RADIO COMMUNICATIONS
FOR PROFESSIONALS

RITRON, INC.

MAINTENANCE AND OPERATING MANUAL
MODEL RM-150
VHF-FM TRANSCEIVER

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4/95 PUBLICATION NO. 01451069D

505 West Carmel Drive
Carmel, Indiana 46032
Phone: 317/846-1201
FAX: 317/846-4978

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SPECIFICATIONS: MODEL RM-150 VHF-FM TRANSCEIVER

GENERAL

FCC ID:	AIE9QZRM-150
Frequency Range:	144-174 MHz
Channels:	1 Tx/Rx
Power Requirements:	12 VDC, nominal
	50 mA Stand-by
	75 mA Receive
	750 mA Transmit
Dimensions:	9.5" L x 6.25" W x 1.4" H
Weight:	1.25 Pounds
Antenna Impedance:	50 Ω

RECEIVER

Receiving System:	Dual Conversion Superheterodyne
Local Oscillator Stability:	5 PPM, -30° to +50° C
Sensitivity:	.3 uV or less for 12 dB SINAD
Selectivity:	Greater than 70 dB at 30 KHz
Image Rejection:	Greater than 60 dB
Intermodulation:	Greater than 60 dB
Noise Squelch Sensitivity:	.25 to 1 uV, adjustable
Receiver Attack Time:	12 ms
	240 ms w/67 Hz CTCSS
	175 ms w/100 Hz CTCSS
	100 ms w/203.5 Hz CTCSS
Receiver Close Time:	30 ms at full squelch
	130 ms w/67 Hz CTCSS
	110 ms w/100 Hz CTCSS
	110 ms w/203.5 Hz CTCSS
Modulation Acceptance:	+/- 6 KHz
Audio Output:	600 mW into 8 Ω with less than 10% THD
Crystal Specification:	Crystal Freq. = (Receive Freq - 10.7 MHz) / 3,
	Third Overtone, Parallel Mode, 32 pF
	RITRON Spec Number 02300004

SPECIFICATIONS (CON'T.)

TRANSMITTER

Frequency Stability:	5 PPM, -30° to +50° C
Modulation:	Direct FM type 16KOF3E
	+/- 5 KHz, adjustable
Spurious and Harmonics:	-50 dBc maximum
Audio Response:	6 dB/octave pre-emphasis
Power Output:	4 Watts typical (3.5 Watts minimum)
	jumper programmable for 2 Watts
Crystal Specification:	Crystal Freq. = Transmit Freq./12,
	Fundamental Mode, Cp = 32 pF
	RITRON Spec Number 02300003

FEATURES

"On-board" CTCSS encoder/decoder for 38 standard EIA sub-audible tones

Transmit CTCSS tone reversal

Program jumpers to select:	Transmitter activation polarity
	Modulation input for voice or data
	Full or 2 Watt transmitter power output
	De-emphasized or flat receiver audio
	High-pass filtered or flat audio
	Line level or amplified received audio output

OPERATING INSTRUCTIONS

GENERAL DESCRIPTION

The RITRON RM-150 transceiver operates in the VHF-FM communications band. Because it can transmit and receive on frequencies assigned to the user by the FCC, the RM-150 MUST BE LICENSED BEFORE USE. Your RITRON dealer will help you obtain an FCC license.

The RM-150 operates on 12 VDC, supplied through the power connector on the RM-150 back panel, or through J301 pin 5. The DC supply used to operate the RM-150 should be able to supply a **MINIMUM** of 1 Ampere of continuous current to the unit for full transmitter power output.

The antenna for the RM-150 is connected to the SO-239 UHF connector located on the rear panel of the enclosure. An antenna is NOT provided with the RM-150; the user should choose an antenna to best suit the particular application.

The RM-150 utilizes several programmable jumpers to provide the user with a number of circuit-operation options. These two-position programmable jumpers are clearly labeled on the "topside" of the RM-150 circuit board. Each programmable jumper is labeled with either "A" or "B" to indicate jumper placement as referenced in the schematic and throughout this manual. For jumper locations, see the RM-150 topside and bottomside parts placement diagrams.

RECEIVER

PJ501 provides de-emphasis of the received audio signals when placed into position "A," but no de-emphasis when placed into position "B." This programmable jumper MUST BE INSTALLED in one of its two positions for proper circuit operation.

PJ101 routes received audio to J301 pin 2 from the output of a 500 mW audio amplifier when placed in position "B," but routes unamplified audio when in position "A." Volume control R145 sets the audio output level from the audio amplifier.

PJ502 routes received audio through a high-pass filter when in position "B," but applies the audio directly when in position "A."

The user can set squelch control R140 to eliminate the noise between transmissions, and to block out weak, unreadable signals. With PJ503 in position "B," rotate R140 counter-clockwise until receiver noise is observed at J301 pin 2; then, set the squelch by rotating R140 clockwise until the noise is just eliminated.

J301 pin 1 provides a squelch output from the receiver. With NO received signal breaking the squelch, pin 1 is at 12 VDC; however, with a received signal present, pin 1 will drop to 0 VDC.

TRANSMITTER

The RM-150 transmitter is keyed at J301 pin 10. With PJ301 in position "B," a DC voltage of 5 VDC or greater at pin 10 will key the RM-150 transmitter. With PJ301 in position "A," pulling J301 pin 10 to ground keys the transmitter.

Transmitter audio is applied at J301 pin 9.

PJ201 "DC isolates" and provides pre-emphasis of the audio-input signal from J301 pin 9 when in position "A," but feeds directly to the limiting amplifier when in position "B."

PJ202 selects the RF power output range. With PJ202 in position "A," the RF power is limited to 2 Watts or less; position "B" allows full power output.

TONE SIGNALING

SW501 selects the sub-audible tone frequency to be used. Refer to the CTCSS Codes and Frequencies chart on page 3 for the switch positions required to program each tone.

The RM-150 receiver may be monitored by releasing J301 pin 4 from ground by placing PJ503 into position "B." This will override the tone-squelch circuitry. A tone-squelch output is provided at J301 pin 3. With a received signal and the proper tone present, J301 pin 3 will drop to 0 VDC. Without the correct tone signaling present, pin 3 will be pulled up to 12 VDC.

PJ504 provides tone-reversal of the sub-audible encode tone. With PJ504 in position "A," the phase of the sub-audible tone is reversed with the release of the transmitter keying input at J301 Pin 10.

PROGRAMMING TONE SIGNALING

1) Refer to the CTCSS chart on the next page and find the desired tone frequency or NOTONE.

NOTE: Programming NOTONE with the CTCSS switch permits the radio user to hear transmissions (while the unit is in tone squelch) that are not coded with a CTCSS tone. NOTONE is not a sub-audible tone that can be transmitted with a carrier signal, but a code that returns the unit to carrier-operated squelch.

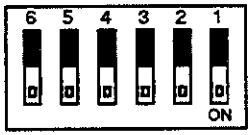
2) Set each of the six levers on the CTCSS programming switch to the positions given in the CTCSS chart. The CTCSS programming switch is indicated as SW501 on the RM-450 topside parts placement diagram. For a "0," set the lever to the ON position. For a "1," set that lever to the OFF position. Refer to the switch illustrated on the next page for lever identification.

CTCSS CODES AND FREQUENCIES

Code	Freq	Switch Lever 1 2 3 4 5 6	Code	Freq	Switch Lever 1 2 3 4 5 6
1	67.0	1 1 1 1 1 1	20	131.8	0 0 1 0 0 1
2	71.9	0 1 1 1 1 1	21	136.5	0 1 1 0 0 0
3	74.4	1 1 1 1 1 0	22	141.3	0 0 1 0 0 0
4	77.0	0 0 1 1 1 1	23	146.2	0 1 0 1 1 1
5	79.7	1 1 1 1 0 1	24	151.4	0 0 0 1 1 1
6	82.5	0 1 1 1 1 0	25	156.7	0 1 0 1 1 0
7	85.4	1 1 1 1 0 0	26	162.2	0 0 0 1 1 0
8	88.5	0 0 1 1 1 0	27	167.9	0 1 0 1 0 1
9	91.5	1 1 1 0 1 1	28	173.8	0 0 0 1 0 1
10	94.8	0 1 1 1 0 1	29	179.9	0 1 0 1 0 0
11	97.4	1 1 1 0 1 0	30	186.2	0 0 0 1 0 0
12	100.0	0 0 1 1 0 1	31	192.8	0 1 0 0 1 1
13	103.5	0 1 1 1 0 0	32	203.5	0 0 0 0 1 1
14	107.2	0 0 1 1 0 0	33	210.7	0 1 0 0 1 0
15	110.9	0 1 1 0 1 1	34	218.1	0 0 0 0 1 0
16	114.8	0 0 1 0 1 1	35	225.7	0 1 0 0 0 1
17	118.8	0 1 1 0 1 0	36	233.6	0 0 0 0 0 1
18	123.0	0 0 1 0 1 0	37	241.8	0 1 0 0 0 0
19	127.3	0 1 1 0 0 1	38	250.3	0 0 0 0 0 0
			NOTONE		1 1 0 0 0 0

"0" = ON
"1" = OFF

SW501 programmed for 250.3 Hz



THEORY OF OPERATION

Refer to the RM-150 schematic while reading the description below.

RECEIVER - RF

A received signal from the antenna first passes through a elliptical-function, low-pass filter (C306, C307, L303, C308, C309, L302, C310, C311); then, L304 and blocking capacitor C104 to a two-section bandpass filter (L101, C105, C106, C107, L102, and L103) whose bandpass response limits the frequency range of the received signals. The filter output connects to the emitter of a common-base RF amplifier Q101. The amplified signal next passes through another two-section banpass filter (L104, C111, C112, L105, and C113), to further reduce the RF bandwidth. C114 couples the amplified signal to the gate of a common-source JFET 1st mixer, Q105.

The receiver 1st local oscillator is a crystal-controlled, third-overtone, cascode Clapp type that consists of Q102, Q103, Y101, and associated components. R105, R106, and R110 set the base bias voltages for Q102 and Q103. When the RM-150 transmitter is operating, +8VDC transmit voltage is applied to the anode of CR102, which disables the receiver local oscillator by reverse biasing Q102. C120 and C121 are the feedback capacitors for Q102 and aid in temperature compensation. L108 prevents the oscillator from operating on the FUNDAMENTAL cut of the crystal by resonating with C121 at about 23 MHz - which destroys the conditions required for oscillation. L107 adjusts the reactance at the crystal leads to be compatible with 32 pF crystals, and R104 is a stabilizing resistor to prevent "free-running" oscillation. C115 nets Y101 to the proper frequency. C119 and thermistor R107 provide temperature compensation of the local oscillator at low temperatures, with R107 removing C119 from the circuit at low temperatures to raise the frequency. L109, C124, C125, L110, and C126 tune the collector output of Q103 to the third harmonic of the oscillator, a frequency 10.7MHz above or below the receive frequency. C127 couples the 1st L. O. signal to the source of 1st mixer, Q105.

The RF input signal drives the gate of mixer Q105, while the 1st Local Oscillator drives the source of the mixer. T101 tunes the mixer output to the difference frequency of 10.7 MHz, which C130 couples to a 10.7 MHz two-pole, monolythic crystal filter, YF101. A four-pole filter (YF101, C132, and YF102) is optional. C132 controls the coupling between YF101 and YF102 when the optional four-pole crystal filter is used.

R117 and R120 match the filter output to the base of Q106. This stage is a grounded-emitter buffer amplifier which provides stable gain, and matches the filter output through C134 to the balanced mixer input, IC101 pin 16.

RECEIVER FM SUBSYSTEM

A multi-function integrated circuit, IC101 and associated components, forms the FM-receiver subsystem. This subsystem performs the functions of: 1) 2nd local oscillator (20.945 MHz), 2) 2nd mixer, 3) 2nd IF amplifier, 4) FM detector and 5) noise amplifier.

IC101 pins 1 and 2, 10.245 MHz crystal Y102, and feedback capacitors C137 and C138 comprise the 2nd local oscillator which, normally, provides low-side injection (10.245 MHz). The 10.7 MHz signal at IC101 pin 16 and the 2nd local oscillator output are mixed, with the resulting 455 KHz mixer output appearing at IC101 pin 3. A 455 KHz, 6-pole ceramic filter, YF103, connects the balanced-mixer output to the input of the limiting IF amplifier at IC101 pin 5. IC101 pin 6 is the decoupled input to the IF amplifier, IC101 pin 7 the limited IF output signal. An internal quadrature detector, whose center frequency is determined by T102, detects the FM IF signal. One input of the quadrature detector connects internally to the IF signal at IC101 pin 7, while the other detector input is the phase-shifted signal from quadrature coil T102 at IC101 pin 8. The demodulated audio output appears at IC101 pin 9 - R126 and C143 filter out any 455 KHz signal at this point. The demodulated audio signal at IC101 pin 9 is then routed through de-emphasis/amplifier IC502B and the audio-gating circuitry for input to audio amplifier IC103.

R127, R128, C144, C145 and R129 form an 8 KHz bandpass filter for the demodulated audio signals from IC101 pin 9 for input to the internal noise amplifier at IC101 pin 10. The noise output at IC101 pin 11 is further amplified by IC102A and applied to a voltage-doubling, negative-peak detector consisting of CR104 and CR105. C149 integrates the detected signal, while R138 and C150 filter and apply the signal to the inverting input of comparator IC102B. The non-inverting input of IC102B is connected through CR106 to R140 , which with R142 sets the DC squelch reference voltage of the comparator. R141 and CR107 set the hysteresis of the comparator circuit. The collector of Q107 is connected to the non-inverting input of comparator IC102B, with the base connected to IC502 pin 1, to pull down the comparator reference voltage when the RM-150 is in transmit and squelch the receiver. The squelch output at IC102B Pin 7 is connected to the audio-gating circuitry and to the base of open-collector transistor Q108. The collector of Q108 connects to J301 pin 1 (Carrier Squelch).

AUDIO-GATING AND HIGH-PASS FILTER

Received audio from IC101 pin 9 is routed to the inverting input of op-amp IC502B through C504 and R507. PJ501, if placed into position "A," provides de-emphasis of the received audio signal at IC502B pin 7. Received audio from pin 7 is routed to the input (pin 24) of tone decoder circuit IC501 for CTCSS tone decoding, and to the input (IC501 pin 23) of an audio high-pass filter used to strip sub-audible tone from the de-modulated audio output. The audio from IC502B pin 7 is also routed to PJ502, along with the output of the high-pass filter at IC501 pin 19. PJ502 is placed into position "A" to provide audio directly from de-emphasis/amplifier IC502B, and in position "B" for high-pass filtered audio.

Tone squelch and carrier squelch gating of the receiver audio signal operates as follows:

1) Analog switch IC503B is controlled by the tone decoder output from IC501 pin 13. With the correct sub-audible tone detected, switch IC503B is "opened" to remove ground from the base of tone squelch output transistor Q501.
2) Analog switch IC503A is controlled by the squelch output at IC102B pin 7 and by the tone squelch output condition of switch IC503B. A received signal with the correct sub-audible tone will "close" switch IC503A and route received audio from PJ502 to PJ101 and to audio amplifier IC103. The squelch output at IC102B turns on IC503A and, via CR504, turns on tone squelch output transistor Q501. If correct sub-audible tone is not detected, switch IC503B is "closed" and will turn off Q501 and "open" switch IC502A via CR504.
3) PJ101 routes unamplified received audio from PJ502 to J301 pin 2 when in position "A," and received audio amplified by IC103 when in position "B." Amplified audio from IC103 is also routed to J301 pin 6 through R147.
4) R145 adjusts the output level of audio amplifier IC103.

TONE SIGNALING

Tone encoding and decoding is accomplished with IC501, a custom CTCSS ENCODE/DECODE circuit. IC504 is a +5VDC voltage regulator used to supply voltage to IC501 pins 1 and 4, op-amp IC502, and analog switch IC503. C502, C503, R501, and 1 MHz crystal Y501 provide a clock reference for IC501 at pins 2 and 3.

SW501 is connected to pins 5 through 10, and is used to program the desired CTCSS (Continuous Tone Coded Squelch System) tone frequency. Refer to the CTCSS TONE CHART on page 3 for specific switch settings.

Demodulated received audio is applied to IC501 pins 23 and 24, the RX AUDIO INPUT and CTCSS TONE INPUT, respectively. If the received sub-audible tone matches the programmed tone frequency, then IC501 pin 15 (RX TONE DETECT OUTPUT) goes "high." This output is integrated by R505 and C510 before being applied to IC501 pin 14 (DECODE COMPARATOR INPUT). If the decode is of sufficient duration, IC501 pin 13 (RX TONE DECODER OUTPUT) goes "low" to open switch IC503B, as previously described. The R505/C510 time constant controls the decode response time, while the R506/C510 time controls the de-response time.

Received audio applied to IC501 pin 23 is high-pass filtered by IC501 to strip the sub-audible tone. The output of the high-pass filter appears at IC501 pin 19, and is applied to PJ502 position "B." Audio is present at this point only if the correct CTCSS tone is decoded, or MONITOR pin 18 of IC501 is "high."

IC501 pin 18 is used to accomplish two functions:
1) MONITOR - when in receive, IC501 pin 18 must be held "low" for CTCSS tone decode operation. This is accomplished by placing PJ503 into position "A," or by pulling J301 pin 4 "low." Without a "low" at IC501 pin 18, R504 pulls pin 18 "high" and IC501 pin 13 goes "low," allowing audio to pass to IC501 pin 19 regardless of the received CTCSS tone frequency.
2) ENCODE TONE REVERSAL - when in transmit, IC501 pin 18 is used to trigger tone reversal of the CTCSS encode tone. IC501 pin 18 must be held "low" (with PJ503 in

position "A" or from J301 pin 4) for this function to work. With the transmitter activated at J301 pin 10, the collector of keying transistor Q303 applies a "high" to IC501 pin 18 via CR506. With PJ504 in position "A," Q502 pulls IC501 pin 17 "low" to activate CTCSS encode tone as described in the "POWER SUPPLY AND TRANSMITTER KEYING" section. Upon de-activation of the transmitter at J301 pin 10, Q303 immediately turns off to return IC501 pin 18 to a "low" state, while Q502 holds IC501 pin 17 "low." IC501 recognizes the change of status at pin 18 with no change at pin 19 and reverses the phase of the CTCSS encode tone.

With the TX ENABLE INPUT at IC501 pin 17 "low," CTCSS encode tone at IC501 pin 16 is routed to speech amp IC202A pin 2 through C509, R220 and R222. R220 is used to adjust the deviation level of the CTCSS encode tone.

POWER SUPPLY AND TRANSMITTER KEYING

The RM-150 VHF transceiver operates on a nominal voltage of +12 VDC; however, operation is possible from +10 VDC to +13.5 VDC. The supply voltage is connected to J301 pin 5 — or wired to the point on the circuit board marked +12 VDC. The +12 VDC source, filtered by C151 and C302, supplies voltage to: audio amplifier IC103; transmitter RF final transistor Q205 via PJ202B; transmitter RF driver transistor Q204; +8 VDC voltage regulator IC301; +8 VDC voltage regulator IC203 (for the modulator) and; pull-up resistors R130 and R520 for J301 pins 1 and 3, respectively.

The +8 VDC output of voltage regulator IC301 supplies voltage to all receiver circuitry: through R101 to the receiver RF amplifier; through R112 to the receiver 1st local oscillator; through Z103 to the mixer; through R121 to the IF subsystem, IC101, with the voltage regulated at +5.1 Volts by CR103; and to noise amplifier IC102 directly from the +8 Volt line.

IC301 supplies voltage to the input of the +5 VDC regulator, IC504, with C501 filtering the +5 Volt line. The +5 Volt line supplies voltage to: custom CTCSS signaling circuit IC501; op-amp IC502 and; analog switch IC503, which is used for audio gating.

IC301 also supplies voltage to the emitter of PNP pass-transistor, Q301. Transmitter keying is initiated at J301 pin 10 to programmable jumper PJ301, as follows: with PJ301 in position "B," a "high" at J301 pin 10 "closes" analog switch IC503C, drawing current through R517 and R518 to turn on PNP pass transistor Q303. Q303 in turn "closes" switch IC503D and, through CR506, applies a "high" to IC501 pin 18. With PJ504 in position "B," switch IC503D pulls IC501 pin 17 TX ENABLE INPUT "low" to activate CTCSS encode tone. Comparator input IC502A pin 2 is pulled "low" via CR505 and switch IC503D, with the resulatant "high" output of the comparator used to turn on switching transistors Q302 and Q502. Q302's collector draws current through R301 and R302 to turn on TX +V pass transistor Q301 and supply voltage to the transmitter oscillator and multiplier stages. With PJ504 in position "A," Q502 pulls IC501 pin 17 TX ENABLE INPUT "low" to activate CTCSS encode tone. The time constant of R511 and C513 allows the transmitter to remain "keyed" for a period of time after the activating signal at J301 pin 10 is released. With PJ301 in position "A," a "low" at J301 pin 10 is required to activate the transmitter.

An +8 VDC regulator, IC203, provides an isolated supply for the transmitter modulator and frequency determining circuits, supplying voltage to limiting amplifier IC201A, 1/2 VCC reference IC201B, low-pass filter IC202B and buffer amplifier/temperature compensation circuit IC202A.

TRANSMITTER - RF SECTION

A fundamental mode, untuned, Clapp crystal oscillator, Q201, generates and controls the transmitter frequency. C208 and C209 are the feedback capacitors with a temperature-coefficient designed to help maintain frequency stability of the oscillator with temperature. Thermistor R238, R236, CR203, and R219 provide frequency stability at low temperatures by shifting the DC voltage at the inverting input of IC202A. The DC output of IC202A is raised at lower temperatures and is applied to CR201, a voltage-variable-capacitance diode, along with audio signals from the transmitter speech amplifier/limiter. The crystal, Y201, is netted to the exact operating frequency by adjusting L201 in the resonant circuit created by L201, C204, and CR201. C205, C206, C207, R204, and Z201 filter and decouple the DC supply to the crystal oscillator.

C210 couples the collector output of oscillator Q201 to the emitter of a common-base tripler, Q202. R209 and R210 provide forward-bias for the base of Q202 while R207 provides a DC return for the emitter. The double-tuned resonant tanks of C214, L202, C215, L203, C216, C217 are tuned to apply the 3rd harmonic of the crystal oscillator to the base of doubler Q203. C212 and C213 form an RF ground for the collector tank of Q202, and together with R208 and Z202 filter the DC supply for the tripler stage.

Q203 is a common-emitter frequency doubler. R211 and R212 provide a slight forward-bias to the base of Q203 to increase its efficiency as a doubler. L204, C220, C221, L205, C222, and C223 tune the collector output of Q203 to the 6th harmonic of the crystal frequency and match it into the base of second doubler Q204. C218, C219, C243, Z203, and R213 decouple the DC supply for Q203.

Q204 is another common-emitter frequency doubler. R214 and Z204 are a DC return for the base-emitter circuit of Q204. R215, Z205, and L207 route collector voltage to Q204 from the +12VDC supply, with L207 providing a collector load for the doubler. C224 couples the output of Q204 to a two-section resonant tank circuit. L208, C225, C230, L209, C231, and C232 tune the output to the 12th harmonic of the oscillator frequency and match it to the base of RF final Q205. C226, C229 and C242 provide an RF ground for the L207 collector load and, with Z205, R215 and C239, filter the DC supply for Q204.

Q205 is a common-emitter, final RF amplifier capable of supplying a maximum of 4 Watts RF power to the RM-150 antenna. A programmable-jumper, PJ202, selects the voltage supplied to the collector of Q205. With PJ202 in position "A," Q205 receives voltage from the +12V line through two resistors in parallel, R216 and R217, for a maximum power output of 2 Watts or less. With PJ202 in position "B," +12 VDC is supplied to Q205 for an RF power output of up to 4 Watts. L210 routes the DC voltage to Q205, and also forms a collector load for the amplifier. Z206 provides a DC return for the base-emitter junction of Q205. L211, C237, C238, and C240 match the output

of Q205 to the 50 Ohm input of the low-pass filter. C233, C234, C235, and C236 provide an RF ground for the collector circuit of Q205, and with Z207 and C239 filter the DC supply for the final stage.

ANTENNA SWITCHING AND LOW-PASS FILTER

A low-pass filter, consisting of C306, C307, L303, C308, C309, L302, C310, removes harmonics of the transmitter output signal and applies the RF output to the antenna. All received signals from the antenna also pass through the low-pass filter before application to the receiver RF input circuitry.

With the RM-150 in the "receive" mode, voltage is NOT applied to the transmitter stages; the receiver 1st local oscillator operates normally; and input-signal "pin-diodes" (CR101 & CR302) do NOT conduct. This removes CR101 from the RX input and back-biases CR302 to prevent the transmittter final stage from affecting Receiver tuning. Therefore, incoming signals from the antenna pass through the low-pass filter; through L304 and C104 to the receiver RF amplifier. The incoming signal is then amplified and demodulated normally.

With the RM-150 in the "transmit" mode, pass transistor Q301 turns "on", which applies +8 VDC to the transmitter stages, and also to the cathode of pin diode CR302 through R305 and L301. Q302 is also "on", with the collector connected to the anode of CR101. DC current through CR302 turns it "on" and allows the RF voltage from final transistor Q205 to pass through to the input of the low-pass filter. Transmitter RF signals are passed through the low-pass filter to the antenna with little or no attenuation. The DC current then passes through L304 to the cathode of CR101 , and through Q302, turning "on" CR101 to provide an RF shunt to ground across the receiver input, preventing the transmitter signals from destroying the receiver amplifier transistor.
Q301 also applies +8VDC to the emitter of Q102 through CR102 to disable the L. O.

TRANSMITTER SPEECH AMPLIFIER

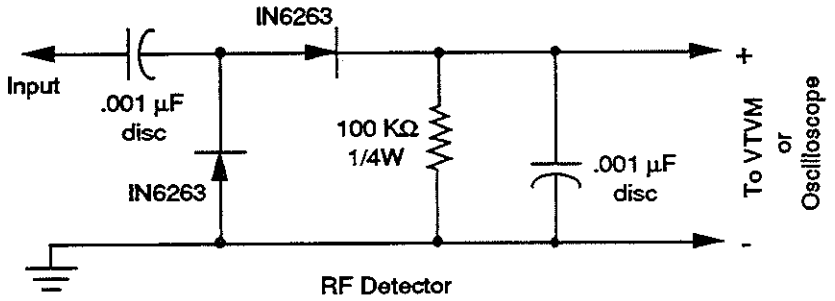
Audio input (TX AUD) to the transmitter speech amplifier is applied to J301 pin 9; the signal is then routed through Z209 to PJ201. PJ201 "DC-isolates" the input signal when in position "A" and provides for direct input to the limiting amplifier when in position "B." PJ201 applies audio signals to the inverting input of the limiting amplifier IC201A. Op-amp IC201A is biased at 1/2 VCC at its non-inverting input by IC201B. The limited audio output of IC201A is routed to the input of a -60 log (f/3K) low-pass filter via R230, which sets the FM deviation level of the transmit signal.

IC202B and associated components form the first two poles of the four-pole low-pass filter, with the output of IC202B applied to the inverting input of IC202A. CTCSS encode signals from IC501 (CTCSS signaling circuit) are also connected to the inverting input of IC202Avia R220, with the non-inverting input biased to 1/2 VCC by IC201B. IC202A, R221, R237, C245, R201 and C201 comprise the second two poles of the four-pole low-pass filter, with the output of IC202A applying audio signals and a 4 VDC bias to the FM modulating device, varactor diode CR201.

ALIGNMENT PROCEDURE

TEST EQUIPMENT

1) 0 to 15 VDC, 1 Amp current-limited power supply.
2) RF Wattmeter, 5 Watts full scale.
3) RF FM signal generator (to 170 MHz).
4) FM deviation meter.
5) Frequency counter (to 170 MHz).
6) VTVM or DMM.
7) RF detector (see the diagram below).
8) Oscilloscope (to 15 MHz).



RADIO PREPARATION

1) Remove the antenna from the threaded connector on the RM-150 back panel.

2) Open the RM-150 enclosure by removing the four #4 screws from the bottom of the enclosure and removing the enclosure top.

3) Connect the power supply, set to 12 VDC, to the unit. Connect the power supply through the connector on the enclosure back panel, or at J301 pin 5 and ground.

RECEIVER IF ALIGNMENT

NOTE: This adjustment should not vary significantly from the factory alignment, and SHOULD NOT be required in the field. When changing the "receive" crystal, alignment should begin with step 11.

1) Connect the radio to an RF signal generator through the back-panel antenna connector.

2) Install the "receive" crystal and tune the signal generator to the "receive" frequency.

3) Frequency modulate the RF signal generator with a 13-Hz sine-wave at 15-KHz deviation.

4) Connect the modulating 13 Hz signal to the horizontal input of the oscilloscope.

5) Connect IC101 pin 16 to the vertical input of the oscilloscope. Set the scope sensitivity for 100 mV/Div.

6) Increase the output level of the RF signal generator until a pattern of two divisions peak-to-peak is seen on the oscilloscope.

7) Adjust T101 to give a shape of maximum amplitude and flatness. Lower the generator output as required to maintain a maximum reading of 3 divisions peak-to-peak.

8) Adjust L101, L102, L104, L105, L109, and L110 to provide the maximum amplitude of the IF response, lowering the RF signal generator output level as required.

9) Adjust C115, frequency trimmer capacitor, to center the response of the IF signal.

10) Set the output of the RF signal generator to 1 micro-volt. Set the oscilloscope input sensitivity for 1 V/Div. Connect the scope input to the junction of R126 and C143. Adjust T102 for a centered and linear "S" curve.

11) Frequency modulate the RF signal generator with a 1 KHz sine-wave at 3 KHz deviation. Set the output of the RF signal generator to 0.3 micro-volts.

12) A final adjustment of L101, L102, L104, L105, L109, and L110 for maximum sensitivity may be made at IC502B pin 7 with PJ501 in position "A," using the quieting or SINAD technique.

TRANSMITTER ALIGNMENT

NOTE: J301 pin 10 must be pulled to ground with PJ301 in position "A." This will activate the transmitter to make the following adjustments:

1) Back the cores out to the top of coils L202, L203, L204, L205, L208, and L209.

2) Install the "transmit" crystal.

3) Connect the radio to an RF Wattmeter through the antenna connector on the RM-150 back panel.

4) Adjust C238 such that the capacitor plates are half-meshed, and place PJ202 in its "B" position.

5) Adjust L202 and L203 for a maximum voltage reading on the base of Q203 as indicated through the RF detector.

6) Adjust L204 and L205 for a maximum voltage reading on the base of Q204 as indicated through the RF detector.

7) Adjust L208 and L209 for a maximum power indication on the Wattmeter.

8) Fine-tune L208, L209 and C238 for maximum power output.

9) Adjust L201 for the exact operating frequency as indicated on the frequency counter.

10) Apply a 1 KHz tone at 3 Volts peak-to-peak to J301 pin 9; then, adjust R230 for +/- 5 KHz deviation, maximum, as indicated on the deviation meter (if sub-audible tone is used, the COMBINED deviation of both VOICE and TONE should equal +/- 5 KHz).

DC Voltages (Transistors)

CONDITIONS

Receiver fully squelched (R140 full CW).
Volume control set to minimum (R145 full CCW).
Supply voltage set to +12 VDC.
PJ502 in position "B," PJ301 in position "B," PJ202 in position "A,"
PJ501 in position "A," PJ504 in position "A," PJ503 in position "A."
All measurements taken using an oscilloscope with 10 MΩ input impedence.

FOR RECEIVE "MODE" MEASUREMENTS: a full-quieting 1µV signal, modulated with the correct sub-audible tone, applied to the receiver.

FOR TRANSMIT "MODE" MEASUREMENTS: transmitter activated with +5 VDC at J301 pin 10, PJ202 set to position "A" for reduced power operation.

FOR STAND-BY "MODE" MEASUREMENTS: no signal applied to the receiver, the transmitter de-activated.

		Receive	Transmit	Stand-by
Q101	E	0.0	0.0	0.0
	B	0.7	0.0	0.7
	C	4.4	0.0	4.4
Q102	E	2.8	6.0	2.8
	B	3.4	3.8	3.4
	C	6.8	7.8	6.8
Q103	E	6.6	7.8	6.6
	B	6.8	7.8	6.8
	C	0.0	0.0	0.0
Q105	D	8.0	8.0	8.0
	G	0.0	0.0	0.0
	S	0.8	0.8	0.8
Q106	E	0.0	0.0	0.0
	B	0.7	0.7	0.7
	C	2.5	2.5	2.5
Q107	E	0.0	0.0	0.0
	B	0.0	0.6	0.0
	C	1.7	0.0	1.7
Q108	E	0.0	0.0	0.0
	B	0.7	0.0	0.0
	C	0.1	12.0	12.0

		Receive	Transmit	Stand-by
Q201	E	0.0	2.0	0.0
	B	0.0	2.1	0.0
	C	0.0	5.6	0.0
Q202	E	0.0	1.0	0.0
	B	0.0	1.6	0.0
	C	0.0	6.8	0.0
Q203	E	0.0	0.0	0.0
	B	0.0	0.4	0.0
	C	0.0	6.6	0.0
Q204	E	0.0	0.0	0.0
	B	0.0	-1.0	0.0
	C	0.0	10.0	0.0
Q205	E	0.0	0.0	0.0
	B	0.0	-0.2	0.0
	C	12.0	8.0	12.0

		Receive	Transmit	Stand-by
Q301	E	8.0	8.0	8.0
	B	8.0	7.2	8.0
	C	0.0	8.0	0.0
Q302	E	0.0	0.0	0.0
	B	0.0	0.7	0.0
	C	8.0	0.1	8.0
Q303	E	5.0	5.0	5.0
	B	5.0	4.2	5.0
	C	0.0	5.0	0.0
Q501	E	0.0	0.0	0.0
	B	0.7	0.0	0.0
	C	0.0	12.0	12.0
Q502	E	0.0	0.0	0.0
	B	0.0	0.7	0.0
	C	5.0	0.0	5.0

DC Voltages (ICs)

		Receive	Transmit	Stand-by
IC101	1	5.0	5.0	5.0
	2	4.4	4.4	4.4
	3	4.9	4.9	4.9
	4	5.1	5.1	5.1
	5	1.0	1.0	1.0
	6	1.0	1.0	1.0
	7	1.1	1.1	1.1
	8	5.1	5.1	5.1
	9	2.0	2.0	2.0
	10	1.9	1.9	1.9
	11	2.0	2.0	2.0
	12	0.0	0.0	0.0
	13	4.5	4.5	4.5
	14	0.0	0.0	0.0
	15	0.0	0.0	0.0
	16	2.0	2.0	2.0
IC102	1	4.0	4.0	4.0
	2	4.0	4.0	4.0
	3	3.9	3.9	3.9
	4	0.0	0.0	0.0
	5	1.7	0.0	0.5
	6	0.0	3.0	3.0
	7	7.3	0.0	0.0
	8	8.0	8.0	8.0
IC103	1	1.3	1.3	1.3
	2	0.0	0.0	0.0
	3	0.0	0.0	0.0
	4	0.0	0.0	0.0
	5	6.0	6.0	6.0
	6	12.0	12.0	12.0
	7	6.2	6.2	6.2
	8	1.4	1.4	1.4
IC201	1	4.0	4.0	4.0
	2	4.0	4.0	4.0
	3	4.0	4.0	4.0
	4	0.0	0.0	0.0
	5	4.0	4.0	4.0
	6	4.0	4.0	4.0
	7	4.0	4.0	4.0
	8	8.0	8.0	8.0

		Receive	Transmit	Stand-by
IC202	1	4.0	4.0	4.0
	2	4.0	4.0	4.0
	3	4.0	4.0	4.0
	4	0.0	0.0	0.0
	5	4.0	4.0	4.0
	6	4.0	4.0	4.0
	7	4.0	4.0	4.0
	8	8.0	8.0	8.0
IC203	1	8.0	8.0	8.0
	2	0.0	0.0	0.0
	3	12.0	12.0	12.0
IC301	1	12.0	12.0	12.0
	2	0.0	0.0	0.0
	3	8.0	8.0	8.0
IC501	1	5.0	5.0	5.0
	2	2.5	2.5	2.5
	3	2.5	2.5	2.5
	4	5.0	5.0	5.0
	5	5.0	5.0	5.0
	6	5.0	5.0	5.0
	7	5.0	5.0	5.0
	8	5.0	5.0	5.0
	9	5.0	5.0	5.0
	10	5.0	5.0	5.0
	11	0.0	0.0	0.0
	12	3.2	1.6	3.2
	13	0.0	5.0	5.0
	14	4.8	4.2	0.4
	15	5.0	0.0	0.0
	16	0.0	2.0	0.0
	17	5.0	0.0	5.0
	18	0.7	4.5	0.7
	19	2.5	2.5	2.5
	20	2.5	2.5	2.5
	21	2.5	2.5	2.5
	22	2.5	2.5	2.5
	23	2.5	2.5	2.5
	24	2.5	2.5	2.5

		Receive	Transmit	Stand-by
IC502	1	0.0	4.2	0.0
	2	5.0	0.5	5.0
	3	1.2	3.5	1.2
	4	0.0	0.0	0.0
	5	2.5	2.5	2.5
	6	2.5	2.5	2.5
	7	2.5	2.5	2.5
	8	5.0	5.0	5.0
IC503	1	2.5	2.5	2.5
	2	2.5	2.5	2.5
	3	5.2	0.0	0.0
	4	0.0	0.0	0.0
	5	0.0	5.0	5.0
	6	0.0	4.6	0.0
	7	0.0	0.0	0.0
	8	5.0	0.0	5.0
	9	0.0	0.0	0.0
	10	0.0	0.0	0.0
	11	4.8	0.0	4.8
	12	0.0	5.0	0.0
	13	4.6	0.0	0.0
	14	5.0	5.0	5.0
IC504	1	5.0	5.0	5.0
	2	0.0	0.0	0.0
	3	8.0	8.0	8.0

TEST POINTS

The test points described below are indicated on the RM-150 schematic and parts placement diagrams.

CONDITIONS

Receiver fully squelched (R140 full CW)
Volume control set to maximum (R145 full CW)
Supply voltage set to +12 VDC
All measurements taken using an oscilloscope with a 10 MΩ input impedence.

FOR RECEIVE "MODE" MEASUREMENTS: a full-quieting 100 μV signal, modulated with a 1 KHz tone at 3 KHz deviation and the correct sub-audible tone, applied to the receiver.

FOR TRANSMIT "MODE" MEASUREMENTS: transmitter activated with +5 VDC at J301 pin 10, PJ202 set to position "A" for reduced power operation. 1 KHz tone applied to J301 Pin 9 at 1 VAC peak-to-peak.

FOR STAND-BY "MODE" MEASUREMENTS: no signal applied to the receiver, transmitter de-activated.

Δ1 RECEIVER RF AMPLIFIER +V

TEST POINT 1 measures 4.4 VDC when in RECEIVE, STAND-BY and TRANSMIT.

Δ2 RECEIVER FIRST LOCAL OSCILLATOR +V

TEST POINT 2 reads 6.8 VDC when in RECEIVE or STAND-BY, and 7.8 VDC when in TRANSMIT.

Δ3 RECEIVER FIRST LOCAL OSCILLATOR

The voltage at TEST POINT 3 may be used to determine the L.O. current when the unit is in RECEIVE or STAND-BY; the number of volts at TP3 equals the number of milliAmps drawn through the L.O. (3 VDC for 3 mA current, typical). TEST POINT 3 measures 6.2 VDC in TRANSMIT to turn OFF the L.O.

Δ4 RECEIVER IF +V

TEST POINT 4 shows 5.1 VDC when in RECEIVE, STAND-BY and TRANSMIT.

Δ5 RECEIVER IF INPUT

TEST POINT 5 measures 2.0 VDC when in RECEIVE, STAND-BY and TRANSMIT. When in RECEIVE, a 10.7 MHz IF signal at 50 mV peak-to-peak appears.

Δ6 RECEIVER NOISE AMP OUTPUT

TEST POINT 6 shows 4.0 VDC when in RECEIVE, STAND-BY and TRANSMIT. When in STAND-BY, 8 KHz noise at 5 V peak-to-peak appears.

Δ7 RECEIVER SQUELCH REFERENCE VOLTAGE

TEST POINT 7 measures 2.0 VDC in RECEIVE, 0.8 VDC in STAND-BY and 0.0 VDC in TRANSMIT.

Δ8 CARRIER SQUELCH OUTPUT

TEST POINT 8 (J301 pin 1) reads 0.0 VDC in RECEIVE, and 12.0 VDC in TRANSMIT or STAND-BY.

Δ9 TONE SQUELCH OUTPUT

TEST POINT 9 (J301 pin 3) shows 0.0 VDC in RECEIVE, and 12.0 VDC in TRANSMIT or STAND-BY.

Δ10 RECEIVER MONITOR

TEST POINT 10 (J301 pin 4) measures 0.0 VDC in RECEIVE, TRANSMIT or STAND-BY with PJ503 in position "A," and 5 VDC in RECEIVE, TRANSMIT or STAND-BY with PJ503 in position "B."

Δ11 +12 VDC SUPPLY VOLTAGE

TEST POINT 11 (J301 pin 5) shows 12.0 VDC in RECEIVE, TRANSMIT or STAND-BY.

Δ12 RECEIVER AUDIO AMP OUTPUT

TEST POINT 12 reads 0.0 VDC when in RECEIVE, TRANSMIT or STAND-BY. When in RECEIVE, the 1KHz received signal at 11 VAC peak-to-peak is present.

Δ13 GROUND

TEST POINT 13 (J301 pin 7) shows 0.0 VDC in RECEIVE, TRANSMIT or STAND-BY.

Δ14 TRANSMIT AUDIO INPUT

TEST POINT 14 at J301 pin 9 reads 0.0 VDC in RECEIVE, TRANSMIT or STAND-BY. The TRANSMIT 1 KHz test tone is applied here.

Δ15 Δ21 Δ22 PJ301 - TRANSMITTER KEYING

TEST POINT 15 (J301 pin 10) activates the transmitter with a "low" when PJ301 is

in position "A" (TEST POINT 21), and with +5 VDC when PJ301 is in position "B" (TEST POINT 22).

Δ16 Δ19 Δ20 PJ502 - AUDIO HIGH-PASS FILTER

TEST POINT 16 measures 2.5 VDC when in RECEIVE, TRANSMIT or STAND-BY. When in RECEIVE: the 1 KHz test signal appears at 0.5 VAC peak-to-peak with PJ502 in position "B" (TEST POINT 20); the 1 KHz signal and the correct sub-audible signal are present with PJ502 in position "A" (TEST POINT 19).

Δ17 Δ18 Δ19 PJ501 - AUDIO DE-EMPHASIS

TEST POINT 17 reads 2.5 VDC when in RECEIVE, TRANSMIT or STAND-BY. When in RECEIVE: the 1 KHz test signal appears at 0.5 VAC peak-to-peak with PJ501 in position "A" (TEST POINT 17); the 1 KHz tone is present at 1 VAC peak-to-peak with PJ501 in position "B" (TEST POINT 18).

Δ23 TRANSMITTER ACTIVATION

TEST POINT 23 measures 4.6 VDC when in TRANSMIT, and 0.0 VDC when in RECEIVE or STAND-BY.

Δ24 Δ25 Δ26 PJ504 - ENCODE TONE REVERSAL

TEST POINT 25 reads 0.0 VDC when in TRANSMIT, and 5.0 VDC when in RECEIVE or STAND-BY. With PJ504 in position "A" (TEST POINT 24), TEST POINT 25 is held at 0.0 VDC for 200 ms after the transmitter is de-activated at J301 Pin 10. With PJ504 in position "B" (TEST POINT 26), TEST POINT 25 measures 5.0 VDC when the transmitter is de-activated at J301 pin 10.

Δ27 MONITOR / TONE REVERSAL INPUT

With PJ503 in position "A," TEST POINT 27 shows 0.7 VDC when in RECEIVE and STAND-BY, and 5.0 VDC when in TRANSMIT.

Δ28 Δ29 Δ30 Δ31 Δ32 Δ33 CTCSS TONE FREQUENCY PROGRAMMING INPUTS

TEST POINTS 28 through 33 read 5 VDC when in RECEIVE, TRANSMIT or STAND-BY with corresponding SW501 switches 6 through 1 open. TEST POINTS 28 through 33 measure 0.0 VDC when in RECEIVE, TRANSMIT or STAND-BY with corresponding SW501 switches 6 through 1 closed.

Δ34 + 5 VDC VOLTAGE REGULATOR

TEST POINT 34 reads 5.0 VDC when in RECEIVE, TRANSMIT or STAND-BY.

Δ35 + 8 VDC VOLTAGE REGULATOR

TEST POINT 35 shows 8.0 VDC when in RECEIVE, TRANSMIT or STAND-BY.

Δ36 TRANSMIT TEMPERATURE COMPENSATION REFERENCE VOLTAGE

TEST POINT 36 measures 6.0 VDC when in RECEIVE, TRANSMIT or STAND-BY at an ambient room temperature of +25°C.

Δ37 1/2 VCC VOLTAGE REFERENCE

TEST POINT 37 reads 4.0 VDC when in RECEIVE, TRANSMIT or STAND-BY.

Δ38 SPEECH AMP OUTPUT

TEST POINT 38 shows 4.0 VDC when in RECEIVE, TRANSMIT or STAND-BY. With the 1 KHz test signal applied to J301 pin 10, TEST POINT 38 measures 2 VAC peak-to-peak when in TRANSMIT.

Δ39 TRANSMIT AUDIO LIMITER OUTPUT

TEST POINT 39 measures 4.0 VDC when in RECEIVE, TRANSMIT or STAND-BY. With the 1 KHz test signal applied to J301 pin 10, TEST POINT 38 shows 8 VAC peak-to-peak when in TRANSMIT.

Δ40 Δ41 PJ201 SPEECH AMP INPUT

TEST POINT 40 or 41 reads 0.0 VDC when in RECEIVE, TRANSMIT or STAND-BY.

Δ42 TRANSMITTER OSCILLATOR +V

TEST POINT 42 reads 7.4 VDC when in TRANSMIT, and 0.0 VDC when in RECEIVE or STAND-BY.

Δ43 SWITCHED TRANSMITTER +V

TEST POINT 42 shows 8.0 VDC when in TRANSMIT, and 0.0 VDC when in RECEIVE or STAND-BY.

Δ44 Δ45 TRANSMITTER FINAL RF AMPLIFIER +V

TEST POINT 45 measures 12.0 VDC (with PJ201 in position "B") in TRANSMIT, RECEIVE or STAND-BY. With PJ201 in position "A" (TEST POINT 44), TEST POINT 45 reads 8.4 VDC in TRANSMIT, and 12 VDC in RECEIVE or STAND-BY.

RM-150 SCHEMATIC REFERENCE PARTS LIST

NOTE: This parts list reflects the most current component values (ECN 1916). If a component value given in the schematic differs from that in the parts list, the parts list should be considered correct.

REF #	DESCRIPTION	RITRON #
C101	.001 MF/Y5P 10% .1"LS RADIAL 50V	01516239
C102	.001 MF/Y5P 10% .1"LS RADIAL 50V	01516239
C103	27 PF/NP0 5% .1"LS RADIAL 50 V.	01510020
C104	3.3 PF/NP0 .25PF .1"LS RDL 50 V.	01510009
C105	6.8 PF/NP0 5% .1"LS RADIAL 50 V.	01510013
C106	.68 PF/P100 .25PF .1"LS RDL 50 V.	01508001
C107	5.6 PF/NP0 5% .1"LS RADIAL 50 V.	01510012
C108	.01 MF/Y5V 20% .2"LS RADIAL 25 V.	01516451
C109	.001 MF/Y5P 10% .1"LS RADIAL 50V	01516239
C110	.001 MF/Y5P 10% .1"LS RADIAL 50V	01516239
C111	10 PF/NP0 5% .1"LS RADIAL 50 V.	01510015
C112	.33 PF AXIAL LEADS	01501107
C113	8.2 PF/NP0 5% .1"LS RADIAL 50 V.	01510014
C114	1.8 PF/NP0 .25PF .1"LS RDL 50 V.	01510006
C115	5-27PF POLYCARB TRIM CAP	01550003
C116	12 PF/NP0 5% .1"LS RADIAL 50 V.	01510016
C117	.01 MF/Y5V 20% .2"LS RADIAL 25 V.	01516451
C118	.001 MF/Y5P 10% .1"LS RADIAL 50V	01516239
C119	6.8 PF/NP0 5% .1"LS RADIAL 50 V.	01510013
C120	33 PF/N75O 5% .1"LS RADIAL 50V.	01510721
C121	47 PF/N750 5% .1"LS RADIAL 50 V.	01510723
C122	.001 MF/Y5P 10% .1"LS RADIAL 50V	01516239
C123	100 PF/N150 5% .2"LS RDL 50 V.	01510127
C124	15 PF/NP0 5% .1"LS RADIAL 50 V.	01510017
C125	1.2 PF/NP0 .25PF .1"LS RDL 50 V.	01510004
C126	10 PF/NP0 5% .1"LS RADIAL 50 V.	01510015
C127	1.2 PF/NP0 .25PF .1"LS RDL 50 V.	01510004
C128	.01 MF/Y5V 20% .2"LS RADIAL 25 V.	01516451
C129	.1 MF/X7R 20% .1"LS RADIAL 50 V.	01515463
C130	8.2 PF/NP0 5% .1"LS RADIAL 50 V.	01510014
C131	.01 MF/Y5V 20% .2"LS RADIAL 25 V.	01516451
C132	CAPACITOR, FACTORY SELECT	01501000
C133	.01 MF/Y5V 20% .2"LS RADIAL 25 V.	01516451
C134	.001 MF/Y5P 10% .1"LS RADIAL 50V	01516239
C135	100 MFD 25VDC ELECT CAP	01503010
C136	.01 MF/Y5V 20% .2"LS RADIAL 25 V.	01516451
C137	39 PF/NP0 5% .1"LS RADIAL 50 V.	01510022
C138	150PF/N150 5% .2"LS RDL 50V CAP	01510129
C139	.1 MF/X7R 20% .1"LS RADIAL 50 V.	01515463
C140	.1 MF/X7R 20% .1"LS RADIAL 50 V.	01515463
C141	10 PF/NP0 5% .1"LS RADIAL 50 V.	01510015
C142	.1 MF/X7R 20% .1"LS RADIAL 50 V.	01515463
C143	.01 MF MYLAR 100V 10%	01501050
C144	.001 MF MYLAR .12"C 5% 100V CAP	01501040
C145	.001 MF MYLAR .12"C 5% 100V CAP	01501040
C146	.01 MF MYLAR 100V 10%	01501050
C147	.01 MF MYLAR 100V 10%	01501050
C148	.1 MF/X7R 20% .1"LS RADIAL 50 V.	01515463
C149	.1 MF/X7R 20% .1"LS RADIAL 50 V.	01515463
C150	.1 MF/X7R 20% .1"LS RADIAL 50 V.	01515463
C151	100 MFD 25VDC ELECT CAP	01503010
C152	220 MF, 16VDC, ELECT .2"LC	01503011
C153	.1 MF/X7R 20% .1"LS RADIAL 50 V.	01515463
C154	.1 MF/X7R 20% .1"LS RADIAL 50 V.	01515463
C155	2.2 MF 50V ELECT.CAP	01503003
C156	1 MF 35V TANTALUM CAPACITOR	01502007
C157	180 PF/N750 5% .2"LS RADIAL 50 V.	01510730
C158	.001 MF/Y5P 10% .1"LS RADIAL 50V	01516239
C159	47 PF/NPO 5% .1"LS RDL 50V	01510023
C201	.001 MF/Y5P 10% .1"LS RADIAL 50V	01516239
C202	.01 MF/Y5V 20% .2"LS RADIAL 25 V.	01516451
C203	.1 MF/X7R 20% .1"LS RADIAL 50 V.	01515463
C204	33 PF/N330 5% .1"LS RADIAL 50 V.	01510321
C205	.1 MF/X7R 20% .1"LS RADIAL 50 V.	01515463
C206	.001 MF/Y5P 10% .1"LS RADIAL 50V	01516239
C207	150 PF/N750 5% .2"LS RADIAL 50 V.	01510729
C208	180 PF/N750 5% .2"LS RADIAL 50 V.	01510730
C209	330 PF/N750 5% .2"LS RADIAL 50 V.	01510733
C210	.01 MF/Y5V 20% .2"LS RADIAL 25 V.	01516451
C211	.1 MF/X7R 20% .1"LS RADIAL 50 V.	01515463
C212	.001 MF/Y5P 10% .1"LS RADIAL 50V	01516239
C213	.01 MF/Y5V 20% .2"LS RADIAL 25 V.	01516451
C214	100 PF/COG 10% .1"LS RADIAL 50 V.	01515027
C215	1.8 PF/NP0 .25PF .1"LS RDL 50 V.	01510006
C216	150PF/N150 5% .2"LS RDL 50V CAP	01510129
C217	220 PF/COG 10% .1"LS RADIAL 50 V.	01515031
C218	.01 MF/Y5V 20% .2"LS RADIAL 25 V.	01516451
C219	.001 MF/Y5P 10% .1"LS RADIAL 50V	01516239
C220	39 PF/NP0 5% .1"LS RADIAL 50 V.	01510022
C221	4.7 PF/NP0 5% .1"LS RADIAL 50 V.	01510011
C222	56PF/NPO 5% .1"LS RADIAL 50V	01510024
C223	68 PF/N150 5% .1"LS RADIAL 50 V.	01510125
C224	4.7 PF/NP0 5% .1"LS RADIAL 50 V.	01510011
C225	10 PF/NP0 5% .1"LS RADIAL 50 V.	01510015
C226	.01 MF/Y5V 20% .2"LS RADIAL 25 V.	01516451
C227	.001 MF/Y5P 10% .1"LS RADIAL 50V	01516239
C228	10 MFD 16V TANT CAP 20%	01502013
C229	150 PF/N750 5% .2"LS RADIAL 50 V.	01510729
C230	1.2 PF/NP0 .25PF .1"LS RDL 50 V.	01510004
C231	12 PF/NP0 5% .1"LS RADIAL 50 V.	01510016
C232	33 PF/NP0 5% .1"LS RADIAL 50 V.	01510021
C233	.001 MF/Y5P 10% .1"LS RADIAL 50V	01516239
C234	.01 MF/Y5V 20% .2"LS RADIAL 25 V.	01516451
C235	.1 MF/X7R 20% .1"LS RADIAL 50 V.	01515463
C236	150 PF/N750 5% .2"LS RADIAL 50 V.	01510729
C237	12 PF/NP0 5% .1"LS RADIAL 50 V.	01510016
C238	5-27PF POLYCARB TRIM CAP	01550003
C239	.1 MF/X7R 20% .1"LS RADIAL 50 V.	01515463
C240	CAPACITOR, FACTORY SELECT	01501000
C241	.01 MF MYLAR 100V 10%	01501050
C242	.001 MF/Y5P 10% .1"LS RADIAL 50V	01516239
C243	150 PF/N750 5% .2"LS RADIAL 50 V.	01510729
C245	.0047 MF MYLAR .12"LS 10%	01501045
C246	10 MF 16V ELECTROLYTIC CAPACITOR	01503006
C247	10 MF 16V ELECTROLYTIC CAPACITOR	01503006
C248	10 MF 16V ELECTROLYTIC CAPACITOR	01503006
C249	.0012 MF, MYLAR	01501069
C250	470 PF COG 10% 50V .1" LS	01515035
C251	270 PF/NPO 5% .2"LS RADIAL 50V	01510032
C252	.01 MF MYLAR 100V 10%	01501050
C301	10 MF 16V ELECTROLYTIC CAPACITOR	01503006
C302	10 MF 16V ELECTROLYTIC CAPACITOR	01503006
C303	.001 MF/Y5P 10% .1"LS RADIAL 50V	01516239
C304	.001 MF/Y5P 10% .1"LS RADIAL 50V	01516239
C305	.001 MF/Y5P 10% .1"LS RADIAL 50V	01516239
C306	150 PF/N750 5% .2"LS RADIAL 50 V.	01510729
C307	6.8 PF/NP0 5% .1"LS RADIAL 50 V.	01510013
C308	2.7 PF/NP0 .25PF .1"LS RDL 50 V.	01510008
C309	18 PF/NPO 5% .1"LS RADIAL 50 V.	01510018
C310	1.0 PF/NPO .25PF .1"LS RDL 50V.	01510003
C311	33 PF/NP0 5% .1"LS RADIAL 50 V.	01510021
C501	10 MFD 16V TANT CAP 20%	01502013
C502	33 PF/NP0 5% .1"LS RADIAL 50 V.	01510021
C503	33 PF/NP0 5% .1"LS RADIAL 50 V.	01510021

RM-150 SCHEMATIC REFERENCE PARTS LIST

REF #	DESCRIPTION	RITRON #
C504	1 MF 35V TANTALUM CAPACITOR	01502007
C505	.1 MF/X7R 20% .1"LS RADIAL 50 V.	01515463
C507	4.7 MFD 20V TANTALUM CAP	01502011
C508	.1 MF/X7R 20% .1"LS RADIAL 50 V.	01515463
C509	.47 MF 35V TANTALUM CAP	01502005
C510	.1 MF/X7R 20% .1"LS RADIAL 50 V.	01515463
C511	150 PF/N750 5% .2"LS RADIAL 50 V.	01510729
C512	.0047 MF MYLAR .12"LS 10%	01501045
C513	1MF 35V TANTALUM CAPACITOR	01502007
CR101	DIODE, PIN, UHF 10W, DO-34PKG	04810032
CR102	1N4148, DIODE/GENERAL PURPOSE	04810001
CR103	1N5231/1N4733 5.1V ZENER	04820006
CR104	1N4148, DIODE/GENERAL PURPOSE	04810001
CR105	1N4148, DIODE/GENERAL PURPOSE	04810001
CR106	1N4148, DIODE/GENERAL PURPOSE	04810001
CR107	1N4148, DIODE/GENERAL PURPOSE	04810001
CR201	MV-2113 VARICAP	04810013
CR203	1N4148, DIODE/GENERAL PURPOSE	04810001
CR204	DIODE, FACTORY SELECT	04810000
CR301	1N4148, DIODE/GENERAL PURPOSE	04810001
CR302	DIODE, PIN, UHF 10W, DO-34PKG	04810032
CR501	1N4148, DIODE/GENERAL PURPOSE	04810001
CR502	1N4148, DIODE/GENERAL PURPOSE	04810001
CR503	1N4148, DIODE/GENERAL PURPOSE	04810001
CR504	1N4148, DIODE/GENERAL PURPOSE	04810001
CR505	1N4148, DIODE/GENERAL PURPOSE	04810001
CR506	1N4148, DIODE/GENERAL PURPOSE	04810001
HD3	RM-150 MANUAL (REV D)	01451069
HD4	10MM SHIELD CAN AURA	02500003
HD16	CRYSTAL SUPPORT	02800114
IC101	MC3357P FM IF SUBSYSTEM	03131010
IC102	LM358N, PNP DUAL OP AMP	03131003
IC103	LM386N-3, AUDIO PWR AMP	03131009
IC201	CA3260E DUAL BI-MOS OP AMP	03131017
IC202	CA3260E DUAL BI-MOS OP AMP	03131017
IC203	LM2930-8V regulator	03131051
IC301	MC78M08CT, 8 VOLTAGE REG	03131015
IC501	MX-365P DIP PKG ENCODE/DECODE	03132058
IC502	CA3260E DUAL BI-MOS OP AMP	03131017
IC503	CD4066BCP, QUAD ANALOG GATE	03134066
IC504	MC78L05CP 5V REGULATOR	03131012
J301	10 PIN METHODE SOCKET	02100157
L101	4.5T SW STANDEX UNICOIL	01850044
L102	4.5T SW STANDEX UNICOIL	01850044
L103	2.5T 0.093LHH 26AWG CW COIL	01870952
L104	3.5T SW STANDEX UNICOIL	01850043
L105	4.5T SW STANDEX UNICOIL	01850044
L106	.15UH MOLDED COIL	01800203
L107	.56 UHY WILCO ML56S-C	01800104
L108	1 UH MOLDED COIL	01800213
L109	3.5T SW STANDEX UNICOIL	01850043
L110	4.5T SW STANDEX UNICOIL	01850044
L201	1.5-5 UH C.T. SHLD COIL	01850106
L202	6.5T SW STANDEX UNICOIL	01850046
L203	6.5T SW STANDEX UNICOIL	01850046
L204	4.5T SW STANDEX UNICOIL	01850044
L205	4.5T SW STANDEX UNICOIL	01850044
L206	4.7 UH WILCO	01800115
L207	5T COIL ON 2.7K 10% 1/4W CC	01800121
L208	3.5T SW STANDEX UNICOIL	01850043
L209	3.5T SW STANDEX UNICOIL	01850043
L210	4.5T 0.093LHH 26AWG CW COIL	01870954
L211	6.5T 0.093LHH 26AWG CW COIL	01870956
L301	1 UH MOLDED COIL	01800213
L302	6.5T 0.093LHH 26AWG CW COIL	01870956
L303	5.5T 0.093LHH 26AWG CW COIL	01870955
L304	4.5T 0.093LHH 26AWG CW COIL	01870954
PJ101	2 PIN SHORTING PLUG	02100075
PJ101	METHODE 1100-1-103-02	02100024
PJ201	2 PIN SHORTING PLUG0	02100075
PJ201	METHODE 1100-1-103-02	02100024
PJ202	2 PIN SHORTING PLUG	02100075
PJ202	METHODE 1100-1-103-02	02100024
PJ301	2 PIN SHORTING PLUG	02100075
PJ301	METHODE 1100-1-103-02	02100024
PJ501	2 PIN SHORTING PLUG	02100075
PJ501	METHODE 1100-1-103-02	02100024
PJ502	2 PIN SHORTING PLUG	02100075
PJ502	METHODE 1100-1-103-02	02100024
PJ503	2 PIN SHORTING PLUG	02100075
PJ503	METHODE 1100-1-103-02	02100024
PJ504	2 PIN SHORTING PLUG	02100075
PJ504	METHODE 1100-1-103-02	02100024
Q101	MPS-H07 NPN VHF AGC AMP	04800003
Q102	MPS3563 NPN RF AMPLIFIER	04800002
Q103	2N4126 PNP GP AUDIO TO-92	04800011
Q105	2N5484 FET, N-CHANNEL	04800037
Q106	MPS3563 NPN RF AMPLIFIER	04800002
Q107	MPS-4124 NPN LOW NOISE AUD.	04800006
Q108	MPS-4124 NPN LOW NOISE AUD.	04800006
Q201	MPS3563 NPN RF AMPLIFIER	04800002
Q202	MPS3563 NPN RF AMPLIFIER	04800002
Q203	MPS-H10 NPN RF AMPLIFIER	04800016
Q204	2N4427 NPN RF AMP TO-5	04801000
Q205	MRF-237 NPN VHF AMP TO-39 4T	04801002
Q207	TRANSISTOR, FACTORY SELECT	04800000
Q301	2N6726 PNP PWR TRAN	04800018
Q302	MPS-W01, PNP TRANS	04800048
Q303	2N4126 PNP GP AUDIO TO-92	04800011
Q501	MPS-4124 NPN LOW NOISE AUD.	04800006
Q502	MPS-4124 NPN LOW NOISE AUD.	04800006
R101	1.8K OHM 5% 1/4W CF	04700136
R102	10K OHM 5% 1/4W CF	04700145
R103	2.2K OHM 5% 1/4W CF	04700137
R104	1.8K OHM 5% 1/4W CF	04700136
R105	22K OHM 5% 1/4W CF	04700149
R106	22K OHM 5% 1/4W CF	04700149
R107	THERMISTOR, 200 OHM	04750101
R108	1K OHM 5% 1/4W CF	04700133
R109	150 OHM 5% 1/4W CF	04700123
R110	100 OHM 5% 1/4W CF	04700121
R111	47 OHM 5% 1/4W CF	04700117
R112	150 OHM 5% 1/4W CF	04700123
R113	10K OHM 5% 1/4W CF	04700145
R114	47 OHM 5% 1/4W CF	04700117
R116	560 OHM 5% 1/4W CF	04700130
R117	3.9K OHM 5% 1/4W CF	04700140
R118	12K OHM 5% 1/4W CF	04700146
R119	3.3K OHM 5% 1/4W CF	04700139
R120	5.6K OHM 5% 1/4W CF	04700142
R121	100 OHM 5% 1/4W CF	04700121
R122	1.8K OHM 5% 1/4W CF	04700136

RM-150 SCHEMATIC REFERENCE PARTS LIST

REF #	DESCRIPTION	RITRON #
R123	1.8K OHM 5% 1/4W CF	04700136
R124	47K OHM 5% 1/4W CF	04700153
R125	22K OHM 5% 1/4W CF	04700149
R126	2.2K OHM 5% 1/4W CF	04700137
R127	6.8K OHM 5% 1/4W CF	04700143
R128	5.6K OHM 5% 1/4W CF	04700142
R129	100K OHM 5% 1/4W CF	04700157
R130	10K OHM 5% 1/4W CF	04700145
R131	10K OHM 5% 1/4W CF	04700145
R132	390 OHM 1/4W 5% CF RESISTOR	04700128
R133	820 OHM 5% 1/4W CF	04700132
R134	10K OHM 5% 1/4W CF	04700145
R135	10K OHM 5% 1/4W CF	04700145
R136	4.7K OHM 5% 1/4W CF	04700141
R137	10K OHM 5% 1/4W CF	04700145
R138	220K OHM 5% 1/4W CF	04700161
R139	100K OHM 5% 1/4W CF	04700157
R140	100K MINI POT,HORZ	04750028
R141	15K OHM 5% 1/4W CF	04700147
R142	10K OHM 5% 1/4W CF	04700145
R143	10K OHM 5% 1/4W CF	04700145
R144	220 OHM 5% 1/4W CF	04700125
R145	10K OHM TRIM POT/HORZ MOUNT	04750008
R146	10 OHM 5% 1/4W CF	04700108
R147	ZERO OHM 5% 1/4W CF RESISTOR	04720009
R148	1K OHM 5% 1/4W CF	04700133
R201	150 OHM 5% 1/4W CF	04700123
R202	12K OHM 5% 1/4W CF	04700146
R203	22K OHM 5% 1/4W CF	04700149
R204	10 OHM 5% 1/4W CF	04700108
R205	390 OHM 1/4W 5% CF RESISTOR	04700128
R206	680 OHM 5% 1/4W CF	04700131
R207	330 OHM 5% 1/4W CF	04700127
R208	10 OHM 5% 1/4W CF	04700108
R209	12K OHM 5% 1/4W CF	04700146
R210	3.9K OHM 5% 1/4W CF	04700140
R211	100 OHM 5% 1/4W CF	04700121
R212	1.2K OHM 5% 1/4W CF	04700134
R213	10 OHM 5% 1/4W CF	04700108
R214	1K OHM 5% 1/4W CF	04700133
R215	22 OHM 1/2W 5% CARBON COMP	04710012
R216	22 OHM 1W METAL FILM RESISTOR	04710824
R217	22 OHM 1W METAL FILM RESISTOR	04710824
R218	FACTORY SELECT 1/4W 5%	04700000
R219	56K OHM 1/4W 5% CF	04700154
R220	100K MINI POT,HORZ	04750028
R221	10K OHM 5% 1/4W CF	04700145
R222	68K OHM 5% 1/4W CF	04700155
R223	10K OHM 5% 1/4W CF	04700145
R224	10K OHM 5% 1/4W CF	04700145
R225	82K OHM 5% 1/4W CF	04700156
R226	68K OHM 5% 1/4W CF	04700155
R227	10K OHM 5% 1/4W CF	04700145
R228	56K OHM 1/4W 5% CF	04700154
R229	220K OHM 5% 1/4W CF	04700161
R230	10K OHM TRIM POT/HORZ MOUNT	04750008
R231	5.6K OHM 5% 1/4W CF	04700142
R232	FACTORY SELECT 1/4W 5%	04700000
R233	FACTORY SELECT 1/4W 5%	04700000
R234	FACTORY SELECT 1/4W 5%	04700000
R235	FACTORY SELECT 1/4W 5%	04700000
R236	39K OHM 5% 1/4W CF	04700152
R237	10K OHM 5% 1/4W CF	04700145
R238	THERMISTOR, 10K OHM	04750100
R239	FACTORY SELECT 1/4W 5%	04700000

REF #	DESCRIPTION	RITRON #
R240	FACTORY SELECT 1/4W 5%	04700000
R241	FACTORY SELECT 1/4W 5%	04700000
R301	1K OHM 5% 1/4W CF	04700133
R302	150 OHM, 1/2W, 5% CF RESISTOR	04710022
R303	10K OHM 5% 1/4W CF	04700145
R304	100K OHM 5% 1/4W CF	04700157
R305	330 OHM 5% 1/4W CF	04700127
R306	1K OHM 5% 1/4W CF	04700133
R501	1M OHM 5% 1/4W CF	04700169
R503	10K OHM 5% 1/4W CF	04700145
R504	10K OHM 5% 1/4W CF	04700145
R505	560K OHM 5% 1/4W CF	04700166
R506	820K OHM 5% 1/4W CF	04700168
R507	100K OHM 5% 1/4W CF	04700157
R508	220K OHM 5% 1/4W CF	04700161
R509	100K OHM 5% 1/4W CF	04700157
R510	10K OHM 5% 1/4W CF	04700145
R511	270K OHM 5% 1/4W CF	04700162
R512	220K OHM 5% 1/4W CF	04700161
R513	270K OHM 5% 1/4W CF	04700162
R514	100K OHM 5% 1/4W CF	04700157
R515	4.7K OHM 5% 1/4W CF	04700141
R516	10K OHM 5% 1/4W CF	04700145
R517	10K OHM 5% 1/4W CF	04700145
R518	10K OHM 5% 1/4W CF	04700145
R519	33K OHM 5% 1/4W CF	04700151
R520	10K OHM 5% 1/4W CF	04700145
R521	10K OHM 5% 1/4W CF	04700145
R522	100K OHM 5% 1/4W CF	04700157
R523	100K OHM 5% 1/4W CF	04700157
R524	100K OHM 5% 1/4W CF	04700157
SW501	6 POSITION DIP SWITCH	05100023
T101	10.7MHZ IF XFORMER/ZAMCO	05600001
T102	455KHZ IF XFORMER/ZAMCO	05600002
Y102	10.245MHZ 2ND LO XTAL	02300004
Y501	1 MHZ XTAL SUB-MINIATURE HC-45	02300028
YF101	10.7MHZ 2 POLE MONO FILT	02301001
YF102	10.7MHZ 2 POLE MONO FILT	02301001
YF103	455KHZ CERAMIC FILTER (6 POLE)	02301009
Z101	FAIR-RITE BEAD ON AXIAL LEADS	01801029
Z102	FAIR-RITE BEAD ON AXIAL LEADS	01801029
Z103	FAIR-RITE BEAD ON AXIAL LEADS	01801029
Z105	FAIR-RITE BEAD ON AXIAL LEADS	01801029
Z201	FAIR-RITE BEAD ON AXIAL LEADS	01801029
Z202	FAIR-RITE BEAD ON AXIAL LEADS	01801029
Z203	FAIR-RITE BEAD ON AXIAL LEADS	01801029
Z204	FAIR-RITE BEAD ON AXIAL LEADS	01801029
Z205	FAIR-RITE BEAD ON AXIAL LEADS	01801029
Z206	FAIR-RITE BEAD ON AXIAL LEADS	01801029
Z207	FAIR-RITE BEAD ON AXIAL LEADS	01801029
Z209	FAIR-RITE BEAD ON AXIAL LEADS	01801029

REVISIONS		
REV	ECN #	DATE
Q	1695	4/23/98

VHF RF AMPLIFIER

1st LOCAL OSCILLATOR

10.7 MHZ I.F.

2nd L.O.

455KHZ I.F.

CTCSS ENCODER/DECODER

TONE SQUELCH

AUDIO AMP

AUDIO LIMITER/18dB OCTAVE LOW PASS

DE-EMPHASIS

TX KEYING

PTT

+8V REGULATOR

TO CR181 CATHODE

TO RF AMPLIFIER C184

TO R139

TO Q382 COLLECTOR

RF INPUT FROM L384

ANTENNA

* FACTORY SELECT

▽ TEST POINTS

LAST NUMBERS USED

C159	C252	C311	C513
R148	R241	R386	R524
L118	L211	L304	
Q188	Q287	Q303	Q582
Z185	Z209		
CR187	CR284	CR382	CR586

NUMBERS MISSING

R115	C244	C506
Q184	Q286	R582
Z184	Z208	
	CR282	

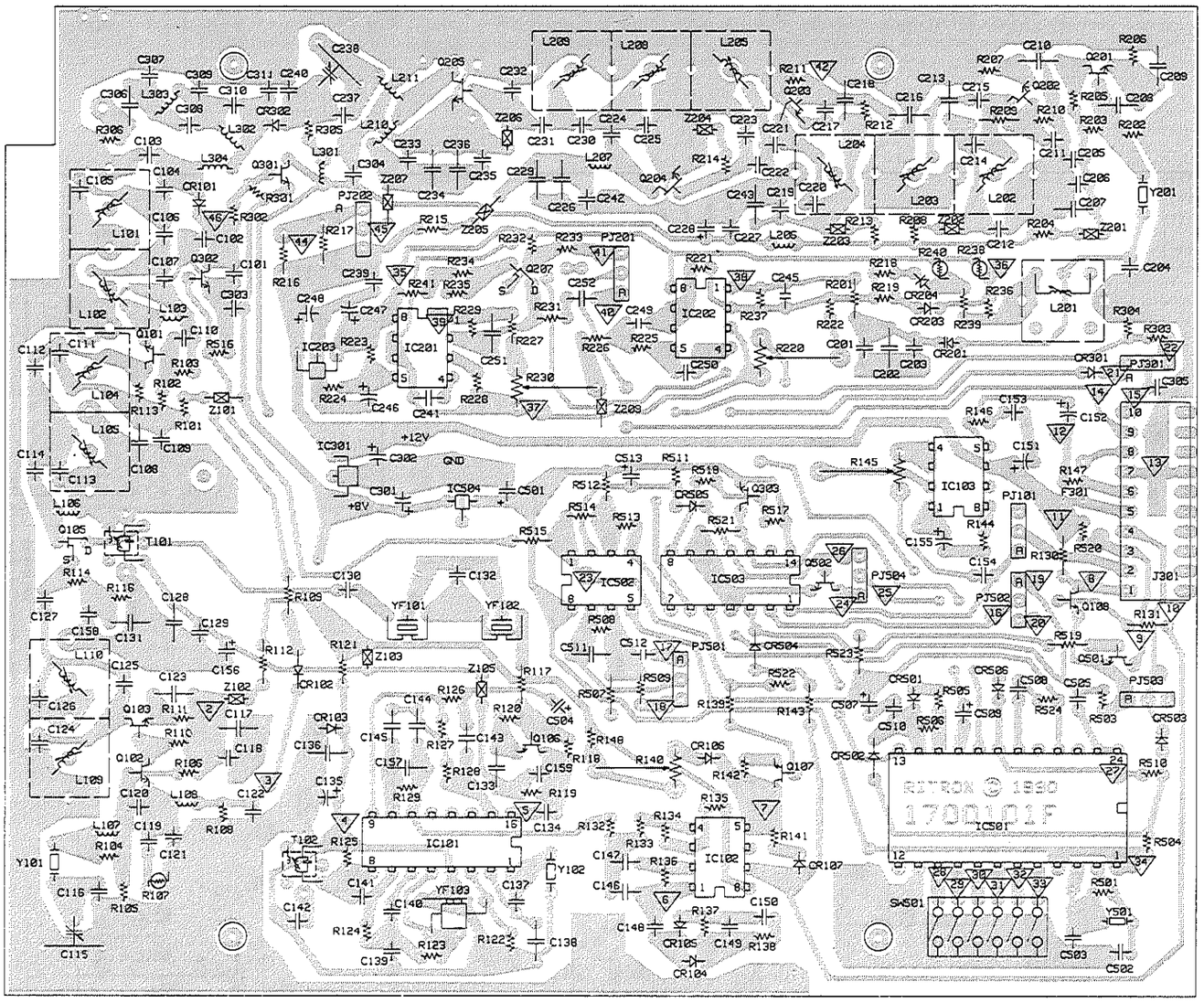
LAST ECN #1695

TOPSIDE PARTS PLACEMENT	1750101	REV N
BOTTOMSIDE PARTS PLACEMENT	1760101	REV L
PC BOARD	1700101	REV F

RITRON INC
505 W CARMEL DRIVE CARMEL IN 46032

RM-150
SCHEMATIC

SIZE	FSCM NO.	DWG NO.	REV
D		1770101	Q
	DATE 4/25/90	PLOT 4/25/90	

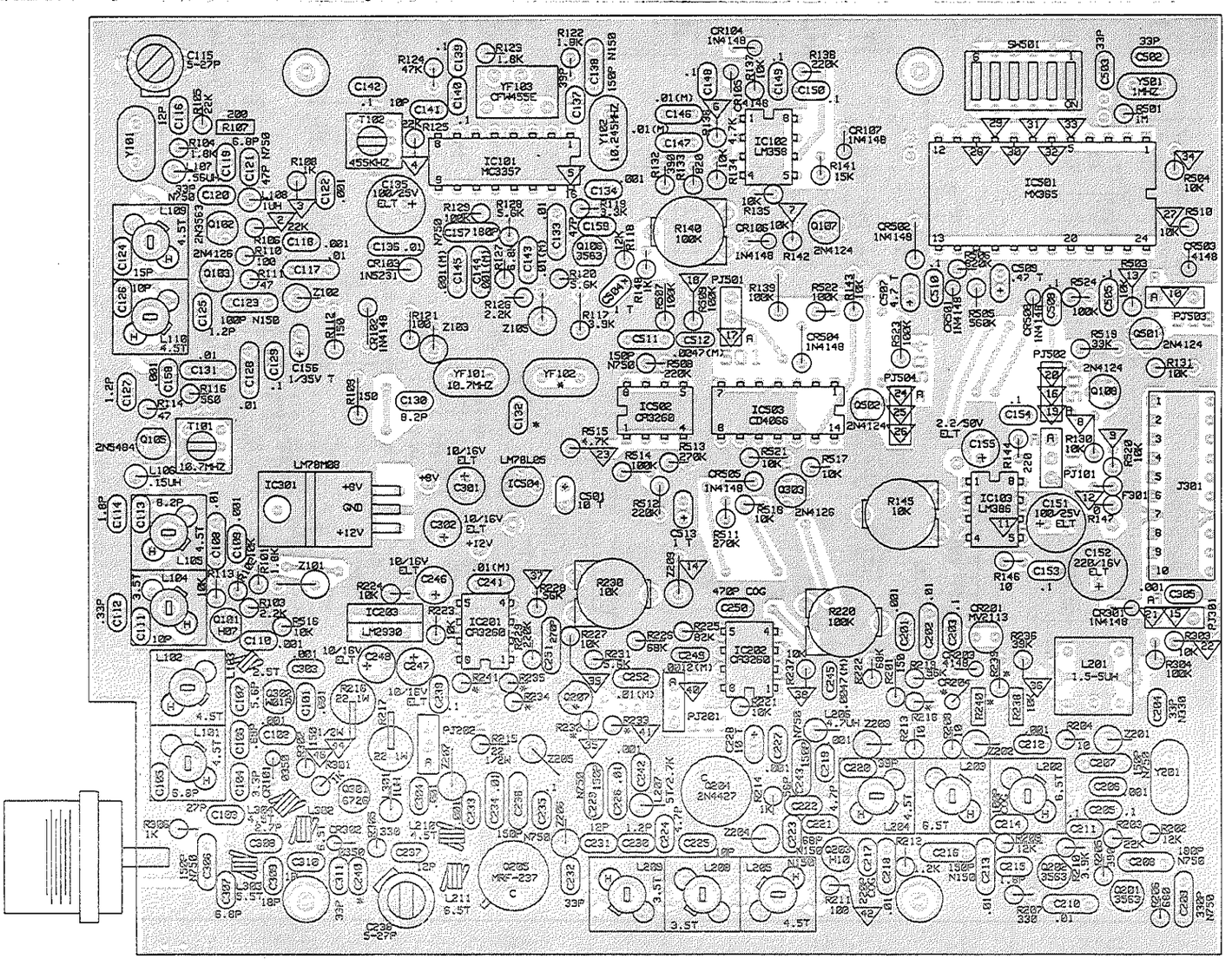


SCHEMATIC 1770101 REV Q
TOPSIDE PARTS PLACEMENT 1750101 REV N
PC BOARD 1700101 REV F

LAST ECN #1695

RITRON INC
CARMEL IN

RM-150
BOTTOMSIDE PARTS PLACEMENT
1760101
REV L



SCHEMATIC 1770101 REV Q
BOTTOMSIDE PARTS PLACEMENT 1760101 REV L
PC BOARD 1700101 REV F

RITRON INC
CARMEL IN

* DENOTES FACTORY SELECT

LAST ECN #1695

RM-150
TOPSIDE PARTS PLACEMENT
1750101
REV N