INSTRUCTION MANUAL

FT-780R

YAESU MUSEN CO., LTD.

TOKYO JAPAN

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FT—780R
MICROPROCESSOR CONTROLLED
0.7 METER ALL—MODE TRANSCEIVER

GENERAL DESCRIPTION

The FT-780R is a revolutionary, high performance USB, LSB, FM, and CW transceiver for the most demanding 70 cm operator. Controlled by a NMOS 4-bit microprocessor, the FT-780R features full PLL synthesis in 10 Hz, 100 Hz, 1 kHz, 25 kHz (US model), and 100 kHz steps. The extremely compact size of the FT-780R 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 repeatrer operation.

Among the convenience features of your FT-780R are receiver offset tuning for CW and SSB, and a digitally synthesized dual VFO system. For satellite work, the transmit frequency may be varied to counter Doppler shift.

We recommend that you read this manual in its entirety, so as to derive maximum benefit from your new FT-780R, an exciting breakthrough from the communications experts .... Yaesu.

SPECIFICATIONS

GENERAL

Frequency coverage:
*430,00 – 439.99 MHz Lowband model
**440,00 – 449.99 MHz Highband model

Modes of operation:
SSB (USB, LSB), CW, and FM

Synthesizer steps:

SSB, CW	10 Hz, 100 Hz, 1 kHz
FM	1 kHz, 25 kHz, 100 kHz

Frequency stability:
±10 ppm (–10°C – +60°C)

Power requirements:
13.8 volts DC, negative ground

Current consumption:
DC 0.5 amps receive
DC 4.0 amps transmit

Antenna impedance:
50 ohms

Case size:
60 (H) x 180 (W) x 250 (D) mm

Weight:
Approx. 3.0 kg

TRANSMITTER

Power input:

SSB	30 watts PEP
FM/CW	30 watts DC

Carrier suppression (SSB):
Better than 40 dB

Unwanted sideband suppression (SSB):
Better than 40 dB

Spurious emission (SSB):
At least 60 dB down

Frequency response:
400 – 2600 Hz (–6 dB)

FM Deviation:
±5 kHz

Microphone impedance:
600 ohms

RECEIVER

Sensitivity:

SSB, CW	0.5 μV for 20 dB S/N
FM	12 dB SINAD 0.35 μV
	1 μV S/N 35 dB

Selectivity:

SSB, CW	2.2 kHz at 6 dB down
	4.8 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

* Model A, B
** Model X

Model	Frequency Range (MHz)	Synthesizer Steps (Hz)						Tone Burst Frequency (Hz)	Preset Frequency (MHz)	Repeater Offset Frequency (MHz)
		SSB, CW			FM					
		S	M	F	S	M	F			
A	430.00 – 439.99	10	100	1K	1K	25K	100K	1800	435.00	±5
X	440.0 – 449.99	10	100	1K	1K	25K	100K	1800	445.00	±5
B	430.0 – 439.99	10	100	1K	1K	25K	100K	1750	433.00	±7.6

SEMICONDUCTOR

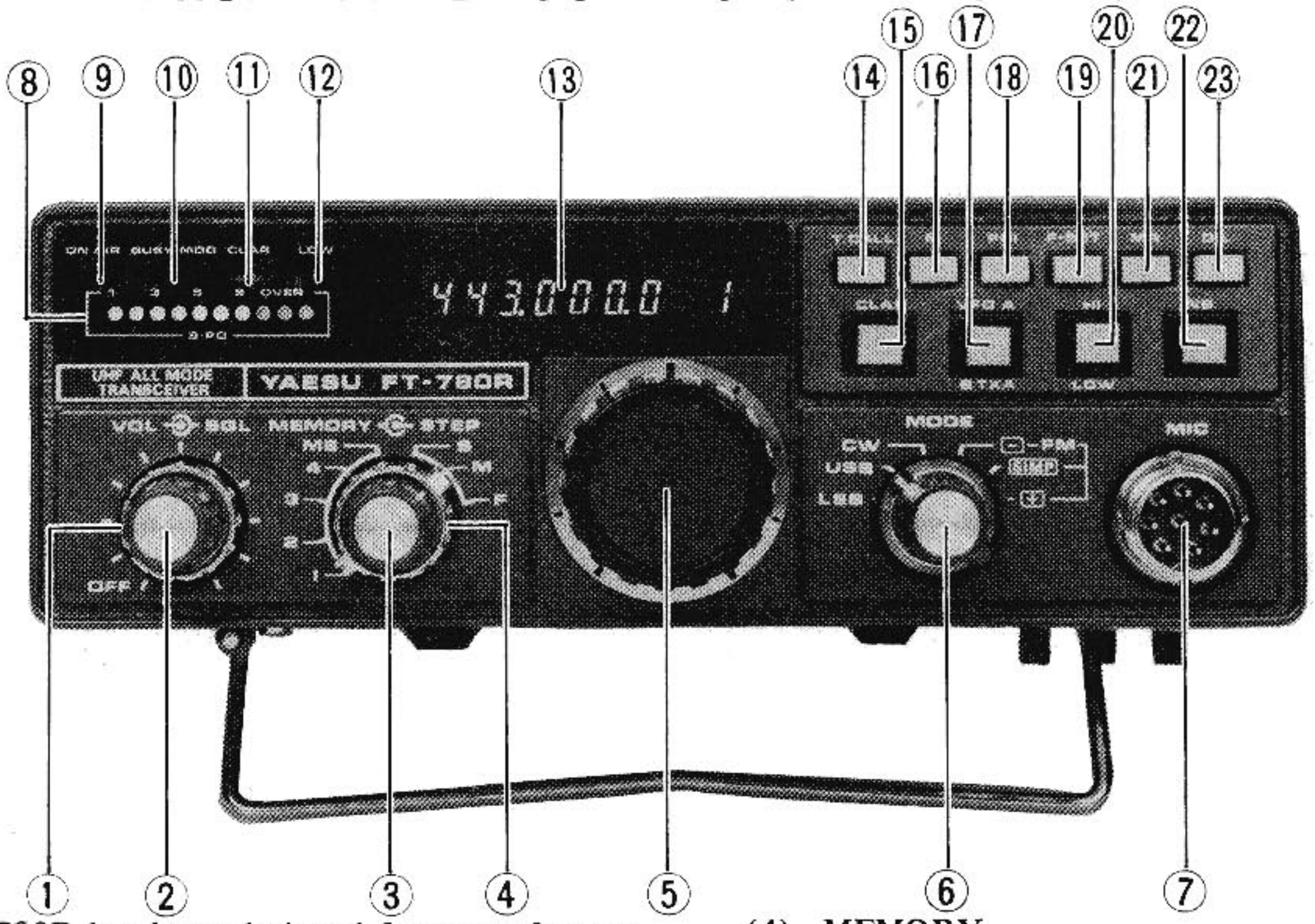
IC:	
HD10551	2
M57716	1
MB84024B	1
MC1496P	2
MC14002B	1
MC14011B	2
MC14069UB	2
MC14094B	4
MC14504B	1
MC14518B	1
SN16913P	3
TA7612AP	1
TC5081P	2
TC5082P	1
TC9122P	2
μPC78L05	3
μPC577H	1
μPC1037H	1
μPC2002H	1
μPC7808H	2
μPD1511-018	1
FET:	
2SK19TM-GR	3
2SK30A-Y	1
3SK73Y	9
3SK97	1
Transistor:	
2SA496-O/Y (2SB548)	2
2SA564Q	3
2SA733P/Q	19
2SC460B	3
2SC535B	8
2SC945K	1
2SC945P	37
2SC1383R	1
2SC1426	1
2SC1583	3
2SC1815GR	4
2SC2002L	1
2SC2026	4
2SC2053	1
2SC2407	1
2SC2785E	3
MPS-A13	2
Diode:	
1S188FM	7
1S1555	4
1SS53	74
1SS97	7
10D1	3
1T25	4
HZ6A-L	1
HZ11B-1	1
MI301	3
U05B	1
LED:	
TLG205	2
TLG226	5
TLR205	2
TLR226	3
TLY226	2
FCD:	
LD8231/F1P9C5	1

Specifications subject to change without notice of 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.
8.	ACC Connector	(P0090188)	1 ea.

FRONT PANEL CONTROLS AND SWITCHES



The FT-780R has been designed for ease of operation. However, the operator may not be familiar with some controls since the FT-780R 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	25 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 0.7 meter amateur band. It is activated when the DIL button is pushed.

When the transceiver is initially turned on, the display will indicate *435.000.0 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). Selection of simplex or*±5 MHz repeater shift is also provided on this switch.

(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 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 7 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)

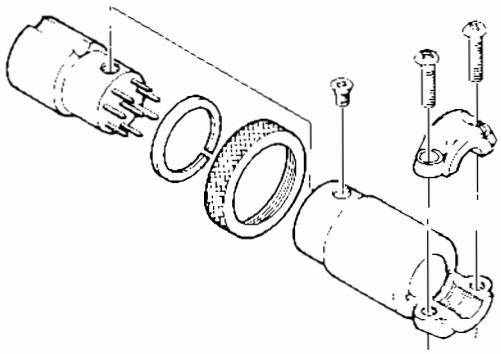
This button transfers frequency control from the main dial to the memory channels.

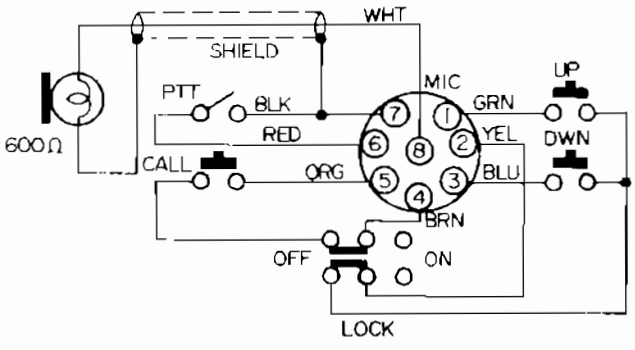
(22) NB (Noise Blanker)

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

(23) DIL (Dial)

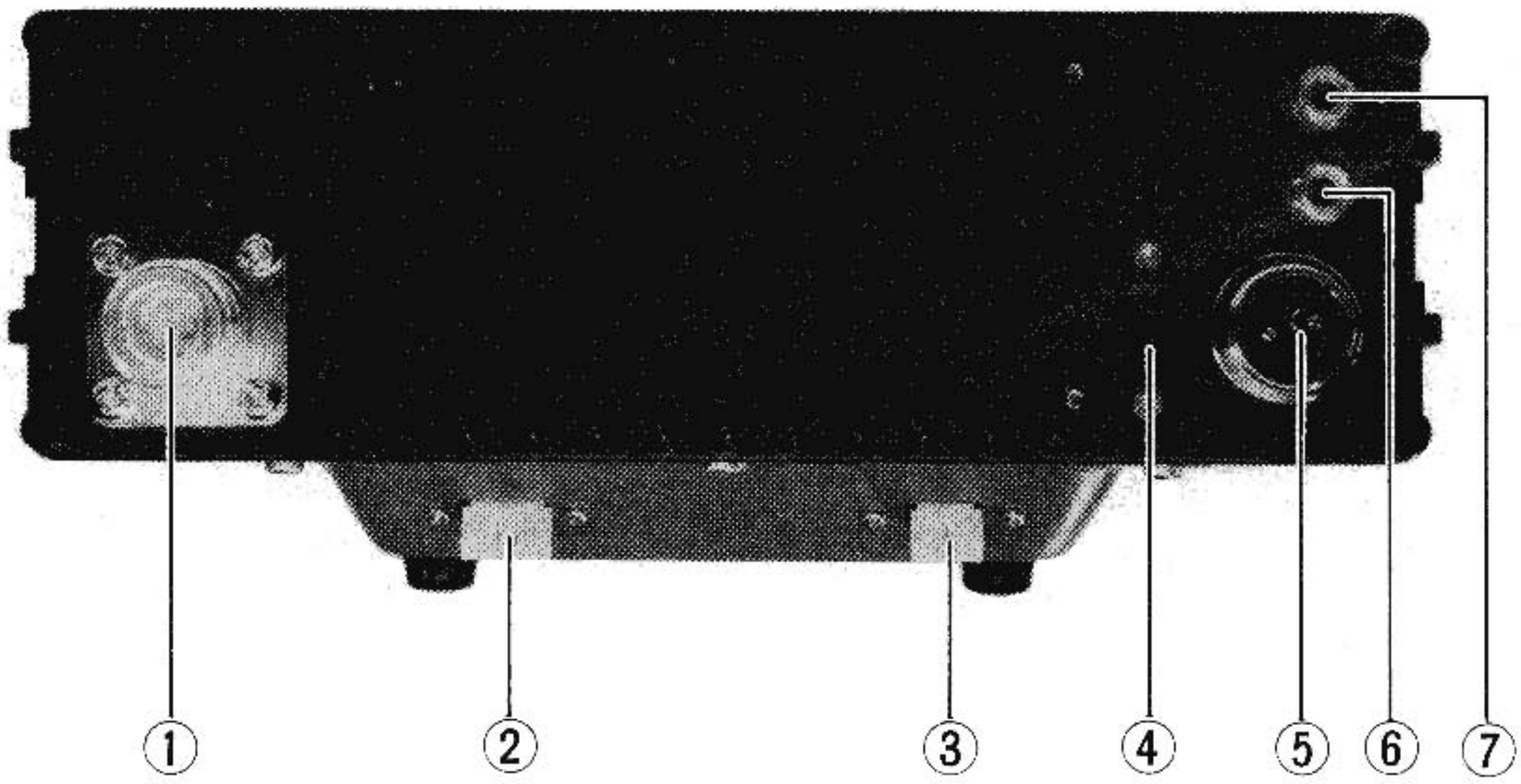
This switch, when pressed, transfers frequency control from the memory channels to the main tuning dial.





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) ACC CONNECTOR

This connector supplies output for the external S/PO meter and the stand-by control line for the external control (TX-GND).

(4) 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.

(5) POWER

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

(6) EXT SP

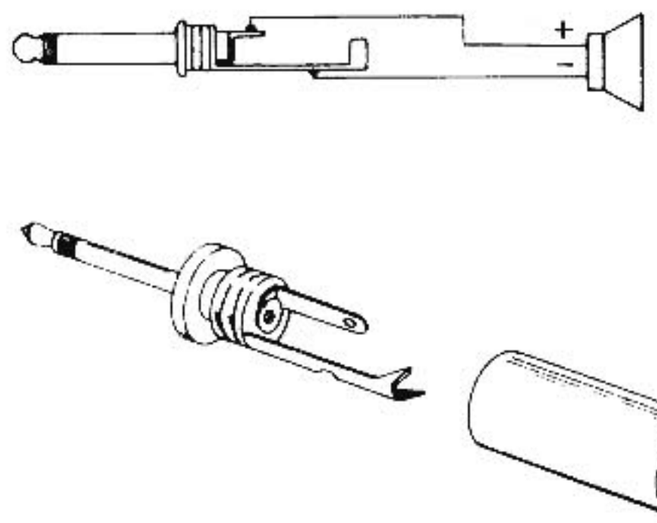
This is a miniature phone jack for connection to an external speaker. Insertion of a plug into this jack automatically cuts off the internal speaker.

(7) KEY

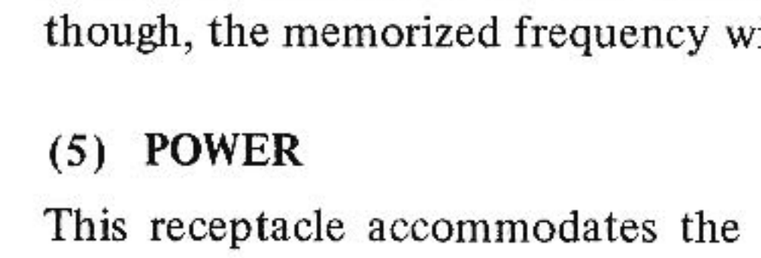
This is the key jack for CW operation. The key-up voltage is +8V, while the key-down current is approximately 1mA.

WARNING

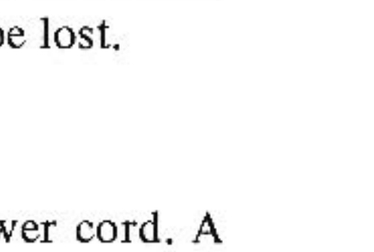
WHEN REPLACING FUSES, BE CERTAIN TO USE A FUSE OF 5 AMP RATING. OUR WARRANTY DOES NOT COVER DAMAGE CAUSED BY USE OF AN IMPROPER FUSE.



EXTERNAL SPEAKER CONNECTIONS



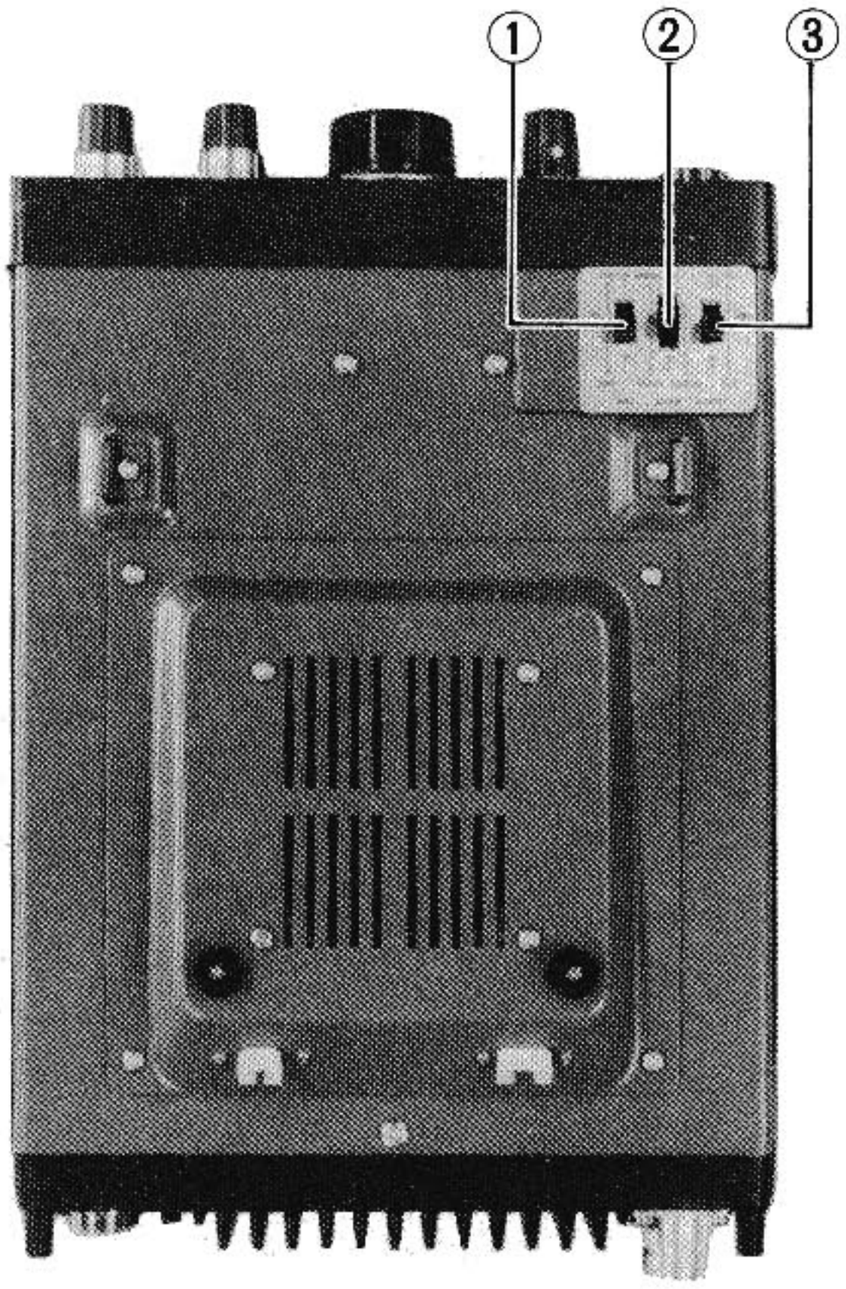
TONE IN CONNECTOR



ACC CONNECTOR

KEY CONNECTIONS

UNDERSIDE CABINET SWITCHES



(1) SAT (Satellite)

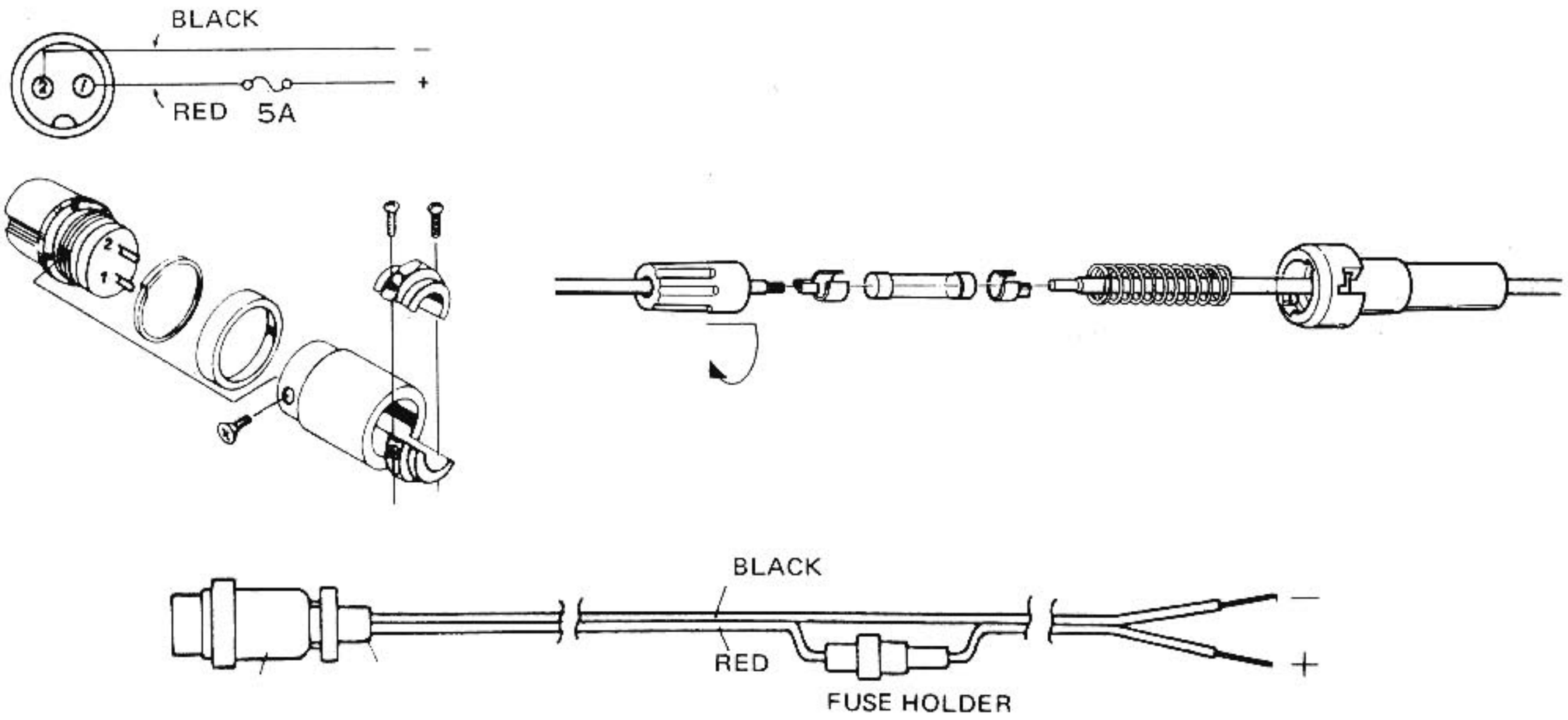
This switch allows the operating frequency to be changed while transmitting. This feature is useful especially for satellite operation, for it allows the operator to zero on the proper frequency within the satellite passband. Neither VFO A/B TXA nor the CLARIFIER function works when the SAT switch is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



POWER CORD CONNECTIONS

INSTALLATION

ANTENNA CONSIDERATIONS

The FT-780R 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 wavelenght 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 "heliax" cable may be used.

MOBILE INSTALLATION

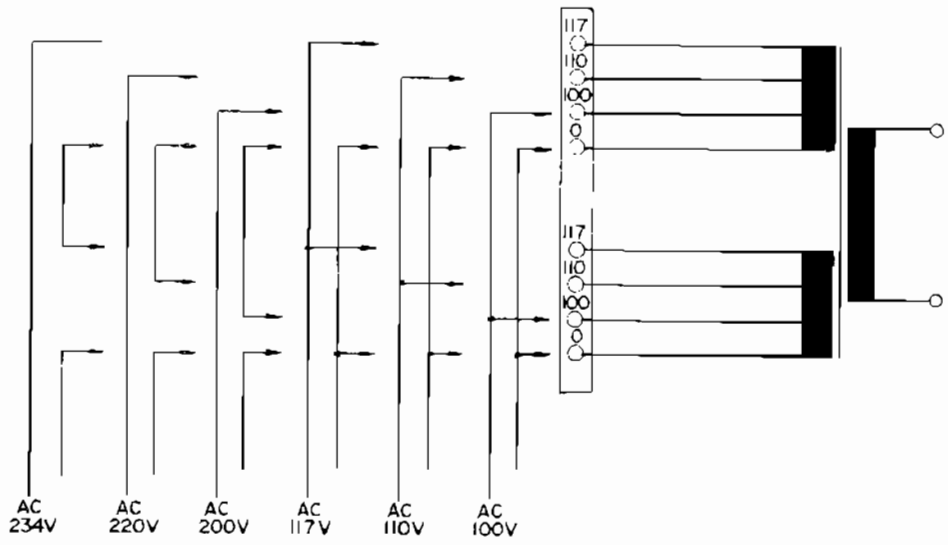
For mobile service, the FT-780R should be installed where the digital display, controls, and microphone are easily accessible for operation. The transceiver may be installed in any position without loss of performance. A suitable location would be stop the transmission tunnel. A universal bracket is 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.



FP-80A POWER TRANSFORMER PRIMARY CONNECTIONS

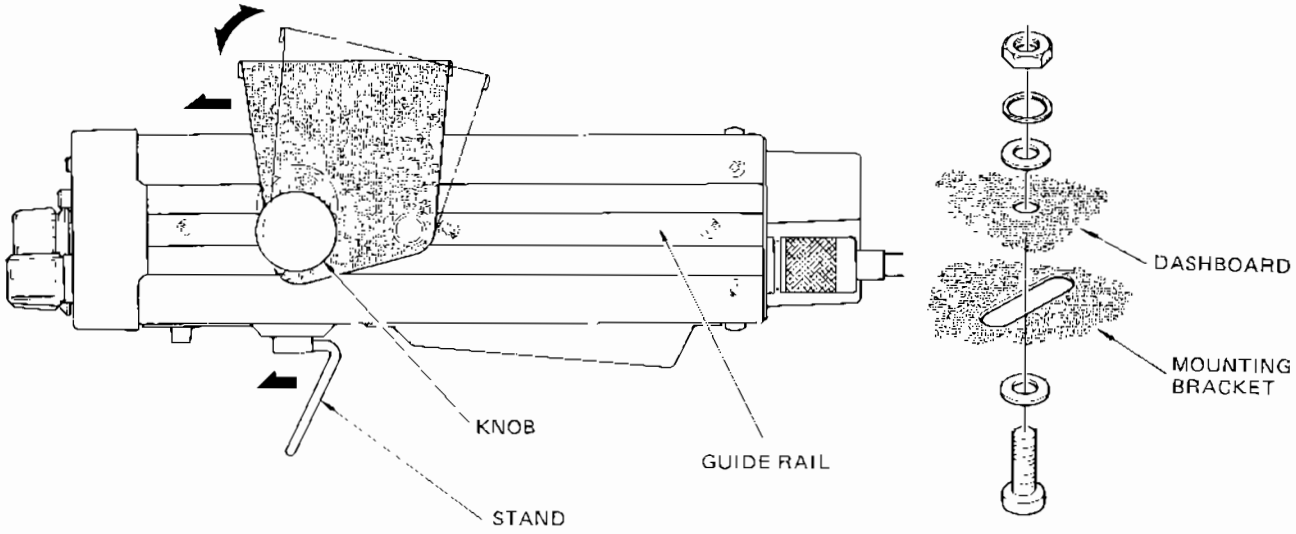


Figure 1

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.

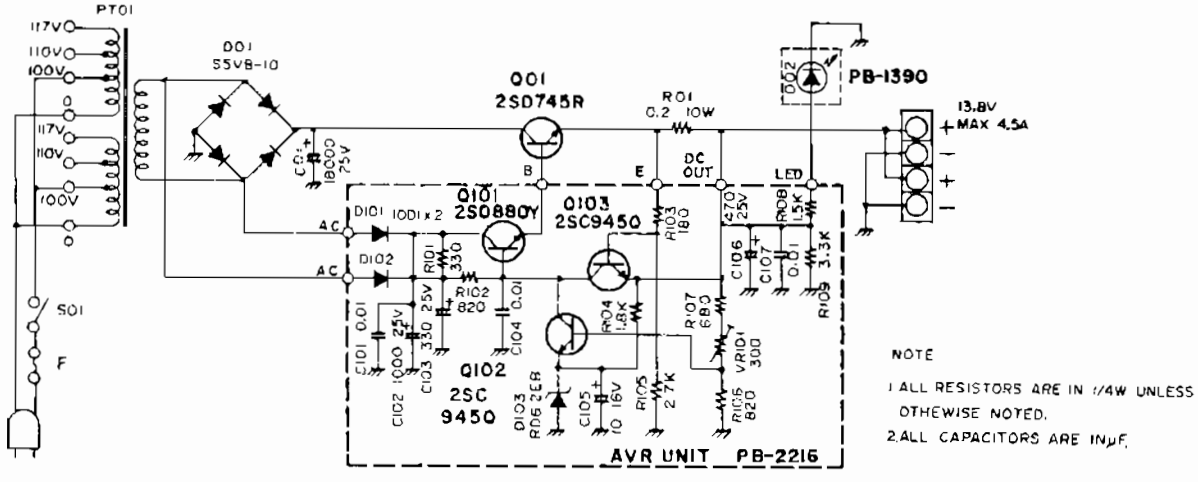
WARNING

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-780R transceiver. See your Yaesu dealer.



FP-80A POWER SUPPLY

OPERATION

The all solid-state design of the FT-780R 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 *445.000.0 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 *449.999.9 MHz, the next step is 440.000.0 MHz. While transmitting, the operation frequency can not be changed in any operation modes except the satellite mode.

* A model.

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 be turned off initially.

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 smoothly. 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 drift, 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 (25 kHz) position, as almost all FM stations use 25 kHz steps. When you change the operating mode from SSB/CW to FM, 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'PO 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 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 446.640.0 MHz. Now rotate the MEMORY switch to position 1. Press the M button to store 446.640.0 MHz into memory channel position 1.

(2) Now rotate the main tuning dial to another frequency (for example 446.360.0 MHz). For instant return to 446.640.0 MHz, press MR button, the 446.640.0 1 will be displayed on the digital readout.

(3) To return again to 446.360.0 MHz, press DIL, and you will be operating on 446.360.0 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 describer 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 bottm 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-780R for priority operation.

(1) First program one or more memory channels for priority use. For example, store 446.640.0 MHz into memory channel 1. Set the bottom panel SCAN switch to MAN. Rotate the main dial to the desired frequency (for example 446.360.0 MHz).

(2) Now set the MEMORY switch to 1 and push MR to recall 446.640.0 MHz; now push the PRI (priority) switch. The display will indicate 446.360.0 P, and every 7 seconds the display will switch to 446.640.0 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 +5 MHz (+7.6 MHz), and - 5 MHz (7.6 MHz) are built into the FT-780R. To select these shifts, set the bottom panel RPT switch to the + or – position respectively.

(2) To cover unusual repeater splits, you can use the VFO A/B TXA feature.
Example: receive frequency 448.640 MHz with 1 MHz split. Rotate the main tuning dial to the 447.640 MHz and press the VFO A/B TXA button on the front panel; now the transmit frequency, 447.640 MHz, is memorized. Rotate the main tuning dial to 448.640 MHz for receiving. If you close the PTT switch, your transmit frequency will be shifted to 447.640 MHz.

(3) A 1750 or 1800 Hz tone generator is included with your transceiver for accessing repeater requiring such a tone. When the T.CALL switch is pushed, a tone will be superimposed on your transmitted signal. This switch also activates the PTT function, and transmits the access tone, for as long as the switch is held. An external tone or burst generator, optional FTS-64E may be connected through the rear panel TONE IN CONNECTOR.

INITIALIZING FREQUENCY/BACKUP FEATURE

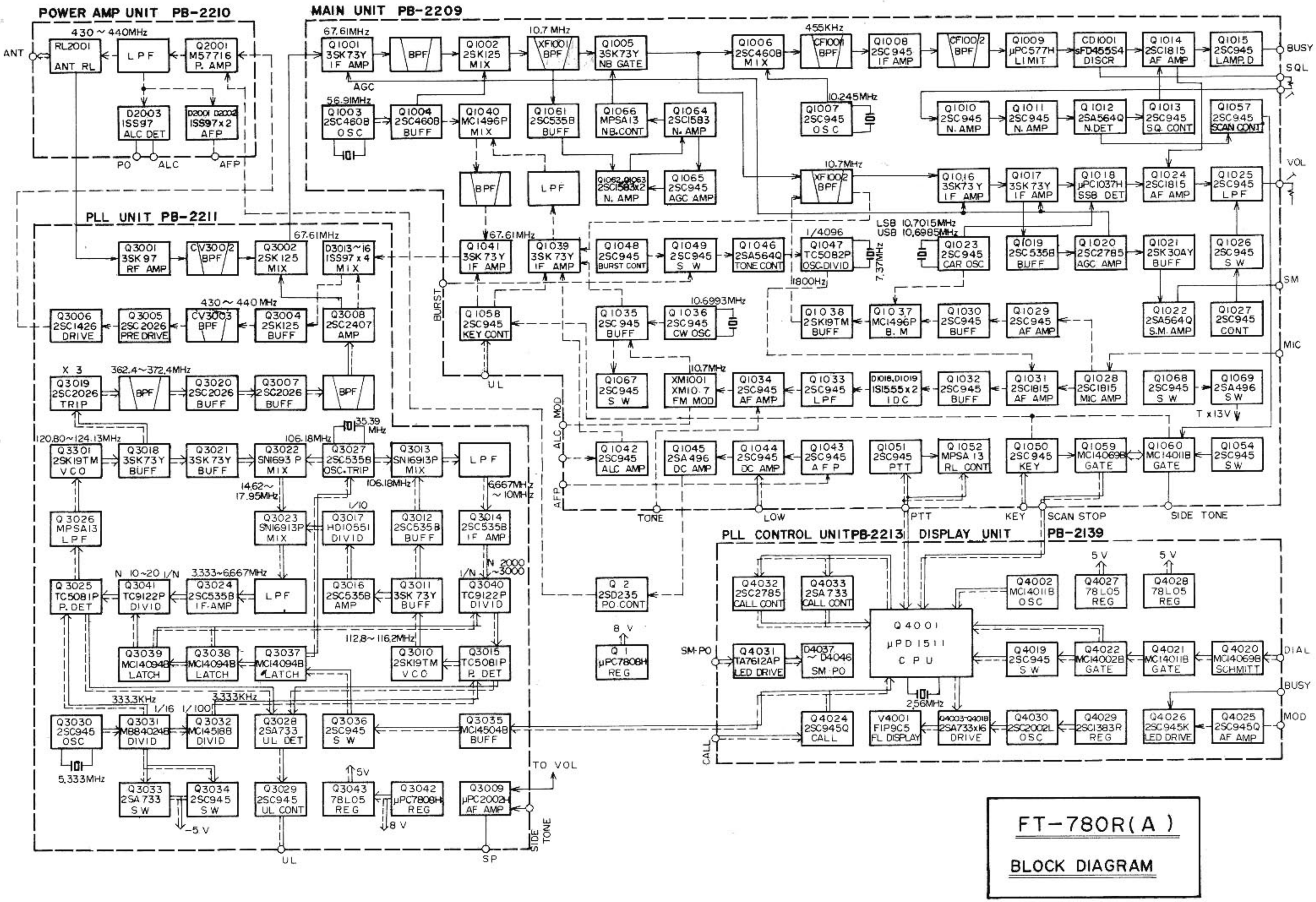
The FT-780R includes a backup feature which will hold all memory frequencies, as well as dial frequency, when the front panel power switch is turned off. So long as the DC power to the rear apron power jack is not interrupted, these frequency will be held. When the power is again turned on, the frequency 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 FT-780R 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 ±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.

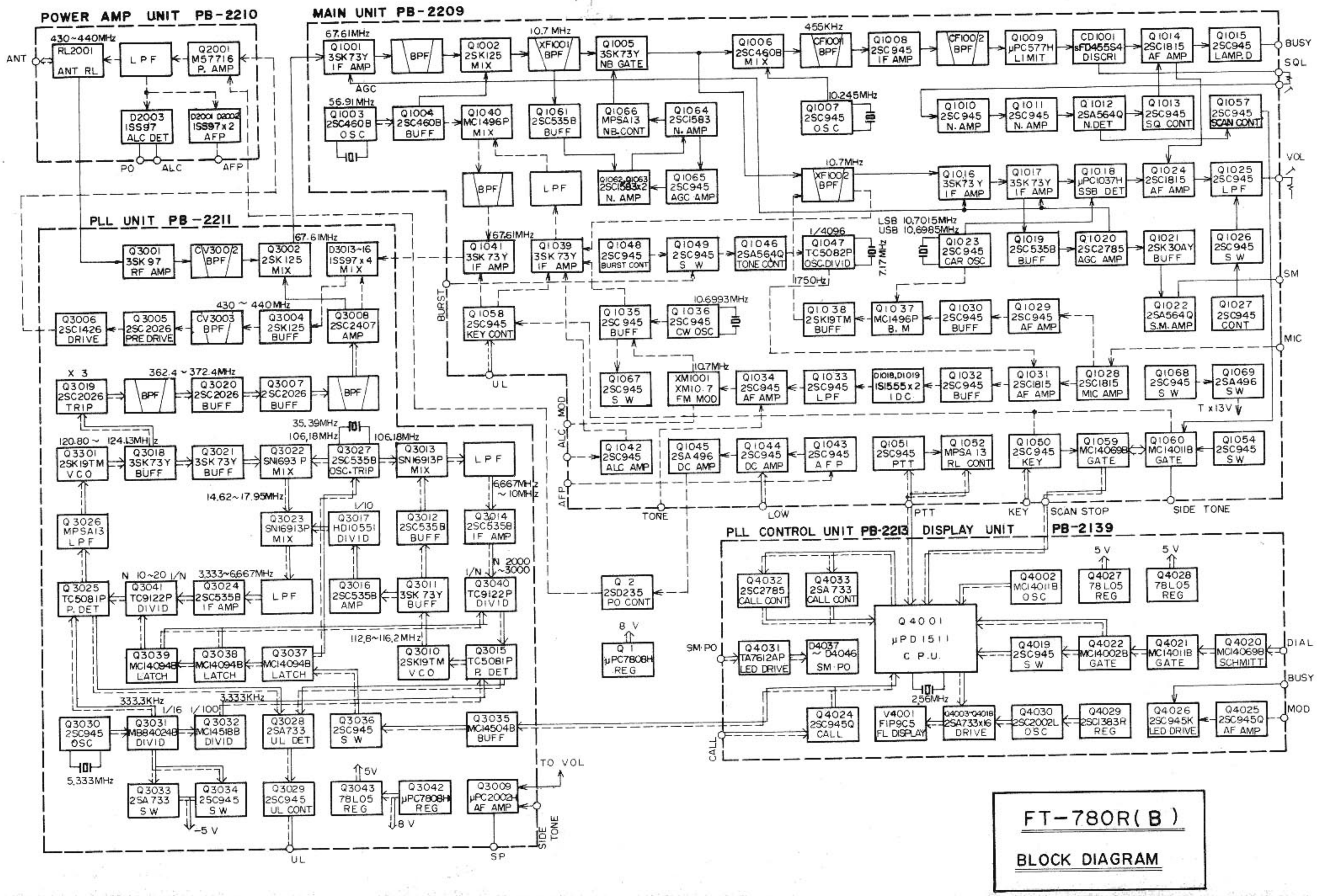
To allow frequency change during transmission, set the bottom panel SAT (Satellite) switch to ON. For most satellite work on SSB or CW, the synthesizer step switch should be set to Slow or Medium. You may now close the PTT switch and vary your frequency as desired. Note that your receiver frequency will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

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



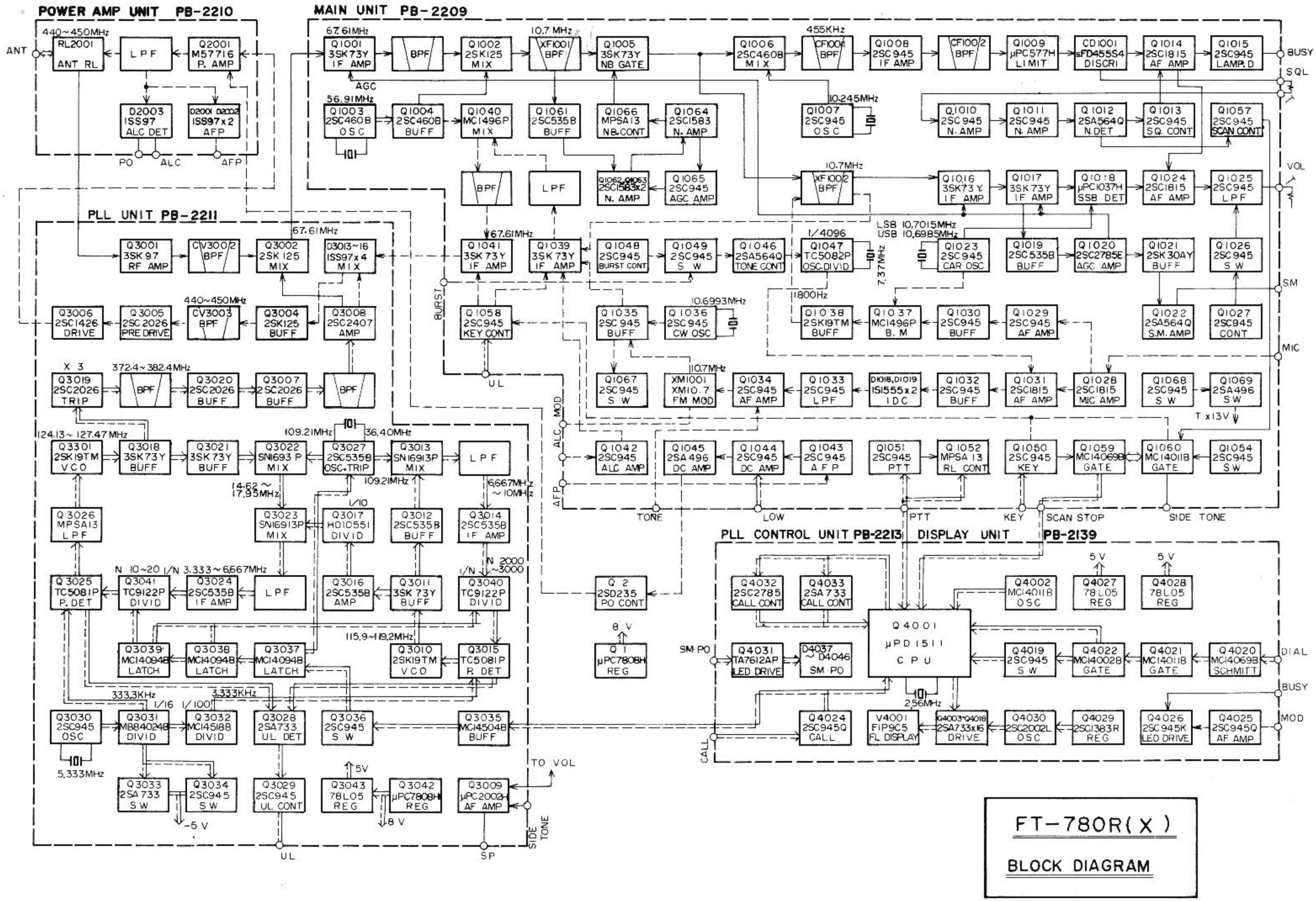
FT-780R(A)

BLOCK DIAGRAM



FT-780R(B)

BLOCK DIAGRAM



FT-780R(X)

BLOCK DIAGRAM

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 diagrams for specific circuit details.

RECEIVER

The RF signal from the antenna jack is applied to the PLL UNIT through a low pass filter and the antenna relay, RL_{2001}. The signal is amplified by Q_{3001} **(3SK97)**, a dual gate GaAs FET with excellent rejection of cross modulation and intermodulation. The amplified signal is fed to the 1st mixer, Q_{3002} **(2SK125)**, where the RF signal is mixed with a local signal delivered from Q_{3008} **(2SC2407)**, resulting in a 67.61 MHz first IF signal.

The first IF signal is amplified by Q_{1001} **(3SK73Y)** and then passed through a stagger tuned bandpass filter to the second mixer Q_{1002} **(2SK125)**. The signal is then mixed with a second local signal of 56.91 MHz, which is delivered from buffer Q_{1004} **(2SC460)**, thus producing a second IF signal (10.7 MHz).

The 2nd IF signal is passed through a monolithic crystal filter, XF_{1001} **(10M30B)**, which has ±15 kHz bandwidth, and amplified by Q_{1005} **(3SK73Y)**, which acts as a switch driven by the NB (noise blanker) circuit. The amplified signal from Q_{1005} is fed to IF amplifiers for each mode.

FM mode signals are fed to 3rd mixer Q_{1006} **(2SC460)**, where the signal is mixed with a 10.245 MHz local signal, resulting in a 455 kHz 3rd IF signal.

The 3rd IF signal is passed through a ceramic filter, CF_{1001}, which has a ±4.5 kHz bandwidth, and then fed to the FM mode IF amplifier.

The filtered signal is amplified by Q_{1008} **(2SC945Q)** and passed through CF_{1002}, which has a ±7.5 kHz bandwidth. The filtered FM signal is amplified by Q_{1009} **(μPC577H)** and demodulated by CD_{1001} and D_{1002}, D_{1003} **(1S188FM)**. The demodulated FM signal is amplified by Q_{1014} **(2SC1815GR)** and then fed to the AF amplifier.

SSB and CW mode signals from the Q_{1005} are passed through a crystal filter, XF_{1002}, which has a very high shape factor, to improve adjacent frequency selectivity. The filtered SSB signal is amplified by Q_{1016} and Q_{1017} **(3SK73Y)**, and then fed to the balanced demodulator, Q_{1018} **(μPC1037H)**, where a carrier signal is applied from the carrier oscillator Q_{1023} **(2SC945P)**; 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 Q_{1024} and Q_{1025} **(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, Q_{3009} **(μPC2002H)**, providing about 2 watts of audio output to the speaker.

S-METER CIRCUIT

A portion of the amplified IF signal is fed to Q_{1019} **(2SC535B)**, a buffer amplifier, through C_{1080}. The amplified signal is then applied to the AGC detector, D_{1009}/D_{1010} **(1S188FM)**. The rectified signal is amplified by DC amplifier Q_{1020} **(2SC2785E)** 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 (CD_{1001}, D_{1001}, D_{1002}) is fed to noise amplifiers Q_{1010} and Q_{1011} **(2SC945P)** through VR_{1001} and the SQ Control **(VR_{1b})**, and then rectified by Q_{1012} **(2SA564)**. The rectified signal is fed to the base of Q_{1013} **(2SC945P)**, the squelch control circuit.

When no carrier is present, the rectified DC voltage is applied to the base of Q_{1013}, to turn Q_{1014} **(2SC1815GR)** on. With conduction of Q_{1012}, the base of Q_{1014} is grounded, squelching the audio amplifier.

When a carrier is present, the rectified DC voltage is reduced, the audio amplifier Q_{1014} then recovers to normal operation. The BUSY lamp switch, Q_{1015} **(2SC945P)**, 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 2nd IF signal from monolithic filter XF_{1001-1} is amplified by Q_{1061} **(2SC535B)**, Q_{1062}, Q_{1063}, and Q_{1064} **(2SC1583)**. The output signal is rectified by D_{1042} and D_{1043} **(1S188FM)**, producing a DC voltage. This DC voltage is amplified by Q_{1066} **(MPSA13)** and fed to gate 2 of Q_{1005}, the noise blanker gate. A portion of the DC voltage is amplified by Q_{1065} **(2SC945P)**, and then fed to Q_{1062}, Q_{1063} **(2SC1583)** as a noise blanker AGC voltage. When impulse-type noise is received, the induced DC voltage reduces the gain of Q_{1005}, 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 C_{1204}/R_{1257} is long. Normal signals, though, induce the noise blanker AGC voltage, reducing the gain of the noise amplifier, allowing normal signal flow at Q_{1005}.

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 Q_{1028} **(2SC1815GR)** and Q_{1029} **(2SC945P)**, the audio level is adjusted to the proper level by VR_{1004}, and is applied through an active lowpass filter, Q_{1030} **(2SC945P)**, to the double balanced modulator Q_{1037} **(MC1496P)**. Here the audio signal modulates the 10.7 MHz carrier signal delivered from the carrier oscillator Q_{1023} **(2SC945P)**, resulting in a 10.7 MHz double-sideband signal. The signal is amplified by Q_{1038} **(2SK19TM-GR)** and fed to XF_{1002}, a crystal filter, where the unwanted sideband is sliced out. The SSB signal is amplified by Q_{1039} **(3SK73)**, and then fed to mixer Q_{1040} **(MC1496)** and mixed with a local signal from the PLL Unit, resulting in a 67.61 MHz SSB signal.

The SSB signal is passed through $T_{1014}-T_{1016}$, which minimizing spurious radiation. The signal is then amplified by Q_{1041} **(3SK73Y)**, and fed to PLL unit.

The SSB signal applied to mixer $D_{3013} \cdot D_{3016}$ **(1SS97)** is mixed with the local signal from the PLL circuit, resulting in a proper operating frequency. Next the signal is buffered by Q_{3004} **(2SK125)**, and fed through cavity CV_{3003}, which eliminates spurious harmonics, thus providing a clean SSB signal. The signal is then amplified by Q_{3005} **(2SC2026)** and Q_{2006} **(2SC1426)** to the level necessary to drive the power amplifier circuit.

FM

The output audio signal at Q_{1028} is amplified by Q_{1031} **(2SC1815GR)** and Q_{1032} **(2SC945P)** and fed to IDC circuit, consisting of D_{1018} and D_{1019}, which clips both positive and negative peaks to control the maximum possible deviation; the clipped signal is then passed through an active lowpass filter to eliminate harmonics above the speech range caused by clipping. The output signal is amplified by Q_{1034} **(2SC945P)** to a sufficient audio level and applied to the FM modulation module XM_{1001} for modulation, and the maximum deviation is adjusted by VR_{1006} prior to delivery to Q_{1039}. The signal path is then identical to that of the SSB signal.

CW

For CW, the 10.8107 MHz carrier signal is generated by Q_{1036} **(2SC945P)**, amplified by Q_{1035} **(2SC945P)**, and fed to IF amplifier Q_{1039}. The signal path is then identical to that of the SSB signal.

The key line is connected to switching transistor Q_{1058} **(2SC945P)** through inverter Q_{1060} **(MC14011B)**, which controls the gate voltages at Q_{1039} **(3SK73)** and Q_{1041} **(3SK59Y)**, thus turning the RF signal on and off.

An RC circuit connected to the base of Q_{1058} produces an ideal keying waveshape for click-free CW operation. The key line is also connected to side tone oscillator Q_{1059} **(MC14069UB)** for

monitoring of the code signal during CW operation. In order to operate on semi-break-in, the Schmitt trigger and delay circuit at Q_{1059} activates the RX-TX changeover relay.

POWER AMPLIFIER CIRCUIT

The RF signal from the Main Unit is amplified by Q_{2001} **(M57716)** 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_{1044} is grounded through VR_{1010}, and the collector current of Q_{1044} is decreased. Because the output power of Q_{2001} is controlled by Q_{1044}, the drive level to Q_{2001} is decreased, thus reducing the RF output power to approximately 1 watt.

TONE BURST CIRCUIT

When the T.CALL switch is pressed, the base of Q_{1046} **(2SA564A)** is grounded, and DC voltage is applied to tone burst oscillator Q_{1047} **(TC5082P)** to generate a 1750 Hz or 1800 Hz tone signal. The tone is superimposed on the transmit signal as long as the switch is held.

ALC (Automatic Level Control) CIRCUIT

A portion of the output power from Q_{2001} is applied through strip line to rectifier D_{2003} **(1SS97)** producing a DC voltage. The DC voltage is amplified by DC amplifier Q_{1042} **(2SC1815Y)** and fed to gate 2 of Q_{1039} to control its gain, thus preventing overdrive. The ALC level is adjusted by VR_{1008} for proper drive to Q_{2001}.

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 coupled through a stripline to detector, D_{2002} **(1SS97)**.

The detected AFP voltage is applied through VR_{2002} to Q_{1043} **(2SC945P)** in the Main Unit. As the reflected power increases, the AFP voltage also increases, and consequently Q_{1043} conducts. The voltage at gate 2 of Q_{1039} **(3SK73Y)** then decreases, 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

Voltage Controlled Oscillator VCO-1, consisting of Q_{3301} **(2SK19TM)**, D_{3002}/D_{3003} **(1T25)**, and associated circuitry, generates a signal at 128.80 – 124.13 MHz. This signal is multiplied by a factor of three at Q_{3019} **(2SC2026)**, then fed through a bandpass filter to eliminate spurious responses. The filtered signal is then amplified by Q_{3020} and Q_{3007} **(2SC2060)**, passed through another bandpass filter, then amplified further by Q_{3008} **(2SC2047)** prior to delivery to the receiver first mixer, Q_{3002} **(2SK125)** or the transmit mixer, $D_{3013} - D_{3016}$ **(1SS97)**.

A portion of the signal from buffer Q_{3008} is amplified by Q_{3007} **(2SC2026)** and applied to mixer Q_{3022} **(SN16913)**, where the VCO signal is mixed with a local signal at 106.18 MHz delivered from Q_{3027} **(2SC3027)**. The resulting signal at 14.62–17.95 MHz is, in turn, delivered to another mixer, Q_{3023} **(SN16913)**, where the 14.62–17.95 MHz signal is mixed with a local signal at 11.28–11.68 MHz from PLL Loop 2. The resulting PLL IF signal at 3.333–6.667 MHz is fed through a lowpass filter, consisting of L_{3048}, L_{3049}, C_{3131}, C_{3132}, and C_{3133}, then amplified by Q_{3024} **(2SC535B)**. The output from Q_{3024} is then fed to a programmable divider, Q_{3041} **(TC9122P)**, where the PLL IF signal is divided according to the ratio programmed by the Central Processing Unit (CPU).

VCO-2 consists of Q_{3012} **(2SK19TM)**, D_{3002}/D_{3003} **(1T25)**, providing a signal at 112.8–116.2 MHz. The VCO signal is buffered through Q_{3011} **(3SK73Y)** and Q_{3012} **(2SC535B)**, while a portion of the output from Q_{3011} is amplified by Q_{3016} **(2SC535B)** in order to drive the 1/10 divider, Q_{3017} **(HD10551)**, where the 112 MHz signal is divided by 10 and delivered to mixer Q_{3023} in PLL Loop 1.

The buffered output from Q_{3012} is fed to the PLL Loop 2 local mixer, Q_{3013} **(SN16913)**, where the 112 MHz signal is mixed with a local signal at 106.18 MHz, generated by Q_{3027}. The output from the mixer, at 6.667 10.000 MHz, is passed through a low-pass filter to IF amplifier Q_{3014} **(2SC535B)**.

The amplified signal is then applied to a programmable divider, Q_{3040} **(TC9122P)**, which divides the frequency by a factor of 2000–3000, resulting in a 3.333 kHz signal. This signal is applied to a phase detector, Q_{3015} **(TC5081P)**, where it is compared with a reference 3.333 kHz signal delivered from Q_{3032} **(MC14518)**. Any phase difference is converted into an error-correcting voltage, which is used to control varactor diodes in the PLL, locking the PLL on the proper frequency.

PLL local oscillator/tripler Q_{3027} **(2SC535B)** oscillates either in 3 Hz steps (for control of PLL Loop 1) or 0.3 Hz (to control PLL Loop 2). The resultant synthesis provides local oscillator steps of 10 Hz.

The CPU command signals, which control the dividing ratio of Q_{3041}, are converted into series by Q_{3037}–Q_{3039} **(MC14094)**. The control signal is also delivered to programmable divider Q_{3040} in PLL Loop 2 and to the VCXO oscillator/tripler, Q_{3027}.

When any VCO is unlocked, an error voltage from the phase detector is fed to the unlock control circuit, consisting of Q_{3028} **(2SA733)** and Q_{3029} **(2SC955)**. The amplified DC voltage is applied to a key control circuit so as to disable transmit capability under conditions of PLL unlock.

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 500 MHz.

(2) Vacuum Tube Voltmeter (VTVM): Hewlett-Packard Model 410B or equivalent, with an RF probe good to 500 MHz.

(3) Dummy Load/Wattmeter: bird Model 43 + UHF Dummy Load.

(4) AF Signal Generator: Hewlett-Packard Model 200AB or equivalent.

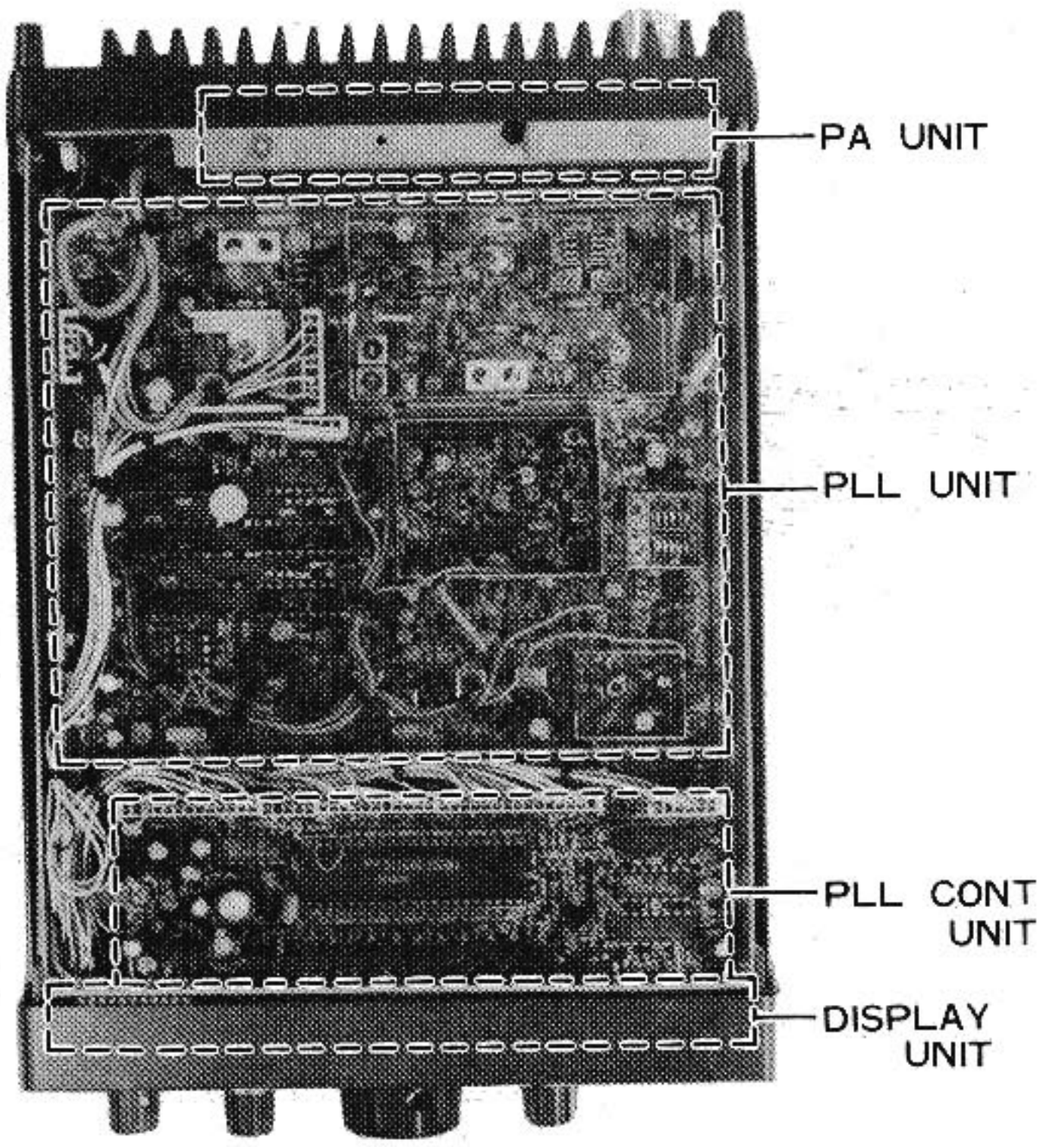
(5) IF Sweep Generator: capable of output at 10.81 MHz.

(6) RF Sweep Generator: capable of output at 420–460 MHz.

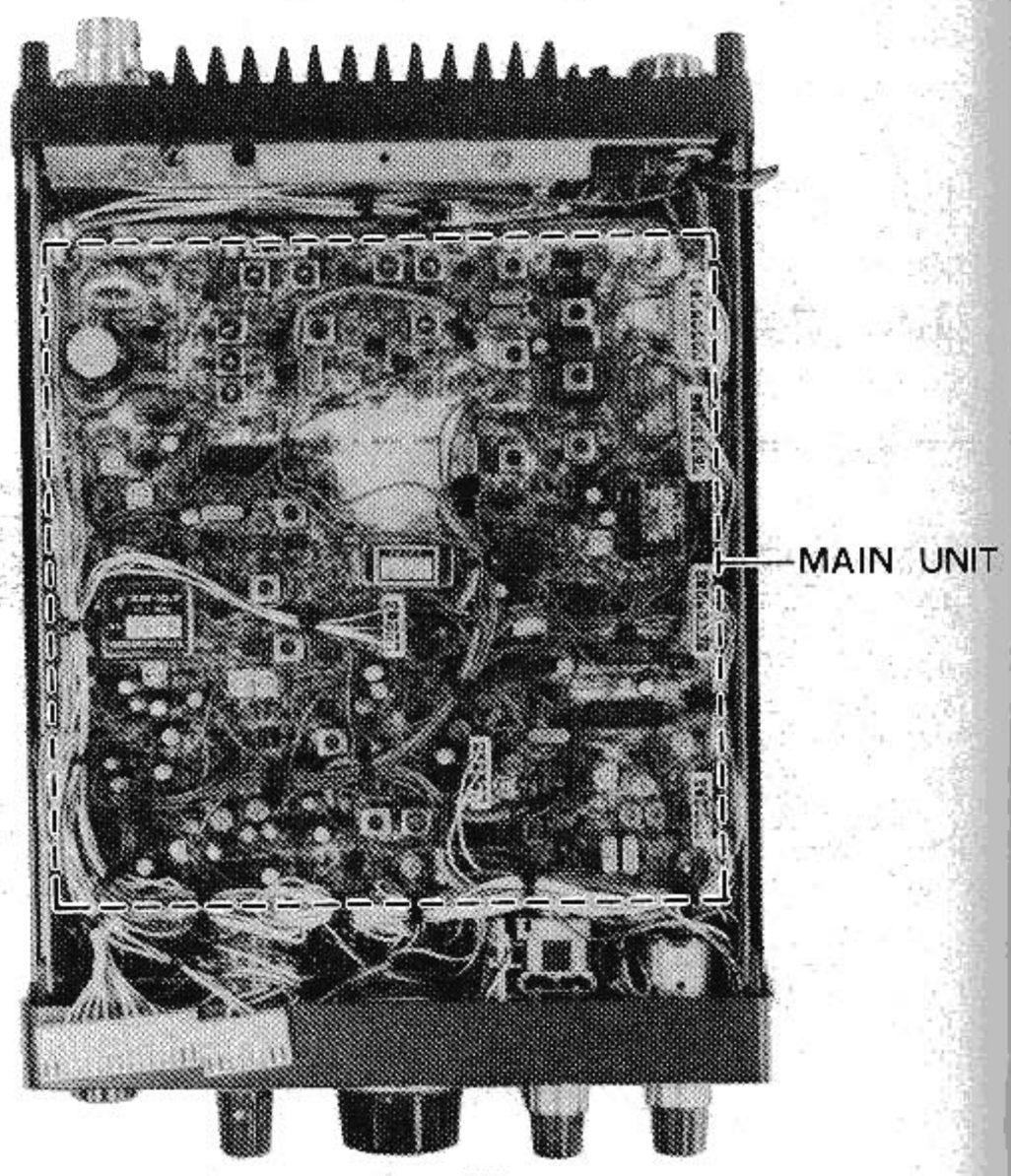
(7) Oscilloscope: Hewlett-Packard Model 1740A or equivalent.

(8) FM Deviation Meter

(9) Precision Frequency Counter: Yaesu Model YC-500 or equivalent, with resolution to 0.01 kHz and frequency coverage to 500 MHz.



Top View



Bottom View

UNIT LOCATIONS

PERFORMANCE CHECKS

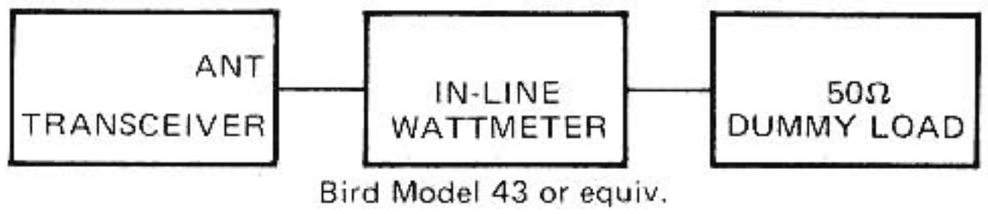
Make all performance checks at 13.8 VDC under load.

Check the transmitter power output as follows:

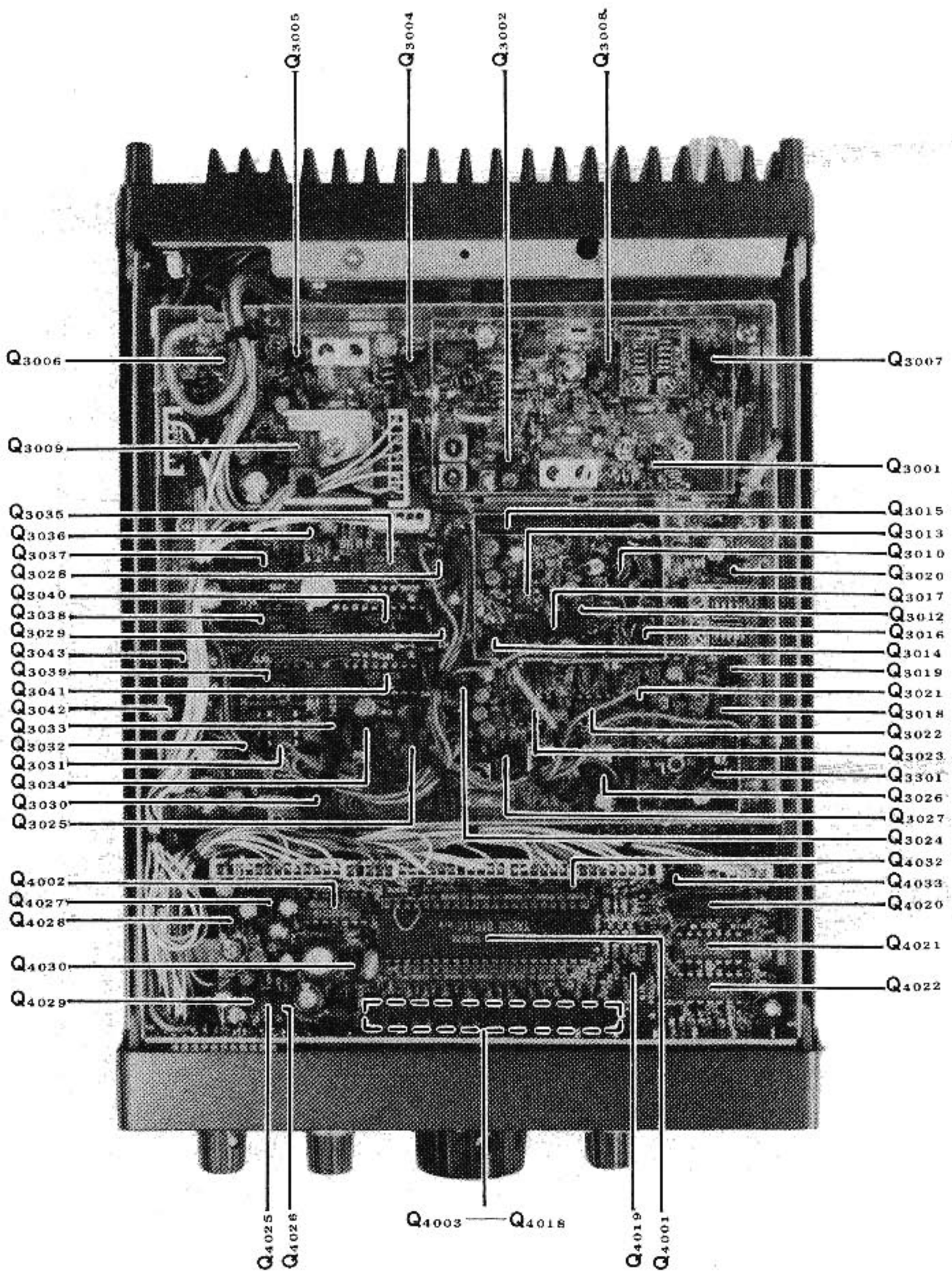
(a) Connect a suitable dummy load/wattmeter to the antenna jack.

(b) Set the MODE switch to the FM SIMP 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.



PO TEST SETUP

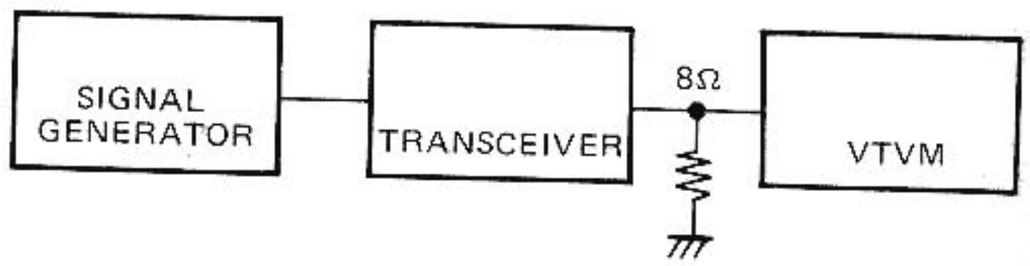


PART LOCATIONS (Top View)

Check the receiver sensitivity as follows:

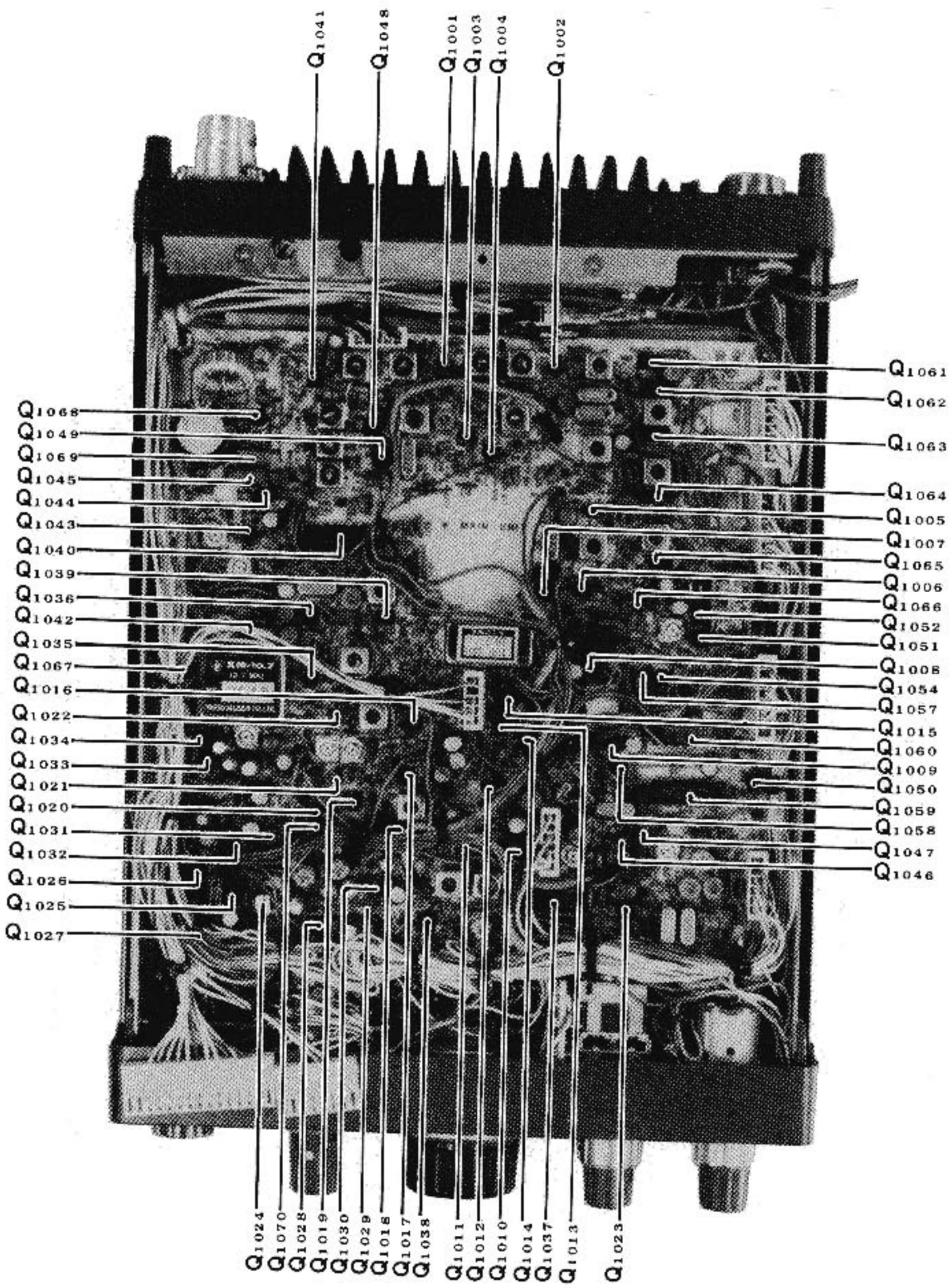
(a) Connect an AC VTVM to the SP jack. Set the MODE switch to the FM position and rotate the SQUELCH control fully counterclockwise.

(b) Connect the RF output of a precision UHF 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 μV.



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 μV 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

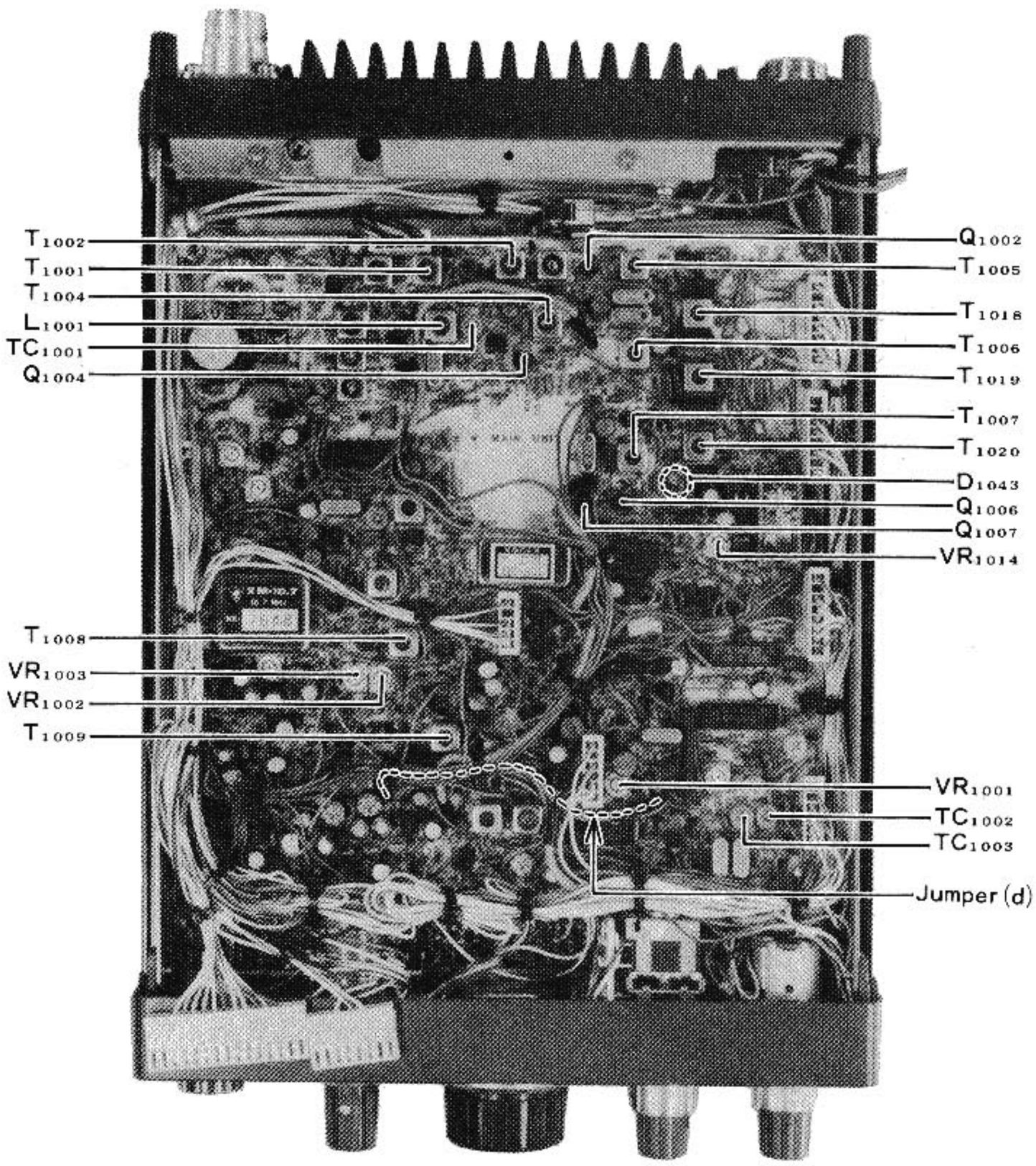
1) 2nd Local Oscillator

a) Set the MODE switch to FM SIMP, and connect the RF probe of a VTVM to the collector of Q_{1004}.

b) Adjust TC_{1001} to the point where the deflection on the VTVM shows 10% less than the peak. Be certain the oscillator is working in a stable manner.

c) Connect a frequency counter to the gate of Q_{1002} and rotate the core of L_{1001} for a reading of exactly 56.91 MHz.

d) Connect the probe of a VTVM to the gate of Q_{1002} and adjust the core of T_{1004} for maximum deflection on the VTVM (400–500mV RMS).



ALIGNMENT AND TEST POINTS FOR RECEIVER

2) 2nd IF Amplifier

a) Set the MODE switch to FM SIMP, and adjust VR_{1001} to the fully counterclockwise position.

b) Connect a sweep generator to the gate of Q_{1002} and connect an oscilloscope, through a detector, to the base of Q_{1006}.

c) Set the frequency of the sweep generator to 10.7 MHz, and apply output from the generator.

d) Adjust T_{1005}, T_{1006} and T_{1007} until the scope pattern illustrated in Figure 2 is obtained.

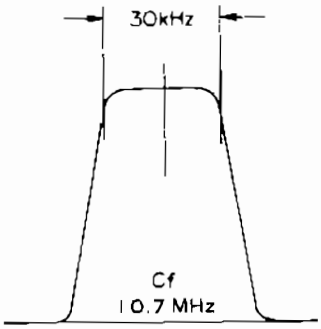


Figure 2

3) 3rd Local Oscillator

a) Set the MODE switch to FM SIMP. Connect the probe of a VTVM to the emitter of Q_{1007}, and measure the oscillation level. The nominal value is 50mV – 150mV RMS.

b) Connect a frequency counter to the emitter of Q_{1007}.

c) Check the oscillation frequency, which should be 10.245 MHz ±200 Hz.

4) SSB Carrier Oscillator

a) Set the MODE switch to LSB.

b) Pre-adjust TC_{1002} and TC_{1003} to their half capacity positions.

c) Connect the probe of a VTVM to the inner wire of JUMPER SHIELD (d), referring to the RX alignment point photo for the exact location.

d) Measure the output level on both LSB and USB. The nominal value is 150mV – 200mV. (TC_{1002} and TC_{1003} should be adjusted according to the alignment procedure for the TX section.)

5) RF Amplifier

a) Connect a UHF sweep generator to the antenna jack, and connect an oscilloscope, through a detector, to the drain of Q_{3002}.

b) Set the frequency of the generator to 435 MHz (Model X: 445 MHz).

c) Adjust TC_{3001}, TC_{3002} and CV_{3002} until the scope pattern illustrated in Figure 3 is obtained.

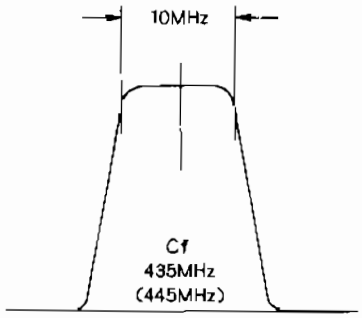


Figure 3

6) Total Sensitivity Adjustment

a) Set the MODE switch to USB or LSB.

b) Connect a standard signal generator to the antenna jack, and set the output level to approximately 10 dBμ (3.16 μV).

c) Adjust T_{1001}, T_{1002}, T_{1008} and T_{1009} on the MAIN unit, and T_{3001}, T_{3002} and TC_{3003} on the PLL unit for maximum deflection on the S-meter.

7) S-meter Full Scale Setting

a) Rotate VR_{1002} fully clockwise to make sure that all the LED's are illuminated on the S-meter scale.

b) Set VR_{1002} to the point where all the LED's go off.

c) Apply a 20 dBμ (10 μV) signal from the signal generator and adjust VR_{1003} so that 7 LED's are illuminated.

d) Reduce the output from the generator to 0 dBμ (1μV) and adjust VR_{1014} to the point where 2 LED's are illuminated.

e) Repeat Steps c and d a few times to obtain an accurate reading.

8) Noise-Blanker Adjustment

a) Set the MODE switch to CW, and push the NB switch on.

b) Connect a signal generator to the antenna jack, and set the output level to 5 dBμ (1.78 μV).

c) Set the transceiver to receive the signal from the generator.

d) Connect a DC voltmeter (full scale: 2.5V) to the cathode of D_{1061} and ground.

e) Adjust T_{1018}, T_{1019} and T_{1020} for a maximum reading on the voltmeter scale.

9) Squelch Adjustment

a) Set the MODE switch to FM.

b) Set the front panel SQL control to the fully clockwise position.

c) Apply a 0 dBμ (1 μV) signal with ±3.5 kHz deviation at 1 kHz to the antenna jack.

d) Adjust VR_{1001} to the point where the squelch just opens.

TRANSMITTER SECTION

Unless otherwise indicated, always perform the 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 amplifier module.

1) Bandpass Filter Adjustment

a) Set the MODE switch to USB or LSB.

b) Connect a sweep generator to the source of Q_{3004}, and set the frequency of the sweep generator to 435 MHz (Model X; 445 MHz).

c) Unplug the plug connected to J_{3006}, and temporarily terminate J_{3006} with a 50 ohms resistor.

d) Connect an oscilloscope to the terminated J_{3006}, through a detector.

e) Close the PTT switch and adjust TC_{3004}, TC_{3005}, TC_{3006} and CV_{3003}, until the scope pattern illustrated in Figure 4 is obtained.

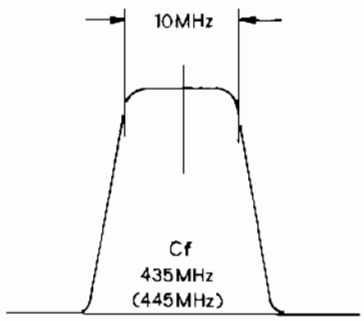


Figure 4

2) Mixer/Interstage Alignment

a) Tune the transceiver to 435 MHz (Model X; 445 MHz), and set the MODE switch to CW.

b) Connect a UHF dummy load/power meter to the antenna jack, and connect a CW key to the key jack on the transceiver.

c) Rotate VR_{1009} fully clockwise, and rotate VR_{1008} fully counterclockwise.

d) Close the key and adjust T_{1012}, T_{1013}, T_{1014}, T_{1015}, T_{1016} and T_{1017} for maximum deflection on the power meter.

3) CW Carrier Oscillator

a) Connect a frequency counter to pin 1 of J_{1001}.

b) Set the MODE switch to CW and close the key.

c) Adjust TC_{1004} for a reading of 67.6093 MHz with a tolerance of ±100 Hz.

4) ALC Adjustment

a) Set the MODE switch to FM, and close the PTT switch.

b) Adjust VR_{1008} for an output of 10 watts on the power meter.

5) PO Meter Adjustment

a) Set the MODE switch to FM, and close the PTT switch.

b) Adjust VR_{2003} to illuminate 9 LED's on the S/PO meter.

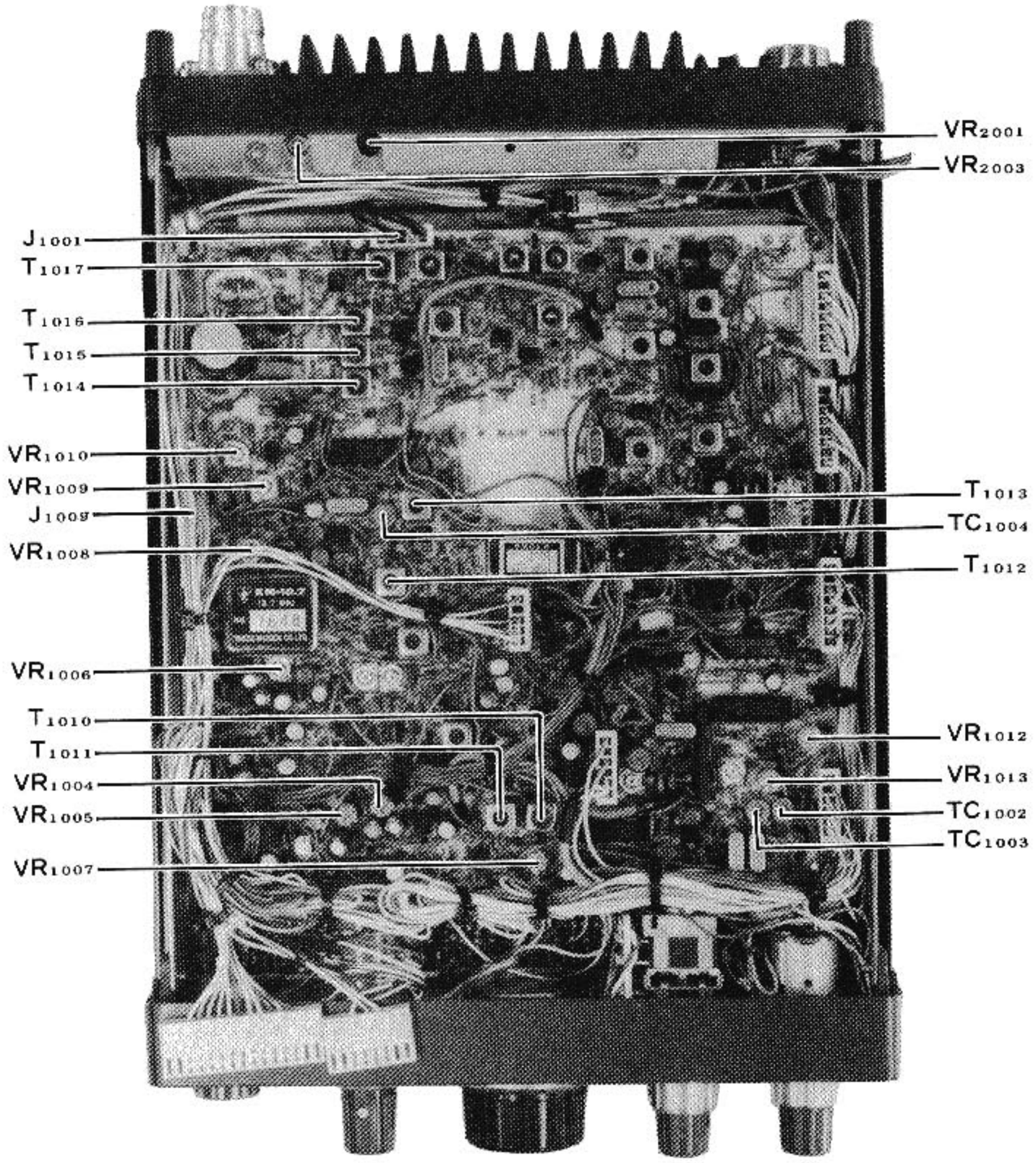
6) AFP Adjustment

a) Connect a DC voltmeter to pin 6 of J_{1009} on the Main Unit and ground. Connect a DC ammeter (full scale: 10A) to the DC line from the power supply.

b) Set the MODE switch to FM and close the PTT switch.

c) Adjust VR_{2001} for minimum indication on the DC voltmeter. Now return to RX.

d) Remove the dummy load from the antenna jack. Close the PTT switch, and adjust VR_{1009} so the reading on the ammeter goes down to less than 3 amps.



ALIGNMENT AND TEST POINTS FOR TRANSMITTER

7) Low Power Output Setting

a) Set the HI/LOW switch to the LOW position, and key the transmitter in the FM mode.

b) Adjust VR_{1010} for an output of 1 watt on the wattmeter.

8) FM Modulator Adjustment

a) Refer to Fig. 5, and set up the transceiver and test equipment as shown.

b) Set VR_{1005}, 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 VR_{1006} 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 VR_{1005} 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.

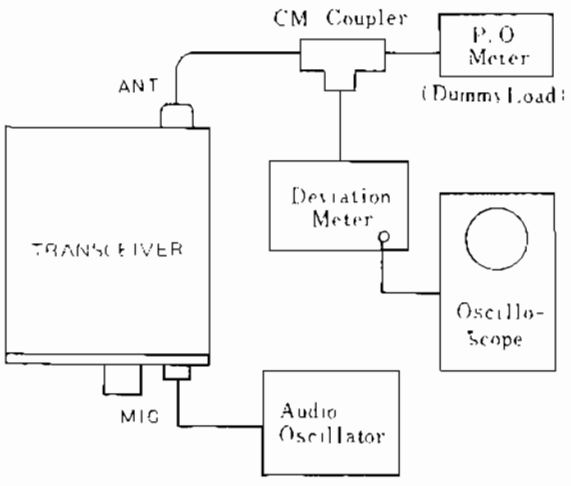


Figure 5

9) 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 VR_{1004} to the center of its range, and apply a 1 kHz, 1 mV signal from the audio generator to the mic jack.

c) Adjust T_{1010} and T_{1011} 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 VR_{1004} for an output of 8 watts.

b) Set the MODE switch to USB and the frequency of the audio generator to 400 Hz. Adjust TC_{1002} for an output of 2 watts.

c) Set the MODE switch to LSB, and the frequency of the audio generator to 400 Hz. Adjust TC_{1003} 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 VR_{1007} 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 VR_{1007} may be necessary to achieve good carrier nulling on both modes.

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

a) Adjust VR_{1013} for the desired monitoring level on CW operation.

b) Adjust VR_{1012} for the desired CW VOX relay hang time.

PLL SECTION

NOTE: The PLL circuit is very critical in its adjustment. Alignment must only be performed by an experienced technician. All alignments should be performed at a temperature within the range of 20° - 30°C, preferably, near the center of this range.

1) VCV Lines Adjustment

a) Set the MODE switch to LSB, the STEP switch to "M", and tune the transceiver to 434.999.9 MHz (Model X; 444.999.9 MHz).

b) Connect the DC probe of a VTVM to TP_{3001}, and adjust the core of L_{3029} for a reading of exactly 6.0V.

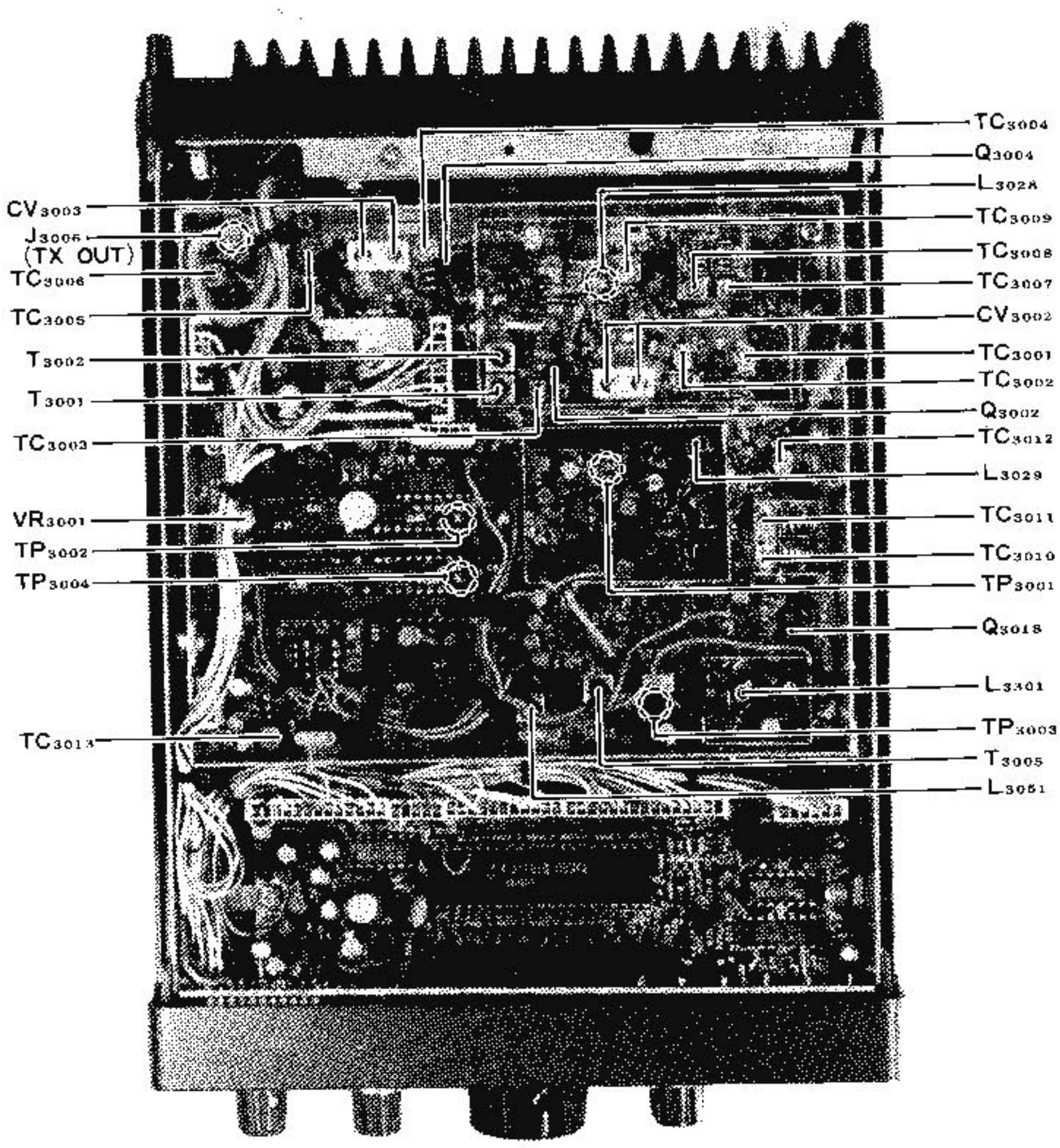
c) Change the MODE switch to USB, and tune the transceiver to 434.999.9 MHz (Model x; 444.999.9 MHz).

d) Connect the DC probe of the VTVM to TP_{3003}, and adjust the core of L_{3001} for a reading of exactly 6.5V on the VTVM.

2) Multiplier Stage Adjustment

a) Set the MODE switch to LSB, the STEP switch to "M", and tune the transceiver to 434.999.9 MHz (Model X; 449.999.9 MHz).

b) Connect the RF probe of the VTVM to TP_{3002}, and adjust the core of T_{3005} for a maximum reading on the VTVM. A nominal value is approximately 3V P-P.



ALIGNMENT AND TEST POINTS FOR PLL

3) PLL Bandpass Filter Adjustment

a) Connect a UHF sweep generator to gate 1 of Q_{3018}, and connect an oscilloscope, through a detector, to the gate of Q_{3002}.

b) Set the frequency of the sweep generator to 367.4 MHz (Model X; 377.4 MHz).

c) Adjust TC_{3007}, TC_{3008}, TC_{3009}, TC_{3010}, TC_{3011} and TC_{3012} until the scope pattern illustrated in Figure 6 is achieved.

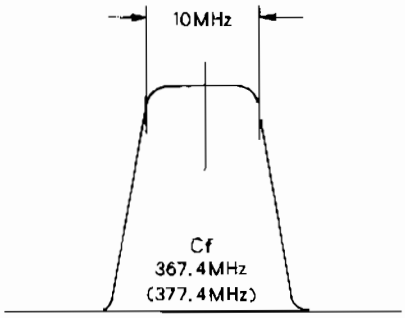


Figure 6

4) PLL Reference Oscillator and PLL Local Oscillator Adjustment

a) Connect a frequency counter to TP_{3002}.

b) Adjust TC_{3013} for a reading of 9.996.667 MHz.

c) Set the MODE switch to LSB, the STEP switch to "S" and tune the transceiver to 435.000.0 MHz (Model X; 445.000.0 MHz).

d) Connect the frequency counter to the lead of L_{3028}, and adjust the core of L_{3051} for a reading of 367.388.50 MHz (Model X; 377.388.50 MHz) on the counter.

e) Change the frequency to 434.999.9 MHz (Model X; 444.999.99 MHz), and adjust VR_{3001} for a reading of 367.388.49 MHz (Model X; 377.388.49 MHz).

f) Repeat steps b through e a few times, until the proper frequency is obtained at each step.

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

Symbol No.	Part No.	Description
PB-2143	F0002143	Printed Circuit Board (for S1)
PB-2132	F0002132	Printed Circuit Board (for J7)
PB-2214	F0002214	Printed Circuit Board (for Q1, Q2, C4, C5)
PB-2222	F0002222	Printed Circuit Board (for J9)
		IC
Q01	G1090294	μPC7808H
		TRANSISTOR
Q02	G34023500 /Y	2SD2350/Y
		DIODE
D01	G2090034	Silicon U05B
		POTENTIOMETER
VR01 (with S07)	J62800048	DM11A825A-5M1112 10KΩB/10KΩA
		RESISTOR
R03	J02245562	Carbon film 1/4W SJ 5.6kΩ
R02	J01245103	" " " TJ 10kΩ
R01	J01245104	" " " " 100kΩ
		CAPACITOR
C02	K12171102	Ceramic 50WV E 0.001μF (DD105E102P50V02)
C04,05	K40120475	Electrolytic 16WV 4.7μF (16RL4R7)
C01	K40129006	" " RE 470μF (16RE470)
C06–12	K21170002	Feed thru 50WV 0.001μF (ECK-Y1H102WE)
		SPEAKER
SP01	M4090047	SS-77KYH 8Ω 1W
		SWITCH
S01	N0190066	SBU-2045
S02	N0190079	SRN-4086N
S03	Q9000115	EWT-XDBS2050B
S04,06	N6090010	SSF-22-55
S05	N6090011	SSH-23-05
S08	N6090004	SSF-22-08B
S07 (with VR01)	–	
		RECEPTACLE
J01	P0090158	FM-214-8SS
J02	P0090010	FM-142S
J03	P1090209	N-R
J04,05	P1090005	SG-8050
J06	P0090036	5048-14A
J07	P0090173	EMCS0450M
J08	P0090041	5048-07A
J09	P0090186	EMCS0350M
		PLUG
P01 (with wire)	T9203840	5208-04
P02 "	T9203850	5208-07
P03 "	T9203860	5208-07
P04 "	T9203870	5208-07
P05 "	T9203880	5208-05
P06 "	T9203890	5208-05
P07 "	T9203900	5208-04
P08 "	T9203910	5208-06
P09 "	T9203920	5208-12
P10	P1090229	5253-3
P11 (with wire)	T9203930	5208-05
P14 "	T9203940	5208-12
P15 "	T9203950	5208-04
P16 "	T9203960	5208-10
P17 "	T9203970	5208-14
P18 "	T9203980	5208-05
P20	P1090216	5253-7

MAIN UNIT

Symbol No.	Part No.	Description
PB-2209A	F0002209A	Printed Circuit Board
	C0022090	PCB with Components
		IC
Q1009	G1090072	μPC577H
Q1018	G1090101	μPC1037H
Q1037,1040	G1090340	MC1496P
Q1059	G1090126	MC14069UB
Q1060	G1090068	MC14011B
Q1047	G1090239	TC5082P
		FET
Q1001,1005,1016, 1039,1041	G4800730Y	3SK73-Y
Q1002	G3801250	2SK125
Q1021	G3800301Y	2SK30A-Y
Q1038	G3090035	2SK19TM-GR
		TRANSISTOR
Q1045,1069	G3104960O /Y	2SA496-O or Y
Q1012,1022,1046	G3105641Q	2SA564A-Q
Q1003,1004,1006	G3304600B	2SC460-B
Q1019,1061	G3305350B	2SC535-B
Q1007,1008,1010, 1011,1013,1015, 1023,1025–1027, 1029,1030,1032, 1033–1036, 1042–1044,1048, 1049,1050,1051, 1054,1057,1058, 1065,1067,1068	G3309451P	2SC945-P
Q1014,1024,1028, 1031	G3318150G	2SC1815-GR
Q1062–1064	G3315830	2SC1583
Q1020,1070	G3327850E	2SC2785E

Q1052,1066	G3090005	MPS-A13	
		DIODE	
D1001,1004–1008, 1011–1017, 1020–1025, 1028–1030,1034, 1036–1041, 1044–1049, 1051–1053	G2090027	Silicon	1SS53
D1002,1003,1009, 1010,1042.1043. 1050	G2001880F	Germanium	1S188-FM
D1018,1019	G2015550	Silicon	1S1555
D1031,1032	G2090001	〃	10D1
		CRYSTAL	
X1001	H0102324	HC-18/U	56.910MHz
X1002	H0100720A	〃	10.245MHz
X1003	H0100513	〃	10.6993MHz
X1004 (US Model)	H0101983	〃	7.3728MHz
X1004 (EU Model)	H0101982	〃	7.168MHz
X1005	H0100512	〃	10.6985MHz
X1006	H0100511	〃	10.7015MHz
		FILTER	
XF1001	H1102027	10M30B	
XF1002	H1102028	10F-2D	
CF1001	H3900200	CFW455E (LFH-15S)	
CF1002	H3900030	LFB15	
		CERAMIC DISCRIMINATOR	
CD1001	H7900040	SFD-455S4	
		MODULATOR MODULE	
XM1001	H9500320	XM-10.7	
		RESISTOR	
R1138	J02245100	Carbon film	1/4W SJ 10Ω
R1006,1018,1065, 1072,1106,1164, 1169,1170,1174, 1175,1177,1178, 1186–1188,1237, 1269,1270	J02245560	〃 〃	〃 〃 56Ω
R1066,1262	J01245560	〃 〃	〃 TJ 56Ω
R1012,1015,1016, 1049,1073,1099, 1101,1132,1135, 1139,1143,1155, 1160,1181,1209, 1245,1248,1251, 1255,1259,1279	J02245101	〃 〃	〃 SJ 100Ω
R1005,1017,1023, 1071	J02245151	〃 〃	〃 〃 150Ω
R1027,1043,1077, 1110,1113,1146, 1154,1208	J02245221	〃 〃	〃 〃 220Ω
R1052	J02245331	〃 〃	〃 〃 330Ω
R1080,1119,1179, 1253,1271	J02245471	〃 〃	〃 〃 470Ω
R1007,1056,1273	J02245561	〃 〃	〃 〃 560Ω
R1010,1151	J02245821	Carbon film	1/4W SJ 820Ω
R1173	J01245821	〃 〃	〃 TJ 820Ω
R1025,1060,1078, 1142,1145,1150, 1152,1156,1176, 1190,1196,1206, 1242,1244	J02245102	〃 〃	〃 SJ 1kΩ
R1153	J01245102	〃 〃	〃 TJ 1kΩ
R1051,1149	J02245122	〃 〃	〃 SJ 1.2kΩ
R1172	J01245122	〃 〃	〃 TJ 1.2kΩ
R1004,1013,1022, 1031,1047,1064, 1070,1098,1246, 1250	J02245152	〃 〃	〃 SJ 1.5kΩ
R1030,1033–1035, 1048,1057,1059, 1074,1086,1088, 1090,1136,1144, 1162,1165,1197, 1199	J02245222	〃 〃	〃 〃 2.2kΩ
R1029,1040,1042, 1148	J02245332	〃 〃	〃 〃 3.3kΩ
R1089,1090	J02245392	〃 〃	〃 〃 3.9kΩ
R1008,1024,1045, 1063,1069, 1093–1095,1102, 1105,1118,1122, 1123,1133,1159, 1168,1180,1191, 1195,1235,1236, 1247,1249,1260, 1261	J02245472	〃 〃	〃 〃 4.7kΩ
R1036,1037,1140	J02245562	〃 〃	〃 〃 5.6kΩ
R1254,1263	J02245682	〃 〃	〃 〃 6.8kΩ
R1009,1011,1014, 1019,1046,1082, 1083,1087,1096, 1112,1114,1124, 1126,1157,1158, 1189,1193,1194, 1198,1204,1205, 1207,1210,1240, 1261,1265,1268, 1276,1281	J02245103	〃 〃	〃 〃 10kΩ
R1081	J01245103	〃 〃	〃 TJ 10kΩ
R1053,1097,1129	J02245123	〃 〃	〃 SJ 12kΩ
R1054,1075,1130, 1131,1227,1228, 1231	J02245153	〃 〃	〃 〃 15kΩ
R1084,1103,1252, 1264	J02245183	〃 〃	〃 〃 18kΩ
R1038,1044,1104, 1109,1137,1141, 1161,1163,1184, 1185,1211,1212, 1232,1266,1267, 1274,1275	J02245223	〃 〃	〃 〃 22kΩ
R1003,1021,1062, 1068,1167,1182, 1257	J02245273	〃 〃	〃 〃 27kΩ
R1091,1092,1107, 1137,1200,1215, 1223,1239	J02245473	〃 〃	〃 〃 47kΩ
R1055,1111,1219	J02245563	〃 〃	〃 〃 56kΩ
R1125	J02245683	〃 〃	〃 〃 68kΩ
R1076	J02245823	〃 〃	〃 〃 82kΩ
R1002,1020,1061, 1067,1115,1127, 1128,1166,1183, 1201,1203,1220, 1221,1243,1277	J02245104	〃 〃	〃 〃 100kΩ
R1039,1041,1116, 1282	J02245154	〃 〃	〃 〃 150kΩ

R1026,1032,1050, 1218,1238	J02245224	Carbon film 1/4W SJ 220kΩ	C1075,1076	K00175101	Ceramic 50WV SL 100pF (DD105SL101J50V02)
R1028,1100,1134, 1147,1256	J02245334	" " " " 330kΩ	C1136,1138	K00175221	" " " 220pF (DD107SL221J50V02)
R1120,1202,1258	J02245474	" " " " 470kΩ	C1050,1203	K00175331	" " " 330pF (DD107SL331J50V02)
R1079,1085,1192, 1213,1230	J02245105	" " " " 1MΩ	C1137	K00175471	" " " 470pF (DD109SL471J50V02)
R1217	J01245105	" " " TJ 100kΩ	C1014,1018,1019, 1047,1056,1077, 1084,1087,1094, 1095,1132,1133, 1139,1153,1155, 1156,1158–1161, 1163–1165,1175, 1185,1186,1193, 1214,1216, 1224–1226, 1228 1230	K12171102	" " E 0.001μF (DD105E102P50V02)
R1001	J02245225	" " " SJ 2.2MΩ			
R1214,1229	J02245335	" " " " 3.3MΩ			
			C1003,1004,1006, 1009,1015,1016, 1020,1022, 1066 1068,1071, 1072,1074,1089, 1107,1113,1115, 1118–1121,1125, 1126,1127,1131, 1140 1142, 1149–1151,1167, 1188,1194,1196, 1197,1205,1207, 1210,1213, 1217–1219, 1221 1223,1227, 1238,1239	K14170103	" " FZ 0.01μF (DD106FZ103Z50V02)
		THERMISTOR			
TH1001	G9090001	SDT-250			
		POTENTIOMETER			
VR1010	J51730472	P6-S3NA 4.7kΩ			
VR1001	J51730103	" 10kΩ			
VR1005	J51745103	H0651A013-10KB			
VR1002	J51730473	P6-S3NA 47kΩ			
VR1004	J51745473	H0651A017-47KB			
VR1007	J51745104	H0651A019-100KB			
VR1012	J51745154	H0651A020-150KB			
VR1003	J51730474	P6-S3NA 470KΩB			
VR1011	J51730104	P6-S3NA 100KΩB			
		CAPACITOR	C1040,1049,1091, 1109	K19149001	" 25WV 0.001μF (UAT04X102K-L05AE)
C1007,1145	K00172020	Ceramic 50WV SL 2pF (DD104SL020C50V02)	C1041,1043,1045, 1102	K19149009	" " 0.0047μF (UAT05X472K-L05AE)
C1117	K00172030	" " " 3pF (DD104SL030C50V02)	C1090	K19149011	" " 0.0068μF (UAT05X682K-L05AE)
C1064	K00172040	" " " 4pF (DD104SL040C50V02)	C1023,1108,1169, 1177–1179,1235	K19149013	" " 0.01μF (UAT05X103K-L05AE)
C1143	K02172040	" " CH 4pF (DD104CH040C50V02)	C1042,1079	K19149017	" " 0.022μF (UAT06X223K-L45AE)
C1027,1130	K00172050	" " SL 5pF (DD104SL050C50V02)	C1024,1025,1199, 1200,1201,1208, 1236	K19149021	" " 0.047μF (UAT08X473K-L45AE)
C1001,1008,1146, 1147	K02173060	" " CH 6pF (DD104CH060D50V02)	C1182	K19149025	" " 0.1μF (UAT13X104K-L46AE)
C1231	K00173070	" " SL 7pF (DD104SL070D50V02)	C1044,1048,1055, 1184,1242	K40179002	Electrolytic 50WV 0.1μF (50RC2-R1)
C1005,1152	K02173080	" " CH 8pF (DD104CH080D50V02)	C1070,1073,1092, 1097–1099,1101, 1103,1104, 1110–1112,1204, 1211,1220,1234	K40170105	" " 1μF (50RL1)
C1017	K02175150	" " " 15pF (DD104CH150J50V02)			
C1116	K02173150	" " SL 15pF (DD104SL150D50V02)			
C1122	K06175150	" " UJ 15pF (ECC-D1H150JU)	C1162,1176	K40140475	" 25WV 4.7μF (25RL4R7)
C1026,1065,1144, 1148,1241	K00175220	" " SL 22pF (DD104SL220J50V02)	C1039,1051,1054, 1069,1080,1081, 1093,1096,1100, 1106,1114,1157, 1206,1209	K40120106	" 16WV 10μF (16RL10)
C1129	K00175270	" " " 27pF (DD104SL270J50V02)			
C1170,1171	K00175330	" " " 33pF (DD104SL330J50V02)	C1166	K40129008	" 16WV RE 33μF (16RE33)
C1012	K06175330	" " UJ 33pF (DD104UJ330J50V02)	C1187	K40129019	" " RC 1000μF (16RC1000)
C1002	K00175470	" " SL 47pF (DD104SL470J50V02)	C1168	K70167104	Tantalum 25WV 0.1μF (CS15E1V0R1M)
C1010	K06175470	" " UJ 47pF (ECC-D1H470JU2)	C1232	K70167474	" " 0.47μF (CS15E1VR47)
C1088,1240	K00175560	" " SL 56pF (DD104SL560J50V02)	C1212,1233	K70147105	" " 1μF (CS15E1E010M)

C1078,1174	K70167225	" " (CS15E1V2R2M)	2.2μF
C1173	K70127475	" 16WV (CS15E1C4R7M)	4.7μF
C1086,1124	K51176101	Styrol 50WV (50SU101K)	100pF
C1030,1031,1085 1123	K51176151	" 25WV (50SU151K)	150pF
		TRIMMER CAPACITOR	
TC1001 1004	K91000075	TZ03R200A	20pF
		INDUCTOR	
L1002	L1190004	FL4H-R68M	0.68μH
L1010,1011	L1190006	FL4H-1R2M	1.2μH
L1012	L1190009	FL4H-3R3M	3.3μH
L1009	L1190027	FL5H-390K	39μH
L1003,1013,1014	L1190020	FL5H-151K	150μH
L1008	L1190038	FL5H-271K	270μH
L1004	L1190017	FL5H-102K	1mH
L1006,1007	L1190040	S4-102K	1mH
L1001	L0020417		
		AF CHOKE COIL	
CH1001	L2030067A	FR14/7/5-200IF	
		TRANSFORMER	
T1001 1004, 1014–1017	L0020825		
T1005–1009,1012, 1013,1018 1020	L0020187		
T1010	L0020910		
		CONNECTOR	
J1001,1007	P0090050	5048-04A	
J1002 - 1004	P0090054	5048-07A	
J1005,1006	P0090042	5048-05A	
J1008	P0090051	5048-06A	
J1009	P0090038	5048-12A	
		RELAY	
RL1001	M1190006	221D012	
	L919000	Ferrite Beads RI 3x3-1	
	Q5000038	Terminal TP-I	

PA UNIT

Symbol No.	Part No.	Description
PB-2210	F0002210	Printed Circuit Board
	C0022100	PCB with Components
		POWER MODULE
Q2001	G1090341	M57716
		DIODE
D2001–2003	G2090118	Shottky barrier 1SS97
D2004	G2090027	Silicon 1SS53
D2005	G2090001	" 10D1

		RESISTOR
R2005	J02245560	Carbon film 1/4W SJ 56Ω
		POTENTIOMETER
VR2001	J50716201	RV8-FAS 200Ω
VR2003	J50716503	RV8-FAS 50kΩ
		CAPACITOR
C2001,2004,2005, 2008,2009,2012, 2018–2023	K12171102	Ceramic 50WV E 0.001μF (DD105E102P50V02)
C2002,2006,2010	K14170103	" " FZ 0.01μF (DD106FZ103Z50V02)
C2013	K00179001	" " SL 0.5pF (DD104SL0R5C50V02)
C2024	K02179001	" " CH 1pF (DD104CK010C50V02)
C2026,2027	K02179003	" " " 2pF (DD104CK020C50V02)
C2016,2017	K00172040	" " SL 4pF (DD104SL040C50V02)
C2015	K00173060	" " " 6pF (DD104SL060D50V02)
C2014	K00173070	" " " 7pF (DD104SL070D50V02)
C2025	K02173090	" " CH 9pF (DD104CH090D50V02)
		INDUCTOR
L2001–2003,2007	L1020673	
L2004	L0020903	
L2005,2006	L0020767	
L2008	L0020342	
		RELAY
RL2001	M1590002	CX-1051
	Q5000011	Wrapping Terminal C
J2001 (with wire)	T9204010A	5240-061

PLL UNIT

Symbol No.	Part No.	Description
PB-2211	F0002211	Printed Circuit Board
	C0022110	PCB with Components
		IC
Q3043	G1090084	78L05
Q3042	G1090294	μPC7808H
Q3009	G1090164	μPC2002H
Q3013,3022,3023	G1090012	SN16913P
Q3015,3025	G1090048	TC5081P
Q3040,3041	G1090247	TC9122P
Q3017	G1090296	HD10551
	G1090064	34024PCQM
Q3031	G1090342	MB84024B

Q3032	G1090108	MC14518B	
Q3035	G1090312	MC14504B	
Q3037–3039	G1090343	MC14094B	
		FET	
Q3010	G3090035	2SK19TM-GR	
Q3002,3004	G3801250	2SK125	
Q3011,3018,3021	G4800730Y	3SK73-Y	
Q3001	G4800970	3SK97	
		TRANSISTOR	
Q3028,3033	G3107331P	2SA733-P	
Q3012,3014,3016, 3024	G3305350B	2SC535-B	
Q3029,3030,3034, 3036	G3309451P	2SC945-P	
Q3006	G3314260	2SC1426	
Q3005,3007,3019, 3020	G3320260	2SC2026	
Q3008	G3324070	2SC2407	
Q3026	G3090005	MPS-A13	
		DIODE	
D3001,3004,3005	G2090033	Silicon MI-301	
D3002,3003	G2015550	" 1S1555	
D3007,3008,3010, 3011	G2090027	" 1SS53	
D3006,3009	G2090107	Varactor 1T25	
D3012	G2090176	Zener HZ6L-A1	
D3013–3016	G2090118	Shottky barrier 1SS97	
		CRYSTAL	
X3002	H0102327	HC-18/U 5.3333MHz	
X3001 (LOW BAND)	H0102410A	HC-18/U 35.3928MHz (430–440MHz)	
X3001 (HIGH BAND)	H0102411	HC-18/U 36.4029MHz (440–450MHz)	
		RESISTOR	
R3047	J02245010	Carbon film 1/4W SJ 1Ω	
R3046	J01245229	" " " TJ 2.2Ω	
R3005,3121	J02245100	" " " SJ 10Ω	
R3018	J01245180	" " " TJ 18Ω	
R3028	J02245330	" " " SJ 33Ω	
R3009,3010,3021, 3087,3118	J02245560	" " " " 56Ω	
R3035,3055,3059, 3074,3076,3092, 3094,3095,3104	J02245101	" " " " 100Ω	
R3004	J02245121	" " " " 120Ω	
R3029,3083	J01245221	" " " TJ 220Ω	
R3038,3057,3062, 3084,3098	J02245221	" " " SJ 220Ω	
R3045	J10276221	Carbon composition 1/2W GK 220Ω	
R3017,3019,3140	J01245331	Carbon film 1/4W TJ 330Ω	
R3025,3049	J02245331	" " " SJ 330Ω	
R3079	J02245471	" " " " 470Ω	
R3011,3012,3042, 3069,3100	J02245681	" " " " 680Ω	

R3016	J01245681	Carbon film 1/4W TJ 680Ω
R3008,3027,3030, 3078,3101,3107, 3114,3116,3122	J02245102	" " " SJ 1kΩ
R3061,3067,3081, 3097	J02245152	" " " " 1.5kΩ
R3039,3099	J02245222	" " " " 2.2kΩ
R3110	J02245332	" " " " 3.3kΩ
R3026,3033	J02245472	" " " " 4.7kΩ
R3077	J01245562	" " " TJ 5.6kΩ
R3068,3082	J02245562	" " " SJ 5.6kΩ
R3001,3043,3048, 3051,3070,3088, 3112,3115,3119, 3139,3141	J02245103	" " " " 10kΩ
R3053,3054,3072, 3073,3090,3091, 3117,3124,3128	J02245223	" " " " 22kΩ
R3065,3105,3106, 3108,3109,3123, 3138	J02245473	" " " " 47kΩ
R3126,3127	J02245563	" " " " 56kΩ
R3044,3051,3060, 3066,3071,3089, 3111,3113	J02245104	" " " " 100kΩ
R3096	J02245154	" " " " 150kΩ
R3057	J02245224	" " " " 220kΩ
R3140	J02245334	" " " " 330kΩ
R3132,3137	J20249213	Metallic film " " 49.9kΩ
R3131,3136	J20249212	" " " " 100kΩ
R3130,3135	J20249211	" " " " 200kΩ
R3133	J20249214	" " " " 243kΩ
R3129,3134	J20249210	" " " " 402kΩ
		POTENTIOMETER
VR3001	J51745474	H0651A 470KΩB
		THERMISTOR
TH3001	G9090008	31D26
		CAPACITOR
C3014,3072	K00179001	Ceramic 50WV 0.5pF (DD104SL0R5C50V02)
C3113	K00172010	" " 1pF (DD104SL010C50V02)
C3191	K00172020	" " SL 2pF (DD104SL020C50V02)
C3045,3068,3097, 3117	K02179004	" " CH 3pF (DD104CH030C50V02)
C3048,3104,3105	K02172040	" " " 4pF (DD104CH040C50V02)
C3073	K00172040	" " SL 4pF (DD104SL040C50V02)
C3074,3080,3122	K00172050	" " " 5pF (DD104SL050C50V02)
C3064	K06173060	" " UJ 6pF (ECC-D1HI060DU)
C3011	K02173060	" " CH 6pF (DD104CH060D50V02)
C3015,3061	K02173080	" " " 8pF (DD104CH080D50V02)

C3035,3101	K02173100	Ceramic 50WV CII (DD104CH100D50V02)	10pF	C3054,3157	K40170105	Electrolytic (50RL1)	50WV 1μF
C3065,3148	K06173100	〃 〃 UJ (ECC-D1H100DU)	10pF	C3034,3037,3039, 3086,3108,3136, 3139,3156,3162, 3165,3170	K40120106	〃 (16RL10)	16WV 10μF
C3188,3189	K00173100	〃 〃 SL (DD104SL100D50V02)	10pF				
C3152	K02175102	〃 〃 CH (DD104CH120J50V02)	12pF	C3067	K40129012	〃 (16RC2-10)	〃 10μF
C3092,3093,3123, 3124	K00175150	〃 〃 SL (DD104SL150J50V02)	15pF	C3176	K40129002	〃 (16RE47)	〃 47μF
C3111,3158,3185	K02179009	〃 〃 CH (DD104CH220J50V02)	22pF	C3056,3144,3163, 3179,3181	K40109001	〃 (10RE100)	10WV 100μF
C3125	K00175270	〃 〃 SL (DD104SL270J50V02)	27pF				
C3001	K00175330	〃 〃 〃 (DD104SL330J50V02)	33pF			**TRIMMER CAPACITOR**	
C3016,3017,3020, 3021	K00175390	〃 〃 〃 (DD104SL390J50V02)	39pF	TC3004	K91000060	ECV-1ZW 02X53N	2pF
C3025,3029,3030, 3082	K00175470	〃 〃 〃 (DD104SL470J50V02)	47pF	TC3001,3002, 3005,3007, 3008,3010, 3011	K91000059	〃 04X53N	4pF
C3081,3128,3131, 3133	K00175560	〃 〃 〃 (DD104SL560J50V02)	56pF	TC3012	K91000055	〃 06X53N	6pF
C3090,3132	K00175101	〃 〃 〃 (DD105SL101J50V02)	100pF	TC3003,3009,3014	K91000028	〃 10X53N	10pF
				TC3006	K91000029	〃 20X53	20pF
C3159,3160	K00175151	〃 〃 〃 (DD104SL151J50V02)	150pF	TC3013	K91000075	TZ03R 200A	20pF
C3003,3004,3006, 3009,3010,3012, 3013,3018,3019, 3024,3026,3028, 3031–3033,3036, 3038,3041,3044, 3046,3047,3049, 3051,3053,3055, 3060,3066, 3069–3071,3083, 3085,3089,3095, 3096,3098–3100, 3102,3103,3106, 3107,3109,3110, 3112,3114,3115, 3134,3137, 3145–3147,3153, 3154,3172,3175, 3177,3178,3180	K12171102	〃 〃 E (DD105E102P50V02)	0.001μF				
						INDUCTOR	
				L3030	L1190108	FL3H-R68M	0.68μH
				L3054	L1190004	FL4H-R68M	0.68μH
				L3005,3037	L1190005	FL4H-1R0M	1μH
				L3052	L1190006	FL4H-1R2M	1.2μH
				L3047	L1190011	FL4H-4R7K	4.7μH
				L3033	L1190013	FL4H-6R8K	6.8μH
				L3032,3036,3048, 3049	L1190014	FL4H-100K	10μH
				L3035	L1190120	FL5H-471K	470μH
				L3034,3050,3053	L1190017	FL5H-102K	1mH
				L3029	L0020716		
				L3051	L0020825		
C3075 3077,3079, 3091,3094,3116, 3118–3121,3126, 3127,3129,3130, 3135,3138,3143, 3151,3161,3167, 3186,3187,3190	K14170103	〃 〃 FZ (DD106FZ103Z50V02)	0.01μF	L3001,3002,3012, 3018	L0020900		
				L3003,3006,3010, 3015,3025,3043	L1020672		
				L3004,3009,3011, 3013,3019,3020, 3021,3027,3031, 3038,3040,3045, 3046	L1020673		
C3084	K19149013	〃 25WV (UAT05X103K-L05AE)	0.01μF	L3007,3008	L0020824		
C3155	K19149017	〃 〃 (UAT06X223K-L45AE)	0.22μF	L3016,3026,3039	L0020840		
				L3017,3028	L0020474		
C3088,3142,3164, 3169,3173,3174	K19149021	〃 〃 (UAT08X473K-L45AE)	0.047μF	L3023,3024,3041, 3042	L0020902		
C3058	K19149025	〃 〃 (UAT13X104K-L46AE)	0.1μF	L3044	L0020901		
C3087	K70167474	Tantalum 35WV (CS15E1VR47)	0.47μF				
						RESONATOR	
C3166	K70127475	〃 16WV (CS15E1C4R7M)	4.7μF	CV3002,3003 (LOW BAND)	Q9000064	252MT-1001A (430–440MHz)	
C3005,3027,3182, 3183,3184	K22170004	Ceramic chip 50WV (CYC12Y5V1H102)	0.001μF	CV3002,3003 (HIGH BAND)	Q9000063	252MT-1003A (440 450MHz)	
C3022,3023	K21170002	Feed thru 50WV (ECKY1H-102WE)	0.001μF				
C3141	K54200002	Polyester film (B32560-A1474-J)	0.47μF			**TRANSFORMER**	
				T3003,3004	L0190007		

T3005	L0020345	
T3001,3002	L0020825	
		CONNECTOR
J3001	P0090041	5048-03A
J3002	P0090042	5048-05A
J3003	P0090037	5048-08A
J3004	P0090050	5048-04A
J3005,3006	P1090210	TMP-JV
	L9190001	Ferrite Beads RI 3x3-1
	Q5000016	Terminal TP-E
	Q5000026	" TP-F

VCO UNIT

Symbol No.	Part No.	Description
PB-2212A	F0002212A	Printed Circuit Board
	C0022120	PCB with Components
		FET
Q3301	G3090035	2SK19TM-GR
		DIODE
D3301,3302	G2090107	Varactor 1T25
		RESISTOR
R3306	J02245101	Carbon film 1/4W SJ 100Ω
R3305	J02245331	" " " " 330Ω
R3301,3302,3303, 3304	J02245473	" " " " 47kΩ
		THERMISTOR
TH3301	G9090008	31D26
		CAPACITOR
C3305	K06172040	Ceramic 50WV UJ 4pF (ECC-D1H040CU)
C3307	K06172050	" " " 5pF (ECC-D1H050CU)
C3306	K02173070	" " CH 7pF (DD104CH070D50V02)
C3304	K02173080	" " " 8pF (DD104CH080D50V02)
C3308	K06175150	" " UJ 15pF (ECC-D1H150JU)
C3301–3303,3309	K12171102	" " E 0.001μF (DD105E102P50V02)
C3310	K40129012	Electrolytic 16WV RC-2 10μF (16RC2-10)

		INDUCTOR
L3301	L0020716	
L3302	L1190108	FL3H-R68M 0.68μH
	Q5000016	Terminal TP-E

PLL CONTROL UNIT

Symbol No.	Part No.	Description
PB-2213A	F0002213A	Printed Circuit Board
	C0022130	PCB with Components
		IC
Q4001	G1090344	μPD1511-018
Q4002,4021	G1090068	MC14011B
Q4020	G1090126	MC14069UB
Q4022	G1090174	MC14002B
Q4027,4028	G1090084	78L05
		TRANSISTOR
Q4003–4018,4033, 4034	G3107331P /Q	2SA733P or Q
Q4019,4025	G3309451P /Q	2SC945P or Q
Q4026	G3309451K	2SC945K
Q4029	G3313830R	2SC1383R
Q4030	G3320020L	2SC2002L
Q4032	G3327850E	2SC2785E
		DIODE
D4001–4008,4010, 4012–4027,4034, 4036,4054–4058	G2090027	Silicon 1SS53
Q4033	G2001880F	Germanium JS188FM
Q4035	G2090143	Zener HZ11B-1
		CERAMIC
X4001	H7900080	CSA 2.56MA
		RESISTOR
R4044	J10276829	Carbon composition 1/2WGK 8.2Ω
R4042	J10276221	" " " " 220Ω
R4043	J02245271	Carbon film 1/4W SJ 270Ω
R4041	J02245331	" " " " 330Ω
R4039	J02245471	" " " " 470Ω
R4046	J02245122	" " " " 1.2kΩ
R4047	J02245152	" " " " 1.5kΩ
R4023	J02245222	" " " " 2.2kΩ
R4037,4040	J02245472	" " " " 4.7kΩ
R4006,4056	J02245103	" " " " 10kΩ
R4061	J01245103	" " " TJ 10kΩ
R4004	J02245153	" " " SJ 15kΩ
R4024–4026	J02245223	" " " " 22kΩ
R4062	J01245223	" " " TJ 22kΩ
R4003	J02245273	" " " SJ 27kΩ

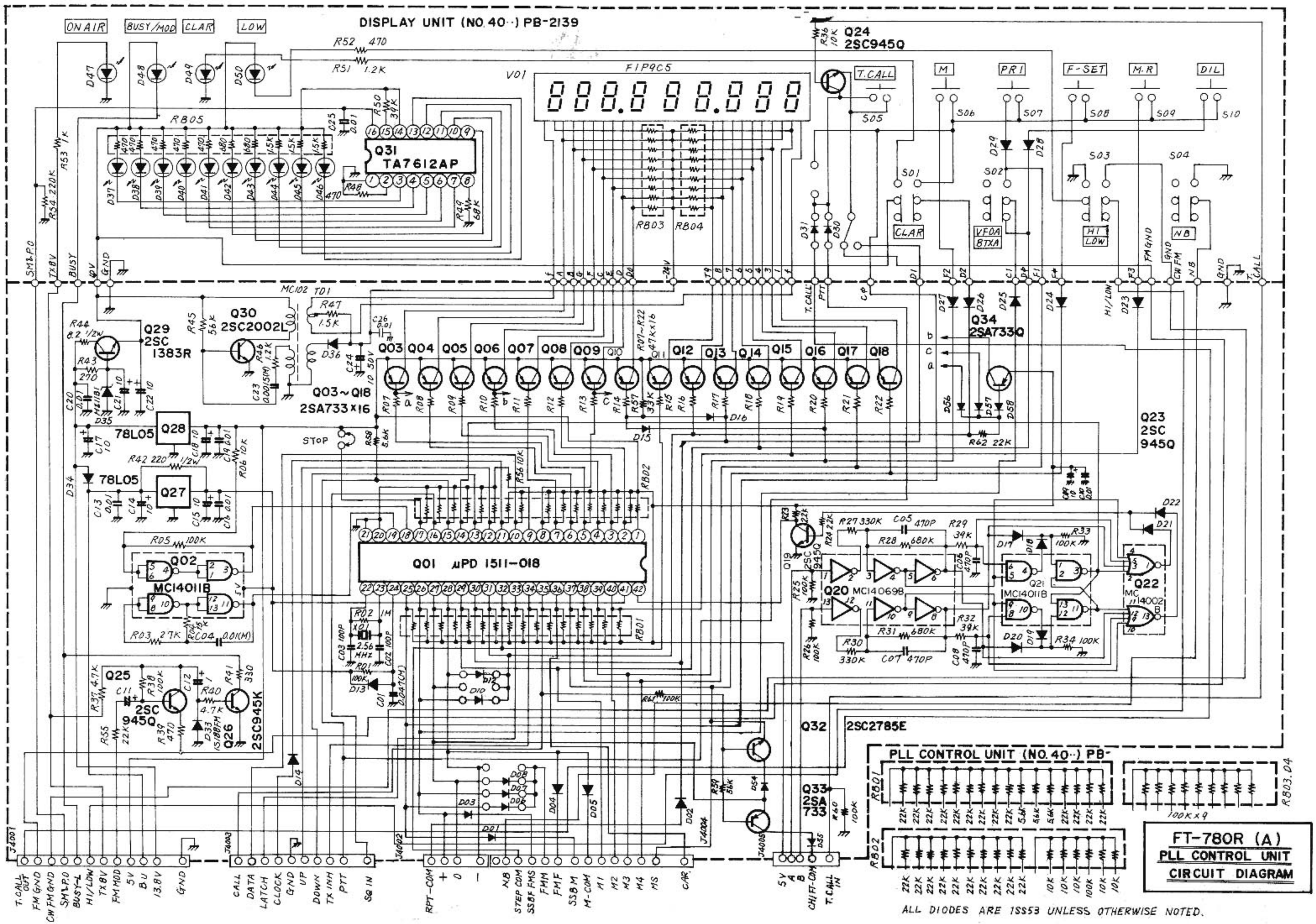
R4057	J02245333	Carbon film 1/4W SJ 33kΩ			**IC**
R4029,4032	J02245393	" " " " 39kΩ	Q4031	G1090241	TA7612AP
R4007–4022	J02245473	" " " " 47kΩ			
R4045,4059	J02245563	" " " " 56kΩ			
R4001,4005,4025, 4026,4033,4034, 4038	J02245104	" " " " 100kΩ			**TRANSISTOR**
			Q4024	G3309451P /Q	
R4060	J01245104	" " " TJ 100kΩ			
R4027,4030	J02245334	" " " SJ 330kΩ			
R4028,4031	J02245684	" " " " 680kΩ			**DIODE**
R4002	J02245105	" " " " 1MΩ	D4028,4029 4030,4031,4032	G2090027	Silicon 1SS53
		BLOCK RESISTOR			
PB4001	Q80000006				**LED**
PB4002	Q80000007		D4037–4041	G2090144	TLG226
			D4042,4043	G2090145	TLY226
			D4044–4046	G2090142	TLR226
		CAPACITOR	D4047,4049	G2090137	TLR205
C4002,4003	K00175101	Ceramic 50WV SL 100pF (DD105SL101J50V02)	D4048,4050	G2090136	TLG205
C4005–4008	K10176471	" " B 470pF (DD104B471K50V02)			
					RESISTOR
C4010,4013,4016, 4019,4020	K14170103	" " FZ 0.01μF (DD106FZ103Z50V02)	R4048	J02245471	Carbon film 1/4W SJ 470Ω
			R4052	J01245471	" " " TJ 470Ω
C4023	K50177152	Mylar " " 0.0015μF (50F2U152M)	R4053	J02245102	" " " SJ 1kΩ
			R4051	J01245122	" " " TJ 1.2kΩ
C4004	K50177103	" " " 0.01μF (50F2U103M)	R4036	J02245223	" " " SJ 22kΩ
			R4050	J02245393	" " " " 39kΩ
C4001	K50177473	" " " 0.047μF (50F2U473M)	R4049	J02245683	" " " " 68kΩ
			R4054	J01245224	" " " TJ 220kΩ
C4011,4012	K40170105	Electrolytic 50WV 1μF (50RL1)			
					BLOCK RESISTOR
C4009,4014,4015, 4017,4018,4021, 4022	K40120106	" 16WV 10μF (16RL10)	RB4003,4004	Q80000001	
			RB4005	Q80000002	
C4024	K40170106	" 50WV 10μF (50RL10)			
					SWITCH
			S4001 - 4004	N4090036	SUT-110
		DC-DC CONVERTER	S4005 - 4010	N5090003	KEF10901
T4001	L3030078	MC-102C			
		CONNECTOR			
J4001	P0090038	5048-12A			
J4002	P0090050	5048-04A			
J4003	P0090052	5048-10A			
J4004	P0090036	5048-14A			
J4005	P0090042	5048-05A			
	Q5000007	F. Terminal			

DISPLAY UNIT

Symbol No.	Part No.	Description
PB-2139C	F0002139C	Printed Circuit Board
	C0021390	PCB with Components
		DISPLAY TUBE
V4001	G6090008	LD8231/F1P9C5

ACCESSORIES

Symbol No.	Part No.	Description
	M3090028	Microphone YM-40
	T9002805	Power Cord Assembly
	Q0000005	Fuse 5A
	P0090034	P-2240
	R0062300	Stand A
		ACC PLUG
	P0090188	EMCHUM0301W (Housing)
	Q5000034	EMCKNMOID (Contact)
		TONE IN PLUG
	P0090174	EMCHUM0401W (Housing)
	Q5000034	EMCKNMOID (Contact)



FT-780R (B)
PLL CONTROL UNIT
CIRCUIT DIAGRAM

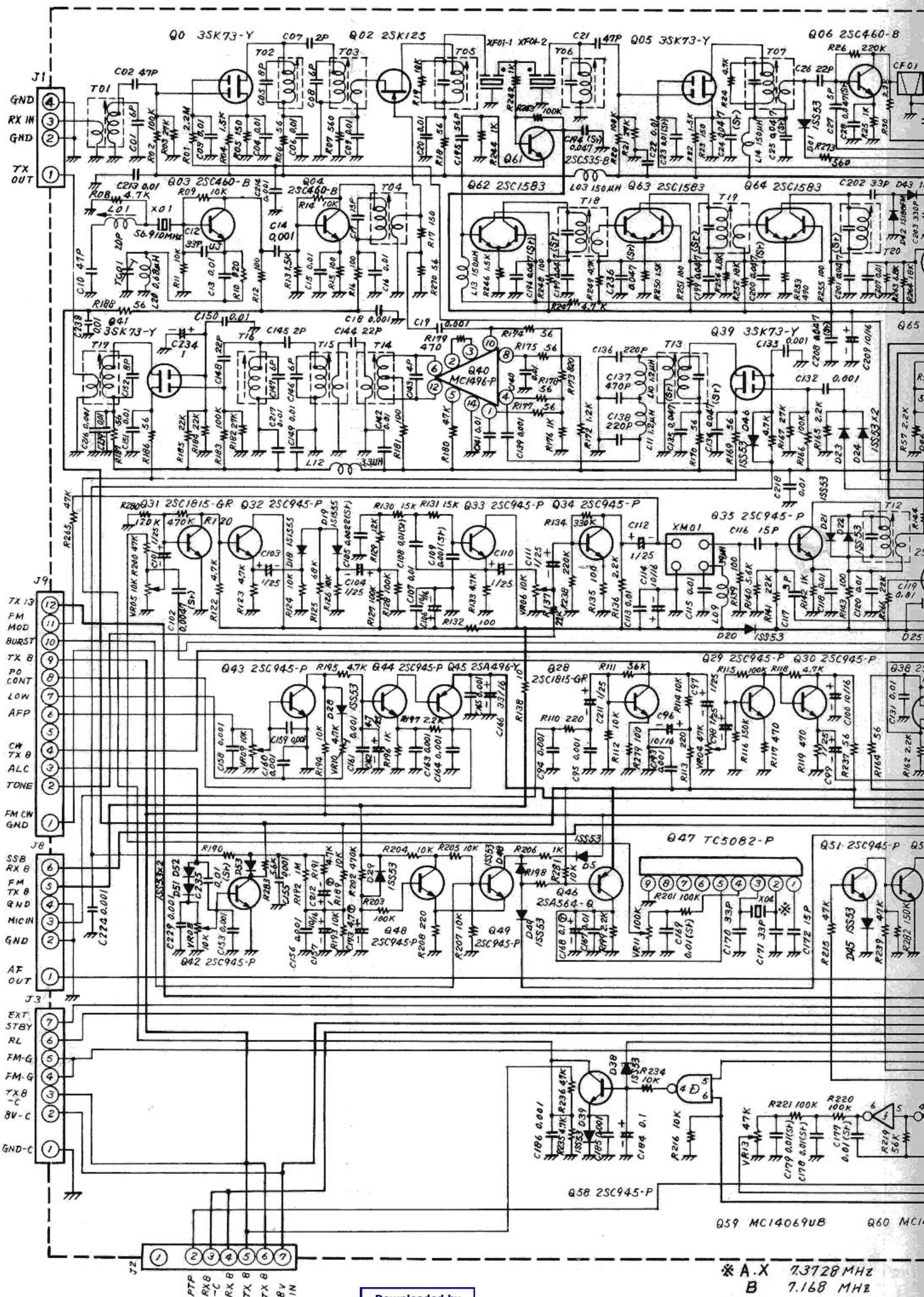
ALL DIODES ARE 1SS53 UNLESS OTHERWISE NOTED.

FT-780R(X)
PLL CONTROL UNIT
CIRCUIT DIAGRAM

ALL DIODES ARE 1SS53 UNLESS OTHERWISE NOTED.

PLL CONTROL UNIT (NO.40-) PB

DISPLAY UNIT (NO.40-) PB-2139



FT-780R(A,B,X)
MAIN UNIT
CIRCUIT DIAGRAM

PLL CONTROL UNIT PB-2213A
DISPLAY UNIT PB-2139C

P14/J4001: GND, 13.8V, BU, 5V, FM MOD, TXB, LOW, BUSY-L, SM.PO, CW FM GND, FM GND, T.CALL OUT, P15/J4002, -, 0, +, RPT-C, SQ IN, P16/J4003, PTT, TX INH, DOWN, UP, GND, CLOCK, LATCH, DATA, CALL, P17/J4004, CAR, M5, M4, M3, M2, M1, M-C, SSB M, FM F, FM M, SSB F, STEP-C, NB, P18/J4005, T.CALL, SHIFT-C, B(1), A(2), 5V(3)

MIC J1

S3 DIAL

P23 13.8V IN

P22 13.8V OUT

P1/J1001: TX OUT, GND, RX IN, GND

P2/J1002: CALL, PTT, RXB-C, RXB, TXB, TXB, 8V IN

P3/J1003: GND-C, 8V-C, TXB-C, FM GND, FM GND, RL, EXT-STBY

P4/J1004: TX INH, CWB, PTT, NB, BUSY, CLEAR, KEY

P5/J1005: SIDE TONE, SSB TXB, CWRX SSBB, LSB-G, USB CW-G

MAIN UNIT
PB-2209A

P9/J1009: Tx13, FM MOD, BURST, TXB, PO CONT, LOW, AFP, CW TXB, ALC, TONE, CW FM GND

P8/J1008: SSB RXB, FM TXB, GND, MIC IN, GND, AF OUT

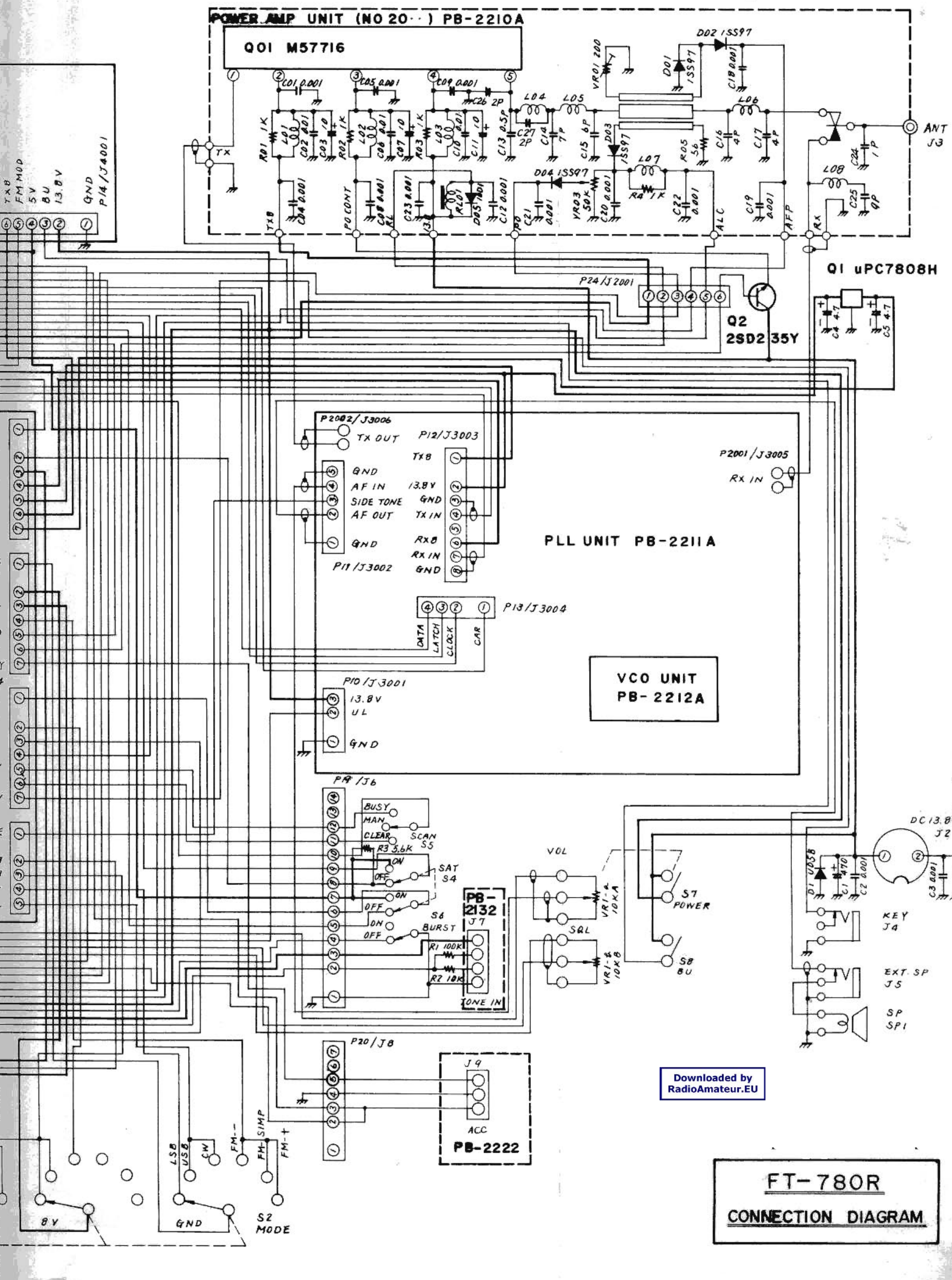
P7/J1007: FMRxB, BUSY-L, SM, PO

P6/J1006: UL, T.CALL, GND, SQ IN, SQ OUT

PB-2143

S1: M-C, M1, M2, M3, M4, M5, FM, SSB, STEP, MEMORY

RPT, STEP, SHIFT, TXB, RXBV, BV



FT-780R

CONNECTION DIAGRAM

Q07 2SC2026

Q20 2SC2026

Q19 2SC2026

J02

GAD
AF IN
SIDE TONE
AF OUT
GND
GND
RX OUT
R×8
GND
TX IN
GND
13.8
TX 8

Q09 μPC2002H

J03

Q16 2SC535-B

Q17 HD10551

Q27 2SC535-B

Q23 SN16913P

Q24 2SC535-B

Q43
78L05

Q21
3SK73-Y

VCO UNIT PB-2212(NO33··)

Q22 SN16913P

Q01 2SK19TM-GR

Q18 3SK73-Y

Q41

TC9122P

Q36 2SC
945-P

Q33 2SA733-P

Q25

TC5081P

Q29
2SC945-P

J01

13.8 IN
UL
GND

Q34
2SC945-P

Q26
MPSA13

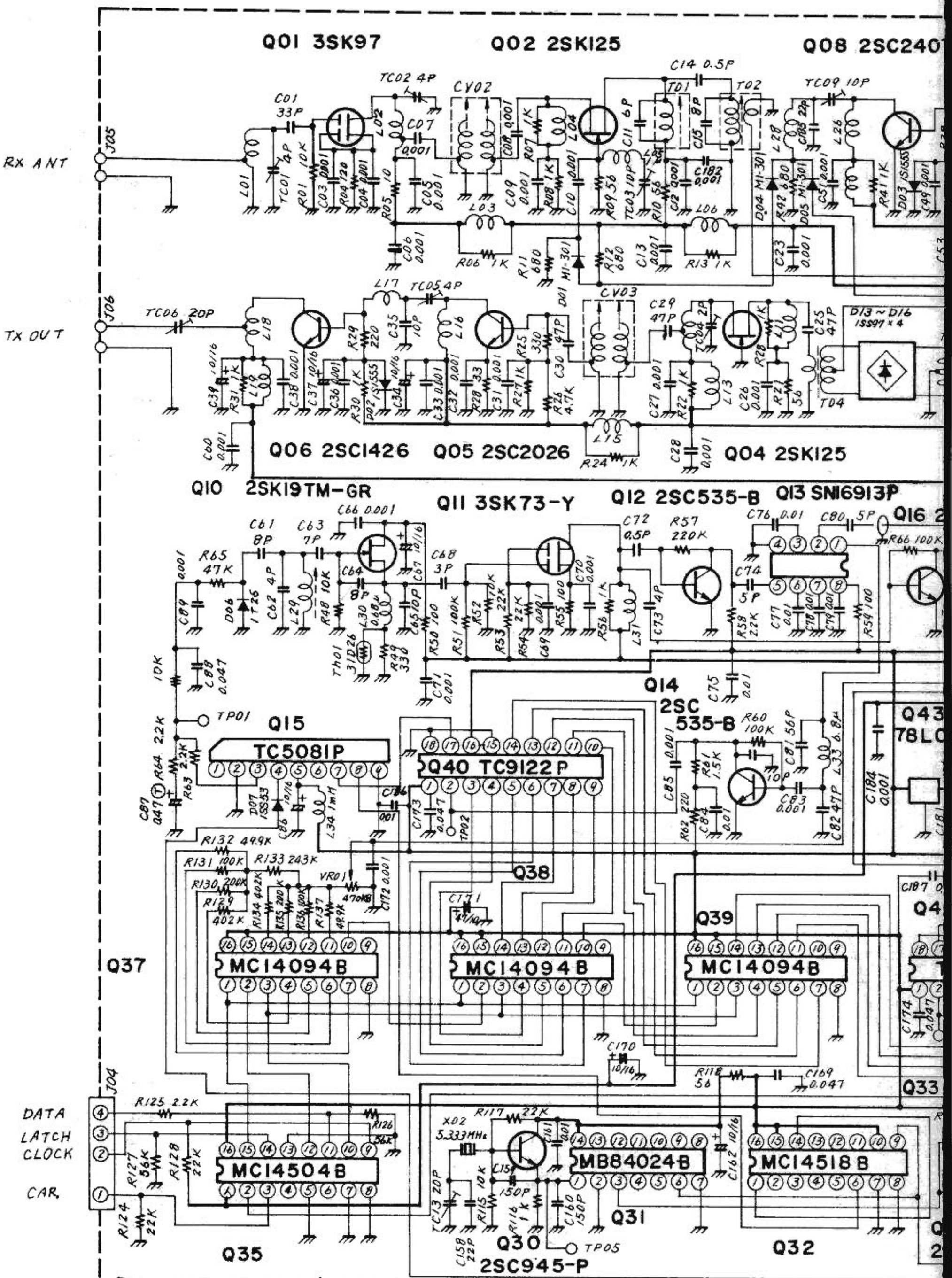
Q28
2SA733-P

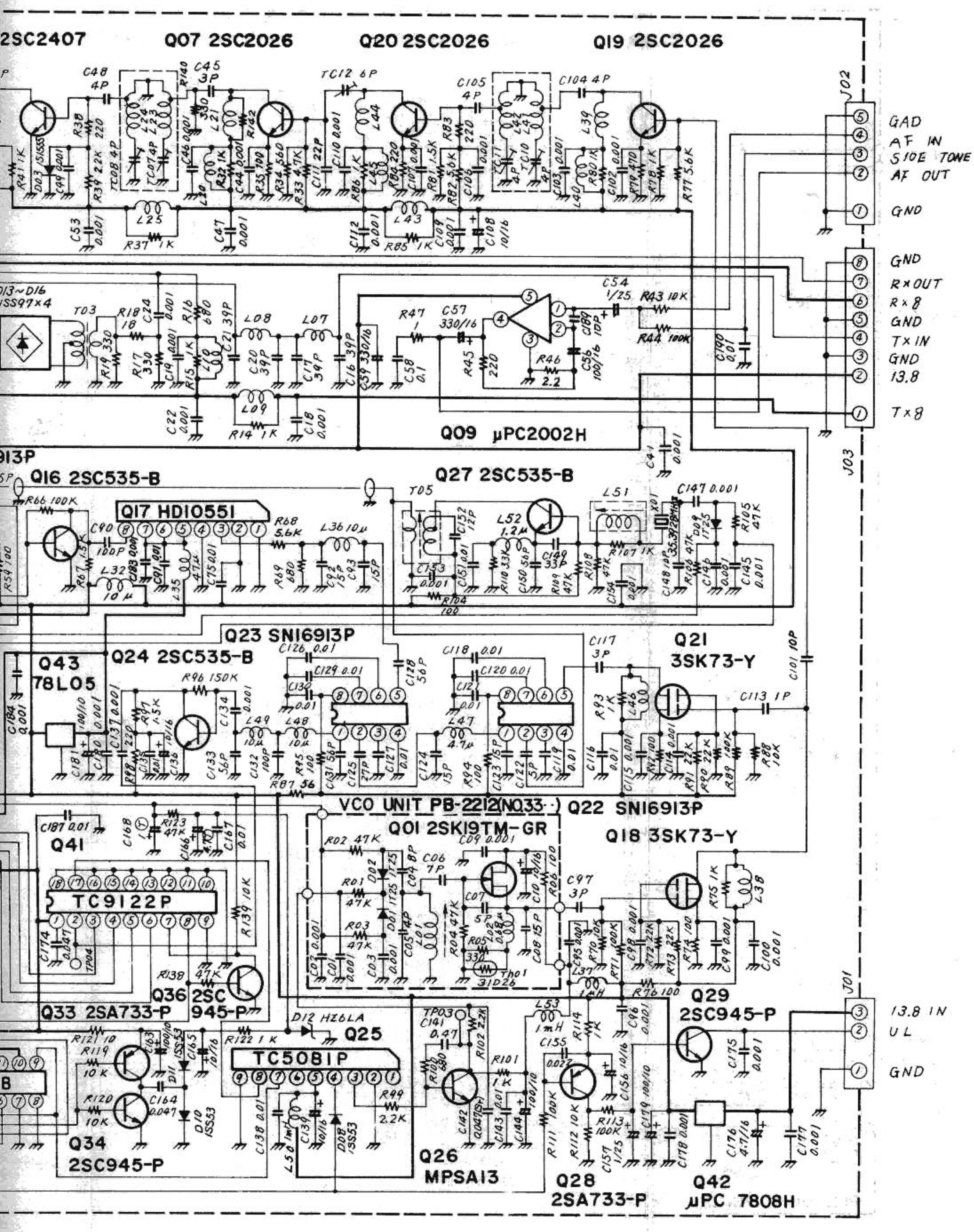
Q42
μPC 7808H

FT-780R(A)

PLL UNIT

CIRCUIT DIAGRAM





FT-780R(B·X)

PLL UNIT

CIRCUIT DIAGRAM