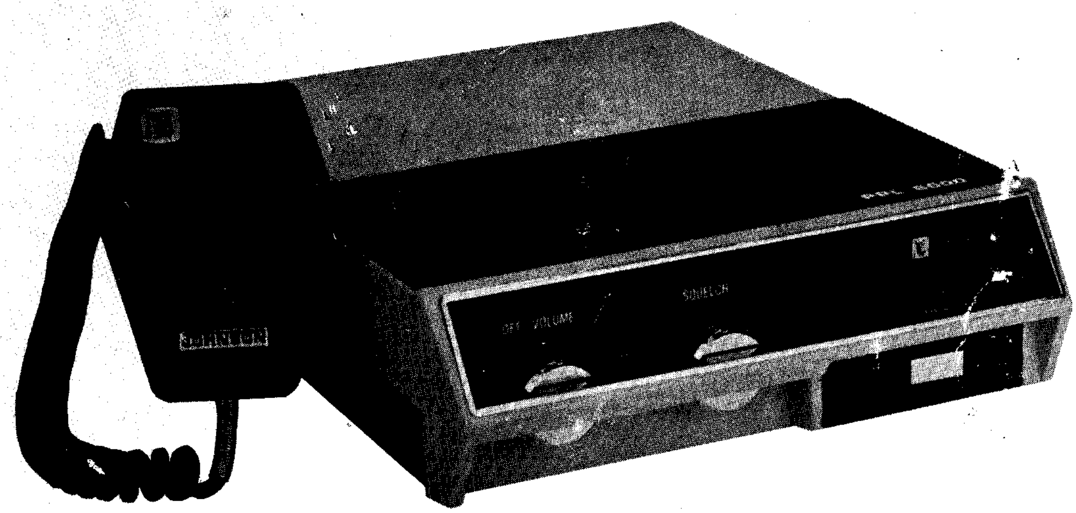
Shop

SERVICE MANUAL

JOHNSON
PPL-6060
450-512 MHz FM
TWO-WAY RADIO



1st Printing
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June, 1978

13.8 VDC OPERATED
15 WATT RF OUTPUT
PART NO. 242-6060-XXX

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SECTION 1
GENERAL INFORMATION

1.1 SCOPE OF MANUAL

This service manual includes installation, service and alignment instructions for the PPL-6060 UHF FM transceiver, Part No. 242-6060-XXX. Revision sheets, service bulletins and service manual additions will be published as changes are made to this transceiver.

1.2 TRANSCEIVER DESCRIPTION

The Johnson PPL-6060 UHF FM transceiver is completely solid state and provides 15 watts of RF power in the 450 to 512 MHz range. Audio processing in the transmitter and receiver is accomplished by linear operational amplifiers. The receiver uses an integrated limiter/quadrature detector for audio reproduction.

The self-contained unit weighs approximately 2.13 kg and can be dash or hump mounted in a mobile installation.

1.3 PPL-6060 MODELS

The following breakdown shows the part number scheme used for the PPL-6060 models.

242 - 6060 - X XX

- 242: Two Way Radio
- 6060: 15 Watt UHF Transceivers
- X:
  - 1 = One channel
  - 2 = Two channel
  - 3 = Two transmit, one receive
  - 4 = Four channel
  - 5 = One channel Canadian
  - 6 = Two channel Canadian
- XX: System, Refer to Table 1-1

TABLE 1-1
SYSTEM OPTIONS

Included Accessories		System Part Numbers							
Description	Part Number	01	02	03	04	05	06	07	08
Speaker, 4 Inch External	250-0064-003						x	x	x
DC Cable and Mounting Kit	023-4144-001	x	x	x	x	x	x	x	x
Microphone, Heavy Duty	250-0740-004	x	x	x	x	x	x	x	x
Receiver Crystal [1][2]	521-6xxx-xxx		x	x	x	x	x	x	x
Transmitter Crystal [1][2]	521-0xxx-xxx		x	x	x	x	x	x	x
Call Guard*	023-3997-001			x		x	x		x
Internal Accessory Mounting Kit	023-3050-003				x	x		x	x
Time Out Timer	023-3008-003				x	x		x	x

NOTES:

[1] The number of crystals required depends upon the channel capability.
[2] Crystal part numbers are determined by the frequency assignment. The crystal part number includes the compensating component.
* Early transceivers may be equipped with Universal Call Guard, Part No. 544-9005-202.

1.4 TRANSCEIVER IDENTIFICATION

The E. F. Johnson Company uses a strip of cloth tape attached to the chassis heat sink fin which includes the transceiver model number, revision letter, date of manufacture and serial number.

Example:

Model No.	Revision Letter	Date Mfd.	Warranty No.
6060	A	068	87237

1.5 FACTORY CUSTOMER SERVICE

A liaison between the customer and the factory is provided by the E. F. Johnson Company Customer Service Department. This department is available for consultation and availability of local and factory repair facilities.

If you write to the Customer Service Department, please include any information that may be helpful in solving your problem.

Contact: E. F. Johnson Company
Customer Service Department
Waseca, Minnesota 56093
Phone: (507)835-6222

1.6 FACTORY RETURNS

Repair service is normally available through local authorized Johnson FM radio Service Centers; a list of these service centers is available from the factory Customer Service Department upon request. Do not return any equipment to the factory without authorization from the Customer Service Department. Return all accessories used with the transceiver.

1.7 REPLACEMENT PARTS

The authorized Johnson Service Centers stock commonly needed replacement parts. When a part is not available locally, it can be ordered from the Customer Service Department. When ordering, please supply the following information:

Model number of the unit
Warranty number of the unit
Description of the part
Part number of the part

SECTION 2
SPECIFICATIONS

2.1 GENERAL

Frequency Range	450-512 MHz
Channels	1, 2, 4
Channel Spacing	25 kHz
Dimensions of Enclosure	60 mm x 191 mm x 264.5 mm
Unit Weight	2.13 kg
Compliance	FCC Type Designation 242-6060 Parts 15, 21, 89, 91, 93, 95
Channel Spread	2 MHz
Duty Cycle	100%
IF Frequencies	10.7 MHz and 455 kHz
Battery Drain	0.4 amperes at 13.8 VDC squelched
Input Impedance	50 ohm nominal
Speaker Impedance	3 ohm

2.2 RECEIVER

(Measurements made per EIA RS-204A)

Sensitivity	
EIA 12 dB SINAD	0.30 μV
20 dB quieting	0.40 μV
Squelch Sensitivity	0.25 μV
Modulation Acceptance	± 7.5 kHz
Selectivity	-80 dB
Spurious and Image	-85 dB
Intermodulation	-75 dB
Audio Output Power	5 watts at 5% distortion (3 ohm)
Audio Response	+2, -8 dB from a 6 dB/octave de-emphasis characteristics, from 300 to 3000 Hz
Hum and Noise	50 dB
Frequency Stability	± 5 PPM

2.3 TRANSMITTER

(Measurements made per EIA RS-152B)

RF Power Output	15 watts minimum
DC Input Power	60 watts maximum
Spurious and Harmonic	-66 dB
Audio Distortion	Less than 3% at 1000 Hz, ±3kHz deviation
Audio Frequency Response	+1, -3 dB from a 6 dB/octave pre-emphasis characteristics, from 300 to 3000 Hz
FM Hum and Noise	-60 dB
Modulation	15F2 and 16F3
Frequency Stability	± 5 PPM from -30 to +60^{o}C
Channel Spread	5 MHz
Duty Cycle	20%
Load Impedance	50 ohms
Battery Drain	4.5 amperes at 13.8 VDC
Circuit Protection	5 ampere fuse

The E. F. Johnson Company reserves the right to change prices or specifications without notice and without incurring obligations. Transceiver specifications are included for reference only. Refer to current product advertising sheets for up-to-date specifications.

SECTION 3
INSTALLATION

3.1 SCOPE OF INSTRUCTIONS

Since each transceiver installation has its own peculiarities, only a checklist of important steps and unique operations is included herein. These instructions are intended as a general guideline to familiarize the installer with the installation components and connections of this transceiver.

3.2 MOBILE INSTALLATION

a. Prior to installation, bench check the transceiver for receiver sensitivity, transmitter frequency, deviation and power output.

b. Install the antenna in the desired location and route the transmission line to the transceiver location. Refer to the antenna manufacturer's installation instructions for details.

c. Refer to Figure 3-1 for mobile installation component information.

d. Select the proper components for your installation and mount the transceiver using necessary hardware. Connect the antenna transmission line and power source as outlined below.

1. Disconnect negative battery cable.

2. Route the red lead from power connector through firewall (either using an existing hole or cutting a new one, as necessary). The hole must be large enough to clear the fuseholder and should be sealed with putty.

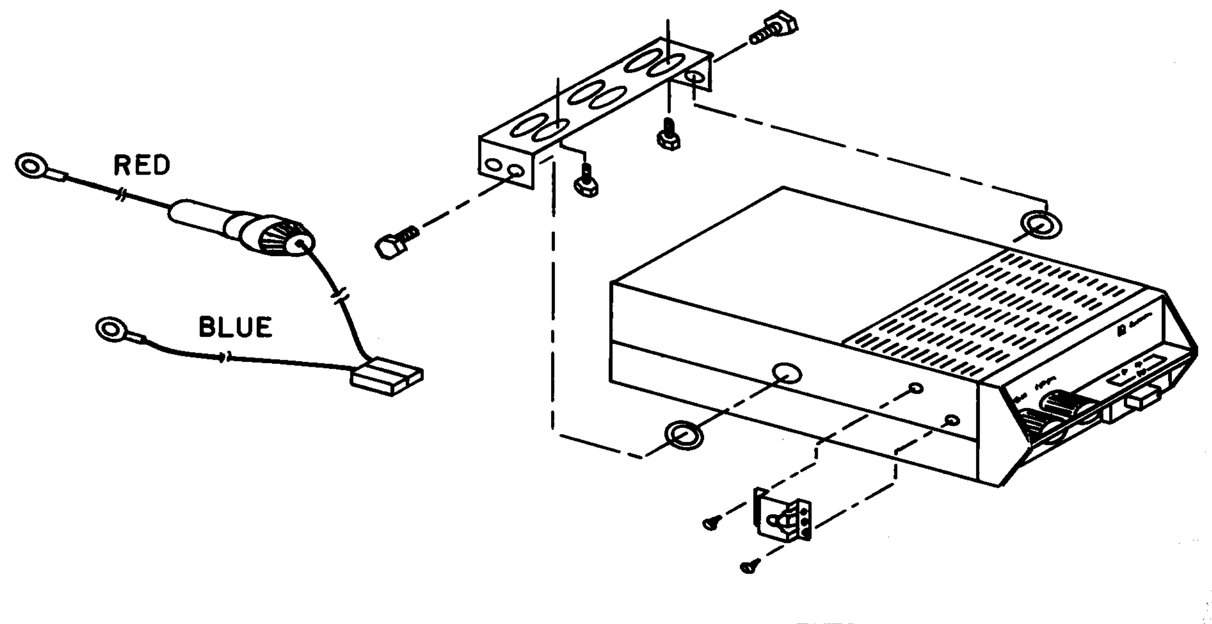
3. Connect the ring terminal of the red lead to the positive (+) terminal of the battery.

4. Connect the ring terminal of the blue power lead to a good ground point of the vehicle.

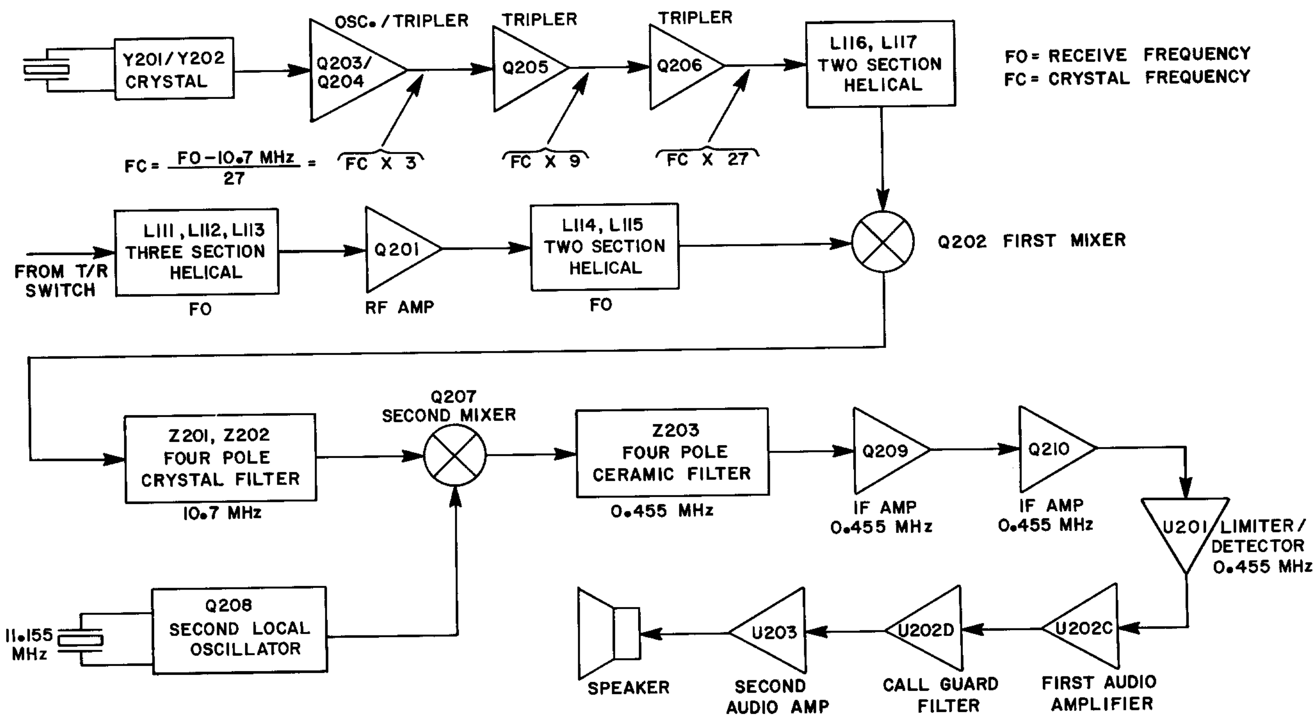
5. Plug the power connector into the rear of the transceiver.

6. Reconnect the negative battery cable.

7. Perform an operational test of the system.



MOBILE INSTALLATION COMPONENTS
FIGURE 3-1
37-297-002



RECEIVER BLOCK DIAGRAM
FIGURE 4-1
37-297-003

SECTION 4
CIRCUIT DESCRIPTION

4.1 GENERAL

The PPL-6060 transceiver is a fully solid state FM transceiver operating in the 450 to 512 MHz frequency range. The transceiver operates on one or more channels utilizing crystal controlled oscillators and linear operational amplifiers for receive and transmitter audio processing and squelch. Helical filters are employed in the receiver front end and in the transmitter predriver for selectivity and filtering. The transmitter RF power output is controlled by a discrete three stage power control circuit.

4.1.1 Receiver

Refer to the receiver block diagram, Figure 4-1. The receiver is a dual conversion type with RF selectivity as determined by helical filters. The received RF is coupled from transmit/receive switch CR1, CR2, CR3 and CR4 to the three section helical filter L111, L112 and L113. The filtered RF is then amplified by RF amplifier Q201 and filtered again by L114 and L115 then coupled to the gate of mixer transistor Q202. The receive oscillator, Q203; first tripler Q205 and second tripler Q206 provide the mixing frequency for the high IF to the mixer through a two-stage helical filter L116 and L117. The mixing frequency, at the source of Q202, is the receive frequency minus 10.7 MHz. The output of mixer Q202, 10.7 MHz, is filtered through four pole crystal filter Z201, Z202 and coupled to the base of second mixer Q207. The second receiver oscillator, Q208, operates at 11.155 MHz which is injected to the second mixer base lead. The difference output of 455 kHz from the second mixer is filtered through four pole crystal filter Z203 then amplified through two stages of IF amplification Q209 and Q210 which provide approximately 55 dB of gain. The receive audio is derived by limiter/quadrature detector U201 and amplified by U202C, U202D and U203 to drive the speaker.

4.1.2 Transmitter

Figure 4-2 shows the block diagram of the transmitter. A quad operational amplifier, U301, provides audio processing in the transmitter. First audio amplifier U301A provides amplification and impedance matching to the audio from the microphone. Clipper U301B is the audio compressor along with CR308, CR309, CR310, and CR311. Further gain and filtering are accomplished by U301C and U301D respectively. Audio modulation is applied to transmit oscillator Q301 through deviation adjust R305. The transmit oscillator crystal frequency is multiplied 24 times to the UHF frequency ranges by amplifier/multipliers Q303, Q304 and Q306. Buffer amplifier Q305 provides gain and isolation between the oscillator stages and the RF amplifier stages. The modulated RF frequencies are then amplified by three stages of discrete transistor amplifiers to provide 16 watts RF output power. The output of the final amplifier is coupled through a low pass harmonic filter to the antenna. A DC sample is coupled from the final amplifier to the power control circuit. The power control circuit, Q101, Q102 and Q103 senses if the transmitted RF power is too high or too low and, as a result, controls the gain of the predriver stage to adjust the transmitter radiated power output.

4.2 RECEIVER

4.2.1 Transmit and Receive Switching

In the receive mode, diodes CR1 through CR4 are biased off and the $\lambda/4$ wave line provides low impedance to the UHF frequencies. The receive signal is coupled through C12 of the receiver. To keep the receive signal out of the transmitter, CR1, CR2, L5 and C16 form a parallel tuned circuit that is resonant at the receive frequency which provides maximum impedance to those frequencies.

In the transmit mode, supply voltage is connected to CR1, CR2, CR3 and CR4 causing them to conduct which allows the transmit RF signals to pass and are coupled to the antenna jack through C15. To isolate the receiver from the transmit RF, a series resonant circuit consisting of C10, C11 and the inductance of CR3 and CR4 together with the impedance characteristics of the $\lambda/4$ wave line provide a high impedance to the transmit frequencies.

Supply voltage from J1 is filtered by L101, L102, C361 and C362 and connected to receive switch Q402, RF amplifier Q201, first mixer Q202, audio amplifier U203, channel indicator LED's and light bulbs DS401, DS402 and DS403 directly through ON/OFF switch S1. The remainder of the receive circuitry utilizes 9.1 volts DC supply voltage from regulator, Q403. When S1 is closed, 13.8 volts DC is connected to the emitter of Q403 through 10 ohm resistor R406 and to the base of Q403 through series diodes CR403 and CR404. Due to the voltage drop across the diodes, Q403 is forward biased which allows CR405 to regulate the receiver supply voltage at 9.1 volts DC.

In transmit, the PTT line from the microphone places a ground through CR402 on the base of Q402 causing Q402 to turn off. With Q402 cut off, Q403 bias current is removed which disables the receiver circuitry. The ground from the microphone also causes Q401 to conduct which connects supply voltage to the transmitter circuits. To indicate the transmit mode, transmit indicator LED CR406 conducts. Transmit supply voltage is also connected to transmit/receive switching diodes CR1 through CR4 as discussed above.

4.2.2 Filter, RF Amplifier and First Mixer

In the receive mode, the RF signals from the antenna are coupled through a $\lambda/4$ wave line section, through coupling capacitor C12 to helical resonant cavities L111, L112 and L113. The helicals are tuned by adjusting screws into or out of the cavities to pass the band of frequencies between 450 and 512 MHz. The cavities attenuate these frequencies approximately 2.5 dB. An L section match is provided by L201 and C201 between the helicals and the base of RF amplifier Q201. Resistors R201, R202, R203 and R204 provide DC bias voltage for Q201. The supply voltage is RF bypassed through C203 and C202. The emitter is bypassed through C204. The collector of Q201 is matched to the two section helical filter by L202 and L203. The filter output is matched to the mixer input by the position of the tap on L115 and coil L204.

The amplified RF is filtered by two section helical L114 and L115, which causes approximately 2 dB loss, and applied to the base of mixer Q202. The output of the mixer is transformer coupled from the drain of Q202. Transformer T201 and C205 are tuned to 10.7MHz. The mixer gain is approximately 6 to 8 dB. An impedence match between the secondary of T201 (1500 ohms) and the input of the crystal filter (approximately 3300 ohms) is provided by L208 and C240.

4.2.3 Oscillator Tripler, First Tripler and Second Tripler

Oscillator Q204 is not used in a one channel transceiver. Since its operation is identical to oscillator Q203, this dicussion may be applied to both circuits.

The oscillator circuit is a modified Colpitts circuit with the collector of Q203 tuned to the third harmonic of the crystal frequency. The oscillator output frequency is tuned by T202 and T203. A passive temperature compensation scheme is used with thermistor RT201 controlling the effective capacitance of the oscillator. Crystal compensating capacitor C215 is a factory selected part and is shipped with the crystal. Frequency adjustment is provided by C213 and the range of adjustment may be extended by changing the value of C211.

The first oscillator crystal frequency may be determined by using the following formula:

$$\text{Crystal Frequency} = \frac{\text{Channel frequency} - 10.7\ \text{MHz}}{27}$$

The oscillator output circuit is coupled by T202 and T203 to the base of first tripler Q205 through capacitor C228. The first tripler is a frequency multiplier circuit whose output is tuned to the third harmonic of the input frequency by L206 and C232 and coupled to the base of second tripler Q206 by C233. A tripler test voltage is rectified by CR201 and connected to TP201. Second tripler Q206 output is tuned to the third harmonic of the input by two section helical filter L116/L117. The signal from the second tripler is coupled to the source of first mixer Q202 by C207.

4.2.4 10.7 MHz Crystal Filter and Second Mixer

The hermetically sealed four pole crystal filter, Z201/Z202, provides sharp selectivity with good temperature stability. The filter operates on a center frequency of 10.7 MHz and has a 13 kHz bandwidth. Second mixer impedance matching is adjusted by L209. The filter introduces approximately 1 dB of loss to the IF frequencies.

Second mixer Q207 mixes the 10.7 MHz IF signal from the crystal filter with 11.155 MHz from second oscillator Q208. The output of the second mixer is the difference frequency which is 455 kHz. The 455 kHz is coupled through T205, C252 and C253 to the input of the 455 kHz ceramic filter. The signal gain in the second mixer is approximately 20 dB.

4.2.5 Second Oscillator

Second oscillator Q208 operates as a parallel mode Colpitts circuit with the feedback being controlled by C248 and C249. Crystal Y203 functions as a parallel resonant element and may oscillate at either 11.155 MHz or, at optional low side injection frequency, 10.245 MHz. High side injection, 11.155 MHz, is used for most receivers. The signal from the second oscillator is coupled to the base of second mixer Q207 through coupling capacitor C250.

4.2.6 First and Second IF Amplifiers

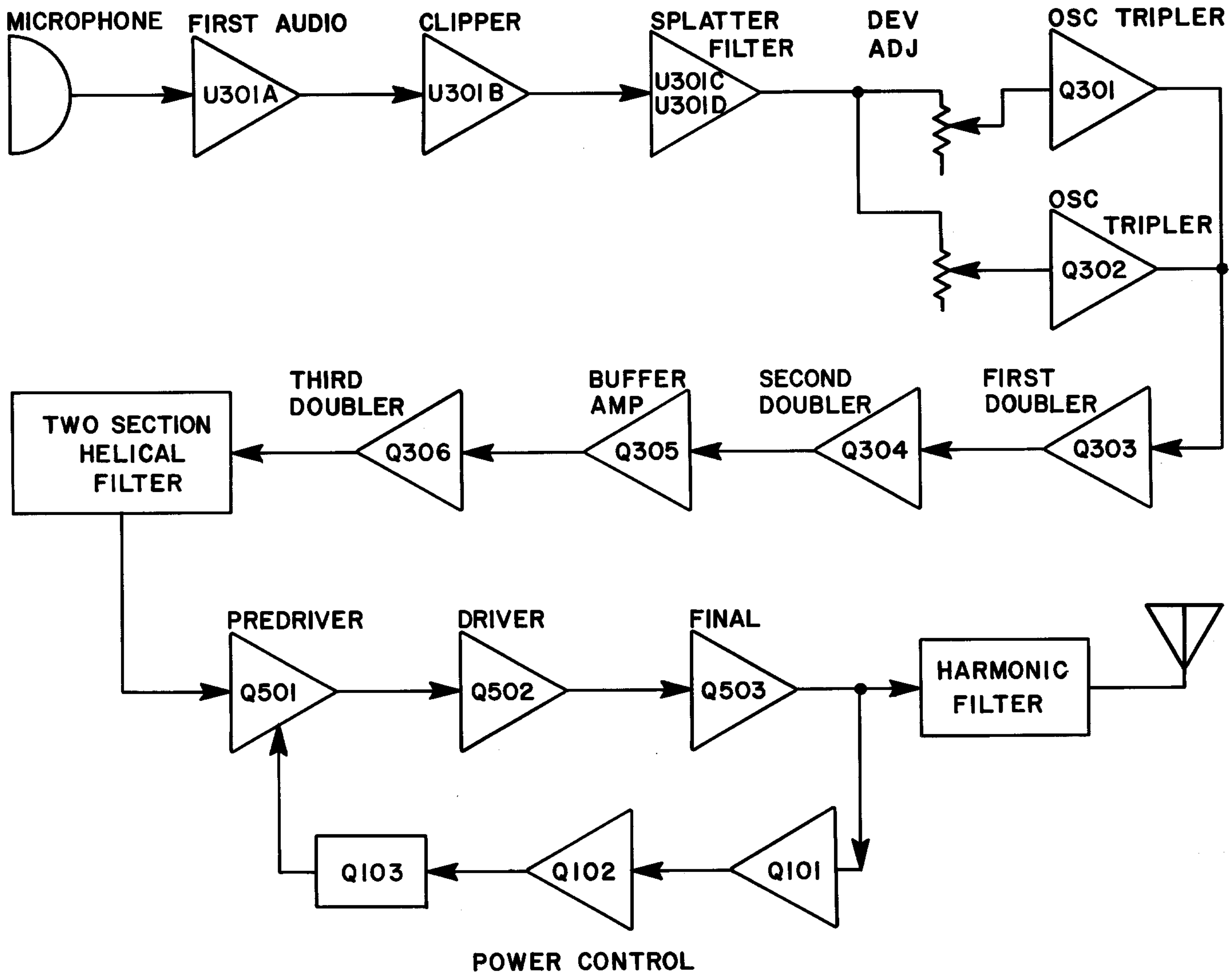
First and second IF amplifier Q209 and Q210 function as common emitter amplifiers to provide between 50 and 55 dB of gain. The output of Q209 is AC coupled to the base of Q210 through C256. The output of Q210 is direct coupled through C260 to the input of limiter/quadrature detector U201. An IF test voltage is rectified by CR202 and connected to TP202.

4.2.7 Limiter/Quadrature Detector

Integrated circuit U201 contains IF amplifier, limiter, detector and audio preamplifier circuitry. This circuitry provides between 55 and 70 dB of gain. The detector operates as a quadrature type which means that a 90° phase shift audio recovery process is used. Inductor T206 adjusts the detector and is tuned for maximum undistorted audio output.

4.2.8 First Audio Amplifier, Call Guard Filter and Audio Power Amplifier

The detected audio from the detector is coupled through the RC network consisting of C270, C272, R245 and R246 which provides audio shaping characteristics at the high and low audio frequencies. The gain of U202C is established by the ratio of feedback resistance and input resistance with C273 providing the de-emphasis characteristic. The output of the first audio amplifier is coupled to the inverting input of Call Guard filter U202D through RC network C274, C275, C276, R250 and R251 which determines the frequency bandpass characteristics of the stage. The output of U202D is audio only with the Call Guard tones removed. The audio frequencies are coupled to the inverting input of audio power amplifier U203 through C277, R253 and volume control R254. Audio power amplifier U203 amplifies the audio to over five watts depending on the setting of the volume control. The amplified audio is coupled from U203 pin 4 to speaker LS1 through C286. The series RC circuit of R274 and C287 dampen the oscillations caused by the inductive effects of the speaker voice coil. A feedback path of R272, R273 and C285 sets the closed loop gain of U203.



TRANSMITTER BLOCK DIAGRAM
FIGURE 4-2
37-297-004

← FOLDOUT

4.2.9 Squelch Filter/Amplifier/Detector/Switch/Gate

The operation of the squelch circuit depends upon the presence or absence of an on-frequency RF carrier. Without an on-frequency signal input to the receiver, high frequency noise is coupled through C278 and C279 to the base of squelch filter Q211. The filter stage is an emitter follower which provides unity gain and has a sharp roll-off below 10 kHz to prevent received voice audio from desensing the following squelch stages. The high frequency noise is coupled from the squelch control through C280 and R259 to the inverting input of squelch amplifier U202A. The gain of the squelch amplifier is determined by the resistance ratio of feedback resistance R262 to input resistance R259. The amplified output of U202A is coupled through C281 to squelch detector diodes CR204/CR205. The detector circuit; consisting of CR204, CR205, C282, C294, R263 and R264 rectifies the noise which is then connected to the inverting input of squelch switch U202B. The squelch switch acts as an inverter which controls the squelch gate. When no on-frequency signal is present in the receiver, the output of U202B is zero volts which causes Q213 to conduct. As Q213 turns on, the current through Q213 and R271 disables U203 at pin 2 which disables receiver audio. Since the audio power amplifier has B+ applied in transmit, CR206 is biased on by transmit B+ to provide a current path from U203 pin 2 through CR206 which keeps U203 disabled. The squelch tail is eliminated by the time constant provided by CR203 and C282.

When an on-channel signal is received, the voltage at U202 pin 11 goes to approximately zero volts. The output of U202B is inverted and appears at U202 pin 10 at approximately 8 volts. The 8 volts from U202 pin 10 is connected to the base of Q213 as reverse bias to turn Q213 off. When Q213 stops conducting, the current path through U203 pin 2, R271 and Q213 is removed which enables audio amplifier U203 and the receiver audio.

4.3 TRANSMITTER

4.3.1 First Audio, Clipper, Second Audio and Splatter Filter

Transmit audio from pin 1 of the microphone connector is coupled through C320 to the noninverting input of first audio amplifier U301A. The first audio amplifier provides impedance matching and a gain of approximately 6 as determined by the ratio of R322 to R321. The amplified audio from U301A is coupled through pre-emphasis network R323/C323 to the inverting input of audio clipper U301B. To provide audio clipping, the audio signal from U301B controls the current flow through R327, CR311, CR310 and R326. The bias voltage on the noninverting input as developed by R317 and R318 is equal to the DC voltage on the inverting input, which allows the operational amplifier to be perfectly linear. As the audio signal at the output of U301B goes positive, CR309 conducts causing the positive voltage at U301B output to increase conduction through CR311 and CR310 to limiting on positive audio peaks. As the output of U301B goes negative, CR308 conducts, which connects that negative voltage to the anode of CR310 and slows conduction to limit the negative audio peaks. The limited audio is applied to the inverting input of audio amplifier U301C which provides a gain of approximately 5 as established by the resistance ratio of R330 to R329. Splatter filter U301D prevents adjacent channel interference. It functions as a low pass filter as determined by C326, C325, R331, R332 and R333.

This filter removes any high frequencies generated during amplitude limiting. The feedback path through R334 keeps the bias level at U301C noninverting input constant for stability. The output of splatter filter U301D is connected to the frequency deviation control.

4.3.2 Oscillator Tripler, First Doubler and Second Doubler

The transmit audio is connected to the deviation control, R305 (and R304 in two channel transceivers). Frequency modulation of the respective oscillator is accomplished by varying the capacitance of the varactor diode, CR303, (and CR302 in two channel transceivers) at the audio rate. The oscillator is a modified Colpitts type with the collector of Q302 tuned to the third harmonic of the crystal frequency by L304. Temperature compensation is provided by RT301 and C311. Frequency adjustment is provided by C307 and the range of adjustment may be extended by changing the value of C309.

The transmitter oscillator crystal frequency can be determined by using the following formula:

$$\text{Crystal Frequency} = \frac{\text{Channel Frequency}}{24}$$

An oscillator test voltage is rectified by CR313 and connected to TP301.

The oscillator output is coupled to first doubler Q303 by the filter network, C329, C330 and L305. First doubler Q303 operates as a common emitter amplifier with the output tuned to the second harmonic of the input by T301 and L306. Second doubler Q304 is also a common emitter amplifier with the output tuned to the second harmonic of the input by L307 and L308. A test point, TP302, is connected to the emitter of Q304.

4.3.3 Buffer Amplifier and Third Doubler

The output of the second doubler is coupled to the base of buffer amplifier Q305 by filter network consisting of C344, C345 and L308. The buffer is a common emitter amplifier with a relatively high gain. The buffer amplifier increases the signal level enough to drive the third doubler. The output of buffer Q305 is tuned to pass the same frequencies as the second doubler by L309, L310 and C348. Third doubler Q306 is a common emitter amplifier with its output tuned to the second harmonic of the input by L312, C357 and two section helical filter L118/L119. A test point is connected to the emitter of second doubler Q306. RF choke L311 isolates the supply voltage line. The RF level at the output of L118/L119 is approximately 250 m watts.

4.3.4 Predriver, Driver and Final

NOTE

The predriver, driver and final stages have voltage applied regardless of the setting of the ON/OFF switch, S1.

All power levels listed in this discussion depend upon the setting of R105. It is assumed that the power output adjust, R105, is set for 16 watts power output.

Predriver Q507 raises the signal level to approximately 1 watt. A trap at frequencies of 1/2 of the transmit frequency is provided by C502 and L501 at the input to Q501. To prevent transmitter oscillations, a feedback network of R502 and C504 is provided from collector to base of predriver Q501.

The output of the predriver is impedance matched to the input of driver Q502 by L503, C505, C506, C507, C509, C510 and the 50 ohm stripline. The driver is biased class "C" and L504/R504 provide the bias DC ground return. The driver raises the signal level to approximately 5 watts.

The output of the driver is impedance matched through 50 ohm stripline to the input of final power amplifier Q503 by C512, C513, C514, C515 and C516. The final is also biased class "C" and L506/R505 provide the bias DC ground return. The final power amplifier raises the signal level to approximately 16 watts. The output of the final power amplifier is matched to 50 ohms by C517, C518, C519, C520, C521 and 50 ohm stripline.

The amplified UHF RF signals are filtered by the pi type harmonic filter consisting of C2, C3, L1, C4, C5, L2, C6, C7, L3, C8 and C9. The capacitors are ceramic disc type and, since lead inductance is prevalent, they must be mounted as close to the PC board as possible. L1, L2 and L3 are merely loops of 22 AWG wire.

4.3.5 Power Control Circuit

The collector current of Q503 is monitored through R506 causing a voltage drop. This same voltage drop is developed across R103. The voltage drop across R104 and R105 is divided by the drop across R103 to determine the gain of Q101. The voltage at Q101 collector varies the rate at which Q102 and Q103 conduct. Therefore if the current through the final transistor and R506 increases, a similar increase in current occurs through R103 which causes the collector voltage of Q101 to increase. When the collector voltage of Q101 increases, it causes Q102 and Q103 conduction to decrease. Q102 and Q103 are in series with supply voltage for the pre-driver and act as variable resistors. So when the conduction of Q102 and Q103 decreases, it appears as a larger resistance to the supply voltage and more voltage is dropped across the transistors which reduces the gain of the pre-driver. If the output power decreases (current through R506 decreases), the opposite happens and power increases.

To make the output power insensitive to supply voltage changes CR103 develops a circuit reference voltage.

To adjust transmitter power output, vary R105 which varies the conduction of Q101. The collector voltage of Q101 sets the amount of voltage present at the pre-driver. At full power 13.2 volts is present at Q501, and at 16 watts 4 to 8 volts is Q501 collector voltage.

Typically, the voltage at TP101 will be 4 to 8 volts when the output power is 16 watts and 13.2 volts when the output power is at maximum.

SECTION 5
SERVICING

5.1 GENERAL

All the components in the PPL-6060 are mounted on one printed circuit board. The only wires in the transceiver are those connecting the microphone connector to the PC board, those connecting the speaker to the audio output and the coax from the antenna jack to the PC board.

5.1.1 Preventive Maintenance

The transceiver should be put on a regular maintenance schedule and an accurate performance record should be maintained. Important checks are receiver quieting sensitivity, sinad, transmitter frequency, deviation and power output.

5.1.2 Visual Inspection

Always give a defective transceiver a quick visual check before attempting to isolate troubles. Look for overheated or discolored components, pinched or broken wires and cold solder joints. Be suspicious of solder joints that appear to have excessive solder, too little solder or dull and uneven coloring.

5.1.3 Replacement Parts

A replacement parts list, in alphanumerical order for ease of location, is included at the back of this service manual.

The transistors used in this transceiver are specially selected for specific parameters and are listed with E. F. Johnson part numbers. To obtain maximum transceiver performance, replace defective transistors with the type listed in the parts list section.

5.2 TEST INSTRUMENTS

Refer to Table 5-1 for the recommended test instruments used for transceiver service and alignment. Test instruments with equivalent specifications can be substituted.

TABLE 5-1
RECOMMENDED TEST INSTRUMENTS

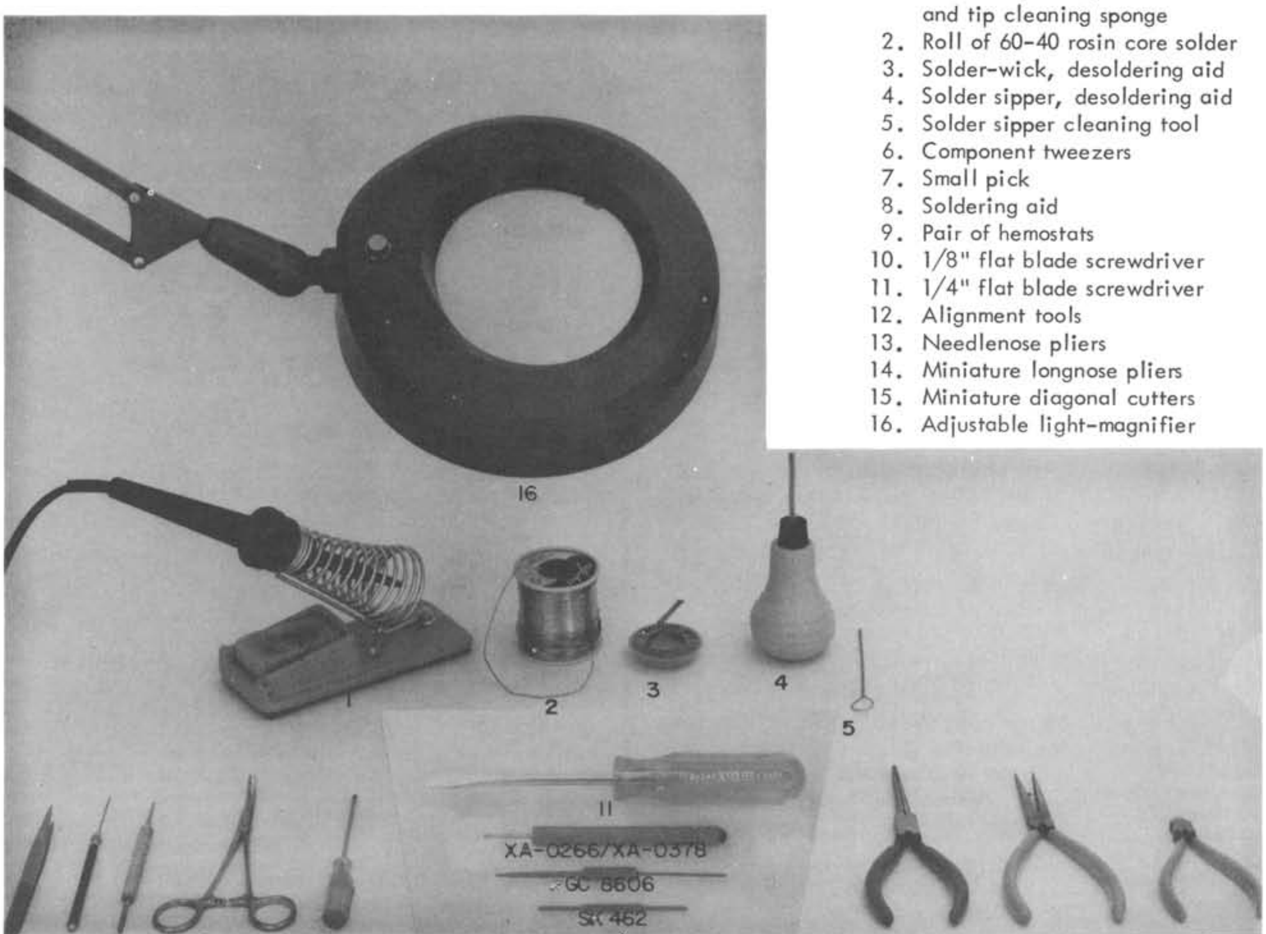
TEST INSTRUMENT	REQUIRED SPECIFICATIONS	USE	SUGGESTED INSTRUMENT TYPE*
RF Signal Generator	450-512 MHz range, calibrated output 0-100 μV, internal and external modulation capability with internal frequency of 1 kHz at 5 kHz deviation.	Receiver service and alignment.	Cushman CE-3 monitor with fused 20 dB pad.
VTVM	1.5 to 15 volts AC/DC. Input Z 10 mΩ.	Measure receiver and transmitter voltages.	Triplett Model 600
AC VTVM	100 mV to 1.2 V RMS.	Squelch voltage readings.	Hewlett-Packard 400E
Audio Generator	6 Hz to 3 kHz at a voltage level of 0 to 10 volts.	Deviation and receiver performance checks.	Hewlett-Packard 204D
Speaker Load	3 ohm speaker and resistive load with switching provisions.	Receiver tests.	Fabricated
AC Power Supply	13.8 VDC, 4.5 amperes.	Primary supply voltage during servicing.	
Wattmeter	450 to 512 MHz 10 to 50 watts 50 ohms	Transmitter load, measure power output.	Bird 43 with UHF element.
Oscilloscope	10 MHz frequency range. Calibrated sweep.	Signal tracing and audio distortion checks.	Hewlett-Packard 1222
Deviation Monitor	0 to 5 kHz deviation range.	Measure transmitter deviation.	Cushman CE-3 monitor.
Frequency Meter	Frequency range of 450 to 512 MHz. Sensitivity of 10 mV or less.	Measure receiver and transmitter frequencies.	Cushman CE-3 monitor.

*Test equipment with equivalent specifications may be substituted.

5.3 SERVICE AND ALIGNMENT TOOLS

Refer to Figure 5-1 for service and alignment tool requirements.

1. 47 watt soldering iron with holder and tip cleaning sponge
2. Roll of 60-40 rosin core solder
3. Solder-wick, desoldering aid
4. Solder sipper, desoldering aid
5. Solder sipper cleaning tool
6. Component tweezers
7. Small pick
8. Soldering aid
9. Pair of hemostats
10. 1/8" flat blade screwdriver
11. 1/4" flat blade screwdriver
12. Alignment tools
13. Needlenose pliers
14. Miniature longnose pliers
15. Miniature diagonal cutters
16. Adjustable light-magnifier



The service tools shown are standard types with the exception of the following:

Item 3, solder-wick	-special braid type desoldering aid which is very useful for multiconnection and IC desoldering applications.	Item 9, pair of hemostats	-can be used as a semiconductor heat sink, small component puller and third hand.
Item 4, solder sipper	-desoldering aid which is used to remove molten solder from the printed circuit board and component connection.	Item 14, Miniature diagonal cutters	-its small flat jaw makes it very useful in limited access areas for cutting component leads flush with the printed circuit board.
Item 7, small pick	-useful for the cleaning of printed circuit board holes.	Item 15, adjustable light-magnifier	-a servicing aid which enables concentration of light and magnification at any viewing angle.

SERVICE AND ALIGNMENT TOOLS

FIGURE 5-1

37-297-005

5.4 RECEIVER

Refer to Figure 5-2, receiver troubleshooting flow chart, to help isolate a problem to a particular section of the receiver.

5.4.1 Defective Stage Isolation

After a trouble has been traced to a particular section, refer to the following procedure for defective stage isolation.

a. Supply Voltages

1. Measure the voltages listed in Table 5-2 and compare your readings with those listed in Table 5-2.

2. Isolate the defect by measuring resistance and voltages in the circuit.

TABLE 5-2
SUPPLY VOLTAGE READINGS

Test Point	Voltage Reading (Volts DC)
J1	13.8
S1/L101	13.8
J402	13.8
Q403 emitter	12.8
Q403 collector	9.1

Voltages measured with 13.8 VDC for supply voltage and radio in squelched condition and using a high impedance DC voltmeter (approximately 10 megohm).

b. Squelch

1. Measure Q211, U202A, U202B and Q213 DC voltages and compare them with those on the schematic.

2. With no signal input, refer to Table 5-3, measure listed voltages and compare your readings with those listed.

TABLE 5-3
SQUELCH VOLTAGE READINGS

Test Point	Signal Voltage (Noise)
R244/C270	300 mV RMS
Q211 emitter	100 mV RMS
U202 pin 9	450 mV RMS (threshold)
	1.2 V RMS (tight)

Test Conditions: No RF signal input to receiver. Measurements made with HP 400E AC voltmeter or equivalent.

c. Audio

CAUTION

When measuring voltages on U203, do not short pin 4 to pin 5 as this will destroy U203.

1. With the squelch control fully CCW, measure and compare the DC voltages of U202C, U202D and U203 with those listed on the schematic.

2. Lift the end of R244 that connects to U201 pin 6 and inject a 1 kHz signal at a level of 250 mV RMS to the open end of R244.

3. With the volume control set for 3.9 V RMS (5 watts into 3 ohms of clipped audio) across the speaker, measure and compare signal readings with those in Table 5-4.

TABLE 5-4
AUDIO STAGE SIGNAL TRACING

Test Point	Signal Voltage Readings (P-P)
U202 pin 4	850 mV
U202 pin 5	950 mV
U203 pin 1	300 mV
U203 pin 4	10.6 V (measure on C286 lead)
J2	10.5 V

Test Conditions: Inject a 250 mV RMS, 1 kHz signal into R244 (disconnected from U201). Volume control set for 3.9 V RMS audio at J2. Readings taken with HP 1222 oscilloscope with a X1 probe.

d. Front End/IF

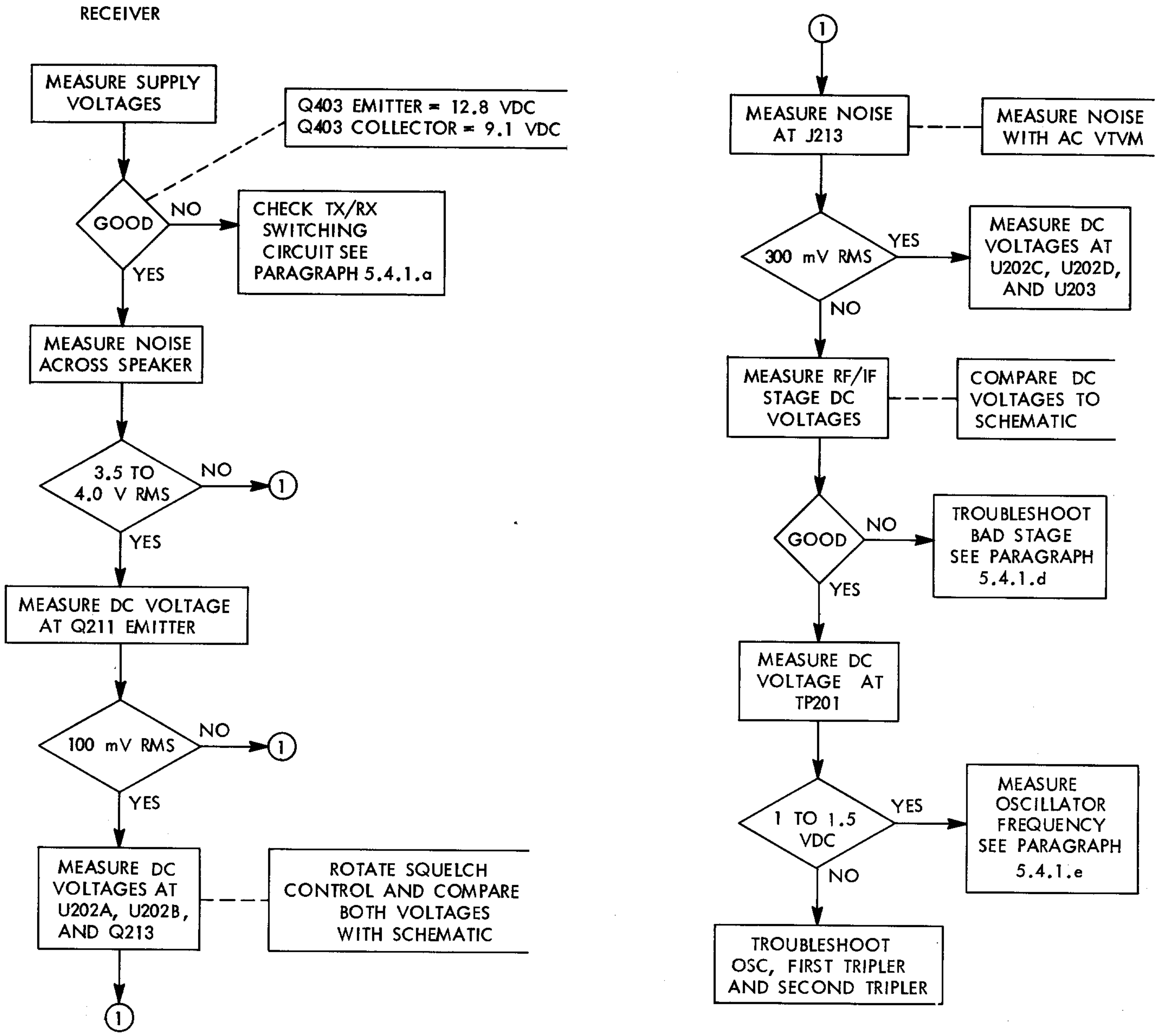
1. Remove L203 and inject an unmodulated RF signal into the tap of L114 at a level of 0.45 μV for 20 dB quieting sensitivity. (It may be necessary to retune L114 and L115.)

2. Inject an unmodulated RF signal at the junction of C201/L201 at a level of 0.25 μV for 20 dB quieting sensitivity. (It is necessary to retune L111 through L115.)

e. Oscillator Tripler/Tripler/Tripler

1. Measure the oscillator frequency by placing a pickup loop near Q206.

2. Measure DC voltages at Q203 (and Q204 in two channel units), Q205 and Q206 and compare them to those listed in Table 5-5.



RECEIVER TROUBLESHOOTING FLOW CHART
FIGURE 5-2
37-297-006

TABLE 5-5 RECEIVER OSCILLATOR DC VOLTAGES		
Test Point	Crystal In	Crystal Out
Q203 base	3.0	3.0
Q203 emitter	2.9	2.3
Q203 collector	8.1	8.4
Q205 base	2.1	2.6
Q205 emitter	2.3	1.9
Q205 collector	8.3	8.5
TP201	1 to 1.5	0.0
Q206 base	- 0.4	.7
Q206 collector	8.1	8.5

Test Conditions: No RF signal into receiver. Measurements made with high impedance DC voltmeter.

5.4.2 Defective Component Isolation

After a trouble has been isolated to a particular stage, use DC voltage and resistance readings to isolate a defective component. Refer to the schematic diagram for typical voltage readings. Use an oscilloscope for waveform analysis, especially for audio troubles.

5.5 TRANSMITTER

Refer to Figure 5-3, transmitter troubleshooting flow chart, to help isolate a problem to a particular section of the transmitter.

5.5.1 Defective Stage Isolation

After a trouble has been traced to a particular section, refer to the following procedure for defective stage isolation.

a. Supply Voltages

1. Key the transmitter and measure the DC voltage at Q401 emitter. A reading of 13.8 VDC should be measured.

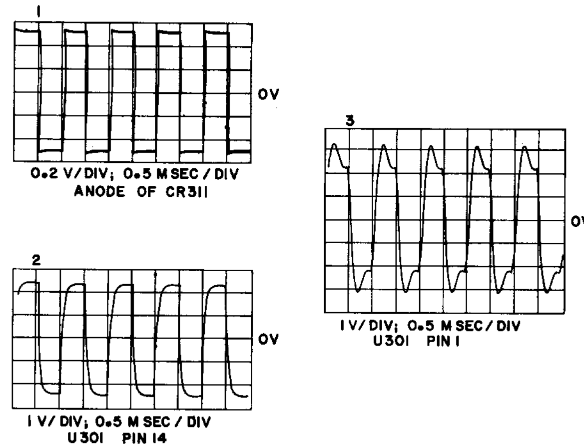
2. Key the transmitter and measure the DC voltage at CR401 cathode. A reading of 9.1 VDC should be measured.

b. Audio

1. Inject a 1 kHz tone at a level of 400 mV RMS to pin 1 of the mic jack. Key the transmitter.

2. Using an oscilloscope, measure and compare the audio signals as listed in Table 5-6.

TABLE 5-6 TRANSMITTER AUDIO SIGNAL TRACING		
Test Point	Volts (P-P)	Waveform
CR311 anode	1	1
U301 pin 14	5	2
U301 pin 1	7	3



37-297-012

Test Conditions: Inject 1 kHz, 400 mV signal to pin 1 of mic jack. Deviation adjusted for 4.5 kHz. Measurements taken with HP 1202 oscilloscope.

TABLE 5-7 TRANSMITTER OSCILLATOR DC VOLTAGES		
Test Point	Crystal In	Crystal Out
Q301 base	2.7	2.7
Q301 emitter	2.2	2.2
Q301 collector	8.7	8.7
Q303 base	1.3	1.8
Q303 emitter	1.7	1.1
Q303 collector	13.3	13.6
Q304 base	0.7	0.9
Q304 emitter	2.1	0.2
Q304 collector	13.5	13.7
Q305 base	0.5	0.6
Q305 emitter	0.0	0.0
Q305 collector	9.5	13.7
Q306 base	1.5	0.6
Q306 emitter	2.3	0.0
Q306 collector	7.6	13.5
Q501 base	-0.4	0.5
Q501 emitter	0.0	0.0
Q501 collector	4 to 8	13.2

c. Oscillator/First Doubler/Second Doubler/Buffer/ Third Doubler

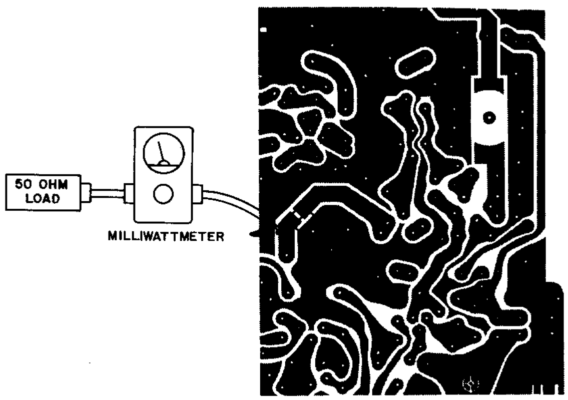
1. With the transmit crystal inserted, measure and compare the voltage readings as listed in Table 5-7.

2. With the transmit crystal removed, measure and compare the voltage readings as listed in Table 5-7.

3. With the transmit crystal inserted, cut the pad between tap on L119 and C501 and solder a short length of coax to the center tap of L119. Refer to Figure 5-4.

4. Connect the coax installed in step 3 to a milliwattmeter, key the transmitter. The wattmeter should indicate approximately 250 mW after retuning L118 and L119.

1 Unsolder C501 and cut pad as shown.



TRANSMITTER POWER TEST POINT
FIGURE 5-4
37-297-008

d. Pre-Driver/Driver/Final

1. With the transmitter crystal removed and the transmitter keyed, measure the DC voltage, on pre-driver Q501 and compare your readings with those on the schematic.

2. Measure the DC voltages on the collectors of driver Q502 and final Q503 with the transmit crystal removed and transmitter keyed.

3. Remove DC bias return from driver (L504) and measure the base/emitter resistance. A good transistor will read approximately 150 ohms.

4. Remove DC bias return from final (L506) and measure the base/emitter resistance. A good transistor will read approximately 150 ohms.

NOTE

When replacing Q502 or Q503 be careful to physically mount the new part as close to the board as possible.

When troubleshooting the final transistor, suspect the mini Underwood capacitors for shorts.

5.5.2 Power Control

CAUTION

Portions of the power control circuit can be damaged if shorted to ground. Exercise extreme caution when making meter readings in this circuit so as to not short the circuit to ground.

a. Measure the voltage drop across R506. With normal power output, approximately 0.25 volt should be measured. This voltage is affected by RF.

b. Measure the voltage drop across R103. This voltage should be the same as measured in step a. This voltage is also affected by RF.

c. Measure the voltage drop across the emitter base junction of Q101 and across CR102. These voltages should be approximately 0.7 volt DC.

d. Measure the voltage at TP101, at 16 watts output power this voltage should be 4 to 8 volts. As this voltage increases, output power increases and as this voltage decreases, output power decreases.

5.5.3 Defective Component Isolation

After a trouble has been isolated to a particular stage, use DC voltage and resistance readings to isolate a defective component. Refer to the schematic diagram for typical voltage readings. Use an oscilloscope for waveform analysis, especially audio troubles.

SECTION 6
ALIGNMENT AND PERFORMANCE TESTS

6.1 GENERAL

A complete and detailed alignment procedure is included here for use after a frequency change or major repair. Since service shop test instruments and alignment requirements vary, we suggest that a short alignment procedure be extracted from this detailed information for use after minor repair to peak transceiver performance.

Refer to the foldout sheet at the end of this section for alignment points called out in the following alignment procedure.

NOTE

The bottom cover must be attached to the transceiver during alignment.

In two channel units, always perform alignment and tune up with the transceiver operating on the lowest frequency channel.

6.2 RECEIVER ALIGNMENT

NOTE

If the transceiver needs a complete alignment i.e. it will not work at all, preset L111 through L117 as far out of the cavity as they will go (the helical screws will not come completely out of the casting) and set L209 fully clockwise then counterclockwise 1/2 turn.

Connect a DC power supply set at 13.8 volts to J1 and a 3 ohm resistive load to J2 (speaker jack). Refer to Figure 6-1 for suggested test setup. Set squelch control fully counterclockwise, set volume control to midrange and disconnect microphone and transmit crystal to avoid transmitting into signal generator.

6.2.1 First Oscillator/Tripler Alignment

a. Connect the ground lead of a DC voltmeter to the transceiver chassis, and the positive lead to TP201.

b. Adjust T202, T203 and L206 for a maximum meter reading. Repeat this step for a maximum DC voltage at TP201.

c. With the voltmeter still connected to TP201, adjust L116 for a maximum meter indication, then adjust L117 for a dip indication. These readings are fairly small, so watch carefully.

6.2.2 First Oscillator Frequency Adjustment

a. Set the communications monitor or frequency counter to 10.7 MHz below the channel frequency.

b. Loop couple the oscillator frequency from TP201. Adjust C213 and/or C214 to the proper injection frequency. The PPL-6060 uses low side injection, which is 10.7 MHz below the on channel frequency. The receive on channel frequency may be read off the top of the receive oscillator/tripler crystal. If you have a two channel radio, both C213 and C214 will have to be adjusted.

c. In case the proper injection frequency cannot be adjusted, C211 and C212 will have to be changed to a different value. Refer to Table 6-1 for replacement values.

TABLE 6-1
RECEIVER CAPACITOR REPLACEMENTS (C211/C212)

Description	Part Number
22 pF ±5%, N220	510-3017-220
27 pF ±5%, N220	510-3017-270
33 pF ±5%, N220	510-3017-330
43 pF ±5%, N220	510-3017-430

6.2.3 Receiver Front End and 10.7 MHz Filter Alignment

a. Connect an RF signal generator to the antenna connector. Set the signal generator to the proper receive channel frequency modulated with a 1000 Hz tone and the deviation set to 3 kHz.

b. Connect an AC voltmeter and oscilloscope across the speaker load.

c. Connect the DC voltmeter negative lead to the transceiver chassis and the positive probe to TP202 and note the voltmeter reading.

d. Increase the signal generator output until a voltage increase is noted on the DC voltmeter. Now check the oscilloscope display for an audio waveform.

e. Adjust L115, L114, L111, L112 and L113 for a maximum voltmeter reading at TP202. While tuning, reduce the signal generator output to keep the voltage at TP202 below 1 volt.

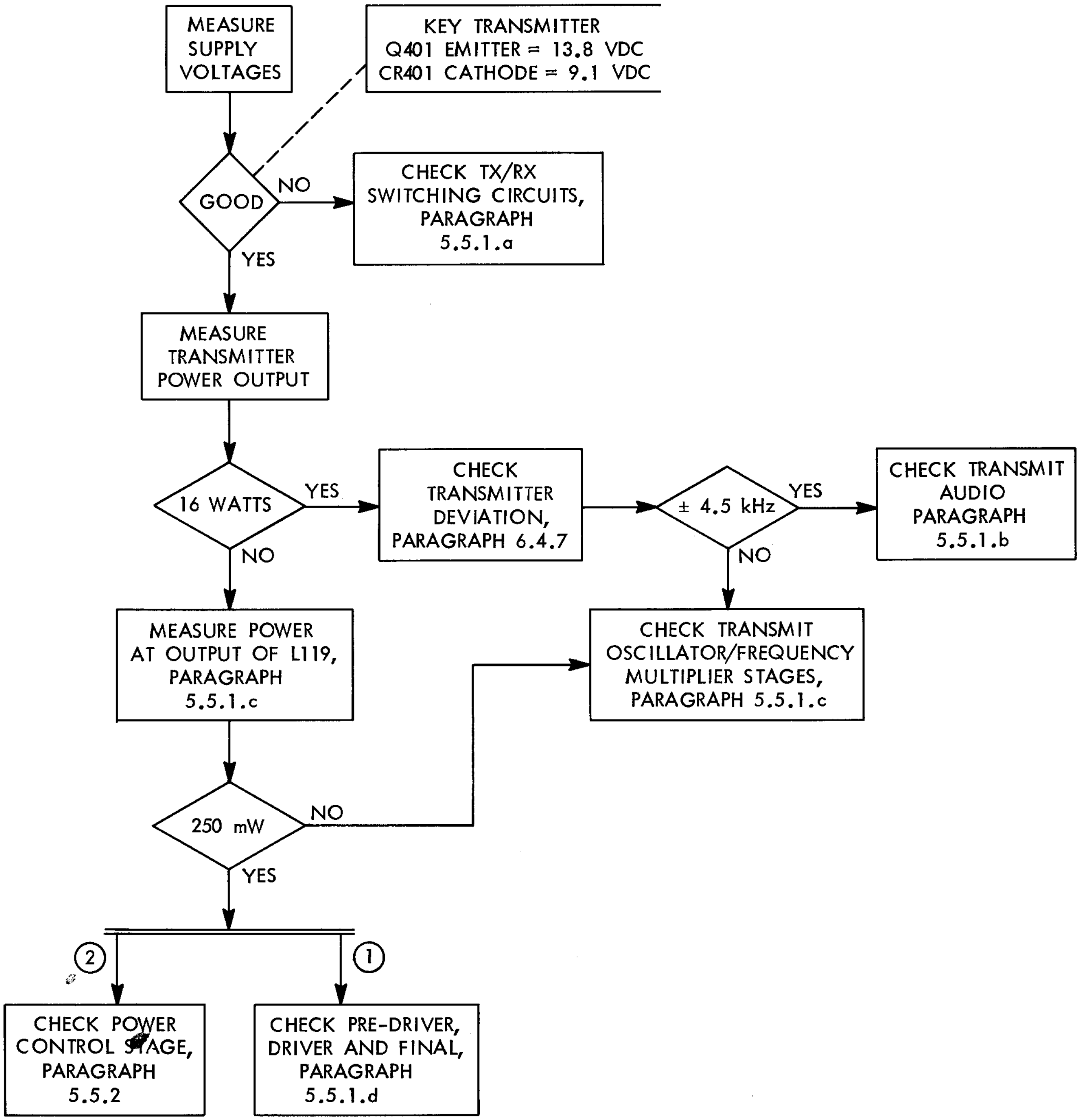
f. Adjust T201, L209 and T205 for a maximum voltage indication at TP202. Again, reduce signal generator output to keep voltage at TP202 below 1 volt.

g. Repeat step f to ensure maximum front end sensitivity.

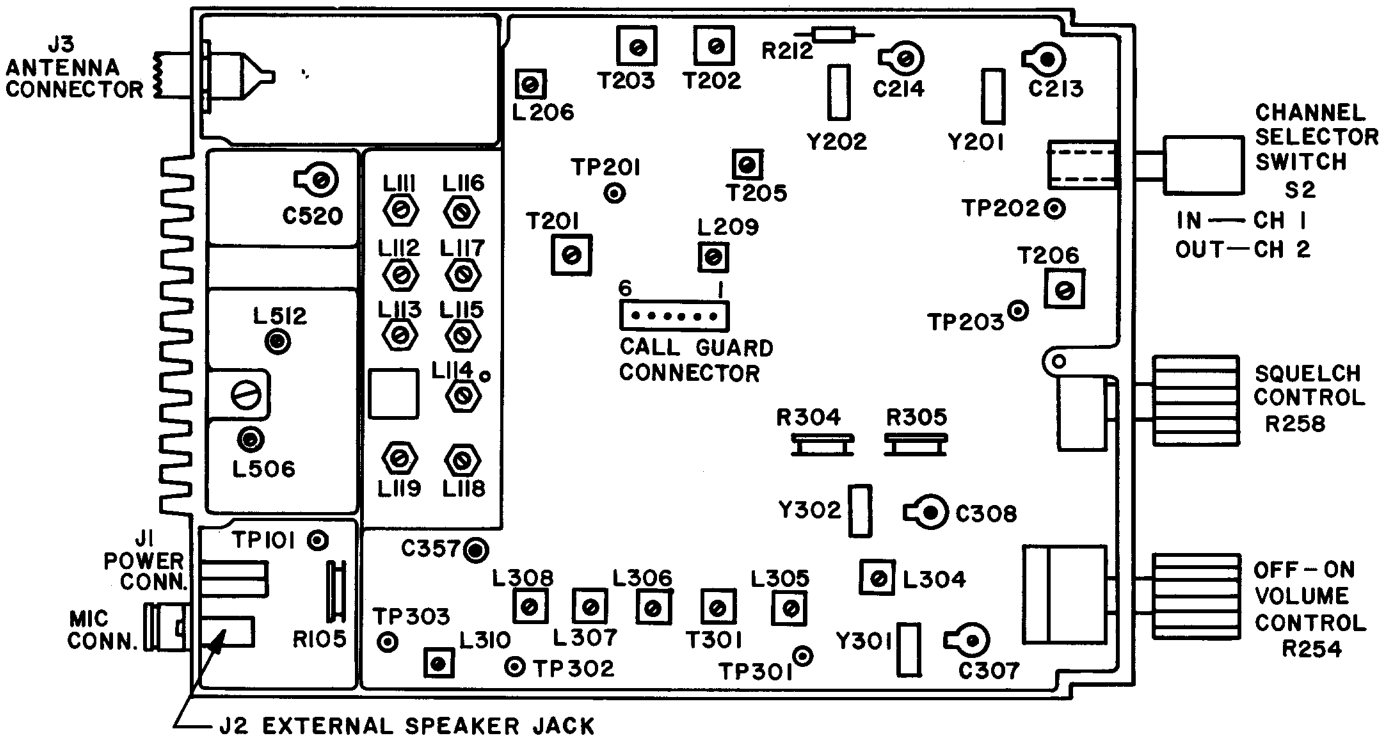
6.2.4 Limiter/Quadrature Detector Alignment

a. Set the RF input to 100 μV, modulated with 1 kHz at 3 kHz deviation. Adjust T206 for maximum non-distorted audio output as seen on the oscilloscope, keep the volume control turned down to prevent audio clipping.

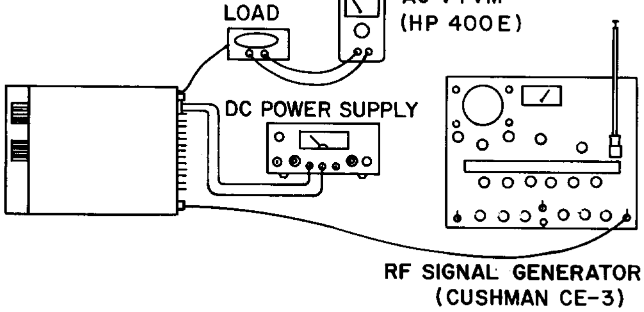
b. Readjust L116, L117, L115, L114, L111, L112 and L113 for a maximum voltage indication at TP202.



TRANSMITTER TROUBLESHOOTING FLOW CHART
FIGURE 5-3
37-297-007

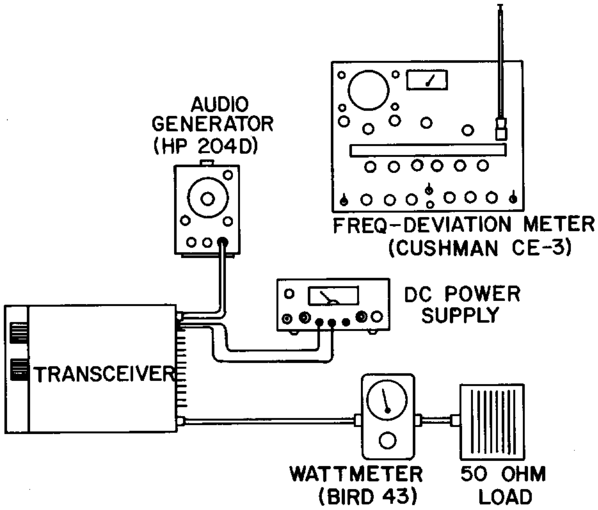


ALIGNMENT POINTS DIAGRAM
37-297-011



RECEIVER TEST SETUP
FIGURE 6-1
37-297-009

16A



TRANSMITTER TEST SETUP
FIGURE 6-2
37-297-010

6.3 RECEIVER PERFORMANCE TESTS

6.3.1 Quieting Sensitivity

a. Remove the modulation from the signal generator and adjust its output to zero microvolts. Adjust transceiver volume control for zero dB reference reading on AC VTVM.

b. Then set RF signal generator output to 0.5 microvolt unmodulated. The AC VTVM reading should decrease a minimum of 20 dB.

c. Quieting sensitivity can be improved by adjusting L115, L114, L111, L112 and L113.

d. Decrease signal generator output to 0.4 microvolt, the AC VTVM should indicate a minimum of 20 dB.

6.3.2 EIA SINAD Sensitivity (Using Sinadder)

a. Connect sinadder across speaker.

b. Set signal generator output to 0.3 microvolt modulated with 1 kHz at 3 kHz deviation.

c. The sinadder should read 12 dB or greater.

6.3.3 EIA SINAD Sensitivity (Using Heath IM-58 Harmonic Distortion Meter)

a. Set signal generator to 100 microvolts modulated with 1kHz at 3kHz deviation.

b. Connect the distortion meter to the external speaker jack. Set the distortion meter RANGE control to SET LEVEL and SENSITIVITY control to 100%. Adjust LEVEL control and transceiver volume control for 3.9V RMS at the speaker.

c. Switch the range switch to 200-2000 position and adjust BALANCE and TUNING controls to null out the 1kHz signal (switch the SENSITIVITY control as necessary). Decrease generator output for 0.3 microvolt. The null should occur at least 12 dB below the reference from step b.

$$\frac{\text{Signal + Noise + Distortion}}{\text{Signal + Noise}} = 12 \text{ dB or more}$$

6.3.4 Squelch Sensitivity (Squelch Threshold)

a. Set the RF signal generator output to zero microvolts modulated at 1000 Hz, adjust the deviation to ± 3 kHz.

b. Adjust the volume control to a comfortable listening level.

c. Rotate the squelch control to the point where the noise just disappears.

d. Increase the signal generator output until you hear a tone in the speaker. This should occur when the signal generator output is 0.25 microvolt or less.

6.3.5 Squelch Sensitivity (Tight Squelch)

a. Set the RF signal generator output to zero microvolt and adjust the deviation to ± 5 kHz.

b. Rotate the squelch control fully clockwise.

c. Increase the signal generator output for an audible tone from the speaker. This should occur at a generator output of 1 microvolt or less.

6.3.6 Receiver Netting

If the transceiver is being installed as one of several units in a system and the base transmitter is known to be on the correct frequency, mobile receiver first oscillators may be "netted" by the following procedure:

a. Key the base transmitter modulated with 1 kHz at ± 3 kHz deviation.

b. Adjust the receiver (C213 for channel 1 and C214 for channel 2) for a maximum AC VTVM indication across the speaker output.

6.4 TRANSMITTER TUNEUP

NOTE

When tuning the transmitter, key and unkey the microphone as you perform each step. Keeping the microphone keyed for long periods of time is not recommended. Tune transmitter on lowest frequency channel.

Connect the 13.8 VDC power supply to the transceiver power jack, J1. Attach the microphone to the mic jack, and connect a wattmeter and 50 ohm dummy load to the antenna connector as shown in Figure 6-2. Preset C357, C506, C512 and C520 for midrange then set L118 and L119 to the top.

6.4.1 Oscillator/Tripler

a. Connect the negative probe of a DC voltmeter to the transceiver chassis and the positive probe to TP301.

b. Key the transmitter and tune L304 and L305 for a maximum voltmeter indication at TP301.

c. Repeat step b to achieve best voltmeter indication.

6.4.2 First Doubler

a. Connect the DC voltmeter positive probe to TP302.

b. Key the transmitter and adjust T301 and L306 for a maximum voltmeter indication.

c. Repeat step b to achieve best voltmeter indication.

6.4.3 Second Doubler and Buffer Amplifier

a. Connect the DC voltmeter positive probe to TP303.

b. Key the transmitter and adjust L307, L308 and L310 for a maximum voltmeter indication. These readings are fairly broad.

c. Repeat step b to achieve best voltmeter indication.

6.4.4 Third Doubler

NOTE

This voltage may increase as transmitter heats up.

a. Connect the DC voltmeter positive probe to TP101.

b. Key the transmitter and adjust L118, L119 and C357 for a minimum voltmeter indication.

c. Repeat step b to achieve minimum voltmeter indication.

6.4.5 Pre-Driver, Driver and Final

a. Set power adjust control R105 fully clockwise (as viewed from the back of the transceiver).

b. Key the transmitter and adjust C506, C512 and C520 for a maximum RF power output reading on the wattmeter (20-25 watts).

c. Repeat step b several times to achieve maximum RF power output.

d. Key the transmitter, readjust R105 for 16 watts and then readjust C520 for maximum RF power output indication on the wattmeter.

e. Key the transmitter and adjust R105 for 16 watts RF power output.

6.4.6 Transmit Oscillator Frequency Adjustment

a. Loop couple a communications monitor or equivalent frequency measuring instrument near the transmit harmonic filter.

b. Key the transmitter and adjust C307 (and C308 in two channel units) to the correct transmit frequency.

NOTE

If unable to achieve the proper transmit frequency, replace C309 (and C310 in two channel units) with a value from Table 6-2.

TABLE 6-2
TRANSMITTER CAPACITOR REPLACEMENT
(C309 and C310)

Description	Part Number
22 pF ±5%, 100V 1DM15	510-0001-220
27 pF ±5%, 100V 1DM15	510-0001-270
33 pF ±5%, 100V 1DM15	510-0001-330
39 pF ±5%, 100V 1DM15	510-0001-390
43 pF ±5%, 100V 1DM15	510-0001-430
47 pF ±5%, 100V 1DM15	510-0001-470
56 pF ±5%, 100V 1DM15	510-0001-560
68 pF ±5%, 100V 1DM15	510-0001-680

6.4.7 Transmit Deviation

a. Apply a 1 kHz 400 millivolt RMS AC sine wave to the microphone input.

b. Key the transmitter and adjust R305 (and R304 in two channel units) for ± 4.5 kHz deviation.

6.5 TRANSMITTER PERFORMANCE TESTS

6.5.1 Transmit Frequency Check

a. Loop couple the communications monitor or equivalent to the transmit harmonic filter.

b. Key the transmitter, the transmit frequency should be on the correct channel frequency.

6.5.2 Transmit Deviation Check

a. Key the transmitter and apply a 1 kHz, 400 millivolt RMS AC tone to the microphone input.

b. Total transmitter deviation should be ± 5 kHz maximum.

6.5.3 Transmit Power Output Check

a. Key the transmitter.

b. Power output should be 16 watts as indicated on wattmeter.

SECTION 7
PARTS LIST

SYMBOL NO.	DESCRIPTION	PART NO.
C1	33 pF ±5% 50V N750 disc	510-3020-330
C2	3.3 pF ±5% NPO 50V disc	510-3013-339
C3	Capacitor	510-3013-279
C4	4.7 pF ±5% 50V NPO disc	510-3013-479
C5	5.6 pF ±5% NPO 50V disc	510-3013-569
C6	4.7 pF ±5% 50V NPO disc	510-3013-479
C7	5.6 pF ±5% NPO 50V disc	510-3013-569
C8	Capacitor	510-3013-279
C9	2.2 pF ±0.5 pF 50V NPO disc	510-3013-229
C10	11 pF ±5% NPO 50V disc	510-3013-110
C11	12 pF ±5% 50V NPO disc	510-3013-120
C12	33 pF ±5% 50V N750 disc	510-3020-330
C13	Same as C12	
C14	Same as C12	
C15	Same as C12	
C16	Same as C12	
C101	10 µF 25V aluminum	510-4125-100
C102	33 pF ±5% 50V N750 disc	510-3020-330
C103	Same as C102	
C104	Same as C102	
C105	10 µF 25V aluminum	510-4125-100
C106	33 pF ±5% 50V N750 disc	510-3020-330
C107	Same as C106	
C201	10 pF ±5% 50V NPO disc	510-3013-100
C202	33 pF ±5% 50V N750 disc	510-3020-330
C203	1000 pF ±20% 50V Y5U disc	510-3002-102
C204	33 pF ±5% 50V N750 disc	510-3020-330
C205	10 pF ±5% 50V NPO disc	510-3013-100
C206	Capacitor	510-3528-103
C207	Capacitor	510-3529-102
C211	39 pF N220	510-3017-390
C212	Same as C211	
C213	Capacitor	187-0109-005
C214	Same as C213	
C217	91 pF ±5% 100V 1DM10	510-0002-910
C218	Same as C217	
C219	300 pF ±5% 100V 1DM10	510-0002-301
C220	Same as C219	
C221	Capacitor	510-3528-103
C222	Same as C221	
C223	Same as C221	
C224	120 pF ±5% 50V N150 disc	510-3016-121
C225	2.2 pF ±0.5 pF 50V NPO disc	510-3013-229
C226	100 pF ±5% 50V N150 disc	510-3016-101
C228	1000 pF ±20% 50V Y5U disc	510-3002-102
C229	82 pF ±5% 100V 1DM10	510-0002-820
C230	Capacitor	510-3528-103
C231	0.01 µF ±20% 16V Y5S disc	510-3010-103
C232	3 pF ±0.5 pF 50V NPO disc	510-3013-309
C233	8.2 pF ±0.5 pF 50V NPO disc	510-3013-829
C234	10 pF ±5% 50V NPO disc	510-3013-100
C235	Capacitor	510-3529-102
C237	5.1 pF ±0.5 pF 50V NPO disc	510-3013-519
C238	0.01 µF ±20% 16V Y5S disc	510-3010-103
C239	5 pF ±0.5 pF 50V N750 disc	510-3020-509
C240	3.3 pF ±5% NPO 50V disc	510-3013-339
C241	0.33 pF ±5% 500V comp	510-9002-338
C242	4.7 pF ±5% 50V NPO disc	510-3013-479
C243	82 pF ±5% 100V 1DM15	510-0001-820
C244	39 pF ±5% 50V N750 disc	510-3020-390
C245	0.01 µF ±20% 16V Y5S disc	510-3010-103
C246	47 pF ±5% 50V N750 disc	510-3020-470
C247	Capacitor	510-3528-103

SYMBOL NO.	DESCRIPTION	PART NO.
C248	130 pF ±5% 50V NPO disc	510-3013-131
C249	270 pF ±5% 50V N750 disc	510-3020-271
C250	3 pF ±5% 500V composition	510-9002-309
C251	0.1 µF +80/-20% 3V Y5T disc	510-3009-104
C252	200 pF 50V N3300	510-3023-201
C253	82 pF ±5% 100V 1DM15	510-0001-820
C254	0.1 µF +80/-20% 10V Y5U disc	510-3008-104
C255	100 pF axial	510-3512-101
C256	Capacitor	510-3528-103
C257	0.1 µF +80/-20% 10V Y5U disc	510-3008-104
C258	470 pF axial	510-3527-471
C259	100 pF axial	510-3512-101
C260	0.1 µF +80/-20% 10V Y5U disc	510-3008-104
C261	Capacitor	510-3528-103
C262	0.1 µF +80/-20% 10V Y5U disc	510-3008-104
C263	Same as C262	
C264	Same as C262	
C265	10 pF ±5% 50V NPO disc	510-3013-100
C266	270 pF ±5% 100V 1DM15	510-0001-271
C267	Capacitor	510-3528-103
C268	0.0022 µF flat foil	510-1003-222
C269	33 pF ±5% 50V N750 disc	510-3020-330
C270	0.0068 µF flat foil	510-1003-682
C271	0.001 µF flat foil	510-1003-102
C272	0.0068 µF flat foil	510-1003-682
C273	0.001 µF flat foil	510-1003-102
C274	0.01 µF ±10% 250V flat foil	510-1003-103
C275	Same as C274	
C276	Same as C274	
C277	0.022 µF ±10% 250V flat foil	510-1003-223
C278	470 pF ±5% 100V 1DM15	510-0001-471
C279	Same as C278	
C280	1000 pF ±5% 100V 1DM15	510-0001-102
C281	1 µF ±10% 35V submin tub	510-2075-109
C282	6.8 µF ±20% 35V dipped	510-2045-689
C284	1 µF 50V aluminum	510-4150-109
C285	10 µF 25V aluminum	510-4125-100
C286	1000 µF	510-4116-102
C287	0.1 µF ±20% 16V Y5S disc	510-3010-104
C288	Same as C287	
C290	22 µF ±10% 10V submin tub	510-2072-220
C291	10 µF 25V aluminum	510-4125-100
C292	Capacitor	510-3528-103
C293	100 pF axial	510-3512-101
C294	22 µF 25V aluminum	510-4125-220
C301	0.01 µF ±20% 16V Y5S disc	510-3010-103
C302	100 pF ±20% 50V Y5U ceramic	510-3002-101
C303	0.47 µF ±20% 16V Y5S disc	510-3010-473
C304	Same as C303	
C305	470 pF ±5% N1500 50V	510-3121-471
C306	Same as C305	
C307	Capacitor	187-0109-005
C308	Same as C307	
C309	47 pF ±5% 100V 1DM15	510-0001-470
C310	47 pF ±5% 50V NPO disc	510-3013-470
C313	91 pF ±5% 100V 1DM10	510-0002-910
C314	Same as C313	
C315	300 pF ±5% 100V 1DM10	510-0002-301
C316	Same as C315	
C317	Capacitor	510-3528-103
C318	Same as C317	
C319	10 µF 25V aluminum	510-4125-100
C320	0.1 µF +80/-20% 10V Y5U disc	510-3008-104

PARTS LIST (cont'd)

SYMBOL NO.	DESCRIPTION	PART NO.
C321	0.1 µF ±10% 250V flat foil	510-1003-104
C322	0.01 µF ±20% 16V Y5S disc	510-3010-103
C323	0.0047 µF ±10% 250V flat foil	510-1003-472
C324	470 pF ±5% 100V 1DM15	510-0001-471
C325	0.0047 µF ±10% 250V flat foil	510-1003-472
C326	360 pF ±5% 100V 1DM10	510-0002-361
C327	1 µF 50V aluminum	510-4150-109
C328	43 pF ±5% 50V N150 disc	510-3016-430
C329	3 pF ±0.5 pF 50V NPO disc	510-3013-309
C330	470 pF ±5% 100V 1DM15	510-0001-471
C331	39 pF ±5% 50V N150 disc	510-3016-390
C332	5.1 pF ±0.5 pF 50V NPO disc	510-3013-519
C333	1000 pF ±20% 50V Y5U disc	510-3002-102
C334	Capacitor	510-3528-103
C335	Capacitor	510-3529-102
C336	18 pF ±5% 50V N150 disc	510-3016-180
C337	1.8 pF ±0.5 pF 50V NPO disc	510-3013-189
C338	27 pF ±5% 50V N150 disc	510-3016-270
C339	39 pF ±5% 50V N150 disc	510-3016-390
C340	100 pF ±20% 50V Y5U ceramic	510-3002-101
C341	8.2 pF ±0.5 pF 50V N150 disc	510-3016-829
C342	1000 pF ±20% 50V Y5U disc	510-3002-102
C343	Capacitor	510-3528-103
C344	1 pF ±5% 500V composition	510-9002-109
C345	12 pF ±5% 50V N150 disc	510-3016-120
C346	6.8 pF ±0.5 pF 50V N150 disc	510-3016-689
C347	10 µF 25V aluminum	510-4125-100
C348	27 pF ±5% 50V N150 disc	510-3016-270
C349	12 pF ±5% 50V N150 disc	510-3016-120
C350	22 pF ±5% 50V N150 disc	510-3016-220
C351	100 pF ±20% 50V Y5U ceramic	510-3002-101
C352	33 pF ±5% 50V N750 disc	510-3020-330
C353	Same as C352	
C354	100 pF ±20% 50V Y5U ceramic	510-3002-101
C355	1000 pF ±20% 50V Y5U disc	510-3002-102
C357	Capacitor	512-1005-082
C359	Capacitor	510-3529-102
C360	33 pF ±5% 50V N750 disc	510-3020-330
C361	Same as C360	
C362	100 pF axial	510-3512-101
C363	Capacitor	510-3528-103
C364	0.1 µF +80/-20% 10V Y5U disc	510-3008-104
C365	0.01 µF ±20% 16V Y5S disc	510-3010-103
C366	33 pF ±5% 50V N750 disc	510-3020-330
C401	10 µF 25V aluminum	510-4125-100
C402	33 pF ±5% 50V N750 disc	510-3020-330
C403	Capacitor	510-3528-103
C404	100 pF ±20% 50V Y5U ceramic	510-3002-101
C405	0.01 µF ±20% 16V Y5S disc	510-3010-103
C501	10 pF 250V mini mica	510-0019-100
C502	5.6 pF ±5% NPO 50V disc	510-3013-569
C503	33 pF ±5% 50V N750 disc	510-3020-330
C504	0.047 µF ±20% 16V Y5S disc	510-3010-473
C505	Capacitor	510-3013-279
C506	Capacitor	512-1005-082
C507	24pF mini underwood	510-0019-240
*C507	30 pF mini underwood	510-0019-300
C508	33 pF ±5% 50V N750 disc	510-3020-330
C509	39 pF mini underwood	510-0019-390
C510	Same as C509	
C511	33 pF ±5% 50V N750 disc	510-3020-330
C512	Capacitor	512-1005-083
C513	5.1 pF ±0.5 pF 50V NPO disc	510-3013-519
C514	3.3 pF ±5% NPO 50V disc	510-3013-339
C515	24pF mini underwood	510-0019-240
*C515	30 pF mini underwood	510-0019-300
C516	Same as C515	
*C516	30 pF mini underwood	510-0019-300
C517	Same as C515	
*C517	30 pF mini underwood	510-0019-300
C518	Same as C515	
*C518	30 pF mini underwood	510-0019-300
C519	5.6 pF ±5% NPO 50V disc	510-3013-569
C520	Capacitor	187-0109-005
C521	5.6 pF ±5% NPO 50V disc	510-3013-569
C522	33 pF ±5% 50V N750 disc	510-3020-330
C523	0.01 µF ±20% 16V Y5S disc	510-3010-103
C524	47 µF ±20% 15V dipped	510-2043-470
CR1	MPN 3401 VHF pin diode	523-1000-013
CR2	Same as CR1	
CR3	Same as CR1	
CR4	Same as CR1	
CR101	1N4003 200V 1A rectifier	523-0001-002
CR102	1N881/1N645 diode black	523-1000-881
CR103	9.1V ±5% 1W zener	523-2003-919
CR201	1N4148 silicon diode	523-1000-883
CR202	Same as CR201	
CR203	Same as CR201	
CR204	Same as CR201	
CR205	Same as CR201	
CR206	Same as CR201	
CR208	Same as CR201	
CR301	6.2V ±5% 1W zener	523-2003-629
CR302	MV 839 82 pF ±5% VVC D07	523-0009-010
CR303	Same as CR302	
CR308	1N4148 silicon diode	523-1000-883
CR309	Same as CR308	
CR310	Same as CR308	
CR311	Same as CR308	
CR313	Same as CR308	
CR401	9.1V ±5% 1W zener	523-2003-919
CR402	1N67A 80V 30MA germ	523-1000-067
CR403	1N4148 silicon diode	523-1000-883
CR404	Same as CR403	
CR405	9.1V ±5% 1W zener	523-2003-919
DS401	Wedge base lamp	549-3601-021
DS402	Same as DS401	
DS403	Same as DS401	
EP101	Ferrite bead	517-2002-002
EP102	Same as EP101	
EP203	1/2 in coil shield	578-0002-002
EP204	3/4 x 1/2 shield	978-0565-076
EP205	TO92 xstr shield	578-0004-001
EP206	1/4 in coil shield	578-0003-001
EP301	Same as EP206	
EP304	Coil shield	578-0003-002
EP305	Same as EP304	
EP306	1/4 in coil shield	578-0003-001
EP307	Same as EP306	
EP308	Same as EP306	
EP310	Same as EP306	
EP311	Therma-film TO39 washer	574-5005-006
EP401	Ferrite bead	517-2002-002
EP402	LED assembly	023-3996-001
EP403	Same as EP402	
EP404	Same as EP402	
EP501	0.14 x 0.13 ferrite bead	517-2002-001
EP502	0.14 x 0.13 ferrite bead	517-2002-001
EP503	Same as EP502	

*Use with Motorola final transistors

SYMBOL NO.	DESCRIPTION	PART NO.
EP504	Heat sink for TO39	013-1074-001
EP600	Black ext plas tubing	042-0240-770
J2	3.6 mm jack enclosed	515-2001-011
J3	Antenna jack	142-0101-004
J101	6 pin male connector	515-9031-036
J202	0.06 dia solderless pin	586-3502-001
J203	Same as J202	
J209	Same as J202	
J210	Same as J202	
J213	Same as J202	
J304	Same as J202	
J305	Same as J202	
J306	Same as J202	
J310	Same as J202	
J401	Same as J202	
J402	Same as J202	
J403	Same as J202	
	Microphone connector	023-3994-001
L1	Hair pin inductor	016-2174-001
L2	Hair pin inductor	016-2174-002
L3	Hair pin inductor	016-2174-001
L4	3.5T coil 26 AWG	542-0001-035
L5	Same as L4	
L101	2T choke	023-3170-004
L102	Same as L101	
L111	Coil	016-2169-002
L112	Helix coil	016-2169-001
L113	Coil	016-2169-003
L114	Coil	016-2169-002
L115	Coil	016-2169-005
L116	Same as L115	
L117	Coil	016-2169-003
L118	Coil	016-2169-006
L119	Coil	016-2169-004
L201	1.5T coil 26 AWG	542-0001-015
L202	5.5T coil 26 AWG	542-0001-055
L203	2.5T coil 26 AWG	542-0001-025
L204	1.5T coil 26 AWG	542-0001-015
L205	6.8 μH RF choke	542-3004-689
L206	0.17 - 0.22 μH var ind	542-1012-011
L207	2.5T coil 26 AWG	542-0001-025
L208	30 mH shielded coil	542-4003-300
L209	5.0 - 8.6 μH var ind	542-1012-001
L301	1 μH ±2.0% axial choke Q85	542-3002-005
L302	Same as L301	
L304	0.22 - 0.37 μH var ind	542-1006-017
L305	Same as L304	
L306	0.17 - 0.22 μH var ind	542-1012-011
L307	Variable inductor	542-1012-013
L308	Same as L307	
L309	6.5T coil 26 AWG	542-0001-065
L310	Variable inductor	542-1012-013
L311	2T choke	023-3170-004
L312	2.5T coil 26 AWG	542-0001-025
L501	5.5T coil 26 AWG	542-0001-055
L502	2T choke	023-3170-004
L503	1.5T coil 26 AWG	542-0001-015
L504	2T choke	023-3170-004
L505	2T choke	023-3170-004
L506	Same as L505	
L507	Same as L505	

SYMBOL NO.	DESCRIPTION	PART NO.
LS1	3.2 ohm speaker with wires	023-3995-001
MP1	Top cover	023-3993-001
MP2	Bottom cover	017-2124-001
MP3	Casting	015-0875-001
MP4	Shield	017-2165-001
MP5	Front panel assembly	023-3992-002
MP201	Crystal clip	032-0589-001
MP202	Same as MP201	
MP301	Same as MP201	
MP302	Same as MP201	
MP310	Beo spacer for TO39	539-0005-001
MP604	Knobs, volume and squelch	032-0608-001
MP605	Channel selector knob	547-0006-003
Q101	SI PNP 50 MHz amp TO92	576-0003-017
Q102	Same as Q101	
Q103	SI PNP 80V 7A TO220	576-0002-021
Q201	SI PNP UHF amp MPS H83	576-0003-016
Q202	J-FET low noise RF TO92	576-0006-009
Q203	Low noise 3002	576-0003-051
Q204	Same as Q203	
Q205	SI NPN FM osc/mul TO92	576-0003-002
Q206	Same as Q205	
Q207	SI NPN general purpose TO92	576-0003-011
Q208	SI NPN FM osc/mul TO92	576-0003-002
Q209	SI NPN general purpose TO92	576-0003-011
Q210	Same as Q209	
Q211	Same as Q209	
Q213	SI PNP 50 MHz amp TO92	576-0003-017
Q301	Low noise 3002	576-0003-051
Q302	Same as Q301	
Q303	SI NPN FM osc/mul TO92	576-0003-002
Q304	Same as Q303	
Q305	1W 175 MHz amp TO39	576-0004-008
Q306	NPN 0.75W UHF amp TO39	576-0004-060
Q401	SI PNP 80V 7A TO220	576-0002-021
Q402	SI NPN general purpose TO92	576-0003-011
Q403	SI PNP 80V 7A TO220	576-0002-021
Q501	MRF 515	576-0004-059
Q502	5W driver	576-0004-061
Q503	20W final	576-0004-062
R1	100 ohm ±10% 1/2W	569-1004-101
R2	Same as R1	
R102	4.7k ohm ±10% 1/4W	569-1002-472
R103	27 ohm ±10% 1/4W	569-1002-270
R104	100 ohm ±10% 1/4W	569-1002-101
R105	2k 1/8W PC trim pot	562-0004-202
R106	10k ohm ±10% 1/4W	569-1002-103
R107	82 ohm ±10% 1/2W	569-1004-820
R201	10k ohm ±10% 1/4W	569-1002-103
R202	39k ohm ±10% 1/4W	569-1002-393
R203	100 ohm ±10% 1/4W	569-1002-101
R204	1k ohm ±10% 1/4W	569-1002-102
R205	4.7k ohm ±10% 1/4W	569-1002-472
R206	2.7k ohm ±10% 1/4W	569-1002-272
R207	4.7k ohm ±10% 1/4W	569-1002-472
R208	Same as R207	

PARTS LIST (cont'd)

SYMBOL NO.	DESCRIPTION	PART NO.	SYMBOL NO.	DESCRIPTION	PART NO.
R209	2.7k ohm ±10% 1/4W	569-1002-272	R273	10 ohm ±10% 1/4W	569-1002-100
R210	Same as R209		R274	2.7 ohm ±10% 1/4W	569-1002-279
R211	470 ohm ±10% 1/4W	569-1002-471	R275	1k ohm ±5% 1/4W	569-0513-102
R212	Same as R211		R276	Same as R275	
R213	100 ohm ±10% 1/4W	569-1002-101	R277	10k ohm ±10% 1/4W	569-1002-103
R214	Same as R213		R278	Same as R277	
R215	22k ohm ±10% 1/4W	569-1002-223	R279	10 ohm ±10% 1/4W	569-1002-100
R216	10k ohm ±10% 1/4W	569-1002-103	R301	470 ohm ±10% 1/4W	569-1002-471
R217	470 ohm ±10% 1/4W	569-1002-471	R302	27k ohm ±10% 1/4W	569-1002-273
R218	100 ohm ±10% 1/4W	569-1002-101	R303	56k ohm ±10% 1/4W	569-1002-563
R219	100k ohm ±10% 1/4W	569-1002-104	R304	50k 1/8W PC trim pot	562-0004-503
R220	47k ohm ±10% 1/4W	569-1002-473	R305	Same as R304	
R221	4.7k ohm ±10% 1/4W	569-1002-472	R306	1k ohm ±10% 1/4W	569-1002-102
R222	10k ohm ±10% 1/4W	569-1002-103	R307	Same as R306	
R223	2.2k ohm ±10% 1/4W	569-1002-222	R308	33k ohm ±10% 1/4W	569-1002-333
R224	22k ohm ±10% 1/4W	569-1002-223	R309	Same as R308	
R225	39k ohm ±10% 1/4W	569-1002-393	R310	47k ohm ±10% 1/4W	569-1002-473
R226	1k ohm ±10% 1/4W	569-1002-102	R311	Same as R310	
R227	1.5k ohm ±10% 1/4W	569-1002-152	R312	27k ohm ±10% 1/4W	569-1002-273
R228	33k ohm ±10% 1/4W	569-1002-333	R313	Same as R312	
R229	820 ohm ±10% 1/4W	569-1002-821	R314	470 ohm ±10% 1/4W	569-1002-471
R230	470 ohm ±10% 1/4W	569-1002-471	R315	Same as R314	
R231	27k ohm ±10% 1/4W	569-1002-273	R316	100 ohm ±10% 1/4W	569-1002-101
R232	100k ohm ±10% 1/4W	569-1002-104	R317	12k ohm ±5% 1/4W CF	569-0513-123
R233	470 ohm ±10% 1/4W	569-1002-471	R318	10k ohm ±5% 1/4W CF	569-0513-103
R234	3.9k ohm ±10% 1/4W	569-1002-392	R319	100k ohm ±10% 1/4W	569-1002-104
R235	15 ohm ±10% 1/4W	569-1002-150	R320	22k ohm ±10% 1/4W	569-1002-223
R236	3.9k ohm ±10% 1/4W	569-1002-392	R321	15k ohm ±5% 1/4W CF	569-0513-153
R237	100k ohm ±10% 1/4W	569-1002-104	R322	100k ohm ±5% 1/4W CF	569-0513-104
R238	27k ohm ±10% 1/4W	569-1002-273	R323	3.3k ohm ±10% 1/4W	569-1002-332
R239	100k ohm ±10% 1/4W	569-1002-104	R325	100k ohm ±10% 1/4W	569-1002-104
R240	1k ohm ±10% 1/4W	569-1002-102	R326	150k ohm ±5% 1/4W CF	569-0513-154
R241	10 ohm ±10% 1/4W	569-1002-100	R327	Same as R326	
R242	22k ohm ±10% 1/4W	569-1002-223	R328	150k ohm ±10%	569-1002-154
R243	4.7k ohm ±10% 1/4W	569-1002-472	R329	22k ohm ±10% 1/4W	569-1002-223
R244	5.6k ohm ±10% 1/4W	569-1002-562	R330	100k ohm ±10% 1/4W	569-1002-104
R245	39k ohm ±10% 1/4W	569-1002-393	R331	68k ohm ±5% 1/4W	569-0513-683
R246	Same as R245		R332	33k ohm ±5% 1/4W	569-0513-333
R247	560k ohm ±10% 1/4W	569-1002-564	R333	68k ohm ±5% 1/4W	569-0513-683
R248	Same as R247		R334	100k ohm ±10% 1/4W	569-1002-104
R249	3.3k ohm ±10% 1/4W	569-1002-332	R335	47k ohm ±10% 1/4W CC	569-1002-473
R250	12k ohm ±10% 1/4W	569-1002-123	R336	10k ohm ±10% 1/4W	569-1002-103
R251	180k ohm ±10% 1/4W	569-1002-184	R337	1.8k ohm ±10% 1/4W	569-1002-182
R252	Same as R251		R338	100k ohm ±10% 1/4W	569-1002-104
R253	1k ohm ±10% 1/4W	569-1002-102	R339	100 ohm ±10% 1/4W	569-1002-101
R254	Volume pot	562-0028-011	R340	10 ohm ±10% 1/4W	569-1002-100
R255	22k ohm ±5% 1/4W	569-0513-223	R341	3.3k ohm ±10% 1/4W	569-1002-332
R256	100k ohm ±5% 1/4W	569-0513-104	R342	220 ohm ±10% 1/4W	569-1002-221
R257	Same as R256		R343	150 ohm ±10% 1/4W	569-1002-151
R258	Squelch pot	562-0028-001	R344	10k ohm ±10% 1/4W	569-1002-103
R259	15k ohm ±5% 1/4W	569-0513-153	R345	10 ohm ±10% 1/4W	569-1002-100
R260	1k ohm ±10% 1/4W	569-1002-102	R346	3.3k ohm ±10% 1/4W	569-1002-332
R261	330k ohm ±10% 1/4W	569-1002-334	R347	150 ohm ±10% 1/4W	569-1002-151
R262	270k ohm ±5% 1/4W	569-0513-274	R348	100 ohm ±10% 1/4W	569-1002-101
R263	22k ohm ±5% 1/4W	569-0513-223	R349	Same as R348	
R264	10k ohm ±10% 1/4W	569-1002-103	R350	47 ohm ±10% 1/2W	569-1004-470
R265	100k ohm ±5% 1/4W	569-0513-104	R351	3.3k ohm ±10% 1/4W	569-1002-332
R266	1.8M ohm ±5% 1/4W	569-0513-185	R352	150 ohm ±10% 1/4W	569-1002-151
R267	390k ohm ±5% 1/4W	569-0513-394	R353	22 ohm ±10% 1/4W	569-1002-220
R268	47k ohm ±10% 1/4W	569-1002-473	R354	10k ohm ±10% 1/4W	569-1002-103
R269	Same as R268		R401	1k ohm ±10% 1/4W	569-1002-102
R270	22k ohm ±10% 1/4W	569-1002-223	R402	Same as R401	
R271	100 ohm ±10% 1/4W	569-1002-101	R403	56 ohm ±10% 1/2W	569-1004-560
R272	470 ohm ±10% 1/4W	569-1002-471	R404	10k ohm ±10% 1/4W	569-1002-103

SYMBOL NO.	DESCRIPTION	PART NO.
R405	330 ohm ±10% 1/4W	569-1002-331
R406	10 ohm ±10% 1/4W	569-1002-100
R407	470 ohm ±10% 1/4W CC	569-1002-471
R408	Same as R407	
R501	3.3k ohm ±10% 1/4W	569-1002-332
R502	56 ohm ±10% 1/4W	569-1002-560
R503	150 ohm ±10% 1/4W	569-1002-151
R504	Same as R503	
R505	150 ohm ±10% 1/2W CC	569-1004-151
R506	0.1 ohm 2W	569-2004-108
R801	2.7 ohm ±10% 1/4W	569-1002-279
R802	Same as R801	
RT101	500 ohm thermistor	569-3001-002
RT201	Thermistor	569-3001-003
RT202	Same as RT201	
RT301	Same as RT201	
RT302	Same as RT201	
S2	Channel selector switch	583-4008-040
T201	10MM 10.7 MHz IF xfmr	592-5013-012
T202	10MM 150 MHz xfmr	592-5009-016
T203	Same as T202	
T205	7MM 455 kHz disc coil	592-5022-005
T206	10MM 455 kHz IF xfmr	592-5006-007
T301	6-32 5-1/4T tap at 2	592-5022-001
TP101	Red PC jack bulk	105-0852-901
TP201	Same as TP101	
TP202	Same as TP101	
TP203	Same as TP101	
TP301	Same as TP101	
TP302	Same as TP101	
TP303	Same as TP101	

SYMBOL NO.	DESCRIPTION	PART NO.
U1	PC board	035-0379-001
U201	CA 3089 FM IF system	544-2002-007
U202	MC 3301 quad op amp	544-2005-001
U203	IC 8W audio pentawatt	544-2006-012
U301	Quad diff input op amp	544-2020-003
W3	22 sol copper wire	071-0271-240
W4	Same as W3	
W5	Same as W3	
X201	Crystal socket	126-0110-016
X202	Same as Y201	
X301	Crystal socket	126-0110-016
X302	Same as Y301	
X401	Light socket base lamp	550-0005-001
X402	Same as X401	
X403	Same as X401	
Y203	11.155 MHz 32 pF HC-18/U	519-0009-001
Z201	Crystal filter	532-0006-001
Z202	Same as Z201	
Z203	Ceramic filter 455-15	532-2004-001
	Fused cable assembly U-2	
	Consists of:	
	12 str cu vin r	071-0911-642
	12 str cu vin bu	071-0911-646
	Power connector	515-9033-001
	Power connector	515-9033-002
	Power connector contact	515-9033-006
	Fuse 5A 250V FB MTH	534-0003-030
	Fuseholder HDJ-B	534-1004-005
	Neg gnd warning tag	559-4014-001
	42864-2 terminal lug	586-0007-010

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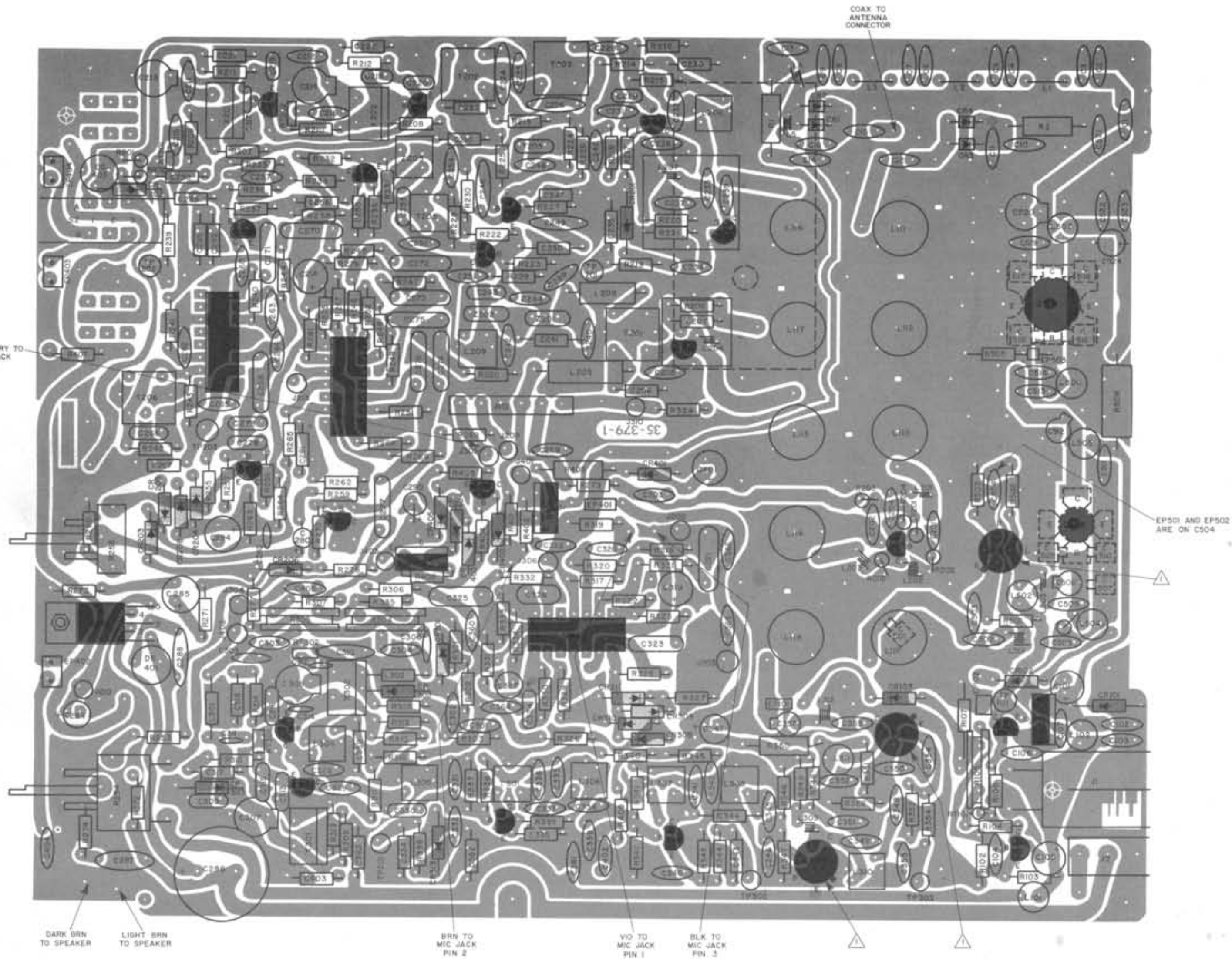
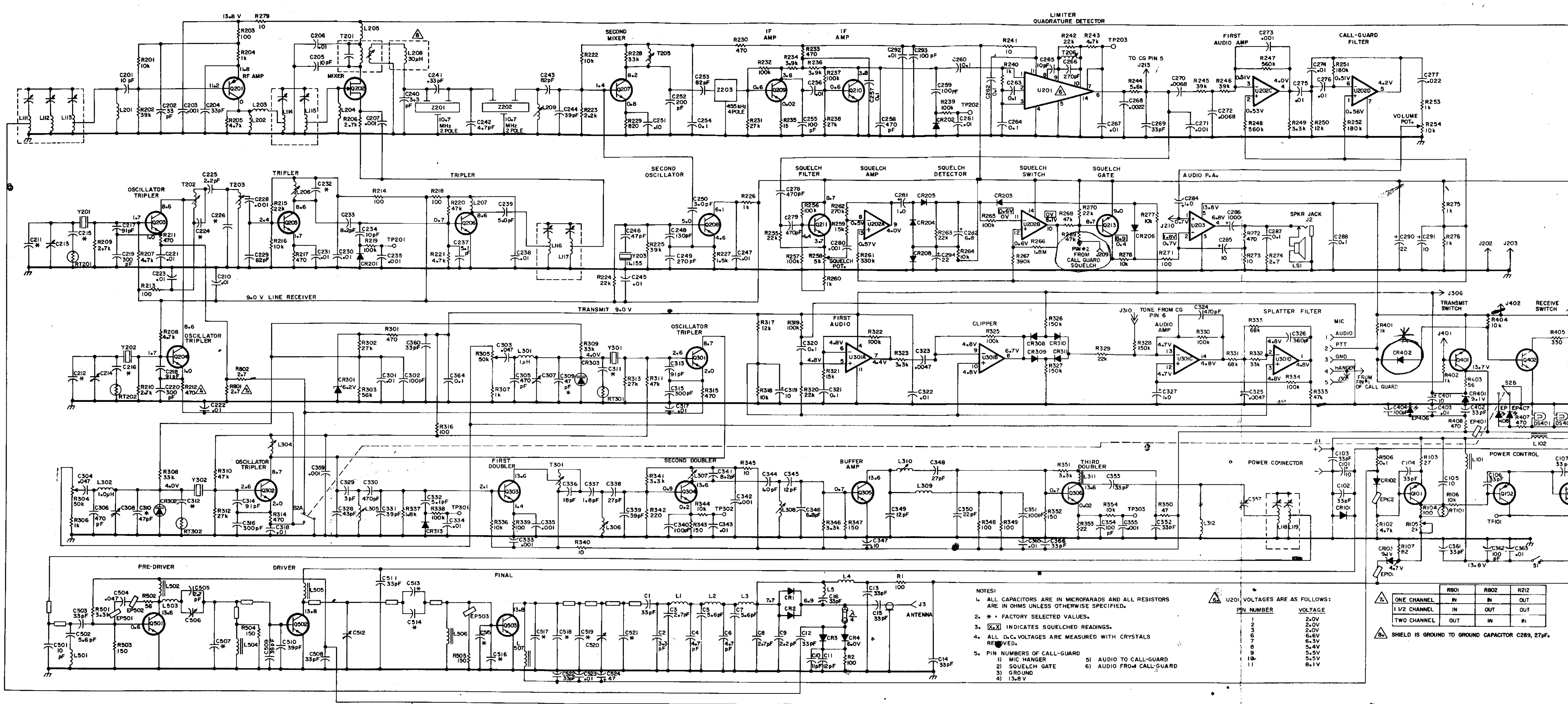


TRANSCEIVER PRINTED CIRCUIT BOARD
(SOLDER SIDE VIEW)



NOTES:

1. ALL CAPACITORS ARE IN MICROFARADS AND ALL RESISTORS ARE IN OHMS UNLESS OTHERWISE SPECIFIED.
2. * = FACTORY SELECTED VALUES.
3. $\boxed{X.X}$ INDICATES SQUELCHED READINGS.
4. ALL D.C. VOLTAGES ARE MEASURED WITH CRYSTALS REMOVED.
5. PIN NUMBERS OF CALL-GUARD
   1) MIC HANGER
   2) SQUELCH GATE
   3) GROUND
   4) 13.8 V
   5) AUDIO TO CALL-GUARD
   6) AUDIO FROM CALL-GUARD

6. U201 VOLTAGES ARE AS FOLLOWS:

PIN NUMBER	VOLTAGE
1	2.0V
2	2.0V
3	2.0V
6	6.6V
7	6.3V
8	5.4V
9	5.5V
10	5.5V
11	8.1V

7.

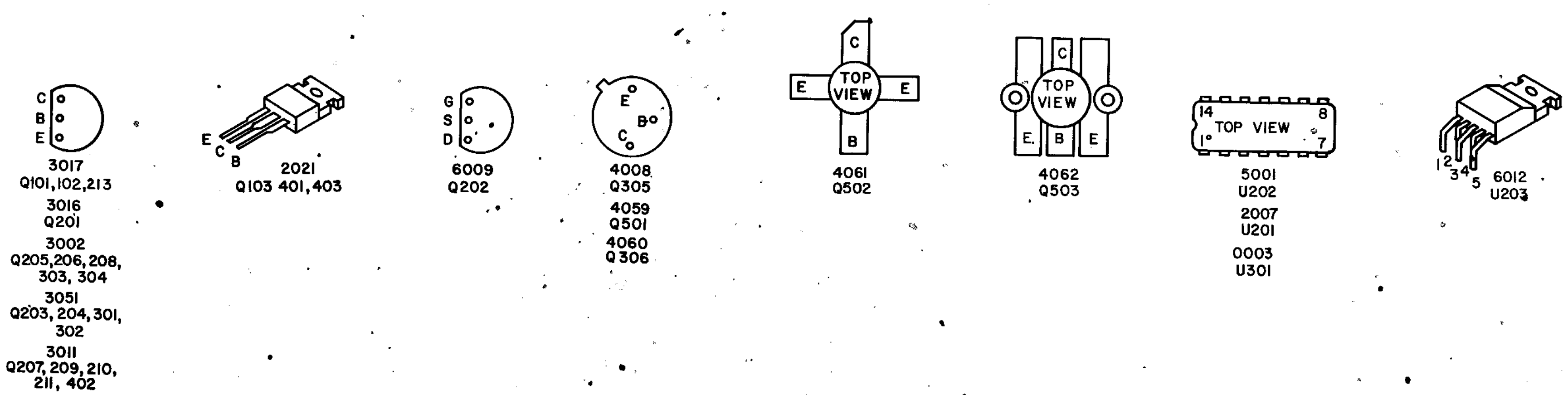
	R801	R802	R212
ONE CHANNEL	IN	IN	OUT
1 1/2 CHANNEL	IN	OUT	OUT
TWO CHANNEL	OUT	IN	IN

8. SHIELD IS GROUND TO GROUND CAPACITOR C289, 27pF.

* Staying Partly Keyed (leaky)

Semiconductor basing is bottom view unless otherwise stated

37-297-013



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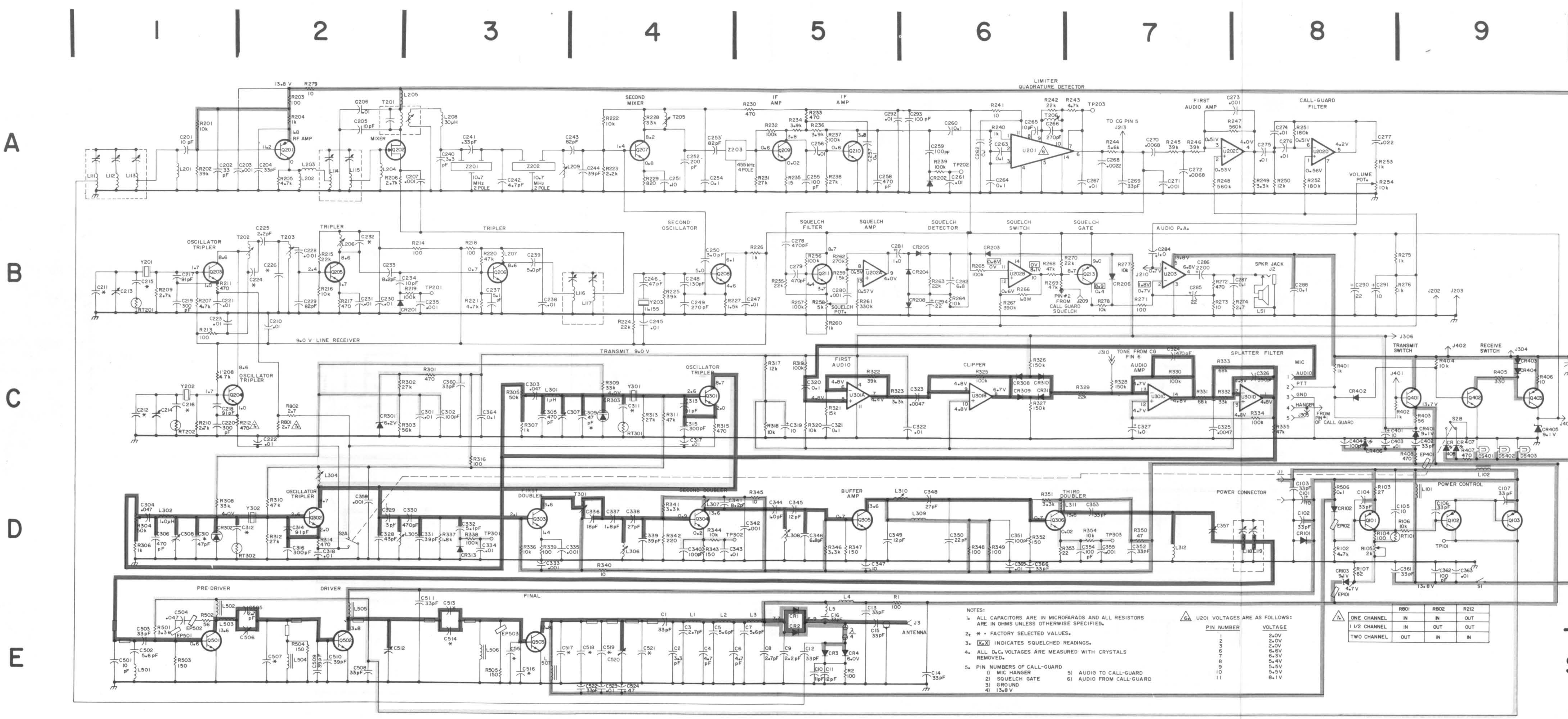
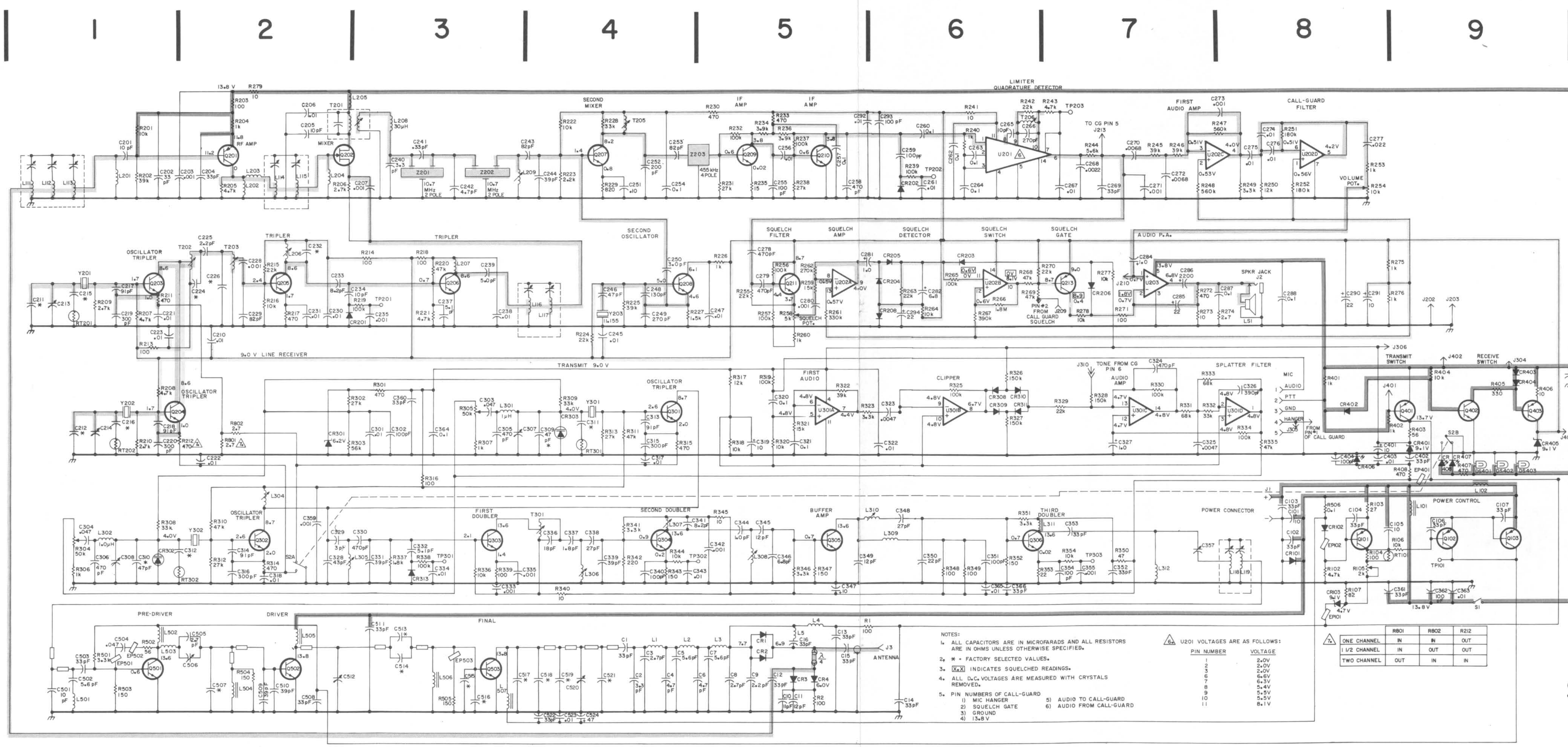
PPL-6060 SCHEMATIC DIAGRAM
(FOR UNITS WITH "A" OR LATER MODEL DESIGNATOR ON SERIAL NUMBER STICKER)



PPL 6060 TRANSMIT SCHEMATIC

FOR TRAINING PURPOSES ONLY - 1978

DC SUPPLY AND SWITCHED VOLTAGE LINES
DC REGULATED AND CONTROL LINES
TRANSMIT SIGNAL PATH



NOTES:

1. ALL CAPACITORS ARE IN MICROFARADS AND ALL RESISTORS ARE IN OHMS UNLESS OTHERWISE SPECIFIED.
2. * = FACTORY SELECTED VALUES.
3. $\boxed{X.X}$ INDICATES SQUELCHED READINGS.
4. ALL D.C. VOLTAGES ARE MEASURED WITH CRYSTALS REMOVED.
5. PIN NUMBERS OF CALL-GUARD
   1) MIC HANGER
   2) SQUELCH GATE
   3) GROUND
   4) 13.8 V
   5) AUDIO TO CALL-GUARD
   6) AUDIO FROM CALL-GUARD

6. U201 VOLTAGES ARE AS FOLLOWS:

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1	2.0V
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3	2.0V
6	6.6V
7	6.3V
8	5.4V
9	5.5V
10	5.5V
11	8.1V

7.

	R801	R802	R212
ONE CHANNEL	IN	IN	OUT
1 1/2 CHANNEL	IN	OUT	OUT
TWO CHANNEL	OUT	IN	IN

PPL 6060 RECEIVE SCHEMATIC

DC SUPPLY AND SWITCHED VOLTAGE LINES

DC REGULATED AND CONTROL LINES

RECEIVE SIGNAL