INSTRUCTION MANUAL

FT-223

YAESU MUSEN CO., LTD.
TOKYO JAPAN

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F T - 2 2 3

2 M E T E R F M T R A N S C E I V E R

GENERAL

The model FT-223 is a compact transceiver specifically designed to provide high performance for amateur VHF/FM service. The transceiver is completely solid state with provision for operation of up to 23 crystal controlled channels between 144 and 148 MHz. The advanced circuit design features prevent damage to the transistors in case of high antenna VSWR, or reversed power supply polarity, while an adjustable "tone-burst" generator is included for repeater actuation. An additional feature, is an optional tone squelch circuit for a selective calling system. The heavy gauge metal case provides an extremely rugged package, light in weight, yet virtually immune to the effects of shock and vibration.

The FT-223 VHF/FM transceiver is supplied complete with all mounting hardware, cables, connectors and accessories required for a mobile installation, as shown in Figure 1.

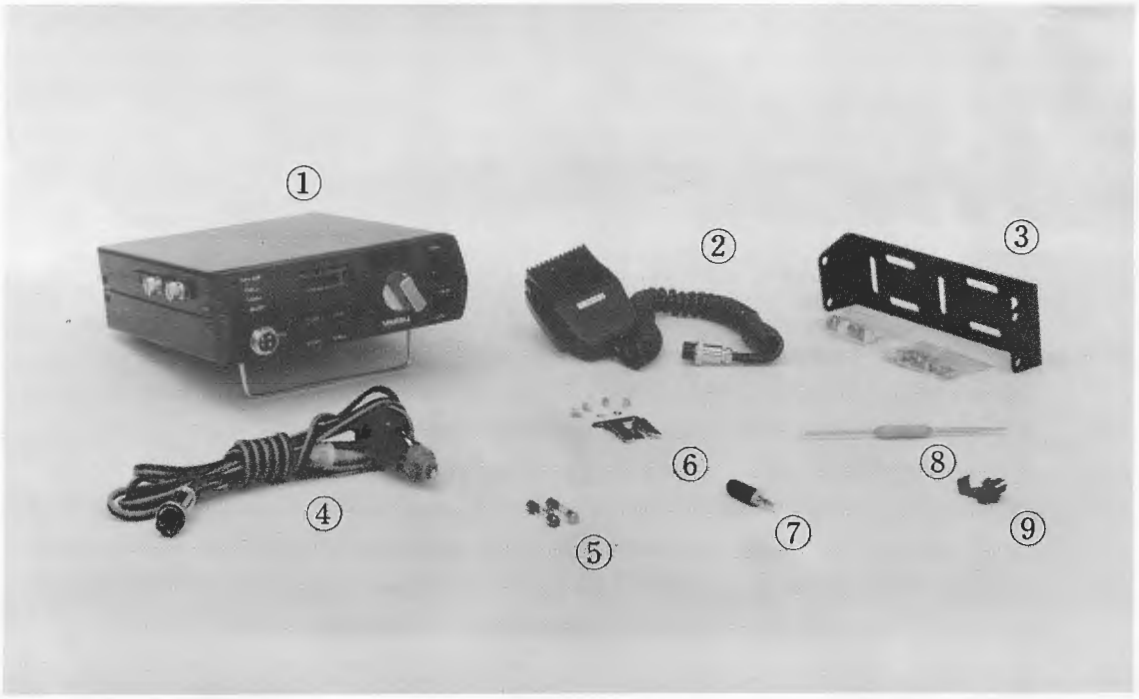
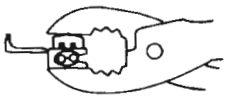


Figure 1.

1. Transceiver with built-in 3" speaker (3 channels factory installed).
2. Dynamic push-to-talk microphone with retractable coiled cord.
3. Universal mounting bracket (with screws, washers and nuts).
4. Power cable (with cigarette lighter adapter).
5. Spare fuses.
6. Microphone hanger.
7. Miniature phone plug for external speaker.
8. Alignment tool.
9. Tap connector.

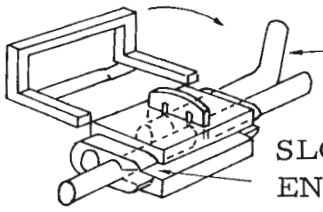
HOW TO USE THE TAP CONNECTOR

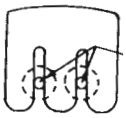
1. Do NOT strip insulation from wires.
2. The tap connector will handle most wire sizes used in automotive instrument panels.
3. Slide the "hot" lead into tap connector as shown.
4. Insert transceiver power lead 3/4 of the way into connector (just past metal connector element).
5. Using pliers, press the metal connector element until it is FLUSH.
6. Fold the hinged cover over the connector element and snap firmly in place.



CONNECTION MADE WITH ANY PLIERS TYPE TOOL BY DRIVING ELEMENT OVER WIRES

PLASTIC INSULATOR WITH HINGED "SNAP-IN" COVER





SELF-STRIPPING "U" TYPE SPRING PRESSURE CONNECTOR ELEMENT

Figure 2

The compact design of the FT-223 transceiver makes it ideal for mobile installation, operating directly from the vehicle's 12 Volt battery. For base station use, an accessory model, FP-2 Two-Way Power Supply, provides operating voltage plus a large external speaker.

SPECIFICATIONS

GENERAL

Frequency Coverage	-	144 to 146 MHz or 146 to 148 MHz
Number of Channels	-	23 (3 channels supplied) an optional external VFO can be used
Speaker	-	Internal 3" dynamic speaker with provision for connecting external 4 ohm dynamic speaker
Microphone	-	Dynamic push-to-talk microphone with retractable coiled cord
Power Requirement	-	13.5 Volts DC, ±10%
Current Consumption	-	0.45 Amp receive 1.2 Amp transmit (LOW) 2.3 Amp transmit (HI)
Metering	-	Illuminated front panel meter indicates relative received signal strength and transmitter power output
Dimensions	-	180 (W) x 60 (H) x 220 (D) mm
Weight	-	2.5 Kg

TRANSMITTER

RF Output	-	10 Watts (HI) or 1 Watt (LOW) into 50 ohm load at 13.5 Volts DC
Frequency Stability	-	±0.002%
Crystal Multiplication	-	12 times
Modulation	-	F3 (phase modulation)
Deviation	-	Up to ±10 kHz (factory adjusted at ±5 kHz)

Audio Response	-	+1, -3 dB of 6 dB/Octave pre-emphasis characteristic from 300 to 2500 Hz
Spurious Emissions	-	60 dB below carrier minimum
Tone Burst	-	Nominally one second at 1800 Hz (adjustable between 1300 & 3000 Hz)

RECEIVER

Type	-	Double conversion superheterodyne (crystal controlled)
Intermediate Frequency	-	10.7 MHz first IF; 455 kHz second IF
Sensitivity	-	-4 dB for 20 dB quieting
Selectivity	-	±6 kHz at 6 dB; ±12 kHz at 60 dB
Audio Output	-	2 Watts at 4 ohms

INSTALLATION

GENERAL

The model FT-223 transceiver is designed primarily for mobile service, requiring only an antenna and a 13.5 Volts DC power source for operation. However, when operated in conjunction with model FP-2 Two-Way Power Supply, the transceiver provides an efficient compact base station. The FP-2 power supply provides 13.5 Volts DC to operate the transceiver from an AC power source. The transceiver has been factory pre-tuned and requires no adjustments for normal operation into a 50 ohm load.

The antenna location is the most important consideration in either a base or mobile installation, with effective communication range directly related to antenna height. The antenna should always be in the clear and as high as possible, however, a minimum distance of 5 feet should be maintained between the VHF and other antennas. Also, in mobile installation, it is advisable to locate the antenna as far from the engine as practical, in order to minimize ignition noise pick-up. In all installations ensure that the antenna VSWR is less than 1.5:1.

For mobile installation, the most popular antenna types are either a 1/4 wave whip with unity gain, or a 5/8 wave affording approximately 3.5 dB gain. Mobile antennas are available from most dealers who handle two-way mobile radio equipment, or other local electronic suppliers.

To minimize losses in the antenna system, use the shortest length of coaxial cable that is practical, avoiding any sharp angles or kinks. Use type RG-8/U cable if the transmission line length exceeds 25 feet, while RG-58/U is suitable for shorter lengths. For all bends, form the cable into a radius not less than 10 times its diameter.

MOBILE INSTALLATION

In mobile service the FT-223 should be installed where the controls, indicators, and microphone are easily visible and accessible for operation. The unit may be mounted in any position without loss of performance. Suitable locations are under the dash, atop the transmission tunnel, etc. A universal bracket is supplied with the transceiver for this purpose. Install the FT-223 as follows (refer to Figure 3):

1. Use the universal mounting bracket as a template to locate the mounting holes. Use a 3/16" diameter drill for these holes and allow clearance for the transceiver, its controls and the connecting cables. Secure the mounting bracket with the screws, washers and nuts supplied as shown in "3A".

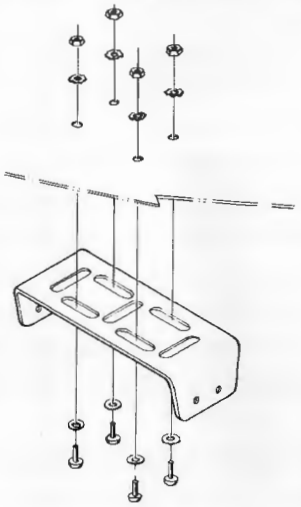


Figure 3A.

2. Install the transceiver in the mounting bracket, securing with the four knurled head screws and washers as shown in "3B".

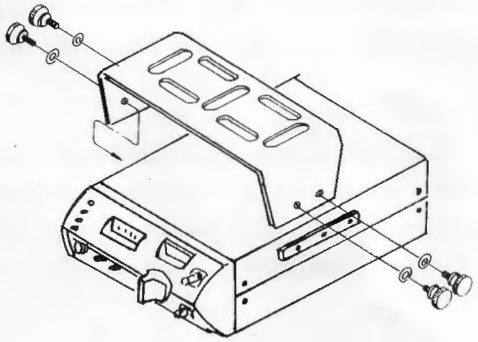


Figure 3B.

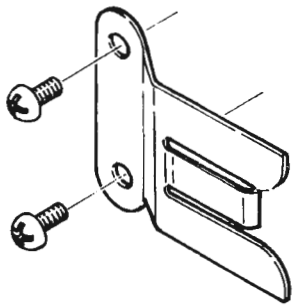


Figure 3C

4. The supplied power cable may be plugged directly into the vehicle's cigarette lighter receptacle for casual operation if desired. For a permanent installation, the lighter plug may be removed and the leads routed directly to the battery (red positive, black negative or ground), or the nearest termination to the battery; i.e. ignition switch, fuse block, etc. If it is necessary to extend the power leads, use #16 AWG insulated copper wire and do not extend the leads further than required to prevent excessive voltage drop.

CAUTION

Before connecting the power cable to the transceiver, check the battery voltage with the engine running (battery charging). If the voltage exceeds 14 Volts DC, the regulator should be readjusted so the highest charging rate does not exceed 14 Volts. Also, be sure to observe proper polarity when making battery connections (reversed polarity will not damage the FT-223 due to the protective circuitry incorporated in the design, however, the equipment will not operate under this condition).

5. Connect the power cable to the POWER receptacle on the rear panel.

6. Connect the 50 ohm antenna cable to the ANT receptacle on the rear panel.

7. Connect the microphone cable to the 4-pin microphone receptacle on the front panel.

8. An external 4 ohm speaker may be connected at the SP receptacle on the rear panel if desired (this automatically disconnects the internal speaker). Use the external speaker plug supplied.

BASE STATION INSTALLATION

As a base station, the FT-223 requires a source of 13.5 Volts DC at 2.6 amperes. This source may be obtained from the accessory, FP-2 power supply.

CONTROLS & SWITCHES

The FT-223 VHF/FM transceiver has been designed for ease of operation. Be sure you thoroughly understand the function of each control and indicator before operating the equipment. The operating functions are as follows.

FT-223 VHF/FM TRANSCEIVER

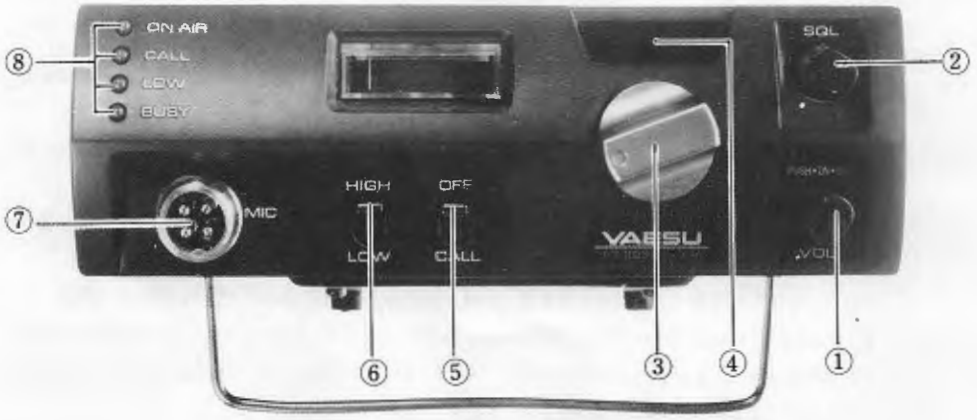


Figure 4.

1.	VOLUME Control	-	The VOLUME control adjusts the receiver audio output level (applies power when pushed in).
2.	SQUELCH (SQL) Control	-	The SQUELCH control adjusts the receiver squelch threshold sensitivity. An optional tone squelch circuit is activated when rotated to the extreme CCW position marked TONE.
3.	CHANNEL Selector	-	The 23 position CHANNEL selector switch selects the desired operating channel.
4.	CHANNEL Indicator	-	The channel indicator shows the selected operating channel (illuminated when power is applied).
5.	CALL Switch	-	When depressed, the CALL switch selects a preset channel regardless of the CHANNEL selector switch position and CALL lamp lights up.
6.	HI-LOW Switch	-	The HI-LOW switch selects the desired power output, 10 watts in HI position, or 1 watt in LOW position. In LOW position, LOW lamp lights up.
7.	Microphone Receptacle	-	Four-pin connector is used for microphone input and push-to-talk relay actuation.
8.	INDICATORS - ON AIR	-	The red lamp lights up in the "transmit" mode.
	CALL	-	The red lamp lights up when the CALL channel is selected.
	LOW	-	The red lamp lights up when the transceiver is operated at LOW power.
	BUSY	-	The red lamp lights up when the signal is received.

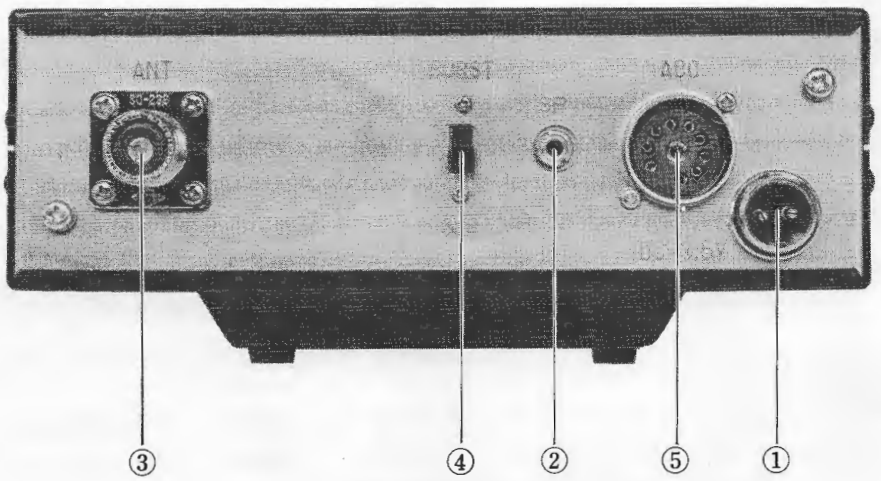


Figure 5

REAR PANEL

1. POWER Receptacle - Two-pin connector is used for connection to 13.5 Volts DC (negative ground) power source, vehicle battery, or FP-2 power supply.

2. SP Receptacle - Audio output is provided at this receptacle for an external speaker (or speaker in FP-2 power supply). Output impedance is 4 ohms and the internal speaker will be disabled when a plug is inserted.

3. ANT Receptacle - UHF type coaxial receptacle for connection of antenna.

4. BURST Switch - 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 with "tone access" repeater operation.

5. ACC Socket - The ACCESSORY socket is used for external VFO operation.

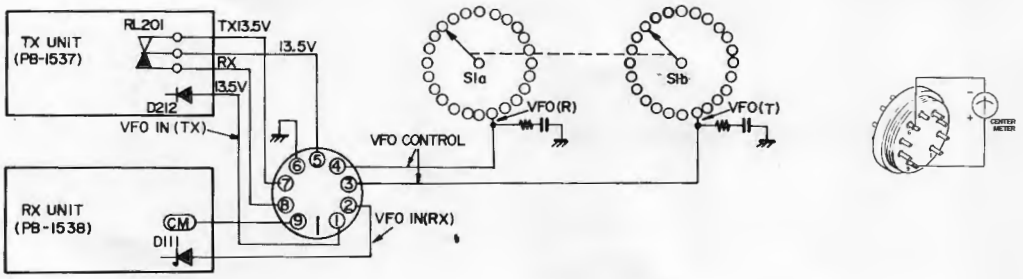


Figure 6

OPERATION

OPERATING PROCEDURE

1. Push the VOLUME control switch to apply power. The channel indicator and meter will illuminate.

2. Set the CHANNEL selector to the desired channel as shown in the channel indicator window. Ensure that the CALL switch is at "OFF" position. When the CALL switch is in the "ON" position, the preset channel is selected regardless of the CHANNEL selector switch position. For preset channel operation, set the CALL switch to "CALL" position.

3. Rotate the SQUELCH control fully counter-clockwise to TONE position and slightly rotate clockwise beyond TONE position. For selective calling position, set the SQL control to TONE position.

4. Adjust the VOLUME control for a normal listening level (background noise or a station if one is transmitting).

5. When the channel is clear (background noise only), rotate the SQUELCH control clockwise until the receiver is silenced. Perform this step carefully so as not to go beyond the silencing point or the receiver will not respond to weak signals.

6. Set the HI-LOW switch to the desired power output position.

7. If operating on a repeater channel requiring "tone access", set the BURST switch on the rear panel to the "ON" position. The "tone burst" will be applied to the carrier each time the push-to-talk lever on the microphone is depressed.

   NOTE: Refer to the Tone Adjustments paragraph to change the tone frequency or duration (factory set for 1800 Hz and one second).

8. When ready to transmit, hold the microphone close to your mouth, depress the push-to-talk lever and speak distinctly at a normal conversational level. Check that the red "transmit" indicator illuminates and the meter indicates upward.

THEORY OF OPERATION

GENERAL

Functional operation of the model FT-223 VHF/FM transceiver is illustrated in the Block Diagram, Figure 6
Refer to the schematic diagram for the circuit description.
The transceiver consists of a crystal controlled transmitter and receiver operating on any of the 23 channels within the frequency range of 144 to 148 MHz. In addition to 22 channels which are selected by the CHANNEL selector switch, one "most-often-used" channel may be preset for ease of operation. Solid state circuitry is employed throughout and the transceiver is designed to operate from a 13.5 Volt ±10% DC negative ground power source.

TRANSMITTER SECTION

The transmitter section produces an FM (phase modulation method) output signal.

The audio signal from the microphone is amplified by an integrated circuit Q201 (TA7061AP) which works as amplifier and an IDC (Instantaneous Deviation Control) circuit. The IDC circuit, clips both positive and negative peaks when they exceed a predetermined level to limit the maximum deviation of the transmitter. The IDC control, VR202, permits the deviation to be adjusted, and is nominally factory set for a deviation of ±5 kHz. When wide band transmission is desired, VR202 must be readjusted to provide a maximum deviation of ±10 kHz.

FT-223 BLOCK DIAGRAM

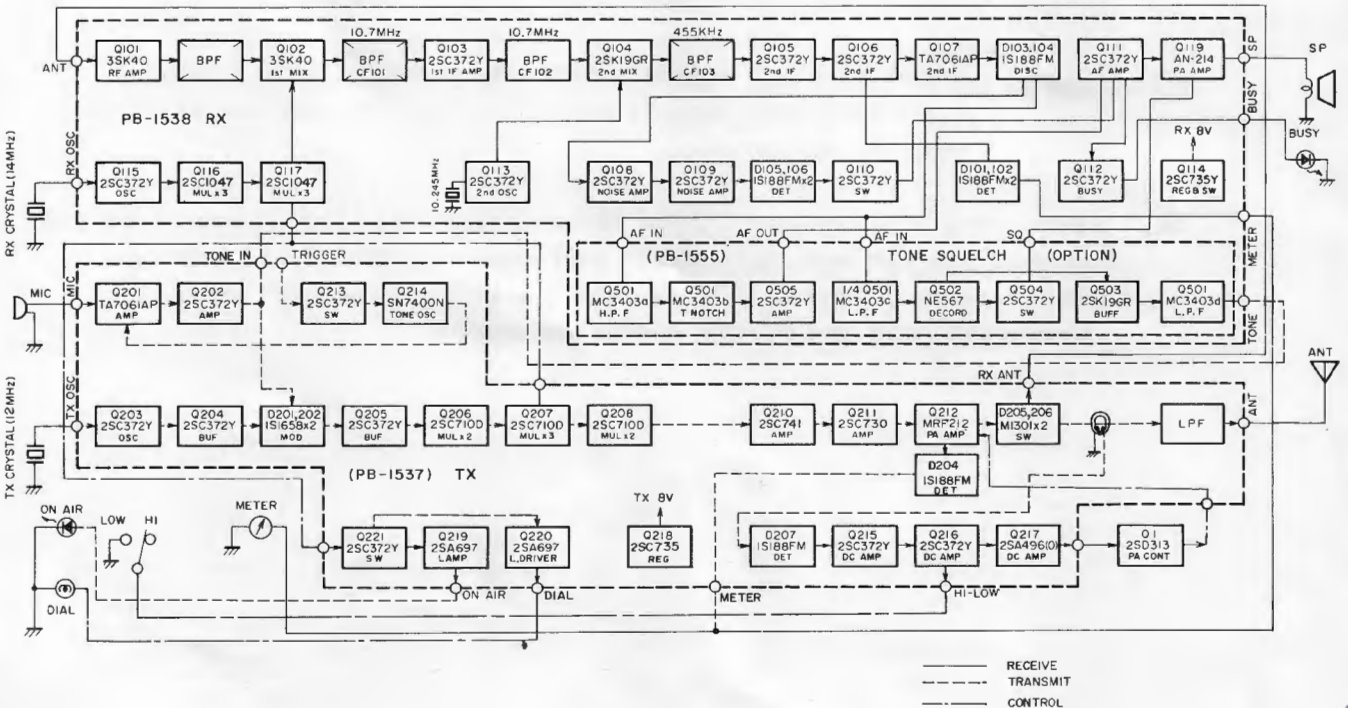


Figure 6

The limited audio signal is applied through a low-pass filter to Q202, 2SC372Y where it is amplified and applied to the phase modulator, varactor diode D201, 1S1658. The low-pass filter limits the transmitter modulation spectrum by attenuating frequencies above the speech range.

The oscillator, Q203, 2SC372Y, operates on the crystal frequency to generate the initial RF signal. The crystal frequency is in the 12 MHz range, and is determined as follows:

$$\text{Crystal Frequency (MHz)} = \frac{\text{Output Frequency (MHz)}}{12}$$

Trimmer capacitors TC401 through TC423 permit each of the 23 crystals to be individually set to frequency. Output from Q203 is amplified by Q204, 2SC372Y, and applied across transformer L203.

The audio signal from Q202 varies the bias applied to D201 and D202, in turn causing the capacity of the diodes to vary in accordance with the audio voltage. As D201 and T201 and D202 and T202 are in series, the capacity change in the diode effectively changes the resonant frequency to produce a phase shift at an audio rate in the input of Q205, 2SC372Y in the exciter stage.

The angular phase shift from the modulator is relatively small, therefore the crystal frequency is multiplied twelve times to obtain the desired deviation at the output frequency of 144 to 148 MHz. The modulated 12 MHz signal is applied through the buffer amplifier Q205, 2SC372Y to the multiplier chain consisting of a doubler Q206, 2SC710D, a tripler Q207, 2SC710D, and a doubler Q208, 2SC710D where the necessary frequency multiplication is provided.

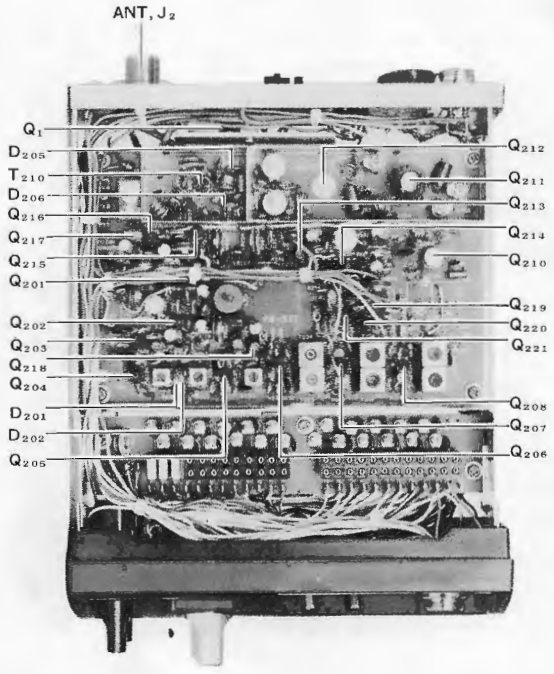


Figure 7 Bottom View

The frequency modulated 146 to 148 MHz signal is amplified by Q210, 2SC741, Q211, 2SC730 and Q212, MRF212 and applied through a two stage pi-network to the antenna. A diode D204, 1S188FM rectifies a small portion of the RF output and applies the resultant DC voltage to the meter where is provides an indication of relative power output from the transmitter. The meter sensitivity is adjusted by VR204 and it is set for indication of 8 on the meter scale at 10 watts on a 50 ohm resistive load.

If the transmitter is keyed without an antenna connected, or if a high SWR exists in the antenna system, the reflected power is detected through T210 and a diode D207, 1S188FM produces DC voltage. Q215, 2SC372Y conducts with the DC voltage applied through VR209 causing Q216, 2SC372Y to decrease its collector current. Thus, the emitter voltage of Q217, 2SA496(0) is lowered causing Q1, 2SD313 to decrease current and the supply voltage to the PA amplifier Q212 is lowered to prevent damage of the transistor. The protection level is set by VR209. This circuit is also used to switch the output power down to 1 watt where the HI/LOW switch is set to LOW position. The amount of power reduction may be adjusted by VR208.

The antenna change-over circuit consists of the switching diodes D205 and D206, M1 301.

RECEIVER SECTION

The 146 to 148 MHz input signal from the antenna is amplified by FET Q101, 3SK40Mon RF board, and applied through five hi-Q slot-coupled resonators to the first mixer, Q102, 3SK40M.

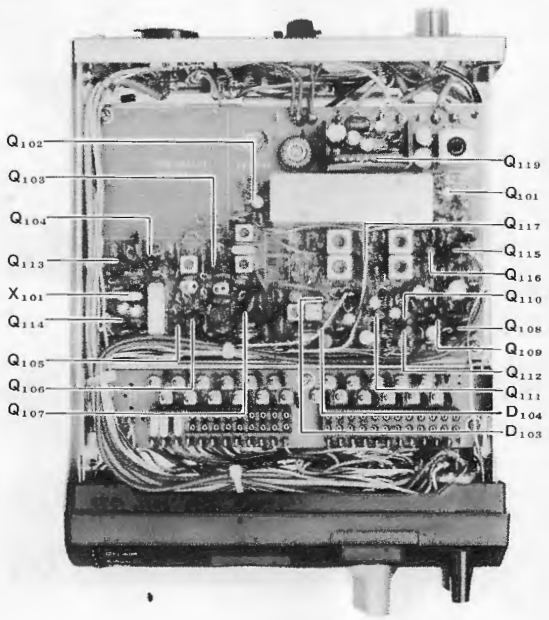


Figure 8 Top View

The use of an FET RF amplifier, together with the slot-coupled resonators combines to minimize effects of cross modulation and other spurious responses while providing a low noise figure for the receiver front end.

The 144 to 148 MHz signal is heterodyned with the output of the first local oscillator by Q102 and produces the first IF, 10.7 MHz. The first local oscillator injection frequency is 10.7 MHz below the input signal frequency in all cases. The fundamental crystal frequency is multiplied nine times to obtain the injection frequency. The crystal frequency is in the 14-15 MHz range and is determined as follows:

$$\text{Crystal Frequency (MHz)} = \frac{\text{Signal Frequency (MHz)} - 10.7}{9}$$

The first local oscillator consists of a crystal oscillator, Q115, 2SC372Y and triplers Q116 and Q117, 2SC1047. The 10.7 MHz output from Q102 is applied through a crystal filter, CF101 to the first IF amplifier Q103, 2SC372Y. The amplified first IF signal is applied to the second mixer Q104, 2SK19GR through additional ceramic filter, CF102 which further reduces spurious responses. The 10.7 MHz signal is heterodyned with the 10.245 MHz output of the second local oscillator, Q113, 2SC372Y to produce the second IF, 455 kHz, at the output of Q104.

The 455 kHz IF circuit consists of Q105, Q106, 2SC372Y and amplified and limited by IC Q107, TA7061. The ceramic filter, CF103, provides the narrow band selectivity for the receiver, and the limiting action of Q107 removes any amplitude variations in the signal applied to the discriminator, D103 and D104, 1S188FM.

The discriminator produces an audio output in response to a corresponding frequency (or phase) shift in the 455 kHz IF signal. The discriminator output is amplified by Q111, 2SC372Y and is applied across the VOLUME control, VR1, to the input of the IC audio amplifier Q119, AN214 and also to the squelch circuit. The output from Q119 is applied to the internal speaker and also the SP receptacle where an external 4 ohm speaker may be connected if so desired.

The squelch circuit consists of Q108 through Q110, 2SC372Y. When no carrier is present in the 455 kHz IF, the "noise" at the discriminator output is amplified by Q108 and Q109 and detected by D105 and D106, 1S188FM to produce a DC voltage. This DC voltage is applied to turn Q110 "on". With Q110 "on" the base of Q111 is grounded to quiet the audio amplifier. When a carrier is present in the 455 kHz IF the quieting action of the receiver removes the noise at the discriminator output and Q110 is turned "off", permitting normal operation of Q111. The SQUELCH control, VR2, permits the squelch threshold sensitivity to be adjusted by setting the level at the input of Q108.

When an optional TONE SQUELCH circuit is incorporated, the squelch circuit opens only for the signals which accompany the preset TONE signal with SQUELCH control at TONE position.

The 455 kHz output from Q106, 2SC372Y is also applied to the S-meter rectifiers, D101 and D102, 1S188FM. The diodes rectify the signal and the resulting DC voltage is applied to the meter where it provides an indication of relative signal strength. The S-meter control, VR101, permits the meter circuit sensitivity to be adjusted.

TONE BURST CIRCUIT

The tone burst circuit consists of a timing generator and a gated multivibrator. When the BURST switch is set to the "ON" position, the DC voltage is applied to Q214, SN7400N. The transmitter, "keyed" at +13.5 volts DC is applied to Q213, 2SC372Y to trigger the 4-gate NAND logic timing generator. The timing generator produces an output pulse applied to the multivibrator which produces a tone output that is applied to the microphone input of the transmitter section. The tone frequency is adjustable between 1300 and 3000 Hz by VR206, while the output level (deviation) is adjustable by VR207 and the burst duration by VR205.

TONE SQUELCH CIRCUIT (Optional)

The Tone Squelch operation permits private communications on crowded channels. The tone squelch circuit disables the audio circuit of receiver until a preset tone signal is received.

The transmitted signal is modulated by the tone signal within 70 Hz to 250 Hz which is below the 300 Hz to 3000 Hz voice frequency range used in radio communications.

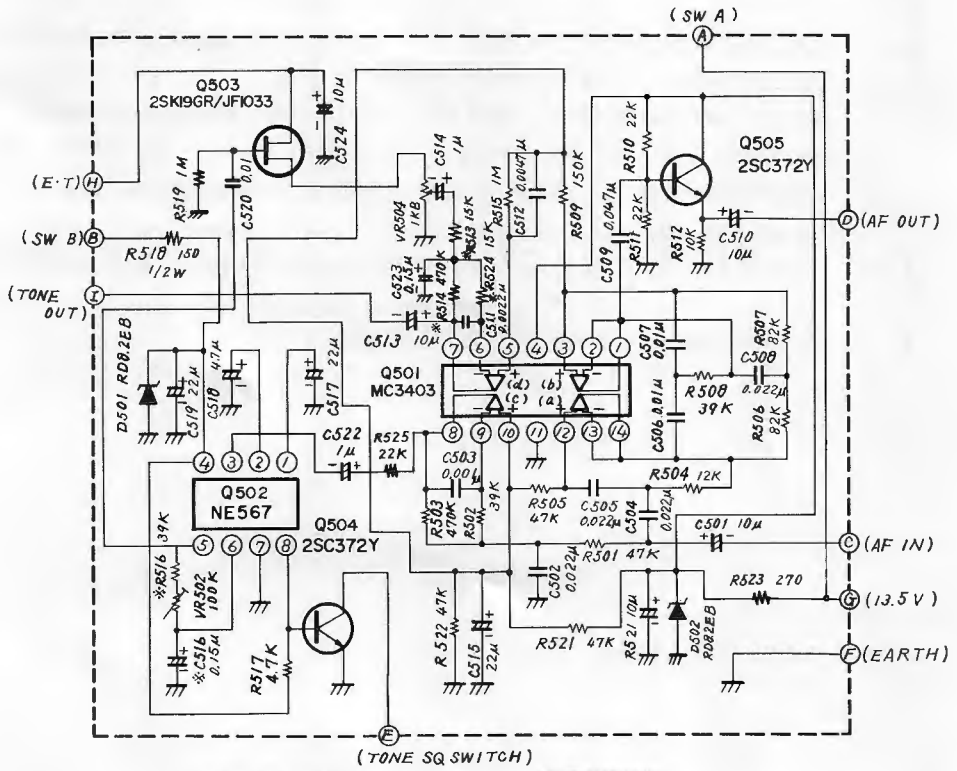
The tone signal is generated by Q502, NE567 and its frequency is set by R516, VR502 and C516. The level of the tone signal is set by VR504 and it is fed through a buffer amplifier, Q503, 2SK19GR to the low pass filter consisting of unit "d" of an operational amplifier Q501, MC3403. The tone signal is then superimposed to the speech signal by Q202. The constants for preset frequency are obtained from the chart.

The audio output signal from the receiver discriminator is fed to the unit "a" of Q501, MC3403. The unit "a" of Q501 forms a high pass filter and the unit "b" of Q501 forms a T-notch filter. Both filters remove the tone signal from the audio signal which is then fed through an audio amplifier Q505, 2SC372Y to the receiver audio amplifier Q111.

The tone signal passes through a low pass filter by unit "c" of Q501 and is fed to Q502, NE567. When the tone signal has the same frequency as preset for transmitting, the voltage of pin 8 of Q502 becomes low causing Q504, 2SC372Y to "OFF". In turn, proper bias voltage is applied to Q119 for normal operation.

Without proper tone signal, Q504 conducts, removing the proper bias from Q119 to disable the audio circuit.

As the conventional carrier squelch circuit is operative when the tone squelch is switched in, the busy lamp lights up when any carrier is received.



TONE SQUELCH (PB-1555A) OPTION

Figure 9

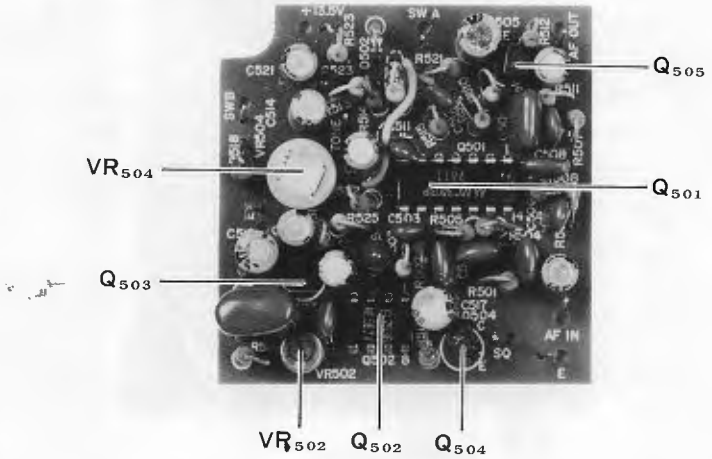


Figure 10

MAINTENANCE

GENERAL

Your model FT-223 VHF/FM transceiver has been carefully aligned and tested prior to shipment from the factory. The reliability of the solid state devices used in the FT-223 should provide years of trouble free service if the transceiver is not abused and normal routine maintenance is carried out.

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

1. Do not exceed 15 volts DC at the POWER receptacle. When operating mobile, check the battery voltage under load (transmitter "keyed") with the engine running fast enough so the ammeter shows "charge". Also, do not operate the FT-223 if the supply voltage is below 12 volts DC.

2. Do not apply any DC potentials at the ANT receptacle.

3. Avoid direct exposure to water.

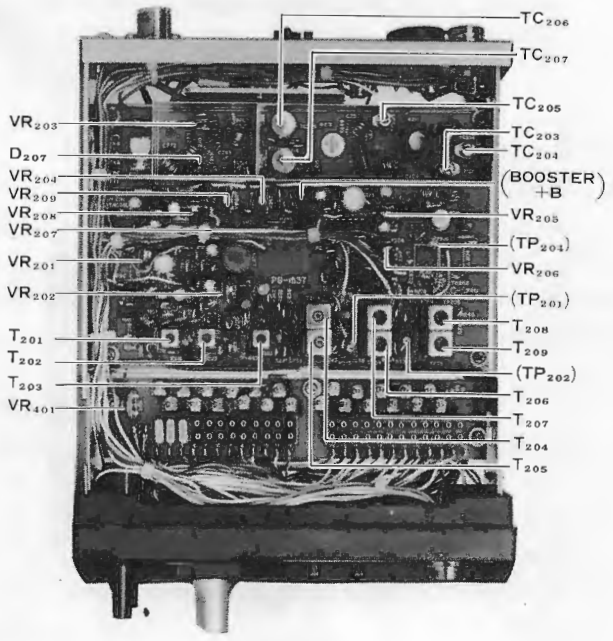


Figure 11 Alignment Point - Bottom View

ROUTINE MAINTENANCE

Routine maintenance should be limited to keeping the transceiver clean, and periodic performance checks of the transmitter RF output and receiver 20 dB quieting sensitivity.

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

Performance Checks:

N O T E

Make all performance checks at 13.5 volts DC (under load). Use a battery of adequate capacity, or the model FP-2 power supply. Do not use a battery charger to power the FT-223.

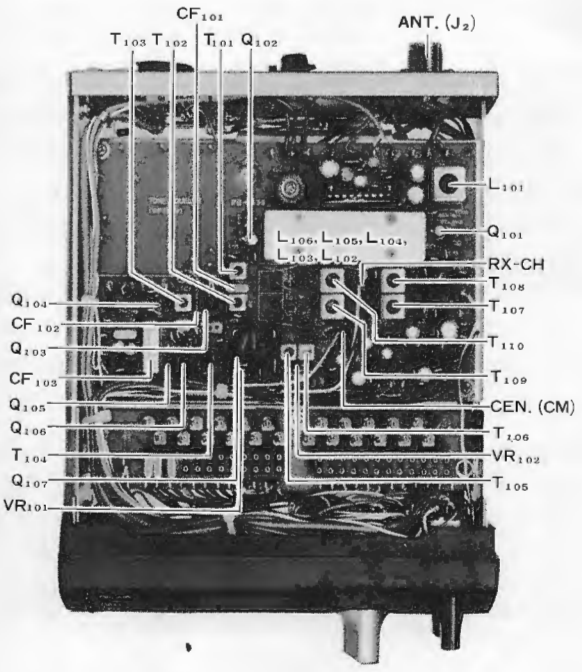


Figure 12 Alignment Point - Top View

1. Check the transmitter RF output as follows:

   (a) Connect a suitable 50 ohm dummy load/RF wattmeter to the ANT receptacle.

   (b) "Key" the transmitter in both HI and LOW positions and check the power output. The power should be approximately 10 and 1 watt respectively, and the S-meter should read between 6 and 7 in the HI position.

   (c) Repeat step (b) for each channel.

2. Check the receiver 20 dB quieting sensitivity as follows:

   (a) Connect an AC VTVM to the SP receptacle and adjust the SQUELCH control fully counter-clockwise (switch "ON" position).

   (b) Connect the RF output of a precision VHF signal generator to the ANT receptacle and with no signal input note the voltage reading on the VTVM. Adjust the VOLUME control and VTVM range as required to obtain an approximate full scale reading (do not change the VOLUME setting after this adjustment is made).

   (c) Set the signal generator to the proper input frequency for the CHANNEL selector position and adjust the output amplitude until the VTVM reads 1/10th (20 dB decrease) of the reading in step (b). The signal generator output amplitude at this point is the 20 dB quieting sensitivity and should be approximately 0.3 microvolts.

   (d) Repeat steps (b) and (c) for each channel.

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

ADJUSTMENTS

Internal adjustments should be limited to those described in the following paragraphs. Remove the 8 screws on the side of the cabinet and lift up the case to obtain access to the interior.

1. Discriminator Crossover Adjustment - adjust the discriminator crossover point as follows:

(a) Connect a 25-0-25uA DC meter between CM out terminal on the printed board and ground.

(b) Adjust the FT-223 for normal operation without the antenna connected.

(c) Connect the RF output of a precision signal generator through a 0.01 uf capacitor to the base of Q103. Monitor the signal generator output with a frequency counter if possible.

(d) Adjust the signal generator for a 100 microvolt output at exactly 455 kHz (±100 Hz or less).

(e) Using the alignment tool, carefully adjust the cores in primary and secondary of L105 and L106 to obtain a "zero" indication on the meter.

2. Crystal Trimmer Adjustment - adjust the receiver and transmitter crystal trimmers as follows:

(a) Connect a 25-0-25 uA DC meter between CM out terminal and ground.

(b) Adjust the FT-223 for normal operation.

(c) Connect the output of a precision VHF signal generator (0.0001% minimum tolerance) to the ANT receptacle.

(d) Set the CHANNEL selector to the desired channel and adjust the signal generator to provide a signal at the exact input frequency.

(e) Using a non-metallic alignment tool, adjust the appropriate trimmer capacitor, TC301 through TC303 on RX crystal board to obtain a "zero" indication on the meter.

(f) Repeat steps (d) and (e) for each channel.

(g) Disconnect the signal generator from the ANT receptacle and connect a 50 ohm dummy load in its place. Couple the frequency counter to read the frequency of the transmitted signal.

(h) Key the transmitter and using the alignment tool adjust the appropriate trimmer capacitor, TC401 through TC423 on TX crystal board, until the correct frequency is indicated on the frequency meter.

(i) Repeat step (h) for each channel.

NOTE

When the discriminator is accurately adjusted, the receiver crystal trimmers may be adjusted by receiving an accurate frequency signal. With the meter connected to CM position, adjust trimmers for zero (center) meter indication receiving accurate frequency signal against the receiving channel.

3. Tone Adjustments - adjust the tone burst generator as follows:

(a) Connect a 50 ohm dummy load to the ANT receptacle.

(b) Disconnect the microphone to prevent accidentally voice modulating the transmitter.

(c) Temporarily connect pin 9 and pin 13 of Q214 for continuous oscillation.

(d) Adjust the FT-223 for normal operation and set the BURST switch to the "ON" position.

(e) If a frequency counter is available, connect its input between pins 2 (hot) and 1 (ground) of the microphone receptacle. Key the transmitter by grounding pin 3 (push-to-talk) of the microphone receptacle and adjust potentiometer VR206 until the counter indicates the exact tone frequency desired.

(f) Disconnect pin 9 and pin 13 of Q214.

(g) Key the transmitter and adjust potentiometer VR205 until the tone burst duration, as monitored in step (e) or (f), is the desired length (one second maximum).

(h) Adjust an FM deviation meter to display the transmitter deviation. Key the transmitter and check that the deviation does not exceed ±5.0 kHz. If the deviation exceeds ±5.0 kHz, adjust potentiometer VR207 as required.

4. Deviation Adjustment - adjust the transmitter deviation as follows:

(a) Connect a 50 ohm dummy load and a deviation meter to the ANT receptacle as illustrated.

(b) Disconnect the microphone to prevent accidentally voice modulating the transmitter.

(c) Adjust the FT-223 for normal HI power operation (BURST switch OFF). Set VR201 and VR202 to the mid point of its range.

(d) Connect the output of an audio oscillator between pins 2 (hot) and 1 (ground) of the microphone receptacle. Adjust the oscillator for a 1 millivolt output at 1000 Hz.

(e) Adjust an FM deviation meter to display the transmitter deviation. Key the transmitter by grounding pin 3 of the microphone receptacle and adjust T201 through T203 until a sine wave pattern is obtained on the scope.

NOTE

If only a wide band operation is desired, set VR202 for ±10 kHz, however, if only a narrow band is desired, adjust it for ±5 kHz.

(f) Set the audio oscillator to 25 mV output and adjust VR202 for ±5 kHz deviation.

(g) Set the audio oscillator for a 2.5 millivolt output at 1 kHz and key the transmitter. Adjust potentiometer VR201 for a deviation of ±3.5 kHz.

(h) Disconnect the audio oscillator and set the BURST switch to the "ON" position. Key the transmitter and check that the tone burst deviation does not exceed the maximum of step (e). If it does, readjust potentiometer VR207 as required.

5. Output Meter and Automatic Final Protection Adjustments - adjust the output meter and automatic final protection circuits as follows:

(a) Connect a 50 ohm dummy load/RF wattmeter to the ANT receptacle.

(b) Adjust the FT-223 for normal HI power operation.

(c) Key the transmitter and check that the meter reads 8 with approximately 10 watts shown on the RF wattmeter.

(d) If the meter reading is below 8 or above 8 in step (c), adjust potentiometer VR204 as required.

(e) Set VR209 to a fully clockwise position. Connect VTVM between cathode of D207 (+) and ground (-). Key the transmitter and adjust VR203 for minimum VTVM reading. Carefully observing the power output, rotate VR209 slowly in a counter-clockwise direction until the output power starts to drop. Turn the VR209 back slightly (approximately 5 degrees).

(f) Measure the DC voltage of the supply voltage to PA transistor. It should be 13 volts.

(g) Disconnect the dummy load and check if the DC voltage in step (f) falls down less than 6 volts to protect the final transistor.

6. HI-LOW Adjustment - adjust the HI-LOW switch as follows:

(a) Connect the dummy load/RF wattmeter to the ANT receptacle.

(b) Set the HI-LOW switch to LOW position.

(c) Key the transmitter and adjust VR208 for a 1 watt output.

7. S-Meter Adjustments - adjust the S-meter circuit as follows:

(a) Connect the RF output of a precision VHF signal generator to the ANT receptacle.

(b) Set the signal generator to the proper input frequency for the CHANNEL selector position and adjust the output amplitude to 20 dB. Check that the S-meter reads 10.

(c) If the S-meter reading is not 10 in step (b), adjust potentiometer VR101 on the printed board as required.

EXPANDING CHANNEL CAPABILITIES

Your FT-223 transceiver is supplied with crystals installed for three channels. You may add up to 20 more sets of crystals to provide for operation on the frequencies used in your area.

1. Ordering Crystals: The crystals used in your FT-223 are manufactured to extremely close tolerance to match the electrical characteristics of the oscillator circuits. It is recommended that whenever you wish to install additional crystals in the transceiver, you should obtain these from your dealer to assure proper functioning of the circuitry under varying environmental conditions.

Crystal Specification

	Receiver	Transmitter
TYPE	HC-25/U	HC-25/U
Frequency MHz	$\frac{\text{RX Freq} - 10.7}{9}$	$\frac{\text{TX Freq}}{12}$
Tolerance	±20 PPM	±20 PPM
Parallel Capacitance	30 PF	30 PF
Drive Level	10 mW	5 mW
Effective Resistance	less than 20 ohms	less than 20 ohms

2. Installing Additional Channels: To install additional channels in your FT-223, proceed as follows:

(a) Remove the 8 screws on the side of the cases and lift the cases out of the transceiver.

(b) Install the new crystals in their appropriate sockets on the transmitter and receiver circuit boards.

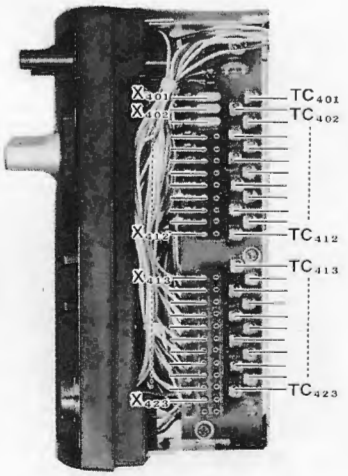


Figure 13

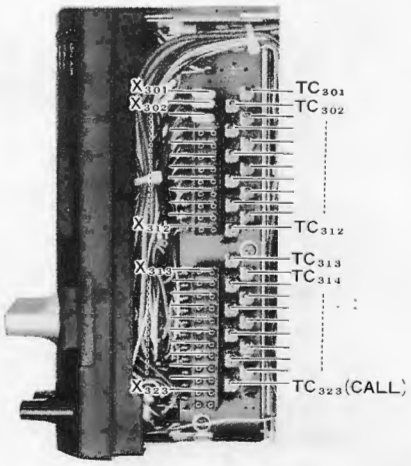


Figure 14

NOTE

The channel indicator dial is marked 1 through 23. The 23rd position is for an optional external VFO. The crystal sockets are located from left to right corresponding to the channel number starting at 1. The 23rd socket is for a "CALL" channel.

(c) Adjust the new crystals to frequency as described in ADJUSTMENTS.

(d) Carry out the transmitter and receiver performance checks to ensure proper operation on each new channel installed.

TROUBLE-SHOOTING

Solid state devices, such as the ones used in your FT-223, exhibit extreme reliability in operation. However, unlike vacuum tubes, any failure within a solid state device (diode, integrated circuit, or transistor), is usually catastrophic. The device will either function, or not function, therefore, trouble-shooting can be conducted easily by a signal tracing method to localize the trouble to a particular circuit. A signal generator and oscilloscope provide the most convenient means of such signal tracing. The voltage and resistance measurements tabulated for the transistors and integrated circuits may be used to verify a suspected failure, or improper level in the transceiver.

RESISTANCE CHART

	B (G)	E (S)	C (D)		B	E	C
Q_1	2.6K	∞	95	Q_{202}	9K	100	9K
				Q_{203}	4K	1K	5.9K
Q_{111}	G_1 ∞ G_2 40K	100	300	Q_{204}	3.8K	470	5.7K
Q_{102}	G_1 0 G_2 1.8K	100	300	Q_{205}	3.9K	470	6K
Q_{103}	3.5K	150	480	Q_{206}	1.9K	220	2.5K
Q_{104}	100K	1K	1K	Q_{207}	940	100	2K
Q_{105}	100K	0	3.3K	Q_{208}	450	47	2.1K
Q_{106}	4.4K	470	400	Q_{210}	0	10	2K
Q_{108}	200K	0	2K	Q_{211}	0	0	2K
Q_{109}	100K	1.3K	3.3K	Q_{212}	0	0	∞
Q_{110}	5K	0	3.3K	Q_{213}	720	0	5K
Q_{111}	8.7K	1K	2K	Q_{215}	1.2K	0	950
Q_{112}	3K	0	∞	Q_{216}	5.6K	470	∞
Q_{113}	4K	1K	400	Q_{217}	∞	560	560
Q_{114}	540	260	100	Q_{218}	2.8K	5.6K	2K
Q_{115}	3.6K	1K	400	Q_{219}	27K	2K	34K
Q_{116}	3.6K	330	270	Q_{220}	27K	100	56
Q_{117}	1.9K	220	270	Q_{221}	3.2K	0	5.5K

VOLTAGE CHART

	B (G)	E (S)	C (D)			B	E	C	
Q_1	13.0 V	12.4 V	13.5 V	AFP:OFF	Q_{202}	0.77 V	0.11 V	4.5 V	
					Q_{203}	1.4	0.95	8.2	
Q_{101}	G_1 0 G_2 5.0	0.2	8.0		Q_{204}	2.4	1.75	7.5	
Q_{102}	G_1 0 G_2 0.9	0.2	8.0		Q_{205}	1.9	1.3	7.0	
Q_{103}	1.8	1.1	6.0		Q_{206}	1.4	2.0	13.0	
Q_{104}	0	2.0	7.4		Q_{207}	0.55	2.3	13.5	
Q_{105}	0.6	0	1.8		Q_{208}	0.62	0.82	1.8	
Q_{106}	1.6	0.9	8.0		Q_{210}	0	0.31	13.5	
Q_{108}	0.6	0	1.2		Q_{211}	0	0	13.5	
Q_{109}	4.3	3.6	4.8		Q_{212}	0	0	12.4	
Q_{110}	0.3/0.6	0	1.9/0	SQ: OFF/ON	Q_{213}	0.6	0	5.0	BURST: ON
Q_{111}	1.9	1.2	5.0		Q_{215}	0.32/0.6	0	11.5/0.35	AFP: OFF/ON
Q_{112}	0.6	0	0	BUSY:ON	Q_{216}	10.0	10.0	12.0	
Q_{113}	1.0	0.6	8.0		Q_{217}	12.0	12.7	12.7	
Q_{114}	9.0	8.2	13.5		Q_{218}	9.0	8.4	13.5	
Q_{115}	1.4	1.1	8.2		Q_{219}	13.1	12.8	13.5	
Q_{116}	1.3	0.9	8.2		Q_{220}	13.5	13.5	9.7	
Q_{117}	0.6	1.0	8.2		Q_{221}	0.66	0	13.5	

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Q_{107}	6.6K	2K	400	0	400	6.6K	6.6K							
Q_{119}	800	0	1.2K	2.3 K	30K	0	35K	72K	90					
Q_{201}	6.2K	2K	6.8K	0	4K	6.8K	6.4K							
Q_{214}	∞	∞	∞	∞	∞	∞	0	1K	400	1K	∞	1K	4K	330

Measured with VTVM.
Values are in OHMS.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Q_{107}	1.9	1.9	7.8	0	6.5	1.9	1.9							
Q_{119}	6.3	0	7.6	10.7	6.1	0	6.1	12.8	13.5					
Q_{201}	1.8	1.8	7.6	0	6.2	1.8	1.8							
Q_{214}	0	3.3	3.3	2.4	2.4	2.2	0	2.8	5.0	0.9	0.1	2.8	4.2	5.0

Measured with VTVM.
Values are in VOLTS DC.

Q_{101}~Q_{117}……Transmit 0 V
Q_{201}~Q_{221}……Receive 0 V

FT-223 PARTS LIST

MAIN CHASSIS

Q	TRANSISTOR		
1			2SD313(2SD235)
D	DIODE		
1			DS130YD(10D1)
R	RESISTOR		
	CARBON COMPOSITION		
3		½W	180Ω
4~7		〃	680Ω
	CARBON FILM		
8,9		¼W	22Ω
10		〃	470Ω
VR	POTENTIOMETER		
1		EVH-YPBK 25A14	10KΩA
2		EVH-COQK 25B53	5KΩB
C	CAPACITOR		
	CERAMIC DISC		
6,7		50WV	15PF
4,5		〃	0.01μF
	ELECTROLYTIC		
1		16WV	470μF
L	INDUCTOR		
1	LPF COIL		
M	METER		
1			#003454
SP	SPEAKER		
1		SM-77	
S	SWITCH		
1	CHANNEL		
2	CALL	SLE14201	SWITCH BOARD
3	HIGH/LOW	SLE12201	PB-1567
4	BURST	SSF-22-08	
5	POWER	(VR_1)	
6	SQL	(VR_2)	
J	RECEPTACLE		
1	MIC	FM144S	
2	ANT	JSO239	
3	POWER	FM142S	
4	EXT. SP	SG8050	
5	ACC	SB7706	
6	INT. SP	CN1463	
PL	PILOT LAMP		
1	DIAL	14V 40mA	
2	METER	6V 30mA	
3~6	LED	ASSEMBLY	
		PB-1566 LED BOARD	
		PL3~6 LED RD-4	

RX UNIT

PB	PRINTED CIRCUIT BOARD		
1538(A~Z)			
Q	IC, FET & TRANSISTOR		
107		IC	TA7061AP
119		〃	AN214
104		FET	2SK19GR
101,102		FET	3SK40M
103,105,106,108~113		Tr.	2SC372Y
115			
114		〃	2SC735Y
116,117		〃	2SC1047
D	DIODE		
101~106,110		Ge	1S188FM
111		〃 (GB)	1S1007
107		Si	1S1555
109		Zener	WZ090
X	CRYSTAL		
101		HC-18/U	10245kHz
CF	FILTER		
101		FMT-15A	
102		SFE-10.7MS	
103		CFR-455F	
R	RESISTOR		
	CARBON FILM		
148,159		¼W	10Ω
103,104,107,108,167		〃	100Ω
111		〃	150Ω
122~124,146,152,158,170		〃	220Ω
112,155,169		〃	330Ω
120,147		〃	470Ω
140		〃	820Ω
125,126,145,151		〃	1KΩ
115,135,141		〃	1.5KΩ
105,142,156		〃	2.2KΩ
114,117,131,133		〃	3.3KΩ
109,127,128,144,150,153		〃	4.7KΩ
118,134		〃	5.6KΩ
121,136		〃	10KΩ
164		〃	12KΩ
110,149		〃	15KΩ
106		〃	18KΩ
119,154,157,165		〃	22KΩ
143		〃	33KΩ
166		〃	39KΩ
139		〃	47KΩ
137		〃	56KΩ
102,129		〃	68KΩ
101,113,116,130,132,138		〃	100KΩ
168			
VR	POTENTIOMETER		
102		TR-11	10KΩB
101		TR-11	100KΩB
C	CAPACITOR		
	CERAMIC DISC		
168		50WV	1PF(CH)
163,188		〃	3PF(〃)
152		〃	5PF(〃)
167,169		〃	8PF(〃)
189		〃	10PF(SL)
162,164		〃	22PF(CH)
158		〃	39PF(〃)
148		〃	47PF(〃)
115,139,156,157,191		〃	100PF(〃)
124		〃	120PF(〃)
149,150		〃	150PF(〃)
104,105,111,118,165,173		〃	0.001μF
183,190			
101~103,106,107,109		〃	0.01μF

112,113,116,117,125, 151 154,159～161,166, 170 187,192	50WV	0.01μF
186	50WV	0.047μF
	MYLAR	
134,138,140,142,177	50WV	0.01μF
135,136,141	〃	0.022μF
120,121,126～129,131 137	〃	0.047μF
180	〃	0.1μF
	STYROL	
130	50WV	330PF
132	〃	0.001μF
	ELECTROLYTIC	
145,147,175	16WV	1μF
133	〃	3.3μF
143,144	〃	4.7μF
153,155	〃	10μF
146,178,179	〃	22μF
176	〃	33μF
181,184	〃	47μF
182	〃	100μF

L	INDUCTOR		
101	ANTENNA	R12-4091	#220105
102～106	RESONATOR	2914A	#220185
107,111	RFC	250μH	
108,109	〃	1mH	
110	NOISE FILTER	SN8S-500	

T	TRANSFORMER		
101,102	10.7MHz IFT	3010	#220186
103	〃 〃	3005	#220187
104	455kHz 〃	M312-162N	#220188
105	DISCRIMINATOR	4861D	#220182
106	〃	4861E	#220183
107,108		R12-4797	#220110
109,110		R12-4102	#220111

TX UNIT

PB PRINTED CIRCUIT BOARD

1537(A～Z)

Q	IC & TRANSISTOR	
201	IC	TA7061AP
214	〃	SN7400N
217	Tr	2SA496
219,220	〃	2SA697
202～205,213,215,216,221	〃	2SC372Y
206～208	〃	2SC710D
211	〃	2SC730
218	〃	2SC735Y
210	〃	2SC741
212	〃	MRF212

D	DIODE	
204,207,208,210,211	Ge	1S188FM
212	〃(GB)	1S1007(1N270)
205,206	Si	MI301
209	Zener	WZ050
203	〃	WZ090
201,202	Varactor	1S 1658

R	RESISTOR	
	CARBON FILM	
232,242	1/4W	10Ω
238,240,270	〃	47Ω
203,208,235,239	〃	100Ω
271	〃	150Ω
213,217,253,255	〃	220Ω
245	〃	330Ω
256	〃	390Ω
216,226,228,236,244,251 261,274	〃	470Ω
202,254	〃	560Ω
204,212,233,243,252,262	〃	1KΩ
229,260	〃	2.2KΩ
209	〃	3.3KΩ
207,211,214,219,220,224 227,246,248,249,258,268 269	〃	4.7KΩ
266	〃	5.6KΩ
218,223	〃	6.8KΩ
237	〃	8.2KΩ
201,215,257,259	〃	10KΩ
225,230,234	〃	15KΩ
205,210,247,250,265,267	〃	22KΩ
221	〃	33KΩ
206	〃	68KΩ
222	〃	100KΩ
	CARBON COMPOSITION	
273	1/2W	220Ω

VR	POTENTIOMETER	
201,203,206	TR11	470ΩB
202,205,207	〃	1KΩB
208,209	〃	4.7KΩB
204	〃	100KΩB

C	CAPACITOR	
	CERAMIC DISC	
262,268	50WV	0.5PF(CH)
247	〃	1PF(〃)
225,241	〃	2PF(〃)
235	〃	3PF(〃)
245,246	〃	6PF(〃)
256	〃	8PF(〃)
266,289	〃	9PF(〃)
222,226,270	〃	15PF(〃)
257,272	〃	20PF(〃)
267,288	〃	22PF(〃)
271	〃	30PF(〃)
218,239,240	〃	33PF(〃)
230,249	〃	47PF(〃)
243	〃	56PF(〃)
233,234	〃	68PF(〃)
237	〃	82PF(〃)
227,231,255,261,285	〃	100PF(〃)
216,217	〃	220PF(〃)
201,202,204,248,252,254 260,263～265,269,286 287,292	〃	0.001μF
219～221,223,224,228 229,232,236,238,242,244 290,291,293	〃	0.01μF
283	〃	0.047μF
	MYLAR	
214,274,277,278	50WV	0.022μF
211,212		0.047μF
	TANTALUM	
203	35WV	0.1μF

276	35WV	0.47μF
	ELECTROLYTIC	
210,213,215,279～281	16WV	1μF
205,207,253,259,273,282	〃	10μF
208	〃	22μF
206,209	〃	47μF
275	〃	330μF
TC	TRIMMER CAPACITOR	
203～205	ECV-1ZW 20×32	20PF
206,207	TC-10 60P	60PF
L	INDUCTOR	
201	RFC	100mH
202,221	〃	1mH
205,217	〃	#220197
209,213	〃	#220068
207	〃	#220190
208	〃	#220191
210,215	〃	#220192
212	〃	#220193
216	〃	#220194
218	〃	#220195
219,220	LPF	#220196
T	TRANSFORMER	
201～203	3009	#220189
204,205	8137	#220070
206～209	R12-4102	#220111
210		#220069
RL	RELAY	
201	G2E DC 12V	

RX LOCAL OSC UNIT

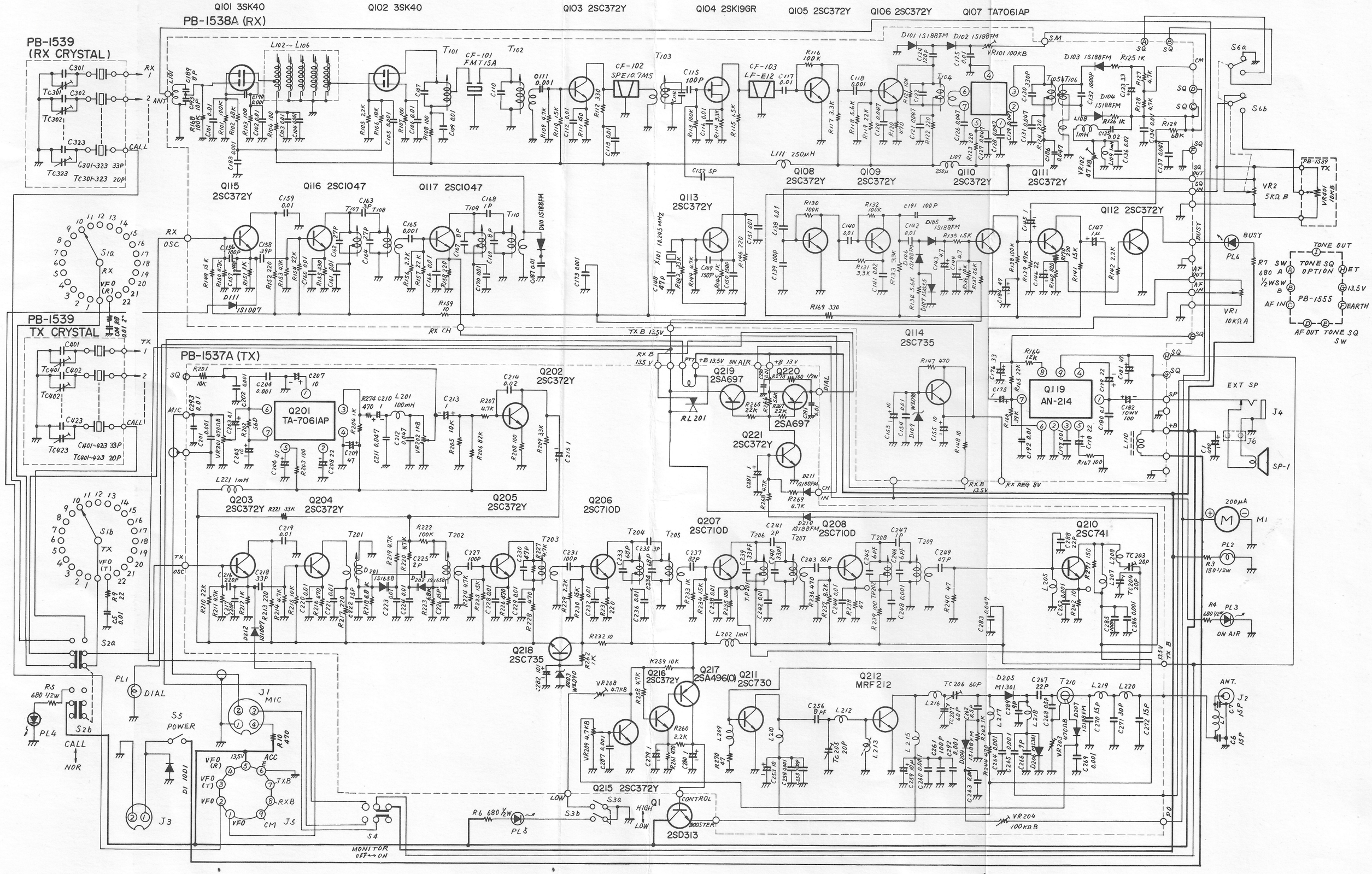
PB	PRINTED CIRCUIT BOARD	
1539(A～Z)		
X	CRYSTAL	
301～323	HC-25/U	
C	CAPACITOR	
	CERAMIC DISC	
301～323	50WV	33PF(CH)
TC	TRIMMER CAPACITOR	
301～323	ECV-1ZW 20×53	20PF
XS	CRYSTAL SOCKET	
301,302	S-14 12P	

TX OSC UNIT

PB	PRINTED CIRCUIT BOARD	
1539(A～Z)		
X	CRYSTAL	
401～423	HC-25/U	
C	CAPACITOR	
	CERAMIC DISC	
401～423	50WV	33PF(CH)
TC	TRIMMER CAPACITOR	
401～423	ECV-1ZW 20×53	20PF
XS	CRYSTAL SOCKET	
401,402	S-14 12P	
VR	POTENTIOMETER	
401	TR-11	10KΩB

TONE SQUELCH UNIT (OPTION)

PB	PRINTED CIRCUIT BOARD	
1555(A～Z)		
Q	IC, FET & TRANSISTOR	
501	IC	MC3403
502	〃	NE567
503	FET	2SK19GR
504,505	Tr	2SC372Y
D	DIODE	
501	Zener	RD8.2EB
R	RESISTOR	
	CARBON FILM	
518	¼W	100Ω
512	〃	10KΩ
504	〃	12KΩ
510,511,517	〃	22KΩ
502,508	〃	39KΩ
501,505,521,522	〃	47KΩ
506,507	〃	82KΩ
509	〃	150KΩ
503	〃	470KΩ
515,519	〃	1MΩ
513,524		15/KΩ8.2KΩ※
514	〃	470KΩ/270KΩ※
516	〃	39KΩ/33KΩ※
VR	POTENTIOMETER	
501,504	SR-19	1KΩB
502	TM062P	100KΩB
C	CAPACITOR	
	MYLAR	
503	50WV	0.001μF
512	〃	0.0047μF
506,507,520	〃	0.01μF
502,504,505,508,511	〃	0.022μF
509	〃	0.047μF
516	〃	0.15μF/0.1μF※
	ELECTROLYTIC	
514,522	16WV	1μF
501,510,513,521,524	〃	10μF
515,517,519		
	TANTALUM	
523	35WV	0.15μF
518	〃	4.7μF



NOTES.

1. ALL RESISTORS IN Ω 1/4W ±10% UNLESS OTHERWISE NOTED.
2. ALL CAPACITORS IN μF UNLESS OTHERWISE NOTED. ±— 16WV

FT-223
CIRCUIT DIAGRAM

YAESU