Section III. CP-2003 CIRCUIT ANALYSIS

2-17. Antenna Coupler RF Section, Modules RF1, RF2 and RF3 (fig. 2-56 thru 2-68)

The RF section of the antenna coupler comprises three modules, designated RF1, RF2 and RF3. Figure 2-56 shows the block diagram of the RF section, and the main control lines between the MNC module (para. 2-18) and the RF section.

a. <u>Block Diagram Analysis (fig. 2-56).</u>

(1) RF3 module. The RF3 module contains the sensors used to monitor antenna matching. The module also contains auxiliary circuits, which control the operation of the electronic switches used to route the RF signal according to the operating mode.

(a) Signal path.

1. During antenna matching, the TUNE/NORM switch is open, and the RF IN signal, arriving from the AM module, is connected by the input TUNE switch to the 3dB attenuator. The attenuator ensures that the power reflected towards the RF power amplifier during matching does not exceed the allowable limits.
The attenuated RF signal is applied to the sensor assembly. The sensor assembly provides information on load phase, load resistive component (R), load conductive component (G) and load VSWR. The sensor assembly also checks that enough RF power is available for proper antenna matching. The sensor information is sent to the microprocessor on the MNC module, where it is processed by the matching algorithm.
From the sensor assembly, the RF signal passes through another TUNE switch to the first bypass switch, BP1. This switch is used to select between direct connection to the DIPOLE connector on module RF3, or connection

through the matching network, located in the RF1 and RF2 modules.

2. During normal operation, after antenna matching is completed, the two TUNE switches are opened, and the RF signal is connected to the BP1 switch, by means of the TUNE/NORM switch.

(b) Switch test circuit. The switch test circuit is used to test the operation of the various electronic switches. The test is done by first turning off all the switches, then turning on each individual switch, one at a time, driving current via the V1 line and checking that the resulting DC current is within the allowable limits. Test results are indicated by two lines, BIT L and BIT H, because there are two types of electronic switches.
The switch test circuit is enabled during self-test, by means of the BIT line, received from the microprocessor in the MNC module.

(2) RF2 module. The RF2 module comprises the main part of the matching network. The topology of the matching network is shown in figure 2-56. The RF2 module also comprises matching components used only for dipole antenna matching. The values of the matching network components are changed by means of diode switches, controlled by the microprocessor in the MNC module, via its I/O interface.

(3) RF1 module. The RF1 module contains matching components specific to whip antennas, and the WHIP/DIP selector which selects between the whip and dipole paths.

b. <u>Module RF3, Circuit Analysis (fig. 2-57 thru 2-66).</u>
(1) Diode switches, general (fig. 2-58). The routing of the RF signal in the RF3 module is controlled by means of seven identical diode switches. Only the circuit of the TUNE/NORM switch will be analyzed in detail. The other diode switches operate in a similar way.

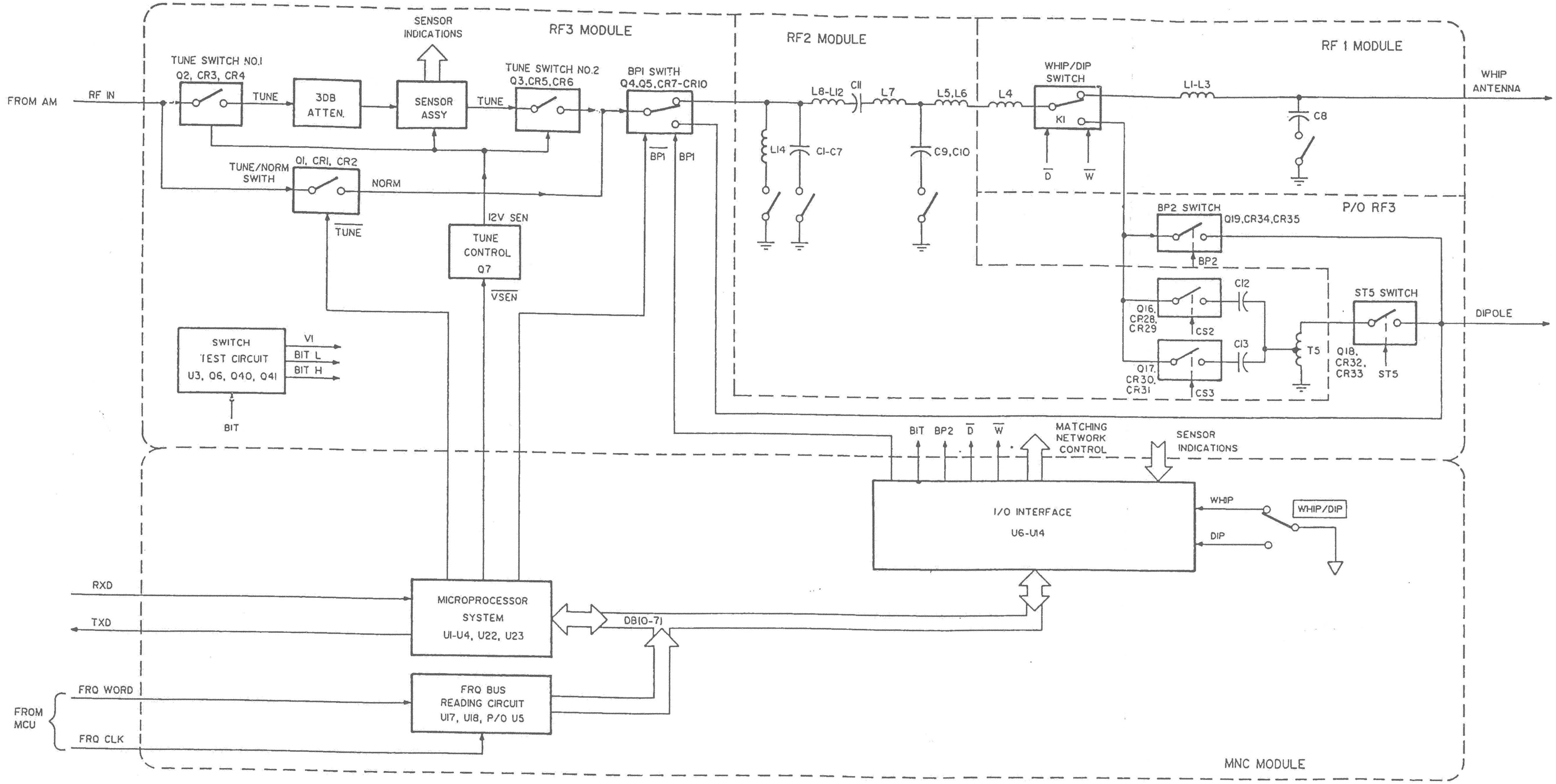
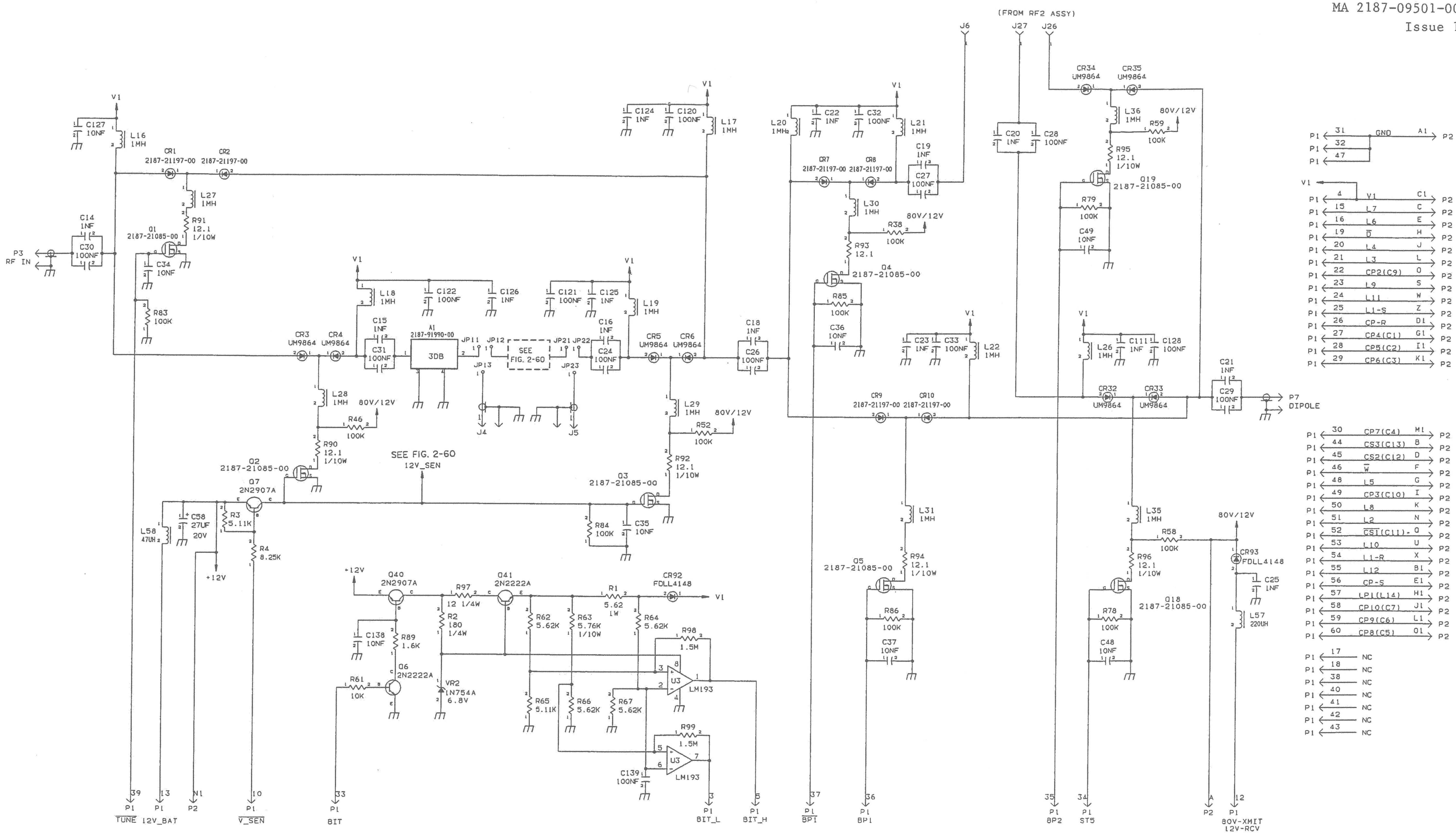


Figure 2-56. Antenna Coupler RF Section, Block Diagram



NOTES
1. UNLESS OTHERWISE SPECIFIED ALL RESISTORS ARE IN OHMS, 1/8W,1%.
2. CR36-CR41 ARE MATCHED PAIR DIODES. P/N 2187-21192-00.

Figure 2-57. Module RF3, Schematic Diagram

The circuit is built around FET Q1, and diodes CR1 and CR2. Figure 2-58 shows the simplified diagram of the TUNE/NORM switch.

The operation of this switch is controlled by the TUNE* line, arriving from the MNC module.

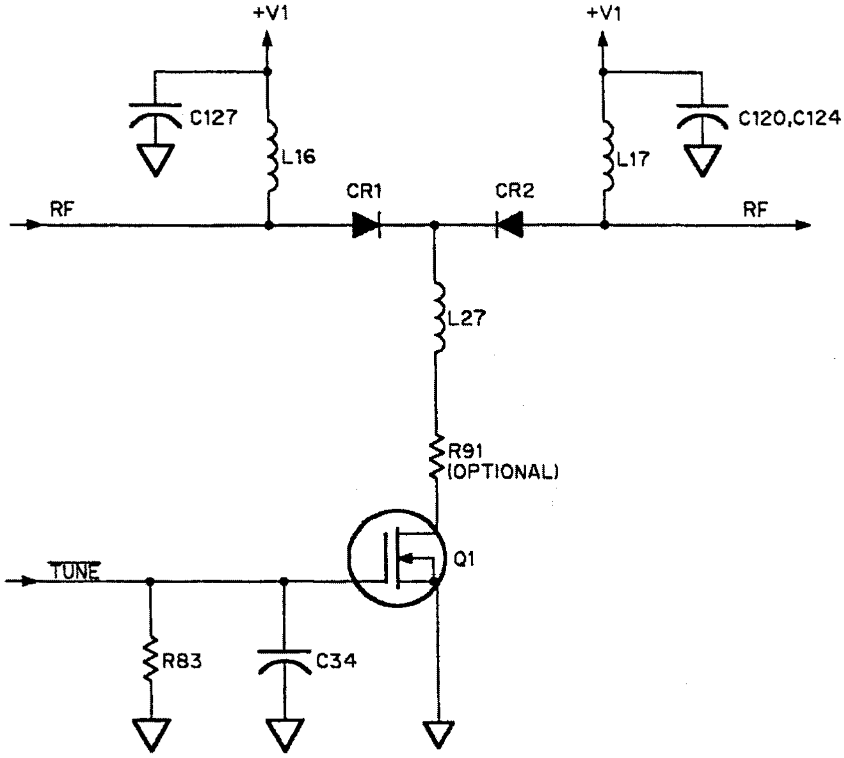


Figure 2-58. TUNE/NORM Switch, Simplified Diagram

(a) When the TUNE* control line is at a high level, Q1 conducts. As a result, the diodes CR1 and CR2 conduct, because of the DC current flowing through them from the +V1 supply line, via L16, L17, L27, R91 and Q1. The +V1 supply line provides +5V in the transmit mode, and +2V in the receive mode.

Thus, the RF signal passes through the diodes CR1 and CR2, and is connected to the BP1 switch.

(b) When the TUNE* control line is at a low level, Q1 is cut-off.

(c) Some switches are connected via a serial resistor to the 80V/12V supply line. The 80V/12V supply line provides +80V in the transmit mode, and +12V in the receive mode. As a result, the diodes are reverse-biased, and provides a more effective blocking to the RF signal path.

(2) RF signal path (fig. 2-57).

(a) Tune mode. During antenna matching process, the V-SEN* control line is at a low level. Transistor Q7 conducts and +12V connects to the gates of Q2 and Q3. Consequently, the two TUNE switches (Q2, CR3, CR4 and Q3, CR5, CR6) close. During matching, the TUNE* control line is at a low level, and the TUNE/NORM switch (Q1, CR1, CR2) is opened.

Thus, the RF signal passes via diodes CR3, CR4 and capacitors C15, C31 to the attenuator. The attenuator attenuates the RF signal by 3dB. The attenuated RF signal is applied to the sensor assembly, which provides the information necessary for performing the antenna matching algorithm (para. (5) below).

From the sensor assembly, the RF signal passes via C16, C24, CR5, CR6, C18, C26, and is applied to the BP1 switch. The BP1 switch comprises two diode switch circuits, built around Q5, CR9, CR10 and Q4, CR7, CR8. These diode switches are controlled by the BP1 and BP1* lines, respectively. The control signals on these lines are always complementary.

1. When direct connection to the dipole antenna is required, the BP1 line is at a high level. Diodes CR9 and CR10 conduct and connect the RF signal to the dipole antenna, via connector P7 (see fig. 2-56). In this case, the BP1* line is at a low level, and the diodes CR7 and CR8 are cut-off.

2. When connection to the matching network is required, the BP1 line is at a low level, and BP1* line at a high level. Therefore, the RF signal is connected to the matching network located in the RF2 module, via the diodes CR7, CR8, capacitors C19, C27 and connector J6.

(b) Normal operation. During normal operation (receive or transmit mode), the V-SEN* line is at a high level. Transistor Q7 is cut-off, and the gates of Q2 and Q3 are pulled to a low level by the resistor R84. Therefore, the two TUNE switches are opened (diodes CR3 thru CR6 are reverse-biased), and the attenuator and the sensor assembly are disconnected.

At the same time, the TUNE* line is at a high level, and the TUNE/NORM switch is closed (diodes CR1 and CR2 conduct). As a result, the receive and transmit signals pass directly between the RF IN connector (P3) and the BP1 switch, thereby bypassing the sensor assembly.

(3) ST5 and BP2 switches. The ST5 switch is built around Q18, CR32 and CR33. The BP2 switch is built around Q19, CR34 and CR35. These switches are used to select between direct connection of the dipole antenna to the WHIP/DIP switch, located in module RF1, or connection through a matching components specific to the dipole antenna (C12, C13 and T5), located in module RF2 (see fig. 2-56).

(a) When the dipole antenna is in use, the ST5 control line from MNC module is at a high level. Consequently, the diodes CR32 and CR33 conduct, and connect the dipole antenna (connected at connector P7) to transformer T5 in module RF2, via connector J27. At the same time, the BP2 line is at a low level, and the BP2 switch is opened (diodes CR34 and CR35 are cut-off).

(b) When the dipole antenna is in use, but the matching components C12, C13 and T5 in module RF2 are not required for tuning, the BP2 control line is at a high level. As a result, the diodes CR34 and CR35 conduct, and connect the dipole antenna directly to the WHIP/DIP switch, located in module RF1, via connector J26. At the same time, the ST5 line is at a low level, and the ST5 switch is opened.

(c) When the whip antenna is in use, or when the matching network is bypassed (see para. (2) above), the BP2 and ST5 control lines are both at a low level. Consequently, the BP2 and ST5 switches are both opened.

(4) Switch test circuit. The switch test circuit is built around comparators U3-1, U3-7 and transistors Q6, Q40, Q41. During self-test, the switch test circuit connects +5V to the +V1 supply line, and checks the current flowing through each of the switches, by monitoring the voltage across the current sense resistor R1. The test principle is explained in para. a.(1)(b) above.

(a) The switch test circuit is controlled by the BIT control line, arriving from the MNC module. During self-test, the BIT line is at a high level and the transistor Q6 is saturated. +12V voltage is applied to the voltage regulator, composed of R2 and VR2, and thereby the operation of the switch test circuit is enabled. The voltage drop across VR2 passes through the emitter-follower Q41, and is applied via the current sense resistor R1 and diode CR92 to the +V1 supply line.

(b) The comparators U3-1 and U3-7 monitor the current consumption via the +V1 supply line. The comparator U3-1 drives the BIT H line, and comparator U3-7 drives the BIT L line.
Only the operation of comparator U3-7 will be analyzed. The comparator U3-1 operates in a similar way, except that its output rises to a high level when the current exceeds 75mA.

The voltage drop across current sense resistor R1 is sampled by the voltage dividers R63, R66 and R64, R67 and is applied to comparator U3-7 inputs (pins 5 and 6, respectively). R99 provides a small amount of hysteresis. When the current flowing through R1 is below 22mA, the voltage at the inverting input of U3-7 (pin 6) is higher than the voltage at the non-inverting input (pin 5). As a result, the output of U3-7 is at a low level.

When the output current exceeds 22mA, the voltage drop across R1 increases, causing the voltage at the inverting input of U3-7 to decrease. In this case, U3-7 output rises to a high level.

(5) Sensor assembly (fig. 2-59 thru 2-67). Figure 2-59 shows the block diagram of the sensor assembly, and figure 2-60 shows the schematic diagram.

(a) Block diagram analysis (fig. 2-59). The sensor assembly receives the RF IN signal from the 3dB attenuator. The RF signal passes through the current transformers T1 thru T4, and is applied to the second TUNE switch (see para. (1) (a) above). The RF voltage is sampled by capacitive voltage dividers.

The supply voltage for the sensor assembly arrives via the 12V SEN line from the tune control circuit (transistor Q7). The tune control circuit connects +12V to the 12V SEN supply line only during antenna matching, therefore the sensor assembly circuits operate only in the tune mode.

The sensor assembly provides the following digital indications:

1. PH-H - indicates load phase angle: a high level on this line indicates an inductive load, and a low level

indicates a capacitive load. This indication is used when operating in the frequency range of 6.75-30MHz.

2. PH-L - same as PH-H, except that this indication is used in the frequency range of 1.5-6.75MHz.

3. VF - high level on this line indicates that the RF power at the sensor assembly input exceeds 5W.

4. G - high level on this line indicates that the load conductance exceeds 0.02mho.

5. R - high level on this line indicates load resistance above 50ohm.

6. L.T - high level on this line indicates that the VSWR exceeds 1.5:1.

7. H.T - high level on this line indicates that the VSWR exceeds 3:1.

NOTE

In the equations appearing in this paragraph, vectors are designated by bold capital letters.

(b) PH-H phase sensor (fig. 2-60, 2-61). The PH-H phase sensor is built around CR37, CR36 and U1A. Figure 2-61 shows the simplified diagram of the circuit. The RF section of this circuit measures the phase between the load current and the load voltage. Referring to fig. 2-58.A, the RF current is sampled by transformer T1. The voltage induced in the transformer secondary is proportional to the load current, and is 90° out of phase with it. This voltage is applied to the anodes of diodes CR36 and CR37.

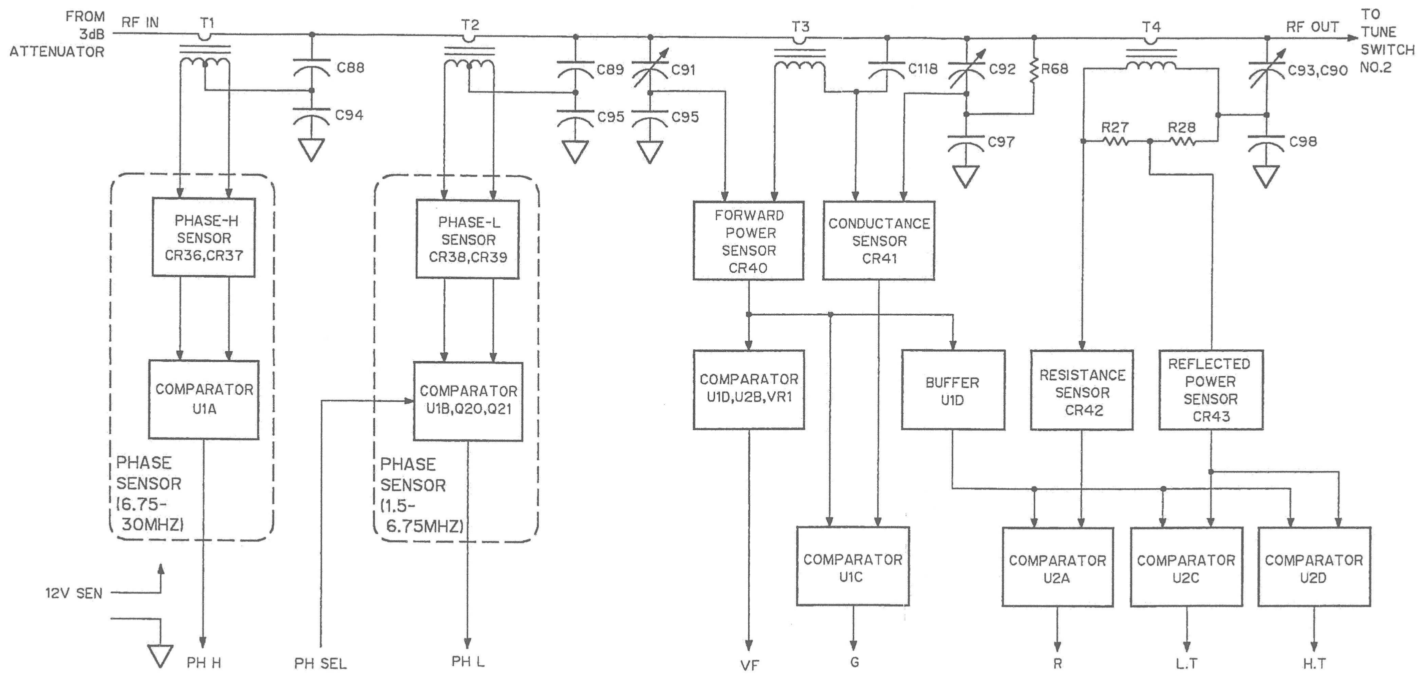
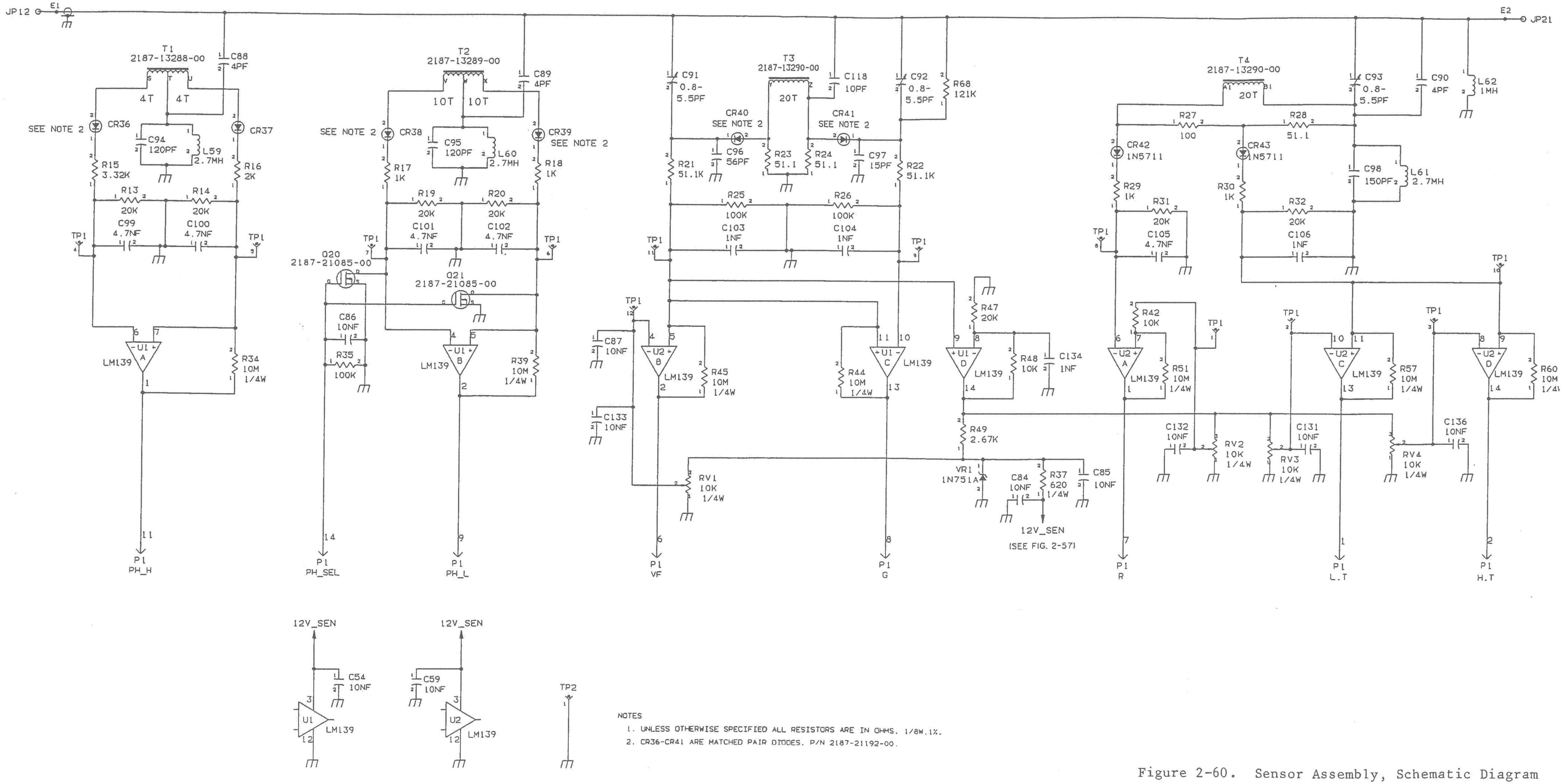


Figure 2-59. Sensor Assembly, Block Diagram



NOTES

1. UNLESS OTHERWISE SPECIFIED ALL RESISTORS ARE IN OHMS. 1/8W.1%.
2. CR36-CR41 ARE MATCHED PAIR DIODES. P/N 2187-21192-00.

Figure 2-60. Sensor Assembly, Schematic Diagram

The RF voltage is sampled by a voltage divider composed of capacitors C88 and C94. Inductor L59 is an RF choke, and its purpose is to close the DC path to ground for the rectifier diodes CR36 and CR37. The voltage sample is applied to the center tap of the transformer T1 secondary.

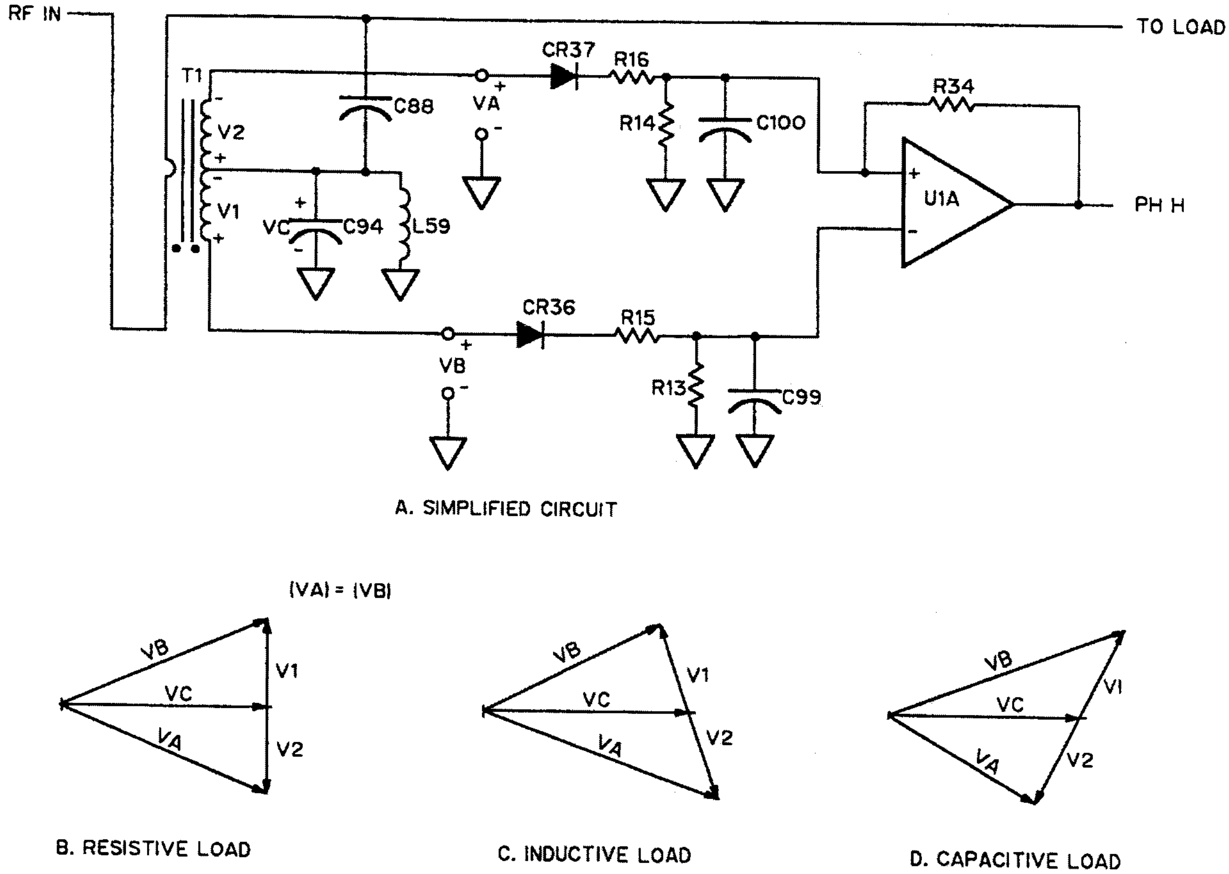


Figure 2-61. PH-H Phase Sensor, Simplified Diagram and Typical Phasor Diagram

The phase angle between the voltage across capacitor C94 and the voltage across the secondary of transformer T1, depends on the load impedance. The detector built around CR37 receives the vectorial sum (VA) of the voltages across C94 (VC) and across the secondary upper half (V2).

$$VA = VC + V2$$

The detector built around CR36 receives the vectorial sum (VB) of the voltages across C94 (VC) and across the secondary lower half (V1).

VB = VC + V1

These voltages are rectified by CR37 and CR36 and filtered by R16, R14, C100 and R15, R13, C99, respectively. The resulted DC voltages are proportional to the magnitudes of VA and VB.

The effect of load phase variation on the rectified voltages is illustrated in fig. 2-61.B, C and D

1. Resistive load (fig. 2-61.B). The VC voltage is in-phase with the load current. Therefore, a phase difference of 90° exists between V1, V2 and VC. As a result, VA and VB have equal magnitudes.

2. Inductive load (fig. 2-61.C). The VC voltage leads the load current. As a result, the VA voltage is larger than the VB voltage.

3. Capacitive load (fig. 2-61.D). The VC voltage lags the load current. As a result, the VA voltage is smaller than the VB voltage.

The comparator U1A compares the VA and VB magnitudes. R34 provides a small amount of hysteresis. When the VA voltage is larger than the VB voltage (inductive load), the output of U1A rises to a high level. When the VA voltage is smaller than the VB voltage (capacitive load), U1A output falls to a low level.

(c) PH-L phase sensor (fig. 2-60). The PH-L phase sensor is built around CR38, CR39, U1B, Q20 and Q21. The operation of this circuit is similar to the operation of the PH-H phase sensor, except that this circuit is used when operating in the frequency range of 1.5-6.75MHz.

When the operating frequency is higher, the PH SEL control line is at a high level. Q20 and Q21 are saturated, and pull the inputs of U1B to ground. This action protects the comparator U1B, that can be damaged as a result of large RF voltages that could be induced in the transformer secondary when the operating frequency is above 6.75MHz.

(d) Forward power sensor (fig. 2-60, 2-62). The forward power sensor comprises the detector built around CR40, comparator U2B, and amplifier U1D. The simplified diagram of the forward power detector is shown in fig. 2-62.A.

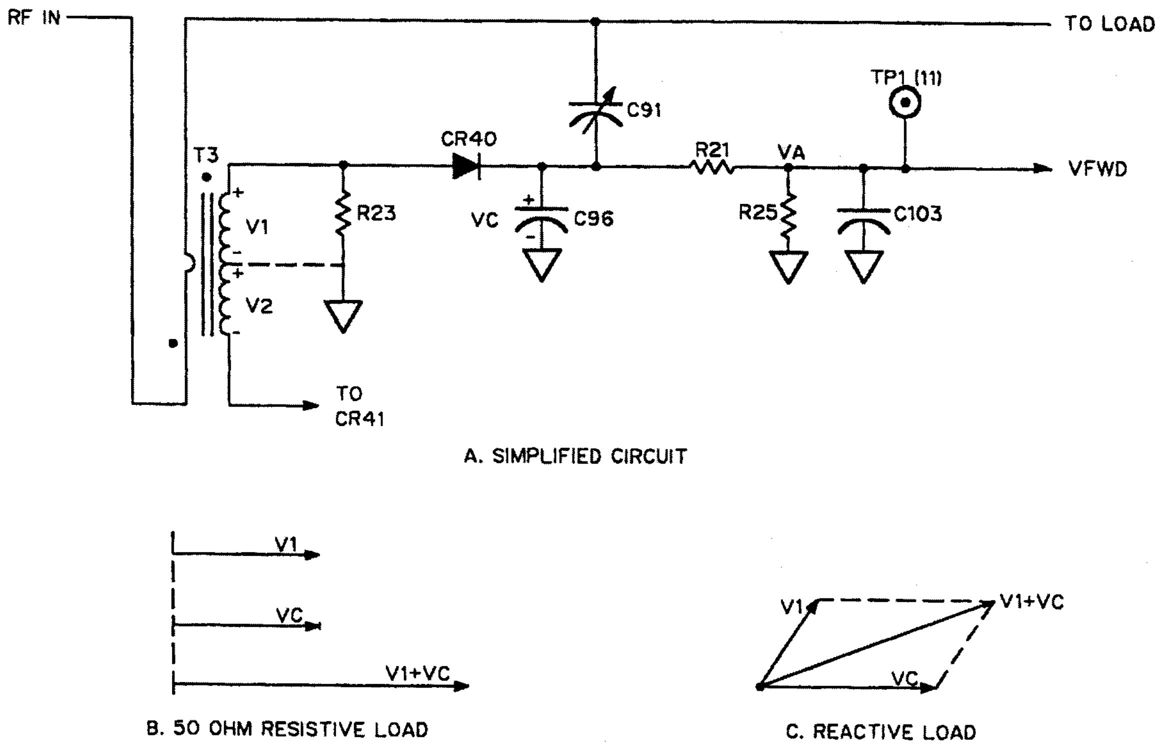


Figure 2-62. Forward Power Detector Operation

The detector built around CR40 provides a DC voltage proportional to the forward power (refer to fig. 2-62.A). The RF load voltage is sampled by a capacitive voltage divider, consisting of the trimmer capacitor C91 and the fixed capacitor C96. The voltage across C96, designated VC, comprises components of the forward and the reflected RF load voltages:

$$VC = VF + VR$$

The RF current induces a voltage across the secondary of T3. Since the input impedances of the two detectors (CR40 and CR41) connected to the transformer secondary are equal, half of the T3 secondary voltage develops across R23. This voltage is designated V1. V1 magnitude is proportional to that of the load current:

$$V1 = K\ (IF - IR)$$

The vectorial sum of V1 and VC is rectified by diode CR40 and filtered by R21, R25 and C103. Thus, the voltage at TP1(11), designated VA, is proportional to the magnitude of the vectorial sum of V1 and VC.

$$VA = |VC + V1| = |VF + VR + K(IF - IR)|$$

Trimmer C91 is adjusted so that when the RF power source is connected to the load and the RF IN is loaded with a 50-ohm load, that means the RF current flows in the reverse direction, the VA voltage will be near zero. For this condition, V1 (reflected) will be of the same magnitude as the VC (reflected), so the following formulae will be valid for normal working conditions.

$$VA = |VF + VR + VF - VR| = |2VF|$$

The effect of the load variation on the rectified voltage is illustrated in fig. 2-62.B,C.

1. Resistive 50ohm load (fig. 2-62.B). VC is in-phase with the RF current, and its magnitude equals that of V1, therefore maximum forward power indication is provided.

2. Inductive or capacitive load (fig. 2-62.C). In this case, the non-zero phase angle of the load causes a phase difference between VC and V1. As a result, the magnitude of the vectorial sum of voltages V1 and V2 decreases, as illustrated in fig. 2-62.C.

3. Effect of load resistance variation. When load resistance decreases below 50ohms, the current phasor V1 increases, but the voltage phasor VC decreases. The end result is that their sum decreases.
Similarly, when load resistance increases above 50ohms, the current phasor decreases and the voltage phasor increases, therefore their sum decreases. In either case, the VFWD voltage decreases, in proportion to the forward power.

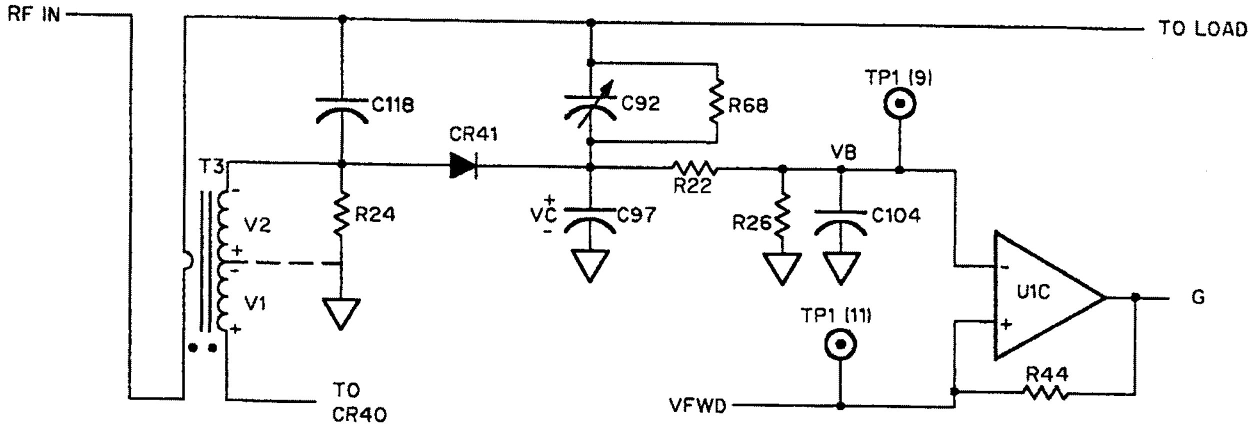
The VF comparator U2B receives the VFWD voltage from the detector and compares it with a reference voltage. The reference voltage is provided by Zener diode VR1 and the potentiometer RV1. Resistor R45 provides a small amount of hysteresis.

When the input power of the sensor assembly exceeds approx. 5W, the VFWD voltage (at TP1(11) exceeds the reference voltage (at TP1(12), and U2B output rises to a high level. When the input power is too low. U2B output falls to a low level.

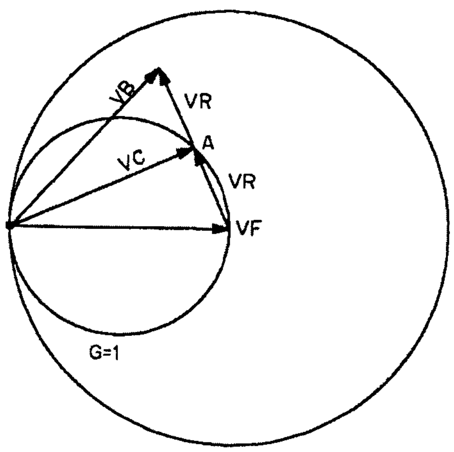
The VF indication is sent to module MNC.

The DC voltage provided by the forward power detector (CR40) is also applied to the amplifier U1D. The gain of U1D is determined by ratio of R48, R47. The amplified voltage is used as a reference voltage for the R, L.T and H.T comparators, thereby making their outputs independent of the absolute power level.

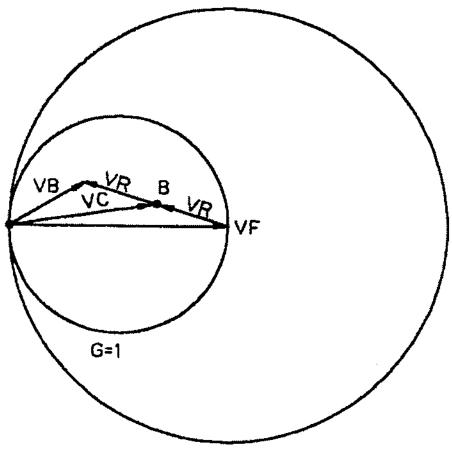
(e) G (conductance) sensor (fig. 2-60, 2-63). The G sensor is built around CR41 and U1C. Figure 2-63 shows the simplified diagram of this sensor.



A. SIMPLIFIED CIRCUIT



B. 0.02MHO CONDUCTANCE



C. CONDUCTANCE MORE THAN 0.02MHO

Figure 2-63. G Sensor Operation

1. Detector. The detector built around CR41 rectifies the vector sum of the voltage proportional to the load current (provided by current transformer T3, across R24), and the load voltage sample, provided by the capacitive voltage divider C92, C97. Capacitor C118 and resistor R68 are used for frequency compensation.

The voltage across R24, which is 180° out-of-phase with the RF current, is designated V2:

$$V2 = -K(IF - IR)$$

The voltage across C97, designated VC, is applied to the cathode of CR41. This voltage comprises components of the forward and reflected RF load voltages:

$$VC = A(VF + VR)$$

The voltage across CR41, which is the vectorial sum of VC and V2, is rectified and filtered by R22, R26 and C104. The resulting voltage is proportional to the difference between the load voltage and load current. This voltage, designated VB, is applied to the inverting input of the comparator U1C.

$$VB = |VC + V2| = |A\ (VF + VR) - K\ (IF - IR)|$$

The trimmer capacitor C92 is adjusted so that when a 50ohm load is connected, the voltages at the inputs of U1C are equal. The conductance of a 50ohm load is 0.02mho. When C92 is properly adjusted, VB is given by the following equation:

$$VB = |VF + 2VR| = |VC + VR|$$

2. Reactive load with 0.02mho conductance (fig. 2-63). Figure 2-63.B illustrates a typical load impedance having a conductive component of 0.02mbo, represented by point A on the G=1 circle of the Smith Chart. In this case, the magnitude of VB voltage (at TP1(9)) equals the VFWD voltage provided by the forward power sensor (at TP1(11).

3. Reactive load with conductance above 0.02mho (fig. 2-63.C). Point B within the G=1 circle of the Smith Chart shown in figure 2-63.C represents a typical reactive load with a conductance above 0.02mho. In this case, VB magnitude is less than the magnitude of VFWD voltage. As a result, U1C output rises to a high level.

4. Conductance smaller than 0.02mho. When the conductive component of the load impedance decreases below 0.02mho (outside the G=1 circle of the Smith Chart), VB magnitude exceeds the magnitude of the VFWD voltage. In this case, U1C output falls to a low level.

(f) R (resistance) sensor (fig. 2-60, 2-64, 2-65). The R sensor is built around CR42 and comparator U2A. The simplified diagram of the R sensor is shown in fig. 2-65.

1. Detector. The RF load voltage is sampled by a capacitive voltage divider, C90, C93, C98. Inductor L61 closes DC path to ground for the rectifier diodes CR43 and CR42. The voltage sample across C98, designated VC, is applied to the lower tap of the transformer T4. This voltage comprises components of the forward and reflected RF load voltages:

$$VC = A(VF + VR)$$

The RF current induces a voltage in the secondary of T4. This voltage, designated VT4, is in anti-phase with the current, and its magnitude is much larger than the magnitude of the voltage across C98.

$$VT4 = -(V1 + V2) = -K(IF - IR)$$

The detector built around CR42 receives the vectorial sum of the VC voltage and the voltage across the secondary of T4, and provides a DC voltage proportional to their vectorial sum (at TP1(8)). This voltage, designated VRES, is applied to the inverting input of the comparator U2A.

$$VRES = |VC + VT4| = |A(VF + VR) - K(IF - IR)|$$

When trimmer capacitor C93 is properly adjusted (as explained in para. g. below), VRES is given by:

$$VRES = |2VR - VF|$$

2. Comparator, U2A. The threshold voltage of U2A is adjusted by the potentiometer RV2. RV2 reduces the DC voltage provided by the VFWD amplifier, U1D (see para. (d) above). The potentiometer RV2 is adjusted so that when a 50ohm load is connected, the voltages at the inputs of U2A are equal.

3. 50-ohm load resistance (fig. 2-65.A). Figure 2-65.A illustrates the Smith Chart for a typical load impedance with a resistive component of 50ohm. This load impedance is represented by point A on the R=1 circle of the Smith Chart. In this case, VRES magnitude (at TP1(8)) equals the threshold voltage at the non-inverting input of U2A (see para. 2. above).

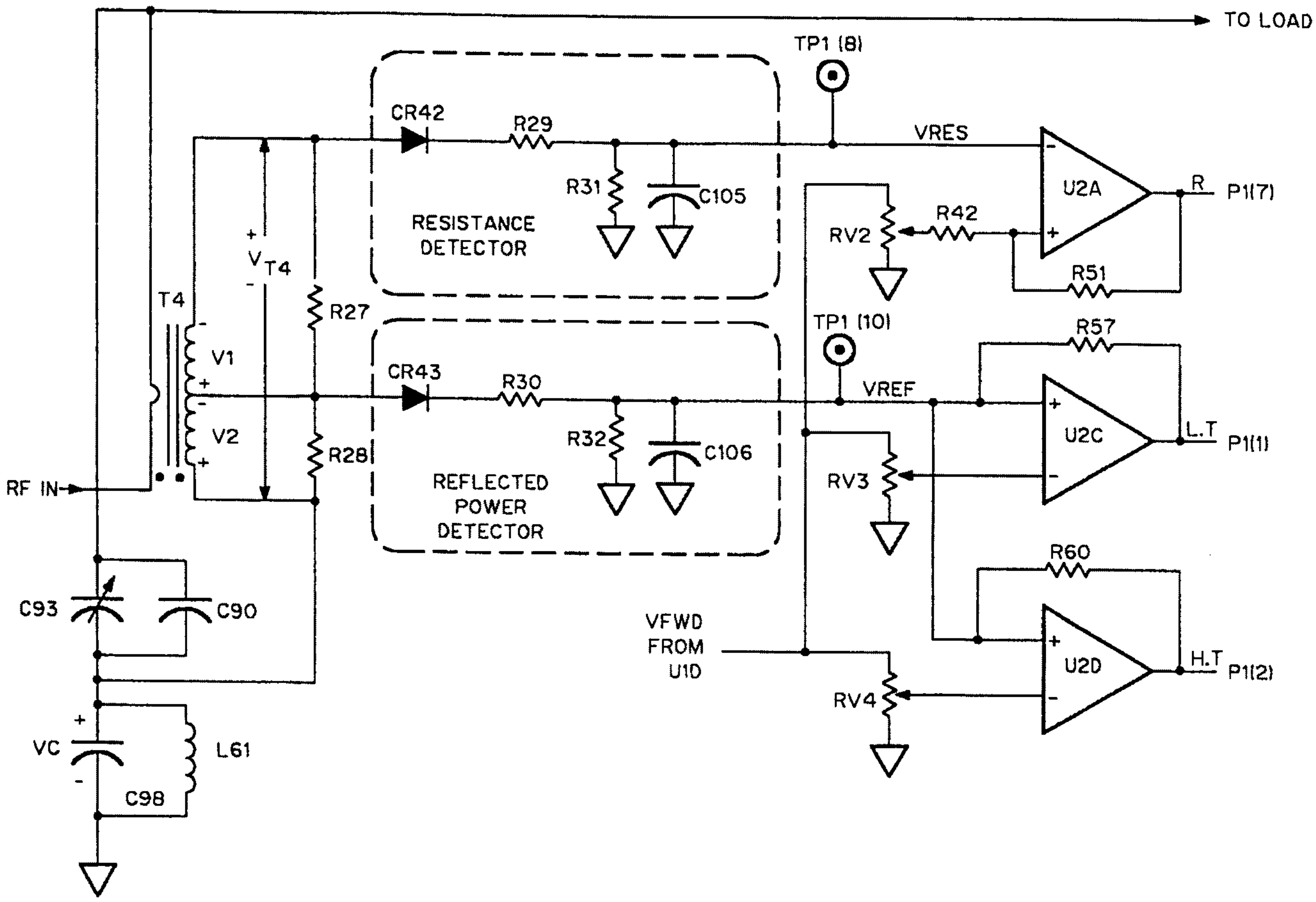
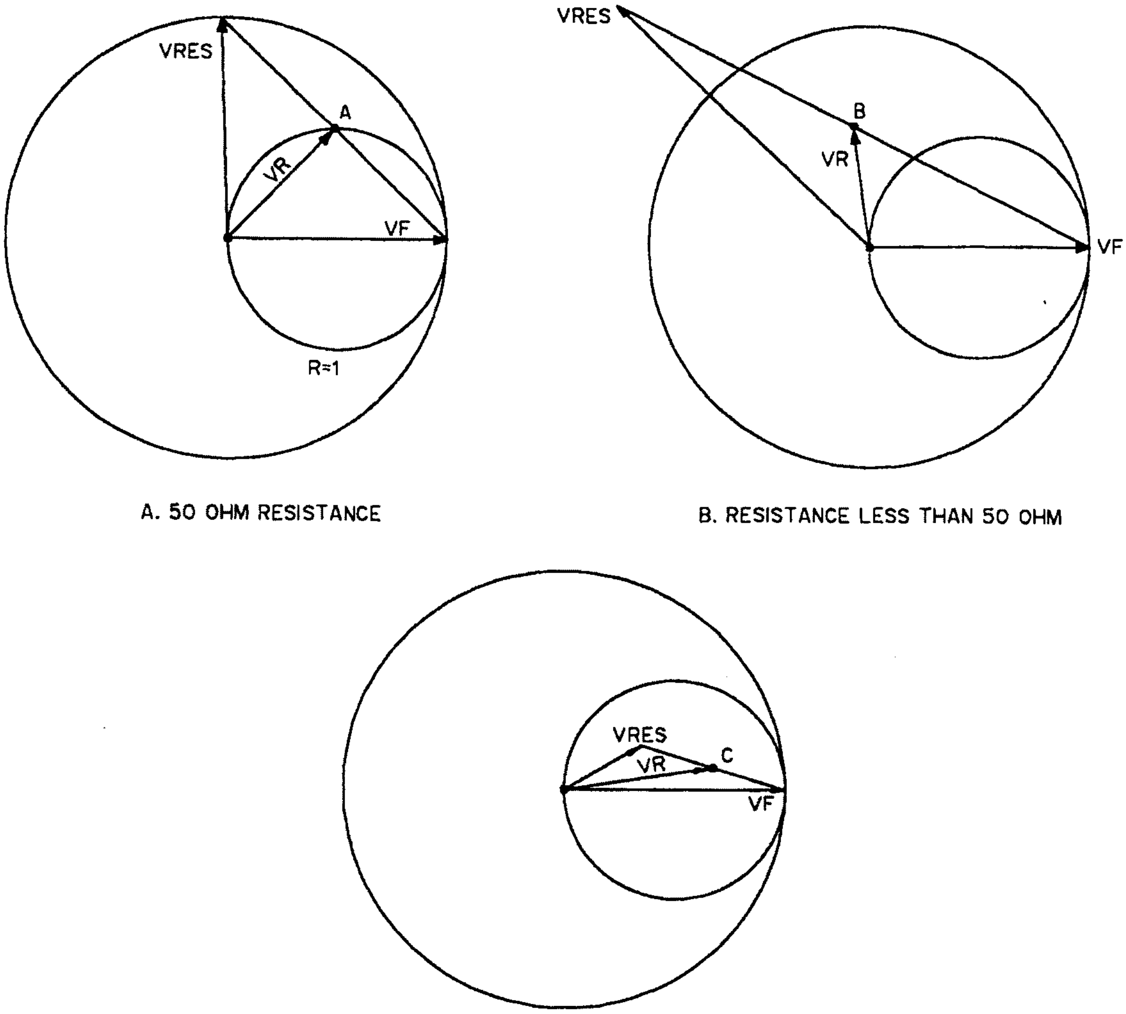


Figure 2-64. R and VSWR Sensors, Simplified Diagram

4. Load resistance smaller than 50ohm (fig. 2-65.B). A load impedance with a resistive component smaller than 50ohm is represented by point B on the Smith Chart. In this case, VRES magnitude increases. As a result, U2A output falls to a low level.

5. Load resistance higher than 50ohm (fig. 2-65.C). When the resistive component of the load impedance increases above 50ohm, designated by point C on the Smith Chart, the VRES voltage decreases. As a result, U2A output rises to a high level.



A. 50 OHM RESISTANCE

B. RESISTANCE LESS THAN 50 OHM

B. RESISTANCE MORE THAN 50 OHM

Figure 2-65. Resistance Sensor Operation

(g) VSWR sensor (fig. 2-60, 2-64). The VSWR sensor comprises a reflected power detector, built around CR43, and comparators U2C and U2D. The simplified diagram of this circuit is shown in figure 2-64.

The operation of the reflected power detector (CR43) is similar to the operation of the resistance detector (CR42), explained in para. (f) above, except that the detector receives the vectorial sum of the voltage across C98 (VC) and only a fraction of the voltage developing across the secondary of T4 (across R28), designated V2.

The resulting voltage at TP10 is designated VREF:

$$VREF = |VC + V2| = |A(VF + VR) - B(IF - IR)|$$

The trimmer C93 is adjusted so that the magnitude of VC and V2 are equal for a 50ohm resistive load (perfect matching). As a result, VREF is:

$$VREF = |2VR|$$

The effect of load variation on the rectified voltage is described below.
Fig. 2-66 shows typical phasor diagrams.

1. 50ohm resistive load (fig. 2-66.A). In this case, VC is equal in magnitude and 180° out-of phase with respect to voltage V2. The voltage at the anode of CR43 is then zero, and so is the output voltage of the rectifier, thus corresponding to zero reflected power.

2. Effect of inductive or capacitive load (fig. 2-66.B). In this case, the non-zero phase of the load causes a phase difference between the VC and V2 voltages. Consequently, a non-zero voltage is applied to the anode of CR43, indicating the existence of reflected power.

3. Effect of load resistance variation (fig. 2-66.C,D). In either case, a voltage develops at the anode of CR43, indicating the existence of reflected power.

The HT comparator, U2D, receives the DC voltage provided by the reflected power detector (CR43) at TP1(10), and compares it with a sample of a VFWD voltage. This sample is provided by the potentiometer RV4, which divides the voltage provided by the VFWD amplifier, U1D (see para. (d) above). When the reflected power exceeds the value corresponding to the upper threshold (VSWR approx. 3:1), the output of U2D rises to a high level. When the reflected power is smaller, U2D output falls to a low level.

The LT comparator circuit, built around U2C, is similar to the HT comparator circuit, except that its threshold is adjusted by RV3 for a VSWR of approximately 1.5:1.

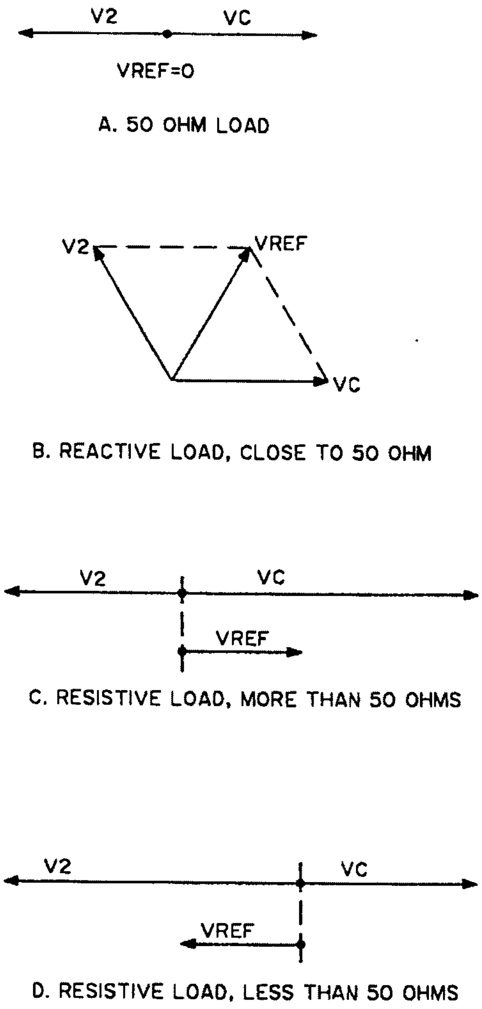


Figure 2-66. Reflected Power Detector, Typical Phasor Diagrams

c. Module RF2, Circuit Analysis (fig. 2-67).

(1) Inductor L14 and capacitors C1 thru C7. Inductor L14 and capacitors C1 thru C7 are connected through the diode switches,

controlled by Q8 thru Q15, between the input line of the matching network (connector J6) and the ground (see fig. 2-56). The capacitors C1 thru C7 are binary-related (ratio of approx. 2:1 between successive capacitor values).

These components are connected by means of eight identical diode switches, controlled by the control lines CP4 thru CP10, and LP1. A component is connected when its diode switch is closed, by applying a high level on the corresponding control line. Only the diode switch used to connect C1 will be analyzed in detail. The operation of the other diode switches is similar.

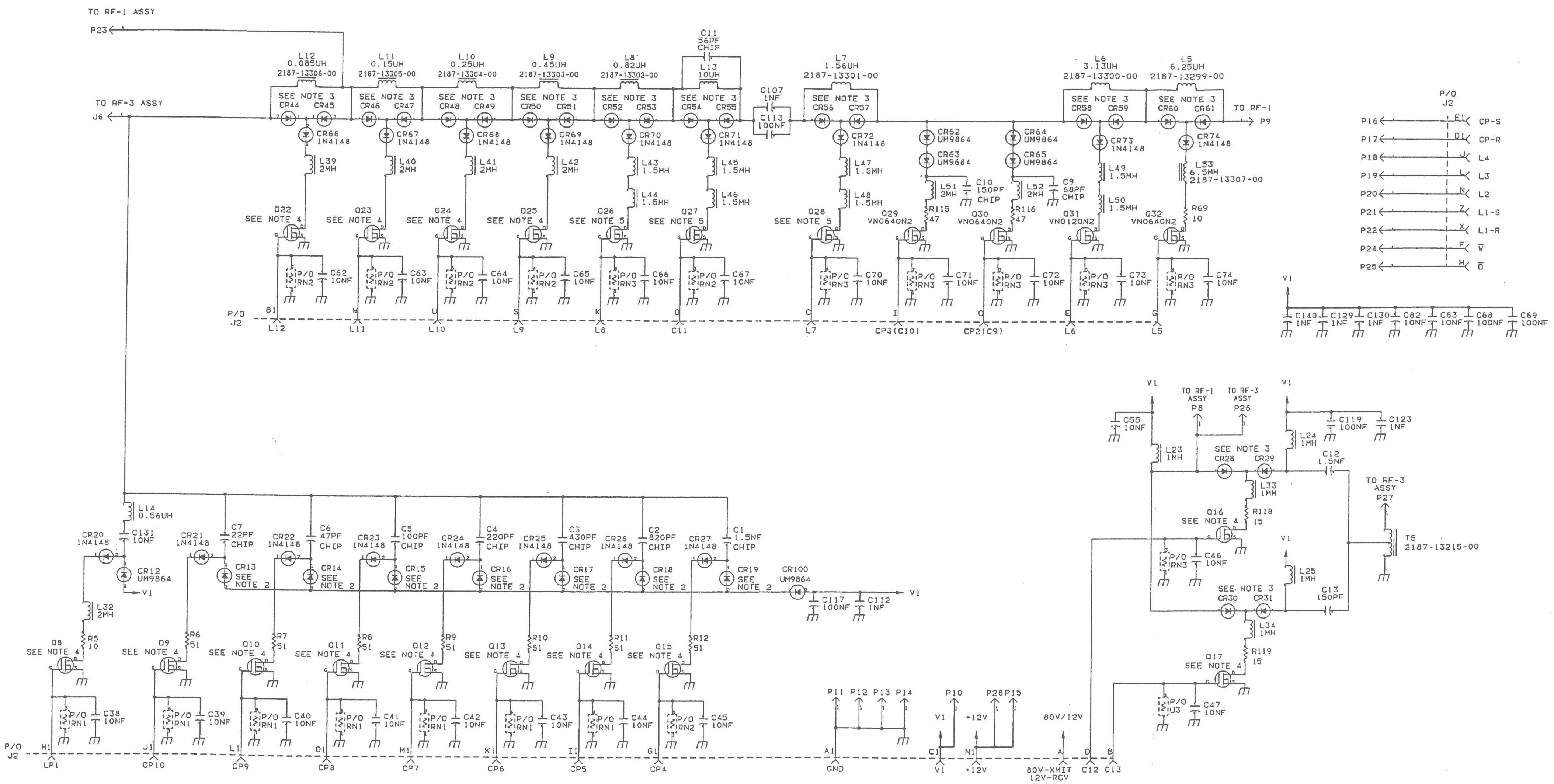
The diode switch of the capacitor C1 comprises Q15 and diodes CR19 and CR27. This circuit is controlled by the CP4 line, arriving from the MNC module.

(a) When the CP4 control line is at a high level, Q15 conducts. As a result, the diodes CR19 and CR27 conduct, because of the DC current flowing through them from the +V1 supply line, via CR100, CR19, CR27, R12 and Q15. Thus, the capacitor C1 is connected to RF between the matching network input (connector J6) and ground, via CR19, CR100, C112 and C117.

(b) When the CP4 control line is at a low level, Q15 is cut-off. Diodes CR27, CR19 and CR100 are not biased, and consequently the capacitor C1 is disconnected.

(2) Inductors L5 thru L12, and capacitor C11. These components are connected in series between the input line of the matching network (connector J6) and the other matching network components, located in module RF1, via connector P9. Refer to figure 2-56 for matching network topology.

Nine diode switches are used to bypass those components which are not required for tuning. A component is bypassed when its diode switch is closed, by applying a high level on the corresponding control line.



NOTES:

1- UNLESS OTHERWISE SPECIFIED: ALL RESISTORS ARE IN OHMS. 1/4W.
2- DIODES CR13-CR19. ARE P/N: 2187-21177-00.
3- DIODES CR28-CR31; CR44-CR61. ARE P/N: 2187-21197-00.
4- TRANSISTORS Q8-Q17; Q22-Q25. ARE P/N: 2187-21085-00.
5- TRANSISTORS Q26-Q28; Q31. ARE P/N: 2187-21090-00.
6- RN1,RN2,RN3 ARE RESISTORS. 7×100KOHMS,E/O.

Figure 2-67. Module RF2, Schematic Diagram

Only the circuit of the diode switch of L12 will be analyzed in detail. The other circuits operate in a similar way.

The diode switch of the inductor L12 comprises Q22, and diodes CR44, CR45 and CR66. The circuit is controlled by the L12 control line, arriving from module MNC.

(a) When the L12 control line is at a high level, Q22 conducts. Diodes CR44 and CR45 conduct, because of the DC current flowing through them from the +V1 supply line (connector P23), via L12, CR44 and via CR45, into CR66, L39 and Q22. Thus, the inductor L12 is RF shorted by diodes CR44 and CR45. The DC supply voltage +V1 arrives from module RF1 via connector P23.

(b) When the L12 control line is at a low level, Q22 is cut off. Diodes CR44 and CR45 are not biased, and as a result, the RF signal passes through L12.

(3) Capacitors C9 and C10. Capacitors C9 and C10 are connected through the diode switches controlled by Q30 and Q29 (respectively), between the junction of inductors L6 and L7 and the ground (see fig. 2-56). These diode switches are controlled by the control lines CP2 and CP3, respectively.

(a) A capacitor (C9 and/or C10) is connected when its diode switch is closed (i.e, corresponding diodes conduct), by applying a high level on the corresponding control line. The DC supply voltage for these switches arrives from module RF1 via connector P9, and is applied through the inductors L5 and L6.

(b) When the control line, CP2 or CP3, is at a low level, the corresponding switch is opened and the capacitor is disconnected.

(4) Capacitors C12, C13 and transformer T5. C12, C13 and T5 are matching components specific to the dipole antenna (see fig. 2-56). The upper tap of T5 is connected via connector P27 to the ST5 switch in module RF3. The capacitors C12 and C13 are connected through the diode switches, built around Q16 and Q17, respectively, between the center tap of T5 and the WHIP/DIP switch in module RF1 (via connector P8).

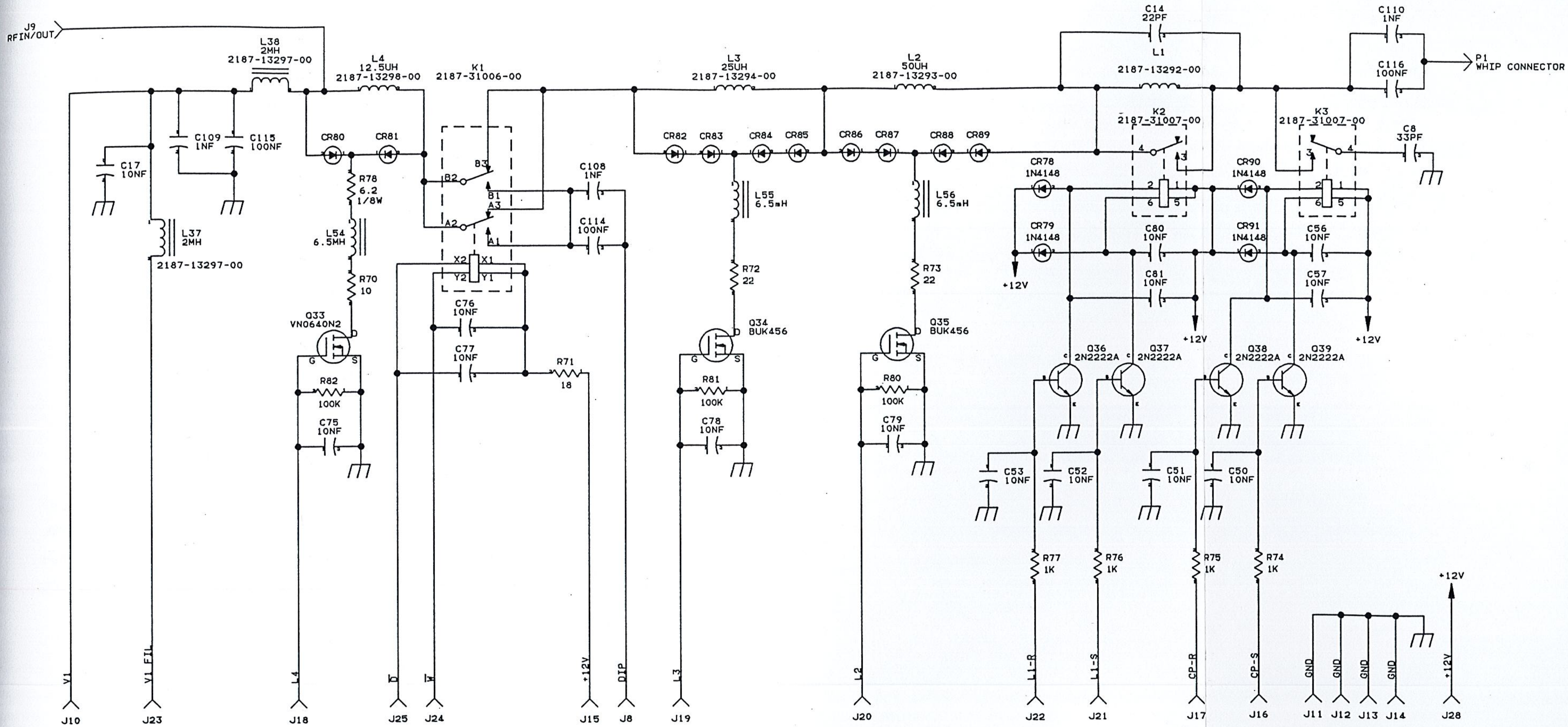
The diode switches of capacitors C12 and C13 are controlled by the control lines C12 and C13, respectively. A capacitor is connected when its diode switch is closed, by applying a high level on the corresponding control line. The operation of these switches is similar to the operation of the L12 switch, explained in para. (2) above.

d. Module RF1, Circuit Analysis (fig. 2-68).

(1) General. The RF1 module contains inductor L4 (part of the matching network), and the WHIP/DIP selector, which selects between the WHIP and DIP path. In addition, the RF1 module contains inductors L1 thru L3 and capacitor C8, which are matching components used only for matching a whip antenna. Refer to figure 2-56 for matching network topology included in module RF1.

(2) Inductor L4. Inductor L4 is connected in series between the matching network in module RF2 (via connector J9) and the WHIP/DIP selector K1 (contacts A2, B2). The diode switch, composed of Q33 and diodes CR80 and CR81, bypasses the inductor when it is not required for tuning. The DC supply voltage for the switch arrives from module RF2 on the +V1 supply line, via connector J10, and is applied via the choke L38. This DC voltage is also connected via connector J9 and via choke L37 and connector J23 to the diode switches in module RF2.

The diode switch circuit is controlled by the L4 control line, arriving from module MNC via connector J18. The inductor L4 is bypassed when the diode switch is closed, by applying a high level on the L4 control line. The operation of this circuit is similar to operation of the L12 switch in module RF2, explained in para. c.(2) above.



NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   ALL RESISTORS ARE IN OHM. 1/4W.
2. CR80-CR89, ARE P/N 2187-21177-00
3. L54,L55,L56, ARE P/N 2187-13307-00

Figure 2-68. Module RF1, Schematic Diagram

(3) WHIP/DIP selector. The WHIP/DIP selector is a latching relay, K1, controlled by the control lines D* and W*. K1 contacts remain in the last assumed position without requiring continuous application of power to its coils.

(a) Selection of whip antenna. To connect the whip antenna, the microprocessor in the MNC module sends a low level pulse via the W* control line. This pulse is applied to the Y2 terminal of the relay K1. K1 then connects the matching network (inductor L4) to the whip antenna path (inductor L3). After the control pulse ends, K1 remains in its position.

(b) Selection of dipole antenna. To connect the dipole antenna, the microprocessor sends a low level pulse via the D* control line, which is connected to the X2 terminal of K1. K1 then connects the matching network (inductor L4) to the DIP line (connector J8). This line is connected to the BP2 switch in module RF3, and to the components used for dipole antenna matching in module RF2 (fig. 2-56). After the pulse ends, the relay remains in its position.

(4) Inductors L1 thru L3. The inductors L1 thru L3 are connected in series between the WHIP connector and contacts A3, B3 of the WHIP/DIP relay K1. The latching relay K2 and the diode switches built around Q35 and Q34 bypass those inductors not required for tuning.

(a) Inductors L2 and L3. The diode switches of inductors L2 and L3 are similar to the diode switch of inductor L12 in module RF2, explained in para. c.(2) above. These switches are controlled by the control signals arriving from module MNC via connectors J20 and J19, respectively. The DC voltage for these switches is applied via inductor L4 and the contacts A2, B2 and A3, B3 of relay K1.

(b) Inductor L1. The latching relay K2 is controlled by the control lines L1-S and L1-R.

1. To bypass the inductor L1, the microprocessor in module MNC sends a positive pulse via the L1-S control line. This pulse is applied via transistor Q37 to the set input of K2 (contact 6). The relay K2 closes and bypasses the inductor L1.

2. To insert L1 in the RF path, the microprocessor sends a positive pulse via the L1-R control line. This pulse is applied via Q36 to the reset input of K2 (contact 2). The contacts of relay K2 open, and the RF signal passes through the inductor L1.

(5) Capacitor C8. Capacitor C8 is connected through the contacts of the latching relay K3 to the output line of the matching network. The relay K3 is controlled by the control lines CP-S and CP-R. The CP-S command is used to connect the capacitor, and the CP-R command is used to disconnect it. The operation of this relay is similar to the operation of K2 relay, explained in para. (4)(b) above.

2-18. MODULE MNC
(fig. 2-69 thru 2-74)

The MNC module contains a microprocessor system, which controls the operation of the CP-2003, and implements the antenna matching algorithm. The microprocessor in the MNC module communicates with the microprocessor in the RT-2001 MCU module via two serial data lines. The microprocessor receives operational information from the RT-2001, reads the frequency bus from the RT-2001, and also reads the status information from various CP-2003 modules. The microprocessor processes this information and generates appropriate control commands to the RF section of the antenna coupler.

a. Block Diagram Analysis (fig. 2-69).

(1) Microprocessor. The MNC module uses a 80C31 microprocessor, operating at a clock rate of 7.3728MHz. The clock rate is determined by the crystal Y1.

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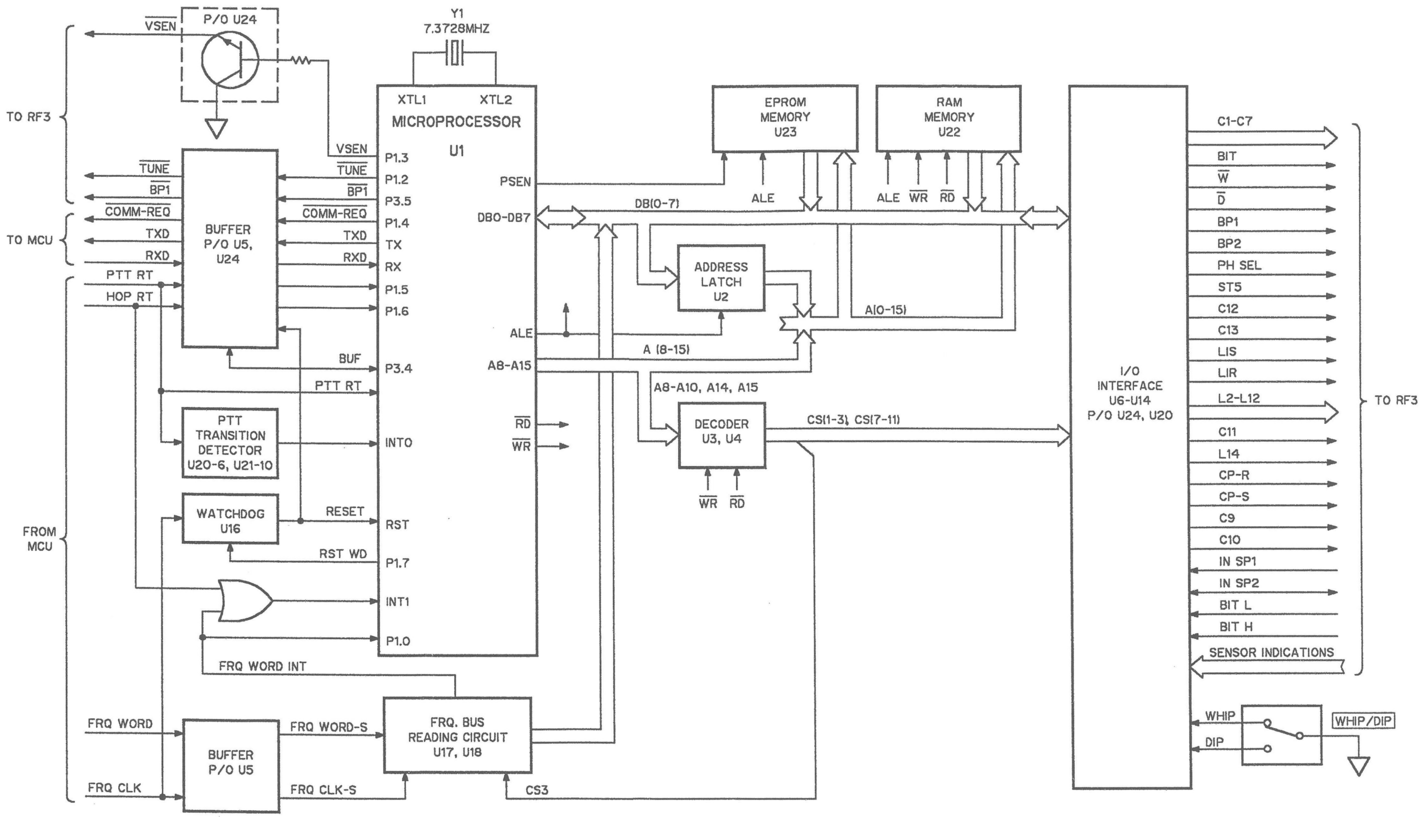

Figure 2-69. Module MNC, Block Diagram

(2) Address latch. The address latch stores the lower-address byte, received from the microprocessor on the DB0 thru DB7 lines at the beginning of a memory or I/O access. The addressing byte appearing at the outputs of the address latch is combined with the higher-order byte, appearing at the A8-A15 microprocessor outputs, to form the complete 16-bit address.

(3) Buffer. The buffer is used to send control signals to the RF3 module, and to communicate with the microprocessor in the MCU module of the RT-2001.
A section of the buffer is used to read the frequency information received via the frequency bus.

(4) Decoder. This circuit decodes the address and the RD and WR signals provided by the microprocessor, and generates chip-select signals for the various circuits connected to the microprocessor bus.

(5) EPROM memory. This circuit contains up to 32kbyte of program code.

(6) RAM memory. This circuit provides up to 8 kbyte of temporary storage. The RAM memory is used for storage of variables, tables and data generated during program execution. In addition, the RAM stores operational parameters.

(7) I/O interface. The I/O interface circuit is used by the microprocessor to send control signals to the other CP-2003 modules and read data from the sensors located in the RF section.

(8) PTT transition detector. This circuit interrupts the microprocessor upon each change in the PTT line status. Thereby, the microprocessor identifies each transition from receive to transmit mode, and vice versa.

(9) Frequency bus reading circuit. The frequency data is provided by the RT-2001 on the frequency bus. The frequency bus reading circuit extracts the frequency data received serially via the bus and transfers

it to the internal data bus. Each time a new byte of the frequency information is received, an interrupt is applied to the microprocessor.

(10) Watchdog. This circuit monitors the operation of the local microprocessor system, and resets the microprocessor if normal program execution is disrupted.
The watchdog circuit counts the clock pulses accompanying the frequency data, and generates a reset command if it is not reset before a certain number of clock pulses is received. This mechanism can also be used by the microprocessor in the MCU module to send a reset command to the microprocessor in the antenna coupler, using the frequency bus.

b. Microprocessor Operation. The main function of the microprocessor is to control the matching network and perform the antenna matching algorithm. The matching algorithm is executed after a frequency change, and after transmission is started.

(1) During reception, the matching network is preset to obtain optimal matching.

(2) At the start of transmission, or upon switching to a new frequency, a matching process is performed, to obtain optimal matching between antenna and the RF power amplifier. This process is optimized for rapid matching, and the resulting values of the matching network components are stored in the memory, for reuse when the same frequency is reached again. This provides an improved starting point for the matching algorithm when changing frequencies.

(3) When transmission ends, the matching network is preset to obtain optional matching (see para. (1) above).

c. Circuit Analysis (fig. 2-70 thru 2-73). Figure 2-71 shows the functional interconnections between the internal circuits of module MNC:

- MICRO circuits, shown in fig. 2-72A.
- WD circuits, shown in fig. 2-72A.

- I/O circuits, shown in fig. 2-72A.
- MEMORY circuits, shown in fig. 2-72B.

(1) Microprocessor operation. The functions performed by the microprocessor are determined by a set of program instructions stored in the EPROM U23. The RAM U22 is used to store temporary variables and tables required for program execution and programming commands.

U1 includes all the circuits necessary for fetching, interpreting and executing instructions stored in the memory. The microprocessor addresses the memory or other input/output circuits via a 16-bit address bus. Data and instructions are transferred to and from the microprocessor via an eight-bit bidirectional data bus. The microprocessor provides the timing and control signals for proper data transfer.

(a) U1 block diagram. U1 is an eight-bit microcontroller that contains a central processing unit (CPU), a clock generator, a 128-word RAM, two 16-bit programmable counters and a universal asynchronous receiver/transmitter (UART). Figure 2-70 shows the functional block diagram of U1.

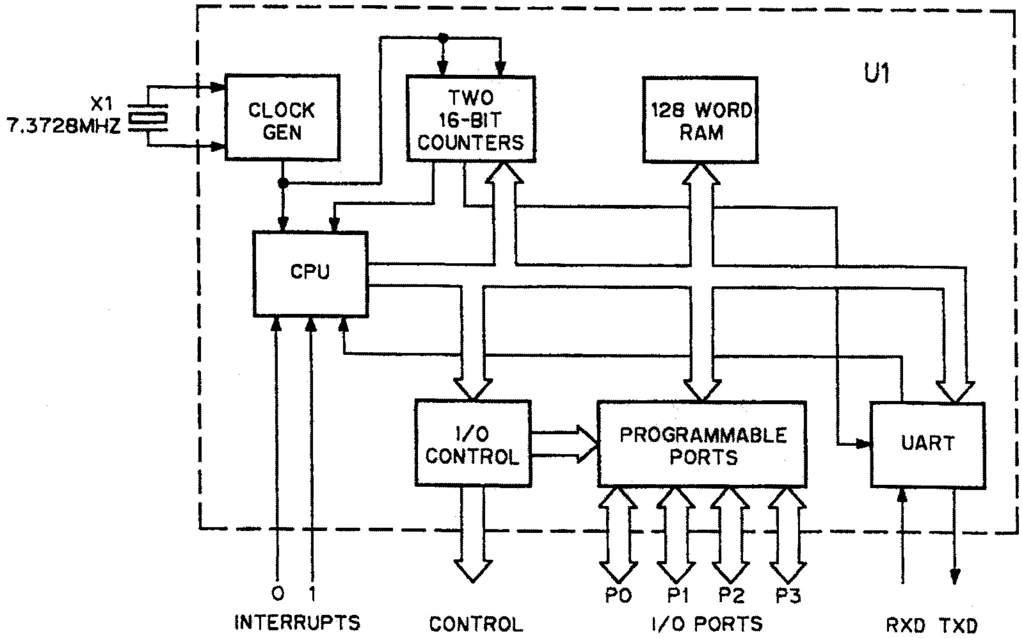

Figure 2-70. Module MNC, Microcontroller Block Diagram

(b) Microprocessor timing. The time required for the microprocessor to execute an instruction depends on the type of instruction and on the internal clock frequency of the microprocessor. U1 operates at a clock rate of 7.3728MHz provided by the internal clock generator and the external crystal Y1. An instruction cycle consists of one to four machine cycles.

(c) Data and address transfer. Data is transferred to and from U1 via an eight-bit bidirectional data bus designated DB0 thru DB7 (pins 39 thru 32 respectively). These lines are used for bidirectional data transfer between the microprocessor U1 and the memory circuits and input buffers.
Memory addresses have a length of 16 bits[the low-order address bits A0 thru A7 are transferred via the data bus lines, and the high-order address bits A8 thru A15 are transferred on a separate group of eight lines, A8 thru A15 (pins 21 thru 28, respectively).
The low-order address bits (A0 thru A7) are latched into the address latch U2 on the falling edge of the ALE signal (pin 30 of U1).

(d) Read cycles.

1. Reading from EPROM U23. Reading from the EPROM is controlled by the PSEN* and ALE signals (U1, pins 29, 30, respectively). When reading, the ALE line assumes a low level and enables U23 outputs. Upon the falling edge of the PSEN* signal, the data stored at the location indicated by the address applied to U23 appears on the data bus. Figure 2-70 shows the timing diagram of a typical EPROM read cycle.

2. Reading from RAM U22 and other components addressed by the microprocessor. Reading from these components is controlled by the RD* signal (pin 17 of U1). This signal assumes a low level during reading, and a high level at any other time. When reading, the low level on the RD*

line enables the outputs of the selected component (RAM, frequency bus reading circuit, or input buffer). As a result, the data stored at the selected component indicated by the address lines appears on the data bus.

(e) Write cycles. Writing data to RAM (U22) is controlled by the WR* signal (pin 16 of U1). This signal assumes a low level during writing and a high level at any other time. The low level on the WR* line enables writing the bits appearing on the data bus line to the memory location indicated by the address lines.

(f) Interrupts. The internal interrupt system of U1 allows asynchronous control of the microprocessor operation. This interrupt system can receive interrupt request from five maskable sources: the INT0* and INT1* lines, the serial communication system (UART) and the two internal counters, designated TIMER0 and TIMER1.

1. Via the INT0* line, the microprocessor receives an interrupt request from the PTT interrupt circuit started by PTT-RT input line.

2. Via the INT1* line, the microprocessor receives interrupts after each frequency change, and upon reception of every frequency byte by the frequency bus reading circuit.

Upon reception of an interrupt request enabled by the software, the microprocessor begins executing the program from the address indicated by the interrupt routine.

The priority of each interrupt source can be sorted in two levels. The enabled interrupts are controlled by the software.

(g) Internal counters.

1. Counter TIMER0 is used by the CPU.

2. TIMER1 is used by the serial communication system (UART) comprised in the microprocessor.

(h) Serial communication channel (UART) operation. The serial communication channel is implemented by means of an asynchronous full-duplex receiver/transmitter. The UART is used for communication between the microprocessor, the RT-2001 and the CP-2003. The output data is transmitted serially via the TXD line (pin 11) and serial input data is accepted at the RXD input (pin 10). The data word frame contains 10 bits: one start bit, eight data bits and one stop bit. The transmission rate is determined by the rate of overflow pulses generated by TIMER1, divided by 32 or 64. The division ratio is determined by the software.

1. Transmission. The CPU writes the data to be transmitted into the shift register serving the UART. In the first stage, the start bit is transmitted. In the second stage, the shift register receives a shift instruction, and data loaded into the shift register is transmitted on the TXD line (pin 11), starting with the least significant bit (LSB). After ending data bit transmission, the stop bit is transmitted.

2. Reception. The process begins when a high-to-low transition appears at the RXD input (pin 10). The RXD input is sampled three times during each receive clock cycle, to confirm the signal level. The received bit is determined by majority voting, i.e. according to the level of the input signal detected during at least 2 out of the 3 samples taken during one receiver clock cycle.

a. If during the reception of the start bit, the majority decision is that the signal is high, the receive process is aborted and will restart after detecting the next high-to-low transition in the input signal level.

b. After detection of a valid start bit, the bit detected during the following receive clock cycle is loaded into the receive shift register of the UART.

c. The process of bit reception and loading into the receive shift register repeats itself until all the data bits are received.

After receiving one additional bit (the stop bit), the UART transmits an interrupt request to the CPU, and the CPU reads the data stored in the receive shift register.

(i) Initialization. The microprocessor starts program execution after receiving the +5V supply voltage on the VCC line (pin 40), and a reset pulse, by the POWER ON RESET circuit (see para. (8)(c)).

(j) Input/output ports. The input/output ports are used to transfer information to/from the microprocessor via bi-directional ports. The functions of the bi-directional ports are listed in table 2-20.

Table 2-20. MNC Microprocessor, Functions of the Bi-Directional Ports

No.	Port	U1 Pin	Designation	Function
1	P1-0	1	FRQ WRD INT	Indicates reception of a frequency byte
2	P1-1	2	-	Spare

Table 2-20. MNC Microprocessor, Functions of the Bi-Directional Ports (Cont'd)

No.	Port	U1 Pin	Designation	Function
3	P1-2	3	TUNE*	High level at this output selects the normal path in the RF section of antenna coupler
4	P1-3	4	V SEN	High level at this output selects the tune path and activates the sensor assembly in the RF section of antenna coupler
5	P1-4	5	COMM-REQ*	Communication request to RT-2001
6	P1-5	6	PTT RT	PTT control line from RT-2001
7	P1-6	7	HOP	Pulse, indicating the end of the frequency data
8	P1-7	8	RST WD	Reset pulses for the watchdog circuit
9	P3-4	14	BUF	Low level at this output enables buffer U5
10	P3-5	15	BP1	Control signal for the BP1 switch in module RF3

(2) Address latch (fig. 2-72A). The microprocessor addresses the EPROM and RAM memories via 16 address lines, controlled by pins 21 thru 28 and 32 thru 39 of U1.

(a) The lower byte of the address appearing on the 8 bus lines, DB0 thru DB7, is latched into U2 when the ALE line (pin 30 of U1), connected to the C input (pin 11) of U2, rises to a high level. The higher-order byte A8 thru A15 is present at ports P2-0 thru P2-7 (pins 21 thru 28) of U1 throughout the instruction cycle.

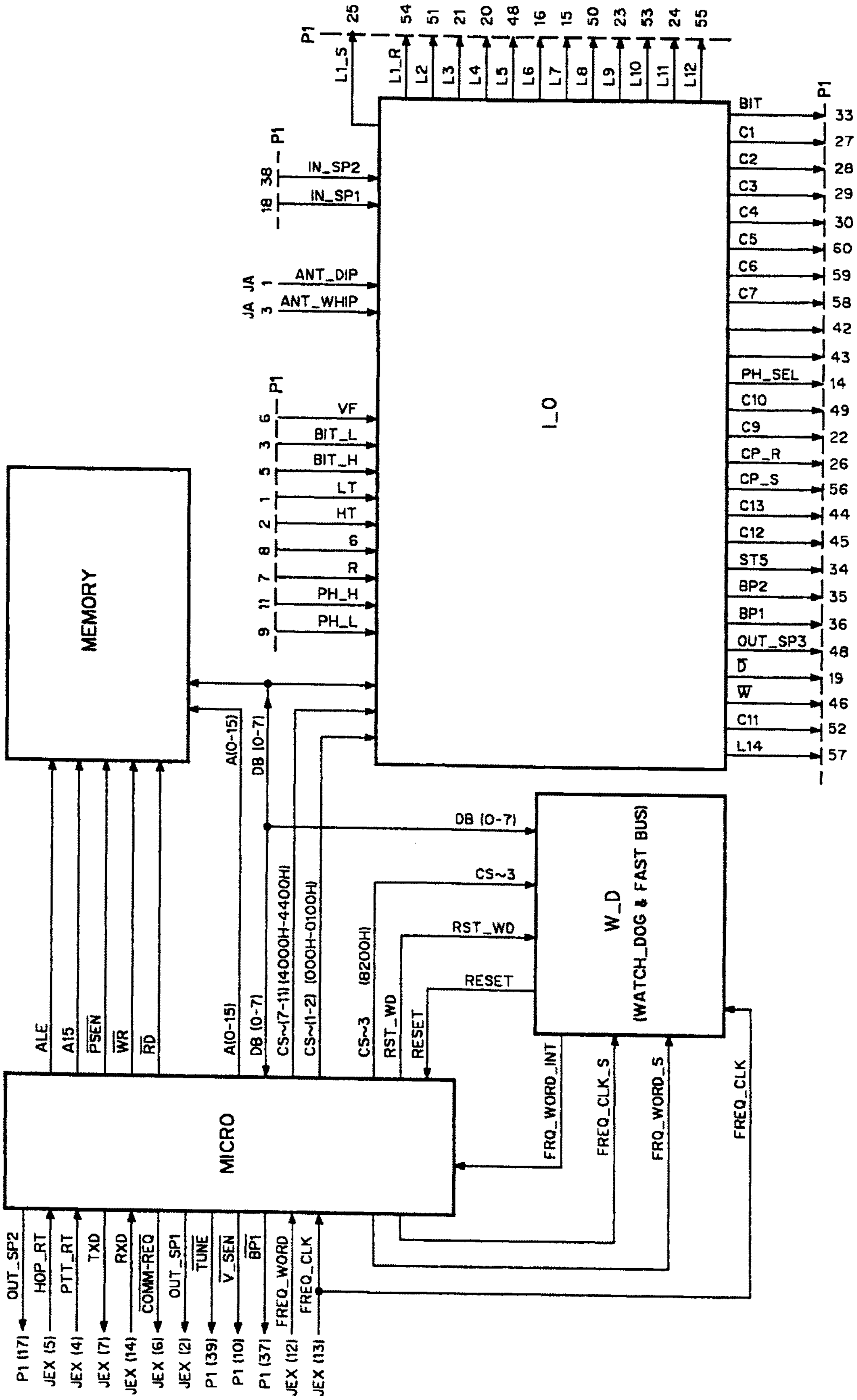

Figure 2-71. Module MNC, Functional Interconnection Diagram

(b) After the lower address byte is latched into U2, the data bus (lines D0 thru D7) is used for data transfer, while the full 16-bit address is now available on address lines A0 thru A15.

(3) Address decoder. The address decoder comprises two decoders, U3 and U4.

(a) Decoder U3. The decoder U3 provides chip-select signals to the I/O interface components and frequency bus reading circuit. The decoder is enabled when the address lines A14 and A15 and RD* control line from the microprocessor are at a low level. Address lines, A8 thru A10, connected to the decoder select inputs, determine which decoder output, Y0 to Y7, falls to a low level. When the decoder is disabled, all the outputs are at a high level.

(b) Decoder U4. The decoder U4 provides chip-select signals to the I/O interface components. The decoder is enabled when the A14 address line is at high level, and the A15 address line and the WR* control line are at low level. Address lines A8 thru A10, connected to the decoder select inputs, determine the decoder output that assumes a low level.

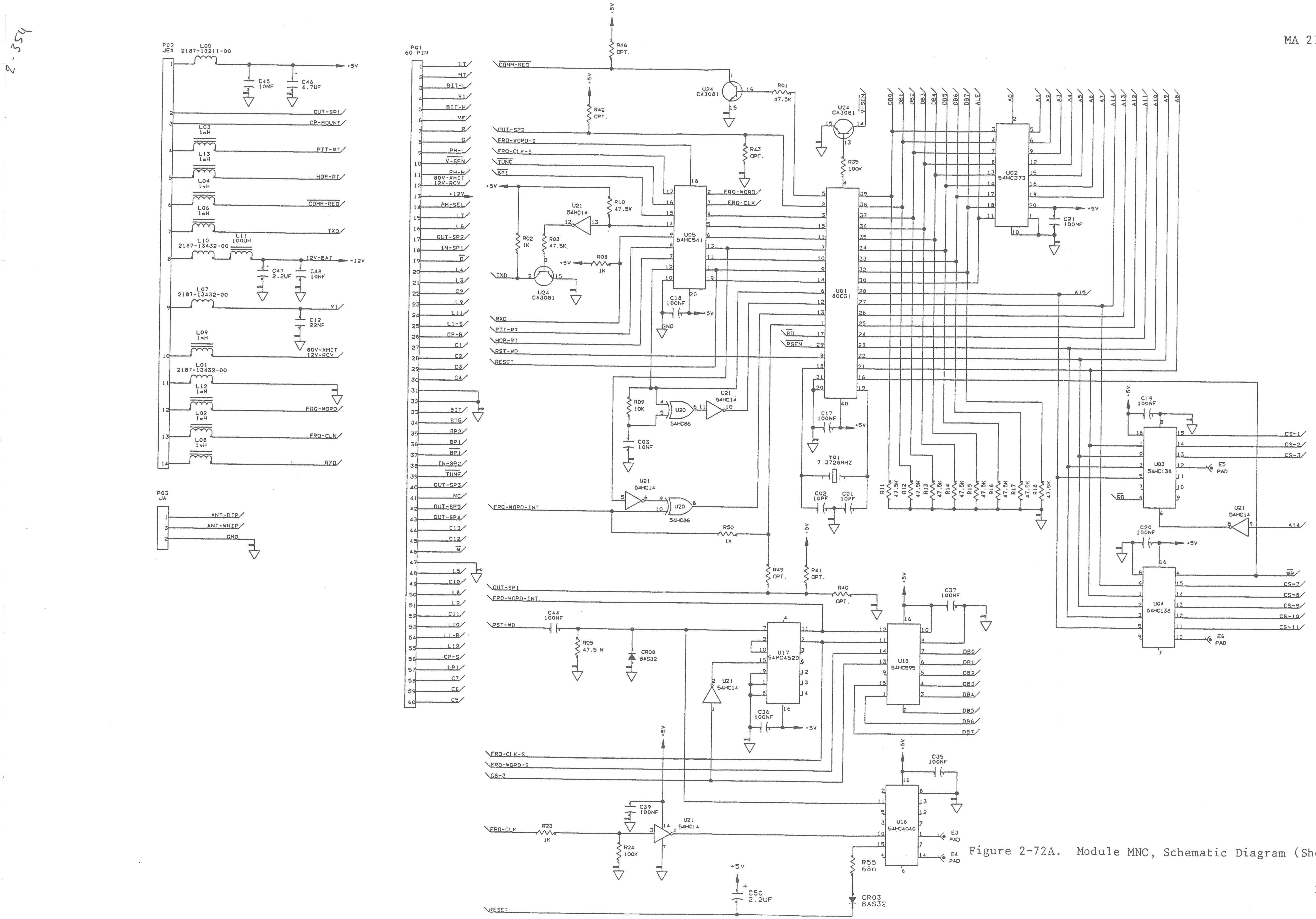

Figure 2-72A. Module MNC, Schematic Diagram (Sheet 1 of 2)

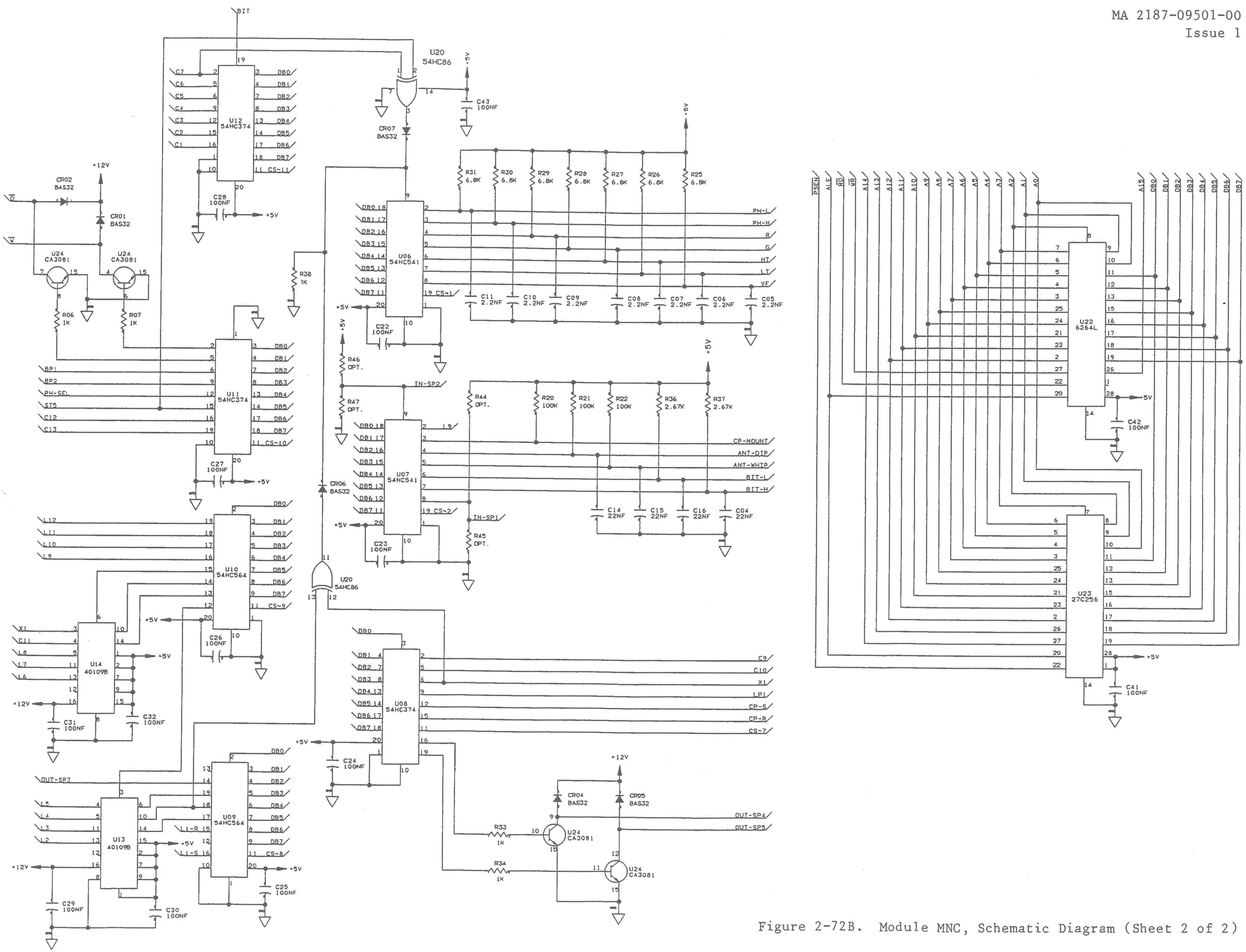

Figure 2-72B. Module MNC, Schematic Diagram (Sheet 2 of 2)

Refer to table 2-21 for the allocation of component addresses.

Table 2-21. MNC Chip-Select Signal Generation

No.	Address								Address Range	Control		Chip-Select	Enabled Component
	A15	A14	A13	A12	A11	A10	A9	A8		RD*	WR*		
1	0	0	0	0	0	0	0	0	0000-00FF	0	1	CS1	Input buffer U6
2	0	0	0	0	0	0	0	1	0100-01FF	0	1	CS2	Input buffer U7
3	0	0	0	0	0	0	1	0	0200-02FF	0	1	CS3	FRQ bus reading circuit, U17, U18
4	0	0	0	0	0	0	1	1	0300-03FF	0	1	-	Spare
5	0	0	0	0	0	1	X	X	0400-07FF	0	1	-	Spare
6	0	0	-	-	-	-	-	-	0800-3FFF	-	-	-	Not used
7	0	1	0	0	0	0	0	0	4000-40FF	1	0	CS7	Output latch U8
8	0	1	0	0	0	0	0	1	4100-40FF	1	0	CS8	Output latch U9
9	0	1	0	0	0	0	1	0	4200-42FF	1	0	CS9	Output latch U10
10	0	1	0	0	0	0	1	1	4300-43FF	1	0	CS10	Output latch U11
11	0	1	0	0	0	1	0	0	4400-44FF	1	0	CS11	Output latch U12
12	0	1	0	0	0	1	0	1	4500-45FF	1	0	-	Spare
13	0	1	0	0	0	1	1	X	4600-47FF	1	0	-	Spare

Note: X - "Don't care" condition

(4) EPROM circuit (fig. 2-72B). The EPROM U23 contains 32 kilobytes of memory. To read data stored in a specific EPROM location, the 15-bit address of that location is applied, via the address bus, to the address inputs (AO through A14) of the EPROM. The ALE line, applied to pin 20 of the EPROM, is used to enable the EPROM.

When the PSEN* signal applied to an EPROM falls to a low level, the data stored in the location pointed to by the 15-bit address appearing on the address bus, is made available at the EPROM outputs (pins 11 thru 19). The EPROM data is sent to the microprocessor via the data bus.

(5) RAM circuit (fig. 2-72B). The RAM U22 is enabled by the ALE signal generated by U1 (pin 30), applied to the RAM enable input (pin 20).

(a) RAM writing. When the WR* signal, applied to input pin 27 of the RAM, falls to a low level, the chip-select and address signals are latched into the RAM and the data appearing on the data bus is written into the RAM location pointed to by the latched address. Data is applied to the RAM via bidirectional ports DBO through DB7 (pins 11 through 19).

(b) RAM reading. To read data from the RAM, the 13-bit address of the data storage location is applied to the RAM address ports and the chip-select signal is pulled to a low level. When the RD* signal, applied to input pin 22 of the RAM, falls to a low level, the data stored in the location pointed to by the 13-bit address, is made available at the RAM bidirectional ports (DBO thru DB7).

(6) I/O interface and line drivers. This circuit comprises five latches (U8 thru U12), two buffers (U6, U7), two drivers (U13, U14) and transistors comprised in U24. The latches are used to transfer control signals to the other CP-2003 modules, and the buffers are used to read the information arriving from them. Drivers U13, U14 and the transistors comprised in U24 drive matching network switches.

(a) Writing to latches. The microprocessor writes data to the latches via the bidirectional data bus DB0 thru DB7. Since the data bus is connected to all the latches, a chip-select signal is used to enable the desired latch (para. (3) above). The microprocessor sets each bit of the data byte according to the desired function. Upon the rising edge of the chip-select signal, the data byte is latched into the selected latch.

(b) Line drivers. The control signals L2 thru L8 from the latches U9 and U10, and the control signal C11 from U8 are connected to the drivers U13 and U14. These drivers convert the logic levels provided by the latches to drive signals for the switches in the RF section of CP-2003.

Transistors contained in U24 provide drive signals W* and D* for the WHIP/DIP selector relay, in module RF1.

(c) Reading from buffers. Reading from the buffers U6 and U7 is controlled by the chip-select signals CS1 and CS2, which are used to enable the desired buffer (para. (3) above).

1. When the CS1 signal is at a low level, the buffer U6 is enabled, and the microprocessor can read the status of the lines connected to the inputs of U6, via the bidirectional bus.

2. In a similar way, when the CS2 signal is at a low level, the microprocessor can read the data applied to U7 inputs.

(d) I/O interface testing. One output line of each of the latches U8, U9 and U11, U12 is connected via the XOR gates U20-11 and U20-3 (respectively) to the A8 input of U6 (pin 9). In addition, one output of U10 is connected to the A1 input of U7 (pin 2). When testing the I/O interface, the microprocessor writes known data to those latch outputs, reads their status via the buffers U6 and U7, and then compares the data with the expected values.

(7) PTT transition detector. This circuit interrupts the microprocessor upon each change in the PTT line status (rising or falling edge). The PTT signal arriving from the RT-2001 via the buffer U5 (pin 12) is applied to the PTT transition detector, comprising R9, C3, XOR gate U20-6 and inverter U21-10. This circuit operates as a differentiator. U21-10 output provides a narrow negative-going pulse upon the rising or falling edge of the PTT signal. This pulse interrupts the microprocessor via the INTO* input. Figure 2-73 also shows typical transition detector waveforms.

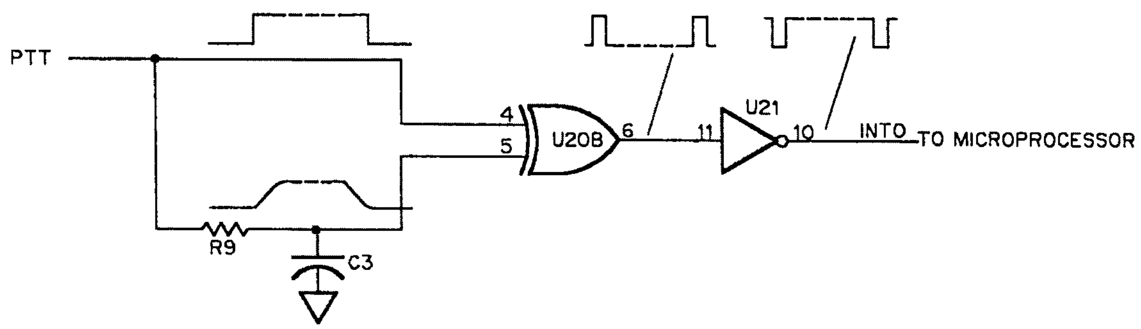

Figure 2-73. PTT Transition Detector Operation

(8) Watchdog circuit. The watchdog circuit is built around the 12-stage binary counter U16.

(a) During normal operation, the counter counts the clock pulses accompanying frequency data, arriving via FRQ CLK line. The microprocessor can reset the watchdog counter by applying a high level pulse on the RST WD line (U1, pin 8).

This pulse passes via the rising edge detector, composed of C44, R5 and CR8, to the reset input of the counter U16 (pin 11).

(b) During normal operation, the counter is reset periodically. Thus, its Q11 output (pin 15) never assumes a high level. If normal execution of microprocessor software is disrupted, the reset pulse will not appear on time (at pin 11), and counter output Q11 will eventually rise to a high level. This high level passes via diode CR3 to the RST input of the microprocessor. The microprocessor is reset, and it returns to normal operation.

(c) The microprocessor is also reset upon power-on, by means of capacitor C50. When the power is first connected, +5V appears on the RESET line, and resets the microprocessor. After the C50 charges, the voltage on the RESET line falls to 0V, and allows the microprocessor to start normal program execution.

(9) Buffer. The buffer circuit comprises U5 and transistors contained in U24.

(a) The serial communication and frequency bus lines and various control signals are connected to the inputs of the buffers contained in U5. Buffer operation is controlled by the BUF signal from the microprocessor and the RESET signal from watchdog circuit, connected to the enable inputs of U5 (pins 19 and 1 respectively). During normal operation, these signals are low, U5 is enabled and transfers the input data to its outputs.

(b) In addition, transistors contained in U24 are used to apply the communication request and serial transmit data on the COMM-REQ* and TXD lines to the RT-2001, and the VSEN* control line to module RF3.

(10) Frequency bus reading circuit. This circuit is built around the serial-in/parallel-out shift register U18 and the strobe pulse generator, counter U17.

(a) The serial frequency information frame consisting of 96 bits, is applied via the FRQ WORD S line to the data input (pin 14) of U18. This data is accompanied by the data bus clock (FRK CLK S) and the end of frequency hopping (HOP-RT) lines.

(b) The serial frequency information is read in groups of eight bits. Thus, to read all the 96 bits of the frequency information, 12 read cycles are needed.
The data is clocked into U18 by the rising edges of the FRQ CLK S pulses, applied to pin 11 of U18. These FRQ CLK S pulses are also applied to the clock input of the counter comprising U17/1 (pins 1 through 7) and U17/2 (pins 9 thru 15).
After 8 data bits are clocked into U18, the Q1 output of U17/2 (pin 11) rises to a high level. This low-to-high transition is applied to LCLK input (pin 12) of U18, and as a result the 8-bit data (stored inside U18) is latched into the output stage of U18.

(c) At the same time, the low-to-high transition at Q1 output of U17/2 passes via the FRQ WORD INT line and XOR gate U20-8, and interrupts the microprocessor U1, via the INT1* input. The microprocessor checks the status of HOP RT* line, in order to identify the source of the interrupt, and then reads the received data byte from U18. The microprocessor sends the address of U18 to the address decoder, which pulls the CS3* chip-select signal to a low level. The low level applied to the OE* input of U18 enables its operation, therefore the data byte stored in U18 is made available at its outputs (pins 15, and 1 thru 7).
This data byte is sent to the microprocessor U1 directly via the data bus.

(d) The counter U17/2 is reset by the CS3* line connected to its RST input (pin 15) via inverter U21-2. When the microprocessor reads the received data byte from U18, it sends a low level via the CS3* line. The counter U17/2 is reset, and is ready to count the next 8 bits.

(e) The procedure described above repeats until entire 96 bits of the frequency data is ready by the microprocessor.

(f) Approximately 1.5 milliseconds after the end of the frequency data frame, a high level pulse arrives via the HOP RT* line. This pulse is sampled by the microprocessor to synchronize the frequency change.

c. MNC Module Software (fig. 2-74).

(1) The operation of the CP-2003 and the protocols used by CP-2003 to communicate with the microprocessors in the RT-2001 are controlled by the software stored in the EPROM U23.
The main functions of the software are:

(a) Initialization upon turn-on.

(b) Transmission and reception of UART messages towards and from the microprocessor in module MCU.

(c) Reception of the frequency data via the frequency bus reading circuit.

(d) Reading of the status information from the various CP-2003 modules, by means of the I/O interface.

(e) Processing of the information received from the RT-2001 and various CP-2003 modules, and generation of the appropriate control commands for various CP-2003 modules.

(f) Implementation of the antenna matching algorithm.

(g) Self-testing (BIT).

(2) Scheduler software modules (fig. 2-74). The software is modular and comprises the following modules.

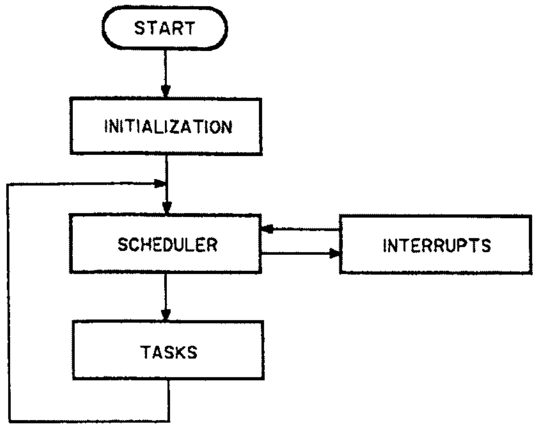

Figure 2-74. MNC Module, Software Organization

(a) INITIALIZATION module. Performs microprocessor initialization and determines the initial values for the various variables. After ending its execution, it enables the interrupts and calls the scheduler program.

(b) SCHEDULER module. Receives information from the other software modules, processes the received information and operates the tasks.

(c) INTERRUPTS module.

1. Handles reading and writing of data from and to the UART comprised in the microprocessor.

2. Upon reception of INTO* interrupt, reads the interrupt request received from the PTT interrupt circuits.

3. Upon reception of INT* interrupt, reads the interrupt request received from the PTT interrupt circuits.

(d) TASKS. The software comprises tasks, used by the scheduler. The tasks perform all the operations listed in para. (1) above, under control of the scheduler.

CHAPTER 3

MAINTENANCE

Section I. GENERAL

NOTE

The AJ, SEC, CCW, INTERNAL MODEM, FLASH, DUAL, NCW and/or AM modes are optional. Throughout this chapter refer to the circuits, performances requirements, signals, lines, tests, or measurements related to these modes as optional.

3-1. Scope of Maintenance

a. This chapter provides maintenance instructions for the PRC-2200, including testing and troubleshooting. These instructions complement the operator maintenance instructions appearing in the PRC-2200 operator manual.

b. The systematic troubleshooting techniques begin with visual, mechanical and operational checks.

c. The test procedures include visual and mechanical test procedures (para. 3-4) and electrical test procedures (para. 3-5, 3-6). These procedures set forth specific requirements that a repaired PRC-2200 must meet before it is returned to the using organization.

3-2. Organization of Troubleshooting Procedures

a. General. The first step in troubleshooting a defective PRC-2200 is to sectionalize the fault, which means tracing the fault to a major unit. The second step is to localize the fault to a defective module, sub-assembly or area.

b. Sectionalization. The following procedures and tests are arranged to minimize the effort and time expended in troubleshooting the equipment.

(1) Visual inspection. Visual inspection may indicate faults without testing or making measurements. Check the front panel indicators and display for faults and inspect wiring and module assemblies for physical damage.

(2) Operational tests. Operational tests frequently indicate the general location of a fault. Carrying out the equipment performance checks given in the operator's manual will help in determining the exact nature of the fault. Pay special attention to all the fault indications provided by the PRC-2200.

c. Localization and Isolation. Faults are identified by activating the off-line self-test and reading the diagnostics information displayed by the RT-2001. The diagnostics information includes a fault description or code, and the suspected module.
Refer to para. 3-6 for detailed instructions.

d. Intermittent Faults. The possibility of intermittent faults should not be overlooked. To reveal the defect, check the wiring, the coaxial cables, the connections, and the plugs and jacks of the various modules.

3-3. Test Equipment Required

a. Table 3-1 lists the general-purpose test equipment required for testing and troubleshooting the PRC-2200. If the specified equipment models are not available, other test equipment having similar characteristics may be used.

Table 3-1. General-Purpose Test Equipment

No.	Test Equipment	Manufacturer	Model	Qty
1	Counter	Hewlett-Packard	5316A	1
2	Power Supply	Horizon	SR 3610	2
3	RF Millivoltmeter	Boonton	9200	1
4	Signal Generator	Marconi	2018	1
5	Multimeter	Hewlett-Packard	3478A	1
6	Audio Analyzer	Hewlett-Packard	8903A	2
7	Attenuator, 30dB	Bird	8322	2
8	Attenuator, 0-120dB	Hewlett-Packard	3550	1
9	Oscilloscope	Tektronix	7633	1
10	Plug-in, Dual Trace	Tektronix	7A26	1
11	Plug-in, Delaying Time	Tektronix	7B85	1

b. Special-Purpose Test Equipment. Table 3-2 lists the special-purpose test equipment, including radio accessories, that are required for testing and troubleshooting the PRC-2200.

Table 3-2. Special-Purpose Test Equipment

No.	Test Equipment	Qty
1	Interface Box for PRC-2200	1
2	Accessories and Cables	1
3	Audio Combiner	1
4	Whip Simulator	1
5	Battery, TNC-2188	2
6	Whip Antenna Kit, AT-1741/H	2
7	Handset, H-250/GR	2
8	Control Handset, H-739/GR	2
9	Loudspeaker, LSA-108	2

Section II. TEST PROCEDURES

3-4. Visual Inspection and Mechanical Tests

a. Inspection. Inspect each part as directed in Table 3-3. Repair and/or replace components found to be defective and/or damaged.

Table 3-3. Visual Inspection and Mechanical Tests

Sequence	Item to be inspected	Procedure
1	Protective case	a. Inspect for damage, loose or missing parts or screws. b. Remove dust and dirt. c. Check the condition of painted metal surfaces and panel lettering. Spot-paint bare metal surfaces. NOTE Do not paint or polish with abrasives connectors and display windows d. Tighten all screws on covers, sides and controls. Replace missing screws.
2	Connectors	a. Check that all connectors are securely mounted. b. Inspect shell and contacts for damage and corrosion. c. Clean and remove all foreign matter. d. Clean connector caps. Replace if missing.
3	Controls	a. Check for looseness and damage. b. Turn controls through each of their positions and check that they operate freely, without binding or excessive looseness.

Table 3-3. Visual Inspection and Mechanical Tests (Cont'd)

Sequence	Item to be inspected	Procedure
4	Keyboard	a. Check for damage to rubber cover. b. Check for proper operation.
5	Display windows	a. Clean dirt and dust. b. Check for cracks.
6	RF OUT connector	a. Check center contact for damage and corrosion. b. Clean thoroughly and remove all foreign matter.
7	RMT/DATA and rear connectors	a. Clean and remove all foreign matter. b. Clean connector contacts.
8	Battery connector	a. Check for corrosion or damage to contacts b. Clean connector contacts.
9	CP-2003 and battery cover clamps	a. Check clamps for damage or looseness. b. Check that a good battery pack can be securely clamped to the unit.

WARNING

Prolonged breathing of cleaning compound may be dangerous[make certain that adequate ventilation is provided. Do not use near a flame. Avoid contact with the skin. If contact with skin is made, immediately wash off with water.

b. Cleaning. Inspect the exterior of the unit. The surfaces should be clean and free of dirt, grease and other contaminants.

(1) Remove dust and other loose dirt with a soft clean cloth.

(2) Remove grease, fungus and ground-in dirt from the cases: use a lightly dampened cloth (not wet) with a cleaning compound such as trichloroethylene.

(3) Remove dirt from plugs and jacks with a brush.

(4) Clean the front panel displays and keyboard with a soft clean cloth. If dirt is difficult to remove, dampen the cloth with water[mild soap may be used for more effective cleaning.

CAUTIONS

1. Do not press display window faces when cleaning.

2. Do not use solvents for cleaning display window and keyboard.

3. Do not use compressed air for cleaning the panel: this may damage the keyboard and the breather valve.

3-5. PRC-2200 Test Procedure

a. General.

(1) This paragraph provides electrical test procedures for PRC-2200.

(2) After successfully completing the tests given in this paragraph, perform a communication test with another good PRC-2200, located at a distance of at least 50 meters.

(3) It is recommended that the tests described below be performed in the specified order. Prepare the PRC-2200 for test as instructed in para. b. below, then assemble the test set-ups as required by the test procedure detailed in para. c. below.
See detailed operating instructions for the PRC-2200 in the operator manual.

(4) Record any malfunction found during the test procedure and refer to Section III: "TROUBLESHOOTING PROCEDURES" for systematic troubleshooting instructions.

(5) In case a trouble is found which could cause damage to the equipment, stop operation immediately and troubleshoot and repair the equipment before continuing the tests.

b. Preparation for Test. Prepare the PRC-2200 for testing as follows:

(1) Set the function control of the PRC-2200 under-test to OFF.

(2) Remove the battery from the PRC-2200 under-test.

(3) Turn the DC power supply on, adjust output voltage to 13.5 $\pm$ 0.2V and its current limit to 7A, and then turn the power supply off.

NOTE

> Always measure PRC-2200 supply voltage at the battery connector, in order to take into account any voltage drop that may occur on the power cable, especially in the transmit mode.

(4) Connect the DC power supply to the battery connector of the PRC-2200. Pay attention to connection polarity, in accordance with the marking on the battery connector.

(5) Turn the DC power supply on. When the function control of the PRC-2200 is set to OFF, no current should be drawn from the power

supply. If current is drawn, disconnect immediately the DC power supply and troubleshoot the test set-up and the PRC-2200 under test.

c. Test Procedure.

(1) Input power.

(a) Current consumption in the receive mode.

1. Set the PRC-2200 under test to CLR.
2. Connect test setup as shown in Figure 3-1.
3. Adjust the supply voltage for 13.5VDC (measure voltage in the receive mode at the PRC-2200 battery posts).
4. Set the controls of the PRC-2200 under test as follows:

Control	Setting
SQ	OFF
Mode	VOICE
Modulation	USB
Frequency	16.0000MHz
WHIP/DIP Switch	DIP

5. Adjust signal generator for 16.001MHz, 0.7 uV signal.
6. Adjust PHONE output to 3V(RMS)/600 ohm on the audio analyzer. Use the volume control.
7. Measure PRC-2200 under test current on multimeter. The current shall be less than 260 mA (3.5 watts).
8. Turn the PRC-2200 under test off.

(b) Current consumption in the transmit mode.

1. Connect test setup as shown in Figure 3-2.
2. Set the PRC-2200 under test to CLR and SQ-OFF.
3. Adjust the supply voltage, measured during transmission (in CW mode) at the PRC-2200 battery posts, to 13.5VDC.
4. Verify that the PRC-2200 under test is in USB, VOICE.
5. Adjust the tone at PRC-2200 microphone audio input to 5 mV, at a frequency of 800Hz, using the audio analyzer.

6. Place the PRC-2200 under test into transmission by activating the PTT (VOICE) switch on the interface box.
7. Verify that the output power of the PRC-2200 under test is 20W (43dBm ± 1dB), as indicated by RF millivoltmeter.
8. Measure the current drawn by the PRC-2200 on the multimeter. The current shall be less than 4.44A (60W).
9. Release the PTT switch.
10. Turn the PRC-2200 under test off.

(2) Function meter test.

(a) Signal level meter.

1. Set the PRC-2200 under test to CLR and SQ-OFF.
2. Connect the test setup as shown in Figure 3-1.
3. Verify that the power supply voltage, measured in the receive mode at the PRC-2200 battery posts, is 13.5VDC.
4. Tune the PRC-2200 under test to 16.0000MHz.
5. Adjust the frequency of the signal generator to 16.0010MHz, change RF input level from the 3 to 10000 microvolts and check that the number of arrows displayed by the function meter increases steadily from 1 to 5.
6. Turn the PRC-2200 under test OFF.

(b) Power output level meter.

1. Connect the test setup as shown in Figure 3-2.
2. Set the PRC-2200 under test to USB, CW.
3. Verify that the power supply voltage, measured in the transmit mode at the PRC-2200 battery posts, is 13.5VDC.
4. Tune the PRC-2200 under test to 16.0000MHz.
5. Set the transmit output of the PRC-2200 under test to 5W.
6. Place the PRC-2200 under test into transmission by activating the PTT (VOICE) in the interface box.
7. Check that 1 or 2 arrows appear on the LEVEL display.
8. Deactivate the PTT (VOICE) in the interface box.
9. Set the transmit output power of the PRC-2200 under test to 10W.

10. Place the PRC-2200 under test into transmission by activating the PTT (VOICE) in the interface box.
11. Check that the number of arrows appearing on the LEVEL display is 2 to 4.
12. Deactivate the PTT (VOICE) switch in the interface box.
13. Set the transmit output power of the PRC-2200 under test to 20W.
14. Place the PRC-2200 under test into transmission by activating the PTT (VOICE) in the interface box.
15. Check that the number of arrows appearing on the LEVEL display is 4 or 5.
16. Deactivate the PTT (VOICE) switch in the interface box and turn the PRC-2200 under test OFF.

(c) Battery condition indication.

1. Connect the test setup as shown in Figure 3-2.
2. Verify that the supply voltage, measured at the PRC-2200 battery posts, is 13.5VDC.
3. Set the PRC-2200 under test to CLR and SQ-OFF.
4. Select the VOICE mode.
5. Tune the PRC-2200 under test to 16.000MHz.
6. Press the TEST key until the message BATT appears, then press ENT.
7. Vary slowly the supply voltage, measured at the PRC-2200 battery posts, from 10.5 to 14.5V, and check that the number of arrows appearing on the LEVEL display increases steadily from 1 to 5.
8. Turn the PRC-2200 under test OFF.

(3) Frequency accuracy.

(a) Connect the test setup as shown in Figure 3-3.
(b) Verify that the supply voltage, measured at the PRC-2200 battery posts, is 13.5VDC.
(c) Set the PRC-2200 under test to CLR and SQ-OFF, CW, USB.
(d) Tune the PRC-2200 under test to 16.000MHz.

(e) Place the PRC-2200 under test into transmission by activating the PTT (VOICE) switch on the interface box.

(f) Measure the frequency. The frequency shall be within 16.001000 $\pm$16Hz.

(g) Turn the PRC-2200 under test OFF.

(4) Receiver sensitivity.

(a) Set the PRC-2200 under test to CLR and SQ-OFF.

(b) Connect the test setup as shown in Figure 3-1.

(c) Verify that the supply voltage, measured in the receive mode at the PRC-2200 battery posts, is 13.5VDC.

(d) Set the PRC-2200 under test to USB, VOICE.

(e) Connect the audio analyzer to the RXBB output on the interface box.

(f) Tune the PRC-2200 under test to 1.5MHz (F_o).

(g) Set signal generator frequency to (F_o+1kHz).

(h) Set signal generator level to 0.7 microvolts.

(i) Measure SINAD using the audio analyzer. The SINAD shall be at least 10dB.

(j) Repeat the measurements for all the following test frequencies: 2.0000, 4.2222, 7.5555, 10.8888, 13.2222, 20.7000, 29.9100MHz.

(k) Select the CW mode, and repeat steps (f) thru (i).

(l) Select the CCW mode and repeat steps (f) thru (i) with signal generator level adjusted to 0.7 microvolts.

(m) Set the PRC-2200 under test to LSB, VOICE tune its frequency to 13.2222MHz (F_o) and the frequency of the signal generator to (F_o-1kHz).

(n) Repeat step h. thru i.

(o) Turn the PRC-2200 under test OFF.

(5) Receiver audio output.

(a) Set the PRC-2200 under test to CLR and SQ-OFF.

(b) Connect the test setup as shown in Figure 3-1.

(c) Verify that the supply output voltage, measured in the receive mode at the PRC-2200 battery posts, is 13.5VDC.

(d) Tune the PRC-2200 under test to 16.0000MHz and set the modulation to USB, VOICE.

(e) Set signal generator frequency to 16.001MHz.

(f) Adjust signal generator to 0.7 uV.

(g) Adjust the volume control of the PRC-2200 under test to maximum.

(h) Measure the audio output by means of the audio analyzer connected to the phone output: it should be 3VRMS/50ohm minimum.

(i) Select the CCW mode and repeat step (h).

(j) Select the VOICE mode with the audio analyzer connected to the RXBB output. The output level should be 0.5VRMS minimum.

(k) Set the PRC-2200 under test to LSB, and tune the signal generator to 15.9990MHz. With the audio analyzer connected to the PHONE output, repeat step (h).

(l) Connect the audio analyzer to the RXBB output. The output level should be 0.5VRMS minimum.

(m) Turn the PRC-2200 under test OFF.

(6) Transmitter output power.

(a) Connect the test setup as shown in Figure 3-4.

(b) Verify that the supply voltage, measured during transmission (CW mode) at the PRC-2200 battery posts, is 13.5VDC.

(c) Adjust audio generator frequency to 800Hz.

(d) Set the PRC-2200 under test to CLR and SQ-OFF. Adjust the microphone input voltage of the PRC-2200 under test to 5mVRMS.

(e) Set the PRC-2200 under test to USB, VOICE.

(f) On the PRC-2200 under test, select an output power of 20W.

(g) Tune the PRC-2200 under test to 1.5000MHz.

(h) Place the PRC-2200 under test into transmission by activating the PTT (VOICE) switch on interface box.

(i) Measure the output power on the RF millivoltmeter: it should be 42 to 44dBm.

(j) Release the PTT switch of the interface box.

(k) Repeat the test at the following test frequencies: 1.5000, 2.0000, 4.2222, 7.5555, 10.8888, 13.2222, 20.7000, 29.9100MHz.

(l) Tune the PRC-2200 under test to 20.700MHz.

(m) Set the PRC-2200 under test to LSB and repeat steps (h) thru (j).

(n) Set the PRC-2200 under test to AM and repeat steps (h) thru (j). The output power should be 42 to 45dBm.

(o) Select the CW mode on the PRC-2200 under test and repeat steps (h) thru (j).

(p) Select the CCW mode on the PRC-2200 under test and repeat steps (h) thru (j).

(q) Adjust audio analyzer output to 0dBm while connected to the TXBB input on the interface box.

(r) Repeat steps (e) thru (k) using the PTT (DATA) switch.

(s) Turn the PRC-2200 under test OFF.

(7) WHIP output power.

(a) Connect the test setup as shown in Figure 3-5.

(b) Verify that the supply voltage, measured during transmission (CW mode) at the PRC-2200 battery posts, is 13.5VDC.

(c) Set the WHIP/DIP switch to WHIP.

(d) Set the PRC-2200 under test to USB, CW.

(e) Tune the PRC-2200 under test to 1.5MHz.

(f) Place the PRC-2200 under test into transmission by activating the PTT (VOICE) switch on the interface box.

(g) Measure the output power on the RF millivoltmeter. Add the whip simulator correction factor, 1.2dB, to the measured level. The result should be at least 34dBm.

(h) Repeat the test at the following test frequencies: 4.9900, 5.0000, 6.5000, 7.9900, 8.0000, 9.0000, 9.9000, 11.5000, 12.9990, 13.0000, 15.0000, 16.9999, 17.0000MHz.
The result (after adding 1.2dB) should be at least 36dBm.

(i) Repeat the test at the following test frequencies: 2.0000, 2.5000, 4.5000, 19.0000, 21.9990, 25.0000, 29.9999MHz. The result (after adding 1.2dB) should be at least 38dBm.

(j) Deactivate the PTT (VOICE) switch in the interface box and turn off the PRC-2200 under test.

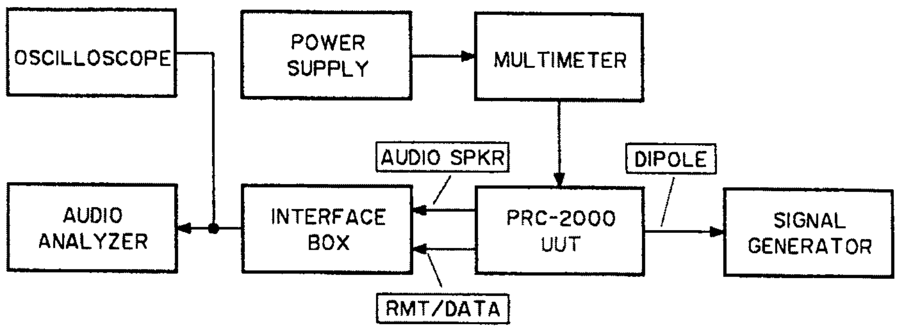

Figure 3-1. Test Set-up No. 1

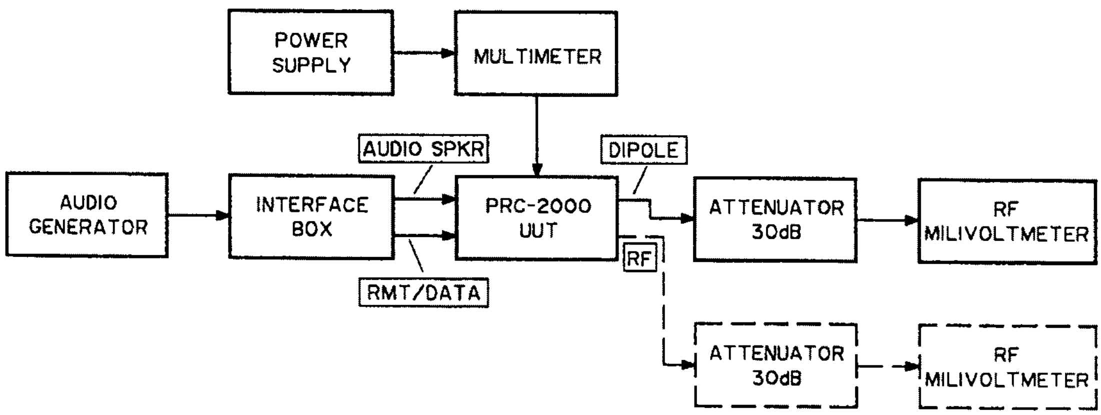

Figure 3-2. Test Set-up No. 2

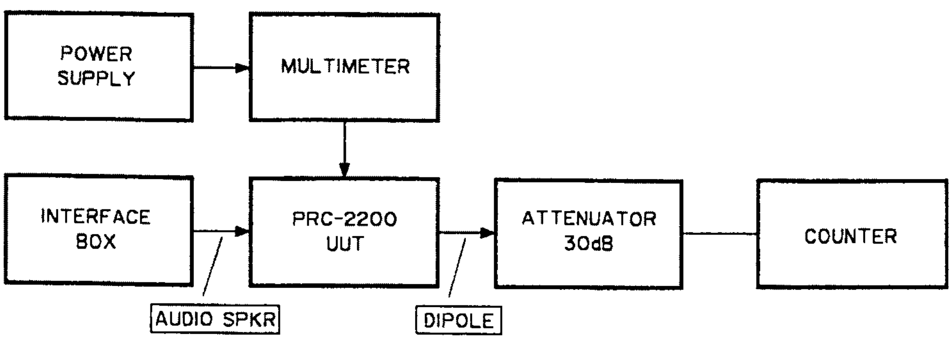

Figure 3-3. Test Set-up No. 3

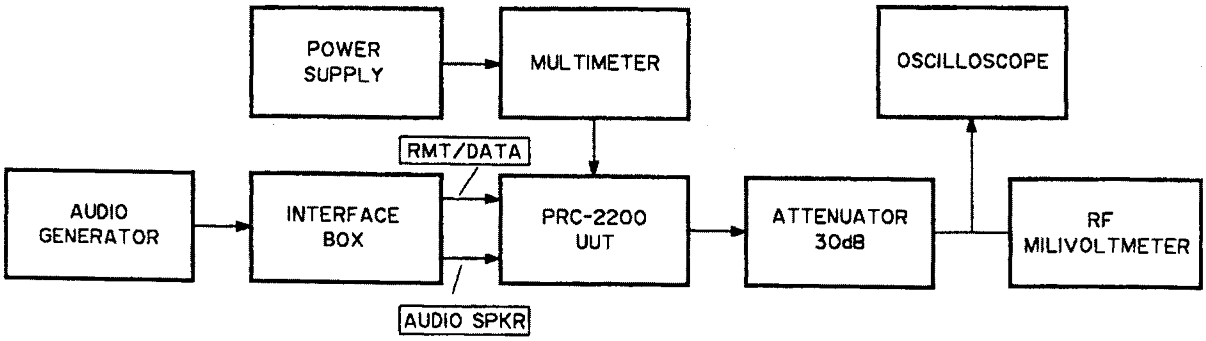

Figure 3-4. Test Set-up No. 4

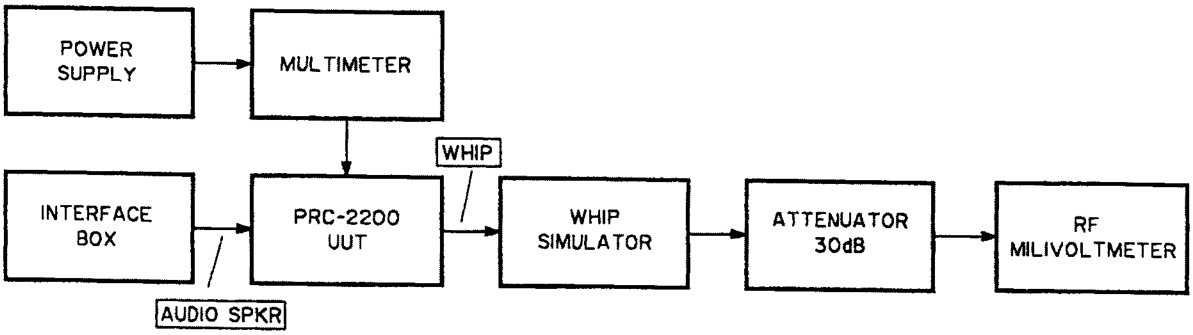

Figure 3-5. Test Set-up No. 5

3-6. Functional Test Procedures

a. General. This paragraph provides functional test procedures for the PRC-2200, consisting of: RT-2001A P/N 2187-09010-30, CP-2003 P/N 2187-09100-00. The test shall be performed after completing the tests of para. 3-5 when applicable. If you are not familiar with PRC-2200 operating procedure, refer to the PRC-2200 operator manual. Record any malfunction found during the test procedure and refer to Section III: "TROUBLESHOOTING PROCEDURES" for systematic troubleshooting instructions.

b. Preparation for Test. The test set-up for the tests described in para. c.(1) to (15) below comprises a PRC-2200 under test and an approved PRC-2200 that serves as a reference unit. Prepare the two PRC-2200 units for operation as follows:

(1) Connect the appropriate accessories to both PRC-2200 units.

(2) Perform battery test on the PRC-2200 under test: press twice the TEST key, press ENTER and verify that the battery is full (BATT-OK message and 4 or 5 arrows on the LEVEL display).

(3) Erase the contents of the battery protected memory of both PRC-2200 units by setting the function selector to the ERS position (pull and turn) and then pressing the ENT key. After erasing, set the function selectors of both units to OFF and then to CLR.

(4) Press the TIME key and verify that the correct time-of-day (TOD) and date are loaded. If both, time and date are incorrect, load it yourself according to the test performance time.

(5) Set the channel selector of both PRC-2200 units to M.

(6) Tune both PRC-2200 units to 2.2200MHz.

(7) Connect whip antennas to both units and set their WHIP/DIP switch to WHIP.

After completing the preparations, perform the tests described in para. c. below:

- The tests described in para. (1) thru (5) are performed only on the PRC-2200 under-test.

- The tests described in para. (6) thru (16) are communication tests which are performed using the two PRC-2200 units, located at a distance of approximately 50 meters.

c. Test Procedures.

Safety Precautions

1. Communication tests must be performed only with fully extended antennas.

2. Transmission times should be kept as short as possible.

(1) Channel selector.

(a) Sequentially set the channel selector to each of its positions. Check that at positions 1 thru 8, the numbers 01 thru 08 are displayed, respectively, and that the number 19 is displayed at the KB position.

(b) Set the channel selector to M. Check that the number 00 is displayed.

(2) LEDs, lighting and function selector.

(a) Press the LITE key several times until the message LITE ON appears on the display, then press ENT.

(b) Sequentially set the function selector to CLR, SEC and AJ. Check that at each position the corresponding LED lights and that the keypad and display lighting is activated.

(c) Set the function selector to RMT. Check that the lighting is turned off and the message REMOTE appears on the display.

(d) Set the function selector to CLR.

(3) Control handset.

(a) Connect the control handset to the 6-pin connector,CONT/AUDIO.

(b) On the PRC-2200 under test, set the channel selector to M and the function selector to CLR.

(c) Press LITE key several time until the message LITE LED appears, then press ENT.

(d) Set the control handset channel selector to PNL. Check that the number 00 (channel M on the front panel channel selector) appears on the channel display.

(e) Sequentially set the control handset channel selector to each of its positions. Check that the appropriate channel number appears on the display.

(f) Set the control handset channel selector to PNL.

(g) Set the control handset function selector to PNL. Check that the CLR LED lights (according to the position of the front panel function selector).

(h) Sequentially set the control handset function selector to CLR, SEC and AJ. Check that at each position the corresponding LED lights.

(i) Set the control handset function selector to PNL.

(4) Backup battery.

(a) Turn off the PRC-2200 under test for 1 minute.

(b) Turn on the PRC-2200 under test. Check that the frequency is 2.2200MHz (as set in the preparation for test - para. b.(6) above) and that the time-of-day (TOD) is correct.

(5) NO-MATCH indication.

(a) Tune the PRC-2200 under test to 1.5000MHz.

(b) Set the WHIP/DIP switch on the CP-2003 to DIPOLE.

(c) Press the PTT on the handset.

(d) Check that NO-MATCH is displayed and a beep is heard in the handset earphone (or loudspeaker).

(e) Tune the PRC-2200 under test to 2.2200MHz.

(f) Set the WHIP/DIP switch to WHIP.

(g) Press the PTT on the handset.

(h) Check that the NO-MATCH indication does not appear.

(6) Communication test - SQ-OFF, VOICE, USB.

(a) Set the two PRC-2200 units to USB, VOICE, SQ-OFF mode on channel M.

(b) On both units, adjust the volume controls for a convenient listening level.

(c) Press PTT on handset H-250/GR of the PRC-2200 unit under-test, and count to 10. Check for normal indications and that the numbers are clearly received by the approved PRC-2200 unit.

(d) Repeat step (c) above for activating transmission from the approved PRC-2200 unit to the PRC-2200 under test.

(e) Repeat steps (c) and (d) above for the frequencies of 1.7777MHz, 16.4444MHz, and 29.9000MHz.

(f) Set both PRC-2200 unit to a frequency of 2.2200MHz.

(7) Communication test - AM, VOICE, SQ-OFF.

(a) Set the two PRC-2200 units to AM, VOICE, SQ-OFF.

(b) On both units, adjust the volume controls for a convenient listening level.

(c) Perform a communication test on channel M. Check for normal indications and good reception.

(8) Communication test - SQ-OFF, VOICE, LSB.

(a) Set the two PRC-2200 units to LSB, VOICE, SQ-OFF.

(b) Repeats para. (6) (c) and 6 (d) above on channel M.

(9) Communication test - SQ-OFF, CW, USB.

(a) Set the two PRC-2200 units to USB, CW, SQ-OFF.

(b) Perform a communication test as follows:

1. On both units, adjust the volume controls for a convenient listening level.

2. On the unit under test, activate transmission by short (approximately 0.5 second) and long (approximately 1 second) pressings on the handset PTT.

3. Listen for corresponding short and long beeps on the handsets of both PRC-2200 units.

(c) Repeat the communication test for activating transmission from the approved PRC-2200 unit to the PRC-2200 under test.

(10) Communication test - USB, VOICE, SQ-SYLABIC.

(a) Set the two PRC-2200 units to USB,VOICE,SQ-SYLAB on channel M.

(b) On both units, adjust the volume controls for a convenient listening level.

(c) Perform a communication test as follows:

1. After changing the operating mode, wait for a few seconds until the syllabic squelch of both units close (silence).

2. Transmit a message from the PRC-2200 under test to the approved PRC-2200 unit in accordance with para. (6) (c) above.

3. On the approved PRC-2200, check for normal indications and good reception. Pay attention that the first syllabes are also received. Wait for a few seconds after reception is ended, until the syllabic squelch is closed (silence).

4. After a few more seconds of silence, transmit a message from the operator of the approved PRC-2200 unit to the PRC-2200 under test in accordance with para. (6) (c) above.

5. On the PRC-2200 under test, check for normal indications and good reception. Pay attention that the first syllabes are also received. Check that the syllabic squelch is closed a few seconds after the reception is ended.

(11) Communication test - SQ-SEL.C.

(a) Set the two PRC-2200 units to SEL.C.

(b) Set the PRC-2200 under test to channel 1 and the approved PRC-2200 to channel 2. Perform a communication test and check for normal indications and for appropriate transmission and reception addresses on the two channels.

(c) Repeat para. (6) (c) and (6) (d) above for this mode.

(d) Repeat the communication test in accordance with step (c) above for frequencies of 6.6666, 19.7777 and 25.1111MHz.

(e) Set the two PRC-2200 units to CW, and perform a communication test as described in para. (9) (b) and (c). Perform the test only at one frequency, for example 25.1111MHz.

(f) Set the two PRC-2200 units to a frequency of 4.2222MHz.

(12) Communication test - SEC.

(a) Set the two PRC-2200 units to SEC.

(b) Set the PRC-2200 under test to channel 1 and the approved PRC-2200 to channel 2. Perform a communication test and check for normal indications and good transmission and reception addresses on the two channels.

(c) Check that the same encryption keys are used on the two units on channels 1 and 2, respectively.

(d) Repeat para. (6) (c) and (d) above for this mode.

(e) Repeat para. (6) (b) above for 12.5555MHz.

(f) Set the two PRC-2200 units to CW mode, and perform a communication test as described in para. (9) (b) and (9) (c) above.

(g) Set both PRC-2200 unit to VOICE.

(h) Set both PRC-2200 units to a frequency of 4.2222MHz.

(13) Communication test - AUTO CALL.

(a) Set the PRC-2200 under test to channel 4 and the approved PRC-2200 to channel 5.

(b) Set the two PRC-2200 units to AUTO-1 and SCAN modes.

(c) Check that both PRC-2200 units display the appropriate transmission and reception addresses.

(d) On both PRC-2200 units, perform the LEARN procedure by momentarily pressing the handset PTT.

(e) Perform link establishment by pressing PTT in one of the units.

(f) Check that the message READY is displayed on both PRC-2200 units.

(g) Repeat para. (6) (c) and (6) (d) above.

(h) REPLACE procedure. To check communication on another frequency while maintaining the link with the other radio set, press the FRQ key of the PRC-2200 under test, then press ENT. After a short time, the link will switch to another frequency. Check that the message READY is displayed on both PRC-2200 units.

(i) Set the two PRC-2200 units to CW, and perform a communication test as described in para. (9) (b) and (9) (c) above.

(j) Perform the LINK DISCONNECT procedure by pressing the RST key on one PRC-2200 unit. Check for DISCONNECT messages on the display on the radio and for SCAN messages on the two PRC-2200 units.

(k) Set both PRC-2200 units to VOICE.

(14) Communication Test-FLASH.

(a) Set the PRC-2200 under test to channel 1 and the approved PRC-2200 to channel 2. Perform a communication test and check for normal indications and for appropriate transmission and reception addresses on the two channels.

(b) On the PRC-2200 under test, press the DATA key until the FLASH message appears on the FUNCTION display of the PRC-2200 unit.

(c) On the PRC-2200 under test, press the ENT key.

(d) On the PRC-2200 under test, enter three digits on the FREQUENCY display by pressing keys 1, 2 and 3 and then ENT.

(e) On the PRC-2200 under test, check that the message PRESS PTT appears on the display.

(f) On the PRC-2200 under test, press PTT.

(g) On the approved PRC-2200, check reception of message 1 2 3 on the FREQUENCY display and that the audio alert is activated.

(h) On the approved PRC-2200, press PTT. On the PRC-2200 under test, check that:

1. Message 1 2 3 is received on the FREQUENCY display.
2. The audio alert is activated.

(i) On the PRC-2200 under test, check that the ACK message appears on the display.

(j) On the PRC-2200 under test, press RST and check that the previous mode is displayed in the display of the PRC-2200 under test, and that the audio alerts stops in both PRC-2200 units.

(15) Communication Test - DUAL.

(a) Set the two PRC-2200 units to DUAL mode in accordance with the following procedure:

1. On both PRC-2200 units, set the CHANNEL selector to KB.

2. Set the PRC-2200 under test to channel 10 and the approved PRC-2200 to channel 11.

3. On both PRC-2200 units, press the PROG key until the message DUAL appears on the display of the unit, then press ENT.

(b) Perform a communication test as described in para. (6) (b), (c) and (d) above.

(c) On both PRC-2200 units, set the CHANNEL selector to M.

(16) Self-test (BIT).

(a) On the PRC-2200 under test set to channel selector to M and the function selector to CLR.

(b) Perform self-test.

1. On the PRC-2200 under test, press the TEST key until the BIT message is displayed, then press ENT.

2. On the PRC-2200 under test, check that the message TEST-OK! is displayed at the end of the BIT test.

3. On the PRC-2200 under test press PTT and press TEST key until the BIT message is displayed, then press ENT and immediately release the PTT.

4. On the PRC-2200 under test check that the message TEST-OK! is displayed at the end of the BIT test.

5. Check the contents of the BUG lists for the three options: HRD, PRSNT and PASS. Check that there are no malfunctions.

Section III. TROUBLESHOOTING

3-7. Preparation for Troubleshooting

The PRC-2200 has an extensive self-test and diagnostics facility, which is described in detail in para. 2-6. Before starting PRC-2200 troubleshooting, make sure you are thoroughly familiar with the use and technical details of the self-test and diagnostics facility.

a. <u>General Troubleshooting Procedures.</u>

(1) The first step in the troubleshooting of a defective PRC-2200 is to classify the problem according to the four categories listed below:

(a) Total failure: the PRC-2200 cannot receive, nor transmit.

(b) Transmit failure: the failure mainly affects the transmit functions (e.g. loss of output power, transmission of unmodulated carrier, no transmission in certain bands or frequencies, etc.).

(c) Receive failure: the failure mainly affects the receive functions (e.g. loss of sensitivity, squelch inoperative, distorted reception, etc.).

(d) Control system failure: failure is apparently related to the control interfacing and display functions (e.g. no display, incomplete display, no response to keyboard inputs, etc.)

(2) After broadly identifying the general category that best describes the failure, operate the self-test and diagnostics function as follows:

(a) Turn lighting on, select CLR operation and set CHANNEL selector to M.

(b) Activate the off-line test (BIT).

(c) To display alarm messages stored in the HRD-ERR table, perform the following actions:

1. Press the TEST key several times, until the message BUG LIST appears on the display, then press ENT.

2. Press TEST key until the message HRD-ERR is displayed, then press ENT.

3. The display now shows the first hardware failure code. To see the additional failure codes, press the TEST key. After the last code is displayed, or when no failures are detected, you will see END-OF-TB.

4. Repeat 1 thru 3 for the PRSNT-ERR, and PASS-ERR messages.

(d) To display the password-protected alarm messages, perform the following actions:

1. Press the TEST key until the message PASSWORD appears on the display, then press ENT.

2. Enter the number of the channel now in use. For example, enter 00 if channel M is selected. Enter 01 if CH1 is selected.

3. The message MC PASS will appear on the display. Press ENT: the message READY will appear.

4. Enter the number 07, then press ENT.

5. The message READY ON appears on the display, press the RST key.

6. To display the failures contained in the HRD-ERR table, perform the actions described in para.(a) thru (c) above.

NOTE

To display the password-protected fail messages CP FLT 30 thru CP FLT 97, related to fail message CP FLT 06, perform para. (d) above.
To display the password-protected alarm messages related to alarm messages RT FLT 01 thru RT FLT 15 see para (e) below.

Table 3-4 lists all the failure messages. The messages are arranged in alphabetic order.

NOTE

The malfunctions marked with an asterisk in parentheses (*) could also be caused by a malfunction in the self-test system, therefore modules MCU and MB should also be checked.

Table 3-4. Failure Codes

No.	FAIL Code or Message	Description and Probable Cause
1	ADC FAIL	A/D converter problem in the MCU module. Followed by TRNS FAIL message. Transmission is disabled. Indicates hardware problem in the MCU module.
2	ANT SLC	Antenna selector or connections are defective. Followed by CP FAIL message. Transmission is disabled. Indicates hardware problem in the CP-2003.
3	COMM FAIL	Failure in serial communication between module MCU and CP-2003. Check module MNC of CP-2003 (*).

Table 3-4. Failure Codes (Cont'd)

No.	FAIL Code or Message	Description and Probable Cause
4	CP DRIVE	CP-2003 sensors did not detect RF power during matching. Followed by NO MATCH message. Indicates hardware problem in the CP-2003 or in the transmit path.
5	CP FAIL	CP-2003 defective. Transmission is disabled.
6	CP FLT 01	Defective EPROM U23, address bus or data bus in module MNC.
7	CP FLT 02	Defective RAM U22, address bus or data bus in module MNC.
8	CP FLT 03	Defective I/O interface in module MNC. Check U6-9, U7-2, U20, CR6 and CR7 in module MNC.
9	CP FLT 04	WHIP/DIP selector does not operate properly. Check WHIP/DIP selector and buffer U7 (pins 4, 5) in module MNC.
10	CP FLT 05	The DC test of the CP-2003 RF switches cannot be activated: - Defective DC test circuit in module RF3. Check U3, Q6, Q40 and Q41. - Defective test control circuit in module MNC. Check U7-6, U7-7 and U12-19. - +12V is missing. - V1 (+5V/+2V) is shorted to ground.
11	CP FLT 06	Failure in the DC test of the CP-2003 RF switches. For more details refer to the password protected section of the BUG LIST (see para. 3-7(2)(c)).

Table 3-4. Failure Codes (Cont'd)

No.	FAIL Code or Message	Description and Probable Cause
12	CP FLT 30	Failure of I/O interface test, L3, latch U9-18 in module MNC
13	CP FLT 31	Failure of I/O interface test, C11, latch U8-6 in module MNC
14	CP FLT 32	Failure of I/O interface test, L9, latch U10-16 in module MNC
15	CP FLT 33	Failure of I/O interface test, ST5, latch U11-15 in module MNC
16	CP FLT 34	Failure of I/O interface test, C7, latch U12-2 in module MNC
17	CP FLT 66	WHIP/DIP switch does not operate properly. - Check U11 (pins 2 and 5) and U24 (pins 4, 6, 7 and 8) in module MNC. - Check K1 in module RF1.
18	CP FLT 67	The TUNE/NORM switch does not operate properly. - Check U1(3) and U5(16) in module MNC. - Check Q1, CR1, CR2, L27 and R91 in module RF3.
19	CP FLT 68	Tune control circuit and TUNE switch do not operate properly. - Check U1(4) and U24(14) in module MNC. - Check Q7, R4, Q2, CR3, CR4, L28, R90, Q3, CR5, CR6, L29 and R92 in module RF3.

Table 3-4. Failure Codes (Cont'd)

No.	FAIL Code or Message	Description and Probable Cause
20	CP FLT 69	BP1* switch does not operate properly. - Check U1(15) and U5(15) in module MNC. - Check Q4, CR7, CR8, L30 and R93 in module RF3.
21	CP FLT 70	The switch of capacitor C9 does not operate properly. - Check U8(2) in module MNC. - Check Q30, CR64, CR65, L52 and R116 in module RF2.
22	CP FLT 71	The switch of capacitor C10 does not operate properly. - Check U8(5) in module MNC. - Check Q29, CR62, CR63, L51 and R115 in module RF2.
23	CP FLT 72	The switch of capacitor C11 does not operate properly. - Check U8(6), U14(4) in module MNC. - Check Q27, CR54, CR55, CR71, L13, L45 and L46 in module RF2.
24	CP FLT 73	The switch of inductor L14 (LP1) does not operate properly. - Check U8(9) in module MNC. - Check Q8, L14, CR12, CR20, L32 and R5 in module RF2.
25	CP FLT 74	BP1 switch does not operate properly. - Check U11(6) in module MNC. - Check Q5, CR9, CR10, L31 and R94 in module RF3.

Table 3-4. Failure Codes (Cont'd)

No.	FAIL Code or Message	Description and Probable Cause
26	CP FLT 75	BP2 switch does not operate properly. - Check U11(9) in module MNC. - Check Q19, CR34, CR35, L36 and R95 in module RF3.
27	CP FLT 77	ST5 switch does not operate properly. - Check U11(15) in module MNC. - Check Q18, CR32, CR33, L35 and R96 in module RF3.
28	CP FLT 78	The switch of capacitor C12 does not operate properly. - Check U11(16) in module MNC. - Check Q16, CR28, CR29, R118 and L33 in module RF2.
29	CP FLT 79	The switch of capacitor C13 does not operate properly. - Check U11(19) in module MNC. - Check Q17, CR30, CR31, R119 and L34 in module RF2.
30	CP FLT 80	The switch of inductor L4 does not operate properly. - Check U9(19), U13(5) in module MNC. - Check Q33, CR80, CR81, L54, R70 and R78 in module RF1.

Table 3-4. Failure Codes (Cont'd)

No.	FAIL Code or Message	Description and Probable Cause
31	CP FLT 81	The switch of inductor L3 does not operate properly. - Check U9(18), U13(11) in module MNC. - Check Q34, CR82, CR83, CR84, CR85, L55 and R72 in module RF1. - If CP FLT 81 occurs together with CP FLT 66 and CP FLT 82 failures, check first the WHIP/DIP switch in module RF1.
32	CP FLT 82	The switch of inductor L2 does not operate properly. - Check U9(17), U13(13) in module MNC. - Check Q35, CR86, CR87, CR88, CR89, L56 and R73 in module RF1. - If CP FLT 82 occurs together with CP FLT 66 and CP FLT 81 failures, check first the WHIP/DIP switch in module RF1.
33	CP FLT 83	The switch of inductor L12 does not operate properly. - Check U10(19) in module MNC. - Check Q22, CR44, CR45, CR66 and L39 in module RF2.
34	CP FLT 84	The switch of inductor L11 does not operate properly. - Check U10(18) in module MNC. - Check Q23, CR46, CR47, CR67 and L40 in module RF2.

Table 3-4. Failure Codes (Cont'd)

No.	FAIL Code or Message	Description and Probable Cause
35	CP FLT 85	The switch of inductor L10 does not operate properly. - Check U10(17) in module MNC. - Check Q24, CR48, CR49, CR68 and L41 in module RF2.
36	CP FLT 86	The switch of inductor L9 does not operate properly. - Check U10(16) in module MNC. - Check Q25, CR50, CR51, CR69 and L42 in module RF2.
37	CP FLT 87	The switch of inductor L8 does not operate properly. - Check U10(15), U14(5) in module MNC. - Check Q26, CR52, CR53, CR70, L43 and L44 in module RF2.
38	CP FLT 88	The switch of inductor L7 does not operate properly. - Check U10(14), U14(11) in module MNC. - Check Q28, CR56, CR57, CR72, L47 and L48 in module RF2.
39	CP FLT 89	The switch of inductor L6 does not operate properly. - Check U10(13), U14(13) in module MNC. - Check Q31, CR58, CR59, CR73, L49 and L50 in module RF2.

Table 3-4. Failure Codes (Cont'd)

No.	FAIL Code or Message	Description and Probable Cause
40	CP FLT 90	The switch of inductor L5 does not operate properly. - Check U10(12), U13(4) in module MNC. - Check Q32, CR60, CR61, CR74, L53 and R69 in module RF2.
41	CP FLT 91	The switch of capacitor C7 does not operate properly. - Check U12(2) in module MNC. - Check Q9, CR13, CR21 and R6 in module RF2.
42	CP FLT 92	The switch of capacitor C6 does not operate properly. - Check U12(5) in module MNC. - Check Q10, CR14, CR22 and R7 in module RF2.
43	CP FLT 93	The switch of capacitor C5 does not operate properly. - Check U12(6) in module MNC. - Check Q11, CR15, CR23 and R8 in module RF2.
44	CP FLT 94	The switch of capacitor C4 does not operate properly. - Check U12(9) in module MNC. - Check Q12, CR16, CR24 and R9 in module RF2.

Table 3-4. Failure Codes (Cont'd)

No.	FAIL Code or Message	Description and Probable Cause
45	CP FLT 95	The switch of capacitor C3 does not operate properly. - Check U12(12) in module MNC. - Check Q13, CR17, CR25 and R10 in module RF2.
46	CP FLT 96	The switch of capacitor C2 does not operate properly. - Check U12(15) in module MNC. - Check Q14, CR18, CR26 and R11 in module RF2.
47	CP FLT 97	The switch of capacitor C1 does not operate properly. - Check U12(16) in module MNC. - Check Q15, CR19, CR27, R12 in module RF2.
48	CP MISING	No communication between the microprocessors in the MCU and MNC modules. Followed by PWR 0.1W message. Indicates hardware problem in the CP-2003 (*).
49	DEFLT CHN	The RT-2001 loads automatically the default parameters. Followed by LOAD PARM message. Check backup battery on module AUDIO.
50	FATAL FLT	Major problem that prevents normal operation. See suspected modules in BUG LIST (*).
51	FRQ FAIL	Frequency fault in the CP-2003. Followed by FATAL FLT message. Check the CP-2003, module MCU or module SYNT (*).

Table 3-4. Failure Codes (Cont'd)

No.	FAIL Code or Message	Description and Probable Cause
52	INV PARM	Parameter entered by the operator is invalid, e.g. a frequency out of range, selection of squelch off in secure operation, etc.
53	INV KEY	Operator pressed an invalid button on the keypad, e.g. a function key during frequency entry, etc.
54	INV KY/CS	SEC or AJ key entered by the operator is invalid and/or has incorrect checksum.
55	LOAD FAIL	Loading of parameters from a loader (G-10) or from another radio set failed. Check connections, loader, and modules PANEL and MCU in the radio.
56	LOAD PARM	Usually appears after activation of the ERS function. Indicates that the operational parameters were lost. If appearing without previously erasing the memory, may indicate problem with backup battery (in module AUDIO) or RAM, U11 in module MCU (*).
57	LOW BATT!	Supply voltage is too low. Transmission is disabled. Replace battery or troubleshoot power supply (PS) module (*)
58	LRN FAIL	Antenna matching problem, for AJ or AUTO operation, which causes VSWR larger than 3:1. Check antenna, CP-2003, module AM and module RF (*).

Table 3-4. Failure Codes (Cont'd)

No.	FAIL Code or Message	Description and Probable Cause
59	NO LOADER	Loading of parameters from a loader (G-10) or from another radio set failed. Check connections, loader, and modules PANEL and MCU in the radio.
60	NO MATCH	Antenna matching problem for CLR and SEC operation, causing the VSWR to exceed 3:1. Check antenna, CP-2003, module AM and module RF (*).
61	NO TARGET	Loading of parameters into another radio set or to (G-10) loader failed. Check connections, loader modules PANEL and MCU in the radio.
62	PS FAIL	Problem with +5V/+2V voltage on transmission. Indicates hardware problem in the CP-2003 or in the PS module (*).
63	PTT FAIL	Disconnection or short-circuit on the PTT line to the CP-2003. Followed by TRNS FAIL message. Transmission is disabled. Indicates hardware problem in the CP-2003 (*).
64	PWR FAIL	Before performing antenna matching, the RF output power differs slightly from the required level. This malfunction does not necessarily require corrective actions. Check modules AM, CP-2003 (*).

Table 3-4. Failure Codes (Cont'd)

No.	FAIL Code or Message	Description and Probable Cause
65	PWR 0.1W	If followed by FATAL FLT, check module AM *. If followed by CP MISING, check module CP *.
66	RT FLT 01	Failure in primary tests on CPU and RTC. Check module MCU. Check U4, U8 and inputs in module MCU (for more information see para (e) bellow).
67	RT FLT 02	Failure in CPU tests. Check module MCU. Check U4, U6, U30 in module MCU. (For more information see para. (e) below).
68	RT FLT 03	Failure in DC voltages test: +5V, -5V, +12V in module AUDIO. Check modules AUDIO, MCU, PS (*). Check U8, U30, U29 in module MCU. (For more information see para. (e) below).
69	RT FLT 04	Failure in INT SW, INT MC interrupt tests. Check module MCU. Check U4, U8, U9 in module MCU. (For more information see para. (e) below).
70	RT FLT 05	Failure in RAM tests. Check module MCU. Check U6, U4, U1, U2, U3, U7 in module MCU. (For more information see para. (e) below).

Table 3-4. Failure Codes (Cont'd)

No.	FAIL Code or Message	Description and Probable Cause
71	RT FLT 06	Failure in PGA-XC3042 loops tests INT BIT, UNLOCK/NMI. Check modules MCU, SYNTHESIZER, CP (*). Check U8, U9, U30, U4 in module MCU. Check U6 in module MB. (For more information see para. (e) below).
72	RT FLT 07	Failure in LSI TIMING and interface circuits tests. Check module MCU. Check U8, U9, U4 in module MCU. (For more information see para. (e) below).
73	RT FLT 08	Failure in PANEL port test. Check modules MCU, PANEL. Check U30 in module MCU, U3 in module DISPLAY. (For more information see para. (e) below).
74	RT FLT 09	Failure in FSK TIMERS on CPU and loops test. Check module MCU. Check U4, U30, U8, U9 in module MCU. (For more information see para. (e) below).
75	RT FLT 10	Failure in FSK tones loops test. Check modules AUDIO, MCU (*). (For more information see para. (e) below).
76	RT FLT 11	Failure in 1KHz CW tone loops test. Check modules AUDIO, MCU, SYNTHESIZER (*). Check the path of the 10KHz signal from SYNTHESIZER module to AUDIO. (For more information see para. (e) below).

Table 3-4. Failure Codes (Cont'd)

No.	FAIL Code or Message	Description and Probable Cause
77	RT FLT 12	Failure in CODEC and DMA loops tests. Check modules MCU, AUDIO (*). (For more information see para. (e) below).
78	RT FLT 13	Failure in LPF1 and LPF2 loops tests. Check modules MCU, AUDIO (*). (For more information see para. (e) below).
79	RT FLT 14	Failure in EPROM test. Check module MCU. Check U5, U7, U4 in module MCU. (For more information see para. (e) below).
80	RT FLT 15	Failure in WATCH DOG test. Check module MCU. Check U30, reset line to U30, U29 in module MCU. (For more information see para. (e) below).
81	RT FLT 61	Failure in USB and RF FILTER No. 1 on S-METER, in RECEIVE test. Check modules RF, IF (*).
82	RT FLT 62	Failure in USB and RF FILTER No. 2 on S-METER, in RECEIVE test. Check modules RF, IF (*).
83	RT FLT 63	Failure in USB and RF FILTER No. 3 on S-METER, in RECEIVE test. Check modules RF, IF (*).

Table 3-4. Failure Codes (Cont'd)

No.	FAIL Code or Message	Description and Probable Cause
84	RT FLT 64	Failure in USB and RF FILTER No. 4 on S-METER, in RECEIVE test. Check modules RF, IF (*).
85	RT FLT 65	Failure in USB and RF FILTER No. 5 on S-METER, in RECEIVE test. Check modules RF, IF (*).
86	RT FLT 66	Failure in USB and RF FILTER No. 6 on S-METER, in RECEIVE test. Check modules RF, IF (*).
87	RT FLT 67	Failure in USB and RF FILTER No. 7 on S-METER, in RECEIVE test. Check modules RF, IF (*).
88	RT FLT 68	Failure in LSB and RF FILTER No. 6 on S-METER, in RECEIVE test. Check modules RF, IF (*).
89	RT FLT 69	Failure in IF-IO-LEVEL in TRANSMIT test. Check modules AUDIO, IF (*).
90	RT FLT 70	Failure in AM-ENVELOPE in TRANSMIT test. Check modules IF, AM (*).
91	RT FLT 71	Failure in SIGNALING test. Check modules AUDIO, MCU.

Table 3-4. Failure Codes (Cont'd)

No.	FAIL Code or Message	Description and Probable Cause
92	RT FLT 72	Failure in SIDE TONE test. Check modules AUDIO, MCU.
93	RT FLT 73	Failure in module AM existance test (5V test on module AM). Check module AM (*).
94	RT FLT 74	Failure in AM CURRENT test in receive. Check module AM (*).
95	RT FLT 75	Failure in AM CURRENT measurement in transmit. Check module AM (*).
96	RT FLT 76	Failure in LEARN FAIL on transmit BIT test. Check module CP (*). See other possible failures in BUG-LIST.
97	RT FLT 77	Failure in POWER on transmit BIT test. Check module AM (*). See other possible failures in BUG-LIST.
98	RT FLT 78	Failure in module RF existance test (PTT line check). Check module RF (*).
99	RT FLT 79	Failure in module IF existance test (IF DC voltages measurement on IF-AM-METER). Check module IF (*).

Table 3-4. Failure Codes (Cont'd)

No.	FAIL Code or Message	Description and Probable Cause
100	RT FLT 80	Failure in ADC on end of conversion tests. Check module MCU.
101	RT FLT 81	Failure in +5V measurement. Check module PS (*).
102	RT FLT 82	Failure in Main battery 12V test. Same as in message No. 57. Check main battery. Check module PS (*).
103	RT FLT 83	Failure in BACKUP BATTERY test. Check backup battery in module AUDIO (*).
104	RT FLT 84	Failure in MB test No. 4. Check modules MB, MCU. Check U1, U5 in module MB.
105	RT FLT 85	Failure in MB test No. 3 (power control). Check modules MB, MCU. Check U2, U5 in module MB.
106	RT FLT 86	Failure in MB test No. 2 (RST AGC control). Check modules MB, MCU. Check U3, U5 in module MB.
107	RT FLT 87	Failure in MB test No. 1 (PTT OUT control). Check modules MB, MCU. Check U4, U5 in module MB.

Table 3-4. Failure Codes (Cont'd)

No.	FAIL Code or Message	Description and Probable Cause
108	RT FLT 89	Failure in RECEIVE test on PHONE (AUDIO OUTPUT POWER test). Check modules AUDIO, IF (*).
109	RT FLT 90	Failure in RECEIVE current measurement. Hardware problem which causes ADC failure and disables transmission. Check module PS, any module (*).
110	RT FLT 91	Failure in module AUDIO existance test (5V measurement AUDIO module). Check module AUDIO (*).
111	RTSF FAIL	Failure of serial communication between module MCU and the external equipment connected to the RMT/DATA connector. COMM REQ FRONT line is active constantly. - Check connection to external equipment. - Check modules PANEL and MCU.
112	RTSR FAIL	Failure of serial communication between module MCU and CP-2003, via the rear connector. COMM REQ REAR line is active constantly. Check CP-2003 (*).
113	SILENT	Operator pressed PTT when the radio set is in the receive-only (RCV ONLY) state.

Table 3-4. Failure Codes (Cont'd)

No.	FAIL Code or Message	Description and Probable Cause
114	TRNS FAIL	1. Major transmitter hardware problem, which disables transmission. May also appear when a fault does not allow antenna matching. See suspected modules in BUG LIST. - Check antenna, CP-2003 and modules AM, RF (*). or 2. Battery not able to supply power for transmission.
115	UNLOCK	Synthesizer unlocked. Transmission is disabled. Check module SYNT and CP-2003 (*).
116	USE H/S	The control handset is connected to the radio set, and its selectors are not at the PNL (PANEL) position, but the operator used a front panel control.

(e) Table 3-5 lists the password-protected alarm coded messages related to alarm messages RT FLT 01 thru RT FLT 15 that are described in Table 3-4. The password-protected alarm coded messages listed in Table 3-5 are listed to be used for troubleshooting at D level senior technicians who have been trained and are proficient in performing depot-level maintenance on this type of electronic equipment.

To display the password-protected alarm coded messages that are listed in Table 3-5, perform the following procedure:

1. Press the TEST key several times, until the message PASSWORD appears on the display, then press ENT.

2. Enter the number of the channel now in use (00-19), then press ENT. The message MC PASS will appear on the display.

3. Press TEST key until 'AJ PASS' appears on the display.

4. Press ENT. The message READY will appear on the display.

5. Enter 52 and then press ENT.

6. A message that has a format XXXX=CD AB shall appear on the display. This message comprises two alarm code fields, AB and CD. For the interpretation of these alarm codes, see table 3-5.

7. If the content of field AB is "FF", this indicates that there are no more alarms - press RST.

8. If the content of field CD is FF:

   a. Record the content of the AB field (this is the last alarm).
   b. Press the RST key.

9. If the contents of fields AB and CD differ from FF act as follows:

   a. Record the content of the AB and of the CD fields.
   b. There are additional alarm codes. To display the additional alarm codes press 41, then ENT.

NOTE

The malfunctions marked with an asterisk could also be caused by a malfunction in the self-test system, therefore, modules MCU and MB should also be checked.

Table 3-5. Password Protected Failure Codes

Message and Recommended action in Table 3-4	Activated by Failure Code	Interpretation, Probable Cause and Recommended Action
RT FLT 01 (Check module MCU)	11	No change in Real Time Clock (RTC). In module MCU check LSI timing U8 and the following inputs to U8: - U8-2 for 560 KHz - U8-66 for 2688 KHz - U8-83 for 32 KHz. If input signals do not exist, check U30.
	12	Failure in LSI timing (U8) or CPU (U4) in module MCU. Data reading from RTC not good: check U8. Failure in CPU interrupt controller: check U4.
	13-15	Failure in CPU timer: In module MCU check U4.
RT FLT 02 (Check module MCU)	21	Failure in CPU register. In module MCU check U4.
	22-23	Failure in DMA 0: In module MCU check U4, U6 and U30.
	24-25	Failure in DMA 1: In module MCU check U4, U6 and U30.

Table 3-5. Password Protected Failure Codes (Cont'd)

Message and Recommended action in Table 3-4	Activated by Failure Code	Interpretation, Probable Cause and Recommended Action
RF FLT 03 (Check modules AUDIO, MCU, PS)	31	Failure in voltage measurement in module AUDIO. Failure in measurement of ripple on DC voltages +5V, -5V, +12V.
	32	Failure in voltage measurement in module AUDIO. Failure in measurement of DC voltages: +5V, -5V, +12V.
	33	Failure in voltage measurement in module AUDIO. Failure in measurement of DC voltages: +5V, -5V.
RF FLT 04 (Check module MCU)	41	Failure of INT SW on interrupt test. In module MCU check U8, U9, U4.
	42	Failure of INT MC on interrupt test. In module MCU check U8, U9, U4.
RF FLT 05 (Check module MCU)	51	Failure in RAM write/read test. In module MCU check U6, U4.
	52	Failure in RAM address test. In module MCU check U6, U4, U1, U2, U3.
	53	Failure in RAM 1K full test. In module MCU check U6, U4.
	54	Failure in RAM 32K full test. In module MCU check U6, U4.
	55	Failure in RAM overlap test. In module MCU check U6, U4, U7.

Table 3-5. Password Protected Failure Codes (Cont'd)

Message and Recommended action in Table 3-4	Activated by Failure Code	Interpretation, Probable Cause and Recommended Action
RT FLT 06 (Check modules MCU, SYNT, CP, MB)	61	Failure of U30 in INT BIT test. In module MCU check U8, U9, U4, U30.
	63	Failure in UNLOCK port test (frequency bus data is valid). In module MCU check U8, U9, U4, U30.
	64	Failure in NMI interrupt test (frequency bus data is not valid). In module MCU check U8, U9, U4, U30.
	65	Failure in UNLOCK port test (frequency bus data is not valid). In module MCU check U8, U9, U4, U30.
RT FLT 07 (Check module MCU)	72-75	Failure in LSI TIMING internal clocks or in counters test. In module MCU check the following inputs to U8: - U8-2 for 560 kHz - U8-66 for 2688 kHz - U8-83 for 32 kHz. In module MCU check U8, U9.
	76-78	Failure in LSI timing test using U30. In module MCU check the following inputs to U8: - U8-2 for 560 kHz - U8-66 for 2688 kHz - U8-83 for 32 kHz. In module MCU check U8, U9, U30.
RT FLT 08 (Check modules MCU, PANEL)	81	Failure in PANEL port test. In module MCU check U30[in module DISPLAY check U3.

Table 3-5. Password Protected Failure Codes (Cont'd)

Message and Recommended action in Table 3-4	Activated by Failure Code	Interpretation, Probable Cause and Recommended Action
RT FLT 09 (Check module MCU)	91-97	Failure in FSK timers on CPU and loops test. In module MCU check U4, U30, U8, U9.
RT FLT 10 (Check modules AUDIO, MCU, (*))	A1-AA	Test FSK tones loops. If tones do not appear on FSK GEN line (module AUDIO, P1-43), check module MCU. <u>A1, A2, A3, A5 alarm codes:</u> Each time one of these alarm codes is displayed it indicates a failure in a tone test on the following path: FSK GEN line, module AUDIO: LPF 3.5KHz (U6-7), TX selector (U3), TR combiner (U17-13, 14) ALC bypass (U16-3), BIT-2 line, input selector (U1), G1 line to BPF (U8), detectors CODEC input selector (U15) and back to MCU module via line CODEC IN, according to the following codes:
	A1	Failure in 2.4 kHz tone test in the above described path.
	A2	Failure in 2.7 kHz tone test in the above described path.
	A3	Failure in 3.0 kHz tone test in the above described path.
	A5	Failure in 3.3 kHz tone test in the above described path.
		<u>A4, A6, A7, A8 alarm codes:</u> Each time one of these alarm codes is displayed, it indicates a failure in the following path of the FSK tones:

Table 3-5. Password Protected Failure Codes (Cont'd)

Message and Recommended action in Table 3-4	Activated by Failure Code	Interpretation, Probable Cause and Recommended Action
RT FLT 10 (Cont'd)		FSK GEN line,SPF 3150Hz, HTX selector (U10), TR combiner (U17-3),ALC bypass (U16-3), BIT-2 line, input selector (U1), G1 line to BPF (U8), detectors CODEC input selector (U15) and back to MCU module via line CODEC IN, according to the following codes:
	A4	Failure in 3.0 kHz tone test on the above described path.
	A6	Failure in 3.3 kHz tone test or in selector U10 and controls test in the above described path.
	A7	Failure in 3.3 kHz tone test in the above described path.
	A8	Failure in 3.3 kHz tone test within the ALC circuit (U16-5), in the above described path.
		A9 and AA alarm codes indicate a failure in the test performed by comparing two tones in the following path from module MCU to module AUDIO: FSK GEN line, LPF 3.500 Hz, TX selector U3, TR combiner, U16-3, BIT-2 line, U1, G1 line to U8, detector, LOH switch (U23), comparator (U13), HARD FSK line and back to TIMING circuit on module MCU, according to the following failure codes:
	A9	Failure in activated 3.3 kHz tone, compared to not activated 3.0 kHz tone. "1" logic (+5V) expected on HARD FSK line (pin 31) if test is good.
	AA	Failure in activated 3.0 kHz tone, compared to not activated 3.3 kHz tone. "0" logic (0V) expected on HARD FSK line (pin 31) if test is good.

Table 3-5. Password Protected Failure Codes (Cont'd)

Message and Recommended action in Table 3-4	Activated by Failure Code	Interpretation, Probable Cause and Recommended Action
RT FLT 11 (Check modules AUDIO, MCU, SYNTHESIZER, (*))		Check the 10 kHz signal path from module SYNTHESIZER to module AUDIO (pin 29) divider to 1 kHz (U22), line CW GEN, BPF 1 kHz (U6), TX selector (U3), TR combiner (U17), ALC BYPASS (U16-3), BIT-2 line, input selector (U1), LPF1 (U14), line LPF OUT, codec input selector (U15), and via line CODEC IN to the MCU module. If the above loop is good, check module MCU.
	B1	Failure in 1 kHz tone test in the above described path.
	B2	Failure in TX0 control to TX selector test: check TX0 control circuit or selector.
	B3	Failure in TX1 control to TX selector test: check TX1 control circuit or selector.
	B4	Failure in testing the FOR (Front or Rear) control to input selector. Check FOR control or selector.
	B5	Failure in DOV (Data or Voice) control to input selector test: Check DOV control or selector.
	B6	Failure in FMI control to input selector test: Check control or selector.
	B7	Failure in ALC BY control to ALC bypass selector test: Check control or selector.

Table 3-5. Password Protected Failure Codes (Cont'd)

Message and Recommended action in Table 3-4	Activated by Failure Code	Interpretation, Probable Cause and Recommended Action
RT FLT 12 (Check modules MCU, AUDIO, (*))	C1	Failure in CODEC and DMA loops test in the following loop: 3.0 kHz tone from module MCU via line CODEC OUT to CODEC input selector (U15) in module AUDIO and back to module MCU via line CODEC IN. If the loop is good, check module MCU.
RT FLT 13 (Check modules MCU, AUDIO, (*))	D1-D7	Failure in LPF1 and LPF2 loops test in the following loop: 2.7 KHz signal from MCU module via line CODEC OUT to AUDIO module, LPF2 (U18), VO line, TX SELECTOR (U3), TR COMBINER (U17), ALC BYPASS (U16-3), line BIT-2, INPUT SELECTOR (U1), LPF1 (U14), line LPF1 OUT, INPUT SELECTOR CODEC (U15), back to MCU module through line CODEC IN, according to the following alarm codes:
	D1-D3	Failure in LPF1 loop test.
	D4-D7	Failure in LPF2 loop test.
RT FLT 14	E1, E2	Failure in EPROM (U5) test. In module MCU check U5, U7.
	E1	Failure in checksum test.
	E2	Failure in overlap test.
RT FLT 15	F1, F2	Failure in watchdog test. In module MCU check U30 and reset line to U30, U24.
	F1	Failure in watchdog test.
	F2	U30 does not receive reset.

3-8. Troubleshooting Instructions

a. Preparation for Troubleshooting. After gathering the relevant information, as explained in para. a. above, prepare the PRC-2200 for troubleshooting as instructed below:

(1) Troubleshooting set-up. If the malfunction is detected during testing according to para. 3-5 or 3-6 above, use the relevant test set-up as a troubleshooting set-up, and prepare the PRC-2200 for troubleshooting as explained in para. (2) below.

(2) Physical preparation. For efficient troubleshooting, access is required to the PRC-2200 modules. Refer to Section IV for instructions. Make sure all the coaxial cables connecting between the PRC-2200 modules are properly installed and connected to the mating receptacles. The coaxial cables accessed on the motherboard side of the RT-2001 are identified in figure 3-11B, and the cables on the modules side are identified in figure 3-12.

NOTE

Modules RF1 and RF2 in the CP-2003 are assembled together and form one assembly. Do not separate the modules for troubleshooting and/or repair purposes. Always replace the complete assembly.

b. Troubleshooting Instructions. Table 3-6 presents systematic troubleshooting instructions for isolating and locating the defective module or sub-assembly.

Whenever several modules must be replaced as part of the troubleshooting process, and the failure is isolated in another module, reinstall the original modules replaced during troubleshooting in the PRC-2200.

CAUTIONS

1. PRC-2200 modules contain components sensitive to electrostatic discharge. Hold modules by their sides: do no touch components or module contacts.

2. Disconnect the power supply cable from the PRC-2200 or remove its battery before removing or inserting modules. Inserting or removing a module under power may cause damage.

(1) Refer to Section I: "GENERAL TROUBLESHOOTING PROCEDURES" for general troubleshooting instructions. Reference should also be made to the detailed schematic diagrams and circuit operation analysis presented in Chapter 2 in case a trouble exists which is not covered by the troubleshooting procedure given in the following charts. In this case, analyze trouble symptoms using the schematic diagrams and prepare a troubleshooting procedure.

(2) After a trouble is isolated, follow the repair instructions given in Section IV: "REPAIRS" below.

(3) After correcting the trouble and repairing the unit, repeat again the test procedures given in para. 3-5 and 3-6.

Table 3-6. Troubleshooting Chart for PRC-2200

No.	Trouble Symptoms	Probable Cause	Corrective Action
1	No response after turn-on	a. Defective connection between the battery and the PS module	a. Check for 13.5VDC at the positive contact TR01 on module PS. If not present, check the battery and the post connecting between the battery and module PS.

Table 3-6. Troubleshooting Chart for PRC-2200 (Cont'd)

No.	Trouble Symptoms	Probable Cause	Corrective Action
1	Cont'd	b. Defective 7A fuse, FL1	b. Check for 13.5VDC at pin Z of the PS connector J2 on the motherboard. If not present, check the fuse FL1 and replace if necessary.
		c. Defective main power supply	c. Replace module PS
		d. Defective function selector or connections	d. Replace front panel assembly
		e. Defective battery voltage wiring on CP-2003	d. Check continuity between contacts 1 and 2 on the rear connector of the RT-2001 and CP-2003.
2	After turn-on, a random display appears	a. Defective 1A fuse, FL2	a. Check fuse FL2 in module PS and replace if necessary
		b. Defective module,MCU	b. Replace module MCU
3	Receiver audio output on PHONE output (pin B of the AUDIO connectors) not as required (low level, low sensitivity, etc.)	a. Defective BP1 switch or TUNE switch on module RF3	a. Connect test setup as shown in fig. 3-1. Set signal generator level to 0.7 microvolts (-110dBm) and measure the audio output power at PHONE line. If not as required, perform the following actions: 1. Disconnect the red coaxial cable from RF REAR connector, P2, of module AM (on the motherboard side) and apply instead at the module connector a -110dBm signal at the operating frequency

Table 3-6. Troubleshooting Chart for PRC-2200 (Cont'd)

No.	Trouble Symptoms	Probable Cause	Corrective Action
3	Cont'd		2. Measure the audio output power: - If not as required, continue to cause b. - If as required, check the coaxial cable W7 connecting between module AM and the rear connector. If the cable is in good condition, replace module RF3. If problem persists, replace CP chassis. If the problem persists, replace chassis.
		b. Defective REAR/FRONT switch or BYPASS switch on module AM	b. Disconnect the coaxial cable W5 from RX/100mW connector, J4, of module RF (on the motherboard side) and apply instead at the module connector a -110dBm signal at the operating frequency. Measure the audio output power: - If not as required, continue to cause c. - If as required, check the coaxial cable W5 connecting between module RF and module AM. If the cable is in good condition, replace module AM.

Table 3-6. Troubleshooting Chart for PRC-2200 (Cont'd)

No.	Trouble Symptoms	Probable Cause	Corrective Action
3	Cont'd	c. Defective receive path circuits of module RF or defective module SYNT	c. Disconnect the coaxial cable, W4, from IF INPUT/OUTPUT connector J1, of module IF (on the modules side) and apply instead at the module connector a -84dBm signal at a frequency of 5.251MHz. Measure the audio output power: - If not as required, continue to cause d. - If as required, check module SYNT as follows: 1. Set the operating frequency to 10.00MHz and the modulation to USB. 2. Disconnect the coaxial cable W3 from F1, J1 connector of module RF (on the modules side) and check at the disconnected end of the cable that the frequency of the F1 signal is 119.35MHz and its level is -1 to +4dBm. 3. Disconnect the coaxial cable W2 from connector J2 of module RF and check at the disconnected end of the cable that the frequency of the F2 signal is 114.6MHz and its level is -1 to +4dBm

Table 3-6. Troubleshooting Chart for PRC-2200 (Cont'd)

No.	Trouble Symptoms	Probable Cause	Corrective Action
3	Cont'd		4. Disconnect the coaxial cable W1 from connector 5.25MHz J2 of module IF (on the motherboard side) and check at the disconnected end of the cable that the level of the 5.25MHz signal is 0dBm ± 1.5dB If one or more of these three signals is not as required, check the coaxial cables of signals F1, F2 and 5.25MHz (W3, W2 and W1, respectively). If the cables are in good condition, replace module SYNT. If all three signals are as required, check the coaxial cable W4. If it is in good condition, replace module RF.
		d. Defective receive path circuits and controls on module IF, AUDIO, MCU or PANEL	d. Check for demodulated signal at pin 10 of connector J7 on the motherboard: 1. If not present, set the PRC-2200 to USB, VOICE and check that the SSB* and AM/SSB* (optional) control lines (pins 24, and 11 (optional) of connector J7, respectively) are at low levels.

Table 3-6. Troubleshooting Chart for PRC-2200 (Cont'd)

No.	Trouble Symptoms	Probable Cause	Corrective Action
3	Cont'd		- If present, replace module IF. - If not present, replace module MCU. If the problem persists, replace RT-2001 chassis 2. If present, replace module AUDIO. If the problem persists, replace module MCU. If the problem persists, replace front panel assembly.
		e. Defective wiring or latch U1 on motherboard	e. Replace chassis
4	No reception or low sensitivity in the SSB, NCW or AM modes	a. Defective control lines SSB* or AM/SSB*	a. Check the levels of control lines SSB* and AM/SSB* (optional) at pins 24 and 11 optional, respectively, of connector J7 on the motherboard. 1. If as required, continue to cause b. 2. If not as required, replace module MCU. If the trouble persists, replace the chassis.
		b. Defective SSB, NCW or AM filter (if applicable) module IF	b. Replace module IF.

Table 3-6. Troubleshooting Chart for PRC-2200 (Cont'd)

No.	Trouble Symptoms	Probable Cause	Corrective Action
5	No reception in all the operating modes except for AM (if applicable)	a. Defective 5.25MHz signal	a. Disconnect the coaxial cable, W1, from 5.25MHz connector, J2, of module IF (on the motherboard side) and check that the 5.25MHz signal is present at the disconnected end of the cable W1. 1. If present, replace module IF. 2. If not present, check the coaxial cable W1. If the cable is in good condition, replace module SYNT.
6	No reception in a specific range of frequencies	a. Defective FIL SEL 1,2,4 control lines signals, for module RF	a. Check for appropriate binary levels (refer to para. 2-11.c.(2)) at the FIL SEL 1,2,4 lines (pins 4,3,2 of connector J4, respectively): - If as required, continue to cause b. - If not as required, replace module MCU. If the problem persists replace RT-2001 chassis.
		b. One of the seven band-pass filters in module RF is defective	b. Replace module RF.
7	Failure in volume control (para. 3-5.c.(6))	Defective volume potentiometer or audio circuits	Check whether audio output power changes at all when rotating the volume potentiometer.

Table 3-6. Troubleshooting Chart for PRC-2200 (Cont'd)

No.	Trouble Symptoms	Probable Cause	Corrective Action
7	(Cont'd)		1. If there is no significant change, replace front panel assembly. 2. If there is a change but not as required in the test, replace module AUDIO. If the problem persists, replace MCU module. If the problem persists, replace chassis assembly.
8	Failure in transmitter output power test	a. Defective CP-2003 modules	a. Perform the transmitter output power test in the USB VOICE mode (para. 3-5.c.(6)(a) thru (h)). Measure the output power at the DIPOLE connector. If not as required (43dBm $\pm$ 1dB), perform the following actions: 1. Disconnect the coaxial cable from the RF REAR connector, P2, of module AM (on the motherboard side). Connect a 50-ohm load to connector P2 on module AM. Press PTT and measure the RF level at connector P2 on module AM: it should be 42 to 45dBm: - If not, continue to cause b. - If correct, replace module RF3. If the trouble persists, replace modules RF1/RF2. If the problem persists, replace CP-2003 chassis

Table 3-6. Troubleshooting Chart for PRC-2200 (Cont'd)

No.	Trouble Symptoms	Probable Cause	Corrective Action
8	(Cont'd)	b. Defective transmit path circuits in module AM	b. Disconnect the coaxial cable W6 from AM DRIVE connector, J5, of module RF (on the motherboard side). Press PTT and measure the RF level at the disconnected end of the cable: it should be +6dBm ± 2dB across a 50-ohm load: - If not, continue to cause c. - If it is correct, check the coaxial cable W6. If the cable is in good condition, replace module AM.
		c. Defective transmit path circuits of module RF or defective SYNT module	c. Disconnect the coaxial cable W4 from IF INPUT/OUTPUT connector, J1, of module IF (on the modules side). Press PTT and measure the IF level at the disconnected end of the cable: it should be -24dBm ± 1dB at a frequency of 5.25MHz: - If not, continue to cause d. - If the IF level is as required, check module SYNT as follows: 1. Set the operating frequency to 10.00MHz and the modulation to USB.

Table 3-6. Troubleshooting Chart for PRC-2200 (Cont'd)

No.	Trouble Symptoms	Probable Cause	Corrective Action
8	(Cont'd)		2. Disconnect the coaxial cable W3 from connector F1, J1 of module RF (on the modules side) and check at the disconnected end of the cable that the frequency of the F1 signal is 119.35MHz and its level is -1 to +4dBm. 3. Disconnect the coaxial cable W3 from connector F2, J2 of module RF (on the modules sides) and check at the disconnected end of the cable that the frequency of the F2 signal is 114.6MHz and its level is -1 to +4dBm 4. Disconnect the coaxial cable W1 from connector F2, J2 of module IF (on the modules sides) and check at the disconnected end of the cable that the frequency of the 5.25MHz signal is 0dBm ± +1.5dB If one or more of these three signals is not as required, check the coaxial cables carrying the signals F1, F2 and 5.25MHz (W3 W2 and W1, respectively).

Table 3-6. Troubleshooting Chart for PRC-2200 (Cont'd)

No.	Trouble Symptoms	Probable Cause	Corrective Action
8	(Cont'd)		If the cables are in good condition, replace module SYNT. If all three signals are as required, check the coaxial cable W4. If it is in good condition, replace module RF.
		d. Defective transmit path circuits and controls on module IF, AUDIO, MCU or PANEL	d. Press PTT and check for modulated signal at a level of 270 $\pm$ 30 millivolt RMS at pin 19 of connector J10 on the motherboard: 1. If present, replace module IF. 2. If not present, replace module AUDIO. If the problem persists, replace module MCU. If the problem persists, replace front panel assembly.
		e. Defective motherboard	e. Replace chassis
9	No transmission in the VOICE mode only	a. Defective microphone amplifier card	a. Replace front panel assembly.
		b. Defective AUDIO module	b. Replace modules AUDIO. If the problem persists, replace module MCU.
10	No transmission in the CW, and NCW mode (if applicable) only	No 10kHz clock signal	1. Check for 10kHz clock signal at pin 17 of connector J9 on the motherboard. If not present, replace module SYNT.

Table 3-6. Troubleshooting Chart for PRC-2200 (Cont'd)

No.	Trouble Symptoms	Probable Cause	Corrective Action
10	(Cont'd)		2. Check for 10kHz clock signal at pin 29 of connector J10 on the motherboard. - If not present, replace the chassis - If present, replace module AUDIO. If problem persists, replace module MCU.
11	When pressing PTT, (voice and data) the PRC-2200 does not switch to transmission (receiving noise is still heard)	Defective PTT signals	Replace MCU. If problem persists, replace panel assembly.
12	Failure in WHIP output power test only (para. 3-5.c.(7))	Defective WHIP path circuits or controls	Replace modules RF1/RF2. If the problem persists, replace CP-2003 chassis.
13	Failure in frequency accuracy test (para. 3-5.c.(3))	Defective 3.5MHz TCXO on module SYNT	Set the operating frequency to 10.000MHz. Check at connector J1 of module SYNT (on the modules side) that the frequency of the signal is 119.35MHz ± 1.8kHz. If not, replace module SYNT.
14	When receiving in the SQ-SYLABIC mode, receiver noise is continuously heard	Defective syllabic squelch	Replace modules AUDIO. If the problem persists, replace module MCU.

Table 3-6. Troubleshooting Chart for PRC-2200 (Cont'd)

No.	Trouble Symptoms	Probable Cause	Corrective Action
15	No transmission in a specific range of frequencies	a. Defective FIL SEL 1,2,4 control signals for module AM b. One of the 7 band-path filters in module AM is defective	a. Check for appropriate binary levels at the FIL SEL 1,2,4 lines (pins 8,9,23 of connector J6, respectively. - If as required, continue to cause b. - If not as required, replace module MCU. If the problem persists, replace RT-2001 chassis b. Replace module AM.
16	No TXBB signal when using an external modem (or failure in transmitter output power test - para. 3-5.c.(6) (Transmission performance in all other modes is good)	Defective TX DATA buffer or connections	Check that the TXBB signal at pin 24 of connector J10 is 0.775V RMS: - If as required, replace module AUDIO. If the problem persists, replace module MCU. - If not as required, replace front panel assembly.
17	No RXBB signal when using an external modem (or failure in receiver audio output power test - para. 3-5.c.(5)(j). The reception in all other modes is good.	Defective RXBB buffer or connections	Check that the RXBBF signal at pin 6 of connector J10 is at least 0.5VRMS: - If as required, replace FRONT PANEL assembly. - If the problem persists, replace module MCU. - If not as required, replace module AUDIO. - If problem persists, replace RT-2001 chassis.

Table 3-6. Troubleshooting Chart for PRC-2200 (Cont'd)

No.	Trouble Symptoms	Probable Cause	Corrective Action
18	No lighting of display and keypad	Defective AC/DC converter on module PANEL	Replace front panel assembly
19	In SQ-OFF and SQ-SYLAB IC, the PRC-2200 operates normally but there is no reception with SQ-SEL.C.	Defective module AUDIO	Replace modules AUDIO. If the problem persists, replace module MCU.

Section IV. REPAIRS

3-9. Scope

a. The repair duties normally assigned to maintenance staff are:

(1) Replacement of RT-2001 motherboard cover (para. 3-10).

(2) Replacement of RT-2001 modules cover (para. 3-11).

(3) Replacement of RT-2001 front panel assembly (para. 3-12).

(4) Replacement of RT-2001 modules (para. 3-13 thru 3-19).

(5) Replacement of fuses on module PS (para. 3-20).

(6) Replacement of CP-2003 modules (para. 3-21).

(7) Replacement of backup lithium battery on module AUDIO (para. 3-22).

(8) Replacement of RT-2001 chassis (para. 3-23).

(9) Replacement of CP-2002 chassis (para. 3-24).

(10) All repair duties assigned to lower maintenance categories, such as replacement of connector covers, knobs, etc.

3-10. **Replacement of Modules Cover**
(fig. 3-6)

a. General. The modules cover includes a gasket and a breather located in the center of the cover. After opening the modules cover, check condition of breather and gasket. If the gasket is not in good condition, replace it as instructed in c. below. If the breather is not in good condition, replace the cover.

b. Modules Cover Removal.

(1) Identify the modules cover according to figure 3-6.

(2) Loosen the six captive screws holding the modules cover in place, and remove the cover.

c. Gasket Replacement (fig. 3-7). Before reinstalling the modules cover, check gasket condition. The gasket should not have any breaks, cuts or twists and must lie evenly within groove. Replace the gasket when doubt exists as to its condition. Refer to fig. 3-7 and follow the procedure given below:

(1) Use tweezers or a small screwdriver to pry out the gasket.

(2) Thoroughly clean the gasket groove.

(3) Prepare a new gasket as follows:

(a) Measure the exact length of gasket required for filling the groove, and add about 0.5cm. Cut the gasket at an angle of 45°.

(b) Cut the other end at the same angle, so that the ends fit one over the other as neatly as possible.

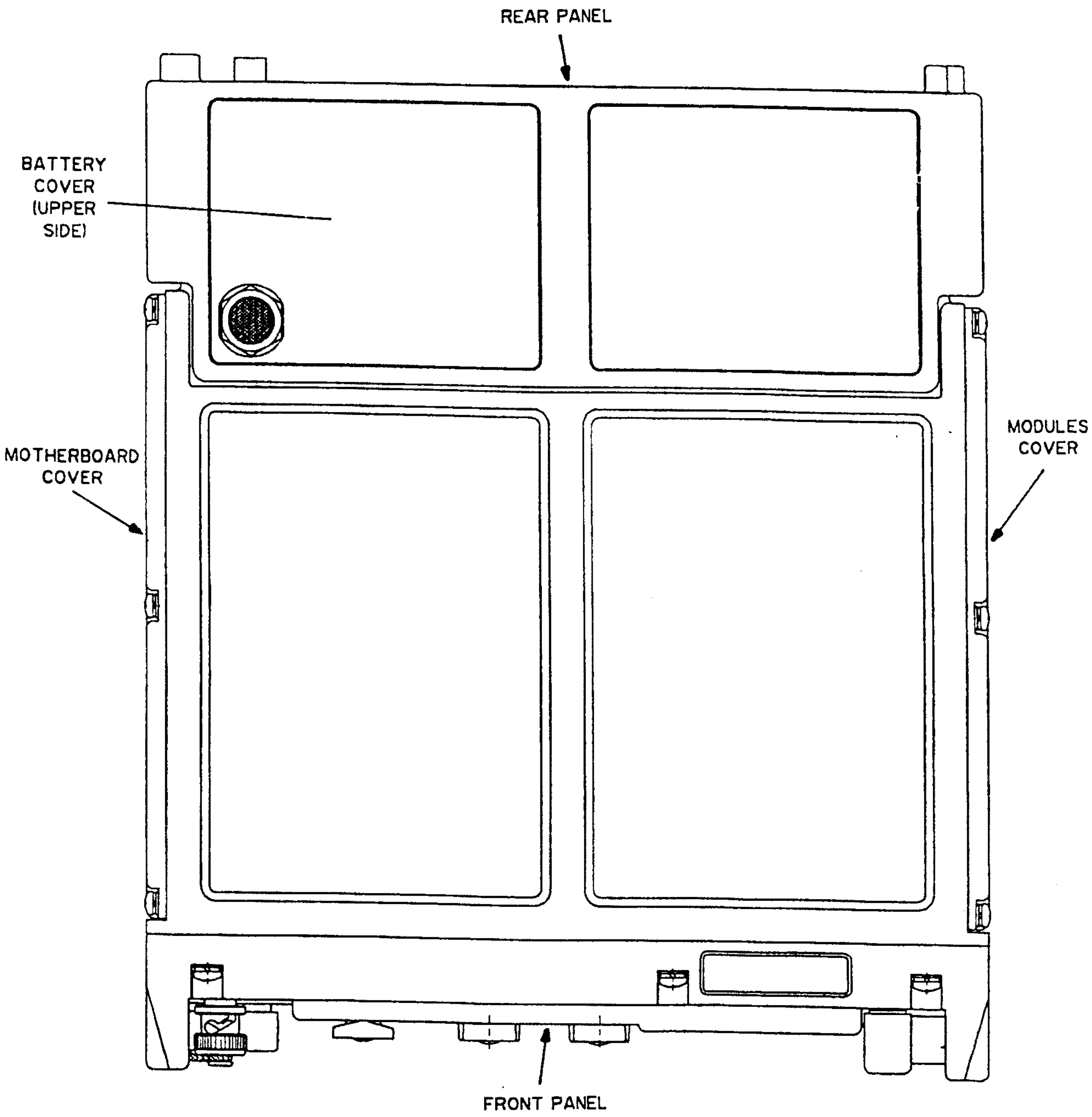

Figure 3-6. Cover Identification

(4) Spread a few drops of Dow Corning RTV-732 adhesive on the bottom of the groove (one every 5 cm). Wipe off excess adhesive.

(5) Insert the replacement gasket. Press evenly with the fingers to seat the gasket, and glue the two ends with one drop of RTV.

(6) Spread a thin layer of silicone grease, Mfg.Cat.No. 2101-12303-05, on the gasket.

d. Reinstalling the Modules Cover.

(1) Check that the cover contains a breather and check that the gasket is in good condition.

(2) Orient the cover in its place and tighten its six screws.

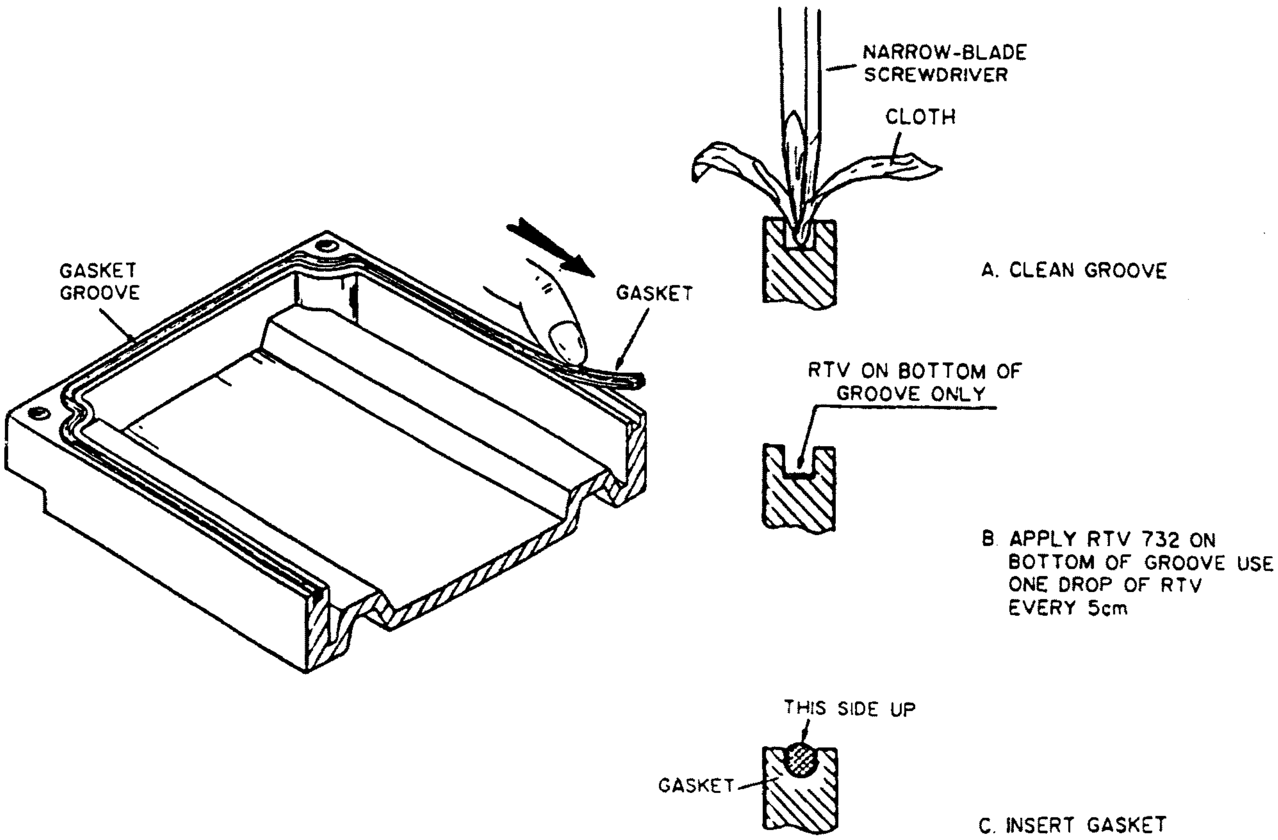

Figure 3-7. Gasket Installation

3-11. Replacement of Motherboard Cover (fig. 3-6)

a. General. The motherboard cover includes a gasket, but does not include breather. After opening the cover, check condition of the gasket and replace it if necessary.

b. Cover Removal.

(1) Identify the motherboard cover according to figure 3-6.

(2) Loosen the six captive screws holding the modules cover in place, and remove the cover.

c. Reinstalling the Motherboard Cover.

(1) Check that the cover does not contain a breather and check condition of gasket.

(2) Orient the cover in its place and tighten its six screws.

3-12. Replacement of Front Panel Assembly (fig. 3-6)

a. General. The front panel is replaced as a unit. After opening front panel, check the condition of its gasket and replace it if necessary.

b. Front Panel Removal.

(1) Loosen the six captive screws holding the front panel in place.

CAUTION

Do not unscrew or tighten one screw completely before the other. Take up, alternately, one turn at a time from each screw.

(2) Position the PRC-2200 on its rear panel, hold the panel with two hands and lift it gently from the chassis.

(3) Disconnect the coaxial cable from the front panel RF connector, designated P2.

c. Gasket Replacement. Before reinstalling the front panel, check gasket condition and replace it if necessary, as explained in para. 3-10.c. above.

d. Reinstalling the Front Panel.

(1) Position the case on the rear panel.

(2) Connect the coaxial cable to the front panel RF connector, P2.

(3) Position the front panel over the case. Take care that the coaxial cable would not be clamped when you close the panel.

(4) Push the front panel into position and then tighten its screws by hand.

(5) Use a Philips screwdriver to tighten completely the screws. Tighten the screws alternately, starting with the screws at the opposite ends of a diagonal, then those at the ends of the other diagonal.

Do not tighten one screw completely and then the others: take up one turn at a time from each screw sequentially in the order described.

e. Replacement of External Panel Components (fig. 3-8). Figure 3-8 and Table 3-7 identify external front panel components.

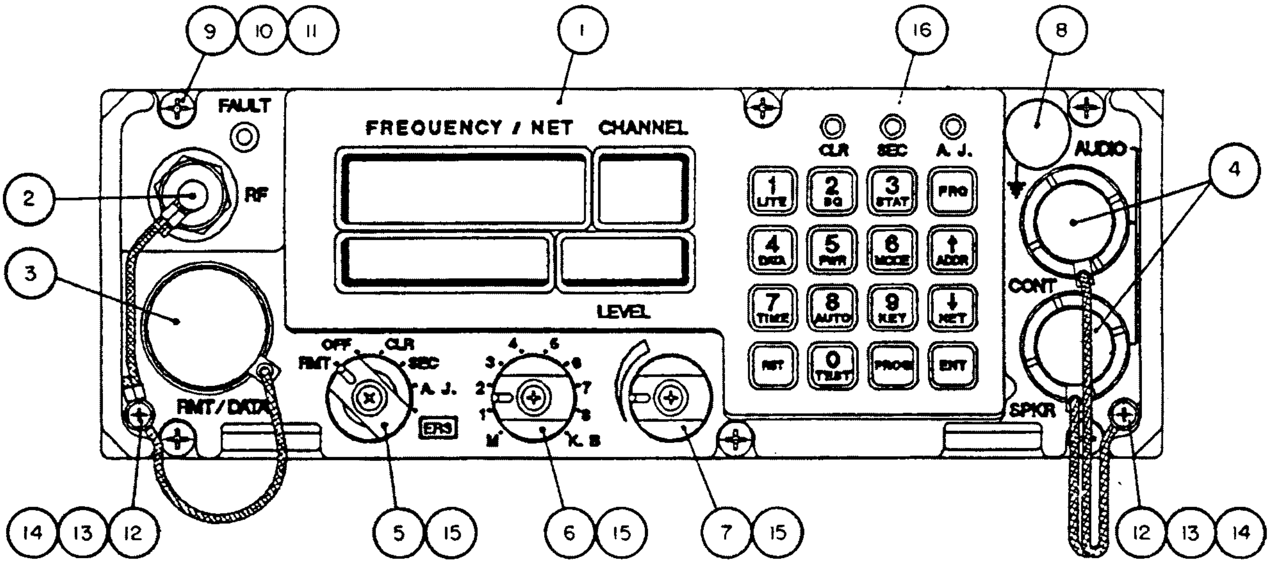

Figure 3-8. RT-2001, Front Panel Components

Table 3-7. External Front Panel Components

No.	Mfg. Cat. No.	Description	Qty
1	2187-91100-00	PANEL assembly	1
2	2187-96380-00	Cover assembly for RF connector	1
3	2187-96370-00	Cover assembly for RMT/DATA connector	1
4	2187-96350-00	Cover assembly for AUDIO connector	2
5	2187-40030-00	Knob, function control	1

Table 3-7. External Front Panel Components (Cont'd)

No.	Mfg. Cat. No.	Description	Qty
6	2187-40080-00	Knob, channel control	1
7	2187-96110-00	Knob, volume control	1
8	2187-33200-00	Cover for grounding post	1
9	2187-39030-00	Screw	6
10	2187-39070-00	Washer, flat	6
11	2187-39060-00	Washer, spring	6
12	2187-52312-00	Screw	2
13	2187-53240-00	Washer, flat	2
14	2187-42660-00	Spacer	2
15	2187-52110-00	Screw, No. 6 32x3/16"	3
16		Identification label	1

3-13. Replacement of Module MCU

a. Removal.

(1) Remove the front panel assembly as described in para. 3-12.b. above.

(2) Loosen the eight screws fastening module MCU to the chassis. Keep the washers in a safe place.

(3) Use tool Mfg. Cat No. 21870817300 to extract the module. Do not touch the module components.

b. Reinstalling Module MCU.

(1) Position the MCU module to its place. Push the module firmly down until connector P1 is engaged fully.

(2) Tighten the eight screws with washers fastening the MCU module to the chassis.

(3) Reinstall the front panel assembly as described in para. 3-12.d. above.

3-14. Replacement of Module AUDIO
(fig. 3-6, 3-9.A)

a. Removal of Module AUDIO.

(1) Open the modules cover as described in para. 3-10.b.

(2) Identify module AUDIO according to figure 3-9.A.

(3) Use the Allen key side of the extractor (shown in figure 3-9.A) to unscrew the two captive Allen screws securing module AUDIO (item 1 in figure 3-9.A).

(4) Screw the threaded side of the extractor into one of the two supporters of module AUDIO (item 2 in figure 3-9.A) and pull out the module.

(5) Use tool Mfg. Cat No. 21870817300 to extract the module. Do not touch the module components.

b. <u>Reinstalling Module AUDIO.</u>

(1) Push the module into its place until the connector of module AUDIO fully engages with the mating connector on the motherboard.

(2) Tighten the two Allen screws (items 1 in figure 3-9.A).

(3) Close the module cover as described in para. 3-10.d. above.

3-15. **Replacement of Module IF**
(fig. 3-9, 3-10)

a. <u>Removal of Module IF.</u>

(1) Open the two side covers as described in para. 3-10.b. and 3-11.b. above.

(2) Identify module IF according to figure 3-9.A.

(3) Disconnect the coaxial connector 5.25MHz, J1 from module IF (see figure 3-9.B).

(4) Disconnect the coaxial connector 5.25MHz, J2 from module IF (see figure 3-10).

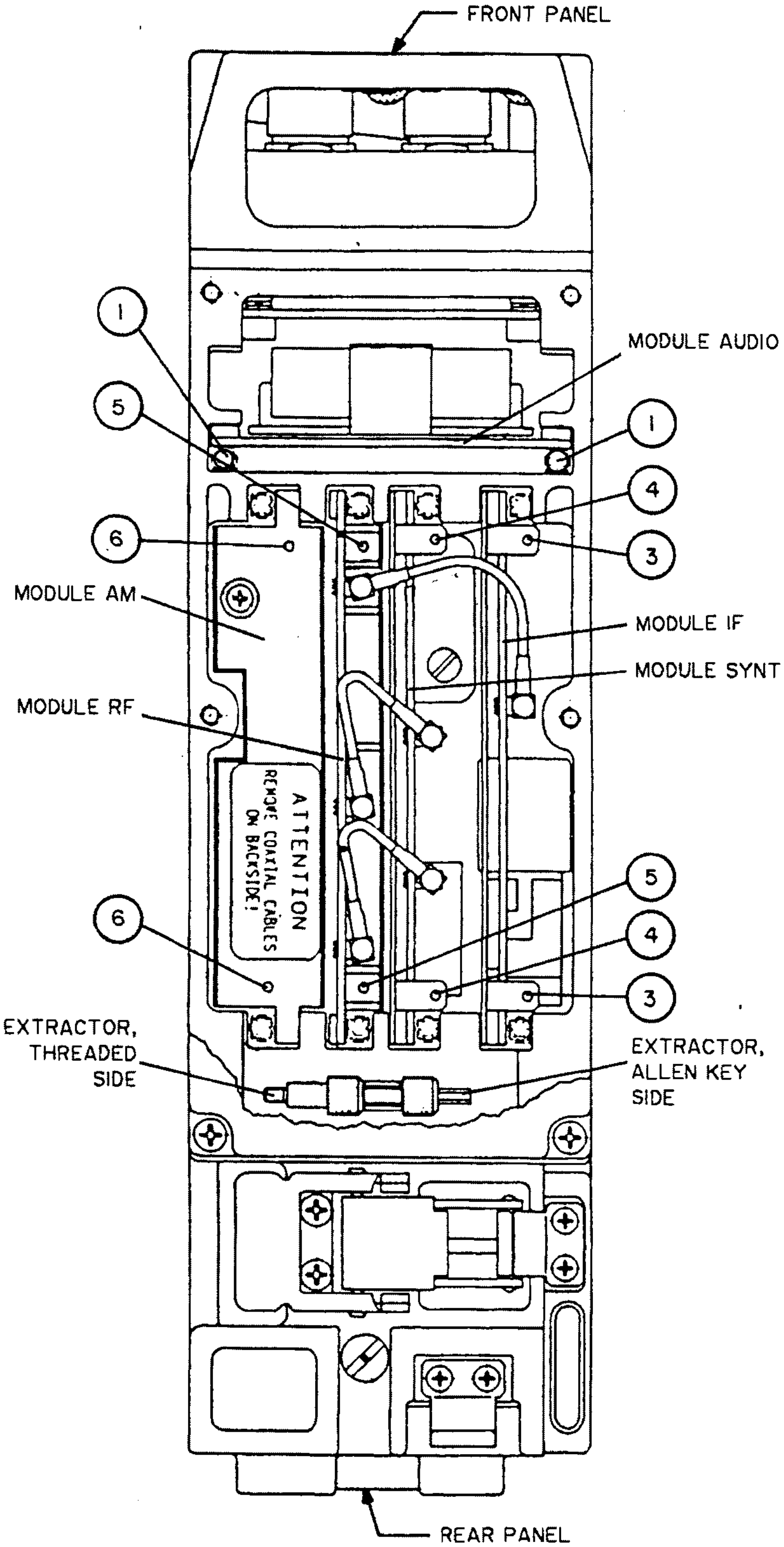

Figure 3-9.A. View on Modules Side (Sheet 1 of 2)

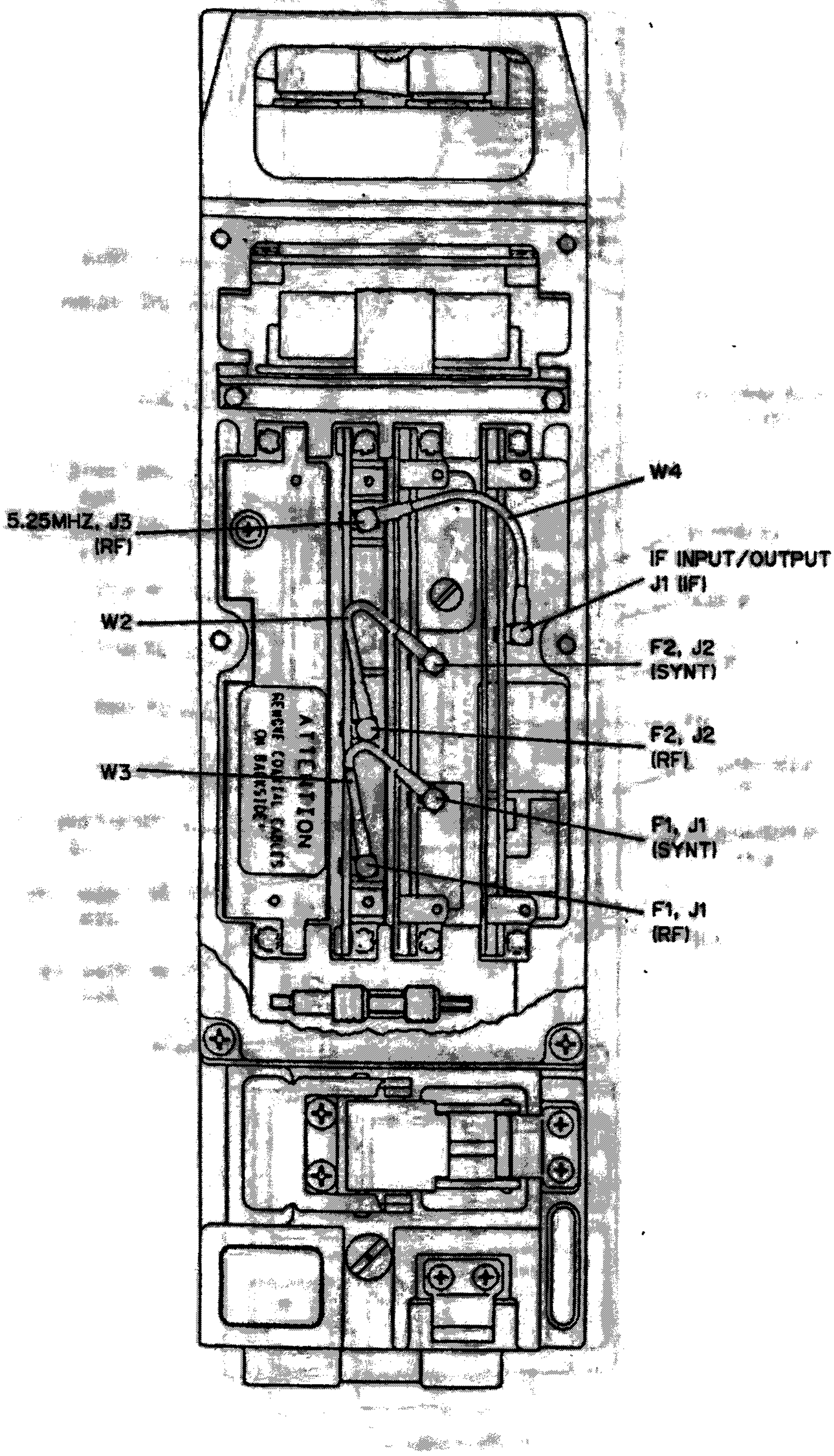

Figure 3-9.B. View on Modules Side (Sheet 2 of 2)

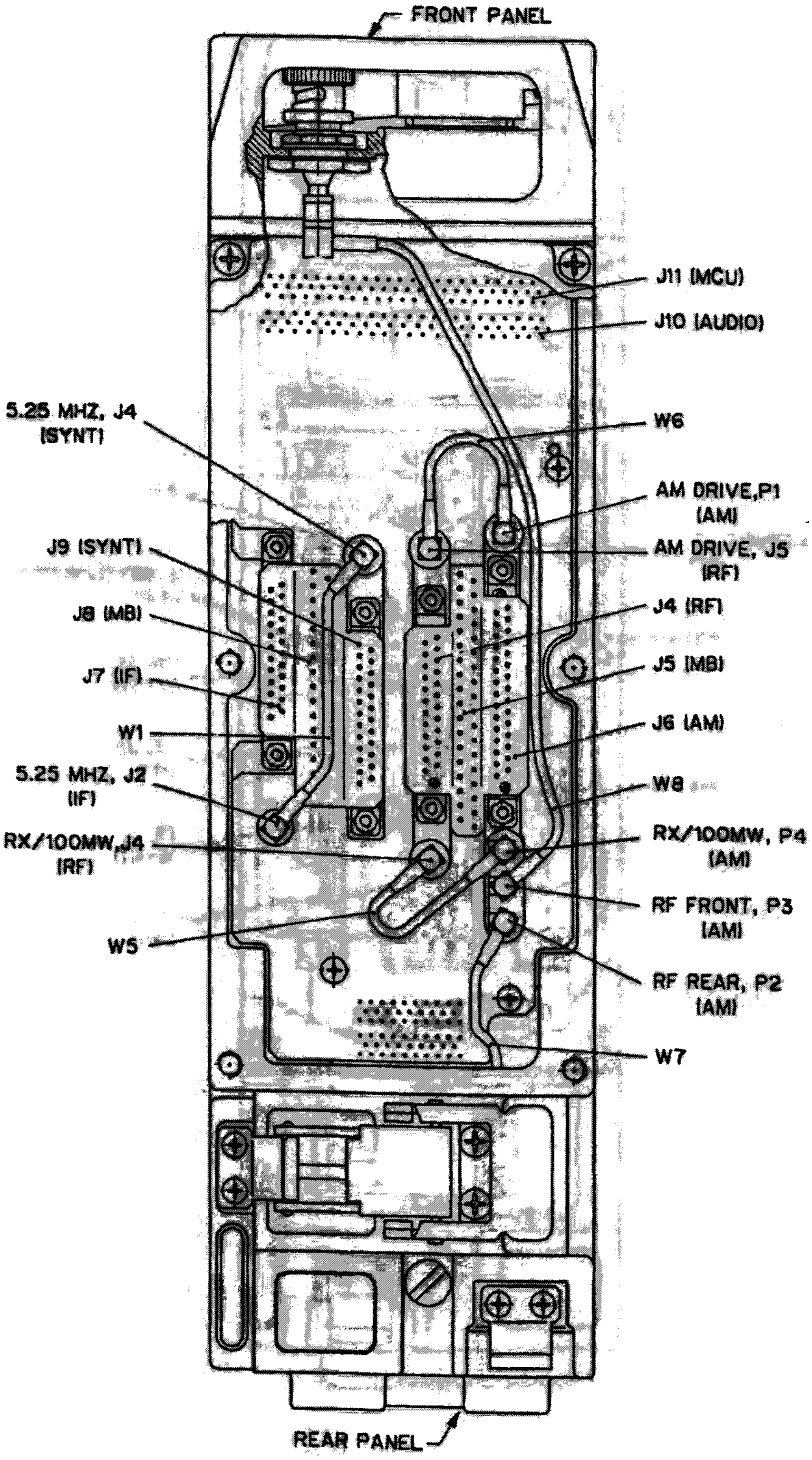

Figure 3-10. View on Motherboard Side

(5) Use the Allen key side of the extractor shown in figure 3-9.A to unscrew the two captive Allen screws securing module IF.

(6) Screw the threaded side of the extractor into one of the two holes of module IF (item 3 in figure 3-9.A) and pull out the module.

b. <u>Reinstalling Module IF.</u>

(1) Position the IF module as shown in figure 3-9.A and push the module until the connector of module IF fully engages with the mating connector on motherboard.

(2) Tighten the two Allen screws of module IF.

(3) Reconnect the coaxial connectors disconnected in para. a.(3) and (4) above.

(4) Close the two side covers as described in para. 3-10.d. and 3-11.d. above.

3-16. Replacement of Module SYNT
(fig. 3-9, 3-10)

a. <u>Removal of Module SYNT.</u>

(1) Open the two side covers as described in para. 3-10.b. and 3-11.b. above.

(2) Identify module SYNT according to figure 3-9.A.

(3) Disconnect the coaxial connectors F1, J1 and F2, J2 from module SYNT (see figure 3-9.B).

(4) Disconnect one of the two connectors of the coaxial cable W4, connecting between modules IF and RF (see figure 3-9.B).

(5) Disconnect the coaxial connector 5.25MHz, J4 from module SYNT (see figure 3-10).

(6) Use the Allen key side of the extractor shown in figure 3-9.A to unscrew the two captive Allen screws securing module SYNT.

(7) Screw the threaded side of the extractor into one of the two holes of module SYNT (item 4 in figure 3-9.A) and pull out the module.

b. Reinstalling Module SYNT.

(1) Position the SYNT module as shown in figure 3-9.A and push the module until the connector of module SYNT fully engages with the mating connector on motherboard.

(2) Tighten the two Allen screws of module SYNT.

(3) Reconnect the coaxial connectors disconnected in para. a.(3) thru (5) above.

(4) Close the two side covers as described in para. 3-10.d. and 3-11.d. above.

3-17. Replacement of Module RF
(fig. 3-9, 3-10)

a. Removal of Module RF.

(1) Open the two side covers as described in para. 3-10.b. and 3-11.b. above.

(2) Identify module RF according to figure 3-9.A.

(3) Disconnect the coaxial connectors 5.25MHz J3, F1 J1 and F2 J2 from module RF (see figure 3-9.B).

(4) Disconnect the coaxial connectors AM DRIVE, J5 and RX/100mW, J4 from module RF (see figure 3-10).

(5) Use the Allen key side of the extractor shown in figure 3-9.A to unscrew the two captive Allen screws securing module RF.

(6) Screw the threaded side of the extractor into one of the two ends of module RF (item 5 in figure 3-9.A) and pull out the module.

b. Reinstalling Module RF.

(1) Position the RF module as shown in figure 3-9.A and push the module until the connector of module RF fully engages with the mating connector on motherboard.

(2) Tighten the two Allen screws of module RF.

(3) Reconnect the coaxial connectors disconnected in para. a.(3) thru (4) above.

(4) Close the two side covers as described in para. 3-10.d. and 3-11.d. above.

3-18. Replacement of Module AM
(fig. 3-9, 3-10)

a. Removal of Module AM.

(1) Open the two side covers as described in para. 3-10.b. and 3-11.b. above.

(2) Identify module AM according to figure 3-9.A.

(3) Disconnect the coaxial connectors AM DRIVE P1, RX/100mW P4, RF FRONT P3 and RF REAR P2 from module AM (see figure 3-10).

(4) Use the Allen key side of the extractor shown in figure 3-9.A to unscrew the two captive Allen screws securing module AM.

(5) Screw the threaded side of the extractor into one of the two ends of module AM (item 6 in figure 3-9.A) and pull out the module.

b. <u>Reinstalling Module AM.</u>

(1) Position the AM module as shown in figure 3-9.A and push the module until the connector of module AM fully engages with the mating connector on motherboard.

(2) Tighten the two Allen screws of module AM.

(3) Reconnect the coaxial connectors disconnected in para. a.(3) above.

(4) Close the two side covers as described in para. 3-10.d. and 3-11.d. above.

3-19. Replacement of Module PS
(fig. 3-11)

a. <u>Removal of Module PS.</u>

(1) Position the case on its upper side (battery cover side).

(2) Loosen the eight captive screws of the PS module cover and remove the cover.

(3) Check the gasket condition and replace it if necessary, as explained in para. 3-10.c. above.

(4) Use a Philips screwdriver to release the six screws fastening module PS to the case (item 1 in figure 3-11). Keep the washers in a safe place.

(5) Use a Philips screwdriver to release the two screws connecting the module to the battery posts (item 2 in figure). Note that these two screws and their washers are slightly different from the other six screws (these two screws are shorter and their washers are larger). Therefore, to prevent error, keep these screws and washers separately.

(6) Use the Allen side of the extractor located under the modules cover (see fig. 3-9.A) to loosen the two screws of the connector P1 (item 3 in figure 3-11).

NOTE

Do not unscrew or tighten one screw completely before the other. Take up, alternately, one turn at a time from each screw.

(7) Take the module out. Hold the module by its sides: do not touch its components.

b. Reinstalling Module PS. Install the replacement PS module key reversing the procedure described in a. above.

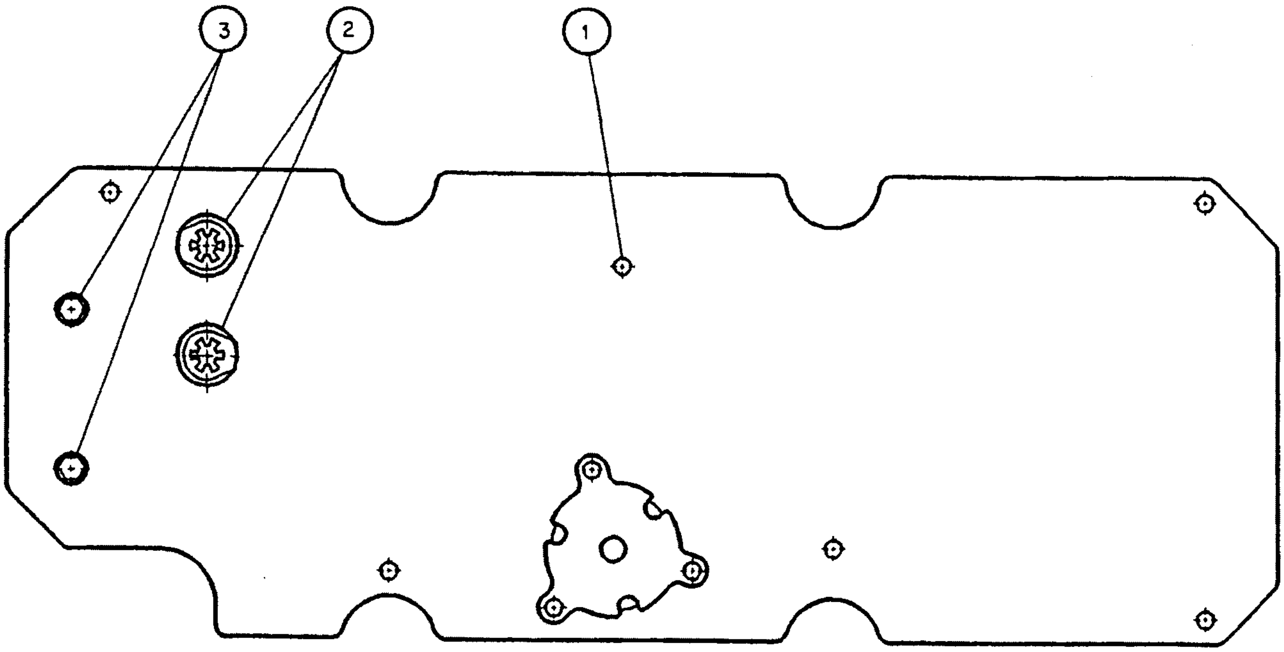

Figure 3-11. Module PS, Solder Side

3-20. Replacement of Fuses Located on Module PS (fig. 3-12)

a. Remove module PS as described in para. 3-19.a above.

b. Identify the fuse to be replaced according to figure 3-12, and replace it using a solder iron.

c. Install the PS module by reversing the procedure described in para. 3-19.a. above.

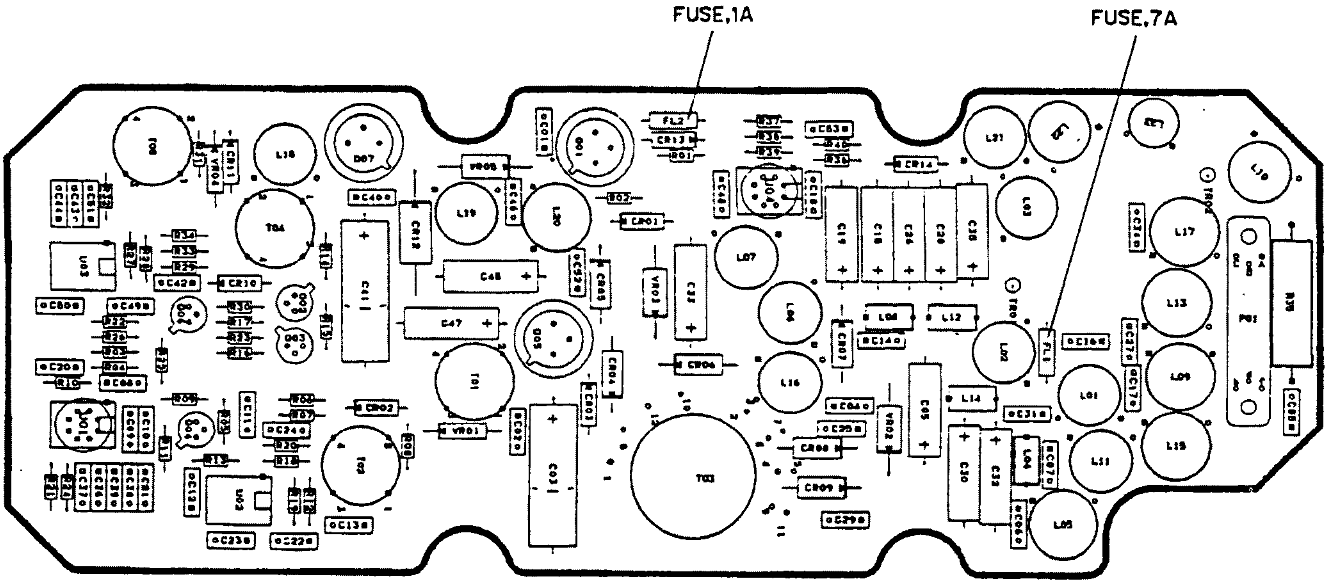

Figure 3-12. Module PS, Fuse Location

3-21 Replacement of CP-2003 Modules (fig. 3-13, 3-14)

a. <u>Replacement of Modules RF1, RF2 or RF3.</u> Modules RF1, RF2 and RF3 are connected together as shown in figure 3-14. Modules RF1 and RF2 must be replaced as one unit. Module RF3 is replaced separately from the other two modules.

(1) Removal of modules RF1/RF2 and RF3.

(a) Position the CP-2003 on the lower side (see fig. 3-13).

(b) Loosen the six captive screws of the upper cover and remove the cover.

(c) Check the gasket condition and replace it if necessary as explained in para. 3-10.c. above.

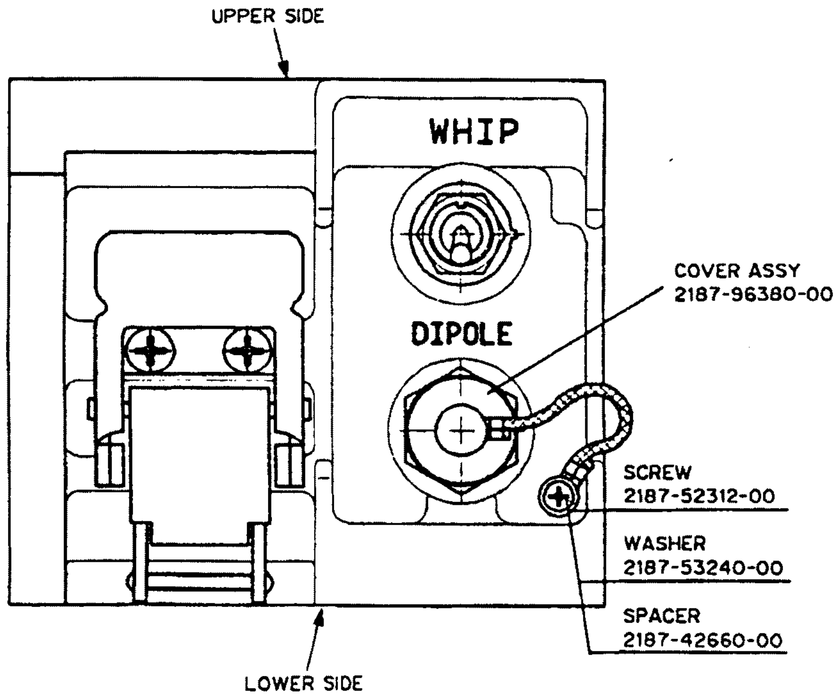

Figure 3-13. CP-2003, External View

(d) Loosen the six captive screws connecting the three modules to the case.

(e) Pull out two screws at the opposite ends of a diagonal (item 1 in figure 3-14) and pull out the three modules.

(f) To separate between module RF3 and modules RF1/RF2, loosen the two captive screws (item 2 in figure 3-14). Afterwards, separate carefully between the two connectors connecting between module RF3 and module RF2 (item 3 in figure 3-14). Pay special attention not to bend the three pins (items 4, 5, 6) during module separation.

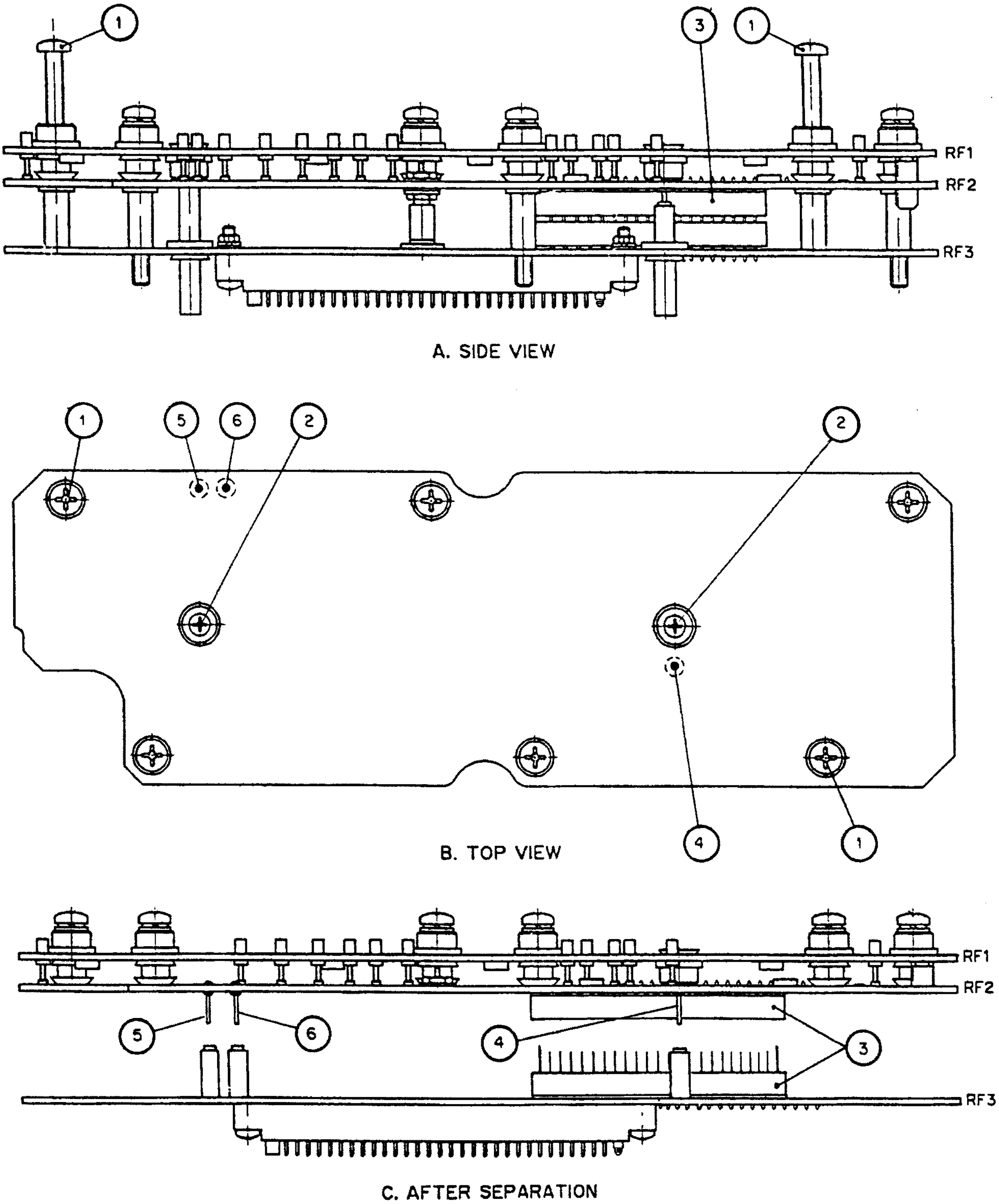

Figure 3-14. Modules RF1/RF2 and RF3 Assembly

(2) Reinstalling modules RF1/RF2 and RF3.

(a) Position the modules as shown in figure 3-14 below. Pay special attention that the three pins (items 4, 5, 6) will fit exactly in the jacks.

(b) Press the two parts of the connector (item 3) until they fully engage.

(c) Tighten the two screws (item 2 in figure 3-14).

(d) Place the modules in the case and press them until all the connectors of module RF3 are fully engage with the mating connectors on the chassis.

(e) Tighten the six screws (item 1 in figure 3-14).

(f) Close the upper cover by fastening its six captive screws.

b. <u>Replacement of Module MNC (figure 3-15).</u>

(1) Removal of module MNC.

(a) Remove the RF1/RF2 and RF3 modules as described in para. a.(1) above.

(b) Pull the cord connected to connector P2 until the connector is disconnected from the mating connector on module MNC.

(c) Position the case on the upper side (figure 3-15).

(d) Loosen the six captive screws fastening the cover to the case and remove the cover.

(e) Check the gasket condition and replace it if necessary, as explained in para. 3-10.c. above.

(f) Unscrew the six screws fastening module MNC to the case. Keep the washers in a safe place.

(g) Unscrew the two screws at the sides of the 60-pin connector P1. Keep the washers in a safe place.

(h) Disconnect the white, brown and red wires connecting the WHIP/DIP switch to module MNC, from points D, G and W on module MNC, respectively (see figure 3-15), and remove the module.

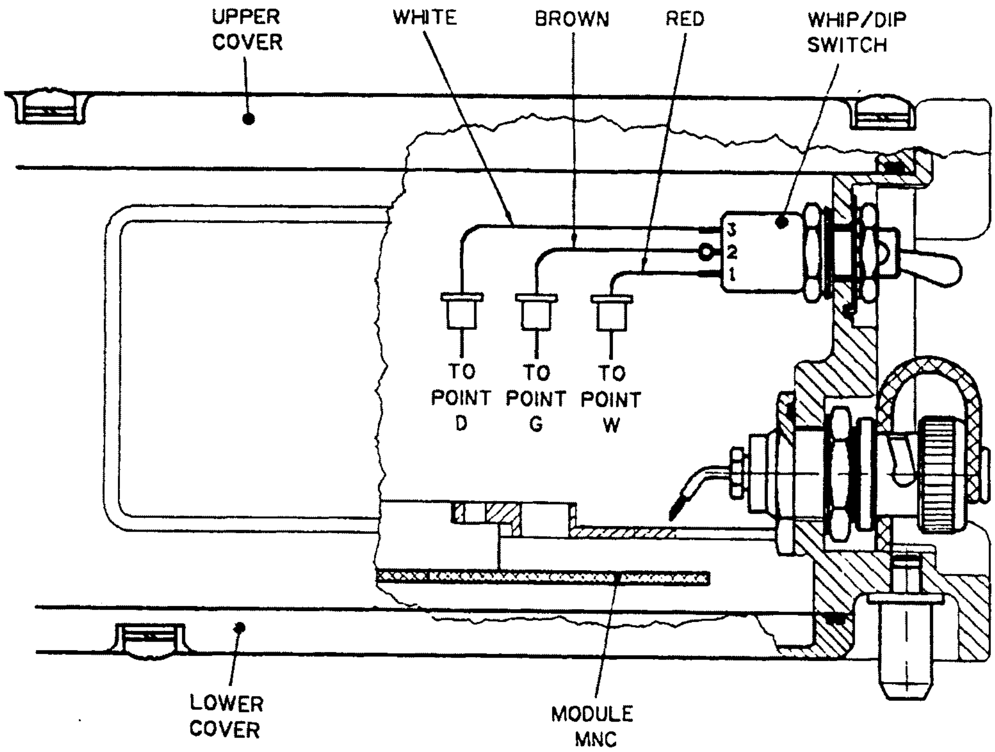

Figure 3-15. WHIP/DIP Switch and Wiring

(2) Reinstalling Module MNC.

(a) Reconnect the white, brown and red wires to points D, G and W on module MNC, respectively (see figure 3-15).

(b) Position the MNC module to its place.

(c) Tighten the two screws at the sides of the 60-pin connector P1.

(d) Tighten the six screws fastening module MNC to the case.

(e) Position the lower cover in its place and tighten its six screws.

(f) Position the case on the lower side.

(g) Reconnect connector P2 to the mating connector on module MNC. Push the connector firmly down until the connector engages fully.

(h) Reinstall the RF1/RF2 and RF3 modules as described in para. 3-21.a.(2) above.

3-22. Replacement of BATTERY Card on Module AUDIO
(figures 3-16 thru 3-18)

NOTE

The backup lithium battery is an integral part of the battery card. When you have to replace the lithium battery, always replace the BATTERY card.

a. Removal.

(1) Remove the AUDIO module according to para. 3-14.a.

WARNING

Lithium batteries contain dangerous chemicals and may explode if improperly handled. Observe the following safety precautions during handling of Lithium batteries:

1. Do not short-circuit battery leads, or BATTERY card contacts.
2. Do not puncture or burn used batteries.
3. Used batteries/BATTERY cards must be properly disposed of, according to regulations.

(2) Identify the BATTERY card according to figure 3-16.

(3) Identify the two screws that secure the BATTERY card, according to figure 3-17.

(4) Unscrew the securing screws.

(5) Remove the BATTERY card. Pay special attention not to bend the four pins of the BATTERY card when you separate the BATTERY card from the AUDIO module.

(6) Immediately stow the BATTERY card in an appropriate plastic bag in order not to short the battery leads.

b. Installation.

(1) Identify the BATTERY card contacts on the AUDIO module, according to figure 3-18.

(2) Position the replacement BATTERY card on the components side of the AUDIO module, in accordance with the proper polarity of the battery (Polarity inscriptions exist on the AUDIO module, on the BATTERY card and on the battery. Pay special attention that the four pins of the BATTERY card will fit exactly in the jacks (figure 3-18).

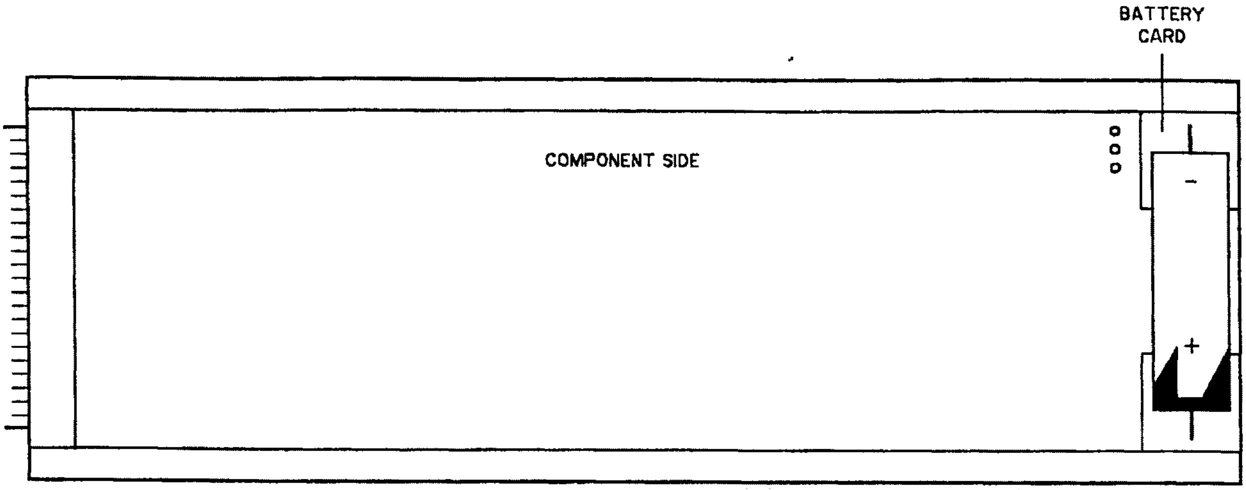

Figure 3-16. Module Audio, Component side with Battery Card Installed

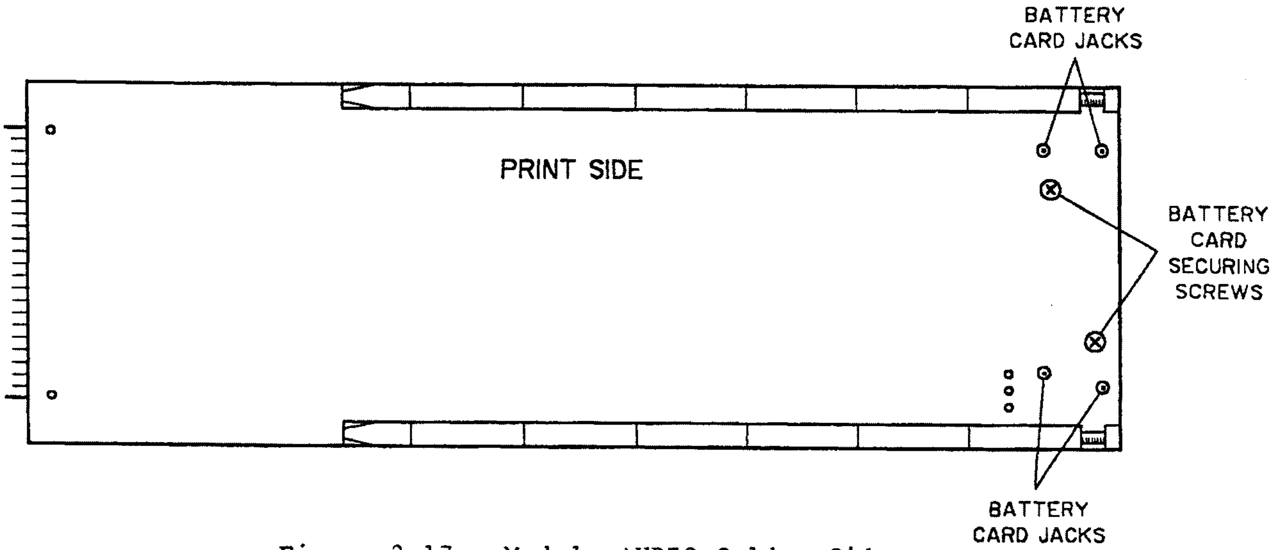

Figure 3-17. Module AUDIO Solder Side

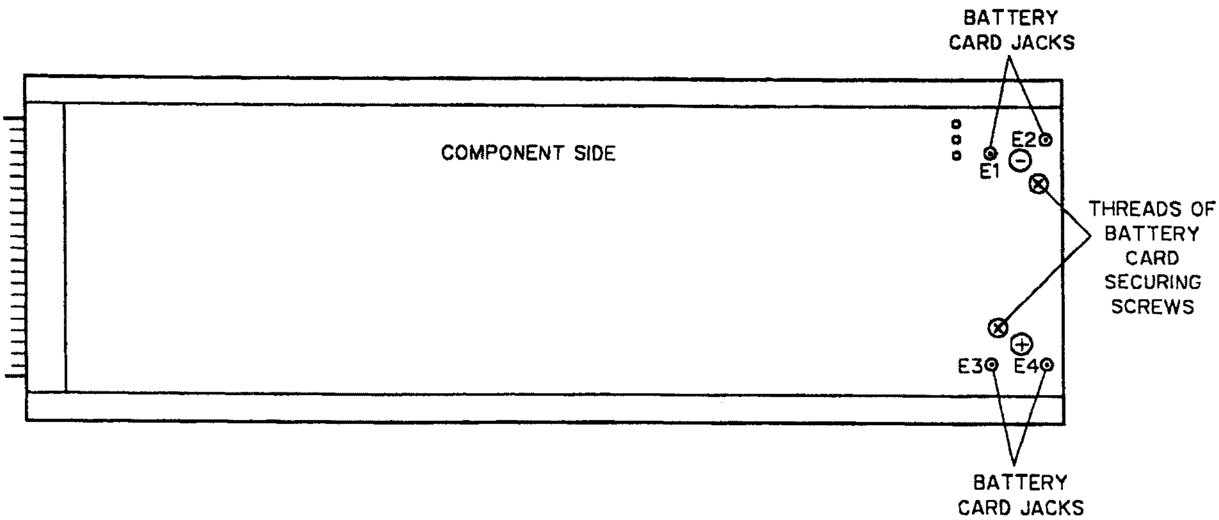

Figure 3-18. Module AUDIO, Component Side, Battery Card Removed

(3) Carefully insert the BATTERY card pins in the AUDIO module jacks E1 thru E4 in accordance with figures 3-18 and 3-16. Pay attention not to bend the BATTERY card pins when inserting the BATTERY card.

(4) Push the BATTERY card until it is well positioned on the AUDIO module, in accordance with figure 3-16.

(5) On the soldering side of module AUDIO, identify the two threads of the BATTERY card securing screws in accordance with figure 3-17.

(6) Screw the two screws that secure the BATTERY card to the AUDIO module.

(7) Reinstall the AUDIO module according to para. 3-14.b.

(8) Reinstall the front panel assembly according to para. 3-12.d.

3-23. Replacement of RT-2001 Chassis

Remove all the modules from the chassis of the RT-2001 and install them in a replacement chassis.

3-24. Replacement of CP-2003 Chassis

Remove the RF modules and MNC module from the chassis of the CP-2003 and install them in a replacement chassis.