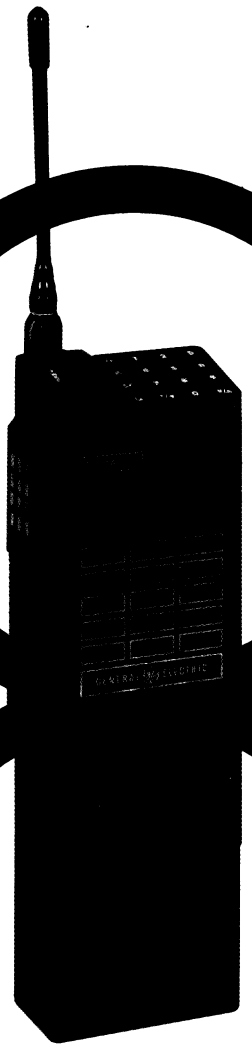
MOBILE RADIO

GE-MARC V™ PERSONAL

TWO-WAY RADIO
MAINTENANCE MANUAL LBI31394A



800 MHz
GE-MARC V PERSONAL
TWO-WAY FM RADIO

GENERAL ELECTRIC

TABLE OF CONTENTS

SPECIFICATIONS

SYSTEM

FREQUENCY RANGE	
Transmitter	806 to 825 MHz
Receiver	851 to 870 MHz
BATTERY DRAIN @ 7.5 VDC	
Transmitter	1.4 amperes maximum
Receiver	
Idle Mode	50 milliamperes
Rated Audio	180 milliamperes
DIMENSIONS (HxWxD)	8.8" X 2.8" x 1.5" (with battery)
WEIGHT	31 ounces (With Battery)
CHANNEL CAPACITY	180

TRANSMITTER (KT-254-A)

POWER OUTPUT	2 Watts
CHANNEL SPACING	25 kHz
SPURIOUS RESPONSE	-46 dB
AUDIO SENSITIVITY	8 to 14 millivolts
DISTORTION	Less than 5%
DEVIATION SYMMETRY	0.5 kHz maximum
RF OUTPUT IMPEDANCE	50 ohms
FREQUENCY STABILITY	±0.00025%

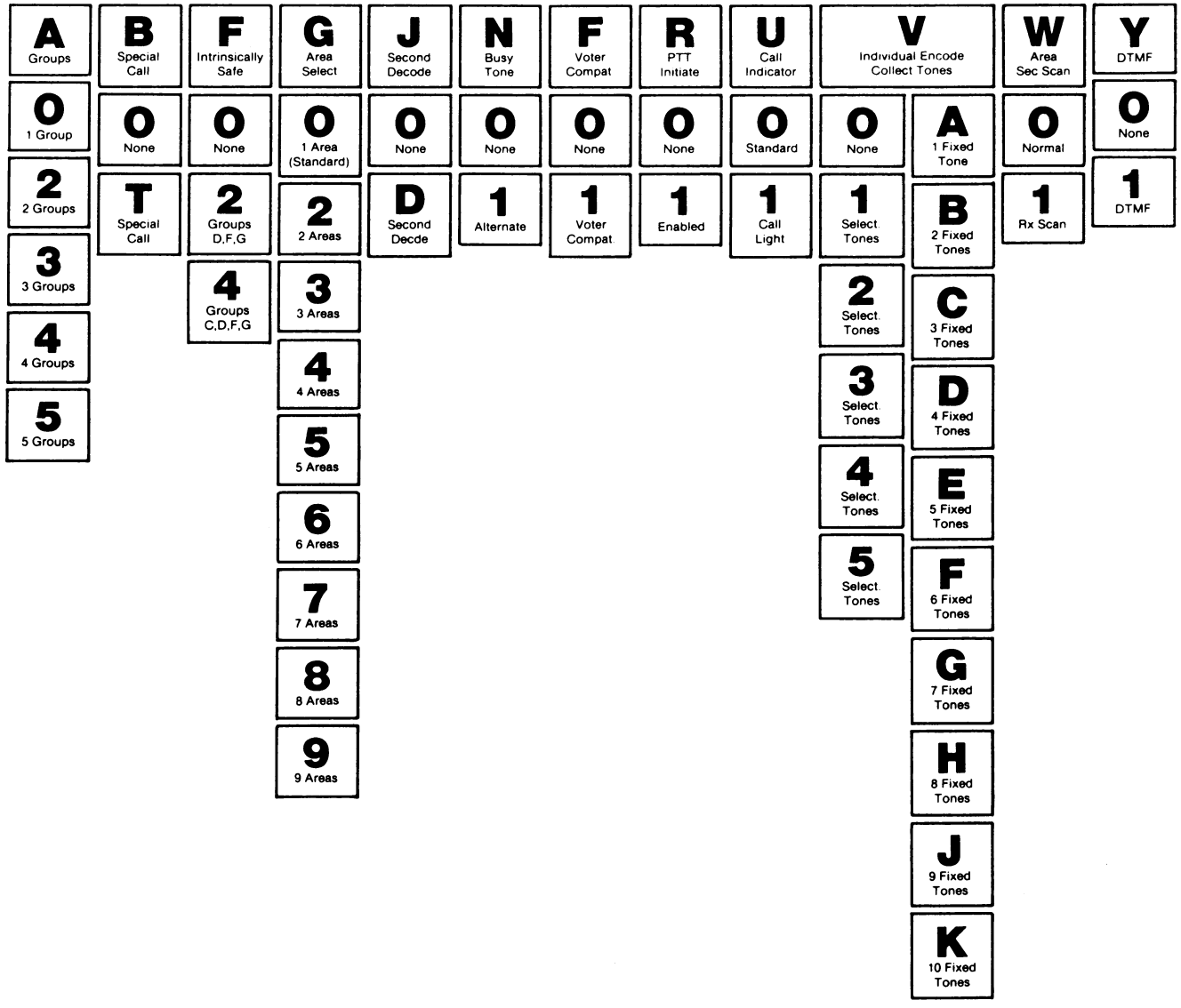
RECEIVER (ER-152-A)

AUDIO OUTPUT	500 milliwatts into 8 ohms
DISTORTION AT RATED POWER	< 5%
SENSITIVITY (12 dB SINAD)	0.35 uV
SELECTIVITY	-70 dB
SPURIOUS RESPONSE	-70 dB
INTERMODULATION	-65 dB
MODULATION ACCEPTANCE	±7 kHz
RF INPUT IMPEDANCE	50 ohms

COMBINATION NOMENCLATURE

Digits 1 & 2	Digit 3	Digit 4	Digit 5	Digit 6	Digit 7	Digit 8	Digit 9	Digit 10
Product Code	Package	Tx/Rx Frequency Range (MHz)	Programming	Channel Spacing	RF Power	Maximum Channel Capacity	Control	Power Source
P7	**B** Basic	**CANADIAN BDR** **1** Tx 806-811 Rx851-856 MHz	**C** Customer	**5** 25 kHz	**5** 1.7-3.8 Watts	**S** Synthesized 180	**K** Deluxe	**N** 750 mAh NiCd
		USA 2 **2** Tx 811-816 Rx 856-861 MHz						**M** 1200 mAh NiCd
		USA 1 **3** Tx 816-821 Rx 861-866 MHz						**X** No Batt
		AUS **4** Tx 820-825 Rx 865-870 MHz						
		MEXICAN BDR **5** Tx 811-816 Rx 856-861 MHz						

STRUCTURED OPTIONS



DESCRIPTION

The General Electric's MPX GE MARC V Personal radio is a self-contained FM transmitter/receiver with frequency synthesizer and microprocessor controller, designed to operate in all standard GE MARC V systems.

Each radio uses 19 circuit modules. Each module utilizes a thick film monolythic hybrid integrated circuit, containing, when possible, the complete electronic function. Each module plugs or is soldered into a specific socket on the system board.

The transmit circuit employs a 5th mode crystal oscillator in conjunction with the synthesizer module to provide the basic transmit reference frequency. After preamplification and doubling in an intermediate module, the 2 watt output power is developed by an exciter and PA module. A power control module insures the correct level of power output at the antenna. The only adjustments are frequency, modulation, and power level. No RF tuning of the transmit circuit is required or possible. The maximum multi-frequency switching range is limited only by the ability to control the synthesizer.

The receive circuit is a single conversion design, using another 5th mode crystal oscillator in conjunction with the synthesizer module to provide the receiver injection. A 21.4 MHz. IF is standard.

There are six tuning adjustments in the receive circuit. Five of the adjustments are RF helical resonators tuned for maximum receive sinad. The sixth adjustment is a frequency set.

The Transmitter type designation is KT-254-A, and the Receiver designation is ER-152-A.

A CMOS microcomputer located on an auxiliary printed wire board controls the radio's operation. The program is contained in a metal-masked ROM in the computer chip, while customer options are contained in Lithium battery-backed CMOS RAM. A thick-film hybrid contains a watchdog timer circuit and other support circuitry.

The power supply for the radio is a rechargeable 7.5 VDC battery pack. Two battery packs are available: a 750 mAh capacity and a 1200 mAh capacity. A system voltage regulator supplies a continuous 5.4 VDC and a keyed 5.4 VDC, while another regulator supplies two more continuous 5.4 VDC outputs.

OPERATION

TO SEND A GROUP OR BASE CALL MESSAGE

1. Turn the power on.
2. Adjust the audio volume.
3. Select the AREA.
4. GROUP OR INDIVIDUAL - Select the desired GROUP by depressing "G", then the Group number. If an individual is to be called, depress "G", then "0", then the ID number. Depress the I/C key.

   BASE CALL - Depress the SC key.

   The red LED will flash and the transmit relay can be heard clicking as the radio searches for an open channel. The WAIT flag will be on. When a channel is acquired, the 2 tone CALL READY alert will be heard signalling that the radio is now ready for communication.

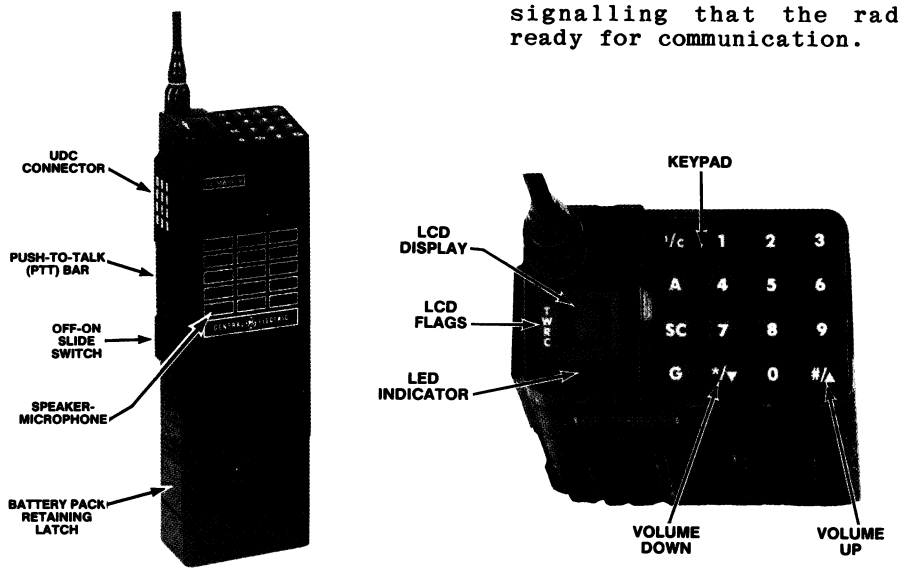


Figure 1 - Operating Controls

5. Depress the PTT bar and speak clearly and distinctly in a normal voice into the microphone in the lower left corner of the speaker grill on the front of the radio. Release the PTT to hear the other unit.

6. Keep calls brief to allow access to the system, and to conserve battery life.

7. When the call is completed, disconnect from the system by depressing the I/C key.

TO PLACE A TELEPHONE CALL*

1. Turn the power on.

2. Adjust the aduio volume.

3. Select the AREA.

4. Depress the SC or I/C key. The red LED will flash and the transmit relay can be heard clicking as the radio searches for an empty channel. The WAIT flag will be on. When the channel is acquired, the radio will alert the user with the 2-tone CALL READY. To obtain a telephone connection, depress the PTT bar and while holding down, press the "*". Release the PTT and wait for a dial tone. At this time, a telephone number may be dialed in the normal manner--by first depressing the PTT bar and then the numbers (continuing to hold the PTT down). The PTT bar may be released between digits, but must be down when the number is depressed. Listen for each number (tone) to be completed before dialing the next.

   At the end of dialing, release the PTT bar. Clicks may be heard as the DTMF tones are converted to dial pulses, and then the normal interrupted ringing tones. When the other party answers, identify yourself by depressing the PTT bar and speaking in a clear, normal voice into the microphone in the lower left corner of the speaker grill on the front of the radio. (To avoid confusion, it may be useful to explain to the other party that you cannot hear them when you are taking).

   To terminate the call, depress the PTT and then "#" to "hang up the phone". Release the PTT and then depress the I/C key to disconnect from the system.

* The exact operation depends upon the system configuration.

TO RECEIVE A TELEPHONE CALL

A telephone call is preceeded by the two-tone alert, followed by ringing tones. To "pick up the telephone", depress the PTT, and while holding, press the "*" star. Release the PTT and proceed in a normal manner.

BATTERY PACK REPLACEMENT

To remove the battery pack from the radio:

1. Turn the radio OFF.
2. Pull the battery pack retaining latch down away from the radio, and turn the battery pack one-quarter turn to the left. The battery pack can now be detached from the radio.

To re-connect the battery pack to the radio:

1. Hold the battery pack at a 90° angle to the radio as shown in the Figure 2.
2. Align the large tab marked with an arrow on the battery pack connector with the large cut-out on the radio socket.
3. Press the battery pack connector into the socket on the radio and turn the battery pack one-quarter turn to the right until the latch clicks.

There are several chargers and charge rates available for charging the battery packs. For specific instructions refer to the applicable charger Operating Manual.

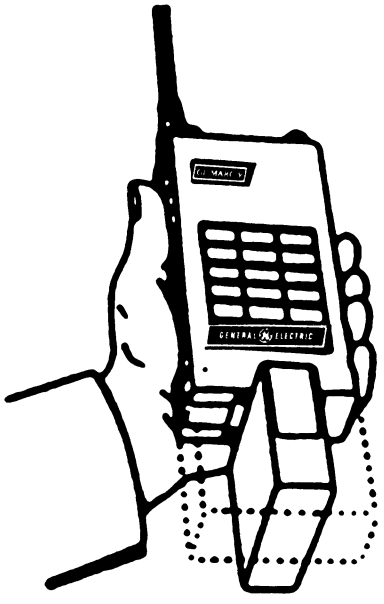


Figure 2 - Battery Pack Replacement

OPERATING TIPS

The following conditions tend to reduce the effective range of Two-Way Radios, and should be avoided whenever possible.

- Operating the radio in low areas of the terrain, or while under power lines or bridges.
- Operating the radio inside of a vehicle, or in a metal or steel-framed building unless using an outside antenna.
- Obstructions such as mountains or buildings between the person sending and the person receiving the messages.

In areas where transmission or reception is poor, some improvement may be obtained by insuring the antenna is vertical. Moving a few meters in another direction or moving to a higher elevation may also improve communication.

SYSTEM DESCRIPTION

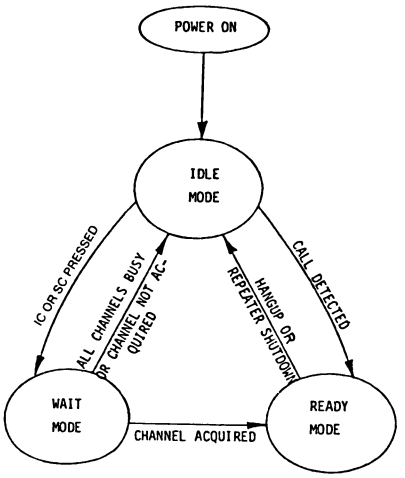
The GE-MARC V™ trunked radio system permits improved access to available RF channels, freedom from annoyance by other users' conversations and a degree of privacy for the user.

The GE MARC V system consists of a repeater for each channel and the users' radio units. The system uses tone signalling, with each unit assigned a two-tone combination. Groups or fleets of radios are assigned the same tones, so that any unit can talk to all the other units in the group.

When originating a call, the radio identifies an idle repeater channel and interrogates it with a single burst of "busy" tone. Upon receipt of the first (busy) tone, the repeater keys its transmitter and sends a burst of "acquisition" tone back to the mobile unit. When the interrogating mobile receives the acquisition tone, it then transmits a "collect" tone and "group" tone, which the repeater passes to all idle units in the system. The idle radios, which continually scan all channels, will stop on the active channel if they recognize the collect tone, and wait for the group tone. If the group tone is detected, the radios will open their audio circuits and alert the operator of an incoming call. If either the collect or group tone is not recognized, the idle units will resume their scan of the channels. Once a radio is "locked" on a channel, it will remain there until the repeater times out or the operator clears the radio.

The radio will always be in one of three operational modes: idle, wait, or ready. The radio enters the idle mode when power is turned on and begins scanning channels for incoming calls. The wait mode is entered when the user places a call. The radio remains in the wait mode until a channel is acquired or it determines that all channels are busy. The ready mode or conversation mode is indicated by an alert tone and the mode indicator.

Figure 3 identifies the three operational modes and the conditions that cause the radio to transfer from one mode to another. Figure 4 defines the signal timing when originating and receiving a call. Figures 5 through 7 are the sequence flow charts for each operational mode.



IDLE MODE - UNIT IS SCANNING CHANNELS FOR CALLS.

WAIT MODE - UNIT ACQUIRES A CHANNEL AND TRANSMITS SIGNALLING TONES.

READY MODE - UNIT IS LOCKED ON A CHANNEL, ALLOWING VOICE COMMUNICATION.

RC 4158A

Figure 3 - Operational Modes

IDLE MODE

When the radio is in the idle mode, the speaker is muted and all channels are sequentially scanned for an incoming call. An incoming call is first identified by the presence of a collect tone on one of the channels. Upon receipt of a collect tone, the personal radio looks for a group or individual tone on the channel for a brief interval. If the group or individual tones are not detected, the mobile will advance to the next channel and continue looking for an incoming call.

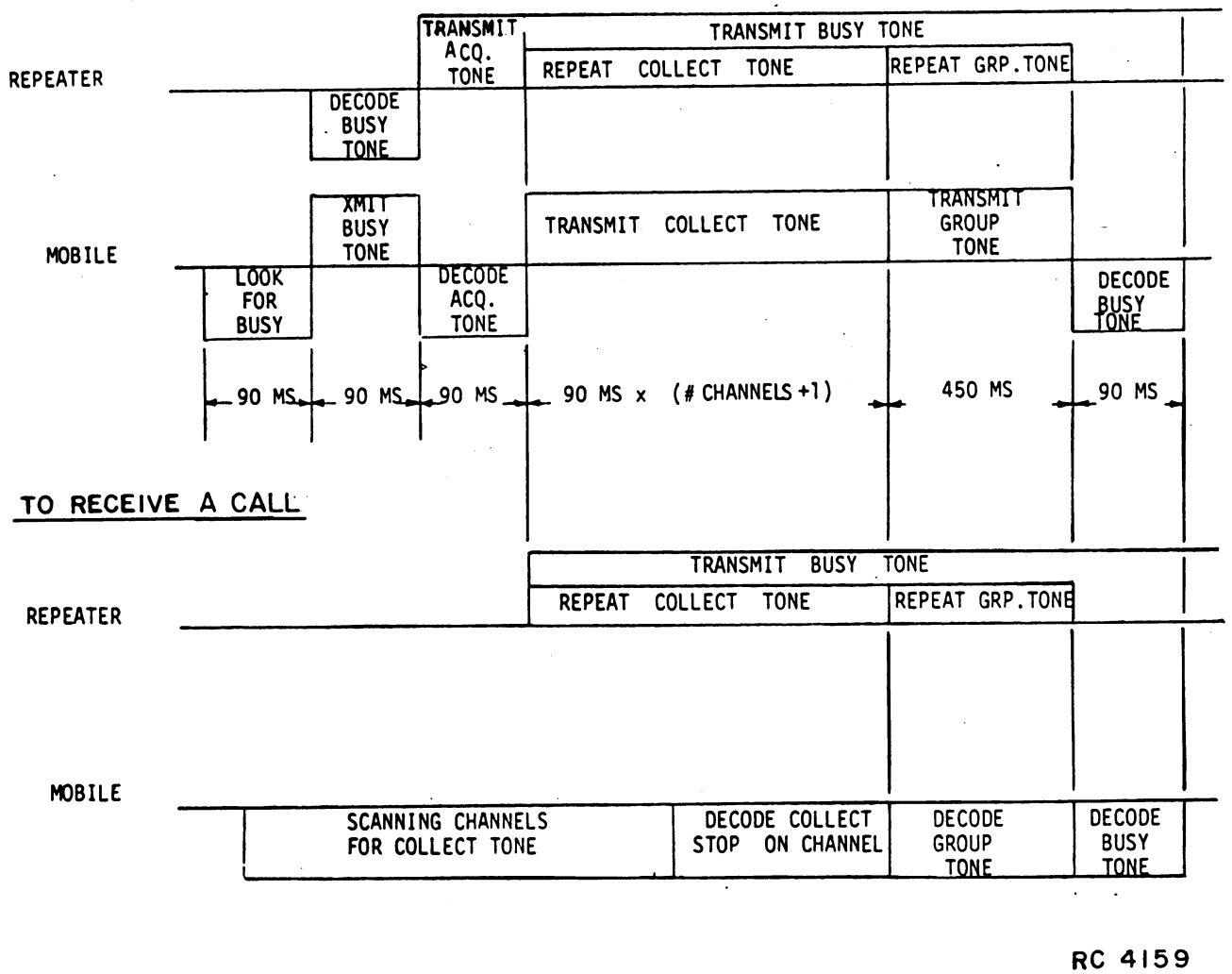


Figure 4 - Signal Timing

If both the collect and group or individual tones are detected, the radio then looks for a busy tone. (Detection of an individual tone establishes a personal "line" between the radio and the control station.) If a busy tone is detected, the radio sounds the alert tone, turns on the RDY indicator and CALL light (if programmed) and enters the ready mode. The radio may now be used in the conventional push-to-talk mode, and will remain on the channel until the operator hangs up or until the repeater drops the busy tone causing the radio to revert to the idle mode. If busy tone is not detected, the mobile unit remains in the idle mode and continues scanning the channels for an incoming call.

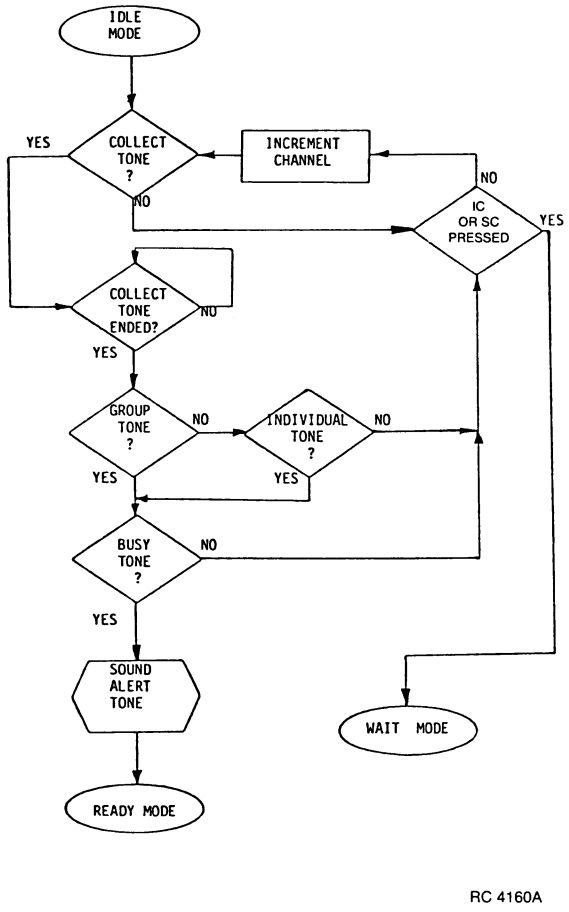


Figure 5 - Idle Mode

WAIT MODE

When the radio is in the "idle" mode depressing the I/C or SC Button will transfer the unit immediately to wait mode, initiating execution of a sequence which scans for an idle channel. In the "wait" mode, the radio looks for busy tone on the channel for a brief interval; if busy tone is detected, the unit advances to the next channel. If an idle channel is not found, the unit reverts to the idle mode.

When an idle channel is found, the radio transmits a burst of busy tone to acquire the repeater, to which the repeater responds with a burst of acquisition tone. Upon receipt of the acquisition tone, the radio proceeds with transmission of collect tone and group tone, after which it once again looks for busy tone from the repeater. If busy tone is detected, the unit alerts the operator and enters the ready mode. If busy tone is not detected, the unit advances to the next channel and tries again. If no channel can be acquired, the radio reverts to the idle mode and a steady one-second tone will alert the operator that a channel was not acquired.

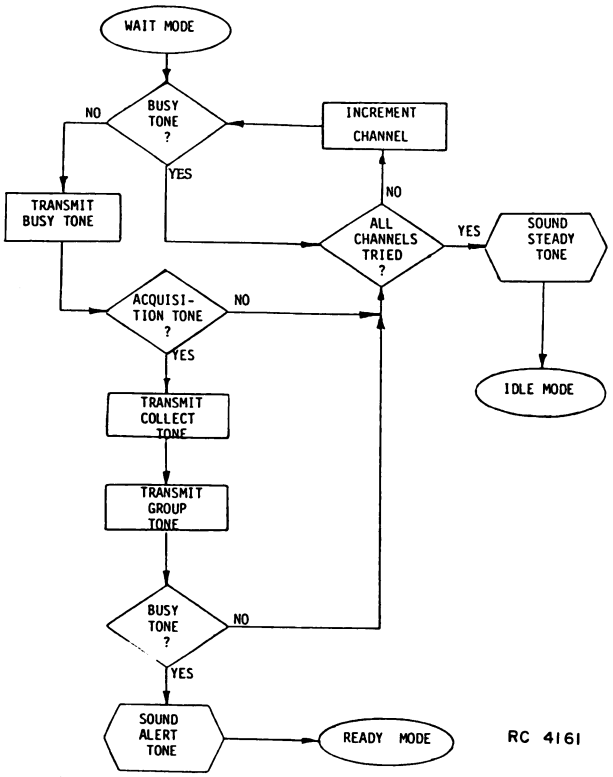


Figure 6 - Wait Mode

READY MODE

When an incoming call has been detected, or an idle channel has been acquired, the radio enters the ready mode. In this the audio and push-to-talk circuits are enabled, the speaker is unmuted, and the operator is alerted by a READY light and an alert tone. The radio can then be used in the conventional push-to-talk manner, and will remain on the channel until the operator hangs up or the repeater drops busy tone causing the unit to revert to idle mode.

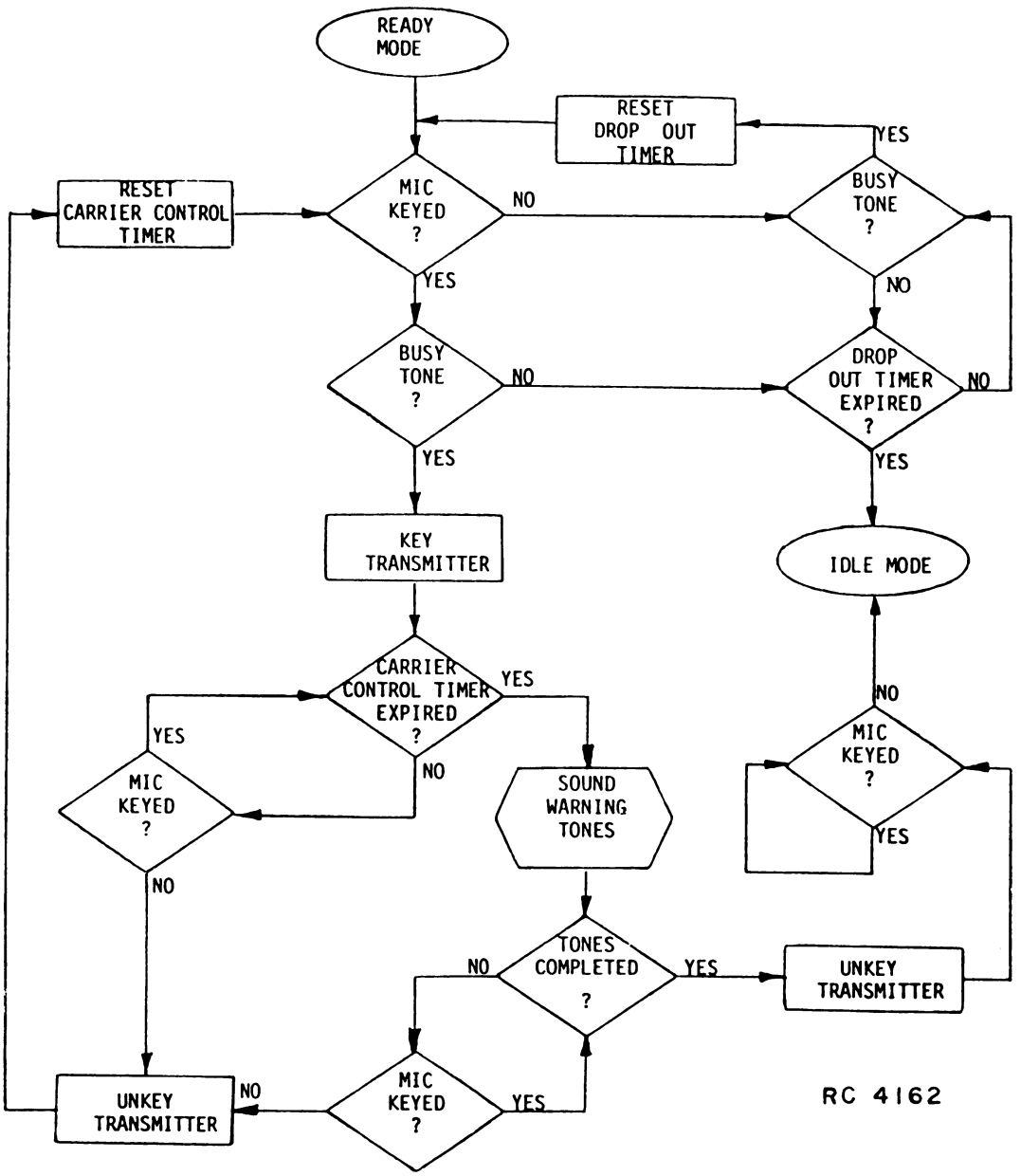


Figure 7 - GE MARC V Ready Mode

SYSTEM ANALYSIS

The General Electric GE MARC V Personal radio is a completely modularized, two-way, FM communication system, utilizing a multi-layered system board. The system board contains all circuit modules for the control, transmit, receive, and voltage regulation circuits. A flexible wiring harness makes connection from the system board to the radio controls on the top assembly.

All control leads which are "barred", such as $\overline{\text{PTT}}$, means that the function indicated occurs when the lead is in a low voltage condition.

Circuit illustrations shown in the following text are simplified representatives of actual circuits. They are intended only to illustrate basic functions.

TRANSMIT CIRCUITS

The GE MARC V transmit circuit (See Block Diagram in Figure 8) consists of the following integrated circuit modules:

Audio Processor (TX-AA)
Amplifier/Doubler (TX-FX)
Exciter (EX)
Power Amplifier (PA)
Power Controller (PC)
Antenna Relay (RY)
Filter Network (FN)
Digital Tone Detector (DTD)

Audio Processor Module (TX-AA)

The audio processor module provides an audio input designated EXT MIC at Pin 13 for an external microphone and an audio input designated INTL MIC at Pin 14 for an internal microphhone (refer to Figure 9). Normally, audio is accepted from the external microphone unless the PTT lead is in a low voltage condition. The PTT lead in a low voltage condition means the radio has been keyed by the PTT bar on the control side of the radio. Keying the radio with the PTT bar gates off the external microphone and gates on the internal microphone. Microphone gating is typically -55 dB.

Audio from either microphone input is amplified and brought out of the processor at the output designated PRE-AMPL OUT at Pin 9. The audio is jumpered to the input designated AUDIO IN at Pin 6. Audio jumpered to Pin 6 is connected through an active pre-emphasis amplifier and an active peak-to-peak clipper limiter circuit. The limiter output can be attenuated by more than 60 DB by pulling the lead designated MIC MUTE at Pin 4 to ground. The MIC MUTE lead is used to mute microphone inputs when options are used which transmit data. The output of the limiter circuit is applied to the input of a summing amplifier.

The summing amplifier accepts the input of tone modulation from the DTD module by way of TONE MOD pot R912. The output of the summing amplifier passes through an active post limiter filter and out of the processor at the lead designated AUDIO OUT, Pin 2. The output of the audio processor is applied through MOD ADJ pot R907 and audio switch CR 909 to Mod In on Pin 5 of the VCO.

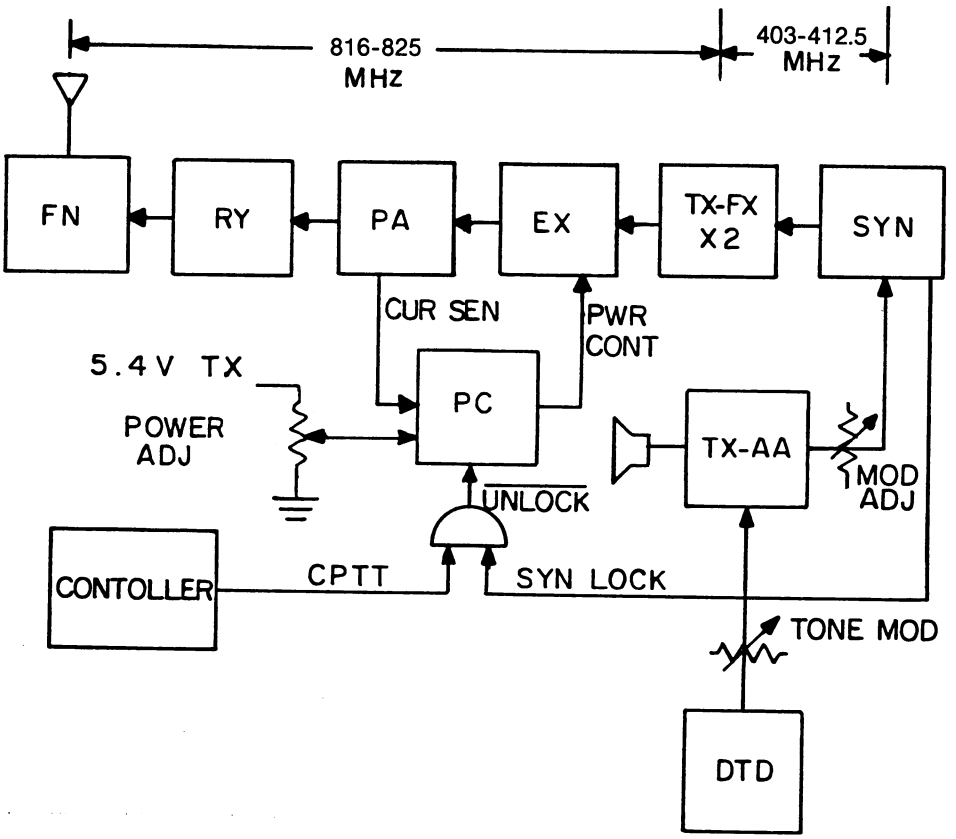


Figure 8 - Transmitter Block Diagram

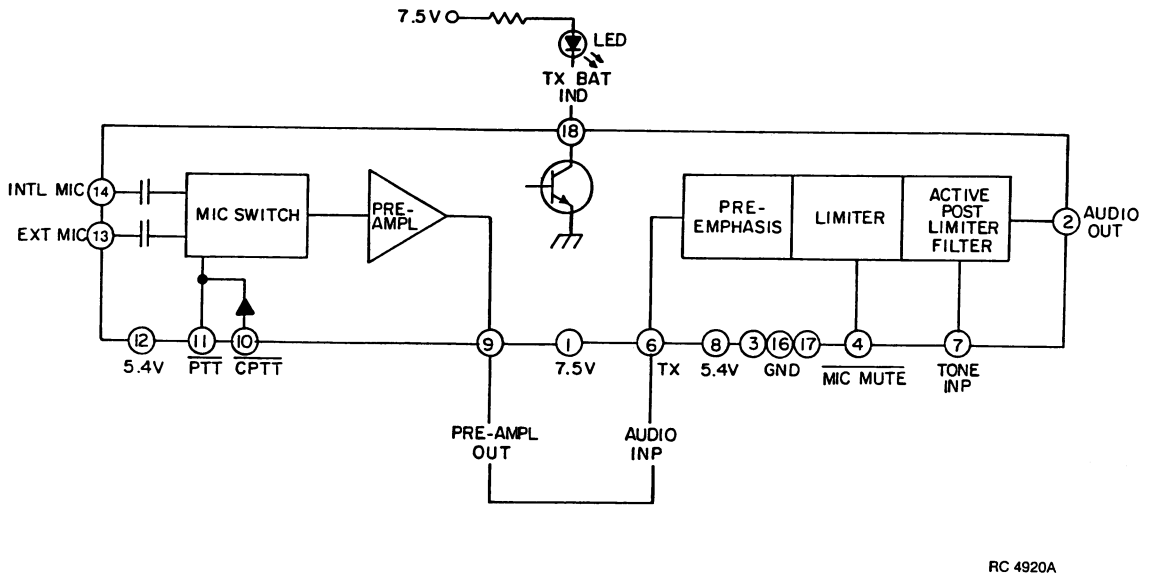


Figure 9 - Audio Processor

DOUBLER MODULE (TX FX)

Doubler amplifier (TX FX) is a four stage RF amplifier with the input on Pin 2 covering the frequency range of 405 to 413 MHz. The output on Pin 12 is tuned to cover the frequency range of 810 to 826 MHz. A 5 milliwatt RF signal on the input will produce a 100 milliwatt signal on the output. Several tuned networks reduce the level of the one-half frequency at the output (See Figure 10).

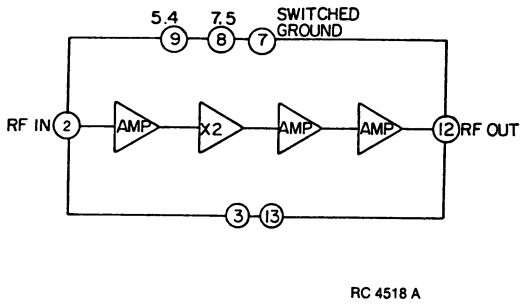


Figure 10 - Transmitter Doubler Module

citer Module (EX)

The EX module is a two stage RF amplifier module with an input and output impedance of 50 ohms. The first stage has its DC power supplied by the Power Control Module (PC).

The 100 milliwatts of RF drive from Pin 4 of the TX-FX module to Pin 11 of the EX module is coupled to the input of the first RF amplifier stage where it is amplified to approximately 275 milliwatts (See Figure 11). The second RF amplifier stage amplifies the 275 milliwatts approximately 1.0 watt. The 1.0 watt output from Pin 1 of the EX module is connected to Pin 8 of the Power Amplifier Module (PA).

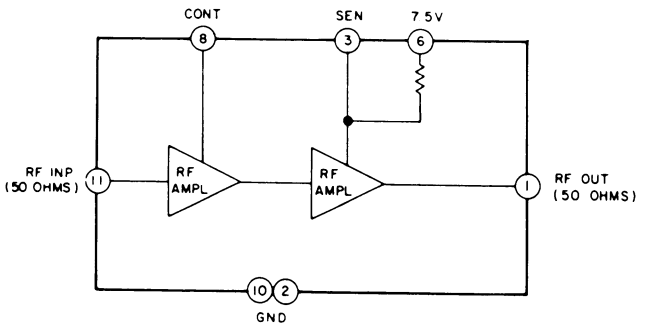


Figure 11 - Exciter

Power Amplifier Module (PA)

The PA module is a single stage RF amplifier module and like the exciter module has an input and output impedance of 50 ohms. The RF power output from Pin 1 of the EX module is connected to

Pin 8 of the PA module where it is applied to the input of the RF power amplifier stage (See Figure 12).

The RF power amplifier stage amplifies the 1.0 watt input from the EX module to a typical power output level of 3 watts at Pin 1. The output at Pin 1 is connected through the antenna relay (RY) to Pin 1 of the filter network module (FN). A minimum power level of 2 watts is on the output of the FN module.

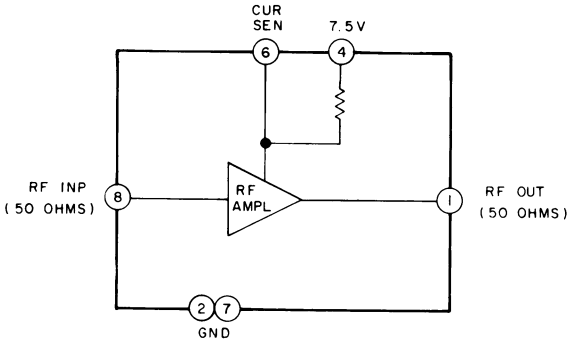


Figure 12 - Power Amplifier

Power Control Module (PC)

The RF power output of the radio is regulated by sensing variations in the current drain of the transmit final PA module to control the supply voltage of an earlier driver stage. Supply voltage cannot be applied to the driver stage until the transmit circuit is keyed, applying 5.4 volts to Pin 5 of the PC module. Also, the $\overline{\text{UNLOCK}}$ lead at Pin 1 of the PC module must be high, indicating that the synthesizer is running on the correct operating frequency.

When the transmit circuit is keyed, the output of a reference generator, determined by the HI PWR ADJ control, is applied to the positive (+) input of a comparator amplifier (See Figure 13). The current sensing element in the final PA module is connected to Pin 7 of the PC module and to the negative (-) input of the comparator amplifier. The amplifier is enabled when the $\overline{\text{UNLOCK}}$ lead goes high. Until then, the output of the amplifier is high and the series regulator is held off. When the $\overline{\text{UNLOCK}}$ lead goes high, the output of the amplifier goes low causing the series regulator to conduct and apply maximum supply voltage to the driver stage.

As the PA module begins to draw more current and the power increases, the changing voltage drop across the sensing element causes the series regulator circuit to regulate the supply voltage to maintain constant current flow through the PA module and constant RF power output.

Filter Network Module (FN)

The output of the EX/PA module or the output off the PA module is connected to Pin 1 of the filter network module (FN). The FN module is a passive L/C general parameter low pass filter with an insertion loss of less than .4 dB in the pass band range of 806-870 MHz. It also has a rejection of greater than 30 dB in the stop band range of 1612-8700 MHz. The output of the FN module on Pin 7 is connected to the system antenna.

Carrier Controlled Timer (CT)

The carrier controlled timer module provides a transmit interrupt, 30 seconds after the transmit circuit has been keyed. Other time periods of 60 or 90 seconds can be obtained by replacing the printed run between H907 and H908, on the system board, with a resistor (See Figure 14).

Keying the transmit circuit causes the $\overline{\text{PTT}}$ lead on Pin 8, of the CT module to go low and start the time-out timing sequence. When the time period for the transmit interrupt has elasped, a time-out signal to the regulator circuit unkeys the transmit circuit.

A DC voltage on Pin 12, of the CT module, will mute the receive audio and an alert tone, also on Pin 12 of the CT module, will be applied to the receiver audio. The alert tone will be heard from the speaker as long as the $\overline{\text{PTT}}$ bar is pressed. A momentary release of the $\overline{\text{PTT}}$ bar resets the CT module.

DIGITAL TONE DETECTOR (DTD)

The DTD module generates the GE MARC V signalling tones, and sums in DTMF tones. Both high and low level busy tone may be generated. Refer to the description in the receiver section.

RECEIVER CIRCUITS

The receive circuit, as shown in Figure 15, consists of the following integrated circuit modules.

RF Amplifier/Receive Converter Module (RA/RC)
IF Pre-amplifier Module (IA-1)
IF Amplifier Module (IA-2)
Crystal Discriminator Module (XD)
Audio Amplifier Module (RX-AA)
Digital Tone Detector Module (DTD)
Tone Filter Module (T-FN)

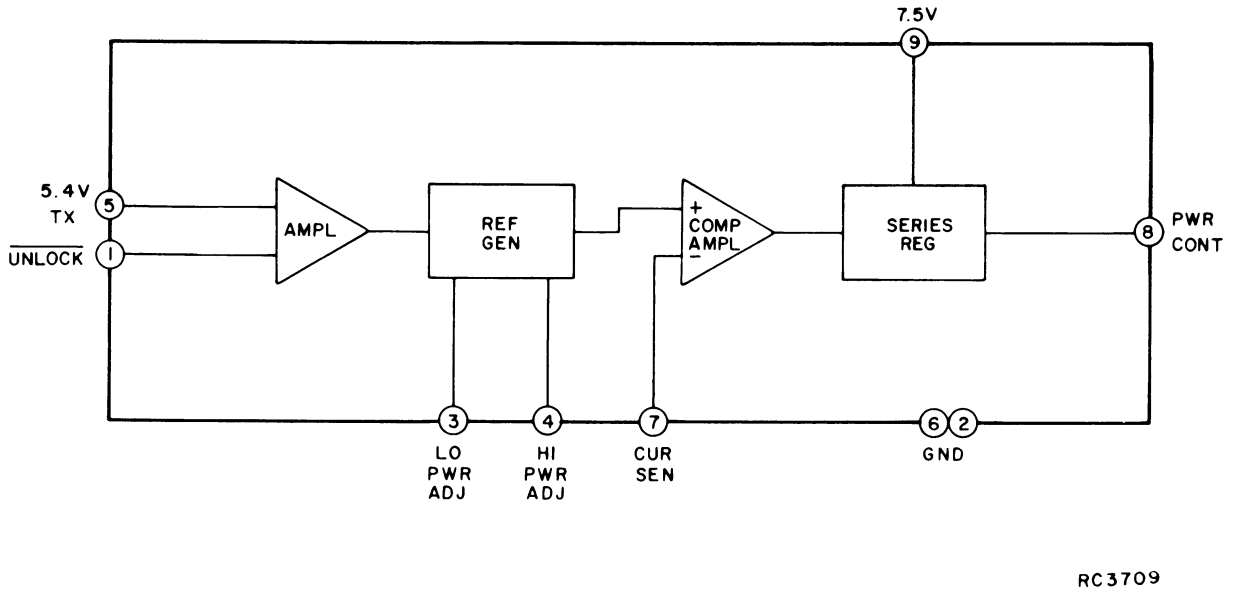
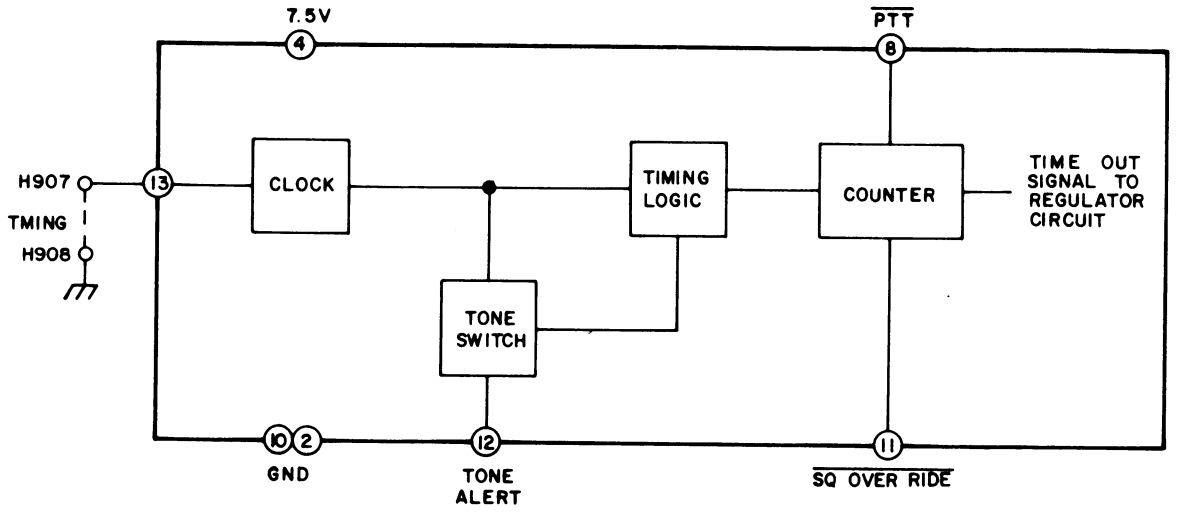


Figure 13 - Power Control



TMING	RESISTOR VALUE CONNECTED BETWEEN H907 AND H908	GE PART NO.
60 SECONDS	430K	3R151P434J
90 SECONDS	820K	3R151P824J

RC3723A

Figure 14 - Carrier Controlled Timer

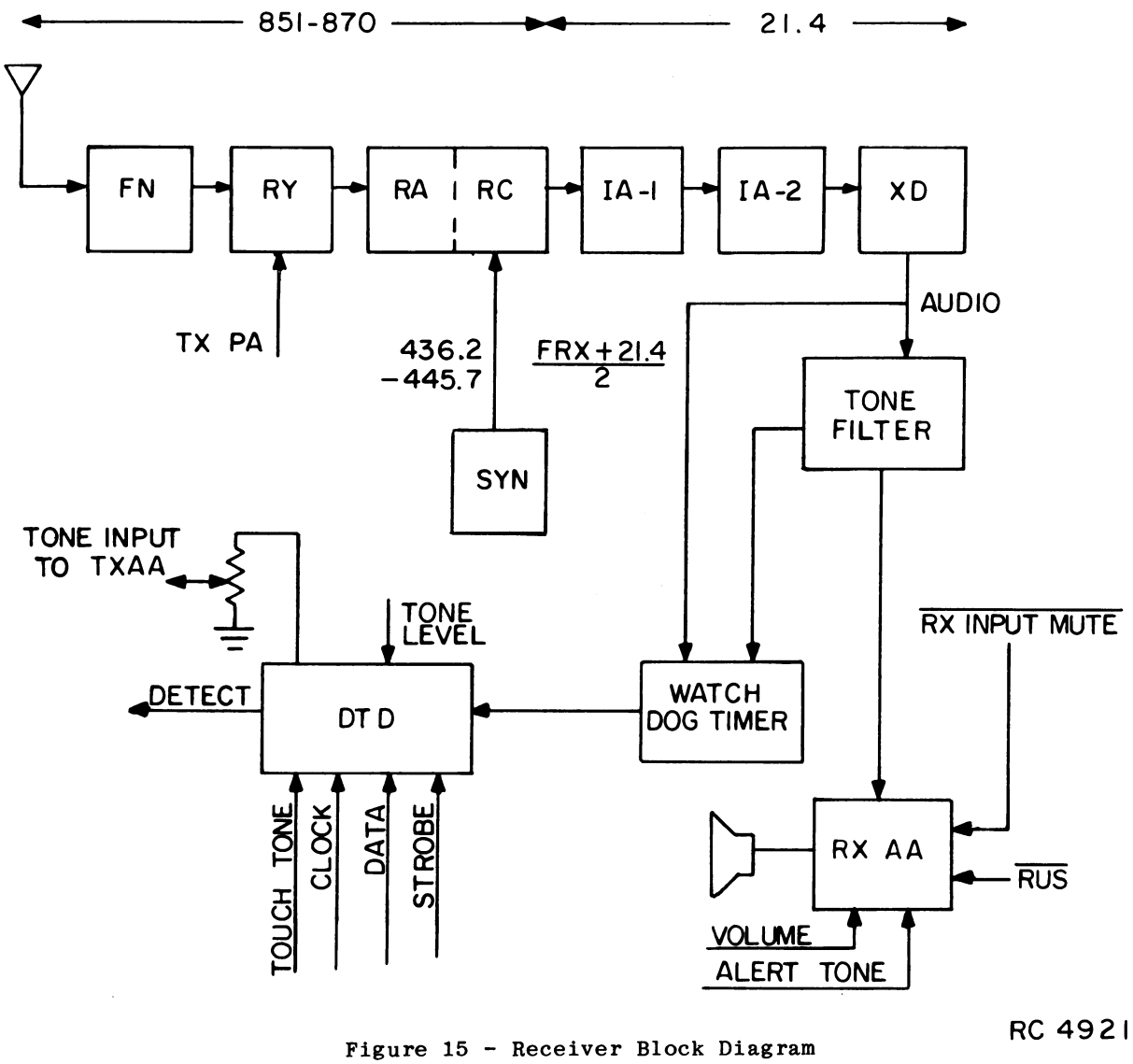


Figure 15 - Receiver Block Diagram

RF AMPLIFIER/RECEIVE CONVERTER MODULE (RA/RC)

The RF Amplifier/Receiver Converter module contains five helical resonators, tuned for best receive circuit quieting, an RF amplifier circuit and a passive harmonic diode mixer circuit (See Figure 16).

RF from the antenna is coupled through transmit low-pass filter FN and antenna relay RY to the input of the RA/RC module. Low-pass filter FN is used in the receive circuit because of the 3rd mode response of the helical resonators in the RA/RC module. The low-pass filter also provides additional selectivity for the receive circuit.

The RF signal on the input of the RA/RC is coupled through two helical resonators to the input of a grounded emitter, broadband RF amplifier. This amplifier provides 10 dB of power gain to compensate for the loss of the last three resonators. The output of the RF amplifier is coupled through these helical resonators to drive a harmonic mixer circuit. The 851 to 870 MHz RF signal on the RF input of the RA/RC module, and the 436.2-445.7 MHz signal from the synthesizer module, doubled in the mixer to produce the high side injection signal of 872.4 to 891.4 MHz provides a difference of 21.4 MHz as a IF on the output.

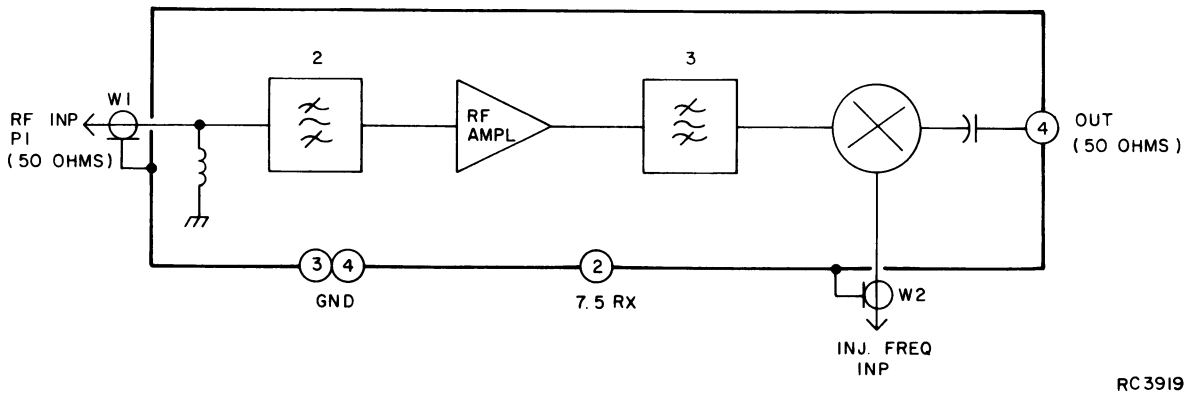


Figure 16 - RF Amplifier/Receive Converter Module

The RC module has a typical conversion loss of 0 dB between the RF input and IF output. All inputs and output of the RA/RC module have 50 ohm impedances. The +4 dBm injection frequency level, provided by the Synthesizer module, is connected to the injection frequency input through a 50 ohm stripline.

The output of the RA/RC module is connected to the input of the IF pre-amplifier (IA-1).

IF Pre-amplifier Module (IA-1)

The IF Pre-amplifier module contains an amplifier circuit and a four pole crystal filter (See Figure 17). The 21.4 MHz IF signal from the RC module feeds the input of an amplifier stage providing a 15 dB power gain. The 21.4 MHz IF is connected through the crystal filter with the output on Pin 1. The IA-1 module has an input impedance of 50 ohms and an output impedance of approximately 1200 ohms. The output of the IA-1 module is connected to the input of IF amplifier module IA-2.

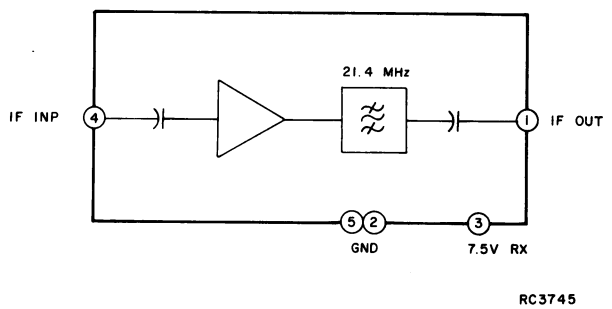


Figure 17 - IF Amplifier

IF Amplifier Module (IA-2)

IF Amplifier module IA-2 contains a 45 dB power gain stage and a 4-pole crystal filter. Input and output impedances of this module are approximately 1200 ohms. The input to the IA-2 module is fed from the output of the IA-1 module. Both input and output pins of the IA-2 module are AC coupled, with the output driving the crystal discriminator module (XD).

Crystal Discriminator Module (XD)

The crystal discriminator module contains two additional IF amplifier stages for an added 90 dB gain. The discriminator module also contains a crystal resonator, FM detector circuit and audio amplifier circuit (See Figure 18). The 21.4 MHz IF input is connected to the input of the IF amplifier stages for gain and limiting. The output of the amplifier stages is connected through the crystal resonator to the FM detector circuit.

The recovered audio from the detector circuit is amplified and buffered to a 1K impedance and drives the DISC-output lead. This lead feeds the audio to the squelch, audio, and optional tone modules. A typical audio level of 200 millivolts rms is achieved with a 3kHz deviation at an audio frequency of 1kHz. The frequency response is flat within $\pm$1 dB over the useful audio range of DC-3000 Hz.

Audio Amplifier Module (RX-AA)

The audio amplifier module contains an active low-pass filter, an active notch filter, an attenuator circuit and

an audio power amplifier circuit (See Figure 19). Audio from the DISC lead is connected through the low-pass filter to de-emphasize the audio high frequencies and provide the desired audio response. The output of the low-pass filter is connected to the input of the notch filter. The notch filter eliminates the presence of any low frequency noise in the recovered audio. The output of the notch filter is connected to the input of the attenuator circuit.

The attenuator circuit is DC voltage controlled and provides a greater than 70 dB range for the volume control. The module provides filtering for the DC control voltage, reducing any noise from the controller. The output of the attenuator circuit is connected to the input of the audio power amplifier circuit.

The audio power amplifier circuit provides 500 milliwatts audio output, with 5% maximum distoration, into a capacitor coupled eight ohm speaker.

The output of the audio power amplifier has thermal overload protection making it indestructable into open or shorted loads.

The audio power amplifier is controlled by the RUS control lead. When the lead is high the amplifier is in the standby mode.

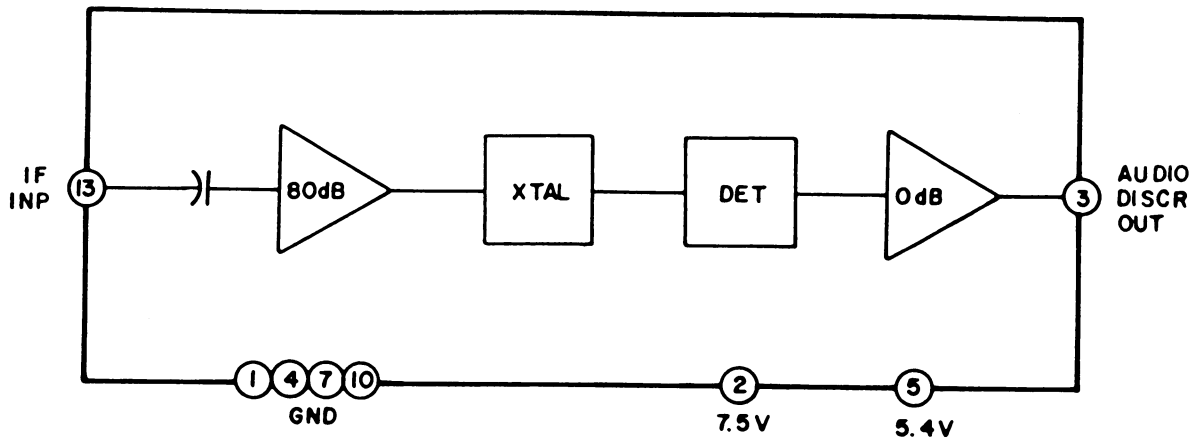


Figure 18 - Crystal Discriminator

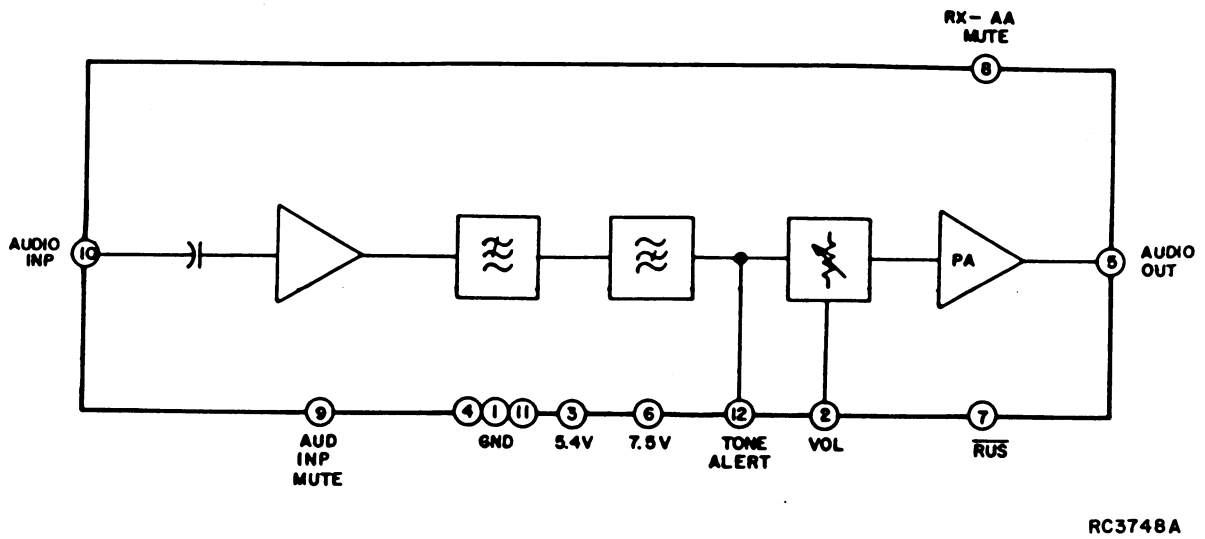


Figure 19 - Audio Amplifier

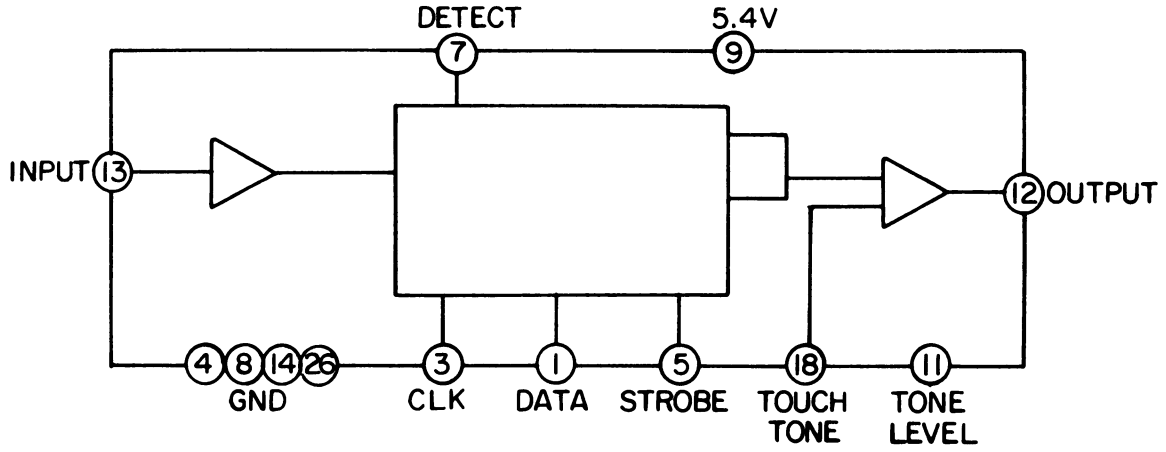


Figure 20 - Tone Detector

The $\overline{\text{RUS}}$ lead shuts down the current to the attenuator circuit and the audio power amplifier circuit. The RX-AA MUTE lead shuts down the current to the power audio amplifier muting the audio output.

TONE DETECTOR MODULE (DTD)

The DTD module generates single tones by summing two digital waveforms (See Figure 20). Detection of this same tone frequency is accomplished by comparing tones appearing at the input with the generated tone. When a tone of > 4 mv. of the correct frequency is present at the input, the detect line goes high, indicating a detect. Tone frequencys and detection bandwidth are set by loading a serial bit pattern on Pin 1. A clock and strobe are used to facilitate this loading. The tone level of approximately 430 mv. can be reduced by 10 dB by switching Pin 11 low. This is used to reduce the busy tone deviation during normal voice transmission. Touch tones generated by the controller are summed in with the normal tone and also appear at the tone output.

TONE FILTER MODULE (T-FN)

The tone filter module accepts the discriminator audio output and provides a path to the receive audio amplifier through a lowpass notch filter, and a separate path through a highpass filter which is used during low level busy tone detection in the receive mode (Figure 21). The lowpass notch filter has a double band-reject function at the busy tone frequency to reject both the normal and the alternate busy tone. The high pass filter has a cutoff frequency of approximately 3 kHz.

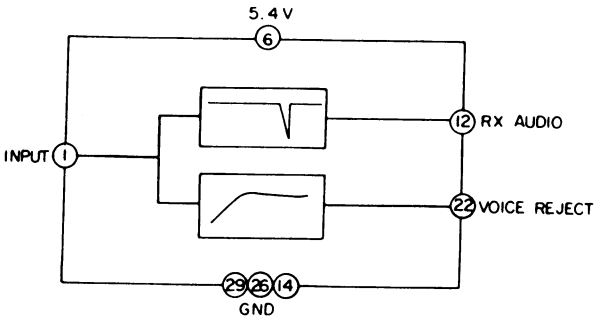


Figure 21 - Tone Filter

SYNTHESIZER

DESCRIPTION

The synthesizer provides the receiver injection (high side) and transmitter reference frequency. Since the receiver uses a doubling mixer, the injection occurs at (Fo+21.4)/2, thus

requiring injection frequencies in the range of 436-446 MHz. A low level transmitter reference is generated at Fo/2, producing synthesizer frequencies in the range of 403 to 412.5 MHz. An auxiliary module provides a second voltage regulator to provide a clean supply for the VCO, and to supply bias current for the extra modules.

SYNTHESIZER CIRCUITS

Synthesizer (FS) contains PLL and VCO modules
Oscillator modules RX-XO/TX-XO
Voltage regulator VR/B

SYNTHESIZER

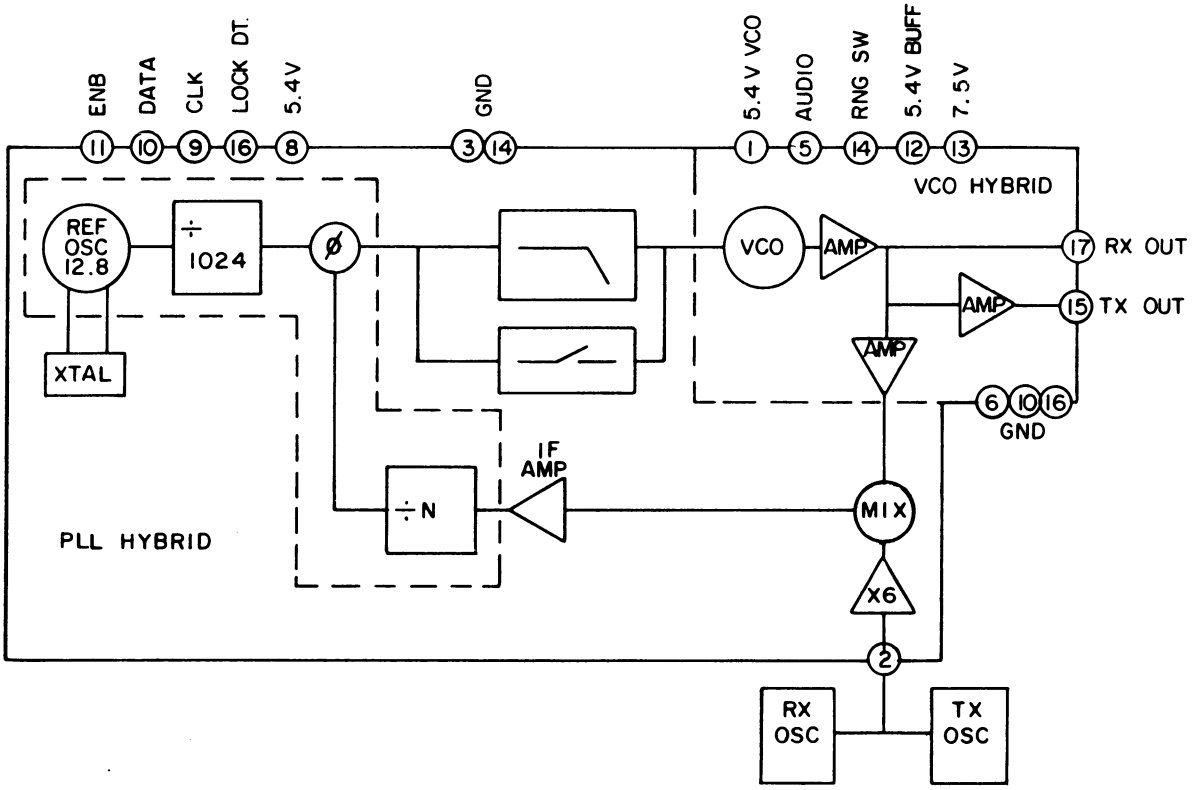
The VCO used to generate the receive and transmit references is phase locked to a stable crystal reference oscillator through the use of PLL. This feedback loop mixes the VCO frequency down to a signal in the range of 7-10 MHz; divides this signal with a programmable divider to 12.5 kHz; and generates a VCO control signal by comparing the 12.5 kHz fed back with a 12.5 kHz signal derived by dividing a 12.8 MHz crystal oscillator by 1024. As the least significant bit in the programming is changed, the VCO is forced to change by 12.5 kHz, thus generating 25 kHz channel spacings when the VCO signal is doubled.

The injection for the mix-down is obtained by multiplying the output of a 5th mode 2 ppm oscillator by six(6).

The synthesizer circuitry is contained on 2 modules, the VCO module, and the PLL module. These are housed together inside a rigid casting to provide electrical shielding and acoustical rigidity. Connections between the two modules are made through the casting center wall with wires. The VCO is attached with low temperature solder and the PLL with RTV. The module plugs into berg sockets in the PWB and is retained by 4 screws.

PLL

The PLL module contains the oscillator multiplication circuitry, a bipolar active mixer, a 2 stage IF amplifier providing approximately 1vpp output, and a synthesizer chip. The synthesizer chip contains the divide by N circuitry, a digital phase detector, reference oscillator, and divide by R circuitry (12.8 MHz oscillator is divided



RC 4924

Figure 22 - Synthesizer Block Diagram

by 1024 to produce the 12.5 kHz reference). An external crystal and 2 feedback capacitors are required to complete the oscillator circuitry. The phase detector output is integrated and filtered with a passive low pass filter followed by a 12.5 kHz notch filter to reduce the level of reference modulation on the VCO.

This DC output represents the error between the VCO frequency (phase), and the reference, and is applied to the varicap in the VCO tuning circuit to keep the VCO on frequency. A lock detect output is developed from the LD output of the synthesizer chip. This is "anded" with the CPTT output from the computer to prevent transmission before the VCO is on frequency.

Serial data from the computer is shifted into the PLL module to set the division parameter which establishes the frequency. A clock signal is provided on another input, and the data is latched with the enable input.

VCO

The VCO uses a JFET in the grounded gate configuration as the basic oscillator. A high gain bipolar is connected in parallel across the FET to provide additional gain. The resonant circuit which determines the frequency of oscillation is formed by a stripline of approximately 1/8th wavelength partially shorted on one end to provide a net inductance, and a parallel capacitance formed by the frequency control varicap, and a trimmer which is used to set the center frequency at the factory.

When transmit is selected, capacitance is switched in, lowering the VCO center frequency approximately 33 MHz. Modulation frequencies are limited by the loop dynamics to approximately 300 Hz.

The VCO output is coupled into a high gain cascode amplifier which produces +5 dBm at the output. The output of this amplifier is coupled into the receiver mixer through stripline in the system board. This output is also fed back to the PLL down-mixer through a two stage buffer amplifier. The transmitter signal is obtained by turning on a low gain buffer amplifier connected across the receiver output port.

SYNTHESIZER SUPPLY REGULATOR (VR/B)

The power supply regulator generates two 5.4v outputs which are used to power the synthesizer (Figure 23). A compensated regulator chip is used to produce the first voltage, which powers the VCO oscillator and the fifth mode oscillator's TC line. This output can deliver 15 mA, and is well decoupled to provide a clean voltage to power the VCO. The second voltage is referenced to the first and is used to power the rest of the circuitry. It can deliver approximately 80 mA.

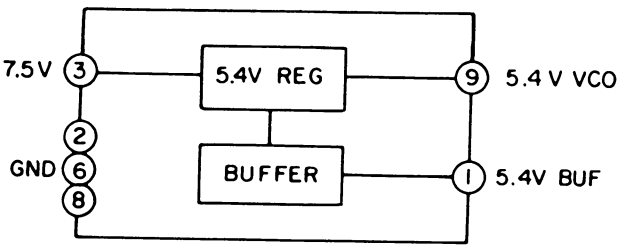


Figure 23 - Synthesizer Regulator

Oscillator Module (RX-XO) (TX-XO)

The oscillator module is self-contained and fully temperature compensated (See Figure 24). A basic colpitts fifth mode oscillator circuit operates in the frequency range of 65.9 to 72.7 MHz. The output of the oscillator circuit is connected through a cascade common base buffer circuit to Pin 3 of the module. The output is typically 1 milliwatt.

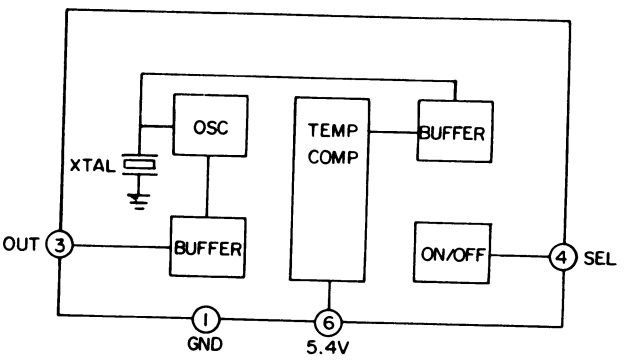


Figure 24 - RX/TX Oscillator

Temperature compensation for the oscillator circuit is achieved by biasing a voltage variable capacitive diode with a correction voltage. The correction voltage is derived from a "S" shaped, correction voltage vs temperature curve.

The frequency of the oscillator module is trimmed using a slug tuned coil molded into the oscillator header providing a multi-turn resolution.

The output of the oscillator module is connected to Pin 2 of the PLL module (FS).

SYSTEM CONTROL MODULES

The System Control function is accomplished by the controller module, located on a separate plug-in printed wiring board. The controller module contains the following elements:

- Microcomputer
- CMOS Ram
- Lithium Battery
- Watch Dog Timer Module (WDT)

The controller board is a 4-layer board which has the microcomputer on it. The 40-pin microcomputer is mounted in a socket so that the two memory chips can be located underneath it. The hybrid also contains the watch-dog timer and memory protect circuits.

The microcomputer has the following main characteristics:

- 32 I/O lines
- 2096 bytes of mask ROM
- 112 bytes of RAM
- 16-bit timer

Refer to the Table of Contents for the microcomputer Schematic Diagram and a description of the microcomputer software.

CMOS RAM

The customer information is contained in two 1Kx4 CMOS RAMs. The memory information is retained when the radio is turned off by power drawn from the Lithium Battery. Circuitry on the controller board only allows the RAM to be written to from the connector on the radio top. The microcomputer interfaces with this connector and provides the actual data transfer. The microcomputer periodically READS information from the RAM.

LITHIUM BATTERY

The Lithium Battery GE Part Number 19A702912P1, has a rating of 160 mAh. Nominal Standby Drain (Radio OFF) is 25 nanoamperes.

WATCH DOG TIMER

The WDT module serves to monitor the computer operation and generate a reset if a malfunction occurs (See Figure 25). Pulses which occur every 5 ms are generated on Pin 28 of the microprocessor and are used to discharge a timing capacitor in the reset oscillator located in the WDT. Failure of the 5 ms pulses allows the oscillation to occur and provide the reset function on Pin 34. Also located on the WDT are a divider integrated circuit, and a transmission gate integrated circuit. The divider circuit uses the 3.58 MHz microcomputer clock to produce a 1.79 MHz clock used by the DTD module, and a 27.9 kHz clock used as timing input to the microcomputer.

The three transmission gates serve the following functions: (X) selects an input to the DTD from either the discriminator output, or from the high-pass output of the tone filter. The discriminator output is selected when the X control is High, and is used during the idle mode to allow detection of the Collect and Group tones. The tone filter output is used during Receive to allow detection of the low level busy tone. (Y) connects the DAC output to the Receive audio volume control input during receive. This is controlled by the CPTT control signal, which is low during receive. During transmit the volume control is disconnected. (Z) selects the source of the audible "beeps" used to alert the user. During IDLE and RECEIVE, the control CPTT is low, and selects Pin 28 of the microprocessor through a level lowering resistor. The audible alert tones are generated on Pin 28 by toggling the output level at the correct repetition rate. This is summed with the alert tone output of the VR/CT module and routed to the alert tone input of the RXAA module. When a "beep" is required, 28 is caused to toggle, and switch Q907 if turned on. During TRANSMIT, the output of the Z gate is connected to the DAC output. Any DTMF tones are generated by the DAC and are routed both to the Transmitter audio amplifier through the DTD module, and to the Receiver audio amplifier through Q907. In this manner, audible DTMF tone feedback is accomplished.

LCD DRIVER

The radio uses an integrated circuit (IC) for the driver. When Pin 4 of the IC is grounded, the DATA ENABLE Line is held low, allowing data to be strobed in. The circuit requires 36 strobe bits to clock in all the data. The data format is a leading "1" followed by the 32 data bits. The 32 data bits are latched after the 36th clock is complete. The data is strobed in on the rising edge of the clock signal. The output to the LCD is changed only if the new data is different from the old data.

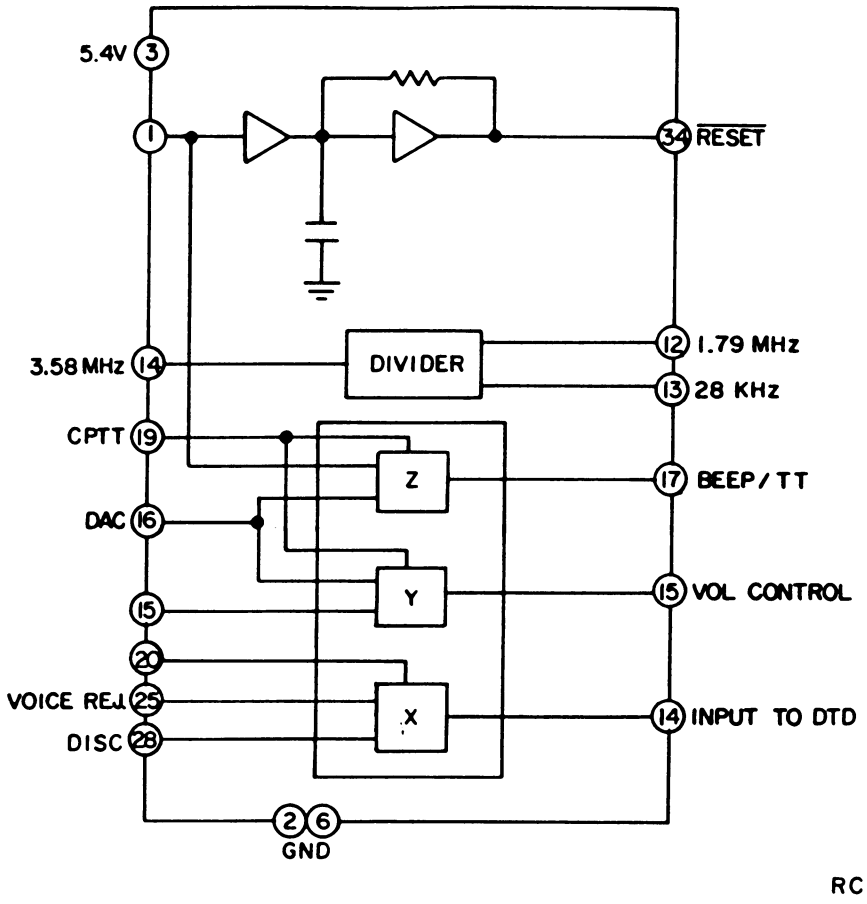


Figure 25 - Watch Dog Timer

Every data bit set to a "1" will turn on a segment of the LCD, so the data should contain trailing '0's to complete the data transfer. R1 and C1 form the timing elements for the Back Plane Clock.

LCD DISPLAY

The display acts as a set of 18 capacitors with one side all tied in common. This represents the 18 segments used on the GE MARC V PERSONAL LCD. When an AC voltage is impressed across one of the capacitors between it's lead and the common lead, the dielectric is alternately charged and discharged. This turns on a LCD segment. When the impressed AC voltage is zero, the dielectric is discharged; turning off the LCD segment. Only about 10 volts peak to peak AC is needed to turn on a segment. When a 5 volt peak-peak squarewave is applied to the common leg and another 5 volt squarewave applied to one of the segments (assuming the two signals are at the same frequency), the segment could be either on or off. It is 'on' if the two signals are 180 deg. out of phase hence generating a 10 volt peak-peak signal differentially across the segment. Or 'off' if the two signals are in phase, generating a 0 volt peak-peak signal differentially across the segment. This is done by the LCD driver.

The common terminal is driven continuously at a rate anywhere between about 30 Hz and 200 Hz. This continuous signal is refered to as the Back Plane clock or 'BP' clock. The signal on this pin should be a 0 to 5 volt squarewave with a frequency between 30 Hz and 200 Hz. It is generated on the hybrid by R1 & C1 and the internal oscillator. The signals for the other segments i.e. DIGIT #1, DIGIT #2, and the four annunciators (See Figure 26) are also 0 to 5 volt squarewaves but they can be either in phase or out of phase with the backplane signal. To test the condition of the individual segments, a differential AC measurement can be made to see if the impressed voltage is correct to turn on the segment. Also the average differential DC voltage across the segment

must be within limits otherwise the LCD will 'plate out' on the glass, shortening the life of the LCD.

POWER DISTRIBUTION

Power for the Portable radio is supplied by a 7.5 Volt battery pack connected to connector J702 (See Figure 27). The negative terminal of the battery pack connects through the shell of connector J702 and a flexible metal strap to the system board ground pattern. The positive terminal of the battery pack connects through the system ON/OFF switch and flexible printed wire board to the system board for distribution.

Some modules on the system board operate directly from the battery voltage or through a R-C de-coupled 7.5 volt lead for noise reduction.

A continuous and keyed 5.4 volts is provided by voltage regulator module (VR), and two more continuous supplies are provided by VR/B.

Voltage Regulator Module (VR)

The voltage regulator module, powered from the 7.5 volts supply, current limited and highly stable, generates a continuous 5.4 volt output (See Figure 28). During transmit when the DPTT lead is low, the regulator module also provides a keyed 5.4 volt output for transmit functions. When the transmit circuit is keyed the regulator module activates the system relay by saturating a keying transistor.

External Power

An external power source can be connected at J701-12. When Pin 12 of J701 is pressed, battery voltage is removed from the radio. The radio may now be powered by an external 7.5V source, completely by-passing ON/OFF switch S701. In vehicular chargers, the radio is turned on and off from the charger. The DC return should be the ground contact on the battery pack.

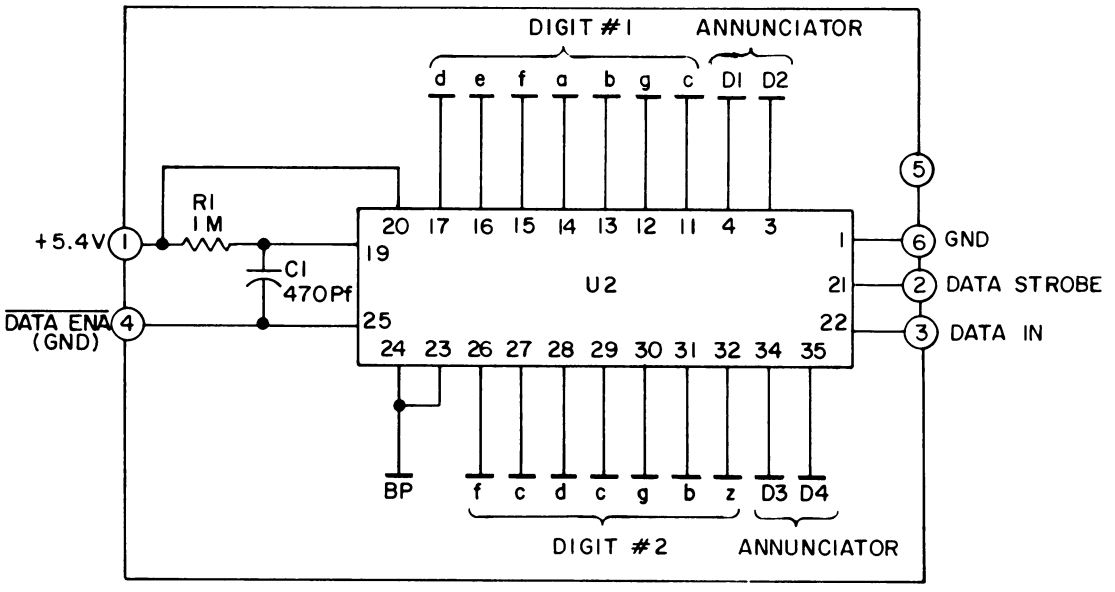
WARNING

When powering the radio from an external supply for service purposes, use a suitable fused 5 Amp supply or a 3 amp current limited supply. DO NOT USE a PE battery pack because a system short can cause unrepairable damage to the multi-layered system board or to the flexible printed board.

BATTERY PACK

Two battery packs, one with 750 mAh capacity and one with 1200 mAh capacity are available for use with the MPX radio. Both battery packs contain six nickel cadmium battery cells to provide a nominal 7.5 volts DC output.

To protect the battery pack from external short circuits, the positive (+) charging contact is diode protected and the positive output terminal is fused. The fuse is replaceable.



RC 4928

Figure 26 - Annunciator Module

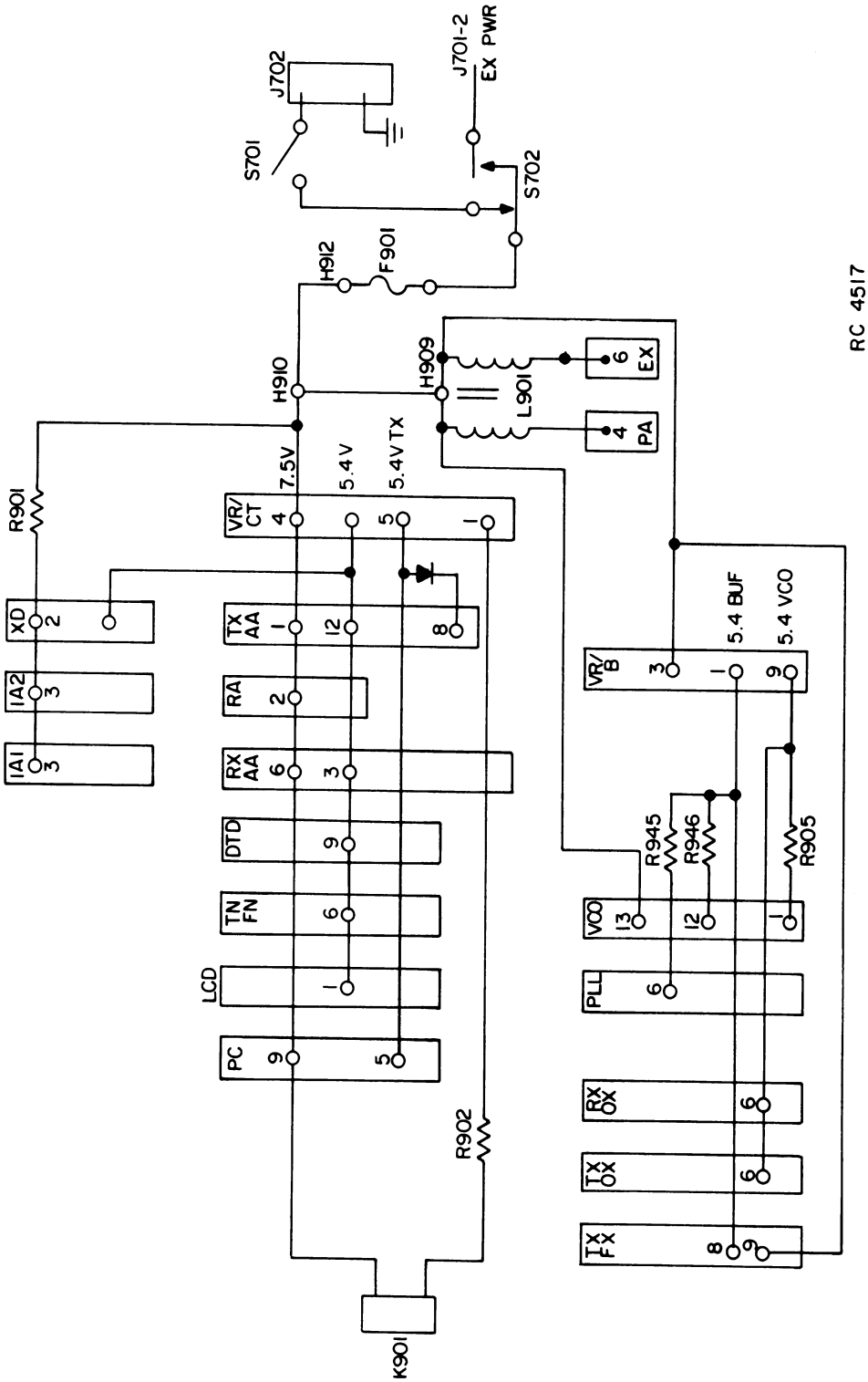


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Figure 27 - Power Distribution

An internal thermistor senses variations in battery pack temperature to automatically control a charger and provide a maximum charge without overheating the battery pack. Both battery packs can be recharged in one hour.

The battery pack is fully charged and shipped to the customer ready for use. If the battery pack is stored for any length of time it should be fully recharged before placing into service.

Charger combinations for re-charging the battery packs are available with charge times of 1-hour, 3-hours and 14-hours. A combination can be a single unit desk or a vehicular charger. It can also be a wall or bench mounted rack charger with a multiple of charge units.

Charge Level

The charge level of the battery packs can be measured by connecting a voltmeter across the charge contacts and measuring the voltage with the transmitter keyed.

For the rechargeable battery packs, a fully charged battery pack should provide a reading of 7.5 and 8 Volts. A fully discharged battery pack should provide a reading of no less than 6 Volts.

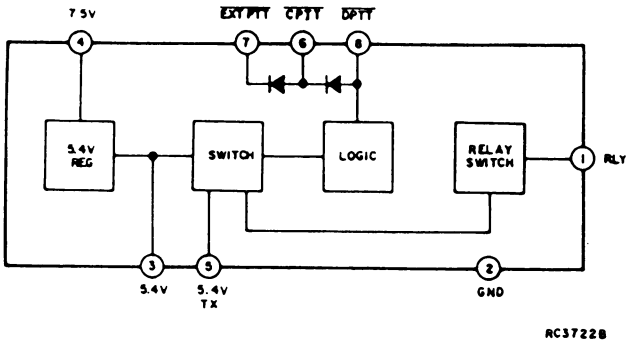


Figure 28 - Voltage Regulator

Battery Check

One of the best service checks for the series rechargeable battery packs can be easily obtained by measuring the milliampere-hour capacity. The results of the measurement can then be compared with the rated capacity of the battery pack to determine the general condition of the rechargeable batteries.

First, it is necessary to find the percentage of rated capacity. This is obtained by measuring the time it takes to discharge a fully charged battery pack until the voltage drops to 6.0 Volts. The proper load resistor for each of the battery packs is shown in Table 1.

Then use the formula $\frac{T}{60} = \%$ where "T" is the time in minutes required to discharge the battery pack to 6 Volts and % is the percentage of rated capacity the battery delivered to a load. For example: assume the standard battery pack voltage dropped to 6 Volts in 50 minutes:

$$\frac{50}{60} = .83 \text{ (percentage of capacity)}$$

Now multiply the percentage of capacity by its rated capacity (See Table 1):

$$.83 \times 750 \text{ mA} = 622.5 \text{ mAh}$$

The 622.5 milliampere-hours is the actual capacity of the battery pack.

NOTE

As the voltage drops very fast near the end of the discharge cycle, be very careful to avoid discharging the battery pack below 6.0 Volts.

Table 1 - Capacity Measurement Data

RECHARGEABLE BATTERY PACK	RATED CAPACITY	AVERAGE DISCHARGE RATE (for 60 minutes)	LOAD RESISTOR (R L)	END VOLTAGE
19D429763G3 (6 cells)	750 mAh	750 mA	10 Ohms 8 Watts	6 VDC
19D429777G3 (6 cells)	1200 mAh	1200 mA	6.25 Ohms 12 Watts	6 VDC

TEST MODE

A test mode is included as an option in each GE MARC V PERSONAL radio. If the option is enabled, it allows the technician to:

1. Transmit and receive Half-duplex on 3 different test frequencies. The frequencies are also options.
2. Turn the microphone on and off.
3. Transmit any of the GE MARC V tones, as well as test ones of 300, 1000, and 3000 Hz. The tones (including busy) may be disabled.
4. Detect any of the selected tones using the R flag as a visual indicator.
5. Set the tone deviation to either high or low.
6. Increment the volume up and down.
7. Mute and unmute the audio.
8. Select either a Hi-pass or All-pass filter ahead of the tone detector.

OPERATION

If the option is present in the radio, enter the TEST MODE by depressing the following keys in order: "G", "0", "A", "0". Squelch noise will be heard in the audio when the mode is entered, as the radio has no carrier squelch circuitry. At this point, the radio is configured in the following manner:

RECEIVE

Audio set to the level present before the TEST MODE was entered.
The All-pass filter is inserted ahead of the tone detector.
Test channel 1 is selected.
BUSY TONE is selected (#46 = 3051.8 Hz).

TRANSMIT

Microphone disabled ***
BUSY TONE transmitted at HIGH deviation
Test channel 1 selected
Receiver muted
DTMF tones enabled.

The following keys may be used to select other configurations:

KEY

1 RX/TX on test channel 1--tone 46 is loaded each time the key is depressed.

2 RX/TX on test channel 2--tone 46 is loaded each time the key is depressed.

3 RX/TX on test channel 3--tone 46 is loaded each time the key is depressed.

4 Selects the voice reject filter ahead of the tone detector (for use in detecting busy tone).

5 Selects an all pass filter ahead of the tone detector (for use in detecting all tones except busy)

6 Mutes the microphone

7 Enables the microphone

8 Sets transmit tone deviation (internal tones) to LOW (used to set busy tone to 1 kHz deviation)

9	Sets transmit tone deviation to high (appx 10 dB above low)
0	Returns the radio to the IDLE MODE
I/C	Used to decrement the tone selected for detection or transmission. The tone number appears in the LCD display. To reset to tone 46, push the channel key already selected. Selection of tone 40 or 39 disables the tone generator/ detector
S/C	Volume--push once for each step. Mutes the receiver.
A	Volume Up--push once for each step. Mutes the receiver.
G	Unmutes the receiver
^,v	Ramps the volume up, down very rapidly.
Numeric Keys	In transmit, used to send DTMF tones

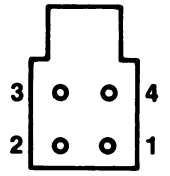
GE MARC V PERSONAL TEST TONES

TONE NUMBER	FREQUENCY
1	604.23
2	631.54
3	662.26
4	692.99
5	727.12
6	761.26
7	795.40
8	832.95
9	870.50
10	911.47
11	952.43
12	996.81
13	1041.19
14	1088.98
15	1140.18
16	1191.39
17	1246.01
18	1304.04
19	1362.08
20	1423.52
21	1488.38
22	1556.66
23	1628.35
24	1717.10
25	1795.62
26	1877.55
27	2051.65
28	2143.82
29	2239.40
30	2341.82
31	2447.64
32	2556.88
33	2672.95
34	2792.43
35	508.65
36	529.13
37	556.44
38	587.16
39	0.00
40	0.00
41	300.41
42	3000.67
43	1000.22
44	1962.89
45	2918.74
46	3051.87 (default loaded when a channel selected)

GENERAL ELECTRIC COMPANY • MOBILE COMMUNICATIONS DIVISION
WORLD HEADQUARTERS • LYNCHBURG, VIRGINIA 24502 U.S.A.

GENERAL ELECTRIC*
U.S.A.

SEND DATA TO RADIO



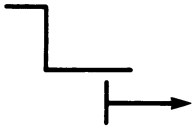
CONNECTOR ON RADIO

RADIO PROGRAM JACK

PIN

4. LOAD SW  **FROM PGMR**

1. DATA  **CLOCK FROM RADIO**

2. $\overline{IRQ}$  **FROM PGMR**

DATA

3. GND

IRQ GOING LOW INITIATES TRANSFER
RADIO READS DATA ON A NEGATIVE CLOCK EDGE
DATA LEVEL CHANGES ON A POSITIVE CLOCK EDGE

Loading the radio involves copying new data into the radio. This is written into the CMOS RAM. The hardware protect line should be kept low to enable the RAM.

i) $\overline{IRQ}$ should be initially high.

ii) Load SW should be low throughout the transfer.

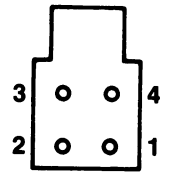
iii) Interconnect the cord between the radio and the unit. Initiate the transfer from the programming unit.

iv) $\overline{IRQ}$ going low will initiate the transfer.

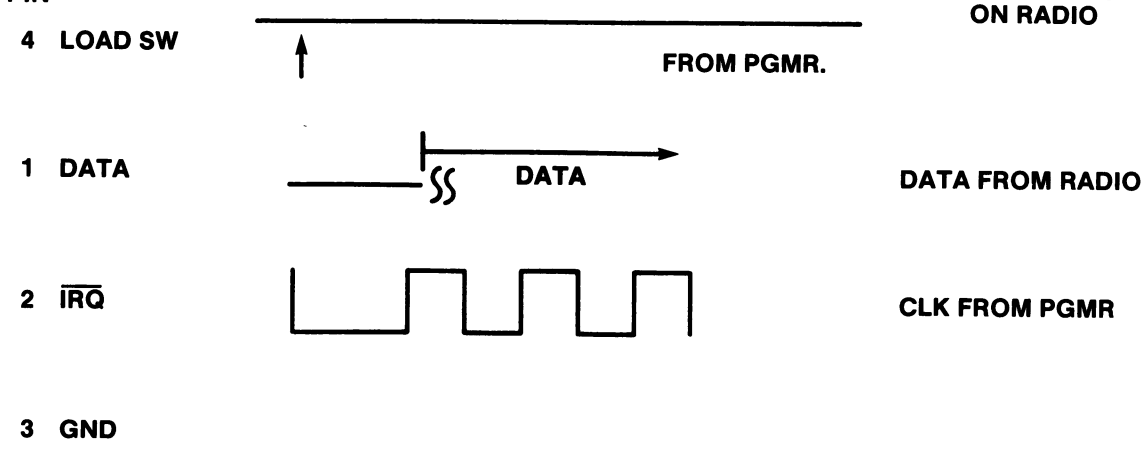
v) After the wait period the radio will begin to provide a clock on Data. The programming unit should provide data to the radio on Data2. The radio will read this data on the negative edges of the clock.

vi) There are 1024*8 bits to be transferred. Each device will keep a bit count thus at the end of the transfer each device will stop. The programming box should leave $\overline{IRQ}$ high at the end of the transfer to avoid re-interrupting the radio when it returns to normal mode.

READ DATA FROM RADIO



CONNECTOR ON RADIO



IRQ GOES LOW TO INTERRUPT THE PROCESSOR

DATA CHANGES ON A POSITIVE EDGE

DATA VALID ON NEXT NEGATIVE EDGE

Dump - Radio to Unit

Dumping involves dumping the radio's CMOS RAM to the programming unit. This is used mainly to verify that the load was completed, although it has other uses as well. The dump is initiated by the programming unit.

The following is the procedure:

i) Load SW is kept high all through the interface. This protects the memory against glitches etc. $\overline{IRQ}$ must also be high.

ii) Connect the umbilical cord between the radio and the programming unit.

iii) Start the dump from the programming unit.

iv) The programming unit brings the $\overline{IRQ}$ line low. This causes the processor in the radio to be interrupted.
Data will be valid on the negative edges.
Data will change on the positive edge.

There are 1024*8 bits to be transferred. The radio and the unit will keep a bit count. Thus both devices will know when the transfer is completed.

v) When the last data bit is put out on Data 1 the $\overline{IRQ}$ line should be set high. This is to ensure that the radio will not be interrupted when at the end of the transfer it returns to normal mode.

vi) Of course all calls are lost and all keys are ignored during this process.

vii) When the radio returns to normal mode it will beep signifying the end of the transfer. Then remove the interconnect cord.

MICROPROCESSOR PIN ASSIGNMENTS

1 **RESET** - - hardware reset from the WDT
2 **IRQ** - - pulled high in normal operation - - used to interrupt the uP for load/read of the RAM
3 **NUM** - - pulled low through 10K - - self test pin
4 **Address 6 on RAMS;** DQ0 on U3 - - also scan line for 6,#
5 **Address 5 on RAMS;** DQ1 on U3 - - also scan line for 5,0
6 **Address 4 on RAMS;** DQ2 on U3 - - also scan line for 4,*
7 **Address 3 on RAMS;** DQ3 on U3 - - also scan line for A, G
8 **Address 0 on RAMS;** DQ0 on U2 - - also scan line for 3, 9
9 **Address 1 on RAMS;** DQ1 on U2 - - also scan line for 2, 8
10 **Address 2 on RAMS;** DQ2 on U2 - - also scan line for 1, 7
11 **Address 7 on RAMS;** DQ3 on U2 - - also scan line for I/C, SC
12 **Address 8 on RAMS**
13 **Address 9 on RAMS**
14 **Enable** line from computer - - used to allow writing to RAMS
15 Used to turn Q1 on to allow reading of RAM. Waveform is inverse of waveform at RAM. Chips are addressed by computer; then falling edge latches the addresses. Data appears on the data lines until the rising edge of the enable line creates floating outputs.
16 **Synthesizer enable** - - normally low waveform goes high approximately 9ms. to latch frequency information into synthesizer chip, and also to switch PLL bandwidth.
17 CPTT line - - High during transmit. Also goes to WDT to switch gate Y (DAC switch) and Z (Beep/DTMF switch)
18 **MIKE MUTE** - - low to turn mike on
19 **TONE LEVEL** - - high for 3kHz tone deviation; also used as the load switch sense line to determine whether to send or receive data from the suitcase programmer.
20 **GROUND**
21 **dtd strobe** - - used to clock data into DTD when tone frequency changes.
22 Used by WDT to control gate X (DTD input signal)
23 **DATA** - - data transfer to synthesizer, DTD, and LCD. Used as clock line when data is sent to the computer (RAM) from the suitcase programmer
24 **msb of dac** 16
25 **dac 8**
26 **dac 4**
27 **dac 2**
28 **lsb of dac.** Also used to reset WDT every 5ms. to prevent a total radio reset. Pulses occur more often during BEEPs, and may be low pulsing high, or high pulsing low, depending on the volume control setting.
29 **Display strobe** - - used to clock data into LCD driver.
30 **RUS** - - used to control RXAA output amplifier. High for audio on.
31 **KBD HI** - - used to sense keyboard line I/C through 6
32 **KBD LOW** - - used to sense keyboard line SC through #
33 **CPTT** - - input from VT/CT or UDC. Used during RX/TX to control radio operation. If channel acquisition from the PTT bar on the side of the radio is enabled as an option, this lead is used as the sense lead.
34 **dtd detect** - - input to computer from DTD indicating that the tone programmed into the DTD is being detected.
35 **BEEP SWITCH** - - controls Q907 which switches side tone into the RXAA output circuit.
36 **RX INPUT MUTE** - - controls the input amplifier in the RXAA module
37 **TIMER - - 27 kHz** input from the WDT used for internal timing in the uP.
38 **Output of the internal oscillator/amplifier.** The 3.58 MHz. clock on this pin is used internally by the computer and is divided down in the WDT to provide the DTD clock and the TIMER clock.
39 **Input of the internal oscillator/amplifier.** Normally cannot be measured without stopping the oscillator.
40 **B+**

TRANSMITTER ALIGNMENT

EQUIPMENT REQUIRED

1. Wattmeter (3 Watts)
2. 30 dB Attenuator
3. Deviation Monitor

PRELIMINARY CHECKS & ADJUSTMENTS

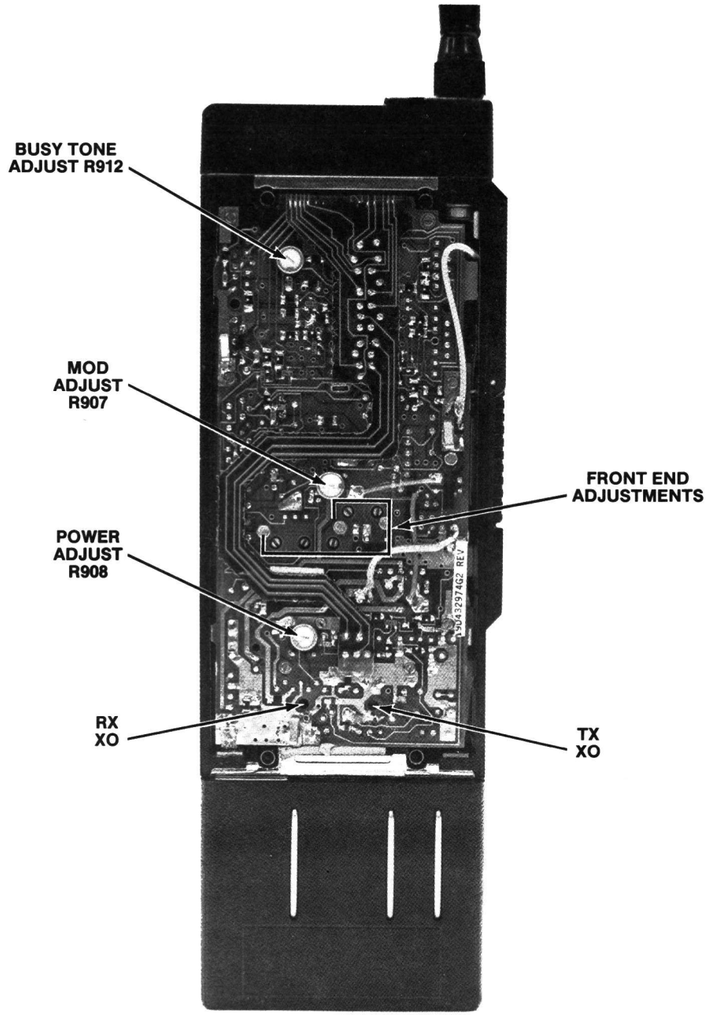
1. Connect the cable from Test Adaptor 4EX12A12 to the UDC jack on the side of the radio.
2. Connect the transmitter output to the wattmeter.
3. Turn potentiometers R904, R907 and R912 fully counterclockwise.
4. Place the radio in the test mode by pressing G, O, A, O.
5. Place the PTT switch on the 4EX12A12 in the PTT position and check to see if the transmit indicator LED on the radio lights.

TRANSMITTER

STEP	PROCEDURE
	OUTPUT POWER
1.	With the transmitter keyed, set power adjust control R904 for 2 watts ±0.1 watts. Then check the power output and current on the other two test frequencies.
	FREQUENCY ADJUST
2.	Unkey the PTT on the 4EX12A12 and attach the RF output of the radio through a 30 dB pad to a frequency counter. Key the 4EX12A12 and adjust the transmitter frequency to 818.4875 MHz ±200 Hz. Check the transmitter frequency at the band edges (test frequency 2 - 820.9875 MHz and test frequency 3 - 816.0125 MHz). Frequencies shown for USA1.
	MODULATION ADJUST
3.	Unkey the PTT. Attach the attenuated RF output from the radio to a modulation meter. Push key 1 to select test frequency 1. While observing the LCD display, push the I/C button 6 times to obtain tone #40 (this disables the tone). Attach a 120 mV rms 1 kHz tone to the TX AUDIO input on the 4EX12A12. Depress the 7 key to turn on the microphone and external audio. Key the 4EX12A12 PTT and adjust modulation potentiometer R907 for 3.5 ±.1 kHz.
	BUSY TONE MODULATION ADJUST
4.	Unkey the PTT and push key 6 to disable the external modulation. Push key 1 to load the busy tone and then key 8 to set the internal deviation to low. Key the PTT on the 4EX12A12 and adjust busy tone deviation control R912 for 1 ±.1 kHz. Unkey the PTT, push key 7 to add the external tone, and check that the total deviation is less than 4.5 kHz. Recheck the other two test frequencies.

TEST FREQUENCIES

	1	2	3
USA1	818.4875	820.9875	816.0125
USA2	813.4875	815.9875	811.0125
MEX BDR	813.4750	815.9750	811.0000
CAN BDR	808.4875	810.975	806.0125
AUS	822.4875	824.9875	820.0125



RECEIVER ALIGNMENT

EQUIPMENT REQUIRED

1. Signal Generator
2. Test Adaptor 4EX12A12
3. IF Generator 4EX9A10
4. AC Voltmeter

PRELIMINARY CHECKS & ADJUSTMENTS

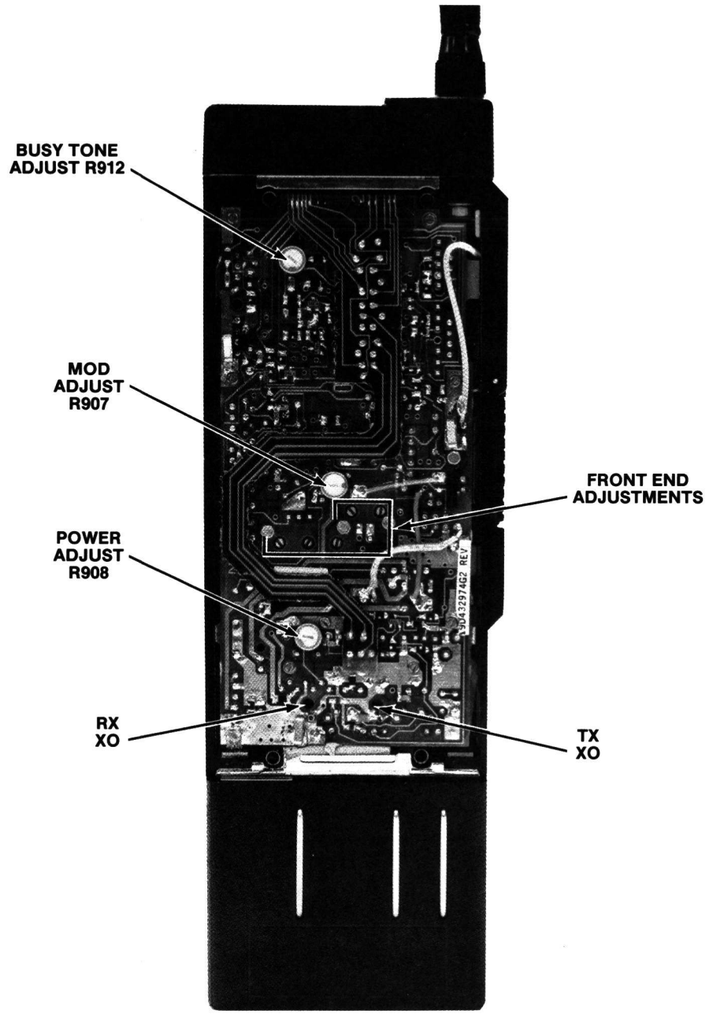
1. Connect the cable from Test Adaptor 4EX12A12 to the UDC connector on the side of radio.
2. Turn the radio on.
3. Place the radio in the test mode by pressing G, O, A, O. This sets the receiver on 863.4875 MHz (test frequency 1).
4. Make sure the PTT toggle switch on the 4EX12A12 is not set on PTT, and that the speaker switch is in the SPKR position.

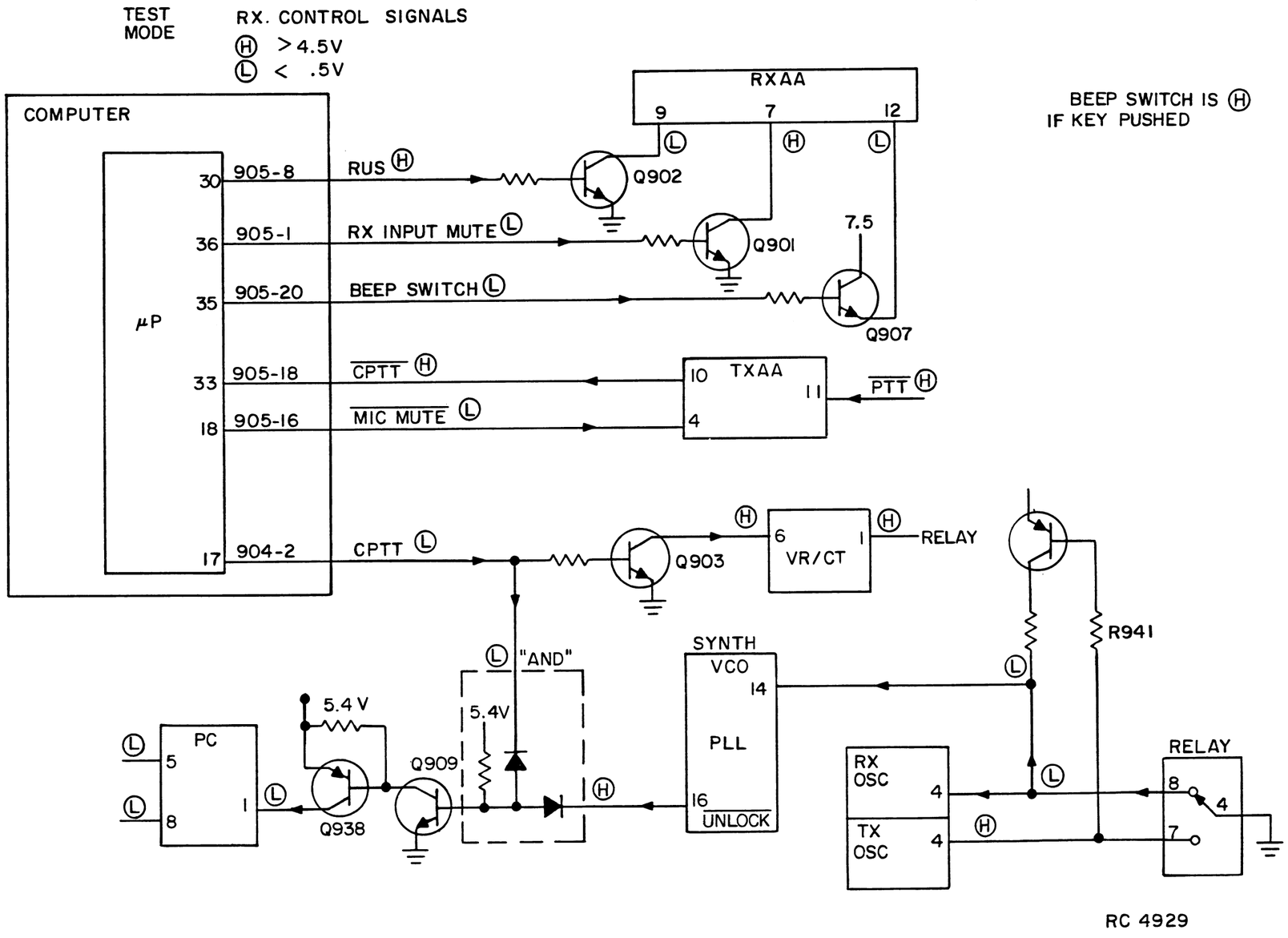
ALIGNMENT PROCEDURE

STEP	PROCEDURE
	FREQUENCY ADJUSTMENT
1.	Connect a signal generator to the RF jack on the 4EX12A12, and set the generator on the test frequency (863.4875 MHz). Set the RF output for approximately 20 dB quieting.
2.	Loosely couple a 21.4 MHz IF signal from IF generator 4EX9A10 to the IF section of the radio until an audible beat frequency is heard. Then adjust the Receive oscillator control for zero beat frequency.
	RATED OUTPUT POWER
3.	Set the generator for 1 kHz modulation with 3 kHz deviation, and increase the level to -80 dBm. Attach an AC voltmeter to the speaker output on the test box. Adjust the radio audio to be as close to 2 volts as possible by first depressing the key for maximum volume then depressing the SC key 6 times. Check that this setting is as close as possible on the low side of 2 volts. After each level change it will be necessary to press the "G" key to turn the audio on.
	FRONT END
4.	Adjust the 5 helical resonators for best SINAD, reducing the signal generator output as necessary to maintain 12 dBs. The 12 dB SINAD should be less than 0.35 uV. Repeat this measurement at the band edges by selecting key 2 (865.9875 MHz) and then key 3 (861.0125 MHz). (USA1)

TEST FREQUENCIES

	1	2	3
USA1	863.4875	865.9875	861.0125
USA2	858.4875	860.9875	856.0125
MEX BDR	858.4750	860.9750	856.0000
CAN BDR	853.4875	855.9875	851.0125
AUS	867.4875	869.9875	865.0125





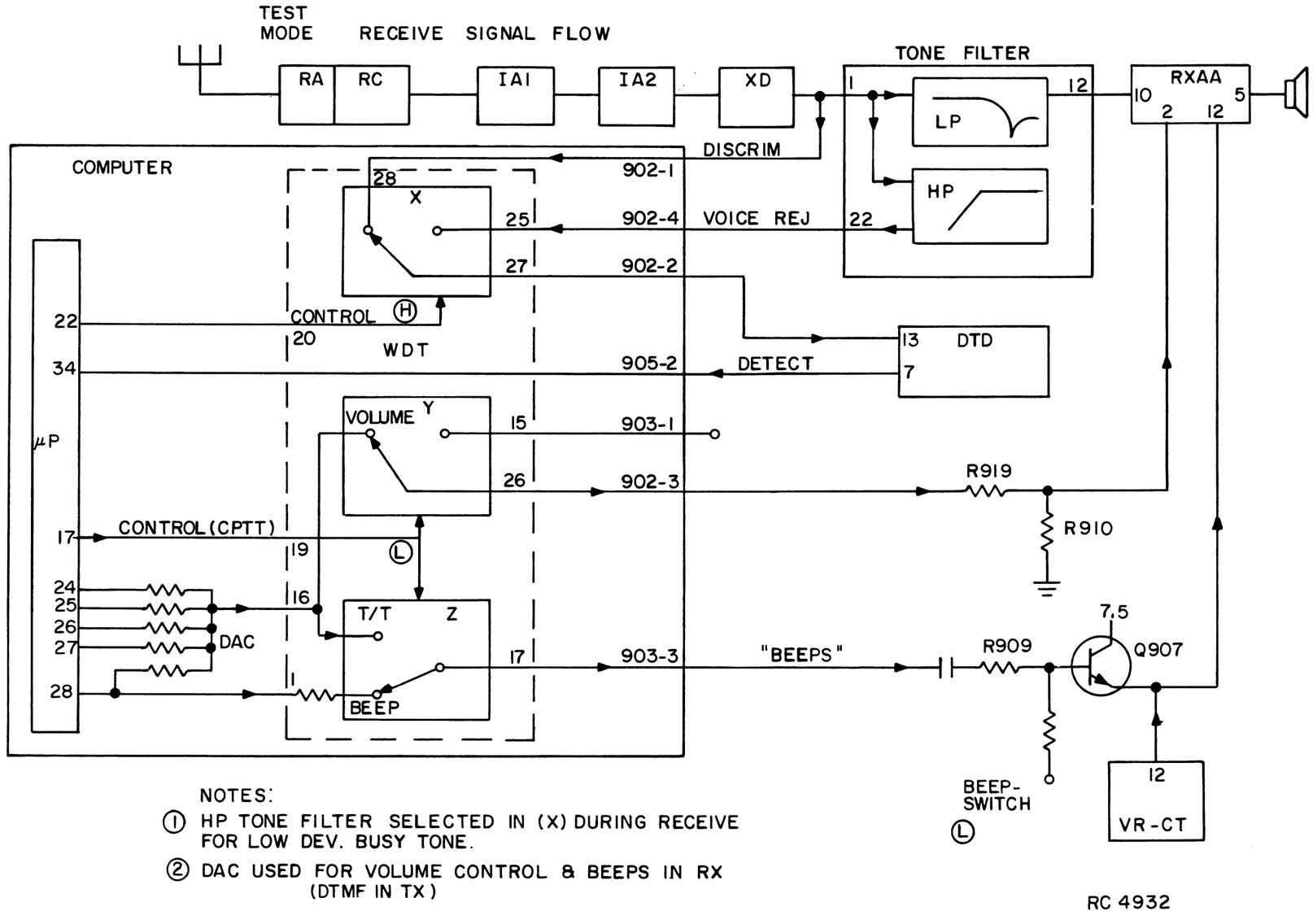
BEEP SWITCH IS Ⓗ IF KEY PUSHED

RC 4929

TROUBLESHOOTING PROCEDURE

RX CONTROL SIGNAL

30 Issue 1

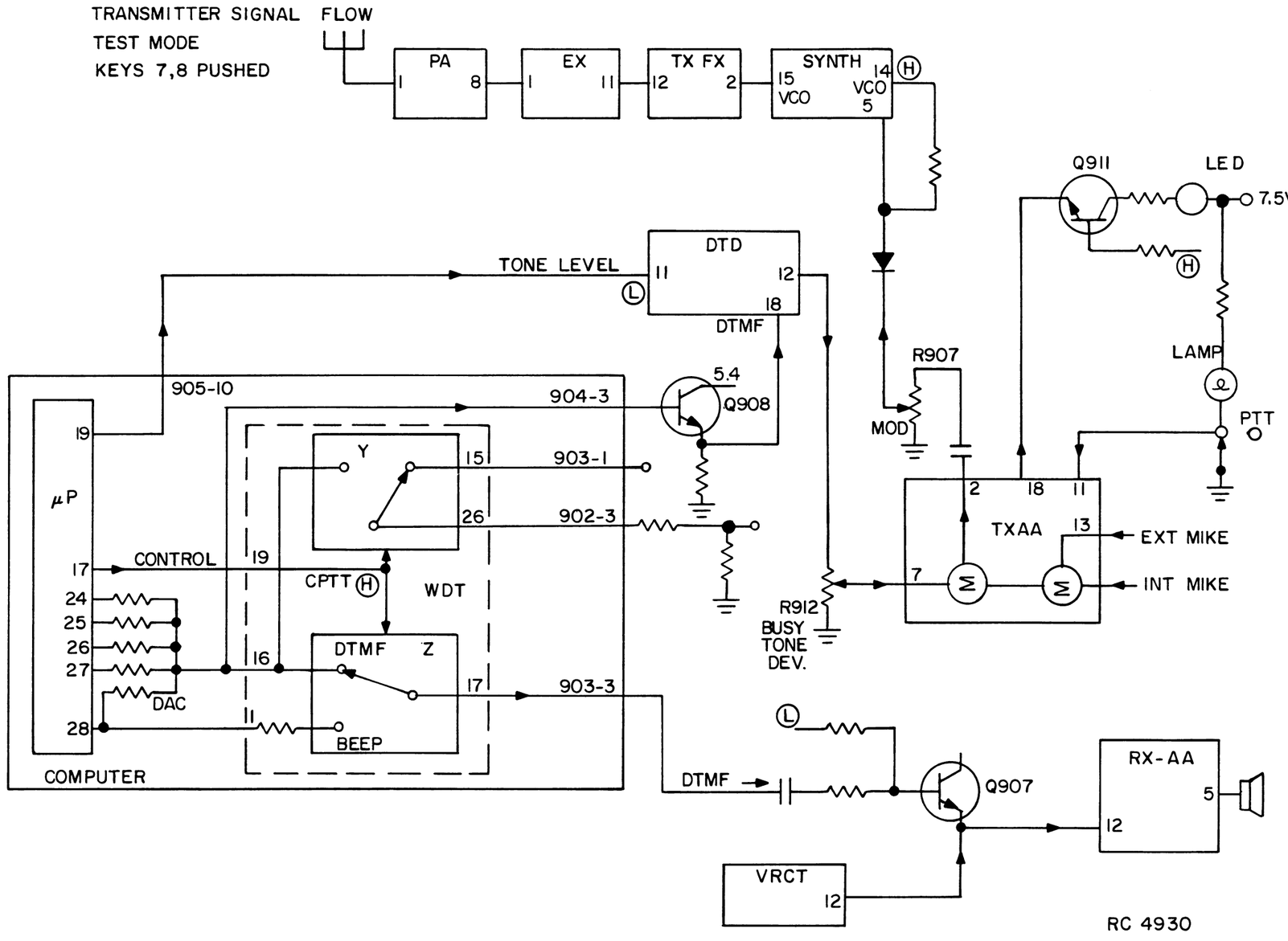


NOTES:

① HP TONE FILTER SELECTED IN (X) DURING RECEIVE FOR LOW DEV. BUSY TONE.

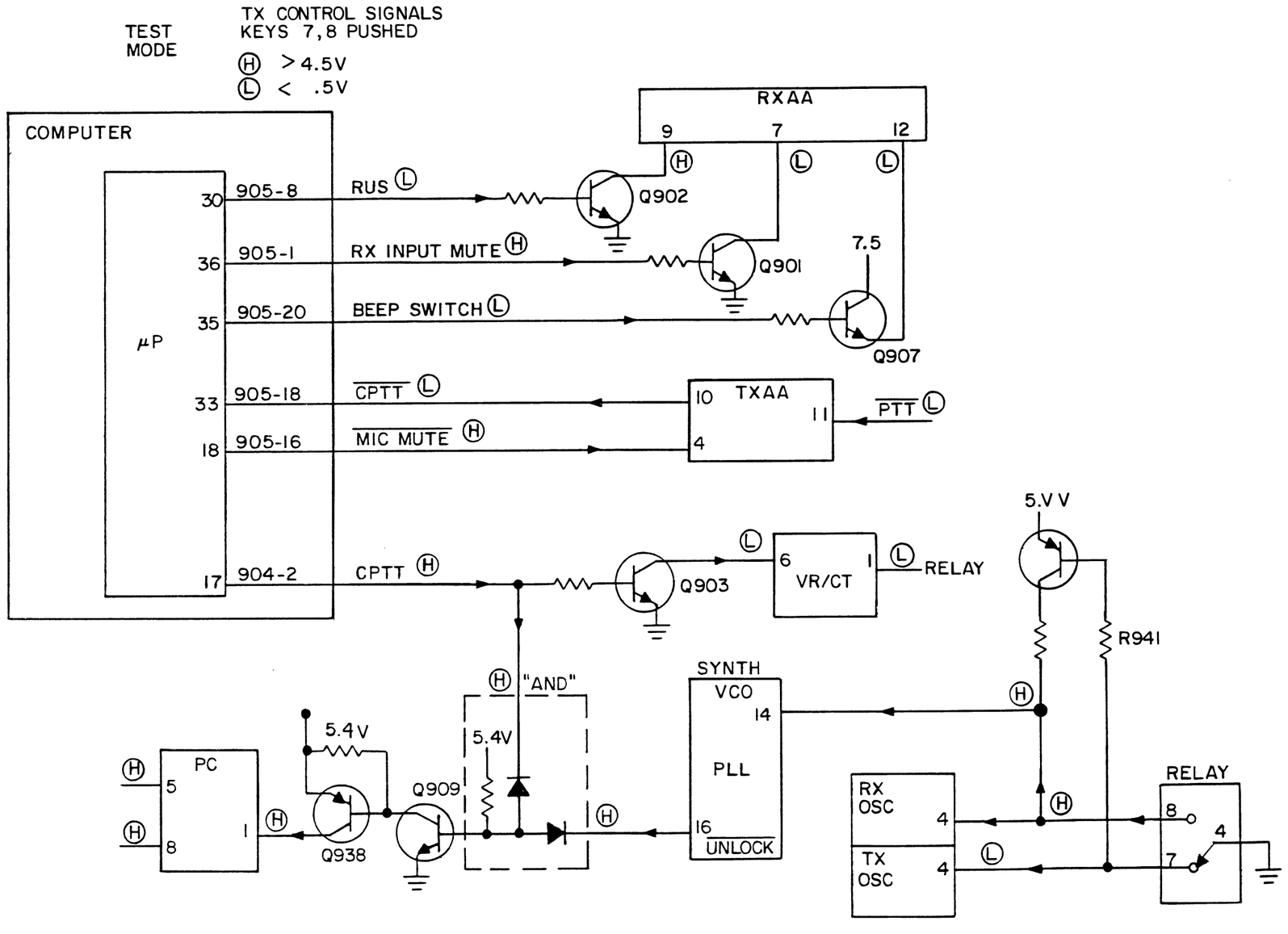
② DAC USED FOR VOLUME CONTROL & BEEPS IN RX (DTMF IN TX)

RC 4932



TROUBLESHOOTING PROCEDURE

TRANSMITTER SIGNAL FLOW


TEST MODE
TX CONTROL SIGNALS
KEYS 7,8 PUSHED
Ⓗ >4.5V
Ⓛ < .5V
COMPUTER
μP
30 905-8 RUS Ⓛ
36 905-1 RX INPUT MUTE Ⓗ
35 905-20 BEEP SWITCH Ⓛ
33 905-18 CPTT Ⓛ
18 905-16 MIC MUTE Ⓗ
17 904-2 CPTT Ⓗ
RXAA
9 7 12
Q902
Q901
7.5
Q907
TXAA
10 4 11
PTT Ⓛ
Q903
6 VR/CT 1
RELAY
5.V V
R941
Ⓗ "AND"
5.4V
5.4 V
PC
5 8 1
Q909
Q938
SYNTH
VCO 14
PLL
16 UNLOCK
RX OSC 4
TX OSC 4
RELAY
8 4 7

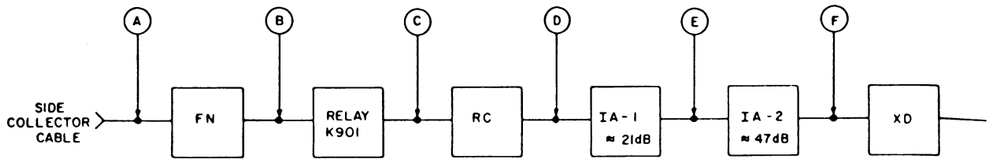
RC 4933

RX GAIN CHECKS

Receive - Gain Checks

Connect an RF generator to the side connector test cable. Set the generator output for the receive frequency at 10 millivolts. Measure the level at the input to the IA-2 module with an RF voltmeter. If this voltage is good, (refer to chart below) measure the gain level at the output of the IA-2 module. If this voltage is low, replace the IA-2 module. If this voltage is good, replace the XD module.

If the voltage at the input of IA-2 is low, check the gain of the receive front end and IA-1 as described below.



RC4238

UHF AND 800 MHz GAINS
(typical)

A. 10 millivolts
B. 10 millivolts
C. 10 millivolts
D. Can not be measured
E. 26 millivolts
F. 266 millivolts (Max = 300 millivolts)

Sensitivity Check:

Unplug the receive front end modules, RC and FS. Connect a 21.4 MHz IF generator to the input of IA-1. Measure 12 dB SINAD. SINAD should be 0.11 uV @ 21.4 MHz. With the RC and FS modules plugged in and the RX-OX module removed, the SINAD should be 0.14 uV.

If these measurements are good, replace the receive front end modules RC and FS. If these measurements are not good, check the gain of IA-1 as described below.

IA-1 and IA-2 Gain Check:

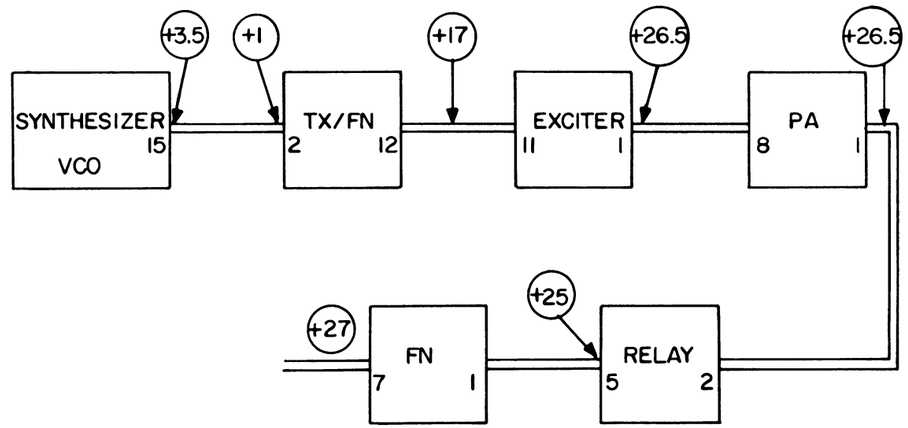
With the receive front end modules, RC and FX removed and a 21.4 MHz IF generator connected to the input of IA-1, set the generator output level to 40 millivolts, as read on the RF voltmeter, at the output of IA-1. Move the voltmeter to the input of IA-1. Increase the generator output level until the voltmeter again reads 40 millivolts. The difference in the two generator settings should be approximately 21 dB. If this gain is low replace IA-1.

The gain of the IA-2 module can also be measured using the same method as with IA-1. The gain of this module should be approximately 47 dB.

TROUBLESHOOTING PROCEDURE

PERFORMANCE CHECK

TRANSMITTER GAIN CHECKS



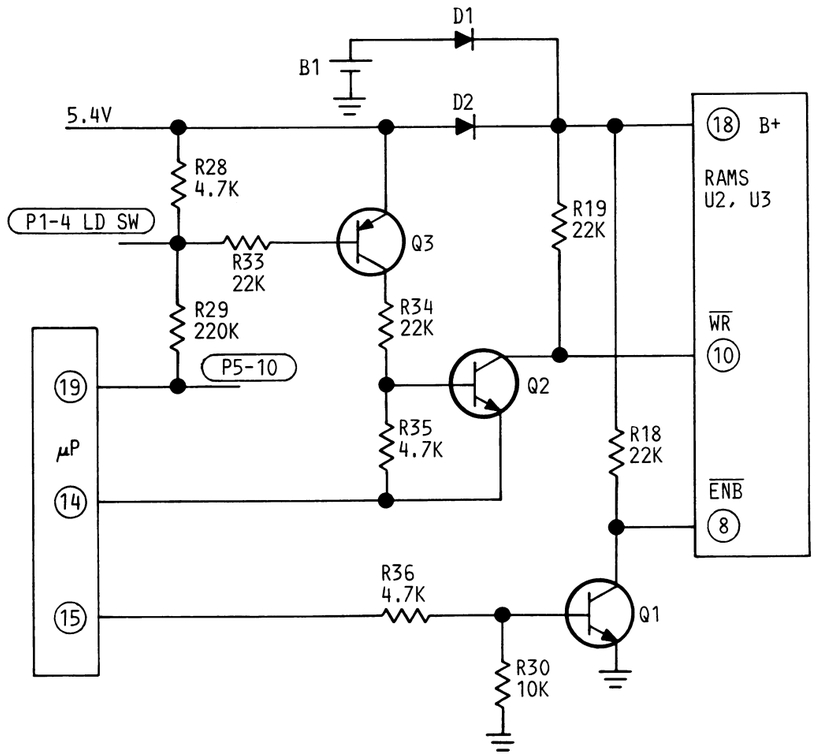
① POWER LEVELS MEASURED THROUGH 50Ω COAX (<6") INTO POWER METER

② POWER CONTROL TURNED UP (CW)

③ ANTENNA OR UDC CONNECTOR TERMINATED

RC 4934

COMPUTER READ/WRITE CIRCUITRY

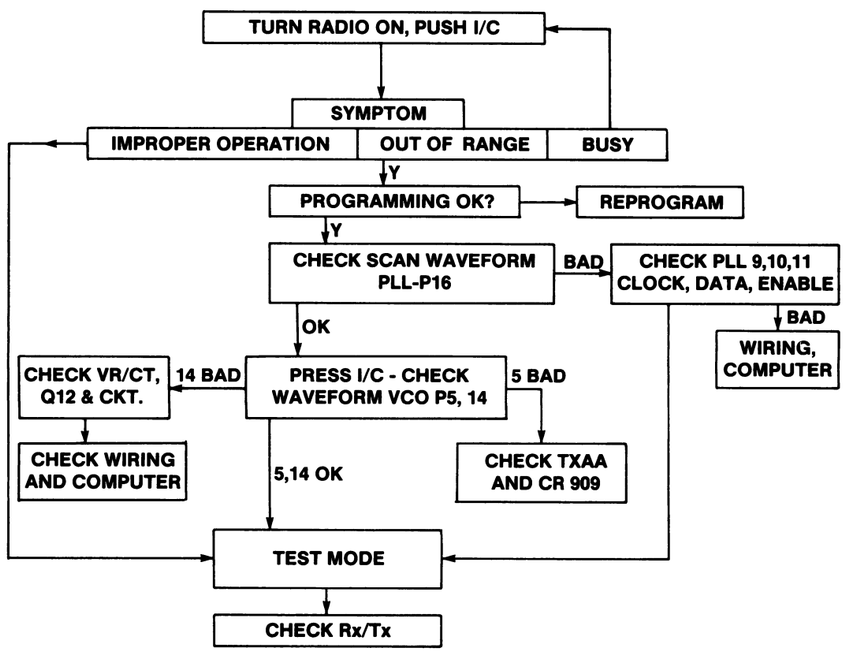


RC 4935

TROUBLESHOOTING

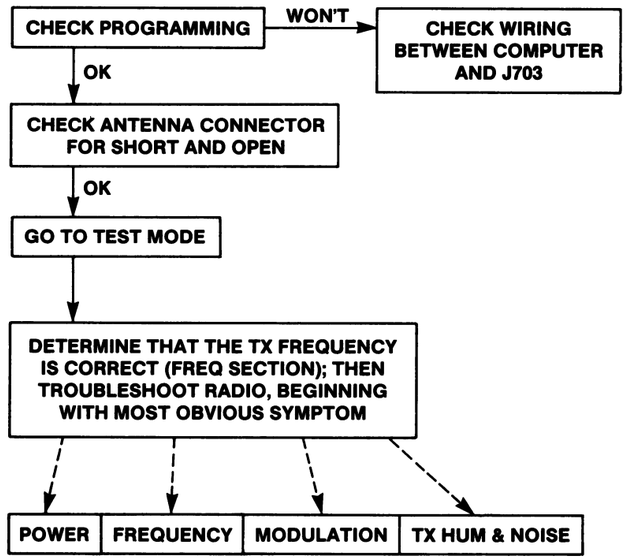
DETERMINE WHETHER THE PROBLEM LIES IN THE COMPUTER, OR ON THE SYSTEM BOARD. THEN USE THE APPROPRIATE SECTION I.E. COMPUTER, RX, TX, TO ISOLATE THE FAULT.

RADIO CAN'T INITIATE A CALL



TRANSMIT MALFUNCTION

TRANSMIT TROUBLESHOOTING REQUIRES A PROPERLY FUNCTIONING COMPUTER MODULE. POWER SUPPLY VOLTAGES ARE ASSUMED CORRECT

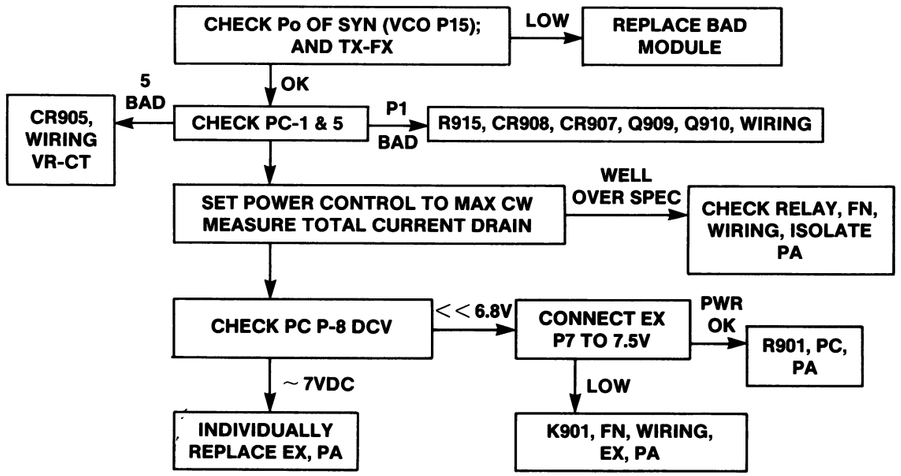


TROUBLESHOOTING PROCEDURE

TRANSMIT

TRANSMIT

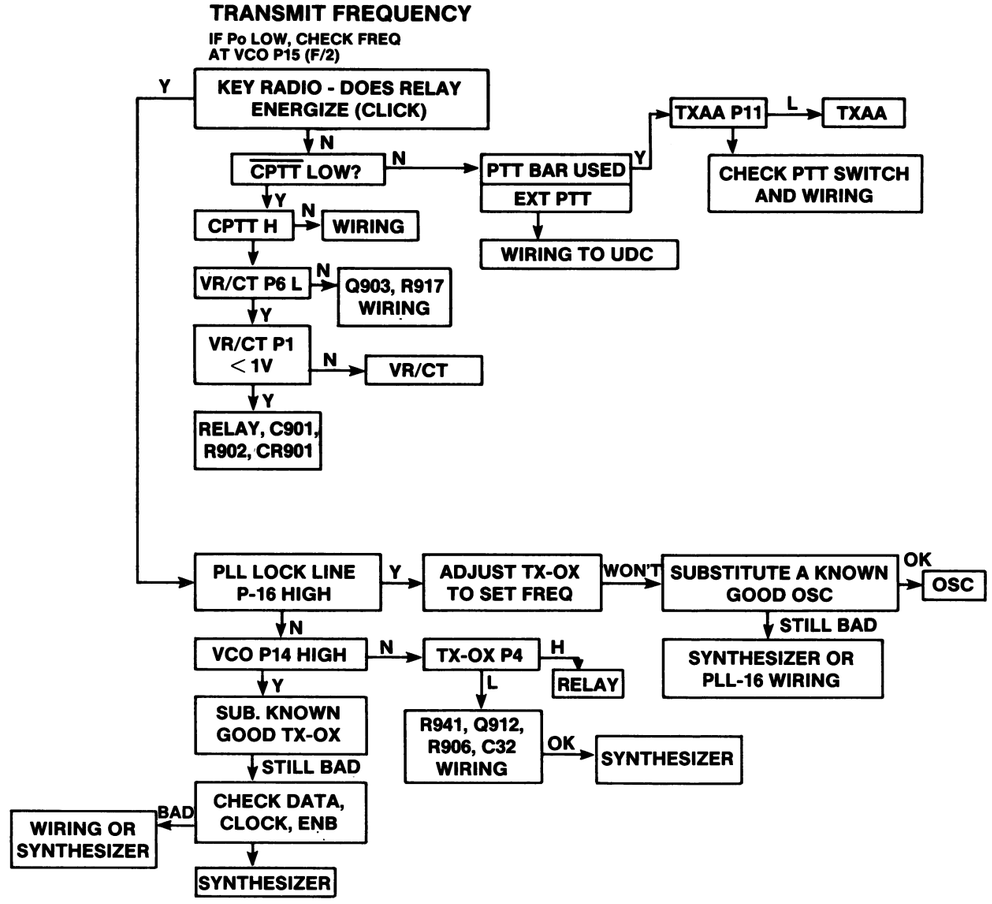
TRANSMIT POWER (FREQ OK)



TRANSMIT

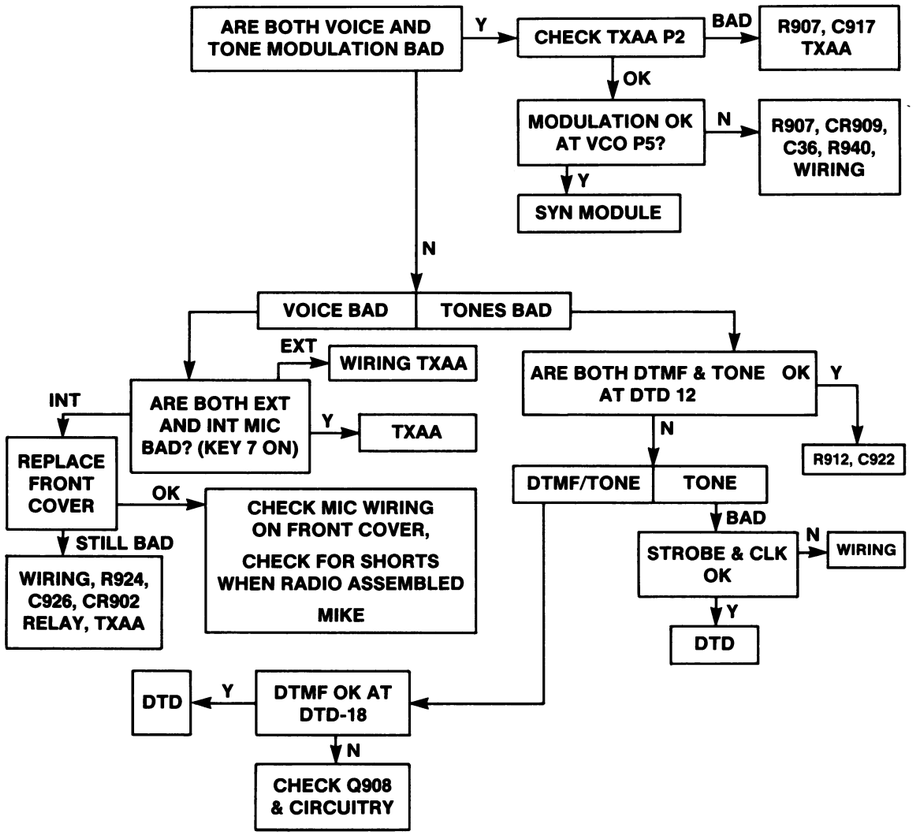
TRANSMIT FREQUENCY

IF Po LOW, CHECK FREQ AT VCO P15 (F/2)



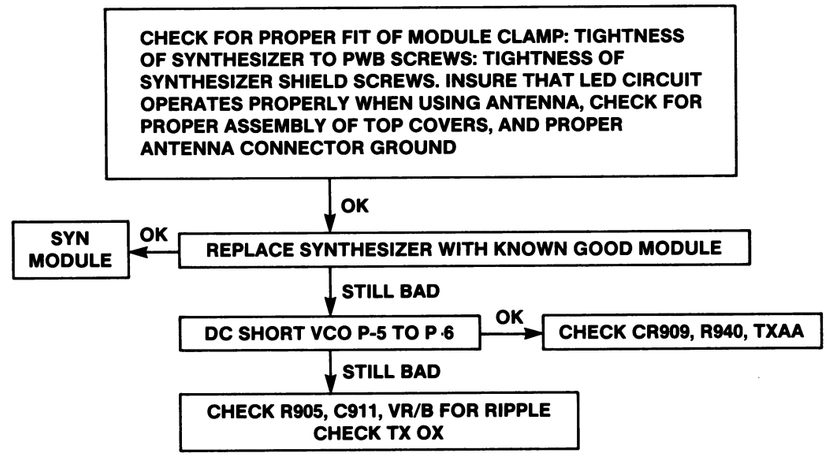
TRANSMIT

TRANSMIT MODULATION



TRANSMIT

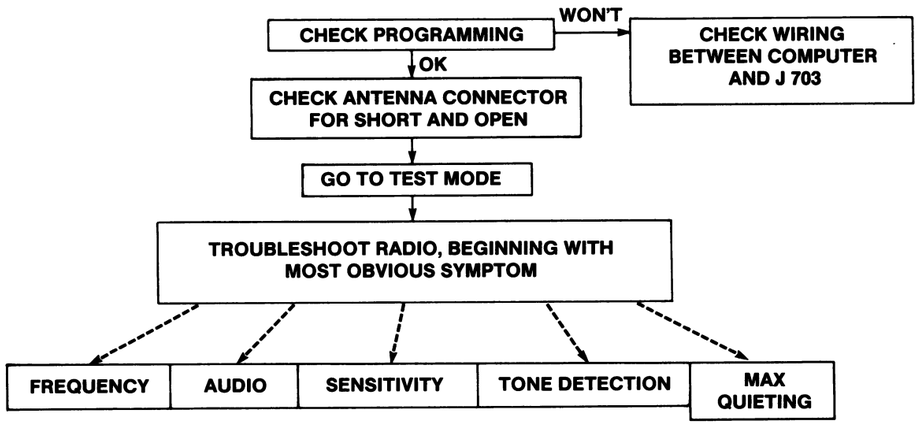
TRANSMIT HUM & NOISE



TROUBLESHOOTING PROCEDURE

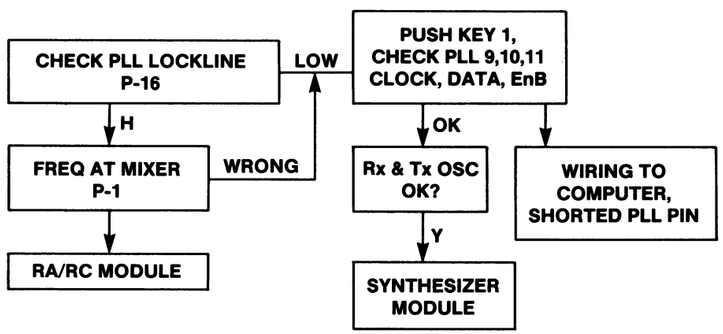
RECEIVE MALFUNCTION

RECEIVE TROUBLESHOOTING REQUIRES A PROPERLY FUNCTIONING COMPUTER MODULE. POWER SUPPLY VOLTAGES ARE ASSUMED CORRECT.



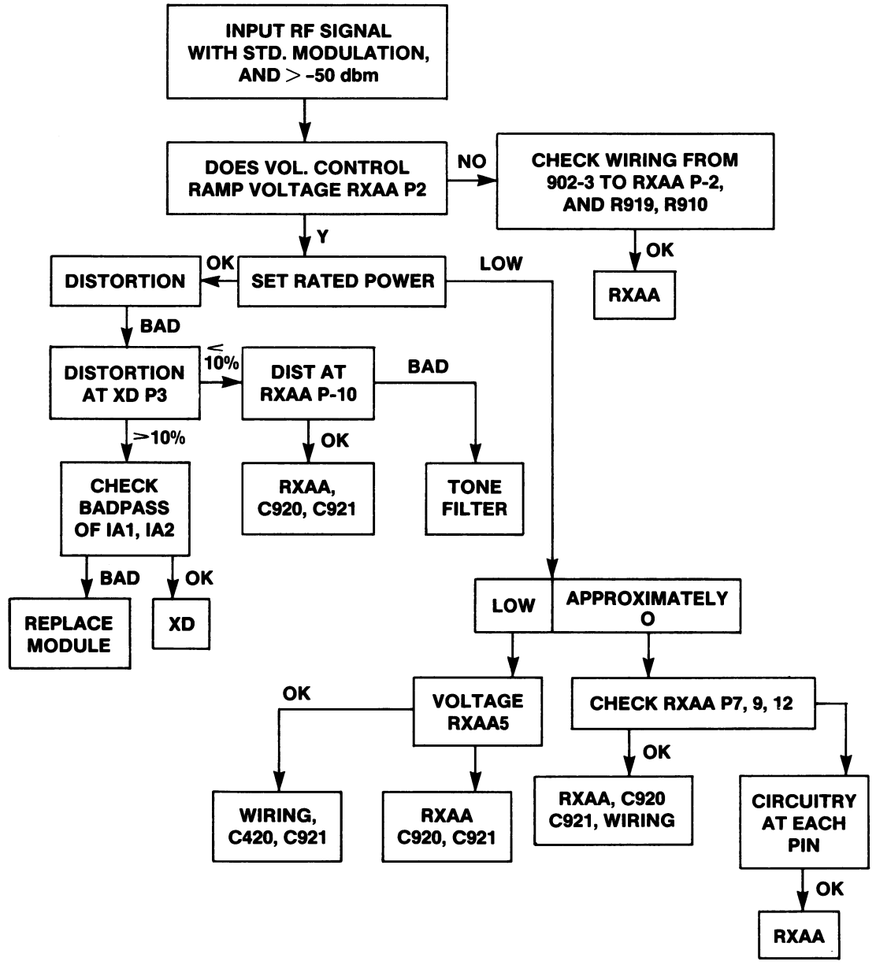
RECEIVE

RECEIVE FREQUENCY



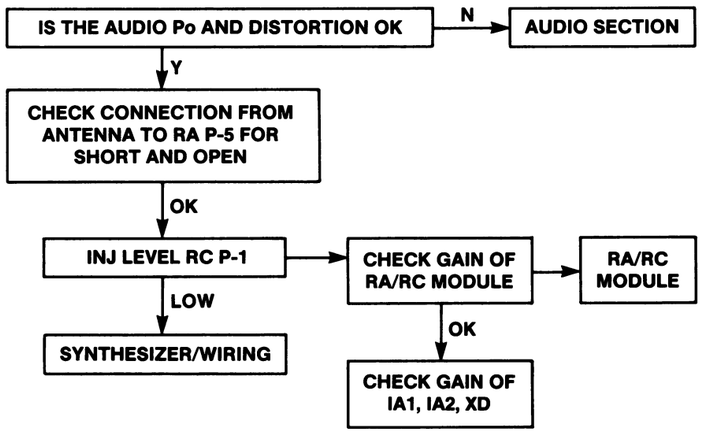
RECEIVE

AUDIO (FREQ. OK)

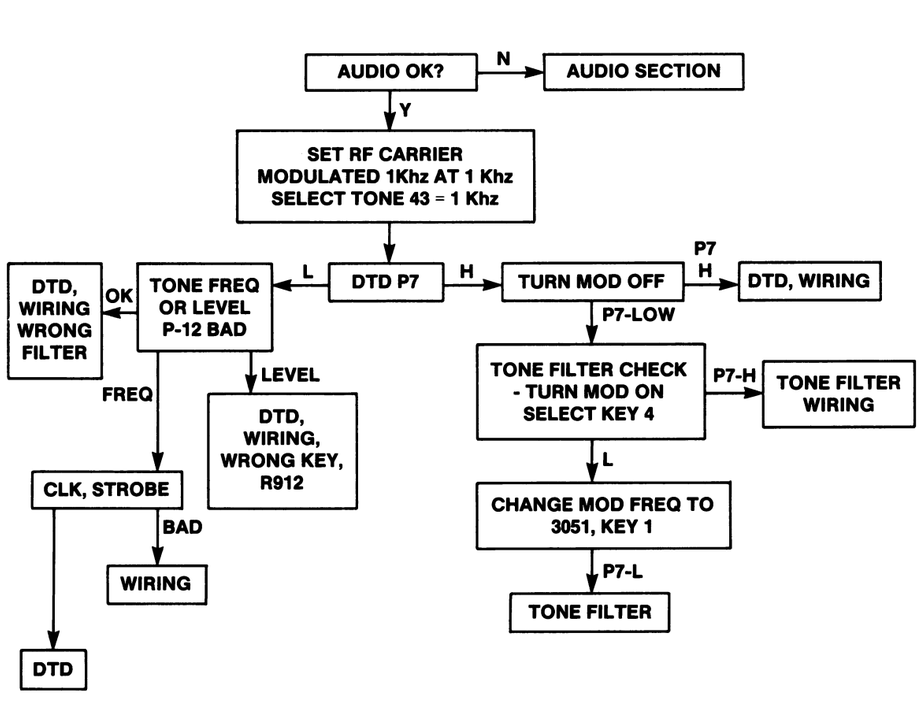


RECEIVE

SENSITIVITY (FREQ. OK.)

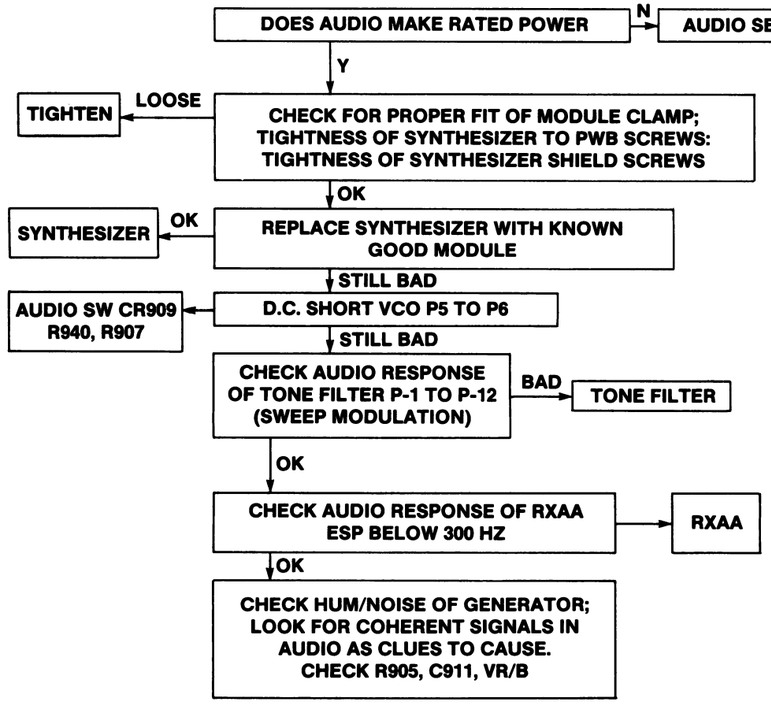


RECEIVE TONE DETECTION (FREQ OK)



RECEIVE

MAX QUIETING

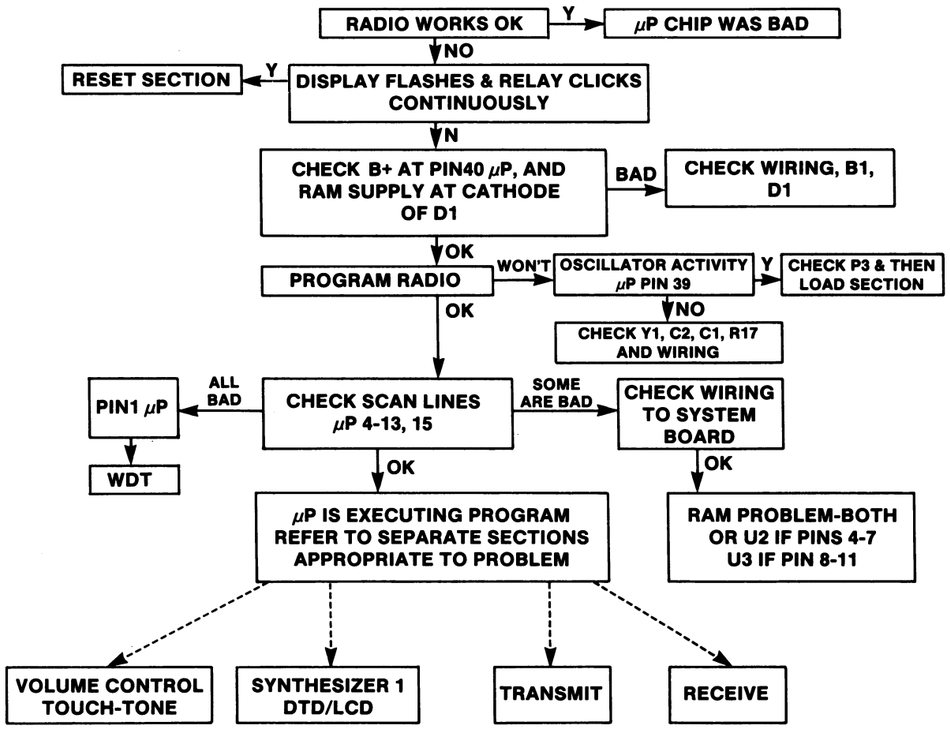


TROUBLESHOOTING PROCEDURE

COMPUTER MALFUNCTION

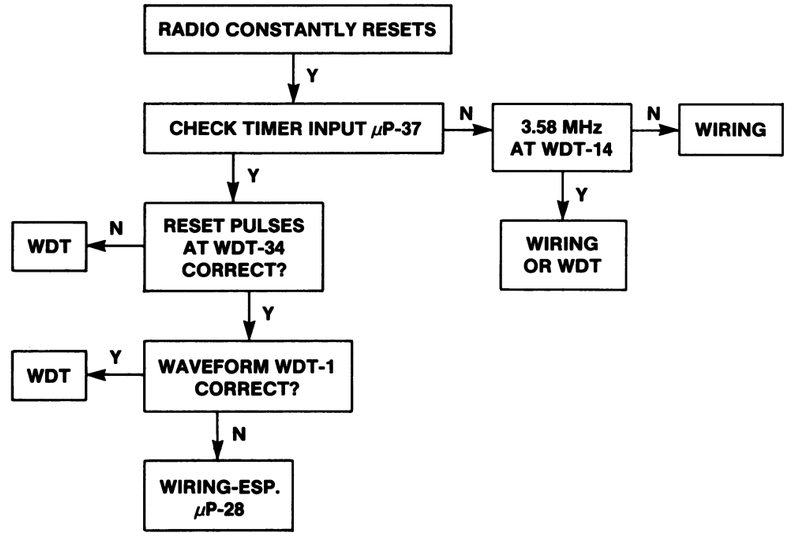
TROUBLESHOOTING REQUIRES: (1) PROPERLY OPERATING SYSTEM BOARD; AND (2) A GOOD μPROCESSOR CHIP #19A702872P1

REPLACE μP CHIP IN BAD PROCESSOR BOARD WITH GOOD CHIP AND PLUG PROCESSOR INTO GOOD SYSTEM BOARD. APPLY POWER TO RADIO AND TURN ON.



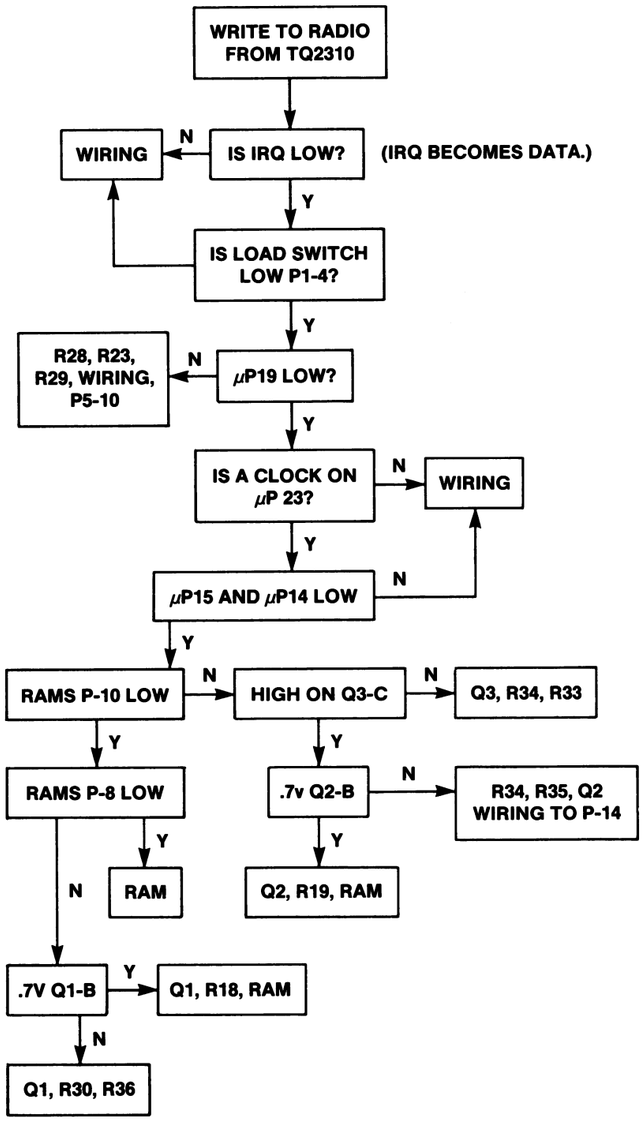
COMPUTER

HARDWARE RESET



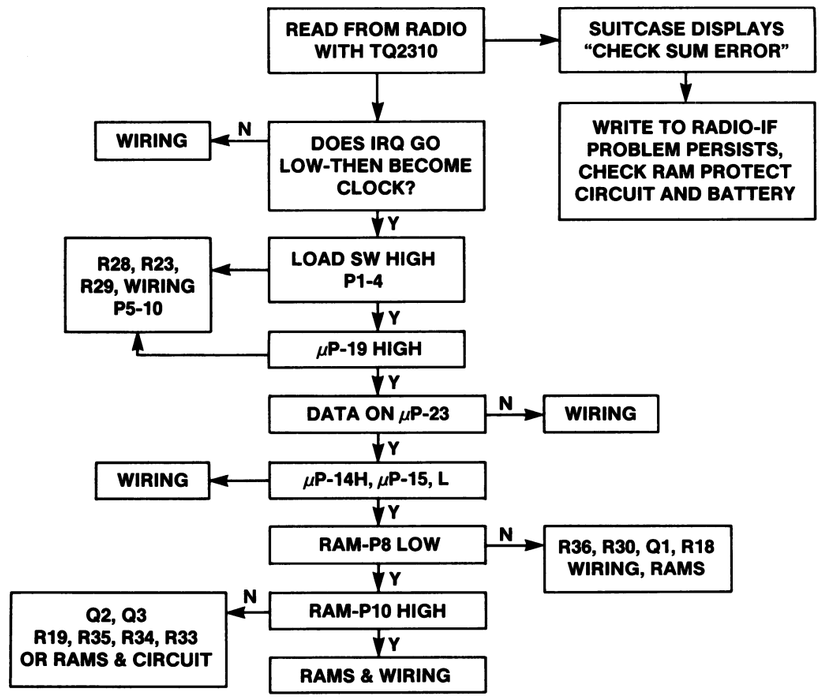
COMPUTER

LOADING FROM EXTERNAL PROGRAMMER



COMPUTER

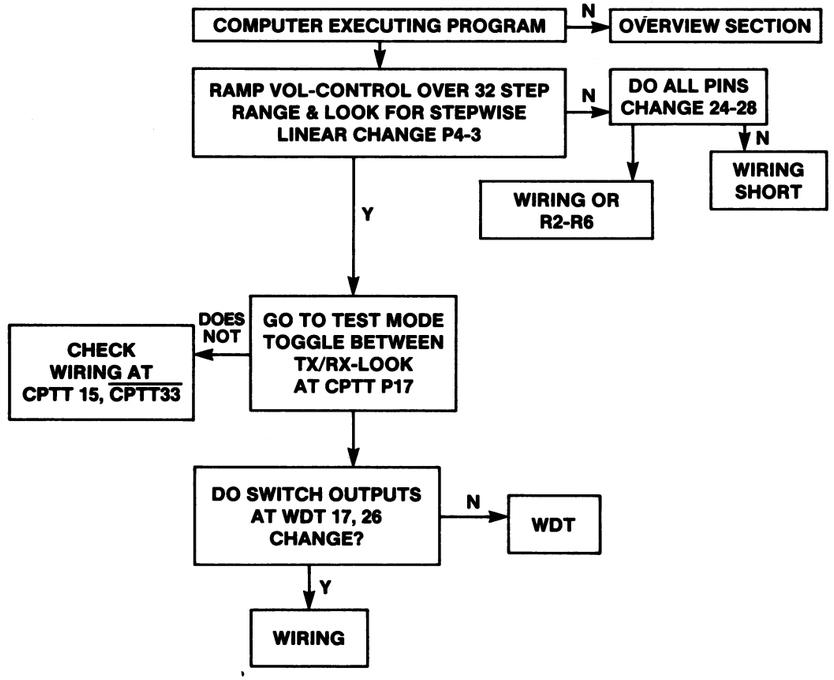
READING FROM RADIO



TROUBLESHOOTING PROCEDURE

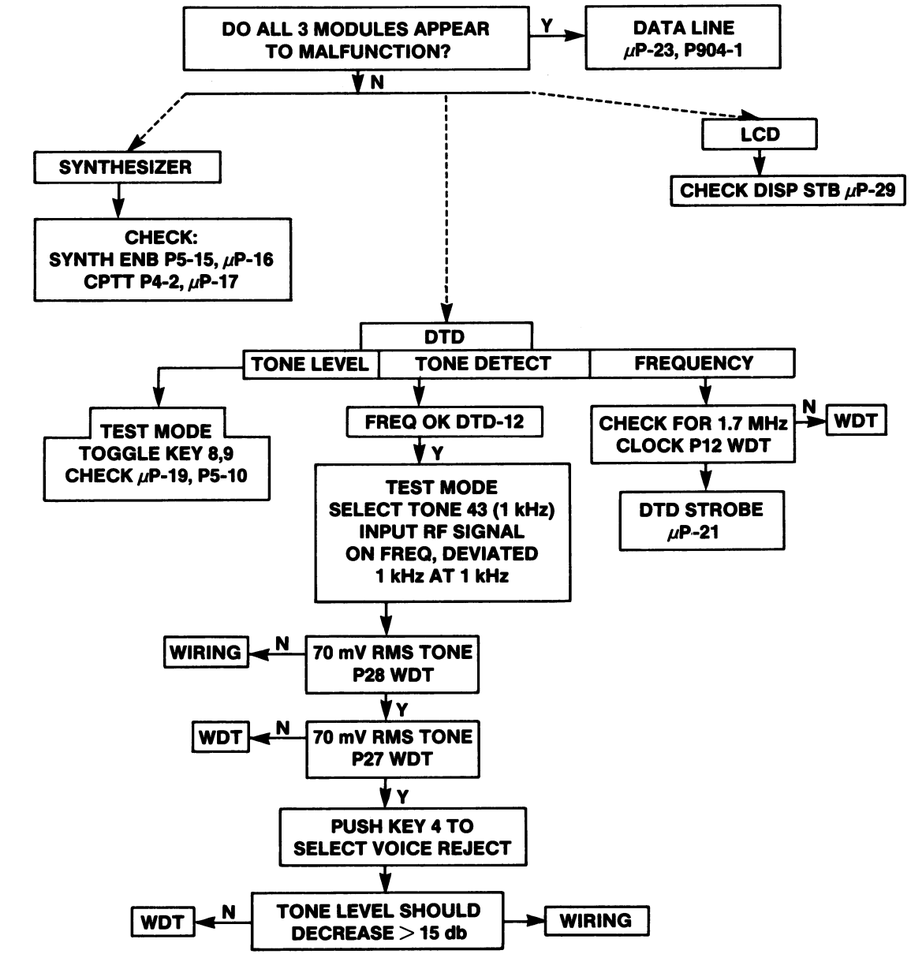
COMPUTER

VOLUME CONTROL/TOUCH-TONE



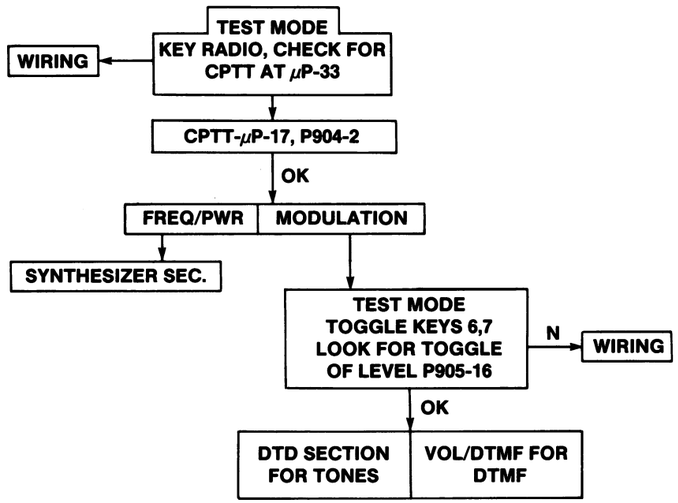
COMPUTER

SYNTHESIZER/DTD/LCD



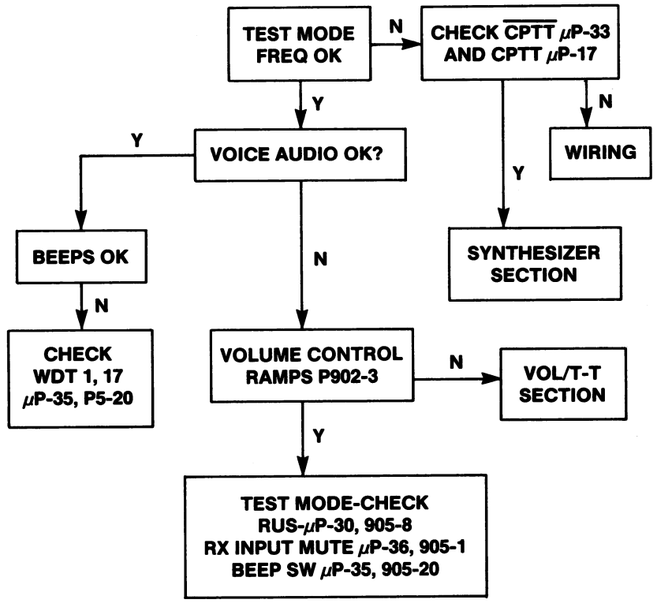
COMPUTER

TRANSMIT



COMPUTER

RECEIVE



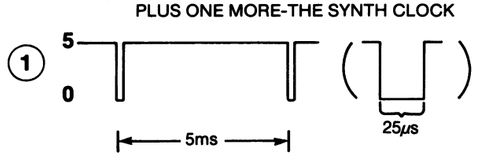
TROUBLESHOOTING PROCEDURE

μP WAVEFORMS - IDLE

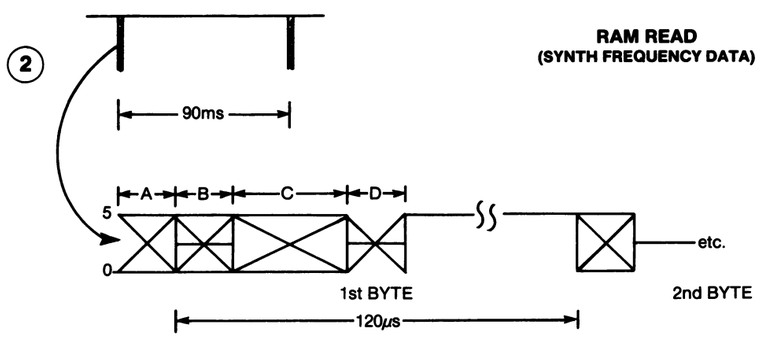
PIN

1	H
2	H
3	L

4-10 CONTAINS 2 SUPERIMPOSED WAVEFORMS, WITH PIN 11 HAVING THE 2, PLUS ONE MORE-THE SYNTH CLOCK



KEYBOARD SCAN



RAM READ
(SYNTH FREQUENCY DATA)

A ADDRESS VALUE - 1 OR 0

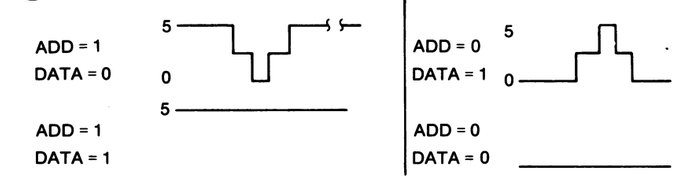
B RAM ENABLE OCCURS - μP AND RAM MAY OR MAY NOT CONTEND FOR LINE

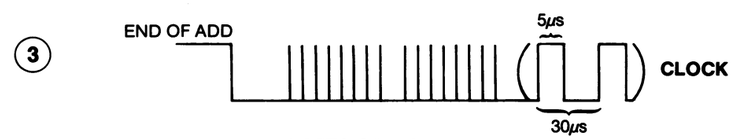
C DATA OUT OF RAM IS VALID, AND μP IS AN INPUT

D μP SWITCHES TO OUTPUT, & DATA STILL LATCHED AT RAM OUTPUT - MAY BE CONTENTION

EXAMPLES

2 CONTINUED





2 SETS OF EIGHT

PIN

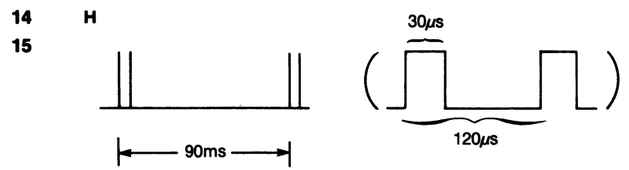
12

13

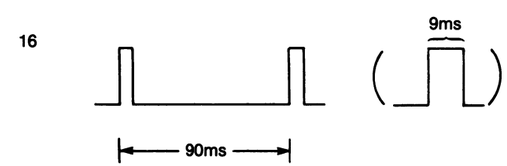
14 H

15

Same as Waveform 1 and 2, except that no data information occurs - only address

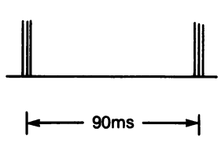


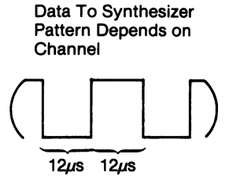
16



PIN

17 L
18 L
19 H
20 L
21 L
22 H
23

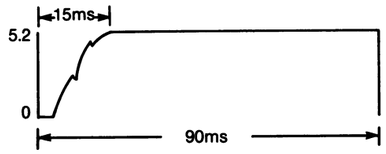




24 L
25 H
26 L
27 H
28 L
29 L
30 L
31 H
32 H
33 H
34 L
35 L
36 H
37 27.96 kHz CLOCK ~ 36 μs REP. RATE
38 3.58 MHz SINE WAVE (DISTORTED)
39 CAN'T MEASURE
40 5.4V

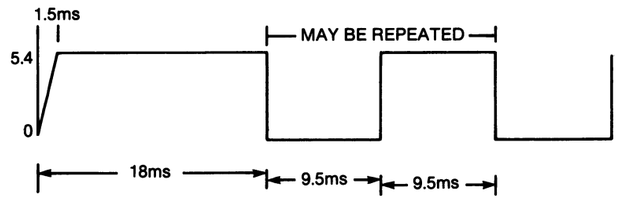
MISC. WAVEFORMS

RX SCAN (PLL P-16)

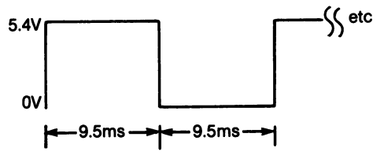


SYNTHESIZER	**DATA-PLL-10**	SAME AS μP-23
	CLOCK PLL-11	SAME AS μP-11
	ENABLE	SAME AS μP-16
DTD	**CLK**	1.7 MHz CLOCK
	STROBE	SAME AS μP-21
LCD	**STROBE**	SAME AS μP-29

POWER ON RESET μP-1

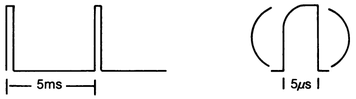


RESET WAVEFORM μP-1 (PIN 1 OF WDT SHORTED)



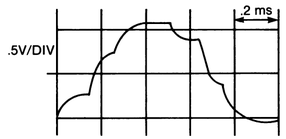
RESET WAVEFORM WDT-1

OR



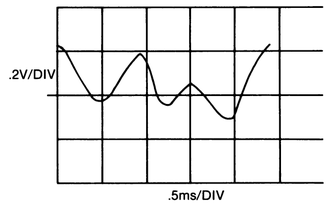
DEPENDS UPON VOL CONTROL SETTING

DTD TONE OUTPUT P12 (1 kHz = TONE 43)



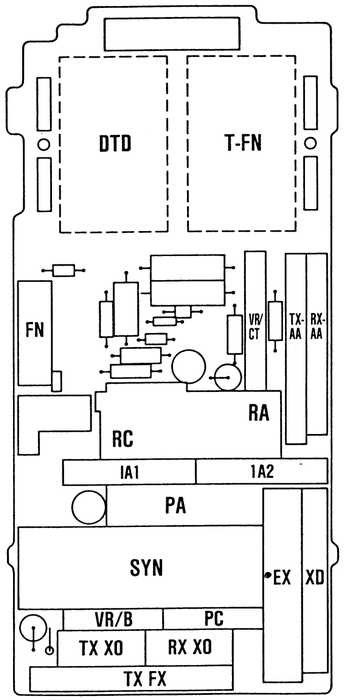
AC COUPLED SCOPE

DTMF OUTPUT DTD P12 "0" (DTD TONE 40 SET)



AC COUPLED SCOPE

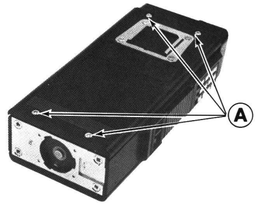
MODULE LAYOUT



Disassembly Procedure

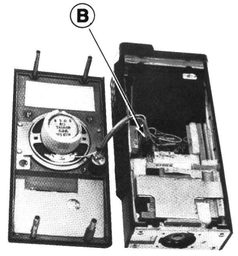
EQUIPMENT REQUIRED

- # 8 Torx Driver.
- Push out tool 19B234436G1.
- Small flat-blade screwdriver.
- Needlenose pliers.
- Antenna nut removal tool ST2308.
- Pencil-type soldering iron (40-60 watts) with a fine tip.
- Vacuum solder extractor



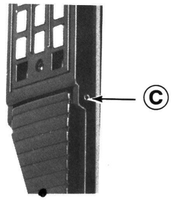
STEP 1.

To gain access to the radio, loosen, but do not remove, the four captive screws at (A). Carefully remove the back cover. For normal radio alignment, the back cover is all that need be removed. When tightening the captive screws, they should be no tighter than 4 ± .5 inch-pounds.



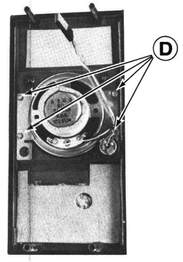
STEP 2.

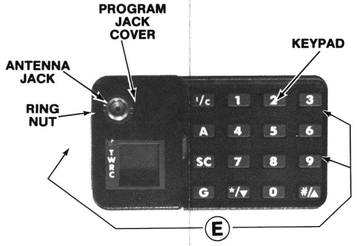
To gain access to the module side of the radio, step 1 must be completed and the radio turned over. Carefully remove the front cover and disconnect the speaker at (B).

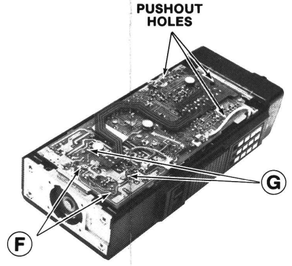


STEP 3.

To remove the PTT switch, push out pin at (C). The PTT bar should come right out.







STEP 4.

To replace the speaker and microphone remove the four screws holding the speaker retaining plates and remove the speaker (D). The microphone is held in place only by the rubber mike boot and can easily be removed.

STEP 5.

To replace keypad assembly, LED, night light, or LCD display, first remove the antenna by unscrewing it from the antenna connector. Remove the nut below the antenna and remove the programming connector cover. Remove 3 screws (E) which retain the top cap, and slide the top cap off. Remove the rubber keypad.

STEP 6.

To remove computer cover, place radio with back side exposed. Remove 4 retaining screws. Turn radio over and remove the cover. The computer may now be removed by pushing with tool 19B234436G1 at the 3 spots indicated, and then removing the computer. When reassembling, care must be taken to align all connectors, to not break the WDT module, and to avoid pinching wires under the computer cover.

To remove modules from the system board, remove both front and back covers.

Plug-in modules can be removed by using a simple bent paper clip as a tool to push the module from the board. A number 64 drill bit in a pin vise makes a sturdier and more permanent tool. A piece of .036 steel wire can be used in place of the drill bit. Ground pins with knockout bottoms, are present on the system board for each module except for the Ex, and PA and SH modules. To remove a module, take the paper clip, insert it into the ground pin of the module to be removed (F) and push the module from the board.

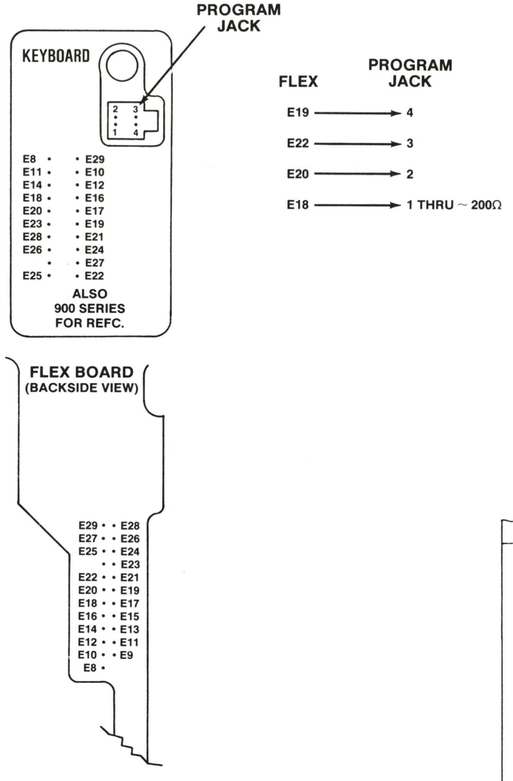
Some modules have screws holding them in place. Before attempting to push a module from the board, remove any screws present (G).

WARNING

Modules are expensive and can be damaged by excessive heat or mishandling. It is recommended that extensive troubleshooting be performed before replacing any soldered-in module. Refer to the Troubleshoot Procedures listed in the Table of Contents of this publication.

To remove a soldered-in module, hold the soldering iron against the bottom of the printed circuit board to melt the solder holding the module lead.
Remove the melted solder from the lead(s) with the de-soldering tool.
When the solder has sufficiently been removed from the lead(s), the flat blade screwdriver may be used to break loose any residual solder and remove the component from the board
Solder in the new component on the bottom side of the board using the small pencil tip on the soldering iron.

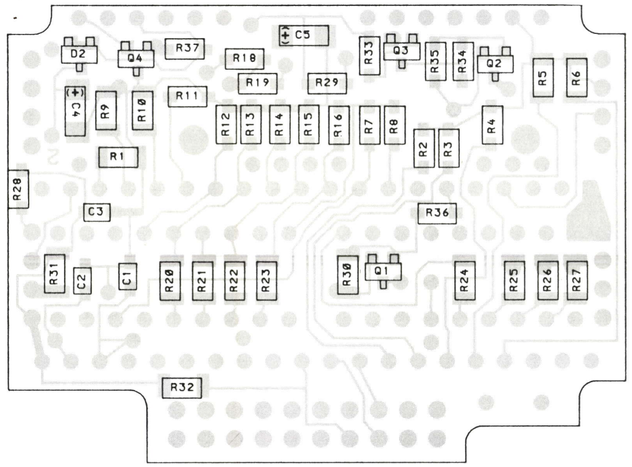
FLEX BOARD CONNECTIONS TO KEYPAD



FLEX	PROGRAM JACK
E19	4
E22	3
E20	2
E18	1 THRU ~ 200Ω

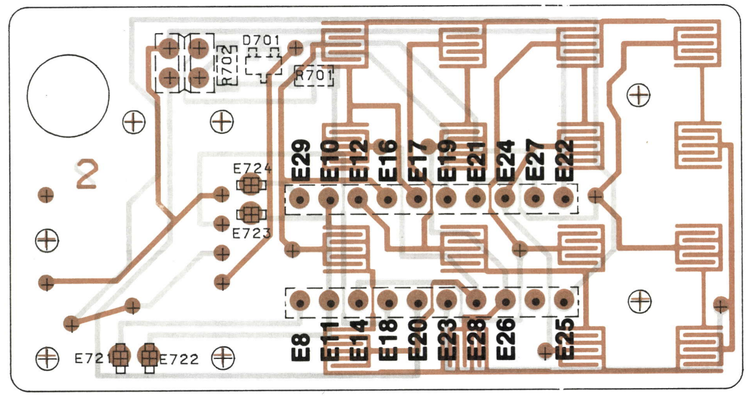
E9	E7
E13	E6
E15	E5
E16	E3
E18	E4

PROCESSOR BOTTOM VIEW



(19A144791, Sh. 4, Rev. 2) 4th Layer

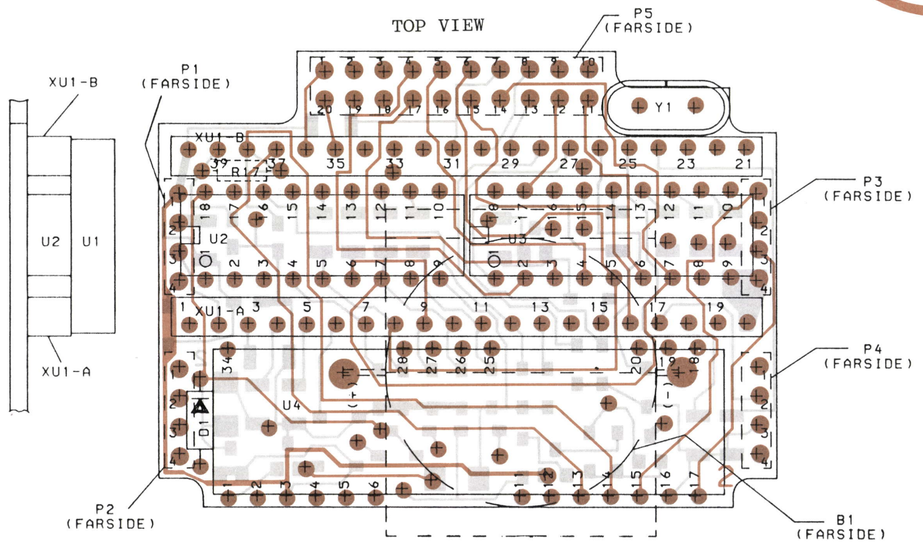
KEYPAD



(19C331997, Rev. 3)
(19A144495, Sh. 1, Rev. 2)
(19A144495, Sh. 2, Rev. 2)

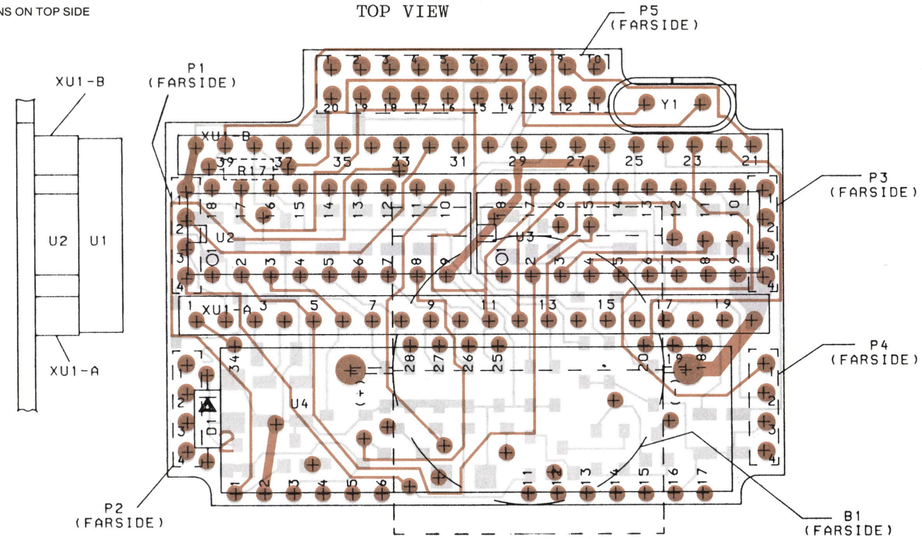
RUNS ON BOTTOM SIDE
RUNS ON BOTH SIDES
RUNS ON TOP SIDE

TOP VIEW



(19A144791, Sh. 1, Rev. 2) 1st Layer
(19A144791, Sh. 4, Rev. 2) 4th Layer

TOP VIEW



(19A144791, Sh. 2, Rev. 2) 2nd Layer
(19A144791, Sh. 3, Rev. 2) 3rd Layer

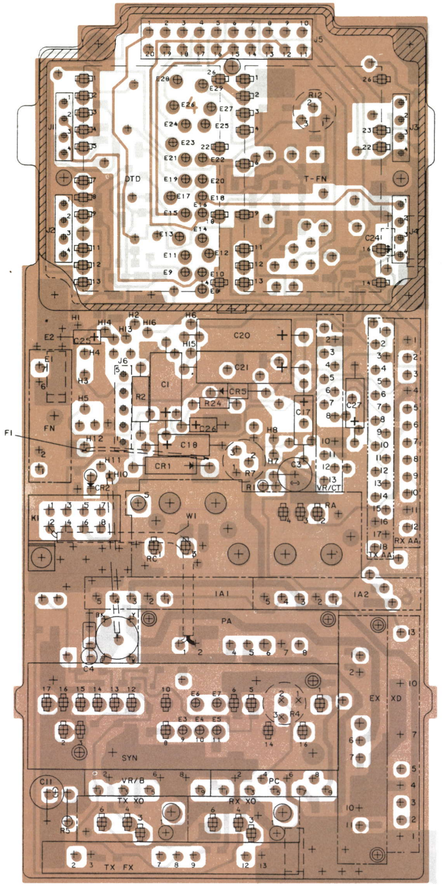
(19C331981, Rev. 4)

OUTLINE DIAGRAM

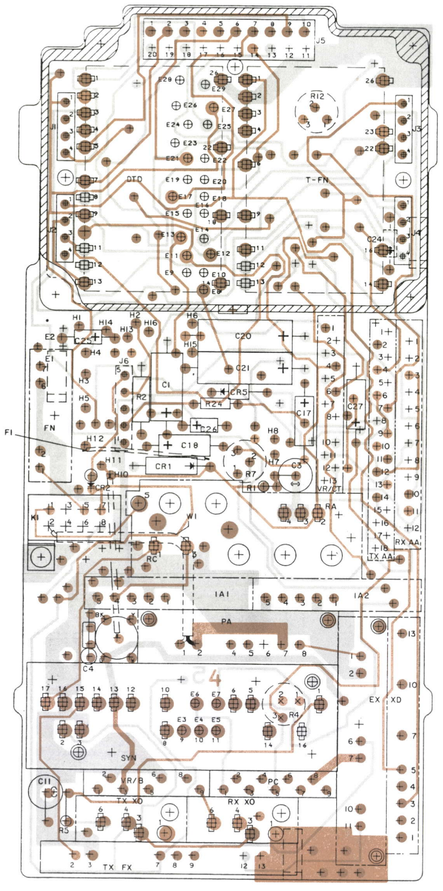
SYSTEM BOARD

(Front view)

PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. ALL DESIGNATIONS ARE 900 SERIES. EXAMPLE C1- C901.



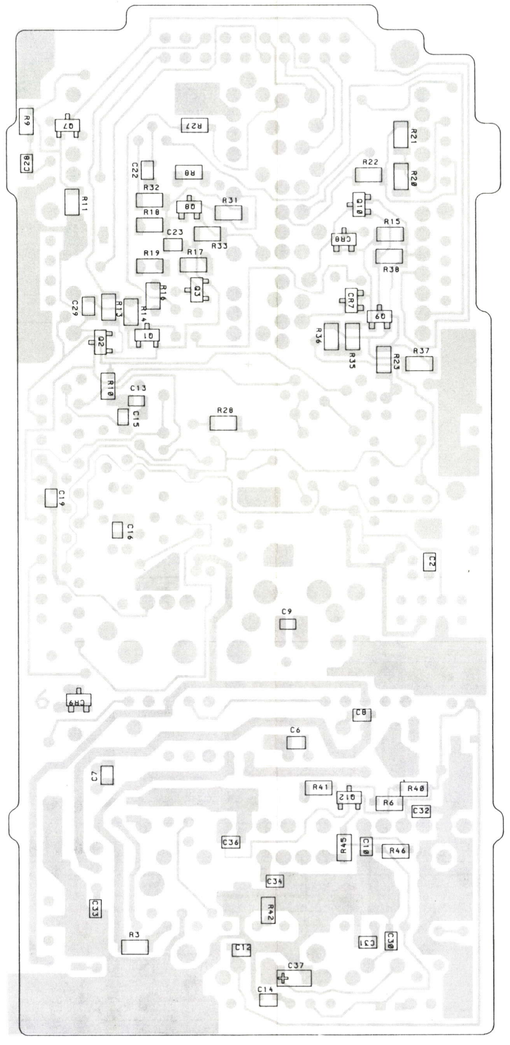
(19A144536, Sh. 1, Rev. 4) 1st Layer
(19A144536, Sh. 4, Rev. 6) 4th Layer



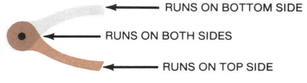
(19A144536, Sh. 2, Rev. 4) 2nd Layer
(19A144536, Sh. 3, Rev. 5) 3rd Layer

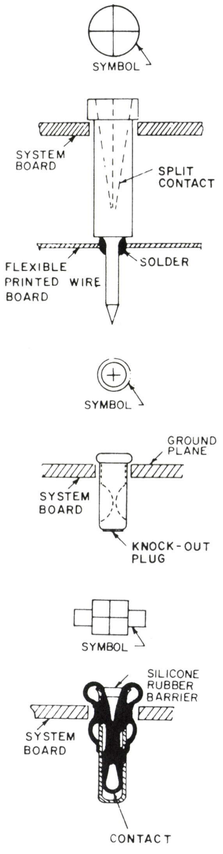
(19D437083, Rev. 5)

BACK VIEW



(19D432974, Sh. 3, Rev. 6)
(19A144536, Sh. 4, Rev. 6)



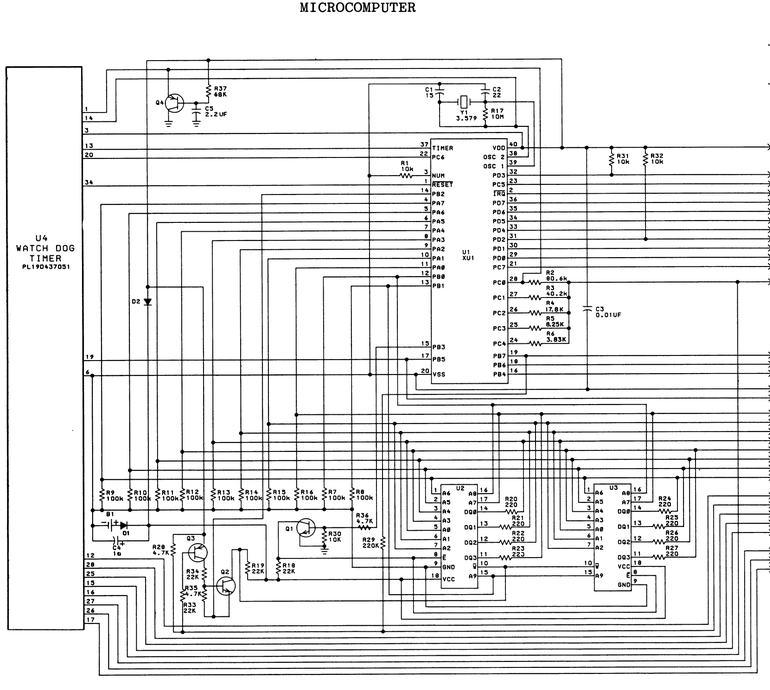


RC3776A

CONTACT IDENTIFICATION

OUTLINE DIAGRAM

MICROCOMPUTER



ALL RESISTORS ARE 1/4 WATT UNLESS OTHERWISE SPECIFIED AND RESISTOR VALUES IN OHMS UNLESS FOLLOWED BY K=1000 OHMS OR MEG=1,000,000 OHMS. CAPACITOR VALUES IN PICOFARADS (EQUAL TO MICROMICROFARADS) UNLESS FOLLOWED BY UF=MICROFARADS. INDUCTANCE VALUES IN MICROHENRYS UNLESS FOLLOWED BY MH=MILLIHENRYS OR H=HENRYS.

(19D437077, Rev. 3)

(19B622560, Rev. 8)

ALL RESISTORS ARE 1/8 WATT UNLESS OTHERWISE SPECIFIED AND RESISTOR VALUES IN OHMS UNLESS FOLLOWED BY K=1000 OHMS OR MEG=1,000,000 OHMS. CAPACITOR VALUES IN PICOFARADS (EQUAL TO MICROMICROFARADS) UNLESS FOLLOWED BY UF=MICROFARADS. INDUCTANCE VALUES IN MICROHENRYS UNLESS FOLLOWED BY MH=MILLIHENRYS OR H=HENRYS.

MODEL NO.	REV. LETTER
PLI19D432877481	B

SCHEMATIC DIAGRAM

Issue 2

PARTS LIST

LBI31395A

GE MARC V PERSONAL MODULE LIST

SYMBOL	GE PART NO.	DESCRIPTION
DTD	19D437506G1	Digital Tone Decoder.
EX	19D430903G2	Exciter. 820 MHz.
FN	19D432795G1	Low Pass Filter.
FS	19D437149G1	Frequency Synthesizer. (USA-1, TX 816-821 MHz, RX 861-866 MHz).
	19D437149G2	Frequency Synthesizer. (USA-2 and MEXICAN BORDER, TX 811-816 MHz, RX 856-861 MHz).
	19D437149G3	Frequency Synthesizer. (CANADIAN BORDER, TX 806-811 MHz, RX 851-856 MHz).
	19D437149G4	Frequency Synthesizer. (AUSTRALIAN, TX 820-825 MHz, RX 865-870 MHz).
IA1	19D430888G1	Amplifier.
IA2	19D430890G1	IF Amplifier.
PA	19D430905G2	Power Amplifier.
PC	19D430871G2	Power Control.
RC	19D430033G2	Amplifier/Mixer.
RX-AA	19D430878G2	Audio Amplifier.
RX-XO	19A137645G15	Oscillator. (USA-1, 72.351042 MHz).
	19A137645G19	Oscillator. (USA-2, 71.934375 MHz).
	19A137645G21	Oscillator. (MEXICAN BORDER, 71.933333 MHz).
	19A137645G23	Oscillator. (CANADIAN BORDER, 71.517708 MHz).
	19A137645G25	Oscillator. (AUSTRALIAN, 72.684375 MHz).
T-FN	19D430707G1	Tone Filter.
TX-AA	19D430877G2	Audio Amplifier.
TX-FX	19D437118G1	Buffer.
TX-XO	19A137645G16	Oscillator. (USA-1, 66.817708 MHz).
	19A137645G20	Oscillator. (USA-2, 66.401042 MHz).
	19A137645G22	Oscillator. (MEXICAN BORDER, 66.400000 MHz).
	19A137645G24	Oscillator. (CANADIAN BORDER, 65.984375 MHz).
	19A137645G26	Oscillator. (AUSTRALIAN, 67.151042 MHz).
VR/B	19D433701G1	Voltage Regulator.
VR-CT	19D433436G6	Voltage Regulator.
XD	19D430880G1	Limiter/Detector.

*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES.

PARTS LIST

SYSTEM BOARD 19D432974G1 AND ASSOCIATED PARTS

ISSUE 2

SYMBOL	GE PART NO.	DESCRIPTION
		- - - - - - - - - - CAPACITORS - - - - - - - - - -
C901	5491674P42	Tantalum: 47 uF ±20%, 6 VDCW; sim to Sprague Type 162D.
C902	19A702061P21	Ceramic: 15 pF ±5%, 50 VDCW, temp coef 0 ±30 PPM.
C903	5491674P30	Tantalum: 39 uF ±20%, 10 VDCW; sim to Sprague Type 162D.
C904	5491674P36	Tantalum: 3.3 uF ±20%, 10 VDCW; sim to Sprague Type 162D.
C905	19A700221P33	Ceramic: 15 pF ±5%, 100 VDCW, temp coef -80 PPM.
C906	19A702061P5	Ceramic: 2.2 pF ±0.5 pF, 50 VDCW, temp coef 0 ±120 PPM.
C907	19A702061P3	Ceramic: 1.5 pF ±0.5 pF, 50 VDCW, temp coef 0 ±250 PPM.
C908	19A702052P14	Ceramic: 0.01 uF ±10%, 50 VDCW.
C909	19A702061P29	Ceramic: 22 pF ±5%, 50 VDCW, temp coef 0 ±30 PPM.
C910	19A702052P14	Ceramic: 0.01 uF ±10%, 50 VDCW.
C911	19B200240P19	Tantalum: 100 uF ±20%, 6 VDCW.
C912	19A702061P25	Ceramic: 18 pF ±5%, 50 VDCW, temp coef 0 ±30 PPM.
C913	19A702061P49	Ceramic: 56 pF ±5%, 50 VDCW, temp coef 0 ±30 PPM.
C914	19A702061P25	Ceramic: 18 pF ±5%, 50 VDCW, temp coef 0 ±30 PPM.
C915 and C916	19A702061P49	Ceramic: 56 pF ±5%, 50 VDCW, temp coef 0 ±30 PPM.
C917	5491674P34	Tantalum: 15 uF ±20%, 6 VDCW; sim to Sprague Type 162D.
C918	5491674P37	Tantalum: 10 uF ±20%, 10 VDCW; sim to Sprague Type 162D.
C919	19A702052P14	Ceramic: 0.01 uF ±10%, 50 VDCW.
C920 and C921	19B200240P19	Tantalum: 100 uF ±20%, 6 VDCW.
C922	19A702052P14	Ceramic: 0.01 uF ±10%, 50 VDCW.
C923	19A702052P10	Ceramic: 4700 pF ±10%, 50 VDCW.
C924 thru C926	5491674P1	Tantalum: 1 uF +40-20%, 10 VDCW; sim to Sprague Type 162D.
C927	5491674P34	Tantalum: 15 uF ±20%, 6 VDCW; sim to Sprague Type 162D.
C928 and C929	19A702052P14	Ceramic: 0.01 uF ±10%, 50 VDCW.
C931	19A702061P49	Ceramic: 56 pF ±5%, 50 VDCW, temp coef 0 ±30 PPM.
C932 and C933	19A702061P61	Ceramic: 100 pF ±5%, 50 VDCW, temp coef 0 ±30 PPM.
C934	19A702061P49	Ceramic: 56 pF ±5%, 50 VDCW, temp coef 0 ±30 PPM.
C936	19A702061P49	Ceramic: 56 pF ±5%, 50 VDCW, temp coef 0 ±30 PPM.
C937	19A701779P109	Tantalum: 6.8 uF ±10%, 6 VDCW.
		- - - - - - - - - - DIODES - - - - - - - - - -
CR901	5494922P1	Silicon: sim to Hughes 1N456.
CR902	19A115250P1	Silicon, fast recovery, 225 mA, 50 PIV.

*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES.

SYMBOL	GE PART NO.	DESCRIPTION
CR905	19A700047P1	Silicon, 100 mW continous dissapation.
CR907 and CR908	19A700155P2	Silicon; sim to Bat 18.
CR909	19A702526P1	Silicon. (Schottky Barrier); sim to BAT 17.
		- - - - - - - - - - TERMINALS - - - - - - - - - -
E3 thru E29	19A134591P1	Contact, electrical: sim to Augat LSG-1AG14-14.
		- - - - - - - - - - FUSES - - - - - - - - - -
F901	19A115060P42	Fuse Kit.
		- - - - - - - - - - JACKS - - - - - - - - - -
J901 thru J904	19A702210P4	Printed wire: 4 contacts rated @ 2 amps; sim to Berg 76310-004.
J905	19A703022P10	Printed wire: 20 contacts rated @ 2 amps; sim to Berg 65781-046.
J906	19A701329P1	Contact, electrical: rated @ 3 amps; sim to Berg 75404-001. (Quantity 5).
		- - - - - - - - - - RELAYS - - - - - - - - - -
K901	19B209666P1	Sensitive, hermetic sealed: 90 ohms ±10%, 5.75 to 9.0 VDC nominal, 2 form C contact; sim to C.P. Clare MF1401G03.
		- - - - - - - - - - COILS - - - - - - - - - -
L901	19B232664G1	Coil.
		- - - - - - - - - - TRANSISTORS - - - - - - - - - -
Q901 thru Q903	19A700076P2	Silicon, NPN.
Q907 thru Q909	19A700076P2	Silicon, NPN.
Q910	19A700059P1	Silicon, PNP.
Q912	19A700059P2	Silicon, PNP.
		- - - - - - - - - - RESISTORS - - - - - - - - - -
R901	19A134564P1	Metal film: 15 ohms ±5%, 1/4 w.
R902	19A700106P45	Composition: 180 ohms ±5%, 1/4 w.
R903	19B800607P182	Metal film: 1.8K ohms ±5%, 200 VDCW, 1/8 w.
R904	19A134512P8	Variable: 50K ohms ±5%, 1/2 w.
R905	3R151P560J	Composition: 56 ohms ±5%, 150 VDCW, 1/8 w.
R906	19B800607P680	Metal film: 68 ohms ±5%, 200 VDCW, 1/8 w.
R907	19A134512P7	Variable, cermet: 50K ohms ±10%, 1/2 w; sim to A-B A2A503.
R908	19B800607P223	Metal film: 22K ohms ±5%, 200 VDCW, 1/8 w.
R909	19B800607P104	Metal film: 100K ohms ±5%, 200 VDCW, 1/8 w.
R910	19B800607P273	Metal film: 27K ohms ±5%, 200 VDCW, 1/8 w.
R911	19B800607P224	Metal film: 220K ohms ±5%, 200 VDCW, 1/8 w.
R912	19A134512P8	Variable: 50K ohms ±5%, 1/2 w.
R913 thru R915	19B800607P103	Metal film: 10K ohms ±5%, 200 VDCW, 1/8 w.
R916	19B800607P104	Metal film: 100K ohms ±5%, 200 VDCW, 1/8 w.
R917	19B800607P103	Metal film: 10K ohms ±5%, 200 VDCW, 1/8 w.
R918	19B800607P223	Metal film: 22K ohms ±5%, 200 VDCW, 1/8 w.
R919	19B800607P393	Metal film: 39K ohms ±5%, 200 VDCW, 1/8 w.
R920	19B800607P103	Metal film: 10K ohms ±5%, 200 VDCW, 1/8 w.
R921	19B800607P223	Metal film: 22K ohms ±5%, 200 VDCW, 1/8 w.
R922	19B800607P471	Metal film: 470 ohms ±5%, 200 VDCW, 1/8 w.

SYMBOL	GE PART NO.	DESCRIPTION
R923	19B800607P561	Metal film: 560 ohms ±5%, 200 VDCW, 1/8 w.
R924	3R151P561J	Composition: 560 ohms ±5%, 1/8 w.
R927	19B800607P391	Metal film:390 ohms ±5%, 200 VDCW, 1/8 w.
R928	19B800607P222	Metal film: 2.2K ohms ±5%, 200 VDCW, 1/8 w.
R931 and R932	19B800607P223	Metal film: 22K ohms ±5%, 200 VDCW, 1/8 w.
R933	19B800607P472	Metal film: 4.7K ohms ±5%, 200 VDCW, 1/8 w.
R935	19B800607P563	Metal film: 56K ohms ±5%, 200 VDCW, 1/8 w.
R936	19B800607P473	Metal film: 47K ohms ±5%, 200 VDCW, 1/8 w.
R937	19B800607P563	Metal film: 56K ohms ±5%, 200 VDCW, 1/8 w.
R938	19B800607P473	Metal film: 47K ohms ±5%, 200 VDCW, 1/8 w.
R940	19B800607P473	Metal film: 47K ohms ±5%, 200 VDCW, 1/8 w.
R941	19B800607P123	Metal film: 12K ohms ±5%, 200 VDCW, 1/8 w.
R942	19B800607P472	Metal film: 4.7K ohms ±5%, 200 VDCW, 1/8 w.
R945 and R946	19B800607P180	Metal film: 18 ohms ±5%, 200 VDCW, 1/8 w.
		- - - - - - - - - - CABLES - - - - - - - - - -
W1	19A137417G5	RF Cable.
		- - - - - - - - - - MISCELLANEOUS - - - - - - - - - -
	19A121175P13	Insulator, plate. (Located under K1).
	19B232662P1	Support. (K1).
	19B800608P2	Rivet, tubular. (Secures K1 support).
		ASSOCIATED PARTS
	19D429763G3	Battery. 75 mAH.
	19D429777G3	Battery. 1200 mAH.
	19B801219P1	Antenna, whip.
	19B233301G1	Tuning tool. (Recessed screw driver).
	19B234436G1	Tuning tool. (Round both ends).
		HARDWARE KIT 19A148075G1
	19A134793P1804	Screw, thd. forming: No. 1-64 x 5/32. (Secures System Board at center - Quantity 3).
	19A134793P1805	Screw, thread forming: No. 1-64 x 7/32. (Secures System Board near E1 - Quantity 1).
	N75P1002	Machine screw, brass, pan head: No. 0-80 x 1/8. (Secures top & bottom of System Board - Quantity 8).
	19A134582P1	Washer, non-metallic. (Located between EX & PA modules and System Board).
	19C328742P1	Ground clip. (IA2).
	19C336303P1	Ground clip. (PA).
	19C336387P1	Module clip. (Protects all lower modules from vibration).
	19B232682P11	Pad. (Located under flex circuit).
	19C331914G1	Cover, microprocessor.
	19B232678P7	Vibration packing. (Located at end of XIA-RX XO-TONE DETECTOR).
	19B232678P2	Vibration packing. (Located by TX-AA).
	19B232678P8	Vibration packing. (Located by TX-XO & PA).
	19B232678P9	Vibration packing. (Located between IA2 and TX-AA, RX-AA).

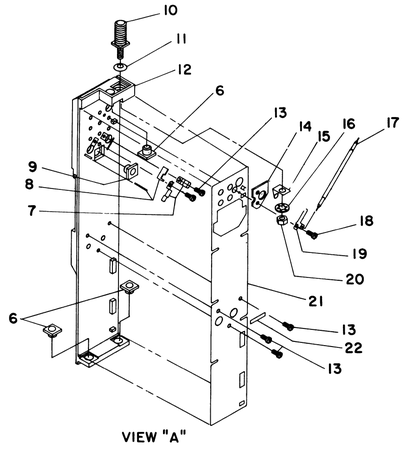
PARTS LIST

LBI31410

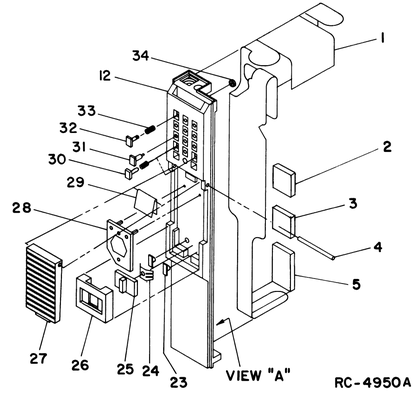
MECHANICAL PARTS RC 4950

SYMBOL	GE PART NO.	DESCRIPTION
1	19D429686P1	Flex board.
2	19B232682P23	Pad.
3	19B232682P9	Pad.
4	19A134585P1	Pin, spring. (Part of S702).
5	19B232682P5	Pad.
6	19A137410P1	Bushing. (Secures base assembly to side rails).
7	19A144581G1	Contact. (Part of S703 & S704).
8	19B234407G5	Contact. (Part of S703 & S704).
9	19B232415P1	Bushing.
10	19C851265P1	Antenna stud.
11	19A115983P13	Packing.
12	19B234529G1	Left side rail.
13	19A134588P1	Drive screw. (Part of S703 & S704).
14	19B232672P2	Insulator. (Part of S705).
15	19B234494P1	Ground strap. (Part of S705).
16	M414P16C	Lockwasher, internal tooth, W2.2.
17	19A137417G4	Cable wire, approx 2 inches long. (W703).
18	19A134588P4	Screw, panhead: No. 0 - 40 x 1/4. (Part of S705).
19	19B232670P1	Contact. (Part of S705).
20	19A700034P3	Hexnut: M2.5 x 0.45.
21	19C328385P2	Shield.
22	19A137609G2	Strap.
23	19B234407G3	Contact. (Part of S701).
24	19B232560P1	Spring. (Part of S701).
25	19A137826G1	Slide. (Part of S701).
26	19C328373P1	Plate. (Part of S701).
27	19C328176P1	Button. (Part of S702).
28	19B800847P1	Switch, push: contacts rated 25 uA @ 9 VDC; sim to Bowmar KB3256-1D. (Part of S702).
29	19A137414P1	Spring. (Part of S702).
30	19B234407G4	Contact. (Part of S703 & S704).
31	19B234407G1	Contact. (J701-2 thru J701-9, J701-11).
32	19B234407G2	Contact. (Part of S703-S705).
33	4035235P13	Spring. (Part of S703-S705).
34	19A137413P1	Seal. (Part of S703-S705).

*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES.



VIEW "A"



VIEW "A"

RC-4950A

PARTS LIST

PROCESSOR
19C331889G1

ISSUE 2

SYMBOL	GE PART NO.	DESCRIPTION
		- - - - - - - - - - - - BATTERIES - - - - - - - - - -
B1	19A702912P1	Lithium, 160 mAh, 3 VDC, sim to Panosonic BR2325-1P.
		- - - - - - - - - - - - CAPACITORS - - - - - - - - - -
C1	19A702061P21	Ceramic: 15 pF ±5%, 50 VDCW, temp coef 0 ±30 PPM.
C2	19A702061P29	Ceramic: 22 pF ±5%, 50 VDCW, temp coef 0 ±30 PPM.
C3	19A702052P14	Ceramic: 0.01 uF ±10%, 50 VDCW.
C4	19A700051P3	Tantalum: 1 uF ±20%, 10 VDCW; sim to Sprague 194D74X0020A3.
C5	19A701779P13	Tantalum: 2.2 uF ±20%, 10 VDCW.
		- - - - - - - - - - - - DIODES - - - - - - - - - -
D1	19A700047P1	Silicon, 100 mW continous dissapation.
D2	19A702526P2	Silicon. (Schottky Barrier); sim to BAT 17.
		- - - - - - - - - - - - PLUGS - - - - - - - - - -
P1 thru P4	19A700072P201	Printed wire: 4 contacts rated @ 2 1/2 amps; sim to Berg 75160-301-04.
P5	19A702333P10	Printed wire: 20 contacts rated @ 1 amp; sim to Berg 65610-420.
		- - - - - - - - - - - - TRANSISTORS - - - - - - - - - -
Q1 and Q2	19A700076P2	Silicon, NPN.
Q3 and Q4	19A700059P2	Silicon, PNP.
		- - - - - - - - - - - - RESISTORS - - - - - - - - - -
R1	19B800607P103	Metal film: 10K ohms ±5%, 200 VDCW, 1/8 w.
R2	19A702931P388	Metal film: 80.6K ohms ±1%, 200 VDCW, 1/8 w.
R3	19A702931P359	Metal film: 40.2K ohms ±1%, 200 VDCW, 1/8 w.
R4	19A702931P325	Metal film: 17.8K ohms ±1%, 200 VDCW, 1/8 w.
R5	19A702931P289	Metal film: 8250 ohms ±1%, 200 VDCW, 1/8 w.
R6	19A702931P257	Metal film: 3830 ohms ±1%, 200 VDCW, 1/8 w.
R7 thru R16	19B800607P104	Metal film: 100K ohms ±5%, 200 VDCW, 1/8 w.
R17	3R151P106J	Composition: 10 Megohm ±5%, 150 VDCW, 1/8 watt.
R18 and R19	19B800607P223	Metal film: 22K ohms ±5%, 200 VDCW, 1/8 w.
R20 thru R27	19B800607P221	Metal film: 220 ohms ±5%, 200 VDCW, 1/8 w.
R28	19B800607P472	Metal film: 4.7K ohms ±5%, 200 VDCW, 1/8 w.
R29	19B800607P224	Metal film: 220K ohms ±5%, 200 VDCW, 1/8 w.
R30 thru R32	19B800607P103	Metal film: 10K ohms ±5%, 200 VDCW, 1/8 w.
R33 and R34	19B800607P223	Metal film: 22K ohms ±5%, 200 VDCW, 1/8 w.
R35 and R36	19B800607P472	Metal film: 4.7K ohms ±5%, 200 VDCW, 1/8 w.
R37	19B800607P683	Metal film: 68K ohms ±5%, 200 VDCW, 1/8 w.
		- - - - - - - - INTEGRATED CIRCUITS - - - - - - - -
U1	19A702872P3	Microcomputer: (CMOS, 8-BIT).
U2 and U3	19A701823P1	Digital: STATIC RAM; sim to Harris HM1-6514-9.
U4	19D437061G1	Timer.
		- - - - - - - - - - - - SOCKETS - - - - - - - - - -
XU1A and XU1B	19A134344P4	Integrated circuit: 20 contacts; sim to Amp 583773-9.
		- - - - - - - - - - - - CRYSTALS - - - - - - - - - -
Y1	19A702511G1	Quartz: Frequency 3.579545 MHz.
		- - - - - - - - - - - - MISCELLANEOUS - - - - - - - - - -
	19A115965P10	Terminal, stud: sim to Sealectro 229-3017-00-0-470. (Used with B1).
	19B232682P22	Pad. (Used with B1).
	19B232682P9	Pad. (Used with Y1).

*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES

PARTS LIST

CASE ASSEMBLY
19D437168G1

ISSUE 2

SYMBOL	GE PART NO.	DESCRIPTION
		SIDE RAIL 19D429373G7
		- - - - - - - - - - - - JACKS - - - - - - - - - -
J701		Connector. Includes:
	19B234407G1	Contact. (J701-2 thru 9,11).
	19B234407G2	Contact. (J701-10, 12).
	19B234407G4	Contact. (J701-1).
	4035235P13	Helical spring. (Used with J701-1, 10, 12).
	19A137413P1	Seal. (Used with J701-1, 10, 12).
		- - - - - - - - - - - - SWITCHES - - - - - - - - - -
S701		Switch. Includes:
	19C328373P1	Plate.
	19A137826G1	Slide.
	19B232560P1	Spring.
	19B234407G3	Contact. (Quantity 2).
S702		Switch. Includes:
	19B800847P1	Switch.
	19C328176P1	Button.
	19A137414P1	Spring.
	19A134585P1	Spring pin.
S703 and S704		Switch. Includes:
	19A144581G1	Contact.
	19B234407G5	Contact.
	19A134588P1	Drive screw.
S705		Switch. Includes:
	19B234407G2	Contact.
	4035235P13	Helical spring.
	19A137413P1	Seal.
	19B232670P1	Contact.
	19B232672P1	Insulator.
	19B232671P1	Contact.
		- - - - - - - - - - - - CABLES - - - - - - - - - -
W703	19A137417G4	Cable wire.
		KEYPAD 19C331996G1
		- - - - - - - - - - - - DIODES - - - - - - - - - -
D701	19A700083P3	Zener, 200 mW max; sim to BZX-84-C5V6.
		- - - - - - - - - - - - TERMINALS - - - - - - - - - -
E701 thru E720	19A704474P1	Terminal strip. (Quantity 2).
E721 thru E724	19B209648P1	Contact, electrical.
J703	19A702333P2	Connector, PWB, 4 contacts; sim to Berg 65610-404.
		- - - - - - - - - - - - RESISTORS - - - - - - - - - -
R701 and R702	19B800607P101	Metal film: 100 ohms ±5%, 200 VDCW, 1/8 w.
		BASE 19C328377G3, G4
		- - - - - - - - - - - - CAPACITORS - - - - - - - - - -
C1	19A700007P65	Ceramic: 150 pF ±5%, 50 VDCW; temp coef 0 ±30 PPM.
		- - - - - - - - - - - - MISCELLANEOUS - - - - - - - - - -
	19D433728G1	Display Driver.
	19B234323G1	Top Cover Assembly.
	19C328376G2	Side Rail.
	19B234328G1	Top Plate.

*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES

PARTS LIST

FRONT COVER
19D432007G6

ISSUE 1

SYMBOL	GE PART NO.	DESCRIPTION
		- - - - - - - - - - CAPACITORS - - - - - - - - - -
C3 and C4	19A700221P33	Ceramic: 15 pF ±5%, 100 VDCW, temp coef -80 PPM.
		- - - - - - - - - - SPEAKERS - - - - - - - - - -
LS1	19A134460P1	Permanent magnet: 2 inches, 8 ohms ±10%, imp 500 mW, 450 ±100 Hz resonant freq; sim to Pioneer A50AP13-01F.
		- - - - - - - - - - MICROPHONES - - - - - - - - - -
MK1	19A134461P1	Cartridge: 200-850 ohms imp, 1.5-10 VDC; sim to PRIMO EM-60-PM12.
		- - - - - - - - - - PLUGS - - - - - - - - - -
P906		Connector. (Part of W2). Includes:
	19A702405P5	Shell.
	19A702405P26	Contact, electrical: rated @ 3 amps. (Quantity 5).
		- - - - - - - - - - CABLES - - - - - - - - - -
W2	19B233023G2	5 conductor: approx. 4 3/4 inches long. (Includes P906).
		MECHANICAL PARTS
	19B232496P1	Plate. (Secures LS1 to cover).
	19A134793P1804	Screw, thd. forming: No. 1-64 x 5/32. (Secures LS1 plates to cover).
	19B232682P1	Pad. (Located on bottom left edge of cover).
	19B232682P2	Pad. (Located in center bottom of cover).
	19B232682P22	Pad. (Located at top of cover).
	19B232498P1	Microphone boot.
	19D429300P1	Speaker Grille.
	19A137709P1	Spacer. (Quantity 4 - Mates with rear cover screws).
	19A134583P2	Cover seal, rubber, B Case.
	4033714P14	Solderless terminal. (Located at lower right of LS1).
	19C328382G11	RF Cover.
	19A148155P1	Nameplate. (GE - MARC V).

PARTS LIST

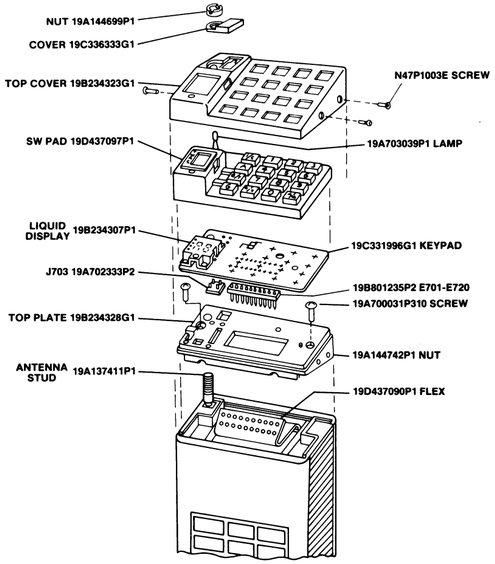
REAR COVER
19D429534G10
(SEE RC3850A)

ISSUE 2

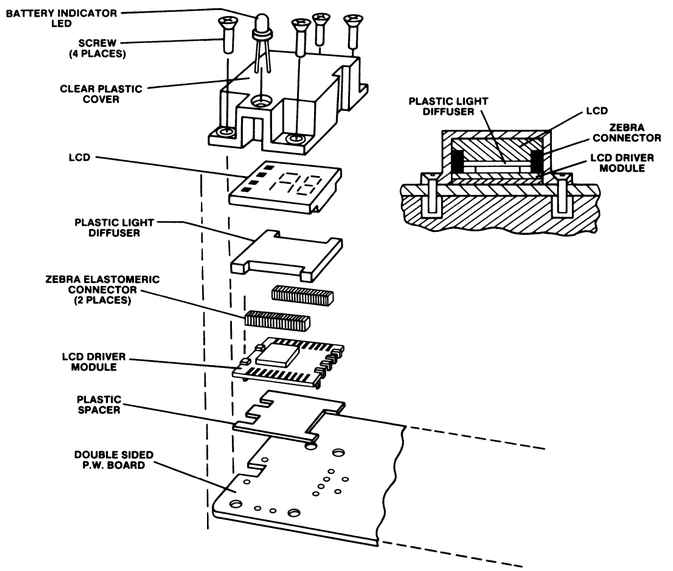
SYMBOL	GE PART NO.	DESCRIPTION
1	N327P9010Y6	Rivet, tubular.
2	19A702863P1	Machine screw: TORX®DRIVE, No. M2.5 X .45 - 13.
3	19A700032P3	Lockwasher, tooth, steel, metric: 2.5.
4	19C328374G10	Cover.
5		Not Used.
6	19C336055P1	Pad.
7		Not Used.
8	19A134583P2	Seal.
9		Not Used.
10	19C336056P1	Insulator.
11		Not Used.
12	19C850865P1	Mounting clip.
13	19A702459P1	Pressure sensitive tape.

*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES

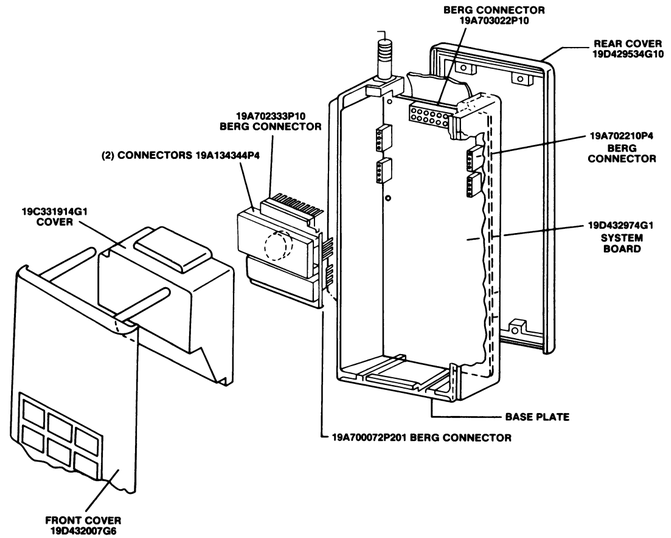
TOP COVER AND KEYPAD ASSEMBLY

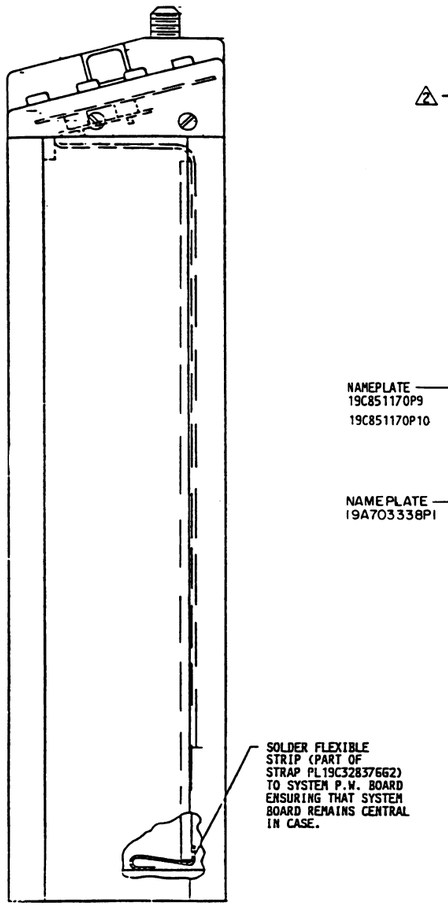


LCD ASSEMBLY

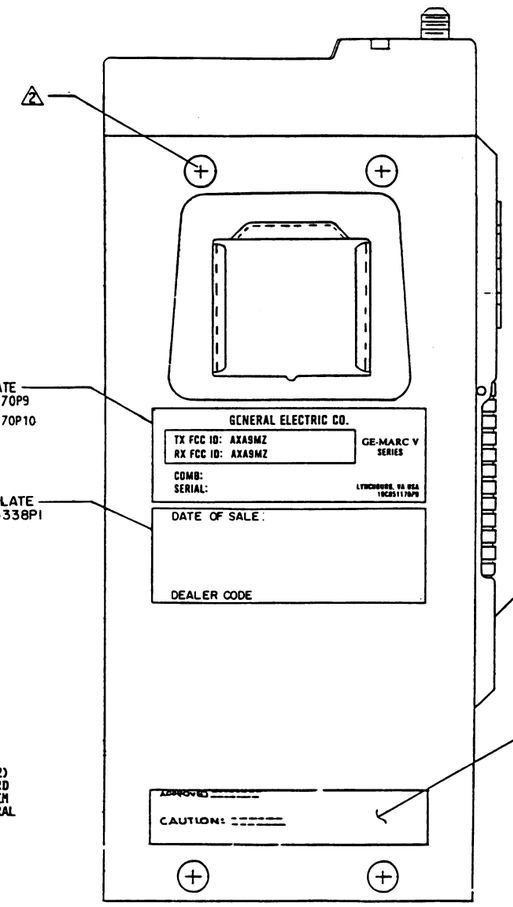


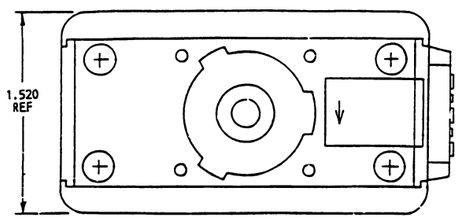
COVERS, SIDE RAILS AND BASE PLATE ASSEMBLY

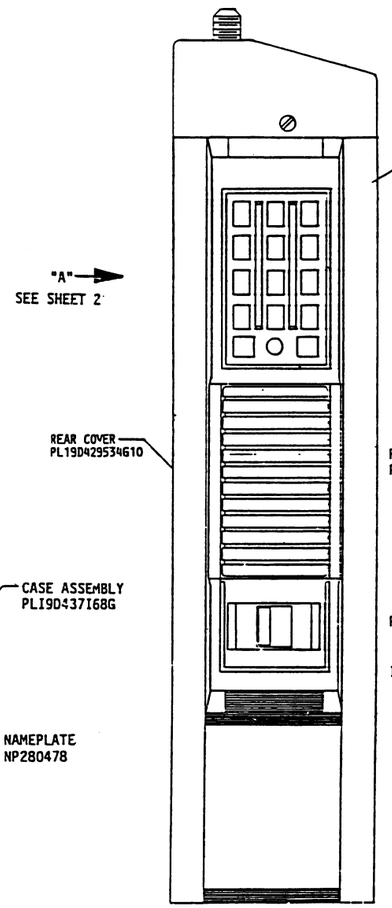


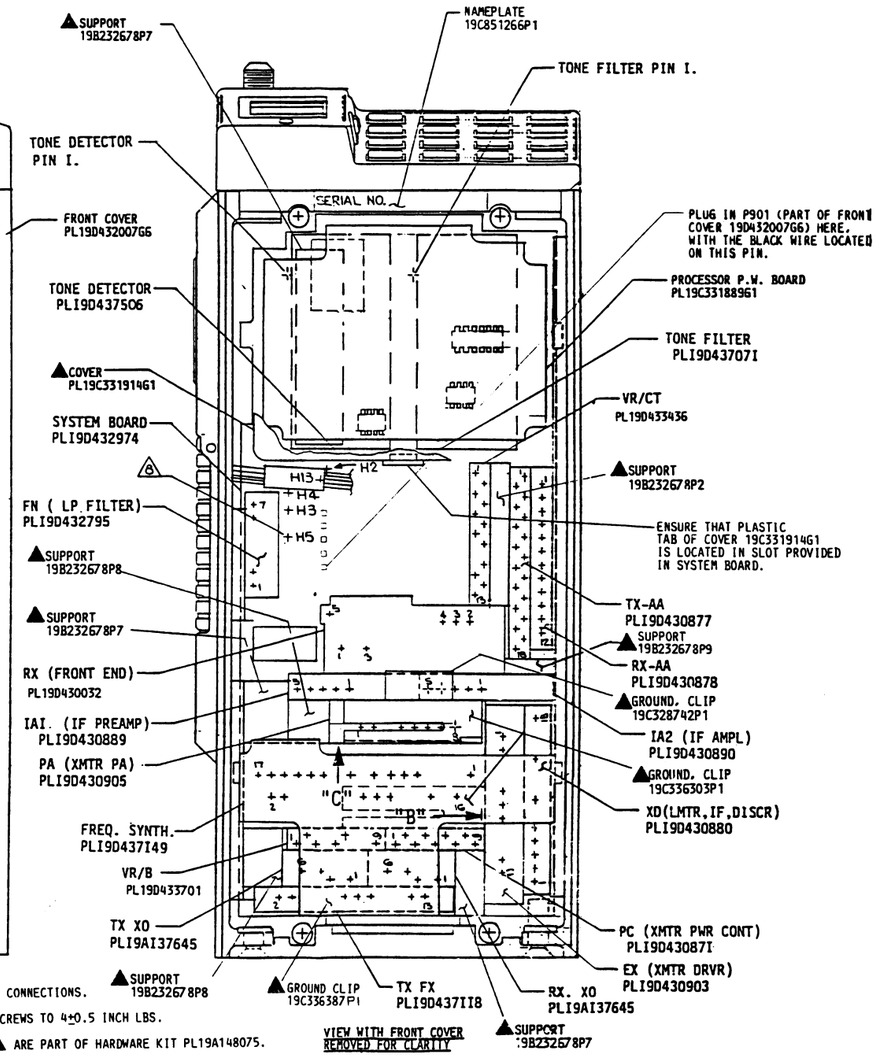


SOLDER FLEXIBLE STRIP (PART OF STRAP PL19C328376G2) TO SYSTEM P.W. BOARD ENSURING THAT SYSTEM BOARD REMAINS CENTRAL IN CASE.







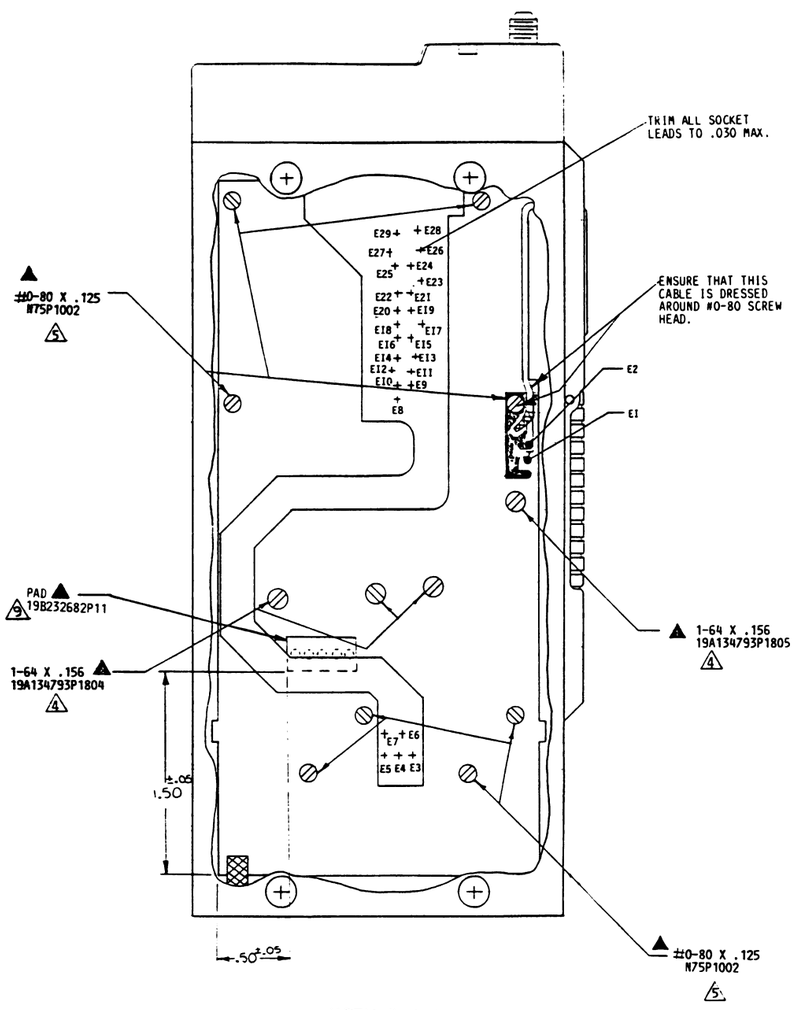


NOTES:

1. SOLDER ALL ELECTRICAL CONNECTIONS.
2. TORQUE M2.5 PANHEAD SCREWS TO 4±0.5 INCH LBS.
3. ITEMS IDENTIFIED BY ▲ ARE PART OF HARDWARE KIT PL19A148075.
4. TORQUE #1-64 SCREWS TO 1.5 - 2.0 INCH LBS.
5. TORQUE #0-80 SCREWS TO 16±5 INCH OZ.
6. ASSEMBLE IN ACCORDANCE WITH TEST SPEC

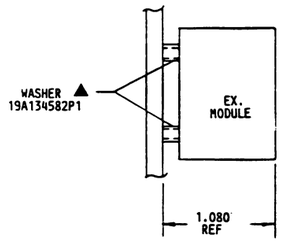
8. WIRE TERMINALS H2, H3, H4, H5 AND H13 TO BE SLEEVED.
13. REMOVE ADHESIVE LINER FROM PAD 19B232682P11 AND STICK TO FACE OF SYSTEM BOARD 19D432974 IN POSITION SHOWN.

19D437172, Sh. 1, Rev. 9

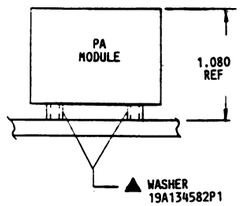


VIEW " A "
(COVER BROKEN AWAY)

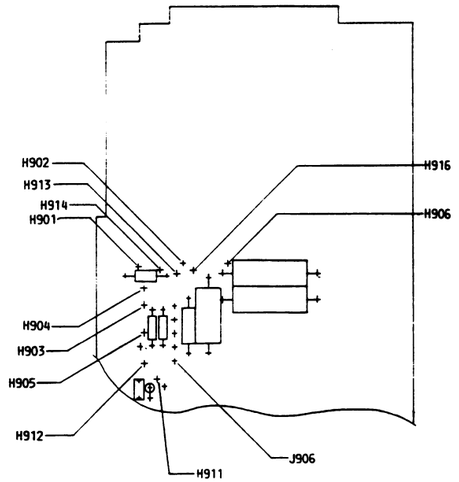
NOTE: ALL "E" NUMBERS SHOWN ABOVE ARE 900 SERIES.



VIEW " B "



VIEW " C "



CONNECTIONS CHART	
FROM	TO
SIDE RAIL RED LEAD	H912
SIDE RAIL W/GRAY LEAD	H905
SIDE RAIL ORANGE LEAD	H903
SIDE RAIL VIOLET LEAD	H904
PIT S702 T28-BK	H901
SIDE RAIL W/BLUE LEAD	H914
SIDE RAIL BLACK LEAD	H913
SIDE RAIL BROWN LEAD	H902
SIDE RAIL YELLOW LEAD	H906
SIDE RAIL W/BROWN LEAD	H915
SIDE RAIL GREEN LEAD	H916

APPENDIX A

PROGRAMMING INFORMATION

FOR THE

GE MARC V PERSONAL RADIO

The GE Suitcase Programmer provides the capability to both load and read customer information from the Radio ram storage. The information is transferred through a 4-wire connection to a covered connector on the top of the radio. This is accomplished with the radio turned on when the computer displays "1-write to radio".

The software to perform the GE MARC V functions is contained in a ROM in the Program Storage Module. When power is applied, one of two menus will appear, either the PRIMARY MENU, or the GE MARC V menu. The PRIMARY MENU is listed below as a reference.

PRIMARY MENU

1. Calculator
2. Clock/Controller
3. File System
4. Run SNAP Programs
5. GE MARC V PERSONAL
6. Hex Edit/Prom Programmer (if supplied)
7. Self Test
8. Typewriter

If in the Primary Menu, select GE MARC V personal by pressing key 5. A rotating menu will appear, providing the following functions:

PRIMARY MENU--returns the computer to the primary menu.

PROGRAM-REVIEW--provides the ability to generate a new set of RAM information, or modify an old set. The information may be obtained either from a radio, from a saved internal file, or generated new. Once the information is established, it may be saved in a file, or written directly to a radio.

PRINTOUT--prints the radio ram information (supplied either from the computer file, or the radio) on the miniprinter module. If so desired, a complete ram hex dump can be obtained at the end of the normal print. This hex dump is not usually very useful.

COPY-SINGLE--reads from a radio or a file, and writes to either a radio or a file.

COPY-MULTIPLE--reads from radio or file, and then allows programming of more than one radio. This function also optimizes system performance by rotating the first channel in each area as each radio is loaded. This prevents excess 1st channel loading because of call initiation always starting at the first channel.

The normal procedure for programming a radio from "scratch" is shown below. Modifying an existing set of information is essentially the same. At any time, one may start over by pressing clear. If the suitcase is left unused for a period of time, it turns itself off. Press "ON" to resume operation.

PROGRAMMING

When 2-program/review is selected, several questions are asked, and then a menu of items is displayed. It is especially convenient to think of the menu items as a verticle set of shelves, each shelf containing a piece of ram information. When a menu item (column) is selected, the contents of the top shelf are displayed. To change the contents, position the flashing cursor over the character by using → or ← , and then pushing the new character key. The information being edited is only in the computers' working ram, and this change is temporarily saved until editing is complete.

Once the first line is complete, the next line (shelf) down may be accessed with the key. One can move up and down at any time by using the ↑ or ↓ key. When this column of information is complete, push ENTER to save this column temporarily and return to the menu for other editing.

The questions asked first are:

1--NEW DATA 2--OLD DATA.
Select "1" to input complete new information. If "1" is selected, the program goes directly to the menues. If "2" is slected it is assumed that a set of information exists either in a radio, or is the saved GE MARC V file in the computer. If "2" is selected, the program goes to the next question.

READ FROM: 1=PERSONAL RADIO 2=PERSONAL FILE
If "2" is selected, the computer loads the contents of the saved file into the menu locations, and then displays the menues. If "1" is selected, it is assumed that a programmed radio is available, and will supply the ram information. DO NOT press "1" until:

Radio is turned on (cable NOT connected)

Cable is connected

When "1" is pressed, the data transfer begins, and "- - - - WAIT 8 SECONDS." is displayed. At the end of a successful transfer, the menu is displayed. An unsuccessful transfer results in the error message "CHECKSUM ERROR". This is due to the radio not being turned on; or the cable not being plugged in; or a faulty radio, or improper radio ram information. The latter can be caused by the improper uP software version in the radio, or by a "glitch" in the RAM information.

The GE MARC V menu contains the items:

1 ID
2 AREAS
3 OPTIONS
4 OPTIONAL TONES
5 GROUP TONES
6 INDIVIDUAL TONES
7 CALIBRATION
8 PRINT FOR REVIEW
9 PROGRAM/REVIEW COMPLETE

9 completes the editing and allows for saving the file in the internal computer memory, or for writing directly to a radio. NOTE: A successful write to a radio destroys the recently edited information in the computer.

INFORMATION IN EACH MENU LOCATION

ID

U-Proc. verl revl ***(cannot be changed)
ID

AREAS

Area 1 loc 1 chan (xxx)
Area 1 loc 2 chan (xxx)
etc. through 20 channels

Area 2 loc 1 chan (xxx)
etc. through 20 channels

continue for 9 areas

OPTIONS

```
Allow calibration mode (x)
Enable DTMF tones (x)
Initiate on PTT (x)
Alternate busy tone (x)
Multi-area scan (x)
Min coll tone (x) chan long
On power up volume (xx)
Minimum volume (xx)
Tx busy tone len (xxxx) msec
Num key tone len (xx) x25ms
* # key tone len (xx) x25ms
Chan 1 tx freq (xxx.xxxx) mhz
```

OPTIONAL TONES

```
Ind/rcv (xx)  Lt (x)
Spl call (xx) (xx) (collect, group)
```

GROUP TONES

```
Group 1 (xx) (xx)  Lt (x) (collect, group)
Group 2      etc
Group 3
Group 4
Group 5
```

INDIVIDUAL TONES

Set for 10 ID tones (x)

for (x) = y	for (x) = n
Ind/tx 0 (xx)	Ind/tx 1 (xx) (xx) (collect, Ind)
Ind/tx 1 (xx)	Ind/tx 2 (xx) (xx)
Ind/tx 2 (xx)	Ind/tx 3 (xx) (xx)
etc through Ind/tx 9	etc through Ind/tx 5

CALIBRATION

```
Calibration 1 channel (xxx)
Calibration 2 channel (xxx)
Calibration 3 channel (xxx)
```

PRINT FOR REVIEW

```
ID
AREAS
OPTIONS
OPTIONAL TONES
GROUP TONES
INDIVIDUAL ENCODE TONES
CALIBRATION
ALL
```

DESCRIPTION

ID

The first line cannot be changed, and only serves as a method of determining which software version is being used. The second line may be used to identify the particular radio, and consists of up to 16 characters or spaces.

AREAS

Input the channel numbers for each area. Channels less than 100 require a leading zero or zeroes. Twenty channels are allowed in each area, and each area must have

at least one channel for the next higher area to be allowed. Once the channels are entered with the enter key, they are sorted to accomplish minimum frequency distance between channels. In normal systems, this should never be more than 80 channels. A warning is given if this occurs. If multi-area scan is selected, the total number of channels must be less than 21.

OPTIONS

Allow calibration mode--when (y), allows the radio to be placed in the test mode from the keypad. Normally used for radio alignment and testing.

Enable DTMF tones--when (y), activates the keypad during transmit to allow DTMF tone transmission for telephone interconnect.

Initiate on PTT--when (y), allows call initiation (not SC) from the PTT bar. Useful when the radio is worn on the belt and used with a headset.

Alternate busy tone--when (y), replaces the normal busy tone (3051 Hz) with the alternate busy tone (2918 Hz). Normally not used.

Multi-area scan--Appears in the menu only when two or more areas exist, and the number of channels is less than 21. Used to scan all areas for calls, but has no effect on the area in which calls are placed.

Min coll tone--value determines the length of time that the collect tone is transmitted. A normal system requies this to be (number of channnels scanned +1) x 90ms. The value entered is increased by 1 in the computer.

On power up volume (xx)--This sets the default value for the audio level when the radio is turned on. The value may be an integer between 1 and 31. 1 is almost inaudible, while 31 is full volume.

Min volume--Sets the lowest level to which the audio may be ramped. Values are integers from 1 to 31, but must be less than or equal to the power on volume.

Tx busy tone len--Number of milliseconds that the busy tone is transmitted when acquiring a channel. Intended for use in voting systems, and should otherwise be left at 90 ms. Values may be 1-1275 ms.

Num key tone len--Used to set the length of time a DTMF tone number key is transmitted. This length is controlled by the radio uP, and is independent of the time the key is held down. Value entered is multiplied by 25 ms. Values of less than 6 (150ms) are not recommended for use in normal telephone systems.

* # key tone len-- similar to Num key len, but applies to the * and # keys.

Chan 1 tx freq (xxx.xxxx)Mhz.--Used by the suitcase computer to calculate the channel frequencies. It does not affect the actual channel frequencies. The default value of 820.9875MHz is channel 1 in the USA1 band.

OPTIONAL TONES

Ind/rcv--tone number for the Individual decode tone (second decode) an Ind/RCV must always be included. If lt (x) is (y), the call flag in the LCD display will be lit when this tone is decoded.

Spl call--collect and group tone selected when the SC key is used to initiate a call.

GROUP TONES

Group tone 1--Collect and group tone numbers of group 1. When Lt (x) is (y), the call flag will be lit if this group tone is decoded. Note that the collect tone may be changed in each group. Group tones 2-5 are similar.

INDIVIDUAL TONES

Allows selected transmission of group tones over and above the group calls and SC. This feature operates in two modes. When the question "SET FOR 10 ID TONES" is answered (y), this feature allows the user to select one of ten preselected tones (0-9) to be sent in place of the group tone when the I/C key is pressed. The call uses the collect tone of the group presently selected. After the call is placed, or if any key other than I/C is pressed, the radio reverts to normal operation. The second mode of operation occurs if the question "SET FOR 10 ID TONES" is answered (n). In this case, the user has the use of 5 preselected sets (1-5) of collect and group tones over and above the regular groups--but only in call initiate. As above, after the specially selected collect and group are sent, or if any key other than I/C is pressed, the radio reverts to normal operation in the group previously selected.

CALIBRATION--Allows the selection of channels selected for use in test mode operation.

PRINT FOR REVIEW--Prints the selected menu on the printer.

PROGRAM/REVIEW COMPLETE--After all editing is complete, this menu allows the information to be saved in an internal file named GE MARC PERSONAL, or to be written directly to a radio. If a successful data transfer is completed to a radio, the information will be erased from the computer. In most cases, it is safer to save the information in the internal file, and then write to the radio using #4 or #5 of the GE MARC V main menu.

CHANNEL PLAN (MEXICO)

kHz	815 MHz CHAN. NO.	815 MHz HEX CODE	814 MHz CHAN. NO.	814 MHz HEX CODE	813 MHz CHAN. NO.	813 MHz HEX CODE	812 MHz CHAN. NO.	812 MHz HEX CODE	811 MHz CHAN. NO.	811 MHz HEX CODE
975	001	FF02	041	D702	081	AF02	121	8702	161	5F02
950	002	FE02	042	D602	082	AE02	122	8602	162	5E02
925	003	FD02	043	D502	083	AD02	123	8502	163	5D02
900	004	FC02	044	D402	084	AC02	124	8402	164	5C02
875	005	FB02	045	D302	085	AB02	125	8302	165	5B02
850	006	FA02	046	D202	086	AA02	126	8202	166	5A02
825	007	F902	047	D102	087	A902	127	8102	167	5902
800	008	F802	048	D002	088	A802	128	8002	168	5802
775	009	F702	049	CF02	089	A702	129	7F02	169	5702
750	010	F602	050	CE02	090	A602	130	7E02	170	5602
725	011	F502	051	CD02	091	A502	131	7D02	171	5502
700	012	F402	052	CC02	092	A402	132	7C02	172	5402
675	013	F302	053	CB02	093	A302	133	7B02	173	5302
650	014	F202	054	CA02	094	A202	134	7A02	174	5202
625	015	F102	055	C902	095	A102	135	7902	175	5102
600	016	F002	056	C802	096	A002	136	7802	176	5002
575	017	EF02	057	C702	097	9F02	137	7702	177	4F02
550	018	EE02	058	C602	098	9E02	138	7602	178	4E02
525	019	ED02	059	C502	099	9D02	139	7502	179	4D02
500	020	EC02	060	C402	100	9C02	140	7402	180	4C02
475	021	EB02	061	C302	101	9B02	141	7302	181	4B02
450	022	EA02	062	C202	102	9A02	142	7202	182	4A02
425	023	E902	063	C102	103	9902	143	7102	183	4902
400	024	E802	064	C002	104	9802	144	7002	184	4802
375	025	E702	065	BF02	105	9702	145	6F02	185	4702
350	026	E602	066	BE02	106	9602	146	6E02	186	4602
325	027	E502	067	BD02	107	9502	147	6D02	187	4502
300	028	E402	068	BC02	108	9402	148	6C02	188	4402
275	029	E302	069	BB02	109	9302	149	6B02	189	4302
250	030	E202	070	BA02	110	9202	150	6A02	190	4202
225	031	E102	071	B902	111	9102	151	6902	191	4102
200	032	E002	072	B802	112	9002	152	6802	192	4002
175	033	DF02	073	B702	113	8F02	153	6702	193	3F02
150	034	DE02	074	B602	114	8E02	154	6602	194	3E02
125	035	DD02	075	B502	115	8D02	155	6502	195	3D02
100	036	DC02	076	B402	116	8C02	156	6402	196	3C02
075	037	DB02	077	B302	117	8B02	157	6302	197	3B02
050	038	DA02	078	B202	118	8A02	158	6202	198	3A02
025	039	D902	079	B102	119	8902	159	6102	199	3902
000	040	D802	080	B002	120	8802	160	6002	200	3802

TABLE 9 - TX FREQUENCY/CHANNEL/HEX CONVERSION CHART

CAN BDR USA 2 USA 1 AUSTRALIA	810 MHz 815 MHz 820 MHz 824 MHz		809 MHz 814 MHz 819 MHz 823 MHz		808 MHz 813 MHz 818 MHz 822 MHz		807 MHz 812 MHz 817 MHz 821 MHz		806 MHz 811 MHz 816 MHz 820 MHz	
kHz	CHAN. NO.	HEX CODE	CHAN. NO.	HEX CODE	CHAN. NO.	HEX CODE	CHAN. NO.	HEX CODE	CHAN. NO.	HEX CODE
9875	001	FF02	041	D702	081	AF02	121	8702	161	5F02
9625	002	FE02	042	D602	082	AE02	122	8602	162	5E02
9375	003	FD02	043	D502	083	AD02	123	8502	163	5D02
9125	004	FC02	044	D402	084	AC02	124	8402	164	5C02
8875	005	FB02	045	D302	085	AB02	125	8302	165	5B02
8625	006	FA02	046	D202	086	AA02	126	8202	166	5A02
8375	007	F902	047	D102	087	A902	127	8102	167	5902
8125	008	F802	048	D002	088	A802	128	8002	168	5802
7875	009	F702	049	CF02	089	A702	129	7F02	169	5702
7625	010	F602	050	CE02	090	A602	130	7E02	170	5602
7375	011	F502	051	CD02	091	A502	131	7D02	171	5502
7125	012	F402	052	CC02	092	A402	132	7C02	172	5402
6875	013	F302	053	CB02	093	A302	133	7B02	173	5302
6625	014	F202	054	CA02	094	A202	134	7A02	174	5202
6375	015	F102	055	C902	095	A102	135	7902	175	5102
6125	016	F002	056	C802	096	A002	136	7802	176	5002
5875	017	EF02	057	C702	097	9F02	137	7702	177	4F02
5625	018	EE02	058	C602	098	9E02	138	7602	178	4E02
5375	019	ED02	059	C502	099	9D02	139	7502	179	4D02
5125	020	EC02	060	C402	100	9C02	140	7402	180	4C02
4875	021	EB02	061	C302	101	9B02	141	7302	181	4B02
4625	022	EA02	062	C202	102	9A02	142	7202	182	4A02
4375	023	E902	063	C102	103	9902	143	7102	183	4902
4125	024	E802	064	C002	104	9802	144	7002	184	4802
3875	025	E702	065	BF02	105	9702	145	6F02	185	4702
3625	026	E602	066	BE02	106	9602	146	6E02	186	4602
3375	027	E502	067	BD02	107	9502	147	6D02	187	4502
3125	028	E402	068	BC02	108	9402	148	6C02	188	4402
2875	029	E302	069	BB02	109	9302	149	6B02	189	4302
2625	030	E202	070	BA02	110	9202	150	6A02	190	4202
2375	031	E102	071	B902	111	9102	151	6902	191	4102
2125	032	E002	072	B802	112	9002	152	6802	192	4002
1875	033	DF02	073	B702	113	8F02	153	6702	193	3F02
1625	034	DE02	074	B602	114	8E02	154	6602	194	3E02
1375	035	DD02	075	B502	115	8D02	155	6502	195	3D02
1125	036	DC02	076	B402	116	8C02	156	6402	196	3C02
0875	037	DB02	077	B302	117	8B02	157	6302	197	3B02
0625	038	DA02	078	B202	118	8A02	158	6202	198	3A02
0375	039	D902	079	B102	119	8902	159	6102	199	3902
0125	040	D802	080	B002	120	8802	160	6002	200	3802

TX FREQUENCY/CHANNEL/SWITCH SETTING CONVERSION CHART

kHz	820 MHz CHAN. NO.	820 MHz CHAN SW. SET	819 MHz CHAN. NO.	819 MHz CHAN SW. SET	818 MHz CHAN. NO.	818 MHz CHAN SW. SET	817 MHz CHAN. NO.	817 MHz CHAN SW. SET	816 MHz CHAN. NO.	816 MHz CHAN SW. SET
9875	001	C7	041	9F	081	77	121	4F	161	27
9625	002	C6	042	9E	082	76	122	4E	162	26
9375	003	C5	043	9D	083	75	123	4D	163	25
9125	004	C4	044	9C	084	74	124	4C	164	24
8875	005	C3	045	9B	085	73	125	4B	165	23
8625	006	C2	046	9A	086	72	126	4A	166	22
8375	007	C1	047	99	087	71	127	49	167	21
8125	008	C0	048	98	088	70	128	48	168	20
7875	009	BF	049	97	089	6F	129	47	169	1F
7625	010	BE	050	96	090	6E	130	46	170	1E
7375	011	BD	051	95	091	6D	131	45	171	1D
7125	012	BC	052	94	092	6C	132	44	172	1C
6875	013	BB	053	93	093	6B	133	43	173	1B
6625	014	BA	054	92	094	6A	134	42	174	1A
6375	015	B9	055	91	095	69	135	41	175	19
6125	016	B8	056	90	096	68	136	40	176	18
5875	017	B7	057	8F	097	67	137	3F	177	17
5625	018	B6	058	8E	098	66	138	3E	178	16
5375	019	B5	059	8D	099	65	139	3D	179	15
5125	020	B4	060	8C	100	64	140	3C	180	14
4875	021	B3	061	8B	101	63	141	3B	181	13
4625	022	B2	062	8A	102	62	142	3A	182	12
4375	023	B1	063	89	103	61	143	39	183	11
4125	024	B0	064	88	104	60	144	38	184	10
3875	025	AF	065	87	105	5F	145	37	185	0F
3625	026	AE	066	86	106	5E	146	36	186	0E
3375	027	AD	067	85	107	5D	147	35	187	0D
3125	028	AC	068	84	108	5C	148	34	188	0C
2875	029	AB	069	83	109	5B	149	33	189	0B
2625	030	AA	070	82	110	5A	150	32	190	0A
2375	031	A9	071	81	111	59	151	31	191	09
2125	032	A8	072	80	112	58	152	30	192	08
1875	033	A7	073	7F	113	57	153	2F	193	07
1625	034	A6	074	7E	114	56	154	2E	194	06
1375	035	A5	075	7D	115	55	155	2D	195	05
1125	036	A4	076	7C	116	54	156	2C	196	04
0875	037	A3	077	7B	117	53	157	2B	197	03
0625	038	A2	078	7A	118	52	158	2A	198	02
0375	039	A1	079	79	119	51	159	29	199	01
0125	040	A0	080	78	120	50	160	28	200	00

N.P.280826

APPENDIX B

MICROCOMPUTER PROGRAM DESCRIPTION

The radio operates in several different modes which are variations of the basic GE MARC V modes of IDLE, WAIT, and RECEIVE/TRANSMIT. In addition, two other auxilliary modes - the TEST MODE, and the LOAD/DUMP mode facilitate static testing and user parameter configuration. These are all detailed in the following description:

Idle Mode

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Turn on

The radio is turned on by using the on/off switch positioned below the push-to-talk switch on the side. The radio defaults to group 1, area 1 and mid-volume. The LCD is cleared. The idle mode is re-entered after each call.

Note that calls may be originated by using the push-to-talk switch, if that option is enabled, otherwise initiation of calls is by use of the INITIATE/CLEAR switch on the top of the radio.

The keyboard and display are lit by a lamp near the display. Pressing the push-to-talk switch at any time the radio is on will light the lamp.

There is no squelch circuit in the radio, it is not required in a tone controlled system.

Idle mode, incoming calls

The radio begins scanning it's channels. If the scan multiple areas option is enabled the radio will scan all channels in all areas. No more than 20 channels may be in the radio in this case. If multiple area scan is not enabled or if more than 20 channels are in the radio it will only scan the currently selected area.

Upon detecting a collect tone the radio will then check for the current group tone. If the group tone is not detected it will check for individual decode tone, if that option was selected. Selecting the option will of course require that one or more tones also be specified.

The radio will inform the user of the call by turning on it's call flag on the LCD and sounding a high-low tone sequence. It will then enter the receive state.

Idle mode, Area change

If the AREA key is pressed the LCD will display the current area as 'Ax', whatever 'x' happens to be. Note that while this is being displayed the radio is still scanning for calls. If a call comes in it will handle it as usual. If the operator then pushes a valid digit key the area will change and this change will be displayed on the LCD. Valid values depend on the radio programming but are in the range 1 to 9. The new area will remain on display on the LCD. Should the operator use any other key, instead of a digit key, it will supercede the area key entry.

It might be noted that the radio can have 1 to 9 areas inclusive. It can be programmed to have any number in this range. Each area can have 1 to 20 channels, therefore the radio can have 180 channels.

Idle mode, Group change

If the GROUP key is pressed the LCD will display the current group as 'Gx', whatever 'x' happens to be. As with Area change incoming calls are not lost. Valid group values again depend on the parameters set up in the radio, but valid values are in the range 1 to 5. The radio can be programmed to take any number in this range, the collect and group tone numbers must also be specified for each group.

Idle mode, Volume change

Using the VOLUME UP or VOLUME DOWN keys will cause the speaker to emit a tone and the volume will rise or fall depending on the key. At the maximum or minimum the volume change will stop.

Idle mode, Individual encode change

Provided that the option is enabled the radio can transmit up to 10 individual encode tones, or up to 5 pairs of collect and individual tones. The exact number of tones is set up in the programming. To change the current individual tone press the GROUP key followed by digit 0. Then the LCD will display 'iO', indicating that a tone has not been selected, and the default value of 0 is assumed. Pressing another valid digit will cause the "O" to change to the tone number selected. During the time that the radio is waiting for a digit key incoming calls will not be lost. Furthermore use of any other valid key will be treated as usual.

The next time a call is initiated this individual tone or pair of tones will not be sent out again, rather the previously selected group and collect tones will be used. Each subsequent individual call requires an explicit selection of the individual to be called.

Idle mode, initiate call

A call is initiated by using the INITIATE/CLEAR key. The radio will start to search for a channel in the current area. If it has the multi area scan option it will return to the first channel of the area last specified. If not it will start searching for a free channel in the current area from the current channel.

The current group and collect tones are used. When a channel has been found the ready flag on the LCD will turn on and the radio will emit a two tone beep.

If the radio is out of range, i.e. no acknowledgement from any repeater, it will sound an out of range alarm of three beeps. Also if the system is busy, i.e. no channels available, the radio will sound a system busy alarm of one beep.

The push-to-talk switch is used to transmit. The transmit flag on the LCD is turned on whenever the transmitter is active. The push-to-talk switch only affects the lamp when no channel has been acquired.

Idle mode, Special/Call functions

Using the SPECIAL/CALL key will cause the radio to initiate a call as outlined above provided that the option is enabled. However the radio will send out it's special call collect and group tones. Typically this function would serve to enable telephone interconnect systems.

Receive Mode
******* ****

When in receive mode the ready flag in the LCD is on. If any signal fading occurs the radio will not be squelched but the drop-out timer will be started and the ready flag will be turned off. After a programmable delay typically 500 ms., the radio reverts to idle mode.

Receive mode, volume change

When in receive mode the VOLUME UP and VOLUME DOWN keys are active. Thus the volume can be increased or decreased at will. When the maximum or minimum is reached there is no further change. No beep tone is emitted in this mode since the user can hear the actual level of conversation and adjust it to suit.

Receive mode, Clear down

Using the INITIATE/CLEAR key when in receive mode will cause the radio to cancel the call in progress, mute the receiver and revert to the idle mode.

Transmit Mode

Transmit mode

As mentioned above the transmitter is keyed by using the push-to-talk switch. The transmit flag on the LCD is activated.

Transmit mode, transmitting tone dialing signals

If the option is allowed tone dialing signals can be transmitted using the keypad keys. A separate tone burst duration may be programmed for digits and other keys. Typically digits will last 150 ms. and other tones like * and # keys will be longer depending on the system being controlled. The digits 0-9 along with * and # are typically used for telephone applications, but the remaining control keys A, G, etc. also may be used to send the less common A, B, C, and D tone pairs used in 16 tone systems. Both tone frequencies for all 16 keys are individually programmable using the hex programmer system, and are not limited to DTMF. Never program a 0 frequency tone as the time to send it will be infinity and the radio will cease to function.

Transmit mode, Clear down

Using the INITIATE/CLEAR key on the radio during transmit mode while push-to-talk is not depressed will cause the radio to revert to idle mode.

Test Mode

Test mode operation

Entering test mode

Normally use the programming device. In certain cases it may be desirable to allow the user to enter the test mode from the keyboard. The option to do this must be enabled by a qualified serviceman using the programming device. Once enabled, the user may get into the test mode by attempting to enter the non-existant GROUP 0 AREA 0.

Once in the test mode, then all of the keyboard keys are active, but their functions are different and unlabled. They function as follows

0 Exit the test mode and reset the radio

1 Send/Rec on test channel 1 and reset the test tone to BUSY

2 Send/Rec on test channel 2 and reset the test tone to BUSY

3 Send/Rec on test channel 3 and reset the test tone to BUSY

4 Enable the voice reject filter to the DTD circuit, i.e. use the HI-PASS mode.

5 Disable the voice reject filter

6 Mute the microphone

7 Enable the microphone

8 Set the transmit tone level to the lower state, i.e. 1 kHz deviation for all tones.

9 Set the transmit tone level to the higher state, i.e. 3 kHz deviation on all tones.

I/C Decrement the tone number. When the test mode is initiated or when a new channel is selected, the current tone number is set to 46. See the list in this document for complete information, but note that tone 46 is BUSY, 45 is alternate BUSY, 44 is QUIET, 43 is 1000 Hz, 42 is 3000 Hz, and 41 is 300 Hz. These tones are not intended for measurements to verify specifications, as their purity is not acceptable, but rather as a maintenance aid.

SC Volume down one step, with beep

A Volume up one step, with beep

G Unmute the receiver. The receiver will be muted after each control operation except channel select.

*↑ Volume up FAST, no beep. Fast in this case means very fast, maybe even too fast. This function is for computer aided test equipment but is still available for manual operation with reservations.

#v Volume down FAST, same***

LOAD DUMP MODE:

An external interrupt initiates this mode. Further interrupts are disabled, and then one of the output ports is converted to an input. It checks if the Load Switch is high or low. If it is high it knows that a dump is involved and if low it knows that a load (of data) is required.

If a load is involved the radio sources the clock on the Data line and reads the input, on negative edges, on the Interrupt request line. It is possible to convert the Interrupt request line to an input. Should the first eight bits loaded be all zero the software assumes that Test mode is to be entered and changes the mode accordingly. After 1024 8 clocks the code goes into an endless loop and waits for the watch dog timer to reset the radio.

If a dump is involved the radio senses the clocks on the Interrupt request line and outputs data on the Data line. Again after the required number of clocks the program enters an endless loop and waits for a reset.

The bus consists of 4 wires, these are as follows.

Ground	-	System ground
Load Switch	-	CMOS RAM Protect. A high signal on this line disables the RAM from writes. A low enables writes. This line also indicates if a load or a dump operation follows.
Data	-	Data flow from the radio to the unit
$\overline{\text{IRQ}}$	-	Data flow from the unit to the radio

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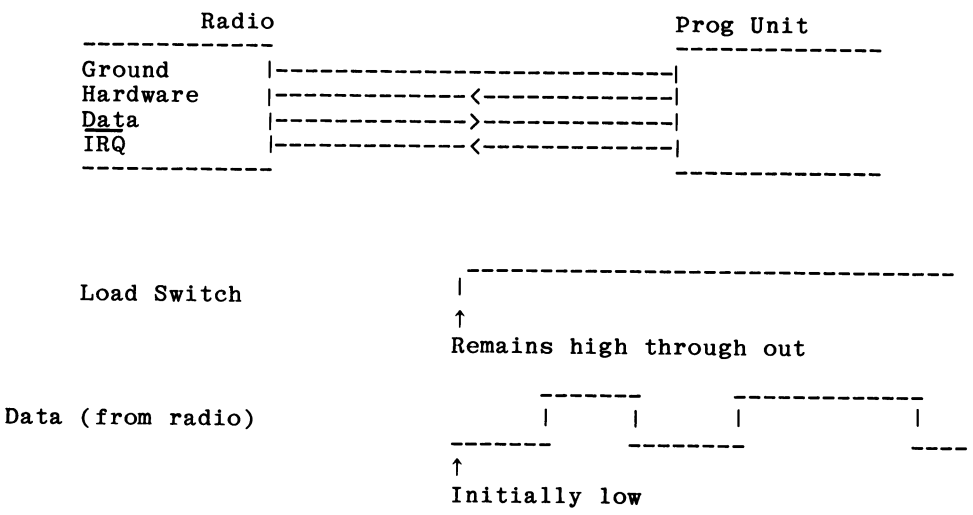
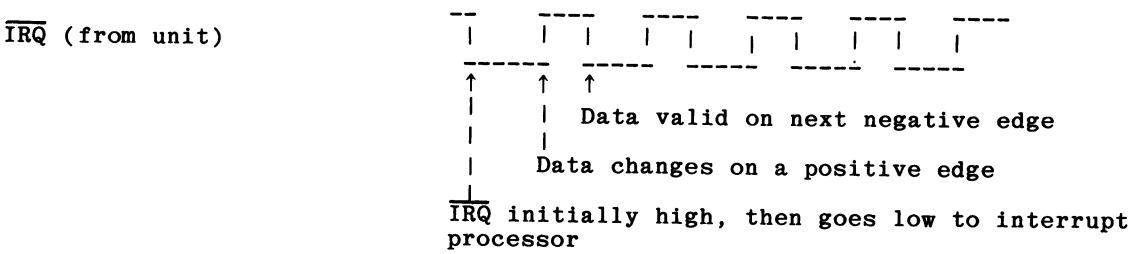
Signal path directions





Dump - Radio to Unit

Dumping involves dumping the radio's CMOS RAM to the programming unit. This is used mainly to verify that the load was completed, although it has other uses as well. The dump is initiated by the programming unit.

The following is the procedure:

1. Load Switch is kept high all through the interface. This protects the memory against glitches etc. IRQ must also be high.

2. Connect the umbilical cord between the radio and the programming unit.

3. Start the dump from the programming unit.

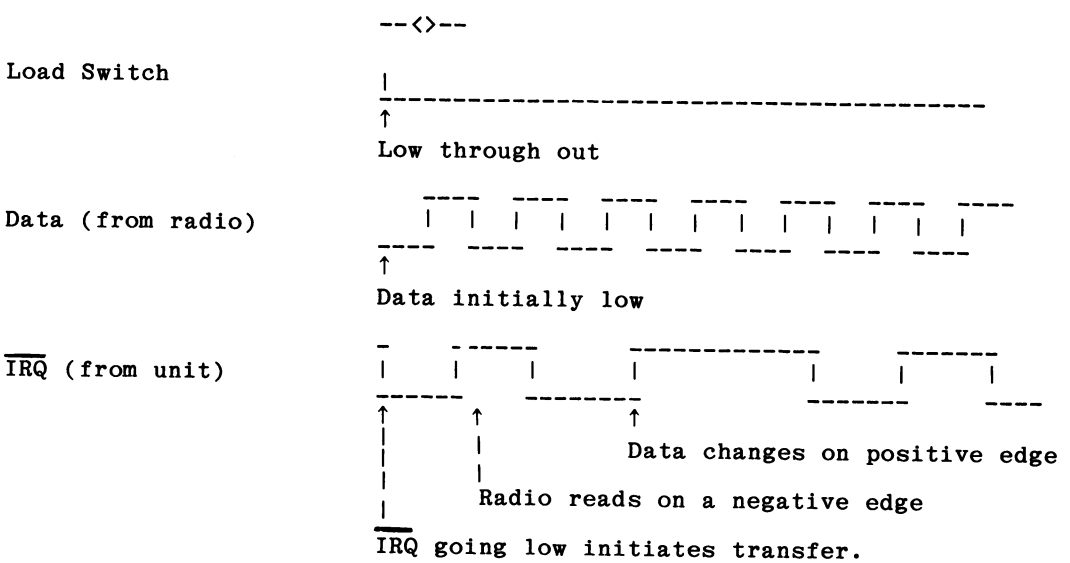
4. The programming unit brings the IRQ line low. This causes the processor in the radio to be interrupted. Data will be valid on the negative edges. Data will change on the positive edge.

   There are 1024 8 bits to be transferred. The radio and the unit will keep a bit count. Thus both devices will know when the transfer is completed. The period of the clock will have to be determined. The duty cycle will be approximately 50:50.

5. When the last data bit is put out on Data the IRQ line should be set high. This is to ensure that the radio will not be interrupted when at the end of the transfer it returns to normal mode.

6. Of course all calls are lost and all keys are ignored during this process.

7. When the radio returns to normal mode it will beep signifying the end of the transfer. Then remove the interconnect cord.



Load - Unit to Radio

Loading the radio involves copying new data into the radio. This is written into the CMOS RAM. The hardware protect line should be kept low to enable the RAM.

1. $\overline{IRQ}$ should be initially high.

2. Load Switch should be low throughout the transfer.

3. Interconnect the cord between the radio and the unit. Initiate the transfer from the programming unit.

4. $\overline{IRQ}$ going low will initiate the transfer.

5. After the wait period the radio will begin to provide a clock on Data1. The programming unit should provide data to the radio on $\overline{IRQ}$. The radio will read this data on the negative edges of the clock. The clock period will be determined but should have a duty cycle of approximately 50:50.

6. There are 1024 8 bits to be transferred. Each device will keep a bit count thus at the end of the transfer each device will stop. The programming box should leave $\overline{IRQ}$ high at the end of the transfer to avoid re-interrupting the radio when it returns to normal mode.

Outline of available options

The following are the available options

1. Multi-area scan

   If there are less than or equal to 20 channels programmed in the radio enabling multi-area scan, scan will allow all channels to be scanned even if they are spread out over several areas.

2. Test mode from keyboard enable

   Enabling this option allows the user to enter 'A0G0' from the keyboard and enter the test mode. This function is not intended for other than FCC licensed persons any may be only enabled using the programming device. A system operator may wish to use a radio in a non-standard configuration for test purposes, but no normal user should be allowed access to this mode. Should an operator permit a user access to the test mode then he should assure that the three test area frequencies are programmed with frequencies for which that user has been authorized, and should expect the radio to perform in a manner not consistent with normal system conventions. The general use of a radio in the test mode is not recommended for profit making systems.

3. Dual tone signalling allowed

   Enabling this option allows the keypad to send DTMF or telephone signalling tones while push-to-talk is pressed.

4. Individual tone encode

   Individual tone encode will allow the radio to call 1 to 5 other radios having individually programmed collect and individual decode tones or up to 10 radios having individually programmed individual decode tones and a common collect tone.

5. Special Call encode

   Enabling this option and specifying a collect and group tone, tone allows the user to call special stations or telephone interconnect devices with a single keystroke.

6. Individual decode allowed

   Enabling this option permits the radio to decode, in addition to the usual collect and group sequence, a second tone encoded in the individual position to be used for signalling a specific radio.

7. PUSH-TO-TALK initiates call

   Enabling this option causes the push-to-talk switch to operate similar to the I/C switch when the radio is in the idle mode. This would permit initiating a call from a remote control microphone for example.

8. Ten individual encode tones

   When this option is enabled, then individual encode tones are numbered from 0 to 9 and the collect tone currently selected by the GROUP number is used for encode and decode.

   When this option is disabled, then individual encode tones are numbered from 1 to 5 and each encode tone comprises a pair of values, one for the collect tone and one for the individual encode tone. This permits calling specific radios not assigned to the same group.

DEFINITIONS

THERE ARE 1024 BYTES OF CMOS BATTERY POWERED RAM IN THE GE MARC V RADIO.

THE PURPOSE OF EACH BYTE IS AS FOLLOWS:

HEX ADDR	NAME	EXPLANATION
000	RADIO TYPE	Normally 0A HEX. Identifies GE MARC V radio
001	PROGRAMMING METHOD	Initially 01H. Changes if different programmer is required by software revision
002	SOFTWARE REVISION	Changes when software is revised, i.e. the function changes.
003	EDIT LEVEL	Changes when software is fixed, i.e. the function does not change, but some bug has been fixed.
004-005	JOHNSON BYTES	
006-00F	10 CHAR ID	String belongs to user.
010	DEFAULT AREA	Typically 01H Area selected when power is applied
011	DEFAULT CHANNEL	Typically 01H Channel selected when power is applied
012	DEFAULT GROUP	Typically 01H Group selected when power is applied
013	CURRENT VOLUME SETTING	Typically 08H Volume level when power is applied
014	DURATION OF (0)-(9) KEYS (DTMF TONES)	Typically 14H, Minimum 10H Increments of 5 MS.
015	DURATION OF (*)-(#) KEYS (DTMF TONES)	Typically 28H, Minimum 10H Increments of 5 MS.
016	5 MS TIMER	Always 8BH (139D) never change
017	TONE DET. ATTACK TIME	Typically 04H Increments of 5 MS. Modify with caution
018	TONE DET. DECAY TIME	Typically 04H Increments of 5 MS. Modify with caution
019	ACQUISTION TONE ATTACK TIME	Typically 03H Increments of 5 MS. Modify with caution
01A	ACQUISTION TONE DECAY TIME	Typically 14H Increments of 5 MS. Modify with caution
01B	BUSY TONE ATTACK TIME	Typically 02H Increments of 5 MS. Modify with caution
01C	XMIT BUSY TONE TIME	Typically 12H Increments of 5 MS. Increase for operation in voting systems
01D	BUSY TONE TIME OUT	Typically 16H Increments of 5 MS. Modify with caution
01E	DROP-OUT TIMER LIMIT	Typically BEH (190D). Values less than 8CH may cause squelch tail after loss of busy tone. Increments of 5 MS.

01F	GROUP TONE ATTACK TIME	Typically 14H Increments of 5 MS. Modify with caution
020	SAVED DEFAULT AREA	Initially 01H
021	TOTAL NO OF CHANNELS	Set to total of all channels in all areas
022	MIN COLL TONE LENGTH	Typically 06H. Maximum 17H. May be increased to allow additional detect time for EPIC.
023	OPTION BYTE	
	BIT 7 TEN INDIVIDUAL ID CODES	If SET then bytes 043-04C will be interpreted as 10 individual encode tone nos. If CLR then bytes 043-047 will be interpreted as 5 individual encode tone nos. and bytes 048-04C will be interpreted as 5 associated collect tone nos.
	BIT 6 PTT INITIATES CALL	If SET then the PTT switch will function like I/C If CLR then call may only be initiated using I/C
	BIT 5 INDIVIDUAL DECODE ALLOWED	If SET then individual tone (second) decode is allowed If CLR then no decode occurs
	BIT 4 SC ALLOWED	If SET then pressing the SC key initiates a call using byte 000 for collect and byte 000 for group tones If CLR then the SC key is disabled
	BIT 3 INDIVIDUAL ENCODE ALLOWED	If SET then individual encode tones may be sent If CLR then no individual encodes are allowed
	BIT 2 DTMF TONE ENCODE ALLOWED	If SET then pressing any key while transmitting will send DTMF Tone according to the table of bytes 000-000 If CLR then pressing any key while transmitting will have no effect
	BIT 1 TEST MODE ALLOWED	If SET then user may access test mode functions by attempting to access GROUP 0 AREA 0 which does not exist
	BIT 0 MULTI-AREA SCAN	If SET then all channels in all areas are scanned during idle mode. There must be no more then 20 channels total as set in byte 021
024	MINIMUM VOLUME	Lowest level to which VOLUME may be set. Min 00H Max 1FH Typically 02H.
025	MAX CHAN AREA 1	Highest Channel no in each area Min 00H Max 14H
026	MAX CHAN AREA 2	
027	MAX CHAN AREA 3	
028	MAX CHAN AREA 4	Sum of these numbers is placed in byte 021
029	MAX CHAN AREA 5	
02A	MAX CHAN AREA 6	Allocated from lowest area no. Byte 02E determines whether entry is valid

02B	MAX CHAN AREA 7	
02C	MAX CHAN AREA 8	
02D	MAX CHAN AREA 9	
02E	MAXIMUM AREA NO.	Highest numbered area allowed. Bytes 025-02D may be set to 0 in areas greater than this
02F	MAXIMUM GROUP NO.	Highest numbered group allowed.
030	MAXIMUM NO. IND. ENC.	Highest numbered individual encode tone number plus 1. (Indiv enc tones are 0 to 9, so to enable all 10 tones enter 10.) If the TEN ID option (bit 7 in byte 023) is clear, then individual enc tone and collect tone pairs are numberd 1 to 5 rather than 0 to 9, so to enable all 5 tone pairs enter 5.
031	BUSY TONE NO	For standard busy enter 46 For alternate busy enter 45
032	ACQUISITION TONE NO	In all standard systems enter 44
033	CURRENT COLL TONE NO.	Derived from the collect tone specified for the default group in byte 012 and the table of bytes 000-000
034	INDIV. DEC TONE NO.	The individual decode tone number to which this radio responds if byte 021 bit 5 permits individual decodes.
035	CURRENT GRP TONE NO.	Derived from the group tone specified for the default group in byte 012 and the table of bytes 000-000
036	CURRENT IND. ENC. NO.	Default individual encode tone number. If the TEN ID option (but 7 in byte 023) is clear, then min=0 and max=limit set in byte 030 minus 1 (not more than 9). If the TEN ID option bit is LOW then min=1 and max=limit set in byte 030 (not more than 5).

037	GROUP 1 TONE	Group tone when group 1 selected
038	GROUP 2 TONE	Group tone when group 2 selected
039	GROUP 3 TONE	Group tone when group 3 selected
03A	GROUP 4 TONE	Group tone when group 4 selected
03B	GROUP 5 TONE	Group tone when group 5 selected
03C	GROUP 1 COLL TONE	Collect tone when group 1 selected
03D	GROUP 2 COLL TONE	Collect tone when group 2 selected
03E	GROUP 3 COLL TONE	Collect tone when group 3 selected
03F	GROUP 4 COLL TONE	Collect tone when group 4 selected
040	GROUP 5 COLL TONE	Collect tone when group 5 selected
041	SC GROUP TONE	Group tone when SC is selected
042	SC COLL TONE	Collect tone when SC is selected

	10 ID OPT bit 7 set ----	5 PAIR OPT bit 7 clear --- (in byte 023)	
043	IND ENC 0	PAIR 1 ID	The meaning of this 10 byte table varies according to bit 7 of the option byte 023
044	IND ENC 1	PAIR 2 ID	
045	IND ENC 2	PAIR 3 ID	
046	IND ENC 3	PAIR 4 ID	
047	IND ENC 4	PAIR 5 ID	
048	IND ENC 5	PAIR 1 COLL	
049	IND ENC 6	PAIR 2 COLL	
04A	IND ENC 7	PAIR 3 COLL	
04B	IND ENC 8	PAIR 4 COLL	
04C	IND ENC 9	PAIR 5 COLL	

04D-07F UNUSED
