

**INSTRUCTION
MANUAL
FT-480R**

YAESU MUSEN CO., LTD.

TOKYO JAPAN

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FT-480R

MICROPROCESSOR CONTROLLED 2 METER ALL-MODE TRANSCEIVER



GENERAL DESCRIPTION

The FT-480R is a revolutionary, high performance USB, LSB, FM, and CW transceiver for the most demanding 2-meter operator. Controlled by a NMOS 4-bit microprocessor, the FT-480R features full PLL synthesis in 10 Hz, 100 Hz, 1 kHz, 20 kHz (US model), and 100 kHz steps. The extremely compact size of the FT-480R makes this model particularly well suited for mobile use.

The microprocessor chip allows never-before-possible operating flexibility. As many as four memory channels may be programmed to your favorite frequencies, and by switching to the MEMORY SCAN position, all four memory channels will be scanned.

Digital display of the operating frequency is provided. The front panel meter consists of a string of bright LED's, for easy monitoring of the received signal strength and transmitter output.

The standard microphone features a PTT switch and up/down scanning controls plus a tone call button for repeater operation.

Among the convenience features of your FT-480R are receiver offset tuning for CW and SSB, and a digitally synthesized dual VFO system.

We recommend that you read this manual in its entirety, so as to derive maximum benefit from your new FT-480R, an exciting breakthrough from the communications experts . . . Yaesu.

SPECIFICATIONS

GENERAL

Frequency coverage:

*143.500–148.500 MHz

Modes of operation:

SSB (USB, LSB), CW, and FM

Synthesizer steps:

SSB, CW 10 Hz, 100 Hz, 1 kHz

*FM 1 kHz, 20 kHz, 100 kHz

Power requirements:

13.8 volts DC, negative ground

Current consumption:

DC 0.5 amps receive

DC 3.0 amps transmit

Antenna impedance:

50 ohms

Case size:

60 (H) x 180 (W) x 240 (D) mm

Weight:

Approx. 2.9kg

TRANSMITTER

Power input:

SSB 30 watts PEP

FM/CW 30 watts DC

Carrier suppression:

Better than 40 dB

Unwanted sideband suppression:

Better than 40 dB

Spurious emission (SSB):

At least 60 dB down

Frequency response:

300–2700 Hz (–6 dB)

FM Deviation:

±5 kHz

Microphone impedance:

600 ohms

RECEIVER

Sensitivity:

SSB, CW 0.5 μ V for 20 dB S/N

FM 0.35 μ V for 20 dB QS

Selectivity:

SSB, CW 2.4 kHz at 6 dB down

4.1 kHz at 60 dB down

FM 14 kHz at 6 dB down

25 kHz at 60 dB down

Image response:

Better than –60 dB

Audio output impedance:

8 ohms nominal

Audio output:

2.0 watts @ 10% THD

* USA Model (Model A)

Model	Frequency Range (MHz)	Synthesizer Steps (Hz)						Tone Burst Frequency (Hz)	Preset Frequency (MHz)
		SSB, CW			FM				
		S	M	F	S	M	F		
A	143.5–148.5	10	100	1K	1K	20K	100K	1800	147.00
B	144.0–146.0	10	100	1K	1K	25K	100K	1750	145.00
C	143.5–148.5	10	100	1K	1K	25K	100K	1750	147.00
D	144.0–146.0	10	100	1K	1K	12.5K	25K	1750	145.00
E	143.5–148.5	10	100	1K	1K	12.5K	25K	1750	147.00

SEMICONDUCTORS

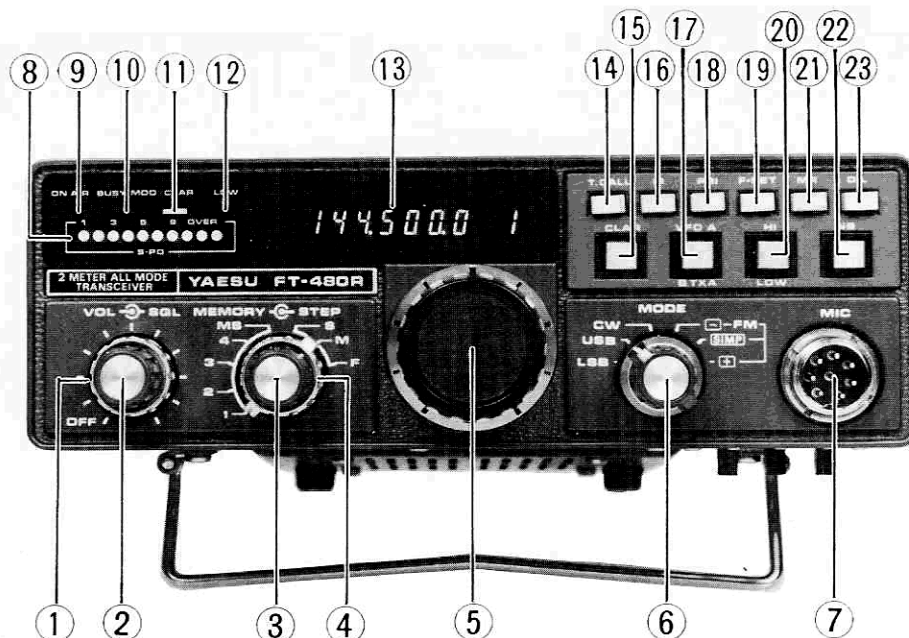
IC: MC1496G 1 MC14011B 4 MC14560B 2 MC14028B 1 MC14069B 1 MC14002B 1 μA78L05 3 μPC7808H 1 μPC577H 1 μPC1037H 1 μPC2002V 1 μPC7805H 1 μPD4094B 3 μPD1511-11 1 TC9122P 2 TC5081P 2 TC5082P 2 SN16913P 2 SN76514N 1 HD10551 2 MB8718A 1 TA7612AP 1	2SK19TMGR 3 2SK30AY 1 2SK51 1 3SK59Y 1 3SK70 1 3SK73Y 8	MPSA13 2 Diode: 1S188FM 18 1S1007 4 1S1555 1 1S2209 14 U05B 1 1SS53 91 10D1 4 MV104 2 HZ11B-1 1
	Transistor: 2SA715C 1 2SA733P/Q 20 2SC535A 5 2SC535B 3 2SC732TMBL 1 2SC945P 1 2SC945Q 37 2SC945K 1 2SC1383R 3 2SC1583 3 2SC1674L 2 2SC1815Y 5 2SC1815GR 3 2SC1945 1 2SC2002L 1 2SC2053 1 2SC2166 1 2SC2785E 1	LED: TLG-205 2 TLR-205 2 TLR-226 3 TLY-226 2 TLG-226 5
FET: 2SK19TMY 1		FCD: LD8231/F1P9C5 1

Specifications subject to change without notice or obligation.

ACCESSORIES

- | | | | |
|----|-------------------------|-------------|-------|
| 1. | Microphone | (M3090028) | 1 ea. |
| 2. | Power Cord | (T9002805) | 1 ea. |
| 3. | Spare Fuses (5A) | (Q0000005) | 2 ea. |
| 4. | Stand | (R0062300A) | 1 ea. |
| 5. | Miniature Phone Plug | (P0090034) | 2 ea. |
| 6. | Mobile Mounting Bracket | (R0062900) | 1 ea. |
| 7. | TONE IN Connector | (P0090174) | 1 ea. |

FRONT PANEL CONTROLS AND SWITCHES



The FT-480R has been designed for ease of operation. However, the operator may not be familiar with some controls since the FT-480R utilizes modern computer technology. Be sure you thoroughly understand the function of each control and indicator before operating this equipment.

(1) SQL

The squelch control quiets the receiver in the absence of a signal on FM. It should be set to the point where the background noise just disappears, in order to provide maximum sensitivity.

(2) VOL

This control is the main ON/OFF switch for the transceiver, and it also sets the audio output level to the speaker. Clockwise rotation increases the audio output level.

(3) STEP

The 3 positions of this switch control the tuning rate of the Main dial, as shown in Table 1.

STEP SWITCH POSITION	MAIN DIAL FREQUENCY COVERAGE PER STEP	
	SSB/CW	FM
S	10 Hz	1 kHz
M	100 Hz	*20 kHz
F	1 kHz	*100 kHz

Table 1

* USA Model (Model A)

(4) MEMORY

This switch selects the MS mode (Memory Scan) or one of the four frequencies that the operator has programmed into memory. Memory scan control is exercised via the UP/DOWN switches on the microphone.

(5) MAIN TUNING KNOB

The tuning knob is used to control the receive and transmit frequencies over the entire 2 meter amateur band. It is activated when the DIL button is pushed.

When the transceiver is initially turned on, the display will indicate 147.000.0 MHz, and the dial may be turned from that point to the desired operating frequency.

(6) MODE

This switch selects the mode of operation: USB (upper sideband), LSB (lower sideband), CW (code operation), and FM (frequency modulation).

This switch also selects the FM transmitting frequency.

— : The transmitting frequency is 600 KHz lower than the receive frequency.

SIMP : Simplex operation.

+ : The transmitting frequency is 600 KHz higher than the receive frequency.

(7) MIC

The MIC jack is used for microphone input, PTT control, and scanner control lines.

(8) S/PO

A string of LEDs provides indication of signal strength and relative power output.

(9) ON AIR

This indicator lights up during transmission.

(10) BUSY/MOD

This indicator has a dual function: it will light up when the channel is occupied, or indicate modulation during FM transmissions.

(11) CLAR Indicator

This lamp lights when the clarifier switch is pushed.

(12) LOW

This lamp lights when the HI/LOW switch is in the LOW position.

(13) Digital Display

The digital display indicates the operating frequency. In the priority mode, the character "P" will be illuminated at the far right-hand side of the window. Also, the memory channel in use will be indicated for easy frequency reference.

(14) T.CALL

When this switch is pushed, the PTT line will close, and a 1750 Hz or 1800 Hz tone will be transmitted for accessing repeaters.

(15) CLAR

The clarifier switch allows ± 10 kHz offset of the receive frequency from the dial or memory frequency. Clarifier tuning is accomplished via the main tuning dial. When the CLAR switch is pushed, the scanning step selector should be set to 10 Hz or 100 Hz; if not, control will be returned to the main dial, with the clarifier being disabled.

(16) M (Memory)

This switch is used for programming a frequency into memory.

(17) VFO A/B TXA

This switch, when pressed, allows split operation using the two internal VFOs.

(18) PRI

While operating in the dial tuning mode, the PRIORITY switch allows scanning of the main dial and one of the memorized frequencies every 5 seconds. The SCAN switch controls the stopping of the scanner on a busy or clear channel.

(19) F.SET

This switch, when pressed, clears all digits of the operating frequency below the step frequency you are using.

(20) HI/LOW

This switch, when pressed, reduces the transmitter power from 10 watts to 1 watt RF output.

(21) MR (Memory Recall)

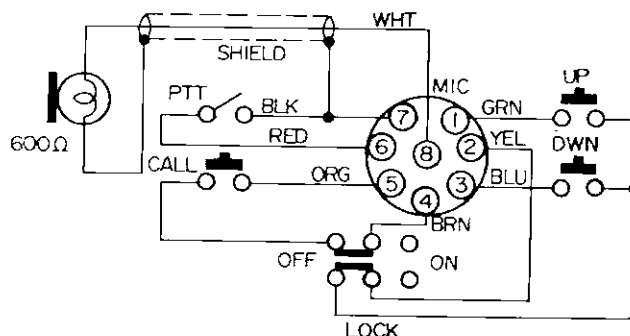
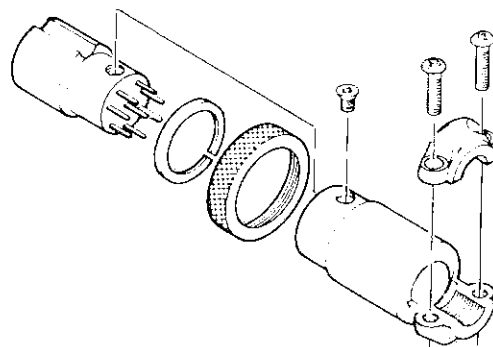
This button transfers frequency control from the main dial to the memory channels.

(22) NB (Noise Blanker)

This switch, when pressed, activates the noise blanker for minimizing pulse-type noise.

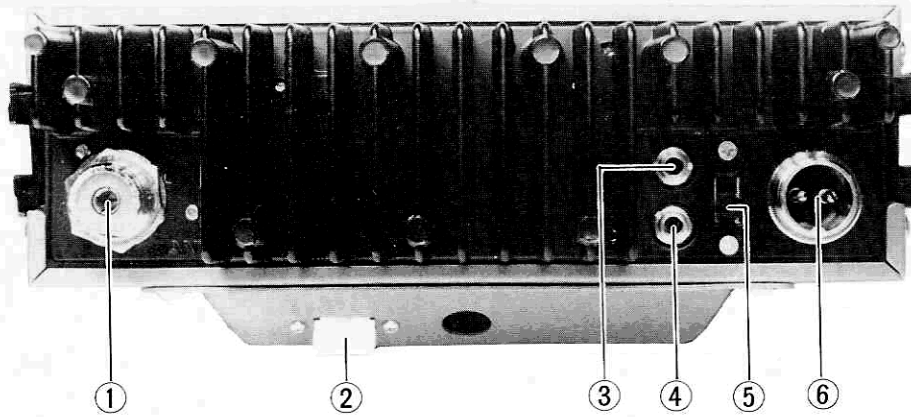
(23) DIL (Dial)

This switch, when pressed, transfers frequency control from the memory channels to the main tuning dial.



YM-40 MICROPHONE CONNECTIONS

REAR PANEL CONNECTIONS AND SWITCH



(1) ANT

This is the main antenna connector.

(2) TONE IN CONNECTOR

This connector is provided for the optional external FTS-64E Tone Encoder, which synthesizes 32 CTCSS or tone burst frequencies.

(3) KEY

This is the key jack for CW operation. The key-up voltage is 3.5 V, while the key-down current is approximately 1 mA.

(4) EXT SP

This is a miniature phone jack for connection to an external speaker. Insertion of a plug into this jack automatically cuts off the internal speaker.

(5) BACKUP

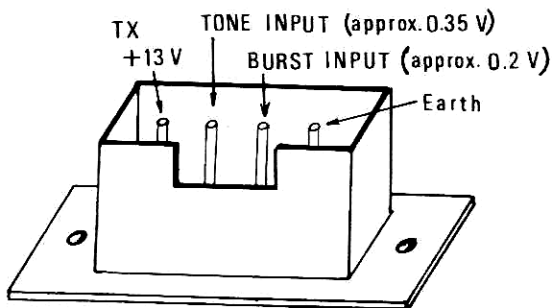
When this switch is placed in the ON position, and DC power is still connected to the POWER connector, the memory circuit will still be held in operating condition. If DC power is removed, though, the memorized frequency will be lost.

(6) POWER

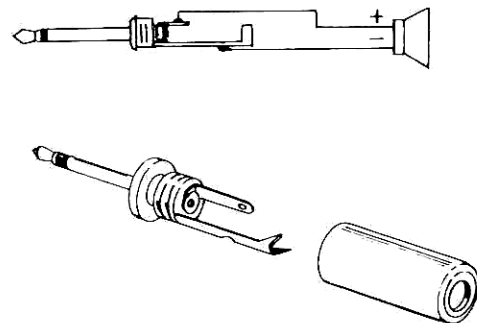
This receptacle accommodates the power cord. A fuse rated at 5 amps is located in the power cord.

WARNING

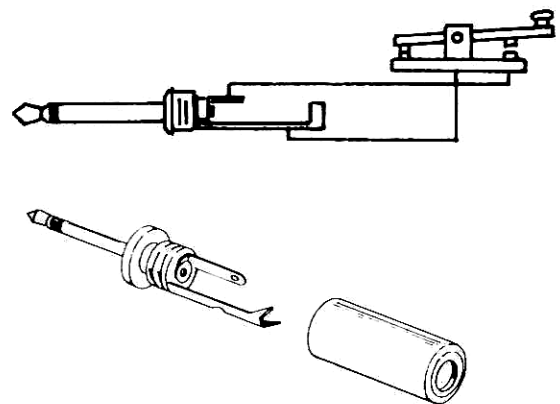
WHEN REPLACING FUSES, BE CERTAIN TO USE A FUSE OF 5 AMP RATING. OUR WARRANTY DOES NOT COVER DAMAGE CAUSED BY USE OF AN IMPROPER FUSE.



TONE IN CONNECTOR

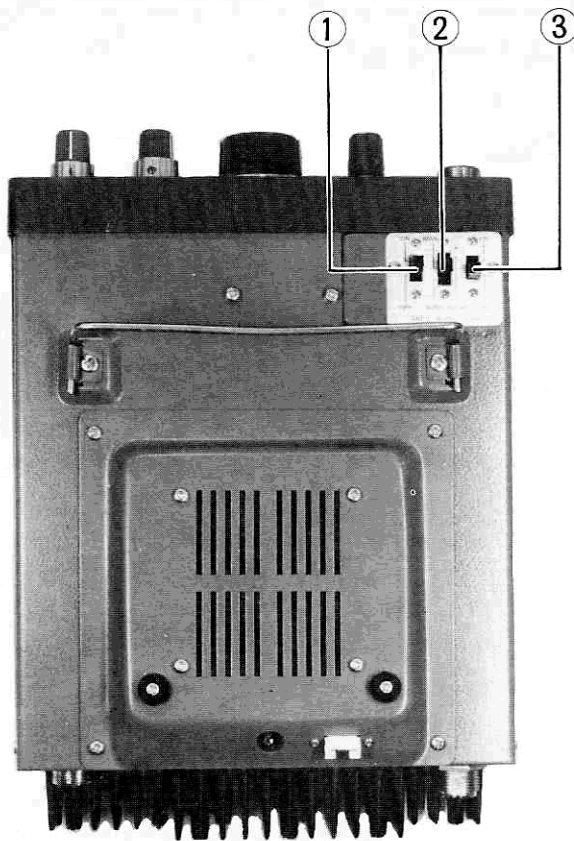


EXTERNAL SPEAKER CONNECTIONS



KEY CONNECTIONS

UNDERSIDE CABINET SWITCHES



(1) SAT (Satellite)

This switch allows the operating frequency to be changed while transmitting. This feature is useful especially for satellite operation, for it allows the operator to zero on the proper frequency within the satellite passband. Neither VFO A/B TXA nor the CLARIFIER function works when the SAT switch is placed in the ON position.

(2) SCAN

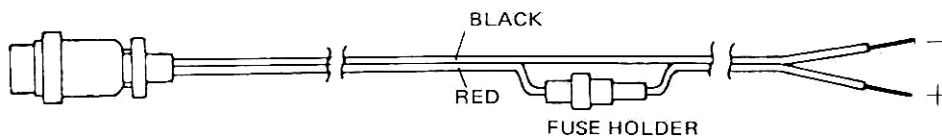
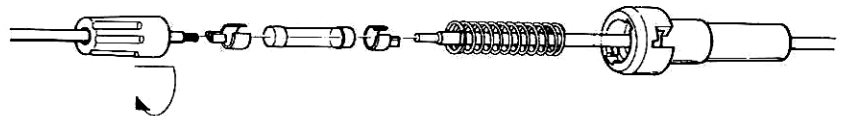
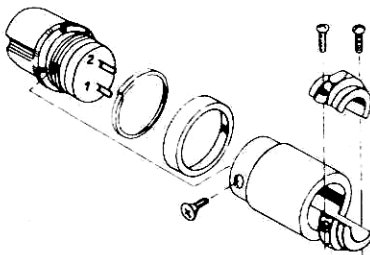
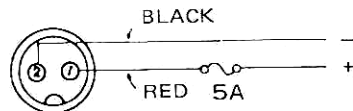
This switch will select scanning stop on a busy or clear channel in the FM mode. Manual scanning stop is also provided on all modes.

(3) BURST

The BURST switch applies a short "tone burst" to the carrier at the start of each transmission in the "ON" position. This is normally used only for "tone access" repeater actuation.

CAUTION

THE WIRE STAND SHOULD BE INSERTED IN THE MOUNTING HOLES ON THE BOTTOM COVER IN ORDER TO PREVENT DAMAGE TO THE SWITCHES ON THE COVER.



POWER CORD CONNECTIONS

INSTALLATION

ANTENNA CONSIDERATIONS

The FT-480R is designed for operation using an antenna presenting a 50 ohm resistive load. The automatic final transistor protection circuitry will reduce the power output to protect the transistors when a high antenna SWR is encountered. The SWR on the antenna should, if possible, be kept below 1.5 : 1 at all times to secure full output from the transceiver.

In most cases, coverage is a function of antenna height. The antenna for base station operation should be located as high and in the clear as possible. Vertical polarization is standard for FM communications in most areas, so be sure that your antenna is oriented appropriately. Popular antennas for base station use include the 5/8 wavelength vertical or one of the many stacked dipole arrays. For accessing repeaters a long distance away, a Yagi or other high gain directional array may be required.

For mobile applications, the most popular antennas are the 1/4 wavelength vertical and the 5/8 wavelength vertical, which shows approximately 3 dB gain over the 1/4 wavelength vertical.

Do not economize on coaxial cable, as much power can be wasted in lossy transmission line. For mobile use, the RG-58A/U type of coax may be used. To minimize loss, use the shortest length that is possible. For base stations, use type RG8A/U coaxial cable. For very long runs, type RG17A/U, aluminum-jacketed "foamflex" coax, or air dielectric "heliac" cable may be used.

The optional antenna duplexer AD-1 allows the operation on both 50 and 144 MHz using a single antenna (RSL-50 or RSL145).

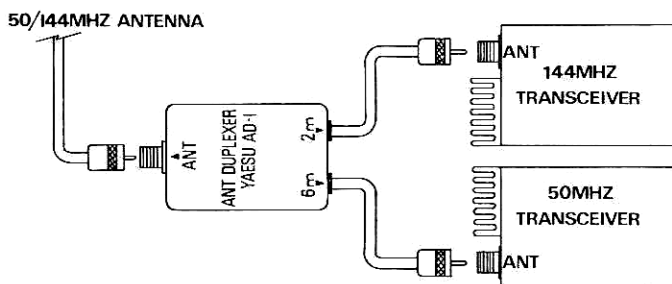
See your Yaesu dealer.

MOBILE INSTALLATION

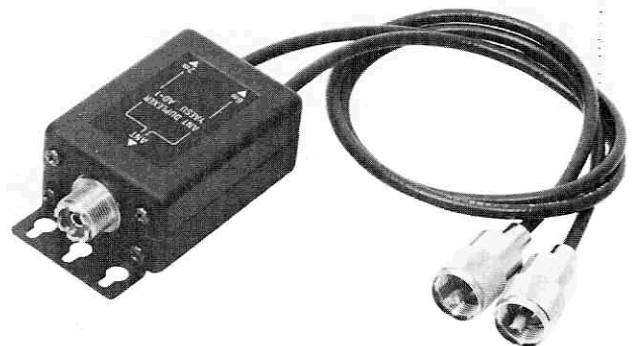
For mobile service, the FT-480R should be installed where the digital display, controls, and microphone are easily accessible for operation. The transceiver may be installed in any position without loss of performance. A suitable location would be atop the transmission tunnel. A universal bracket is supplied with your transceiver for mobile installation. Refer to Fig. 1 for mounting details.

1. Use the universal mounting bracket as a template for positioning the mounting holes. Use a 3/16" diameter bit for drilling these holes, allowing clearance for the transceiver, its cables and microphone, and its controls. Secure the mounting bracket with the screws, washers, and nuts supplied, as shown in the drawing.
2. Ease the transceiver into the guide rail, and slide it into the desired position. Tighten the knobs on the outside of the universal bracket to secure the transceiver.
3. The microphone hanger may be installed wherever convenient for access to the microphone.

Power connections should be made directly to the automobile battery. Routing through the cigarette lighter may cause the lighter fuse to blow if the fuse is not of sufficient rating. As well, connection directly to the battery allows the memory circuits to remain activated when the ignition is turned off, using the BACKUP switch.



AD-1 ANTENNA DUPLEXER



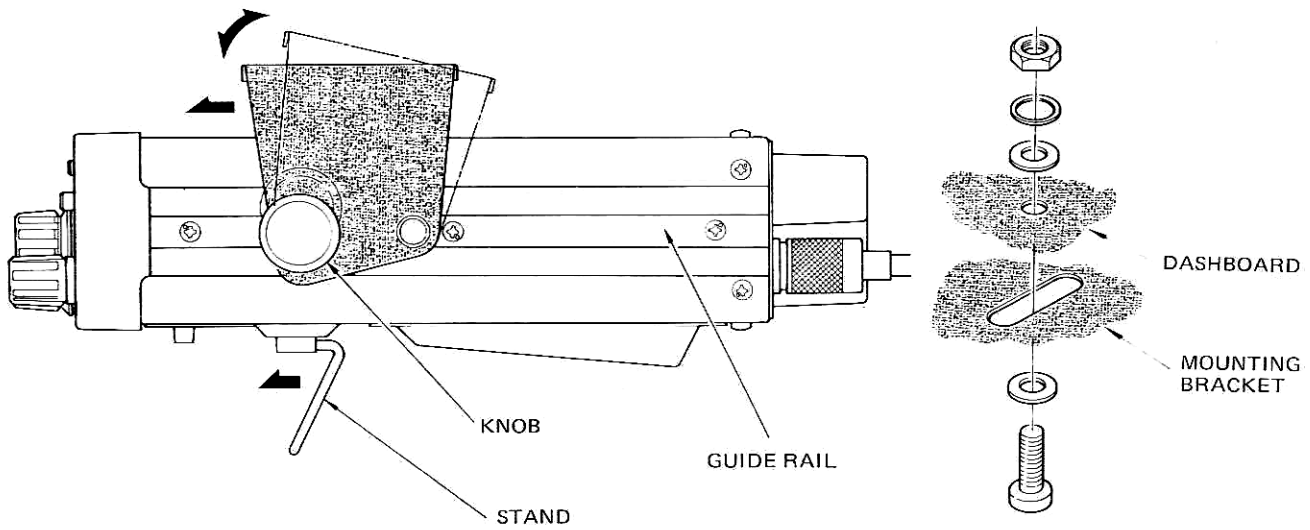


Figure 1

Connect the RED lead of the power cord to the POSITIVE (+) battery terminal, and connect the BLACK lead to the NEGATIVE (-) terminal. If it is necessary to extend the power cable, use #16 AWG insulated copper wire, and use the minimum length practicable to reduce voltage drop.

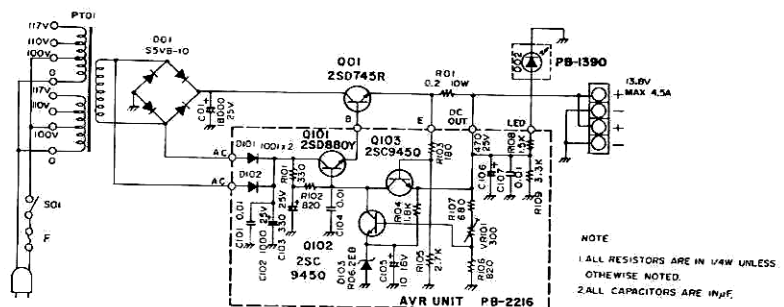
WARNING

NEVER APPLY AC POWER TO THE REAR PANEL POWER JACK OF THE TRANSCEIVER. NEVER CONNECT A DC POWER SOURCE OF GREATER THAN 15 VOLTS TO THE REAR PANEL POWER JACK. ALWAYS REPLACE FUSES WITH A FUSE OF THE PROPER RATING. FAILURE TO OBSERVE THESE SIMPLE PRECAUTIONS WILL VOID ALL WARRANTIES ON THIS EQUIPMENT.

Connect the power cable to the POWER receptacle on the rear apron, connect the coaxial cable from the antenna to the rear apron ANT receptacle, and connect the microphone to the jack appropriate for the microphone in use. An external speaker may be connected to the rear apron SP jack, if desired. Use the speaker plug supplied with the transceiver. Insertion of a plug into this jack automatically cuts off the internal speaker.

BASE STATION INSTALLATION

A base station mounting stand is supplied with your transceiver, to provide easier viewing of the display and controls. A power supply capable of supplying 5 amps at 13.8 VDC is required for operation from AC mains. The FP-80A AC power supply option provides the required 13.8 VDC for the FT-480R transceiver. See your Yaesu dealer.



FP-80A POWER SUPPLY

OPERATION

The all solid-state design of the FT-480R means that tuning procedures are very simple. The following paragraphs will describe the tuning procedures for receiver and transmitter operation.

INITIAL CHECK

Before connecting the transceiver to the power supply, be certain that a fuse of the proper rating is in use, and that a 50 ohm antenna has been connected to the antenna jack.

FREQUENCY SELECTION USING MAIN DIAL

When the transceiver is initially turned on, the digital display will read the preset frequency 147.000.0 MHz, and frequency control will be via the main tuning dial. After memory, scanning, or priority operation, pressing the DIL button will return control to the main dial. Rotate the dial to secure the operating frequency desired. Since tuning steps depend on the combination of the MODE switch and STEP switch as shown in Table 1, use the synthesizer step for easy tuning. When the upper or lower bandedge is reached the next synthesizer step will automatically be to the opposite bandedge. Thus, after 148.499.9 MHz, the next step is 143.500.0 MHz. While transmitting, the operation frequency can not be changed in any operation modes except the satellite mode.

RECEIVER OPERATION

Preset the controls and switches as follows:

MODE Desired mode
SQL Fully counterclockwise
STEP Desired synthesizer step
VFO A/B TXA . . . VFO "A" position
SCAN MAN position
All other switches should initially be turned off.

Rotate the VOL control clockwise to turn the transceiver on and adjust for a comfortable level.

(1) SSB mode

Using the main tuning dial, tune in an SSB signal. The STEP switch should be set to M or F position so that you can secure the operating frequency

desired in 100 Hz or 1 kHz steps. When you get close to the desired frequency, set the STEP switch to S position for 10 Hz step in order to tune in the signal clearly. When pulse type noise such as ignition noise is encountered, press the NB (noise blanker) switch.

(2) CW mode

With the clarifier off, 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 function.

(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.

Set the STEP switch to the M (20 kHz) position, as almost all FM stations use 20 kHz steps. When you change the operating mode from SSB/CW to FM, you may clear the display and operating frequency to the next lowest 20 kHz step by pressing the F STEP button. All the digits of the operating frequency below 10 kHz will be set to zero by pressing the F.SET button.

When the channel is clear, rotate the SQL control to the point where the background noise is just silenced. Do not rotate the SQL control much beyond this threshold point, or else the receiver will not respond to weak signals. The BUSY/MOD lamp will light up when the squelch circuit is opened. If the S-meter wobbles, or if it is impossible to obtain clear audio, it is possible that the incoming signal is on another mode such as SSB.

TRANSMITTER

Before transmission, be certain that the frequency on which you are going to operate is clear to prevent interruption of the other station's operation. It is important that an antenna or dummy load be connected to the antenna jack at all times.

(1) SSB mode

Set the MODE switch to SSB and close the microphone PTT switch; the ON AIR lamp should light

up. Speak into microphone in a normal voice; the S.P.O LEDs will light up according to the relative output power.

(2) CW mode

Plug a key into the KEY jack on the rear panel. In the key-down condition, the 8–9 LEDs of the indicator will light up. Since the semi-break-in circuit is furnished, when the key is closed, your keying activates the transmitter, and the 800 Hz side tone will be heard from the speaker. With the HI/LOW switch pressed, the power output of 10 watts may be reduced to 1 watt, and the LOW lamp will light up.

(3) FM mode

Set the MODE switch to FM, and close the microphone PTT switch. When transmitting, 8–9 LEDs which show relative output power will light up, and the BUSY/MOD lamp will be illuminated according to the voice input. On this mode, 10 watts of RF output power can also be reduced to 1 watt by pressing the HI/LOW button.

MEMORY OPERATION

A total of four memory channels are available for operation. Storage and recall of memory channels allows considerable operating flexibility. The storage and recall procedure is extremely simple.

- (1) Rotate the main tuning dial to the desired frequency, for example 144.640.0 MHz. Now rotate the MEMORY switch to position 1. Press the M button to store 144.640.0 MHz into memory channel position 1.
- (2) Now rotate the main tuning dial to another frequency (for example 144.360.0 MHz). For instant return to 144.640.0 MHz, press MR button, the 144.640.0 1 will be displayed on the digital readout.
- (3) To return again to 144.360.0 MHz, press DIL, and you will be operating on 144.360.0 MHz.
- (4) Memory channels 2, 3 and 4 may be programmed and recalled as above.
- (5) When you push the MR button, the far right LED on the readout will illuminate, indicating the memory channel.

- (6) To return frequency control to the main tuning dial, push the DIL button.
- (7) Set the STEP switch to the desired step before activating the clarifier in the memory operation. Changing the synthesizer step with the CLAR switch ON will lock the operating frequency.

SCANNER OPERATION

Fingertip switches, located on the microphone, allow convenient frequency control, while driving. The simple operating procedure is described below.

- (1) Set the bottom panel SCAN switch to the MAN position. Push the DIL switch to select operation on the dial frequency.
- (2) Press the microphone UP switch for an instant to shift the frequency up by one step. If you hold the UP button for more than 1/2 second, the scanner will be activated. To stop the scan, press the PTT switch or one of the scanning controls on the microphone. If you push the PTT switch, no transmission will occur; release the PTT switch, then press it again for normal transmission.
- (3) To scan lower in frequency, use the same procedure, but press the DWN button.
- (4) In the FM mode, to halt the scan automatically on a busy channel, set the bottom panel SCAN switch to BUSY. In this mode, when the scanner encounters a signal strong enough to open the receiver squelch, scanning will stop. When the bottom panel switch is placed in the CLEAR position, the scan will stop when a clear channel (one where the squelch will not open) is found.
- (5) To scan only the memory channels, rotate the MEMORY switch to the MS (memory scan) position. Now press the UP or DWN switch on the microphone. The scanning rate for memory scan will be approximately two channels per second. The scan may be halted in any of the ways discussed previously. The BUSY and CLEAR positions of the SCAN switch are particularly helpful when scanning the memory channels in the FM mode.

PRIORITY CHANNEL OPERATION

A priority channel may be used in conjunction with a memory channel for increased flexibility. Here is how to set up the FT-480R for priority operation.

- (1) First program one or more memory channels for priority use. For example, store 144.640.0 MHz into memory channel 1. Set the bottom panel SCAN switch to MAN. Rotate the main dial to the desired frequency (for example 144.360.0 MHz).
- (2) Now set the MEMORY switch to 1 and push MR to recall 144.640.0 MHz and then push the PRI (priority) switch. The display will indicate 144.360.0 P, and every 5 seconds the display will switch to 144.640.0 MHz allowing you to check it for activity.
- (3) If you have other frequencies stored in memory, you may rotate the MEMORY switch to select one for use with the priority channel.
- (4) In the FM mode, you may use the SCAN switch to good advantage during priority operation, as described in SCANNER OPERATION.
- (5) If you wish to return to normal operation from the priority mode, push the DIL button. Now control is shifted back to the main dial.

REPEATER OPERATION

- (1) Repeater shifts of +600 kHz, and -600 kHz are built into the FT-480R. To select these shifts, set the MODE switch to the + or - position respectively.
- (2) To cover unusual repeater splits, you can use the VFO A/B TXA feature.
Example: receive frequency 144.640 MHz with 1 MHz split. Rotate the main tuning dial to the 145.640 MHz and press the VFO A/B TXA button on the front panel; now the transmit frequency, 145.640 MHz, is memorized. Rotate the main tuning dial to 144.640 MHz for receiving. If you close the PTT switch, your transmit frequency will be shifted to 145.640 MHz.

- (3) A 1750 or 1800 Hz tone generator is included with your transceiver for accessing a repeater requiring such a tone. With the BURST switch ON, pushing the microphone PTT will cause insertion of an 0.5 second tone at the beginning of each transmission. When the T.CALL switch is pushed, a tone will be superimposed on the signal being transmitted, for as long as the switch is held. An optional external tone or burst generator, FTS-64E may be connected through the rear panel TONE IN connector.

INITIALIZING FREQUENCY/BACKUP FEATURE

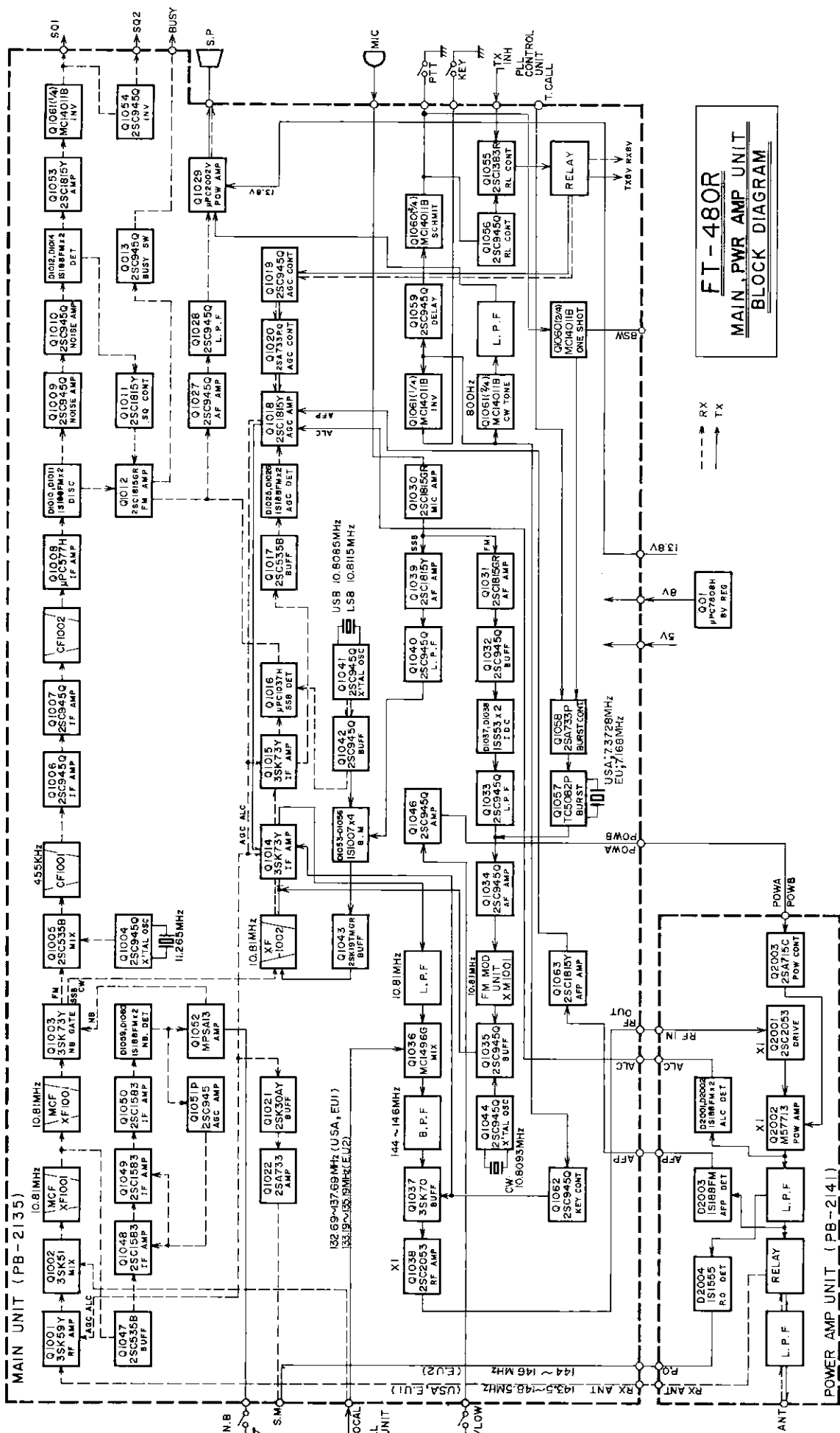
The FT-480R includes a backup feature which will hold all memory frequencies, as well as dial frequency, when the front panel power switch is turned off. So long as the DC power to the rear apron power jack is not interrupted, these frequency will be held. When the power is again turned on, the frequency and mode (memory priority, dial, etc.) last used will be recalled, but scanning mode is automatically reset to dial mode. However, if the power cord is connected to 13.8 VDC circuit that is switched off along with the automobile ignition, all memory channels as well as the dial frequency will be reset to the preset frequency.

SATELLITE OPERATION

The FT480R includes provision for changing the transmitting frequency while you are transmitting (some other synthesized transceivers lock up during transmission). The ability to change frequency in this manner is important during satellite operation, as Doppler shift may cause your downlink frequency to be $\pm 3-4$ kHz from a predicted value. While listening on the downlink, and sending a series of dots, satellite operators can usually find themselves quite quickly.

To allow frequency change during transmission, set the bottom panel SAT (Satellite) switch to ON. For most satellite work on SSB or CW, the synthesizer step switch should be set to Slow or Medium. You may now close the PTT switch and vary your frequency as desired. Note that your receiver frequency will also change if you rotate the main dial.

When the SAT switch is set to ON, the \pm repeater shift and receive clarifier features are disabled.



FT-48OR
MAIN, PWR AMP UNIT
BLOCK DIAGRAM

--- RX
 --- TX

CIRCUIT DESCRIPTION

The block diagram and circuit description to follow will provide you with a better understanding of this transceiver. Please refer to the block and schematic diagram for specific circuit details.

RECEIVER

The RF signal from the antenna jack is applied to the MAIN UNIT through a lowpass filter and the antenna relay, RL₂₀₀₁. The signal is amplified by Q₁₀₀₁ (3SK59Y), a dual gate MOS FET with excellent rejection of cross modulation and intermodulation. The amplified signal is fed to the 1st mixer, Q₁₀₀₂ (3SK51-03), where the RF signal is mixed with a local signal delivered from the PLL UNIT, resulting in a 10.81 MHz first IF signal.

The first IF signal is passed through a monolithic crystal filter, XF₁₀₀₁ (108M30B), which has ±15 kHz bandwidth, and amplified by Q₁₀₀₃ (3SK73Y), which acts as a switch driven by the NB (noise blanker) circuit. The amplified signal from Q₁₀₀₃ is fed to IF amplifiers for each mode.

FM mode signal is fed to 2nd mixer Q₁₀₀₅ (2SC535B), where the signal is mixed with an 11.265 MHz local signal, resulting in a 455 kHz 2nd IF signal.

The 2nd IF signal is passed through a ceramic filter, CF₁₀₀₁, which has a ±4.5 kHz bandwidth, and then fed to the FM mode IF amplifier.

The filtered signal is amplified by Q₁₀₀₆ and Q₁₀₀₇ (2SC945Q) and passed through CF₁₀₀₂, which has a ±7.5 kHz bandwidth. The filtered FM signal is amplified by Q₁₀₀₈ (μPC577H) and demodulated by CD₁₀₀₁ and D₁₀₁₀/D₁₀₁₁ (1S188FM). The demodulated FM signal is amplified by Q₁₀₁₂ (2SC1815GR) and then fed to the AF amplifier.

SSB and CW mode signals from the Q₁₀₀₃ are passed through a crystal filter, XF₁₀₀₂, which has a very high shape factor, to improve adjacent frequency selectivity. The filtered SSB signal is amplified by Q₁₀₁₄ and Q₁₀₁₅ (3SK73Y), and then fed to the balanced demodulator, Q₁₀₁₆ (μPC1037H), where a carrier signal is applied from the carrier oscillator Q₁₀₄₁/Q₁₀₄₂ (2SC945Q); the detected audio output is then fed to the AF amplifier.

The audio signals from each demodulator are passed to the active lowpass filter, which consists of Q₁₀₂₇ and Q₁₀₂₈ (2SC945Q) to eliminate the unwanted noise portion of the signal. The audio signal is then fed, through the AF gain control, to the audio output amplifier, Q₁₀₂₉ (μPC2002V), providing about 2 watts of audio output to the speaker.

S-METER CIRCUIT

A portion of the amplified IF signal is fed to Q₁₀₁₇ (2SC535B), a buffer amplifier, through C₁₀₈₀. The amplified signal is then applied to the AGC detector, D₁₀₂₅/D₁₀₂₆. The rectified signal is amplified by DC amplifier Q₁₀₁₈ (2SC1815Y) for AGC control. This AGC voltage is delivered to the front panel S.PO indicator to illuminate LEDs according to the input signal strength.

SQUELCH CIRCUIT

A portion of the demodulated FM signal from the ceramic discriminator (CD₁₀₀₁, D₁₀₁₀, D₁₀₁₁) is fed to noise amplifiers Q₁₀₀₉ and Q₁₀₁₀ (2SC945Q) through VR₁₀₀₂ and the SQ Control (VR_{1b}), and then rectified by D₁₀₁₂ and D₁₀₁₄, a voltage doubling circuit. The rectified signal is fed to the base of Q₁₀₁₁ (2SC1815Y), the squelch control circuit.

When no carrier is present, the rectified DC voltage is applied to the base of Q₁₀₁₁, to turn Q₁₀₁₂ (2SC1815GR) on. With conduction of Q₁₀₁₁, the base of Q₁₀₁₂ is grounded, squelching the audio amplifier.

When a carrier is present, the rectified DC voltage is reduced; and the audio amplifier Q₁₀₁₂ then recovers to normal operation. The BUSY lamp switch, Q₁₀₁₃ (2SC945Q), is also activated by the rectified voltage from the demodulator to illuminate the BUSY lamp when a carrier is present.

NB (Noise Blanker) CIRCUIT

A portion of the IF signal from monolithic filter XF₁₀₀₁ is amplified by Q₁₀₄₇ (2SC535B), Q₁₀₄₈, Q₁₀₄₉, and Q₁₀₅₀ (2SC1583). The output signal is rectified by D₁₀₅₉ and D₁₀₆₀, producing a DC voltage. This DC voltage is amplified by Q₁₀₅₂ (MPSA13) and fed to gate 2 of Q₁₀₀₃, the noise blanker gate. A portion of the DC voltage is amplified by Q₁₀₅₁, and then fed to Q₁₀₄₈, Q₁₀₄₉ (2SC1583) as a noise blanker AGC voltage. When impulse-type noise is received, the induced DC voltage reduces the gain of Q₁₀₀₃, and blocks the signal path momentarily. The noise AGC control voltage is not, however, induced by such impulse-type noise, because the time constant of C₁₂₄₃/R₁₂₇₃ is long. Normal signals, though, induce the noise blanker AGC voltage, reducing the gain of the noise amplifier, allowing normal signal flow at Q₁₀₀₃.

TRANSMITTER

The discussion of the signal flow on transmit will be on a mode by mode basis.

SSB

The audio input signal from the microphone is amplified by Q₁₀₃₀ (2SC1815GR) and Q₁₀₃₉ (2SC1815Y). The audio level is adjusted to the proper level by VR₁₀₀₇, and is applied through an active lowpass filter, Q₁₀₄₀ (2SC945Q), to the ring modulator, D₁₀₅₃–D₁₀₅₆. Here the audio signal modulates the 10.81 MHz carrier signal delivered from the carrier oscillator Q₁₀₄₁ (2SC945Q) and buffer Q₁₀₄₂ (2SC945Q), resulting in a 10.81 MHz double-sideband signal. The signal is amplified by Q₁₀₄₃ (2SK19TM-GR) and fed to XF₁₀₀₂, a crystal filter, where the unwanted sideband is sliced out. The SSB signal is then amplified by Q₁₀₁₄ (3SK73Y) and fed via a lowpass filter on to mixer Q₁₀₃₆ (MC1496G) and mixed with a local signal from the PLL Unit, resulting in a 143.5–148.5 MHz SSB signal.

The SSB signal is passed through T₁₀₁₀–T₁₀₁₄, which are tuned exactly to the operating frequency by varactor diodes, thus minimizing spurious radiation. The signal is then amplified by Q₁₀₃₇ (3SK70), and Q₁₀₃₈ (2SC2053) to the proper level for driving the power amplifier circuit.

FM

The output audio signal at Q₁₀₃₀ is amplified by Q₁₀₃₁ (2SC1815GR) and Q₁₀₃₂ (2SC945Q) and fed to the IDC circuit, consisting of D₁₀₃₇ and D₁₀₃₈, which clips both positive and negative peaks to control the maximum possible deviation. The clipped signal is then passed through an active lowpass filter, Q₁₀₃₃ (2SC945Q) to eliminate harmonics above the speech range caused by clipping. The deviation level is set by VR₁₀₀₆ before passing the signal on to Q₁₀₃₄ (2SC945Q) to be amplified to the correct level and fed in to the FM modulation unit XM₁₀₀₁.

The remainder of the signal path is then identical to that of the SSB signal.

CW

For CW, the 10.8107 MHz carrier signal is generated by Q₁₀₄₄ (2SC945Q), amplified by Q₁₀₃₅ (2SC945Q), and fed to IF amplifier Q₁₀₁₄.

The key line is connected to switching transistor Q₁₀₆₂ (2SC945Q) through inverter Q₁₀₆₁ (MC14011B), which controls the gate voltages at Q₁₀₁₄ (3SK73Y) and Q₁₀₃₇ (3SK59Y), thus turning the RF signal on and off.

The signal path is then identical to that of the CW signal.

An RC circuit connected to the base of Q₁₀₆₂ produces an ideal keying waveshape for click-free CW operation. The key line is also connected to side tone oscillator Q₁₀₆₁ (MC14011B) for monitoring of the code signal during CW operation. In order to operate on semi-break-in, the Schmitt trigger and delay circuit at Q₁₀₆₀ (MC14011B) activates the RX-TX changeover relay.

POWER AMPLIFIER CIRCUIT

The RF signal from the Main Unit is amplified by Q₂₀₀₁ (2SC2053) and Q₂₀₀₂ (M57713) in the Power Amplifier Unit, delivering approximately 10 watts of RF output to the antenna through a lowpass filter.

POWER CONTROL CIRCUIT

When the HI/LOW switch is set to the LOW position, the base of Q_{1046} is grounded through VR_{1012} , and the collector current of Q_{1046} is decreased. Because the output power of Q_{2001} is controlled by Q_{2003} , the drive level to Q_{2002} is decreased, thus reducing the RF output power to approximately 1 watt.

TONE BURST CIRCUIT

When the PTT switch is pressed, the one-shot multivibrator consisting of Q_{1060} (A2, 3) (MC-14011B) is activated to generate a pulse of 0.5–1 second duration. The pulse switches Q_{1058} (2SA-733P) to supply DC voltage to Q_{1057} (TC5082P), where a 1750 or 1800 Hz tone signal is generated. Pressing the T.CALL switch also switches Q_{1058} and generates a tone signal. The tone is fed to the FM MIC amplifier and superimposed on the transmit signal.

ALC (Automatic Level Control) CIRCUIT

A portion of the output power from Q_{2002} is applied through C_{2020} to rectifiers D_{2001} and D_{2002} producing a DC voltage. The DC voltage is ampli-

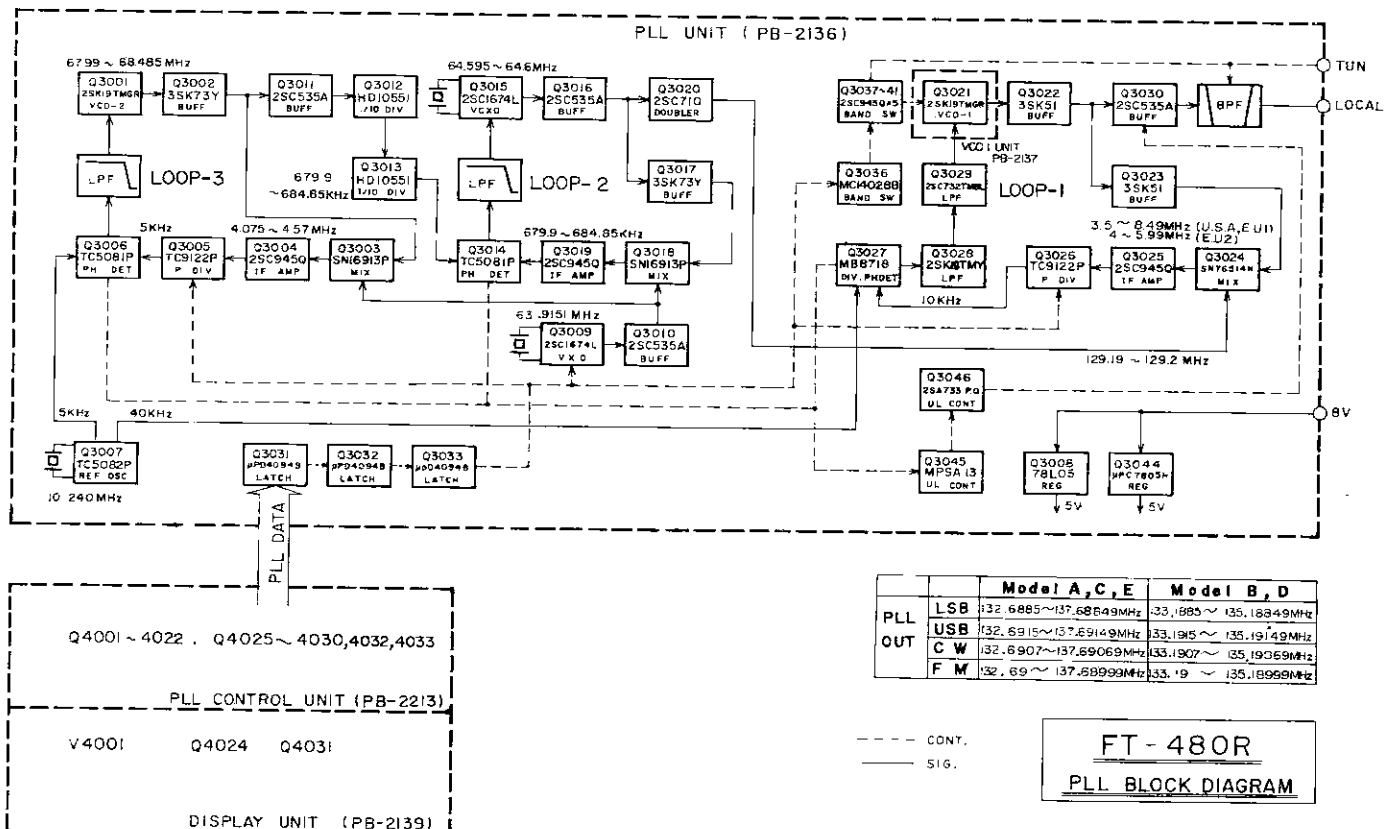
fied by DC amplifier Q_{1018} (2SC1815Y) and fed to gate 2 of Q_{1014} to control its gain, thus preventing overdrive. The ALC level is adjusted by VR_{1003} for proper drive to Q_{2002} .

AFP (Automatic Final Protection) CIRCUIT

If the transmitter is activated without an antenna being connected, or if a high VSWR is present at the antenna jack, the reflected power is detected through T_{2001} and D_{2003} . The detected AFP voltage is applied through VR_{2002} to Q_{1063} (2SC1815Y) in the Main Unit. As the reflected power increases, the AFP voltages also increases and consequently Q_{1063} conducts. The signal is fed to Q_{1018} (2SC1815Y), this decreases the voltage at gate 2 of Q_{1014} (3SK73Y), resulting in lower output power. When the transceiver is correctly matched to an antenna, full power output will be obtained.

PLL CIRCUIT

The PLL circuit is comprised of three PLL oscillators each consisting of a reference crystal oscillator, a programmable divider, a prescaler, and a phase comparator. The PLL produces local signals for the receiver and transmitter stages, using a synthesis scheme which produces 10 Hz steps.



PLL Circuit Configuration

The local signal 132.6900 MHz – 137.6899 MHz is generated by Q₃₀₂₁ (2SK19TM-GR) VCO-1 in the PLL Loop 1, amplified by buffers Q₃₀₂₂ (3SK51-03) and Q₃₀₃₀ (2SC535A), and passed through BPF circuit to eliminate spurious radiation. The signal is then coupled to the Main Unit.

A portion of the signal from the buffer Q₃₀₂₂ is amplified by Q₃₀₂₃ (3SK51) and applied to the mixer Q₃₀₂₄ (SN76514N), where the signal is mixed with a heterodyne signal of 129 MHz from PLL Loop 2, and its frequency is divided by programmable divider Q₃₀₂₆ (TC9122P). The digital phase comparator Q₃₀₂₇ (MB8718) compares the phase of signal from the programmable divider with that of 40 kHz reference frequency obtained from crystal oscillator Q₃₀₀₇ (TC5082P) (via a 1/4 divider), producing an error-correction DC voltage. The output DC voltage is passed through an active lowpass filter consisting of Q₃₀₂₈ (2SK19TM-Y) and Q₃₀₂₉ (2SC732TM-BL), and fed to the VCO-1 to control its oscillation frequency.

In PLL Loop 2, a 64 MHz signal generated by the VCXO Q₃₀₁₅ (2SC1674L) is fed to buffer Q₃₀₁₆ (2SC535A) and on to doubler Q₃₀₂₀ (2SC710) before passing to mixer Q₃₀₂₄ (SN76514N) in PLL 1.

A portion of the VCXO signal is taken to buffer amplifier Q₃₀₁₇ (3SK73Y) before passing to mixer Q₃₀₁₈ (SN16913P), where the signal is mixed with a 63 MHz signal generated by VCXO Q₃₀₀₉ (2SC1674L) and Q₃₀₁₀ (2SC535A), resulting in a 600 kHz signal. The 600 kHz signal is amplified by Q₃₀₁₉ (2SC945Q) and fed to phase comparator Q₃₀₁₄ (TC5081P), which compares the phase of the signal with that of the 600 kHz signal from PLL Loop 3, producing an error-correction DC voltage. The DC voltage is passed through a lowpass filter and fed to the VCXO to control its oscillation frequency.

In PLL Loop 3, a 60 MHz signal is generated by VCO-2 Q₃₀₀₁ (2SK19TM-GR) and applied through buffers Q₃₀₀₂ (3SK73Y) and Q₃₀₁₁ (2SC535A) to a prescaler, Q₃₀₁₂/Q₃₀₁₃ (HD10551), which divides its frequency by 1/100, thus producing a 600 kHz signal. A portion of the output of Q₃₀₀₂ is fed to mixer Q₃₀₀₃ (SN16913P), where the signal is mixed with a 63 MHz signal which is generated by

Q₃₀₀₉ (2SC1674L), and applied through a programmable divider to phase comparator Q₃₀₀₆ (TC5081P) which compares the phase of the signal with that of 5 kHz signal which is generated by Q₃₀₀₇ (TC5082P), producing an error-correction DC voltage. The DC voltage is passed through a lowpass filter and fed to the VCO-2 Q₃₀₀₁ to control its oscillation frequency.

The frequency control signal from the PLL Control Unit is fed to Serial/Parallel converters Q₃₀₃₁ - Q₃₀₃₃ (μ PC4094B) and converted into BCD code to control the dividing ratio of the programmable divider and the VCO and VCXO oscillating frequency in each PLL loop.

When any VCO is unlocked, an unlock signal from the phase comparator is fed to the unlock control circuit consisting of Q₃₀₄₅ (MPSA13) and Q₃₀₄₆ (2SA733P), which controls buffer Q₃₀₃₀ (2SC535A) to mute the output from the PLL oscillator to prevent spurious radiation.

PLL Control Circuit

In the PLL Control Unit, a 4 bit parallel processing CPU is used to control the operating frequency, UP/DOWN scanning, priority channel, or memory channel selections. The CPU has one input port, three I/O ports and four output ports. The CPU processes input data by means of the main dial or other control switches in accordance with the program stored in an ROM for control of the PLL frequency, indication of the operating frequency, or memory channels on digital display. The CPU is also furnished with a function to halt transmission when any VCO is unlocked, resulting in a fail-safe system.

MAINTENANCE AND ALIGNMENT

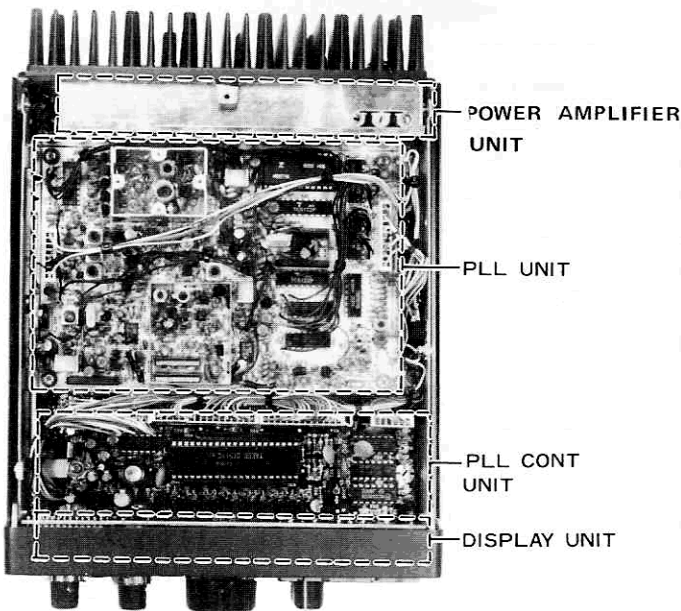
This equipment has been carefully aligned and tested at the factory prior to shipment. If the instrument is not abused, it should not require other than the usual attention given to electronic equipment.

Service or replacement of a major component may require considerable realignment. Under no circumstances, though, should realignment be attempted unless the operation of the transceiver is fully understood, the malfunction has been carefully analyzed, and the fault has definitely been traced to misalignment rather than part failure. Service work must only be performed by experienced personnel using the proper test equipment.

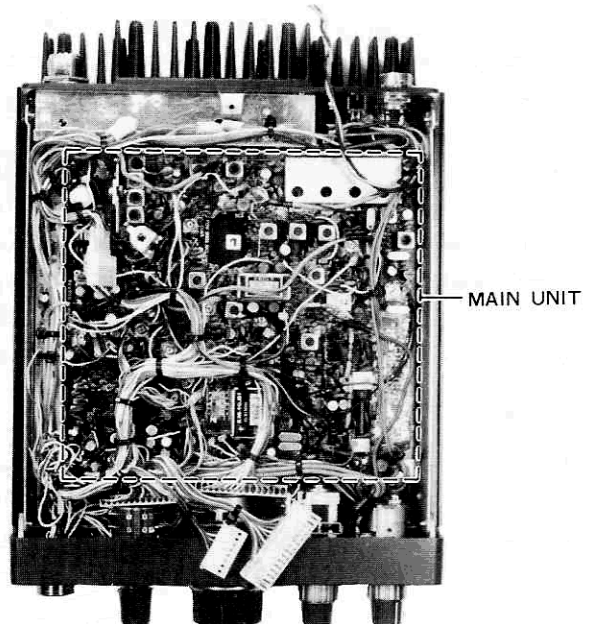
Never align this transceiver without having a 50 ohm dummy load connected to the antenna jack, unless otherwise noted. Troubleshooting using an antenna can result in misleading indications on test equipment.

EQUIPMENT REQUIRED

- (1) RF Signal Generator: Hewlett-Packard Model 8640B or equivalent, with one volt output at 50 ohms, and frequency coverage to 150 MHz.
- (2) Vacuum Tube Voltmeter (VTVM): Hewlett-Packard Model 410B or equivalent, with an RF probe good to 150 MHz.
- (3) Dummy Load/Wattmeter: Yaesu Model YP-150Z or equivalent.
- (4) AF Signal Generator: Hewlett-Packard Model 200AB or equivalent.
- (5) IF Sweep Generator: capable of output at 10.81 MHz.
- (6) RF Sweep Generator: capable of output at 143–149 MHz.
- (7) Oscilloscope: Hewlett-Packard Model 1740A or equivalent.
- (8) FM Deviation Meter
- (9) Precision Frequency Counter: Yaesu Model YC-500 or equivalent, with resolution to 0.01 kHz and frequency coverage to 150 MHz.



Top View



Bottom View

UNIT LOCATIONS

PERFORMANCE CHECKS

Make all performance checks at 13.8 VDC under load.

Check the transmitter power output as follows:

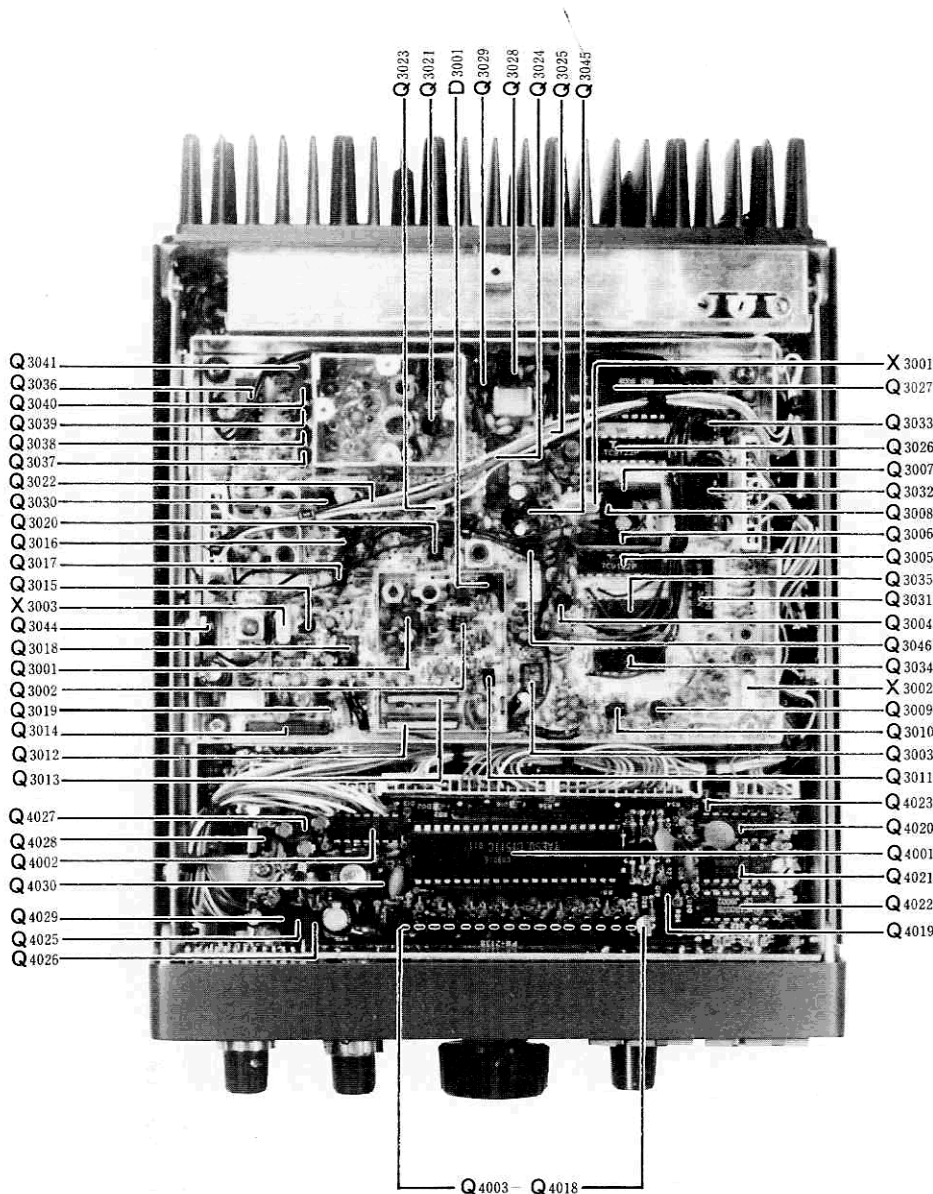
- (a) Connect a suitable dummy load/wattmeter to the antenna jack.
- (b) Set the MODE switch to the FM position, and key the transceiver while observing the power output, which should be approximately 10 watts. At full power output, 8-9 LED's will light up on the S.PO indicator.

- (c) Set the MODE switch to SSB, and key the transmitter. Speak in a normal voice into the microphone; 8-9 LED's should light up.



Bird Model 43 or equiv.

PO TEST SETUP



PART LOCATIONS (Top View)

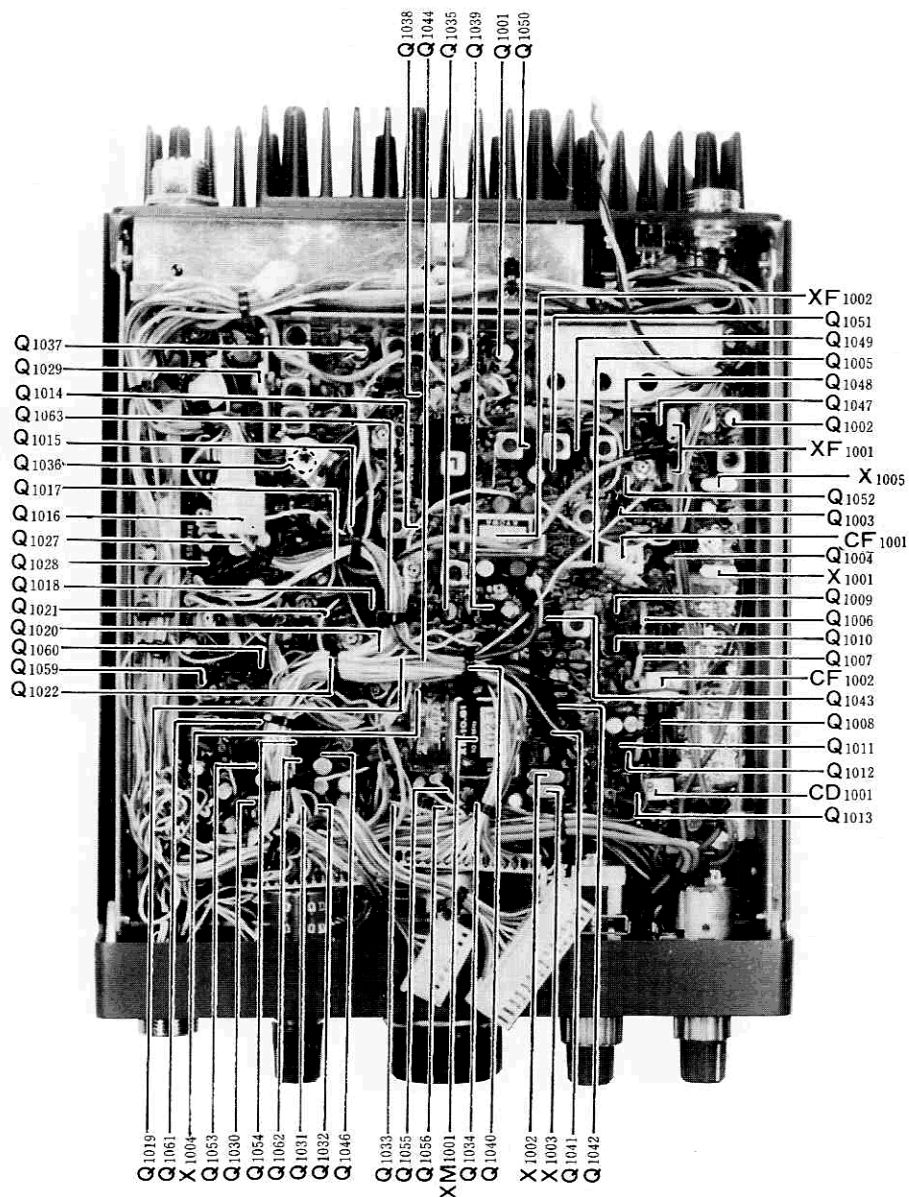
Check the receiver sensitivity as follows:

- (a) Connect an AC VTVM to the SP jack. Set the MODE switch to the FM position and rotate the SQUELCH control fully counterclockwise.
- (b) Connect the RF output of a precision VHF signal generator to the antenna jack 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.



RX SENSITIVITY TEST SETUP

- (c) Set the signal generator to the receiver frequency of the transceiver, and adjust the output amplitude of the signal generator until the VTVM reads 20 dB (1/10 voltage) below 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 μ V.



PART LOCATIONS (Bottom View)

- (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 main dial for a maximum VTVM reading.
- (e) 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 45 mV for a 20 dB S/N ratio.

If the above check indicates a need for realignment, it is recommended that the unit be returned to the dealer for servicing. The sophisticated CPU and control circuitry, in particular, are so critical that they should not be touched by other than an experienced technician. Attempts to realign the transceiver tuned circuits without the proper equipment may result in degraded transceiver performance.

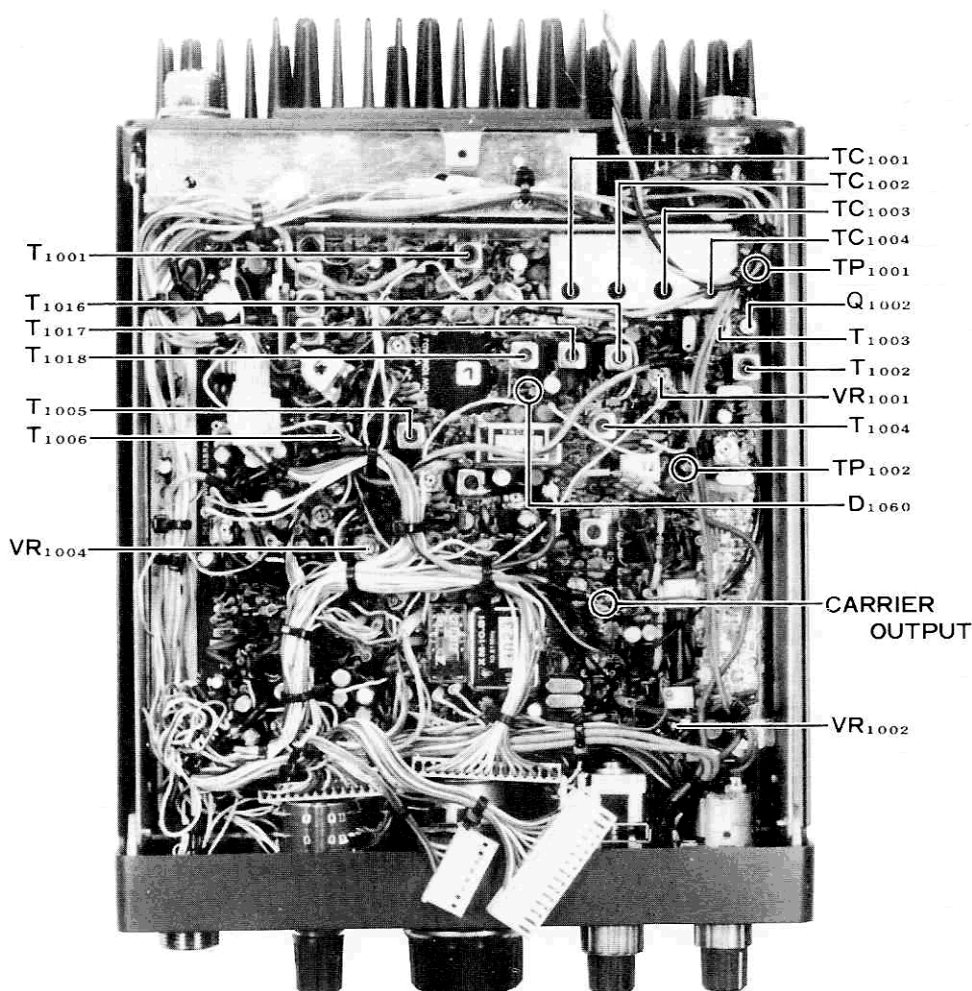
RECEIVER SECTION

(1) 2nd Local Oscillator

- a) Set the MODE switch to FM, and connect the RF probe of a VTVM to TP₁₀₀₂.
- b) Measure the RF injection voltage. A nominal value is 0.5 V – 0.7 VRMS.
- c) Connect a frequency counter to TP₁₀₀₂ and check to see that the oscillation frequency is correct: 11.265 MHz.

(2) 1st IF Amplifier

- a) Set the MODE switch to FM, and adjust VR₁₀₀₁ to the fully counterclockwise position.



ALIGNMENT AND TEST POINTS FOR RECEIVER

- b) Connect a sweep generator to gate 1 of Q_{1002} (TP_{1001}). Connect an oscilloscope, through a detector, to the secondary winding of T_{1004} .
- c) Set the frequency of the sweep generator to 10.81 MHz, and apply output from the generator.
- d) Adjust T_{1003} and T_{1004} until the scope pattern illustrated in Fig. 2 is obtained.

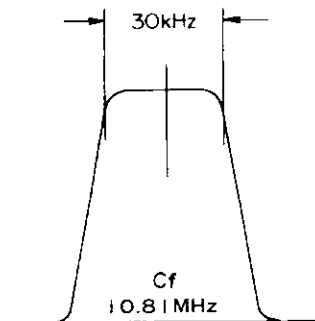


Figure 2

(3) SSB Carrier Oscillator

- a) Set the MODE switch to LSB.
- b) Connect the RF probe of the VTVM to the CARRIER OUTPUT terminal on the Main Unit (where C_{1212} and a shielded cable are connected), and measure the oscillation level. A nominal value is 170–230 mV RMS.
- c) Set the MODE switch to USB. Measure the oscillation level in the same way as in the step (b). A nominal value is 170–230 mV RMS.

(4) SSB IF Circuit

- a) Set the mode switch to USB or LSB.
- b) Connect a signal generator to TP_{1001} , and set its output level to 15 dB μ (5.62 μ V) at 10.81 MHz.
- c) Peak T_{1004} , T_{1005} , and T_{1006} for a maximum S.PO indication.

(5) RF Amplifier

- a) Set the output level and frequency of the generator to 10 dB μ (3.16 μ V) at 146 MHz.
- b) Set the receiver frequency to 146 MHz, and adjust T_{1001} , T_{1002} , TC_{1001} – TC_{1004} for a maximum S.PO indication.

(6) S-Meter Full Scale Setting

- a) Rotate VR_{1004} fully clockwise to make sure that all the LED's on the S-meter scale are illuminated.
- b) Set VR_{1004} to the point where all the LED's go off.
- c) Apply a 4 dB μ (1.584 μ V) signal from the signal generator and adjust VR_{1001} so that only one LED is illuminated.

(7) Noise-Blanker Adjustment

- a) Set the MODE switch to USB or LSB.
- b) Set the receiver frequency to 146 MHz.
- c) Adjust the output level and frequency of the signal generator to 5–10 dB μ (1.78 μ V–3.16 μ V) at 146 MHz. Temporarily connect TP_{1002} to ground with a clip lead, in order to disable the 2nd local oscillator.
- d) Connect a voltmeter (full scale: 2.5V) to the cathode of D_{1060} and ground. Adjust T_{1016} , T_{1017} , and T_{1018} for a maximum reading on the voltmeter scale.

(8) Squelch Adjustment

- a) Set the MODE switch to FM.
- b) Set the front panel SQL control to the 9 o'clock position.
- c) Adjust VR_{1002} so that the receiver is just muted. Now apply a signal from the signal generator. A signal of approximately –13 dB μ (0.224 μ V) with ± 3.5 kHz deviation at 1 kHz should be required to trip the squelch.

TRANSMITTER SECTION

Unless otherwise indicated, always perform transmitter alignment with a dummy load connected to the antenna jack. If the AFP circuits are being aligned, an improper load impedance at a critical time could result in the destruction of the final transistors.

(1) TX Strip Trimmer Adjustment

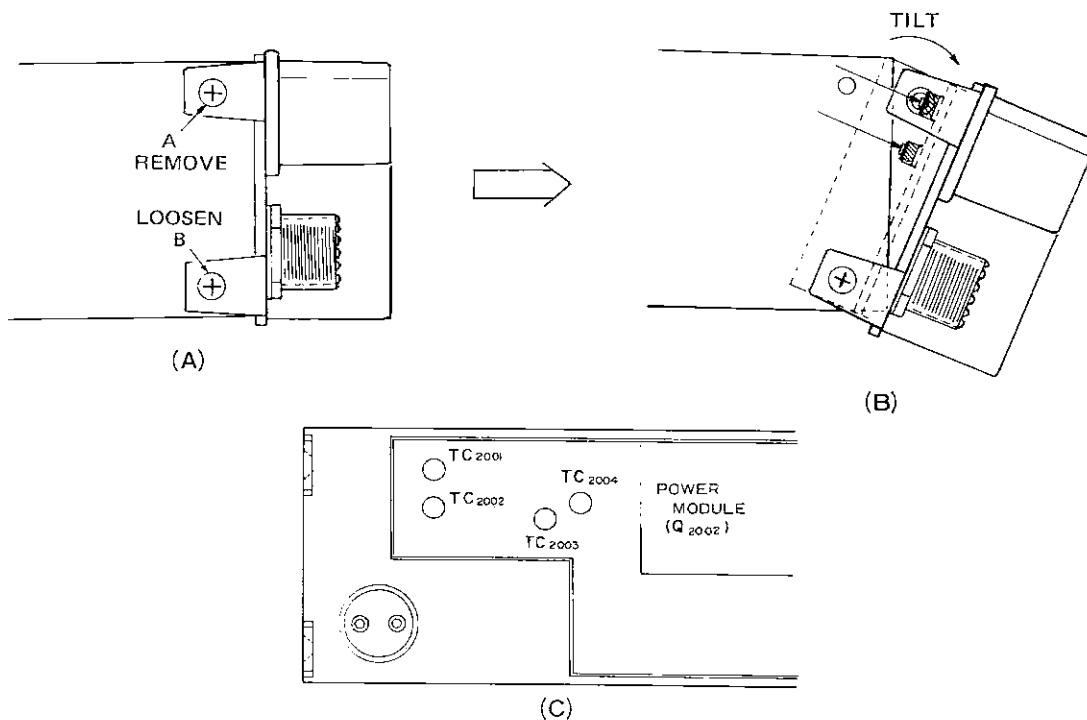
- Set the MODE switch to FM, and the transmitter frequency to 146.00 MHz.
- With a dummy load/wattmeter connected to the antenna jack, advance VR₂₀₀₂ and VR₁₀₀₃ fully counterclockwise.
- Squeeze the microphone PTT switch, and adjust TC₂₀₀₁–TC₂₀₀₄* for maximum power output as indicated on the wattmeter.

* In order to adjust these trimmers, remove the two screws marked "A", and loosen the two screws marked "B" on the side panels. Then tilt the Final Unit as shown below.

** TC₂₀₀₁–TC₂₀₀₄ require no realignment unless final transistors are replaced.

(2) Mixer/Interstage Alignment

- Temporarily disconnect the RF OUT cable from the Main Unit.
- Terminate the RF OUT terminals with a 50 ohm resistor, and connect the RF probe of a VTVM to the RF OUT terminals.
- Set the transmitter frequency to 145.5 MHz, MODE to FM, and key the transceiver.
- Adjust T₁₀₁₀–T₁₀₁₄, TC₁₀₀₅, and TC₁₀₀₆ for a maximum reading on the VTVM.



POWER AMPLIFIER UNIT

(3) CW Carrier Oscillator

- a) Set the MODE switch to CW.
- b) Connect the RF probe of a VTVM to TP₁₀₀₆ and key the transceiver.
- c) Adjust T₁₀₀₉ for a reading of 100 mV RMS on the VTVM.
- d) Connect a frequency counter to TP₁₀₀₆, and adjust TC₁₀₁₀ for a reading of exactly 10.8093 MHz on the counter.

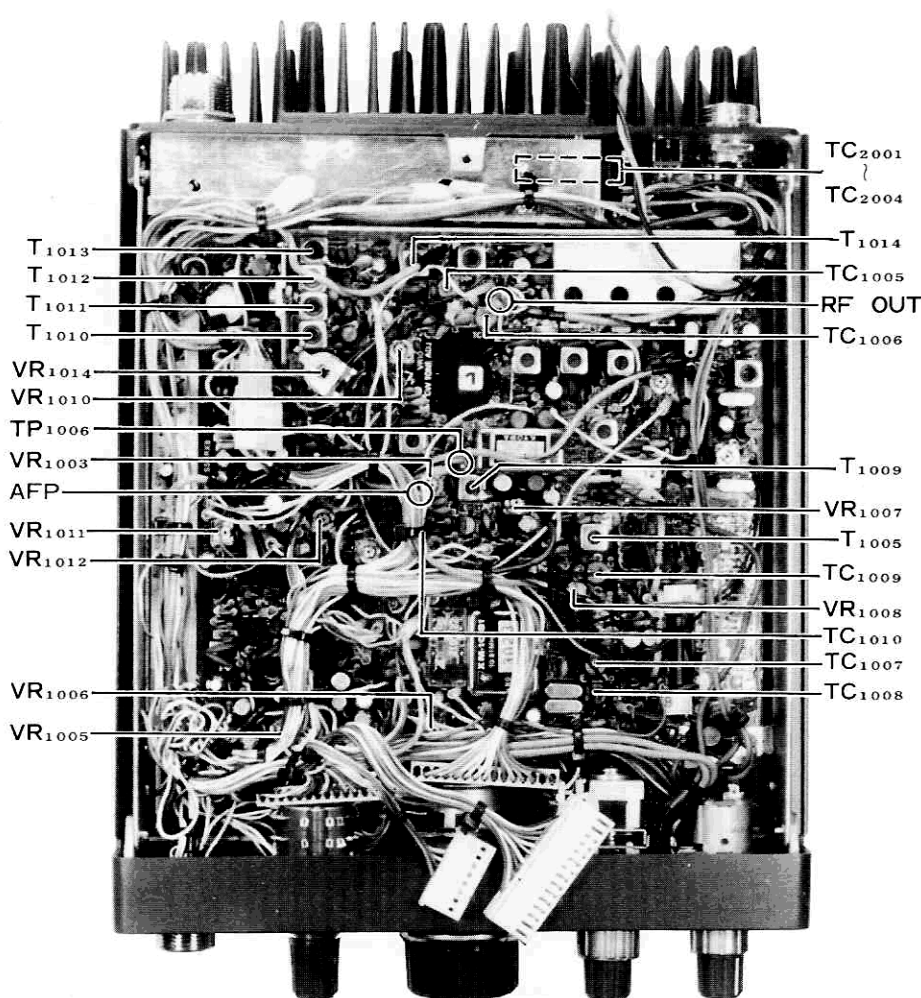
(4) ALC/PO Adjustment

- a) Set the MODE switch to FM.
- b) With a dummy load/wattmeter connected to the antenna jack. Key the transceiver.
- c) Adjust VR₁₀₀₃ for an output of 10 watts on the wattmeter.

- d) Adjust VR₂₀₀₁ so as to illuminate 9 LED's on the S.PO indicator.

(5) AFP Adjustment

- a) Connect a DC voltmeter to the AFP terminal on the Main Unit and ground.
- b) Rotate VR₂₀₀₂ fully counterclockwise.
- c) Set the MODE switch to FM.
- d) Adjust VR₂₀₀₃ for minimum indication on the DC voltmeter.
- e) Disconnect the 50 ohm dummy load, and connect a 165 ohm, 10 watt dummy load to the antenna jack. Key the transceiver.
- f) Adjust VR₂₀₀₂ so as to illuminate 8 LED's on the S.PO indicators. Now return to RX.
- g) Remove the dummy load from the antenna jack, Close the PTT switch, and check to see that the current consumption is less than 2 amps.



ALIGNMENT AND TEST POINTS FOR TRANSMITTER

(6) Low Power Output Setting

- a) Set the HI/LOW switch to the LOW position, and key the transmitter in the FM mode.
- b) Adjust VR₁₀₁₂ for an output of 1 watt on the wattmeter.

(7) FM Modulator Adjustment

- a) Refer to Fig. 3, and set up the transceiver and test equipment as shown.
- b) Set VR₁₀₀₅, located on the Main Unit, to the center of its range, and apply a 1 kHz, 15 mV signal from the audio generator to the mic jack.
- c) Adjust VR₁₀₀₆ for a deviation of ± 4.5 kHz while observing the signal waveform on the scope.
- d) Now reduce the audio generator output level to 1.5 mV, and adjust VR₁₀₀₅ for a deviation of ± 3.5 kHz. Check to see that the waveform on the scope is not distorted.
- e) Turning the audio generator on and off, make sure that the BUSY/MOD indicator illuminates along with the changing audio input.

(8) SSB Modulator Adjustment

(A) Balanced Modulator Output Transformer Adjustment

- a) With a dummy load/wattmeter connected to the antenna jack, set the MODE switch to USB or LSB.
- b) Set VR₁₀₀₇ to the center of its range, and apply a 1 kHz, 1 mV signal from the audio generator to the mic jack.
- c) Adjust T₁₀₁₅ for maximum power output.

(B) SSB Carrier Point Adjustment

- a) Apply a 1 kHz, 1.2 mV signal from the audio generator to the mic jack, and adjust VR₁₀₀₇ for an output of 8 watts.
- b) Set the MODE switch to USB and the frequency of the audio generator to 300 Hz. Adjust TC₁₀₀₈ for an output of 2 watts.
- c) Set the MODE switch to LSB, and the frequency of the audio generator to 300 Hz. Adjust TC₁₀₀₇ for an output of 2 watts.

(C) Carrier Balance Adjustment

- a) Temporarily short the mic input terminal of the mic jack (pin 8) to ground with a clip lead. Set the MODE switch to USB.
- b) While monitoring the carrier on a monitor receiver, adjust VR₁₀₀₈ and TC₁₀₀₉ for a minimum S-Meter reading (or minimum signal level if no S-Meter reading occurs).
- c) Switch between USB and LSB, and compare the output levels with no modulation. Adjustment of VR₁₀₀₈, TC₁₀₀₉ may be necessary to achieve good carrier nulling on both modes.

(9) CW Side Tone Frequency/Semi-break-in Delay Adjustment

- a) Adjust VR₁₀₁₀ for the desired monitoring level on CW operation.
- b) Adjust VR₁₀₁₁ for the desired CW VOX relay hang time.

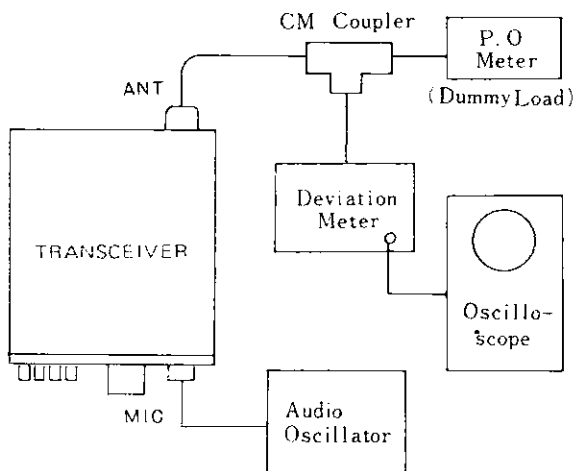


Figure 3

PLL SECTION

NOTE: The PLL circuit is very critical in its adjustment. Alignment must only be performed by an experienced technician. All alignment should be performed at a temperature within the range 15°–30°C, preferably near the center of this range.

(1) VCV Line Adjustment

(A) PLL 1 Adjustment

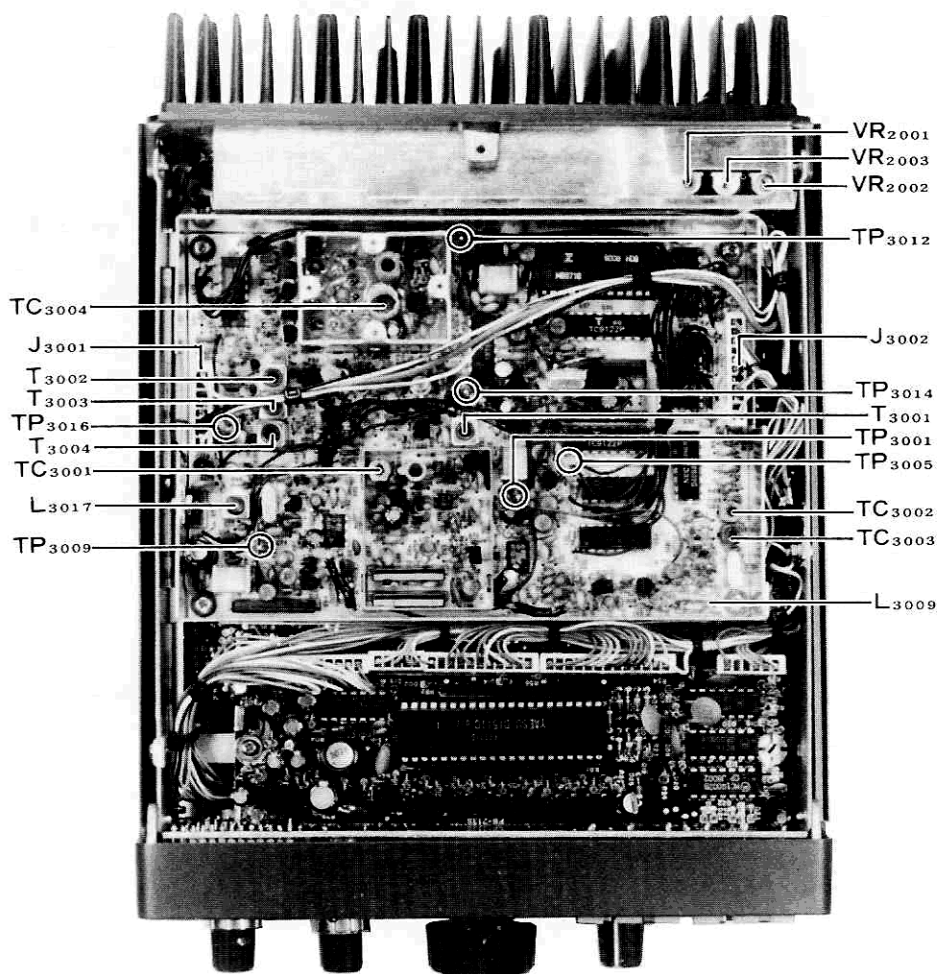
- a) Set the STEP switch to "M," the MODE switch to FM, and tune the transceiver to 145.9900 MHz.
- b) Connect the DC probe of the VTVM to TP₃₀₁₂, and adjust TC₃₀₀₄ for a reading of exactly 6.5 V.

(B) PLL 2 Adjustment

- a) Set the STEP switch to "M," the MODE switch to USB, and tune the transceiver to 145.0099 MHz.
- b) Connect the DC probe of the VTVM to TP₃₀₀₉, and adjust L₃₀₁₇ to secure a reading of 3.5 V.

(C) PLL 3 Adjustment

- a) Set the STEP switch to "M," MODE switch to USB, and tune the transceiver to 145.0099 MHz.
- b) Connect the DC probe of the VTVM to TP₃₀₀₁, and adjust TC₃₀₀₁ to secure a reading of 3.5 V.



ALIGNMENT AND TEST POINTS FOR PLL

(2) Multiplier Stage Adjustment

- a) Set the STEP switch to "M," the MODE switch to USB, and tune the transceiver to 145.0099 MHz.
- b) Connect the RF probe of the VTVM to TP₃₀₁₄, and adjust T₃₀₀₁ for a maximum reading on the VTVM.

(3) PLL Output Bandpass Filter Adjustment

- a) Set the STEP switch to "F," the MODE switch to FM, and tune the transceiver to 145.4000 MHz.
- b) Connect the RF probe of the VTVM to TP₃₀₁₆, and peak T₃₀₀₂, T₃₀₀₃, and T₃₀₀₄ for a maximum meter reading.

(4) PLL Local Frequency

- a. Connect a frequency counter to TP₃₀₁₆.
- b) Set the STEP switch to "S," the MODE switch to USB, and tune the transceiver to 144.00000 MHz.
- c) Adjust TC₃₀₀₂ for a reading of exactly 133.19150 MHz on the frequency counter.
- d) Change the transceiver display frequency to 144.00009 MHz, using the Main Dial.
- e) Adjust TC₃₀₀₃ for a reading of exactly 133.19159 MHz on the frequency counter.
- f) Repeat steps (b), (c), (d) and (e) several times to ensure complete frequency adjustment.

NOTE: In order to achieve the specified frequencies for the above alignment steps, some presetting of the display will be required (because the 10 Hz digit is not displayed). Push the F.SET button, switch to USB, then set the STEP switch to "S". The precise frequency may then be set using the main dial.

PARTS LIST

MAIN CHASSIS			MAIN UNIT		
Symbol No.	Part No.	Description	Symbol No.	Part No.	Description
PB-2143	F0002143	Printed Circuit Board (for S03)	PB-2135C	F0002135C	Printed Circuit Board
				C0021350	PCB with Components
PB-2132	F0002132	Printed Circuit Board (for J08)			
					IC
Q01	G1090294	IC μPC7808H	Q1008	G1090072	μPC577H
			Q1016	G1090101	μPC1037H
			Q1029	G1090284	μPC2002V
		DIODE	Q1036	G1090061	MC1496G
D01	G2090034	U05B	Q1060,1061	G1090068	MC14011B
			Q1057	G1090239	TC5082P
		POTENTIOMETER			
VR01 (with S09)	J62800048	DM11A825A5M1112			FET
			Q1001	G4800590Y	3SK59Y
		RESISTOR	Q1002	G4800510C	3SK51
R01	J02245103	Carbon film 1/4W SJ 10kΩ	Q1003,1014,1015	G4800730Y	3SK73Y
R02	J02245104	" " " " 100kΩ	Q1021	G3800301Y	3SK30AY
			Q1037	G4800700	3SK70
		CAPACITOR	Q1043	G3090035	2SK19TMGR
C01,02	K40170105	Electrolytic 50WV 1μF (50RL1)			TRANSISTOR
C03	K40129006	" 16WV 470μF (16RE470)	Q1004,1006,1007, 1009,1010,1013, 1019,1027,1028, 1032-1035, 1040-1042,1044, 1046,1054,1056, 1059,1062	G3309450Q	2SC945Q
		SPEAKER			
SP01	M4090047	SS-77KYH			
		SWITCH	Q1051	G3309450P	2SC945P
S01	N0190066	SBU-2045	Q1005,1017 1047	G3305350B	2SC535B
S02	N0190079	SRN-4086N	Q1011,1018,1039, 1053,1063	G3318150Y	2SC1815Y
S03	Q9000083A	EWT-XDB S3550B			
S03 (with board)	C0021430		Q1012,1030,1031	G3318150G	2SC1815GR
S04,08,06	N6090004	SSF-22-55	Q1020,1022,1058	G3107331P	2SA733 P or Q
S07	N6090002	SSH-23-05	Q1038	G3320530	2SC2053
			Q1048,1049,1050	G3315830	2SC1583
		RECEPTACLE	Q1055	G3313830R	2SC1383R/S
J01	P0090158	FM-214-8SS	Q1052	G3090005	MPSA13
J02	P0090010	FM-142S			
J03	P1090028	MBR06D			DIODE
J04,05	P1090005	SG8050	D1006,1015, 1017-1024, 1027-1029, 1037-1043, 1049-1052, 1057,1061-1065, 1067-1073,1075, 1077-1081	G2090027	1SS53
J06,11	P0090054	5048-07A			
J07	P0090036	5048-14A			
J08	P0090173	EMCS0450M			
J08 (with board)	C0021320				
		PLUG			
P01	T9203770A	5208-07	D1010-1012,1014, 1025,1026,1030, 1059,1060	G2001880F	1S188FM
P02	T9203140B	5208-10			
P03	T9203150A	5208-12			
P04	T9203800	5208-04	D1013	G2015550	1S1555
P06	T9203170	5208-12	D1044-1048	G2022090	1S2209
P07	T9203180	5208-5	D1053-1056	G2010070	1S1007
P09	T9203230C	5208-14	D1066	G2090001	10D1
P12	T9203280A				
					CRYSTAL
			X1001	H0101100A	11.265 MHz
			X1002	H0100992	10.8115 MHz
			X1003	H0100991	10.8085 MHz
			X1004	H0102288	10.8093 MHz
			X1005	H0101983	7.3728 MHz
			X1005	H0101982	7.168 MHz (EUROPE MODEL)

		CRYSTAL FILTER	R1216	J02245392	Carbon film	1/4W SJ	3.9kΩ
XF1001	H1102021	108M30B	R1018,1136,1146,	J02245472	" "	" "	4.7kΩ
XF1002	H1102022	10F-2D	1218,1305,1329				
		CERAMIC FILTER	R1045,1046,1053,	J02245562	" "	" "	5.6kΩ
CF1001	H3900220	LF-H12S	1100,1152,1159,				
CF1002	H3900030	LF-B15	1163,1181,1209,				
			1277,1283,1310,				
			1327				
			R1016,1088	J02245682	" "	" "	6.8kΩ
		CERAMIC DISCRIMINATOR	R1148	J02245822	" "	" "	8.2kΩ
CD1001	H7900040	455-DW-8	R1023,1026,1055,	J02245103	" "	" "	10kΩ
			1079,1093,1094,				
			1096,1104,1134,				
			1135,1137,1154,				
			1177,1180,1224,				
			1226,1229,1232,				
			1243,1265,1269,				
			1275,1279,1282,				
			1284,1293,1298,				
			1303,1304,1306,				
			1307,1311,1322				
		MODULATOR MODULE					
XM1001	H9500390	XM-10.81					
		RESISTOR					
R1141	J02245010	Carbon film	1/4W SJ	1Ω			
R1140	J02245229	" "	" "	2.2Ω			
R1211	J02245220	" "	" "	22Ω			
R1007,1013,1017, 1078,1084,1204, 1207	J02245560	" "	" "	56Ω	J10216103	Carbon composition	1/8W GK 10kΩ
R1063	J01245560	" "	" TJ	56Ω	R1126,1219,1233	J02245123	Carbon film 1/4W SJ 12kΩ
R1173	J02245680	" "	" SJ	68Ω	R1286,1290	J02245153	" " " " 15kΩ
R1188	J02245820	" "	" "	82Ω	R1169	J02245183	" " " " 18kΩ
R1028,1044,1085, 1175,1179,1190, 1231,1235,1236, 1242,1245,1257, 1260,1263,1267, 1333	J02245101	" "	" "	100Ω	R1031,1047,1048, 1171,1220,1228, 1246,1264,1272, 1276,1278,1287, 1309	J02245223	" " " " 22kΩ
R1024,1064,1065, 1182,1183,1326	J01245101	" "	" TJ	100Ω	R1144,1162,1164	J02245273	" " " " 27kΩ
R1005,1021,1076, 1083,1147	J02245151	" "	" SJ	150Ω	R1176,1268,1291	J02245333	" " " " 33kΩ
R1139,1172,1234, 1237,1238	J02245221	" "	" "	220Ω	R1004,1020	J02245393	" " " " 39kΩ
R1060	J02245331	" "	" "	330Ω	1075,1080,1202, 1324	J02245393	" " " " 39kΩ
R1059	J02245391	" "	" "	390Ω	R1011,1012,1025, 1058,1151,1280, 1281	J02245473	" " " " 47kΩ
R1066,1193,1222, 1253,1266,1330	J02245471	" "	" "	470Ω	R1056,1168,1252	J02245563	" " " " 56kΩ
R1070,1178,1323	J02245561	" "	" SJ	560Ω	R1128,1145,1158	J02245683	" " " " 68kΩ
R1142	J02245681	" "	" "	680Ω	R1133	J02245823	" " " " 82kΩ
R1185	J02245821	" "	" "	820Ω	R1003,1019,1074, 1081,1095,1127, 1132,1138,1150, 1156,1161,1170, 194-1199,1201, 1206,1212,1270, 1273,1292	J02245104	" " " " 100kΩ
R1006,1022,1027, 1033,1062,1071, 1072,1077,1082, 1087,1090,1091, 1097,1130,1149, 1157,1174,1184, 1192,1208,1213, 1241,1244,1256, 1258,1259,1261, 1262,1274,1325, 1328,1331	J02245102	" "	" "	1kΩ	R1057,1155,1160, 1215	J02245124	" " " " 120kΩ
R1073	J01245103	" "	" TJ	1kΩ	R1038,1040,1049, 1051	J02245154	" " " " 150kΩ
R1054,1102,1103, 1191,1205,1210, 1217,1230	J02245152	" "	" SJ	1.5kΩ	R1089,1214,1255	J02245184	" " " " 180kΩ
R1061	J02245182	" "	" "	1.8kΩ	R1200	J02245224	" " " " 220kΩ
R1015,1034,1037, 1039,1041-1043, 1067-1069,1099, 1129,1165,1187, 1221,1254,1308	J02245222	" "	" "	2.2kΩ	R1239,1294	J02245334	" " " " 330kΩ
R1299	J02245272	" "	" "	2.7kΩ	R1240	J02245474	" " " " 470kΩ
R1050,1052,1086, 1131,1143,1166, 1186,1223,1225, 1227,1289,1302	J02245332	" "	" "	3.3kΩ	R1271,1297	J02245564	" " " " 560kΩ
					R1288	J02245684	" " " " 680kΩ
					R1285,1296	J02245824	" " " " 820kΩ
					R1098,1101,1295, 1300	J02245105	" " " " 1MΩ
					R1092,1301	J02245155	" " " " 1.5MΩ
					R1002	J02245225	" " " " 2.2MΩ
						THERMISTOR	
					TH1001	G9090001	SDT-250

POTENTIOMETER			C1003,1004,1006, 1019,1023,1026, 1033,1065,1071, 1085,1124,1131, 1132,1151,1183, 1190,1193,1218, 1228,1230,1245, 1261,1264,1266, 1272-1274,1277, 1281	K13170102	Ceramic 50WV 0.001μF (DB200YF102Z75L2)
Part No.	Code	Description			
VR1001	J51730222	P6-S3NA 2.2kΩ			
VR1002-1006, 1009,1010	J51730103	P6-S3NA 10kΩ			
VR1011	J51730104	P6-S3NA 100kΩ			
VR1007,1012	J51730223	P6-S3NA 22kΩ			
VR1008	J51737201	3321P 200Ω			
VR1014	J51729503	RV8-FAN50kΩ			
CAPACITOR			C1005,1007,1008, 1009,1024,1025, 1030,1037, 1066-1068,1073, 1076,1082-1084, 1086-1088,1090, 1092,1098,1100, 1127,1152,1154, 1155,1156,1169, 1160-1165,1171, 1182,1185,1188, 1191,1192,1199, 1200,1202,1203, 1206,1209,1211, 1213,1214,1215, 1219,1223,1229, 1251,1263	K13170103	" " 0.01μF (DB201YF103Z5L5)
Part No.	Code	Description			
C1175	K00179001	Ceramic 50WV SL 0.5pF (DD104SL0R5C50V02)			
C1267	K00172010	" " " 1pF (DD104SL010C50V02)			
	K00172020	" " " 2pF (DD104SL020C50V02)			
C1020,1173,1177	K02179003	" " CH 2pF (DD104CK020C50V02)			
C1224	K00172030	" " SL 3pF (DD104SL030C50V02)			
	K00172040	" " " 4pF (DD104SL040C50V02)			
C1011-1013,1001	K02172050	" " CH 5pF (DD104CH050C50V02)	C1027,1042,1043, 1051,1072, 1145,1197,1252	K19149026	(UAT04V102K-L05AE) " 25WV 0.001μF
C1174,1176,1180, 1186	K06173060	" " UJ 6pF (ECC-D1H060DV)			
C1280	K00173060	" " SL 6pF (DD104SL060D50V02)	C1257	K19149001	(UTA04X102K-L05AE) " 25WV 0.001μF
C1269	K00173070	" " SL 7pF (DD104SL070D50V02)	C1078,1120,1270	K19149005	(UAT04X222K-L05AE) 25WV 0.0022μF
C1167,1168	K06173080	" " UJ 8pF (DD104UJ080D50V02)	C1136,1144,1196	K19149007	(UAT05X332K-L05AE) 25WV 0.0033μF
C1069	K02173080	" " SL 8pF (DD104SL080D50V02)	C1055,1056,1060, 1070,1096,1119, 1232,1235,1237, 1239	K19149013	(UAT05X103K-L05AE) 25WV 0.01μF
C1080,1172,1178	K00173100	" " " 10pF (DD104SL100D50V02)	C1146	K19149015	(UAT08X153K-L45AE) 25WV 0.015μF
C1015,1018,1216	K02173100	" " CH 10pF (DD104CH100D50V02)	C1052-1054,1246	K19149017	(UAT04X223K-L05AE) 25WV 0.022μF
C1038,1153,1276	K00175150	" " SL 15pF (DD104SL150J50V02)	C1028,1029, 1039-1041, 1044-1050,1074, 1075,1079,1081, 1233,1236,1238, 1240,1253,1254	K19149021	(UAT08X473K-L45AE) 25WV 0.047μF
C1010	K02175150	" " CH 15pF (DD104CH150J50V02)			
C1016,1017	K02175180	" " " 18pF (DD104CH180J50V02)	C1058,1063,1129	K19149025	(UAT13X104K-L46AE) 25WV 0.1μF
C1181,1210,1212	K00175220	" " SL 22pF (DD104SL220J50V02)			Electrolytic
C1220	K00175270	" " " 27pF (DD104SL270J50V02)	C1258	K40179005	50WV 0.47μF (50RC2-R47)
C1204,1205	K02179011	" " CH 27pF (DD104CH270J50V02)	C1091,1097, 1116-1118,1121, 1123,1133,1137, 1138,1140,1141, 1143,1147,1148, 1150,1194,1243, 1247,1256,1260	K40170105	" 1μF (50RL1)
C1241,1248,1249	K00175330	" " SL 33pF (DD104SL330J50V02)			
C1034	K00175390	" " 39pF (DD104SL390J50V02)	C1268	K40179001	" 1μF (50RC2-1)
C1059	K00175470	" " 47pF (DD104SL470J50V02)	C1255	K40149001	25WV 4.7μF (25RE4R7)
C1217	K02175470	" " CH 47pF (DD106CH470J50V02)	C1061,1062	K40149011	" 4.7μF (25RC2-4R7)
C1077,1093,1094, 1234,1271	K00175101	" " SL 100pF (DD105SL101J50V02)	C1250,1262,1265	K40120106	16WV 10μF (16RL10)
C1157,1159	K00175221	" " " 220pF (DD107SL221J50V02)	C1184	K40120226	" 22μF (16RL22)
C1242	K00175331	" " " 330pF (DD107SL331J50V02)	C1064,1089,1134, 1135,1139,1142, 1149,1195,1198, 1244,1259	K40109002	10WV 47μF (10RE47)
C1158	K00175471	" " " 470pF (DD109SL471J50V02)	C1122	K40109001	" 100μF (10RE100)
			C1125	K40109007	" 220μF (10RE220)
			C1128	K40129001	16WV 330μF (16RE330)
			C1130	K40129003	" 1000μF (16RL1000 KOHO)

		Tantalum	R2007	J02245222	Carbon film 1/4W 2.2kΩ
C1201	K70167474	35WV 0.47μF (CS15E1VR47)	R2008	J02245103	" " " 10kΩ
C1099	K70127225	16WV 2.2μF (CS15E1C2R2M)	R2009	J02245104	" " " 100kΩ
		Styrol			
C1036,1208,1222	K51176101	100pF (50SU101K)			POTENTIOMETER
C1035,1207,1221	K51176221	220pF (50SU221K)	VR2003	J50716201	RV8FAS 200Ω
			VR2001	J50716103	" 10kΩ
		TRIMMER CAPACITOR	VR2002	J50716503	" 50kΩ
TC1001-1004	K91000074	10pF (TZ03T110A)			
TC1005-1010	K91000075	20pF (TZ03R200A)			CAPACITOR
		INDUCTOR	C2020	K00179001	Ceramic 50WV SL 0.5pF (DD104SL0R5C50V02)
L1016	L1190004	(FL4HR68M0.68μH) 0.68μH	C2022,2025	K00172010	" " " 1pF (DD104SL010C50V02)
L1010,1011	L1190006	(FL4HR1R2M 1.2μH) 1.2μH			
L1001	L1190116	(FL4HR33M) 0.33μH	C2034	K00173060	" " " 6pF (DD104SL060D50V02)
L1003	L1190117	(S-4 15μH) 15μH			
L1007,1008,1014,1015,1017	L1190016	(FLSH101K) 100μH	C2017	K00173070	" " " 7pF (DD104SL070D50V02)
L1005,1006	L1190040	(S-4 1mH) 1mH	C2001	K00173100	" " " 10pF (DD104SL100D50V02)
L1012	L0020829				
L1013	L0020725		C2019,2028,2029	K00175150	" " " 15pF (DD104SL150J50V02)
L1002	L0020302				
		TRANSFORMER	C2002,2007	K00175220	" " " 22pF (DD104SL220J50V02)
T1001,1002 1010-1014	L0020345		C2018	K00175270	" " " 27pF (DD104SL270J50V02)
T1003,1005,1006,1015	L0020187		C2035	K00175330	" " " 33pF (DD104SL330J50V02)
T1004,1009,1016-1018	L0190001		C2033	K00175390	" " " 39pF (DD104SL390J50V02)
		CHOKE COIL	C2003,2005,2011-2016,2024,2026,2027,2030,2031,2032	K13170102	" " " 0.001μF (DB200YF102Z5L2)
CH1001	L2030067	FRI4/7/5-2001F			
		RELAY	C2004,2006 2021	K14179002	" " " 0.01μF (RD204YM103Z50V)
RL1001	M1190006	FBR221D012			
	L9190001	Ferrite Beads RI 3x3-I	C2023	K70167105	Tantalum 35WV 1μF (CS15E1V010M)
	Q5000026	Terminal TP-E	C2008-2010	K40129004	" 16WV 10μF (16RE10)
					INDUCTOR
			TC2001-2004	K91000075	20pF (TZ03R200A)
			L2001,2003	L0020193	
			L2002	L0020195	
			L2004-2006,2010	L1020469	
			L2007	L0020190	
			L2008,2009	L0020430	
			L2011	L0020334	
		TRANSISTOR			TRANSFORMER
Q2001	G3320530	2SC2053	T2001	L0020069	
Q2003	Q3107150	2SA715C			
		POWER MODULE	RL2001	M1190006	RELAY FBR221-D012
Q2002	Q1090295	M57713		Q5000016	Terminal TP-E
		DIODE			
D2001-2003	G2001880F	Germanium 1S188FM			
D2004	G2015550	Silicon 1S1555			
		RESISTOR			
R2003	J02245479	Carbon film 1/4W 4.7Ω			
R2001	J02245101	" " " 100Ω			
R2002	J02245821	" " " 820Ω			

PA UNIT

PLL UNIT			R3089,3122	J02245182	Carbon film	1/4W SJ	1.8kΩ
Symbol No.	Part No.	Description	R3091	J02245222	" "	" "	2.2kΩ
PB-2136D	F0002136B	Printed Circuit Board	R3124	J02245392	" "	" "	3.9kΩ
	C0021360	PCB with Components	R3017,3042	J02245472	" "	" "	4.7kΩ
			R3093	J02245562	" "	" "	5.6kΩ
		IC, FET and TRANSISTOR	R3092	J02245822	" "	" "	8.2kΩ
Q3003,3018	G1090012	IC SN16913P	R3019-3022,3024, 3029,3035,3040, 3044,3048,3060, 3076,3095,3101, 3128	J02245103	" "	" "	10kΩ
Q3005,3026	G1090247	" TC9122P					
Q3006,3014	G1090048	" TC5081P					
Q3007	G1090239	" TC5082P					
Q3008	G1090084	" μPC78L05					
Q3012,3013	G1090296	" HD10551	R3023,3025,3043, 3086,3105,3106, 3108,3115,3117, 3119,3121,3123, 3127	J02245223	" "	" "	22kΩ
Q3024	G1090062	" SN76514N					
Q3027	G1090153	" MB8718					
Q3031-3033	G1090297	" μPD4094B					
Q3034	G1090298	" MC14560B					
Q3036	G1090088	" MC14028B	R3030,3034,3047, 3094	J02245333	" "	" SI	33kΩ
Q3044	G1090299	" μPC7805H					
Q3001	G3090035	FET 2SK19TMGR	R3001-3003, 3006-3008,3041, 3051-3053, 3070-3072, 3078-3080,3097, 3099,3100	J02245104	" "	" "	100kΩ
Q3002,3017	G4800730Y	" 3SK73Y					
Q3022,3023	G4800510C	" 3SK51					
Q3028	G3090034	" 2SK19TMY					
Q3004,3019,3025, 3037-3041	G3309450Q	Tr 2SC945Q					
Q3009,3015	G3316740L	" 2SC1674L	R3013,3058,3084	J02245184	" "	" "	180kΩ
Q3010,3011,3016, 3030	G3305350A	" 2SC535A					
Q3020	G3307100	" 2SC710	TH3001	G9090008			THERMISTOR 31D26
Q3029	G3307320G	" 2SC732TMBL					
Q3046	G3107331P /Q	" 2SA733 P or Q	C3165	K00179001	Ceramic	50WV SL	0.5pF (ED06J0.5PSL)
Q3045	G3090005	" MPS-A13	C3160,3166,3169	K02179003	" "	" CH	2pF (DD104CK020C50V02)
		C SOCKET	C3052,3082	K00172020	" "	" SL	2pF (DD104SL020C50V02)
QS3001	P3090034	116-24-30-114	C3085	K00172030	" "	" SL	3pF (DD104SL030D50V02)
		DIODE	C3047	K02172030	" "	" CH	3pF (DD104CH030D50V02)
D3002-3007, 3023,3024,3015	G2090027	Silicon 1SS53	C3003,3011,3131	K02172050	" "	" CH	5pF (DD104CH050C50V02)
D3001	G2090043	Varactor MV104					
D3016-3018,3008	G2022090	" 1S2209	C3024,3054,3057, 3149	K00172050	" "	" SL	5pF (DD104SL050C50V02)
		CRYSTAL	C3046,3074	K06172050	" "	" UJ	5pF (DD104UJ050C50V02)
X3001	H0102367	10.240 MHz	C3006	K06173060	" "	" UJ	6pF (DD104UJ060D50V02)
X3002	H0102291	63.9151 MHz					
X3003	H0102289	64.595 MHz					
		RESISTOR					
R3011,3056,3077	J02245100	Carbon film 1/4W SJ 10Ω	C3005,3161,3167, 3168	K06173070	" "	" UJ	7pF (DD104UJ070D50V02)
R3005,3009,3012, 3018,3028,3046, 3054,3057,3062, 3063,3073,3081, 3083,3090,3098	J02245101	" " " " 100Ω	C3002,3099	K02173080	" "	" CH	8pF (DD104CH080D50V02)
R3087	J02245151	" " " " 150Ω	C3138	K00173080	" "	" SL	8pF (DD108SL080D50V02)
R3031,3036,3049, 3088,3096	J02245221	" " " " 220Ω	C3042	K02173100	" "	" CH	10pF (DD104CH100D50V02)
R3004	J02245331	" " " " 330Ω	C3014,3060,3063, 3096,3135	K00173100	" "	" SL	10pF (DD104SL100D50V02)
R3045	J02245471	" " " " 470Ω	C3163	K00175120	" "	" SL	12pF (DD104SL120J50V02)
R3016,3116	J02245681	" " " " 680Ω					
R3075,3118	J02245821	" " " " 820Ω	C3064,3065,3158, 3190,3015,3016	K00175150	" "	" SL	15pF (DD104SL150C50V02)
R3014,3015,3027, 3039,3059,3061, 3085,3102-3104, 3129,3130	J02245102	" " " " 1kΩ	C3043,3080	K02175150	" "	" CH	15pF (DD104CH150J50V02)
R3120	J02245122	" " " " 1.2kΩ	C3022,3147,3184	K00175180	" "	" SL	18pF (DD104SL180J50V02)
R3038	J02245152	" " " " 1.5kΩ					

C3004,3044	K02179009	" " CH 22pF (DD104CH220J50V02)	L3012,3013,3021	L1190113	INDUCTOR (FL3HR22M) 0.22μH
C3048	K06175220	" " UJ 22pF (ECC-D1H220-JU)	L3004,3015 L3002,3010,3011, 3018	L1190109 L1190004	(FL3HR33M) 0.33μH (FL4HR68M) 0.68μH
	K00175220	" " SL 22pF (DD104SL220J50V02)	L3005,3006,3035, 3036	L1190015	(FL3HR120K) 12μH
C3170	K00175330	" " SL 33pF (DD104SL330J50V02)	L3041	L1190016	(FL5H101K) 100μH
C3010,3073,3075, 3076	K06175330	" " UJ 33pF (DD104UJ330J50V02)	L3022	L1190038	(FL5H271K) 270μH
	K02179013	" " CH 33pF (DD105CH330J50V02)	L3007,3008,3016, 3023,3037-3040, 3024	L1190017	(FL5H102K) 1mH
C3023,3148	K00175390	" " SL 39pF (DD104SL390J50V02)	L3003,3009,3014, 3019,3020,3032, 3033	L0020774	
C3045	K02175390	" " CH 39pF (DD105-257CH390J50V02)	L3017	L0020821	
C3030,3031	K02175470	" " CH 47pF (DD106CH470J50V02)	L3001	L0020793	
C3055,3056,3058, 3059,3086,3087, 3192	K00175470	" " SL 47pF (DD104SL470J50V02)			TRANSFORMER
			T3001-3004	L0020345	
C3051	K06175470	" " UJ 47pF (ECC-D1H470JU2)			CONNECTOR
			J3001	P0090054	5048-07A
C3185	K00175101	" " SL 100pF (DD105SL101J50V02)	J3002	P0090052	5048-10A
C3093,3094	K00175391	" " SL 390pF (DD104SL391J50V02)			
C3050	K12171102	" " 0.001μF (DD105E102P50V02)	VCO 1 UNIT		
			Symbol No.	Part No.	Description
			PB-2137A	F0002137A	Printed Circuit Board
				C0021370	PCB with Components
C3066,3077,3097, 3100,3102,3136, 3132-3134,3137, 3159,3141-3145, 3162,3164, 3183,	K10179016	" " 0.001μF (DD201YB102K5L5)			FET
			Q3021	G3090035	2SK19TMGR
C3001,3007,3012, 3013,3017-3021, 3025,3026,3028, 3032,3035-3041, 3049,3053,3061, 3062,3067,3078, 3079,3081,3083, 3084,3088, 3090-3092,3098, 3101,3146,3150, 3151,3153,3156, 3171,3173,3179, 3181,3197	K13170103	" " 0.01μF (DD107F103Z50V02)			DIODE
			D3009-3013	G2090027	1SS53
			D3014	G2090043	MV104
					RESISTOR
			R3064	J00245101	Carbon film 1/4W VJ 100Ω
			R3065	J00245150	" " " " 150Ω
			R3069	J00245102	" " " " 1kΩ
			R3066-3068	J00245104	" " " " 100kΩ
C3070,3072,3089, 3095	K19149013	" " 0.01μF (UTA05X103M-L05AE)			THERMISTOR
C3155,3175,3182, 3189	K19149021	" " 0.047μF (UAT08X473M-245AE)	TH3002	G9090008	31D26
C3029,3069,3154	K54200001	Polyester film 100V 1μF (B32561-A-1105J)			CAPACITOR
C3027,3033,3068, 3071,3152, 3157,3172	K70127106	Tantalum 16V 10μF (CS15E1C100M)	C3103,3111, 3119-3123	K12171102	Ceramic 50WV 2.5m/m 0.001μF (DD105E102P50V02)
			C3106,3124	K10179016	" " 5m/m 0.001μF (DD201YB102K5L5)
C3180	K40170105	Electrolytic 50V 1μF (50RL105)	C3107,3110	K06172030	" " UJ 3pF (DD104UJ030C50V02)
C3008,3034,(3178) 3186-3188	K40120106	" 16V 10μF (16RL106)	C3113,3116	K02172040	" " CH 4pF (DD104CM040C50V02)
C3174	K40120476	" 16V 47μF (16RL476)	C3112	K02173080	" " CH 8pF (DD104UJ080D50V02)
			C3108	K02173090	" " CH 9pF (DD104CH090D50V02)
		TRIMMER CAPACITOR			
TC3003	K91000056	TZ03Z070A6 7pF	C3105	K06175120	" " UJ 12pF (DD104UJ120J50V02)
TC3001	K91000074	TZ03T110A 10pF			
TC3002	K91000030	ECV1ZW40X53N 40pF	C3115	K02179009	" " CH 22pF (DD104CH220J50V02)

C3126-3130	K70147105	Tantalum 25WV 1μF (CS15E1E010M)	R4057	J02245333	Carbon film 1/4W 33kΩ
			R4029,4032	J02245393	" " " 39kΩ
C3125	K70127106	" 16WV 10μF (CS15E1C100M)	R4007-4022	J02245473	" " " 47kΩ
			R4045,4059	J02245563	" " " 56kΩ
C3104	K40120106	Electrolytic 16WV 10μF (16RL106)	R4001,4005,4033, 4034,4038,4060	J02245104	" " " 100kΩ
			R4025,4026,4027, 4030	J02245334	" " " 330kΩ
		TRIMMER CAPACITOR			
TC3004	K91000056	TZ03Z070A 7pF	R4028,4031	J02245684	" " " 680kΩ
			R4002	J02245105	" " " 1MΩ
		INDUCTOR			
L3025	L1190004	(FL4H R68M) 0.68μH			BLOCK RESISTOR
L3028,3029	L1190110	(FL3H 4R7K) 4.7μH	RB4001	Q80000006	22kX13/5.6kX3
L3026	L0020359A		RB4002	Q80000007	22kX10/10kX6
					CAPACITOR
PLL CONTROL UNIT			C4010,4013,4016, 4019,4020,4026	K13170103	Ceramic 50WV 5m/m 0.01μF (DB201YF103Z5L5)
Symbol No.	Part No.	Description	C4002,4003	K00175101	" " " SL 100pF (DD105SL101J50V02)
PB-2213	F0002213	Printed Circuit Board			
	C0022130	PCB with Components	C4005-4008	K10176471	" " " 470pF (DD104B471K50V02)
		IC			
Q4001	G1090300	μPD1511-018	C4023	K50177152	Mylar " " 0.0015μF (50F2U152M)
Q4002,4021	G1090068	MC14011B			
Q4020	G1090126	MC14069B	C4004	K50177103	" " " 0.01μF (50F2U103M)
Q4022	G1090174	MC14002B			
Q4027,4028	G1090084	78L05	C4001	K50177473	" " " 0.047μF (50F2U473M)
		TRANSISTOR	C4011,4012	K40170105	Electrolytic 50WV 1μF (50RL1)
Q4003-4018, 4033	G30107331P /Q	2SA733 P or Q	C4009,4014,4015, 4017,4018,4021, 4022,4024	K40120106	" " 16WV 10μF (16RL10)
Q4019, 4025	G3309450Q	2SC945Q			
Q4026	G3309450K	2SC945K			
Q4029	G3313830R	2SC1383R			
Q4030	G3320020L	2SC2002L			DC-DC CONVERTER
Q4032	G3327850E	2SC2785E	T4001	L3030078	0392-1030-063
		IC SOCKET			
QS4001	P3090037	116-42-30-144			CONNECTOR
			J4001,4004	P0090038	5048-12A
		DIODE	J4003	P0090052	5048-10A
D4001-4008, 4010-4027,4034, 4036,4054,4055	G2090027	Si 1SS53	J4005	P0090042	5048-05A
			J4002	P0090050	5048-04A
D4033	G2001880F	Ge 1S188FM		Q5000007	F Terminal
D4035	G2090143	Zener HZ11B-1			
		CERAMIC			
X4001	H7900080	CSA2.56M 2.56 MHz			
		RESISTOR	DISPLAY UNIT		
R4044	J10276829	Carbon composition 1/2W 8.2Ω	Symbol No.	Part No.	Description
			PB-2139B	F0002139B	Printed Circuit Board
R4042	J10276221	" " " 220Ω		C0021390	PCB with Components
R4043	J02245271	Carbon film 1/4W 270Ω			
R4041	J02245331	" " " 330Ω			DISPLAY TUBE
R4039	J02245471	" " " 470Ω	V4001	G6090008	LD8231/F1P9C5
R4046	J02245122	" " " 1.2kΩ			
R4047	J02245152	" " " 1.5kΩ			IC
R4023	J02245222	" " " 2.2kΩ	Q4031	G1090241	TA7612AP
R4037,4040	J02245472	" " " 4.7kΩ			
R4058	J02245562	" " " 5.6kΩ			TRANSISTOR
R4004,4006,4056, 4061	J02245103	" " " 10kΩ	Q4024	G3309450Q	2SC945Q
R4024,2055	J02245223	" " " 22kΩ			DIODE
R4003	J02245273	" " " 27kΩ	D4028-4032	G2090027	1SS53

DIODE INSTALLATION CHART FOR PLL CONTROL UNIT

	TYPE A	TYPE B	TYPE C	TYPE D	TYPE E
Frequency Coverage	143.5-148.5 MHz	144.0-146.0 MHz	143.5-148.5 MHz	144.0-146.0 MHz	143.5-148.5 MHz
Channel Separation for FM Mode	S 1kHz M 20kHz F 100kHz	S 1kHz M 25kHz F 100kHz	S 1kHz M 25kHz F 100kHz	S 1kHz M 12.5kHz F 25kHz	S 1kHz M 12.5kHz F 25kHz
D4004	X	X	X		
D4006		X	X	X	X
D4007	X	X	X		
D4011	X		X		X
D4051				X	X
D4052				X	X
D4053				X	X

X = install a diode (1SS53)

Blank = vacant

