Wilson

MARK II
2.5 WATT

MARK IV
4 WATT

AMATEUR 2 METER
VHF HAND-HELD TRANSCEIVER

OPERATING AND SERVICE MANUAL

INFORMATION

Blank pages were omitted and the schematic pages have been merged into a single page.

Enjoy

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ILLUSTRATIONS

NOTE: Schematic drawing, Page 20 and Circuit Board Overlay, Page 18 have been positioned on pull-out sheets so they may be fully visable while making reference to any part of the text.

ACCESSORIES:

BC-2
Desk Type
Battery Charger

WC-14
Wall Charger

CC-1
Cigarette Lighter
12VDC Charger

SM-2
Speaker Mic

BP-4
Battery Pack

LC-3,
LC-3P (For TTP)
Leather Case

TTP
Touch-Tone®
Pad

Digitran

Data
Cromarics

SECTION 1 — OPERATION

1.1 TRANSCEIVER DESCRIPTION

The Wilson MARK Series personal portable radio is an extremely compact, highly reliable two-way frequency modulated (FM) radio designed for operation in the 144-148 MHz frequency range. The MARK II produces 2.5 watts and the MARK IV produces 4 watts of power output. Up to six channels are available and may be conveniently switched as required. A separate speaker and microphone are incorporated for better audio quality. The receiver design incorporates features to assure optimum sensitivity under congested interference prone conditions. A large push-to-talk transmit switch is prominently located on the side of the case such that it may be operated conveniently by the thumb or fingers for right or left hand operation. A line of convenience accessories is available for operation and battery charging.

1.2 POWER/VOLUME CONTROL

(See Figure 2-1). Activating the knob marked "VOL/OFF" in the clockwise direction applies power to the unit. Counter-clockwise is off. The VOLUME control adjusts the sound level from the speaker. Volume setting does not affect battery drain during squelched (no signal) conditions. If the unit is operated un-squelched and no signal is heard, the volume should be set as low as possible to reduce battery drain. Volume setting does not affect the transmitted signal in any way.

1.3 SQUELCH CONTROL/TONE SWITCH

Proper use of the SQUELCH control prolongs battery life between charges and prevents reception of distracting noise and interference. Rotate the SQUELCH control fully counterclockwise, but do not switch the TONE switch. Rotate the VOLUME control clockwise until a "rushing" noise is heard. Rotate the SQUELCH control clockwise to a point just past that in which the background noise is cut off (squelches). This is the normal SQUELCH control setting. Battery life is directly proportional to the amount of sound coming from the speaker. A low setting of the VOLUME control and keeping the unit "squelched" will produce maximum battery life. If intermittent reception is a problem, rotate the SQUELCH control counter-clockwise. The TONE switch is incorporated as part of the SQUELCH control, but is only operational when optional tone equipment is installed.

1.4 CHANNEL SELECTOR SWITCH

The CHANNEL selector switch is marked with positions A, B, C, D, E & F. This allows selection of up to six channels transmit and receive. The switch is rotated for selection of the desired channel.

1.5 MICROPHONE/SPEAKER RECEPTACLE

The MICROPHONE/SPEAKER receptacle is a six pin connector that provides for connection of an accessory speaker/mike (SM-2).

1.6 PUSH-TO-TALK SWITCH

Depress the PUSH-TO-TALK switch completely and hold to transmit. To receive the reply, release the switch completely.

1.7 MICROPHONE

The MICROPHONE is located below the center of the speaker grille. While transmitting, speak into the microphone grille in a normal voice from one to two inches away.

1.8 OPERATION AT EXTENDED RANGE

To increase range between units, the following has been found effective:

(a) Orient the antenna vertically.
(b) Rotate SQUELCH control counter-clockwise allowing some background noise to be heard.
(c) Move unit away from shielding caused by near-by buildings.
(d) Elevate the unit as high as possible over the surrounding terrain.
(e) Speak slowly and distinctly in to the MICROPHONE or accessory SPEAKER/MICROPHONE with your lips about one inch from the grille; do not shout.
(f) Be sure the unit has fully charged batteries.

1.9 ON CHANNEL INTERFERENCE

You might notice that stations in other nearby systems use your frequency. If the stations are quite weak and stations in your system relatively strong, you might be able to adjust the SQUELCH control

on your unit to reduce the number of calls heard from stations in the other system. Use of TONE controlled squelch in your system can eliminate interference from other systems.

1.10 OPERATIONAL PRECAUTION

Reception of excessively strong signals may cause damage to the receiver. Use of this unit in close proximity to a base station antenna or closer than twenty inches from another unit is not recommended. Transmission without the antenna may cause damage to the transmitter. An antenna or a dummy load should always be connected to the ANTENNA receptacle before transmitting.

1.11 BATTERY INFORMATION

If the sound from the speaker or range between units is noticably reduced, recharge the battery. New batteries will reach full charge in 7 hours. After this, batteries should be charged for one and a half to two times as long as the radio has been used. Use of the BC-2 desk top charger, WC-14 wall charger or CC-1 mobile charger is recommended. Normal charge rate is 110 mA. Never exceed a 150 mA charge rate.

SECTION 2 — SPECIFICATIONS

2.1 GENERAL

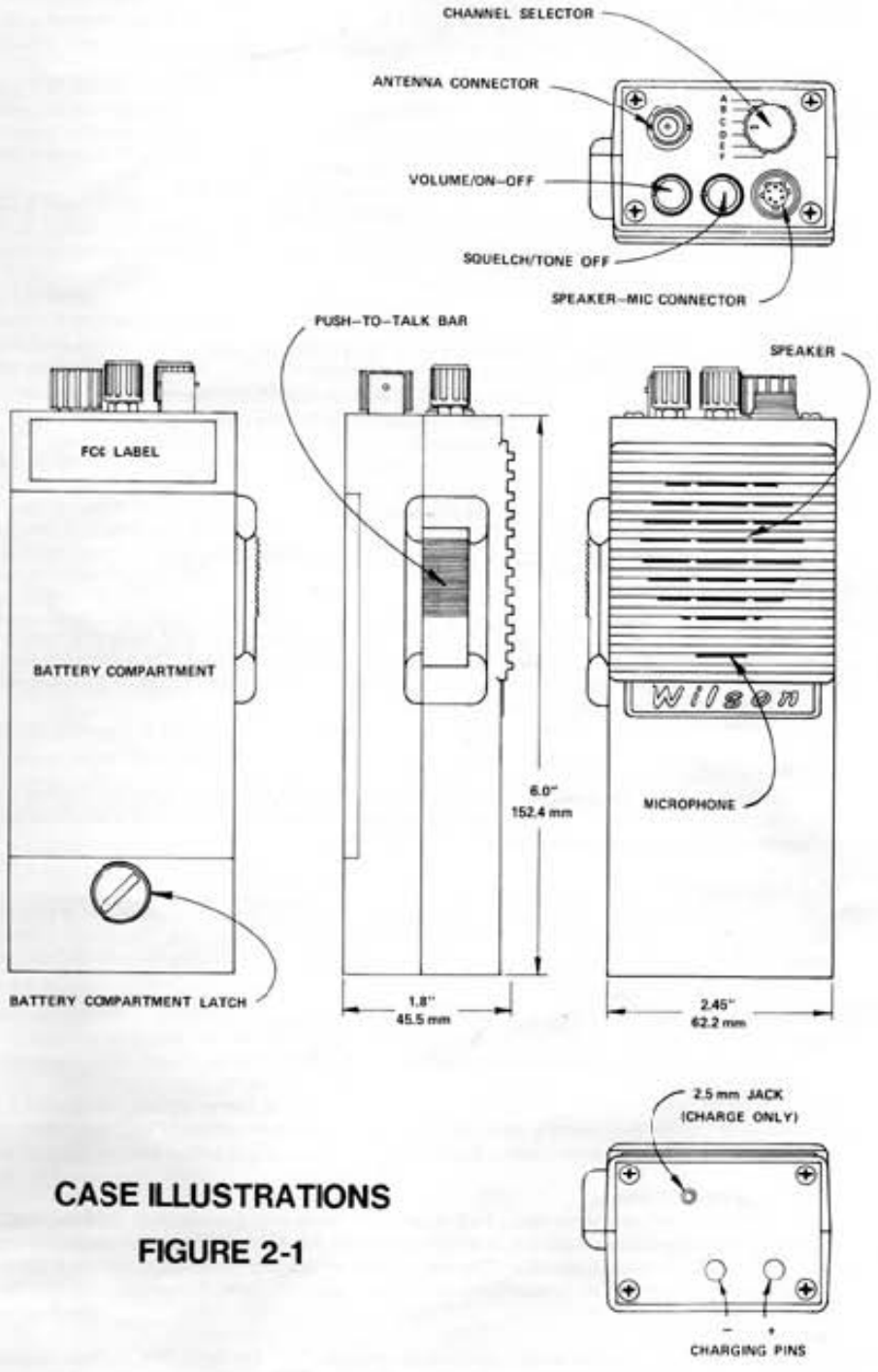
Frequency range	144-148 MHz
Channels	Six
Channel spacing	15 KHz
Dimensions	6" (H) x 2.45" (W) x 1.8" (D) (152.40 x 62.2 x 45.72 mm)
Unit weight	16 oz. (0.45 kg) includes battery pack
Antenna	Rubber coated flexible
Microphone	Magnetic internal or external speaker/mike accessory (SM-2)
Power consumption	Receive: 15 mA squelched 100 mA full AF output Transmit: 500 mA @ 2.5W (MARK II) 800 mA @ 4.0W (MARK IV)
Power source	Nickel cadmium battery pack
Operating temperature	-10° C to $+50^{\circ}$ C
Relative humidity	$+40^{\circ}$ C –95% or less

2.2 RECEIVER

Sensitivity	0.3 microvolts for 20 dB quieting
Squelch sensitivity	0.25 microvolts or less @ threshold
Selectivity	–80 dB at ± 12 KHz
Spurious and image rejection	–60 dB
Audio output power	500 mW @ less than 10% distortion
Frequency stability	0.002% from -30° C to $+60^{\circ}$ C
Crystal frequency	$\frac{\text{Channel frequency} - 10.7\ \text{MHz}}{9}$
Crystal type	HC-25/U or HC-18/U
Intermediate (IF) frequencies	10.7 MHz & 455 KHz

2.3 TRANSMITTER

RF output	2.5 watts (MARK II) 4.0 watts (MARK IV)
Output impedance	50 ohms
Spurious & harmonic rejection	–50 dB
Audio frequency response	+1, –3 dB per octave pre-emphasis characteristics from 300 to 3000 Hz
FM noise	50 dB below 2/3 rated deviation @ 1000 Hz
Frequency stability	± 0.001% from -30° C to $+60^{\circ}$ C (25° C reference) depends on crystals
Modulation	16F3: ± 5 KHz for 100% @ 1000 Hz
Crystal multiplication	12 times
Crystal type	HC-25/U or HC-18/U



CASE ILLUSTRATIONS

FIGURE 2-1

2.4 POWER SUPPLY

Power source	10.8 VDC nicad battery pack, 500 mAH rating
Current drain	Squelched: 15 mA
	Rated AF out: 100 mA
	Transmit: 500 mA (2.5W), 800 mA (4.0W)
Battery life	8 hours: 5% transmit, 5% receive, 90% standby duty cycle

2.5 ACCESSORIES

SM-2	External speaker/microphone
LC-3	Leather carrying case without TTP
LC-3P	Leather carrying case with opening for TTP
BP-4	Rechargeable nicad battery pack
DC-2	Desk top battery charger
WC-14	Portable wall charger
CC-1	Mobile charger

2.6 FEATURES

Physical	Light weight, small ruggedly constructed
Enclosure	High impact LEXAN® case
State-of-the-Art design	Silicon transistors throughout, independent voltage regulation for transmitter, solid state antenna switching (no relays), two IF filters, low level audio clipping to prevent over modulation.
Flexibility	External speaker/mike connector, six transmit and receive channels. Uses a Nicad Battery Pack

SECTION 3 — CIRCUIT DESCRIPTION

3.1 GENERAL

The Wilson MARK Series is a hand-held, dual conversion superheterodyne VHF frequency modulated transceiver. The transmitter and receiver share a single printed circuit board. The transmitter uses an independent microphone element installed below the speaker on the speaker grille. A panel connector is provided for an external speaker microphone.

3.2 RECEIVER

3.2.1 RF Amplifier

Refer to the transceiver block diagram. An incoming signal from the antenna is coupled through a low pass filter, and bandpass filter to Q1, (Page 7), the receiver RF amplifier. The signal is amplified by Q1 and passes through selectivity elements and to the first mixer Q2.

3.2.2 First Oscillator

Q10, the first oscillator, is a crystal oscillator using an HC-25/U fundamental crystal. Six crystal positions are available each with individual trimmer capacitors for receiver netting. The output from Q10 emitter is coupled by C13 to the source of Q2, the first mixer. The following formula can be used to determine the first oscillator crystal frequency.

$$\text{Crystal Frequency} = \frac{\text{Channel Frequency} - 10.7}{9}$$

3.2.3 First Mixer

The output of Q2, the first mixer is tuned by T5 to the difference frequency of the input signals from the RF amplifier and oscillator multiplier, or 10.7 MHz.

3.2.4 Crystal Filter

The 10.7 MHz monolithic crystal filter, FL1, is located in series with the output of the first mixer. Input and output impedance matching is provided by T5 and T6. Filter output is link coupled from T6 to the base of Q3, the first IF amplifier. The crystal filter provides a flat-topped, extremely steep sided selectivity curve for superior image rejection.

3.2.5 Second Oscillator

The second oscillator, a parallel mode colpitts type operates at 10.245 MHz. The oscillator output is taken off the emitter of Q11, the second oscillator transistor, and coupled to the base of the second mixer, Q4, by C21.

3.2.6 Second Mixer
The second mixer inputs, 10.7 MHz from the crystal filter and 10.245 MHz from the second oscillator are difference mixed. The collector of Q4, the second mixer, is connected to the input of 455 KHz ceramic filter FL2. FL2 further improves adjacent channel selectivity and spurious rejection.

3.2.7 IF, Limiter
The 455 KHz second IF signal from FL2 is coupled through R17 to the IF amplifier chain made up of cascade amplifiers, Q5, Q6, Q7 and Q8. Limiting is provided by Q9. The output of the limiter is fed to discriminator filter FL3.

3.2.8 Discriminator
FL3, D2 and D3 make up the discriminator. Any unbalance in phase shift which appears across FL3 is detected, causing either D1 or D2 to conduct and develop audio across VR2, the volume control.

3.2.9 Audio
Audio from the discriminator is applied to a de-emphasis network made up of R30 and C33. The de-emphasis network restores the pre-emphasized received signal to its original form, before the transmitter audio pre-emphasized it. The de-emphasized audio is applied to VR2, the volume control. Audio is taken off the movable contact of VR2 and coupled through C59 to the input of audio driver Q15. Q15 in turn drives the audio output stage made up of Q16, Q17 and Q18.

3.2.10 Squelch
Squelch action is entirely dependent upon the presence or absence of an on-frequency RF carrier. When no carrier is being received, noise is taken from the output of the limiter, Q9. This noise component is filtered and amplified by Q12, and rectified by Q13. When noise is present, a DC output develops across the base switching transistor Q14. Q14 is driven into saturation, which disables Q15 by removing the DC voltage.

When an on-frequency carrier is present, noise level is reduced. On the collector the input of the noise rectifier Q13 is reduced to such low level that Q14 is no longer driven into saturation. Q14 presents a high impedance from collector to ground which returns the voltage to Q15 and Q16, the audio pre-amp and pre-driver, enabling audio amplification.

3.2.11 Voltage T-R Switch
During receive, Q29 is normally conducting, furnishing receiver B+ and D7 is non-conducting. During transmit, Q30 is switched on by the PTT switch, which turns off Q29 by D7 conducting to ground. Diode D6 regulates transmitter B+.

3.3 TRANSMITTER
3.3.1 Introduction
The transmitter utilizes ten transistors and two diodes. The transmitter delivers 2.5 watts (MARK II) or 4 watts (MARK IV) RF output power to a 50 ohm load. Refer to the schematic and transceiver block diagram, while following the transmitter circuit description.

3.3.2 Audio
Microphone audio is amplifed by Q26 and Q27. The output of Q27 is at a level suitable for limiting and clipping by diodes D4 and D5. Integrator Q28, couples the processed audio through L12, R88 and C84 to the phase modulator Q20. VR3 is the modulation level (deviation) control.

3.3.3 Oscillator, Modulator and Integrator
Q19, the oscillator, operates in a colpitts circuit. Output from the emitter of Q19 is phase modulated by Q20 and applied to the first doubler Q21. T10, in the collector of Q20 is tuned to twice the fundamental crystal frequency.

3.3.4 Frequency Multipliers
The frequency multiplier stages consists of Q21, Q22 and Q23. These stages are amplifiers with the collectors tuned to two or three times the input frequency. Q21 functions as a doubler, Q22 as a tripler and Q23 as a doubler. Crystal oscillator output frequencies and deviation are multiplied a total of twelve times.

3.3.5 Driver
Q24 is a class C amplifier coupled through matching network L4, C101, C102 and L5 to the base of Q25. Q24 amplifies the RF to a power level adequate to drive final amplifier Q25.

BLOCK DIAGRAM

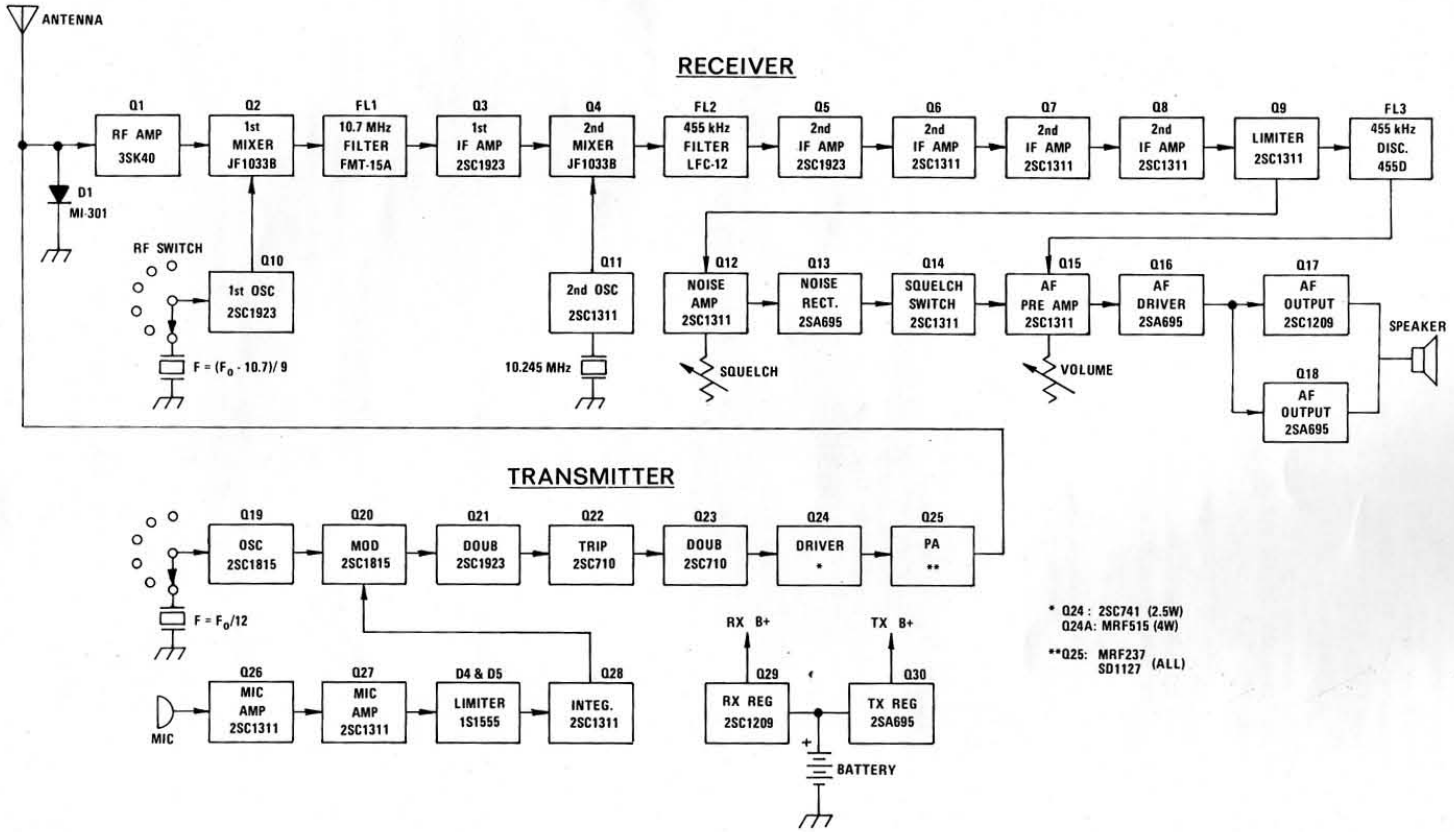


FIGURE 3-1

3.3.6 RF Final Amplifier

Q25, the final amplifier raises the RF power level to 2.5 watts output for the Mark II or 4 watts for the Mark IV. C105, L8, C106 and C107 provide adequate harmonic attenuation and impedance matching.

Lowpass filter C108, L10, C109, L11 and C110 provide additional reduction of spurious radiation on transmit and increase off frequency signal rejection on receive.

SECTION 4 — SERVICING

4.1 GENERAL

READ THIS SECTION CAREFULLY BEFORE SERVICING THE TRANSCEIVER.

4.1.1 Disassembly

The Wilson MARK II, MARK IV transceivers consist of a single circuit board which includes transmitter and receiver components. They can be easily disassembled according to Figure 5-1, (Page 13), however, extra care should be taken not to break any wire or component, especially those along the edges of the board. For easier servicing, the back case and the bottom plate may be disconnected.

4.1.2 General Soldering Information

The same basic soldering practices used on other printed circuit boards can be implemented. Use a 50 watt temperature controlled soldering iron. Apply the amount of heat that will cause the solder to flow quickly, but do not apply it too long. Use a small soldering tip to prevent solder bridges. Do not apply excess solder. Use a vacuum desoldering device to remove excess solder from the circuit board.

4.1.3 Tuning Information

Unnecessary tuning wastes valuable servicing time and can actually degrade the performance of a unit if not accomplished by an experienced technician.

Use proper tools only, especially for the slugs in the coil forms. Section 5 includes detailed tuning instruction. Test points referenced are locations on the circuit board only, not Jacks.

4.1.4 Preventive Maintenance

The transceiver should be put on a regular maintenance schedule, and an accurate record of its performance should be maintained. Important items to check are receiver sensitivity, transmitter frequency, deviation and power output. See Section 5 for detailed performance test.

4.2 SWITCHING MALFUNCTION

4.2.1 To incorporate an external speaker microphone, solid state switching is used in the transceiver. If no receive or no transmit occurs, check Q29, Q30. Q29 collector should be normally high and will go near zero when PTT is pressed. In return Q30 emitter will go high.

4.2.2 Be sure Q29 collector voltage will go near zero when PTT is pressed. Otherwise, the receiver is always "ON" and its local oscillator will mix with the transmitting signal and cause spurious emissions, even though the unit may look like it is working quite normally. Check Q29 and D7 for repair.

4.2.3 If Q30 is shorted and exhibits some voltage on receive, this will disable audio amplifier and cause no receive. Replace Q30.

4.3 RECEIVER MALFUNCTION

4.3.1 General

Receiver can be divided into front end, 10.7 MHz IF, 455 KHz IF, Squelch and Audio amplifier.

4.3.2 Front End Local Oscillator

Connect an RF probe or an oscilloscope to the emitter of Q10, and check oscillation of T8 and T9 that they are tuned to the 9th harmonic of the crystal. To tune properly, connect a spectrum analyzer to the source of Q2. If not available, follow the instruction of Section 5. Use of an RF probe is not recommended on Q2 since the coils might tune to the 8th or 10th harmonic. D1 can be checked in circuit by an ohmmeter. Q1 can be checked by an ohmmeter according to the voltage chart.

4.3.3 10.7 MHz IF

Connect an RF probe or an oscilloscope to the emitter of Q11 to check oscillation. Inject 10.7 MHz signal to the source of Q2, or to the base of Q3. To test FL1, a monolithic filter, a sweep generator can be used, however, the easiest way is to connect a FM signal generator to J1 whose output is turned down to about a 20 dB quieting point, and is modulated at 1 KHz, 5 KHz deviation. Now tune T5 and T6 for the minimum audio distortion. It is important to make sure that the generator frequency is properly set to generate an IF signal at the center of the bandpath of FL2. See Section 5 about the local oscillator trimmer setting.

Improper settings of T5 and T6, or a defective FL1 will cause audio distortion and squelch talkout.

4.3.4 455 KHz IF

Q5 to Q9 consists of two sections of cascade amplifiers and a buffer amplifier. Check the voltages of each transistor following the voltage chart, or do an oscilloscope signal tracing. For a quick gain check, touch the base of Q5 and pick up a local broadcasting station.

4.3.5 Squelch and Audio Amplifier

Follow the voltage chart and check the voltages for each transistor. If there is no voltage at the base of Q15, the whole audio amplifer is disabled. Therefore, make two voltage readings squelched and unsquelched. The collector voltage of Q13 should rise according to the clockwise rotation of the squelch potentiometer.

4.4 TRANSMITTER MALFUNCTION

4.4.1 General

Transmitter consists of crystal oscillator modulator, multiplier and RF amplifier.

4.4.2 Oscillator Test

Check the line voltage along D6. It must be a stable 5 volt. Check wires from the crystals to the switch and from the switch to the base of Q19. Connect an RF probe to the emitter of Q19 for an oscillation check, or connect an ohmmeter to TP1 and shunt a crystal momentarily. If the voltage decreases slightly, the oscillator stage will be working normally.

4.4.3 Modulator

Any inexpensive oscilloscope can be used for faster signal tracing. Apply about a 1 KHz audio signal through pin 1 of J3, or whistle into the microphone.

4.4.4 Multiplier Test

Follow Section 5 transmitter alignment procedure and check voltage relationship between (TP1 and T10, Section 5.2.2) (TP2 and T11, T12, Section 5.2.3) (TP3 and T13, L2, Section 5.2.4). If any coil does not tune properly, check the related tuning or resonance capacitor, or coupling and bypass capacitor and the coil itself. To check the transistors, remove from the circuit board and check with an ohmmeter. A defective coupling capacitor may cause a unit to appear to be working normally with the tuning slugs at slightly different positions than normal. Generally when this occurs, spurious emissions will be excessive.

4.4.5 RF Amplifier

If everything else is working normally, and C101, C107 trimmer capacitors are set halfway, some power should appear by gradually adjusting L3. If not, check Q24 and Q25. Connect a current meter at 500 mA in the power line. Check if the current increases by adjusting L2 and L3. If so, Q24 may be working normally. To check Q25 it may be easier to pull it out from the circuit board, and do a resistance test. If the current reads about 500 mA and Q25 gets hot, but there is no output, check for a short or open circuit between the final matching network and J1 with an ohmmeter.

SECTION 5 — ALIGNMENT

5.1 RECEIVER

5.1.1 Connections and settings

5.1.1.1 Adjust the SQUELCH control to its maximum CCW position and the VOLUME control just far enough CW to turn the unit on.

5.1.1.2 Apply power to the unit. If you use a battery pack, it must deliver 10.8 VDC, if not, the unit must be connected to a suitable source.

5.1.1.3 Measure the 10.8 VDC line at the collector of Q29. It should be 10.8 ± 0.3 VDC.

5.1.2 Discriminator

The discriminator is fixed (ceramic resonator), no alignment necessary.

5.1.3 First oscillator, multiplier peaking.

T5, FL1, T6 and T7 are factory aligned. Do not touch unless a new filter (FL1) is required to be installed. See Section 4.3.3 for alignment.

5.1.4 Front end peaking.

5.1.4.1 Connect an RF signal generator (unmodulated) to J1 (ant. input). Adjust the output of the generator to about 100 uV set to the channel frequency; adjust T8 first, then T9 until some quieting occurs. It might be necessary to adjust the crystal trimmers (C34, C35, C36, C37, C134, C135) to obtain quieting on frequency.

5.1.4.2 Turn the signal generator output down gradually, adjusting T1 thru T4. Repeat adjustments to T8 and T9.

5.1.4.3 Set the signal generator output to .5 uV and adjust the crystal trimmer for the best quieting on the frequency. At this point the discriminator voltage might not show zero voltage due to the manufacturers tolerance, however, the important thing is that the local oscillator is set to bring the input signal to the center of the band pass of FL1 and FL2.

5.1.4.4 Set the signal generator output to about 10 uV and sweep the generator plus and minus from the center frequency. The noise level should come up at about the same frequency shift both directions.

5.1.4.5 Set the signal generator to .5 uV output and modulate it at 1 KHz, 3 KHz deviation. A noise free 1 KHz tone should be heard from the speaker.

5.1.5 Receiver Performance Test

5.1.5.1 Quieting Sensitivity

1. Connect a AC-VTVM to the speaker output of J3.
2. Disconnect the unit from the signal generator and turn the receiver SQUELCH control to its maximum CCW position. Advance the VOLUME control until the AC-VTVM indicates 1 volt of noise.
3. Connect the signal generator (unmodulated output) and advance the attenuator till the AC-VTVM reads .1 volt. This should occur betweem .3 uV and .5 uV.

5.1.6 Squelch Sensitivity and Squelch Talk-Out

5.1.6.1 Disconnect the signal generator from the unit. Set the SQUELCH control to the threshold. Modulate the signal generator 1 KHz, 3 KHz deviation and connect to the unit. Turn the generator output to open the squelch. The attenuator reading should be between .2 and .3 uV.

5.1.6.2 Set the SQUELCH control full CW position and turn up the signal generator till the squelch opens again. The reading should be less than 3 uV. Set the signal generator at about 10 uV and set the SQUELCH control at threshold. Turn up the deviation of the signal generator more than 5 KHz. The squelch should not close again at less than 7 KHz deviation.

5.1.7 Distortion Test

5.1.7.1 Sinad Sensitivity

Set the signal generator at .4 uV, 3 KHz deviation at 1 KHz.

5.1.7.2 Turn the VOLUME control half way clockwise. Set the distortion meter range control to the "set level" and range switch to the 30% position.

5.1.7.3 Adjust the input sensitivity control of the distortion meter to read 0 dB on the meter scale.

5.1.7.4 Set the range control to "Distortion" and null 1 KHz, adjusting both tuning and null.

5.1.7.5 The meter reading should drop more than 12 dB.

5.1.8 Audio output and distortion determination.

5.1.8.1 Set the signal generator to 1000 uV output (3 KHz deviation at 1000 Hz).

5.1.8.2 Set the VOLUME control to produce 2 V RMS across the speaker terminals.

5.1.8.3 Set the meter range switch of the distortion meter to "100%" and adjust the input sensitivity control for a full scale reading.

5.1.8.4 Set the range to switch to "distortion" and balance out 1 KHz. The meter should indicate below 10 in the 10% position.

5.2 TRANSMITTER ALIGNMENT

5.2.1 Connections and Settings

5.2.1.1 Connect a calibrated 5 watt wattmeter and 50 ohm dummy load to J1 with a 3 ft. long RG-58/U cable.

5.2.1.2 Connect power to the unit.

5.2.2 Oscillator/1st doubler

Attach a DC voltmeter 0-1V range to TP1. Adjust T10 slug for a dip.

5.2.3 Tripler

Attach a DC voltmeter 0-2V range to TP2. Adjust T11 for a maximum reading. Readjust T10 alternately with T11 for a maximum reading. Adjust T12 for a dip.

5.2.4 2nd Doubler

Attach a DC voltmeter 0-2V range to TP3. Adjust T13 for a maximum reading. Readjust T12 and T13 alternately for a maximum reading. Adjust for a dip on L2. (Spread L2 for higher frequency coverage or compress for a lower frequency coverage).

5.2.5 Driver

While observing the wattmeter, adjust L3 for some power output. Alternately adjust L2 and L3 for a maximum reading.

5.2.6 Power amplifier

While observing the wattmeter adjust C101 and C107 (20 Pf. trimmers) for maximum power output.

5.2.7 Repeat 5.2.5 and 5.2.6 to obtain maximum power out. At this stage never go back to T10-T13 and turn the slugs.

5.2.8 Set a crystal trimmer to the frequency.

5.3 DEVIATION ADJUSTMENT

5.3.1 Connect an audio generator to Pin 1 (mike input) terminal of J3. Set to about 100 mV, 1000 Hz. (100 mV input is about 20 dB greater than that level required for a 3 KHz deviation).

5.3.2 Set VR3 for 5 KHz deviation. The deviation symmetry should be within 500 Hz.

5.3.3 Sweep the audio generator from 300 Hz to 6000 Hz. If the deviation increases more than 5 KHz, readjust VR3.

5.3.4 Turn down the audio generator output to produce a clean sine wave on the deviation monitor scope at 1000 Hz.

5.3.5 Sweep the audio generator again from 300 Hz to 6000 Hz and check 6 dB/octave modulation characteristic and 12 dB/octave roll off after 3000 Hz.

5.3.6 Disconnect the audio generator and talk into the microphone at normal speech level from one to two inches away.

5.3.7 If there is not enough deviation, shunt R97 mic-gain control resistor.

5.3.8 Talk loudly into the microphone and watch the deviation monitor. Regardless how loud you talk, deviation should not exceed 5 KHz.

5.4 VOLTAGE, POWER OUTPUT, AND FREQUENCY MEASUREMENTS

5.4.1 Couple a frequency counter to the unit.

5.4.2 While keying the unit, change the power supply voltage from 8 to 12 V. The output frequency should not change.

5.4.3 Set the power supply to 11 volts.

5.4.4 Power output should be 2.5 W (MARK II) or (MARK IV).

5.4.5 Drop the voltage to 9 V. Power should not drop more than one half.

5.5 SPURIOUS AND HARMONIC RADIATION MEASUREMENTS

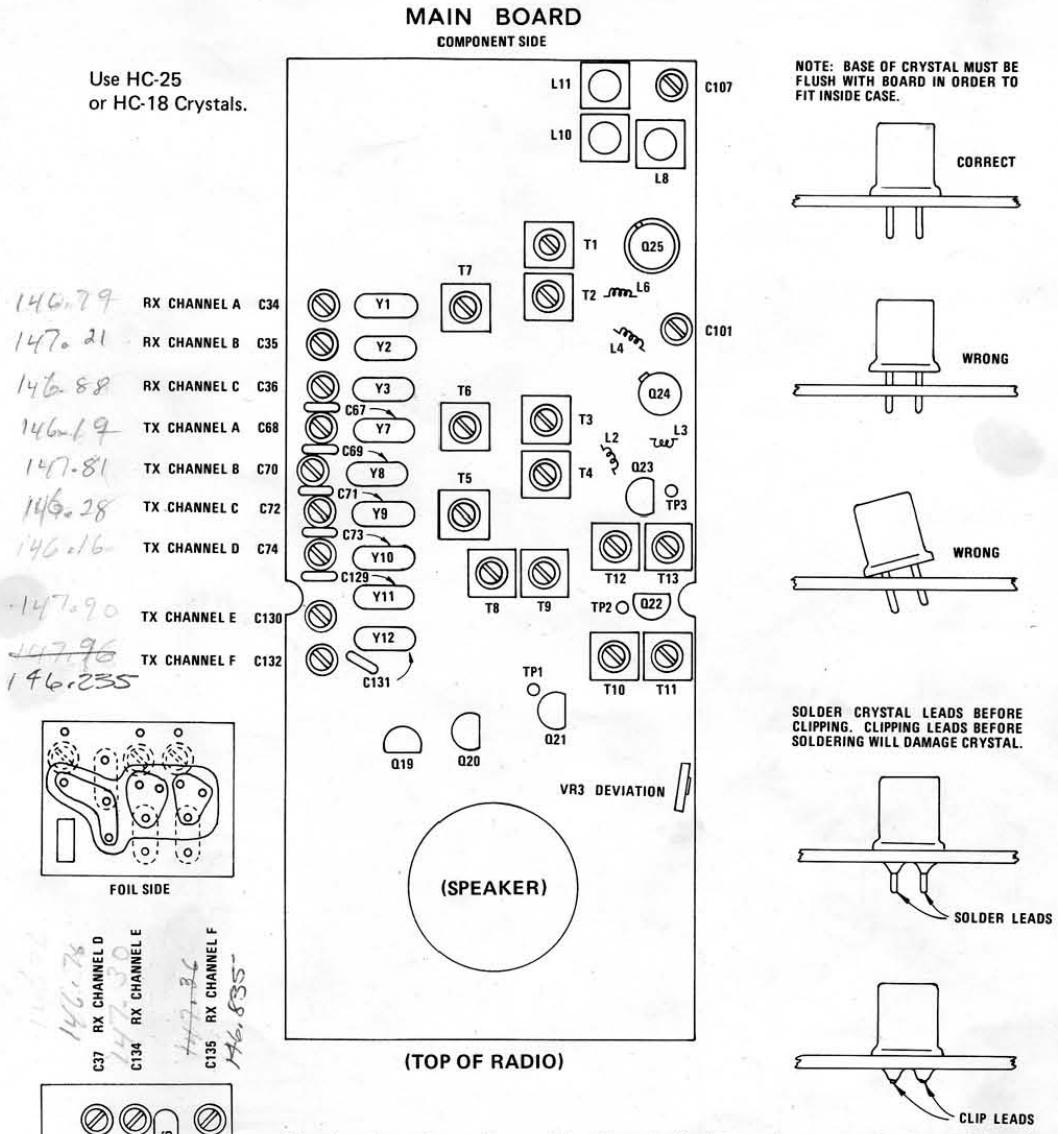
5.5.1 Connect the unit to an in-line 30 dB power attenuator to a spectrum analyzer.

5.5.2 Set the analyzer to 100 MHz per division and a 3 MHz resolution. The input attenuator of the analyzer should be set on the proper level. Do not overload the analyzer.

5.5.3 Key the unit to transmit. All the spurs must be more than 50 dB below carrier. 55 dB is typical.

5.5.4 Tune the analyzer to the carrier frequency and set 5 MHz/Division, 300 KHz resolution.

5.5.5 Key the unit to transmit. 11th and 13th harmonics of a crystal should be 70 dB down.



Occasionally a transmit crystal will not adjust to a frequency due to variation in crystal load capacitance. Rather than obtaining a new crystal, an easy way to bring the crystal onto frequency is to change the associated 47 pf capacitor to a smaller value if frequency is too low or a higher value if frequency is too high. Change value in 5 to 10 pf steps (example, 35 pf or 55 pf). Channel A is C67, B is C69, C is C71, D is C73, E is C129, F is C131.

The following formula can be used to determine the first oscillator crystal frequency:

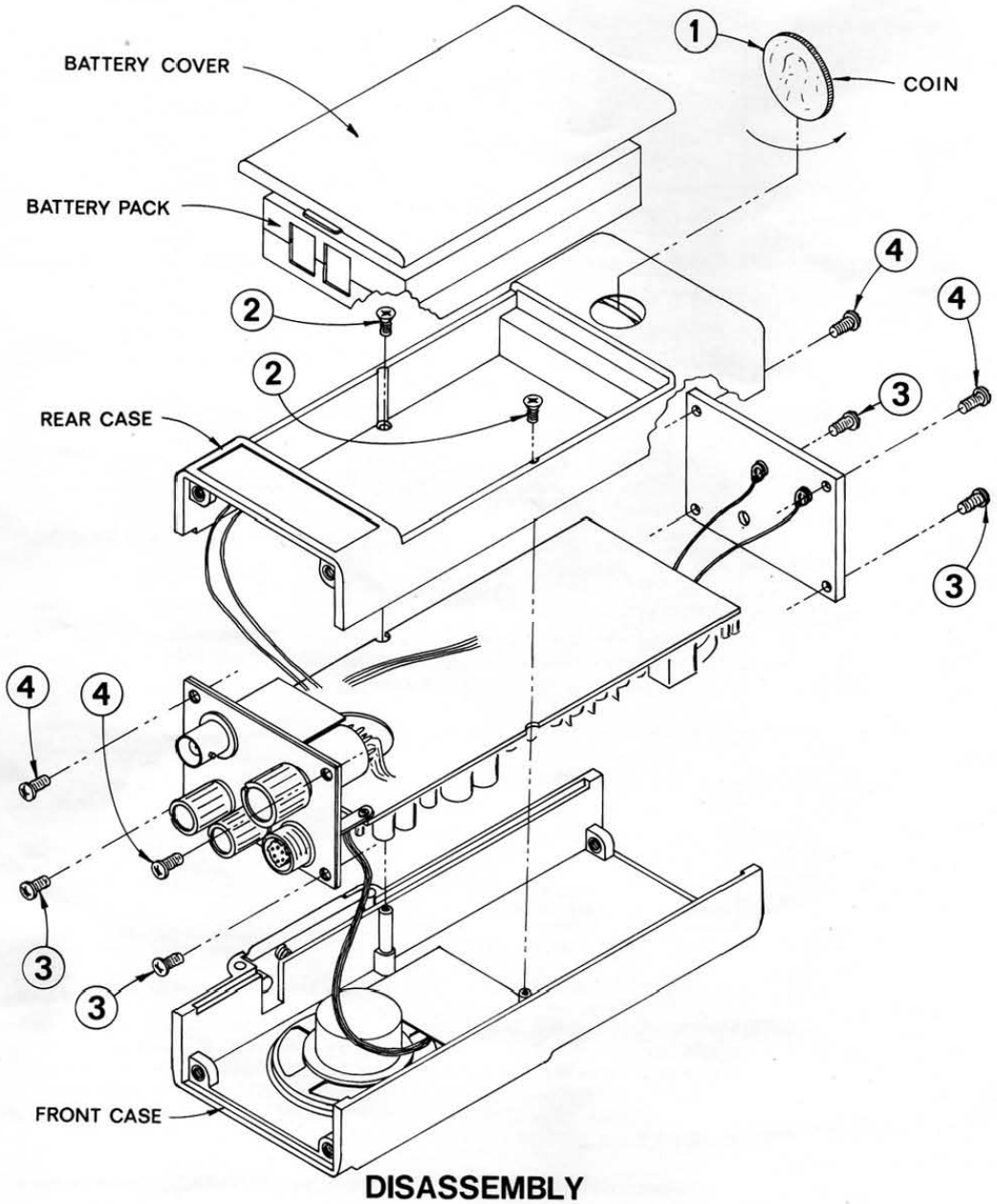
$$\text{XTAL FREQ.}^{*} = \frac{\text{desired Freq.} - 10.7}{9}$$

For transmit frequency, use :

$$\text{XTAL FREQ. TX} = \frac{\text{desired Freq.}}{12}$$

*Note: The correlation and load capacity for the Mark II and Mark IV is the same as used for the 1402 and 1405 hand-helds.

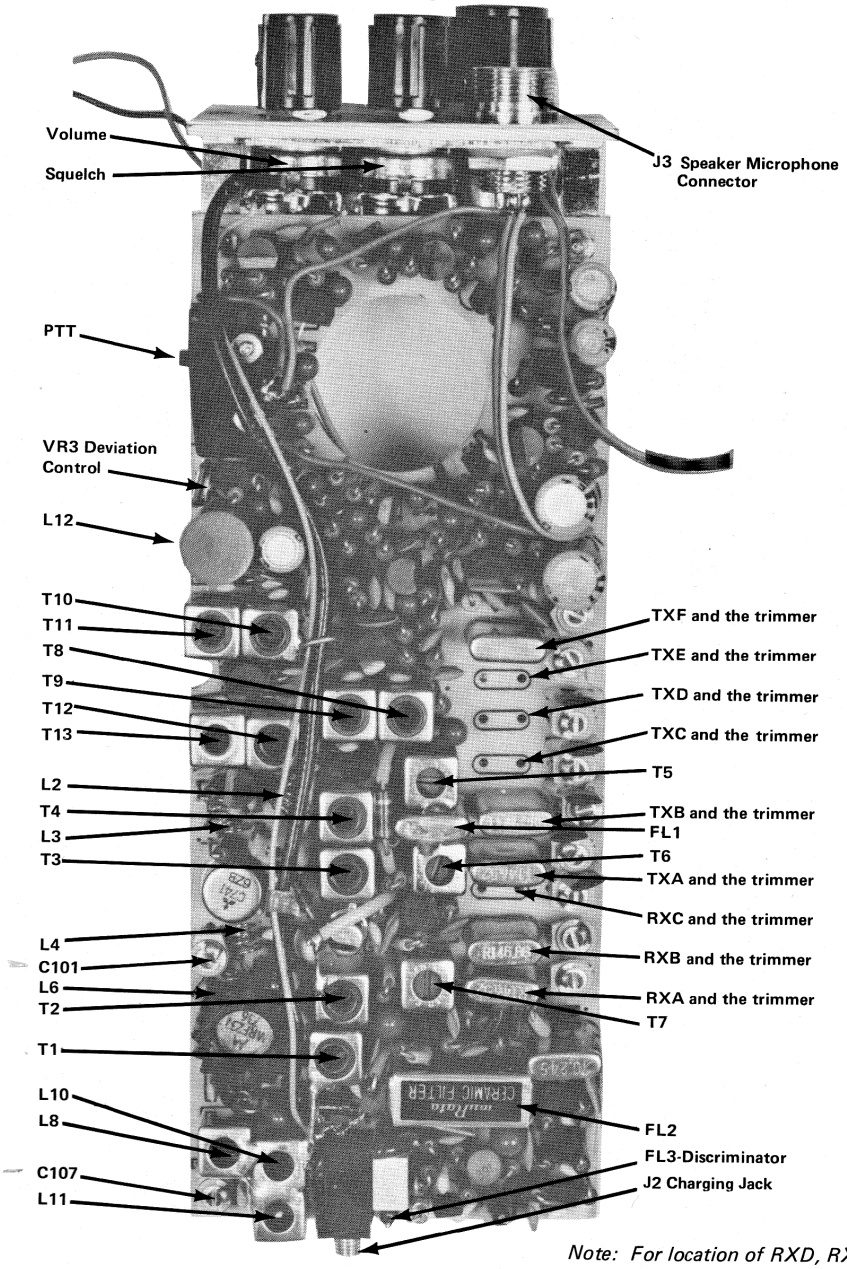
FIGURE 5-2 CRYSTAL PLACEMENT DIAGRAM



DISASSEMBLY

1. Turn Latch with coin, and remove Battery Cover and Battery Pack.
2. Remove screws (2) (two places).
3. For alignment only, remove screws (3) (four places) and Front Case.
4. For repair and crystal installation, remove screws (4) (four places) and Rear Case.

FIGURE 5-1



Note: For location of RXD, RXE, RXF, See Page 12, Figure 502)

FIGURE 5-3
PARTS PLACEMENT

SECTION 6

PARTS LIST

(Note) *T: Tantalum Solid Cap.* *M: Mylar*
C: Ceramic Cap. *E: Electrolytic Cap.*
CSL: Silver Mica *CB: Silver Mica*

Symb.	Name	Spec.	Part #
Q1	Transistor	3SK40-M	Q10001
Q2	"	JF1033-B	Q10002
Q3	"	2SC1923-O	Q10003
Q4	"	JF1033-B	Q10002
Q5	"	2SC1923-O	Q10003
Q6	"	2SC1311-E	Q10004
Q7	"	2SC1311-E	Q10004
Q8	"	2SC1311-E	Q10004
Q9	"	2SC1311-E	Q10004
Q10	"	2SC1923-O	Q10003
Q11	"	2SC1311-E	Q10004
Q12	"	2SC1311-E	Q10004
Q13	"	2SA695-D	Q10005
Q14	"	2SC1311-E	Q10004
Q15	"	2SC1311-E	Q10004
Q16	"	2SA695-D	Q10005
Q17	"	2SC1209-D	Q10006
Q18	"	2SA695-D	Q10005
Q19	"	2SC1815-Y	Q10007
Q20	"	2SC1815-Y	Q10007
Q21	"	2SC1923-O	Q10003
Q22	"	2SC710-D	Q10008
Q23	"	2SC710-D	Q10008
Q24	"	2SC741	Q10009
Q24A		MRF515	
Q25	"	MRF237	Q10010
Q26	"	2SC1311-E	Q10004
Q27	"	2SC1311-E	Q10004
Q28	"	2SC1311-E	Q10004
Q29	"	2SC1209-D	Q10006
Q30	"	2SA695-D	Q10005
D01	Diode	MI-301	D10001
D02	"	IS188FM	D10002
D03	"	IS188FM	D10002
D04	"	IS1555	D10003
D05	"	IS1555	D10003
D06	"	WZ050	D10004
D07	"	IS1555	D10003
D08	"	IN4001	D10005
XF	10.7 Xtal Filter	FMT-15A	XF1001
X13	Xtal HC-18/U	10.245 MHz 2nd OSC.	XF1002
FL2	Cermic Filter 455 KHz	LFC12	CF1001
FL3	455 Discriminator		CD1001

Symb.	Name	Spec.	Note
R1	Resistor	2.2K	¼ Watt
R2	"	2.2K	"
R3	"	27K	"
R4	"	100 ohm	"
R5	"	27K	"
R6	"	22 ohm	"
R7	"	10 ohm	"
R8	"	3.3K	"
R9	"	100 ohm	"
R10	"	6.8K	"
R11	"	22K	"
R12	"	470 ohm	"
R13	"	100 ohm	"
R14	"	39 ohm	"
R15	"	3.3K	"
R16	"	1.5K	"
R17	"	1.5K	"
R18	"	56K	"
R19	"	56K	"
R20	"	4.7K	"
R21	"	56K	"
R22	"	4.7K	"
R23	"	56K	"
R24	"	4.7K	"
R25	"	4.7K	"
R26	"	150K	"
R27	"	3.3K	"
R28	"	10K	"
R29	"	10K	"
R30	"	10K	"
R31	"	22 ohm	"
R32	"	27K	"
R33	"	10K	"
R34	"	470 ohm	"
R35	"	220 ohm	"
R36	"	220K	"
R37	"	2.2K	"
R38	"	10K	"
R39	"	100 ohm	"
R40	"	220 ohm	"
R41	"	220K	"
R42	"	4.7K	"
R43	"	10K	"
R44	"	10K	"
R45	"	10K	"
R46	"	47K	"
R47	"	2.2K	"
R48	"	18K	"
R49	"	56K	"
R50	"	330K	"
R51	"	2.2K	"
R52	"	3.3K	"
R53	"	100 ohm	"
R54	"	120 ohm	"

Symb.	Name	Spec.	Note
R55	Resistor	470 ohm	¼ Watt
R56	"	220 ohm	"
R57	"	2.2 ohm	"
R58	"	2.2 ohm	"
R59	"	39 ohm	"
R60	"	10K	"
R61	"	10K	"
R62	"	560 ohm	"
R63	"	4.7K	"
R64	"	100 ohm	"
R65	"	10K	"
R66	"	1K	"
R67	"	1K	"
R68	"	10K	"
R69	"	33K	"
R70	"	100 ohm	"
R71	"	100 ohm	"
R72	"	100 ohm	"
R73	"	22 ohm	"
R74	"	39 ohm	"
R75	"	100 ohm	"
R76	"	75 ohm	"
R77	"	100K	"
R78	"	3.3K	"
R79	"	1.5K	"
R80	"	47K	"
R81	"	1.5K	"
R82	"	47K	"
R83	"	1.8K	"
R84	"	5.6K	"
R85	"	12K	"
R86	"	6.8K	"
R87	"	4.7K	"
R88	"	100 ohm	"
R89	"	10K	"
R90	"	2.2K	"
R91	"	220 ohm	"
R92	"	1K	"
R93	"	470 ohm	"
R94	"	470 ohm	"
R95	"	10K	"
R97	"	56 ohm	"

Symb.	Name	Spec.	Part #
VR1	Var. Resistor	Squelch	VR1001
VR2	"	Volume	VR1002
VR3	"	Modulation	VR1003

Symb.	Name	Spec.	Note
C1	Capacitor	470P	CB
C2	"	15P	CSL
C3	"	.001	C
C4	none		
C5	Capacitor	1P	CSL
C6	"	8P	CSL
C7	"	.001	C
C8	"	.001	C
C9	"	.001	C
C10	"	8P	CSL
C11	"	1P	CSL
C12	"	7P	CSL
C13	"	33P	CSL
C14	none		
C15	Capacitor	.01	C
C16	none		
C17	Capacitor	.01	C
C18	"	.01	C
C19	"	.01	C
C20	none		
C21	Capacitor	5P	CSL
C22	"	.01	CF
C23	"	220P	CSL
C24	"	470P	CB
C25	"	220P	CSL
C26	"	.01	C
C27	"	470P	CB
C28	"	470P	CB
C29	"	15P	CSL
C30	"	.01	CT
C31	"	470P	C
C32	"	470P	CB
C33	"	.033	Mylar
C34	"	20P	CT
C35	"	20P	CT
C36	"	20P	CT
C37	"	20P	CT
C38	"	.01	C
C39	"	68P	CNPO
C40	"	150P	CN150
C41	"	10P	CSL
C42	"	1P	CSL
C43	"	.01	C
C44	"	4.7 16V	T
C45	"	10P	CSL
C46	"	.022	C
C47	"	47P	CNPO
C48	"	47P	CNPO
C49	"	.01	C
C50	"	10	T
C51	"	.022	C
C52	"	10	T
C53	"	.1	T
C54	"	4.7	T
C55	"	4.7	T
C56	"	.01	C
C57	"	1	T
C58	"	.022	C
C59	"	4.7	T
C60	"	4.7	E
C61	"	.0033	Mylar
C62	"	22	E
C63	"	.001	C
C64	"	.001	C
C65	"	100	E
C66	"	47	E
C67	"	47P	CNPO
C68	"	20P	CT
C69	"	47P	CNPO
C70	"	20P	CT
C71	"	47P	NPO
C72	"	20P	CT
C73	"	47P	CNPO
C74	"	20P	CT
C75	"	.001	C
C76	"	220P	CN750
C77	"	56P	CN750

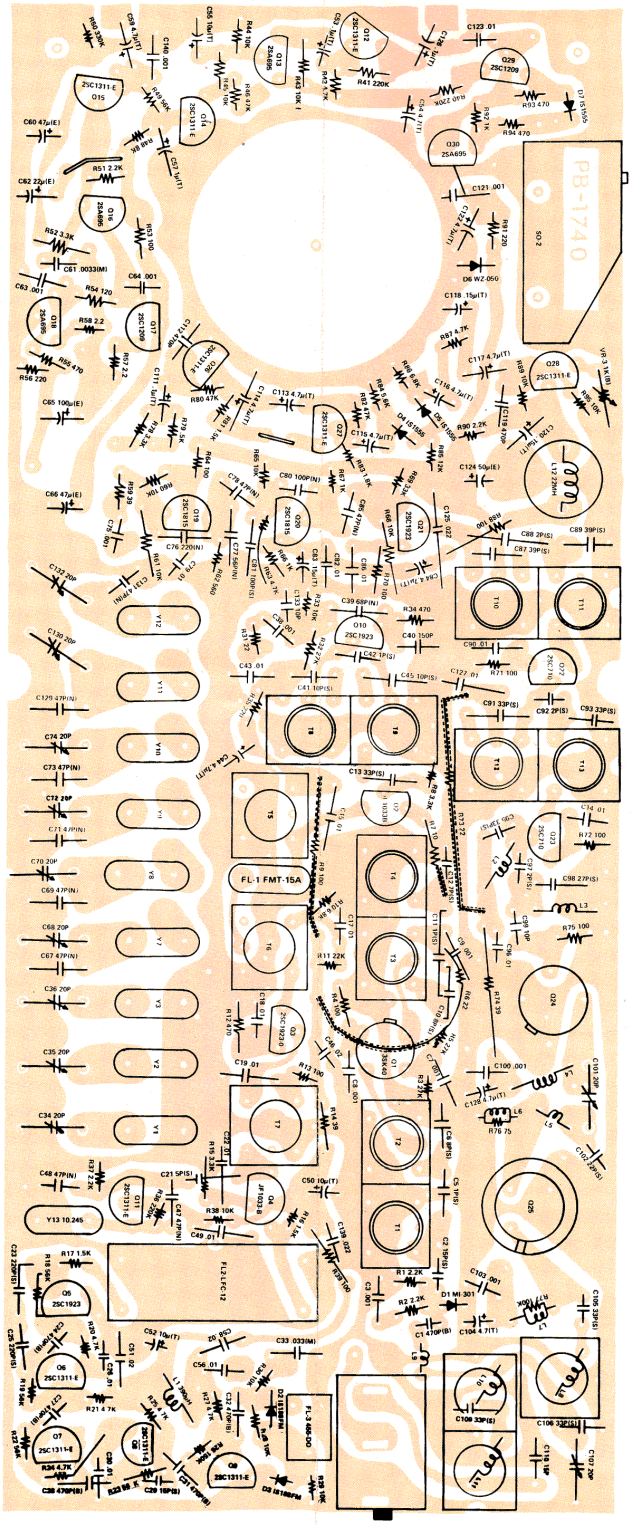
Symb.	Name	Spec.	Note
C78	"	47P	CSL
C79	"	.01	C
C80	"	100P	CSL
C81	"	100P	CSL
C82	"	.01	C
C83	"	.15	T
C84	"	4.7	T
C85	"	47P	CSL
C86	"	.01	C
C87	"	39P	CSL
C88	"	2P	CSL
C89	"	39P	CSL
C90	"	.01	C
C91	"	33P	CSL
C92	"	2P	CSL
C93	"	33P	CSL
C94	"	.01	C
C95	"	33P	CSL
C96	"	.01	C
C97	"	2P	CSL
C98	"	27P	CSL
C99	"	10P	CSL
C100	"	.001	C
C101	"	20P	CT
C102	"	22P	CSL
C103	"	.001	C
C104	"	4.7	T
C105	"	33P	CSL
C106	"	33P	CSL
C107	"	20P	CT
C108	none		
C109	Capacitor	33P	CSL
C110	"	15P	CSL
C111	"	.1	T
C112	"	470P	C
C113	"	4.7	T
C114	"	4.7	T
C115	"	4.7	T
C116	"	4.7	T
C117	"	4.7	T
C118	"	.15	T
C119	"	470P	C
C120	"	.15	T
C121	"	.001	C
C122	"	4.7	T
C123	"	.001	C
C124	"	47	E
C125	"	.022	C
C126	"	.1	T
C127	"	.001	C
C128	"	4.7	T
C129	"	47P	CSL
C130	"	20P	CT
C131	"	47P	CNPO
C132	"	20P	CT
C133	"	10P	CN470
C134	"	20P	CT
C135	"	20P	CT
C136	"	.001	CSL
C137	"	470p	CB
C138	"	25p	CB

Symb.	Name	Spec.	Note
C139	Capacitor	.022	C

Symb.	Name	Spec	Part #
L1	RFC	390 µH	L10001
L2	Coil	Air Wound	L10002
L3	Coil	Air Wound	L10002
L4	Coil	Air Wound	L10002
L5	Coil	Air Wound	L10003
L6	RFC	Wound on Resistor	L10004
L7	Coil	Air Wound	L10005
L8	Coil	Air Wound	L10006
L9	Coil	Air Wound	L10007
L10	Coil	Air Wound	L10008
L11	Coil	Air Wound	L10008
L12	RFC	22 mH	L10009
SC1	Shielded Coil	Air Wound	
SC2	" "	" "	
SC3	" "	" "	
T1	RX	Coil	T10001
T2	RX	Coil	T10001
T3	RX	Coil	T10001
T4	RX	Coil	T10001
T5	10.7	Coil	T10002
T6	10.7	Coil	T10002
T7	10.7	Coil	T10002
T8	L.O	Coil	T10003
T9	L.O	Coil	T10003
T10	TX	Coil	T10004
T11	TX	Coil	T10004
T12	TX	Coil	T10004
T13	TX	Coil	T10004
SP1	Speaker	8 ohm	SP1001
MK1	Mic Element		ME1001
S1	6 ch Selector Switch		S61001
S2	PTT Micro Switch		SM1001
S3	Part of VR2		
K1	Knob Volume		KN1001
K2	Knob Squelch		KN1001
K3	Knob Channel		KN1002
H5	Heat Sink Final		H51001
J3	6 Pin Female Conn.		FC1016
P1	6 Pin Male Jack for FP1016		MP1016
J1	BNC Ant. Conn. Female		FC1001
RD5	Rubber Flex Ant. 146 MHz		RD5101

Center Screws for Rear Case:
2 x 56 by 3/16 Flat Head Black Oxide

Screws for Top and Bottom
4 - 40 x ¼" Black Oxide



CIRCUIT BOARD OVERLAY

VOLTAGE MEASUREMENTS

RECEIVER:

FET'S	G1	G2	S	D
Q1	0	5.0	0.32	10.4
Q2	0	/	1.0	9.8
Q3	0	/	1.2	9.2

TRANSISTORS	E	B	C
Q3	0.95	1.25	10.2
Q5	0	0.60	1.0
Q6	4.9	5.2	6.0
Q7	0	0.60	1.3
Q8	4.8	5.0	6.6
Q9	0	0.60	1.3
Q10	2.2	2.6	8.6
Q11	0.80	0.75	3.30
Q12	0	0.60	5.00
Q13	10.0 (10.0)	9.6(10.0)	4.0 (0)
Q14	0 (0)	0.6(0)	0 (9.0)
Q15	0.4 (7.2)	0 (6.8)	11.0 (9.2)
Q16	0 (10.0)	11.0(9.2)	11.0 (6.6)
Q17	0.3 (6.0)	0 (6.6)	11.0 (11.0)
Q18	0.3 (6.0)	0 (5.4)	0 (0)

( ) indicates that squelch is open

TRANSMITTER:

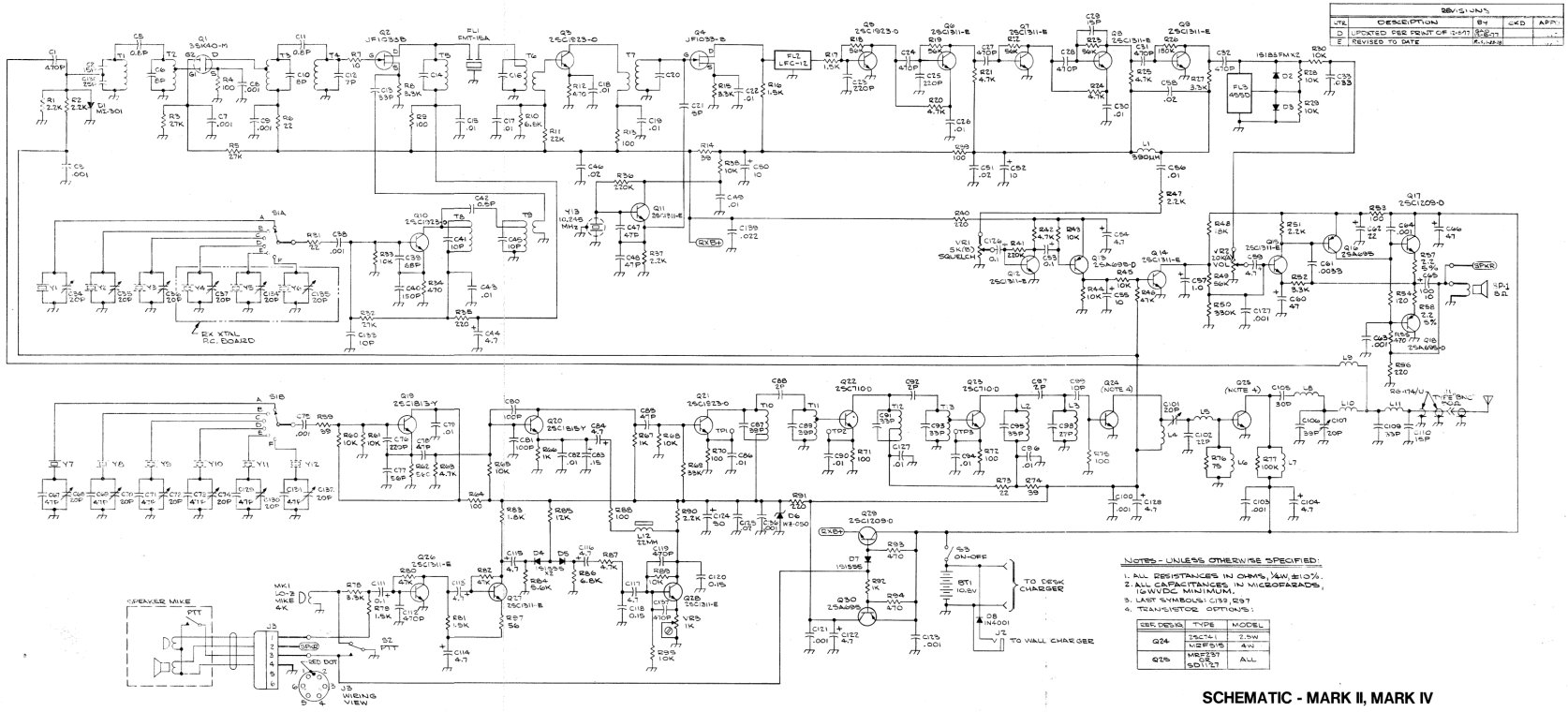
TRANSISTORS	E	B	C
Q19	1.8	2.4	4.7
Q20	1.0	1.4	4.0
Q21	0.4	.8	5.0
Q22	1.3	0	10.2
Q23	1.4	0	10.0 [10.6]
Q24	0	0	10.6 [8.8]
Q25	0	0	11.0
Q26	0	0.6	1.0
Q27	2.4	3.0	3.6
Q28	0.2	0.8	1.8

[ ] indicates Mark II

SWITCHING:

TRANSISTORS	E	B	C
Q29	10.3 (0.2)	11.0 (0.8)	11.0 (11.0)
Q30	11.0 (11.0)	11.0 (9.8)	0 (10.4)

( ) indicates transmit mode



NOTES - UNLESS OTHERWISE SPECIFIED:

1. ALL RESISTANCES IN OHMS, ¼W, ±10%.
2. ALL CAPACITANCES IN MICROFARADS, 16WVDC MINIMUM.
3. LAST %-SYMBOLS: C139, R97
4. TRANSISTOR OPTIONS:

SEE DESIG.	TYPE	MODEL
Q24	2SC741	2.5W
	MRF515	4W
Q25	MRF557 SD1127	ALL

SCHEMATIC - MARK II, MARK IV