NAVSHIPS 95681

TECHNICAL MANUAL

for

RADIO SET

AN/PRC-40 AX

DEPARTMENT OF THE NAVY
BUREAU OF SHIPS

28 January 1964

LIST OF EFFECTIVE PAGES

PAGE NUMBERS	CHANGE IN EFFECT	PAGE NUMBERS	CHANGE IN EFFECT
Title Page	ORIGINAL	5-1 to 5-13	ORIGINAL
ii to v	ORIGINAL	5-14 (blank)	
1-0 to 1-4	ORIGINAL	5-15 to 5-16	ORIGINAL
2-1 to 2-2	ORIGINAL	6-1 to 6-3	ORIGINAL
3-1 to 3-2	ORIGINAL	6-4 (blank)	
4-1 to 4-17	ORIGINAL		
4-18 (blank)			

Space Avionics Inc. 1200 First St. Alexandria, Va. Contract NObsr-87270

Errors found in this publication (other than obvious typographical errors) which have not been corrected by means of Temporary Changes or Permanent Changes should be reported on a user activity comment sheet NAVSHIPS 4914 (10-62) FSN 0105-503-9850. Such report should include the complete title of the publication and the publication number, identify the page and line or figure and location of the error, and be forwarded to the Publications and Information Retrieval Branch of the Bureau of Ships.

All requests for this publication should be directed to the Naval Supply Depot, 5801 Tabor Avenue, Philadelphia 20, Pennsylvania.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

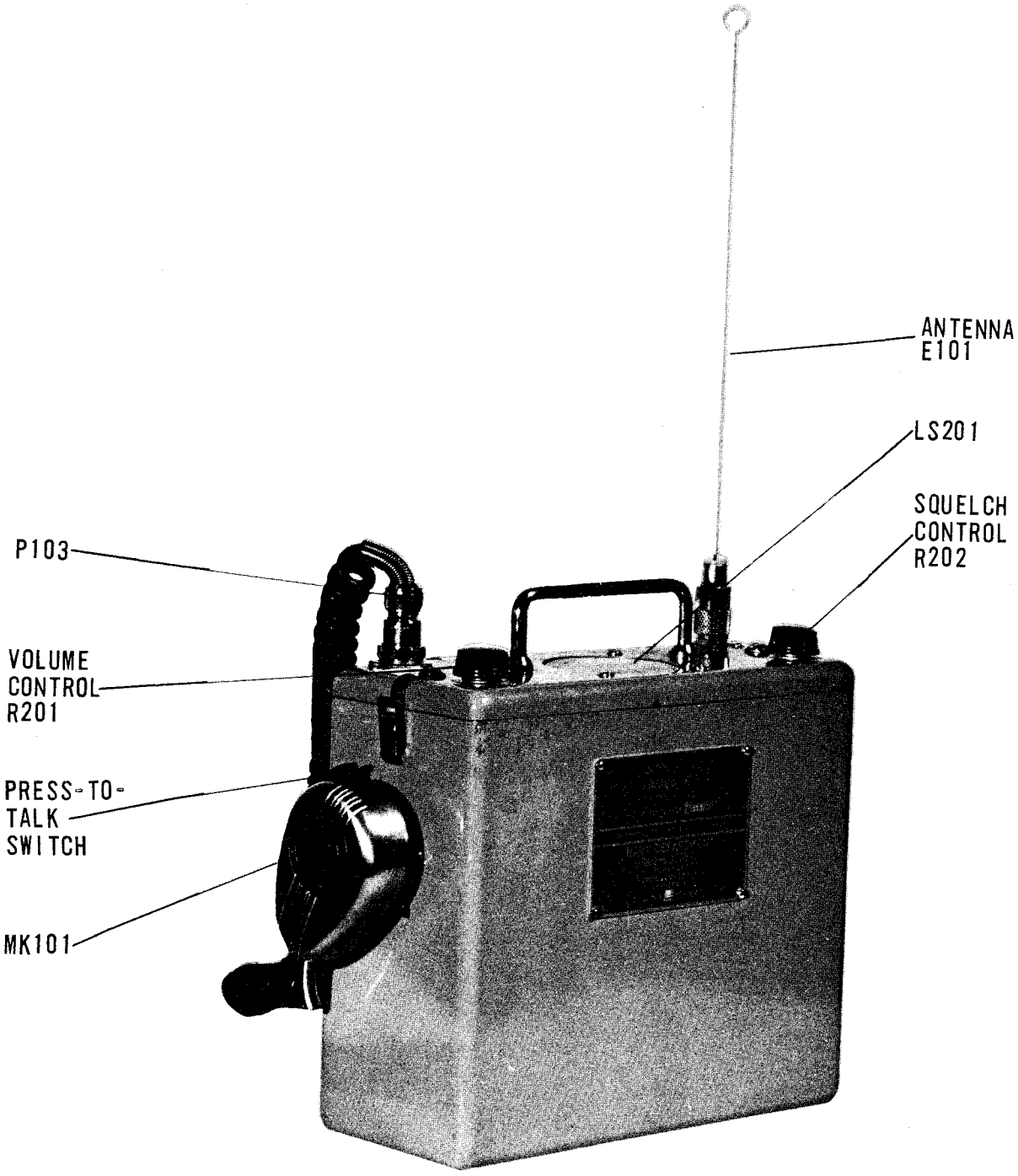


Figure 1-1. Radio Set AN/PRC-40AX, Overall View

SECTION I

GENERAL INFORMATION

1-1. SCOPE

This Technical Manual will be in effect upon receipt and is to be used only in conjunction with Radio Set AN/PRC-40AX. Extracts from this publication may be made to facilitate preparation of other Department of Defense publications.

1-2. GENERAL DESCRIPTION

Radio Set AN/PRC-40AX is a portable wide-band (15 KC) FM transmitter-receiver. The receiver and transmitter are constructed on printed circuit boards which mount plug-in modules. Transistors are used throughout both the receiver and transmitter. A self-contained battery supplies all operating power for the equipment.

Radio Set AN/PRC-40AX may be tuned to transmit and receive any single frequency within the range of 132 to 152 MC. The AN/PRC-40AX has an effective range of up to ten miles, depending on environment. Under average conditions, effective voice communication will be maintained between AN/PRC-40AX's within a distance of two miles.

1-3. RELATION TO OTHER EQUIPMENT

Radio Set AN/PRC-40AX is remanufactured from Radio Set AN/PRC-40 and will operate with AN/PRC-40 units and with other wide-band FM transmitters and receivers utilizing a frequency within the range 132 to 152 MC.

1-4. REFERENCE DATA

a. Transmitter

(1) Type of Transmission: Frequency Modulation
(2) Frequency Range: 132 to 152 MC (by crystal selection)
(3) Power Output: 0.8 watt at 132 and 142 MC, 0.7 watt at 152 MC. into a 50-ohm load
(4) Modulation Capability: $\pm$15 kc deviation
(5) Frequency Response: +1 - 3 db from 500 cps to 3,000 cps
(6) Noise Level: at least -40 db below $\pm$10 kc modulation level
(7) Distortion: Maximum of 8% total distortion at $\pm$10 kc modulation
(8) Crystal Frequency: 1/12 of operating frequency.
(9) Audio Input: Push-to-talk hand microphone

b. Receiver

(1) Type of Reception: Frequency Modulation
(2) Frequency Range: 132 to 152 MC (by crystal selection)
(3) Sensitivity: At least 20 db of noise quieting with 4 microvolts of cw signal
(4) Audio Output: Self-contained loudspeaker
(5) Crystal Frequency: F = (Input freq. in MC minus 8.5)/3

(6) Power Source Required: None; self-contained battery with 100 hours operating life

c. Antenna: 1/4-wave, whip type

d. Physical Characteristics:
Dimensions: 11 1/2" wide x 10" high x 5" deep
Weight: 11.5 lbs, including battery
Carrying Case: Canvas with shoulder strap and backpack straps

e. Number of operators required: One

f. Crystal Complement:

(1) Y 101 Space Avionics Inc. Part No. 101179-1 or special type CR-18U, with tolerance of 0.0025% from -30° to +60° C.

XMTR 150.09 MHz

One required for selected operating frequency

(2) Y 201 Crystal, 8200.000 kc frequency; HC-6/U holder

One required

(3) Y 202 Space Avionics Inc. Part No. 101179-2 or special type CR-52/U, with tolerance of 0.0025% from -30° C. to +60° C.

RCVR 148.41 MHz

One required for selected operating frequency

1-5. EQUIPMENT SUPPLIED

Radio Set AN/PRC-40AX is supplied complete and ready to operate, except for two frequency determining crystals and the battery. The set consists of the following units and publications.

a. Radio Receiver-Transmitter RT-507/PRC-40AX complete with microphone, antenna, and battery cable
b. Radio Set Case CY-2625/PRC
c. Plug-in unit removal tool
d. Technical Manual for Radio-Set AN/PRC-40AX (NAVSHIPS 95681)

1-6. EQUIPMENT AND SUPPLIES REQUIRED BUT NOT SUPPLIED

Refer to table 1-1 for equipment and supplies required but not supplied.

TABLE 1-1. EQUIPMENT AND SUPPLIES REQUIRED BUT NOT SUPPLIED

QTY PER EQUIP	NOMENCLATURE		REQUIRED USE
	NAME	DESIGNATION	
1	Battery, Dry:	PN 301144 Space Avionics, Inc.	Power Source
1	Volt-Ohm-Milliameter (20,000 ohm-per-volt)	AN/PSM-4 See note	Test and alignment
1	FM-AM Signal generator	202-H Boonton Radio Co.	
1	RF Wattmeter	AN/URM-43A See note	Test and alignment
1	Frequency Meter	TS-186/UP See note	Test and alignment
1	Deviation Meter	Mod AR 1-A See note A. R. F. Products, Inc.	Test and alignment
1	Crystal (Y 101)	Refer to paragraph 1-4f.	Select transmitter frequency. Refer to Section 5 for method of calculating frequency
1	Crystal (Y 202)	Refer to paragraph 1-4f.	Select receiver frequency. Refer to Section 5 for method of calculating frequency.

NOTE: Refer to Tables 5-1 and 5-3 for alternate equipment.

1-7. PREPARATION FOR RESHIPMENT

No special precaution need be taken when packing the equipment for reshipment other than to remove the battery.

TABLE 1-2. PLUG-IN UNITS USED IN RADIO SET AN/PRC-40AX

REF DES	NOMENCLATURE
Z101	Transmitter oscillator circuit
Z102	Audio deviation control
Z103	Phase modulator circuit
Z104	Amplifier, oscillator frequency
Z105	Frequency tripler
Z106	First frequency doubler
Z107	Second frequency doubler
Z108	Final output and driver
Z109	Antenna and transmit-receive relay
Z201	Antenna input and RF amplifier
Z202	RF amplifier
Z203	Mixer, high frequency IF
Z204	Oscillator and multiplier, high IF
Z205	Filter, 8.5 MC
Z206	Oscillator and mixer, low frequency
Z207	Filter, 300 KC bandpass
Z208	Amplifier, Low IF frequency, 300 KC
Z209	Discriminator and limiters
Z210	Amplifier, audio frequency
Z211	Squelch circuit

SECTION 2

INSTALLATION

2-1. UNPACKING AND HANDLING

Radio Set AN/PRC-40AX is shipped in a carton, with the microphone, plug-in unit removal tool, and battery cable packed in the position normally occupied by the battery. Open the carton and remove the equipment.

No special precautions are required. Avoid rough handling and dropping of the equipment. Store the carton in a clean, dry place for future use or reshipment.

2-2. INSTALLATION PROCEDURE

Radio Set AN/PRC-40AX is a self-contained equipment. Since it is portable, no fixed installation requirements exist for the equipment. Before operation is possible, however, the battery must be installed, and the microphone MK101 and the antenna E101 must be connected.

a. BATTERY. --The battery required for operation of the AN/PRC-40AX is not supplied with the equipment. Proceed as follows to install the battery. Be certain that the VOL control is in the OFF position.

(1) Loosen the two latches on the sides of the case.
(2) Remove the unit from its case.
(3) Secure the battery to the unit by means of two 10-32 x 3/8" screws.
(4) Connect the snap fasteners on cable W301 to the battery. Plug in P301 as illustrated in figure 5-4.
(5) After installing the crystals and completing the alignment procedure, install the unit in the case and secure with the two latches. The plug-in unit removal tool may be stored in the bottom of the case where it will be held in position by the battery.

b. CRYSTALS. --Determine the desired operating frequency and, referring to Section 5, calculate frequencies for Y101 and Y202. Refer to table 1-1 and obtain from local supply sources the two crystals of the correct frequency. Install Y101 (transmitter crystal) in the socket located between plug-in units Z106 and Z102. Install Y202 (receiver crystal) in the socket located between plug-in units Z205 and Z206. After changing frequency, both the transmitter and receiver must be aligned and the antenna cut to the proper length. Refer to Section 5 for alignment instructions.

Note

Most radio sets and spare plug-in units are factory aligned to an operating frequency of 142 MC

c. MICROPHONE. --The microphone is supplied with a coiled cable terminated with a connector plug P103. Insert plug P103 into the MICROPHONE receptacle J102 located on the top panel of Radio Set AN/PRC-40AX. Make sure the plug is firmly and properly seated. Screw the threaded locking ring onto the MICROPHONE receptacle. A bracket is mounted on the end of the Radio Set AN/PRC-40AX cabinet for holding the MICROPHONE when not in use.

d. ANTENNA. --The 1/4 wave "whip" antenna E101 is supplied with a coaxial mounting connector attached to the base of the antenna. Insert the antenna into the coaxial ANTENNA receptacle J101, located on the top panel of Radio Set AN/PRC-40AX. Secure the antenna by screwing the connector locking ring firmly onto the ANTENNA receptacle.

e. CANVAS CARRYING CASE. --If it is desired to utilize the canvas carrying case, disconnect the microphone and antenna and insert the equipment into the canvas case. Next, connect the microphone by inserting the cable connector through the rubber grommet in the top left side of the case, then installing it into the receptacle. Insert the microphone in the side pocket of the case. Install the antenna in a similar manner through the rubber grommet in the top right side of the case.

Caution

Be certain that the antenna is installed prior to operating the transmitter.

SECTION 3

OPERATORS SECTION

3-1. FUNCTIONAL DESCRIPTION

Radio Set AN/PRC-40AX is intended to provide voice communication at a distance of two miles under average conditions. Radio Set AN/PRC-40AX contains a wide-band (15 KC) FM receiver and transmitter. A mercury battery supplies the required operating voltage.

3-2. PREPARATION FOR USE

a. Rotate the SQ (squelch) control to its maximum counterclockwise position.

b. Turn VOL (volume) control slowly clockwise. This turns the set "on". A click will be heard when the switch closes.

c. Advance the VOL control until a loud hissing noise is heard from the loudspeaker.

d. Slowly rotate the SQ control clockwise until the hissing sound disappears. This is the correct operating position for the SQuelch control.

e. Adjust the VOLume control to a comfortable listening level for the given received signal.

Note

Conserve battery life. Since there are no indicator lights or receiver noise to indicate that the set is on, be certain to turn the set off when not in use.

3-3. OPERATING PROCEDURES

a. Turn set "on" as discussed in paragraph 3-2 above.

Caution

Be certain that the antenna is installed prior to operating the transmitter.

b. TO TRANSMIT MESSAGE. --Hold the microphone with the hand in such a manner that the "press-to-talk" switch can be easily released as well as firmly depressed. Hold the microphone facing the mouth, eight inches from the lips. Depress the "press-to-talk" switch and speak into the microphone using a natural, moderate speaking voice. Do not shout. Release the "press-to-talk" switch as soon as the message is completed.

Note

A message cannot be received when the "press-to-talk" switch is depressed. When replacing the microphone in the side pocket of the carrying case, be certain that the "press-to-talk" switch is not depressed.

c. TO RECEIVE MESSAGE. --The Radio Set will receive any incoming signal when the set is turned "on" and the "press-to-talk" switch on the microphone is not depressed. The message will be heard from the loudspeaker mounted in the center of the top panel. Position the Radio Set with the loudspeaker facing the listener for maximum efficiency. Adjust the volume control for the desired listening level. The squelch control, previously adjusted, will suppress most of the interfering noise.

3-4. OPERATOR'S MAINTENANCE

Batteries require periodic replacement depending upon use and age. The batteries provide approximately one hundred hours operating time at an ambient temperature of 70° F. This time is figured for a normal operating day of 8 hours, during which time the transmitter is operated 10% of the time, the receiver is operated at full volume 10% of the time, and the receiver is operated in a standby condition with reduced volume during the remaining 80% of the time. Replace the battery after one hundred hours of such usage, or when performance becomes noticeably degraded.

3-5. EMERGENCY MAINTENANCE

Most of Radio Set AN/PRC-40AX circuitry is contained in replaceable plug-in assemblies. This design feature permits rapid emergency repair during battle conditions. No technical knowledge of the circuitry is required other than location of the various plug-in assemblies.

Emergency repair is accomplished by substitution. This requires a complete set of plug-in assemblies (table 1-2) which are known to be good and which are prealigned for the frequency of operation. Refer to figure 5-5 for instructions for removing plug-in units.

Note

The alignment of Z201 through Z207 and Z209 is affected by different frequencies of reception. Alignment of the other plug-in assemblies in the receiver is not affected by the frequency of reception. The alignment of all plug-in assemblies in the transmitter except Z102, Z103, and Z109 is affected by a change in operating frequency.

When trouble appears in the receiver, replace each plug-in assembly until the defective assembly is located. It may be necessary to "touch-up" the alignment of Z205 if Z201 through Z204 have been replaced.

When trouble appears in the transmitter, replace each module, one at a time. Make a test transmission after each module change to determine which module is defective. Be certain to use only modules which have been prealigned to the particular operating frequency.

Note

When shipped from the factory, most units and spare modules are aligned to operate at a frequency of 142 MC.

Caution

Do not operate the transmitter without the antenna.

TROUBLE SHOOTING

4-1. FUNCTIONAL DESCRIPTION

Radio Set AN/PRC-40AX consists of three functional sections: transmitter, double conversion receiver, and battery power supply. The transmitter and receiver are constructed on separate printed circuit boards. Replaceable plug-in assemblies are used throughout the Radio Set. (See table 1-2.) A single antenna is used for both transmitting and receiving. Pushing the "press-to-talk" switch on the microphone actuates a relay which switches the antenna from receiver input to transmitter output. The same relay also switches operating voltage from the receiver to the transmitter. Figure 4-1 is a block diagram of the Radio Set AN/PRC-40AX. Each block in the receiver and transmitter represents a replaceable plug-in assembly.

a. TRANSMITTER. --The transmitter (figure 4-1) is a phase-modulated or indirect FM type. The transmitter consists of nine replaceable plug-in assemblies (Z101 through Z109, including relay circuit Z109), antenna E101, and microphone MK101. Depressing the "press-to-talk" switch on MK101 energizes the relay Z109 which applies operating voltage to the transmitter and switches antenna E101 to the transmitter output of Z108. Speaking into the microphone applies an audio signal to the deviation control Z102. The audio signal is clipped and shaped in Z102 and applied to phase modulator Z103 where it modulates the RF carrier. The RF carrier is generated in the transmitter oscillator Z101. The oscillator is crystal-controlled. The output of the oscillator is applied to phase modulator Z103.

Modulation of the signal occurs in Z103. The modulated signal is then amplified in Z104 and applied to frequency tripler Z105, the output of which is three times the input or oscillator frequency. The output of Z105 is doubled in Z106, the output of which is doubled again in Z107. The carrier frequency at the output of Z107 is, therefore, 12 times the oscillator frequency.

The output of Z107 is applied to the driver and final output stages in Z108. The output of Z108 is applied, through contacts of relay Z109, to antenna E101. The transmitted carrier frequency is the twelfth multiple of the oscillator frequency.

Releasing the microphone "press-to-talk" button de-energizes relay Z109. Releasing relay Z109 removes the operating voltage from the transmitter, switches the 17 VDC from transmitter to receiver, and switches the antenna from the transmitter output to the receiver input.

b. RECEIVER. --The receiver operates when the "press-to-talk" button on the microphone is not depressed. The receiver consists of eleven plug-in assemblies (Z201 through Z211), loudspeaker LS201, relay circuit Z109, and antenna E101.

During operation, the received FM signal voltages produced in the antenna circuit are coupled to Z201 through contacts of relay Z109. The weak RF signal from the antenna is amplified in Z201 and Z202 and applied to the high frequency mixer Z203. Also applied to Z203 is the output of the crystal controlled high frequency oscillator and multiplier unit Z204.

The oscillator signal and the incoming RF signal are mixed together in Z203. The heterodyne action produces several frequencies at the output of Z203, among which is the difference frequency of 8.5 MC. The output of Z203 is applied to filter Z205, which is tuned to 8.5 MC.

An 8.5 MC signal therefore appears at the output of Z205. This signal is applied to the low frequency oscillator and mixer assembly Z206. Plug-in assembly Z206 contains an 8.2 MC crystal controlled oscillator and the low frequency mixer. The output of Z206 contains the difference frequency of 300 KC (the low frequency IF) which is applied to 300 KC filter Z207.

Filter Z207 is a bandpass filter with a center frequency of 300 KC. The bandpass of Z207 is approximately 20 KC wide at 6 db down, and is between 60 KC and 120 KC wide at 80 db down.

The output of Z207 is applied to the 300 KC amplifier Z208 which contains the low IF amplifier stages. The amplified 300 KC IF at the output of Z208 is applied to the limiters and discriminator Z209.

The 300 KC signal applied to Z209 is limited and detected. After detection, a stage of impedance matching is used to produce a low impedance output for Z209.

The audio signal appearing at the output of Z209 is applied through the volume control to the input of audio amplifier Z210. The output of Z210 is an audio signal of sufficient power to operate loudspeaker LS201.

A squelch circuit Z211 is also used in Radio Set AN/PRC-40AX. Noise voltages exist in the discriminator output during the absence of an incoming signal. The noise voltages above 3000 cycles are applied through a high-pass filter to an output terminal on Z209. These noise voltages are applied through the squelch control to the input of squelch circuit Z211. Plug-in assembly Z211 amplifies the noise voltage and rectifies the amplified voltage. The output of Z211 is, therefore, a positive DC voltage. This DC voltage is applied to an input terminal of audio amplifier Z210, where it provides cutoff bias for silencing the receiver output during the absence of an incoming signal.

c. POWER SUPPLY. -- Power for Radio Set AN/PRC-40AX is supplied by a self-contained 17 v dc battery which is attached beneath the printed circuit boards.

4-2. DETAIL CIRCUIT THEORY

Most of the circuitry in Radio Set AN/PRC-40AX is contained in sealed plug-in assemblies. These plug-in assemblies, with the exception of Z108 and Z109, are sealed and not repairable. The circuitry contained therein is discussed briefly and in sufficient detail to enable an understanding of the function of each plug-in assembly and how it affects the operation of the equipment.

4-3. RECEIVER ANALYSIS

The receiver is completely transistorized and is comprised of eleven sealed plug-in assemblies, loudspeaker, and antenna. (See figures 5-3 and 5-6.)

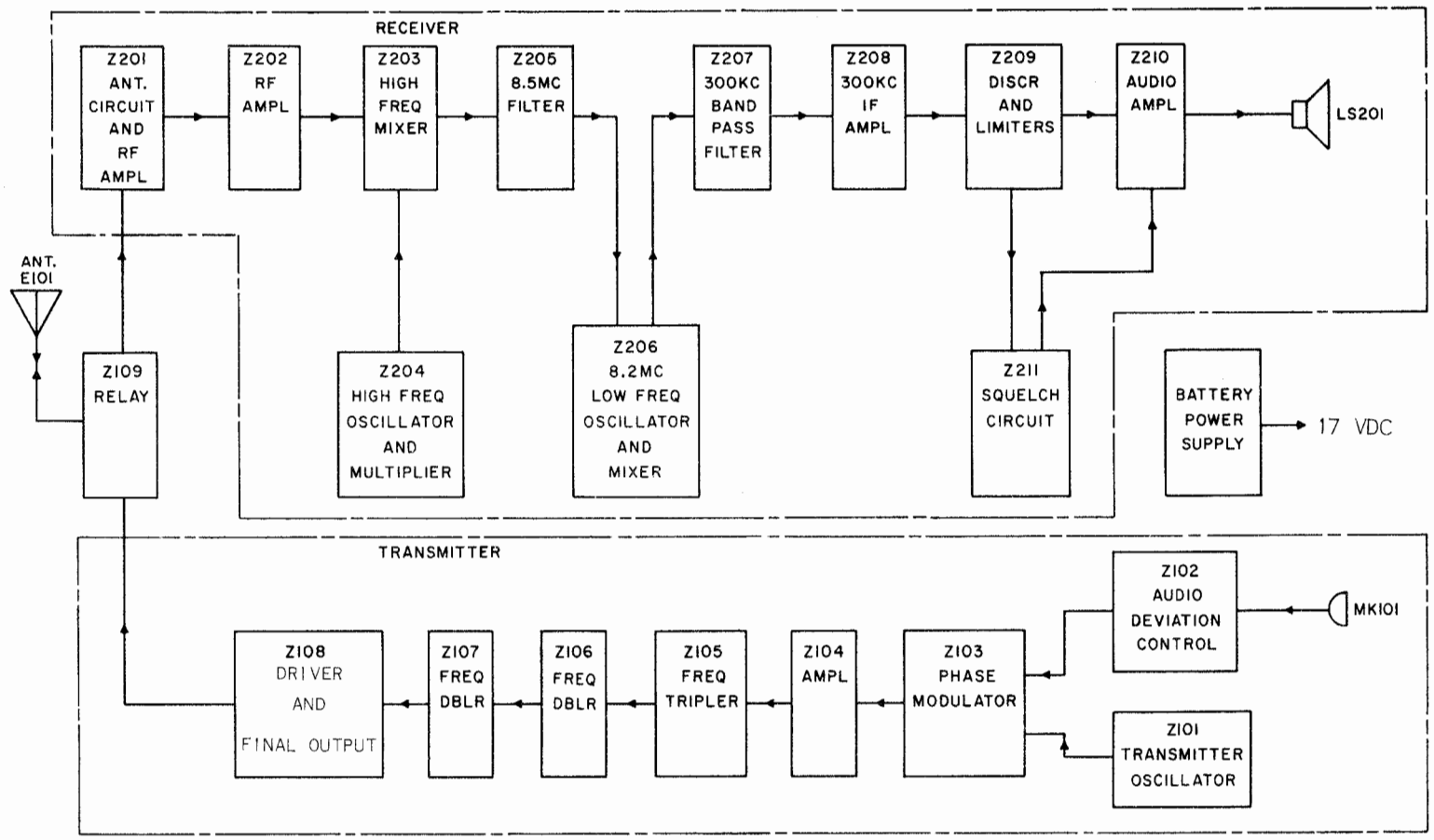


Figure 4-1 Block Diagram, AN/PRC-40AX

a. INCOMING SIGNAL. -- The receiver in Radio Set AN/PRC-40AX may be tuned to receive any single frequency between 132 and 152 MC. The incoming signal appears at antenna E101 and is applied to pin 14 of Z109 (figure 5-7). The "press-to-talk" switch on the microphone is not depressed and the relay is de-energized. The incoming signal is therefore applied to pins 2 and 3 of Z201 through the relay contacts.

b. OPERATING VOLTAGE. -- The relay in Z109 is de-energized when Radio Set AN/PRC-40AX is in the receive condition. The + 17 VDC applied to pin 5 of Z109, therefore, appears at pin 9 of Z109 due to the normally closed contacts of the relay. The +17 VDC at pin 9 of Z109 is applied to the transistors in the receiver. In the transmit mode of operation, the relay is energized and operating voltage is disconnected from the receiver circuits.

c. Z201, ANTENNA INPUT. -- The incoming signal appears at pins 2 and 3 of Z201 and is applied to a parallel resonant circuit consisting of L1 and C1, which are tuned to resonate at the incoming signal frequency. The signal is then capacitively coupled by C4 to the emitter of transistor Q1, which is connected in the grounded base configuration. The collector output of Q1 appears at pins 5 and 7 of Z201. Operating voltage for the stage is applied at pin 6. The RF signal at the output of Z201 is applied to pins 8 and 6 of Z202.

d. Z202, RF AMPLIFIER. -- The RF signal from Z201 is applied to a parallel resonant circuit consisting of L1 and C1 in Z202. This circuit is tuned to resonate at the incoming signal frequency. The signal is capacitively coupled to the emitter of Q1, which is connected in the grounded base configuration. The collector output of Q1 appears at pins 5 and 7 of Z202 and is applied to Z203.

e. Z203, MIXER. -- This plug-in assembly contains the high frequency mixer stage. The received RF signal is applied to pins 6 and 8 and the high frequency oscillator output of Z204 is applied to pin 2. These two signals are applied to a double tuned resonant circuit. The incoming RF is applied to the primary of the double tuned circuit, and the oscillator signal is injected into the secondary of the double tuned circuit. Capacitors C1 and C2 of Z203 tune the double resonant circuit to the incoming RF signal frequency. The signals are then capacitively coupled by C5 to the emitter of Q1 which is connected in the grounded base configuration.

The collector output appears at pin 7 of Z203 and consists of several frequencies, one of which is the desired difference frequency of 8.5 MC. Assume the antenna input signal is 140 MC. This signal appears at pins 6 and 8 of Z203. The oscillator signal applied to pin 2 of Z203 would be 131.5 MC, which is 8.5 MC below the incoming frequency.

Regardless of the incoming signal frequency, the oscillator frequency applied to pin 2 of Z203 is always 8.5 MC lower than the incoming signal frequency.

f. Z204, HIGH FREQUENCY OSCILLATOR. -- This plug-in assembly contains the high-frequency oscillator less crystal, and frequency multiplier stage. The crystal Y202 is mounted in a receptacle on the printed circuit board outside the sealed plug-in assembly.

The crystal is easily changed when the frequency of reception is changed. The third overtone mode of vibration of the crystal is utilized in the oscillator.

Note

The term overtone is used in place of the term harmonic because the overtone frequencies are not ordinarily in exact integral ratios to the fundamental. The third overtone, therefore, occurs at approximately, but not exactly, three times the resonant frequency of the crystal in the fundamental mode of vibration.

The third-overtone crystal Y202 is connected in the base circuit of oscillator Q1. A series capacitor is provided in the crystal circuit for fine frequency adjustment.

The tuned circuit L1 in the collector circuit of Q1 is tuned to the third overtone frequency of crystal Y202. The oscillator frequency appearing at L1 is coupled by C4 to the base of frequency multiplier Q2. A parallel resonant circuit consisting of L2 and C5 in the collector circuit of Q2 is tuned to the third harmonic of the third overtone frequency of the crystal. The multiplied oscillator signal is tapped off L2 and applied to pin 3 of Z204, where it is then connected to pin 2 of Z203 and mixed with the received RF signal.

g. Z205, FILTER. - This plug-in assembly is an 8.5MC filter. The filter contains parallel resonant circuits tuned to the high IF frequency of 8.5 MC. This filter is used to reject the image frequencies. Since the high IF frequency remains at 8.5 MC for any incoming signal, this filter is tuned to develop maximum output voltage at 8.5 MC. The output signal appearing at pin 14 of Z205 is applied to pin 3 of Z206.

h. Z206, LOW FREQUENCY OSCILLATOR. -- This plug-in assembly contains both the low frequency local oscillator and the mixer. The oscillator Q1 is crystal controlled by crystal Y201 which is located outside of the plug-in unit. The crystal frequency is 8,200.000 KC at all times. The oscillator output of 8.2 MC is coupled by C3 to the emitter of mixer Q2. The high IF signal input of 8.5 MC is applied to the base of mixer Q2, producing the difference frequency of 300 KC in the collector circuit. The low IF frequency output of Q2 is applied to pin 2 of Z207.

i. LOW FREQUENCY IF. -- The use of transistors in the IF and limiter stages requires consideration of a new system approach. Transistor limiters introduce instability problems when the limiting stage has both its input and output tuned. Severe limiting also causes a change in the transistor operating point, resulting in changes in transitor impedance levels with consequent changes in the selectivity of the limiter tuned circuits. However, by placing all the selectivity in one filter network (Z207), the need for tuned interstage-coupling networks throughout the IF and limiter stages is eliminated. This allows the use of simple RC-coupled limiters and IF amplifier stages, removing the possibility of instability and the tedious alignment procedures required by cascaded tuned stages using transitors. This lumped

selectivity (Z207) is placed between the mixer, Z206, and the IF amplifier Z208.

j. Z207, FILTER. -- This plug-in assembly is a 300 KC pass band filter which provides all the selectivity for the low frequency IF amplifier and limiter. The low frequency mixer, Z206 output is applied to pin 2 of filter Z207. The filter has a steep attenuation on either side of the pass band with relatively flat pass band response. The pass band response of Z207 is approximately 20 KC wide at 6 db down, and between 60 and 100KC wide at 80db down. The insertion loss is approximately 6 db. The filter is tuned and then sealed to maintain maximum accuracy and stability. The output of the filter appears at pin 16 of Z207, where it is applied to pin 16 of Z208.

k. Z208, AMPLIFIER. -- This plug-in assembly contains the 300 KC low frequency IF amplifiers. Three RC-coupled amplifier stages are used with a total gain of approximately 90 bd. The output appears at pin 2 of Z208 and is connected to pin 16 of Z209.

l. Z209, DISCRIMINATOR. -- This plug-in assembly contains the limiters, the discriminator, and an emitter follower for impedance matching. The amplified 300 KC IF signal appearing at pin 16 of Z209 is applied to two RC-coupled limiters Q1 and Q2. After limiting, the signal is detected by the discriminator. The resulting audio information is coupled to the base of emitter follower Q3, which is used for impedance matching and power gain. The audio output is coupled from the emitter of Q3 to pin 1 of Z209, thence to volume control R201.

m. VOLUME CONTROL. -- Volume control R201 is located on the top panel of the AN/PRC-40AX. The audio information at pin 1 of Z209 is applied through plug P201 and cable W201 to one end of the volume control R201. The other end of R201 is connected to ground, placing the total resistance of the control across the output of Z209 at all times. The desired audio signal is obtained at the center arm of the control and applied to pin 14 of Z210.

n. Z210, AUDIO AMPLIFIER. -- This plug-in assembly contains an audio amplifier and push-pull output stage. The output of Z210 appears at pin 1. The audio information is then applied to the loudspeaker LS201 through W204 and P204. During a no-signal condition, a squelch voltage from Z211 is applied to pin 2 of Z210 to eliminate background noise.

o. Z211, SQUELCH CIRCUIT. -- The squelch circuit is required because when no signal is being received, the limiter input voltage consists only of noise voltages. Most of these noise voltages are below the limiter saturation level and so the limiters act as normal voltage amplifiers in which amplitude variations, up to saturation level, will be recognized. Because the discriminator detects both FM and AM signals, the AM noise voltages present at the limiter output will be detected, amplified, and heard at the speaker. The squelch circuit is inserted to eliminate this noise output from the speaker during a no-signal condition.

A high-pass filter is placed in the output of the discriminator (Z209). This high-pass filter applies noise voltages above 3000 cycles to pin 9 of Z209. The noise voltage is then applied to one end of squelch control R202 through W202 and P202. The desired amplitude of noise voltage is obtained

at the center arm of the control and applied to pin 1 of Z211. The noise voltage is amplified by Q1 and Q2 in Z211 and then applied to a voltage doubler and rectifier consisting of CR1 and CR2. The output appearing at pin 6 of Z211 is therefore a positive DC voltage whose magnitude is dependent upon the noise present and the setting of squelch control R202. This positive DC squelch voltage is applied to pin 2 of Z210. In Z210 the DC squelch voltage is used to bias the first audio amplifier Q1. Proper adjustment of squelch control R202 will produce sufficient bias to cut off audio amplifier Q1 in Z210, thereby eliminating the noise output from the speaker.

When a signal is being received, the various noise voltages are superimposed on the IF carrier. The carrier, with the noise superimposed on the envelope, will be of sufficient amplitude to saturate the first limiter. A saturated limiter stage has sufficient input signal to produce constant amplitude output with a varying amplitude input. The output of the first limiter is then an RF signal essentially free of amplitude variation. As a result, no significant AM noise voltage above 3000 cycles will appear in the discriminator out. The squelch circuit is inoperative and the desired a audio signal is heard at the loudspeaker.

4-4. TRANSMITTER ANALYSIS

The transmitter is comprised of nine plug-in assemblies, the microphone MK101, and antenna E101. Transistors are used in all of the plug-in assemblies. Refer to figure 5-7.

a. Z101, OSCILLATOR. -- This plug-in assembly contains the transmitter oscillator which is controlled by crystal Y101, mounted on the printed circuit board outside Z101. A series capacitor C1 is provided for slight adjustments to the crystal frequency. The crystal is connected in the base circuit of transitor Q1 through pins 4 and 6 of Z101. The collector circuit of Q1 contains a parallel resonant circuit consisting of C5, C6 and tuneable coil L1. This circuit is tuned to resonate at the crystal frequency. The oscillator signal is applied to pin 5 of Z101, and then to pin E of phase modulator Z103.

The oscillator frequency is multiplied several times before it reaches the antenna. Because the transmitter of Radio Set AN/PRC-40AX contains one frequency tripler and two frequency doubler stages, the total frequency multiplication is twelve times. Consequently, the frequency of Y101 is 1/12 of the final carrier frequency.

b. Z102, AUDIO DEVIATION CONTROL. -- This plug-in assembly controls the amount of deviation of the transmitted signal. The assembly contains a clipper, a low-pass filter, a variable resistor for setting the amount of deviation, and two stages of wave shaping. Depressing the "press-to-talk" switch on microphone MK101 and speaking into the microphone applies the voice frequency signal from the microphone to pin 2 of Z102.

The voice information is clipped by Q1 and then passed through a low-pass filter and variable resistor R8, which adjusts the amount of frequency deviation. The audio signal is reshaped, amplified, and applied to audio transformer T1 in Z102. The voice modulating signal appears at pin 14 of Z102 and is applied to pin B of Z103.

c. Z103, PHASE MODULATOR. -- The phase modulator is an electrically variable delay line, varied by the audio modulating signal. The audio modulating signal is applied across one coil (pins B and A). The other coil is in series with the RF signal path. The amplitude of the audio signal at pin B of Z103 effects a phase shift in the RF signal at pins E and D of Z103, while the frequency of the audio affects the rate of phase shift in the RF signal. The phase shift is a result of the varying delay time. The resultant output is an indirect FM signal in which the amplitude of the audio determines the amount of frequency deviation and the frequency of the audio determines the rate of frequency deviation.

The FM signal appears at pin D of Z103. The signal must now be amplified and multiplied. Frequency multiplication is required to increase the carrier frequency and also to increase the amount of frequency deviation.

d. Z104, AMPLIFIER. -- The signal appearing at pin 15 of Z104, is applied to Amplifier Q1 through a parallel resonant circuit consisting of L1, C1, and C2. This circuit is tuned by L1 to resonate at the crystal Y101 frequency (11 MC to 12.7 MC). The collector circuit of Q1 contains a parallel resonant circuit consisting of L2, C4, C7, and C5, which is also tuned to the crystal frequency. The signal is removed from the resonant circuit and applied through pin 1 of Z104 to pin 16 of Z105.

e. Z105, FREQUENCY TRIPLER. -- The modulated RF applied to pin 16 of Z105 has a center frequency equal to the frequency of crystal Y101. This signal is applied to Q1 in Z105. The collector circuit of Q1 contains a parallel resonant circuit consisting of L2, C4 and C5, tuned by L2 to resonate at the third harmonic of the input (crystal) frequency. The output of Z105 appears at pin 3 and is then applied to pin 9 of Z106.

f. Z106, FIRST DOUBLER. -- Q1 is a grounded base frequency doubler in which the collector is tuned to the second harmonic of the input frequency which is the sixth multiple of the crystal Y101 frequency. The output of Z106 appears at pin 2 and is applied to pin 8 of Z107.

g. Z107, SECOND DOUBLER. -- This assembly contains a grounded base transistor which functions as a frequency doubler. The input at pin 8 is fed to the emitter of Q1. The collector circuit of Q1 is a tank circuit consisting of L3, C4, and C3, which resonates at twice the input frequency. The output at pin 14 is now twelve times the crystal frequency and is applied to the input of Z108 at pin 5.

h. Z108, FINAL OUTPUT AND DRIVER. -- This unsealed module contains three transistors. Transistor Q1 is a driver stage for the parallel output transistors Q2 and Q3. The RF input signal is applied to the emitter of grounded base amplifier Q1. The collector circuit of Q1 feeds an untuned pi network from which the final output transistors Q2 and Q3 are fed separately through equalizing net works. The output collectors are connected together and feed loosely coupled transformer T1. The output tank(L6, C7, and C6) is tuned for maximum output power by tuning C7 and by physically adjusting the coupling of T1 to obtain the rated output power with the loosest coupling possible (moving the two coils as far apart as possible while still obtaining the required output power). By coupling as loose as possible the highest efficiency is obtained, minimizing the possibility of overheating the

transistors and susbequent burn out. The output of Z108 is applied to antenna E101 through switching relay Z109.

i. Z109, RELAY. -- This plug-in assembly contains the relay which switches operating voltage from receiver to transmitter and which switches the antenna from receiver to transmitter. The relay is controlled by the "press-to-talk" switch on the microphone MK101. In the receive position, the volume control switch is closed and the "press-to-talk" switch is not depressed. The relay is not energized, and the relay contacts are in the position illustrated in figure 5-7. The receiver signal path from antenna to receiver is closed from pins 14 to 15 of Z109, and a current path is closed between pins 5 and 9 of Z109, which applies the +17 VDC to the receiver.

The "press-to-talk" switch is depressed to operate the transmitter. Depressing this switch closes a current path from the +17 VDC at pin 5 of Z109, through the coil of the relay, to pin 6 of Z109, to pin 1 of P103, to the microphone carbon button and switch, through the switch, and finally through pin 3 of P101 to ground. This current produced by the +17 VDC supply energizes the relay in Z109. The antenna is now connected through contacts of the relay to pin 16 of Z109, applying the transmitter output signal to the antenna for transmission. Simultaneously the 17+ VDC at pin 5 of Z209 is switched from the receiver (supplied from pin 9) to the transmitter (supplied from pin 11). The +17 VDC at pin 3 of Z109 is applied to pin 1 through a closed contact of the relay. This supplies the +17 VDC to the transmitter stages Z107 and Z108. If a piece of dry paper is inserted between the contacts connected to pins 1 and 3, the voltage to Z107 and Z108 is supplied through R1 (27 ohms). This limits the voltage and current supplied to Z107 and Z108 to prevent burn out of the Z108 transistors during tuning operations.

Note

Always insert a dry piece of paper between contact connected to pins 1 and 3 of the relay when tuning the final stages of the transmitter to prevent burn out of these transistors.

4-5. TROUBLE SHOOTING

This section furnishes information for isolating troubles in Radio Set AN/PRC-40AX quickly. The process of trouble-shooting is greatly simplified by the use of sealed plug-in assemblies. These replaceable assemblies plug into the printed circuit boards, and are easily accessible by removing the cabinet.

Trouble shooting and repair of the Radio Set AN/PRC-40AX may be accomplished in emergencies without test equipment. All that is required is a complete set of plug-in assemblies that are known to be good and are pre-tuned for the correct operating frequency. Simply change one plug-in assembly at a time in the transmitter or receiver until normal operation is restored. When a set of plug-in assemblies is not available for performing the check-by-substitution, the defect may be located by use of the following techniques.

4-6. TEST EQUIPMENT AND SPECIAL TOOLS

A special tool is required for removing the plug-in assemblies from the printed circuit boards. This tool is manufactured by Industrial Radio Corporation and listed as part number 2B0115. The plug-in assemblies contain spring clips which engage in slots in the printed circuit boards. The tool is used to depress the spring clip. Figure 5-5 illustrates the tool and the method of using it to depress the spring clip.

Table 4-1 lists the test equipment required for trouble shooting Radio Set AN/PRC-40AX.

TABLE 4-1. TEST EQUIPMENT

Name	AN Type	Alternate
Volt-Ohm-Milliammeter (20,000 ohms per volt) or VTVM	AN/PSM-4	Simpson Electric Model 260
FM-AM Signal Generator		Boonton Radio Co Model 202H
RF Wattmeter	AN/URM-43A	Bird Electronic Corp. Model 61
Deviation Meter		A. R. F. Products, Inc. Model AR1-A
Frequency Meter	TS-186/UP	Gertch Model FM 3

NOTE: Refer to tables 5-1 and 5-2 for alternate equipment

4-7. OVERALL TROUBLE SHOOTING

Overall trouble shooting consists of localizing the trouble to a functional section. Radio Set AN/PRC-40AX consists of three functional sections; the receiver, the transmitter, and the battery power supply.

a. PRELIMINARY CHECK. -- Visual inspection is the first step in trouble shooting. Inspect all cables and wiring for broken connections, frayed insulation and shorted wires. Inspect connectors (plugs and receptacles) for tight connections. Inspect printed circuit boards for breaks or cracks in etched wiring. Make sure all plug-in assemblies are free from mechanical damage and are securely seated. Check battery and antenna connections. Inspect the entire chassis for signs of burns and mechanical damage.

b. CONTROL SETTINGS. -- Place volume control R201 in approximately the center of its rotational travel limits. This wil automatically turn the equipment on. Place the squelch control R202 in its maximum counterclockwise position.

c. OVERALL TROUBLE SHOOTING CHART. -- Table 4-2 lists steps to be performed to localize the trouble to the battery power supply, the receiver, or the transmitter.

4-8. FUNCTIONAL SECTION TROUBLE SHOOTING

Having localized the defect to a functional section, tables are furnished to help isolate the trouble to the replaceable part within the functional section. No table is furnished for the power supply because of its simplicity. The only check necessary is to measure the voltage at P301. The functional section at fault (receiver or transmitter) is generally discovered by lack of, or faulty reception or transmission. Table 4-3 is a trouble-shooting chart for the receiver and table 4-4 is a trouble-shooting chart for the transmitter. The voltage readings in the normal indication column may vary $\pm$ 20%.

4-9. TYPICAL TROUBLES

Table 4-5 is a list of typical troubles which may be encountered in Radio Set AN/PRC-40AX. Column 1 lists various troubles, column 2 lists the nature of the trouble, and column 3 lists the symptoms of the trouble.

4-10. VOLTAGE MEASUREMENTS

a. RF VOLTAGES. -- Radio Set AN/PRC-40AX is designed for ease in servicing. Several of the plug-in units contain half-wave diode rectifiers which supply DC voltage test points. These diodes rectify the RF voltage at the output of the plug-in assembly. The rectified output is supplied as a positive DC voltage to a separate pin on the printed circuit board and identified by T. P. on top of the applicable plug-in assembly. The voltage measured at these test points indicates the existence and relative amplitude of RF voltages without special RF probes or RF voltmeters.

b. DC POWER SUPPLY VOLTAGE. -- Because this unit has been modified from a hybrid transmitter (vacuum tubes and transistors) to an all transistor unit, reference to figure 5-2 indicates evidence of the high voltage and filament supply voltages etched into the chassis near Z108 and Z107. This is no longer true as these points labeled C+15 now provide +17 VDC when energized.

TABLE 4-2. OVERALL TROUBLE SHOOTING CHART

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP FOR ABNORMAL INDICATION
1.	(B7) Figs. 5-2 and 5-7	Turn set on. Set VOM for +50 VDC. Connect common lead to chassis. Measure voltage at test point while holding the microphone "press-to-talk" switch depress.	VOM reads +16 VDC while "press-to-talk" switch is depressed.	Check Z109, P301, BT 301, and printed circuit.
2.	(3) Figs. 5-1 and 5-7	Set VOM for +50 VDC and measure voltage at test point. This test point is the DPST switch on R201. One set of contacts is no longer used but will have voltage if Z107 is in place.	VOM reads +17 VDC while "press-to-talk" switch is depressed.	Check power supply, switch, cabling, and printed circuit.
3.	Loudspeaker	Turn volume control R201 to clockwise position. Turn squelch control R202 to maximum counterclockwise position.	Noise is audible from the loudspeaker LS201 when no signal is being received.	Check receiver.
4.	Loudspeaker	Slowly advance the squelch control while listening to the speaker output.	Noise disappears as squelch cut-off is reached.	Check receiver circuit.
5.	(B6) Figs. 5-2 and 5-7	Rotate squelch control to maximum counterclockwise position. Set RF-signal generator to the frequency of	The noise disappears with input signals of 1 μv or greater due to increased signal to noise ratio.	Check receiver.

TABLE 4-2. OVERALL TROUBLE SHOOTING CHART (CONT)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP FOR ABNORMAL INDICATION
		reception (132 to 152 MC). Connect the generator output to the antenna. Set the signal output at 1 μv.		
6.	B_6 Figs. 5-2 and 5-6	Remove the signal generator. Connect the antenna receptacle to an RF power meter. Depress the "press-to-talk" switch.	The RF power meter reads 1 watt min.	Check transmitter.
7.	B_6 Figs. 5-2 and 5-7	Loosely couple the frequency meter to the antenna link and depress the "press-to-talk" switch. Check the frequency. Do not operate without antenna load.	Frequency must be the desired frequency of transmission (132 MC to 152 MC).	Check C1 of Z101. Check alignment.
8.	B_6 Figs. 5-2 and 5-7	Remove the frequency meter and loosely couple the deviation meter to antenna link. Depress the "press-to-talk" switch and speak loudly into the microphone.	The frequency deviation reads 15 KC maximum or lower as determined by R8 in Z102.	Adjust R8 of Z102. Check microphone and connections.

TABLE 4-3. RECEIVER TROUBLE SHOOTING CHART

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP FOR ABNORMAL INDICATION
1.	A_8 Figs. 5-2 and 5-7	Turn the set on. Set VOM for +15 VDC and measure voltage at test point.	VOM reads +15 VDC.	Check Z109, volume control switch, power supply, and printed circuit.
2.	A_1 Figs. 5-1 and 5-6	Set VOM for +50 VDC and connect to test point at Z204.	VOM reads +6 to +14 VDC.	Check crystal Y101 and Z204.
3.	A_3 Figs. 5-1 and 5-6	Set the signal generator to the receiver frequency (132 to 152 MC) at a 1 μv output. Connect the generator output to the antenna. Set the VOM for +50 VDC and connect to the test point for pin 14 of Z207.	VOM reads +12 VDC.	Check Z201 through Z207.
4.	A_4 Figs. 5-1 and 5-6	Set VOM for +50 VDC and connect to test point for pin 8 of Z208.	VOM reads between +5 & +15 VDC, depending on input signal.	Check Z208.
5.	A_5 Figs. 5-1 and 5-6	Set VOM for +2.5 VDC and connect to test point for pin 8 of Z209.	VOM reads +0.9 VDC.	Check Z209.
6.	Loud-speaker	Remove signal generator. Rotate squelch control to maximum counterclockwise position. Rotate volume control R201 to maximum clockwise position.	A loud hissing noise is heard from the loud-speaker LS201.	Check Z209, R201, Z210, and LS201.

TABLE 4-3. RECEIVER TROUBLE SHOOTING CHART (CONT)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP FOR ABNORMAL INDICATION
		Slowly rotate squelch control to the maximum clockwise position.	Hissing noise disappears.	Check R202, Z209, and Z211.

TABLE 4-4. TRANSMITTER TROUBLE SHOOTING CHART

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP FOR ABNORMAL INDICATION
1.	B_7 Figs. 5-2 and 5-7	Set VOM for +50 VDC. Depress the "press-to-talk" switch and measure voltage at test point (top jumper wire).	VOM reads +16 VDC.	Check power supply, switch or volume control, Z109, and printed circuit.
2.	B Figs. 5-2 and 5-7	Set VOM for +50 VDC and connect to test point. Depress the microphone "press-to-talk" switch.	VOM reads +6 and +12 VDC.	Check Y101 and Z101.
3.	B_1 Figs. 5-2 and 5-7	Connect VOM to test point. Depress "press-to-talk" switch.	VOM reads approximately +8 to +12 VDC.	Check Z103 and Z104.
4.	B_2 Figs. 5-2 and 5-7	Set VOM for +50 VDC and connect to test point. Depress "press-to-talk" switch.	VOM reads +16 to +22 VDC.	Check Z105.
5.	B_3 Figs. 5-2 and 5-7	Connect VOM to test point. Depress "press-to-talk" switch.	VOM reads +2.2 to +2.7 VDC.	Check Z106 or Z107.

TABLE 4-4. TRANSMITTER TROUBLE SHOOTING CHART (CONT)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP FOR ABNORMAL INDICATION
6.	B_4 Figs. 5-4 and 5-7	Connect VOM to test point. Depress "press-to-talk" switch.	VOM reads at least +1 VDC.	Check Z107.
7.	B_5B Figs. 5-4 and 5-7	Connect VOM to test point. Depress "press-to-talk" switch.	VOM reads +1 VDC.	Check Z108.
8.	B_6 Figs. 5-2 and 5-7	Connect RF watt-meter to antenna receptacle J101. Depress "press-to-talk" switch.	Power output reads 0.8 watt at 132 or 142 MC and 0.7 watt at 152 MC.	Check Z108 alignment or Z109 Relay contacts.
9.	B_6 Figs. 5-4 and 5-7	Loosely couple the deviation meter to test point at link. Hold "press-to-talk" switch depressed and speak loudly into microphone.	Deviation reads maximum of 15 KC, or less if desired, depending upon setting of R8 in Z102.	Check Z102, Z103, and microphone.

TABLE 4-5. RADIO SET AN/PRC-40AX, TYPICAL TROUBLES

TROUBLE	NATURE OF TROUBLE	SYMPTOM
Subnormal transmitter operation	Detuned transmitter, incorrect antenna length, battery low.	Reduced transmitter output when operating voltages are normal.
Subnormal receiver operation	Detuned receiver or defective plug-in assembly.	Reduced receiver sensitivity when operating voltages are normal.
Transmitter RF carrier not being modulated	Defective microphone, deviation control Z102, or phase modulator Z103.	Transmitter operating, RF carrier present without modulation.
Squelch circuit inoperative	Defective control R202, squelch circuit Z211, or discriminator Z209.	Noise heard from speaker during no input signal condition.
Both receiver and transmitter completely dead	Defective switch on volume control or defective power supply.	No sound at loudspeaker and no transmission
Microphone "press-to-talk" switch does not function.	Defective "press-to-talk" switch or defective relay Z109.	Receiver operates but does not shut off when "press-to-talk" switch is depressed.

SECTION 5

MAINTENANCE

5-1. FAILURE, PERFORMANCE AND OPERATIONAL REPORTS

The Bureau of Ships no longer requires the submission of Failure Reports for all equipments. Failure Reports and Performance and Operational Reports are to be accomplished for designated equipments only to the extent required by existing directives. (Refer to Electronics Installation and Maintenance Book, NAVSHIPS 900,000.) All failures shall be reported for those equipments requiring the use of Failure Reports.

5-2. PREVENTIVE MAINTENANCE

Preventive maintenance for the AN/PRC-40AX consists only of:

a. Maintaining normal cleanliness.
b. Replacing a weak battery.
c. Realigning the receiver and transmitter when performance is degraded. Refer to paragraph 5-3 for instructions.

5-3. RECEIVER AND TRANSMITTER ALIGNMENT

Included in this section are instructions for reassembly and alignment of transmitted and receiver. Data are provided for alignment, adjustment, and calibration to obtain optimum performance. All slug tuned coils accessible for alignment contain threaded plastic locking plugs. These plugs are tightened against the core to prevent detuning caused by vibration. The plastic locking plugs must be removed before alignment and replaced after alignment.

5-4. RECEIVER ALIGNMENT

a. GENERAL. -- The radio receiver can be aligned to receive any frequency within the 132 to 152 MC band. The high IF frequency is 8.5 MC. By employing crystals of different frequencies and realigning the receiver, any frequency within the entire above-mentioned band may be received. The low IF frequency is 300 KC. The second local oscillator uses an 8200.000 KC crystal, Y201.

b. CALCULATING CRYSTAL FREQUENCY. -- The following formula is used to calculate the third overtone frequency of crystal Y202 to receive any input frequency within the band of 132 to 152 MC.

$$FY202 = \frac{(\text{Rec Input Frequency in MC minus } 8.5)}{3}$$

Where: FY202 = Third overtone frequency of crystal Y202 in MC.

c. CALCULATING INPUT FREQUENCY. -- Use the following formula to calculate the input frequency in MC which can be received with a given crystal Y202.

Rec Input Frequency = 3 FY202 + 8.5

Where: FY202 = Third overtone frequency of Y202 in MC.

The number 8.5 appearing in the above formulae represents the high IF frequency in megacycles.

Note

Use only Space Avionics Inc. Part No. 101179-2 or CR-52/U TYPE, except tolerance shall be ±.0025% from -30° to +60° C.

d. RECEIVER ALIGNMENT EQUIPMENT. -- Table 5-1 lists the test equipment required for alignment of the receiver.

TABLE 5-1. TEST EQUIPMENT FOR RECEIVER ALIGNMENT

NAME	AN TYPE	ALTERNATE
Volt-Ohm-Milliammeter (20,000 ohm-per-volt)	AN/PSM-4	Simpson Electric Model 260
FM-AM Signal Generator		Boonton Radio Co. model 202 H or CYK202H or Marconi Instruments model 1066B

e. RECEIVER ALIGNMENT PROCEDURE. -- The step-by-step alignment procedure is given in table 5-2. Keep test leads as short as possible and provide good RF grounds for all test equipment. Check and calibrate test equipment frequently. Unless otherwise specified, use only as much signal generator output voltage as required for a good readable indication on a low meter range. Location of assemblies and test points may be found on figures 5-1 and 5-3.

5-5. RECEIVER SENSITIVITY TEST

a. GENERAL. -- The sensitivity of the receiver signifies how effectively the receiver is operating. One of the principal influences in the sensitivity of an FM receiver is the requirement that the receiver should not be responsive to AM effects. This is determined by the limiter and detector stages.

The sensitivity of a receiver is the characteristic which decides the minimum strength of signal input needed to produce sufficient limiting action to reduce the noise voltage output a specified amount. Because an increase in signal strength reduces the AM noise output, the reduction is calculated in db and termed "quieting action". A four-microvolt signal at the antenna of the Radio Set AN/PRC-40AX receiver will produce 20 db or better of quieting action.

b. TEST EQUIPMENT. -- The test equipment listed in table 5-1 is required for checking the sensitivity of the receiver.

c. SENSITIVITY TEST PROCEDURE. -- The following step-by-step procedure will determine the sensitivity of the receiver.

(1) Connect the signal generator to the antenna input connector (J101).

(2) Set the AN/PSM-4 for AC volts and connect across the loudspeaker LS201 voice coil.

(3) Adjust signal generator accurately to the receiver signal frequency and rotate attenuator for zero signal output.

(4) Turn "on" receiver and rotate squelch control to maximun counterclockwise position.

(5) Rotate receiver volume control R201 for a 0.5 volt reading on the voltmeter. This represents the noise voltage.

(6) Rotate the signal generator attenuation control until the noise voltage indicated by the milli-voltmeter decreases to 0.05 volts.

(7) Check the signal generator output voltage. This should be four microvolts, or less if the receiver is correctly adjusted and operating properly.

(8) If a meter with a db scale is available, it may be used as follows: With zero generator output, adjust volume control for 20 db on the meter. Increase generator output until meter reads 0 db. Generator output should be four microvolts or less.

TABLE 5-2

AN/PRC-40AX RECEIVER ALIGNMENT PROCEDURE

Step	Procedure	Test Point	Results
1	Turn receiver on and install proper crystal (Y202) in its socket. Align L1 Z204 for maximum output. Note: Turn receiver off - then on to see if oscillator restarts. If it does not, detune slightly until it restarts satisfactorily	A1	Approx. 6 to 14 volts
2	Note: The voltage at this point varies from approximately 5 volts with no signal present to 15 volts with enough signal present to saturate this stage. During the tuning process always keep the signal between these two limits - increasing the generator output if the signal does not appear and decreasing the signal generator if the voltage goes to saturation.	A4	
	Connect the R.F. signal generator to the antenna connector and tune it to the operating frequency. Set the output control to just high enough to obtain an indication of signal at the test point. Now fine tune the	A4	

Table 5-2 AN/PRC-40AX RECEIVER ALIGNMENT PROCEDURE (CONT)

Step	Procedure	Test Point	Results
	signal generator frequency for maximum output at the test point. Then in order tune Z205, (L1, L2, L3), Z204 C5, Z203 C1 and C2, Z202 C1 and Z201 C1. Remember to reduce the signal generator output as saturation is reached at the test point.		
	At this point a measurement of sensitivity can be made by connecting an A.C. meter on the loudspeaker terminals and measuring the amount of signal required for 20 db of quieting. For 1 V RMS noise at the speaker, 4 microvolts of signal should produce 20db of quieting.		4uv for 20db
3	Connect an FM signal generator that has been adjusted precisely to the operating frequency and set for ± 10Kc deviation to the antenna terminals. Adjust C2 Z204 for the best sine wave (least distortion) while viewing the test point on an oscilloscope.	A6	

5-6. TRANSMITTER ALIGNMENT

a. GENERAL. -- The transmitter may be tuned to radiate any single frequency between 132 and 152 megacycles, provided that the correct frequency crystal (Y101) is used for the transmitter oscillator.

b. CALCULATING CRYSTAL FREQUENCY. -- The following formula is used to determine the crystal frequency FY101 required to transmit any desired frequency within the band of 132 and 152 MC.

$$FY101 = \frac{(\text{Xmtr Carrier Frequency in MC})}{12}$$

Where: FY101 = Crystal Y101 frequency in MC.

From the above formula it may be seen that the transmitter crystal Y101 frequency must be within 11000.000 KC and 12666.666 KC to transmit within the band of 132 to 152 MC.

Note

Use only Space Avionics Inc. Part No. 101179-1 or CR-18/U TYPE, except tolerance shall be ±.0025% from -30° C. to +60° C.

c. TRANSMITTER ALIGNMENT EQUIPMENT. -- Table 5-3 lists the test equipment required for alignment of the transmitter.

d. TRANSMITTER ALIGNMENT PROCEDURE.-- The alignment of the transmitter is accomplished by use of the step-by-step procedure in table 5-4. During the tuning operation, heavy currents are drawn from the batteries and the transmitter transistors are subjected to overload conditions. The transmitter should therefore be turned on only during the actual tuning periods.

Note

Perform the transmitter turning procedure in an RF shielded enclosure or with the antenna removed and the RF wattmeter connected to J101 as a dummy load. Never operate the transmitter without a properly cut antenna or dummy load.

TABLE 5-3. TEST EQUIPMENT FOR TRANSMITTER ALIGNMENT

NAME	AN TYPE	ALTERNATE
Volt-Ohm-Milliammeter (20,000 ohms per volt)	AN/PSM-4	Simpson Electric Model 260
Deviation Meter		A.R.F. Products, Inc. Model AR1-A or Marconi Instruments, Mod. 791D
RF Power Meter	AN/URM-43A	Hewlett-Packard Mod. 413B with 478A thermal mount
Frequency meter or counter	TS-186/UP	Gertch Model FM 3

TABLE 5-4. TRANSMITTER ALIGNMENT TABLE

STEP	TEST POINT	PROCEDURE	ADJUST	NOTES
1.	-	Remove the transceiver from its case.		
2.	-	Unscrew and remove 6 plastic locking plugs from the six tuning coils in the transmitter plug-in units. (Z104 has 2 coils.)		
3.	-	Insert a dry piece of paper between the contacts 1 and 3 of relay Z109. These contacts are SPST and are the furthest removed from the relay coil.		This step causes lower than normal dc voltage to be applied to the final amplifier, thus

TABLE 5-4. TRANSMITTER ALIGNMENT TABLE (CONT)

STEP	TEST POINT	PROCEDURE	ADJUST	NOTES
		(A 27 ohm resistor is in parallel with the contacts)		preventing transistor burnout.
4.	-	Calculate the crystal frequency for the desired operating frequency and install the correct crystal in Y101.		
5.	-	Connect a power meter or a 50-ohm dummy antenna load with a tee for connecting an RF voltmeter (10 v range). Connect microphone. In following adjustment procedures, depress the "push-to- talk" switch only when making adjustments.		
6.	B	Connect voltmeter, + to T.P.B.	Z101, L1 for max.	6 to 12 VDC
7.	B1	Connect voltmeter, + to T.P.B1	Z104, L2 for max., then L1 for max.	8 to 12 VDC
8.	B2	Connect voltmeter, + to T.P.B2. This is a low Q circuit and the adjustment will be very broad.	Z105, L2 for max.	16 to 22 VDC
9.	B3	Connect voltmeter, + to T.P.B3	Z106, L3 for max. Then rotate counterclockwise until voltage at T.P.B3 just starts to drop.	2.25 to 2.6 VDC
10.	B4	Connect voltmeter, + to T.P.B4	Z107, L3 for max. Then rotate counterclockwise until voltage just starts to drop.	Approx. 1 VDC

TABLE 5-4. TRANSMITTER ALIGNMENT TABLE (CONT)

STEP	TEST POINT	PROCEDURE	ADJUST	NOTES
11.	RF Voltmeter at J101	Adjust Z108 capacitor for a max. power or highest RF voltmeter reading.	Z108, C7 for max. See Note 1.	Approx. 5-1/2 V (0.6 watt)
12.	-	Repeat Steps 10 & 11		
13.	-	Turn off the transmitter and remove the paper from between the contacts of relay Z109.		
14.	-	Full power is now applied to the output stage. Do not make gross adjustment of variable capacitor in Z108. If trouble is experienced in making these adjustments, turn off transmitter immediately, reinstall the paper in relay Z109, and repeat steps 10 thru 14.	Z107, L3 for max. reading at B4. Z108, C7 for max. power or RF voltmeter reading of 0.8 watt at 132 MC 0.8 watt at 142 MC 0.7 watt at 152 MC	Approx. 1-1/2 V
15.	-	Remove all test equipment and install antenna cut to the correct length for the operating frequency.		
16.	-	Loosely couple the frequency meter to the antenna.	C1 in Z101 for correct frequency of transmission	
17.	-	Remove the frequency meter and loosely couple the deviation meter to the antenna. Depress the "press-to-talk" switch and speak loudly into the microphone while observing the deviation meter.	Adjust R8 in Z102 for desired frequency deviation. Maximum permisible deviation is 15 KC.	

Note 1. Observe that alignment tool capacitance affects reading. Close capacitor slightly beyond peak point so that when alignment tool is removed, output power will be at maximum.

Note 2. Occasionally a transmitter will oscillate, but not under the control of Y101. This condition can be detected by observing a power output even though Y101 is removed from the circuit. Correct the condition by slightly detuning L2 of Z104 or replacing Z104.

5-7. ANTENNA LENGTH

To obtain optimum performance of the AN/PRC-40AX, the antenna must be cut to resonate at the frequency for which the set is aligned. Table 5-5 lists the overall length of the antenna required for different frequencies of operation.

Note

The length given in table 5-5 is the distance measured from the top of the coaxial connector to the top of the loop. The loop should have a diameter of approximately 5/16 inches. To cut the antenna for a new frequency, add 2-1/2 inches to the dimensions given in table 5-5: one inch to form the loop and 1-1/2 inches to insert in the coaxial connector. If the antenna wire is not to be unsoldered from the coaxial connector, add 1 inch to the length listed in table 5-5 and form the loop. When installing a new antenna in the connector, be certain to insert the wire to the bottom of the connector before soldering.

TABLE 5-5. ANTENNA LENGTH VS FREQUENCY

FREQUENCY IN MC	LENGTH IN INCHES (SEE NOTE)	FREQUENCY IN MC	LENGTH IN INCHES (SEE NOTE)
132	20-52/64	143	19-17/64
133	20-43/64	144	19-8/64
134	20-34/64	145	18-63/64
135	20-25/64	146	18-54/64
136	20-16/64	147	18-45/64
137	20-7/64	148	18-36/64
138	19-62/64	149	18-27/64
139	19-53/64	150	18-18/64
140	19-44/64	151	18-9/64
141	19-35/64	152	18
142	19-26/64		

NOTE: This length is the distance from the top of the loop to the top of the coaxial connector. Refer to paragraph 5-7 before cutting the antenna for a new frequency.

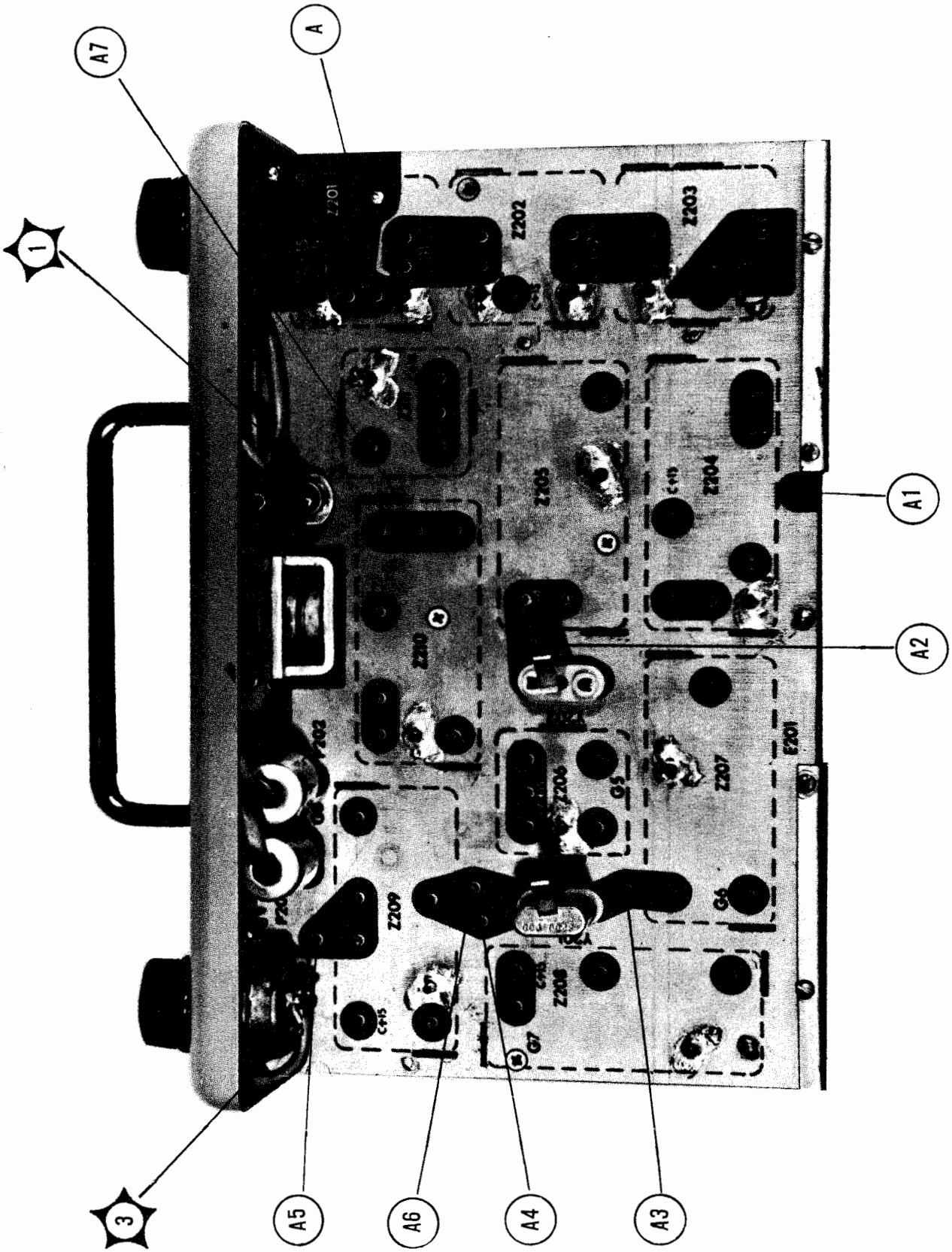


Figure 5-1. Receiver Printed Circuit Board.

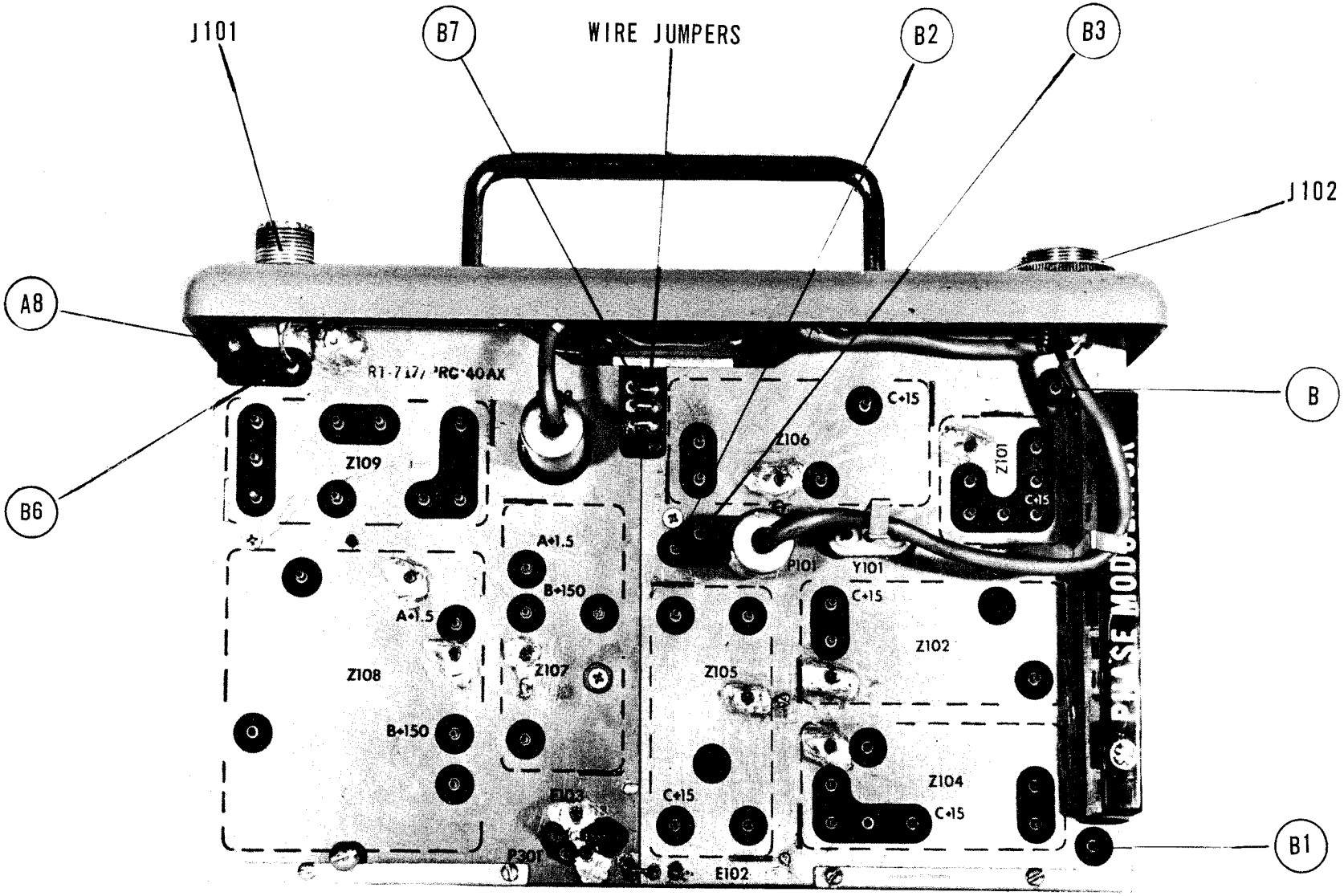


Figure 5-2. Transmitter Printed Circuit Board

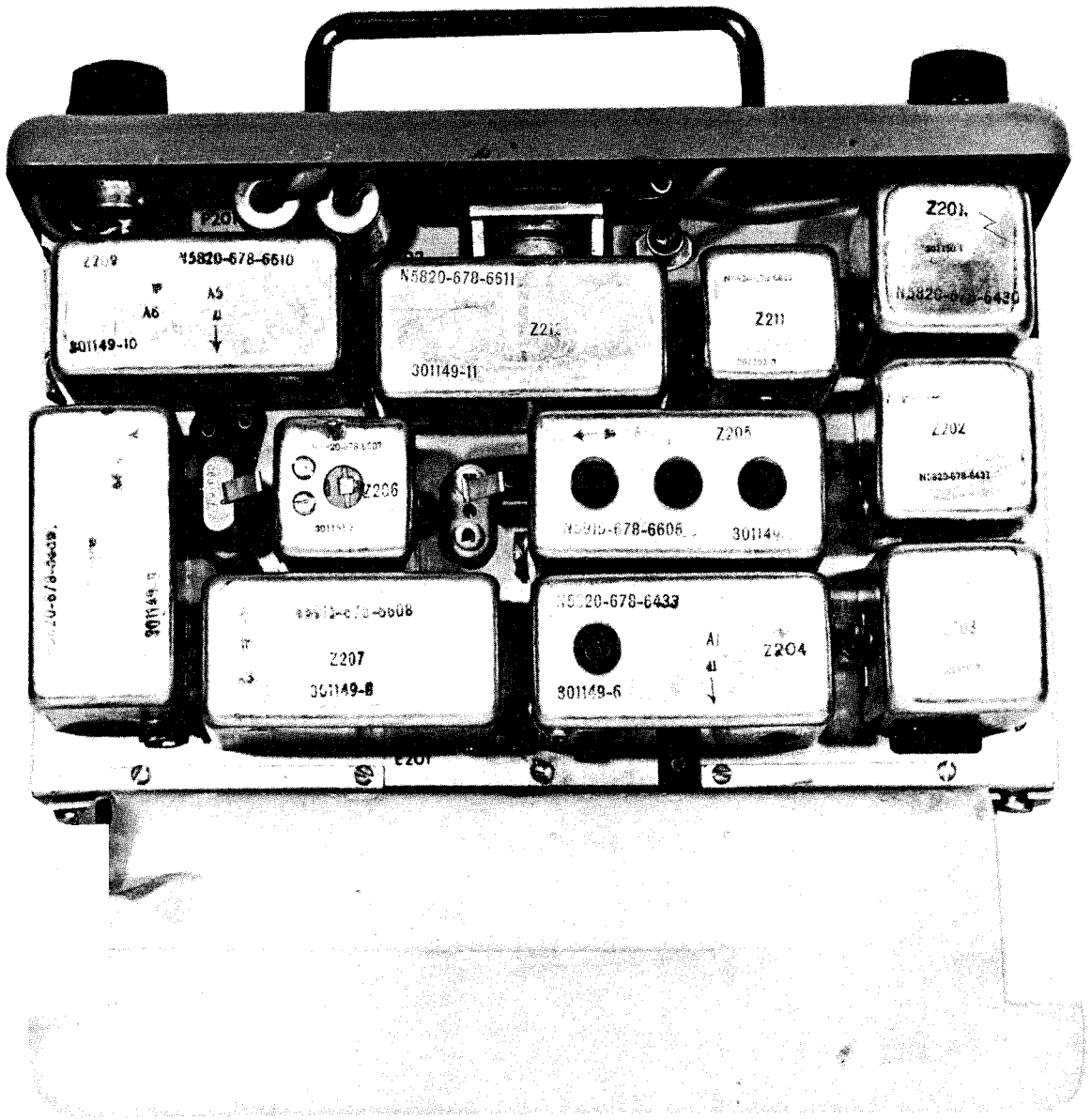


Figure 5-3. Receiver with Power Supply.

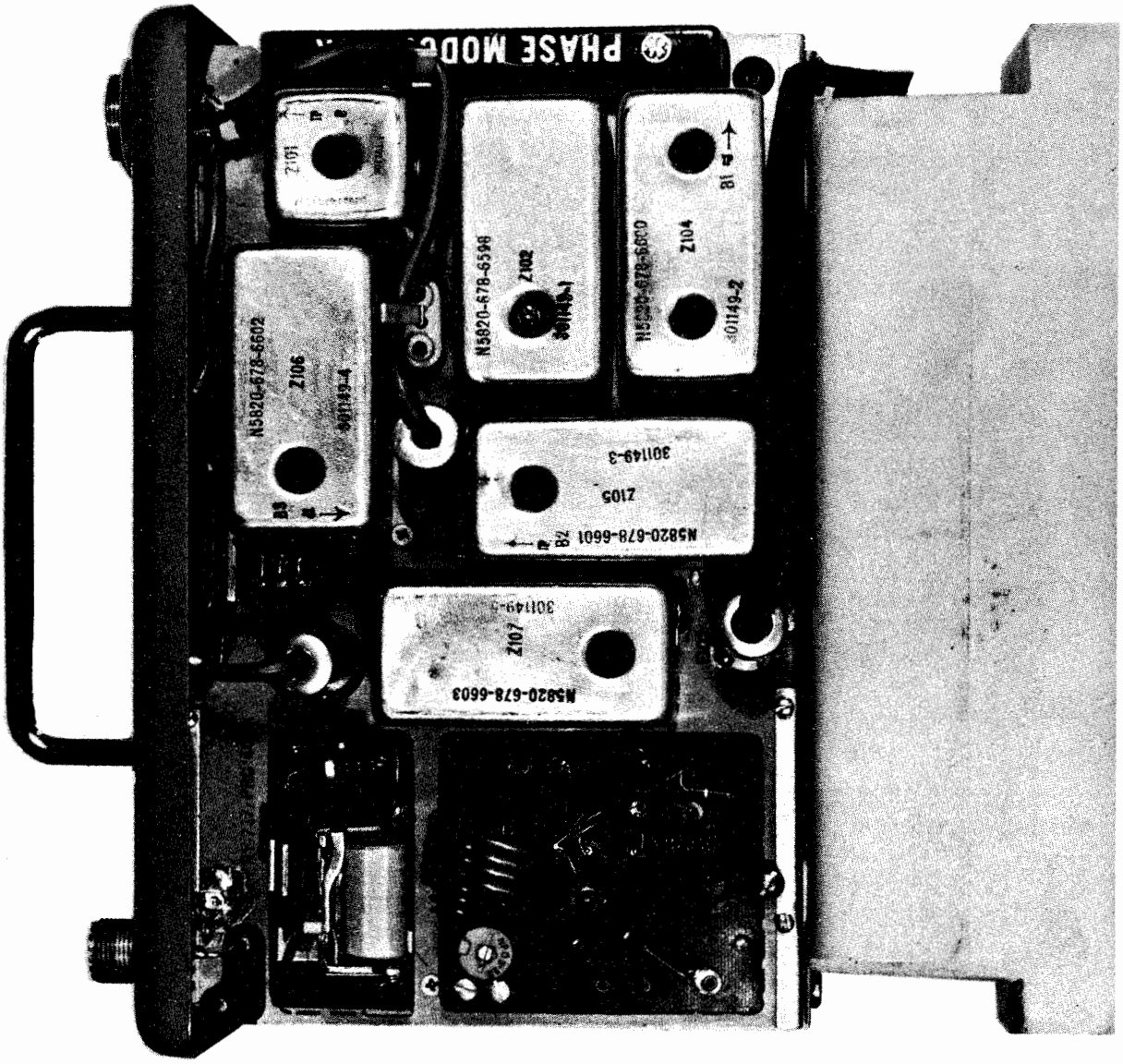


Figure 5-4. Transmitter with Power Supply.

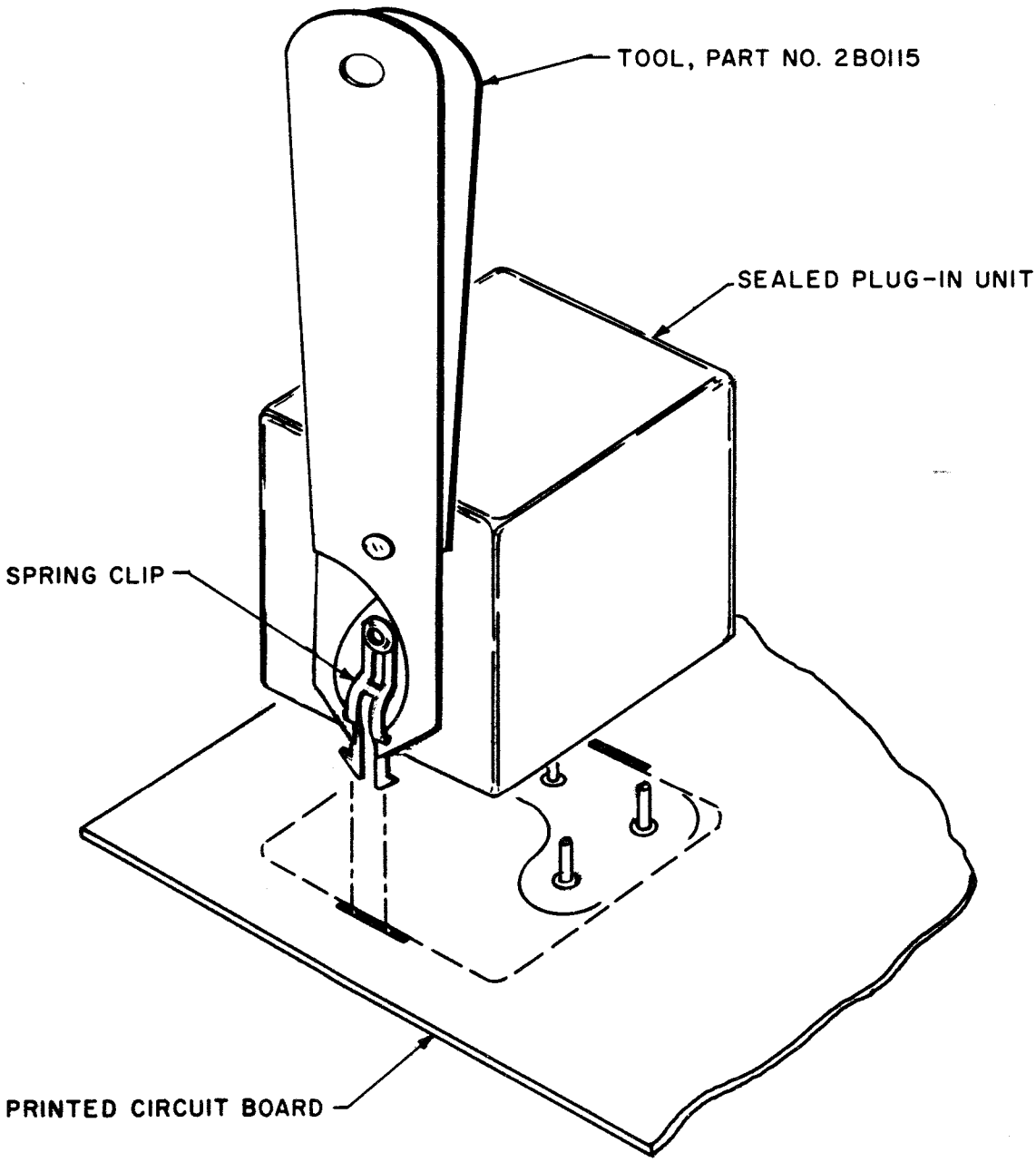


Figure 5-5. Removing Plug-In Assembly.

SECTION 6

PARTS LIST

6-1 INTRODUCTION

Table 6-1 lists the maintenance parts of Radio Set AN/PROC-40AX. Column 1 lists the reference designation and is arranged in alpha-numeric order. Column 2 lists the name of the part, the manufacturer's part number and the coded names of the manufacturers. Column 4 provides reference to an illustration showing the part.

To obtain a manufacturer's name and address, determine his code number from table 6-1 and refer to table 6-2 for the name and address.

TABLE 6-1. MAINTENANCE PARTS LIST

REF. DESIG.	NAME AND DESCRIPTION	FIG. NO.
BT301	BATTERY, DRY: PN 301144, Mfg. 14518	
E101	ANTENNA: with Connector; PN 201206, Mfg. 14518	
E105	COVER, CANVAS: PN 401134, Mfg. 14518	
E202	KNOB: PN 1475U, Mfg. 72512	
E203	KNOB: PN 1475T, Mfg. 72512	
J102	CONNECTOR, RECPT. ELECT: PN 91-PC 4F, Mfg. 02660	
LS201	LOUDSPEAKER, P.M.: PN S-3124, Mfg. A	
MK101	MICROPHONE, CARBON: PN 9004, Mfg. 74384	
P101	CONNECTOR, PLUG, ELECT: PN 91-MPF4S, Mfg. 02660	
P201	CONNECTOR, PLUG, ELECT: PN 91-MPF3S, Mfg. 02660	
P202	CONNECTOR, PLUG, ELECT: PN 91-MPF3S, Mfg. 02660	
P301	CONNECTOR, PLUG, ELECT: PN 91-MPF5S, Mfg. 02660	
R201	RESISTOR, VARIABLE: w/Switch; PN, Mfg. 71590	

TABLE 6-1 (CONT)

REF. DESIG.	NAME AND DESCRIPTION	FIG. NO.
R202	RESISTOR, VARIABLE: PN BA11, Mfg. 71590	
W102	CABLE ASSEMBLY: w/Connector; PN B9041A, Mfg. 74384	
W301	CABLE ASSEMBLY: PN 301154, Mfg. 14518	
Y101	CRYSTAL, FIXED: PN 101179-1, Mfg. 14518	
Y202	CRYSTAL, FIXED: PN 101179-2, Mfg. 14518	
Z101	OSCILLATOR, R-F: non-repairable assy; PN 301151-1, Mfg. 14518	
Z102	CONTROL, MODULATOR: non-repairable assy.; PN 301149-1, Mfg. 14518	
Z103	MODULATOR, R-F: non-repairable assy.; PN 201204, Mfg. 14518	
Z104	AMPLIFIER, R-F: non-repairable assy.; PN 301149-2, Mfg. 14518	
Z105	FREQUENCY MULTIPLIER: non-repairable assy.; PN 301149-3, Mfg. 14518	
Z106	FREQUENCY MULTIPLIER: non-repairable assy.; PN 301149-4, Mfg. 14518	
Z107	FREQUENCY MULTIPLIER: non-repairable assy.; PN 301149-5, Mfg. 14518	
Z108	AMPLIFIER, R-F: non-repairable assy.; PN 301152, Mfg. 14518	
Z109	RELAY ASSEMBLY: non-repairable assy.; PN 301153, Mfg. 14518	
Z201	AMPLIFIER, R-F: non-repairable assy.; PN 301150-1, Mfg. 14518	
Z202	AMPLIFIER, R-F: non-repairable assy.; PN 301150-2, Mfg. 14518	
Z203	MIXER STAGE, FREQ.: non-repairable assy.; PN 301150-3, Mfg. 14518	
Z204	OSCILLATOR, R-F: non-repairable assy.; PN 301149-6, Mfg. 14518	
Z205	FILTER, BANDPASS: non-repairable assy.; PN 301149-7, Mfg. 14518	

REF. DESIG.	NAME AND DESCRIPTION	FIG. NO.
Z206	CONVERTER, FREQ.: non-repairable assy.; PN 301151-2, Mfg. 14518	
Z207	FILTER, BAND PASS: non-repairable assy.; PN 301149-8, Mfg. 14518	
Z208	AMPLIFIER, R-F: non-repairable assy.; PN 301149-9, Mfg. 14518	
Z209	DISCRIM., FREQ: non-repairable assy.; PN 301149-10, Mfg. 14518	
Z210	AMPLIFIER, A-F: non-repairable assy.; PN 301149-11, Mfg. 14518	
Z211	LIMITER, ELECT., NOISE: non-repairable assy.; PN 301151-3, Mfg. 14518	

TABLE 6-2. LIST OF MANUFACTURERS

MFG. CODE NUMBER	NAME	ADDRESS
02660	Amphenol-Borg Electronics Corp.	Broadville (Chicago), Ill.
14518	Space Avionics, Inc.	Alexandria, Virginia
71590	Centralab, Division of Globe Union, Inc.	Milwaukee, Wisconsin
72512	Harry Davies Moulding Co.	Chicago, Ill.
74384	Turner Co.	Cedar Rapids, Iowa
A	Oakton Industries	

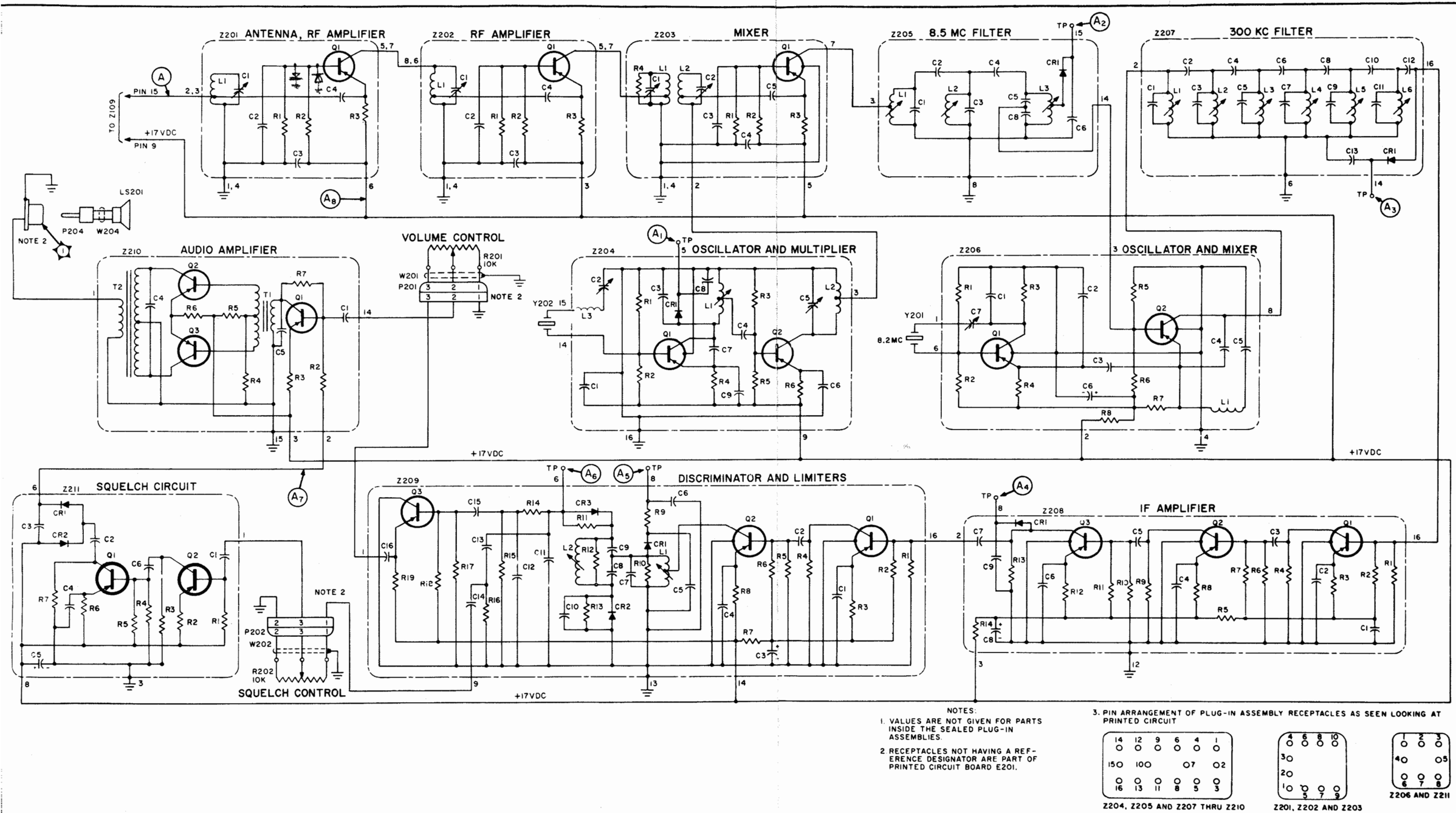
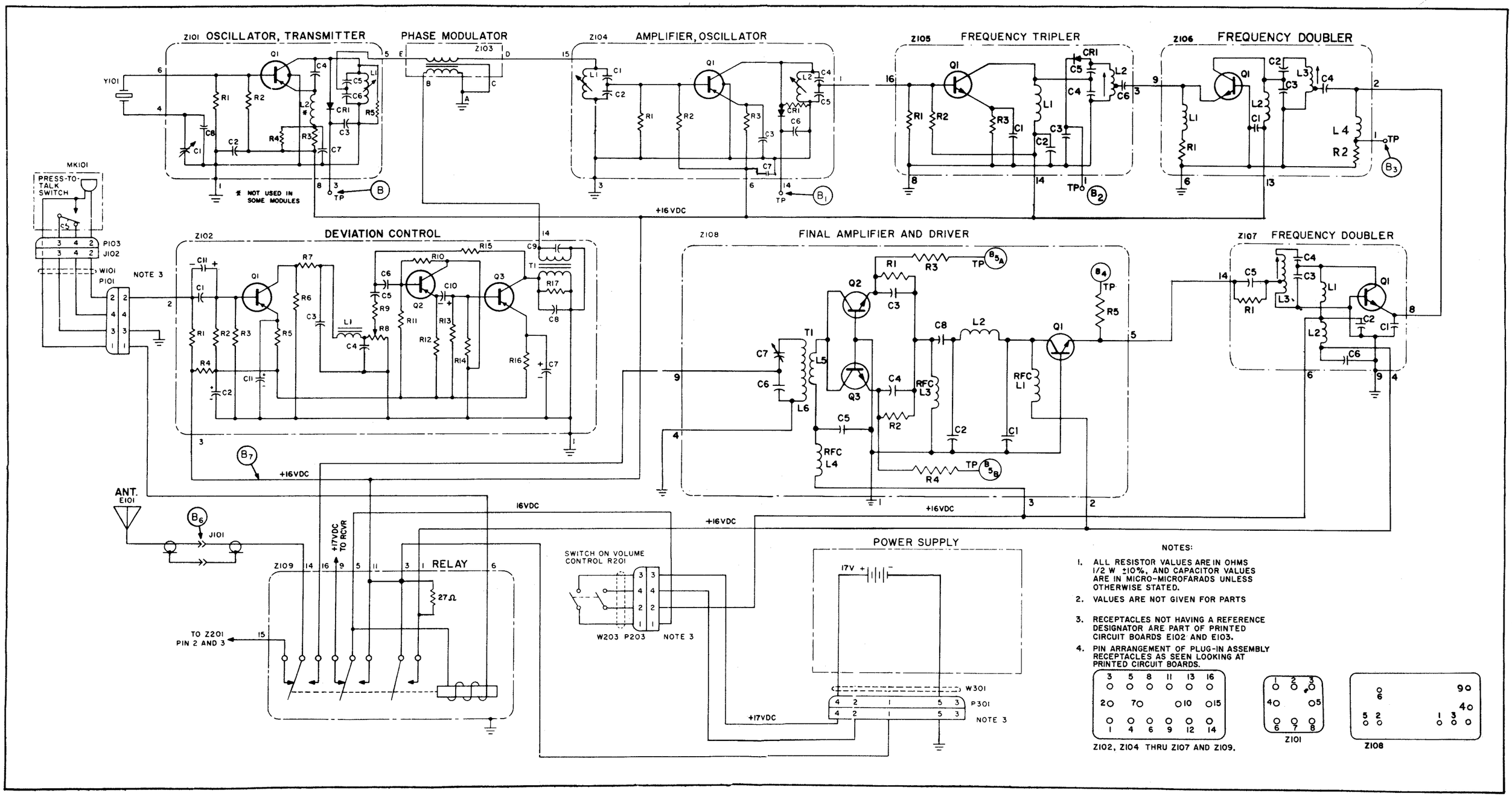


Figure 5-6. Receiver Schematic Diagram, AN/PRC-40AX.



NOTES:

1. ALL RESISTOR VALUES ARE IN OHMS 1/2 W ±10%, AND CAPACITOR VALUES ARE IN MICRO-MICROFARADS UNLESS OTHERWISE STATED.
2. VALUES ARE NOT GIVEN FOR PARTS
3. RECEPTACLES NOT HAVING A REFERENCE DESIGNATOR ARE PART OF PRINTED CIRCUIT BOARDS E102 AND E103.
4. PIN ARRANGEMENT OF PLUG-IN ASSEMBLY RECEPTACLES AS SEEN LOOKING AT PRINTED CIRCUIT BOARDS.

Figure 5-7. Transmitter Schematic Diagram, AN/PRC-40AX