

Instruction Manual

FT-225RD

FT-225R

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YAESU MUSEN CO, LTD
TOKYO JAPAN

ALL-MODE VHF MEMORY TRANSCEIVER

FT-225RD FT-225R



The FT-225RD two meter transceiver is a precision-built communications module bringing state-of-the-art features together in a compact, rugged package. Capable of operation over the entire 144-148 MHz range, the FT-225RD provides the flexibility of SSB, CW, AM, and FM operation, and Yaesu's exciting memory feature, which allows storage and recall of any frequency within the 1 MHz band being used, is available as an option. Advanced PLL (Phase Locked Loop) circuitry offers unsurpassed stability and a clean, spurious-free output signal. All circuits are fully solid state, and computer type plug-in modules are used for increased reliability and ease of maintenance.

The FT-225RD provides output power in excess of 25 watts on FM, SSB, and CW, and 8 watts on AM. Deluxe features which are built into every FT-225RD are digital plus analog readout, VOX, semi-break-in CW with sidetone, noise blanker, discriminator center meter, and offset tuning (clarifier) for both receive and transceive frequencies. For tone burst repeater accessing, a programmable tone burst generator is included. The FT-225R, with analog display only, contains a crystal calibrator for precise frequency determination.

The VFO coverage of the two-meter band is in 1 MHz segments, to avoid frequent changes of the bandswitch when crossing the 500 kHz point. In addition to VFO or optional memory operation, 44 crystal-controlled channels (11 channels x 4 bands) are possible. Repeater shift, which is normally set to 600 kHz, may be set to an alternative split of up to 1 MHz by the addition of an optional crystal or by use of the memory system.

The transceiver is entirely self-contained, requiring only an antenna and a power source for operation. The FT-225RD is normally supplied with 117 VAC and 13.6 VDC capability, but the power transformer may be rewired for operation from 100/110/117/200/220/234 VAC power. Two power cords are supplied with the transceiver. Selection of AC or DC operation is made by insertion of the proper line cord into the rear panel receptacle.

The transceiver weighs approximately 9 kg, and is 280 mm wide, 125 mm high, and 315 mm deep. Construction using heavy-gauge steel provides an extremely rugged package which is virtually immune to the effects of vibration and shock which are encountered in mobile service.

SPECIFICATIONS

GENERAL

Frequency Range:

144 — 145 MHz
145 — 146 MHz
146 — 147 MHz
147 — 148 MHz

Frequency Readout:

Digital readout to 0.1 kHz, analog display resolution better than 1 kHz.

Modes of Operation:

LSB, USB, CW, AM, FM.

Frequency Stability:

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

Intermediate Frequencies:

First IF = 10.7 MHz
Second IF = 455 kHz

Antenna Impedance:

50 ohms unbalanced.

Repeater Split:

600 kHz installed, any split up to 1 MHz possible with optional crystal.

Power Requirements:

AC 100/110/117/200/220/234 Volts,
50/60 Hz
DC 11.5 — 16.0 Volts, negative ground

Power Consumption:

AC Receive 30 VA
Transmit 160 VA at full output power
DC Receive 1.2 A
Transmit 6.5 A

Size:

280 (W) x 125 (H) x 315 (D) mm

Weight:

Approx. 9.0 kg

RECEIVER

Sensitivity:

SSB/CW 0.3 μ V for 10 dB S/N
FM 0.35 μ V for 20 dB QS
AM 1.0 μ V for 10 dB S/N
(400 Hz 30 % modulation)

Selectivity:

SSB/CW/AM 2.3 kHz at 6 dB down
4.1 kHz at 60 dB down
FM 12 kHz at 6 dB down
28 kHz at 60 dB down

Image Response:

Better than -60 dB

Spurious Response:

Better than 1 μ V at antenna input

Audio Output Impedance:

4 ohms nominal

Audio Output:

2 watts @ 10% THD

TRANSMITTER

Audio Response:

350 ~ 2600 Hz \pm 3 dB

Carrier Suppression:

Better than -40 dB

Unwanted Sideband Suppression:

Better than -40 dB

Spurious Radiation:

Better than -60 dB

FM Deviation:

Factory set at \pm 5 kHz, maximum \pm 12 kHz

Power Output:

SSB 24 watts PEP
FM/CW 25 watts DC
AM 8 watts DC

SEMICONDUCTOR COMPLEMENT

Integrated Circuits (IC):

μ PC14305	1
μ PC14308S	2
μ PC78L05	1
μ PC1037H	1
TA7045M	1
TA7061AP	2
μ A703HC	1
SN76514	1
SN75450B	1
SN75453	3
MC14011B	4
MC4044P	1
(μ PC1008C)	
MSM561	1
MSM5564	1
MSM5576	1
F4011	1
TC5032	1

Field Effect Transistors (FET):

2SK19BL	1
2SK19GR	11
2SK19Y	1
3SK40M	2
3SK51	2

Transistors:

2SA496	1
2SA564A	1
2SA695	1
2SB529	1
2SC372Y	34
2SC373	9
2SC496	7
2SC710	2
2SC711	1
2SC730	1
2SC735Y	2
2SC784R	10
2SC1000BL	2
2SC1000GR	4
2SC2053	2
2SD313D	2
2SD359	1
2N5591	1
MRF212	1
MJ802	1

Germanium Diodes:

1S188FM	9
1S1007(GB)	10

Silicon Diodes:

1S1555	65
1S1941	1
10D1	14
MC301	5
U05B	1

Varactor Diodes:

1S2208	2
1S2209	14
1SV50	1
FC63	1

Zener Diodes:

1N4732	1
WZ090	1
WZ110	1

Light Emitting Diodes (LED):

GD4-203SRD	11
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LED Display:

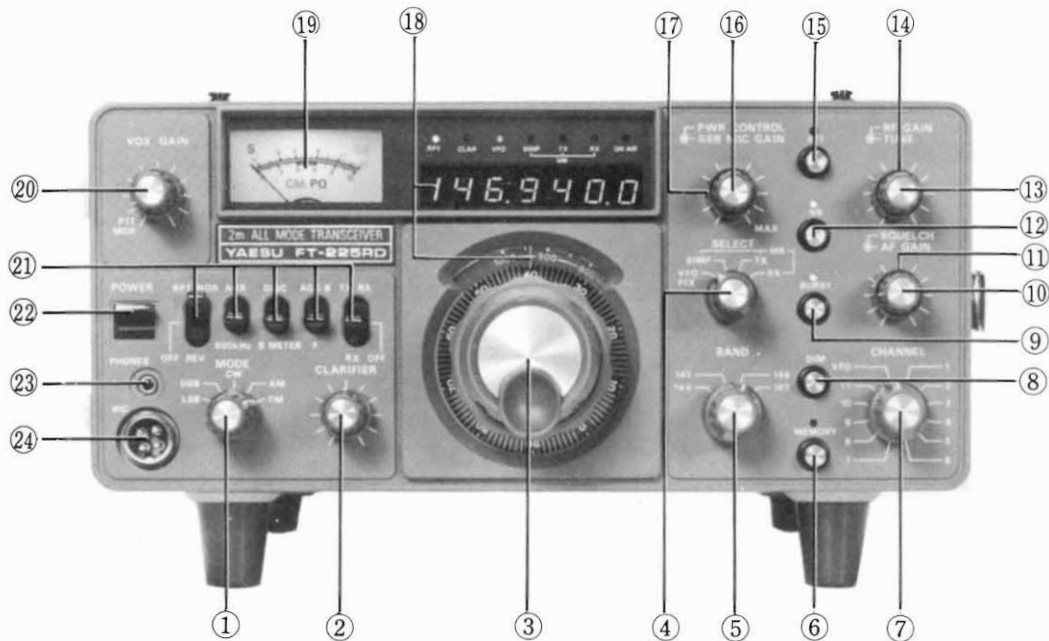
5082-7740	7
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Specifications subject to change without notice.

CONTROLS AND SWITCHES

This transceiver has been specifically designed for ease of operation and versatility. All internal controls have been carefully preset at the factory. The operator may, however, be unfamiliar with the operation of some of the controls, and improper adjustment thereof may result in poor transceiver

performance. The various front panel controls and switches are described in the following section, and the operator should be familiar with the function of every control before attempting transceiver operation.



(1) MODE switch

This switch chooses the mode of operation: LSB, USB, CW, AM, or FM.

(2) CLARIFIER

The clarifier control allows a means of offsetting the transmit or receive frequency ± 4 kHz from the frequency established by the main VFO dial.

(3) MAIN TUNING DIAL

The tuning control is a dual rate, double-shaft mechanism which provides for both fast and slow tuning rates. The main dial skirt is calibrated in 1 kHz increments, and the analog dial window is calibrated in 100 kHz increments. Determination of the 1 MHz band segment is made by the BAND switch.

(4) SELECT switch

This switch selects frequency control between the VFO/FIX mode and memory (optional) control of the transmit, receive, or transceive frequency.

(5) BAND switch

The BAND switch selects one of the four 1 MHz segments of the two-meter band.

(6) MEMORY

When the optional memory unit is installed, a new frequency may be stored in memory by pressing the MEMORY switch.

(7) CHANNEL

This switch selects between VFO control or one of the 11 crystal controlled positions available per band.

(8) DIM

This switch, when pressed, dims the front panel lamps and the digital display for reduced power consumption or nighttime mobile operation.

(9) BURST

This switch activates the tone burst generator.

(10) AF GAIN

The AF GAIN control adjusts the audio output level to the speaker and headphones. Clockwise rotation increases the audio output level.

(11) SQUELCH

This control adjusts the FM receiver squelch threshold level.

(12) NB

This switch, when pressed, activates the noise blanker for elimination of pulse-type noise. The noise blanker is not operative in the FM mode, because impulse noise is amplitude modulation and the FM receiver does not respond to such noise.

(13) TUNE

The TUNE control peaks all transceiver signal circuits for the frequency being used.

(14) RF GAIN

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

(15) ATT

When pushed, the ATT (RF attenuator) places approximately 20 dB of attenuation in the incoming receive signal path, thus preventing overload of the receiver front end.

(16) SSB MIC GAIN

This control varies the output from the microphone amplifier stages for SSB and AM operation. The control has sufficient range to permit the use of any 500–600 ohm dynamic microphone.

(17) PWR CONTROL

This control allows continuously variable power output adjustment, when it is desirable to reduce the level of the transmitted signal, as, for example, when a transverter is used that requires very little driving power.

(18) DIAL

Frequency readout is by means of the digital and the analog displays. The digital display reads out

all digits of the operating frequency, with resolution to 100 Hz. The analog sub-dial is calibrated every 100 kHz, and the BAND switch and main dial skirt are used to establish the precise operating frequency.

(19) METER

The meter reads signal strength or FM discriminator center current on receive, and relative power output on transmit.

(20) VOX GAIN

The VOX GAIN control selects between PTT and MOX (manual transmit) operation, and adjusts the level of the VOX amplifier stage.

(21) FUNCTION switches

RPT

This switch is used for repeater operation. For operation in the U.S., the transmitter frequency is shifted 600 kHz lower in the 144, 145, and 146 MHz bands, and in the 147 MHz band, the transmit frequency is shifted 600 kHz higher. The offset may be reversed by placing this switch in the REV position.

AUX/600 kHz

This switch selects the normal 600 kHz repeater offset or an auxiliary split established through use of an optional crystal.

DISC

This switch selects between meter indication of discriminator center current or signal strength on receive.

AGC

This switch selects between slow and fast AGC action.

CLARIFIER switch

The CLARIFIER switch selects between transceive frequency or receive frequency offset using the clarifier control. In the center (horizontal) position the clarifier is switched off.

(22) POWER

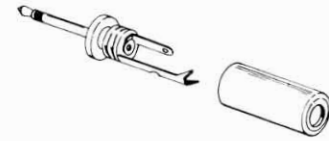
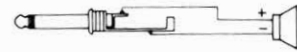
This is the main ON/OFF switch for both AC and DC operation.

(23) PHONES

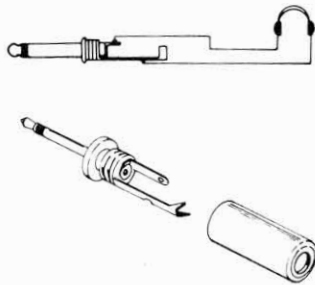
This is a miniature phone jack for use of headphones or a speaker. The internal speaker is disabled when a plug is inserted into this jack.

(24) MIC

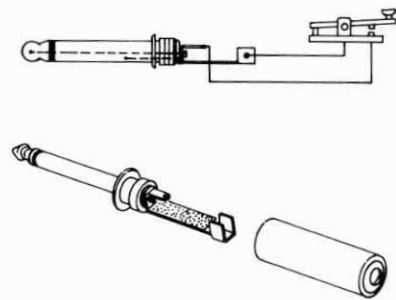
This is a four-conductor jack for microphone and PTT connections.



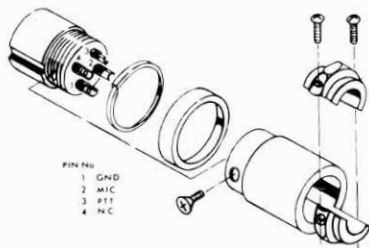
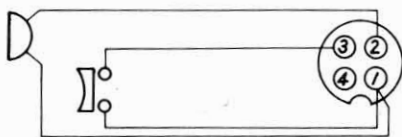
Speaker Plug



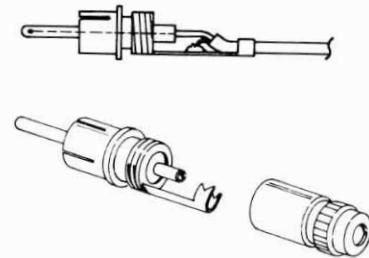
Headphone Plug



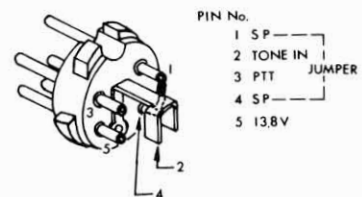
Key Plug



Microphone Connector

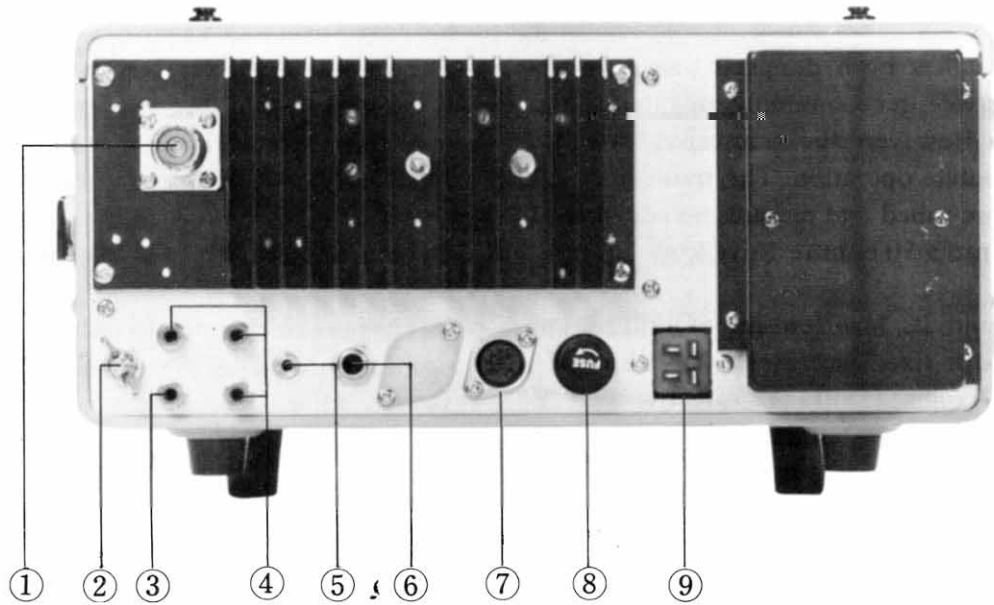


Phono Plug



Tone In Plug

REAR PANEL CONNECTIONS



(1) ANT

UHF female coaxial connector for antenna input.

(2) GND

Ground connection.

(3) ALC

ALC (automatic level control) input.

(4) RL (make, break, common)

Relay contacts for control of station equipment.

(5) SP

External speaker audio output.

(6) KEY

Key jack for CW operation.

(7) TONE-IN

Tone pad input jack.

(8) FUSE

Fuse holder. For AC operation, a 3 amp fuse is used on 117 volts, and a 2 amp fuse is used for 220 volt operation. For DC operation, a 10 amp fuse is located in the DC power cord. When replac-

ing fuses, be certain to replace the blown fuse with one of the proper rating. **WARRANTY DOES NOT COVER DAMAGE CAUSED BY IMPROPER FUSE REPLACEMENT.**

(9) POWER receptacle

Both AC and DC cables are connected to this receptacle. They are both supplied with the transceiver.

INSTALLATION

GENERAL

The FT-225RD has been designed primarily for base station service, requiring only an antenna and power source. However, the transceiver provides for efficient mobile operation. The transceiver has been factory pre-tuned and requires no adjustment for operation into a 50 ohm resistive load.

The antenna and its location are of critical importance in both fixed and mobile operation. In most cases, communications effectiveness is directly related to antenna height. The antenna should be as high and in the clear as possible, and a minimum separation of 5 feet should be maintained between VHF and other antennas. In mobile operation, it is desirable to locate the antenna as far away from the engine as practicable so as to avoid noise pickup from the ignition system. The most popular mobile antennas are the 1/4 wavelength whip, and the 5/8 wavelength whip which provides approximately 3.5 dB gain over the 1/4 wavelength whip. The Yaesu RSL-145 mobile antenna is available through your dealer.

To minimize loss in the antenna system do not economize on coaxial cable, and use the shortest length of cable that is practical, avoiding sharp angles or kinks. Use type RG8A/U if the transmission line length exceeds 25 feet, while RG-58A/U may be used for shorter runs. Type RG-17A/U, air-dielectric "heliac", or aluminum-jacketed foam-dielectric coax should be used for very long runs.

BASE STATION INSTALLATION

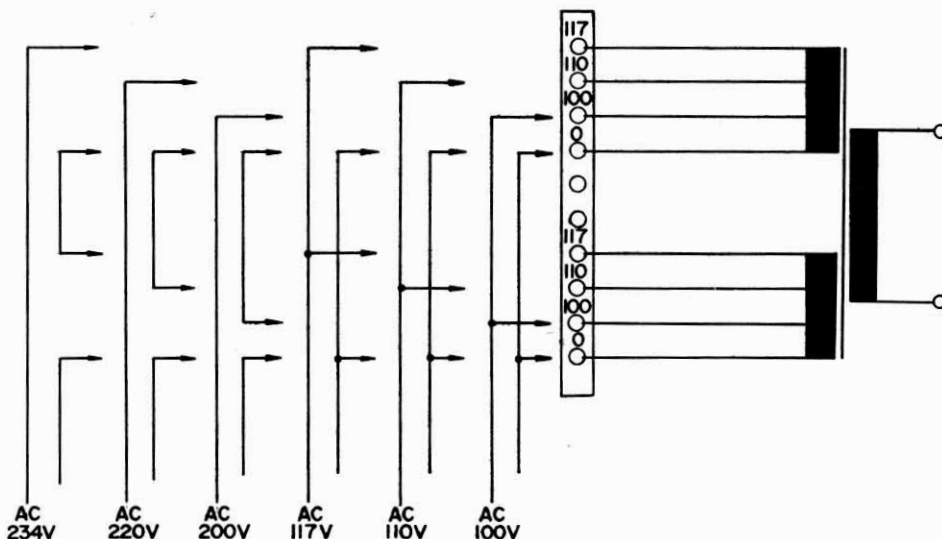
The transceiver is designed for use in many areas of the world where the supply voltage may differ from the operator's local supply voltage. Therefore, before connecting the AC cord to the power outlet, be absolutely certain that the voltage marked on the rear of the transceiver agrees with the local AC supply voltage. If not, please refer to the transformer primary winding chart for the proper 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 for the local supply voltage: 3 amps for 117 volts and 2 amps for 220 volts. The transceiver should be connected to a good ground. The ground lead should be connected to the terminal marked GND on the rear panel.

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.



POWER TRANSFORMER PRIMARY CONNECTIONS

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 is available. A minimum of two inches of air space is recommended to allow proper air flow around the transceiver. You may put it on the seat but be sure there is clearance between the cabinet bottom and the seat. Since the transceiver requires an average of 6.5 A on transmit, the fuse in the DC power cable should be rated for 10 amps.

When making connections to the car battery, be certain that the RED lead is connected to the positive (+) terminal and the BLACK lead is connected to the negative (-) terminal of the battery. Reversed connections could permanently damage the transceiver. The power cable should be as short as possible, and should be connected to the battery so as to take advantage of the filtering action of the battery.

Prior to operating the transceiver in a mobile installation, the voltage regulator setting should be checked. In many vehicles, the voltage regulation is very poor, and in some cases the regulator may be set for an excessively high charging voltage. As the battery and regulator age, the maximum voltage while charging can increase to a very high level. This is not only detrimental to the battery, but it may damage the transceiver. The transceiver is designed to operate from a source voltage of 11–16.5 volts. It is desirable to set the regulator so that the highest charging voltage does not exceed 14 volts, so as to give a margin of safety. The transceiver should be switched OFF when the vehicle is started so as to prevent voltage transients from damaging the transistors.

It is recommended that the microphone furnished with this transceiver be used: however, any quality microphone of 500–600 ohm impedance may be used. Refer to Fig. 2 for the microphone plug wiring connections. The microphone bracket may be put on the side of the cabinet, or at any other convenient place by drilling two 2.5 mm holes spaced 13 mm.

A speaker is built into the transceiver. However, audio output is also available for use with an external speaker. Any speaker having an impedance of 4 ohms may be used. When an external speaker plug is inserted in the EXT SP jack on the rear panel, the internal speaker is disabled.

OPERATION

The tuning procedure for this transceiver is not complicated. However, care should be exercised in operation to ensure peak performance. The following paragraphs describe the procedure for receiver and transmitted tuning.

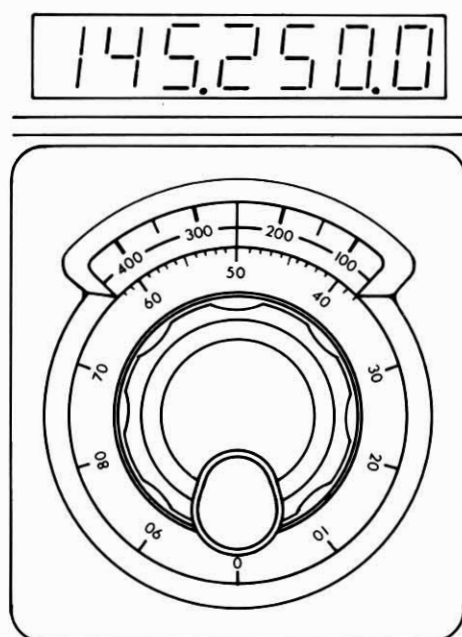
INITIAL CHECK

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

FREQUENCY READOUT

The digital display includes all digits of the operating frequency, with accuracy to 0.1 kHz.

The analog display consists of three components: the bandswitch, the analog dial window, and the main tuning dial skirt. For example, let us say it is desired to operate on 145.250 MHz. The bandswitch should be placed in the "145" position, the main dial should be rotated so that the dial window indicates half way between "200" and "300", and the dial skirt should indicate "50". By changing the position of the bandswitch, this positioning of the main tuning dial will also yield 144.250, 146.250, and 147.250 MHz.



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 segment
RPT.....	Lever position horizontal to OFF position
AUX/600 kHz.....	Lever position horizontal for 600 kHz shift
DISC.....	Lever position horizontal to S-meter position
CLAR.....	Lever position horizontal to OFF position
Main tuning dial.....	Desired operating frequency
VOX GAIN.....	PTT
AF GAIN.....	Adjust subsequently for comfortable level
RF GAIN.....	Fully clockwise position
SELECT.....	VFO/FIX
CHANNEL.....	VFO
SQUELCH.....	Fully counter-clockwise
NB.....	OFF (not depressed)
ATT.....	OFF (not depressed)
AGC.....	Slow or fast, as desired

Connect the appropriate power cord to the proper power source, and connect an antenna to the 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 and digital display LED's should light up; the transceiver is now ready to operate. Peak the TUNE control for maximum receiver background noise; this will also peak the transmitter circuits for maximum power output.

(1) SSB and AM Modes

Using the main tuning control, tune in an SSB signal. Upper sideband (USB) is the more commonly used mode for 2 meter SSB operation; if, however, the incoming station, cannot be tuned in, he or she may be using lower sideband (LSB). The RF GAIN control is normally set to the fully clockwise position, but if the incoming signal is extremely strong, or if you are trying to copy a weak station adjacent to an extremely strong station, reducing the RF GAIN control setting may improve reception. When pulse-type noise such as ignition noise is encountered, press the NB (noise blanker) switch.

(2) CW Mode

With the clarifier in the OFF position, tune in a CW signal. When the incoming signal is tuned to a beat note of 800 Hz, your transmit frequency will coincide with that of the other station. If another beat note is desired, or if the other station drifts, then use the clarifier control.

(3) FM Mode

Using the main tuning control, tune in an FM signal for a maximum and steady S-meter reading and a clear, natural voice output from the speaker. For accurate tuning, set the meter switch to the DISC position, and carefully readjust the tuning control until the pointer is exactly vertical (zero on the discriminator scale).

If the S-meter wobbles, or if it is impossible to obtain clean audio, it is possible that the incoming signal is on another mode, such as SSB.

FREQUENCY CALIBRATION

(1) FT-225RD (Digital plus analog model)

The digital display is automatically calibrated, and no further adjustment is needed. The analog dial skirt should be rotated so that it coincides with the frequency shown on the digital display.

(2) FT-225R (Analog model)

A. SSB/CW Modes

Activate the MARK switch, rotate the main tuning dial to the nearest 100 kHz point, and tune in the marker signal for a zero beat (lowest pitch frequency). Rotate the dial skirt, so as to align the "0" calibration with the vertical calibration

marking. The transceiver must be recalibrated when changing modes, as, for example, when changing from LSB to USB.

B. AM Mode

Activate the MARK switch, and rotate the main tuning dial to the nearest 100 kHz point, and tune in the marker signal for a maximum S-meter reading. Rotate the dial skirt to align the "0" calibration with the vertical calibration marking.

C. FM Mode

Place the meter switch in the DISC position. Activate the MARK switch, and rotate the main tuning dial to the nearest 100 kHz point. Tune in the marker signal for a vertical indication of the meter pointer ("0" on the discriminator center meter). Rotate the dial skirt for calibration at the "0" point, as in the previous sections.

NOTE: WHEN THE MARKER SWITCH IS ACTIVATED, THE ANTENNA IS DISCONNECTED FOR EASIER CALIBRATION.

TRANSMITTER

Connect a 50 ohm dummy load or matched antenna to the coaxial fitting on the rear panel. If the TUNE control has been adjusted no further adjustment is needed for full transmitter output. The adjustment of the TUNE control for maximum output is very broad.

For adjustment of the power output level, the PWR CONTROL may be rotated as required. Some transverters require very little drive power for proper operation, and this control allows the operator to control the transmitter output level as needed.

(1) SSB Mode

The SSB MIC GAIN control should be adjusted while speaking in a normal voice a long syllable such as the word "four". The SSB MIC GAIN control should only be advanced to the point where the output does not increase further. Excessive advancement of the gain control will result in splatter and distortion, thus reducing intelligibility. The microphone PTT switch may be used, or the VOX circuitry may be utilized (see part (5) of this section).

(2) AM Mode

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

(3) CW Mode

Plug a key into the KEY jack on the rear panel. In the key-down condition, the meter will indicate between 6 and 8 on the relative output scale. For semi-break-in operation, advance the VOX GAIN control until the sidetone oscillator activates the VOX relay when the key is closed. For PTT operation, rotate the VOX GAIN control to the PTT position. Keying is accomplished by closing the DC 8V line to ground. Key down current is approximately 8 mA. Use caution when utilizing an electronic keyer so as to avoid damage due to reversed polarity.

(4) FM Mode

Push the PTT switch on the microphone while speaking normally into the microphone. The mic gain is automatically set in the FM mode. While transmitting, the relative output meter will read between 6 and 8. Release the microphone PTT switch for return to receive.

(5) VOX (Voice Controlled) Operation

Adjust the VOX GAIN control on the front panel until your voice actuates the transmitter while you are speaking in a normal voice into the microphone. Set the antitrip control VR₄₀₂, which is located on the AF AMP UNIT, to the minimum point that prevents the speaker output from tripping the VOX circuit. Do not use more VOX GAIN nor ANTITRIP than necessary. Adjust the DELAY control VR₄₀₁ for the desired release time. The RELAY control provides a coarse adjustment for the relay sensitivity, and this has been preset at the factory. The RELAY and DELAY controls are also located on the AF AMP UNIT.

(6) PTT Operation

Push-to-talk operation is accomplished by rotating the VOX GAIN control to the PTT position (but not into the click-stop, which is the MOX position). The PTT circuit may then be activated

either by the microphone PTT switch, or by a footswitch. If a footswitch is used, it may be connected through the rear panel TONE IN jack; the switch should be connected between pin 3 and ground.

REPEATER OPERATION

The transmit frequency may be shifted 600 kHz for repeater operation. When the RPT switch is in the NOR (normal) position, the transmit frequency is shifted 600 kHz lower in the 144, 145, and 146 MHz bands, and 600 kHz higher in the 147 MHz band (US model). These relations are reversed when the RPT switch is placed in the REV position. That is, on the 144, 145, and 146 MHz bands, when the RPT switch is placed in the REV position, the receive frequency is shifted 600 Hz down; on 147 MHz, the receive frequency is shifted 600 kHz up. Extreme caution should be exercised so as not to transmit outside the amateur bands while using the RPT switch.

In some areas, repeater splits other than 600 kHz have been authorized. In this case, an optional crystal may be installed in the local unit to provide repeater splits of up to 1 MHz. The AUX/600 kHz switch must be placed in the AUX position for actuating the optional crystal.

Determination of the AUX crystal frequency is made as follows:

Band 144 (144.0–145.0 MHz)	$(125.1 + \text{Shift frequency}) \div 9$
	$(125.1 - \text{Shift frequency}) \div 9$
Band 145 (145.0–146.0 MHz)	$(126.1 + \text{Shift frequency}) \div 9$
	$(126.1 - \text{Shift frequency}) \div 9$
Band 146 (146.0–147.0 MHz)	$(127.1 + \text{Shift frequency}) \div 9$
	$(127.1 - \text{Shift frequency}) \div 9$
Band 147 (147.0–148.0 MHz)	$(128.1 + \text{Shift frequency}) \div 9$
	$(128.1 - \text{Shift frequency}) \div 9$

Example 1

Calculate the crystal frequency for -800 kHz shift in the 146 MHz band segment (TX frequency 800 kHz lower):

$$(127.1 - 0.8) \div 9 = 14.033 \text{ MHz}$$

Example 2

Calculate the crystal frequency for +800 kHz shift in the 147 MHz band segment (TX frequency 800 kHz higher):

$$(128.1 + 0.8) \div 9 = 14.3222 \text{ MHz}$$

When the optional memory unit is installed, the output frequency of the repeater may be stored by pressing the MEMORY button and placing the SELECT switch in the SIMPLEX position. By placing the RPT switch in the NOR or REV positions, the desired offset will occur. If the repeater input and output frequencies are within the same 1 MHz width of the BAND switch, the input frequency may be stored in memory, and then recalled for transmission only by placing the SELECT switch in the TX MR position. The VFO can then be tuned to the output frequency of the repeater. In this way, "oddball" splits can be accommodated.

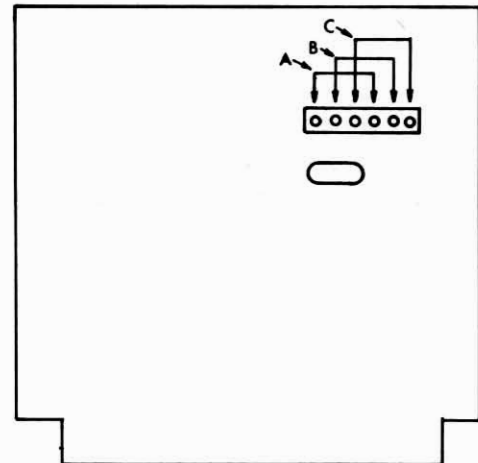
Tone actuated repeaters can be accessed by means of the built-in tone burst generator, which is actuated by pressing the BURST switch on the front panel. With this button depressed, pushing the microphone PTT switch will cause insertion of the burst signal at the beginning of each transmission.

The audio frequency of the tone burst signal may be programmed for any frequency between 671 and 2900 Hz, by use of a crystal and by positioning the selector plug on the tone burst unit. The US model normally is set up for 1800 Hz operation, and the European model for 1750 Hz operation. The charts will show the relation between the position of the selector plug, the crystal frequency, and the tone frequency. Moving the selector plug will change the tone frequency by a factor of two or four, as shown in the charts.

Tone Frequency (Hz)	Multiplier	Plug Position	Crystal Frequency (kHz)
671-1342	4096	A	2750-5500
1343-2685	2048	B	2750-5500
2686-2900	1024	C	2750-2970

Crystal frequency = Tone frequency × Multiplier.

Table 2



BAND	Simplex/Split	Local Frequency (MHz)	Crystal Frequency (MHz)	Multiplier
144	Simplex	★ 125.1	13.9000	×9
	+600kHz Shift	125.7	13.9666	
	-600kHz Shift	★ 124.5	13.8333	
145	Simplex	★ 126.1	14.0111	
	+600kHz Shift	126.7	14.0777	
	-600kHz Shift	★ 125.5	13.9444	
146	Simplex	★ 127.1	14.1222	
	+600kHz Shift	127.7	14.1888	
	-600kHz Shift	★ 126.5	14.0555	
147	Simplex	★ 128.1	14.2333	
	+600kHz Shift	★ 128.7	14.3000	
	-600kHz Shift	127.5	14.1666	

Table 1 (★ US model)

CRYSTAL CONTROLLED OPERATION

In addition to normal VFO operation, eleven crystals may be selected by the channel switch on the front panel for crystal controlled operation. Such operation is often useful for operation on favorite calling or repeater frequencies. Since the 2 meter band is divided into four segments in the FT-225RD, these eleven crystals could provide for operation on 44 different frequencies.

The crystal holders accept standard HC-25/U type crystals. All crystal frequencies must fall between 8,200 kHz and 9,200 kHz. A trimmer capacitor is connected in series with each crystal to permit fine tuning of the crystal frequency; Adjustment of this trimmer will move the crystal frequency approximately 1 kHz.

The correct crystal frequency for any desired operating frequency may be determined by using the following formula:

$$f_x = f_0 - f_1$$

where f_x = crystal frequency
 f_0 = operating frequency
 f_1 = a constant shown in Table 3

Example: Calculate the required crystal frequency for 144.25 MHz CW operation.

$$f_x = f_0 - f_1 = 144250 - 135799.3 = 8450.7 \text{ kHz}$$

It can be seen from the chart that a crystal for 144.51 MHz FM can also be used for 145.51, 146.51, and 147.51 MHz FM by changing the position of the BAND switch.

BAND (MHz)	f_1			
	LSB(MHz)	USB(MHz)	AM-FM (MHz)	CW (MHz)
144~145	135.8015	135.7985	135.8000	135.7993
145~146	136.8015	136.7985	136.8000	136.7993
146~147	137.8015	137.7985	137.8000	137.7993
147~148	138.8015	138.7985	138.8000	138.7993

Table 3

MEMORY OPERATION

(With optional MEMORY UNIT installed)

The memory circuitry can be used to store any frequency within a 1 MHz band segment for recall and control of the receive, transmit, or transceive frequencies. A frequency is memorized by pressing the MEMORY button, and the frequency is recalled by positioning the SELECT switch as needed. In the SIMPLEX position, the transceive frequency is locked on the memorized frequency. In the TX MR position, the transmitter is locked on the memorized frequency, and the receiver is controlled by the main VFO (or FIX unit). In the RX MR position, the receiver is locked on the memorized frequency, and the transmitter is controlled by the main VFO.

Caution should be observed during repeater operation: if the SELECT switch is in the TX MR position, for example, and the RPT switch is in the NOR position, the 600 kHz shift will be applied to the memorized frequency, which will be recalled during transmission periods. Unless the operator is careful, an unwanted repeater may be activated, causing interference to other users.

Optional batteries inserted in the MEMORY UNIT will allow the memorized frequency to be held, even though the FT-225RD is turned off.

For most repeater work, the memorized repeater frequency can be recalled by placing the SELECT switch in the SIMPLEX position, and placing the RPT in the NOR or REV position as needed. The main VFO may then be turned to another frequency, such as another repeater or calling frequency; return to the VFO frequency is made by placing the SELECT switch in the VFO/FIX position. Alternatively, the repeater input frequency may be memorized and recalled by placing the SELECT switch in the TX MR position; the VFO can then be turned to the repeater output frequency, and the RPT switch should be OFF.

CIRCUIT DESCRIPTION

GENERAL

The block diagram and circuit description below will provide you with a better understanding of the transceiver. Computer-type plug-in modules are utilized throughout this transceiver.

The FT-225RD uses 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 a 455 kHz second IF is used for FM. A single conversion transmitter, utilizing a 10.7 MHz high frequency crystal filter for SSB generation, and varactor diode frequency modulation of a 10.7 MHz crystal oscillator, is incorporated.

Each printed board has its own parts numbers, beginning, usually with number -01. For example, the IF amplifier transistor 2SC784R on PB-1778 is Q201.

RECEIVER

RX RF UNIT (PB-1746)

The 144 MHz input signal from the antenna is fed through the antenna relay RL₇₀₁ to pin 5 of the RX RF unit. The signal is then amplified by RF amplifier Q₁₀₂ (3SK51), a field effect transistor, and then fed to gate 1 of the first mixer Q₁₀₃ (3SK40M), where the input signal is heterodyned with a 133.3 MHz to 137.3 MHz signal delivered from the PLL unit, thus producing an IF signal of 10.7 MHz at the drain of Q₁₀₃.

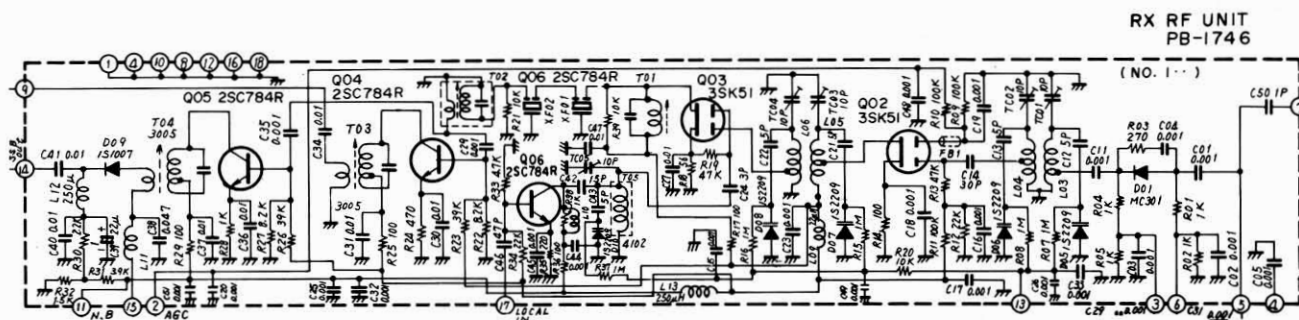
The input and output circuits of the RF amplifier utilize a double tuned circuit, which is sharply tuned to the center of the band by varactor diodes D₁₀₅ — D₁₀₈ (1S2209), thus eliminating cross modulation and intermodulation effects.

The IF signal passes through crystal filters XF₁₀₁ and XF₁₀₂ (both 10M2A2), and the SSB, AM, and CW signal is then fed to the first IF amplifier Q₁₀₅ (2SC784R); the FM signal is fed to Q₁₀₄ (2SC784R). The amplified SSB, CW or AM signal is fed through a noise blanker gate diode D₁₀₉ (1S1007) to pin 14 of the printed board, while the amplified FM signal is fed to pin 9.

SSB IF UNIT (PB-1778)

The SSB, AM, and CW signal from pin 14 of the RX RF unit is fed through pin 3 of the SSB IF unit. The signal is then fed through a diode switch and a crystal filter XF₂₀₁ (XF10A) to the IF amplifier Q₂₀₁ (2SC784R). The signal is amplified by Q₂₀₁ and Q₂₀₈ (TA7045M), and then fed to the balanced demodulator Q₂₀₉ (μ PC1037), 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 25 of the printed board. The IF signal is further amplified by Q₂₀₂ (2SK-19GR), and detected by the AM detector D₂₀₄ (1S188FM) in the AM mode. The audio signal is then fed through pin 28 to the MODE switch S3D.



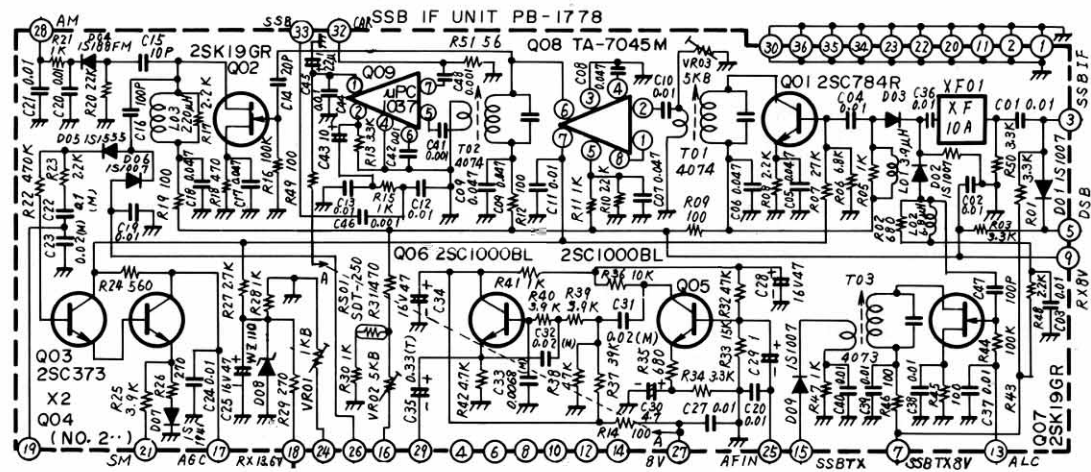
RX RF UNIT

A portion of the IF signal output from Q₂₀₂ is rectified by D₂₀₅ (1S1555) and D₂₀₆ (1S1007) for AGC (automatic gain control) purposes. The AGC voltage is amplified by Q₂₀₃ and Q₂₀₄ (both 2SC373); this voltage controls the gain of IF amplifiers Q₂₀₁ and Q₂₀₈. A portion of the AGC voltage is fed through pin 17 to the RX RF unit to control the gain of RF amplifier Q₁₀₂. The AGC voltage is amplified by the S-meter amplifier Q₂₀₄ (2SC373) and fed to the S-meter through the DISC/S METER switch on the front panel.

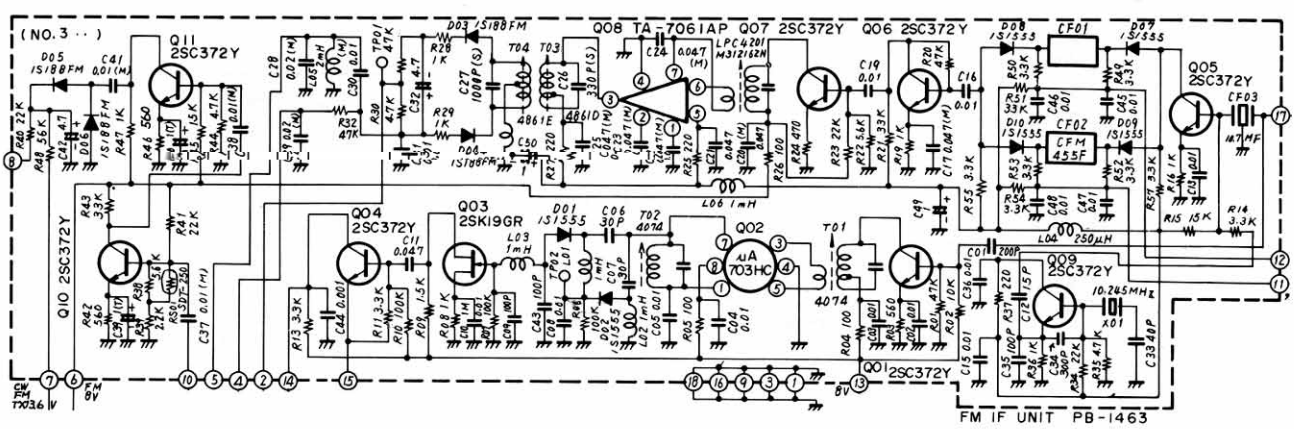
The audio signal from the MODE switch is pre-amplified by Q₂₀₅ and Q₂₀₆ (both 2SC100BL) and fed through pin 29 to the AF AMP unit.

FM IF UNIT (PB-1463)

The FM IF signal from pin 17 of the printed board is fed through a ceramic filter CF₃₀₃ (10.7 MF BR) to the second mixer Q₃₀₅ (2SC372Y), where the 10.7 MHz signal is mixed with the 10.245 MHz signal generated by the second heterodyne oscillator Q₃₀₉ (2SC372Y), thus producing a 455 kHz second IF signal. The 455 kHz IF signal is fed through a ceramic filter CF₃₀₂ to the second IF amplifier Q₃₀₆ and Q₃₀₇ (both 2SC372Y) and also to the amplifier limiter Q₃₀₈ (TA7061AP), which removes any amplitude modulation component of the signal. The output of Q₃₀₈ is applied to the discriminator D₃₀₃ and D₃₀₄ (both 1S188FM). The discriminator produces an audio output in response



SSB IF UNIT



FM IF UNIT

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 the 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 potentiometers VR₆ and VR_{1b} to the noise amplifier Q₃₁₀ and Q₃₁₁ (2SC372Y), and is detected by D₈₀₅ and D₈₀₆ (1S188FM). The DC voltage is applied from pin 8 to the squelch controller Q₄₀₁ (2SC372Y) in the AF AMP unit.

The 10.7 MHz signal is also applied to the noise blanker amplifier Q₃₀₁ (2SC372Y). The signal is amplified by Q₃₀₁ and Q₃₀₂ (μ A703HC). The noise rectifier diodes D₃₀₁ and D₃₀₂ (1S1555) produce a DC voltage which is amplified by noise pulse amplifier Q₃₀₃ (2SK19GR).

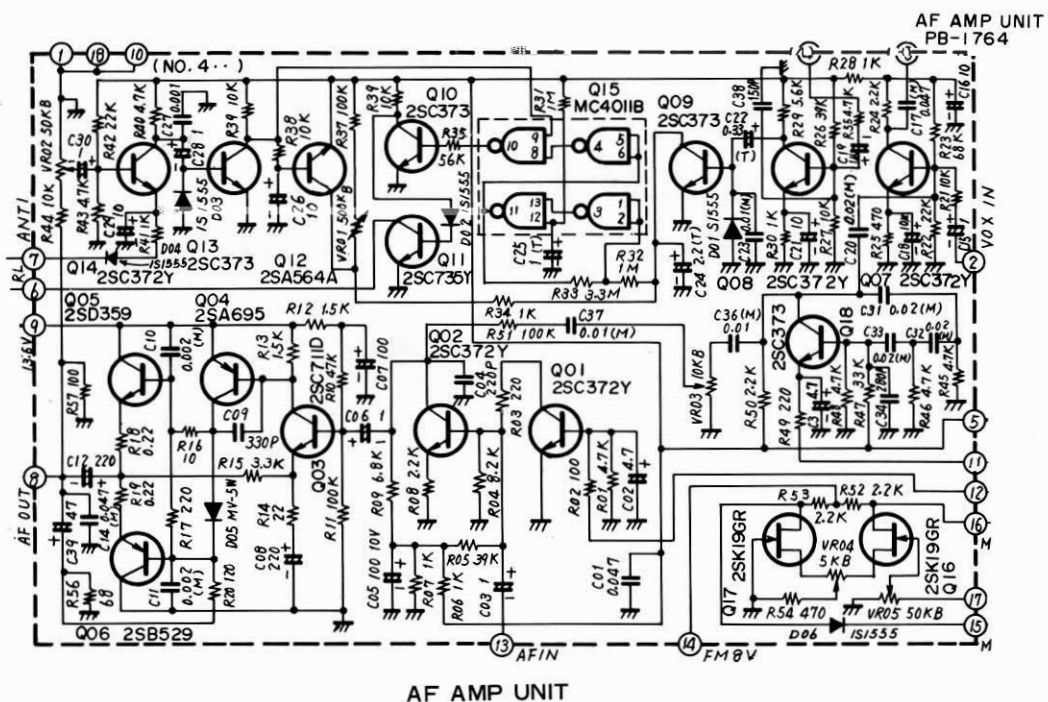
Under normal conditions, Q₃₀₃ conducts, producing the cut-off voltage to the base of gate controller Q₃₀₄ (2SC372Y); in turn, the high collector voltage of Q₃₀₄ is supplied from pin 15 to the gate diode D₁₀₉ (1S1007) in the RX RF unit, which conducts to pass the signal freely. With pulse noise, Q₃₀₄ conducts, and its collector voltage drops, causing the gate diode D₁₀₉ to disconnect the IF signal during the noise pulse duration.

AF AMP UNIT (PB-1764)

The audio signal is pre-amplified in the SSB IF unit and fed through pin 13 to the audio amplifier stage consisting of Q₄₀₂ (2SC372Y), Q₄₀₃ (2SC711), Q₄₀₄ (2SA695), Q₄₀₅ (2SD359), and Q₄₀₆ (2SB529). The audio power amplifier uses OTL (output transformerless) 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 Q₄₀₁ (2SC372Y), which conducts when only noise (no signal) is present; in turn, the audio input is grounded to quiet the audio amplifier. When the signal is present, Q₄₀₁ is cut off, and the audio amplifier operates normally. DC voltage is also applied from pin 12 to quiet the audio amplifier when the PLL circuit is unlocked.

A portion of the microphone input is delivered to pin 2 of the printed board. The speech signal is amplified by Q₄₀₇ and Q₄₀₈ (both 2SC372Y) and is applied to the base of Q₄₀₉ (2SC373), which conducts with the speech signal, causing the collector to reach the "low" state. When a speech signal is not present, Q₄₀₉ cuts off, and the voltage across C₄₂₄ becomes "high".



C₄₂₄, VR₄₀₁, R₄₃₇, and R₄₃₄ form the delay circuit to adjust the VOX relay hold time. The collector voltage is applied to NAND gate Q₄₁₅ (MC14011B), causing pin 8 to become "high". When pin 8 and pin 9 are "high", pin 10 of Q₄₁₅ becomes "low", causing Q₄₁₀ (2SC373) to cut off; in turn, relay controller Q₄₁₁ (2SC735) actuates the VOX relay.

The antitrip circuit provides a bucking voltage to prevent the speaker output from tripping the transmitter. The receiver audio output is connected through ANTITRIP potentiometer VR₄₀₂ to the antitrip amplifier Q₄₁₄ (2SC372Y). Amplifier Q₄₁₃ (2SC373) will conduct with the rectified voltage, thus keeping the potential at pin 9 of Q₄₁₅ "low", thus maintaining Q₄₁₅ in an "off" configuration while receiving.

The collector voltage of Q₄₁₃ is also fed to the base of Q₄₁₂, which conducts with high collector voltage on Q₄₁₃, causing Q₄₁₄ to become "high" rapidly for immediate relay actuation when a speech signal appears in the microphone circuit.

The tone oscillator Q₄₁₈ (2SC373) 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 Q₄₁₈. It is coupled through sidetone level control VR₄₀₃ to the receiver audio amplifier Q₄₀₃ for sidetone monitoring on CW. The output from Q₄₁₈ is also coupled to the VOX amplifier Q₄₀₈ for semi-break-in CW operation. In the FM mode, a DC voltage at the discriminator output is applied from pin 17 to the differential amplifier Q₄₁₆ and Q₄₁₇ (2SK19GR).

When the frequency of the received signal is shifted from the discriminator center, the resulting DC voltage causes either Q₄₁₆ or Q₄₁₇ to conduct, and the amount of shift is displayed on the meter when the meter switch is in the DISC position. VR₄₀₄ balances the differential amplifier, and VR₄₀₅ calibrates the sensitivity of the meter.

TRANSMITTER

MIC AMP (UNIT PB-1753)

The speech signal from the microphone is fed from pin 23 to the first microphone amplifier Q₅₀₂ (2SC1000GR). The input impedance of the microphone amplifier is 600 ohms. This signal is controlled in amplitude by the MIC GAIN control between pins 27 and 20, and is amplified by the second microphone amplifier Q₅₀₃ (2SC1000GR), and applied to emitter follower Q₅₀₄ (2SC372Y) to be delivered to the ring modulator D₅₀₇ — D₅₁₀ (1S1007).

The carrier oscillator Q₅₀₇ (2SC372Y) oscillates at 10.7015 MHz for LSB, 10.6985 MHz for USB, and 10.6993 MHz for AM/CW, depending on the position of the MODE switch. In the CW position, 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 on receive. The MODE switch selects the crystal by means of a diode switch. The output from the oscillator is fed through the buffer amplifier Q₅₀₈ (2SC372Y) to the balanced ring modulator D₅₀₇ — D₅₁₀ (1S1007). The carrier signal output from the buffer amplifier Q₅₀₈ is fed from pin 20 to the SSB IF unit for SSB and CW reception. Carrier balance is obtained with potentiometer VR₅₀₅ and trimmer capacitor TC₅₀₄. The double sideband, suppressed carrier signal is amplified by Q₅₀₉ (2SK19GR) and fed from pin 17 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 15, and the carrier signal is fed through T₅₀₂ to carrier amplifier Q₅₀₆ (2SC372Y). The amplified carrier is fed from pin 3 to the EXCITER unit.

The audio signal output from Q₅₀₄ is fed from pin 22 to pin 12 of the EXCITER unit to be amplified to a sufficient level for low level amplitude modulation.

In the FM mode, the speech signal delivered to pin 23 of the MIC AMP unit is amplified by Q₅₀₂ (2SC1000GR) and Q₅₀₁ (TA7061AP), a limiter amplifier, and is fed through deviation control potentiometer VR₅₀₂ (narrow) or VR₅₀₃ (wide) to pin 7 of the TONE BURST unit. Here it is amplified through an active low-pass filter circuit, Q₁₁₀₄

(2SC1000GR), which attenuates all audio frequency components above 2700 Hz. The signal is further amplified by Q₁₁₀₅ (2SC1000GR) and applied to the modulator, varactor diode D₅₀₁ (FC63). The frequency modulated signal is then amplified by Q₅₀₆ (2SC372Y) and fed through a diode switch to the EXCITER unit.

EXCITER UNIT (PB-1762)

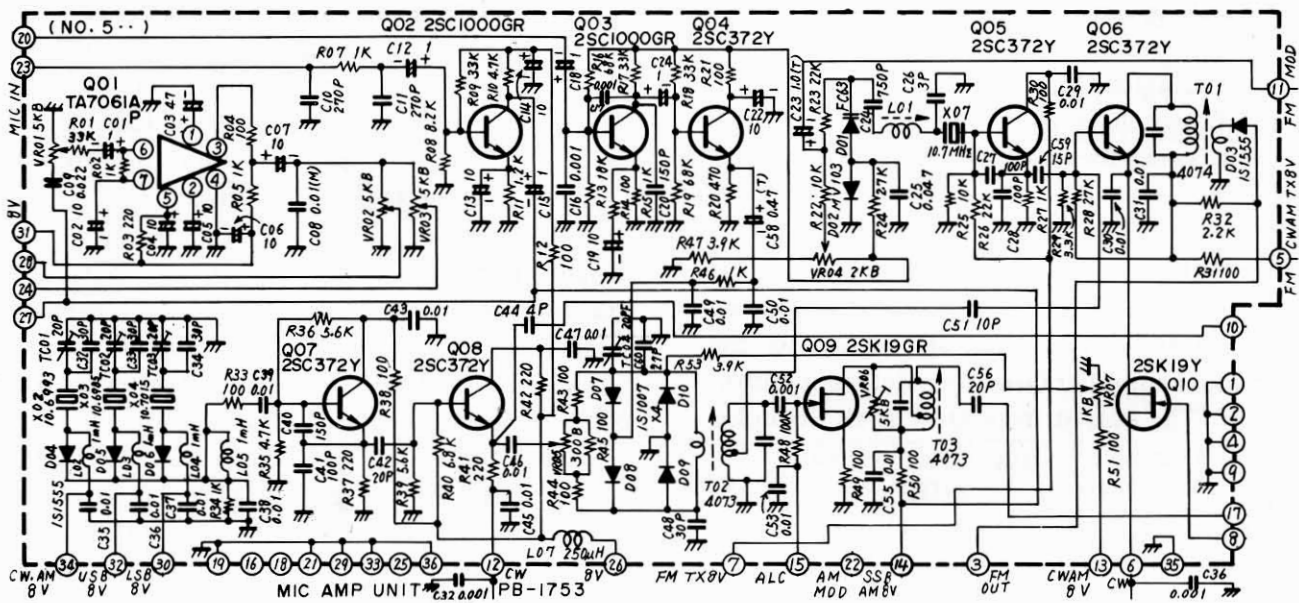
The SSB output signal from the SSB IF unit, as well as the AM, CW, and FM output signals (10.7 MHz) from the MIC AMP unit, are fed to the EXCITER unit from pin 3 and pin 5, respectively.

The 10.7 MHz signal is fed to the balanced mixer consisting of Q₆₀₁ and Q₆₀₂ (2SK19GR), where the signal is mixed with the 133.3 to 137.3 MHz heterodyne signal delivered from pin 4 of the printed board, thus producing a 144—148 MHz signal. The output signal from the balanced mixer

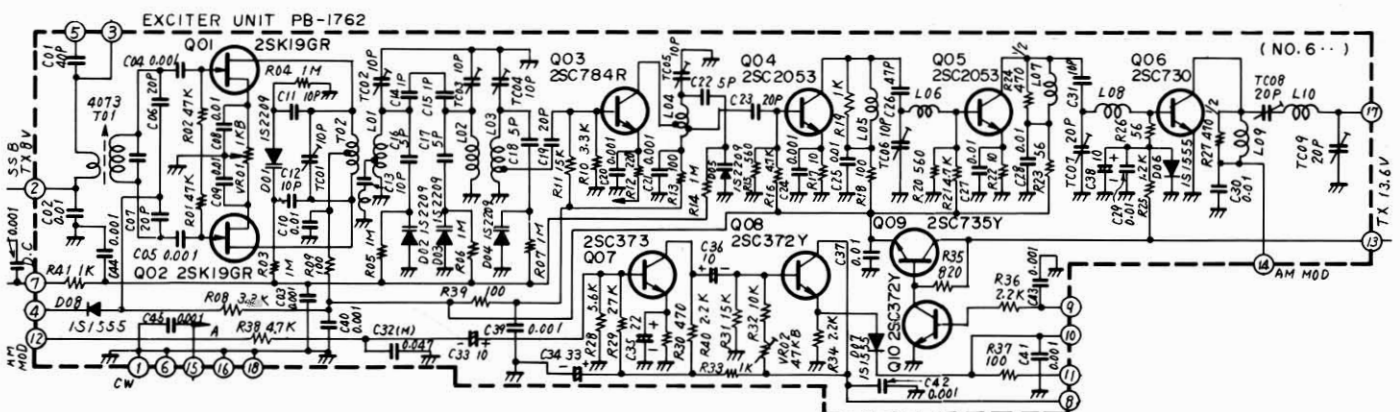
passes through the tuned circuits consisting of T₆₀₂ and L₆₀₁—L₆₀₃, which are tuned by varactor diodes D₆₀₁—D₆₀₄ (1S2209), in which voltages are preset in accordance with the position of the bandswitch. Thus, the circuit is tuned exactly to the operating frequency, and spurious radiation is effectively eliminated. The signal is then amplified by the amplifier chain consisting of Q₆₀₃ (2SC784R), Q₆₀₄ and Q₆₀₅ (2SC2053), and Q₆₀₆ (2SC730), and delivered from pin 17 to the BOOSTER unit.

The DC voltage for Q₆₀₁ through Q₆₀₄ is supplied through Q₆₀₉ (2SC735Y). When the PLL circuit is unlocked, the controller transistor Q₆₁₀ (2SC372Y) stops conducting, and in turn Q₆₀₉ stops supplying DC voltage for Q₆₀₁—Q₆₀₄.

The speech signal from pin 22 of the MIC AMP unit is fed through the AM amplifier Q₆₀₇ (2SC373) and emitter follower Q₆₀₈ (2SC372Y) to the AM modulator Q₂ (2SD213D), which controls the supply voltage for Q₆₀₆ (2SC730).



MIC AMP UNIT



EXCITER UNIT

BOOSTER UNIT (PB-1744, PB-1745)

The signal from the EXCITER unit is fed to the BOOSTER unit and amplified by the driver amplifier Q₇₀₁ (MRF212) and the final amplifier Q₇₀₂ (2N5591), which delivers 25 watts of RF power to the antenna through a two-stage low-pass filter.

The bias voltage is stabilized at 9 volts by zener diode D₇₀₁ (1N4732). Two diodes, D₇₀₂ and D₇₀₃ (both 10D1), are used to protect the final 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 D₇₀₄ (1S1555), which delivers the resulting DC voltage to the meter, where an indication of the relative power output is provided.

The DC voltage obtained from rectifying a small portion of the RF output by the ALC diodes D₇₀₇ and D₇₀₈ (1S1555) is applied to the gate of Q₂₀₇ in the SSB IF unit and Q₅₀₉ in the MIC AMP unit. Diodes D₇₀₇ and D₇₀₈ are biased by the ALC threshold control VR₇₀₃. Thus, the gain of Q₂₀₇ and Q₅₀₉ is controlled in order to control automatically the driving level to the PA transistor, in order to prevent any distortion caused by overdrive.

Blocking diodes D₇₁₄ and D₇₁₅ disconnect the supply voltage to Q₇₀₂ while the antenna is disconnected for marker calibration (analog model).

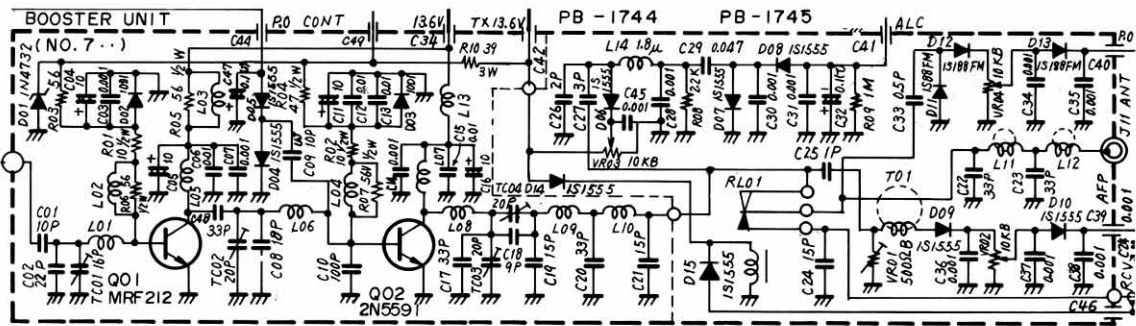
TONE BURST UNIT (PB-1752)

When the PTT switch is activated, a DC voltage is applied to trigger Q₁₁₀₁ (F-4011), which generates a pulse of duration 0.5 — 1 second. The pulse switches Q₁₁₀₃ (2SC372Y) to supply DC voltage to Q₁₁₀₂ (MSM5576), where the clock signal is divided by 1024, 2048, or 4096, producing an accurate tone burst frequency. The burst signal is fed to the base of the MIC amplifier Q₁₁₀₄ (2SC1000GR).

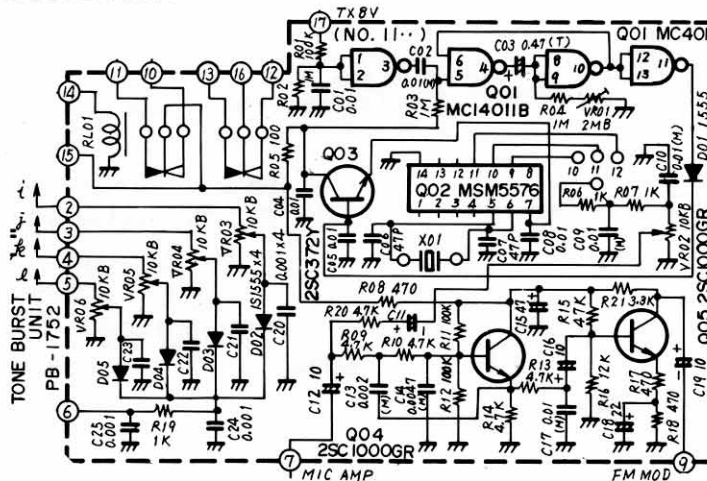
The tone duration is set by VR₁₁₀₁, and the tone level is set by VR₁₁₀₂.

The exact tone frequency is determined by a crystal and the plug position, as described in the OPERATION section.

In the European model, the tone burst signal is activated by depressing the BURST switch.



BOOSTER UNIT



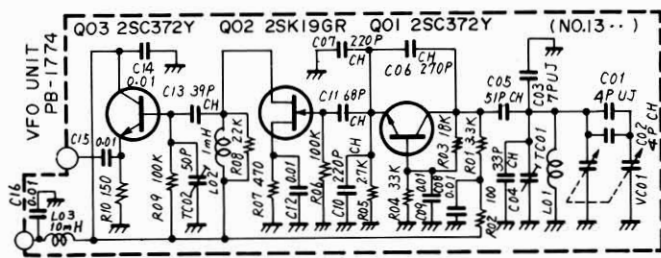
TONE BURST UNIT

COMMON CIRCUITS

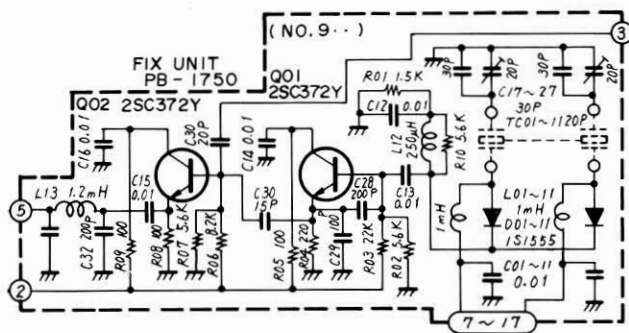
The FT-225RD utilizes a phase locked loop (PLL) system for the heterodyne oscillator, which provides a stable signal varying from 133.3 to 137.3 MHz, thus providing coverage of the entire 2 meter band.

VFO UNIT (PB-1774)

The VFO module board is installed in the VFO chassis. The VFO (variable frequency oscillator) Q1301 (2SC372Y) generates an 8,200 to 9,200 kHz signal, thus producing a 1 MHz tuning 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 Q1302 (2SK19GR) and Q1303 (2SC372Y) to pin 3 of the FIX oscillator board. The buffer amplifier provides isolation and amplification of the VFO signal.



VFO UNIT



FIX UNIT

FIX UNIT (PB-1750)

In addition to VFO or optional memory operation, 11 crystals may be employed for crystal controlled operation with the selector switch located on the front panel.

The FIX channel crystal oscillator Q901 (2SC372Y) oscillates at the frequency of the crystal selected by the diode switch D101 — D111 (1S1555). The output is fed from pin 8 through the buffer amplifier Q902 (2SC372Y) to the PLL UNIT.

The signal from the VFO also passes through this buffer stage and through jumper J26 or the memory unit to the PLL unit.

The crystal frequency falls between 8,200 kHz and 9,200 kHz, and is determined by the formula $f_x = f_0 - f_1$ where f_x is the crystal frequency, f_0 is the operating frequency, and f_1 is a constant found in Table 3 on page 14.

LOCAL UNIT (PB-1805)

The local oscillator generates a heterodyne signal which is used to convert the VCO (voltage controlled oscillator) signal into an 8,200 — 9,200 kHz signal; this is used for the comparison of the phase with that of the reference VFO signal.

The crystal controlled oscillator Q801 (2SC372Y) oscillates at the fundamental frequency of the crystal. A varactor diode D813 (1SV50), connected to the base of Q801, is used as a clarifier to shift the oscillator frequency for offset tuning.

The output from the oscillator is fed to the frequency multiplier stage Q802 and Q803 (both 2SC784R), producing the ninth harmonic at its output. The crystal is selected by a diode switch connected to the bandswitch. The relation between the frequency and band is shown in Table 1. The multiplied signal is then fed from pin 33 to the PLL unit.

For repeater operation, a fundamental crystal at 14.0555 MHz, X807, is used to generate a heterodyne signal of 126.5 MHz, when the bandswitch is set to the 144, 145, or 146 MHz bands. X808 (fundamental frequency 14.300 MHz) is used to

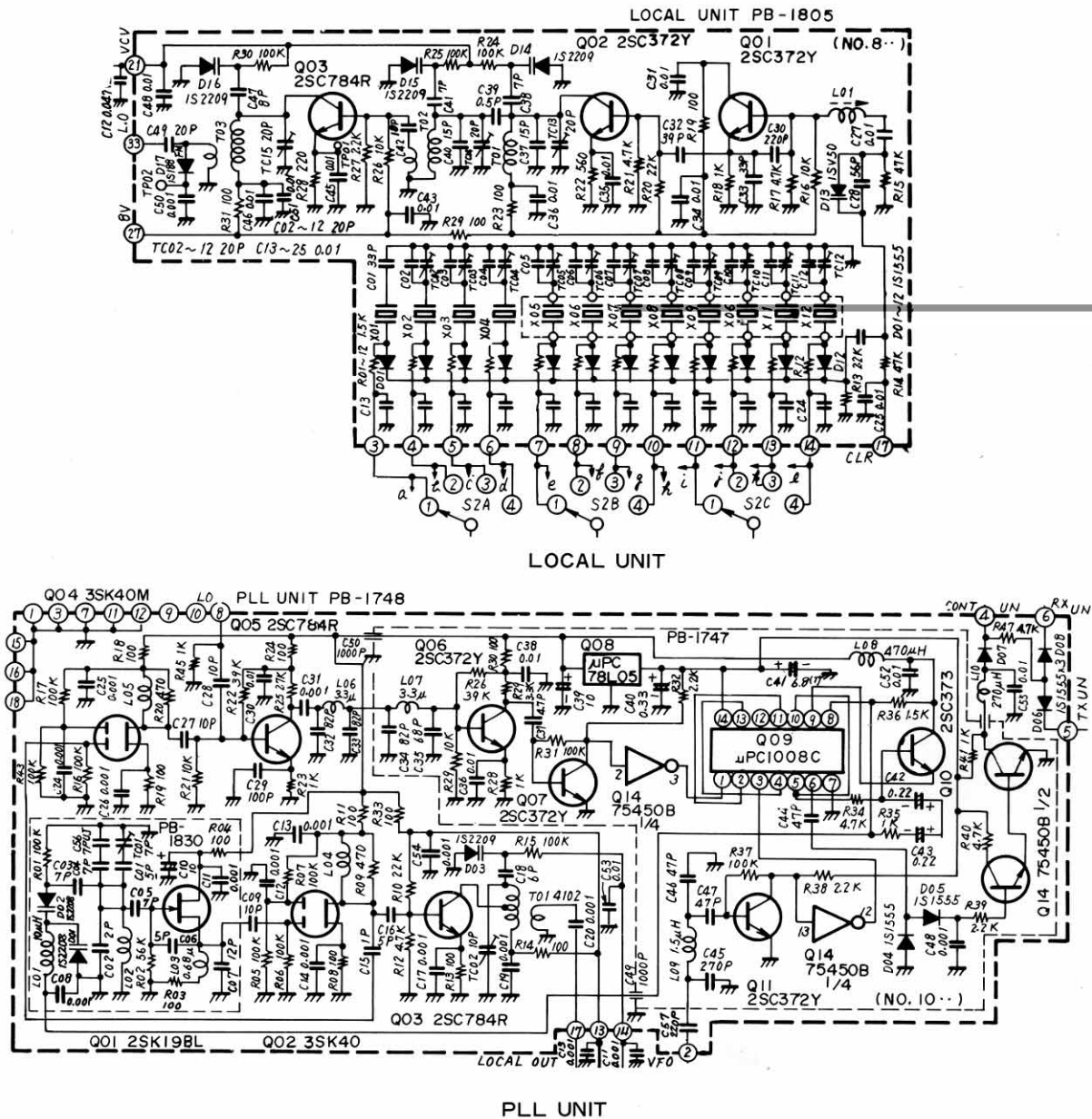
generate a 128.7 MHz signal, which is 600 kHz higher than the normal heterodyne signal, when the bandswitch is set to the 147 MHz band. A relay, RL₁₁₀₁, which is located on the TONE BURST unit, is used to select the above crystals when the RPT switch S₁₅₀₅ is activated.

When the RPT switch is in the NOR position, the crystals are selected as above. When the RPT switch is placed in the REV position, the receive frequency is shifted down in the 144, 145, and 146 MHz bands, and the receive frequency is shifted up in the 147 MHz band. In the REV position, the analog dial indicates the transmit frequency, while the digital display indicates the receive and transmit frequencies properly.

PLL UNIT (PB-1748)

The PLL unit generates a heterodyne signal for the transmitter and receiver mixer in conjunction with the phase locked oscillator.

A voltage controlled oscillator Q₁₀₀₁ (2SK19GR) generates a signal between 133.3 and 137.3 MHz, which is determined by L₁₀₀₂ and D₁₀₀₁/D₁₀₀₂ (both 1S2208). The output from Q₁₀₀₁ is fed through a two-stage buffer amplifier consisting of Q₁₀₀₂ and Q₁₀₀₄ (both 3SK40M), to the mixer Q₁₀₀₅ (2SC784R), where the signal is mixed with the 125.1 MHz signal delivered from the local oscillator, thus producing an 8.2–9.2 MHz comparison signal.



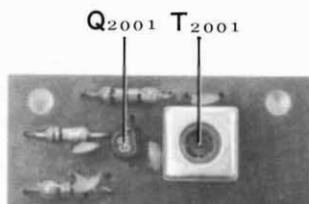
The comparison signal is amplified by Q₁₀₀₆ and Q₁₀₀₇ (both 2SC372Y), and the wave is shaped by Q₁₀₁₄ (SN75450B). The output of Q₁₀₁₄ is fed to a phase comparator Q₁₀₀₉ (MC4044P), which compares the phase of the comparison signal against that of the reference signal, and any difference is converted into an error correcting DC voltage. The DC voltage is amplified by Q₁₀₀₂ to control the frequency of the VCO.

When the VCO is unlocked, the pulse signal appearing at pin 6 of Q₁₀₀₉ is rectified by D₁₀₀₄ and D₁₀₀₅ (both 1S1555). The rectified DC voltage is amplified by Q₁₀₁₄ and fed to the counter unit to turn the LED's off, indicating that the VCO is unlocked.

The DC voltage switches Q₄₀₁ in the AF AMP unit to quiet the receiver when the PLL is unlocked. In transmit, this voltage switches Q₆₁₀ in the EX-CITER unit to turn the transmitter off.

OSC UNIT (PB-1761) (Digital model only)

The unit is installed in the digital model to produce a 129.3 MHz heterodyne signal for the counter. A crystal controlled oscillator Q₁₇₀₁ (2SC373) oscillates on 14.3667 MHz, and its output is multiplied 9 times by triplers Q₁₇₀₂ and Q₁₇₀₃ (both 2SC710), producing the 129.3 MHz heterodyne signal. The diode switch connected in series with crystal X₁₇₀₁ compensates the frequency when changing modes.



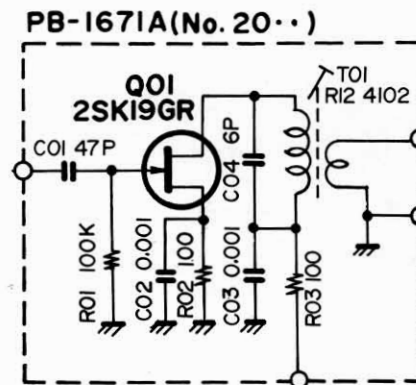
COUNTER UNIT (PB-1734, PB-1735)

The frequency of operation is indicated in MHz, kHz, and to 100 Hz resolution by seven large LED's.

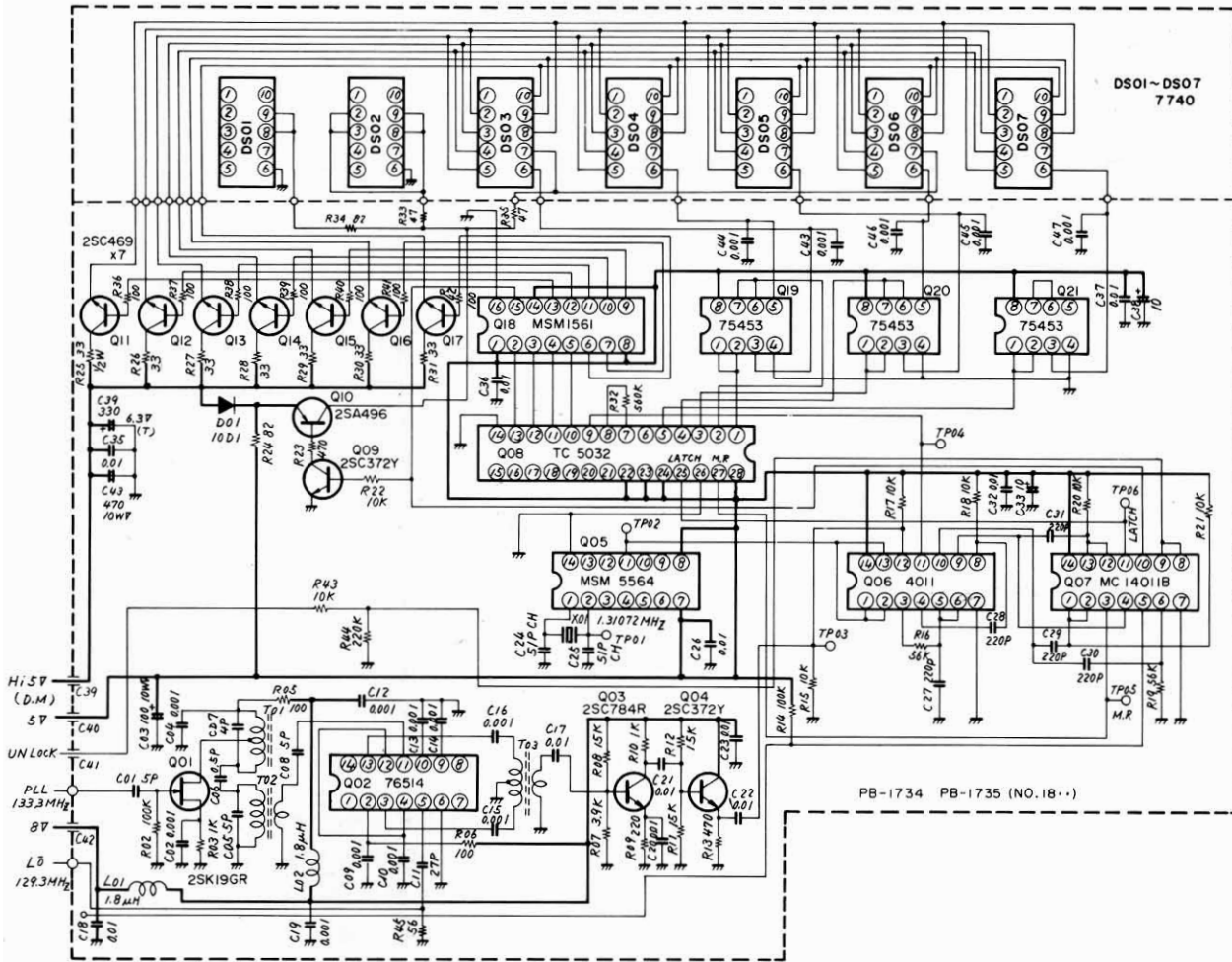
The heterodyne signal for the counter is delivered to pin 5 from the PLL unit, and amplified by Q₁₈₀₁ (2SK19GR). It is then fed to the double balanced mixer Q₁₈₀₂ (SN76514), where the signal is mixed with the 129.3 MHz heterodyne signal, producing a 4 to 6 MHz signal at its output.

The 4 — 6 MHz signal is amplified by Q₁₈₀₃ (2SC-784R) and fed through a waveform shaper Q₁₈₀₄ (2SC372Y) to a counter gate Q₁₈₀₆ (F4011), which counts the pulses which pass while the gate is opened. The pulses are fed to the six digit decade counter Q₁₈₀₈ (TC5032P), which counts 100 Hz, 1 kHz, 10 kHz, 100 kHz, and 1 MHz. The BCD output signal from Q₁₈₀₈ is fed through LED dimmer Q₁₈₁₈ (MSM561) and Q₁₈₁₁ — Q₁₈₁₇ (all 2SC496) to the display LED's, Q₁₈₂₂ — Q₁₈₂₈ (all HP5082-7740). Q₁₈₁₉ — Q₁₈₂₁ (SN75453) work as a series of switches operated by a timing signal delivered by Q₁₈₀₈ to select the output of Q₁₈₀₈ which drives the display in the sequence 100 Hz, 1 kHz, 10 kHz, 100 kHz, 1 MHz.

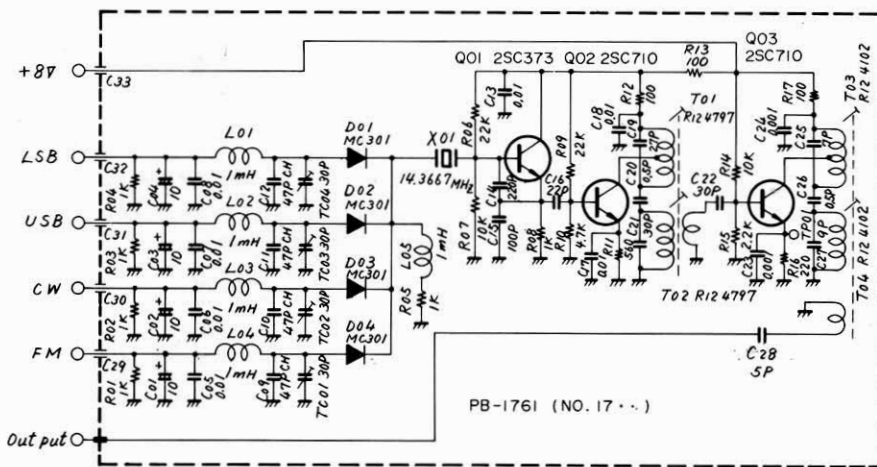
When the unlock signal is received from the PLL unit, Q₁₈₀₉ (2SC372Y) and Q₁₈₁₀ (2SA496) generate a blanking signal to the LED driver.



VFO BUFFER UNIT



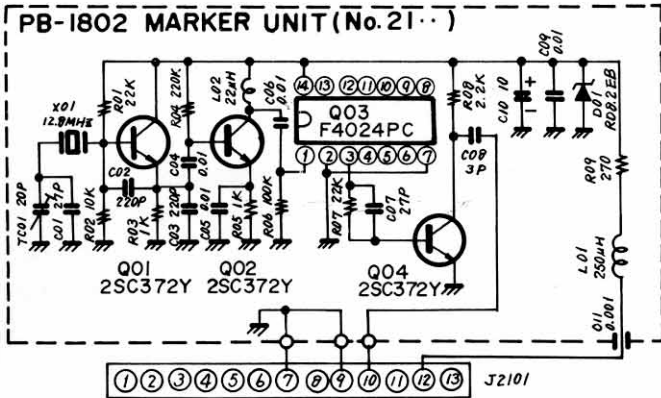
COUNTER UNIT



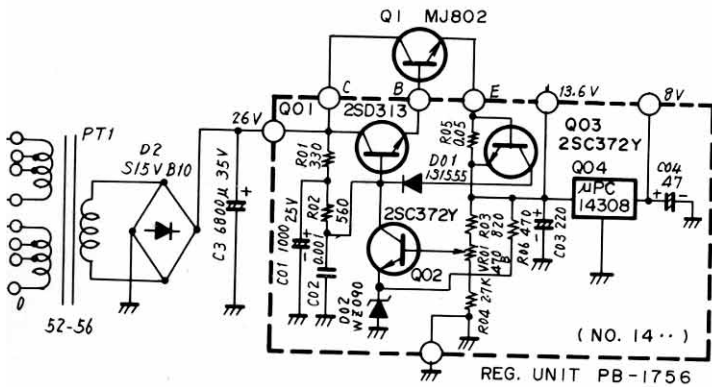
OSC UNIT

MARKER UNIT (PB-1802) (Analog model only)

The crystal marker generator Q₂₁₀₁ (2SC372Y) generates a 12.8 MHz signal, and its output is fed through buffer amplifier Q₂₁₀₂ (2SC372Y) to frequency divider Q₂₁₀₃ (34024PC), where the 12.8 MHz signal generates a 100 kHz marker signal. The marker signal is fed through a buffer amplifier Q₂₁₀₄ (2SC372Y) to the RX RF unit. When the marker switch is activated, the antenna relay is actuated, disconnecting the antenna.



MARKER UNIT



REG UNIT

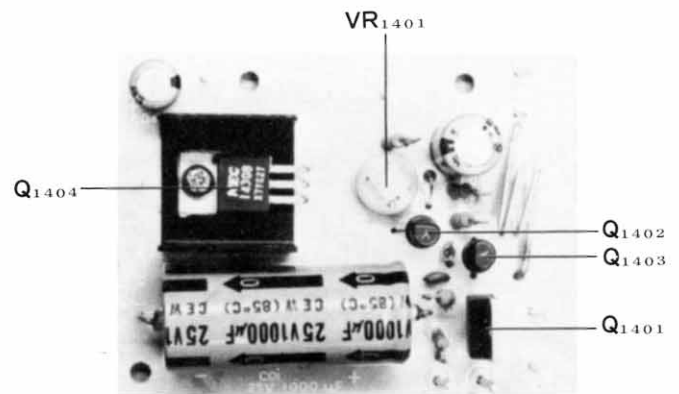
POWER SUPPLY & REGULATOR UNIT (PB-1469)

The power supply has been designed to operate from 100/110/117/200/220/234 V AC 50/60 Hz, or 12 V DC, negative ground. Inserting the appropriate power cord into the rear panel receptacle makes the necessary connections for operation from an AC or DC supply.

For AC operation, the DC voltage is supplied from the bridge rectifier unit D₂ (S15VB10), which is connected to a 20 volt, 6 amp secondary winding of the power transformer. The DC voltage is regulated at 13.6 volts by the voltage regulator circuit consisting of Q₁₄₀₁ (2SD313D) and Q₁ (MJ802).

Since such circuits as the VFO, local oscillator, and PLL require an extremely stable voltage, the 13.6 V DC supply is further stabilized at 8 volts by voltage regulator Q₁₄₀₄ (µPC14308). Q₁₄₀₃ (2SC372Y) switches to disable the voltage regulator (consisting of Q₁ and Q₁₄₀₁) when the current exceeds the preset value.

For DC operation, the positive voltage is connected to pin 3 and the negative voltage to pin 4 of power receptacle J₁. To protect the circuits from reversed polarity of the DC voltage, D₁ (U05B) conducts heavily under reversed polarity conditions to blow the line fuse in the DC cord. It is placed between pin 3 and ground on J₁.



REG UNIT (PB-1756)

MAINTENANCE & ALIGNMENT

GENERAL

Your FT-225RD transceiver has been carefully aligned and tested at the factory prior to shipment. The reliability of the solid-state devices used in the FT-225RD should provide years of trouble-free service if the transceiver is not abused, and if routine maintenance is carried out.

The following precautions should be observed, so as 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 that voltage determined by the transformer primary winding.
- (3) When replacing fuses, be certain to use a fuse of the proper rating for the voltage being used.
- (4) Do not exceed 14 volts DC, at the POWER receptacle, for DC operation. When operating mobile, the battery voltage should be measured with the battery under load (transmitter "keyed" in the FM mode), with the engine running fast enough so that the ammeter shows a "charge". In addition, do not operate the FT-225RD if the supply voltage is less than 12 volts DC.
- (5) Avoid direct exposure to sunlight or water.

ROUTINE MAINTENANCE

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

Cleaning:

When the transceiver has been used in a dusty or sandy environment, the interior should be cleaned periodically. A vacuum cleaner or low pressure air blower should be used.

Accumulated dirt may be removed with a soft brush. Check that the interior is thoroughly dry before replacing the cabinet and/or operating the equipment. Wipe the exterior with a damp cloth when necessary.

PERFORMANCE CHECKS

Make all performance checks at 13.6 volts DC (under load), or on the appropriate AC voltage as determined by the transformer primary wiring.

Check the transmitter as follows:

- (a) Connect a suitable 50 ohm dummy load/RF wattmeter to the ANT receptacle.
- (b) Set the MODE switch to the FM position, and key the transmitter while observing the power output, which should be approximately 25 watts. At full power, the S-meter should indicate between 6 and 8 on the relative power output scale.
- (c) Set the MODE switch to SSB, and key the transmitter. Speak in a normal voice into the microphone. The output meter should indicate between 3 and 5 nominally.

Check the receiver sensitivity as follows:

- (a) Connect an AC VTVM to the SP jack. Set the MODE switch to the FM position, and set the SQUELCH control fully counterclockwise.
- (b) Connect the RF output of a precision VHF signal generator to the ANT receptacle and note the VTVM reading with no signal input. Adjust the AF GAIN control and the VTVM range, as required, to obtain a full scale VTVM reading. Do NOT change the setting of the AF GAIN control after this calibration has been 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 1/100th (20 dB decrease) of the reading in step (b). The signal generator output voltage at this point is the 20 dB quieting sensitivity, and it should be approximately $0.35 \mu\text{V}$.
- (d) Set the MODE switch to SSB, and connect the AC VTVM to the speaker output. Apply an unmodulated $0.5 \mu\text{V}$ signal from the signal generator, and tune the transceiver tuning dial for a maximum VTVM reading.
- (e) Advance the RF Gain control to the fully clockwise position, and adjust the AF GAIN control for a reading of 450 mV on the VTVM.

- (f) Reduce the signal generator output, and read the VTVM; the VTVM reading should be less than 45 mV for a 10 dB S/N ratio.

If the above checks indicate a need for realignment, it is recommended that the unit be returned to the dealer for this procedure. Alignment requires special test equipment not normally available to the average station owner. Adjustment of the tuned circuits without the proper equipment or technical expertise will result in degraded transmitter performance.

ALIGNMENT

SOME OF THE FOLLOWING ALIGNMENT PROCEDURES REQUIRE SPECIAL TEST EQUIPMENT AND TECHNICAL KNOWLEDGE, AND SHOULD ONLY BE ATTEMPTED BY AN EXPERT TECHNICIAN.

AF AMP UNIT (PB-1764)

(1) **CW Semi-break-in**

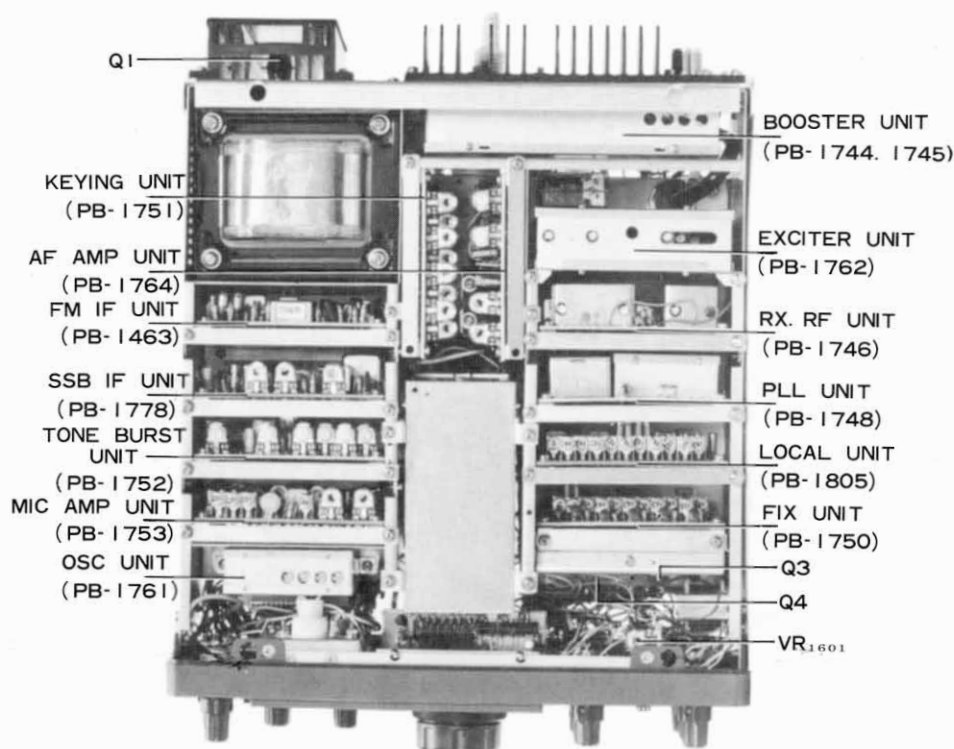
Adjust VR₄₀₁, the DELAY control, for the desired relay hold time.

(2) **CW Sidetone Level**

Adjust VR₄₀₃ for the desired sidetone level.

(3) **Antitrip**

Set the ANTITRIP control, VR₄₀₂, to the minimum point that will prevent the speaker output from activating the VOX. The DELAY control, VR₄₀₁, may be adjusted for the desired relay hold time.



TOP VIEW

(4) Discriminator Center Meter

Set the controls as follows:

CHANNEL . . . VFO

MODE FM

DISC OFF (S-meter position)

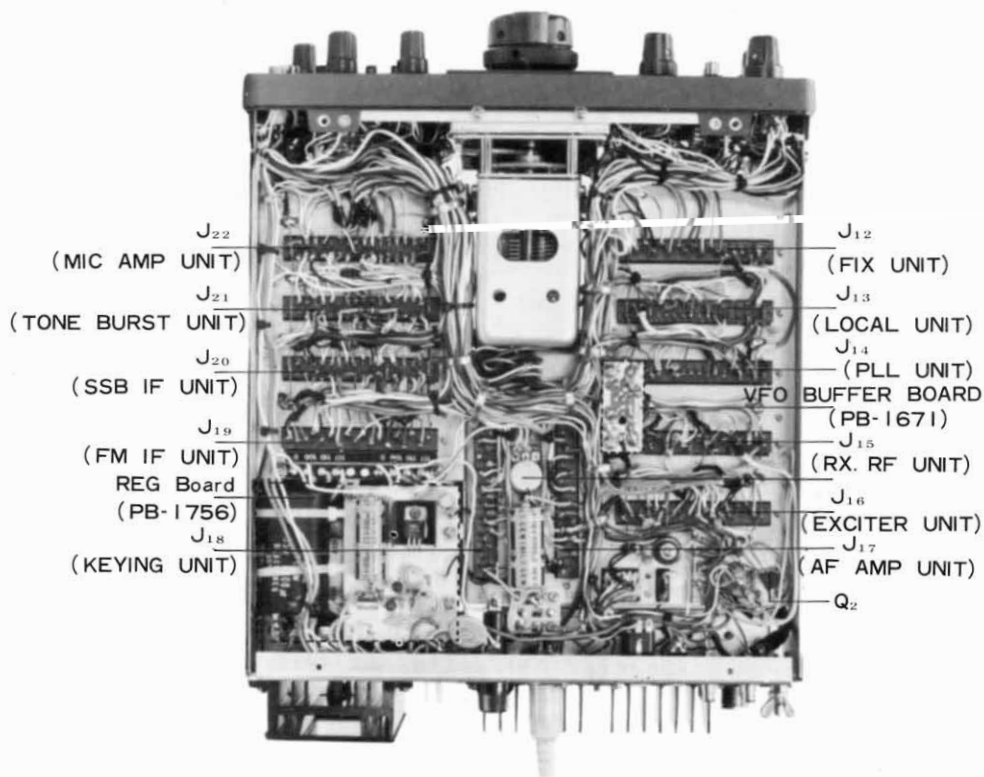
RF GAIN . . . Fully clockwise

MARKER . . . ON (Analog model; for RD,
connect signal generator to
antenna receptacle)

Tune the transceiver for a maximum S-meter reading on the marker or signal generator signal. Tune the main dial so as to find the center of the maximum signal indication. Place the meter switch in the DISC position, and adjust the center potentiometer VR₄₀₄ so that the meter pointer is exactly at midscale on the meter. Check to see that the meter moves an equal amount on either side of the center for an equal frequency excursion. Shift the VFO frequency 10 kHz lower than the reference signal, and adjust the DISC potentiometer, VR₄₀₅ for a meter reading of 2 on the DISC scale.



AF AMP UNIT (PB-1764)



BOTTOM VIEW

MARKER UNIT (PB-1802) (Analog model only)

(1) Frequency Adjustment

Connect a frequency counter, through a 100 pF capacitor, to the collector of Q₂₁₀₂ (2SC372Y). Adjust TC₂₁₀₁ to set the crystal frequency exactly to 12.800 MHz. If a frequency counter is not available, use an external HF receiver, and zero the 100 kHz marker signal against WWV or JJY.

CW KEYING UNIT (PB-1751)

Voltage Adjustment for the Varicap Tuning Circuit

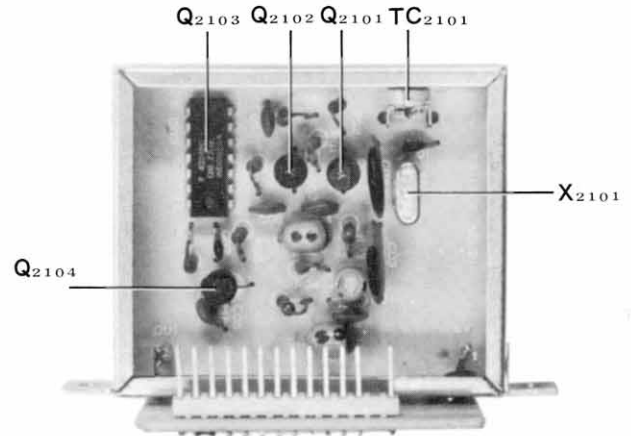
Measure the voltage at pins 2, 3, 4, 5, 14, 15, 16, and 17, with the VTVM connected between ground and the pin under test.

Adjust the appropriate potentiometer, VR₁₂₀₁ — VR₁₂₀₈, for the following pin voltages.

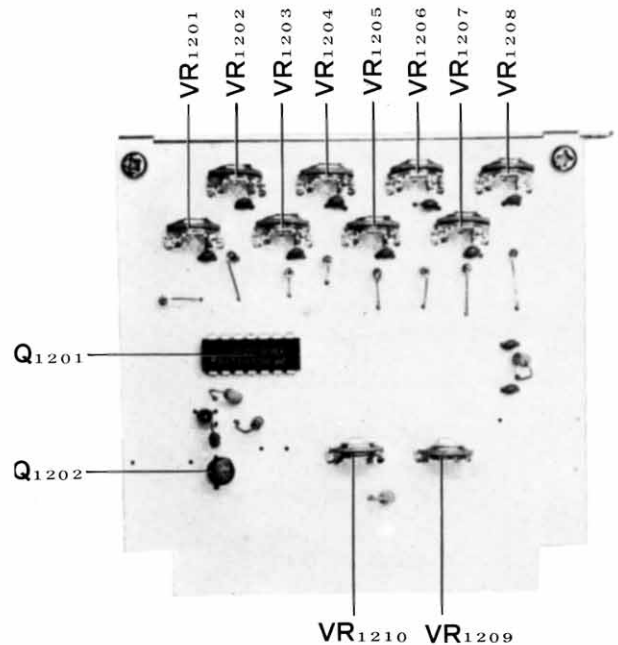
	BAND	VOLTAGE	
VR 1201	144	2.5 V	
VR 1202	145	3.5 V	
VR 1203	146	4.5 V	
VR 1204	147	5.5 V	
VR 1205	144 RPT	1.9 V	★ TX - 600kHz shift
VR 1206	145 RPT	2.9 V	"
VR 1207	146 RPT	3.9 V	"
VR 1208	147 RPT	5.9 V	★ TX + 600kHz shift

TUNE control 12 O'clock

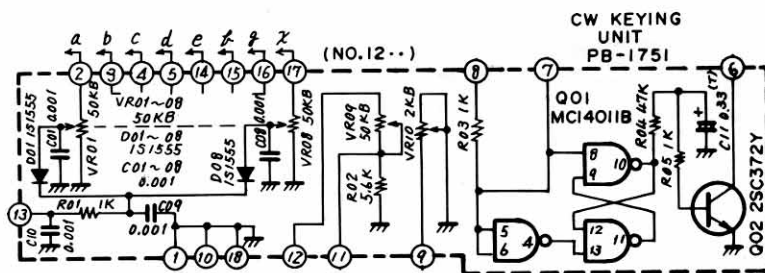
★ US model



MARKER UNIT (PB-1802)



CW KEYING UNIT (PB-1751)



CW KEYING UNIT

SSB IF UNIT (PB-1778)

(1) S-Meter Setting

Disconnect the antenna from the coax receptacle. Set the MODE switch to the AM position, and set the RF GAIN control to the fully clockwise position. Adjust VR₂₀₁ ("ZERO") until the meter indicates zero. Then set the RF GAIN control fully counter-clockwise. Adjust VR₂₀₂ ("FULL SCALE") until the meter reads full scale. Return the RF GAIN control to the fully clockwise position, and connect a signal generator to the antenna receptacle. Set the output of the signal generator to 144.5 MHz with an output of 0 dB, and tune the receiver to the generator signal. Place the TUNE control in the 12 o'clock position, and adjust VR₂₀₃ for a reading of S3 on the S-meter. Repeat the above procedures until the full scale, zero, and S3 readings are achieved for the above settings.

MIC AMP UNIT (PB-1753)

(1) SSB Carrier Frequency

Connect a 50 ohm dummy load, such as the Yaesu YP-150, to the antenna receptacle, and connect the output of an audio oscillator to the microphone input. Set the MODE switch to an SSB mode. Apply a 1 kHz audio signal to the microphone input, and adjust the SSB MIC GAIN control or the audio oscillator output for an RF output of 10 watts as indicated on the wattmeter. Change the audio frequency to 350 Hz, and adjust TC₅₀₃ for LSB and TC₅₀₂ for USB to obtain 2.5 watts output. Change the audio frequency to 2600 Hz; the RF output should be 2.5 watts.

(2) AM and CW Carrier Frequency

Tune the transceiver in the USB mode into a dummy load, and use another receiver to monitor the transmitted signal. Tune the external receiver until the transmitted voice quality is natural. Change the FT-225RD to AM (leave the external receiver in the USB mode), and adjust TC₅₀₁ for a zero beat as heard in the external receiver.

(3) Carrier Balance

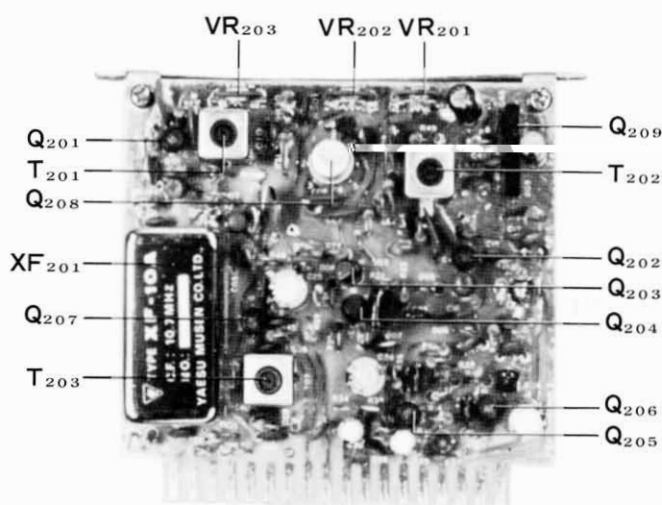
Connect a dummy load to the antenna receptacle, and the RF probe of a VTVM to the center conductor of the antenna receptacle. Set the MODE switch to LSB. Set the SSB MIC GAIN control to

the fully counter-clockwise position, and set the VOX GAIN switch to the MOX position. Adjust VR₅₀₅ and TC₅₀₄ ("CARRIER BALANCE") alternately to minimize the VTVM reading.

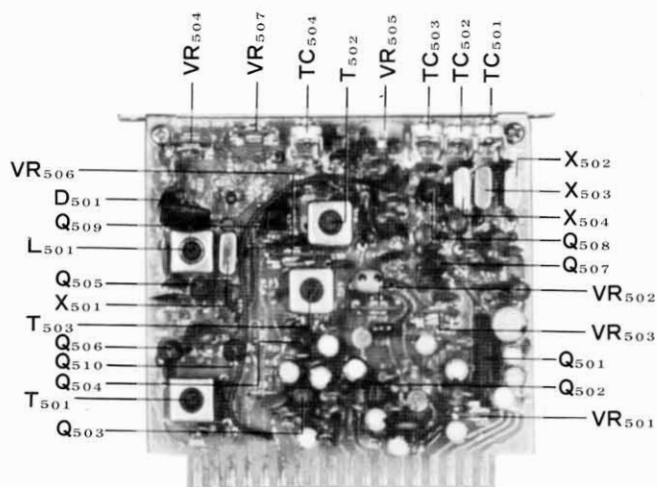
Repeat this procedure on USB, then repeat the procedure, so that a minimum reading is obtained on both sidebands.

(4) CW Carrier Level

Set the CW level control, VR₅₀₇, to the point where the RF output no longer increases when the control is advanced.



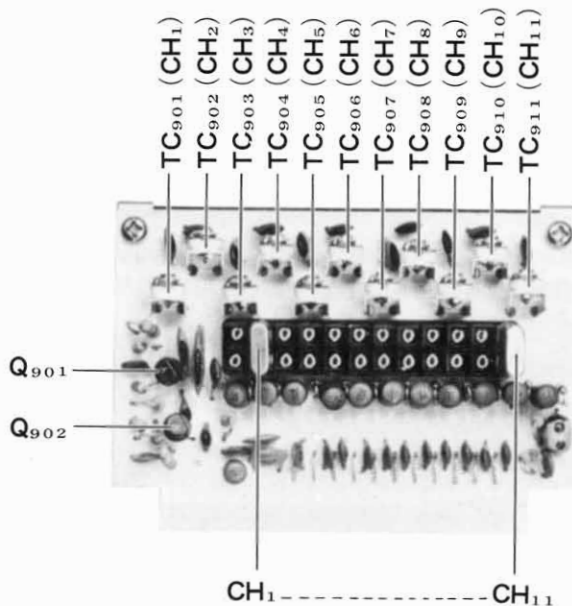
SSB IF UNIT (PB-1778)



MIC AMP UNIT (PB-1753)

FIX UNIT (PB-1750)

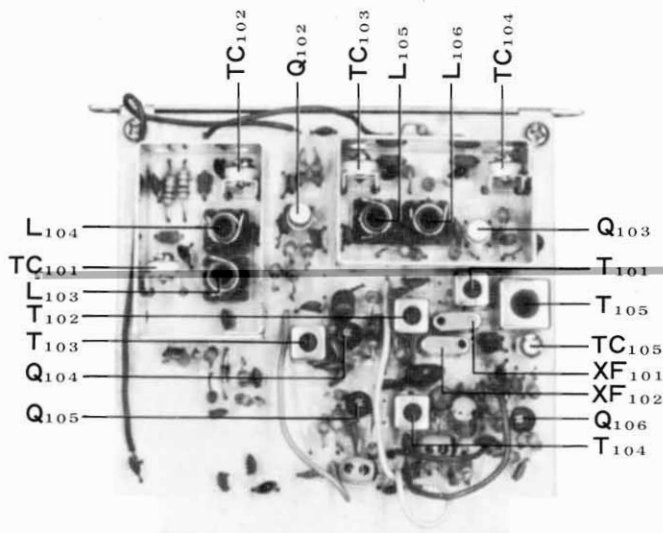
Precise frequency alignment of the fixed channel crystals may be made by adjusting TC₉₀₁ – TC₉₁₁.



FIX UNIT (PB-1750)

RX RF UNIT (PB-1746)

Set the BAND switch to 144, the CHANNEL switch to VFO, the RF GAIN control fully clockwise, and the MODE switch to USB. Tune the VFO to a 10 dB signal at 144.500 MHz from a signal generator connected to the antenna receptacle. Peak TC₁₀₁, TC₁₀₂, TC₁₀₃, and TC₁₀₄ for a maximum S-meter reading. If the majority of your operating is done in the upper part of the band (146 – 148 MHz), it is recommended that this alignment be performed on 146.5 MHz.



RX RF UNIT (PB-1746)

EXCITER UNIT/BOOSTER UNIT (PB-1762), (PB-1744), (PB-1745)

(1) Power Output

It is recommended that an insulated alignment tool be used for this alignment. Connect a dummy load to the antenna receptacle. Set the BAND switch to 145, the CHANNEL switch to VFO, and the MODE switch to FM. Set the VFO to 145.00 MHz, and set the VOX GAIN control to the MOX position. Peak TC₆₀₁ – TC₆₀₉ and TC₇₀₁ – TC₇₀₄ for maximum power output.

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

Repeat the above alignments alternately on 144.1, 145.0, and 147.9 MHz until unity power output is obtained across the band.

(2) PO Meter Set

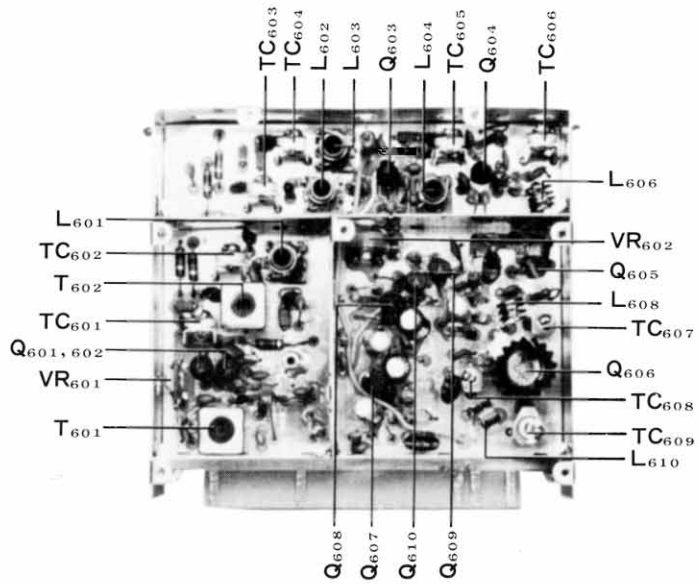
The PO (Power Output) meter indicates relative power output. After completion of the above power output alignment, set the meter control VR₇₀₄ to the point where the meter pointer indicates 80% of full scale at full output.

(3) AM Carrier Level

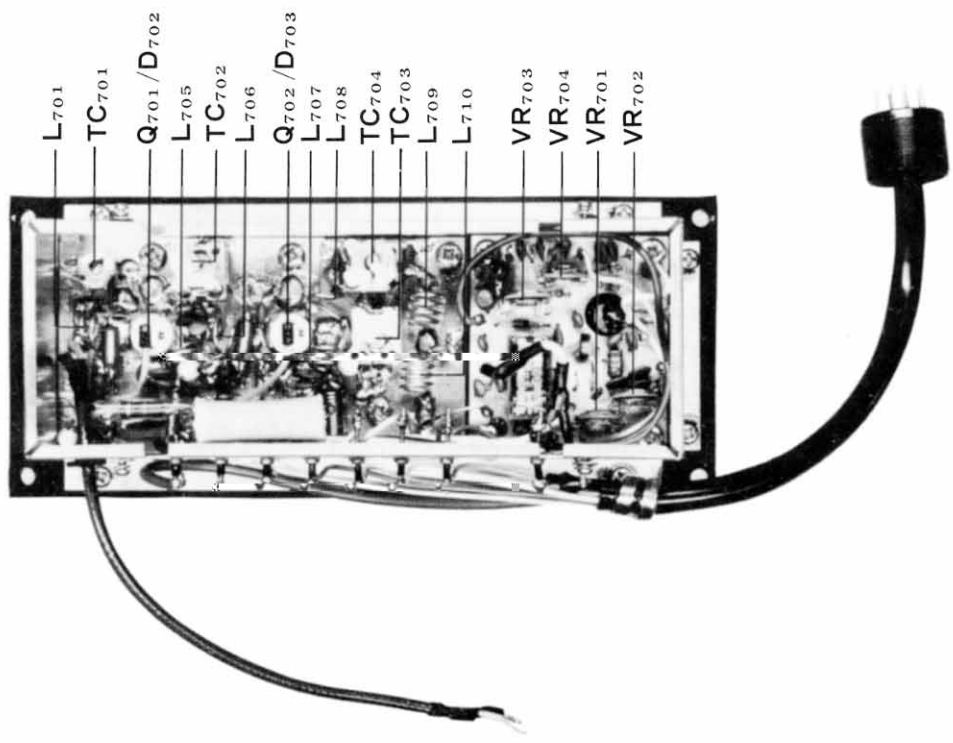
Set the MODE switch to AM. Adjust VR₆₀₂, in the EXCITER UNIT, for 8 watts unmodulated carrier output into a dummy load.

(4) ALC Threshold

Connect the output from a two-tone signal generator to the microphone input, and connect a dummy load/wattmeter to the antenna receptacle. Set the BAND switch to 145, the CHANNEL switch to VFO and the MODE switch to USB. Set the VOX GAIN control to the MOX position. Apply a 1 kHz single tone signal to the microphone input, and adjust the signal generator output until the power meter shows 2.5 watts. Then apply a 1.5 kHz tone, and adjust its level to produce 2.5 watts output. Leaving these levels at the preset position, apply the 1 kHz/1.5 kHz two-tone signal, and adjust VR₇₀₃ for a power output of 3 watts.



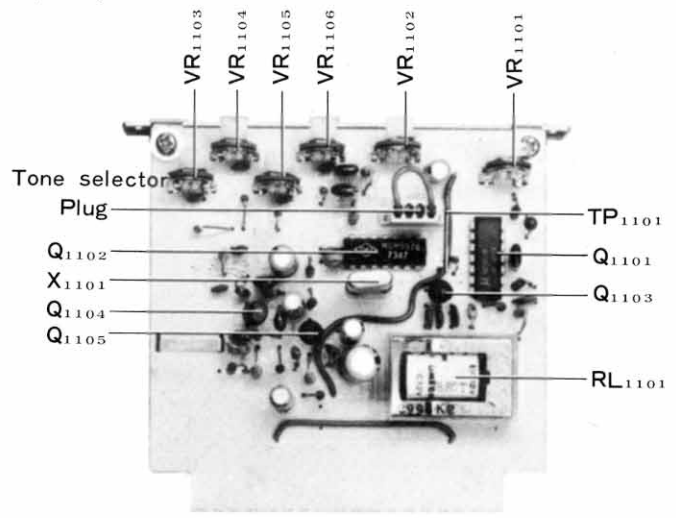
Exciter unit (PB-1762)



BOOSTER UNIT (PB-1744, 1745)

TONE BURST UNIT (PB-1752)

The burst signal is automatically transmitted when the PTT switch on the microphone is keyed, and when the BURST button is depressed. The length of the burst signal is preset at the factory for approximately 0.5 second. Adjustment of the burst length is made by VR1101. Clockwise rotation increases the length of the burst.

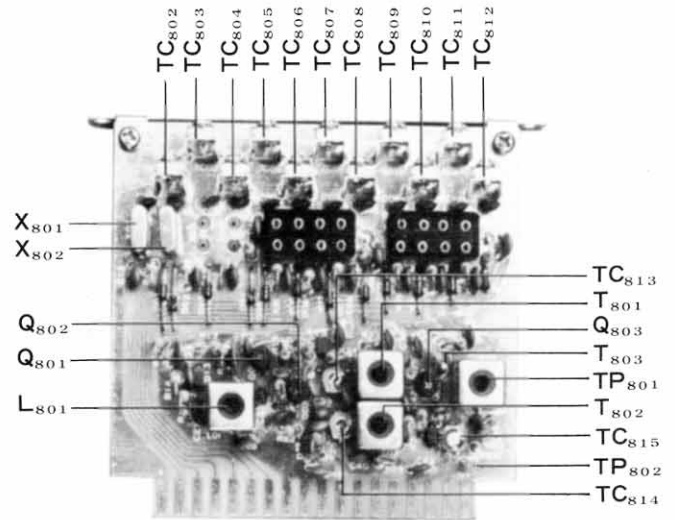


TONE BURST UNIT (PB-1752)

LOCAL UNIT (PB-1805)

Set the MODE switch to USB, the BAND switch to 144.0, and the CHANNEL switch to VFO. Connect a frequency counter to pin 33 of J₁₃. Adjust L₈₀₁ to 125.1 MHz ±100 Hz. Set the BAND switch to 145.0, and adjust TC₈₀₂ to 126.1 MHz ±100 Hz. In like fashion, adjust TC₈₀₃ for 127.1 MHz ±100 Hz for 146.0 MHz, and TC₈₀₄ to 128.1 MHz ±100 Hz for 147.0 MHz.

Set the RPT switch to NORM, the AUX/600 kHz switch to 600 kHz, and the BAND switch to 144.0 MHz, and adjust TC₈₀₆ to 125.5 MHz ±100 Hz. Likewise, adjust TC₈₀₇ to 126.5 MHz ±100 Hz for 146.0 MHz, and TC₈₀₈ to 127.5 MHz ±100 Hz for 147.0 MHz.



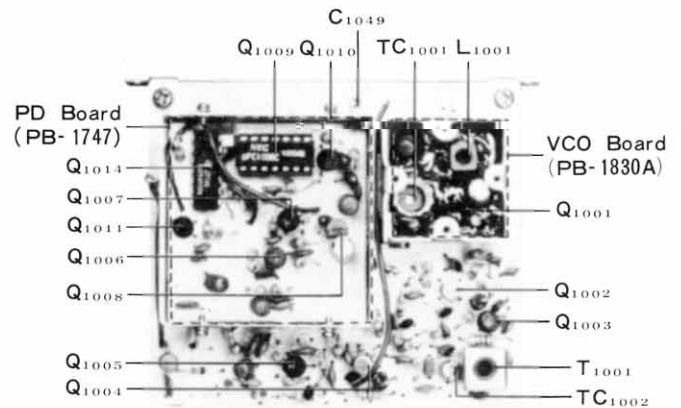
LOCAL UNIT (PB-1085)

Disconnect the frequency counter and connect it to pin 5 of J₁₂. Adjust the main tuning dial for a reading of 8200 kHz on the frequency counter. Set the analog sub-dial to zero. Adjust TC₁₈₀₂ on PB-1761 until the digital display reads 144.0015 MHz, making sure that the MODE switch is still on USB. Adjust TC₁₈₀₁ for a reading of 143.9985 with the MODE switch on LSB; adjust TC₁₈₀₄ for a reading of 144.0000 on FM; adjust TC₁₈₀₃ to 143.9993 MHz on CW, transmit mode.

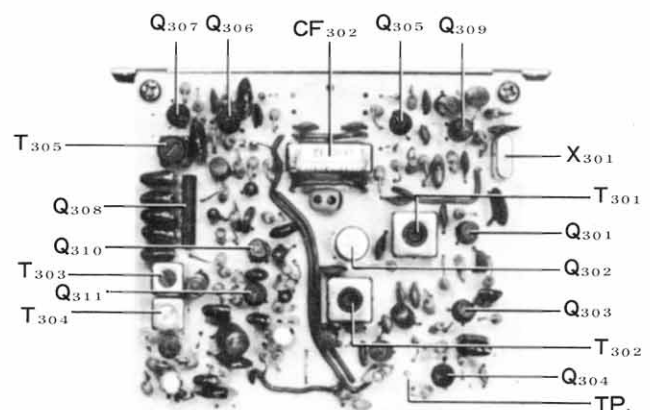
PLL UNIT (PB-1748)

This unit does not require any adjustment unless major components are changed, and if this happens, precise measuring equipment is required for alignment. The following simple alignment can, though, be made:

Turn the transceiver to 144.0000 MHz. Connect a VTVM DC probe to C₁₀₄₉ (feedthrough capacitor) and adjust TC₁₀₀₁ for a reading of exactly 1.75 volts on the VTVM. Check to see that the PLL circuit locks at all frequencies.



PLL UNIT (PB-1748, 1747, 1830)



FM IF UNIT (PB-1463)

SQUELCH THRESHOLD

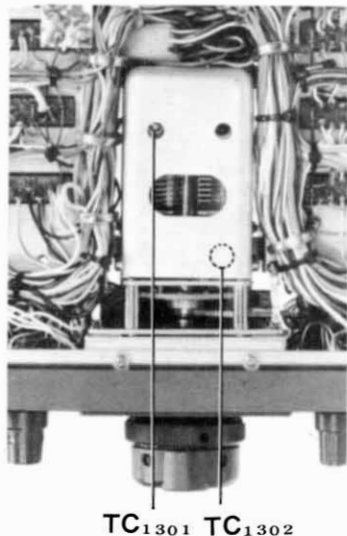
Disconnect the antenna from the receptacle. Set the BAND switch to 144, the CHANNEL switch to VFO, the RF GAIN control fully clockwise, the MODE switch to FM, and the SQUELCH control to the 9 o'clock position. Adjust VR₆ to the point where the receiver is just silenced. Do not go beyond this threshold point, or the SQUELCH control will not function properly.

FM DEVIATION ADJUSTMENT

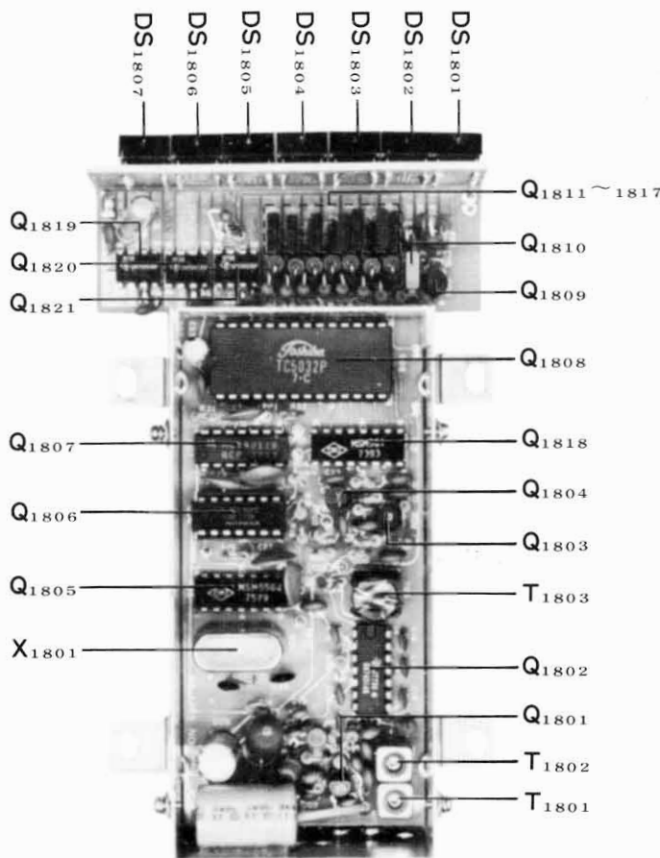
Connect a dummy load and an FM deviation meter to the antenna receptacle, and connect the output of an audio oscillator to the microphone input. Set the MODE switch to FM and the VOX GAIN control to MOX. Set VR₅₀₁ to the fully clockwise position, and VR₅₀₄ to the center of its range.

Apply a 1 kHz 3 mV audio signal to the microphone input. Observe the wave form on the oscilloscope display which is connected to a frequency deviation meter. Adjust VR₅₀₄ until a sine wave is obtained in the scope pattern.

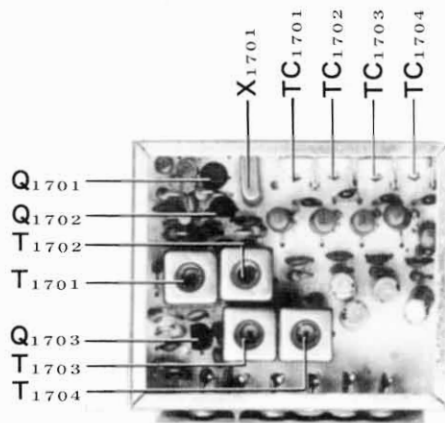
Connect a frequency counter to pin 3 of the MIC AMP UNIT and disconnect the audio signal input to the microphone input. Adjust L₅₀₁ until the oscillating frequency becomes exactly 10.7 MHz. Connect the audio generator to the microphone input again, and adjust the input level until +5 kHz deviation with a sine wave pattern is obtained. If a sine wave is not obtained, repeat the above procedures. Increase the input level to 25 mV, and adjust VR₅₀₂ for +5 kHz deviation.



TC₁₃₀₁ TC₁₃₀₂
VFO COMPARTMENT



COUNTER UNIT (PB-1735, 1803)



OSC UNIT (PB-1761)

PARTS LIST

		THERMISTOR							
RS201	29090001	SDT-250							
		CRYSTAL FILTER						INDUCTOR	
XF201	71000020	XF10A	# 210027		L201	53020032	Micro Inductor	FL-4H	3.9 μ H
					L202	53020006	"	"	6.8 μ H
					L203	53010004	"	FL-5H	220 μ H
		RESISTOR							
R251	40143560	Carbon Film	$\frac{1}{4}$ W	VJ	56 Ω				
R209,212,214,219,245	40143101	"	"	"	100 Ω			TRANSFORMER	
R246,249		"	"	"	"	T201,202	54140740	R12-4074	# 220150
R226,229	40143721	"	"	"	270 Ω	T203	54140730	R12-4073	# 220149
R218,231	40143471	"	"	"	470 Ω				
R224	40143561	"	"	"	560 Ω				
R202,235	40143681	"	"	"	680 Ω				
R204,205,211,215,221	40143102	"	"	"	1K Ω				
R228,230,241,247		"	"	"	"				
R208,210,217,223,248	40143222	"	"	"	2.2K Ω	FM IF unit			
R227	40143272	"	"	"	2.7K Ω	Symbol Number	Parts Number	Description	
R201,203,213,234,250	40143332	"	"	"	3.3K Ω	PB-1463 C-3340	60414633	Printed Circuit Board	
R225,239,240	40143392	"	"	"	3.9K Ω		014633AZ	PCB with components	
R242	40143472	"	"	"	4.7K Ω				
R206	40143682	"	"	"	6.8K Ω				
R236	40143103	"	"	"	10K Ω				
R233	40143153	"	"	"	15K Ω			IC, FET & TRANSISTOR	
R220	40143223	"	"	"	22K Ω	Q302	25000111	IC	μ A703HC
R207	40143273	"	"	"	27K Ω	Q308	25000099	"	TA7061AP
R237	40143393	"	"	"	39K Ω	Q303	22800195	FET	2SK19GR
R232,238	40143473	"	"	"	47K Ω	Q301,304~307,309~	22303724	Transistor	2SC372Y
R216,244	40143104	"	"	"	100K Ω	Q311			
R222	40143474	"	"	"	470K Ω				
R252	41143102	"	"	TJ	1K Ω				
								DIODE	
						D303~306	21001880	Germanium Diode	1S188FM
						D301,302,307~310	21015550	Silicon	1S1555
		POTENTIOMETER							
VR201	49906102	EVL-SOAA-00B13			1K Ω B				
VR202,203	49906502	EVL-SOAA-00B 53			5K Ω B			THERMISTOR	
						RS301	29090001	SDT-250	
		CAPACITOR							
C215	31820100	Ceramic Disc	50WV	10PF	NPO			CRYSTAL	
C214	31820200	"	"	20PF	NPO	X301	71800061	HC-18/U	10.245MHz
C216,247	31820101	"	"	100PF	NPO				
C241,248	30820102	"	"	0.001 μ F					
C201~204,210~213, C219,220,221,224, C226,227,236~240, C242,244	30820103	"	"	0.01 μ F				CERAMIC FILTER	
C205~209,217,218	30820473	"	"	0.047 μ F		CF302	71200009	CFM455F/LF-C12	
C233	36825682	Mylar	"	0.0068 μ F		CF303	71200010	10.7MF-BR	
C223,231,232	36825223	"	"	0.02 μ F					
C222	36825104	"	"	0.1 μ F					
C235	36526334	Tantalum	35WV	0.33 μ F				RESISTOR	
C229	34220105	Electrolytic	16WV	1 μ F		R304,305,326	40143101	Carbon Film	$\frac{1}{4}$ WVJ 100 Ω
C230	34220475	"	"	4.7 μ F		R325,327,337	40143221	"	" " " " 220 Ω
C243	34220106	"	"	10 μ F		R324	40143471	"	" " " " 470 Ω
C245	34220226	"	"	22 μ F		R303,342,346	40143561	"	" " " " 560 Ω
C225,228,234	34220476	"	"	47 μ F		R308,319,328,329,336,347	40143102	"	" " " " 1K Ω

PARTS LIST

R309	40143152	Carbon Film	¼W	VJ	1.5KΩ			IC, FET & TRANSISTOR	
R339, 340	40143222	" "	" "	" "	2.2KΩ	Q415	25000111	IC	MC14011B
R311, 313, 314, 321, 343 R349~356	40143332	" "	" "	" "	3.3KΩ	Q416, 417	22800195	FET	2SK19GR
R301, 330, 331, 335, 344	40143472	" "	" "	" "	4.7KΩ	Q412	22105641	Silicon Transistor	2SA564A
R322, 338	40143562	" "	" "	" "	5.6KΩ	Q404	22106950	"	2SA695
R302	40143103	" "	" "	" "	10KΩ	Q406	22205290	"	2SB529
R315, 316, 345	40143153	" "	" "	" "	15KΩ	Q401, 402, 407, 408, 414	22303724	"	2SC372Y
R323, 334, 341	40143223	" "	" "	" "	22KΩ	Q409, 410, 413, 418	22303730	"	2SC373
R320, 332	40143473	" "	" "	" "	47KΩ	Q403	22307110	"	2SC711
R348	40143563	" "	" "	" "	56KΩ	Q411	22307354	"	2SC735Y
R306, 307, 310	40143104	" "	" "	" "	100KΩ	Q405	22403590	"	2SD359
								DIODE	
						D401~404, 406	21015550	Silicon Diode	1S1555
						D405	29090013	Varistor	MV-5W
		CAPACITOR							
C312	31829050	Ceramic Disc	50WV	5PFSL					
C306, 307	31829330	" "	" "	" "	33PFSL				
C309, 343	31829101	" "	" "	" "	100PFSL				
C301	31829221	" "	" "	" "	220PFSL	R416	40143100	Carbon Film	¼W VJ 10Ω
C333	31820400	" "	" "	" "	40PF CH	R414	40143220	" "	" " 22Ω
C344	30820102	" "	" "	" "	0.001μF	R456	40143680	" "	" " 68Ω
C302~305, 308, 313, C315, 316, 319, 336, C345~348	30820103	" "	" "	" "	0.01μF	R457	40143101	" "	" " 100Ω
C310, 330, 331, 337, 338 C341	36825103	Mylar	" "	" "	0.01μF	R420	40143121	" "	" " 120Ω
C328, 329	36825223	" "	" "	" "	0.02μF	R403, 417, 449	40143221	" "	" " 220Ω
C311, 317, 320~325	36825473	" "	" "	" "	0.047μF	R425, 454	40143471	" "	" " 470Ω
C339, 340, 349, 350	36526105	Tantalum	25WV	1μF		R406, 407, 428, 430, 434	40143102	" "	" " 1KΩ
C335	36824101	Styrol	50WV	100PF		R441			
C326, 334	36824331	" "	" "	" "	330PF	R412, 413	40143152	" "	" " 1.5KΩ
C327	36824102	" "	" "	" "	1000PF	R402, 408, 424, 450, 452, 453	40143222	" "	" " 2.2KΩ
C332, 342	34220475	Electrolytic	16WV	4.7μF		R415	40143332	" "	" " 3.3KΩ
						R401, 440, 443, 445, 446	40143472	" "	" " 4.7KΩ
						R448, 455			
						R429	40143562	" "	" " 5.6KΩ
						R409	40143682	" "	" " 6.8KΩ
						R404	40143822	" "	" " 8.2KΩ
						R421, 427, 436, 438, 439	44143103	" "	" " 10KΩ
						R444			
						R422, 442	40143223	" "	" " 22KΩ
						R447	40143333	" "	" " 33KΩ
		INDUCTOR							
L301~303, 306~308	53020001	Micro Inductor	FL5H	1mH		R405, 426	40143393	" "	" " 39KΩ
L305	53020002	" "	" "	2mH		R410	40143473	" "	" " 47KΩ
L304	53010003	" "	EL0610	250μH		R435	40143563	" "	" " 56KΩ
						R423	40143683	" "	" " 68KΩ
						R411, 437, 451	40143104	" "	" " 100KΩ
						R431, 432	40143105	" "	" " 1MΩ
						R433	40143335	" "	" " 3.3MΩ
		TRANSFORMER							
T301, 302	54140740	R12-4074		# 220150		R418, 419	40124029	Wire Wound	½W 0.22Ω
T303	54148614	R12-4861D		# 220182					
T304	54148615	R12-4861E		# 220183					
T305	55000278	7MC312162N		# 220188					
								POTENTIOMETER	
TP301, 302	91100008	Wrapping Terminal C				VR404	49906502	EVL-SOAA-00B53	5KΩB
						VR403	49906103	EVL-SOAA-00B14	10KΩB
						VR402	49907053	EVL-VOAA-00B 54	50KΩB
						VR405	49906503	EVL-SOAA-00B 54	50KΩB
						VR401	49907504	EVL-VOAA-00B 55	500KΩB
AF AMP unit									
Symbol Number	Parts Number	Description							
PB-1764	60417640	Printed Circuit Board							
	017640AZ	PCB with components							

PARTS LIST

CRYSTAL SOCKET				FIX unit		
Symbol Number	Parts Number	Description				
XS801,802	69000006	S-14-12P		PB-1750	60417500	Printed Circuit Board
					017500AZ	PCB with components
		RESISTOR				
R819,823,829,831	40143101	Carbon Film	¼W	VJ	100Ω	
R828	40143221	" "	" "	" "	220Ω	
R822	40143561	" "	" "	" "	560Ω	
R818a	40143102	" "	" "	" "	1KΩ	
R801~812	40143152	" "	" "	" "	1.5KΩ	
R813,827	40143222	" "	" "	" "	2.2KΩ	
R817,821	40143472	" "	" "	" "	4.7KΩ	
R816,826	40143103	" "	" "	" "	10KΩ	
R820	40143223	" "	" "	" "	22KΩ	
R814,815	40143473	" "	" "	" "	47KΩ	
R824,825,830	40143104	" "	" "	" "	100KΩ	
		DIODE				
				D901~911	21015550	Silicon Diode 1S1555
		CRYSTAL				
				X901~905	—	HC-25/U Option #210055
		CAPACITOR				
C839	31829059	Ceramic Disc	50WV	0.5PF	SL	
C844,852	31829030	" "	" "	3PF	SL	
C838,841	31829070	" "	" "	7PF	SL	
C847	31829080	" "	" "	8PF	SL	
C837,840	31829150	" "	" "	15PF	SL	
C842	31829180	" "	" "	18PF	SL	
C849	31829200	" "	" "	20PF	SL	
C832	31829390	" "	" "	39PF	SL	
C802~812	31827200	" "	" "	20PF	UJ	
C801,833	31827330	" "	" "	33PF	UJ	
C828	31827560	" "	" "	56PF	UJ	
C830	31827221	" "	" "	220PF	UJ	
C850	30820102	" "	" "	0.001μF		
C813~827,831,834~836	30820103	" "	" "	0.01μF		
C843,845,846,848						
C851	30325103	Chip	25WV	0.01μF		
		CAPACITOR				
				C930	31820080	Ceramic Disc 50WV 8 PF CH
				C931	31820200	" " " 20PF CH
				C917~927	31820300	" " " 30PF CH
		TRIMMER CAPACITOR				
				C929	31820101	" " " 100PFCH
TC802~812	39000007	ECV-1ZW	20×40	20PF		
TC813,814	39000011	"	20×53	20PF		
TC815	39000010	"	10×53	10PF		
		INDUCTOR				
L801	54150999	R12-5099X		#220313		
		TRIMMER CAPACITOR				
				TC901~911	39000007	ECV-1ZW 20×40 20PF
		TRANSFORMER				
T801,802	54147970	R12-4797		#220110		
T803	54141020	R12-4102		#220111		
		INDUCTOR				
				L901~911	53020001	Micro Inductor FL5H 1mH
				L912	53010003	" 250μH
				L913	53020012	" FL4H 1.2μH
TP801,802	91100008	Wrapping Terminal C				

PARTS LIST

		DIODE					CONNECTOR		
D1101~1105	21015550	Silicon Diode	1S1555	J1101	68060013	3022-06A			
		CRYSTAL					PLUG		
X1101	71500174	HC-25/U	(1800Hz Tone) 3.6864MHz	# 210060-1	P1101	67040006	3021-04		
	71500188	"	(1750Hz Tone) 3.584MHz	# 210060-2					
		"	Option	# 210060-3					
		CRYSTAL SOCKET			KEYING unit				
XS1101	69010012	HC-25/U	SD0105	Symbol Number	Parts Number	Description			
				PB-1751A	60417511	Printed Circuit Board			
					017511AZ	PCB with components			
		RESISTOR							
R1105,1122~1125	40143101	Carbon Film	1/4W VJ	100Ω					
R1117,1118	40143471	" "	" "	470Ω			IC & TRANSISTOR		
R1106,1107,1119	40143102	" "	" "	1KΩ	Q1201	25000114	IC	MC14011B	
R1121	40143332	" "	" "	3.3KΩ	Q1202	22303724	Transistor	2SC372Y	
R1108~1110,1113, R1114,1120	40143472	" "	" "	4.7KΩ					
R1116	40143123	" "	" "	12KΩ					
R1115	40143473	" "	" "	47KΩ			DIODE		
R1101,1111,1112	40143104	" "	" "	100KΩ	D1201~1208	21015550	Silicon Diode	1S1555	
R1102~1104	40143105	" "	" "	1MΩ					
R1126	41143105	" "	" TJ	1MΩ					
		POTENTIOMETER							
VR1101	49907205	EVL-VOAA00B26	2MΩB						
VR1102	49907103	" " 14	10KΩB						
VR1103~1106	49906103	" SOAA00B14	10KΩB						
		CAPACITOR							
C1106,1107	31829470	Ceramic Disc	50WV	47PF SL	C1201~1210	30820102	Ceramic Disc	50WV 0.001μF	
C1120~1125	30820102	" "	" "	0.001μF	C1211	36526334	Tantalum	35WV 0.33μF	
C1101,1104,1105,1108	30820103	" "	" "	0.01μF					
C1113	36825222	Mylar	" "	0.002μF					
C1114	36825472	" "	" "	0.0047μF					
C1102,1109,1110,1117	36825103	" "	" "	0.01μF					
C1103	36526474	Tantalum	35WV	0.47μF			POTENTIOMETER		
C1111	34220105	Electrolytic	16WV	1μF	VR1210	49906202	EVL-SOAA-B23	2KΩB	
C1112,1116,1119	34220106	" "	" "	10μF	VR1201~1209	49906503	" " B54	50KΩB	
C1118	34220226	" "	" "	22μF					
C1115	34220476	" "	" "	47μF					
		RELAY			VFO unit				
RL1101	70000033	LZN2-1			Symbol Number	Parts Number	Description		
					PB-1774	60417740	Printed Circuit Board		
						017740AZ	VFO unit assembly		
		FET & TRANSISTOR							
	91100008	Wrapping terminal C			Q1502	22800195	FET	2SK19GR	
					Q1301,1303	22303724	Silicon Transistor	2SC372Y	

PARTS LIST

Q1818	25000085	IC	MSM561	C1843	34120477	Electrolytic	16WV	470 μ F
Q1819~1821	25000154	"	SN75453					
Q1801	22800195	FET	2SK19GR					
Q1803	22307842	Transistor	2SC784R					
Q1804,1809	22303724	"	2SC372Y					
Q1810	22104963	"	2SA496					
Q1811~1817	22304960	"	2SC496			TRIMMER CAPACITOR		
Q1822~1828	21090135	7 Segment LED	5082-7740	TC1801	39000011	ECV-1ZW	20 \times 53	20PF
		IC SOCKET				INDUCTOR		
DS1801	68140008	116-14-30-114	14P	L1801,1802	53020014	Micro Inductor	FL4H 1.8 μ H	
DS1802	68280001	116-28-30-114	28P					
						MINI CONNECTOR		
					67100007	5048-10A		
						TRANSFORMER		
		DIODE		T1801,1802	55003261			# 220312
D1801	21090011	Silicon Diode	10D1	T1803	55003174			# 220209
					91001102	Seal terminal A-102		
		CRYSTAL		TP1801~1806	91100008	Wrapping terminal C		
X1801	71600033	HC-6/W	1.31072MHz	# 210056				
					67200003	Board joint 163740		
		RESISTOR				LED board		
R1833,1835	40143470	Carbon Film	$\frac{1}{4}$ W VJ	47 Ω	Symbol Number	Parts Number	Description	
R1845	40143560	" "	" "	56 Ω	PB-1801	60418010	Printed Circuit Board	
R1824,1834	40143820	" "	" "	82 Ω		018010AZ	PCB with components	
R1805,1806,1836~1842	40143101	" "	" "	100 Ω				
R1809	40143221	" "	" "	220 Ω				
R1813,1823	40143471	" "	" "	470 Ω				
R1803,1810	40143102	" "	" "	1K Ω			DIODE	
R1807	40143392	" "	" "	3.9K Ω	D1901~1907	21090140	LED GD-4 203SRD	
R1815,1817,1818, R1820~1822,1843	40143103	" "	" "	10K Ω				
R1808,1811,1812	40143153	" "	" "	15K Ω				
R1816,1819	40143563	" "	" "	56K Ω			RESISTOR	
R1802,1814	40143104	" "	" "	100K Ω	R1901~1905	42124331	Carbon Composition $\frac{1}{2}$ W 330 Ω	
R1844	40143224	" "	" "	220K Ω				
R1832	40143564	" "	" "	560K Ω				
R1825~1831	42124330	" composition	$\frac{1}{2}$ WGK	33 Ω				
							BUFFER AMP board	
					Symbol Number	Parts Number	Description	
					PB-1671A	60416711	Printed Circuit Board	
						016711AZ	PCB with components	
		CAPACITOR						
C1824,1825	31820510	Ceramic Disc	50W	51PF CH				
C1806	31829059	" "	" "	0.5PFSL				
C1801,1805,1807,1808	31829050	" "	" "	5PF SL				
C1811	31829270	" "	" "	27PF SL			FET	
C1827~1831	31829221	" "	" "	220PFSL	Q2001	22800195	FET 2SK19GR	
C1802,1804,1809,1810 C1812~1816,1819, C1844~1848	30820102	" "	" "	0.001 μ F				
C1817,1818,1820~ C1823,1826,1832,1836 C1837	30820103	" "	" "	0.01 μ F			RESISTOR	
					R2002,2003	41143101	Carbon Film $\frac{1}{4}$ W TJ 100 Ω	
					R2004	41143102	" " " " 1K Ω	
					R2001	41143104	" " " " 100K Ω	
C1734	36916337	Tantalum	"	6.3WV 330 μ F				
C1839~1842	32821102	Feed Thru	50WV	0.001 μ F				
C1833,1838	34220106	Electrolytic	16WV R	10 μ F				
C1803	34120107	"	10WV R	100 μ F				

PARTS LIST

		CAPACITOR					TRIMMER CAPACITOR	
C2004	31829060	Ceramic Disc	50WV 6PF	SL	TC2101	39000007	ECV 1ZW	20×40
C2001	31829470	⋄ ⋄ ⋄	47PF	SL				
C2002,2003	30820102	⋄ ⋄ ⋄	0.001μF					
INDUCTOR								
					L2101	53010002	Micro Inductor	22μH
					L2102	53010003	⋄ ⋄	250μH
TRANSFORMER								
T2001	54141020	R12-4102		# 220111				
						91100008	Wrapping terminal C	
MARKER unit								
Symbol Number	Parts Number	Description						
		Printed Circuit Board			RELAY board			
PB-1802	60418020	Marker board			Symbol Number	Parts Number	Description	
PB-1804	60418040	Connector board			PB-1829	60418290	Printed Circuit Board	
	018020AZ	Marker unit with components				018290AZ	PCB with components	
IC & TRANSISTOR								
Q2103	25000108	IC	34024PC				RELAY	
Q2101,2102,2104	22303724	Transistor	2SC372Y		RL2301	70000031	BR-211 D012M	
DIODE								
D2101	21090139	Zener	RD8.2EB		ACCESSORIES			
					Symbol Number	Parts Number	Description	
						77000011	Microphone Assembly YE-11 with Microphone hanger, Screws	
						67040001	Microphone Plug FM-144P	
		CRYSTAL				67020005	Antenna plug	PL-259
X2101	71800060	HC-18/U	12.8MHz			67050003	Accessory plug	CP-0084
						67020002	Key plug	SH-3001
						67020003	External Speaker plug	P-2240
						67020003	Headphone plug	P-2240
		RESISTOR				67030002	Plug adaptor	KA-409
R2109	40143271	Carbon Film	¼W	VJ 270Ω		67020001	RCA plug	CN-7017P
R2103,2105	40143102	⋄ ⋄ ⋄	⋄	1KΩ		73000003	Fuse 3A (AC)	
R2108	40143222	⋄ ⋄ ⋄	⋄	2.2KΩ		73000005	Fuse 10A (DC)	
R2102	40143103	⋄ ⋄ ⋄	⋄	10KΩ		96000001	AC power cord	# 240011
R2101,2107	40143223	⋄ ⋄ ⋄	⋄	22KΩ		68040005	Power plug	QMSP4FK
R2106	40143104	⋄ ⋄ ⋄	⋄	100KΩ		96000003	DC power cord	# 240068
R2104	40143224	⋄ ⋄ ⋄	⋄	220KΩ		68040005	Power plug	QMSP4FK
						69000002	Fuse holder	SN1102
						67020008	Cigarette lighter adaptor	
CAPACITOR								
C2101,2107	31820270	Ceramic Disc	50WV 27P	CH				
C2102,2103	31820221	⋄ ⋄ ⋄	220PF	CH				
C2108	31829030	⋄ ⋄ ⋄	3PF	SL				
C2104~2106,2110	30820103	⋄ ⋄ ⋄	0.01μF					
C2111	32821102	Feed Thru	50W	1000PF				
C2109	35220106	Electrolytic	16W	10μF				