DRAKE

SERVICE MANUAL

UV-3

FM TRANSCEIVER

PRINTED IN U.S.A.

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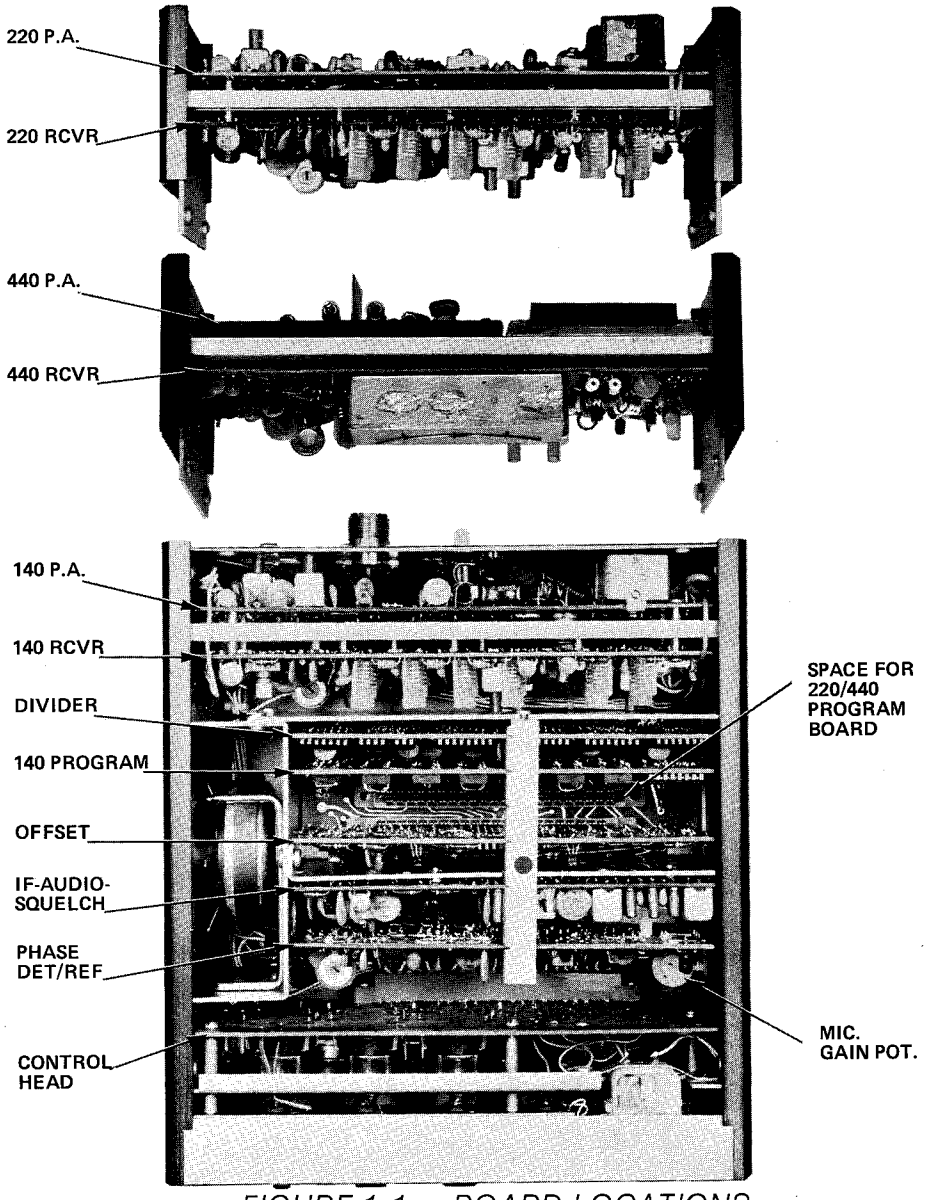

FIGURE 1-1. BOARD LOCATIONS

1-1. Locating Area of Difficulty.

The modular design of the UV-3 permits easy exchange of most of the printed circuit boards. All P.C. boards are easily removed with the exception of the power amplifier sections, the receiver front end, and the VCO sections. The first step in trouble-shooting the UV-3 should be interchanging suspected P.C. boards with boards known to be in good operating condition. In most cases the problem will involve just one board and substituting boards will easily isolate the problem. Locating problems on the receiver front end, VCO, and the power amplifier will necessitate removing these boards from the chassis. The heat sinks that these boards are mounted on may be unbolted and moved clear of the chassis, permitting access to the components and test points. Once the problem area is isolated, refer to the appropriate section of the manual for a full description of the circuit.

NOTES:

CHAPTER 2

RECEIVER/VCO'S

2-1. 140 MHz Receiver/VCO.

The receiver board for each band is mounted on the front side of the heat sink for that module. Remove the rear panel from the transceiver and remove any additional modules that may be mounted behind the 140 MHz heat sink. All modules are held in place by four mounting screws through the side frames. Remove all screws and carefully slide the heat sink clear of the chassis. Do not exert excessive force on the wire harness connecting the heat sink and the attached boards to the main chassis. If it is necessary to unsolder leads or cables going to the rear panel, carefully note their original placement. When service work is finished, all wires must be placed back in the respective original positions. After the receiver front end is positioned for servicing, refer to figure 2-2 for placement of all the components.

The 140 Receiver board consists of four major sections; The receiver front end or RF amplifier, the mixer, the voltage-controlled-oscillator (VCO), and the low-pass filter for the control line. Figure 2-1 shows all the circuit DC voltages for both receive and transmit.

The signal from the antenna is fed through a low-pass filter (located on rear panel) and antenna relay located on the 140 P.A. board (which is mounted on the opposite side of the heat sink). Capacitors C841 and C844 match the antenna to the 2 pole band-pass filter consisting of L812, L813, C842, and C845. This filter is centered at 146.00 MHz and attenuates signals that are outside the 2 meter band. Transistor Q812 is an enhancement mode FET which is biased for optimum gain and noise figure. The drain of the FET drives a four pole band-pass filter consisting of L814, L815, L816, L817, and the associated capacitors. This filter section is also centered at 146.00 MHz and provides additional selectivity in the front end. The output of the filter is coupled to a J-FET mixer Q813. Injection from the VCO is coupled to the source of Q813, and is 10.7 MHz lower in frequency than the signal to be received. Q811 is a buffer for the VCO and has a resonant circuit for a collector load. L810, C837, and C838 form a resonant circuit at approximately 135 MHz and provides matching to the 300 ohm source resistance of mixer Q813. The mixer has a drain impedance consisting of T801 and C840 which resonates at 10.7 MHz. The secondary of T801 provides drive to the 50 ohm input of the IF/AUDIO board. R850 supplies DC to a PIN diode switch located at the input of the IF amplifier.

Transistors Q803 and Q806 are cross coupled to form an oscillator which runs at approximately 67 MHz for receive and 74 MHz for transmit. The frequency of oscillation is determined primarily by L804, C809, and varicap CR801. Transistors Q802, Q801, Q800, and Q805 operate as switches to parallel capacitors C801, C803, and C805 with C809 and CR801, thereby lowering the frequency of oscillation by 10.7 MHz for receive. Varicap CR804 is loosely coupled to the resonant circuit described above. On transmit the signal from the audio amplifier/processor circuitry, changes the capacitance of CR804, and produces a change in the frequency of the VCO. The level of audio applied to CR804 is determined by the setting of R820, the deviation control. The exact frequency of the VCO is determined by the value of the control line voltage which is developed by the phase detector. During receive, the control line will have a value of 3 to 7 volts. Resistors R828, R829, R839, capacitors C832, C833, and C823 form a notch filter at 5 kHz to remove the reference frequency from the control line.

The VCO provides drive to the power amplifier (during transmit), the divider board (continuously), and the mixer (during receive). Two buffer stages are provided to increase isolation between the three outputs of the VCO. The buffer made of Q808 operates over the frequency range of approximately 135 MHz to 150 MHz and drives transformer T800. This transformer splits the VCO output to provide drive to the P.A. and divider chain. Each output of T800 should be approximately 2.8 Vp-p or 1.0 V rms. Transistor Q810 acts as a buffer for the VCO and drives the doubler made of Q809. Q809 then drives the buffers Q808 and Q811, discussed earlier. Transistors Q804 and Q807 apply voltage to the entire board when the "BAND" switch is in the "140" position.

140 VCO BOARD

DES	DESCRIPTION	PART #
C800	Capacitor, Mica, 20 pF ± 5%, DM-15	3170010
C801	Capacitor, Ceramic Disc, 15 pF ± 5%, NPO	3160510
C802	Capacitor, Mica, 490 pF ± 5%, DM-15	3170410
C803	Capacitor, Variable Trimmer, 1.2-10 pF	3205370
C804	Capacitor, Ceramic Disc, 6.8 pF ± 5%, NPO	3160240
C805	Capacitor, Mica, 20 pF ± 5%, DM-15	3170010
C806	Capacitor, Ceramic Disc, 470 pF ± 20%, Z5U	3161350
C807	Capacitor, Mica, 20 pF ± 5%, DM-15	3170010
C808	Capacitor, Ceramic Disc, 470 pF ± 20%, Z5U	3161350
C809	Capacitor, Mica, 30 pF ± 2%, DM-15	3170030
C810	Capacitor, Ceramic Disc, .001 μF ± 20%, Z5U	3161380
C811	Capacitor, Ceramic Disc, 470 pF ± 20%, Z5U	3161350
C812	Capacitor, Tantalum, 22 μF ± 20%, 15 V	3183050
C813	Capacitor, Mica, 490 pF ± 5%, DM-15	3170410
C814	Capacitor, Ceramic Disc, .001 μF ± 20%, Z5U	3161380
C815	Capacitor, Ceramic Disc, .005 μF ± 20%, Z5U	3161470
C816	Capacitor, Tantalum, 10 μF ± 20%, 25 V	3183030
C817	Capacitor, Ceramic Disc, .005 μF ± 20%, Z5U	3161470
C818	Capacitor, Composition, 0.68 pF	3187040
C819	Capacitor, Ceramic Disc, .01 μF ± 20%, Z5U	3161520
C820	Capacitor, Ceramic Disc, 27 pF ± 5%, NPO	3160650
C821	Capacitor, Ceramic Disc, 220 pF ± 20%, Z5U	3161270
C822	Capacitor, Ceramic Disc, 68 pF ± 5%, N750	3160990
C823	Capacitor, Mica, 5000 pF ± 1%, DM-20	3170710
C824	Capacitor, Ceramic Disc, .005 μF ± 20%, Z5U	3161470
C825	Capacitor, Ceramic Disc, 27 pF ± 5%, NPO	3160650
C826	Capacitor, MYLAR, .01 μF ± 10%, Z5U	3184040
C827	Capacitor, Ceramic Disc, .005 μF ± 20%, Z5U	3161470
C829	Capacitor, Tantalum, .1 μF ± 10%, 35 V	3183098
C830	Capacitor, Ceramic Disc, .001 μF ± 20%, Z5U	3161380
C831	Capacitor, Ceramic Disc, 470 pF ± 20%, Z5U	3161350
C832	Capacitor, Mica, 2400 pF ± 2%, DM-19	3170650
C833	Capacitor, Mica, 2400 pF ± 2%, DM-19	3170650
C834	Capacitor, Ceramic Disc, 220 pF ± 20%, Z5U	3161270
C835	Capacitor, Ceramic Disc, .001 μF ± 20%, Z5U	3161380
C836	Capacitor, Ceramic Disc, 20 pF ± 5%, NPO	3160580
C837	Capacitor, Ceramic Disc, 25 pF ± 5%, NPO	3160620
C838	Capacitor, Ceramic Disc, 100 pF ± 5%, N750	3161060
C839	Capacitor, Ceramic Disc, 68 pF ± 5%, N750	3160990
C840	Capacitor, Ceramic Disc, 68 pF ± 5%, N750	3160990
C841	Capacitor, Tubular, 3.3 pF, NPO	3185070
C842	Capacitor, Composition, .68 pF	3187040
C843	Capacitor, Ceramic Disc, .001 μF ± 20%, Z5U	3161380
C844	Capacitor, Tubular, 3.3 pF, NPO	3185070
C845	Capacitor, Composition, 1.5 pF	3187070
C846	Capacitor, Ceramic Disc, 470 pF ± 20%, Z5U	3161350
C847	Capacitor, Ceramic Disc, .005 μF ± 20%, Z5U	3161470
C848	Capacitor, Ceramic Disc, 470 pF ± 20%, Z5U	3161350
C849	Capacitor, Composition, .15 pF	3187005

DES	DESCRIPTION	PART #
C850	Capacitor, Composition, .15 pF	3187005
C851	Capacitor, Composition, .15 pF	3187005
C852	Capacitor, Ceramic Disc, 6.8 pF ± 5%, NPO	3160240
C853	Capacitor, Tubular, 4.5 pF, NPO	3185100
C854	Capacitor, Ceramic Disc, 5 pF ± 5%, NPO	3160150
C855	Capacitor, Ceramic Disc, 5 pF ± 5%, NPO	3160150
C856	Capacitor, Ceramic Disc, .005 μF ± 20%, Z5U	3161470
C857	Capacitor, Ceramic Disc, 18 pF ± 5%, NPO	3160550
C858	Capacitor, Ceramic Disc, 470 pF ± 20%, Z5U	3161350
CR800	Diode, 1N4148	3020090
CR801	Diode, MV-104	3020274
CR802	Diode, 1N4148	3020090
CR804	Diode, MV-104	3020274
U800	Integrated Circuit, 78L05ACP	3040030
L800	Choke, RF, 5.6 μH	3520510
L801	Choke, RF, 5.6 μH	3520510
L802	Choke, RF, 5.6 μH	3520510
L803	Choke, RF, 5.6 μH	3520510
L804	Coil, Variable, 3½ T (Drake A46090-7)	3524087
L805	Choke, RF, 5.6 μH	3520510
L806	Coil, Variable, 2½ T (Drake A46097-1)	3524091
L807	Choke, RF, 5.6 μH	3520510
L808	Choke, RF, 5.6 μH	3520510
L809	Coil, Variable, 2½ T (Drake A46097-1)	3524091
L810	Coil, Variable, 2½ T (Drake A46097-1)	3524091
T801	Coil, Variable, 20 T Pri., 2T Sec. (Drake)	A46099
L812	Coil, Variable, 4½ T (Drake A46090-1)	3524081
L813	Coil, Variable, 4½ T (Drake A46090-1)	3524081
L814	Coil, Variable, 4½ T, Tapped (Drake A46090-2)	3524082
L815	Coil, Variable, 4½ T (Drake A46090-1)	3524081
L816	Coil, Variable, 4½ T (Drake A46090-1)	3524081
L817	Coil, Variable, 4½ T (Drake A46090-1)	3524081
Q800	Transistor, 2N3563	3030060
Q801	Transistor, 2N4402	3030120
Q802	Transistor, 2N3904	3030105
Q803	Transistor, SPF-796, Matched FET	3030355
Q804	Transistor, TIP-32	3030379
Q805	Transistor, 2N3563	3030060
Q806	Transistor, SPF-796, Matched FET	3030355
Q807	Transistor, 2N3904	3030105
Q808	Transistor, 2N3563	3030060
Q809	Transistor, 2N3563	3030060
Q810	Transistor, 2N3563	3030060
Q811	Transistor, 2N3563	3030060
Q812	Transistor, MFE-521	3030262
Q813	Transistor, J-309	3030500
R800	Resistor, Carbon Comp., 10 kΩ ± 10%, ¼ W	3220235
R801	Resistor, Carbon Comp., 1 MΩ ± 10%, ¼ W	3220355
R802	Resistor, Carbon Comp., 47 kΩ ± 10%, ¼ W	3220285

DES	DESCRIPTION	PART #
R803	Resistor, Carbon Comp., 27 Ω ± 10%, ¼ W	3220020
R804	Resistor, Carbon Comp., 3.3 MΩ ± 10%, ¼ W	3220365
R805	Resistor, Carbon Comp., 470 Ω ± 10%, ¼ W	3220110
R806	Resistor, Carbon Comp., 470 Ω ± 10%, ¼ W	3220110
R807	Resistor, Carbon Comp., 10 Ω ± 10%, ¼ W	3220005
R808	Resistor, Carbon Comp., 1 MΩ ± 10%, ¼ W	3220355
R809	Resistor, Carbon Comp., 47 Ω ± 10%, ¼ W	3220035
R810	Resistor, Carbon Comp., 470 Ω ± 10%, ¼ W	3220110
R811	Resistor, Carbon Comp., 3.3 kΩ ± 10%, ¼ W	3220200
R812	Resistor, Carbon Comp., 150 Ω ± 10%, ¼ W	3220065
R813	Resistor, Carbon Comp., 470 Ω ± 10%, ¼ W	3220110
R814	Resistor, Carbon Comp., 47 Ω ± 10%, ¼ W	3220035
R815	Resistor, Carbon Comp., 100 Ω ± 10%, ¼ W	3220055
R816	Resistor, Carbon Comp., 47 Ω ± 10%, ¼ W	3220035
R818	Resistor, Carbon Comp., 10 kΩ ± 10%, ¼ W	3220235
R819	Resistor, Carbon Comp., 1.5 kΩ ± 10%, ¼ W	3220175
R820	Resistor, Variable, 5 kΩ (CTS RL-7153)	3260120
R821	Resistor, Carbon Comp., 68 kΩ ± 10%, ¼ W	3220300
R822	Resistor, Carbon Comp., 100 Ω ± 10%, ¼ W	3220055
R823	Resistor, Carbon Comp., 6.8 kΩ ± 10%, ¼ W	3220220
R824	Resistor, Carbon Comp., 1.5 k ± 10%, ¼ W	3220300
R825	Resistor, Carbon Comp., 470 Ω ± 10%, ¼ W	3220110
R826	Resistor, Carbon Comp., 68 Ω ± 10%, ¼ W	3220045
R827	Resistor, Carbon Comp., 3.3 kΩ ± 10%, ¼ W	3220200
R828	Resistor, Metal Film, 13.0 kΩ ± 1%, ¼ W	3220445
R829	Resistor, Metal Film, 13.0 kΩ ± 1%, ¼ W	3220445
R830	Resistor, Carbon Comp., 15 kΩ ± 10%, ¼ W	3220245
R831	Resistor, Carbon Comp., 220 Ω ± 10%, ¼ W	3220075
R832	Resistor, Carbon Comp., 1.5 kΩ ± 10%, ¼ W	3220175
R833	Resistor, Carbon Comp., 100 Ω ± 10%, ¼ W	3220055
R834	Resistor, Carbon Comp., 6.8 kΩ ± 10%, ¼ W	3220220
R835	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R836	Resistor, Carbon Comp., 6.8 kΩ ± 10%, ¼ W	3220220
R837	Resistor, Carbon Comp., 100 Ω ± 10%, ¼ W	3220055
R838	Resistor, Carbon Comp., 15 kΩ ± 10%, ¼ W	3220245
R839	Resistor, Carbon Comp., 6.8 kΩ ± 5%, ¼ W	3220219
R840	Resistor, Carbon Comp., 22 Ω ± 10%, ¼ W	3220015
R841	Resistor, Carbon Comp., 1.5 kΩ ± 10%, ¼ W	3220175
R842	Resistor, Carbon Comp., 68 Ω ± 10%, ¼ W	3220045
R843	Resistor, Carbon Comp., 100 Ω ± 10%, ¼ W	3220055
R844	Resistor, Carbon Comp., 36 kΩ ± 5%, ¼ W	3220280
R845	Resistor, Carbon Comp., 75 kΩ ± 5%, ¼ W	3220305
R846	Resistor, Carbon Comp., 56 Ω ± 10%, ¼ W	3220040
R847	Resistor, Carbon Comp., 47 Ω ± 10%, ¼ W	3220035
R848	Resistor, Carbon Comp., 330 Ω ± 10%, ¼ W	3220090
R849	Resistor, Carbon Comp., 1 MΩ ± 10%, ¼ W	3220355
R850	Resistor, Carbon Comp., 1 kΩ ± 10%, ¼ W	3220160
R851	Resistor, Carbon Comp., 47 Ω ± 10%, ¼ W	3220035
T800	Power Splitter (Drake)	A46100

NOTES:

NOTES:

2-2. 220 MHz Receiver/VCO.

The receiver board for the 220 MHz band is mounted on the front side of the heat sink for the 220 MHz module. Remove the rear panel from the transceiver, and remove any additional modules that may be mounted behind the 220 MHz module. Remove all screws that hold the module and carefully slide the heat sink clear of the chassis. Do not exert excessive force on any wire harnesses or cables. If it is necessary to unsolder any wires, take care to note the exact positions, since it is essential that each wire be placed back in the original position after repair work is completed.

Refer to figure 2-4 for the placement of all components on the 220 MHz receiver board. The receiver board for 220 MHz is very similar to the 140 MHz receiver board and is composed of four major sections; The RF amplifier, the Mixer, the voltage-controlled-oscillator, and the low-pass filter for the control line. Figure 2-3, the schematic diagram, shows all the DC voltages for each section during receive and transmit operations.

The signal from the antenna is matched to a 2 pole band-pass filter by capacitors C1041 and C1045. The band-pass filter consists of L1012, C1042, L1011, and the G1 capacitance of Q1011. This filter is centered at 222.5 MHz and provides rejection for signals out of the "220 MHz" band. Transistor Q1011 is an enhancement mode FET which is biased for optimum gain and noise figure. Q1011 provides approximately 10 dB gain and drives a 4 pole band-pass filter consisting of L1013, L1014, L1015, L1016, and the associated capacitors. The band pass filter provides additional selectivity and feeds one gate of a dual gate MOSFET mixer, Q1012. Injection from the VCO is coupled to the second gate of the mixer and is 10.7 MHz higher in frequency than the signal to be received. Q1010 is a VCO buffer with L1010, C1035, and C1038 forming a resonant circuit centered at 233 MHz. The drain of Q1012 feeds a 10.7 MHz resonant circuit made of C1040 and T1001. The secondary of T1001 provides a match to the input of the IF amplifier. Resistor R1052 provides a voltage to turn on the appropriate PIN diode switch on the IF/AUDIO board.

Transistors Q1002 and Q1005 form a voltage controlled oscillator which operates at approximately 110 to 118 MHz. The frequency of oscillation is determined by L1004, C1008, and CR1002 during receive operation. Transistors Q1000, Q1001, and Q1004 parallel capacitors C1001, C1003, and C1005 with C1008 and C1002 during transmit. The VCO, therefore, runs approximately 10.7 MHz higher in frequency during receive. Varicap CR1004 is modulated by the audio signal from the microphone amplifier/processor circuit located on the phase detector board. CR1004 is coupled to the VCO and changes its frequency of oscillation when driven by an audio signal. The level of audio applied to CR1004 is determined by the setting of R1021, the deviation control. The exact frequency of the VCO is determined by the value of the control line voltage applied to CR1002 and the level of audio applied to CR1004. During receive, the control line voltage should be approximately 5.0 volts. L1004 is adjusted to provide 223 MHz at the VCO output (T1000) for a control line voltage of 5.0 volts. Resistors R1029, R1030, and R1039 along with capacitors C1033, C1034, and C1024 form a 5kHz notch filter to remove any reference frequency which might be on the control line. R1028 and C1030 form a low-pass filter for the control line. Two buffer stages are provided to increase isolation between the three outputs of the VCO. The buffer made of Q1007 operates over a range of approximately 220 to 235 MHz and drives transformer T1000. This transformer provides two isolated outputs from the VCO, one output to drive the P.A. and the other output to drive the divider chain. Each output of T1000 should be approximately 2.0 Vp-p or 0.7 V rms.

Transistor Q1009 acts as a VCO buffer and drives the doubler stage made of Q1008. The doubler output is coupled to the buffers Q1007 and Q1010, discussed previously.

Transistors Q1003 and Q1006 operate as a power supply switch that supplies voltage to the entire board when the "BAND" switch is in the "220 MHz" position.

220 VCO BOARD

DES	DESCRIPTION	PART #
C1000	Capacitor, Mica, 20 pF ± 5%, DM-15	3170010
C1001	Capacitor, Tubular, 3.3 pF, NPO	3185070
C1002	Capacitor, Mica, 490 pF ± 5%, DM-15	3170410
C1003	Capacitor, Variable Trimmer, 1.2-10 pF	3205370
C1004	Capacitor, Tubular, 4.3 pF, NPO	3185090
C1005	Capacitor, Ceramic Disc, 9 pF ± 5%, NPO	3160320
C1006	Capacitor, Ceramic Disc, 150 pF ± 20%, Z5U	3161170
C1007	Capacitor, Mica, 20 pF ± 5%, DM-15	3170010
C1008	Capacitor, Mica, 20 pF ± 5%, DM-15	3170010
C1009	Capacitor, Ceramic Disc, 470 pF ± 20%, Z5U	3161350
C1010	Capacitor, Ceramic Disc, .001 μF ± 20%, Z5U	3161380
C1011	Capacitor, Ceramic Disc, 470 pF ± 20%, Z5U	3161350
C1012	Capacitor, Mica, 490 pF ± 5%, DM-15	3170410
C1013	Capacitor, Tantalum, 68 μF ± 20%, 6 V	3183075
C1014	Capacitor, Ceramic Disc, .005 μF ± 20%, Z5U	3161470
C1015	Capacitor, Ceramic Disc, .001 μF ± 20%, Z5U	3161380
C1016	Capacitor, Ceramic Disc, .005 μF ± 20%, Z5U	3161470
C1017	Capacitor, Tantalum, 10 μF ± 20%, 25 V	3183030
C1018	Capacitor, Ceramic Disc, .01 μF ± 20%, Z5U	3161520
C1019	Capacitor, Composition, 1.5 pF	3187070
C1020	Capacitor, Ceramic Disc, 6.8 pF ± 5%, NPO	3160240
C1021	Capacitor, Ceramic Disc, 27 pF ± 5%, NPO	3160650
C1022	Capacitor, Ceramic Disc, 150 pF ± 20%, Z5U	3161170
C1023	Capacitor, Ceramic Disc, 150 pF ± 20%, Z5U	3161170
C1024	Capacitor, Mica, 5000pF ± 1%, DM-20	3170710
C1025	Capacitor, Ceramic Disc, 7.5 pF ± 10%, NPO	3160270
C1026	Capacitor, MYLAR, .01 μF ± 10%, Z5U	3184040
C1027	Capacitor, Ceramic Disc, 470 pF ± 20%, Z5U	3161350
C1028	Capacitor, Ceramic Disc, 150 pF ± 20%, Z5U	3161170
C1030	Capacitor, Tantalum, .22 μF ± 10%, 35 V	3183100
C1031	Capacitor, Ceramic Disc, 150 pF ± 20%, Z5U	3161170
C1032	Capacitor, Ceramic Disc, 150 pF ± 20%, Z5U	3161170
C1033	Capacitor, Mica, 2400 pF ± 2%, DM-19	3170650
C1034	Capacitor, Mica, 2400 pF ± 2%, DM-19	3170650
C1035	Capacitor, Ceramic Disc, 6.8 pF ± .25 pF	3160240
C1036	Capacitor, Ceramic Disc, 470 pF ± 20%, Z5U	3161350
C1037	Capacitor, Ceramic Disc, 12 pF ± 5%, NPO	3160430
C1038	Capacitor, Ceramic Disc, 8.2 pF ± 5%, NPO	3160300
C1039	Capacitor, Ceramic Disc, 33 pF ± 5%, NPO	3160700
C1040	Capacitor, Ceramic Disc, 68 pF ± 5%, N750	3160990
C1041	Capacitor, Composition, 2.0 pF	3187080
C1042	Capacitor, Composition, .68 pF	3187040
C1043	Capacitor, Ceramic Disc, 150 pF ± 20%, Z5U	3161170
C1044	Capacitor, Ceramic Disc, 150 pF ± 20%, Z5U	3161170
C1045	Capacitor, Composition, .47 pF	3187030
C1046	Capacitor, Ceramic Disc, 150 pF ± 20%, Z5U	3161170
C1047	Capacitor, Composition, .18 pF	3187007
C1048	Capacitor, Composition, .18 pF	3187007
C1049	Capacitor, Ceramic Disc, 150 pF ± 20%, Z5U	3161170
C1050	Capacitor, Ceramic Disc, 5 pF ± 5%, NPO	3160150
C1051	Capacitor, Tubular, 2.2 pF, NPO	3185050

DES	DESCRIPTION	PART #
C1052	Capacitor, Tubular, 3.3 pF, NPO	3185070
C1053	Capacitor, Tubular, 3.3 pF, NPO	3185070
C1054	Capacitor, Ceramic Disc, .005 μF $\pm$ 20%, Z5U	3161470
C1055	Capacitor, Ceramic Disc, 5 pF $\pm$ 5%, NPO	3160150
C1056	Capacitor, Ceramic Disc, .005 μF $\pm$ 20%, Z5U	3161470
C1057	Capacitor, Ceramic Disc, 150 pF $\pm$ 20%, Z5U	3161170
CR1000	Diode, 1N4148	3020090
CR1001	Diode, 1N4148	3020090
CR1002	Diode, Varactor, MV104	3020274
CR1003	Diode, 1N4148	3020090
CR1004	Diode, Varactor, MV104	3020274
U1000	Integrated Circuit, 78L05ACP	3040030
L1000	Choke, RF, 3.3 μH	3520505
L1001	Choke, RF, 3.3 μH	3520505
L1002	Choke, RF, 3.3 μH	3520505
L1003	Choke, RF, 3.3 μH	3520505
L1004	Coil, Variable, 1½ T (Drake A46090-6)	3524086
L1005	Choke, RF, 3.3 μH	3520505
L1006	Coil, Variable, 2½ T (Drake A46097-1)	3524091
L1007	Choke, RF, 3.3 μH	3520505
L1008	Choke, RF, 3.3 μH	3520505
L1009	Coil, Variable, 2½ T (Drake A46097-1)	3524091
L1010	Coil, Variable, 2½ T (Drake A46097-1)	3524091
L1011	Coil, Variable, 3½ T (Drake A46090-3)	3524083
L1012	Coil, Variable, 3½ T (Drake A46090-3)	3524083
L1013	Coil, Variable, 3½ T (Drake A46090-5)	3524085
L1014	Coil, Variable, 3½ T (Drake A46090-3)	3524083
L1015	Coil, Variable, 3½ T (Drake A46090-3)	3524083
L1016	Coil, Variable, 3½ T (Drake A46090-3)	3524083
Q1000	Transistor, 2N4402	3030120
Q1001	Transistor, 2N3563	3030060
Q1002	Transistor, SPF796, Matched FET	3030355
Q1003	Transistor, TIP-32	3030379
Q1004	Transistor, 2N3563	3030060
Q1005	Transistor, SPF796, Matched FET	3030355
Q1006	Transistor, 2N3904	3030105
Q1007	Transistor, 2N3563	3030060
Q1008	Transistor, 2N3563	3030060
Q1009	Transistor, 2N3563	3030060
Q1010	Transistor, 2N3563	3030060
Q1011	Transistor, MFE521	3030262
Q1012	Transistor, MFE521	3030262
R1000	Resistor, Carbon Comp., 10 kΩ $\pm$ 10%, ¼ W	3220235
R1001	Resistor, Carbon Comp., 6.8 kΩ $\pm$ 10%, ¼ W	3220220
R1002	Resistor, Carbon Comp., 27 Ω $\pm$ 10%, ¼ W	3220020
R1003	Resistor, Carbon Comp., 1 MΩ $\pm$ 10%, ¼ W	3220355
R1004	Resistor, Carbon Comp., 3.3 MΩ $\pm$ 10%, ¼ W	3220365
R1005	Resistor, Carbon Comp., 470 Ω $\pm$ 10%, ¼ W	3220110
R1006	Resistor, Carbon Comp., 1 kΩ $\pm$ 10%, ¼ W	3220160
R1007	Resistor, Carbon Comp., 10 Ω $\pm$ 10%, ¼ W	3220005
R1008	Resistor, Carbon Comp., 1 MΩ $\pm$ 10%, ¼ W	3220355

DES	DESCRIPTION	PART #
R1009	Resistor, Carbon Comp., 150 Ω ± 10%, ¼ W	3220065
R1010	Resistor, Carbon Comp., 470 Ω ± 10%, ¼ W	3220110
R1011	Resistor, Carbon Comp., 3.3 kΩ ± 10%, ¼ W	3220200
R1012	Resistor, Carbon Comp., 470 Ω ± 10%, ¼ W	3220110
R1013	Resistor, Carbon Comp., 1 kΩ ± 10%, ¼ W	3220160
R1014	Resistor, Carbon Comp., 150 Ω ± 10%, ¼ W	3220065
R1015	Resistor, Carbon Comp., 150 Ω ± 10%, ¼ W	3220065
R1016	Resistor, Carbon Comp., 470 Ω ± 10%, ¼ W	3220110
R1017	Resistor, Carbon Comp., 47 Ω ± 10%, ¼ W	3220035
R1018	Resistor, Carbon Comp., 100 Ω ± 10%, ¼ W	3220055
R1019	Resistor, Carbon Comp., 10 kΩ ± 10%, ¼ W	3220235
R1020	Resistor, Carbon Comp., 1.5 kΩ ± 10%, ¼ W	3220175
R1021	Resistor, Variable, 5 kΩ (CTS RL-7153)	3260120
R1022	Resistor, Carbon Comp., 100 Ω ± 10%, ¼ W	3220055
R1023	Resistor, Carbon Comp., 68 kΩ ± 10%, ¼ W	3220300
R1024	Resistor, Carbon Comp., 6.8 kΩ ± 10%, ¼ W	3220220
R1025	Resistor, Carbon Comp., 470 Ω ± 10%, ¼ W	3220110
R1026	Resistor, Carbon Comp., 1.5 kΩ ± 10%, ¼ W	3220175
R1027	Resistor, Carbon Comp., 56 Ω ± 10%, ¼ W	3220040
R1028	Resistor, Carbon Comp., 3.3 kΩ ± 10%, ¼ W	3220200
R1029	Resistor, Metal Film, 13 kΩ ± 1%, ¼ W	3250445
R1030	Resistor, Metal Film, 13 kΩ ± 1%, ¼ W	3250445
R1031	Resistor, Carbon Comp., 15 kΩ ± 10%, ¼ W	3220245
R1032	Resistor, Carbon Comp., 220 Ω ± 10%, ¼ W	3220075
R1033	Resistor, Carbon Comp., 1.5 kΩ ± 10%, ¼ W	3220175
R1034	Resistor, Carbon Comp., 6.8 kΩ ± 10%, ¼ W	3220220
R1035	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R1036	Resistor, Carbon Comp., 100 Ω ± 10%, ¼ W	3220055
R1037	Resistor, Carbon Comp., 6.8 kΩ ± 10%, ¼ W	3220220
R1038	Resistor, Carbon Comp., 100 Ω ± 10%, ¼ W	3220055
R1039	Resistor, Carbon Comp., 6.8 kΩ ± 5%, ¼ W	3220219
R1040	Resistor, Carbon Comp., 15 kΩ ± 10%, ¼ W	3220245
R1041	Resistor, Carbon Comp., 36 kΩ ± 5%, ¼ W	3220280
R1042	Resistor, Carbon Comp., 22 Ω ± 10%, ¼ W	3220015
R1043	Resistor, Carbon Comp., 1.5 kΩ ± 10%, ¼ W	3220175
R1044	Resistor, Carbon Comp., 100 Ω ± 10%, ¼ W	3220055
R1045	Resistor, Carbon Comp., 30 kΩ ± 5%, ¼ W	3220272
R1046	Resistor, Carbon Comp., 47 Ω ± 10%, ¼ W	3220035
R1047	Resistor, Carbon Comp., 36 kΩ ± 5%, ¼ W	3220280
R1048	Resistor, Carbon Comp., 100 Ω ± 10%, ¼ W	3220055
R1049	Resistor, Carbon Comp., 56 Ω ± 10%, ¼ W	3220040
R1050	Resistor, Carbon Comp., 75 kΩ ± 5%, ¼ W	3220305
R1051	Resistor, Carbon Comp., 510 kΩ ± 5%, ¼ W	3220347
R1052	Resistor, Carbon Comp., 1 kΩ ± 10%, ¼ W	3220160
R1053	Resistor, Carbon Comp., 360 kΩ ± 5%, ¼ W	3220342
R1054	Resistor, Carbon Comp., 100 Ω ± 10%, ¼ W	3220055
R1055	Resistor, Carbon Comp., 47 Ω ± 10%, ¼ W	3220035
T1000	Power Splitter (Drake)	A46100
T1001	Transformer, IF, 20 T Pri., 2 T Sec. (Drake)	A46099

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2-3. 440 MHz Receiver/VCO.

The 440 MHz Receiver/VCO module may be removed and positioned for servicing as described in the first paragraph of section 2-1.

The 440 Receiver/VCO consists of four major sections; an RF amplifier (the 440 MHz receiver preamp is located on the 440 MHz PA board), the mixer, the voltage-controlled-oscillator (VCO), the buffers, and the control line/modulator circuitry. Figure 2-5 shows all the DC voltages for both receive and transmit.

The signal from the antenna is fed through a PIN diode antenna switch, and a two stage preamplifier located on the 440 P.A. board (mounted on the opposite side of the heat sink). The signal is then fed to a helical band-pass filter that provides out-of-band and image rejection. The output of the helical BPF is coupled through capacitor C1244 to transistor Q1215, a junction-field effect transistor (J-FET). Q1215 operates as a grounded-gate amplifier and has a gain of approximately 6 dB. The output of Q1215 is matched to the mixer Q1216 by L1224, L1225, C1256, and C1257. Capacitors C1245, C1252, C1253, resistors R1243, and R1244 decouple Q1215 from the supply line. The mixer Q1216 is an enhancement mode FET that receives the injection signal from the VCO buffer Q1213. The injection signal is 10.7 MHz lower in frequency than the desired signal to be received. The mixer output drives the resonant load C1243 and T1200. The output of T1200 is coupled to the IF/AUDIO board.

Transistors Q1203 and Q1206 form a low noise, push-pull, class C oscillator which operates at approximately 72 MHz for receive and 74 MHz for transmit. The frequency of oscillation is determined primarily by L1204, C1208, and varicap CR1201. Transistors Q1200 and Q1204 operate as switches that parallel capacitors C1201 and C1204 with capacitor C1208, thereby lowering the VCO frequency by 10.7 MHz during receive. Varicap CR1203 is loosely coupled by capacitors C1203 to the resonant circuit consisting of L1204, C1208, and CR1201 during transmit. The audio signal from the audio amp/processor (located on the Phase detector/ref board) produces changes in the value of CR1203 which in turn causes a change in the resonant frequency of the VCO (direct FM). The level of audio applied to CR1203 is determined by the setting of R1222, the deviation control. The center frequency (or VCO frequency with no audio modulation) is determined by the value of the control line voltage which is developed by the phase detector. Normal control line voltage is from 4 to 6.5 volts. Resistors R1230, R1231, R1239, capacitors C1229, C1238, and C1239 form a 5 kHz notch filter to remove the reference frequency from the control line.

The output of the VCO is coupled through capacitor C1222 to a buffer amplifier consisting of Q1212 and associated components. This stage provides approximately 6 dB gain and drives a tripler stage Q1211 and associated components. Inductor L1212 and capacitor C1224 resonate at approximately 221 MHz and form a matching network, along with C1228 and L1217 to drive Q1208. The stage consisting of transistor Q1208 and associated components, works as a doubler and has an output of 432 to 450 MHz. Inductor L1205 and capacitor C1211 resonate at 432 to 450 MHz and drive the J-FET amplifier, Q1210. This stage operates as a grounded-gate amplifier which has a gain of approximately 6 dB, and provides drive to three other buffer amplifiers Q1209, Q1213, and Q1214. Most amplifier devices have less gain at high frequencies, therefore, more stages are required to develop adequate signal levels. The three amplifier stages Q1209, Q1214, and Q1213 are provided to assure adequate drive to the mixer, divider, and power amp. The stage Q1209 operates as a grounded-gate J-FET amplifier which provides drive to the 440 P.A. through the matching network L1208 and C1221. The stage Q1214 and associated components, also operates as a grounded-gate amplifier; providing drive to the divider board through the matching network L1215 and C1235. Resistor R1225 provides current to switch "on" a diode that couples this VCO to the divider board. Variable resistor R1241 is adjusted for optimum signal level to the divider board. The third buffer stage Q1213, operates as a grounded-gate amplifier which has a gain of approximately 6 dB, and drives gate G2 of the mixer Q1216, through the matching elements L1216 and C1242.

This buffer arrangement provides each output with the optimum signal level and also provides isolation between each of the outputs.

440 VCO BOARD

DES	DESCRIPTION	PART #
C1200	Capacitor, Mica, 20 pF ± 5%, DM-15	3170010
C1201	Capacitor, Variable Trimmer, 1.2-10 pF	3205370
C1202	Capacitor, Mica, 490 pF ± 5%, DM-15	3170410
C1203	Capacitor, Tubular, 4.3 pF, NPO	3185090
C1204	Capacitor, Mica, 20 pF ± 5%, DM-15	3170010
C1205	Capacitor, Ceramic Disc, 220 pF ± 20%, Z5U	3161270
C1206	Capacitor, Mica, 20 pF ± 5%, DM-15	3170010
C1207	Capacitor, Ceramic Disc, 220 pF ± 20%, Z5U	3161270
C1208	Capacitor, Mica, 39 pF ± 5%, DM-10	3170035
C1209	Capacitor, Leadless Ceramic Disc, .001 μF ± 20%	3163080
C1210	Capacitor, Leadless Ceramic Disc, .001 μF ± 20%	3163080
C1211	Capacitor, Tubular, 2.7 pF, NPO	3185060
C1212	Capacitor, Ceramic Disc, 220 pF ± 20%, Z5U	3161270
C1213	Capacitor, Mica, 490 pF ± 5%, DM-15	3170410
C1214	Capacitor, Tantalum, 68 pF ± 20%, 6 V	3183075
C1215	Capacitor, Leadless Ceramic Disc, .001 μF ± 20%	3163080
C1216	Capacitor, Leadless Ceramic Disc, .001 μF ± 20%	3163080
C1217	Capacitor, Ceramic Disc, 220 pF ± 20%, Z5U	3161270
C1218	Capacitor, Ceramic Disc, .001 μF ± 20%, Z5U	3161380
C1219	Capacitor, Tantalum, .22 μF ± 10%, 35 V	3183100
C1220	Capacitor, Tubular, 2.2 pF, NPO	3185050
C1221	Capacitor, Tubular, 2.2 pF, NPO	3185050
C1222	Capacitor, Composition, .68 pF	3187040
C1223	Capacitor, Ceramic Disc, .01 μF ± 20%, Z5U	3161520
C1224	Capacitor, Ceramic Disc, 6.8 pF ± 5%, NPO	3160240
C1225	Capacitor, Ceramic Disc, 15 pF ± 5%, NPO	3160510
C1226	Capacitor, Ceramic Disc, 220 pF ± 20%, Z5U	3161270
C1227	Capacitor, Ceramic Disc, 33 pF ± 5%, N750	3160705
C1228	Capacitor, Composition, 1.5 pF	3187070
C1229	Capacitor, Mica, 5000 pF ± 1%, DM-20	3170710
C1230	Capacitor, Ceramic Disc, 20 pF ± 5%, NPO	3160580
C1231	Capacitor, Tubular, 1.5 pF, NPO	3185020
C1232	Capacitor, Mylar .01 μF	3184040
C1233	Capacitor, Ceramic Disc, .005 μF ± 20%, Z5U	3161470
C1234	Capacitor, Tubular, 2.2 pF, NPO	3185050
C1235	Capacitor, Tubular, 2.7 pF, NPO	3185060
C1236	Capacitor, Tantalum, .22 μF ± 10%, 35 V	3183100
C1237	Capacitor, Leadless Ceramic Disc, .001 μF ± 20%	3163080
C1238	Capacitor, Mica, 2400 pF ± 2%, DM-19	3170650
C1239	Capacitor, Mica, 2400 pF ± 2%, DM-19	3170650
C1240	Capacitor, Ceramic Disc, 220 pF ± 20%, Z5U	3161270
C1241	Capacitor, Ceramic Disc, .001 μF ± 20%, Z5U	3161380
C1242	Capacitor, Ceramic Disc, 33 pF ± 5%, N750	3160705
C1243	Capacitor, Ceramic Disc, 68 pF ± 5%, N750	3160990
C1244	Capacitor, Ceramic Disc, 10 pF ± 10%, NPO	3160370
C1245	Capacitor, Ceramic Disc, 220 pF ± 20%, Z5U	3161270
C1246	Capacitor, Ceramic Disc, .001 μF ± 20%, Z5U	3161380
C1247	Capacitor, Variable Trimmer, 1.2-10 pF	3205370
C1248	Capacitor, Variable Trimmer, 1.2-10 pF	3205370
C1249	Capacitor, Variable Trimmer, 1.2-10 pF	3205370
C1250	Capacitor, Variable Trimmer, 1.2-10 pF	3205370

DES	DESCRIPTION	PART #
C1251	Capacitor, Ceramic Disc, 33 pF ± 5%, N750	3160705
C1252	Capacitor, Ceramic Disc, 33 pF ± 5%, N750	3160705
C1253	Capacitor, Ceramic Disc, 220 pF ± 20%, Z5U	3171270
C1254	Capacitor, Ceramic Disc, .001 μF ± 20%, Z5U	3161380
C1255	Capacitor, Ceramic Disc, .005 μF ± 20%, Z5U	3161470
C1256	Capacitor, Tubular, 2.2 pF, NPO	3185050
C1257	Capacitor, Leadless Ceramic Disc, .001 μF ± 20%	3163080
CR1200	Diode, 1N4148	3020090
CR1201	Diode, Varicap, MV104	3020274
CR1202	Diode, 1N4148	3020090
CR1203	Diode, Varicap, MV104	3020274
U1200	Integrated Circuit, 78L05ACP	3040030
L1200	Choke, RF, 5.6 μH	3520510
L1201	Choke, RF, 5.6 μH	3520510
L1202	Choke, RF, 5.6 μH	3520510
L1203	Choke, RF, 5.6 μH	3520510
L1204	Coil, Variable, 3½ T (Drake A46090-4)	3524084
L1205	Coil, 1¾ T	B-46157-3
L1206	Choke, RF, 5.6 μH	3520510
L1207	Ferrite Bead	3523200
L1208	Coil, 1¾ T	B46157-7
L1209	Coil, ¾ T	B46157-4
L1210	Choke, RF, 5.6 μH	3520510
L1211	Choke, RF, 5.6 μH	3520510
L1212	Coil, Variable, 2½ T (Drake A46097-1)	3524091
L1213	Ferrite Bead	3523200
L1214	Ferrite Bead	3523200
L1215	Coil, 1¾ T	B46157-2
L1216	Coil, 1¾ T	B46157-7
L1217	Coil, Variable, 2½ T (Drake A46097-1)	3524091
L1218	Ferrite Bead	3523200
L1219	Coil, 2½ T	A65007
L1220	Coil, 2½ T	A65007
L1221	Coil, 2½ T	A65007
L1222	Coil, 2½ T	A65007
L1223	Coil, 1¾ T	B46157-2
L1224	Coil, 1¾ T	B46157-1
L1225	Coil, 1¾ T	B46157-6
Q1200	Transistor, 2N3563	3030060
Q1201	Transistor, 2N4402	3030120
Q1202	Transistor, 2N3904	3030105
Q1203	Transistor, SPF796, Matched FET	3030355
Q1204	Transistor, 2N3563	3030060
Q1205	Transistor, TIP-32	3030379
Q1206	Transistor, SPF796, Matched FET	3030355
Q1207	Transistor, 2N3904	3030105
Q1208	Transistor, MPS-H10	3030294
Q1209	Transistor, J-310	3030501
Q1210	Transistor, J-310	3030501
Q1211	Transistor, MPS-H10	3030294
Q1212	Transistor, 2N3563	3030060
Q1213	Transistor, J-310	3030501
Q1214	Transistor, J-310	3030501
Q1215	Transistor, J-310	3030501
Q1216	Transistor, MFE-521	3030262
T1200	Transformer, Variable	A46099

DES	DESCRIPTION	PART #
R1200	Resistor, Carbon Comp., 10 kΩ ± 10%, ¼ W	3220235
R1201	Resistor, Carbon Comp., 47 kΩ ± 10%, ¼ W	3220285
R1202	Resistor, Carbon Comp., 10 Ω ± 10%, ¼ W	3220005
R1203	Resistor, Carbon Comp., 1 MΩ ± 10%, ¼ W	3220355
R1204	Resistor, Carbon Comp., 3.3 MΩ ± 10%, ¼ W	3220365
R1205	Resistor, Carbon Comp., 470 Ω ± 10%, ¼ W	3220110
R1206	Resistor, Carbon Comp., 470 Ω ± 10%, ¼ W	3220110
R1207	Resistor, Carbon Comp., 100 Ω ± 10%, ¼ W	3220055
R1208	Resistor, Carbon Comp., 1 MΩ ± 10%, ¼ W	3220355
R1209	Resistor, Carbon Comp., 3.3 kΩ ± 10%, ¼ W	3220200
R1210	Resistor, Carbon Comp., 47 Ω ± 10%, ¼ W	3220035
R1211	Resistor, Carbon Comp., 100 Ω ± 10%, ¼ W	3220055
R1212	Resistor, Carbon Comp., 100 Ω ± 10%, ¼ W	3220055
R1213	Resistor, Carbon Comp., 68 Ω ± 10%, ¼ W	3220045
R1214	Resistor, Carbon Comp., 47 Ω ± 10%, ¼ W	3220035
R1215	Resistor, Carbon Comp., 47 Ω ± 10%, ¼ W	3220035
R1216	Resistor, Carbon Comp., 33 kΩ ± 10%, ¼ W	3220275
R1217	Resistor, Carbon Comp., 100 Ω ± 10%, ¼ W	3220055
R1218	Resistor, Carbon Comp., 47 Ω ± 10%, ¼ W	3220035
R1219	Resistor, Carbon Comp., 22 kΩ ± 10%, ¼ W	3220260
R1220	Resistor, Carbon Comp., 100 Ω ± 10%, ¼ W	3220055
R1221	Resistor, Carbon Comp., 1.5 kΩ ± 10%, ¼ W	3220175
R1222	Resistor, Variable, 5 kΩ (CTS RL 7153)	3260120
R1223	Resistor, Carbon Comp., 68 kΩ ± 10%, ¼ W	3220300
R1224	Resistor, Carbon Comp., 15 kΩ ± 10%, ¼ W	3220245
R1225	Resistor, Carbon Comp., 1 kΩ ± 10%, ¼ W	3220160
R1226	Resistor, Carbon Comp., 68 Ω ± 10%, ¼ W	3220045
R1227	Resistor, Carbon Comp., 470 Ω ± 10%, ¼ W	3220110
R1228	Resistor, Carbon Comp., 68 Ω ± 10%, ¼ W	3220045
R1229	Resistor, Carbon Comp., 3.3 kΩ ± 10%, ¼ W	3220200
R1230	Resistor, Metal Film, 13 kΩ ± 1%, ¼ W	3250445
R1231	Resistor, Metal Film, 13 kΩ ± 1%, ¼ W	3250445
R1232	Resistor, Carbon Comp., 15 kΩ ± 10%, ¼ W	3220245
R1233	Resistor, Carbon Comp., 15 kΩ ± 10%, ¼ W	3220245
R1234	Resistor, Carbon Comp., 100 Ω ± 10%, ¼ W	3220055
R1235	Resistor, Carbon Comp., 100 Ω ± 10%, ¼ W	3220055
R1236	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R1237	Resistor, Carbon Comp., 47 Ω ± 10%, ¼ W	3220035
R1238	Resistor, Carbon Comp., 2.2 kΩ ± 5%, ¼ W	3220185
R1239	Resistor, Carbon Comp., 6.8 kΩ ± 5%, ¼ W	3220219
R1240	Resistor, Carbon Comp., 100 Ω ± 10%, ¼ W	3220055
R1241	Resistor, Variable, 5 kΩ	3260660
R1242	Resistor, Carbon Comp., 22 Ω ± 10%, ¼ W	3220015
R1243	Resistor, Carbon Comp., 22 Ω ± 10%, ¼ W	3220015
R1244	Resistor, Carbon Comp., 22 Ω ± 10%, ¼ W	3220015
R1245	Resistor, Carbon Comp., 27 kΩ ± 5%, ¼ W	3220265
R1246	Resistor, Carbon Comp., 47 Ω ± 10%, ¼ W	3220035
R1247	Resistor, Carbon Comp., 1 kΩ ± 10%, ¼ W	3220160
R1248	Resistor, Carbon Comp., 68 Ω ± 10%, ¼ W	3220045
R1249	Resistor, Carbon Comp., 22 kΩ ± 10%, ¼ W	3220260
R1250	Resistor, Carbon Comp., 1 MΩ ± 10%, ¼ W	3220355
R1251	Resistor, Carbon Comp., 2.2 MΩ ± 10%, ¼ W	3220360

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CHAPTER 3

POWER AMPLIFIERS

3-1. 140 MHz Power Amplifier.

The power amplifier (P.A.) for the 140 MHz band is located on the back side of the heat sink in the 140 MHz module. Service work on the P.A. board should be attempted only when the 140 MHz module is removed from the main chassis. Avoid excessive force on all cables and wires, and do not attempt to transmit when the P.A. printed circuit board is removed from the heat sink. Transistor Q905 must be securely in contact with the heat sink during transmit or device failure will occur.

The 140 MHz power amplifier (P.A.) consists of four stages of gain and associated interstage matching networks. High and low power output is accomplished by a Hi/Lo power switching circuit which is also located on the (P.A.) printed circuit board.

Refer to figure 3-2 for placement of all the components on the P.A. board. Figure 3-1, 140 MHz P.A. Schematic shows the entire schematic for the 140 MHz P.A. and gives DC voltages present in each stage. Waveforms and voltages are also shown for various test points in the amplifier chain.

The input stage transistor Q902, receives approximately 1.0 V rms (2.8 Vp-p) of drive from the VCO (located on the 140 Receiver/VCO Board). Transistor Q902 operates as a class A amplifier having a gain of 8 dB. L904, C921, and C926 form the load for Q902 and accomplish matching to the second stage. Approximately 4 Vp-p is developed at the base of Q903, a class C amplifier. L901, C916, and two stripline elements match the output of Q903 to the input of Q904. Approximately 6 Vp-p is applied to the base of Q904, which also operates as a class C amplifier. This stage produces approximately 12 dB gain with a stripline element for a collector load. L908, C914, C923, C915, C924, and L909 form the interstage matching network between Q904 and Q905. Resistor R906 and capacitor C930 stabilize Q904 at low frequency.

The output stage Q905, provides 8 to 9 dB gain and develops approximately 25 watts of output power. The voltage swing of 28 Vp-p at the collector of Q905 is stepped up to a 100 Vp-p swing at the output of the matching network formed by L902, L905, C917, C918, C913, L906, L907, C919, and C920. The collector-to-base feedback network formed by R903, C910, C911, and L903 reduces the gain of the output stage at lower frequencies and provides stabilization. A small amount of the output voltage is tapped off by C925 and drives the meter rectifier circuit composed of CR902, C931, R908, and C932, which provides an indication of relative power output. Capacitors C903, C906, C905, C909, C908, C902, and C901 are all bypass capacitors for the various amplifier stages.

The antenna relay K900, switches the antenna from the receiver board to the P.A. output for the transmit mode. K900 is activated when the push-to-talk line is grounded. Power is removed from the Receiver/VCO board and applied to the low level stages of the P.A./Driver board.

Transistors Q900 and Q901 constitute the Hi/Lo Power switching circuit. +13.8 volts is always present at the collector of Q905, but is only applied to Q902, Q903, and Q904 during transmit. Q900 is turned off when the Hi/Lo POWER switch is in the "LO" position, allowing the base voltage of Q901 to be approximately 3.8 volts. The emitter of Q901 then supplies approximately 3.1 volts to the driver. An output power of approximately 1 watt may be obtained at this voltage. In the "HI" power mode, Q900 is turned on and 13.2 volts appears at the base of Q901. The emitter voltage then increases to 13.0 volts and full rated output power is attained.

140 P.A. BOARD

DES	DESCRIPTION	PART #
C900	Capacitor, Ceramic Disc, 470 pF ± 20%, Z5U	3161350
C901	Capacitor, Tantalum, 10 μF ± 20%, 25 V	3183030
C902	Capacitor, Ceramic Disc, 470 pF ± 20%, Z5U	3161350
C903	Capacitor, Tantalum, 10 μF ± 20%, 25 V	3183030
C904	Capacitor, Ceramic Disc, 470 pF ± 20%, Z5U	3161350
C905	Capacitor, Tantalum, 10 μF ± 20%, 25 V	3183030
C906	Capacitor, Ceramic Disc, 470 pF ± 20%, Z5U	3161350
C907	Capacitor, Ceramic Disc, .001 μF ± 20%, Z5U	3161380
C908	Capacitor, Ceramic Disc, .005 μF ± 20%, Z5U	3161470
C909	Capacitor, Ceramic Disc, 470 pF ± 20%, Z5U	3161350
C910	Capacitor, Tantalum, 10 μF ± 20%, 25 V	3183030
C911	Capacitor, Ceramic Disc, .001 μF ± 20%, Z5U	3161380
C912	Capacitor, Ceramic Disc, 470 pF ± 20%, Z5U	3161350
C913	Capacitor, Variable Trimmer, .9-7 pF (B2525C1)	3205130
C914	Capacitor, Mica, 100 pF ± 5%, 500 V, DM-15	3170110
C915	Capacitor, Mica, 20 pF ± 5%, 1 kV, DM-20	3170020
C916	Capacitor, Ceramic Disc, 15 pF ± 5%, NPO	3160510
C917	Capacitor, Variable Trimmer, 1.5-20 pF (B2525C2)	3205140
C918	Capacitor, Ceramic Disc, 9 pF ± 5%, NPO	3160320
C919	Capacitor, Ceramic Disc, 18 pF ± 5%, NPO	3160550
C920	Capacitor, Ceramic Disc, 18 pF ± 5%, NPO	3160550
C921	Capacitor, Ceramic Disc, 20 pF ± 5%, NPO	3160580
C922	Capacitor, Mica, 250 pF ± 10%, 350 V (Metal Clad)	3171500
C923	Capacitor, Ceramic Disc, 39 pF ± 5%, NPO	3160760
C924	Capacitor, Variable Trimmer, 1.5-20 pF (B2525C2)	3205140
C925	Capacitor, Composition, .33 pF	3187010
C926	Capacitor, Ceramic Disc, 47 pF ± 5%, NPO	3160840
C927	Capacitor, Ceramic Disc, 20 pF ± 5%, NPO	3160580
C929	Capacitor, Ceramic Disc, 470 pF ± 20%, Z5U	3161350
C930	Capacitor, Ceramic Disc, .001 μF ± 20%, Z5U	3161380
C931	Capacitor, Ceramic Disc, .005 μF ± 20%, Z5U	3161470
C932	Capacitor, Ceramic Disc, 470 pF ± 20%, Z5U	3161350
C933	Capacitor, Ceramic Disc, 470 pF ± 20%, Z5U	3161350
C934	Capacitor, Ceramic Disc, 470 pF ± 20%, Z5U	3161350
C935	Capacitor, Ceramic Disc, 470 pF ± 20%, Z5U	3161350
CR900	Diode, 1N4148	3020090
CR901	Diode, 1N4148	3020090
CR902	Diode, 1N4148	3020090
CR903	Diode, 1N4005/B5G5	3020220
K900	Relay	3620105
L900	Ferrite Bead	3523200
L901	Coil, Variable (Drake A46097-1)	3524091
L902	Coil, 3¾ T (Drake)	A46094-4
L903	Coil, 11 T (Drake)	A46094-7
L904	Coil, Variable (Drake A46097-1)	3524091
L905	Coil, 2½ T (Drake)	A46094-6
L906	Coil, 3¾ T (Drake)	A46094-3
L907	Coil, 3¾ T (Drake)	A46094-3
L908	Coil, 1¾ T (Drake)	A46094-5
L909	Coil, 2¾ T (Drake)	A46094-2
L910	Choke, RF, 3.3 μH	3520505
L911	Choke, RF, 3.3 μH	3520505
Q900	Transistor, 92PU51	3030325
Q901	Transistor, MJE-5983 or 2N6486	3030278

DES	DESCRIPTION	PART =
Q902	Transistor, 2N3866	3030296
Q903	Transistor, 2N4427	3030130
Q904	Transistor, SRF2281	3030295
Q905	Transistor, MRF 238	3030296
R900	Resistor, Variable, Carbon, 10 k	3260130
R901	Resistor, Carbon Comp., 470 Ω ± 10%, ¼ W	3220110
R902	Resistor, Carbon Comp., 6.8 Ω ± 10%, ¼ W	3220004
R903	Resistor, Carbon Comp., 15 Ω ± 10%, ¼ W	3220010
R904	Resistor, Carbon Comp., 820 Ω ± 10%, ¼ W	3220145
R905	Resistor, Carbon Comp., 47 Ω ± 10%, ¼ W	3220035
R906	Resistor, Carbon Comp., 470 Ω ± 10%, ¼ W	3220110
R907	Resistor, Carbon Comp., 33Ω ± 10%, ¼ W	3220025
R908	Resistor, Carbon Comp., 33 kΩ ± 10%, ¼ W	3220275
R909	Resistor, Carbon Comp., 15 Ω ± 10%, ¼ W	3220010
R910	Resistor, Carbon Comp., 6.8 kΩ ± 10%, ¼ W	3220220
R911	Resistor, Carbon Comp., 100 Ω ± 10%, ¼ W	3220055
R912	Resistor, Carbon Comp., 1 kΩ ± 10%, ¼ W	3220160

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3-2. 220 MHz Power Amplifier.

The power amplifier for the 220 MHz band is located on the back side of the heat sink in the 220 MHz module. Service work on the P.A. board should be attempted only when the 220 MHz module is removed from the main chassis. Avoid excessive force to any cable or wiring harness. Do not transmit while the P.A. board is removed from the heat sink or the final amplifier may over dissipate and fail.

Figures 3-4 shows the component placement for the 220 MHz P.A. board and figure 3-3 is the schematic which shows important waveforms and voltages.

The 220 MHz power amplifier consists of four gain stages, four interstage matching networks, and a HI/LO POWER switching circuit.

An input voltage of approximately 0.9 V rms, from the 220 MHz VCO, is applied to the first stage. Transistor Q1102 operates as a class A amplifier that has a gain of 6 dB, and receives the input through the coupling capacitor C1116. Diode CR1101 keeps the VCO from feeding through the amplifier when power is removed from the 220 MHz module. Inductor L1107, capacitors C1124, and C1125 form a resonant load for Q1102 and matches Q1102 to Q1103. The drive level to Q1103 should be approximately 1.0 Vrms and the gain of the stage should be 6 dB, resulting in a collector voltage of 6.7 Vrms. Inductor L1105, capacitors C1117, C1127, C1128, and the stripline inductor match the collector of Q1103 to the base of Q1104. Transistor Q1103 is a class C amplifier which has an input voltage of 1.5 Vrms and provides 12 Vrms at the junction of C1118 and C1129. The output of Q1104 is coupled to Q1105 through the matching network made up of capacitors C1118, C1129, C1130, C1131, and the two stripline elements.

Transistor Q1105 is the final output stage and has a gain of 9 dB. Inductors L1103 and L1106 are made of ferrite beads and form the collector load of Q1105. Capacitors C1119, C1120, and C1121 form a matching network with L1108 and the stripline element. The low output impedance of Q1105 is matched to the 50Ω output impedance. Inductors L1109, L1110, capacitors C1122, and C1123 form a low-pass filter to attenuate any harmonics that may be present in the output of Q1105. The output voltage is approximately 25 volts rms for high power.

A small portion of the output voltage is tapped off the output by capacitor C1132 and is fed to diode CR1102, where it is rectified. The resultant DC voltage is applied to the S-meter, where it gives an indication of relative output power.

Capacitors C1112, C1113, C1109, C1110, C1111, C1105, C1106, and C1104 provide RF bypassing of the supply line for each of the amplifier stages.

The antenna relay, K900A, switches the antenna from the 220 Receiver/VCO board to the P.A. output for the transmit mode. K900A is actuated when the Push-to-talk line is grounded. The relay also switches the power supply from the 220 MHz Receiver/VCO board to the P.A. board during transmit operation.

Transistors Q1100 and Q1101 constitute the HI/LO POWER switching circuit for the 220 MHz module. A voltage of +13.8 volts DC is always applied to the collector of Q1101, but is only applied to Q1104 and Q1105 during high power transmit. Transistor Q1100 is saturated for high power and therfore puts approximately 13.5 volts DC on the base of Q1101. Transistor Q1101 operates as an emitter follower and will have a voltage of approximately 12.6 volts DC at the emitter. This voltage is the collector or supply voltage for Q1104 and Q1105 for HI POWER.

Transistor Q1100 is turned "off" for low power and the base voltage of Q1101 drops to approximately 4.4 volts DC. This results in an emitter voltage of approximately 3.7 volts DC which is supplied to Q1104 and Q1105. At this voltage the output power will be typically 1.0 watt.

The voltages shown on the 220 MHz P. A. schematic may be measured accurately with a high frequency Voltmeter with a low capacitance probe. The test points shown on the schematic were chosen because these points were only slightly affected by test probe capacitances of 2 to 5 picofarads. Any test probe used should have the shortest ground lead possible. A long ground lead acts as an antenna and all measurements will be affected.

220 P.A. BOARD

DES	DESCRIPTION	PART #
C1100	Capacitor, Ceramic Disc, 150 pF ± 20%, Z5U	3161170
C1101	Capacitor, Ceramic Disc, 150 pF ± 20%, Z5U	3161170
C1102	Capacitor, Tantalum, 10 μF ± 20%, 25 V	3183030
C1103	Capacitor, Ceramic Disc, 150 pF ± 20%, Z5U	3161170
C1104	Capacitor, Ceramic Disc, 150 pF ± 20%, Z5U	3161170
C1105	Capacitor, Ceramic Disc, .01 μF, 25 V	3161520
C1106	Capacitor, Tantalum, 10 μF ± 20%, 25 V	3183030
C1107	Capacitor, Ceramic Disc, 150 pF ± 20%, Z5U	3161170
C1108	Capacitor, Tubular, 15 pF ± 2%, NPO	3185180
C1109	Capacitor, Ceramic Disc, 150 pF ± 20%, Z5U	3161170
C1110	Capacitor, Ceramic Disc, .01 μF, 25 V	3161520
C1111	Capacitor, Tantalum, 10 μF ± 20%, 25 V	3183030
C1112	Capacitor, Ceramic Disc, 150 pF ± 20%, Z5U	3161170
C1113	Capacitor, Ceramic Disc, 150 pF ± 20%, Z5U	3161170
C1114	Capacitor, Mica, 12 pF ± 5%, DM-15	3170005
C1115	Capacitor, Ceramic Disc, 150 pF ± 20%, Z5U	3161170
C1116	Capacitor, Ceramic Disc, 47 pF ± 5%, NPO	3160840
C1117	Capacitor, Ceramic Disc, 5 pF ± 5%, NPO	3160160
C1118	Capacitor, Mica, 20 pF ± 5%, DM-15	3170010
C1119	Capacitor, Tubular, 5 pF, NPO	3185120
C1120	Capacitor, Variable Trimmer, 1.5-20 pF (B2525C2)	3205140
C1121	Capacitor, Mica, 12 pF ± 5%, DM-15	3170005
C1122	Capacitor, Mica, 20 pF ± 5%, DM-15	3170010
C1123	Capacitor, Tubular, 15 pF ± 2%, NPO	3185180
C1124	Capacitor, Ceramic Disc, 6.8 pF ± 5%, NPO	3160240
C1125	Capacitor, Ceramic Disc, 35 pF ± 5%, NPO	3160730
C1126	Capacitor, Ceramic Disc, 150 pF ± 20%, Z5U	3161170
C1127	Capacitor, Variable Trimmer, 1.5-20 pF (B2525C2)	3205140
C1128	Capacitor, Ceramic Disc, 8.2 pF ± 5%, NPO	3160300
C1129	Capacitor, Variable Trimmer, 1.5-20 pF (B2525C2)	3205140
C1130	Capacitor, Mica, 12 pF ± 5%, DM-15	3170005
C1131	Capacitor, Mica, 20 pF ± 5%, DM-15	3170010
C1132	Capacitor, Composition, .47 pF	3187030
C1133	Capacitor, Ceramic Disc, 150 pF ± 20%, Z5U	3161170
C1134	Capacitor, Ceramic Disc, .001 μF ± 20%, Z5U	3161380
C1135	Capacitor, Ceramic Disc, 150 pF ± 20%, Z5U	3161170
C1136	Capacitor, Ceramic Disc, 150 pF ± 20%, Z5U	3161170
C1137	Capacitor, Ceramic Disc, 150 pF ± 20%, Z5U	3161170
C1138	Capacitor, Ceramic Disc, 150 pF ± 20%, Z5U	3161170
CR1100	Diode, 1N4148	3020090
CR1101	Diode, 1N4148	3020090
CR1102	Diode, 1N4148	3020090
CR1103	Diode, 1N4005/B5G5	3020220
K1100	Relay, Transmit-Receive	3620105
L1100	Choke, RF, Ferrite Bead	3523200
L1101	Choke, RF, Ferrite Bead	3523200
L1102	Choke, RF, Ferrite Bead	3523200
L1103	Choke, RF, Ferrite Bead, 2 T	A46138-2

DES	DESCRIPTION	PART #
L1104	Coil, 4 T	A46139
L1105	Coil, 2½ T	B46094-8
L1106	Choke, RF, Ferrite Bead, 2 T	A46138-2
L1107	Coil, Variable, 2½ T (Drake A46097-1)	3524091
L1108	Coil, 1½ T	B46094-9
L1109	Coil, 2½ T	B46094-8
L1110	Coil, 2½ T	B46094-8
L1111	Choke, RF, Ferrite Bead, 2 T	A46138-1
L1112	Choke, RF, Ferrite Bead	3523200
Q1100	Transistor, 92PU51	3030325
Q1101	Transistor, MJE5983	3030278
Q1102	Transistor, SD1143	3030521
Q1103	Transistor, SD1131	3030520
Q1104	Transistor, 2N3866	3030095
Q1105	Transistor, 2N3563	3030060
R1100	Resistor, Carbon Comp., 3.3 kΩ ± 10%, ¼ W	3220200
R1101	Resistor, Carbon Comp., 1 kΩ ± 10%, ¼ W	3220160
R1102	Resistor, Carbon Comp., 10 Ω ± 10%, ¼ W	3220005
R1103	Resistor, Carbon Comp., 2.2 kΩ ± 10%, ¼ W	3220190
R1104	Resistor, Carbon Comp., 820 Ω ± 10%, ½ W	3230175
R1105	Resistor, Carbon Comp., 1 kΩ ± 10%, ¼ W	3220160
R1106	Resistor, Carbon Comp., 1.5 kΩ ± 10%, ¼ W	3220175
R1107	Resistor, Carbon Comp., 100 Ω ± 10%, ¼ W	3220055
R1108	Resistor, Carbon Comp., 47 kΩ ± 10%, ¼ W	3220285
R1109	Resistor, Carbon Comp., 10 Ω ± 10%, ¼ W	3220005
R1110	Resistor, Carbon Comp., 6.8 kΩ ± 10%, ¼ W	3220220
R1111	Resistor, Carbon Comp., 100 Ω ± 10%, ¼ W	3220055
R1112	Resistor, Carbon Comp., 68 Ω ± 10%, ¼ W	3220045

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3-3. 440 MHz Power Amplifier.

The 440 MHz power amplifier is located on the back side of the heat sink of the 440 MHz module. The 440 MHz module will always be located behind the 140 MHz module in multiband models. The 220 MHz module will be mounted behind the 440 MHz module, and must be removed to permit servicing of the 440 MHz module. Service work on the 440 MHz module should be attempted only when the module is moved clear of the main chassis. Avoid excessive force to all cables and wires; replace wiring in the respective original positions after servicing. Refer to Figure 3-6 for the component placement of the 440 P.A.

Extreme care must be exercised if it is necessary to remove the printed circuit board from the heat sink. The RF power module U1300 must be handled with great care to avoid stressing the leads.

The 440 MHz Power Amplifier module (refer to Figure 3-5, 440 P.A. schematic) consists of a power amplifier section, an RF amplifier section, a high/low power control section, and a transmit/receive switching circuit.

The power amplifier section consists of a grounded-gate amplifier Q1307, which has a gain of 6 dB. The signal from the VCO is coupled to the source of Q1307 by the means of C1331 and the stripline inductor. Capacitor C1323 is part of the input matching network. Resistor R1323 is part of the input matching network. Resistor R1323 biases Q1307 for optimum gain and is bypassed by C1334. The drain of Q1307 has a load, composed of a stripline inductor and C1332, which drives the matching network consisting of C1324, another stripline inductor, and C1325.

The output of the above matching network drives Q1308, a common emitter amplifier which has approximately 7 dB gain. Transistor Q1308 is slightly biased by R1319 and R1320. Inductor L1309 decouples the base of Q1308 from the bias network. Low frequency stabilization is accomplished by the network composed of R1322, C1316, C1317, and a stripline inductor. The output of Q1308 is matched to the input of U1300 by L1304, a S.L. inductor, and C1326. Inductor L1312 provides a DC path to ground for the input stage of U1300.

The RF power module U1300 has a three stage amplifier which provides approximately 19 dB gain. The high level stages of U1300 are supplied by Q1304, the high/low power control. Pin 3 of U1300 should have approximately 3.5 volts DC when operated in the low power mode. This voltage is determined by the value of R1311, which is adjusted to provide 1 watt in "low" power. Transistor Q1303 is turned on for high power operation and increases the base current of Q1304. This action results in the collector voltage of Q1304 increasing to 13.0 volts. A supply voltage of 13 volts will allow the output power of U1300 to be approximately 12 watts.

The output of U1300 is coupled to the antenna through CR1303, C1327, and C1328. Diode CR1303 is a PIN diode that is turned on during transmit to couple U1300 to the antenna.

During the transmit operation, the PTT line is grounded and Q1300 is turned on. When Q1300 conducts, the collector voltage goes to approximately 13 volts and operating voltage is supplied to Q1307, Q1308, and U1300. PIN diodes CR1303 and CR1302 conduct during the transmit operation. Diode CR1302 appears as a short circuit across the input to the RF amplifier Q1306.

During the receive operation, Q1300 is turned "off", removing power from the power amplifier sections, causing diodes CR1303 and CR1302 to appear as open circuits. Transistor Q1302 is switched "on" and operating voltage (approximately 13 volts DC) is supplied to the receiver stages composed of Q1306, Q1305, and several stages located on the VCO board.

The signal from the antenna is coupled to the source of Q1306 by the means of C1328, L1311, and C1322. Inductor L1308 and C1322 provide and input matching network to Q1306. Transistor Q1306 operates as a grounded-gate amplifier which has a gain of 10 dB. The drain load of Q1306 is composed of L1314 and L1315, which also provides matching to the 2nd RF amplifier. Capacitor C1309 and L1302 form an input matching network to the source of Q1305. The output of Q1305 is coupled to the helical resonator through L1316 and L1317.

A small portion of the output signal is coupled to the meter rectifier by C1330. Diode CR1304 and C1333 form a peak detector that developes a voltage that is proportional to output power. The front panel meter monitors this voltage and gives an indication of output power during the transmit operation.

The following devices were not mentioned in the circuit discussions since they function as RF bypass and decoupling elements:

Capacitors				*Inductors*	
C1334	C1300	C1311	C1313	L1313	L1310
C1320	C1314	C1301	C1312	L1303	L1307
C1306	C1319	C1315	C1302	L1304	L1301
C1303	C1308	C1318	C1310	L1305	L1300
C1307	C1304	C1321	C1337	L1306	
C1305	C1335	C1336			

440 P.A. BOARD

DES	DESCRIPTION	PART #
C1300	Capacitor, Ceramic Disc, 150 pF ± 20%, Z5U	3161170
C1301	Capacitor, Ceramic Disc, 150 pF ± 20%, Z5U	3161170
C1302	Capacitor, Electrolytic, Axial, 1000 μF, 15 V	3180290
C1303	Capacitor, Ceramic Disc, 150 pF ± 20%, Z5U	3161170
C1304	Capacitor, Tantalum, 1 μF ± 20%, 35 V	3183010
C1305	Capacitor, Ceramic Disc, 150 pF ± 20%, 15 V	3161170
C1306	Capacitor, Leadless Ceramic Disc, .001 μF ± 20%	3163080
C1307	Capacitor, Ceramic Disc, 150 pF ± 20%, Z5U	3161170
C1308	Capacitor, Leadless Ceramic Disc, .001 μF ± 20%	3163080
C1309	Capacitor, Ceramic Disc, 10 pF ± 5%, NPO	3160360
C1310	Capacitor, Leadless Ceramic Disc, .001 μF ± 20%	3163080
C1311	Capacitor, Ceramic Disc, 33 pF ± 5%, NPO	3160700
C1312	Capacitor, Ceramic Disc, .005 μF ± 20%, Z5U	3161470
C1313	Capacitor, Leadless Ceramic Disc, .001 μF ± 20%	3163080
C1314	Capacitor, Ceramic Disc, .001 μF ± 20%, Z5U	3161380
C1315	Capacitor, Ceramic Disc, 33 pF ± 5%, NPO	3160700
C1316	Capacitor, Tantalum, 10 μF ± 20%, 25 V	3183030
C1317	Capacitor, Ceramic Disc, 150 pF ± 20%, Z5U	3161170
C1318	Capacitor, Ceramic Disc, .001 μF ± 20%, Z5U	3161380
C1319	Capacitor, Tantalum, 1 μF ± 20%, 35 V	3183010
C1320	Capacitor, Tantalum, 1 μF ± 20%, 35 V	3183010
C1321	Capacitor, Leadless Ceramic Disc, .001 μF ± 20%	3163080
C1322	Capacitor, Ceramic Disc, 10 pF ± 5%, NPO	3160360
C1323	Capacitor, Tubular, 5.3 pF, NPO	3185130
C1324	Capacitor, Ceramic Disc, 33 pF ± 5%, NPO	3160700
C1325	Capacitor, Ceramic Disc, 3.3pF ±5%, NPO	3161470
C1326	Capacitor, Ceramic Disc, .005 μF ± 20%, Z5U	3161470
C1327	Capacitor, Ceramic Disc, 150 pF ± 20%, Z5U	3161170
C1328	Capacitor, Ceramic Disc, 33 pF ± 5%, NPO	3160700
C1329	Capacitor, Composition, 1.5 pF	3187070
C1330	Capacitor, Composition, .33 pF	3187010
C1331	Capacitor, Ceramic Disc, 15 pF ± 5%, NPO	3160510
C1332	Capacitor, Tubular, 1.0 pF, NPO	3185010
C1333	Capacitor, Ceramic Disc, 150 pF ± 20%, Z5U	3161170
C1334	Capacitor, Ceramic Disc, 33 pF ± 5%, NPO	3160700
C1335	Capacitor, Leadless Ceramic Disc, .001 μF ± 20%	3163080
C1336	Capacitor, Ceramic Disc, .001 μF ± 20%, Z5U	3161380
C1337	Capacitor, Tantalum, 10 μF ± 20%, 25 V	3183030
CR1300	Diode, 1N4148	3020090
CR1301	Diode, 1N4148	3020090
CR1302	Diode, UM9401	3020330
CR1303	Diode, UM9401	3020330
CR1304	Diode, 1N4148	3020090
CR1305	Diode, 1N4148	3020090
CR1306	Diode, 1N4005	3020220
U1300	Module, Transistor, RF Power	3031000
L1300	Inductor, 1 Ferrite Bead	3523200
L1301	Inductor, 1 Ferrite Bead	3523200
L1302	Inductor, 1¾ T	B46157-7
L1303	Choke, RF, 3.3 μH	3520505

DES	DESCRIPTION	PART #
L1304	Inductor, 1¾ T	B46157-1
L1305	Inductor, 3 Ferrite Beads	3523200
L1306	Inductor, 3 Ferrite Beads	3523200
L1307	Inductor, 1 Ferrite Bead	3523200
L1308	Inductor, 1¾ T	B46157-7
L1309	Choke, RF, 3.3 μH	3520505
L1310	Choke, RF, 3.3 μH	3520505
L1311	Inductor, 1¾ T	B46157-2
L1312	Choke, RF, 3.3 μH	3520505
L1313	Inductor, 1 Ferrite Bead	3523200
L1314	Inductor, 1¾ T	B46157-5
L1315	Inductor, 1¾ T	B46157-1
L1316	Inductor, 1¾ T	B46157-5
L1317	Inductor, 1¾ T	B46157-1
Q1300	Transistor, 92PU51	3030325
Q1301	Transistor, 2N3904	3030105
Q1302	Transistor, 2N3904	3030105
Q1303	Transistor, 92PU51	3030325
Q1304	Transistor, TIP42	3030415
Q1305	Transistor, J-310	3030501
Q1306	Transistor, J-310	3030501
Q1307	Transistor, J-310	3030501
Q1308	Transistor, MRF515	3030297
R1300	Resistor, Carbon Comp., 10 Ω ± 10%, ¼ W	3220005
R1301	Resistor, Carbon Comp., 680 Ω ± 10%, ½ W	3230170
R1302	Resistor, Carbon Comp., 47 k ± 10%, ¼ W	3220285
R1303	Resistor, Wire Wound, .51 Ω ± 5%, 1 W	3250027
R1304	Resistor, Carbon Comp., 1 kΩ ± 10%, ¼ W	3220160
R1305	Resistor, Carbon Comp., 470 Ω ± 10%, ¼ W	3220110
R1306	Resistor, Carbon Comp., 10 Ω ± 10%, ¼ W	3220005
R1307	Resistor, Carbon Comp., 1 kΩ ± 10%, ¼ W	3220160
R1308	Resistor, Carbon Comp., 10 Ω ± 10%, ¼ W	3220005
R1310	Resistor, Carbon Comp., 220 Ω ± 10%, 1 W	3240040
R1311	Resistor, Carbon Comp., 1 kΩ ± 10%, ¼ W	3220160
R1312	Resistor, Carbon Comp., 3.3k ± 10%, ¼ W	3220200
R1313	Resistor, Carbon Comp., 4.7 kΩ ± 10%, ¼ W	3220210
R1314	Resistor, Carbon Comp., 10 Ω ± 10%, ¼ W	3220005
R1315	Resistor, 22Ω, 2 W	3240360
R1316	Resistor, Carbon Comp., 220 Ω ± 10%, 1 W	3240040
R1317	Resistor, Carbon Comp., 100 ± 10%, ¼ W	3220055
R1318	Resistor, Carbon Comp., 10 Ω ± 10%, ¼ W	3220005
R1319	Resistor, Carbon Comp., 1 kΩ ± 10%, ¼ W	3220160
R1320	Resistor, Carbon Comp., 33 Ω ± 10%, ¼ W	3220025
R1321	Resistor, Carbon Comp., 100 ± 10%, ½ W	3230115
R1322	Resistor, Carbon Comp., 56 Ω ± 10%, ¼ W	3220040
R1323	Resistor, Carbon Comp., 47 Ω ± 10%, ¼ W	3220035
R1324	Resistor, Carbon Comp., 43 kΩ ± 5%, ¼ W	3220283
R1325	Resistor, Carbon Comp., 47 kΩ ± 10%, ¼ W	3220285
R1326	Resistor, Carbon Comp., 10 Ω ± 10%, ¼ W	3220005

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CHAPTER 4

PHASE DETECTOR - REFERENCE OSCILLATOR - AUDIO PROCESSOR

4-1. Phase Detector/Reference Oscillator.
The Phase Detector/Reference Oscillator printed circuit board is a plug-in board located behind the control head. The Phase Det/Ref board is composed of four sections, the microphone amplifier, 5 kHz reference oscillator, phase detector, and out-of-lock detector. Refer to Figures 4-1 and 4-2.

The integrated circuit U201, has four amplifier stages that process the audio from the microphone. Approximately 2.5 millivolts (rms) is required as an input to the first amplifier section U201A. Resistor R207 is adjusted for an output of 130 millivolts (p-p) at the output of U201A. Inductor L200 and capacitor C207 form an RF filter to prevent strong RF signals from getting into the input of U201. The second stage U201B, is designed to provide +6 dB/octave pre-emphasis from 300 Hz to 3 kHz. The output of U201B drives the limiter, composed of R216, R217, R218, CR200 and CR201, which has an output of 800 millivolts (p-p). Resistor R206 and capacitor C200 form a low-pass filter to eliminate harmonics that may be generated by the limiter. The last stage U201D, is an active filter which provides a −12 dB/octave roll-off above 3 kHz. The output of U201D is coupled to the appropriate VCO where it modulates the varicap diode. Transistor Q200 removes the supply voltage to U201 except during transmit.

The reference frequency for the synthesizer is established by the oscillator circuit comprised of Q201, Y200, and associated components. The output of Q201 is set to exactly 5.000 MHz by adjusting C220. Q204 is a buffer amplifier required to drive the integrated circuit divider chain consisting of U202 and U203. U202 divides the 5.000 MHz reference by 100 and U203 divides the output of U202 by 10. The resultant output of U203 is a 5.000 kHz square wave that is coupled to transistor Q202. Q202 is switched "on" very briefly at a 5 kHz rate, to discharge capacitor C224. C224 is charged through the constant current source formed by transistor Q203. The charging rate for C224 is determined by the setting of potentiometer R235. The resulting ramp voltage developed across C224, should have a minimum voltage of 1.0 volt and a maximum voltage of 7.5 volts. Transistor Q205 is a source follower which isolates the voltage developed across C224. Resistor R234 is the "source" resistance for Q205 and has the same ramp voltage as the capacitor C224. Transistors Q207 and Q208 are switches that are turned "on" by the input pulses coming from the divider board. When Q207 and Q208 are momentarily "on", the ramp voltage across R234 is applied to capacitor C230. Pulses from the divider board are exactly 5.00 kHz if the synthesizer is "locked". If the synthesizer is not "locked", the pulses from the divider board will not be exactly 5.00 kHz, and the ramp voltage across R234 will be sampled at different voltages on the ramp. The resultant voltage across C230 will be variable instead of constant. The variations of voltage will be in a direction that will tend to correct the VCO frequency and generate a 5.00 kHz pulse at the divider board output. This action will result in the synthesizer being forced to a "locked" condition.

Transistor Q209 is a FET buffer which allows the charge on C230 to change only through the transistor switch Q207. The voltage across R250 is the same as the voltage across C230, and it is this voltage that drives the VCO.

The voltage developed across R250 is the "Control Line" voltage and is monitored by the integrated circuit U204. U204A and U205B operate as comparators which monitor the control line voltage to determine if it is between 3.0 to 6.9 volts. If the control line voltage is not 3.0 to 6.9 volts, then the VCO is operating at a frequency outside the band of legal frequencies, or the synthesizer is out-of-lock. A control line voltage other than 3.0 to 6.9 volts will result in Q210 being turned off, and this condition will allow U204D to oscillate at approximately 1 kHz. This voltage will be coupled to the audio amplifier on the IF/AUDIO board and an audible tone will serve as an "out-of-band" and "out-of-lock" indication.

U204C is an inverter which monitors the "inhibit transmit" line. The 140 PROGRAM BOARD, and 220/440 PROGRAM BOARDS have "inhibit diodes" that are used in unprogrammed channels to provide an input to U204C if operation on an unprogrammed channel is attempted. If U204C receives an input from any unprogrammed channel, the output will go to a low state and transistors Q211 and Q212 will be turned off. Q211 and Q212 form a switch that must be "on" before the antenna relay can actuate and switch to the transmit mode. When U204C detects an input on the inhibit line, its output will go low, allowing Q210 to turn off. U204D will begin oscillating and a tone will be heard to indicate operation on an unprogrammed channel.

Transistor Q206 and zener diode CR207 form a series-pass regulator which has an output of 9.0 volts. U201 and U204 both require a stable supply voltage for proper operation. Q206 and CR207 also provide power line filtering to remove alternator whine in mobile installations.

PHASE DETECTOR BOARD

DES	DESCRIPTION	PART #
C200	Capacitor, Mica, 490 pF ± 5%, DM-15	3170410
C201	Capacitor, Tantalum, .22 μF ± 10%, 35 V	3183100
C202	Capacitor, Ceramic Disc, 47.0 pF ± 5%	3160840
C203	Capacitor, Tantalum, 1 μF ± 20%, 35 V	3183010
C204	Capacitor, Tantalum, 1 μF ± 20%, 35 V	3183010
C205	Capacitor, Ceramic Disc, .001 μF ± 20%, Z5U	3161380
C206	Capacitor, Tantalum, 10 μF ± 20%, 25 V	3183030
C207	Capacitor, Ceramic Disc, .001 μF ± 20%, Z5U	3161380
C208	Capacitor, Ceramic Disc, 470 pF ± 20%, Z5U	3161350
C209	Capacitor, Mica, 600 pF ± 5%, DM-19	3170480
C210	Capacitor, Tantalum, 10 μF ± 20%, 25 V	3183030
C211	Capacitor, Ceramic Disc, .001 μF ± 20%, Z5U	3161380
C212	Capacitor, Ceramic Disc, .01 μF ± 20%, Z5U	3161520
C213	Capacitor, Ceramic Disc, 150 pF ± 20%, Z5U	3161170
C214	Capacitor, Ceramic Disc, .01 μF ± 20%, Z5U	3161520
C215	Capacitor, Ceramic Disc, .01 μF ± 20%, Z5U	3161520
C216	Capacitor, Tantalum, 10 μF ± 20%, 25 V	3183030
C217	Capacitor, Ceramic Disc, .01 μF ± 20%, Z5U	3161520
C218	Capacitor, Ceramic Disc, .0024 μF ± 20%, Z5U	3161440
C219	Capacitor, Ceramic Disc, 12 pF ± 5%, N2200	3160415
C220	Capacitor, Variable Trimmer, 1.2 — 10 pF	3205370
C221	Capacitor, Ceramic Disc, 12 pF ± 5%, N750	3160410
C222	Capacitor, Ceramic Disc, 27 pF ± 5%, NPO	3160650
C223	Capacitor, Ceramic Disc, 13 pF ± 5%, N750	3160450
C224	Capacitor, Ceramic Disc, .0024 μF ± 20%, Z5U	3161440
C225	Capacitor, Ceramic Disc, .005 μF ± 20%, Z5U	3161470
C226	Capacitor, Ceramic Disc, 220 pF ± 20%, Z5U	3161270
C227	Capacitor, Ceramic Disc, .01 μF ± 20%, Z5U	3161520
C228	Capacitor, Ceramic Disc, .1 μF, X5U, 16 V	3161680
C229	Capacitor, Electrolytic, Axial, 250 μF, 15 V	3180220
C230	Capacitor, Mica, 600 pF ± 5%, DM-19	3170480
C231	Capacitor, Tantalum, 1 μF ± 20%, 35 V	3183010
C232	Capacitor, Ceramic Disc, .05 μF ± 80%, M16V	3161600
C233	Capacitor, Ceramic Disc, .01 μF ± 20%, Z5U	3161520
C234	Capacitor, Ceramic Disc, 220 pF ± 20%, Z5U	3161270
C235	Capacitor, Ceramic Disc, 150 pF ± 20%, Z5U	3161170
C236	Capacitor, Tantalum, 22 μF ± 20%, 15 V	3183050
C237	Capacitor, Tantalum, 1 μF ± 20%, 35 V	3183010
CR200	Diode, 1N4148	3020090
CR201	Diode, 1N4148	3020090
CR202	Diode, 1N4148	3020090
CR203	Diode, 1N4148	3020090
CR204	Diode, 1N270	3020010
CR205	Diode, 1N4148	3020090
CR206	Diode, 1N270	3020010
CR207	Diode, 1N4740A	3020120
U201	Integrated Circuit, MC3401P	3040130
U202	Integrated Circuit, SN74390N	3040477
U203	Integrated Circuit, SN74LS90N	3040508
U204	Integrated Circuit, MC3302P	3040120
Q200	Transistor, 2N4402	3030120
Q201	Transistor, 2N5950	3030190

DES	DESCRIPTION	PART #
Q202	Transistor, 2N3904	3030105
Q203	Transistor, 2N4402	3030120
Q204	Transistor, 2N3904	3030105
Q205	Transistor, 2N5953	3030200
Q206	Transistor, 2N3904	3030105
Q207	Transistor, 2N3904	3030105
Q208	Transistor, 2N3904	3030105
Q209	Transistor, 3N204	3030230
Q210	Transistor, 2N3904	3030105
Q211	Transistor, 2N3904	3030105
Q212	Transistor, 2N3566	3030070
R200	Resistor, Carbon Comp., 470 kΩ ± 10%, ¼ W	3220345
R201	Resistor, Carbon Comp., 47 kΩ ± 10%, ¼ W	3220285
R202	Resistor, Carbon Comp., 470 kΩ ± 10%, ¼ W	3220345
R203	Resistor, Carbon Comp., 1 MΩ ± 10%, ¼ W	3220355
R204	Resistor, Carbon Comp., 220 kΩ ± 10%, ¼ W	3220330
R205	Resistor, Carbon Comp., 180 kΩ ± 10%, ¼ W	3220325
R206	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R207	Resistor, Variable, 5 kΩ (CTS RL-7153)	3260120
R208	Resistor, Carbon Comp., 470 Ω ± 10%, ¼ W	3220110
R209	Resistor, Carbon Comp., 270 kΩ ± 10%, ¼ W	3220335
R210	Resistor, Carbon Comp., 47 kΩ ± 10%, ¼ W	3220285
R211	Resistor, Carbon Comp., 1 kΩ ± 10%, ¼ W	3220160
R212	Resistor, Carbon Comp., 1 kΩ ± 10%, ¼ W	3220160
R213	Resistor, Carbon Comp., 10 kΩ ± 10%, ¼ W	3220235
R214	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R215	Resistor, Carbon Comp., 2.2 MΩ ± 10%, ¼ W	3220360
R216	Resistor, Carbon Comp., 1.2 kΩ ± 10%, ¼ W	3220170
R217	Resistor, Carbon Comp., 10 kΩ ± 10%, ¼ W	3220235
R218	Resistor, Carbon Comp., 1.2 kΩ ± 10%, ¼ W	3220170
R219	Resistor, Carbon Comp., 1 MΩ ± 10%, ¼ W	3220355
R220	Resistor, Carbon Comp., 680 kΩ ± 10%, ¼ W	3220350
R221	Resistor, Carbon Comp., 10 kΩ ± 10%, ¼ W	3220235
R222	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R223	Resistor, Carbon Comp., 47 Ω ± 10%, ¼ W	3220035
R224	Resistor, Carbon Comp., 3.3 Ω ± 10%, ¼ W	3220002
R225	Resistor, Carbon Comp., 3.3 Ω ± 10%, ¼ W	3220002
R226	Resistor, Carbon Comp., 470 Ω ± 10%, ¼ W	3220110
R227	Resistor, Carbon Comp., 1 kΩ ± 10%, ¼ W	3220160
R228	Resistor, Carbon Comp., 1 MΩ ± 10%, ¼ W	3220355
R229	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R230	Resistor, Carbon Comp., 2.2 kΩ ± 10%, ¼ W	3220190
R231	Resistor, Carbon Comp., 3.3 kΩ ± 10%, ¼ W	3220200
R232	Resistor, Carbon Comp., 22 kΩ ± 10%, ¼ W	3220260
R233	Resistor, Carbon Comp., 3.3 kΩ ± 10%, ¼ W	3220200
R234	Resistor, Carbon Comp., 2.7 kΩ ± 10%, ¼ W	3220195
R235	Resistor, Variable, 5 kΩ (CTS RL-7153)	3260120
R236	Resistor, Carbon Comp., 1 kΩ ± 10%, ¼ W	3220160
R237	Resistor, Carbon Comp., 56 Ω ± 10%, ¼ W	3220040
R238	Resistor, Carbon Comp., 27 kΩ ± 10%, ¼ W	3220270

DES	DESCRIPTION	PART #
R239	Resistor, Carbon Comp., 47 Ω ± 10%, ¼ W	3220035
R240	Resistor, Carbon Comp., 3.3 kΩ ± 10%, ¼ W	3220200
R241	Resistor, Carbon Comp., 470 Ω ± 10%, ¼ W	3220110
R242	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R243	Resistor, Carbon Comp., 100 Ω ± 10%, ¼ W	3220055
R244	Resistor, Carbon Comp., 2.2 kΩ ± 5%, ¼ W	3220185
R245	Resistor, Carbon Comp., 27 kΩ ± 10%, ¼ W	3220270
R246	Resistor, Carbon Comp., 10 kΩ ± 10%, ¼ W	3220235
R247	Resistor, Carbon Comp., 4.7 kΩ ± 5%, ¼ W	3220208
R248	Resistor, Carbon Comp., 68 kΩ ± 10%, ¼ W	3220300
R249	Resistor, Carbon Comp., 27 kΩ ± 10%, ¼ W	3220270
R250	Resistor, Carbon Comp., 1.5 kΩ ± 10%, ¼ W	3220175
R251	Resistor, Carbon Comp., 3.3 kΩ ± 5%, ¼ W	3220198
R252	Resistor, Carbon Comp., 27 kΩ ± 10%, ¼ W	3220270
R253	Resistor, Carbon Comp., 150 kΩ ± 10%, ¼ W	3220320
R254	Resistor, Carbon Comp., 47 kΩ ± 10%, ¼ W	3220285
R255	Resistor, Carbon Comp., 47 kΩ ± 10%, ¼ W	3220285
R256	Resistor, Carbon Comp., 100 Ω ± 10%, ¼ W	3220055
Y200	Crystal, 5.000 MHz	3120111

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CHAPTER 5

IF AMPLIFIER - AUDIO AMPLIFIER - SQUELCH

5-1. IF Amplifier-Audio-Squelch.

Figure 5-2 shows the component layout for the IF-AUDIO-SQUELCH printed circuit board. The schematic, figure 5-1, shows the circuit diagram and important waveforms and voltages.

There are three possible inputs to the IF-AUDIO-SQUELCH board. The receiver front end/VCO board that is operational, provides a DC current that switches "on" the correct PIN diode CR301, CR304, or CR305. Capacitor C301 and inductor L301 match the 50 Ω input to the impedance of the 6 pole crystal filter Y300. The output of Y300 is coupled to the dual gate MOSFET Q300, by the inductor L302, and capacitor C313. Q300 is a depletion mode MOSFET that provides approximately 20 dB gain at 10.7 MHz. Capacitor C307 and inductor L300 form a resonant drain load for Q300 and C309 couples the signal to the input of IF detector integrated circuit U300.

One section of U300 functions as a mixer to convert the incoming 10.7 MHz signal down to 455 kHz. U300 has its own internal oscillator circuitry which requires crystal Y301 as the frequency determining element. Capacitors C308 and C302 also form part of the oscillator circuit and help stabilize Y301 against variations due to temperature change. U300 processes the 455 kHz signal by passing it through 5 limiter stages and then to a quadrature demodulator. Inductor L303 and capacitor C317 resonate at 455 kHz and C311 provides a 90 degree phase shift required by the demodulator. The output of the detector is coupled to an internal amplifier which provides an audio output of approximately 300 millivolts. The recovered audio is buffered by transistor Q302 after passing through a low-pass filter (to remove 455 kHz from the recovered audio) composed of R320, R321, C324 and C325. Q302 operates as an emitter-follower and provides a low impedance drive to the volume and squelch controls. The squelch control feeds part of the recovered audio (and noise) to a high pass filter network consisting of C321, C320, C319, R318, and R319. The output of this network is mostly a noise voltage and is coupled back to a high gain amplifier inside U300. The internal amplifier has a gain of approximately 100 and amplifies only the high frequency components (5kHz–8 kHz) of the recovered audio. The output of this amplifier is considered the "noise" voltage and is further amplified by transistor Q301, which drives the noise rectifier composed of CR311, CR309, and C348. The noise rectifier will have an output if the transceiver receives a very weak signal (less than 0.1 microvolt) or no signal at all. The presence of a noise voltage will turn on transistor Q308, which will then ground the gate of Q305, the audio gate. The collector of Q308 provides a "Scan Control" signal to the offset board. When the transceiver is in a "Scan" mode, the collector of Q308 goes high to indicate the presence of a signal on the scanned channel. The scan circuitry on the Offset board will keep the transceiver operating on the "scanned" channel until activity on that channel ceases.

The audio gate transistor Q305 is turned "off" when a noise voltage turns on Q308. The audio amplifier receives no audio when Q305 is "off". When the noise voltage decreases for a received signal, the audio gate Q305, turns on and couples audio to the audio amplifier U301. The audio amplifier, frequency shapes the audio and provides drive to the audio power amplifier transistors Q303 and Q306. The output of Q303 and Q306 is coupled to the speaker through capacitor C333.

Transistor Q309 switches capacitor C349 into the noise rectifier circuit when the transceiver is receiving a normal channel. When the transceiver switches to a "scanned" channel, capacitor C349 is removed from the noise rectifier circuit and the resultant squelch tail becomes shorter. The presence of a long squelch tail during the scan operations may be regarded as a distraction and is therefore eliminated by removing C349. In normal (non scan) operation C349 is switched back into the circuit to lengthen the squelch tail. The longer squelch tail proves to be beneficial during mobile operation when flutter may be present on a weak signal.

The push-to-talk line is brought onto the IF-AUDIO-SQUELCH board to remove the supply voltage from the IF detector U300, and turn "on" transistor Q304. Q304 sources current to C349 and Q308, to turn Q305 "off", and remove the audio input to U301. This action allows the transceiver to switch from receive to transmit without a squelch being heard.

Transistor Q307 is the S meter amplifier and receives an input signal from the IF detector U300. Diodes CR308 and CR310 form a voltage doubler to supply the meter for full-scale reading, providing an input signal of 40 microvolts.

Figure 5-1, the schematic, provides DC voltage readings for each pin of U300 and U301. These voltages should be present during receive and should be within 10%. The voltages on U300 are removed during transmit.

IF—AUDIO BOARD

DES	DESCRIPTION	PART #
C300	Capacitor, Ceramic Disc, .01 μF ± 20%, Z5U	3161520
C301	Capacitor, Ceramic Disc, 35 pF, ± 5%, NPO	3160730
C302	Capacitor, Ceramic Disc, 68 pF ± 5%, NPO	3160950
C303	Capacitor, Tantalum, 22 μF ± 20%, 15 V	3183050
C304	Capacitor, Ceramic Disc, .05 μF + 80%, M16V	3161600
C305	Capacitor, Ceramic Disc, 5 pF ± 5%, NPO	3160150
C306	Capacitor, Ceramic Disc, 5 pF ± 5%, NPO	3160150
C307	Capacitor, Mica, 220 pF ± 5%, DM-15	3170240
C308	Capacitor, Ceramic Disc, 56 pF ± 5%, NPO	3160890
C309	Capacitor, Ceramic Disc, .001 μF ± 20%, Z5U	3161380
C310	Capacitor, Ceramic Disc, .05 μF + 80%, M16V	3161600
C311	Capacitor, Ceramic Disc, 10 pF ± 5%, N750	3160340
C312	Capacitor, Ceramic Disc, 3.3 pF ± .25 pF, N750	3160070
C313	Capacitor, Ceramic Disc, 35 pF ± 5%, NPO	3160730
C314	Capacitor, Ceramic Disc, .005 μF ± 20%, Z5U	3161470
C315	Capacitor, Ceramic Disc, .01 μF ± 20%, Z5U	3161520
C316	Capacitor, Ceramic Disc, 330 pF ± 10%, Y5E	3161300
C317	Capacitor, Mica, 430 pF ± 5%, DM-15	3170390
C318	Capacitor, Ceramic Disc, .1 μF + 80%, 12 V	3161660
C319	Capacitor, Ceramic Disc, .001 μF ± 20%, Z5U	3161380
C320	Capacitor, Ceramic Disc, .001 μF ± 20%, Z5U	3161380
C321	Capacitor, Ceramic Disc, .001 μF ± 20%, Z5U	3161380
C322	Capacitor, Ceramic Disc, .001 μF ± 20%, Z5U	3161380
C323	Capacitor, Tantalum, 10 μF ± 20%, 25 V	3183030
C324	Capacitor, Ceramic Disc, .001 μF ± 20%, Z5U	3161380
C325	Capacitor, Ceramic Disc, .001 μF ± 20%, Z5U	3161380
C326	Capacitor, Tantalum, 1 μF ± 20%, 35 V	3183010
C327	Capacitor, Tantalum, 1 μF ± 20%, 35 V	3183010
C328	Capacitor, Ceramic Disc, .005 μF ± 20%, Z5U	3161470
C329	Capacitor, Electrolytic, Axial, 1000 μF, 15 V	3180290
C330	Capacitor, Tantalum, 1 μF ± 20%, 35 V	3183010
C331	Capacitor, Tantalum, .22 μF ± 10%, 35 V	3183100
C332	Capacitor, Tantalum, 1 μF ± 20%, 35 V	3183010
C333	Capacitor, Electrolytic, Axial, 250 μF, 15 V	3180220
C334	Capacitor, Tantalum, .22 μF ± 10%, 35 V	3183100
C335	Capacitor, Ceramic Disc, .05 μF + 80%, M16V	3161600
C336	Capacitor, Ceramic Disc, 68 pF ± 5%, N750	3160990
C337	Capacitor, Tantalum, 10 μF ± 20%, 25 V	3183030
C338	Capacitor, Ceramic Disc, 470 pF ± 20%, Z5U	3161350
C339	Capacitor, Tantalum, 1 μF ± 20%, 35 V	3183010
C340	Capacitor, Ceramic Disc, .02 μF + 80%, Z5U	3161580
C341	Capacitor, Ceramic Disc, .01 μF ± 20%, Z5U	3161520
C342	Capacitor, Ceramic Disc, .01 μF ± 20%, Z5U	3161520
C343	Capacitor, Ceramic Disc, 150 pF ± 20%, Z5U	3161170
C344	Capacitor, Ceramic Disc, .001 μF ± 20%, Z5U	3161380
C345	Capacitor, Ceramic Disc, .005 μF ± 20%, Z5U	3161470
C346	Capacitor, Ceramic Disc, .05 μF + 80%, M16V	3161600
C347	Capacitor, Ceramic Disc, .05 μF + 80%, M16V	3161600
C348	Capacitor, Tantalum, 1 μF ± 20%, 35 V	3183010
C349	Capacitor, Tantalum, 2.2 μF ± 20%, 35 V	3183021
C350	Capacitor, Tantalum, 1 μF ± 20%, 35 V	3183010

DES	DESCRIPTION	PART #
CR300	Diode, 1N4148	3020090
CR301	Diode, MPN-3404	3020265
CR302	Diode, 1N751A	3020050
CR303	Diode, 1N4148	3020090
CR304	Diode, MPN-3404	3020265
CR305	Diode, MPN-3404	3020265
CR306	Diode, 1N4148	3020090
CR307	Diode, 1N4148	3020090
CR308	Diode, 1N270	3020010
CR309	Diode, 1N4148	3020090
CR310	Diode, 1N270	3020010
CR311	Diode, 1N4148	3020090
U300	Integrated Circuit, MC3357P	3040590
U301	Integrated Circuit, MC1385P	3040111
L300	Coil, 1 μH (Drake A46096)	3500095
L301	Coil, 5 μH (Drake A46096)	3500095
L302	Coil, 5 μH (Drake A46096)	3500095
L303	Coil, 300 μH (Drake A46096)	3500095
Q300	Transistor, 3N204	3030230
Q301	Transistor, 2N3904	3030105
Q302	Transistor, 2N3904	3030105
Q303	Transistor, MJE2050	3030273
Q304	Transistor, 2N4402	3030120
Q305	Transistor, 2N5953	3030200
Q306	Transistor, MJE2150	3030277
Q307	Transistor, 2N3904	3030105
Q308	Transistor, 2N3904	3030105
Q309	Transistor, 2N3904	3030105
R300	Resistor, Carbon Comp., 100 $\Omega \pm 10\%$, ¼ W	3220055
R301	Resistor, Carbon Comp., 820 $\Omega \pm 10\%$, ¼ W	3220145
R302	Resistor, Carbon Comp., 47 $\Omega \pm 10\%$, ¼ W	3220035
R303	Resistor, Carbon Comp., 15 k$\Omega \pm 10\%$, ¼ W	3220245
R304	Resistor, Carbon Comp., 1.8 k$\Omega \pm 10\%$, ¼ W	3220180
R305	Resistor, Carbon Comp., 2.2 k$\Omega \pm 10\%$, ¼W	3220190
R306	Resistor, Carbon Comp., 470 $\Omega \pm 10\%$, ¼ W	3220110
R307	Resistor, Carbon Comp., 470 $\Omega \pm 10\%$, ¼ W	3220110
R308	Resistor, Carbon Comp., 68 $\Omega \pm 10\%$, ¼ W	3220045
R309	Resistor, Carbon Comp., 1.5 k$\Omega \pm 10\%$, ¼ W	3220175
R310	Resistor, Carbon Comp., 680 $\Omega \pm 10\%$, ¼ W	3220140
R311	Resistor, Carbon Comp., 47 k$\Omega \pm 10\%$, ¼ W	3220285
R312	Resistor, Carbon Comp., 22 k$\Omega \pm 10\%$, ¼ W	3220260
R313	Resistor, Carbon Comp., 1 k$\Omega \pm 10\%$, ¼ W	3220160
R314	Resistor, Carbon Comp., 3.9 k$\Omega \pm 10\%$, ¼ W	3220205
R315	Resistor, Carbon Comp., 6.8 k$\Omega \pm 10\%$, ¼ W	3220220
R316	Resistor, Carbon Comp., 82 $\Omega \pm 10\%$, ¼ W	3220050
R317	Resistor, Carbon Comp., 6.8 k$\Omega \pm 10\%$, ¼ W	3220220
R318	Resistor, Carbon Comp., 22 k$\Omega \pm 10\%$, ¼ W	3220260
R319	Resistor, Carbon Comp., 22 k$\Omega \pm 10\%$, ¼ W	3220260
R320	Resistor, Carbon Comp., 3.3 k$\Omega \pm 10\%$, ¼ W	3220200
R321	Resistor, Carbon Comp., 3.3 k$\Omega \pm 10\%$, ¼ W	3220200

DES	DESCRIPTION	PART #
R322	Resistor, Carbon Comp., 470 Ω ± 10%, ¼ W	3220110
R323	Resistor, Carbon Comp., 180 Ω ± 10%, ¼ W	3220070
R324	Resistor, Carbon Comp., 22 kΩ ± 10%, ¼ W	3220260
R325	Resistor, Carbon Comp., 1 kΩ ± 10%, ¼ W	3220160
R326	Resistor, Carbon Comp., 12 kΩ ± 10%, ¼ W	3220240
R327	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R328	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R329	Resistor, Carbon Comp., 3.3 kΩ ± 10%, ¼ W	3220200
R330	Resistor, Carbon Comp., 1.5 kΩ ± 10%, ¼ W	3220175
R331	Resistor, Wire Wound, .51 Ω ± 5%, 1 W	3250027
R332	Resistor, Carbon Comp., 1 kΩ ± 10%, ¼ W	3220160
R333	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R334	Resistor, Carbon Comp., 3.9 kΩ ± 10%, ¼ W	3220205
R335	Resistor, Variable Trimmer, 25 kΩ (CTS R253B)	3260670
R336	Resistor, Carbon Comp., 1 MΩ ± 10%, ¼ W	3220355
R337	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R338	Resistor, Carbon Comp., 6.8 kΩ ± 10%, ¼ W	3220220
R339	Resistor, Carbon Comp., 33 kΩ ± 10%, ¼ W	3220275
R340	Resistor, Carbon Comp., 12 kΩ ± 10%, ¼ W	3220240
R341	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R342	Resistor, Wire Wound, .51 Ω ± 5%, 1 W	3250027
R343	Resistor, Carbon Comp., 2.2 kΩ ± 10%, ¼ W	3220190
R344	Resistor, Carbon Comp., 18 kΩ ± 10%, ¼ W	3220255
R345	Resistor, Carbon Comp., 680 Ω ± 10%, ¼ W	3220140
R346	Resistor, Carbon Comp., 15 kΩ ± 10%, ¼ W	3220245
R347	Resistor, Carbon Comp., 12 kΩ ± 10%, ¼ W	3220240
R348	Resistor, Carbon Comp., 1 kΩ ± 10%, ¼ W	3220160
R349	Resistor, Carbon Comp., 18 kΩ ± 10%, ¼ W	3220255
R350	Resistor, Carbon Comp., 12 kΩ ± 10%, ¼ W	3220240
Y300	Crystal Filter Set (Drake A46082)	3140122
Y301	Crystal, 10.245 MHz	3120135
Y302	Filter, Ceramic (MuRata CFU 455 E)	3140405
Y303	Filter, Ceramic (MuRata CFU 455 E)	3140405

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CHAPTER 6

CONTROL HEAD

6-1. Digital Troubleshooting.

Troubleshooting the digital boards will necessitate the use of a 60 pin card extender for the 140 program board and a 44 pin extender for the remaining boards.

Each of the digital boards will be provided with a known set of input signals and checked for an output. An incorrect output will then give an indication of the faulty component or components.

6-2. Control Head.

Figure 6-1 shows the schematic for the Control Head. Connections to the Control Head are designated by numbers and letters; figure 6-2 shows the 44 pin connector and the placement of pins 1, 22, A, and Z. The connector is viewed with the Control Head removed from the radio. Measurements made on the Control Head connector will, however, be made with the Control Head plugged into the UV-3 mainframe. To obtain access to all pins of the Control Head connector, it is necessary to remove both the top and bottom covers of the radio.

Set the front panel controls as follows:

"RCV FREQ"–146.000 "BAND" –140
"PWR" –HIGH "CHAN" –DIAL
"SCAN" –OFF "OFFSET"–SMP

Measure the voltages present on each pin of the Control Head and compare with the following chart.

Pin	Voltage	Pin	Voltage	Pin	Voltage
B	+12V	X	OV	13	0.5V
C	+5V	Y		14	0.5V
D	+0.5V	Z	OV	15	0.5V
E	+0.5V	1	+12V	16	0.0V
H	+0.5V	2	+4.5V	17	0.5V
J	+0.5V	3	+0.5V	18	0.5V
K	+5V	4	+4.0V	19	+5.6V
L	0.5V	5	+4.0V	20	0-1k (SQUELCH)
M	0.5V	6	+0.5V	21	
N	0.5V	7	+0.5V	22	OPEN
P	0.5V	8	+0.5V	A	0-1k (Volume)
R	0.5V	9	+0.5V		
S	0.5V	10	+0.5V		
T	0.5V	11	+0.5V		
U	+5V	12	+0.5V		
W	0.5V				

Any voltage that varies 10% or more from the above chart could indicate problems in the circuitry associated with that pin. Adjust the controls as follows and measure the voltage changes at the indicated pins.

Place "band" switch in *220*. Pin C = 0.5V, Pin 3 = 0.5V, Pin D = +4.5V.

Switch to *440*. Pin C = 0.5V, Pin D = 0.5V, Pin 3 = +4.5V.

Place "Channel" to *1*, Pin E = +4.5V, Pins H, 8, J, 4, 5 = 0.5V.

Place "Channel" to *2*, Pin H = +4.5V, Pins E, 8, J, 4, 5 = 0.5V.

Place "Channel" to *3*, Pin 8 = +4.5V, Pins E, H, J, 4, 5 = 0.5V.

Place "Channel" to *4*, Pin J = +4.5V, Pins E, H, 8, 4, 5 = 0.5V.

All other pins should have the same voltage as indicated by the chart. After test, reset switches as described for original test.

The test chart indicates voltages for pins P, M, K, S, 15 and 14. The "Offset" switch determines which pin will have a high (+4.5V to 5.5V) voltage present. The "Offset" is operational only when the "Channel" switch is in the dial position. The following table indicates the pin that is high for each setting of the "Offset" switch.

Offset	+4.5V–5.5V	0–0.5V
S	K	M, P, 14, 15, S
–	M	K, P, 14, 15, S
+	P	K, M, 14, 15, S
X	14	K, M, P, 15, S
Y	15	K, M, P, 14, S
Z	S	K, M, P, 14, 15

The "Scan" control switches pin T or 17 to 4.5 V depending on the desired mode. Pin T is 4.5 V to 5.5 V and pin 17 is 0.5V for Scan Dial. Pin 17 is 4.5 to 5.5V and pin T is 0.5 for Scan Ch. 4. Both pins are 0.5V for Scan off.

The "PWR" switch grounds pin X for operation at high power. Pin X may be greater than 12 volt in low power, but must go to 0.0V for high power.

The "Add" switch applies 4.0 to 5.0 volts to pin V in the 5 kHz position. Otherwise, pin V should be less than 0.5 V. The "Channel" selector must be in the Dial position for this measurement.

The "RCV FREQ" selector switches may be tested by referring to the following chart. Four different test frequencies are to be selected on the "RCV FREQ" switches. The chart shows which pins are high (+4.5V to 5.5V) and which pins are low (0.5V).

RCV Freq	High Pins	Low Pins
144.11	4, 10, 13	9, 5, 6, N, 7, L, R, 11, 12
145.22	4, 6, L, 12	9, 5, N, 7, 10, R, 11, 13
146.44	4, 5, 7, 11	9, 6, N, L, 10, R, 12, 13
147.88	4, 5, 6, N, R	9, 7, L, 10, 11, 12, 13

Any variation from the above should indicate the area of difficulty.

CONTROL HEAD ASSY.

DES	DESCRIPTION	PART #
C100	Capacitor, Electrolytic, Axial, 1000 μF, 15V	3180290
C101	Capacitor, Ceramic Disc, 220 pF ± 20%, Z5U	3161270
C102	Capacitor, Ceramic Disc, 220 pF ± 20%, Z5U	3161270
C103	Capacitor, Ceramic Disc, 220 pF ± 20%, Z5U	3161270
C104	Capacitor, Ceramic Disc, 220 pF ± 20%, Z5U	3161270
C105	Capacitor, Ceramic Disc, .005 μF ± 20%, Z5U	3161460
C106	Capacitor, Ceramic Disc, .005 μF ± 20%, Z5U	3161460
CR100	Diode, 1N4148	3020090
CR101	Diode, 1N4148	3020090
CR102	Diode, 1N4148	3020090
CR103	Diode, 1N4148	3020090
CR104	Diode, 1N4148	3020090
CR105	Diode, 1N4148	3020090
CR106	Diode, 1N4148	3020090
CR107	Diode, 1N4148	3020090
CR108	Diode, 1N4148	3020090
CR109	Diode, 1N4148	3020090
CR110	Diode, 1N4148	3020090
CR111	Diode, 1N4148	3020090
CR112	Diode, 1N4148	3020090
CR113	Diode, Light Emitting	3472052
CR114	Diode, 1N270	3020010
DS100	Lamp, 14 V., 80 mA	3471900
DS101	Lamp, 14 V., 80 mA	3471900
DS102	Lamp, 14 V., 80 mA	3471900
DS103	Lamp, 14 V., 80 mA	3471900
DS104	Lamp, 14 V., 80 mA	3471900
J101	Jack, Microphone, 4 Pin	3281735
L100	Choke, RF, 3.3 uH	3520505
L101	Choke, RF, 3.3 uH	3520505
L102	Choke, RF, 3.3 uH	3520505
L103	Choke, RF, 3.3 uH	3520505
M101	Meter, RF Level (Drake A46072)	3580270
R100	Resistor, Carbon, Comp., 1 kΩ ± 10%, ¼W	3220160
R101	Resistor, Variable, On-Off Volume, 1 kΩ (Drake A46077)	3260630
R102	Resistor, Variable, Squelch, 1 kΩ (Drake A46078)	3260631
S100	Switch, Rotary, Dial Frequency (Drake A46021)	3660960
S101	Switch, Rotary, Dial Frequency (Drake A46021)	3660960
S102	Switch, Rotary, Dial Frequency (Drake A46021)	3660960
S103	Switch, Toggle, DPDT, 5 kHz	3670852
S104	Switch, Toggle, SPDT, Low Power	3670850
S105	Switch, Toggle, SPDT Center Off, Scan	3670851
S106	Switch, Power, Mounted on Volume Control	3260631
S107	Switch, Rotary, Band (Drake A46022)	3660970
S108	Switch, Rotary, Channel (Drake A46023)	3660980
S109	Switch, Rotary, Offset (Drake A46024)	3660990

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CHAPTER 7
OFFSET BOARD

7-1. Offset Board.

The "Offset" board provides the various transmit offsets for each band, and also provides the 10.7 MHz offset required in the receive mode. The scan control circuitry is also located on the offset board. Accurate troubleshooting of the offset board will require a "Control Head" that is in proper working condition, since most of the inputs to the "Offset" Board come from the Control Head. Refer to figure 7-1, "Offset" Board, for the circuit schematic and pin designations. All pin measurements on the board are made from the bottom of the radio.

Set the front panel controls as follows:
BAND–140 SCAN–OFF RCV FREQ–6.00
CHAN–DIAL PWR–LO
OFFSET–SMP ADD–0

Pins 9, 5, 4, 11, X, 18, S, 8, and F should be +4.5 to 5.5V. Pin H should be 8 to 12 volts and pin 15 should be 4.5 to 5.5 volts with the BAND switch in the 140 and 440 positions. Pin 15 should be 0.5V with the BAND switch in the 220 position. Pins 12, T, L, M, N, W, Y, Z, 20, 21, and 22 should be 0.5V.

With the "Offset" switch in the SMP position, pin 12 should be +4.5V when the push-to-talk (PTT) switch is depressed. Pins F, X, S, and 18 should go to a low state of 0.5V during transmit.

TRANSMIT operation with the "BAND" switch in the 140 position and the OFFSET switch in the (−) or (+) position will result in pins X and 18 going to the high (4.5 to 5.5V) state. A (+) offset will result in pin 15 being in a low state (0 to 0.5V), and a (−) offset will cause pin 15 to go high.

TRANSMIT operation with the "BAND" switch in the 220 position will cause pins N, X, and 18 to go high. A (+) offset will leave pin 15 in the low state and a (−) offset will cause 15 to go high.

TRANSMIT operation with the BAND switch in the 440 position will bring pins L and N to a high state. A (+) offset will again result in pin 15 being in a low state and a (−) offset will cause pin 15 to go high.

Programming area for three additional offsets is provided on the OFFSET board. Offsets "X", "Y", and "Z" may be programmed with diodes as desired. Selection of X, Y, or Z offset will then cause certain output pins to go high, depending upon the programming. Pin 12 will only go high if X, Y, or Z is selected and a 5 kHz value is programmed. Pin 15 goes high only for a negative value of transmit offset. Pins T, L, M, and N go high for offsets 0 to 9 MHz while W, X, 18 and S go high for 0 to 0.9 MHz values. Pins Y, Z, 20, and 23 go high for offsets having 0 to 10 kHz values.

The scan control circuitry is also located on the OFFSET board. Place the SCAN switch in the Dial position and measure pin C for 5.6 volts. Set the CHANNEL selector to 4 and measure 4.0 to 4.5 volts on pin 2. Every 3 seconds (approx.) the voltage should go to 0.5 volts for 30 to 50 Msec at pin 2. Pin 9 should have very short (approx. 30-50 milliseconds) pulses present and these measurements should be made with an oscilloscope. The maximum voltage should be 4.0 to 4.5 volts.

OFFSET BOARD

DES	DESCRIPTION	PART #
C401	Capacitor, Ceramic Disc, .005 ± 20%, Z5U	3161470
C402	Capacitor, Tantalum, 10 μF ± 20%, 25 V	3183030
C403	Capacitor, Tantalum, 22 μF ± 20%, 15 V	3183050
CR401	Diode, 1N270	3020010
CR402	Diode, 1N4148	3020090
CR403	Diode, 1N4148	3020090
CR404	Diode, 1N4148	3020090
CR405	Diode, 1N4148	3020090
CR406	Diode, 1N4148	3020090
CR407	Diode, 1N4148	3020090
CR408	Diode, 1N4148	3020090
CR409	Diode, 1N4148	3020090
CR410	Diode, 1N4148	3020090
CR411	Diode, 1N4148	3020090
CR412	Diode, 1N4148	3020090
CR413	Diode, 1N4148	3020090
CR414	Diode, 1N4148	3020090
CR415	Diode, 1N4148	3020090
CR416	Diode, 1N4148	3020090
CR417	Diode, 1N4148	3020090
CR418	Diode, 1N4148	3020090
CR419	Diode, 1N4148	3020090
CR420	Diode, 1N4148	3020090
CR421	Diode, 1N4148	3020090
CR422	Diode, 1N4148	3020090
CR423	Diode, 1N4148	3020090
CR424	Diode, 1N4148	3020090
CR425	Diode, 1N4148	3020090
CR426	Diode, 1N4148	3020090
CR427	Diode, 1N4148	3020090
CR428	Diode, 1N4148	3020090
U401	Integrated Circuit, MC14081BCP	3041070
U402	Integrated Circuit, MC14081BCP	3041070
U403	Integrated Circuit, MC14081BCP	3041070
U404	Integrated Circuit, MC1455P1	3040113
U405	Integrated Circuit, SN74LS09N	3040504
Q401	Transistor, 2N3904	3030105
Q402	Transistor, 2N3904	3030105
Q403	Transistor, 2N3904	3030105
Q404	Transistor, 2N3904	3030105
Q405	Transistor, 2N4402	3030120
Q406	Transistor, 2N3904	3030105
R401	Resistor, Carbon Comp., 1 kΩ ± 10%, ¼ W	3220160
R402	Resistor, Carbon Comp., 470Ω ± 10%, ¼ W	3220110
R403	Resistor, Carbon Comp., 10 kΩ ± 10%, ¼W	3220235
R404	Resistor, Carbon Comp., 1 kΩ ± 10%, ¼ W	3220160
R405	Resistor, Carbon Comp., 1 kΩ ± 10%, ¼ W	3220160

DES	DESCRIPTION	PART #
R406	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R407	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R408	Resistor, Carbon Comp., 1 kΩ ± 10%, ¼ W	3220160
R409	Resistor, Carbon Comp., 1 MΩ ± 10%, ¼ W	3220355
R410	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R411	Resistor, Carbon Comp., 4.7 kΩ ± 10%, ¼ W	3220210
R412	Resistor, Carbon Comp., 10 kΩ ± 10%, ¼ W	3220235
R413	Resistor, Carbon Comp., 330 Ω ± 10%, ¼ W	3220090
R414	Resistor, Carbon Comp., 10 kΩ ± 10%, ¼ W	3220235
R415	Resistor, Carbon Comp., 220 Ω ± 10%, ¼ W	3220075
R416	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R417	Resistor, Carbon Comp., 2.2 kΩ ± 10%, ¼ W	3220190
R418	Resistor, Carbon Comp., 22 kΩ ± 10%, ¼ W	3220260
R419	Resistor, Carbon Comp., 220 kΩ ± 10%, ¼ W	3220330
R420	Resistor, Carbon Comp., 220 kΩ ± 10%, ¼ W	3220330
R421	Resistor, Carbon Comp., 2.2 kΩ ± 10%, ¼ W	3220190
R422	Resistor, Carbon Comp., 4.7 kΩ ± 10%, ¼ W	3220210
R423	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R424	Resistor, Carbon Comp., 220 kΩ ± 10%, ¼ W	3220330
R425	Resistor, Carbon Comp., 22 kΩ ± 10%, ¼ W	3220260
R426	Resistor, Carbon Comp., 22 kΩ ± 10%, ¼ W	3220260
R427	Resistor, Carbon Comp., 22 kΩ ± 10%, ¼ W	3220260
R428	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R429	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R430	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R431	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R432	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R433	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R434	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R435	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R436	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R437	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R438	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R439	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R440	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R441	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R442	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R443	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R444	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R445	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R446	Resistor, Carbon Comp., 470 kΩ ± 10%, ¼ W	3220345
R447	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315

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CHAPTER 8

220/440 MHz PROGRAM BD.

8-1. 220/440 MHz Program Board.

The 220/440 MHz PROGRAM BOARD has only four integrated circuits; the troubleshooting procedure is to verify that each I.C. operates properly. The output pins of the board will have voltages present that depend upon the diode programming of the board. The following table lists an I.C. pin that will go high (4.5 to 5.5 volts) for certain switch settings. Refer to Figure 8-2 for component placement.

Pin 11, U501, goes high for "220" Band and Channel 1. ("BAND" switch set to "220" position and CHANNEL selector set to "1".)

Pin 10, U501, goes high for "220" Band and Channel 2.

Pin 4, U501, goes high for "220" Band and Channel 3.

Pin 3, U501, goes high for "220" Band and Channel 4.

Pin 11, U502, goes high for "220" Band and Channel 1 during transmit.

Pin 10, U502, goes high for "220" Band and Channel 2 during transmit.

Pin 4, U502, goes high for "220" Band and Channel 3 during transmit.

Pin 3, U502, goes high for "220" Band and Channel 4 during transmit.

Pin 11, U503, goes high for "440" Band and Channel 1. (Band switch now set to "440" position and Channel selector set to "1".)

Pin 10, U503, goes high for "440" Band and Channel 2.

Pin 4, U503, goes high for "440" Band and Channel 3.

Set the SCAN switch to the CH 4 position and set the CHANNEL switch to the DIAL position. Observe pin 2 with an oscilloscope and check for very short (approx. 30-50 milliseconds) pulses of 4.5 volts. Pin 9 should have 4.5 volts present. Every 3 seconds the voltage should go to less than 0.5 volts for 30-50 milliseconds.

If an incorrect voltage appears at a pin, the problem may be traced to components that drive that particular pin. Integrated circuits U401, U402, and U403 should be checked according to the following procedure. The CHANNEL selector must be in the Dial position for the following measurements.

Pin 4, U401, goes high for (−) or (+) offset during transmit.

Pin 11, U401, goes high for "X" offset during transmit.

Pin 3, U401, goes high for "Y" offset during transmit.

Pin 10, U401, goes high for "Z" offset during transmit.

Pin 10, U402, goes high for (−) offset during transmit.

Pin 11, U402, is high for the "140" or "440" band during receive.

Pin 4, U402, goes high for (−) or (+) offset in the "140" band during transmit.

Pin 3, U402, goes high for (−) or (+) offset in the "220" band during transmit.

Pin 4, U403, goes high for (−) or (+) offset in the "440" and during transmit.

Pin 11, U403, goes high for "SMP" or "O" offset during transmit. (CHANNEL selector must be in Dial position.)

One additional check should always be made; pin K of the OFFSET board must always go high during transmit.

Pin 3, U503, goes high for "440" Band and Channel 4.

Pin 11, U504, goes high for "440" Band and Channel 1 during transmit.

Pin 10, U504, goes high for "440" Band and Channel 2 during transmit.

Pin 4, U504, goes high for "440" Band and Channel 3 during transmit.

Pin 3, U504, goes high for "440" Band and Channel 4 during transmit.

Pin 14 of all integrated circuits is the supply pin and should be +5.5 volts whenever the transceiver is operating.

220/440 PROGRAM BOARD

DES	DESCRIPTION	PART #
CR501	Diode, 1N4148	3020090
CR502	Diode, 1N4148	3020090
CR503	Diode, 1N4148	3020090
CR504	Diode, 1N4148	3020090
CR505	Diode, 1N4148	3020090
CR506	Diode, 1N4148	3020090
CR507	Diode, 1N4148	3020090
CR508	Diode, 1N4148	3020090
U501	Integrated Circuit, MC14081BCP	3041070
U502	Integrated Circuit, MC14081BCP	3041070
U503	Integrated Circuit, MC14081BCP	3041070
U504	Integrated Circuit, MC14081BCP	3041070

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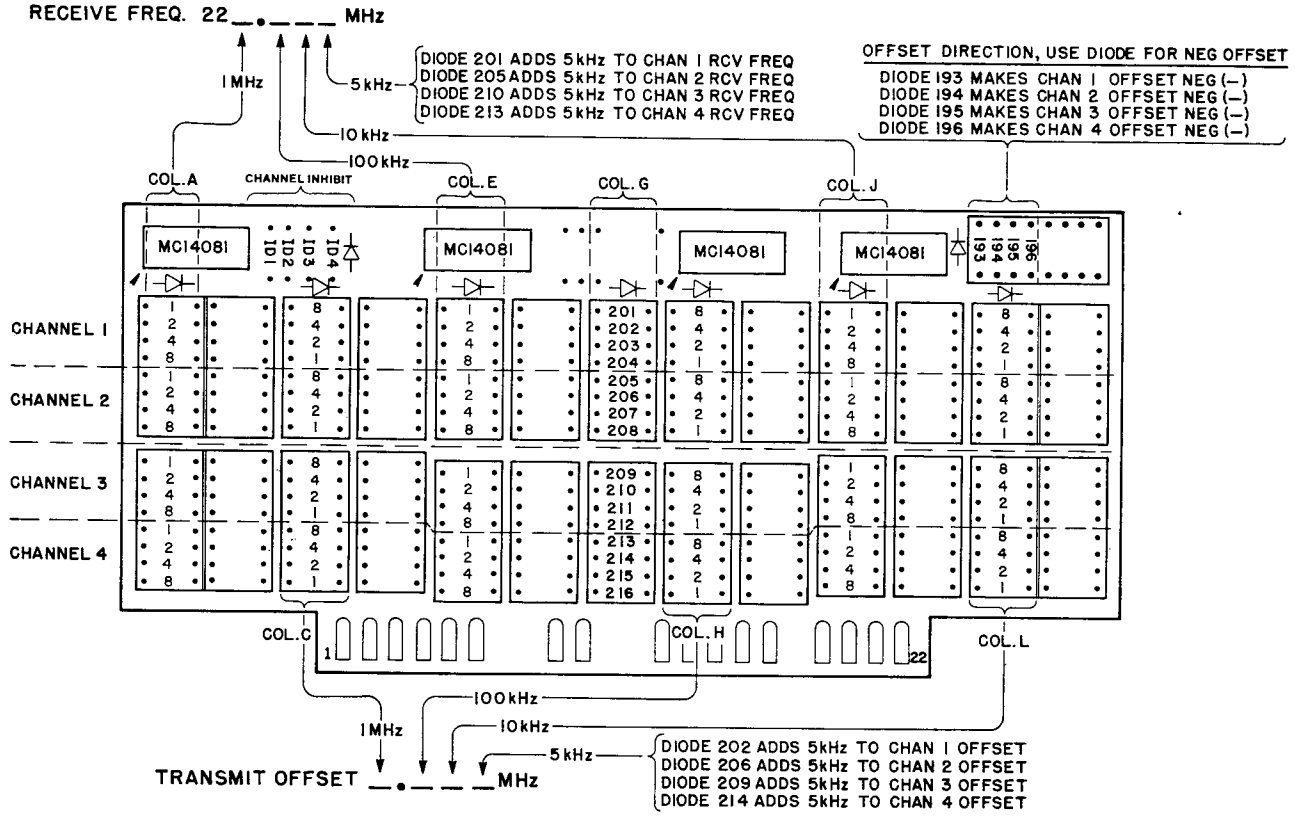
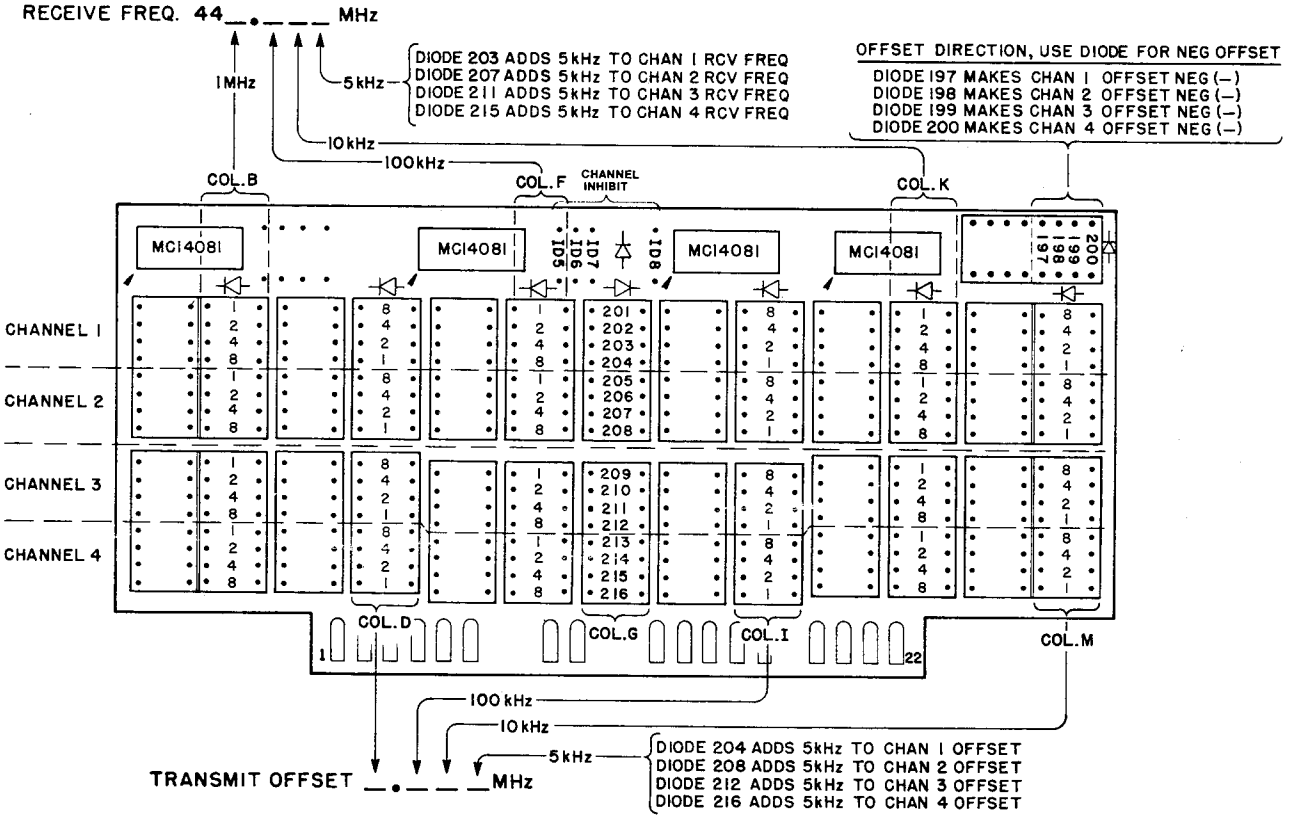


220 PROGRAMMING



440 PROGRAMMING

CHAPTER 9
140 MHz PROGRAM BOARD

9-1. 140 MHz Program Board.

The 140 MHz program has 2 I.C.'s that determine the programmed channel to be loaded into the synthesizer. Operating on Channel 1 of the 140 MHz band will result in pin 3 of U601 going high (4.5 V to 5.5 V). The following table lists the outputs of U601 and U602 and the required input conditions. Use 44 pin extender. Refer to Figure 9-2 for component placement.

Pin 11, U601, goes high for "140" Band and Channel 2.

Pin 4, U601, goes high for "140" Band and Channel 3.

Pin 10, U601, goes high for "140" Band and Channel 4.

The above voltages are present in receive and transmit. The following voltages are present ONLY IN TRANSMIT.

Pin 11, U602, goes high for "140" Band and Channel 1.

Pin 3, U602, goes high for "140" Band and Channel 2.

Pin 10, U602, goes high for "140" Band and Channel 3.

Pin 4, U602, goes high for "140" Band and Channel 4.

The following procedure tests for plus and minus offset. Measure pin 5 of U603, U604, U605, U606, and U608. These pins should be at 5 volts for a negative transmit offset and at 0.5 volts for a positive transmit offset on all bands. These pins will also be at 5 volts during receive for the 140 MHz and 440 MHz bands.

The following procedure tests for the proper voltages during simplex operation. Measure pin 9 of U603, U604, U605, U606, and U608. This pin should be at 5 volts only in transmit when the "Channel" selector is set to the Dial position.

The next test is involved with determining the operation of I.C.'s U603, U604, U605, U606, and U607 in the various offset modes. Set the following switches as follows: CHANNEL selector to "Dial", OFFSET selector to "SMP", BAND switch to "140", and SCAN switch to "OFF". In the receive mode, 10.7 MHz is loaded into the above I.C.'s. Measure the following pins for a high level or low level according to the chart.

I.C.	High Pins	Low Pins	No Connection
U603	1,5,10,14	2,3,4,9,6,7,11, 12,13	8
U604	5,10,13,14	1,2,3,4,6,7,9, 11,12	8
U605	1,2,3,5,12,14	4,6,7,9,10,11, 13	8
U606	5,10,13,14	1,2,3,4,6,7,9, 11,12	8
U607	5,10,13,14	1,2,3,4,6,7,9, 11,12	8
U608	5,7,9,14,16	1,2,3,4,6,8,11	10,12,13,15

Press PTT switch and note that pin 9 of I.C.'s U603, U604, U605, U606, and U607 goes high. Refer to Figure 9-3 and program 147.84 into Channel 1 and 146.21 into Channel 2 as shown. Program a minus 600 kHz offset for Channel 1 and a positive 600 kHz offset for Channel 2. Set the CHANNEL switch to the "1" position and the BAND switch to the "140" position. Place the PWR switch in the "Lo" position.

Measure the following pins on the I.C.'s listed. Depress the PTT switch for these measurements.

I.C.	High Pins	Low Pins	No Connection
U603	5,10,13,14	All Others	8
U604	5,10,13,14	All Others	8
U605	2,3,5,12,13,14	All Others	8
U606	5,10,13,14	All Others	8
U607	5,7,9,15,16	All Others	
U608	5,10,13,14	All Others	8

Set the CHANNEL switch to "2" and measure all pins on the following I.C.'s. Depress PTT for these measurements. (PWR switch in "LO" position).

I.C.	High Pins	Low Pins	No Connection
U603	14	All Others	8
U604	14	All Others	8
U605	2,3,11,12,14	All Others	8
U606	14	All Others	8
U607	16	All Others	
U608	14	All Others	8

Place CHANNEL switch in the "Dial" position and the BAND switch in the "140" position. Move the ADD switch "0" to "5" and measure U607 pin 11. This pin should be low when the ADD switch is in the "0" position and high when the ADD switch is in the "5" position.

This concludes testing of the 140 Program Board. Any measurements that do not agree with the tables should indicate the areas of difficulty.

140 PROGRAM BOARD

DES	DESCRIPTION	PART #
CR601	Diode, 1N4148	3020090
CR602	Diode, 1N4148	3020090
CR603	Diode, 1N4148	3020090
CR604	Diode, 1N4148	3020090
CR605	Diode, 1N4148	3020090
CR606	Diode, 1N4148	3020090
CR607	Diode, 1N4148	3020090
CR608	Diode, 1N4148	3020090
U601	Integrated Circuit, MC14081BCP	3041070
U602	Integrated Circuit, MC14081BCP	3041070
U603	Integrated Circuit, MC14561BCP	3041145
U604	Integrated Circuit, MC14561BCP	3041145
U605	Integrated Circuit, MC14561BCP	3041145
U606	Integrated Circuit, MC14561BCP	3041145
U607	Integrated Circuit, MC14560BCP	3041140
U608	Integrated Circuit, MC14561BCP	3041145
R601	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R602	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R603	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R604	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R605	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R606	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315

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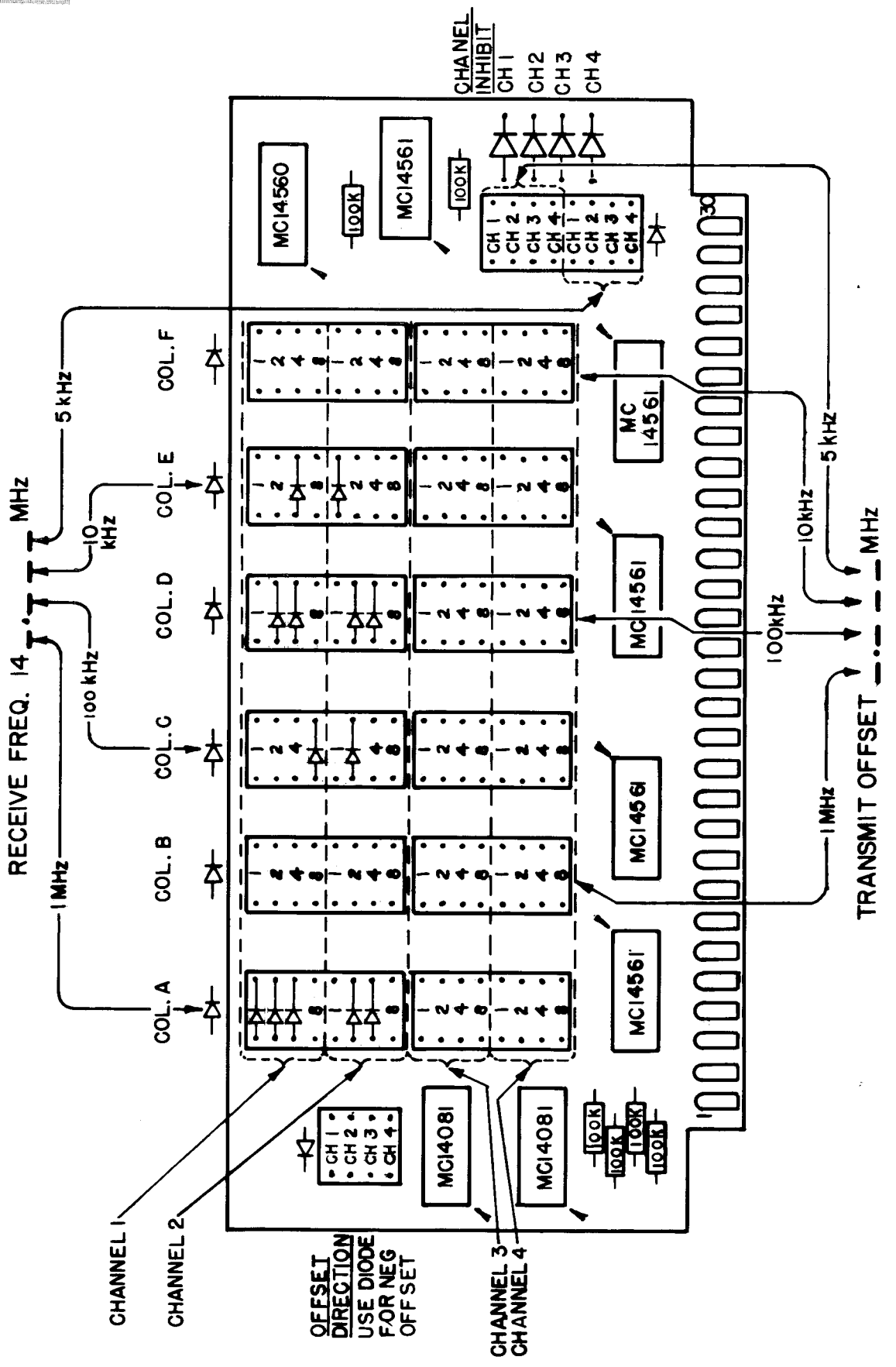

FIGURE 9-3. PROGRAMMING OF 140 MHz PROGRAM BOARD

CHAPTER 10

DIVIDER BOARD

10-1. Divider Board.
The Divider Board will be tested in a similar manner as the 140 Program Board. It is assumed that the Control Head, Offset Board, and 140 Program Board have been previously tested and are in proper working order.

Measure the following I.C.'s as indicated in the table. Refer to Figure 10-2, the Divider Board. Set the BAND switch to "140", the CHANNEL selector to "Dial", the OFFSET switch to "SMP", the SCAN switch to "OFF", and the RCV FREQ to 146.845.

I.C.	High Pins (+5 V)	Low Pins (0.5 V)	Pulses
U708	4,5,10,16	1,2,8,11,14	3,6,7,12, 13
U707	4,5,10,11, 13,16	2,8,14	1,3,6,7,9, 12,15
U706	4,10,11, 14,16	2,5,8	1,3,6,7,9, 12,15
U705	4,5,10,16	2,8,11,14	1,3,6,7,9, 12,13,15
U704	4,10,14,16	2,5,8,11	1,3,6,7,9, 12,13,15
U717	4,5,7,9,12, 13,16	1,2,3,6,8,10, 11,14,15	
U716	2,4,5,7,9,11, 12,15,16	1,3,6,8,10, 13,14	
U715			
U715	1,6,7,9,13, 16	2,3,4,5,8,10, 11,12, 14,15	
U719	4,5,7,9,11, 15,16	1,2,3,6,8,10, 12,13,14	

Adjust the RCV FREQ to 147.21. Leave other controls as described in the previous step. Again, measure the I.C. pin voltages and compare with the table below.

I.C.	High Pins	Low Pins	Pulses
U708	4,5,10,16	1,2,8,11, 14,15	3,6,7,9,12, 13
U707	4,5,10,11, 13,16	7,8,14	1,3,6,7,9, 12,15
U706	4,10,11,13, 14,16	2,5,8	1,3,6,7,9, 12,15
U705	4,5,10,14, 16	2,8,11	1,3,6,7,9, 12,13,15
U704	4,5,10,16	2,8,11,14	1,3,6,7,9, 12,13,15
U717	4,5,7,9,12, 13,16	1,2,3,6,8, 10,11, 14,15	
U716	2,4,5,9,11, 12,14, 15,16	1,3,6,7,8, 10,13	
U715	1,2,7,11, 13,16	3,4,5,6,8,9, 10,12, 14,15	
U714	5,7,9,13,14, 15,16	1,2,3,4,6,8, 10,11,12	

Integrated circuits U709, U710, and U711 are hex buffers which interface the CMOS I.C.'s to the TTL I.C.'s. The output pins of each buffer stage are the same as the input to that stage. Pin 1 of I.C.'s U709, U710, and U711 is the supply voltage and should always be 5.0 volts.

The above test procedure is by no means comprehensive. It is not practical to check each I.C. for all the possible input conditions, therefore, two frequencies were chosen that change each input line at least once.

The above tests do not actually check I.C.'s U704 to U708 for proper counting, but instead, test the inputs to assure the proper number is loaded into the counters. If all tests to this point coincide exactly with the tables, then it may be assumed that the problem exists in I.C.'s U701 to U708. Testing of this portion of the Divider would necessitate very sophisticated equipment. Therefore, the remaining test will only test for slower pulse trains.

1) Check I.C.'s U701 through U703, U712, and U713 for 5.2 volts on pin 16 or pin 14, according to the schematic.
2) Measure the VCO input to pin 15 of U703 with an RF voltmeter (capable of operation to 150 MHz). Minimum input should be 0.8 volts (p-p) or 0.3 volts rms.
3) Measure the following I.C. pins for a 5 kHz pulse. Pin 9, U701, pin 3 of U704 through U708, and pin 1, U713. This pulse will not be 5 kHz if the input from the VCO is inadequate, or if there is a problem on the Phase Detector board, or if U701 through U708 is defective.
4) Measure pins 1 and 6 of U704 through U708 for a square wave of 5.0 volts maximum and 0.5 volts minimum.

The following test will determine the proper operation of the divider chain and decode logic. If it is determined that the divider chain is operating properly, then any problems that exist are likely to be in switches, program boards, or the I.C.'s U709 through U717. Make the following measurements. Set Dial to 146.000 MHz.

I.C.	Pin	Frequency
U704	6	3.380 MHz
U705	6	6.765 MHz
U705	1	675 kHz
U706	6	675 kHz
U706	1	650 kHz
U707	6	650 kHz
U707	1	5.00 kHz
U701	9	5.00 kHz
U703	7	6.765 MHz

The preceding tests will most likely detect a faulty connection, defective I.C., etc. Subtle failure modes in the divider chain, however, may not always be detected by the tests. If problems persist after the above test, and the Control Head, Offset Board, and 140 Program Board are known to be working properly, then the Divider Board should be returned to the factory for servicing.

DIVIDER BOARD

DES	DESCRIPTION	PART #
C701	Capacitor, Ceramic Disc, .005 μF ± 20%, Z5U	3161470
C702	Capacitor, Ceramic Disc, .005 μF ± 20%, Z5U	3161470
C703	Capacitor, Ceramic Disc, .005 μF ± 20%, Z5U	3161470
C704	Capacitor, Ceramic Disc, .005 μF ± 20%, Z5U	3161470
C705	Capacitor, Ceramic Disc, .005 μF ± 20%, Z5U	3161470
C706	Capacitor, Ceramic Disc, .005 μF ± 20%, Z5U	3161470
C707	Capacitor, Ceramic Disc, .005 μF ± 20%, Z5U	3161470
C708	Capacitor, Ceramic Disc, .005 μF ± 20%, Z5U	3161470
C709	Capacitor, Tantalum, 1 μF ± 20%, 35 V	3183010
C710	Capacitor, Ceramic Disc, .005 μF ± 20%, Z5U	3161470
C711	Capacitor, Ceramic Disc, .005 μF ± 20%, Z5U	3161470
C712	Capacitor, Ceramic Disc, .005 μF ± 20%, Z5U	3161470
C713	Capacitor, Ceramic Disc, .005 μF ± 20%, Z5U	3161470
C714	Capacitor, Ceramic Disc, .005 μF ± 20%, Z5U	3161470
C715	Capacitor, Ceramic Disc, .005 μF ± 20%, Z5U	3161470
CR701	Diode, 1N4148	3020090
CR702	Diode, 1N4148	3020090
CR703	Diode, 1N4148	3020090
U701	Integrated Circuit, MC12014P	3040705
U702	Integrated Circuit, MC10131P	3040620
U703	Integrated Circuit, MC12013P	3040700
U704	Integrated Circuit, MC4016P	3040140
U705	Integrated Circuit, MC4016P	3040140
U706	Integrated Circuit, MC4016P	3040140
U707	Integrated Circuit, MC4016P	3040140
U708	Integrated Circuit, MC4016P	3040140
U709	Integrated Circuit, MC14050BCP	3041050
U710	Integrated Circuit, MC14050BCP	3041050
U711	Integrated Circuit, MC14050BCP	3041050
U712	Integrated Circuit, SN74LS74N	3040506
U713	Integrated Circuit, SN7400N	3040270
U714	Integrated Circuit, MC14560BCP	3041140
U715	Integrated Circuit, MC14560BCP	3041140
U716	Integrated Circuit, MC14560BCP	3041140
U717	Integrated Circuit, MC14560BCP	3041140
R701	Resistor, Carbon Comp., 470 Ω ± 10%, ¼ W	3220110
R702	Resistor, Carbon Comp., 470 Ω ± 10%, ¼ W	3220110
R703	Resistor, Carbon Comp., 470 Ω ± 10%, ¼ W	3220110
R704	Resistor, Carbon Comp., 1 kΩ ± 10%, ¼ W	3220160
R705	Resistor, Carbon Comp., 68 Ω ± 10%, ¼ W	3220045
R706	Resistor, Carbon Comp., 56 Ω ± 10%, ¼ W	3220040
R707	Resistor, Carbon Comp., 56 Ω ± 10%, ¼ W	3220040
R708	Resistor, Carbon Comp., 68 Ω ± 10%, ¼ W	3220045
R709	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R710	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R711	Resistor, Carbon Comp., 390 Ω ± 10%, ¼ W	3220100
R712	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R713	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R714	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R715	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315

DES	DESCRIPTION	PART #
R716	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R717	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R718	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R719	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R720	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R721	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R722	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315
R723	Resistor, Carbon Comp., 100 kΩ ± 10%, ¼ W	3220315

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CHAPTER 11

ALIGNMENT PROCEDURES

11-1. Phase Detector Ramp Voltage Adjustment.

1) Attach a calibrated oscilloscope to the junction of the 2.7 k (R234) resistor and the source of the 2N5953 transistor (Q205) on the phase detector board.
2) Adjust white pot (R235) at left end of board (viewing unit from front) until ramp just stops flat topping.
3) Minimum voltage of sawtooth should be 1.0 volt and maximum voltage should be approximately 8.0 volts.

11-2. 140 MHz VCO Alignment/Deviation Adjustment.

1) With the VCO/P.A. assembly removed for servicing, set the "Band" selector to "140", set "Channel" selector to "Dial", set "Offset" selector to "SMP", set "Power" switch to "Lo" and "Add" switch to "0". Select 146.000 MHz on Dial.
2) Attach VTVM to control line, (pin 5 of phase detector board).
3) Attach microphone to microphone jack and connect output to dummy antenna/attenuator.
4) Depress PTT switch and adjust VCO coil, L804, for control line voltage of 5 volts. If transmitter is close enough to being tuned that some output power is obtained, counter should read 146.000 MHz.
5) Release PTT switch and reset Dial to 148.000 MHz and adjust trimmer C803 on VCO board, for a control line voltage of 5.5 volts.
6) With unit still on receive, readjust Dial to 146.000 MHz and measure the control line voltage. A reading 4.0 to 4.5 volts should be measured.
7) Couple dummy load to deviation meter.
8) Attach audio generator to microphone jack, along with a means to activate the PTT switch.
9) Activate PTT switch and feed in a 30 millivolt, 1 kHz signal.
10) Adjust deviation pot (R820) on VCO board for a 5 kHz deviation.
11) Reduce audio level to 3 mV and adjust microphone gain on phase detector board for ± 3 kHz deviation.

11-3. 140 MHz RF Amplifier and Mixer Alignment.

1) Remove microphone from microphone jack and connect antenna jack to signal generator.
2) Set dial to 146.000 MHz and "SMP".
3) Adjust "Squelch" maximum CCW and advance "Volume" control until noise is at a comfortable level.
4) Set signal generator to 146.000 MHz and adjust output level for half-scale reading on meter.
5) Pretune RF amp input coils (L812, L813), band-pass filter coils (L814, L815, L816, L817), 10.7 MHz IF coils T801, X2 Multiplier (L809) and receive buffer amp coil (L810). Reduce generator level for half-scale reading as coils are tuned.
6) Retune RF amp input coils by loading coil not being tuned with pliers and tuning opposite coil. Readjust signal generator for half-scale reading.
7) To tune band-pass filter, detune end coils by running slugs all the way in. Tune center coils by loading coil not being tuned. Tune end coils by loading adjacent coils. Readjust signal generator for half-scale as coils are tuned.
8) Recheck tuning of receiver buffer amp coil and X2 multiplier coil. These coils should be fine tuned for best SINAD at 145.000 MHz. Generator output should be reduced to a level which will produce 12 dB SINAD.

11-4. 140 MHz Power Amplifier Alignment.

1) Reconnect antenna connector of unit to dummy load and wattmeter.
2) Set power switch on "high" power and set dial to 146.000 MHz simplex.
3) Depress microphone button and alternately adjust all three trimmers (C924, C917, C913) on P.A. board for maximum power output.
4) Depress microphone button and adjust both slug tuned coils (L901, L904) on P.A. board and P.A. buffer coil on VCO board for maximum power output.
5) Switch to 147.000 MHz and retune the three P.A. trimmers for maximum power output.
6) The output power should be 20 watts minimum at 144 MHz and 145 MHz, 25 watts nominal at 146 MHz and 148 MHz.
7) Reinstall VCO/P.A. assembly and rear cover onto main chassis.

11-5. 220 MHz VCO Alignment/Deviation Adjustment.

1) With the VCO/P.A. assembly removed for servicing, set the BAND selector to "220", set CHANNEL selector to "Dial", set OFFSET selector to "SMP", set POWER switch to "LO", and set Add switch to "0". Select 223.000 MHz on dial.
2) Attach VTVM to control line, pin 5 of phase detector board.
3) Attach microphone to microphone jack, and connect output to dummy antenna/attenuator. A counter should be connected to dummy antenna/attenuator output.
4) Adjust VCO coil, L1004, for a control line voltage of 5.0 volts.
5) Depress PTT switch and adjust trimmer, C1003, on VCO board for a control line voltage of 5.0 volts. If transmitter is close enough to being tuned that some output power is obtained, counter should read 223.000 MHz.
6) Readjust dial to 220.000 MHz and depress PTT switch. Control line voltage should be 3.9 volts to 4.2 volts. Readjust dial to 225.000 MHz and depress PTT switch. Control line voltage should be 5.6 to 6.0 volts.
7) Couple dummy antenna/attenuator to deviation meter.
8) Attach audio generator to microphone jack along with a means to activate PTT switch.
9) Activate PTT switch and feed in a 30 mV, 1 kHz signal.
10) Adjust deviation pot on VCO board for 5 kHz deviation.
11) Microphone gain is adjusted in section 11-2.

11-6. 220 MHz RF Amplifier/Mixer Alignment.

1) Remove microphone from microphone jack and connect antenna jack to signal generator.
2) Set dial to 223.500 MHz, simplex.
3) Adjust SQUELCH maximum CCW and advance VOLUME control until noise is at a comfortable level.
4) Set signal generator to 223.500 MHz and adjust output level for half-scale reading on "S" meter.
5) Pretune RF amp input coils (L1011, L1012), band-pass filter coils (L1013, L1014, L1015, L1016), 10.7 MHz IF coil (T1001), X2 multiplier (L1009) and receive buffer amp coil (L1010) for maximum meter reading. Readjust output of signal generator to keep meter reading near half-scale.
6) To tune band-pass filter (L1013, L1014, L1015, L1016), detune end coils by running slugs all the way in. Tune center coils by loading coil not being tuned. Tune end coils by loading coil adjacent to coil being tuned. Readjust signal generator for half-scale meter reading as coils are tuned.
7) Recheck tuning of receiver buffer amp coil and X2 multiplier coil. These coils should be fine tuned for best SINAD at 223.500 MHz. Generator output should be reduced to a level which will produce 12 dB SINAD. Sensitivity for a 12 dB SINAD should be less than 0.5 microvolts nominal for 220 to 222 MHz and less than 0.35 microvolt nominal for 222 to 225 MHz.

11-7. 220 MHz Power Amplifier.

1) Reconnect antenna to dummy load and wattmeter.
2) Set POWER switch to "Hi" and dial to 223.000 MHz simplex.
3) Depress microphone button and alternately adjust all three trimmers on P.A. (C1127, C1129, C1120) for maximum power output. Verify with counter that output is 223.000 MHz.
4) Solder a short piece of wire across P.A. board RF input.
5) Depress microphone button and adjust slug tuned coil on P.A. board (L1107) and P.A. buffer coil on VCO (L1006) board for maximum power output. REMOVE JUMPER WIRE after adjustment is performed.
6) Power output should be 10 watts minimum between 220 and 225 MHz with a 13.8 volt supply.
7) Reinstall VCO/P.A. assembly and rear cover onto main chassis.

11-8. 440 MHz VCO Alignment/Deviation Adjustment.

1) Disconnect wires going to +13R, control line, PA output and divider board terminals of 440 VCO board.
2) Temporarily connect a stable external +5V source to control line terminal. (A jumper may be run from control line terminal to regulator end of R1218.)
3) Connect an R.F. voltmeter to divider board terminals of VCO board. Connect counter to VCO output of PA terminal. (50Ω impedance.)
4) Preset divider buffer pot to minimum resistance.
5) Position band switch on 440 band and turn unit on.
6) Tune L1204 (VCO coil) for 440 MHz output frequency. (±200 kHz is close enough.)

7) Tune L1212 and L1217 (tripler coils) for maximum output. Alternately load one coil by applying 3.3 k Ω resistor to ground at 1.5 pf coupling capacitor (C1288) while tuning the other coil. (The end of C1228 nearest edge of board is on L1212 side.)
8) Tune L1205 (doubler coil) for maximum by spreading or squeezing coil.
9) Tune L1209 (buffer coil) for maximum output by pushing loop away from or toward P.C. board.
10) Readjust slug in VCO coil L1204 for 445 MHz ±100 kHz. (This is the final setting of this coil.)
11) Move R.F. voltmeter to output to P.A. terminals of VCO board. Tune L1208 for maximum output by spreading or squeezing coil.
12) Turn off unit and reconnect wire going to ±13R terminal. Turn back on and adjust C1201 for output frequency of 443.3 MHz ±100 kHz.
13) Note that coils L1215 and L1216 do not require alignment but should be squeezed for maximum inductance. L1223 is not tuned.
14) Turn off unit and remove temporary connection to control line. Reconnect all lines disconnected in step 1, and disconnect control line from 5 volt source.
15) Couple dummy load to antenna terminal and connect deviation meter to dummy load.
16) Attach audio generator to microphone jack along with a means to activate the PTT switch.
17) Activate PTT switch and feed in a 30 millivolt, 1 kHz signal.
18) Adjust deviation pot (R1222) on VCO board for a 5 kHz deviation.
19) Reduce audio level to 3 mV and adjust microphone gain (R207) on phase detector board for ±3 kHz deviation.

11-9. 440 MHz RF Amplifier/Mixer Alignment.

1) Remove PTT switch.
2) Attach signal generator to 440 MHz antenna terminal and adjust it and UV-3 frequency to 445 MHz.
3) Adjust both R.F. amp drain coils on P.A. board and L1224, L1225, and T1200 on VCO board for maximum S-meter reading. Keep reducing generator level as coils are tuned so that meter reading does not exceed ½ scale reading.

11-10. Helical Resonator Alignment.

1) Disconnect helical resonator from circuit at both input and output ends and connect one end to 50 Ω signal generator and the other on R.F. voltmeter with 50 Ω input impedance. (Generator should be set for about 1 volt output.) Do not overheat leads or they may unsolder inside resonator.
2) Set signal generator to 445 MHz.
3) Rough peak C1247 through C1250 for maximum output.
4) Detune C1247 and C1250 each 20 dB by tuning capacitors toward maximum capacity.
5) Load C1248 through alignment hole, and peak C1249 for maximum.
6) Load C1249 through alignment hole and peak C1248 for maximum.
7) Keeping load on C1249, peak C1250 for maximum. Remove load from C1249.
8) Load C1248 through alignment hole and peak C1247 for maximum. Remove load.
9) Check response by sweeping generator from 440 to 450 MHz. Maximum insertion loss from 440 to 450 is 9 dB. Maximum ripple across 440 to 450 MHz should be 4 dB.
10) Disconnect voltmeter and generator and reconnect resonator to circuit. (Note that resonator cannot be tuned until it is installed on board because it must be taken apart for installation.)

11-11. Divider Input Level Adjustment.

1) Attach dummy load to 440 antenna terminal and adjust frequency knobs to 449 MHz.
2) Install PTT switch in mic jack and place in transmit mode. (Zero offset, scan off, and channel switch on normal.)
3) Turn power supply down to 11 volts.
4) Increase resistance in divider lead pot (R1241) until unit goes out of lock as evidenced by sounding of out of lock alarm.
5) Then decrease resistance until unit just goes into a locked condition. (Out of lock tone will stop.) It will be necessary to alternately release and depress PTT as adjustment is made.
6) Return to receive condition and change frequency to 440 MHz. If unit goes out of lock, reduce resistance a little more until it just comes back on.
7) Return power supply voltage to 13.8 VDC.

11-12. 440 MHz Power Amplifier.

There are no adjustments for the 440 MHz PA.

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PARENT BOARD

DES	DESCRIPTION	PART #
C1400	Capacitor, Ceramic Disc, 15 pF ± 5%, NPO	3160510
C1401	Capacitor, Tantalum, 1 μF ± 20%, 35 V	3183010
C1402	Capacitor, Ceramic Disc, 330 pF ± 20% Z5U	3161300
C1403	Capacitor, Tantalum, .22 μF ± 10%, 35 V	3183100
C1405	Capacitor, Ceramic Disc, 470 pF ± 20%, Z5U	3161350
C1406	Capacitor, Ceramic Disc, 470 pF ± 20%, Z5U	3161350
C1407	Capacitor, Ceramic Disc, 150 pF ± 20%, Z5U	3161170
CR1400	Diode, 1N4148	3020090
CR1401	Diode, 1N4148	3020090
CR1402	Diode, 1N4148	3020090
CR1403	Diode, 1N4005, B5G5	3020220
CR1404	Capacitor, Tantalum, 10 μF ± 20%, 25 V	3183030
R1400	Resistor, Carbon Comp., 1 kΩ ± 10%, ¼ W	3220160
R1401	Resistor, Carbon Comp., 1 kΩ ± 10%, ¼ W	3220160
R1402	Resistor, Carbon Comp., 39 Ω ± 10%, ¼ W	3220030
R1403	Resistor, Carbon Comp., 4.7 Ω ± 10%, 1 W	3240003

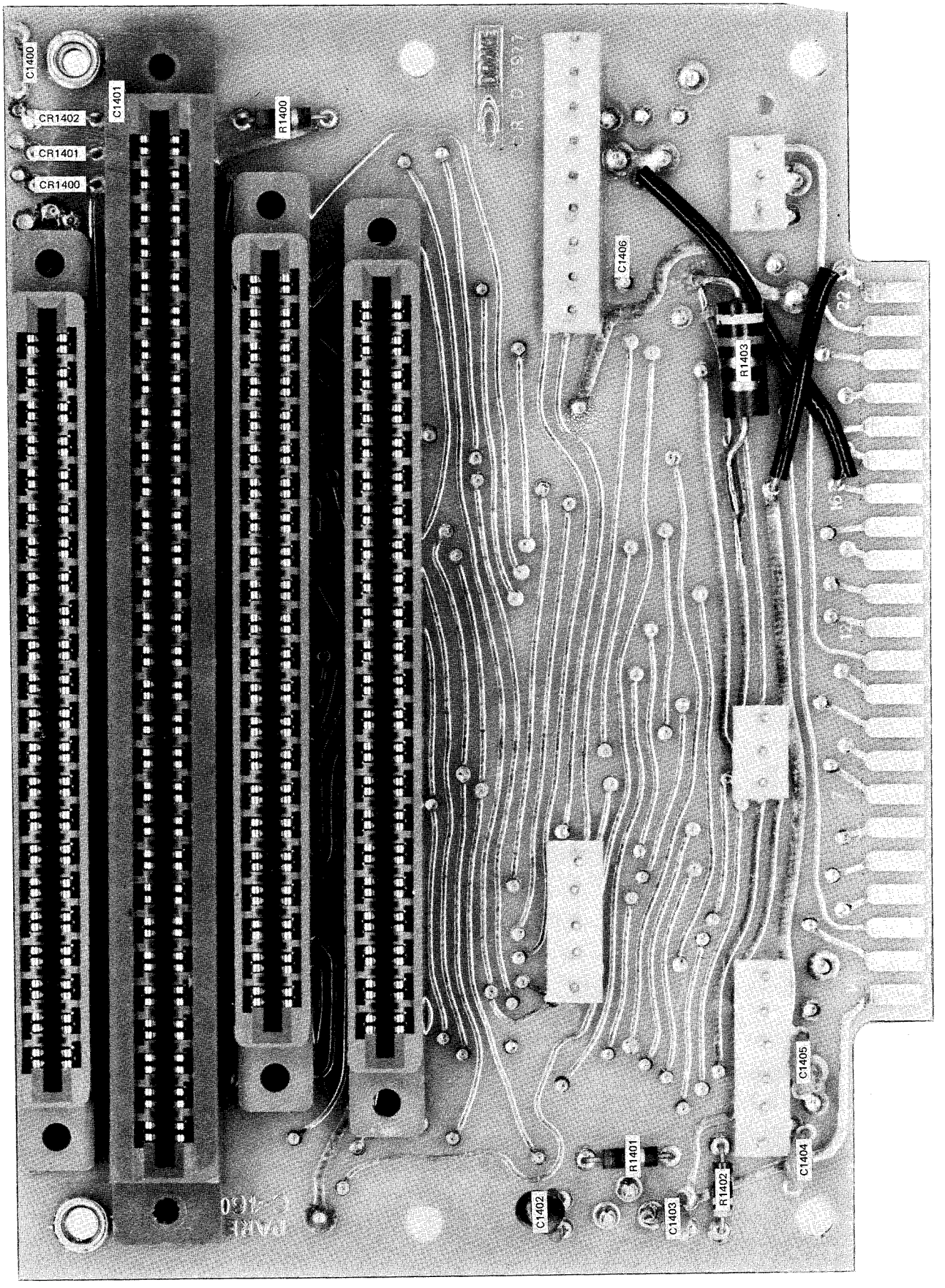
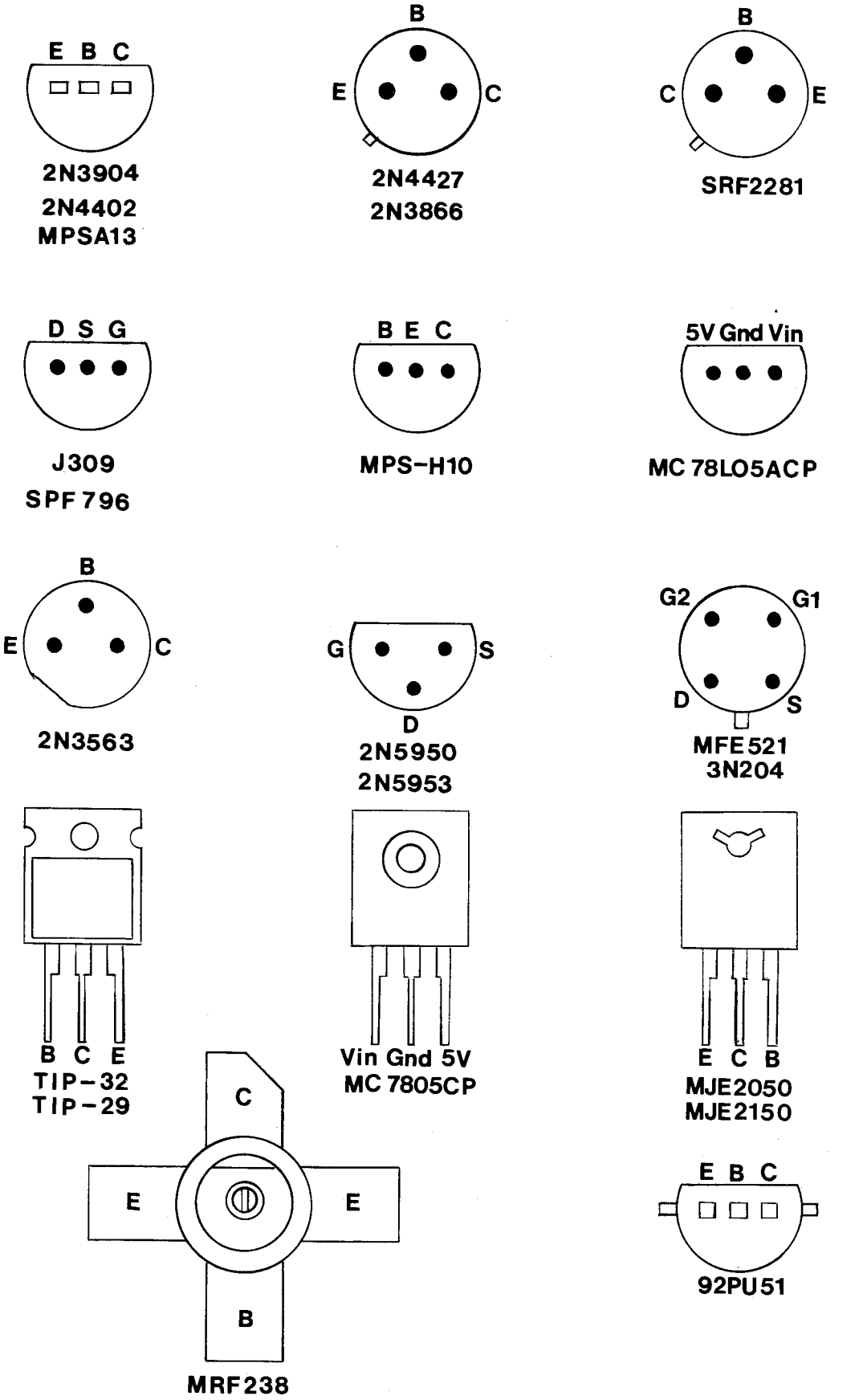


FIGURE 11-1. PARENT BOARD



SEMICONDUCTOR LEAD CONFIGURATION (BOTTOM VIEWS)

FIGURE 12-1. SEMICONDUCTOR PINOUTS