be as short as possible to minimize voltage drop and to provide a low impedance path from the transceiver to the battery.

Prior to operating the transceiver in a mobile installation, the voltage regulator setting should be checked. In many vehicles, the voltage regulators are very poor and in some cases the regulator may be adjusted for an excessively high charging voltage. As the battery and regulator age, the maximum voltage while charging can increase to a very high level which is not only detrimental to the battery but could cause damage to the transceiver.

The transceiver is designed to operate from a source voltage range of 11 to 14 volts. It is necessary to carefully set the regulator so that the highest charging voltage does not exceed 14 volts. The transceiver should be switched "OFF" when the vehicle is started in order to prevent voltage transients from damaging the transistors.

It is recommended that the microphone furnished with this transceiver be used, however any other microphone of 500 ~ 600 ohm impedance may be used. Refer to Figure 2 for the microphone plug connections. The microphone bracket may be put on the side of the cabinet. It may also be put at any convenient place by making two 2.5 m/m holes spaced 14 m/m.

A speaker is built into the transceiver, however the audio output is also available for an external speaker use. Any speaker having a 4 ohm impedance may be used and when the external speaker plug is plugged into the EXT SP jack on the rear panel, the built-in speaker is disabled.

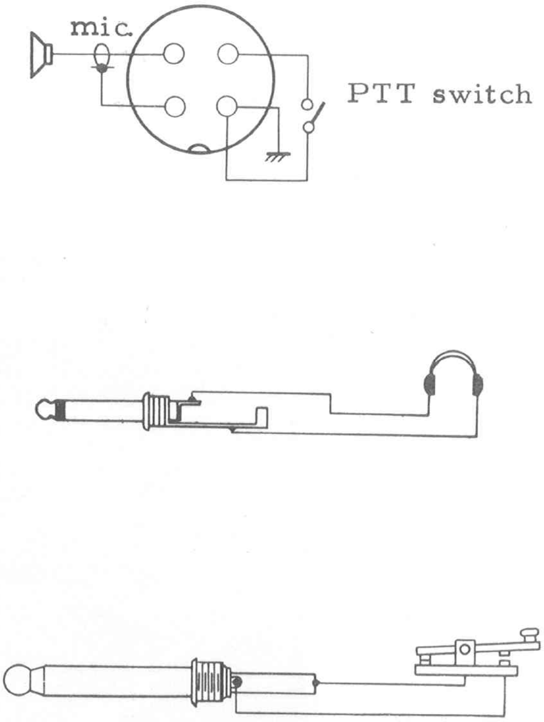


Figure 2 : Connection

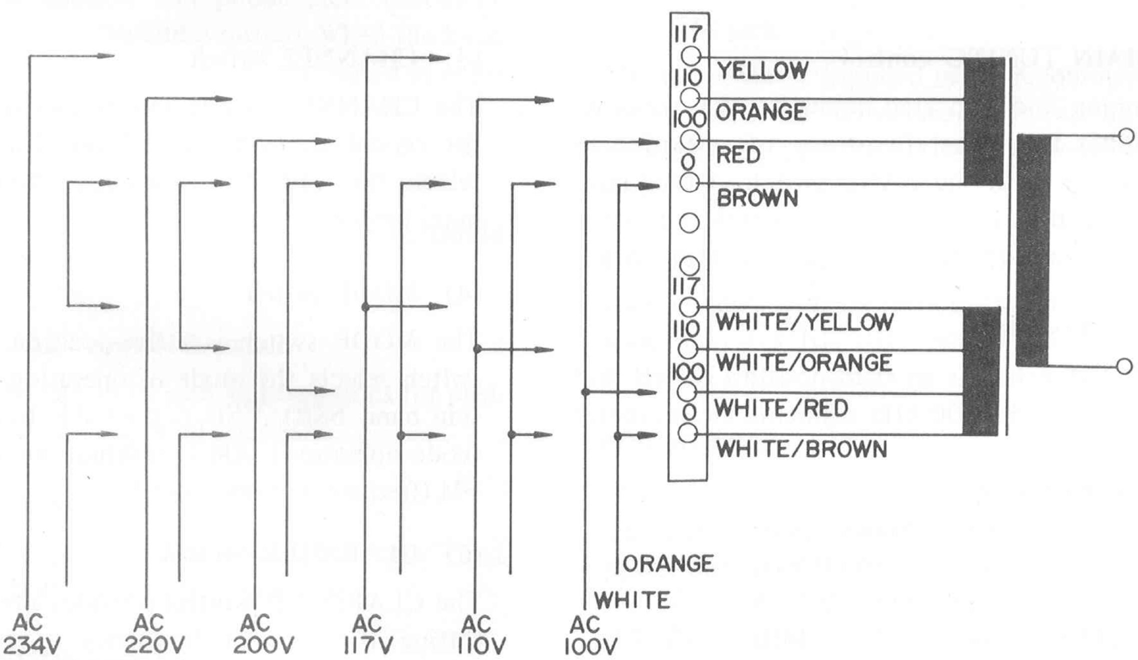


Figure 3 : Transformer Primary Wiring

CONTROLS AND SWITCHES

The transceiver has been specifically designed for flexible operation and versatility. All internal controls have been preset at factory. Several of the controls are unusual in operation, and improper adjustment may result in poor quality signals. The various front panel controls and their functions are described in the following section. Be certain that you thoroughly understand the function of each control before operating the transceiver.

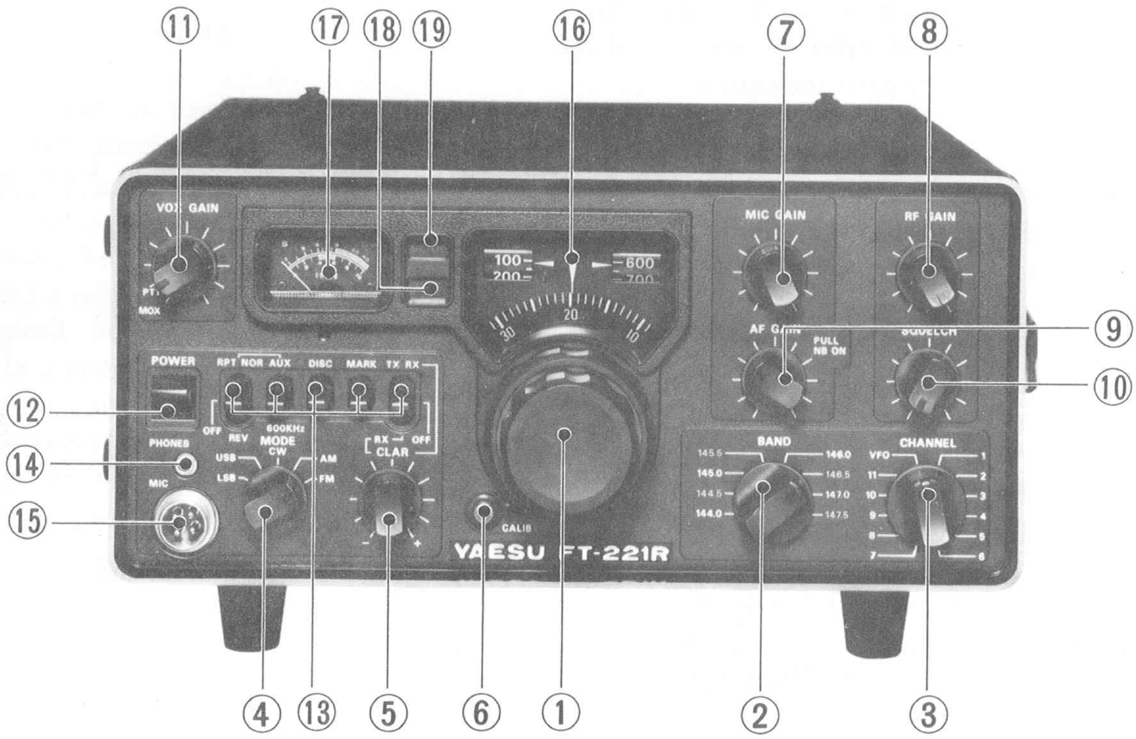


Figure 4 : **Front Panel Controls & Switches**

(1) MAIN TUNING control

The tuning knob, located below the dial window, determines the actual frequency of operation in combination with the BAND switch. A dual rate, concentric dial drive system is employed for a coarse and fine setting of the operating frequency.

(2) BAND switch

The BAND switch is an eight-position switch that selects one of the 500 kHz segments in two meter amateur band.
These segments are:

144.0	:	144.0 ~ 144.5 MHz
144.5	:	144.5 ~ 145.0 MHz
145.0	:	145.0 ~ 145.5 MHz
145.5	:	145.5 ~ 146.0 MHz
146.0	:	146.0 ~ 146.5 MHz
146.5	:	146.5 ~ 147.0 MHz
147.0	:	147.0 ~ 147.5 MHz
147.5	:	147.5 ~ 148.0 MHz

(3) CHANNEL switch

The CHANNEL switch selects one of 11 crystals for crystal controlled operation. This switch also selects the VFO for continuous tuning with the main tuning knob.

(4) MODE switch

The MODE switch is a five-position switch. This switch selects the mode of operation: LSB (lower side band SSB), USB, (upper side band SSB), CW (code operation), AM (amplitude modulation) and FM (frequency modulation).

(5) CLARIFIER control

The CLARIFIER control provides a means of OFF setting the receiver frequency approximately 4 kHz to either side of the transmitting frequency. Thus it is possible to set the pitch of the voice or signal you are receiving to the most readable point without affecting your transmitting frequency. Its use is particularly valuable in "net" operation when several participants may be transmitting slightly off frequency. The CLARIFIER control may be switched off with CLARIFIER switch and the receiver locked to the transmitting frequency. Normally you will want to keep the CLARIFIER in the OFF position until the initial contact is made. The CLARIFIER switch may also be used to change both transmitting and receiving frequencies simultaneously when the CLARIFIER switch is put in the TX-RX position.

(6) CALIB.

When depressed, this button locks the 1 kHz dial for dial calibration.

(7) MIC GAIN control

The MIC GAIN control varies the audio level from the microphone amplifier stages. The control has sufficient range to permit the use of any 600 ohm dynamic microphone.

(8) RF GAIN control

The RF GAIN control varies the gain of the receiver RF and IF amplifiers. Maximum sensitivity is obtained when the control is set to the fully clockwise position.

(9) AF GAIN control & switch

The AF GAIN control adjusts the audio output level to the speaker and phone jack. Clockwise rotation increases the audio output. When the knob is pulled out, the noise blanker is activated in order to minimize pulse type noises.

(10) SQUELCH control

This control adjusts the receiver squelch threshold level.

(11) VOX GAIN control & switch

This controls the VOX gain and functions for push to talk, stand-by or manual operation.

(12) POWER switch

The POWER switch turns transceiver "ON" and "OFF" for both AC and DC operation.

(13) FUNCTION switches

RPT

This switch is used for repeater operation.

In the NOR (normal) position, the transmitter frequency shifts 600 kHz down and in the REV (reverse) position, the receiver frequency shifts 600 kHz up.

AUX/600 kHz

Selects the repeater shift frequency. In the 600 kHz position, the TX or RX frequency shifts 600 kHz with the REPEATER switch ON. Any split within 1 MHz can be installed as option. Refer to Repeater Operation paragraph on Page 12.

DISC

This switch selects the meter to read discriminator center current for FM reception.

MARK

100 kHz calibrator switch.

CLAR

Clarifier switch. Turns the CLARIFIER on in upper position, and off in middle position. In the TX-RX position, the CLARIFIER works for both transmit and receive.

(14) PHONE jack

Phone jack for an external headphones or speaker. The internal speaker is disconnected when the headphone plug is inserted.

(15) MIC jack

The microphone supplied is the recommended one for use with the transceiver, however any microphone having a 500 to 600 ohm impedance may be used.

(16) DIAL

Dial window for frequency readout. The coarse scale indicates 100 kHz increments and fine scale indicates 1 kHz increments.

(17) METER

The meter indicates signal strength, FM discriminator center current in receive and relative power output in transmit.

(18) CLAR lamp

This lamp lights when the CLARIFIER is in use.

(19) RPT lamp

This lamp lights when the repeater switch is ON.

REAR PANEL CONNECTIONS

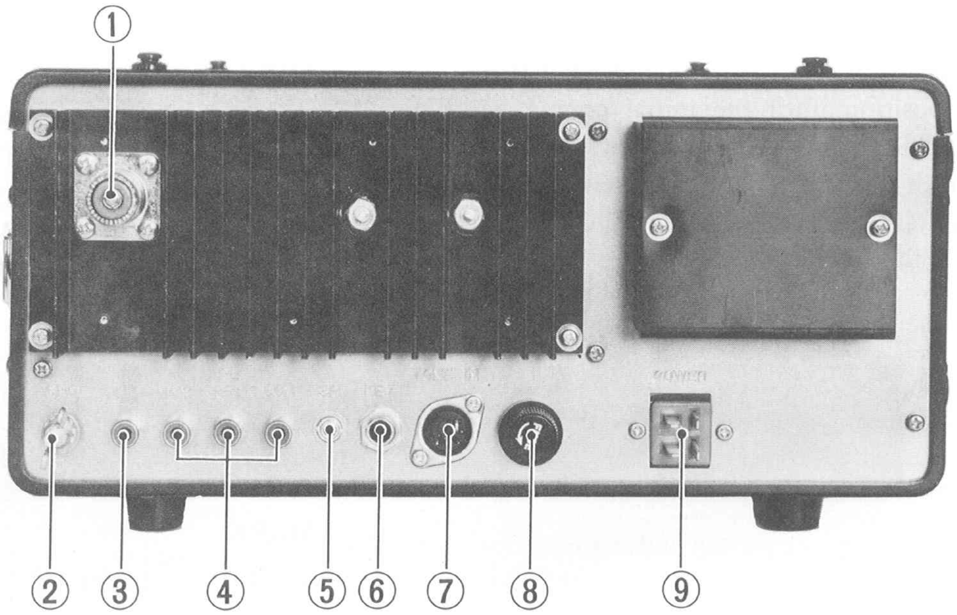


Figure 5 : Rear Panel Connections

(1) ANT

Coaxial connector for an antenna.

(2) GND

Ground connection.

(3) ALC

ALC (automatic level control) input.

(4) RL

Relay contacts for the control of external equipment.

(5) SP jack

External speaker audio output.

(6) KEY jack

Key jack for code operation.

(7) TONE-IN

Tone-pad input jack.

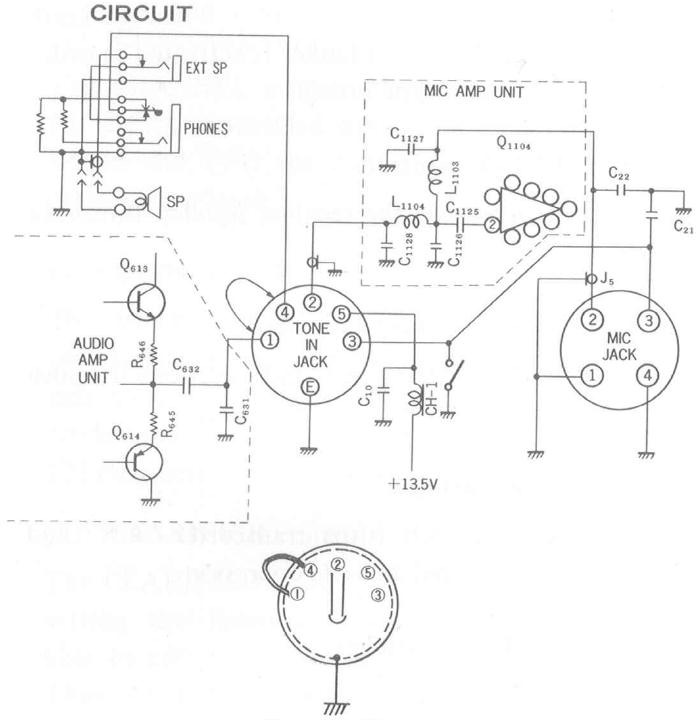
(8) FUSE

Fuse holder. For AC operation, a 2 amp fuse is used on 100/117 volts and, a 1 amp fuse on 200/234 volts.

(9) POWER receptacle

Both AC and DC cables are supplied with the transceiver.

TONE IN & MIC JACK CIRCUIT



Tone in Plug

Figure 6

OPERATION

The tuning procedure of the transceiver is not complicated, however care should be exercised when tuning to insure peak performance of the equipment. The following paragraphs describe the procedure for receiver and transmitter tuning.

INITIAL CHECK

Before connecting the transceiver to a power source, carefully examine the unit for any visible damage. Check that all modules and crystals are firmly in place and that controls and switches are operating normally. Ensure that voltage specification marked on the rear panel matches the supply voltage.

DIAL READOUT

The main tuning dial is color coded with the band selector switch for proper frequency readout. When the band selected is marked in white on the transceiver front panel, the operator reads the white scale on the main tuning drum. When the band selected is marked in amber the operator reads the amber scale. The main tuning drum is marked in 50 kHz increments. This provides a coarse frequency setting within the band. The round subdial on the dial window surrounding the tuning knob is scaled in 1 kHz increments and provides fine settings of the transceiver operating frequency. The following example will familiarize yourself with the relationship of main and subdial frequency readout.

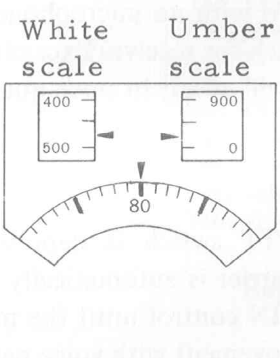


Figure 7

Read the white scale on main dial for the bands 144.0, 145.0, 146.0 and 147.0, and amber scale for 144.5, 145.5, 146.5 and 147.5.
Then the setting shown in the example would be 144.480 MHz on 144.0 BAND switch setting, and 145.480 MHz on 145.0. And also the frequency would be 144.980 MHz on 144.5 BAND switch setting, and 145.980 MHz on 145.5.

RECEIVER

After the transceiver is properly set up for operation, set the controls and switches as follows;

POWER ·············· Down to "OFF" position.
MODE ·············· Desired mode.
BAND··············· Desired band.
RPT ················ Lever position horizontal to OFF position.
AUX-600 kHz ······· Lever position horizontal to 600 kHz shift
DISC················ Lever position horizontal to OFF position.
MARK··············· Lever position horizontal to OFF position.
CALR··············· Lever position horizontal to OFF position.
NOR-REV··········· "NOR" position.
MAIN TUNING DIAL ··Desired operating frequency.
VOX GAIN··········· PTT.
AF GAIN ············ Desired audio level.
RF GAIN ············ Fully clockwise position.
CHANNEL··········· VFO.
SQUELCH ··········· Fully counter-clockwise position.

Connect the cord supplied to the appropriate power source, and an antenna to antenna connector on the rear panel.

CAUTION

PERMANENT DAMAGE WILL RESULT IF IMPROPER SUPPLY VOLTAGE IS APPLIED TO THE TRANSCEIVER. WARRANTY DOES NOT COVER THE DAMAGE CAUSED BY IMPROPER SUPPLY VOLTAGE.

Turn on the POWER switch. The dial and meter lamps should light up, and the transceiver is now ready to operate.

(1) **SSB and AM Modes**

Using the main tuning control (VFO), tune in an incoming signal. USB (upper side band) is mostly used for 2 meter SSB operation. When the received signal can not be heard clearly, then change to the opposite side band. The RF GAIN control is normally set to the fully clockwise position, but if the incoming signal is extremely strong, it is recommended to turn this control back to prevent overload of the front end. When there is noise caused by automobiles, pull the AF GAIN control out to switch on the NB (noise blanker) in order to eliminate these pulse type noises.

(2) **CW Mode**

With the CLARIFIER switch in the OFF position, tune in a signal until an 800 Hz beat tone is heard. Under this condition, your transmitting frequency coincides with the received signal. If you desire to hear a beat tone of your choice, then use the CLARIFIER control.

(3) **FM Mode**

Using the tuning control, tune in an incoming signal for a maximum and steady S-Meter reading where a natural voice is heard. For accurate tuning, set the DISC switch to the upper ON position. Carefully readjust the tuning control until the meter indicates zero (half way of the full scale).
If the S-Meter indication wabbles or if a clean audio output is not available, it is very likely that the signal is in the SSB mode. In this case, turn the MODE switch to USB or LSB position, and carefully tune the tuning control until a clear voice is heard. It is important that the CLARIFIER switch be set to the OFF position when calling the another station. After the initial contact is made, then the CLARIFIER may be used for the desired listening sound.

FREQUENCY CALIBRATION

(1) **SSB Mode**

Set the CLARIFIER to the OFF position, and the tuning control to the 100 kHz point on the dial nearest to the desired frequency. Set the MARK switch to the upper position. While pressing the CALIB knob to lock the dial, tune the tuning control for a zero beat. The transceiver must be recalibrated when changing the mode of operation: USB, LSB, AM or CW.

(2) **FM Mode**

Set the CLARIFIER to the OFF position, and the tuning control to the 100 kHz point in the round dial nearest to the desired operating frequency. Set the MARK switch and DISC switch to ON position. While pressing the CALIB knob down to lock the dial, tune the main tuning control until the meter indicates the green portion of its scale.

NOTE: WHEN THE MARKER SWITCH IS IN THE "ON" POSITION, THE ANTENNA IS DISCONNECTED FOR EASIER CALIBRATION.

TRANSMITTER

Connect a 50 ohm dummy load or a matched antenna to the coaxial fitting on the rear panel. Since the transmitter section utilizes wide band techniques no tuning control is necessary except the main tuning control to select the operating frequency. Plug the microphone into the MIC jack and select the desired mode. Push down the PTT (push-to-talk) switch on the microphone and speak into the microphone.

(1) **SSB Mode**

The meter indicates maximum deflection on voice peak and zero with no microphone input. Release the PTT switch for receive. Excessive setting of the MIC GAIN will result in poor quality transmitted signals.

(2) **AM Mode**

When the PTT switch is depressed, the proper amount of carrier is automatically inserted. Adjust the MIC GAIN control until the meter indicates a very slight movement with voice peaks while speaking into the microphone normally.

(3) CW Mode

Plug the key into the KEY jack on the rear panel. In the key down condition, the meter will show a 6 to 8 relative power output, and with the key up, the receiver will recover. The break-in delay time may be adjusted with VR_{601}, under the top cover.

(4) FM Mode

Set the MIC GAIN control to the 12 o'clock position and push the PTT switch on the microphone while speaking normally into the microphone. The meter will show a 6 to 8 relative power output. Release the PTT switch on the microphone for receive.

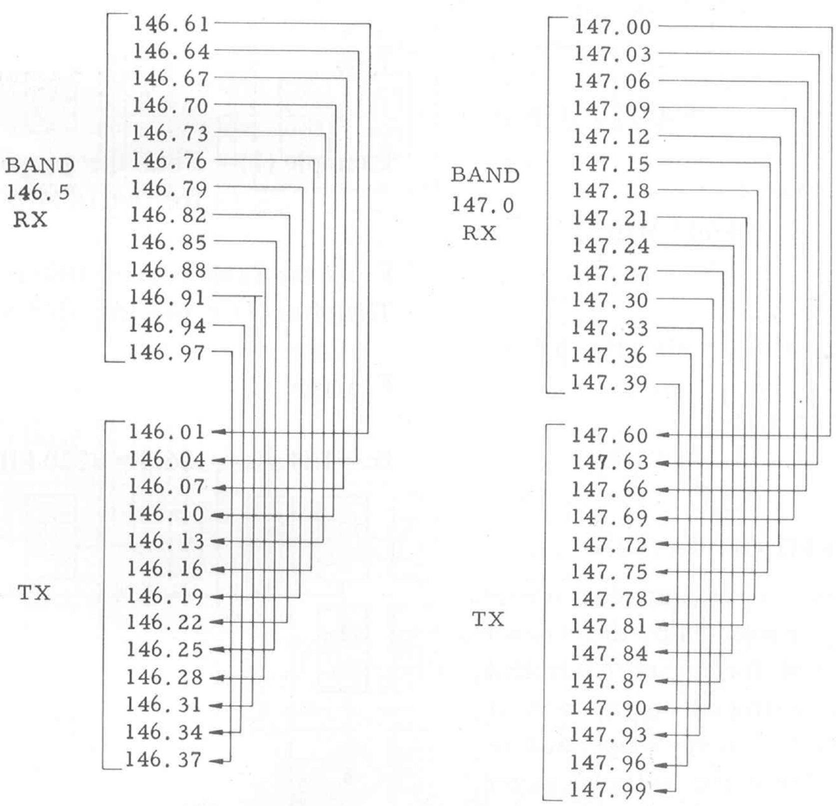
(5) VOX (Voice Controlled) Operation

Adjust the VOX GAIN control on the front panel until your voice actuates the transmitter while speaking normally into the microphone. Set the ANTITRIP control to the minimum point in order to prevent the speaker output from tripping the VOX circuit. Do not use more VOX GAIN or ANTITRIP GAIN than necessary. Adjust the DELAY control for a suitable release time. The RELAY control provides coarse adjustment for relay sensitivity and this control has been preset at factory. These controls are located on the AF AMP UNIT under the top cover.

REPEATER OPERATION

Transmitting and receiving frequencies may be shifted 600 kHz for repeater operation. When the REPEATER switch is ON (upward position) with NOR-REV switch in the NOR (normal) position, the transmitted frequency is shifted 600 kHz down from the dial readout. With the NOR-REV switch at REV position, the received frequency is shifted 600 kHz down from the dial readout. The U.S. model has an automatic cross-over system in which this shift is automatically reversed from 147.0 to 148.0 MHz.

In NOR operation, the transmitting frequency is shifted 600 kHz down for the frequency range of 146.61 through 146.97 MHz and shifted 600 kHz up for the frequency range of 147.00 through 147.39. This is shown on the chart on Figure 8. These relations are reversed with the NOR-REV switch in the REV position. Extreme caution should be observed so as not to transmit outside



Repeater Frequency Chart for U.S. Model

Figure 8

the amateur bands with repeater switch ON. The most repeaters use 600 kHz split between transmitter and receiver frequencies, however, other split than 600 kHz has been adopted in some areas.

When the AUX/600 kHz switch is in the AUX position, the frequency is shifted to any frequency within 1 MHz determined by the optional crystal installed in the local unit. The RPT lamp lights up when the repeater switch is ON.

Tone actuated repeaters can be operated with the built-in tone burst signal which is automatically inserted by the push-to-talk switch at the start of a transmission. When the microphone PTT switch is depressed for 0.2 – 0.5 seconds before the voice transmission, the burst tone signal is inserted at the beginning of the transmission. Normal operation of the PTT switch does not generate the burst signal. The frequency of the burst signal may be adjusted from 1500 to 2000 Hz with VR_{1002} under the top cover.

AUX crystal specification is calculated as follows:

BAND 146.5 ; X MHz = (127.8 – shift frequency) ÷ 9

BAND 147.0 ; X MHz = (128.3 + shift frequency) ÷ 9

Example 1
Calculate crystal frequency for –800 kHz shift in 146.5 MHz segment.
(TX frequency 800 kHz lower)
X MHz = (127.8 – 0.8) ÷ 9 = 14.111 MHz

Example 2
Calculate crystal frequency for +800 kHz shift in 147.0 MHz segment.
(TX frequency 800 kHz higher)
X MHz = (128.3 + 0.8) ÷ 9 = 14.344 MHz

CRYSTAL CONTROLLED OPERATION

In addition to the normal VFO controlled operation, eleven crystals may be selected by the channel switch on the front panel for crystal controlled operation. This crystal controlled operation is of great advantage when the transceiver is operated on the preset frequencies. Since the entire 2 meter band has been split into eight bands, eleven crystals can be used as 88 crystal controlled channels.

The crystal holders accept standard, HC-25/U type crystals. All crystal frequencies must fall between 8,000 kHz and 8,500 kHz. A trimmer capacitor has been connected in series with each crystal to permit proper frequency adjustment. Adjustment of this trimmer will change the crystal frequency approximately 1 kHz. The correct crystal frequency for any desired operating frequency may be determined by using the following formula:

$$fx = fo - f_1$$

where fx : crystal frequency
fo : operating frequency
f_1 : given from Table 1

BAND (MHz)	LSB (kHz)	USB (kHz)	FM (MHz)
144.0–144.5	136001.5	135998.5	136.0
144.5–145.0	136501.5	136498.5	136.5
145.0–145.5	137001.5	136998.5	137.0
145.5–146.0	137501.5	137498.5	137.5
146.0–146.5	138001.5	137998.5	138.0
146.5–147.0	138501.5	138498.5	138.5
147.0–147.5	139001.5	138998.5	139.0
147.5–148.0	139501.5	139498.5	139.5

Table 1

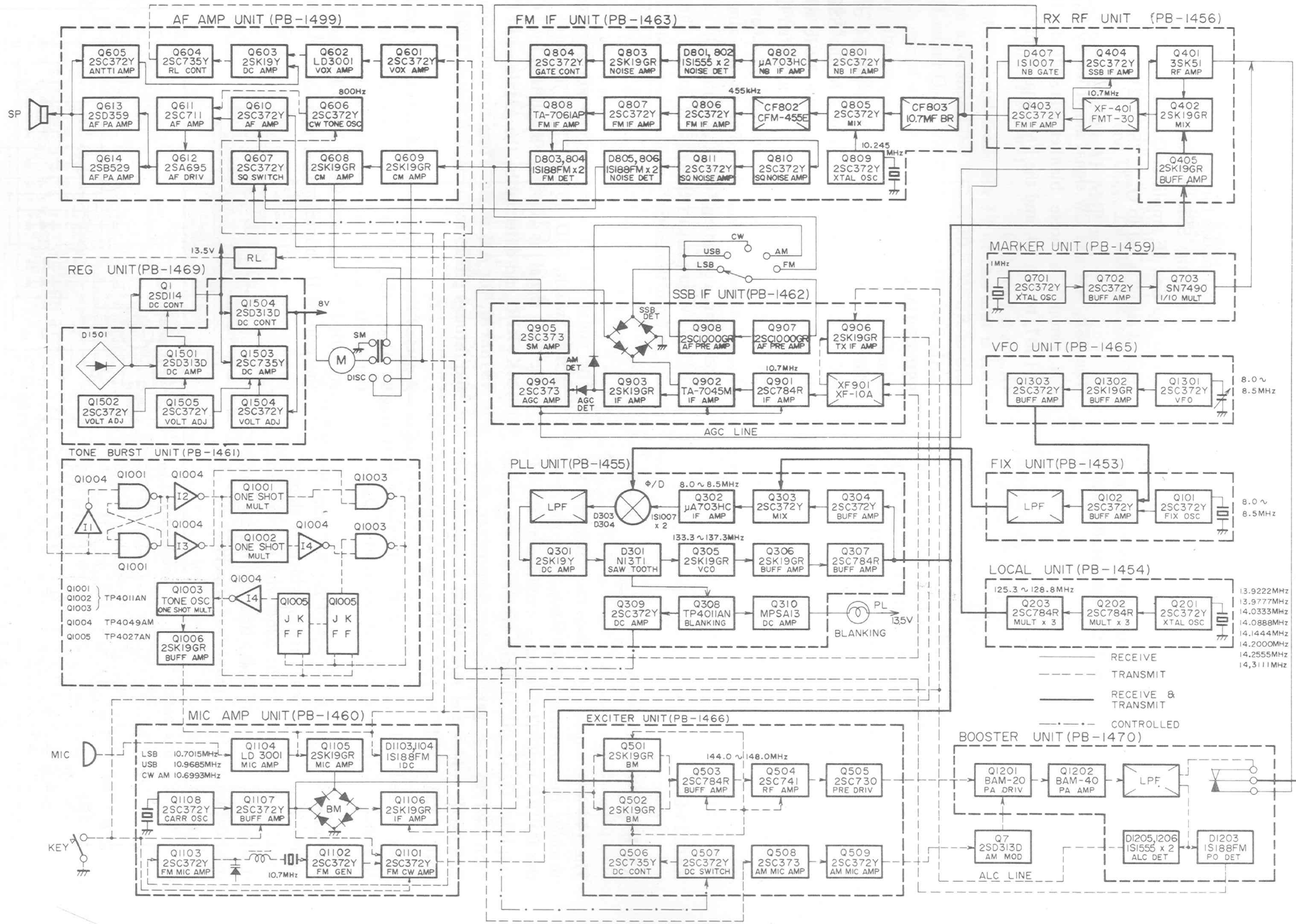
Example (1)– Find the proper crystal frequency for 144.15 MHz USB operation

From the Table 1, f_1 for USB is 135998.5.
Therefore, fx = 144.15 – 135.9985 = 8151.5 kHz

Example (2)– 144.72 MHz FM operation

fx = 144.72 – 136.5 = 8220 kHz

FT-221R BLOCK DIAGRAM



CIRCUIT DESCRIPTION

GENERAL

The block diagram and the circuit description that follows with provide you will a better understanding of this transceiver. Computor type plug-in modules have been adoped throughout the transceiver.

The transceiver consists of a single conversion receiver with a 10.7 MHz IF for SSB, CW and AM, a double conversion receiver with a 10.7 MHz first IF and 455 kHz second IF for FM. A single conversion transmitter, utilizing a 10.7 MHz high frequency crystal filter for SSB generation and varactor diode frequency modulation on 10.7 MHz crystal oscillator is incorporated.

NOTE:
The parts number starts with the number shown below the printed board designation. For example, the field effect transistor 3SK51 in RX RF unit PB-1456 is Q_{401}.

RECEIVER

RX RF UNIT (PB-1456)

The 144 MHz input signal from the antenna is fed through the antenna relay, RL_{1201}, to pin 5 of the RX RF unit. The signal is amplified by the RF amplifier Q_{401}, **3SK51** field effect transistor, and then fed to the gate of the first mixer Q_{402}, **2SK19GR**, where the input signal is heterodyned with a 133.3 MHz to 137.3 MHz signal, delivered from phase-lock-loop unit, and thus produces an IF signal of 10.7 MHz at the drain circuit of Q_{402}.

The input and output circuits of the RF amplifier utilize a double tuned circuit, which is sharply tuned to the center of the band with the varactor diodes, D_{401} through D_{404}, thus eliminating cross modulation and intermodulation effects.

The IF signal passes through crystal filter XF401, FMT-30, and the SSB, AM and CW signal is then fed to the first IF amplifier Q_{404}, **2SC372Y**, while the FM signal is fed to Q_{403}, **2SC372Y**.

The SSB, AM and CW signal amplified by Q_{404} is fed through a noise blanker gate diode D_{407}, **1S1007**, to pin 14, and the FM signal amplified by Q_{403} is fed to pin 9.

SSB IF UNIT (PB-1462)

The SSB, AM and CW signal from pin 14 of the RX RF unit is fed through pin 3 to the SSB IF unit. The signal is fed through the diode switch and a crystal filter, XF-9, to the IF amplifier Q_{901}, **2SC784R**. The signal is amplified by Q_{901} and Q_{902}, **TA7045M**, and then fed to the ring demodulator consisting of D_{904} through D_{907}, **1S1007**, where a carrier signal is applied through pin 32 from the carrier oscillator in the MIC AMP unit.

The audio output is fed through pin 33 and the MODE switch, S3D, to pin 28 of the same unit. The IF signal is further amplified by Q_{903}, **2SK19GR**, and detected by the AM detector D_{910}, **1S188FM**, for AM mode. Then the audio signal is fed through pin 25 to the MODE switch S3D.

A part of the IF signal output from Q_{903} is rectified by D_{908}, **1S1007**, and D_{913}, **1S-1555**, for AGC (automatic gain control). The AGC voltage is amplified by Q_{904} and Q_{905}, **2SC373** and controls the gain of IF amplifier Q_{901} and Q_{902}. A part of

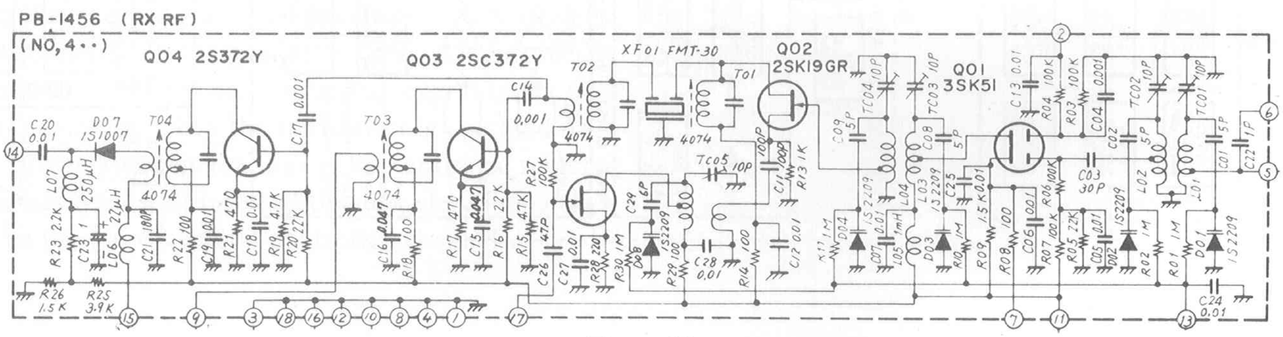


Figure 10

it is fed through pin 17 to the RX RF unit to control the gain of the RF amplifier Q_{401}. The AGC voltage is amplified by the S-meter amplifier Q_{905}, **2SC373**, and fed to the S-meter through the DISC/SM switch on the front panel.

The audio signal from the MODE switch is preamplified by Q_{907} and Q_{908}, **2SC1000GR** and fed through pin 29 to the AF AMP unit.

FM IF UNIT (PB-1463)

The FM IF signal from pin 17 of this unit is fed through a ceramic filter CF_{803}, 10.7 MFBR to the second mixer Q_{805}, 2SC372Y, where the 10.7 MHz signal is mixed with the 10.245 MHz signal generated by the second heterodyne oscillator Q_{809}, **2SC372Y**, producing a 455 kHz second IF signal. The 455 kHz IF signal is fed through the ceramic filter, CF_{802}, to the second IF amplifier Q_{806} and Q_{807}, **2SC372Y**, and the amplifier limitter Q_{808}, **TA7061AP**, which removes any amplitude modulation component on the signal. The output from Q_{808} is applied to the dsicriminator D_{304} and D_{305}, **1S188FM**. The discriminator produces an audio output in response to a corresponding frequency (or phase) shift in the 455 kHz IF signal. The discriminator output is then fed to the common audio amplifier stage in SSB IF unit through the MODE switch.

For FM reception, when no carrier is present in the 455 kHz IF, the noise at the discriminator output is fed through the squelch threshold potentiometer, VR_6, to the noise amplifier Q_{810} and Q_{811}, **2SC372Y**, and detected by D_{805} and D_{806}, **1S188FM**. The DC voltage is applied from pin 8 to the squelch controller Q_{607}, **2SC372Y**, in the AF AMP unit.

The 10.7 MHz signal is also applied to the noise blanker amplifier Q_{801}, **2SC372Y**. The signal is amplified by Q_{801}, 2SC372Y, and Q_{802}, **μA703HC**.

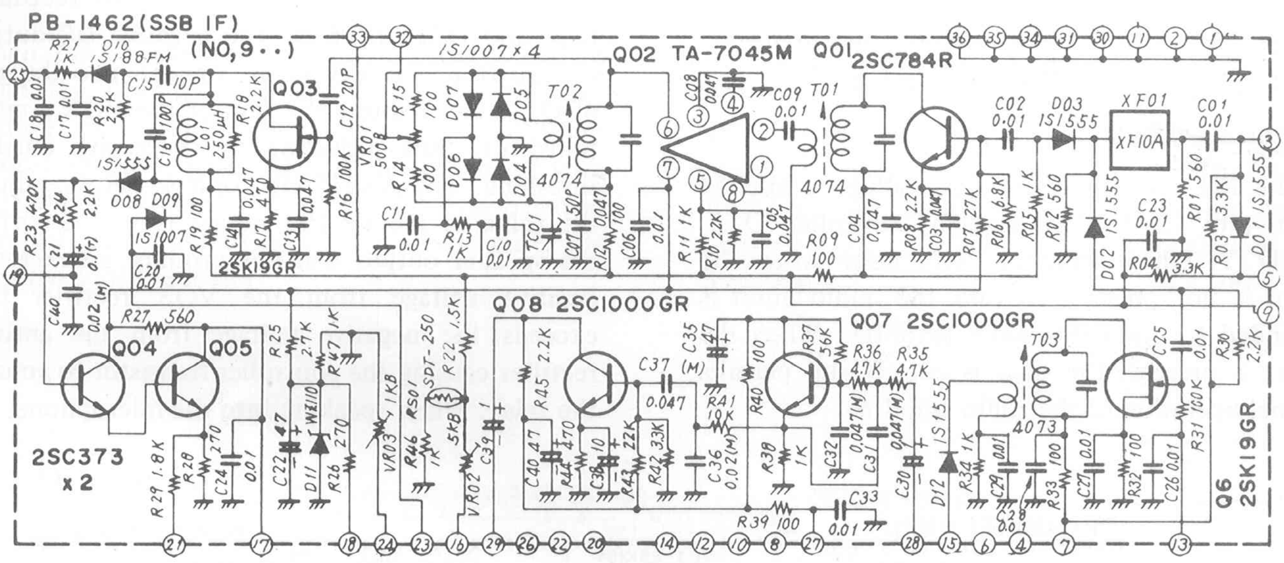


Figure 11

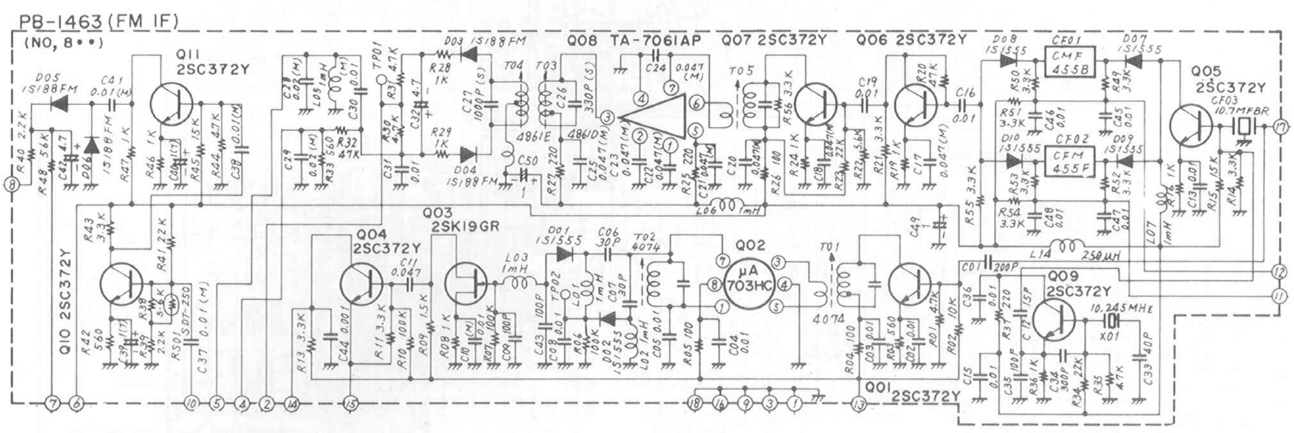


Figure 12

The noise rectifier diodes D_{801} and D_{802}, **1S1555**, produce a DC voltage which is amplified by following noise pulse amplifier Q_{803}, **2SK19GR**.

Under normal conditions, Q_{803} conducts producing the cut-off voltage to the base of the gate controller Q_{804}, **2SC372Y**, in turn the high collector voltage of Q_{804} is supplied from pin 15 to the gate diode D_{407}, **1S1007**, in the RX RF unit which conducts to pass the signal freely. With pulse noise, Q_{804} conducts and its collector voltage drops causing the gate diode D_{407} to disconnect the IF signal during the noise pulse exists.

AF AMP UNIT (PB-1499)

The audio signal pre-amplified in the SSB IF unit is fed through pin 13 to the audio amplifier stage consisting of Q_{610}, **2SC372Y**, Q_{611}, **2SC711**, Q_{612}, **2SA695**, Q_{613}, **2SD359** and Q_{614}, **2SB529**. The audio power amplifier circuit utilizes the OTL (output transformer less) circuitry and delivers 2 watts output to the speaker from pin 8.

In the FM mode, the squelch voltage is applied from pin 12 to the squelch controller Q_{607}, **2SC372Y**, which conducts with noise when the signal is not present, in turn the audio input is grounded to quiet the audio amplifier. When the signal is present, the Q_{607} is cut-off and permits normal operation of the audio amplifier.

The DC voltage is also applied from pin 12 to quiet the audio amplifier when the phase lock loop circuit is unlocked.

The speech output from the first microphone amplifier is fed through the VOX GAIN control potentiometer, VR_7, to the VOX amplifier Q_{601}, **2SC372Y**, and Q_{602}, **LD-3001**, from pin 2.

The amplified signal is fed to the VOX rectifier, D_{601} and D_{602}, **1S1555**. The rectified DC voltage is applied to the gate of the VOX relay controllers Q_{603}, **2SK19Y**, and Q_{604}, **2SC735Y**, causing them to conduct and actuate the VOX relay, RL_1, on the main chassis.

The ANTITRIP circuit provides a threshold voltage to prevent the speaker output from tripping the transceiver into the transmit mode. The receiver audio output voltage is connected through the ANTITRIP potentiometer, VR_{603}, to the antitrip amplifier Q_{605}, **2SC372Y**, and fed to rectifiers, D_{603} and D_{604}, **1S1555**. The negative DC output voltage from the rectifier is connected to the gate of Q_{603}, and reduces the gain of the VOX control transistor, thus providing the necessary antitrip threshold. The ANTITRIP control, VR_{603}, adjusts the value of the antitrip voltage threshold so that the speaker output will not produce an excessive positive voltage from the VOX rectifier that exceeds the negative voltage from the antitrip rectifier causing the controller transistor to actuate the relay. When speaking into the microphone, the

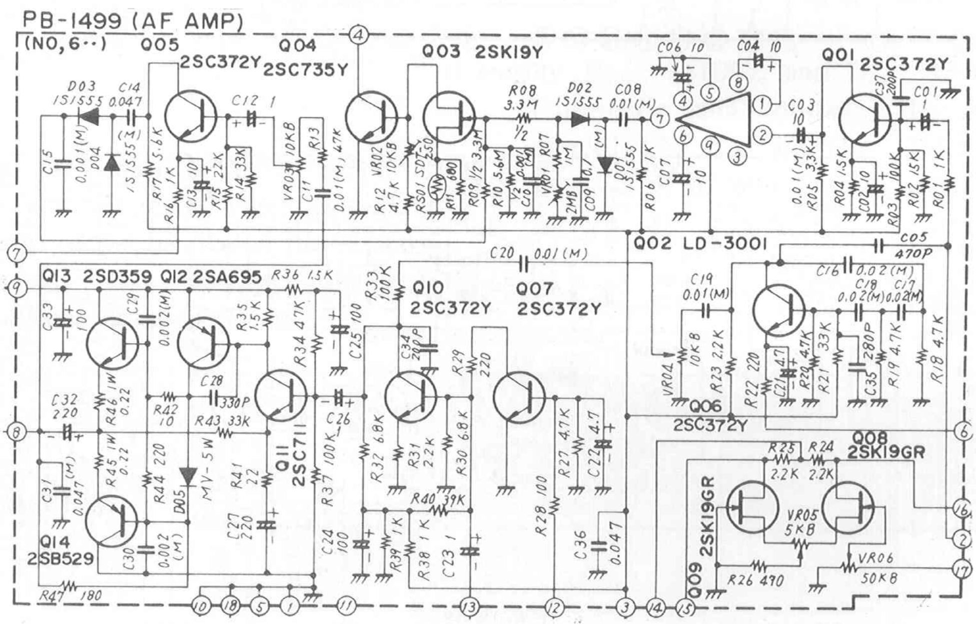


Figure 13

positive voltage will exceed the negative antitrip voltage and actuate the relay. VR_{602} provides coarse adjustment for relay sensitivity.

Relay hold tone will be determined by the DELAY control potentiometer, VR_{601}.

The tone oscillator Q_{606}, **2SC372Y**, operates when the MODE switch is in the CW position. It is a phase shift oscillator operating at approximately 800 Hz.

The tone output is activated by the keying circuit through the emitter circuit of Q_{606} and coupled through sidetone level control, VR_{604}, to the receiver audio amplifier, Q_{601}, for sidetone monitoring in CW operation. The output from Q_{606} is also coupled to the VOX amplifier, Q_{602}, for break-in CW operation. In the FM mode, a DC voltage at the discrimination output is applied from pin 17, to the differential amplifier Q_{608} and Q_{609}, **2SK19GR.**

When the frequency of received signal is shifted from the discriminator center, the resulting DC voltage causes either Q_{608} or Q_{609} to conduct indicating the amount of shift on the meter with the DISC switch in the ON position. VR_{605} balances the differential amplifier and VR_{606} calibrates the sensitivity of the meter.

TRANSMITTER

MIC AMP UNIT (PB-1460)

The speech signal from the microphone is fed from pin 31 to the first microphone amplifier, half of Q_{1104}, **LD-3001**. The input impedance of the microphone amplifier is 600 ohms. This signal is controlled in amplitude by the MIC GAIN control between pins 29 and 31, and is amplified by the second microphone amplifier, the other half of Q_{1104}, and applied to the source follower Q_{1105}, **2SK19GR**, to be delivered to the ring modulator D_{1108} through D_{1111}, **1S-1007**.

The carrier oscillator Q_{1108}, **2SC372Y**, oscillates at 10.7015 MHz for LSB, 10.6985 MHz for USB and 10.6993 MHz for AM/CW depending upon the MODE switch position. In the CW mode, the carrier oscillator oscillates at 10.6993 MHz for transmit and 10.6985 MHz for receive producing an 800 Hz beat note in the receive mode. In the AM mode, the carrier oscillator does not function while receiving. The MODE switch selects the crystal by means of a diode switch. The output from the oscillator is fed through the buffer amplifier Q_{1107}, **2SC372Y** to the balanced ring modulator D_{1108} through D_{1111}, **1S-1007**. The

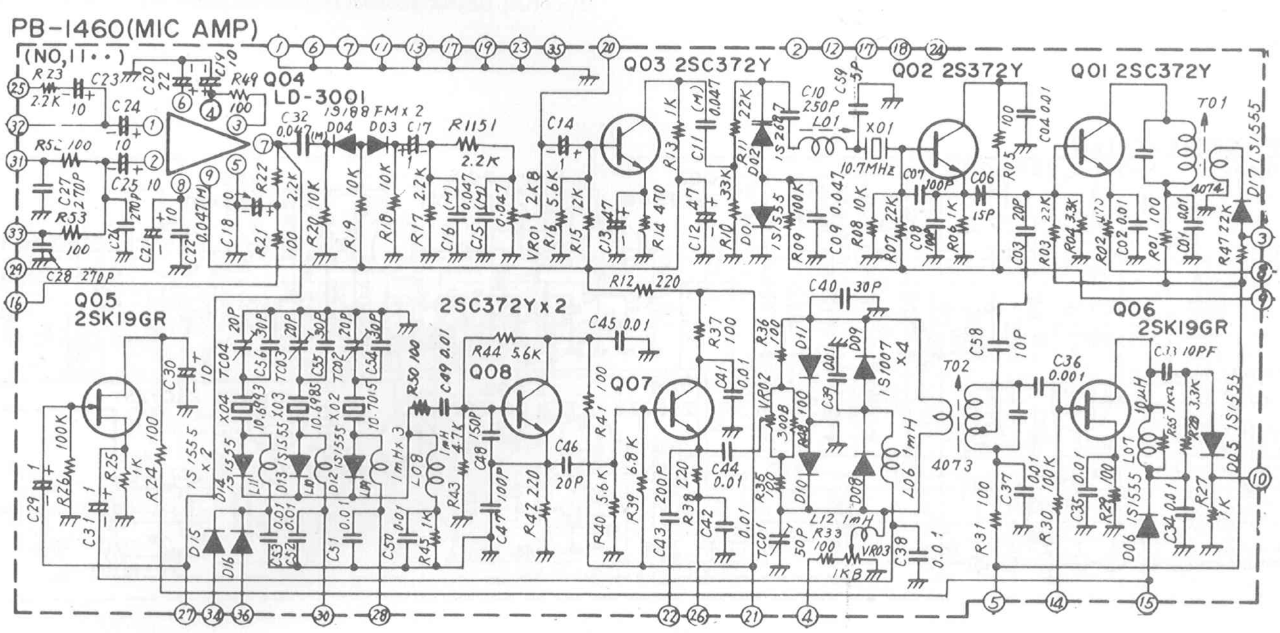


Figure 14

carrier signal output from the buffer amplifier, Q_{1107}, is fed from pin 22 to the SSB IF unit for SSB and CW reception. Carrier balance is obtained with potentiometer, VR_{1002}, and the trimmer capacitor, TC_{1101}. The double side band, suppressed carrier signal is amplified by Q_{1106}, **2SK19GR**, and fed from pin 10 to pin 5 of the SSB IF unit. In the AM and CW modes, the balanced modulator is unbalanced by the DC voltage applied from pin 4 and the carrier signal is fed through T_{1102} to carrier amplifier Q_{1101}, **2SC372Y**. The amplified carrier is fed from pin 3 to the EXCITER unit.

The audio signal output from Q_{1104} is fed from pin 27 to pin 12 of the EXCITER unit to be amplified to a sufficient level for low level AM modulation.

In the FM mode, a crystal oscillator Q_{1102}, **2SC372Y**, generates a 10.7 MHz signal which is shifted by the varactor diode D_{1102}, **1S2687**, in accordance with the speech voltage. The audio signal from the microphone amplifier, Q_{1104}, is applied to the IDA (instantaneous deviation adjustment) circuit. The IDA circuit, composed of diodes D_{1103} and D_{1104}, **1S188FM**, clips both positive and negative peaks when they exceed a predetermined level in order to limit the maximum deviation of the transmitter.

The limited audio signal is applied through a low pass filter and deviation potentiometer, VR_{1101}, to the audio amplifier Q_{1103}, **2SC372Y**, where it is amplified and applied to the modulator, varactor diode D_{1102}. The low pass filter limits the transmitter modulation spectrum by attenuating the frequencies above the speech range.

The frequency modulated signal is then amplified by Q_{1101}, **2SC372Y**, and fed through the output transformer T_{1101} to pin 5 of the EXCITER unit.

When the MODE switch is in the CW position, the emitter circuit of Q_{1107} and Q_{1101} are connected to the key jack through pin 8 and pin 26.

EXCITER UNIT (PB-1466)

The SSB, AM, CW and FM output signal (10.7 MHz) from the MIC AMP unit is fed to the EXCITER unit from pin 3 and pin 5.

The 10.7 MHz signal is fed to the balanced mixer, consisting of Q_{501} and Q_{502}, **2SK19GR**, where the signal is mixed with the 133.3 to 137.3 MHz heterodyne signal delivered from pin 4, producing a 144 to 148 MHz signal. The output signal from the balanced mixer passes through the tuned circuits consisting of L_{501} through L_{504}, which are tuned by the varactor diodes D_{501} through D_{504}, **1S2209**, in which voltages are preset in accordance with the band switch position. Thus the circuit is tuned exactly to the operating frequency com-

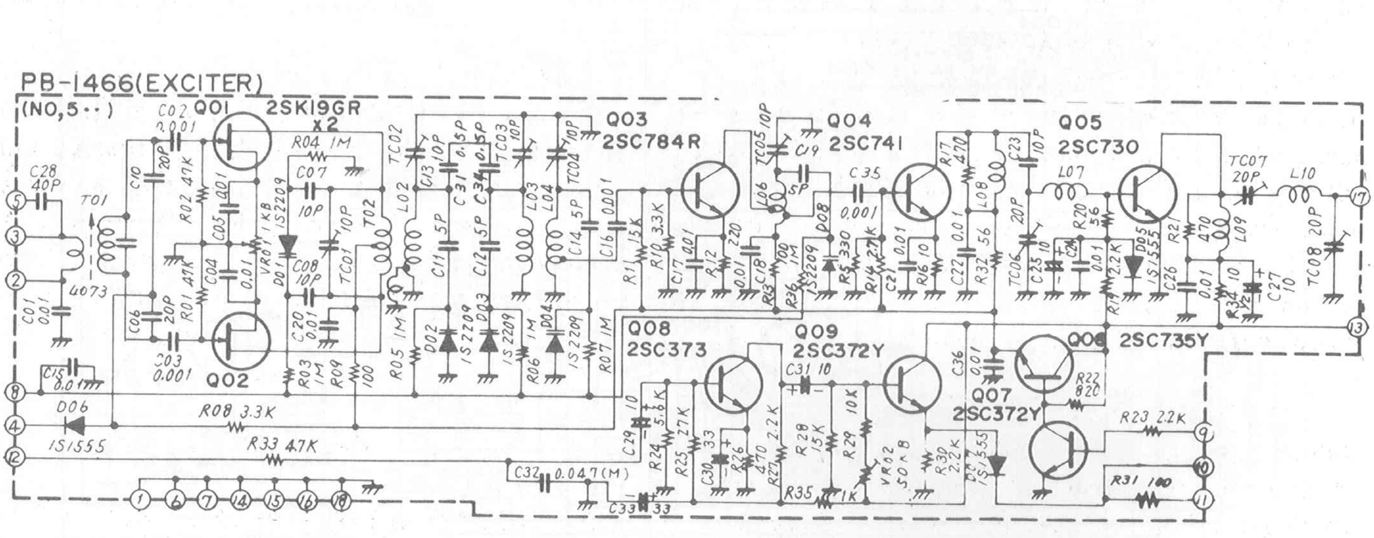


Figure 15

pletely reducing any spurious radiation. The signal is then amplified by the amplifier chain Q_{503}, **2SC784R**, Q_{504}, **2SC741**, and Q_{505}, **2SC730**, and delivered from pin 17 to the BOOSTER unit.

The DC voltage for Q_{501} through Q_{504} is supplied through Q_{506}, **2SC735Y**. When the phase lock loop circuit is unlocked, the controller transistor Q_{507}, **2SC372Y**, stops conducting and in turn Q_{506} stops supplying the DC voltage for Q_{501} through Q_{504}.

The speech signal from pin 27 of the MIC AMP unit is fed through the AM amplifier Q_{508}, **2SC373**, and emitter follower Q_{509}, **2SC372Y**, to the AM modulator Q_7, **2SD313D**, which controls the supply voltage for Q_{1201}, **BAM-20**, in the BOOSTER unit.

BOOSTER UNIT (PB-1470)

The signal from EXCITER unit is fed to the BOOSTER unit and amplified by the driver amplifier Q_{1201}, **BAM20**, and the final amplifier Q_{1202}, **BAM-40**, which delivers 10 watts of RF power to the antenna through a two stage, low-pass filter. The DC voltage to Q_{1201} is supplied through the AM modulator Q_7, **2SD313D**.
The bias voltage is stabilized at 9 volts by a zener diode D_{1209}, **1N4740**. Two diodes D_{1201} and D_{1202}, **10D1**, are used to protect the power transistor from damage due to heating by reducing the bias voltage when the temperature rises. A small portion of the RF output is rectified by a diode D_{1203}, **1S188FM**, which delivers a resulting DC voltage to the meter where it provides an indication of relative power output from the transceiver.

The DC voltage obtained from rectifying a small portion of the RF output by the ALC diodes D_{1205} and D_{1206}, **1S1555**, which are biased by the ALC threshold control VR_{1201}, is applied to the gate of Q_{906} in the SSB IF unit and Q_{1106} in the MIC AMP unit. This controls their gain in order to automatically control the driving level to the PA transistors in order to prevent any distortion caused by overdrive.

Block diodes D_{1207} and D_{1208} disconnect the supply voltage to Q_{1202} while the antenna is disconnected for marker calibration.

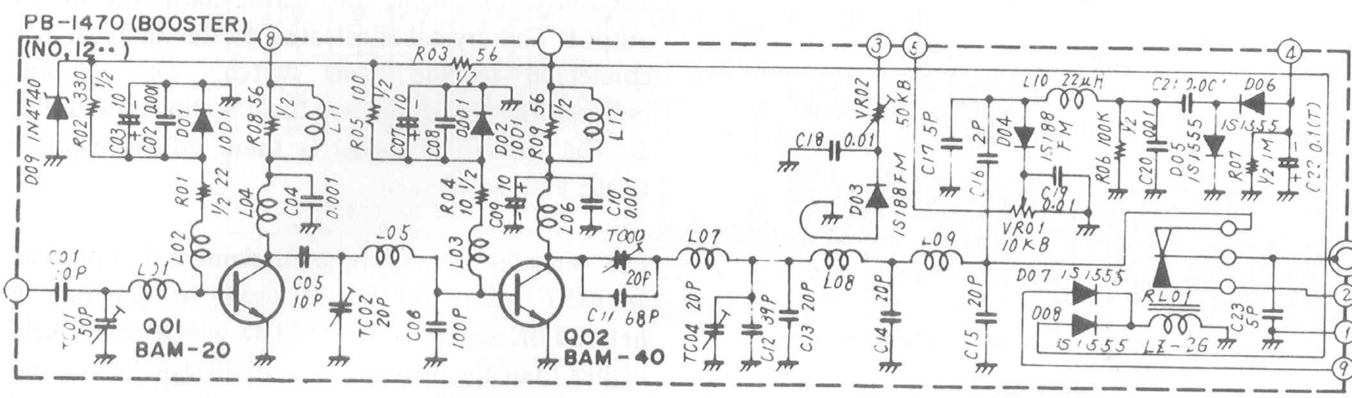


Figure 16

OTHER CIRCUITS

Some circuits work for both transmitting and receiving and are described as follows:

PLL CIRCUIT: VFO unit PB-1465
FIX unit PB-1453
LOCAL unit PB-1454
PLL unit PB-1455

The FT-221R utilizes a phase lock loop system for the heterodyne oscillator providing a stable signal varying from 133.3 through 137.3 MHz to cover the entire 2 meter band.

VFO UNIT (PB-1465)

The VFO module board is installed in the VFO chassis. The VFO (variable frequency oscillator) Q_{1301}, **2SC372Y**, generates an 8,000 to 8,500 kHz signal and produces a 500 kHz main tuning dial range. Frequency drift is minimized through the use of a temperature compensation circuit utilizing a differential trimmer capacitor. The signal is fed through the amplifier buffer stage Q_{1302}, **2SK19GR**, and Q_{1303}, **2SC372Y**, to pin 11 of the FIX oscillator board. The buffer amplifier provides isolation and amplification of the VFO signal.

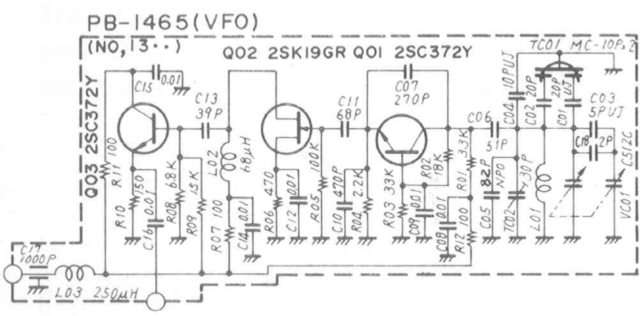


Figure 17

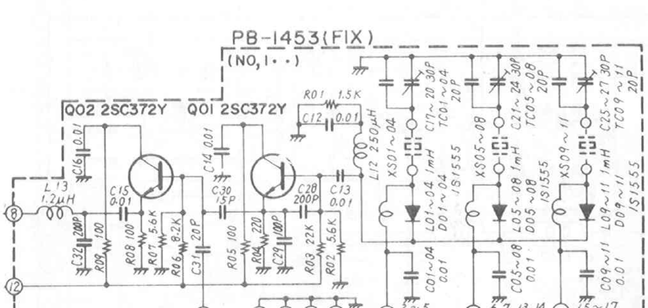


Figure 18

FIX UNIT (PB-1453)

In addition to normal VFO operation, 11 crystals may be selected for crystal controlled operation with the selector switch located on the front panel of the transceiver.

The FIX channel crystal oscillator Q_{101}, **2SC372Y**, oscillates at the frequency of the crystal selected by the diode switch D_{101} through D_{111}, **1S1555**. The output is fed from pin 8 through the buffer amplifier Q_{102}, **2SC372Y**, to the PLL unit.

The signal from the VFO also passes through this buffer stage to the PLL unit.

The crystal frequency falls between 8,000 and 8,500 kHz and is determined as follows.

$$fx = f_0 - f_1$$

where f_1 is given in Table 1 on page 12 and f_0 is the operating frequency.

LOCAL UNIT (PB-1454)

This oscillator generates a heterodyne signal which is used to convert the VCO (voltage controlled oscillator) signal to an 8,000 to 8,500 kHz signal, which is used for the comparison of the phase with that of the reference (VFO) signal.

The crystal controlled oscillator Q_{201}, **2SC372Y**, oscillates at the fundamental frequency of the crystal. A varactor diode D_{226}, **1SV50**, connected to the base of Q_{201}, is used as a clarifier to shift the oscillator frequency for receiver off-set tuning.

The output from the oscillator is fed to the frequency multiplier stage, Q_{202} and Q_{203}, **2SC784R**, producing the ninth harmonic at its output. The crystal is selected by the diode switch connected to the band switch. The relation between the frequency and band is shown on Table 2. The multiplied signal is then fed from pin 3 to the PLL unit.

For repeater operation, a fundamental crystal at 14.1333 MHz, X210, is used to generate a heterodyne signal of 127.2 MHz which is 600 kHz higher than the normal heterodyne signal when the band switch is set to the 146.5 MHz segment and X211 (fundamental frequency 14.3222 MHz) is used to generate 128.3 MHz signal which is 600 kHz higher than the normal heterodyne signal when the band switch is set to the 147.0 segment. A relay, RL_{1001} in the tone burst unit is used to select the above crystals with the Repeater switch, S_8, in the ON position. When the Normal-Reverse switch, S_9, is set to the NOR position, the relay selects the repeater crystal on transmit that shifts the transmitting frequency down 600 kHz in the 146.5 MHz segment and shifts up 600 kHz in the 147.0 MHz band. The main VFO tuning dial indicates the received frequency.

With S_9 in the REV position, the relay selects the repeater crystal on receive that shifts the receiver frequency down 600 kHz in the 146.5 MHz segment and shifts up 600 kHz in the 147.0 MHz segment. The main tuning dial now indicates the transmitted frequency.

BAND	Crystal No.	Crystal Frequency	Local Frequency
		MHz	MHz
144.0	X_{201}	13.9222	125.3
144.5	X_{202}	13.9777	125.8
145.0	X_{203}	14.0333	126.3
145.5	X_{204}	14.0888	126.8
146.0	X_{205}	14.1444	127.3
146.5	X_{206}	14.2000	127.8
	X_{210}	*14.1333	127.2
147.0	X_{207}	14.2555	128.3
	X_{211}	*14.3222	128.9
147.5	X_{208}	14.3111	128.8

*Repeater for US Model.

Table 2

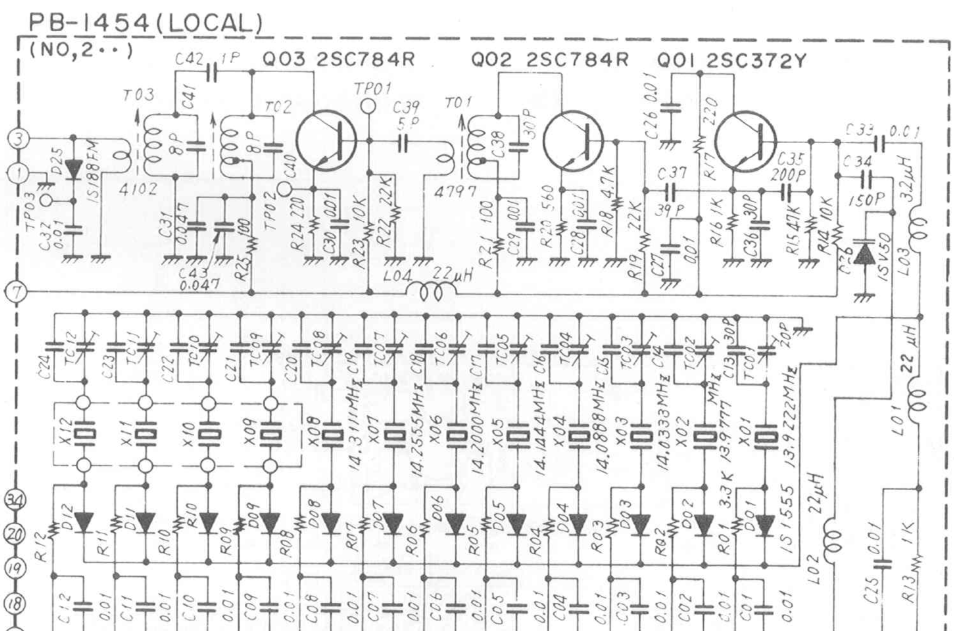


Figure 19

PLL UNIT (PB-1455)

This unit generates a heterodyne signal for the transmitter and receiver mixer in conjunction with the Phase Lock oscillator.

A voltage controlled oscillator Q_{305}, **2SK19GR**, generates a signal between 133.3 MHz and 137.3 MHz which is determined by L_{301}, TC_{301}, C_{324}, D_{305} and D_{306}. The varactor diode, D_{305}, changes the frequency by the DC voltage which is delivered from the phase detector amplifier Q_{301}, **2SK19GR**. The varactor diode, D_{306}, is used to shift the oscillating frequency in accordance with the band switch setting for a stable lock of the VCO. The output from the VCO, Q_{305}, is fed through a two stage buffer amplifier Q_{306}, **2SK19GR**, Q_{307}, **2SC784R**, to the mixers, Q_{405} in receive, Q_{501} and Q_{502} in transmit.

A portion of the output from Q_{306} is amplified through the buffer amplifier Q_{304}, **2SC372Y**, and is fed to the mixer Q_{303}, **2SC372Y**, where the signal from local oscillator unit is converted into a 8,000 to 8,500 kHz comparison signal.

This comparison signal is amplified by the amplifier Q_{302}, **μA703HC** and fed to the phase detector circuit consisting of diodes, D_{303} and D_{304}, **1S-1007**.

The phase detector compares the phase of the comparison signal with that of the reference signal which is fed through pin 17 from the FIX unit (VFO or FIX crystal signal), and any phase difference is converted into an error correcting voltage. This error voltage is amplified by Q_{301}, **2SK19GR**, and fed to the varactor diode D_{305}, **1SV50**, which changes the output signal phase to track the input.

The programmable unijunction transistor D_{301}, **N13T1**, generates a sawtooth wave when the VCO is unlocked. The sawtooth wave is used to lock the VCO. A portion of it is fed to the inverter Q_{308}, and rectified by Q_{310} **1S1555**.

The rectified voltage causes Q_{309}, **2SC372Y**, to conduct and its emitter voltage is used to conduct Q_{607} in the AF unit thus shorting the audio input to quiet the receiver when the PLL is unlocked.

In transmit, this voltage controls Q_{507} in the EXCITER unit causing Q_{506} cut off to disable the exciter stages. Thus, the transmitter and receiver stop functioning when the VCO is unlocked. With this voltage, a multivibrator Q_{308}, **TP4011AN**, produces a blanking pulse which controls the pilot lamp driver Q_{310}, **MPSA13**, causing the pilot lamp to flicker indicating VCO unlock.

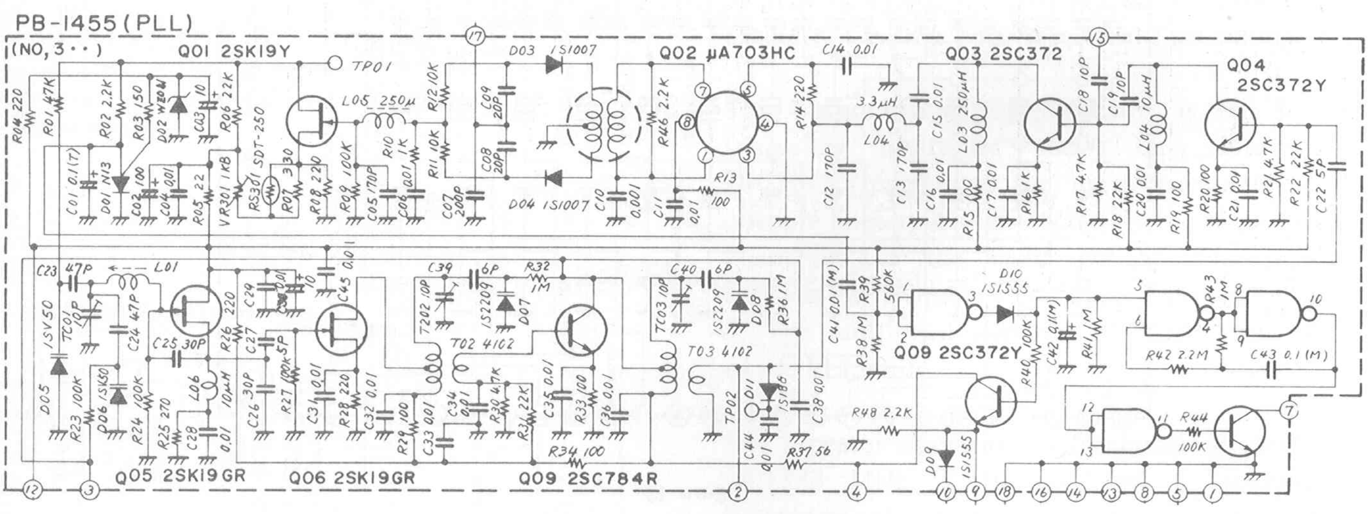


Figure 20

MARKER UNIT (PB-1459)

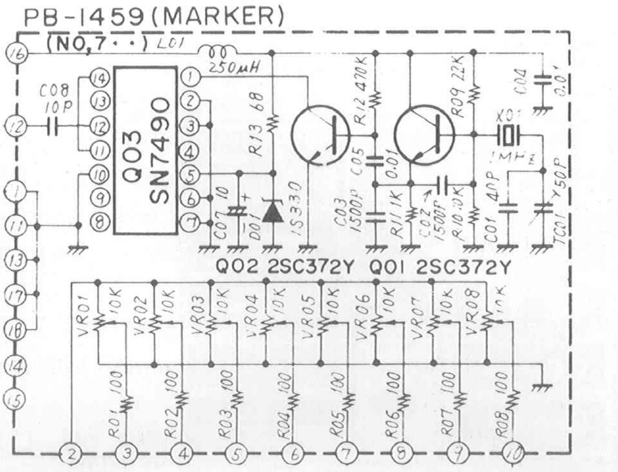


Figure 21

The crystal marker generator Q_{701}, 2SC372Y, generates a 1 MHz signal, and its output is fed through the buffer amplifier Q_{702}, 2SC372Y, to the frequency divider Q_{703}, SN7490N, where the 1 MHz signal generates a 100 kHz marker signal. When the marker switch is ON, the antenna relay is activated to disconnect the antenna.

Potentiometers VR_1 through VR_8 are installed in this board. These potentiometers are set to change the tuning frequency of the VCO and the exciter tuning circuits.

TONE BURST UNIT (PB-1461)

The tone burst signal is automatically transmitted in the following manner. When the PTT switch of the microphone is pressed momentarily before a normal transmission, the rapid voltage change in the PTT circuit causes a pulse to be fed to the tone burst control circuit consisting of Q_{1001}, Q_{1002}, Q_{1003}, **TP4011AN**, and Q_{1004}, **TP4049AN**, thus activating the tone burst oscillator Q_{1003}, **TP4011AN**.

Normal push-to-talk operation does not produce a pulse to activate the tone burst oscillator.

The tone frequency may be adjusted to any frequency between 1000 to 2000 Hz with VR_{1002} and the tone burst duration may be adjusted with VR_{1001}. The tone signal output level may be adjusted with VR_{1003}. The output from the tone burst oscillator is fed through the buffer Q_{1006}, **2SK19GR**, to pin 29 in the MIC AMP unit.

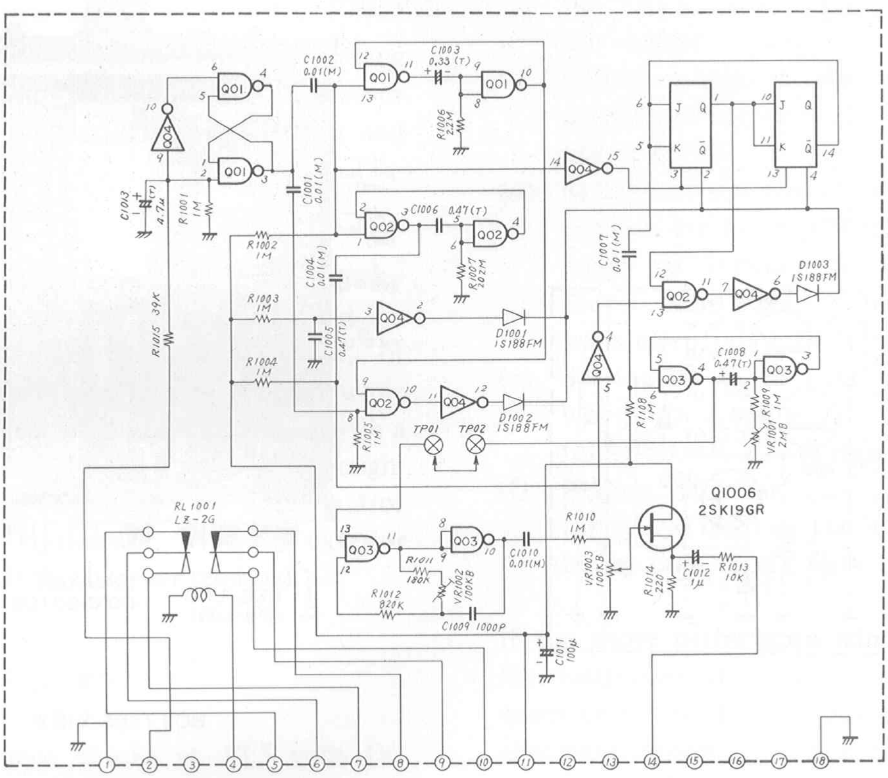


Figure 22 TONE BURST UNIT PB-1461

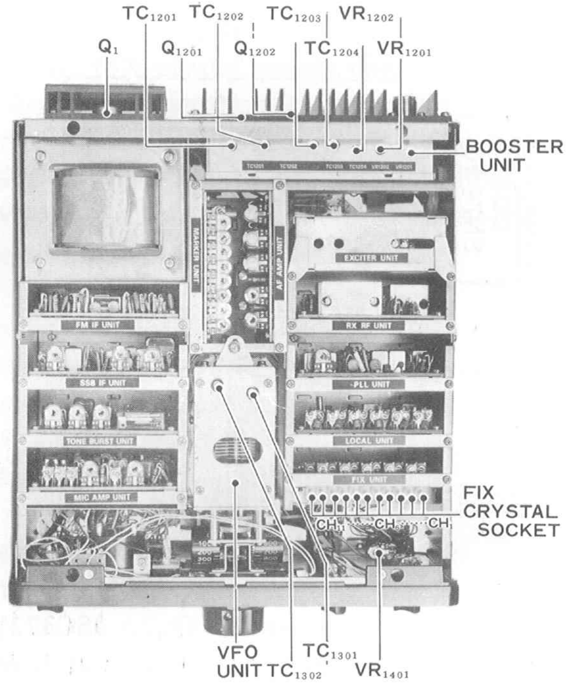
POWER SUPPLY & REGULATOR UNIT (PB-1469)

The power supply has been designed to operate from 100/110/117/200/220 or 234 volts AC 50/60 Hz, or 12 volts DC, negative ground. Inserting the appropriate power plug into the rear panel receptacle makes the necessary connections to operate the supply in either mode, AC or DC.

For AC operation, the DC voltage is supplied from the bridge connected rectifier unit D_{150}, **M4B-5,** which is connected to a 20 volt, 3.5 amps secondary winding of the power transformer. The DC voltage is regulated at 13.5 volts by the voltage regulator circuit consisting of Q_{1501}, **2SD313D,** and Q_1, **2SD114.**

Since such circuits as the VFO, local oscillator PLL circuit, require an extremely stabilized voltage, the 13.5 volts DC voltage is further stabilized at 8 volts by the voltage regulator Q_{1503}, **2SC735Y,** Q_{1504}, **2SD313D,** and Q_{1505}, **2SC372Y.**

For DC operation, the positive voltage is connected to pin 3 and the negative voltage to pin 4, of the power receptacle, J_1. To protect the circuits from any reverse connection of the DC voltage, D_1, **DS130YD,** conducts heavily in the reverse polarity connection to blow the line fuse in the DC cord. It is placed between pin 3 and ground on J_1.



TOP VIEW

Figure 24

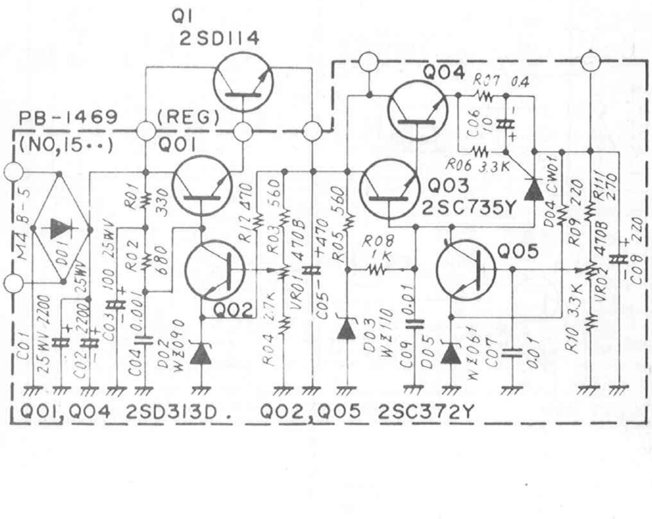
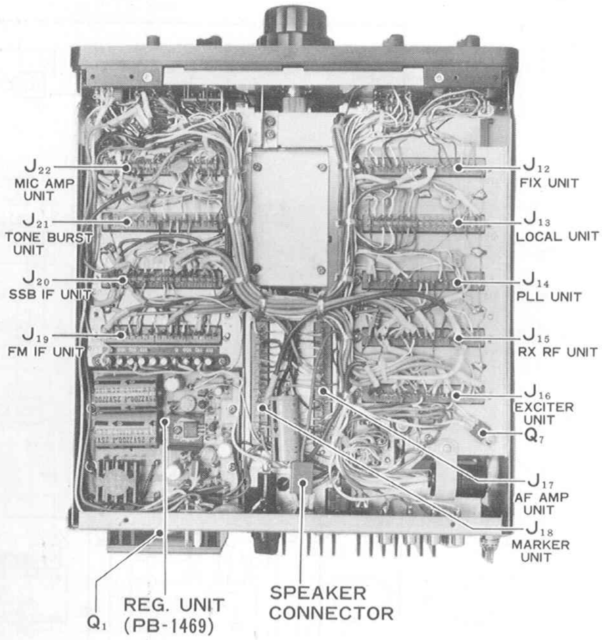


Figure 23



BOTTOM VIEW

Figure 25

MAINTENANCE & ALIGNMENT

GENERAL

Your model FT-221R transceiver has been carefully aligned and tested at factory prior to shipment. The reliability of the solid-state devices used in the FT-221R should provide years of trouble free service if the transceiver is not abused and normal, routine maintenance is carried out.

The following precautions should be observed to prevent damage to the transceiver:

(1) Do not interchange the AC and DC power cords.
(2) Do not apply any AC voltage other than the voltage determined by the transformer wiring.
(3) Do not exceed 14 volts DC, at the POWER receptacle, on DC operation. When operating mobile, check the battery voltage under the load (transmitter "keyed" in FM mode) with the engine running fast enough so the ammeter shows a "charge". In addition, do not operate the FT-221R if the supply voltage is below 12 volts DC.
(4) Avoid direct exposure to sunshine or water.

ROUTINE MAINTENANCE

Routine maintenance should be limited to keeping the transceiver clean, and periodic performance checks of the transmitter RF power output and the receiver sensitivity.

Cleaning:

When the transceiver has been used in dusty or sandy areas, the interior should be periodically cleaned. A vacuum-cleaner, or low pressure air source should be used, while any accumulated dirt may be removed with a soft brush. Check that the interior is thoroughly dry before replacing the case and/or operating the equipment. Wipe the exterior with a damp cloth whenever required.

PERFORMANCE CHECKS

Make all performance checks at 13.5 volts DC (under load) or AC with the appropriate voltage as determined by the transformer wiring.

Check the transmitter output as follows:

(a) Connect a suitable 50 ohm dummy load/RF wattmeter to the ANT receptacle.
(b) Set the MODE switch to FM and key the transmitter while observing the power output. The power should be approximately 10 watts, and the S-meter should read between 6 and 8.
(c) Set the MODE switch to SSB and key the transmitter. Speak normally into the microphone. The output meter should show 3 to 5 watts mean value.

Check the receiver sensitivity as follows:

(a) Connect an AC VTVM to the SP receptacle, set the MODE switch to FM and set the SQUELCH control fully counter-clockwise.
(b) Connect the RF output of a precision, VHF signal generator to the ANT receptacle and with no signal input note the VTVM reading. Adjust the VOLUME control and VTVM range, as required, to obtain an approximate full scale reading. (DO NOT change the VOLUME control setting after this adjustment is made.)
(c) Set the signal generator to the receiving frequency of the transceiver and adjust the output amplitude of the signal generator until the VTVM reads 1/10th (20 dB decrease) of the reading in step (b). The signal generator output voltage at this point is the 20 dB quieting sensitivity, and should be approximately 0.3μV.
(d) Set the MODE switch to SSB position and connect the AC VTVM to the speaker output. Apply an unmodulated, 0.5μV signal, from the standard signal generator and tune the transceiver for a maximum VTVM reading.
(e) Set the RF GAIN control to the fully clockwise position and adjust the AF GAIN control for a 450 mV VTVM reading.
(f) Reduce the signal generator output and read the VTVM reading. The VTVM reading should be less than 45 mV for a 10 dB S/N ratio.

If the above performance checks indicate a need for realignment it is recommended that the transceiver be returned to the dealer for alignment. The alignment procedures require special test equipment and techniques not normally available to the average owner. Attempts to realign the tuned circuits without proper test equipment will result in degraded performance of the transceiver.

ALIGNMENT

SOME OF THE FOLLOWING ALIGNMENT PROCEDURES REQUIRE SPECIAL TEST EQUIPMENT AND TECHNIQUES AND SHOULD ONLY BE DONE BY AN EXPERT TECHNICIAN.

AF AMP UNIT

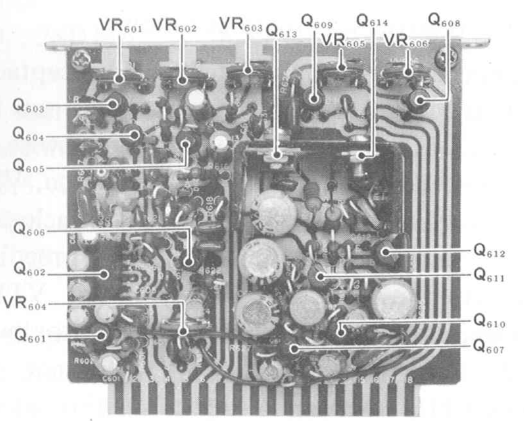


Figure 26

(1) CW Break-In

Adjust VR_{601}, DELAY control, for a suitable release time.

(2) CW Sidetone Level

Adjust VR_{604} for a suitable side tone level.

(3) Relay Sensitivity & Antitrip

Set the controls as follows:

- VR_{602} RELAY······Fully CCW
- MIC GAIN ·········Fully CCW
- VOX GAIN ········PTT
- MODE ·············LSB or USB

Slowly rotate the RELAY control, VR_{602}, until the relay activates, then return the control carefully counter clockwise until the relay releases. This release point is the proper setting for the RELAY sensitivity control. Set the MIC GAIN control to the 2 o'clock position and the VOX control on the front panel to the 12 o'clock position. Speaking normally into the microphone, make sure that your voice activates the relay. Tune in a signal and adjust the AF GAIN on the front panel to a comfortable listening level. Set the ANTITRIP control, VR_{603}, to the minimum point that will prevent the speaker output from tripping the VOX. Adjust the DELAY control, VR_{601}, for a suitable relay release time.

(4) Discriminator Meter Center

Set the controls as follows:

- CHANNEL···VFO
- MODE ······FM
- DISC ·······OFF (down position)
- RF GAIN····Fully CW
- MARKER····ON (up position)

Tune the transceiver for maximum S-meter reading at a marker signal. This maximum reading has a 3 kHz width and the VFO should be set to the center of the signal. Turn the DISC switch on and adjust the center potentiometer, VR_{605}, until the meter indicates mid point on the scale. Check that the meter moves equally toward both ends when the VFO frequency is shifted equally up or down. Shift the VFO frequency 10 kHz lower than the zero center meter indication, and adjust the DISC potentiometer, VR_{606}, until the meter indicates 2.

MARKER UNIT

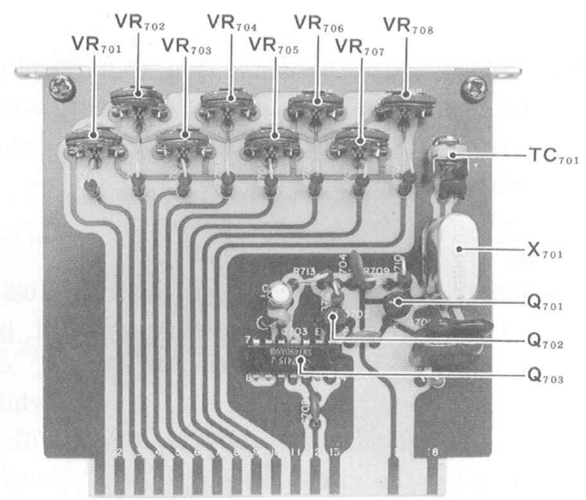


Figure 27

(1) Frequency Adjustment

Connect a frequency counter, through a 100 PF capacitor, to the collector of Q_{702}, 2SC372Y. Adjust TC_{701} to set the crystal frequency to 1 MHz.

When the counter is not available, use another H.F. receiver and calibrate the 1 MHz signal against WWV or JJY.

(2) Voltage Adjustment for the Varicap Tuning Circuit

Measure the voltage at pins 3, 4, 5, 6, 7, 8, 9 and 10 with a VTVM connected between the pins and ground.

Adjust the appropriate potentiometer, VR_{701} to VR_{708}, for following pin voltages:

Pin No.	3	4	5	6	7	8	9	10
Adjust. VR No.	701	702	703	704	705	706	707	708
Volt. DC. V.	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5

Table 3

SSB IF UNIT

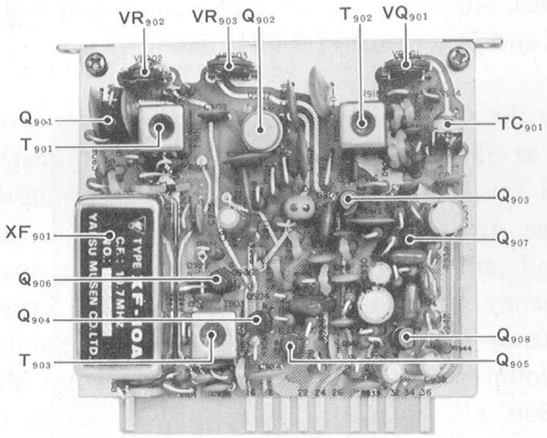


Figure 28

(1) S Meter Setting

Disconnect the antenna from the coax receptacle. Set the MODE switch to the AM mode. Set the RF GAIN control on the front panel to the fully clockwise position. Adjust VR_{913} (ZERO) until the meter indicates zero. Then set the RF GAIN control to the fully counter clockwise position. Adjust VR_{902} (FULL SCALE) until the meter indicates full scale. Repeat above procedures until the meter indicates zero and full scale with above mentioned RF GAIN settings.

(2) Carrier Balance (SSB Receive)

Disconnect the antenna.

Set the MODE switch to either the LSB or USB modes, and the RF GAIN control fully counter clockwise. Adjust VR_{901} and TC_{901} (CARRIER BALANCE) alternately until the S-meter indicates full scale. Change the MODE switch to CW position and check if the S-meter indicates exactly full scale.

MIC AMP UNIT

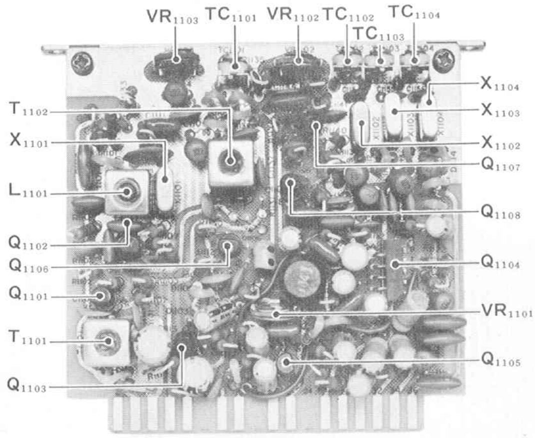


Figure 29

(1) SSB Carrier Frequency

Connect a dummy load, such as the YAESU YP-150, to the antenna receptacle and the output of an audio oscillator to the microphone input. Set the MODE switch to an SSB mode. Apply 1 kHz audio signal to the microphone input and adjust the MIC GAIN control or the output level from the audio oscillator for 10 watts RF output on the dummy load. Change the audio frequency to 350 Hz, and adjust TC_{1102} for LSB and TC_{1103} for USB to obtain 2.5 watts output. Check if the power output decreases to 2.5 watts when the audio frequency is moved to approximately 2600 Hz.

(2) AM and CW Carrier Frequency

Tune the transceiver in the USB mode and monitor the transmitted USB signal for the most natural voice quality while using another receiver. Change the mode of the transceiver to AM (with the monitor receiver in the USB mode), and adjust TC_{1104} for a zero beat against a carrier signal.

(3) **Carrier Balance (SSB Transmit)**

Connect a dummy load to the antenna receptacle and the RF probe of a VTVM to the inner conductor of coax cable at the antenna receptacle. Set the MODE switch to the LSB mode. Set the MIC GAIN control to the fully CCW position. Set the VOX switch to MOX position. Adjust VR_{1102} and TC_{1101} (CARRIER BALANCE) alternately to minimize the VTVM reading.

Repeat this procedure until a minimum reading is obtained equally for both side bands.

(4) **CW Carrier Level**

Set the CW level control, VR_{1105}, to the point where the output power starts to saturate.

FIX UNIT

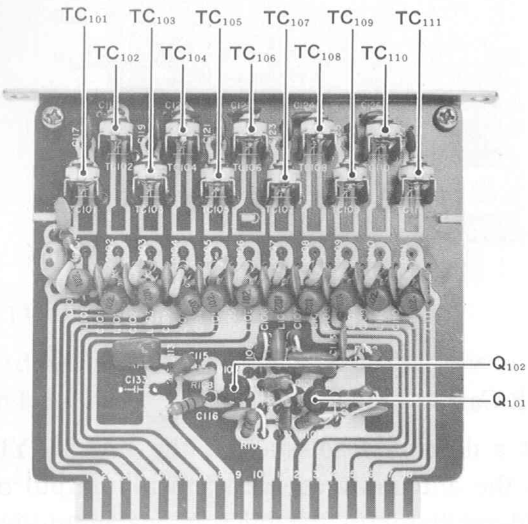


Figure 30

The crystal frequency may be precisely adjusted with TC_{101} to TC_{111} for on-frequency crystal controlled operation.

LOCAL UNIT

Set the MODE switch to USB, the BAND switch to 144.0, the CHANNEL switch to VFO, the MARK switch to OFF and the RPT switch to the OFF position. Connect a frequency counter to TP_{201} and adjust the oscillator frequency to 41.7666 MHz with TC_{201}. Set the MARK switch to the ON position and zero beat against the marker signal at 144.0 MHz on the VFO tuning dial. Set the BAND switch to 144.5 MHz and adjust TC_{202} to zero beat, then adjust TC_{203} for 145.0 MHz, TC_{204} for 145.5 MHz, TC_{205} for 146.0 MHz, TC_{206} for 146.5 MHz, TC_{207} for 147.0 MHz and TC_{208} for 147.5 MHz for a zero beat against the marker signal.

For the U.S. model, set the RPT switch to REV, the AUX/600 kHz switch to 600 kHz and the BAND switch to 146.5. Adjust TC_{210} for zero beat. Change the BAND switch to 147.0 and adjust TC_{211} for zero beat. For the European model, set the BAND switch to 145.0 and adjust TC_{210} for zero beat. During the above repeater frequency adjustment, the VFO dial is set to the zero beat obtained in the preceding adjustment.

For the frequency split other than 600 kHz, the crystal calculated by the formular in page 12 is installed in X_{209} socket for 146.5 MHz band and in X_{212} socket for 147.0 MHz band. Set the AUX/600 kHz switch to AUX position.

For the split frequency in 100 kHz order, such as 800, 900 or 1000 kHz, use the internal marker signal to calibrate as described in 600 kHz procedures. Adjust TC_{209} for zero beat on 146.5 MHz band and TC_{212} on 147.0 MHz band.

When the split frequency is not in 100 kHz order, such as 850 kHz or 940 kHz, the internal marker signal can not be used. In such a case, connect a precise frequency counter between TP_{201} and ground and adjust TC_{209} or TC_{212} for exact frequency which is 3rd harmonics of the crystal frequency given from the formular. For example, the counter frequency should be 42.31666 MHz for 850 kHz split on 146.5 MHz band, as the crystal frequency is $(127.8 - 0.85) \div 9 = 14.1055$ MHz.

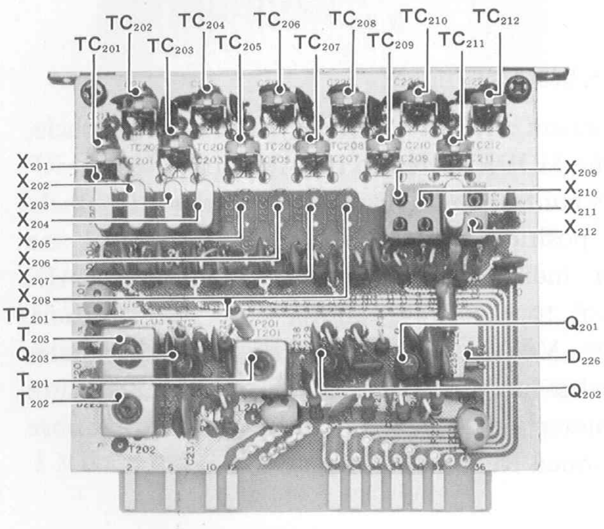


Figure 31

PLL UNIT

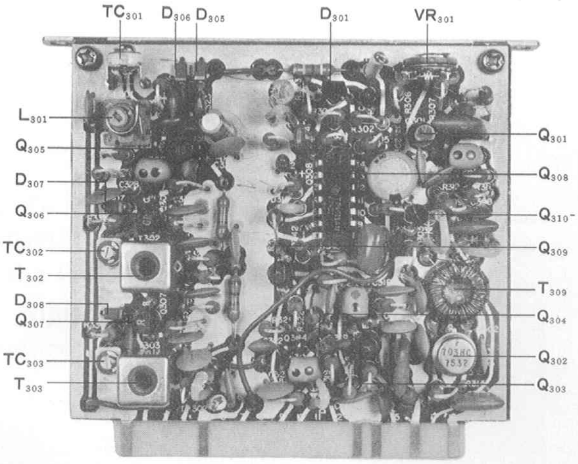


Figure 32

This unit does not require any adjustment unless major components are changed, and, as such, requires precise measuring equipment for alignment. When the PLL circuit is unlocked, the pilot lamps start flikering. Adjust VR_{301} until the circuit locks and the pilot lamps stop flikering. Check that the circuit locks at all segments and entire VFO range.

RX RF UNIT

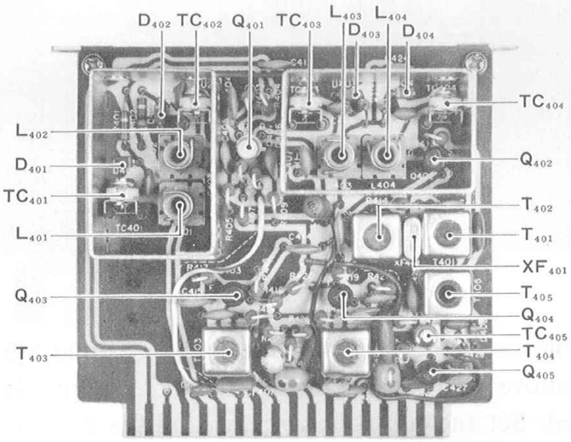


Figure 33

Set the BAND switch to 144.0, the CHANNEL switch to VFO, the RF GAIN control fully clockwise and the MODE switch to the USB mode. Tune the VFO to a signal (144.20 MHz, 10dB) from a signal generator connected to the antenna receptacle. Peak TC_{401}, TC_{402}, TC_{403} and TC_{404} for a maximum S-meter reading. In areas that use the high side of the band, 146 to 148 MHz, it is recommended to perform above procedures on 146.20 MHz.

EXCITER UNIT/BOOSTER UNIT

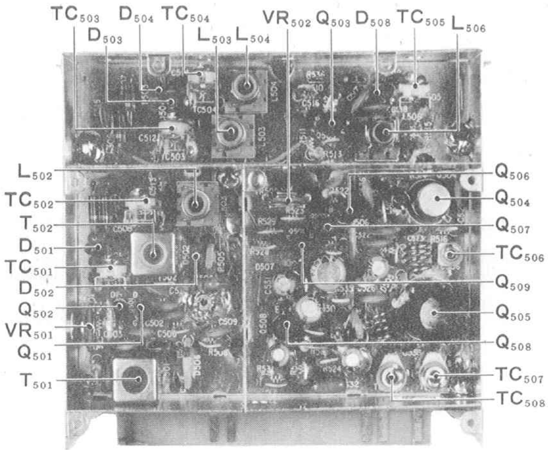


Figure 34

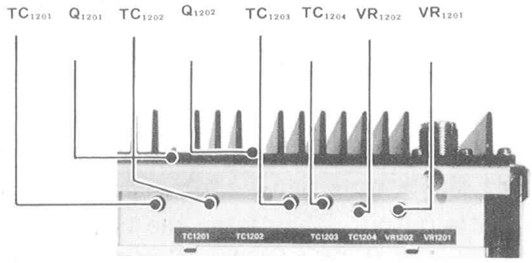


Figure 35

(1) Power Output

It is recommended that an insulated wand be used for the alignment of the booster unit. Connect a dummy load to the antenna receptacle. Set the BAND switch to 145.0, the CHANNEL switch to VFO and the MODE switch to FM. Set the VFO to 145.0 MHz. Set the VOX control to the MOX position. Peak TC_{501} through TC_{508} and TC_{1201} through TC_{1204} for maximum power output.

Change the frequency to 144.1 MHz and repeat above procedures for maximum power output. Change the frequency to 147.9 MHz and repeat above procedures for maximum power output.

Repeat the procedures alternately on 144.1 MHz, 145.0 MHz and 147.9 MHz until unity power output is obtained over 144 to 148 MHz.

(2) **PO Meter Set**

The PO (Power Output) meter indicates relative power output. After the completion of the above power output alignment, set the meter control, VR_{1202}, to the point where the meter indicates 80% of full scale.

(3) **AM Carrier Level**

Set the MODE switch to the AM position. Adjust VR_{502}, in the EXCITER UNIT, for 2.5 watts unmodulated carrier output on the dummy load.

(4) **ALC Threshold**

Connect the output from a two-tone signal generator to the microphone input and dummy load to the antenna receptacle. Set the BAND switch to 145.0, the CHANNEL switch to VFO, the MODE to USB and the MIC GAIN to the 12 o'clock position. Set the VOX GAIN control to the MOX positoin. Apply a 1 kHz single tone signal at first and adjust the signal generator output until the power meter shows 2.5 watts. Then apply a 1.5 kHz single tone signal and adjust its output for 2.5 watts output. Then leave the output levels of both tones at the set level and apply a 1 kHz/1500 kHz, two tone signal, of the above set level. Adjust VR_{1201} until the power meter indicates 3 watts.

SQUELCH THRESHOLD

Disconnect the antenna. Set the BAND switch to 144.0, the CHANNEL switch to VFO, the RF GAIN to the fully CW position, the MODE switch to FM and SQUELCH control to the 9 o'clock position. Adjust VR_{1401} to the point where the receiver is just silenced. Do not go beyond this threshold point or the SQUELCH control on the front panel will not function properly.

FM DEVIATION ADJUSTMENT

Connect a dummy load and FM deviation meter to the antenna receptacle. Set the MODE switch to FM and the MIC GAIN control to the 2 o'clock position. Apply a 20 mV, 1 kHz audio signal to the microphone input, and set the VOX control to the MOX position. Adjust VR_{1101} in the MIC AMP UNIT for a deviation of ±5 kHz.

TONE BURST UNIT

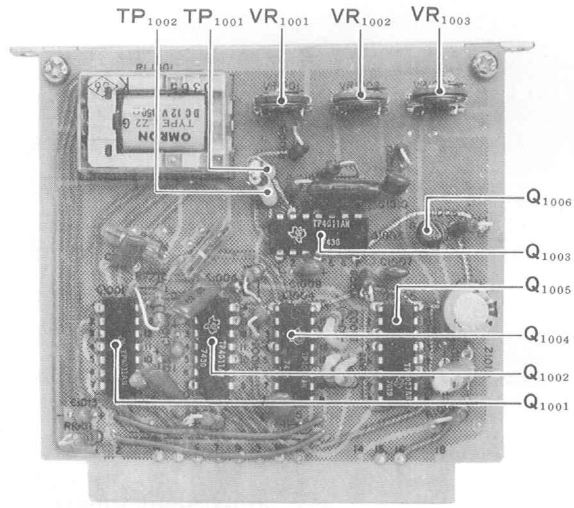


Figure 36

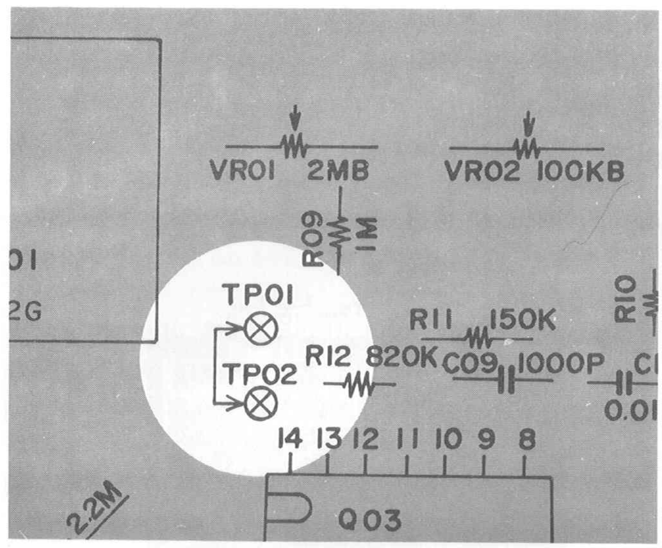


Figure 37

The adjustment of this unit should be done after the above FM deviation alignment has been completed. Set the controls, switches and the deviation meter as described in the deviation adjustment. Remove the tone burst unit from the chassis and disconnect the connection of the two test points as illustrated in order to obtain a continuous tone signal during the alignment. Insert the unit into its socket.

Set the MIC GAIN control to the 2 o'clock position and the VOX GAIN control to the MOX position. Measure the burst tone signal frequency at the deviation meter output. Adjust VR_{1002} to the desired frequency. Adjust VR_{1003} for ±3.5 kHz deviation.

Set the VOX GAIN control to the PTT position and remove the unit from its socket. Reconnect the disconnected test points and reinstall it into its socket.

The burst signal is automatically transmitted when the PTT switch on the microphone is keyed twice as, i.e., key 0.5 second, receive 0.5 second and then transmit. The deviation of the burst signal is preset at the factory to approximately 0.5 second. It may be adjusted with VR_{1001}. A clockwise rotation produces a longer deviation.

REGULATOR UNIT

Use an AC supply for this alignment. Connect a VTVM DC probe to the 13.5 volt line of the power supply unit. Adjust VR_{150} for a 13.5 volt VTVM reading. Connect the VTVM to the 8 volt line and adjust VR_{1502} for a 8 volt VTVM reading.

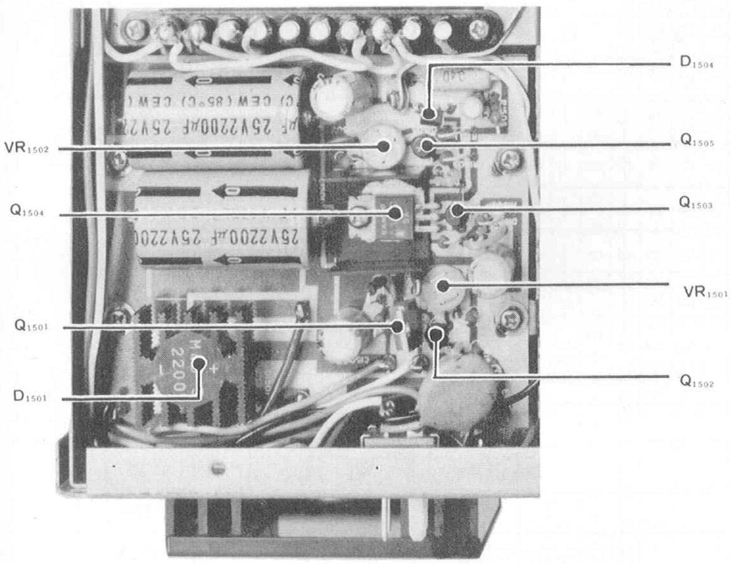


Figure 38

FM IF UNIT

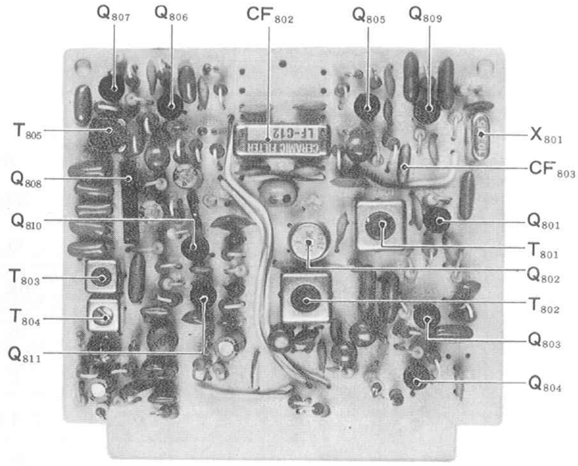


Figure 39

CONNECTOR RESISTANCE CHART

PIN \ UNIT	FIX	LOCAL	PLL	RX RF	EXCITER	AF AMP	MARKER	FM IF	SSB IF	TONE BURST	MIC AMP
	J_{12}	J_{13}	J_{14}	J_{15}	J_{16}	J_{17}	J_{18}	J_{19}	J_{20}	J_{21}	J_{22}
1	E	E	E	E	E	E	E	E	E	E	E
2	∞	E	0	2.6K	250	0	53※	5.5K	E	1.7K	E
3	∞	0	2.3K	—	250	53※	2.4K	E	3.5K	—	6K
4	∞	—	53※	E	0	74※	2.5K	500	—	450	3.2K
5	∞	E	E	0	6K	—	2.5K	10	700	53	300
6	∞	E	45※	∞	E	∞	3K	1K	—	53	E
7	∞	53	160※	0	E	0	3K	300	250	∞	E
8	∞	—	E	E	2.4K	0	3K	1.6K	—	2.4K	0
9	E	E	2K	0	2K	40※	2.7K	E	53※	2.4K	12K
10	E	E	160※	E	2.6K	E	2.3K	2.5K	—	∞	700
11	∞	—	—	53※	2.6K	—	E	E	E	350	E
12	53※	—	53※	E	100K	1.6K	∞	—	—	—	E
13	∞	—	E	2.4K	1.1K	850	E	53※	700K	—	E
14	∞	—	E	3.5K	E	1K	—	3.3K	—	850	700K
15	∞	—	0	3.3K	E	2.1K	—	100K	250	—	250
16	∞	—	—	E	E	1.5K	2.4K	E	500	—	250
17	∞	—	∞	0	∞	5.5K	E	0	2.6K	—	E
18	E	—	E	E	E	E	E	E	46※	E	E
19		—							—		E
20		—							—		650
21		∞							300		53※
22		54※							—		500
23		—							400		E
24		—							400		E
25		—							∞		9K
26		—							—		0
27		—							53※		9K
28		—							500		∞
29		—							4.5K		850
30		—							E		2.2K
31		—							E		∞
32		—							500		5K
33		17K							1.9K		∞
34		—							E		1K
35		E							E		E
36		E							E		E

Switch, Knob Position

POWER···OFF MODE···FM BAND···144.0 CHANNEL···VFO RF GAIN···MAX VOX GAIN···PTT

AF GAIN, MIC GAIN, SQUELCH }···CENTER

FUNCTION SW···OFF

Measured with 20KΩ/V

Values are in OHMS

CONNECTOR VOLTAGE CHART

UNIT	J12		J13		J14		J15		J16								J17				J18		J19				J20		J21		J22									
	FIX		LOCAL		PLL		RX RF		EXCITER								AF AMP				MARKER		FM IF				SSB IF		TONE BURST		MIC AMP									
									USB. LSB		CW		AM		FM		USB.LSB CW.FM		CW				USB.LSB CW.AM		FM						LSB		USB		CW		AM		FM	
	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T
1	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
2	0	0	E	E	0	0	7.2	0	0	8.0	0	0	0	0	0	0	0	0	0	0	8.0	8.0	0	0	0	0	E	E	E	E	E	E	E	E	E	E	E	E	E	E
3	0	0	0	0	2.0	2.0	0	0	0	8.0	0	0	0	0	0	0	8.0	8.0	8.0	8.0	2.0	2.0	E	E	E	E	0	2.8	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	8.0	8.0	E	E	0	0	0	0	0	0	0	0	13.5	0	13.5	0.5	2.5	2.5	0	0	0.05	0	0	0	0	0	0	0	0	0	0	7.3	0	7.3	0	0
5	0	0	E	E	E	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3.0	3.0	0	0	0	0	1.8	2.2	8.0	8.0	0	0	0	0	0	8.0	0	8.0	0	8.0
6	0	0	E	E	0	0	0	0	E	E	E	E	E	E	E	E	0.6	0.6	0.6	0	3.5	3.5	0	0	7.2	0	0	0	8.0	8.0	E	E	E	E	E	E	E	E	E	E
7	0	0	8.0	8.0	0.7	0.7	0	0	E	E	E	E	E	E	E	E	0	0	0	0	4.0	4.0	0	8.0	0	8.0	0	8.0	0	0	E	E	E	E	E	E	E	E	E	E
8	0	0	0	0	E	E	E	E	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	0	0	0	0	4.5	4.5	0	0.65	0.65	0.59	0	0	2.0	2.0	0	0	0	0	0	0	0	0	0	0
9	E	E	E	E	0	0	0	0	0	0	0	0	0	0	0	0	13.5	13.5	13.5	13.5	5.0	5.0	E	E	E	E	8.0	0	2.0	2.0	0	0	0	0	0	0	0	0	0	7.2
10	E	E	E	E	0	0.7	E	E	0	13.0	0	12.4	0	4.3	0	12.4	0	0	0	0	5.5	5.5	0	0	0	0	0	0	0	0	1.8	2.2	1.8	2.2	1.8	1.6	1.8	1.6	1.8	1.6
11	0	0	0	0	0	0	8.0	0	0	13.0	0	12.6	0	4.3	0	12.6	—	—	—	—	E	E	0	0	0	0	E	E	0	0	E	E	E	E	E	E	E	E	E	E
12	8.0	8.0	0	0	8.0	8.0	E	E	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0	0.65	0	0.55	0	0	0	0	7.3	0	0	0	0	0	E	E	E	E	E	E	E	E	E	E
13	0	0	0	0	E	E	2.0	2.0	0	13.5	0	13.5	0	13.5	0	13.5	0	0	0	0	E	E	8.0	8.0	8.0	8.0	0	0	0	0	E	E	E	E	E	E	E	E	E	E
14	0	0	0	0	E	E	0	2.8	E	E	E	E	E	E	E	E	0	0	0	0	0	0	5.2	4.2	5.2	4.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	5.2	4.2	E	E	E	E	E	E	E	E	0	0	0	0	0	0	5.8	4.7	0	0	0	8.0	0	0	0	8.0	0	8.0	0	0	0	0	0	0
16	0	0	0	0	0	0	E	E	E	E	E	E	E	E	E	E	0	0	0	0	0	0	E	E	E	E	1.6	0	0	0	0	8.0	0	8.0	0	8.0	0	8.0	0	8.0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	E	E	0	0	0	0	7.0	0	0	0	E	E	E	E	E	E	E	E	E	E
18	E	E	0	0	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	13.5	0	E	E	E	E	E	E	E	E	E	E	E	E
19			0	0																							0	0			E	E	E	E	E	E	E	E	E	E
20			0	0																							0	0			0	0	0	0	0	0	0	0	0	0
21			0	0																							0	0			8.0	8.0	8.0	8.0	8.0	8.0	8.0	0	8.0	8.0
22			8.0	8.0																							0	0			0	0	0	0	0	0	0	0	0	0
23			0	0																							0.85	0			E	E	E	E	E	E	E	E	E	E
24			0	0																							0.85	0			E	E	E	E	E	E	E	E	E	E
25			0	0																							0	0			0	0	0	0	0	0	0	0	0	0
26			0	0																							0	0			0	0	0	0	0	0	0	0	0	0
27			0	0																							8.0	8.0			0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
28			0	0																							0	0			0	0	0	0	0	0	0	0	0	0
29			0	0																							0	0			7.3	7.3	0.1	0.1	0	0	0	0	0	0
30			0	0																							E	E			0.1	0.1	7.3	7.3	7.3	0	0	0	0	0
31			0	0																							E	E			0	0	0	0	0	0	0	0	0	0
32			0	0																							0	0			0	0	0	0	0	0	0	0	0	0
33			0	0																							0	0			0	0	0	0	0	0	0	0	0	0
34			0	0																							E	E			0	0	0	0	0	0	0	0	0	0
35			3.8	3.8																							E	E			0	0	0	0	0	7.3	0	7.3	0	0
36			E	E																							E	E			E	E	E	E	E	E	E	E	E	E

Measured with VTVM.
Values are in VOLTS DC.

VOLTAGE CHART

FIX Unit

	E	B	C		E	B	C
Q101	0.9	1.4	7.7	Q102	2.2	2.9	5.8

LOCAL Unit

	E	B	C		E	B	C		E	B	C
Q201	2.4	2.5	7.6	Q202	1.1	1.3	7.9	Q203	0.9	1.4	7.6

PLL Unit

	E(S)	B(G)	C(D)		E(S)	B(G)	C(D)		E(S)	B(G)	C(D)
Q301	1.6	0	4.5	Q305	0.9	0	5.4	Q309	0	0	8.0
Q303	0.9	1.4	8.0	Q306	1.0	0	5.9	Q310	0	0.7	1.3
Q304	0.5	1.1	7.5	Q307	0.5	0.8	7.2				

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Q302	7.2	–	1.5	E	1.5	–	7.2	7.5						
Q308	4.9	4.9	0.2	8.0	0	1.9	E	8.0	8.0	0	8.0	0	0	8.0

RX RF Unit

	E (S)		B (G)		C (D)		G_2			E (S)		B (G)		C (D)	
	R	T	R	T	R	T	R	T		R	T	R	T	R	T
Q401	1.5	0	1.6	0	8.0	0.1	3.9	0	Q404	0.7	0	1.4	0	7.9	0.1
Q402	1.6	1.1	0	0	7.9	0.1			Q405	1.0	0	0	0	7.7	0
Q403	1.2	0	1.8	0	7.8	0.1									

EXCITER Unit (on Transmit)

	LSB.USB.CW			AM.FM		
	E(S)	B(G)	C(D)	E(S)	B(G)	C(D)
Q501	1.3	0	12.1	1.4	0	11.8
Q502	1.3	0	12.1	1.4	0	11.7
Q503	1.2	1.9	12.0	1.2	1.9	11.9

	LSB.USB.CW			AM.FM		
	E(S)	B(G)	C(D)	E(S)	B(G)	C(D)
Q504	0.4	1.2	10.1	0.4	1.2	10.0
Q505	0	0.7	13.4	0	0.7	13.4
Q506	12.5	13.3	13.5	12.5	13.3	13.5

	LSB.USB.CW			AM.FM		
	E(S)	B(G)	C(D)	E(S)	B(G)	C(D)
Q507	0	0	13.3	0	0	13.3
Q508	1.1	1.8	5.4	1.1	1.8	5.4
Q509	4.9	5.5	13.5	4.9	5.5	13.5

Receive……0V

AF AMP Unit

	LSB.USB.CW AM			FM		
	E(S)	B(G)	C(D)	E(S)	B(G)	C(D)
Q601	0.4	1.0	7.0	0.4	1.0	7.0
Q603	0.4	0	0.6	0.4	0	0.6
Q604	0	0.6	12.9	0	0.6	12.9
Q605	0.4	1.0	5.8	0.4	1.0	5.8
Q606	2.9	1.0	8.0	2.9	1.0	8.0

	LSB.USB.CW AM			FM		
	E(S)	B(G)	C(D)	E(S)	B(G)	C(D)
Q607	0	0	0.6	0	0	0.6
Q608	0	0	0	★1.9	0	★5.7
Q609	0	0	0	★2.6	0	★6.3
Q610	0	0.6	3.8	0	0.6	3.8
Q611	8.5	9.1	12.9	8.5	9.1	12.9

	LSB.USB.CW AM			FM		
	E(S)	B(G)	C(D)	E(S)	B(G)	C(D)
Q612	13.5	12.9	7.5	13.5	12.9	7.5
Q613	6.8	7.4	13.5	6.8	7.4	13.5
Q614	6.8	6.2	0	6.8	6.2	0

★FM Transmit……0V

	1	2	3	4	5	6	7	8	9
Q602	4.7	2.8	2.2	2.1	0	0.5	0.7	1.1	8.0

MARKER Unit (Marker Switch……ON)

	E	B	C		E	B	C
Q701	1.9	2.4	8.0	Q702	0	0.3	1.6

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Q703	1.6	0	0	0	5.1	0	0	1.4	1.4	0	0.7	1.7	0	0.7

FM Unit

	LSB.USB.CW AM			FM		
	E(S)	B(G)	C(D)	E(S)	B(G)	C(D)
Q801	1.8	2.5	7.7	1.8	2.5	7.7
Q803	0	1.9	5.1	0	1.9	5.1
Q804	5.8	5.8	5.3	5.8	5.8	5.3

	LSB.USB.CW AM			FM		
	E(S)	B(G)	C(D)	E(S)	B(G)	C(D)
Q805	0	0	0	★1.3	★0.7	★7.2
Q806	0	0	0	★1.4	★2.1	★2.5
Q807	0	0	0	★0.7	★1.4	★7.0

	LSB.USB.CW AM			FM		
	E(S)	B(G)	C(D)	E(S)	B(G)	C(D)
Q809	0	0	0	★0.6	★1.3	★7.0

★FM Transmit……0V

		1	2	3	4	5	6	7	8
Q802	T・R	7.0	–	1.5	0	1.5	–	7.0	7.5
Q808	FM・R	1.8	1.8	6.8	0	5.5	1.8	1.8	
	T・R	0	0	0	0	0	0	0	

SSB IF Unit

	E(S)		B(G)		C(D)			E(S)		B(G)		C(D)			E(S)		B(G)		C(D)	
	R	T	R	T	R	T		R	T	R	T	R	T		R	T	R	T	R	T
Q901	0.7	0	0.7	0	7.3	0	Q905	0	0	0.7	0	7.2	0	Q908	0.3	0.3	1.0	1.0	5.8	5.8
Q903	1.1	0	0	0	7.8	0	Q906	0	0.6	0	0	0	7.0							
Q904	0.7	0	0.7	0	7.3	0	Q907	5.3	5.3	5.9	5.9	6.8	6.8							

		1	2	3	4	5	6	7	8
Q902	R	0	1.2	0	1.8	5.5	7.6	7.3	0
	T	0	0	0	0	0	0	0	0

TONE BURST Unit

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Q1001	R	0	0	8.0	0	8.0	8.0	0	0	0	8.0	0	8.0	7.2	8.0		
	T	8.0	8.0	0	8.0	0	0	0	0	0	8.0	0	8.0	7.2	8.0		
Q1002	R · T	7.2	8.0	0	8.0	0	0	0	0	8.0	8.0	8.0	0	0	8.0		
Q1003	R · T	0	0	8.0	0	8.0	7.3	0	8.0	8.0	0	8.0	7.2	0	8.0		
Q1004	R	8.0	0	7.2	0	7.3	0	8.0	0	0	8.0	8.0	0	0	7.2	0	8.0
	T	8.0	0	7.2	0	7.3	0	8.0	0	8.0	0	8.0	0	0	7.3	0	8.0
Q1005	R · T	0	8.0	0	0	8.0	8.0	0	0	0	0	0	0	0	8.0	0	8.0

	S	G	D
Q1006	0.9	0	8.0

BOOSTER Unit (on Transmit)

	LSB.USB.CW			AM			FM		
	E(S)	B(G)	C(D)	E(S)	B(G)	C(D)	E(S)	B(G)	C(D)
Q1201	0	0.7	12.3	0	0.6	3.6	0	0.6	11.7

	LSB.USB.CW			AM			FM		
	E(S)	B(G)	C(D)	E(S)	B(G)	C(D)	E(S)	B(G)	C(D)
Q1202	0	0.7	13.5	0	0.4	13.3	0	0.2	13.1

Receive……0V

VFO Unit

	E(S)	B(G)	C(D)		E(S)	B(G)	C(D)		E(S)	B(G)	C(D)
Q1301	2.1	2.7	4.4	Q1302	1.6	0	7.6	Q1303	1.6	2.1	6.9

MIC AMP Unit

	LSB. USB						CW						AM						FM					
	E(S)		B(G)		C(D)		E(S)		B(G)		C(D)		E(S)		B(G)		C(D)		E(S)		B(G)		C(D)	
	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T	R	T
Q1101	0	0	0	0	0	0	0	4.9	0	2.6	0	8.0	0	1.9	0	2.6	0	7.8	0	2.2	0	2.6	0	7.8
Q1102	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.6	0	2.2	0	7.2
Q1103	1.5	1.5	2.1	2.1	3.9	3.9	1.5	1.5	2.1	2.1	3.9	3.9	1.5	1.5	2.1	2.1	3.9	3.9	1.5	1.5	2.1	2.1	3.9	3.9
Q1105	0	2.2	0	0	0	7.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Q1106	0	0.7	0	0	0	7.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Q1107	3.0	3.0	3.4	3.4	6.8	6.8	3.0	4.9	3.4	3.4	6.8	8.0	2.7	3.0	3.4	3.4	6.8	6.7	2.7	2.7	3.4	3.4	6.8	6.8
Q1108	2.5	2.5	1.9	1.9	6.8	6.8	2.5	2.5	2.1	2.3	6.8	6.8	2.3	2.5	1.4	1.8	6.9	6.8	2.3	2.3	1.3	1.4	6.9	6.9

		1	2	3	4	5	6	7	8	9
Q1104	R	4.1	2.4	1.8	1.7	0	0	0	0.7	6.2
	T	4.1	2.4	1.8	1.7	0	0.5	3.3	1.2	6.9

REG Unit

	E	B	C		E	B	C		E	B	C
Q1501	14.1	14.6	22.6	Q1503	8.7	9.3	13.5	Q1505	6.1	6.7	9.3
Q1502	9.0	9.7	14.6	Q1504	8.0	13.5	8.7	Q_1	13.5	14.1	22.5

AM Mod(Q7)

	E		B		C	
	R	T	R	T	R	T
USB USB CW	0	12.3	0	12.9	0	13.5
AM	0	3.6	0	4.2	0	13.4
FM	0	11.7	0	12.3	0	13.2

PARTS LIST

MAIN CHASSIS			
PB	**PRINTED CIRCUIT BOARD**		
1471 (A～Z)	LED	BOARD	
1552 (A～Z)	SWITCH	BOARD	
Q	**TRANSISTOR**		
1		2SD114	
7		2SD313D	
D	**DIODE**		
1	Si Bridge	DS-130-YD	
6～10	Si	10D-1	
11	LED	GD-4	
12		RD-4	
13		TLR-108	
R	**RESISTOR**		
	CARBON COMPOSITION		
16	¼W		10KΩ
15	¼W		100KΩ
19	½W		10Ω
17	½W		56Ω
18	½W		100Ω
14,	½W		220Ω
13, 21	½W		470Ω
11, 12	½W		33KΩ
VR	**POTENTIOMETER**		
4	EWK-DOAS 15023	500ΩB/500ΩC	
5	VM13A-5M3121	5KA	
8	EVH-BOAS-15A53	5KA	
6	VM20A	5KB	
7	VM11A5M	10KA	
3	EVH-BOAS-15B54	50KB	
10	EVH-BOAS-15B53	5KB	
9	EVL-SOAA-00B54	50KB	
C	**CAPACITOR**		
	DIPPED MICA		
16, 17, 18	50WV		100PF
22	50WV		300PF
	CERAMIC DISC		
14, 28～32	50WV		0.001μF
33, 13	50WV		0.01μF
11～12, 15, 19～21, 23, 27	50WV		0.047μF
24～26	500WV		0.01μF
1, 2	1.4KV		0.0047μF
PT	**POWER TRANSFORMER**		
1	52-36		
CH	**CHOKE COIL**		
1	SN-8S-500		
M	**METER**		
1	SP-38A		
SP	**SPEAKER**		
1	SA-70H		
RL	**RELAY**		
1	AE-3171		
RLS	**RELAY SOCKET**		
1	AE-3860		
S	**SWITCH**		
1	ESR-E22CR15D		
2	ESR-448R15A		
3	ESR-485R15A		
4	SP-2022		
5	SLE-12301		
6, 7	SLE-12251		
8	SLE-14201		
9	SLE-14301		
J	**JACK**		
1	QMS-AB4M		
2	CS-250		
3	SG-7615		
4	SG-8050		
5	FM-144J		
6	XG-8018		
7～10	CN-7017J		
11	SO-239		
12, 14～19, 21	3305-018-011		
13, 20, 22	1150-036-009		
25	CN-1463		
P	**PLUG**		
24	SI-8501		
F	**FUSE**		
1	2A		
2	1A		
FS	**FUSE HOLDER**		
1	SN-1001 #2		
PL	**PILOT LAMP**		
1～3	14V		40mA

FIX UNIT			
PB	**PRINTED CIRCUIT BOARD**		
1453 (A～Z)	FIX OSC CIRCUIT		
1500 (A～Z)	CRYSTAL BOARD		
Q	**TRANSISTOR**		
101, 102	2SC372Y		
D	**DIODE**		
101～111	Si 1S1555		
X	**CRYSTAL**		
101～111	HC-25/U (OPTION)		
XS	**CRYSTAL SOCKET**		
101～111	S2-101P		
R	**RESISTOR**		
	CARBON FILM		
105, 108, 109	¼W		100Ω
104	¼W		220Ω
101	¼W		1.5KΩ
102, 107	¼W		5.6KΩ
106	¼W		8.2KΩ
103	¼W		22KΩ
C	**CAPACITOR**		
	DIPPED MICA		
130	50WV		15PF
131	50WV		20PF
117～127	50WV		30PF
129	50WV		100PF
128, 132	50WV		200PF
	CERAMIC DISC		
101～116	50WV		0.01μF
TC	**TRIMMER CAPACITOR**		
101～111	ECV-1ZW 20×40		20PF
L	**INDUCTOR**		

101～111	EL0610-102K	1mH
112	EL0610-251K	250μH
113	FL-3H 1R2M	1.2μH

LOCAL UNIT

PB	**PRINTED CIRCUIT BOARD**		
1454 (A～Z)	LOCAL OSC CIRCUIT		
Q	**TRANSISTOR**		
201			2SC372Y
202, 203			2SC784R
D	**DIODE**		
201～212	Si		1S1555
225	Ge		1S188FM
226	Varactor		1SV50
X	**CRYSTAL**		
201	HC-18/U		13.92222MHz
202	〃		13.97777MHz
203	〃		14.03333MHz
204	〃		14.08888MHz
205	〃		14.14444MHz
206	〃		14.20000MHz
207	〃		14.25555MHz
208	〃		14.31111MHz
210 (Repeater)	HC-25/U		★(14.13333MHz)
211 (Repeater)	〃		★(14.32222MHz)
★US Model★★EuropeanModel★★(14.02222MHz)			
XS	**CRYSTAL SOCKET**		
201	S-14		
R	**RESISTOR**		
	CARBON FILM		
221, 225	¼W		100Ω
217, 224	¼W		220Ω
220	¼W		560Ω
213, 216	¼W		1KΩ
222	¼W		2.2KΩ
201～212	¼W		3.3KΩ
215, 218	¼W		4.7KΩ
214, 223	¼W		10KΩ
219	¼W		22KΩ
C	**CAPACITOR**		
	DIPPED MICA		
242	50WV		1PF
239	50WV		5PF
240, 241	50WV		8PF
213～224, 236, 238	50WV		30PF
237	50WV		39PF
234	50WV		150PF
235	50WV		200PF
	CERAMIC DISC		
201～212, 225～230, 232, 233	50W		0.01μF
231, 243	50WV		0.047μF
TC	**TRIMMER CAPACITOR**		
201～212	ECV-1ZW 20×40		20PF
L	**INDUCTOR**		
203	＃221026		3.2μH
202, 204, 201	EL0610-220K		22μH
T	**TRANSFORMER**		
201	R-12	＃4797	
202, 203	R-12	＃4102	

PLL UNIT

PB	**PRINTED CIRCUIT BOARD**		
1455 (A～Z)	PLL CIRCUIT		
Q	**IC FET & TRANSISTOR**		
302		IC	μA703HC
308			TP4011AN
301		FET	2SK19Y
305, 306		〃	2SK19GR
303, 304, 309			2SC372Y
307			2SC784R
310			MPSA13
D	**DIODE**		
301		PUT	N13T1
309, 310		Si	1S1555
311		Ge	1S188FM
303, 304			1S1007
302		Zener	WZ061
305, 306		Varactor	1SV50
307, 308		Varactor	1S2209
R	**RESISTOR**		
	CARBON FILM		
305		¼W	22Ω
305, 337		¼W	56Ω
313,315,319,320,329,333, 334		¼W	100Ω
303		¼W	150Ω
304, 308, 314, 326, 328		¼W	220Ω
325		¼W	270Ω
307		¼W	330Ω
310, 316,		¼W	1KΩ
302, 345, 346		¼W	2.2KΩ
317, 321, 330		¼W	4.7KΩ
311, 312		¼W	10KΩ
306, 318, 322, 331		¼W	22KΩ
301		¼W	47KΩ
309,323,324,327,340,344		¼W	100KΩ
339		¼W	560KΩ
332, 336, 338, 341, 343		¼W	1MΩ
	CARBON COMPOSITION		
342		¼W	2.2MΩ
RS	**THERMISTOR**		
301	SDT-250		
VR	**POTENTIOMETER**		
301	KVL-SOAA-00B13		1KB
C	**CAPACITOR**		
	DIPPED MICA		
322, 327		50WV	5PF
339, 340		50WV	6PF
318, 319		50WV	10PF
308, 309		50WV	20PF
325, 326		50WV	30PF
323, 324		50WV	47PF
305, 312, 313		50WV	170PF
307		50WV	200PF
	CERAMIC DISC		
304,306,310,311,314～317		50WV	0.01μF
320,321,328,329,331～336,344, 345			
	MYLAR		
341		50WV	0.01μF
343		50WV	0.1μF
	TANTALUM		
301, 342		35WV	0.1μF
	ELECTROLYTIC		
303, 330		16WV	10μF
302		16WV	100μF

TC	TRIMMER CAPACITOR		
301		ECV-1ZW 10×40	10PF
302, 303		ECV-1ZW 10×51	10PF
L	INDUCTOR		
302		FL-3H-3R3M	3.3μH
304, 306		RFC	10μH
303, 305		RFC	250μH
301		OSC #221013	
T	TRANSFORMER		
309		#221014	
302, 303		R-12 4102	

RX RF UNIT

PB	PRINTED CIRCUIT BOARD		
1456 (A～Z)	RX RF CIRCUIT		
Q	FET & TRANSISTOR		
401	FET	3SK51	
402, 405	〃	2SK19GR	
403, 404		2SC372Y	
D	DIODE		
407	G.B	1S1007	
401～404, 408	Varactor	1S2209	
XF	CRYSTAL FILTER		
401	FMT-30		
R	RESISTOR		
	CARBON FILM		
408, 414, 418, 422, 429	¼W		100Ω
428	¼W		220Ω
417, 421	¼W		470Ω
413	¼W		1KΩ
409, 426	¼W		1.5KΩ
423	¼W		2.2KΩ
425	¼W		3.9KΩ
415, 419	¼W		4.7KΩ
416	¼W		15KΩ
405, 420	¼W		22KΩ
403, 404, 406, 407, 427	¼W		100KΩ
	CARBON COMPOSITION		
401, 402, 410, 411, 430	¼W		1MΩ
C	CAPACITOR		
	DIPPED MICA		
422	50WV		1PF
401, 402, 408, 409	50WV		5PF
429	50WV		6PF
403	50WV		30PF
426	50WV		47PF
411	50WV		100PF
421	50WV		180PF
	CERAMIC DISC		

404, 414, 417		50WV	0.001μF
405～407, 412, 413, 418～420, 424, 425, 427, 428,		50WV	0.01μF
415, 416		50WV	0.047μF
	ELECTROLYTIC		
423		16WV	1μF
TC	TRIMMER CAPACITOR		
401～405		ECV-1ZW 10×40	10PF
L	INDUCTOR		
401		#221003	
402		#221004	
403		#221005	
404		#221006	
406		EL0610-220K	22μH
407		EL0610-251K	250μH
405		EL0610-102K	1mH
T	TRANSFORMER		
401～404		R-12 4074	
405		R-12 4102	

EXCITER UNIT

PB	PRINTED CIRCUIT BOARD		
1466 (A～Z)	EXCITER CIRCUIT		
Q	FET & TRANSISTOR		
501, 502	FET	2SK19GR	
507, 509		2SC372Y	
508		2SC373	
505		2SC730	
506		2SC735Y	
504		2SC741	
503		2SC784R	
D	DIODE		
505～507	Si	1S1555	
501～504, 508	Varactor	1S2209	
R	RESISTOR		
	CARBON FILM		
516	¼W		10Ω
520, 532	¼W		56Ω
509, 513, 531	¼W		100Ω
512	¼W		220Ω
515	¼W		330Ω
526	¼W		470Ω
522	¼W		820Ω
535	¼W		1KΩ
519, 523, 527, 530	¼W		2.2KΩ
514	¼W		2.7KΩ
508, 510	¼W		3.3KΩ
533	¼W		4.7KΩ
524	¼W		5.6KΩ
529	¼W		10KΩ
511, 528	¼W		15KΩ
525	¼W		27KΩ
501, 502	¼W		47KΩ
	CARBON COMPOSITION		
503～507, 536	¼W		1MΩ
534	½W		10Ω
VR	POTENTIOMETER		
501		EVL-SOAA-00B13	1KB
502		EVL-SOAA-00B54	50KB
C	CAPACITOR		
	DIPPED MICA		

511, 512, 514, 519	50WV		5PF
507, 508, 516, 523, 537, 538	50WV		10PF
510, 506, 535	50WV		20PF
528	50WV		27PF
	CERAMIC DISC		
513, 534	50WV		1PF
502, 503	50WV		0.001μF
501, 504, 505, 509, 515,	50WV		0.01μF
517, 518, 520~522, 524, 526, 536			
	MYLAR		
532	50WV		0.047μF
	ELECTROLYTIC		
525, 527, 529, 531	16WV		10μF
530	16WV		22μF
533			33μF
TC	**TRIMMER CAPACITOR**		
501~505	ECV-1ZW 10×40		10PF
506	ECV-1ZW 20×51		20PF
507, 508	ECV-1ZW 20×32		20PF
L	**INDUCTOR**		
503		#221008	
504, 502		#221009	
507, 510		#221018	
508, 509		#221017	
506		#221036	
T	**TRANSFORMER**		
501		R-12 4073	
502		#221035	

AF UNIT

PB	**PRINTED CIRCUIT BOARD**		
1499 (A~Z) AF CIRCUIT			
Q	**IC FET & TRANSISTOR**		
602	IC	LD-3001	
603	FET	2SK19Y	
608, 609	〃	2SK19GR	
612		2SA695	
614		2SB529	
601, 605, 606, 607, 610		2SC372Y	
611		2SC711	
604		2SC735Y	
613		2SD359	
D	**DIODE**		
601~604	Si	1S1555	
605	Varistor	MV-5W	
R	**RESISTOR**		
	CARBON FILM		
642	¼W		10Ω
641	¼W		22Ω
628	¼W		100Ω
647	¼W		180Ω
622, 629, 644	¼W		220Ω
626	¼W		470Ω
611	¼W		680Ω
601, 616, 638, 639	¼W		1KΩ
604, 635, 636	¼W		1.5KΩ
623, 624, 625, 631	¼W		2.2KΩ
605, 614, 643	¼W		3.3KΩ
606, 612, 618, 619, 620, 627	¼W		4.7KΩ
617	¼W		5.6KΩ
630, 632	¼W		6.8KΩ
602	¼W		15KΩ
615	¼W		22KΩ
621	¼W		33KΩ
640	¼W		39KΩ
634, 613	¼W		47KΩ
603, 633, 637	¼W		100KΩ
607	¼W		1MΩ
	CARBON COMPOSITION		
608, 609	½W		3.3MΩ
610	½W		5.6MΩ
	WIRE WOUND		
645, 646	1 W		0.22Ω
RS	**THERMISTOR**		
601		SDT-250	
VR	**POTENTIOMETER**		
605		EVL-SOAA-00B53	5KB
602, 603		EVL-VOAA-00B14	10KB
604		EVL-SOAA-00B14	10KB
606		EVL-SOAA-00B54	50KB
601		EVL-VOA -00B26	2MB
C	**CAPACITOR**		
	DIPPED MICA		
634, 637	50WV		200PF
635	50WV		280PF
628	50WV		330PF
	CERAMIC DISC		
636	50WV		0.047μF
	MYLAR		
610, 615	50WV		0.001μF
629, 630	50WV		0.002μF
605, 608, 611, 619, 620	50WV		0.01μF
616~618	50WV		0.02μF
614, 631	50WV		0.047μF
609	50WV		0.1μF
	ELECTROLYTIC		
601, 612, 623, 626	16WV		1μF
621, 622	16WV		4.7μF
602~604, 606, 607, 613	16WV		10μF
624	10WV		100μF
625, 633	16WV		100μF
627, 632	16WV		220μF

MARKER UNIT

PB	**PRINTED CIRCUIT BOARD**		
1459 (A~Z)	MARKER CIRCUIT		
Q	**IC & TRANSISTOR**		
703	IC	SN7490N	
701, 702		2SC372Y	
D	**DIODE**		
701	Zener	WZ050	
X	**CRYSTAL**		
701		HC-6/U 1MHz	
R	**RESISTOR**		
	CARBON FILM		
713	¼W		68Ω
701~708	¼W		100Ω
711	¼W		1KΩ
710	¼		10KΩ
709	¼		22KΩ
712	¼W		470KΩ
VR	**POTENTIOMETER**		
701~708		EVL-SOAA-00B13	10KB
C	**CAPACITOR**		
	DIPPED MICA		

708	50WV	10PF
701	50WV	40PF
702, 703	50WV	1500PF
	CERAMIC DISC	
704, 705	50WV	0.01μF
	ELECTROLYTIC	
707	16WV	10μF
TC	**TRIMMER CAPACITOR**	
701	ECV-1ZW 50×40	50PF
L	**INDUCTOR**	
701	EL0610-251K	250μH
	FM IF UNIT	
PB	**PRINTED CIRCUIT BOARD**	
1463 (A～Z)	FM IF CIRCUIT	
Q	**IC FET & TRANSISTOR**	
802	IC μA703HC	
808	〃 TA7061AP	
803	FET 2SK19GR	
801, 804～807, 809～811	2SC372Y	
D	**DIODE**	
801, 802, 807～810	Si 1S1555	
803～806	Ge 1S188FM	
X	**CRYSTAL**	
801	HC-18/U	10.245MHz
CF	**CERAMIC FILTER**	
802	CFM 455E(F)	
803	10.7MF-BR	
R	**RESISTOR**	
	CARBON	
804, 805, 826	¼W	100Ω
825, 827, 837	¼W	220Ω
824	¼W	470Ω
803, 833, 842	¼W	560Ω
808, 816, 819, 828, 829,	¼W	1KΩ
836, 846, 847		
809	¼W	1.5KΩ
839, 840	¼W	2.2KΩ
811, 813, 814, 821, 843,	¼W	3.3KΩ
849～856		
801, 830, 831, 835, 844	¼W	4.7KΩ
822, 838	¼W	5.6KΩ
802	¼W	10KΩ
815, 845	¼W	15KΩ
823, 834, 841	¼W	22KΩ
820, 832	¼W	47KΩ
848	¼W	56KΩ
806, 807, 810	¼W	100KΩ
RS	**THERMISTOR**	
801	SDT-250	
C	**CAPACITOR**	
	DIPPED	
812	50WV	15PF
806, 807	50WV	30PF
833	50WV	40PF
809, 835, 843	50WV	100PF
801	50WV	200PF
834	50WV	300PF
	CERAMIC DISC	
844	50WV	0.001μF
802～805, 808, 813, 815,	50WV	0.01μF
816, 819, 836, 845～848		
	MYLAR	

810, 830, 831, 837, 838, 841	50WV	0.01μF
828, 829	50WV	0.02μF
811, 817, 818, 820～825	50WV	0.047μF
	STYROL	
826	50WV	330PF
827	50WV	1000PF
	TANTALUM	
839, 840	25WV	1μF
	ELECTROLYTIC	
849, 850	16WV	1μF
832, 842	16WV	4.7μF
L	**INDUCTOR**	
804	EL0610-251K	250μH
801～803, 806, 807	EL0610-102K	1mH
805	EL0610-202K	2mH
T	**TRANSFORMER**	
801, 802	R-12 4074	
803	4861D	
804	4861E	
805	3004	
	SSB IF UNIT	
PB	**PRINTED CIRCVIT BOARD**	
1462 (A～Z)	SSB IF CIRCUIT	
Q	**IC FET & TRANSISTOR**	
902	IC TA7045M	
903, 906	FET 2SK19GR	
904, 905	2SC373	
901	2SC784R	
907, 908	2SC1000GR	
D	**DIODE**	
901～903, 912, 913	Si 1S1555	
910	Ge 1S188FM	
904～907, 909	G.B 1S1007	
911	Zener WZ110	
XF	**CRYSTAL FILTER**	
901	XF-10A	
R	**RESISTOR**	
	CARBON FILM	
909, 912, 914, 915, 919,	¼W	100Ω
932, 933, 939, 940		
926, 927	¼W	270Ω
917, 944	¼W	470Ω
901, 902, 927	¼W	560Ω
934, 938, 946, 947, 905	¼W	1KΩ
911, 913, 912		
929	¼W	1.8KΩ
908, 910, 918, 930, 945	¼W	2.2KΩ
925	¼W	2.7KΩ
903, 904, 942	¼W	3.3KΩ
935, 936	¼W	4.7KΩ
906	¼W	6.8KΩ
941	¼W	10KΩ
920, 924, 943	¼W	22KΩ
907	¼W	27KΩ
937	¼W	56KΩ
916, 931	¼W	100KΩ
923	¼W	470KΩ
RS	**THERMISTOR**	
901	SDT-250	
VR	**POTENTIOMETER**	

901	EVL-SOAA-00B52	500B
903	EVL-SOAA-00B13	1KB
902	EVL-SOAA-00B53	5KB
C CAPACITOR		
DIPPED MICA		
915	50WV	10PF
912	50WV	20PF
916	50WV	100PF
CERAMIC DISÇ		
901, 902, 909~911, 906	50WV	0.01μF
917, 918, 920, 923, 929, 933		
903~905, 907, 908, 913, 914	50WV	0.047μF
MYLAR		
932	50WV	0.0047μF
936	50WV	0.02μF
931, 937	50WV	0.047μF
ELECTROLYTIC		
930, 939	16WV	1μF
938	16WV	10μF
934, 935, 922	16WV	47μF
TANTALUM		
921	35WV	0.1μF
TC TRIMMER CAPACITOR		
901	ECV-1ZW 50×40	50PF
L INDUCTOR		
901	EL0610-251K	250μH
T TRANSFORMER		
901, 902	R-12	4074
903	R-12	4073
TONE BURST UNIT		
PB PRINTED CIRCUIT BOARD		
1461 (A~Z)	TONE BURST CIRCUIT	
Q IC & FET		
1001~1003	IC	TP4011AN
1005		TP4027AN
1004		TP4049AN
1006	FET	2SK19GR
D DIODE		
1001~1003	Ge	1S188FM
R RESISTOR		
CARBON FILM		
1014	¼W	220Ω
1013	¼W	10KΩ
1015	¼W	39KΩ
1011	¼W	180KΩ
1012	¼W	820KΩ
1001~1005, 1008~1010	¼W	1MΩ
CARBON COMPOSITION		
1006, 1007	¼W	2.2MΩ
VR POTENTIOMETER		
1002, 1003	EVL-SOAA-00B15	100KB
1001	EVL-SOAA-00B26	2MB
C CAPACITOR		
DIPPED MICA		
1009	50WV	1000PF
MYLAR		
1001, 1002, 1004, 1005,	50WV	0.01μF
1007, 1010		
TANTALUM		
1003	35WV	0.33μF
1006, 1008	35WV	0.47μF
ELECTROLYTIC		

1012	16WV	1μF
1013	16WV	4.7μF
1011	16WV	100μF
RL RELAY		
1001	LZ-2G	
MIC AMP UNIT		
PB PRINTED CIRCUIT BOARD		
1460 (A~Z)	MIC AMP CIRCUIT	
Q IC FET & TRANSISTOR		
1104	IC	LD-3001
1105, 1106	FET	2SK19GR
1101~1103, 1107, 1108		2SC372Y
D DIODE		
1101, 1105, 1106, 1112~1117	Si	1S1555
1103, 1104	Ge	1S188FM
1108~1111	G.B	1S1007
1102	Varactor	1S2687
X CRYSTAL		
1101	HC-18/U	10.7000MHz
1102	HC-18/U	10.7015MHz
1103	HC-18/U	10.6985MHz
1104	HC-18/U	10.6993MHz
R RESISTOR		
CARBON FILM		
1101, 1105, 1121, 1124, 1129	¼W	100Ω
1133, 1141, 1148, 1149, 1150, 1152, 1153		
1112, 1135, 1136, 1138, 1142, 1137	¼W	220Ω
1114, 1102	¼W	470Ω
1106, 1113, 1125, 1127, 1145	¼W	1KΩ
1117, 1122, 1123, 1147, 1151	¼W	2.2KΩ
1104, 1128	¼W	3.3KΩ
1143	¼W	4.7KΩ
1116, 1140, 1144	¼W	5.6KΩ
1139	¼W	6.8KΩ
1108, 1118, 1120	¼W	10KΩ
1115,	¼W	12KΩ
1107, 1111	¼W	22KΩ
1103	¼W	27KΩ
1110, 1119	¼W	33KΩ
1109, 1126, 1130	¼W	100KΩ
VR POTENTIOMETER		
1102	EVL-SOAA-00B32	300B
1103	EVL-SOAA-00B13	1KB
1101	EVL-SOAA-00B23	2KB
C CAPACITOR		
DIPPED MICA		
1159	50WV	3PF
1158	50WV	10PF
1106		15PF
1146	50WV	20PF
1140, 1154~1156	50WV	30PF
	50WV	
1107, 1108, 1147	50WV	100PF
1148	50WV	150PF
1143	50WV	200PF
1110	50WV	250PF
1126~1128	50WV	270PF
CERAMIC DISC		
1136	50WV	0.001μF
1101, 1102, 1104,	50WV	0.01μF
1133~1135, 1138, 1139, 1141,		
1142, 1144, 1145, 1149~1153		
1109, 1132	50WV	0.047μF

	MYLAR		
1111, 1115, 1116, 1122	50WV		0.047μF
	ELECTROLYTIC		
1114, 1117, 1129, 1131	16WV		1μF
1118, 1119, 1121, 1123~1125, 1130	16WV		10μF
1120	16WV		22μF
1112, 1113	16WV		47μF
TC	**TRIMMER CAPACITOR**		
1102~1104	ECV-1ZW 20×40		20PF
1101	ECV-1ZW 50×40		50PF
L	**INDUCTOR**		
1101	#221024		
1107	EL0610-100K		10μH
1106,1108, 1109,1110,1111,1112	EL0610-102K		1mH
T	**TRANSFORMER**		
1101	R-12	#4074	
1102	R-12	#4073	

BOOSTER UNIT

PB	**PRINTED CIRCUIT BOARD**		
1470 (A~Z)	BOOSTER CIRCUIT		
Q	**TRANSISTOR**		
1201	BAM-20		
1202	BAM-40		
D	**DIODE**		
1201, 1202	Si	10D-1	
1205~1208		1S1555	
1203, 1204	Ge	1S188FM	
1209	Zener	1N4740	
R	**RESISTOR**		
	CARBON COMPOSITION		
1204	½W		10Ω
1201	½W		22Ω
1203	½W		56Ω
1205	½W		100Ω
1202	½W		330Ω
1206	½W		100KΩ
1207	½W		1MΩ
VR	**POTENTIOMETER**		
1201	EVL-SOAA-00B14		10KB
1202	EVL-SOAA-00B54		50KB
C	**CAPACITOR**		
	DIPPED MICA		
1216	50WV		2PF
1217, 1223	50WV		5PF
1201, 1205	50WV		10PF
1213~1215	50WV		20PF
1212	50WV		39PF
1211	50WV		68PF
1206	50WV		100PF
	CERAMIC DISC		
1202, 1204, 1208, 1210	50WV		0.001μF
1218~1220	50WV		0.01μF
	MYLAR		
1221	50WV		0.001μF
	TANTALUM		
1222	35WV		0.1μF
	ELECTROLYTIC		
1203, 1207, 1209	16WV		10μF
TC	**TRIMMER CAPACITOR**		
1201	ECV-1ZW 50×40		50PF
1202~1204	TSN-P-100DS		20PF
L	**INDUCTOR**		
1201, 1207	#221019		
1204~1206, 1208~1209	#221020		
1211, 1212	#221021		
1202, 1203	#221022		
1210	EL0610-220K		22μH
RL	**RELAY**		
1201	LZ-2G	DC12	450Ω

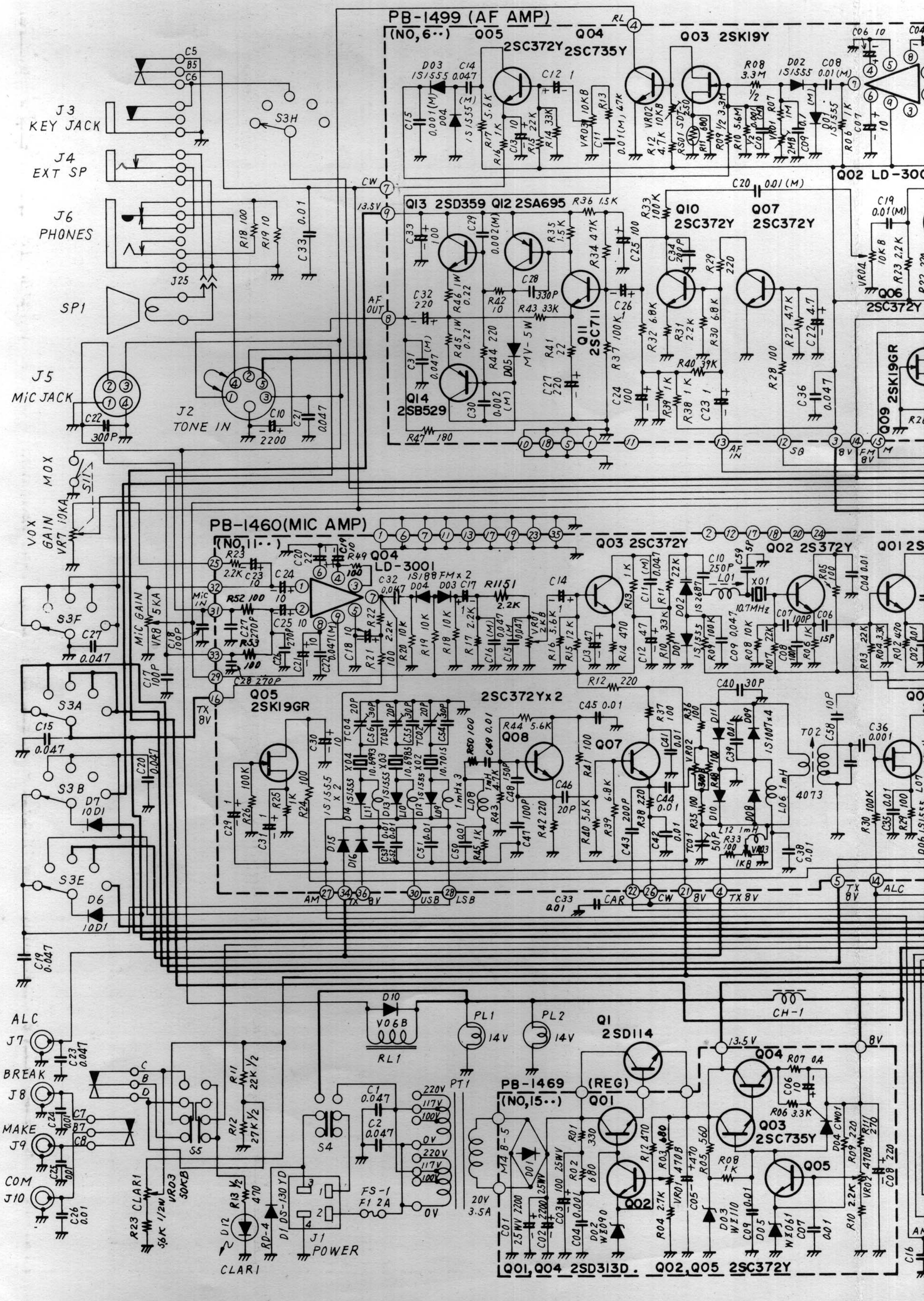
VFO UNIT

PB	**PRINTED CIRCUIT BOARD**		
1465 (A~Z)	VFO CIRCUIT		
Q	**FET & TRANSISTOR**		
1302	FET	2SK19GR	
1301, 1303		2SC372Y	
R	**RESISTOR**		
	CARBON FILM		
1307, 1311, 1312	¼W		100Ω
1310	¼W		150Ω
1306	¼W		470Ω
1304	¼W		2.2KΩ
1301	¼W		3.3KΩ
1308	¼W		6.8KΩ
1309	¼W		15KΩ
1302	¼W		18KΩ
1303	¼W		33KΩ
1305	¼W		100KΩ
C	**CAPACITOR**		
	DIPPED MICA		
1318	50WV		2PF
1302	50WV		20PF
1313	50WV		39PF
1306	50WV		51PF
1311	50WV		68PF
1307	50WV		270PF
1310	50WV		470PF
	CERAMIC DISC		
1308, 1309, 1312, 1314~1316	50WV		0.01μF
	CERAMIC TC		
1303	500WV		5PF UJ
1304	500WV		10PF UJ
1301	500WV		20PF UJ
1305	500WV		82PF NPO
	CERAMIC FEED THRU		
1317	ECK-L1H102PE		1000PF
VC	**VARIABLE CAPACITOR**		
1301	C512C		
TC	**TRIMMER CAPACITOR**		
1301	MC10P×2		
1302	KC-30P		
L	**INDUCTOR**		
1301	#221025		
1302	EL0610-680K		68μH
1303	EL0610-251K		250μH

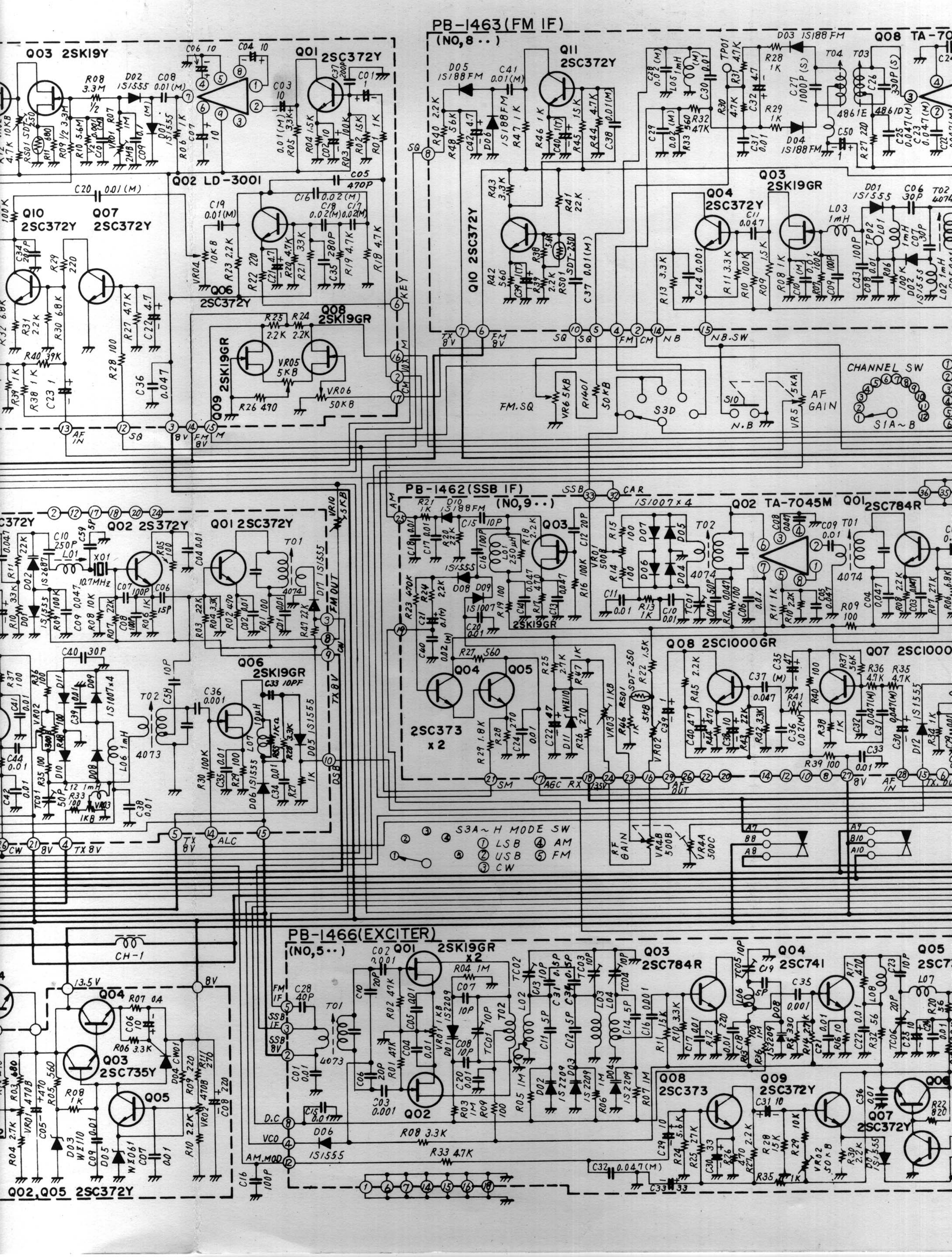
REG UNIT

PB	**PRINTED CIRCUIT BOARD**		
1469 (A~Z)	REG CIRCUIT BOARD		
Q	**TRANSISTOR**		
1502, 1505		2SC372Y	
1503		2SC735Y	
1501, 1504		2SD313D	
D	**DIODE**		
1501	Si Bridge	M4B-5	
1505	Zener	WZ-061	
1502		WZ-090	
1503		WZ-110	
1504	Thyristor	CW-01B	
R	**RESISTOR**		
	CARBON FILM		
1509		¼W	220Ω
1511		¼W	270Ω
1501		¼W	330Ω
1512		¼W	470Ω
1505		¼W	560Ω
1502, 1503		¼W	680Ω
1508		¼W	1KΩ
1504		¼W	2.7KΩ
1506, 1510		¼W	3.3KΩ
	WIRE WOUND		
1507		1 W	0.4Ω

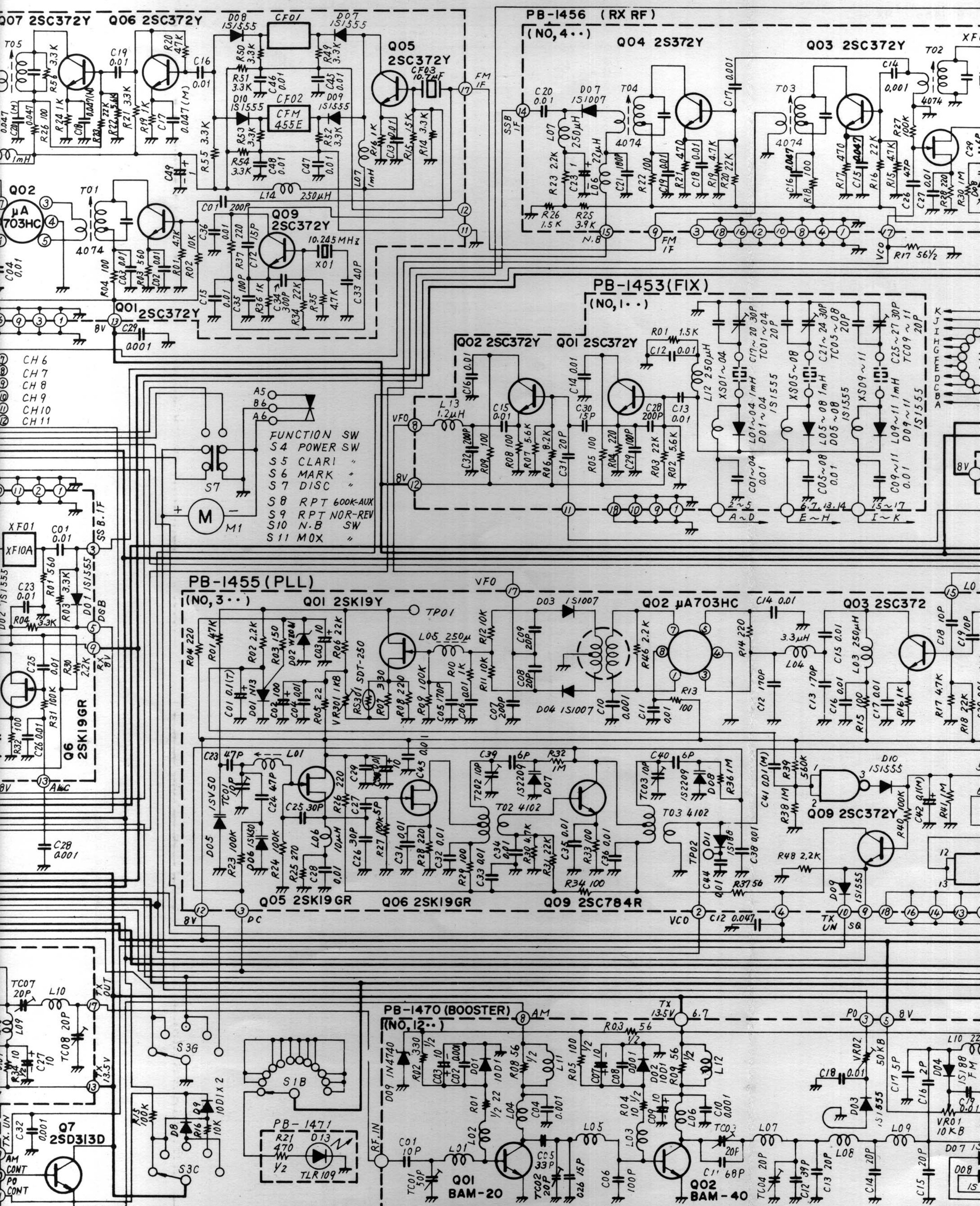
VR	**POTENTIOMETER**		
1501, 1502		SR-19R	470ΩB
C	**CAPACITOR**		
	CERAMIC DISC		
1504		50WV	0.001μF
1507, 1509		50WV	0.01μF
	ELECTROLYTIC		
1506		16WV	10μF
1503		16WV	100μF
1508		16WV	220μF
1505		16WV	470μF
1501, 1502		25WV	2200μF

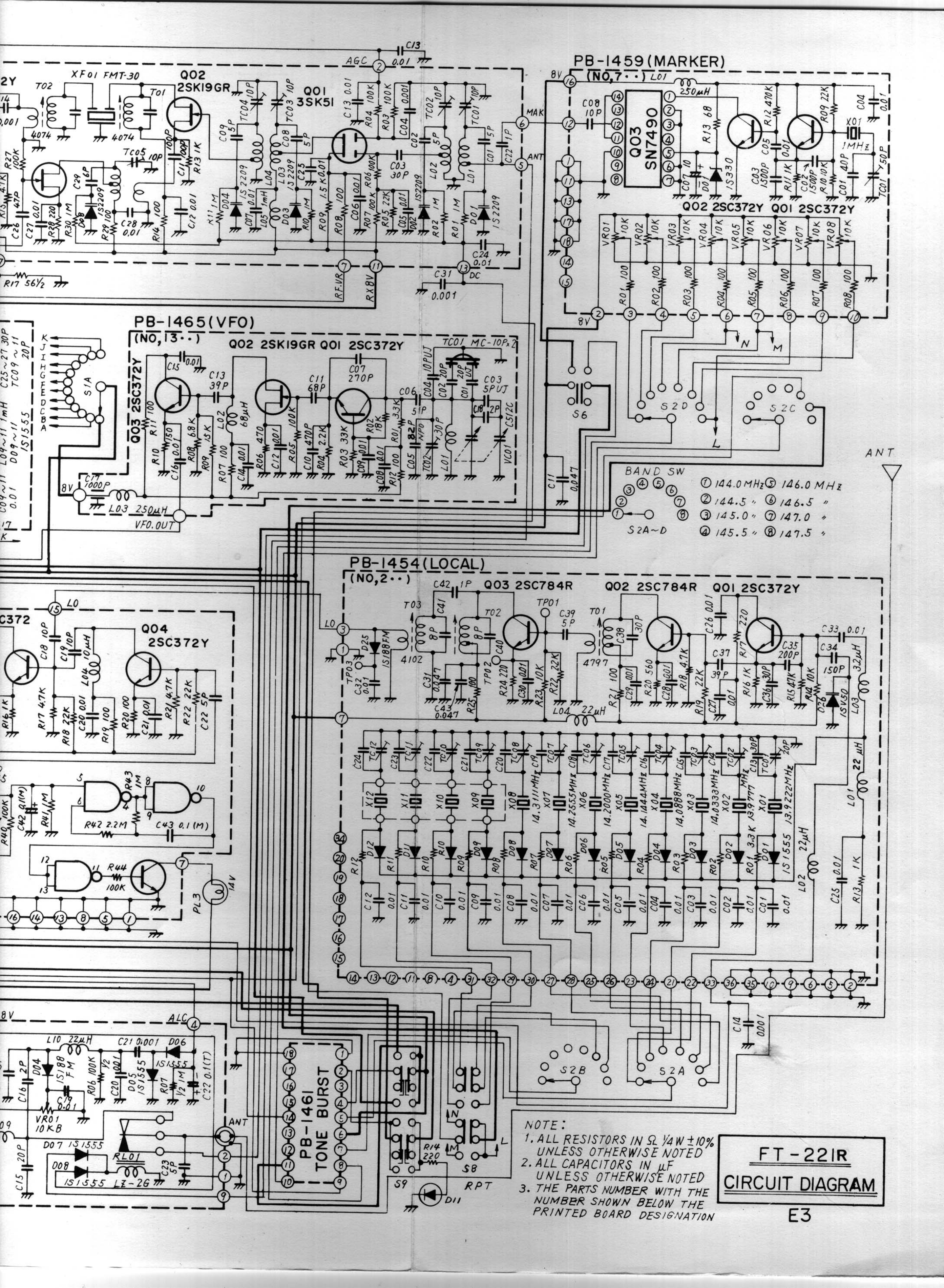


PB-1499 (AF AMP)
(NO,6··)
Q05 2SC372Y
Q04 2SC735Y
Q03 2SK19Y
Q02 LD-3001
Q13 2SD359
Q12 2SA695
Q11 2SC711
Q10 2SC372Y
Q07 2SC372Y
Q06 2SC372Y
Q09 2SK19GR
Q14 2SB529
J3 KEY JACK
J4 EXT SP
J6 PHONES
SP1
J5 MIC JACK
J2 TONE IN
S3H
MOX
VOX GAIN VR7 10KA
PB-1460(MIC AMP)
(NO,11··)
Q04 LD-3001
Q03 2SC372Y
Q02 2SC372Y
Q05 2SK19GR
2SC372Yx2
Q08
Q07
S3F
S3A
S3B
S3E
MIC GAIN VR8 5KA
10.7MHz
ALC J7
BREAK J8
MAKE J9
COM J10
R23 CLAR1
VR03 50KB
CLAR1
S5
S4
J1 POWER
FS-1 F1 2A
PT1
RL1
PL1 14V
PL2 14V
CH-1
Q1 2SD114
PB-1469 (REG)
(NO,15··)
Q01, Q04 2SD313D.
Q02, Q05 2SC372Y
Q03 2SC735Y
20V 3.5A
13.5V
8V



PB-1463(FM IF)
(NO,8··)
PB-1462(SSB IF)
(NO,9··)
PB-1466(EXCITER)
(NO,5··)
Q02 LD-3001
Q02 TA-7045M
CHANNEL SW
S1A~B
AF GAIN
FM.SQ
N.B
S3D
S3A~H MODE SW
① LSB ④ AM
② USB ⑤ FM
③ CW
RF GAIN
CH-1
Q02,Q05 2SC372Y


PB-1456 (RX RF)
(NO, 4 • •)
Q04 2S372Y
Q03 2SC372Y
Q07 2SC372Y
Q06 2SC372Y
Q05 2SC372Y
Q09 2SC372Y
Q01 2SC372Y
Q02 μA 703HC
CFM 455E
10.245 MHz
FM IF
SSB IF
PB-1453 (FIX)
(NO, 1 • •)
Q02 2SC372Y
Q01 2SC372Y
CH6
CH7
CH8
CH9
CH10
CH11
FUNCTION SW
S4 POWER SW
S5 CLARI
S6 MARK
S7 DISC
S8 RPT 600K-AUX
S9 RPT NOR-REV
S10 N.B SW
S11 MOX
PB-1455 (PLL)
(NO, 3 • •)
Q01 2SK19Y
Q02 μA703HC
Q03 2SC372
Q05 2SK19GR
Q06 2SK19GR
Q09 2SC784R
Q09 2SC372Y
Q6 2SK19GR
PB-1470 (BOOSTER)
(NO, 12 • •)
Q01 BAM-20
Q02 BAM-40
PB-1471
TLR109
Q7 2SD313D
AM CONT
PO CONT
S1B
S3G
S3C



NOTE:
1. ALL RESISTORS IN Ω 1/4W ±10% UNLESS OTHERWISE NOTED
2. ALL CAPACITORS IN μF UNLESS OTHERWISE NOTED
3. THE PARTS NUMBER WITH THE NUMBER SHOWN BELOW THE PRINTED BOARD DESIGNATION

FT-221R
CIRCUIT DIAGRAM

E3

YAESU